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STUDY OF VARIOUS METEOROLOGICAL PARAMETERS IN DROUGHT PRONE AREAS OF GULBARGA DISTRICT IN KARNATAKA, INDIA

1. Meteorology deals with the structure of the tropical atmosphere and processes that occur in the tropics. The analysis and forecasting require information on the state of atmosphere (www.file////pasta-Kaustubh/c/eshwar/docs/drought2.html, 1991). The quality and quantity of initial data is decisive for a reliable grid of an objective analysis to be produced and a skilled forecast to result.

However the key role is played by rainfall in the occurrence of drought in an area, the other factors also *viz*., temperature, sunshine, humidity, soil texture, vapour pressure, evaporation, vegetation, soil moisture, stream flow etc. are some of the critical parameters interact to produce drought situation. Continuous measurement and analysis of these parameters are used in the assessment of climatic change on spatial distribution of drought conditions on global, regional, drainage basin and local level event preparedness.

Scientists have predicted that the average global temperature will increase approximately 1° C (2° F) by 2025 and 3° C (5° F) by 2100. In the past 100 years the global temperature has increased 0.45° C (0.8° F). This increase by itself is within the normal variability and, although it may be result of climate change, between 1891 and 1992 however, the nine warmest years for the global temperature have occurred since 1980.

With the projected global temperature increase, scientists generally agree that the global hydrological cycle will also intensify. General Circulation Modal (GCM) indicates that global precipitation could increase 7-15 %. Meanwhile, global evapotranspiration could increase 5-10 %. Thus the combined impacts of increased temperature, precipitation, and evapotranspiration will affect snowmelt, runoff and soil moisture condition. The models generally show that precipitation will increase at high latitudes and decrease at low and mid-latitudes therefore, in mid continent regions, evapotranspiration will be greater than precipitation and there exist the potential for more severe, longer-lasting droughts in these areas. In addition, the increased temperature alone will cause the water in the oceans to expand, causing an estimated sea level rise of 20 cm by 2030.

2. *Data collected and methodology* - For the detailed study of the district, the various meteorological data were collected. The average monthly rainfall data of all the ten talukas of the district from 1961 to 2008 (48 years) were collected from Drought Monitoring Cell, Bangalore, Indian Meteorological Department Sub-division, Bangalore and Agricultural Department, Gulbarga. The other hydro meteorological data like relative humidity, vapour pressure, wind velocity, potential evapotranspiration and cloudiness of the Gulbarga district of 40 years average were collected from India Meteorological Department Sub-division, Bangalore.

From the average monthly rainfall data from 1961 to 2008 (48 years) the average annual rainfall values are computed. For the basic data preparation and to compute various hydro meteorological parameters *viz*., relative humidity, vapour pressure, wind velocity, potential evapotranspiration and cloudiness the Microsoft EXCEL software were used. With the help of IRS 1D (PAN+LISS-III) merged imagery satellite data, average monthly rainfall data from (1961 to 2008) using GIS Arc. View software the district isohyetal map was also prepared.

3. *Results & discussions* - Gulbarga district is one among the drought prone districts of Karnataka State. All the ten talukas of the Gulbarga district were identified as drought prone talukas. In the analysis the parameters such as rainfall, temperature, relative humidity, potential evapotranspiration, vapor pressure, wind velocity and cloudiness had been presented and discussed.

3.1. *Location, extent and accessibility of the study area* - Gulbarga district has been situated towards North-Eastern part of the State of Karnataka extended on latitude 16° 12' and 17° 46' North and longitude 76° 04' and 77° 42' East. The average height from the mean sea level of the district is about 693 m. The district having the total area around 16, 240 sq km, and accounts 8.45 per cent of the Karnataka state area.

