Ministry of Environment and Tourism
Government of the Republic of Namibia



Vital Signs of Namibia 2004

An Integrated State of the Environment Report

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2004

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List of abbreviations

BCLME	Benguela Current Large Marine Ecosystem (Project)
BENEFIT	Benguela Environment Fisheries Interaction and Training (Programme)
CBNRM	Community-based natural resource management
CO_2	Carbon dioxide
DEA	Directorate of Environmental Affairs
DWA	Department of Water Affairs
DWF	distant water fleet
EEZ	Exclusive Economic Zone
EIA	environmental impact assessment
EIS	Environmental Information System
EMIN	Environmental Monitoring and Indicators Network
FDI	foreign direct investment
FOA	Fisheries Observer Agency
GDP	gross domestic product
GNP	gross national product
HDI	Human Development Index
ISoER	Integrated State of the Environment Report
LDIS	Land Degradation Information System
MAWRD	Ministry of Agriculture, Water and Rural Development
MET	Ministry of Environment and Tourism
MFMR	Ministry of Fisheries and Marine Resources
MME	Ministry of Mines and Energy
MTP	Medium-term Plan
NAPCOD	Namibia's Programme to Combat Desertification
NBSAP	National Biodiversity Strategic Action Plan
NCCC	Namibian Climate Change Commission
NCEI	National Core Environmental Indicator
NDP	National Development Plan
NGO	non-governmental organisation
NTFP	non-timber forest product
ODS	ozone-depleting substance
OECD	Organisation for Economic Cooperation and Development
PAN	protected area network
P–S–R	Pressure–State–Response
SADC	Southern African Development Community
SEG	sustainable economic growth
SoER	State of the Environment Report
SST	sea surface temperature
TAC	total allowable catch
UN	United Nations
UNCBD	United Nations Convention on Biological Diversity
UNCED	United Nations Conference on Environment and Development (1992)
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WSSD	World Summit for Sustainable Development (2002)

Foreword

The State of the Environment Reporting (SoER) was promoted during the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992. Agenda 21 adopted at the UNCED particularly called for the improvement and availability of environmental information for decision making. Since then SoE reporting has become more popular, and many countries have published similar reports.

The Namibia's State of Environment Reporting (SoER) is a system for regular, systematic analysis and evaluation of Namibia's environment. The first major products of this system were seven thematic SoERs, namely: freshwater resources (1999); social and economic environment (1999); agriculture and land resources (1999); mining, industry, energy and transport (1999); waste management and pollution control (2001); biodiversity, parks and tourism (2002); and marine environment (2003). While addressing relevant environmental issues, it was recognised that isolated actions of the thematic SoERs were insufficient to stem the increasing environmental problems and address such problems integrally.

As a signatory to the various environmental Conventions, and given Namibia's Constitutional provision for environmental management and conservation, as well as the national Vision 2030 towards sustainable development, it is necessary to have reliable and updated information on the state of the environment for improved decision making, establish linkages between different environmental problems and address them integrally. This Integrated State of the Environmental Report (ISoER), which I'm proud to introduce here, responds to this need. It is the first comprehensive attempt to date to assess the state of the environment. In so doing, this ISoER is based on the National Core set of Environmental Indicators, which allow cross linkage of environmental problems. ISoER addresses pressures on and the condition of the environment as well as addressing society's response to those pressures and conditions.

Since this report was written already in 2004, the information represents up to that period. It covers most of the environmental issues of national importance with the aim of improving understanding of these environmental issues, and to give guidelines for sound environmental management and best practices. Moreover, the report assesses the availability of environmental data required for improved decision-making as well as makes provision for further research recommendations.

The report is written to enhance decision making for sustainable development, and to this end, social and economic factors cannot be separated from biophysical factors of the environment. It is thus hoped that all concerned agencies, in the government and the private sector, would find this ISoER an important tool in evaluating options for the ongoing and future actions needed to reduce environmental impacts.

Finally, I wish to express my sincere gratitude to all organisations and individuals who participated in the preparations of this ISoER.

Netumbo Nadi-Ndaitwah, MP
MINISTER

Executive summary

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National Circumstances
Key Findings
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Purpose of the report

There is both scientific evidence and anecdotal information that the Namibian environment and its resource base have changed over time. With the inevitable presence of population growth and associated demands for food, such an inference can even be drawn in the absence of empirical evidence. Regarding this change, however, the following questions need to be asked:

- Is the change positive or negative?
- If either, what is its magnitude?
- Once the magnitude has been quantified, how does this affect our present and future generations?
- What can we do to mitigate or combat negative changes?

This report attempts to answer these questions by presenting past and current trends, highlighting the effects if such trends continue, and comparing our current situation with proposed directions to meet our development goals. Where appropriate, the report highlights local, regional and national efforts supported by Government and other agencies, and their achievements. The report also makes recommendations for the improvement of monitoring and enforcement through thorough policy implementation and the generation of adequate data. What we fail to achieve with this report, due to specific constraints, is an analysis and review of policies that are directed at management, conservation and development in the environment, economic and social sectors.

National circumstances

Namibia is a country with typical desert conditions: dry, with high variation in rainfall and its distribution. Namibia's location along the south-western coast of southern Africa means its climate is influenced by the cold Benguela Current that flows northward. However, it is Namibia's geographic location in three overlapping, major climatic systems – the Intertropical Convergence Zone, the Subtropical High Pressure Zone, and the Temperate Zone – that dictate the climate. Altitude in the country ranges from sea level to a height of 2,606 m, with the interior basin averaging an altitude of 100 m.

The total land surface area measures 824,268 km^2, of which much is exposed bedrock with huge deposits of sand in the Namib and Kalahari Deserts. Mineral resources include coal, copper, diamonds, gold, uranium, and zinc, while offshore fossil fuels comprise oil and gas.

Rainfall in Namibia is known to be temporally and spatially extremely variable. Variation in annual rainfall ranges from an average of 600 mm per annum in the north-east to 25 mm per annum in the south-west. This characterises the spatial distribution in a north-east to south-west gradient. The majority of Namibia receives summer rainfall between October and April, with January, February and March constituting the heart of the rainy season. The remainder of the year is characterised by virtually no rainfall except for the south-western part, which receives rain during the winter months – May to August. Water is an extremely scarce resource in Namibia and is currently characterised as the No. 1 limitation to development. The hot and dry climate is responsible for high evaporation rates, giving the country a water deficit that mimics the spatial distribution of rainfall. Only 1% of rainfall replenishes groundwater aquifers. To ensure sustainable utilisation and avoid possible groundwater pollution, such resources need to be monitored frequently and managed carefully. The main perennial rivers occur along the southern and northern borders of the country and include the Orange in the south; the Kunene, Okavango and Zambezi in the north; and the Kwando–Linyanti that crosses the Caprivi Region in the north-east. Rivers, springs, oshanas (temporary water bodies that form after rains) and pans in the interior of the country are not permanent, but remain a valuable source of water.

Agriculture is a popular activity that is conducted on large commercial, subsistence, and small commercial scales. Livestock farming and dryland crop production dominate the industry. Agriculture is a substantial contributor to the country's gross domestic product (GDP) and a significant livelihood provider to the majority of Namibians who depend on subsistence farming. Cattle farming is a big revenue-earner. Other types of cultivation include fruit, pearl millet (mahangu), sorghum, sunflower, and wheat.

The natural resource base of the country comprises a large array of biodiversity – inclusive of woodlands and wildlife, mineral deposits, a small area of arable land (2%), and a large area of arid rangeland. The total land surface area is home to five biomes, subdivided into 29 broad vegetation categories. Tourism is one of the top five GDP contributors and relies heavily on the abundance and distribution of wildlife and the spectacular, unspoilt landscape Namibia offers. The State's protected area network (PAN) in Namibia currently amounts to 22.9% of the total surface area due to the 2004 declaration of the Sperrgebeit as a protected area. Previously, the PAN covered over 13% of the total land surface area of the country – which was already higher than the World Conservation Union's recommended 10%. Land tenure is divided into three categories, namely freehold (42% of total land area), communal (38%, owned by the State but on which specific communities traditionally hold rights of use), and State-owned land (20%, used for specific Government purposes).

The mining sector in Namibia is dominated by diamond mining. Copper, gold, lead, salt and uranium are also mined, while new developments include a zinc mine and refinery, and the offshore exploration of natural gas.

The fisheries and fish-processing sector, although a variable contributor to GDP, remains important socio-economically. Fisheries are dominated by demersal species such as the valuable Cape hake and horse mackerel; the pelagic industry, which depends on the pilchard catches and high-value crustaceans such as crab and rock lobster. Namibia's fish stocks have shown varying degrees of recovery from severe pre-Independence overfishing. Following Independence the poor performance of the pelagic industry is attributed to adverse periodic environmental conditions and El Niño events. Marine and freshwater aquaculture currently ranks high on the priority list of the Ministry of Fisheries and Marine Resources (MFMR) as a measure to sustain Namibia's position as a player in the global seafood production industry and to secure the livelihoods of thousands of people working in the sector.

Key findings

Land degradation and desertification

Pressures

- Population density and growth are key pressures on the environment. High population densities in resource-abundant areas place severe strain on the environment. This relates to the unsustainable harvesting of forest resources, wild plants and animals; unsustainable land-use practices; and the clearing of large tracts of land for farming and housing.
- Livestock pressure is another key pressure and contributor to land degradation. In areas where human population densities are high, people tend to keep livestock – which adds to the pressure on the environment. In areas where livestock densities exceed the carrying capacity of the land, severe pressure is exerted on forest, land and water resources.

State

- Large areas of land in northern Namibia are severely degraded due to deforestation, overgrazing, overstocking, high population pressure, unsustainable farming practices, and the clearing of large tracts of land for crop farming.
- In southern Namibia, overgrazing and overstocking have also rendered larger areas of land infertile and close to denudation.
- Moreover, the arid environment in Namibia in general accelerates human-induced land degradation towards desertification.

Responses

- Local, regional and national level monitoring are required to gain a better understanding of the causes, rate and magnitude of desertification, as is the implementation of pilot projects to test the effectiveness of integrated land uses.

Status of biodiversity

Pressures

- Population pressure is found to be a key pressure on biodiversity. As people seek to sustain their livelihoods they harvest wild plants and animals unsustainably. Clearing of land for housing and crop cultivation also threatens biodiversity.

- The PAN's inadequate coverage is recognised as a factor that increases likely threats to biodiversity. The distribution of many major taxonomic groups is totally excluded or barely overlap with the PAN, so sensitive species are at the mercy of human impact. Moreover, areas of high diversity and endemism still lack adequate protection.
- Development initiatives and land uses pose threats to biodiversity. Habitat destruction is highlighted as the common threat among all taxonomic groups. Large housing, industrial and economic developments may not take cognisance of the biodiversity in a specific area – especially where a proper environmental impact assessment (EIA) is not done.
- A lack of information, although not a direct pressure, prevents the execution of thorough quantitative assessments of biodiversity. Not knowing the ecology, distribution ranges, abundance and conservation status of species puts them in danger of extinction.
- Current and potential harm of invasive and alien species pose additional threats to biodiversity. Lack of knowledge also undermines the ability to thoroughly assess the threats pose to environmental, social and economic health.

State

- Namibia's biodiversity is largely intact, with very few recorded extinctions. However, given the current pressures and lack of information, some species may already be severely threatened.

Responses

- Namibia's National Biodiversity Programme and National Biodiversity Task Force have been instrumental in the following:
- Reviewing current and devising new legislation and policies for the conservation, protection and management of biodiversity
- Conducting a biodiversity country study that serves as a broad inventory and status report
- Establishing thematic cross-sector working groups to deal with specific thematic issues relating to biodiversity, e.g. alien invasive species, wetlands, mountains, and marine biodiversity
- Developing short- to medium-term projects to generate information and data, generate public awareness, attend to international obligations, and conserve areas of high diversity and endemism
- Developing Namibia's Ten-year Strategic Plan of Action for Sustainable Development through Biodiversity Conservation – 2001–2010, and
- Drafting the Environmental Management Bill.
- A national review of invasive alien species in Namibia, commissioned by the Southern African Biodiversity Support Programme, provides information on the scope and scale of invasive aliens, legal and policy frameworks, an institutional analysis, networks of experts, national and regional programmes, and recommendations.

Water availability and quality

Pressures

- Although not of an anthropogenic nature, Namibia's unforgiving arid environment is a pressure on water. High evaporation rates limit the amount of water available in temporary water bodies after the rain.
- Population growth and industrial development and growth also put pressure on the availability of water.
- Pollution of underground water not only threatens water quality but also its availability. The contamination of underground water cannot be reversed, and the water is rendered useless for human consumption. This further decreases the amount of water available. Major threats to the quality of underground water can be mitigated via human intervention. The preventing seepage from landfills, limiting the use of agricultural pesticides, preventing the irresponsible discharge of waste water, preventing leakage from underground petroleum storage tanks, and limiting discharge by fishing factories should be prioritised.

State

- The loss of temporary water sources due to high evaporation is characteristic of Namibia's climate and water availability.
- The country is highly dependent on the frequency, amount and distribution of rainfall on an annual basis to recharge groundwater sources and fill up temporary yet important water bodies. Without water, agriculture is impossible.
- Rainfall is deemed to become more intensified and shorter in time from year to year. For example, rainfall used to be spread across the entire rainy season with intensified showers during the heart of the season (January to

March). Nowadays, rainfall is characterised by heavy showers over a short time period. Being unprepared for this change due to an inherent reliance on rain later in the season may result in losing out on valuable water.

- Groundwater resources are still relatively abundant, given an annual increase in water demand due to human population growth. The prospect of desalinating sea water is once again on the table to supplement water availability along the central coast.
- The quality of groundwater is predominantly excellent, but we need to guard against threats of contamination.

Responses

- The Ministry of Agriculture, Water and Rural Development (MAWRD) and the City of Windhoek commissioned a Water Demand Management Country Study on behalf of the World Conservation Union (formerly the International Union for the Conservation of Nature and Natural Resources/IUCN). This study assessed the degree to which water demand management is practised in Namibia. Due to Namibia's general scarcity of water it is important to know whether current, fully accessible water sources are managed effectively based on current demand. This improves planning for the future and for the cost-effective development of new augmentation schemes.
- The MAWRD also initiated the Namibia Water Resource Management Review. The Review produced various the matic studies to assess water resources strategically, water use and conservation, and current capacities in the water sector, and made recommendations for the future.
- In 1998, the Ministry of Environment and Tourism (MET) commissioned a State of the Environment Report on water in the country. This study thoroughly reviewed water resources, use and demand, as well as institutional, management and conservation aspects and capacities.
- Many stakeholders generate awareness about responsible water consumption and conservation.

Status of selected natural resources

Pressures

- Population growth is a key pressure on the abundance of natural resources. As the population increases, so does the demand for food, shelter and income. In unregulated areas, people are prone to harvest resources unsustainably to meet basic domestic needs and to pay for essential services.
- Excessive effort, such as too many vessels out fishing, and overcapitalisation in the fisheries sector may be perceived as current pressures on marine resources. Many fish stocks have not recovered to healthy levels since Independence, while many new business enterprises have entered the industry. In the midst of unfavourable environmental conditions, fishing companies are in dire need of higher quotas to ensure current employment levels in the industry. Furthermore, climate change projections for Namibia are harsh, and may severely affect the fishing industry.

State

- Many wildlife populations, especially in northern Namibia, have increased in number since the inception of the Community-based Natural Resource Management (CBNRM) Programme. Wildlife populations are currently at healthy levels and both conservancy game guards and MET extension staff monitor species regularly.
- The desert-dwelling elephant population in north-western Namibia is not excluded from the increase in wildlife observed in conservancies. The elephant population has reached healthy abundance, to the extent that Namibia has approached the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Secretariat to approve the annual sales of 2,000 metric tons of ivory. Too many elephants in an area can pose dangers to both the environment (its habitats and ecosystem) and humans: a fact of which the MET is well aware.
- Although the MFMR has done a commendable job in rebuilding fish stocks and expelling all unlicensed vessels from Namibia's Exclusive Economic Zone (EEZ), many stocks are still dwindling. Small pelagics are very susceptible to environmental anomalies, and struggle to reach healthy levels. Cape hake, a high earner of foreign revenue, are currently exploited at low levels compared with the 1970s. Overall, although the industry still manages to remain in business, there is little scientific evidence to support an ongoing positive trend in stock replenishment. Mariculture, practised on a large scale with promising economic viability, may offer the opportunity for wild fish stocks to recover – that is if environmental change does not severely affect stocks in the coming years.

Responses

- Conservancies continued to monitor their wildlife populations and are advised by the MET's scientific staff on annual take-off rates. Where populations attain numbers high above the land's carrying capacity, translocation to less inhabited areas is a possibility.
- The MFMR continues to do research to better their understanding of the Benguela Current and the processes associated with it. In addition, the MFMR has adopted an ecosystem approach to fisheries management, which takes a holistic and not species-based approach to managing marine resources.
- Other responses taken toward conserving natural resources not assessed for this study include continuous improvement of knowledge and databases to put resource managers in a better position to conserve, protect and manage these assets. The declaration of protected areas, e.g. forest parks, is another response that can provide tangible results.

Pollution and toxins

Pressures

- A major threat is the increase in the number of motor vehicles in towns and cities. This will increase the amount of carbon dioxide (CO_2) released from vehicles and, thus, the amount of pollution. In Windhoek this could become a severe issue as the urbanisation rate increases.
- Development along the coast may increase marine pollution. Although no severe pollution currently takes place, with the increase in naval traffic, the development of large-scale mariculture, the possible advent of a desalination plant, and the commercial production of natural gas, this picture might change.

State

- Namibia currently faces no severe threats regarding pollution and toxins that pose harm to human and environmental health.
- Burning of fuel wood in rural homesteads causes pollution that poses direct harm to both the environment and humans and may cause respiratory problems.
- The geographic placement of Windhoek makes the city prone to the entrapment and accumulation of vehicle emissions and dust in the air. Over time, this will affect air quality and enhance the greenhouse effect.

Responses

- Namibia does not have appropriate instruments in place to mitigate excess pollution and the occurrence of toxins. However, much has been done towards alleviating this problem, and the MET is busy gathering information to devise appropriate strategies to resolve it.

Solid waste management

Pressures

- Population growth in the absence of improved waste disposal is a pressure on the environment. More people generate more waste – and if proper waste disposal and management is not in place, this will cause littering and the irresponsibility dumping of harmful chemical or toxic wastes that are dangerous to human and environmental health.
- The improper allocation and development of waste disposal sites currently pose threats to underground water resources.

State

- Namibia is generally a clean country, with Windhoek being renowned throughout Africa for its cleanliness.
- However, littering occurs across Namibia and in varying degrees of severity. Areas that lack proper waste collection and disposal mechanisms are prone to excessive littering of waste items that can be harmful to the environment and to human health.
- In many instances, waste disposal sites are not properly planned, designed or commissioned. As a result, such sites seem to take no cognisance of the surrounding natural environment, underground water, nearby urban or rural homesteads, or the carrying of toxins or harmful chemicals by air and water.

Responses

- Waste management and the control of littering rest with local authorities and, specifically, municipalities, although some municipalities do not have good structures in place to deal with such issues. However, much has been done towards alleviating this problem, and the MET is busy gathering information to devise appropriate strategies to resolve it.

Greenhouse effect and ozone depletion

Pressures

- There are currently no severe pressures in

Namibia that will enhance the greenhouse effect and/or contribute to ozone depletion. Although rapid and large increases in emission of greenhouse gases will qualify as a pressure, this is unlikely as the country is committed to meeting the United Nations Framework Convention on Climate Change (UNFCCC) targets.
- CO_2 emissions from motor vehicles are the only known pressure at present.

State
- Evidence suggests that Windhoek has become warmer over the past 100 years, especially since the 1980s. Increases in temperatures increase rates of evaporation, which implies faster disappearance of surface water.
- Current emissions that contribute to global warming are negligible, and Namibia is categorised as a net sink of greenhouse gases.
- Namibia does not produce any fossil fuels.
- Regarding the consumption of ozone-depleting substances (ODSs), Namibia is well on track to meet the targets outlined by the UNFCCC.

Responses
- As a signatory to the UNFCCC, Namibia is aware of the need to monitor the emissions of greenhouse gases and the consumption of ODSs.
- Stakeholders are made aware of the commitment to curb excessive emissions and to phase out the use of ODSs.

Social issues and the natural environment

Pressures
- Increasing evidence of HIV/AIDS will compromise our ability to conserve and protect our environment.

State
- The Human Development Index (HDI) measured for Namibia was above 0.7 in 1998 and has been just above 0.6 ever since. This drop in HDI may be due to an increase in the population, with no increase in the indicators used to determine the HDI.
- HIV/AIDS rates are still alarmingly high, especially in the north-eastern Namibia's Caprivi Region. However, research conducted by the Ministry of Health and Social Services (MHSS) suggests that the trend in HIV/AIDS incidence will stabilise over the next few years.
- Currently, 100% of people living in urban areas have access to safe water, while over 60% of the rural population enjoys this basic commodity at safe levels.
- In rural areas, sanitation facilities are inadequate and at times totally absent: overall access is still below 20%. Unsanitary conditions are not only dangerous to human health, but to the natural environment too. On the other hand, urban areas enjoy close to 100% access to sanitation facilities.

Responses
- Improved school enrolment and a move towards income equality will definitely increase Namibia's HDI over time. The Ministry of Basic Education, Sport and Culture tries to ensure that the majority of Namibians at least have primary education to ensure literacy.
- The MHSS, in collaboration with local and international non-governmental organisations (NGOs), continuously generates awareness about HIV/AIDS and its causes, and educates people about safe sex.
- The Government has devised a National Strategic Plan on HIV/AIDS that is implemented through five-year Medium-term Plans (MTPs). Namibia entered MTP III in 2004. These MTPs target sectors with specific strategies to educate people about the causes of HIV/AIDS, counselling those living with HIV/AIDS, behaviours and attitudes toward causal sex, and other prevention and treatment strategies.

Economic issues and the natural environment

Pressures
- The extraction of minerals exerts pressure on the natural environment and may alter it to a state beyond complete rehabilitation. This is currently the case for diamond mining in southern Namibia.

State
- Diamond mining has caused severe damage to the natural environment. This includes the destruction of coastal and near inshore habitats and general changes to the landscape.
- Non-timber forest products (NTFPs) are currently produced and sold in a rather uncontrolled environment. Relying on natural resources, local carvers and craftsmen and -women harvest woody resources without specific regulation, which may contribute to

high levels of deforestation.
- NTFPs also compromise wild plants and animals that are harvested for consumption and income.
- The exploitation of NTFPs is currently not monitored.

Responses
- Regarding current financial support for environmental management and protection, total Government funding for environment and related sectors has declined over the past few years. In a country where people and the economy are heavily reliant on natural resources, and in the midst of climate change, more funds will need to be directed toward research that can provide information for the way forward in terms of the conservation, protection, management and sustainable utilisation of natural resources.
- The MET has drafted the Environmental Management Bill that will allow for better enforcement of commitments to preserving and rehabilitating the environment following the closure of mines. This Bill also articulates the necessity for EIAs when large developments that may pose threats to the environment are planned.
- Because crafts are sold to tourists, and in order to know the current and future potential of the industry, it would be beneficial to record data on sales and quantities of products. Such data can also serve as a proxy for the amount of natural resources harvested in the absence of other reliable sources.
- The Centre for Research, Information and Action in Namibia (CRIAA) is involved in projects dealing with NTFPs and, specifically, Namibian wild plants that hold valuable extracts and substances. As far as possible, CRIAA collects data on the sale of products, who produces them, and in what quantities they are produced.

What is a State of the Environment Report?

The three principal aspects of sustainable development – social, economic and ecological – are interlinked and act reciprocally. This is an undeniable reality as we observe, for example, how the decline in fish stocks (ecological) affects the production and export of fishery products (economic) and people's job security in the industry (social). Many other examples can be highlighted to demonstrate the reciprocal relationship between the three aspects of sustainable development using the State of the Environment Report (SoER) process.

Firstly, an assessment of the state of the environment defines environment as encompassing the above three principal aspects. The assessment is done through the identification of easily interpretable but rigorous indicators as a means to report on the environmental, social and economic status of the country. An indicator is defined as any variable that can be measured and monitored to reveal something of relevance to a particular issue.

Secondly, the reporting process follows a framework that provides an overall picture of the influences from pressures that result in changes in the condition of the environment as well as

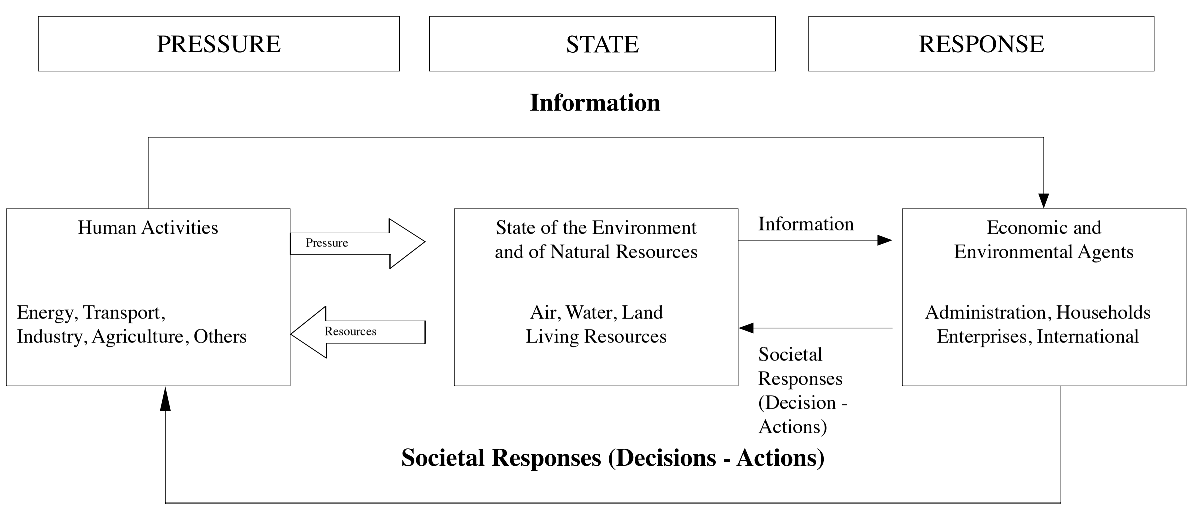

Figure 1: The Pressure-State-Response framework (Organization for Economic Cooperation and Development, 1993)

the social and economic spheres. Though there are several frameworks to use, the Pressure–State–Response (P–S–R) framework is chosen here for its simplicity (see Figure 1). Developed by the Organisation for Economic Cooperation and Development (OECD), the P–S–R framework is the one most widely used to identify the right indicators for monitoring objectives. It reports on human activities (pressures) that impact on the condition of the environment (state), and tabulates the societal responses to those pressures and changes. The SoER presents a vast amount of information and data of various types and sources in formats such as graphs, illustrations, maps, text boxes, and photographs. The SoER provides information on the most pressing environmental issues and assesses what is causing environmental change and what we are doing about it. The SoER could be written thematically, e.g. on the theme of loss of biodiversity or socio-economics, or it could integrate various themes and address them together due to their linkages. Namibia has already produced a number of thematic SoERs (downloadable from the MET website), including the following:

- Agriculture and land resources
- Fresh water
- Socio-economics
- Industrialisation
- Parks, tourism and biodiversity
- Waste, and
- The marine environment.

The present report, Namibia's first Integrated State of the Environment Report (ISoER), is designed to –

- provide pertinent and appropriate environmental information for policy, planning and decision-making processes and to the public at large
- provide current and comprehensible information to all stakeholders on Namibia's trend towards achieving its national development goals, including Vision 2030
- enhance public understanding on the causes and status of environmental issues, and what responses there have been
- empower people and organisations to improve their environment and quality of life for themselves and future generations, and
- act as an early warning mechanism towards sustainable development in Namibia.

Why do we need a State of the Environment Report?

National commitment

Namibia's dedication to a sound ecological, social and economic process of development is rooted deeply in its Constitution, policies and legislation. Perhaps the most important of these currently is Namibia's Second National Development Plan (NDP2), covering the period 2001/2–2005/6. NDP2 is a national development strategy for Namibia and consists of long-and medium-term development goals. Its objectives are to –

- reduce poverty
- create employment
- promote economic empowerment
- revive and sustain economic growth
- reduce inequalities in income distribution
- reduce regional development inequalities, and
- promote gender equality and equity.

According to the National Planning Commission[1], Namibia's continued economic growth depends to a large extent on its rich natural resources and unique arid environment. Thus, NDP2 initiates the difficult but necessary process of taking into account aspects of environment and sustainability in sector, cross-sector and regional development planning. To give effect to these commitments, the Government commenced various programmes and projects that address the need for development as well as the requirements of sound environmental management. Certain key questions concerning these objectives are as follows:

- Are the sustainable development principles being achieved?
- What is the status of Namibia's environment, and is it improving or deteriorating?
- Which components of the natural environment are changing, and how fast is the pace of change?
- What components of the natural environment should Namibia monitor?
- What should Namibia monitor in a cost-effective and efficient way, i.e. what should be our key indicators of change and how do we select them?

Footnotes

[1] **Agency responsible for planning national priorities and directing the course of national development.**

- How do we translate the information gained from these exercises into decision-making for improved environmental awareness?

These questions led the MET to establish the SoER as a national reporting strategy to monitor the state of the environment. This strategy should promote environmentally sustainable development practices by providing updated environmental information to the policy, planning and decision-making processes.

International commitment

The intergovernmental United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro, Brazil, in 1992, was pivotal in strengthening the integration of environmental issues and concerns into a global, regional and national decision-making process, resulting in the adoption of Agenda 21, UNCED's plan of action. Principle 4 of Agenda 21 proclaimed that environmental protection (particularly biodiversity) and development are linked, thus highlighting the integration of environmental and socio-economic issues. Important in the SoER process is Chapter 40 of Agenda 21, which calls for information to be produced for decision-makers. Chapter 40 also emphasises that everyone is simultaneously a user and provider of information in sustainable development. One of the activities of Chapter 40 requests that indicators of sustainable development be devised. The full implementation of Agenda 21 was reiterated at the World Summit for Sustainable Development (WSSD), held in Johannesburg, South Africa, in 2002. The refined WSSD implementation plan identified targets and timetables for various issues. Some important WSSD targets for Namibia by the year 2015 are to –

- prevent the loss of biodiversity
- halve the proportion of people who live on less than one United States (US) dollar a day
- halve the proportion of people who are unable to reach or afford safe drinking water
- attain sustainable fisheries, and
- promote and develop partnerships to enhance health and education with the objective of achieving improved health and literacy by 2010.

Numerous countries, including Namibia, became signatories to the multilateral environmental agreements that came out of the UNCED, such as the Convention on Biological Diversity, the Framework Convention on Climate Change, the Convention to Combat Desertification, the Ramsar Convention on Wetlands, and the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. Namibia actively supports these Conventions and international treaties to conserve biological diversity, use it in a sustainable manner, and ensure the fair and equitable sharing of its benefits from the utilisation of genetic resources.

How was the ISoER developed?

This ISoER was produced by the MET's Directorate of Environmental Affairs. Its compilation required close collaboration with various stakeholders and contributors nationally. The activity was funded under the Environmental Information Systems Unit through a bilateral cooperation agreement between the Governments of the Republic of Namibia and the Republic of Finland.

The report is the result of an extensive consultative

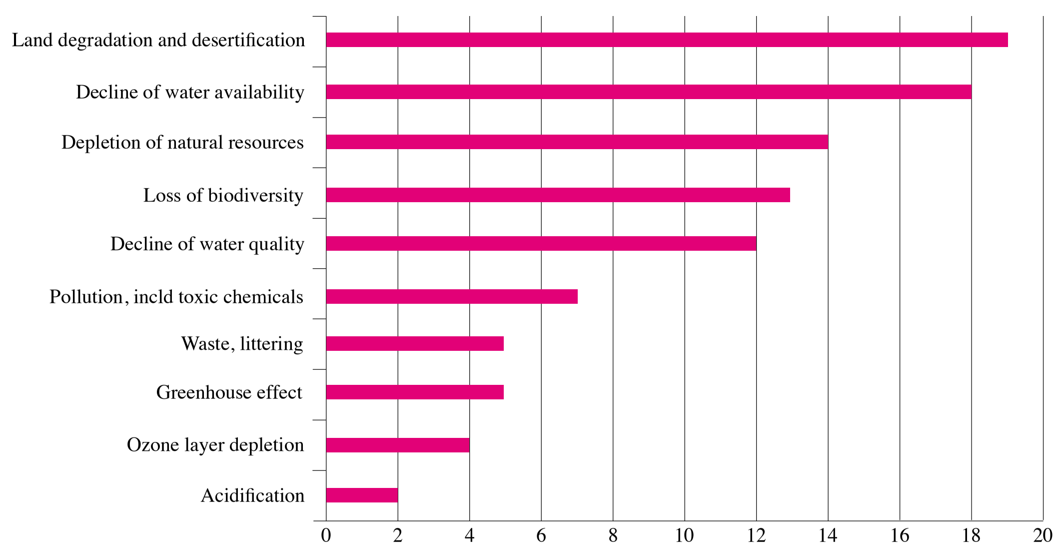

Figure 2: Namibia's top ten environmental issues in order of least importance to most importance, from bottom to top (Nakanuku et al. 2001).

process that commenced in June 2001 with the establishment of an Environmental Monitoring and Indicators Network (EMIN). EMIN is a formal network of resource managers, researchers and technical staff from line ministries, NGOs, parastatals and the private sector. Since its inception in 2001, a series of EMIN workshops have been held for three consecutive years. The overall objective of EMIN is to bring institutions and individuals together to deliberate issues and concerns pertinent to Government policies on environmental planning in particular, and sustainable development in general. Thus, EMIN forms a platform that is conducive to discussing and reporting on indicators and their monitoring. Moreover, EMIN encourages data-sharing, and for this reason initiated the compilation of a spatial data-sharing policy in 2002. EMIN is spearheaded by the MET.

In 2001, EMIN identified and selected Namibia's top ten environmental issues (Figure 2) and the indicators for each such issue as well as a preliminary set of National Core Environmental Indicators (NCEIs) (see Annex 1). The NCEIs, on which this ISoER is based, consist of 43 environmental, social and economic indicators that cover prominent issues in Namibia at present. The NCEIs were prioritised by EMIN members in a plenary session. The Analytical Hierarchy Process (AHP), which is the most widely used multi-criteria method of analysis, was used to select indicators. The AHP converts subjective assessments into a set of weights where pair-wise comparisons are made between criteria and indicators. The criterion for the initial selection of an indicator was data availability, followed by relevance, scientific credibility, and responsiveness.

Structure of the Integrated State of the Environment Report

This version of the ISoER is written rather technically, while follow-up editions will be presented in non-technical language to be understood by the various stakeholders – inclusive of the general public.

Most environmental issues are interrelated in one way or another. Therefore, throughout the report, linkages with other indicators or environmental issues are identified to reveal explicit associations.

This report has nine thematic chapters, presented as key findings in this Executive Summary. Each chapter briefly describes the theme (state), which is followed by discussing the cause of the phenomenon (pressure) and the actions taken by Namibia, either through the implementation of national strategies or international obligations (responses). The various indicators are then introduced, after which each indicator is presented in detail. Each chapter concludes with recommendations related specifically to monitoring, followed by a list of references for further reading. Figure 3 is a representation of the whole developmental process of this publication.

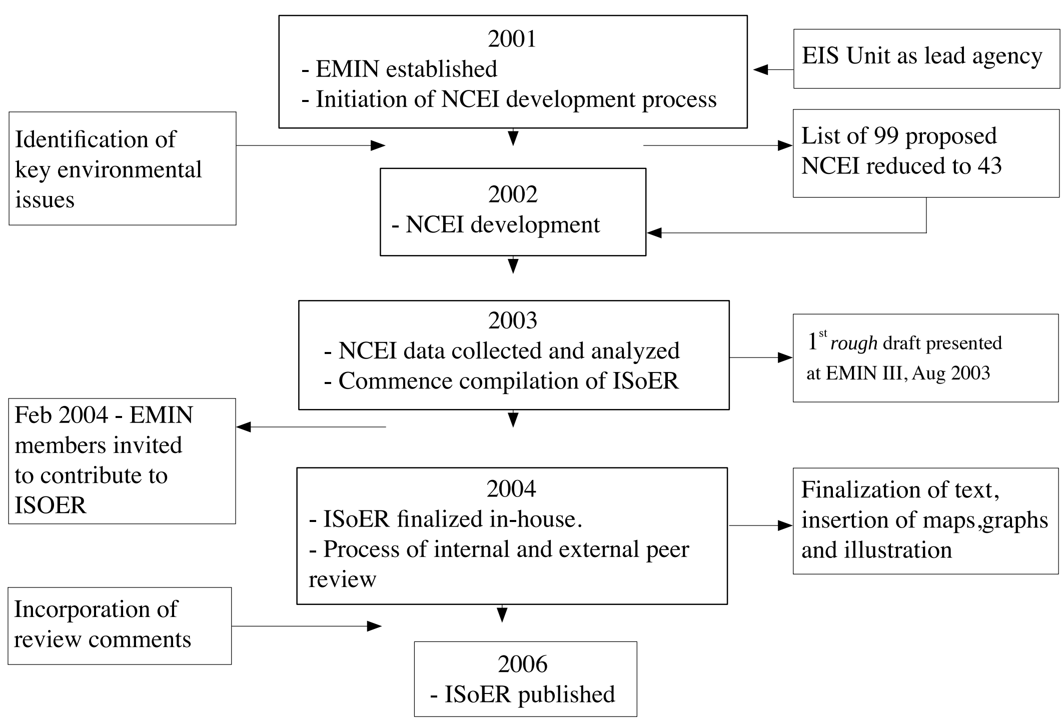

Figure 3: Developmental process toward the publication of the ISoER

Annex 1: National Core Environmental Indicators

Issue[2]	No.	Indicator	Type[3]	Data availability[4]	Proposed by[5]	Organisation responsible[6]
Desertification	1	Desertification index	S	2	State of the Environment Report (SoER)	Desert Research Foundation of Namibia
	2	Forest area	S	1	Organisation for Economic Cooperation and Development (OECD)	Department of Forestry (DF) in the Ministry of Environment and Tourism (MET)
	3	Forest biomass	S	1	Environmental Information Systems (EIS) Programme	DF in the MET
	4	Amount of livestock in selected areas	P	1	EIS	← Ministry of Agriculture, Water and Rural Development (MAWRD) for borehole data ← Veterinary Services Department of the MAWRD
	5	Dominant land use and form of land tenure	P	2–3	Second Environmental Monitoring and Indicators Network Workshop (EMIN2)	MLRR
	6	Population pressure	P	1–2	EMIN2	2001 Census
Decline in water availability	7	Annual run-off	S	1	SoER	MAWRD

Footnotes

[2] Environmental issue defined at the first EMIN workshop in 2001.
[3] Position in the pressure–state–response (P–S–R) framework; indicates to which category a particular indicator belongs.
[4] Refers to the assumption made before data acquisition and testing by the Second EMIN Workshop work groups.
[5] The organisation that proposed or has used the indicator.
[6] Organisation assumed by EMIN to hold the data or have the capacity to organise monitoring to acquire the data concerned.

Issue[2]	No.	Indicator	Type[3]	Data availability[4]	Proposed by[5]	Organisation responsible[6]
Decline in water availability	7	Annual run-off	S	1	SoER	MAWRD
	8	Mean annual rainfall	S	1	SoER	MAWRD
	9	Groundwater level and abstraction	S, P	1	SoER	MAWRD
	10	Extent of monitoring network	R	1	SoER	MAWRD
	11	Water use and economic efficiency	P, R	1	EMIN2	MAWRD
Depletion of natural resources	12	Large mammals in north-western Namibia (north of the Ugab River)	S	1	Meta-database survey	Elephant and Giraffe Project in the MET
	13	Income earned by communities involved in the national Community-based Natural Resource Management (CBNRM) Programme	R	1	Meta-database survey	Namibia Nature Foundation
	14	Harvesting of marine resources	P	1	SoER	Ministry of Fisheries and Marine Resources (MFMR)
	15	Regulation and control of harvesting of marine resources	R	1	SoER	MFMR
Loss of biodiversity	16	Conservation areas	R	1	SoER	MET
	17	Coastal development	P	2	SoER	DF in the MET

Issue[2]	No.	Indicator	Type[3]	Data availability[4]	Proposed by[5]	Organisation responsible[6]
	18	Threatened and extinct species per taxonomic group	S	Birds and plants = 1; mammals and reptiles = 1–2; other taxa = 3	South Africa (SA)	MET
	19	Changes in status of selected endangered habitats	S	2–3	EMIN2	MET
	See No. 5	Dominant land use and forms of land tenure	P	3	EMIN2	← MET ← Ministry of Lands, Resettlement and Rehablitation (MLRR)
	20	Changes in status of alien invasive species	P	3	EMIN2	← MET ← MAWRD
Decline in water quality	21	Surface water quality	S	1	SoER	← MAWRD ← NamWater
	22	Groundwater quality	S	1	SoER	← MAWRD ← NamWater
Pollution and toxins	23	Annual unleaded petrol market penetration	P, R	1	SoER	← Ministry of Mines and Energy (MME) ← Directorate of Environmental Affairs (DEA) in the MET
	24	Marine pollution	S	2	SoER	MFMR
	25	Air pollution in Windhoek	S	3	SA	Municipalities

Issue[2]	No.	Indicator	Type[3]	Data availability[4]	Proposed by[5]	Organisation responsible[6]
Waste	26	General waste produced per capita per year	P	2	SA	← Municipalities ← DEA in the MET
	27	Hazardous waste produced per sector per year	P	3	SA	← Municipalities ← DEA in the MET
Greenhouse effect	28	Annual energy consumption (fossil fuels or renewable energy)	P, R	2	SoER	MME
	29	Mean annual rainfall	S	1	SoER	Meteorological Office
	30	Index of upwelling	S	1	SoER	← Meteorological Office ← MFMR
	31	Mean annual temperature	S	1	SA	← Meteorological Office ← MFMR
	32	Greenhouse gas emissions (carbon dioxide, nitrous oxide and methane)	P	2	SA	MET
Ozone depletion	33	Consumption of ozone-depleting substances	P	1	SA	Ministry of Trade and Industry (MTI)
Socio-economic issues	34	Human Development Index	S	2	OECD	← United Nations Development Programme (UNDP) ← Ministry of Health and Social Services (MHSS)
	35	HIV prevalence in pregnant women	S	1	OECD	← UNDP ← MHSS

Issue[2]	No.	Indicator	Type[3]	Data availability[4]	Proposed by[5]	Organisation responsible[6]
	35	HIV prevalance in pregnant women	S	1	OECD	← UNDP ← MHSS
	36	Child under-5 mortality rate	S	1-2	OECD	← UNDP ← MHSS
	37	Access to clean water and sanitation	S	1-2	Vision 2030	← MHSS ← MAWRD ← United Nations Children's Fund (UNICEF)
Economic issues	38	Sustainable economic growth	S	1-2	SoER	← Ministry of Finance (MF) ← Bank of Namibia
	39	Government capacity for environmental management	R	2	SA	MET
	40	Budgetary allocation to enviromental research	R	1	SA	MET
	41	External inflows	S	1-2	OECD	← MF ← Bank of Namibia
	42	Expected exhaustion date with current effort of mining of selected minerals	P	2	EMIN2	MME
	43	Income earned from non-timber forest products	R	2-3	EMIN2	← DF in the MET ← Environmental Economics Unit of the DEA in the MET

Column 4 Indicator code (also refers to the description list)

Chapter 1: Land degradation and desertification

Introduction
Chapter Overview
Assessment of Indicators
Recommendations
References

Introduction

This chapter presents land degradation and desertification indicators. However, prior to any in-depth discussions, it is important to define the terms *land degradation* and *desertification*. *Land degradation* occurs due to unsustainable farming practices, increased human and livestock population pressure, deforestation, long fallow periods, uncontrolled bush fires and fencing. *Desertification*[7] is recognised by many as a combination of processes of land degradation taking place in arid and semi-arid environments (such as Namibia's), whereby fertile land is gradually converted into desert – losing its productivity and ability to support populations. Although natural processes of change are recognised, the impact of human land use is considered as paramount to the process (Quan et al. 1994).

Natural environmental change will occur over time whether or not it is conducive to human livelihoods. However, human-induced impacts can be controlled although this is an enormous challenge for authorities. Population growth in itself is a huge factor (Ashley 1994), influencing not only the process and rate of land degradation, but also the abundance of other natural resources. Given no alternative ways to secure livelihoods, the rationale is that, as populations increase, more pressure will be exerted on their immediate natural environment as they fend for food and means to generate income. In Namibia, a community inhabiting a specific area has lifestyles consisting of diverse activities, habits and practices. A single rural household can depend on the environment for –

- wood as fuel for cooking and building material (for huts, kraals and fencing)
- wild foods (fruits, vegetables and meat/fish) for consumption and income
- land for crop and livestock farming, and
- water for irrigation and consumption.

If 1,000 such households inhabited a resource-abundant area with a carrying capacity[8] for only 300 households, two possible trends will be observed in the area over time:

- The population of people and livestock will eventually increase to almost double, and
- Resources will diminish rapidly with the concomitant rapid demand for livelihood support.

Land forms the basis of human existence and is at the receiving end of all pressures exerted as we strive – and, sometimes, struggle – to maintain our livelihoods.

What causes these phenomena?

When we consider the driving forces behind land degradation and desertification, a multitude of issues need to be borne in mind. Seely and Jacobson (1994) describe these linked phenomena as complex problems with *ultimate causes* such as poverty, and *proximate causes* such as agricultural mismanagement. Each of the two examples can be further dissolved in a number of component or sequential causes. Furthermore, the two levels of causation lead to processes such as overgrazing or erosion, that are embedded in states of environmental degradation. An array of factors contributing to land degradation and desertification is operative in Namibia and includes numerous issues related to population growth. The most important nature-induced concern is the variability of rainfall in the country. For this, Seely and Jacobson (ibid.) strongly motivate the need to develop an institutional memory of the consequences of this variability. They also emphasise that, although the socio-economic consequences of desertification are recognised, decision-makers should address it thoroughly and bring about the necessary changes. The major socio-economic factors stemming from ultimate causes include the following (ibid.):

Footnotes

[7] The 1992 United Nations Earth Summit defined it as "land degradation in arid, semi-arid and sub-humid areas resulting form various factors, including climatic variations and human activities".
[8] The maximum population of a particular species that can be supported by a given habitat or area.

1. Increasing population of people and livestock
2. The country's wealth distribution profile becoming more stratified, distinct socio-economic classes with the majority classified as poor
3. Changes in demand from the rural population on the subsistence system
4. Change in the valuation of the subsistence system in relation to points 1 and 3 above
5. Reaction to drought rather than planning for drought, and
6. Acceptance and reliance on a commercial crop economy with decreased use of traditional foods and arid-adapted subsistence patterns.

The proximate causes of desertification in Namibia manifest themselves in four primary ways (ibid.), namely –

- as a reduction in vegetation cover and subsequent soil denudation following –
  - overgrazing
  - bush encroachment[9], and
  - deforestation[10], and
- an impoverished soil base resulting from overcultivation.

Extent of risk caused by these phenomena

According to Tshikesho (1996), 30% of the world's surface is threatened with desertification and 75% of this total (approximately 3.3 million km^2) is considered to be moderately degraded already. Given the world's present food-producing land at about 13 million km^2, the above figures are significant. Cardy (1993) maintains that 40 million people in Africa suffer from malnutrition due to desertification; of these, about 2 million are suspected to be suffering from starvation and close to death. Although desertification is spread worldwide, i.e. no continent is unaffected, it has only recently been perceived as a serious global problem. For the first time, the current growth rate of the global population has awakened us to the possibility of running out of resources and, more importantly, the threat of being *unable* to feed ourselves (Tshikesho 1996).

Nationally, we can relate to global impacts and threats of desertification. As our population increases, we tend to exert more pressure on the environment for its goods and services. In the midst of increasing deforestation, overgrazing and overcultivation, Namibia will be faced with the lack of pastures for grazing, infertile soil for agriculture, the concentration of people in selected 'resource-abundant' environments, and the abandonment of previous settlement areas. This will amplify the loss of productive land, lack of forest resources and pastures, and the general decrease in food availability to rural and marginalised communities.

Chapter overview

Namibia's inherent arid environment and variable rainfall makes it extremely vulnerable to desertification, even in the absence of human impact. Only 2% of the land surface cover is arable, with more than 40% comprising a large area of arid rangeland. The remainder of land consists of the Namib and Kalahari Deserts.

Land use and tenure forms

The insecurity of land tenure in communal areas has been suggested as a factor contributing to land degradation. It is argued that farmers with tenure insecurity try to get the most out of the land for the period during which they have access to it. This, driven by unsustainable practices and poor management, results in unprecedented pressure – leading to deforestation, overgrazing, and the loss of essential soil nutrients. The contribution of land use to desertification is well understood, but not adequately quantified in severely degraded areas. Land-use practices coupled with human population pressure are responsible for the removal of large tracts of forest, clearing of huge areas of land for cultivation, and the permanent settlement of large numbers of livestock in restricted areas. The role played by the form of tenure still needs to be better understood.

Current farming practices do not conform to adaptive management strategies, whereby the intensification of farming relies on the weather and climatic conditions as well as the availability of pasture and water. Commercial farmers are reliant on drought relief during bad years and wish to further intensify their production even when the environment shows an increasingly diminished resilience as the years go by. Current land uses related to farming (crops and livestock) are not conducive to sustainable production in the long term, and in the midst of climate change, only

Footnotes

[9] Refers to the invasion of unpalatable woody bush in grazing areas. Bush encroachment is a major form of land degradation in commercial farming areas, and affects 12% of the country's land surface area (Barnard 1998).

[10] Refers to the extensive cutting down of forests for the purpose of extracting timber or fuel wood, or to clear land for development or agriculture.

accelerates the desertification process. It is hoped that integrated land-use planning will provide a partial solution to the problem.

Livestock pressure in north-central Namibia

The main cause of livestock pressure is overstocking, which is in turn related to rapid expansion of human population settlement and livestock numbers. Overstocking occurs when the number of animals kept on a piece of land exceeds its carrying capacity. Overstocking of cattle in the communal lands is 'normal' because it is the way a farmer ensures his survival. Local people reason that they will suffer less impact during years of extreme drought when they have large numbers of cattle, so they refuse to destock during good years. Recommended stocking rates are exceeded by 40% in some instances, resulting in severe land degradation. Grazing areas lie abandoned and denuded, unsuitable even for crop farming, due to the loss of soil fertility. Although some peasant farmers have resorted to owning goats and donkeys due to their ability to browse on a wider range of vegetation, the pressure exerted by livestock persists, increases, and spreads as human populations and their distribution increase.

It is important to define carrying capacities in communal areas in particular, where pastoralists take advantage of their livestock's mobility to search for grazing. This will put farm managers in a better position to know when there is overstocking or not. In northern Namibia and in some of the southern parts, the areas around permanent settlements and secure water points are severely degraded and almost ecologically irreparable.

Population pressure

Namibia's population is projected to increase linearly at a rate of between 2.5 and 3.0% per annum until the year 2021. Climate change projections, although still rather vague due to the lack of proper understanding of underlying processes, sketch a very grim picture for Namibia in terms of the abundance and availability of natural resources. Moreover, as stated previously, the country is vulnerable to desertification – even in the absence of human pressures. Over 60% of the population is rural, and lives in the northern parts of the country where resources were perceived to be abundant. The heavy reliance of the rural population and the Namibian economy on natural resources cannot be overemphasised. Population pressure currently results in land degradation that ultimately leads to the total desertification of areas that once bore resources in relative abundance. As the population grows, so does its demand for food and shelter. Large areas of land are cleared for homesteads and crop cultivation. Wild fruits and other forest products are harvested at accelerating rates to provide food, income, building material and fuel. Land degradation has been escalating, and this is evident from the high population densities in and around urban centres in the north-central areas, along the north bordering perennial rivers, and in areas where water availability is secured. It is a popular notion that the poor impact the environment negatively and that they are the ones most affected when the environment is degraded. Older generations of local people still recall the lush vast grasslands in north-central Namibia when they first arrived with their parents, and today recognise the long distances they need to walk daily for fuel wood. The environment has been altered due not only to long-term climate changes, but also – and more so – to severe human pressure and negative impact. The question is, where will people go and how will they secure their livelihoods once the resources are depleted?

Forest area change

Deforestation was noted in Namibia as early as the late 1800s. Indigenous peoples used to be divided by lush ranges of dense mopane trees, but today, tribes are almost integrated spatially. In 1886, the missionary Hugo Hahn noted a mopane forest measuring 60 km in width separating the Ondonga and Uukwanyama communities. By 1936, this band of forest had been reduced to 40 km; in 1950, it spanned only 10 km. Today, this forest has vanished due to the demand for wood as fuel and building material. The Directorate of Forestry (DoF) reported an average loss of 73,000 ha of forest per annum from 1990 to 2000. This will increase given the current rate of population growth, leaving more large tracts of land denuded and infertile. Due to the current lack of forest resources, rural households are forced to buy wood or travel long distances to collect or to buy wood, which impacts on the daily functioning and productivity of households. In addition, a proportion of an already low income needs to be allocated for wood, which is a daily necessity for cooking. The loss of vegetation affects not only the amount of water retained for aquifer replenishment, but also the rate of runoff after the rains and the area's biodiversity. In addition, the destruction of forest is responsible for the loss of habitat and inhabitant species. Such occurrences are currently increasingly commonplace in Namibia.

Assessment of indicators

INDICATOR 1A: Land-use change and forms of land tenure

Land tenure and degradation: A historical perspective

Land tenure in Namibia has assumed a largely dualistic form, stemming from the colonial regime. Colonialists dispossessed indigenous peoples of large tracts of land for use by European settlers. Indigenous communities were confined to racially and ethnically defined 'reserves'; and those who did not lose their land entirely were subjected to rigid boundaries, as in the case of former Ovamboland (Werner 1994). This land division set the scene for colonial commercial agriculture production, while strict controls were put in place in respect of production and stock numbers in indigenous agriculture. This system of agricultural development founded the relatively severe tenurial dualism between subsistence and commercial farming in Namibia. Western forms of tenure (freehold title) became characteristic of land used in the commercial farming sector, while land rights in the reserves remained communal or shared.

The broadly dualistic nature of land tenure systems in Namibia has generated interesting viewpoints on the relationship between land tenure and land degradation. Since the 1930s and 1940s people have related land degradation to land tenure systems. Colonial officials reported the process of desertification in large areas set aside in the reserves for pastoralists (ibid.). Overgrazing and overstocking were also identified as promoting land degradation in certain areas as traditional pastoralists were not able to herd their livestock to other areas for grazing. Reserve farmers were urged to reduce their livestock numbers as part of a proposed solution. At this point land tenure was regarded as part of the problem of land degradation. Land tenure reform was regarded as the only long-term solution, whereby changes were suggested in the system of grazing management, intensifying agricultural production due to limited land, and the introduction of fenced camps to facilitate rotational grazing. In the 1980s the idea of fenced camps for rotational grazing was implemented on a significant scale at Okamatapati, the south-eastern part of what was then Ovamboland; prior to Namibia's Independence in 1990, it was also implemented in the Kavango Mangetti. This long-term strategy to transform the form of land tenure involved the privatisation of communal land through fenced-off subdivisions. In his deliverance at the 24th Congress of the Grassland Society of Southern Africa in 1989, J Diergaardt, the Minister of Agriculture and Nature Conservation in South Africa at the time, confirmed this long-term plan (ibid.).

Following Namibia's Independence, the MAWRD in their contribution to the Transitional NDP identified the "present unequal land tenure system" as a huge problem because it caused overgrazing in communal areas (ibid.). Their contribution concluded that "the lack of property rights in the communal areas makes it difficult to enforce soil conservation regulations" (ibid). Another, not surprising, contribution by the same Ministry is a policy objective to develop systems "whereby commercial rights of farmers in the communal areas can be established and maintained" (ibid.). For another approach to the argument of whether specific forms of land tenure lead to land degradation, see Box 1.1.

Box 1.1: 'Tragedy of the Commons'– G. Hardin's (1968) theory on land tenure and degradation

All land under communal tenure is entrusted to the chief of a community for distribution and every member of the community or tribe has an inalienable right to a portion of land – be it residential, grazing or farming purposes. Under this system no one person has sufficiently secure land tenure. This causes people to have little interest in long term conservation because they are constantly faced with issues pertaining to private and communal interests. In respect of shifting cultivation – the possibility of access to new fields encourage rural people to exploit rather than to conserve the land. According to the theory, in pastoral systems herdsmen are encouraged to increase their herd as the private benefit of grazing an extra head of cattle on a common range outweighs the private cost because the cost of maintaining the rangelands is the responsibility of the group. This inevitably leads to land degradation as a result of overstocking and overgrazing.

Source: Werner 1994

Land tenure and land use

Figure 1.1 shows different land-use categories across Namibia, while Figure 1.2 shows the percentages allocated to these different land uses.

Land, as a basic and essential natural resource, can be used in various ways. A single piece of land can have alternative uses in one year depending on the

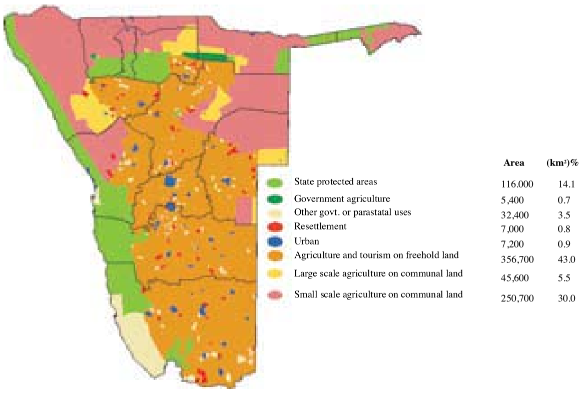

Figure 1.1: Eight different land use categories in Namibia (Mendelsohn et al. 2000

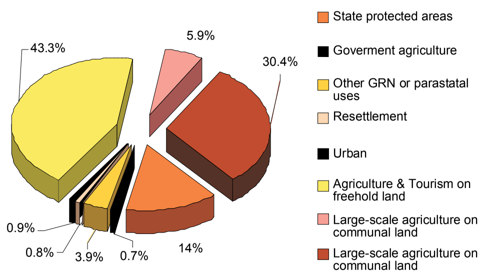

Figure 1.2: Land uses as percentage of entire surface area coverage of Namibia. (Mendelsohn et al. 2002)

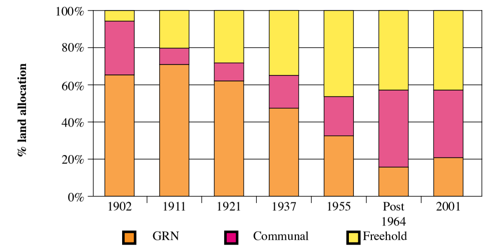

Figure 1.3: Government (GRN), communal and freehold land allocation (in percentage) as calculated from maps by mendelsohn et al., (2002)

season and/or changes in trends in the environment and/or the economy. On a macro scale, to a large extent land use in Namibia has remained the same since the beginning of the 1900s. Pastoralism[11], crop farming and cattle farming characterised Namibia from as early as 1902, when the country was still a German protectorate (Mendelsohn et al. 2000). Local leaders at the time negotiated rights with German officials and companies to use the land. Many of the land-use agreements were speculative in the hope that the discovery of diamonds and gold in South Africa would later occur in Namibia.

By the end of 1902, about 6% of land was accounted for as freehold farmland (occupied by German companies or individuals), while 30% was recognised as communal land. The remaining 64% was land either used by the Government or not yet allocated (ibid.). Figure 1.3 shows the transition of land ownership over time from majority Government-owned land, to increasing freehold and communal land ownership. Crop and cattle farming, whether at communal or commercial level, has maintained a strong presence since the early 1900s and continues to contribute to the economy of the country and the livelihoods of rural communities. Land use in Namibia today can be categorised as predominantly agricultural, with farming being the main activity in most parts of the country. Other uses include mining, tourism and State-protected areas for conservation. Much has changed since the first crop was harvested from fertile land in Namibia thousands of years ago.

Most land in Namibia is only suitable for extensive agricultural production (Ashley 1994). Commercial land is mainly used for livestock farming, supplemented by game exploitation. A growing number of commercial farms are devoting efforts exclusively to wildlife farming and tourism. Agro-pastoralist systems are common in communal areas, featuring a combination of extensive livestock management with small-scale crop farming and a diverse use of wild resources and trees (ibid.). The north-west and north-east of Namibia are rich in wildlife populations, and tourism developments in these areas have been rapid. From an environmental perspective, current farming practices are ecologically and economically unsustainable although subsidised by Government (ibid.; Krugman 2002).

The current affects of agriculture include (Krugman 2002) –

- unsustainable use of land, leading to degradation
- pressure on water resources, which leads to salinisation, lowered water tables, and the sedimentation of rivers, and
- changes in biodiversity, especially in communal areas.

Description

This indicator highlights the effect that changes in land use have on land degradation and desertification, due to changes in the form of land tenure.

Footnotes

[11] A farming practice that involves the movement of livestock to different grazing areas, and is dependent on climatic and environmental factors such as rainfall, water and pasture availability.

Results and trends

Land use and change

In principle, land-use practices have not changed much although the intensity of farming and the harvesting of wild foods and forest resources have increased significantly due to increases in population. The population density per square kilometre has increased, thus increasing competition among people to secure food and income. This leads to more pressure being exerted on the environment as more time is spent farming, catching fish, relaying water, collecting wood for fuel, exploring new grazing pastures to cater for livestock numbers in excess of the land's carrying capacity, and clearing land for cultivation. These processes lead to land degradation and, ultimately, desertification as land becomes infertile.

Forms of tenure

Figure 1.3 demonstrates a trend of changes in forms of land tenure from a majority percentage (>60%) State-owned land in the early 1900s to almost equal percentages of freehold and communal land and only 20% State-owned land by 2001. Major contributors to desertification are unsustainable farming practices and population pressure, in addition to the country's variable climate and rainfall. Unsustainable farming practices are marked by exceeding the land's carrying capacity for both humans and livestock, overstocking of livestock in grazing areas, overuse of arable land leading to reduced soil fertility, and the loss of biodiversity. Another factor highlighted by Quan et al. (1994) in communal areas is the absence of effective systems governing land and resource rights. As a result there is a situation of open access to common lands, leading to increased vulnerability of scarce natural resources. This is currently the scenario on communal lands, where locals secure land for themselves and engage in unsustainable harvesting and farming practices.

INDICATOR 1B: Livestock pressure in north-central Namibia

Introduction

Namibia's pre-Independence regime undermined the pastoral resource management practices of the indigenous peoples and confined many to small portions of marginal[12] land (Darkoh 1994). This meant a change from a nomadic to a sedentary way of life (Shanyengana 1994). The nomadic lifestyle of Namibia's rural people was characterised by well-adapted livestock farming practices that entailed seasonal migrations to conserve grazing land and water resources all year round (ibid.; Darkoh 1994; Mendelsohn et al. 2000). Such practices prevented the overuse of a particular portion of land and water resources; hence, the movement from one grazing area to another allowed grazing areas to recover on a rotational basis.

Today, due to permanent settlement, land for grazing is limited and livestock pressure increases along with human population growth. The confinement of large numbers of livestock, especially cattle, accelerates land degradation – ultimately causing desertification (Kambatuku 1994). Confined herds are forced to move repeatedly up and down, and to and fro in small areas during grazing, browsing or moving to water resources (ibid.). This causes deforestation (Shanyengana 1994) through trampling that removes perennial, more palatable grasses, while annual, less palatable grasses seem more robust as they recover marginally. Severe trampling in one area does not allow seedlings to grow: the land becomes denuded as it loses fertility because it has no time to recover. Kambatuku (1994) indicates that, although the per capita ownership of cattle is low in Namibia, by virtue of the human population in such areas the number of cattle will exceed the carrying capacity of the land. Communal farmers blame their current spatial confinement on the colonial era (Wolters 1994).

Livestock numbers have increased in north-central Namibia over the years due to the introduction of a reliable water supply via pipelines (Erkkilä 2001). This also encouraged people to settle permanently in areas surrounding such water points. Erkkilä (ibid.) emphasises that many such areas are often not suitable for permanent settlement and sedentary livestock farming – suggesting a high risk of degradation. This indicator highlights the need for the north-central Regions to address livestock pressure as a cause of desertification. Box 1.2 compares the north of the country with the south in respect of livestock pressures.

