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Population Dynamics, the Environment, and Demand for Water and Energy in Namibia

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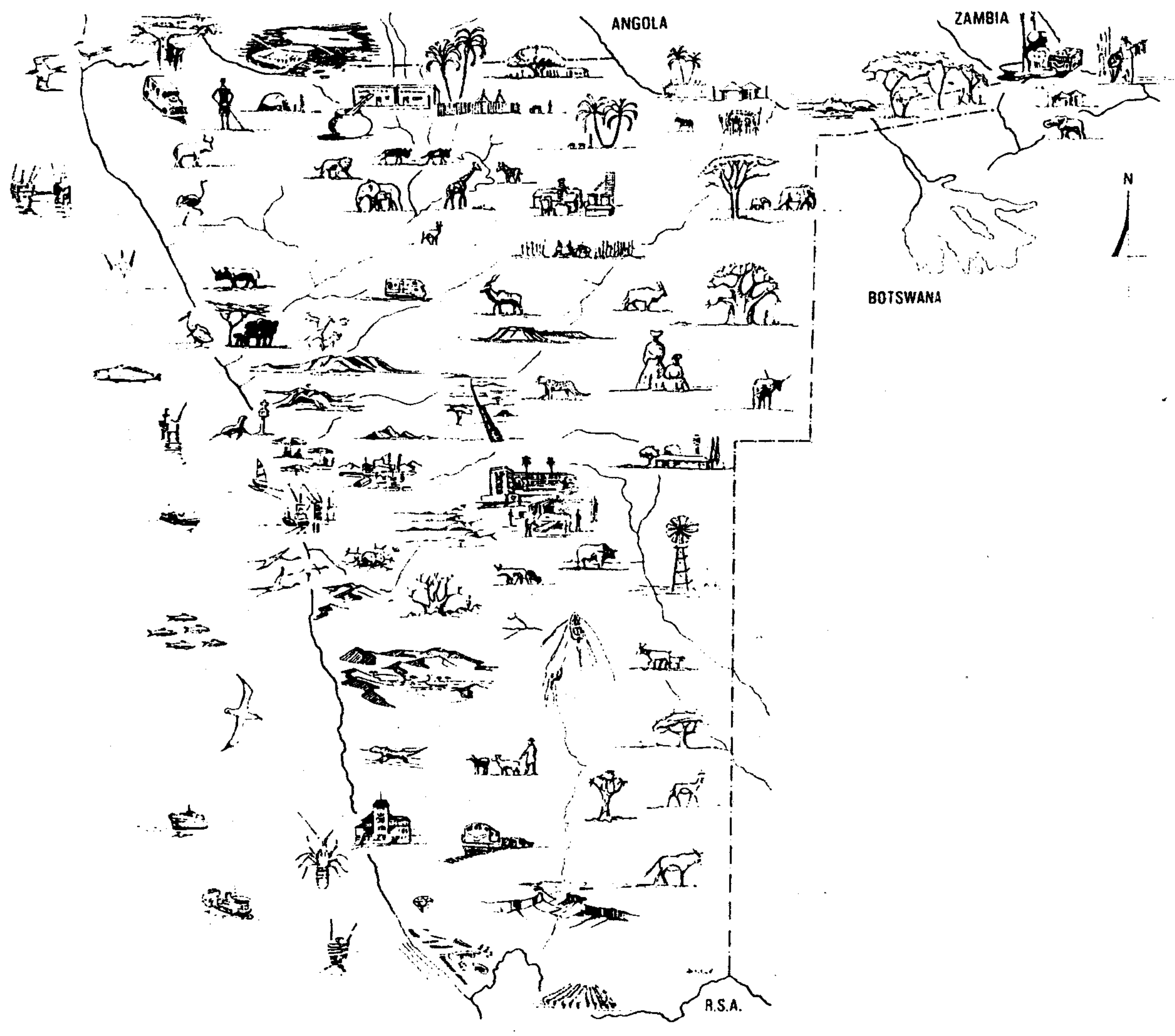

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This series of Research Discussion Papers is intended to present preliminary, new, or topical information and ideas for discussion and debate. The contents are not necessarily the final views or firm positions of the Ministry of Environment and Tourism. Comments and feedback will be welcomed.

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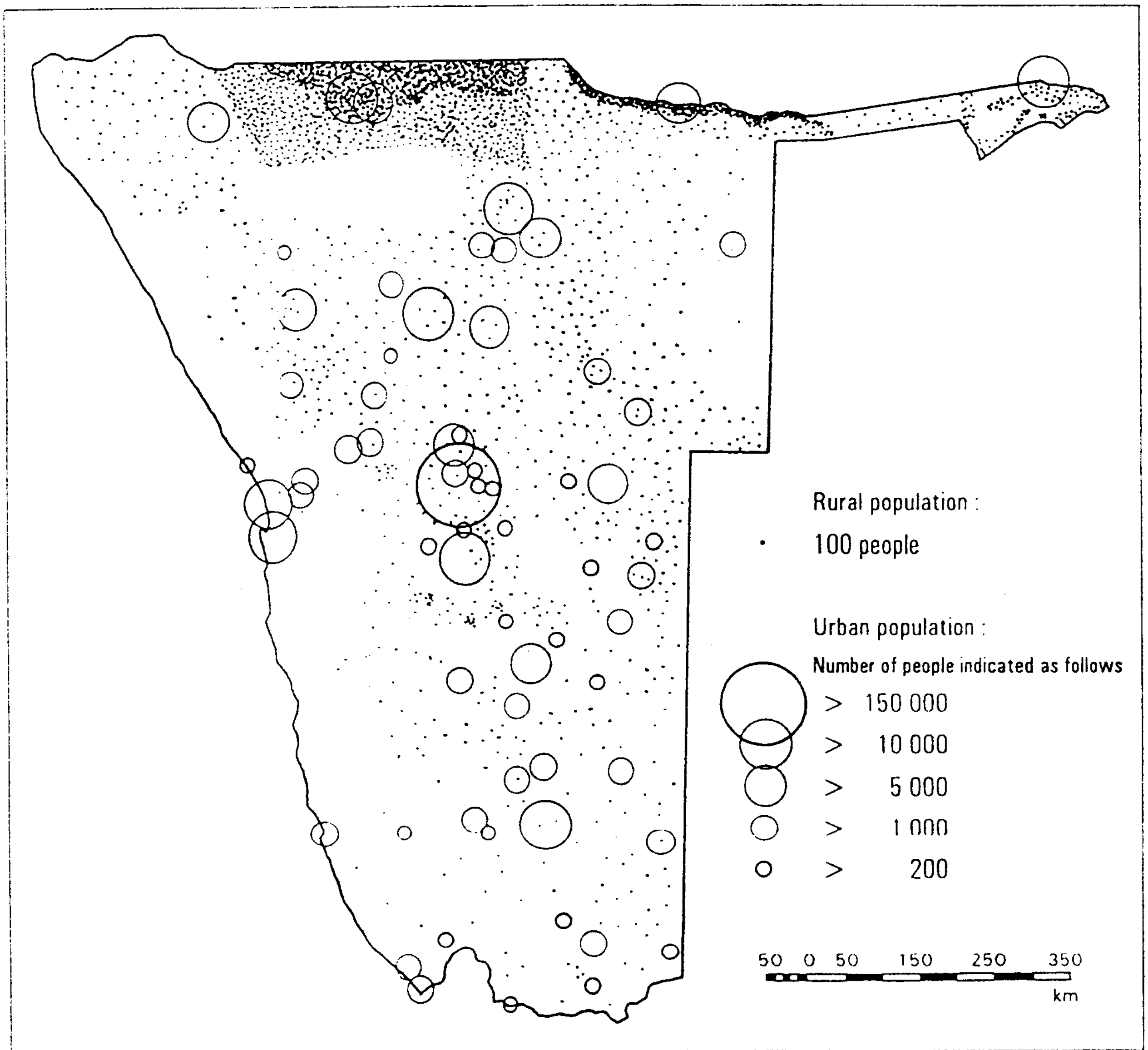
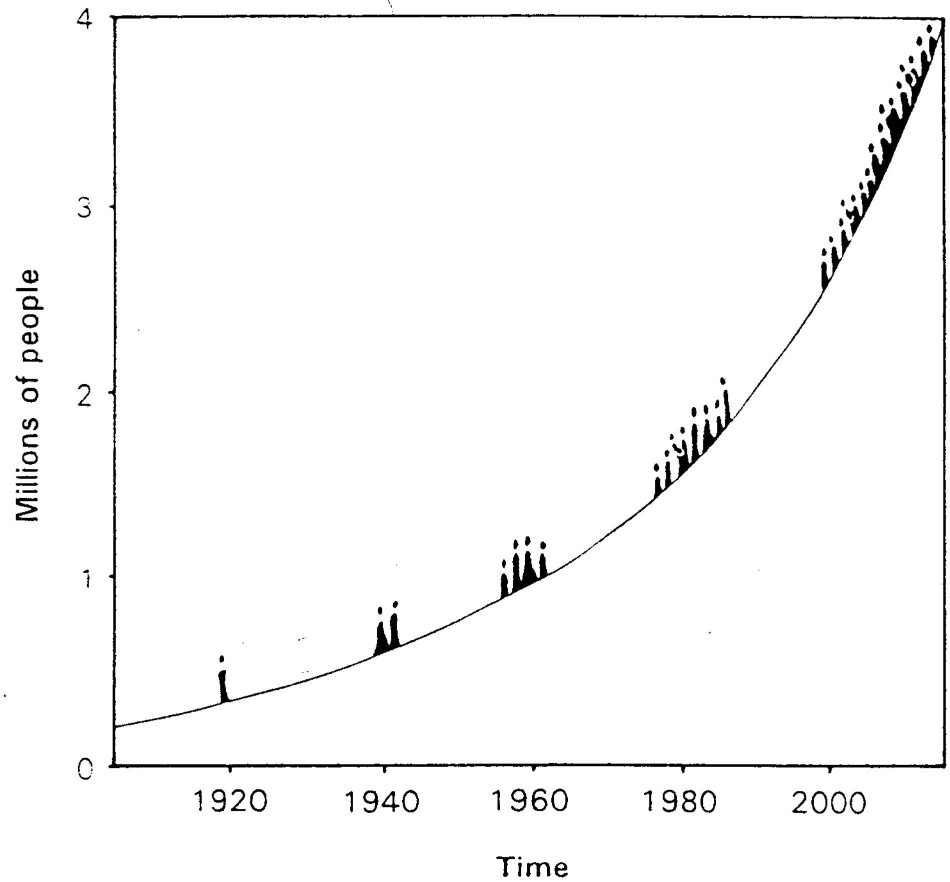
PREFACE

