VARIATION IN FOG INTENSITY/DURATION AND EL NINO

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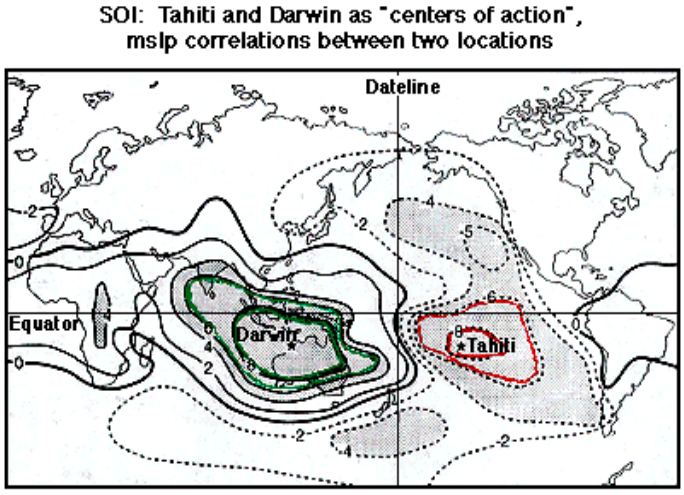
Abstract:

The intensity and duration of Fog over the plains of Punjab has been seen to significantly vary during the past decade. Fog is one of the climatic parameters in the region and appears normally for very short durations of few hours. This figure, it has been seen, crossed 300 hours during the El Nino year of 1997-98. The study conducted in this regard revealed that during El- Nino years, the pressure over the region rises. A correlation of 80% was found to exist between the pressure of Darwin and the upper Punjab and this higher pressure increased stability over the region that creates an atmosphere conducive for the formation of Fog for longer duration in winter season.

Introduction:

The El Nino phenomenon is responsible for flooding in some parts of the Globe and draught like conditions in other parts of the Globe [1]. During warm episodes extra tropical storms and frontal systems follow paths that are significantly different from normal, resulting in persistent temperature and precipitation anomalies in many regions. El Nino is also responsible for large-scale seesaw phenomenon of surface pressure between Indonesia and southeast pacific in which, when pressure is high on one side, it tends to be below on the other. The pressure difference between the two representative centers of Southern Oscillation, Darwin in Australia and Tahiti in south pacific is a good index of a southern Oscillation, and it corresponds well with the variation of sea surface temperature (SST) in the eastern equatorial Pacific. SST in the equatorial Pacific fluctuates between Al-Nino and La-Nina every few years, and similar variation can be seen in surface pressure of both areas.



In this paper an attempt has been made to find the correlation between the El Nino phenomenon and occurrence of fog over Punjab.

Fog over Punjab:

In the upper Punjab the number of hours of Fog has increased drastically in the past decade [2]. The 50 to 60 hours of fog is the climatology of the region but that figure has gone to more than 300 hours in 1997 – 1998.

Usually, fog isn't just composed of plain water droplets. The condensation process occurs more easily with the presence of hygroscopic condensation nuclei in the atmosphere (e.g. dust or salt particles, often caused by pollution). In case of a high concentration of nuclei, the fog will be called smog.

The microstructure of fog depends on the place (nature of hygroscopic condensation nuclei), the time, and the atmospheric conditions. The droplets are small when the fog forms, then grow bigger as condensation occurs.

The fog identified over Punjab is Radiation and Frontal fog. The favorable conditions for radiation fog produced by the radiation cooling at the surface are clear nights, shallow layer of moist air near the ground, long nights, light winds. The radiation fog forms at the ground and are deepest around sunrise, some times an increase in thickness at sunrise due to evaporation of dew supplying moisture to the fog. The frontal system coming from west known as western disturbance brings moisture with it and it is responsible for winter precipitation over upper Punjab. Although the front is not visible in the region but it is observed that after rain the moisture in the air appears as fog due to high-pressure system that comes after western disturbance.