North-central Namibia: A case study of

Footnotes

[12] Land not categorised for prime agriculture or livestock farming purposes. Such land is characterised by poor soils, scant vegetation, minimal water resources, and high susceptibility to degradation.

livestock pressure

Mendelsohn et al. (2000) present a wealth of information and data gathered from various sources in *A profile of north-central Namibia*, which forms the basis of this case presentation. The north-central Regions comprise Ohangwena, Omusati, Oshana, and Oshikoto (see Figure 1.4). Livestock ownership and farming is an essential component of livelihoods in north-central Namibia, so these Regions have large proportions of livestock (ibid.).

From anecdotal information, and before any surveys were done to determine livestock populations in the area, it appears most households owned rather large herds of cattle. But by 1935 already, about 150,000 cattle were estimated to have been in the area. More recently, as the human population increased, the pattern of ownership changed remarkably. Today, the average number of cattle per household is lower, with more divided ownership. One major difference in livestock ownership is between households headed by men and those headed by women. Households maintained by women have less livestock compared with those maintained by men. The north-central area is one of the most densely populated in the country. Densely settled areas with a high density of households are marked by very low numbers of cattle associated with the high number of people. Hence, the average number of cattle is lowest in areas with high human population density: the number of cattle per household in sparsely populated areas ranges from 10–15 in comparison with less than 5 per household in the most densely populated areas. A similar pattern can be observed in the case of goats. Given high variation, the average household in an a densely populated area may be seen as 'poorer' by having fewer animals, compared with a household in a sparsely populated area (ibid.). Nevertheless, many authors (Kambatuku 1994; Klintenberg et al. 2004; Quan et al. 1994; Mendelsohn et al. 2000) acknowledge heavy grazing pressure in northern Namibia, and maintain that further increases in livestock numbers will exacerbate land degradation and desertification. As Kambatuku (1994) points out, heavy grazing pressure persisting throughout the year will not allow young seedlings to establish themselves as they are destroyed as they emerge. Hence, plants in a specific area age and die prior to ensuring any succession, which results in the elimination of such plant communities. Grazers commonly first consume palatable species that tend to disappear first, thus either leaving room for less palatable woody plant species or, through livestock trampling, preventing the reappearance of palatable grasses (ibid.). The presence of large livestock numbers and consequent heavy grazing patterns contribute to land degradation in Namibia. However, the rate of this degradation is a function of various aspects including human population pressure; the presence, location and abundance of pastures; and the location of fresh water.

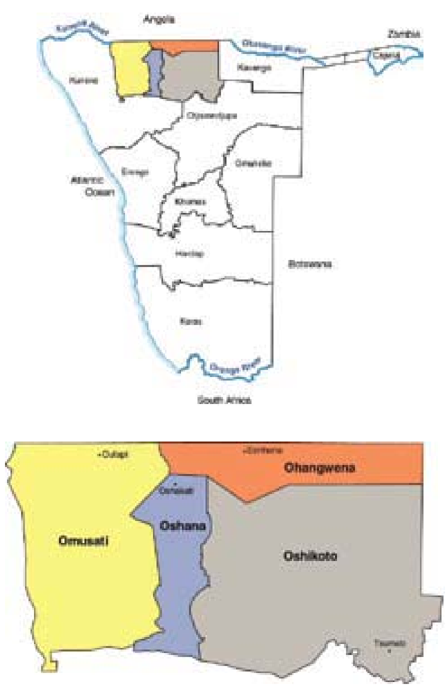

Figure 1.4: The four north-central regions in Namibia; Omusati, Oshana, Ohangwena and Oshikoto (Mendelsohn et al. 2000)

Livestock numbers in Namibia have fluctuated over the past 40–50 years due either to errors in estimation or to severe droughts that at times killed large numbers of cattle. During the most recent severe drought, namely 1992–1993, almost a quarter of all cattle in Namibia died. On the other hand, according to the latest agricultural censuses, the number of goats has increased threefold over the past three decades (Mendelsohn et al. 2000) and the current total human population of Namibia is estimated at 1.8 million (CBS 2003). More than half of this number live in the four north-central Regions, where an increase in the keeping of goats has been observed over the past ten years (MAWRD 2003).

Description

Too many cattle and other livestock on an area of land reduce its vegetation cover; the prolonged effect of this is soil erosion. This indicator highlights the effect of livestock pressure in the north-central parts of Namibia. Reference is made to the expansion of livestock pressure as a function of human population growth.

Results and trends

Livestock pressure as a contributing factor to desertification and land degradation is adequately recognised. In smaller areas, such as the Gellap Ost and Nabaos Biodiversity Observatories (Akhtar-Schuster 2002) in southern Namibia, the Biota Africa research project has surveyed transects to show land degradation caused by severe livestock pressure. This survey compared communal and commercial farmlands separated by a fence. In Photo 1.1, a noticeable fence-line contrast between a commercial and a communal farmland can be seen. This is described by Akhtar-Schuster (ibid.) as the long-lasting impact of severe grazing pressure on the biomass production and species composition of the natural vegetation. Such severe land degradation seriously impacts on the lives and livelihoods of rural communities. In many instances, family members migrate to cities as a strategy to cope with existing and escalating land degradation (ibid.).

Figures 1.5, 1.6, 1.7 and 1.8 show the distribution patterns of cattle, goats, donkeys and sheep, respectively. Apart from sheep, the other livestock have high densities in north-central Namibia – where population density is also high. The high aggregation and increasing numbers of livestock in north-central Namibia is becoming a more severe problem as resources become less abundant year after year. Communal resources are common property, and face unregulated and uncontrolled grazing. Hence, farmers try to capitalise on every piece of grazing land available and many times do not practice any rotational grazing. The condition of vegetation is very important to livestock farmers. However, if the biomass production and floral species composition of an area reduce, so does the quality and availability of grazing.

Figure 1.9 compares estimated carrying capacity with current stocking densities to show areas that are overstocked and areas where there is potential for more stocking. Areas that are severely overstocked generally fall around large settlement areas and include the eastern flood plains in Caprivi, a tract along the Okavango River, Okakarara, Opuwo, Uis, and north-central Namibia. On the other hand, areas to the east of the country in the Kavango, Omaheke and Otjozondjupa Regions still show potential for more stocking. Figure 1.9 also shows trends in the numbers of cattle, sheep and goats since 1990. Cattle numbers remained relatively stable around an estimated 2 million until 1996, whereas they had increased to 2.5 million by 2000 and 2001. For 2002 and 2003, cattle numbers were around 2.3 million.

The following trends in livestock numbers can be observed in Figure 1.10. Sheep numbers declined from around 3.4 million in 1990 to about 2.25 million in 1996. A further decline to almost 2 million is observed for 1998, while numbers increased for the next two years. The total number of sheep for 2003 was estimated at 2.9 million. No trends are observed for the number of goats in Namibia. Since 1990 the number of goats has fluctuated very moderately between 1.5 and 2 million. The current goat population in Namibia is estimated at 2.08 million (MAWRD; unpublished livestock census data).

INDICATOR 1C: Population pressure

Introduction

Namibia's population is rather small in comparison with its total land area. Furthermore, by international standards, Namibia is considered sparsely populated, but population pressure is considerable due to the uneven distribution of people (Figure 1.11) and the population growth rate. Moreover, only 20% of Namibia's surface area is arable, which causes an uneven distribution of the population away from the southern, south-eastern and east-central areas (with a lower average rainfall and land less suitable for agriculture) and towards the central, north-central and north-eastern areas of the country (which have higher average rainfall with land more suitable for agriculture).

> … [R]apidly growing populations can increase the pressure on resources and slow any rise in living standards; thus[,] sustainable development can only be pursued if population size and growth are in harmony with the changing productive potential of the ecosystem.

World Commission on Environment and Development (1994)

According to the Central Bureau of Statistics (CBS 2003), the trend in population distribution has not changed since the 1991 population and housing

Photo 1.1: This photo shows a marked fence - line in contrast between a commercial and a communal farmland (Akhtar - Schuster 2002)

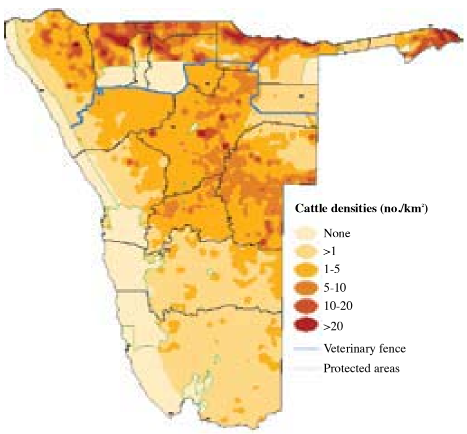

Figure 1.5: Cattle densities in Namibia (Mendelsohn et al. 2002)

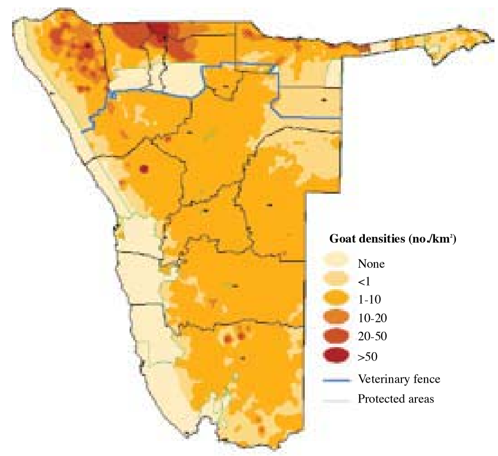

Figure 1.6: Goat densities in Namibia (Mendelsohn et al. 2002)

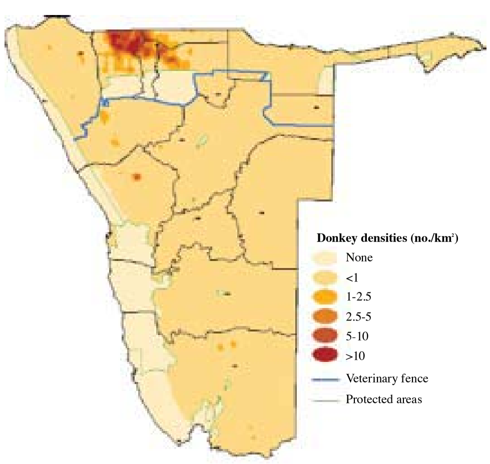

Figure 1.7: Donkey densities in Namibia (Mendelsohn et al. 2002)

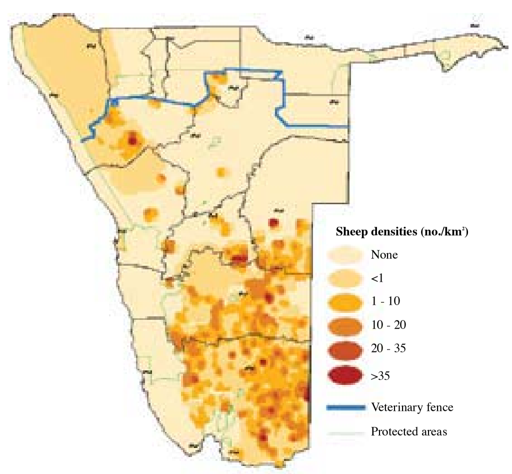

Figure 1.8: Densities of sheep bred for meat (Mendelsohn et al. 2002)

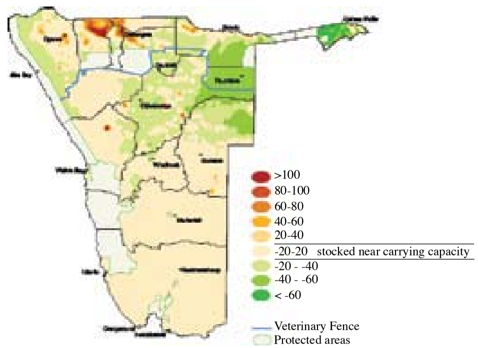

Figure 1.9: The above map shows stocking densities and carrying capacity (kg/hectare). The map indicates areas that are overstocked and areas where there is potential for more stocking (Mendelsohn et al. 2002)

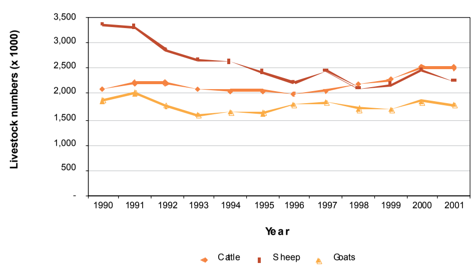

Figure 1.10: Shows trends in the numbers of selected livestock since Independence (Mendelsohn et al. 2002)

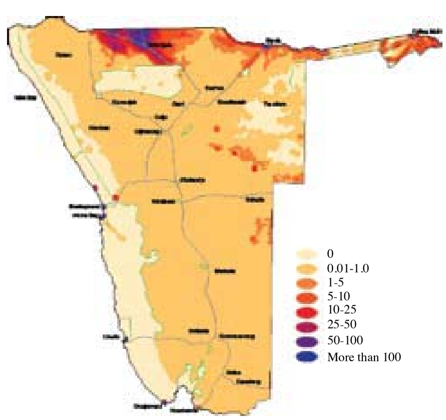

Figure 1.11: Shows the density of people across Namibia (Mendelsohn et al. 2002)

census. The northern part[13] of the country is still the most populous, hosting just over 70% of the total population (Figure 1.12). The two southern Regions, Hardap and Karas (Figure 1.12), only host about 8% of the total population (ibid.). Some 66% of the total population lives in rural areas (ibid.), while the poorest depend almost entirely on land and other natural resources (Mendelsohn et al. 2002).

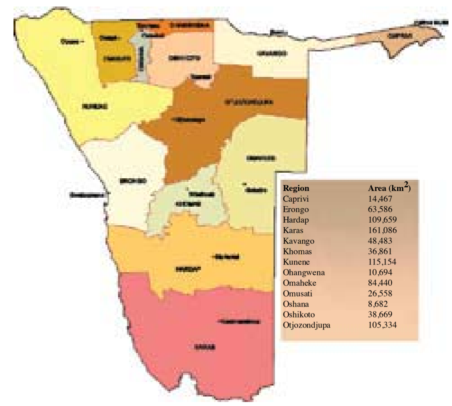

Figure 1.12: Shows the 13 regions of Namibia and their area sizes (Mendelsohn et al. 2002)

This dependency on land includes livestock and crop farming, harvesting of wild fruits and forest resources, and harvesting of wildlife and other fauna. As population increases, especially when alternatives to farming do not arise, unprecedented pressure on land will continue (Ashley 1994). Without the effect of population pressure Namibia's harsh climate, fragile productive land and water scarcity provokes land degradation (Seely & Jacobson 1994). Hence, including population growth, these encompassing factors restrict the land's already limited ability to provide life's staples even further, allowing it to support only a meagre population (Ashley 1994).

People place immense pressure on land resources. Such pressure depends on what people consume, how much they consume, and how it is produced. Given production efficiency, the same amount of natural resources can offer a livelihood to an increasing number of people. However, per capita consumption increases and population growth imply that limited resources provide for fewer and fewer people (ibid.). Livestock farming is important in communal areas and fulfils many functions: it provides meat and milk; it provides manure as fertiliser; it offers traction for ploughing fields; and it is a store of wealth and a mark of status (ibid.). The concern is that population growth is accompanied by growth in livestock populations,[14] which results in overgrazing and a general degradation of the land as the carrying capacity of the environment is exceeded.

Traditionally, Namibian pastoralists practised transhumance: the seasonal movement of livestock between pastures. All those years ago, population

Footnotes

[13] Including the Caprivi, Kavango, Kunene, Ohangewena, Omusati, Oshana, Oshikoto and Otjozondjupa Regions.
[14] In 1994, there were ten times more cattle in Namibia than in 1986 (Ashley 1994).

numbers were relatively low and communities inhabited areas near water resources (Mendelsohn et al. 2000). Nomadic pastoralists and their livestock in the southern and central parts of the country followed grazing pastures and water. Communities in the north were more settled, but relocated their herds temporarily to distant grazing areas after the wet season as palatable grass and water declined (Ashley 1994). Thus, intensive grazing periods were followed by periods of rest, allowing the grazing pasture areas to recover. However, the colonial regime disrupted these traditional practices for many farmers. Land enclosure and forced relocations required some communities to settle in specific areas, preventing them from moving as freely as they had before (ibid.). This led to year-round grazing near settlements.

This indicator attempts to show how Namibia's increase in population inevitably promotes land degradation and desertification in the country.

Description

This indicator uses population density (number of people per km²) to show the effect of population pressure on land degradation and desertification – especially in the northern Regions of the country, where population density and environmental dependency are particularly high.

Results and trends

The results presented incorporate the population projections made by the Central Bureau of Statistics (CBS 2003) for 2006 in order to show trends.

For the decade between 1991 and 2001, both the median and average population densities for Namibia increased, and an increase from that figure is expected for 2006 (Figure 1.13). For the decade in question, average density increased by 1.3 people per km² while median density increased by 0.4 people per km².

Nine out of Namibia's 13 Regions have rural populations exceeding 60% of the total population per Region (Figure 1.14). For Ohangwena and Omusati (Figure 1.12), rural populations comprise 99% of the total population (Figure 1.14). The majority of these rural communities are highly – if not entirely – dependent on land for their livelihood and income generation (see Indicator 1A above).

As is clear from Figure 1.15, the areas that experience the highest increase in population density are those with already high densities: Ohangwena and Oshana. Population density remained virtually

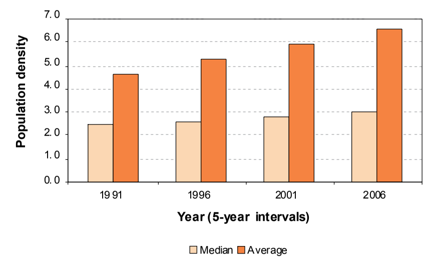

Figure 1.13: Population density for Namibia compared for all census years including projections made for 2006 (CBS 2003)

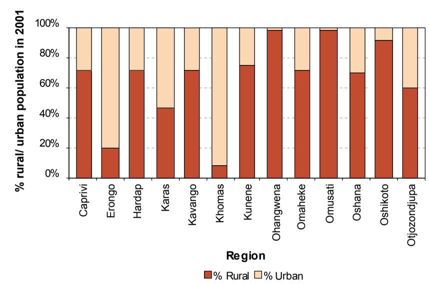

Figure 1.14: Rural and urban populations in 2001, given as a percentage of the total population per region in Namibia (CBS 2003)

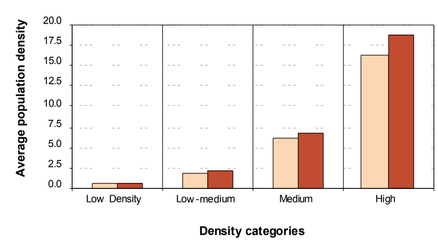

Figure 1.15: Shows population densities for Namibia for 1996 and 2001. See Annex 1.2 for regions categorised according to the 4 density categories

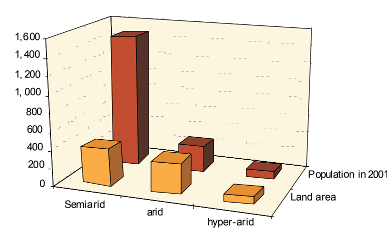

Figure 1.16: Shows a graphic for Namibia based on methodology used by the UNDP and World Resources Institute (WRI) (Murray et al. 1999) to show the dependence of people on drylands

unchanged in the low-density areas since 1996.

Figure 1.16 shows that 81% of Namibia's population is dependent on a semi-arid environment, which constitutes almost 50% of the total land area (approximately 826,000 km²). According to Murray et al. (1999), semi-arid environments have an aridity index[15] of between 0.20 and 0.50 (length of growing period: 60–119 days per annum).

Between 1996 and 2001, population density increased in ten of Namibia's 13 Regions (Figure 1.12; see also Figure 1.14 and Annex 1.1). Population density is generally low across Namibia, with Regions being categorised as follows:

1. Low density (0–1)
2. Low to medium density (0.5–4.5)
3. Medium density (4–10), and
4. High density (15–30).

Only two Regions are categorised as high density: Oshana – which includes Ondangwa and Oshakati, where density is between 100–300 people per km², and Ohangwena, which hosts the highly populated Cuvelai drainage area.

High population density is accompanied by a range of human activities[16] and suggests increased potential for irreversible land degradation (Murray et al. 1999). Pressures exerted in densely populated areas are associated with soil compression, prevention of filtration of water, diminishing productivity of topsoil, and soil erosion over time (Wolters 1994). Density in the Cuvelai drainage area continues to increase, as suggested by population growth projections until 2006 (Annex 1.2; CBS 2003), along a declining natural capital base. This, in turn, suggests unprecedented pressure on land will continue, which exacerbates land degradation and desertification. If no mitigation measures are implemented, communities will soon render land completely unproductive and, hence, degraded, and migrate to areas perceived to be resource-abundant.

Population pressure, therefore, in addition to Namibia's dry climate and marginal environment, contributes towards making the country susceptible to desertification.

INDICATOR 1D: Change in forest area

Introduction

How are forest area and biomass related to land degradation and desertification? To answer this question, let us first look at the extent of forests in Namibia and the importance of forest resources. According to Brown (1992) and Shanyengana (1994), Namibia, as a country characterised as both arid and semi-arid, does not have real forests. Some 80% of the country supports scattered shrubs and trees, while 20% is covered by dry woodlands, 29% by sparse savannas with thorn or mopane, and an additional 29% by sparse savanna but with scattered shrubs and trees. Approximately 12%, equivalent to 100,000 km², supports commercially exploitable timber (Brown 1992).

Rainfall, soil types and landscape are three important factors that influence the vegetation of Namibia (Mendelsohn et al. 2000). Since soil type and landscape are fixed temporally and spatially, rainfall becomes the main determining factor of the growth and abundance of vegetation in time and space. The three factors combined cause a gradient, such that plant life is tallest and most lush in north-eastern Namibia, becoming progressively more sparse and short toward the extreme west and south (Figure 1.17).
Rainfall in the country is characterised by a similar

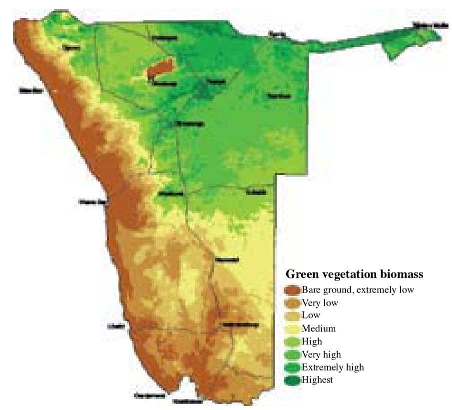

Figure 1.17: Shows the average vegetation biomass production in Namibia. A gradient running from northeast to southwest can be seen in terms of plant production and distribution (Mendelsohn et al. 2002)

gradient: the highest rainfall occurs in the north-east, and the lowest in the south and west. Due to the above vegetation and rainfall characteristics, forested areas are concentrated along the Caprivi, Kavango and Ohangwena Regions. The Grootfontein–Tsumeb–Otavi area is dominated by mixed tree-and-shrub savanna.

Forest resources are of vital importance where trees are in abundance in Namibia. Woodlands and savannas protect environmental stability – by stabilising fragile soils – and water resources. In addition, forest areas support a rich diversity of

Footnotes

[15] The aridity index is calculated as a ratio of mean annual precipitation (moisture gain) to mean annual potential evapotranspiration (moisture loss).
[16] Refer to farming and natural resources harvesting practices that are not sustainable in the long run.

biota, ensuring groundwater recharge and protecting dryland watersheds (ibid.). Forest areas are not only of environmental importance, however: the social and economic importance of forest resources is well understood, especially in northern Namibia. For decades rural Namibians have relied and still rely on forest resources for grazing; building materials for homesteads and kraals; wild foods; fuel wood for cooking, lighting and heating; shelter from the wind and shade from the sun; cosmetics; and medicines. Hence, the livelihoods of thousands of rural Namibians are directly dependent on the availability of forest resources.

Namibia currently faces deforestation at alarming rates. To a great extent, this can be attributed to the increase in human population (Mendelsohn et al. 2000, 2002; Shanyengana 1994), especially in the northern parts of the country. Shanyengana (ibid.) maintains that the rate of deforestation is directly proportional to population growth. Hence, as the population increases, so will the demand for available land for living and farming, and for forest resources to be used for fuel wood, building materials and crafts. How human population growth has affected forest resource can be seen in the following example:
Mendelsohn et al. (2000) highlight four areas in north-central Namibia that have suffered severe deforestation and land degradation over the past five to seven decades. Small-scale farming is practised by most, if not all, rural people in north-central Namibia and has a history as old as the country itself. However, as the population increased over the decades, so did the rate of land cleared for small-scale farming. Up until the 1940s, very little land was used for farming, especially in and around Okalongo and in much of the area around the Cuvelai system. Between 1943 and 1964, however, the areas cleared for farming in Okalongo and its surrounds increased at a rate of 9% a year. This corresponds to a 7.1% increase in household growth per annum for the said period. From 1964 to 1970, the number of households increased at 3.2% a year, corresponding to 2% of land cleared per annum. The rate of land cleared per annum continued at a rate of 2% until 1996, although the number of households increased at 2.1% per annum. By 1996, the area occupied by farms was estimated at 62%, while the remaining 38% could be characterised almost entirely as *oshanas* – where crops are not cultivated. The other three farming areas around 1) Okahao and Tsandi, 2) Onankali and Onyuulae, and 3) Okongo experienced similar rates of human population expansion and land clearance (Table 1.1; see also Mendelsohn et al. 2000:50 for further depictions).

Hugo Hahn, a missionary who lived in Namibia in 1886, recorded a 60-km-wide stretch of mopane woodland between the Uukwanyama and Ondonga kingdoms (Figure 1.18). Around 1936, the forest expanse was 40 km wide; by 1950, some 14 years later, it had already reduced to about 10 km (Shanyengana 1994). Today, the forest no longer exists – which is due to the increase in human population and the concomitant demand for forest goods and services.

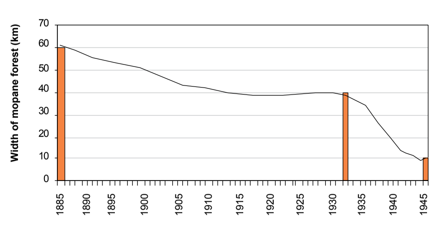

Figure 1.18: Shows the change in width of mopane forest (km) in northern Namibia (Shanyengana 1994)

The loss of vegetation caused by deforestation is rather obvious when one –

- compares images of preserved areas with those of areas with high human population density (e.g. the Ogongo Agricultural College versus surrounding areas/major towns, or the northern border of Namibia versus southern Angola), and
- looks at forested areas and how they change over time due to human settlement (see Mendelsohn et al. 2000).

Visualising deforestation by way of satellite images highlights the role of fresh water as a major limiting factor in semi-arid environments. Water determines the movement and settlement of people and livestock, and its abundance and longevity dictates the period of settlement and expansion of a certain area. The perennial rivers on Namibia's northern borders – the Kunene, Okavango and Zambezi – provide water security to people along with other ecosystem goods and services. Due to water security, communities have settled permanently and expanded along these rivers – and have caused the serious deforestation now under way. Vast areas of land are cleared for crop cultivation, and the demand for wood to be used for fuel, building materials and crafts is rapidly increasing against a declining resource base and increasing distance to the nearest harvestable trees. As a result of rapid deforestation, women in northern Namibia walk vast distances to collect wood or pay more for fuel wood than they once did (Shanyengana 1994). Thus, women spend increasingly more time away from home

Time period	Okalongo	Tsandi	Okongo	Onankali				
	% increase in household numbers	% land cleared	% increase in household numbers	% land cleared	% increase in household numbers	% land cleared	% increase in household numbers	% land cleared
1943-64	7.1	9	-	-	-	-	-	-
1964 - 70/72	3.2	2	4.2	<3	6.5	4.6	7.3	9
1970/7 - 2-96	2.1	2	2.0	2	3.2	3.6	6.8	7

Table1: Shows the % increase in household numbers along with % of land cleared for specific time periods (Mendelsohn et al. 2000)

to collect wood and water, and concomitantly less time providing food, rearing children and attending to general housekeeping.

The Illegal fencing-off of communal land, untimely fires, overstocking of livestock in small areas, and cutting down trees also contribute to the permanent denudation of some areas, leading to desertification. Communal farmers who are relatively well-off sometimes fence off 'their' communal land to prevent the resources being used by outsiders (ibid.). Consequently, the less advantaged overexploit forest resources in marginal areas, and smaller areas become congested with people. The Caprivi, Kavango, Ohangwena, Omusati, Oshana, and Oshikoto Regions are known for untimely forest fires that inhibit the natural regeneration of vegetation. Also related to the fencing-off of communal land is the overstocking of livestock in small areas: some communities have to share a small piece of land that bears large numbers of livestock. In such instances, the carrying capacity may already be exceeded by the human population alone – and yet it needs to support their accompanying livestock. As Shanyengana (ibid.) and Kambatuku (1994) point out, persistent trampling and browsing by livestock on new seedlings and growth undermine the resilience of plants and palatable grasses. Excessive tree-cutting not only results in the loss of soil stability, but also leads to an increase in river run-off and a decrease in water filtration to recharge groundwater resources. Exposed topsoil loses its moisture due to excessive exposure to solar radiation, rendering it infertile and prone to water and wind erosion (Shanyengana 1994). The brownish, muddy run-off observed downstream in ephemeral rivers such as the Kuiseb, Omaruru and Swakop is characteristic of severe soil erosion further upstream.

Description

This indicator presents changes in forest area and biomass over time as influenced by climatic conditions and human-induced pressures. The indicator is important because negative trends –

- show the contribution of deforestation to land degradation and desertification
- highlight the rapid decline of available forest resources, which threatens the livelihood of rural people
- suggest increased future rural–urban migrations as a strategy to cope with the loss of forest resources
- may suggest the severity of current and future threats to the agricultural industry, and
- emphasise present and future challenges for the Government in terms of national sustainable development goals.

Results and trends

In their qualitative assessments, many authors (e.g. Kambatuku 1994; Mendelsohn et al. 2000; Shanyengana 1994) relate deforestation directly to the population depending on forests for resources. Although natural processes accompanied by Namibia's dry environment and variable rainfall play a role in the abundance and availability of forest resources, it is ultimately people's dependency on such resources that drives the rate of deforestation. During the 2001 population and housing census, the rural population of Namibia was estimated to comprise 67% of the total population (down by 2% from 1996) (CBS 2003). Increasing rates of rural–urban migration have been observed over the past few years, as the younger rural population seeks better opportunities in major urban centres. However, the rural population still comprises in excess of two-thirds of the population.This report reiterates the population's dependence on natural resources. Forest resources in particular are in high demand due to their varied use. As the population increases, so does the demand for food, income, building materials, land for cultivation, and pastures for grazing. Clearing land for housing and cultivation can result in vast tracts being denuded (Figure 1.18). In 2000 it was estimated that only 18% of the total land cleared for cultivation had been used to grow crops. For various reasons, the remaining 82% lies abandoned. In some denuded areas, the topsoil has lost its nutrients to such an extent that crop cultivation is impossible. The total population is projected to increase linearly until 2021 (Figure 1.19). Although the rural population decreased between 1996 and 2001, the

Government's rural development initiatives are likely to slow down the rate of rural–urban migration over the next few years. This will retain a substantial number of people in the rural areas and, hence, will continue the serious pressures on forest resources. It is likely, therefore, that the average annual rate of deforestation (= 73,000 ha) will increase along with population growth.

The underdeveloped rural areas of Namibia are subject to severe exploitation so that domestic wood requirements can be met. In northern Namibia, the exploitation of forest resources is unplanned and easily spreads into communal areas. In areas where people have settled permanently near water resources, fuel wood exploitation is an acute problem. The increasing number of livestock, coupled with inadequate pasture management, results in serious overgrazing. Forests are characterised by poor regeneration, which is in turn linked to overgrazing and frequent fires – preventing recruitment and suppressing regeneration. Although fires are an integral part of the ecology of the northern Regions, they are destructive if not adequately planned and managed.

Population pressure is recognised as the main threat to our forests.

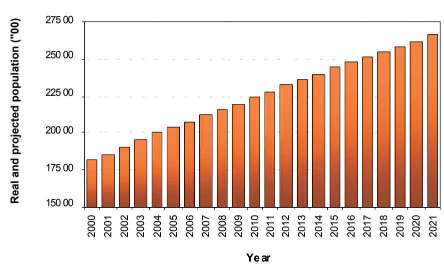

Figure 1.19: Shows Namibia's estimated (2000-2004) and projected (2005-2021) total population (CBS, 2003)

Recommendations

Monitoring and data collection

Namibia's Programme to Combat Desertification (NAPCOD) has done an immense job to establish programmes at local and national level to monitor land degradation. However, it is recommended that –

- such programmes be supported by enough fieldworkers for the actual data collection
- the coverage of the monitoring programme be representative of Namibia
- data generated be stored and managed in an adequate system, and
- regular reports or briefs stem from the latter processes.

If these aspects are in place for monitoring desertification, it will ensure a sufficient sector contribution to annual or periodic integrated environmental assessments and reports. Unfortunately, the Desertification Index could not be presented in this report due to a lack of regular data input into NAPCOD's Land Degradation Information System (LDIS) and human resources for the annual update of the Index. The LDIS produces results via maps and is a very functional and practical tool, not only to visualise the effects of desertification, but also to make the phenomenon easily interpreted by the layperson. It is further recommended that the MET's Directorate of Environmental Affairs takes ownership of the LDIS as well as the responsibility of updating it and providing current information to the general public.

Regarding ongoing monitoring, it is recommended that a thorough review of existing monitoring programmes be conducted to ensure that the measures give a true and reliable picture of what is happening to Namibia's environment.

Stakeholder commitment and cooperation

Land degradation and desertification are adequately recognised in Namibia, and through donor support it has been possible to embark upon efforts to combat these phenomena. Thus far institutional memory has been built, and stakeholders have been brought in for substantial multidisciplinary cooperation and to develop a variety of resources to ensure the efforts to combat desertification are continued. However, stakeholder commitment can be inconsistent, and Government has not yet established a dedicated Division that could adequately target these environmental problems. Many of the concepts and plans to improve combating strategies still rely heavily on the generosity of international donor organisations. For a problem so huge and unforgiving in the midst of Namibia's harsh climate and environmentally dependent rural population, Government should by now have taken full ownership of it. Yet, funds allocated for research are still insufficient, which hampers the ability of field and technical staff to perform optimally. Since these phenomena affect so many Namibians, they deserve high priority and need to be tackled collectively by every citizen.

Policy and decision-making

Land degradation and desertification are intersectoral issues that need multidisciplinary inputs from a range of stakeholders. This has been initiated through NAPCOD, although stakeholder participation can be improved. As a follow-up to this report, and as strongly advocated by the United Nations Environment Programme, the lead organisation dealing with this issue needs to arrange a policy review session. This is necessary since the results of this report may prompt urgent action or intervention regarding our efforts to combat desertification. A cross-sectoral policy review team needs to be established to thoroughly review all policy and related tools currently being used and implemented. As the environment changes, so must our approaches and strategies.

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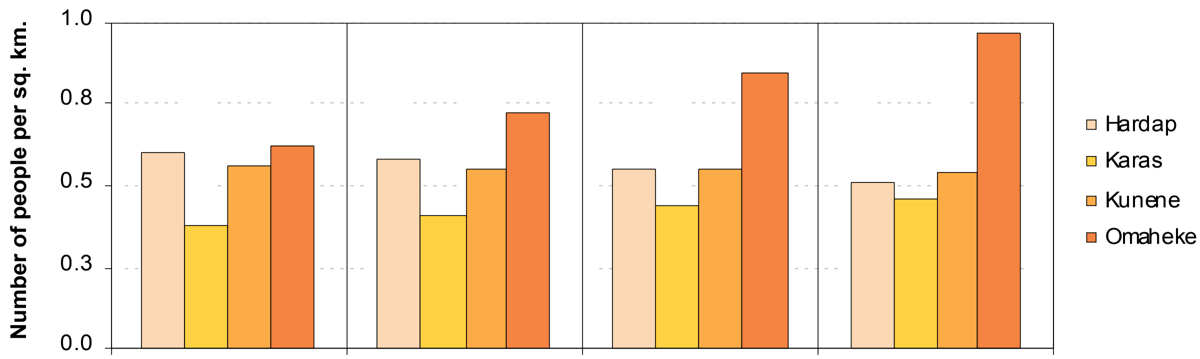
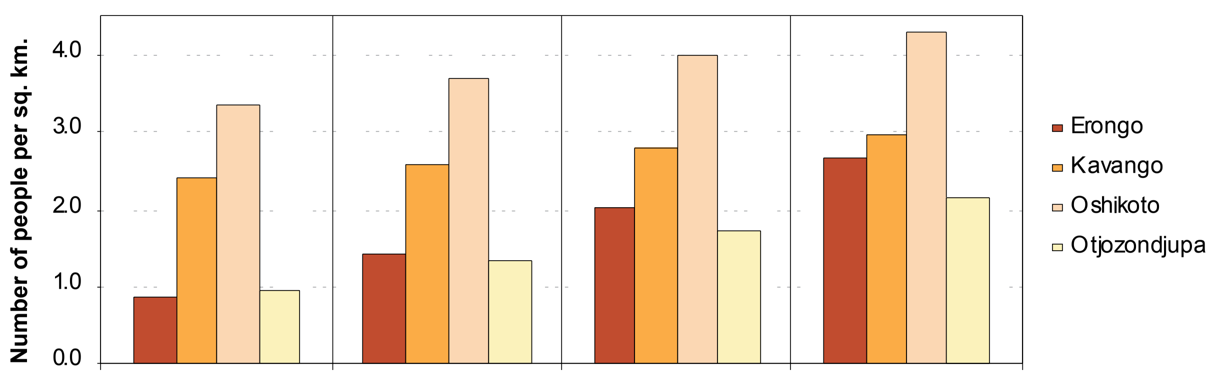
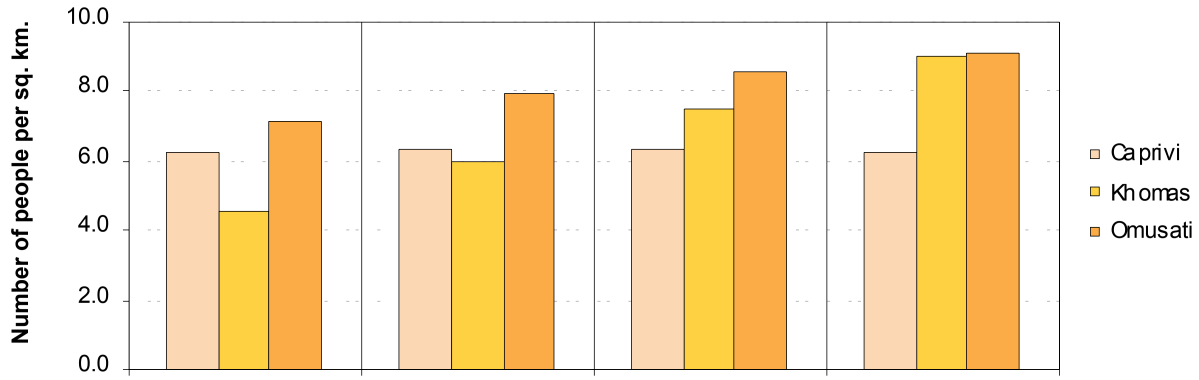
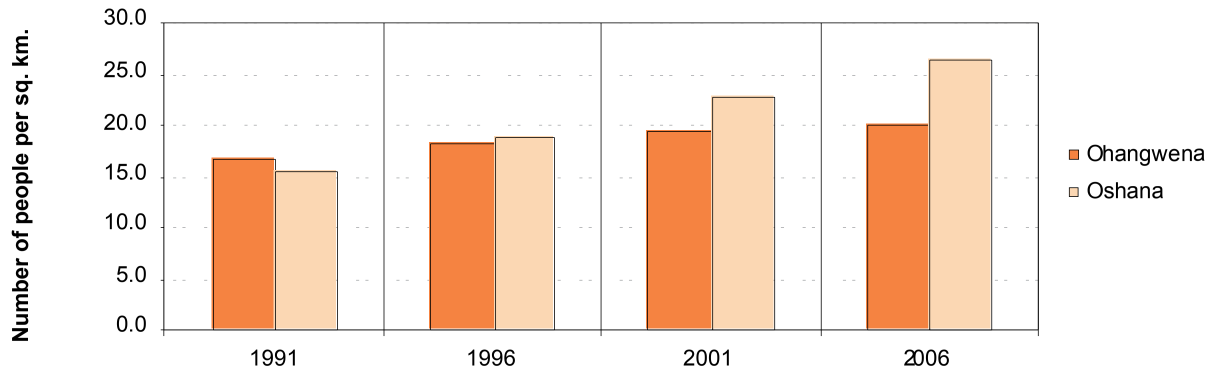
Annex 1.1: Average population densities

Average population densities were calculated for each region for the 5-year intervals given below. Regions were grouped based on their minimum and maximum densities as follows: 1) 0-1 people/ km², 2) 0.5-4.5 people/ km², 3) 4-10 people/ km² and 4) 15-30 people/ km²






Number of people per sq. km.
10.0
8.0
6.0
4.0
2.0
0.0
Caprivi
Khomas
Omusati


Number of people per sq. km.
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1991
1996
2001
2006
Ohangwena
Oshana

Chapter 2: Status of biodiversity

Introduction
Chapter overview
Assessment of indicators
Recommendations
References

Introduction

Biological diversity – or *biodiversity* – is defined as the variability among, within and between organisms from terrestrial, marine and other aquatic ecosystems and their ecological complexes (UN 1994). It is the essence of human survival as it provides necessities such as food, shelter and medicine to the majority of inhabitants of this planet. In 1998, the United Nations (UN) estimated that 24% of the world's population lived in absolute poverty, i.e. people living on less than one United States dollar a day. Sub-Saharan Africa was considered the worst-case scenario, as 46% of its population lived in absolute poverty (UN 2001a). In poverty-stricken areas, biodiversity often contributes to sustainable livelihoods as it represents 'natural capital' that gives economic value to direct and indirect uses of biodiversity (Koziell 1998). Although poverty per se does not cause biodiversity loss, it can lead to depletion of natural resources and, together with an increasing population growth rate, can increase the rate at which biodiversity is lost.

Namibia's distinctive biodiversity is a result of a combination of geological history and climatic conditions (Mendelsohn et al. 2002). Geological processes placed various rock formations that –

- provide important minerals
- produced soils that vary in structure and fertility
- determine the type of plants present, and
- shaped the landscape.

Plant life, in turn, influences the abundance and diversity of animal life. Nonetheless, the climatic conditions have a major effect on the type of life found in Namibia. Years of aridity allowed speciation and evolution to take place, and shaped the biological diversity in Namibia, primarily containing arid, semi-arid and dry-subhumid ecosystems (Barnard 1998; Mendelsohn et al. 2002). Some 85% of the country is arid (annual rainfall <200mm) to semi-arid (maximum annual rainfall <800mm) (Barnard 1998; Mendelsohn et al. 2002) and is, therefore, considered highly susceptible to land degradation (UN 2001b). In addition, water, a key limiting factor that affects biodiversity composition, structure and functioning (Scholes & Walker 1993), also influences the abundance and diversity of species as well as human development.

As an arid country, Namibia has a relatively low number of species compared to more mesic ecosystems (Barnard 1998), but it possesses a high level of endemism (Simmons et al. 1998). The greatest overall terrestrial species diversity is found in the more moist and tropical areas in north-eastern Namibia, as well as central Namibia and the smaller highlands in the south-west that support very high numbers of species (Mendelsohn et al. 2002). In contrast, the more arid western zone of the country is home to most endemic species, being concentrated in the Namib lowland, the escarpment and the highlands (ibid.). According to Simmons et al. (1998) and Mendelsohn et al. (2002), the high level of endemism in Namibia may have been influenced by climatic conditions such as alternating wet and dry cycles over the past 20 million years. Endemics have small distribution areas and are, thus, more vulnerable to extinctions when pressures such as alien invasive or habitat destruction take place (Ricklefts 1996; Simmons et al. 1998). Conservation efforts focused on high endemism areas, therefore, are essential in reducing global loss of species. Plants, invertebrates, reptiles and frogs in Namibia were found to be high in endemism (>10% of total respective species), while endemism for mammals, birds and fish was found to be relatively low (below 10% of total species for each) (Simmons et al. 1998). Endemism for all known vertebrates and plants is closely associated with rocky substrates, while endemic insects and arachnids are associated with gravel plains and sand dune movements (ibid.). Namibia's two hotspots, the Succulent Karoo biome in the south-west and the Kaoko area in the far north-west are also located within this endemic zone (ibid.; Maggs et al. 1998). Hotspots are defined as areas of high endemism and species richness.

Climate, soil type, altitude and topography also affect vegetation type. Namibia has 29 broad vegetation types that are grouped into five major ecological communities. Such communities, also known as biomes, are classification systems that help us understand the structure and functioning of large ecological systems. Biomes are also easily recognisable by their distinctive vegetation, and the fact that the characteristics of one biome usually integrate gradually into the next (Ricklefts 1996).

What causes the phenomenon?

Although Namibia's climate has created different levels of species distributions across the country, the harsh dryness also poses a threat to biodiversity. An increase in dry climatic conditions can intensify land degradation and desertification in areas that are poorly managed and overutilised, thus leading to problems such as overharvesting of scarce natural resources and food insecurity. According to Barnard (1998), the biggest threats to Namibia's unique fauna and flora are rapid population growth and human development, which often results in habitat conversion of natural areas. The conversion of natural land to agricultural land, poor land management, and inappropriate development of infrastructure are primary threats to plant diversity (Maggs et al. 1998). Other threats to biodiversity include bush encroachment, which leads to the reduction of woody tree diversity (Barnard 1998), alien invasive species, and habitat conversion of wetlands, because 10% of mammals are dependent on freestanding water and a further 10% are dependent on or restricted to wetland habitats (Griffin 1998). Globally, land-use change, climate change, nitrogen deposition, introduction of alien species, and increasing levels of atmospheric CO_2 are predicted as the main threats to loss of biodiversity (Sala et al. 2001). Habitat conversion, alien invasive species and bush encroachment are some of the greater threats that Namibia is facing.

Habitat conversion

Biodiversity is largely under threat because of increasing pressures on the environment, which is mostly caused by human beings. Several authors affirm that the primary cause of loss of biodiversity is habitat transformation of natural areas, which is a direct result of the expansion of the human population and its activities (Baskin 1997; Erhlich 1989; Norgaard 1989; Sala et al. 2001; Wilson 1989a). Land-use change, collectively with change in social standards and improved technology, are thought to increase the rate at which biodiversity is lost (Norgaard 1989). Natural areas are being transformed to large-scale agricultural land, which results in homogenisation, i.e. a reduction of diversity (Baskin 1997; Norgaard 1989). The building of houses and roads transforms natural areas into urban areas in order to accommodate the increasing human population (Murphy 1989). The destruction of habitats is thought to be the major cause of biota extinctions. Habitats are reduced to small patches, reducing species' natural home ranges. These small patches or fragments become similar to island biogeographical systems, which are known for their higher extinction rates (Wilson 1989a). Although extinctions are a natural occurrence, previous mass extinctions have shown a pattern of long biological stability followed by sudden mass die-offs of species (Raup 1989). The current permanent loss of species is occurring at a rapid rate and it might result in the biggest cataclysm of all time (ibid.; Baskin 1997; Wilson 1989a, 1989b).

Alien invasive species

Alien invasive species are species introduced, either deliberately or accidentally, into areas where they have not formerly occurred (Elton 1958).

Alien invasive species further reduce biodiversity and are predicted to become the second-largest threat to biological diversity in the future (Sala et al. 2001). Although some (e.g. Barnes & De Jager 1996) believe invasive alien species to be enriching the diversity of certain areas, many such species are pests and can cause major economic damage (Mooney 1989). In some cases, they can actually reduce diversity by out-competing indigenous species.

Bush encroachment

Bush encroachment, the increase in the extent and density of woody vegetation, is a common problem in savannas and is economically damaging. *Savanna* is a biome co-dominated by grasses and trees (Scholes & Walker 1993). The causes of bush encroachment are still obscure. However, the lack of determining factors that control the balance between trees and grasses are attributed to the increase in the woody component in an area (Van Rooyen 2002). Determining factors that play a role in bush encroachment include reduction in veld fires, and replacement of wild herbivores by large herds of domestic herbivores. Restriction of movement of herbivores by fences, poor grazing management, artificial water points, and human disturbances are often also cited as reasons for an increase in woody plant density (ibid.). Bush encroachment intensifies soil erosion and surface water run-off, and decreases the grazing capacity of an area for decades.

What is the extent of risk caused by the phenomenon?

On average, Namibia accommodates 2.1 people per km^2, but the population is unevenly distributed.

Approximately 70% of the 1.8 million people live in rural communities (CBS 2003), and depend heavily and directly on biodiversity for their survival, especially in the northern part of the country, which accommodates about 11.65 people per km^2 (Mendelsohn et al. 2000). Firewood, medicinal plants, construction materials and veld foods are just some examples of the biodiversity that rural communities use as substitutes for a lack of financial resources and infrastructure (MET 1999a, 2000). The lack of water, human population pressure, and the annual population increase of 2.6% (GRN 2002) collectively place Namibia's biodiversity under pressure from the various forms of land use. Pressures include land clearing, expanding agriculture, deforestation, poaching, and habitat degradation through poor land management and unsustainable use of natural resources – all of which eventually cause land degradation and desertification (MET 1999b, 2000). Consequently, a loss of biodiversity could exacerbate poverty, leading to an increased dependence on the remaining natural resources in a negative feedback spiral, and eventually to urban migration, which further reduces the quality of life – especially with high-density housing.

International Conventions

Namibia ratified the United Nations Convention on Biological Diversity (UNCBD) in March 1997 as a means of protecting the abundance and diversity that so many Namibians directly depend on for their livelihoods. The UNCBD objectives are to conserve biological diversity, use it in a sustainable manner, and ensure the fair and equitable sharing of its benefits in the utilisation of genetic resources (UN 1994, 2001b). The UNCBD also urged that, in order to meet the UNCBD objectives, developed countries should assist their developing counterparts by investing in national reporting and monitoring projects and programmes and/or to support capacity-building (UN 2000a). It additionally requested signatory states to develop a set of principles to design national monitoring programmes based on indicators in order to assess the status and trend of biodiversity at all levels: species, ecosystem, landscape and genetic. Other commitments include national reporting on the implementation of the objectives of the Convention, promoting public awareness on the environment, conducting environmental assessments, and cooperating with other technical and scientific institutions (UN 2000a, 2000b). The UNCBD reporting framework is obligatory to signatory countries and is to be developed within the UNCBD targets. The UNCBD aims to reduce global biodiversity loss significantly by the year 2010, while the WSSD implementation plan targets 2015 as the year by which biodiversity loss needs to have been stopped.

Chapter overview

Namibia's unique landscapes and contrasting environmental phenomena are home to a wide variety of plant and animal species. Some (e.g. Simmons et al. 1998; Smit 2002a, 2002b; Venter 2002) have described the biodiversity as being largely intact, although the current under-representation of the national Protected Area Network (PAN) may pose the biggest threat to endemic, near-endemic and threatened species. Knowledge about the status of species under major taxonomic groups is still limited for some groups, and efforts are continuing to increase our knowledge base regarding the conservation and endemism status, abundance and distribution of species. The lack of quantitative information has made this assessment rather incomplete. However, this report built on available information as presented by Barnard (1998) and other sources. A number of initiatives are either already under way or are planned for the near future to ensure the continuous expansion of our knowledge base.

Coastal development

This indicator was designed to use the abundance, distribution and conservation status of particular specie as a measure of coastal development. Namibia's approximately 1,500-km-long coastline is home to an enormous assemblage of birds, most of which are particularly popular. At the time this assessment commenced, no indicator species had been used; however, a proxy was used to demonstrate the use of possible species. Coastal development is a reality in and around Namibia's five coastal towns. In these areas, development entails the promotion of the Economic Processing Zone (EPZ) as a gateway for regional/global trade, the recent prioritisation of aquaculture development, coastal urban population expansion due to migrations, real estate development, tourism development, and increased naval traffic. Major structural development activities usually encompass large areas of land that may be home to several species. The impact of such development affects biodiversity not only in terms of physical habitat destruction, but also through water, air, soil, and noise pollution and the impairment of ecological processes. The lack of thorough EIAs will overlook the sensitivity of an area, its biodiversity, and its ecological processes. Legislation that requires a thorough EIA and its appropriate enforcement is currently not in place, which allows for discrepancies in these EIA processes. Based on the proxy used for this indicator, development affects the biodiversity of the coast. The linear density of feeding birds was surveyed, and a comparison was made between those feeding within and those feeding outside diamond mining areas in south-western Namibia. According to the survey, the linear density of feeding birds is higher outside the diamond mining area. This may suggest a lower abundance of food and habitat destruction inside such areas. The proper selection and testing of other indicator species may reveal more in-depth results about the effect of coastal development. The entire coastal strip is under some degree of protection by law, but the degree to which biodiversity is being conserved is questionable in the absence of rigorous monitoring and enforcement.

Threatened and extinct species per major taxonomic group

This indicator serves to offer information about the current percentage of threatened and extinct species per major taxonomic group, i.e. insects, mammals, freshwater fish, reptiles, birds and amphibians. The percentage expressed as threatened or extinct species per major taxonomic group should be monitored and recorded annually, with specific notes on a particular threatened or extinct species. Due to the lack of information and data, numerous gaps still exist when it comes to defining the conservation status of major taxonomic groups and species under severe threat. For those groups for which data are available, a short summary is presented regarding the number of species under threat. The most common threat is habitat degradation. Many of the groups are not adequately presented within the current PAN.

The PAN also does not adequately cover all centres of high **plant** diversity and endemism in Namibia. Of the 13 main vegetation types identified by Giess (1998), 8 include protected areas and some of these represent less than 5% of the vegetation type. Areas of high human density where plant resources are heavily utilised and areas of immense botanical importance are at great risk of habitat degradation. The greatest threat to **insects** is thought to be wide-scale habitat conversion, although the lack of information on insects makes it difficult to conduct a comprehensive analysis on this. **Freshwater fish** species occurring in the country's perennial rivers are threatened principally by habitat destruction, overfishing, introduction of alien species, poor river catchment management, and water abstraction. Information deficiency causes an increasing gap when it comes to knowledge about **fungi**, **arachnids** and **lichens**: all three are rather poorly known and actual threats cannot be comprehensively analysed. While **amphibians** are poorly represented in the PAN, less than 2% of all endemics are threatened. The conservation status of large **mammals** is better known than that of small mammals. Much confusion still exists about the taxonomy of smaller mammals, which might make it difficult to assess a particular species' conservation status. More than 18% of the mammals are threatened, with less than 1% of the endemic mammals threatened and about 2% being extinct. Major threats to mammals include habitat destruction and conversion. **Birds** are potentially the best-known faunal group in Namibia and have been extensively researched over the years. Some 3% of all birds are extinct, 13% are critically endangered, while 27% are vulnerable. Birds occurring in wetland and coastal habitats are the most threatened groups, while actual threats are habitat degradation, poisoning and hunting.

Selected endangered habitats

Sensitive habitats have not been identified for most of Namibia. Some ecologically sensitive areas fall within the PAN, while four areas have been declared as Ramsar wetland sites. Although Namibia's PAN currently covers more than 20% of the country's total land surface area, this does not imply that all endemic species, ecological hotspots and sensitive areas are adequately covered. Namibia's terrestrial endemism is largely distributed in a band stretching from the north-west to the south-west of the country. High endemism occurs in the dry central and west-central parts, in and around the Etosha Basin area, and in the dry north-west of the country. The fact that so many endemics occur in hilly western and dry areas suggests that most of these species evolved over the past 20 million years. This spatial pattern of endemism also reflects the importance of arid habitats in supporting specially adapted and unique species found only in Namibia.

Barnard's (1998) work highlighted a number of high-endemism areas in need of urgent protection and conservation. This report reiterates the urgent need to include such areas under the current PAN. Future work should aim at demonstrating the spatial distribution of threatened endemic species, in order to enhance decision-making regarding their explicit protection.

Due to the lack of capacity for periodic field monitoring and surveying, data generation is slow and hinders the process of thoroughly evaluating the conservation status of endemic species. Such species occurring in and outside the PAN are continuously under threat of population expansion, deforestation, urban and rural development, land degradation, marine habitat degradation, and marine pollution. Periodic monitoring and regular updating of species and habitat inventories will aid in assessing Namibia's biodiversity and providing appropriate information for decision-makers. This is an urgent matter in Namibia.

Invasive, alien, and invasive alien species

Namibia is currently in her infancy when it comes to quantitative information about invasive, alien and invasive alien species. Species that are both alien and invasive or rigorously invasive pose threats to ecological, economic and human health, and the lack of information about their potential threats put us in a less responsive position. Such species currently impact on the ecology and biodiversity of sensitive and rather resilient areas. The invasion of alien bush-encroaching species currently costs Namibia millions of dollars. There may be other, currently undetected invader alien species that impair ecological processes, cause human harm, and affect our economy. Although scientists are unable to pinpoint specific large threats at this time (apart from bush encroachment), it is important for Namibia to put all the instruments – legal and scientific – in place to adequately combat any future threats. A workshop held in 2004 set the stage for commitment toward implementing the required legal and scientific tools to –

- compile inventories of and categorise such species
- draft, approve and effect the necessary legislation regarding the importation, breeding, harbouring and trade in such species, and
- regularly monitor the situation and enforce the law.

Assessment of indicators

INDICATOR 2A: Coastal development

Introduction

Namibia's coastline is sparsely inhabited, but the five major towns welcome development initiatives for economic and socio-economic benefit. *Coastal development* is defined by this report as the expansion of town boundaries due to migration, physical and infrastructural development, the invasion of environmentally sensitive areas, the commencement of activities that generate sources of pollution that affect the environment and living resources, and the expansion of existing industrial activities.

With a growing population accompanied by growing demands for food, shelter and jobs, the environment runs the risk of being degraded or overexploited with a consequent loss in numbers within species, reduction of their geographic ranges, and a general loss of biodiversity and habitat. Following Independence, the Namibian Government emphasised the positive characteristics of the country to attract foreign investment for development (Tarr & Figuiera 1999). Such characteristics include prevailing peace and stability, infrastructure, the well-developed ports and harbours that serve as gateways to the southern African subregion, and the wide open spaces that can be earmarked for structural development. Thus far, many projects have been established and are planned to be close to very sensitive areas such as river mouths, wetlands and the coast (ibid.) In addition, coastal settlements have seen increases in human population over the past few years as rural people seek better opportunities in urban centres (ibid.; CBS 2002). The informal settlement and initial joblessness of migrants pose serious challenges to the environment and social dynamics of the towns affected. Littering and the lack of sanitation facilities are major concerns, along with the fact that areas of informal settlement are not necessarily allocated by authorities. The area between Swakopmund and Walvis Bay is home to the largest populations of resident and migrant birds along the coast (Tarr & Figueira 1999). The demand for residential erven, especially in Swakopmund, may prompt housing development schemes toward Walvis Bay – thus conflicting with the feeding, nesting and breeding grounds of birds like the near-endemic Damara Tern. Also see figure 2.1

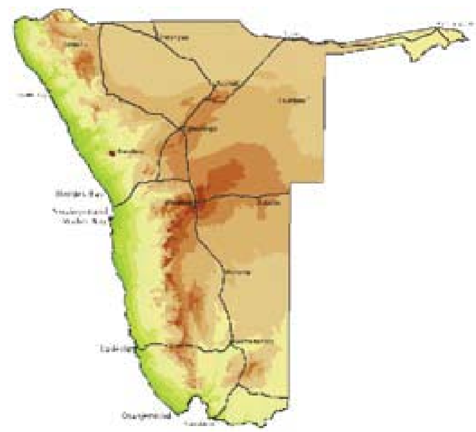


Figure 2.1: Shows the five towns along Namibia's coast (Mendelsohn et al. 2002)

Ideally, indicator species for which abundance, geographical occurrence and migratory paths are known should be selected and monitored to show changes in the coastal environment. At the time of assessing this indicator, none such species had been pre-identified, thus posing further challenges to this task. With the assistance of Dr Rob Simmons, an ornithologist with the MET at the time (2004), we were able to use a proxy to show the use of indicator species in such an assessment. His work did not use any one particular species, but observed the density of a number of feeding birds in and outside the diamond mining areas in southern Namibia. An elaborate account of his study features under the "Trends" section later in this section.

Protection of the coastline

Almost the entire coastline is protected. The Skeleton Coast Park (17,450 km^2) along the northern coast stretches southward from the Kunene River to the Ugab River; the National West Coast Recreation Area (7,800 km^2, including the Cape Cross Seal Reserve) stretches from the Ugab River to Swakopmund; the Namib Naukluft Park (49,768 km^2) lies between Sandwich Harbour and Hottentot's Bay; and the recent declaration by Parliament of the Sperrgebiet as a State-protected area that stretches from Hottentot's Bay to the Orange River (Maartens 2003). Namibia and South Africa also concluded a Memorandum of Understanding on 17 August 2001, in terms of which they established the Ai-Ais–Richtersveld Transfrontier Park.

Thus, the total reach of State-protected areas along the coast amounts to over 100,000 km^2 – representing 12% of the country's land surface area. However, the National West Coast Recreation Area carries a lower conservation status than the others, and is subjected to heavy recreation pressure by holidaymakers. This area coincides with expansive lichen fields and bird nesting grounds (Maartens 2003). With the recent declaration of the Sperrgebiet as a State-protected area, it is foreseen that the areas around Lüderitz and Oranjemund will also be managed for conservation.

The coastline is also home to several coastal wetlands that can be regarded as important and sensitive. Wetlands are usually bird hotspots and host a splendid array of biodiversity. Namibia is committed to manage and protect such areas, which include the Kunene River mouth, the Cape Cross lagoon, the Mile 4 salt works, the Walvis Bay wetlands, Sandwich Harbour, the Lüderitz lagoon, and the Orange River mouth (Barnard 1998; Tarr & Figuiera 1999). The Ramsar Convention caters for such areas and articulates the need to preserve biotic diversity, monitor life-support systems, and ensure the sustainable use of the resources (Tarr & Figuiera 1999). However, only the Walvis Bay lagoon and Sandwich Harbour are declared Ramsar sites (ibid.).

Coastal development in Namibia and perceived impact on biodiversity

Diamond mining is popularly associated with Namibian industry. This activity has existed since 1908, after the first diamond was discovered in the Sperrgebiet in south-western Namibia (ibid.). Ever since, mining has continued to be an environmentally degrading and invasive activity. The biggest single operation is Mining Area No. 1 (MA1), which lies north of Oranjemund, along Namibia's south-western coast. This operation is associated with degradation of tremendous magnitude – some to an irreparable extent. Tarr and Figuiera (ibid.) report that the former intertidal zone, covering 110 km in length and 300 m in width, has been completely removed with its biodiversity; today, only barren bedrock remains. The magnitude of operations in MA1 has been so great and of such a long duration that significant rehabilitation at this point is impossible because no money has been set aside for it. In some areas, un-maintained seawalls that were used to push the ocean further offshore allowed natural reclamation by the ocean and it is hoped that biodiversity will return through natural processes (ibid.). It is ironic that such mass environmental degradation is flanked, to the immediate east, by the Sperrgebiet, an area of pristine and expansive landscapes inhabited by impressive biodiversity.

Diamond mining activities have also been under way in the Skeleton Coast Park since the early 1980s, despite its status as nature reserve. Mining operations in the Park have shown no regard for the environment. Mining officials drove wherever they pleased, and engaged in recreational angling, private tourism, excavation of trenches, and littering (ibid.). It is now more than ten years since the mines have closed, but the area bears remnants of severe degradation. As Tarr and Figuiera (ibid.) point out, "Decades of mining have violated the beauty and wilderness atmosphere of the Skeleton Coast Park …".

Fishing is the second-largest activity along the coast and, apart from recreational angling, the shore-based impact is quite localised. Large-scale commercial fishing occurs offshore, while the landings are processed onshore at facilities in Walvis

Bay and Lüderitz. The fish-processing industry is highly regulated and issues like waste management and pollution have never surfaced as serious concerns. The "Harvesting of marine resources" indicator (Indicator 4C, Chapter 4) addresses the history of exploitation of fishery resources, current trends, and future prospects.

Tourism also challenges the integrity and health of the environment and its inhabitants. Tarr and Figuiera (ibid.) have categorised eight activities with varying degrees of impact on the environment: shore-based angling, ski-boat angling, nature tours, general leisure, off-road driving, paragliding, crayfishing, and pleasure flights. Each of these activities involves at least 1 or even up to 11 possible impacts that are rated as *high*, *medium* or *low*. High-impact activities refer to current serious problems that warrant immediate attention.

