SDP 12

Water balance, use and management in the Omaruru Basin

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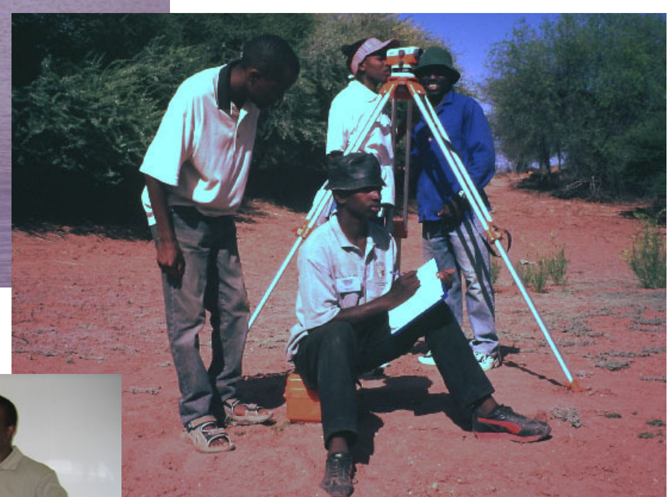


Introduction

Namibia is one of the driest countries in sub-Saharan Africa in terms of mean annual rainfall. Ninety per cent of the country's total area of 824 272km^2 is classified as desert, arid or semi-arid land. Coinciding with this aridity, Namibia is subject to extreme rainfall variability with annual rainfall between 0 and 750mm.

There are twelve major ephemeral rivers in north-western Namibia, which support a vast variety of ecological and economical activities. These rivers run only after significant rainfall episodes, normally during the summer months of December to April.

Groundwater meets 57% of Namibia's current water demand and surface water the remainder (Windhoek Consulting Engineers, 2000). Unfortunately, these water sources are not often located where they are needed. Furthermore, much of the groundwater surrounding ephemeral rivers is too saline for human use. It is therefore common to invest extensively in pipelines, inter-basin transfer, and improved water abstraction techniques.

Namibia's water consumption 1999

Sector	Urban[1]	Rural[2]	Agriculture	Mining	Tourism	Industry	Total
Water consumption	57	5.7	213	13.4	2.3	5.6	297
% of total	19.2	2	71.7	4.5	0.75	1.85	100

1 Urban includes domestic, commercial and institutional consumers and losses

2 Rural is domestic demand only

(Windhoek Consulting Engineers, 2000)

The Omaruru River supports a diverse blend of agricultural activities, urban and rural settlements, vegetation and wildlife. Due to the increased water demand and water related problems arising in the area, the 12th Summer Desertification Programme investigated the water balance and management of the Omaruru catchment.

The commercial farmers in the upper Omaruru catchment are said to influence river flow to the lower catchment through the creation of farm dams. These farmers are reliant on their dams to supplement borehole recharge, as watering points for their livestock and game and as tourist sites for trophy hunting and game viewing. In this study, a detailed water balance for the Omaruru catchment was created from dam surveys and satellite image analysis. This technical survey was augmented through a series of interviews with urban and rural community members, town councillors, traditional leaders, government officials, and game, livestock and irrigation farmers.

The study found that the 71 farm dams in the upper catchment do not significantly affect river flow in years of average rainfall. However, they are shown to have the potential to influence river flow locally on tributaries of the greater Omaruru River and may affect river flow in a minor way in years of low rainfall. Decreasing trends in river flow over the past 50 years are more likely a result of variability in long-term rainfall patterns.

The perceptions regarding water use vary widely depending on location (upstream versus downstream) in the catchment. Furthermore, there is little or no water demand management in the catchment. Individuals seldom know how much water they use and there are no water metering systems installed to help identify water problem areas. In rural areas, water point committees are often disorganised or non-existent.

There is the need for a more unified effort to educate residents in the catchment regarding trends in rainfall and river flow. Also, there is a need for a system of monitoring and information sharing among basin water stakeholders to steer development in the catchment in a sustainable manner in the face of limited water resources.