Burning of coal:

The four-year (1998-01) research undertaken by SUPARCO clearly shows [3] that the fog in Lahore and other parts of Punjab is a result of coal burning in the Northern cities of India. The chemical analysis of the fog samples which were collected over a period of four years and analyzed in the New York State Laboratory in Albany, USA, clearly indicate that the chemical composition of the fog is of coal. The satellite picture of the area during fog, shows the fog extending from Bihar to West Punjab in Pakistan, with the bulls eye over UP India.

Data and Methods:

In this study 5 stations in upper Punjab are considered (a) Faisalabad (b) Lahore (c) Jhelum (d) Sargodha (e) Sialkot. The monthly and annual data on Pressure, Fog frequency, Maximum/Minimum temperature, Relative Humidity and rain fall for the period 1990-2000 has been used [2].

The monthly data of pressure and anomaly for Darwin was taken from NCEP (National Center for Environmental Prediction).

The average of M.S.L pressure at 0000UTC and 1200UTC was calculated. Relative Humidity was taken at 0000UTC.For fog frequency the number of hours of fog was calculated and then number of hours of fog in each winter season was calculated.

Results and Discussion:

Data of sea surface temperature (SST) of Pacific Ocean from 1990 to 2000 is tabulated showing the staring and ending of warming in the different regions of Pacific Ocean with their time of maximum temperature anomaly.

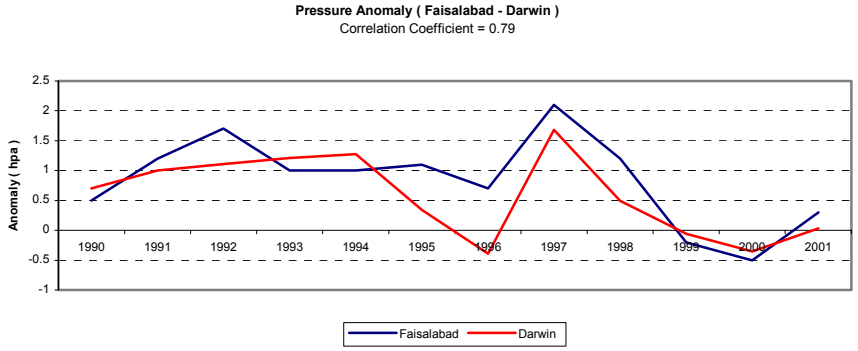
Table (1):

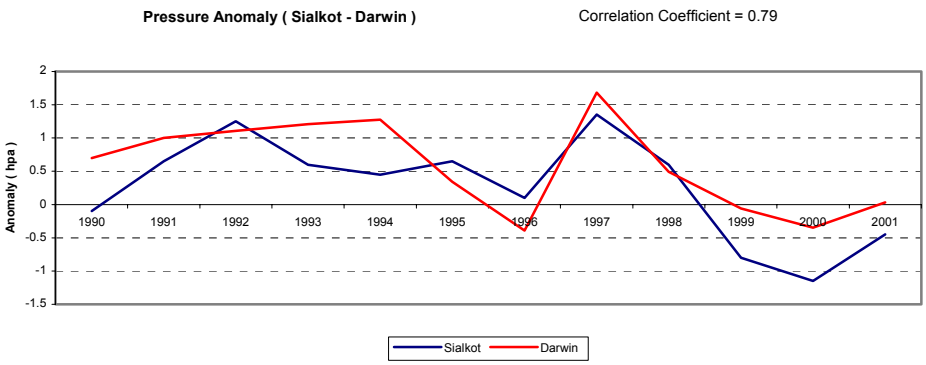
El- Nino Year	Nino 1+2 (0 – 10 °S) (90°W - 80°W)	Nino 3 (5°N - 5°S) (150°W – 90°W)	Nino 4 (5°N - 5°S) (160°E - 150°W)	Nino 3.4 (5°N - 5°S) (170°W - 120°W)
1991 – 1992 (MODERATE)	Start : May 1991 Maximum : April 1992 Anomaly = 2.34°C End : Jul.1992	Start : May 1991 Maximum : May 1992 Anomaly = 1.37°C End : Jun 1992	Start : Dec. 1989 1st Maximum : Dec 1991 Anomaly = 1.17°C 2nd Maximum : Nov 1994 Anomaly = 1.27°C End : Jul.1995	Start : Jan. 1990 Maximum : Jan. 1992 Anomaly = 1.9°C End : July 1992

