Rainfall Structure of Thar
"The Great Indian Desert"

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CONTENTS

Foreword

The most parts of South West Rajasthan are part of Thar Desert. The economy of this region is mainly dependent upon agriculture and animal husbandry. The total annual rainfall of this region is also significantly less than the other parts of the state. Its geographical location is such that this region is mostly dependent upon rain water. The other sources of water like rivers, lakes and water reservoirs / dams, etc, are almost nil in the region. This region has lowest annual normal rainfall in the country. The period of monsoon over this region is shortest (two months) in the whole country. Most parts of this region receive very little rain and it has a large variability on temporal and spatial scale. Drinking and other water requirements for living beings are basically fulfilled with rain water only. Kharif crops are totally rain fed in the region and production varies with the amount and frequency of rainfall. Rain is thus the primary and most important source for survival. Bearing the above facts in mind, it becomes essential to know the rainfall features over the "Indian Thar region". These features are important tools for planning purposes in various disciplines like water management, agriculture operations, industrial development, etc. The present booklet is an effort to summarise the district wise rainfall features of the Thar Desert.

The report contains daily, weekly, monthly, seasonal and annual rainfall summaries for different districts of the Thar Desert of Rajasthan. The seasonal statement contains the monthly rainfall distribution, extremes and its variability. The probability of occurrence of wet and dry weeks is also described in detail.

I appreciate the authors for their valued contribution in bringing out this Monograph "Thar Desert of Rajasthan". I am sure people of the region, the state administrators and the planners will find this publication very useful.

April, 2014
New Delhi

L. S. Rathore
Director General of Meteorology
India Meteorological Department

Summary

The most parts of South West Rajasthan are part of Thar Desert. This region has lowest annual normal rainfall in the country its geographical location is such that this region is mostly dependent upon rain water. The period of monsoon over this region is shortest (two months) in the whole country. Drinking and other water requirements for living beings are basically fulfilled with rain water only. Kharif crops are totally rain fed in the region and production varies with the amount and frequency of rainfall. Rain is thus the primary and most important source for survival. The report contains daily, weekly, monthly, seasonal and annual rainfall summaries for different districts of the Thar Desert of Rajasthan. The seasonal statement contains the monthly rainfall distribution, extremes and its variability. The probability of occurrence of wet and dry weeks is also described in detail. These features are important tools for planning purposes in various disciplines like water management, agriculture operations, industrial development, etc.

CHAPTER - I

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Geography and Physiography

Location

1.1 The Thar Desert of Rajasthan, also known as the Great Indian Desert is a large arid region in the northwestern part of the Indian subcontinent and forms a natural boundary running along the border between India and Pakistan with an area of more than 100,000 km^2 within the Indian state of Rajasthan and covering mainly the districts of Jaisalmer, Barmer, Bikaner and Jodhpur and some region of the states of Punjab and Haryana. It extends from the Sutlej river and is surrounded by the Aravali ranges on the east, on the south by the salt marsh known as the Great Rann of Kutch (parts of which are sometimes included in the Thar), and on the west by the Indus river in Pakistan. Its boundary to the large thorny steppe to the north is ill-defined. It lies mostly in Rajasthan and extends into the southern portion of Haryana and Punjab states and into northern Gujarat state.

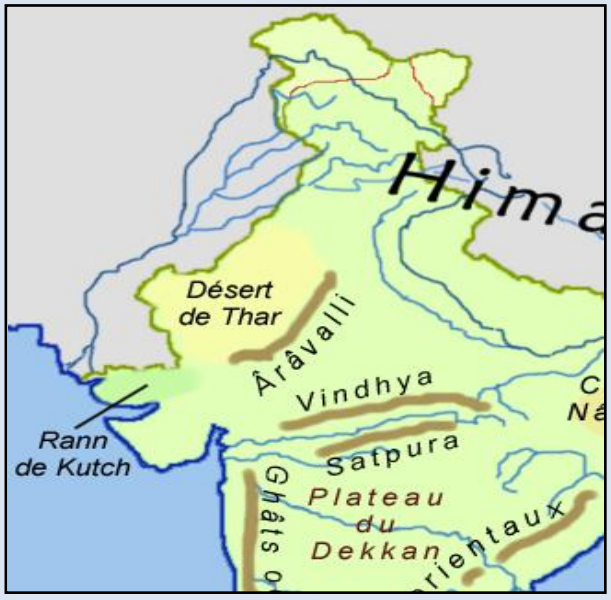


Fig.1.1 The position of Thar Desert

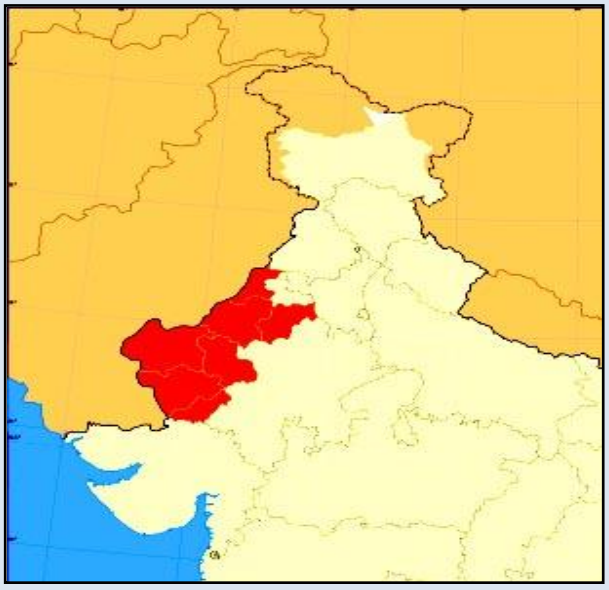


Fig.1.2 The position of Thar Desert

Physiography and Geology

1.2 The Thar Desert slopes imperceptibly towards the Indus plain and surface unevenness is mainly due to sand dunes. The dunes in the south are higher, sometimes rising upto 152 m whereas in the north they are lower and rise to 16 m above the ground level. The Aravali forms the main landmark to the south-east of Thar Desert. The soils of this region are sandy to sandy-loam in texture. The consistency and depth varies according to the topographical features. Some of these soils contain a high percentage of soluble salts in the lower horizons, turning water in the wells poisonous.

Origin

1.3 The origin of the Thar Desert is a controversial subject. Some consider it to be 4000 to 10,000 years old, whereas others state that aridity started in this region much earlier. Another theory states that area turned to desert recently perhaps around 2000 - 1500 BC. Around this time the Ghaggar-Hakra ceased to be a major river. It now terminates in the desert but at one time was a water source for the Indus Valley Civilization centre of Mohen-jo-daro. It has been observed through remote sensing techniques that Late Quaternary climatic changes and geotectonic changes have played a significant role in modifying the drainage courses in this part and a large number of palaeo-channels exist.

1.4 Most studies did not share the opinion that the palaeochannels of the Sarasvati river coincide with the bed of the present-day Ghaggar and believe that the Sutlej along with the Yamuna once flowed into the present riverbed. It has been postulated that the Sutlej was the main tributary of the Ghaggar and that subsequently the tectonic movements might have forced the Sutlej westwards, the Yamuna eastwards and thus dried up the Ghaggar-Hakra.

Thar in Ancient Literature

Fig. 1.3 The position of Thar Desert (Yellow colour)

Fig.1.4 Course of Sarasvati River through Thar Desert in Iron Age Vedic India

1.5 The Sarasvati river is one of the chief Rigvedic rivers mentioned in ancient Hindu texts. The Nadistuti hymn in the Rigveda (10.75) mentions the Sarasvati between the Yamuna in the east and the Sutlej in the west, and later Vedic texts like Tandya and Jaiminiya Brahmanas as well as the Mahabharata mention that the Sarasvati dried up in a desert.

Agriculture

1.6 The Thar is one of most heavily populated desert areas in the world and the main occupation of people living here is agriculture and animal husbandry. Because of the large variability in rainfall on temporal and spatial scale, agriculture is not a dependable proposition in this area as after the rainy season, at least 33% of crops fail. Animal husbandry, trees and grasses, intercropped with vegetables or fruit trees, is the

most viable model for arid and drought-prone regions. The region faces frequent droughts. Overgrazing due to high animal populations, wind and water erosion, mining and other industries result in serious land degradation.

Fig. 1.5 Bajra is the main kharif crop in Thar

1.7 The agricultural production is mainly from the Kharif crops. The Kharif crops are the crops that are seeded in the months of June and July and grown in the rainy season. These crops are harvested in September and October and include bajra, pulses such as guar, jowar (*Sorghum vulgare*), maize (*zea mays*), sesame and groundnuts. In past few decades the development of canals, tube wells etc. has changed crop pattern. Now the desert districts in Rajasthan have started producing Rabi crops like wheat, mustard, cumin seed and other cash crops also. Thar region of Rajasthan is the main opium producer and consumer area.

Livestock

Fig.1.6 Camel ride in the Thar Desert near Jaisalmer

1.8 In the last few years, the Rajasthan desert has seen many changes, including a manifold increase of both the human and animal population. Animal husbandry has become popular due to the difficult farming conditions. At present, there are ten times more animals per person in Rajasthan than the national average, and overgrazing is also a factor affecting the environment. A large number of farmers in Thar Desert depend on animal husbandry for their livelihood. Cow, buffalo, sheep, goats, camel and ox consist of major cattle population. Barmer district has the highest cattle population out of which sheep and goats are in majority. Thar region of Rajasthan is the biggest wool-producing area in India. Of the total wool production in India, 40-50% comes from Rajasthan. The most important tree species in terms of providing a livelihood in Thar Desert communities is *Procopius cineraria*.

Energy

1.9 The Thar Desert is an ideal place for generation of electricity from wind power. According to an estimate, Rajasthan state has got a potential of 5500 Megawatt wind power generation. Solar energy also has a great potential in this region as most of the days during a year are cloud free.

Salt Water Lakes

1.10 There are a number of salt water lakes in Thar Desert. These are Sambhar, Pachpadra, Tal Chhapar, Phalodi and Lunkaransar where Sodium chloride salt is produced from salt water whereas Didwana lake produces Sodium Sulphate salt.

People

Fig.1.7 Huts in the Thar Desert

1.11 About 40% of the total population of Rajasthan state lives in Thar Desert. The main occupation of the people in this region is agriculture and animal husbandry. In past years there has been a tremendous increase in human population as well as animal population. This has led to improper control of grazing and extensive cultivation resulting in the deterioration of vegetation resources. The increase of human and livestock population in the desert has led to deterioration in the ecosystem resulting in degradation of soil fertility. The Thar Desert is the most densely populated desert in the world, with a population density of 83 people per km^2 v/s 7 in other deserts. Jodhpur, the largest city in the region, lies in the scrub forest zone. Bikaner and Jaisalmer are located in the desert proper.

Water Sources

Fig. 1.8 Johads are common water sources

Fig. 1.9 Tanks for drinking water

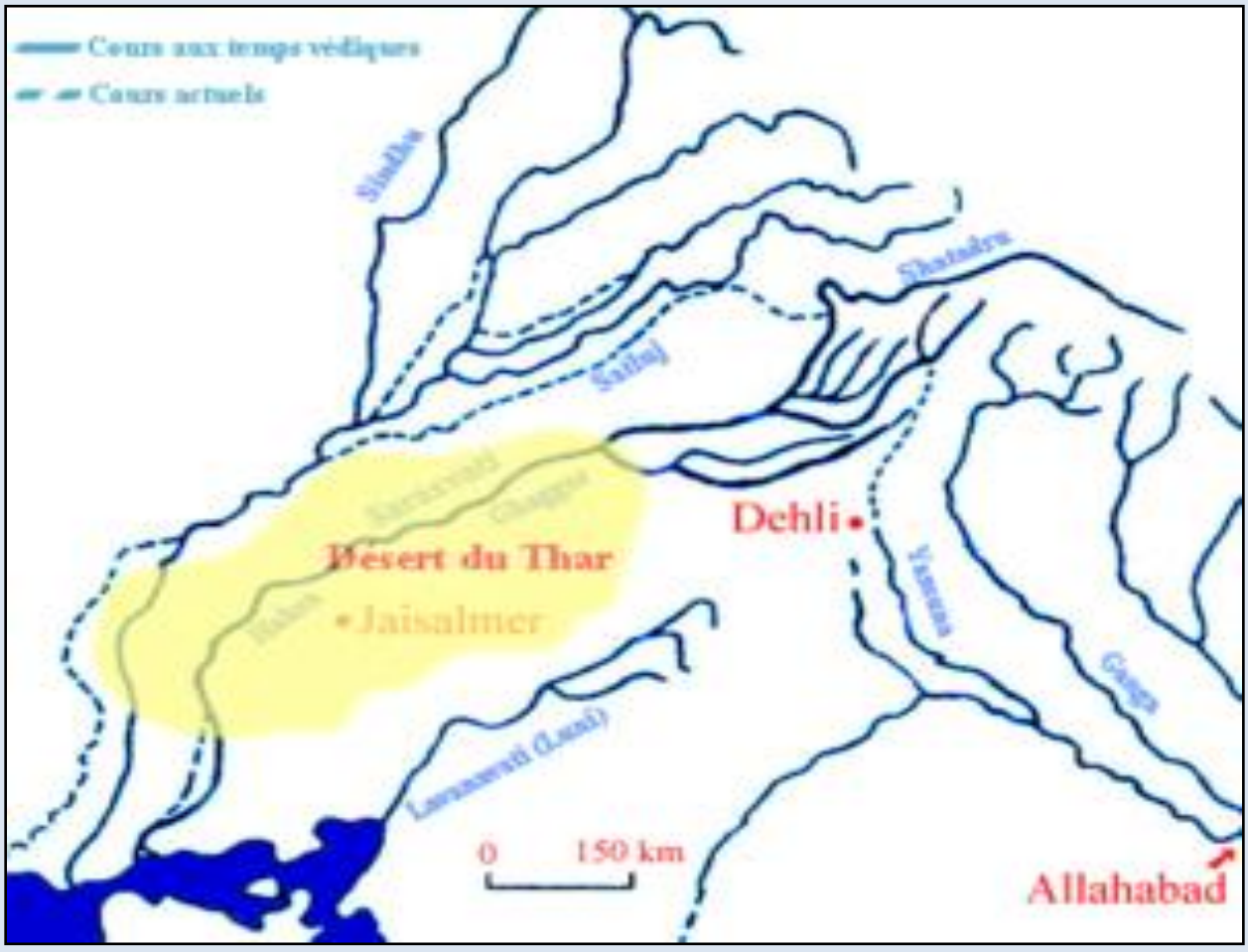


Fig. 1.10 Course of River Luni

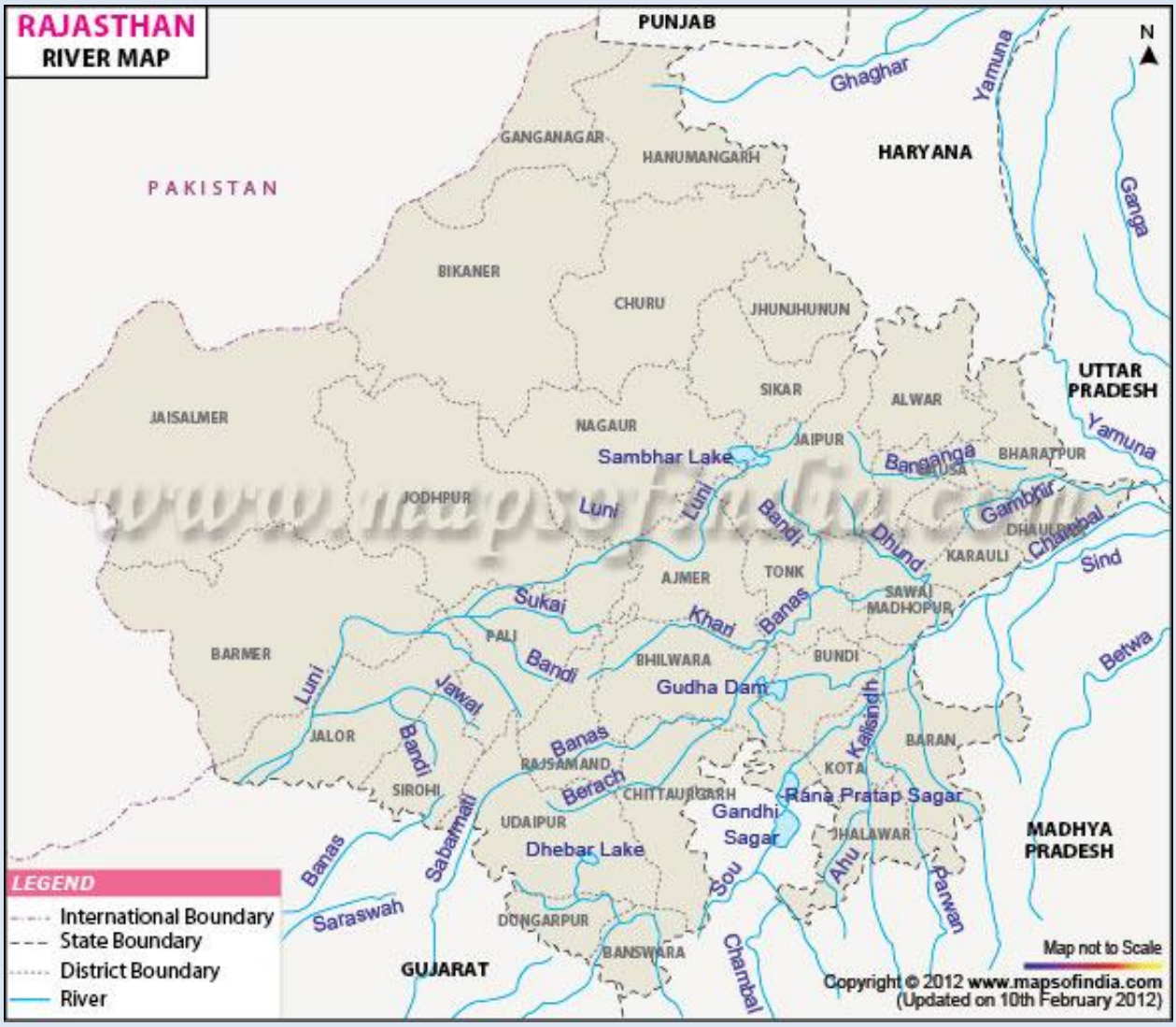


Fig. 1.11 River Map of Rajasthan

1.12 Natural (tobas) or man-made (johads), both types of small, intermittent ponds, are often the only source of water for animals and humans in the true desert areas. The river Luni is the only natural water source that drains inside a lake in the desert. It originates in the Pushkar valley of the Aravali Range, near Ajmer and ends in the marshy lands of Rann of Kutch in Gujarat, after travelling a distance of 530 km. It is a rainy season river.

1.13 In the recent developments, the Rajasthan Canal system is the major irrigation scheme of the Thar Desert which helps to check spreading of the desert to fertile areas. It is world's largest irrigation system which is being extended in an attempt to make the desert arable. It runs south-southwest in Punjab and Haryana but mainly in Rajasthan

for a total of 650 kilometers and ends near Jaisalmer, in Rajasthan. After the construction of the Indira Gandhi Canal, irrigation facilities were available over an area of 6770 km² in Jaisalmer district and 37 km² in Barmer district. The canal has transformed the barren desert of this district into rich and lush fields. Crops of mustard, cotton, and wheat now flourish in this semi-arid western region replacing the sand there previously. Besides providing water for agriculture, the canal also supplies drinking water to hundreds of people in the desert areas. Map showing Thar Desert of Rajasthan along with different districts is shown in Fig.1.12 and District wise stations maps of this region are shown in Fig.1.13.

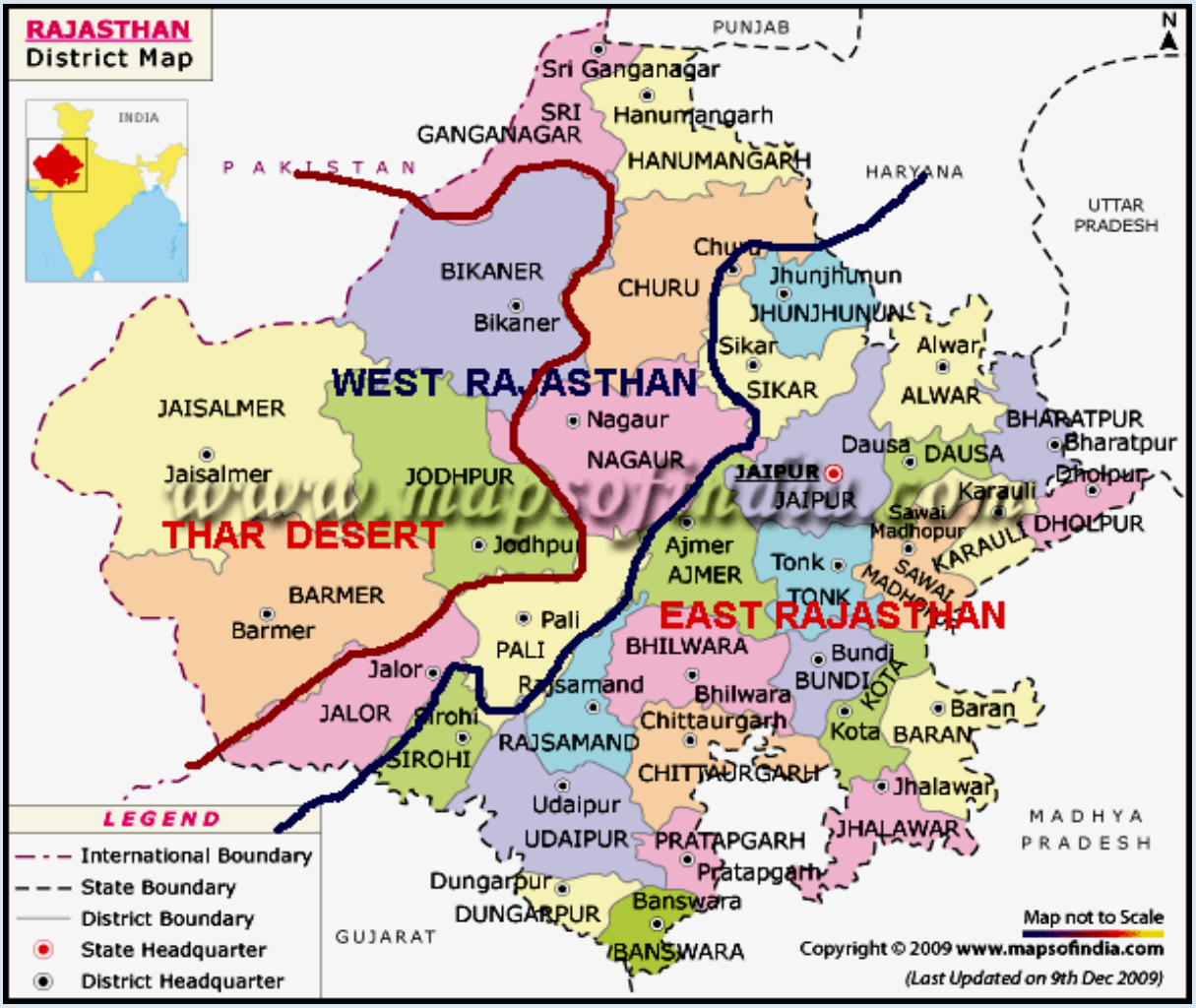
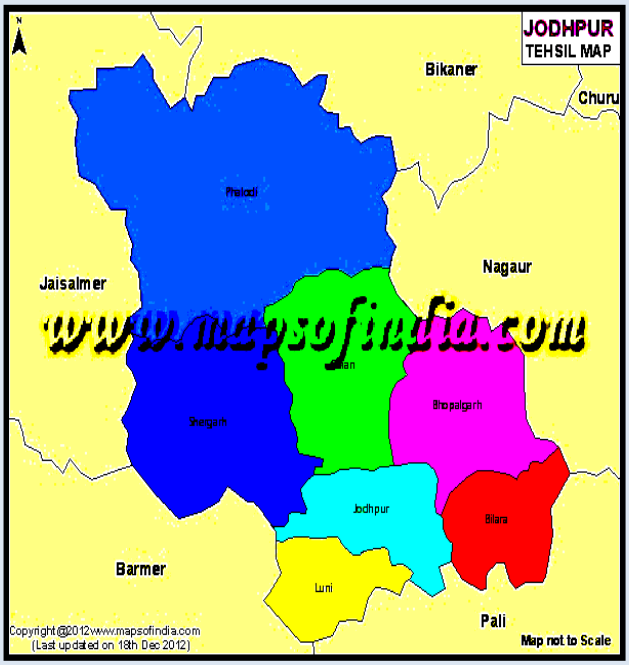


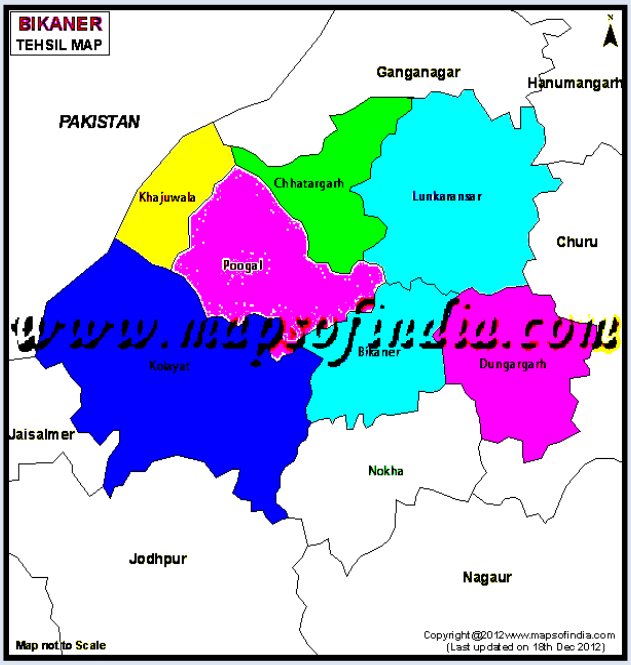
Fig.1.12 Location Map of Thar Desert of Rajasthan

Jaisalmer

Barmer



Jodhpur



Bikaner

Fig.1.13 Stations maps of different districts of Thar Desert

District wise area of Thar Desert is given as follows :-

S. No.	District/Region	Area in sq. km.	% Area
1	Jaisalmer	38401	32
2	Jodhpur	22850	19
3	Barmer	28387	24
4	Bikaner	30248	25
	Thar Desert of Rajasthan	119886	100

1.14 The Rajasthan desert which forms a major portion of the Thar Desert is the biggest desert in India and encompasses mainly the districts of Jaisalmer, Barmer, Bikaner and Jodhpur. In fact the Rajasthan Desert comprises the desert triangle of three cities - Jaisalmer, Bikaner and Jodhpur. This desert is spread over 119886 sq.km. (approx.) of area and is 35% of the total area of the state. Jaisamer district covers the largest (32%) and Jodhpur district the least (19%) desert area. Other two districts namely Bikaner and Barmer districts cover about 25% and 24% area, respectively.

CHAPTER - II

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General Climate

General climate of Thar Desert of Rajasthan is dry and hot. Mainly three seasons namely summer, rainy and winter are observed over the region. Summer season generally starts from the mid March and continues up to the end of June. May and June are the peak summer months. During summers, days are very hot and longer. Day maximum temperatures range between 45 deg. Celsius and 49 deg. Celsius on many days. However, summer nights are quite pleasant because of its soil characteristics. The ever recorded maximum temperature (49.4 deg.cel.) of this region was observed at Bikaner on 28th May 1914. Night temperatures significantly drop as compared to the day temperatures. Heat wave and hot day conditions are observed on many occasions over this region. Strong and dust raising hot winds during afternoon hours are the common feature during peak summer period. Due to large scale heating during summer months, a low pressure area develops over the region called the "*heat low*" which prevails up to the end of monsoon season. Due to formation of strong pressure gradient and neighborhood, strong dust raising winds called "*ANDHIS"* are observed on a few occasions over this region. The effect of these "*ANDHIS*" is also observed over other parts of the state as well as the neighboring states of the country namely Haryana, Punjab, UP, Delhi and West MP. The day time visibility drops considerably during these weather events affecting the normal activities in different fields. However, these weather events bring a relief from higher day temperatures. During the summer season, days are very dry as humidity drops below 20%. At the end of summer season (June end), due to incursion of moisture from Arabian Sea, high temperatures and unstable atmosphere conditions prevail over the region. Dust storm / Thunder storm activities associated with light to moderate rainfall are a common feature during afternoon hours. On some occasions, strong winds with gale force are also observed damaging the infrastructures at many places. These activities continue till the onset of monsoon. Summer prevails for a longer duration than other seasons.

Monsoon generally sets over the region in the beginning of July and lasts up to the end of August. Rains are observed only for two months (July and August). Monsoon sets over Kerala coast around 1st June and is last to reach this region (around 1st July). On the other hand, the withdrawal of monsoon commences first from this region (around 1st September). 97% of the annual rainfall is observed during monsoon season with a highest variability in the country. The annual (251 mm) over the Thar Desert is also least in the country. The cumulative seasonal monsoon rainfall over Thar Desert during recent 56 years (1957-2012) is shown in fig. 6.3.1.

Generally, monsoon withdraws from the region during middle of September. Afterwards, day and night temperatures again start rising and the hot conditions prevail up to the end of October, although the weather during this period (middle of September to October) becomes comparatively hot and dry with clear sky. The day temperatures range 35 to 40 deg. Celsius. A high pressure area develops over this region in the lower troposphere and the moisture incursion from Arabian Ocean stops during this period resulting in clear sky conditions. Weather during November is quite pleasant from tourist point of view.

Winter conditions start developing over the region during the beginning of November month and as a result day and night temperatures start falling slowly over the region. The peak winter conditions are observed during December and January. Winter is also very chilly over most parts of the Thar Desert. The minimum temperature even drops below freezing level on some occasions. The lowest minimum temperature of -5.9 deg. Celsius was observed at Jaisalmer on 12th January 1967. The average minimum temperature during winter months is less than 10 deg. Celsius. Winters are also extreme over the region and generally continue up to the middle of February.

After middle of February, the day and night temperatures again start rising slowly. Weather during March month becomes pleasant from the tourist point of view. Weather during November and March months over Thar Desert attracts a lot of local and international tourists for a visit to the region. Mean monthly and extreme maximum / minimum temperatures and rainfall features over different parts of the region are shown

in Fig. 2.1 Monthly temperatures, rainfall and rainy day patterns are almost similar over different parts of the desert. However, rainfall decreases gradually as we move westwards and thus Jaisalmer district gets the least average rainfall (159 mm) and Jodhpur district gets the highest (270 mm) during monsoon season.

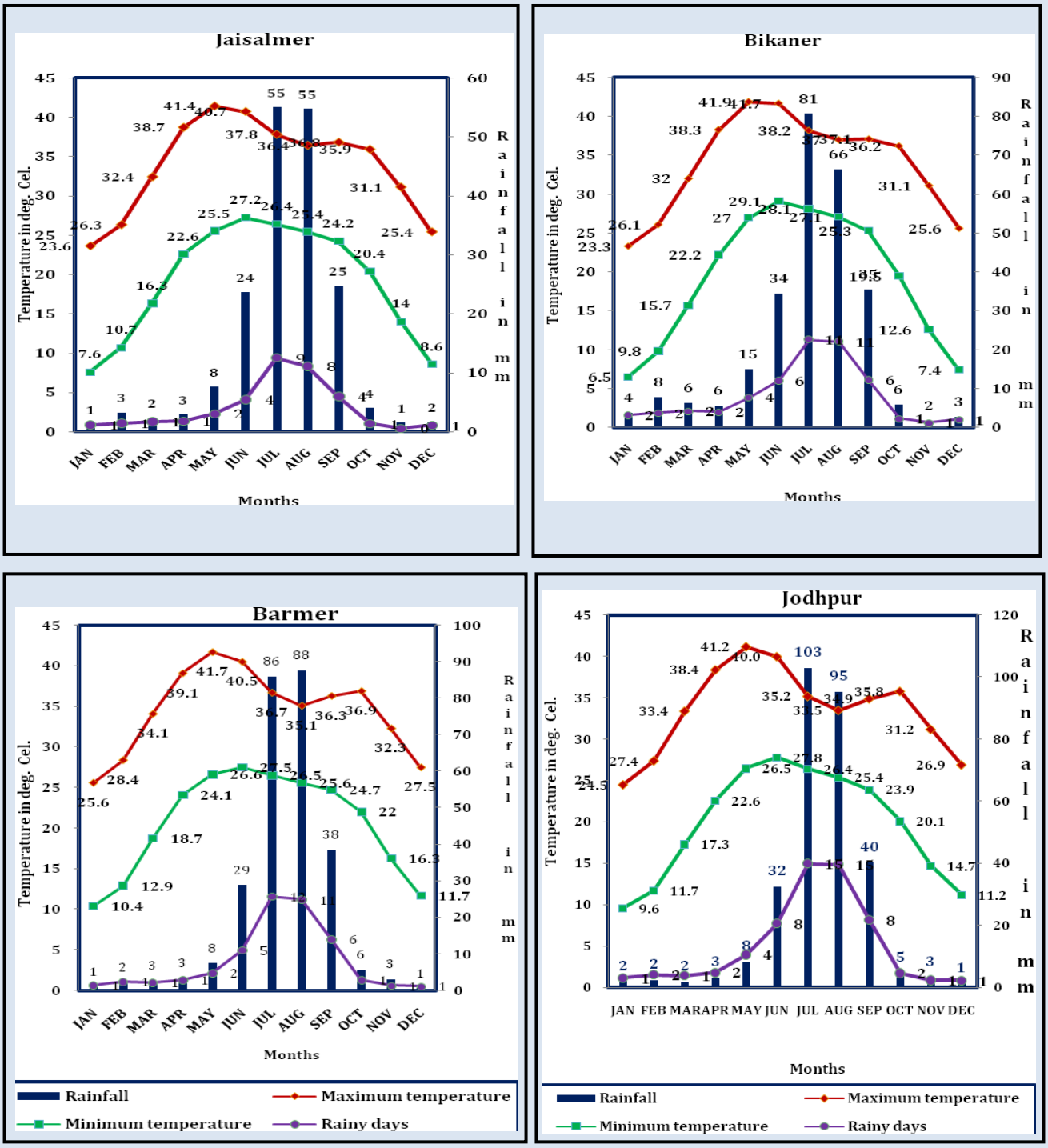

Fig. 2.1 Normal minimum, maximum temperatures, rainfall and rainy days of Thar Desert of Rajasthan

Stations	Extreme Temperatures in Degree Celsius.	
	Highest	Lowest
Jaisalmer	49.2 (4th June 1991)	- 5.9 (12 Jan. 1967)
Bikaner	49.4 (28th May1914)	- 4.0 (26 Jan 1964)
Barmer	49.1 (7th June 2011)	- 1.7 (15 Jan. 1935)
Jodhpur	48.9 (25th May 1932)	- 2.2 (31 Jan 1905)

2.1 Data Used

Daily rainfall data for the period 1957-2012 (56 years) of 30 rain - gauge stations (listed below), functioning under the state Government and India Meteorological Department at station and sub station levels has been used to define the rainfall features of Thar Desert of Rajasthan. Each station is represented by at least one rain gauge station. The district rainfall of different temporal scales has been worked out as the simple average of all stations level rain gauge. The rainfall features of the whole region are based upon the area weighted average district rainfalls.

