THE MART/AZR PROJECT

HIGH ELEVATION RESEARCH IN PAKISTAN

Pakistan Agricultural Research Council
ARID ZONE RESEARCH INSTITUTE
Brewery Road, Quetta, Pakistan.

No. 19

METEOROLOGICAL DATA ANALYSIS OF BALUCHISTAN

by

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April 1988

MART / AZR PROJECT RESEARCH REPORTS

This research report series is issued by the Management of Research and Technology Project/Arid Zone Research Component (MART/AZR). This project is financially sponsored by the Mission to Pakistan of the United States Agency for International Development (USAID).

The project contract is implemented by the International Center for Agricultural Research in the Dry Areas (ICARDA) and Colorado State University (CSU) at the Pakistan Agricultural Research Council's Arid Zone Research Institute (AZRI).

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METEOROLOGICAL DATA ANALYSIS OF BALUCHISTAN

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INTRODUCTION

Under contract to the International Center for Agricultural Research in the Dry Areas of Aleppo, Syria, Hydroconsult Ltd of U.K. has undertaken a study of agrometeorology in Baluchistan. This report describes the results of this study.

The purpose of the study was the development of a computer-based facility for risk-based analyses of agroclimatalogical variables. An understanding of the relationship between agricultural production and these variables is essential if progress in research programmes is to be achieved.

DATA

The development of this study was facilitated by the creation of a computerised database of daily rainfall from manual records for the period 1891 to 1946 held at the U.K. Meteorological Office. This database was slightly adapted for the explicit purposes of this study, resulting in a database of 104 stations. Quality control checks were undertaken on these records, which showed that the quality of the records is in general high. Records for 4 stations for more recent years were added, but these were found to be of lower quality.

Temperature data (daily maximum and minimum) were acquired from the Pakistan Meteorological Department, and a parallel database developed, containing records for 3 stations. These data were found to be of medium to poor in quality.

A data management package has been developed for the meteorological data. This is particularly aimed at a facility for manual entry of more data to expand the databases, particularly temperature.

ANALYSIS PACKAGE

The primary product arising from the study is a computer-based package for the probabilistic analysis of meteorological data. This package has been developed and tested, and is loaded on the IBM-AT microcomputers installed at the Arid Zone Research Institute in Quetta.

The package is designed to be used by people not normally familiar with the use of computers (and this facet has been successfully demonstrated at AZRI). The LOTUS spreadsheet package has been adopted as a programming vehicle.

The package can be used to perform a frequency analysis on an annual series of any selected variable. By the careful phrasing of questions, it becomes possible to gain valuable agronomic insights into the effect of climate on agricultural production.

ANALYSIS

Following the development of the computer-based package, a number of analyses have been performed.

In the case of precipitation, this has been examined initially for all stations on an annual and seasonal (summer and winter) basis. Statistical summaries have been produced which show the annual and seasonal rainfalls to be expected for a range of exceedance probabilities between 10% and 90%. The statistics derived have also been used in the production of a series of 10 maps showing contours of selected meteorological variables throughout the Province. The most important of these maps are those showing the spatial variability of annual, summer (June-September) and winter (October-May) average rainfall within Baluchistan. Conclusions are drawn, particularly with respect to the prevailing weather mechanisms.

The production of statistical summaries has been extended to a shorter time scale for a smaller sample of 16 stations. Rainfalls to be expected in 12 monthly and 36 decad durations for the same range of exceedance probabilities are given.

A much smaller range of analyses has been undertaken on temperature. The date of first frost has been analysed for the 3 locations, as well as the date of last frost. More comprehensive analyses should be possible when more temperature can be loaded using the data management facility.

1. INTRODUCTION

1.1 Background

Baluchistan is a semi-arid environment in which the prudent use of a scarce resource such as water is vital. This statement is nowhere more true than in the area of dry-land rainfed agriculture, in which an understanding of the effect of agrometeorological elements such as rainfall and temperature on agricultural production is important.

The scope of work of the MART project (AZR component) calls for "the research to ensure that proposed management changes encourage the most efficient use of scarce water". The categorisation of environmental events within their quantified historical context is integral to appropriate germplasm selection, the assessment of agronomic technological innovations and the economic risk factors involved with potential changes within the farming systems of Baluchistan.

In planning activities, agrometeorological variables such as rainfall and temperature are useful but should be viewed as random or stochastic variables. In this context, this statement means that their future behaviour is unpredictable. However, their future unpredictability should not be seen as a reason for ignoring them in planning. This is because, although we cannot say exactly what their behaviour will be, we can say something about the probability of their taking certain values or ranges of values. By the examination of historical records of meteorological variables, it is possible to derive statistical information which can be used in answering questions arising from the type of research application mentioned above.

Baluchistan is fortunate in having an excellent database of meteorological information dating from late in the last century. A recent project (Packman,1987), sponsored by the U.K. Overseas Development Administration, undertook the loading onto computer of an archive (kept at the U.K. Meteorological Office) of data from 137 rainfall stations within the Province dating from 1891 to 1946. The establishment of the database in a computer-accessible form opens up extensive possibilities for detailed statistical analyses of historic time-series of rainfall data. The use of this database, in conjunction with a dedicated statistical analysis package, is a powerful tool in gaining an adequate understanding of the relationship between meteorology and agriculture.

The primary objective of the study described in this report has been the development of a computer-based facility for statistical analysis for use in conjunction with the database described above. This facility has been used to derive statistical summaries for stations within the Province, and for mapping a number of precipitation statistics. This work is described later

The two weather systems have a mirror in the two parts of the Province, the north-western part which tends to be dominated by winter precipitation and the south-eastern part which is dominated by the summer season. More comprehensive and excellent descriptions of these weather systems may be found elsewhere (Wirasat Ullah Khan,1980; and the Pakistan Meteorological Department,1971).

1.3 Previous work

Work has been done on the agrometeorology of the Province, albeit without the benefit of such a comprehensive computer-based information system. Some of this work will be briefly described here, and a more detailed appreciation of this work can be gleaned from the references.

Some early analyses of rainfall relevant to upland Baluchistan were undertaken by Roy & Bhattacharya(1932) and Husain(1950). These references describe the historical and spatial character of precipitation in and around the Quetta Valley, and the first concerns itself with shorter (hourly) duration rainfalls. The analyses are relevant to some of the upland areas of the Province.

As part of a wider U.N. study into the water resources of Baluchistan, Wirasat Ullah Khan(1980) undertook a very substantial examination of the hydrometeorology of the Province. Many of the precipitation stations used in the present study were used by Wirasat Ullah Khan, who produced maps of annual and seasonal precipitation normalised on the period 1910 to 1950. He used altitude as an aid to the draughting of isohyets, which in the opinion of the Writer is a mistake since precipitation is preferentially induced by relief rather than altitude. Despite this, the reference has been in recent years, and still is, an excellent source of information. In addition to rainfall, he analysed a comprehensive range of other agrometeorological variables.

Other workers (for instance, BMIADP,1986; and Davis,T.G.,1982) have more recently conducted probabilistic analyses on the same rainfall data. Earlier studies on temperature have been reported for Quetta by Naqvi et al(1965) and for a wider range of stations within the Province by Qaiyum Hamid & Hassan(1970).

1.4 Contents of the Report.

The database of rainfall and temperature is described in the next section of the report, including a brief examination of the quality of the data. This is followed by a description of the computer-based statistical analysis package, with theoretical bases where these are appropriate. A Users Manual for the operation of the package is included as an Appendix to the report.

The analyses performed using the facility are described in sections 4 & 5. Statistical summaries are presented, as well as a maps of selected meteorological variables. Conclusions drawn are somewhat tentative, being more appropriate to meteorological considerations than agricultural ones.

2. METEOROLOGICAL DATA

2.1 The O.D.A. rainfall database

Under contract to the U.K. Overseas Development Administration (O.D.A.), the U.K. Institute of Hydrology undertook a programme (Packman,1987) to digitise the archive of Baluchistan daily rainfall data. The end-product is a comprehensive computerised database.

The O.D.A. database consists of daily records of rainfall from a total of 139 stations, as well as an executable program for the extraction of data. The data consists of records dating from January 1891 for some stations, until December 1946. Many stations have records for the full 56 years. The Institute of Hydrology has gone to great pains to undertake exhaustive quality control checks on the data, a list of the few unresolved anomalies being given by Packman(1987). The size of this task should not be underestimated, and the quality of the database has made our present task much easier than it would otherwise have been.

The O.D.A. database is in the form of sequential files on a monthly basis, data from all stations being stored on a single monthly file. Unfortunately, this is not a convenient format for practical purposes, because, in order to extract information for a given station, records from **all** stations have to be read. This exercise is very extravagant in terms of computer run-time. The first exercise has therefore been to convert the database to a structure based on station files, using the program supplied by the Institute of Hydrology.

Although the database has been adapted in this study, the original O.D.A. database is still available and considered to be in the public domain, either at the U.K. Institute of Hydrology or at the Arid Zone Research Institute in Quetta. The latter also holds computer listings of the daily and monthly data.

2.2 The revised rainfall database

The revised database consists of a total of 104 stations. The reduction of the number of stations from the O.D.A. list has been due to the following:-

1. 23 stations with less than 5 complete years of data were ignored.
2. 7 duplicate stations (eg LORALAI SO, duplicating LORALAI HL) have been ignored except as a cross-check in the quality control procedures.
3. 4 stations have been combined to a single record (eg HARNAI HL Feb1911-Dec1946 and HARNAI RY Jan1891-Dec1922).
4. NAKAS and NASAK were confirmed by the Institute of Hydrology to be the same station and were combined.

If the database were to be used for time-series analysis, then those combined records arising from item 3 above should be used with caution, as considerable rainfall gradients are observable.

Some editing of the records for some stations has been necessary to eradicate gaps in the record. Months have been added (as missing data) at the start and/or end of some station records, as well as in the middle of the record in a few cases (for instance, KHUZDAR). The resulting records are of complete years starting in January and ending in December. Some minor adjustments have been made to station names.

Table 2.1 contains a complete list of stations contained in the revised database, together with the period of record and the station latitude and longitude. Figure 2.1 shows the locations of the 104 stations. The distribution of stations is not ideal, the network in some areas such as the South and North of the Province being less dense than might be wished for. Interestingly, the majority of stations were located on railway lines, the lines of railway stations being detectable on figure 2.1.

2.3 Recent rainfall data

Four stations with more recent records have been loaded into the database. These, although sharing (at least approximate) locations with earlier stations, have been kept separate from the earlier records. These data have been obtained from Pakistan Meteorological Department printouts, for stations at Kalat, Khuzdar, Muslimbagh and Samungli (Quetta). They are stored in the database with the names KALAT2, KHUZDAR2, MUSLIMB2 and SAMUNGLI respectively.

2.4 Rainfall data format

The data is stored in two forms, daily rainfalls and monthly totals. Although the monthly totals may be derived from the daily data, the former is useful because computer access time is much shorter when the monthly form can be used.

The daily data are stored in the compacted ASCII format designed by Packman(1987). It would be quite impractical in terms of storage requirement to store all data values since the vast majority of these are zero. Although the compacted version, demonstrated in Figure 2.2, is slightly awkward to read, it represents an efficient means of storage. Each line represents one month's data, with the month and year being the first two items. This is followed by a series of 6-digit integers, the first 2 digits of which are the date and the last 4 the recorded rainfall in one-hundredths of an inch. A zero where the date should be indicates no more rainfall until the end of the month, and '99' indicates missing data until the end of the month.

It should not matter that the data format described above is somewhat indigestible because this format is transparent to the

NO.	FILENAME	STATION	PERIOD	YRS	QUALITY	LAT.	LONG.
			CHAGAI DISTRICT				
12	CHAGAI	Chagai	1911 -1925	15	GOOD	29-18'	64-42'
14	DALBANDN	Dalbandin	1911 -1946	36	GOOD	28-53'	64-24'
20	GALANGUR	Galangur	1906 -1933	28	GOOD	29-35'	66-15'
36	KISHINGI	Kishingi	1906 -1946	41	GOOD	29-35'	66-09'
51	MIRJAWA	Mirjawa	1919 -1931	13	FAIR	29-01'	61-25'
104	MUSHKICH	Mushki Chah	1911 -1917	7		28-50'	62-33'
62	NOKKUNDI	Nokkundi	1926 -1946	21	GOOD	28-49'	62-45'
63	NUSHKI	Nushki	1900 -1946	47	GOOD	29-34'	66-01'
73	ROBAT	Robat	1910 -1919	10	GOOD	29-29'	63-17'
99	YAKMACH	Yakmach	1925 -1931	7	FAIR	28-45'	63-51'
			KACCHI DISTRICT				
1	ABIGUM	Abigum	1896 -1946	51	FAIR	29-49'	67-21'
8	BELLPAT	Bellpat	1891 -1946	56	FAIR	28-59'	68-01'
9	BHAG	Bhag	1935 -1946	12	FAIR	29-03'	67-49'
16	DHADAR	Dhadar	1931 -1946	16	GOOD	29-28'	67-39'
21	GANDAWA	Gandawa	1912 -1946	35	GOOD	28-37'	67-29'
24	HIROK	Hirok	1891 -1946	56	GOOD	29-56'	67-14'
25	JHATPUT	Jhatput	1891 -1946	56	FAIR	28-22'	68-23'
41	LEHRI	Lehri	1923 -1946	24	FAIR	29-12'	68-12'
42	LINDSAY	Lindsay	1891 -1946	56	GOOD	29-13'	67-56'
44	MACH	Mach	1892 -1946	55	GOOD	29-52'	67-20'
61	MIRPUR	Mirpur	1935 -1946	12	POOR	?	?
52	MITHRI	Mithri	1891 -1946	56	GOOD	29-25'	67-55'
56	MUSHKAF	Mushkaf	1894 -1946	53	FAIR	29-34'	67-44'
64	NUTTAL	Nuttal	1891 -1946	56	GOOD	28-45'	68-04'
65	OCIPUR	Ocipur	1926 -1931	6	FAIR	29-39'	67-34'
66	PANIR	Panir	1893 -1946	54	GOOD	29-41'	67-33'
69	PISHI	Pishi	1899 -1946	48	FAIR	29-43'	67-29'
72	RINDLI	Rindli	1891 -1941	51	FAIR	29-30'	67-33'
93	TEMPLEDR	Temple Dera	1891 -1946	56	GOOD	28-33'	68-13'
97	USTA	Usta	1935 -1946	12	FAIR	28-11'	68-04'
			KALAT DISTRICT				
28	KALAT	Kalat	1891 -1946	56	GOOD	29-02'	66-35'
29	KANAK	Kanak	1906 -1946	41	GOOD	29-58'	66-46'
35	KIRDAGAP	Kirda Gap	1906 -1946	41	GOOD	29-44'	66-27'
38	KOLPUR	Kolpur	1891 -1946	56	FAIR	29-54'	67-08'
47	MANGOCHR	Mangochar	1912 -1946	35	GOOD	29-22'	66-37'
50	MASTNGRD	Mastung Road	1906 -1946	41	GOOD	29-51'	66-50'
49	MASTUNG	Mastung	1911 -1946	36	FAIR	29-48'	66-50'
82	SHAIKHWA	Shaikhwasil	1907 -1946	40	FAIR	29-52'	66-34'
87	SORAB	Sorab	1925 -1946	22	FAIR	28-29'	66-16'
88	SPEZAND	Spezand	1901 -1946	46	GOOD	29-58'	67-00'

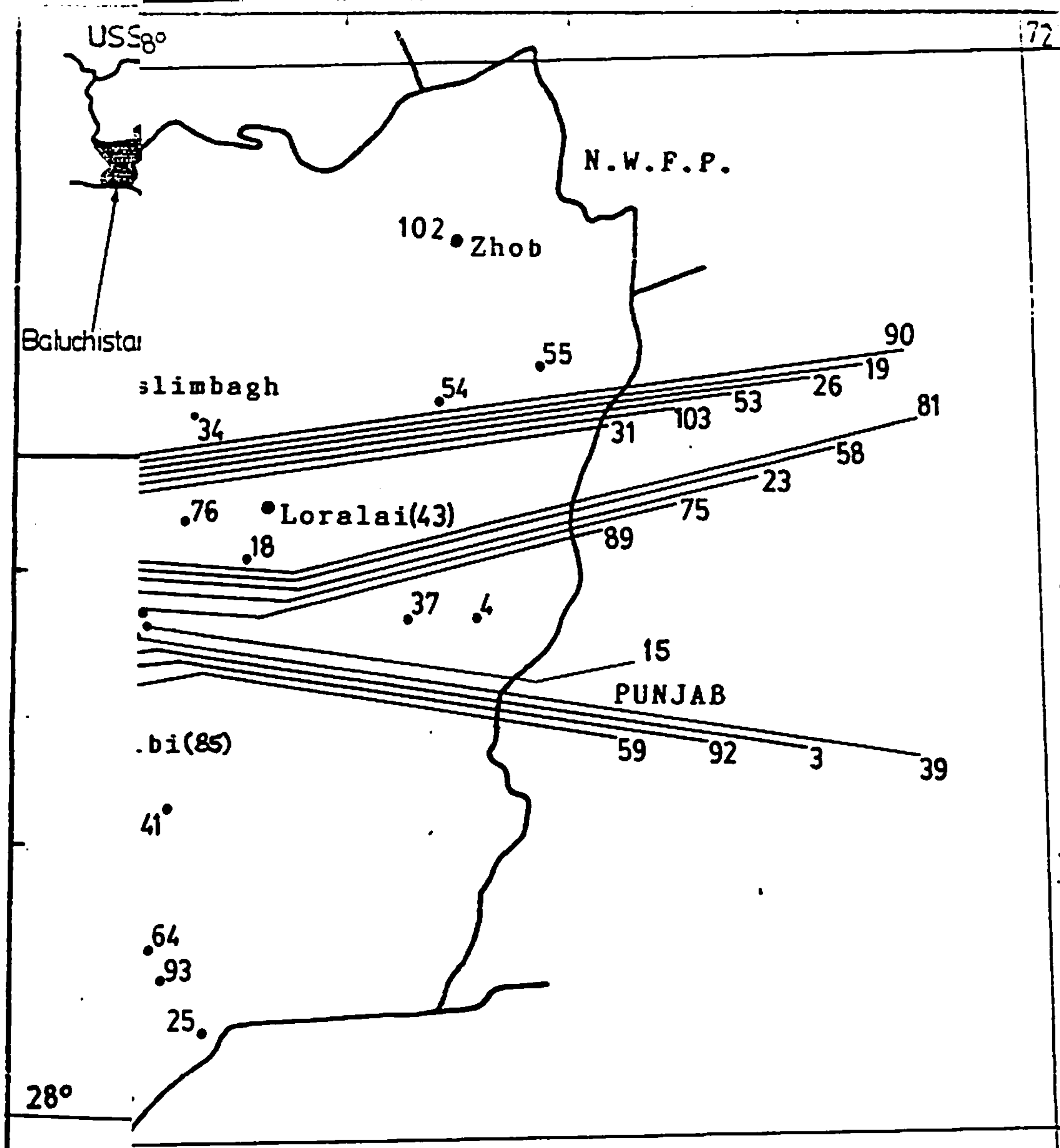
TABLE 2.1: Rainfall stations (page 1 of 3)

NO.	FILENAME	STATION	PERIOD	YRS	QUALITY	LAT.	LONG.
		KHUZDAR DISTRICT					
32	KHUZDAR	Khuzdar	1912 -1946	34	GOOD	27-42'	66-37'
48	MASHKAI	Mashkai	1913 -1946	34	GOOD	27-55'	66-06'
80	SARUNA	Saruna	1913 -1946	34	GOOD	26-28'	67-05'
98	WADH	Wadh	1935 -1946	12	FAIR	27-28'	66-27'
101	ZEHRI	Zehri	1935 -1946	12	FAIR	28-34'	66-44'
		LORALAI DISTRICT					
4	BARKHAN	Barkhan	1911 -1946	36	FAIR	29-53'	69-43'
18	DUKI	Duki	1900 -1946	47	GOOD	30-11'	68-34'
43	LORALAI	Loralai	1892 -1946	55	GOOD	30-24'	68-36'
55	MUSAKHEL	Musa Khel	1911 -1946	36	GOOD	30-52'	69-49'
76	SANJAWI	Sanjawi	1911 -1946	36	GOOD	30-15'	68-20'
		MAKRAN DIVISION					
6	BELA	Bela	1912 -1946	35	FAIR	26-14'	66-19'
45	MAND	Mand	1911 -1946	36	GOOD	26-05'	62-00'
2	ORMARA	Ormara	1912 -1946	35	GOOD	25-13'	64-37'
67	PANJGUR	Panjgur	1911 -1946	36	GOOD	26-58'	64-06'
68	PASNI	Pasni	1911 -1946	36	GOOD	25-16'	63-29'
86	SONMIANI	Sonmiani	1912 -1946	35	GOOD	25-27'	66-39'
95	TURBAT	Turbat	1911 -1946	36	GOOD	25-59'	63-05'
		PISHIN DISTRICT					
5	BARSHORE	Barshore	1909 -1921	13	POOR	30-46'	67-13'
10	BKK	Bund K. Khan	1909 -1946	38	GOOD	30-40'	67-02'
11	BOSTAN	Bostan	1891 -1946	56	GOOD	30-26'	67-01'
13	CHAMAN	Chaman	1893 -1946	54	GOOD	30-56'	66-27'
19	FULLERS	Fullers Camp	1891 -1907	17	FAIR	30-27'	67-13'
22	GULISTAN	Gulistan	1891 -1946	56	GOOD	30-36'	66-35'
30	KHANAI	Khanai	1891 -1946	56	GOOD	30-29'	67-09'
33	KILLABDU	Killa Abdullah	1891 -1946	56	GOOD	30-43'	66-38'
40	KUCHLAK	Kuchlak	1891 -1946	56	GOOD	30-21'	66-56'
70	PISHIN	Pishin	1891 -1946	56	GOOD	30-35'	66-59'
74	SABURA	Sabura	1913 -1919	7	FAIR	31-03'	67-16'
78	SARANAN	Saranan	1895 -1946	52	GOOD	30-34'	66-52'
83	SHEBO	Shebo	1930 -1946	17	GOOD	30-32'	66-56'
84	SHELABAG	Shela Bagh	1892 -1946	55	FAIR	30-49'	66-35'
90	SURKHAB	Surkhab h/w	1930 -1946	17	GOOD	30-35'	67-05'
91	SYADHAMD	Syad Hamid	1891 -1915	25	GOOD	30-35'	66-45'
94	TORMORGA	Tor Morga h/w	1930 -1946	17	GOOD	30-42'	67-04'
100	YARUKARZ	Yaru Karez	1891 -1946	56	GOOD	30-31'	66-57'

