WATER USE PATTERNS: A Study of High-Income Residences

SEPTEMBER 1994 - JUNE 1995

Occasional Paper No.5

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Elias S. Shanyengana

Edited by

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ABBREVIATIONS

DRFN: Desert Research Foundation of Namibia.

MAWRD: Ministry of Agriculture, Water and Rural Development.

SDMR: Swedish Diplomatic Mission's Residences.

SIDA: Swedish International Development Authority.

WHO: World Health Organisation

ACKNOWLEDGEMENTS

This document is the result of a collaborative effort between the Swedish diplomatic mission, the Swedish International Development Authority (SIDA), the Desert Research Foundation of Namibia (DRFN) and the Windhoek municipality.

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EXECUTIVE SUMMARY

This study was carried out by the Desert Research Foundation of Namibia (DRFN), and sponsored by the Swedish International Development Authority (SIDA). The study investigated water-use patterns within the Swedish diplomatic residences, with the aim of identifying main uses of water and areas of water wastage within households, creating awareness, as well as investigating appropriate water-saving techniques. Input from the Windhoek City Engineer's Department was sought to ensure that the study tied in with the Municipality's larger objective of decreasing water demand through demand management strategies.

Owing to natural adverse hydro-climatic conditions, Namibia is the driest country in Southern Africa. Water is therefore a scarce and finite resource, and must be used sparingly and judiciously. This scarcity is manifested in the severe water shortages faced by some parts of the country, including Windhoek, the capital city.

Early 1995, the Windhoek municipality estimated that if the current "runoff drought" persists and a 30 percent savings on the current consumption rate is not achieved by the end of August 1995, the City's water reserves will only last until February 1997. Considering that only about 14%, 11% and 8% savings on the water consumption were achieved during April, May and June respectively, the major dam supplying the City (the Von Bach Dam at Okahandja) could dry-up by November 1996. This date would creep nearer every month, unless the required water savings is achieved. However, with good rains, inflow into the dams supplying the City, and only if the growth of water demand is kept at 5 percent per annum or below, the water resources could meet the City's demand until the year 2003. It is therefore imperative that water demand management strategies are investigated and implemented.

Foreign diplomatic missions, excluding a few, have the highest per capita water consumption in Windhoek. Daily water consumption within foreign diplomatic residences ranges from about 0.6 m3/day (600 litres/day), to about 15.5 m3/day (15,500 litres /day).

The seven residences studied are located within some of Windhoek's high-income suburbs namely: Eros Park, Ludwigsdorf and Klein Windhoek. The Swedish diplomatic residences covered in this study have a mean total daily water consumption of 2.855 $\pm$ 1.075 m3/day (about 2,855 litres/day), and a mean per capita consumption of 0.884 $\pm$ 0.344 m3/person/day (about 800 litres/person/day). The study found that about 82 percent of the total daily water consumption was mainly used for watering the garden, a mean daily consumption of about 2.213 m3/annum (including swimming pool water consumption).

An average swimming pool (25 m2) within the study residences, if uncovered, could loss up to 0.233 m3/day (233 litres/day) to evaporation, which is about 11 percent of the total 80 percent [1]external consumption in the household, and 9 percent of total household water consumption. Such a water loss represents about 85 m3/annum (equivalent to N$450, 00), which is more than the mean monthly water consumption.

Two of the Swedish diplomatic missions loose about N$791,21 per year due to evaporative loss from uncovered swimming pools. The total cost of purchasing the recommended pool covers (for the two residences) could be recovered and a savings of N$592,42 incurred over a period of two years.

Evidently, there is immense potential for water demand management at the studied residences, and Windhoek residences in general. However, more detailed information on water-saving techniques and alternatives needs to be readily available through specialised departments e.g., within the municipality.

There is an urgent need for the dissemination of information on water-savings techniques and alternatives. Furthermore, the implementation of the municipal water-saving policy is needed to guarantee the judicious and sparing use of the City's water resources. Such a policy would promote public water-savings awareness, and would also gear the private sector such as nurseries, but also plumbers, and hardware suppliers toward the marketing of water-saving goods and services. Only then can water demand management for Windhoek succeed.

[1] External water consumption refers to water use outside the house (such as in the garden and swimming pool).

INTRODUCTION

The extremely low and variable rainfall, as well as high potential evaporation rates contribute to make Namibia one of the driest countries in Southern Africa. This implies that the water resources are scarce and finite, and must therefore be used judiciously and sparingly.

Most Namibian settlements such as Windhoek were established at localities of permanent natural surface waters such as springs, a point which emphasises the scarcity and role this resource plays as the principal limiting factor in arid and semi-arid environments (5). Windhoek's water resources have since dwindled due to dropping regional water tables (2), mainly as a result of increased population pressure and development (resulting into an increased water demand) and as a result, additional water sources had to be considered (6).

Similar to towns such as Gobabis and Khorixas, Windhoek has a serious problem; that of meeting its increasingly high water demand (6). With a population estimated between 180,000 to 200,000 people, the high water demand stems mainly from a very limited water resource base, increasing development and population pressure, as well as the unsparing use of water by some citizens. Up until recently, attempts to contain the soaring water demand have been limited to the introduction of the block tariff system in 1992, and a series of short-lived water awareness campaigns, conducted by the municipality. Such awareness campaigns include the very successful 1981/82 campaign, which resulted in a 45% savings on water consumption (1), and an unsuccessful one which was introduced during the first half of 1992 (6). The 1992 campaign, however, achieved some success later in the year, after the introduction of block tariffs.

Aggravated by the current "run off drought" situation, Windhoek's water problem has reached alarming heights, such that the City is now faced with a serious water shortage. The water resources required to meet the increasing demand for the Central area of Namibia (Windhoek included) until 2020 would require an investment of about N$ 2 400,00 million (5).

Recently, the Windhoek municipality announced that if the current runoff drought persists and a 30% savings on the current rate of water consumption is not achieved by August this year (1995), the water resources available to the City would only last until December 1996 (1, 4).

The current water situation has fuelled an awareness campaign in both electronic and print media, as well as the enforcement of water saving techniques by the municipality. For instance, negligent and injudicious use of water such as washing cars with hosepipes, watering gardens during the periods 10:00 am and 16:00 p.m., as well as having an uncovered swimming pool, is liable to a fine not exceeding N$2 000,00 or imprisonment not exceeding a maximum period of six months (4).

The water saving campaign mainly targets Industrial and commercial users, the municipality itself, as well as residences of foreign diplomatic missions and other high income households, such as found in Erospark, Ludwigsdorf , Klein Windhoek and Pionierspark suburbs.

There are about 33 foreign diplomatic missions in Namibia, and except for a few, these missions have some of the highest per capita water consumption in Windhoek. However, the 1992/93 water consumption figures indicate a decrease in water consumption within most diplomatic missions (6). Additional efforts to save water within some of the missions include closer links with the municipality (e.g., the British High Commission), appropriate gardening (e.g., at the American embassy), and this SIDA sponsored study to investigate water use patterns and enhance water demand management within the Swedish diplomatic residences.

Having funded an earlier study on water use within the Kuiseb River Catchment by University of Namibia students and the DRFN, The Swedish International Development Authority (SIDA) made funding available for the investigation of water use within Swedish diplomatic residences in Windhoek. The Embassy Water Audit (EWA) as was latter referred to, engaged the Swedish embassy staff, the Windhoek municipality, and the DRFN, during the period September 1994 to September 1995. The study aimed at creating awareness amongst the embassy staff and investigating water use patterns, as well as the possibility of implementing simple water demand management strategies within the residences. The acquired information could then be applied (where possible) to other foreign diplomatic residences, other high income residences (e.g., in Erospark, Ludwigsdorf and Klein Windhoek) and Windhoek residences at large. Thus the study contributes towards the larger Windhoek municipality's attempt to reduce water demand through demand management strategies.

MATERIALS AND METHODS

Description of studied residences:

The study was carried out on seven Swedish diplomatic residences, which are located within some of Windhoek's high income suburbs, namely Eros park, Ludwigsdorf and Klein Windhoek. The residences have a mean erven area (plot size) of 1167± 495 m2, 233± 180 m2 lawn area, 25± 10.4 m2 swimming pool surface area and a mean daily water consumption of about 2.855 ± 1.057 m3/day (recorded between 1991 and 1994). The number of people per household varies from 1 to 7(the mean is about 3.5 persons), and the mean per capita water consumption is about 0.884 ± 0.344 m3/person/day. This is comparable to other high income residences in Windhoek; average erven area 1760 m2 (1993 municipal survey), 3 - 4 people per household and the average swimming pool surface area is about 8 x 4 m, that is 32 m2 (4).

Data collection

Data on water consumption between the period 1989 to 1994 were obtained from the Windhoek municipality. Additional information such as the number of persons per household was provided by the residents. The gardener at each residence recorded water meter readings before and after watering the garden, in order to determine external (outdoors) and [2]internal (indoors) consumption, during the study period. For each watering day, the meter reading difference was taken to represent external consumption.

To consolidate the obtained figures, additional water meters were installed at two of the residences, in order to measure total external consumption.

Similarly, the time spent watering the lawn was recorded and discharge rates measured, in order to determine total lawn consumption and consequently the consumption per square metre of lawn. Mean monthly potential evaporation figures obtained from the Weather Bureau were used to calculate evaporation from swimming pool surfaces. The current municipal block tariffs (i.e. 01 august 1995; N$ 5,13/m^3 for any water consumption above 80 m^3/month) were used to estimate the cost incurred through water wastage.

Gardeners at the Swedish diplomatic residences work mostly between 08:00 am and 13:00 p.m.

[2] Internal water consumption refers to water use within the house (such as for bathing and cooking)

This implies that any external water consumption such as car washing and watering of lawns between 13:00 p.m. on that day and 08:00 a m the following day would have been calculated as internal water consumption. The external consumption figure in this report therefore only represents a conservative estimate of the actual external consumption.

