SDP 2

Water Usage Patterns in the Kuiseb Catchment Area

(with emphasis on sustainable use)

1993/1994

Authors:

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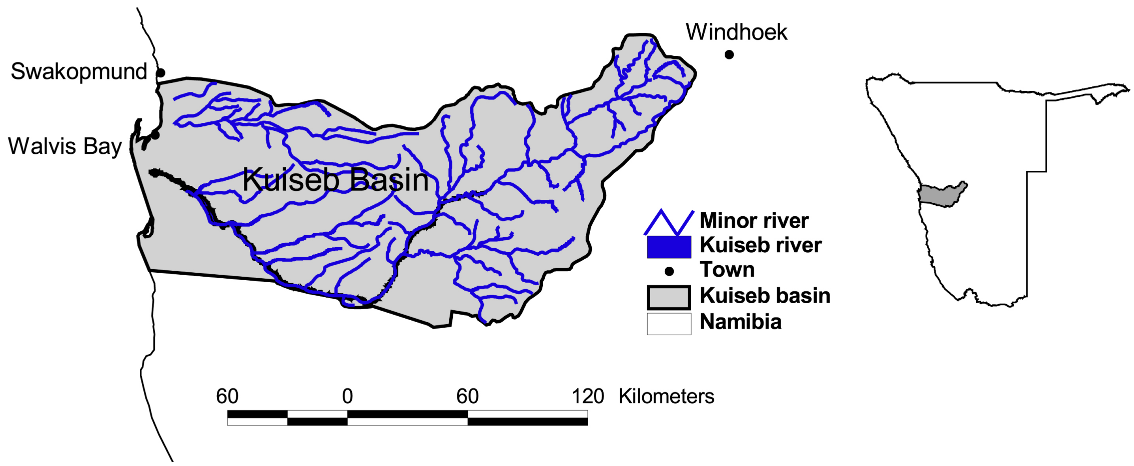
Introduction

North western Namibia is drained by 12 westward flowing ephemeral rivers, eight of which originate on freehold tenure farmland. The Kuiseb, the most economically developed of these rivers, supports a major port and two coastal towns, which are prime tourist and recreation destinations. Commercial and communal farmers, the Namib-Naukluft Park, the Gobabeb Centre and, until recently, a large uranium mine are also located along or supplied by the river. The main objective of SDP2 was to gather information on the per capita use of water in an arid, ephemeral river catchment and bring this information to the attention of the Department of Water Affairs and other stakeholders. It also aimed to enhance participants' understanding of the application of first principles and simple research techniques to obtain information that is relevant to sustainable development.

Six major user groups in the Kuiseb River Catchment were identified:

- commercial farmers in the upper catchment
- Topnaar communal farmers
- Gobabeb Centre
- the port town of Walvis Bay in the lower catchment
- the tourist town of Swakopmund and
- the Rössing uranium mine.

The highest per capita use of water was among higher economic groups in the coastal towns, who used it for their gardens, and at the Gobabeb Centre, which immediately started to use water more economically at the recommendation of SDP2. Evaporation from farm dams and reservoirs in the upper Kuiseb was identified as an important cause of water loss that is not easy to address. During this study the large Donkersan Dam was being proposed in the upper Kuiseb but this plan was later abandoned.The study also found that many water users were aware of a growing water shortage and recommended that existing water sources be conserved and that user groups' awareness of their mutual interdependence be increased. Most stakeholders strongly supported plans to develop a desalination plant to serve the west coast. Information gathered by SDP2 was passed on to other bodies and researchers and to the government. It formed the basis for other SDP studies on the Kuiseb and for actions undertaken by the Walvis Bay Municipality.



The Kuiseb Catchment area including the main river and tributaries.

Interviews with members of the different consumer groups identified, and a study of relevant literature, formed the basis of research during the project.

A number of actions were taken in the Kuiseb Basin and elsewhere in Namibia at least partly based on this study.

- Charlie Shanyengana, at the invitation of Sida, undertook a study of the water use by Swedish Embassy staff residences in Windhoek and worked out guidelines on how this extravagant amount could be reduced.
- The Gobabeb Centre reduced their watering of garden trees – some died and some lived – thereby reducing the amount of water used from the riparian aquifer. Further water demand management actions followed and today the Centre recycles all its water and uses some of this recycled water for expanding its gardens.
- Water demand management was also initiated in Walvis Bay and this programme has grown through the years.
- Over the longer term, this study provided the baseline for SDP8 and SDP9 which, in turn, had combined ramifications. All the information from these three SDPs and from the Sida-funded Ephemeral Rivers book was then used to support the initiation of the Kuiseb Basin Management Committee, the first of its kind in Namibia, in line with the newly adopted Water Policy (2000) and the more recent Water Resources Management Act (2004).
- Experience from the Kuiseb, initiated by this SDP, has informed Basin Management Committee formation in at least four other basins of Namibia.

