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ON THE LONG TERM DROUGHT PREDICTION OVER SAURASHTRA & KUTCH

1. Among the natural hazards like floods, tropical cyclones, earthquakes, etc., which are generally localized in devastation, drought is often widespread in extent. Drought is a creeping phenomenon without a recognizable beginning, whose effects accumulate over a considerable period of time (Tannehill, 1947).

Problem of forecasting of drought has inherently remained probabilistic in large parts (Rowell, 1998). The probabilistic approach is extensively exploited in Australia through deciles, where drought is the main forecasting problem. In larger countries like India, U.S., China, Brazil, Australia, etc. drought would rarely, if ever, affect the entire country. In India in past century drought have rarely affected more than 50% of the country with an exception of 1918 when nearly 70% was affected (Chowdhury, *et al*., 1989). There are certain preferred pockets in India where droughts have been occurring with increased frequency in the last 25 years or so. Saurashtra and Kutch is one such area in India where the drought incidence is surprisingly equal to even the arid West Rajasthan (Sinha Ray and Shewale, 2001). The present study aims at discussing some characteristic features of droughts in Saurashtra & Kutch.

TABLE 1

Rainfall statistics

Months	Mean rainfall (mm)	S.D. (mm)	C. V. (%)
Jun	87.7	94.1	107.3
Jul	205.6	118.9	57.8
Aug	118.2	92.2	78.0
Sep	77.5	69.8	90.2
Jun + Jul	293.3	145.8	49.8
Jun + Jul + Aug	411.5	168.9	41.0
Jun + Jul + Aug + Sep	488.9	190.9	39.0

It utilises 100 years (1901-2000) monsoon rainfall data of the region. The four months, June to September have been assumed to constitute the monsoon season. The data have been collected from the various records of India Meteorological Department, Pune.

The thresholds of declaring drought are arbitrary in most cases, not linked to quantified impact on any specific human activity of the region. In the absence of any precise and universally accepted definitions, in this work a drought is assumed to be experienced when the seasonal rainfall deficiency exceed 25%.

2. Based on 100 years data the normal rainfall and other associated statistic are given in Table 1. July seems to be the rainiest month with rainfall of 20.5 cms contributing to 42% of seasonal total followed by August receiving 11.8 cm with 24% of the monsoon rainfall in the region. In the month of monsoon onset *i.e*. June and its withdrawal in September the respective rainfall are 8.8 and 7.7 cms with 18% and 16% of rainfall received during the 2 months. However, these two months witness record variability *viz*. 107 and 90% respectively. Over 100% variability in June reflects the high uncertainty of monsoon advancing over Saurashtra & Kutch whereas in September the rainfall is mostly contributed by the sporadic thunderstorms associated with retreating monsoon.

The mean monthly rainfall for the four monsoon months prepared by Parthasarathy *et al*. (1995) were found to be substantially less than obtained in the present study. This was marked so in June (≈25%) and September (about 12%). Difference in rainfall in the two means is rather difficult to explain. Perhaps a large number of drought between 1871 to 1900 particularly 1875, 1877, 1889, 1890, 1894, 1899 etc. has resulted in lowering the mean in their study compared to the present one.

3. In the Indian sub-continent there are some preferred areas where drought incidence is more frequent. For example, west Rajasthan and Saurashtra & Kutch have highest probability of its incidence with an average incidence once in every four years. To make matters worse, the drought in this region often persists. The probability of drought occurring in two consecutive drought years has been observed equally high (*i.e*. nearly 24%) whereas occurrence of drought consecutively for three years is in Saurashtra & Kutch and has been observed only once between 1985 to 1987. The atmospheric circulation which controls drought over the arid west including Saurashtra & Kutch is probably different from those affecting summer rainfalls over rest of the sub-continent. This variability could be attributed to internal variability of atmospheric circulation, over the region, chiefly the mild tropospheric circulation resulting in such prolonged drought extending to three years. For obvious reasons rainfall in the drought year is much less than the normal. In the 25 years of drought, the mean rainfall worked as 25.1 cm, 49% below normal. Rainfall in Saurashtra & Kutch is itself low in quantum and a deficiency of this magnitude does have excruciating economic and social and even environmental impact, bringing untold miseries to the masses. In years prior to the occurrence of drought, the mean rainfall worked out as 54.9 cm (12% above normal). The mean rainfall of those years, which were not drought years following drought year, was marginally more *i.e*. 57.4 cm (17% above normal). In other words, if a drought year does not succeed a drought year, one can expect fairly good amount of rainfall in the succeeding year.