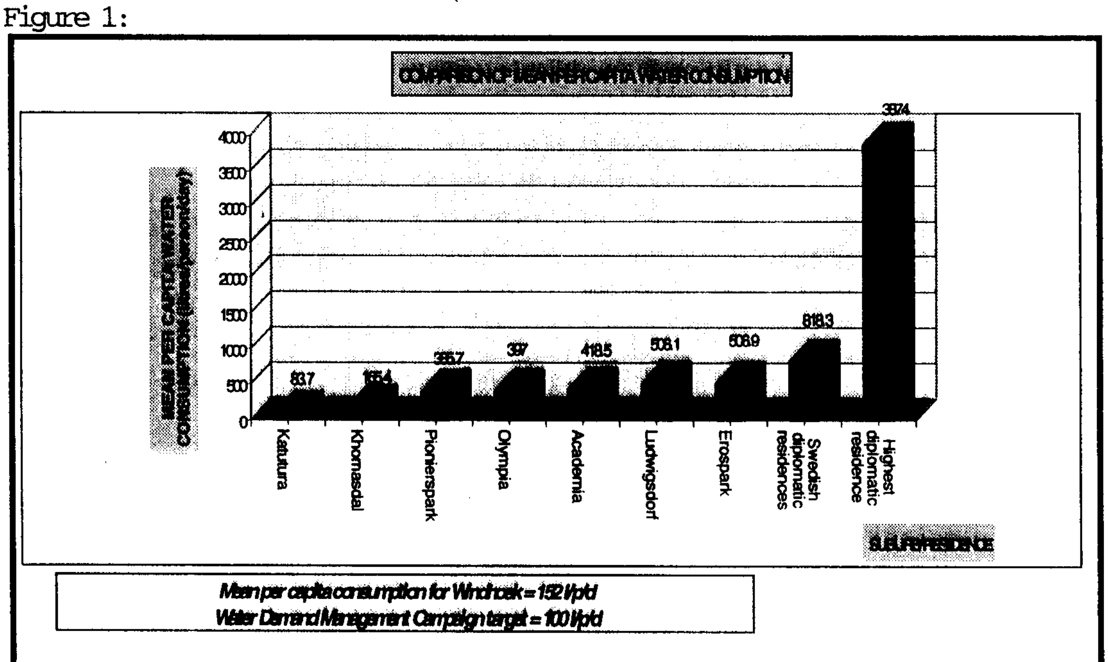
The seventh residence (Conrad Rust str. 14) was not thoroughly studied because it is relatively newly acquired and there was no permanent gardener to see to the day to day recording of water consumption. As a result, water consumption data from this residence is not included unless otherwise stated.

RESULTS

a) General

Foreign diplomatic residences have some of the highest per capita water consumption in Windhoek. The figure below, presents a comparison of per capita water consumption between Windhoek's suburbs and two diplomatic missions, namely: the Swedish diplomatic residences, and the highest recorded water consuming diplomatic residence in the City.

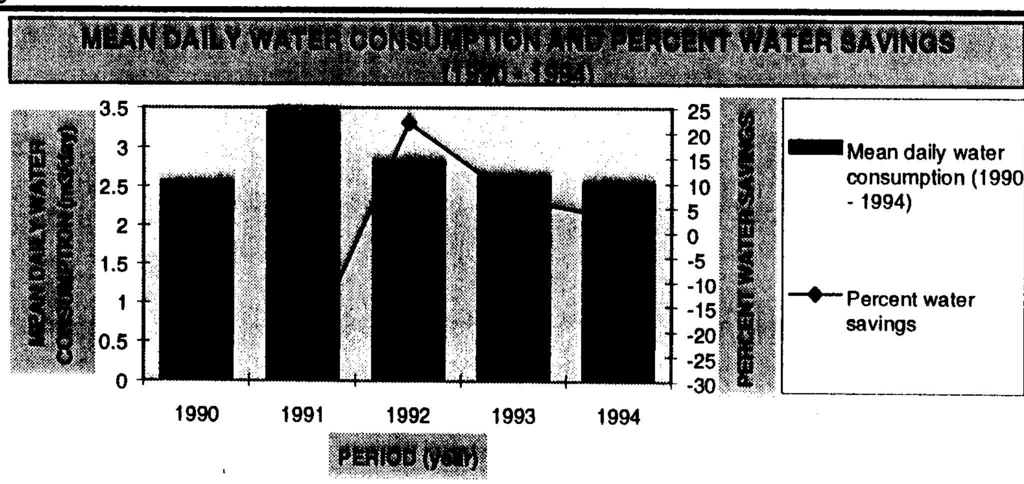
Figure 1:



The figure above, indicates that per capita water consumption at the highest recorded diplomatic residence is about eight times the per capita consumption in a Windhoek high-income residence, and five times that of an average Swedish diplomatic residence.

Most Swedish diplomatic residences were acquired during 1991, resulting in an increase in mean water consumption at the residences of about 26%, compared to water consumption in 1990. The consumption then steadily decreased at an annual rate of about 11% over the period between 1991 and 1994 as indicated below, figure 2.

Figure 2:



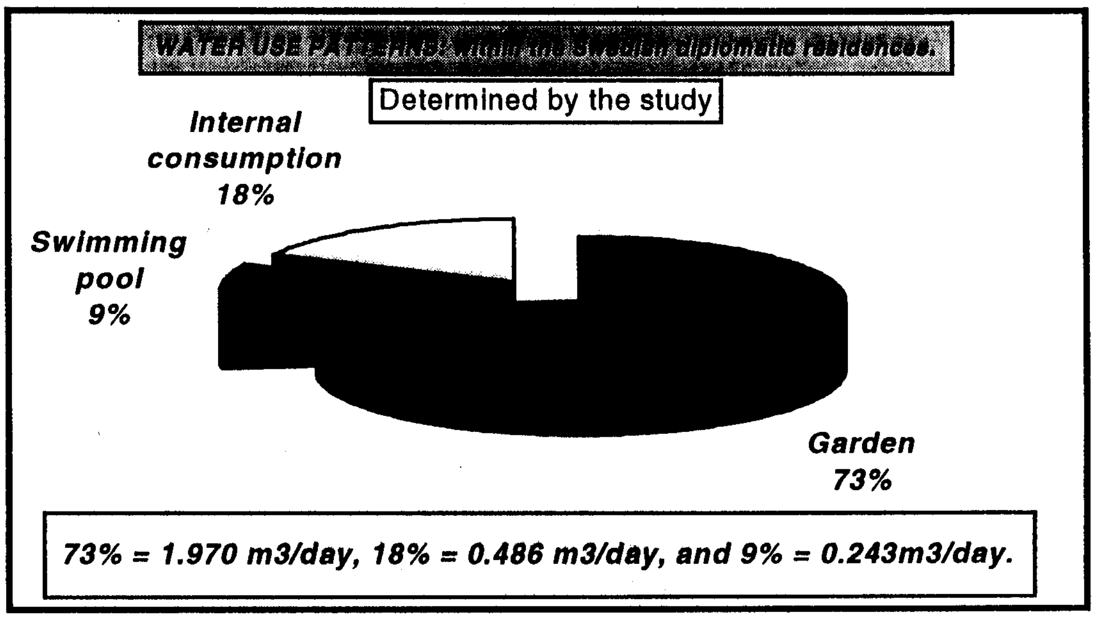
Upon taking up residence water consumption increased by 26%
From 1991 onwards overall saving is about 11% per annum.

Table 1: Mean daily water consumption, erven area and percent external consumption

HOUSE	MEAN CONSUMPTION: 1991 - 1994 (m3/day) (4)	MEAN CONSUMPTION: study period. (m3/day)	ERVEN AREA (m2)	PERCENT EXTERNAL CONSUMPTION
De Jager 96	2.382		1550	
Becky 10	2.875	2.808	1781	87
Kasteel 32	2.521	2.208	1287	88
Gever 49	1.466	1.423	582	75
Stein 10	4.634	3.860	1220	
Erosweg 125	3.251		582	
MEAN	2.885	2.699	1167	82.75

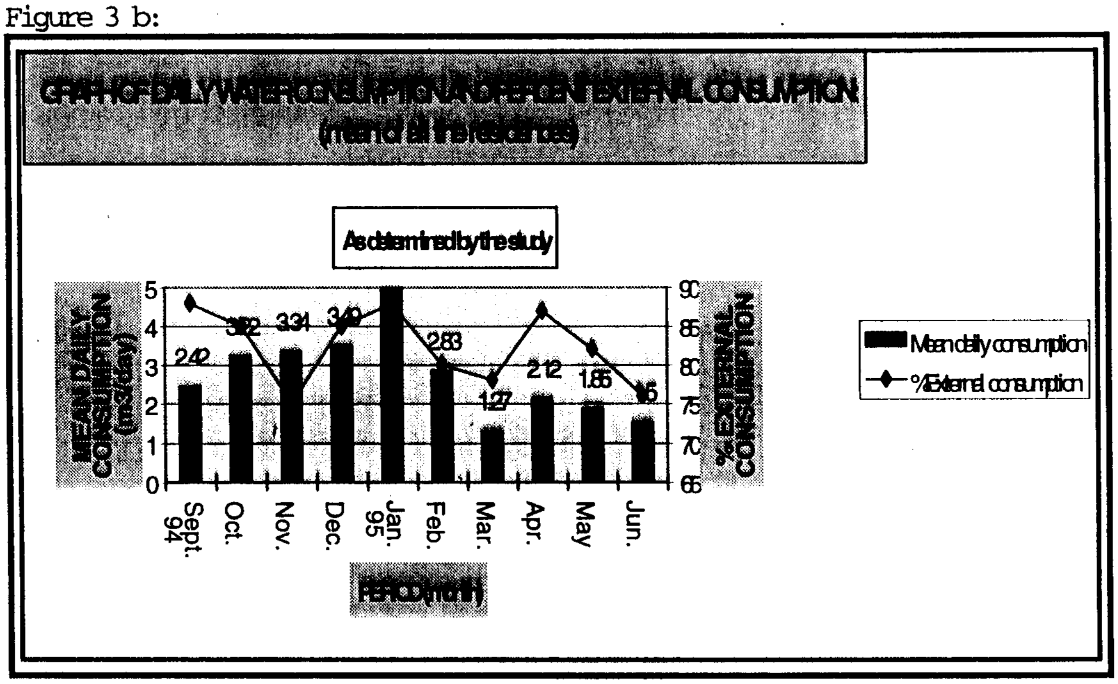
Table 1: During the period 1991 to 1994, a mean daily water consumption of about 2.855 m3/day, that is about 85.65 m3/month was recorded, whilst a mean daily water consumption of about 2.699 m3/day was recorded during the study period.