Overview of water input into the Kuiseb Catchment Area (KCA)

The KCA covers an area of 28 000km^2. Rain is the only means of water input into the catchment and provides runoff into the Kuiseb River from its tributaries. The runoff is trapped in farm dams and seeps through the sand and permeable rock formations to recharge the underground water resources and forms temporary pools from which game and livestock drink.

Rainfall ranges from 300-350mm in the western catchment to less than 14mm at Swakopmund and is highly erratic and unreliable, as it is in the rest of Namibia. The upper Kuiseb is the only part of the catchment that contributes significantly to runoff, which is essential for the recharge of the lower desert aquifers. However, since runoff rarely makes it to the lower Kuiseb below Swartbank, the recharge of this aquifer is almost entirely through subsurface flow. It is estimated that it takes 70 years for water to reach the sea through seepage and underground flow after rain has fallen in the Khomas Hochland (Wilken and Fox 1978).

Not much is known about the recharge of aquifers in the upper KCA. Interviews and field studies have shown that a substantial number of boreholes regularly run dry. The unreliability of these boreholes has prompted farmers to build farm dams to simultaneously supplement boreholes and recharge the water table. The dams can support livestock for a year if they are filled to capacity, however, they tend to silt up making infiltration difficult and are also subject to high evaporation loss.

An interesting alternative method of enhancing recharge of underground water and water storage is the construction of sand dams – dams filled with sand that trap and “store” water underground, greatly reducing evaporation.

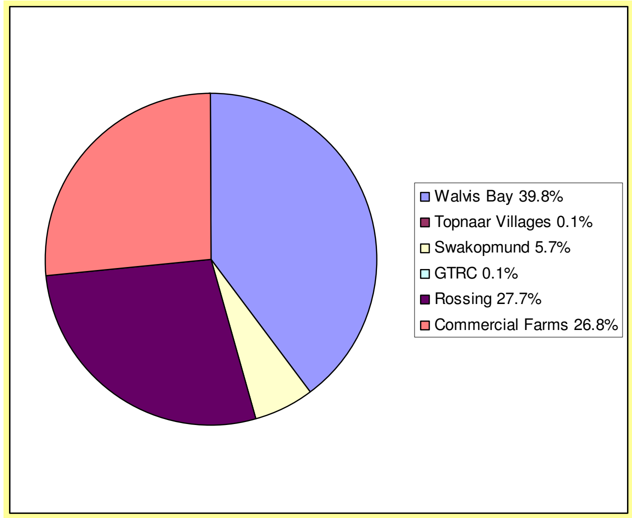
Overview of water output from the KCA

The major cause of water loss in the KCA and Namibia as a whole is evaporation. The arid climate in Namibia results in 83% of rainfall evaporating immediately. Of the remaining 17%, 15% seeps through soil and remains as soil water with 2% trapped in dams. Only 1% of the seepage is available for aquifer recharge as 14% is used by vegetation (Heyns 1992). The small percentage of runoff trapped in dams is subjected to intense daily evaporation. These dams or reservoirs are often supplemented by water extracted from aquifers, which exacerbates the problem.

While Kuiseb River floods reach the sea very infrequently, these episodes are critical to sustain the vegetation in the lower Kuiseb. The quality of the water in the aquifers has deteriorated over time, most likely as a result of over-extraction of water from the lower Kuiseb. The resultant failure of subsurface water to reach the sea allows seawater to enter the aquifers. This results in there being less space in the aquifer for fresh water. Boreholes tap the less dense fresh water floating on the top of the aquifer, thus making more space for the saline seawater. Saline water has already been detected more than 4km inland.

