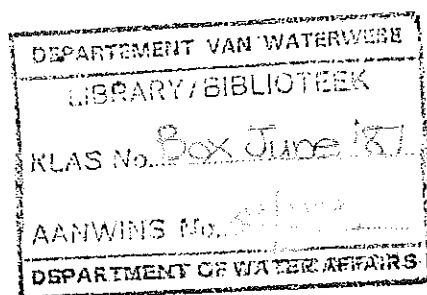REPORT ON A SOIL SURVEY IN AREAS WHICH COULD BE
IRRIGATED FROM THE PROPOSED NECKARTAL DAM ON THE
FISH RIVER

VOLUME   3

AGROCLIMATIC SUMMARY

JUNE 1987

AGROCLIMATOLOGICAL DATA

FOR

THE FISH AND TRIBUTARY RIVER VALLEYS

TO THE SOUTH-WEST OF KEETMANSHOOP

1. LOCATION:

The area under consideration comprises the river valleys of the Fish and its tributaries, particularly the Lowen River, which are aligned approximately north-east - south-west in the area bounded by:

$26^\circ 45'S$ $17^\circ 45'E$ $27^\circ 03'S$ $17^\circ 45'E$

$26^\circ 45'S$ $17^\circ 57'E$ $27^\circ 03'S$ $17^\circ 57'E$

The nearest First Order Meteorlogical Station is located at Keetmanshoop, approximately 20 km to the north-east of the area under consideration, and located on the banks of the Fish River. Seeheim, at which precipitation is recorded, is located within the western portion of the area, approximately 1 km from the left bank of the Fish River.

Station	Latitude	Longitude	Altitude	Record Period
*Keetmanshoop (Town)	26° 35'S	18° 08'E	1004 m	1899 - 1948
*Keetmanshoop (Airport)	26° 32'S	18° 07'E	1066 m	1951 - 1984
Seeheim	26° 49'S	17° 48'E	710 m	24 - 25 years

* Note: Time periods of data availability are variable; in all cases the longest available period of data will be used.

The area is located within the climatic region known as Desert and Poor Steppe of southern South West Africa / Namibia (Schulze, 1965).
It is a fairly open area with an altitude of approximately 700 m, and small non-perennial river valleys with relief of approximately 20m crossing the area. Higher ground, with an elevation of approximately 150 m above the surrounding area, exists to the east of the area.

The comparative elevation of Keetmanshoop implies that conditions will be slightly moister and cooler than it is in the valley bottoms.