Figure 3a:



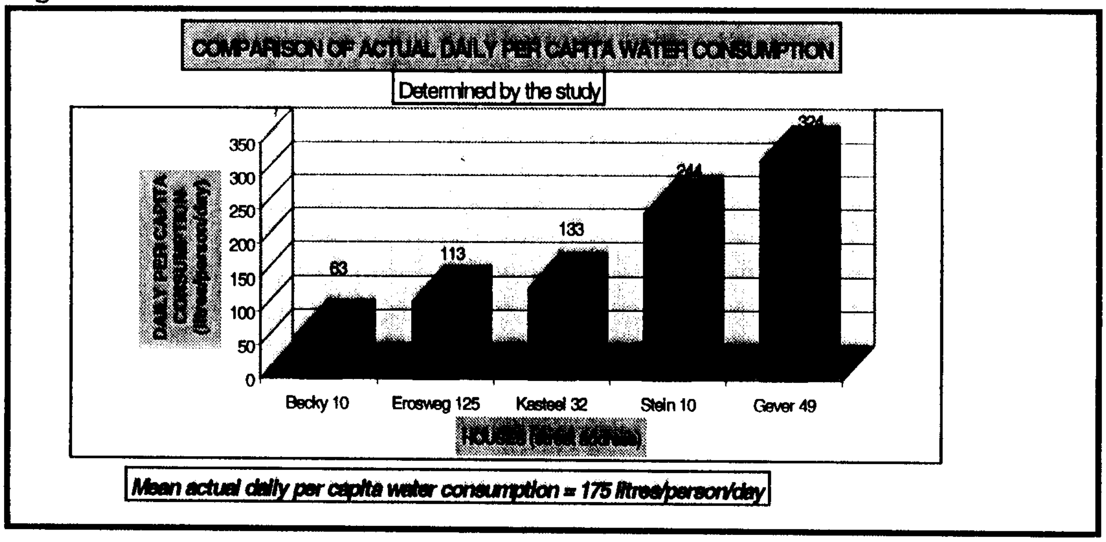
As shown in the above figure, the study found that about 82 percent (2.213 m3/day) of the total mean daily water consumption was used mainly as external consumption, and the remaining 18 percent (0.486 m3/day) as internal consumption. The 82 percent external consumption represents water used by the garden (73 percent), and by the swimming pool, that is, if it is uncovered (9 percent).

Figure 3 b:



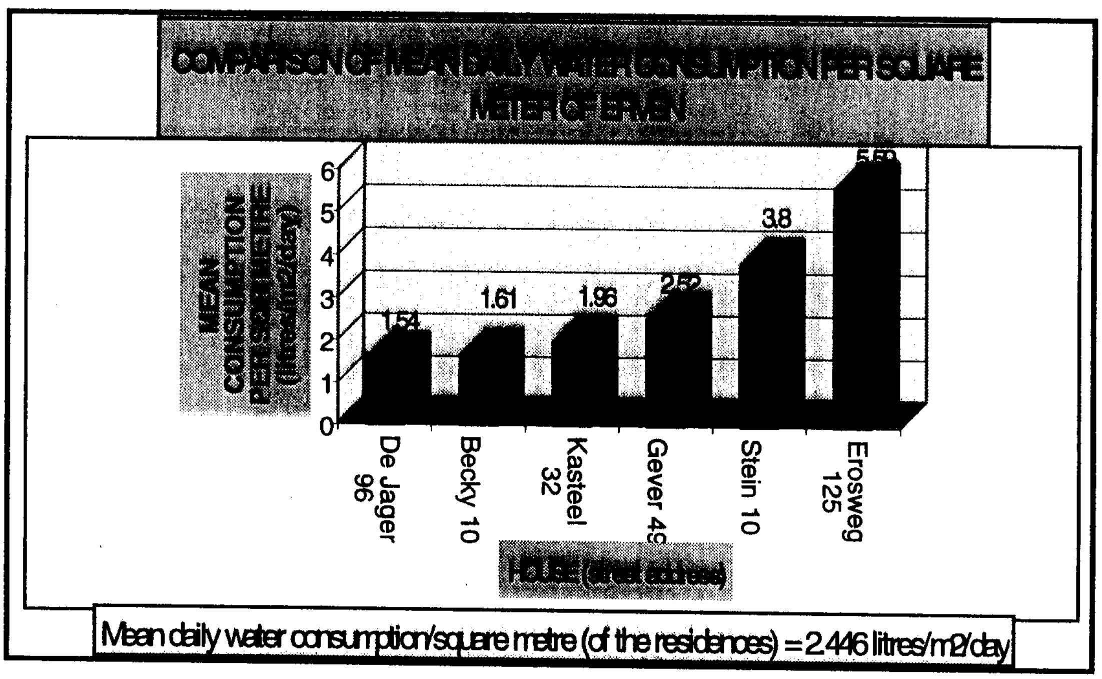
Above, the figure shows the mean daily water consumption and percent external water consumption at the residences, during the study period.

Figure 4:



The study shows a mean [3]actual daily per capita water consumption of 0.175 m3/person/day (175 litres/person/day). Above, figure 4 shows the actual daily per capita water consumption for each of the residences.

Figure 5:



[3]Actual per capita watef consumption refers to the actual volume of water used by each individual within the house; determined by dividing the internal water consumption by the number of people staying at the residence.

Above, figure 5 presents water consumption per square metre (erven area) for each residence. The figure also indicates residences of low (left; De Jager str.96 has the lowest water consumption), and high water consumption.

b) Individual household:

This section presents graphs of mean daily water consumption (1990 - 1994) as well as tables of mean daily water consumption and percent external consumption, as determined for the individual households. The section also provides a water consumption profile for each residence.

House 1: Kasteel str. 32.

Erf. 2666WW
Erven area: 1287 m2
Lawn area: 61 m2

Determined from municipal data (1991 - 1994)

Mean daily water consumption: = 2.521 m3/day
Mean water consumption per erven area: = 1.96 litres/m2/day
Per capita water consumption (1993): = 1.11 m3/person/day.

Determined by this study (Sept. 1994 - Jun. 1995)

Mean total daily water consumption (during study period): = 2.208 m3/day
Mean external water consumption: = 1.943 m3/day (88%).
Mean internal water consumption: = 0.265 m3/day (12%).
Actual mean per capita water consumption: = about 133 litres/person/day.

The residence has the smallest lawn, which is watered everyday from Monday to Friday by means of a sprinkler system. It also has a 4 X 9 m swimming pool with a pool cover. Amongst the study residences, Kasteel str.32 has the third lowest water consumption (fig.5).

Figure 6a:

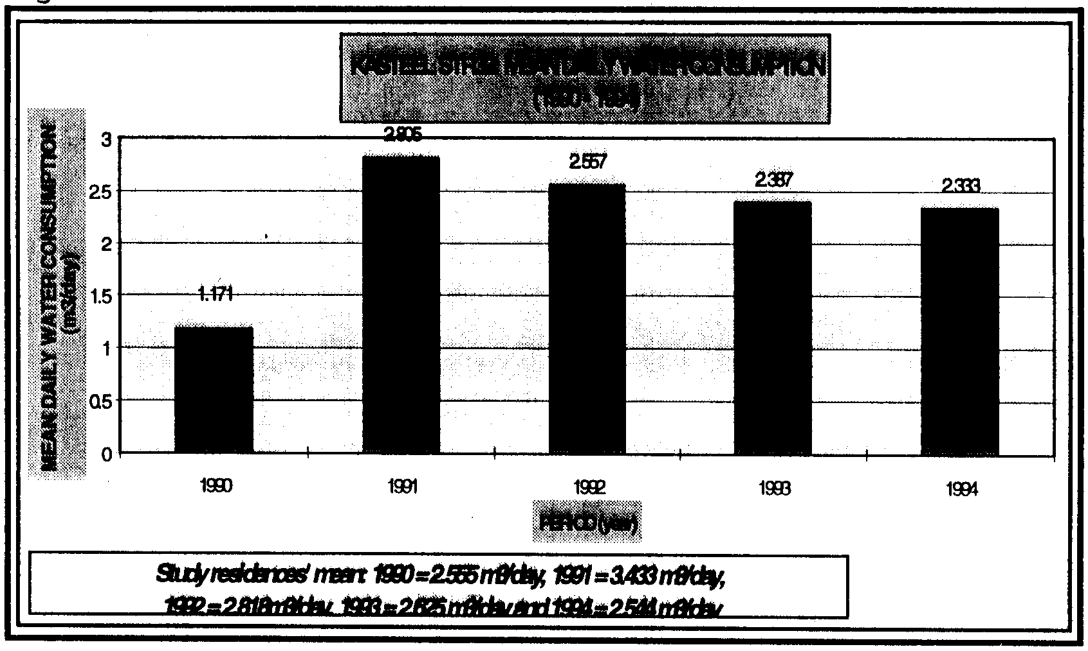
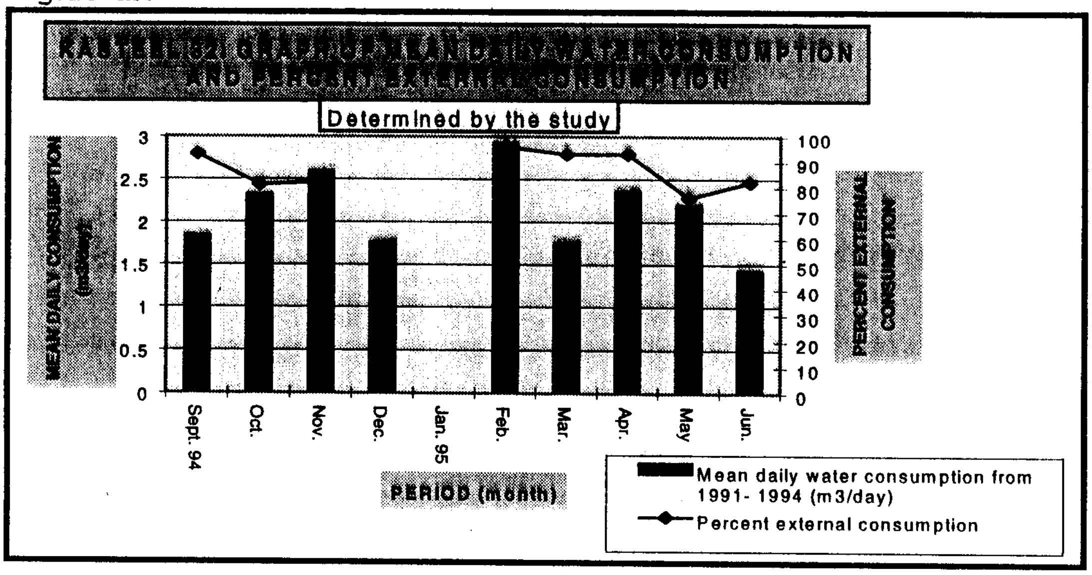


Figure 6b:



House 2: Gever str. 49

Erf. No. 2743 KW
Erven area: 582 m2
Lawn area: 217 m2

Determined from municipal data (1991 -1994)

Mean total daily water consumption: = 1.466 m3/day
Mean water consumption per erven area: = 2.52 litres /m2/day.
Per capita water consumption (1993): = 1.3 m3/person/day.

During the study period (Sept. 1994 - Jun. 1995)

Mean total daily water consumption: = 1.423 m3/day.
Mean external water consumption: = 1.067 m3/day (75% of total).
Mean internal water consumption: = 0.356 m3/day i.e. 356 litres/day.
Actual per capita water consumption: = 324 litres/person/day.