TABLE 2.1: Rainfall stations (page 2 of 3)

NO.	FILENAME	STATION	PERIOD	YRS	QUALITY	LAT.	LONG.
		QUETTA DISTRICT					
7	BELELI	Beleli	1891 -1946	56	GOOD	30-15'	66-57'
60	NARNULLA	Nar Nullah	1909 -1919	11	GOOD	?	?
71	QUETTA	Quetta	1891 -1946	56	GOOD	30-12'	67-01'
79	SARIAB	Sariab	1900 -1946	47	GOOD	30-05'	66-58'
96	URAK	Urak	1914 -1946	33	GOOD	30-16'	67-11'
		SIBI DIVISION					
3	BABKACH	Babar Kach	1891 -1946	56	GOOD	29-47'	67-58'
15	DALUGAL	Dalugal	1892 -1897	6	FAIR	29-53'	68-06'
17	DIRGI	Dirgi	1891 -1937	47	GOOD	30-19'	67-31'
23	HARNAI	Harnai	1891 -1946	56	GOOD	30-06'	67-56'
26	KACH	Kach	1891 -1943	53	GOOD	30-26'	67-18'
27	KACHKOTL	Kachkotal	1891 -1898	8	FAIR	?	?
31	KHOST	Khost	1891 -1946	56	GOOD	30-13'	67-35'
37	KOHLU	Kohlu	1911 -1946	36	GOOD	29-54'	69-16'
39	KUCHALI	Kuchali	1891 -1897	7	FAIR	29-50'	68-02'
46	MANGI	Mangi	1891 -1937	47	GOOD	30-21'	67-30'
53	MUDGORGE	Mud Gorge	1891 -1908	18	FAIR	30-23'	67-24'
58	NAKAS	Nakas	1891 -1946	56	GOOD	30-08'	67-48'
59	NARI	Nari	1891 -1946	56	GOOD	29-40'	67-55'
75	SANARI	Sanari	1891 -1925	35	GOOD	30-01'	68-02'
81	SHAHRIG	Shahrig	1891 -1946	56	GOOD	30-12'	67-42'
85	SIBI	Sibi	1891 -1946	56	GOOD	29-33'	67-53'
89	SPINTANG	Spin Tangi	1891 -1946	56	GOOD	29-52'	68-08'
92	TANDERI	Tanderi	1891 -1896	6	FAIR	29-45'	67-58'
103	ZIARAT	Ziarat	1911 -1946	36		30-23'	67-51'
		ZHOB DISTRICT					
34	KILLSAIF	Killa Saifulla	1901 -1946	46	GOOD	30-42'	68-22'
54	MURGHA	Murgha	1911 -1946	36	GOOD	30-44'	69-15'
57	MUSLIMB	Muslimbagh	1901 -1946	46	GOOD	30-49'	67-44'
77	SANZAL	Sanzal	1893 -1944	52	FAIR	31-11'	67-57'
102	ZHOB	Zhob	1892 -1946	55	GOOD	31-21'	69-27'

TABLE 2.1: Rainfall stations (page 3 of 3)



