EPISODIC FLOOD EVENTS OF RIVERS CROSSING THE DESERT

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1. INTRODUCTION

Very little rainfall, on average less than 50 mm/a, occurs in the Namib Desert. Its water resources are dependant on water brought down from subsurface or surface flow out of the inland where more favourable rainfall conditions prevail. The most important water resources are created by three of Namibia's western flowing rivers, which cross the central Namib into the Atlantic Ocean (see FIGURE 1), i.e. the Omaruru, Swakop and Kuiseb Rivers. These form linear oases in the desert, not in the form of permanently flowing open water, but by the episodic recharge of the sandy aquifers underlying the river bed.

These aquifers are the resources which nature relies upon for the sustaining of vegetation (Kuiseb), for irrigation (Swakop), for human consumption by the coastal town (Kuiseb and Omaruru) and mining (Kuiseb and Omaruru).

An understanding of the hydrological features of the episodic recharge events is essential for the optimal management of these resources.

2. FLOOD CHARACTERISTICS

Floods in Namibia are often of the "flash flood" type, characterized by an almost instantaneous rise and a short duration (see FIGURE 2). This is caused by a combination of the following factors:

- these floods are generated by convective rainfall storms with a high intensity and a short duration;

- these storms occur in catchments with a more or less impermeable soil and an immediate, but short-lasting, reaction;

- the vegetation cover often deteriorates due to droughts and/or bad grazing management.

This is especially true where the floods enter the desert after traversing the escarpment in steep canyons which have little absorbing floodplains. Further into the desert, particularly in the Kuiseb, the riverbed widens, but still only the major floods will last longer than a few days and be turbulent enough to stir up sealing silt layers to be able to introduce a notable rise of the groundwater table.

In the desert floods move down with a typical "wetted front" interface. The larger the floods are, the wider the area they have to wet and the more they are subject to losses.

3. RECENT HYDROLOGICAL HISTORY

3.1 OMARURU

(see FIGURE 3)

On average the Omaruru reaches the sea every second year. However on many occasions the runoff is too insignificant to have an effect on recharge, and, on average, only once every ten years replenishment is brought to the underground water.

3.2 SWAKOP

(see FIGURE 4)

According to historic evidence the Swakop also used to flow into the sea half of the years. This pattern was broken in the seventies: since 1976 the river did not reach the coast for eight years. In 1985 the river flowed again into the sea and, although it has been flowing through the desert several times since then, it was never with the same magnitude as before.

3.3 KUISEB

(see FIGURE 5)

Also the Kuiseb is reported to have reached the sea on more than one occasion (eight times since the beginning of the century). The last time there was strong flow into the sea was in 1962/63, while in 1973/74 it just reached the Mouth. In more recent years floods barely passed Rooibank.

4. HYDROLOGICAL PARAMETERS

4.1 EPISODICAL CHARACTER

Two types of episodic mechanisms are possible. The first is a "cyclic" one, where the exceptional incident occurs with a more or less constant recurence, e.g. sun-spot generated events. The second is the "erratic" or "random" one, where only an average time interval in between events can be calculated.

Return period is the specific hydrological term used for the average time interval, and it is the cause of a great deal of misunderstanding because of its statistical implication. For instance an event with a return period of 10 years can easily happen in three consecutive years and then not anymore for another thirty years.

If floods were of a true cyclic nature, river flow and recharge would be more reliable, but this is not the case for the type of events observed in the western flowing rivers. There may therefore be long periods of drought and short periods of no drought.

4.2 PATTERN CHANGES

Whereas for the Omaruru no systematic change in the frequency and the magnitude of flood events can be discerned, there has been a marked decrease for both the Swakop and the Kuiseb Rivers.

Important questions are now:

- is this a random temporary situation or does it indicate a trend?

- if there is a trend, what is the reason, and will it carry on in future?

The following considerations must be borne in mind:

- There has been a severe rainfall drought in the central area of the country in the late seventies and early eighties, which sufficiently explains the absence of floods in the desert during that period;

- Two major impoundments were built on the Swakop River in the past two decades; Von Bach Dam (1970) and Swakoppoort Dam (1977) with a combined interception capacity of 110 million cubic metres. This might explain, for this river specifically, why the recovery after the drought period was only partial. It indicates that the trend of a lower frequency of floods in the desert will persist.

