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Ministry of Agriculture, Fisheries, Petroleum and Minerals
Directorate of Agriculture
- Water Resources Department -

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RAINFALL
In the Muscat Area

Water Resources OMA 73/009
Field Document No. 1.

FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS

Muscat 1976

Water Resources

OMA 73/009

Field Document No.1

RAINFALL IN MUSCAT AREA

P.M. Horn

This paper was produced as a part of the work of the Water Resources Department of the Directorate General of Agriculture, Ministry of Agriculture, Fisheries, Petroleum and Minerals, Sultanate of Oman.

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This Project Document has yet to receive the endorsement of the Food and Agriculture Organisation of the United Nations and does not necessarily present the opinions or recommendations of that Organisation.

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FOREWORD

This is planned as one of a series of papers covering available climatological and water resource data within the Sultanate of Oman.

During the preparation of this paper, all records for the past decade have been thoroughly reviewed and researched. It has been possible to detect some errors in previously published versions, and their correction is one of the objectives of this publication. Search into older records is still going on, but meanwhile the data is urgently needed for application in numerous fields.

This paper has therefore been printed in an interim format this time. Section 2 covers old record before 1967, and this can be reviewed subsequently if more detail can be obtained. Sections 3 and 4, covering current records, are final and need only to be updated in the course of time.

Generally the span of record available is far too short for definitive interpretation, and this paper is therefore regarded rather as a tabulation, than interpretation, but some general comment has been included. Further details, or the most recent records, can be obtained from the Water Resources Department of the Ministry of Agriculture, Fisheries, Petroleum and Minerals.

Data is only available because of the work put in by individuals in maintaining the records, so it is appropriate to acknowledge with thanks, the assistance of the Meteorological Department, and of past and present staff of Petroleum Development (Oman), the French and British Embassies, and Renardet-Sauti-I.C.E.

1: TEXT

1:1 Introduction

This paper covers all available record for the area within an approximate 50 kilometer radius of Muscat - other record will be covered in subsequent papers.

Before 1967, only summarized data for Muscat is available (except some incomplete record for Azaibah for the period 1963 - 1967). Thereafter there is record for both Muscat and Mina al Fahal : remaining stations were added in 1973 or subsequently.

The main particulars of all stations are listed in Table 1:1 and locations are shown in Fig. 1. There is a considerable density of stations within this area: but no advantage could be obtained by reducing or transferring any station: meanwhile this density allows a valuable sample of localized spatial variability; and close quality control. Unless otherwise noted, all are conventional daily rain gauges of one or other standard type.

1:2 General description of rainfall

Winter and early spring are the predominant rainfall seasons on the Eastern coast. The seasonal wind is the dry NE monsoon, but this is periodically interrupted by the passage of depressions and cold fronts from the north-west: All significant rainfall periods are associated with synoptic situations of this type; and tend to be typically wide spread over large areas, but with local variations in intensity.

Lesser rainfalls may sometimes also occur in the unsettled conditions during the passage of the I.T.C.Z.

In summer, the predominant rainwind is the moist SW monsoon which brings the well known Salalah rainfall, and also good rain on the interior slopes of the mountain ranges ^{1/} These ranges however, effectively block any penetration to the NE coast, which is almost totally dry between mid May and mid October. Rare convective storms (and even rarer cyclonic storms) can however occur; these tend to be localized but can be very intense

Orography strongly influences the spatial distribution, both locally and on the regional scale.

1:3 Variability in Time

The gaps in record, and form of statistics, do not favour conventional calculations of rolling averages or cumulative departures. However, longterm annual averages, over a decade or more, appear to be fairly stable as revealed by the following values.

^{1/} It seems probable that in the early seventies the interior may have suffered the same rainfall deficiency from limited northward penetration of the monsoon, as in sub Saharan African and North Yemen, but there is no factual evidence on this point.

Table 1:2 - Long Term Averages - Muscat

<u>Period</u>	<u>No. of years</u>	<u>Annual Mean</u>
1894 - 1910	17	101
1911 - 1930	20	101
1935 - 1942	7	83
1951 - 1965	15	104
1967 - 1976	<u>9</u>	<u>126</u> (mid '67 - mid '76)
	68	103

This table might be taken to imply a slight upward trend, but the last decade has included two exceptional years, and would anyway be lower if the probable (low) value for 1967 were included.

Probably the highest ten year value since 1893 was 131 mm for the period 1909 - 1918 : the probable lowest value is 53 mm for 1918 - 1927. Statistics for numbers of raindays in the most recent decade are remarkably similar to those quoted in Table 2:1.

Use of annual figures tend to obscure the fact that "good years" rainfalls are in fact often limited to single months, separated by prolonged rainless periods. The alluvial aquifers of the Batinah depend upon regular replenishments, and frequency and duration of droughts are therefore a critical factor. During the 68 years of record, periods excluding 20 months without significant recharge, have occurred about 14 times - i.e. they may be expected about twice in any decade. The longest period was 45 months (1901 - 1904).

Defining drought

1:4 Recent Rainfall

The winter season of 1971/'72 was the best in the 68 years of record : that of 1975/76 was the sixth or seventh - i.e. the rainfall that will occur once in a decade, on average. Both are also notable in that the rainfall was spread over several months, allowing maximum benefit. Between these two events however there was a long almost rainless period, lasting from February 1973 through December 1975 interrupted by the single good rainfall month of February 1975.

Groundwater conditions were therefore probably at a near maximum in the early summers of 1972 and 1976, and at near minimum at the ends of 1974 and 1975.

1:5 Variability in Space

As previously noted, orography has a strong influence on spatial distribution. It seems probable that Muscat and its immediate south east coast, where the mountains reach directly to the sea, enjoys a marginally higher rainfall than the flatter coast to the northwest. However, rainfall on the Batinah Coast increases inland near the foothills of the main ranges. Available record, and experience, also suggest a localized rainshadow effect within the Semail basin. This hypothesis must be tested with further rain gauges, because it could have a significant effect on the assessment of the heavily exploited groundwaters of this drainage systems

/...