BALUCHISTAN

PROVINCE OF PAKISTAN

FIGURE 2.1

LOCATIONS OF RAINFALL STATIONS

ND

```
KHUZDAR
JAN1912   99
FEB1912   99
MAR1912   99
APR1912   99
MAY1912   99
JUN1912   99
JUL1912   1000151400501600311900103100l0
AUG1912   05000910001413005031 0034
SEP1912
OCT1912
NOV1912
DEC1912   150058
JAN1913
FEB1913   140075180050190050
MAR1913   230019
APR1913
MAY1913   220030
JUN1913   070010200010230010
JUL1913   010010200010230015260020290010000055
AUG1913   020120040050070030090040140090250100
SEP1913
OCT1913
NOV1913   290050300100
DEC1913   010150
JAN1914   180010
FEB1914   130100140150210020270010
MAR1914   260010
APR1914   050010160090
MAY1914
JUN1914
JUL1914   100010110030120040220100230130250080
AUG1914
SEP1914   110080230045
OCT1914   280050
NOV1914   020080210085
DEC1914
JAN1915   310030
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FIGURE 2.2: Example of compacted rainfall data

normal user. Appreciation of the format would be useful to any user accessing the data for other applications, and, to further assist in this respect, a listing of the computer program to extract statistics from the daily data is given in Appendix A. This program was written in FORTRAN, and the data-read module could be lifted by anyone wishing to write another program for the analysis of these data.

The second form of the data is as monthly totals. These are stored in LOTUS spreadsheet files (one for each station). Where monthly totals are adequate in other applications, this form would be much easier to use. Monthly listings of these data are avaialble at the Arid Zone Research Institute in Quetta.

2.5 Quality assessment of rainfall data

Although considerable effort had been expended on the checking of records in the original database (Packman,1987), further quality control procedures have been carried out. This has been achieved by double-mass analysis, in which the cumulative totals from one station are compared with those from another in the same vicinity. In practice, networks of stations based on provincial districts were used, and it is less important that the stations should be closely located than that at least one reliable station should be found in each group.

A typical example of a double-mass plot for two stations is shown in figure 2.3. This shows cumulative rainfall in millimeters for KALAT plotted against QUETTA for the contiguous years of record 1891 to 1946. This plot shows only small deviations from a straight line, indicating that both records are of good quality. Some such plots show changes of slope (often traced to changes of gauge location) or excessive scatter, indicating lower quality of one or other (or conceivably both) of the records. A single plot does not indicate which record is suspect, but cross-reference to other stations usually indicates the culprit. The double-mass exercise was performed on groups of stations in the same vicinity.

In general terms, the quality of the records in the database for the pre-1947 stations is high. An assessment of the quality for each station is given in table 2.1, the record being assessed as GOOD, FAIR or POOR. It is difficult to assess the quality of very short records, so that these seldom receive a favourable score. In the type of analysis performed in this study, reliability of derived statistics is very much a function of record length, so that the shorter records are of secondary value.

There are very few missing data, and the overall impression is good. It offers a favourable view on the standard of data collection programme in this period.

The same conclusion cannot be drawn from the more recent records, a view confirmed by earlier workers in the field (for instance,

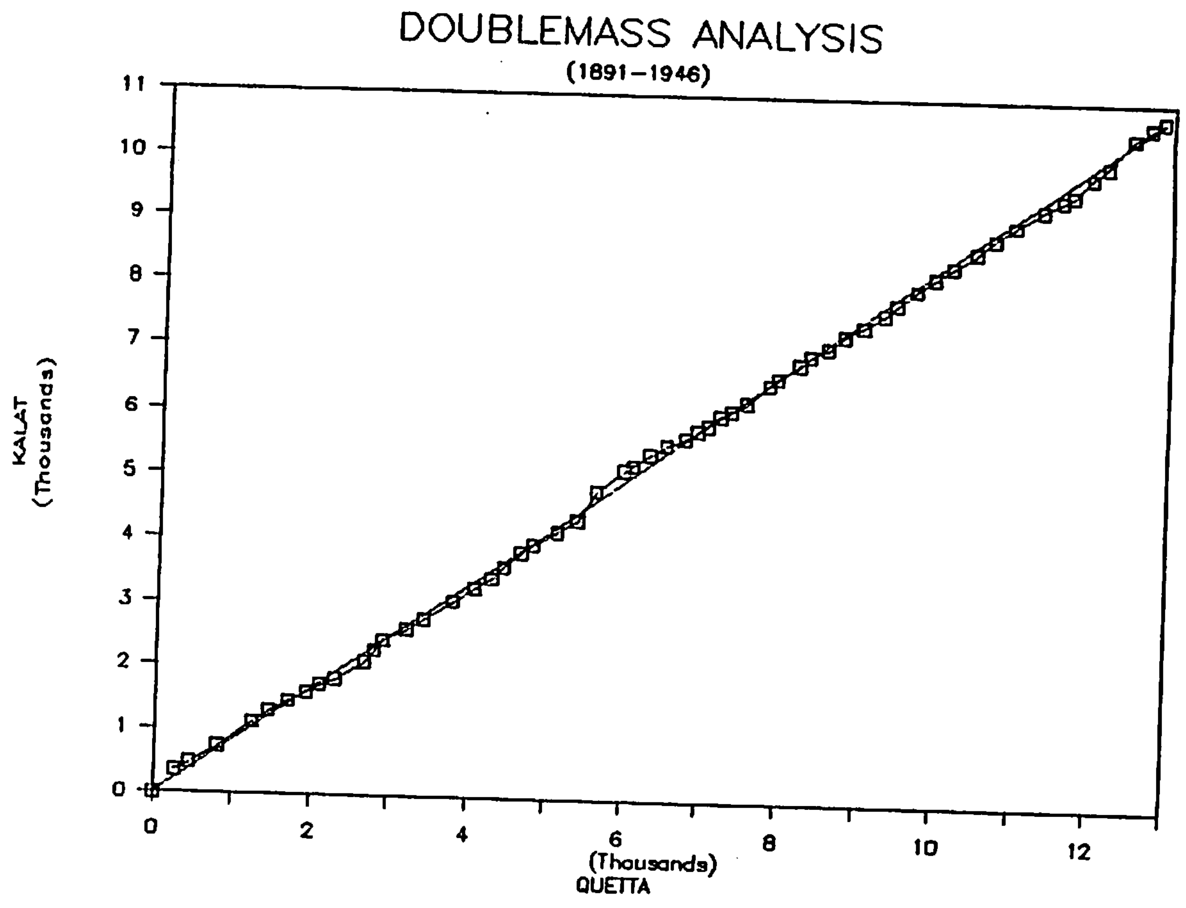

FIGURE 2.3: Example of double-mass plot

Wirasat Ullah Khan,1980). The four stations with post-1946 record show many missing data values, and, where this is so, much of the record is suspect. Although it is valuable to have these records, their presence is not important **in this application**. They have therefore been substantially ignored.

2.6 Temperature data

Temperature is probably the second most important agroclimatic variable after rainfall. Unfortunately, there is not such a comprehensive database available for temperature, although it has to be said that there is less spatial variability than in rainfall. Within a locality, there is a general relationship between temperature and altitude, being between .5 and 1 'C decrease in mean temperature for every 100m increase in elevation. This relationship can be used in extrapolating statistics from one location to another.

Data of daily minimum and maximum temperatures were obtained on computer listings for five stations from the Meteorological Department. All these stations had missing data, caused either by missing recordings or by data processing errors. Of the stations held, three stations were considered to be of sufficient quality to be worth loading onto the database. Brief details of these stations are given in table 2.2.

Station	Years of record
KHUZDAR	1965 - 1986
LORALAI	1960 - 1968
SAMUNGLI	1960 - 1986

Table 2.2: Details of temperature stations

Infilling of missing data was undertaken for these stations where missing periods did not exceed three days (it was found necessary to relax this constraint in the case of Loralai). The result is an adequate data set, the length of which for Khuzdar and Samungli is sufficient for the types of statistical analyses to be undertaken here. The number of stations is less than adequate, but more data are available (in manual if not computerised form) at the Meteorological Department.

2.7 Database management facility

It is envisaged that more rainfall and temperature data could usefully be added to the database. For this purpose, a data entry facility has been developed as an adjunct to the computer-based package described in the next section. This facility has been written as a partial database management system, concentrating on data entry. Although it performs many of the functions of such a system, it is no substitute for a thorough knowledge of the overall package by the person in charge of it.

A detailed breakdown of the database management system, as well as details of the structure of the database, may be found in the Users Manual in Appendix B.

3. THE ANALYSIS PACKAGE

3.1 Specifications

A computer-based package has been developed for the probabilistic analysis of meteorological data, designed to operate in harness with the database described above. This package, known as BELINDA, is suitable for mounting on any IBM-compatible computer having a hard disk with approximately 4 Mbytes available disk-space (the RAM requirement is small). The storage requirement is mainly taken up by the database. A LOTUS (at least version 2) spreadsheet program is required, as a vehicle for the analysis programs.

The package has been mounted, and is successfully running, on a TOSHIBA T2100 and an IBM AT. The facility has been designed for ease of use (employing LOTUS 123 as a programming vehicle) even by those without programming experience. The package has been extensively tested in its use at AZRI.

Details of the package, and instructions for its use are given in the Users Manual, a copy of which may be found in Appendix B. In this section of the report, we have restricted ourselves to a description of the technical and scientific background to the facility.

3.2 Frequency analysis

The probabilistic approach to the data is known as Frequency Analysis. The objective is to ascertain the probability of any given event occurring, where an event is an user-specified range of values of a meteorological variable such as rainfall or temperature. These are continuous variables, by which is meant that they can take an infinite number of different values. This means that the probability of the variable taking a **particular** value is effectively zero, so that we need to adopt the concept of an 'exceedance probability'. This is the probability of a given value of the variable being equalled or exceeded. If the exceedance probability of an annual rainfall of 200mm is 0.40, then this means that probability is 0.40 (or 40%) that the rainfall in a given year will be greater than 200mm. Alternatively, 200mm will be exceeded on an **average** of 4 years out of 10, and the rainfall will be less on an **average** of the other 6.

The other important concept is that of an annual series. An annual series is a series of values of a variable, one for each year of record. It could be a series of annual totals, or a more complex variable such as monthly total rainfalls or the lowest daily temperature between 15 January and 1 March. The important feature is that there should be a single value for each year of record. Within each year, an "event" will need to be defined in order to extract the appropriate statistic.

The frequency analysis is performed on this annual series, and consists of assigning on the basis of these data the exceedance probability associated with a range of possible values of the variable involved. This is achieved by fitting a theoretical probability distribution to the data, and using this to define the relationship between exceedance probability and the variable.

3.3 Probability distributions

There are no a priori theoretical justifications for the use of any particular probability distribution in a given frequency analysis problem with respect to meteorological events. Selection of an appropriate distribution is on the basis of goodness of fit to data, and a choice of three probability distributions are available within the package. These are NORMAL, LOGNORMAL and GAMMA.

The Normal distribution is the commonest of all distributions used in frequency analysis. It is a 2-parameter distribution, its parameters being estimated by the mean and standard deviation of the data sample. Its most important feature is that it has a symmetrical bell-like shape. Details of the distribution may be found in any statistical textbook (for instance, Hahn,1977). Suffice it to say here that the probability density function of the Normal distribution is incorporated into the program as a look-up table. The Normal distribution is found to be suitable for most applications involving temperature.

It is found that observed probability distributions of variables involving rainfall are not symmetrical, but tend to be positively skewed. This is because the distribution of rainfall is constrained on the left-hand side by zero, but is effectively unconstrained on the right-hand side. While not necessarily being effectively so for annual rainfalls in temperate climates, it is especially so in the arid environment where rainfall variables tend to take low (and often even zero) values. For this reason, the Normal distribution seldom provides an adequate description of rainfall, so that other distributions are preferred.

One answer is to take a logarithmic transformation of the data, and to fit a Normal distribution to these. This has the effect to negate the tendency towards positive skew, and it is known as the Lognormal distribution. Parameters are estimated by the mean and standard deviation of the logarithmically transformed sample values. The Lognormal distribution has been successfully applied to rainfall variables on many occasions (for instance, Huff & Neill,1959).

The most popular distribution in current use for describing rainfall for agroclimatic applications (for instance Stern et al,1982; Keatinge et al,1986) is the Gamma distribution. This is the sum of n (where in practice n does not have to be an integer) exponentially distributed random variables. The result is a positive skewed distribution having 2 parameters LAMDA and NU. The parameters are best estimated by the method of maximum likelihood (Greenwood & Durand,1960), corrected for bias by the method suggested by Bowman & Shenton (1970). As for the other two distributions, there is no analytical solution to the equations describing the cumulative probability distribution. The relationship between exceedance probability and the variable is embedded in a look-up table within the package, the table having been taken from Hahn(1977), who provides an excellent description of this distribution in particular as well as a useful treatise on the whole subject of frequency analysis. Any reader interested in discovering more on this subject is referred to this excellent reference.

3.4 Truncated distributions

Special care needs to be taken in fitting any probability distribution to a series of a rainfall variable containing zeroes. In the case of temperature, on the other hand, zero can occur within an untruncated distribution because negative as well as positive values may occur.

There is a problem encountered in parameter estimation with the Lognormal and Gamma distributions in attempting to take logarithms of zero, although this can be overcome by making a small addition to the data values. But, secondly, little success in fitting will be had if more than one or two zeroes are present due to the truncated character of the sample.

The problem is overcome in the analysis package by removing rainfall values of zero, performing the frequency analysis on the non-zero values alone, and then reintroducing the zeroes at the end by consideration of the theorem of total probability. In this particular circumstance, the exceedance probability can be estimated from the following version of the theorem:-

$$\mathrm{prob}(X>x) = \mathrm{prob}(X>x|X=0)\mathrm{prob}(X=0) + \mathrm{prob}(X>x|X=0)\mathrm{prob}(X=0)$$

Since $\mathrm{prob}(X>x|X=0)$ is zero, the relationship reduces to:-

$$\mathrm{prob}(X>x) = \mathrm{prob}(X>x|X=0)\mathrm{prob}(X=0)$$

The interpretation of this equation is that the exceedance probability of a given value of a variable is the product of (a) the exceedance probability of the variable ignoring zeroes and (b)the probability of the variable taking a non-zero value.

This effectively takes care of the truncation problem for rainfall. Problems could nevertheless occur if the user attempts to fit Lognormal or Gamma distributions to temperature data containing zeroes. This should not be a problem, because the Normal distribution is usually appropriate for applications involving temperature.

3.5 Example of the package application

The theoretical considerations described above are embedded in the computer programs, and the user will be asked questions by the package with respect to stations to be analysed, particular variables to be used and choice of distribution. The Users Manual in Appendix B is the best source of reference for this process, best read at the same time as running the program. Experience has shown that Users become accustomed to the package quickly and without difficulty.

At the end of the frequency analysis, the User is shown a frequency plot, an example of which is shown in figure 3.1. This plot permits the user to make a subjective judgement about the goodness of fit of the chosen distribution to the data, which in this case may be deemed to be good. Care should be taken here to distinguish between lack of fit (which reflects on the suitability of the distribution) and sampling error (which is the general scatter around the curve and is a function of the data sample rather than the distribution). The latter is to be expected, and will usually increase with distance from the centre of the distribution.

An interesting feature of the graph in figure 3.1 is the upward-curving character of the distribution, which is a reflection of the skewness of the distribution of the sample. For convenience, the x-axis is a Normal reduced variate, so that the plot would show a straight line if a Normal distribution had been attempted.

The purpose of the plot is to allow the User to see how good a fit the chosen distribution is to the data, and he has the opportunity to try an alternative if dissatisfied.

The end-product is a summary, an example of which is shown in figure 3.2. The main item of interest is the two columns at centre-bottom which show the exceedance probability for a range of values of the variable. Values of the variable for particular selected exceedance probabilities (or vice versa) can also be estimated, which would be shown at bottom right of the summary.

The computer software is the major product of the consultancy, and the package is now the property of the Pakistan Agricultural Research Council. It is mounted on the IBM AT microcomputers at their Arid Zone Research Institute at Quetta.

The best way to obtain an appreciation of the capabilities of the facility is to use the package, which is designed to be user-friendly. The purpose of the package is to act as a tool, capable of answering questions in an efficient manner. Care needs to be taken in phrasing the correct questions.

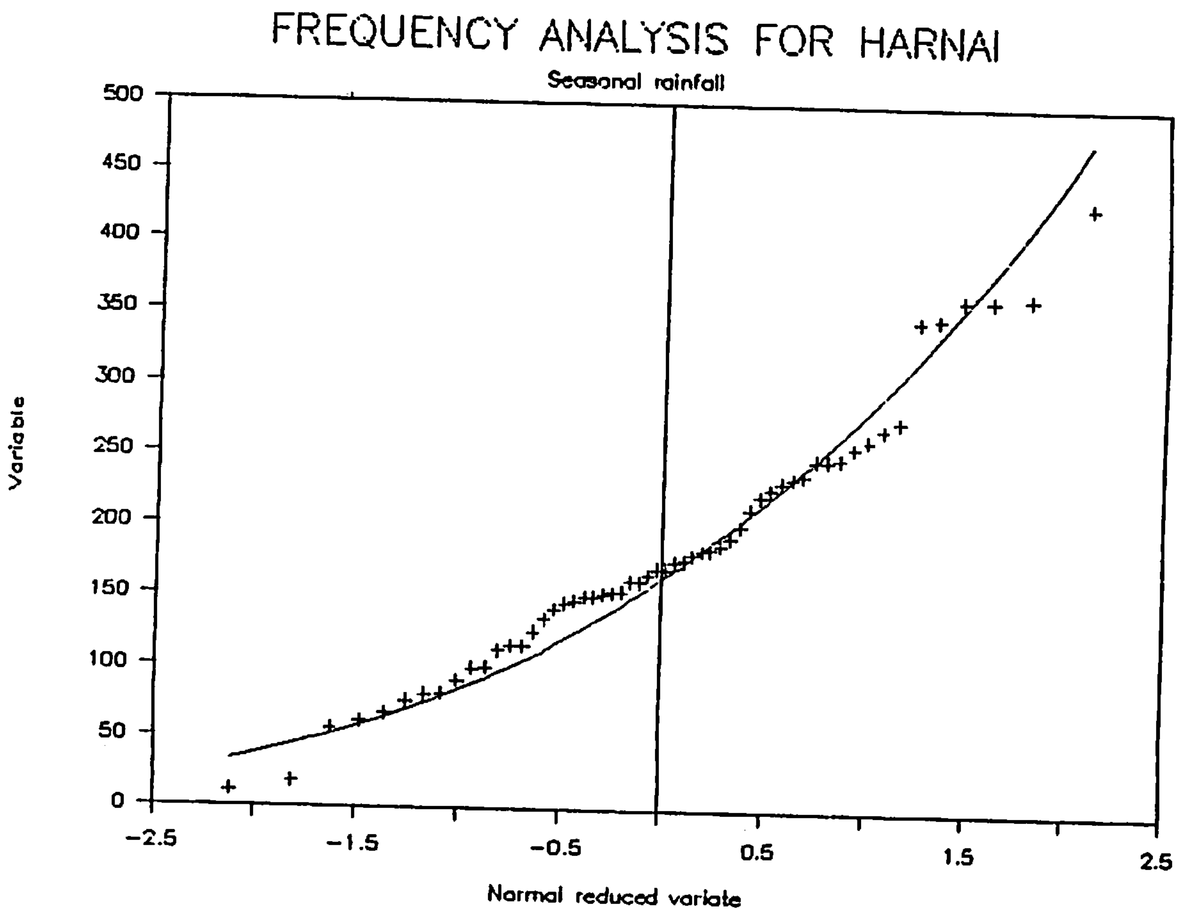

FIGURE 3.1: Example of frequency plot

BALUCHISTAN METEOROLOGICAL DATA					
FREQUENCY ANALYSIS FOR HARNAI 1891 to 1946					
VARIABLE: Seasonal rainfall JUN to SEP					
No. of years	56	GAMMA DISTRIBUTION		PROB	VAR
Missing values	0	Parameters:-			
		LAMDA	0.017		
Sample size	56	NU	3.129		
Mean	184	EXC PROB	VARIABLE		
S.D.	89	0.90	69		
		0.80	96		
No. of zeros	0	0.70	119		
Nonzero sample	56	0.50	165		
Mean of nonzeros	184	0.30	221		
S.D. of nonzeros	89	0.20	261		
Prob. of > zero	1	0.10	324		

FIGURE 3.2: Example of analysis summary

4. ANALYSIS OF RAINFALL

4.1 Introduction

The second part of the consultancy involved the detailed analysis using the facility described in the above section. By no extent do these analyses represent the limit of useful analyses which may be undertaken. The primary constraint in this respect is the number of questions which may be posed, based on agronomic considerations (other possible applications, such as in engineering, are beyond the scope of this study). A particular area of special interest lies in the probability of events defined by the combination of precipitation and temperature. At the present time, the temperature database needs to be expanded if this latter area is to be investigated.

Some conclusions are drawn as the analyses are described. These conclusions are necessarily incomplete, relating more to meteorological than agronomic aspects. Further conclusions could be drawn as to the implications of the analyses described below, particularly in the area of agricultural domain delineation.

4.2 Statistical summaries of rainfall

Frequency analyses were undertaken initially for all stations for annual and seasonal rainfall. The two seasonal divisions were arbitrarily chosen as summer (June-September) and winter (October-May). The first is of particular interest in assessing the likelihood of receiving a 'planting rain' for long-maturity wheat or barley crops. The second relates particularly to the total water availability during the growing season of winter crops.

The analyses were restricted to a normalising period from 1901 to 1940. The choice of this period was dictated by the requirements of the mapping exercise described in section 4.3. Where stations had records in excess of this period, records outside the range were ignored. Where shorter records were used, the results were adjusted by reference to longer reliable records at other stations as near to the site as possible.

Statistical summaries of all these frequency analyses for all stations have been tabulated and are given in Appendix C. They give the values of the annual and seasonal rainfall totals for a range of exceedance probabilities between 10% and 90%. It is envisaged that these statistical summaries will act as a source of reference, by providing information directly to interested parties relating to sites at or near to rainfall stations.

Further statistical summaries have also been produced for a smaller subset of 16 stations at shorter durations. Precipitation totals for 12 individual months and 36 decads (10-day periods) corresponding to the same range of exceedance probabilities have been analysed. These statistical summaries are given in Appendix D for the 16 stations. All years of record for any given station have been used. This has the advantage of using all the available information at a given site, but the disadvantage in that care will need to be taken in making quantitative comparisons between different sites if the periods of record from which the statistics are derived are not the same.

Care needs to be taken in the interpretation of these statistics. It is not possible to add together the shorter-term statistics of the same probability to give the probability of rainfall over a longer duration.

4.3 Normal isohyetal maps

One of the advantages of such a powerful dataset is the opportunity to prepare maps describing the spatial variability of interesting rainfall-based variables. A series of 10 maps have been prepared based on the series of analyses of annual and seasonal precipitation described in section 4.2. These maps may be found in Appendix E.

The chief determinant of the positions of contours in these maps is the statistical data derived for each of the stations in the database, the locations of which were shown in figure 2.1. This figure demonstrates that the density of stations is not uniform, a greater concentration of stations being found in the central portion of the Province. Where the density of stations is high, it was found that there was good agreement between stations and the positions of the contours could be determined almost solely on the basis of the station statistics. Away from these areas of high station density, the locations of the contours is much more uncertain and depends on subjective judgement.

A normalising period 1901 to 1940 has been chosen, in order that statistics derived from different station locations might be compared. Where records are shorter than the normalising period, then the statistics have been adjusted by cross-correlation with nearby longer-term stations (the normal ratio method). Where records are shorter than 10 years, this can lead to considerable uncertainties in the derived statistics. Where these short-term stations were located in areas where the station density was high, they could be safely ignored. However, in areas of sparse density, they provide the only information. Much of the southern and south-western parts of the Province have data starting in about 1912, but this is not considered a serious inaccuracy when the statistics are adjusted.

The main secondary factor in determining the position of contours is relief, albeit in a more informal fashion than the station statistics. In this context, relief is not so much altitude as an area of increasing altitude facing the direction of the prevailing weather. For this reason, it is important to look at seasonal as well as annual rainfall, and map numbers 1, 4 and 7 (the average annual, average summer and average winter precipitation) will be examined together.

The isohyetal map of average summer precipitation (June to September inclusive) is shown in Map Number 4. It was pointed out in section 1.2 that the escarpment acted as a barrier to movement of monsoonal disturbances. This is reflected in the high summer rainfall in the eastern extremities of the Province, particularly in Loralai and Sibi Districts and the eastern portions of Khuzdar and Bela Districts. Contour positions were difficult to locate in this latter region due to the sparsity of data. The high 150mm isohyet located to the north of Bela is based on an informal consideration of data collected at stations during the 1960's and was also identified by Wirasat Ullah Khan (1980). It is supposed that this area of higher summer rainfall could be caused by monsoonal disturbances being funnelled in a northerly direction up the Sonmiani Valley to the south of Bela. There is some uncertainty in the rainfall surface in this general area, and it has to be accepted that there could be higher isohyets within this belt as well as up the escarpment to the east of Khuzdar District. The map confirms that there is little summer rainfall in upland Baluchistan beyond what may be described as the escarpment areas. The area of highest summer rainfall is around Musa Khel in the north of Loralai District close to the Punjab border.

The map of average winter (October-May) precipitation is shown in Map Number 7, and displays the opposite effect to that detected for summer rainfall. In the main, it is upland Baluchistan which receives more winter rainfall. As discussed in section 1.2, the disturbances which cause winter precipitation come from the West and north, and it is particularly the areas of moderate to strong relief in the north of Pishin and Zhob Districts which receive the most precipitation. Furthermore, it is noticeable that the band of strong relief between Quetta and Ziarat induces a preferential tendency towards winter rainfall in this area.

Annual precipitation is an amalgam of the effects of summer and winter weather. The combination is shown in Map Number 1, which is of average annual precipitation. The area of highest rainfall is concentrated through the north of Sibi District into Loralai District, most of which is received in summer. The exception to this is the mountainous band between Quetta and Ziarat which may be the only part of the Province which receives significantly large amounts of rainfall from both sources.

In and around the Quetta Valley, there are appreciable gradients in the rainfall surface. This can be demonstrated by considering the annual average rainfalls for Beleli(180mm), Urak(319mm), Quetta at Brewery Road(222mm), Sariab(172mm) and Spezand(135mm). All these records may be considered to be reliable and consistent, and the variability may be explained in physical terms. Urak is part of the mountainous band between Quetta and Ziarat which receives appreciable precipitation in both main seasons. Locals consider the Dasht Valley containing Spezand to be a rainfall shadow, probably from both directions.

While the Quetta Valley may represent a particularly complex part of the rainfall surface, the above example provides a cautionary warning with respect to the interpretation of these maps. Quite considerable variations in rainfall can occur over short distances in the mountainous regime found throughout most of the Province.

A further consideration relates to the fact that almost all stations are located in valleys, and therefore these statistics may not relate to (probably higher) rainfall in mountains nearby. For agricultural applications, this location of gauges in the areas where this activity takes place is very appropriate. Care will have to be taken, however, when these maps are used for estimation of catchment water resources, because it seems likely that these rainfall isohyets represent an underestimate of **areal** rainfall.

Map Number 10 shows contours of the ratio of summer to winter precipitation. The line marked 1 (equal summer and winter) marks the division between the two zones, the region to the left of the line being dominated by winter precipitation and that to the right by summer rainfall. The closeness of the central contours is an indication of how little of the Province receives considerable precipitation in **both** seasons.

4.4 Probabilistic maps of rainfall

The isohyetal maps described above aim to describe the spatial variability of average rainfall. The maps described in this section relate to the probability of specified precipitation being exceeded.

Maps 2 and 3 show contours of probability of exceeding 200mm and 300mm annual rainfall respectively. These demonstrate that the probability of receiving sufficient rainfall to sustain reliable agricultural yields is low in most parts of the Province. Further maps elaborate on this conclusion with particular respect to seasonal rainfall.

Maps 5 and 6 show contours of probability of exceeding 20mm and 40mm summer rainfall respectively. Summer rainfall is of particular interest where long-maturity wheat strains are used for summer and autumn planting. The amount of rainfall considered adequate for summer planting is uncertain, but is probably in the range 20 to 40mm. The maps suggest that those areas receiving appreciable summer rainfall (Loralai and parts of Zhob, Sibi, Khuzdar and Bela Districts), particularly where Sailaba or water-harvesting practices are used, have sufficient likelihood of receiving a planting rain that long-maturity strains of wheat and other grain crops might be appropriate. On the other hand, the probability of receiving an appreciable planting rain in most of upland Baluchistan (particularly Quetta and Pishin districts) is so low that it is more sensible to concentrate on short-maturity crops, planting on the basis of winter rains rather than relying on residual soil moisture from infrequent summer rains.

Maps 8 and 9 show contours of probability of exceeding 100mm and 200mm winter rainfall respectively. This is of interest in considering the probability of receiving adequate moisture during the normal growing season. As could be expected, the North-West parts of the Province are better served in terms of the reliability of winter rainfall. A complication here arises because it may be that there are areas which receive reliable summer rains for early planting but are unreliably served by the winter rains in periods related to growing and grain-filling phases.

If some of these conclusions seem somewhat pessimistic, this comes as no surprise to those who live and work in the Province. Firstly, they emphasise the fact that drought-resistance may be the most important requirement in germplasm development. Secondly, they highlight the need to maximise the available resource by adopting specialised management practices such as Sailaba, Manda Sailaba, water-harvesting and conjunctive water use.

5. ANALYSIS OF TEMPERATURE

5.1 Analysis of first frost

The analysis package was used to estimate the probability of receiving a frost before a given date in the autumn. This statistic is particularly relevant to the germination phase for winter crops as well as to vegetable and fruit production.

Figure 5.1 shows the probability distributions of receiving a frost before a given date for the three stations loaded onto the database. It shows that, for instance, there is a high risk of frost before the end of November at Quetta (Samungli), whereas the lower elevation at Khuzdar suffers little risk in this respect before the beginning of December. Loralai, although only slightly lower in altitude than Quetta, has risk of frost delayed by almost a month. This is probably due to its easterly location relative to the cold north-westerly airstreams associated with the western disturbances which become prevailing during this season.

Similar analyses could be done for frosts of differing severity, as has been done by Qaiyum Hamid & Hassan(1970).

5.2 Analysis of last frost

The package can be used to analyse in the same way the probabilities of frosts at the end of the winter season. This is of particular interest to fruit production when the trees are in blossom, frost damage having a deletarious and irretrievable effect on crop production.

Figure 5.2 shows the probability of receiving frost after a given date, and shows the expected opposite trend to that shown for first frosts. The colder regime of the higher altitude site at Quetta has frosts persisting later in the spring. The Quetta result is compared with that found by Naqvi et al (1965) for the same site but a different period of record. It shows fair agreement.

When the temperature database is expanded to embrace further temperature stations, it should be possible to map dates of first and last frosts using altitude as a secondary determinant in the location of contours.

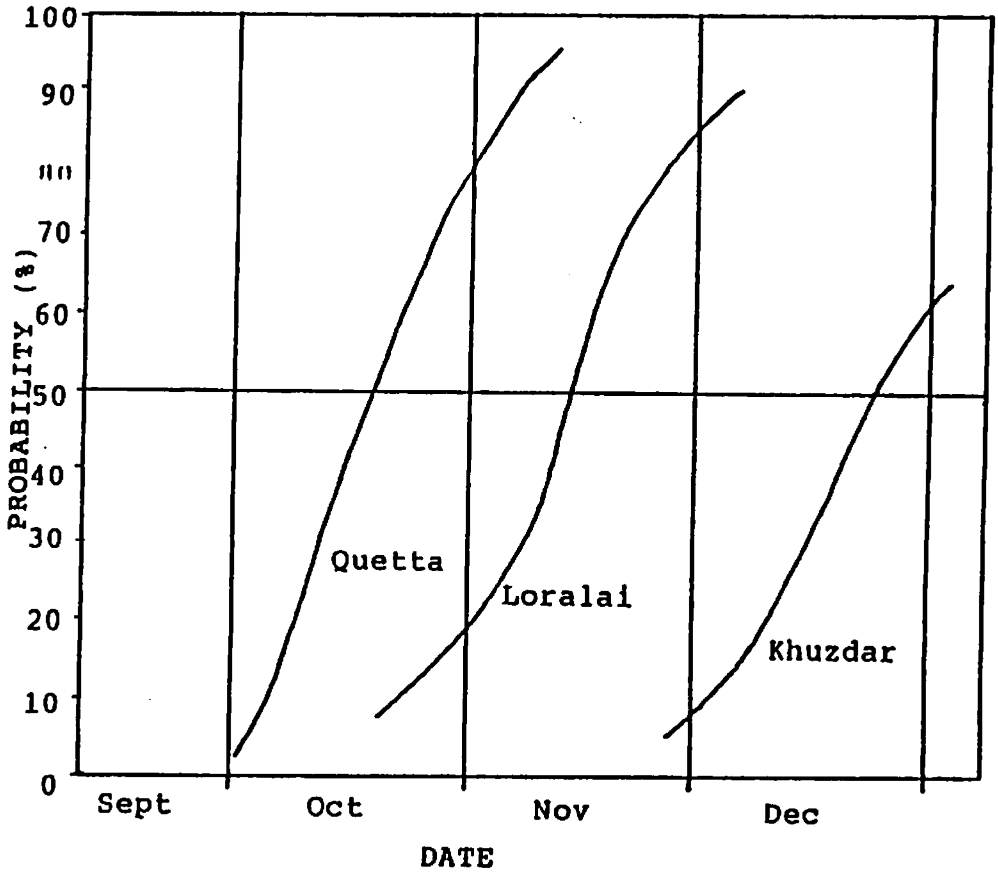

FIGURE 5.1: Probability of frost of 0°C before a given date

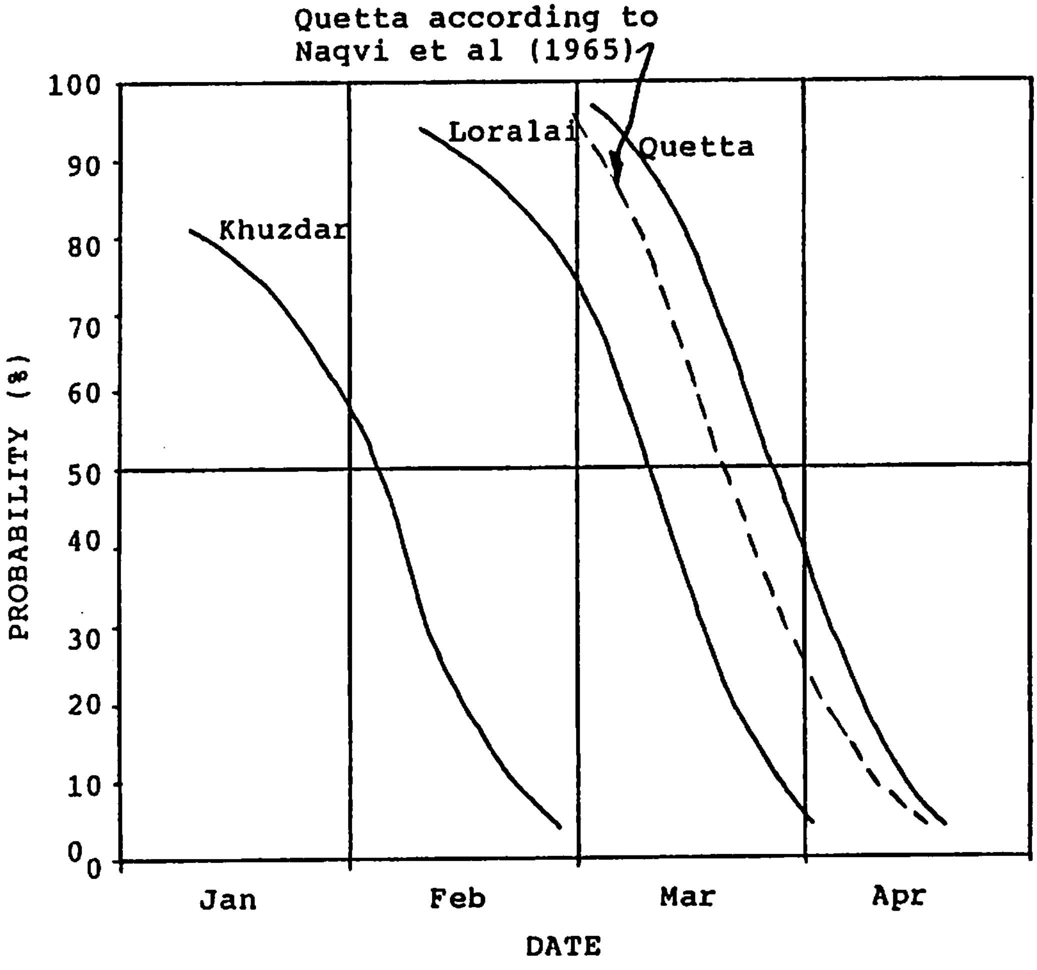

FIGURE 5.2: Probability of frost of 0·C after a given date

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ACKNOWLEDGEMENTS

The tasks described in this report were greatly assisted by the excellent work done by the Institute of Hydrology on the preparation of the O.D.A. database, particularly with respect to the quality control of the data by John Packman.

Much assistance was given to the Consultant by ICARDA and AZRI staff during his visit to Quetta in February/March 1988. The contributions of Ms Fehema and Mr Samiullah in the extensive analyses of rainfall data are particularly acknowledged.

The draughting facilities generously extended by Halcrow-ULG in Quetta are gratefully acknowledged.

Many opinions were solicited and generously offered by many individuals in several organisations in Quetta, all of which are acknowledged.

APPENDIX A

Computer listing of daily rainfall
data extraction program

APPENDIX A

```
C   Program to read daily data (compacted version)
C   and to extract pertinent statistics.
C
      DIMENSION IRF(30),ID(30),MONTH(12)
      DIMENSION IMO(12),IX(12,31),IDAT(730)
      CHARACTER*3 MONTH,AMON
      CHARACTER*8 STT
      DATA (MONTH(I),I=1,6)/'JAN','FEB','MAR','APR','MAY','JUN'/
      DATA (MONTH(I),I=7,12)/'JUL','AUG','SEP','OCT','NOV','DEC'/
      DATA (IMO(I),I=1,12)/31,28,31,30,31,30,31,31,30,31,30,31/
      OPEN (8,FILE='INPUT.DAT')
      OPEN (9,FILE='OUTPUT.DAT')
C
C   menu for what to extract
C
      WRITE (6,*)
      WRITE (6,*)
      WRITE (6,*) '          BBBBB    EEEEEE   LL       II   NN   NN   DDDDD
     &    AA'
      WRITE (6,*) '          BBBBBB   EEEEEE   LL       II   NN   NN   DDDDDD
     &   AAAA'
      WRITE (6,*) '          BB   BB  EE       LL       II   NNN NN   DD   DD
     &   AAAA'
      WRITE (6,*) '          BB   BB  EE       LL       II   NNN NN   DD   DD
     & AA  AA'
      WRITE (6,*) '          BBBBBB   EEEEEE   LL       II   NNNNNN   DD   DD
     & AA  AA'
      WRITE (6,*) '          BBBBBB   EEEEEE   LL       II   NNNNNN   DD   DD
     &AA      AA'
      WRITE (6,*) '          BB   BB  EE       LL       II   NN NNN   DD   DD
     &AAAAAAAA'
      WRITE (6,*) '          BB   BB  EE       LL       II   NN NNN   DD   DD   A
     &AAAAAAAAA'
      WRITE (6,*) '          BBBBBB   EEEEEE   LLLLLL   II   NN   NN   DDDDDD   A
     &A        AA'
      WRITE (6,*) '          BBBBB    EEEEEE   LLLLLL   II   NN   NN   DDDDD   AA
     &          AA'
      WRITE (6,*)
      WRITE (6,*) '          PACKAGE FOR THE ANALYSIS OF BALUCHISTAN DAIL
     &Y RAINFALL'
      WRITE (6,*)
      WRITE (6,*)'         This portion of the package extracts statisti
     &cs from'
      WRITE (6,*)'         daily data to yield an annual series  (one va
     &lue for'
      WRITE (6,*)'         each year)  of  rainfall amounts ready for fr
     &equency'
      WRITE (6,*)'         analysis. The form of the statistic is the am
     &ount of'
      WRITE (6,*)'         rainfall  (maximum or minimum)  in  a given d
     &uration'
      WRITE (6,*)'         during a specified sampling interval.'
      WRITE (6,*)
      WRITE (6,*) '  Specify start of sampling interval (ddmm): '
      READ (5,*) IST
```