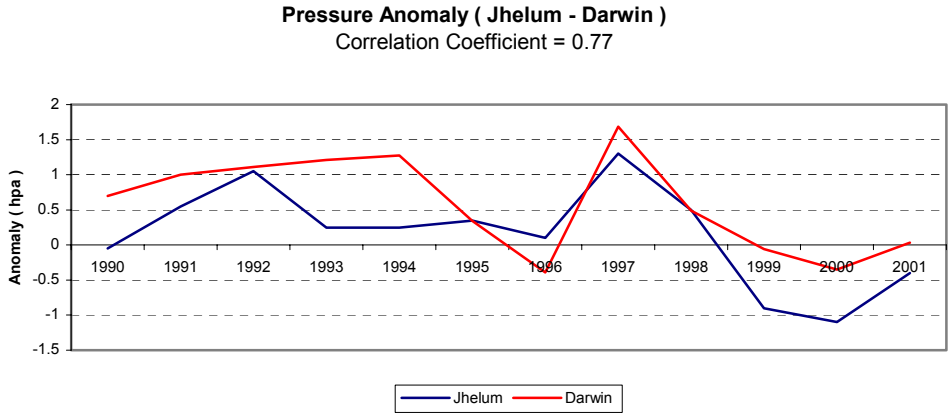
1994 – 1995 (WEAK)	Start : Oct. 1994 Maximum : Jan. 1995 Anomaly = 0.91°C End : Feb.1995	Start : Oct. 1994 Maximum : Dec. 1994 Anomaly = 0.98°C End : Feb 1995		Start : Dec. 1992 1st Maximum : May 1993 Anomaly = 1.06°C 2nd Maximum : Dec 1994 Anomaly = 1.4°C End : Apr.1995
1997 – 1998 (STRONG)	Start : Mar. 1997 1st Maximum : Aug. 1997 Anomaly = 4.01°C 2nd Maximum : Dec. 1997 Anomaly = 4.13°C End : Oct.1998	Start : April 1997 Maximum : Dec. 1997 Anomaly = 3.68°C End : May 1998	Start : Dec. 1996 Maximum : Nov. 1997 Anomaly = 1.13°C End : May 1998	Start : April 1997 Maximum : Nov. 1997 Anomaly = 2.8°C End : Jun.1998

Analysis of mean sea level pressure:

The simple time series graphs were the primary tool for the study of variation of pressure over the period of 10 years. The major finding is the pressure pulse.



