RESEARCH PROJECT

TOPIC: THE INVESTIGATION OF FOG FREQUENCY AND OCCURRENCE PATTERNS IN THE CENTRAL NAMIB AS A POSSIBLE ALTERNATIVE SOURCE OF WATER SUPPLY TO THE TOPNAAR COMMUNITY ALONG THE KUISEB RIVER IN THE NAMIB DESERT.

DUPLICATE

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ABSTRACT

In a country known for its aridity, the Namib is the driest part. Some of the poorest people in Namibia live here, one such a community is the Topnaar, a group of Nama speaking people that lives along the Kuiseb River in the Central Namib.

The Kuiseb River, which is the major source of water for the more developed Central Namib, is being mined. The coast of Namibia receives virtually no rain, but precipitation caused by advection fog from the Atlantic Ocean represent substantial quantities. If the collection of fog water in this area is feasible, this additional source of water may improve the lives of people at present and support other kinds of development in the future. Indigenous plants and animals have already taken advantage of this water source, but man has not yet learned to use it for his own needs.

The benefits of fogharvesting will be to provide additional fresh water where sufficient supply is limited. It also offers the potential development of even small-scale agriculture. In a water limited environment, additional water from fogharvesting can only enhance the quality of life for the Topnaar community.

To make a success of this project, the major considerations to be taken into account would be to analyze fog precipitation in its broadest terms. Above all, it would look into the regularity and quantity of fog precipitation, frequency and reliability, potential yields and potential users. These analyses can only be fully understood against the geomorphology and meteorological background of the study area.

Fogharvesting technology is successfully applied along the coastal parts of Chile since 1987. Today several parts of the world use fog-harvesting technology. Meteorological conditions along the Namib coast are surprisingly similar to those in Chile to warrant considering a feasibility study here.

The basic technology involves the construction of simple fog water collectors made of propylene mesh to intercept fog droplets, which are driven by the wind onto the net. The water runs off the nets and collects into troughs. Experimental sites for this project is already established in the desert at Gobabeb by the Desert Research Foundation and at Hamilton Range by the Department of Water Affairs. Both institutions granted permission to make use of existing data for this research project.

. INTRODUCTION

1.1 RESEARCH METHODOLOGY

The first part of this study was done by means of a literature survey. The major aim of this survey was to obtain a realistic figure for the volume of fog that might be collected under Namibian conditions as well as the temporal aspects related to fog formation. The available literature was mostly on the climatic conditions of the Namib, the aspects of fog formation, topography and geomorphology of the Namib and the potential consumers of fogharvesting and was mostly in the form of journals, scientific articles, and research papers from various researchers and books.

The meteorological data used was obtained from the Desert Research Foundation of Namibia in Gobabeb. The data consist of fog rolls from which fog precipitation, the days of fog occurrence and the hours at which it occurred were recorded over 16 years at Gobabeb and 10 years at Hamilton Range. The site at Hamilton Range exists for a shorter period than the one Gobabeb.

Data from these rolls were processed to obtain figures for monthly occurrences of fog days; hours rounded off to the nearest hour and precipitation respectively at the two stations. In order to determine if there is a need for the possible additional water from fogharvesting, interviews were conducted with the Topnaar community, the potential consumers of the fog water. At Swartbank, Klipneus and Soutrivier, villages where about 5 -- 10 people lives, (most of the children and men are at school and work in Walvis Bay) the people expressed a need for more water especially for their livestock and to plant crops. They also complained that their water source is far from the village and they have to walk long distances to access the water and that these sources mostly boreholes are unreliable as water is only available when the wind blows. Some of the people were angry as many people came to interview them about their water needs but not much has been done so far.

Study of this nature is hampered by the quality of the data, its availability and the processing thereof. In some cases, the needed information was not available due to several reasons: - sometimes there was no ink in the weather apparatus, or the clock was faulty and being repaired or the fog rolls were jammed and could not record the information efficiently. Although these shortcomings are not too serious, there could be an undercount of the fog days and hours at both stations.

1.2 GEO – ECOLOGY OF THE STUDY AREA

The Namib could be divided morphologically in four regions namely the extreme southern Namib – south of Lüderitz; the central Namib Dune Sea south of the Kuiseb, the Central Namib gravel plains north of the Kuiseb River and the Northern Namib and Skeleton Coast. The area under investigation is the transitional zone of the Central Namib. (Map 1) Gobabob is located on the northern bank of the Kuiseb River, about 100km from the Atlantic Ocean. The river arises in the Khomas Highlands 24km west of Windhoek and drains an area of dissected country before entering the Namib. For about 150km from the coast, the river cuts the Namib Plain northwards and the Dune Namib to the south in the half.

Rainfall varies with evaporation rates throughout the catchment. The upper part of the catchment has a maximum average rainfall of about 400mm per year falling between January and March (A. Botelle and K. Kowalski, 1995). The river system experiences periods when the water table drops as the river changes its courses as well as wetter periods after flooding depending on inputs from the upper catchment. Several private farm dams were constructed in the headwaters of the catchment. These led to the withholding of runoff, which is essential for recharching groundwater (Jacobson et al. 1995).

The importance of the Kuiseb River as a water career can be viewed in that it is the most important natural resource for the Topnaar community because it manipulates where the people can live and how the other resources can be used. The relationship between the Topnaar community and the Kuiseb River environment is typical of an ecosystem in that features like interdependency, adaptability, unpredictability and limits can be clearly noticed in this area.