However, despite local variations, the general level of seasonal rainfall in Muscat is determined by the frequency (or absence) of suitable synoptic situations. This will apply equally to the whole region, and hence in general terms the Muscat time sample should be applicable to all the Eastern Batinah. Certainly this has been the case for the three years for which a wider sample is available, but in other years the Northern Batinah may enjoy rainfall conditions which do not arrive at Muscat, and hence too wide an extrapolation is not desirable. Similarly the Muscat sample cannot be used for the interior, as it does not reflect the summer rainfall component.

1:6

Short period rainfalls

Again, the available record is not favourable to conventional analysis. However, from table 2:1 the greatest rainfall daily was 79mm in 38 years. If to this 38 years is added the ten years mid 1967-mid 1968, then the greatest 24 hour fall in 48 years was the 110mm of August 1970, and the 79mm becomes the second greatest within the same period. 50mm was exceeded at least ten times during this period, and deriving the frequencies of lesser rainfalls from the recent decade, the following approximate return periods are obtained.

<u>24 hour rainfall</u>	<u>approx. return period</u>
110 mm	49 +
79 mm	25
61 mm	12 - 16
50 mm	5
30 mm	1
20 mm	0.5

The resulting curve (Fig. 2) is not ideal but probably gives reasonable working values except for the most extreme events.

There is only very limited data for periods of less than 24 hours, available record for Muscat, Rumais, Rustaq, Nizwa and Saiq may be found on the files in the Water Resources Department. It may be noted that the rainfall of August 1970 lasted only 9 hours, and that in general terms atmospheric humidities can sustain rains of very high intensity. Flood hazards, therefore, are very real and should never be underestimated.

1:7

Symbols used in tables

- signifies no rainfall
- X signifies no record
- a signifies partial (incomplete) record for month or year
- T signifies trace rainfall
- () value has been synthesized

Table I - List of Stations

<u>Station</u>	<u>Co Ords</u>	<u>Alt.</u>	<u>Period of Record</u>
Muscat (Embassy)	6627-26120	20m	British Embassy 1893-1961 PDO 1962-1966 British Embassy 1967-1973 French Embassy 1975-date
Matrah (Corniche)	6592-26134	2m	February 1976 - date
Dar Sait	6569-26122	25m	November 73 (?) - date
Ruwi	6577-26093	40m	January 1974 - date
Mina al Falal (PDO)	6553-26134	5m	March 1967 - date
Azaiba (PDO)	6385-26095	-	1963-1967 - incomplete
Seeb Airport	6317-26090	-	December 1974 - date
Bid Bid	6150-25925	225m	March 1972 - date

Two temporary stations near Seeb are currently operated by Scott Wilson Kirkpatrick and Partners - See section 3:4.

For Quryat area, see Section 4.

/...