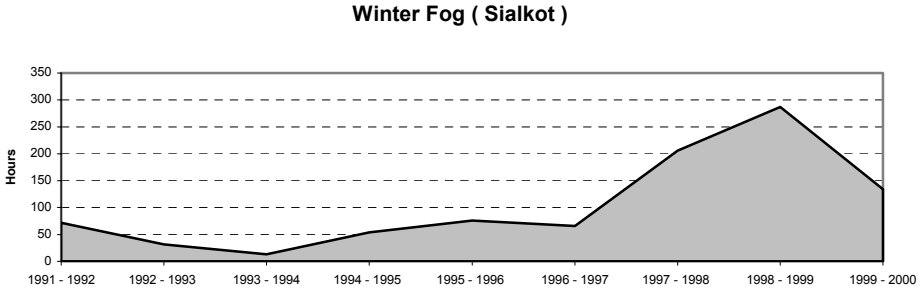


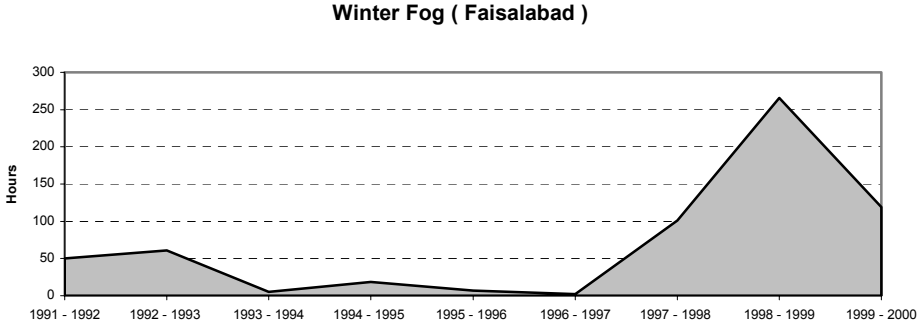


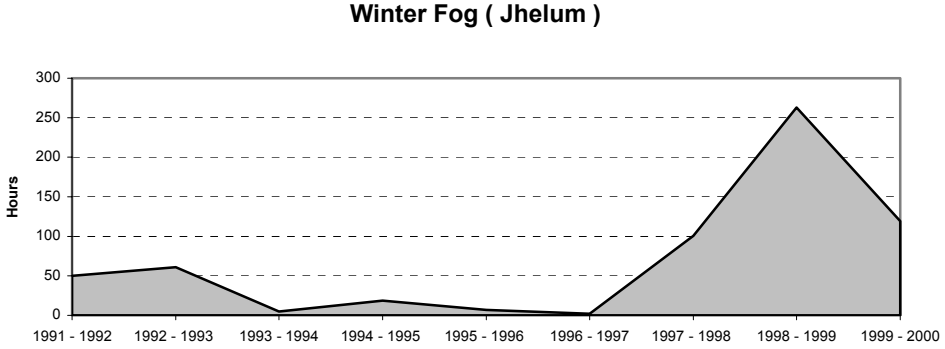
The time series of all 5 stations showed almost the same pulsating character of pressure. The three peak values of higher pressure are clearly visible in the years 1991-1992, 1995-1996 and 1997-1998. For example the maximum value of pressure is visible in 1997 in which the El Nino was strongest as shown in Table (1) The 1997 El Nino started in the month of April and the warming reached a maximum value in September. The high-pressure peak is coinciding with this period. The similar behavior is observed in other El Nino periods. As the El Nino starts the pressure over Darwin Starts increasing where as the pressure over Tahiti starts decreasing. The pressure anomalies of the selected stations and Darwin have shown a correlation of almost 0.8 i.e. the variation of pressure from normal of stations of upper Punjab and of Darwin from its normal are showing same behavior.

Analysis of fog:

The same pulsating character in the graphs is visible as seen in case of pressure. It is again observed that the fog duration during El-Nino year is more than normal. Keeping in mind that 1991-1992 was moderate, 1994-1995 was weak and 1997-1998 was a very strong El Nino, it is clear that the duration of fog in 1991-1992 was more than the duration in 1994-1995 and the number of hours of fog is much







higher in 1997-1998 in the strong El Nino year.

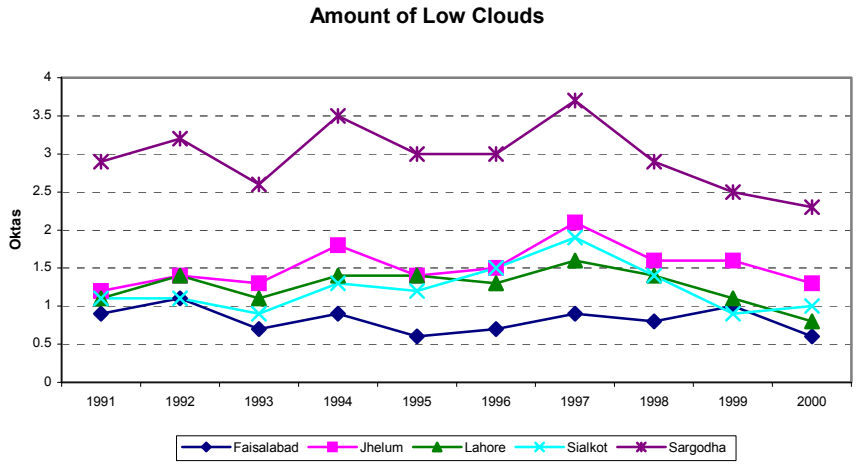
The increase in duration of fog is in phase with El Nino events strength as seen in case of pressure.

There is a delayed effect seen in all the stations i.e. the duration of fog keep on showing increasing trend even after the end of El Nino event.