The Hamilton Range is a 400-500 meters high ridge running in a NNE – SSW direction parallel to the coast at a distance ~~of~~ about 30 km east of Walvis Bay. Observations by the Desert Ecological Research Unit showed that the highest frequency of fog formation occurred in a band 30 – 50 km east of Walvis Bay over a period of 1976 – 1981. It consist of weathered marble which outcrops under Swakop Shists and pegmatite and represents the metamorphic belt running parallel between Namibia's coastline and its Great Escarpment.

1.3 OVERALL CLIMATE OF THE AREA

The climate of the study area and the Namib Desert as a whole has been studied extensively by many researchers. Overall it is described as arid to hyper – arid but relatively cool in coastal areas and hotter inland. This is mainly due to the latitudinal position of the region and the effects of subtropical anticyclonic cells situated over the south Atlantic Ocean (Lancaster, 1989). Fog is formed as a result of moist oceanic air flowing over the cold Benguella current. The warm moist air is cooled when flowing over the current until dew point is reached and fog forms (Heydorn and Tinley, 1980; Estie, 1986). Advective fogs are a clearly different characteristic of the Namib climate and are felt for over 100km inland (Goudie, 1972; Lancaster et al, 1984). The occurrence of fog is often associated with southwesterly winds. The contrast in temperatures between the desert and the cold ocean waters drives the winds blowing around the South Atlantic Anticyclone inland as a SSW – SW sea breeze throughout the year (Lancaster 1989).

1.3.1 Rainfall

The central coastal strip of the Namib receives less than 20mm rain per year (J. Olivier, 1993). Most rains fall during January to April (Schulze 1969) and increases steadily inland to reach about 60mm at a distance of 100km from the sea (Olivier, 1992). Therefor Hamilton Range, about 30 km from the sea has an annual rainfall figure, which is less than the mean of 27mm calculated at the automatic weather station at Gobabeb (Lancaster et al, 1984)

1.3.2 Temperature

As a result of the cold ocean, the temperatures in the Namib region are mostly moderate throughout the year. There is a relation of higher temperatures to the distance from the coast. Whereas the minimum daily temperatures average 13°C - 16°C throughout the region, the maximum daily temperatures range form 17°C at the coast to 28°C – 33°C further inland at Gobabeb (Lancaster, 1989). The minimum daily temperatures in the area range during the season June to August from 4°C - 8°C and in the season January to March from 15°C - 18°C.

1.3.3 Relative Humidity

Relative humidity is also strongly influenced by the distance from the sea. Since the Hamilton Range is nearer to Walvis Bay at the coast, the relative humidity there is higher than at Gobabeb. The long-term mean annual humidity at Walvis Bay is recorded at 87% contrasting to the 50% at Gobabeb (Lancaster et al, 1984). When the easterly "berg" wind blows, the humidity in the whole area becomes very low, but this remains a rarity limited in timespan.

2. FOG OCCURRENCE

2.1 FREQUENCY OF FOG OCCURRENCE

Perusal of figures 1 and 2, indicating the average number of fog days per month for the periods 1982-1992 at Hamilton Range and 1981-1996 at Gobabeb respectively, reveals a high degree of fog occurrence throughout the year in the Namib Desert. However, there is also a clear pattern of high and low fog occurrence seasons at both stations. The well-known trend of the decrease in fog occurrence with distance from the sea (Lydolph 1957; Logan 1960; Meigs 1966; Besler, 1972; Seely 1972, 1987; Lancaster et al. 1984) is also well illustrated by the two figures.

The average number of fog days for the said period was higher at Hamilton Range closer to the coast, especially during May to July than it was at Gobabeb. This is persistent with earlier findings that in the winter along the coast, winds are lighter and conditions favoring fog formation occurs frequently (Nieman et al., 1978; Taljaard 1979). However, contradicting to this, the highest monthly fog incidence at Hamilton Range was recorded at 9.7 days in September. At Gobabeb higher numbers of fog days were recorded during the spring / summer season (September to March) than it was during the winter months. The highest monthly fog incidence occurred in October and was recorded at 6,5 days for the period 1981-1996.

2.2 DURATION OF FOG EPISODES

Figures 3 and 4 give an indication of the average number of fog occurrence hours per month for Hamilton Range and Gobabeb respectively over a certain time period. Holding against the background the fact that it is not always possible to determine the exact starting and dying time of fog episodes from the fog rolls, some information could be deduced. It is clear that overall, the duration of fog events were greater at Hamilton Range, closer to the coast than at Gobabeb further inland. This is due to the effect of the Benguella upwelling system on temperatures (J. Olivier, 1993).

The fog data perused during this study reveals that at Hamilton Range, most fog occurred during the early hours of the day between 2h00 and 7h00 and between 5h00 and 8h00. However, very few fog incidences were recorded from midnight until 8h00 in the morning lasting for about 6-8 hours. The longest fog episode was recorded at 54,1 hours and occurred at Hamilton Range in August during the period 1982-1992.