S. No.	Districts/Stations			
	Jodhpur	Bikaner	Barmer	Jaisalmer
1	Jodhpur	Bikaner	Barmer	Jaisalmer
2	Phalodi	Lunkaransar	Chohtan	Fatehgarh
3	Bilara	Kolayat	Pachpadra	Pokran
4	Shergarh	Nokha	Sheo	Ramgarh
5	Osian	Chattargarh	Siwana	Sam
6	Bhopalgarh	Dungargarh	Baitu	Nokh
7	Jaswant Sagar	Pugal	Gudamalani	
8	Luni	Khajuwala	Ramsar	

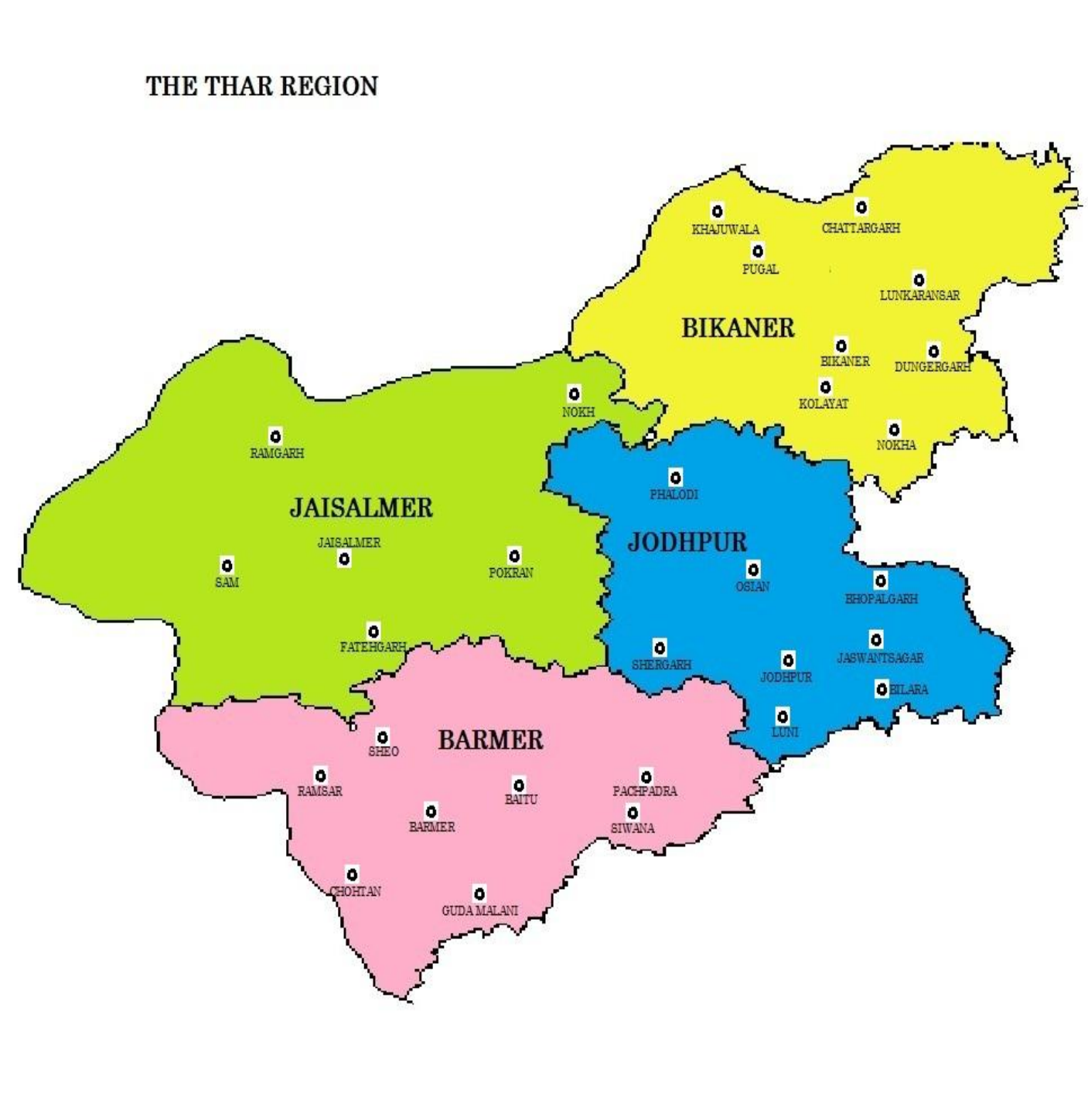

Fig. 2.2 Raingauge stations of Thar Desert of Rajasthan

CHAPTER- III

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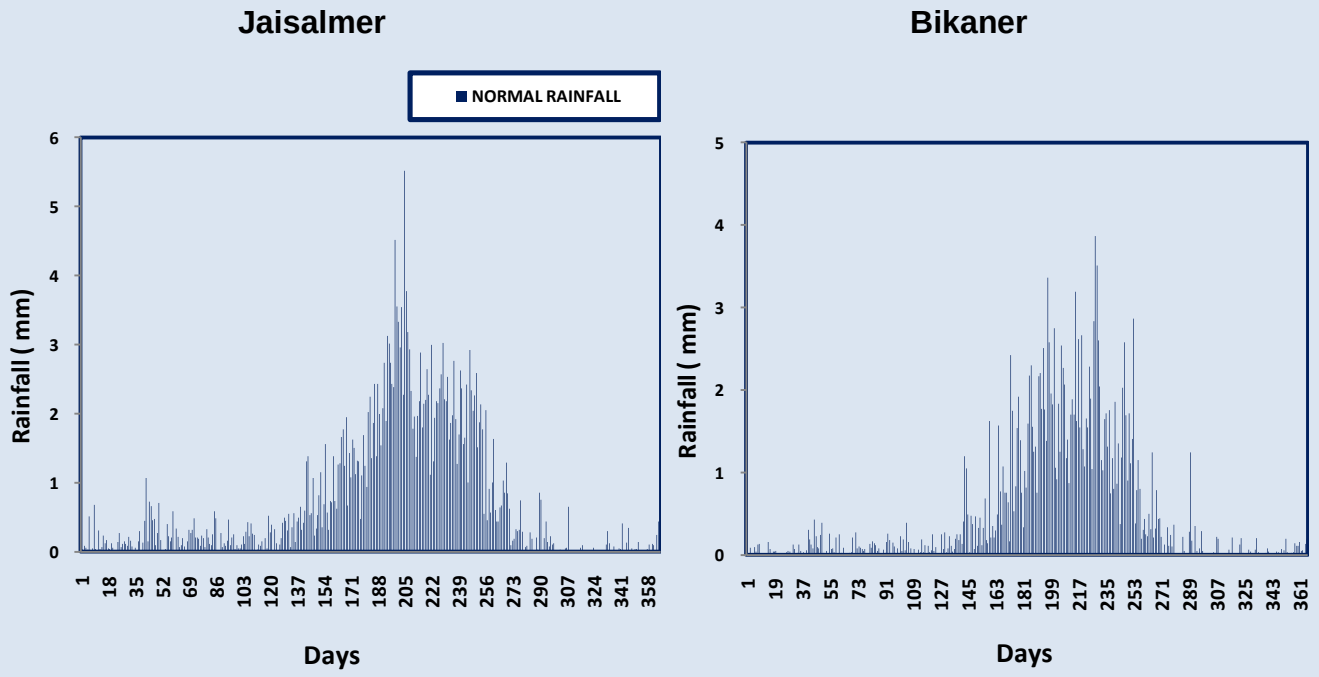
Rainfall Features

3.1 Rainfall

In this chapter daily, weekly, monthly and seasonal features of rainfall over Thar Desert have been described.

3.1.1 Daily Rainfall Description

Daily district wise normal rainfall is shown in Fig.3.1.1.1 which shows that rainfall is insignificant during the period from January to end of May and middle of September to end of the year. The highest daily normal value of the order of 5 to 6 mm is observed around 190th to 215th day of the year. The rainfall increases from beginning of July and attains its peak value around 190thto 215th day and then starts decreasing up to end of September. A drastic decrease in rainfall takes place after the 300th day and there are occasional spells of rain during rest days of the year.



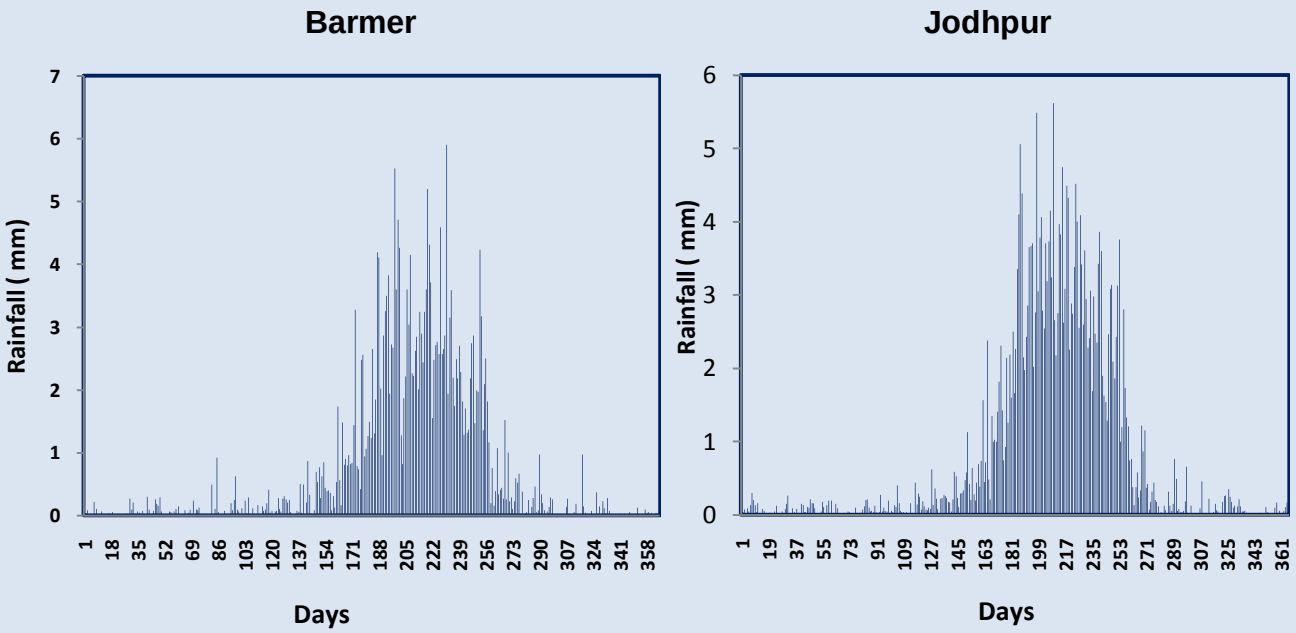
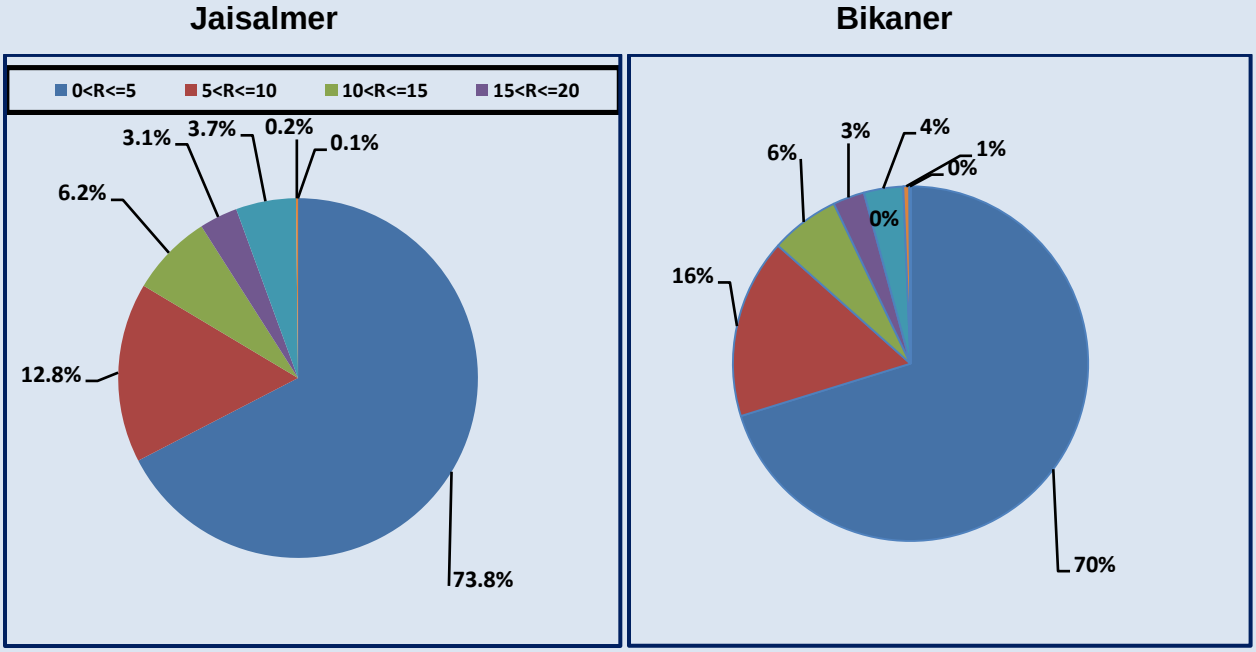


Fig. 3.1.1.1 Daily normal rainfall over different parts of Thar Desert

Daily district wise normal rainfall distribution in different range is shown in Fig.3.1.1.2 which reveals that in about 70 to 74% cases the daily rainfall occurs less than 5 mm ; in 13 to 16% cases it ranges between 5 to 10 mm and in 6 to 7 % cases it ranges between 15 to 20 mm. The daily rainfall exceeding 50 mm is rare. However , there are cases when it was observed in the range of 50 to 150 mm and even more also.



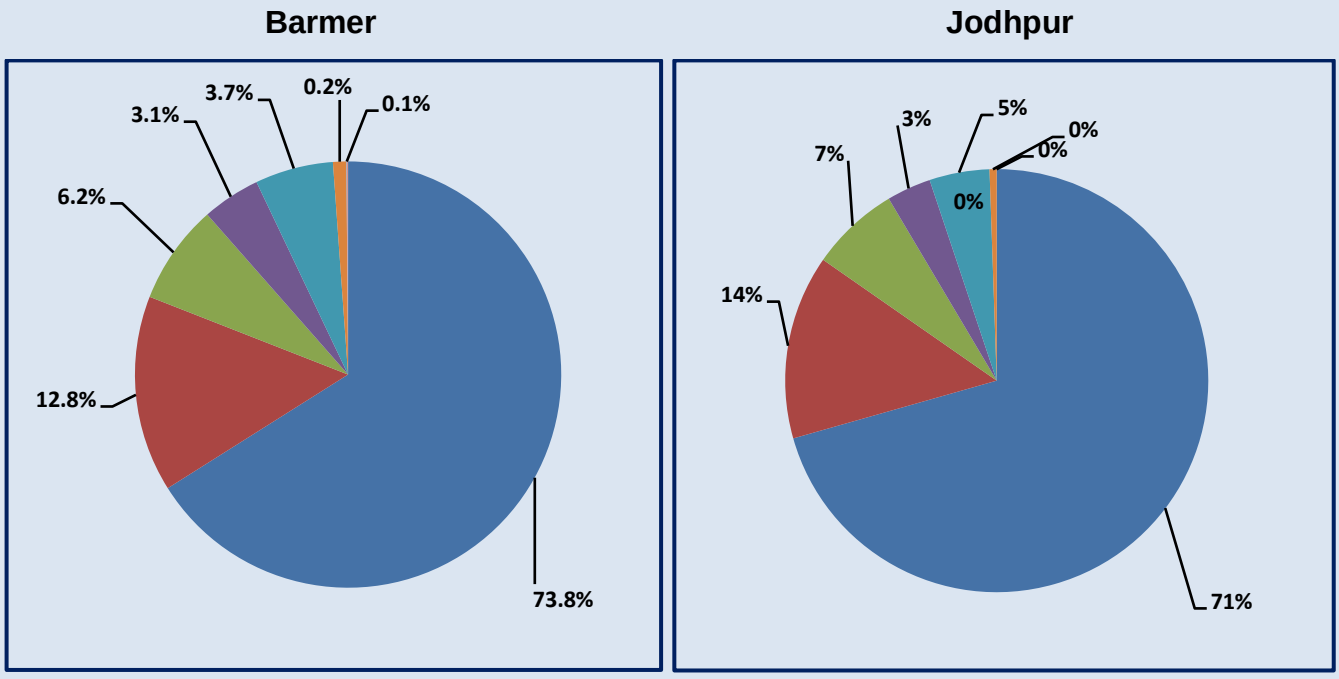


Fig.3.1.1.2 Daily rainfall distribution in different ranges over different districts of Thar Desert of India

3.1.2 Weekly Rainfall Description

Weekly normal rainfall over Thar Desert gradually increases from 24th week to 29th week and then gradually decreases up to 42nd week (Fig. 3.1.2.1). A sudden increase in weekly rainfall during 33th and 36th week is also observed. The highest (21 mm) rainfall is observed during 29th week (first week of August). The weekly rainfall decreases drastically even to less than 2 mm from 40th week (1st week of October) onward. This trend continues up to the 20th week (end of May). Weekly rainfall during peak monsoon season varies between 12 to 21 mm. During Monsoon season weekly rainfall attains its highest value during 5 weeks time (9 mm during 25th week to 21 mm during 29th week) while abatement takes place in 10 weeks time (21 mm during 29th week to 4 mm during 39th week). District wise weekly normal rainfall over the Indian Thar Desert and its parts is shown in figure 3.1.2.1

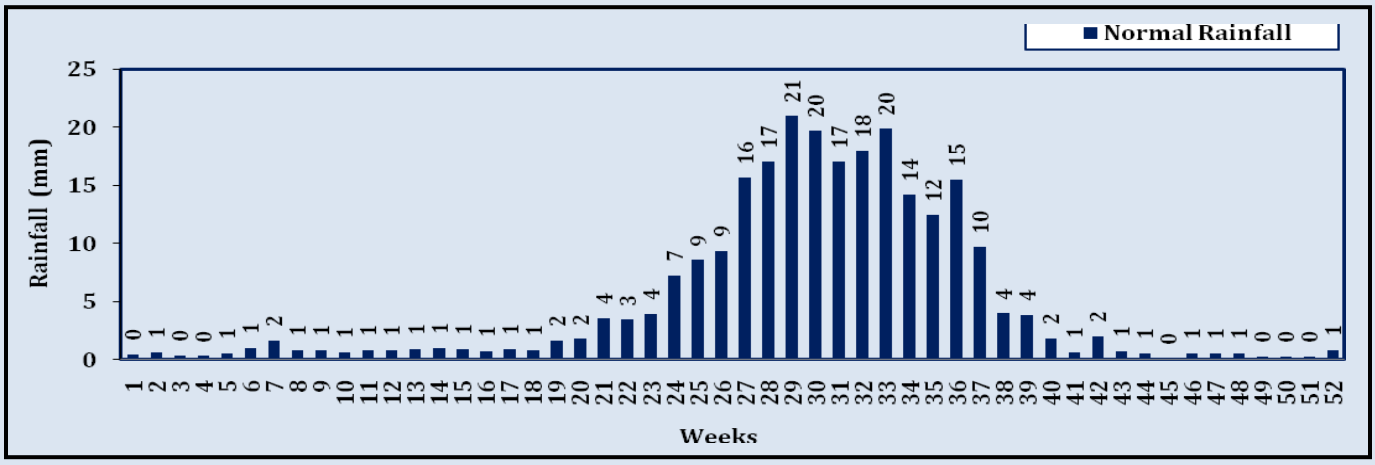
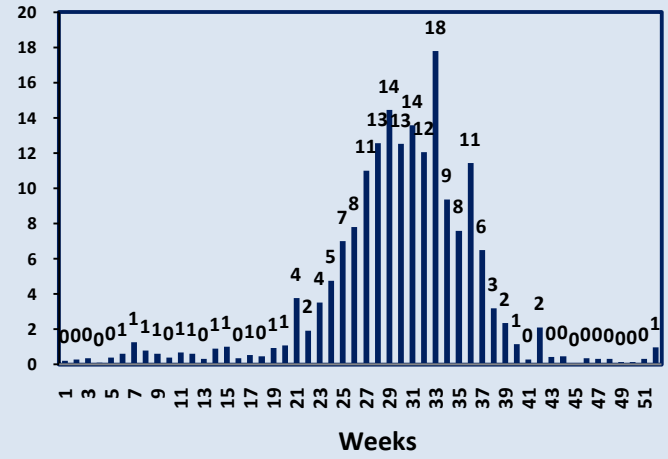
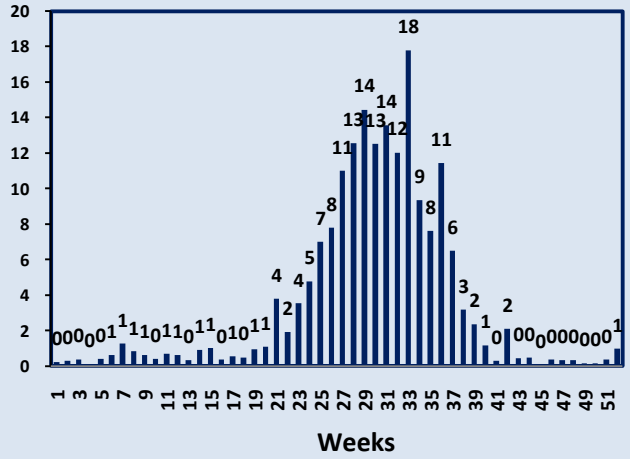


Fig.3.1.2.1 Weekly normal rainfall over Thar Desert.

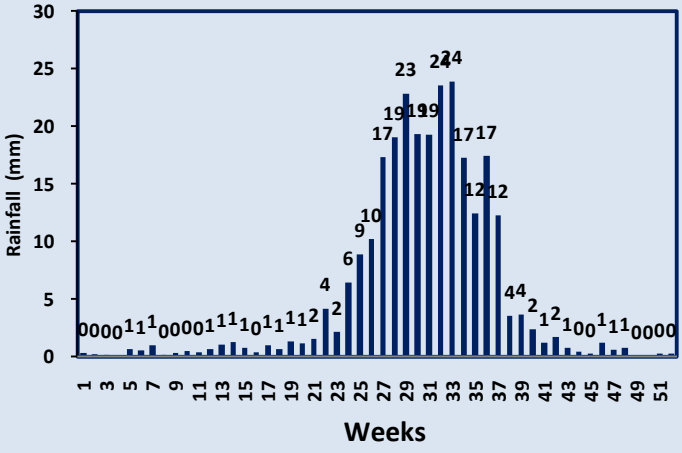
Jaisalmer



Bikaner



Barmer



Jodhpur

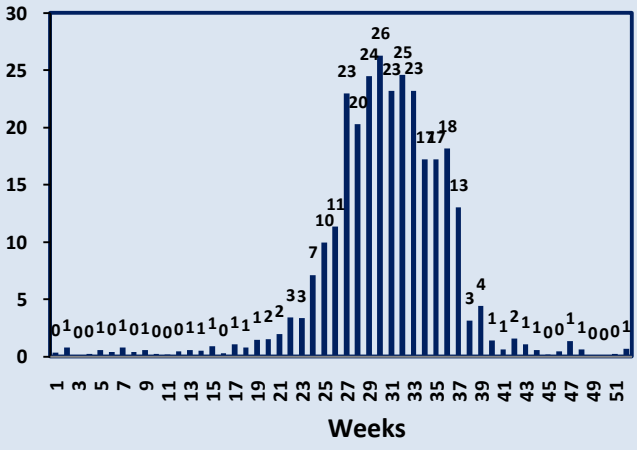


Fig.3.1.2 .2 Weekly normal rainfall over different parts of Thar Desert of Rajasthan

3.1.3 Monthly Rainfall Description

Monthly normal rainfall distribution of Thar Desert is shown in Fig.3.1.3.1 and Fig.3.1.3.2.These figures show that the highest monthly rainfall of 80 mm (32% of annual rainfall) is realized in July and 74 mm(29% of annual rainfall) rainfall is observed during August. The total monthly rainfall is insignificant (less than 11 mm) in all other months of the year except monsoon months (June to September) . The monthly rainfall during June and September is 30mm and 34 mm respectively. The July and August are the main rainy months. Monthly rainfall is about 2% or less of the annual rainfall in the each month during the period from October to April . It is 4% in May.

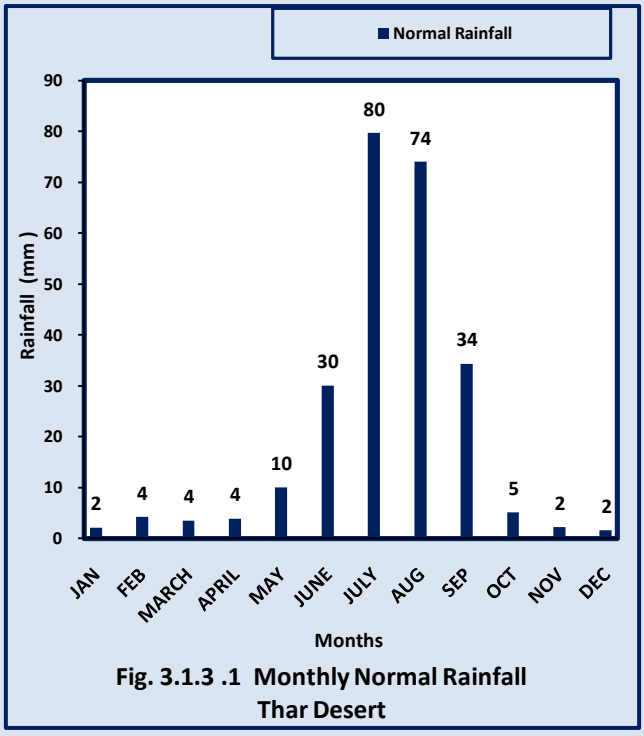


Fig. 3.1.3 .1 Monthly Normal Rainfall Thar Desert

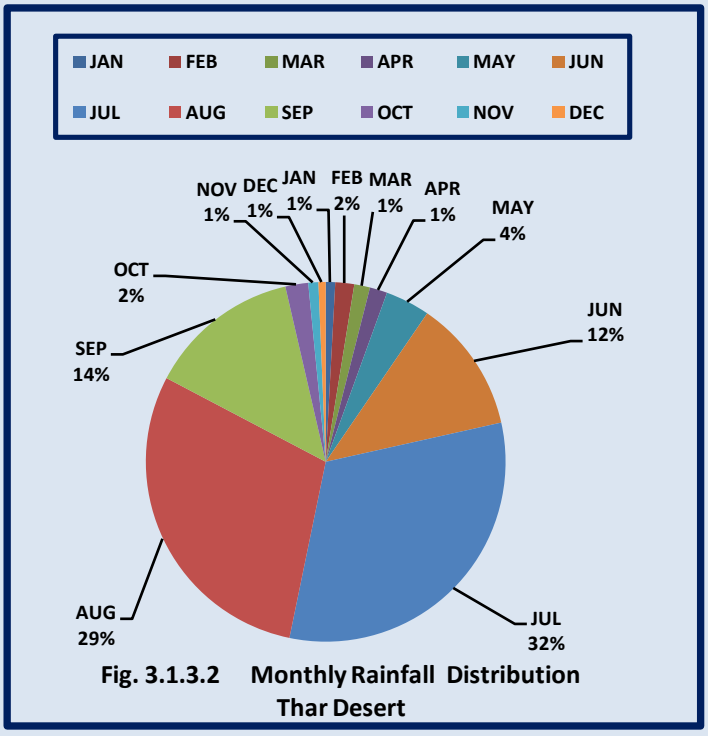


Fig. 3.1.3.2 Monthly Rainfall Distribution Thar Desert

Fig. 3.1.3.1 Fig. 3.1.3.2

(Monthly normal rainfall of Thar Desert of Rajasthan)

3.1.4 Seasonal / Annual Rainfall Description

Seasonal and annual normal rainfall distribution along with their variability (in terms of Standard Deviation & Coefficient of Variation) is shown in Fig. 3.1.4.1 and Fig. 3.1.4.2 Total annual normal rainfall of Thar Desert is 251 mm with 38% coefficient of variation (CV). Total rainfall during post monsoon season is lowest (7 mm) among all seasons. The rainfall is rather more in Summer (18 mm) and Winter (8 mm) seasons than Post monsoon. A significant increase in rainfall is observed from summer (18 mm) to monsoon season (218 mm). The highest (CV 184 %) rainfall variability is observed in Post Monsoon season, while the lowest (CV 42 %) in Monsoon season. About 90% of the annual rainfall is realised during the monsoon season. The contribution of winter, summer and post monsoon season's rainfall is 3%, 4% and 3% respectively.

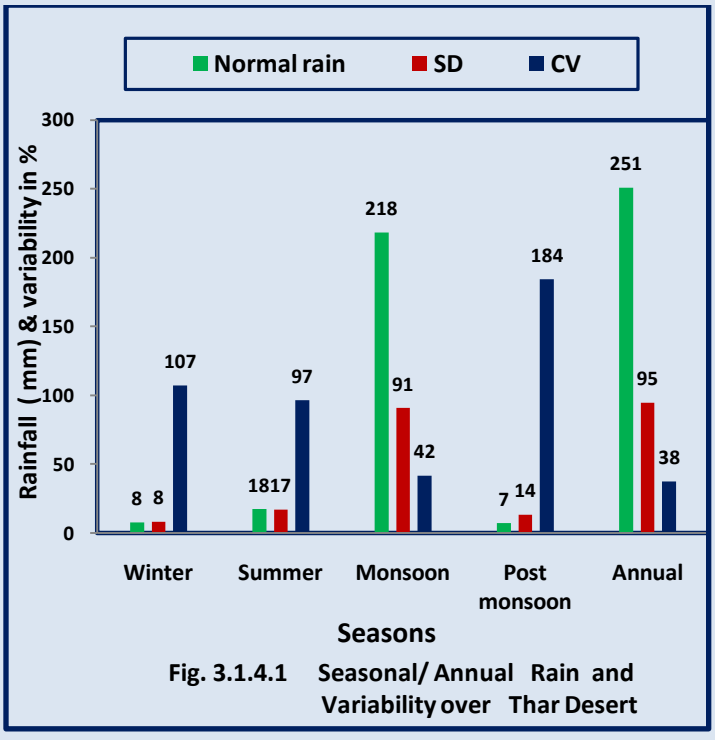


Fig. 3.1.4.1 Seasonal/ Annual Rain and Variability over Thar Desert

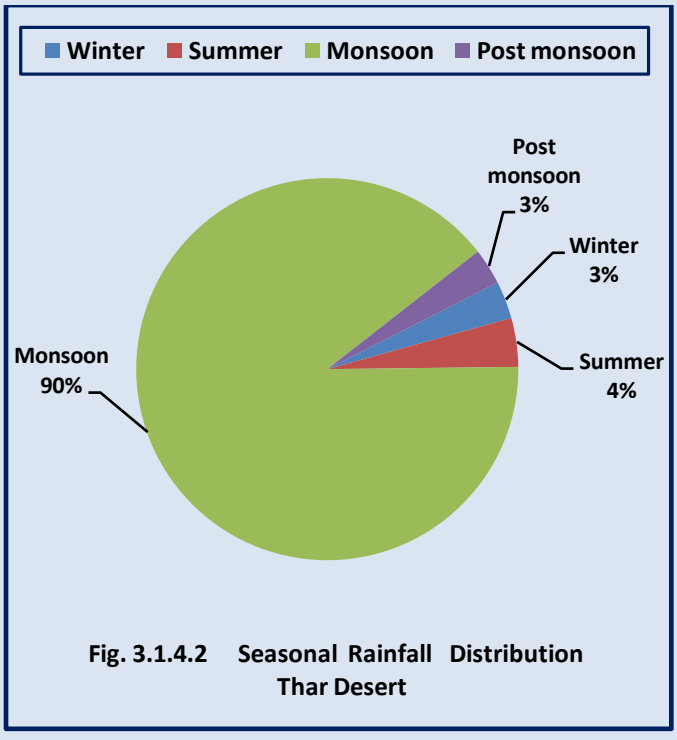


Fig. 3.1.4.2 Seasonal Rainfall Distribution Thar Desert

Fig.3.1.4.1 **Fig.3.1.4.2**

(Seasonal and annual normal rainfall of Thar Desert of Rajasthan)

The district wise seasonal, annual rainfall distribution and varibility in rainfall are shown in Fig,3.1.4.3. The lowest (182 mm) annual rainfall is observed over Jaisalmer district and the Highest (297 mm) over Jodhpur district. Bikaner (265 mm)and Barmer(267 mm) districts receive almost same order of annual rainfall. Barmer district shows larger rainfall variabilty during Summer (CV-134%), winter(CV-142%) and Monsoon (CV-59%)season in comparision to other districts of the region. But during post monsoon season,Bikaner district has largest rainfall variability among all districts.

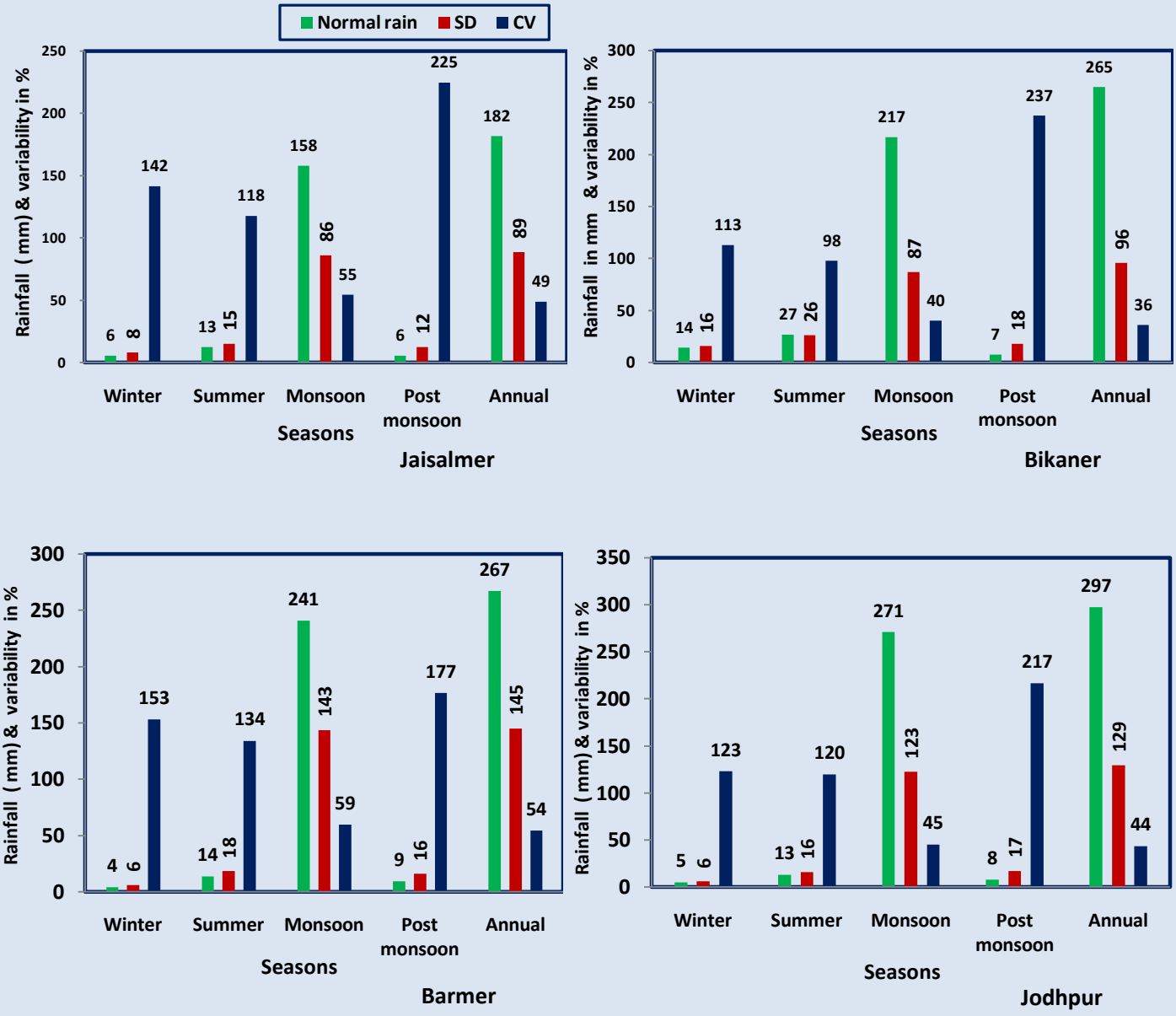


Fig. 3.1.4.3 Seasonal / Annual Rainfall and their variability over different parts of Thar Desert

3.2 Rainy Days

Annual variation of rainy days is shown in Fig. 3.2.1. The annual rainy days over Thar Desert are 88 days. The lowest (53) rainy days have been observed during year 1969 while the highest (148) days during year 1979. The normal annual rainy days over Jaisalmer, Bikaner, Barmer and Jodhpur districts are 35, 48, 43 and 59 days, respectively. The lowest (15, 29, 21) rainy days were observed in Jaisalmer, Bikaner and Barmer districts during the years 1969and 2002 both, respectively while Jodhpur district observed lowest (18) rainy days during the year 2009. The highest (56, 74,66 & 117) rainy days were observed over Jaisalmer, Bikaner,Barmer and Jodhpur districts during the years 1961, 1997,1994 and 1979, respectively.

Weekly normal rainy days are less than 1 day during the whole year except the monsoon season. During 27th to 34th week the normal weekly rainy days are about 2 to 3 days over Jaisalmer, Bikaner and Barmer districts while these are 3 to 4 days over Jodhpur district. On the other hand, there are instances during winter , summer and post Monsoon season when rainfall is observed on more than 5 days in a week (6th,7th ,14th& 50th) in Bikaner district and (13th , 15th , 47th , & 51th weeks) in Jodhpur district . Fig.3.2.2 & 3.2.3).