Fig. 1

LOCATION PLAN & OROGRAPHY

Scale 1:500,000

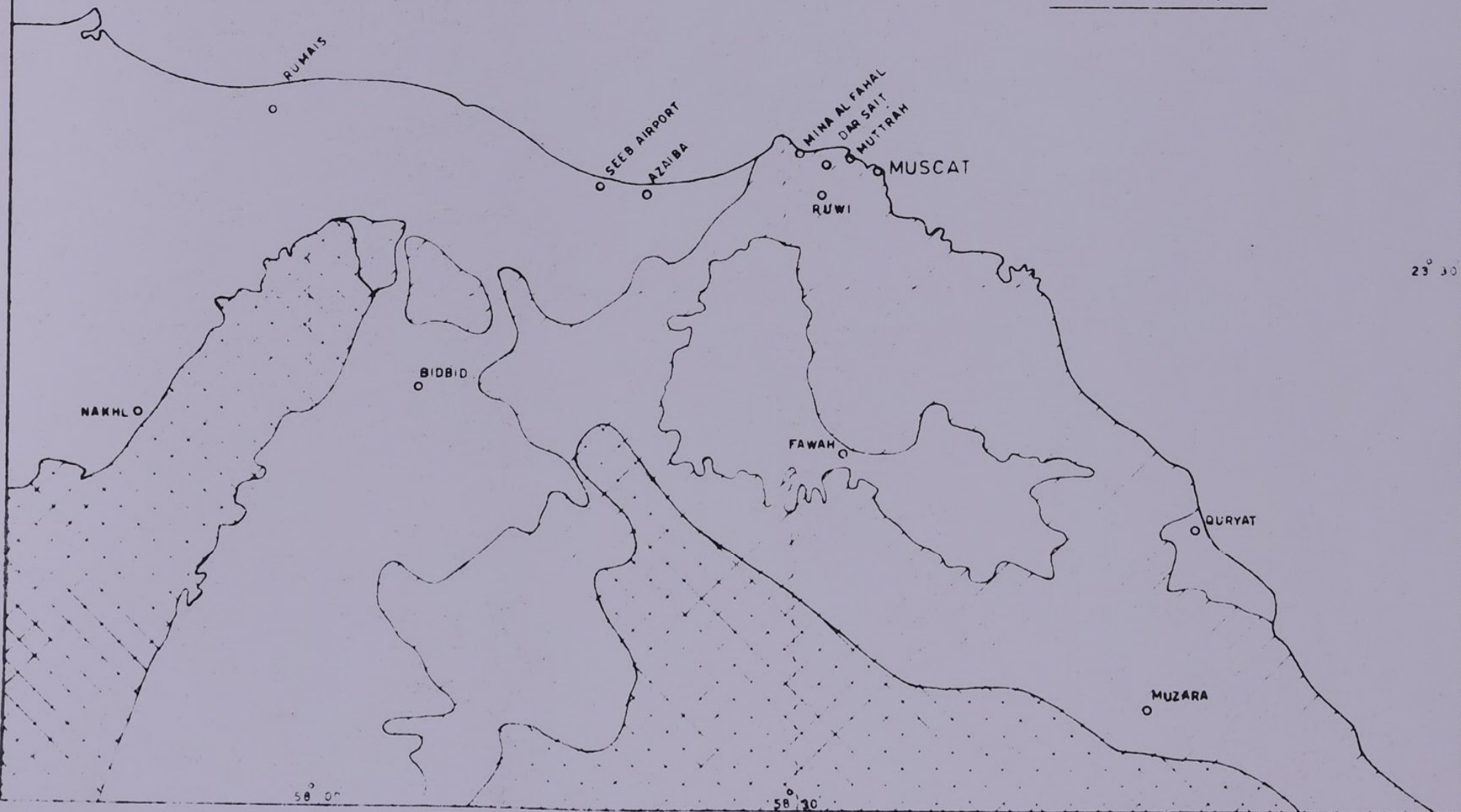
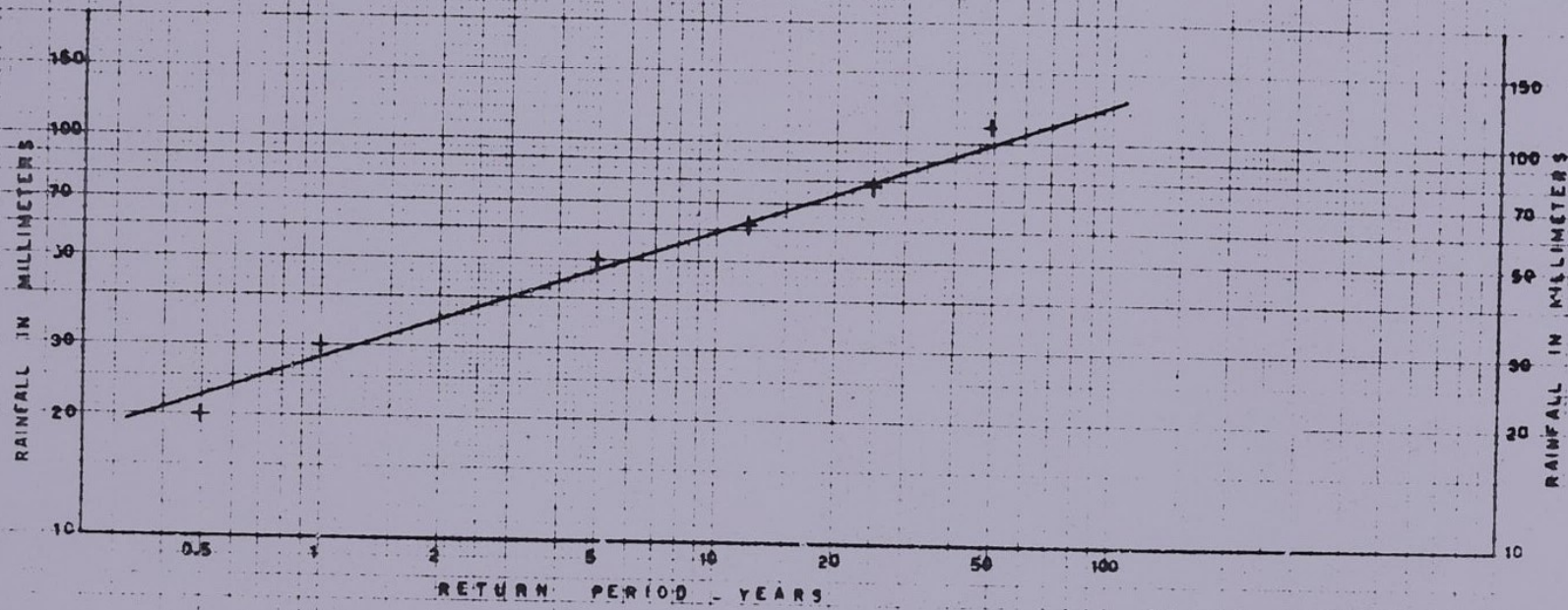


Fig. 2

24 HOUR RAINFALLS, MUSCAT



SECTION 2

RECORD PRIOR TO 1967

Muscat is the only station within this area for which long records exist.

There are scraps of record for 1861; regular records at the then Political Agency (i.e. British Embassy) commenced in 1893. This record continued until * 1929. In 1930 it was transferred to Beit Al Falaj (approx. 1 km. inland from the present Dar Sait Station). Record for 1931 - early 1935 cannot be traced.

In September 1935 record at the Embassy was revived: and was subsequently continued as a small weather station for the Met. Department of the then Government of India. The climate station was closed in May 1959 but rainfall record continued through 1961 inclusive.

Record for the period 1962 - February 1966 inclusive, was in fact taken at the house of the Manager of PD (O), Muscat, less than one kilometer from the Embassy site, it has always been attributed to Embassy record and is similarly treated here (as is also the 1930 record which is sufficiently indicative of the general rainfall of the year).

Recording was resumed at the British Embassy in September 1967 and detail record is shown in Section 3 of this paper.

Available Record

Monthly values since 1893, with gaps as noted above, have been published in several recent consultant reports; original source being "World Weather records".

Apart from this, the only greater detail currently available is a summary of 38 unspecified years during the periods 1893-1929 and 1935-1944, shown in Table 2:1 following. Copies of old climate summaries for the period 1952-1966, extracted from old embassy records, are available and have been cross-checked against the monthly values shown above.

For the period 1962-1966 these agree with published monthly values, and P.D.(O) summaries, except for some minor differences in conversion between inches and millimeters, which have been corrected in this paper.