Fog episodes at Gobabeb were generally longer in the winter months (July and August), but contradictingly, the longest episodes were recorded at 22,6 and 25 hours in September and October respectively. Whereas the morning fog lasted mostly until 8h00 at Hamilton Range, it lasted for longer than 10h00 at Gobabeb. At Hamilton Range fog episodes were also persistent in March, May, June and July. This longer duration of fog episodes in winter months at both stations can be ascribed to the fact that there is a decrease in wind speed and frequency at the coast during this season (J. Olivier, 193). Evening fog episodes (20h00 –24h00) are low at both stations. At Gobabeb some of these episodes were recorded during August to November.

2.3 PRECIPITATION POTENTIAL

In contrast to the text above on fog occurrence and frequency, the precipitation of fog has been observed to increase from the coast to a distance of about 35 – 60km inland and decrease further eastwards (Lancaster et al., 1984). Earlier studies revealed that most fog precipitation occurs at a height of 300 – 600m above MSL (Lancaster et al., 1984) therefor the initial increase in precipitation amounts could be related to altitude. Perusal of figures 5 and 6 indicates that this is precisely the case at Hamilton Range, a 400-500m high ridge compared to the precipitation amounts at Gobabeb.

The greatest monthly fog precipitation amount for the period 1982-1992 was recorded at Hamilton Range at 20,4mm in September. At Gobabeb the highest amount of monthly fog precipitation for the period 1981-1996 was recorded at 7.8mm in October.

3.SOCIO – ECONOMIC ASPECTS

4.1 Population

The Topnaar or #Aonin are a Nama tribe living along the lower Kuiseb for several hundred years. They are generally classified as an ethnic group because of their bonds to their traditional ways of life. There are about 350-450 adults and children living in 13 scattered settlements within the valley from Homeb to Rooibank (Kooitjie, 1994; Namibian Census 1991). For further information about the location of these settlements see Map 2. Some of them are living and working in Walvis Bay, but are having close ties with their people at home. The Topnaar communities depend largely on livestock for making a living and these in turn depends entirely on the river vegetation for food. The !nara melon fields of the Kuiseb is an important source of food, medicine and income to the people.

4.2 Water usage and needs

Water is mostly used for household purposes and livestock in the different settlements. The consumption rates differ with the number of inhabitants and the number of livestock among the settlements. It is also directly related to the income – the more you earn the more water you use. Some households use about 25L water per day and others only about 10L.

The Department of Water Affairs is responsible for maintaining the water extraction network schemes throughout the catchment. As a response to the increasing water crisis of the Topnaars, they provided several boreholes to the community. (Maps 3 and 4) These boreholes provided a fairly enough solution to the crisis, but the problem was not completely eliminated. The people now had less control over their water supplies and they considered the diesel / wind pumps to be unreliable since it depends on variables like equipment and wind. They could also not always afford to repair the equipment when broken.

4.3 Land - use patterns

The Topnaar community adapted to their hyper-arid environment over the years by naturally accepting a land tenure system, which correlates with the variability of the desert environment. The typical land - use of the Topnaars include the hunting of wild animals, stock herding, maintenance of small irrigated gardens, harvesting of the !nara melon and utilization of the riverine vegetation for firewood, medicine, shelter and food. Since the government owns all of their land, the Topnaar is limited to a small piece of their traditional area, and because many of the regulations are in conflict with their traditional land use practices, the people are increasingly becoming distanciated from their environment.

5 SYNTHESIS

The aim of this study was to investigate the volume of fog that might be collected under Namibian conditions as well as some temporal aspects related to fog formation. Generally it looked into the regularity and quantity of fog precipitation, the frequency and reliability thereof and the potential users of fog water collection. To achieve this, a set of data obtained from fog rolls were studied and analyzed. On these rolls the number of fog occurrence days, the hours at which it occurred and the amount of precipitation were recorded for the periods 1982 - 1992 at Hamilton Range and 1981 –1996 at Gobabeb.

Monthly occurrences of fog days, hours and precipitation amounts were obtained from these data and perusal thereof revealed the following:

1. There is a high degree of fog reliability throughout the year in the Central Namib.
2. There is a pattern of high and low fog occurrence seasons at both stations. The highest frequency of fog days occurs during winter at the coast and during spring /summer at inland stations.

3. Fog episodes generally last longer in winter months at inland stations.
4. Fog precipitation is higher at the station closer to the coast and decrease sharply inland.

Although the diagrams compiled shows this information, the before- mentioned constraints gives some doubt and their accuracy and reliability.

ASPECTS IDENTIFIED FOR FURTHER INVESTIGATIONS

Additional analyses and more data sets are needed to verify the findings of this study. Several aspects of fog formation remain to be investigated:

- Temporal and spatial variations in fog occurrence
- The monitoring of yields – (in)accuracy of measurements
- The locations of stations and the availability of optimal yield
- The alternatives of fog screens and heights and the technology involved.

ACKNOWLEDGEMENTS

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My sincere thanks to the Department of Water Affairs who granted permission to make use of information and statistics generated in the course of their project of fog water collection.

