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Rainfall variability (Annual and seasonal) in Anand of Middle Gujarat (India)

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ABSTRACT : India is predominantly an agricultural country. Success or failure of crops in any year is always crucial for the development of Indian economy, which in turn controls the economy of the country. In 1950s and 1960s, Indian budget was regarded as a gamble on the monsoon rains. The average rainfall in Gujarat varies from 33 to152 cms. The southern region of the state has an average rainfall ranging from 76 to 152 cms, Dangs district having the highest average of about 190 cms. The northern districts have a rainfall varying from 51 to 102 cms. But the Arabian sea and the Gulf of Cambay in the west and the forest covered hills in the east soften the rigors of climatic extremes. The rainfall at Anand (Middle Gujarat Agro-Climatic Zone-3) is ranged between 286.9 mm to 1693.4mm. The Rainfall variability (Annual and Seasonal) in Anand for the period 1970-2009 for 39 years were studied for their variability.

KEY WORDS : Rainfall data, Rainfall variability (Annual and Seasonal)

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India's economy is dependent on the agricultural production, which in turn is dependent one of the monsoon rainfall and its distribution. The year to year fluctuation in rainfall as well as the fluctuation within the monsoon season governs the crop growth, development and yield. Earlier studies on rainfall probability in India have been carried by many workers (Singh *et al.*, 2009; IMD, 2010 and Halikatti *et al.*, 2010). South-west monsoon rainfall (received during June to September) determines the fate of dry land farmers as well as the status of national food security in India almost every year. The need for information about south-west monsoon rainfall is great in these areas. An accurate long-range forecast can help farmers increasing agricultural productivity in good rainfall years and negate the sudden downturns in agricultural production during anticipated drought years by giving farmers sufficient time to adopt drought resistant crop varieties and appropriate crop, soil and water management practices. The Indian meteorological Department (IMD) is now able to make all- India long- range forecasts of south-west monsoon rainfall accurately using power regression model based on 16 regional and global parameters from 1988 onwards.

The India Meteorological Department (IMD) has been issuing operational long- range forecasts for summer monsoon rainfall for more than one century. Since 1988, the operational forecasts have been issued using the 16 Parameter Power Regression and Parametric models for the summer monsoon rainfall over the country as a whole (IMD, 2010). For review of these operational forecasts and other related research efforts and problems. These forecasts have provided useful information on rainfall fluctuations and abnormalities which have been helpful to the planners. However, for a country with inherent spatial variability of monsoon rainfall there would always be some areas of deficient rains even in the best monsoon years or some areas of flood even in worst monsoons (Parthasarathy *et al.*, 1993). Walker (1924), Shukla (1987) and Gregory (1989) suggested that rainfall over several subdivisions of India should be grouped together to deduce area averages for large homogeneous regions. They further showed that the consideration of the local distribution characteristics of seasonal rainfall in dividing the country into homogeneous regions yielded better formulae for forecasting than when India was treated as one unit. Indian meteorological department (IMD) was giving long-range rainfall forecast every year on the basis of 16 parameters and now reduces 8 parameters since 2003. IMD's 8 parameters were 1. Arabian sea (SST), 2.Eurasian Snow Cover, 3. NW Europe temperature, 4. Nino 3 SST anomaly (Previous year), 5. South Indian Ocean (SST Index), 6. East Asia Pressure, 7. Northern hemisphere 50Hpa wind pattern, 8. Europe Pressure Gradient and July

Table A : Annual rainfall (mm) during 1970-2009 at Anand Agricultural University, Anand

Sr. No.	Period	Range	Mean	S.D	CV (%)
I	1970-2009	286.9-1693.4	909.4	370.2	40.7
II	1970-1993	358.1-1633.4	908.0	366.5	40.3
III	2000-2005	431.7-1693.4	885.7	473.0	53.4
IV	2006-2009	389.1-1414.9	977.2	434.1	44.4

South Indian Ocean 50 Hpa zonal wind and Nino 3.4 SST tendency are also considered (Rajeevan *et al.*, 2004).