2. RAINFALL:

Rainfall District: J1 (SAWB, 1972)   Rainfall Section: 418 - 419

The generalised rainfall distribution over southern South West Africa / Namibia displays a gradual increase from west to east and north-east (Figure 1).
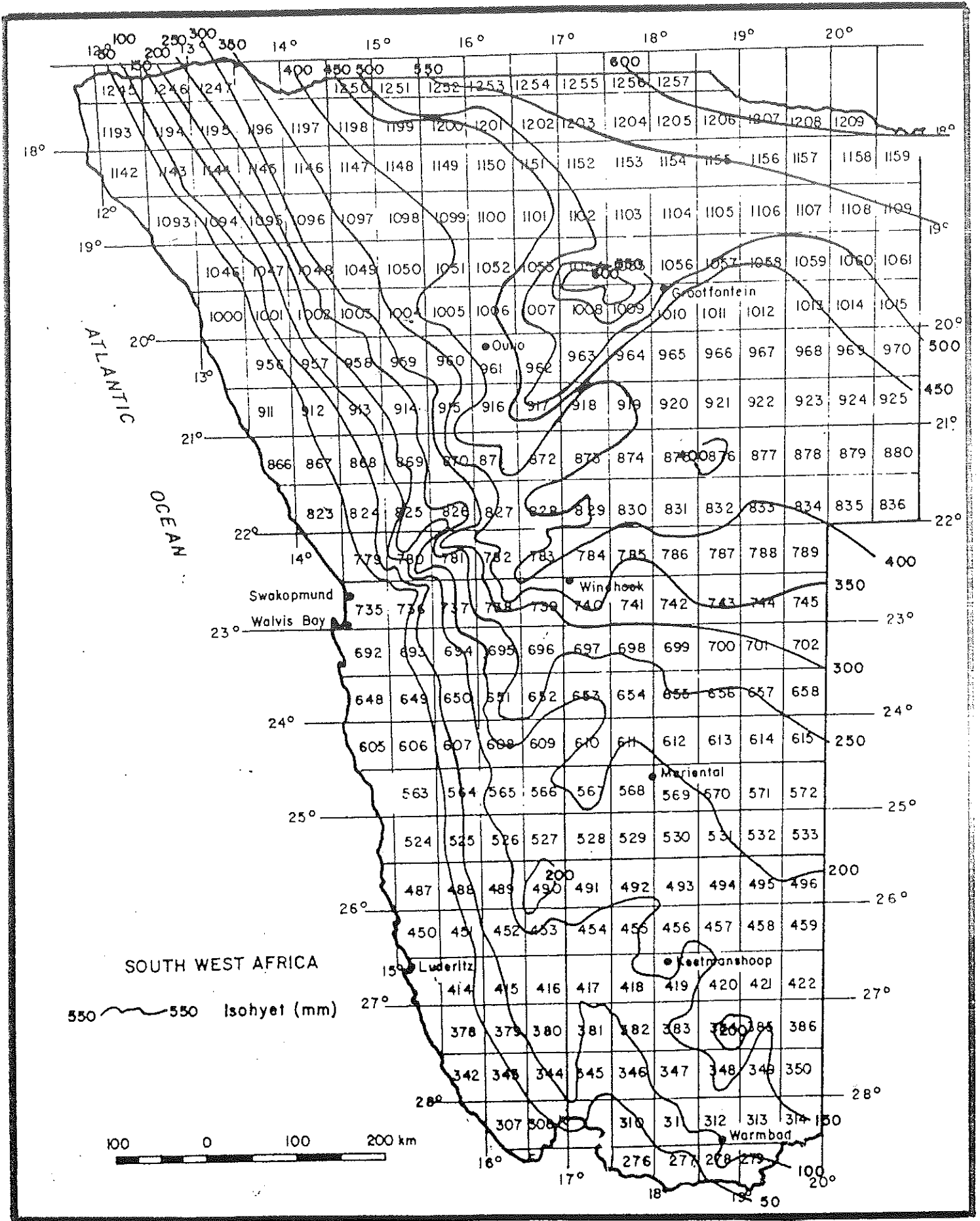
FIGURE 1: Mean annual isoheyts for South West Africa / Namibia (after: Richardson and Midgley, 1979).

The local pattern would display similar trends, enhanced by orographic effects in the east and north-east.

Annual Rainfall:

	Keetmanshoop	Seeheim
Mean annual rainfall	146 mm (78 years)	120,7 mm (24-25 years)
Maximum annual rainfall	549 mm (1974); 376% of mean	
Minimum annual rainfall	20,1 mm (1908) 14% of mean	

Drought Rainfall:

Keetmanshoop: 1901 -1950

Driest Quinquennium recorded:

1906 - 1910: 98,0 mm ; 73,5% of mean for period

Wettest Quinquennium recorded:

1936 - 1940: 146,1 mm ;109,6% of mean for period

A drought year is defined as one in which less than 85% of the normal annual rainfall is received.

Monthly Rainfall:

Keetmanshoop: (78 years)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Mean (mm)	23	33	38	15	4	1	1	1	3	5	10	12	146
% of annual total	16	23	26	10	3	,7	,7	,7	2	3	7	8	100
Av no of days with rain	4,3	6,5	6,4	3,0	1,5	0,9	0,4	0,3	0,3	1,5	2,2	2,7	30,0

Seeheim: (24-25 years)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Mean (mm)	21	38	24	9	2	1	1	,8	,6	4	7	12	120,4
% of annual total	17	32	20	7	2	,8	,8	,7	,5	3	6	10	100
Av no of days with rain	2	3	3	1	,6	,5	,1	,3	,1	,8	1	2	14,4

Rainfall receipt is dominated by a summer maximum between November and March, with a peak in February-March, typical of Rainfall Region J1 (SAWB, 1972).

Most of this rain is brought by convectional showers during summer and autumn. On rare occasions single showers may account for the normal annual precipitation.