The period of drought alone does, however, not fully explain why the Kuiseb's river régime has shown a similar decline over the past 10 to 15 years (see FIGURE 6). There is no evidence of major developments in the catchment recently. Apart from irregular changes in the rainfall pattern, one would like to speculate that the catchment response has been modified through a change of unknown nature in catchment management.

5. CONCLUSION

Because of the high variability experienced in the rainfall, and consequently runoff, the importance of further monitoring the hydrology of these rivers should be appreciated.

DRAINAGE SYSTEM IN NAMIBIA

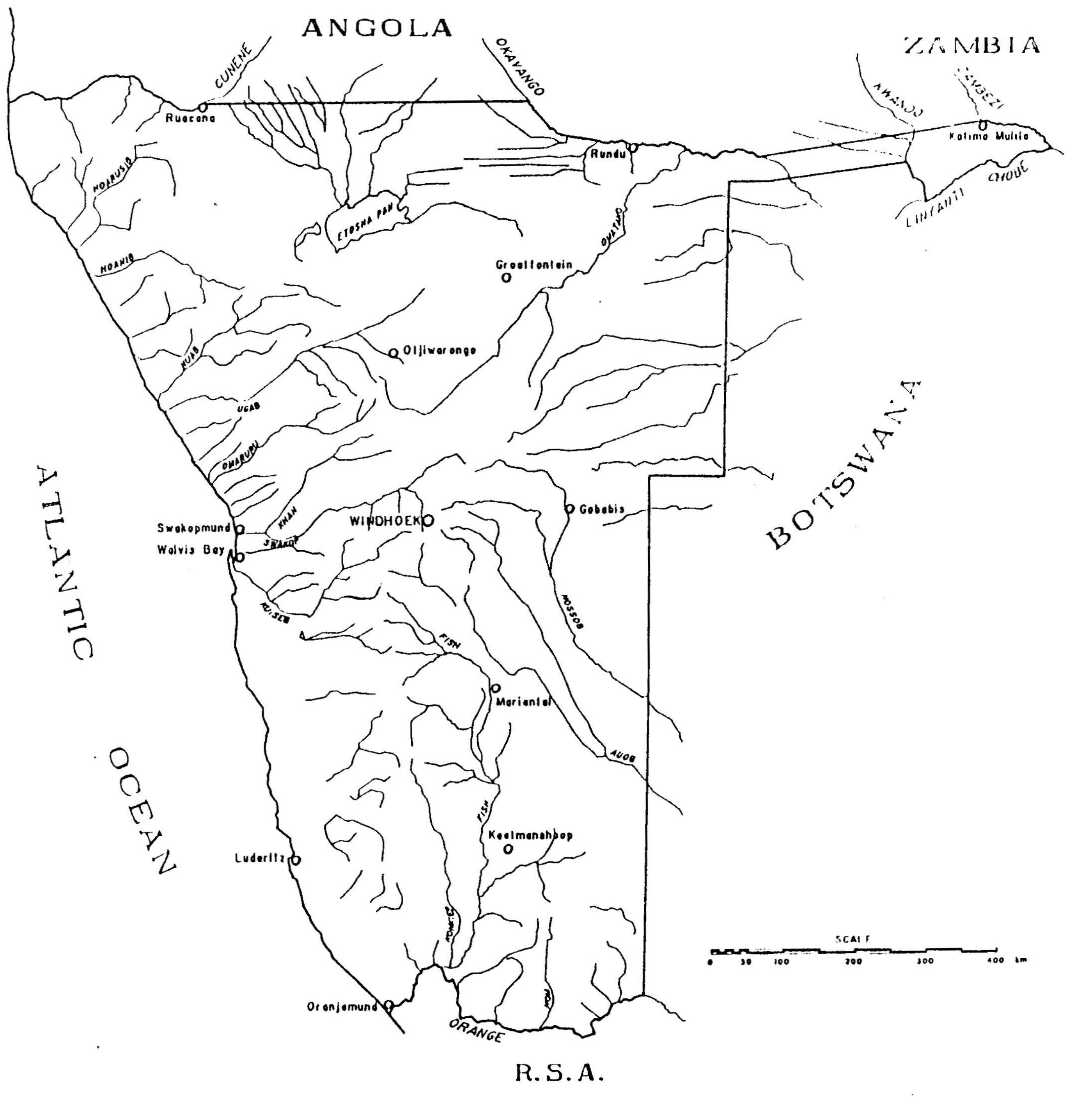

FIGURE 1