3.2. *Climate, vegetation, agriculture and crops in Gulbarga district* - The climate of the Gulbarga district is sub-tropical, semi-arid type with moderate to severe summer, moderate winter and having low erratic rainfall. The average annual rainfall is 800 mm and it is bimodal in nature by spreading over 6 months from June to November. The south-west monsoon season contributes about 80 per cent of the annual rainfall. September is the rainiest month, and the district gets little rain during the later part of the summer and post monsoon months, mostly as a thunder showers. The temperature starts increasing after the month of February and reaches its peak in the month of May with a mean daily maximum of 43º Celsius and mean minimum of 22º Celsius. In 48 years of study the highest annual rainfall of 1214 mm was recorded in the year 1975. The year 1972 received the

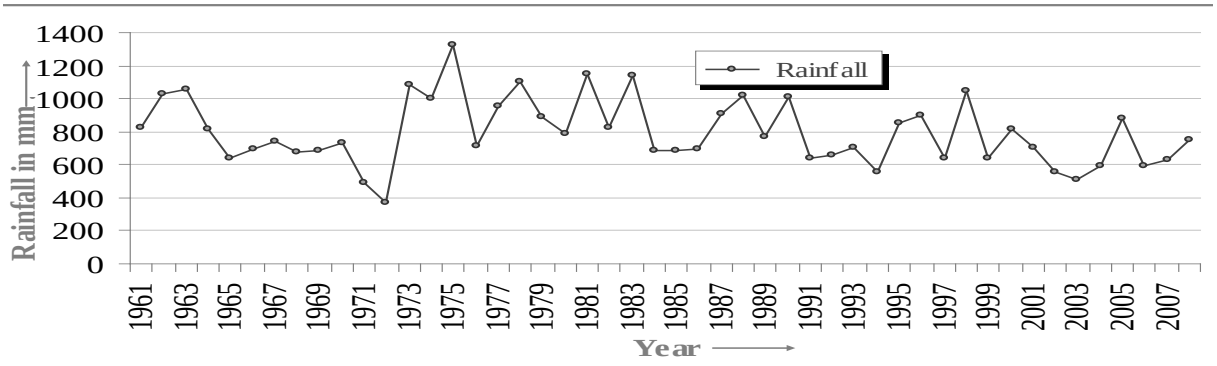

Fig.1. Rainfall pattern of Gulbarga district (from 1961 to 2008) in mm

lowest rainfall of 366 mm (District Statistical officer 2006).

3.3. *Rainfall pattern in Gulbarga district* - South-west monsoon season consist of the two currents which originate in the south Bay of Bengal and the Arabian sea during the hot weather season. The Bay currents move North-East. They are deflected by Arakan hills and the hills of Assam and then by the eastern range of Himalayas, which are originally South-Westerly will appear as southeasterly, give very heavy rainfall, which are called the western disturbances (Jay Rami Reddy, 2004).

From the study it is indicated that the district rainfall is mainly depends on depressions in Arabian Sea and Bay of Bengal currents. The district is situated in a rain shadow area. The rainfall distribution with space and time is not uniform. There is a lot of spatial variation in the occurrence of rainfall in the district. The lowest rainfalls received 366.3, 494.3 and 513.5 mm in 1972, 1971, 2003 respectively, and the highest rainfall received is 1326.2, 1147.2, and 1137.9, mm in 1975, 1981, and 1983 respectively. From the study of rainfall it is observed that there was rainfall during the deficit years, and due to lack of timely rainfall, the available rainfall was no use to the farmers. Study of monthly average rainfall indicates that the maximum rainfall is in the month of July (322.1mm) followed by August (211.3 mm). During the Pre-monsoon period the minimum monthly average rainfall is 2.2 mm (January) and max. is 6.9 mm (May) Similarly during North-East monsoon period the minimum monthly average rainfall is in December (10.8 mm) and maximum is in October (41.2 mm). It indicates that high variations in the monthly rainfall distribution occur in the district. The seasonal and annual rainfall distribution for the Gulbarga district as a whole indicates that, 71 per cent of the annual normal rainfall is received during south-west monsoon season, 17 per cent during North-East monsoon, and the remaining 12 per cent is received during pre-monsoon period. More than 80 per cent of the cultivable area in the district is rain fed. It also reveals that there has been an increase in the rainfall trend up to 1963 in all talukas of the district the downward trend of rainfall indicated from 1964 and it continues up to 1972, 1971 and 1972 years receives considerably very less rainfall (Fig. 1). The increasing trend of rainfall again noticed from the year 1974 with little fluctuation it will follow the same trend up to 2001 from the year 2002 again decreasing trend of rainfall is noticed in few of the talukas of the district. Also the study indicated that the rainfall is light during January and February the average rainfall does not exceed more than 5-6 cm. also the same pattern is observed in north east monsoon period With average rainfall between10-12 cm, the south-west monsoon season is the principal rainy season for almost the entire district. This season accounts for 80 per cent or more of the total annual rainfall. The rainfall normally occurs in the months of June, July, August and September; and this is due to South-West monsoon. The break or long breaks in the monsoon results to drought situations in the district.

