herbal products. Besides using traditional methods, knowledge of molecular biology and molecular pharmacognosy may be useful to distinguish herbal drugs by molecular marker assay. And an understanding of genetic engineering may help conserve wild resources. Special efforts should be made to standardize raw material and herbal products used by clinicians in India.

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Prediction of the Indian summer monsoon rainfall for 2013 based on past rainfall data

As in previous years, the India Meteorological Department (IMD) has issued a press release[1] that the June–September monsoon rainfall for the country as a whole, i.e. the all-India rainfall (AIRF) is expected to be about 98% of the long-term average (LTA) of 89 cm, with a model error of ±5%. A week before this announcement a private agency issued a forecast[2] that AIRF will be 103% of LTA with an error margin of 4%. AIRF includes the whole of India made up of four sub-regions: Central India (CEIND), North East India (NEIND), North West India (NWIND) and South Peninsular India (PEIND). AIRF is naturally statistically correlated with some of the regional values, but the regions among themselves are not all well correlated. Table 1 shows the basic statistics and Table 2 shows the correlation among the five data series of IMD. It is seen that characterization of AIRF is not a good reflection of what to expect in NEIND and PEIND.

As long-term forecasting of the monsoon is of scientific and of general interest, it is worthwhile to have alternate methods of prognosis. In earlier publications[3,4], Iyengar and Raghu Kanth proposed the method of decomposing the rainfall data series (R_i) into the sum of two uncorrelated time series (I_i and y_i). The first one (I_i) is the dominant Intrinsic Mode Function which is non-Gaussian but amenable for forecasting using ANN methods. The second component (y_i) is nearly Gaussian and hence standard linear regression methods are sufficient for modelling and forecasting. It is found that the method has significant skill to foreshadow rainfall on large space scales with the confidence level progressively decreasing as the data series represents

Table 1. Regional statistics and forecast for 2013

Region	m_R (cm) (1951–2000)	σ_R (cm) (1951–2000)	Coefficient of variation (%)	m_F (cm), forecast for 2013	σ_F (cm), standard error of forecast	Forecast % departure from normal
All-India	88.75	9.26	10.43	76.02	3.64	–14.34
NWIND	61.50	11.43	18.59	44.29	4.56	–27.98
NEIND	143.83	14.75	10.26	147.85	5.82	+2.79
CEIND	97.55	14.30	14.66	70.77	5.30	–27.45
PEIND	71.55	10.85	15.16	72.48	3.61	+1.30

NWIND, North West India; NEIND, North East India; CEIND, Central India; PEIND, South Peninsular India.

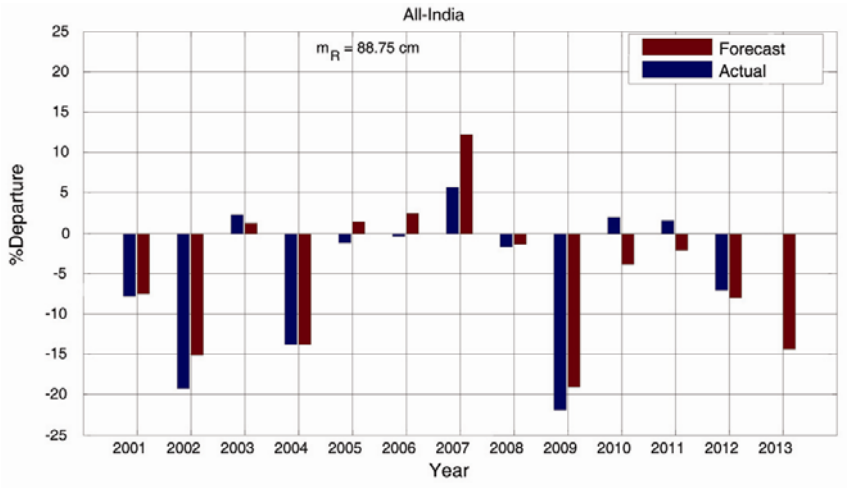

Figure 1. Percentage departure from normal rainfall and one-step-ahead point forecast (2001–2013).