It is also observed that the same trends are present in El Nino events of 1980's For example in the strong El Nino event of 1982-1983 the number of days of fog were 21 and 23 in 1982 and 1983 respectively in Faisalabad. Although the frequency of fog was not so pronounced but the behavior was in phase with the El Nino events.

Analysis of low clouds:

The peak values of all the stations are found in the year 1992, 1994 and 1997. The increase in the amount of low clouds has significance because it indicates the

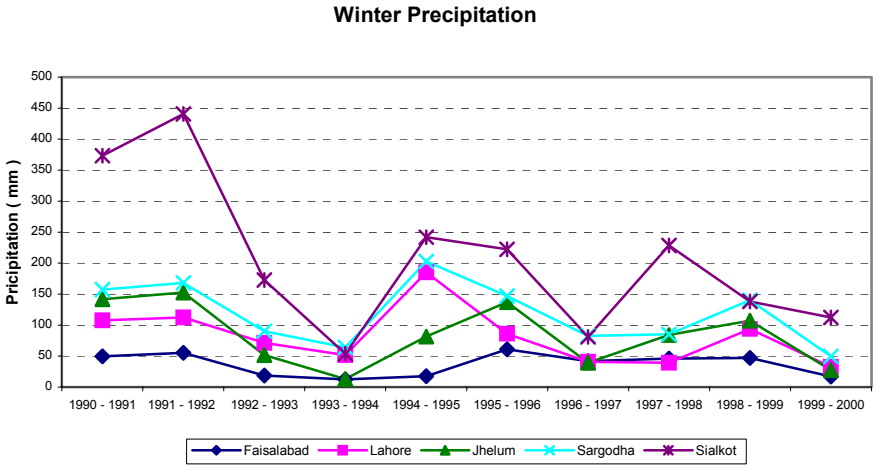


increase in the moisture contents in the lower layers of the atmosphere. It is in conformity with the increase in Relative Humidity during the same periods.

Analysis of winter precipitation:

For precipitation analysis the total Precipitation of the months December, January, February, March was taken. Normally for winter precipitation months in Pakistan are January, February and March but the month of December is included because in El Nino years the rain in this month is quite significant. The situation in the month of November is discussed separately.

There is a slight increasing behavior in precipitation in all the stations in the year 1991-1992, this in more pronounced in Sialkot. There is almost same behavior of

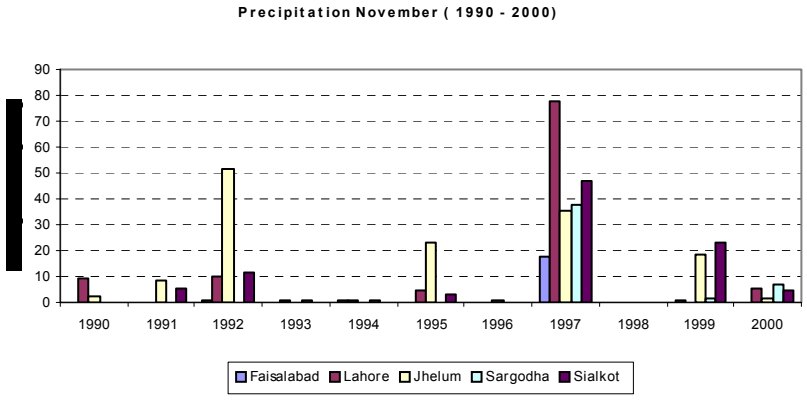


increase in precipitation in the years 1994-1995.In Sargodha, Sialkot and Lahore the peak values are clearly visible in this period where as in Faisalabad and Jhelum the trend is increasing but the peak value is in the winter of 1995-1996 i.e. there is a delayed effect in these stations. The similar situation is visible in 1997-1998 winters.