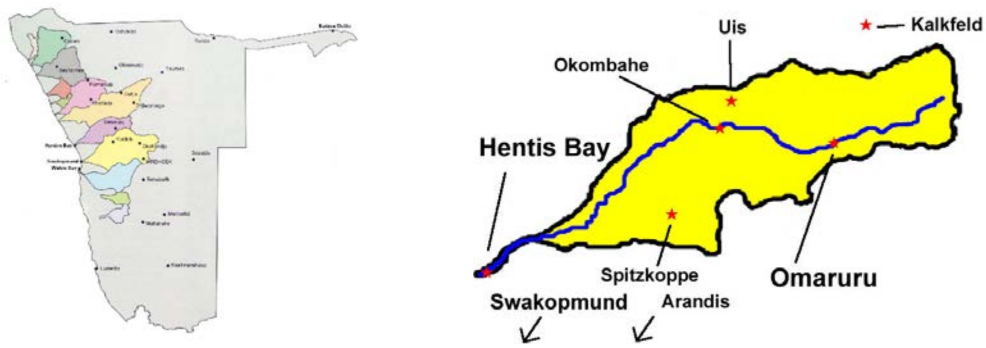
The objectives of this study were to:

- develop a water balance model of the Omaruru catchment from data collected through measuring dams and interviewing major water users and managers in the area, such as inhabitants of towns, irrigation, livestock and game farmers and others. For dams, features like catchment area, dam areas and volumes were determined
- find out how water is used and what the demands in the Omaruru are, especially by towns, commercial, communal and irrigation farmers and others
- determine the types of water management strategies that the users in the area apply and also identify perceptions of water users in the area and compare them to the actual measured and/or modelled situations.

Water use in the Omaruru catchment

There are twelve large catchments of ephemeral rivers in western and north-western Namibia. All of these rivers support a rich assemblage of vegetation and wildlife critical to agriculture and tourism. They also provide water for important towns such as Swakopmund and Walvis Bay. These rivers and their catchments are thus not only important to the people living in the region, but also to the nation as a whole.

The Omaruru River has a catchment area of approximately 13 100km^2. It stretches from Mount Etjo, over 2 080m above sea level, to Henties Bay at the coast and is 330km long. Ninety-eight per cent of the catchment is defined as agricultural area (46% commercial and 52% communal) and the last 2% is within the West Coast Recreation Area.



The Omaruru Catchment (yellow on the map of Namibia) and the centres dependent for water from the catchment.

There are two larger urban centres in the catchment, Omaruru and Henties Bay, and three settlement areas, Kalkfeld, Okombahe and Spitzkoppe. Swakopmund, Uis, Arandis and Rössing Mine lie outside the catchment, but are considered to be part of the basin, as the Omdel water scheme and dam in the lower catchment supplies them with water.

Commercial farmers in the study area farm with wildlife and small and large livestock, and produce vegetables, wine and bottled water. These activities require different forms of water management.

The ultimate source of water for irrigation farmers is boreholes. Some farmers use this water as flood irrigation, although sprinklers and drip irrigation are more common. Drip irrigation is the most water-efficient irrigation system in Namibia today, but not suitable for all types of vegetables.

Livestock and game farmers need to provide animals with sufficient water for drinking every day. The animals can drink water with some silt and mud and dams are thus well suited as water points especially for wildlife. Most dams do not hold water the entire year and it is necessary to have alternative water sources when they have dried up. Most farmers have boreholes, from which they distribute water through a network of pipelines to water points on the farm.

Water demand is a major issue in the Omaruru basin due to a rapid population growth, which results from high birth rates as well as people moving into the basin. Most of the towns and settlements are growing, but the growth rates vary. The number of commercial farm units is fairly stable, without any dramatic changes in the past years. Neither communal farmers nor people who seek employment in the urban centres tend to emigrate out of the area. When new industries establish themselves, people generally arrive from outside the communities.

Three different **biomes** are present in the catchment:

1. In the west the river runs through the central Namib **Desert** with a sparse but diverse perennial shrub flora and with lichen fields that are unique to the area between the Omaruru and Kuiseb rivers
2. Further upstream the rainfall increases and the vegetation changes from desert to **semi-desert** which is dominated by open grasslands
3. The eastern part receives the highest rainfall and consists of **thornbush savannah**.

Riparian forests

Trees are able to establish themselves along the riverbed because of a shallow water table that persists even if rainfall is low. Well adapted to the high variability in flow regimes, most trees can survive several years without river flow. If the river does not carry water for a long period, the water table will sink and the older trees may die. These riparian forests are crucial to the communities along the river in the western part of the catchments.