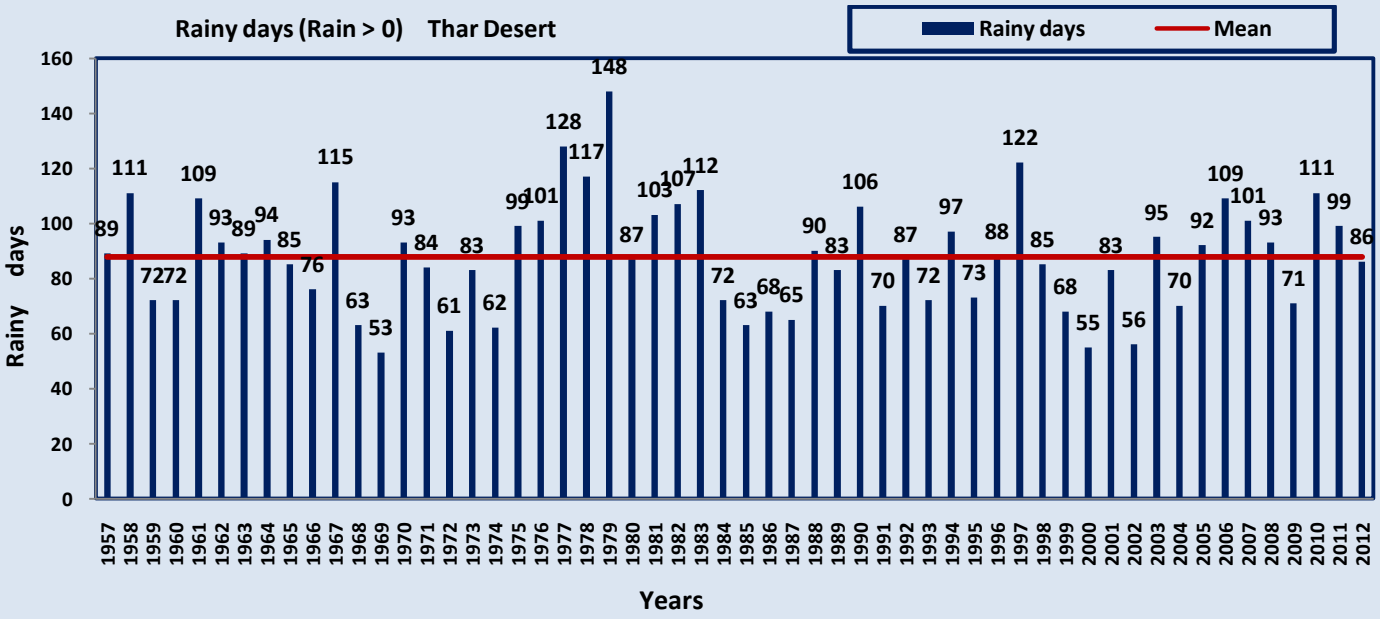


Fig. 3.2.1 Rainy days variability over Thar Desert

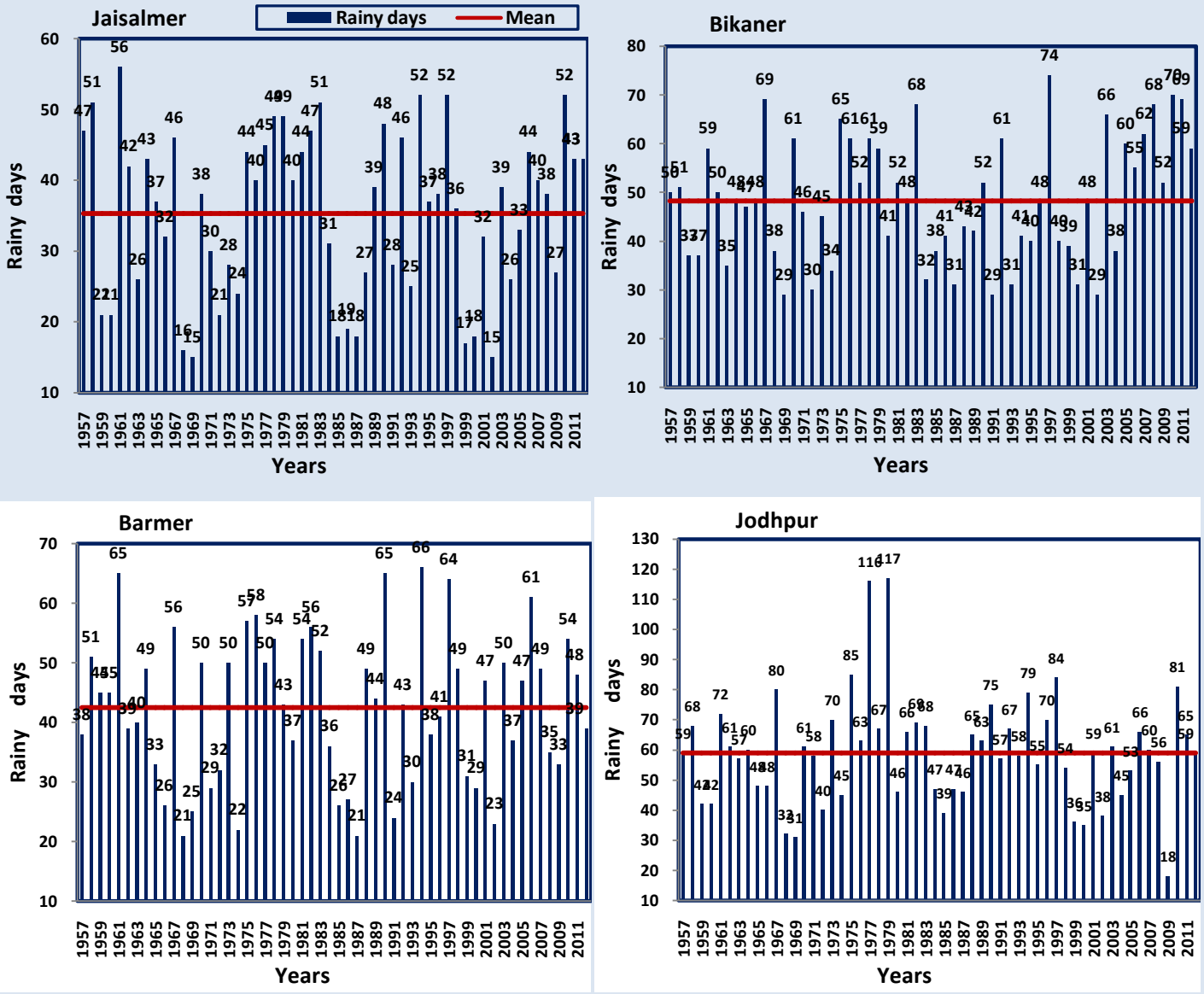
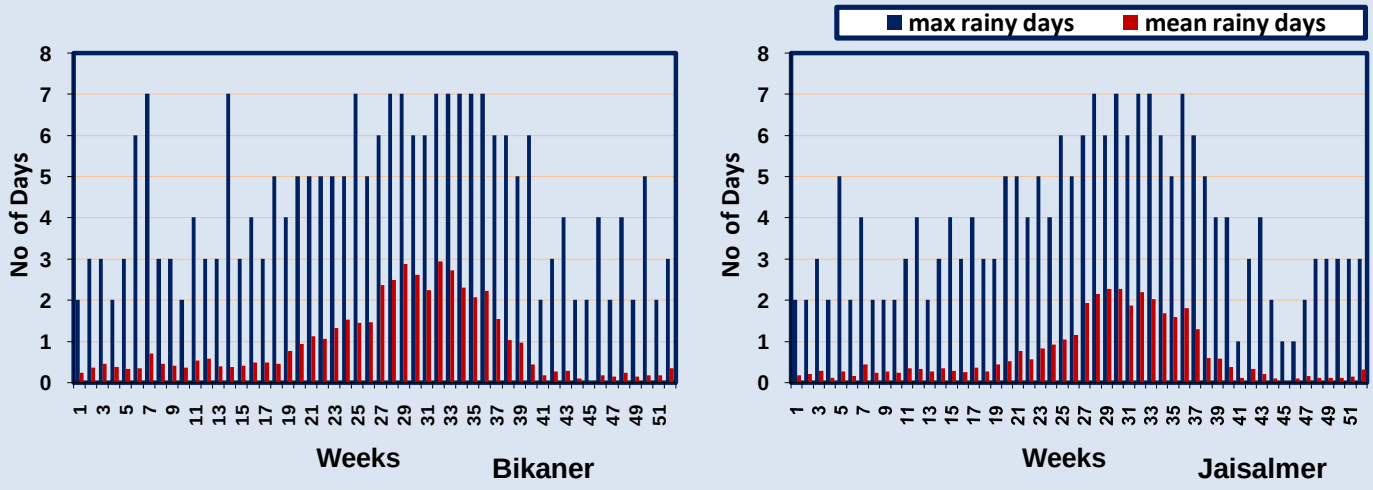


Fig.3.2.2 Rainy days variability over different districts of Thar Desert



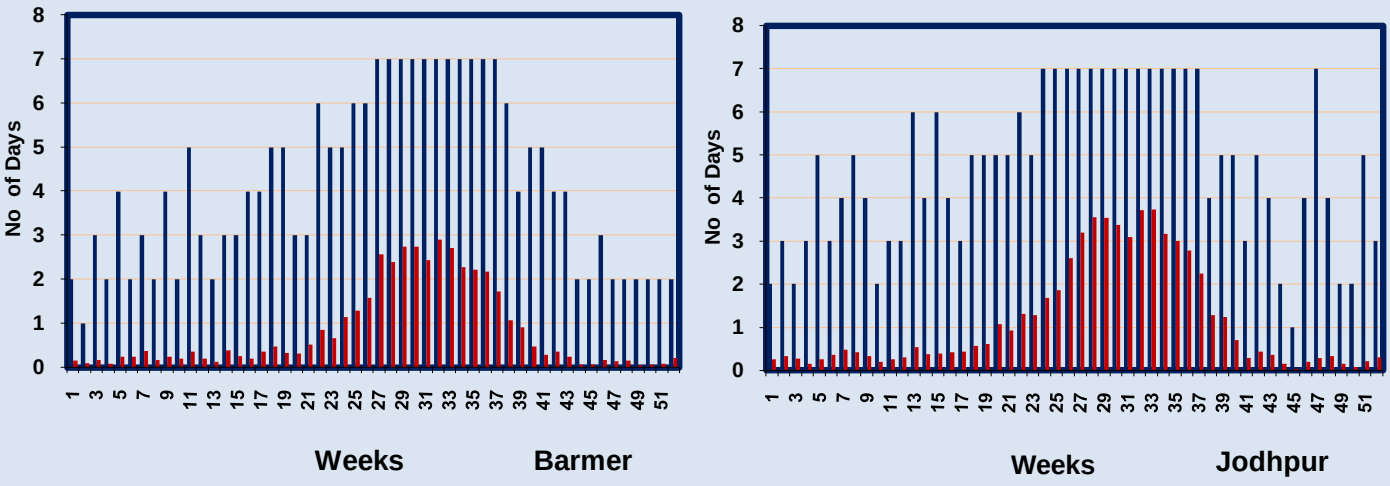


Fig. 3.2.3 Weekly normal and maximum rainy days over different disticts of Thar Desert

3.3 Probability Distribution of Weekly Rainfall

The weekly probability distributionof rainfall over Thar Desert is shown in Fig.3.3.1. The prbability of weekly rain less than 5 mm during the periods 1st to 20th week and 39th to 52nd week is even less than 25%. During peak monsoon season,the probability of weekly rain less than 5 mm is more than 75% ; between 11 and 17 mm is about 50% and more than 17mm is only 25%.

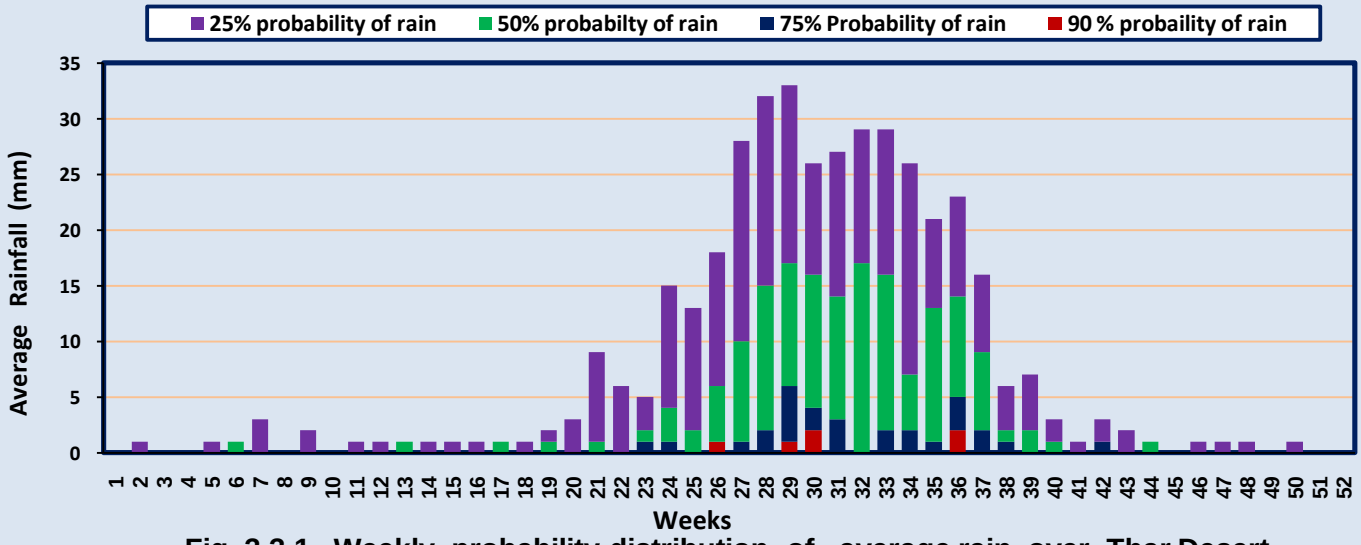


Fig. 3.3.1 Weekly probability distribution of average rain over Thar Desert

Year to year weekly rainfall distribtion over Thar Desert is shown in Fig. 3.3.2. Out of 52 weeks in a year, normally 27 weeks get rainfall. The distribution among weeks is: 17 weeks between 0.1 and 5 mm; 3 weeks between 5 and 10 mm; 2 weeks between 10 and 15 mm; 1 weeks between 15 and 20 mm; 3 weeks between 20 and 50 mm; 1 weeks between 50 and 100 mm; 06 weeks between 100 and 150 mm and 1 week between 150 to 200 mm rainfall. The average weekly rainfall in different ranges is shown in Fig.3.3.3. In about 49% cases the weekly rainfall observed is less than 5 mm. The rainfall range is 5 to 10 mm in 11% cases ; 10 to 15 mm in 7% cases ; 15 to 20 mm in 5% cases ; 20 to 50 mm in 15% cases ; 50 to 100 mm in 10% ; 100 mm to 150 mm in 0.5 % cases and in 150 mm to 200 mm in only 0.1 % cases.

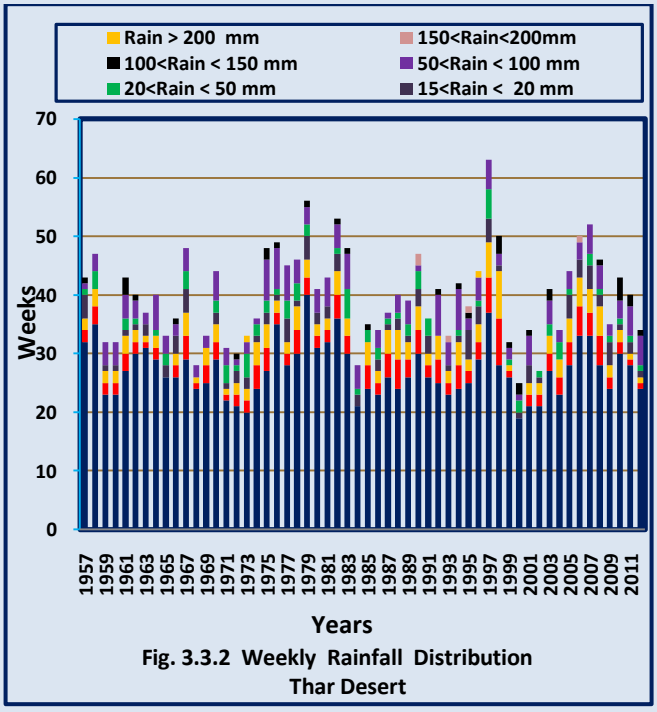


Fig. 3.3.2 Weekly Rainfall Distribution Thar Desert

Fig. 3.3.2

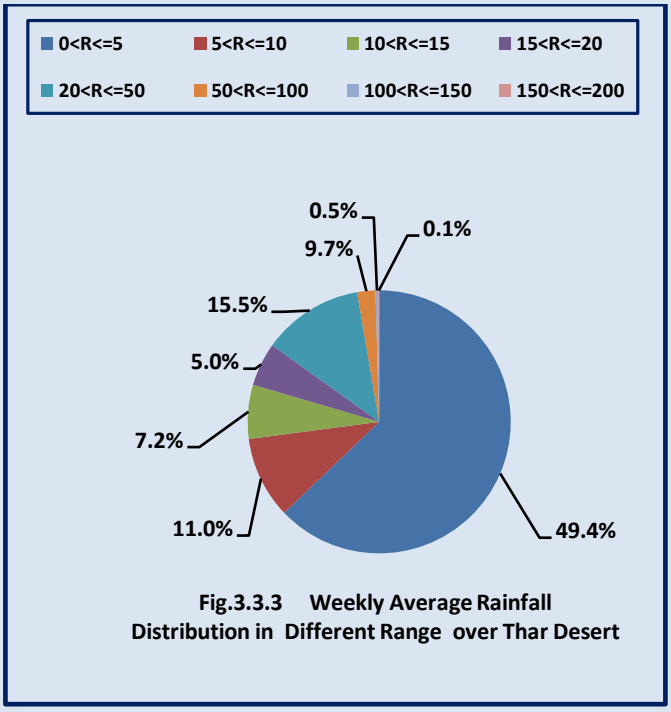


Fig.3.3.3 Weekly Average Rainfall Distribution in Different Range over Thar Desert

Fig. 3.3.3

Weekly Probability distribution of dry (rain < 5mm) and wet (rain > 5 mm) weeks under different conditions is shown in Fig. 3.3.4. It can be concluded that probability of occurance of dry weather during different weeks of winter, first half of

summer and post monsoon seasons is more than 80% . Probability of two successive wet weeks is less than 20% during these seasons. Chances of rainy weeks gradually increases from 20% (22nd week) to more than 90% (30th week) . The probability of wet week during July and August months lies between 90 to 100%. The chances of two successive wet weeks is about 60 to 80% during these two months . The probability of wet week when its preceding week is dry, is also very high (more than 90%) during these two months. All these prbabilitites gradually decease after 33rd week onwards and become even less than 20% during 40th week.

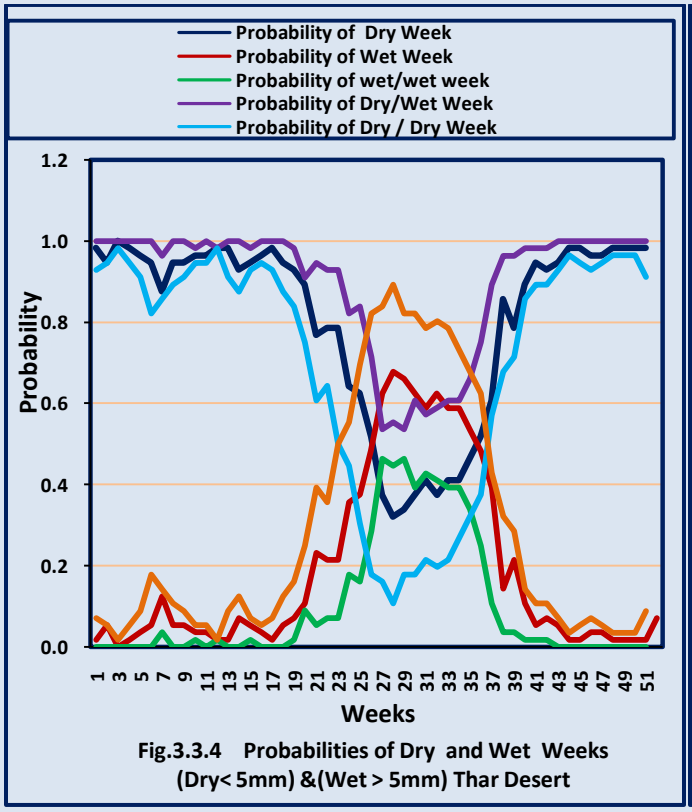


Fig.3.3.4 Probabilities of Dry and Wet Weeks (Dry< 5mm) &(Wet > 5mm) Thar Desert

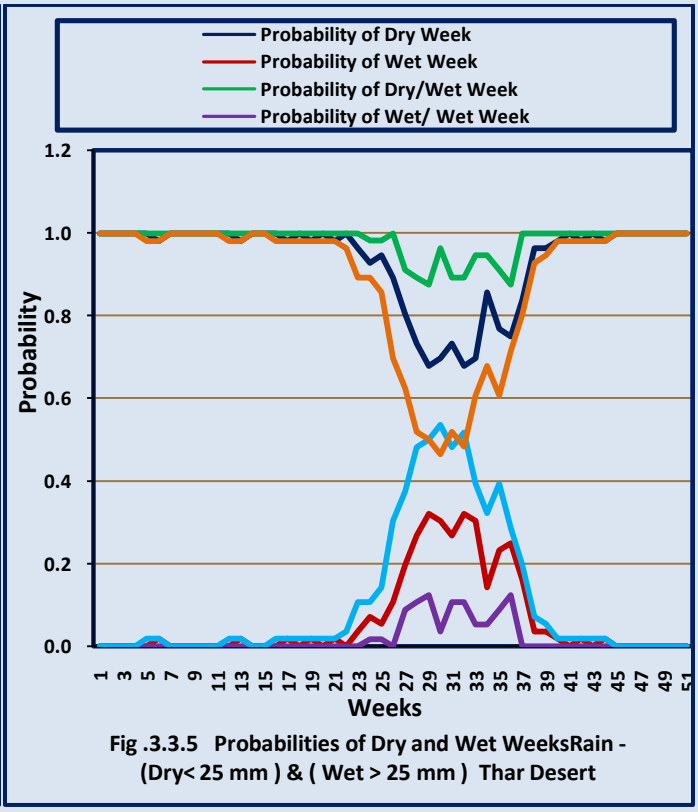


Fig .3.3.5 Probabilities of Dry and Wet WeeksRain - (Dry< 25 mm) & (Wet > 25 mm) Thar Desert

CHAPTER- IV

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Winter Season

Winter season over the Thar Desert begins from December and lasts upto the month of February. Peak winters are observed in January. Rainfall is realised over the area during passage of western isturbances over the nortern parts of Rajasthan interacting with easterly waves from south.

4.1 Monthly Rainfall Distribution

Monthly rainfall distribution over the Desert area is shown in Fig.4.1.1. The lowest (1.6mm, 20% of seasonal rain) monthly rainfall is realised in December, the highest (4.3 mm, 53% of seasonal rain) is realised in February and about 2.1mm (27% of the seasonal rain) in January.

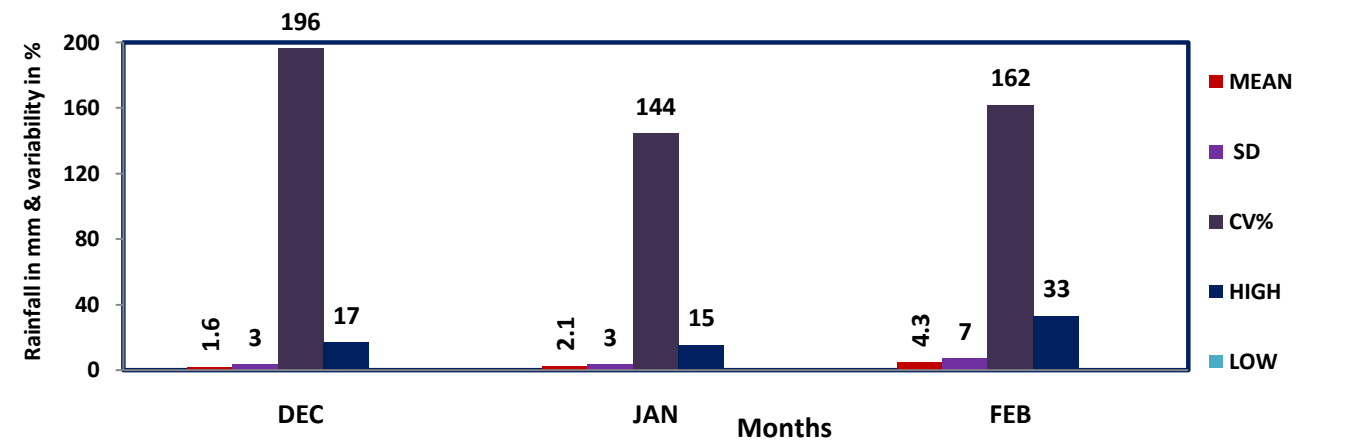

Fig. 4.1.1 Monthly rainfall features during winter season over Thar Desert

The variability of monthly rainfall during winter season is shown in Fig. 4.1.2. It can be conluded that during this season the normal rainfall is 8 mm only. During February month the total rainfall does not exceed 33mm while in December and January the total monthly rainfall does not exceed 17 mm and 15 mm respectively. The normal monthly rainfall during December, January and Febuary is 1.6 mm, 2.1 mm and

4.3 mm respectively along with their respective variability (CV) 196%, 144% and 162%. Year to year monthly rainfall variability over the whole region is shown in Fig. 4.1.2.

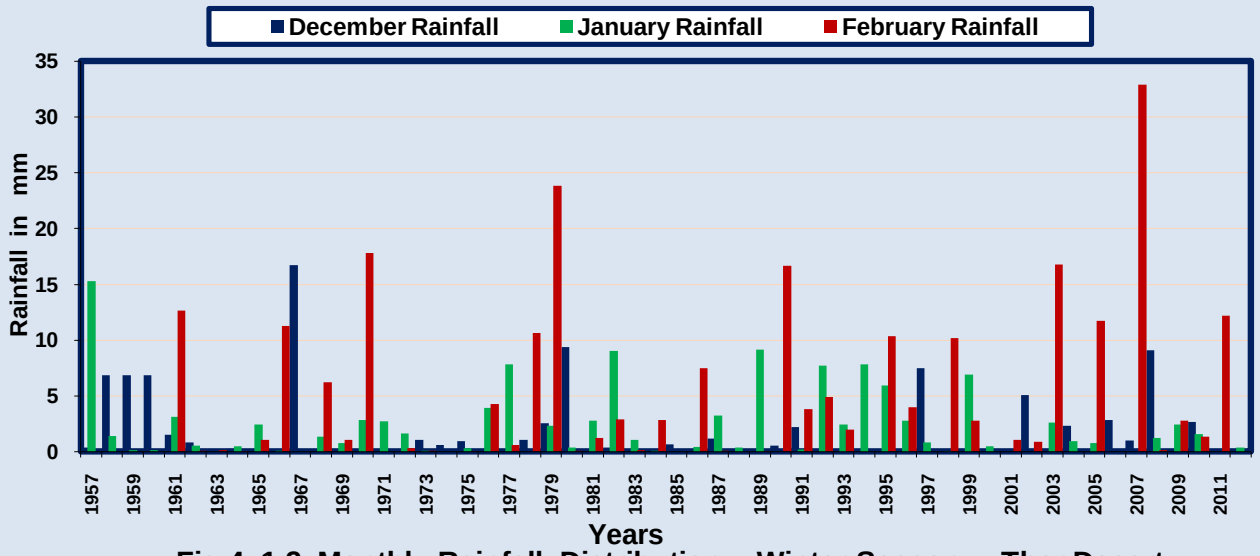

Fig.4 .1.2 Monthly Rainfall Distribution Winter Season Thar Desert

4.2 Seasonal Rainfall Distribution

Seasonal rainfall variability during winter season, as shown in Fig. 4.2.1 indicates that long period average (LPA) of winter rainfall is only 8mm with Coefficient of Variation 107%. The highest rainfall (36 mm) of this season was observed during the year 2006 while no rainfall was observed during a number of years. No significant trend in the seasonal rainfall is observed during the study period of 56 years (1956-2012) over this desert region.

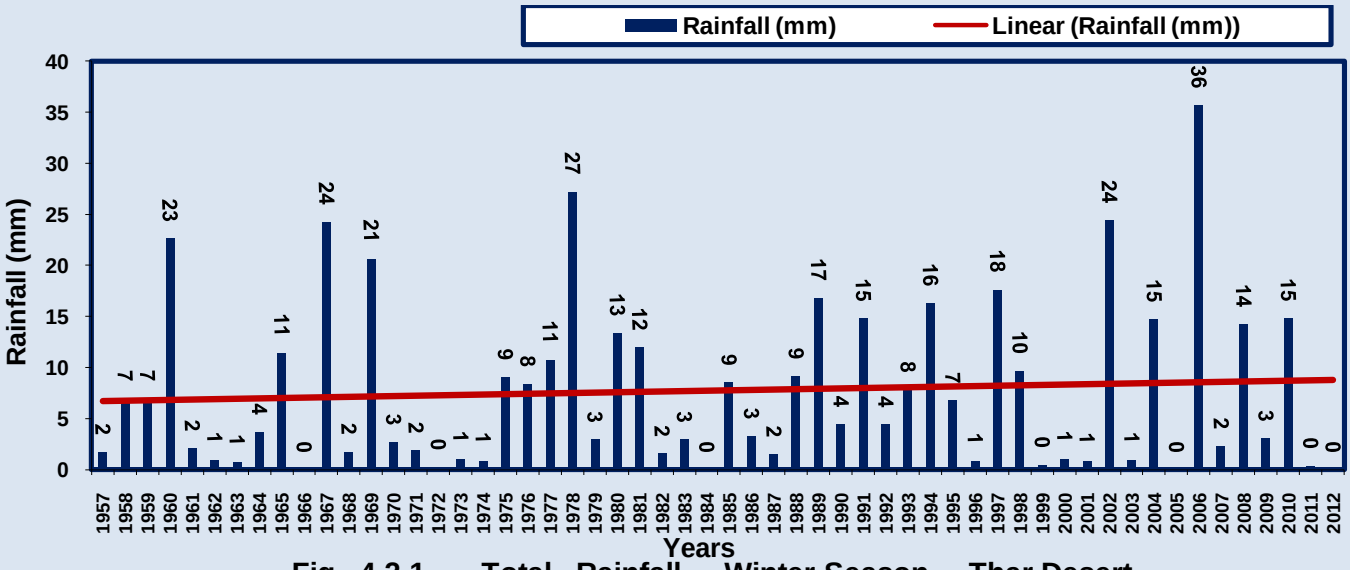

Fig. 4.2.1 Total Rainfall - Winter Season Thar Desert

CHAPTER – V

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Summer Season

Practically, May and June are the main summer months over most parts of the Thar Desert. This season begins from the month of March and lasts upto end of June. The duration of this season is also of three months,but during most of the years summers extend upto the end of June. Rainfall, during this season is generally observed in the wake of thundery activities associated with dust storm during afternoon or night hours.

5.1 Monthly Rainfall Distribution

Monthly rainfall distribution during Summer season is as shown in Fig. 5.1.1 which indicates that about 3.6 mm rainfall of this season is observed during March, 3.9 mm in April and 10.1 mm in May. April is the driest month of this season. The highest (216 %) rainfall variability is observed in March and the lowest (112%) in May. The monthly rainfall has not exceeded 50 mm, 36 mm and 44 mm during March, April and May months respectively . On the other hand nil rainfall has also been reported during all these months of the year.

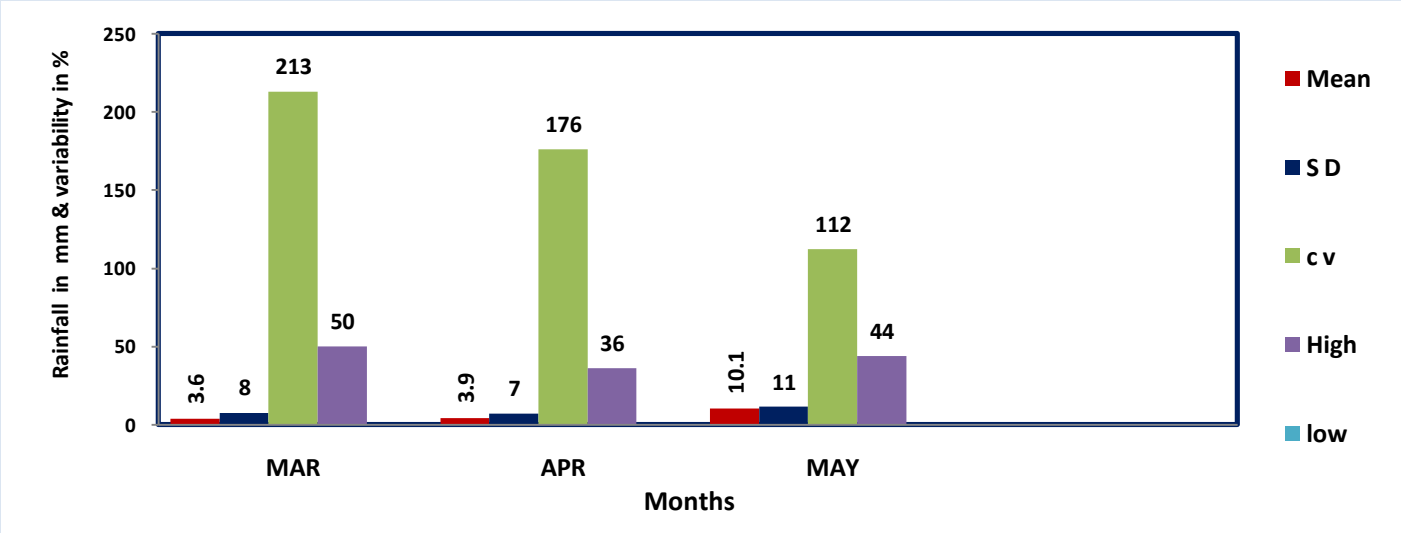

Fig. 5.1.1 Monthly rainfall features during summer season over Thar Desert

Year to year variability of monthly rain during summer season is as shown in Fig. 5.1.2 which reveals that monthly rainfall is not significant (less than 10 mm) on most ocassions during March and April during the study period. During the year 1967, March month received about 50 mm of rainfall, which is highest monthly rainfall ever recorded in this month. During the years 1982 and 1983, both April and May months observed very good total rainfall (30 to 40 mm).

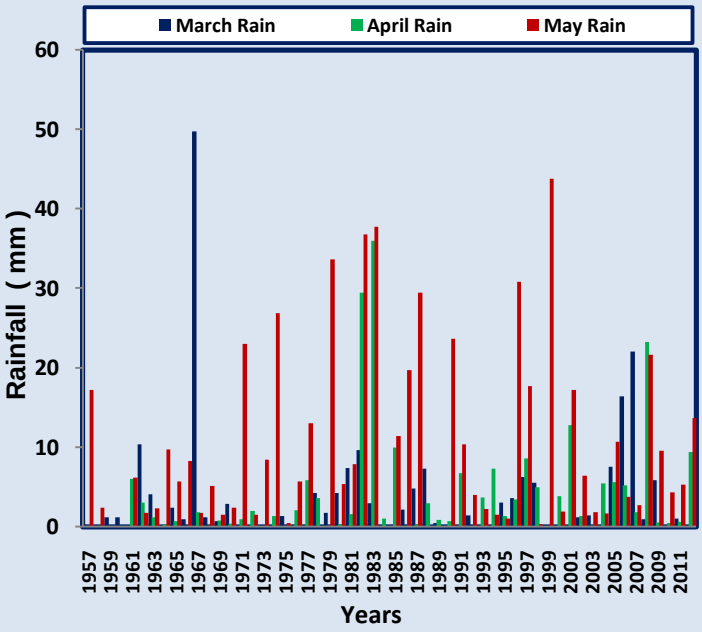

Fig. 5.1.2. Monthly Rainfall Distribution Summer Season Thar Desert

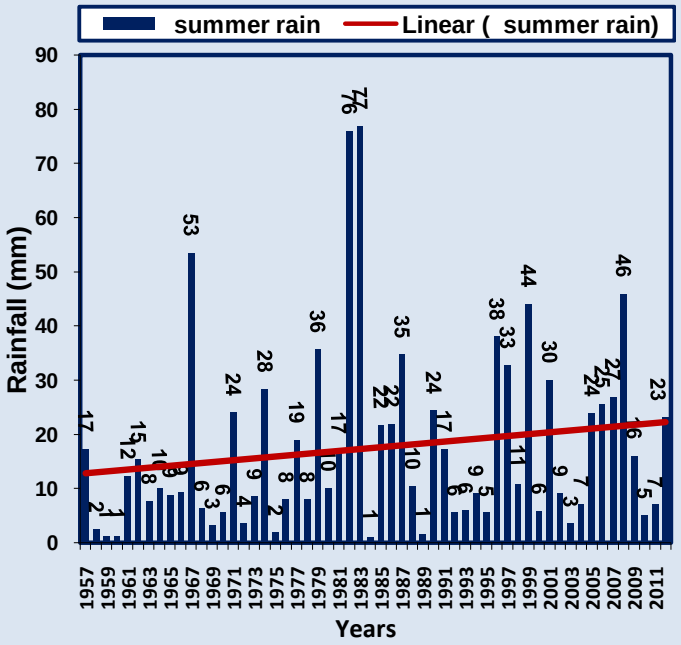

Fig.5.1.3 Summer Seasonal Rainfall variability Thar Desert

5.2 Seasonal Rainfall Distribution

Variability of the seasonal rainfall is shown in Fig. 5.1.3. It can be concluded from the figure that average summer season rainfall of Thar Desert is 18 mm with 97% of variability. The highest (77 mm) seasonal rainfall was observed during the year 1983 while the lowest (0.0 mm) during the year 1980 only. During early part of the season the rainfall is not signficant. However, during the later part rainfall increases considerably due to convective activities. During the study period of 56 years (1957-2012), a slight rising trend in the seasonal rainfall is noticed over the desert area.