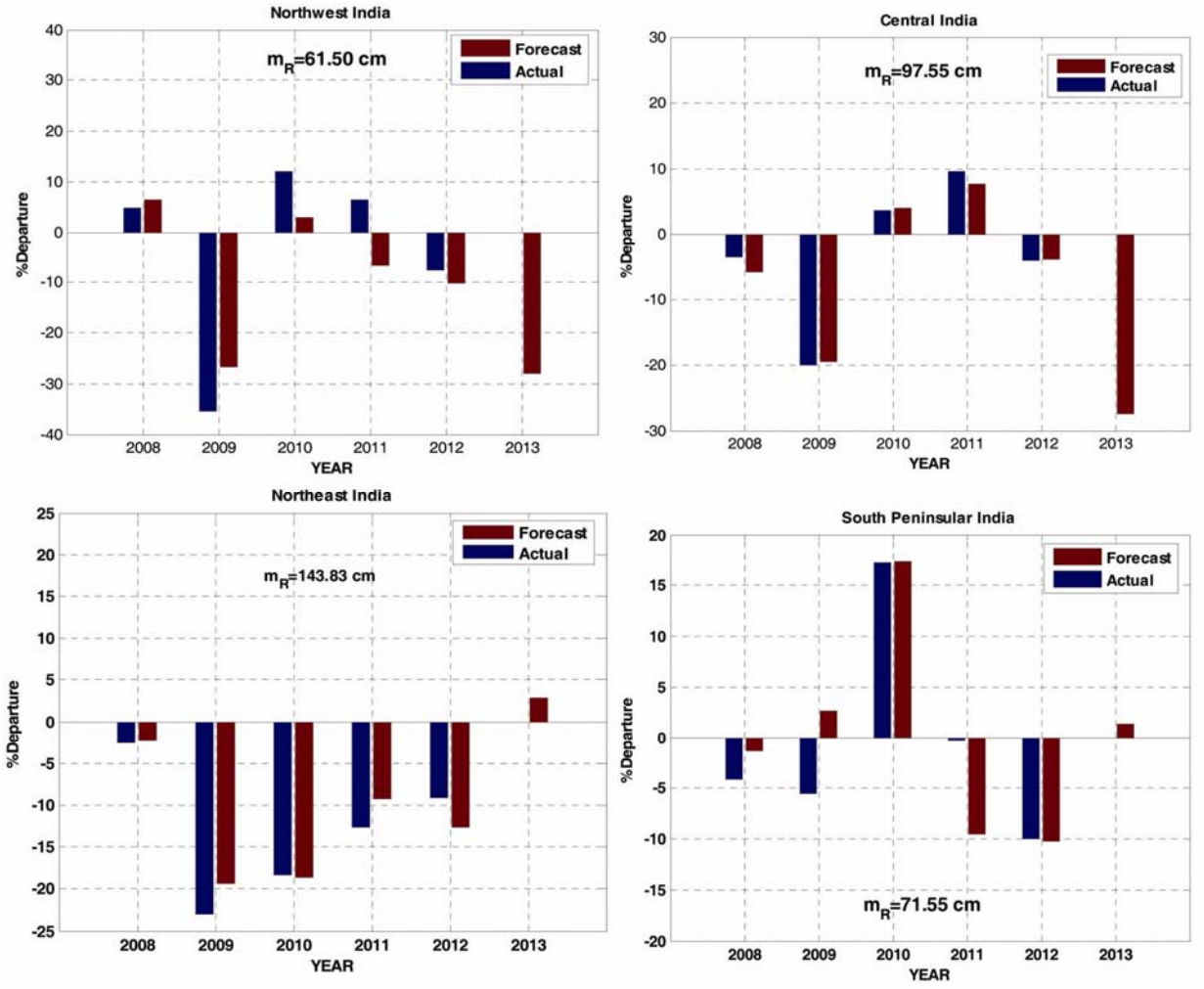

Figure 2. Percentage departure from normal rainfall and one-step-ahead point forecast (2008–2013).

Table 2. Correlation structure of IMD rainfall data

Regions	All-India	NWIND	NEIND	CEIND	PEIND
All-India	1.00	0.88	0.12	0.88	0.67
NWIND	0.88	1.00	–0.02	0.68	0.52
NEIND	0.12	–0.02	1.00	–0.12	–0.08
CEIND	0.88	0.68	–0.12	1.00	0.48
PEIND	0.67	0.52	–0.08	0.48	1.00

smaller regions. It is also found that to get robust results, a long time series of at least 100 years would be required. The data series used by us in previous years was the one available from the Indian Institute of Tropical Meteorology (IITM), which is not the same as the official data of IMD. This year we have been able to get the official time-series data from IMD for the period 1901–2012. This has encouraged us to prepare a quantitative forecast of the rainfall amount for the June–September season. We report here our forecast for the year 2013 based on the five seasonal rainfall time series of IMD. The results are presented in Figures 1 and 2 in the form of percentage departure from LTA shown in Table 1. To give an intuitive feel to the reliability or otherwise of the present approach, a few past one-step forecasts, obtained by curtailing the series up to the respective previous year, are also shown. Since forecasting accuracy is subject to many constraints and may change over the years, it would be informative if other researchers also exhibit each year the performance of their model for the previous 5–10 years.

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