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HAMILTON RANGE
Average number of fog hours per month for the period 1982-1992

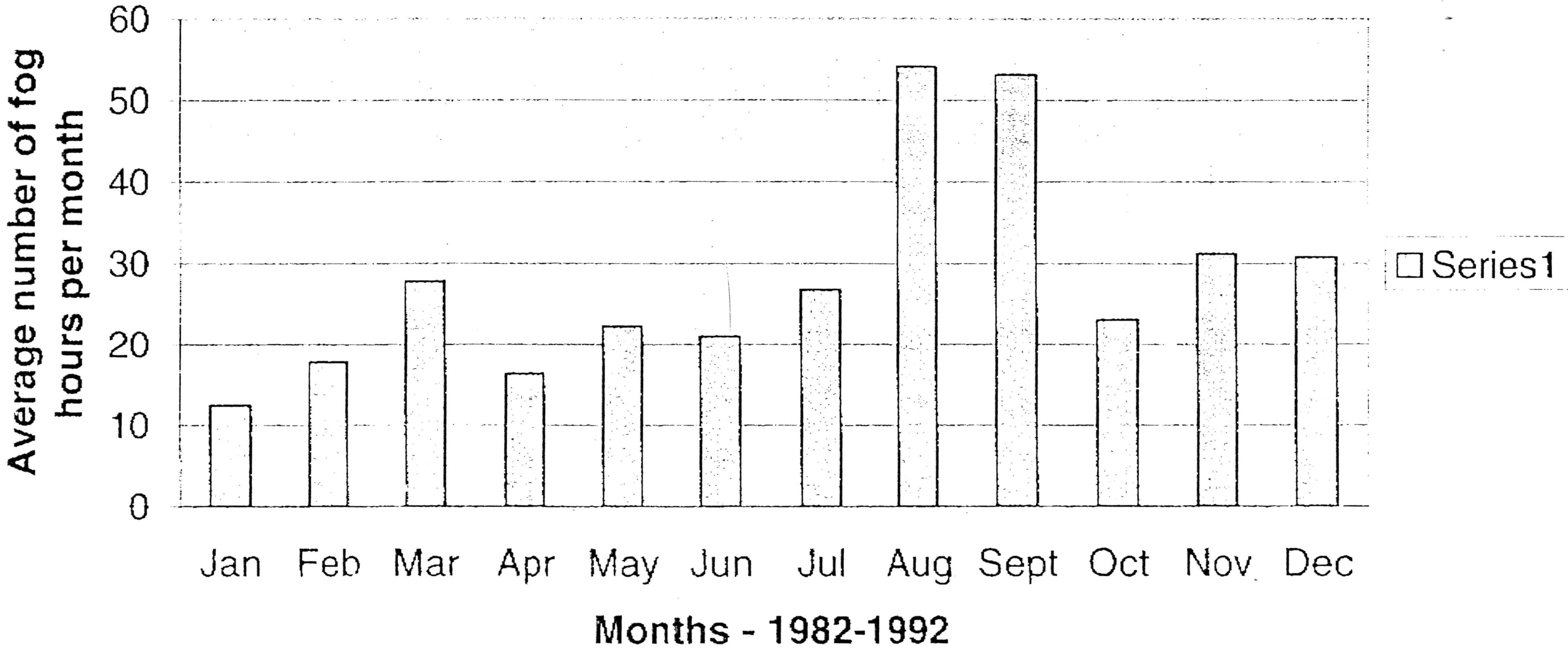
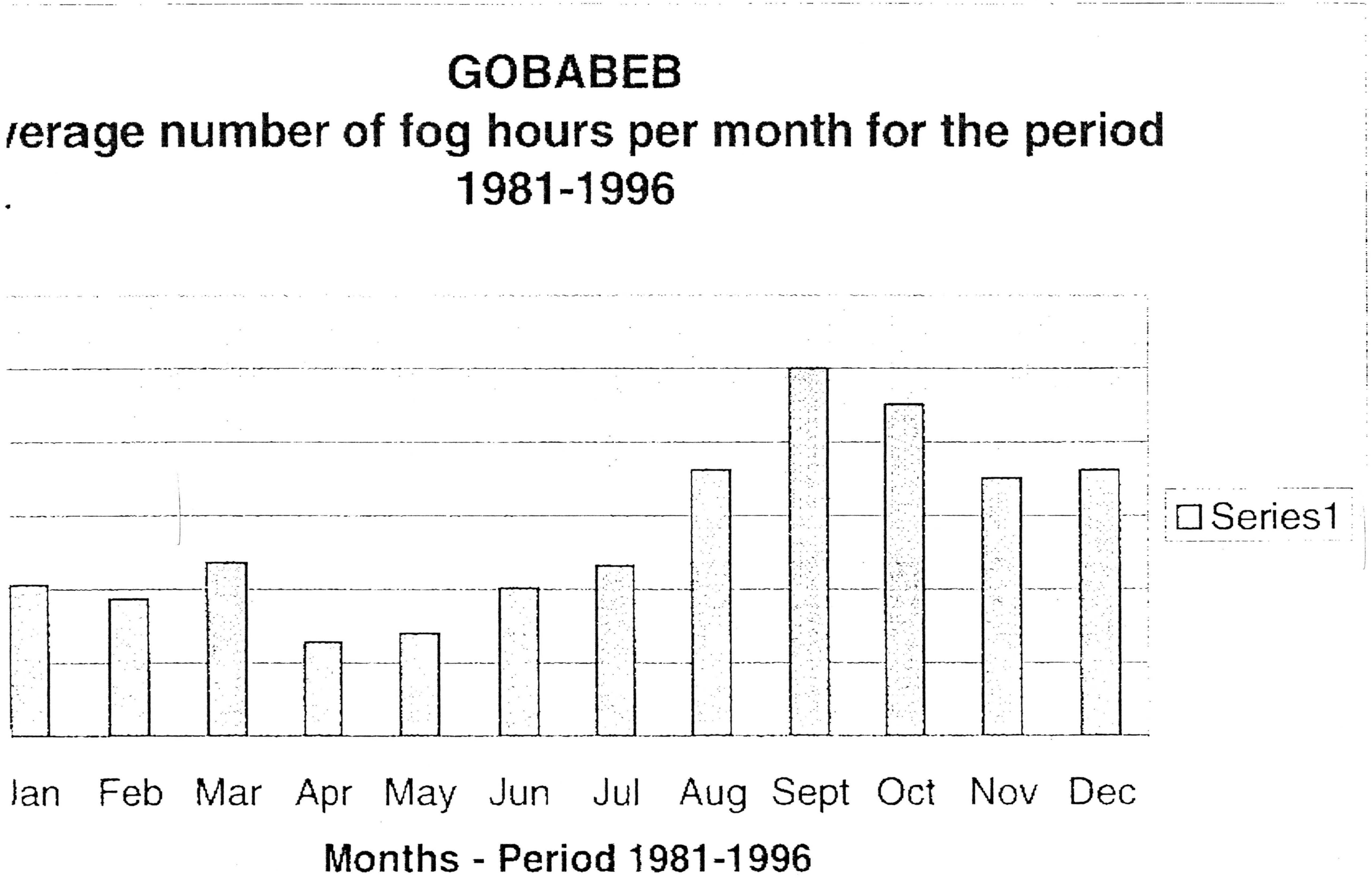