The residence's lawn is watered twice per week with a hosepipe. This house also has a 4 X 9 m swimming pool without a pool cover. Evaporative water loss from the swimming pool amounts to about 335 litres/day, which is equivalent to 10,050 litres/month; about N$ 53,27/month. Of the six residences studied, Gever str.49 has the third highest water consumption (fig.5).

Figure 7a:

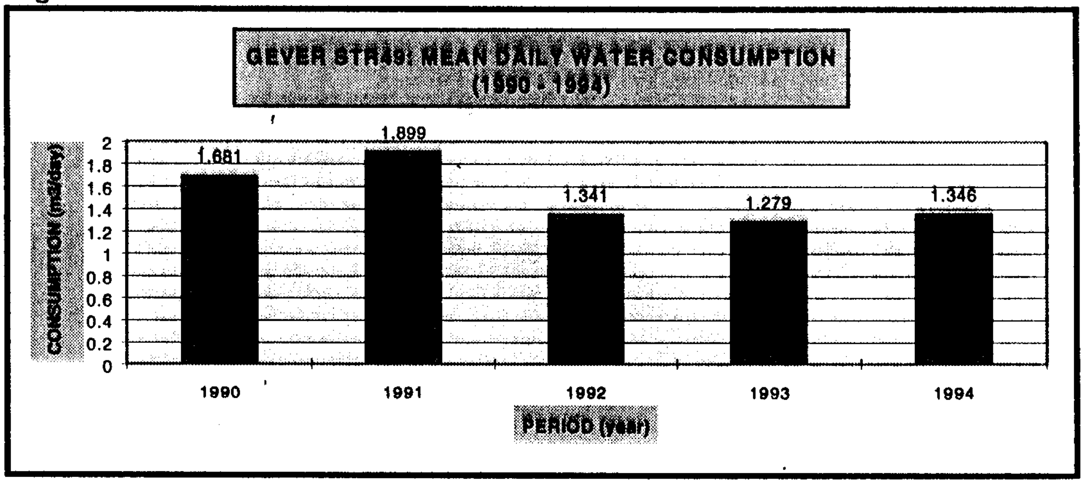
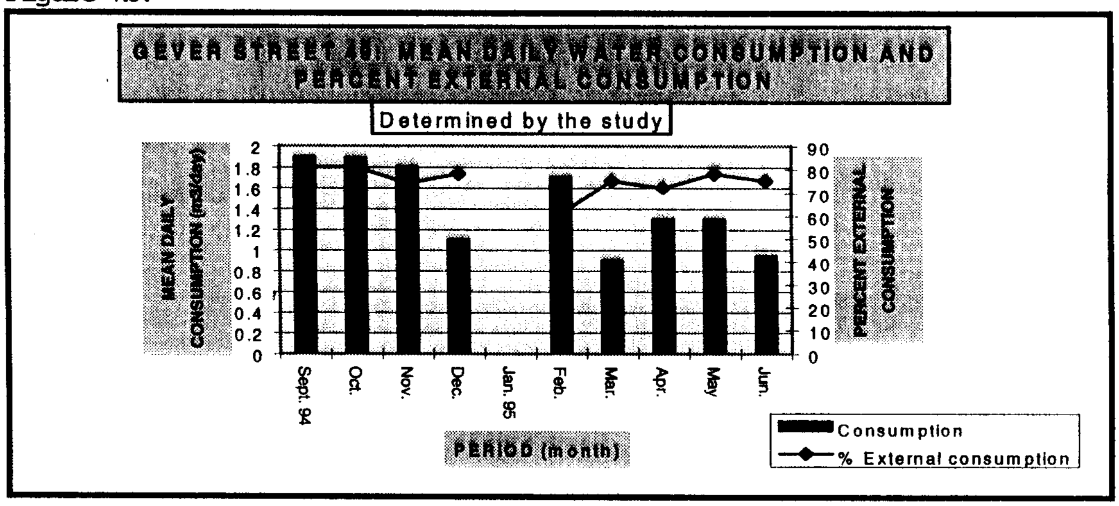


Figure 7b:



House 3: Stein str. 10

Erf. No. 2592 KW
Erven area: 1220 m2
Lawn area: 298 m2

Determined from municipal data (1991 -1994)

Mean total daily water consumption: = 4.634 m3/day
Mean water consumption per erven area: = 3.80 litres/m2/day.
Per capita water consumption (1993): = 0.860 m3/person/day.

During the study period (Sept. 1994 - Jun. 1995)

Mean total daily water consumption: = 3.860 m3/day.
Mean external water consumption: = 3.127 m3/day (81% of total).
Mean internal water consumption: = 0.733 m3/day i.e. 733 litres/day.
Actual per capita water consumption: = about 244 litres/person/day.

The residence has the second largest lawn, which is watered twice per week with a sprinkler system. This residence also has the most exotic garden, of all the residences. It has a 8 x 3.75 m2 swimming pool with a pool cover. Of the six residences studied, Stein str.10 has the second highest water consumption (fig.5).

Figure 8a:

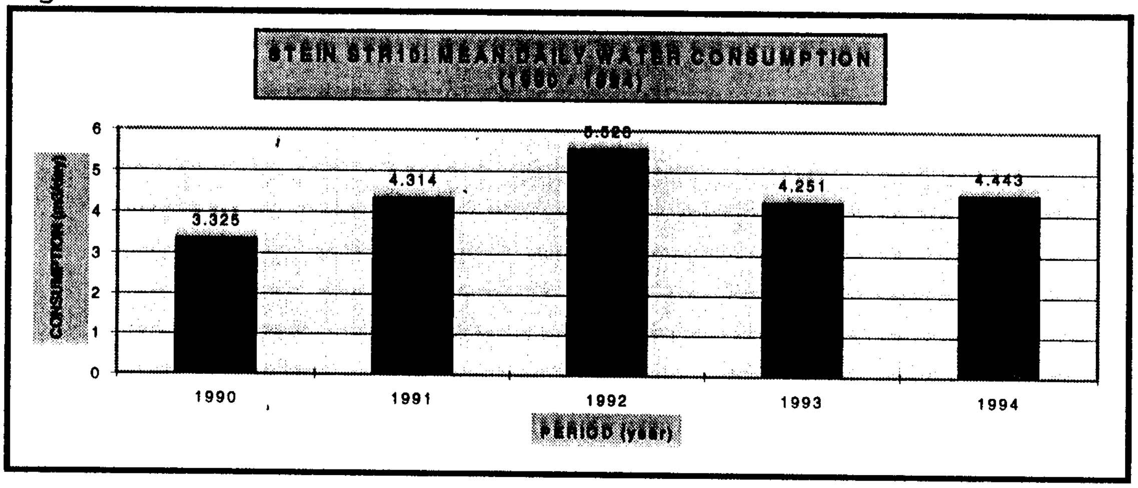
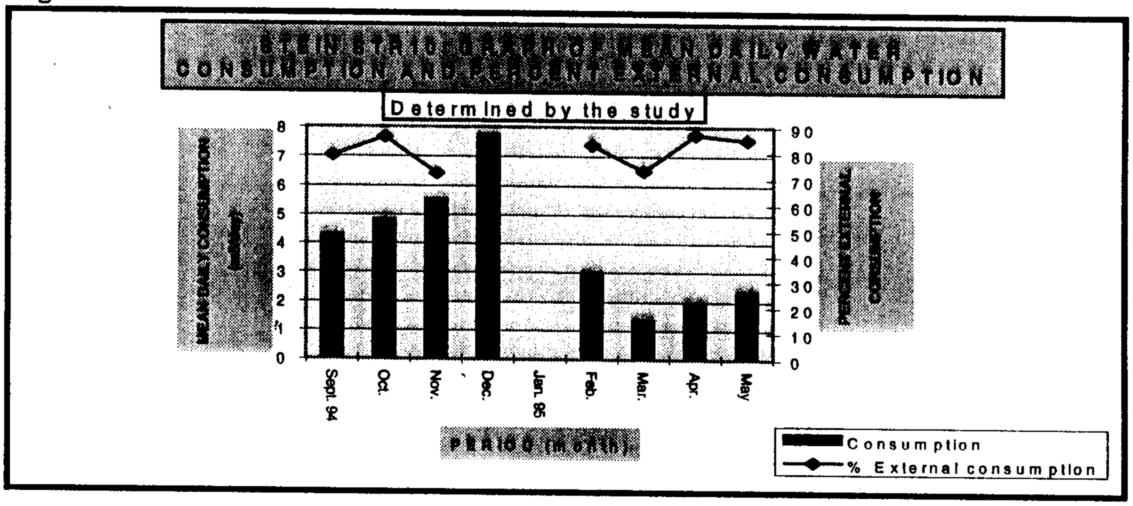


Figure 8b:



House 4: Becky str. 10
Erf. No. 2699 KW
Erven area: 1781 m2
Lawn area: 560 m2

Determined from municipal data (1991 -1994)
Mean total daily water consumption: = 2.875 m3/day
Mean water consumption per erven area: = 1.61 litres/m2/day.
Per capita water consumption (1993): = 0.480 m3/person/day.
During the study period (Sept. 1994 - Jun. 1995)
Mean total daily water consumption: = 2.808 m3/day.
Mean external water consumption: = 2.471 m3/day (88% of total).
Mean internal water consumption: = 0.337 m3/day i.e. 337 litres/day.
Actual per capita water consumption: = 63 litres/person/day.

The residence has the largest erven and lawn areas. The lawn is watered twice per week with a sprinkler system. This residence also has a 2.6 x 7 m swimming pool with a pool cover. Of the six residences studied, Becky str.10 has the second lowest water consumption (fig.5).