For the period 1952 - 1961 the sources also agree, or with insignificant differences (conversion etc.) except as follows:-

- 1952 -- very dissimilar
- 1955 - totals agree but distribution is different
- 1956 - monthly records show rain in January summary shows Nil
-- monthly records show rain in December, summary shows 147
- 1961 -- in monthly records, values for July, November and December have twice been "converted" from inches to mm (e.g. original value of 0.02ins for July was converted to 0.5 mm, misread as 0.5 in and again converted to 12.7 mm).

* See Addenda.

In this paper, record for ¹⁹⁵⁶1956 and 1961 has been corrected as noted on the foregoing page; previously published values have been accepted for 1952 and 1955.

Table 2:1 - Summarized averages for 38 years during 1893-1929 and 1935-1944

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Amount in mm	28	8	10	10	<2	2	<2	<2	0	2	10	18	96
Max. 24 hr fall	79	56	43	51	5	61	5	10	0	38	53	56	79
Raindays > 1mm	2	1	1	1	Less than 1 in 10						1	2	8

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Table 2:2:a.

MUSCAT

MONTHLY RAINFALL
1893-1900

	J	F	M	A	M	J	J	A	S	O	N	D		
1893	-	39	x	x	x	x	x	x	x	x	1	13	a	
1894	11	57	7	5	-	-	8	-	-	-	-	31	119	
1895	106	16	65	-	-	-	-	-	-	-	18	-	205	
1896	63	4	39	-	-	-	-	-	-	4	77	-	187	
1897	13	16	1	-	-	-	-	-	-	-	-	-	30	
1898	2	3	36	-	-	64	-	-	-	-	14	3	122	
1899	-	7	40	-	-	-	-	-	-	-	-	3	48	
1900	64	34	17	-	-	-	-	-	-	-	23	63	201	

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Table 2:2:b

MUSCAT

MONTHLY RAINFALL
1901-1920

	J	F	M	A	M	J	J	A	S	O	N	D		
1901	-	12	28	-	-	-	-	-	-	-	-	13	53	
1902	-	7	-	7	-	-	-	-	-	25	-	13	52	
1903	10	-	-	11	-	1	-	-	-	-	1	3	26	
1904	-	3	3	-	-	-	-	-	-	-	18	1	25	
1905	31	46	56	-	-	-	-	-	-	T	5	2	140	
1906	15	33	37	-	-	6	-	1	-	-	-	40	132	
1907	6	79	-	22	-	-	-	-	-	-	5	4	116	
1908	6	-	10	3	-	-	-	-	-	-	-	5	24	
1909	115	-	-	-	-	-	-	-	-	-	-	54	169	
1910	24	-	11	-	-	-	-	-	-	-	-	38	73	
1911	67	3	7	-	-	-	-	-	-	-	18	6	101	
1912	60	12	0	97	-	-	-	7	-	-	5	25	206	
1913	-	99	22	-	-	-	-	-	-	-	-	14	135	
1914	3	42	2	-	-	9	3	1	-	14	45	22	141	
1915	7	1	3	32	-	-	-	-	-	-	-	7	50	
1916	98	30	5	98	-	-	-	15	-	20	-	-	266	
1917	60	19	-	2	-	-	-	-	-	-	-	24	105	
1918	4	-	10	8	-	-	-	-	-	-	-	39	61	
1919	22	22	20	-	4	-	-	-	-	-	-	-	68	
1920	6	14	1	-	-	-	-	-	-	-	4	-	25	

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Table 2:2:c

MUSCAT

MONTHLY RAINFALL
1921-1940

	J	F	M	A	M	J	J	A	S	O	N	D		
1921	4	-	-	-	-	-	-	-	-	-	25	15	44	
1922	6	6	-	-	-	-	-	-	-	-	-	-	12	
1923	7	8	-	36	-	-	-	-	-	-	20	39	110	
1924	3	6	-	-	-	-	-	-	-	-	-	19	28	
1925	7	2	5	-	-	-	-	-	-	44	1	-	59	
1926	25	-	9	6	-	-	-	-	-	-	-	39	72	
1927	-	17	-	10	-	-	4	-	-	-	10	9	50	
1928	47	56	-	-	-	-	-	-	-	-	53	19	175	
1929	8	3	-	-	-	-	-	-	-	-	34	116	161	
1930	142	1	1	6	-	-	-	-	-	-	-	-	150	(Beit Falaj)
1931						No record							x	
1932						"	"						x	
1933						"	"						x	
1934						"	"						x	
1935	x	x	x	x	x	x	x	-	-	-	-	-	a	
1936	143	6	28	-	-	-	-	-	-	-	12	-	189	
1937	29	45	-	-	-	-	-	-	-	-	-	27	101	
1938	-	-	-	-	-	-	-	-	-	10	-	20	30	
1939	-	75	-	-	-	-	-	-	-	-	-	23	98	
1940	21	-	10	-	-	-	-	-	-	-	-	55	86	

