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Short communication

Annual and seasonal variability of climate in South Saurashtra Agroclimatic zone

D.D.SAHU
Agrometeorological cell, Department of Agronomy
Junagadh Agricultural University, Junagadh – 362001.
ddsahu1950@yahoo.co.in

Climate is the most dominating factor influencing the suitability of a crop in a particular region. Inter seasonal climatic variability in terms of temperature and rainfall in Gujarat was studied by Parmar et al (2005) using daily historical weather data. Dixit et al (2005) studied the rainfall variability in Kankan region In this paper annual and the inter seasonal variability of all weather parameters using 41 years weather data (1965-2005) has been studied for Junagadh under south Saurashtra Agroclimatic zone. Junagadh (21° 31'N, 70°33' E 61.0 m amsl) is located on the lap of mount Girnar at the middle of Saurashtra region of Gujarat. The climate of the region is characterized as semi-arid high rainfall zone with dry winter and humid summer.

The daily weather data from 1965 to 2005 recorded at Agrometeorological Observatory, Junagadh Agricultural University were transformed into standard weekly (1 to 52 weak) means and totals. As per IMD standards the year was divided into four seasons as summer (10th to 22nd week), monsoon (23rd to 39th week), post monsoon (40th to 49th week), and winter (49th to 9th week) in order to study the annual and seasonal climatic behavior in terms of statistical properties like mean, median, standard deviation (SD) and coefficient of variation (CV%). From the weekly values of 52 weeks of 41 years annual and seasonal values were derived.

Annual variability

The variability of weather parameters on annual basis is presented in Table 1.

The annual mean maximum and minimum temperature at Junagadh are 34.4°C and 19.9°C respectively. The CV% of minimum temperature is higher than the maximum temperature. The average temperature is 27.1°C with 3% variability. The annual mean daily BSS is 7.6 hrs with a variability of 6.4%. The annual average evaporation is 6.6 mm per day with 12% coefficient of variation. The annual average rainfall is 876.2 mm with 50.5% variability and 443mm standard deviation. The highest annual rainfall of 2793.7 mm was received in the year 1983 in 52 rainy days. The annual average rainy day is 37 days with a standard deviation of 10 days. In 1987 the lowest rainfall of 145.1mm was recorded in 13 rainy days. The highest rainfall of 1390.0 mm was recorded on 21st June 1983, the rarest event in the region.

Variability during summer seaso

The climatic variability for summer season (Table 2) reveals that the mean maximum temperature is 38.3°Cwith standard deviation of 1.4°C and variability of 3.7 percent. The highest maximum temperature of 42.3°C was observed in 1973 and the lowest (32.5°C) in the year 1967. The mean wind speed for summer season is 9.2 kmph with variability of 14.4 percent. The mean BSS for the season is 9.7 hrs with 7.3% variability. Highest BSS during the season was in 1978 and the lowest in 1997. The mean daily evaporation rate for summer season is 10.1 mm with 12.4% variability. The rainfall during summer was very low i.e. 11.8 mm with one rainy day.

Variability during monsoon season

The statistical properties of climatic parameters are given in Table 3. The mean maximum temperature for monsoon season is 32.9°C ranging from 30.6°C in 1994 to 37.7°C in 1974. The mean minimum temperature is 24.3°C with a range of 11.9 to 26.3°C and higher variability of 10.9 percent. The bright sun shine hours are the lowest during this season with higher variability. The rate of evaporation is also low (5.0 mm) with a variability of 21.4 percent.

The mean rainfall for monsoon season is 814.3

Table 1: Annual variability in weather parameters at Junagadh (1965-2005)

Weather parameters	Mean	Median	SD	CV%	Value		Year	
					Highest	Lowest	Highest	Lowest
Maximum Temp ^{0}C	34.4	34.1	1.0	3.0	37.6	32.2	1973	1967
Minimum Temp ^{0}C	19.9	19.9	1.4	7.1	22.8	14.1	1987	1972
Mean Temp ^{0}C	27.1	26.9	0.8	3.0	29.5	24.9	1987	1972
RH1 (%)	75.0	76.0	4.4	5.9	81.0	65.0	1989	1966
RH2 (%)	42.0	42.0	3.6	8.6	48.0	34.0	1985	2002
Mean RH (%)	59.0	60.0	3.4	5.8	64.0	51.0	1998	2002
Wind speed (kmph)	7.7	7.8	1.7	21.7	9.8	4.1	1987	1981
BSS (hr)	7.6	7.5	0.5	6.4	8.7	6.8	1987	1994
Evaporation (mm)	6.6	6.4	0.8	12.0	8.4	5.4	1969	1980
Rainfall (mm)	876.2	856.4	442.9	50.5	2793.7	145.1	1983	1987
Rainy days	37.0	38.0	10.0	26.8	54.0	13.0	1975	1987

Table 2: Weather variability during summer season.