The isohyetal map was constructed by plotting the precipitation amounts for each station on a suitable map and then drawing lines of equal precipitation (isohyets) at proper intervals (Indian Standard Code, 1970). The Isohyetal map of the district indicated low rainfall in the central portion with increasing trend towards the district boundaries from all direction and also with decreasing trend of rainfall towards North-West direction. According to the isohyetal study, the mean minimum rainfall was observed in Gulbarga and Afzalpur talukas of the district. A low rainfall zone of less than 500 mm existed in the boundary of Afzalpur and Gulbarga taluka and towards

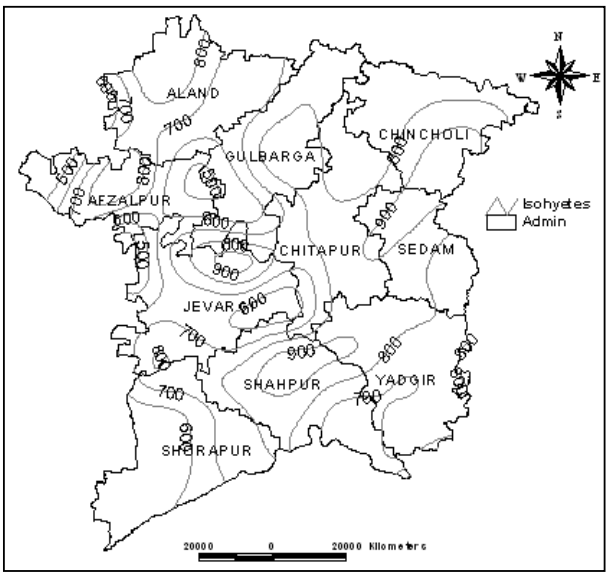

Fig. 2. Isohyetal map for Gulbarga district in Karnataka, India

northern part of Afzalpur. The mean maximum rainfall was observed in Shahapur, Sedam and Chincholi talukas of the district having the isohyetal values of 900 mm as seen in Fig. 2. The isohyetal values were decreased in district boundaries. High rainfall zone with annual rainfall in the range of 800-900 mm existed in the central part of the district in Jewargi, Shahapur Yadgir Sedam and Chincholi talukas.

3.4. *Temperature* - In general the degree of temperature is determined from the radiation balance. Temperature varies from place to place mainly with respect to geographical conditions (Tarakanov, 1970). Multi-year droughts are generally associated with higher than normal surface air temperature 1986 drought in southeastern US had associated surface air temperature, much higher than normal of the year (Nagarajan, 2003). It was the warmest July in the 20thcentury.1962-65 drought in North-East of USA was a major drought that was associated with lower than normal surface air temperature in all seasons.

On the basis of 40 years data the mean highest maximum temperature recorded at Gulbarga was 46.3° C on 1 June 1992 and 22 May 1994. And mean highest minimum temperature recorded at Gulbarga was 7.8° C on Nov 1965. From the middle of February the temperature rises rather rapidly till May which is the hottest month. The temperatures (Fig. 3) starts increasing after the month of February and reaches its peak in the month of May with a mean daily maximum of 42.8° C and mean minimum of 22.1º C and after July the temperature decreases rapidly and reaches a minimum values in the months of November and December.

