Scientific Analysis Of Indian Monsoon: Prediction Through Decades

Dr. Sarbari Mukhopadhyay

Asst. Professor in Geography

Maynaguri College

District – Jalpaiguri

Email Id: sarbari.geography@gmail.com

Mobile No. : 9474010737

ABSTRACT:

Research on Indian monsoon rainfall distribution and its forecast has become significant through decades. Our agriculture as well as Indian economy largely depend on monsoon wind system. The study is also associated with several parameters like temperature atmospheric pressure, wind pattern and Himalayan snow cover. Another vital parameter that forms a major part of this research is EL NINO. Recently team of scientists from different parts of the world emphasized on Tipping Elements for the development of monsoon wind system. These parameters are temperature, pressure, variation between land and sea, coriolis force, oscillation of winds, presence of Himalayan range. Scientists have claimed that the idea of Tipping elements highlights the interaction of a local weather phenomena and a global one. It is proved that ocean has a strong control oven monsoon.

Key Words:- Indian Monsoon, Parameters, Tipping Elements, Forecast

INTRODUCTION: Improved forecast of monsoon wind is essential for the people of India as well as south Asian people because the Indian summer monsoon supplies the majority of water for agriculture and industry in south Asia and is therefore critical to the well being of a billion people. Active and break periods in the monsoon have a major influence on the success of farming or agricultural activities. Whereas year-wise variation in the rainfall have a economic consequence on an international scale. Researcher said with the growing population and developing economy of India, understanding and predicting the monsoon is vital. Running computer models on high-performance computing (HPC) facilities is essential for such forecast and prediction services. Climate scientist "Roxy Mathew Koll" who is currently leading researcher on climate agrees that the ocean has a strong control over how the monsoon varies every year.

OBJECTIVE :

The main objective of this paper is to find out the researches on monsoon forecast through decades.

DATA BASE:

Primarily, Secondary data have been used to get the real scenario of Indian Monsoon Forecast.

METHODOLOGY:

On the basis of secondary data, detail study of the characteristics of Indian monsoon has been identified. Mainly three parameters have been considered by scientists like temperature, pressure and wind.On the basis of these indicators they establish the fortune of Indian agriculture by predicting the onset of monsoon in time.

ANALYSIS: The first official forecast was issued on 4th June 1886. Even much earlier H.F. Blanford, Meteorological Reporter to the Government of India was probably the first to make an unofficial forecast in 1881 based on the varying extent and thickness of the Himalayan snow cover in spring. After that Sir Gilbert Walker introduced Long Range Weather Forecasting by using the concept of co-relation in 1909 (science Reporter,1994). Walker developed a multi regression of forecast model which used from parameters including (a) Himalayan Snow accumulation at the end of May (b) the South American Pressure during spring, (c) the Mauritius pressure during May and (d) the Zanzibar (Present Tanzania) rainfall during April and May. This model was used by the Indian Meteorological department from 1909 to 1915. In 1916, Walker added one more parameter i.e. the rainfall of May of Ceylon (now Sri Lanka).But in those cases the level of accuracy of predication desired could not be achieved. Thus a new method was being acutely felt.

A mathematical Model was introduced by a team headed by Dr. Vasant in 1988. This model considered the impact of 16 global, regional and local weather parameters (Table -1). Six of these parameters are temperature dependent, three of wind patterns, five on atmospheric pressure and two related to snow cover.

It is known to us that monsoon circulation is a thermally driven low pressure area arising due to the temperature difference between the vast Asian continent and the Indian Ocean. Temperatures are thus considered to be directly linked with the monsoon rainfall and so, form an important component of the model.

The second group of parameters is related to pressure. Low pressure system is ideal for monsoon rainfall. A measure of the Monsoon Low Pressure area is the ‘Southern Oscillation Index’ (SOI). The intensity of SOI is measured by the difference in sea level pressure of different places of the world. If the SOI is positive, that is the low pressure over the Indian Ocean is below normal and high pressure over the Pacific is above normal, it is conducive for good rainfall. While the negative value of SOI implies higher pressure over North Indian Ocean and so an indifferent monsoon.