Description

This indicator aims to identify certain indicator species that can be used to assess coastal development and its impact on the environment. Increases or decreases in numbers and distributional ranges of such species may suggest the extent of coastal development and its impact.

Trends

Simmons (2003) has used the linear density of feeding birds per kilometre to assess the impact of mining in the Sperrgebiet. By doing so he compared numbers of birds per 10 km in the same sandy beach (or sandy beach with kelp, or rocky beach with kelp habitats) inside and outside the Sperrgebiet. The linear density was lower inside the mining areas than outside, and the number of species (however common they were) was also lower inside.

It is well known that mining activities can alter landscapes severely, along with the degradation of ecosystems and habitats. Simmons' (2003) work suggests coastal development has reduced the distributional range and numbers of birds occurring within the Sperrgebiet. Similar surveys around Lüderitz, Swakopmund and Walvis Bay may show similar results. Infrastructural development/expansion has taken place in coastal towns, but whether or not this has affected endemic species needs to be determined.
Namibia's fishing industry has shown no significant physical expansion over the past ten years, and records on biodiversity have not reported the threat of extinction of any marine species. Black cormorants are good indicators of the wealth of fish fauna, but it cannot be inferred from this that they are an index of coastal development.

INDICATOR 2B: State conservation areas

Introduction

What is a conservation area and why are such areas important?
In layperson's terms, this report defines *conservation area* as a geographical area, be it land, water or a combination of both, identified for the management and protection of biological diversity, landscapes and human culture. According to Brown (1992), it is essential to protect Namibia's rich biodiversity, landscapes and human culture. He notes that such encompassing conservation needs to be regarded as a fundamental component of our legacy for future generations. As Brown (ibid.) points out, Namibia's rich biodiversity is important for the following reasons:

- It represents an irreplaceable portion of global biodiversity
- It serves as a major attraction for tourists
- It provides numerous Namibians with recreational, research and educational opportunities
- It contributes to Namibia's characteristic ambience, and
- Most importantly, it forms the backbone of the country's subsistence and market-based economies.

Because human populations exert severe pressures on the natural environment, the protection of special places and ecological areas needs to be considered in a multifaceted approach if we are determined to conserve our natural heritage. Post-Independence conservation approaches need to be considered on a case-by-case basis, due to the overlapping occupancy of humans and important or threatened flora and fauna species and ecological areas and landscapes.

The PAN was established in 1907. By Namibia's Independence in 1990 the PAN consisted of 14 protected areas, covering 13.1% of the total land mass (Barnard et al. 1998; Brown 1992). Protected areas were designed with short-term political considerations in mind, and to cater for the recreational needs of foreigners and minority populations (both ibid.). Due to Namibia's uneven distribution of biodiversity (Barnard 1998) some protected areas are not representative of regional diversity; nor are they appropriate for the protection of the systems they represent (Brown 1992), e.g. the allocation of desert land for conservation because it was alleged to have little other value (Barnard et al. 1998).

The Namibian Government aims to protect special areas that are representative of the landscapes and ecological diversity of the country. In this light the long-term goal is to allocate 10% as protected space for each vegetation type, with a representative selection of special features (Brown 1992). It is also thoroughly acknowledged that humans and wildlife compete for the same resources; so the involvement of local communities in conservation efforts that they agree with is essential. A more open approach to conservation has been developed in Namibia: natural corridors for game migrations have been reinstated, community members participate in monitoring, and conservancies have been expanded. As local people develop more awareness about their environment and the benefits of its protection, they are bound to be more supportive and involved in conservation efforts.

This indicator features an analysis of the current PAN while pointing out areas where conservation is needed.

Current area under State protection

Namibia has 21 proclaimed nature reserves or national parks (Figure 2.2), which together constitute 14% of the total land surface area (MET 2000). These range from the huge Namib–Naukluft (49,768 km^2), Etosha (22,270 km^2) and Skeleton Coast (16,390 km^2) National Parks to the smallest, Popa Game Park (0.25 km^2) (Barnard 1998; Maartens 2003; MET 2000). With the recent declaration of the Sperrgebiet as a State-protected area, the total PAN amounts to 22.9% of Namibia's land surface area. The Sperrgebiet is currently the largest coastal national park in Africa, covering 72,600 km^2. Many declared conservation areas have more or less the same status (although the West Coast Recreational Area has lower conservation status), including various State forests that have not been formally proclaimed. In addition, two wetland habitats, the Walvis Bay lagoon and Sandwich Harbour, are protected under the Ramsar Convention and are especially important for the large number of birds that occur there (Maartens 2003). Other wetlands for which Ramsar status would be beneficial include the Kunene River mouth, the Orange River mouth, the Cape Cross lagoon, the Mile 4 salt works, and the Lüderitz lagoon. Trends in the geographic location of the proclaimed parks are discussed later herein.

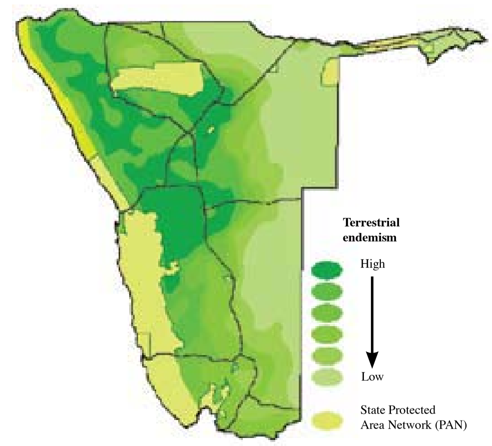


Figure 2.2: Shows the State PAN versus the overall terrestrial endemism in Namibia (Mendelsohn et al. 2002)

The CBNRM Programme

Namibia currently has 31 registered communal conservancies, covering more than 9% of the country's total land surface area. This number is expected to increase as more conservancies keep emerging. These conservancies occur in 7 of the 13 Regions. Conservancies in the Kunene Region occupy 32% of the total area of that Region, which extends across the desert, desert–savanna and savanna biomes in the north-west of the country. According to the biome classification provided in Mendelsohn et al. (2002), this will cover the Namib Desert, Nama Karoo, and tree-and-shrub savanna biomes. The objectives of the CBNRM Programme include the sustainable management and use of natural resources as well as the safeguarding of biodiversity. However, there is no monitoring programme in place that is directed to broader biodiversity monitoring: conservancy members only monitor the distribution and numbers of wildlife that are of economic benefit to them. A number of emerging conservancies are in the pipeline for registration and it is important that the MET, as the lead organisation, promotes the implementation of broader biodiversity monitoring programmes and management. Such programmes will generate data that can be used for local, regional and national assessments.

Transfrontier conservation areas

A *transfrontier conservation area* is essentially a cross-border region with different component areas where different forms of conservation status such as national parks, private game reserves, communal natural resource management areas and even hunting concession areas apply. Although the areas concerned may also contain fences, major highways, railway lines or other forms of barriers that separate various parts within them, the areas border each other and are jointly managed for the long-term sustainable use of natural resources.

Transfrontier conservation areas have gained substantial popularity and support in southern Africa. In 2003, Namibia and South Africa undertook to establish the Ai-Ais–Richtersveld Transfrontier Conservation Park, which spans 6,222 km^2 (Figure 2.3), and there are plans in the pipeline for more such initiatives in the southern African subregion.

Figure 2.3: The Ai-Ais-Richtersveld Transfrontier Park across the southern border of Namibia (Department of Environmental Affairs and Tourism – South Africa 2004)

Description

The indicator provides a summary of the percentage and extent of the PAN and its coverage in terms of endemism, biodiversity, biomes and other ecologically important areas.

Results and trends

Namibia's PAN (Figure 2.7) covers a land surface area well in excess of 22%, and exceeds the 10% minimum set by the World Conservation Union (IUCN). This may sound impressive, but the distribution of conservation areas is highly skewed toward desert and saline desert habitats. Hence, the PAN does not evenly represent Namibia's endemism and diversity. Although the recent addition of the Sperrgebiet (within desert habitats) is a major contribution to the PAN, there is an immediate need to expand it to include wetlands, all major vegetation types, all biomes, and the protection of sensitive and endangered habitats.

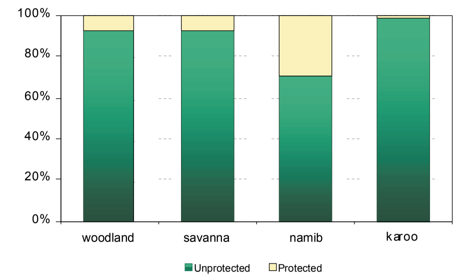


Figure 2.4: The percentage area protected within each biome (Barnard 1998)

From Figure 2.4 it is clear that three out of every four biomes are badly under-represented. Only 8.4% of the woodland and 7.5% of the savanna biomes are protected, while only 1.6% of the Karoo biome is protected. Observe also (Figure 2.6) that the northern perennial rivers are poorly represented in the PAN. As regards the Zambezi River, 0% is protected, while a mere 3% of the Okavango River is. Most of the areas around these rivers are highly populated and the environment is being degraded severely on a daily basis. Urgent protection is needed to rescue the degrading and fading biodiversity of these important freshwater systems. Furthermore, only 4 of the 14 major vegetation zones in the country are protected. Six savanna types are virtually unrepresented, while

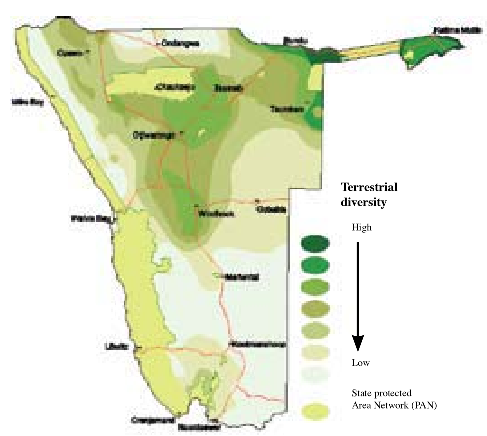


Figure 2.5: The State PAN versus overall terrestrial diversity (Mendelsohn et al. 2002)

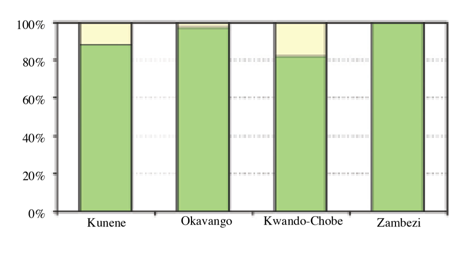


Figure 2.6: The percentage area protected along the length of northern perennial rivers (Barnard 1998)

the mountain savanna – a unique vegetation type – is wholly unprotected.

According to Barnard (1998), the addition of conservancies, private nature reserves and game farms (Figure 2.7) contribute impressively toward mitigating the ecological skew in the PAN. Many of the unrepresented vegetation types are included via these conservation efforts. In addition, however, mainly species of economic and socio-economic importance are currently monitored and protected by commercial and communal conservancies. Slowly but surely, the protection of culturally important plant and animal species is gaining popularity. From Figure 2.2 it is clear that much of Namibia's endemism still falls outside the current PAN. Similarly (Figure 2.5), much of the overall terrestrial diversity has not been attended to under the PAN. Many scientists have emphasised the urgent need to expand the current network. In this regard, the outcome of a recent baseline study on the required extent of the expansion of the PAN will serve to confirm the need for it, and will hopefully bring about action.

INDICATOR 2C: Changes in status of selected endangered habitats

Introduction

The "State conservation areas" indicator (indicator 2B above) addresses the inadequacy of the PAN as articulated by Barnard et al. (1998), the MET (2000), and other scientists and stakeholders. The tendency of the PAN to only protect desert biomes leaves other areas of high diversity, endemism and ecological importance unprotected and exposed to negative human impact. This ecologically skewed protection has been partly mitigated by the CBNRM Programme since its inception (ibid.).

This mitigation is further aided by private nature reserves and game farms registered with the MET that occur on both freehold and communal land. Conservancies on private farmland cover in excess of 25,000 km^2 through the central savanna areas, and play a significant role in improving the protection of numerous vegetation types (ibid.). The emergence of communal conservancies in the north-eastern, east-central, and north-western parts of the country show great potential in addressing the PAN's inadequacies. Despite these initiatives' contribution, however, it is not yet enough to ensure that species and their habitats are thoroughly monitored and protected.

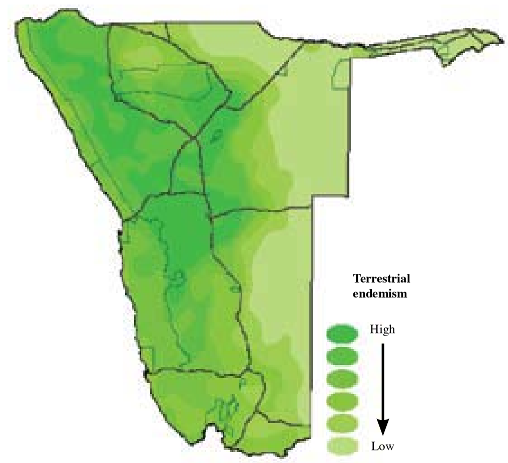


Figure 2.7: Overall terrestrial endemism (Mendelsohn et al. 2002)

Endemism

Plants and animals that are native to an area because they occur there naturally or originate from there are said to be *endemic*. This account is based on the work of Barnard et al. (1998) as readdressed by the MET (2000). There is a general lack of baseline information and data on the ecology and diversity of most Namibian plants and animals. This is contrary to the fact that a large portion of the country is under one or other form of conservation. Hence, even areas under strict State protection suffer from a lack of extensive data on the biogeography and ecology of their diversity. This paucity of information makes it very difficult to concretely assess the conservation status of animals, plants and habitats, and even to define the conservation status of major taxonomic groups (Barnard et al. 1998; MET 2000). Nevertheless, it is worth remarking on the ecological status of those species for which information and data do exist, and highlighting species that are ill defined, while promoting the implementation of relevant conservation tools. Barnard et al. (1998) have shown broad areas of endemism for major taxonomic groups in Namibia. Mendelsohn et al. (2002) have produced a similar work in the *Atlas of Namibia: A portrait of the land and its people*. The maps generated by Mendelsohn et al. (ibid.) have been adapted for this study to compare the PAN and overall terrestrial endemism (Figure 2). By means of this comparison, the extent to which endemism is protected under the existing PAN becomes clear.

Description

The indicator summarises the number of endemic and near-endemic species in Namibia, i.e. species that occur only in Namibia and nowhere else in the world. By using flora and fauna species, the indicator should measure the degree of protection afforded to endangered habitats.

Results and trends

Endangered habitats have not been defined as such in Namibia, although the literature does refer to areas of high endemism and terrestrial diversity that are at great – and increasing – risk. Although this lack of a definition of such areas makes it difficult to analyse the indicator, the report has made a worthwhile attempt to look at them.

Most of Namibia's endemic plants, invertebrates, reptiles, birds and mammals are distributed in a zone running along the north-west to the south-west, with relatively high endemism around central Namibia (Figure 2.8) (ibid.; Barnard et al. 1998). However, some species of tortoises, snakes, lizards, and worm lizards show a high degree of occurrence to the north-east of the country, where the PAN is largely non-existent (Barnard et al. 1998). As regards endemic insects, the recent declaration of the Sperrgebiet as a State-protected area may ensure they no longer suffer severe habitat destruction due to diamond mining operations. Although no extinctions have been reported in the insect taxa, it is suspected that some species have been exterminated.

As mentioned earlier, other wetlands for which conservation (Ramsar) status will be beneficial are the Kunene River mouth, the Orange River mouth, the Cape Cross lagoon, the Mile 4 salt works, and the Lüderitz lagoon.

From the under-representation of biomes in the PAN, it is clear that endemics occurring in the south-east of the Nama Karoo, and in the north-central and north-eastern tree-and-shrub savanna are seriously under-protected or completely unprotected. As mentioned earlier, the commercial and communal conservancies in these areas probably do mitigate the problem somewhat, but this can only be confirmed once data are available. National protected areas, by nature of their objectives, prohibit the exploitation of resources by the general public and may serve the presumption that species occurring within them are protected. However, with a lack of capacity to implement relevant policies and enforce regulations, adequate protection of species and their habitats cannot be confirmed for all such areas. Also, currently communal conservancies have no monitoring mechanisms in place to record data on the number and distribution of locally occurring species, i.e. broader biodiversity. Monitoring does exist, but is directed at wildlife populations and other species of commercial value from which a direct livelihood can be derived.

BOX 2.1: *The Southern Namibia Restoration Ecology (SNARE) Project*

The Namibian National Biodiversity Programme embarked on a new project that contributes to the global Convention on Biological Diversity (CBD) signed during the Rio Earth Summit in 1992. This project's the long-term goal, through balancing conservation and development needs aims to restore disturbed areas by natural means. Many development projects, associated with clearing and earth moving, have potentially detrimental impacts on the environment. It is a prerequisite to understand the ecosystems and natural process to try counteract impact on the environment, which might be irreversible, with natural processes. The Project aims to apply this idea all over Namibia and a pilot project is implemented in the southern Namib Desert, the Sperrgebiet. The southern Namib Desert is of utmost conservation importance comprising:

- one of the few 'hotspots' of plant diversity of international conservation importance in an arid region;
- the richest succulent flora on earth; and
- a centre of diversity for many reptile, mammal and insect groups.

Due to restricted access, most parts of the southern Namib are hitherto relatively pristine and consequently have great tourism appeal. However, recent development plans are locally threatening southern Namib ecosystems.

Goal

The issues of identifying and prioritising endemic species and their under-protected or unprotected status are amply addressed in the National Biodiversity Strategic Action Plan (NBSAP), which covers a ten-year period (Barnard et al. 2000). The NBSAP's first objective is to (ibid.) –

> [s]trengthen the detailed implementation of the Constitution of the Republic of Namibia (Article 95 (l) by adopting specific measures to improve the protection of ecosystems, biological diversity and ecological processes, and to improve the sustainability of biological resource use.

The following strategic aims (SAs) under the NBSAP objectives are directly in line with the focus of this indicator (ibid.: 26):

- SA 1.1: Identify and fill specific gaps in the PAN
- SA 1.2: Promote and support communal and freehold conservancies
- SA 1.3: Strengthen conservation measures in and outside protected areas
- SA 1.4: Address the needs of endemic and threatened species, and
- SA 1.5: Strengthen ex-situ and in-situ conservation capacity.

In 1994, the MET made public its Policy on the Conservation of Biotic Diversity and Habitat Protection. This Policy is in line with the objectives and goals of the UNCBD. In an earlier assessment of the country's biodiversity, the MET (2000) strongly recommended the adoption of this Policy at national level in order for it to serve as the framework for biodiversity use and protection. Besides strengthening the call for the adoption of the Policy, this report also strongly recommends the implementation of the five strategic aims proposed by the NBSAP, as mentioned above.

INDICATOR 2D: Threatened/extinct species per major taxonomic group

Introduction

Many authors describe Namibia's biodiversity as largely intact, although threats to this diversity are associated with the increase in human activities related to development. Nonetheless, Namibia shows commitment toward the protection and conservation of biodiversity through the establishment and expansion of protected areas and other legal instruments. Furthermore, the need for ongoing research and surveying of the abundance and distribution of species is apparent to most stakeholders and scientists, despite existing constraints related to funding and capacity. Species of all sizes and sorts play important ecological roles at small and large scales. The complete wipe-out of a specific plant or animal species may affect an entire food chain and impair ecological processes. Apart from the ecological importance of species, plants and animals are also important for Namibia's tourism industry. The country's wide, open spaces serve as habitats for thousands of species that attract an impressive amount of tourists annually with their beautiful colours, endemicity, global rarity, sheer size, and ecological importance. The power of the aesthetics of biodiversity amazes people the world over, and the advent of ecotourism has placed monetary value to species that were otherwise disregarded. Tourism is only one aspect that addresses the economic importance of biodiversity and, in a country like Namibia, this is definitely not overlooked or underrated. The economy relies on the diversity and abundance of natural resources ranging from minerals, fossil deposits, and plant and animal species. Hence, the abundance and accessibility of biodiversity is of immense importance socially and economically. Rural people are also heavily reliant on biodiversity to sustain everyday living.

Plant and animal species become threatened/endangered when their abundance has decreased to levels that may cause extinction (Griffin 2003). A species is extinct when there is reasonable evidence that it is no longer locally existent, i.e. that each and every individual has been wiped out. In Namibia, threatened species are usually well known, although there are cases when an insufficiently known species borders on threatened/endangered status. In such cases, due to the lack of knowledge, the chances of extinction may be high. Relevant institutions continue their efforts to increase knowledge about biodiversity and its status, although numerous constraints are characteristic of this slow and, at times, discontinuous process. Local people are increasingly encouraged and brought in to monitor and record species occurrence and distribution, but this largely focuses on species of socio-economic importance. There may also be a suspected bias in the data collected, resulting from sampling (observation) errors, since the ordinary person is not familiar with the scientific method.

It is important to have sufficient data on a species' ecology, abundance, distribution, migration (when applicable), biology, and other characteristics. It is equally important to periodically update such data to keep track of the wealth and health of Namibia's biodiversity.

Conservation status categories

There are a number of conservation status categories. This section highlights the ones used for major animal and plant taxonomic groups. Griffin (ibid.) applied an older Red Data List developed by the World Conservation Union (IUCN) for his assignment of provisional conservation status to animal species. The categories taken from Griffin (ibid.) and highlighted in this study are *extinct*, *endangered*, *vulnerable*, and *rare*.

As stated earlier, a species is *extinct* when there is reasonable evidence that it is no longer locally extant. It is important to note that reintroductions from non-Namibian populations do not reverse this status.

A species is in *endangered*, i.e. in danger of extinction, when its survival is unlikely due to the continuation of causal factors. Included in this category are taxa whose numbers and habitats have been severely reduced.

Vulnerable species are likely to move into the endangered category if current causal factors continue to negatively impact on their abundance. This category includes taxa of which all or the majority of the populations have been reduced due to overexploitation, intensive habitat degradation, or other environmental disturbances.

Rare species are perceived to comprise small populations that are not, or are thought not to be, presently vulnerable or endangered. Due to their rarity, however, they are believed to be at risk. Such species may be insufficiently known and can be thinly spread across an extensive range in Namibia. This category includes species with restricted distributional ranges, intermediate endemicity (26–74%), and possible local abundance. Due to such a species' overall limited range, it may not be secure (i.e. not well protected). This category has been included in this assessment based on the above description, and to point to species that are in dire need of serious protection (ibid.).

Overview of major taxonomic groups

This section briefly touches on the real or perceived conservation status of major taxonomic groups in Namibia. The data presented in the following section support these summaries and the interpreted trends provide further detailed information on such groups.

Birds

According to Simmons (2003), 40 species of birds in Namibia fall in the following categories: *extinct*, *critically endangered*, *endangered*, *vulnerable*, *near-threatened*, *rare/peripheral*, or *data-deficient*. Figure 2.9 shows the percentage of each category for the 40 species identified.

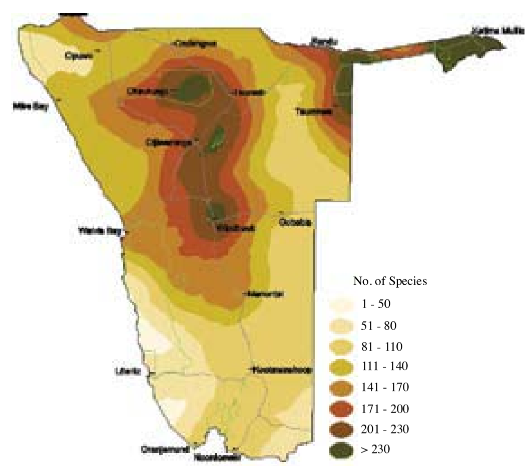


Figure 2.8: Bird Diversity

Plants

Data on numbers and distributional ranges of plants in Namibia are still deficient to a large extent Figure 2.10. Although no trend can be displayed, it is worth mentioning and noting that the Southern African Botanical Diversity Network, as its 14th report, published the Southern African Plant Red Data Lists (RDLs) (Golding 2002). This publication features ten Southern African Development Community (SADC) countries, and covers plants in the following categories: *extinct*, *threatened*, *lower-risk*, and *data-deficient*. The Namibian RDL, consisting of 1,152 taxa, is still preliminary since ongoing studies and fieldwork are continuously being undertaken to verify existing information and to gain new insights in areas of uncertainty (ibid.). In fact, the latter RDL only features spermatophytes[17], due to knowledge deficiency about the taxonomy and distribution of lower plants (ibid.). Also see figure 2.11

Footnotes

[17] A division of the plant kingdom containing plants that reproduce by means of seeds.

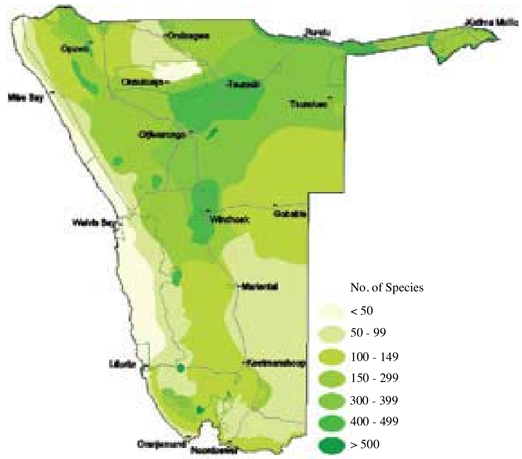


Figure 2.9: Plant Diversity

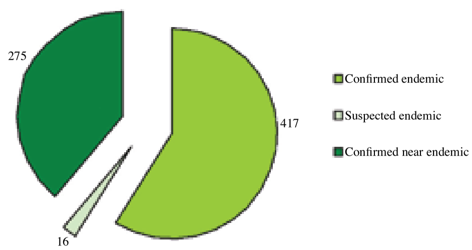


Figure 2.10: Number of plant taxa and their endemic status taxa on the Namibian RDL (Golding 2002)

Mammals

According to Griffin (1998), larger mammalian species – especially those of economic value – have undergone major reductions in their distributional ranges. The ranges of plains zebra and lions have been reduced by at least 95% over the past 200 years. Other species regarded as vulnerable are springbok, gemsbok and leopard. Vulnerable mammal species are found in a north-easterly direction; today, the north-eastern Regions are a haven for mammals that previously had broad ranges in Namibia.

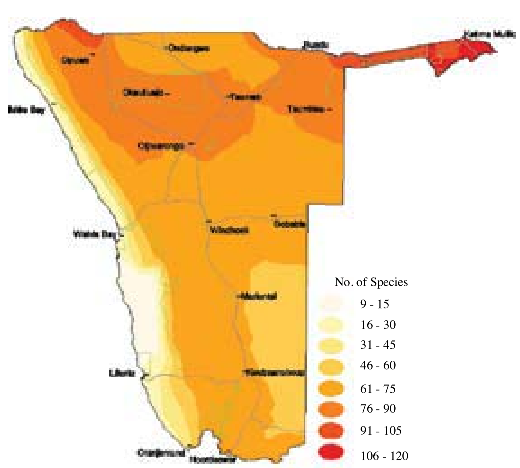


Figure 2.11: Mammal Diversity

Insects

Unlike vertebrates, small, fast-breeding insects may be more resilient to environmental change or disturbance (Barnard 1998). Barnard (ibid.) also maintains that the major conservation problems faced by insects are related to the degradation and destruction of their habitats. The Sperrgebiet is a centre of insect endemism in Namibia and has suffered habitat disturbance due to diamond mining. No extinctions have been confirmed, but diamond mining in that area is suspected to have exterminated some species. Although threat levels are generally low at the moment, this assessment may change speedily due to fast population growth, increased industrialisation and agronomic development, poor coordination of development, and erratic political will to prescribe rural environmental protection measures (all ibid.).

Freshwater fish

There are only five freshwater species endemic to Namibia (ibid.). This is considered surprising, due to the numerous isolated wetlands where speciation could occur. Many of the species endemic to bordering rivers are shared with neighbouring countries. Currently, 16 species raise concern for conservation, and 4 factors are highlighted as causes for biodiversity loss in Namibia's fish fauna. These factors include (all ibid.) –

- overexploitation by all size classes by subsistence fisheries
- translocation of species from one basin to another
- the hydrological regulation of rivers, and
- the loss of riparian vegetation.

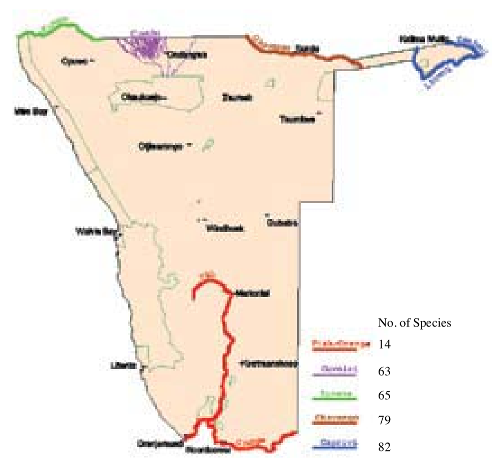


Figure 2.12: Freshwater fish diversity

Amphibians
According to Griffin (2003), only 5 out of 62 species show a degree of conservation concern. However, these species are merely categorised as *rare* or *insufficiently known* (*data-deficient*). Although none are extremely threatened or near-endangered, their being rare and/or insufficiently known already puts them at some degree of risk. Also see figure 2.14.

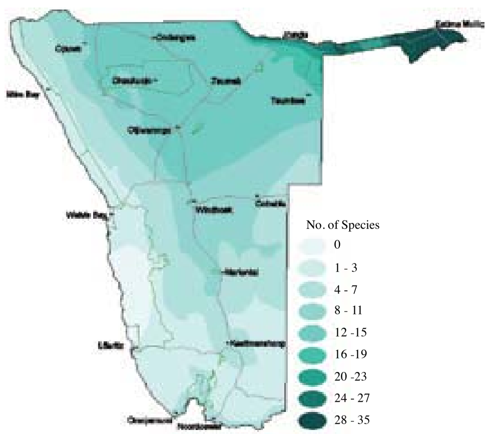


Figure 2.13: Frog Diversity

Reptiles
Griffin (2003) presents 279 species accounts, citing not only an original reference and type locality for each, but also a brief description of its distribution in Namibia. Out of this large number, 58 are threatened, 61 are endemic, and 6 are both endemic and threatened. (Figure 2.15)

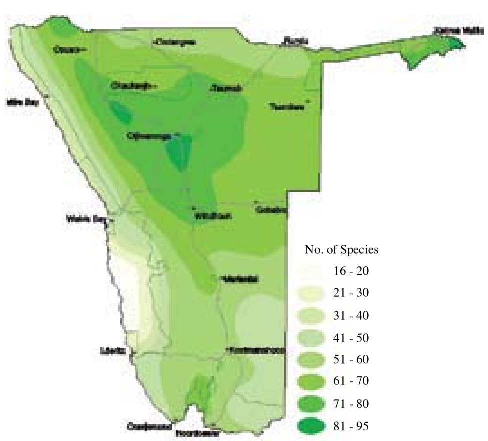


Figure 2.14: Reptile Diversity

Fungi
Information pertaining to the diversity, ecology and economic value of fungi in Namibia is very deficient. According to Barnard et al. (1998) and the MET (2000), there are an estimated 190 species of 47 families. None of these species is endemic, and due to insufficient information their conservation status is unknown.

Lichens
Although lichens are poorly known in Namibia, it has been established that there are numerous species, high community diversity, an unusual dependence on coastal fog, and a number of endemic species (MET 2000). From the Namib Desert alone, 100 species are known, while there are 90 known in the Sperrgebiet and 140 at Waterberg. One genus and a number of species are known to be endemic, and this number will increase as knowledge and information expands. Off-road driving is recognised as a significant threat to lichens in the desert (ibid.).

Arachnids
Ticks and mites are poorly known in Namibia despite their importance when it comes to human and animal health (Barnard et al. 1998). Over 590 species of ticks and mites are known in the country, but it is estimated that this only comprises 20% of the total tick and mite fauna (MET 2000). Spiders have been well studied although the 587 known species are believed to comprise only 20% of the total spider fauna (ibid.). Many endemic species are found in the drier western parts of the country. Regarding solifuges, only 47 of the 124 species known in Namibia are thought to be endemic. The majority are endemic to the Namib Desert, while others are endemic to the highland savanna areas of central Namibia.

The number of known scorpion species is 56, of which 14 are endemic. The conservation status of Namibian arachnids has not been analysed due to the lack of basic data on the ecology, distribution and taxonomy of this group. Large numbers of endemic species are potentially threatened due to their exclusion from the existing PAN (ibid.).

Photo 2.1: A Namibian solifuge
(National Museum, www.natmus.cul.na)

Description

This indicator measures the loss of biodiversity in Namibia with reference to the number of extinct and endangered species per major taxonomic group.

Results and trends

Although much of Namibia's biodiversity is argued to be intact, the above results indicate that substantial numbers of species within large taxonomic groups are threatened and vulnerable. The lack of knowledge regarding groups and their species makes it difficult to assess their conservation status, so current severe and future potential threats are not addressed. The distribution maps of some groups make it clear that many groups and species fall outside the current PAN, while some barely overlap with the PAN. Barnard et al. (1998) iterated the urgent need to expand the PAN in order to ensure that species and their habitats are included and, hence, protected. The PAN does not adequately cover all centres of high **plant** diversity and endemism in Namibia. Of the 13 main vegetation types identified by Giess (1998), 8 include protected areas – and some of these represent less than 5% of the vegetation type. Areas of high human density where plant resources are heavily utilised as well as areas of greatest botanical importance are at great risk of habitat degradation (Figure 2.16 and 2.17).

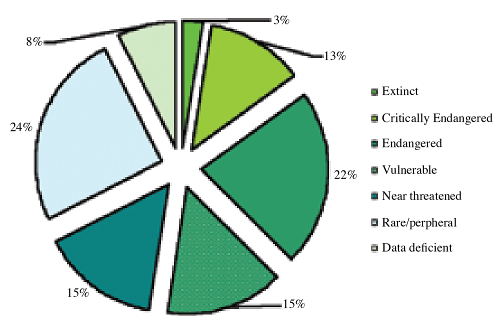


Figure 2.15: Red data birds in Namibia (Simmons 2003)

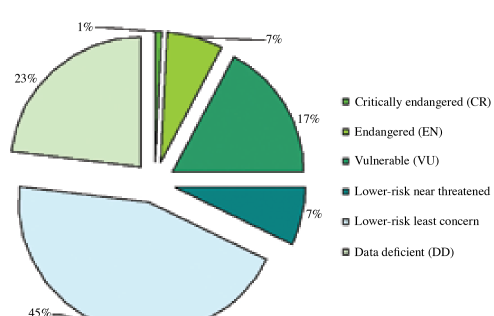


Figure 2.16: A summary of the Plant Red Data List assessment for Namibia (Golding 2002)

The greatest threat to **insects** is thought to be wide-scale habitat conversion, although the lack of information on insects makes it difficult to conduct a comprehensive analysis (MET 2000). **Freshwater fish** species occurring in the perennial rivers are threatened principally by habitat destruction, overfishing, introduction of alien species, poor river catchment management and water abstraction (ibid.). Information deficiency causes an increasing gap when it comes to knowledge about **fungi**, **arachnids** and **lichens**: all three are rather poorly known and actual threats cannot be comprehensively analysed. While **amphibians** are poorly represented in the PAN (Figures 2.14 and 2.19), less than 2% of all endemics are threatened (Griffin 2003). The conservation status of large **mammals** is better known than that of small mammals. However, much confusion still exists about the taxonomy of smaller mammals, which might make it difficult to assess a particular species' conservation status. More than 18% of the mammals are threatened, with less than 1% of the endemic mammals threatened and about 2% being extinct (Figure 2.18; ibid.). Major threats to mammals include habitat destruction and conversion. **Birds** are potentially the best-known faunal group in Namibia, and have been extensively researched over the years (MET 2000). According to Simmons (2003), 3% of all birds are extinct, 13% are critically endangered, and 27% are vulnerable (Figure 2.16). Birds occurring in wetland and coastal habitats are the most threatened groups, while threats are habitat degradation, poisoning and hunting (MET 2000).

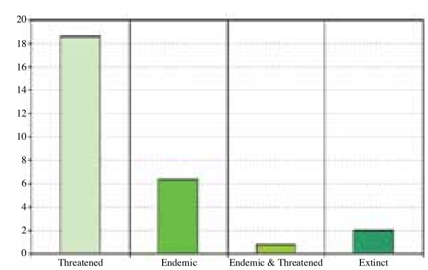


Figure 2.17: Percentages of total mammals under various conservation categories in Namibia. (Griffin 2003, unpublished)

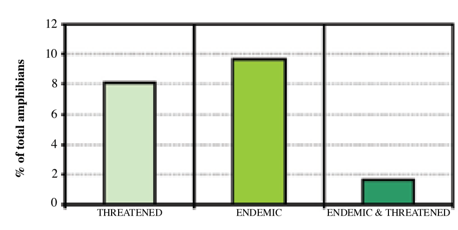


Figure 2.18: The above figure shows various conservation categories as percentages of total amphibians in Namibia (Griffin 2003, unpublished)

INDICATOR 2E: Alien, invasive, and alien invasive species in Namibia

Introduction

Venter (2002), in his account of *invasive alien* **species in Namibia, defined such species as those "whose establishment and spread threaten ecosystems, habitats or species[,] posing economic or environmental harm".**

The Alien Invasive Species Working Group of the National Biodiversity Task Force held a workshop on such species in Namibia in May 2004. Prior to the workshop, great confusion existed about the use of terminology regarding alien and invasive species in a national context. Hence, one of the objectives of this workshop was to arrive at a working definition of such species, because it was recognised that an alien species was not necessarily invasive, and vice versa. The following definitions were derived during the workshop (NNBTF 2004):

- *Indigenous species* is a species that occurs or has occurred naturally in Namibia
- *Indigenous invasive species* is a species that occurs naturally in Namibia, but which causes or has the potential to cause harm to the environment, the economy, or human health
- *Alien species* is a species that does not naturally occur in Namibia, but has been introduced into the country either directly or indirectly, and
- *Alien invasive species* is a non-indigenous species that causes or has the potential to cause harm to the environment, the economy or human health.

Clearly, *invasive species* can be either indigenous or alien.

The above definitions will be applied and popularised, but may be amended where necessary.

Invasive and alien species tend to be very aggressive in securing a niche – even at the expensive of local species – where they can thrive and spread (Maartens 2003). Economic setbacks can be enormous: the invasion of bush encroacher species on commercial farmland is estimated to cause millions of Namibia dollars in losses on an annual basis (De Klerk 2004). Thus, the potential harm of alien and invasive species is recognised. However, research needs to be done to provide more quantitative information. For many alien and invasive species identified, information about their ecology, abundance, distribution ranges, nature and degree of the threat they pose, and their rate of invasion are still poorly documented or totally unknown. However, this lack of information should not stop stakeholders from putting in place the necessary legal, institutional and protective instruments to prevent the further spread of currently known alien and invasive species, and to avoid the entrance and spread of potential alien and invasive species.

Overview of past and present research

Twenty years ago, at the annual professional officers' meeting of the then Directorate of Nature Conservation and Recreation Resorts, the problem of alien invasive species was highlighted (Bethune et al. 2004). Several publications resulted from workshop sessions during this meeting, including a South African National Programmes Report on the distribution of invasive and potentially invasive species in different parts of Namibia (ibid.). Much of the information on the status of invasive plants in Namibia originated from these and other publications in the 1980s. Until recently, research done by the then Department of Water Affairs (DWA) in the early 1980s was the only detailed work on invasive alien species, with innovative research on the weed *Salvina molesta*. Recent detailed studies include Pierre Smit's doctoral thesis on *Prosopis* (Smit 2002a, 2002b) and studies on black-faced impala (Bethune et al. 2004).

In terms of the overall national situation of alien invasive species, the recently released work by Bethune et al. (ibid.) offers a vast amount of information. Their comprehensive account addresses part and present studies, the scope and scale of invasive alien species in Namibia, the legal and policy framework, an institutional analysis, networks of experts, national and regional programmes, and recommendations. The study reviews the current status of data and information on alien invasive species and current trends in the status of alien invasive animals and plants. Their recommendations are featured later in this chapter. Their studies can serve as a working document for the way forward in dealing effectively and holistically with alien invasive species in Namibia.

Renewed interest has sprouted more recently through activities executed by members of the Alien Invasive Species Working Group. These activities include Smit and Steenkamp's (2002) publication of the poster entitled *Namibia's Nasty Nine*, showing the most invasive alien plant species; work by Joubert and Cunningham (2002) and Cunningham et al. (2004) highlighting the distribution dynamics of some species; and recognising the need to reduce the threat from alien invasive species to biodiversity and the inclusion of this as a strategic aim in *Namibia's Ten-year Strategic Plan of Action for Sustainable Development through Biodiversity Conservation – 2001–2010* (Barnard et al. 2000). More recent work includes ongoing workshops by the Working Group (Bethune et al. 2004); and ongoing research on *Prosopis* and a report by Venter (2002) on invasive alien species in Namibia. In May 2004, the MET's Directorate of Environmental Affairs and the Southern Africa Biodiversity Support Programme held a strategic planning session on alien and invasive species in Namibia. This session built on the existing Ten-year Strategic Plan (Barnard et al. 2000). Presentations on terminology, legislation in the agricultural sector, and recent studies on *Prosopis* were made by members of the working group. The *Prosopis* presentation served as an example of a project without major adverse impacts (Bethune et al. 2004).

Description

This indicator provides an account of the recent national review of invasive alien species in Namibia (ibid.). No quantitative information is offered and this section can be regarded as providing information to generate further awareness. For more comprehensive information, the reader is referred to Bethune et al. (ibid.).

Trend

According to Venter (2002), invasive alien species are not a major problem in Namibia. However, Bethune et al. (2004) find this to be a rather complacent perception that is due to –

- the paucity of research capacity: Due to the lack of qualified research personnel, very little research has been done on alien invasive species and the focus has mainly been on the distribution of relatively few species
- Namibia's aridity, i.e. it is unlikely that many alien species will become invasive
- little information being available as regards the recent distribution and population dynamics of invasive species, and
- even less information being available about socio-economic and ecological impacts.

Main invasive alien plants

The review done by Bethune et al. (ibid.) identified 15 major invasive alien plant species in Namibia. These include plants identified in the 1984 list and in *Namibia's Nasty Nine*, as well as three potentially severe invasive aquatic species. Many of the most invasive plants are closely linked to watercourses and riparian vegetation. Rivers serve not only as water sources but also as conduits for translocation – which indicates that Namibia's wetlands are extraordinarily vulnerable to potential infestations (ibid.).

Main invasive alien animals

Eleven alien animal species were identified by Bethune et al. (ibid.) as having the potential of becoming extremely invasive in Namibia. The aquatic species, with the exception of a mussel species (Photo 2.2), all pose serious a threat should they become established in the perennial rivers. These include a freshwater crayfish species, a snail species, a mussel species and three freshwater fish species, as well as a terrapin species that is internationally considered as one of the 100 worst invasives. Terrestrial species include the domestic cat (*Felix catus*, Photo 2.3), the hybrid (*Felix catus/lybica*) and the well-established rodents that are common at the coast. The rodents can easily pose health and economic risks.

Photo 2.2: Mediterranean mussel: Mytilus galloprovincialis (Bethune et al. 2004)

Photo 2.3: The domestic cat, Felis catus (source: SABSP, Windhoek)

Goals and results

The first goal is to devise appropriate strategies – be they policies, monitoring programmes or other mechanisms – to prevent the possible threat that currently inhabitant invasive alien species might pose. Where policies, regulations, etc. exist they should be reviewed on the background of global trends in preventing the spread and possible effects of invasive alien species. The second goal is to implement proper control and inspection mechanisms for the import and export of invasive alien species. Thirdly, relevant people should be trained to inspect the entrance of invasive aliens into Namibia, how to deal with existing species, and how to prevent their geographical spread. Lastly, the Namibian population at large should be made aware of the possible dangers/threats these species pose to personal, environmental, indigenous species, and ecosystem health. Four major steps are identified in the war against invasive alien species: prevention, early detection, eradication, and control. The implementation success of these four steps can be ensured by sound monitoring programmes that provide current and up-to-date information on the status of invasive alien species.

Recommendations

Monitoring and data collection

Current monitoring programmes should form a basis for the design of a national-level monitoring programme, as appropriate, taking into account that a number of monitoring projects are not designed for the purposes of the SoER. New indicator development initiatives should be done vis-à-vis other programmes and institutes to ensure that they complement each other and reduce duplication.

A more extensive network-based joint use and analysis of monitoring results should be promoted amongst scientists, management and policy-makers. This will also pave the way for integrated monitoring sites across different habitat types and land uses for comparison.

It is important to monitor indicators on different land uses for comparison. This is because land-use change is predicted to become the No. 1 threat to the loss of biodiversity in the developing world.

Each existing monitoring programmes should re-evaluate their objectives if this has not been done within the last five years. Clear objectives regarding why, what and how to monitor should be emphasised.

Each monitoring programme should attempt to field-test its respective indicators to guarantee their effectiveness. Local monitoring initiatives should feed into a national-level strategy.

A map depicting ecological regions will be useful in selecting monitoring sites, as one can apply indicators that might be specific to the prevailing environmental conditions. The biomes and vegetation map (Figure 9) could be a good first step to stratifying more similar sites. If possible, one test site per eco-region should be established where indicators can be monitored.

It is imperative to test all indicators. Indicators are currently chosen based on the availability of data and might not always be the best possible set to reveal underlying processes. Testing for accuracy is as important, as an indicator in one environment could reveal something different in another environment.

Biodiversity protection and conservation

Expand the current PAN to include all areas of importance in respect of ecological and biological diversity.

Information and data

Research needs to be prioritised so that more knowledge can be generated about species on which information is highly deficient. Information regarding the ecology, distribution, abundance and taxonomy of such species will allow for better assessment of biodiversity in Namibia.

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Chapter 3: Water availability and quality

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Introduction

Namibia is a dry country characterised by arid and semi-arid environments with prolonged periods of droughts, but floods also occur in the north-east of the country. It is the most arid country in southern Africa. The limited natural available water (surface water and groundwater) is a critical limiting factor and a challenge to development objectives in the country. Water is an important driving force to developmental objectives as outlined in the visionary national blueprint, *Vision 2030* (GRN 2004). Internationally, the importance of water to development, human health and well-being was underlined in mid-1993 when the United Nations' new Commission on Sustainable Development made improvement of water quality to be one of the first priorities for technology transfer from wealthy countries to poorer nations. Sustainable water utilisation and conservation is, thus, essential for every water consumer. Of the entire planet's renewable resources, fresh water may be the most unforgiving because it is difficult to purify, expensive to transport, and impossible to substitute: water is essential to life.

The occurrence and availability of water resources is largely governed by the interactions of climatic, geological and environmental settings – which includes all human activities. Ground condition and climatic components, which include precipitation and its mode of occurrence, radiation, humidity, temperature, wind and evapotranspiration, have the most influence on the availability and occurrence of economic water resources. Hence, a meaningful national assessment of water availability must remove seasonal and short-term variability to isolate trends and patterns that have regional and national significance. The assessment and interpretation of climatic data requires a focus on the interrelationships that exist within the various climatic components and their overall influence on water availability. This influence depends on the variability of precipitation, evaporation, transpiration, radiation, temperature and wind patterns. Evapotranspiration – which represents the combination of evaporation from open water bodies and transpiration from vegetation – and precipitation are among the major components of climate that control the availability of water at any given time and place. Evapotranspiration is a function of temperature, humidity, wind, and solar radiation.

The analysis and evaluation of climatic data such as those on precipitation can be undertaken using current statistical methods. Such an analysis and evaluation will include the wettest year on record, three- or five-year rolling averages, or the ten-year period with the highest year-average precipitation. The influence of ground conditions and local environmental settings can be evaluated using techniques such as thematic mapping. Uncertainties associated with the data can be minimised using statistical techniques. Evaluations of the influence of climatic components on water occurrence and availability can be focused on established long- and short-term trends of annual and monthly variations of precipitation and evaporation. Although average precipitation can be used as an indicator for assessing the short- and long-term variations of rainfall, these average figures do not necessarily represent the overall water budgets – especially in arid and semi-arid environments. The following factors determine the overall water budget during a rainfall event:

1. *Depressional storage* is the water that collects in small depressions on the ground surface, which is dependent upon the initial soil moisture status. The local ground condition, particularly its geomorphology, and the environmental setting have a major influence on depressional water storage.
2. *Evapotranspiration* is the water that returns to the atmosphere from open water bodies and vegetation.
3. *Infiltration* is the water that percolates into the ground, replenishing soil moisture and the water table (groundwater). This largely depends on the type of ground condition (permeable or impermeable) found in a particular area and the intensity of the rainfall.
4. *Interception* is the water trapped by flora and fauna in the catchment, including water needs by humans; interception is a function of the local environmental setting.

5. *Surface run-off* (surface water) is water that has not undergone any of the above processes and flows into the surrounding stream and river channels. Run-off is controlled largely by the ground, the environmental setting, and the intensity of the rainfall.

All the above processes are very active in Namibia's arid and semi-arid environments. The type and characteristics of rock or soils with respect to the ability to allow water flow as well as the ability to store water is critical to groundwater occurrence and availability. For the Namibian environment, the time between rainfall events is often long and unpredictable; and when the catchment is partially dry at the start of a rainfall event, it will initially collect water in hollows and depressions. Some of this rainwater will infiltrate into the soil, replenishing the groundwater and soil moisture. This is an equilibrium process: as the water content of the soil increases, the infiltration rate decreases. When the rate at which rain falls on the catchment (intensity) is greater than the rate at which processes 1 to 4 in the list above – in combination – are removing it, the excess will flow in the rivers channels as run-off. Part of the rain that flows as run-off into the surrounding river channels and is eventually collected in man-made dams, so common in Namibia, is known as the *effective rainfall.* Effective rainfall, which constitutes a fraction of the total rainfall, differs for every storm and varies in time and place throughout the duration of the storm.

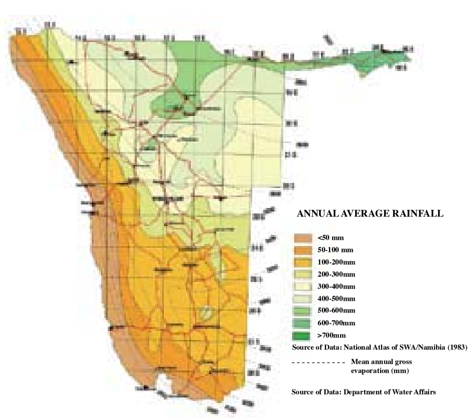

Figure 3.1: Evaporation map of Namibia (Namibia Meteorological Office). Evaporation has been measured by observing the fall in water depth in a standard water-tight metal pan. This observed evaporation is usually higher than would be expected from a large open water surface such as a dam, and a reduction factor has to be applied. In figure 1, lines of equal annual evaporation are shown based on all observed data up to 1987. Estimates for the coastal belt are considered approximate only, based as they are, on very few data.

Water availability

Rainfall distribution throughout the country varies considerably with evaporation in excess of precipitation (Figure 3.1). Water availability also varies from year to year, making arid and semi-arid regions vulnerable to a succession of dry years, such as the drought that gripped the country in 1982–1983 and 1992–1993. These variations can be attributed to changing weather conditions and, to some extent, water-use demands.

Socio-economic factors greatly influence access to water. Namibia, like many other developing countries, lacks the capital and technology to tap potential water resources such as those that can be extracted from sea water by desalination. Among the greatest single influences on the availability of fresh water is the ever-growing human population. Higher population numbers, coupled with increasingly higher standards of living, boost demand for finite quantities of water and intensify competition and tension among users. With increasing urbanisation, industrialisation and

Water Source	Annual Amount of Water Available with Installed Capacity (Mm3/annum)	Potencial Amount of Water Available (Mm3/annum)
Dams and Ephemeral Rivers	**92.7**	**200**
Perennial Rivers	**170**	**170**
Perennial Rivers	**150**	**300**
Other Water (Recycled)	**10**	**10**
TOTAL	**422.7**	**680**

Table: 3.1: Total Water Availability (Department of Water Affairs, 2003)

agricultural developments in different parts of the country, including much of the arid zones with limited water resources, the demand for more water continues to be a challenge.

Water availability and use are a function of the total flow of water through a basin, its quality, and the structures, laws, regulations, and economic factors that control its use. Because water availability and water use are closely linked, the term *water availability* will be used for brevity in this chapter to include both water availability and water use. Table 3.1 summarises the total water availability from the different sources with the current installed capacity. This gives Namibia a current water availability of

423 Mm^3 per annum. However, if all potential water sources were developed, the amount of water available would be 680 Mm^3 per annum (DWA 2003).

Groundwater in Namibia

Economically useful groundwater resources in Namibia are located in porous aquifers (unconsolidated deposits) and fractured aquifers (hard rock terrain) as well as aquitards and aquicludes (DWA 2001). The regional fractured aquifers are characterised by fractured hard rock with secondary porosity and permeability, and include dolomitic and quartzitic rocks, respectively, in the north-central areas around the Otavi Mountains and central highlands, particularly the southern part of Windhoek. The sandstones in the southern and quartzites in the eastern parts of the country are also a potential aquifer. The aquitards and aquicludes consist of local metamorphic, volcanic and igneous rocks found in different parts of the country (DWA 2001; Geological Survey of Namibia 1999). These aquitards and aquicludes provide vital sources of local water supplies for many small settlements and farm holdings throughout the country. The regional unconsolidated porous sediments have primary porosity and permeability and consist of gravels, calcretes, sands and silts of the Namib Desert (palaeochannels) and the thick Kalahari deposits of the southern, eastern, northern and north-eastern parts of the country. Figure 3.2 illustrates the types and distributions of aquifers in Namibia.

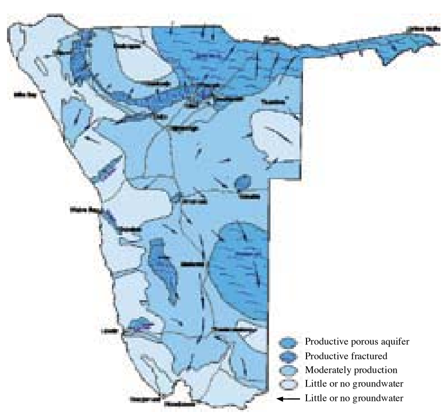

Figure 3.2: Aquifer types, distribution in Namibia and overall production (Mendelsohn et al. 2002)

The amount of groundwater available at any given time is dependent on the hydrogeological settings of the area and the recharge from rainfall or artificially. Table 3.2 shows the preliminary estimated sustainable yield in millions of cubic metres per annum for a number of the main aquifers in Namibia (DWA 2003), whereas Figure 3.3 shows the amount of water extracted from boreholes for different uses. The amount of water an aquifer can store is much higher than the amount that can be abstracted. The sustainable yield is the amount of water that can be abstracted from an aquifer without having a significant impact on the water table. However,

Aquifer	**Estimated Sustainable Yield (Mm3/annum)**
Grootfontein Karst	14.6
Otjiwarongo	3.2
Khorixas	2.2
Omaruru	2.5
Nei-Neis	0.6
Omdel	8.2
Karibib	0.183
Usakos	0.28
Kuiseb	5
Osona	1.25
Rehoboth	2.5
Tsumeb Aquifers (Including Abenab)	18
Stampriet Artesian Basin	8
Windhoek	1.73
Other Groundwater	81.7
Total	**150.0**

Table: 3.2: Preliminary Estimated Sustainable Yield of Aquifers in Namibia (DWA 2003)

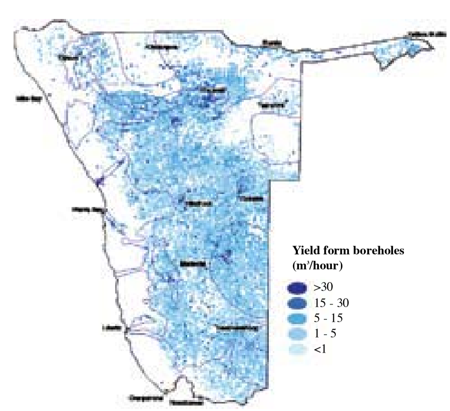

Figure 3.3: Yields from boreholes (Mendelsohn et al. 2002)

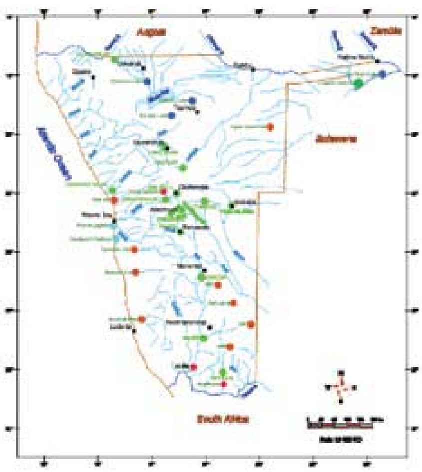

Figure 3.4: Location of wetlands in Namibia (DWA 2001)

the potential for an aquifer to store more water than can be extracted from it is an important aspect that can be utilised for artificial recharge. A typical example of such a system is the Omdel Dam scheme, which recharges the downstream aquifer of the Omaruru River. Another similar scheme is the recharge of the Windhoek aquifer.

When one looks at the availability of groundwater, therefore, it is imperative to look at the sustainable yield and not the stored reserve of an aquifer. This is because the sustainable yield indicates what can be abstracted on a long-term basis whilst the stored reserve may only provide an indication of the magnitude of the aquifer. If overexploitation of a resource occurs, then eventual exhaustion of the groundwater may occur – resulting in the unavailability of water for future generations.

Surface water in Namibia

Namibia is dry for most of the year and, during rain events, the larger portion of rainwater is usually lost through evaporation. Run-off occurs in the form of surface flow, particularly in areas with impermeable ground conditions or where the infiltration capacity of the ground has been exceeded. The *interflow* is that part of the surface run-off that infiltrates into the ground and is forced to flow laterally due to vertical variation in permeability in a given area. More than 80% of the precipitation in Namibia is in the form of summer thunderstorms and less than 20% of precipitation is in the form of fog along the coastal areas.

Namibia has no perennial rivers except those along its borders, namely the Kunene, Okavango, Zambezi and Kwando–Linyanti–Chobe in the north, and the Orange in the south (Plate 3.1). However, all these perennial rivers have their sources outside Namibia, and are shared with other countries. It is estimated that about 23% of the water used in Namibia is derived from these rivers (DWA 2001). Nonetheless, most of the country has no access to this water due to the long distances between the rivers and the major urban centres. Consequently, only 0.1% of the total annual flow of these rivers is abstracted in Namibia. The interior of the country has only ephemeral rivers, which only flow for a short time after the rainfall in their catchment areas. The majority of ephemeral rivers flow towards the Atlantic Ocean, forming linear oases as they cross the Namib Desert. In the central and southern parts of the country, limited surficial drainage networks flow towards the Kalahari Basin in the east. A number of large dams have been built on almost all the major ephemeral rivers for storing and supplying water to major urban centres, and for flash-flood control (Figure 3.4 and Table 3.3). The percentages of catchment land area of the large river systems within Namibia are shown in Table 3.4.

According to a draft technical report by the DWA (2003), the figure for the total capacity for dams in Namibia is just over 700 Mm^3 of water. This implies that if these dams were all filled to capacity, the availability of water resources from dams would be quite high compared with Namibia's current water consumption of 280 Mm^3 in 2001–2002. However, Namibia has very little rainfall: and the little it receives is also very erratic across space and time – which means that the figure of 700 Mm^3 of water is very unlikely to be available at any specific point in time.

A better indicator of the long-term availability of water from a dam is the 95% safe yield (DWA 2003). The *yield* is the amount of water that can be supplied from a reservoir or catchment during a specified period. The *95% safe yield* is the yield that can be expected 95% of the time. The sum of the 95% safe yields for all the dams in Namibia is 92.7 Mm^3 of water per annum (DWA 2003). This indicator of availability states that Namibia can be guaranteed an amount of at least 92.7 Mm^3 of water in one year from dams, in 95% of the years. However, this may not be true on a countrywide scale, due to the highly variable precipitation and the non-existence of countrywide linkages of dams, resulting in a shortage of water in one area and a surplus in others.

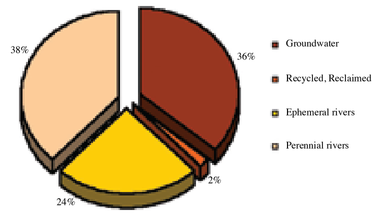

Figure 3.5: Water Sources used in Namibia in 1996 (van der Merve 1999)

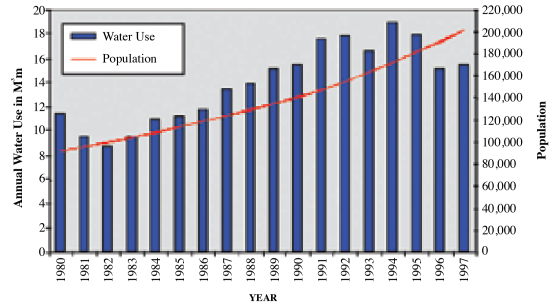

Figure 3.6: Water Consumption and Population in Windhoek (van der Merve 1999)

Name of Dam	River Name	Capacity (Mm3)	95% Safe Yield (Mmn3/a)
Dreihuk	Hom	15.5	nil
Friedenau	Kuiseb	6.7	0.5
Hardap	Fish	294.6	55.5
Naute	loewen	83.6	12.0
Oanob	Oanob	34.5	4.2
Olushandja	Etaka	42.3	n/a
Omaruru Delta	Omaruru	41.3	5.2*
Omatako	Omatako	43.5	2.0
Otjivero Main	White Nossob	9.8	0.7
Otjivero Silt	White Nossob	7.8	-
Swakoppoort	Swakop	63.5	4.5
Von Bach	Swakop	48.6	6.5
Avis	Avis	2.4	0
Bondels	Satco	1.1	0
Daan Viljoen	Black Nossob	0.4	0.01
Goreangab	Gammans	4.2	1.4
Omatjenne	Omatjene	5.1	0
Tilda Viljoen	Black Nossob	1.2	0.15
TOTAL		706.1	92.7

Table 3.3: Surface water sources and characteristics

Water supply, use and socio-economic benefits

The high and ever-increasing water demands for domestic use, agriculture, mining and all other related human activities are a huge strain on the limited available freshwater resources. In addition, pollution due to the increasing human population and developmental activities associated with providing the required infrastructure is a threat to the freshwater resources. Namibia's water is supplied from three natural sources: groundwater, ephemeral surface water, and perennial surface water (i.e. from dams). Waste water reclamation in Windhoek represents another 'source' of water, providing roughly 3.5 Mm^3 of Windhoek's annual supply. Namibia's total potential safe yield of domestic water sources is estimated to be 500 Mm^3 per annum, made up of 200 Mm^3 of surface water and 300 Mm^3 of groundwater (DWA 2003). The portion of the annual water supply coming from each source varies from year to year, depending on rainfall. In 1996, for example, the total water supply constituted 36% groundwater, 38% perennial surface water, and 24% from ephemeral rivers (Figure 3.5).

Agriculture is the single biggest drain on water supplies, accounting for 71.7% of the total water used in Namibia in 1999 alone (Table 3.5)[18]. The demands of domestic/household use account for just over 20%. The remainder, less than 10%, is shared amongst mining, tourism and other sectors. Patterns of use may vary from Region to Region, depending on the level of social and economic development, climate and population size. Although a considerable amount of farming in the country still relies on rainfall, the high water consumption figures associated with the agricultural industry mostly represent irrigation. The use of water by stock farming, although an agricultural activity, is minor compared with irrigation consumption (Van der Merwe 1999). The highest water consumption in urban centres is in the Swakop Basin (WCE 2000), which is home to approximately 297,809 people and includes Arandis, Karibib, Okahandja, Otjimbingwe, Swakopmund, Usakos and Windhoek. Urban water consumption in the Swakop Basin was 21.2 Mm^3 in 1999, which was about 37% of the total used for urban suppliers in that year (WCE 2000). The most populous basin is the Cuvelai, with approximately 699,020 people. The Cuvelai Basin has the highest rural domestic demand, namely about 3.6 Mm^3 per annum, which is about 63% of the total water use for rural domestic purposes in Namibia. In 1999, domestic water consumption in the Cuvelai Basin was 10.9 Mm^3. The relationship between water consumption and population is demonstrated in Figure 3.6 for the city of Windhoek.