```
      ID1=INT(IST/100.)
      IM1=(IST/100.+.0001-INT(IST/100.))*100
      DO 14 I=1,IM1
   14 ISTART=ISTART+IMO(I)
      ISTART=ISTART-IMO(IM1)+ID1
      WRITE (6,*) '  Specify end of sampling interval (ddmm): '
      READ (5,*) IEN
      ID2=INT(IEN/100.)
      IM2=(IEN/100.+.0001-INT(IEN/100.))*100
      DO 13 I=1,IM2
   13 IEND=IEND+IMO(I)
      IEND=IEND-IMO(IM2)+ID2
C
C   Cater for overyear facility
C
      IFLAG=1
      IFROG=0
      IF (IEND.GT.ISTART) GO TO 30
      IFLAG=2
      IFROG=365
      IEND=IEND+365
C
   30 WRITE (6,*) '  Specify rainfall duration (days): '
      READ (5,*) IDUR
      WRITE (6,*) '  Specify maximum or minimum (1 or 2): '
      READ (5,*) IHL
      NPOSS=IEND-ISTART-IDUR+2
      WRITE (6,*)
      WRITE (6,*) '                    Thank you'
      WRITE (6,*) '              Now please wait awhile'
C
C  read data for each year
C
      READ (8,1040) STT
 1040 FORMAT(A8)
      DO 2 K=1,110
      IF (IFLAG.LT.2) GO TO 31
      DO 32 I=1,365
   32 IDAT(I)=IDAT(I+365)
   31 DO 15 I=1,12
      DO 16 J=1,31
   16 IX(I,J)=0
   15 CONTINUE
      DO 3 J=1,12
      READ (8,1050,END=600) AMON,IY,ANY,(ID(L),IRF(L),L=1,20)
 1050 FORMAT (A3,I4,A3,20(I2,I4))
      II=1
      DO 4 I=1,31
      IF (ID(II).EQ.99) GO TO 5
      IF (ID(II).NE.I) GO TO 4
      IX(J,I)=IRF(II)
      II=II+1
      GO TO 4
    5 IF (IRF(II).LT.0) GO TO 6
      LIM=IRF(II)+1
```

```
      DO 7 L=LIM,31
    7 IX(J,L)=-999
      GO TO 3
    6 LIM=-IRF(II)
      DO 8 L=1,LIM
    8 IX(J,L)=-999
      I=LIM+1
      II=II+1
    4 CONTINUE
    3 CONTINUE
C
C  change to 365 array
C
      IJ=0
      DO 17 I=1,12
      DO 18 J=1,IMO(I)
   18 IDAT(J+IJ+IFROG)=IX(I,J)
   17 IJ=IJ+IMO(I)
C
C  extract statistic
C
      ISTAT=0
      IF (IHL.GT.1.5) ISTAT=9999
      DO 19 I=1,NPOSS
      ISUM=0
      DO 20 J=1,IDUR
   20 ISUM=ISUM+IDAT(ISTART+J+I-2)
      IF (ISUM.GT.ISTAT.AND.IHL.LT.1.5) ISTAT=ISUM
      IF (ISUM.LT.ISTAT.AND.IHL.GT.1.5) ISTAT=ISUM
      IF (ISUM.LT.0) GO TO 25
   19 CONTINUE
      ISTAT=INT(ISTAT*.254+.5)
      IF (ISTAT.LT.0) THEN ISTAT=-999
      GO TO 24
   25 ISTAT=-999
   24 IF (K.EQ.1.AND.IFLAG.EQ.2) GO TO 2
      WRITE (9,*) (IY-IFLAG+1),ISTAT
C
C  go on to next year
C
    2 CONTINUE
C
  600 CLOSE (8)
      WRITE (9,1040) STT
      AMON = 'Max.'
      IF (IHL.GT.1.5) AMON='Min.'
      WRITE (9,1235) AMON,IDUR
 1235 FORMAT (A4,I3,'-day rainfall')
      WRITE (9,1236) ID1,MONTH(IM1),ID2,MONTH(IM2)
 1236 FORMAT (' between',I3,A3,' and',I3,A3)
      WRITE (9,*) '888'
      CLOSE (9)
      WRITE (6,*) '  Job complete'
  700 STOP
      END
```

APPENDIX B

Users' Manual

APPENDIX B

```
BBBBB    EEEEEE  LL      II  NN   NN  DDDDD        AA
BBBBBB   EEEEEE  LL      II  NN   NN  DDDDDD      AAAA
BB   BB  EE      LL      II  NNN  NN  DD   DD     AAAA
BB   BB  EE      LL      II  NNN  NN  DD   DD    AAAAAA
BBBBBB   EEEEEE  LL      II  NNNNNN   DD   DD    AA  AA
BBBBBB   EEEEEE  LL      II  NNNNNN   DD   DD   AAA  AAA
BB   BB  EE      LL      II  NN  NNN  DD   DD   AAAAAAAA
BB   BB  EE      LL      II  NN  NNN  DD   DD  AAAAAAAAAA
BBBBBB   EEEEEE  LLLLLL  II  NN   NN  DDDDDD   AA      AA
BBBBB    EEEEEE  LLLLLL  II  NN   NN  DDDDD   AA        AA
```

STATISTICAL ANALYSIS PACKAGE

FOR

BALUCHISTAN METEOROLOGICAL DATA

USERS MANUAL

April 1988

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TABLE OF CONTENTS

1. INTRODUCTION

BELINDA is a computer-based package for the statistical analysis of rainfall and temperature. It has been developed specifically for the examination of Baluchistan meteorological data, under a contract between the International Center for Agricultural Research in the Dry Areas, Aleppo, Syria and Hydroconsult Ltd., Lower Trengale, Liskeard, U.K.. The facility is the property of the Pakistan Agricultural Research Council.

A purpose-built database for the storage of daily and monthly data has been developed in conjunction with the package. This database has been developed from that constructed by the Institute of Hydrology from archived records, between 1891 and 1946 inclusive, held at the U.K. Meteorological Office. A database management system has been appended, in order that further data may be loaded on to the system.

No prior detailed knowledge of computers or programming is required for operation of the package. LOTUS 123 has been used as a vehicle for the data handling and analysis, although there are some routines written in FORTRAN. All this should be transparent to the user.

Information is requested from the user through simple-to-read menus. Two methods are used with LOTUS for selecting an item in a menu. The user can move the cursor using the arrow keys to the appropriate option and then press RETURN. Alternatively, this option can be invoked simply by pressing the first letter of the option (no RETURN is required here). Throughout the text in this manual, the requirement for the user to press the RETURN key is denoted by <rtn>.

The package is fairly self-explanatory in its execution, but assumes an appreciation of the theory of frequency analysis. Descriptions of the details of distributions used and other matters are described in the final report of the Contract.

Section 2 below describes the structure of the package. This description is useful for anyone maintaining the package, but is optional reading for the normal user. Section 3 describes the database, including tables showing stations and their filenames. Section 4 contains a full description of the operation of the package, and section 5 contains a description of the database management system.

2. PACKAGE STRUCTURE

BELINDA is designed to be operated from a hard disk of a fully IBM-compatible machine. A total of 4 Mbytes of disk storage should be available. A copy of LOTUS 123 Version 2 spreadsheet package should also be available on the machine. If not already available, an appropriate PATH instruction should be included in the system's AUTOEXEC file in order to permit the use of LOTUS from anywhere in the system. If this is not possible, then an appropriate version of LOTUS will need to be stored in a subdirectory of RAINFALL (see below).

The file structure of the package and its associated database consists of a root directory called RAINFALL with 6 subdirectories as follows:-

```
                  ___ ENTRY
                  ___ DAT
RAINFALL          ___ PROGS
                  ___ TEMP
                  ___ PLOTS
                  ___ LOTUS (optional)
```

Subdirectory WKS contains rainfall data in the form of monthly totals in millimetres in LOTUS format.

The DAT subdirectory contains daily rainfall in a compacted form in an ASCII file for each station. This format, an example portion of which is shown in figure 2.1, leaves out the zeros which comprise the vast majority of data values. Each line contains data for one month, the format being month and year followed by as many 6-integer data items as there are raindays in that month. The first two integers contain the date, and the remaining four the depth of rainfall on that date in hundredths of an inch. If the number 99 is encountered in the date, this indicates missing data. Note that, although the daily data are stored in hundredths of an inch, the package itself operates in millimetres. The DAT subdirectory also contains an executable program file called EXTRACT.EXE (programmed in FORTRAN), which is called by other portions of the package in order to extract appropriate statistics from the daily rainfall files.

Most of the LOTUS spreadsheet files are stored in the PROGS subdirectory. Many of the program macros are stored as overlays.

The subdirectory TEMP contains the temperature data in ASCII files in daily maximum and minimum form. It also contains an executable program called TEMP.EXE (similar to EXTRACT) which extracts relevant statistics from the temperature data.

The package produces a screen plot of the distribution fit as a matter of routine. If the user wishes to obtain a hard copy of this plot, then he will be invited to create a file containing this information. This will be automatically stored in the PLOTS subdirectory, and can later be printed using the LOTUS PrintGraph option. It is a good idea to enter this subdirectory periodically and delete files which are no longer required.

The programs appropriate to the database management system are stored in the subdirectory ENTRY. This will be described in