METHODOLOGY

The rainfall at Anand (Middle Gujarat Agro-Climatic Zone-3) ranged between 286.9 mm to 1693.4 mm. The Rainfall variability (Annual and Seasonal) in Anand for the period 1970-2009 for 39 years (Table A) were studied for their variability. The Anand (Middle Gujarat Agro-Climatic Zone-3) located (latitude - 22^0 35' N, longitude- 72^0 58' E). The standard deviation (SD) was higher (370.2) with a co-efficient of variation (CV) of 40.7 per cent indicating higher variability. During better rainfall years 1970 to 1993 (23 years) was higher 908.0 with higher SD (366.5) and CV (40.3%). During the years 2000 to 2005 (5 years) the rainfall ranging slightly from 431.7 to 1693.4 with mean 885.7 mm and higher SD (473.0mm) with a very high CV (53.4%). Only last four years (2006-2009) the annual rainfall ranging small to higher rainfall (389.1-1414.9mm) with mean 977.2mm with SD 434.1 with high CV (44.4%).

RESULTS AND DISCUSSION

During the seasonal rainfall variability (Table 1) last 12 years (1998-2009) indicated that pre-monsoon season rains were deficient in 8 years with deviation ranging from (40.0 to 90.0%) and excess in 3 years (48.0 to 82.0%) as against the normal rainfall 12.1 mm. During the months of South-West (SW) monsoon season (*i.e.* June to September), the rainfall ranged from the lowest 361.6 mm in 2000 to the highest 1688.0 mm in 2005 as against the normal 823.2 mm.Rainfall was deficient continuously from 1998 (19.2%) to 2003 (26.0%) indicating drought and severe drought conditions. Drought intensity was classified as per IMD [Normal (N) rainfall mean (±10%; slight drought (-11 to 25%), MD-moderate drought (-26 to 49%) and S-severe drought (-50 % and above). Rainfall was more than 30 per cent of normal in 2003 till to 2008 indicating normal or excess rainfall. The post –monsoon season rainfall (October to December) after 1999 continuously 2009 was deficient upto 16.0 (2001) to 98 per cent (2004) indicating reduced rainfall compared to normal 49.3 mm in post-monsoon season which may affect the *Rabi* crops (October to December). The annual rainfall was 2004 and 2008, while excess rainfall 1998, 2003, 2005 to 2007 (2.0 to 56.0%) and three years are moderate drought 1999, 2000 and 2002 (46.o to 51.9%) and one year slightly drought during 2009 with (56%).

The rainfall pattern and seasonal distribution is changing over time. This information is helpful disaster like flood, drought etc. Scope in water management and crop planning of the different stations of India and adjoining countries. The forecast of monsoon will be useful for the Indian farmers, storage of water in dams for irrigation purpose, domestic use of water and production of electricity.

Table 1 : Annual and Seasonal variability during (1997-2009) Anand (Middle Gujarat Agro-Climatic Zone-3)

Sr. No.	Seasons	Normal (mm)	1998**	1999*	2000*	2001*	2002*	2003**	2004	2005**	2006**	2007**	2008	2009*
1.	Pre-monsoon	12.1	0.0	18.6	65.8	1.2	0.0	23.2	7.2	0.0	56.7	2.8	4.0	0.0
	(Jan-may)													
	Deviation (%)	-	-	-35.0	-82.0	-90.0	-	-48.0	-40.0	-	-79.0	-77.0	-67.0	-
2.	South-west monsoon	823.2	1018.6	384.2	361.6	666.8	478.0	1112.2	857.8	1688.0	1358.2	1140.6	957.4	380.9
	(June-September)													
	Deviation (%)	-	-19.2	-53.3	-56.0	-19.0	-42.0	-26.0	-4.0	-51.2	-39.3	-28.0	-14.0	-54.0
3.	Post monsoon	49.3	92.7	22.4	4.3	41.4	0.0	0.0	1.0	5.4	0.0	0.0	0.0	8.2
	Deviation (%)	-	-47.0	-55.0	-93.3	-16.0	-	-	-98.0	-89.0	-	-	-	-83.4
	Total rainfall	884.6	1111.3	425.2	431.7	709.4	478.0	1135.4	866.0	1693.4	1414.9	1143.5	961.4	389.1
	Deviation (%)	-	-20.4	-51.9	-51.2	-19.8	-46.0	-22.0	-2.0	-47.8	-37.5	-22.6	-8.0	-56.0
	Drought intensity	-	E	MD	MD	SLD	MD	E	N	E	E	E	N	SD

Note: * Deficient rainfall years ** Excess rainfall years N-Normal (Mean ±10), E-Excess, D-Deficient
Drought Intensity: - Slight drought (-11 to 25%), MD-Moderate Drought (-26 to 49%), S-Severe Drought (-50 % and above)

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