Another parameter that form a major component of the model is the much dreaded ELNINO – the phenomenon of formation of long stretches of warm water off the Peru coast. With the appearance of an EL-NINO, pressure begins to rise over Australia and Indonesia and SOI begins to fall and become negative. This may lead to a total failure of rainfall over India (Science Reports 1994)

Research also shows that excessive and persistent snow cover over Eurasia during winter can delay and weaken the spring and summer heating of landmasses that is necessary for the establishment of large scale monsoon flow. On the basis of these sixteen parameters the study of monsoon rain has been developed.

To begin with the 16 parameters were looked at in combinations of 2, 3 and 4 to find out how well they predicted the monsoon.

Table 1: Analysis of 16 parameters

		Temperature						wind			Pressure					Snow cover			
Year	Monsoon condition	(-)EI Nino (Same year)	(+) EI Nino (Previous year)	(+) North India (March)	(+)East Coast of India (March)	(+Central India (May)	Northern (+) Hemisphere (winter)	(+) 500 hPa (April)	(-) 50 hPA (Winter)	(+) 10 hPa Zonal (January)	(+) Northern Hemisphere (January to april)	(+) S.O.I. (Spring)	(-) Darwin (Spring)	(-) Argentina (April)	Indian Ocean (-) Equatorial (January to May)	Himalayan (-) (January to March)	Eurasian (Pervious (-) December)	No. Of parameters	% of favourable parameters

1951	D	F	U	U	U	F	U	U	P	U	U	U	F	U				4/13	31
1952	N	F	U	U	U	F	F	U	F	F	U	U	U	F				6/13	46
1953	N	U	U	F	F	F	F	F	F	U	U	U	U	F				7/13	54
1954	N	F	F	F	F	F	U	F	U	F	F	U	F	U				9/13	69
1955	N	F	U	F	F	F	F	F	U	F	F	F	F	F				11/13	85
1956	N	F	U	F	U	F	U	F	U	F	F	F	F	F				9/13	69
1957	N	U	U	U	U	U	U	F	F	U	U	U	U	U				2/13	15
1958	N	F	F	F	F	F	F	F	U	U	F	U	U	F	U	F		10/15	67
1959	N	F	U	F	U	F	F	F	F	F	F	F	F	F	F	U		12/15	80
1960	N	F	U	U	U	U	F	F	U	U	F	F	F	F	F	F		9/15	60
1961	N	F	U	F	F	F	F	U	F	F	F	U	U	F	F	U		10/15	67
1962	N	F	U	U	U	U	F	U	F	U	U	F	U	U	F	F		6/15	40
1963	N	F	U	U	U	U	F	U	F	F	U	F	F	F	F	F		9/15	60
1964	N	F	U	F	F	U	U	F	F	F	F	F	F	U	F	F		11/15	73
1965	D	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U		0/15	0
1966	D	F	F	U	F	U	F	U	F	F	U	U	U	F	U	F		8/15	53
1967	N	F	U	U	U	U	U	F	F	U	F	F	U	U	F	F	F	8/15	50
1968	D	F	U	U	U	U	U	U	U	U	F	F	U	U	F	U	U	4/15	25
1969	N	F	U	F	F	F	U	F	F	F	U	U	U	F	U	F	U	9/115	56
1970	N	F	U	F	F	F	F	F	F	U	U	U	U	F	U	F	F	10/15	63