Water is one of the most important driving forces to development in various sectors ranging from mining to agriculture, and has a central role to play in the realisation of the national development objectives, including Vision 2030. In order to understand the significance of water, one has to look at the economic benefits and values of water use in each sector. The economic benefits measure the general contribution of water to socio-economic well-being, while the economic value of water in each sector considers the contribution of water to final product value. Water value can be used to assess economic efficiency of the allocation of water (DWA 2003). *Economic efficiency* is based on the concept that water should go to the highest-value producer, a concept being adopted for commercial water uses in the new water policies. Water consumption for production purposes, such as agriculture and industry, provides economic benefits such as incomes, employment, and foreign exchange earnings. While these benefits

Sector	Rural[1]	Urban[2]	Agriculture		Mining	Tourism	Industry	Total
			Irrigation	Stock				
Water consumption Mm^3/yr	5.7	57.0	135.9	77.1	13.4	2.3	5.6	297.0
Percentage Total %	21.1 1.9	19.3	71.7 45.7	26.0	4.5	0.8	1.9	100.0

1 Rural = domestic

2 Urban = domestic + institutional + commercial

Table 3.4: Water Consumption in Namibia by Category for 1999 in Mm^3 (WCE 2000)

Footnotes

18 No recent data were available at the time of writing.

do not measure the exclusive contribution of water to economic value, they do measure the broadly defined socio-economic benefits from the use of water in one sector relative to another, or in one region of a country relative to another, or in one country relative to another.

International Conventions and national policies

On the international front, there are some UN international framework initiatives focusing on water, but to which Namibia is not yet a co-signatory. Such initiatives include the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (the Water Convention). In May 1997, the UN General Assembly adopted the Convention on the Law relating to the Non-navigational Uses of International Watercourses. The Convention is intended to strengthen national measures for the protection and ecologically sound management of transboundary surface waters and groundwaters. The Convention obliges parties to prevent, control and reduce water pollution from point and non-point sources. It also includes provisions for monitoring, research and development, consultations, warning and alarm systems, mutual assistance, institutional arrangements, and the exchange and protection of information, as well as public access to information.

Regionally, a number of bilateral agreements on shared rivers such as the Okavango, Kunene, Orange and Zambezi have been concluded, and are based on regional initiatives that started in the early 1990s. These initiatives include the creation of the SADC Water Sector, the signing of the Protocol on Shared Water Resources, the active presence of the Global Water Partnership, and the organisation of the Round Table Initiative spearheaded by the United Nations Development Programme (UNDP) and SADC Water. The Namibia Water Partnership was the third to be launched in southern Africa after Zambia's and Zimbabwe's. From 2004 to 2008, the Namibia Water Partnership aims at contributing to equitable access to freshwater resources by all sections of the population, especially the rural and urban poor. A large proportion of Namibia's urban and rural population is without safe drinking water and proper sanitation. In its activities, the Partnership plans to enhance understanding of integrated water resources management (IWRM) principles, identify gaps in the implementation of IWRM, and build capacities that are required to implement IWRM programmes and activities. The Namibia Water Partnership is hosted by the Desert Research Foundation of Namibia.
Since Namibia's Independence in 1990, the Government has reworked and updated numerous legal instruments and policies governing the use and ownership of water resources. Article 100 of the Constitution stipulates the following:

> Land, water and natural resources below and above the surface of the land and in the continental shelf and within the territorial waters and the exclusive economic zone of Namibia shall belong to the State if they are not otherwise lawfully owned.

The new National Water Policy and the Water Resource Management Bill are among recent initiatives that have taken the country's aridity into account. Both documents recognise the need for efficient water resources management. The MAWRD presently controls and regulates all water use, based on the old South African Water Act, 1956 (No. 54 of 1956) and the Namibian Water Sanitation Sector Policy of 1993. The MAWRD also remains responsible for the overall management of water resources in the country with the prime objective of ensuring that they will be properly investigated and utilised on a sustainable basis to cater for the needs of both humans and the environment

Chapter overview

Mean annual rainfall

With the ever-changing global, regional and local climatic patterns, the past, present and future mean annual rainfall trends do not look promising. The numbers of rainfall events, expressed as an annual average in days, range from 10–30 days. The length of the rainy season, expressed as the number of months with more than 50 mm of rain, ranges from 1–2 months. Droughts have become common in recent years, affecting at least one part of the country each year. Although average precipitation has been used as an indicator for assessing the short- and long-term influences of rainfall on water availability, these average figures do not necessarily represent the overall water budgets in a specific area. This is so because the time between rainfall events is often long and unpredictable. Nonetheless, because the data sets required for the accurate prediction of effective rainfall are often not readily available, mean annual rainfall can be used as an indicator. Measurements of rainfall that can be used to provide information on rainfall variability and, hence, on the state of water availability include annual and daily rainfall totals and rainfall seasonality, which are then averaged to obtain an indication of trends.

Annual river run-off

Annual river run-off from ephemeral rivers could contribute significantly to the water supply in rural areas if a higher percentage were to be considered as a safe yield. Due to the country's erratic rainfall conditions, ephemeral river run-off harnessed in dams is unreliable and irregular. Estimates indicate that the safe yield from surface water for these rivers is at least 200 Mm^3 per annum, or 40% of the total water resources available in the interior of the country. The DWA has constructed a number of major dams in the courses of the country's ephemeral rivers. On average, only 13% of the capacity in these dams is available as a safe yield.

Water use and economic efficiency

Since this is a relatively new study area in Namibia, no direct trends are visible. It may be expected that as soon as data for the mid- to late 1990s are analysed, a relatively short time-series can be interpreted if distinct trends are observed. For now, however, the indicator merely serves an informative function by showing the percentage of water used per sector from a particular source and the economic contribution (in Namibia dollars) of each sector per consumption of a cubic metre of water. Commercial agriculture is the biggest consumer overall, drawing large percentages of water from perennial and ephemeral rivers. In contrast, commercial agriculture has the lowest economic contribution per unit of water consumed. One might think as the largest consumer of bulk water, agriculture might have a parallel economic contribution.

Quality of groundwater

Much of Namibia's groundwater is of excellent to good quality. However, many of the groundwater resources are in danger of pollution by the factors elaborated on earlier in this section. None of the tailings dams used for the disposal of mining tailings is lined, and this poses an existing and future threat to groundwater resources located in and around mining areas. Also, in many instances the selection of sites for the allocation of landfills is not done in a step-by-step, strategic manner, which poses a problem if landfills are not sufficiently lined. Rainfall, directly and via river run-off, is the only replenishing source for groundwater. In rural areas in particular, the upstream pollution of ephemeral river water results in contaminated water entering underground sources, leading to its contamination in turn. In addition, the use of insecticides and pesticides in the agriculture sector should be controlled and monitored, especially in areas where valuable groundwater is found, i.e. productive aquifers of excellent quality. Water is recognised as the most important limiting factor to sustainable development; and, in the absence of reliable perennial inland water sources, high value is placed on groundwater resources. Hence, pollution and possible contamination should be avoided at all costs via existing legal, regulatory and conservation instruments.

Assessment of indicators

INDICATOR 3A: Mean annual rainfall

Introduction

Namibia is characterised by low precipitation and high evaporation, meaning that only a small amount of fresh water can be captured for human use. Rainfall and, consequently, river flow and groundwater recharge are extremely variable. A generalised countrywide average rainfall is approximately 272 mm, and all of that may fall within a few days. Mean annual gross evaporation varies from less than 2,500 mm along the coastal and north-eastern parts of the country to in excess of 3,800 mm in the south-east (Figure 3.1). Annual evaporation rates exceed average rainfall by up to six times in most parts of the country. As a result, much of the country's water supply is largely dependent on the limited available surface water and groundwater sources.

Description

The performance of rainfall serves as a useful indicator to water availability potential. In particular, temporal rainfall indicators, such as those based on rainfall time-series, can show trends and cycles in rainfall performance. Rainfall is also a key determinant of the growing season and the type of agriculture practised – as water is limiting for many human activities. Rainfall directly influences surface run-off, stream flow and groundwater recharge.

Results and trends

With the ever-changing global, regional and local climatic patterns, the past, present and future mean annual rainfall trends do not look promising. The number of rainfall events, expressed as an annual average range in days, range from 10–30 days. The length of the rainy season, expressed as the number of months with more than 50 mm of rain, ranges from 1–2 months. Droughts have become common in recent years, affecting at least one part of the country each year. Although average precipitation has been used as an indicator for assessing the short- and long-term influences of rainfall on water availability, these average figures do not necessarily represent the overall water budgets in a specific area. This is so because the time between rainfall events is often long and unpredictable. Nonetheless, because the data sets required for the accurate prediction of effective rainfall are often not readily available, mean annual rainfall can be used as an indicator. Measurements of rainfall that can be used to provide information on rainfall variability and, hence, on the state of water availability include annual and daily rainfall totals and rainfall seasonality, which are then averaged to obtain an indication of trends. Also see figure 3.7.

Goal

With the future rainfall prospects pointing in the direction of drier periods and more of them, preventing pollution and protecting and conserving our currently limited water resources should be the ultimate goal. This can only be achieved through a well-coordinated, combined-effort approach from users and policy-makers, to the various specialists involved in the water sector.

INDICATOR 3B: Annual river run-off

Introduction

The country's low rainfall, high temperatures and high rate of evaporation result in most of the rainfall being lost to evaporation and evapotranspiration. Very little precipitation ends in surface run-off for possible usage by the various sectors. Water flow in rivers in the interior parts of Namibia is intermittent and unreliable, thus decreasing the potential of development of surface water sources (ephemeral rivers) (DWA 2001).

Description

This indicator shows river run-off that could be used by various sectors. River run-off data are available for perennial as well as for selected ephemeral rivers such as the Swakop. The perennial rivers are shared with neighbouring states. At present, Namibia has access to about 180 Mm^3 per annum from the Kunene River, 500 Mm^3 per annum from the Orange, and 125 Mm^3 per annum from the Okavango (DWA 2003).

Results and trends

The data in Figure 3.8a–e show annual river run-offs for selected perennial rivers, measured in Mm^3 per annum (values on the Y axis).

Annual river run-off from ephemeral rivers can contribute significantly to the water supply in rural areas if a higher percentage were to be considered as a safe yield. Due to the country's erratic rainfall conditions, ephemeral river run-off harnessed in dams is unreliable and irregular (Figures 3.8a–3.8e). Estimates indicate that the safe yield from surface water for these rivers is at least 200 Mm^3 per annum, or 40% of the total water resources available in the interior of the country. The DWA has constructed a number of major dams in the country's ephemeral rivers. On average only 13% of the capacity in these dams is available as a safe yield.

Goal

Access to clean water for all, conservation, and effective management are the main goals of international, regional and national water policy frameworks and initiatives. However, in order to achieve these goals, baseline data on the amount of available water resources and their mode of occurrence (surface water, groundwater, etc.) are critical to decision- and policy-makers. Hence, a comprehensive national assessment of water availability needs to be undertaken by removing seasonal and short-term variability to isolate trends and patterns that have regional and national significance.

INDICATOR 3C: Water use and economic efficiency

Introduction

Economic efficiency is based on the concept that water should go to the highest-value producer – a concept being adopted for commercial water uses in the new water policies. The DWA has only recently started to devote time to study this aspect of water use, availability, and economic efficiency. A pilot study based on data collected for 1993 was completed in June 1997 (Lange 1997). More data exist, and the DWA is still busy analysing the estimates for annual comparison. Water scarcity in Namibia is a result of low rainfall, few perennial rivers, few dams, and unsuitable ground conditions. Water resources in Namibia are already utilised to full or near-full capacity. Although most people are aware of the scarcity, water is still wasted irresponsibly.

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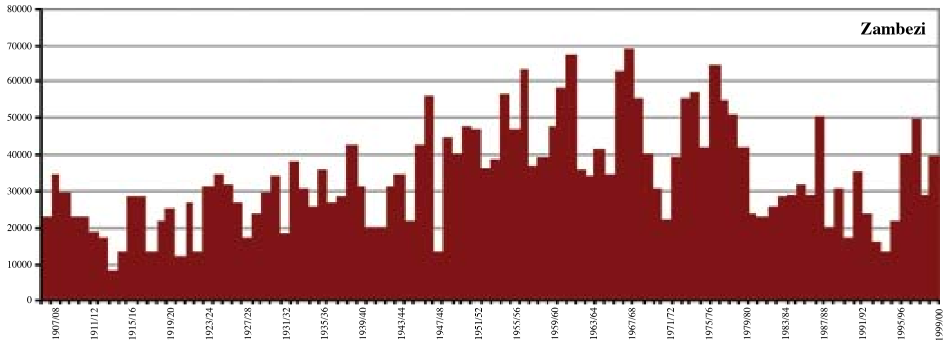
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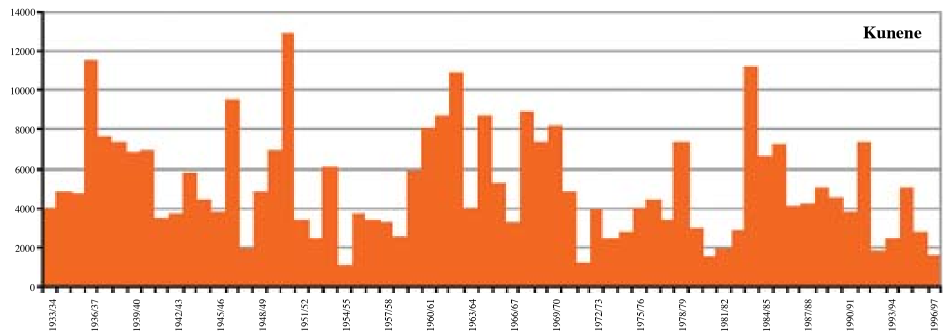
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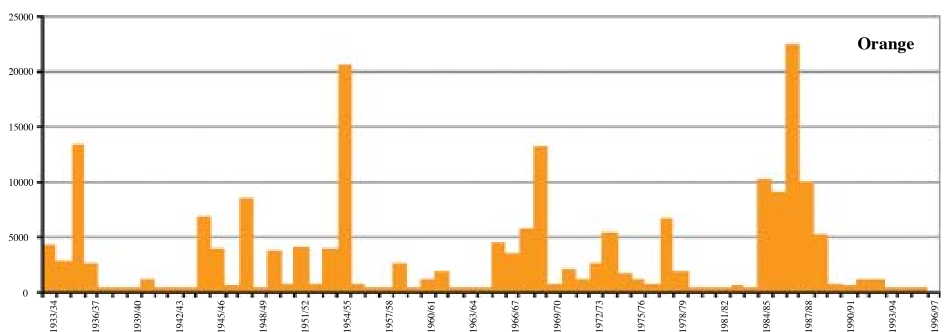
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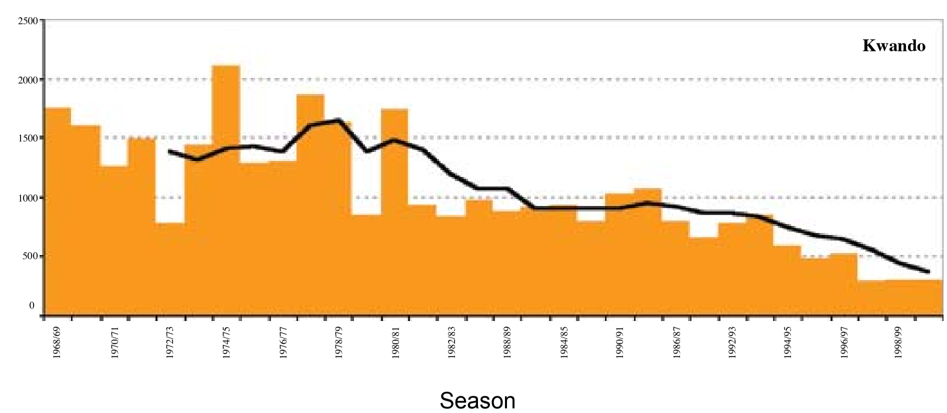
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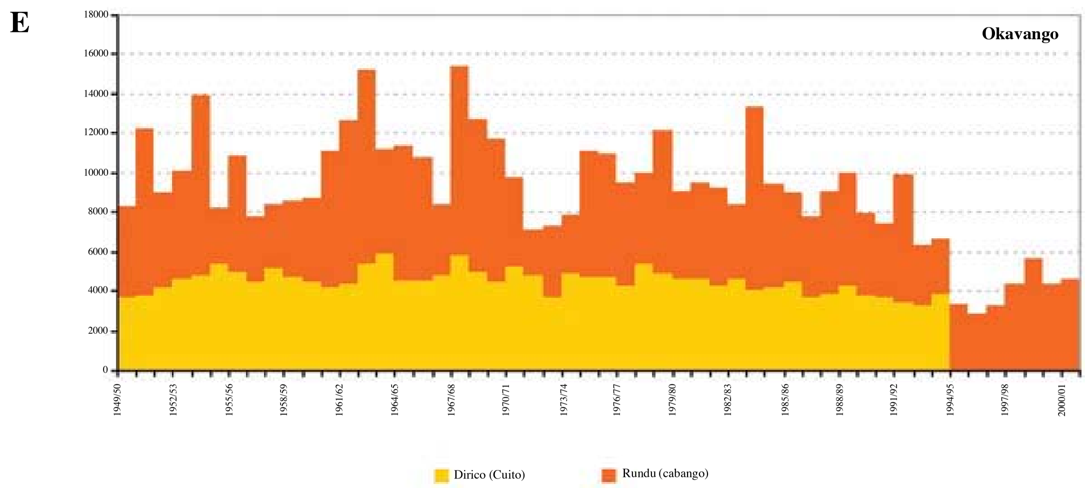

Figure 3.7: A-E: Shows annual river runoff for all perennial rivers bordering Namibia (Mendelsohn et al. 2002)

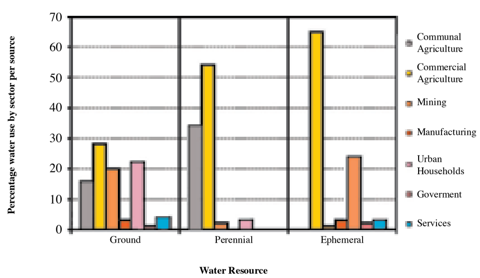

Figure 3.8: Shows the water resources and their distribution among sectors

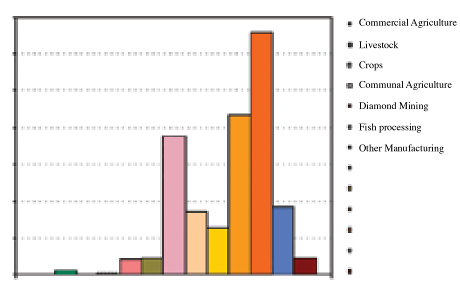

Figure 3.9: Shows the economic contribution (N$) of each sector per cubic meter of water consumed

Description

Levies charged by municipal authorities are a function of the cost directly associated with the technology and infrastructure that provides water, sewage discharge facilities, and recycling facilities. This creates a difference in levies associated with water provision to various towns, so residents may pay more in some towns than in others. This is due to highly developed water infrastructure in other towns resulting in higher capital and operational costs that are then passed on to consumers. However, using the water demand management systems, cost savings due to trimming down infrastructure can be applied when water consumption stabilises.

Results and trends

Since this is a relatively new study area in Namibia, no direct trends are visible. It may be expected that as soon as data for the mid- to late 1990s are analysed, a relatively short time-series can be interpreted if distinct trends are observed. For now, however, the indicator merely serves an informative function by showing the percentage of water used per sector from a particular source (Figure 3.9) and the economic contribution (in Namibia dollars) of each sector per consumption of a cubic metre of water (Figure 3.10). Commercial agriculture is the biggest consumer overall, drawing large percentages of water from perennial and ephemeral rivers. In contrast, Figure 3.10 reveals that commercial agriculture has the lowest economic contribution per unit of water consumed. One might think as the largest consumer of bulk water, agriculture might have a parallel economic contribution.

Goals

The allocation of water to various sectors should reflect the importance of such sectors to the realisation of Vision 2030. Water is an important

Determinant	Group A	Group B	Group C	Group D
Calcium (Ca)	< 375	500	1000	> 1000
Chloride (Cl)	< 250	500	1200	> 1200
Conductivity	< 150	300	400	> 400
Flouride (F)	< 1.5	2	3	> 3
Potassium (K)	< 200	400	800	> 800
Magnesium (Mg)	< 290	420	840	> 840
Sodium (Na)	< 100	400	800	> 800
Nitrogen (N)	< 10	20	40	> 40
pH (acidity)	6 – 9	5.5 – 6 or 9 – 9.5	4 – 5.5 or 9.5 – 11	< 4 or > 11
Sulphate (SO_4)	< 200	600	1200	> 1200
Total Dissolved Solids (TDS)	< 1500	2000	3000	> 3000
Total hardness	< 300	650	1300	> 1300

Table 3.5: Shows the guidelines for the assessment of drinking water for human consumption. This is with regard to chemical, physical and bacteriological quality (measured in mg/l for all except conductivity (mS/m) and pH (dimensionless) (WET 1999).

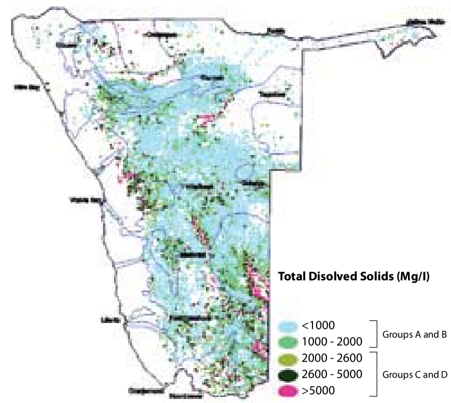

Figure 3.10: Shows the quality of underground water (Mendelsohn et al. 2002) as defined using the Drinking

driving force in respect of socio-economic developmental objectives, as outlined in Vision 2030. Water consumption for production purposes, such as agriculture and industry, provides economic benefits such as incomes, employment, and foreign exchange earnings. While these benefits do not measure the exclusive contribution of water to economic value, they do measure the broadly defined socio-economic benefits from the use of water in one sector relative to another, or in one region of a country relative to another, or in one country relative to another.

INDICATOR 3D: Quality of groundwater

Introduction

As mentioned throughout this report, Namibia is an arid country with perennial rivers only on its northern and southern borders. Essentially, therefore, the country has no surface water except for a few ephemeral rivers, springs, man-made dams and ephemeral pans (*oshanas*) (Krugman 2001; Mendelsohn et al. 2002; WET et al. 1999). Some of the ephemeral river run-off is collected and stored in dams for temporary use by small-scale farmers and on a larger scale for use in urban areas (WET et al. 1999). Generally, surface water is not used for large-scale domestic and industrialised consumption: these are catered for by groundwater. The DWA (2003) estimates the annual available water from groundwater sources at 35.5% of the total available water in the country, with potential availability estimated at 44.1%.

Groundwater abundance is not the only criterion that determines availability for consumption. Equally important is the quality of water. As WET et al. (ibid.) point out, the health of groundwater resources in Namibia needs to be thoroughly assessed in order to determine its usefulness. Factors used to determine such usefulness include the following (in no particular order):

- Proximity to consumers
- Borehole, well or spring yield
- The nature of the water-bearing strata
- Chemical and bacteriological composition of the water
- Stored volume of water and replenishment (recharge), and
- Susceptibility of a groundwater resource to pollution.

Two factors of relevance to this indicator are the chemical and bacteriological composition of the water, and the susceptibility of a groundwater resource to pollution.

Drinking Water Quality Guidelines

In 1988, the then DWA introduced Drinking Water Quality Guidelines that are still being applied in determining the quality of water. However, the current use of these guidelines remains an internal practice only, since they have not been officially approved by following Namibia's post-Independence Government (WCE 2000). These Guidelines record bacteriological, aesthetic and inorganic determinants of concern, and set strict limits for the classification of water. In terms of the Guidelines, water quality is classified as follows (WET et al. 1999; see also Table 3.6):

- A: Water of excellent quality (very safe for human and animal consumption)
- B: Water of good quality (still safe for human and animal consumption)
- C: Water with a low health risk (unfit for human consumption)
- D: Water with a higher health risk (unfit for human or animal consumption)

Pollution of groundwater resources

The quality and fitness of water is defined using a measure of the total dissolved solids (TDS) it contains. The TDS is a measure of the overall concentration of chemicals such as sulphates, nitrates, fluorides and various salts (R Roeis 2004, Control Technician; pers. comm.). If the quality of groundwater is determined to have TDS in excess of 3,000 mg per litre, such water is unfit for human consumption and can be dangerous for livestock. Water with TDS levels above 5,000 mg per litre is not suitable even for livestock (Mendelsohn et al. 2002). Thus, it is extremely important to avoid any anthropogenic pollution or contamination of any water resource.

Pollution of groundwater resources can occur via single or multiple sources, point sources, or non-point sources (WCE 2000). The major sources of pollution are –

- agriculture and gardening
- underground storage tanks for chemicals and petroleum
- landfills, and
- mines.

Agriculture and gardening

Surface and groundwater can be contaminated by chemicals stemming from fertilisers and other products used in agriculture and gardening. Large-scale use of pesticides in the agricultural sector has been responsible for the contamination of groundwater sources, which poses severe health threats to humans. Rivers sometimes transport insecticides and pesticides to the recharge site of important groundwater resources. The seepage of such chemicals during replenishment contaminates the water. Such chemicals not only affect the groundwater and surface water, but may also threaten local biodiversity depending on their concentration in the water (ibid.).

Underground tanks

Underground tanks are used for the storage of petroleum and chemical products. In the event of leakage, underground tanks can cause long-lasting contamination of groundwater (ibid.). The case of the Aroab borehole during the 1980s is a good example of just such an event: underground petrol storage tanks contaminated the water that contributed about 31% of the total water supply to the town. In 1989, the water was sampled again and was still highly polluted (ibid.).

Landfills are the most common way of disposing of municipal waste such as garden refuse, domestic garbage, building rubble, industrial solid waste, industrial waste water, and sludge from municipal treatment facilities (ibid.). When water infiltrates the waste, and if the landfill is not adequately lined, this will form a leachate that can move downward and reach the groundwater. Depending on the composition of waste, landfill leachate can contain harmful concentrations of organic and inorganic contaminants. A determinant of the rate of pollution is the amount of water percolating through the refuse. In places where rainfall is low, solid wastes have less chance of polluting groundwater resources. No examples are available for this means of pollution and contamination, which might be due to the lack of control and monitoring at solid-waste disposal sites.

Mines

Tailings from mining operations are disposed of into tailings dams. This can cause contamination of groundwater by substances, often acidic, used in milling and extraction. None of the tailings dams in Namibia are lined. The tailings dams at the Tsumeb Mine raise particular concern due to the supply of drinking water from the Tsumeb aquifer (ibid.).

Description

This indicator presents an overall picture of Namibia's groundwater quality as determined using the above criteria.

Results and trends

From Figure 3.11 it can be observed that much of Namibia's groundwater is of excellent to good quality. However, many of the groundwater resources are in danger of pollution by the factors elaborated above. None of the tailings dams used for the disposal of mining tailings are lined and this poses an existing and future threat to groundwater resources located in and around mining areas. Also, the selection of sites for the location of landfills is in many instances not done gradually and strategically, which poses a problem if landfills are not sufficiently lined. Rainfall, directly and via river run-off, is the only replenishing source for groundwater. In rural areas in particular, the upstream pollution of ephemeral river water results in contaminated water entering underground sources, which in turn leads to contamination. The use of insecticides and pesticides in the agriculture sector should be controlled and monitored, especially in areas where valuable groundwater is found, i.e. productive aquifers bearing water of excellent quality. Water is recognised as the most important limiting factor to sustainable development; and, in the absence of reliable perennial inland water sources, high value is placed on groundwater resources. Hence, pollution and possible contamination should be avoided at all costs via existing legal, regulatory and conservation instruments.

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Chapter 4: Status of selected natural resources

Introduction
Chapter Overview
Assessment of Indicators
Recommendations
References
Annex 4.1

Introduction

Namibia is extremely dependent on its natural resource base, especially economically, in terms of its contribution to GDP, and at subsistence level through the provision of food and income. Natural resources are currently utilised in mining, commercial and communal agriculture, commercial and subsistence fishing, wildlife-based tourism, and the harvesting of wild resources (flora and fauna) (Lang & Motinga 1997). Namibia's arid environment, variable climate and erratic rainfall impose serious constraints for the sustainable use of renewable resources against the backdrop of an increasing population, especially in rural areas. In addition, resource rent generated from finite resources like minerals are used for current consumption and not reinvested in other assets to secure future wealth and livelihood once such resources are depleted (Lang 2003). Communities in rural areas are almost entirely dependent on natural resources for their livelihood and income generation. Namibia's growth rate is 2.6% per annum (down from 3.1% in 1991), suggesting that the population will double over the next 27 years (NPC 2003). Many researchers and scientists have highlighted the overexploitation or deterioration of certain natural resources such as rangeland (Ashley 1994; Seely & Jacobson 1994), water (Ashley 1995), inland fisheries (Hay 1995), and floral and faunal biodiversity (Barnard 1998; Byers 1997; Jacobson et al. 1995). For many resources where formal management structures are lacking, unsustainable exploitation trends are expected to continue – due especially to rapid population growth in some areas. Diversification of resource use, e.g. through bioprospecting and biotrade initiatives, may create alternative exploitable resources; but as the population increases with concurrent livelihood demands, such attempts may soon suffer overexploitation trends – as is the case with conventional/traditional resources.

In many areas in Namibia, especially rural areas, there are no formal resource management structures in place. Traditional leaders once held ultimate authority over land allocation, but today their roles and functions are not well understood. Due to the absence of effective resource management practices, communities continue to harvest and utilise natural resources at unsustainable levels. Agricultural land is under increasing threat due to overgrazing, overstocking, extreme population density, bush encroachment, and deforestation, which decreases the amount of farmable land a year. According to Hay (1995), exploitation of fishery resources in the Okavango River along Namibia's northern border are close to or exceeding maximum sustainable yield for the system. This is suggested by declining trends in fish stocks, reduction in sizes of individual fish (due to fishing pressure), and the proportion of longer-living species in the catch. All of the above are signs of overfishing. Namibia's commercial marine fisheries have done well, considering the new Government's inheritance, at Independence in 1990, of severely depleted fish stocks (MFMR 2004; Willemse 2002). The MFMR has devoted serious time and effort to devising a strategic action plan for the development of marine and freshwater aquaculture to supplement current marine commercial and subsistence freshwater fisheries.

This Chapter features the following indicators: elephants and giraffes in north-western Namibia; income generated by the CBNRM Programme; harvesting of marine resources; and regulation and control over the harvesting of marine resources.

What threatens natural resources in Namibia?

The biggest threats to natural resources in Namibia are the impact of people and population growth. Unlike the population, the natural resource base does not constantly increase. Population density in certain constituencies exceeds 10,000 people per km^2, and in such areas natural resources are already highly degraded. The annual population growth rate is estimated at 2.6% – at which rate the population will double in the next 27 years (NPC 2003). Hence, the excessive demand on limited resources will gradually increase over time and the increasing scarcity of resources will be accompanied by increasing threats to people's livelihood. The number of people for which the environment can comfortably cater on a per capita basis will concomitantly decrease. Current and future envisaged pressures on natural resources can be mitigated through appropriate policies, management strategies, and approaches to sustainable resource utilisation. However, the success of such measures depends on the level of knowledge people possess about their environment, and their participation in the conservation and management of natural resources. Continuous efforts to educate the public should intensify, therefore, and current approaches need to be reinvented where no progress has been made. In addition, policy- and decision-makers need to remain committed enough to divert necessary resources toward the conservation of natural resources, which form the backbone of Namibia's socio-economic support system.

Extent of risk caused by the threats

The depletion of natural resources in Namibia spells doom for the livelihood of many rural and urban dwellers. Picture the following scenario: most households, communities and tribes in northern Namibia are entirely dependent on natural resources: crop and livestock farming, traditional fishing, harvesting of wild foods, and other, non-consumptive means such as using timber as a building material. If a severe shortage arises, given the lack of outside intervention, many people will starve and, consequently, die. The standard of daily living – which is extremely low – of more than 60% of the population is dependent on the goods and services offered by the natural environment. In addition to the circumstances of the rural population, urban dwellers also depend on the wealth of natural resources – although not for direct personal consumption. Thousands of urban Namibians are employed by industries founded on natural resources. In 2000, the fishing industry employed 6% of the working population. The coastal towns of Lüderitz, Swakopmund and Walvis Bay are heavily reliant on the wealth of marine resources. Fishing provides jobs that allow children to have food and attend school. It also allows businesses that supply goods and services to the fishing companies to thrive. Moreover, not only those directly involved in fishing benefit: a stream of benefits is generated that support the livelihoods of thousands of people who are not directly concerned with fishing. This holds true for Namibia's mining industry as well, and is confirmed through the successful CBNRM Programme. The CBNRM Programme involves communities in the management and conservation of natural resources within their conservancies, while community members benefit through sustainable utilisation of such resources. Yet again, if for whatever reason this support system collapses, thousands of Namibians will be in dire need of food and income.

International Conventions and frameworks

Namibia is a signatory to the Convention on Biological Diversity established during the Rio Earth Summit in 1992. Its main objectives are (UN 1992) –

> … the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and appropriate funding.

Namibia adopted the Rome Declaration on Responsible Fisheries in March 1999 that serves as a global treaty for the implementation of the Code of Conduct for Responsible Fisheries adopted by the UN Food and Agriculture Organisation (FAO) Conference at its 28th Session in October 1995.

Angola, Namibia and South Africa established institutions to enhance the management of fishery resources and capacity-building, namely the Benguela Current Large Marine Ecosystem (BCLME) Project and the Benguela Environment Fisheries Interaction and Training (BENEFIT) Programme. The BCLME Project has a transdisciplinary approach to the conservation and management of resources derived from the Benguela Current, while BENEFIT serves as the Project's scientific wing.

National policies and measures

The *Government Gazette* publishes regulations relating to the exploitation of marine resources following each series of amendments to the Marine Resources Acts, 1992 (No. 29 of 1992) and 2000 (No. 27 of 2000). Regulations are very detailed and emphasise infringements that are prosecutable by law. It is the responsibility of each individual/group and/or company engaged in harvesting marine resources to be familiar with the regulations and to abide by the laws stipulated. In addition to regulations, a Fisheries Observer Agency (FOA) was established in 2002 to monitor fishermen's on-board and onshore operations and activities. Fisheries observers (on-board) and inspectors (onshore) are familiar with the regulations and, as far possible, ensure that they are followed.

Chapter overview

The importance of natural resources in Namibia cannot be overemphasised. From subsistence farming to high-tech diamond mining, natural resources support not only the economy, but also socio-economic aspects and the people's social well-being. This Chapter features selected natural resources or sectors of them, as prioritised by stakeholders during the selection and development of indicators. Hence, this assessment makes no claim to a thorough assessment of natural resources, but could serve as an example for the future assessment of other specific resources.

In the midst of a growing population with concurrently growing demands, it is essential to know the current state of natural resources and exploitation levels. The CBNRM Programme has thus far been hailed as an initiative that has brought people closer to their resources and has been responsible for the recovery of some wildlife populations. Conservancies show a heavy reliance on wildlife and other natural resources since they secure the livelihoods of their communities through ecotourism ventures. Elephants, with their enormity and demanding presence, have attracted attention for most of their existence. Such attention has not always been beneficial to them, as hunters pursued them for their valuable tusks. Namibia's desert-dwelling elephant population in the north-west was heavily reduced during the early 1980s due to war and drought. Today, this population is close to 800.

Namibia has always been associated with industrial marine fisheries. This sector supports the livelihoods of thousands of coastal residents and contributes substantially to the GDP. More than 90% of fish and fishery products, including shellfish, are exported overseas. Any negative impact in the industry will have negative impacts downstream on employees and other businesses that provide goods and services to the sector. Hence, the local coastal business community often refer to a poor fishing season when business is not good.

The CBNRM Programme has shown immense growth since its inception in 1996. This is in terms of the number of conservancies registered and gazetted, the number of people benefiting from such conservancies, and economic benefits to the country overall. Many conservancies still receive donor assistance, whereas more than 50% generate an income to finance their operational costs and declare dividends to their members. In 2003, the income generated by the CBNRM Programme was estimated at N$14.5 million, compared with N$3.5 million in 2000. In 2003, income ranged from a maximum of just over N$1.8 million (Uibasen) to a minimum of N$65,000 (Sorris Sorris). A further developmental aspect of the Programme is the relocation of game into conservancies for the promotion of tourism-related activities, and the provision of meat to communities based on annual, pre-calculated offtake rates. Successful joint ventures between conservancy members and private hunters, tour operators and businessmen have led to diversification of resources and, subsequently, diversification of income. More conservancies are in the pipeline and local people are developing a sense of partnership and ownership. The CBNRM has proven successful in providing jobs to community members, especially via tourism and the increase in wildlife numbers. The CBNRM experience suggests that, once communities start to take responsibility for their environment and they realise the economic and aesthetic benefits of doing so, they tend to conserve and protect. In 2002 the CBNRM Programme contributed N$39 million to the national economy.

Elephants in north-western Namibia

Elephants are a keystone species, and are sometimes referred to as the 'engineers of the jungle' because they have such a tremendous impact on their environment. They consume massive amounts of food and water, create roads through the bush, and dig waterholes. It is likely that having either too many or too few elephants in an area has a detrimental effect on an ecosystem. It is possible that some places have too many, such as the parks in the Caprivi and north-eastern Kavango Regions. This has resulted in irreversible damage to the delicate riverine habitat along the Okavango River, with few large trees left standing. The economic implications are related to the destruction of unique habitats that support specialised and valuable plant and animal species such as the lechwe. In addition, an ecosystem damaged by elephants might be less appealing to tourists, which entails a reduction in tourism revenue.

The population of desert-dwelling elephants in north-western Namibia was very low during the early 1980s due to war and severe droughts. However, as the latest survey results suggest, elephant numbers have recovered to their 1960s levels of between 600 and 800. Disease is still a problem, with one animal dying of anthrax in around 1991/2, prompting the MET to immunise all other animals in the area. In the light of expanding elephant numbers in north-western Namibia and the relative stability of that area, more research is needed on their movement and behaviour patterns.

Harvesting of marine resources

The levels of most of Namibia's commercial marine fish stocks were very low at Independence in 1990. The MFMR took a firm position on rebuilding stocks, imposing a moratorium on illegal fishing vessels and instituting a Namibianisation policy. Since Independence some stocks have shown rapid recovery, while others remain depressed due mainly to unfavourable environmental conditions and excess fishing. Regarding the latter, for some species landings have been above the total allowable catch (TAC) for successive years, suggesting too much pressure on the stocks. Many people in the industry remain pessimistic about some stocks recovering to healthy levels. A thorough understanding of the dynamics of the Benguela ecosystem still remains a major constraint, and the predicted effects of climate change only exacerbate the situation. Nonetheless, the MFMR remains committed to the management and sustainable use of the resources while continuously developing their capacities to conduct their work more effectively.

Monitoring and control of the harvesting of marine resources

Since the formal establishment of the MFMR, illegal fishing and associated practices have been minimal in comparison with pre-Independence practices. Rigorous beach, water and air patrols, along with the presence of observers on fishing vessels, go a long way towards ensuring that Namibia's marine resources are protected and not overexploited. The "Harvesting of marine resources" indicator (indicator 4C) shows that many commercial stocks are still in dire straits, which scientists believe can be attributed to environmental conditions. Others argue that the current levels of fishing (the number of fishing vessels per fishery) are excessive. Therefore, fishing companies place huge pressure on decision-makers for adequate TACs, which often results in pressure on the resources. As more data become available, a follow-up assessment will show trends in the monitoring and control over the EEZ and its inhabitant resources. It should be noted that fisheries are not the only threat to the abundance of resources and the biodiversity of the Benguela ecosystem: other coastal land and marine resource uses also need to be assessed.

Assessment of indicators

INDICATOR 4A: Trends in the CBNRM Programme

Introduction

Severe wildlife poaching – especially of black rhino and desert-dwelling elephant, accompanied by the worst drought for decades, significantly reduced the wildlife populations along most of the northern parts of Namibia prior to Independence (Humphrey & Humphrey 2003). In the 1982–1983 period, a community game guard system was established in the north-west of the country. This system bestowed authority upon traditional leaders to appoint local people as wildlife extension officers with the aim to cease poaching (ibid.). This initiative proved successful, expanded rapidly, and contributed to the establishment of Namibia's CBNRM Programme. In 1994 the community at Torra Bay appointed four senior and respected local residents, with sound knowledge of the area, its people and wildlife, as community game guards (ibid.). After Independence, the new Government realised that conservation legislation, which had granted only commercial farmers conditional wildlife utilisation rights since 1968, was discriminatory and inconsistent with the Constitution. Therefore, in November 1996, an amendment to the conservation legislation was gazetted, allowing rural communities to obtain conditional rights to wildlife occurring within their areas. When the legislation came into force, Torra was already registered as a Trust to be recognised

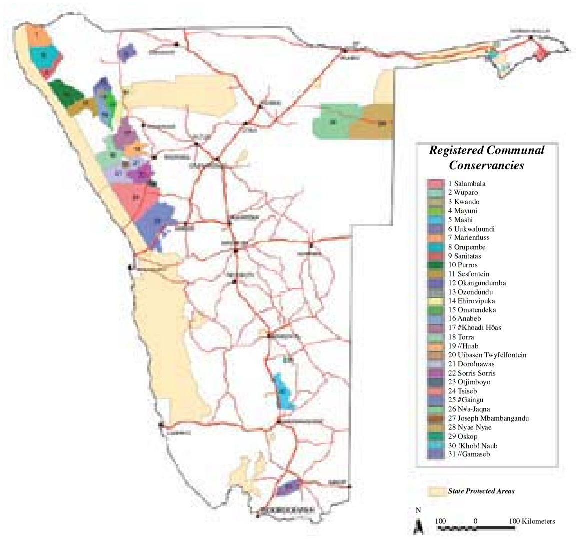

Figure 4.1: Registered communal conservancies in Namibia MET, 2002

as a legal entity to enter into partnership with Wilderness Safaris Namibia (WSN) (ibid.). With the advent of the CBNRM Programme in 1996, the Torra Conservancy was established within a short period of time because the community institution already existed.

Namibia's CBNRM Programme seeks to improve the quality of life of rural Namibians by empowering them to care for their environment while they derive benefits from natural resources (Long 2004). The Programme is supported by Government – specifically the MET, donor organisations, local NGOs, and communities. Since the Programme's inception in 1996, many conservancies experienced economic and socio-economic development due to joint ventures with private tour operators, hunters and tourism investors. To date, 29 conservancies have been registered and gazetted (Figure 4.1), covering an area of 71,394 km^2 (almost 9% of Namibia's land surface area), with 37,000 registered individuals and incorporating a quarter of a million people (ibid.). A further 35 conservancies – incorporating an estimated 50,000 to 60,000 more people across the country – are preparing for registration.

Description

This indicator shows trends in income generated from the CBNRM Programme and the conservation of wildlife populations.

Results and trends

Thus far, the CBNRM Programme has shown immense growth from a financial perspective (Figure 4.3) in terms of the number of conservancies registered and gazetted, and the number of people benefiting from them (Figure 4.4). From Figure 4.2 an increasing trend in income earned from different sources is observed, although donor agencies still inject substantial amounts of money into the Programme. According to Long (ibid.), the

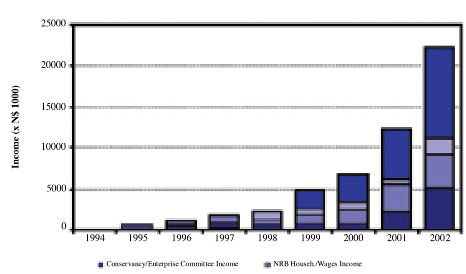

Figure 4.2: Shows income from different sources generated by the CBNRM program in Namibia (Long 2004)

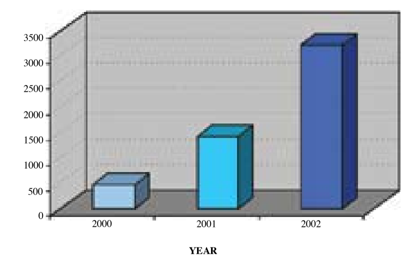

Figure 4.3: Shows cash revenue generated by conservancies. Such revenues exclude donor funding and/ or any other contributions not generated by conservancies (LIFE Program, 2002)

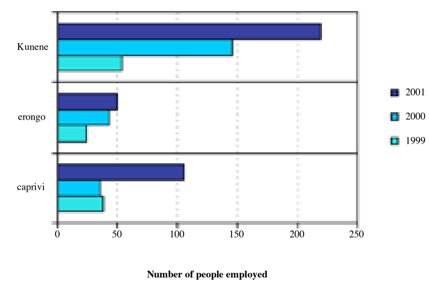

Figure 4.4: Number of people, by region, employed in local jobs from communal area tourism (Long 2004)

Programme generated income estimated at N$14.5 million in 2003, compared with N$3.5 million in 2000. This suggests immense growth – especially considering an estimated 50% of conservancies currently generate income (ibid.). In 2003, income ranged from just over N$1.8 million (Uibasen) to N$65,000 (Sorris Sorris). A further developmental aspect of the Programme is the relocation of game into conservancies for the promotion of tourism-related activities, and the provision of meat to communities based on annual, pre-calculated offtake rates. Successful joint ventures between conservancy members and private hunters, tour operators and businessmen have led to diversification of resources and, subsequently, diversification of income. More conservancies are in the pipeline, and local people are developing a sense of partnership and ownership.

The CBNRM has proven successful in providing jobs to communal people, especially through tourism. Figure 4.4 demonstrates the increasing number of people in tourism jobs for three Regions from 1999 to 2001. Annex 4.1 shows the increase in wildlife numbers attributable to the CBNRM in north-western Namibia. Once communities start to take responsibility for their environment and realise the economic and aesthetic benefits of doing so, they tend to conserve and protect. The CBNRM Programme has ably demonstrated this since 1996.

Box 4.1: CBNRM - contributing to the national economy

The World Wildlife Fund (WWF), a partner organisation to the CBNRM, has undertaken basic analyses on the total revenues generated by trophy hunting concessions, joint ventures, thatching grass, and the community based tourism enterprises (CBTEs) the CBNRM has directly assisted with establishment. Some activities are end products while the thatching grass (sold as raw material) has generated a stream of benefits including transport and value addition toward the final product (LIFE Programme 2002). Table 1 below resulted from this analyses and shows the respective income generated that amounts to a grand total contributing to the national economy for 2002.

Table 3.1: Shows the results of the WWF analyses of CBNRM income toward the national economy (LIFE Program 2002).

Type of enterprise	Total estimated 2002 turnover (N$)
Joint-venture Lodges	13,429,615
Trophy Hunting	4,390,000
Thatching Grass	14,325,000
Other Direct Incomes	3,955,037
Grand Total	**36,099,652**

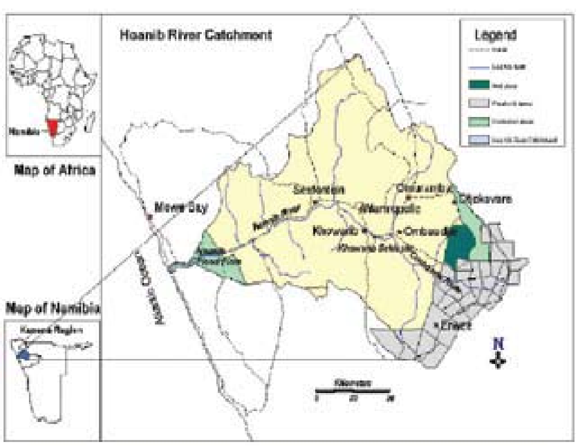

Figure 4.5: North-western Namibia (Legget undated)

Goals

The Programme should ultimately be self-sustainable, whereby communities are fully responsible for deriving their livelihood from natural resources and by safeguarding the biodiversity and abundance of such resources. For conservancies to develop in currently under-represented areas, the implementation of pending legislation and policies, and the implementation of various monitoring and management tools within established conservancies is crucial (see also Box 4.1).

INDICATOR 4B: Elephants in north-western Namibia

Introduction

This indicator uses abundance and distribution data for elephants in north-western Namibia to show trends. The abundance of large mammals may suggest healthy environmental conditions and an increased rate in reproductive success, as well as decreased human-induced mortalities. Evidence of an increase in numbers of the three main elephant populations in northern Namibia may suggest the advantage of the CITES Convention.

North-western Namibia is very isolated, yet scenically spectacular (Figure 4.5). Human habitation has long been associated with the Kunene Region, with old settlements estimated to have existed approximately 600 years ago (Kinahan 1991). Today, the population of this area is estimated at 7,000 people, who live mostly in the eastern section of the catchment where rainfall is highest. However, nomadic peoples such as the Himba have seasonally used the entire area.

The emergence of conservancies under the CBNRM Programme has brought a modern change to traditional land-use practices, and in some areas has resulted in a change of attitude and tolerance amongst communities for wildlife, especially elephants. People are now starting to recognise the aesthetic, tourism and ecological value of elephants and now alert the authorities when there is a problem animal rather than kill it.

Elephants are a keystone species, and are sometimes referred to as the 'engineers of the jungle' because they have such a tremendous impact on their environment (Sutton n.d.). They consume massive amounts of food and water, create roads through the bush, and dig waterholes. It is likely that having either too many or too few elephants in an area has a detrimental effect on an ecosystem. It is possible that some places have too many, such as the parks in the Caprivi and north-eastern Kavango Regions. For instance, elephants are known to inhabit parks such as the Mahango on the Okavango River only during the dry season. Recently it has been observed that a few members of the growing elephant population in the park remain there for the entire year (ibid.). Their behaviour could perhaps be explained as being due to the loss of traditional migration paths because of increased human development, a veterinary fence along the Namibia–Botswana border, and the war in Angola. This has resulted in irreversible damage to the delicate riverine habitat along the Okavango River, with few large trees left standing. The economic implications are related to the destruction of unique habitats that support specialised and valuable plant and animal species such as the lechwe. In addition, an ecosystem damaged by elephants might be less appealing to tourists, which entails a reduction in tourism revenue (ibid.).

Description

Elephants and giraffes as big and abundant mammals have important ecological functions through the sequence of grazing, which probably is affecting the whole vegetation and through that affects the living conditions of various species.

Results and trends

Before the 1900s there were probably between 2,500 and 3,500 elephants in north-western Namibia. This population was hunted extensively by Boer and European hunters in the later part of the 19th century without ever really decreasing their numbers (Leggett et al. 2001, cited in Viljoen 1987).

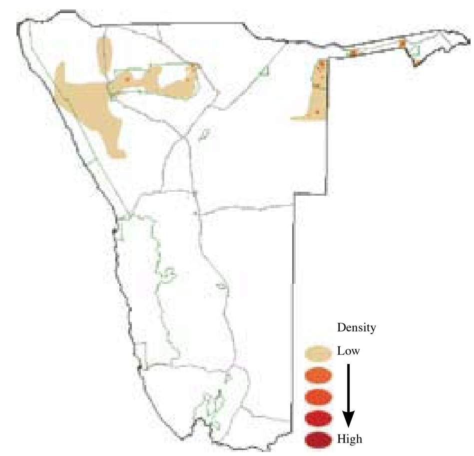

Figure 4.6: Distribution and density of elephants in Namibia

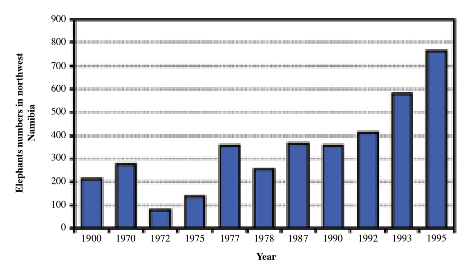

Figure 4.7: Shows an increasing trend in the elephant population of Namibia during the 1900s

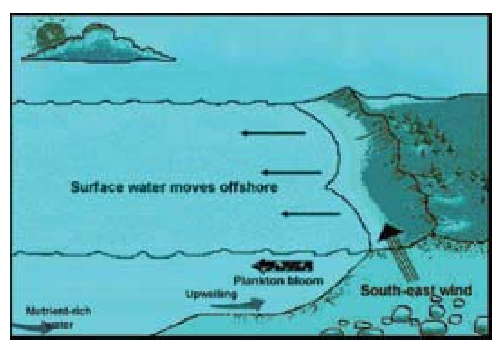

Figure 4.8: Upwelling occurs when strong southerly winds blowing parallel to the coastline cause a westerly offshore movement of coastal surface water causing nutrient-rich deeper water to "well up" and replace the surface water (Botha 1998). Pelagic organisms thrive on this process.

Footnotes

[19] Small fast-growing species such as sardines and anchovy occurring in the upper part of the water column in the ocean. These are usually reduced to fishmeal and oil.
[20] Two examples from Namibia are the valuable Cape hake species and the lesser valuable Cape horse mackerel species that occur deeper in the ocean from about 200-300 metres.

Due to expanding human settlements, hunting and poaching, the number of elephants in the north was thought to be between 600 and 800 by the 1960s (Leggett et al. 2001). This number was further reduced by war and drought to approximately 357 individuals by 1983 (ibid.). They latest survey results suggest that elephant numbers have recovered to 1960s levels (ibid.). Disease is still a problem, with one animal dying of anthrax in around 1991/2, prompting the MET to immunise all other animals in the area. Leggett et al. (2001) maintain that, in the light of expanding elephant numbers in north-western Namibia and the relative stability of that area, more research is needed on their movement and behaviour patterns. Also see figures 4.6, 4.7 and 4.8

INDICATOR 4C: Harvesting of marine resources

Introduction

Namibia's fishing industry is based on the Benguela Current, one of the four eastern boundary upwelling systems in the world, which is rich in pelagic[1] and demersal[2] fish populations supported by high plankton productivity generated by intense upwelling.

Namibia's offshore marine fishery resources suffered severe exploitation at the hands of foreign fishing nations (Willemse 2002). FAO (2001) reported a threefold increase in global fishery catches over the past few decades, from 40 million metric tons in 1961 to 120 million metric tons by 1998.

Fishing and vessel technology improved rapidly during the 1950s, which brought about the intensification of harvesting methods and allowed for longer fishing periods due to on-board freezing and processing capacity, and the ability to travel far distances to fish. As fishing grounds became depleted in the northern hemisphere, fishermen started moving from the 'core' fishing areas of the world to unexploited fishing grounds (Caddy & Gulland 1983). During the 1960s more than 300 distant water fleet (DWF) vessels were spotted along the Namibian coast (Sumaila 1998), suggesting fishing pressure of unprecedented magnitude. Namibia was under South African rule and foreign nations did not recognise South Africa's authority over Namibian marine resources. Thus, the Benguela Current was regarded as a common pool resource where access was neither restricted nor limited (Willemse 2002). DWFs targeted mainly Cape horse mackerel (*Trachurus capensis*) and Cape hake (*Merluccius* species). Prior to 1990, Portugal and the former Union of Soviet Socialist Republics (USSR) caught 88% of the hake available off the Namibian coast, while Bulgaria, Cuba, Poland, Romania, Spain and the USSR caught 78% of the horse mackerel (Sumaila 1998). Much of the catch was processed on-board, and shipped off to the vessels' respective home countries without any benefits accruing to Namibia or its people. An analysis of trends in landings indicates increasing catches and associated stages of the fishery during the 1950s and 1960s, followed by a decline from early 1970 to the present day (Figure 4.2).

At Independence in 1990, many of Namibia's commercial marine resources were severely depleted. Since then, some stocks have started to recover and a few have done so dramatically, while others remain in depressed states (Iyambo 2001). From 1990 onwards, therefore, the new Namibian Government implemented sound management policies, obliged the participation of the previously disadvantaged in the industry, and secured the livelihoods of many Namibians.

The Benguela Current upwelling system can be extremely variable, influencing the abundance and distribution of stocks. This inherent variability, in addition to past overexploitation, causes major changes in fish abundance in the south-western coastal region (O'Toole 1997). The occurrence of major environmental anomalies since 1982 has caused major fluctuations in the distribution and abundance of especially pilchard/sardine and anchovy. Due to periodically unfavourable environmental conditions, the task of managing Namibia's marine fishery resources sustainably is a serious challenge to both decision-makers and fishermen.

The fishing industry in Namibia is important economically and socio-economically. Since Independence, the fishing industry's contribution to GDP – measured in current prices –increased from 2.1% in 1990 to 5.9% in 2001 (NPC 2003) (Annex 4.1). Over the past few years, fisheries have experienced some hardship: pelagic fish stocks have decreased due mainly to environmental changes, as have foreign earnings due to fluctuations in the US dollar–South African rand exchange rate. Socio-economically, the industry supports three coastal towns: Lüderitz, Swakopmund, and Walvis Bay. Thousands of people are employed by the industry, ranging from top managerial positions to labourers and artisans. The social welfare of these towns is without any doubt dependent on the stability of the industry, which relies on the abundance and distribution of marine fishery resources. With so much at stake, the importance of continuous research and resource management by the MFMR cannot be overemphasised to ensure long-term harvesting at sustainable levels.

Description

Using total landings, which include by-catches, this indicator shows trends in marine fishery resource catches.

Results and trends

This section features total landings for Namibia's marine fisheries from 1990 to 2002 (Figure 4.9) and historical landings from 1950 to 2002 (Figure 4.10).

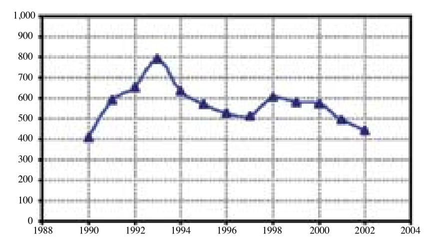

Figure 4.9: Total fisheries landings for Namibia since independence (MFMR 2002)

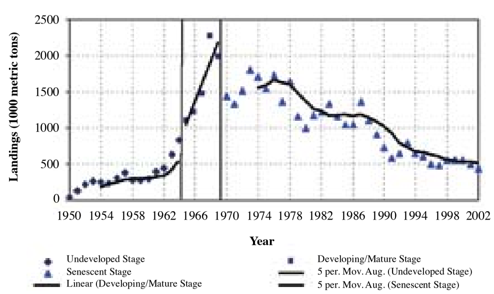

Figure 4.10: Shows historical trends in landings for the Namibian fishery since 1950. Note the three developmental stages of the fishery based on landings trends (Willemse 2002)

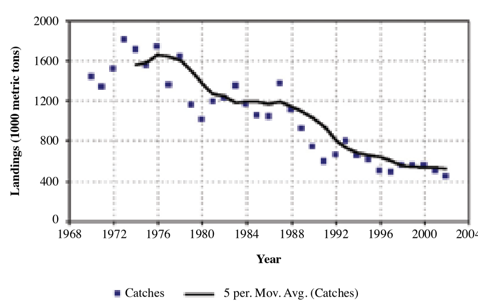

Figure 4.11: Shows a decreasing trend in catches for the Namibian fishery from 1970 to 2002. Fluctuations in total landings can be observed until 1983 thereafter catches declined with a brief increase in 1993 (Willemse 2002; MFMR 2002).

It also computes a ratio of landings versus TACs, which is used to measure fisheries management.

Fisheries landings increased after Independence, and reached a peak of close to 800,000 metric tons by 1993. These were the highest recorded total landings after Independence. For the remainder of the 1990s and the beginning of 2000, landings remained relatively stable with a declining trend observed for the final three years of the decade. This was due mainly to unfavourable environmental conditions that affected small pelagic fish stocks in particular. Landings for many of the major commercial stocks started to decline from 1999, with zero TAC declared for pilchard in 2002. Anchovy remained in a depressed state for most of the 1990s, but landings increased from 146 metric tons in 2000 to more than 6,000 metric tons in 2001, and shot up to approximately 40,000 metric tons in 2002.

Based on historical catch figures, Namibia lost millions of dollars due to virtually no participation in the fishery and the lack of control over marine resources prior to Independence. Catches peaked during the late 1960s and, following the collapse of the pilchard/sardine stocks, the trend in total landings has been declining (Jurgens 1998).

Landings show a declining trend for the period 1970–2002 (Figure 4.3). The history of the fishery confirms increased development, diversification of target species, and excessive fishing effort – especially from the 1960s onwards. More than 300 DWF nations trawled the Namibian coast at the time. After the collapse of the sardine fishery in 1968, catches started to decline, a trend that can be observed from 1970 to 2002 (Figures 4.10 and 4.11). After Independence, although many stocks were in depleted states, catches increased from about 400,000 metric tons in 1990 to almost 800,000 metric tons in 1992. Thereafter, catches gradually declined to approximately 500,000 metric tons in 1997 (Figure 4.9). A brief increase of roughly 100,000 metric tons was observed in 1998, followed by gradual declining catches until 2004 (Figure 4.9).

From an ecosystem perspective, major fluctuations are suggested in species dominance from 1970 to 2002. Most marine ecosystems generally have a high abundance of low trophic-level intermediate species – such as pilchard, anchovy, juvenile horse mackerel and pelagic goby in the case of Namibia – that dominate fisheries catches, i.e. represent the highest numbers in catch compositions. However, from Figure 4.11 it is apparent that this was not the case for Namibia following the collapse of

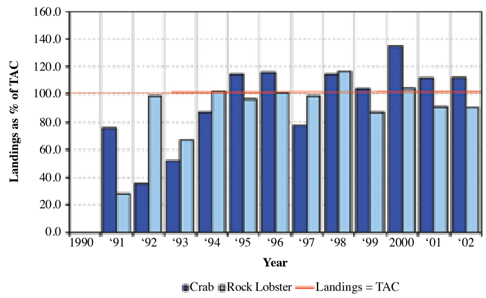

Figure 4.12: Shows total landings for crab and rock lobster as a percentage of total allowable catch (TAC). The inserted red line indicates where landings equalled 100% of the TAC. Where the % exceeds the red line it may suggest heavy fishing pressure.

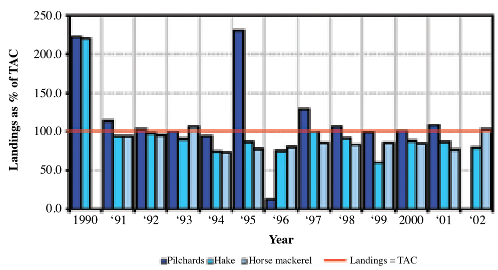

Figure 4.13: Shows total landings for pilchard, Cape hakes and adult horse mackerel as a percentage of total allowable catch (TAC). The inserted red line indicates where landings equalled 100% of the TAC. Where the % exceeds the red line it may suggest heavy fishing pressure. (MFMR 2004)

pilchard/sardine stocks in 1968. Heavy fishing pressure impaired the ecosystem due to shifts in the abundance ratio of piscivorous (i.e. fish- and shellfish-eating species such as Cape hake) to planktivorous (i.e. plankton-eating species such as pilchard and anchovy) fish. Such changes upset the balance of the ecosystem, affect primary fisheries production upwards, and threaten the existence of species along the Benguela as they already battle against periodically unfavourable environmental conditions. It is fair to say that so much damage done to the system, over and above socio-economic demands and unfavourable environmental conditions, the MFMR's job is definitely an overwhelming challenge.

With reference to Figures 4.12 and 4.13, TAC is calculated for each species and used as an output control, i.e. to ensure that no excess fishing occurs to endanger stock levels. Calculating landings as a percentage of TAC shows whether the fishery has met the TAC, caught below it, or exceeded it. Figure 4.12 reveals that crab have been caught above the TAC for most of the years from 1990 to 2002. The latest annual report by the MFMR (2004) does not suggest that the stock is in danger, however. Rock lobster landings only exceeded the TAC once, i.e. by 16% in 1998. The MFMR (ibid.) indicates that the biomass remained stable for new recruits to the fishery but declined for adult lobsters. Total fishable biomass was estimated below 2,000 metric tons, while a TAC of 400 metric tons is regarded as a precautionary measure (ibid.). For the three major commercial finfish species, the following is observed: only pilchard landings exceeded the TAC a number of times (Figure 4.13), while hake exceeded it once (in 1990) and horse mackerel twice (in 1993 and 2002) in the period reveiwed. Pilchard landings exceeded the TAC by more than 100% in 1995, leading to the landing of a mere 12% of the TAC in 1996 (ibid.).

After Independence, the MFMR imposed strict controls (see also the "Regulation and control over marine resources" indicator) over Namibia's newly proclaimed EEZ along with stock rebuilding and Namibianisation policies. Since then, some stocks have started to recover and a few have done so dramatically, while others remain in depressed states due, recently at least, to anomalous environmental conditions

Goals

- To continue to improve scientific and management capacity to allow deeper understanding of the Benguela Current as a large marine ecosystem
- To compute optimum levels of fishing efforts for individual stocks in order to use such levels in a precautionary approach, and
- To continue with, and extend where necessary, the presence of fishery observers aboard commercial vessels, to oversee offshore operations and to report infringements.