```
KHUZDAR
JAN1912   99
FEB1912   99
MAR1912   99
APR1912   99
MAY1912   99
JUN1912   99
JUL1912   1000151400501600311900103100l0
AUG1912   0500091000141300503100034
SEP1912
OCT1912
NOV1912
DEC1912   150058
JAN1913
FEB1913   140075180050190050
MAR1913   230019
APR1913
MAY1913   220030
JUN1913   070010200010230010
JUL1913   0100102000102300152600202900100000055
AUG1913   0201200400500700300900401400902501000
SEP1913
OCT1913
NOV1913   290050300100
DEC1913   010150
JAN1914   180010
FEB1914   130100140150210020270010
MAR1914   260010
APR1914   050010160090
MAY1914
JUN1914
JUL1914   1000101100301200402201002301302500080
AUG1914
SEP1914   110080230045
OCT1914   280050
NOV1914   020080210085
DEC1914
JAN1915   310030
FEB1915
MAR1915   090020
```

FIGURE 2.1: Example of compacted daily rainfall data

detail in section 5.

3. THE DATABASE

3.0 Rainfall data

The rainfall database has been derived from a database produced by the U.K. Institute of Hydrology from archived records kept at the U.K. Meteorological Office. A fuller description of this database can be found elsewhere, as well as a discussion of the analyses performed in order to assess their quality.

The database consists of 104 stations, which can be found sorted on a district basis in table 3.1. This table is appropriate at the time of going to press, and will need to be amended when further data are added to the database. It should be noted that the first column contains the FILENAMES for each station (constrained to be no more than 8 letters long), while the second contains their full names. It is the first (the filename) which should be used upon request from the package.

3.1 Temperature data

The rainfall database has been obtained from computerised files obtained from the Meteorological Department. These ASCII files have been read, after editting, using a BASIC program. It is recommended that manual loading may be the most appropriate method of loading further data.

Table 3.2 indicates brief details of the 3 stations in the database at the present time.

4. PACKAGE OPERATION

4.0 Starting

The operation of the package is invoked by entering the RAINFALL directory and typing BELINDA <rtn>. The user will be offered the choice of three options as follows:-

ANALYSIS DATA

The DATA option is for database management, which is described in section 5. Upon selection of the ANALYSIS option, a further menu is displayed:-

MONTHLY DAILY TEMPTURE RAINDAYS

The MONTHLY option derives statistics for analysis from the monthly rainfall totals. The DAILY option derives these from daily rainfall data. There is in fact nothing that the first

NO.	FILENAME	STATION	PERIOD	YRS	QUALITY	LAT.	LONG.
			CHAGAI DISTRICT				
12	CHAGAI	Chagai	1911 -1925	15	GOOD	29-18'	64-42'
14	DALBANDN	Dalbandin	1911 -1946	36	GOOD	28-53'	64-24'
20	GALANGUR	Galangur	1906 -1933	28	GOOD	29-35'	66-15'
36	KISHINGI	Kishingi	1906 -1946	41	GOOD	29-35'	66-09'
51	MIRJAWA	Mirjawa	1919 -1931	13	FAIR	29-01'	61-25'
104	MUSHKICH	Mushki Chah	1911 -1917	7		28-50'	62-33'
62	NOKKUNDI	Nokkundi	1926 -1946	21	GOOD	28-49'	62-45'
63	NUSHKI	Nushki	1900 -1946	47	GOOD	29-34'	66-01'
73	ROBAT	Robat	1910 -1919	10	GOOD	29-29'	63-17'
99	YAKMACH	Yakmach	1925 -1931	7	FAIR	28-45'	63-51'
			KACCHI DISTRICT				
1	ABIGUM	Abigum	1896 -1946	51	FAIR	29-49'	67-21'
8	BELLPAT	Bellpat	1891 -1946	56	FAIR	28-59'	68-01'
9	BHAG	Bhag	1935 -1946	12	FAIR	29-03'	67-49'
16	DHADAR	Dhadar	1931 -1946	16	GOOD	29-28'	67-39'
21	GANDAWA	Gandawa	1912 -1946	35	GOOD	28-37'	67-29'
24	HIROK	Hirok	1891 -1946	56	GOOD	29-56'	67-14'
25	JHATPUT	Jhatput	1891 -1946	56	FAIR	28-22'	68-23'
41	LEHRI	Lehri	1923 -1946	24	FAIR	29-12'	68-12'
42	LINDSAY	Lindsay	1891 -1946	56	GOOD	29-13'	67-56'
44	MACH	Mach	1892 -1946	55	GOOD	29-52'	67-20'
61	MIRPUR	Mirpur	1935 -1946	12	POOR	?	?
52	MITHRI	Mithri	1891 -1946	56	GOOD	29-25'	67-55'
56	MUSHKAF	Mushkaf	1894 -1946	53	FAIR	29-34'	67-44'
64	NUTTAL	Nuttal	1891 -1946	56	GOOD	28-45'	68-04'
65	OCIPUR	Ocipur	1926 -1931	6	FAIR	29-39'	67-34'
66	PANIR	Panir	1893 -1946	54	GOOD	29-41'	67-33'
69	PISHI	Pishi	1899 -1946	48	FAIR	29-43'	67-29'
72	RINDLI	Rindli	1891 -1941	51	FAIR	29-30'	67-33'
93	TEMPLEDR	Temple Dera	1891 -1946	56	GOOD	28-33'	68-13'
97	USTA	Usta	1935 -1946	12	FAIR	28-11'	68-04'
			KALAT DISTRICT				
28	KALAT	Kalat	1891 -1946	56	GOOD	29-02'	66-35'
29	KANAK	Kanak	1906 -1946	41	GOOD	29-58'	66-46'
35	KIRDAGAP	Kirda Gap	1906 -1946	41	GOOD	29-44'	66-27'
38	KOLPUR	Kolpur	1891 -1946	56	FAIR	29-54'	67-08'
47	MANGOCHR	Mangochar	1912 -1946	35	GOOD	29-22'	66-37'
50	MASTNGRD	Mastung Road	1906 -1946	41	GOOD	29-51'	66-50'
49	MASTUNG	Mastung	1911 -1946	36	FAIR	29-48'	66-50'
82	SHAIKHWA	Shaikhwasil	1907 -1946	40	FAIR	29-52'	66-34'
87	SORAB	Sorab	1925 -1946	22	FAIR	28-29'	66-16'
88	SPEZAND	Spezand	1901 -1946	46	GOOD	29-58'	67-00'

TABLE 3.1: RAINFALL STATIONS (page 1 of 3)

NO.	FILENAME	STATION	PERIOD	YRS	QUALITY	LAT.	LONG.
		KHUZDAR DISTRICT					
32	KHUZDAR	Khuzdar	1912 -1946	34	GOOD	27-42'	66-37'
48	MASHKAI	Mashkai	1913 -1946	34	GOOD	27-55'	66-06'
80	SARUNA	Saruna	1913 -1946	34	GOOD	26-28'	67-05'
98	WADH	Wadh	1935 -1946	12	FAIR	27-28'	66-27'
101	ZEHRI	Zehri	1935 -1946	12	FAIR	28-34'	66-44'
		LORALAI DISTRICT					
4	BARKHAN	Barkhan	1911 -1946	36	FAIR	29-53'	69-43'
18	DUKI	Duki	1900 -1946	47	GOOD	30-11'	68-34'
43	LORALAI	Loralai	1892 -1946	55	GOOD	30-24'	68-36'
55	MUSAKHEL	Musa Khel	1911 -1946	36	GOOD	30-52'	69-49'
76	SANJAWI	Sanjawi	1911 -1946	36	GOOD	30-15'	68-20'
		MAKRAN DIVISION					
6	BELA	Bela	1912 -1946	35	FAIR	26-14'	66-19'
45	MAND	Mand	1911 -1946	36	GOOD	26-05'	62-00'
2	ORMARA	Ormara	1912 -1946	35	GOOD	25-13'	64-37'
67	PANJGUR	Panjgur	1911 -1946	36	GOOD	26-58'	64-06'
68	PASNI	Pasni	1911 -1946	36	GOOD	25-16'	63-29'
86	SONMIANI	Sonmiani	1912 -1946	35	GOOD	25-27'	66-39'
95	TURBAT	Turbat	1911 -1946	36	GOOD	25-59'	63-05'
		PISHIN DISTRICT					
5	BARSHORE	Barshore	1909 -1921	13	POOR	30-46'	67-13'
10	BKK	Bund K. Khan	1909 -1946	38	GOOD	30-40'	67-02'
11	BOSTAN	Bostan	1891 -1946	56	GOOD	30-26'	67-01'
13	CHAMAN	Chaman	1893 -1946	54	GOOD	30-56'	66-27'
19	FULLERS	Fullers Camp	1891 -1907	17	FAIR	30-27'	67-13'
22	GULISTAN	Gulistan	1891 -1946	56	GOOD	30-36'	66-35'
30	KHANAI	Khanai	1891 -1946	56	GOOD	30-29'	67-09'
33	KILLABDU	Killa Abdullah	1891 -1946	56	GOOD	30-43'	66-38'
40	KUCHLAK	Kuchlak	1891 -1946	56	GOOD	30-21'	66-56'
70	PISHIN	Pishin	1891 -1946	56	GOOD	30-35'	66-59'
74	SABURA	Sabura	1913 -1919	7	FAIR	31-03'	67-16'
78	SARANAN	Saranan	1895 -1946	52	GOOD	30-34'	66-52'
83	SHEBO	Shebo	1930 -1946	17	GOOD	30-32'	66-56'
84	SHELABAG	Shela Bagh	1892 -1946	55	FAIR	30-49'	66-35'
90	SURKHAB	Surkhab h/w	1930 -1946	17	GOOD	30-35'	67-05'
91	SYADHAMD	Syad Hamid	1891 -1915	25	GOOD	30-35'	66-45'
94	TORMORGA	Tor Morga h/w	1930 -1946	17	GOOD	30-42'	67-04'
100	YARUKARZ	Yaru Karez	1891 -1946	56	GOOD	30-31'	66-57'

TABLE 3.1: RAINFALL STATIONS (page 2 of 3)

NO.	FILENAME	STATION	PERIOD	YRS	QUALITY	LAT.	LONG.
		QUETTA DISTRICT					
7	BELELI	Beleli	1891 -1946	56	GOOD	30-15'	66-57'
60	NARNULLA	Nar Nullah	1909 -1919	11	GOOD	?	?
71	QUETTA	Quetta	1891 -1946	56	GOOD	30-12'	67-01'
79	SARIAB	Sariab	1900 -1946	47	GOOD	30-05'	66-58'
96	URAK	Urak	1914 -1946	33	GOOD	30-16'	67-11'
		SIBI DIVISION					
3	BABKACH	Babar Kach	1891 -1946	56	GOOD	29-47'	67-58'
15	DALUGAL	Dalugal	1892 -1897	6	FAIR	29-53'	68-06'
17	DIRGI	Dirgi	1891 -1937	47	GOOD	30-19'	67-31'
23	HARNAI	Harnai	1891 -1946	56	GOOD	30-06'	67-56'
26	KACH	Kach	1891 -1943	53	GOOD	30-26'	67-18'
27	KACHKOTL	Kachkotal	1891 -1898	8	FAIR	?	?
31	KHOST	Khost	1891 -1946	56	GOOD	30-13'	67-35'
37	KOHLU	Kohlu	1911 -1946	36	GOOD	29-54'	69-16'
39	KUCHALI	Kuchali	1891 -1897	7	FAIR	29-50'	68-02'
46	MANGI	Mangi	1891 -1937	47	GOOD	30-21'	67-30'
53	MUDGORGE	Mud Gorge	1891 -1908	18	FAIR	30-23'	67-24'
58	NAKAS	Nakas	1891 -1946	56	GOOD	30-08'	67-48'
59	NARI	Nari	1891 -1946	56	GOOD	29-40'	67-55'
75	SANARI	Sanari	1891 -1925	35	GOOD	30-01'	68-02'
81	SHAHRIG	Shahrig	1891 -1946	56	GOOD	30-12'	67-42'
85	SIBI	Sibi	1891 -1946	56	GOOD	29-33'	67-53'
89	SPINTANG	Spin Tangi	1891 -1946	56	GOOD	29-52'	68-08'
92	TANDERI	Tanderi	1891 -1896	6	FAIR	29-45'	67-58'
103	ZIARAT	Ziarat	1911 -1946	36		30-23'	67-51'
		ZHOB DISTRICT					
34	KILLSAIF	Killa Saifulla	1901 -1946	46	GOOD	30-42'	68-22'
54	MURGHA	Murgha	1911 -1946	36	GOOD	30-44'	69-15'
57	MUSLIMB	Muslimbagh	1901 -1946	46	GOOD	30-49'	67-44'
77	SANZAL	Sanzal	1893 -1944	52	FAIR	31-11'	67-57'
102	ZHOB	Zhob	1892 -1946	55	GOOD	31-21'	69-27'

TABLE 3.1: RAINFALL STATIONS (page 3 of 3)

FILENAME	STATION	PERIOD	YRS	QUALITY	LAT.	LONG.
KHUZDAR	Khuzdar	1965-1986	22	FAIR	27-42'	66-37'
LORALAI	Loralai	1960-1968	9	POOR	30-24'	68-36'
SAMUNGLI	Samungli	1960-1986	27	GOOD	30-13'	67-00'

TABLE 3.2: TEMPERATURE STATIONS

option can achieve that cannot be obtained from the second. However, in practice, analysis of monthly data is quicker than the same analysis using daily data and is preferred where possible. The TEMPTURE option analyses temperature data, and the RAINDAYS option analyses the number of raindays in a specified period.

The operation of the package will be described fully for the MONTHLY option. Deviations from this pattern for the DAILY, TEMPTURE and RAINDAYS options are confined to the data extraction rather than the analysis phase and these will be described afterwards in sections 4.2, 4.3 and 4.4 respectively.

4.1 Analysis of monthly data

Selection of the MONTHLY option will introduce the following request:-

4.1.1 **Specify station for analysis:**

The FILENAME, rather than the full name, for the station should be specified followed by <rtn>. Refer to table 3.1. Upper or lower case can be used, although the former will give a neater printout at the end.

At this point the data is loaded into the worksheet, and the user will be offered the following menu:-

4.1.2 **ANNUAL SEASONAL MONTHLY**

The ANNUAL option will analyse annual rainfall totals for the chosen station. The SEASONAL option will examine a part of the year (including cross-year such as November to March). If this option is selected, the user will be asked to specify the start and end months (eg type 4 <rtn> for April). The MONTHLY option will analyse rainfalls for a particular month, which the user will be asked to specify.

The package will now derive a complete annual series of the selected statistic. From this stage, the analysis is similar for the other options (DAILY or TEMPTURE) in 4.0. The user will now be offered a further choice:-

4.1.3 **ALL SOME**

The ALL option will perform the frequency analysis on all years except those which are missing. The SOME option will perform the analysis for a subset of these years, and the user will be asked to specify start and end years. The first allowable year will be obvious from the spreadsheet, but reference should be made to table 3.1 in order to ensure that the specified end year is present for the chosen station. After some delay, the user will be offered a further menu:-

4.1.4 NORMAL LOGNORMAL GAMMA

This menu refers to the statistical distribution which the user would like to use in the frequency analysis. The NORMAL distribution is recommended for use for the analysis of temperature data. LOGNORMAL is often adequate for the analysis of rainfall data, except when there are some near-zero values in the data set. GAMMA is a better choice for rainfall data in the latter case, but it takes a longer time.

When the distribution has been fitted, the execution of the program pauses and a plot of the frequency analysis is shown on the screen. This plot shows the chosen distribution in relation to the data and may be used to assess the goodness of fit of the distribution. Pressing any key at this point will continue the execution of the program, and a summary of the analysis will be shown on the screen. A further menu is also displayed:-

4.1.5 PFROMX XFROMP NEITHER

Examination of the summary will indicate whether further specific information is required. The PFROMX option will use the distribution selected to estimate the exceedence probability of a particular value of the rainfall, for which the user will be asked. The XFROMP option performs the inverse estimation by calculating the rainfall of an exceedance probability specified by the user.

If either of these two options are selected, the result of this choice will be displayed in the summary and the user returned to the above menu. When sufficient pairs of rainfall and exceedance probability have been calculated, then program execution may be continued by selecting the NEITHER option. The next menu is displayed:-

4.1.6 PRINT PLOT NEITHER

Selection of the PRINT option will, assuming that a printer is online, give a hard copy of the summary printed on the screen. To this will be added a listing of the annual series from which the statistics were derived. The PLOT option saves a copy of the plot displayed on the screen earlier. This plot can be printed using the LOTUS GraphPrint option. Selection of either of these options will return the user to the above menu, and program execution is continued by choosing the NEITHER option. The next menu is displayed:-

4.1.7 DISTN RUN QUIT

If the user wishes to attempt to fit an alternative distribution, then the DISTN option should be chosen. This puts the user into the middle of the above sequence, and the distribution menu in section 4.1.4 will be offered. The RUN option will return the user to the initial menu in section 4.1. The QUIT option should be self-explanatory.

4.2 Analysis of daily data

This section describes the operation of the package as it differs from the above for the analysis using daily data, as selected by the DAILY option in section 4.0. Selection of this option will result in the package requesting the user to specify the station for analysis. Note again that this should be the FILENAME if this is different from the full name. The package temporarily leaves LOTUS at this point, and the following items of information will be requested:-

4.2.1 **Specify start of sampling period (ddmm):**

Specify end of sampling period (ddmm):

Specify rainfall duration (days):

Specify maximum or minimum (1 or 2):

In order to demonstrate this data requirement, assume that the user requires to analyse the statistics of the highest rainfall in a 7-day period between 1 July and 15 September. The response to item 1 above is 0107<rtn>, to item 2 is 1509<rtn>, to item 3 is 7<rtn> and to item 4 is 1<rtn>. The sampling interval can cross years (ie 15 December to 31 January).

Having provided this information, the user will be asked to wait awhile while the statistics are derived. The sequence of operations continues as for the MONTHLY option at section 4.1.3, requesting the user to specify whether all or some part of the record is required.

4.3 Analysis of temperature data

This section describes the operation of the package as it differs for the analysis of temperature data, as selected by the TEMPTURE option in section 4.0. Selection of this option will result in the package requesting the user to specify the station for analysis. Note again that this should be the FILENAME if this is different from the full name.

The package temporarily leaves LOTUS at this point, and user-supplied information will be requested. In addition to the information described in 4.2.1 above, the user will be asked to specify whether the package should use mean, minimum or maximum daily temperature.

When this information has been supplied, the package returns to the sequence of operations as described for the MONTHLY option in section 4.1.3.

4.4 Analysis of raindays

