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FIVE YEARS AHEAD PREDICTION OF INDIAN DROUGHTS; A TRIUMPH FOR SOLAR TERESTRIAL RELATIONS

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ABSTRACT

In a paper entitled " Expected Droughts To Attack India In Few Years Time", the Indian government was warned in 1996 of a severe drought which was anticipated to attack India. Repeated alerts in several papers were made. In January 2000, in the world meteorological organization WMO Long-Range Forecast workshop, it was forecasted that India would face droughts shortly. Indeed a horrible drought in April attacked the western provinces of India as well as Pakistan and Afghanistan. So severe is the drought that even camels died. This drought may last for some time.

Based on the coherence between precipitation cycles both in England- Wales as well as India and Solar Wolf- Gleissberg cycles of duration 80-120 years, It was possible to forecast drought migration from England to Paris and India .

The maximum cross correlation between filtered precipitation cycles in England- Wales and India occur at a lag of 38 years. The cyclicity is zero at 1 year and 22 years in coincidence with the Hale 22 years solar magnetic cycles. Nine turning points occurred in English- Welsh precipitation cycles between the period 1787-1970. Cross correlation between sunspot number and precipitation in the 10 time spans between the turning points indicate very high correlation coefficients between solar activity and precipitation over England and Wales, the sign of which alternates between negative and positive. In other words, solar activity control of precipitation is time and location dependent. A tenth order polynomial nicely fit Wolf – Gleissberg cycles as well as Indian and Parisian smoothed precipitation cycles, however higher order polynomial is needed to fit the smoothed English Welsh Precipitation.

1-INTRODUCTION

The Earth's weather machine is an exquisitely complex affair, in which many processes are simultaneously at work. . Clearly however .the weather system is principally driven by the sun (Roberts 1976).

Precipitation records for England and Wales provide a long time series starting 1766 that can be studied in relation to the solar Wolf-Gleissberg cycles. Reliable sunspot numbers are considered since 1749. It was the purpose of the original paper to find out solar terrestrial relations of the order of 80-100 years and determine precipitation cycles in order to predict forthcoming droughts and severe precipitation in both England- Wales as well as India.

Solar terrestrial stimuli is very important in weather and climate forecasting. It may well be , in another decade or so that extended forecasting will be unthinkable without consideration of solar activity(Roberts 1976).

2-SOLAR ACTIVITY:A TOOL FOR LONG-RANGE FORECAST

Some efforts have been done by solar terrestrial researchers in the field of long range forecast of droughts e.g. Roberts (1976). A possible meteorological response to variable solar activity is the apparent long-term trend in the occurrence of droughts in the Great Plains region of North America.. There is also some evidence that droughts in parts of the former Soviet Union follow the same general pattern. As a matter of fact , if there is sun-precipitation positive correlation, then droughts tend to occur at sunspot minimum and to be accompanied by El Nino events. This happened during the period of low solar activity around 1900, droughts occurred in Ethiopia in 1877,1900 and 1913. On similar grounds This lead the author to successfully predict the 1997-98 El Nino event a year and half ahead Yousef 1996 a&b) ,but how can this be done?.

Important climatic features ,such as droughts and unusually growing seasons, are dependant on the solar cycle to such an extent that significant progress could be made in forecasting the occurrence of these features if some account were taken of the expected levels of solar activity in the future(King 1973). This is almost the approach followed by the author in drought-flood forecast: Prediction of the

coming solar activity, studies of drought-flood hazards in identical circumstances then projection of this knowledge into the future.

A solar cycle of 80 yr. average duration , known as Wolf-Gleissberg cycles exists and is shown in fig 1. In 1997-98 this cycle was terminated and we have just entered into a period of weak 12 yr. solar activity cycles which may last for 2-3 solar cycles (Yousef 1995a, Yousef et al 2000). Smoothed precipitation cycles for England-Wales, India and Paris are produced from earlier papers used in the prediction of Indian droughts (Yousef 199 b, 1996 a,b and c,1998a and b, 1999 and 2000 a&b, Yousef .and El Kuhaimi 1996) where repeated calls of warning to the Indian authorities were made. In addition, a paper entitled " Expected Droughts To Attack India In Few Years Time" was given to a high Indian authority in 1996 who has taken the responsibility of informing the Indian government and of calling for a drought workshop in India to be ready for the expected drought.