Water for human use is mainly drawn from boreholes sunk all along the river. The six groups identified, use water in the following proportions in the following diagramme:

Interactions because of dependence on a common source of water are not restricted to human-human relations only. Should water levels drop to a point where no preferential plant species can access the water, the support base of life will be destroyed. No forage for livestock or wildlife will be available. The consequences are more far-reaching for the desert, where the lack of vegetation cover and big floods allows dune encroachment. Severe water extraction in the Rooibank area is manifested by dunes encroaching at 8m per year, mortality of shallow rooted palm trees planted by missionaries and the total failure of !nara plants, an essential food and economic resource for the Topnaar people.



Water use by commercial farmers in the upper KCA

Namibia is increasingly dependent on the agricultural sector and farming can be expected to play an ever growing role in the future. One hundred and nine commercial farms occupy the entire headwater area of the KCA occupying an area of 9 500km^2. Information was gathered from four farmers through personal interviews and a review of available literature. All farms were livestock farms.

The main sources of water on the farms are boreholes and dams, supplied by rainwater. Livestock on farms - mainly cattle and sheep - are the major water users and are estimated by the farmers to use on average 90% of the total water consumption. Water use for domestic and gardening purposes is unknown. Absence of water meters in the entire catchment prevents gathering of statistics on water consumption for schools, guest farms and stock farms in the upper catchment.

Development is taking place in the whole catchment area and this leads to the increase of boreholes and dams on commercial farms. According to farmers no authorisation is needed to build farm dams with a volume of less than 20 000m^3 and only requires agreement with their neighbours. Farmers refute the allegations that their dams have a negative impact on downstream flow, claiming that many of the dams in the area are over 30 years old.

The only available estimate of the number of dams in the area was made in 1974 and stood at 407. This puts the total volumetric capacity of the dams at 16 Mm^3, which could have a severe impact on the runoff volume of water during seasons of low rainfall. A study is in progress to quantify the current influence of smaller dams in the upper Kuiseb and could lead to restrictions on dam building if the results show they have a negative effect.

While dams may have a negative effect on the lower catchment area, they are beneficial in the upper Kuiseb as they indirectly supplement boreholes on farms by recharging local groundwater levels.

Amongst others, this study **recommends** that farmers:

- Investigate the feasibility of sand dams where possible,
- Ensure the sustainability of new boreholes and
- Establish a means of monitoring water consumption on farms.

Recommendations of this study include:

- the reduction of livestock to conserve vegetation and water and encourage new seedlings to establish
- Alternative sources of water should be investigated, namely, desalination
- Piping desalinated water from the coast to the villages could be considered
- Monitoring of water use patterns at boreholes by the Topnaars to determine their impact
- Further research on the ecosystem of the lower Kuiseb, especially on the ecology of the !nara plants.

Water Use by the Topnaars

The Topnaars, descended from the Khoi-san, are the oldest inhabitants of the lower KCA. While previously nomadic hunter-gatherers and fishermen, they have now settled in permanent villages. This is due partly to the fact that the lower Kuiseb was declared a national park, restricting their movements and activities, and also because of provision of permanent water. There are ten settlements along the lower Kuiseb where inhabitants rear goats, grow small vegetable gardens and harvest the indigenous !nara melons (*Acanthosicyos horridus*). Small stock mainly feed off *Acacia erioloba* and *Faidherbia albida* leaves and pods.

The Topnaar communities are very vulnerable to a lowering of the water table. The !nara fields, each initially owned by individual families but now harvested at random, have dwindled due to fewer flood events and lack of groundwater. The !nara melon and its pips are a valuable source of food and income, as the pips are sold to dealers in Walvis Bay and exported elsewhere as a delicacy. As a result of the dwindling !nara fields, the Topnaars have become ever more dependent on goats for a livelihood. Traditionally the Topnaars needed to dig only two to three meter wells to obtain groundwater. Presently they are using boreholes from 15 – 33m deep provided by the Department of Water Affairs.

Presently more than two thirds of the Topnaar population live in towns, mainly Walvis Bay and only visit the villages during weekends, holidays and the festive season.

The study found signs of severe over-utilisation of the vegetation along parts of the lower Kuiseb, with the browse-line decreasing in height the further one moves from the villages. This, combined with the lack of ground water, could lead to irrevocable damage to the lower Kuiseb ecosystem affecting not only the Topnaars but the wildlife and other organisms dependent on the river.

Personal interviews and a study of available literature show that water use by the Topnaars is negligible compared to other users. This may however, change with the installation of modern boreholes providing a source of water for more stock and bigger gardens.