This paper builds on a 1994 paper on Population Growth and Renewable Resource Management[1], written by Caroline Ashley (Ministry of Environment and Tourism) for the first national population conference, organised by the Population Planning Unit. That paper reviewed the evidence that population growth and other pressures are degrading Namibia's resources of productive land and water, and outlined some strategies for supporting a growing population. The present paper summarises findings of the previous paper, and goes further in two ways: firstly, in addition to land and water, energy resources have been included (in cooperation with the Energy Directorate, MME); secondly, this paper focuses less on assessing the current situation and more on policy recommendations to be included in Namibia's emerging population policy. Comments and feedback will be welcomed.



Population distribution in Namibia.
The dense concentration of people in the Cuvelai drainage basin and along the Okavango River is clearly visible



An illustration of the past and projected population growth rate in Namibia

I INTRODUCTION

The majority of Namibians live in rural areas, where their livelihood depends directly on renewable resources -- productive land, fresh water, and the flora and fauna they support. Growth of the Namibian economy is equally dependent on natural resources: fish, agricultural land, wildlife and scenic wilderness, and water. However, the supply of environmental products and services may not be able to keep up with Namibia's rapid population growth, resulting in lower average living standards. Worse, the increased pressure placed on the environment by more and more people, may result in over-utilisation of resources and environmental degradation. Thus Namibia's environmental wealth, so essential for future generations, would shrink.

This gloomy scenario, however, can be alleviated, if not eradicated. The ability of the environment to sustain us depends on how we manage it. The pressure we put on the resource base depends on what and how much we consume. Therefore to cope with rapid population growth, and to ensure that the environment is sustained and can sustain future generations of Namibians, changes are needed in the management and consumption of natural resources. This paper highlights some of the key resources and constraints, and outlines proposed policies for the future. It focuses on three types of natural resources:

- productive land, and the flora and fauna it supports
- water
- energy.

For each, the recent trends in balancing growing demand against constrained supply are assessed, strategies for coping with rapid population growth are explored, and policy recommendations made.

II ENVIRONMENTAL CONSTRAINTS AND HUMAN PRESSURE

II.A AN ARID ENVIRONMENT

Namibia is one of the most arid countries in the world. Rainfall is low and variable, evaporation rates high, and there are no permanently-flowing rivers between the southern and northern borders. Rain falls in short sharp bursts, resulting in low infiltration, and can be highly localised. Just as critical as average rainfall is its variability. The driest areas suffer most variability. This means years of well-below-average rainfall, or drought, are to be expected. This variability demands flexible land-use in order to prevent degradation, because what the land can sustain in a wet year becomes over-exploitation in a dry one.
The key implications of this aridity are:

- water is scarce: difficult and expensive to locate and extract;
- the majority of the land is only suitable for extensive livestock or game farming;
- the land has an inherently low carrying capacity (of animals and humans);
- carrying capacity fluctuates with rainfall;
- there is a risk of irreversible degradation.

Therefore the capacity of the natural resource base to continue sustaining growing populations is questionable.

II.B HUMAN PRESSURE ON RESOURCES

The low and variable rainfall has shaped people's land settlement and management patterns. As one of the world's most arid countries, it is not surprising that Namibia is also one of the least densely populated. Average population density is 1.7 people per square kilometre[2] (countries such as Pakistan and Turkey, of a similar size, support 30 times as many people). In the past, settlement was confined to those areas with regular water (such as the Cuvelai drainage basin with seasonal "oshanas", along the Okavango river, riverine areas of East Caprivi, and near Windhoek's springs) while transhumance (seasonal cattle movement) was practised elsewhere. Nomadic pastoralism, as practised by the Ovahimba, is a way of coping with variations in pasture between areas and years.[1]

However, with growth of population and economic development, settlement has intensified in areas with natural water, and expanded to areas dependent on engineered supply. Today, human pressure on the environment is growing because:

- most of the population still rely directly on natural resources: wood for building and fuel, crops and wild foods for food, livestock for wealth and income. Given the slow growth of non-agricultural employment, such direct dependence is likely to continue for generations to come.

- urbanisation and industrial development may reduce pressure on the land but involve lifestyles and activities that consume much more of the scarcest resource -- water -- and increase demand for energy.

- population is unevenly distributed: over a quarter (28%) of Namibia's total population lives in just over 1% of the land (10,000 km^2) in the Cuvelai drainage area.[11] Population densities here rise as high as 100 people per square km[9].

- traditional resource management practices have been disrupted: by forced relocation, increased population density, modern infrastructure and techniques, decline of traditional structures and values, or lack of adaptation of traditional techniques to changing circumstances such as dense population.

- at 3% per year[16], the population growth rate is high by international standards and if sustained will result in a doubling of the population in 23 years. This growth, combined with the needs and expectations of the majority of Namibians for higher living standards, is exerting unprecedented pressure on Namibia's resources. Supply of environmental resources and services cannot simply be expanded to match population growth: water cannot be created; resources that are in principle renewable, such as forest, decline if over-harvested; and the most basic ecological functions, such as top soil formation, decomposition, and water purification occur slowly at nature's pace.

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1 Arid areas produce intense seasonal variations in the amount of vegetation they support, due to plants' adaptations to dry periods. Some survive as dormant seeds, some by dying back above ground to survive underground, and others remain apparent but provide little food or fodder. The next rain brings a burst of vegetation. These pulses in productive activity determine the animal and human population that can be supported. Nomadic pastoralism is a human adaptation to these pulses - it exploits vegetation when and where it occurs, and avoids excessive pressure on any single area of land during dry periods.

III SOIL, LAND, FLORA AND FAUNA

The vast majority of Namibians still live in rural areas, where they directly depend on productive land, both for farming and for providing a host of other materials, from wild foods to timber and fuelwood. However, the fertility of the soil and productivity of the land is under pressure.

A TRENDS IN RESOURCE USE, AVAILABILITY AND PRODUCTIVITY

FERTILE SOIL AND CROPS: LOST PRODUCTIVITY

In the central northern areas, nearly all the land suitable for growing crops is already used. This land scarcity leads families to settle more marginal land (which produces less and is more easily degraded), or over-crop existing farms, leading to declining soil fertility. Crop yields have fallen in Okavango and other northern areas. In Okavango this has been clearly correlated with continuous use of the same plot: i.e. techniques of slash and burn with minimal crop rotation were suitable when families could switch to new land every few years, but lead to declining fertility now that they are confined to the same field.[20]

> Research indicates that the most productive arable land has already been over-utilised in Kavango. The fact that millet output per hectare is no higher in riverine villages than inland areas, suggests that the inherent advantages of alluvial soils have been eroded over time and productivity has fallen. Also, land distant from villages (which has been farmed less intensively than land nearby) is significantly more productive.[20]

TREES, PLANTS, AND FORESTS: DEFORESTATION

Though only 20% of Namibia is classed as woodland, 80% of the land supports trees and shrubs. These woodlands and savannas are essential to environmental stability, sustainable agricultural production and food security, because they protect watersheds, facilitate groundwater recharge, stabilise soils against wind and water erosion, and maintain bio-diversity. In rural areas, trees are vital sources of construction timber and cooking fuel. They also supply shade, material for household implements, fruits and nuts for nourishment, bark, leaves, berries and roots for medicine; and a habitat for edible caterpillars and birds. Wild plants, such as wild spinach and tubers, add to nutrition and food security, particularly in times of drought.[11]

Though woodland is, in theory, a renewable resource, in practice human exploitation has far exceeded the rate of renewal across the country. The main causes are clearance of land for agriculture and felling of trees for timber.[2] For example, around Oshakati and Ondangwa, mopane woodland has been transformed into 1-2 metre-high shrubland and cultivated fields.[8] In the north, 80% of homes are built using indigenous timber and thatch, and traditional Owambo construction methods which are estimated to consume more wood than any other form of traditional architecture in southern or central Africa.[8] This has put great pressure on the most popular termite-resistant hardwoods, such as mopane (*Colophospermum mopane*). As timber becomes more scarce, people resort to smaller and less resistant branches, so need

[2] Cutting live trees for firewood is unusual, but may be occurring more frequently due to fuelwood commercialisation.

to fell more trees more frequently. As fuelwood becomes increasingly scarce in the central Cuvelai, commercial fuelwood cutting adds pressure on remaining trees to the east and west.