Figure 9a:

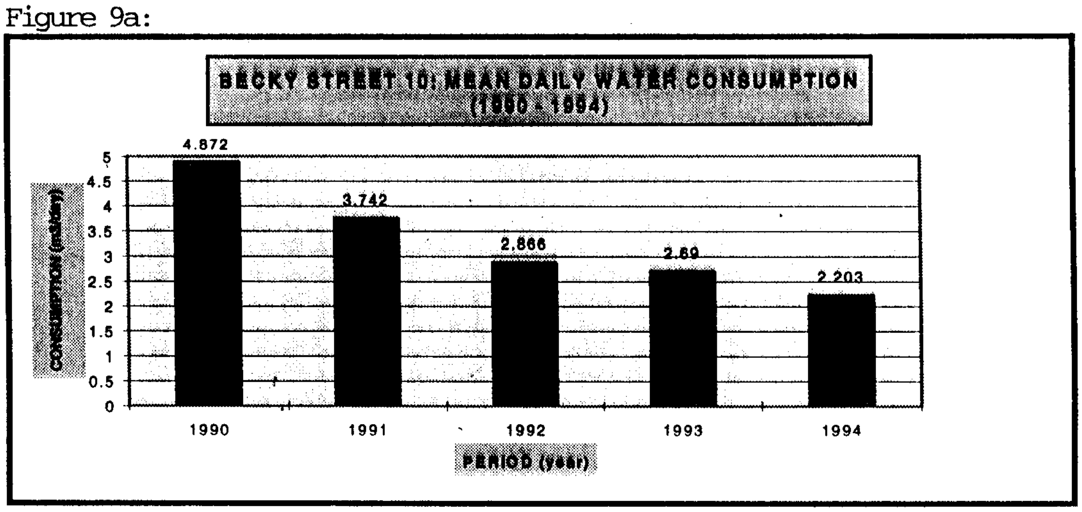
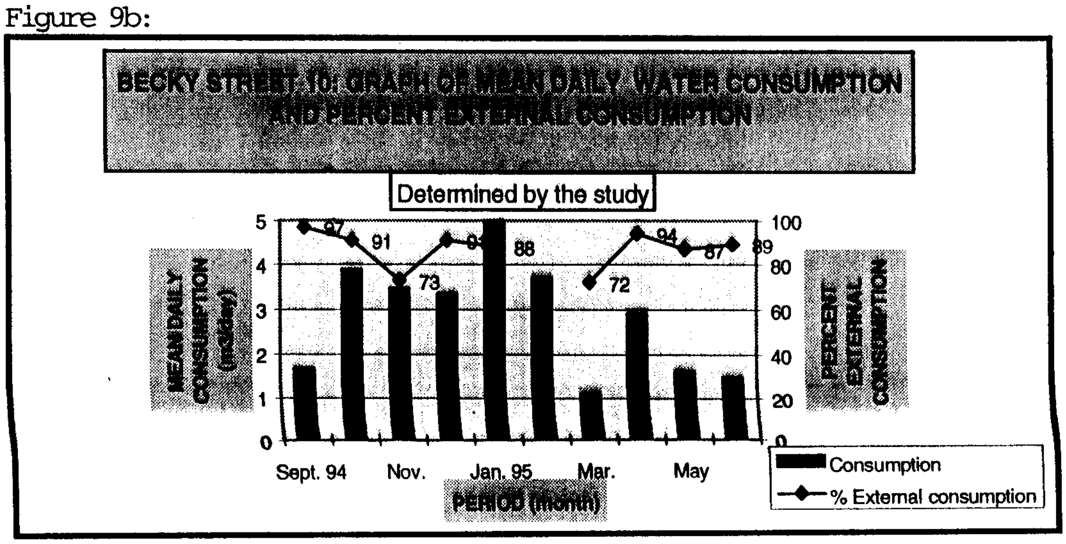


Figure 9b:

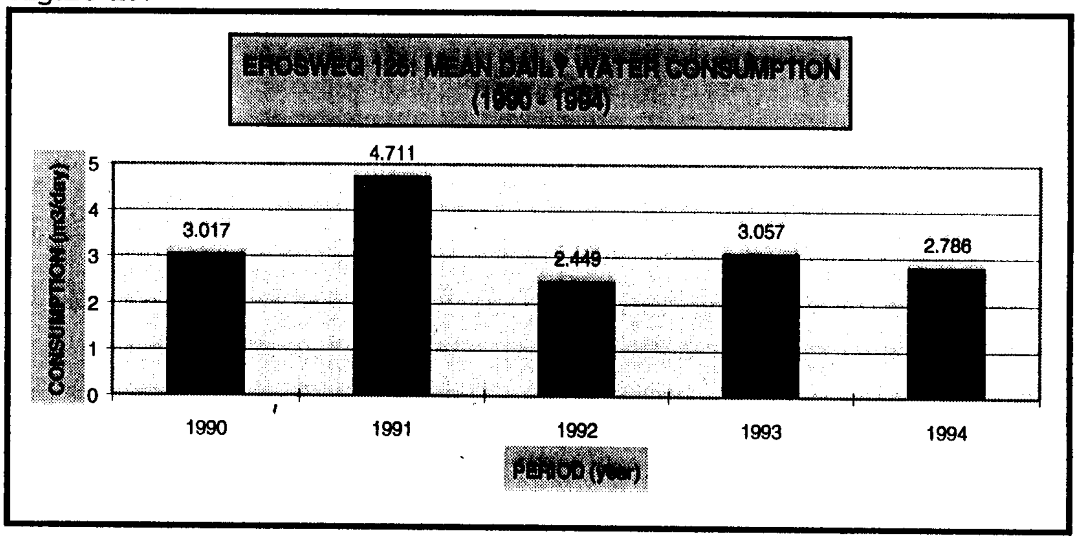


House 5: Erosweg str. 125
Erf. No. 2743 KW
Erven area: 582 m2
Lawn area: 128 m2

Determined from municipal data (1991 -1994)
Mean total daily water consumption: = 3.251 m3/day
Mean water consumption per erven area: = 5.59 litres/m2/day.
Per capita water consumption (1993): = 0.770 m3/person/day.

During the study period (Sept. 1994 - Jun. 1995)
Actual per capita water consumption: = 113 litres/person/day.
The lawn was watered twice per week with a hose-pipe. However, during the study period, it was hardly watered. The residence has a 4 x7.6 m swimming pool with a pool cover. Of the six residences studied, Erosweg str.125 has the highest water consumption (fig.5).

Figure 10:

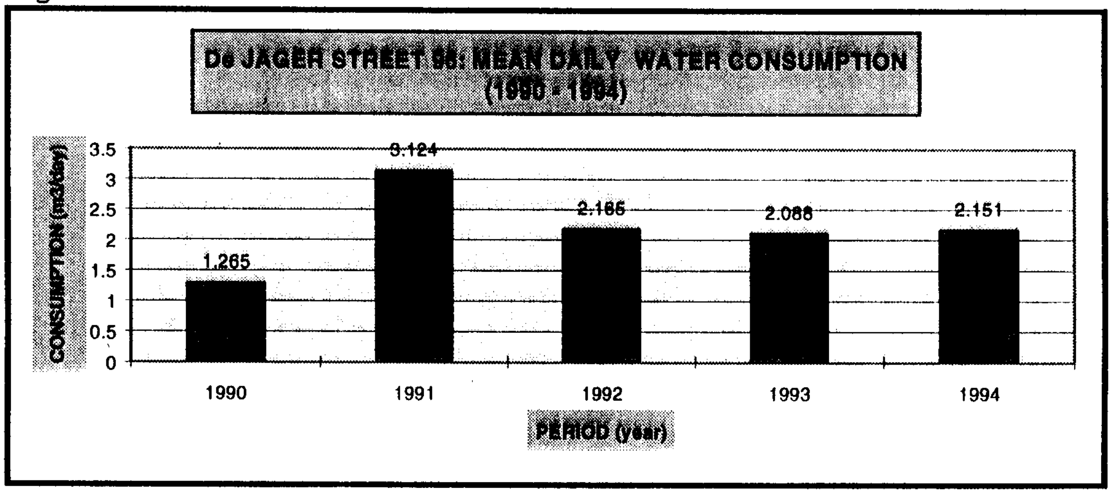


House 6: De Jager. 96
Erf. No. 49 EP
Erven area: 1550 m2
Lawn area: 133 m2

Determined from municipal data (1991 -1994)
Mean total daily water consumption: = 2.382 m3/day
Mean water consumption per erven area: = 1.54 litres/m2/day.
Per capita water consumption (1993): = 0.390 m3/person/day.

The lawn was watered twice per week with a hose-pipe. However, during the study period, it was only occasionally watered. The residence has a 3 x 5 m swimming pool with a pool cover. Of the six residences studied, De Jager str.96 has the lowest water consumption (fig.5).

Figure 11:



DISCUSSION

According to a study that was conducted in Calabar- Nigeria, several factors were found to influence per capita water consumption (6), namely:

- Income of the household
- Price per unit of water
- Household size
- Average age of household (stage in family life cycle)
- Number of taps in the housing unit
- Number of water using habits
- Number of supply sources (municipal, boreholes, rain water, wells, et cetera) available to the household
- Distance to source of water supply (standpipe, borehole, well et cetera), and
- Regularity in the flow of pipe borne water

This study looked into some of the above-mentioned factors, and several other's, namely: the erven area, household size, Number of taps as well as water using habits within and outside the house, area of the lawn, and the irrigation system used for watering the garden. The households studied fall under high-income households, and even though these residences' water consumption might not necessarily be influenced by the unit price of water (because the water bills are paid by the Embassy, and not by the individuals residing in the houses), several findings could still be extrapolated to other high-income households within Windhoek.

Compared to 1990, the total daily water consumption of the SDR's increased by about 26 percent in 1991 (fig. 2).

This increase is likely to be as a result of the change of owners/leasees of most of the residences; from the earlier occupants to Swedish diplomatic staff, in 1991. The consumption, however, steadily declined by about 11 percent per annum, over the period 1991 to 1994, with an outstanding 22 percent savings obtained in 1992. For 1992, water savings in individual residences range from as low as -22 percent (Stein str.10) to about 92 percent (Erosweg 125). Further comparison of the mean total daily water consumption for 1991 -1994 to the daily consumption obtained for the study period also indicates a 7 percent savings, during the study period. This percent savings is expected to be even higher, when the cooler months of July and August which are relatively low water consumption, and holiday months (see fig.2) are incorporated into the mean consumption obtained during the study period.

Several reasons could account for the decreased water consumption. The municipal water-saving campaign as well as the introduction of permanent block tariffs in 1992 for instance, could account for the exceptionally high water savings recorded at the residences, in 1992. (fig. 2). Like-wise, the low consumption during the study period could be partially as a result of a continued awareness from 1992, but more so, as a result of this study. The study had a major impact on the residents, especially the gardeners.

Internal Water consumption.

The study found that water-use within the house only accounts for about 18 percent (486 litres/day) of the household's total daily water consumption (fig. 3). The study further indicates that, Of the internal water consumption volume, one person uses about 175 litres per day ("actual daily per capita consumption" (fig. 4). This figure is crucial, and could be used when planning for water-use, and water demand management within high-income households.

Currently, National and municipal planning is based on per capita water consumption figures, which are determined by dividing the total daily water consumption by the number of residents, in the residence. Such a figure could provide loopholes for water wastage within households.

To mention a few such loopholes: not every high-income household has an exotic garden; some do not even have gardens, therefore planning based on such a high figure could encourage wastage of "excess water" and consequently cause severe water demand management problems.