Daily Rainfall:

Keetmanshoop (85 years):

Av no of days with 10 mm or more	4,1	days
Av no of days with 1 mm or more	19,3	days
Max no of days with ≧1 mm	44	days
Min no of days with ≧1 mm	9	days
Av no of days with 0,1 mm or more	28,0	days

Max rainfall received in 24 hours: 100 mm in 1957

Highest recorded and expected rainfall for certain return periods (mm):

Keetmanshoop (1953 - 1972):

	Recorded	Expected		
		25 years	50 years	100 years
15 min	17,7	17,3	20,6	23,8
30 min	21,0	24,3	28,9	33,5
45 min	27,8	28,4	33,8	39,2
60 min	32,0	29,9	35,6	41,2
24 hours	62,0	43,0	51,0	59,0

Rainfall Variability:

Rainfall variability (% deviation from mean annual rainfall):

approximately 54%

which high variability corresponds with a high degree of unreliability.

Thunderstorms:

Keetmanshoop: 28 days - all months, especially January to March

Hail:

Keetmanshoop: 0,6 days between October and May

Fog:

Keetmanshoop: Nocturnal - 1,1 days during May - July and November

Snow:

Keetmanshoop: 0,1 days during August

Cloud Cover:

Keetmanshoop:	08h00	14h00	20h00
(eighths)	1,7	2,0	2,0

3. EVAPORATION:

Keetmanshoop ($\pm$ 4 years):

These figures are likely to be slightly lower than those for the area under consideration because of the greater elevation and hence slightly cooler conditions at Keetmanshoop.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Class A Pan (mm)	465	373	328	251	185	170	206	246	323	396	465	495	3903
Symons Pan (mm)	373	307	274	213	150	132	160	185	234	292	351	378	3049

Seasonal distribution of evaporation:

Summer: 34%   Autumn: 20%   Winter: 16%   Spring: 29%

4. ATMOSPHERIC MOISTURE:

a. Water Vapour Pressure (Keetmanshoop):

	Annual	January	July
Mean (mb) 08h00	8,9	10,8	5,7
Mean (mb) 14h00	7,7	7,6	6,1

b. Saturation Deficit (Keetmanshoop):

	Annual	January	July
Mean (mb) 08h00	9,7	15,6	4,0
Mean (mb) 14h00	28,8	43,0	15,7

c. Relative Humidity (Keetmanshoop):

	Annual	January	July
Mean (%) 08h00	48,0	44,0	52,0
Mean (%) 14h00	21,0	19,0	23,0
Mean (%) 20h00	25,0	23,0	28,0

Due to the slightly greater elevation of Keetmanshoop, the above conditions are likely to be slightly moister than would be expected in the valleys of the area under consideration.

5. SOLAR RADIATION AND SUNSHINE:

Keetmanshoop:

2 years data:	Annual	January	July
Solar radiation at top of atmosphere (cal/cm^2/day)	774	1013	516
Total solar and sky radiation at the earth's surface	566	721	391

10 years data:			
Mean daily hours sunshine	10,7	11,6	9,9
% possible duration	89	85	93
No of days with no sunshine	0,4	0,0	0,0
No of days with 90 - 100% of possible	264	19,5	26,8

6. TEMPERATURE:

Keetmanshoop:

Mean monthly and daily Temperatures (^{o}C):

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Mean monthly	26,7	26,1	24,6	21,0	16,9	14,0	13,8	15,3	18,9	21,4	24,2	25,9	20,7
Highest daily Maximum	42,1	40,3	40,6	36,4	33,0	29,0	29,5	33,9	37,0	39,9	40,8	41,2	42,1
Lowest daily Minimum	7,5	7,7	6,2	1,0	-0,3	-3,6	-4,0	-4,7	-0,6	1,0	3,5	5,2	-4,7

No of days with Maximum Temperature $> 35^{o}$C: 63,7 (September - April)

No of days with Maximum Temperature $> 30^{o}$C: 161,0 (August - May)

No of days with Minimum Temperature $> 20^{o}$C: 37,1 (September - June)

No of days with Minimum Temperature $< 0^{o}$C: 3,6 (March; June - September; Novembe

No of days with Minimum Temperature $< 2,5^{o}$C: 0,1 (July - August)

Extreme Temperatures:

	Maximum (^{o}C)	Minimum (^{o}C)
Recorded:	41,2	-4,0
Expected with 25 Year return period:	42,4	-7,6
Expected with 50 year return period:	43,1	-9,1
Expected with 100 year return period:	43,9	-10,7

FROST:

3,6 days in March, June to September and November.