> In 1866, missionary Hugo Hahn recorded a 60 km belt of mopane woodland between the Uukwanyama and Ondonga kingdoms. Fifty years later the belt was 40 km wide, and in the 1950s, 10 km wide. Today it no longer exists.[8]
>
> Deforestation has also been acute along rivers on the northern border with Angola, where accessible water and good soils attract farmers. For example, along the Okavango about 70% of riparian forest is estimated to have been lost, and with it associated forest species.[3]

WETLANDS DEGRADATION

Wetlands (including rivers, floodplains, pans, and ephemeral rivers) play a key role in sustaining biodiversity, a range of essential ecological functions, and productivity of natural resources. For example, the mixed subsistence economy within the Cuvelai drainage basin is dependent on seasonal floods to regenerate grazing, replenish the water table and soil nutrients, and provide a rich protein source of fish.

Degradation of wetlands appears to be occurring already. In the Cuvelai, roads and canals have disrupted oshanas, and hence availability of water for groundwater recharge and vegetation growth in "downstream" areas.[11] In Okavango and Caprivi, water pollution has increased with increasing human settlement. Siltation of the Okavango has been caused by clearing and over-grazing of forests and vegetation, which cause soil erosion. This ultimately affects the flood and flow of the river.[18] Both researchers and local people perceive a decline in fish stock sizes and diversity, attributable to a range of factors including siltation, changed flooding, heavy winter-season grazing, harvesting of reeds and grasses in the floodplains, chemical pollution, and over-fishing.[18]

Pressure on these sites is likely to continue as growing populations result in increased demand for water, grazing, cleared land, timber, hydro-power, fish, etc. Because the benefits of wetlands are often long-term, indirect, and shared by many people rather than by individual owners or managers, they are often not appreciated. However, recognition of the value of wetlands and wise management strategies will be essential if further degradation, and hence declining productivity of local ecosystems, is to be avoided.

GRAZING AND LIVESTOCK: SCARCITY AND DEGRADATION

Raising livestock in Namibia's arid environment requires access to large areas of land, so that livestock can follow the rain and grass. However, the rising livestock population combined with land enclosure under colonialism have created shortages of grazing land. This scarcity is all too evident in the long-standing political demands for re-distribution, the increasing use of more marginal grazing land, the growing trend of fencing-off communal land for private use, and the fact that up to half of households own no cattle in the more densely populated north.

The growth of the rural population, and the ten-fold increase in cattle numbers in the last eighty years[21], have contributed to the shortage and over-utilisation of grazing. But as Figure 1 indicates, there are several causes. In the past, pastoralists and their stock followed the rain and vegetation, so after intensive grazing, the grass was left to rest. Today, there are permanent water points, farming communities are more settled, former seasonal grazing areas are likely to be occupied by others, and traditional land management systems have weakened. So grazing is often year round at the same place. This breaks a guiding principle of arid land management: flexible response to rainfall. What the land can support in a good rain year is *over-grazing* in a dry year. Thus the problem is not necessarily too many cattle, but too many for too long in one place.

The results of over-grazing are particularly evident around boreholes and settlements. The balance of perennials to annuals, and of palatable to non-palatable grasses, shifts, vulnerability to drought and erosion increases, and overall productivity goes down. Livestock have to be reduced in number or moved elsewhere.[17]

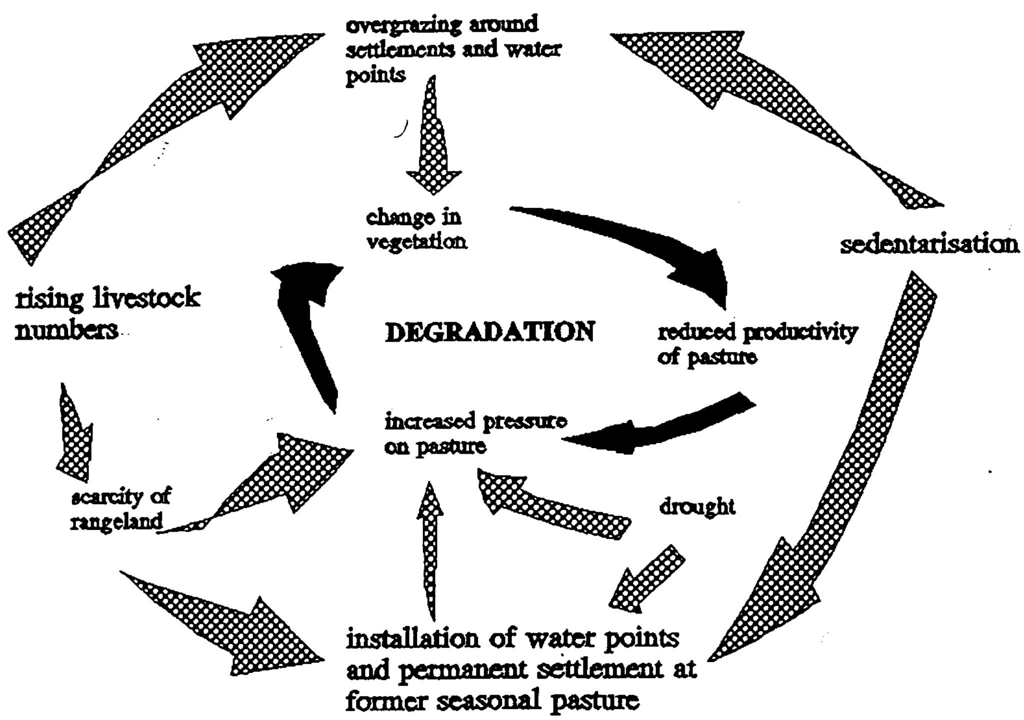


Figure 1: Cycle of Rangeland Degradation

RESULTS: LOWER LIVING STANDARDS

The results of these changes are lower living standards for rural people. Even those that still have livestock have to take them further way to find pasture, which means their milk and manure is less accessible. Families in crop-producing areas are not self-sufficient, and have to purchase commercial mealie-meal to fill the gap. Women spend longer collecting firewood or switch to less efficient substitutes, such as cow dung and maize cobs, which in turn affects soil fertility. Fences made of thinner and less-termite resistant wood take longer to build and need to be replaced more frequently.

THE ECONOMIC COSTS OF LAND DEGRADATION

Land degradation affects farmers' living standards, food supply, workload, and income. In turn, it undermines the output and growth of the whole economy. These economic losses are not easy to measure because they are long-term and difficult to separate from short-term drought cycles, and because many of the resources the land provides are not sold commercially, so are difficult to price.

Despite these problems, recent research[17] estimated some economic costs of desertification for farmers in Uukwaluudhi, a district in Omusati, on the western edge of the Cuvelai drainage basin. In this area, tree cover has diminished and pasture around the homes and water points is degraded. Families have therefore lost access to fuelwood, fencing, and grazing for livestock. With fewer, less-nourished, or more distant cattle, they also have less milk for nutrition and dung for manuring their crops.

If a family bought commercial replacements for the resources lost:

- a bundle of fuelwood per day
- fencing for one-fifth of a mahango field
- spinach, meat, or other protein to replace lost milk output
- mealie-meal to replace harvest losses of 1-2 months mahango
- 2 cattle and 3 goats lost due to increased impact of drought

then the total cost would be over N$2,000 per year.

It is clear that this is much more than most rural families can afford. In practice, they buy some substitutes, such as mealie-meal, but also make do with less, switch to natural substitutes (such as marula nuts for fuel), and spend more time trying to gather resources. The poorest families, with least cash, time, and transport, are least able to adapt.

Assuming similar losses for other cattle-owning and crop-growing households in the northern communal areas, the *long-term land degradation could be costing families around $80 million per year in lost income and increased expenditure.* It is reducing their food and energy security, limiting the development of agriculture in the region, and increasing vulnerability to drought.