The studied residences have a per capita consumption of about 800 litres/person/day, which implies that planning with per capita water consumption figures could result into a high "water excess", which would encourage and most probably end up in irresponsible use of water by residents.

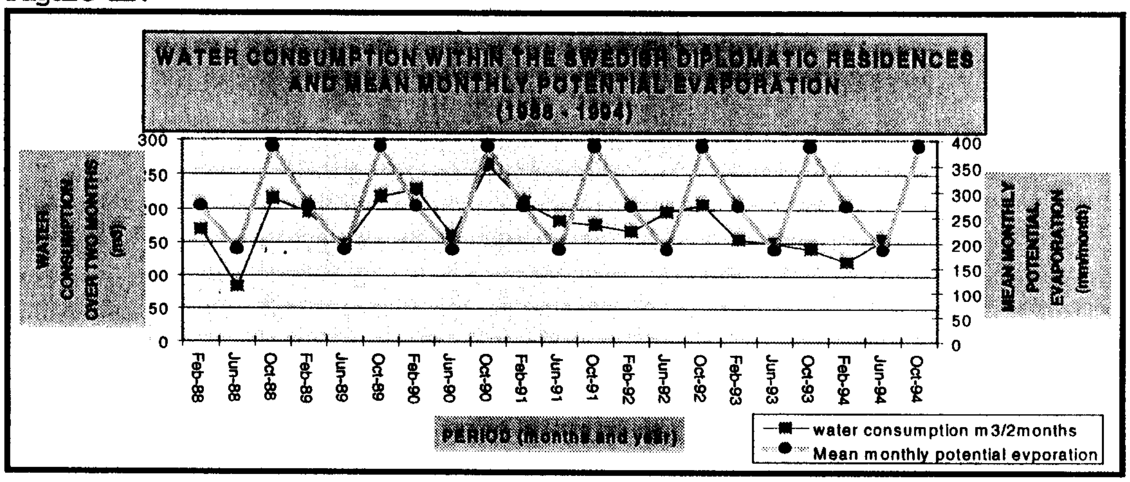
The author recognises the complexity of such planning, and the fact that garden and swimming pool consumption figures would need to be incorporated into such a plan. This issue is therefore further scrutinised, in the coming sections.

<u>External water consumption</u>

Within the studied residences, external water consumption accounts for more than 82 percent of the total daily water consumption (fig. 3). Of the 82 percent, about 73% (i.e., 1,970 litres/day) is used in the garden, and the remaining 9 percent (i.e., 243 litres/day) is lost through evaporation, from the swimming pool (if uncovered).

Namibia has a natural water deficit (i.e., the mean annual potential evaporation rate exceeds mean annual rainfall). Such climatic conditions would influence water consumption. Figure 3b, in the results' section, indicates higher total daily water consumption and percent external water consumption during the summer months, as opposed to relatively low ones during winter. This seasonality is well supported by the figure below; peak consumption between October and December (attimes September and January included), and the lowest consumption between February and July.

Figure 12:

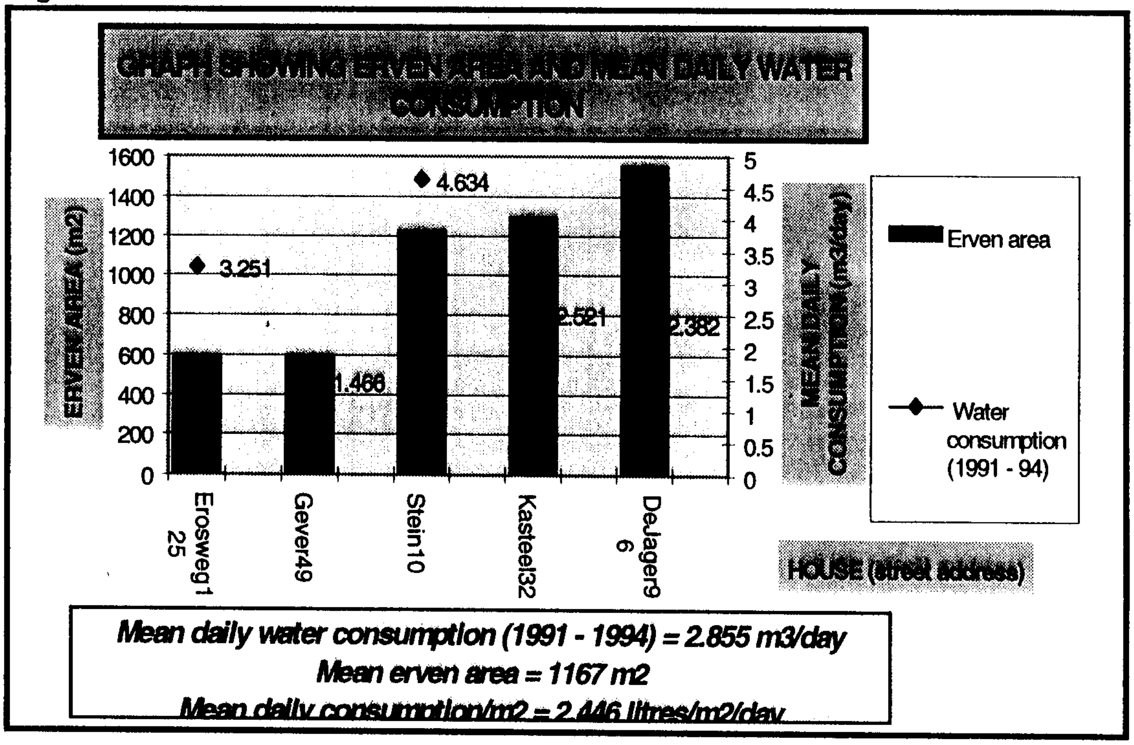


The high water consumption during the period between October and December (fig. 12) is mainly due to higher mean potential evaporation during this period of the year, whilst low consumption during February to July can be attributed to lower mean potential evaporation, as and rainfall.

This water-use seasonality needs to be planned for, by both the user and supplier. Such planning could involve educating gardeners and garden owners on plants' water requirements, the use of deciduous plants, as opposed to ever-greens, and possibly, increased tariffs during peak seasons of consumption.

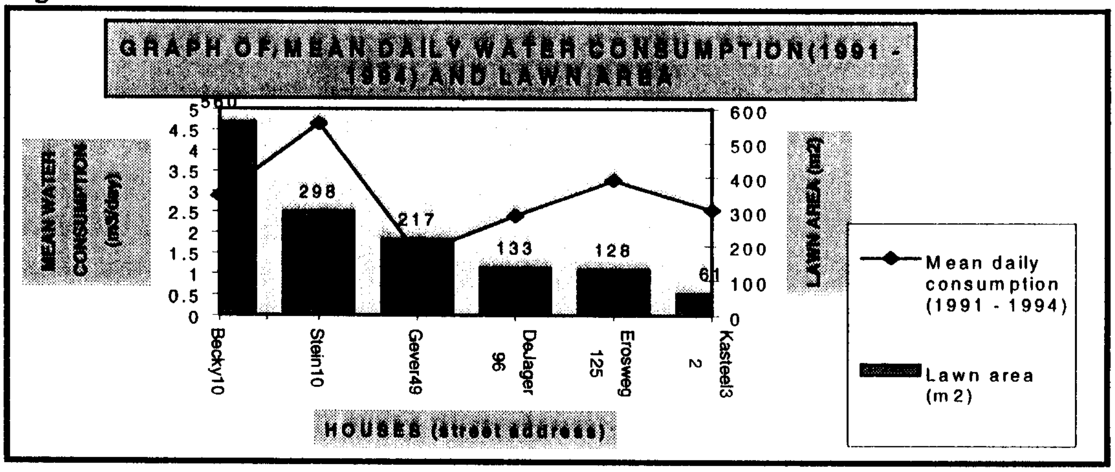
A 1986 survey conducted in Windhoek indicates that water consumption tends to increase with erven area (erf size). This increase in consumption can be attributed to higher incomes, bigger and more exotic gardens, swimming pools, and luxurious water consuming appliances (6). Below, the figure shows a graph of mean daily water consumption and erven area for each of the residences studied.

Figure 13:



As shown above, and unlike the municipal survey, no correlation between erven area and the water consumption was found. This could, however, be attributed to the small sample size, used in this study. Nonetheless, this information provides a tool for the comparison of water consumption among residences of varying erven areas. Figures of water consumption per erven area indicate that of all the residences studied, De Jager street 96 has the lowest water consumption (fig. 5). Similarly, the figure below indicates that there is no correlation between lawn area and the water consumption.

Figure 14 :



The lack of correlation between lawn area and the water consumption may be attributed to the different types of irrigation methods used at the households.

Watering of lawns by hosepipe, as opposed to sprinkler systems is commonly believed to use a lot more water, as indicated in the above figure (see also table2). Until late, only the Becky str.10 and Stein str.10 residences had sprinkler systems on their lawns, as a result even though they have the biggest and greenest lawns, their [4]lawn consumption is considerably lower than those of the other residences (table 2). It is therefore justified to state that the relatively low lawn consumption at the two residences is mainly due to efficient watering systems (the sprinkler system) at these residences. Below, Table 2 shows water consumption per lawn area, and the irrigation system used, at each residence

Table 2:

RESIDENCE	LAWN AREA (m^2)	LAWN CONSUMPTION (litres/m^2/day)	GARDEN-WATERING SYSTEM
Becky str.10	560	3.93	sprinkler
Stein str.10	298	11.35	sprinkler
Gever str. 49	217	4.93	hosepipe
DeJager96	133	13.08	hosepipe
Erosweg 125	128	18.54	hosepipe
Kasteel 32	61	30.16	hosepipe
MEAN	233	13.67	

[4] The daily lawn consumption (consumption/square metre of lawn/day) was determined using daily water consumption figures, percent garden consumption and the lawn area.

As indicated earlier, over-watering of the garden is one of the major areas of water wastage in the studied households, and as a result, the study attempted to estimate this factor. Through a sprinkler system, a lawn requires an application of about 1000 litres/m^2/annum (2.740 litres/m^2/day), to be in a lush green condition, and even 200 litres/m^2/annum (0.548 litres/m^2/day), can still keep it in a reasonable condition (7).

By using an average crop factor of about 0.5 (for kikuyu grass species) to represent the lawn, the study determined that a lawn requires about 4.66 litres/square metre/day, of which about 0.986 litres is obtained from rain (in Windhoek, with an average rainfall of about 360 mm/annum), and only about 3.674 litres/m^2 should be applied by the gardener. This figure does not differ much from the earlier one, and because it was logically and reasonably determined, it was used to estimate the quantity of water lost due to over-watering, at the residences. It should, however, be understood that the following are estimations, mainly performed to illustrate and give an indication of how much water, and money has probably been lost through over-watering.