It is obvious from fig 1 that there is a coherence between the smoothed precipitation cycles and Solar Wolf-Gleissberg cycle. The main roots of the precipitation cycles (i.e. drought conditions) lies within the intermediate weak solar cycles in between the Wolf-Gleissberg cycles. For the three cases studied , there are two precipitation cycles within one Wolf-Gleissberg cycle. This implies that there are two heavy precipitation periods separated by a drought condition.

Since it was forecasted that 1997 will be the end of the last Wolf-Gleissberg (Yousef 1995a), as shown in fig 1 lower right, then it was readily expected in 1995 by extrapolation that drought will attack England-Wales in the near future. In deed this forecast came true and drought prevailed in England in the same year. North of France droughts were also expected to follow (Yousef 1996a). From figs 1& 2 , English –Welsh droughts occurred in 1782-88, 1806-1812, 1855s,1892-1901, 1925-29 and finally 1995-97/98 . On the other hand , droughts in India occurred in 1898-1907 and 1931-37. This implied that during the common periods of existing data in those two far placed countries, droughts in England-Wales preceded those in India by 6 years. Thus it was forecasted then that droughts in India are to be expected in few years (about 6 years). Indeed drought attacked west of India, Afghanistan and Pakistan in April 2000.

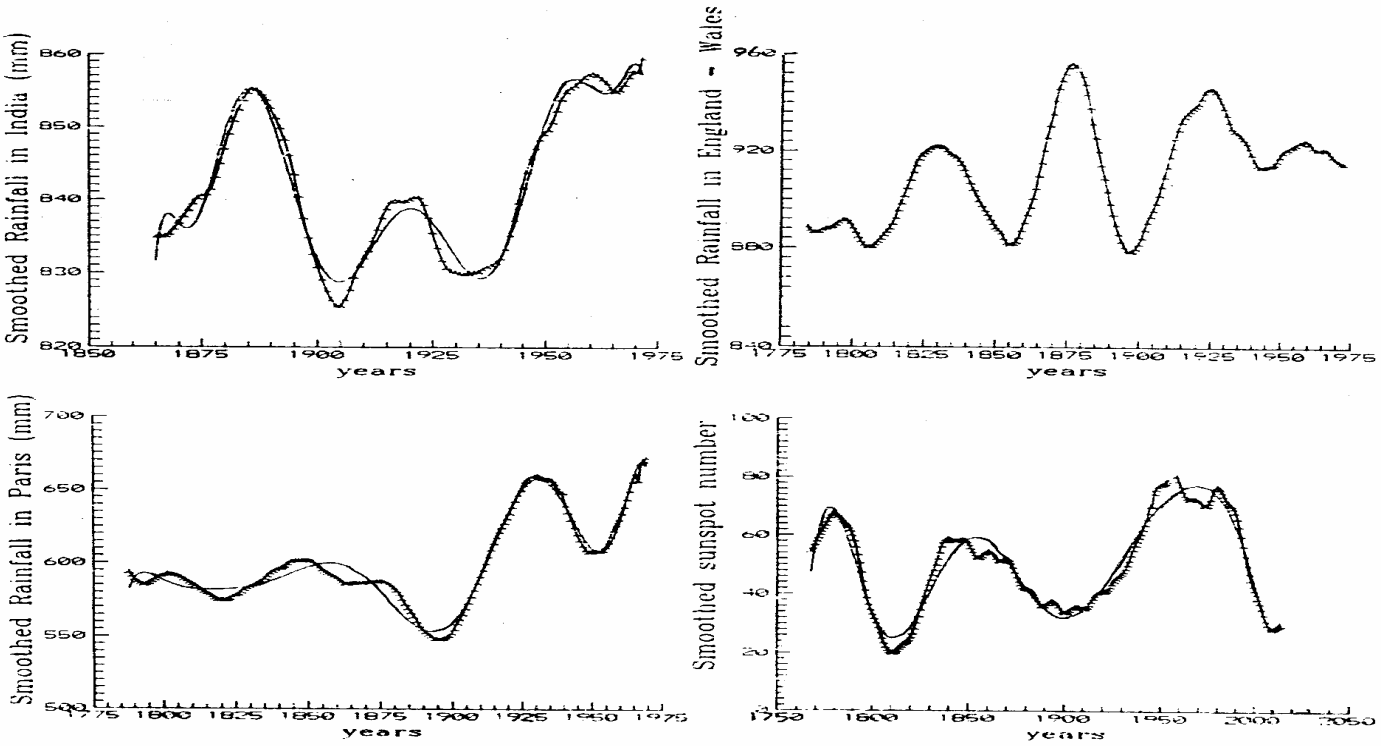
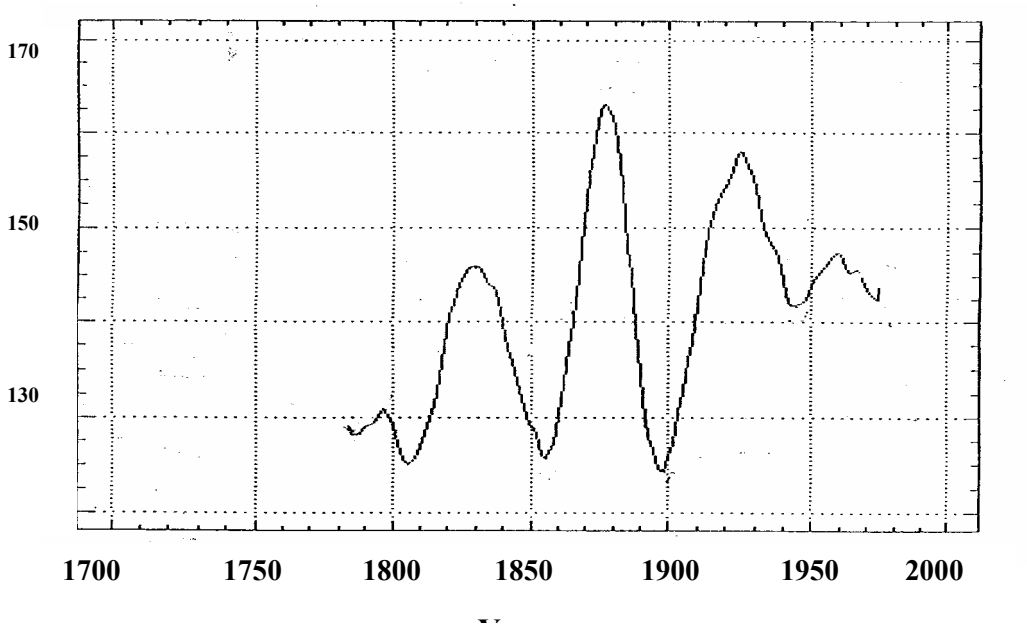