Figure 3


GOBABEB
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1981-1996
Series1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
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Nov
Dec
Months - Period 1981-1996

Figure 4

HAMILTON RANGE
Average number of fog precipitation per month for the period 1982-1992

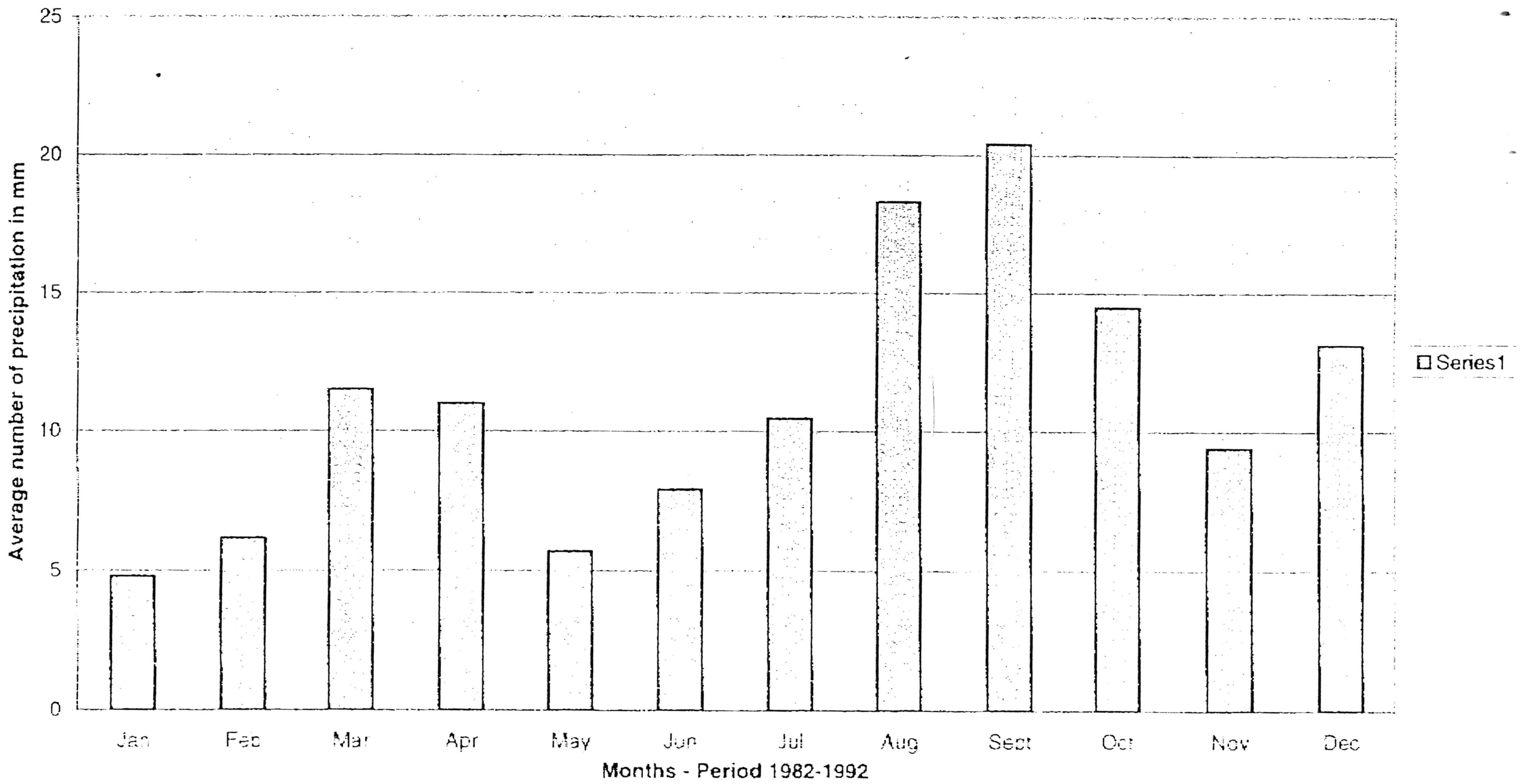


Figure5

GOBABEB