EXAMPLE OF HYDROGRAPH OF FLOOD IN DESERT

STATION : SESRIEM
RIVER : TSAUCHAB

NUMBER : 3022M01
SEASON : 85/86

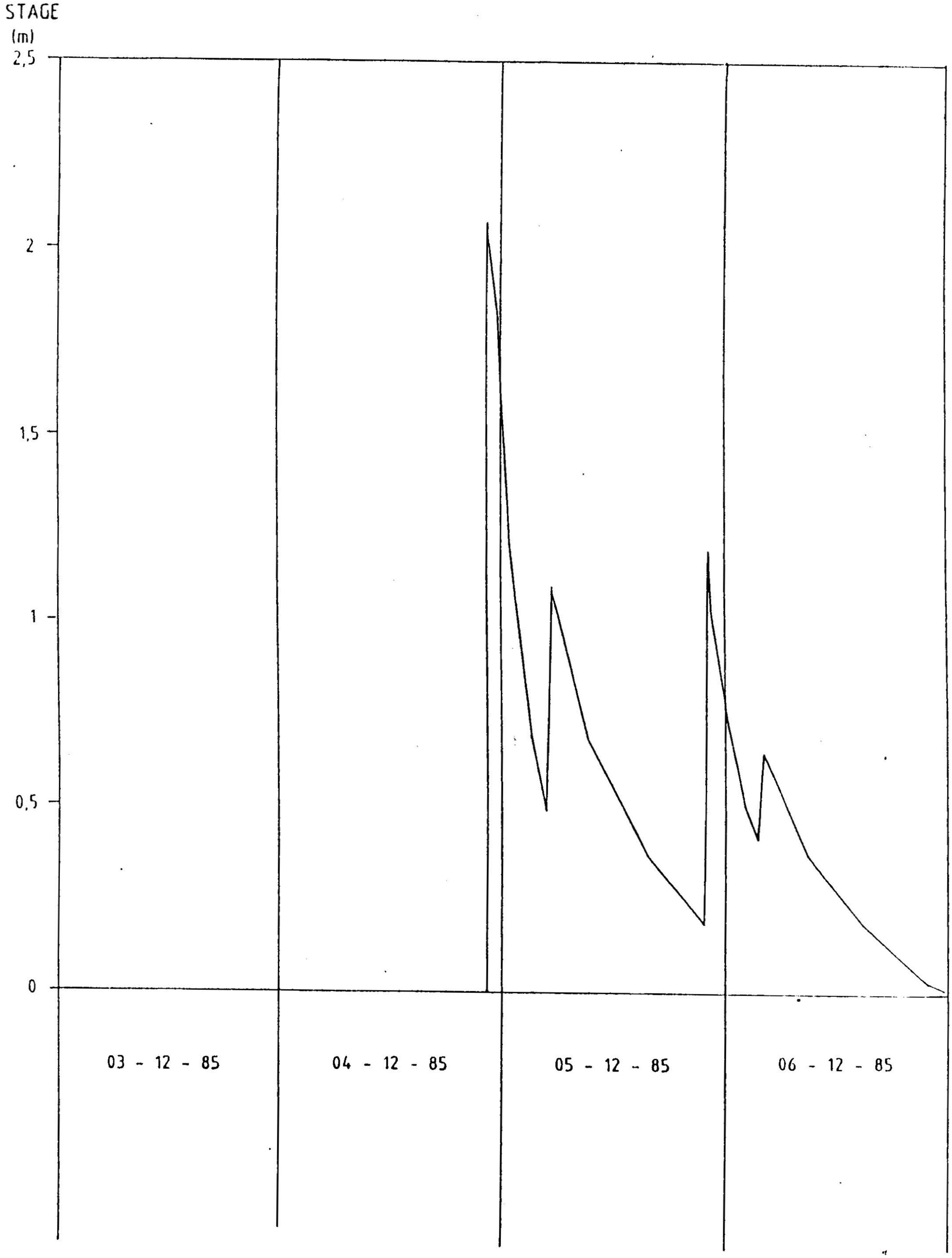

FIGURE 2

FLOW AT HENTIES MONUMENT

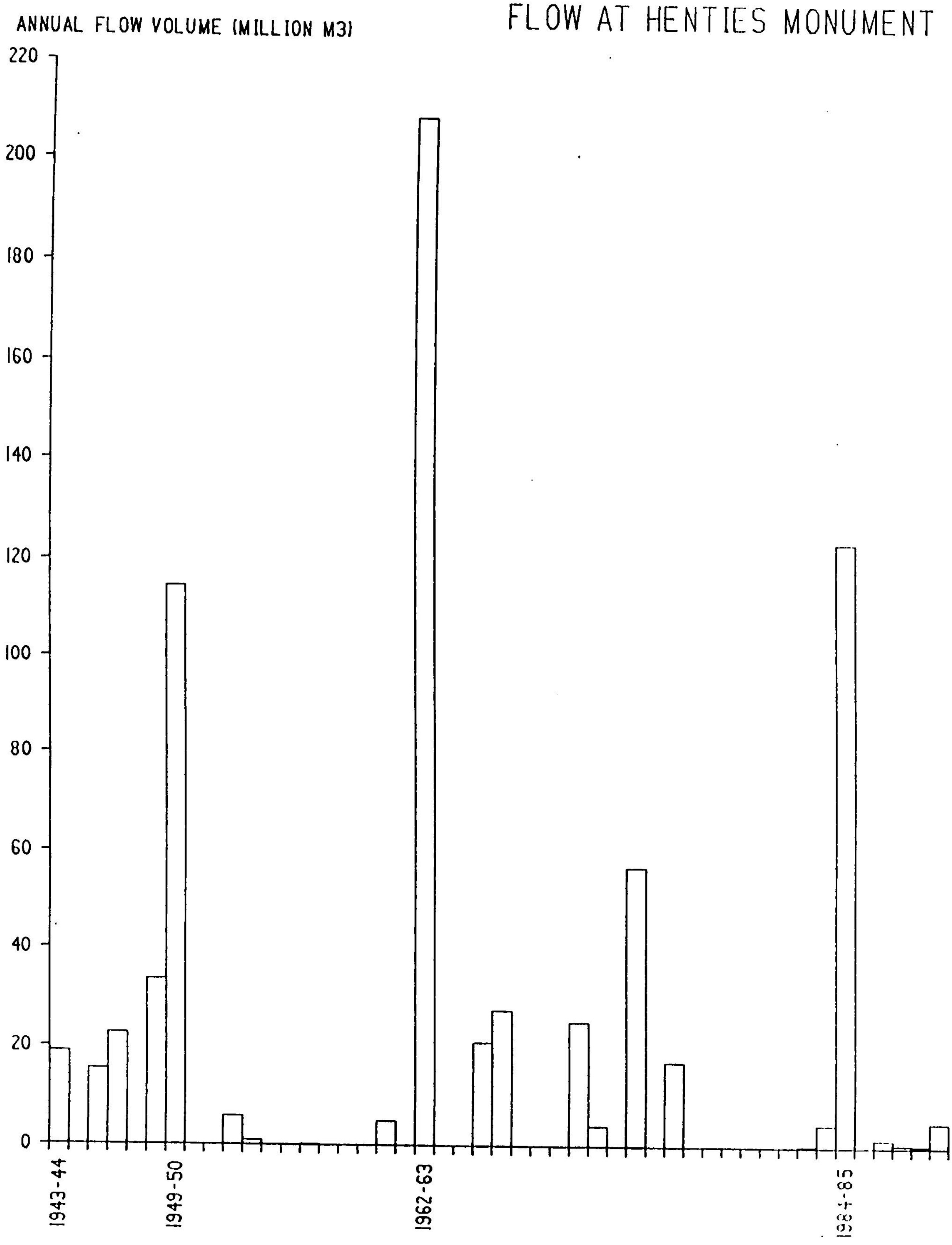

FIGURE 3