The area under consideration lies at a lower altitude than Keetmanshoop and hence is likely to experience slightly higher temperatures, but with a possibility of more frequent frost particularly in valley bottoms.

7. WIND:

Prevailing winds in the area under consideration are dominated by the anticyclonic circulation patterns over southern Africa, and their disturbance by cyclonic systems which travel over the region at frequent intervals, both summer and winter. Prevailing winds are mainly south-south-westerly, especially during summer, and north-north-easterly, particularly during autumn and winter.

Alignment of the valleys and the presence of higher ground to the east and north-east is likely to accentuate these air flow patterns, with a funnelling effect in the valleys and a downslope drainage from the higher ground at night, resulting in possible enhancement of wind speeds.

Mean hourly wind speeds:

Keetmanshoop:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Wind speed (m/s)	4,0	3,5	3,4	3,5	3,8	4,3	4,4	4,5	4,2	4,4	4,3	4,1	4,1

These wind conditions are further illustrated in the wind roses below (Figure 2).
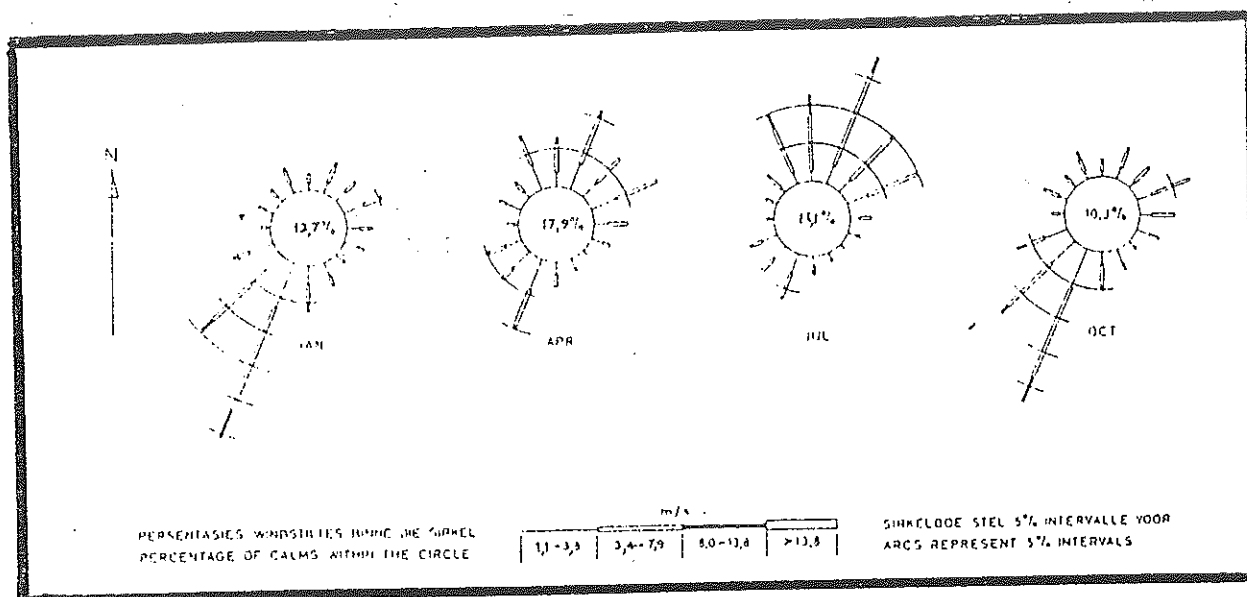
FIGURE 2: Wind roses for Keetmanshoop (after: SAWB, 1960b)

Extreme wind speeds (m/s):

	JAN	MAR	JUN	SEP
Highest recorded wind speed	16	16	16	22
Highest recorded gust	33	29	28	32

Return Period:	25 years	50 years	100 years
Highest expected wind speed	21,7	22,8	23,9
Highest expected gust	41,0	44,9	47,8

These winds may be associated with dust storms similar to the 'haboobs' of the Sudan*.

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* The haboob forms ahead of a thunderstorm as winds lift dust or sand into a huge, tumbling dark cloud that may extend horizontally for over 150 km and rise vertically to the base of the thunderstorm.

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