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Table 2:2:a

MUSCAT

MONTHLY RAINFALL

1941-1960

	J	F	M	A	M	J	J	A	S	O	N	D		
1941	-	0.5	13.5	20.0	-	-	-	-	-	-	-	-	34.0	
1942	4.0	29.0	-	-	-	-	-	-	-	-	-	8.5	41.5	
1943	87.0	x	x	x	x	x	x	x	x	x	x	x	a.	
1944	x	x	x	x	x	x	x	x	x	x	-	166.0	a.	
1945	1.0	-	-	-	-	x	x	x	x	x	x	x	a.	
1946	-	x	x	-	-	-	-	-	-	-	-	14.0	a.	
1947	-	2.5	14.0	-	-	-	-	x	x	x	x	x	a.	
1948	29.0	44.5	25.0	2.5	-	-	x	x	x	x	x	x	a.	
1949	x	x	x	x	x	x	x	x	x	x	x	x	x	
1950	16.5	4.0	1.5	1.5	2.5	-	0.5	x	x	x	x	x	a.	
1951	-	-	62.0	-	-	-	-	-	-	1.0	-	6.0	69.0	
1952	52.0	-	-	1.0	-	-	-	-	-	-	-	16.0	69.0	
1953	2.0	27.0	-	-	5.0	-	-	-	-	-	-	15.0	49.0	
1954	11.0	10.0	1.0	2.0	-	-	-	-	-	-	-	1.0	25.0	
1955	97.0	7.0	70.0	-	-	-	-	-	-	-	-	14.0	188.0	
1956	12.2	13.2	-	0.5	-	-	37.1	-	-	-	-	171.0	234.0	
1957	109.0	-	-	62.0	9.0	-	-	-	-	-	9.0	36.0	225.0	
1958	53.0	-	-	-	2.0	-	5.0	-	-	-	-	16.0	76.0	
1959	10.9	-	21.8	2.5	-	-	-	-	-	-	68.6	12.7	115.5	
1960	13.7	-	-	18.3	36.8	-	-	-	-	-	24.1	16.0	108.9	

For record 1961-1976 see Section 3

Section 3 - Record since 1967 . Inclusive

- Table 3 : 1 - Annual Rainfall
- Tables 3 : 2 - Monthly Rainfall
- Section 3 : 3 - Daily Rainfall , various tables
- Section 3 : 4 - Details of Stations

For symbols used in records , see Sect 1 : 7

Raingauges used are of one or other standard types and conventional exposures . Nominally they are read daily at 08.00 or 09.00 but - especially in older record - it was sometimes at irregular times , and / or with minor confusion of dates : therefore record may be adjusted \pm one day .

Old record was very dependent upon the interest of the individual concerned : during his absence minor gaps may be suspected in the record as noted in table 3:3:1 . Such suspected gaps have not been synthesized : any error is not significant . Occasionally , there are two slightly different versions of the same record (conversion to mm , rounding of decimals etc) : in such cases it has been preferred to accept previously published values .

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Table 3:1

ANNUAL RAINFALL 1967-76

MUSCAT AREA

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976				
Muscat	a	144.8	74.2	141.7	97.5	265.4	96.8	(25.0)	80.0					
Dar Sait	x	x	x	x	x	x	x	(23.3)	83.6					
Ruwi	x	x	x	x	x	x	x	27.5	79.5					
Mina al Fahal	a	117.9	43.9	118.0	88.8	263.6	102.5	26.9	86.4					
Seeb Airport	x	x	x	x	x	x	x	a	77.1					
Bid Bid	x	x	x	x	x	a	22.1	9.8	51.4					

For Muscat record prior to 1967, See Section 2.

$$y = -7.66 + 0.98x$$

r = 0.98

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Table 3:2 Sheet 2 of 3

MONTHLY RAINFALL
1971-1974

	J	F	M	A	M	J	J	A	S	O	N	D		
						1 9 7 1								
Muscat	15.2	-	-	-	-	-	-	-	-	-	37.5	44.9	97.5	
Mina al Fahal	34.0	0.8	9.0	3.7	-	-	-	-	-	-	5.4	35.9	88.8	
						1 9 7 2								
Muscat	103.9	95.5	47.7	-	-	-	18.3	-	-	-	-	-	265.4	
Mina al Fahal	113.5	58.4	54.0	3.7	-	-	-	-	-	-	23.0	11.0	263.6	
Bid Bid	x	x	(38.3)	37.6	-	-	7.1	1.0	-	-	11.4	4.6	a.	
						1 9 7 3								
Muscat	96.8	-	-	-	-	-	-	-	-	-	-	-	96.8	
Mina al Fahal	104.5	-	-	-	-	-	-	-	-	-	-	-	104.5	
Bid Bid	22.1	-	-	-	-	-	-	-	-	-	-	-	22.1	
						1 9 7 4								
Dar Sait	-	3.0	-	0.3	-	-	-	-	-	-	-	(20.0)	23.3	
Ruwi	7.0	-	-	1.5	-	-	-	-	-	†	†	19.0	27.5	
Mina al Fahal	-	1.6	-	1.1	-	-	-	-	-	-	-	24.2	26.9	
Bid Bid	-	-	-	-	7.5	-	-	-	-	2.3	-	-	9.8	

Section 3 : 3

Daily Rainfall Records 1967 - 1976

- 1967 - 1970 - Only for Muscat are daily rainfall figures available : see record for Muscat in section 3:4
- 1971 - 1973 - Available record for Muscat and Mina al Fahal. See table 3:3:1 .
Only raindays exceeding 2 mm at one or other station , are listed : and dates have sometimes been adjusted by one day.
- 1974 - 1976 - Various stations are available , and are listed in tables 3:3:2 following .
Only those months in which there was significant rainfall are shown ,viz

1974	December
1975	February , Dec
1976	Jan, Feb, March, April , July

For other months when there was little or no rain , see monthly tables in Sect 3: 2 .

TABLE 3 : 3 : 1.