This section describes the operation of the package as it differs for the analysis of raindays, as selected by the RAINDAYS option in section 4.0. A rainday is a day on which there has been recorded rainfall above a given threshold (usually, but not necessarily, zero). The package performs a frequency analysis on the number of raindays in a given period.

As for the other two cases above, the user will be asked for the start and end of the sampling interval. In addition, the user will be asked to specify a threshold (usually zero).

When this information has been supplied, the package returns to the sequence of operations as described for the MONTHLY option in section 4.1.3.

5. DATABASE MANAGEMENT

5.0 Introduction

A database management system has been incorporated into the package, the programs for which are held in the ENTRY subdirectory of the root directory RAINFALL.

In fact, it does not perform all the functions expected of a comprehensive management system, being aimed primarily at requirements of manual data entry. For instance, an editting function is not included, although the entry function has been programmed in such a way that altering single or groups of data values can be done with a minimum of input.

The ENTRY subdirectory contains a main program called DMS, programmed (as are all but one of these programs) in FORTRAN. This routine calls two other executable programs MANAGER and MANAGERT which undertake the data entry function for rainfall and temperature respectively. There are a number of other files called by these, and two ASCII index files called INDEX.SDF and INDEXT.SDF for rainfall and temperature respectively.

On selection of the DATA option at the start-up of the package (see section 4.0 above), a main menu will appear with options of opening a new station, adding data to an existing station and deleting records in each of two subcategories (rainfall and temperature).

In all cases, it has to be stressed that records in the database have to be continuous, even if this means having a substantial period denoted as having missing data. The database will only accept complete years of record for one of three cases:-

(i) for the year preceding the existing record;
(ii) for the year following the existing record;
(iii) replacing an existing year.

This condition is essential in the context of the frequency analysis performed in the package, as there should be no gaps in the record. It is suggested that, if there are two separated records for the same location, these are entered into the database as having two different names.

5.1 Rainfall data

The user will be offered 3 options with respect to rainfall data, opening a new station, adding data to an existing station and deleting records.

In the first case, he will be invited to offer a name, which should be in upper case and no more than 8 letters long. Thereafter the procedure is as for adding data station to an existing station.

The user will be asked to specify the year of record for entering into the database. As described above, this choice can only be between the preceding and the year following the existing record. No other choice will be permitted.

The user will be asked to specify, for each month, the day and the amount of rainfall, a choice of units being offered (millimetres or hundredths of an inch). Entering zero when asked for the day will be understood to mean no more rainfall from the previous date until the end of the month. A '99' in the date indicates missing data for that month. The user is shown the data entered for each month and has the option to re-enter the data if an error is noted. Likewise, the same option is offered on the basis of a summary when data for December has been entered. On a satisfactory conclusion to the data entry for a specified year, the .DAT file, the .WKS (monthly) file and the index is amended accordingly, and the user put back to the original DMS menu.

This procedure is fairly quick, and permits editting of individual records to be undertaken by a complete re-entry of records for a given year.

Records may be deleted, although the user will only be permitted to delete the first or last year of record. If there are no years of record when this option is selected, the station will be deleted from the appropriate index.

5.2 Temperature data

The procedure for temperature data is similar to that described above for rainfall data. However, the data entry procedure is more arduous due to the fact that 2 values (max & min) have to be entered for each of 365 days of the year. For this reason, the existing values for a given month are shown with an option to leave or replace. In the case of entering data for a new year, these values will be zero, and must be replaced. However, this procedure offers a partial editting facility by permitting re-entry of a months data only rather than the complete year.

APPENDIX C

Annual/seasonal statistical summaries
of precipitation
(all stations)

STATION District		90%	80%	70%	60%	50%	40%	30%	20%	10%
		EXCEEDANCE PROBABILITY								
ABIGUM	Annual	46	65	84	101	117	135	162	206	276
(1901-1940)	Winter	10	25	41	56	68	85	108	139	190
Kacchi	Summer	0	5	11	19	30	42	58	80	119
BABAR KACH	Annual	71	92	112	130	150	171	203	245	316
(1901-1940)	Winter	3	11	21	32	46	64	89	120	178
Sibi	Summer	13	25	37	51	70	91	118	154	217
BARKHAN	Annual	202	236	266	295	320	350	387	432	506
(1901-1940)	Winter	53	72	88	106	124	143	165	195	241
Loralai	Summer	85	116	144	168	194	222	256	302	372
BARSHORE	Annual	-	153	184	214	246	283	333	395	-
(1910-1920)	Winter	-	99	133	168	206	250	303	375	-
Pishin	Summer	-	0	0	2	7	14	24	40	-
BELA	Annual	83	108	133	156	180	210	248	299	391
(1912-1940)	Winter	16	31	47	62	77	95	119	151	203
Makran	Summer	8	22	38	59	84	120	165	220	329
BELELI	Annual	81	102	122	141	159	181	209	248	313
(1901-1940)	Winter	49	74	99	121	143	168	199	248	318
Quetta	Summer	0	0	0	2	8	12	17	24	35
BELLPAT	Annual	15	26	37	47	59	74	94	126	186
(1901-1940)	Winter	0	0	3	9	17	26	37	51	76
Kacchi	Summer	0	0	7	17	31	48	68	94	141
BHAG	Annual	44	52	59	65	71	78	88	98	115
(1935-1940)	Winter	4	9	14	21	29	40	52	69	100
Kacchi	Summer	3	7	11	15	19	25	33	43	61
BUND K.K.	Annual	128	152	173	192	210	230	255	290	343
(1910-1940)	Winter	97	126	144	158	171	194	230	290	349
Pishin	Summer	0	0	0	2	6	10	15	22	34
BOSTAN	Annual	114	135	153	171	189	209	232	263	314
(1901-1940)	Winter	86	112	136	156	177	197	222	263	317
Pishin	Summer	0	0	0	0	6	10	15	21	30
CHAGAI	Annual	40	51	61	72	83	95	111	135	174
(1912-1924)	Winter	29	42	54	66	77	90	107	129	163
Chagai	Summer	0	0	0	0	0	0	4	9	17
CHAMAN	Annual	118	138	155	171	187	204	226	253	296
(1901-1940)	Winter	93	118	138	159	181	202	229	263	314
Pishin	Summer	0	0	0	0	1	3	5	8	13
		90%	80%	70%	60%	50%	40%	30%	20%	10%

ANNUAL AND SEASONAL STATISTICAL SUMMARY (Page 1 of 9)

STATION District		90%	80%	70%	60%	50%	40%	30%	20%	10%
DALBANDIN	Annual	51	61	68	77	85	94	105	119	143
(1911-1940)	Winter	33	45	56	66	76	89	101	118	145
Chagai	Summer	0	0	0	0	1	2	5	10	19
DALUGAL	Annual	-	-	227	244	260	278	299	-	-
(1892-1896)	Winter	-	-	79	92	105	121	141	-	-
Sibi	Summer	-	-	100	123	150	174	205	-	-
DHADAR	Annual	61	74	85	96	108	121	136	157	191
(1931-1940)	Winter	6	12	20	29	39	54	72	95	138
Kacchi	Summer	0	11	18	28	39	51	65	83	114
DIRGI	Annual	102	132	160	187	213	244	282	344	442
(1901-1937)	Winter	47	74	101	128	154	186	225	279	366
Sibi	Summer	9	17	25	35	45	58	75	98	136
DUKI	Annual	147	171	191	209	228	249	274	304	354
(1901-1940)	Winter	38	57	76	94	112	135	162	195	251
Loralai	Summer	36	54	69	83	99	117	138	163	205
FULLERS	Annual	-	130	159	185	210	240	278	337	-
(1901-1906)	Winter	-	112	144	177	211	250	296	358	-
Pishin	Summer	-	0	0	0	2	4	7	10	-
GALANGUR	Annual	73	89	102	116	132	149	168	196	240
(1906-1932)	Winter	51	70	86	101	117	133	153	183	226
Chagai	Summer	0	0	0	0	7	14	23	35	53
GANDAWA	Annual	35	51	65	78	91	108	129	160	214
(1912-1940)	Winter	5	10	15	21	28	36	47	60	84
Kacchi	Summer	0	13	23	35	50	68	88	114	160
GULISTAN	Annual	75	98	120	141	163	190	222	270	352
(1901-1940)	Winter	54	82	106	130	158	186	222	274	352
Pishin	Summer	0	0	0	0	0	2	6	11	25
HARNAI	Annual	214	244	268	290	313	338	367	403	459
(1901-1940)	Winter	38	60	80	101	124	149	182	226	295
Sibi	Summer	63	88	112	136	157	180	212	254	318
HIROK	Annual	106	131	153	174	196	220	253	294	364
(1901-1940)	Winter	36	58	80	101	124	152	186	230	303
Kacchi	Summer	0	6	16	28	42	59	82	110	160
JHATPUT	Annual	31	43	55	66	77	91	109	139	189
(1901-1940)	Winter	6	11	15	21	27	36	43	52	70
Kacchi	Summer	4	12	20	30	42	56	75	101	146
		90%	80%	70%	60%	50%	40%	30%	20%	10%

ANNUAL AND SEASONAL STATISTICAL SUMMARY (Page 2 of 9)

STATION District		90%	80%	70%	60%	50%	40%	30%	20%	10%
KACH (1901-1940) Sibi	Annual	151	175	194	212	230	249	271	304	351
	Winter	90	120	145	169	195	221	253	296	360
	Summer	0	0	2	7	13	20	28	43	67
KALAT (1901-1940) Kalat	Annual	107	126	142	158	174	191	211	239	282
	Winter	54	75	94	113	132	155	181	212	264
	Summer	0	8	13	20	27	35	44	57	78
KANAK (1906-1940) Kalat	Annual	83	100	116	131	146	162	183	212	257
	Winter	22	56	88	120	147	160	173	190	225
	Summer	0	0	0	1	8	16	26	39	64
KHANAI (1901-1940) Pishin	Annual	64	86	107	129	152	178	211	267	359
	Winter	54	79	102	127	150	177	211	254	324
	Summer	0	0	0	1	5	9	14	20	31
KHOST (1901-1940) Sibi	Annual	106	132	155	177	199	222	252	300	372
	Winter	47	71	92	111	131	155	183	215	269
	Summer	10	20	30	42	55	70	89	114	158
KHUZDAR (1912-1940) Khuzdar	Annual	92	116	138	158	178	204	235	274	344
	Winter	27	44	58	71	84	100	118	139	175
	Summer	19	32	45	60	77	96	120	150	203
KILLA ABDULA (1901-1940) Pishin	Annual	100	129	156	183	210	243	287	341	439
	Winter	83	140	178	207	230	256	290	325	363
	Summer	0	0	0	0	0	2	8	17	30
KILLA SAIFUL (1901-1940) Zhob	Annual	83	103	121	137	153	171	196	229	282
	Winter	47	62	75	87	100	113	129	151	184
	Summer	5	13	21	30	42	55	72	93	132
KIRDA GAP (1906-1940) Kalat	Annual	73	94	114	131	149	170	198	238	304
	Winter	54	76	95	114	135	156	184	217	272
	Summer	0	0	0	0	5	9	16	25	41
KISHINGI (1906-1940) Chagai	Annual	93	110	124	138	152	167	186	210	249
	Winter	62	83	102	120	137	155	178	209	255
	Summer	0	0	0	0	4	7	12	19	28
KOHLU (1911-1940) Sibi	Annual	182	208	229	249	268	290	314	344	393
	Winter	55	71	84	97	110	124	141	162	194
	Summer	87	108	126	142	159	177	200	225	265
KOLPUR (1901-1940) Kalat	Annual	79	102	124	143	163	187	218	262	336
	Winter	40	63	85	105	127	156	188	227	295
	Summer	0	0	0	7	18	35	54	68	105
		90%	80%	70%	60%	50%	40%	30%	20%	10%

ANNUAL AND SEASONAL STATISTICAL SUMMARY (Page 3 of 9)

STATION District		90%	80%	70%	60%	50%	40%	30%	20%	10%
		EXCEEDANCE PROBABILITY								
KUCHALI	Annual	-	143	160	175	190	207	227	253	-
(1891-1896)	Winter	-	27	37	47	60	76	98	132	-
Sibi	Summer	-	70	81	92	104	117	133	154	-
KUCHLAK	Annual	105	124	139	155	172	189	210	238	282
(1901-1940)	Winter	67	91	112	132	154	176	204	241	298
Pishin	Summer	0	0	0	0	3	7	13	23	37
LEHRI	Annual	65	77	86	96	106	117	128	147	174
(1924-1940)	Winter	6	11	17	23	30	39	49	62	86
Kacchi	Summer	15	25	35	46	58	73	92	112	150
LINDSAY	Annual	37	48	58	66	75	85	100	118	150
(1901-1940)	Winter	0	5	10	17	24	33	44	55	78
Kacchi	Summer	0	12	20	30	42	55	69	86	117
LORALAI	Annual	139	160	179	196	212	230	252	280	323
(1901-1940)	Winter	53	72	90	107	124	144	168	195	241
Loralai	Summer	22	34	46	57	70	84	102	126	164
MACH	Annual	107	131	152	173	194	217	249	288	353
(1901-1940)	Winter	36	55	72	90	110	132	159	194	251
Kacchi	Summer	8	18	29	42	57	75	99	134	193
MAND	Annual	67	86	105	120	135	152	177	214	271
(1911-1940)	Winter	33	53	73	94	114	138	170	213	282
Makran	Summer	0	0	0	0	0	7	15	27	59
MANGI	Annual	106	131	154	175	196	218	246	293	362
(1901-1936)	Winter	46	72	100	124	149	179	218	271	355
Sibi	Summer	0	7	14	21	27	35	46	62	88
MANGOCHAR	Annual	88	102	113	124	135	146	161	178	206
(1913-1940)	Winter	34	51	67	84	100	118	140	174	224
Kalat	Summer	0	3	8	15	23	30	38	49	67
MASHKAI	Annual	85	104	121	136	151	168	190	220	268
(1914-1940)	Winter	21	31	40	51	62	75	90	109	140
Khuzdar	Summer	29	45	59	71	84	99	115	137	172
MASTUNG	Annual	105	123	138	152	165	180	198	222	259
(1912-1940)	Winter	71	92	108	127	143	161	183	210	252
Kalat	Summer	0	1	4	7	12	18	24	33	48
MASTUNG ROAD	Annual	69	87	105	121	138	156	180	218	277
(1906-1940)	Winter	47	71	90	109	128	149	173	206	257
Kalat	Summer	0	0	0	0	0	4	10	19	30
		90%	80%	70%	60%	50%	40%	30%	20%	10%

ANNUAL AND SEASONAL STATISTICAL SUMMARY (Page 4 of 9)

STATION District		90%	80%	70%	60%	50%	40%	30%	20%	10%
		EXCEEDANCE PROBABILITY								
MIRJAWA	Annual	16	22	28	34	40	47	57	73	99
(1920-1930)	Winter	2	12	21	28	36	44	57	73	98
Chagai	Summer	0	0	0	0	0	0	0	0	0
MITHRI	Annual	39	51	62	72	84	98	114	138	179
(1901-1940)	Winter	5	11	16	22	29	37	49	62	86
Kacchi	Summer	6	13	20	30	41	56	72	94	134
MUD GORGE	Annual	-	175	197	213	231	251	273	305	-
(1901-1908)	Winter	-	118	142	165	189	214	245	284	-
Sibi	Summer	-	6	10	14	18	23	30	42	-
MURGHA	Annual	204	238	267	295	322	351	389	434	508
(1911-1940)	Winter	44	65	86	106	125	150	180	216	278
Zhob	Summer	92	118	139	160	180	202	228	260	310
MUSA KHEL	Annual	325	358	384	406	428	450	477	512	563
(1911-1940)	Winter	77	100	118	137	156	177	201	229	275
Loralai	Summer	173	200	221	240	257	274	295	324	364
MUSHKAF	Annual	42	55	66	79	91	108	126	151	197
(1901-1940)	Winter	3	11	19	27	36	47	59	77	106
Kacchi	Summer	0	13	20	31	44	56	72	94	130
MUSHKI CHAH	Annual	-	25	30	34	38	43	49	59	-
(1912-1916)	Winter	-	26	30	33	36	40	44	49	-
Chagai	Summer	-	0	0	0	0	0	0	4	-
MUSLIMBAGH	Annual	108	130	150	169	189	211	238	273	331
(1901-1940)	Winter	69	94	115	135	158	182	212	245	302
Zhob	Summer	0	1	5	10	17	25	34	49	74
NAKAS	Annual	166	196	221	244	268	296	329	367	432
(1901-1940)	Winter	37	58	77	97	116	140	169	202	259
Sibi	Summer	56	78	98	118	135	156	181	215	268
NARI	Annual	57	74	89	104	120	137	160	196	253
(1901-1940)	Winter	2	9	16	26	38	52	70	95	139
Sibi	Summer	0	23	39	52	64	78	99	127	169
NOKKUNDI	Annual	20	24	27	31	35	39	44	50	60
(1926-1940)	Winter	0	14	22	28	34	40	48	60	76
Chagai	Summer	0	0	0	0	0	0	0	0	0
NUSHKI	Annual	74	91	105	120	137	155	177	206	255
(1901-1940)	Winter	55	76	97	111	128	147	170	202	249
Chagai	Summer	0	0	0	0	0	1	5	12	23
		90%	80%	70%	60%	50%	40%	30%	20%	10%

ANNUAL AND SEASONAL STATISTICAL SUMMARY (Page 5 of 9)

STATION District		90%	80%	70%	60%	50%	40%	30%	20%	10%
NUTTAL	Annual	14	22	30	40	51	66	84	112	169
(1901-1940)	Winter	0	1	4	9	16	22	31	43	63
Kacchi	Summer	0	0	10	20	33	46	62	82	116
OCIPUR	Annual	-	46	52	58	65	73	81	91	-
(1926-1930)	Winter	-	11	14	17	20	23	28	34	-
Kacchi	Summer	-	17	22	27	34	42	53	69	-
ORMARA	Annual	39	57	78	96	114	139	171	229	331
(1912-1940)	Winter	9	23	36	55	78	105	140	183	262
Makran	Summer	0	0	0	1	7	15	30	59	110
PANIR	Annual	33	47	62	73	86	103	124	154	210
(1901-1940)	Winter	9	19	29	39	49	61	76	97	131
Kacchi	Summer	0	0	3	12	24	36	51	70	103
PANJGUR	Annual	57	71	83	96	109	124	143	167	209
(1911-1940)	Winter	22	35	47	59	73	88	109	134	176
Makran	Summer	0	0	2	9	18	27	40	57	86
PASNI	Annual	33	54	76	98	121	149	184	229	305
(1911-1940)	Winter	26	43	60	78	97	121	150	186	249
Makran	Summer	0	0	0	0	4	8	14	26	56
PISHI	Annual	39	52	62	75	89	105	126	154	205
(1901-1940)	Winter	3	14	24	35	48	62	81	107	150
Kacchi	Summer	0	4	8	16	26	38	52	70	102
PISHIN	Annual	134	158	177	196	216	236	261	296	349
(1901-1940)	Winter	104	134	160	185	209	236	267	307	369
Pishin	Summer	0	0	0	1	5	9	14	20	31
QUETTA	Annual	134	157	176	193	210	227	250	281	327
(1901-1940)	Winter	91	119	143	165	185	208	240	274	330
Quetta	Summer	1	4	7	11	16	22	29	37	53
RINDLI	Annual	36	52	66	82	99	117	141	180	246
(1913-1940)	Winter	0	9	17	27	37	50	66	85	121
Kacchi	Summer	0	11	22	33	47	64	86	113	163
ROBAT	Annual	-	62	71	81	92	104	118	136	-
(1910-1917)	Winter	-	61	74	85	95	105	118	139	-
Chagai	Summer	-	0	0	0	0	0	0	0	-
SABURA	Annual	-	104	140	177	216	266	333	448	-