CHAPTER-VI

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Monsoon Season

This is the main rainy period in the Thar Desert. Most of the gross rainfall is observed during this season only. Generally monsoon sets over the region during the 1st week of July and lasts upto the middle of September. Period from June to September is considered as the Monsoon season for the district. Rainfall during this season is observed on account of low pressure systems formed in the Bay of Bengal and moving from east to NW direction and oscillation of the Monsoon trough from north to south and vice versa from its normal position. On some ocassions the rainfall over the area also occurs due to low pressure area formed over north Arabian ocean and its movement towards south Rajasthan. Heavy rainfall over the region is generally realised with the interaction of western disturbances and low pressure areas moving either from Bay of Bengal or Arabian ocean over and around the region. During some years low pressure areas formed over the north Arabian sea and their movement toward South east Rajasthan also gave a very good amount of rainfall over this region.

6.1 Onset and Withdrawl of Monsoon

Monsoon generally sets over the Thar Desert during first week of July and withdraws during middle of September. The year to year variability is shown in Fig. 6.1.1.

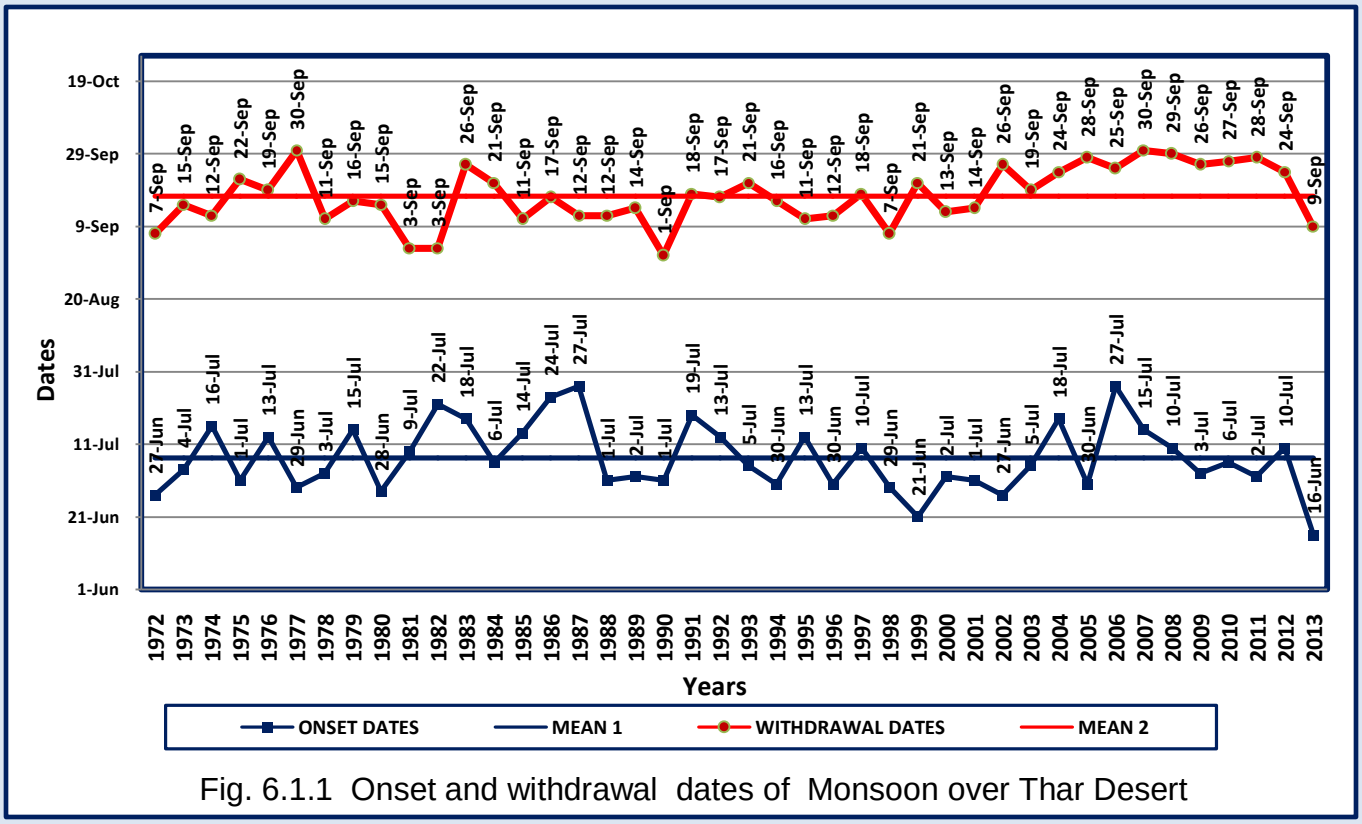

Fig. 6.1.1 Onset and withdrawal dates of Monsoon over Thar Desert

6.2 Monthly Rainfall Distribution

Monthly rainfall distribution during monsoon season is as shown in Fig. 6.2.1 and Fig. 6.2.2. Only 14% and 16% rainfall of this season is observed during June and September respectively. July and August are the main rainy months. Both these months receive about 70% rainfall of the season. July gets the highest (36%) while August receives about 34% rainfall of the season. The normal monthly rainfall of June, July, August and September are 30 mm, 80 mm, 74 mm and 34 mm respectively. The highest (108%) rainfall variability is noticed in the September month and the lowest (56%) in July. During the study period, the monthly rainfall has not exceeded the limit of 185 mm, 184 mm, 297 mm and 133 mm in June, July, August and September months, respectively.

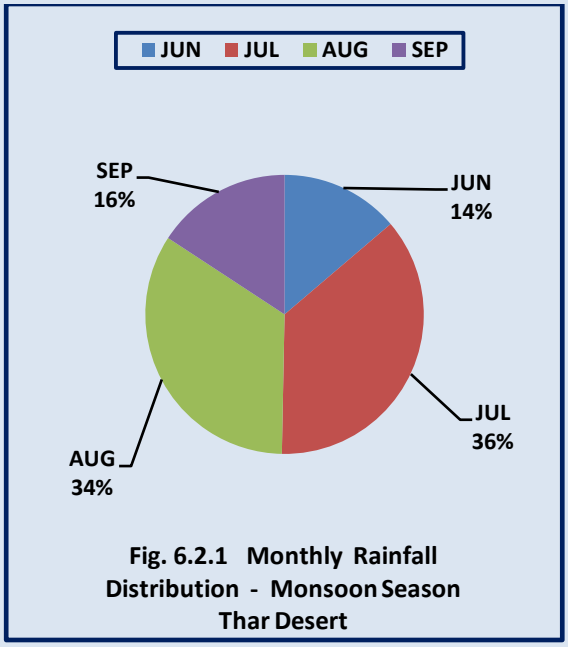

Fig. 6.2.1 Monthly Rainfall Distribution - Monsoon Season Thar Desert

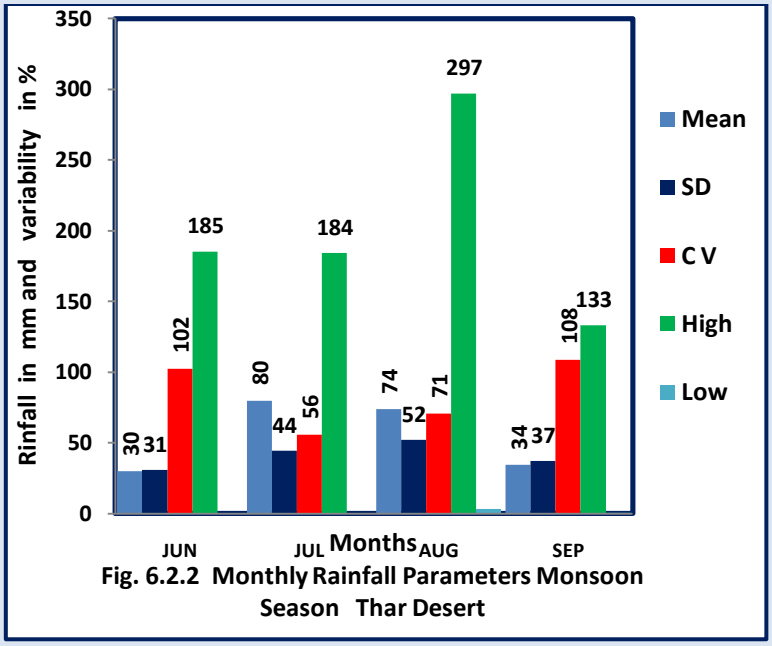

Fig. 6.2.2 Monthly Rainfall Parameters Monsoon Season Thar Desert

Fig. 6.2.1 Fig. 6.2.2

Variability of monthly rainfall for all the four months together and each month separately is shown in Fig. 6.2.3 to Fig 6.2.4. The highest monthly rainfall realised during June, July, August and September months is 185 mm (year 1996), 184 mm (year 1995), 297 mm (year 1973) and 133 mm (year 1992) respectively and the lowest monthly rainfall observed is 0.0 mm (year 1968), 0.0 mm (year 2002), 03 mm (year 1993) and 0.0 mm (year 1968) respectively.

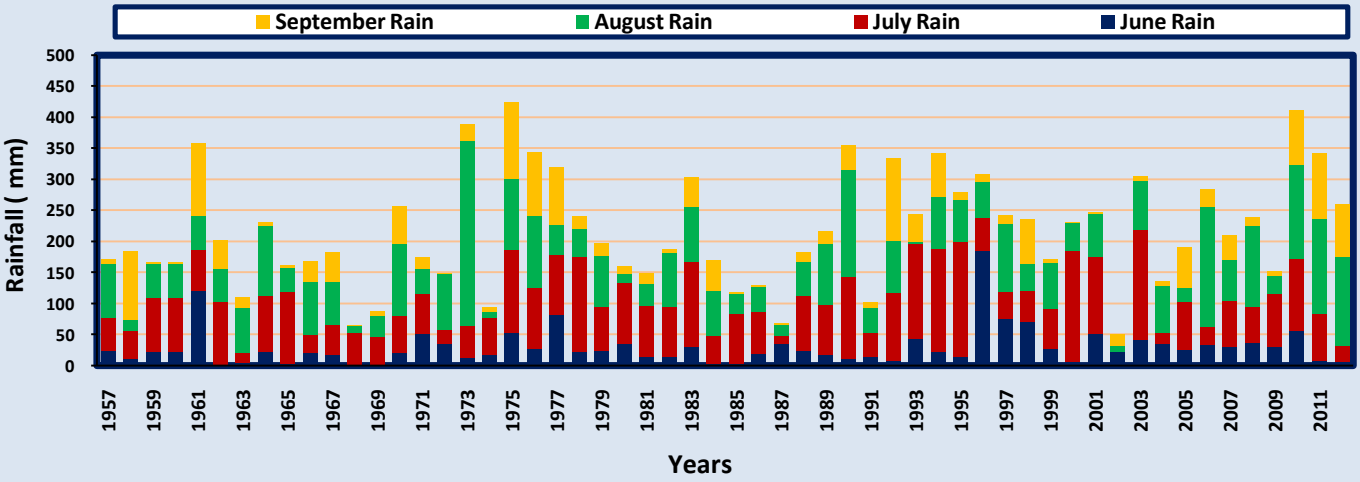

Fig. 6.2.3 Monthly Rainfall Distribution Monsoon Season Thar Desert

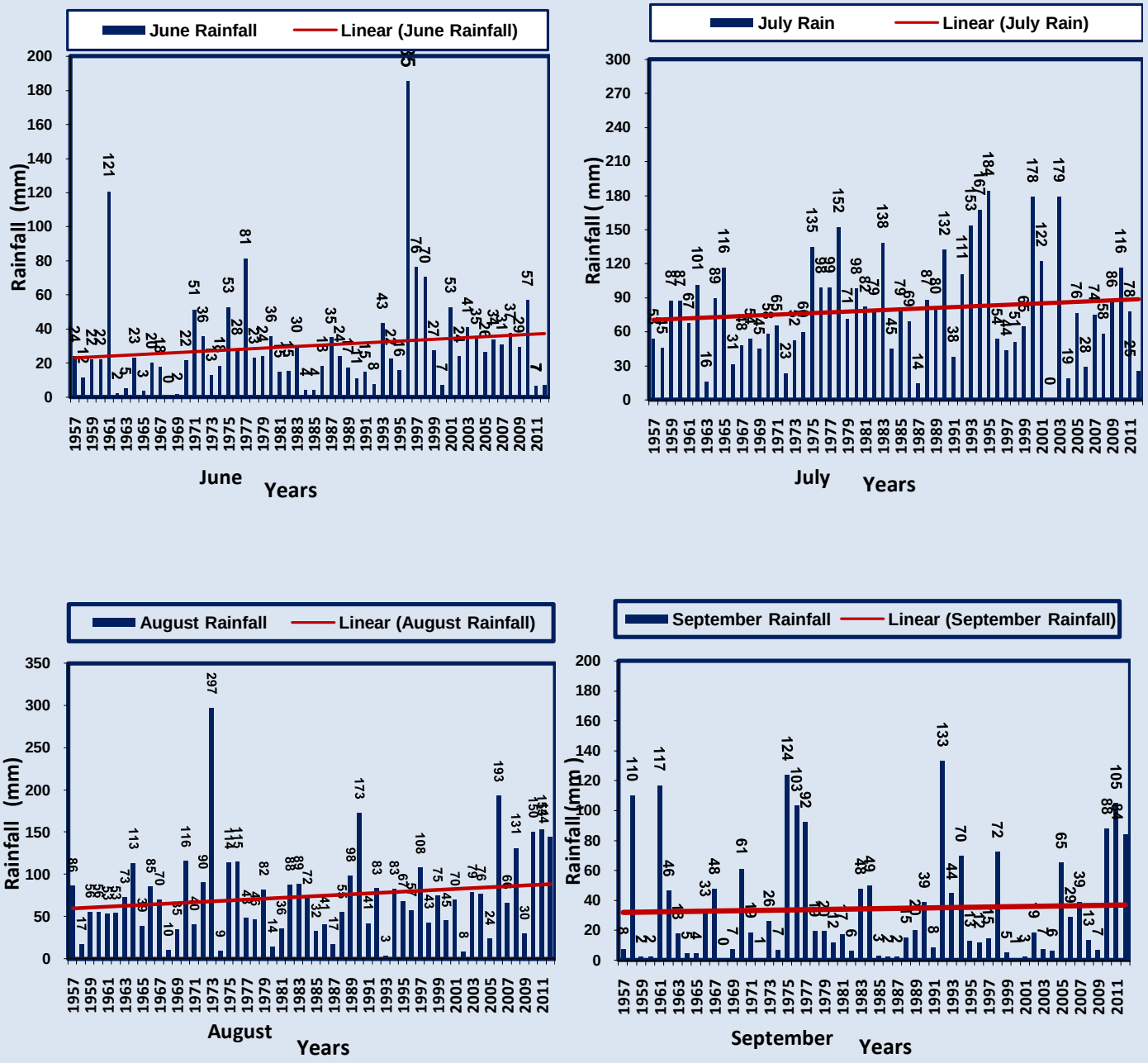

Fig. 6.2 4 Monthly rainfall variability over Thar Desert during Monsoon Season

6.3 Seasonal Rainfall Distribution

Variability of the seasonal rainfall is shown in Fig.6.3.1. The average seasonal rainfall of the Thar Desert is about 218 mm with CV 42%. The highest (425 mm) rainfall was realised during the year 1975 and the lowest (50 mm) during 2002. The year 1968, 1969, 1974 and 1987 were the severe drought years and 1961, 1973, 1975 and 2010 were the excess rainfall years for this region. No significant trend is noticed in the monsoon seasonal rainfall over the Thar desert region of Rajasthan during the study period of 56 years (1956-2012).

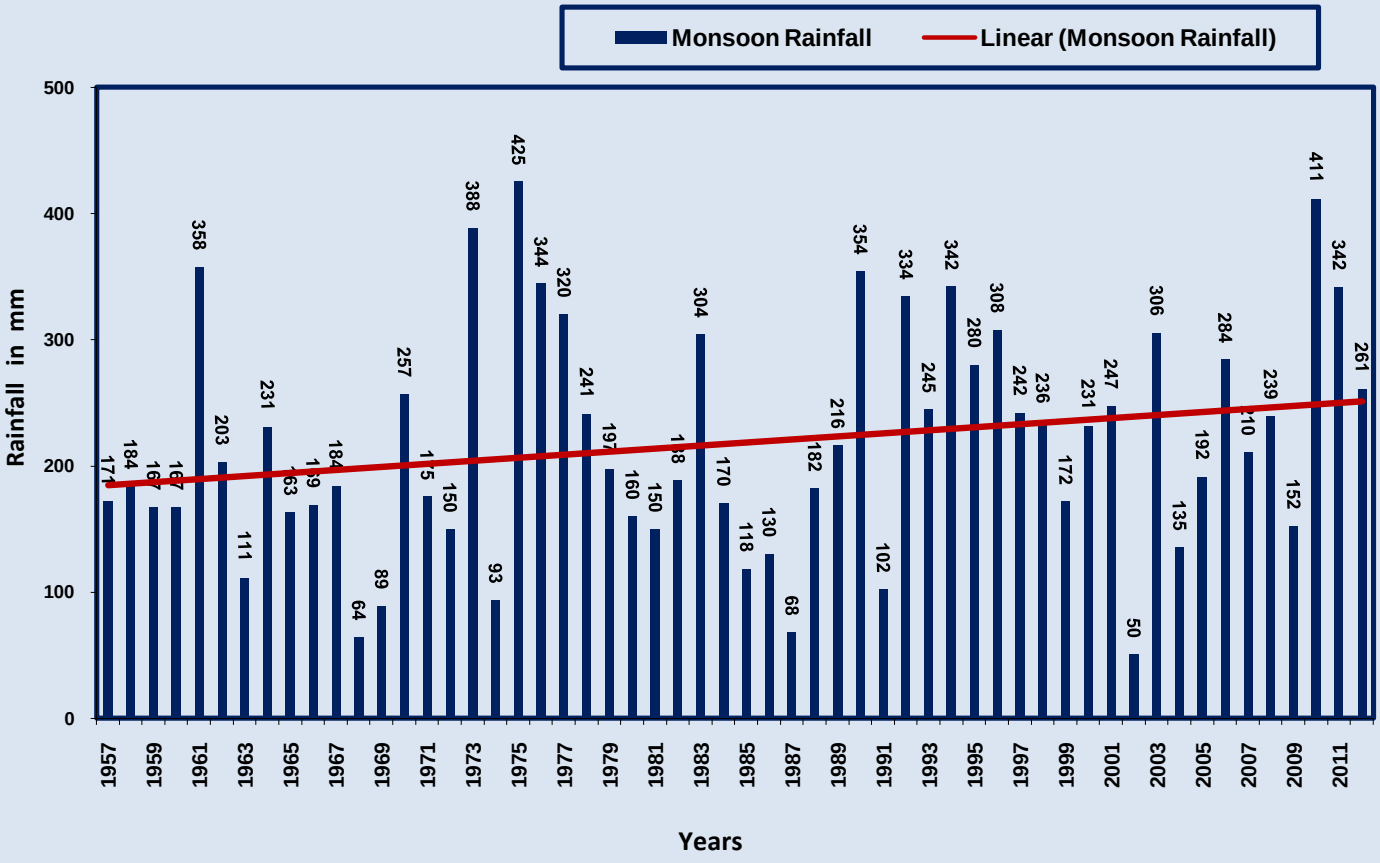

Fig. 6.3.1 Monsoon Rainfall (June to September) Thar Desert

6.4 Monsoon Duration

Annual duration of monsoon is shown in Fig. 6.4.1 which reveals that average duration of monsoonal rain over the district is about 10.3 weeks. However, the shortest duration of 8 weeks was observed during the years 1974, 1981, and 1986 while the longest duration of 13 weeks during the years 1977, 1999, 2002, 2005 and 2011. However, duration of Monsoon season shows an increasing trend during the study period of 56 years (1957-2012). Thus, *an increase of two weeks is noticed in the duration of monsoon season during past 57 years*.

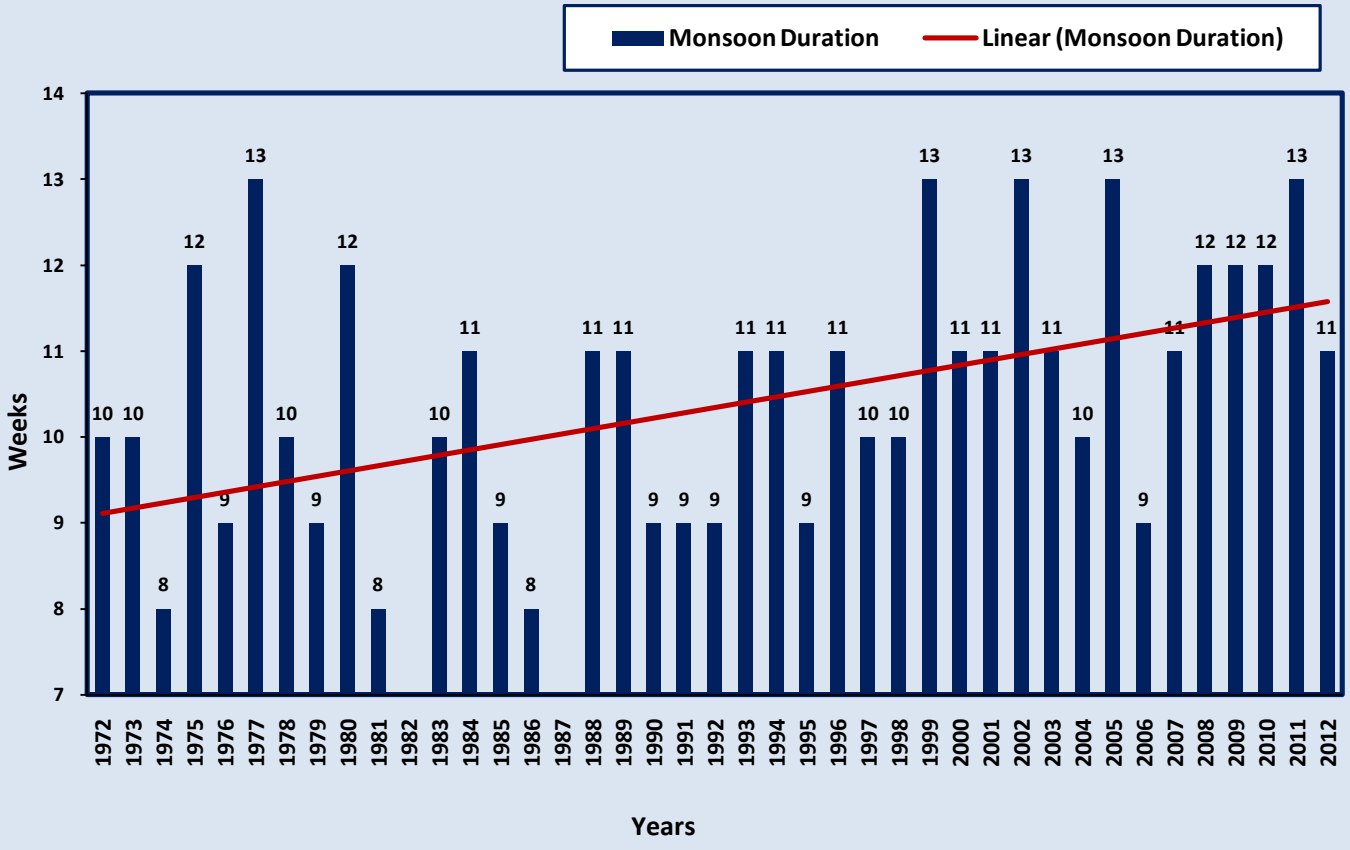

Fig.6.4.1 Monsoon Duration for Thar Desert

CHAPTER -VII

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Post Monsoon Season

After withdrawal of monsoon from the Thar Desert the dry and hot weather prevails over the region in October and November. This period of two months is referred to as the Post Monsoon season. Some times, rainfall is also realised over the region during this season either due to the western disturbances moving from west to east or late withdrawal of south-west monsoon.

7.1 Monthly Rainfall Distribution

Monthly rainfall parameters are shown in Fig.7.1.1 These figure reveal that about 5.2 mm of the seasonal rainfall (7.5 mm) of this season is realised during October and rest 2.3 mm during November. A large variability (of the order of 245%) in the total monthly rainfall is observed in both the months. During the study period the highest (69 mm and 29 mm) monthly rainfall has been observed in October and November months, respectively.

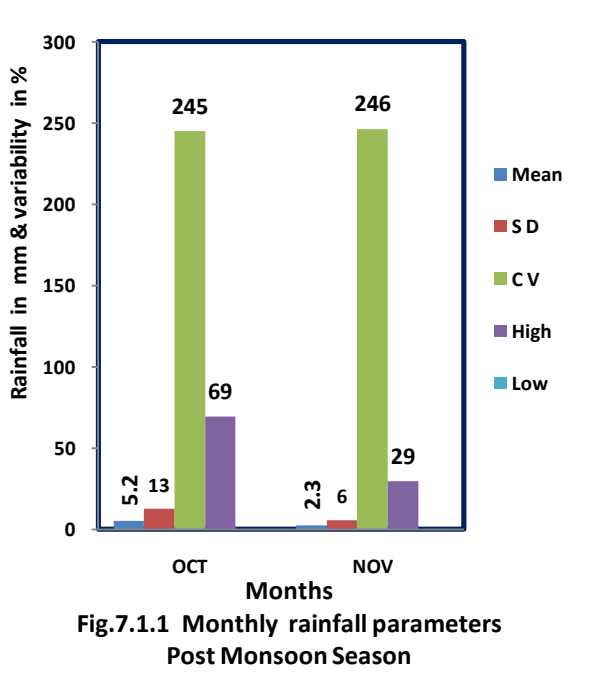

Fig.7.1.1 Monthly rainfall parameters Post Monsoon Season

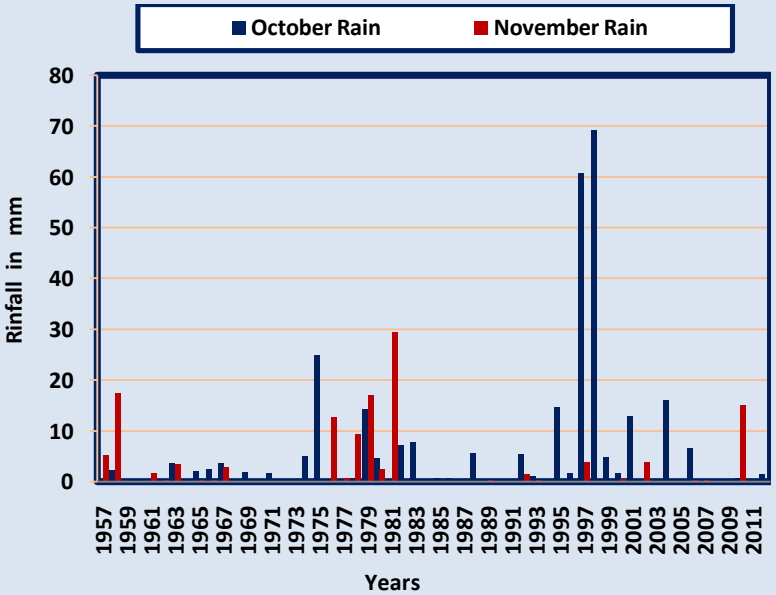

Fig. 7.1.2 Monthly Rainfall Distribution - Post Monsoon Season Thar Desert

A large variability is observed in the monthly rainfall of October and November. The highest (69.1mm) monthly total rainfall of this season has been observed during October 1998, while the corresponding figure for November is 29.4 mm (year 1981) Fig. 7.1.2.

7.2 Seasonal Rainfall Distribution

Seasonal rainfall variability during post monsoon period is shown in Fig. 7.2.1. It shows that the average rainfall of post monsoon season over Thar Desert is only 7 mm with CV 184%. *This season has a highest rainfall variability among all seasons. The* highest (69 mm) rainfall was recorded during the year 1998 and the lowest (0.0 mm) during a number of years.

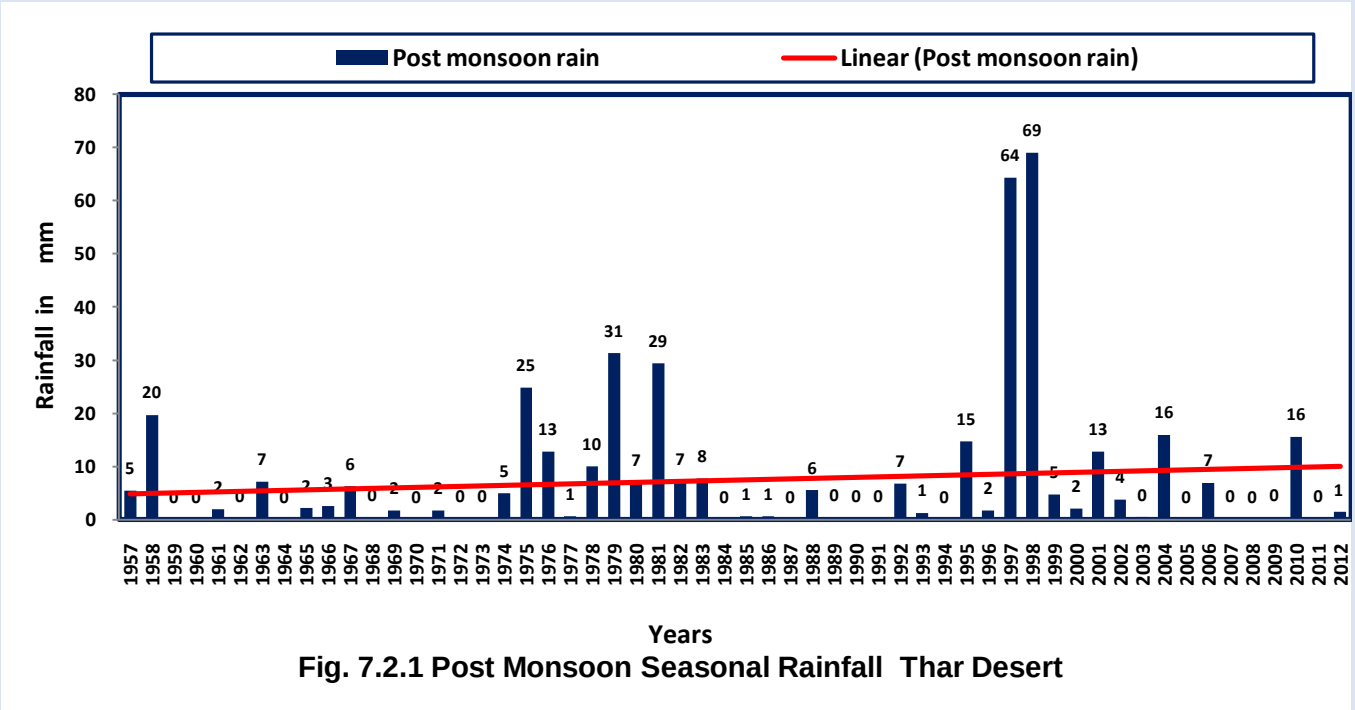

Fig. 7.2.1 Post Monsoon Seasonal Rainfall Thar Desert

CHAPTER - VIII

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Rainfall Features Annual

8.1 Thar Desert

Annual rainfall variability over Thar Desert is shown in Fig. 8.1.1 and Fig. 8.1.2. It can be concluded that the average annual rainfall of Thar Desert is 251 mm with a CV of 38%. The highest (461 mm) rainfall was realised during the year 1975 and the lowest (73 mm) during 1968. The annual rainfall during 1975 was about 80% more than the long period average (251 mm). During past 56 years, annual total rainfall remained excess (rain > 19% of LPA) in 17 years, normal in 19 years (rain +19% to -19% of LPA), deficit in 16 years (rain -20% to -59% of LPA) and scanty in 3 years (rain <= -60% of LPA). *Over the study period 0f 56 years (1956-2012) the total annual rainfall over Thar Desert of Rajasthan shows an increasing trend.* However, no significant cyclic behaviour is observed. An increase of about 20% has been observed during past 56 years. During past 20 years about 70% of the years have observed more than LPA annual rainfall. Year to year annual rainfall variability over Jaisalmer, Bikaner, Barmer and Jodhpur districts of Thar Desert is shown in Fig. 8.1.3 to Fig. 8.1.7, Fig 8.2.1 & Fig 8.2.2 . The normal / variability (CV) / highest / lowest annual rainfall over different regions of Thar Desert are as: Jaisalmer (182mm / 49% / 391mm / 54mm), Bikaner (265mm / 36% / 518mm / 69 mm), Barmer (267 mm / 54% / 707mm / 54mm) and Jodhpur (298 mm / 44% / 681 mm / 93 mm). Highest (298 mm) and lowest (182 mm) annual normal rainfall was observed at Jodhpur and Jaisalmer districts respectively. Out of these four districts of Thar Desert, three viz. Jaisalmer, Bikaner, and Barmer districts show an increasing trend in the annual rainfall over the study period (1956 - 2012) while Jodhpur district does not show any significant trend. Thus, extreme south west part of the Thar Desert shows an incresing trend in the annual rainfall. Among all these four districts: Barmer district shows the highest (54%) variability in the annual rainfall while lowest (36%) in Bikaner district.