Weather parameters	Mean	Median	SD	CV%
Maximum Temp ^{0}C	38.3	38.6	1.4	3.7
Minimum Temp ^{0}C	21.6	22.3	2.5	11.8
Mean Temp ^{0}C	29.9	30.2	1.3	4.4
RH1 (%)	72.0	72.0	5.4	7.5
RH2 (%)	30.0	29.0	5.1	17.1
Mean RH (%)	51.0	51.0	4.7	9.2
Wind speed (kmph)	9.2	9.4	1.3	14.4
BSS (hr)	9.7	9.7	0.7	7.3
Evaporation (mm)	10.1	9.8	1.3	12.4
Rainfall (mm)	11.8	0.0	17.6	149.0
Rainy days	0.8	0.0	1.0	133.0

Table 3: Weather variability during monsoon season.

Weather parameters	Mean	Median	SD	CV%	Value		Year	
					Highest	Lowest	Highest	Lowest
Maximum Temp ^{0}C	32.9	32.7	1.3	4.1	37.7	30.6	1974	1994
Minimum Temp ^{0}C	24.3	24.9	2.6	10.9	26.3	11.9	1987	1972
Mean Temp ^{0}C	28.6	28.7	1.0	3.4	30.7	25.7	1974	1972
RH1 (%)	89.0	89.0	2.4	2.7	93.0	81.0	1973	1981
RH2 (%)	67.0	67.0	3.9	5.8	74.0	60.0	1994	2000
Mean RH (%)	78.0	78.0	2.0	3.3	83.0	73.0	1994	1981
Wind speed (kmph)	9.7	9.3	1.7	17.6	12.6	7.2	1987	2001
BSS (hr)	4.0	4.0	0.9	22.4	6.3	2.1	1987	1994
Evaporation (mm)	5.0	5.0	1.1	21.4	7.4	2.6	1987	1983
Rainfall (mm)	814.3	775.4	447.6	55.8	2776.7	138.2	1983	1987
Rainy days	33.0	33.0	9.4	28.3	51.0	11.0	1988	1987

Table 4: Weather variability during post-monsoon season.

Weather parameters	Mean	Median	SD	CV%	Value		Year	
					Highest	Lowest	Highest	Lowest
Maximum Temp ^{0}C	35.3	35.3	1.3	3.7	38.1	33.0	1987	1981
Minimum Temp ^{0}C	18.4	18.5	1.9	10.3	22.1	13.6	1976	1974
Mean Temp ^{0}C	26.8	26.6	1.1	4.1	29.6	25.2	1987	2000
RH1 (%)	71.0	72.0	6.6	9.3	83.0	54.0	1993	1966
RH2 (%)	34.0	33.0	6.5	19.8	45.0	19.0	1981	2002
Mean RH (%)	53.0	53.0	5.0	11.3	64.0	40.0	1998	2002
Wind speed (kmph)	4.7	4.8	1.4	31.1	7.5	2.6	1987	1989
BSS (hr)	8.8	8.9	0.6	6.5	9.9	7.9	1984	2004
Evaporation (mm)	5.4	5.0	1.1	20.3	8.5	4.2	1987	1984
Rainfall (mm)	47.3	19.2	67.1	141.9	235.0	0.0	1982	-
Rainy days	2.0	2.0	2.3	111.3	10.0	0.0	1975	-

Table 5: Weather variability during winter season.

Weather parameters	Mean	Median	SD	CV%	Value		Year	
					Highest	Lowest	Highest	Lowest
Maximum Temp ^{0}C	31.4	31.5	1.2	3.8	35.4	29.2	1996	1967
Minimum Temp ^{0}C	12.4	12.1	1.1	9.0	15.3	10.3	2002	1975
Mean Temp ^{0}C	21.9	21.8	0.9	4.1	24.0	20.4	2002	1994
RH1 (%)	63.0	66.0	7.8	12.4	75.0	43.0	1993	1966
RH2 (%)	28.0	27.0	7.5	26.8	49.0	14.0	1986	2000
Mean RH (%)	46.0	46.0	6.4	14.8	60.0	30.0	1986	2000
Wind speed (kmph)	6.0	6.0	1.6	26.4	8.8	2.8	1967	1989
BSS (hr)	9.2	9.3	0.6	6.5	10.3	7.6	1975	2004
Evaporation (mm)	5.8	5.6	0.8	14.4	8.3	4.0	1968	1984
Rainfall (mm)	3.6	0.0	10.0	277.0	52.3	0.0	1967	-
Rainy days	0.3	0.0	0.6	204.5	3.0	0.0	1967	-

Table 6: Onset and withdrawal of monsoon at Junagadh.