B STRATEGIES FOR BALANCING GROWING DEMAND WITH SUSTAINABLE SUPPLY

The prospects for supporting an even larger population from the land do not look good. There are no technological fixes to convert desert areas to agricultural land, nor to increase productivity of arid pasture, crops, or trees in the way that "green revolution" chemicals have boosted productivity in wetter climes.

However, it is important to look deeper into the causes of scarcity and degradation. Population growth is only one cause of the problems. The inevitably low and variable rainfall, another key factor, is even less susceptible to intervention. But to cope with these two challenges, a third, critical factor -- poor resource management -- could and should be addressed. In addition, the way we use and the amount we benefit from primary production, can also be improved.

In the case of *fuelwood and timber* supply, it is true that population growth has simply far outstripped natural regeneration of woodland. Even so, better management could alleviate the shortage in some areas. For example, the coppicing vigour of mopane means there is potential for coppice forestry in some areas. Nevertheless, unless rural populations are able to switch surprisingly rapidly to alternative energy and building materials, human and environmental costs of loss of tree cover are likely to escalate. It is essential therefore to develop substitutes over the long term, while protecting those wooded areas most critical for soil stability and watershed protection.

The environmental constraints to increased *crop production* are severe: sandy soil, low rainfall, and low potential for either artificial fertilisers or irrigation (95% of the country is classified as having no or little irrigation potential,[5] and even in much of the 5%, irrigation would generally be an inefficient use of water and capital). However, other constraints which could be tackled include: farmers' lack of access to seeds, equipment, and seasonal labour, minimal use of improved cultivation practices such as inter-cropping, agro-forestry and water conservation, and lack of opportunities for processing, marketing, and generally adding value to their crop.

> There are clear indications that productivity of crop production can be increased by improving farming techniques, despite low rainfall and soil fertility and without irrigation or chemical fertilisers. Research shows a significant difference in millet yields per hectare between rich and poor households in Okavango, and between male- and female-headed households in former Owambo. Faced with the same rain fall and soil fertility, those with more finance, tools and time can produce more from the land.[20]

The shortage and degradation of *grazing land* is the most complex issue, both politically and ecologically, to unravel. The ten-fold increase in cattle numbers[21] is certainly one source of pressure on pasture, but other changes in distribution and use of land (relocations, reduced seasonal mobility, decline of community structures, and installation of drought-relief water points) have all contributed to uneven concentrations of livestock.

In this context, supporting more livestock and more pastoralists is a daunting challenge. Opening up new grazing areas is of limited potential: it would require not only expensive water installations, but also management plans to ensure sustainable use. Dividing commercial farms into many small plots for communal farmers would be neither ecologically or economically viable, although shifting large communal herd owners to commercial areas could ease access for smaller farmers in communal land.

The most important strategies are improved pasture management and increased productivity. More sustainable management requires community management structures with land-use rights, some form of rotational grazing, means of destocking and restocking in drought cycles, research, monitoring and improved understanding of pasture change, and many other changes that can only occur over the long term. There is also potential to increase economic productivity -- so the same primary production of grass provides more output in terms of household benefits and income. For example, improved marketing and processing of livestock products, or introducing wildlife products and tourism could increase cash income in some areas. Mechanisms for increasing access to manure and traction could offset losses due to lost access to or ownership of cattle.

With these improved management measures, the environmental costs of increased pressure on the land could be minimised and the land could continue to sustain a growing population. But still it could not keep up with a doubling every 23 years. Making do with less will also be needed if the resources are to stretch to the next generation. This means reducing dependence on the land, and switching to alternatives: fuels and building materials other than wood, sources of household security and status other than cattle, commercial (imported) food, and alternative sources of jobs and incomes (and of foreign exchange to buy the imports).

C: POLICY RECOMMENDATIONS

To prevent rural population growth resulting in degradation of the resource base

1. Promote more sustainable management practices of renewable natural resources both at local level and in planning:

- develop local forest management, such as coppicing of mopane for sustainable extraction, in appropriate areas;
- develop local management of boreholes and grazing for livestock; ensure new boreholes are in the context of a land/grazing management plan;
- develop local tenure rights and institutions necessary for local management of resource use: e.g. along the lines of the MET Conservancy Policy for local management of wildlife and tourism, the SARDEP pilot areas for management of livestock and rangeland;
- discourage/prevent private fencing-off of communal grazing land that reduces access for other farmers;
- ensure livestock routes between seasonal grazing areas are kept open and not fenced off;
- support farming strategies that respond to drought with livestock mobility, de-stocking and re-stocking.
- ensure protection and management of key wetlands and watersheds;

To enable a growing population to be supported

2. Increase the productivity of resource base:

- explore and promote techniques of increasing crop production per hectare in ways that are sustainable: e.g. water conservation measures, improved harvesting, storage and processing;

- develop combined livestock and wildlife utilisation in areas with high potential;
- increase opportunities for livestock marketing and product processing;

3. **Reduce dependence on primary production, and develop alternatives**:

- promote alternative fuels and energy sources to biomass energy;
- promote alternative fencing and building materials;
- decentralise economic development opportunities to reduce dependence on agriculture in rural areas.

To achieve all the above

4. **Invest in strengthening environmental management**:

- increase environmental training and skill-development at all levels;
- adapt extension services skills, messages, and responsibilities;
- decentralise some resource management responsibilities to local level, and create local tenure rights;
- improve understanding of indigenous knowledge and skills in resource management, and build on the existing skills.

For effective implementation, these policy recommendations need to be translated into specific actions by Ministries/Departments of Agriculture, Water, Lands, Environment, Energy, and reflected in the budgeting, planning, and economic development approach of the Government and Regions.

IV WATER RESOURCES

Apart from the rivers on the northern and southern borders, and an abundance of salt water in the ocean, Namibia suffers from an acute scarcity of water. Of the rain that falls, it is estimated that in general, approximately 83% evaporates, and 14% is transpired by plants. This leaves 2% to enter drainage systems where some can be harvested from reservoirs, and just 1% to re-charge groundwater resources.[5]

With today's population, water is already running short. Water tables have sunk, wells dried up, and fossil water, thousands of years old, is being extracted. Scarcity of water has the potential to constrain the development of virtually all other sectors, ranging from major developments in industry such as mines and factories, to targets for improved health related to potable water for homes. However, dealing with scarcity through major investments will have wide-ranging environmental and economic impacts: extracting water can affect eco-systems, increased use of energy (for water pumping and desalinisation) will affect imports, hydro-sites, and competing energy uses, and the high cost of water will affect household budgets, industry's competitiveness, and the national economy. The effects of degradation of water resources can spread far and wide through complex ecological chains -- affecting downstream users, vegetation, wildlife, seasonal flood and recharge patterns.

A RECENT TRENDS IN WATER SUPPLY AND DEMAND

Around 50% of rural households still lack proper access to a reliable source of safe water.[13] Increasing their access is a government priority. However, elsewhere, the problem is not insufficient supply but excessive demand.

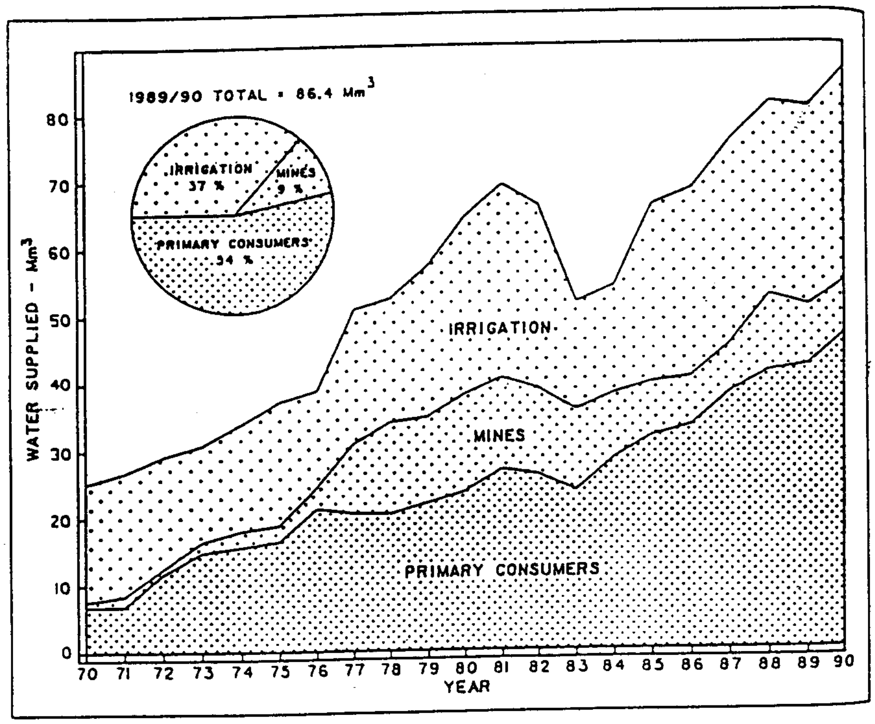


Figure 2: Growth in state water supplied to major consumers, 1970 to 1990[5]
"Primary consumers" represents domestic and industrial urban consumers, rural residents, and livestock. Figures only include water supplied by the Directorate of Water Affairs, and exclude other rural consumption.