COMPARISON OF DAILY RAINFALLS

MUSCAT AND MINA AL FAHAL . 1971 -1973 inclusive

Date	Muscat	Mina Al Fahal	Remarks
24. 1.71	15.2	34.0	
10. 3.71	-	9.0	Omission ?
7. 4.71	-	3.7	"
10.11.71	19.0	-	
11.11.71	11.4	4.0	
12.11.71	6.6	1.4	
20.12.71	37.3	31.4	
30.12.71	7.6	4.5	
<hr/>			
18. 1.72	16.0	23.6	
19. 1.72	6.9	9.6	
24. 1.72	12.0	27.0	(Muscat 7.4 + 4.6)
30. 1.72	15.7	7.8	
31. 1.72	53.3	45.5	
1. 2.72	32.8	31.5	
2. 2.72	8.1	} 25.3	
3. 2.72	24.1		
4. 2.72	7.6		
11. 2.72	22.9	1.6	
8. 3.72	-	4.3	
10. 3.72	43.4	37.5	
14. 3.72	4.3	11.2	
20.4. 72	-	3.7	Omission ?
4. 7.72	18.3	-	"
23.11.72	-	23.0	"
16.12.72	-	11.0	" ?
<hr/>			
1. 1.73	(15.0	
2. 1.73	(68.3	19.3	
3. 1.73	(28.2	
4. 1.73	20.6	39.1	
5.1 .73	7.9	0.9	

Note : Only raindays with at least 2 mm at one or other site ,
are tabulated .

y

x

$$y = 4.68 + 0.72x \quad r = 0.77$$

Table 3: 3: 2 (a)

Major Daily Rainfalls 1974 -1975

Month & Year	Day	Muscat	Muttrah	Dar Sait	Ruwi	Minaal Fahal	Seeb Airport
Decemb.							
1974	28	(15.0)	X	(20.0)	19.0	24.2	0.1
Februa.							
1975	4	6.8	X	5.0	14.5	5.2	3.0
	9	13.0	X	16.3	17.0	17.8	12.7
	10	0.5	X	4.3	6.1	7.4	2.8
	11	0.6	X	28.0	{40.1	50.6	29.8
	12	57.0	X	26.3		-	-
Decemb.							
1975	26	0.8	X	1.0	0.5	0.8	20.3 (2)

- 1) Only major raindays are shown : for remaining periods see monthly summaries .
- 2) 10.5 mm at Rumais on this day
- 3) Dates for individual stations sometimes corrected ± 1 day.

Table 3 : 3 : 2 (b)

Major Daily Rainfalls - 1976 (to ~~Sept~~ ^{Dec.} incl.)

Month	Day	Muscat	Mittrah	Dar Sait	Ruwi	Mina Fahal	Seeb Airport	
Jan.	1	13.0	x	(18.0)	24.5	0.5	8.4	
	27	-	x	-	-	30.0	Tr	
	28	15.5	x	(33.0)	18.5	18.7	7.6	
	29	16.0	x	{	1.2	-	-	
Feb.	2	18.0	x	{	7.0	15.2	8.9	
	7	6.0	7.5	{22.5	12.0	6.5	15.0	
	17	2.5	x	(1.5)	1.2	1.7	1.8	
	21	33.0	40 .4	32.0	48.0	29.2	16.8	
March	10	3.0			Tr	3.2	3.0	
	11	6.0	9.5	↑	3.0	1.8	10.0	
	15	-	T	↑	T	-	5.0	
	16	3.0	{	16.6	2.5	-	2.0	
	17	-	{2.7	↓	-	1.9	1.0	
	18	-	-	↓	-	-	2.0	
	19	1.0	{4.0	↓	4.5	2.2	6.0	
	20	3.0		↓	1.0	3.5	15.0	
	21	-	2.3	3.4	6.5	4.0	-	
	23	1.0	-	-	-	4.5	0.3	
	24		{	{	0.5	0.5	0.3	
	25		{8.9	{7.9	T	30.5	12.4	
	26	{	36.0	36.0	38.4	34.0	-	-
	27	-	2.0	Tr	1.0	-	-	
April	6	3.8	3.5	3.0	4.0	4.8	4.6	
	8	16.0	17.3	14.0	22.3	16.9	13.0	
	21	15.0	25.3	25.3	24.0	15.1	12.7	
July	24	8.0	13.8	10 0	3.5	16.1	2.4	

See notes Table 3: 3: 2 (a)

x_1 x_2 x_3 x_4 x_5

$$y = 1.4 + 1.1 \cdot x_1 \quad r = 0.97$$

$$y = 1.8 + 0.98 \cdot x_2 \quad r = 0.96$$

$$y = -0.2 + 1.1 \cdot x_3 \quad r = 0.86$$

$$y = 4.0 + 0.6 \cdot x_4 \quad r = 0.53$$

$$y = 4.2 + 0.3 \cdot x_5 \quad r = 0.56$$

Section 3 : 4

Notes on Stations

These notes describe the location of the sites, and quality and period of record for each station. Individual station records are not shown but complete records for any station may be derived from section 3 : 2 and 3:3, or by application to the Water Resources Department.

Muscat

(various stations), Sept 1967 to date, with gaps.
See pages immediately following.

Muttrah

(Corniche) Feb 1976 to date, daily record.
Raingauge is installed in the Water Resources Compound.
on Muttrah seafront.

Dar Sait

(Port Authority Compound - old Hochtief Camp)
Raingauge is installed in the small met station, on
a spur overlooking Dar Sait valley, about $1\frac{1}{2}$ kms from
the sea. Date of installation not known.
Nov 1973 - Nov 1974 inclusive - only monthly totals
available

Dec 1974 - no record - synthesized.

Jan 1975 to date : daily record. Quality of record
indifferent during late 1975 and early 1976 but no
major omissions except 1st Jan 1976, which has been
synthesized. Some cumulative totals during Fe-
bruary and March, but basically satisfactory and now
good.

Ruwi

(Water Resources Compound - old Renardet compound)
January 1974 to date, daily record.
On roof in Water Resources compound, in the southern
part of Ruwi proper.
Recording was rather unsystematic during first years
of record but there are no significant omissions
except mid February 1975 whose rainfall has been
derived from published monthly totals. Recording is
now to conventional standards.

Mina al Fahal

(P.D (O)). March 1967 to date
In small climate station, on the sea front adjacent
the main offices of Petroleum Development (Oman).
From 1967 through 1970 only monthly totals are now
available : daily values thereafter.
Record of good quality throughout.