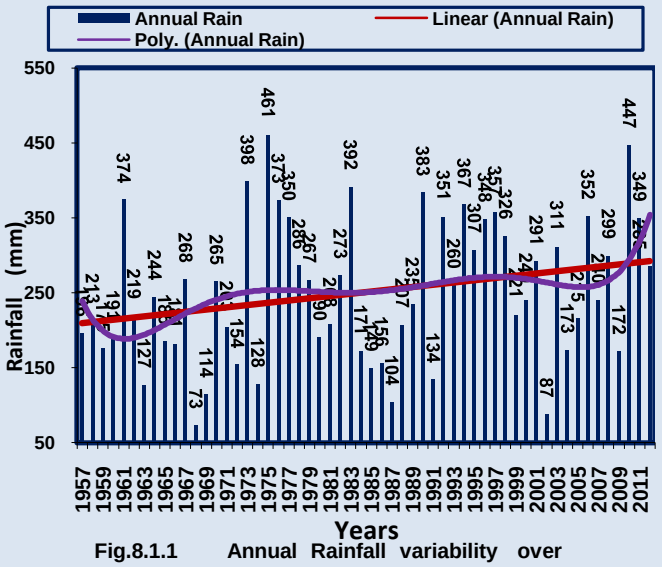


Fig.8.1.1 Annual Rainfall variability over Thar Desert

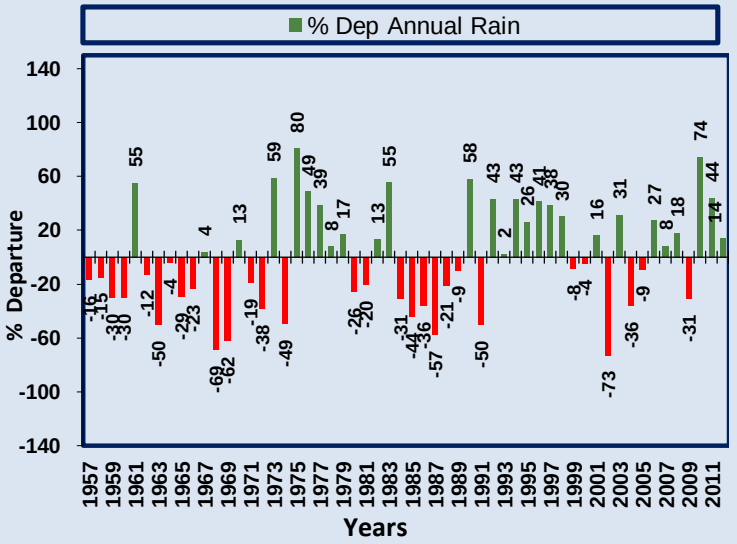
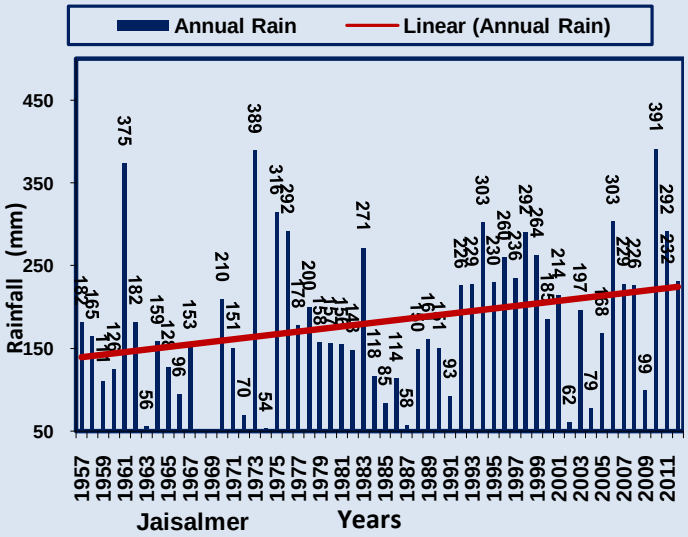
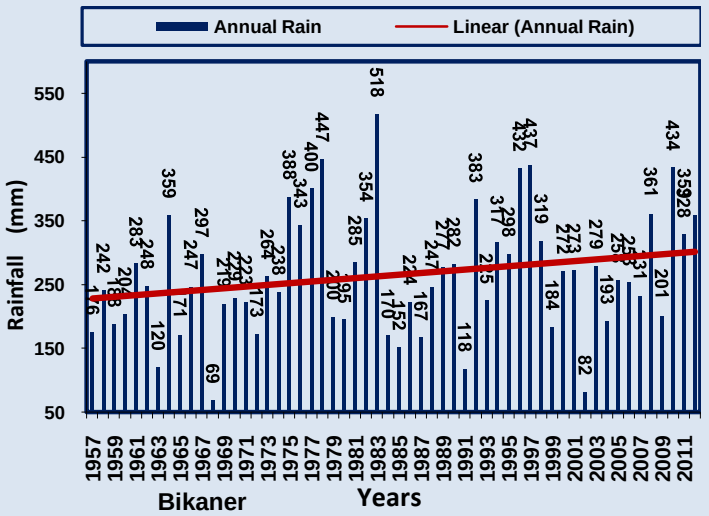
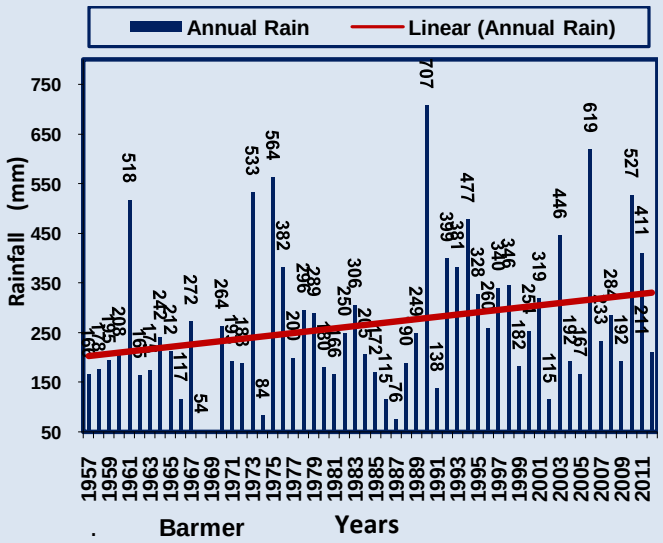


Fig.8.1.2 %Deparure of Annual Rainfall from LPA Thar Desert







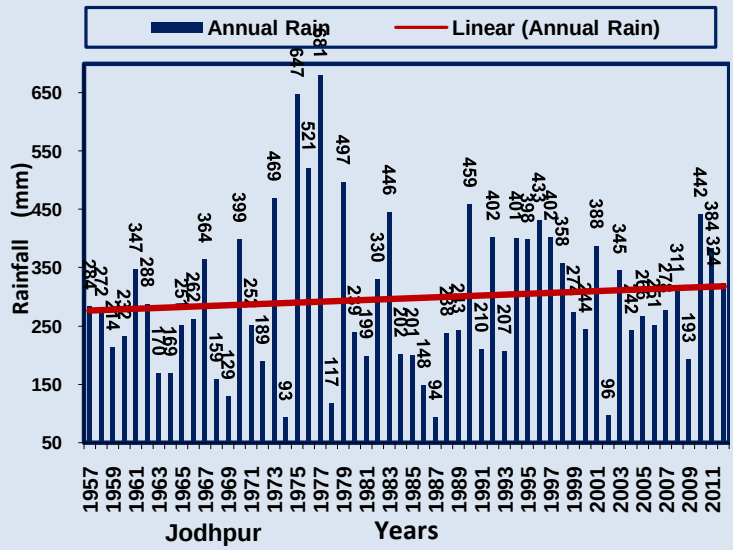


Fig. 8.1.3 Annual rainfall variability over different districts of Thar Desert

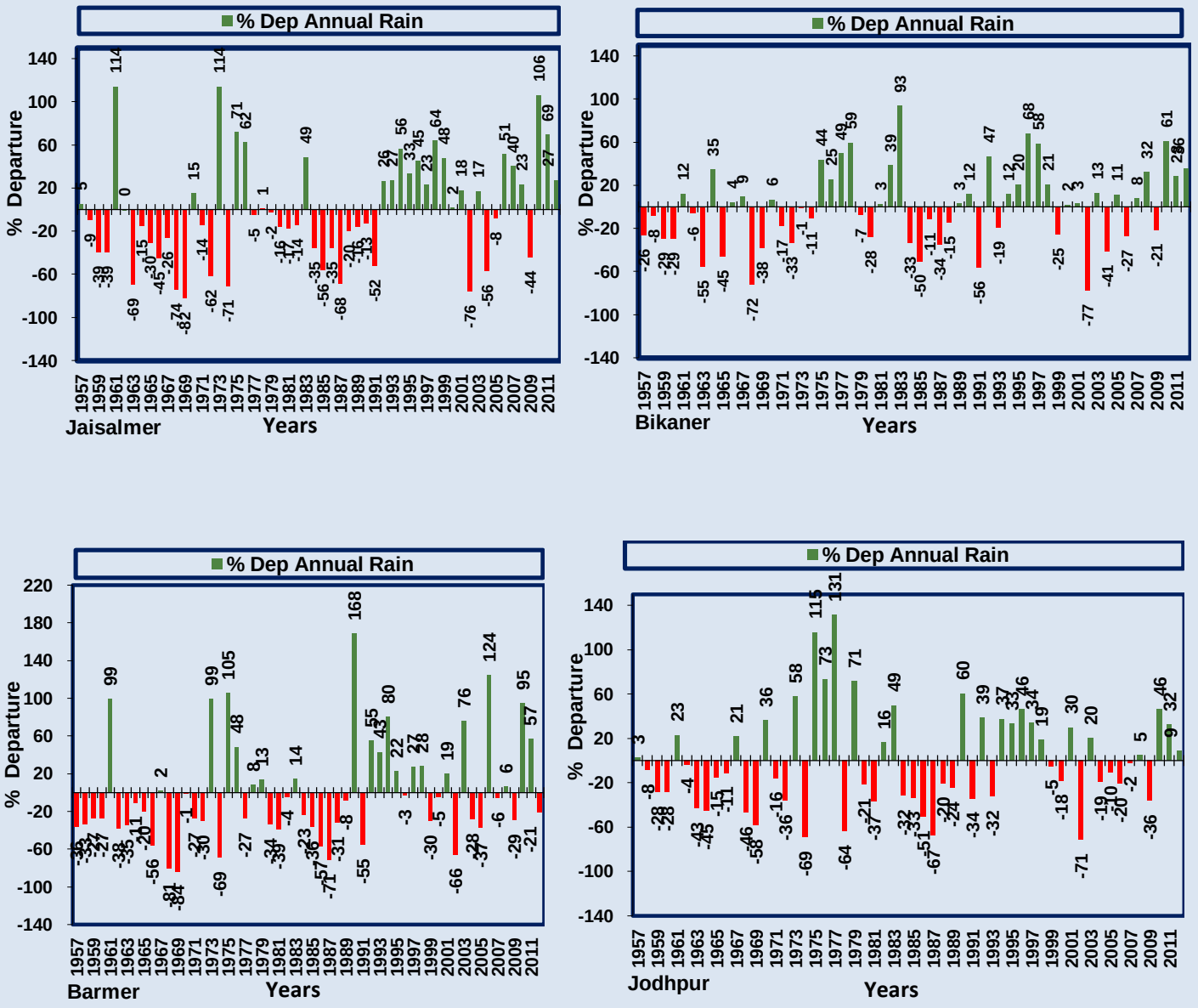


Fig 8.1.4 % Departure of annual rainfall from LPA over different districts of Thar Desert.

8.2 District Wise Annual Rainfall Distribution

The district-wise annual normal rainfall and rainy days are shown in Fig. 8.2.1 and Fig. 8.2.2. The figures show that the annual normal rainfall of different districts of Thar Desert varies between 182 mm to 298 mm. Jodhpur district observed highest annual rainfall of the order of 298 mm while Jaisalmer district observed only 182 mm (lowest among the districts). The annual district wise rainy days vary between 35 to 59 days. The lowest (35 days) is observed in Jaisalmer district and the highest (59 days)

in Jodhpur district. The average annual rainy days of Thar Desert are 88 days. The annual rainfall variability within the Thar Desert fluctuates from 36% to 54%. The lowest (36%) variability was observed at Bikaner district and the highest (54%) at Barmer district.

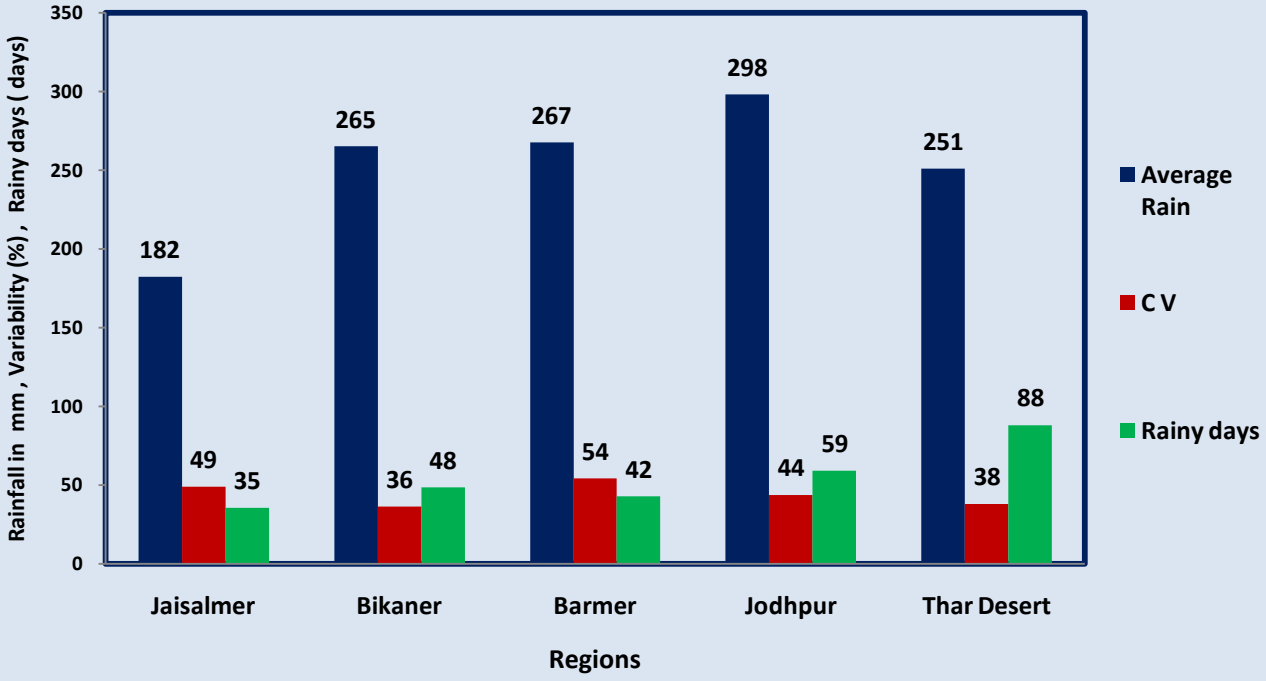
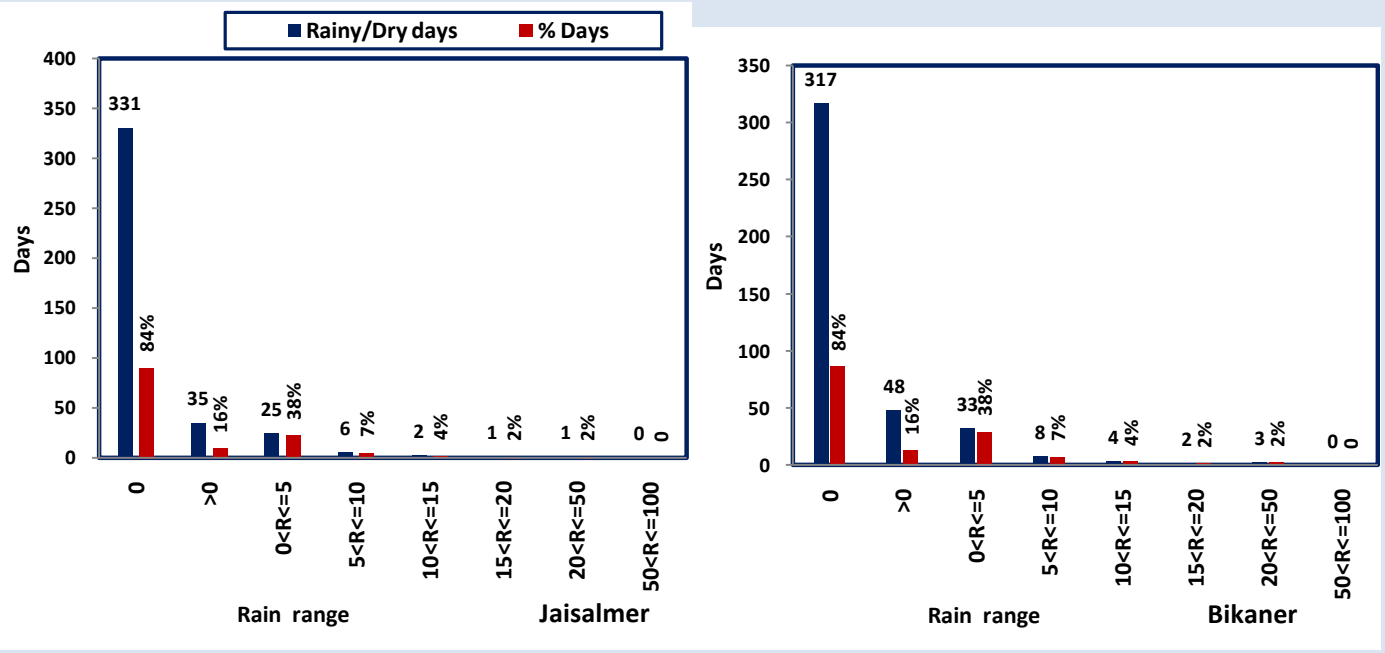


Fig 8.2.1 District wise annual rainfall, rainy days and variability

The annual district wise rainfall distribution in different range is shown in Fig 8.2.2. Normally, annual dry days over different districts of the Desert region vary from 307 to 331 days. Highest (331) number of dry days are observed over Jaisalmer district and the lowest (307) over Jodhpur district. Daily rainfall of exceeding 15 mm over any district occurs on 6 ocassions or less in a year. Out of 35 rainy days over Jaisalmer district, 25 days observed less than 5 mm rainfall. In Jodhpur, Barmer and Bikaner districts, these figures are 42 days out of 59 ; 28 days out of 43 and 33 days out of 48 respectively.



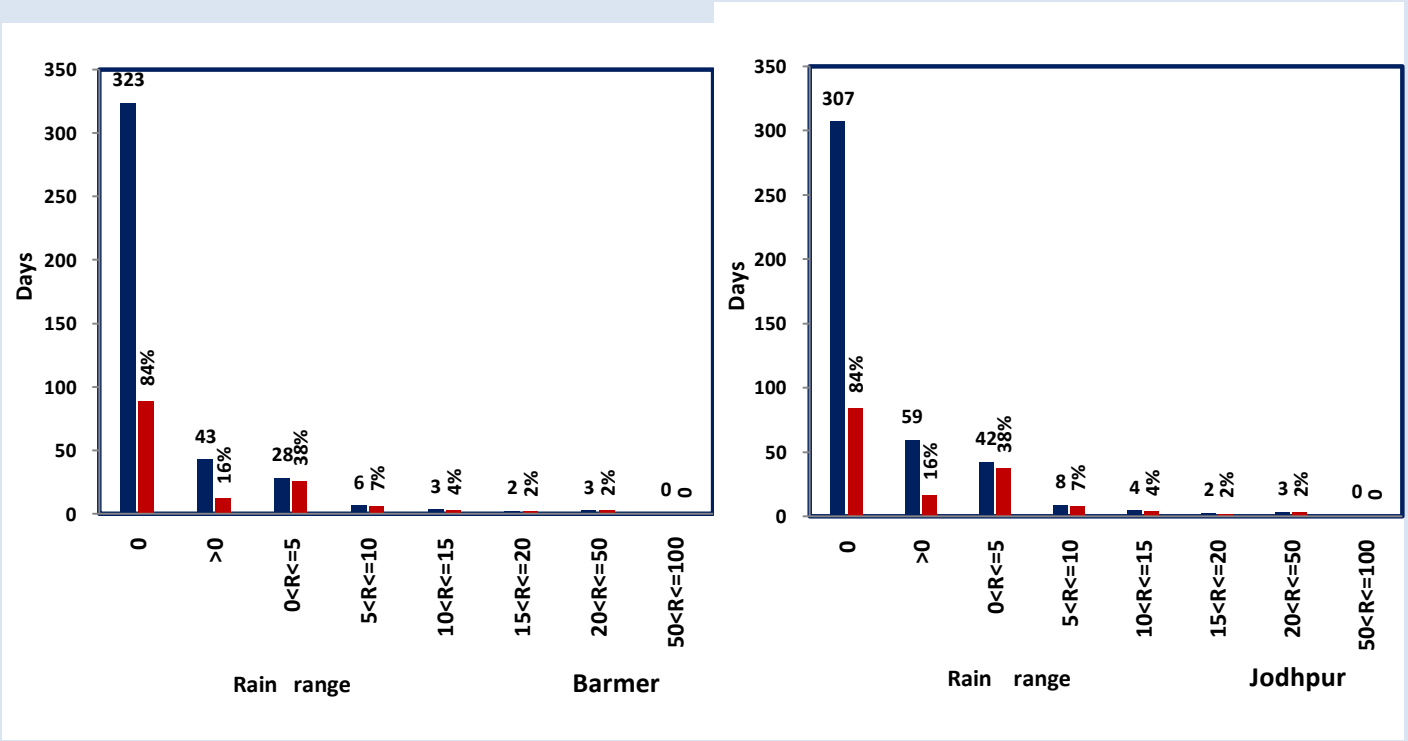


Fig. 8.2.2 Rainy days over different districts of Thar Desert

8.3 Station wise Rainfall Distribution

8.3.1 Jaisalmer District

The stations-wise annual normal rainfall and rainy days are shown in Fig. 8.3.1. It shows that the annual normal rainfall of different stations of Jaisalmer district varies between 134 mm to 203 mm. Pokran station observes the highest (203 mm) and Ramgarh station the lowest (134 mm) annual rainfall. The annual station wise rainy days within the district vary between 8 to 13 days. The highest (13 days) is observed in Pokran station and the lowest (8 days) in Ramgarh station.

The rainfall variability in different stations varies from 57% to 105%. The lowest (57%) variability is observed in Jaisalmer and Nokh stations while the highest (105%) in Sam. Almost all stations are showing the same (60 to 70%) variability except the Sam, where it is quite large (105% CV).

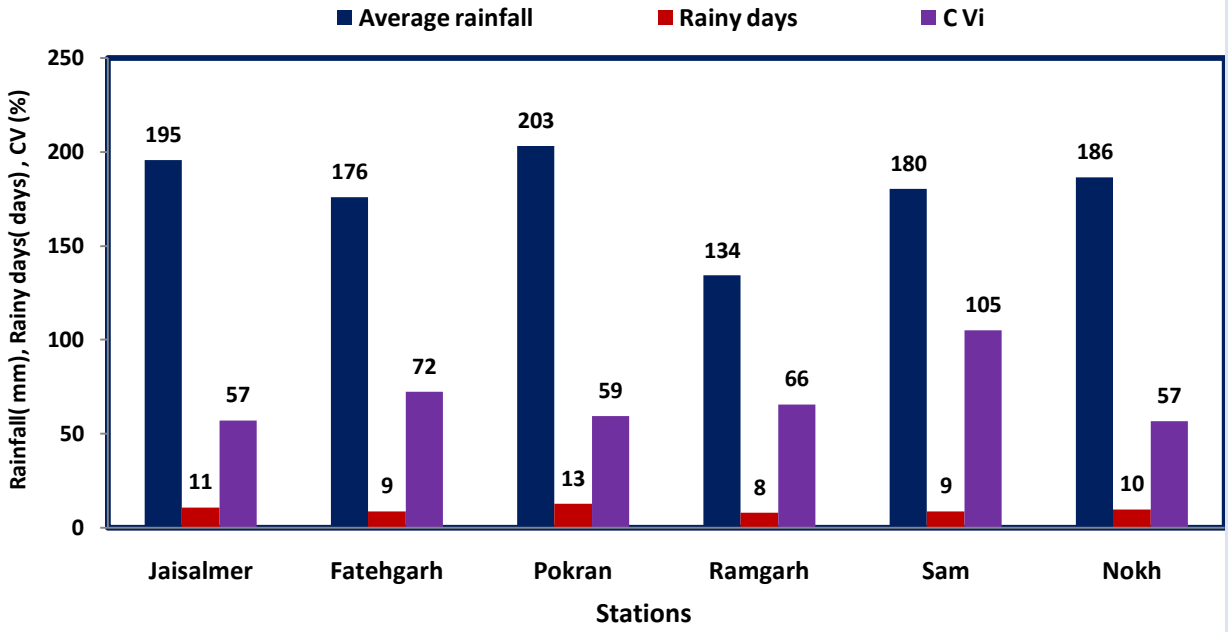


Fig. 8.3.1.1 Average Annual rainfall rainy days and rainfall variability within Jaisalmer district

8.3.2. Jodhpur District

The stations-wise annual normal rainfall and rainy days are shown in Fig. 8.3.2.1. Which shows that the annual normal rainfall of different stations of Jodhpur district varies between 215 mm to 416 mm. Bilara station observed highest annual rainfall of the order of 416 mm while Phalodi station observed only 215 mm (lowest among the stations). The annual stations wise rainy days within the district varies between 14 to 22 days. The highest (22 days) is observed in Bilara station and the lowest (14 days) in Phalodi station.

The rainfall variability in different stations varies from 39% to 53%. The lowest (39%) variability is observed in Osian station while the highest (53%) in Jaswant Sagar and Shergarh.

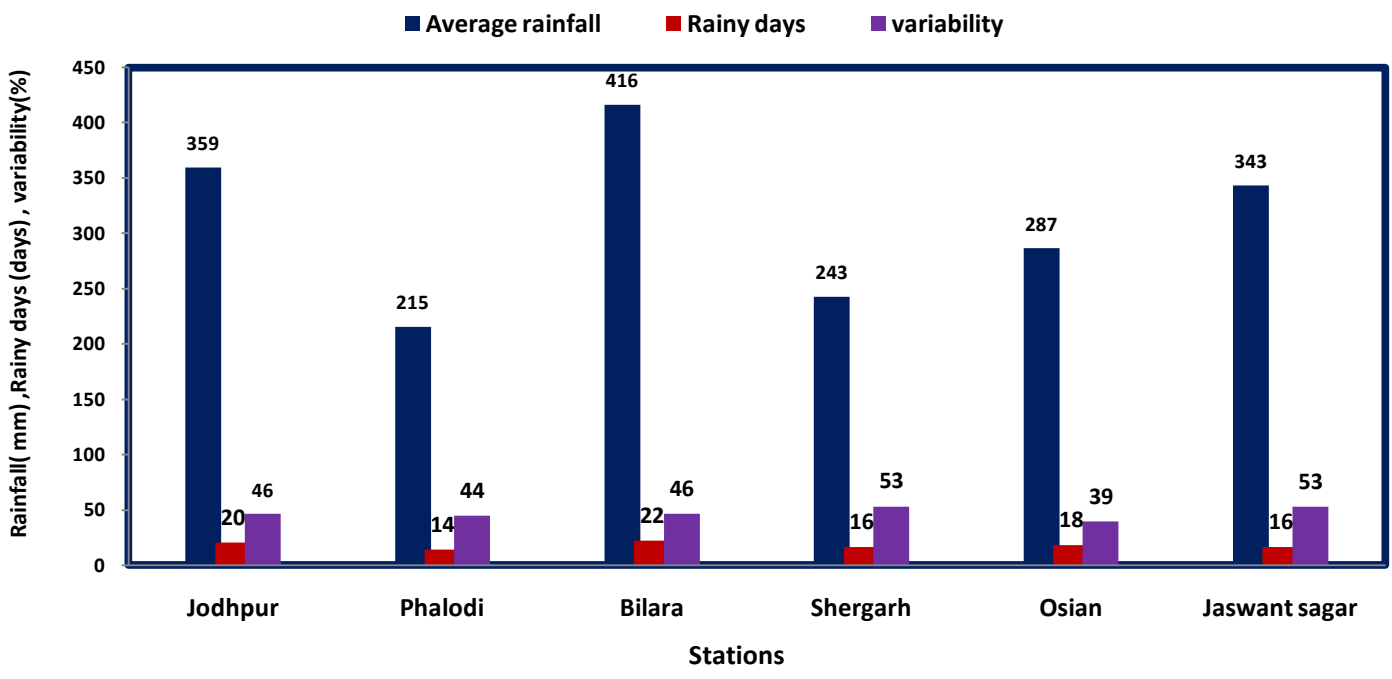


Fig. 8.3.2.1 Average annual rainfall , rainy days and C V within Jodhpur district

8.3.3. Bikaner District

The station-wise annual normal rainfall and rainy days are shown in Fig. 8.3.3.1, which shows that the annual normal rainfall of different stations of Bikaner district varies between 264 mm to 320 mm with the highest (320 mm) over Dungargarh and the lowest (264 mm) over Bikaner station. The annual station wise rainy days within the district varies between 16 to 20 days. The highest (20 days) is observed at Nokha and the lowest (16 days) at Kolayat station.

The rainfall variability in different stations of district fluctuates from 38% to 56%. The lowest (38%) variability is observed at Bikaner station while the highest (56%) at Kolayat.

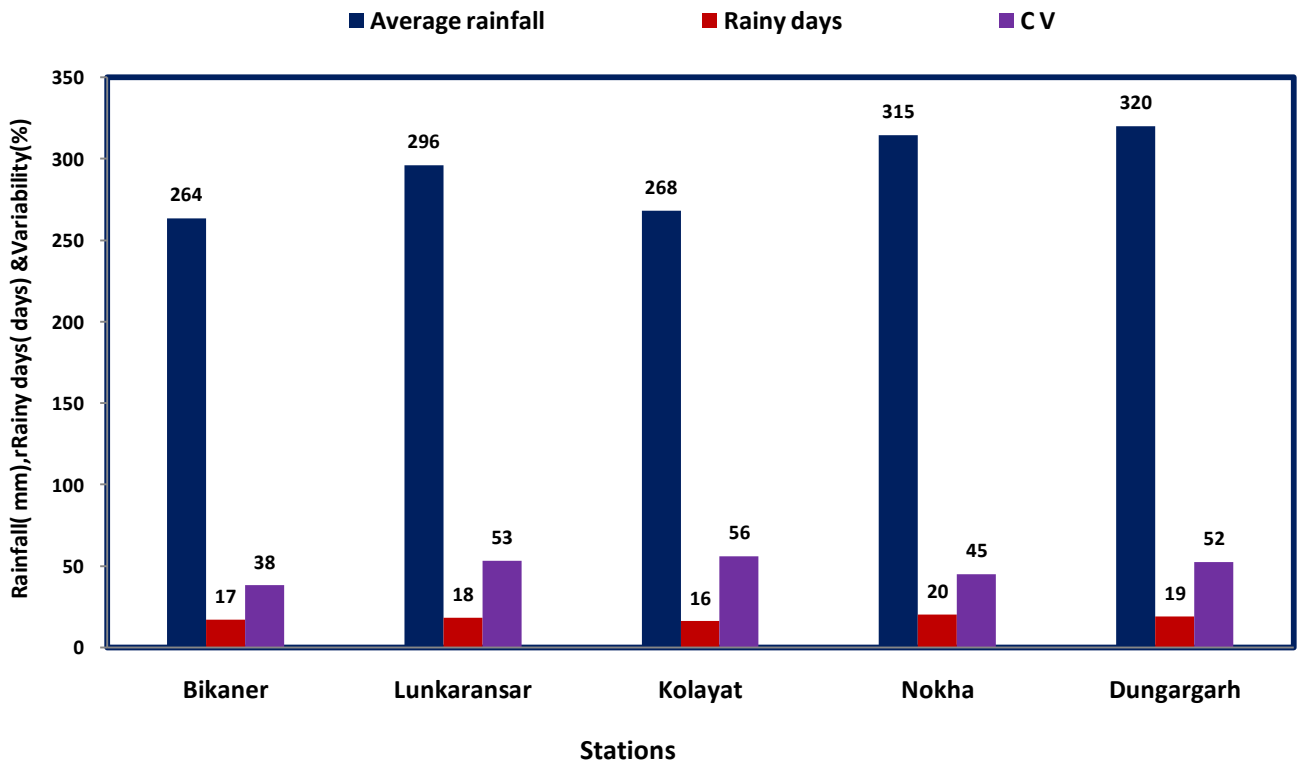


Fig. 8.3.3.1 Average annual rainfall , rainy days and rainfall variability within Bikaner district

8.3.4 Barmer District

The station-wise annual normal rainfall and rainy days are shown in Fig. 8.3.4.1. It shows that the annual normal rainfall of different stations of Barmer district varies between 221 mm to 350 mm with the highest (350 mm) at Siwana and the lowest (221 mm) at Sheo. The annual station wise rainy days within the district varies between 13 to 17 days. The highest (17 days) is observed at Siwana and the lowest (13 days) at Sheo.

The rainfall variability in different stations varies from 50% to 65%. The lowest (50%) variability is observed in Sheo station while the highest (65%) in Chohtan.

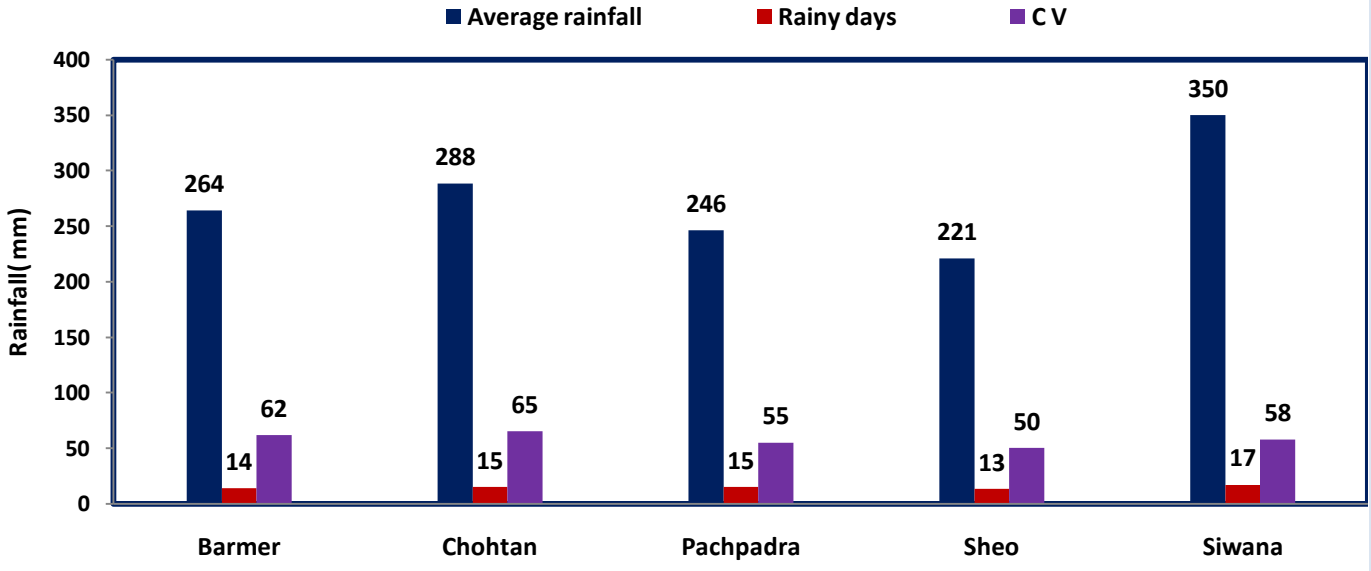


Fig. 8.3.4.1 Average Annual rainfall within Barmer district

CHAPTER – IX

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Extreme Rainfall

9.1. Jaisalmer District

The extreme rainfall observed on different temporal scales over different stations of the Jaisalmer district is shown in Fig. 9.1.1 to Fig. 9.1.7. The highest / lowest annual rainfall of Jaisalmer, Fatehgarh, Pokran, Ramgarh, Sam and Nokh stations are (513 mm / 28 mm), (527 mm / 16 mm), (540 mm / 29 mm), (386 mm / 2 mm), (1304 mm / 8 mm) and (522 mm / 13 mm) respectively. The highest (1304 mm) and lowest (2 mm) annual rainfall were realized in Sam and Ramgarh stations respectively. One day highest rainfall of 204 mm on 16 August 1973 at Jaisalmer; 180 mm on 19 July 1993 at Fatehgarh; 175mm on 21 June 1996 at Pokran; 180 mm on 21 September 1988 at Ramgarh, 230 mm on 21 June 1996 at Nokh and 240 mm on 17 August 1973 at Sam.