FLOW AT SWAKOPMUND

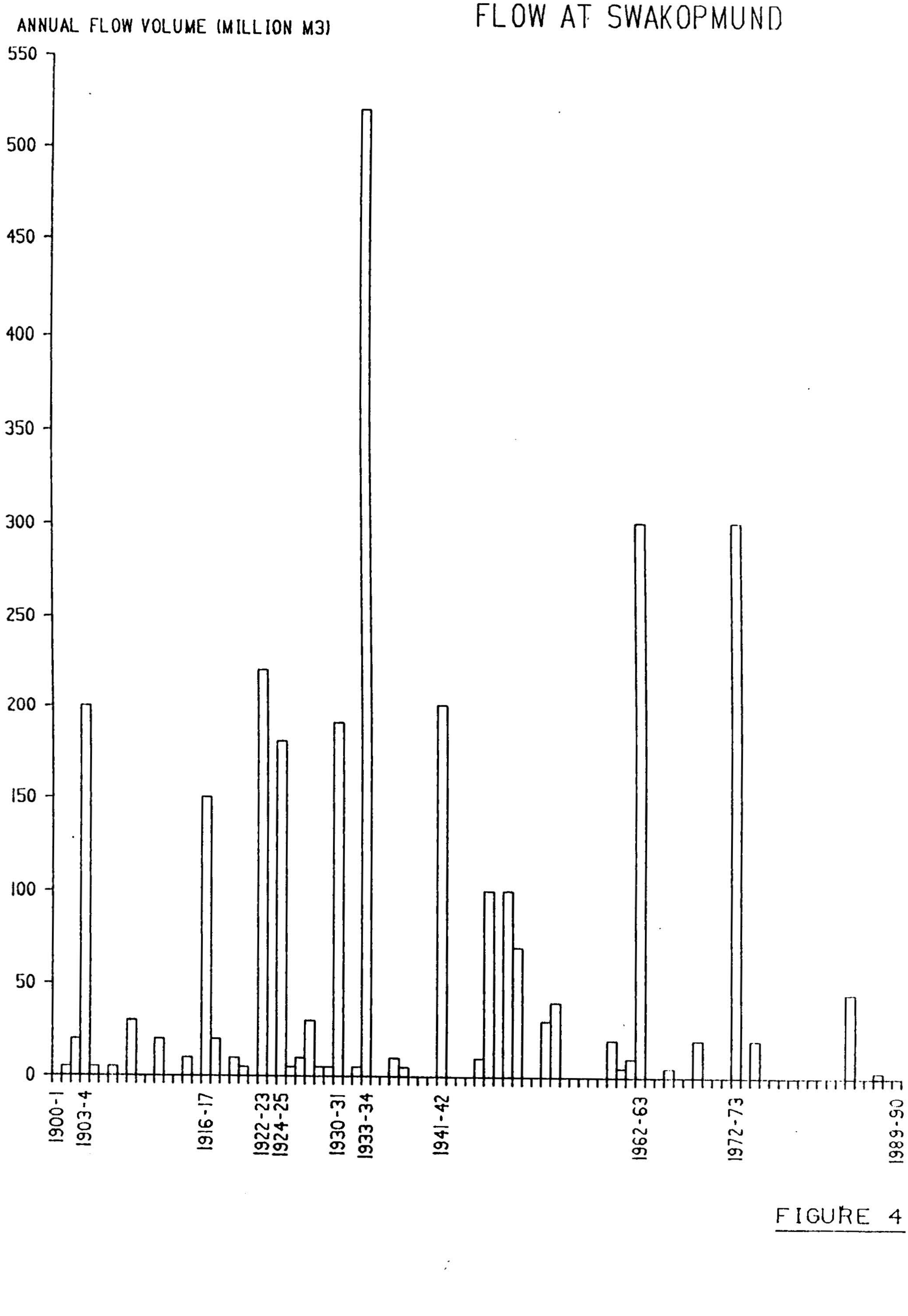

FIGURE 4

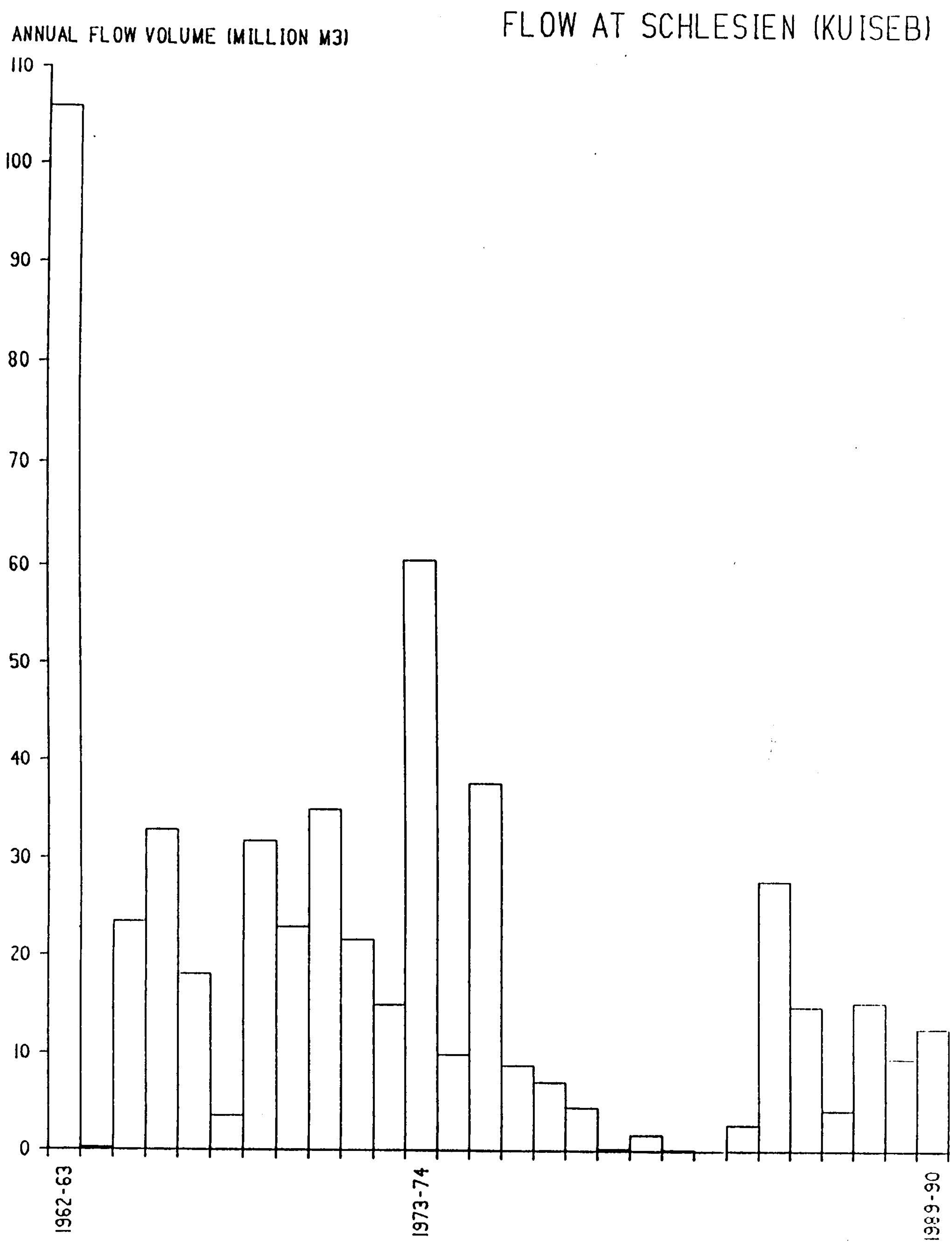
FLOW AT SCHLESIEN (KUISEB)
ANNUAL FLOW VOLUME (MILLION M3)
110
100
90
80
70
60
50
40
30
20
10
0
1962-63
1973-74
1989-90