(1913-1918)	Winter	-	69	111	155	196	255	337	433	-
Pishin	Summer	-	0	0	2	5	12	25	43	-
		90%	80%	70%	60%	50%	40%	30%	20%	10%

ANNUAL AND SEASONAL STATISTICAL SUMMARY (Page 6 of 9)

STATION District		90%	80%	70%	60%	50%	40%	30%	20%	10%
SANARI	Annual	181	212	238	262	287	316	348	389	456
(1901-1924)	Winter	21	38	56	75	98	124	158	206	285
Sibi	Summer	33	57	81	107	135	168	207	267	362
SANJAWI	Annual	135	159	179	198	216	238	263	294	346
(1912-1940)	Winter	51	72	91	109	128	150	176	207	259
Loralai	Summer	18	29	40	52	64	78	95	119	158
SANZAL	Annual	56	84	111	143	180	225	294	386	576
(1901-1940)	Winter	34	118	169	208	229	265	302	362	440
Zhob	Summer	0	0	0	0	0	0	0	7	11
SARANAN	Annual	106	128	147	164	180	197	220	255	306
(1901-1940)	Winter	74	104	128	150	171	195	226	260	316
Pishin	Summer	0	0	0	0	0	0	6	15	30
SARIAB	Annual	65	90	113	133	154	177	205	244	303
(1901-1940)	Winter	47	71	92	112	132	155	183	217	273
Quetta	Summer	0	0	1	7	14	22	31	42	63
SARUNA	Annual	32	57	78	96	115	138	168	212	290
(1913-1940)	Winter	0	9	17	24	31	39	50	68	94
Khuzdar	Summer	0	22	39	58	79	104	134	173	239
SHAHRIG	Annual	200	232	259	284	309	336	369	411	476
(1901-1940)	Winter	47	70	93	115	136	163	195	236	302
Sibi	Summer	51	75	96	118	143	168	200	244	311
SHAIKHWASIL	Annual	95	118	138	158	179	204	235	272	338
(1907-1940)	Winter	65	91	117	140	162	186	218	262	328
Kalat	Summer	0	0	0	0	3	7	12	20	35
SHEBO	Annual	161	177	191	202	213	226	240	256	282
(1930-1940)	Winter	80	108	134	156	179	205	237	275	337
Pishin	Summer	0	0	0	1	6	14	22	31	50
SHELA BAGH	Annual	168	206	241	271	303	340	384	447	548
(1901-1940)	Winter	116	163	207	250	291	339	397	473	592
Pishin	Summer	0	0	0	0	0	4	10	17	26
SIBI	Annual	70	85	98	111	124	139	158	182	223
(1901-1940)	Winter	11	20	27	36	46	58	72	91	123
Sibi	Summer	12	23	32	44	58	74	94	121	167
SONMIANI	Annual	33	48	62	77	95	117	147	187	267
(1912-1940)	Winter	4	12	19	27	34	41	53	71	98
Makran	Summer	0	6	17	29	46	69	97	132	201
		90%	80%	70%	60%	50%	40%	30%	20%	10%

ANNUAL AND SEASONAL STATISTICAL SUMMARY (Page 7 of 9)

STATION (Period) District		90%	80%	70%	60%	50%	40%	30%	20%	10%
		EXCEEDANCE PROBABILITY								
SORAB	Annual	114	131	145	158	171	185	201	223	256
(1925-1940)	Winter	47	67	85	102	120	138	160	195	245
Kalat	Summer	0	0	6	12	21	31	44	63	95
SPEZAND	Annual	48	65	82	98	115	137	165	205	278
(1901-1940)	Winter	42	60	78	94	108	126	147	177	223
Kalat	Summer	0	0	0	0	8	11	17	23	32
SPIN TANGI	Annual	127	152	173	193	214	237	264	302	362
(1901-1940)	Winter	17	30	43	57	75	94	120	153	210
Sibi	Summer	28	48	68	89	110	134	167	206	273
SURKHAB H/W	Annual	168	192	213	231	247	265	287	318	363
(1930-1940)	Winter	94	128	155	185	217	251	293	340	420
Pishin	Summer	0	0	0	0	2	7	16	29	49
SYAD HAMID	Annual	90	114	137	156	180	208	241	284	361
(1901-1915)	Winter	81	110	135	159	184	211	244	286	351
Pishin	Summer	0	0	0	1	4	6	8	11	15
TANDERI	Annual	-	153	169	188	206	225	248	277	-
(1891-1895)	Winter	-	33	43	55	68	84	105	138	-
Sibi	Summer	-	80	92	104	116	129	145	176	-
TEMPLE DERA	Annual	15	23	31	41	52	67	86	116	177
(1901-1940)	Winter	0	3	7	12	19	25	34	44	62
Kacchi	Summer	0	4	9	18	30	44	60	78	114
TORMORGA H/W	Annual	181	202	219	235	249	265	283	306	341
(1930-1940)	Winter	98	130	158	185	213	244	281	325	397
Pishin	Summer	0	0	0	1	5	8	15	26	44
TURBAT	Annual	70	88	103	119	135	152	174	208	261
(1911-1940)	Winter	27	45	64	84	104	129	161	201	270
Makran	Summer	0	0	0	3	10	17	26	40	64
URAK	Annual	223	249	271	290	307	327	350	377	421
(1914-1940)	Winter	129	163	189	217	245	278	312	350	415
Quetta	Summer	9	16	24	33	43	54	69	91	126
USTA	Annual	-	40	50	62	74	89	108	136	-
(1935-1940)	Winter	-	8	14	21	28	40	54	75	-
Kacchi	Summer	-	1	5	11	18	27	37	50	-
WADH	Annual	-	81	101	120	138	159	188	234	-
(1935-1940)	Winter	-	26	42	58	75	96	122	165	-
Khuzdar	Summer	-	10	15	22	28	36	47	61	-
		90%	80%	70%	60%	50%	40%	30%	20%	10%

ANNUAL AND SEASONAL STATISTICAL SUMMARY (Page 8 of 9)

STATION District		90%	80%	70%	60%	50%	40%	30%	20%	10%
		EXCEEDANCE PROBABILITY								
YAKMACH	Annual	-	-	-	-	-	-	-	-	-
(1926-1929)	Winter	-	-	-	-	-	-	-	-	-
Chagai	Summer	-	-	-	-	-	-	-	-	-
YARU KAREZ	Annual	96	117	136	155	172	191	216	251	307
(1901-1940)	Winter	74	99	121	142	164	187	216	253	310
Pishin	Summer	-	-	-	0	2	5	10	17	27
ZEHRI	Annual	-	116	132	146	160	176	194	220	-
(1935-1940)	Winter	-	27	41	55	70	88	113	147	-
Khuzdar	Summer	-	26	33	40	49	58	70	83	-
ZHOB	Annual	181	205	223	240	257	275	297	323	364
(1901-1940)	Winter	70	91	109	126	141	159	181	207	249
Zhob	Summer	44	60	74	87	103	119	139	163	202
ZIARAT	Annual	-	-	-	-	-	-	-	-	-
	Winter	-	-	-	-	-	-	-	-	-
Sibi	Summer	60	80	97	115	132	150	174	202	247
	Annual	-	-	-	-	-	-	-	-	-
	Winter	-	-	-	-	-	-	-	-	-
	Summer	-	-	-	-	-	-	-	-	-
	Annual	-	-	-	-	-	-	-	-	-
	Winter	-	-	-	-	-	-	-	-	-
	Summer	-	-	-	-	-	-	-	-	-
	Annual	-	-	-	-	-	-	-	-	-
	Winter	-	-	-	-	-	-	-	-	-
	Summer	-	-	-	-	-	-	-	-	-
	Annual	-	-	-	-	-	-	-	-	-
	Winter	-	-	-	-	-	-	-	-	-
	Summer	-	-	-	-	-	-	-	-	-
	Annual	-	-	-	-	-	-	-	-	-
	Winter	-	-	-	-	-	-	-	-	-
	Summer	-	-	-	-	-	-	-	-	-
	Annual	-	-	-	-	-	-	-	-	-
	Winter	-	-	-	-	-	-	-	-	-
	Summer	-	-	-	-	-	-	-	-	-
	Annual	-	-	-	-	-	-	-	-	-
	Winter	-	-	-	-	-	-	-	-	-
	Summer	-	-	-	-	-	-	-	-	-
		90%	80%	70%	60%	50%	40%	30%	20%	10%

ANNUAL AND SEASONAL STATISTICAL SUMMARY (Page 9 of 9)

APPENDIX D

Monthly/decad statistical summaries
of precipitation
(16 stations)

STATION.....BELA YEARS.....1912-1946

MONTH	EXCEEDANCE PROBABILITY 90%	80%	70%	60%	50%	40%	30%	20%	10%
January	-	-	-	0	7	11	16	22	32
February	-	-	0	1	5	12	22	38	68
March	-	-	0	1	4	8	15	25	44
April	-	-	-	0	4	9	16	26	42
May	-	-	0	4	9	15	24	35	55
June	-	-	-	0	1	4	10	18	36
July	0	3	14	27	42	61	86	121	181
August	-	-	0	3	10	22	39	66	118
September	-	-	-	-	0	2	8	20	46
October	-	-	-	-	-	-	0	2	9
November	-	-	-	-	-	-	-	0	5
December	-	-	-	-	-	0	4	13	30

DECAD(date)	90%	80%	70%	60%	50%	40%	30%	20%	10%
1 (Jan 1)	-	-	-	-	-	-	-	0	7
2 (Jan 11)	-	-	-	-	-	-	-	0	7
3 (Jan 21)	-	-	-	-	0	1	6	10	18
4 (Jan 31)	-	-	-	-	-	0	2	7	13
5 (Feb 10)	-	-	-	-	-	0	2	7	21
6 (Feb 20)	-	-	-	-	-	-	0	11	36
7 (Mar 1)	-	-	-	-	-	0	3	8	17
8 (Mar 11)	-	-	-	-	-	-	-	0	8
9 (Mar 21)	-	-	-	-	-	-	0	4	14
10 (Apr 1)	-	-	-	-	0	1	5	12	26
11 (Apr 11)	-	-	-	-	-	-	0	4	13
12 (Apr 21)	-	-	-	-	-	-	0	4	9
13 (May 1)	-	-	-	-	-	-	0	6	15
14 (May 11)	-	-	-	-	-	0	4	13	27
15 (May 21)	-	-	-	-	-	0	3	12	28
16 (Jun 1)	-	-	-	-	-	-	-	0	4
17 (Jun 11)	-	-	-	-	-	-	0	1	5
18 (Jun 21)	-	-	-	-	-	-	0	5	26
19 (Jul 1)	-	-	-	0	1	4	9	16	28
20 (Jul 11)	-	-	-	-	0	7	20	42	84
21 (Jul 21)	-	-	-	0	7	20	37	64	111
22 (Aug 1)	-	-	-	-	0	2	11	28	60
23 (Aug 11)	-	-	-	-	0	1	8	19	41
24 (Aug 21)	-	-	-	-	0	2	8	16	30
25 (Sep 1)	-	-	-	-	-	-	0	5	20
26 (Sep 11)	-	-	-	-	-	-	-	0	16
27 (Sep 21)	-	-	-	-	-	-	-	-	0
28 (Oct 1)	-	-	-	-	-	-	-	-	0
29 (Oct 11)	-	-	-	-	-	-	-	-	0
30 (Oct 21)	-	-	-	-	-	-	-	0	1
31 (Nov 1)	-	-	-	-	-	-	-	-	0
32 (Nov 11)	-	-	-	-	-	-	-	-	0
33 (Nov 21)	-	-	-	-	-	-	-	-	0
34 (Dec 1)	-	-	-	-	-	-	-	-	0
35 (Dec 11)	-	-	-	-	-	-	0	2	10
36 (Dec 21)	-	-	-	-	-	-	-	0	2

APPENDIX D

STATION.....DALBANDIN YEARS.....1911-1946

MONTH	EXCEEDANCE PROBABILITY								
	90%	80%	70%	60%	50%	40%	30%	20%	10%
January	1	4	7	11	16	21	27	36	52
February	-	0	5	9	14	20	27	36	52
March	-	0	1	3	5	7	11	15	23
April	-	-	-	0	2	4	7	12	21
May	-	-	-	-	-	0	1	3	7
June	-	-	-	-	-	-	-	0	1
July	-	-	-	-	-	0	1	5	14
August	-	-	-	-	-	-	-	0	5
September	-	-	-	-	-	-	-	-	0
October	-	-	-	-	-	-	-	0	2
November	-	-	-	-	-	-	0	1	5
December	-	0	3	6	10	15	20	28	42

DECAD(date)	90%	80%	70%	60%	50%	40%	30%	20%	10%
1 (Jan 1)	-	-	-	0	1	4	7	11	18
2 (Jan 11)	-	-	0	1	3	6	9	14	22
3 (Jan 21)	-	-	-	0	2	4	8	14	26
4 (Jan 31)	-	-	-	0	1	3	6	11	19
5 (Feb 10)	-	-	-	0	1	4	9	17	31
6 (Feb 20)	-	-	-	-	0	1	4	9	18
7 (Mar 1)	-	-	0	1	2	4	6	9	14
8 (Mar 11)	-	-	-	-	-	0	1	4	8
9 (Mar 21)	-	-	-	-	0	1	2	3	5
10 (Apr 1)	-	-	-	-	0	1	3	7	13
11 (Apr 11)	-	-	-	-	-	-	0	2	6
12 (Apr 21)	-	-	-	-	-	-	0	1	2
13 (May 1)	-	-	-	-	-	-	-	-	0
14 (May 11)	-	-	-	-	-	-	-	0	3
15 (May 21)	-	-	-	-	-	-	-	0	4
16 (Jun 1)	-	-	-	-	-	-	-	-	0
17 (Jun 11)	-	-	-	-	-	-	-	-	0
18 (Jun 21)	-	-	-	-	-	-	-	-	0
19 (Jul 1)	-	-	-	-	-	-	-	0	1
20 (Jul 11)	-	-	-	-	-	-	-	0	3
21 (Jul 21)	-	-	-	-	-	-	-	0	5
22 (Aug 1)	-	-	-	-	-	-	-	0	3
23 (Aug 11)	-	-	-	-	-	-	-	-	0
24 (Aug 21)	-	-	-	-	-	-	-	-	0
25 (Sep 1)	-	-	-	-	-	-	-	-	0
26 (Sep 11)	-	-	-	-	-	-	-	-	0
27 (Sep 21)	-	-	-	-	-	-	-	-	0
28 (Oct 1)	-	-	-	-	-	-	-	-	0
29 (Oct 11)	-	-	-	-	-	-	-	-	0
30 (Oct 21)	-	-	-	-	-	-	-	0	1
31 (Nov 1)	-	-	-	-	-	-	-	-	0
32 (Nov 11)	-	-	-	-	-	-	-	0	3
33 (Nov 21)	-	-	-	-	-	-	-	-	0
34 (Dec 1)	-	-	-	-	0	2	5	10	18
35 (Dec 11)	-	-	-	-	0	2	4	8	14
36 (Dec 21)	-	-	-	-	0	2	7	12	22

STATION....HARNAI   YEARS.....1891-1946

MONTH	90%	80%	70%	60%	50%	40%	30%	20%	10%
	EXCEEDANCE PROBABILITY								
January	0	3	7	12	18	24	33	45	66
February	0	3	8	14	22	31	44	62	93
March	0	4	9	15	22	30	41	56	83
April	0	2	5	8	11	15	20	27	38
May	-	-	-	0	2	5	10	18	31
June	-	0	1	7	13	20	28	39	58
July	17	29	40	52	64	78	95	119	156
August	5	13	22	33	45	61	80	108	156
September	-	-	0	4	9	15	22	32	50
October	-	-	-	-	-	-	0	2	12
November	-	-	-	-	-	-	0	1	10
December	-	-	0	1	5	10	17	28	48

DECAD(date)	90%	80%	70%	60%	50%	40%	30%	20%	10%
1 (Jan 1)	-	-	-	-	0	1	4	9	18
2 (Jan 11)	-	-	-	0	3	7	12	19	32
3 (Jan 21)	-	-	0	1	4	7	12	19	31
4 (Jan 31)	-	-	-	0	1	4	9	17	32
5 (Feb 10)	-	-	-	0	3	8	15	26	44
6 (Feb 20)	-	-	-	0	1	5	11	20	37
7 (Mar 1)	-	-	-	0	4	8	15	24	41
8 (Mar 11)	-	-	-	-	0	4	9	17	31
9 (Mar 21)	-	-	-	0	2	6	11	19	33
10 (Apr 1)	-	-	-	0	3	5	9	14	22
11 (Apr 11)	-	-	-	-	-	0	2	6	13
12 (Apr 21)	-	-	-	-	0	1	5	9	15
13 (May 1)	-	-	-	-	-	-	0	2	12
14 (May 11)	-	-	-	-	-	0	2	5	9
15 (May 21)	-	-	-	-	-	-	0	3	13
16 (Jun 1)	-	-	-	-	-	-	0	5	14
17 (Jun 11)	-	-	-	-	-	0	2	8	18
18 (Jun 21)	-	-	-	0	2	7	14	24	42
19 (Jul 1)	-	-	0	4	8	14	21	32	51
20 (Jul 11)	-	0	5	10	16	23	32	44	65
21 (Jul 21)	0	1	7	13	21	30	42	59	87
22 (Aug 1)	-	-	0	4	10	18	29	45	73
23 (Aug 11)	-	-	0	2	7	15	25	41	71
24 (Aug 21)	-	0	2	6	10	16	22	30	45
25 (Sep 1)	-	-	-	-	0	2	8	17	31
26 (Sep 11)	-	-	-	-	-	-	0	4	21
27 (Sep 21)	-	-	-	-	-	-	-	0	7
28 (Oct 1)	-	-	-	-	-	-	-	-	0
29 (Oct 11)	-	-	-	-	-	-	-	0	1
30 (Oct 21)	-	-	-	-	-	-	-	0	4
31 (Nov 1)	-	-	-	-	-	-	-	-	0
32 (Nov 11)	-	-	-	-	-	-	-	0	1
33 (Nov 21)	-	-	-	-	-	-	-	0	3
34 (Dec 1)	-	-	-	-	-	-	0	3	13
35 (Dec 11)	-	-	-	-	-	-	0	5	23
36 (Dec 21)	-	-	-	-	0	1	5	9	18

STATION.....KALAT YEARS.....1891-1946

MONTH	EXCEEDANCE PROBABILITY								
	90%	80%	70%	60%	50%	40%	30%	20%	10%
January	2	8	14	20	28	37	48	64	91
February	0	4	10	17	26	36	50	70	104
March	5	8	12	16	21	26	32	41	55
April	0	1	3	6	8	11	15	20	30
May	-	-	0	1	2	4	6	10	16
June	-	-	-	-	-	0	3	9	19
July	-	-	0	3	6	10	17	27	45
August	-	-	-	-	0	5	11	20	35
September	-	-	-	-	-	-	-	0	6
October	-	-	-	-	-	-	-	0	15
November	-	-	-	-	-	0	2	9	25
December	0	2	5	8	13	19	26	37	57

DECAD(date)	90%	80%	70%	60%	50%	40%	30%	20%	10%
1 (Jan 1)	-	-	0	2	4	8	12	18	29
2 (Jan 11)	-	0	1	4	7	11	17	24	38
3 (Jan 21)	-	-	0	3	7	12	18	28	44
4 (Jan 31)	-	-	0	1	5	10	17	27	45
5 (Feb 10)	-	-	0	2	6	10	16	25	39
6 (Feb 20)	-	-	0	2	5	9	15	23	37
7 (Mar 1)	0	1	3	5	8	11	15	21	30
8 (Mar 11)	-	-	-	0	2	5	8	13	20
9 (Mar 21)	-	-	-	0	1	4	6	13	21
10 (Apr 1)	-	-	-	0	2	5	8	13	20
11 (Apr 11)	-	-	-	0	1	3	5	7	11
12 (Apr 21)	-	-	-	-	-	0	1	4	9
13 (May 1)	-	-	-	-	-	0	1	3	6
14 (May 11)	-	-	-	-	-	0	2	5	11
15 (May 21)	-	-	-	-	-	-	-	0	3
16 (Jun 1)	-	-	-	-	-	-	-	0	5
17 (Jun 11)	-	-	-	-	-	-	-	0	4
18 (Jun 21)	-	-	-	-	-	-	0	1	7
19 (Jul 1)	-	-	-	-	-	-	0	2	7
20 (Jul 11)	-	-	-	-	-	0	3	8	17
21 (Jul 21)	-	-	-	-	0	3	8	16	29
22 (Aug 1)	-	-	-	-	-	-	0	8	25
23 (Aug 11)	-	-	-	-	0	3	8	16	31
24 (Aug 21)	-	-	-	-	-	-	-	0	4
25 (Sep 1)	-	-	-	-	-	-	-	-	0
26 (Sep 11)	-	-	-	-	-	-	-	-	0
27 (Sep 21)	-	-	-	-	-	-	-	-	0
28 (Oct 1)	-	-	-	-	-	-	-	-	0
29 (Oct 11)	-	-	-	-	-	-	-	-	0
30 (Oct 21)	-	-	-	-	-	-	-	0	3
31 (Nov 1)	-	-	-	-	-	-	-	0	1
32 (Nov 11)	-	-	-	-	-	-	0	2	9
33 (Nov 21)	-	-	-	-	-	-	0	1	5
34 (Dec 1)	-	-	-	-	0	1	4	8	15
35 (Dec 11)	-	-	-	0	1	4	8	14	25
36 (Dec 21)	-	-	0	1	3	6	11	17	28

STATION.....KHUZDAR YEARS.....1912-1946

MONTH	EXCEEDANCE PROBABILITY								
	90%	80%	70%	60%	50%	40%	30%	20%	10%
January	-	-	0	4	10	16	23	33	49
February	5	11	18	25	34	45	60	80	115
March	-	-	0	3	7	13	19	29	46
April	-	-	-	-	0	5	11	17	28
May	-	-	-	0	7	13	19	27	39
June	-	-	-	-	0	7	12	17	25
July	2	12	21	29	38	48	61	78	106
August	1	7	14	21	29	39	51	68	97
September	-	-	-	-	-	-	0	4	8
October	-	-	-	-	-	-	-	0	2
November	-	-	-	-	-	-	-	0	6
December	-	-	-	0	3	7	12	19	32

DECAD(date)	90%	80%	70%	60%	50%	40%	30%	20%	10%
1 (Jan 1)	-	-	-	-	-	-	0	8	23
2 (Jan 11)	-	-	-	-	-	0	1	4	17
3 (Jan 21)	-	-	-	-	0	2	7	11	17
4 (Jan 31)	-	-	-	-	0	2	7	15	29
5 (Feb 10)	-	-	-	0	2	9	16	26	43
6 (Feb 20)	-	-	-	-	-	0	3	12	29
7 (Mar 1)	-	-	-	-	-	0	1	8	16
8 (Mar 11)	-	-	-	-	-	-	0	4	16
9 (Mar 21)	-	-	-	-	0	2	6	12	24
10 (Apr 1)	-	-	-	-	-	-	0	5	15
11 (Apr 11)	-	-	-	-	-	-	0	4	11
12 (Apr 21)	-	-	-	-	-	-	-	0	7
13 (May 1)	-	-	-	-	-	0	2	7	19
14 (May 11)	-	-	-	-	-	-	0	3	14
15 (May 21)	-	-	-	-	-	-	-	0	16
16 (Jun 1)	-	-	-	-	-	-	-	0	4
17 (Jun 11)	-	-	-	-	-	-	0	6	17
18 (Jun 21)	-	-	-	-	-	-	0	4	11
19 (Jul 1)	-	-	-	-	0	5	11	19	33
20 (Jul 11)	-	-	0	5	10	16	22	31	41
21 (Jul 21)	-	0	4	8	13	19	27	37	56
22 (Aug 1)	-	-	-	0	6	12	21	32	51
23 (Aug 11)	-	-	0	3	6	10	15	22	34
24 (Aug 21)	-	-	-	0	4	9	15	23	36
25 (Sep 1)	-	-	-	-	-	-	-	0	9
26 (Sep 11)	-	-	-	-	-	-	-	-	0
27 (Sep 21)	-	-	-	-	-	-	-	-	0
28 (Oct 1)	-	-	-	-	-	-	-	-	0
29 (Oct 11)	-	-	-	-	-	-	-	-	0
30 (Oct 21)	-	-	-	-	-	-	-	-	0
31 (Nov 1)	-	-	-	-	-	-	-	-	0
32 (Nov 11)	-	-	-	-	-	-	-	-	0
33 (Nov 21)	-	-	-	-	-	-	-	-	0
34 (Dec 1)	-	-	-	-	-	-	-	0	5
35 (Dec 11)	-	-	-	-	-	-	0	3	17
36 (Dec 21)	-	-	-	-	-	-	0	5	13

APPENDIX D

STATION.....LORALAI YEARS.....1892-1946

MONTH	EXCEEDANCE PROBABILITY								
	90%	80%	70%	60%	50%	40%	30%	20%	10%
January	0	1	5	8	13	18	24	34	49
February	0	1	6	11	17	24	33	45	66
March	1	7	12	18	24	32	42	55	77
April	0	4	8	11	16	22	28	38	55
May	-	0	2	4	8	12	18	26	41
June	-	-	0	1	4	7	11	16	24
July	4	11	17	23	30	38	49	63	86
August	0	2	6	11	17	26	37	55	86
September	-	-	-	-	-	0	3	8	17
October	-	-	-	-	-	-	0	3	10
November	-	-	-	-	-	-	0	3	12
December	-	-	0	2	6	10	15	22	34
DECAD(date)	90%	80%	70%	60%	50%	40%	30%	20%	10%
1 (Jan 1)	-	-	-	-	-	0	2	6	17
2 (Jan 11)	-	-	-	0	2	5	9	14	22
3 (Jan 21)	-	-	-	0	1	4	7	13	22
4 (Jan 31)	-	-	-	0	2	4	8	14	23
5 (Feb 10)	-	-	-	0	2	5	10	15	25
6 (Feb 20)	-	-	-	0	1	5	10	17	31
7 (Mar 1)	-	0	2	5	8	12	18	26	41
8 (Mar 11)	-	-	-	0	2	5	9	14	23
9 (Mar 21)	-	-	0	2	5	8	13	19	30
10 (Apr 1)	-	-	0	1	3	6	11	16	26
11 (Apr 11)	-	-	-	0	2	5	8	12	20
12 (Apr 21)	-	-	-	-	0	2	6	12	24
13 (May 1)	-	-	-	-	-	0	2	7	19
14 (May 11)	-	-	-	-	0	2	5	10	19
15 (May 21)	-	-	-	-	-	0	2	6	13
16 (Jun 1)	-	-	-	-	-	0	1	5	12
17 (Jun 11)	-	-	-	-	-	-	0	1	4
18 (Jun 21)	-	-	-	-	-	0	3	7	15
19 (Jul 1)	-	-	-	0	1	4	8	14	23
20 (Jul 11)	-	-	0	3	6	11	16	23	34
21 (Jul 21)	-	0	2	6	11	17	24	34	51
22 (Aug 1)	-	-	-	0	3	8	15	25	44
23 (Aug 11)	-	-	-	-	0	1	6	17	39
24 (Aug 21)	-	-	-	-	-	0	2	6	17
25 (Sep 1)	-	-	-	-	-	-	0	2	12
26 (Sep 11)	-	-	-	-	-	-	-	0	1
27 (Sep 21)	-	-	-	-	-	-	-	-	0
28 (Oct 1)	-	-	-	-	-	-	-	-	0
29 (Oct 11)	-	-	-	-	-	-	-	-	0
30 (Oct 21)	-	-	-	-	-	-	-	-	0
31 (Nov 1)	-	-	-	-	-	-	-	-	0
32 (Nov 11)	-	-	-	-	-	-	-	0	3
33 (Nov 21)	-	-	-	-	-	-	-	0	3
34 (Dec 1)	-	-	-	-	-	-	0	5	12
35 (Dec 11)	-	-	-	-	-	0	1	5	15
36 (Dec 21)	-	-	-	-	0	2	5	8	14

STATION.....MANGOCHAR YEARS.....1912-1946

MONTH	EXCEEDANCE PROBABILITY 90%	80%	70%	60%	50%	40%	30%	20%	10%
January	0	2	7	12	19	26	36	50	73
February	-	0	4	8	14	21	31	44	67
March	0	3	7	11	15	20	26	34	47
April	-	-	-	0	2	5	9	14	24
May	-	-	-	-	-	-	-	0	3
June	-	-	-	-	-	-	-	-	3
July	-	-	-	-	0	10	21	32	49
August	-	-	-	-	-	0	3	9	20
September	-	-	-	-	-	-	-	0	16
October	-	-	-	-	-	-	-	-	0
November	-	-	-	-	-	-	-	0	12
December	-	0	1	6	11	17	25	35	53

DECAD(date)	90%	80%	70%	60%	50%	40%	30%	20%	10%
1 (Jan 1)	-	-	-	-	-	0	3	10	23
2 (Jan 11)	-	-	-	-	0	7	11	17	25
3 (Jan 21)	-	-	0	1	5	9	14	22	36
4 (Jan 31)	-	-	-	0	1	5	10	17	28