Water Use by the Gobabeb Centre

The Gobabeb Centre is situated on the banks of the lower Kuiseb River and obtains its water from a local groundwater aquifer pumped by two boreholes 19m deep on the southern bank of the river. The water is classified as D quality as it contains unacceptable levels of salts (mainly sodium sulphate and sodium chloride) for much of the year except after flooding. Despite this, the water continues to be used for domestic purposes and watering livestock owned by staff of the Ministry of Wildlife, Conservation and Tourism who live near the Centre.

Measurements of water use were made between 11 December 1993 and 14 January 1994 at all possible sites, including stock and garden watering, with the help of residents of the Centre. The following weekly measurements were recorded:

Water Use at the Gobabeb Centre

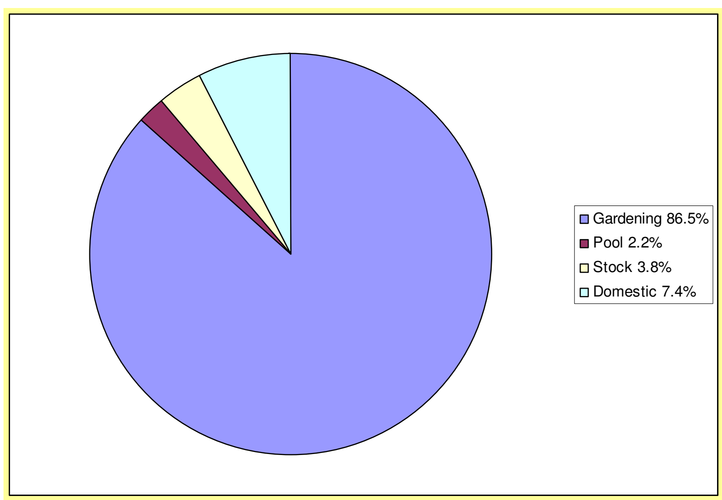
Sites	Total usage	Total volume (litres/week)
Basins	129 fill-ups/week	774.0
Cooking	673.6 cups/week	168.4
Drinking	1 524 cups/week	381.0
Garden at Centre	3 times/week for 195 mins/day with sprinklers	124 294.5
Gardens at houses	3 times/week for 53 mins/day with hoses	3 339.0
Vegetable gardens	2 times/week for 45 mins/day	1 440.0
Showers	72 showers/week	3 686.4
Toilets	118 flushes/week	
Stock	Not determined	

A swimming pool with a surface area of 40.5m^2, which is regularly used by staff and visitors, represents the main source of evaporative loss after gardening.

Assuming an average of 30 persons present during the month (there were fluctuations because of the summer school holidays) the per capita water use was approximately 3m^3/month for all domestic, recreational and research consumption, inclusive of water for Topnaar stock but excluding gardens.

The study's estimate for total water use differed from the recorded borehole output by 4m^3. It is unclear whether this discrepancy could be a result of inaccurate metering, evaporation, leaking pipes or other unidentified causes. The water tower at the Gobabeb Centre is covered, thus evaporation does not seem to be a viable cause.

There are too many fluctuations of people and stock for various reasons in the short term to be able to provide accurate data for the prediction of annual water use at the Centre. Longer term measurements would be necessary to provide a more accurate picture of water use patterns.



Percentage of water use at Gobabeb Centre

Reduction of water use for essentials will be hard to achieve but water use for ornamental gardens and the swimming pool could be radically lessened by adopting appropriate measures. Reduced consumption and visible water conservation would improve the image of the Centre and relevant information could be shared with other rural communities.

Some **recommendations** for water conservation at the Gobabeb:

- Water meters to be fitted at all buildings and long term records kept
- Awareness campaign specific to Gobabeb Centre to be drawn up
- Use of water savings devices adapted
- Replace ornamental plants with indigenous desert species
- Watering of garden to be done at night
- Swimming pool must be covered
- Gobabeb Centre must seek to establish itself as an example of water saving possibilities in Namibia