Fig 1: Coherence between Solar Wolf-Gleissberg cycles and Precipitation cycles for England-Wales, Paris and India. Note their polynomial fittings of the tenth order. Droughts occurred around 1800,1900 and 2000 coinciding with solar minimum between Wolf-Gleissberg cycles.

Fig 2: Smoothed English-Welf precipitation cycles divided into ten sections



CROSS CORRELATION BETWEEN ENGLISH WELSH PRECIPITATION AND SUNSPOT NUMBER

Smoothed precipitation cycles for England and Wales is shown in Fig. 2. The time series has been divided at the 9 turning points leading to 10 files. Cross correlation between the smoothed annual precipitation and sunspot number has been carried out for each of the ten files and the results are shown in Fig. 3. Table I give the sign of the cross-correlation and the lag in years for each of the intervals studied.

Table I
Cross Correlation between Annual Precipitation in England-Wales and Sunspot Number for the Interval 1787-1970

TIME SPAN		SIGN OF CROSS CORRELATION	LAG IN YEARS
1787-1796	10	- ve	Zero
1797-1805	9	+ ve	Zero
1806-1829	24	+ ve	-1
1830-1854	25	- ve	+4-5
1855-1875	21	- ve	-1 to zero
1876-1896	21	+ ve	Zero
1897-1924	28	+ ve	Zero
1925-1944	20	- ve	Zero
1945-1958*	14	+ ve	Zero
1859-1970	11	- ve	Zero

Bold years coincide with the solar inactivity intervals in between Wolf-Gleissberg cycles.

- denotes maximum of Wolf-Gleissberg cycles (Yousef 1995a).

It is obvious that the annual precipitation in England- Wales is highly correlated with the sunspot number during the period 1787-1970, yet the cross- correlation keeps on changing sign. The lag between the two variables is essentially zero, however during the period 1830-1854, the lag was +4—5 years. This lag reduced the correlation coefficient to a rather low value.