Azaiba (P.D.(O). May 1963 - August 1967

Rain gauge was maintained by the P.D. (O) at the old Azaiba airstrip : but record does not claim to be complete and it is certain that there are gaps. Only the monthly values for 1967 are printed here but other record is available on Water Resource Department files .

Seeb Airport

(Met Dept) Dec 1974 to date
At Seeb International Airport . Earlier record for other climate parameters is available , but rainfall record was initiated (by Pan -Am) in December 1974. (Total rain for that month was 0.1 mm on 27 with traces on 2nd , 28th)

Bid Bid

March 1972 - to date
Bid Bid lies in the interior Semail plain , inland from the coast and separated from it by a range of foothills : and flanked by major ranges to the East and West .

Gauge was installed by Scott Wilson Kirkpatrick Staff in the military camp , and daily record maintained by S.A.F. through mid 1974 . Recorded quantities are low but dates are correct and there is no reason to suspect omissions .

In January 1974 a daily gauge , used as a totalizer , was installed alongside the daily and eventually took over . Record was taken by Gibbs & Partners through out 1975 and by Water Resources thereafter . Record is satisfactory throughout : except February 1976 which appears too low to be credible , but no source of error can be detected.

Only monthly record is published here , but old daily record is available on file . The record implies a marked local rainshadow and this unpleasant but important possibility must be tested by further stations.

Scott Wilson Kirkpatrick stations . Two temporary stations were installed in Feb 1976 , on the top of Moascar reservoir and in Geoprosco camp. Coordinates are 6271 -26058 and 6227 - 26083 . Record has not been included as permanence of these stations is unlikely to exceed the current studies .

Station - Muscat (Various sites)

Period of record 1967 to date . (For earlier Muscat record, see Section 2)

Record was resumed at the British Embassy in Sept 1967 through late 1973 . During 1974 there was no record : from Jan 1975 through the present , record is for the French Embassy (Presently , record is also taken at the British Embassy on a private basis)

Original record for the period 1967 - 1973 was mislaid during interdepartmental transfer , and only summaries were available . These had some omissions , and consequently various versions of record have appeared in old reports . Record published here is from an old manuscript extract direct from the original , and represents the definitive version replacing all previous record .

Present experience , and comparison with other stations suggest , that trace rainfalls were often not recorded , and there may be one of two other minor gaps e.g Nov -Dec 1972 . Frequency of rainfall occurrence is therefore somewhat higher than is implied by this sample : apart from this the record is reliable , and good .

Data for the year 1974 has been synthesized from other nearby stations , for completeness . Since this was an extremely dry year , any error is likely to be negligible.

Table³4.....

Daily RAINFALL , MUSCAT 1967 - 1970
 (For period 1971 - 1973 , see table 3: 3: 1)
 For period 1974 to date , see Section 3:/3:2)

	1967 (part year)	
Jan - August	1967 - no record	
12.11.67		16.0 mm
	1968	
31. 1.68		21.5
1/2.2.68		67.0 + 11.5
26. 2.68		11.9
Dec 68		No details , monthly total 29.2
	1969	
3. 1.69		21.6
7. 1. 69		23.9
9. 1. 69		8.6
23. 3. 69		12.2
	1970	
12. 1. 70		8.9
18. 1. 70		20.3
22. 8. 70		110.0 (Duration 9 hours)

SULTANATE OF OMAN
Water Resources Department

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الربيع العسل

سلطنة عمان
دائرة موارد المياه

MUSCAT

MONTHLY RAINFALL
1960 - date

	J	F	M	A	M	J	J.	A	S	O	N	D		
1961	2.3	-	2.3	12.2	14.5	-	0.5	-	-	-	1.8	1.0	34.6	
1962	19.8	-	-	6.9	-	-	72.1	-	-	-	-	20.3	119.1	
1963	-	2.3	-	24.9	94.0	-	-	-	-	-	8.4	11.4	141.0	
1964	11.4	-	10.4	-	-	-	-	-	-	-	-	5.1	26.9	
1965	22.6	-	-	83.1	-	-	-	-	-	-	2.0	-	107.7	
1966	-	87.9	x	x	x	x	x	x	x	x	x	x	a.	
1967	x	x	x	x	x	x	x	x	-	-	17.8	-	a.	
1968	22.8	90.3	2.5	-	-	-	-	-	-	-	-	29.2	144.8	
1969	56.4	5.6	12.2	-	-	-	-	-	-	-	-	-	74.2	
1970	31.7	-	-	-	-	-	-	110.0	-	-	-	-	141.7	
1971	15.2	-	-	-	-	-	-	-	-	-	37.5	44.9	97.5	
1972	103.9	95.5	47.7	-	-	-	18.3	-	-	-	-	-	265.4	
1973	96.8	-	-	-	-	-	-	-	-	-	-	-	96.8	
1974	(-)	(3.0)	(-)	(1.0)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(16.0)	(20.0)	
1975	(0.3)	77.9	-	-	-	-	-	-	-	-	-	0.8	79.0	
1976	44.5	59.5	53.0	35.3	-	-	8.0	-	-	-	-	-		

For record before 1961, See Section 2.

Sect 4

QURYAT AREA

Stations in the Muscat - Quryat area have been included in this paper as they can not convently be included in other regional groupings.

There are at this time 3 stations:-

Quryat	6961 - 25739	Alt 5 meters	installed	5.4.74
Mazara	6910 - 25545	Alt 180 meters	"	1.9.73
Fawah	6617 - 25821	Alt 225 meters	"	1.9.73

Note. The Mazara raingauge is in a deep narrow valley and its equivalent altitude is probably about 500 meters

Quryat is a conventional daily raingauge in the compound of the Agriculture office. There is complete record of satisfactory standard since installation.