1971	N	F	U	U	U	U	U	F	F	F	F	F	F	F	F	U	F	10/16	63
1972	D	U	U	U	U	F	U	U	U	U	F	U	U	F	F	U	U	4/16	25
1973	N	F	F	U	F	F	F	F	F	F	F	U	U	F	U	U	U	10/16	63
1974	D	F	U	F	F	U	U	U	U	U	U	F	F	U	F	U	U	6/16	37
1975	N	F	U	U	F	F	F	F	F	F	F	F	F	F	F	U	F	13/16	81
1976	N	U	U	F	F	U	F	F	F	F	F	F	U	U	F	F	U	10/16	63
1977	N	F	F	F	F	U	U	U	F	F	F	U	U	F	U	F	F	10/16	63
1978	N	F	U	U	U	F	F	U	U	F	U	F	U	U	U	F	U	6/16	37
1979	D	F	U	U	U	U	U	U	U	U	U	U	U	U	U	F	U	2/16	13
1980	N	F	U	F	F	F	F	U	F	F	F	U	U	F	U	U	F	10/16	63
1981	N	F	U	F	F	U	F	F	F	U	U	U	U	U	U	F	F	8/16	50
1982	D	U	U	U	F	U	U	U	U	F	F	U	U	U	U	F	U	4/16	25
1983	N	F	F	U	F	F	F	U	F	F	F	U	U	F	U	F	U	10/16	63
1984	N	F	U	U	U	F	F	U	F	U	F	U	U	U	U	F	F	7/16	44
1985	N	F	U	F	F	F	U	U	F	F	F	U	F	F	F	U	F	11/16	69
1986	D	F	U	F	F	U	F	U	U	U	U	U	U	F	F	U	U	6/16	37
1987	D	U	U	F	U	U	F	F	U	U	U	U	U	F	U	F	U	5/16	31
1988	N	F	F	F	F	F	F	U	F	F	F	F	F	U	F	F	F	14/16	87
1989	N	F	U	F	U	F	F	U	U	U	F	F	F	F	F	F	F	12/16	75
1990	N	F	U	U	F	U	F	F	F	F	F	F	U	F	U	F	U	10/16	63

Note: +ve and –ve signs indicate direct and inver relationship of predictors with monsoon N and indicate normal and deficient monsoon rainfall; F and U indicate favourable and unfavourablesignals frompredictors fornormal monsoon

Table 2 : Forecast Success

YEAR	FORECAST	ACTUAL PERFORMANCE
1968	Bountiful monsoon throughout the country	One of the 3 best monsoons of the country
1989	Monsoon rainfall to be 102% of the long Period average value (model error + 4%)	Monsoon rainfall 101%
	Over 80% of the 35 meteorological sub-Divisions to get normal or excess Rainfall	83% of meteorological sub-division received normal or excess rainfall
1990	Monsoon rainfall to be 101% Model error + 4%	Monsoon rainfall 106%
	Over 80% of meteorological sub-divisions to receive good rain space and time- wise	91% of meteorological sub-divisions received normal to excess rain
1991	Monsoon on the negative side of the "normal", to be 94% (model error ± 4%)	Monsoon on the negative side of normal, 91% of long periods average value while drought Porne areas
	While drought prone areas to be deficient in rains, about 75% of menterol-ogical sub-divisions to get normal rainfall	Many of drought prone areas of the country were deficient, 75% of meteo-rologica sub-divisions got normal rainfall.
1992	India is heading towards A normal monsoon but again On the lower side of the Normal with the Possibility of somewhat Sluggish to begin with Total quantum of monsoon Rainfall in the country As a whole for the monsoon Season (June to September, 1992) is likely to be 92% Of long period average value With estimated model error of + 4%- About 70% of meterorological sub-divisions should get normal or excess rainfall. Some drought prone areas of the country may not receive good rain. Onset is likelv to be delaved.	Onset was delayed by 5;12 days in most parts of the country. Monsoon was sluggish upto mid july. Total rainfall during the period was 93% of the normal of that particualr periods
1993	Normal monsoon. Total rainfall likely to be 103% with an error limit of + 4%. Sixth	Normal monsoon Actual rain 100% of long term average value. 89% of

normal monsoon year in succession. Total rainfall more than that of 1192. Around 85% of 35 meteorological sub-divisions likely to get	**35 meteorological sub-divisions received excess to normal rainfall. Onset of monsoon in kerala was**
normal rainfall. Onset of monsoon over kerala will be around the normal date.	**around normal date. Rainfall was More than that of 1992 as predicted. Sixth normal monsoon year in succession.**

Source – Science Repeoter 1994

The development of research work on monsoon wind system has been changed with time. New concepts, new system of data collection, gradually change the methods of Forecasting.