The rapid growth in water consumption in the last twenty years is illustrated by the steep trend lines depicted in Figure 2. This graph is based only on water supplied by the Department of Water Affairs (DWA), mainly to urban areas and mines. Figure 3 adds in estimates of the unmeasured water consumption in rural areas, to indicate the rough breakdown between different uses. According to these estimates, total water consumption in Namibia grew by 57% in the thirteen years from 1980 to 1993.[4] By 1993/4 it was around 240 million cubic metres. By 2005, this demand will increase to over 300 million cubic metres (and up to 400 million cubic metres if irrigation grows at the same rate as other water uses).[5]

Figure 3: Estimated water consumption by sector, 1980/1 and 1993/4[10]

WATER CONSUMPTION (m^3 per year)	1980/81	1993/94	% increase from 1980 to 1993	% of total 1993/4 consumption
Water supplied by DWA				
livestock	0.86	7.5		
irrigation	28.2	25.0		
urban	18.4	50.8		
mines	13.6	6.1		
Rural consumption, not supplied by DWA (rough estimates)				
livestock	25	30		
domestic	6.5	10		
irrigation	60	110		
Estimated totals per sector				
livestock	26	38	45%	16%
irrigation	88	135	53%	56%
domestic rural	7	10	54%	4%
urban	18	51	176%	21%
mines	14	6	-55%	3%
TOTAL	**153**	**240**	**57%**	**100%**

As these figures show, it is not only rapid population growth that contributes to growing water demand. Agriculture, industry, urbanisation and rising living standards -- along with inefficient use in all of these -- play their part.

- Irrigation is currently the biggest consumer of water, accounting for around 56% of the estimated total in 1993/4. Irrigating one hectare uses as much water as nearly 1,000 cattle or 1,600 rural residents.[10]

- Urbanisation fuels water demand as urban residents generally consume more water. The fastest growth in water consumption has been in urban areas (176% over 13 years). However, the effect of urbanisation also depends on living standards of new urban residents. In Windhoek, residents served by standpipes in high density areas consume 14 to 20 litres per person per day, whereas residents of Erospark and Ludwigsdorf consume around 500 litres per person per day.[4]

- In the industrial sector, mines are the largest -- though diminishing -- consumer. Rossing Uranium uses between 3 and 4 million cubic metres per year, on a full cost-recovery basis.[13]

Until now, water supply has been heavily subsidised by the state. Previous policy was to supply water to match demand, rather than manage demand. The DWA currently charges N$1.20 per litre for Bulk Water Supply to Windhoek, which covers operating costs but very little of the capital cost. If capital costs were to be included, the bulk supply tariff would be around N$2.77 per litre.[10] This means that a realistic tariff for the consumer, to cover the costs of DWA *and* the Municipality would be around N$4 per litre, or N$5 if a contribution to future development costs is included (currently Windhoek residents pay from N$1.85 to N$5.30 per litre). In rural areas, water has to date frequently been provided free of charge.

The result of water subsidies has been a massive subsidy to the big water consumers (the better off), an assumption that the Government has a duty to provide free water on demand, and widespread practice of inefficient and excessive consumption. Some examples of inefficiency include:

- The Department of Water Affairs estimates that in some centres up to a third of water supplied is simply wasted through losses in the distribution network, due to poorly maintained reticulation systems;[3]

- Switching from flood irrigation to drip irrigation at Hardap dam could produce similar crop yields with a fraction of the water. Currently, irrigation water is heavily subsidised. This encourages water to be used for irrigation which would not otherwise be viable. At Hardap, water is supplied at 1.5 cents per m^3, whereas a recent estimate of the cost of providing irrigation water from the Fish River puts the real cost of provision at around 30 cents per m^3.

> In some irrigation schemes, the real cost of the water provided is greater than the value of the crops produced. A recent feasibility study of a potential dam on the Fish River estimated that at a real cost of N$0.30 per m^3, even high value products such as grapes and dates would barely provide a return on investment, let alone basic products such as maize and wheat.[7]

- A typical household swimming pool in Windhoek loses over 40 tonnes of water a year in evaporation. Plastic sheeting would cut this loss by 95%.[15]

It is clear then that future water demand will depend on the rate of population growth, but also on success of policies for improved industrial growth and rising living standards, on the type of agricultural development, the rate of urbanisation, and improved water efficiency.

[3] based on comparisons of reasonable per capita consumption with actual supply, at centres such as Khorixas.[10]

So the question is not just how to supply water for twice as many people over 23 years, but how to supply the industries, towns, farms, and rising living standards that a growing population wants. Meeting the anticipated growth of demand is a daunting prospect, as supply is already constrained:

- Rural water supply is mostly dependent on groundwater and apart from the north and north-eastern areas, indications are that the groundwater potential is fully committed and over-utilised in some areas.[13]

- Increased water abstraction can lead to many environmental changes and hence economic losses. Increasing off-take from ephemeral rivers by building dams doesn't create water -- it merely diverts it from downstream, with significant effects on the flood and flow regime of the river, and hence on the ecology and use of the river downstream. Similarly, extraction from the Kunene and Kavango will affect downstream users and ecosystems (within which the Kunene mouth and Okavango swamps are particularly important). Desalinisation can affect fish spawning, nutrients, and other aspects of the coastal environment.

- In some rural areas, the problem is not so much finding the water to supply, but in managing the tap/borehole once installed. Lack of water is such a constraint on where rural people live and farm that increasing water access at a specific site is bound to attract more people and livestock. This can lead to over-utilisation of surrounding resources, such as grazing, unless clear management responsibilities and structures are in place.

- Water sources in the interior are virtually fully exploited. There are already supply deficits in some regions of the country requiring costly inter-regional water transfers, such as the Eastern National Water Carrier.

- Windhoek's water situation is critical. The available water from three state dams, 46 municipal boreholes, and the Goreangab Reclamation works is 21 million tonnes per year -- barely more than current consumption. If water demand continues to grow at 1991 rates, water supply will be inadequate by 1997, even with extension of Goreangab. If the growth of water demand can be cut to 3% per year, the current sources will be sufficient until 2003.[4] Linking Windhoek to the Okavango will require a N$1 billion investment.

- The water table in the Kuiseb river has fallen from 2-3 metres below the surface to 13 metres (and only 4 m above bed-rock) due to over-abstraction to supply coastal towns and mines.[3]

- Lack of water is already preventing industrial development in towns such as Luderitz, but a second water pipeline there would cost approximately N$35 million capital investment.[10]

B STRATEGIES TO BALANCE SUSTAINABLE SUPPLY AND GROWING DEMAND

To cope with the expected several-fold increase in water demand over the next two decades, three complementary strategies are *all* essential:

(i) *Tap new sources:* Namibia will increasingly have to rely on more abundant, but more expensive, water sources: the ocean to the west, and the border rivers to the north. Desalinisation of ocean water, and pumping of water from the Okavango and Kunene (shared with Angola) will require much higher energy inputs -- at higher environmental and financial costs.

(ii) *Improved management* of existing resources: surface and groundwater resources need to be protected both from over-extraction, and from disruption by other development activities, such as pollution, siltation due to riverine deforestation, and disruption of drainage channels by new roads. The assumption of ever-expanding supply to meet ever-increasing demand must be challenged (as the DWA is now doing).

(iii) *Efficiency:* water conservation must become a way of life, not a temporary concern during drought. Reversing such inefficiencies requires realistic water pricing, incentives, public education, new technologies and infrastructure, and policies to promote low-water-using industries and location of industries in areas nearer water. Given that water is such a scarce and valuable resource, its use must be planned in the national interest, not just determined *de facto* by who has first access.

These recommendations sound obvious and straight-forward. But they present political and economic challenges: for farmers, voters and politicians, expansion of irrigation is appealing even if not practical. "Realistic water pricing" could mean quadrupling charges from $1 to $4 per m^3 at some locations (the estimated current cost of provision in the central regions), and even doubling that again to cover the costs of desalinisation or transport from the Okavango. Some industries would simply no longer be cost-efficient. Others would need to relocate to the riverine and coastal areas. Establishing systems so that the poor pay something, but no more than they can afford, is no easy task. But if limits on water use are not ensured by coordinated planning, they will be forced on us by harsh economic and physical realities.

C: POLICY RECOMMENDATIONS

Implicit in these strategies are a host of policy recommendations, many of which are contained within the Water and Sanitation Policy of DWA (1993).[6] The critical policies for the purposes of a population policy are:

1 **Water pricing and other demand management measures.**
Water prices should be set on the principles of recovering costs (on average), providing incentives for water conservation, reducing demand to match available supply, and ensuring essential supplies are available and affordable.