Soils are generally thin and poorly developed in the western catchments. The arid climate, with its slow weathering producing little organic material, is the main reason for this condition. Alluvial deposits form the most fertile soils in the region and in some areas the alluvial soils can be metres deep. However, they still have limited potential for agricultural production since they are often calcareous and saline. Only in the upper catchment can one find more developed soils, but even there the soil layer is thin and production potential is limited due to relatively low rainfall, high evaporation and water scarcity.

Omaruru Town Municipality is one of a small group of municipalities that operates its own bulk water scheme. Water is abstracted from four boreholes in the immediate vicinity of Omaruru and from two boreholes of the Kransberg scheme east of the town. Omaruru has obtained an abstraction permit from the DWA and is allowed to pump up to 1Mm^3 per year. It also has the highest water consumption per person per day compared with the other towns and settlements in the basin. Okombahe, Henties Bay and Swakopmund get their bulk water from NamWater

Water consumption for some urban centres in the Omaruru basin

Urban centre	Total water consumption (m^3/year)	Population	Water consumed per person/day (litres)
Okombahe	240000	1408	467
Omaruru	855000	4851	483
Swakopmund	2876000	17681	446

(Jacobson et al*,* 1995)

In order to calculate extraction figures for what could be considered sustainable utilisation of water resources in the Omaruru basin, it is critical to have a long-term understanding of river flow and its relation to groundwater recharge. There is however, a significant lack of such data in the literature. The most accurate data available are from the DWA. These records indicate that the Etemba hydrological river flow station has the best and most representative record for river flow in the Omaruru Basin.

Methods

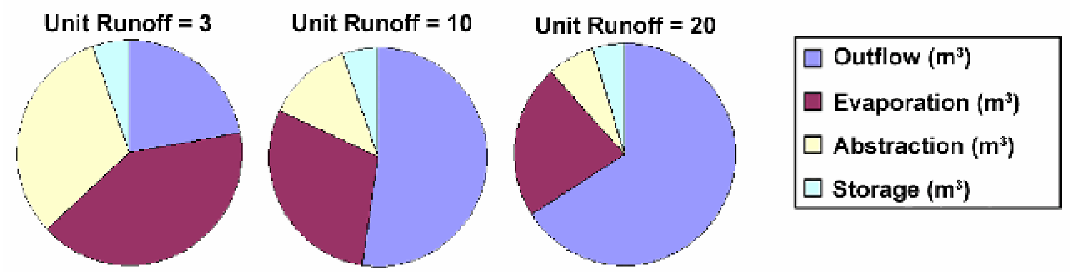
A dam census was conducted to determine the capacity of all dams in the Omaruru catchment area, using a multi-step approach including:

- A survey of 16 earth, concrete and excavated dams in order to determine their depths, surface areas and maximum capacities and the data was used to estimate the capacity of two additional dams.
- Fifty four dams not surveyed were located on existing topographic and satellite images.
- To check the reliability of satellite image location and dam functionality, a DWA helicopter measured the surface areas of the dams by marking their contours.

Basin and inflow models were created and a dam model was extrapolated. Twelve commercial farmers were interviewed to establish a water demand and supply overview. In addition, we conducted a vegetation survey on 12 of the surveyed dams and measured the infiltration rates at all 16 dams.