Till now India's economy, politics and personal fortunes have hinged, historically, on the timing and the adequacy of the monsoon. Even little variation from the expectation of monsoon rainfall can results in disaster like flood, loss of crops. Modern Meteorology has helped great deal. With the advancement of technology, this procedure of forecasting has been developed to a large extent than past.

Recently another team of scientists from different Universities of the world tried to develop this forecast system through their research works.

Although the current methods followed by the Indian Meteorological department are based on statistical models that take into account the temperature, air pressure, humidity at different altitudes on Indian peninsula. The department has traditionally collected a mass of weather data through a nationwide and offshore network of sensors, ballon stations, wind speed by radar. Based on the collected data, and analysis of the records of the past onset of monsoon, the researcher analyse the burst of monsoon. But according to researcher these methods have limitations. It is being affected by anomalous movement of air masses and also when dealing with advanced or delayed dates of withdrawal of the monsoon. T.M. Lenton, in 2008, proposed an idea of seeking a component of the system that reaches a critical point, at which the system undergoes a rapid change of this state or form. That is called a "Tipping Element". Its growth may help forecast the onset of monsoon more easily.

TIPPING ELEMENTS:

In particular, a few days before monsoon onset out going long wave radiation(OLR) shows deep convection over the Bay Of Bengal and Arabian sea, relative humidity increases abruptly in the vertical direction before the onset of monsoon. Whereas, withdrawl of monsoon occurs gradually and is caused by southward movement of ITCZ. This group of scientists mentioned the geographical regions (tipping elements) and use them as observations locations for prediction of onset and withdrawl dates (Veronica et. al,2016).The notion of a tipping element is a component of the Earth system was introduced by Lenton et.al (2008).These group of scientists proposed an approach of monsoon OD and WD, which consists of three main steps (a) the tipping elements of monsoon using a pre cursor of critical transitions that indicates the proximity of the system to a critical threshold.The tipping element is a geographical region, which shows the maximum growth of variance of fluctuations prior to the monsoon onse,(b)they choose the tipping element of the monsoon as optimal observation locations or reference points (c) they also mention a prediction scheme for the onset and withdrawl dates. There are so many factors which control monsoon rainfall. These are temperature, variation of pressure between land and sea, latent heat of condensation, oscillation of winds, coriolis force, presence of Himalayan range. Monsoon wind indicates the upward movement of warm air over the Bay of Bengal and the Arabian Sea, which carries water vapour. The decline of monsoon is marked by a different air flow and replacement of moist air by dry air from Inland. This team of researcher used the data related to daily records of temperature, relative humidity and wind speeds over a closely packed grid covering the region for 65 years from 1951 to 2015. On the basis of this data they worked out the variability of the temperature and relative humidity at each of the grid points during a seven day window just before the onset of monsoon. They observed that the growth was maximum around the Eastern Ghats and North Pakistan regions. After that the plotting of Temperature and Relative humidity of Eastern Ghats and North Pakistan on a graph from before the beginnings and after the end of the monsoon for 65 years, it has been observed that the plots for both indicators, for the two reference points show a constant relationship – the two trends rise and fall, and the plots for each of the reference points intersect, at which point the indicators are equal twice during the period. The days on which intersection happens is right on the date, first of the onset and second the withdrawal of the monsoon.