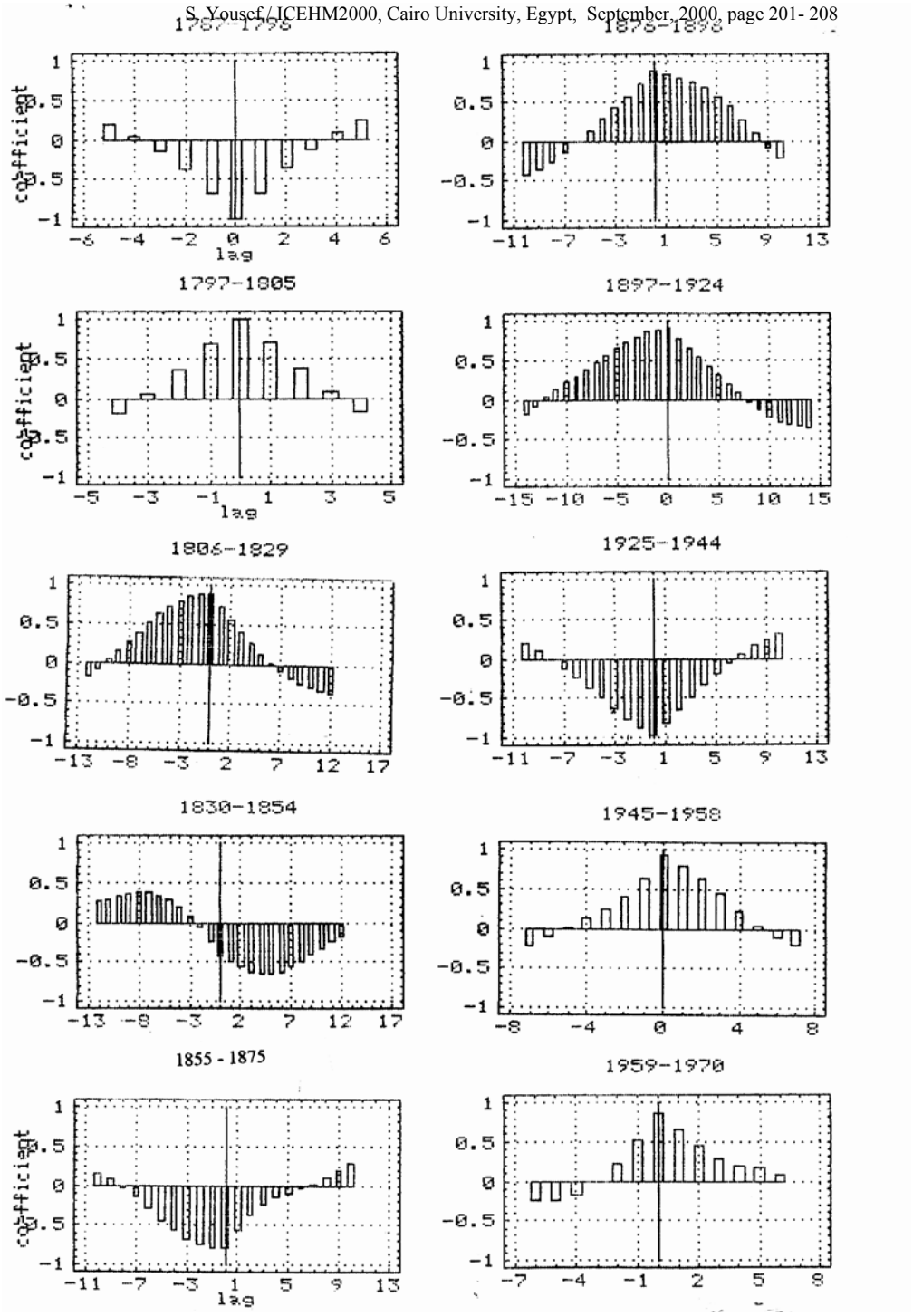


Fig 3: Cross correlation between sunspot number and precipitation in England –Wales for 10 successive time spans determined by he turning points in the corresponding smoothed precipitation cycle shown in fig 2. Note the alternate reversal of the sign of sun-precipitation strong correlation.

CROSS CORRELATION BETWEEN FILTERED PRECIPITATION CYCLES IN ENGLAND-WALES AND INDIA

Such correlation between those far situated places is shown in fig 4. The maximum correlation occur at a lag of 38 years. The cyclicity is zero at 1 year and 22 years in coincidence with the Hale 22 solar magnetic cycle.