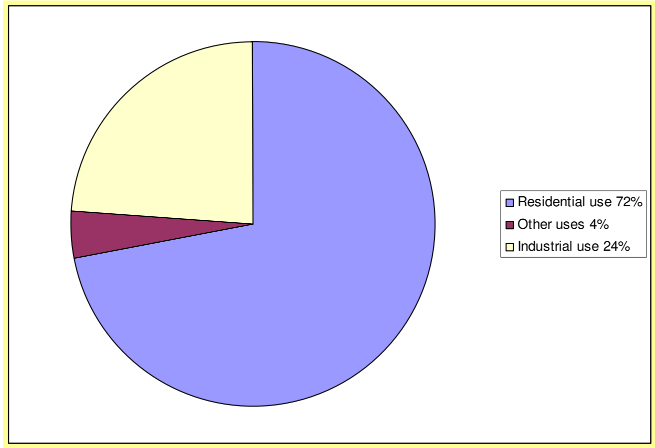
Water use at Walvis Bay

The port town of Walvis Bay, with an area of 112km^2 and a population of approximately 38 000, faces the challenge of meeting rapidly growing water demand. This has resulted in the over-extraction of the available water source, a severe drop in the ground water level and consequent negative ecological and socio-economic impacts on the KCA. Current abstraction is estimated at roughly 200% of the annual recharge rate. Water is obtained from alluvial aquifers using 19 boreholes at the Rooikop and Dorop water schemes on the Kuiseb River.

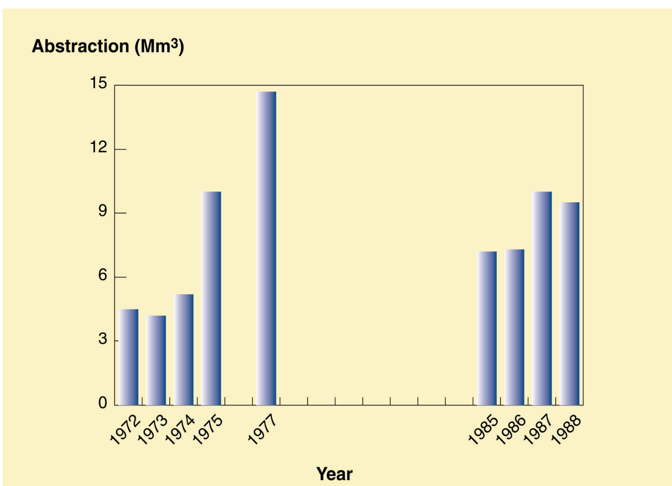
The Kuiseb River only floods on average 23 days a year (at Gobabeb) and the only known floods to have had a significant effect on the water table levels were the floods in 1934, 1963 and 1974. The threat posed by the saline wedge means that the Dorop Scheme can only run for roughly another five years and the high potential for industrial and population expansion pose additional threats to the already exhausted water sources. Encroaching dunes at Rooibank, the frequent collapse and destruction of boreholes, the sand transport by windstorms and the flood protection wall erected on the northern arm of the Kuiseb add to the water problems of the town.

Walvis Bay loses 11% of its water through the present distribution system as illustrated by unspecified losses of 350 000m^3 recorded over the 1991 period. Considering that about 10 000m^3, equivalent to the town's daily water consumption, can be lost in a single pipe burst, efficient maintenance services and computerised leak identification devices would be highly desirable to prevent wastage of this precious resource.

In 1991, statistics showed that 72% of water was consumed by residents and only 27% by industry and other users. The higher the income level of the residents, the higher their consumption of water leading to a total consumption of 55% of Walvis Bay's total water use. The port services on average 10 ships a month and due to awareness of the water shortage by port authorities, they discourage water refill by foreign vessels.



Demand for water in Walvis Bay is currently increasing at a rate of 3.5% per annum. At present water is priced only at its production cost and is subsidised for domestic use. A scaled tariff was introduced as a conservation method (the more residents use, the more they pay) but the rates are still too cheap to have a significant effect on water use.



Abstraction rates for Walvis Bay between 1972 and 1988

While the municipality of the town has embarked on awareness campaigns in an attempt to introduce effective water demand management, all indications are that they have had little, if any effect on consumption. The investigation of industrial and human carrying capacity of the town will place it in a better position to make plans for the future. Populations should be limited and resident's innovations should be encouraged for saving water in their homes i.e. insulation of hot water pipes, placing bricks in cisterns and buying water saving devices such as low flow shower heads.

Development plans include the creation of additional residential and holiday erven, a hotel and extension of the port facilities, which further threaten the already depleted water resource of the town. Sustainable alternatives such as the use of different water sources and re-evaluation of current water use to minimise misuse will have to be considered. Among these possible alternatives, several have been considered for Walvis Bay:

- Underground water sources from further afield
- Other inland alternative sources
- Reclamation
- Desalination

Of the alternatives, reclamation, while expensive because of the high salt concentration in the water, remains a cheaper and comparatively environmentally friendly solution to the first two options. At present reclamation produces non-potable water used on municipal gardens but could be refined to treat water to drinkable quality and possibly process Swakopmund's sewage as well, in order to reclaim a significant amount of water.