After that, the days on which this intersection of the plots would occur based on the data over 14 years. A first approximation of the date of the onset is by extrapolating the trend in the two reference points and a comparison with the data of the preceding 14 years. Closer determination of the onset data is by watching the trend of temperature in North Pakistan, which is steadier than in the Eastern Ghats. Another method for the onset data is by watching the trend of temperature in North Pakistan, which is steadier than in the Eastern Ghats.

Another method for the onset date is with the help of the trends of relative humidity in North Pakistan. For the withdrawal of the monsoon, again the trend of temperature in North Pakistan helps to fix the date. The relative humidity is not useful for fixing the date of withdrawal. The merit of this method is not in being able to pinpoint a closer date, as there is always uncertainty but in being able to make the forecast from over a month to at least two or three weeks earlier for the onset and a month earlier for withdrawal, than what has been possible. Scientists claimed that the idea of tipping elements highlights the interaction of a local weather phenomenon and a global one.

Forecast of rainfall can be done by three ways. The short range forecasting techniques are used to provide day – to – day rainfall forecast. The medium range forecasts are considerably important for agriculture especially during the monsoon season.

In this respect three points are vital. First a good set of observations are required (from land and ocean, day and night from accessible and inaccessible places) Secondly, good communication to relay the data is essential. Finally, the forecast techniques should be perfect and should be based on good computation.

CONCLUSION:

At present India entered the Meteorological Imaging Era (Since 1982) with the launching of INSAT-1 series of Geostationary Satellites which carry the very High Resolution Radiometer (VHRR) instrument capable of imaging clouds over a large region centred on the Indian Longitudes. High Resolution INSAT-VHRR cloud cover images are taken in two spectral bands visible (0.55 – 0.75 µm) and thermal infrared (10.5 – 12.5 µm) about 12 times a day or more. A group of scientists from IITM have been providing experimental real time forecast of Indian Summer Monsoon Rainfall since 2011 using an indigenously developed Ensemble Prediction System (EPS) based on the state-of the-art (Tropmet.res.in). Climate Forecast System Model version 2(CFSv2). The EPS will generate a large number of forecasts from different initial conditions so that the expected forecasts and also the expected spreads uncertainities in terms of probability from this forecast can be informed. Forecast is generated after every 5 day since 16 th May. The Pentad prediction skill may be considered as the intra-seasonal variability prediction skill and is a more rigorous way of evaluating the Model's hindcast skill.In addition to this, some aspects of Intra-seasonal Oscillation are also presented here. Prediction and verification have been done over 4 different homogenous regions of India. The selected regions are Central India(CEI),North-East India(NEI),North West India(NWI), and South Peninsula(SPI) and a broader region, Monsoon Core Zone of India(MZI).

For medium range forecasts the numerical weather predication (NWP) technique is used for which super computer has been installed. With the efforts of the researchers and scientists it might even be possible one day the amount of monsoon rainfall clockwise. The neutral ELNino southern Oscillation (ENSO) in the equatorial Pacific Ocean and Indian Ocean, Dipole (IOD) conditions prevailed. Climate models also predicted the occurrence of weak La Nina condition defined by a cooling of sea waters in the equatorial Pacific Ocean.

It has been observed that in this year(2020), total rainfall in India was 327.0mm in August which was 27% excess rainfall than normal. From 1st June to 31st August total monsoon rainfall in India was 780.3mm where there was 10% of excess rainfall. At the same time when we consider the distribution of monsoon rainfall from 1st June to 20th September, it is also clear that country faced 7% of excess rainfall.

A good monsoon year is crucial for farmers across India which is true for this year (2020) inspite of a nationwide lockdown due to the spread of the Novel corona virus disease (COVID -19).

REFERENCES:

1. Downtoearth.org.in
2. Scientific Reporter, AUGUST, 1994
3. Hastenrath .S (1985) Climate and Circulation of the Tropics. Reidel PP 330-352
4. Report in "The Statesman", 2016