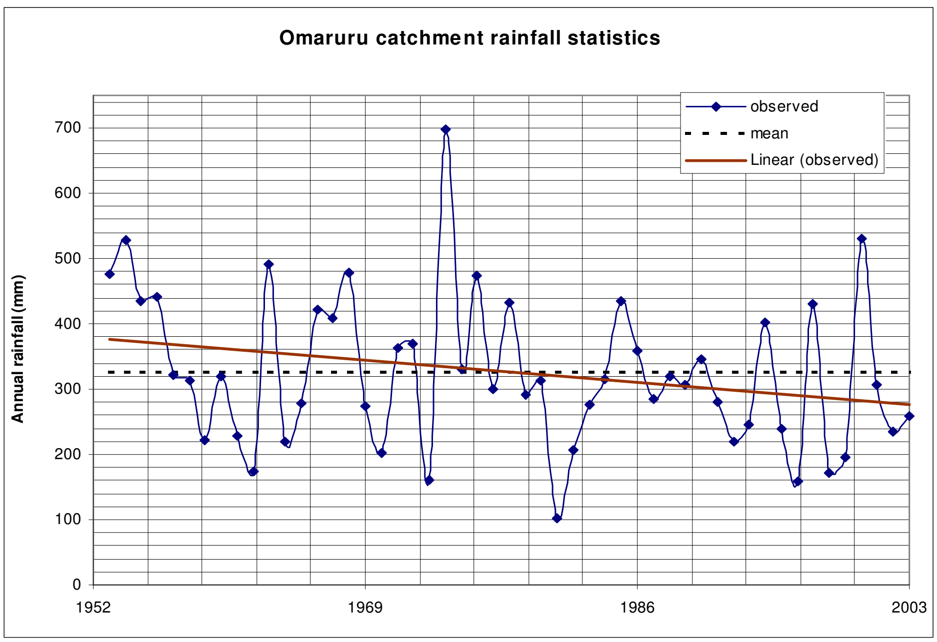
Results

Dams have only a small effect on the flow of the entire river. Even in low flow years, the farm dams can only claim 5% of the total annual runoff. This figure decreases to 2% in years of good runoff. This result is a product of two key result areas. First, the catchments of the farm dams cover only 2.6% of the entire area of the basin. Thus, 97% of the land on which rain falls in the basin will contribute directly to river flow.



Relationship between outflow, evaporation, abstraction and storage at different unit runoff values for a typical dam

Although the dams may not significantly disrupt main channel flow, it does not mean that river flow is not declining and that there is no reason for concern about farm dams. One important point to keep in mind when analysing water in an arid country is that water is not only a scarce commodity, but a highly variable one as well.



Rainfall analysis of Omaruru catchment from 1952 –2003

An average 35% deviation from the mean annual rainfall of 325mm can be expected in the Omaruru basin. In years of exceptional variation, such as in 1996 when only 159mm was received, or in 1976 when the basin saw 697mm of rainfall, a deviation from the mean of over 100% is possible. Because of this stark variability in rainfall, the mean is not a good indicator for the amount of rainfall that can be expected in the basin. It is more useful to know the range of rainfall expected in the region and therefore be able to prepare for both the highest and lowest rainfall years. In the case of the Omaruru basin, such a figure would be 103 – 697 mm of rain per annum.

In addition to the wide annual variability in rainfall, there has been a trend of decreasing rainfall. While a decline of average rainfall of 50mm over the past 50 years may seem alarming, it is impossible to make any statements about the nature of the variation without more long-term rainfall data. Variation in rainfall is common, both on a short and long-term scale. But this recent reduction in rainfall may be related to the suspected decrease in flood intensity and regularity.

In the investigation of the Omaruru we found a significant correlation between river flow and rainfall patterns (p value $< .000005$). While these results indicate that one variable is highly dependent on the other, there is not an exact correlation between the two.

As rain begins to fall, it infiltrates soil by filling in the spaces between soil particles. The rate of infiltration depends on the type of rain and the condition of soil. In the case of soft rain, the soil can absorb rain much faster and there is less runoff. Furthermore, the type and abundance of vegetation in the catchment upstream can affect the runoff of water down the basin gradient and has a significant effect on rates of infiltration. Our results showed an average infiltration rate of 0.88mm/s for the entire catchment. Attached to this figure however, was a high amount of variability suggesting that different farms and farming techniques locally alter the rate of infiltration.

Thus while rainfall can be a good predictor of the amount of runoff that can be expected, there are certainly other factors to consider.

Water demand, supply and management

The municipality of Henties Bay and commercial livestock/game farmers in the upper catchment were the only groups of interviewees that said they did not have a problem with water. All the other groups of people had one or more problems.

It is important to distinguish a permanent critical water situation from one that becomes increasingly worse. During the field trip it became obvious that all areas further away from the main Omaruru River have always had problems both with the supply of water and its quality, while the areas along the Omaruru River have experienced a worsening water situation during the past years. People on the main river channel generally believed that upstream dams caused the water problems, while people living off the main channel believed that it was poor rainfall or type of rainfall that caused water shortages.

The communal farmers interviewed did say that they had water problems, but those were often related to drinking water and not to access for the livestock.

The results showed that all interview groups experience problems with water supply from time to time. There are different reasons for this lack. While commercial farmers are responsible for themselves, communal farmers rely on help from the DRWS. Residents in towns and urban centres rely on the municipalities and the village council. Supply problems were generally related to inability to water livestock/crops at optimum rates. No interviewee suggested that there was a lack of water for domestic purposes, thus suggesting that water problems mainly affect the region on an economic level.