In the study area it was observed that always the temperature lies between mean daily maximum of 43º C some time it reached to 45º C. The rapid increase in temperature in the study area causes increase in potential evapo-transpiration leads more stress on water budget. Also the moisture retention capacity of the soil in the district is the main bottleneck. Also with the various activities of the men in the area, more and more stress is going to be exerted on the natural water resources. The more utilization of water and the increase in temperature the potential evapo-transpiration is also reach to the maximum value and this will disturbing the ecological imbalance, causing more impact on drought situation in the area.

3.5. *Relative humidity* – The relative humidity over Gulbarga district varies from January to December. Normally the humidity is more in the months of July, August, September and October and (Fig. 4) less in the months of February, March, April and May. The period from February to May is the driest part of the year having the relative humidity 21 to 25 per cent. The Gulbarga district now comes under arid to semiarid region (as specified by central water commission). If the relative humidity is decreases below normal the dry air prevailing through out the district. The decrease in relative humidity also can be caused by a lack of water vapor. The study showed that the air during the drought was drier throughout the period. It not only the temperatures were higher but also there was less water vapor in the atmosphere causing more intensive drought.

3.6. *Wind velocity* – Maximum wind velocity is observed in Gulbarga district during June, July and August (17.3 to 16.1 km/hr) and minimum during January and December months (8 to 8.4km/hr). In the district wind moment is generally light with some increase during late summer and Monsoon seasons. The winds blow mainly from the South-West and West during the period from April to September. In October, wind blows commonly between north and east directions. But on some days, they are (Fig. 5) from South-West or West also. During November and December, the winds are mostly North-Easterly or Westerly. In the district considerably the wind velocity is vary low and also wind is dry in major part of the year leads drought situation.