Desalination of brackish water has been identified as a possible alternative that could delay the implementation of sea water desalination to a later stage. Sea water desalination involves the treatment of sea water to a low salinity that would make it good enough for human consumption. The resultant water would then be mixed with water from sustainable underground sources, consequently reducing the cost of the undertaking and its product to the users.

The cost of seawater desalination is currently estimated at about N$6.5/m^3, about 498% of present alluvial groundwater production costs although mixing it with groundwater would reduce the cost to approximately N$3 to N$4/m^3.

This study recommended several actions that government, municipality, industry and residents could take, among which were:

Government

- Investigate desalination of seawater
- Limit development to within the carrying capacity of the water resources
- Institute a policy on industrial use of fresh water and investigate the possibility of erecting seawater pipelines for industries.

Municipality

- Increase length of water storage periods to avoid accidental affects
- Price water at replacement cost and the use it is put to – higher for industry and lower for residential/fixed amount
- Institute efficient metering of all consumers
- Reduce water pressure
- Upgrade reclaimed water to potable level
- Introduce alternative gardening through demonstration and example
- Embark on water demand management campaigns by providing information on water conservation techniques for the consumer.

Industry

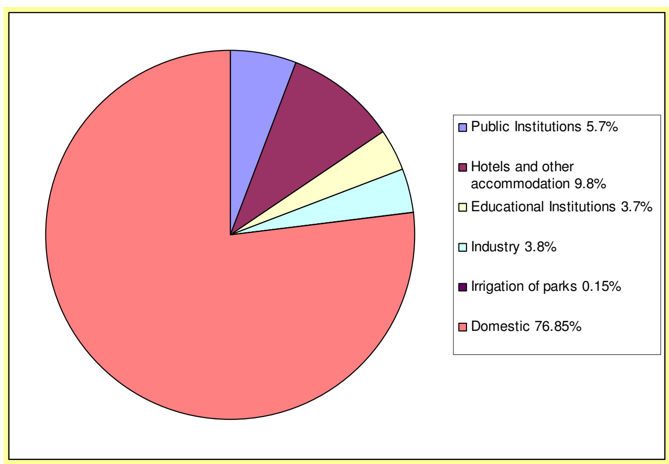
- Use fresh water only when strictly necessary and not to wash floors or other wasteful practices.
- Combine forces and explore the possibility of using seawater for some processes.

Residents

- Apply conservative techniques for using water
- Create alternative, indigenous gardens.

Water use at Swakopmund

Before the establishment of Rössing Uranium Mine near Swakopmund in 1976, the only major users of water from the Kuiseb were Swakopund and Walvis Bay and water extraction and distribution infrastructure were constructed accordingly. In 1976 pipelines to Swakopmund were replaced and upgraded to supply 4Mm^3. In the late seventies water pipelines were constructed from Henties Bay to supply water an additional 11Mm^3 to Swakopmund from the Omdel Storage Reservoir in the Omaruru delta.



Total water consumption patterns for Swakopmund
(Total consumption 253 210 m^3/month)

As is the case in Walvis Bay, stepped tariffs are applied at the cost of N$1.49/m^3 for the first 30m^3, rising to N$2.2/m^3 for consumption of over 61m^3.

Semi-recycled effluent water is used on Municipal gardens. The brewery uses 7000m^3 a month, which is pumped directly from the Swartbank Scheme and is not treated by the Municipality. The Brewery, which pays the same tariff for water as the town's residents, was able to reduce the standard international amount of water needed to produce one litre of beer from 6-8l water/l of beer to 5.56.

The burgeoning tourism industry in Swakopmund also has a direct influence on water consumption, as a three star hotel is required to offer baths, which use a great deal more water than showers.

Several alternative sources to provide water for the town have been suggested. These include a desalination plant to provide the Central Namib Region with water and linking Swakopmund up to the Swakoppoort Dam in the Swakop River Catchment. While the second option is cheaper in the long run, the latter could have seriously detrimental effects on the environment.