The MFMR should continue with its 'best-approach' system for stock assessments in order to provide sound advice on TACs. Trade-offs can at times not be avoided due to conflicting interests and needs, but the MFMR needs to take a firm stand on its decision to ensure that fish remains available as food and a source of income for future generations. In addition, a rapid approach should be devised and implemented for the development of large-scale commercial mariculture that can supplement capture fisheries and possibly serve as an alternative job-providing industry.

INDICATOR 4D: Monitoring and control of harvesting of marine resources

Introduction

Prior to Independence in 1990, Namibia did not have an effective EEZ with proper monitoring, control and surveillance (Manning 1998). DWFs, i.e. fishing vessels from foreign nations, arrived as far back as the early 1960s, and explored Namibia's coast to exploit its living marine resources. The International Commission for South-east Atlantic Fisheries (ICSEAF), established under a UN initiative in 1969, was responsible for Namibia's fisheries prior to 1990, but were ineffectual because they were based in Madrid (Willemse 2002). ICSEAF took the initiative to introduce regulatory measures like catch quotas, minimum mesh sizes, and a closed coastal zone of 25 km off Namibia's coast to protect breeding and spawning grounds of pilchard and anchovy (Moorsom 1984). These attempts to curb excessive fishing efforts proved futile, however, and fish stocks continued to suffer under unsustainable exploitation patterns. According to Bonfil (1998), during the 1960s, 1970s and 1980s, the USSR had a 32% market share in Namibia's fishery, followed by Spain with 26%, and South Africa with 7%. Cape hake stocks declined by more than 50%, while sardine fell to 2% of their previous levels between 1976 and 1986 (Willemse 2002).

The South West African Administration in Namibia at the time attempted to enforce regulatory and control measures, but they were ignored by the DWFs since the international community regarded South Africa's occupation in Namibia as illegal. Fishing companies also did not comply with quota restrictions, and supervision over the fishing activities of small purse-seiners and independent monitoring of production processes proved futile (Moorsom 1984). In addition, fishing companies were suspected of under-recording their actual landings. In the mid-1970s, Government officials were suspected of being bribed to pass pilchard off as 'other species'. Dumping at sea was common and large-scale at times. This was caused by a difficulty to distinguish between sardine and anchovy, and by the rigid demands of companies' catching programmes. Dumping intensified after 1971 when companies feared filling their fishing quotas prematurely and being laid up before the fishing season had ended (ibid.). Hence, due to a lack of management and regulatory regimes, Namibia's fishery resources suffered severe overexploitation together with economic losses, since little or no revenue accrued to Namibians prior to Independence.

After 1990, the new Government assumed control over its EEZ by forfeiting the fishing activities of more than 90% of the unlicensed foreign vessels (Bonfil 1998). This marked a new era for the Namibian fishing industry. Today, the MFMR is challenged with the regulation of fishing capacity at a level consistent with sustainable harvestable resources. To ensure no illegal entrants to the fishery, the MFMR boasts a well-equipped fisheries inspectorate that patrols the coastline and conducts surveillance in the EEZ for any illegal fishing activities or other infringements. In addition, the FOA is responsible for on-board monitoring of fishing vessels to ensure that fishery control measures (input and output controls – see Box 4.2) are conformed with, as set out in the MFMR's Regulations relating to the exploitation of marine resources, as gazetted in December 2001.

Box 4.2: Fisheries control measures

Fisheries control measures are designed and implemented to control the amount of effort used to harvest fishery resources (input controls) and to control the amount of fish and specific species that can be harvested (output control). Below following are examples of controls used in Namibia.

Input controls
These relate to controlling fishing effort (i.e. the number of nets used, the horsepower of the vessel, number of hooks, etc) and gear, and to the permissible time (i.e. specific time of year based on the lifecycle of a species) and place (based on the distribution of the species at different lifecycle stages) that fishing may take place. This is implemented mainly by limiting the number of vessels (also effort) licensed to fish in Namibian waters, setting regulations regarding the types of fishing gear vessels may use, and by restricting the time of year fishing can take place and seasons. Input controls are specific to a fishery but there may be cross-cutting controls applicable to different fisheries.

Output controls
These relate to setting limits (total allowable catch or TAC) and regulations (what type of species may be caught) on the amount of fish that may be caught, and on the size and other characteristics of the fish that may be landed. The main control is by the establishment of TACs and quota allocations.

Source: MFMR 2004

Illegal fishing, both commercial and small-scale, still exists, but to a far lesser extent. Since dumping is prohibited, the MFMR and FOA do their utmost to enforce this regulation. Full credit is due to the MFMR for their efforts to conserve and protect living marine resources, although the highly variable Benguela Current has a large role to play as regards the abundance and distribution of commercially exploitable resources.

In addition to national efforts, Angola, Namibia and South Africa undertook to join forces to

Figure 4.14: Shows the coverage of both the BCLME and BENEFIT Programmes in southern Africa. (The BCLME Project, www.bclme.org)

conserve living marine resources, build technical and scientific capacity, and promote regional marine fisheries management. The BCLME Project is a multinational, cross-sectoral initiative that promotes the management of the living marine resources of the BCLME in an integrated and sustainable manner, and protects the marine environment. The Project is currently funded by the Global Environment Facility (GEF) under its International Waters portfolio on a five-year basis (current funding window: 2002–2006). At present, the Project focuses on key issues, including fisheries, environmental variability, seabed mining, oil and gas exploration and production, coastal zone management, ecosystem health, socio-economics, and governance.

The BENEFIT Programme is also a regional partnership between Angola, Namibia and South Africa. The emphasis of this programme is on research, capacity-building and training. BENEFIT was originally founded in 1995; in 1996, SADC adopted it as a project, and formally inaugurated it in April 1997. Current research is centred on stock assessments and monitoring of environmental parameters related to the natural variability of resources. The core focus is on sardines, anchovy, Cape hake, Cape horse mackerel, and crayfish as primary target species. However, this does not disqualify research of other developing fishery species or straddling stocks, as deemed important within the region of the Benguela Current.

Although much effort is directed to fisheries management on national and regional scales, some scientists believe that natural environmental variability and the difficulty to forecast anomalous events remain the biggest challenge in fisheries management.

Monitoring, control and surveillance efforts by the MFMR and FOA

The following list indicates infringements recorded by the MFMR's Fisheries Inspectorate during routine beach patrols:

- Being in possession of undersized white mussel
- Being in possession of polychaete worms
- Fishing without a valid permit
- Being in possession of undersized rock lobster
- Being in possession of undersized fish, i.e. below 40 cm
- Being in possession of oversized kob (kabeljou) that exceeds 70 cm
- Being in possession of fish that are not in a whole state
- Angling with more than one fishing rod
- Being in possession of more than seven rock lobsters
- Possessing more than ten fish per day per person
- Contravening fishing permit conditions
- Giving false information
- Obstructing officials in the discharge of their duties
- Fishing in a prohibited area, and
- Failure to give notice to fisheries inspectors when going out to fish with a ski-boat.

Each of the above infringements is prosecutable by law, but most cases are resolved through the payment of fines.

Vessel monitoring system

In October 2002 the MFMR installed a vessel monitoring system and associated equipment at the Walvis Bay Monitoring, Control and Surveillance Office. The national system will assist in the monitoring of fishing activities off the Namibian coast – an exercise that supports Namibia's affiliation to International Fisheries Agreements.

Fisheries Observer Agency

The FOA is an executive body established under the Marine Resources Act, 2000. Their core responsibility is to provide fisheries observers to the MFMR to –

- monitor the handling, harvesting and processing of marine resources and related operations and to record data concerning such operations
- collect and record biological and other information related to fishing activities, and
- collect samples of harvested marine resources.

Aerial and water surveillance

The MFMR annually patrols the EEZ with three state-of-the-art patrol vessels, namely the *Tobias Hainyeko*, *Oryx* and *Nathaniël Maxuilili*. In 2002, they covered 176, 39 and 71 days at sea, respectively. The Sea Eagle is the fixed-wing aircraft the MFMR uses for aerial surveillance. In 2002, it undertook 18 missions totalling 97 flying hours, covering a distance of 16,557 nautical miles. During these 18 missions, a total of 454 vessels and cargo ships were observed and their activities recorded (MFMR 2004).

Description

This indicator outlines monitoring and control measures in the fishing industry, and highlights incidences of prosecutable infringements as recorded by the MFMR.

Trends

Since the formal establishment of the MFMR, illegal fishing and associated practices have been minimal in comparison with pre-Independence. Rigorous beach, air and water patrols, along with the presence of observers aboard fishing vessels, ensure to a large extent that Namibia's marine resources are protected and not unduly exploited. The "Harvesting of marine resources" indicator (4C) shows that many commercial stocks are still in dire straits, which scientists believe can be attributed to environmental conditions. Others argue that the current levels of fishing (the number of fishing vessels per fishery) are excessive. Therefore, fishing companies place huge pressure on decision-makers for adequate TACs, which often results in pressure on the resources. As more data become available, a follow-up assessment will show trends in the monitoring and control over the EEZ and its inhabitant resources. It should be noted that fisheries are not the only threat to the abundance of resources and the biodiversity of the Benguela ecosystem: other coastal land and marine resource uses also need to be assessed.

Recommendations

Monitoring and data collection

Data seem to be readily available for three of the four indicators features here, which reflects the frequency of monitoring. The CBNRM Programme seems to have good economic data for most of the prominent activities undertaken. However, monitoring is recommended for some components of the Programme, especially if a holistic economic and socio-economic picture needs to be portrayed to measure the economic performance of conservancies by looking at overall income generated. This would definitely mask low extremities related to per capita income of staff working at lodges as tour guides and general labourers. Ultimately, people need to earn enough money to afford basic necessities.

Data on wildlife are readily available due to efficient monitoring done in conservancies and the assistance of Government field staff. Data for elephants in the north-west were reconstructed from available literature, and provide a good overall picture of the fluctuations in the numbers of animals since the early 1900s. Since Independence, data have been collected on an annual basis, which makes elephant monitoring possible. Nonetheless, it is recommended that the behaviour of elephants be studied in greater depth now that conditions are stable.

Data on fisheries catches are available from as early as the 1950s for most of the commercial and by-catch species. Major trends in catches off Namibia have been analysed. The International Commission for the Southeast Atlantic, together with FAO, was responsible for the capture of data from Namibian waters during pre-Independence. After 1990, the MFMR took over monitoring of resources and recording of data and, today, an array of fisheries and related data are available. Data on monitoring and control over the EEZ are also available. However, at the time of this assessment, such data sets were not available in digital format and, thus, not easily accessible. In addition, the MFMR and the FOA collect data on reported infringements. In the future such data will be easily accessible and will be included in the next cycle of reporting.

Additional indicators

The natural resources presented in this Chapter are not the only prominent ones. It is recommended that, prior to the next reporting cycle, stakeholders be given the chance to once again identify natural resources that need to be assessed.

Most stakeholders who were approached were helpful. At times data were published in reports, journal articles and theses, which made data centralisation very easy. Nonetheless, although few hiccups were experienced, it is recommended that the MET obtain the commitment of at least one person from each of the relevant institutions in respect of contributions to the State of the Environment Report. Thus, such a person, say from the MFMR, would be entirely responsible for the "Monitoring and control of harvesting of marine resources" indicator. This will assure the credibility of the report and broader stakeholder participation.

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Annex 4.1: Wildlife in the Kunene Region

Wildlife sightings recorded for the Kunene Region: 2001–2003

Species	2001	2002	2003
Baboon	144	116	203
Duiker	13	6	3
Elephant	38	24	44
Gemsbok	1,589	2,616	3,484
Giraffe	216	212	189
Hyaena	1	0	0
Jackal	45	79	60
Klipspringer	4	14	20
Kudu	261	297	241
Ostrich	570	659	815
Rhino	1	1	6
Springbok	11,662	14,470	16,733
Steenbok	54	85	114
Zebra	1,200	1,274	1,416

Source: Long 2004

Chapter 5: Pollution and toxins

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Introduction

There is no doubt that achieving a high standard of living with sound environmental protection in developing countries such as Namibia is the ultimate goal of national and international programmes and policies. However, very often, poor regulatory frameworks result in the life-support systems such as the local geosphere (land), hydrosphere (surface and groundwater), atmosphere (air) and the biosphere (biotic environment) being vulnerable to pollution. Almost all industrial and modern infrastructure developments as well as all related services are potential sources of pollution (Table 5.1). It is important to understand the relationships and interactions that exist from the presence or release of a pollutant and their likely effects. Life-support systems have the potential to tolerate and change the characteristics and concentration levels of pollutants and toxins through various processes such as dilution, attenuation and absorption. The chemical and physical properties of pollutants determine the likely changes in the natural environment, and whether these effects persist. At present, there are very limited data available on different industrial emissions. With the exception of the some big companies, particularly mining companies, there are no monitoring programmes for most of the major industries in Namibia.

Category	Industry, Services, Land uses
Food and meat processing	industry
Fisheries and fish processing	industries
Waste management	industry
Agriculture	Industry/land use
Cemeteries	Land uses
Hospitals, clinics, pharmaceuticals and laboratories	Services
Manufacturing, textile and chemical works	Industry
Metal smelters, foundries and metal finishing	Industries
Mining and mineral processing	industry
Power generations (coal & diesel)	industry
Petroleum storage, refineries and service station	industry
Paper, printing, dry cleaning and photography works	Services

Table 5.1: Examples of industries, services and land uses with potential sources of pollution.

The impacts of pollutants emitted into the environment are exacerbated by a lack of effective management tools such as environmental legislation and guidelines governing various industrial developments and operations. However, the relevance and potential impacts of pollution and presence of toxic pollutants in our natural life-support systems largely depends on the following:

- An understanding of the extent of the pollution sources, and the value that society and decision-makers attach to the whole or part of the life-support system that will be impacted
- The importance and value of the life-support system within the biological or ecological hierarchy, and
- The likelihood of pollution or toxic exposure and the ability to quantify its impact, based on the data and methodologies available.

The type of industrial activities found in a particular town or settlement has a direct or indirect relationship to the type of emissions, waste produced, and associated contaminant (pollution) sources (Table 5.2). Similarly, the potential contaminant sources (pollutants) found in a specific area are also directly related to industrial activities there, such as the type of waste produced and the status of the production technology processes used. The level to which these contaminants will be tolerated in the natural environment depends largely on the physical characteristics of the pollutants as well as the demographic setting in which the pollution occurs. Pollution of the environment not only impacts specific systems (air, water, land) directly,

Sector	Developments	Achievements	Potential Environmental issue
Agriculture	Use of nitrogen and phosphorus fertilizer (pesticides and herbicides)	Food security	Increased pesticide and fertilizer residues originating from agricultural activities in the soil and surface water resources. Runoff often transports the residues to surrounding ecosystems
Manufacturing and services	The use of nontoxic, non-flammable elements and compounds such as Chlorofluoro-carbons (CFCs), Solvents, colorants and other chemical compounds	Provisions of goods and services at affordable prices	Emissions of heavy metals and gases as well as related wastes contribute to air, land and water pollution. Compounds such as Chlorofluoro-carbons, Carbon dioxide and Nitro Oxides are believed to be contributing to the depletion of the Ozone layer.
Health	Use of DDT (dichlorodiphenyltrichlor oethane) and associated chlorinated organic insecticides such as DDE (dichlorodiphenyldichloroethylene) and DDD (dichlorodiphenyldichloro ethane)	Improved health and saved lives	Adverse effects on birds and mammals. High levels of DDT can affect the nervous system causing excitability, tremors and seizures. In women, DDE can cause a reduction in the duration of lactation and an increased chance of having a premature baby
Energy	The use of natural fuels such as coal, oil, natural gas and firewood have increased due to increased demand for various industrial developments.	Accelerated industrial development, human mobility and sources of energy for daily economic and household activities	Increased tremendous strains on the already scarce resources of the natural environment. Emissions of heavy metals, gases and related wastes contribute to air, land and water pollution with a direct influence on human health. Modern fuels such as the leaded petrol contribute to higher levels of lead particularly in urban areas.
Exploration, mining and mineral processing	Old, current, large and small scale exploration, mining and mineral processing industries have expanded with increased geological and geophysical data covering almost the entire country	The extraction and processing of minerals will continue to provide government with income for economic diversification and employment opportunities	Increased land degradation, air and water pollution due to heavy metals, dust and gas emissions such as carbon dioxide, hydrogen sulphide, sulphur dioxide and hydrogen cyanide. These substances are pollution and toxic sources that are threats to environmental quality.
Waste Management	The amount of different types of waste produced, number of heavy industries, unsafe and uncontrolled waste disposal facilities are increasing throughout the country. However, there is lack of resources to implement effective waste management programmes such as education, entrepreneurship and technical skill development, sorting, collection, transportation, recycling, reuse, producer responsibility, "promote polluter pay concept", pretreatment and safe waste disposal facilities	Moved from uncontrolled dumping to managed landfills with waste minimization programmes such as recycling and reuse slowly increasing particularly in big municipalities such as Windhoek and Walvis Bay. Efforts are also underway in the development of effective legal instruments y the Directorate of Environmental Affairs	Increase in population and industrialization means increased amount of waste produced with insufficient resources to implement effective waste management programmes. This will result in increased emissions of heavy metals, odors, dust and gases such as methane, carbon dioxide and carbon monoxide which are a threat to environmental quality as well as pollution of the water resources from unsafe waste disposal sites

Table 5.2: Examples relating our strive for a high standard of living through industrialization and related past, current and future environmental problems

but also affects the social, health, economic, political and ecological spectra. The variability in the type of industries and related services found in a specific area, and the nature and size of the settlement in that area, tend to reflect on the nature and level of risk posed by the potential pollutants.

Industrial point sources of pollution and toxins

Heavy and light industrial developments are point sources of pollution and toxins. Since 1990 there has been a significant increase in the number of industrial developments in all the major towns as well as in some of the rural areas. This is clearly demonstrated by the number of industrial developments such as the Ramatex Textile Factory in Windhoek and the Skorpion Zinc Project near Rosh Pinah. The following industries and associated activities are examples of some of the most important point sources of pollution and toxins:

- Heavy and light industries, which include manufacturing, food, chemical, textile industries, retail service stations, and fuel depots
- Solid and liquid waste disposal and management sites involving solid and liquid wastes. These disposal sites handle solid waste comprising inert waste such as garden, demolition and building rubble; general waste such as solid household and commercial waste; and hazardous waste such as medical waste, and industrial solid and liquid wastes. The liquid waste disposal and management sites include sewage works
- Extractive and processing industries such as oil and gas production and processing, exploration, mining and minerals processing, and all other related activities, and
- Agriculture-related industries, covering all agricultural commercial activities and related services.

Due to the readily available data, the mining sector – covering exploration, mining and mineral processing – has been used as an indicator to illustrate the approach targeting industrial point sources of pollution. The number of exploration, mining and mineral processing activities has been on the increase in the past ten years. This trend is important for economic development and job creation. Despite all the benefits, however, some of the associated activities, if not controlled properly, can have short- and long-term impacts on the environment. The likely impacts include land degradation, water pollution, increased solid and liquid waste, and gas emissions – particularly greenhouse gases, which include CO_2. The assessment of the significant short- and long-term impacts of industrial point sources of pollution and toxins needs to take into consideration the economic benefits provided by different types of industries and associated emissions as well as the influence of the natural environment.

A clear understanding of the assessment, monitoring and trend analyses criteria of the influences of pollutants on the past, current and future state of the environment depends largely on identifying and classifying industrial point source pollutants and toxins with respect to quantified associated emissions. Data are available on the number and types of industries located in the industrial parks of most major towns, particularly those industries emitting point source pollutants and toxins. Most municipalities have zoned the land for various uses such as residential and industrial development. In the assessment and evaluation process of the potential pollutant and toxic emissions associated with various industries in different urban land zones, the Source–Pathway–Target Chain is a reliable and effective tool (Tables 5.3–5.5). Source refers to an identified potential pollutant with characteristic influences that can impact on the environment (Table 5.3). Pathway represents the direct or indirect route by which the pollutants may be transferred into the environment for an impact to occur (Table 5.4). The target factors define a component of the environment likely to be impacted if pollutants and toxins are present at a level sufficient to cause an impact (Table 5.5). The target is also sometimes referred to as a receptor or endpoint in ecological assessments.

The assessment of industrial point sources of pollutants and toxins may be interpreted and grouped as shown in Tables 5.3–5.5. The Source–Pathway–Target Chain is an assessment tool that can provide clear results on the likelihood of a change (impact) to the state of the environment (past/present/future). For a degree of intervention to be required, it is very important that the Source–Pathway–Target Chain is complete. The likelihood of an impact occurring even where a contaminant/pollutant and toxic source is present above background concentration or guideline values of acceptability is very low or negligible if neither a pathway by which the pollutants could reach a target of concern is present, nor a target on or in the vicinity of the likely potential source. Therefore, the Source–Pathway–Target Chain procedure is fundamental to any state of the environment assessment associated with industrial point sources of pollution. Examples and characteristics of sources, pathways and targets are shown in Tables 5.3, 5.4 and 5.5, respectively.

Classification	Examples	Industrial Linkages
Toxic gases	Carbon dioxide (CO_2), Carbon monoxide (CO), hydrogen cyanide (HCN), chlorine, phosphine (PH_3), hydrogen sulphide (H_2S), Sulphur dioxide (SO_2)	These sources are emission linked to various industries such as manufacturing, burning of fuels (cars emissions), burning of municipal waste, exploration, mining and mineral processing, service industries
Explosive and Flammable gases	Methane (CH_2), ethane (C_2H_4), carbon monoxide (CO), hydrogen cyanide (HCN), phosphine (PH_3), hydrogen sulphide (H_2S), buten (C_4H_6), hydrogen (H_2)	The sources are linked to petroleum, burning of fuels, service stations, fuel depot landfills sites and other waste disposal sites, manufacturing, exploration, mining and mineral processing
Zootoxic (toxic to animals) metals	Lead (Pb), cadmium (Cd), mercury (Hg), beryllium (Be), arsenic (As)	Associated with exploration, mineral processing, smelters, manufacturing, services and chemical industries, burning of fuels with additives, incineration, power generation
Phototoxic (toxic to plants) metals	Zinc (Zn), copper (Cu), nickel (Ni) boron (B)	Exploration, mining and mineral processing and chemical and services industries, incineration
Combustible, corrosive and reactive inorganic substances	Fuels, oils, acids, alkalis, solvents, oxides, paper, sulphide, cyanide (CN), sulphate, ammonium	Service industries, manufacturing, textiles, service station, food processing, packaging, chemical industries
Aliphatic, aromatic and polycyclic aromatic hydrocarbons	Mineral oils, low molecular weight hydrocarbons, benzene, toluene, xylene, phenol, Naphthalene, pyrene, fluoranthene, anthracene	Petroleum consumption, manufacturing, pharmaceuticals, chemical, coal carbonisation, services
Substitute aliphatic and aromatic compounds	Petachlorophenol, polychlorinated dibenzofurans (PCDFs), polychlorinated biphenyls (PCBs), polychlorinated dibenzofurans (PCDFs), polychlorinated dibenzodioxins (PCDDs)	
Biological agents	HIV, Anthrax, polio, tetanus	Associated with waste from, clinics, Hospitals, pharmaceuticals
Radioactive substances	Radon, radium, cesium^{137}, actnides	Manufacturing, exploration, mining and mineral processing

Table 5.3: Classes and examples of pollution sources and related industrial linkages.

Examples	Category	Remarks
Wind and air	Direct /indirect wind-borne particulate or dust	Pollutants can be transported to the targets of concern from a specific source by wind
Ephemeral rivers and Gullies	Direct leaching, runoff or dumping of contaminants into a river channel	During the rain season contaminants that have been direct or indirectly deposited in the river channels become mobile thereby contaminating the water resources
Discontinuities	Direct or indirect runoff or dumping of pollutants on discontinuous (geological) structures	Discontinuities such as bedding plane, faults, fractures, fissures, solution holes are direct potential pathways for contaminant migration to targets such as groundwater and surface water bodies
Water	Direct dermal contact or indirect ingestion of water	Water (flowing, vapor, uptake) is one of the common pathway through which pollutants can migrate from a source to a target of concern
Flora, Fauna & Human	Direct contact or ingestion	The complex interaction that exists among flora, fauna and humans such as through ingestion, inhalation, excretion, dermal contact and absorption are means through which pollutants can migrate

Table 5.4: Examples and general categories of pollution pathways.

Examples	Potential impact
Life support systems (atmosphere, geosphere hydrosphere & biosphere)	Short and long term effects of pollution on the life support systems such as air pollution including odour, land and soil contamination including loss of biodiversity and food security and pollution of groundwater and surface water resources
Flora, Fauna & Humans	Pollution of the life support systems can result in death, stress causing adverse health effects or defects, acute and chronic toxic effect, loss of habitat or biodiversity. Flowing rivers are source of water supply for human consumption and industrial development and very often the resources are shared with other countries. The pollution of flowing river particularly perennial rivers can results in very serious health effects covering diverse species and large geographical areas
Flowing rivers/Perennial rivers	
Infrastructure	Infrastructure such as offices, houses and all associated services are also targets that are prone to pollution resulting in damage, deterioration, corrosion and even collapse with lose of life
Social economic	Loss of value to the land/ lively hood/ property/amenity due to pollution or presences of toxics have a direct influence on the social fabric of local communities. Potential health impacts often tend to follow

Table 5.5: Examples of targets /receptors and associated potential impact

International Conventions and national policies

Industrial point sources of pollutants and toxins are associated with solid and liquid wastes as well as gas emissions, particularly greenhouse gases, which include CO_2. Namibia acceded to the Treaty on the Protection of the Ozone Layer in 1993. This Treaty was adopted at the Vienna Convention in 1985, followed by the Montreal Protocol in 1987 and the London Amendment in 1990. The main purpose of the Vienna Treaty on the Protection of the Ozone Layer is to protect human health and the environment from increased ultraviolet solar radiation, from adverse impacts such as skin cancer exposure, and from damage to crops. It requires that states reduce their reliance on ozone-depleting substances, and that collaborative research be undertaken to find alternatives to harmful substances such as chlorofluorocarbons (CFCs) and halons. The Treaty specifically urges states to assist developing countries through technology transfer, research and training. Under this Treaty, Namibia is obliged to submit statistics on the production and/or use of CFCs in various industrial activities that are also point sources of pollutants and toxins.

Namibia makes a relatively low contribution to the destruction of the ozone layer compared with some industrialised countries, due to low levels of industrial development and associated emissions.

On the national level, there are various policies governing specific industrial developments and operations. However, there are no specific legal instruments limiting the amounts and levels of emission associated with heavy and light industrial operations. The use of all relevant technical and scientific data in undertaking EIAs associated with industrial developments is mandatory, and is currently applied to all new exploration, mining and mineral processing activities. Following the EIA, effective environmental management plans (EMPs) are developed and implemented with continuous monitoring undertaken by the operator and relevant Government authority. EIA and EMP procedures are currently been applied to various industrial developments throughout the country. However, there is currently no monitoring component due to the lack of effective legal instruments, minimum requirements, and institutional capacity.

In addition, the Minerals (Prospecting and Mining) Act, 1992 provides for environmental protection with respect to exploration, mining and mineral processing activities as industrial point sources of pollutants and toxins. However, the Act, which is currently under review, was promulgated soon after Independence and does not cover the abandoned mines that were operational under previous legislation. Sections 54 and 128 of the Act require the removal of infrastructure such as buildings and the rehabilitation of the site of operation to the satisfaction of the Ministry of Mines and Energy (MME). Furthermore, a Minerals Policy has been developed, which also addresses the gaps that exist with respect to environmental impacts associated with exploration, mining and mineral processing activities. An assessment of the Policy's shortcomings will form part of the current review process of the Act.

Chapter overview

Population growth, urbanisation and industrialisation all contribute to the increase in pollution and the release of toxins into the natural environment. Most pollutants are not visible, cannot be tasted or smelt, and poison the environment with anything that reduces its ability to support life. Although we can easily assume the absence of pollutants, they produce a measurable change in the environment and affect human, plant and animal health. Each year, Namibia deals with more waste and more dangerous waste materials. Pollution becomes intensified: a mixture of pollutants acts simultaneously, and is more hazardous than a single pollutant. The immunity of the environment can be weakened by one pollutant that makes it prone to the dire impacts of other pollutants. Key sources of pollution stem from urban areas and major industrial developments such as mines, large-scale agriculture, and irrigation systems. Burning of fuel wood at household level creates a localised health hazard, while untimely and unmanaged bush fires contribute to air pollution. Poor people are at higher risk because they are more likely to work in polluted environments and suffer from insufficient nutrition, which exacerbates the effects of toxic pollution. Low-income housing typically occurs close to dumping sites; such housing developments also have inadequate waste disposal systems, and are generally prone to pollution and poor air quality. However, due to the lack of adequate baseline information, the overall impact of pollution on environmental and human health is difficult to assess.

Annual fuel consumption

The increasing trend in the amount of petroleum consumption for various fuels is linked to an increasing demand for energy for motor vehicles. Electricity generation resulting in increasing pollutants and toxic emissions, particularly in Namibia's major urban centres, comes as a result of energy demands. However, this does not take into account the rapid pace of urbanisation and the even faster pace of motorisation. Current levels of pollution and the release of toxins from fossil fuels are expected to increase as long as there is an increasing demand and lack of environmentally friendlier alternatives.

Marine pollution

Work done during the Walvis Bay Agenda 21 Local Area Study shows that marine pollution along the Namibian coast is not severe and therefore poses no threat to living marine resources. The study found that some heavy metals were highly toxic and that, if certain concentrations of them were exceeded, it would affect marine life in close proximity to the harbour. Water quality along the harbour in particular is currently not measured on a regular basis. It is expected that current levels of pollution will increase with increased naval traffic, the development of large-scale mariculture, and other developments that may entail discharge of large quantities of inorganic or organic waste.

Air pollution in Windhoek

Air pollution is currently not monitored; or, rather, neither of the two agencies responsible for monitoring it are in fact doing so. Windhoek does not experience threatening levels of air pollution due to the absence of major energy-burning industries. Air pollution is mostly created by CO_2 releases from vehicles, the occasional veld fires, and the release of CO_2 from the Van Eck Power Station. One form of air pollution not caused by human activity is generated by mica dust, which pervades the air in Windhoek between August and October. High winds occurring around that time of year distribute the dust over Windhoek. The city lies in a valley which makes it very prone to air pollution and the entrapment of pollutants. An inversion layer in the air can come about when polluted cooler air descends and remains depressed while warmer air ascends and floats above. Due to no mixing between bottom cooler air and upper warmer air, the pollution is not dispersed: it persists even while it accumulates. This scenario can lead to a build-up of pollutants over time that will eventually affect human health. The congestion of and increase in traffic is already a major contributor to air pollution.

The mining industry as an industrial point source of pollutants and toxins

Introduction

The mining sector is one of the major industries contributing to the GDP, export earnings, Government revenue through taxes and royalties, employment opportunities, and economic and social development. The mining industry encompasses large- and small-scale exploration, mining and mineral processing activities. A successful and sustainable mining industry largely depends on rigorous exploration programmes, i.e. the search for undiscovered terrestrial and marine mineral deposits. Terrestrial mining involves the extraction of minerals from the earth. The mining process may involve digging a shaft (underground method) or pit (open-cast method) or a combination of both methods. In the marine environment, suction and dredging mining techniques are used to mine the seabed. The process of mining very often results in large-scale changing of the landscape due to the large volumes of material that are usually displaced. The material that is mined comprises the required minerals resources and the unwanted waste material that is then processed. Mineral processing involves the removal of impurities; the process used depends on the type of mineral to be recovered. These processes include crushing, floatation, combustion and smelting.

The scale of exploration, mining and mineral processing activities are dependent on various factors such as the size, grade, quality, price and cost recovery associated with the potential mineral deposit. Today, exploration, mining and mineral processing activities cover a wide range of minerals and metals, including the following:

- ***Diamonds:*** This covers both small- and large-scale terrestrial and marine exploration and mining activities, with some 60% of the diamond production in Namibia being conducted offshore. About three diamond processing (cutting and polishing) centres have also been established in the last five years.
- ***Metals:*** Base metals such as copper, lead and zinc are currently produced at major mines in different parts of the country. Gold is the only precious metal produced at one location, in addition to it being produced as a by-product of copper refining process. Currently, there are extensive investments in the exploration of gold and platinum being conducted in different parts of the country. The Ongopolo and Skorpion smelters process metals such as copper, lead and zinc.
- ***Gemstones:*** Some of the varieties are garnets, tourmaline and topaz. The utilisation of Namibia's diverse gemstone resources has great potential for socio-economic development, particularly for informal sector's small-scale miners. Currently, small-scale mining activities in gemstones are higher than in the formal sector. Exploration activities are generally low, however, and there are very few facilities involved in the cutting and polishing of gemstones, and.
- ***Industrial materials:*** These include dimension stone and industrial mineral resources, and account for a very small percentage of mining and exploration activities. Dimension stone such as marble, sandstone, slate and granite are available. Deposits of industrial minerals such as bentonite and fluorspar are also found in some parts of the country. However, only a small quantity of dimension stone and industrial minerals that are mined are processed locally.

Potential environmental impacts of the mining sector

Current and abandoned larger and small-scale exploration, mining and mineral processing activities have a direct and indirect impact on the environment. There are more than 200 abandoned mines in Namibia, and exploration, mining and mineral processing activities are currently on the increase. Some of the environmental impacts associated with such activities of all capacities in the past and present include lose of land value due to land degradation, pollution of water resources, and pollution of air and surrounding ecosystems resulting in loss of biodiversity. Some of the mining sector activities which usually results in environmental impacts include the development of pits, shafts, trenches, tailing waste disposal sites, infrastructure such as housing roads, ore and waste stock pile facilities as well as mineral processing infrastructure. Table 6.6 shows some of the sources of pollutants and toxins associated with past and present small- and large-scale exploration, mining and mineral processing activities that can have an impact on the environment.

Energy consumption

Introduction

The approach to analyses of heavy urban industrial development and the influences on the environment is one that can provide a direct link to the state of the environment. Industrial development is highly dependent on the available sources of energy, which are associated with pollutants. The pollutants are derived directly or indirectly from production of products or provision of services. Energy sources such as petrol, diesel and coal are the driving forces behind industrial development. These energy sources are associated with pollutants such as carbon monoxide, particulates, and heavy metals like lead from leaded fuels. All these pollutants are directly emitted into the surrounding environment. At present, and with the exception of the mining towns such as Tsumeb and Rosh Pinah, there is no effective monitoring programme of any urban settlements in Namibia as regards consumption of these sources of energy.

Petrol consumption

Petrol vehicles built after 1993 are fitted with a

<table>
<tr><th>Sources</th><th>Characteristics</th><th>Source Linkages</th><th>Hazard</th></tr>
<tr><td>Carbon dioxide (CO_2), Carbon monoxide (CO), hydrogen cyanide (HCN), chlorine, phosphine (PH_3), hydrogen sulphide (H_2S), Sulphur dioxide (SO_2)</td><td>These gases have varying characteristics but they are toxic. Some gases such as carbon dioxide and hydrogen sulphide are widely available in the natural environment</td><td rowspan="2">These sources are emission linked to various industries such as burning of fuels around exploration, mining or mineral processing facilities. The majority of these gases are associated with mineral processing activities such as the smelting of copper, lead, zinc and gold</td><td rowspan="2">Higher levels of these gases in the environment can have adverse effect to humans, fauna and flora. Some of these gases are highly toxic flammable and explosive</td></tr>
<tr><td>Methane (CH_2), ethane (C_2H_4), carbon monoxide (CO), hydrogen cyanide (HCN), phosphine (PH_3), hydrogen sulphide (H_2S), buten (C_4H_6), hydrogen (H_2)</td><td>Some of these explosive and flammable gases such methane is widely available in the natural environment. They all have varying characteristics</td></tr>
<tr><td>Dust</td><td>Consist of fine particulate matter and are transported by wind.</td><td>Dust is associated with small and large scale exploration, mining and mineral processing activities.</td><td>Dust particles can cause respiratory problems</td></tr>
<tr><td>Arsenic (As)</td><td>Widely disturbed in environment. Green colour; spoil heaps deposits mostly white. Organic forms less toxic than inorganic forms. Toxicity affects by concentrations of other metals, especially iron. In soils predominantly in an adsorbed form</td><td>By-product of copper and lead smelting; wood preservatives; timber treatment; agricultural chemicals; electroplating; sewage sludge; coal burning</td><td>Toxic. Soluble inorganic compounds of As (III) considered principal toxic species. Water pollution. Proven systematic carcinogen</td></tr>
<tr><td>Cadmium (Cd)</td><td>Natural occurring but non-essential heavy metal. Coloured deposits white, yellow, orange. Low pH increases toxicity with enhanced mobility in soil. Soil temperature, texture, moisture and redox potential all affect toxicity</td><td>Metal mine waste; metal smelters; incineration; coal burning; sewage disposal; manufacture of batteries, fertilisers and pesticides; ceramics; pigments and glass manufacture; foundries; electroplating</td><td>Toxic. Phytotoxic. Water pollution. Covanogen by inhalation</td></tr>
<tr><td>Chromium (Cr)</td><td>Hard, brittle grey metal. Salts have strong and varied colours. Hexavalent compounds are most relevant. All are soluble in water and/or acids</td><td>Metallurgy industries; fly ash; sewage sludge; timber preservatives; pigments tanning plating; Mining/smelting; chemical industries; natural occurrences</td><td>Hexavalent compounds carcinogenic. Corrosive effect on tissue. Phytotoxic. Water pollution</td></tr>
<tr><td>Copper (Cu)</td><td>Malleable, ductile, reddish colour; non-combustible except as a powder. Commonly occurs as sulphates, sulphides and carbonates in the soil</td><td>Smelting; waste from electroplating, chemical scrap yards, sewage sludge; wood preservatives</td><td>Toxic. Irritant. Phytotoxic (especially at low soil pH and low organic matter). Corrosive to rubber</td></tr>
<tr><td>Cyanides (Cns)</td><td>Complex (e.g. ferri/ferrocyanide); blue or blue/grey may cause staining of soils etc. Thiocyanate – red staining of soils and watercourses; HCN odour of sweet almonds. Spent oxides, musty odour. Simple salts (e.g. potassium or sodium cyanide) present greatest risk to humans</td><td>Iron and steel manufacture. Spent oxides from town gas manufacture; electroplating effluent; non-ferrous metal production</td><td>Simple cyanides toxic; phytotoxic; groundwater pollution; toxic to fish. Cyanide salts very soluble</td></tr>
<tr><td>Lead (Pb)</td><td>Heavy, ductile, soft grey, solid, insoluble in water</td><td>Natural occurrences. Mining and smelting batteries; scrap metal; petrol additives; pigment; paints; glass manufacture; fluorspar; mine waste</td><td>Toxic. Water contamination</td></tr>
<tr><td>Mercury (Hg)</td><td>Silvery, heavy, insoluble in water, highly volatile; forms inorganic and organomercury compounds and amalgams with other metals</td><td>Mining and smelting; electrical apparatus; dental products; plastics; wood preservatives; burning of coal, gas, wood and oil; iron and steel works; electroplating</td><td>Toxic, phytotoxic</td></tr>
</table>

Table 5.6: Sources of pollution and toxic associated with the mining sector.

Table 5.6 Continued

Nickel (Ni)	Malleable, silvery metal; inflammable as a dust or powder	Refining of impure nickel oxide; wastes from metal-finishing electroplating, alloy and stainless steel manufacture; enamel and battery production; scrap yards	Toxic; fire (dust or powder). Phytotoxic especially in acid soils
Zinc (Zn)	Shining white metal with bluish-grey lustre. Most simple salts are water soluble	Smelting of ore; wastes from metal finishing pigment; plastics and cosmetics manufacture; sewage sludge; scrap yards.	Fire and explosion from dust; phytotoxic.
Sulphur and Compounds (S)	Sulphur compounds frequently white unless pigmented by cation – e.g. copper sulphate is blue. Sulphides in anaerobic conditions generally black. At pH<4 hydrogen sulphide (H_2S) is liberated, giving odour of bad eggs	Metal ores; waste from pigment manufacture; ceramics; spent oxides from gas manufacture (contain up to 60% free sulphur and up to 3% sulphate)	Corrosive, hydrogen sulphide at low pH phytotoxic, toxic (according to metal salt). Sulphur flammable
Phenols	Class of aromatic organic compounds with characteristic antiseptic odour and acrid burning taste. Simpler compounds, soluble in water	Coal carbonisation; waste from gasworks in coal tars) ammoniacal liquors; rubber; solvents; paper; paints/wood preservatives manufacture; iron and steel	Toxic, corrosive; phytotoxic; water contamination

catalytic converter that uses unleaded petrol. The use of leaded petrol will ruin the converter. On the other hand, many cars built before 1993 can use unleaded petrol with no negative side effects, although they may require slight adjustments to the engine. Vehicle emissions such as lead and particulate matter are dangerous pollutants associated with leaded fuels. Long-term exposure to even low levels of lead can affect mental development in children. The use of poor-quality fuels, substandard vehicle technology, and congestion are major contributors to air pollution in Namibia, particularly in built-up areas and densely populated parts of major towns such as the central business districts of Oshakati, Swakopmund, Walvis Bay and Windhoek. Vehicles that run on adulterated or poorly refined fuel are the greatest source of pollutants, which include greenhouse gases like hydrocarbons and CO_2. Apart from hydrocarbons, nitrous oxides, sulphur dioxide and CO_2, vehicles also emit carbon monoxide, volatile organic compounds and total suspended particulates. Most of these compounds, especially the volatile organic ones like benzene and carbon monoxide, are extremely harmful to humans and animals. Therefore, the increased levels of pollutants in the air may have an influence on the population's health, particularly those already affected by asthma, bronchitis, tuberculosis, or other respiratory problems.

Figure 5.4 shows the fluctuating levels of leaded (93), unleaded (95) and unleaded V Power Super (97) fuel consumed in Namibia. The use of leaded petrol has a direct bearing on the amount of lead and particulate emissions from petrol vehicles. On the other hand, the use of unleaded petrol is associated with benzene and other aromatic hydrocarbons. Methyl tertiary butyl ether (MTBE) is used as a substitute additive in unleaded petrol. These aromatics reduce the potential for the engine to 'knock'. Benzene is a known carcinogen, and it is argued that using unleaded petrol increases the risk of cancer. However, in general, unleaded petrol will not necessarily have a higher benzene level than leaded because a lot depends on the purity of the fuels and the prevailing engine technology.

Diesel consumption

The increase in diesel consumption is linked to increasing use of this fuel by locomotives, heavy trucks, buses, 4x4 vehicles, and some modern sedan cars. In addition, diesel is also used for electricity generation in small settlements, remote households and on farms. Diesel exhaust contains high levels of fine soot known as *small particulate matter* and benzene, which is a known carcinogen. Diesel exhaust also contains high levels of nitrogen oxides which, combined with other pollutants, can create serious health problems. The great concern for exposure to high levels of diesel exhaust is the small particulate matter, namely the microscopic soot that is easily inhaled deep into the lungs. According to research conducted in various parts of the United States of America, the worst type of small particulate matter consists of particles less than 3.5 microns in diameter. Attached to these particles are a variety of toxic polycyclic aromatic hydrocarbons (PAHs), which, if inhaled, can exacerbate conditions such as asthma, emphysema and tuberculosis.

Controlling particulate matter, which is the primary ingredient in thick, black diesel exhaust smoke, remains an important health and aesthetic concern, particularly in built-up areas such as the central business districts of Oshakati, Swakopmund, Walvis Bay and Windhoek. The aesthetic concern regarding diesel exhaust is the soiling and discoloration of buildings and any other surface exposed to soot deposits. To date, most diesel trucks and buses have not used pollution control devices like those used in modern cars. In order to enable modern pollution-control technologies to be effective on trucks and buses as well, therefore, diesel fuel needs to be significantly cleaner than it is today. Diesel contains high levels of sulphur, effectively preventing the use of advanced clean-up technologies. If low sulphur fuels are available, advanced pollution control technologies can remove up to 90% of particulates from diesel exhaust and, with existing technology, manufacturers can significantly reduce emissions from new engines.

Coal consumption

The Van Eck Power Station is located in Windhoek's Northern Industrial Area. For the past 30 years, Van Eck has generated electricity from coal for the growing city. In recent years, however, the station has only been operational during peak loads as a support system for high electricity demand (P Langenhoven, Power Station Superintendent, 2003, pers. comm.). The generation of electricity from coal has been a common practice throughout the world in the past, and a number of power stations – some still operational, others decommissioned – can be found in Namibia today. Also according to Langenhoven (ibid.), Van Eck was commissioned with two units in 1972, followed by another unit in 1973 with the fourth unit commissioned in 1979. The station uses four incinerators: three designed by Yarrow Africa, and one by Babcock & Wilcox Chain Grate Boilers. The boilers used at Van Eck have a total capacity of 136 metric tons an hour, and coal is fired for the production of electricity in furnace temperatures of 1,100 degrees Celsius. Sulphur dioxide, nitrous oxides, CO_2 and particulate emissions are the common air pollution sources associated with coal power stations. Uncontrolled levels of these compounds can seriously affect our life-support systems (atmosphere, hydrosphere, geosphere, and biosphere).

Over the years, however, the amount of coal that has been used at Van Eck has been decreasing due to the changing role of the power station. Namibia's growing electricity demands are now being met by supplementary electricity imported from South Africa. The utilisation of coal for electricity generation also results in pulverised fuel ash (fly ash) residues, the disposal of which requires both a technical and policy consideration. Fly ash disposal has to be undertaken with great care because most of it contains heavy metals that can cause air pollution due to dust from the dumps, can affect the health of the flora and fauna, and can contaminate surface water and groundwater. Namibia uses mainly South African coal, which contains very low concentrations of a number of trace elements in addition to major inorganic constituents of coal ash such as alumina, ferric oxide, lime, potash, silica, and soda. The suitability of a coal for any given purpose depends on the concentration of these elements. Some elements such as arsenic, mercury, uranium and many other trace and major heavy metals are hazards to our health as well as to our environment. Other elements such as cobalt, nickel, molybdenum and vanadium are catalytically active elements that can influence catalytic processes like hydrogenation. The amount (preferably low annual amounts) and quality of coal burned (preferably of good quality, with low levels of elements such as sulphur), and the prevailing condition of the technology used (preferably cleaner technology) are key to understanding the amount and type of emissions and wastes likely to be associated with the use of coal in the energy production process.

International Conventions and national policies

The increased urbanisation, population and the demand for energies such as electricity, diesel and petrol all have a direct influence on the levels of pollutants and toxins in the environment. Some of the emissions such as CO_2, nitrous oxides and hydrocarbons from energy consumption are greenhouse gases. Namibia is a signatory to the UNFCCC. The main objective the UNFCCC is to control and limit the emission of greenhouse gases into the atmosphere, thereby allowing ecosystems time to adapt naturally to gradual climatic change. However, the Convention does not necessarily address the likely potential impacts of such emissions on the health of the local population.

Namibia does not have specific legal instruments such as minimum requirements on specific industrial emission levels. Nonetheless, there are various enactments such as the Atmospheric Pollution Prevention Ordinance (No. 11 of 1976, as amended in 1996), that could be applied to control industrial emissions such as those associated with energy consumption. However, all the relevant pieces of legislation and policies lack institutional

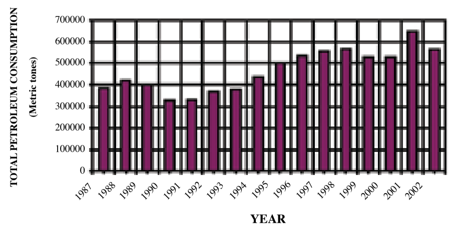


Fig 5.1: Shows an increasing demand of the total amount of petroleum (petrol, diesel and jet fuels) consumed from 1987 to 2002.

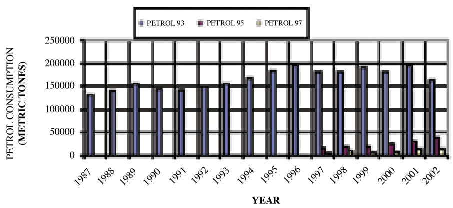


Fig 5.2: Shows a flactuation but steady increasing consumption of leaded petrol (93) from 1987-2002

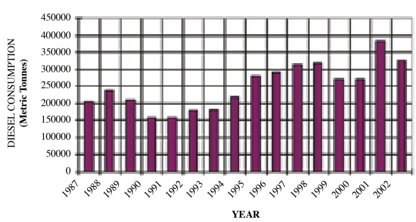


Fig 5.3: Shows an increasing consumption of diesel fuel from 1987 - 2002. The increasing consumption is linked to an increase in vehicle's engine technologies that allows the use of diesel in off-road (4x4) vehicles and even in sedan cars

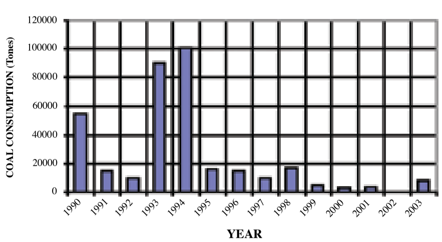


Fig 5.4: Shows the amount of coal used in the production of electricity from 1990 to 2003 with only 178 tonnes used in 2002 at the Van Eck Power Station

enforcement capacity due to fragmented and poorly coordinated institutional support in respect of preventing pollution and toxic emissions. The increasing demand for petrol, diesel, and coal as well as the number of heavy industrial developments in major urban settlements can serve as effective indicators of the current and future state of the environment with respect to the type and level of pollutants and toxins currently and likely to be emitted into the environment.

Fig 5.5: Shows the coastline of Namibia in detail. This entire area is vulnerable to pollution (Molloy & Reinikainen 2003)

Assessment of indicators

INDICATOR 5A: Annual fuel consumption – Unleaded and leaded petrol, diesel and coal

Introduction

Using fuel consumption figures as an indicator of the state of the environment with respect to emission sources (burning of fuels) and targets of concern such as air pollution, particularly in built-up urban centres, can yield reliable information. The ever-increasing amount of fuels consumed may to some extent be translated into a potential increase in the amount of hydrocarbons, nitrous oxides, sulphur dioxide, CO_2, carbon monoxide, volatile organic compounds, and total suspended particulates associated with them. If the levels of these compounds continue to increase, it will have a serious effect on the population's health. The increase in the emission of these compounds can be due to the increasing demand for fuel, increasing populations, and the increasing number of vehicles. However, this should take into consideration the expanding vehicle technology aimed at reducing emissions as well as the ability for the natural environment to reduce pollution levels through processes such as dilution.

Description

The indicator shows what quantities of petroleum-related fuels are consumed, and allows one to derive additional information on the various types of pollutants and toxins associated with the various types of fuels. The relationship between how much of the different fuels is consumed and how high the levels of pollutants are, particularly as regards air pollution, depends on effective air quality monitoring with ambient concentrations linked to health-based guidelines or minimum requirements in order to determine potential impacts.

Results and trends

Figures 5.1–5.4 show energy consumption (petrol, diesel and coal) in Namibia. The data used in the assessment were obtained from the MME's Directorate of Energy and from NamPower's Van Eck Power Station.

The use of unleaded petrol, which includes 95 fuel and V Power Super (97 fuel) with high octane and a very low or negligible lead content, has shown a steady increase since 1997. The continued increase in the use of leaded petrol (93) is directly linked to the higher number of vehicles without catalytic converters. However, as the number of new vehicle models with advanced emission control technology increases, the supply and consumption of leaded petrol will decrease.
Over the years, the use of coal has fluctuated in line with the changing role of the power station and the fact that Namibia's additional electricity demands are now being met by electricity imported from South Africa. This indicates that the amount of gas and ash emissions from Van Eck has also been decreasing.

The increasing trend in the amount of petroleum consumption (Figure 6.3) for various fuels (Figures 5.4– 5.6) is linked to an increasing demand for energy for motor vehicles and electricity generation, for example, resulting in increasing pollutants and toxic emissions – particularly in the country's major urban centres. However, this analysis does not take into account the rapid pace of urbanisation and the even faster pace of motorisation.

Goals

The goal is to have an effective central pollution control body that can develop air quality monitoring programmes and link the amount and types of fuels consumed to specific monitored pollutants and toxins associated with various fuels. Since the introduction of new technology and vehicle scrapping programmes may not always be economically feasible, programmes on vehicle inspection and maintenance (I&M) as well as traffic management ™ are the only solution. With effective emission control programmes, I&M and TM programmes, and use of clean technology and clean fuels, air pollution from vehicle emissions can be reduced substantially through the setting of targets. However, no strategy to reduce pollution will be successful unless time-bound targets are fixed, based on regularly revised long-term data. Currently, no long-term data are available on the extent of air pollution in Namibia. A proper strategy to control air pollution due the energy consumption will require data on monitored levels of individual pollutants and trend analyses in major urban settlements.

INDICATOR 5B: Marine pollution

Introduction

Trends in marine pollution and littering along coastlines are increasing globally. Namibia's coastline (Figure 5.5) is no exception although, thus far, pollution and littering resulting from human activities are negligible when compared with populated industrialised countries (Beyers 2004). Serious pollution originating onshore may be found in close proximity to the harbour towns. These pollutants comprise persistent plastic materials, occasional oil and diesel spills during vessel refuelling, accidental sewage discharges, and organic effluents from the fish-processing industry (Roux 2003; Danida, MFMR & WBM 2003). Beyers (2004) emphasises the need to distinguish clearly between marine pollution and marine litter. The former refers to the contamination of the marine environment by way of oil spills, and effluent discharges from land-based factories and vessels onshore, whereas marine litter includes more visible items such as plastics, glass objects, tin cans and ropes, to name but a few (ibid.). Only five coastal towns occur along Namibia's 1,570 km coastline, and industries are based in close proximity to some of these settlements. There are two harbours in Walvis Bay (central coast) and Lüderitz (southern coast) that cater for naval traffic to and from Namibia (Roux 2003). These two towns also host the entire fishing industry, with the majority of companies and processing facilities based in Walvis Bay. The latter town also has docking facilities and a cargo port that contributes to marine pollution (Danida, MFMR & WBM 2003). Henties Bay is a smaller settlement with no industrial activities, but the advent of mariculture and real estate development poses future threats to the marine environment (Roux 2003). Swakopmund is predominantly a tourist destination. The development of a multimillion-dollar waterfront and other real estate definitely suggests increased future impacts. The extent to which such impacts will consist of pollution cannot be verified at this stage. Oranjemund to the extreme south-west is internationally known for diamond mining, and this industrial activity's destruction of the marine environment has often been debated. The GEF-funded BCLME Project recently commissioned two studies to look at the cumulative effects of diamond mining on the marine environment, which should shed more light on the issue. Trends in marine pollution and associated impacts are expected to increase due to recent increases in naval traffic, continuous growth in urban populations, mariculture industry development, expansion of harbour and fish-processing facilities, and the success of offshore oil and gas explorations (ibid.). Globally, the biodiversity of the marine and coastal environments is at risk from marine litter and discarded fishing gear (ibid.). Risks from the oil industry can be minimised, given that oil spill contingency plans are in place prior to exploration and exploitation. Beyers (2004) classifies the sources of pollution and litter as follows:

- ***Towns:*** Communities at coastal towns are responsible for littering. Plastic shopping bags seem to be the biggest problem since they are easily blown about by prevailing winds from residential areas and municipal dumps.
- ***Beach users and anglers:*** People usually spend extended periods along the coast and dump plastic bags, glass or plastic bottles, commodity packaging, bait boxes, fishing hooks and lines, etc. along the beach.
- ***Fish-processing factories:*** This sector of the fishing industry produces large amounts of waste that includes litter (rubber gloves, plastics, etc.) and pollution (discharge of factory effluents that contain high levels of oils and fat).
- ***Harbours:*** Pollution comprises incidental oil spills from bunkers and hydraulics and bilge water within the port. Crew members also dump litter overboard while vessels are in harbour.
- ***Vessels at sea:*** While at sea, fishing, cargo, and mining vessels act as self-contained facilities. Space is a limiting factor and the lack thereof encourages crew to dump bilge water, damaged fishing nets, plastic ice trays, fishing traps, oil filters, kitchen discharge and all sorts of litter and pollutants into the sea. All vessels anchored outside the port limits have incinerators used for litter disposal. However, such systems operate at a 90% level while 10% of waste is still dumped overboard.
- ***Mariculture:*** This sector is still in its infancy and has low impact on the marine environment via litter and pollution. The MFMR is determined to develop mariculture rapidly over the next few years, and this promises increased littering and pollution associated with higher impact. For example, plastic bottles believed to stem from the seaweed mariculture industry are currently being washed up at Lüderitz. In addition, increased mariculture will generate high levels of metabolic ammonia and organics that will threaten the marine environment.

There are virtually no pollution sources from inland, keeping pollution threats to the marine environment at a very low level (Roux 2003). At this stage there is also no talk of the transfer of potential harmful substances from inland to coastal towns.

Description

The location, nature and volume of effluent discharge (or point source discharges) into coastal waters need to be monitored. The parameters of such monitoring need to be defined on the basis of risks. Concentrations of metals and possibly other toxic organic compounds such as hydrocarbons in sediment or biological tissue need to be measured at six-monthly intervals at suitable intertidal sites in major coastal towns and river mouths, namely Henties Bay, the Kunene River (pesticide traces in mussel tissues), Lüderitz, the Orange River mouth, Oranjemund, Swakopmund, and Walvis Bay.

Trends

Work done during the Walvis Bay Agenda 21 Local Area Study shows that marine pollution along the Namibian coast is not severe and therefore poses no threat to living marine resources. The study found that some heavy metals were highly toxic and that, if certain concentrations of them were exceeded, it would affect marine life in close proximity to the harbour. Water quality along the harbour in particular is currently not measured on a regular basis. It is expected that current levels of pollution will increase with increased naval traffic, the development of large-scale mariculture, and other developments that may entail discharge of large quantities of inorganic or organic waste.

INDICATOR 5C: Air pollution in Windhoek

Introduction

The number of industries generating air pollution in Namibia is very small. The SADC region contributes approximately 2% of the global greenhouse gas emissions, but this figure is expected to increase in the 21st century due to the region's energy consumption and land-use practices (NGR 2001).

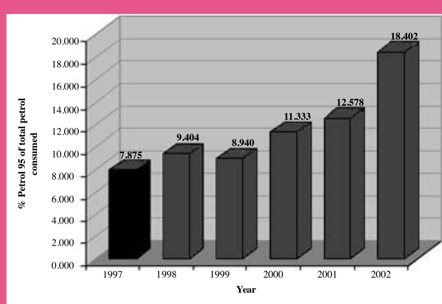
The global climate and human health are threatened by air pollution, which is regarded as an important environmental problem in Africa (ibid.). Air pollution comprises a range of harmful substances, some of which are well known for their negative effects on the environment and human health (ibid.; also see Box 5.1).

Description

This indicator should ideally map ambient (outdoor) sulphur dioxide and nitrogen oxide concentrations in major urban areas throughout Namibia. In addition, it should draw data from existing air quality monitoring networks and should include continuous monitoring of sulphur dioxide. Ambient concentrations should be compared with health-based guidelines in order to determine possible impacts.

Box 5.1: Motor vehicle exhaust in Windhoek

The inserted figure shows an increasing trend in the consumption of unleaded petrol from 1997 to 2002.



The following inference can be drawn from this statistic. Let's assume that this increase in unleaded petrol consumption is parallel to an increase in number of motor vehicles. More cars roaming the streets of the city produce more exhaust. Windhoek lies in a valley and due to temperature inversion the polluted air produced by motor vehicles can remain trapped in the city for a while. Unless some measure of combating the problem is devised we will in future experience higher levels of air pollution by cars, as a function of petrol consumption increase, which may be trapped in the city for prolonged periods of time. Although this is something to ponder on the plausibility thereof will only be challenged when data is available for analysis. Air pollution in Windhoek is currently not measured.

Due to the absence of air quality monitoring networks countrywide, this section presents Windhoek as a case study while using the consumption of petrol to draw an inference on current air pollution and expected increasing trends.

Trends

Air pollution is currently not monitored; or, rather, neither of the two agencies responsible monitors it. Windhoek does not experience threatening levels of air pollution due to the lack of major energy-burning industries (ibid.). Air pollution is mostly created by CO_2 releases from vehicles, the occasional veld fires, and the release of CO_2 from the Van Eck Power Station. One form of air pollution not caused by human activity is generated by mica dust, which pervades the air in Windhoek between August and October. High winds occurring around that time of year distribute the dust over Windhoek. The city lies in a valley which makes it very prone to air pollution and the entrapment of pollutants. An inversion layer in the air can come about when polluted cooler air descends and remains depressed while warmer air ascends and floats above. Due to no mixing between bottom cooler air and upper warmer air, the pollution is not dispersed: it persists even while it accumulates (ibid.). This scenario can lead to a build-up of pollutants over time that will eventually affect human health. The congestion of and increase in traffic is already a major contributor to air pollution.

Recommendations

Monitoring and data collection

This report recommends a thorough inventory and review of all existing monitoring programmes in Namibia. The lack of regular monitoring and data recording makes it difficult to provide a quantitative picture of pollution and toxins and their effects on environmental and human health. In particular, the institution(s) responsible for monitoring air pollution in Windhoek should be urged to commence this exercise to ensure that data will be available for the next cycle of reporting. Constraints and reasons for not monitoring should be identified within relevant institutions.

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Chapter 6: Solid waste management

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References

Introduction

In Namibia today, poor waste management practices pose the most serious and challenging environmental problems associated with infrastructure development and urban land-use planning. Waste products are increasing all the time due to the increasing population, particularly in urban areas, coupled with an increased standard of living and industrialisation. This places enormous strain on existing waste management activities such as collection, transportation, storage, and disposal. It is necessary, therefore, to develop more effective waste management programmes and safe waste disposal practices. Small municipalities, town councils and village councils in Namibia lack effective waste management practices covering collection, transportation and disposal programmes, mainly due to a lack of sufficient resources. There is an increasing acknowledgement by the public and authorities of the importance of adequate and effective waste collection and disposal.

Photo 6.1: Littering in northern Namibia (photo: Nico E. Willemse)

Community involvement in waste management has traditionally been that of a service recipient. In developed and, to some extent, in developing countries, such as Namibia, this is changing and moving more in the direction of active participation in education, awareness campaigns, waste reduction, source separation, and even backyard composting programmes. Communities cannot only be the service receivers: they also need to become service providers through participating in various activities at all levels of the solid waste management industry. Communities in Namibia provide services such as waste collection, street sweeping and clean-up campaigns at a very low level in Namibia. However, community participation in waste management can provide innovative ideas, with the potential for improved efficiency and entrepreneurship opportunities. Public participation can also significantly reduce not only the cost of collection, but also the large amount of waste that we currently produce. Vital waste minimisation programmes such as source reduction and separation, reuse, recycling and producer responsibility only exist on a very low scale, and then mainly in major towns such as Walvis Bay and Windhoek. This is due to a number of factors such as the lack of a legal framework, low public participation, lack of minimum requirements, lack of a market for recycled materials, and low education and awareness levels.

The lack of effective waste management strategies and programmes has resulted in very scant data being available on the type and amount of waste streams produced in Namibia. At present, only the Walvis Bay Municipality and Windhoek City Council have installed weighting facilities at their waste disposal sites in order to accurately record the amount of waste being deposited there. However, even in this situation, the amount of waste recorded at the site may not necessary reflect the total amount of waste produced in, for instance, the entire Windhoek municipal area. This is because some of the waste is illegally dumped in the surrounding marginal lowlands, valleys, and gullies, as well as on garden and building rubble sites that are located in different suburbs around the city.

In theory, there are usually three institutional levels of solid waste management: the national level (ministries/environmental agencies), the regional level (local governments), and the local level (municipalities, town councils, and village councils). Solid waste management largely falls within the regional and local levels in Namibia, with services being provided by local authorities, private contractors, and the unrecognised informal sectors. Most of the local municipalities experience great difficulty in developing and implementing effective solid waste management strategies due to minimal technical expertise and financial resources. The lack of financial resources in so serious in some instances that services only cover collection and transportation costs, with no resources available for reuse, recycling and safe disposal programmes. The informal sector, which includes scavenging activities (informal reuse and recycling), is very important in reducing waste volumes and improving efficiency in resource recovery. However, this informal sector is highly neglected within the waste management industry in Namibia. Overall, the informal sector plays a very important role in the day-to-day survival of families, and has a sustainable great potential for job creation.