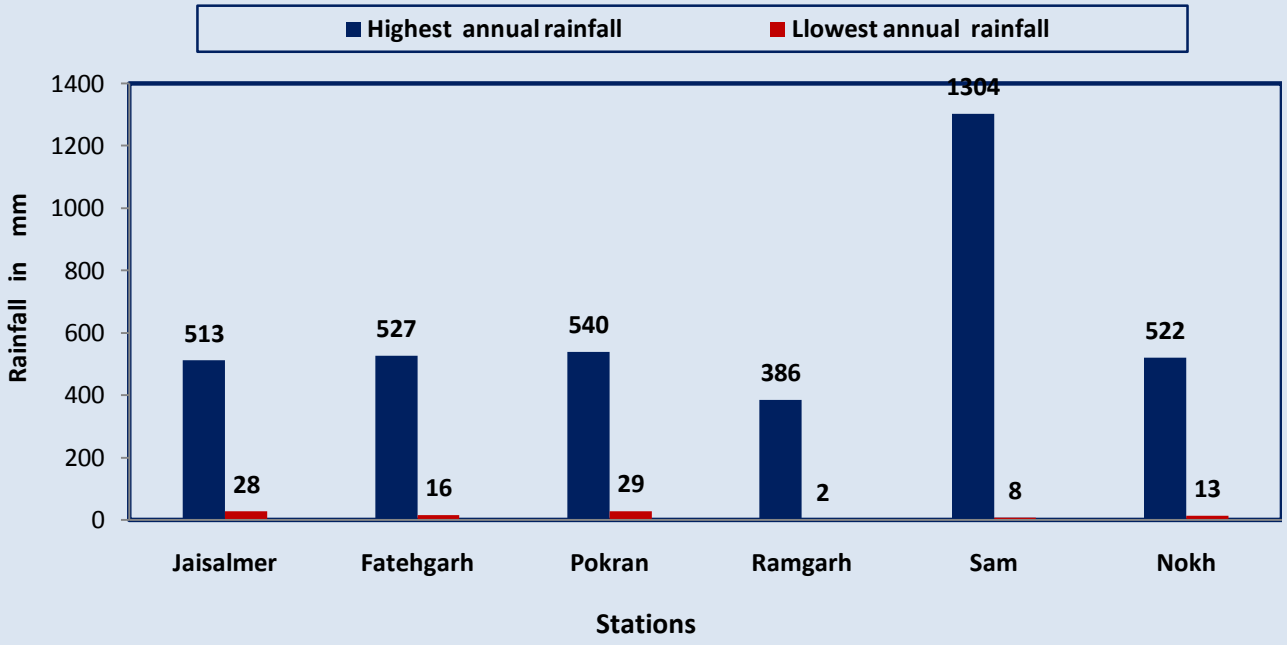

Fig. 9.1.1 Highest and lowest annual rainfall Jaisalmer district

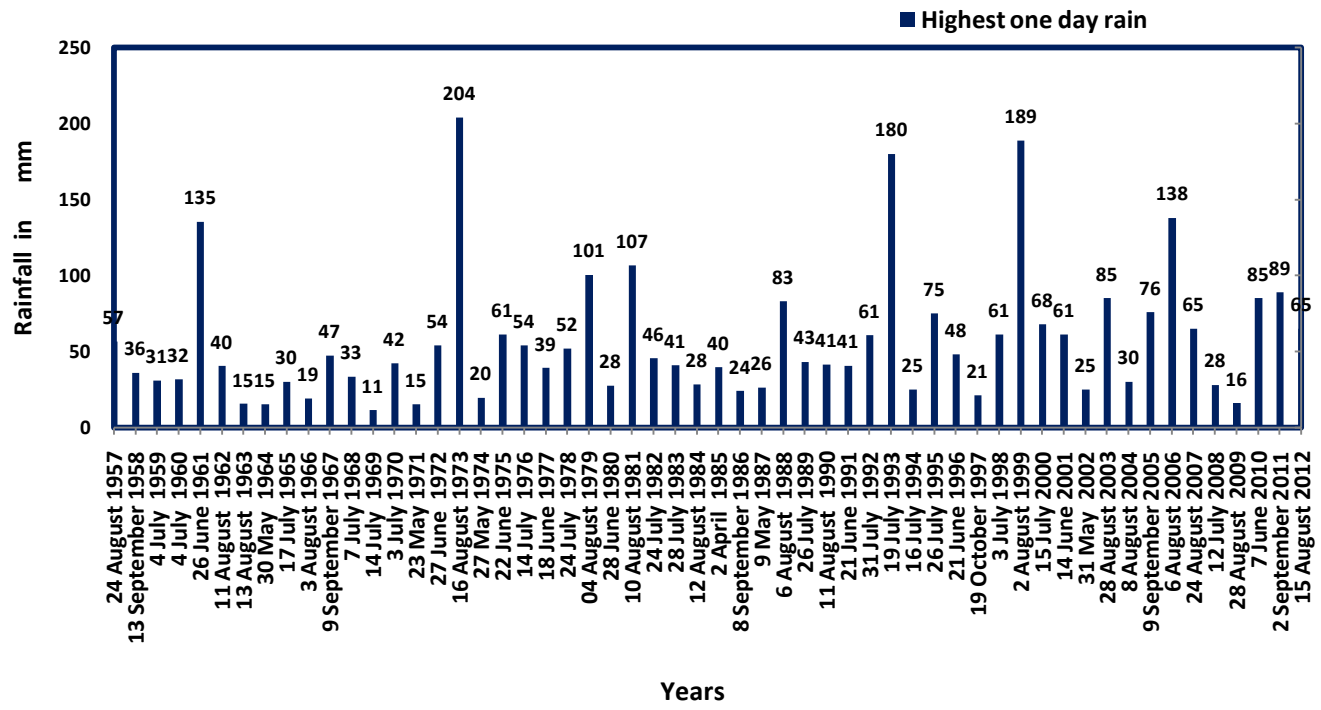

Fig.9.1.2 Highest one day rainfall - Jaisalmer

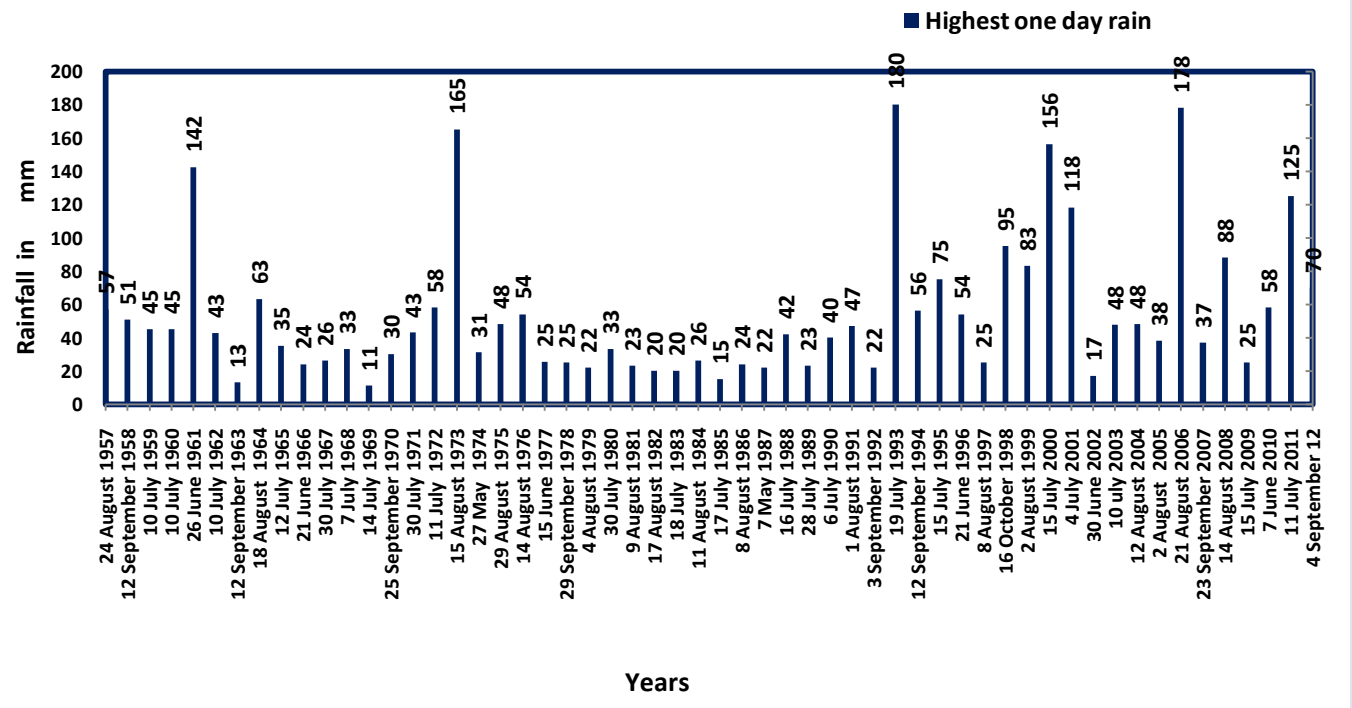

Fig. 9.1.3 Highest one day rainfall - Fatehgarh

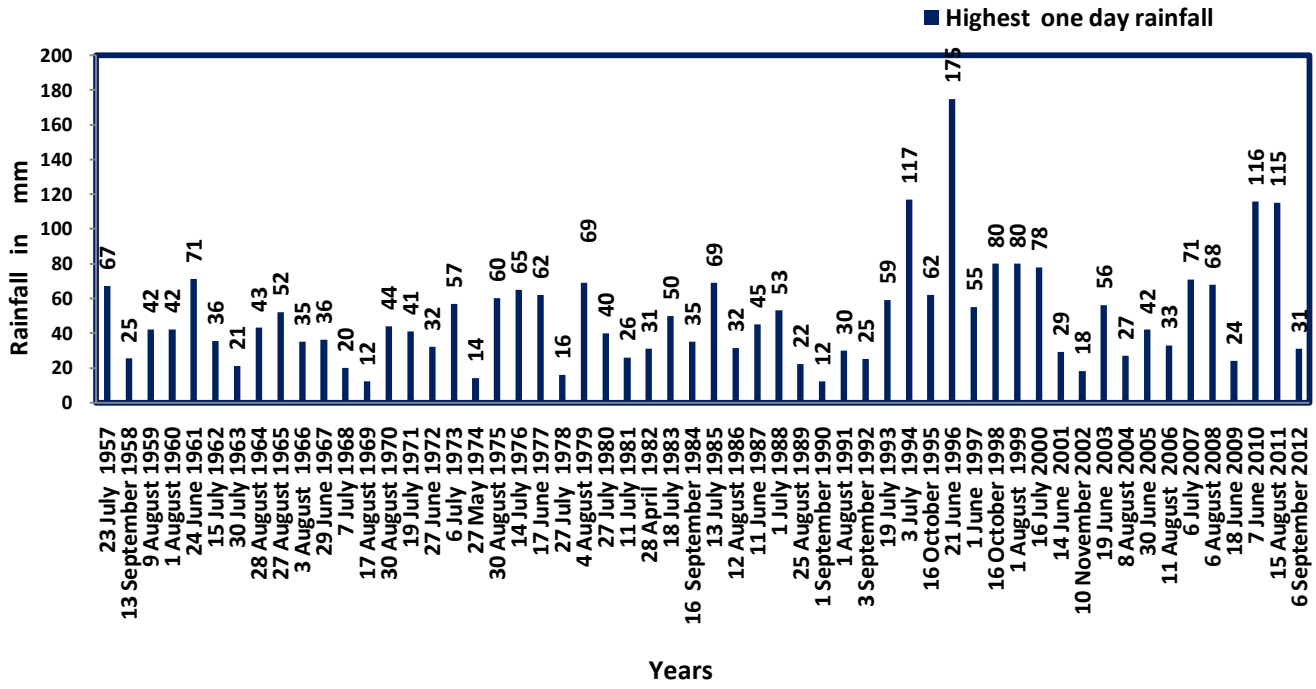

Fig.9.1.4 Highest one day rainfall - Pokran

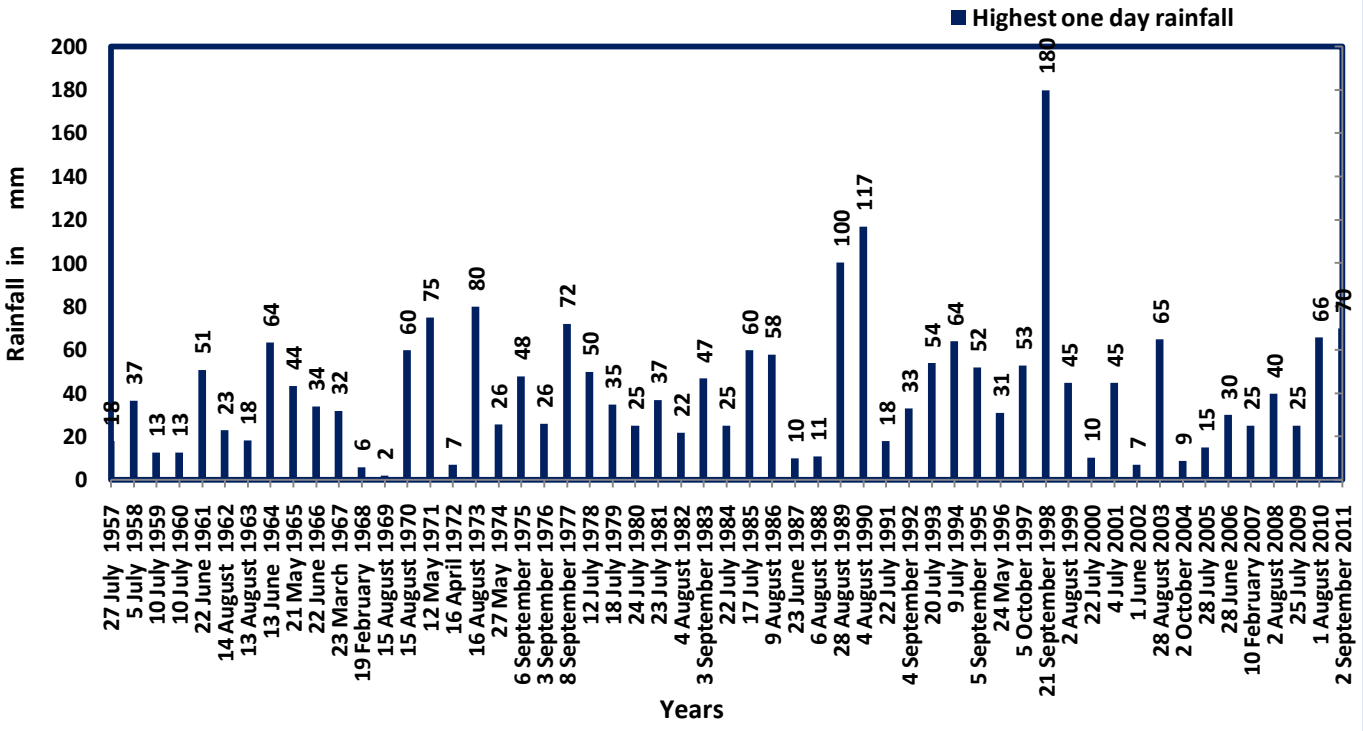

Fig. 9.1.5 Highest one day rainfall - Ramgarh

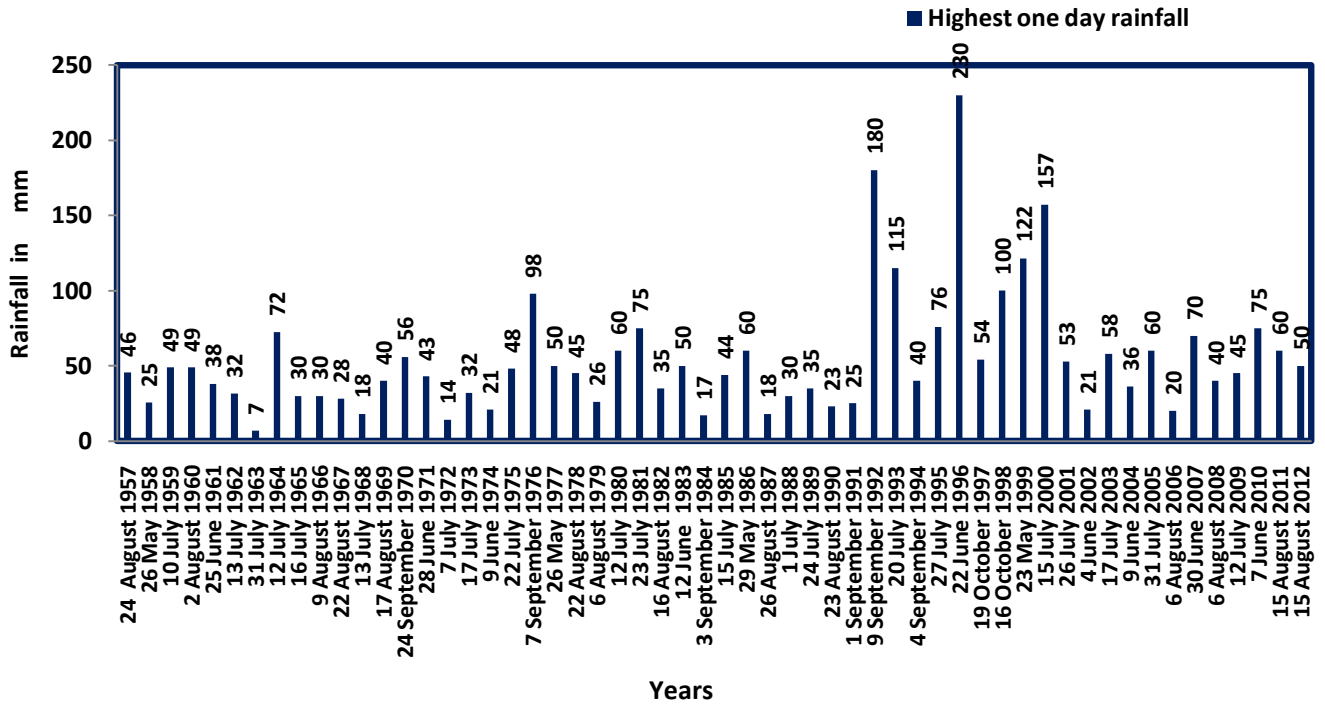

Fig. 9.1.6 Highest one day rainfall - Nokh

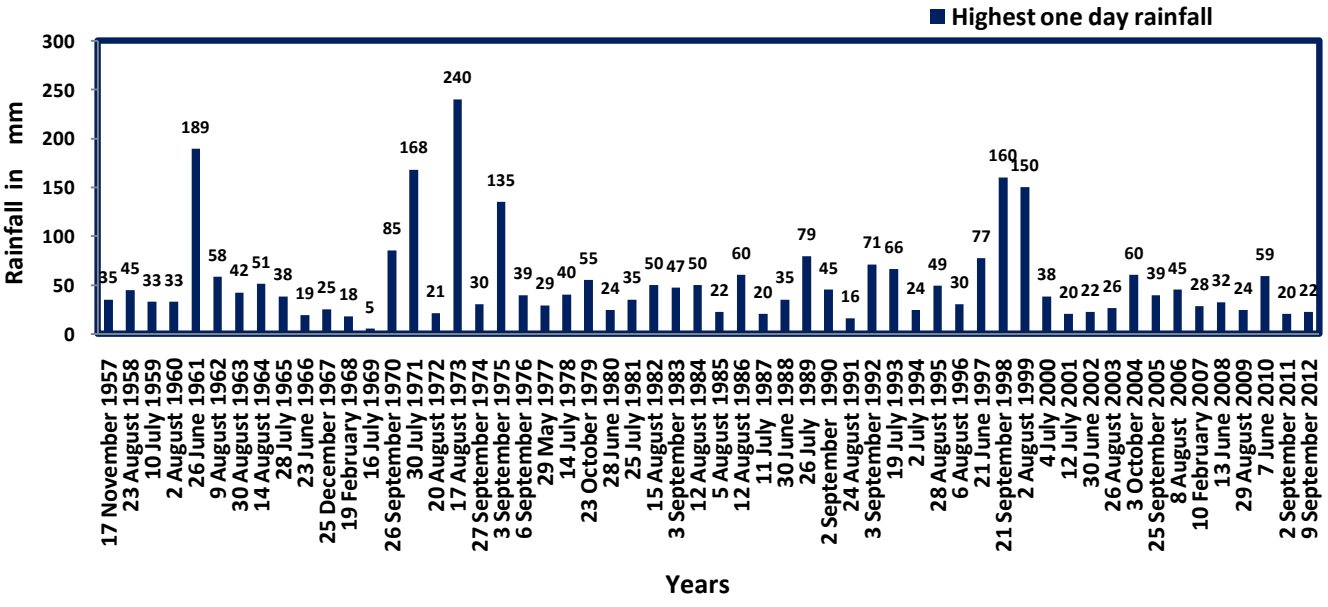

Fig. 9.1.7 Highest one day rainfall - Sam

9.2. Jodhpur District

The extreme rainfall observed on different temporal scales over different stations of the Jodhpur district is shown in Fig. 9.2.1 to Fig. 9.2.7. The highest / lowest annual rainfall of Jodhpur, Phalodi, Bilara, Shergarh, Osian and Jaswant Sagar stations are (815 mm / 91 mm), (486 mm / 14 mm), (1064 mm / 128 mm), (677 mm / 42 mm), (615 mm / 94 mm) and (1088 mm / 80 mm) respectively. The highest (1088 mm) and lowest (14 mm) annual rainfall were realized at Jaswant Sagar and Phalodi stations respectively. One day highest rainfall of 157 mm on 3 July 1990 at Jodhpur; 168 mm on 12 July 1964 at Phalodi; 300 mm on 31 July 1999 at Bilara; 128 mm on 21July 1996 at Shergarh; 125 mm on 10 June 1998 at Osian and 273 mm on 14 September 1957 at Jaswant Sagar, was recorded.

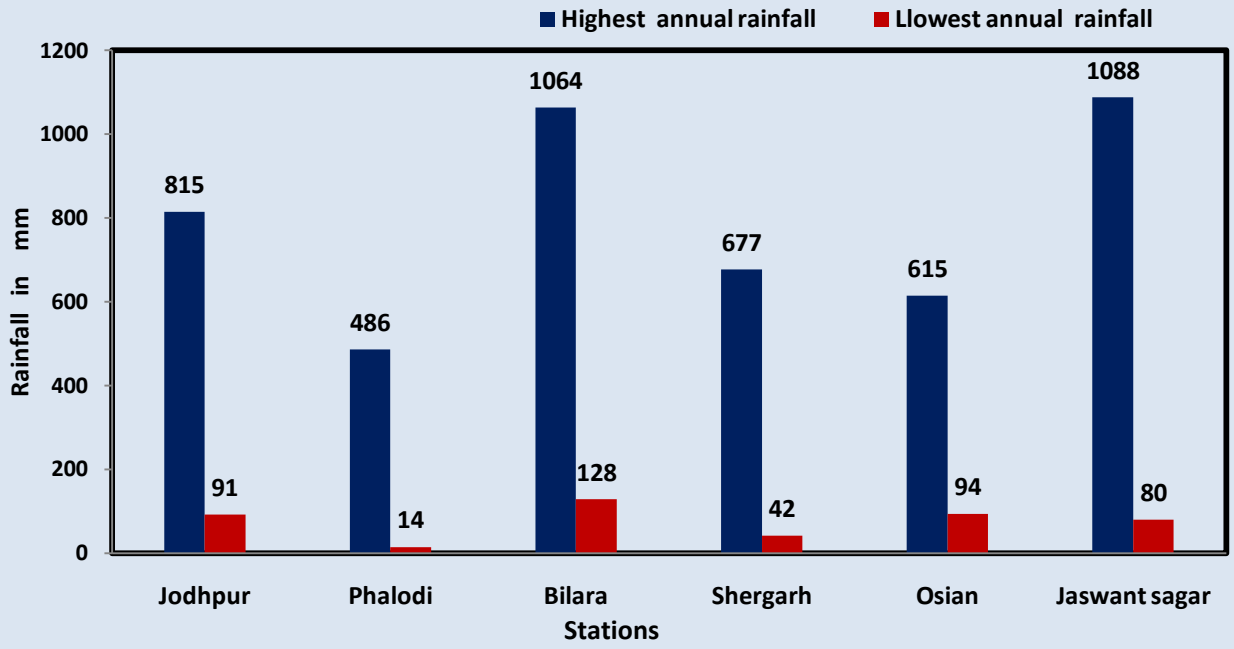

Fig. 9.2.1 Highest and Lowest tehsil wise annual rainfall of Jodhpur district

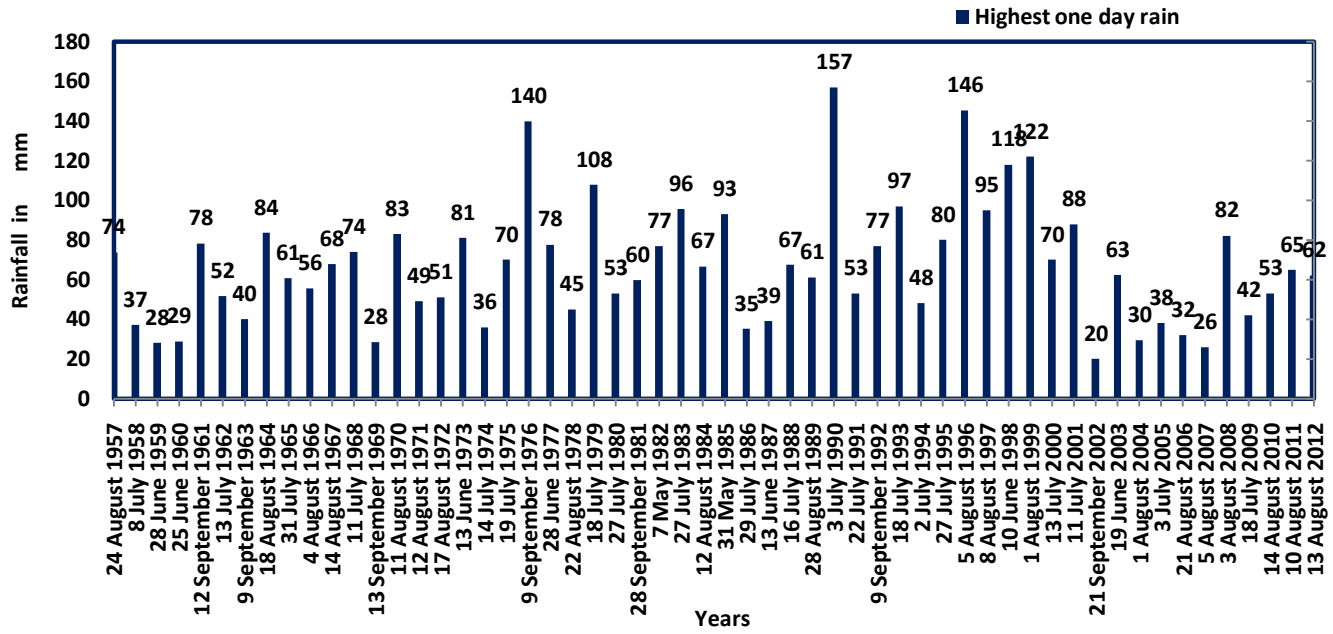

Fig. 9.2.2 Highest one day rainfall - Jodhpur

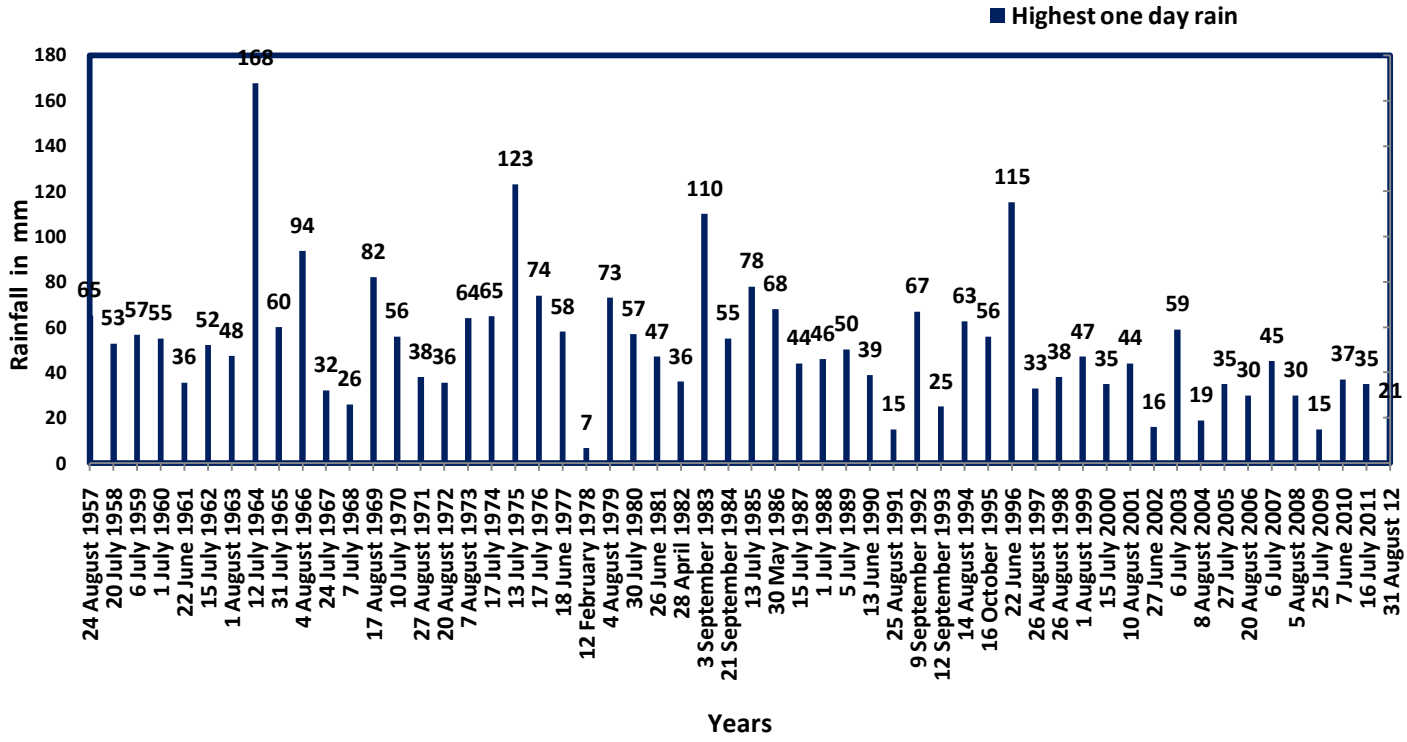

Fig. 9.2.3 Highest one day rainfall - Phalodi

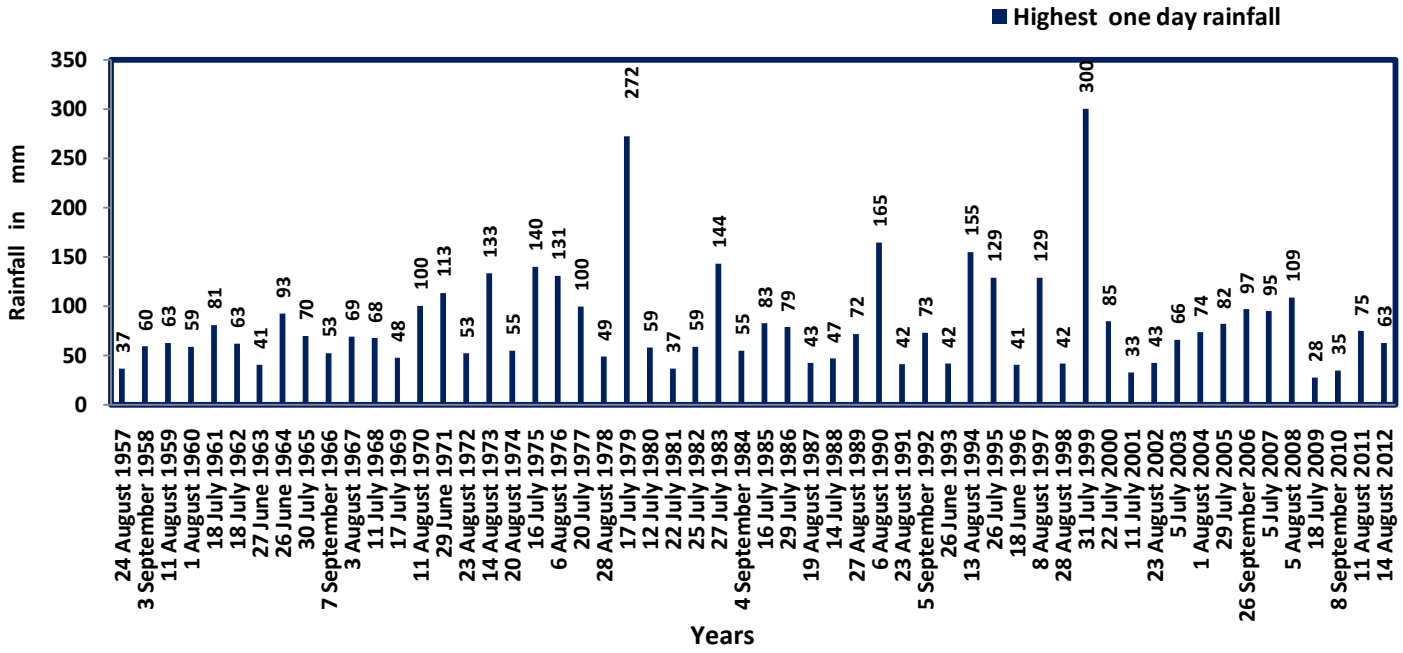

Fig. 9.2.4 Highest one day rainfall - Bilara

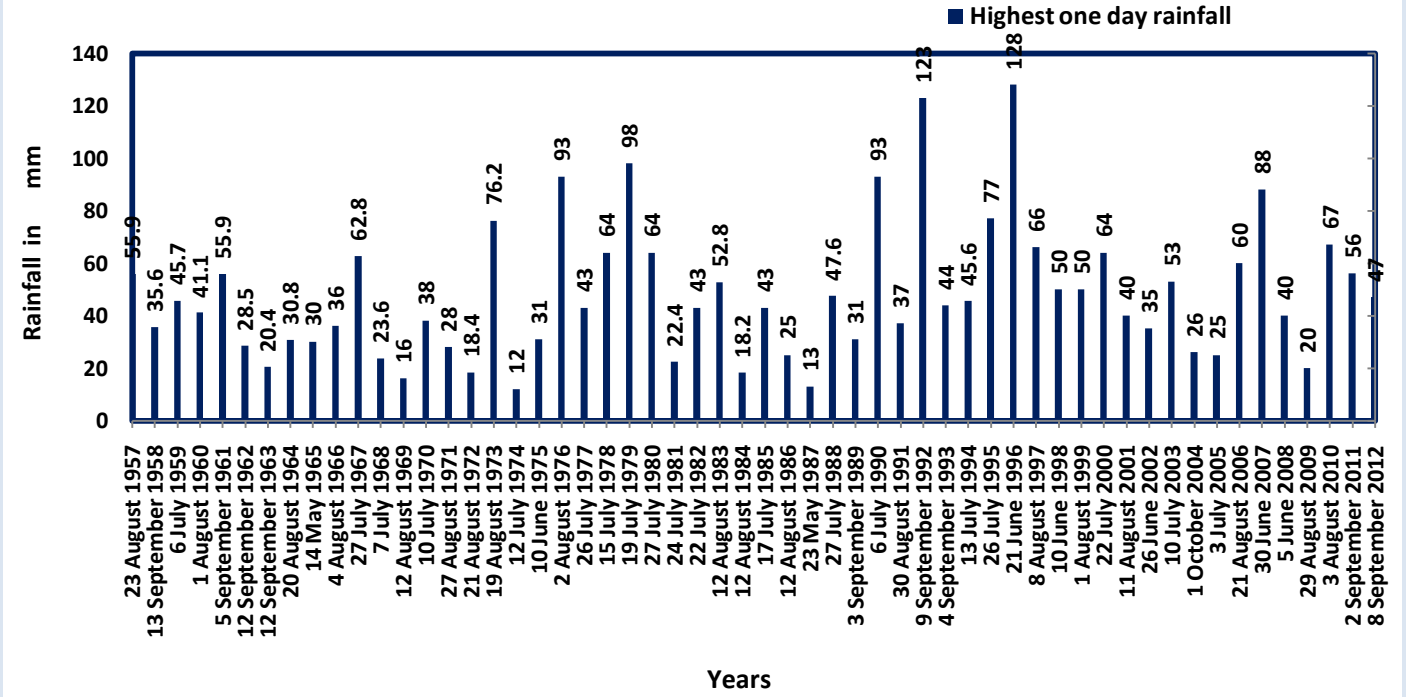

Fig. 9.2.5 Highest one day rainfall - Shergarh

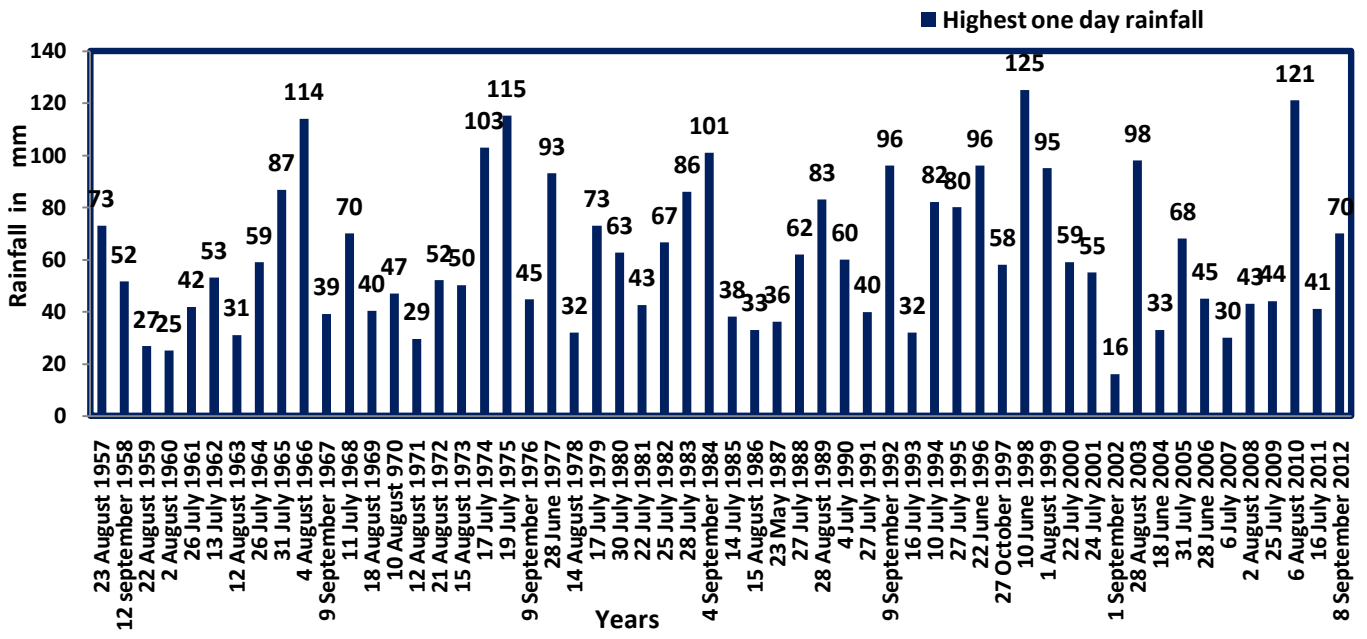

Fig. 9.2.6 Highest one day rainfall - Osian

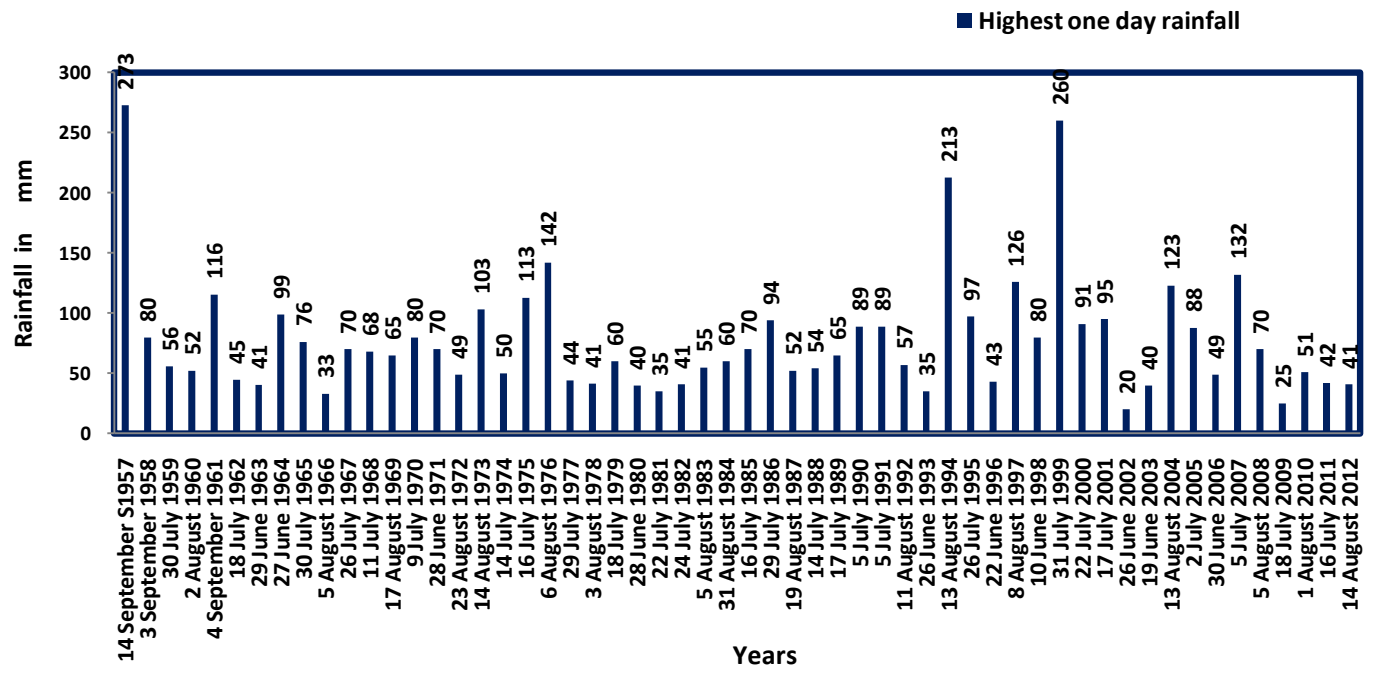

Fig. 9.2.7 Highest one day rainfall - Jaswant Sagar

9.3 Bikaner District

The extreme rainfall observed on different temporal scales over different stations of the Bikaner district is shown in Fig. 9.3.1 to Fig. 9.3.6. The highest / lowest annual rainfall of Bikaner, Lunkaransar, Kolayat, Nokha and Dungargarh stations are (559 mm / 32 mm), (783 mm / 64 mm), (894 mm / 60 mm), (769 mm / 71 m) and (904 mm / 64 mm) respectively. The highest (904 mm) and lowest (32 mm) annual rainfall were realized at Dungargarh and Bikaner respectively. One day highest rainfall of 139 mm on 29 July 2011 at Bikaner; 233 mm on 24 July 2000 at Lunkaransar; 138 mm on 6 August 1973 at Kolayat; 134 mm on 23 June 1996 at Nokha and 262 mm on 26 July 1983 at Dungargarh, was recorded.