Mazara and Fawah are both tipping bucket totalizing rain-gauges with battery operated counter. The more recent record for these sites is uncertain. Possibly there have been some omissions in recording field data, or batteries failing: and for Fawah particularly the tipping mechanism has been sticking.

Record for the 3 stations is summarized in the table following. Uncertain data has not been published: files may be examined in the Water Resources Dept. Office.

ADDENDA - MUSCAT RAINFALL

During the preparation of this paper, additional documents have kindly been traced in the British Embassy and made available.

The first was a typewritten list of annual rainfalls for 1900 - 1956, together with daily rainfalls for 1952 - 1955 and monthly rainfalls for 1956 and part 1957. The source of the values in these lists is not known. The daily values are listed following: these confirm the accepted monthly values with minor exceptions as noted. The monthly tabulations confirm the rainfall of Jan 1956: for Dec 1956 the value shown is 6.50 inches (165 mm) which implies that the value of 171mm should be accepted: the tables in the present publication have been amended accordingly.

The list of annual values is broadly in accordance with previously published figures: where there are discrepancies these are thought to be from errors in the compilation of the list in question. However this list also shows the following values for years for which there was previously nil (or incomplete) record.

1930	300 mm approx.	("About 12ins")
1931	128 mm	(5.03ins)
1932	49 mm	(1.93ins)
1933	110 mm	(4.31ins)
1934	78 mm	(3.07ins)
1935	162 mm	(6.39ins)
1947	89 mm	(3.50ins)
1948	127 mm approx.	(5ins)
1950	32 mm	(1.27ins)

A second source is a compilation of reports for the Persian Gulf Political Agency and Muscat Political Agency, for the period 1874 - 1883. These are selections from the records of the Govt. of India (Foreign Dept) printed by the Foreign Department Press, Calcutta.

It appears extremely probable that observations were maintained at Muscat all through the period, but only certain years have been included in this selection (other years have records for Bushire). The "official year" mentioned in these reports ran from April to the following March, and the climate summaries were tabulated accordingly.

For Muscat, the published record is as follows:-

Year:-	1872/73	73/74	74/75	75/76	77/78	79/80	81/82	82/83.
Apr	(3) ?	-	(1) ?		37			35
May	-	-	(2) ?		-			-
June	-	-	-		-			-
July	-	-	(10) 29		-			-
Aug	-	(1) 13	-		-			-
Sept	-	-	-		-			-
Oct	-	-	-		-			-
Nov	-	(5) 12	-		168			-
Dec	-	(4) 27	-		35			25
Jan	(7) 83	(9) 36	(4) 35		2			6
Feb	(5) 105	(2) 1	(4) 10		97			38
Mar	(6) 9	(5) 27	-		1			10
Total	197	116	74	(310)	340	Nil	147	114

Original readings in inches, have been converted to millimeters. Figures in brackets are for numbers of raindays: note that for April 1872 and April/May 1874 raindays are shown, but no value for depth of rainfall - possibly these were trace rains?

Rainfall for 1875/76 is twice mentioned in the text:-

- (a)during the latter part of 1875 and early 1876heavy storms and floodingabout five times the average quantity.
- (b)good crops....rainfall nearly 12½ inches.....

Rainfall for 1881/82 is shown at the bottom of the tabulations for 1882/83. Nil rainfall for 1879/80 is mentioned in the text. Readings were taken at the Civil Hospital, Muscat - presumably on the roof as height of instrument was 35 feet a.s.l. They appear to have been originated by Lt.Col.E.C.Ross, and mainly carried out by Doctor Jayakar: Doctors Meiklejohn and Peters and Lt.Col. Miles also assisted in compilation.

Muscat appears to have enjoyed well above average rainfall in this period. Those years for which no records were tabulated may be assumed to have had generally "average" rainfalls from the negative implication that extremes might be expected to be mentioned in the texts, and no other such references have been found.

DAILY RAINFALLS, MUSCAT 1952 - 1955.

4.1.52	3.8		
6.1.52	16.2		
18.1.52	31.8	Total Jan	51.8
11.3.52	1.5	Total Mar	1.5
26.4.52	0.5	Total Apr	0.5
29.12.52	0.5		
30.12.52	15.5	<u>Total Dec</u>	<u>16.0</u>
		<u>Total 1952</u>	<u>69.8</u>
3.1.53	1.5	Total Jan	1.5
12.2.53	12.4		
13.2.53	15.0	Total Feb	27.4
22.5.53	1.3		
23.5.53	3.6	Total May	4.9
22.12.53	13.7		
23.12.53	0.8	<u>Total Dec</u>	<u>14.5</u>
		<u>Total 1953</u>	<u>48.3</u>
Jan 1954	Omission?		
2.2.54	10.4		?
27.2.54	1.3	Total Feb	11.7
21.4.54	0.8		
22.4.54	1.0	<u>Total April</u>	<u>1.8</u>
		<u>Total 1954</u>	<u>a</u>
1.1.55	16.3		
3.1.55	1.5		
4.1.55	3.3		
5.1.55	8.4		
6.1.55	16.0		
7.1.55	4.6		
8.1.55	1.3		
9.1.55	12.2		
21.1.55	20.3		
22.1.55	6.4		
23.1.55	3.8	Total Jan	94.1
2.2.55	6.9		
3.2.55	0.5	Total Feb	7.4
9.3.55	41.9		
10.3.55	4.1		
12.3.55	1.0		
13.3.55	22.4		
14.3.55	1.0	Total Mar	70.4
13.12.55	12.4		
14.12.55	1.3	<u>Total Dec</u>	<u>13.7</u>
		<u>Total 1955</u>	<u>185.6</u>

- 1). Original in inches, have been converted to mm.
- 2). Possible minor omissions Jan 1954, Dec 1954, Jan 1955 in this source.