The lack of resources for many local municipalities and councils to provide waste management services has resulted in tons of different types of waste being dumped indiscriminately in unsuitable areas such as dams, perennial rivers, ephemeral river channels, valleys, gullies, marginal lowlands, drains, and even along roadsides. The illegal dumping of waste, which is common in all urban and rural settlements in Namibia, poses a very serious health risk to the population and leads to a general degradation of the environment for millions of people, as well as for flora, fauna, and properties. In addition, the various pollutants and toxins associated with different types of waste dumped in an uncontrolled and unsafe way can be leached by rain water and pollute our freshwater resources. Other emissions such as methane and CO_2, which are greenhouse gases, are also associated with the waste degradation process.
Solid wastes are generated from all kinds of human activities, including domestic, agricultural, commercial, industrial, and sewage treatment (Table 6.1). However, factors such as seasonal variations, lifestyle, demography, geography and regulatory frameworks have a direct influence on the amount and composition of waste produced. The types of waste produced consist mainly of metals, organics, paper, plastics, glass, rubble and miscellaneous substances. These different types of waste can be classified into three categories: hazardous, general, and inert (Mwiya 2003). The terms *hazardous* and *general waste* are used based on the type and characteristics of the harmful substances likely to be contained in a specific type of waste (Table 6.2), and the ability of the toxins to be leachable and mobile. The term *inert waste* is used to classify waste such as garden refuse and some building rubble that may contain non-leachable harmful substances with respect to the prevailing arid and semi-arid climatic conditions (Table 6.2).

Type and amount of hazardous, general and inert waste produced

The amount and composition of waste produced in Namibia depends on many factors, such as seasonal variations, lifestyle, and standard of living (high-, medium- or low-income categories), demography, geography and regulatory frameworks. Large municipalities in some developing countries with data on the amount of waste produced, average 0.64 kg per capita per day for low-income, 0.73 kg per capita per day for medium-income, and 1.64 kg per capita per day for high-income countries (World Bank 1999). The average composition of waste in developing countries with low to middle income constitutes a high percentage of compostable organic matter, ranging from 40% to about 60%, while paper, plastic, glass and metals become more prevalent in the waste streams of middle- and high-income countries. In Namibia, which is a middle-income country, paper, plastics, glass, metals and organic substances make up the bulk of the various types of waste produced (Hochobeb 1999; Mwiya 2002; NGR 2001; Noongo et al. 2002; Tarr 1997; see Plates 6.1 and 6.2 below). All these different types can be grouped into hazardous, general and inert wastes, based on their level of toxicity and the ability of such toxins to be leached and become mobile with respect to the prevailing climatic, environmental and geological conditions. The terms *hazardous* (e.g. liquid or medical waste) and *general waste* (e.g. solid household waste) are used based on the type and characteristics of the harmful substances likely to be contained in a specific type of waste (Table 6.2), and the ability of the inherent toxins to be leachable and mobile. The term *inert waste* is used to classify waste such as garden refuse and some building rubble that may contain non-leachable harmful substances with respect to the prevailing arid and semi-arid climatic conditions (Table 6.2).

Data on the amount of hazardous, general and inert waste produced in Namibia are very limited and, in some towns, non-existent. This is because very few studies been conducted in this field in Namibia to date, and there are no effective waste management programmes to provide more reliable data. With effective waste management programmes, reliable data on the amount of waste reused, recycled and finally disposed of at waste disposal sites could all be integrated into an accurate assessment of the total amount of waste produced in different villages, towns, cities and Regions. The lack of reliable data makes it very difficult to calculate the actual amount of different types of wastes produced at village, town, city, regional or national level. However, results from the limited studies that have been

ACTIVITY	BACKGROUND	REMARKS
Automotive assembling and Servicing activities	Light automotive industries are common in most parts of the county typical of today's modern world. A number of activities ranging from assembling to servicing.	The wastes from all these activities contain contaminant chemicals/substances including heavy metals associated with metals, rubber, fluids and vapours. Waste with this type of substances requires special and effective management programmes in order to minimise their impacts on our environment.
Paint Manufacturing & Other related products.	Paints products are part of modern infrastructural development activities. The waste products are found in every parts of the country	
Tanneries	The industry is relatively small but is associated with hazardous waste streams	
Breweries	Breweries are common and the waste products of breweries are found throughout the country	
Chemical Production	The chemical production industry is most common in all the major towns in Namibia e.g. mining services, agriculture, paints and household chemicals	
Medical and Veterinary Services	Hospitals and clinics are found in all settlements around the country	
Operational and Decommissioned Power Generation Facilities	Coal power stations have been are still a source of electricity for most of the major settlements in Namibia	
Food Processing and Outlets	Food processing and outlet facilities are found in all settlements around the country	
Fisheries	The industry is dominant along the coastal towns	
Mining	Mining is one of the most important industries in Namibia. Minerals produced include diamonds, uranium, gold, coppers, lead, zinc and associated by products	Mining if not managed properly is associated with large-scale environmental damage and pollution sources, mainly heavy metals (see mining section)
Transportation	Public transport in urban areas of Namibia is not adequate and this results in many people using their private vehicles.	Emissions from the burning of fuels particularly the use of leaded petrol and diesel. Emissions include carbon monoxide, lead and particulates
Domestic	Household waste accounts for a significant amount of waste produced in all the urban and rural areas of Namibia	Household waste comprise hazardous (leachable heavy metals, solvents and organics substances), non-hazardous (non leacheable substances such as metals and inert wastes such as building rubble and garden waste
Others	A number of other industries activities that have not been highlighted in this table are also common	The other industrial activities also contains a number of contaminant substances and special management strategies are required

Table 6.1: Examples of the activities associated with different types of waste generation

Photo 6.2: Waste composition at Oshakati waste disposal site. The foreground shows some of the uncovered non-combustible hazardous waste, which is mixed with general, inert, and ash (heap seen in background). Strong odours are common during the rainy season.

Photo 6.3: Waste composition at Rehoboth waste disposal site The photograph shows an environmental damage due to plastics and paper waste. All the surrounding area including the valleys and gullies found around this site are filled with wind and water borne waste derived from the uncovered waste body on the site. Ground level burning of waste is commonly used. There is no control on the access to the site with broken fence.

POTENTIAL CONTAMINANTS	CLASSIFICATION
Metals, including arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel and zinc. Some of these may also be associated with ash from power generation	Hazardous /General waste
Non- metals, including cyanides, chlorides, sulphides and sulphates	
Acids and alkalis such as hydrochloric, phosphoric, sulphuric, caustic solutions and ammoniacal liquors.	
Organic substances, including oils, tarry wastes, solvents and polychlorinated biphenyls	
Miscellaneous waste such as building rubble, glass and other materials such as sharp metal scraps	
Putrescible and biodegradable matter such as household waste, food and vegetable residues and paper packaging	
Biodegradable material associated with household waste may produce flammable and asphyxiant or corrosive gases.	
Secondary sources. Some industrial waste may contain high concentrations of toxic or chemically aggressive substances and their interaction with the environment (air, water and land) can result in toxic material.	
Garden refuse and building rubble	Inert waste

Table 6.2: Potential contaminant (pollutants) substances associated with hazardous and general wastes

conducted in Namibia on waste management in the past ten years clearly indicate that the amount of different types of hazardous, general and inert waste are increasing (Mwiya 2002). The increase in the amount of waste produced means that there is also an increase in demand for the already scarce resources needed in the implementation of effective waste management programmes, i.e. education and skills development, awareness, source reduction, source separation, reuse, recycling, and waste disposal site development.

This lack of resources directly translates into ineffective waste management programmes, resulting in severe impacts to our life-support systems (atmosphere, biosphere, geosphere and hydrosphere). The increasing amount of waste, litter, illegal dumping and unsafe waste disposal sites will have an increased negative influence on our quality of life, whether it relates to our social or economic well-being or our physical health, and on the quality of our water and land as well as the health of our fauna and flora. The ever-increasing amount of wastes produced in Namibia and the increasing negative impacts on the environment are mainly due to the associated increase in population (Mwiya 2002) and industrialisation. In addition, the lack of legal frameworks, legislation, policies, guidelines or minimum requirements on the various stages of waste management industry hinders the efforts and support systems currently being provided by various stakeholders. Furthermore, the lack of resources for implementing effective national, regional, local or community waste management programmes, such as education and skills development, awareness, source reduction, source separation, reuse, recycling, pre-treatment and the safe waste disposal site development, also contributes to the current poor state of the waste management industry in Namibia.

Type, number and location of municipal solid waste disposal sites

The waste management industry in Namibia is still underdeveloped, with municipal solid waste disposal sites in most settlements being regarded as uncontrolled dumps. Consequently, the natural environment is at the receiving end of this trend. Environmental education is vital in order to protect natural systems such as our water resources. But the lack of environmental legislation and local minimum requirements governing waste disposal sites will always be a setback to any effort aimed at improving the current trends of operating dumps without knowing the local geology, groundwater, fauna and flora, as well as the likely negative influences on other surrounding land users. Moreover, although it is clear that current landfilling practices are not sustainable, landfilling remains an important waste disposal option. In addition, there are currently no environmentally acceptable alternatives, with realistic costs, to deal with the volumes of waste that are produced by modern societies. The design and management of municipal solid waste disposal facilities have changed dramatically in the developed world.

In most developed countries in Europe and the

ARID ZONE	WESTERN			SOUTHERN		EASTERN
SITE	LÜDERITZ	WALVIS BAY	SWAKOPMUND	MARIENTAL	KEETMANSHOOP	GOBABIS
TOPOGRAPHY	Lowlands of the Namib Desert	Lowlands of the Namib Desert	Lowlands of the Namib Desert	Flat lowlands of Namib and Kalahari Deserts extensions	Flat lowlands of Namib and Kalahari Deserts extensions	Flat lowlands Kalahari Desert
SOLID GEOLOGY	Mixed gneisses	No outcrops: covered by mobile sand dunes of the Namib Desert	No outcrops: Covered by sands and gravels.	Shales and sandstones	Shales, sandstones and dolerites	Shales, quartzites and minor limestones
SUPERFICIAL GEOLOGY	Gravels, sands & silts	Mobile desert sands	Gravel, sands and silts	Gravel, sands, silts with minor clays	Gravel, sands, silts with minor clays	Gravel, sands and silts
CLIMATE	Arid, precipitation less then 300 mm, annual evaporation of up 3800 mm, temperature vary from -9˚C in winter to 35˚C in summer for some test sites. Flash flood are common only in the Southern Lowlands test zone where summer rains are replaced by winter rainfall.					
VEGETATION	Southern Namib Desert vegetation zone rich in variety of succulents	Central Namib vegetation zone rich in variety of succulents and perennial hard grass	Northern Namib Desert vegetation zone, rich in lichens	Dwarf shrub savanna with seasonal grass and lowland *Acacias*		Camelthorn savanna with a variety of highland and lowland *Acacias*
TYPES OF WASTE	Hazardous including chemicals & medical waste: General waste which include demolition & construction waste: Inert waste which include garden waste and building rubble.					
ESTIMATED TEST SITE AREA (m^2)	44000	95000	45000	55000	112500	66000
SITE ASSESSMENT	Overall, the location of the site is suitable. The environmental impacts such as litter and wind blown waste are caused by poor site operation practices.	The location of Walvis Bay site is suitable but strong winds and lack of suitable daily cover has resulted in impacts such as litter	Overall, the location of the site is suitable. The environmental impacts such as litter and wind blown waste are caused by poor site operation practices.	Overall, the location of the site is suitable. The environmental impacts such as litter and wind blown waste are caused by poor site operation practices. In addition, the poses a risk to surface and groundwater resources due to surface runoff that comes in contact with uncovered waste. Gully erosion is a major problem that is creating channels for contaminant migration.		

Table 6.3: Suitability assessments of the few selected waste disposal sites located in arid part of the Namibia (Mwiya 2003)

United States, waste disposal facilities are highly regulated and the uncontrolled dumping of waste is a thing of the distant past. In Namibia, with the exception of the Kupferberg site in Windhoek and the waste disposal site in Walvis Bay, the majority of waste disposal sites found in many urban and rural settlements started as random dumps, and are still regarded as uncontrolled sites. These dumps are located in areas that are not suitable and are poorly operated.

Field studies and research data sets on municipal waste disposal sites in Namibia are available, however, and cover certain test sites in arid (<300 mm of precipitation; Table 6.3) and semi-arid areas (>300 mm of precipitation; Table 6.4). The MME's Directorate of the Geological Survey of Namibia conducted these studies. Their results have been used to develop a knowledge-based system model methodology (a decision support tool) for the selection, development (design), operation, restoration and aftercare of municipal solid waste disposal sites in arid and semi-arid environments such as Namibia.

Municipal waste disposal sites are associated with a number of environmental impacts. The waste deposited at these sites consists of heterogeneous materials with diverse pollution sources such as gases, metals and non-metals (Table 6.2). Methane and CO_2 are greenhouse gases associated with the various degradation processes of waste deposited

ARID ZONE	WESTERN			SOUTHERN		EASTERN
SITE	LÜDERITZ	WALVIS BAY	SWAKOPMUND	MARIENTAL	KEETMANSHOOP	GOBABIS
TOPOGRAPHY	Lowlands of the Namib Desert	Lowlands of the Namib Desert	Lowlands of the Namib Desert	Flat lowlands of Namib and Kalahari Deserts extensions	Flat lowlands of Namib and Kalahari Deserts extensions	Flat lowlands Kalahari Desert
SOLID GEOLOGY	Mixed gneisses	No outcrops: covered by mobile sand dunes of the Namib Desert	No outcrops: Covered by sands and gravels.	Shales and sandstones	Shales, sandstones and dolerites	Shales, quartzites and minor limestones
SUPERFICIAL GEOLOGY	Gravels, sands & silts	Mobile desert sands	Gravel, sands and silts	Gravel, sands, silts with minor clays	Gravel, sands, silts with minor clays	Gravel, sands and silts
CLIMATE	Arid, precipitation less then 300 mm, annual evaporation of up 3800 mm, temperature vary from -9∞C in winter to 35∞C in summer for some test sites. Flash flood are common only in the Southern Lowlands test zone where summer rains are replaced by winter rainfall.					
VEGETATION	Southern Namib Desert vegetation zone rich in variety of succulents	Central Namib vegetation zone rich in variety of succulents and perennial hard grass	Northern Namib Desert vegetation zone, rich in lichens	Dwarf shrub savanna with seasonal grass and lowland Acacias		Camelthorn savanna with a variety of highland and lowland Acacias
TYPES OF WASTE	Hazardous including chemicals & medical waste: General waste which include demolition & construction waste: Inert waste which include garden waste and building rubble.					
ESTIMATED TEST SITE AREA (m^2)	44000	95000	45000	55000	112500	66000
SITE ASSESSMENT	Overall, the location of the site is suitable. The environmental impacts such as litter and wind blown waste are caused by poor site operation practices.	The location of Walvis Bay site is suitable but strong winds and lack of suitable daily cover has resulted in impacts such as litter	Overall, the location of the site is suitable. The environmental impacts such as litter and wind blown waste are caused by poor site operation practices.	Overall, the location of the site is suitable. The environmental impacts such as litter and wind blown waste are caused by poor site operation practices. In addition, the poses a risk to surface and groundwater resources due to surface runoff that comes in contact with uncovered waste. Gully erosion is a major problem that is creating channels for contaminant migration.		

Table 6.4: Suitability assessments of the few selected waste disposal sites located in semiarid part of the Namibia (Mwiya 2003)

Photo 6.4: One of municipal waste disposal sites located less 1 km to west of Tsumeb town.

The photo shows a major solution channel that has been covered by waste. Chemical weathering of the dolomites has resulted in the formation of these solution features. Local solution holes form part of the regional network which characterises the groundwater occurrence in this area. Despite their significance to the groundwater of this region, waste is dumped right on top of these solution channels. During heavy rain, waste and surface runoff from the entire site flow directly into the groundwater resources.

in a landfill (waste disposal) site. Other gases and complex substances such as total particulate matter, sulphur oxides, carbon monoxide, methane, nitrogen oxides, volatile organic compounds,

Photo 6.5: One of the waste disposal sites located about 500 m north-west of Oshakati.

A river of waste! During the rainy season, this river of waste often flows. Surface and groundwater resources around this site are vulnerable to contamination due to poor waste management practices. Water is very limited and droughts are common and the available limited resources are threatened by human activities such as waste disposal.

chlorobenzenes, benzenes, acetone, styrene and phenol are associated with the open-ground burning of waste commonly used on all waste disposal sites in Namibia. The contaminant ash and other residues from open burning are very often emitted together with dust into the surrounding environment due to a lack of sufficient and effective cover systems.

Odours and leachates are also serious pollutant sources associated with municipal waste disposal site. Odours result from the biodegradable processes of organic waste and are associated with the smell of strong leachates. The production of leachate is linked to the rainwater that runs over uncovered waste or infiltrates into buried waste and mixes with liquids already present in it (Photos 6.2 and 6.3). The process results in contaminant compounds being leached from the solid waste, producing a liquid known as *leachate*. Leachate from waste disposal sites contains very high concentrations of toxic organic and inorganic compounds. Leachate can move as surface run-off during the rainy season into drinking water resources such as dams, lakes and rivers, resulting in water and land contamination (Photos 6.2 and 6.3). Leachate can also move downward from a waste disposal site into groundwater systems and cause contamination (Photo 6.4). Moving groundwater can leach compounds from the waste and become contaminated if the waste is buried below the water table. When leachate mixes with water, it forms a plume that spreads in the direction of flowing water.

However, as one moves away from the source of the plume, the pollutant concentrations often decrease due to dilution, dispersion and retardation processes. The volume of leachate that is produced is a function of water that comes into contact with the uncovered waste or the amount of water that percolates into the refuse (Plates 6.4 and 6.5). Other parameters such as the amount of evaporation, transpiration, liquid input and absorption capacity of the waste also play a role in the amount of leachate produced. Waste disposal can be designed to minimise the formation of leachate as well as control the amount of leachate that can escape from a disposal site. It is clear that the increasing population, the amount of waste produced, and the development and operation of more unsafe and uncontrolled waste disposal sites, particularly in dense urban settlements, will have a profound effect on our own quality of life and that of our life-support systems (atmosphere, biosphere, geosphere and hydrosphere). The integration of all relevant local knowledge is vital for delineating suitable and economical waste disposal site locations, and for developing and implementing appropriate operation, restoration and aftercare procedures to protect the environment.

Relevant technical data on suitable land use for waste disposal development, covering all urban areas in Namibia, will in future be available to decision-makers. The MME's Directorate of the Geological Survey of Namibia has undertaken a nationwide urban thematic mapping programme. The programme is aimed at providing interpreted technical data to decision-makers with respect to land use suitability and environmental protection. The maps for Windhoek are near completion and similar maps will be developed for all other towns in Namibia. The 1:10,000 scale maps for each area consist of the following five layers:

1. A ***superficial geotechnical layer*** that indicates the geotechnical properties of various surface materials such as gravels, sands and silts mapped
2. A ***solid geotechnical layer*** that indicates the geotechnical properties of the different types of rocks such schists, sandstones, shales and quartzites mapped
3. A ***geomorphology layer*** showing all the geomorphic features such as river channels, gullies and slope grades
4. A ***constraint layer*** showing all the constraints that have an influence on various infrastructural developments such as housing, and heavy and light industries, and
5. An ***opportunity layer*** that indicates the infrastructural (including waste disposal site) development opportunities in the different areas mapped with respect to the identified constraints.

International Conventions and national policies

Namibia is a signatory to the Basel Convention adopted in Switzerland in 1989. The Convention addresses the issue of the transboundary movement and disposal of hazardous waste. In addition, the Convention has a long-term objective to minimise the quantity and toxicity of waste. The Convention also recognises the right of any state to ban the import of foreign hazardous waste, as demonstrated in the Namibian Constitution, and stresses that waste should be correctly disposed of within the country of origin. This Convention, together with national policies and effective waste management support programmes that offer technical and entrepreneurship skills development, and raise awareness about reducing and separating waste at its source, and reusing it and recycling it, as well as educating producers about their responsibility such as the concept of 'the polluter pays', are instruments that can change the face of the waste management industry in Namibia.

Nationally, Namibia has a number of different enactments regarding waste management and pollution control, which include the following:

- Article 95 (1) that commits the State, in principle, to putting up policies that will prevent the recycling or dumping of foreign nuclear toxic waste on the territory of Namibia (but it does not cover waste generated in Namibia)

- The Atmosphere Pollution Prevention Ordinance (No. 11 of 1976)
- The Hazardous Substances Ordinance (No. 14 of 1964)
- The Public Health Act, 1919 (No. 36 of 1919), and
- The Seashore Ordinance (No. 37 of 1958).

All of the above pieces of legislation cover pollution prevention and environmental protection matters to some extent. Most of the legislation is currently being revised and modernised by the ministries concerned. However, at present there are no national guidelines, minimum requirements or legislation governing the selection, development, operation, restoration and aftercare of waste disposal sites in Namibia. Nonetheless, it is hoped that the long-awaited Pollution Control and Waste Management Bill will soon be passed in Parliament. This will then become the legal support system to develop the relevant minimum requirements on various components of the waste management industry in Namibia.

Chapter overview

An integrated approach to environmental assessments needs to consider and assess the current state of waste and littering: the practice of disposing wastes and litter, the conditions and quality of disposal sites, the types of waste, and its impact on environmental and human health. Waste is generated as part of peoples' lifestyles. This can occur at domestic and industrial level. And, as a population grows, so does the amount of waste it produces. People's incomes also determine the amount of waste they produce. In Windhoek, the affluent segment of the population generates more waste than people lower on the socio-economic ladder (Figure 6.1). Buying power allows people to afford more luxury items that come in disposable packaging, whereas the less fortunate try to meet basic needs.

As waste is generated, local governments need to ensure that it is properly disposed of. Domestic waste generally does not pose the same type of threat to human health that chemical or toxic wastes do. Thus, there is a need for specially designed disposal methods and sites for the latter types of waste.

Regionally, the production of waste presents an interesting picture across Namibia: Figure 6.2 shows the total waste produced per Region each year. The Kavango, Khomas, Ohangwena and Omusati Regions produce the most waste in the country due to the high population numbers in those Regions. Compared with 1991, these four Regions – including Erongo – also produced a lot more waste in 2001. The substantial increase in waste produced in the Erongo Region corresponds to rural–urban migration and increased development in the coastal towns of Swakopmund and Walvis Bay. The Caprivi Region shows a decrease in waste production for 2001 compared with 1991, while Hardap, Karas, Kunene and Omaheke show very little increase in total waste produced.

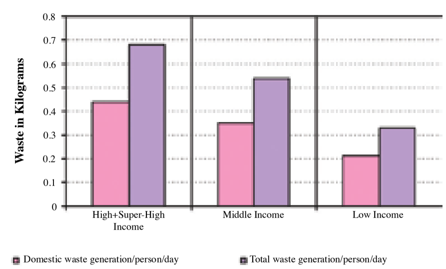

Figure 6.1: Waste production in Namibia

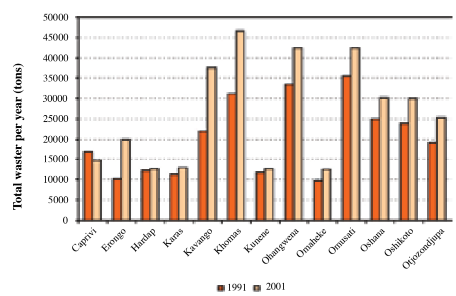

Figure 6.2: Waste production per regions

Waste and litter pose threats to environmental health. Toxic waste water affects the growth of vegetation and animals in and around the disposal area. This can affect the lives and health of people further downstream. The danger of disposing of plastics in the natural environment is well known: they generally take a long time to degrade, and may inhibit the growth of vegetation. The degradation of plastics may also release toxic substances that can pose a danger to plants and animals. Another example is the danger that waste can pose to underground water sources. Discharged waste water can seep through the ground and pollute underground water sources. The contamination of groundwater is irreversible. In addition, if a waste site has not been properly designed, rainwater can draw numerous pollutants from the waste, and these seep through to pollute groundwater sources.

Due to the existing and potential dangers that waste and litter pose, it is important that disposal sites are designed in a way that takes human and environmental health issues into account.

Type and amounts of inert, general and hazardous wastes

Results from the limited studies conducted on waste management in Namibia over the past ten years clearly indicate an increasing trend in the amount of hazardous, general and inert waste. However, actual data on the amount of such waste produced in the country are very limited and, in some towns, non-existent. The ever-increasing amount of waste produced can be interpreted as being linked to the growing population and increasing industrialisation, with few effective national, regional, local or community source reduction, source separation, reuse, recycling and cleaner technology incentives for waste management programmes.

Type, number and location of municipal solid waste disposal sites

Municipal solid waste disposal sites in Namibia have been and still are neighbourhood dumps located on the edge of towns, villages or mining settlements. Similarly, all types of waste have also been and still are being dumped in any readily available hole or depression such as valleys, sand and gravel quarries, and marginal lowlands. Many of the sites are located near residential areas and water supply zones, resulting in high pollution potential to surface water and groundwater as well as being a health risk to the public. During the planning stages of these waste disposal sites, no ground investigations were conducted and no thought was given to pollution and environmental protection. The transformation of the philosophy of leaking and polluting neighbourhood dumps into 'licensed to leak and pollute' seems to be the operating waste disposal design practice in Namibia today. The 'licensed to leak and pollute' form of waste disposal design philosophy is one where a number of dumps are identified, developed and operated for a specific type of waste without taking technical controls such as ground, environmental and climatic data influences into consideration.

Assessment of indicators

INDICATOR 6A: Type and amount of general, hazardous and inert waste produced

Introduction

In Namibia, general, hazardous and inert waste is generated from all kinds of human activities, including domestic, agricultural, commercial, industrial, and sewage treatment. The types of waste produced mainly consist of metals, organics, paper, plastics, glass, rubble, and miscellaneous substances (Plates 6.1 and 6.2). Data on the amount of hazardous, general and inert waste produced in Namibia are very limited and even non-existent in some towns, particularly in small towns. However, results from the limited studies that have been conducted in Namibia on waste management in the past ten years or so clearly indicate that the amounts of different types of waste are increasing (Figure 6.4). The increase in the amount of waste produced means that there is also an increase in demand for the already scarce resources needed in the implementation of effective waste management programmes, namely those associated with education, technical and entrepreneurship skills development, awareness-raising, source reduction, source separation, reuse, recycling, and the ultimate waste disposal site development. The lack of resources in some parts of Namibia has resulted in ineffective waste management programmes, causing severe impacts on the environment. The increasing amount of waste, litter and illegal dumping, and the operation of unsafe waste disposal sites have all had an increased negative influences on our quality of life, whether it relates to our social or economic well-being or our physical health, and on the quality of our water and land as well as the health of our fauna and flora (Photos 6.1 and 6.2).

Low-income countries gross national product (GNP) per capita <US$700 (average US$490)

Middle-income countries (e.g. Namibia) GNP per capita US$980–3,890 (average US$1,410)

High-income countries GNP per capita US$9,700–39,640 (average US$30,990).

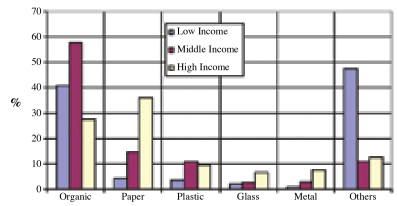

Figure 6.3: Waste composition in developing countries (World Bank, 1999)

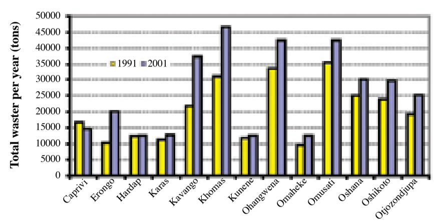

Figure 6.4: Total waste generated per year per region in Namibia

Description

This indicator measures the total annual amount of inert, general and hazardous waste produced per capita. Hazardous waste such as liquid and medical waste, and general waste such as solid household waste are associated with harmful substances (Table 6.2 above). These substances have a high to moderately high ability to be leachable and mobile (Plates 6.1 and 6.2). Inert waste includes garden refuse and some building rubble that may contain non-leachable substances that are harmful to the environment in the context of the prevailing arid and semi-arid climatic conditions in Namibia. However, income levels, standard of living, lifestyle, demography, geography and regulatory frameworks all have direct influences on the amount and composition of waste produced in different parts of the country.

Results and trends

The results of the amount of waste produced and used as an indicator have been derived from an indirect relationship between populations in the various Regions of the country, and the amount of waste likely to be produced (Figure 6.4). Namibia's economic position as a middle-income developing country and the likely composition of different types of waste produced have also been taken into consideration in the assessment (Figure 6.3). Furthermore, the assessment procedure combined data from field investigations (Plates 6.1 and 6.2) as well as other previously conducted studies and records from municipalities such as those in Walvis Bay and Windhoek.

According to a pilot study conducted in Windhoek for different income levels (NGR 2001), domestic waste generation per person per day averaged out at 0.33 kg, while the total waste generated per person per day averaged at 0.52 kg.

Most Regions show an increase in the amount of waste produced. For instance, the Erongo, Kavango, Khomas and Otjozondjupa Regions showed an increased waste generation of 48%, 33% and 24%, respectively, over a ten-year period. This increase is more likely to be linked to the increase in population and rate of industrialisation.

Results from the limited studies conducted on waste management in Namibia over the past ten years clearly indicate an increasing trend in the amount of hazardous, general and inert waste. However, actual data on the amount of such waste produced in the country are very limited and, in some towns, non-existent. The ever-increasing amount of waste produced can be interpreted as being linked to the growing population (Figure 6.4) and increasing industrialisation, with few effective national, regional, local or community source reduction, source separation, reuse, recycling and cleaner technology incentives for waste management programmes.

Goal

The goal is to minimise the ever-increasing amounts of waste produced in Namibia, and thereby decrease the likely and potential negative impacts on the environment through pollution prevention strategies. This can only be achieved by allocating resources for implementing effective national, regional, local and community waste management programmes on education, technical and entrepreneurship skills development, awareness-raising, source reduction, source separation, reuse, recycling, and pre-treatment, as well as by offering cleaner technology incentives and charging waste disposal site taxes. The financial resources necessary to develop and implement effective waste management programmes can be obtained from special taxes or levies applied to products such as packaging materials. However, effective strategies to achieve cleaner production, minimise waste and prevent pollution can only be developed and implemented successfully with the support of an effective environmental legal framework and institutional capacity to enforce the law.

INDICATOR 6B: Type, number and location of municipal solid waste disposal sites

Introduction

Municipal solid waste disposal sites are part of our modern infrastructure and urban development. Most of the urban settlements in Namibia have more than one waste disposal site, generally referred to as dumps. With the exception of Walvis Bay and Windhoek, the majority of these sites have no engineered structures such as leachate management ponds, peripheral fences, or daily cover systems (Tables 6.3 and 6.4; Plates 6.3 and 6.4). Furthermore, some of these sites are located on unsuitable places such as near residential areas, settlements, ecologically sensitive areas and even, in some instances, close to surface water and groundwater resources (Annex 6.1, Figures 6.5a–m). The increasing number and size of uncontrolled waste disposal sites located on unsuitable places has an immense impact on the quality of life for surrounding communities and the fauna and flora. Indeed, waste disposal sites are ever-increasing sources of surface water and groundwater pollution throughout the country.

Description

The type, number and location of municipal solid waste disposal sites in urban settlements throughout the country indicate the relationship between the various types of waste produced, and the effectiveness of waste minimisation programmes. The MME's Directorate of the Geological Survey of Namibia has compiled data on the location of such sites in most of the urban settlements in Namibia (Tables 6.3 and 6.4; Annex 6.1, Figures 6.5a–m). The increased number of waste disposal sites shows little is being reused or recycled; hence, there is a concomitant increase in the strain on suitable land to be used for waste disposal development. The types (uncontrolled or controlled sites), number, and current and likely future size of sites developed on suitable or unsuitable grounds offer a reliable indicator of the likely short- and long-term negative influences of these sites as pollution sources. Municipal waste disposal sites, if not properly controlled, can impact very negatively on the environment. These include visual impacts, loss of land, and lower property prices as the land around certain dumps may be classified as contaminated because of its proximity to a dump. Other negative environmental impacts include odour, loss of biodiversity due to poor site development and management practices, and a source of pollution of surface water and ground water resources.

Results and trends

The knowledge-based approach has been used as an instrument for capturing the required local knowledge for and assessment of the state of municipal solid waste sites in Namibia (Tables 6.3 and 6.4; Annex 6.1, Figures 6.5a–m). A conceptual model has also been developed, consisting of different categories of expert knowledge grouped into climatic, environmental and ground data sets, in order to capture the required local knowledge. The ***climatic*** components used to prepare the figures shown in Annex 6.1 were precipitation, temperature, evapotranspiration, and wind data. The ***environmental*** components comprised the type of industrial activity, the amounts and types of waste, likely contaminants associated with different types of waste, and local ecological and community settings. The ***ground*** components covered the regional and local geology, geomorphology, and surface water and groundwater, as well as in-situ and laboratory stability tests of materials, including indexing the properties of soils and rocks, their mineralogy, and water chemistry analyses.

Municipal solid waste disposal sites in Namibia have been and still are neighbourhood dumps located on the edge of towns, villages or mining settlements. Similarly, all types of waste have also been and still are being dumped in any readily available hole or depression such as valleys, sand and gravel quarries, and marginal lowlands. Many of the sites are located near residential areas and water supply zones, resulting in high pollution potential to surface water and groundwater as well as being a health risk to the public. During the planning stages of these waste disposal sites, no ground investigations were conducted and no thought was given to pollution and environmental protection. The transformation of the philosophy of leaking and polluting neighbourhood dumps into 'licensed to leak and pollute' seems to be the operating waste disposal design practice in Namibia today. The 'licensed to leak and pollute' form of waste disposal design philosophy is one where a number of dumps are identified, developed and operated for a specific type of waste without taking technical controls such as ground, environmental and climatic data influences into consideration.

Goal

As the emphasis on municipal solid waste management shifts from disposal to recovery, the need for information on the physical and chemical composition of the waste involved also increases. Limits and incentives for increasing waste recovery need to be devised and implemented, e.g. offering incentives to increase the proportion of recycling and reusing materials, and imposing landfill taxes to encourage alternatives to final disposal. Waste disposal sites have to be classified into inert, general and hazardous sites with respect to the toxicity associated with a particular type of waste a site is designed to handle. Landfills or waste disposal sites designed for handling pre-treated wastes will have less pollution potential and little or no risks that can be transferred to future generations; such landfills fall within the 'favourable dormant' concept or 'dry tomb' philosophy. The dry tomb philosophy – coupled with effective sorting, pre-treatment of waste, reuse and recycling – is an option that can easily be applied in Namibia, mainly due to the arid and semi-arid climatic conditions here. The natural conditions of these environments should serve as the starting point for devising new strategies and technologies that can make municipal waste disposal sites more sustainable with realistic costs.

The selection, development, operation, restoration and aftercare of municipal solid waste disposal sites in Namibia requires the use of various data sets, including the following:

- Climatic data sets, which include precipitation, evaporation and transpiration, as well as wind speed and direction
- Environmental data sets, which include the ecology, social settings, the type of industry, the type and amount of waste produced, and likely contaminants, and
- Ground data sets, which include geological, geomorphological, hydrological and geotechnical evaluations.

However, success in developing and designing safe and economical municipal waste disposal sites in Namibia largely depends on an effective legal framework, the institutional capacity to enforce the law, and the availability of pragmatic local minimum requirements.

Recommendations

Monitoring and data collection

Data on waste and littering are generally highly deficient. Many municipalities have until recently not monitored and recorded the disposal of waste at disposal sites. Ideally, waste needs to be categorised, weighed and recorded to generate monthly and consequent annual time-series of data. The deficiency of data makes assessments rather qualitative, with no concrete results on the amount and type of waste produced. The principal recommendation here, therefore, is to adopt the Knowledge-based System Model methodology for the selection, investigation, development, monitoring and restoration of waste disposal sites. This will ensure the development of waste disposal sites takes into account an array of factors pertaining to human, environmental and economic health. Where disposal sites exist, they need to be screened using the recommended methodology; based on the outcome of the screening, a decision needs to be taken to either shut down or upgrade the site. Existing monitoring systems need to be evaluated and, where such systems are absent, they need to be designed and implemented. Using the suggested methodology will add enormous value to the role that disposal sites play, and will limit the negative effects of waste on the environment and people's lives. This methodology can also facilitate the development of monitoring systems that not only record the type and amount of waste, but also take into account the condition of the surrounding natural environment.

Review of municipal policies and strategies

It is recommended that municipal policies and strategies in terms of waste management and monitoring be reviewed. For example, it may be that municipalities have strategies on waste management and monitoring that have not been implemented. Also, the constraints related to the lack of implementation need to be identified and tackled. If possible, training should be provided to relevant staff in the use and application of the Knowledge-based System Model methodology. Policies should also be reviewed to assess the extent to which they cover environmental protection and monitoring when it comes to waste and littering.

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Chapter 7: Greenhouse effect and ozone depletion

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Chapter Overview
Assessment of Indicators
Recommendations
References

Introduction

"As an arid, agriculturally marginal country with a low economic growth and flexibility, and a high dependence on natural resource-based industries, including subsistence agriculture and tourism, Namibia currently has limited capacity to adapt to climate change impacts. Namibia is therefore considered to be among the highly vulnerable African countries with regard to climate change."

Initial national communication to the UNFCCC (MET 2002)

The greenhouse effect

The *greenhouse effect* is a natural phenomenon. It helps to heat the earth's surface and atmosphere, and to maintain a temperature that enables life to flourish. Without the greenhouse effect, life on earth would be non-existent as the average temperature would be around -18°C – compared with the current 15°C.

What causes this phenomenon?

When energy released by the sun, it passes through the atmosphere and a number of things take place. In a global context, 26% of this solar energy is reflected back into space by clouds and particles, while about 19% is absorbed by clouds, gases and particles in the atmosphere. Of the remaining 55% passing through the atmosphere, a mere 4% is reflected back into space. Thus, on average, 51% of the sun's radiation reaches the earth's surface. This energy is used in a number of processes including plant photosynthesis, heating the ground surface, melting ice and snow, and water evaporation.

The earth's surface becomes a radiator of energy in the long-wave band (also known as *infrared radiation*). This energy is usually emitted to space. However, only a small portion actually makes it back to space: the majority of infrared emissions are absorbed by a few natural atmospheric gases known as the *greenhouse* gases. As more of this energy is absorbed, additional heat energy is added to the earth's atmospheric system. Atmospheric greenhouse gases, now warmer, start to radiate long-wave energy in all directions. More than 90% of this emission of long-wave energy is directed back to earth, where it is absorbed by the earth's surface. As a consequence, a cycle of radiation (of heat from the earth's surface), absorption (by greenhouse gases), and emission (of long-wave energy back to earth by greenhouse gas molecules) is generated.

As stated earlier, natural greenhouse gases maintain the earth's average temperature at a tolerable 15°C. However, by adding more greenhouse gases to the atmosphere, people are strengthening the greenhouse effect and the earth is becoming warmer and warmer.

Box 7.1: The principle GASES that increase the Greenhouse Effect

Carbon Dioxide (CO_2)
Carbon dioxide is responsible for more than 60% of the greenhouse effect which in turn produces significant changes in the global climate. CO_2 is released into the atmosphere every time that fossil fuel (coal, oil, natural gas) is burned. In the past century of industrial development the quantity of fossil fuel consumes was without precedent: it has been estimated that in the last 10,000 years the CO_2 level has increased by 10% through the natural exchanges that exist between the atmosphere, ocean and land vegetation. While in the past 200 years of industrial development the increase of CO_2 in the atmosphere has been calculated at 30% (UNFCCC) and at the same time massive deforestation of important areas of the planet has reduced the natural CO_2 "sinks" (absorption capacity).

Methane
Methane is a potent greenhouse gas which contributes between 15 – 20% of the greenhouse effect. Methane is released into the atmosphere from urban waste dumps, from some intensive livestock farming systems, from leaks in coal mines and from the production of natural gas

Nitrous Oxide, Clorofluorocarbons, Ozone
These contribute the remaining 20% of the greenhouse effect. The level of Nitrous Oxide has increased by 15% in the last century due to the introduction of intensive agricultural techniques. CFC emissions increased from 1960s until the beginning of the 1990s when, thanks to the Montreal Protocol for the Protection of the Ozone Layer, emissions were stabilized.

Source:http://www.catpress.com/agenergia/download/BrochureCCPEnglish.rtf

Extent of risk caused by the phenomenon

The greenhouse effect does not pose any serious danger to Namibia over the next few decades unless the emission of greenhouse gases accelerates at an alarming rate. Based on projections stemming from the IS92a climate change scenarios, Namibia will, however, be affected. The water sector is currently the most vulnerable, and even without serious climate changes, Namibia faces absolute water scarcity by 2020 (MET–NINC 2002). Given the global scenario, anthropogenic CO_2 emissions will triple, while methane (CH_4) and nitrogen dioxide (NO_2) emissions will double by 2100. Namibia's mean annual temperature is expected to rise by between 2°C and 6°C by 2100. Increases in temperature are likely to promote drought conditions and desertification, which will impact severely on people's livelihoods. Famine is likely to occur. Evaporation rates currently exceed rainfall and, to worsen the situation, evaporation is anticipated to increase by 5% per degree of temperature increase, so a 6°C temperature increase, for example, will increase evaporation by 30%. The agriculture and fisheries sectors run the risk of producing yields lower than the current ones. Moreover, agriculture depends heavily on water. With the prospect of increased evaporation and uncertain rainfall conditions, droughts will occur. During droughts, livestock production falls due to a lack of sufficient forage, milk production declines, the animals' health weakens, and growth rates decline. As an industry that currently supports two-thirds of the population, impacts on household food security will be dramatic. The fishing industry is based on the highly productive Benguela Current Upwelling System, making it one of the most productive marine environments in the world. The upwelling of nutrients occurs during known times of the year, and fish and fishery species benefiting are adapted to the timing and frequency of each event. Any possible changes to the ocean current on Namibia's west coast will, therefore, threaten marine fisheries. Such change may entail the timing, frequency or distribution of upwelling, which will impact on production with significant economic repercussions due to the prominence of the fishing industry in Namibia. A warmer climate will promote diseases that are expected to increase mortality rates amongst infants and other children under 5 years of age.

International Treaties and Conventions

Vienna Convention for the Protection of the Ozone Layer

The implementation of Vienna Convention was preceded by the adoption of the Vienna Convention in 1985, the Montreal Protocol in 1987, and the London Amendment in 1990.

The Convention recognises the need to protect the ozone layer from harmful emissions caused by humans and requires international cooperation and action, based on ongoing scientific research and technological considerations. The primary objective is to protect human health and the environment especially from increased ultraviolet solar radiation. Adverse impacts include increasing skin cancer, damage to crops and increased plankton mortality in the ocean which, in turn, affects our fishing industry. States are required to reduce their reliance on ODSs, and to undertake collaborative research to find alternatives to harmful substances such as CFCs and halons. Developed nations are urged to assist their developing counterparts through technology transfer, research and training. Namibia does not contribute significantly to the destruction of the ozone layer: it acceded to the treaty in 1993 and is, therefore, obliged to assist where possible and appropriate in finding solutions to the ozone problem. Furthermore, we are obliged to monitor and report on the consumption and production of CFCs in industrial activities.

National policies and measures

Namibia currently lacks a national policy that explicitly addresses climate change. A wide range of policies, plans and programmes exist that deal with natural resource management in the context of Namibia's prevailing harsh climatic conditions. However, a specific climate change strategy and action plan are needed for the integration of cross-sectoral policies and to identify, through relevant consultations, priority activities to address climate change issues. In 2001, the Namibian Climate Change Commission (NCCC) was established. The NCCC advises and make recommendations to Government on climate change, including how to meet Namibia's obligations to the UNFCCC.

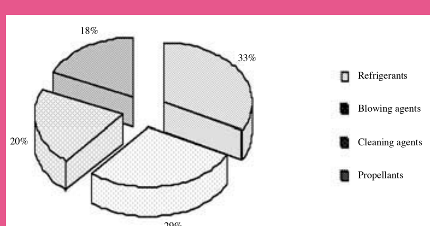
Ozone depletion

The earth's atmosphere is comprised of numerous gases. The central and lower parts of the atmosphere – known as the *stratosphere* and *troposphere*, respectively – contain a small amount of ozone. *Ozone* is a gas with molecules consisting of three oxygen atoms bound together, instead of the two that compose the normal oxygen molecule. Oxygen makes up 21% of the air we breathe. The average concentration of ozone in the atmosphere is about 3 ozone molecules for every 10 million air molecules. Most of the ozone (around 90%) occurs in the stratosphere about 15–30 km above the earth's surface, where it is present at levels of several parts per million by volume (ppmv). If all the ozone in the atmosphere were to settle on the earth's surface, it would form a band about 2–5 mm thick.

Man-made chemicals such as CFCs and halons cause ozone depletion in the upper atmosphere. Severe depletion occurs over Antarctica in spring (March–May), causing the highly publicised 'ozone hole'. However, at all latitudes away from the equator, the layer of ozone that protects us from the harmful radiation of the sun is thinner that it was in the late 1970s. The Montreal Protocol of 1987 led to most CFC and halon use being phased out. However, because CFCs and halons last in the atmosphere for a long time, it will take some decades before the ozone layer completely replenishes itself. Depletion of the ozone layer refers to decreases of the ozone concentration in the stratosphere, caused mainly by emissions of CFCs and halon (Box 7.2), and the

Box 7.2: ***More on CFCs and Halon…***

Chlorofluorocarbons (CFCs) were invented in the late 1920s and early 1930s. This invention was prompted by the need for safer alternatives to the sulphur dioxide and ammonia refrigerants used at the time. CFCs are low in toxicity, non-flammable, noncorrosive, and nonreactive with other chemical species. In addition they bear desirable thermal-conductivity and boiling point characteristics. Due to these favourable properties CFCs became very popular and the demand increased as more applications arose. CFCs are primarily used for coolants in refrigeration systems and air conditioners, as blowing agents in the production of plastic foams, as propellants in air conditioners and as solvent to clean electronic components. Figure 1 below shows the different uses of chlorofluorocarbons as estimated in 1991, of the 682 million kilograms consumed globally.



In 1974 Drs. Molina and Rowland suggested that the group of compounds known as CFCs were likely to deplete the ozone. Their idea was not received favourably until the British Antarctic Survey of 1985 discovered the ozone hole over Antarctica.

The halons are used as fire extinguishing agents, both in built-in systems and in handheld portable fire extinguishers. Halon production in the U.S. ended at the end of 1993 because they contribute to ozone depletion. They cause ozone depletion because they contain bromine. Bromine is many times more effective at destroying ozone than chlorine. Technically, all compounds containing carbon and fluorine and/or chlorine are halons, but in the context of the Clean Air Act, "halon" means a fire extinguishing agent as described above.
Source: The U.S. Environmental Protection

consequent increase in the amount of harmful ultraviolet radiation.

What causes the phenomenon?

Natural phenomena can cause temporary ozone loss; however, chlorine and bromine released from man-made compounds such as CFCs are now accepted as being the main cause of this depletion. Chlorine atoms from CFC molecules and bromine atoms from halons cause the breakdown of the ozone in the ozone layer. CFCs and halons are used in many applications such as refrigerants, anaesthetics, aerosols, firefighting equipment, and the manufacture of materials such as stryrofoam. They were thought to be environmentally neutral, completely safe and chemically inert. However, it was soon found that they were not so ideal when they reached the upper atmosphere. CFCs cannot be destroyed in the lower atmosphere by other chemicals or 'washed' back to earth by rain, so they remain at this level for between 20 and 120 years. When they reach the upper atmosphere, these compounds are first degraded by ultraviolet radiation. Degradation of CFCs leaves a free chlorine atom. The basic cause of ozone layer depletion is that this chlorine atom then breaks up ozone molecules, i.e. it destroys oxygen molecules. Ozone then gradually disappears. One chlorine atom can destroy 100,000 ozone molecules. Bromine compounds, or halons, can also destroy stratospheric ozone. Compounds containing chlorine and bromine from man-made compounds are known as *industrial halocarbons*.

Extent of risk caused by the phenomenon

Although ozone is present in small quantities, it plays a vital role in supporting life on earth. Natural ozone levels in the atmosphere prevent most harmful solar radiation – ultraviolet radiation of relatively short wavelengths, or UVB – from reaching the earth's surface: ozone absorbs a significant portion of the UVB. UVB has been linked to various types of skin cancer, cataracts (an eye ailment), and damage to the human immune system. It is also known to be harmful to crops and some forms of marine life. Changes in the amount of radiation that penetrates to the earth's surface as a result of the thinning of the ozone layer can have potentially severe implications for human health, ecological systems, and global climate.

International Conventions

Namibia is a signatory to the Montreal Protocol on Substances that deplete the Ozone Layer of 1987. As an international treaty, the Protocol obliges all signatory states to phase out both the production and consumption of ODSs. Article 4B of the Protocol, under "Licensing", requires each state to introduce mandatory licensing systems to monitor and control the import and export of controlled substances. Such systems will enable countries to meet the set reduction and phasing-out targets in respect of ODSs. Based on Article 7, "Reporting of data", all member states are also required to record statistical data on the importation of ODSs and to report to the Ozone Secretariat on an annual basis.

Vienna Convention for the Protection of the Ozone Layer

The implementation of the Vienna Convention was preceded by the adoption of the Vienna Convention in 1985, the Montreal Protocol in 1987 and the London Amendment in 1990. The Convention recognises the need to protect the ozone layer from harmful emissions caused by humans, and requires international cooperation and action based on ongoing scientific research and technological considerations. Its main purpose is to protect human health and the environment, especially from increased ultraviolet solar radiation. Adverse impacts include increasing skin cancer, damage to crops, and increased plankton mortality in the oceans – which, in turn, affects our fishing industry. States are required to reduce their reliance on ODSs, and to conduct collaborative research to find alternatives to harmful substances such as CFCs and halons. The Convention specifically urges states to assist developing countries through technology transfer, research and training.

National policies and measures

Namibia is committed to the phasing out of ODSs by the year 2010. The Ministry of Trade and Industry has drafted regulations that, once approved and implemented, will require permits for the importation of ODSs and impose a ban on products that use ODSs. These regulations will not exclude any Southern African Customs Union member states.

Methyl bromide (MeBr) is recognised as a chemical that harms the ozone layer, and was added to the list of controlled ODSs in 1992 (Uugwanga & Von Krosigk 2001). In Namibia, MeBr is used in agricultural production, the cereal industry, wood processing and the fisheries sector. The agriculture sector uses the substance to fumigate soils for grape seedlings along the Orange River. This makes the grape industry the largest consumer of MeBr in the country. The grain- and farm-feed-producing industries use MeBr only in critical cases of insect infestation. The wood processing industry also consumes small amounts for the fumigation of export products. In the fishing industry, MeBr is used to fumigate fishmeal during storage or prior to export for quality control purposes. MeBr is not a registered pesticide in Namibia although it has been used as such for the past ten years and more. The Ministry of Health and Social Services has listed it as a hazardous substance, but an effective control system is still pending. The substance is not for sale in Namibia and is imported mainly from South Africa (ibid.).

Namibia is currently not a noticeable contributor to regional and global greenhouse gas emissions or the consumption of ODSs. However, it is important to try to keep such emissions and the use of ODSs to a minimum in order to contribute positively to the regional and global situation in this regard. Moreover, the population is projected to grow linearly until the year 2021 (NPC 2003). As the population expands, so will our demand for natural resources and energy, whether renewable or non-renewable. However, Namibia has yet not fully exploited the generation and utilisation of renewable energy. This, it is argued, needs to be done if we aim to meet the growing energy demand while developing the country sustainably. Although a negligible contributor to regional and global greenhouse gas emission and ODS consumption, Namibia is not exempted from the impacts of global warming and other effects of environmental change. For example, increases in ambient and sea surface temperatures will severely threaten the lifespan of natural resource-based industries and the availability of water in Namibia. Rainfall is already highly variable and unreliable in the absence of perennial inland water sources. As trends in rainfall are projected to worsen, we should already research alternatives to secure the availability of water for the future.

Chapter overview

Annual energy consumption

Trends in the consumption of electricity have been increasing since 1990. This is the case for both rural and urban areas due to population expansion. The demand for electricity was estimated at 4% per annum; until all households are furnished with an adequate energy supply, this demand can be expected to remain or increase. The current exploitation of biomass energy resources threatens the health of the country's forest resources. As more land lies denuded and abandoned, the demand for woody resources becomes exacerbated. In addition, rural development is a national priority. As long as rural households do not have alternative sources of energy, people will continue to harvest woody resources unsustainably. Namibia does not contribute excessively to greenhouse gas emissions and also does not produce fossil fuels. The current import of fossil fuels is equated to consumption. Although relatively small amounts of greenhouse gases are emitted in the country in association with the consumption of fossil fuels, this does not exempt Namibia from trying to reduce national, regional and global emissions. Thus, Namibia should research the viability of long-term alternatives to fossil fuels and it is time we start using our abundantly available solar and wind resources.

Mean annual rainfall

The availability of surface water and the recharge of groundwater sources are directly dependent on the frequency and intensity of rainfall. Poor rainfall years are marked by lower agricultural production and a general setback in this industry at commercial and communal level. Enhanced greenhouse forcing does not alter the spatial distribution of Namibia's rainfall. Instead, the pattern and intensity of rainfall seem to change intraseasonally. The rainfall season falls between October and April each year. Due to the human-induced greenhouse effect, however, precipitation increases from January to February with relatively little rainfall in the beginning and toward the end of the season. Hence, the greenhouse effect has already caused a shortened but intensified summer rainy season.

Index of upwelling

The high productivity of the cold Benguela Current is attributed to the upwelling of nutrients from the ocean floor that support the growth and, thus, abundance of marine organisms such as commercial fish and shellfish species. Extremely low upwelling intensities were experienced during the summer seasons from 1999 to 2002. This lower-than-average upwelling intensity marked the period from September 2001 to December 2002 in particular. This low upwelling intensity is unprecedented. Low upwelling intensity translates into very low nutrient availability, which may bring about low production in the system. Data suggest that the Benguela Current has been experiencing a shift from positive to negative wind anomalies since 1989, and generally warmer sea surface temperatures since the late 1980s. The trends observed may suggest changes in regional meteorological conditions corresponding to global warming generated by the trapping of greenhouse gases.

Mean annual temperature in Windhoek

Much of the 20th-century temperatures in Windhoek were between 19°C and 20°C, with the 1930s having been a markedly cooler period (closer to 18°C). From the mid- to late 1970s and until now, temperatures have been noticeably warmer on average. This is observed for both average annual and average winter temperatures (during the months of June, July and August). The highest average ever recorded was almost 22°C, in 1998. Whether or not this increase in average annual temperature is due to global warming is still unclear, although the trend corresponds to global warming-related temperature increases regionally and globally. It is important to understand the possible effects and impacts of such warming on natural resource-based industries (agriculture, fisheries and mining), rainfall, and the incidence of disease (MET 2002).

Greenhouse gas emissions

Namibia has a relatively small economy supported by concurrent industrial processes. Hence, its contribution of greenhouse gases on a national, regional and international scale is negligible. According to the 1994 greenhouse gas Inventory, Namibia is a net sink of CO_2. Thus, CO_2 emissions are relatively low compared with other economies in Africa as well as with developed countries. Energy production is dominated by the generation of hydropower, while the shortfall is met via energy import from the Southern African Power Tool. Plans are under way to develop hydropower plants in the lower Kunene and Okavango Rivers, while the Kudu Gas Project continues to explore the production and export of natural gas. The realisation of these developments will erase the need to import coal-derived energy from South Africa. Although the Kudu gas option will increase greenhouse gas emissions in Namibia, on a regional basis it would lead to a reduction of greenhouse gas emissions. The transport sector already contributes significant amounts of such emissions, and this sector is projected to grow along with population growth and increased urbanisation. Land-use changes, the agriculture sector, and the waste and forestry sectors do not contribute significantly to greenhouse gas emissions in Namibia (MET 2002).

Ozone-depleting substances

Similar to low greenhouse gas emissions, Namibia is a low consumer of ODSs. The Ministry of Trade and Industry is responsible for monitoring the consumption (which is equal to the importation) of ODSs. No clear trends can be observed from data showing the consumption of ODSs. Namibia is well on track to meet the phasing-out targets as set out by the UNFCCC.

INDICATOR 7A: Annual energy consumption

Assessment of indicators

Introduction

Energy, in industrial, development and economic terms, usually refers to fossil fuels (in liquid form as petrol or diesel, and in solid form as coal) and renewable energy sources such as biomass energy, wind and solar power, geothermal (power produced from the earth's heat) and hydropower (produced using water). *Fossil fuels* are sources of energy that were created from the fossilised (ageing) remains of dead animals and plants that existed millions of years ago. Natural gas and crude oil originate from the deep burial and decomposition of dead animals and plants. Heat and pressure, in the absence of oxygen, transformed the decomposed material into tiny compartments of gas and crude oil. The oil and gas then travel through the rock pores or channels to eventually collect in reservoirs where they are extracted and refined or processed into a form that can be consumed as energy.

Renewable energy is energy that can be replenished in a short period of time. Hence, unlike fossil fuels that are finite in nature, renewable energy can continuously be regenerated. The five main types of renewable energy sources are briefly defined as follows:

- ***Biomass energy*** is generated from organic material stemming from agricultural waste (such as crop residues and animal manure), municipal waste (such as cardboard, paper and construction debris), industrial waste (such as waste from soaps and detergents, food processing, grain milling, meat packing, organic fibres and leather) and forestry residues (from wood harvesting and processing) (Figure 7.1; Stanton 1995).

- Wind produces ***kinetic energy*** (that is, detected by the direction of the wind) that can be converted into mechanical or electrical energy. Farmers have been using wind energy for many years to pump underground water using windmills – a familiar sight in and around Namibia's farmlands (Photo 7.1).

- Humans have used ***solar (sun) energy*** for as long as they have existed on planet earth. People rely on solar energy for daily activities such as doing laundry. Organism growth is highly dependent on solar energy: plants use solar energy to produce food, animals eat plants, and humans are dependent on both animals and plants to sustain life. Apart from our inherent need for and consumption of solar energy, there are other more advanced uses. Solar energy can be used to generate heat (solar heaters existed in the USA as early as 1890) and electricity. In both instances, the first requirement is to trap solar energy from the sun for conversion to heat or directly to electricity. Technology in these domains is highly advanced and used on large scale in some Western countries.

- ***Geothermal energy*** has also been around for as long as the earth has existed (*geo* means

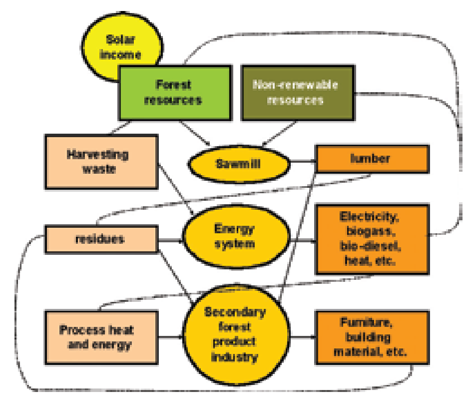


Figure 7.1: It is estimated that only 45% of a tree is used for production of wood and paper, hence 55% is wasted. The above diagram illustrates how more than 90% of a tree can be used if forest residues are converted to biomass energy (Stanton 1995)

Photo 7.1: A photo of a typical wind pump in Namibia that is used by farmers to use wind energy to pump water from underground sources. (Photo by Linette Russell)

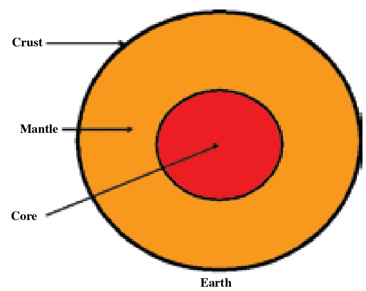


Figure 7.2: A very elementary illustration of the earth's composition below surface

"earth", and *thermal* means "heat"). Below the earth's crust (Figure 7.2) and the top layer of the mantle is a hot liquid rock called *magma*. The crust of the earth floats on this liquid magma mantle. When magma breaks through the surface of the earth in a volcano, it is called *lava*. For every 100 metres one goes below the earth's surface, the temperature of the rock increases by 3ºC. This is the origin of geothermal heat that is used today to generate electricity and supply hot water to thousands of households. The steam resulting from geothermally heated water is used to generate electricity using a specialised turbine. Steam passes through the turbine producing kinetic energy that makes the turbine blades spin – thus producing electricity. Once such a cycle is completed, the steam gets cooled off and is emitted into the atmosphere as an ozone- and environmentally-friendly by-product: water vapour.

- ***Hydroelectricity*** is the generation of electricity using the kinetic energy created by flowing water. Wheels or turbines can be used to make use of the kinetic energy of water. Hydroelectricity is currently produced in northern Namibia at the Ruacana Falls.

Namibia's energy environment

Energy consumption refers to the use of fossil fuels such as petroleum for vehicles, coal for electricity generation, wind and solar power, biomass and geothermal heat to produce energy – conventionally mostly for electricity. Namibia imports all its fossil fuels from South Africa and does not export any (Du Plessis 1999). Liquid fossil fuels include bitumen, petrol, diesel, jet fuel, heavy fuel oil, liquefied petroleum gas, and paraffins (other kerosene). Solid fossil fuels are dominated by coal. The main users of coal in Namibia are TransNamib Ltd and the Van Eck Power Station. The Tsumeb Corporation Limited (TCL) used to import coking coal for its smelter prior to its provisional liquidation. Du Plessis (ibid.) suggests that in 1994 the fraction of carbon oxidised during smelting processes was much higher than that of Van Eck, which was estimated at 88%.

The transport sector currently dominates energy consumption in Namibia and accounts for about 75% of total commercial energy consumption. Trends observed in this sector since Independence suggest further increases, thus reflecting the importance of the service industry in the country (IET 1999). The consumption of electricity is increasing gradually and the observed slow growth is attributed to declining growth in the mining sector, modest increases in rural electricity consumption, and rapid increases in local authorities' consumption (ibid.). Due to the absence of large-scale manufacturing industries, the consumption by industrial processes can be regarded as negligible at present (ibid.). The possible effect of Ramatex has not yet been studied in any detail.

The majority of the population (67%; CBS 2003) still live rural lifestyles in the northern and southern regions of the country, and much of their energy needs are satisfied by biomass energy generated from wood and other domestic waste material (i.e. cardboard, paper, plastic and manure). Due to the lack of studies pertaining explicitly or implicitly to the consumption of non-commercial energy, very little in terms of trends can be stated at this point. However, the White Paper on Energy Policy (MME 1998) and the latest population and housing census (CBS 2003) have a few suggestions about consumption status. The White Paper estimated biomass fuel consumption as being 14% of the total energy consumption, while solar energy represented 1% of that total. The 2001 census report (ibid.) found that 89% of the rural population continue to rely on wood and charcoal from wood for cooking, while almost 22% of this population rely on wood for lighting and heat (ibid.). Rural non-commercial biomass energy consumption accounted for 19% of total energy consumption in 1999 (IET 1999), compared with 22% in 1995 (NPC 1995); commercial energy consumption made up the remaining percentages for the two years compared. This is supported by the percentage change in rural population from 69.5% in 1996 to 67% in 2001 (CBS 2003). Due to the heavy reliance on wood for biomass fuel, much of the northern areas suffer serious deforestation, leading to desertification. The impact of rural energy needs on the environment is addressed in the White Paper (MME 1998), the State of the Environment Report on Namibia's industrialisation environment (IET 1999) and in *Namibia's country study on climate change: An overview of Namibia's vulnerability to climate change* (DRFN

1999).

Energy consumption and greenhouse effect (climate change)

How is annual energy consumption related to the greenhouse effect and to climate change? Modern societies have a profound reliance on fossil fuels (coal, oil and natural gas) to maintain and improve current living conditions. Widespread combustion of fossil fuels increases atmospheric CO_2, thus intensifying the natural greenhouse effect. As human populations grow along with industrial expansion in developed countries and industrialisation in developing countries, the rise in atmospheric CO_2 may be accelerated if counter measures and/or interventions are not implemented. In the absence of such measures or interventions, the earth's temperature will rise in the 21st century, leading to devastating consequences on human, animal and plant life. CO_2 released into the atmosphere due to natural and artificial processes is taken up by plants and converted into oxygen. However, when there is a CO_2 imbalance, i.e. more CO_2 released than what the environment can take up, the surplus CO_2 remains in the atmosphere (troposphere). The excess CO_2 traps heat from the sun that is radiated back into the atmosphere by the earth. It is essential for the earth to radiate excess heat so that a climate that supports life can be maintained. If excess heat has no escape route, the earth will start to warm up (referred to as *global warming*) creating conditions that are not conducive to natural life and associated processes. Hence, continuous emission of greenhouse gases brings about long-term climate change.