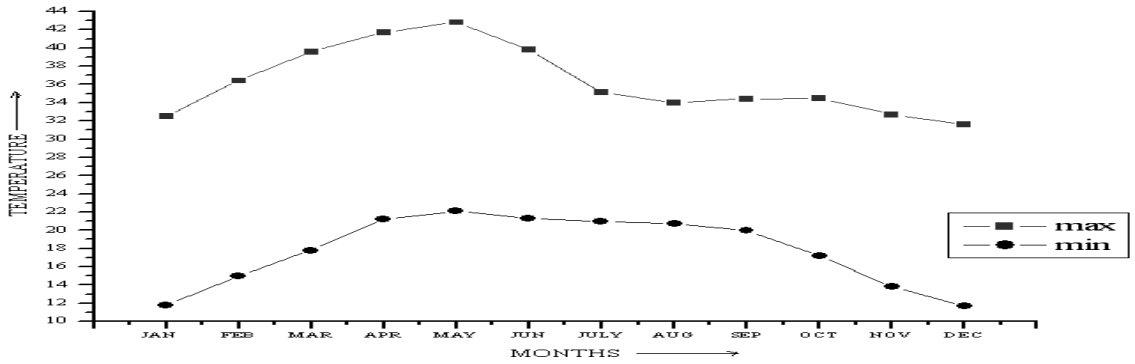

Fig. 3. Mean monthly maximum and minimum air temperature of Gulbarga district

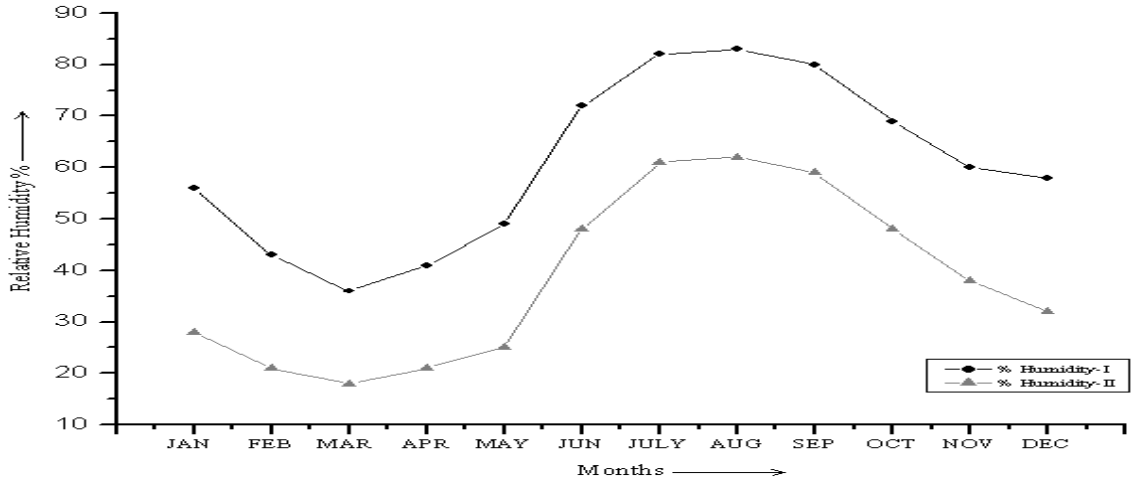

Fig. 4. Mean monthly relative humidity of Gulbarga district

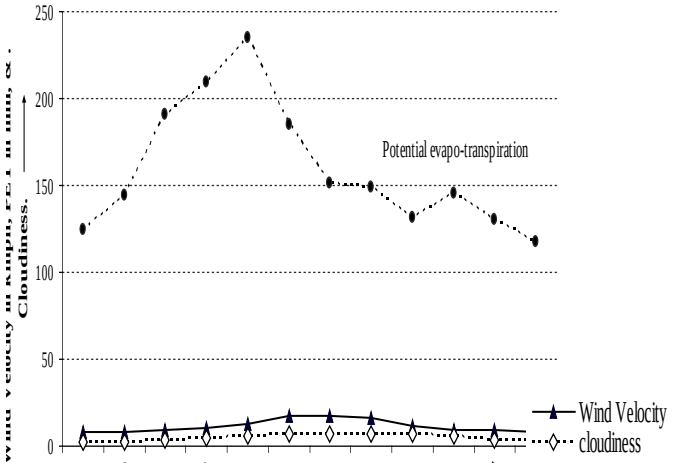

Fig. 5. Mean monthly wind velocity, potential evapotranspiration, cloudiness of Gulbarga district

3.7. *Potential evapotranspiration* – The Mean monthly values of Potential Evapotranspiration of Gulbarga district the highest Potential Evapotranspiration is observed during the hot weather months (Fig. 5) of March to May. The highest values exceeding 234 mm is experienced in May and the lowest value of 117.5 mm in December months. Potential Evapotranspiration has positive relation with temperature and dryness of atmosphere *i.e*., as the temperature and dryness increases PE also increases and it has inverse relationship with the rainfall and humidity. The parameters *viz*., rainfall and humidity are considerably low in the district case more impact on the drought intensity.

3.8. *Cloudiness* – In Gulbarga district the Sky is moderately clouded in the South-West Monsoon. Cloudiness (cumulus homilies) decreases during (Fig. 5) Post Monsoon season. In the rest of the year the sky is generally clear or lightly clouded. As for as the district is concerned the cloud pattern is not similar as discussed above, which will cause drought situation frequently in the district

4. Based on the analysis, the following conclusions were drawn.

(*i*) The analysis for the period of 48 years (1961 to 2008) on two occasions *viz*., 1972 and 2003 large areas in the district experienced severe drought conditions.

(*ii*) The highest Potential Evapotranspiration is observed during the hot weather months of March to May.

(*iii*) In the district the middle of February the temperature rises rather rapidly till May which is the hottest month.

(*iv*) Maximum wind velocity is observed in Gulbarga district during June, July and August and minimum during January and December months.

(*v*) Potential Evapotranspiration in the district has positive relation with temperature and dryness of atmosphere *i.e*., as the temperature and dryness increases PE also increases and it has inverse relationship with the rainfall and humidity.

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