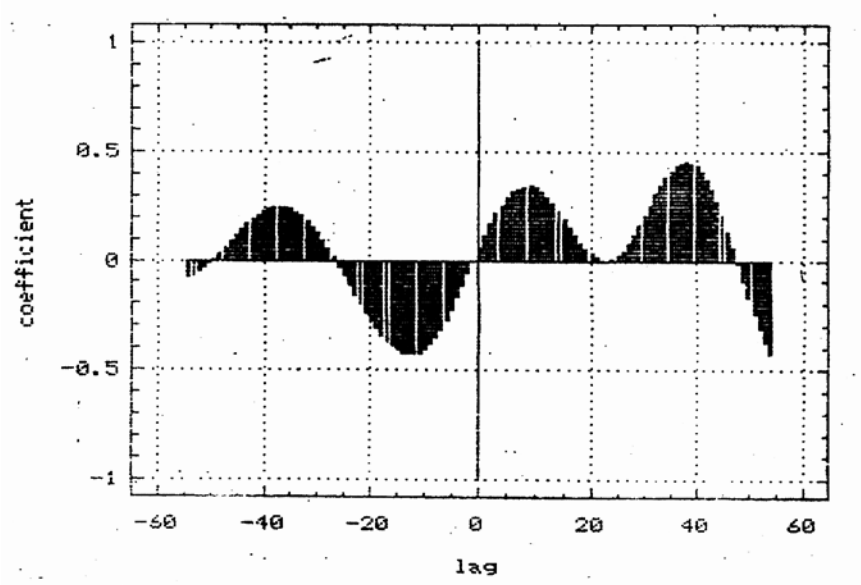


Fig 4: Cross correlation between filtered precipitation in England-Wales and India.

Droughts in England

England was on course for a notable drought from 1995 up to the end of the 1997/98 winter. The summer of 1995 was the driest for EW for the last 200 years.
The following are some extracts from an Internet site describing annual meteorological British events:

1995-1997: (Apr95/Sep97):
1. 30-month precipitation totals up to September 1997 were the lowest on record in England and Wales, with estimated return periods exceeding 200 years in many districts.
1. Winter 94-95: Another (after the previous year) very mild and very wet over winter (Nov to Feb). third mildest winter this century.
2. 1994/95: (winter):
Wettest winter since 1869 taking Britain as a whole.
1995: (Summer):
1. Summer: hot,dry and notably sunny, it was second driest summer in the EWR record (since 1767) i.e. not beating 1976. However, for Britain as a whole (i.e. including Scotland), it was the driest June to August period. In the five month period April to August the rainfall total for England and Wales(EWR) was the lowest for 200 years. For Scotland only, it was the second driest summer on record.
1996: (Annual):
2. A very dry year in the EWP series: 682.2 mm/5th driest in that series (as at 1999).
1997:
2. Another dry autumn: 57% of average rainfall, when we were looking for a wet spell to offset the drought. This makes the third below average autumn in a row. (q.v. the late 80's/early 90's).
. For the UK, British Tornado total probably the highest since 1984. There were 36 tornadoes in 1997, the highest annual total since 1984.
1998:
The earth's temperature in 1998 was easily the highest in the global record starting in 1860. The global mean was about 0.6 deg C above the 1961-90 averages. (The previous warmest was in 1997)

The reason why 1999 was not as warm as 1998, at least in part, was the long-lasting and notable cooling event in the equatorial Pacific - La Nina.)
Almost certainly, for world, the warmest in the record that has been worked up since 1860. The record El Nino, with anomalies of well above +4degC, and in some places up to +5 or +6 deg C, was a major contributor. The average temperature near the surface of the earth in 1997 was the highest so far recorded -- and estimated 0.43 deg C higher than the 1961-90 average. (Based on land-based weather stations and SST from ships.) [Previous warmest was 1995 q.v.]
1997 & 1998: (Christmas holiday period):
On the 24th December 1997 (Christmas Eve), an intense secondary depression tracked north-east across Scotland, bringing wide spread rain and severe gales. Altogether, six people died, many buildings were seriously damaged, thousands of trees were uprooted, electricity supply was disrupted for up to four days
1999: (September):
1. Warmest September, using the CET series, since 1949.
1999: (Annual):
A warm(and fairly sunny) year.