Average number of fog precipitation per month for the period 1981-1996

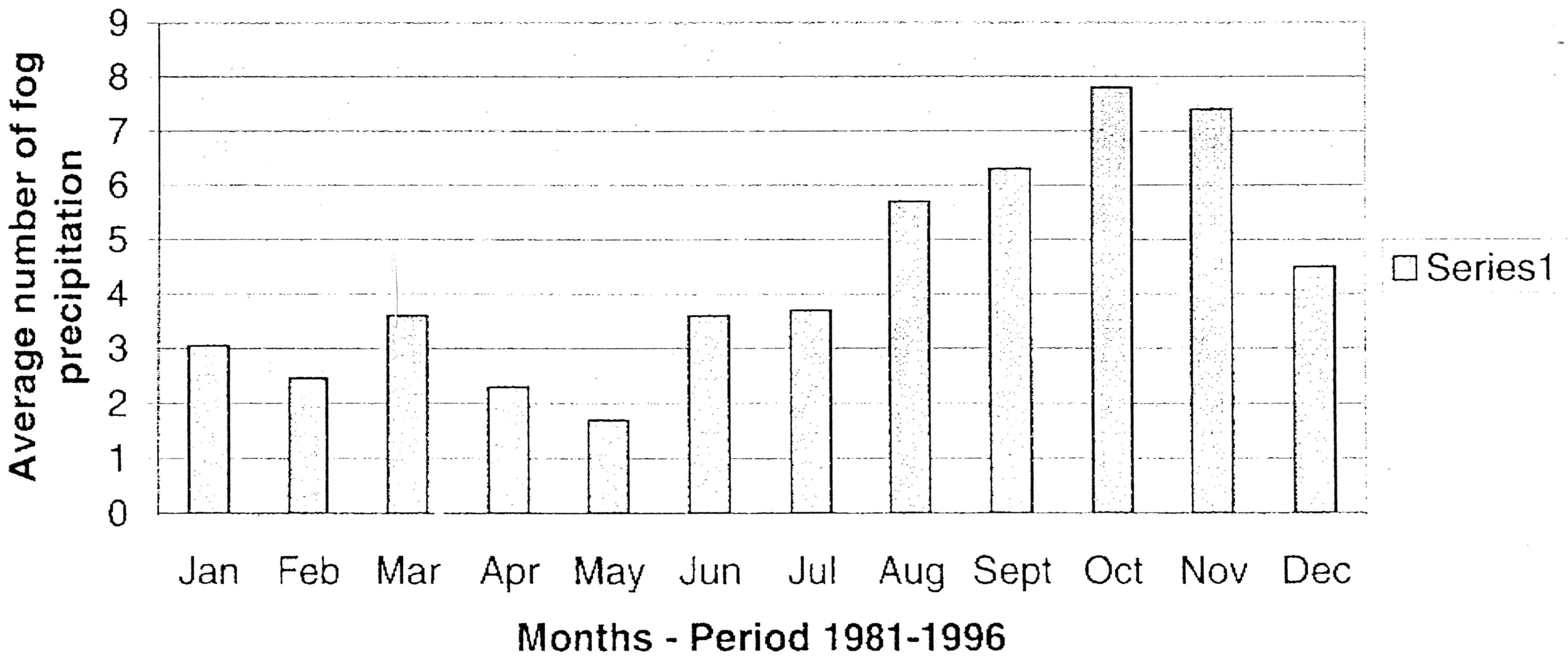
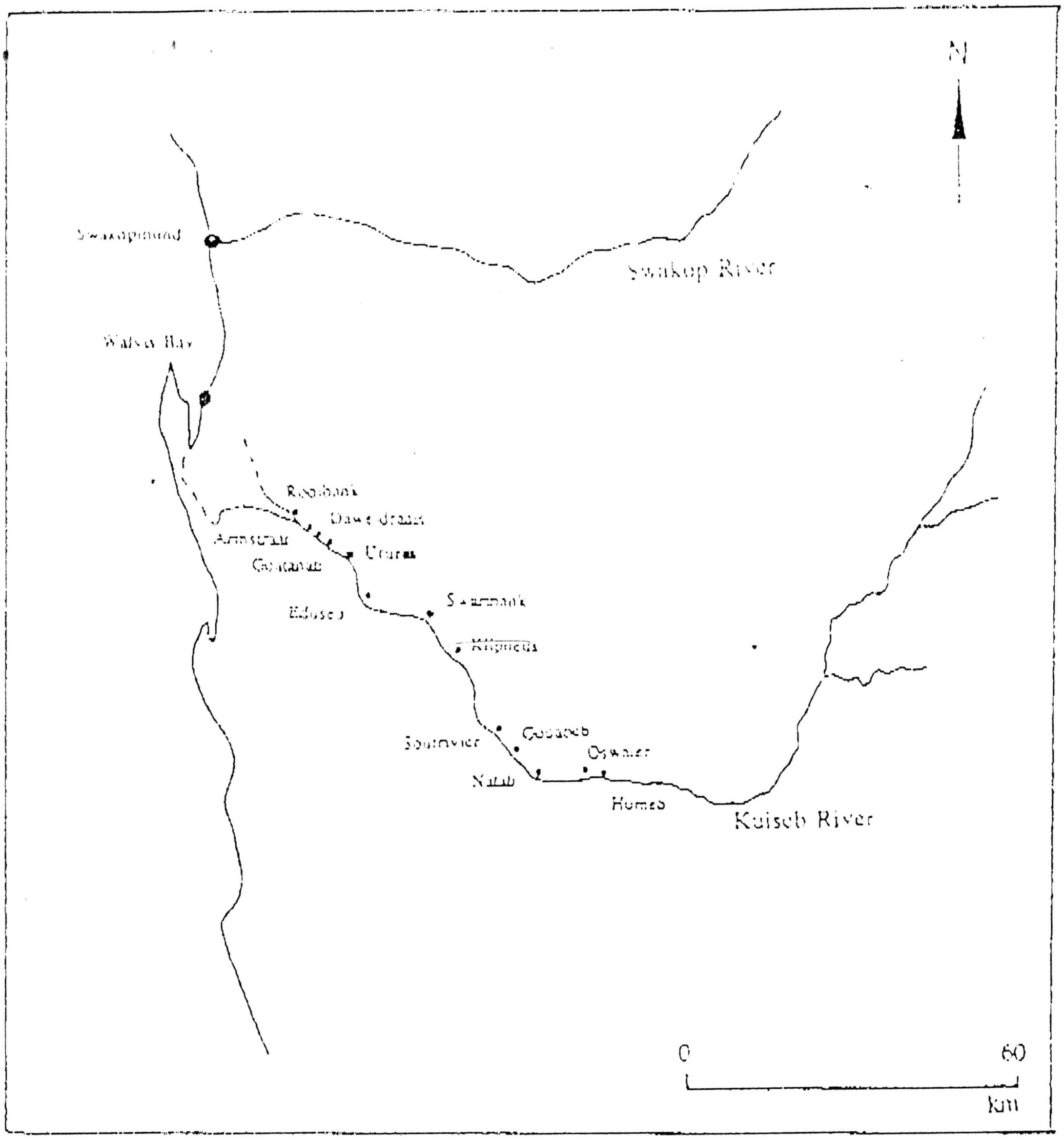
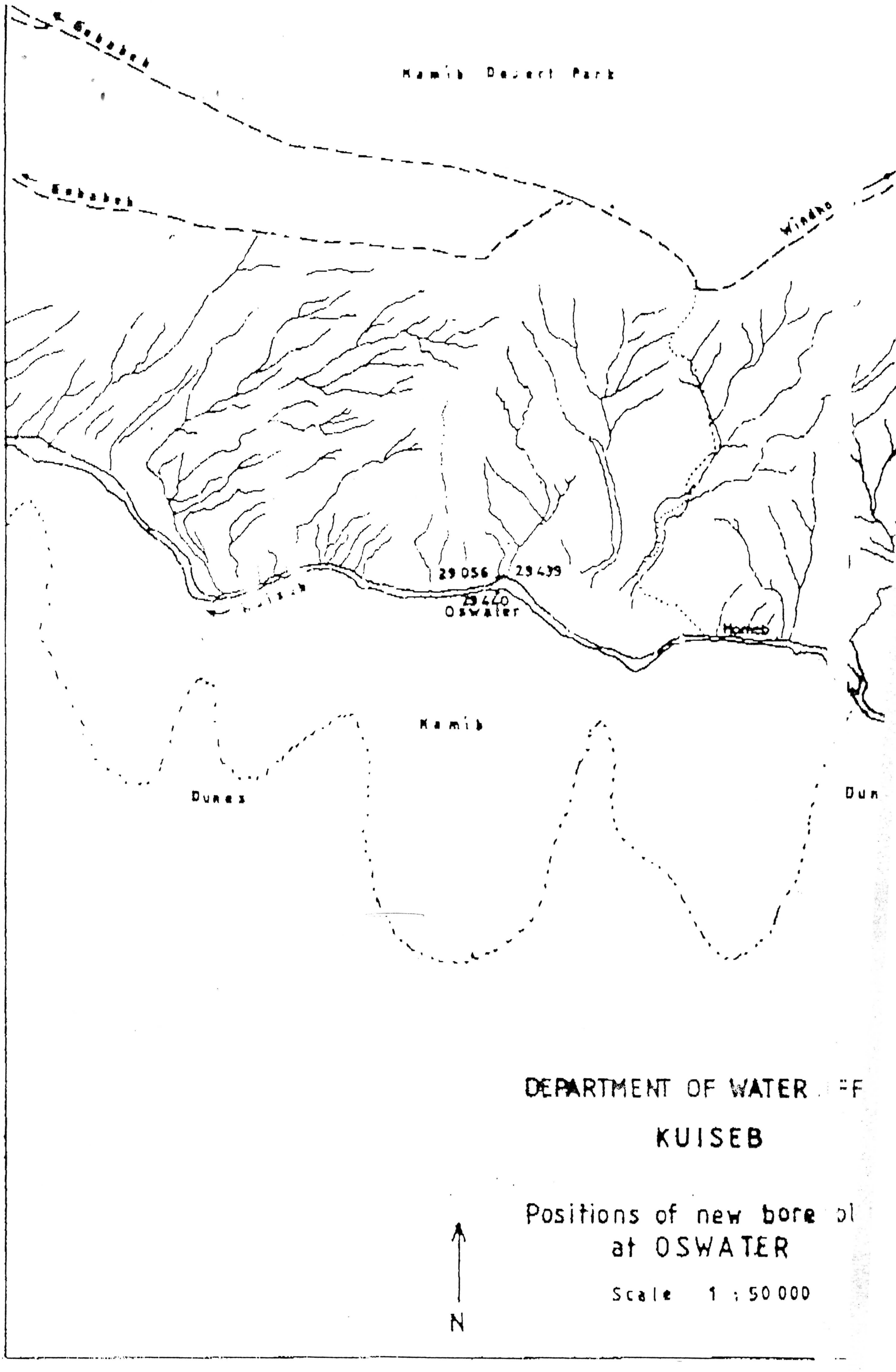