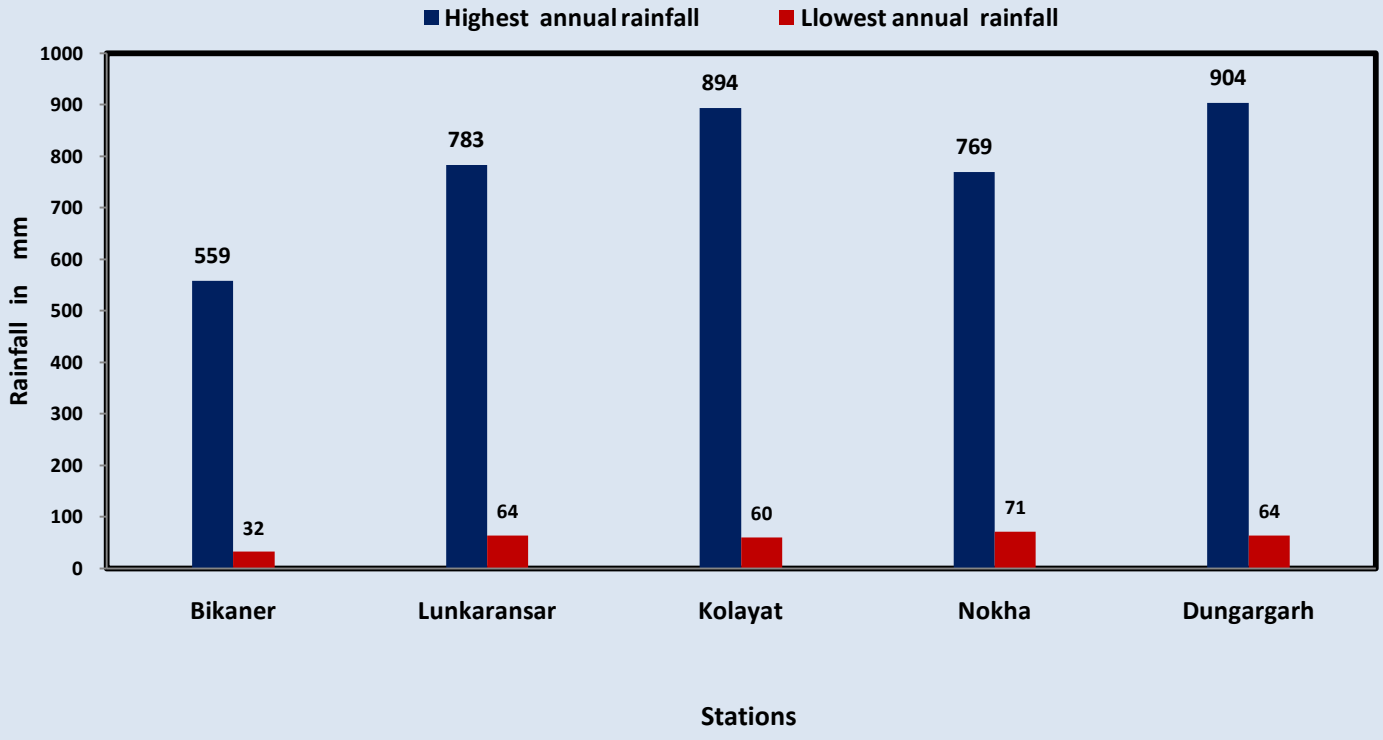

Fig. 9.3.1 Tehsil wise Highest and Lowest annual rainfall

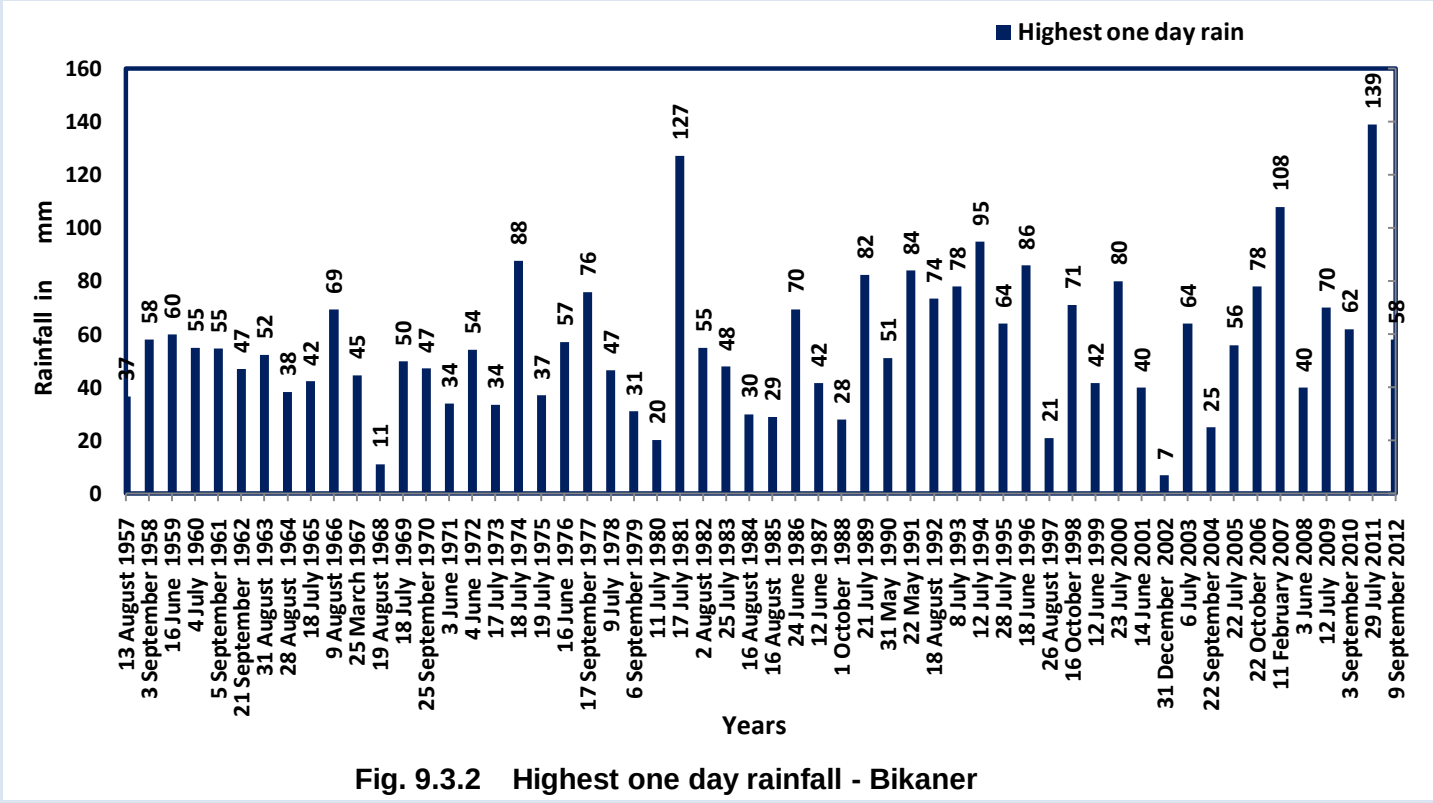

Fig. 9.3.2 Highest one day rainfall - Bikaner

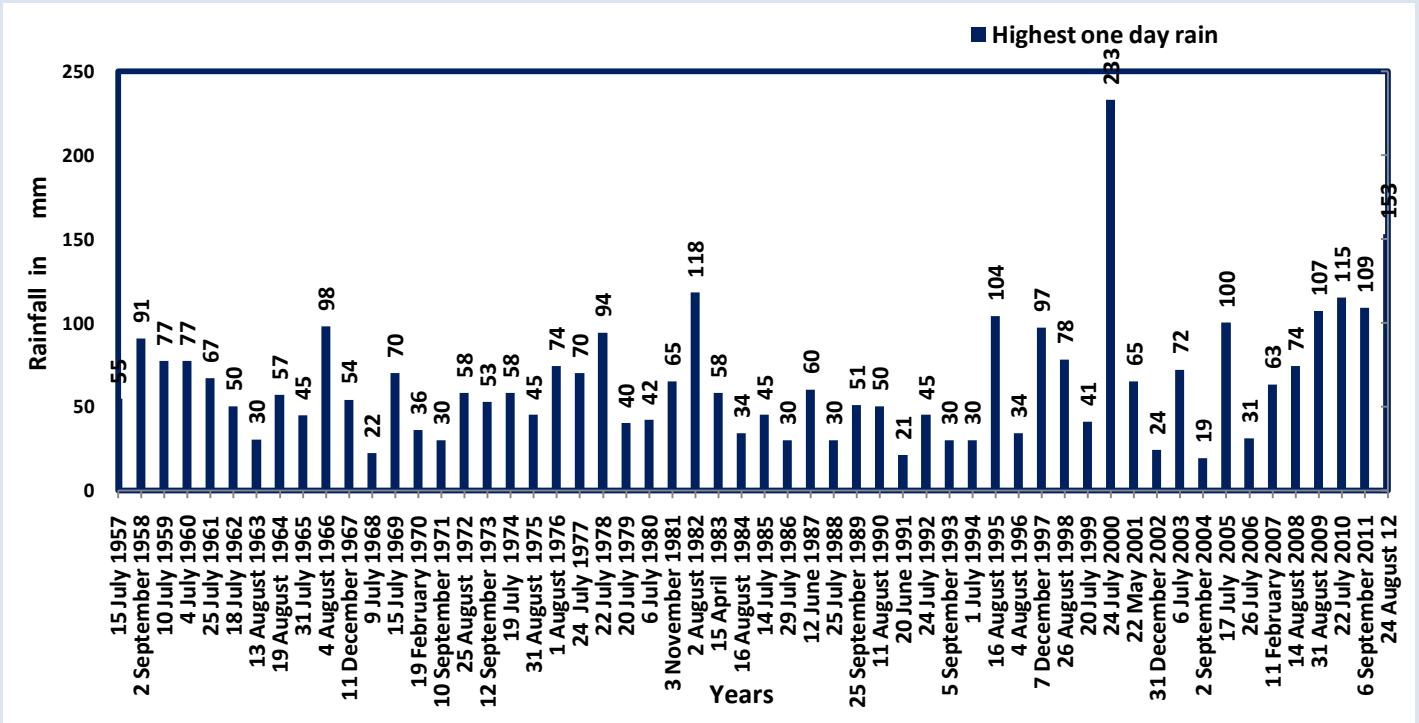

Fig. 9.3.3 Highest one day rainfall - Lunkaransar

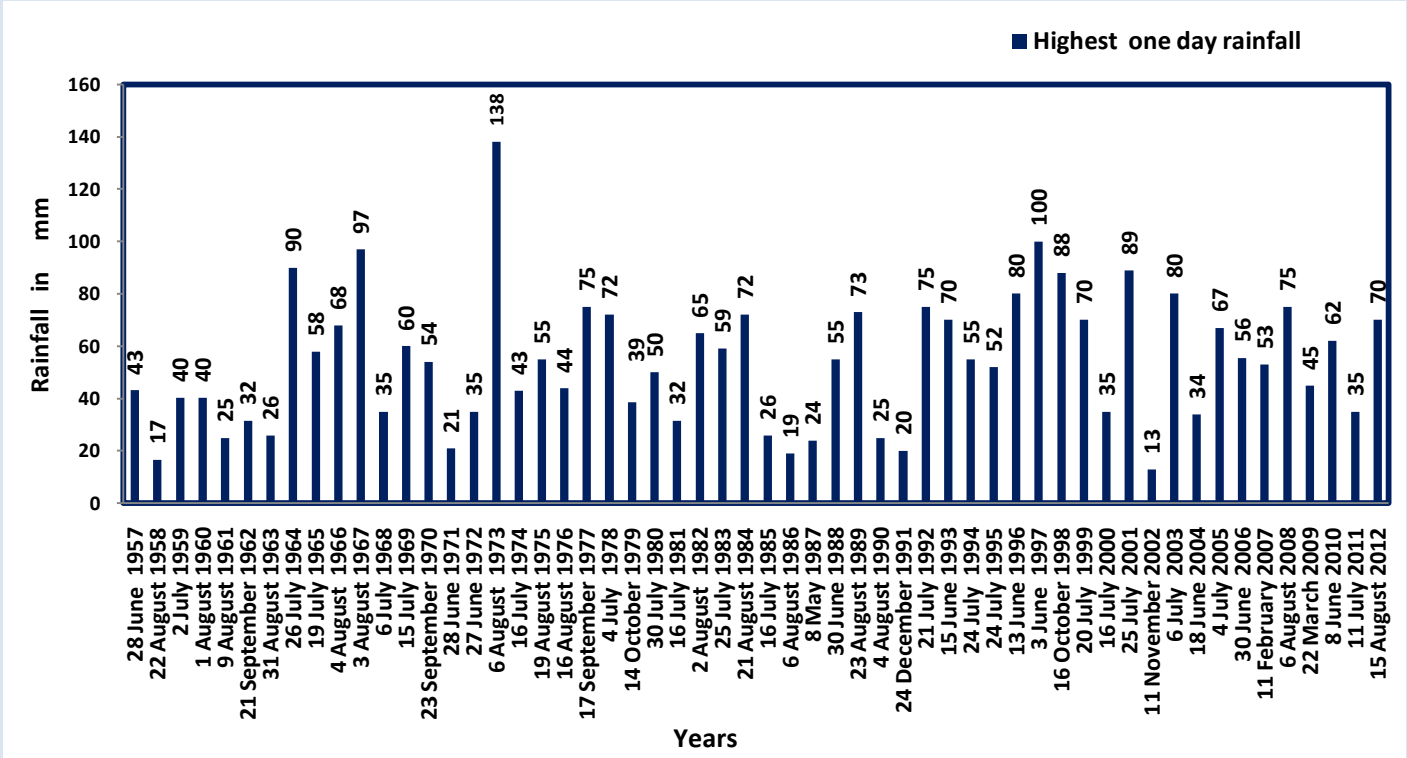

Fig.9.3.4 Highest one day rainfall - Kolayat

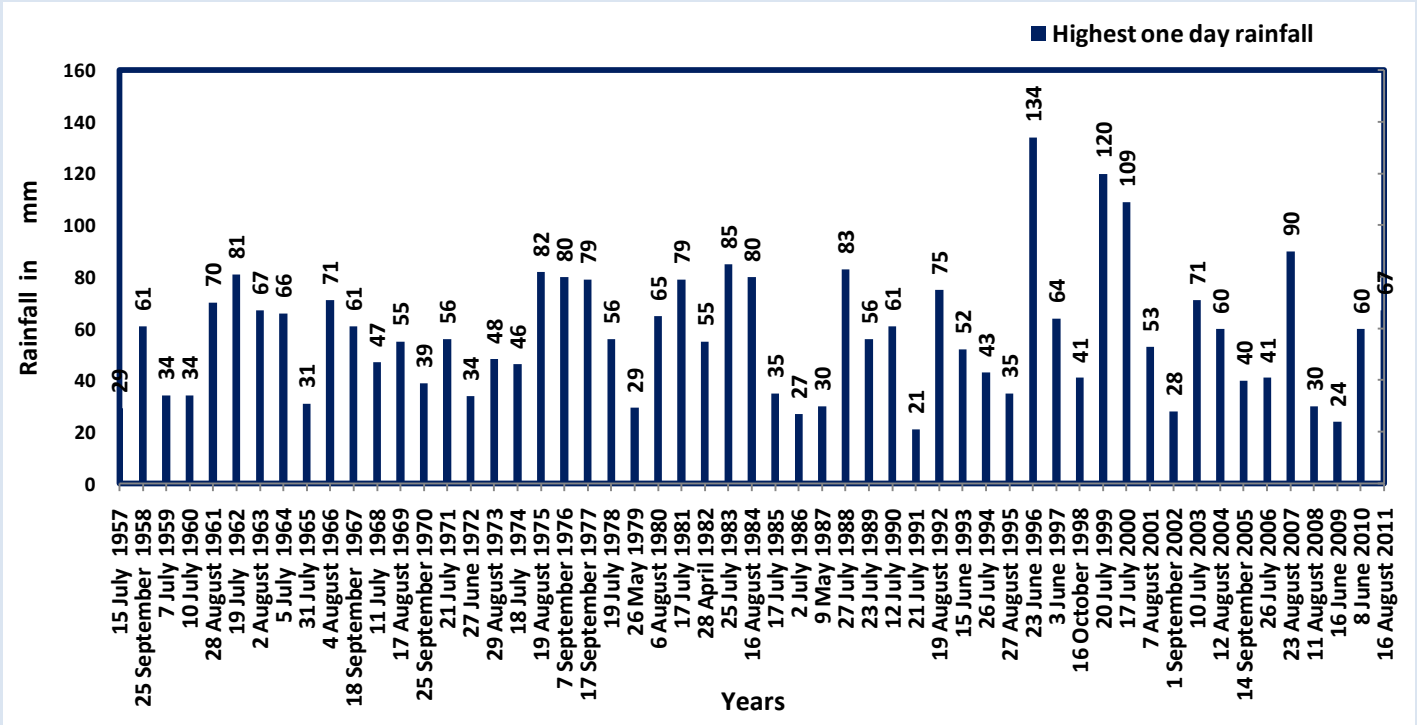

Fig.9.3.5 Highest one day rainfall - Nokha

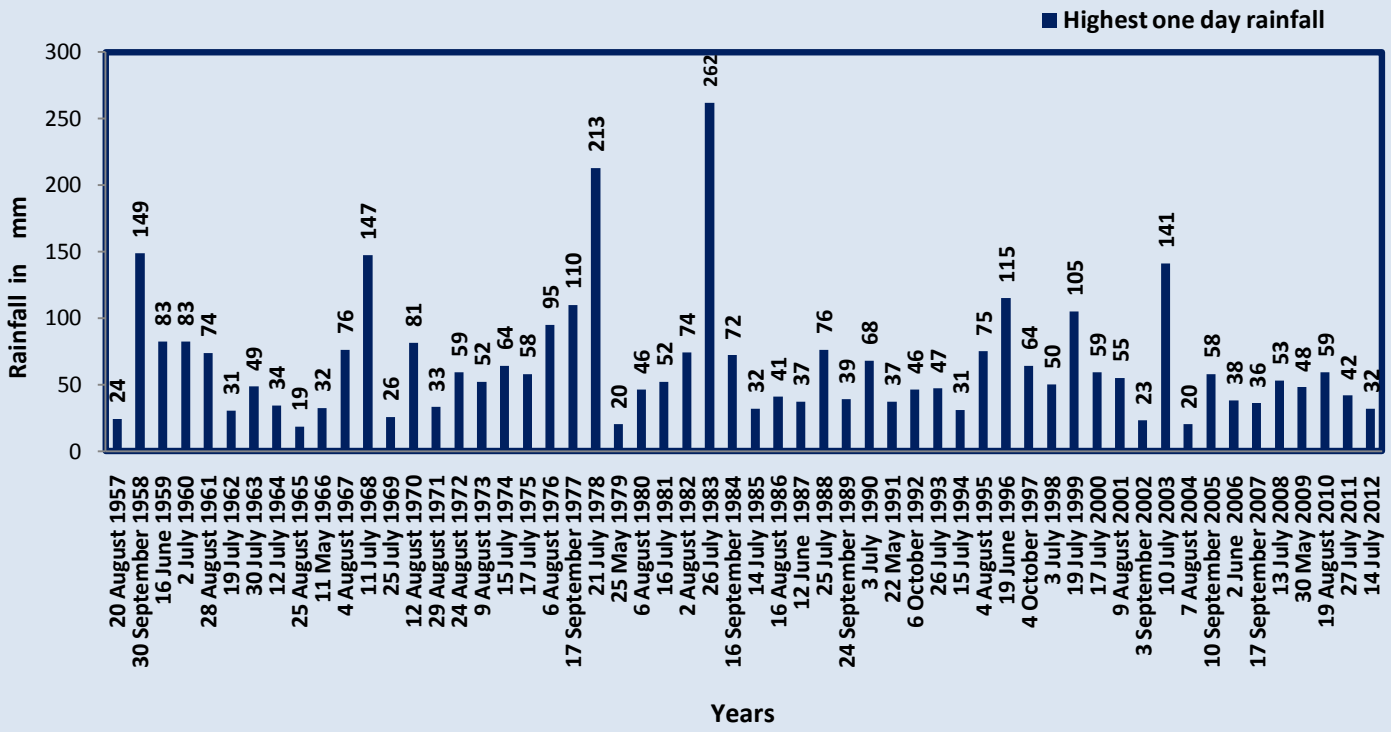

Fig. 9.3.6 Highest one day rainfall - Dungargarh

9.4 Barmer District

The extreme rainfall observed on different temporal scales over different stations of the Barmer district is shown in Fig. 9.4.1 to Fig. 9.4.6. The highest / lowest annual rainfall of Barmer, Chohtan, Pachpadra, Sheo and Siwana stations are (759 mm / 37 mm), (875 mm / 36 mm), (590 mm / 37 mm), (525 mm / 31 m) and (1052 mm / 34 mm) respectively. The highest (1052 mm) and lowest (31 mm) annual rainfall were realized at Siwana and Sheo stations respectively. One day highest rainfall of 312 mm on 8 August 1990 at Barmer; 267 mm on 7 August 1990 at Chohtan; 152 mm on 26 July 1995 at Pachpadra; 170 mm on 19 July 1993 at Sheo and 205 mm on 18 August 1973 at Siwana , was recorded.