Droughts In India

There are evidences of a terrible famine in India which lasted for consecutive twelve years (310 to 298 BC). In another severe drought in Kashmir (1917-1918), the river Jhelum completely dried up(Upadhyay1995).
For ages, monsoon related weather changes have influenced the life of people in the Indian subcontinent. The monsoon is a major source of water in India. In a large and topographically diverse country like India, an erratic or abnormal monsoon causes both droughts and floods simultaneously in different parts of the country. One of the worst droughts in recorded history occurred in 1899, when about three fourths of the country's area experienced a rainfall deficit .
Droughts in 1918 and 1972 affected more than 73% and 43% of the area of the country respectively. Among more recent droughts , the 1982-1983 drought was one of the worst in memory ,for example in Gujarat. Throughout the country, it affected 11 out of 35 meteorological divisions.
The Indian Meteorological Department uses the following definition of droughts. (relative to mean rainfall:

+ 20% or more	Excessive rainfall
+ 19% to –19%	Normal rainfall.
-20 to 59%	Deficient rainfall (drought)
-60% or more	Scanty rainfall (severe drought)

The wide spread drought of 1979-1980 was the most severe accounting for a 20-54% water deficit in about 41% of the countries area.. there has been no apparent linkage between this drought and an ENSO effect. It is also interesting that most of the divisions (except Bihar Plateau that experienced drought in 1979-80, escaped drought in in 1982-83.
As a matter of fact, 1980 was the year of second maxima in solar Wolf- Gleissberg cycle
Athough the regular monitoring of rainfall in India started in 1875, there is enough information for the occurrence of droughts from the year 1800.

The Present Drought In India 2000

After twelve successive good seasons, several parts of the country have come in the grip of a severe drought. According to reports 23,000 villages in 26 districts in Rajasthan , 17,000 villages in 18 districts in Andhra Pradesh, 8,000 villages in 17 districts in Gujarat and 3,200 villages in seven districts in Madhya Pradesh have been affected by drought. Other states like Orissa and Maharashtra have also come under stress. .... The drought is the worst to hit Gujarat in 100 years Kriner(2000).. Apparently the authorities were taken by surprise. Wheat stocks are of the order of 12.8 million tons and rice stocks of the order of 16 million tons much more than the stipulated norm.
The Indian Meteorological Department has claimed that it had predicted the drought nearly six months ago. Drought is not a sudden occurrence.
The present drought also extended to Pakistan and Afganestan. So severe is the drought than even camels died.

General Indian Strategy For Facing Droughts

Famine commissions were set by the British governments in India in 1880, 1898,and 1901 following three famines, later plans were put by Indian governments (Jodha 1988).

i) **For short-term relief**, Initiation of relief works, remission of taxes, and provision of loans to facilitate reinitiating of cropping activity in the post famine period.

ii) **For long-term strategies** was the provision of better railway network to facilitate distributing food supplies within the shortest time, whenever the problem occurred.

iii) **Use of Protective irrigation** was the most important recommendation of the first famine commission concerning the causes rather than the consequences of famine related to the irrigation policy.

iv) **Drought relief programs.** The Indian government maintains a substantial buffer stock of food grains, in 1989 was about 30 million tons. In addition an elaborate public distribution system through more than 25000 fair price shops is maintained throughout the country.

v) **Various soil moisture conservation measures and works relating to minor irrigation** were carried out.

vi) **Rehabilitation support, including input supplies for producing the next crop,** relief employment through programs such as food for work

vii) **Drought prone area program**. Alarmed by the continuing impact of recurrent droughts of 1965-1967 in certain low rainfall regions, Emphasis was put on *dry farming technology and use of watershed concept*

viii) **The present emphasis is on both exploiting the potential of good grain years and minimizing losses from poor rain years.** This is attempted through various measures and the *development of suitable crop varieties*.

ix) **Agroclimatology**.Input of scientific knowledge on Agroclimatology is an important feature of new research approach.

CONCLUSION

The problem of long range forecasting of drought-flood hazards and El Nino and La Nina phenomena can very well be tackled through our improved knowledge of solar terrestrial relations. With some prediction to the expected level of solar activity and studies of historical flood- drought hazards world wide and of drought migration and El Nios teleconnections, one can predict such long range phenomena as they are highly induced by solar forcing. In the present paper which outlined earlier papers, the coherence of the smoothed precipitation cycles were used in predicting 1995-97/98 English-Welsh droughts, French droughts and lastly the 2000 drought. The last drought extended from western part of India to Pakistan and Afghanistan and in my estimation, based on historical drought information it is likely to last for some time and God knows best.

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