The Greenhouse Office of the Australian Government presents the information in Table 7.1 as a means to convert fuel in litres to CO_2 emissions in kilograms. This information was used to convert Namibian fuel consumption statistics into CO_2 emissions per annum to observe trends presented and interpreted in the following sections. For example, a 2.0 Litre Volkswagen Golf 4 consuming 14 litre of petrol per 100 km (at an approximate speed of 170 km/h) will, through its exhaust, emit 32.2 kg of CO_2 for every 100 km travelled at a constant consumption rate. Travelling to Swakopmund at such a consumption rate will result in 112.7 kg of CO_2 emissions. It is assumed that a car travels an average of 20,000 km a year, and for our example it will result in 6,440 kg of CO_2 a year or, simply, 6.44 metric tons of CO_2. This is something to think about – especially in countries where vehicle populations exceed hundreds of thousands (Windhoek's vehicle population is estimated at over 60,000).

Fuel Type	CO_2 emissions per litre of fuel consumed
Petrol	2.3kg CO_2
Liquefied Petroleum Gas (LPG)	1.5kg CO_2
Diesel	2.7kg CO_2

Source: http://www.greenhouse.gov.au/fuellabel/environment.html

Table 7.1: Carbon emissions from fuel types

Renewable energy in Namibia

The use of renewable energy devices is not widespread in Namibia, although biomass fuel provides the primary sources of energy, heat and lighting in rural and peri-urban communities (Hamutwe & Wamukonya 1998). Namibia's abundant renewable energy sources are still virtually unexploited (IET 1999). High solar radiation experienced especially in the south (Box 7.3) and wind resources along the coast have not yet been adequately surveyed, investigated and put to use. The lack of adequate data makes the determination of feasible large-scale projects very difficult, and it is hoped that the meteorological database initiated by the MME in 1998 (ibid.) can soon be put to good use. The establishment and development of feasible renewable energy projects can supplement the demand for energy and may sell energy resources at a lower cost than currently experienced. It is envisaged that the recently established UNDP–GEF–MME Namibian Renewable Energy Programme will execute a number of baseline studies that will initially generate inventories of data sources, data, and private enterprises marketing renewable energy devices. The study results will then be used to determine the feasibility of implementing energy efficiency and conservation strategies through the bulk supply of renewable energy. At present no data are centralised that can provide an insight into the current application and consumption rates of renewable energy devices (Also see figure 7.3).

Description

The indicator shows trends in Namibia's primary

Box 7.3: Untapped solar radiation

Namibia experiences one of the highest solar radiation levels in the world, averaging around 3,300 hours of sunshine per year with an annual mean solar radiation of 2,200 kWh/m^2. The southern most parts of the country easily experiences up to 11 hours of sunshine per day (figure 7.3 after Mendelsohn et al. 2002) and recorded direct solar radiation of 3,000 kWh/m^2/year (IET, 1999). Such magnitudes of radiation can be captured and converted into electrical energy for domestic and industrial consumption.

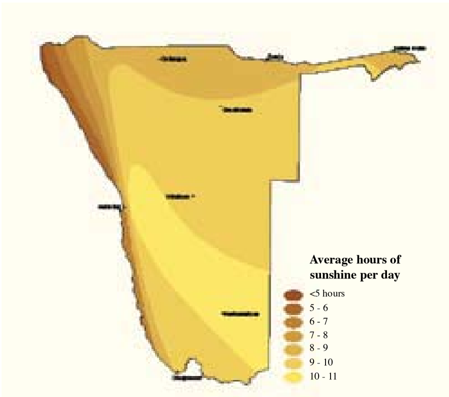


Figure 7.3: Shows average hours of sunshine per day across Namibia

energy supply, and the change in the contribution of renewable energy types and fossil fuels to the total national energy supply. Fuel consumption is also converted into CO_2 emissions to approximate the emissions by motor vehicles based on total imports (= consumption).

Results and trends

From Figures 7.4 and 7.5 an increasing trend can be observed in the consumption of electricity since 1990. The demand for electricity was estimated at 4% per annum; until all households are furnished with an adequate energy supply, this demand can be expected to be maintained for a while. The current exploitation of biomass energy resources threatens the health of the country's forest resources. Forest areas are rapidly cleared for fuel wood and the distance from a village to the nearest adequate woody resources increases as a result. As more land becomes denuded and abandoned, the demand for woody resources is exacerbated. Rural development is a national priority and, as long as rural households do not have alternative sources of energy, people will continue to harvest woody resources at unsustainable levels. Namibia does not contribute excessively to greenhouse gas emissions and also does not produce fossil fuels (Figures 7.6 and 7.7). Current import of fossil fuels is equated to consumption. Although relatively small amounts of greenhouse gases are emitted in the country in association with the consumption of fossil fuels, this does not exempt Namibia from trying to reduce national, regional and global emissions. Thus, Namibia should research the viability of long-term alternatives to fossil fuels and it is time we start using our abundantly available solar and wind resources.

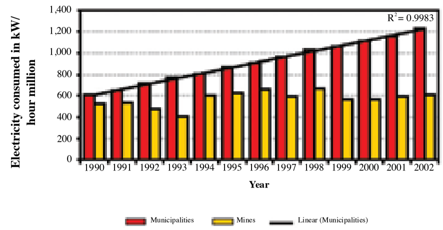


Figure 7.4: Trends in electricity consumption for municipalities and mines in Namibia. As mentioned earlier, electricity consumption by local authorities increases rapidly while that of mining has been stable since 2000

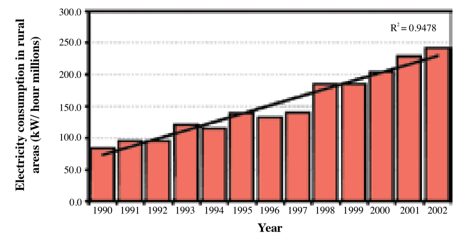


Figure 7.5: The trend in electricity consumption in rural areas. An increasing trend can be observed that corresponds with that of municipalities

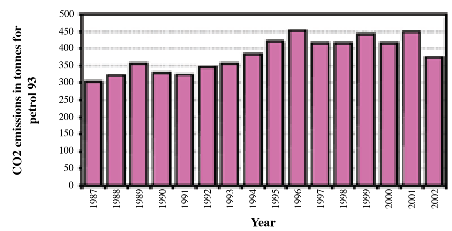


Figure 7.6: The trend in carbon dioxide emissions for Petrol 93

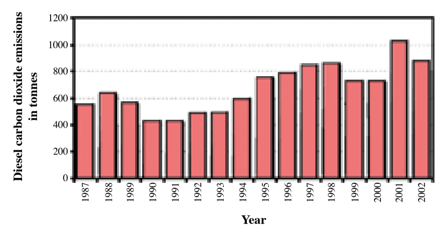


Figure 7.7: The trend in carbon dioxide emissions for Diesel

INDICATOR 7B: Mean annual rainfall

Introduction

The majority of Namibia receives summer rainfall between October and April, with January, February and March constituting the heart of the rainy season (Du Pisani n.d.). The remainder of the year characteristically receives virtually no rainfall except for the south-western parts, like the Sperrgebiet, which experience rain during the winter months (May to August) due to an overlap with the winter region of the north-western parts of the Northern Cape Province in South Africa (ibid.; MET 2002; Tarr 1999). Air masses originating over the Indian Ocean on the eastern side of the sub-continent are responsible for rain in Namibia (Tarr 1999). Due to the long distance travelled, most of the moisture from such air masses are lost, resulting in low and variable amounts of rainfall, a rainfall gradient stretching from the north-east (high rainfall area: >500 mm per annum) to the south-west (low rainfall area: <50 mm per annum) (Figures 7.8 and 7.9), and a naturally dry environment (ibid.).

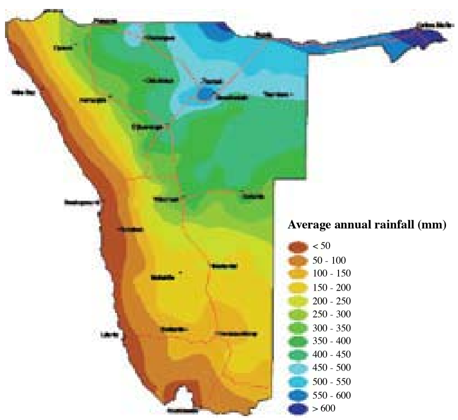


Figure 7.8: Average annual rainfall for Namibia (Mendelsohn et al. 2002)

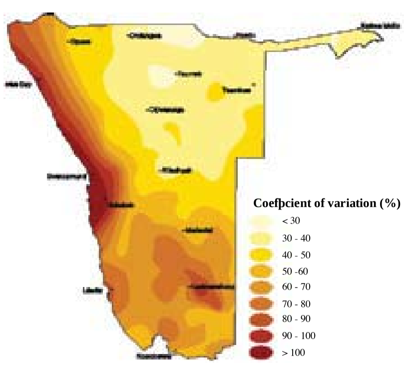


Figure 7.9: Variation in annual rainfall for Namibia (Mendelsohn et al. 2002)

Rainfall in Namibia is known to be meagre and extremely variable from year to year. Variation in annual rainfall ranges from >30% everywhere, to 70% in southern Namibia and 100% in the Namib Desert (MET 2002). This variation is attributed to a network of global ocean currents, changes in sea surface temperature (SST) and rainfall teleconnections between the southern African subregion and the Pacific region. Due to severe deviations from the mean, rainfall is exceedingly unreliable and droughts are common (Tarr 1999). Below-average rainfall often occurs for longer than two successive years (ibid.), a phenomenon that seriously challenges the livelihoods of people and industries. Du Pisani (n.d.) and Mendelsohn et al. (2002) powerfully portray the reliability of annual rainfall across the country by mapping coefficients of variation. A 0% coefficient of variation (CV) denotes total reliability of rainfall, whereas a 100% CV denotes totally unreliable rainfall. Figure 7.9 shows that the central and northern coastal areas of Namibia experience totally unreliable rainfall (with CVs from 90–>100%) compared with the north-central and north-eastern sections of the country, where rainfall reliability is quite high – with CVs from <30–40% (Du Pisani n.d.; Mendelsohn et al. 2002). Areas that experience very unreliable rainfall and where farming is an important livelihood contributor are affected severely during long dry periods.

Description

The indicator shows the five-year running mean of the annual total precipitation.

Results and trends

Rainfall estimates for five stations (Figure 7.10), indicated in Figure 7.11 were analysed to observe trends for a 100-year period, i.e. 1900–2000 (Mendelsohn et al. 2002).

The Katima Mulilo time-series commences from 1940, while rainfall data for Tsumeb have been taken since 1907. Both the Oniipa and Bethanie time-series exhibit gaps and the work by Mendelsohn et al. (ibid.) took cognisance of such inconsistencies when they applied five-year running averages. Observations of the data for all the stations emphasise the year-to-year variability of rainfall in the country, for example, the current year's rainfall may be extremely lower than the previous year's and extremely higher than the next year's. Such is the case for the 1960–1961, 1961–1962 and 1962–1963 rainfall years at Katima Mulilo. In the case of Bethanie, two years of extremely high rainfall – during 1973–1974 and 1974– 1976 – are distinct when one observes the time-series graphically. The use of five-year running averages highlights the cyclic nature of long-term changes. During the 1950s most years were quite wet, followed by a rather dry spell during the 1960s, and then wetter again in the 1970s. The 1980s and 1990s are characterised as an overall dry period although Bethanie and Windhoek received relatively high rainfall.

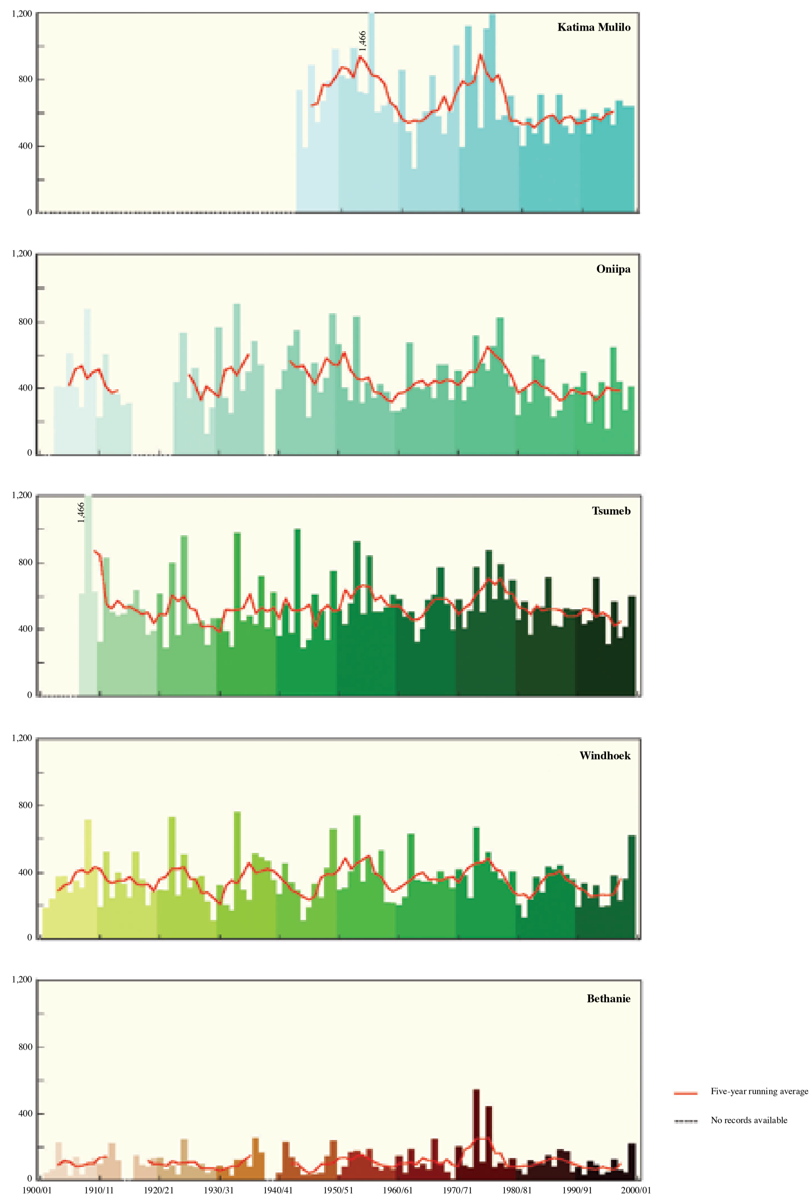


Figure 7.10: Average annual rainfall (mm) for the five stations shown in figure 7.11 (Mendelsohn et al. 2002)

Figure 7.11: Five rainfall stations in Namibia with long time series data (Mendelsohn et al. 2002)

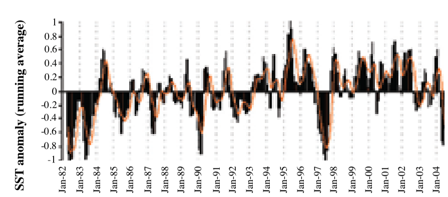


Figure 7.12: Sea surface temperature (running average) along the Namibian coast

Namibia's weather is dominated by shifts in the position of its three major climate systems: the Intertropical Convergence Zone (ITCZ), the Subtropical High Pressure Zone (STHPZ), and the Temperate Zone (TZ) (ibid.). Both the ITCZ and the TZ are areas of high rainfall, while the STHPZ is not. Hence, these three systems are also responsible for the year-to-year variation in rainfall. For instance, years with good rainfall are generally characteristic of a slight southward shift of the ITCZ and a slight northward shift of the TZ. Thus, the inconsistencies in slight shifts of these zones manifest Namibia's high rainfall variability (Tarr 1999).

Rainfall in Namibia is characterised by high variability and unreliability, such that for the rainfall presented for five stations in Figure 7.15, no clear trend can be observed for any of the stations.

Regional rainfall changes due to human-induced greenhouse warming

Beyer and Jacobeit (2002) assessed changes in Namibia's rainfall due to continued global warming. They analysed rainfall data, obtained from the Meteorological Service in Windhoek, from 1951 to 1997 for 84 stations. The study was based on the hypothesis that regional rainfall changes are expected if global warming continues due to man-made releases of atmospheric trace gases that absorb outgoing long-wave radiation from the surface of the earth (ibid.). Their study found that enhanced greenhouse forcing does not alter the spatial distribution of Namibia's rainfall. Instead, the pattern and intensity of rainfall seem to change intraseasonally. Bear in mind that Namibia's rainfall season falls between October and April. The study (ibid.) suggests increased precipitation from January to February, with somewhat little rainfall in the beginning and toward the end of the season – and, hence, a shortened but intensified summer rainy season. This is contrary to Du Pisani's (n.d.) description of the generally perceived rainfall season: moderate showers commencing in September, peak rainfall between January to March, and an abrupt closure of the season thereafter. Hence, the work of Beyer and Jacobeit (2002) provides probable tendencies in the Namibian summer rainfall as influenced by enhanced greenhouse warming. If the rainfall season continues to become shorter and more intense, this may pose serious consequences for the farming industry and serious challenges to decision-makers.

INDICATOR 7C: Index of upwelling

Introduction

The Benguela upwelling system

This region of cool upwelled coastal water ranges from approximately 15°S to 34°S, stretching from southern Angola to the west coast of South Africa. The Benguela upwelling system generates an abundance of marine life along the Namibian coast. Strong southerly winds blowing parallel to the coastline cause a westerly offshore movement of coastal surface water. As a consequence, nutrient-rich water from deeper layers 'wells up' and replaces the surface water (Figure 7.12), a process which encourages the growth of a variety of phytoplankton species (Botha 1998). Thus, strong upwelling forms the basis of high primary production, which itself sustains large zooplankton and pelagic fish stocks. However, the upwelled deep water can sometimes have low oxygen concentrations (caused by degradation of organic matter), thus leading to periodic mass mortality of fish (Bianchi et al. 1999). The magnitude of plankton growth and bottom-up production in the system is dependent on the intensity of the upwelling process that makes nutrients available in the pelagic zone. The weaker the intensity of upwelling, the less plankton available to intermediate pelagic species (sardine and anchovy), which serve as food to larger predatory fish (Cape hake, Cape monkfish, and horse mackerel).

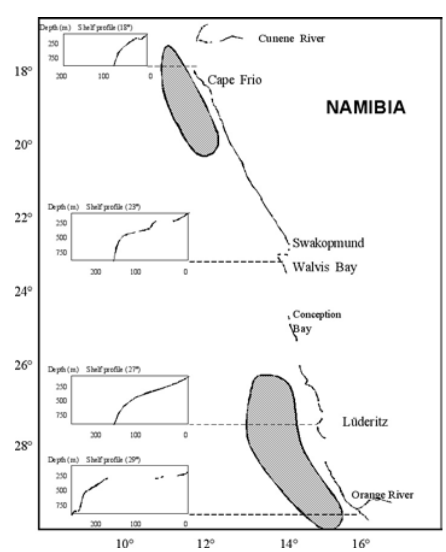


Figure 7.13: Coastal topography and bathymetry off Namibia including the major upwelling areas (shaded) (Willemse 2002)

What influences the intensity of upwelling?

The intensity of upwelling is usually measured by an index composed of aggregated indicators. Many developed countries have devised sophisticated models which incorporate various data sources to derive such an index. For Namibia, we primarily use SST and wind anomaly data to derive a relative index of upwelling intensity. Interpreting the two indicators individually aids in the understanding of the index.

Greenhouse gas emissions are responsible for heating up the earth's atmosphere, thus creating a generally warmer climate over time as more particles which trap heat are released. This rise in temperature also influences the ocean's temperature. A time-series of SST measurements can reveal an increasing trend that may be associated with greenhouse gas emissions and the phenomenon of global warming. However, the linkage between increasing SSTs and global warming needs further, more sophisticated investigations and modelling. For the purpose of this report, we assume a direct linkage and draw on global evidence to support this assumption. The hypothesis is, thus, as the SST anomaly becomes more positive, the more the intensity of upwelling will weaken over time. A similar elaboration is offered for wind anomaly. Positive wind anomaly relates to strong upwelling and, thus, a higher abundance of nutrients in the pelagic zone. A negative change in this trend corresponds with a weaker recycling of nutrients from deeper waters – suggesting lower primary and bottom-up production in the system. Furthermore, such negative trends affect the fish stocks off Namibia and threaten the future of the fishing industry.

Description

The index of upwelling is a composite index that provides information about the intensity of upwelling along the Namibian coast. Drawing on SST and wind anomaly data, this may suggest trends in greenhouse gas emissions.

Results and trends

According to the MFMR (2004), extremely low upwelling intensities were experienced during the summer during the years 1999–2002 (Figure 7.13). Lower than average upwelling intensity marked the period from September 2001 to December 2002 in particular. Based on the 42-year time-series observed in Figure 7.13, this low upwelling intensity is unprecedented. As mentioned earlier this low intensity translates into very low nutrient availability that may bring about low production in the system. From Figure 7.14 a predominantly

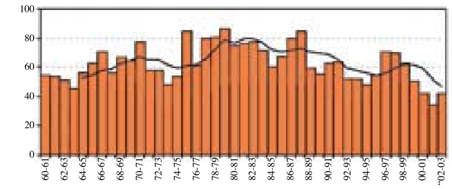


Figure 7.14: The relative measure of upwelling intensity at the Lüderitz upwelling cell

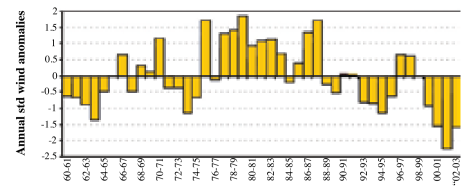


Figure 7.15: The annual standard wind anomaly along the Namibian coast (Klingelhoeffer and Iita 2003, unpublished)

negative wind anomaly can be observed from 1989 to date. This suggests poor westerly winds that usually trigger and generate the upwelling cycle. The anomaly reaches unprecedented negative values during 2001 and 2002. Figure 7.15 shows generally positive SST anomaly after January 1998, although strong negatives can be observed during 2004. The trends observed suggest poor upwelling due to changes in meteorological conditions that correspond to the global warming phenomenon generated by the trapping of greenhouse gases.

INDICATOR 7D: Mean annual temperature in Windhoek

Introduction

Temperature is an important source of energy that sustains life on earth. Global temperature is generated by the sun's radiation. On a more local scale, temperature is governed by a country's geographic location and climate systems. For example, Namibia lies between 17°S and 29°S, exposing it to air movements caused by three major climate systems: the Intertropical Convergence Zone (ITCZ), the Subtropical High Pressure Zone (STHPZ), and the Temperate Zone (TZ) (Mendelsohn et al. 2002). These climate systems determine Namibia's rainfall and air temperature. Due to this geographic position, the country is generally dry with little and variable rainfall – which means very little cloud cover and intense radiation from the sun. The earth's temperature is regulated through a natural process known as the *greenhouse effect*, which entails retaining sufficient heat to promote and sustain animal and plant life. With increased greenhouse gas emissions (such as gases from fossil fuels and smoke from industrial production), a barrier is formed in the troposphere (the earth's lower atmosphere). This gaseous barrier prevents the escape of excess heat from the earth and is known as the *enhanced greenhouse effect*. Thus, as more such gases accumulate, the earth's troposphere acts as an insulant to escaping air, causing the earth to become gradually warmer over time. Namibia is more of a greenhouse gas sink than a source (Du Plessis 1999), however, meaning that it contributes very little to regional and global greenhouse gas emissions (ibid.; MET 2002; Tarr 1998). Thus, from a local perspective, national emissions are highly unlikely to cause changes in long-term temperature (Du Plessis 1999), which may be explained by the transport of continental air masses and global trends caused by greenhouse gas emissions elsewhere. Namibia does not have the human resource and technology capacities to conduct intensive research directed at climate change and greenhouse effect. However, we are aware of the presence of both phenomena, and need to do whatever we can to contribute to global mitigation efforts.

Description

Annual temperature deviations are expressed relative to the World Meteorological Organisation's standards, i.e. the mean annual temperature for the period 1961–1990.

Result and trends

Overview of temperature in Namibia

Figure 7.16 shows the annual temperature across Namibia. Namibia is generally perceived to be a hot country although temperatures vary daily, monthly, seasonally and over longer periods (Mendelsohn et al. 2002). Due to the extreme variability of temperatures recorded for the same place, e.g. a maximum of >40°C in summer and <0°C in winter, animals and plants are perceived to be well adapted (ibid.). However, Barnard (1998) maintains that this variability is challenging to animals and plants. Daily fluctuations are most extreme in the hyper-arid areas, where sufficient vegetation is absent to regulate temperature (ibid.). Along the coast and the tropical north-east, temperatures fluctuate within a narrow range: the daily low and high temperature can differ by 2–5°C. North-central Namibia is generally very hot, with cold mornings and very hot afternoons.

Trends in temperature in Windhoek

A long time-series of temperature, namely from 1910 to 2000, was analysed for the capital city, Windhoek (Figure 7.17). This trend analysis was done for average annual temperatures and average winter temperatures. The analyses reveal that Windhoek's average annual temperature was between 19°C and 20°C throughout most of the 20th century, with a marked colder period starting during the late 1920s and lasting throughout the 1930s (Mendelsohn et al. 2002). What is noticeable is that the last 50 years have been generally warmer in terms of annual average temperature. Tarr (1999) points out that the average annual temperature for Windhoek increased by 0.023°C per annum between 1950 and 1997 – resulting in a 1°C increase in average annual temperature. Hence, the 1980s and 1990s have been the hottest decades for the past century (NMS 1998). February 1998 was extraordinarily hot – a trend that was shared by most southern hemisphere countries. Temperatures for most of Namibia exceeded the average daily maximums by 4°C, and reached over 6°C for Sitrusdal (Outjo) (NMS 1998; Tarr 1999). Also during February 1998, three weather stations – Hardap, Sitrusdal and Okaukuejo – recorded their highest maximum temperatures. According to Tarr (1999), these hot conditions were attributed to El Niño conditions.

The increase in annual temperatures is also visible in the average winter temperature, where an increase above 14°C is observed from the mid-1950s. The fitted five-year running averages for both curves in

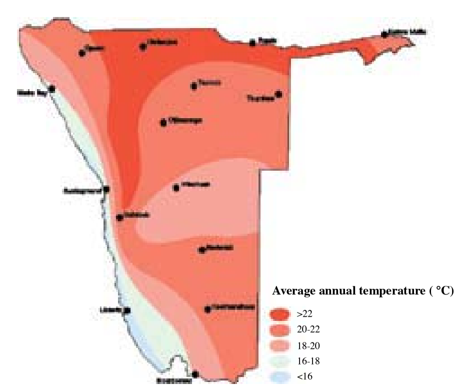


Figure 7.16: Average annual temperature (degrees Celsius, °C) across Namibia (Mendelsohn et al. 2002)

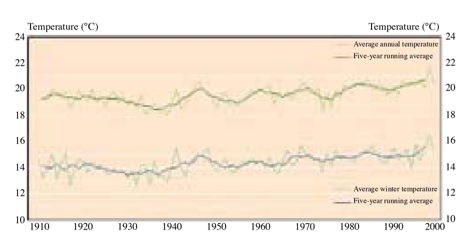


Figure 7.17: Average annual temperature (degrees Celsius, °C) for Windhoek (Mendelsohn et al. 2002)

Figure 7.17 suggest further increases can be expected beyond 2000. Although no scientific evidence is available to support future increases in average annual temperatures, it is a relatively plausible notion to entertain. Windhoek lies in a valley that promotes the entrapment of ozone-depleting substances such as emissions from motor vehicles and dust particles that are prone to retaining heat in the absence of sufficient air circulation. Thus, it could be argued that such trapping of heat in addition to influences from changes in regional and global weather patterns may have caused the observed gradual increase in average annual temperatures in the capital city. Namibia's country study on climate change supports this argument, as it predicts hotter and drier conditions for the country (MET 2002).

From Figure 7.17, the following trend can be inferred: much of the 20th-century temperatures in Windhoek were between 19°C and 20°C, with the 1930s having been a markedly cooler period (closer to 18°C). From the mid- to late 1970s and until now, temperatures have been noticeably warmer on average. This is observed for both average annual and average winter temperatures (during the months of June, July and August). The highest average ever recorded was almost 22°C, in 1998. Whether or not this increase in average annual temperature is due to global warming is still unclear, although the trend corresponds to global warming-related temperature increases regionally and globally. It is important to understand the possible effects and impacts of such warming on natural resource-based industries (agriculture, fisheries and mining), rainfall, and the incidence of disease (MET 2002).

INDICATOR 7E: Greenhouse gas emissions

Introduction

Namibia has no recorded time-series as such for the production of greenhouse gases (see also Figure 7.18). In July 2002, the MET's Directorate of Environmental Affairs produced an *Initial national communication to the United Nations Framework Convention on Climate Change*. Chapter 2 of this document deals with emissions of anthropogenic greenhouse gases and reports on the greenhouse gas produced by anthropogenic activities in 1994. Namibia agreed to adopt 1994 as the base year for the initial recording of greenhouse gas emissions (MET 2002). This section features the greenhouse gas emissions data recorded for 1994, and the projections made in Chapter 3 of the MET document.

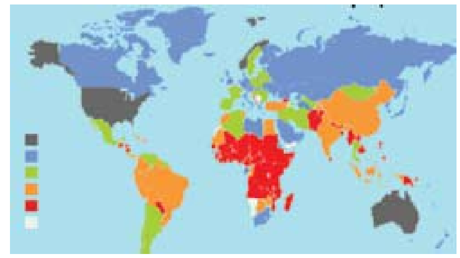


Figure 7.18: Global carbon dioxide emissions in annual tonnes per person

Projected impacts and vulnerability assessment

The Intergovernmental Panel on Climate Change has developed a full set of scenarios consisting of about 30 futures for projected climate change (Table 7.2; MET 2002). The *A* scenarios represent a high-growth, highly globalised world, whereas the *B* scenarios represent a more regionally organised future, with a lower overall growth rate (ibid.). Through globalisation the developing world is expected to experience emission-intensive activities.

Scenarios from Table 7.2 are considered up until 2100 – by which stage only a portion of the eventual climate change and sea-level rise will actually have taken place (MET–NINC 2002). According to projections in the Namibia Initial National Communication (MET–NINC 2002), for the year 2100 the *A1* scenario predicts an increase of 4.5–6°C above the 1961–1990 mean annual temperature for the central plateau region of Namibia, and 2–3°C for the *B1* scenario. From 1950–2000, Windhoek experienced a 0.023°C upward trend in mean annual temperature each year. Future rainfall is predicted to become even more variable than at present – thus threatening Namibia's agriculture industry. Future rainfall projections show small increases of <30 mm a year to extreme decreases of 200 mm a year.

Description

A	*B*	*Scenarios*
1 Tending toward the worst case-scenarios	**1**	Environmental considerations are secondary to growth considerations
2	**2**	Environmental consciousness is an important component

Table 7.2:

This indicator is supposed to project estimates of annual national CO_2 equivalent emissions in kilotons. Due to the lack of data (Du Plessis 1999), a general trend is inferred based on the 1994 greenhouse gas inventory and Namibia's situation.

Results and trends

Namibia has a relatively small economy supported by concurrent industrial processes. Hence, its contribution of greenhouse gases on a national, regional and international scale is negligible. According to the 1994 greenhouse gas Inventory, Namibia is a net sink of CO_2 (MET 2002). Thus, CO_2 emissions are relatively low compared with other economies in Africa as well as with developed countries. Energy production is dominated by the generation of hydropower, while the shortfall is met via energy import from the Southern African Power Tool (Du Plessis 1999). Plans are under way to develop hydropower plants in the lower Kunene and Okavango Rivers, while the Kudu Gas Project continues to explore the production and export of natural gas. The realisation of these developments will erase the need to import coal-derived energy from South Africa. Although the Kudu gas option will increase greenhouse gas emissions in Namibia, on a regional basis it would lead to a reduction of greenhouse gas emissions (MET 2002). The transport sector already contributes significant amounts of such emissions, and this sector is projected to grow along with population growth and increased urbanisation. Figure 7.19 shows an increasing trend in CO_2 emissions produced by liquid petrol from 1992 to 1999. A similar increase in diesel-produced CO_2 is observed from 1992 to 1998, although no clear trend is observable from 1987 to 2002 (Figure 7.20). Land-use changes, the agriculture sector, and the waste and forestry sectors do not contribute significantly to greenhouse gas emissions in Namibia (ibid.).

Goals

Namibia ratified the UNFCCC in May 1995, after which it established an interim Climate Change Advisory Committee. The NCCC was established early in 2001 by the MET, with its main purpose being to direct and oversee Namibia's obligations to the UNFCCC.

The NBSAP has prioritised ten strategic aims (SAs), including "Raise awareness and strengthen capacity to adapt to climate change" as SA6. This SA can be outlined as presented in Table 7.3.

INDICATOR 7F: Ozone-depleting substances

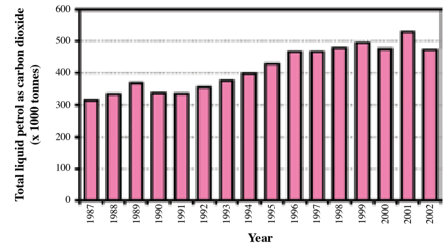


Figure 7.19: Shows total liquid petrol consumption (tonnes) converted to CO_2 emissions in tonnes

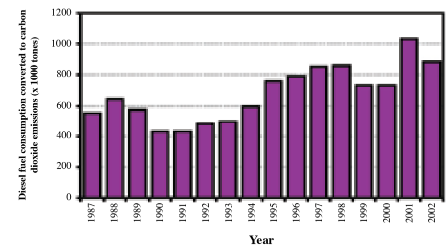


Figure 7.20: Shows total liquid diesel consumption (tonnes) converted to CO_2 emissions in tonnes

Introduction

Namibia has been monitoring the consumption (in metric tons) of ODSs per sector since 1995. The following ODSs are monitored and discussed herein: CFCs, halons, hydrochlorofluorocarbons (HCFCs) and MeBr. Ozone-depleting substances like CFCs and HCFCs are used in refrigeration, while halon is used in fire extinguishers. All such substances are imported. The following figures summarise data for CFCs, halons, HCFCs, and MeBr.

Description

The indicator shows trends of the consumption and import of ODSs in Namibia.

Results and trends

The Ministry of Trade and Industry is responsible for monitoring consumption and importation of ODSs. From Figures 7.21 to 7.24, no clear trends can be observed. However, the Ministry indicated that Namibia is well on track to meet the phasing-out targets set by the UNFCCC (Table 7.4).

Namibia's reported CFC consumption of 24 metric tons in 2001 was above the 'freeze line', thus representing non-compliance. However, in 2002, CFC consumption of 21.4 metric tons was reported, in compliance with the agreed target.

Climate change activities	Target
a. Synthesize relevant regional and national information and scenarios from other sources	Namibia's Initial National Communication to the UNFCCC is submitted by July 2002.
b. Commission analyses of biodiversity impacts in Namibia with appropriate partners.	NINC identifies main areas of impact by July 2002; Climate change impacts on Namibian terrestrial ecosystem boundaries and species distributions are preliminarily analysed by December 2002.
c. Design and implement appropriate awareness programme based on summary information for target audiences in consultation with stakeholders.	An information brochure on the vulnerability of Namibia to CC and potential mitigation strategies is available to key decision-makers by 2003
d. Integrate climate change monitoring and research needs in the design and planning of environmental observatories (EONN sites – Environmental Observatories Network of Namibia).	Indicators of CC are monitored at five EONN sites by 2005.
e. Focus research and management planning on climate change impacts on vulnerable species and areas.	A map of biodiversity priority areas is produced, with at least three relevant CC monitoring research programmes implemented at these sites by 2006.
f. Make results and recommendations regularly available to stakeholders and decision-makers through appropriate media.	Environmental briefing sheets focusing on CC and biodiversity issues are distributed to Parliament at least once yearly by 2003; A pamphlet on strategies to mitigate the effects of CC is distributed to natural resource users by 2004.

Table 7.3: Strategic aim 6 of the NBSAP (MET 2002)

Goal

The Montreal Protocol of 1987 classifies Namibia as an Article 5 country, i.e. a developing country, and we are obligated to meet the agreed reductions and phase-out schedule (Table 7.4).

Year	Target
1999	to freeze the consumption of CFC on the baseline consumption as determined by the average consumption for the period 1995-1998 to be 21.9 tonnes.
2005	reduce the 21.9 tonnes by 50% to be 10.95 tonnes
2007	reduce the 21.9 tonnes by 80% to be 3.3 tonnes
2010	reduce the 21.9 tonnes by 100% to be 0 tonnes

Table 7.4

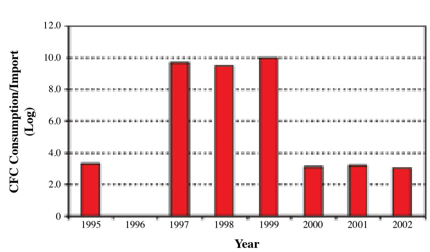


Figure 7.21: Trends in the consumption (= import) of CFCs (source: Ministry of Trade and Industry)

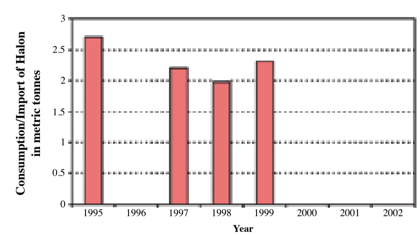


Figure 7.22: Trends in the consumption (= import) of CFCs (source: Ministry of Trade and Industry)

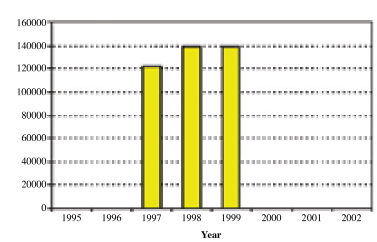


Figure 7.23: Trends in the consumption (= import) of HCFC (source: Ministry of Trade and Industry)

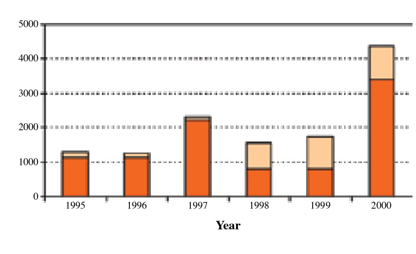


Figure 7.24: Trends in the consumption (= import) of Methyl Bromide (source: Ministry of Trade and Industry)

Recommendations

Monitoring and data collection

Fossil fuel data on petrol, diesel, coal, etc. are generally readily available and are collected annually by the MME. Similarly, rainfall and temperature data are also readily available, with some time-series stretching an entire century (e.g. the Bethanie and Windhoek rainfall stations). Although the reliability of these data can be questionable, they at least provide a best estimate to use for analysis and assessments. For the derivation of an upwelling index, both wind and SST anomaly data are available for a time period sufficient to deduce trends. However, a longer time-series (spanning beyond 40 years) may provide insight into possible cycles that can only be detected by observing a time-series of over 50–100 years. The MFMR has been collecting data regularly since Independence, and provided this culture continues, future assessments may provide more information. An initial greenhouse gas inventory was compiled in 1994 in preparation for Namibia's Initial national communication to the UNFCCC. Although this inventory concluded Namibia's contribution to greenhouse gas emissions was negligible, it needs to be borne in mind that the findings date back ten years. If any monitoring has been instituted since then, analysis for the elapsed ten-year period may show increases in greenhouse gas emissions. Thus, the need for continuous monitoring should not be undermined. In respect of the consumption of ODSs, the Ministry of Trade and Industry has reported no alarming status. Namibia does not produce any ODSs and imports such substances mainly from South Africa. The Ministry continues to monitor the entrance, distribution and consumption of ODSs and advocates the substitution of such substances with environmentally friendly ones. The Ministry is on track with targets set by the UNFCCC for the phasing out of ODSs. As a rule, each of the above indicators should be monitored and collected on an annual basis, to facilitate future periodic assessments. It is strongly recommended that current monitoring programmes be evaluated, especially Namibia's rainfall monitoring network.

Alternative energy sources

This Chapter emphasises the need for Namibia to invest in research for the utilisation of renewable energy sources. It is hoped that the recently launched UNDP–GEF–MME Namibian Renewable Energy Programme will produce tangible results and strategic advice on the large-scale development of renewable energy sources.

Research on the greenhouse effect and ozone depletion

The report recommends the expansion of current collaboration and cooperation between relevant institutions in Namibia and centres in the southern African subregion and further abroad. Predictions maintain that Namibia will suffer due to global warming and climate change, and for a country so reliant on natural resources, it should start its own research culture in this field. Research should be directed toward socio-economic and ecosystem vulnerability to climate change and measures to adapt to such changes (MET 2002). Such research, funded through UNFCCC mechanisms, needs to emphasise impacts on economic development and implications for poverty eradication (ibid.).

The report also recommends research directed at the effect of enhanced greenhouse warming on annual rainfall in Namibia. Such capacities are currently limited in the country, and expert assistance needs to be sought from institutions where this is already ongoing research. Namibia's agricultural industry, whether commercial or communal, relies in its entirety on rainfall – which translates into water availability for consumption (human and livestock), crop cultivation, and groundwater recharge. If the future variability of rainfall can be predicted within plausible ranges of confidence, then the Namibian Government and its people can take early measures to ensure water availability in the future. However, if uncertainty remains the order of the day, then current consumption and demand rates may lead to total scarcity sooner than in 2020.

Development instruments, decision-making and policy

It is essential for Vision 2030, NDPs, sector-based development action plans, and environmental and other cross-cutting policies to adequately address issues pertaining to the greenhouse effect and ozone depletion. Gradual warming of the climate poses severe threats to our natural resources, economy and social well-being. Hence, it is important to integrate existing information on the vulnerability of climate change and measures to adapt to these changes (ibid.).

It is also recommended that a consultative planning process be initiated to develop a strategic framework to address issues pertaining to climate change within existing policies and legislation (ibid.).

Public awareness and training

Existing platforms, networks, initiatives (e.g. the NAPCOD Regional Awareness Programme) and partnerships should be used to generate increasing awareness about climate change issues in Namibia. Capacity needs should be addressed as part of conscious human resource development strategies by the MET and other ministries in order to ensure capacity in the field of climate and environmental change.

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Chapter 8: Social issues and the natural environment

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Chapter Overview
Assessment of Indicators
Recommendations
References

Introduction

This Chapter features five social indicators and their trends that are related to impacts and effects on the natural environment. Negative impacts and effects may at current be quite severe (as in the case of land degradation) or still gaining momentum. It is imperative to assess the social dimension in order to deliver an encompassing integrated environmental assessment of Namibia.

Two things are undeniable:

- As human beings, we are dependent on the natural environment and our well-being often governs our interaction with the environment, and
- Natural resource management focuses on controlling the effect and impact of people on the environment: natural resources cannot be managed, but people can.

Apart from us impacting on the environment, the environment also impacts on our lives. The consumption of contaminated water may cause disease and will threaten the young and the vulnerable in particular. Soil degradation affects crop production, which in turn threatens the livelihoods of subsistence and commercial farmers alike. This reciprocal interaction has existed between humans and their environment for millions of years. In the midst of natural environmental change and growing populations worldwide, the abundance and availability of resources become an increasing concern to all stakeholders. On the other hand, if the social well-being of populations in developing countries does not improve, their ability to mitigate or combat resource degradation will become inadequate.

The indicators look at the social well-being of people with the use of the UNDP's HDI as well as access to water as a prerequisite to sustain life, improved sanitation, HIV/AIDS prevalence in pregnant women, and the mortality rate for children under 5. A relationship between these trends and the environment is sought by looking at people's ability to participate in resource conservation either as users or as conservationist/resource managers.

Social issues and our environment

As mentioned earlier, people are dependent on the natural environment to meeting all their needs; thus, the interactions between people and the environment cannot be dealt with in isolation. It is important to study the impacts of resource utilisation and how best to manage them, so that both human and environmental needs can be met – now and in the future.

Namibia's population is comparatively small and very unevenly distributed (See box 8.1) Many large areas of land remain uninhabited while others are still sparsely populated. In contrast, there are areas where human populations are very dense. Mendelsohn et al. (2002) highlight three main reasons for the stratification of Namibia's population. The first is the distribution and availability of natural resources. More than 60% of the country's population live in rural areas. Rural communities seek areas where there is a reliable availability of drinking water, crop cultivation is possible due to relatively high soil fertility, and rainfall and pasture for livestock grazing is available (ibid.). The latter conditions justify why the majority of the population is settled in the Cuvelai drainage area (north-central Namibia), along the Okavango River, and along the flood plains surrounding the eastern Caprivi Region (see Figure 8.3). Although the latter areas host the majority of the population there are many other rural settlements in other areas where resources are unavailable. The other two reasons not elaborated here are the availability of employment and business opportunities, and the availability of transport, water and other services.

Large numbers of people settle in areas where natural resources are available and this causes severe resource degradation (Figure 8.3). A high HDI for a country represents generally good human well-being, and may assume minimal or no resource overexploitation. People will generally be well educated, with an adult population with a high literacy rate, sufficient per capita income, and high life expectancy. Generally, people bordering on extreme levels of poverty tend to impact negatively on their environment in their struggle to secure food and a livelihood in general.
Human beings are inherently social. This is evident

Box 8.1: Overview of HDI Indicators

The HDI is an index composed of the following indicators; life expectancy at birth, school enrolment, adult literacy and per capita income. Life expectancy at birth is currently severely undermined due to the high incidence of HIV infections. School enrolment has shown increasing numbers over the years although the quality of primary and secondary education has been questioned a number of times. Namibia's adult literacy rate is also increasing and this can be due to one of two things or a combination of both. As the older illiterate population dies off the new adults entering this segment are more illiterate. A spot survey will thus suggest a higher adult literacy rate. On the other hand this trend might be a reflection of current outreach efforts to teach our adult population how to read and write. It is however more likely that the increase in adult literacy is a result of both scenarios described above. According to the NPC (2003) more than 4 out of 5 persons aged 15 and above are literate (see figure 8.1).

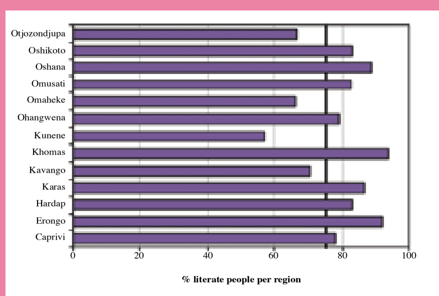

Figure 8.1: Shows the literacy rate per region in Namibia for people aged 15 and above (NPC 2003)

Per capita income, although it has been increasing over the years (see figure 8.2 below), is not a true reflection of Namibian's economic well being. The statistical average figure for this indicator masks the extreme wealth and poverty (NPC 2002) that is a well know characteristic to Namibians. Hence, this may distort the result of the HDI as computed annually by the UNDP-Namibia office.

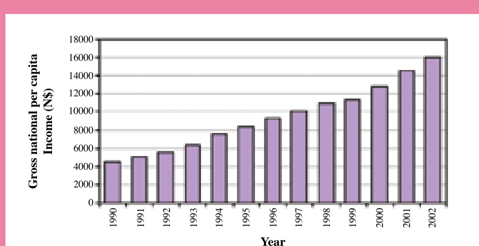

Figure 8.2: Shows per capita income in Namibia (NPC 2003)

Chapter overview

in our interactions and behaviour with others and with our natural environment. Historically, we have interacted with our natural environment to harvest food sources and other materials for the creation of household products and utensils, and for building houses and kraals. This interaction became more and more commercialised over the decades, as did

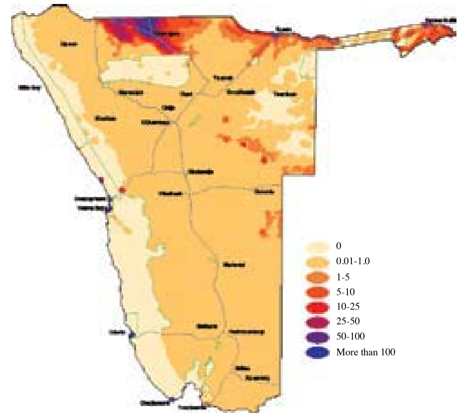

Figure 8.3: Shows the literacy rate per region in Namibia for people aged 15 and above (NPC 2003)

the rate and level of exploitation. As custodians of our natural resources, today we are faced with heavily degraded resources against an increasing demand for food, income and shelter. Our capacity to combat degradation is threatened by the spread of and fatalities associated with HIV/AIDS. Our lack of basic literacy hampers our understanding of environmental change and its impacts, and prevents us from participating in the cause to conserve and utilise resources sustainably. Income inequality places the rural poor in a disadvantaged position to meet their basic needs and forces them to overexploit their environment. The lack of adequate water threatens the health of our children, and poor sanitation, amongst other things, exacerbates this. We are inherently connected to our natural environment and, if for no other reason than dependency, we will always be connected. Hence, the social dimension of environmental degradation and change can never by omitted from an attempt to assess our environment across sectors.

Human Development Index

The HDI for Namibia ranks relatively high in comparison with other sub-Saharan countries. Income inequality remains evident and, due to high and low extremes, a misleading average annual per capita results. The reality that the majority of people earn very low incomes means that we are simply not able to convert the high average income into human development because the funds are simply not there. Due to low incomes, many people have to find other means to secure the livelihoods of their households – hence the common practice of subsistence farming in Namibia. Severe pressure is exerted on the environment as people try to meet their basic needs, and this pressure is expected to increase as the population grows. HIV prevalence in pregnant women (used as a proxy for national prevalence) has increased since Independence, and reached 22% in 2002. Although HIV infections continue to spread throughout the country, claiming numerous lives, research done by the MHSS suggests that it is beginning to stabilise. Data indicate that the current and future most productive segment of the population carries the highest infection rates – threatening the human resources capacity of the country and the capacity to manage, conserve and protect the environment. HIV/AIDS affects the environment and natural resources by reducing our current capacities. Rural farming households become severely affected at the loss of a loved one. The pandemic is a reality in Namibia and if infection rates do not stabilise we will be faced with a low population growth rate, reduction in the current capacity for environmental protection and, possibly, a quickly deteriorating environment.

The mortality rate for children under 5 has declined impressively in Namibia since the 1960s and has been below 75 deaths for every 1,000 live births since 2000. This suggests a general improvement in and access to basic health services as well as better living conditions in which infants are raised. Diarrhoea still claims a large number of infants' lives annually, and the quality of water is a prime suspect in this regard. As the mortality rate for children under 5 further reduces, it may suggest improved environmental conditions although this needs to be acutely monitored for verification.

Access to improved drinking water

Due to the importance of water to sustain life it is essential to ensure communities, especially those in rural areas, have access to safe water. Currently, 100% of people living in urban areas have access to safe water, while over 60% of the rural population enjoy this basic commodity at safe levels. Water is Namibia's No. 1 limiting factor in terms of sustainable development and the need for a culture to conserve water is indispensable. We rely heavily on underground water and the risk of contaminating such reservoirs should be avoided at all costs. Safe drinking water can be used as an indicator of the health of a surrounding area or country, even if it is relayed to remote areas across vast distances. It is a priority of the DWA to continue improving rural communities' access to safe water.

Access to improved sanitation

Adequate sanitation can help prevent air- and waterborne diseases. In rural areas, sanitation facilities are inadequate and at times totally absent, while overall access remains below 20%. Urban areas enjoy close to 100% access to sanitation facilities. Unsanitary conditions are not dangerous only to humans, however: the environment can be adversely affected as well, and this can impact further on human health over time.

Assessment of indicators

INDICATOR 8A: Human Development Index

Introduction

Human development goes beyond the fluctuation of national incomes. It is related to creating an environment in which people can develop their peak potential while engaging in productive and creative lives based on their needs and interests (UNDP 2003). Hence, development is about expanding people's choices in order for them to lead lives they value. The HDI was developed by the UNDP as a composite of indicators including life expectancy, adult literacy, school enrolment, and per capita income. Each of these indicators adds individual weight to the determination of the HDI for each Region and a national HDI for the country. The HDI is calculated and presented in the Human Development Report on Namibia each year, for which the local UNDP office is responsible.

As far as possible, the Namibian HDI follows the approach used for calculating HDI at a global level; but due to the lack of statistical information it has been adapted and is based on longevity, knowledge, and access to resources (UNDP 2001). According to Namibia's Human Development Report (ibid.), life expectancy at birth is a good indicator of *longevity*. Furthermore, life expectancy is directly linked to various additional aspects of human development such as adequate nutrition and health (ibid.). The *knowledge* component of the index is a composite of two indicators: the adult literacy rate, and the school enrolment rate. The adult literacy rate covers the proportion of the population aged 15 years and above (who can read and write in any language) and serves as a rudimentary indicator of the level of education (ibid.). The school enrolment rate targets children aged 7 to 18 years who attend school in each year. This indicator gives no information about the quality of the education system, but may serve as a good indicator of Government's investment in developing human resources (ibid.). The third component, *access to resources*, refers to the resources needed for an acceptable standard of living. Ideally, this should include a number of productive resources such as access to land and capital; however, due to the lack of reliable data, per capita income is assumed as a proxy. Thus, the three components briefly described here are used to calculate an HDI for each Region and the country as a whole.

The concept of human development can easily be related to environmental and sustainability issues, as highlighted by the UNDP's Human Development Report (UNDP 1992):

> [S]ustainable development implies a new concept of economic growth, one that provides fairness in opportunity for all the world's people, not just the privileged few, without further destroying the world's finite natural resources and without compromising the world's carrying capacity.

Description

The HDI is a composite index, which contains indicators on longevity (life expectancy at birth), education (literacy rate and the level of education in the population), and standard of living (measured as real GNP per capita). The index, developed by the UNDP, is used globally for comparison among countries.

Results and trends

From Figure 8.4, no clear trend can be observed: Namibia's HDI increased in minute proportions from 1996 to 1998, after which it began to decline and fell to below 0.7. From the latest Human Development Report (UNDP 2001), the 2000 estimate indicates that Namibia does not convert its high average income to high human development. This is due to the skew distribution of income (Gini coefficient[21] of 0.7) in the country that does not qualify for or justify calculating an average income. A small minority of

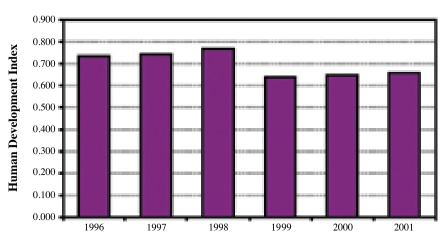

Figure 8.4: The Human Development Index for Namibia over time. HDI estimates for 2001 and 2002 are not yet published but UNDP office in Namibia (UNDP 1996, 1997, 1998, 1999, 2000)

Namibians enjoy a level of social infrastructure in respect of health and education that is equivalent to that in industrialised countries, while the majority lead lives that, in many respects, resemble those of any Sub-Saharan African country. In terms of income and asset distribution, the national economy is so extreme that there is nothing like an 'average' Namibian. In terms of the natural environment, higher HDI scores indicate that more Namibians are becoming literate, school enrolment is increasing, life expectancy is increasing, and the inequality in income distribution is being dealt with. A nation where a high proportion of the population is educated can be assumed to have greater awareness about the use of environmental resources. Higher literacy also means that more people can be reached via print media when awareness is being raised about environmental issues and problems.

According to the UNDP (2000), the Caprivi Region has the lowest HDI and also ranks highest on the Human Poverty Index, implying that more than one-third of the Region's population is severely deprived. This can be compared with the Erongo and Khomas Regions, where approximately 17% of the populations are severely deprived. The latter two Regions are lowest on the Human Poverty Index (ibid.).

INDICATOR 8B: HIV prevalence in pregnant women

Introduction

Symptoms of HIV or AIDS usually become visible or apparent between five to ten years. Therefore, information regarding hospitalisations and deaths from AIDS is inadequate to monitor the status of the pandemic in Namibia. The MHSS conducts an anonymous, unlinked survey among pregnant women every two years, namely its HIV Sentinel Sero Survey. The survey targets selected health facilities on the basis of their geographic distribution and the number of people that visit them. Anonymous and unlinked blood samples from pregnant women are tested for other purposes and offer a practical and affordable means to obtain information on the national HIV situation (MHSS 2002). The age coverage of pregnant women is also assumed to be representative of the sexually active segment of the population (Figure 8.5).
According to results from the 2000 survey (ibid.),

Footnotes
[21] A Gini coefficient of 0 means perfect equality, whereas a coefficient of 1 reflects perfect inequality

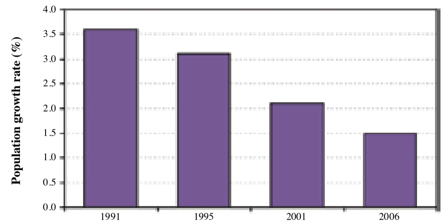

Figure 8.5: Shows the projected population growth rate due to the impact of HIV/ AIDS (MoHSS 2000)

HIV prevalence among pregnant women shows high variation among the different towns. This is presented in the "Results and trends" section below.

HIV/AIDS and the environment

The effects of HIV/AIDS on population growth, the environment and the economically active population still need to be methodically researched in Namibia, although some projections are available. Figure 8.5 shows a rapid decline in the population growth rate of Namibia. The growth rate projected for 2006 due to the impact of HIV/AIDS is 1.5% (ibid.). This growth rate may suggest a tendency toward a lower population turnover.
Hammarskjöld (2003) indicates that research on the effect of HIV/AIDS on the natural environment was published as early as 1990. This early work provided a good picture of the effects of HIV/AIDS on rural households and agricultural production in East Africa. Although much research has focused on agriculture, there is no evidence suggesting the immunity of other environment and natural resource sectors to HIV/AIDS (ibid.): people are infected across borders, and affect all the sectors they work in.

The general livelihood of rural households is affected by HIV/AIDS. Incomes fall and disappear while the need for care, medicine and money for funeral expenses increases. Families in such situations experience an acute need for resources, forcing them to sell agricultural equipment, livestock and/or other assets, thus making farming difficult (ibid.). When an HIV-positive person develops AIDS, s/he can still live for a number of years if substantial care is available. Households with members living with AIDS are required to provide care, and the amounts of time spend farming or engaging in other livelihood generating activities decreases. As a strategy to compensate for this, the workload and household responsibility of other members, particularly women and girls, increase. It is common practice that girls are taken out of school to take care of the sick, help around the house, and assist with farming. This

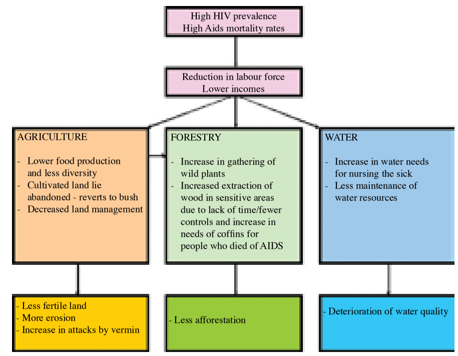

Figure 8.6: Illustrates the affect of HIV/AIDS on three environment/ natural resources sectors (Hammarskjöld 2003)

increases child labour. In the event that the male head of the family falls ill and dies, the family may experience a greater loss. Not only do they lose his labour and specialist farming knowledge, but this often means the loss of knowledge to sell and distribute products as well as the loss of valuable contacts with key partners. Figure 8.6 presents a summary of the affects of HIV/AIDS on the agriculture, forestry and water sectors.

Description

The indicator is based on the results of blood samples drawn from a number of anonymous pregnant women. The unit of measurement is the percentage of all pregnant women tested HIV-positive.

Results and trends

Figure 8.7 shows prevalence per sentinel site for the year 2000. According to health reports for 1998–1999 and 2002 (MHSS 1999, 2002) prevalence has increased in some areas while decreasing in others. In four sites with the highest prevalence, the following changes occurred from 1998 to 2000: Windhoek increased from 23% to 31%; Walvis Bay decreased from 29% to 28%; Katima Mulilo increased from 29% to 33%; and Oshakati deceased from 34% to 28%. The following changes in rural sites close to main roads were observed: Onanjokwe increased

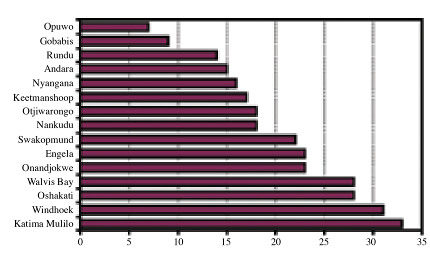

Figure 8.7: HIV prevalence for each of the sentinel sites surveyed in 2000 (MoHSS 2000)

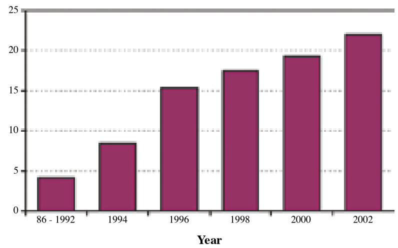

Figure 8.8: HIV prevalence for every second year since 1992. The estimate for the period 1986-1992 is an average for those years (MoHSS 2000)

from 21% to 23%; Engela increased from 17% to 23%; and Andara decreased from 16% to 15%. In three of the major district areas the following changes were observed: Gobabis presented a 0% change, Keetmanshoop showed an increase of 7% to 17%, and Opuwo increased from 6% to 7%. Based on this sentinel site breakdown, no general trend can be observed. However, Figure 8.8 shows an increasing trend in the average percentage for the country.

Using HIV/AIDS prevalence amongst pregnant women as a proxy for the pandemic's status in the nation, the picture is rather grim. Prevalence has been increasing since the first four cases of HIV/AIDS were reported in 1986 (Figure 8.8; cited from MHSS 2004). Although the prevalence rate is still alarmingly high, several research findings suggest that HIV infections are beginning to stabilise in Namibia (ibid.).

HIV/AIDS has been the leading cause of death in Namibia since 1996. From Figure 8.9 it can be observed that people between the ages of 20 and 40 are the ones most likely to be infected with HIV. This is the current and future most productive section of the population, and many still live in rural

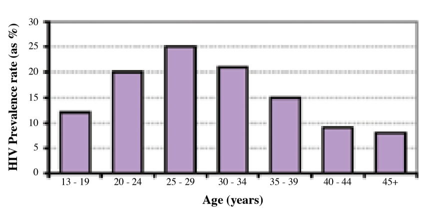

Figure 8.9: HIV prevalence for every second year since 1992. The 1986-1992 is an average for those years (MHSS 2000)

areas or urban centres in close proximity to rural settlements where prevalence is high (Figure 8.6). Apart from demonstrating the effect of HIV/AIDS at household level, Hammarskjöld (2003) highlights the effect of the pandemic on the environment and natural resources in Namibia that is due to the loss of human capacity to manage, conserve and protect (Figure 8.6). In addition, the effects of AIDS are dependent on, and exacerbated by, other existing conditions: poor health, drought (ibid.) and, in the case of Namibia, marginal environments and highly variable and unreliable rainfall.

INDICATOR 8C: Mortality rate for children under 5

Introduction

Child mortality is closely linked to poverty, the lack of safe water, and sufficient sanitation facilities. If infrastructure such as roads and hospitals/clinics are in a poor state, this can also contribute to high child mortality rates. In poorer countries, 70% of the child deaths before age 5 are attributed to a disease or a combination of diseases and malnutrition, which would be preventable in a high-income country. Diseases commonly diagnosed include acute respiratory infections, diarrhoea, measles, and malaria. Rural communities are prone to settle near or in areas where water resources are available. Sanitation and waste disposal are not always of an appropriate standard, which creates opportunities for airborne diseases.

Rural families in Namibia are highly dependent on the environment for their livelihood and in times of poor rainfall, crop and livestock farming becomes even more challenging owing to the already arid environment. Hence, it becomes more difficult for families to generate income, have funds available for food, make the necessary visits to clinics, or move too far from their homesteads. Such a scenario literally traps people in a situation where they are obliged to help themselves – especially in very isolated areas. Children under the age of 5 are susceptible to illness under such limiting conditions and the lack of money cannot ensure timely visits to clinics for medical attention. Thus, people's dependence on the environment and their rural lifestyles in the midst of little or no sanitation facilities can be seen as factors contributing to child mortality.