Water pricing is essential for two reasons:
(i) Water pricing is an effective strategy to encourage efficient use, as experience in Windhoek and other countries testifies. In 1992, a water awareness campaign in Windhoek had little success, whereas the introduction of block tariffs in 1992 substantially changed consumption patterns.
(ii) The current government subsidy on water prices is spread across all water users, irrespective of ability to pay or efficiency of water use. The more you use, the more you are subsidised. Subsidies would be more efficiently used to target low income consumers, and to invest in improving water and sanitation in rural areas.

The block tariff system used by the Windhoek Municipality means that those who use more water in total pay more per litre. Poorer households which use very little water, pay the lowest rate per litre. This strategy combines fairness with conservation incentives and should be promoted nationally. In rural areas, mechanisms need to be developed to facilitate water pricing and identify affordable levels -- but the principle of payment for water must be established.

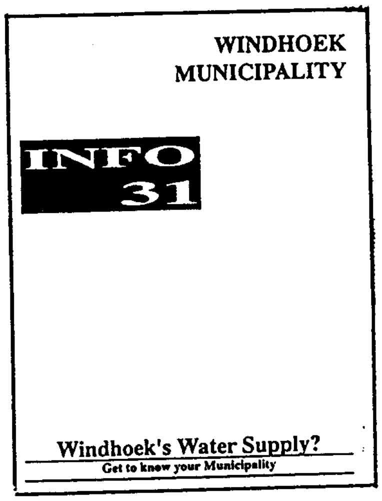
2 **Capacity building of municipalities and the Department of Works** (both of which act as water "retailers") in water management. Many of the principles adopted by Windhoek (see Fig 5) could be usefully applied in other municipalities. In government, water prices are not borne by the consumer ministry but by the Department of Works, so mechanisms for passing on cost savings and providing financial incentives need to be explored.

3 **Analysis of water use of industry** and potential efficiency measures. Research findings should guide policy on where to locate industries, how to set incentives for conservation, and which industries to encourage and discourage as appropriate to Namibia's water situation.

4 **Recognition that extraction of water for one purpose generally entails costs and lost opportunities for other users and the environment.** These "opportunity costs" need to be taken into account in planning sound water use, and if necessary reflected in consumer prices on top of financial operating costs. Strategies to expand water supply need to balance the twin objectives of minimising financial outlay, and minimising environmental and other costs.

5 **Prioritisation of water uses in planning,** and recognition that some uses, such as irrigation, are not efficient. The Water and Sanitation Policy identifies "water for domestic purposes, including livestock watering for both subsistence and commercial farming" as the first priority among competing demands, with the second priority being "water for economic activities such as mining, industries and irrigation." The draft National Development Plan 1[13] states that "the Government will ensure that water consumption reflects the relative contribution of industries to economic development." Charging cost-recovery prices is one way of encouraging this: industries that are "dry" or use water most efficiently will be more viable, while some wet industries, particularly irrigation simply would not be financially viable. However, in addition to pricing, research and planning will be needed to ensure that water allocation is optimal.

Figure 5: Information leaflet on water produced by Windhoek municipality



The available water from state dams, Municipal boreholes and the Goreangab Reclamation works is 21 million kilolitres per year.

To get more water to the city, e.g. from the Okavango river will cost approximately N$2 400 million (1992/93 estimate).

The estimated unrestricted demand of Windhoek for 1994 is 22 million kilolitres. The introduction of block tariffs in 1992 and the public awareness campaign fortunately lowered the expected consumption for 1994 to approximately 18,2 million kilolitres.

After the extension and the upgrading of the Goreangab Reclamation Works, the available water resources will only be sufficient until the year 1997, based on the growth of the city before the 1992/93 drought. If the growth in water consumption can be kept to 5% or lower on the actual water consumption of 1993, the sources (State dams, Municipal boreholes and Reclamation Works after extension and upgrading) will be sufficient until the year 2003.

Where does Windhoek gets its water?

State dams:
These are the three dams, Sartorius von Bach, Omatako and the Swakoppoort dam. The water is purified at Okahandja and pumped to the city over a distance of 65 kilometres. The safe supply of dams is 18 million kilolitres water per annum.

Goreangab Reclamation Works:
The world renowned Municipal Reclamation Works are situated on the northwesterly outskirts of the city. It is capable to produce 1,5 million kilolitres water per annum.

Municipal boreholes:
The Municipality's 46 boreholes has a safe supply of 1,5 million kilolitres water per annum.

What must we do to ensure a long-term water supply to the city?

There should be a continuous awareness that we live in an arid country and that water is a scarce commodity which must be used sparingly. This message must be spread to all, residents, visitors and etc.

It is clear that the management of water demand in the city and in Namibia is one of the most important issues which needs to be addressed as matter of urgency.

The City Council of Windhoek accepted amongst others the following principles on Water Demand Management for Windhoek.:
- that block tariffs be accepted as the most important management tool in order to curb excessive water demand,
- to aim and lower the per capita residential water consumption of 152 litres per day per person to 100 litres per day per person over the next five years,
- all large consumers must be requested to use water sparingly,
- a public campaign must be launched to sensitize users to consume water sparingly and also to get their views and participation.
- local nurseries must be convinced to give guidance and advice on plants and garden lay out in the city aimed using less water,
- the policy to allow two houses on every residential plot must be retained.
- all new parks and sports fields must only be developed in areas where it is possible to be linked to recycled water.
- that, preferably, only indigenous and drought resistant trees and shrubs be planted in public parks and cemeteries,
- no more wet industries must be allowed in Windhoek, unless it is proven that there is no other viable alternative in the country and,
- that a clear target be set to reduce the annual growth in total water consumption to 3% with a maximum of 5% per annum.

6 **Development of infra-structure to increase off-take from the border rivers and exploration of desalinisation**, with due recognition of the increased costs these will impose on the Namibian economy and environment, and exploration of the energy-supply options, various technologies, and environmental implications. Otherwise, water supply cannot be expanded in any sustainable way.

7 **An inter-sectoral policy on urbanisation and a plan for dealing with urban development.**
The strategy for dealing with growing water demand will depend in large part on *where* demand grows, and particularly whether urbanisation accelerates and is accommodated.

8 **Investment in improving water access and sanitation in rural areas.** The DWA target is for 80% of the rural population to have access to safe reliable supplies of water by 2000. This must go in conjunction with:
(i) improved local skills to maintain water points;
(ii) local planning of other natural resource uses.
DWA is already building institutional capacity of Water Committees at the local level to manage installations. Methods need to be explored to build local capacity for broader resource management, and integrate water planning into local land management.

9 **The mandate and financing structure of the proposed para-statal to run Bulk Water supply should clearly prioritise water conservation.** In general, bulk water supply tariffs should broadly cover costs. However, given the high fixed costs of new water infrastructure, the situation could easily occur where the provider needs to *encourage* water consumption to recoup costs in the short term, at the cost of unsustainable growth in demand in the long term. The objective of short term cost-recovery therefore needs to be set within the framework of long term demand management.

10 **Monitoring and management of water resources,** particularly ephemeral rivers, oshanas, and river mouths, to protect against over-utilisation and disruption of essential ecosystems on which so much else depends.

11 **Recognition that water resources are finite.** Even if new infrastructure is built to extract much more water from the Kunene (e.g. 6 m^3 per second as opposed to the current 2 m^3 per second), there will still be limits to growth in water supply. In perhaps 60 years time, political and/or ecological limits on what more can be extracted from the border river will be reached. In the case of other water resources, maximum sustainable off-take has already been reached (or exceeded). Even desalinisation of ocean water is limited to coastal, not pelagic, water. This means that however much consumers are willing to pay, there are physical limits, and these must be taken into account in water management and in planning for future generations.

Although DWA has already established much of the above as policy objectives, implementation also requires development of commitment and capacity in several other ministries (including Trade and Industry, Finance, Regional Government, Works, Fisheries, NPC, Environment and Tourism, and Department of Agriculture), municipalities and Regional Councils, local communities, and amongst the private sector and Namibian public.

More broadly, the challenge of reconciling sustainable water supply with growing population needs due recognition. To date, inter-sectoral government planning as exemplified in the National Development Plan focuses on how to allocated scarce *financial* resources (government budgets), and assesses development in terms of contribution to the economy and jobs. However, questions concerning optimal use of scarce *water* resources, and how sectoral developments will impact water demand, are every bit as important in setting national development priorities and plans to achieve them.

V: ENERGY RESOURCES

Energy resources are fundamental to human and economic activity. At the minimum, everyone needs energy for cooking and lighting. Energy for transport, machines, water pumps, televisions, refrigeration, telephones can also be regarded as essential for the functioning and development of Namibia. And yet, like water, energy is a scarce and expensive resource to provide. Namibia spends almost N$980 million annually, or 15% of Gross Domestic Product, on energy.[14]

Four particular problems facing the energy sector that will affect, or be affected by, population growth are:[12]

- the high cost of providing commercial energy, particularly to rural areas, and the burden of high import bills;
- large disparities in access to energy resources between urban and rural areas;
- inefficient use of energy in urban areas, as measured by specific energy consumption per unit of GDP;
- increasing scarcity of fuelwood in many areas due to deforestation.