5 (Feb 10)	-	-	0	1	5	9	13	20	30
6 (Feb 20)	-	-	-	-	-	0	8	15	25
7 (Mar 1)	-	-	-	0	2	6	10	16	26
8 (Mar 11)	-	-	-	0	1	4	7	10	16
9 (Mar 21)	-	-	-	-	0	1	5	11	21
10 (Apr 1)	-	-	-	-	-	0	1	8	18
11 (Apr 11)	-	-	-	-	-	-	0	2	4
12 (Apr 21)	-	-	-	-	-	-	-	0	4
13 (May 1)	-	-	-	-	-	-	-	-	0
14 (May 11)	-	-	-	-	-	-	-	0	1
15 (May 21)	-	-	-	-	-	-	-	-	0
16 (Jun 1)	-	-	-	-	-	-	-	-	0
17 (Jun 11)	-	-	-	-	-	-	-	-	0
18 (Jun 21)	-	-	-	-	-	-	-	-	0
19 (Jul 1)	-	-	-	-	-	-	-	0	6
20 (Jul 11)	-	-	-	-	-	-	0	2	13
21 (Jul 21)	-	-	-	-	-	0	2	11	29
22 (Aug 1)	-	-	-	-	-	-	0	1	13
23 (Aug 11)	-	-	-	-	-	-	0	2	6
24 (Aug 21)	-	-	-	-	-	-	-	-	0
25 (Sep 1)	-	-	-	-	-	-	-	0	3
26 (Sep 11)	-	-	-	-	-	-	-	-	0
27 (Sep 21)	-	-	-	-	-	-	-	-	0
28 (Oct 1)	-	-	-	-	-	-	-	-	0
29 (Oct 11)	-	-	-	-	-	-	-	-	0
30 (Oct 21)	-	-	-	-	-	-	-	-	0
31 (Nov 1)	-	-	-	-	-	-	-	-	0
32 (Nov 11)	-	-	-	-	-	-	-	0	5
33 (Nov 21)	-	-	-	-	-	-	-	0	4
34 (Dec 1)	-	-	-	-	-	0	1	7	18
35 (Dec 11)	-	-	-	-	0	2	7	14	27
36 (Dec 21)	-	-	-	-	0	2	7	12	22

APPENDIX D

STATION.....MITHRI   YEARS.....1891-1946

MONTH	90%	80%	70%	60%	50%	40%	30%	20%	10%
	EXCEEDANCE PROBABILITY								
January	-	-	-	-	-	0	5	13	25
February	-	-	-	0	1	4	10	18	34
March	-	-	-	-	0	1	5	12	23
April	-	-	-	-	-	-	0	7	18
May	-	-	-	-	-	-	-	0	4
June	-	-	-	-	-	-	0	6	21
July	-	-	-	0	16	24	34	48	72
August	-	-	-	0	5	12	23	38	65
September	-	-	-	-	-	-	-	0	14
October	-	-	-	-	-	-	-	-	0
November	-	-	-	-	-	-	-	-	0
December	-	-	-	-	-	-	0	5	15

DECAD(date)	90%	80%	70%	60%	50%	40%	30%	20%	10%
1 (Jan 1)	-	-	-	-	-	-	-	-	0
2 (Jan 11)	-	-	-	-	-	-	0	2	10
3 (Jan 21)	-	-	-	-	-	-	-	0	11
4 (Jan 31)	-	-	-	-	-	-	0	1	9
5 (Feb 10)	-	-	-	-	-	-	0	4	12
6 (Feb 20)	-	-	-	-	-	-	0	4	15
7 (Mar 1)	-	-	-	-	-	-	-	0	8
8 (Mar 11)	-	-	-	-	-	-	-	0	3
9 (Mar 21)	-	-	-	-	-	-	0	1	7
10 (Apr 1)	-	-	-	-	-	-	-	0	5
11 (Apr 11)	-	-	-	-	-	-	-	-	0
12 (Apr 21)	-	-	-	-	-	-	-	-	0
13 (May 1)	-	-	-	-	-	-	-	-	0
14 (May 11)	-	-	-	-	-	-	-	-	0
15 (May 21)	-	-	-	-	-	-	-	-	0
16 (Jun 1)	-	-	-	-	-	-	-	-	0
17 (Jun 11)	-	-	-	-	-	-	-	-	0
18 (Jun 21)	-	-	-	-	-	-	-	0	13
19 (Jul 1)	-	-	-	-	-	-	0	1	16
20 (Jul 11)	-	-	-	-	-	0	3	10	26
21 (Jul 21)	-	-	-	-	0	9	17	28	45
22 (Aug 1)	-	-	-	-	-	0	4	13	27
23 (Aug 11)	-	-	-	-	-	-	0	6	33
24 (Aug 21)	-	-	-	-	-	-	0	2	13
25 (Sep 1)	-	-	-	-	-	-	-	0	11
26 (Sep 11)	-	-	-	-	-	-	-	-	0
27 (Sep 21)	-	-	-	-	-	-	-	-	0
28 (Oct 1)	-	-	-	-	-	-	-	-	0
29 (Oct 11)	-	-	-	-	-	-	-	-	0
30 (Oct 21)	-	-	-	-	-	-	-	-	0
31 (Nov 1)	-	-	-	-	-	-	-	-	0
32 (Nov 11)	-	-	-	-	-	-	-	-	0
33 (Nov 21)	-	-	-	-	-	-	-	-	0
34 (Dec 1)	-	-	-	-	-	-	-	-	0
35 (Dec 11)	-	-	-	-	-	-	-	-	0
36 (Dec 21)	-	-	-	-	-	-	0	1	6

STATION.....MUSA KHEL YEARS.....1911-1946

MONTH	EXCEEDANCE PROBABILITY								
	90%	80%	70%	60%	50%	40%	30%	20%	10%
January	2	5	7	11	14	18	24	31	44
February	1	4	8	12	17	23	31	41	60
March	5	12	18	24	31	39	49	62	83
April	5	11	16	21	27	34	43	54	73
May	2	6	10	14	19	25	33	43	61
June	0	5	11	18	26	35	47	63	91
July	47	62	74	86	98	111	127	146	177
August	30	42	53	63	74	86	100	118	148
September	-	0	3	8	14	22	32	45	69
October	-	-	-	-	-	0	2	9	26
November	-	-	-	-	-	0	1	4	13
December	-	-	0	2	5	8	13	21	34

DECAD(date)	90%	80%	70%	60%	50%	40%	30%	20%	10%
1 (Jan 1)	-	-	-	-	0	1	5	10	21
2 (Jan 11)	-	-	0	1	3	5	7	10	16
3 (Jan 21)	-	-	-	0	3	5	8	12	18
4 (Jan 31)	-	-	-	0	1	4	8	12	20
5 (Feb 10)	-	-	0	2	5	8	12	16	24
6 (Feb 20)	-	-	0	1	3	6	10	16	28
7 (Mar 1)	-	-	0	6	9	14	19	27	42
8 (Mar 11)	-	-	-	0	2	6	10	16	27
9 (Mar 21)	-	0	1	5	9	13	18	26	38
10 (Apr 1)	-	-	0	6	10	14	20	27	38
11 (Apr 11)	-	-	0	1	4	8	12	18	27
12 (Apr 21)	-	-	-	-	0	3	9	17	32
13 (May 1)	-	-	-	0	3	6	11	18	31
14 (May 11)	-	-	0	3	5	8	12	17	25
15 (May 21)	-	-	-	-	0	2	7	13	23
16 (Jun 1)	-	-	-	-	0	2	6	11	21
17 (Jun 11)	-	-	0	2	5	10	17	26	43
18 (Jun 21)	-	-	0	4	8	12	19	28	46
19 (Jul 1)	0	5	9	14	19	26	34	45	63
20 (Jul 11)	5	10	15	21	26	33	41	52	70
21 (Jul 21)	13	20	27	33	40	48	57	69	89
22 (Aug 1)	3	7	12	18	25	33	44	59	85
23 (Aug 11)	2	6	10	15	20	26	34	45	64
24 (Aug 21)	1	5	8	11	15	19	24	30	41
25 (Sep 1)	-	-	-	0	4	10	16	26	42
26 (Sep 11)	-	-	-	-	0	3	8	15	28
27 (Sep 21)	-	-	-	-	-	-	0	4	11
28 (Oct 1)	-	-	-	-	-	-	-	0	5
29 (Oct 11)	-	-	-	-	-	-	-	0	2
30 (Oct 21)	-	-	-	-	-	-	-	0	10
31 (Nov 1)	-	-	-	-	-	-	-	0	1
32 (Nov 11)	-	-	-	-	-	-	-	0	4
33 (Nov 21)	-	-	-	-	-	-	-	0	3
34 (Dec 1)	-	-	-	-	-	-	0	3	9
35 (Dec 11)	-	-	-	-	-	0	1	6	17
36 (Dec 21)	-	-	-	0	1	3	5	8	14

STATION.....MUSLIMBAGH YEARS.....1901-1946

MONTH	EXCEEDENCE PROBABILITY 90%	80%	70%	60%	50%	40%	30%	20%	10%
January	7	14	21	28	36	45	56	71	95
February	3	8	13	20	27	36	47	64	92
March	5	10	15	21	27	35	44	57	80
April	0	3	5	9	12	16	21	28	40
May	-	-	0	3	6	10	15	21	33
June	-	-	-	-	-	0	1	5	14
July	-	-	0	2	6	11	19	32	55
August	-	-	-	-	0	1	6	15	35
September	-	-	-	-	-	-	-	0	1
October	-	-	-	-	-	-	0	1	6
November	-	-	-	-	-	0	1	4	11
December	0	1	3	7	12	18	26	39	61

DECAD(date)	90%	80%	70%	60%	50%	40%	30%	20%	10%
1 (Jan 1)	-	-	0	1	5	10	17	25	40
2 (Jan 11)	-	0	1	4	7	11	16	24	37
3 (Jan 21)	-	0	2	5	10	15	22	32	50
4 (Jan 31)	-	-	0	1	3	7	12	19	31
5 (Feb 10)	-	0	2	5	8	12	17	24	35
6 (Feb 20)	-	0	1	4	8	13	19	28	44
7 (Mar 1)	0	1	3	6	9	13	19	27	41
8 (Mar 11)	-	0	1	3	5	8	11	15	22
9 (Mar 21)	-	0	1	3	5	9	14	21	34
10 (Apr 1)	-	-	0	1	3	6	9	14	23
11 (Apr 11)	-	-	-	0	1	3	6	10	17
12 (Apr 21)	-	-	-	-	0	1	3	6	12
13 (May 1)	-	-	-	-	-	0	3	9	18
14 (May 11)	-	-	-	-	0	1	4	8	14
15 (May 21)	-	-	-	-	-	-	0	1	8
16 (Jun 1)	-	-	-	-	-	-	-	0	1
17 (Jun 11)	-	-	-	-	-	-	-	0	1
18 (Jun 21)	-	-	-	-	-	0	6	8	12
19 (Jul 1)	-	-	-	-	-	-	0	1	7
20 (Jul 11)	-	-	-	-	-	0	4	11	24
21 (Jul 21)	-	-	-	-	0	1	4	12	27
22 (Aug 1)	-	-	-	-	-	-	0	2	15
23 (Aug 11)	-	-	-	-	-	-	0	4	19
24 (Aug 21)	-	-	-	-	-	-	-	0	1
25 (Sep 1)	-	-	-	-	-	-	-	-	0
26 (Sep 11)	-	-	-	-	-	-	-	-	0
27 (Sep 21)	-	-	-	-	-	-	-	-	0
28 (Oct 1)	-	-	-	-	-	-	-	-	0
29 (Oct 11)	-	-	-	-	-	-	-	-	0
30 (Oct 21)	-	-	-	-	-	-	-	0	2
31 (Nov 1)	-	-	-	-	-	-	-	0	1
32 (Nov 11)	-	-	-	-	-	-	-	0	2
33 (Nov 21)	-	-	-	-	-	-	-	0	5
34 (Dec 1)	-	-	-	-	-	0	3	10	23
35 (Dec 11)	-	-	-	-	0	2	6	12	23
36 (Dec 21)	0	1	3	6	10	16	23	34	54

STATION.....PISHIN YEARS.....1891-1946

MONTH	EXCEEDENCE PROBABILITY 90%	80%	70%	60%	50%	40%	30%	20%	10%
January	10	18	26	35	45	56	71	90	123
February	6	14	22	30	40	51	66	86	119
March	10	17	23	30	37	45	56	70	93
April	1	5	8	11	15	20	26	34	47
May	-	-	0	1	3	5	7	11	17
June	-	-	-	-	-	-	-	0	5
July	-	-	-	-	-	0	4	8	16
August	-	-	-	-	-	0	1	8	18
September	-	-	-	-	-	-	-	-	0
October	-	-	-	-	-	-	-	0	10
November	-	-	-	-	0	2	6	11	21
December	2	7	12	18	24	32	42	56	79

DECAD(date)	90%	80%	70%	60%	50%	40%	30%	20%	10%
1 (Jan 1)	-	-	0	1	5	9	14	21	33
2 (Jan 11)	0	1	5	9	14	20	26	36	52
3 (Jan 21)	-	0	3	8	14	20	29	40	60
4 (Jan 31)	0	1	3	6	10	15	22	32	50
5 (Feb 10)	0	1	4	8	12	18	24	34	50
6 (Feb 20)	-	-	0	2	7	12	19	30	48
7 (Mar 1)	0	3	6	10	14	18	24	31	44
8 (Mar 11)	-	0	2	5	8	13	18	27	41
9 (Mar 21)	-	0	1	3	5	9	14	20	32
10 (Apr 1)	-	-	0	2	5	8	12	17	26
11 (Apr 11)	-	-	0	1	3	5	8	13	21
12 (Apr 21)	-	-	-	-	0	2	4	8	13
13 (May 1)	-	-	-	-	0	1	3	6	10
14 (May 11)	-	-	-	-	-	0	1	4	8
15 (May 21)	-	-	-	-	-	-	-	0	2
16 (Jun 1)	-	-	-	-	-	-	-	-	0
17 (Jun 11)	-	-	-	-	-	-	-	-	0
18 (Jun 21)	-	-	-	-	-	-	-	-	0
19 (Jul 1)	-	-	-	-	-	-	-	0	1
20 (Jul 11)	-	-	-	-	-	-	-	0	5
21 (Jul 21)	-	-	-	-	-	-	-	0	7
22 (Aug 1)	-	-	-	-	-	-	-	0	7
23 (Aug 11)	-	-	-	-	-	-	-	0	7
24 (Aug 21)	-	-	-	-	-	-	-	-	0
25 (Sep 1)	-	-	-	-	-	-	-	-	0
26 (Sep 11)	-	-	-	-	-	-	-	-	0
27 (Sep 21)	-	-	-	-	-	-	-	-	0
28 (Oct 1)	-	-	-	-	-	-	-	-	0
29 (Oct 11)	-	-	-	-	-	-	-	-	0
30 (Oct 21)	-	-	-	-	-	-	-	0	4
31 (Nov 1)	-	-	-	-	-	-	-	0	1
32 (Nov 11)	-	-	-	-	-	-	0	2	8
33 (Nov 21)	-	-	-	-	-	0	1	5	11
34 (Dec 1)	-	-	-	-	0	4	9	16	28
35 (Dec 11)	-	-	-	0	2	6	12	21	36
36 (Dec 21)	-	0	2	5	8	12	17	24	36

STATION.....QUETTA YEARS.....1891-1946

MONTH	EXCEEDENCE PROBABILITY								
	90%	80%	70%	60%	50%	40%	30%	20%	10%
January	8	15	22	29	38	48	60	77	107
February	5	11	18	25	34	45	60	80	115
March	9	15	21	27	33	41	49	61	81
April	2	5	8	11	15	20	26	35	49
May	-	-	0	3	5	8	12	17	25
June	-	-	-	-	-	0	2	7	15
July	-	-	-	0	3	7	12	20	33
August	-	-	-	-	0	2	4	13	25
September	-	-	-	-	-	-	-	0	2
October	-	-	-	-	-	-	0	2	10
November	-	-	-	0	1	3	6	11	19
December	2	5	9	14	19	26	34	46	67

DECAD(date)	90%	80%	70%	60%	50%	40%	30%	20%	10%
1 (Jan 1)	-	-	0	2	5	8	12	18	28
2 (Jan 11)	0	1	5	8	12	17	22	30	42
3 (Jan 21)	0	1	4	8	12	17	24	34	52
4 (Jan 31)	0	1	3	5	8	13	18	26	41
5 (Feb 10)	0	2	4	8	12	16	23	31	46
6 (Feb 20)	-	-	0	3	7	12	20	30	49
7 (Mar 1)	0	3	6	9	13	17	22	29	41
8 (Mar 11)	-	-	0	4	7	11	15	21	32
9 (Mar 21)	-	-	0	4	6	9	13	18	27
10 (Apr 1)	-	0	1	3	5	8	11	16	25
11 (Apr 11)	-	-	0	1	4	6	10	14	22
12 (Apr 21)	-	-	-	0	1	2	4	7	12
13 (May 1)	-	-	-	-	0	1	4	8	14
14 (May 11)	-	-	-	-	-	0	3	7	14
15 (May 21)	-	-	-	-	-	-	0	1	4
16 (Jun 1)	-	-	-	-	-	-	-	0	3
17 (Jun 11)	-	-	-	-	-	-	-	0	2
18 (Jun 21)	-	-	-	-	-	-	0	1	5
19 (Jul 1)	-	-	-	-	-	-	0	2	5
20 (Jul 11)	-	-	-	-	-	-	0	3	13
21 (Jul 21)	-	-	-	-	-	0	4	10	20
22 (Aug 1)	-	-	-	-	-	-	0	2	11
23 (Aug 11)	-	-	-	-	-	-	-	0	8
24 (Aug 21)	-	-	-	-	-	-	-	0	1
25 (Sep 1)	-	-	-	-	-	-	-	-	0
26 (Sep 11)	-	-	-	-	-	-	-	-	0
27 (Sep 21)	-	-	-	-	-	-	-	-	0
28 (Oct 1)	-	-	-	-	-	-	-	-	0
29 (Oct 11)	-	-	-	-	-	-	-	-	0
30 (Oct 21)	-	-	-	-	-	-	-	0	5
31 (Nov 1)	-	-	-	-	-	-	-	0	3
32 (Nov 11)	-	-	-	-	-	-	0	3	8
33 (Nov 21)	-	-	-	-	-	-	0	4	11
34 (Dec 1)	-	-	-	-	0	4	7	13	21
35 (Dec 11)	-	-	-	0	2	5	10	17	29
36 (Dec 21)	-	-	0	5	8	11	15	21	31

STATION.....SANJAWI YEARS.....1911-1946

MONTH	EXCEEDENCE PROBABILITY								
	90%	80%	70%	60%	50%	40%	30%	20%	10%
January	1	4	6	9	13	17	23	32	46
February	0	2	6	11	17	25	35	51	79
March	2	6	10	16	23	31	42	58	86
April	0	3	7	11	16	22	29	39	56
May	-	-	0	3	6	11	17	26	43
June	-	0	1	4	7	10	13	18	28
July	5	11	16	22	29	37	46	60	83
August	o	1	4	9	14	21	31	45	69
September	-	-	-	-	0	2	6	11	21
October	-	-	-	-	-	0	3	7	14
November	-	-	-	-	-	0	2	7	17
December	-	-	0	3	6	10	15	24	40

DECAD(date)	90%	80%	70%	60%	50%	40%	30%	20%	10%
1 (Jan 1)	-	-	-	-	0	1	3	8	18
2 (Jan 11)	-	-	0	1	2	4	7	11	18
3 (Jan 21)	-	-	-	0	3	6	10	15	22
4 (Jan 31)	-	-	-	0	1	4	7	13	22
5 (Feb 10)	-	-	-	0	1	5	10	18	30
6 (Feb 20)	-	-	-	0	2	6	13	24	46
7 (Mar 1)	-	-	0	2	6	10	16	25	39
8 (Mar 11)	-	-	-	0	1	4	9	18	34
9 (Mar 21)	-	-	0	2	4	8	12	19	32
10 (Apr 1)	-	0	2	5	8	12	17	25	37
11 (Apr 11)	-	-	-	-	0	1	3	7	12
12 (Apr 21)	-	-	-	-	0	1	4	9	18
13 (May 1)	-	-	-	-	0	2	6	11	19
14 (May 11)	-	-	-	-	0	1	4	9	18
15 (May 21)	-	-	-	-	-	-	0	4	13
16 (Jun 1)	-	-	-	-	-	0	2	4	7
17 (Jun 11)	-	-	-	-	-	-	0	3	8
18 (Jun 21)	-	-	-	-	-	0	6	12	21
19 (Jul 1)	-	-	-	0	2	4	6	9	12
20 (Jul 11)	-	0	1	4	8	13	18	27	42
21 (Jul 21)	-	0	1	4	8	13	20	31	51
22 (Aug 1)	-	-	-	0	2	6	12	23	44
23 (Aug 11)	-	-	-	-	0	1	4	10	19
24 (Aug 21)	-	-	-	0	1	3	7	12	21
25 (Sep 1)	-	-	-	-	-	-	0	3	11
26 (Sep 11)	-	-	-	-	-	-	-	0	5
27 (Sep 21)	-	-	-	-	-	-	-	0	3
28 (Oct 1)	-	-	-	-	-	-	-	0	3
29 (Oct 11)	-	-	-	-	-	-	-	0	6
30 (Oct 21)	-	-	-	-	-	-	-	0	4
31 (Nov 1)	-	-	-	-	-	-	-	0	4
32 (Nov 11)	-	-	-	-	-	-	-	0	7
33 (Nov 21)	-	-	-	-	-	-	-	0	2
34 (Dec 1)	-	-	-	-	-	-	0	4	10
35 (Dec 11)	-	-	-	-	-	0	3	10	27
36 (Dec 21)	-	-	-	-	0	1	3	6	11

STATION.....SIBI YEARS.....1891-1946

MONTH	EXCEEDENCE PROBABILITY 90%	80%	70%	60%	50%	40%	30%	20%	10%
January	-	-	0	2	5	9	14	22	36
February	-	-	0	2	6	11	17	26	41
March	-	-	0	2	5	8	13	21	34
April	-	-	0	1	2	4	6	9	14
May	-	-	-	-	-	0	3	7	14
June	-	-	-	-	-	0	4	13	30
July	0	3	8	15	22	31	43	60	90
August	-	-	0	5	11	19	30	45	71
September	-	-	-	-	-	0	7	15	27
October	-	-	-	-	-	-	-	0	2
November	-	-	-	-	-	-	-	0	1
December	-	-	-	-	0	2	6	12	22

DECAD(date)	90%	80%	70%	60%	50%	40%	30%	20%	10%
1 (Jan 1)	-	-	-	-	-	-	0	3	7
2 (Jan 11)	-	-	-	-	0	1	4	9	17
3 (Jan 21)	-	-	-	-	-	-	0	6	17
4 (Jan 31)	-	-	-	-	-	0	1	5	12
5 (Feb 10)	-	-	-	-	-	0	4	10	19
6 (Feb 20)	-	-	-	-	-	-	0	5	17
7 (Mar 1)	-	-	-	-	0	1	4	8	15
8 (Mar 11)	-	-	-	-	-	-	0	2	7
9 (Mar 21)	-	-	-	-	-	0	2	6	14
10 (Apr 1)	-	-	-	-	-	0	2	4	7
11 (Apr 11)	-	-	-	-	-	-	0	1	4
12 (Apr 21)	-	-	-	-	-	-	0	2	6
13 (May 1)	-	-	-	-	-	-	-	0	4
14 (May 11)	-	-	-	-	-	-	0	2	7
15 (May 21)	-	-	-	-	-	-	-	0	1
16 (Jun 1)	-	-	-	-	-	-	-	-	0
17 (Jun 11)	-	-	-	-	-	-	-	-	0
18 (Jun 21)	-	-	-	-	-	0	1	8	22
19 (Jul 1)	-	-	-	-	0	2	5	11	23
20 (Jul 11)	-	-	-	0	1	5	11	20	37
21 (Jul 21)	-	-	-	0	5	12	21	32	51
22 (Aug 1)	-	-	-	-	0	1	7	16	32
23 (Aug 11)	-	-	-	-	-	0	6	17	37
24 (Aug 21)	-	-	-	-	-	0	3	8	18
25 (Sep 1)	-	-	-	-	-	-	0	10	24
26 (Sep 11)	-	-	-	-	-	-	-	0	1
27 (Sep 21)	-	-	-	-	-	-	-	-	0
28 (Oct 1)	-	-	-	-	-	-	-	-	0
29 (Oct 11)	-	-	-	-	-	-	-	-	0
30 (Oct 21)	-	-	-	-	-	-	-	-	0
31 (Nov 1)	-	-	-	-	-	-	-	-	0
32 (Nov 11)	-	-	-	-	-	-	-	-	0
33 (Nov 21)	-	-	-	-	-	-	-	-	0
34 (Dec 1)	-	-	-	-	-	-	-	0	4
35 (Dec 11)	-	-	-	-	-	-	0	1	8
36 (Dec 21)	-	-	-	-	-	-	0	3	12

STATION.....TURBAT YEARS.....1911-1946

MONTH	EXCEEDENCE PROBABILITY 90%	80%	70%	60%	50%	40%	30%	20%	10%
January	0	3	9	16	25	36	51	73	111
February	-	0	4	10	18	27	40	58	89
March	-	-	-	0	4	9	14	21	33
April	-	-	-	0	1	4	11	23	48
May	-	-	-	-	-	0	2	8	20
June	-	-	-	-	-	-	0	2	14
July	-	-	-	0	2	7	14	23	38
August	-	-	-	-	-	-	0	2	12
September	-	-	-	-	-	-	-	-	0
October	-	-	-	-	-	-	-	0	3
November	-	-	-	-	-	-	-	0	4
December	-	-	0	4	9	14	21	31	48

DECAD(date)	90%	80%	70%	60%	50%	40%	30%	20%	10%
1 (Jan 1)	-	-	-	-	0	1	7	15	29
2 (Jan 11)	-	-	-	-	0	5	14	29	56
3 (Jan 21)	-	-	-	-	0	5	13	26	52
4 (Jan 31)	-	-	-	-	0	3	10	22	44
5 (Feb 10)	-	-	-	-	0	4	9	16	29
6 (Feb 20)	-	-	-	-	-	0	7	20	45
7 (Mar 1)	-	-	-	-	-	-	0	5	13
8 (Mar 11)	-	-	-	-	-	-	-	0	9
9 (Mar 21)	-	-	-	-	-	0	2	9	16
10 (Apr 1)	-	-	-	-	-	0	3	10	30
11 (Apr 11)	-	-	-	-	-	-	-	0	3
12 (Apr 21)	-	-	-	-	-	-	-	-	0
13 (May 1)	-	-	-	-	-	-	-	-	0
14 (May 11)	-	-	-	-	-	-	0	1	9
15 (May 21)	-	-	-	-	-	-	-	0	3
16 (Jun 1)	-	-	-	-	-	-	-	-	0
17 (Jun 11)	-	-	-	-	-	-	-	-	0
18 (Jun 21)	-	-	-	-	-	-	-	0	5
19 (Jul 1)	-	-	-	-	-	-	-	0	5
20 (Jul 11)	-	-	-	-	-	0	3	10	24
21 (Jul 21)	-	-	-	-	-	-	0	3	14
22 (Aug 1)	-	-	-	-	-	-	-	0	10
23 (Aug 11)	-	-	-	-	-	-	-	-	0
24 (Aug 21)	-	-	-	-	-	-	-	-	0
25 (Sep 1)	-	-	-	-	-	-	-	-	0
26 (Sep 11)	-	-	-	-	-	-	-	-	0
27 (Sep 21)	-	-	-	-	-	-	-	-	0
28 (Oct 1)	-	-	-	-	-	-	-	-	0
29 (Oct 11)	-	-	-	-	-	-	-	-	0
30 (Oct 21)	-	-	-	-	-	-	-	0	1
31 (Nov 1)	-	-	-	-	-	-	-	-	0
32 (Nov 11)	-	-	-	-	-	-	-	0	3
33 (Nov 21)	-	-	-	-	-	-	-	-	0
34 (Dec 1)	-	-	-	-	-	-	0	3	14
35 (Dec 11)	-	-	-	-	-	0	6	14	26
36 (Dec 21)	-	-	-	-	-	0	4	10	21

APPENDIX D

STATION.....ZHOB YEARS.....1892-1946

MONTH	90%	80%	70%	60%	50%	40%	30%	20%	10%
	EXCEEDANCE PROBABILITY								
January	0	2	8	12	16	20	26	34	48
February	2	6	10	15	20	26	33	44	61
March	7	13	19	25	31	39	48	61	81
April	3	9	13	18	22	27	33	42	55
May	-	0	2	5	9	13	20	28	44
June	0	1	4	7	10	15	20	28	43
July	10	18	25	33	42	52	64	81	108
August	6	12	17	24	31	40	51	67	93
September	-	-	-	-	0	2	5	9	18
October	-	-	-	-	-	-	0	3	8
November	-	-	-	-	-	0	2	6	15
December	0	1	3	5	8	11	15	21	31

DECAD(date)	90%	80%	70%	60%	50%	40%	30%	20%	10%
1 (Jan 1)	-	-	-	-	0	1	4	9	19
2 (Jan 11)	-	-	0	1	3	5	8	12	19
3 (Jan 21)	-	-	0	2	4	7	10	14	20
4 (Jan 31)	-	-	0	2	4	7	11	15	23
5 (Feb 10)	-	0	1	3	6	9	13	18	27
6 (Feb 20)	-	0	1	3	5	8	11	16	25
7 (Mar 1)	0	2	5	8	11	15	19	25	36
8 (Mar 11)	-	-	0	2	5	8	12	17	27
9 (Mar 21)	-	0	2	5	8	12	17	25	37
10 (Apr 1)	-	0	3	6	9	12	16	21	30
11 (Apr 11)	-	0	1	3	5	7	11	15	22
12 (Apr 21)	-	-	-	0	1	4	7	11	19
13 (May 1)	-	-	-	-	0	1	3	9	21
14 (May 11)	-	-	-	0	1	3	6	11	18
15 (May 21)	-	-	-	-	-	0	2	7	14
16 (Jun 1)	-	-	-	-	0	1	3	6	12
17 (Jun 11)	-	-	-	-	-	0	2	4	8
18 (Jun 21)	-	-	-	0	3	7	12	19	32
19 (Jul 1)	-	-	0	2	5	9	14	22	35
20 (Jul 11)	-	0	5	9	14	19	25	34	48
21 (Jul 21)	0	2	5	8	12	18	25	35	52
22 (Aug 1)	0	1	4	7	10	14	19	26	38
23 (Aug 11)	0	1	3	6	9	14	20	29	45
24 (Aug 21)	-	-	0	2	4	7	11	17	29
25 (Sep 1)	-	-	-	-	-	0	1	5	12
26 (Sep 11)	-	-	-	-	-	-	-	0	4
27 (Sep 21)	-	-	-	-	-	-	-	-	0
28 (Oct 1)	-	-	-	-	-	-	-	0	1
29 (Oct 11)	-	-	-	-	-	-	-	0	2
30 (Oct 21)	-	-	-	-	-	-	-	0	3
31 (Nov 1)	-	-	-	-	-	-	-	-	0
32 (Nov 11)	-	-	-	-	-	-	-	0	3
33 (Nov 21)	-	-	-	-	-	-	0	1	6
34 (Dec 1)	-	-	-	-	-	0	2	6	13
35 (Dec 11)	-	-	-	-	-	0	3	7	15
36 (Dec 21)	-	-	0	1	2	4	6	9	13