Immunisation is key to reducing the mortality rate for children under 5 in the developing world. Among childhood diseases preventable by vaccine, measles is the leading cause of death. The UN, in their Millennium Development Goals, suggest increased routine vaccinations to at least 90% of all children in a country, followed up by a second round of immunisation against measles as the main strategy to reduce deaths from this disease.
Infant and child mortality rates are basic indicators of a country's socio-economic situation and quality

of life (UNICEF 2002). Hence, the high mortality rates for children under 5 in Namibia appear to indicate poor socio-economic conditions and poor quality of life. Much has been done over the years since Independence to improve health facilities, access to them, access to potable water, and sanitation, but Namibia still has one of the highest income discrepancies in the world. About 60% of the population is rural (NPC 2003) and highly dependent on an environment that is already highly degraded and overpopulated in the populous settlement areas of the country. The ability of people to afford health services and transport to them depends on income or cash; for thousands of households, this is sometimes hard to come by.

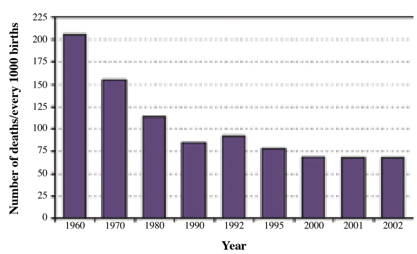

Figure 8.10: Trend in Under 5 Mortality Rate (U5MR) for the given years

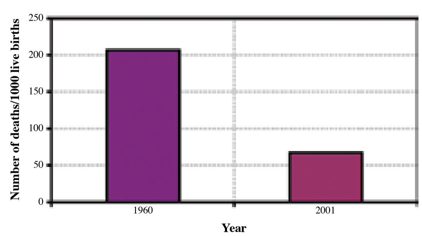

Figure 8.11: Shows a very coarse comparison between 1960 and 2001. Evidently the under 5 mortality rate has decreased significantly.

Description

This indicator shows the number of children who have died at birth or before their fifth birthday, expressed per thousand births. UNICEF (2003) also uses this indicator as their prime HDI for children.

Results and trends

The mortality rate for children under 5 has decreased significantly for over 40 years (Figures 8.10 and 8.11). In 1960, 206 children out of every 1,000 died before their fifth birthday, compared with 67 such deaths in 2001. The 1999 National Demographic Health Survey (MHSS 2000) confirmed that both infant and child mortality have been declining steadily over the past 10 to 15 years (Figure 8.10): the under-five child mortality rate for Namibia for 1996 to 2000 is an average of 62 per 1,000 live births, which is a 25% improvement from an average of 83 children per 1,000 for the period 1988–1992 (ibid.).

The mortality rate for children under 5 has a direct link with the condition of the environment. As mentioned earlier, the lives of rural people can be severely affected if the condition of natural resources is poor, thus compromising their ability to cater for basic needs. Malnutrition is one of the effects of poor agriculture

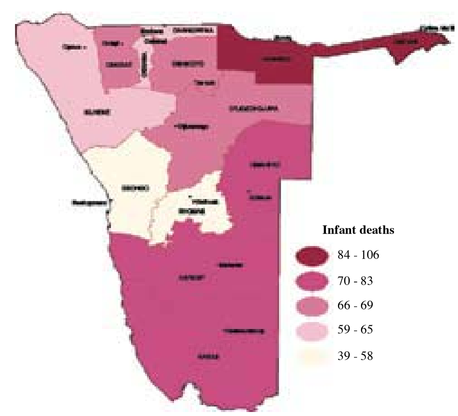

Figure 8.12: Shows the number of infant deaths per 1000 live births by region (taken from NPC 2001)

and livestock production. Poor water quality, and air- and water-borne diseases threaten infants and young children, while poor sanitation serves as a further breeding ground for infections. Access to health facilities plays an important role in further reducing the mortality rate for children under 5. The Government has greatly expanded the country's health facility network, specifically to provide access to such facilities in remote rural areas. Distances to health facilities are still huge in some instances, but at least they can be accessed in a day's travel.

Figure 8.12 offers insight into the regional incidence of mortality amongst children under 5 in Namibia. North-eastern Namibia seems to be most affected – not only by high under 5 child mortality rates, but also high HIV/AIDS prevalence.

INDICATOR 8D: Access to improved drinking water

Introduction

Water is without doubt the most essential resource for the sustenance of life. All living resources depend on water to ensure growth and physiological and biological functioning. In Namibia water is extremely limited and recognised as the country foremost limiting factor in terms of sustainable development (Brown 1992; Krugman 2001). Apart from Namibia's shared perennial rivers along the northern and southern borders there are almost no permanent surface water bodies in the country (Brown 1992). About half of the country's water needs are derived from underground sources of different types. These underground water sources are scattered over the country, with higher density in and around the Khomas Region (MAWRD 2000a). The abundance of these resources is not the focus of this indicator, but rather the quality of the water supplied to rural and urban populations for domestic consumption.

The World Health Organisation (2001) highlights the quantity and quality of water as important in satisfying consumption and hygiene needs. Hence, the importance of safe drinking water cannot be overemphasised in respect of guarding against bacterial, viral and parasitic infections. Such infections are spread when consuming water contaminated by the faeces of humans or animals carrying viruses, bacteria or parasites. This is usually very likely when people source water from communally shared surface water bodies (streams, *oshanas*, rain, lakes, etc). To secure the safety of drinking water, the MAWRD applies its own Drinking Water Quality Guidelines internally. Ideally, these should become national policy, but their adoption still requires Cabinet approval. The DWA, as the custodian of water resources in the country, lists aesthetic, inorganic and bacteriological determinants of concern and limits for classifying water as Group A, B, C or D (MAWRD 2000b). Groups A and B are classified as safe for human consumption. The DWA tests water resources to ensure immediate action in the case of water samples that fail to meet the required applicable quality standards.

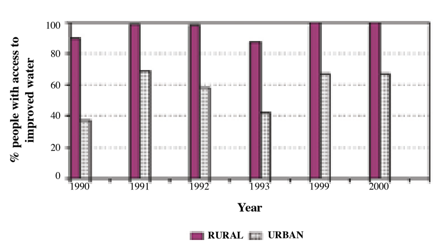

Figure 8.13: Shows the increase in access to improved drinking water in both rural and urban areas across Namibia (WHO 1992, NPC 1991, Demographic Health Survey 1992, WHO/ UNICEF 1996, WHO 1999)

Description

This indicator reports on the percentage of the population, urban and rural, who have access to improved (potable, i.e. Group A or B) drinking water sources. According to the Demographic and Health Survey (1992, 2000) and the National Census in 2001 (NPC 2003) and the World Health Organisation (WHO 2001), communities in Namibia's urban areas have 100% access to potable water facilities. This suggests water availability within 200 m, 20 Litre per person per day, and accessibility 98% of the time. A lower percentage is observed for rural areas.

Results and trends

Accessibility to potable water has increased in both urban and rural areas since Independence in 1990 (Figure 8.13). Access is currently 100% in urban areas, and just over 60% in the rural areas (WHO 2001). Generally, Namibians have decent access to improved water sources although there are still areas in the northern parts of the country where access could be enhanced, and where the quality of water for human consumption is questionable. The DWA engages in continuous efforts to ensure the safety of water for human consumption by testing water samples on a regular basis, especially in high-density areas. Infrastructural development in rural areas will in future facilitate the relay of potable water to 'isolated' communities.

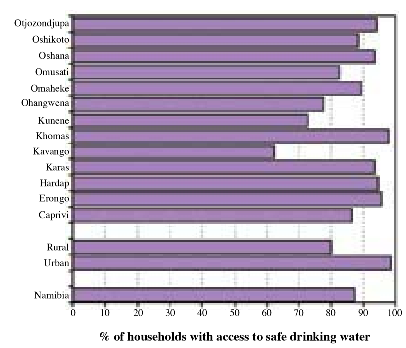

Figure 8.14: Shows the percentage coverage of households per region, for the entire Namibia and for rural vs. urban areas who receive safe drinking water (CBS 2001)

More than half the households in Namibia benefit from piped water within their compounds, while approximately 35% of households obtain water from public pipes and boreholes (NPC 2003). There is still a margin to be bridged between urban and rural households (Figure 8.14), the former benefiting from advanced plumbing infrastructure that provides water directly to their compounds. One out of ten rural households relies on water from natural sources (such as streams and rivers) for drinking and cooking. Regionally, there is a north–south divide in terms of water sources for drinking and cooking (ibid.). The majority of households in the southern and central Regions benefit from piped water delivered to their compounds, while the majority of households in the northern Regions rely on public pipes and boreholes. The Kavango Region has the poorest coverage of households who receive safe water (Figure 8.14). In the latter Region, only 30% of the population obtain water for drinking and cooking from natural sources. The Ohangwena and Kunene Regions, where rural areas make up more than 70% of the total area, also have low coverage percentages in comparison with the southern and central Regions, where urban populations outweigh their rural counterparts (ibid.).

Goals as articulated by stakeholders

In September 1993, Cabinet approved the Water and Sanitation Policy (DWA 1993). This Policy acknowledges not only the importance of water in Namibia as a limited resource, but also the top priority it deserves on the national agenda. Furthermore, the conservation of water is important in Namibia for many reasons, including the following (ibid.):

- Namibia is an arid to semi-arid country with limited water resources
- In most areas, water is difficult to access/locate and sources are finite
- Water is essential for the survival of human beings and the environment
- The health of humans and other fauna depends greatly on the quality of available water
- Rapid population growth and development increases the demand for water and pressure on existing resources
- The development and operation of water resources are expensive because the direct beneficiaries cannot afford the services and require financial assistance to do so, and
- The economy and future development are highly dependent on the availability of water.

It should be noted that the processes leading to the approval of the Water and Sanitation Policy commenced in 1990. In short, the objectives related to water supply are as follows (ibid.):

- Contribute towards improved public health
- Reduce the burden of collecting water
- Promote community-based social development
- Support basic needs for subsistence, and
- Promote economic development.

Given the social, environmental and climatic constraints in Namibia, the goal is to achieve 100% access to improved water sources in the rural areas while sustaining 100% access in urban areas.

INDICATOR 8E: Access to improved sanitation

Introduction

Sanitation is the maintenance of clean conditions, through garbage collection and wastewater disposal, which aid in the prevention of air- and waterborne disease. It is very conceivable that the lack of basic sanitation services can be a breeding ground for diseases in any area. Hence, *improved sanitation* is the establishment or upgrading of infrastructure, such as isolated garbage disposal sites and plumbing facilities, that relay wastewater and remove garbage from within settlement areas. It is thus easily comprehensible that urban areas have a high coverage of satisfactory sanitation services in comparison with rural areas.

A combination of unsafe drinking water and poor sanitation facilities is recognised as a major cause of diarrhoea in infants and children under 5 (MHSS 1999). In Namibia, diarrhoea is observed as one of the major diseases/conditions – the third major cause of death in 2001 – among children under 5 (MHSS 1999, 2001). Diarrhoea is primarily caused by the consumption of unsafe or infected water and poor sanitation. The latter is due to the lack of basic facilities, septic tanks and latrines (WHO 2001). Severe watery diarrhoea dehydrates the body enormously (ibid.); and the lack of water in Namibia can exacerbate the situation, leading to death in many cases – especially in children. Many rural households have no basic hygienic latrines, resulting in more than 70% of rural households using the bush for excretion (NPC 2003).

Bad sanitation causes serious harm. Children exposed to unsanitary conditions, or who drink contaminated water, fall sick more often and more severely. Many die before the age of 5 from water- and sanitation-related diseases, including diarrhoea, cholera, and malaria. In many cases when they do survive, their growth and development is stunted compared to other children.

Description

This indicator reports on the percentage of the urban and rural population with access to improved sanitation facilities.

Results and trend

From Figure 8.14 it can be observed that both urban and rural areas show an increase in access to improved sanitation facilities. In urban areas access improved immensely after Independence from just over 20% to close to 100% in 2000. Improved access in rural areas has not been that rapid, and overall, sanitary facility access remains under 20%. In terms of sanitary toilet facilities the MHSS (2000) estimates a 41% level of access among rural populations. It remains a priority of the Government to continuously increase access to improved sanitation facilities in rural areas.

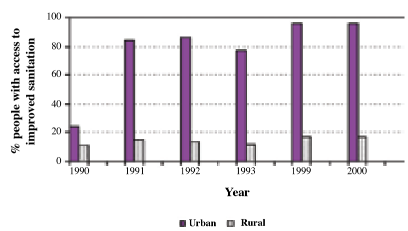

Figure 8.15: Shows the percentage coverage of households per region, for the entire Namibia and for rural vs. urban areas who receive safe drinking water (CBS 2001)

Recommendations

Alternative indicators

During the third annual meeting of the Environmental Monitoring and Indicators Network (EMIN) in 2003, the stakeholders suggested a number of indicators for incorporation into this Chapter. These indicators include the following:

- population growth – to demonstrate the amount of pressure on the environment
- main source of income – to demonstrate the heavy reliance on the environment
- number of households using fuel wood as the main energy source – to demonstrate the pressure on forest resources, and
- number of livestock per household – to demonstrate land-use practices.

None of the above points have been fully incorporated into this Chapter, although population growth is addressed across a number of indicators where population pressure is highlighted. The main source of income has also not been addressed, although income inequality as a possible motivator for environmental degradation is elaborated on. The usage of fuel wood as the main source of energy has been partially covered under the Chapter on desertification and land degradation. Explicit mention is made in the latter chapter of the increased harvesting of forest resources for various household needs, and the affects this has on the environment. The number of livestock per household is also addressed, albeit not exhaustively, under the Chapter on desertification with reference to north-central Namibia. The report attempted to demonstrate, quantitatively and qualitatively, the unprecedented pressure on land resources due to overstocking. In light of the above, the report recommends that indicators proposed by EMIN in 2003 be worked on, i.e. collecting and centralising the data, gathering and reviewing literature, analysing trends, and consulting stakeholders for their interpretation. This will ensure that, by the next cycle of integrated state of the environment reporting, these indicators have been developed.

Monitoring and data collection

For the indicators addressed here, a thorough evaluation of their monitoring programmes is recommended. The indicators in this report were selected based primarily on data availability. Although many stakeholders express confidence in relevant data sets, it is still essential to evaluate existing monitoring programmes in order to validate their reliability, degree of stakeholder confidence, and relevance.

Stakeholder commitment and cooperation

During the development of this report, various stakeholders were contacted for consultation on issues relevant to their core functions and services. Many stakeholders cooperated gladly while others did not due to constraints not elaborated on here. To ensure that Namibian stakeholders thoroughly participate in future reporting processes, a firmer commitment should be established with EMIN members. EMIN largely operates on a voluntary basis, and neither the EIA Unit, the Directorate of Environmental Affairs nor the MET has any right to obligate any member in any environmental assessment activities. The possibility of establishing EMIN as a formal intergovernmental structure should be considered along with other options. A report resulting from sufficient stakeholder participation will bear higher credibility and ownership.

Policy and decision-making

Since Independence, Namibia has produced numerous policies, planning documents and other development tools. Many of these have been devised in isolation – not only from the public, but also from other stakeholders not dealing directly with social issues. In recent years, however, stakeholders have shown themselves to be increasingly open to multidisciplinary or cross-sector discussions. Thanks to this, some policies have been reviewed and adapted, while some very sector-bound policies are still being implemented. The report demonstrates the interaction between environmental and social issues, albeit not exhaustively. In order to ensure Namibia remains on the right track to achieve the goals set in the five-year NDPs, its long-term Vision 2030, and the international Millennium Development Goals, we need to take cognisance of cross-sector influences and participation and align our policy and legal instruments accordingly.

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Chapter 9: Economic issues and the natural environment

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Introduction

Namibia is highly dependent on natural resources for its economic and socio-economic well-being. About 70% of the population derive their livelihood directly or indirectly from natural resources: via minerals, fisheries and agricultural land. Thus, a thorough assessment of sustainable economic growth should not omit natural capital.[22] Internationally, organisations are shifting their emphasis from economic development as growth in GNP, to economic development as a process of 'portfolio management'.[23] This process aims at optimising the management of individual assets and the distribution of wealth among different kinds of assets. Traditionally, national economies transform natural capital into other forms of capital, especially liquid capital, to achieve economic growth without reinvesting in other assets that will cater for future generations (Hartwick & Olewiler 1998; Lange 2003a). This approach is not sustainable in the long term when dealing with non-renewable resources like diamonds. Renewable resources may also run the risk of depletion if not managed optimally and utilised sustainably (Lange 2003a). Sustainable economic development requires that national wealth is non-decreasing over time (Hartwick & Olewiler 1998; Lange 2003a), even in the midst of population growth with concurrent demands for food and livelihood. The omission of, for example, mineral depletion from national accounts will portray a distorted picture of a country's economic wealth. Mineral exploitation is recorded in national accounts as a contribution to GDP and income, but excludes the simultaneous loss of wealth due to depletion (Hartwick & Olewiler 1998). Thus, it is important for wealth-generating resource sectors to have strong economic linkages with other sectors of the economy. In many national economies, political pressure causes the diversion of revenues from natural resource exploitation to fund current consumption – without securing anything to compensate for the loss of natural capital (Lange 2003a). This trend is apparent in Namibia.

During the early 1980s, the United Nations, the OECD, the European Union, the World Bank and country statistical offices addressed the omission of natural capital from asset accounts (Lange 2003a). Their effort produced a standardised framework and methodologies to construct environmental accounts, called the System of Integrated Environmental and Economic Accounts (SIEEA) (UN 2002). The application of the SIEEA allows for the economic valuation of natural resource stocks, and the cost of exhaustion and improvements in these stocks. The value of natural capital can be used to construct accounts for national wealth, which provides a more accurate assessment of sustainable development and economic performance (Lange 2003a).

Box 9.1: Sector growth

Preliminary National Accounts for 2002 reports growth in two out of Namibia's three primary industries; agriculture, fisheries and mining (CBS 2003). Agriculture reported a growth rate of 4.7% compared to a decline of 15.1% in 2001. This may be due to drought experienced over years prior to 2002. The mining industry also reported growth at a rate of 3.9% although suffering a decline of 6.1% in 2001. On the contrary, the fishing industry suffered a blow of 5.9% in addition to a 1.1% decline experienced in 2001. Until recent the sardine stock was at poor or no fishable levels that impacted on the employment, pelagic and the canning sectors. Quotas were made available for 2002 while the stock shows promise for biomass increase (CBS 2003).

Contribution of minerals to sustainable economic growth

Mining is an important sector of the Namibian economy and mineral assets contribute commendably to national wealth. Mineral wealth can provide national economies with the opportunity for economic development by the generation of funding for investment and growth. Thus, funds generated from minerals can be directed into investments that will in future cater for the loss of mineral wealth. This section highlights the role of mineral wealth

Footnotes

[22] Such as oil deposits underground, oceanic fish stocks, and standing timber stocks (Hartwick & Olewiler 1998)

[23] Consisting of all assets, i.e. natural capital, human and social capital, and manufactured capital.

in sustainable economic growth, and compares Botswana with Namibia to show the potential for investment through mineral wealth.

Namibia's mining industry developed at the turn of the 20th century when diamonds were first discovered (Hartmann 1986). Initial reserves were composed of high-quality gem diamonds extracted from rather inexpensive onshore mining sites. Metals such as copper, lead and zinc were exploited after World War II, while uranium mining began in the early 1970s and gold mining at Navachab during the late 1980s. During the 1990s the mining industry in Namibia appeared to be dwindling (Lange 2003b). Most of the onshore diamond reserves were exhausted and moved offshore; the main copper mine shut down, and the markets for uranium were weak. The exploration for offshore gas sparked optimism in the energy industry, but the fields will not be developed in the near future (USGS 2001; Lange 2003a).

The year 2000 marked a substantially better outlook on Namibia's mining industry. Copper mines at Kombat, Otjihase and Tsumeb reopened, while the Skorpion Zinc Mine was under development in 2000. Diamond explorations offshore and in the north-eastern part of the country (near Botswana) yielded positive results (Lange 2003a).

Mining, as an industry based on non-renewable resources, generates income while simultaneously depleting the mineral assets. Income generated is included in GDP, but not the loss of the resource that will inevitably distort the picture portrayed about economic wealth. This distortion can be dealt with through the valuation of mineral assets. Environmental accounts, therefore, estimate the economic value of mineral wealth, the cost of depletion, and the extent to which mineral wealth is being diverted for sustainable economic development/growth (ibid.).

Contribution of fisheries to sustainable economic growth

Namibia's fisheries suffered severe overexploitation prior to Independence in 1990 (Willemse 2002). Numerous DWFs off Namibia's shores were a common phenomenon during the 1950s, 1960s and 1970s, and countries like Spain, the then USSR and South Africa were among the main 'stakeholders' of the industry (ibid.). The fishing industry feeds off the Benguela Current, one of the four eastern boundary currents in the world, which supports a rich composition of fishable stocks. Prior to Independence Namibia was ruled by South Africa

Box 9.2: GDP not a true measure of Namibia's economic growth

Projecting gross domestic product (GDP) trends over time is a popular method for evaluating trends for economic growth. GDP measures the quantity of goods and services produced by the economy, and are generally regarded as an important indicator for economic growth. Namibia's GDP (Figure 9.1) shows rapid growth from the 1980s; a phenomenon that is rather impressive if compared to that of some developed countries. However, analysing the economy of the country from 1920 to 1997 tells a different story as shown in Table 10.1. Although GDP shows a positive annual growth rate this does not reflect the country's true economic growth or well being. Two extremes make it difficult to define the economic well being of an average Namibian. The majority of people, in both urban and rural areas, live in poverty or at the brink of being impoverished. On the other extreme; a minority of Namibians live in wealth beyond local comprehension. These extremes create huge inequalities in income distribution (Gini coefficient = 0.7) in the country that is not reflected in GDP as a measure of economic growth.

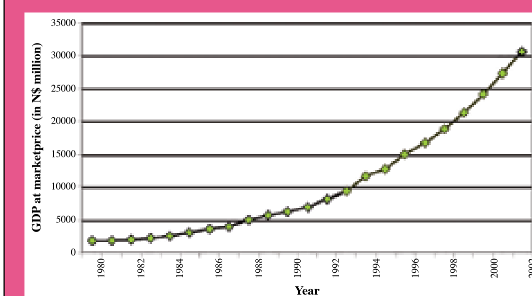

Figure 9.1: Namibia's GDP

who exerted some control over inshore fish stocks. However, the lucrative offshore fish stocks were uncontrolled because foreign countries refused to recognise South Africa's jurisdiction over Namibia's EEZ. Thus, most of Namibia's fisheries were treated as a common pool resource with open access that led to consequent excessive levels of exploitation (ibid.). Following Independence Namibia established control over the 200-nautical-mile EEZ, and fisheries policies were introduced with two main objectives (Lange 2003c):

- To ensure ecologically sustainable management of the resources, and
- To maximise benefits to Namibians from the fishing sector, especially those previously excluded due to discriminatory laws and practices.

Namibia achieved a remarkable transformation of the industry in a relatively short period. Fish stocks have partially stabilised and Government is aiming to restore stocks to 1960s levels. The economic contribution from the industry grew and accounted for 8% of GDP and 26% of merchandise exports in 2000 (NPC 2001a), while employment in the sector more than doubled between 1991 and 1998 (MFMR 2000). Furthermore, the Namibian industry is not subsidised by Government and increased its contribution to State revenue from practically nothing in 1990 to N$103 million in 2000 (NPC 2001b).

The sound management of fisheries stocks as renewable resources is important for the sustainability of Namibia's economy. Until recently the income generated from harvesting fish was included in the national income, but changes in the resource were not accounted for (Lange 2003c). Due to this omission the overexploitation of the resource prior to Independence may appear as an economic success story because the economic value of losses of the resource were not accounted for (ibid.). Similarly, the benefits from reducing current levels of exploitation to recover the stocks, which aims to maintain or increase future levels of fishing, would not be recorded. Sustainable management of the resource is essentially dependent on an economic assessment of the value of the fish stock, the economic loss incurred through overexploitation and depletion, and the potential value of the stock under different management regimes. Such accounts have been established for the three commercially most important marine species, namely hake, pilchard and horse mackerel. Ultimately, accounts for all aspects of the sector – be they commercial capture fisheries, artisanal freshwater or cultivated marine and freshwater fish and shellfish – should be established for a thorough assessment of the resource and its future sustainability.

The Namibian fishing industry generates substantial amounts of resource rent. A system of quota levies is in place with the objective to achieve sustainable and equitable management of the industry. Namibia's industry is highly commercial and tries to achieve socio-economic benefits while maintaining economic efficiency – a difficult challenge. Full recovery of rent is not achievable due to significant annual fluctuations in rent, but recovery of a significant portion of rent expected in the long run is important for the following reasons (ibid.):

1. Rent recovery contributes to sustainable management of the resource by eliminating economic incentives for unsustainable fishing practices
2. Appropriately determined levies – based on biological and economic criteria – create incentives for the most economically efficient (most profitable) level of fishing, and
3. Recovery of rent promotes equity by recovering excess profits that can be used for development that benefits all Namibians and not only those involved in the industry.

Sustainable management of the fishery, as seen in points 1 and 2 above, will ensure this industry contributes to national sustainable economic growth over the long term. Namibia has, thus far, achieved sustainable management through the appropriate setting and enforcement of TACs even when the industry has requested higher TACs. However, the direct economic benefits from fisheries may be limited to a small group of people participating in the industry as owners of fishing companies and fishing industry workers who receive high wages. The only way that fisheries can benefit those not directly involved is when Government appropriates some of the resource rent to fund national level economic development. This argument is similar to the reinvestment of mining revenues in other developmental activities and assets (Lange 2003b, 2003c).

Chapter overview

Environmental/natural resources and the economy are closely interlinked. Resources are harvested and extracted for processing and value addition and then marketed to generate income. At subsistence level, households and communities cultivate crops, rear livestock, and use forest resources and other wild plant and animal products to cater for their daily domestic needs and to generate income. Therefore, the economic well-being of large commercial industries and rural households alike is dependent on the status of the resources on which they rely. Two scenarios that are unsustainable over the long term are currently under way in Namibia. The first of these relates to the commercial diamond-mining sector, which relies on a finite, non-renewable resource, and does not reinvest capital in other assets that can serve as alternatives when mineral resources are depleted. In the event that this happens, thousands of Namibians will be jobless and the economy will be severely affected. Secondly, the exploitation of natural resources by rural communities increases with population growth; and the rapid depletion of some resources already threatens the ability of some households to meet their basic needs. As natural resources become exhausted, in the absence of viable income-generating alternatives, rural people will be left between a rock and a hard place, not knowing where to derive a livelihood from. Natural capital is an important asset in Namibia and its conservation should be enforced. In addition, large commercial industries based on the wealth and health of natural resources should foster a culture of investing money into other assets that can secure the industries' economic and socio-economic contribution into the future.

Sustainable economic growth

Income generated from the fishing and mining industries prior to Independence did not benefit the majority of Namibians. After Independence, the new Government embarked on a thorough assessment of the status of natural resources and, in the case of fisheries, developed stringent policies and regulations for the recovery of fishery stocks. Another objective is to encourage the participation of previously disadvantaged Namibians in the fishing industry. Namibia's wealth, adjusted for inflation, increased by only 20% from 1980 to 2000. Natural capital in 1980 consisted only of minerals and accounted for nearly 25% of total wealth. The share of natural capital fell after that and, by 1990, accounted for only 15% of national wealth – even with the inclusion of fisheries wealth. Per capita wealth dropped sharply by nearly a third less capital in 2000, compared with 1980. Per capita wealth decreased after Independence from N$31,578 in 1990 to a 20-year low of N$27,244 per capita in 1996. By 2000, per capita wealth had increased to N$31,089. The inclusion of minerals and fisheries in the assessment of national wealth does not complete the picture because human and social wealth have not been measured. However, Namibia converts its natural resources into income without investing fast enough to keep up with population growth and accompanying economic pressures.

Percentage of total budget spent on the environment and related sectors

Overall, money allocated toward the environment and related sectors as a percentage of the total annual budget has decreased since the 1992/93 financial year. For 1993, the percentage allocated amounted to 14% of the total budget; during the current financial year (2003/4), close to half of that percentage has been allocated. Using this as a proxy to measure Government's commitment to environmental research, conservation, management and protection, it suggests a rather loose commitment. This trend does not correspond with commitment toward sustainable development as articulated in Vision 2030, NDPs, and sector development instruments. Furthermore, it may suggest the lack of ownership of prominent environmental and related problems, such as poverty and other socio-economic inequalities.

Foreign direct investment

No clear trend is observed since Independence for foreign direct investment (FDI) as a percentage of GDP. FDI reached 9% of total GDP in 2001, marking the establishment of the Ramatex garment and textile project in Namibia. FDI has remained below 5% for most years since Independence, which means that no foreign investments similar to Ramatex were made until 2001.

Some initiatives attracting FDI in Africa do not yield the desired and expected benefits, such as the development of environmental sectors and poverty reduction through employment creation. Capital formation is one of the reasons why FDI is attracted: developing countries hope to benefit from much-needed capital that they hope the foreign investor will inject. In the initial stages of 'Greenfield' investments this may be the case, but in the medium term, the capital outflow outweighs the inflow into the host country.

FDI initiatives may also severely undermine a country's environmental policies and regulations. It is rumoured that no comprehensive EIA was done for the Ramatex FDI initiative. In light of this, recent reports have suggested underground water resources have been polluted via wastewater discharge from the garment and textile factory. Pollution of underground water is irreversible and, in Namibia, where water is the crucial limiting factor to sustainable development, such negligence is unacceptable.

Assessment of indicators

INDICATOR 9A: Sustainable economic growth

Introduction

In order to define *sustainable economic growth* (SEG), we first need to define *sustainable*. According to the Brundtland Report (WCED 1987) and the Earth Summit (UN 1992), *sustainable* is defined as "development that meets the needs of the present generations without compromising the ability of future generations to meet their needs". This definition makes no prior stipulation on the level of resources available per capita consumption against a growing population, nor does it make any prior stipulation on the resource base/capital stocks. Hence, an incorporative definition of *SEG* should

Box 9.3: Resource rent for sustainable economic development: Namibia vs. Botswana

Namibia does not have a policy devoted explicitly to the management of resource rent generated from natural capital. Hence, resource rent is not invested in other assets that will secure the livelihoods of future generations. Botswana on the other hand has a policy that deals explicitly with the management of resource rent. Revenues from Botswana's diamond industry stem from asset sales rather than value addition in production. This realisation prompted the government to reinvest diamond mining revenues to maintain economic growth. This reinvestment may occur in public sector capital (infrastructure), human capital (education and health cares), or in foreign financial assets, which generate annual income (Lange 2003b). If capital is liquidated and used for consumption rather than reinvested then national wealth decreases over time. Botswana's Sustainable Budget Index (SBI) is an indicator that monitors whether government reinvests mineral revenues or use them for public consumption. The SBI rule states that no revenues from minerals should be used for public consumption but only investment.

SBI = Govt. Spending/ Govt. Revenue

SBI < 1.0 - all resource rent invested in public sector and human capital

SBI > 1.0 - liquidation of mineral wealth to fund current consumption – fiscally unsustainable in the long term

See Lange (2003b) for a comprehensive comparison between Namibia and Botswana

take cognisance of changes in human population, capital stock, and consumption patterns over time. *Capital stock* is referred to as natural, technological and other resources. Thus, in light of the above, this report, borrowing from various authors (Daly 1991, Hartwick & Olewiler 1998; Lange 2003a, b, c; Pearce et al. 1990), defines *SEG* to be "growth or development that meets present and future generations' needs while capital stocks remain intact". The question may arise as to how capital stocks can remain intact against a growing population with concomitant needs. Lange (2003) points out that this can be achieved if renewable resources are safeguarded and alternatives to exhaustible resources are developed. Safeguarding of renewable resources can be achieved once per capita income increases. He (ibid.) further notes that Africa's natural resource base is under heavy pressure because the majority of people depend heavily or entirely on natural resources and earn very low incomes. Revenue generated from industries that exploit exhaustible or finite resources needs to be reinvested into alternative commodities and other assets that can substitute economic and socio-economic opportunities currently offered by such industries, especially mining (Box 9.3).

Economic development is traditionally measured from a country's real GDP per capita. However, this indicator may be misleading as a country's real GDP shows an increasing trend (Box 9.2), while enormous income equality exists and capital stocks reduce rapidly.

Based on such realities that will create bias in the analysis of SEG, this section therefore uses annual per capita wealth instead (Figure 9.1) while elaborating on Namibia's two top GDP-earning industries: mining and fisheries.

Namibia has embarked on a trajectory toward sustainable development that includes every sector in the country. Various instruments – NDPs, Vision 2030, Sectoral Development Strategies, to name three broad-based ones – articulate the nation's development intentions; it is, therefore, of gravest importance to assess our past trends in economic development. However, this indicator takes a different approach by not using GDP as a proxy but rather annual per capita wealth. This analysis and presentation is not exhausted and encourages a more inclusive analysis of SEG once natural resource accounts become available for all natural resources in Namibia.

Description

This indicator attempts to give a holistic picture of Namibia's wealth, especially in terms of natural resource capital. Mining and fisheries are the industries for which natural resource accounts have been established, and their contribution to national wealth considered in the long term. Resource rent should ultimately be reinvested into other assets that can secure economic sustainability once non-renewable resources are exhausted or if renewable resources are not well managed.

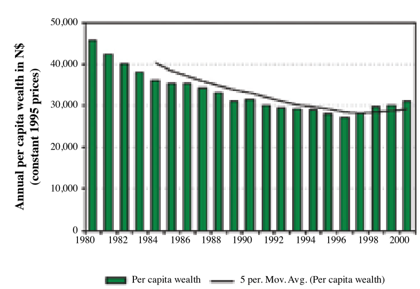

Figure 9.2: Annual per capita wealth in N$ at constant 1995 prices (Lange 2003c)

Annual per capita wealth decline by almost N$20,000 from 1980 to 1996 and trend line suggests an increase following 1996.

Box 9.4: Foreign debt vs. GDP

Foreign debt has remained relatively stable for most of the early 90s and decreased as a percentage of GDP. This may suggest economic growth in terms of foreign debt as a ratio to GDP from 92/93 to 97/98. Toward the end of the 90s foreign debt increased, also observed as a positive annual change in figure 9.3, with corresponding increase as a percentage of GDP. During the 97/98 fiscal year foreign debt was only 1.8% of the GDP compared to 5.6% at the end of the 01/02 fiscal year. Using FD/ GDP as an indicator for sustainable economic growth observes a decrease in the ratio, tending toward a higher percentage of FD in relation to GDP. As ratio, FD/ GDP, tends toward zero so does foreign debt resulting in economic growth. According to Sherbourne et al. (2002), debt has grown faster than GDP. Nominal GDP (i.e. measured in current prices) has only grown by 13.0% on average over the ten fiscal years. Debt stock shows an average increase of 21.2%. It is clear that nominal GDP has grown by less than the debt stock (GDP growth < Debt stock growth) and this suggests that expenditure incurred with borrowed funds has no generated the necessary returns in terms of contributing to higher nominal GDP growth (Sherbourne et al. 2002). Government exceeded their debt target of 25% of GDP at the end of fiscal year 2001/02. This implies that in order for Government to maintain a constant debt to GDP ratio from now on they will have to assure that the debt stock does not grow faster than nominal GDP (Sherbourne et al. 2002). Toward economic growth, the debt stock will ultimately have to decrease, hence a debt to GDP ratio that tends toward zero.

Figure 9.3: Namibia's foreign debts over the years

Results and trends

Resource rent generated from the fishing and mining industries prior to Independence did not benefit Namibia at all. After Independence, the new Government embarked on a thorough assessment of the status of natural resources and, in the case of fisheries, developed stringent policies and regulations for the recovery of fishery stocks. Another major objective is to encourage the participation of previously disadvantaged Namibians in the fishing industry. Namibia's wealth, adjusted for inflation, increased by only 20% from 1980 to 2000. Natural capital in 1980 consisted only of minerals and accounted for nearly 25% of total wealth. The share of natural capital fell after that and, by 1990, accounted for only 15% of national wealth – even with the inclusion of fisheries wealth (Lange 2003c). Per capita wealth dropped sharply by nearly a third less capital in 2000, compared with 1980. Per capita wealth decreased after Independence from N$31,578 in 1990 to a 20-year low of N$27,244 per capita in 1996 (Figure 9.2). By 2000, per capita wealth had increased to N$31,089 (ibid.). The inclusion of minerals and fisheries in the assessment of national wealth does not complete the picture because human and social wealth have not been measured. However, Namibia converts its natural resources into income without investing fast enough to keep up with population growth and accompanying economic pressures (Lange 2003a).

Goals

Namibia is extremely reliant on natural capital for economic and socio-economic growth. In terms of policy, Namibia should incorporate the reinvestment of wealth stemming from natural capital into assets that guarantee the livelihoods of future generations in the national sustainable development policy. Thus, when finite resources like minerals become depleted, then enough alternative resources have been generated to substitute income previously derived from mining. This is an important goal since mineral resources have a limited time horizon and, due to Namibia's highly variable marine environment, that can affect fish stocks adversely. Resource accounts for other natural resources and human and social capital should be constructed for an inclusive assessment of national wealth.

INDICATOR 9B: Percentage of total budget spent on the environment and related sectors

Introduction

Namibia has committed herself to sustainable development. Such a commitment starts with inventorying natural capital stocks, social and socio-economic dimensions (such as the impact of HIV/ AIDS, annual per capita income, and sources of income), technologies, partnerships and cooperation, projects and research initiatives, financial resources, and human capacity. Once we know where we stand at present, we are better able to plan the implementation of activities and initiatives that will steer us toward our future development goals. In a dynamic environment comprised of population growth, migration, climate change, variability of rainfall and changing temperature, marginal and changing land, and declining water availability, it is more important than ever to conduct prioritised research. The outcome of sound research can hopefully provide answers to prominent questions, suggest changes to current practice, and prompt the review of development policies. Disciplined, reliable and prioritised research can help us prepare to respond to a changing environment more effectively.

Numerous research projects were initiated shortly after Independence and most of these short- (2–3-year) to medium-term (3–5-year) projects have been and are still donor-funded. Government, through its relevant ministries, engages in bilateral and multilateral agreements with donor agencies or countries and is usually required to provide a percentage of the contribution either in monetary terms, human resources, infrastructure, equipment and/or technology, or a combination of these. Many of the past and present projects are development-oriented and emphasise capacity-building, technology transfer, knowledge creation, and the foundation of an initiative or concept that should be self-sufficient when donor funding terminates. Many such projects have been successful while a number have failed for reasons not elaborated in this report.

Namibia's commitment to sustainable development can be measured by the use of this indicator to show Government's annual prioritisation for research as a percentage of GNP. Observing an increasing trend will be interpreted by this study as a firm commitment; a decreasing trend cannot be regarded as an implicit lack of commitment, however, and should receive further investigation to determine the reasons behind decreased funding in a particular year.

Why is this indicator important?

Natural resources are the main drivers of Namibia's economy, with agriculture, mining and fisheries dominating the top three places in terms of GDP contribution. Revenue from tourism has increased rapidly over the past few years due to an increased emphasis on ecotourism and wildlife. Conservancies established under the CBNRM Programme contribute increasingly to tourism, which in turn boosts tourism's contribution to GDP while supporting the livelihoods of many Namibians. Agriculture, mining and fisheries are natural resource-based and, as such, are highly dependent on the health and wealth of the environment to remain economically viable. Apart from employing people directly for extraction of ore, harvesting of fish stocks, and rearing livestock and cultivating crops, these industries support the livelihoods of thousands of Namibians downstream. Primary, secondary and tertiary industries, as defined in the National Accounts, are supported through downstream activities. Such activities pertain to processing, value addition, transport, export, retail, investment and financial services, and numerous other informal sectors not adequately monitored. Hence, our natural environment, through its commercial and non-commercial exploitation and diversification, secures a livelihood for the majority of Namibians – even those not directly employed in wither agriculture, mining or fisheries.

Against this background, the prioritisation of environmental research, protection, conservation and management in Namibia should be obvious. Global warming and environmental change have featured prominently over the past decade in discussion fora, high-level planning meetings, prestigious journals and reports, and in decision-making and scientific circles. Namibia is no exception to the rule: indeed, predictions about negative environmental change are rather severe for the industries mentioned. Increased temperature, drier conditions and a rise in sea levels pose serious threats to biodiversity and the industries that rely heavily on it. Food security will become a more difficult challenge than it already is, and the availability of water will become a more severe limiting factor to Namibia's sustainable development. In the light of these predicted changes, the need for research and forecasting is a must if we want to plan for the future.

The lack of substantial funding for environmental research is still one of the major drawbacks of African governments, and the investment of revenue generated by currently lucrative industries for the future is not common practice. Many argue that the current direction of spending amongst African government leaders is skewed away from urgent priorities: a point that still needs to be redressed by many African states.

If we are serious about sustainable development and its primary goals, we need to take ownership of our problems, prioritise them, and take bold steps to ensure that necessary resources are available.

Description

This indicator shows the annual average budgetary allocation to the environment and related sectors expressed as a percentage of total Government spending. Initially, the indicator should have displayed trends in funds allocated for environmental research, reflected as a percentage of GNP. However, due to the delay in data acquisition, it was decided to use spending on the environment and related sectors as a percentage of total Government spending. It also needs to be borne in mind that the data presented here serve only as a proxy to weigh Government's commitment to environmental research and the development of related sectors. This report does not claim the data to be disaggregated, specific or substantial enough to reflect Government's commitment as a matter of fact. It is hoped that the results presented and trends interpreted here will serve to stimulate discussion and decision-making as regards monetary allocations for environmental research.

Results and trends

The data presented below show total spending allocated to a particular environmental or related sector. Hence, there is no aggregation that depicts environmental and related research in sectoral budget allocations. This is a drawback that this report acknowledges, along with the fact that such allocations cater for jobs, equipment, work travel, and other items that may represent the capacity for environmental and related research and management. Thus, as mentioned earlier, the report uses data as proxies to gauge the Government's commitment toward environmental and related research, protection, conservation and management.

The overall trend observed in Figure 9.4, presenting the sum of percentage spending on environmental and related sectors as a percentage of total spending, reflects a reduction in funds allocated to these sectors. Serving as a proxy, this suggests rather a loose commitment toward environmental and related research, protection, conservation and management. Looking at the trends for specific sectors, however, these vary from decreasing to increasing, and no trend is observed, as detailed below:

- ***Agriculture*** (Figure 9.5) shows a rapid increase in total budget percentage after Independence, to above 6% for the 1992/93 financial year. This is followed by a decrease to below 4% for the 1994/95 fiscal year. In 1996/97 more than 5% was allocated, after which a declining trend is observed until 2003/04. For the 2004/05 fiscal year, Government allocated 0.1% more than in 2003/04.
- ***Forestry*** (Figure 9.6) has currently not

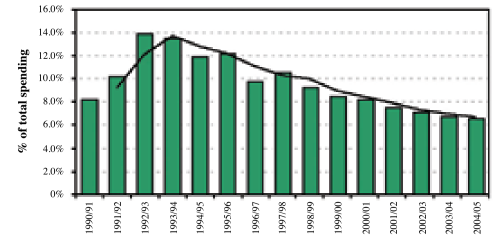

Figure 9.4: Total spending on environment and related sectors as a percentage of total government spending. Below following are graphs depicting trends for all major environmental and related sectors in Namibia.

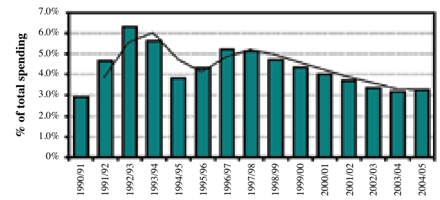

Figure 9.5: Total spending on Agriculture Affairs and Services as a percentage of total government spending

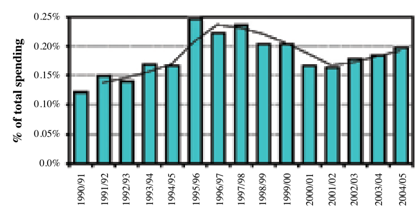

Figure 9.6: The total spending on Forestry Affairs and Services as a percentage of total government spending.

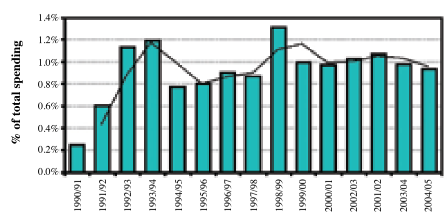

Figure 9.7: The total spending on Fishery Affairs and Services as a percentage of total government spending.

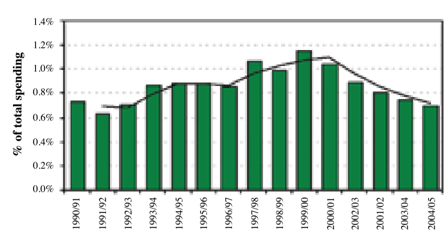

Figure 9.8: Total spending on Wildlife Protection and Preservation Services as a percentage of total government spending.

achieved half a percentile of the total Government spending. Forestry resources are of daily importance to rural households in Namibia. Products derived from such resources include building materials, roofing, fuel for cooking, light and heat, wild foods, equipment (donkey carts, tools) and crafts. Nonetheless, since 2001/02, the percentage allocated to forestry has increased and currently stands at just below 0.2%.

- The ***fishing*** industry (Figure 9.7) was in a very poor state at Independence. Stock levels were low and Namibian ownership in the industry was virtually zero. The MFMR took on the challenge to rebuild stocks, Namibianise the industry, and put in place all policy and other instruments that guide and control exploitation and development. For the first three years after Independence, the budget share increased rapidly until 1993/94. Thereafter, it fell by 0.4% and remained almost stable around 0.8% for four fiscal years. In 1998/99 the allocation reached 1.3%, but dropped by 0.3% in the next financial year. Ever since, the average percentage allocated to fisheries has remained 1%. In 2002 it was estimated that the fishing industry directly employs more than 15,000 people. Many more are employed in downstream and related industries. All decision-makers understand the importance of this industry, with its established infrastructure and technology. The socio-economic importance of this industry is also well understood, a fact of which we are reminded every once in a while when employees fear retrenchment in a year of low stock levels.

- The ***wildlife*** sector (Figure 9.8) has become popular over the past few years as animal wildlife populations increase along with tourism figures, and more conservancies emerge in communal areas. Wildlife has been integrated into traditional cattle ranching to diversify income and to lessen the impact of changing environmental conditions that make traditional farming difficult. Thus, this sector has experienced growth: both economically and in terms of biodiversity. From Figure 9.5 this sector is observed to have experienced an increase of almost 0.6% in budget allocations from 1991/92 until 1999/2000. A peak allocation of more that 1.1% is observed in the latter financial year, followed by a declining trend to date. We might argue that the decrease in budget allocation is due to the continuous growth in the sector. However, to ensure continuous growth and to plan for the future, the Government should invest money in research.

- From Independence until 1995/96, the ***water*** sector (Figure 9.7) spent an average of 4.2% of the total budget. From 1996/97 to date, the average spending has been 1.4% of the total budget. Water is recognised as Namibia's No. 1 limiting factor in terms of development. Namibia is not blessed with an abundance of surface freshwater resources and relies heavily on groundwater and seasonal rains. With a high water deficit, i.e. precipitation being less than evaporation, ephemeral surface water remains available only for short periods of time. Rainfall has also decreased in duration during the rainy season, and is lately characterised by short intense showers. All of these characteristics emphasise the need for research directed at water availability and security, and groundwater extraction and quality.

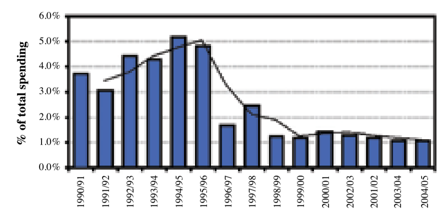

Figure 9.9: Total spending on Water Supply Affairs and Services as a percentage of total government spending.

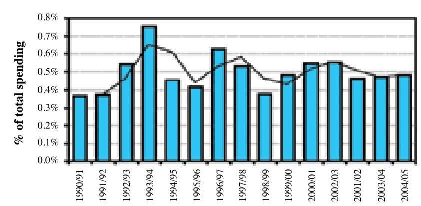

Figure 9.10: Total spending on Mining and Mineral Resources Affairs and Services as a percentage of total government spending.

- From Figure 9.10 no clear trend can be observed for the ***mining*** sector since Independence. The percentage of total spending has remained above 0.35%, reaching a high of 0.75% in 1993/94. This report has not gone as far as exploring reasons for the data in Figure 9.9; however, the following possible influences on the percentage of Government spending on mining can be discerned: taxes paid to Government, trends in employment, trends in and the diversification of mining activities, and revenue generated. Diamond mining is perceived to be a lucrative industry in Namibia, producing in excess of a million carats per annum for the past ten years (Chamber of Mines 1993–2003). Taxes paid to Government have also remained in excess of 36% of total taxable revenue, by means of which Government earned N$339.3 million in 1990 alone (IET 1999). Mining is diversified in terms of minerals extracted. The resources that this sector depends on are finite and non-renewable, so it is imperative to invest in assets now that can benefit the economy when such resources are exhausted.

It should be noted that this report elaborately emphasises Government's commitment toward sustainable development through the development of plans of action, policies and concept documents. Furthermore, the report emphasises developments in the above-mentioned sectors since Independence – whether or not they were spearheaded by Government, the private sector and donor initiatives, joint ventures, and/or bilateral or multilateral agreements. It is acknowledged, therefore, that Government has committed funds to the environment and related sectors, but the question concerns the extent to which it has done so. For example, many policies and other development-guiding instruments are well articulated on paper, but still need to be tested in practice. In addition, the implementation of many of these instruments is constrained by the lack of human, financial and technological resources.

INDICATOR 9C: Foreign direct investment

Introduction

FDI is generally perceived as a major stimulus to economic growth, especially in developing countries such as Namibia. Throughout Africa, policy-makers are focusing extensively on the perceived ability of FDI to overcome obstacles like shortages in financial resources, skills and technology (Mwilima 2003). *FDI* refers to investment directed by a foreign investor to acquire a lasting presence in the country other than his/her home country. From the perspective of a foreign investor, this entails having a minimum 10% equity share in an offshore enterprise (ibid.). FDI takes two forms: 'Greenfield' ('mortar-and-brick') investment, or mergers and acquisitions (M&A). The former involves newly generated assets, whereas the latter is the transfer of assets from a local to a foreign enterprise.
According to research by the UN's Conference on Trade and Development (UNCTAD 2000) for the *World Investment Report 2000*, not only are the benefits of M&As lower than 'Greenfield' investments, they also carry a higher risk of negative effects. This is especially true in the short term.

The United Nations Economic Commission for Africa strongly advocates the attraction of FDI by African nations in order to solve economic problems. The International Monetary Fund (IMF) and the World Bank support this position too. Sub-Saharan African countries have developed a keenness to attract FDI with the perception that it will curb or eliminate social and economic ills such as unemployment, lack of skills, and reduction in output from natural resources. This pro-foreign-investment attitude was encouraged by structural adjustment programmes and the internalisation of neo-liberal assumptions strongly advocated by the IMF and the World Bank (ibid.).

The reasons for African countries' keen interest in FDI can be summarised as being an attempt to improve the security of their capital resource bases, promote entrepreneurship, gain access to overseas markets for exports, improve management techniques, transfer innovation and technology, and reduce unemployment (ibid.). The translation of these into improved natural resources management and utilisation is not explicitly highlighted by Mwilima (ibid.), but can be inferred from more skilled human resources, technology transfer, and improved management. A human resource base qualified in relevant fields will be able to contribute actively toward the conservation and management of natural resources. Additionally, environmentally friendly and efficient technologies may increase the output per unit of natural resource input.

In their attempts to attract FDI to curb unemployment, increase exports, acquire new technology, increase capital, and generate spillovers to benefit other sectors, African governments have lowered entry barriers and opened up most of their sectors to foreign investment. This trend is notable over the past two decades (ibid.).
Governments need to offer incentives as part of

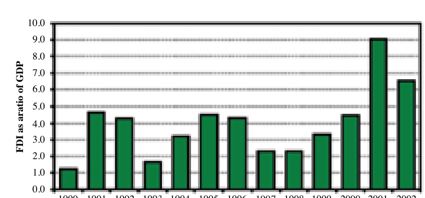

Figure 9.11: FDI as a % of GDP
(Source: The Institute for Public Policy Research)

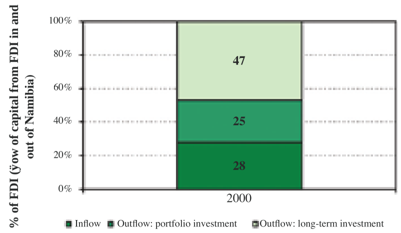

Figure 9.12: The flow of capital from FDI in percentage (Mwilima 2003)

policies used to lure internationally mobile investors. Such incentives include fiscal incentives such as reduced taxes, tax breaks/holidays and exemption from import duties; financial incentives such as grants and loans; and rules-based incentives such as reduced workers' rights, reduced environmental standards, and increased protection for intellectual property rights. However, incentives play a rather limited role in attracting investment, although some governments have created special incentives to attract FDI.

The main goal of any investor is to maximise return on capital input and to keep production costs as low as possible per unit of output. On the other hand, the host country hopes to benefit through development in terms of economic growth, reduced unemployment, and technology and skills transfer. Because the investor and host government do not share the same goals, it becomes rather difficult for African governments to ensure development through FDI.

Description

This indicator expresses FDI as a ratio to GDP.

Results and trends

No clear trend is observed from Figure 9.11 in terms of FDI as a percentage of GDP. FDI reached 9% of total GDP in 2001, marking the inception of the Ramatex garment and textile project in Namibia. FDI has remained below 5% for most years since Independence, which means that no foreign investments similar to Ramatex were made until 2001. According to Mwilima (ibid.), some initiatives attracting FDI in Africa do not yield the desired and expected benefits. Capital formation is one of the reasons why FDI is attracted – developing countries hope to benefit from the much-needed capital they hope the foreign investor will inject. In the initial stages of 'Greenfield' investments, for example, this may be the case; but in the medium term, the capital outflow outweighs the inflow into the host country.


a


b


c

Photo 9.1 a-c: Various species are hunted for food and income by rural communities

a) lechwes
b) tsessebe
c) roan

Namibia is a net exporter of capital: in 2002, for example, Namibia's FDI inflows amounted to N$1.9 billion while outflows to the tune of N$1.7 billion were seen in portfolio investment and N$3.2 billion in other long-term investment (Figure 9.12). Hence, the net capital outflow in 2002 alone amounted to N$3 billion (ibid.). FDI initiatives may also severely undermine a country's environmental policies and regulations. It is rumoured that no comprehensive EIA was done for the Ramatex FDI initiative. In light of this, recent reports have suggested underground water resources have been polluted via wastewater discharge from the garment and textile factory. Pollution of underground water is irreversible and, in Namibia, where water is the crucial limiting factor to sustainable development, such negligence is unacceptable.

INDICATOR 9D: Income from non-timber forest products

Introduction

NTFPs include edible and inedible plants, edible and inedible animals, and medicinal products. They encompass all biological materials other than timber that are extracted from forests for human use. The natural resources that occur in Namibia's densely populated northern areas service a large number of people on a daily basis. The harvesting of natural resources for NTFPs is often of vital importance to local communities and their economies.

Numerous NTFPs are sold and consumed in Namibia. Some products are sold through retailers and/or agencies such as the Rössing Foundation, the Mashi Craft Market and Integrated Rural Development and Nature Conservation, while a large number are also sold on street markets. Economic data for NTFPs are deficient and scattered, particularly for products such as marula oil, thatching grass, and Kalahari melon.

NTFPs provide food and income for rural communities. The majority of African people are not able to purchase all their domestic food (Mulonga 2003). Wild food products provide a cheap alternative source of vitamins, energy, proteins and minerals (ibid.). Although the nutritional value of wild food products in Namibia has not been tested, research indicates that bushmeat[24] is comparable to, if not more nutritious than, domestic meat[25]. Other evidence suggests that meat from wild animals is lower in fat, and equal or better in protein and vitamin content than beef, mutton, chicken or pork (ibid.). The importance of wild resources is underestimated in many parts of Namibia. Around 90% of residents living in the Caprivi Region place a high value on wild food resources as a supplementary food source (Van Rhyn 1995).

In addition, many rural people, especially women, are reliant on wild flora and fauna for income generation through the sale of crafts, meat and fish at local markets. Commonly hunted bushmeat species are duiker, francolin, guineafowl, impala, lechwe, reedbuck, springhare, and warthog. Hunting methods include traps, dogs, snares, spears and guns, or a combination of these (Mulonga 2003). Bushmeat is sold to a range of customers depending on the size and sometimes species of meat; large game is sold along the Botswana border and in villages, whereas prime species such as kudu and buffalo are sold to teachers and Government workers. Only long-term, trusted customers have access to bushmeat on the market (ibid.). Other uses of wildlife include monkey skins for blacksmithing, baboon skins for drum covers, and small and large spotted genet for traditional rituals by traditional healers.

Wild plant species are also utilised and include fruits and vegetables, and bulbs (ibid.). Such resources are harvested from both terrestrial forest and water resources such as rivers and channels. Common fruit species include brown ivory/birdplum (*Berchemia discolor*), water lilies, blue sourplum/small sourplum (*Ximenia americana*), large sourplum (*Ximenia caffra*), sycamore fig (*Ficus sycomorus*), mobola plum (*Parinari curatellifolia*), wild medlar (*Vangueria infausta*), and African mangosteen (*Garcinia livingstonei*). The blue water lily (*Nymphaea nouchali*), a prime resource, is harvested by women and consumed at home or sold. Brown ivory/birdplum is also a prime fruit species that is harvested and sold in large quantities at the local markets from February to June each year (ibid.).

Marula fruits are of high economic value and are used for consumption and processing into other products. Wild vegetables commonly consumed include African cabbage (*Cleome gynandra*) and ligusha (*Corchorus tridens*). Most wild fruits and vegetables are seasonal and some are harvested and dried for later consumption or sold. Women from the Mayuni Conservancy along the Kwando River report water lilies to be an important resource that is harvested and sold to generate income to cover

Footnotes

[24] Refers to meat usually obtained from free ranging vertebrates such as guineafowl, antelope, and other species.

[25] Refers to meat obtained from domesticated or farmed animals such as cattle, goats, pigs and chickens.

school and clinic expenses, and to buy mealie meal and relish. Forest resources are also used to create products that generate an income. Such resources include the makalani palm (*Hyphaene petersiana*) used for woven items such as palm baskets, flat palm bags, palm hats and papyrus reed mats (Murphy & Suich 2003).

Description

This indicator reports on the income generated from NTFPs. An increasing trend may suggest potential for an undeveloped industry that currently supports the livelihoods of thousands of Namibians.

Results and trends

Due to the general deficiency of data for NTFPs, this section mainly features work published in the Directorate of Environmental Affairs' Research Discussion Papers (RDPs). It is assumed that data extracted from RDPs serve as sufficient sources for a first assessment of this indicator.

In 2002 the CBNRM Programme recorded a contribution totalling around N$37.5 million to the national economy (LIFE Programme 2002). NTFPs comprised 5.7% of the total turnover, while thatching grass contributed 3.82%. Thatching grass gave rise to a stream of financial benefits through transport and value-added product development (see Indicator 4A, "Trends in the CBNRM Programme"). Sales of crafts and live game also contribute to income generated from NTFPs, as seen in Table 9.1 (ibid.).

Table 9.1: Income earned from three NFTPs.

NTFPs for a median earning group in the Caprivi Region constitute 59% of income generated from weaving and other livelihood-generating activities (Suich & Murphy 2002). NTFPs include basket sales (37%), thatching grass sales (14%), reed sales (4%), fish sales (2%), and carving sales (2%). Many of the important cash-earning opportunities in the Caprivi are seasonal, indicating the earning of income during a certain period of the year. This was emphasised as a disadvantage by those partaking in case studies to determine the importance of craft-making in the Caprivi Region (ibid.).

NTFPs comprise 62% of the sources of income generated by a top-earning group among communities in the Caprivi. Such NTFPs include basket sales (50%), sales of thatching grass (8%), and reed sales (4%) (ibid.). Results from Figures 9.13 and 9.14 suggest the importance of NTFPs and

Non-timber forest product	Revenue (N$)
Marula oil exports since 2000	1,400,000
Kalahari melon seed exports since 2001	720,000
Thatching grass for 2002 (CBNRM Program)	1,432,500
Crafts	562,221
Live game sales	132,300
Total	4,247,021

Table 9.1: Income earned from three NFTPs

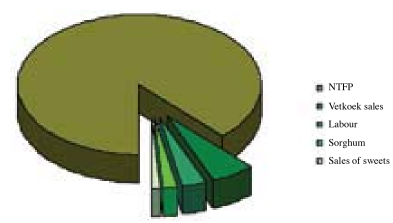

Figure 9.13: Sources of income for a median earning group from weaving and other livelihood activities (Suich & Murphy 2002)

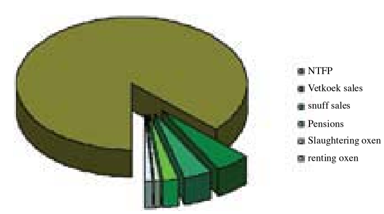

Figure 9.14: Sources of income for a top earning group from weaving and other livelihood activities (Suich & Murphy 2002)

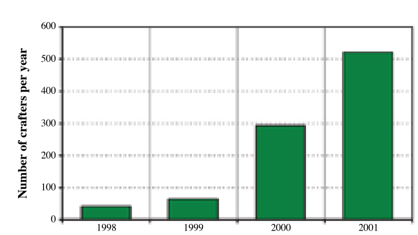

Figure 9.15: Shows the number of crafters per year selling crafts to Rössing Foundation (Suich & Murphy 2002)

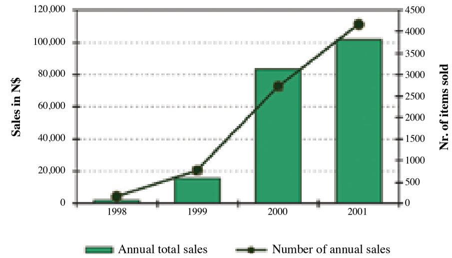

Figure 9.16: Shows the total annual sales by crafters to Rössing Foundation against the number of items sold (Suich & Murphy 2002)

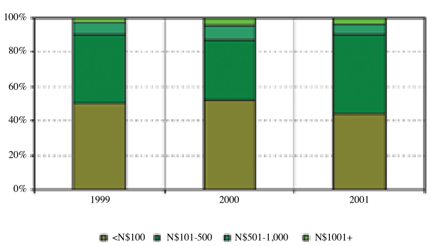

Figure 9.17: Shows the total annual sales by crafters to Rössing Foundation against the number of items sold (Suich & Murphy 2002)

the income generated from it.

Studies done by Suich & Murphy (ibid.) and Murphy & Suich (2003) show the following about NTFPs in Caprivi (see also Figures 9.13 to 9.17):

- It is an important source of livelihood for rural communities, especially those who do not own livestock
- the commercialisation of the industry based on sustainable resource use is a good source of cash for craft producers, and
- there is potential for growth.

Income generated by crafters, i.e. woodcarvers and weavers, depend on the amount of items sold and the average or minimum price per item. Most crafters surveyed in the Caprivi Region sell between two and five items a year, which translates into N$140 a year at most (selling five items at an average price of N$28) (Suich & Murphy 2002). On the other extreme, the highest earner in 2001 was a woodcarver who generated N$8,314 from carvings and N$1,418 from weaving, thus bringing his total income to N$9,732 (ibid.). Although most crafters earn between less than N$100 and up to N$500 a year, a few actually manage to earn up to N$1000 and more a year (Figure 9.17). The tendency is still to earn within the lower two categories, but with 80% earning less than N$500 a year and 35% earning less than N$100.

Craft-making is without any doubt an important livelihood-generating activity, especially in the northern parts of Namibia. Money generated from crafts is used to pay school and clinic fees, buy food, and cover the other day-to-day expenses of rural households. The number of crafters per year and the number of items sold annually show increasing trends, which suggest potential growth for this industry. The Mashi Craft Market and the Rössing Foundation are two known stakeholders who assist crafters by organising them and selling their goods. Similar initiatives directed at other NTFPs will not only guide the sustainable development of a broader NTFP industry, but will also ensure the collection of data for sales, production, state of the resources used, number of people engaged, and income generated.

Goals

The categorisation of NTFPs, as a first step, will facilitate the further establishment of information-generating networks for the gathering and centralisation of data and the assessment of trends in the industry. Before increased development is promoted in this industry, sustainable utilisation of natural/wild resources should be promoted. The example of the CBNRM Programme to start palm tree plantations can be followed and adapted to the conservation of other resources.

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source? (See body text of this Chapter)

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