Particulars	Onset (Week No.)	W
Mean/ Median	24th	39th
Earliest/ shortest	20th (2000)	29th (1
Delayed/ longest	28th (1985)	47th (1
SD	2 weeks	3 week
CV (%)	6.5 %	7.9 %
Early (Out of 41 years)	6	8
Normal (Out of 41 years)	27	28
Late (Out of 41 years)	8	5

mm with a variability of 55.8 percent and standard deviation of 447.6 mm. The highest amount of rainfall 2776.7 mm was received in the year 1983 in 49 rainy days and the lowest of 138.2 mm in 1987 in 11 rainy days. The average rainy days for monsoon season are 33 days with a wide range of variation from11 to 51 days. About 95 percent of annual rainfall is received in 89 percent of rainy days in this season. The median value of monsoon rainfall is 775.4 mm, lower than the mean value.

Variability during post-monsoon season

This is a transition period for harvesting *Kharif* crops and sowing of *rabi* crops. Rainfall in this period

is blessing in disguise, because it causes damage to the matured *Kharif* crops and the moisture accumulated is useful for winter crops.

The mean maximum temperature for post monsoon season is 35.3^{0}C (Table 4) with a variability of 3.7 percent. The mean minimum temperature is 18.4^{o}C with a variability of 10.3 percent. The minimum temperature ranged from 13.6^{0}C in 1974 (13.8^{0}C in 2000) to 22.1^{0}C in the year 1976. The morning and afternoon relative humidity respectively are 70% and 34%. The mean RH is 53 percent. The mean wind speed for the season is 4.7 kmph with a high variability of 31.1 percent, and a range of 2.6 to 7.5 kmph. The mean bright sun shine is 8.8 hr with a narrow range of 7.9 to 9.9 hrs. The rate of evaporation is 5.4 mm for the season. The mean rainfall for post-monsoon season is 47.3 mm which is only 5.5% of annual rainfall and 6% of monsoon rainfall, with two rainy days.

Variability during winter season

The mean maximum temperature for winter season (Table 5) is 31.4^{0}C, ranging from 29.2^{0}Cin 1967 to 35.4^{0}Cin 1996. The mean minimum temperature is 12.4^{0}C with a variability of 9 percent in a range of 10.3 to 15.3^{0}C. The lowest minimum was recorded in 1975 and the highest minimum in 2002. The morning relative humidity is 63% and the afternoon RH is 28%, the lowest among the seasons. The mean evaporation rate is 5.8 mm, Rainfall during the season is very negligible.

Rainfall variability

The rainfall analysis of 41 year (1965-05) indicated that the region received normal annual rainfall of 876.2 mm in 37 days, out of which the monsoon season received 814.3mm (95 per cent) in 33 rainy days. The median value of annual rainfall is 856.4 and for monsoon season it is 775.4 mm. The onset and withdrawal of monsoon (Table 6) rainfall have been computed with a criterion of 25 mm rainfall in a week in 3 rainy days (with rainfall during subsequent weeks) and 10 mm of rainfall in a week with no rainfall in subsequent weeks respectively. Normal onset and withdrawal of monsoon weeks in the region are 24th (11-17 June) and 39th week (24-30 Sep). The average duration of the season is about 15 weeks (25th to 39th week) or 108 days. The shortest monsoon period of four weeks was recorded in the year 1972 and the longest period was 23 weeks in 1998.

The study revealed that in the lowest rainfall year like 1987 the annual minimum and mean temperature, annual wind speed and BSS were the highest and during monsoon season of the year the minimum temperature, wind speed, BSS and evaporation were the highest; during post-monsoon season maximum and mean temperature, wind speed and evaporation were highest. At Junagadh in the last 41 years 1973 was the warmest year with 37.6^{0}C maximum temperature and 1967 was the coldest year with 32.2^{0}C.The coldest winter occurred in 1975 with 10.3^{0}C minimum temperature and the hottest summer was 1973 with 42.3^{0}C.

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