A TRENDS AND PROSPECTS IN ENERGY SUPPLY AND DEMAND

Total energy consumption in 1993 is estimated at 46,621 terajoules[14]. 78% of this was commercial energy -- petroleum products, electricity and coal. All of the petroleum products and coal, and 64% of the electricity, are imported. Although "traditional energy" -- mainly biomass -- counts for only a fifth of energy consumed, it is the primary energy source for 60% of the population.[14]

Energy consumption has grown rapidly since Independence: consumption of electricity by around 4% per year, and petroleum products by around 7% per year.[12] This is due to population growth, economic optimism and expansion, particularly after the re-integration of Walvis Bay, and urbanisation. Data for biomass fuels are not available.

Within the electricity sector, households account for 50% of consumption, even though only 4% of rural households are connected to the grid[12]. The mining industry accounts for a further third. This illustrates that future electricity demand will depend on population growth, the rate of urbanisation, the rate of expansion of electricity to rural areas, and industrial use of electricity. It will also, as noted above, depend on energy needs for water pumping and/or desalinisation. However, as with water, two issues are clear:

- to redress past inequalities and achieve higher living standards, supply of energy resources in rural areas must grow.

- if strategies for economic growth and improved welfare are successful, and combined with anticipated population growth and urbanisation, annual growth in energy demand will be considerable.

CONSTRAINTS TO MEETING GROWING DEMAND

However, there are several constraints to meeting this growing demand:

Natural and technical constraints: a large, arid, sparsely populated country, poorly endowed with conventional energy sources; diminishing biomass resources; damage to the Gove Dam sluice gates in Angola limit Ruacana power station's output; technical complexities constrain the development of the Kudu offshore gas field.

Institutional constraints: shortage of appropriately skilled and experienced manpower; few players in the sector; weak local management of forest resources.

Economic constraints: a relatively small energy-market that makes world-scale investments disproportionately expensive; high costs of distributing energy over long distances and lack of existing supply structures in rural areas; low purchasing power for the majority of rural households relative to commercial energy costs; import costs of current commercial energy; high capital investment costs of developing Namibian power generation capacity.

Environmental and health constraints: damaging environmental effects of burning fossil fuels in power stations and homes (pollution, CO_2), of dumping dry cell batteries (ground water contamination); of building dams for hydro-power (massive disruption to river flow, riparian vegetation and use of resources by people and animals), and of off-shore developments (risk of marine pollution). Deforestation leading to scarcity of fuel wood.

In the light of these constraints and prospective demand, the overall policy objectives for the energy sector are to:[14]

- *increase the availability and provision of energy supplies necessary for improving the quality of life and economic development.*
- *redress inequalities in provision of energy supplies.*
- *ensure that increases in energy supply and utilisation are sustainable.*

B: ALTERNATIVE STRATEGIES FOR MEETING GROWING DEMAND

If we consider four alternative ways of meeting these objectives, the importance of developing new energy sources, especially renewable energy, and promoting energy conservation becomes clear.

1. *Business as usual.*
   One scenario is to meet growing energy demand with "business as usual." Imported energy could meet the increased demand for commercial energy and could be cost-effective. However, it would place growing demands on foreign exchange, and is unlikely to address rural energy needs. The cost of connecting rural households to the grid is enormous: (N$33,000 per kilometre just for the grid).[12] Households would remain dependent on (diminishing supplies of) biomass and on batteries and paraffin, which are affordable but generally inefficient, not cost-effective, and environmentally-hazardous sources of energy.

2. *Energy conservation*

More efficient use of energy cannot eradicate the need to increase supply, but could dramatically reduce the growing pressure on energy resources. Energy efficiency not only alleviates pressure on energy resources, but saves money for consumers. Similarly, measures to increase efficiency of fuelwood use (such as improved cooking techniques, fuel efficient stoves) save users time or energy in collection.

> Energy consumption as a proportion of GDP remains high in Namibia (15% compared to 7% in Japan)[14] due to energy intensive primary industries. The Ministry of Mines and Energy aims to reduce this to 10% by 1999.[14]

3. *New capital investment in conventional energy resources.*

An alternative scenario is to develop Namibian capacity, either at Epupa or the Kudu gas fields. These would provide more than enough energy for energy sufficiency, but would incur massive capital costs (currently estimated at N$1.5 billion for Epupa, and up to N$2 billion for Kudu) so the economic feasibility will depend on the size of market and future costs and revenues. Both schemes would have significant though very different environmental impacts which need to be explored. In both cases, the obstacles to national expansion of the grid remain, so they would be unable to meet demand of dispersed populations in rural areas without further substantial expenditure.

4. *Development of renewable energy resources*

Decentralised electricity supply by means of photovoltaic solar home systems could be used to meet the growing energy demand of rural households. Large scale electricity generation by solar-thermal power plants and wind power plants is also a possibility that needs further investigation. The current assessment of the potential of these renewable energy resources is as follows:

4.1 SOLAR

Namibia has measured daily solar radiation averaging 6.6 kilowatt-hours per square metre per day -- one of the highest in the world.[12] This means that given an average conversion efficiency of solar energy into electricity of about 13%, Namibia's total electricity demand of 1746 gigowatt-hours (GWh) in 1993 could in principle be supplied with a photovoltaic surface of 5.5 km^2![14]

> 1 megawatt (MW) = 1000 kilowatts (KW)
>
> 1 KW = 1000 watts
>
> A system with 1 KW capacity can produce
> 1 KW per hour,
> = 1560 kilowatt-hours (KWh) per year.
>
> A household needs about 100 KWh per year to run TV and lights.

In practice, solar photo-voltaic (PV) technology is at the stage where it is most viable in small units for use at household or local level. This in turn is why it has such potential for meeting energy needs in *rural* areas that are so difficult to address through conventional energy.

At present, solar energy is used mainly by public institutions. e.g. a total capacity of

180 KW has been installed to power remote telecommunications equipment. There are 18 PV pumps systems at game water holes in national parks, with a capacity of 25 KW power, and a further 33 installations planned. Private use of photovoltaic systems for lighting and pumping is also increasing from the current low level of about 500 KW. This represents just a fraction of market potential for solar PV-applications, which is estimated at 1.1 MW for individual systems and 4.7 MW for community electrification. The potential of solar water heating has hardly been tapped and is estimated at 4 MW.[14]

PV systems compare favourably in terms of environmental cost (as long as there is efficient recycling of solar batteries) and can compare favourably in cost with other energy sources if all costs are taken into account. For example, around 200,000 rural households are not connected to the grid. 90% of them purchase an average of 90 litres of paraffin per year, 70% use about 40 dry cell batteries per year for radios, tape-recorders and torches, and many use car batteries for radio and TV.[12] The costs of these are all borne by the household, and are in no way subsidised as are the costs of grid electricity. A household could meet these energy needs for lighting, TV and radio with a small PV unit generating 100 kilowatt-hours per year. This would require an initial investment of around N$3,700. Over twenty years, the average cost, taking into account initial capital and replacement of batteries, would amount to around N$50 per month.[12]

From the households point of view this is more expensive but more convenient than batteries and paraffin. It is also more expensive than getting connected to the (subsidised) grid: if government covered none of the costs, households would be paying around N$6 per KWh compared to just 10 to 20 cents for grid electricity. On the other hand, this option *could* be much more feasible -- if households had access to the information, relevant technology, and credit for the initial investment -- than waiting for the national grid to be extended to remote areas.

From the national point of view, the total cost of solar PV units for the 200,000 rural households would be N$740 million for initial installation, then an average of N$96 million a year over 20 years for replacement batteries, tubes etc. This may seem expensive when compared to the cost of providing equivalent power through conventional energy if only the cost of fuel is taken into account: e.g. N$ 1 - 2 million a year for coal imports. However, when the cost of extending the grid to rural areas, or the billions needed to increase Namibia's power generation capacity, or the environmental cost of fossil fuels

> The capital cost of 200,000 rural household photo-voltaic units would be N$740 million.
>
> This means that half the current estimated cost of an Epupa hydro-power scheme would pay for solar PV systems in every rural household.
>
> Just doubling the current electricity grid to reach more rural homes would cost around N$350 million.
>
> Burning coal to provide equivalent rural electricity would emit 10,000 tonnes of CO_2 a year.[12]
>
> Meeting rural household needs with batteries and paraffin involves the emission of 30 million kg of CO_2 per year, and the dumping of 5.6 million batteries.

and hydro power are taken into account (see box), the solar investment appears more favourable.