Several **recommendations** were made to initiate conservation measures in Swakopmund. These included:

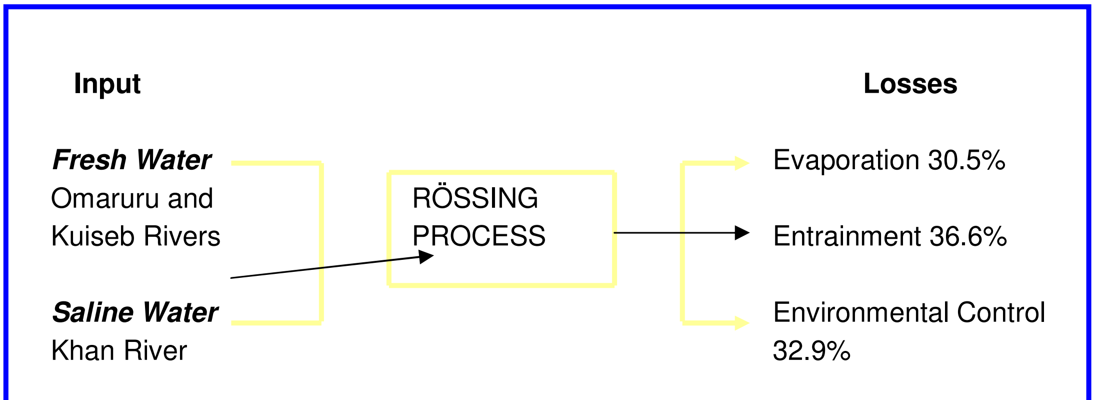
- Use of water-savings devices in households and planting indigenous gardens
- Automation of systems using water to reduce water wastage at factories
- Raise tariffs to reflect the true price of water
- Establish an adequate emergency water supply
- Initiate awareness raising on water demand management at all levels, including hotels.

Water use at Rössing Uranium Mine

Mining contributes the largest percentage income to Namibia's Gross Domestic Product and thus it is important to encourage investment in this field. Rössing is situated about 70km northeast of Swakopmund and the site features the largest known Uranium ore deposit of its kind in the world. It is also the most controversial mine in Namibia because of the risks involved with radioactive material and waste.

Planning and design of the mine was started in 1973 and the plant was in full production by 1978. The mine established the small town of Arandis as an industrial housing project for its workers which, after independence, was handed over to the Namibian Government although the mine continues to pay for many of the amenities.

Water to the mine is supplied at standard commercial rates. The mine consumes an average volume of 8 200m^3/day constituting 1 200m^3 for dust suppression within the open pit and 7 000m^3 for in-plant operations.



Rössing Water Balance

Evaporation is caused by dust suppression and the exposed surfaces of tailings dams as well as environmental control of dust suppression while entrainment is caused by waste disposal of the tailings.

Mine authorities identified evaporation as the most effective area they should focus on to reduce water wastage. By mid-1993, the mine had reduced the evaporative rate of its operations from 28 000m^3/day to 5 900m^3/day within a two year period. Recycling led to a further decrease of fresh water use by 70% in that period. However, the drop in water consumption could also be ascribed partly to the decline in production due to low uranium prices after 1991.

A disagreement was recorded by the students while gathering data between Rössing personnel and Department of Water Affairs (DWA) on the source of their water. Rössing claims it uses no fresh water from the Kuiseb aquifers and receives water only from the Omdel Scheme, while DWA officials claim Omdel and Kuiseb water is mixed at the Swakopmund Reservoir and piped to the mine after treatment.

Fresh water savings initiatives include the following:

- Use of recycled water for road spraying
- Saline water from the Khan River is used in the open pit for dust suppression
- Deepening of the decantation channels to lessen evaporative area and construction of smaller paddies to replace the large tailings dam.
- Water is stored in an underground aquifer for re-use when needed.

The potential of contaminated water seepage and spillage remains a contentious and controversial issue surrounding operations at the mine.

The mine subsidises 100m^3 of water for all employees, although upper management levels prefer to take this in a cash allowance. Employees who receive free water see no need to conserve it, as they do not carry any costs. An attempt to convert the free water allowance to a cash allowance is being negotiated with the Mine Workers Union of Namibia.

As a result of a drop in demand for uranium, Rössing reduced its work week to five days, thus saving water over weekends. However, a renewed demand for the ore would result in increased production and increased water use.

Recommendations for appropriate environmental and water conservation measures included the following:

- Intensified and on-going monitoring of radioactive levels of the tailings
- Water quality control of water withdrawn from the Khan aquifer
- Stricter control by the DWA of water volumes used on the mine
- Vigorous exploration of a desalination option for the entire mining process.