4. With the coefficient of variation in seasonal rainfall nearing 40% the inter-annual variability of the region is substantially large. The high degree of inter-annual variation demand a fairly accurate rainfall forecast for skillful planning of water resources. In such an

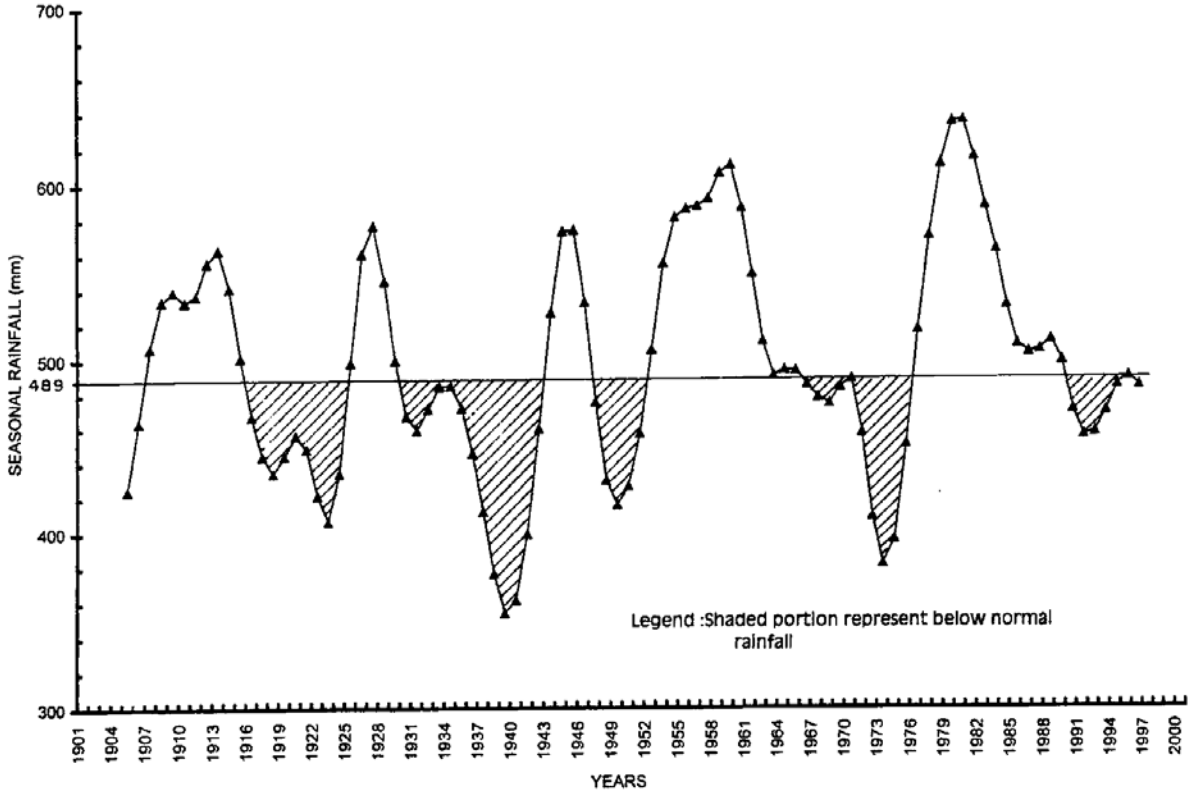

Fig. 1. Average time series of monsoon rainfall smoothened by five term binomial filter

endeavour importance of some regular or even quasi-periodic oscillations cannot be overlooked. Significant quasi-periodic oscillations in monsoon rainfall over some parts of India has been confirmed by Parthasarathy *et al.* (1984), Rase (1996) etc. Koteswaram and Alvi (1970) showed that binomial filters are more suitable than other filters. In the present study low pass filters with 0.01, 0.05, 0.12, 0.20, 0.24, 0.20, 0.12, 0.05 and 0.01 *i.e.*, nine ordinates of Gausian probability curve, were used (WMO 1966) The results of the present analysis (Fig. 1) show distinct presence of cycles or periodicities in the series both high to low frequencies approximately ranging from 10 to 20 years. Of great interest is the 20 year oscillation which approximately is analogous to double sun-spot cycle (Alexander, 1995). Such cycles have been observed in South African rainfall recently by Kalita (1999) and Mason and Tyron (2000). Presence of 20 years cycle in the rainfall series appeared to hold high potential in forecasting.

The following conclusions can be drawn from the study :

(*i*) The drought in Saurashtra & Kutch can occur once in every four years.

(*ii*) Probability of its persisting in two consecutive years is surprisingly equally large though its occurrence for 3 consecutive years is a rare event.

(*iii*) A quasi-periodicity of length approximately equal to double sunspot activity possibly exists in monsoon rainfall over the region.

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