It is evident then that solar PV systems have enormous potential for decentralised power supply, if technical and institutional barriers can be overcome. In line with Government objectives, it can promote sustainable and decentralised development, and improved living standards in rural areas. Solar energy also has potential at the household level in urban areas, particularly for water heating. Substituting the estimated 40,000 electrical geysers by solar water heaters would reduce annual electricity consumption by 48,000 MWh/year, saving the equivalent of 30,000 tonnes of coal, costing over N$7 million, and 45,000 tonnes per year in CO_2 emissions.[12]

4.2 *WIND*

The average wind speed varies across the country, with the greatest speeds in the south and coastal areas, such as Luderitz. There it is suitable for electricity generation, and the possibility of a wind farm in the Luderitz area to supply the grid is being investigated. Further research into coastal potential for wind-power generation on a larger scale is needed.

4.3 *HYDRO POWER*

The only potential for hydro-power in Namibia is on the Kunene River. As mentioned under the Epupa scheme above, the environmental and financial costs of constructing such a scheme need to be weighed against costs of alternatives.

4.4 *BIOMASS*

Whereas the challenge of solar is to *increase* access to a potentially *abundant* energy supply, the challenge of biomass is to help the poorest households cope with *diminishing* access to a long-standing energy source. This can be done by increasing efficiency of woodfuel use so that less is needed, increasing access to woodfuel (e.g. donkey carts, tree management), and/or enabling a switch to other cooking fuels (gas, solar). All of these face social, financial, and organisational constraints. In the long term, the relative importance of biomass will diminish, but meanwhile the importance of fuelwood as a subsistence resource for cooks in the poorest households must not be overlooked. Development of forestry can therefore be an economically, socially and appropriate investment.

In most countries it has been found that rural fuelwood collection has marginal impact on deforestation (the impacts are in the reverse direction), but research is needed to determine whether this is true in Namibia. However, supply of fuelwood by traders to urban areas can often involve cutting of live trees. This can be addressed through developing tree management and tenure rights, while encouraging alternatives fuel use in urban areas.

From this overview it is clear that no single strategy will alone be ideal. A combination of strategies will be needed in the energy sector over the next 20 years or so to address growing energy needs in an affordable and environmentally sustainable way. Although many questions cannot be answered now, it is clear that there is considerable -- and as yet under-exploited -- potential for energy conservation and use of solar and wind energy.

C: POLICY RECOMMENDATIONS

To summarise the policy recommendations emerging from this analysis:

1. **Increase supply to the grid at minimum economic and environmental cost:**
The economic and environmental implications of different strategies need to be compared. i.e. of imported energy, developing Kudu gas fields, or Epupa hydro-power, and of long term development of wind power and solar power for electricity generation. Decisions should be based on the principle of minimising total economic and environmental costs. There is currently insufficient information.

2. **Promote Energy efficiency**
Irrespective of plans to expand future supply capacity, measures to encourage energy conservation are essential to save both money and resources. This will need to cover industrial, mining, urban domestic and rural domestic consumers. Action is needed to:
   - educate consumers, increase awareness of energy conservation;
   - provide incentives for energy conservation, especially through revised tariff structures;
   - increase availability of appropriate technologies.

3. **Meeting rural energy needs**
Promotion of decentralised electrification by means of solar PV systems must be explored to meet power needs in isolated areas[4]. This requires:
   - further research on the technical and financial viability, and on institutional feasibility of establishing and operating systems;
   - subsidies, at least for initial capital costs, and on the principle that capital for grid connections is subsidised;
   - development of skills amongst communities and extension personnel;
   - increased access to appropriate technologies.

   Improved management and use of wood fuel needs to be researched and promoted, given that this will remain the main source of energy of the poorest for some years to come. In particular:
   - access to energy-saving techniques and equipment;
   - action to address the causes of deforestation (e.g. timber, land clearance).
   - rural extension work to promote local tree management.

As with water, the challenge of meeting the needs of growing populations with aspirations for economic and social development must not be under-estimated. The full economic and environmental costs of doing so must be taken into account in planning, and these costs minimised wherever possible.

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4 The Renewable Energy section of the Directorate of Energy in the Ministry of Mines and Energy has begun some of this work, with support of GTZ.

VI SUMMARY AND CONCLUSION

The livelihoods of Namibians and the economy of the country depend on natural resources: water, productive land and energy. And yet there are already indications that these essential resources are increasingly scarce or degraded: water is running short, good grazing land is scarce and in some cases degraded, soil fertility and arable productivity are under pressure, deforestation means that fuelwood and timber are scarce. The majority of the population still lacks access to potable water and modern energy sources, while supplying the luckier minority is increasingly expensive and technically-demanding. Population pressure is one cause of growing scarcity and degradation, though other causes such as inefficient use of resources, excessive consumption by some, and inappropriate management techniques, are just as important.

This means that supporting a rapidly growing population, and fulfilling expectations for rising living standards, from Namibia's natural resource base is a daunting challenge. If mismanaged, it will incur substantial economic and environmental costs. The challenge will only be possible if there are changes in how natural resources are managed and used. As outlined in Figure 6, the four broad principles that need to be followed are:

- improve resource management to ensure sustainability and prevent degradation;
- increase productivity of the resource base;
- increase efficiency of resource use, avoid wasteful consumption;
- tap new resources where possible.

More specifically:

1. *FERTILE SOIL AND PRODUCTIVE LAND*

   There is little opportunity to exploit unused resources in the case of productive land. Using marginal land increases the risk of environmental and socio-economic costs in the medium to long term. Therefore the essential strategy is to *improve land management* to avoid degradation and, where possible, support a growing population. For example: local management and coppicing of trees, combined with promotion of alternatives building materials and rural energy sources; improved crop-growing methods to enhance soil fertility; improved livestock management to maintain transhumance, respond to drought, and manage livestock numbers; and development of "value-added" activities such as mixed game and livestock; marketing and processing of products.

   The policy implications are that Government needs to promote:
   - *decentralised land tenure*, to give communities rights and incentives to manage land for the long term, rather than for short term benefit;
   - *improved access to skills,* training, information and appropriate technology for sound land management;
   - *enhanced understanding* of how resources are locally managed, and how traditional methods could be adapted and improved.

Figure 6: Strategies needed for key natural resources

Resource/ product Strategy	Water	Pasture	Arable land	Trees	Energy
1. Tap new resources	**** ocean, border rivers	* limited potential		* very limited potential	*** sun wind gas (limited)
2. More sustainable and productive management	**** sustainable extraction, wetlands protection	**** manage grazing in response to rainfall; increase value added through processing or wildlife	**** investment in farmers' skills, tools, drought-resistant crops, & value-added processes	** coppice forestry, agro-forestry	** demand side management
3. Make do with less: **a: more efficient use**	**** in industry, agriculture, and towns			*** fuel-efficiency	*** energy conservation
b: switch to (commercial or imported) alternatives		**** long-term reduction in dependence on livestock	** imported food	**** alternative fuels and building materials	

Figure 6 outlines the 3 broad strategies necessary if the key resources are to support more people. The first strategy, to increase supply by exploiting new resources, is most relevant to water and energy, as there is relatively little unused land available for crops, pasture, and trees. However, exploiting new water sources and solar/wind energy faces financial and technical constraints. The second strategy, of more sustainable management, is essential for all five resources, requiring investment and planning with a long-term perspective. The third strategy, to make do with less, is also essential, but can be done either by consuming resources more efficiently (eg water conservation, fuel saving techniques), or reducing dependence on natural resources by switching to alternative resources (shifting from livestock to industry).

2. *WATER*

With water already the scarcest resource, the water demands of a growing population and economy can only be met with the implementation of:

- *demand management*, realistic water pricing, and other incentives for water conservation;
- *prioritisation of competing water demands* according to social and economic contribution, and discouragement of inefficient water uses, e.g. irrigation;
- *exploitation of water sources at the border rivers and ocean* -- with due recognition of the financial, energy, and environmental implications;

In addition, to protect not only water resources, but all the ecosystems and activities dependent on them:

- *protection of water resources,* such as rivers and oshanas, from degradation through either over-extraction, or disruption by other activities.

The inevitable increase in water demand due to population and economic growth *will* impose strains on the Namibian economy and environment, but the above measures will at help reduce such costs.

3. *ENERGY*

As in the case of water, anticipated growth in demand must be met while minimising economic and environmental cost. This requires:

- *demand management and energy conservation,* such as realistic pricing, promotion of energy-efficient technologies;
- *promotion of decentralised solar and wind-power,* particularly to reach rural households;
- *assessment and incorporation of environmental costs* into decision-making.

Without these actions, a growing population will result in degradation of the environment, and face declining living standards in the face of resource scarcity. Even if these strategies are successfully pursued, it will be expensive and/or difficult to meet the resource demands of the growing population. Therefore, three more general policy implications must be addressed:

- action to slow population growth is one way of easing the pressure on natural resources.

- however, other causes of increased pressure are just as -- if not more -- important to address: e.g. expansion of irrigation and high water consumption of urban residents have more impact on overall water consumption than the number of people. Inappropriate land management is as important as the number of livestock. These other factors must be tackled.

- in planning for the future, the scarcity of natural resources must be taken as seriously as the scarcity of financial resources, and strategies pursued that use these resources most efficiently and sustainably.

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