Figure 6



Map 2 : Topnaar Settlements along the Lower Kuiseb


Namib Desert Park
29 056
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Oswater
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Dunes
DEPARTMENT OF WATER
KUISEB
Positions of new bore
at OSWATER
Scale 1 : 50 000
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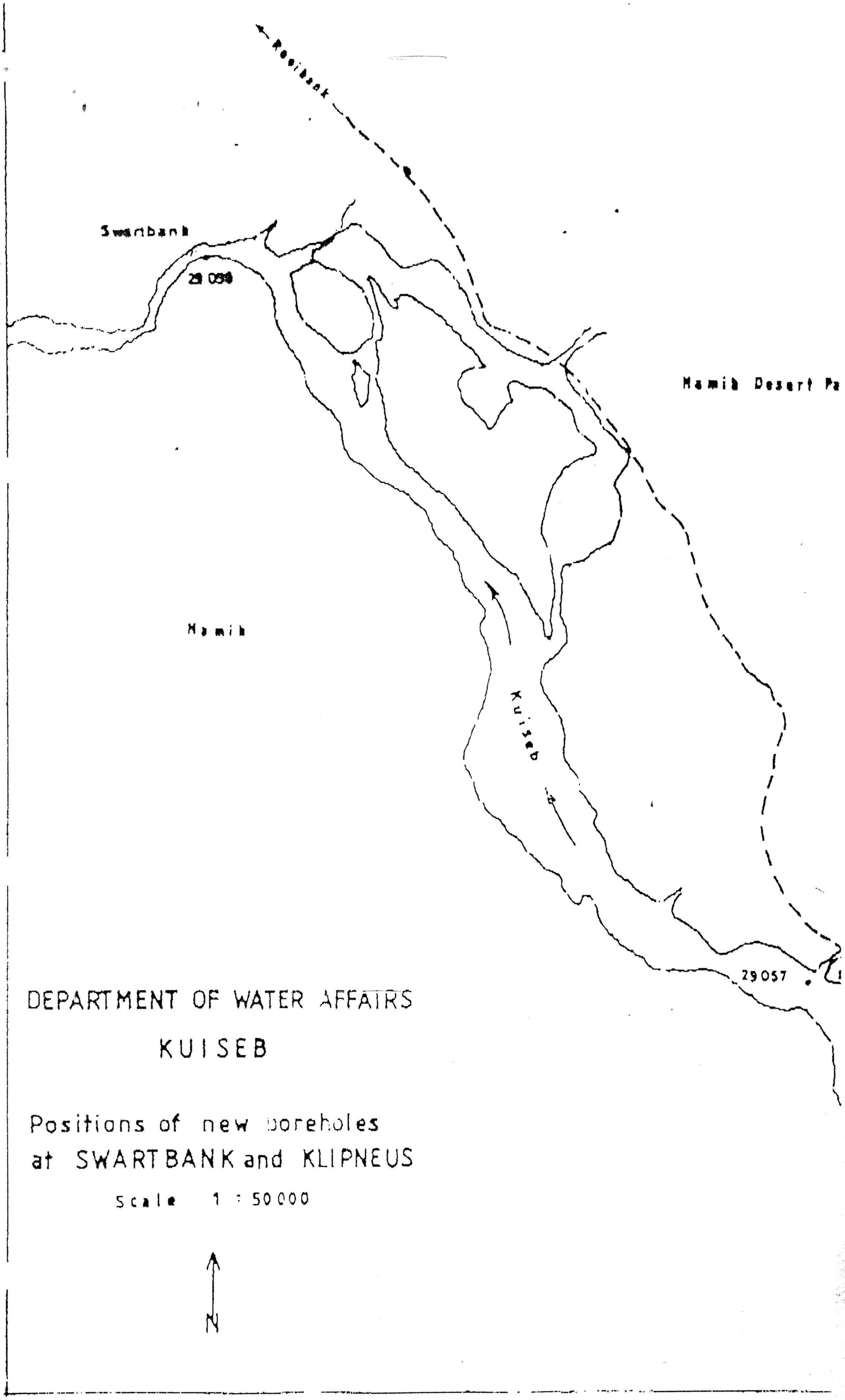
Map 3


Rooibank
Swartbank
29 059
Namib Desert Pa
Namib
Kuiseb
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DEPARTMENT OF WATER AFFAIRS
KUISEB
Positions of new boreholes
at SWARTBANK and KLIPNEUS
Scale 1 : 50 000
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Map 4