FIGURE 5

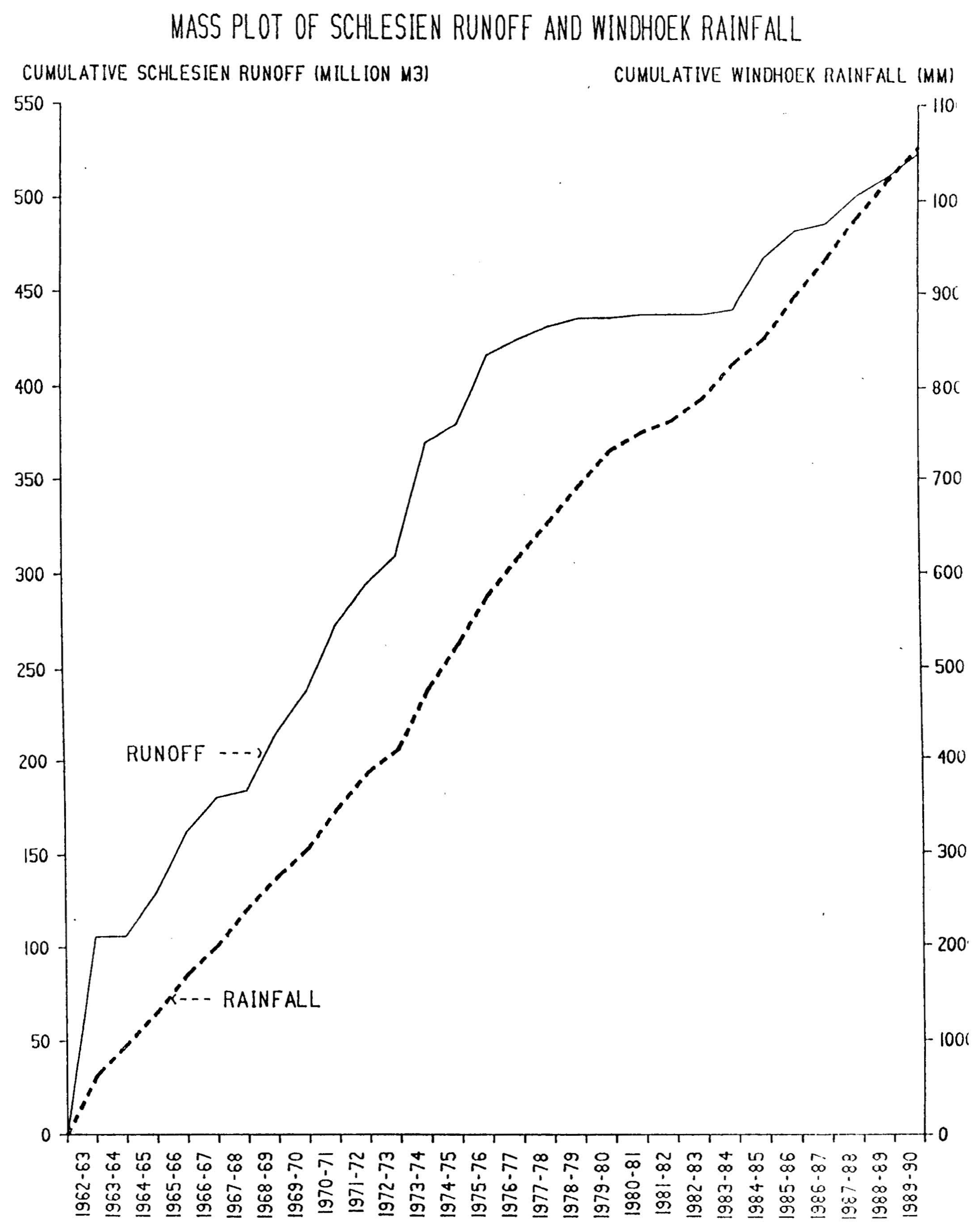
MASS PLOT OF SCHLESIEN RUNOFF AND WINDHOEK RAINFALL
CUMULATIVE SCHLESIEN RUNOFF (MILLION M3)
CUMULATIVE WINDHOEK RAINFALL (MM)
550
500
450
400
350
300
250
200
150
100
50
0
RUNOFF
RAINFALL
1962-63
1963-64
1964-65
1965-66
1966-67
1967-68
1968-69
1969-70
1970-71
1971-72
1972-73
1973-74
1974-75
1975-76
1976-77
1977-78
1978-79
1979-80
1980-81
1981-82
1982-83
1983-84
1984-85
1985-86
1986-87
1987-88
1988-89
1989-90

FIGURE 6