Additional problems experienced by residents in the Omaruru Catchment included:

- dry boreholes and the necessity to deepen or sink new boreholes
- lack of assistance in maintaining boreholes or pumps in communal areas
- water quality – high lime content is not suitable for crop irrigation and the presence of brackish water in boreholes is a problem in communal areas as it forces people to travel long distances for potable water
- dysfunctional water point committees in the communal farming areas as a result of inability to pay for water, illiteracy of committee members and lack of decision-making powers.

A problem specific to communities that live along pipelines, is the accumulation of debt to NamWater because they are unable to pay the monthly fees for water. Water services are cheaper for people who live closer to boreholes than the people living along the pipeline. Settlements close to boreholes only need to supply diesel, and the money available determines how much diesel can be bought per month. Farmers along the pipeline get a monthly bill from NamWater. The taps along the pipeline always have water, compared to prepaid meters that only work as long as there is credit on the card. This makes it possible for the residents to use more water than they can afford. NamWater is threatening to cut the water supply to some of the settlements with the largest debt along the pipeline.

There is a general perception that the river used to flow more often and more regularly. Communal farmers and people downstream claim that they used to have more water and that newly built dams in the upper catchment are the main reason for this. According to the upstream farmers, no new dams have been built in the past years, and the lower water flow downstream is more likely caused by increased demand because of population growth and changes in rainfall patterns.

Communal farmers complained about invisible dams on commercial farms and although none of them had seen one, they had heard about them from reliable sources. Communal farmers and irrigation farmers close to Omaruru expressed similar views on the upstream farmers illegally containing too much water. Possible sources of these beliefs are the presence of visible weirs upstream of communal farmers or they could refer to natural compartments in the bedrock. Commercial farmers, DWA and agricultural extension officers say there are no invisible dams upstream.

Interviews with the different stakeholders raised key issues on inefficiency and losses in the water supply system. These problems include pipe bursts and leakage, illegal connections and the time it takes to repair breakdowns.

Livestock and game

Game farming is becoming increasingly popular, and in the catchment there are many guest and game farms that focus on wildlife rather than livestock. The farmers all said that they changed to game farming because they thought it was easier than keeping livestock. They added that cattle trample much of the grass and that the bushes were under-utilised.

For similar reasons, some farmers changed from cattle to small stock. Small stock both browse and graze, which means that they will utilise the bush more than cattle do. Many of the commercial farmers mentioned bush encroachment as a problem on their farms. Small stock, especially goats, have been used as a way to fight bush encroachment.

Some farmers expressed concern about the future of tourism in the country. Poaching and political conditions were mentioned as the main causes for concern. All farmers, both commercial and communal, had problems with stock theft. For livestock farmers, both commercial and communal, the theft of cattle was a bigger problem than theft of small stock. While the cattle walk around at night, the small stock are usually collected and in the kraal during the night. Cattle are far more valuable than small stock both in social and economic terms.

Whereas commercial farmers often complained about poaching, the communal farmers are more concerned with theft. The result, however, is the same; animals disappear and the farmers lose important income and security.

Conclusions and recommendations

The 71 farm dams found in the catchment can have significant effects on the flow of tributaries in their local catchment areas, but inflow modelling showed that these dams do not significantly affect the flow of the Omaruru River under mean rainfall conditions.

Due to the high correlation between rainfall and runoff, it is most likely that the amount and intensity of rainfall events are the main cause of river flow. The general decrease of river flow over the past 50 years is inevitable due to the long-term decrease in rainfall.

- There is no system for enforcing dam permits in the basin. A system needs to be installed to ensure that new farm dams are within specified limits.

- Development should be encouraged where sufficient water resources are available, and be limited to practices that return maximal social and economical output for minimal water input.

- There is no water demand management in the catchment and perceptions about water problems and water use vary greatly within the catchment. A system of communication should be initiated to allow the various stakeholders in the basin a forum to discuss water-related issues and come up with water demand management guidelines. This system should also inform and teach people in the catchment about historical records of rainfall, river flow and their interrelationship.

- Some water point committees are more effective then others. This system needs to be strengthened through education related to water, borehole maintenance, and community organisation.

- The vast majority of people interviewed in the catchment do not have a good idea about how much water they use. Water metres should be installed on farms and in households to monitor water use, identify water leakage, and encourage water conservation practices.