Except Gever street 49 and Conrad Rust street 14, all the residences have swimming pool covers. Below, table 3, shows the quantity and cost of water lost through evaporation at the two residences.

Table 3:

ACTIVITY	VOLUME (m3/day)	COST (N$/day)	COST (N$/month)	COST (N$/annum)
Evaporation from swimming pools	0.409	2,17	65,03	791,21

Other influencing factor investigated include, the number of outdoor taps and water using habits. All the studied residences had more or less the same number of outdoor taps and water using habits, yet extremely varying water consumptions. It therefore follows that, however, significant for internal consumption, these factors appear to be less significant when considering external water consumption.

The following equation summarises water consumption and use patterns within the studied residences.

mean total daily consumption = (A x 0.01367+ B x 0.0093 +C x 0.175) m3/day

Where A represents Lawn area and, B the swimming pool surface area, and C the number of people in the household. With further research, such a model can be developed to estimate consumption, and monitor water use patterns. Such development would require the use of the recommended and/or appropriate lawn consumption figures (1000 litres/m^2/annum), and actual per capita water consumption figure such as the one recommended by the WHO.

The bigger picture

This section looks at the relevance and general applicability of this study to other Windhoek residences. Not many water use studies have been carried out around Windhoek. Furthermore, the study was carried out on residences at the very extreme of high income groups, thus providing a simplistic and much clearer picture of water use patterns within high income households, in general. The results of the study can therefore be extrapolated to other high income residences in Windhoek.

Within Namibia's major towns such as Walvis Bay and Swakopmund high income residences account for more than 50% of the town's total water consumption, and of the ± 50% consumption, about 60 - 70% is used solely for gardening purposes (5). Even though information on total high income residential water consumption for Windhoek is not available, the above statistics and the study's finding, that more than 80% of the water supplied to the studied residences was used mainly for gardening should be given due consideration. If water use patterns determined by the study are considered to be more or less the same as those of other high income residences then generally, about 80% of total high income group's water consumption is mainly used in the gardens and swimming pools. It therefore follows that even though water demand management should reach the entire general public and all water using activities, there is dire need to concentrate more effort on the exorbitant external (outdoors) water consumption of the high income groups, if we are to achieve short to long-term goals such as the current required 30% savings.

Emphasising the need to concentrate more on external consumption, gardens in particular, a display water saving garden is to be erected within the City centre as part of the study's awareness campaign. Setting up the garden would involve joint efforts from the DRFN, Windhoek municipality and the Wilde Eend Nursery.

The display garden would serve as a constant reminder to garden owners and gardener's, that; with proper soil preparation and the right choice of plants as well as watering periods and technology, a garden could use much less water and still look as beautiful. Several water saving alternatives and techniques are already being used around the City. The following section discusses some of these alternatives.

Available water saving practises and alternatives:

This section reviews a few of the gardening alternatives and water saving methods being practised in Windhoek. Where possible, reference is also made as to where additional information can be obtained.

1) Indoor water use:

A range of indoors water saving infrastructure such as "water saving shower-heads, "automatic shut off nozzles", and low-flush toilets are available at several hardware stores in Windhoek, e.g., at Obeco and Pupkewitz hardware suppliers.

2) Outdoor water use:

a) Indigenous plants and "Namibian lawns".

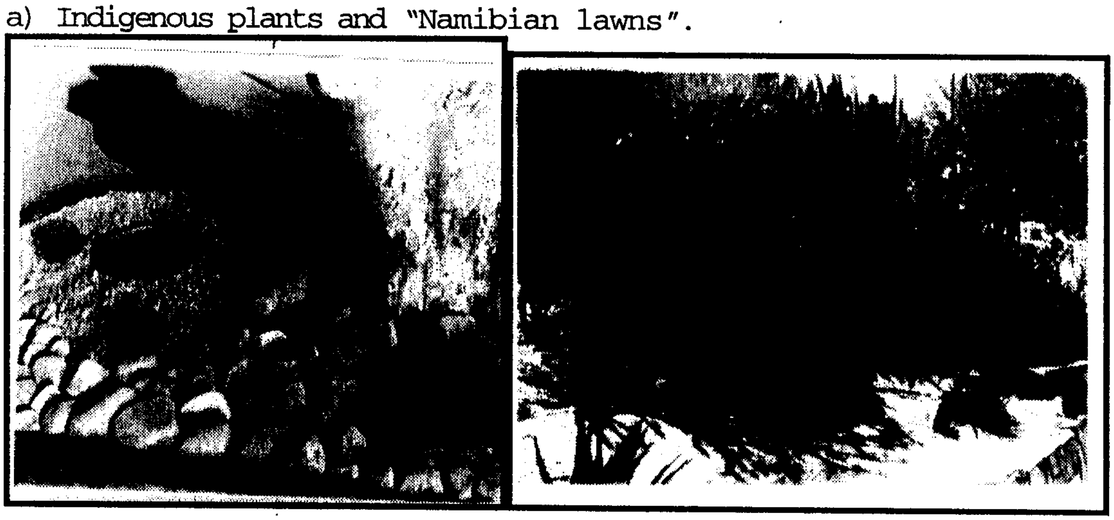


Plate1: Water-saving gardens in Windhoek 1

Several indigenous plants and fine rock and stone particles ("Namibian lawns") are used in a few gardens. The gravel particles/stones are particularly good because they suppress dust, do not heat up as much as tiles and floor paving, and in addition, they act as good erosion control on steep garden terrain.

"Not all indigenous plants require less water; indigenous plants from high rainfall areas such as the Caprivi and Kavango would still require a lot of water" (9). Emphasis should therefore be put on water saving indigenous plants and not just any indigenous plants. Furthermore, people should consider using deciduous plants as opposed to ever-green plants. Deciduous plants require minimal volumes of water; they do not need water for a period of up to three months in a year, and these are the three months of severe water shortage.

More information on indigenous and deciduous plants as well as re-landscaping for "Namibian lawns" can be obtained from several nurseries, such as the Wilde eend nursery in Klein Windhoek.

b) Mulching.

The application of mulch on flower beds, lawns and around trees is also carried out at some residences. The garden mulch is commonly derived from organic material residue such as wood particles and leaves, as well as manure. The mulch helps to keep the lawn temperature low during summer, resulting in reduced evaporative water loss. It also acts as a heat blanket during winter. This temperature regulation decreases heat stress in the plants and consequently prevents the excessive water use which is associated the heat stressed plants (9). An assortment of mulch is available at nurseries within the City, at a cost of about N$ 8,00 - N$12,00 per bag.

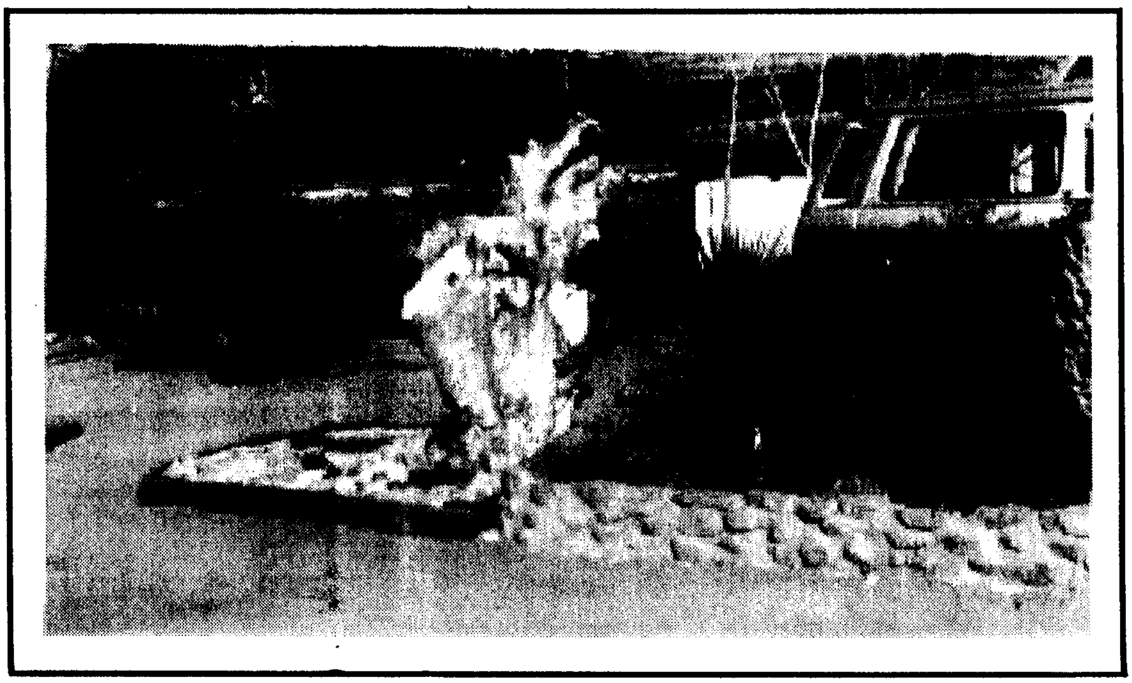


Plate2: Desert, and Mulched gardens.

The exotic part of the garden (right) uses as little water as the desert part (left), because it has water absorbing crystals in it's bed, and mulch.

c) Water absorbing crystals (Alcosorb polymers).

Alcosorb polymers in the garden soil would absorb and store water, releasing it fairly slowly; a single crystals can absorb up to about 400 times it's own volume, in water).

The plant roots can also easily grow into the crystals. Unlike mulch, alcosorb crystals do not necessarily reduce evaporative water loss, and require re-doing the garden (in case of an already established garden). However, they store the water long enough such that garden watering can be carried out only once per week. Alcosorb crystals are widely available at a cost of about N$ 5, 60/m2 (about N$ 45,00/ 8m2 lawn) at some nurseries, such as Wilde Eend and others.