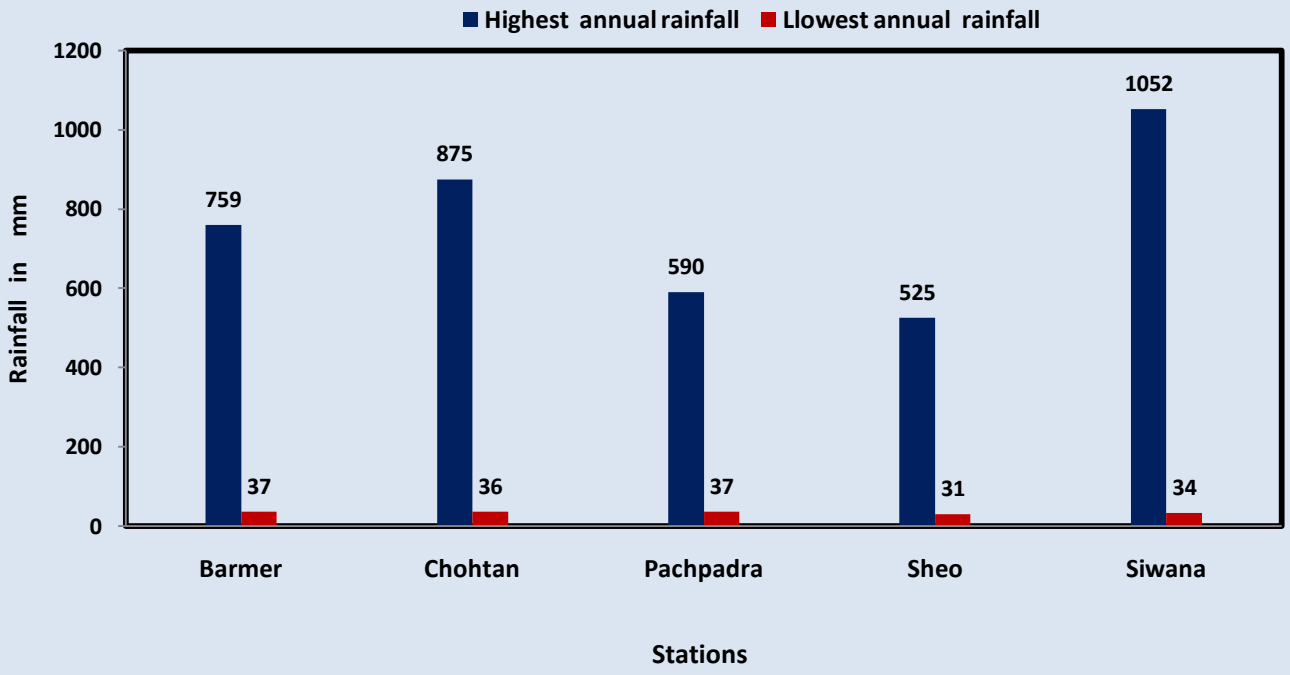

Fig. 9.4.1 Station wise Highest and Lowest annual rainfall

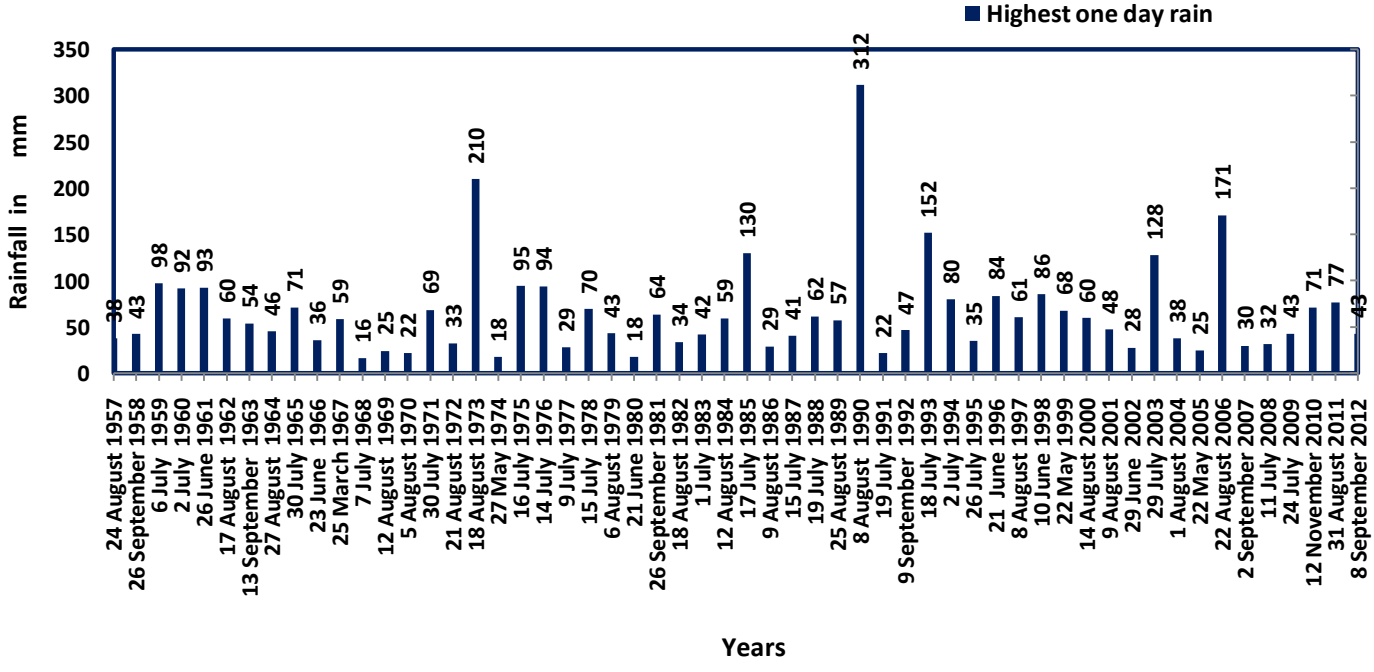

Fig. 9.4.2 Highest one day rainfall - Barmer

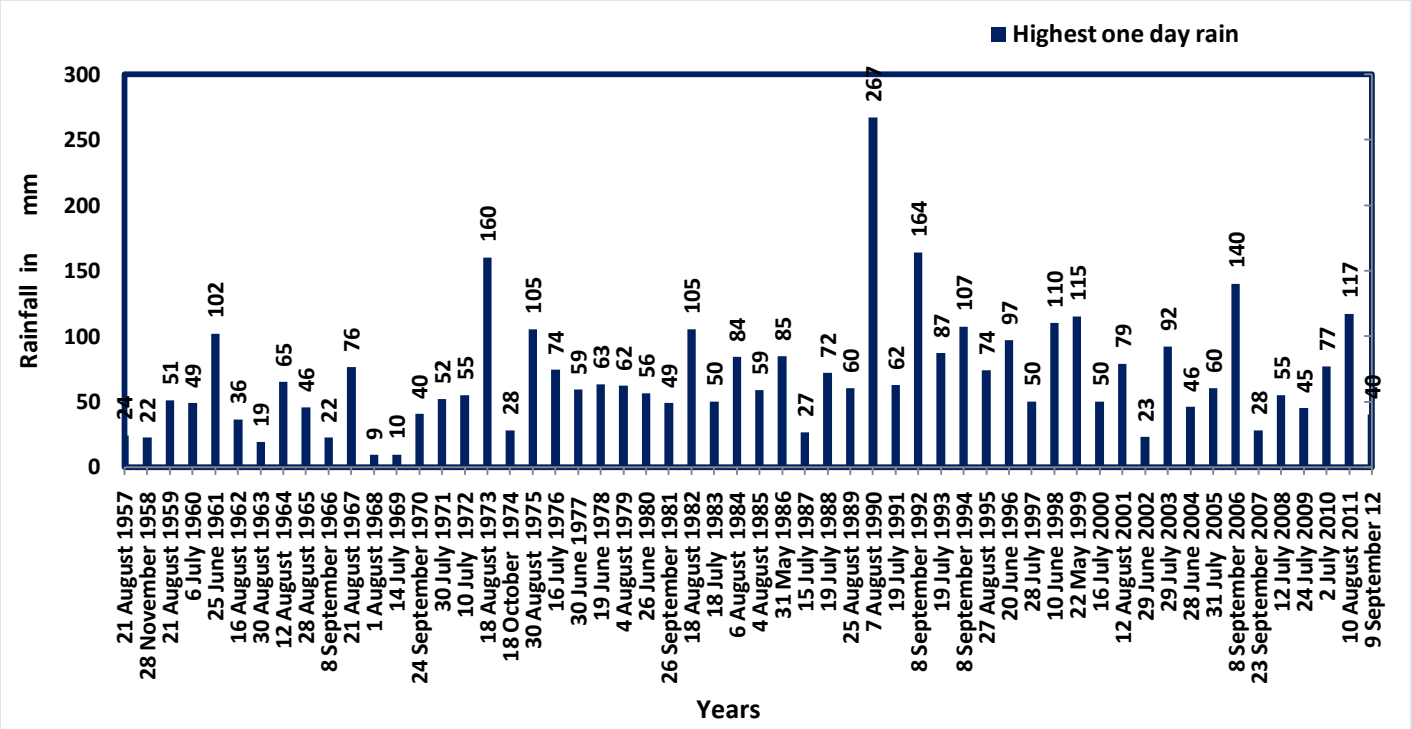

Fig.9.4.3 Highest one day rainfall - Chohtan

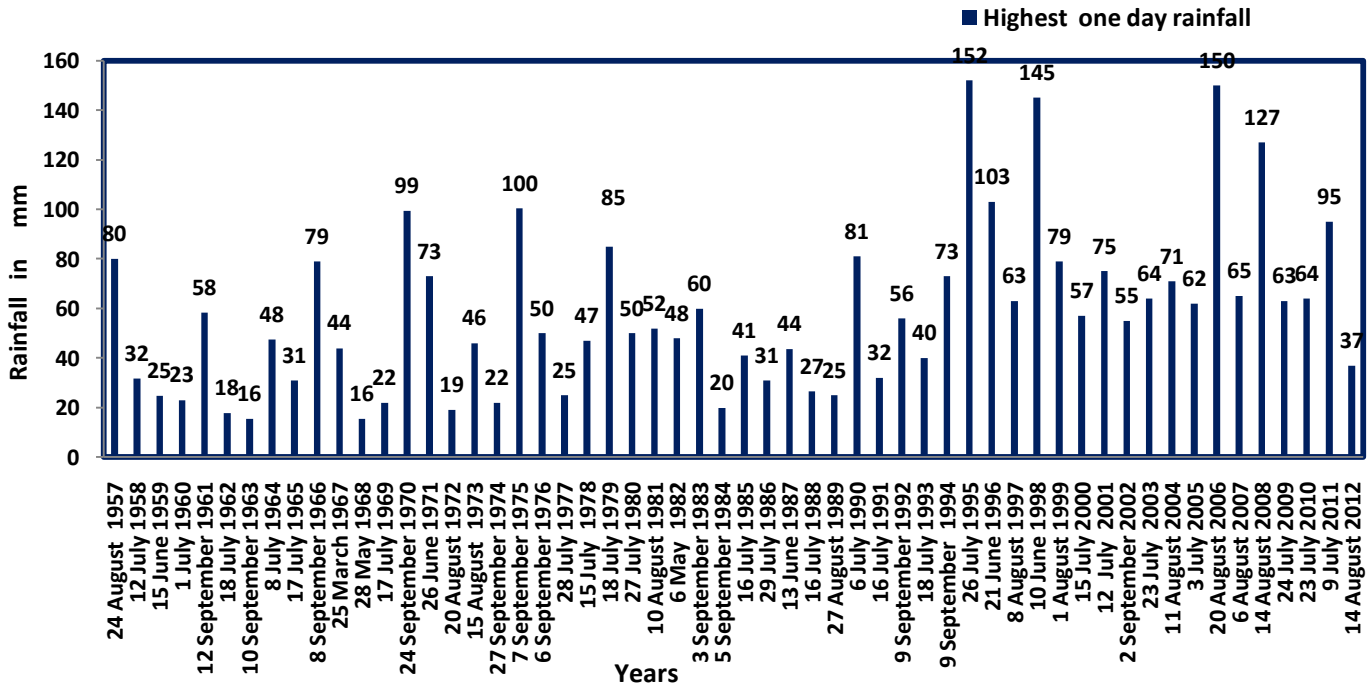

Fig. 9.4.4 Highest one day rainfall - Pachpadra

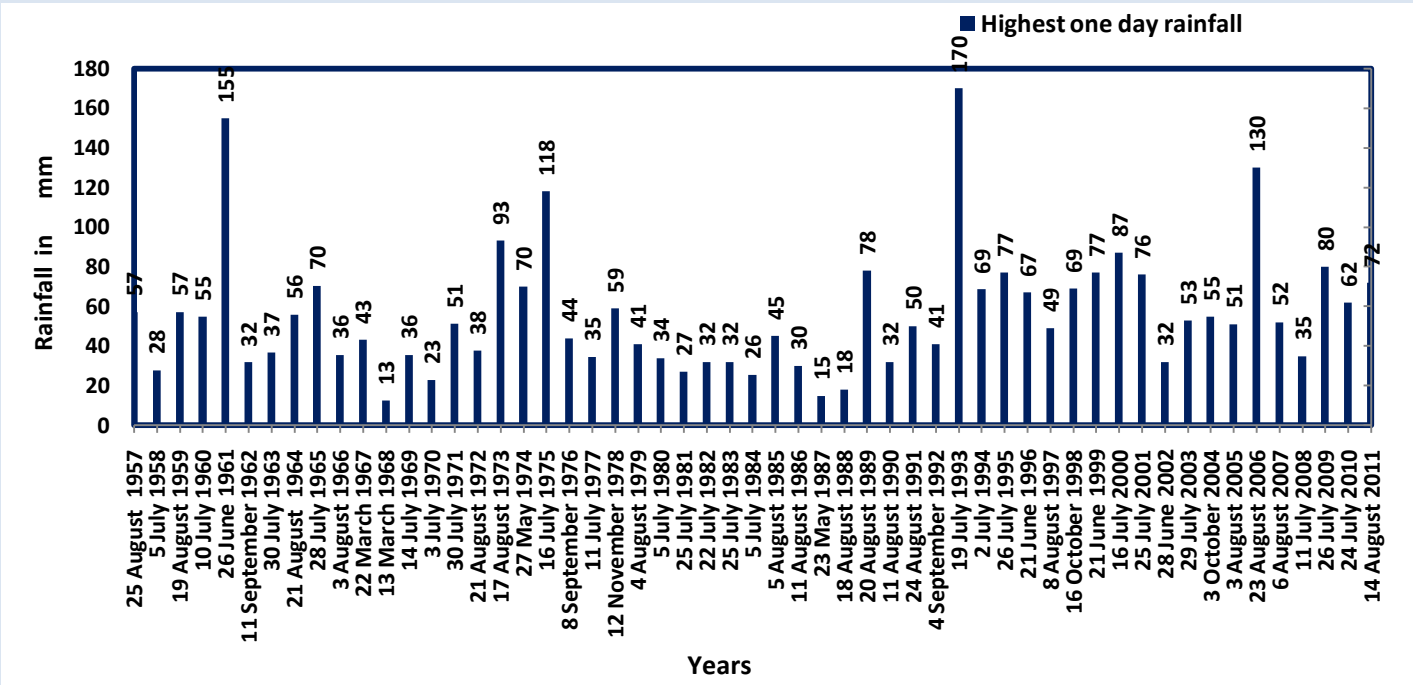

Fig.9.4.5 Highest one day rainfall - Sheo

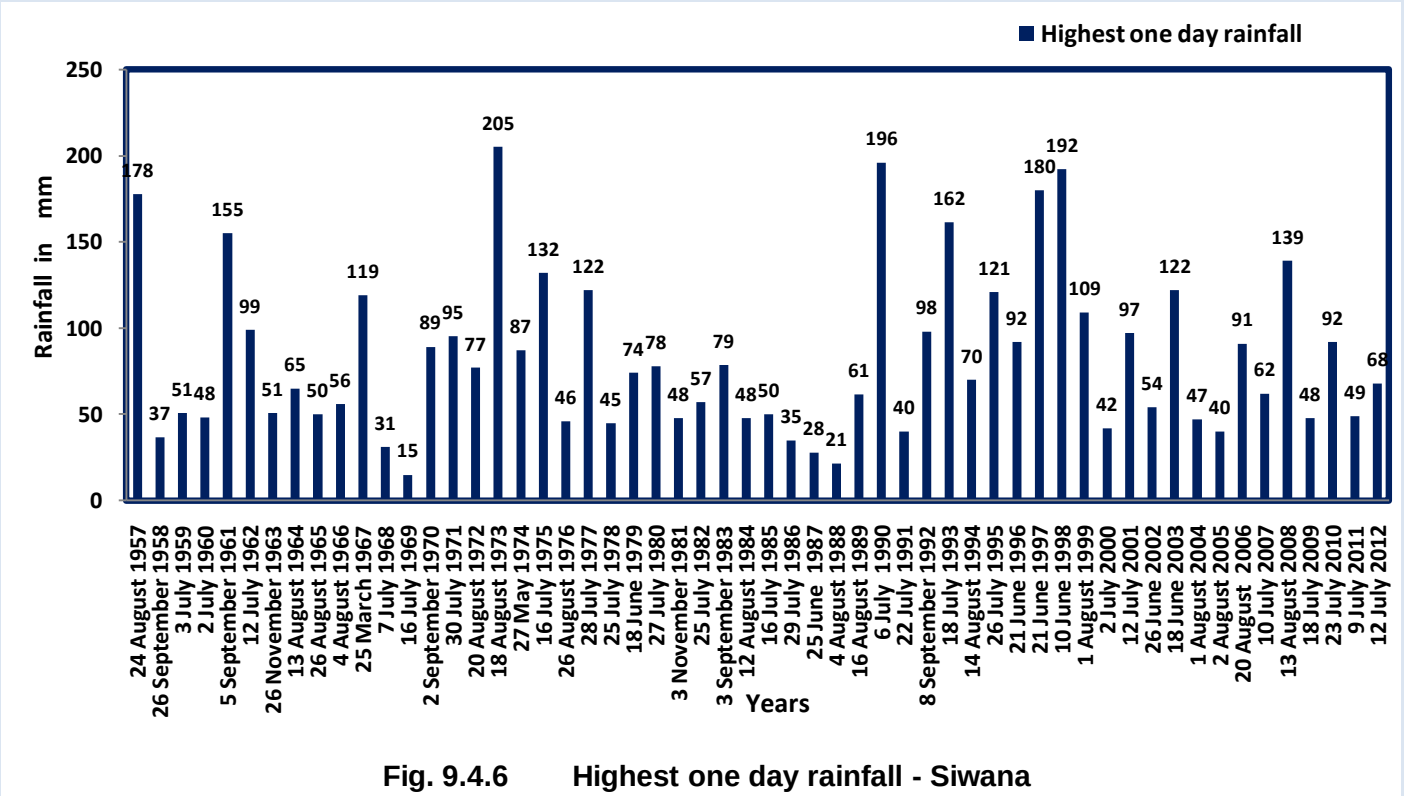

Fig. 9.4.6 Highest one day rainfall - Siwana

Acknowledgment

This work was taken up to know the rainfall structure over the most driest region (Thar Desert) of Rajasthan state and also of the country having the highest rainfall variability in the country and thereby meet the demand of different departments of state government of Rajasthan, research scholars, print and electronic media, general public, planners and industrialists. Authors are grateful to Dr. L.S. Rathore, Director General of Meteorology, India Meteorological Department for providing all facilities to complete this work. Authors also like to thank to Shri Ashok Kumar Sharma and Shri Alok Kulshrestha, SA for collection of data, computation work and valuable assistance. Support rendered by the officers and staff of the office of Additional Director General of Meteorology (Research), Pune for designing, typesetting and printing this publication is duly acknowledged. Thanks are also due to Group Cap. Ravindra Vishen , Scientist 'E' for his valuable suggestions.

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10. "**http://bikaner.nic.in/** ", **Rajasthan Government website.**

Table-1: Seasonal Rainfall of Thar Desert (1957-2012)

Years	Rainfall (mm)					Years	% Departure from LPA			
	Jun-Sep	Oct-Nov	Dec-Feb	Mar-May	Total		Jun-Sep	Oct-Nov	Dec-Feb	Mar-May
1957	171.3	5.5	1.8	17.3	195.8	1957	-21.4	-26.1	-77.3	-1.8
1958	183.8	19.7	7.0	2.5	213.0	1958	-15.7	165.4	-10.0	-85.8
1959	167.0	0.0	7.0	1.3	175.2	1959	-23.4	-100.0	-9.9	-92.8
1960	167.0	0.0	22.6	1.3	190.8	1960	-23.4	-100.0	191.7	-92.8
1961	357.5	2.0	2.1	12.3	373.9	1961	64.0	-73.2	-72.8	-30.2
1962	202.9	0.2	0.9	15.3	219.3	1962	-7.0	-97.9	-87.8	-12.9
1963	111.2	7.1	0.7	7.7	126.6	1963	-49.0	-4.5	-90.9	-56.4
1964	230.6	0.0	3.7	10.1	244.5	1964	5.7	-99.6	-51.9	-42.4
1965	162.9	2.2	11.4	8.9	185.3	1965	-25.3	-70.6	46.9	-49.6
1966	169.0	2.6	0.0	9.3	180.9	1966	-22.5	-65.2	-100.0	-47.0
1967	183.6	6.3	24.3	53.5	267.6	1967	-15.8	-15.1	213.2	204.3
1968	64.2	0.4	1.8	6.4	72.8	1968	-70.5	-95.2	-76.9	-63.7
1969	88.8	1.8	20.6	3.1	114.3	1969	-59.3	-76.0	165.9	-82.3
1970	256.6	0.0	2.7	5.7	265.0	1970	17.7	-100.0	-65.0	-67.7
1971	175.4	1.7	1.9	24.0	203.1	1971	-19.5	-76.7	-75.5	36.6
1972	149.6	0.2	0.3	3.5	153.6	1972	-31.4	-97.1	-96.7	-79.9
1973	388.5	0.2	1.0	8.5	398.2	1973	78.1	-96.8	-86.7	-51.6
1974	93.4	4.9	0.9	28.3	127.5	1974	-57.2	-33.7	-88.2	61.0
1975	425.0	24.8	9.1	1.9	460.8	1975	94.9	234.4	17.0	-89.4
1976	344.2	12.8	8.4	8.0	373.4	1976	57.9	72.6	8.4	-54.7
1977	319.9	0.7	10.7	18.9	350.2	1977	46.7	-91.2	38.0	7.7
1978	240.7	10.0	27.2	8.0	285.8	1978	10.4	34.6	251.0	-54.6
1979	197.0	31.3	3.0	35.6	266.9	1979	-9.7	321.4	-61.8	102.9
1980	159.8	7.0	13.4	10.0	190.1	1980	-26.7	-5.6	72.5	-43.1
1981	149.6	29.4	12.0	16.9	207.9	1981	-31.4	296.4	54.3	-3.8
1982	188.2	7.1	1.6	75.9	272.9	1982	-13.7	-3.8	-79.7	332.2
1983	304.1	7.8	3.0	76.8	391.6	1983	39.5	5.0	-61.8	337.1

1984	170.2	0.1	0.0	1.1	171.4	1984	-21.9	-98.9	-100.0	-94.0
1985	118.3	0.7	8.5	21.6	149.1	1985	-45.8	-91.2	10.1	23.1
1986	130.1	0.6	3.3	21.9	155.9	1986	-40.4	-91.5	-57.5	24.5
1987	67.8	0.0	1.5	34.7	104.1	1987	-68.9	-100.0	-80.2	97.4
1988	181.9	5.5	9.2	10.4	207.0	1988	-16.6	-25.4	18.1	-41.1
1989	216.1	0.4	16.8	1.5	234.7	1989	-0.9	-94.8	116.7	-91.6
1990	354.1	0.2	4.5	24.4	383.2	1990	62.4	-96.7	-42.2	38.7
1991	101.9	0.1	14.8	17.2	134.1	1991	-53.2	-98.1	91.1	-2.0
1992	334.3	6.8	4.4	5.5	351.0	1992	53.3	-8.5	-42.7	-68.5
1993	244.6	1.3	7.8	6.0	259.6	1993	12.1	-83.0	1.2	-66.1
1994	341.7	0.0	16.3	9.1	367.2	1994	56.7	-100.0	110.3	-48.1
1995	280.0	14.7	6.8	5.5	307.0	1995	28.4	98.1	-12.7	-69.0
1996	307.7	1.7	0.8	37.9	348.2	1996	41.1	-77.2	-89.1	115.9
1997	242.2	64.3	17.6	32.7	356.8	1997	11.1	765.9	127.6	86.0
1998	236.2	69.1	9.7	10.9	325.8	1998	8.3	830.5	24.7	-38.2
1999	171.5	4.7	0.5	44.0	220.8	1999	-21.3	-36.1	-93.8	150.7
2000	231.4	2.1	1.1	5.9	240.5	2000	6.1	-71.3	-86.4	-66.6
2001	247.2	12.8	0.9	30.0	290.9	2001	13.4	72.5	-88.7	70.8
2002	50.2	3.7	24.4	9.1	87.5	2002	-77.0	-49.9	215.2	-48.3
2003	305.6	0.5	0.9	3.5	310.5	2003	40.2	-93.5	-88.0	-80.1
2004	135.4	16.0	14.7	7.2	173.3	2004	-37.9	115.3	90.2	-59.2
2005	191.5	0.0	0.0	23.9	215.4	2005	-12.2	-100.0	-100.0	35.9
2006	284.0	6.9	35.7	25.5	352.1	2006	30.2	-6.5	360.3	45.0
2007	210.5	0.2	2.3	26.8	239.7	2007	-3.5	-97.8	-70.0	52.4
2008	239.2	0.0	14.3	45.9	299.4	2008	9.7	-100.0	83.9	161.4
2009	152.2	0.4	3.1	16.0	171.7	2009	-30.2	-94.5	-60.4	-8.7
2010	411.3	15.6	14.8	5.1	446.7	2010	88.6	109.6	91.4	-71.2
2011	341.7	0.2	0.4	7.0	349.2	2011	56.7	-97.7	-95.0	-60.0
2012	260.5	1.4	0.0	23.1	285.1	2012	19.5	-80.6	-100.0	31.4
Mean	218.1	07.4	07.8	17.6	250.8					
SD	90.9	13.7	08.3	17.0	94.6					
CV	41.7	184.4	107.2	96.6	37.7					

District: Jodhpur

Table2.1: Stations wise Annual Rainfall (in mm), Variability and District Rainfall Statistics

Stations/District	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Jodhpur	272.4	307.1	218.2	215	354.8	280.1	259	373.2	284.9	362.6	610.8	187.2	103.7	631.8	268.5	237	651.8
Phalodi	216.7	238.2	170.9	165	316.5	365.7	154.3	346.6	201	255	215.4	98	134.2	374.3	187.7	130.8	354.3
Bilara	343.5	303.1	309.4	301	477.5	314.3	233.1	490.7	472.2	268.4	558.2	278.6	233	642.6	429.9	161	622.8
Shergarh	199.9	249.3	229.1	225	305.3	191.5	119.8	172.3	170	148.4	289.8	61.2	59.8	224.5	151.8	92.6	400.6
Osian	237	190.4	190.1	185	283.8	215.7	98.6	200.2	299.9	344	346	213	128	375.4	226.3	202.3	340.2
Jaswant Sagar	594.7	400.6	273.3	269	531.9	287.2	147.7	408.9	362.9	92	507.5	241	179	561	329	163	586
JODHPUR DIST. (Mean AM)	310.7	281.5	231.8	226.7	378.3	275.8	168.8	332.0	298.5	245.1	421.3	179.8	139.6	468.3	265.5	164.5	492.6
SD	148.2	72.8	51.7	51.0	102.0	63.9	63.6	123.2	110.0	106.8	159.6	84.2	60.2	168.9	101.6	51.0	142.7
CV%	48	26	22	22	27	23	38	37	37	44	38	47	43	36	38	31	29
MEAN(WT)	263.6	257.0	209.4	204.2	343.1	288.1	153.8	307.6	255.7	248.0	341.0	145.9	128.0	407.4	226.6	151.0	429.3
DIFFERENCE	47.1	24.4	22.4	22.5	35.2	-12.3	15.0	24.4	42.8	-3.0	80.2	34.0	11.6	60.8	38.9	13.4	63.3

Stations/District	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Jodhpur	194.4	708.9	645.1	386.2	441.7	572.2	250.2	279.4	451.2	441.9	294.5	209.1	175	165	322.3	304	815
Phalodi	206.9	433.6	383	255	14.4	254	217	195	257	486	145	196.5	168	227.8	166	140	250
Bilara	315.8	1056.5	760	653.9	285.5	1063.9	245.1	182	408	703.1	318	279	278	201.5	442.9	341.6	628
Shergarh	42	273	445	259	382	317	235.2	97.4	249.8	355	110	182.3	64.2	77.9	274.8	229.8	403.2
Osian	298.4	615	361	348.9	269.3	258.5	340.6	204	313	378	255.2	164	173	140	269	256	346
Jaswant Sagar	104.2	1088	752	106	251.1	244	240	111	232	361	263.5	268.3	217	167	377.1	379.6	450.8
JODHPUR DIST. (Mean AM)	193.6	695.8	557.7	334.8	274.0	451.6	254.7	178.1	318.5	454.2	231.0	216.5	179.2	163.2	308.7	275.2	482.2
SD	106.8	328.1	183.4	183.9	146.9	324.7	43.6	66.7	91.3	132.2	84.0	46.8	70.1	51.9	95.9	85.8	205.8
CV%	55	47	33	55	54	72	17	37	29	29	36	22	39	32	31	31	43
MEAN(WT)	191.0	565.1	476.5	304.8	209.7	361.9	249.2	178.0	293.8	445.9	195.4	202.0	162.9	171.2	259.1	228.6	395.7
DIFFERENCE	2.7	130.7	81.2	30.1	64.3	89.7	5.5	0.1	24.7	8.3	35.7	14.5	16.3	-8.0	49.6	46.6	86.4

Stations/District	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Jodhpur	232.5	526	232	396	374	521.1	572.1	577	357.5	273	527	91	359	182	283	210
Phalodi	55.5	252	178	311	143	265	287	233	156	146	251	63	221	79	111	142
Bilara	303.4	496	256	571	581	357	588	321	524	274	336	149	353	496	510	455
Shergarh	204	374	239.6	293.6	377	385	323	240	235	232	346	72.8	353	103	109	221
Osian	211	424	201	544	428	478	387	431	298	192	322	94	483	192	262	205
Jaswant Sagar	272.2	499.6	234	549	556	407	364	321.2	438	274.5	510	80	295	497	411	292
JODHPUR DIST. (Mean AM)	213.1	428.6	223.4	444.1	409.8	402.2	420.2	353.9	334.8	231.9	382.0	91.6	344.0	258.2	281.0	254.2
SD	86.0	103.2	28.5	126.3	157.8	90.6	128.6	130.7	134.3	53.4	111.0	30.4	86.3	189.7	160.1	109.4
CV%	40	24	13	28	39	23	31	37	40	23	29	33	25	73	57	43
MEAN(WT)	165.2	370.8	209.7	397.0	328.1	367.7	368.7	315.2	267.7	203.1	335.2	81.3	321.2	181.3	210.2	212.2
DIFFERENCE	47.9	57.8	13.8	47.1	81.7	34.4	51.5	38.7	67.1	28.8	46.8	10.3	22.8	76.9	70.8	42.0

Stations/District	2007	2008	2009	2010	2011	2012	Mean	SD	CV %	AREA Sq. Km.	STATIONS		RAINY DAYS	Highest	lowest
Jodhpur	205	475.9	156	511	314	480	359.5	165.6	46.1	1875.52	Jodhpur		20	815	91
Phalodi	204	207	64	314	293	172	215.5	95.7	44.4	7657.65	Phalodi		14	486	14
Bilara	417	384	128	339	476	395	416.3	193.4	46.5	1653.27	Bilara		22	1064	128
Shergarh	359	255	67	676.5	566	279.5	242.8	128.7	53.0	3812.88	Shergarh		16	677	42
Osian	200	270.5	139	435	385	416	286.8	112.5	39.2	3502.94	Osian		18	615	94
Jaswant Sagar	445	256	96	317	303	265	343.4	180.6	52.6	1653.27	Jaswant Sagar		16	1088	80
JODHPUR DIST. (Mean AM)	305.0	308.1	108.3	432.1	389.5	334.6	310.7	118.1	38.0	20155.53					
SD	115.1	101.1	38.5	142.7	110.6	114.7	75.9								
CV%	38	33	36	33	28	34	24					MEAN	18		
MEAN(WT)	270.0	270.7	94.0	424.2	378.4	289.3	273.4					SD	3		
DIFFERENCE	35.0	37.4	14.3	7.9	11.1	45.3	37.3					CV %	17		

District: Barmer

Table2.2: Stations wise Annual Rainfall (in mm), Variability and District Rainfall Statistics

Stations/District	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Barmer	182.5	192.2	258.6	255	535.6	168.2	193.6	284.4	308.7	87	235.2	37.1	63.5	163.7	157	113.8	498.9
Chohtan	137.7	156.1	203.5	200	645.4	135.6	123	365.8	126.9	87.8	334.8	39.5	36.4	154	161	165.5	492.5
Pachpadra	130.7	159.4	162.7	155	404.1	71.9	73.5	188.5	168.6	163	276.8	47.4	37	311.3	204.9	112	230.4
Sheo	145.5	146.7	201.1	197	525.1	117.2	178.5	285.3	157.4	123.9	275.2	30.8	70.5	139.8	205	199.1	429.7
Siwana	381.5	271.2	253.8	250.2	904.3	360.1	222.1	343.5	228	215	460	97	34.3	563.3	248.1	238.6	785.2
BARMER DIST. (Mean AM)	195.6	185.1	215.9	211.4	602.9	170.6	158.1	293.5	197.9	135.3	316.4	50.4	48.3	266.4	195.2	165.8	487.3
SD	105.8	51.1	40.2	41.6	188.9	111.5	59.5	68.7	72.0	54.4	87.8	26.7	17.2	179.8	37.5	54.8	198.9
CV%	54	28	19	20	31	65	38	23	36	40	28	53	36	68	19	33	41
MEAN(WT)	171.0	170.8	208.8	204.4	573.4	146.3	153.6	293.4	181.6	126.2	303.0	43.6	51.7	220.7	191.9	167.4	456.7
DIFFERENCE	24.6	14.3	7.1	7.1	29.5	24.3	4.5	0.1	16.3	9.1	13.4	6.8	-3.4	45.7	3.3	-1.6	30.6

Stations/District	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Barmer	50	518.4	509.8	145.8	336.2	205.7	89	212.4	192.6	310.3	245.8	249	97.8	101.2	170.6	266.2	748.2
Chohtan	112	536.6	437	273	231	257.5	212.9	158.4	317.4	249.5	246.4	146	153	40.3	319.5	237.5	761.1
Pachpadra	79	589.6	339	203	237.4	409	144	200	232	317.7	123.3	95.4	84	128	141	148.3	428
Sheo	90	329.8	303.4	179	303	171	150	114	148.4	164	112	104	98	40	96	268.4	174
Siwana	151	743.7	284.1	423.9	309	402.6	258.7	246.4	387	446.3	224.1	174	140	110	132	304	1052
BARMER DIST. (Mean AM)	96.4	543.6	374.7	244.9	283.3	289.2	170.9	186.2	255.5	297.6	190.3	153.7	114.6	83.9	171.8	244.9	632.7
SD	37.8	148.8	95.8	110.4	46.6	110.9	65.8	51.2	96.3	103.5	67.1	62.1	30.1	41.1	86.7	58.9	338.4
CV%	39	27	26	45	16	38	39	27	38	35	35	40	26	49	50	24	53
MEAN(WT)	93.8	495.3	369.8	226.1	279.8	262.5	166.2	167.9	234.6	262.1	177.3	141.1	113.0	71.8	171.8	243.3	533.8
DIFFERENCE	2.6	48.3	4.9	18.8	3.5	26.7	4.7	18.4	20.9	35.4	13.1	12.6	1.6	12.1	0.0	1.5	98.8

Stations/District	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Barmer	49	413	386	608	179	225	365	325	172	222	264	126	475	220	140
Chohtan	94.5	498.2	285	619	313	285.8	344	575	251	254	467	72	474	182	200
Pachpadra	144	430	231	430	401	216	382	339	249	225.5	236	167	506	291	266
Sheo	171	333	396	354	331	290	265	225	223	356	325	81	267	187	176
Siwana	178.4	555.6	443.1	408	274	346	543	450	288	249	271	107	609	262	223
BARMER DIST. (Mean AM)	127.4	446.0	348.2	483.8	299.6	272.6	379.8	382.8	236.6	261.3	312.6	110.6	466.2	228.4	201.0
SD	54.8	84.9	87.2	121.6	81.6	53.2	101.6	133.8	42.9	54.8	92.1	38.1	124.3	47.4	47.6
CV%	43	19	25	25	27	20	27	35	18	21	29	34	27	21	24
MEAN(WT)	130.9	424.2	344.0	473.3	310.8	272.3	347.9	366.4	233.5	278.0	328.6	103.3	424.3	216.7	197.1
DIFFERENCE	-3.5	21.8	4.2	10.5	-11.2	0.3	31.9	16.4	3.1	-16.7	-16.0	7.3	41.9	11.7	3.9

Stations/District	2006	2007	2008	2009	2010	2011	2012	Mean	SD	CV %	AREA Sq. Km.	STATIONS	RAINY DAYS	Highest	lowest
Barmer	759	255	207	167	433.5	343	258	263.8	163.2	61.9	2893.87	Barmer	14	759	37
Chohtan	875	181	294	240	560	605	203	288.0	188.2	65.4	4692.11	Chohtan	15	875	36
Pachpadra	547	294	424	156	501	359	189	246.1	134.8	54.8	3458.27	Pachpadra	15	590	37
Sheo	478	275	191	210	428	310	216	220.7	110.3	50.0	6616.32	Sheo	13	525	31
Siwana	503	288	418	201	722	305	288	349.6	202.3	57.9	2045.15	Siwana	17	1052	34
BARMER DIST. (Mean AM)	632.4	258.6	306.8	194.8	528.9	384.4	230.8	273.6	142.5	52.1	19705.72				
SD	175.2	45.9	111.4	33.9	120.7	125.4	41.1	49.1							
CV%	28	18	36	17	23	33	18	18					MEAN	15	
MEAN(WT)	628.5	254.4	282.3	200.4	503.6	393.2	221.8	260.9					SD	1	
DIFFERENCE	3.9	4.2	24.5	-5.6	25.3	-8.8	9.0	12.7					CV %	10	

District: Bikaner

Table2.3: Stations wise Annual Rainfall (in mm), Variability and District Rainfall Statistics

Stations/District	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Bikaner	199.4	309.9	218	225	374.6	287.5	113.8	284.5	174.1	357.7	323.2	54.4	127.6	298.7	185	278.1	212.9
Lunkaransar	263.6	360.1	261.5	265	282.3	262.3	96.5	269.5	192.6	363.3	278.5	92.4	219.4	328.3	126	161.9	308.2
Kolayat	143	140.5	184.5	190	196.4	158.5	60	443.9	116.3	276	307	80.5	179	393	120.5	175	240.6
Nokha	232.9	305.2	188.1	192	334	332.6	179.2	541	154	301.5	370	157	207	350.4	425.2	227.2	359.3
Dungargarh	196.6	663.3	291.1	295	354.3	181.1	161.5	232.7	133.9	321.6	301	310	63.9	503.5	220	246.8	331.1
BIKANER DIST. (Mean AM)	207.1	355.8	228.6	233.4	308.3	244.4	122.2	354.3	154.2	324.0	315.9	138.9	159.4	374.8	215.3	217.8	290.4
SD	45.1	190.8	46.6	46.0	71.4	73.0	48.5	132.0	30.5	37.1	34.2	102.9	64.0	79.8	124.5	48.8	61.7
CV%	22	54	20	20	23	30	40	37	20	11	11	74	40	21	58	22	21
MEAN(WT)	199.5	253.9	209.9	214.8	272.1	238.1	100.4	393.6	151.8	315.7	314.3	94.1	186.6	353.8	190.2	197.7	276.1
DIFFERENCE	7.6	101.9	18.7	18.6	36.2	6.3	21.8	-39.2	2.4	8.4	1.6	44.8	-27.2	20.9	25.2	20.1	14.3

THESILS/DISTRICT	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Bikaner	363.3	212	364	383.4	340.1	228.6	195.3	409	337	558.5	136.5	161.3	333	188	243	297.9	291.6
Lunkaransar	136	317	462	487.2	580	223	241	262	434	448	122	127	213	175	196	159	270
Kolayat	159.1	270.4	336	286.9	373	299.2	177.9	108.3	335	476	255	104	152	188	144	333	192
Nokha	243.1	769.4	264.6	466.5	395.6	251.4	197.5	234.1	365	601	259	134	183	145	333	342	478
Dungargarh	156.7	459	504.4	604	696	76	259	300	426	904	252	123	247	180	327	314	317
BIKANER DIST. (Mean AM)	211.6	405.6	386.2	445.6	476.9	215.6	214.1	262.7	379.4	597.5	204.9	129.9	225.6	175.2	248.6	289.2	309.7
SD	94.2	222.9	96.8	118.7	153.9	83.6	34.2	108.9	47.8	182.1	69.3	20.8	69.6	17.8	82.2	74.7	105.0
CV%	45	55	25	27	32	39	16	41	13	30	34	16	31	10	33	26	34
MEAN(WT)	201.0	368.6	358.6	387.0	424.7	259.8	200.3	218.0	366.1	505.6	203.7	124.5	201.5	176.5	208.7	285.2	281.9
DIFFERENCE	10.6	37.0	27.6	58.6	52.3	-44.2	13.8	44.7	13.3	91.9	1.2	5.4	24.1	-1.3	39.9	4.0	27.8

Stations/District	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Bikaner	147.9	396	227	314	329	297	137	328	188	147	206	32	245	97	313
Lunkaransar	109	260	122	112	425	331	595	439	156	564	263	64	326	106	339
Kolayat	89	444	246	426	283	540	894	519	368	202	459	60.6	384.7	85.3	276
Nokha	79	500	267	335	242	616	541	234	351	310	270	71	392	205	224
Dungargarh	156	428.5	349	236	445	602	561	348	296	283	209	73	442	115	431
BIKANER DIST. (Mean AM)	116.2	405.7	242.2	284.6	344.8	477.2	545.6	373.6	271.8	301.2	281.4	60.1	357.9	121.7	316.6
SD	34.5	89.7	81.7	117.8	88.2	152.2	269.7	109.1	95.6	160.5	103.6	16.5	75.4	47.9	77.2
CV%	30	22	34	41	26	32	49	29	35	53	37	27	21	39	24
MEAN(WT)	101.3	400.7	215.7	311.7	318.3	463.9	633.3	414.6	283.1	305.8	333.9	59.0	349.6	115.3	287.8
DIFFERENCE	14.9	5.0	26.5	-27.1	26.5	13.3	-87.7	-41.0	-11.3	-4.6	-52.5	1.1	8.4	6.4	28.8

THESILS/DISTRICT	2006	2007	2008	2009	2010	2011	2012	Mean	SD	CV %	AREA Sq. Km.	STATIONS	RAINY DAYS	Highest	lowest
Bikaner	277	362	254	293.5	409	356	343	263.7	100.4	38.1	3084.5	Bikaner	17	559	32
Lunkaransar	207	340	545	416	783	549	558	296.3	157.3	53.1	5036.6	Lunkaransar	18	783	64
Kolayat	223	324.3	334	204	386	259	419	268.2	150.3	56.0	7957.6	Kolayat	16	894	60
Nokha	227	422	314	157	495	480	370	314.7	141.5	45.0	3803	Nokha	20	769	71
Dungargarh	202	231	369	199	417	380	193	320.0	167.2	52.2		Dungargarh	19	904	64
BIKANER DIST. (Mean AM)	227.2	335.9	363.2	253.9	498.0	404.8	376.6	292.6	113.3	38.7	19882				
SD	29.8	69.4	109.9	103.4	164.5	112.6	131.9	25.9							
CV%	13	21	30	41	33	28	35	9					MEAN	18	
MEAN(WT)	228.1	352.8	371.2	262.6	511.0	389.8	433.0	283.5					SD	2	
DIFFERENCE	-0.9	-17.0	-8.0	-8.7	-13.0	15.0	-56.4	9.1					CV %	9	

District: JAISALMER

Table2.4: Stations wise Annual Rainfall (in mm), Variability and District Rainfall Statistics

Stations/District	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Jaisalmer	202.1	210.1	67	134.1	340.3	197.9	30.1	67.1	118	40.4	150.4	74.4	28	241.6	82.1	64.9	311.6
Fatehgarh	242.9	187.4	156.1	156.1	406.1	124	16.2	97	40.8	24	100.5	74.4	28.2	125	89.2	148	332
Pokran	229.5	130.1	154	154	287.5	190.8	84.8	153.4	218.3	210.7	152.6	38	29	190.2	154.4	88.6	141.4
Ramgarh	83.8	72.5	45.4	45.4	299.8	92.3	100.3	184.2	86.5	96	165	13	2	121.5	154	27	244.1
Sam	176.3	125	87.1	87.1	633.5	270.9	82.6	133.1	89.5	76.6	90.7	30	8	331.3	295.8	40.8	1304
Nokh	200.6	195.1	135	135	224.7	144.6	13.4	199.4	140	148	119	45	70	216	214	56.4	108.6
JAISALMER DIST. (Mean AM)	189.2	153.4	107.4	118.6	365.3	170.1	54.6	139.0	115.5	99.3	129.7	45.8	27.5	204.3	164.9	71.0	407.0
SD	56.7	52.9	47.3	43.6	144.5	63.5	38.9	50.7	60.5	69.9	30.6	24.6	23.8	78.7	80.4	43.2	448.4
CV%	30	35	44	37	40	37	71	36	52	70	24	54	87	39	49	61	110
MEAN(WT)	213.5	187.7	98.7	141.5	334.7	187.8	42.1	91.9	134.1	80.8	145.3	65.4	28.3	215.6	100.8	80.2	271.7
DIFFERENCE	-24.3	-34.3	8.8	-22.9	30.6	-17.7	12.5	47.1	-18.6	18.5	-15.6	-19.6	-0.7	-11.4	64.1	-9.2	135.2

THESILS/DISTRICT	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Jaisalmer	93.1	478	345	181	276.1	288.7	170.5	319.2	221.3	337.3	160.4	115.4	65	39	231.5	182	133
Fatehgarh	45	139	340	143.4	146	98	150	23	83	67	69	22	65	30	83	73	203
Pokran	62	339.5	363	203.5	138	178	207.5	108.9	135	434	171	175.5	102	130.5	179.5	108	118
Ramgarh	33.8	240.6	173	247	235	128	75	127	72	136	66	60	125	15	42	259.4	246.5
Sam	71	440	203	123	165	166	142.5	50	134	246	142	22	131.5	50	180	215.2	192
Nokh	94	142	275	189	108	162	148	201	167	335	88	94	167.3	74	82	99	140
JAISALMER DIST. (Mean AM)	66.5	296.5	283.2	181.2	178.0	170.1	148.9	138.2	135.4	259.2	116.1	81.5	109.3	56.4	133.0	156.1	172.1
SD	24.6	146.4	80.1	44.1	64.1	65.1	43.4	108.4	55.0	137.6	47.3	59.5	40.2	41.4	74.1	73.9	49.7
CV%	37	49	28	24	36	38	29	78	41	53	41	73	37	73	56	47	29
MEAN(WT)	79.9	405.2	348.9	182.3	227.1	239.6	177.3	233.5	184.2	330.6	152.7	119.7	74.2	60.7	201.8	151.3	137.2
DIFFERENCE	-13.5	-108.7	-65.7	-1.2	-49.1	-69.5	-28.4	-95.3	-48.8	-71.4	-36.6	-38.2	35.1	-4.2	-68.8	4.8	34.9

THESILS/DISTRICT	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Jaisalmer	127.8	227.3	370.7	196	320.5	190	185	333	248	145	321	63	178	47.3	220.5
Fatehgarh	81	105.5	274	287.7	234.2	211	187	318	233	368	333	44.5	324	148	190
Pokran	84	116.5	147.5	459	237	433	211.5	328	267	208	294.3	48.5	194	85	154
Ramgarh	36	154	154	326.6	162.2	116.8	230	273	182	34	121	9	212	29	57
Sam	63	326	177.5	212	233	116	246	204.1	373	78	79	51	163	77	114
Nokh	97	453.4	268	228	269	522	282.5	336	208.9	279	155	48	209	91	275
JAISALMER DIST. (Mean AM)	81.5	230.5	232.0	284.9	242.7	264.8	223.7	298.7	252.0	185.3	217.2	44.0	213.3	79.6	168.4
SD	31.0	136.6	87.7	98.5	51.8	171.5	37.4	51.8	66.3	125.5	111.7	18.3	57.3	41.1	77.6
CV%	38	59	38	35	21	65	17	17	26	68	51	42	27	52	46
MEAN(WT)	111.6	186.0	304.4	271.6	290.0	252.6	191.8	330.1	251.0	185.9	315.7	57.3	198.5	68.1	200.6
DIFFERENCE	-30.2	44.4	-72.5	13.3	-47.4	12.2	31.9	-31.4	1.0	-0.6	-98.5	-13.3	14.8	11.5	-32.1

THESILS/DISTRICT	2006	2007	2008	2009	2010	2011	2012	Mean	SD	CV %	AREA Sq. Km.	STATIONS	RAINY DAYS	Highest	lowest
Jaisalmer	512.8	195.2	173.5	91	309	277	219	195.5	112.0	57.3	24519	Jaisalmer	11	513	28
Fatehgarh	527	187	342	97	396	493	335	175.8	127.3	72.4	4352.3	Fatehgarh	9	527	16
Pokran	141	401	423	84	540	487	259	202.9	120.6	59.4	9516.8	Pokran	13	540	29
Ramgarh	157	178	139	100	386	162	183	134.2	88.3	65.8		Ramgarh	8	386	2
Sam	256	184.2	88	64.5	226.5	104	131.5	180.4	189.5	105.0		Sam	9	1304	8
Nokh	59	385	181	175	395	326	263	186.4	105.9	56.8		Nokh	10	522	13
JAISALMER DIST. (Mean AM)	275.5	255.1	224.4	101.9	375.4	308.2	231.8	179.2	88.9	49.6	38389				
SD	199.5	107.1	129.3	38.0	104.5	161.5	70.7	24.2							
CV%	72	42	58	37	28	52	30	13					MEAN	10	
MEAN(WT)	422.2	245.3	254.5	89.9	376.1	353.5	242.1	195.1					SD	2	
DIFFERENCE	-146.8	9.8	-30.0	12.0	-0.7	-45.4	-10.3	-15.9					CV %	18	