- Poor land management practices in some regions of the catchment have caused erosion and bush encroachment (upper catchment) and exhausted forage (lower catchment). This is due to overstocking of the land. Rotational grazing and de-stocking during dry periods can be instrumental in reducing land degradation.

- Our modelling showed that rainfall and flow records are sparse and unreliable. There is a need for the installation of electronic recorders to increase climate data and enhance efficiency and availability of recent data.

Bibliography and references

Department of Water Affairs. 1995. *Omdel Dam. State Water Scheme*. Windhoek.
Drewes, H. 2003. *Water supply and demand situation in the Central Namib area*.
Heyns, P et al (eds). 1998. *Namibia's Water, a Decision Makers' Guide*. DRFN. Windhoek.

Hillel, D. 1987 *The efficient use of water in Irrigation*. World Bank. Washington.
Jacobsen, P J, KM Jacobsen and MK Seely. *Ephemeral Rivers and their Catchments.* DRFN. Windhoek, 160 pp.
Mendelsohn, J, A Jarvis, C Roberts, T Robertson. 2002. *Atlas of Namibia. A Portrait of the Land and its People.*Windhoek.
Molles and Dahm. 1992. *Climatic variability and streams and rivers in semi-arid regions. Aquatic ecosystems in semi-arid regions: implications for resource management.* Saskatoon, Environment Canada. pp 197-202.
National Water Policy White Paper. 2000. Ministry of Agriculture, Water and Rural Development. Windhoek.
Stengel, HW. 1966. *The rivers of the Namib and their discharge into the Atlantic.* Desert Ecological Research Unit. Scientific Paper No. 30. Windhoek.
Tyson, PD. 1986. *Climatic change and variation in southern Africa*. Oxford University Press, Cape Town.
Ward, V.1994. *More About Water in Namibia*, Gamsberg MacMillan. Windhoek.
Ward,JD and Bulley,BG.1987. *Aeolian deposits at Henties Bay, Central Namib coast: provenance and engineering implication*. Unpublished report. Windhoek.
Warren and Khogali 1992. *Assessment of desertification and drought in the Sudano-Sahelian region 1985-1991*. UNS Sudano-Sahelian office, New York.

Reports

Alexander & Becker cc. 2000. *Investigation into the amount of surplus weather available from the Omaruru River aquifer*. Report prepared in conjunction with NamWater. Windhoek.
Geohydrology Division.1984. *Evaluation of the groundwater resources of the Omaruru River alluvial aquifer near Nei-Neis.* Report by DWA, South West Africa (Namibia). Windhoek.
Geohydrology Division, Namibia. 1984. *Report detailing groundwater resources, abstraction and the effects of flood events on recharge to the Omaruru River from Omaruru Town to Omburo.* Windhoek.
Geohydrology Division. 1990. *A preliminary evaluation of the groundwater resources of the Omaruru River at Okombahe*. Windhoek.
Hydrology division. 1995.*General Hydrological Conditions and Characteristics of Surface Water schemes in Namibia.* Windhoek.
Meltzer, W. 2003, *Surveying notes*. Hydrologist, Division of Water Affairs. Windhoek.
NamWater 2000. *Pre-feasibility study on bulk water supply for Kalkfeld*. Report by Infrastructure Planning. Windhoek.
Natural Resource Account Project Namibian, 2003, *Water Statistic report.* Windhoek
Windhoek Consulting Engineers. 2000. *Analysis of Present and Future Water Demand in Namibia.* Windhoek.

Correspondence cited

Eggers, A. 2004. E-mail to G. van Langenhove. Runoff and inflow at stations on the Omaruru River.
Eggers, A. 2004. E-mail to G. van Langenhove. Rainfall, Omaruru River catchment.
Drewes, H. 2003. E-mail to G. van Langenhove. Water consumption figures from the Omdel and its consumers.

Holtzhausen, F. 2003. E-mail to G. van Langenhove. Tariff and consumption of water at Swakopmund.
Husselmann, A. 2004. Omaruru list of returns (water consumption of commercial gardens at Omaruru). E-mail to G. van Langenhove, January 24, 2004.
van Wyk, B. 2004. E-mail to G. van Langenhove. From VanWyk presentation.
van Wyk, B. 2004. E-mail to G. van Langenhove. “Herewith the scheme production data (and graphs) of the Cental Namib Area for the period 1997-2002.”