Situation in November:

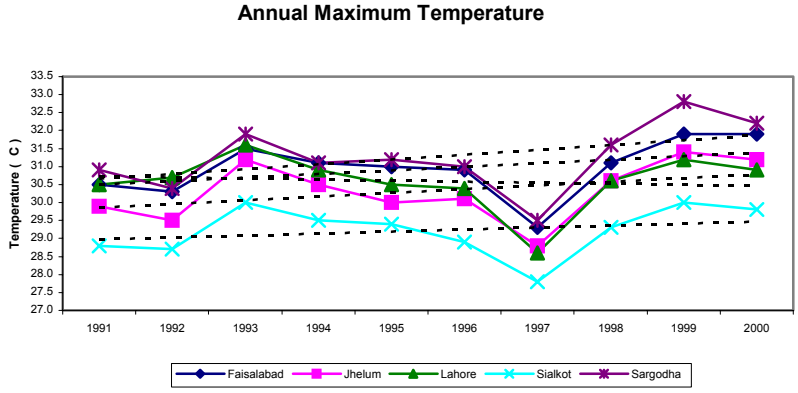
The month of November is the driest month in Pakistan but the situation is quite different in El Nino years. In the Fig 7 it is can be seen that the amount of precipitation is considerably more in the years 1992, 1995 and 1997.

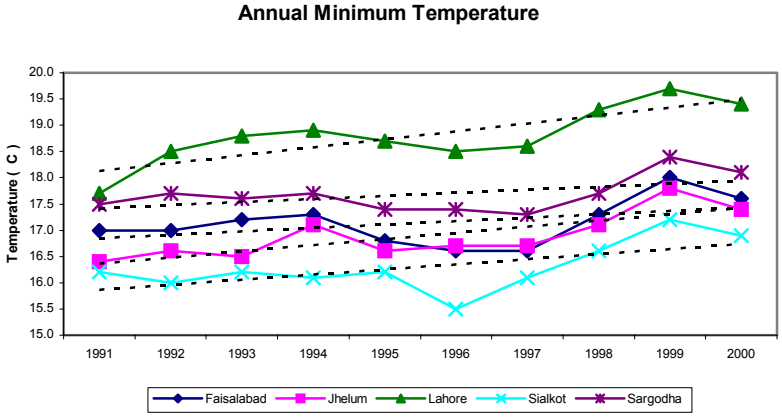
Fig 8: Variation of precipitation in the month of November for the period of 1990-2000.



Analysis of Maximum And Minimum Temperature:

The behavior of Maximum temperature is the same over all the stations of upper Punjab. There is a decreasing trend in 1991-1992, 1994-1995 and 1997-1998. In





1997 there is a sharp decline in the Maximum temperature. The decrease in annual maximum temperature is due to decrease in maximum temperatures in winter as well as in summer i.e. in El Nino years the Maximum temperatures remains below normal.

There is an overall increasing trend in Maximum temperature in all the station except Lahore, which shows slight decreasing trend for the period 1990-2000.

There is an increase in Minimum temperature in the El Nino years. In 1997 the values are significantly higher but in 1991-1992 this behavior is not much evident. It is to be noted that the increase in annual Minimum temperature is due to increase in Minimum temperature in winter season but not in summer season.

There is an overall increasing trend in Minimum temperature in all the stations for the period 1990-2000.

Conclusions:

The correlation coefficient of about 0.8 exists between the pressure anomalies of selected stations and Darwin. So the higher pressure in Darwin during El Nino event is also depicted in the region and this higher pressure increases stability over the region that creates an atmosphere conducive for the formation of Fog for longer duration in winter season.

The frequency of western disturbance is almost one per week, before the arrival of this system there are clear skies due to which the surface cools down and thus helps in the condensation of moisture, which is coming with system and appears as fog. The land use changes i.e. more agricultural activity, better irrigation of land and evapotranspiration by wheat crop adds moisture at lower levels. The topography and lighter winds in the region causes the moisture to stay in the region for longer periods.

The amount of low clouds and relative humidity increases in El Nino years. The decrease in maximum temperature in El Nino years is due to the presence of fog. There is increase in minimum temperature in winter but not in summer is due to fog and low clouds, which resist the radiation cooling of the surface.

Although ENSO and the occurrence of fog are in phase and have a very good relation but there is a missing factor. The phenomenon of fog in 1980's was also in phase with El Nino but the intensity was not that pronounced it seems that the increase in condensation nuclei in 1990's and land use change is enhancing the phenomenon.

References:

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