Future Development

The following issues are regarded as of prime importance when considering planned future development:

- The consequences of the reintegration of Walvis Bay into Namibia in February 1994
- The building of dams in the area in the near future
- The oil exploration along the coast and the impact that the discover of oil would have on the two coastal towns
- The expected growth in population and industry.

There is expected to be an influx of both low and high income groups into the coastal towns, especially after the reintegration of Walvis Bay into Namibia. Investigations have shown that high income groups use disproportionately more water than low/no income groups. With investment and development along the coast, the standard of living is generally expected to increase, which could lead to a demand for consumables that use large amounts of water such as washing machines.

Water is priced below delivery cost but if the DWA cuts the consumption of the high income groups they will, to a large extent, lose the subsidisation of the low income groups’ free water.

It has been proposed to build a dam on the farm Donkersan in the upper reaches of the Kuiseb to provide additional water for Windhoek. This will reduce the run-off to the lower Kuiseb by 70%, adversely affecting inhabitants, vegetation and farmers living downstream.

Possible **alternatives** include the following;

- Expansion of ***existing infrastructure*** to link the coast with the Eastern National Water Carrier or Okavango River
- **Desalination,** which is expensive and difficult because of the plankton rich Atlantic Ocean
- ***Water reclamation and recycling*** – also an expensive, although viable option
- ***Evaporation control*** on dams and open reservoirs

- Design comprehensive ***awareness*** and ***conservation campaigns*** using all available media to take different levels of education into consideration.
- Involve the community in all levels of development planning with ***consultation*** within the affected communities.

The following **recommendations** were included in the study:

- All development should be preceded by environmental impact assessments and economic feasibility studies
- Consultation with all users is essential and not the former top-down approach.
- In all development plans, environmental cost should be taken into consideration through cross-sectoral consultations with relevant ministries.
- Industries should be established on the basis of available resources found in the area.
- Continuation of awareness raising campaigns at all levels is essential.

General recommendations

"Sustainability" and "environmentally friendly" have been the recent keywords in the conditions laid down by donors for governments and NGOs to qualify for aid, however this seems not to have implied the long term sustainability of water resources in the many schemes developed so far. This study therefore recommends:

Planning:

- Government should create a well calculated and carefully constructed national development plan that clearly demarcates development centres. These should take into account assessed long-term sustainability of water supply to a given area, region or town.
- Government should install meters at all extraction and major discharge points in the country to ensure accurate measurements of loss of water.
- There should be a framework drawn up for donor aid so that contributions conform to the water limitations faced by Namibia.
- Donors should screen project proposals for funding on the basis of availability of water for the proposed sites.

Appropriate Technology (alternative sources):

- All new developments should apply technologies that maximize the harvest of forms of water other than water in alluvial aquifers
- Economic incentives should be introduced for efforts aimed at applying such technologies to find alternative sources of water i.e. reclamation, desalination, recycling, sand dams, and fog and rainwater harvesting.
- Determine how architecture can best guarantee rainwater collection and make it a predominant criterion for evaluating tender applications for providing housing.

Management and Monitoring:

- Strict management and monitoring measures should be instituted to curb non-essential water use and wastage.
- Water subsidies for industries which are major water users should cease
- Water quotas to industries should be managed on a fixed rate determined annually and non-compliance should result in heavy penalties.
- Government should enact a law criminalising water wastage
- Communal standing taps in large settlements, over which no-one has the responsibility, should be done away with. Alternatively one person should be allowed to “buy” the water and sell it on to other users.
- Measures should be taken to enforce covering of swimming pools and reservoirs and to promote construction of sand dams.

Education and Training:

- Education is essential to highlight the water problems facing Namibia.
- Programmes and activities should promote a culture of sustainable use and water conservation.
- NGOs and pressure groups need to force the water issue into the political arena.
- Existing and possible alternatives for water use should be highlighted and training provided in these fields.

Appropriate Gardening:

- Sizes of new erven should be reduced to decrease available garden space.
- People should be encouraged to use interesting rocks and indigenous plants in their gardens.
- Gardens should be watered at night to reduce evaporation.

Water flows over long distances both on the surface and underground, making it unrestricted by cultural, regional or national boundaries. Any aspect resulting from non-sustainable and thus unconstitutional utilisation of this resource will similarly not be restricted to certain areas or regions only.

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