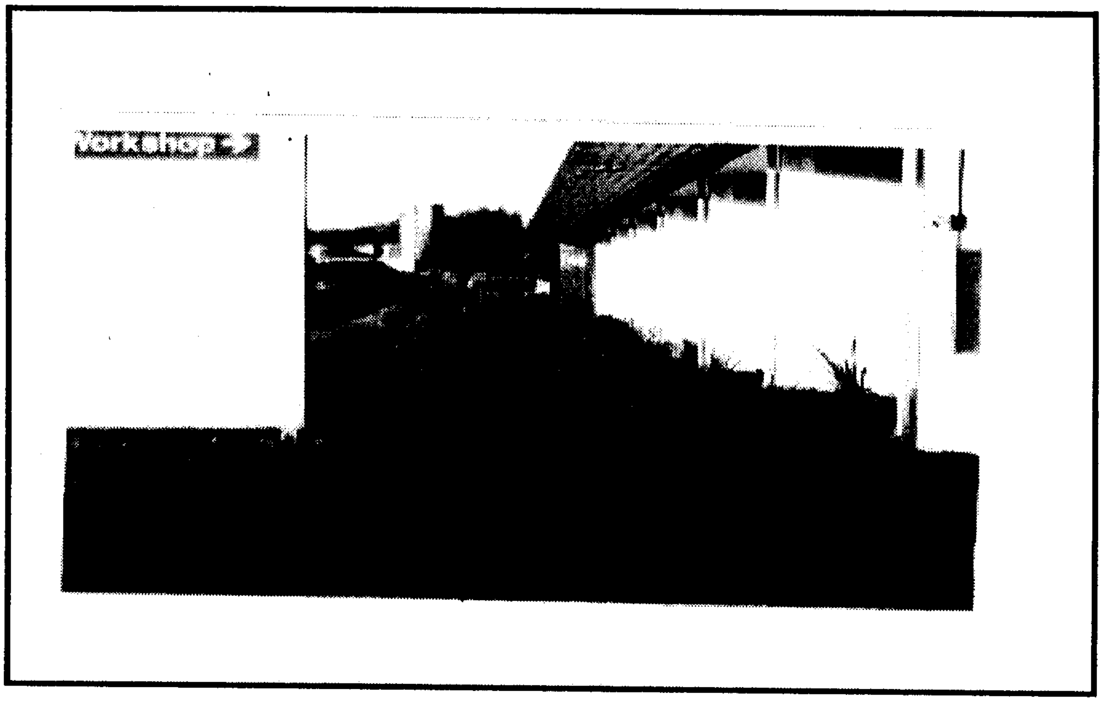


Plate3: The lawn at the HYUNDAI garage.

Even though this lawn is only watered once per week, the alcosorb crystals in the soil store enough water,, keeping the lawn exceptionally green.

d) Water re-use technology

The re-use of grey water from showers, baths and washing machines for gardening purposes, also enjoys some attention within the City. Water from the shower and bath is used directly on the plants, whilst in some cases filters are employed in order to allow the re-use of water from the Kitchen and washing machines. Caution should, however, be taken, because use of grey water, especially in Windhoek, could in the long-run result into serious soil alkalisation.

The Garden Rhapsody Water-Re-using System is designed to automatically water the garden whilst indoors water using activities are taking place. The technology could further be used to supply the filtered water to the toilet cistern and any other possible water re-use devices/installations. This technology is available at a cost of about N$ 2200,00 per unit from the Central Namib water saving Nursery, in Walvisbay (P.O. Box 2562).

e) Swimming pool covers and shades.

The study indicates that evaporative loss from an uncovered swimming pool accounts for about 11% of the 80% total external water consumption (180 - 250 litres/day). Swimming pool covers such as solar blankets are widely available at several pool care centres, such as the pool and garden care section of Ferreira's gardens. Currently, a solar blanket costs about N$ 23,00 per m2. Shadings are also used for wind brake.

CONCLUSION

Even though the Swedish diplomatic residences have one of the lowest water consumption among foreign diplomatic residences in Namibia, their water consumption is still much higher than that of similar high income residences in the City (fig. 1).

The high consumption is mainly a result of:

- large lawns and gardens,
- lack of preparation of garden soils (consequently, the soils dry quickly),
- lack of knowledge on water requirement of plants, which results in over-watering,
- to a lesser extent, uncovered swimming pools (resulting in higher evaporative losses), and other outdoor activities such as walkway and car washing.
- and most importantly, because the residents do not individually pay for their water.

despite an annual water savings of about 11%, the Swedish diplomatic residences can still reduce their water demand, if appropriate water saving habits are practised, and techniques to curb the consumption implemented. Moreover, the costs incurred through water wastage justify the urgent need for water awareness and the implementation of water saving infrastructure such as buying pool covers for two of the residents, currently without pool covers.

The awareness, interest and commitment shown by both the Swedish diplomatic residence owners and gardeners during the period of the study, provide enough evidence that water demand management within these residences can be achieved.

In addition, the high percent water savings achieved at the residences during 1992, probably as a result of the introduction of the block tariffs and the water savings campaign, also indicate that the residents do respond to the water tariffs, consequently indicating the effectiveness of water tariffs. Supported by the above evidence, the author therefore strongly believes that, the high water consumption in the SMDRs and other-high income groups in Windhoek can be reduced considerably. However, in order to effectively reduce water consumption in SDR and other high-income residences, a lot of the water demand management strategies need to concentrate on external water consuming habits.

Furthermore, awareness campaigns also need to provide detailed information on water saving techniques and alternatives, such as the re-use of grey water. Proper soil preparation techniques such as mulching, the use of water saving crystals (alcosorbs), and planting of indigenous trees can only be effective if information on the plants' water requirements is made easily accessible.

In conclusion, the author identifies an urgent need for the dissemination of information on water-savings techniques and alternatives. Furthermore, the implementation of the municipal water-saving policy is needed, to guarantee the judicious and sparing use of the City's water resources. Such a policy would promote public water-saving awareness, and would also gear the private sector, especially nurseries, but also plumbers, and hardware suppliers toward marketing water-saving goods and services. Only then can water demand management for Windhoek succeed.

RECOMMENDATIONS

1) Study residences specific

Realising that water wastage within the studied residences is mainly due to uncontrolled external (outdoors) water consumption, in particular the factors discussed in the discussions section, the study recommends that:

The lawns at Becky str.10, Stein str.10 and Gever str.49 residences should be reduced to atleast 100 m2. Where the land is steep (with potential for soil erosion) such as at the Becky str10 residence, a "[5]Namibian lawn" could be used to cover the bare ground. Alternatively, where reduction of the lawn is not considered as appropriate by the residents, soil preparation such as mulching or the use of alcosorb polymer crystals should be considered.

Lawns furnished with a sprinkler system (e.g., at Kasteel str32, Stein str10 and Becky str10) should only be watered for about fifteen minutes every second day, and preferably before 10:00 am. This watering is, however, unnecessary during the rain and winter seasons, and should thus be carried out only if it is absolutely necessary.

Gardens such as the ones at Becky str.10 and Robyn str.2 should be concentrated on one side of the plot, in order to ease gardening (maintenance) and the implementation of water saving techniques.

The common practise of using hose-pipes at residences with already established sprinkler systems should also be discouraged.

The common practise of re-watering the gardens by the residents after working hours should also be discouraged.

Swimming pool covers should be bought for two of the residences, namely; Gever str.49 and Conrad Rust str.14.

The weekly cleaning (by back-washing) of swimming pools especially at the Kasteel str.32 residence where cleaning is done twice per week, should be reduced to once every two weeks during the winter months, and only once per week during summer.

Cleaning of walkways with a hosepipe, as in the case of the Kasteel str.32 residence should be ceased. If the use of water is an absolute necessity, then a bucket should be used.

Even though car washing at most of the residents is carried out with a bucket, this practise needs to be promoted. Most importantly car washing should only be carried out if it is absolutely necessary, and preferably on the lawn or where the waste water can be re-used.

[5]A "Namibian lawn" refers to fine gravel particles, occassionally used for decoration (see plate X).

2) General

Evidently, outdoors activities such as gardening and swimming pool maintenance are the highest water consumers in high income residences. It is thus critical that for water demand management within high income households to be significantly successful, more efforts are targeted towards these outdoors activities.

a) Gardens

It should be made clear that having exotic gardens in arid and semi-arid environments (Windhoek, in particular) is a luxury, which like any other luxury requires proper planning, maintenance and a financial sacrifice. The study therefore recommends that;

No garden should consist of more than 20% high water consuming/exotic plants. In case of a garden with a percentage higher than 20%, the garden must be furnished with an automatic sprinkler system and soil preparation with mulch and/or alcosorb polymers etc. performed.

Policy should be implemented to ensure that grass lawns are restricted to an area not exceeding 25 m2 per household. Alternatively, lawn watering should be restricted to a maximum volume e.g., 1000 litres per square metre of lawn per year. The last alternative would, however, require a more complex monitoring system.

Watering of residential gardens should be restricted to a maximum period of not more than twice per week (maximum). To ease the enforcement of this recommendation the municipality could restrict garden watering to only two specific days in a week, such as Sundays and Wednesdays.

The Windhoek municipality should consider replacing parts of existing municipal lawns (such as the ones at the municipality's head office and the Zoo park) with Namibian lawns. The recommended watering restrictions should also be implemented for the afore-mentioned lawns. Such a move would boost public awareness and provide practical examples of successful alternative gardening practices.

Garden owners should seriously consider the re-use of grey water for their lawns and plants, where possible. It is, however, recommended that the re-use of [6]grey water for such purposes follows on advice from resourceful personnel (e.g. within the municipality and nurseries), institutions and organisations such as nurseries and herbariums.

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[6]Grey water (in this text) refers to water from the baths, showers, washing machines, and bathroom as well as kitchen sinks. Please note that grey water from the toilets is not considered feasible.

Wet industry, large complexes (e.g., hotels and hostels) and major government institutions which have gardens should also seriously consider re-use of grey water, for gardening and toilet flushing purposes. Installation of grey water filter and re-use systems such as the Rhapsody system, has immense potential for saving water and costs at sites/areas of high water use.

b) Swimming pools

All swimming pools should have pool covers.

Swimming pool back-washing should be done only once per week in summer, and not more than once every two weeks, in winter. Even though back washing does not necessarily consume a lot of water (about 25 - 30 litres/back-wash for an average swimming pool filter at the studied residences), there is a need to save water where ever possible. Such a move is also contributory to the institutionalisation of public awareness.

c) general (frame conditions)

Namibia's water resources are finite. Consequently, water demand management and saving measures should be a way of life, and not only short-lived emergency steps as has been in the past. It is therefore imperative that permanent frame conditions that would guarantee successful and sustainable water demand management are institutionalised.

A water savings policy such as the one which was recently prepared by the Windhoek municipality should be advertised and enforced. Such a policy should not only be a watch dog, but should also be educative and awareness creating.

The Windhoek municipality should consider setting up an easily accessible water savings information centre, preferably in central town. Such a centre could advertise water saving techniques, and also advise water consumers on available water saving techniques as well as new developments (water related) within the City. The centre could also act as an advertiser of the local private sector's (e.g., nurseries, plumbers, swimming pool caterers and hardware suppliers) water saving goods and services, thus fulfilling the necessary task of gearing the local private sector towards marketing water saving goods and services.

Finally, the Windhoek municipality should warn users of their high water consumption (when abnormal for that specific user group), through the monthly water bills. Identification of an abnormally high water consumption should be followed by a residence visitation in order to investigate reasons for the high water consumption and advise the user.

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