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Trends in Rainfall, Length of Growing Period and Drought Occurrence in Karnataka, India

Shivaramu, H. S.,[1] Venkatesh, H.,[2] and Padmashri, H. S.[3]

[1]*University of Agricultural Sciences, GKVK, Bangalore, Karnataka, India*
[2]*University of Agricultural Sciences, Dharwad, Karnataka, India*
[3]*University of Agricultural Sciences, GKVK, Bangalore, Karnataka, India*

Abstract: Climate has a vital role on biosphere of the earth. Of the major climatic parameters, rainfall is one of the most important parameters that influence the agriculture of the region and food production. A study was undertaken to analyze the trend of the rainfall pattern of Karnataka by using the daily rainfall data from 1980 to 2013 of 392 stations and its length of growing period (LGP) along with drought extent. Annual rainfall normals and rainy days normals over different stations was tested Mann-Kendall test was used for significance of trends in annual rainfall and annual rainy days. Also the frequencies of moderate and severe meteorological droughts were computed. Weekly values of precipitation and potential evapotranspiration were considered for computing length of the growing period. The mean annual rainfall of Karnataka in the last thirty three years was 1122±133 mm with a coefficient of variation (CV) of 12 %. Eighty two percent of the stations in the state shown no significant trend in annual rainfall while seventy one percent of the stations shown no significant trend in annual rainy days. Around 97% of the stations in the state show a probability of <10% of occurrence of severe droughts. Drought prone areas have been defined for Karnataka based on LGP concept. LGP varied between 168 days in Aland Taluk of Kalburagi district to 259 days in Beltangadi taluk of Dakshina Kannada district. According to LGP, agro-climatic zones of Karnataka have been re-delineated into new sub zones.

Keywords: Agro-ecological zones, drought, global warming, length of growing period, trends in rainfall

Introduction

Global climate change and its impact on agriculture is becoming an important issue even at the village level to meet the future food requirement at the regional level. The entire habitat of vegetation of an area depends on a

Corresponding author: H.S. Shivaramu, e-mail: *bng.aicrpam@gmail.com*

particular climate and they are accustomed to that. The major climatic parameters are rainfall, temperature, sunshine hours, relative humidity, wind speed etc., of which rainfall was one of the important factors. Rainfall has greater significance on agriculture of the region and food production, especially under Indian conditions, in general, Karnataka in particular.

Agriculture plays a vital role in Karnataka's economy. Agriculture and allied sectors account for about 13% of the Gross State Domestic Product (GSDP) and is among the top three contributors. About 57% of the total households in the State depend upon agriculture as their principal livelihood. About 61% of the total population lives in rural areas and 76% of them have small and marginal farm holdings. The average size of holding has decreased from 3.20 ha (1970-71) to 1.55 ha (2010-11), which is far less than the required economic size of 2.56 ha for Karnataka. Though cultivable area is around 64% (121.61 lakh ha.), only 33% area is under irrigation. Karnataka is second highest drought prone area next to Rajasthan. Due to the inherent nature of high temporal and spatial variability of rainfall in the state, it is important to have in-depth rainfall analysis. With an hypothesis that changing rainfall scenario could contribute to change in agriculture scenario, we have made an attempt to understand, if there exists any significant trend in rainfall, length of growing period (LGP) and drought behavior.

Materials and Methods

Daily rainfall data were collected from different sources like National Data Centre (IMD) and Department of Economics and Statistics (Government of Karnataka) for rain gauge stations working under their control. To work out a reasonable balance between lengths of data, number of stations, as well as making it up to most recent, the data period 1980-2013 for 392 stations were considered for the analysis.

We have made an attempt to calculate annual rainfall normal's and rainy days normal's over different stations. Kendall (1975) developed a procedure to test the trend and named it as Mann-Kendall test. The Mann-Kendall test reliably identifies monotonic linear and nonlinear trends with outliers. This test does not require normally distributed data and is well suited for analyzing datasets that have missing or tied data (Gilbert, 1987). Here we have used the same test to check the significance of trends in annual rainfall and annual rainy days.

Information on LGP helps in the selection of suitable crops, cropping systems, and crop cultivars as it reflect the period of congenial moisture availability. The LGP in any given region represents the climatically determined number of days during which a crop receives enough moisture from soil for its growth. As per the method proposed by agro-ecological zones project of the Food and Agriculture Organization of the UN, LGP was calculated as the period (in days) during a year when precipitation exceeds half the potential evapotranspiration (PET) (Higgins and Kassam, 1981). Weekly values of precipitation and PET were considered for computing LGP for all the taluks in Karnataka.

The frequencies of moderate and severe meteorological droughts were computed based on departures from normal annual rainfall in all taluks of Karnataka. As per IMD criteria, 26-50% deficiency was termed as moderate drought, and >50% was termed as severe meteorological drought.

Results and Discussion

Behavior of monsoons determines the availability of water for crops. Differences in commencement and end of monsoon result in the changes in length of growing period, which helps in choice of crops and their cultivars in about 64 % rain-fed area of the state. Therefore, the amount and distribution of rainfall during the crop growing season determines the productivity.

Annual rainfall of Karnataka

The mean annual rainfall of Karnataka in the last thirty three years was 1122 ± 133 mm with a coefficient of variation of 12 % (Venkatesh *et al*., 2016). Essentially, major part of the state possesses rainy days fewer than 50. The mean annual rainfall and rainy days distribution over the state is depicted in Figure 1 and Figure 2, respectively. Karnataka was divided into three meteorological sub-divisions such as North Interior Karnataka, South Interior Karnataka and Coastal. During the period of 1980-2013, inter-annual variability has been greater during the past 15 years in interior Karnataka in the period of analysis. Trends of rainfall and rainy days are almost the same.

Trends in annual rainfall and rainy days

The significance of the trends resulted from Mann Kendall test is presented in Figure 3 for annual rainfall and in Figure 4 for annual rainy days. 82 % of the stations in the state showed no significant trend (322 stations) in annual rainfall while 71 % showed no significant change (279 stations) with respect to annual rainy days.

Annual rainfall: Of the remaining 70 stations, 51 stations showed positive trend (13% of total stations), while 19 stations negative trend (6% of total stations).

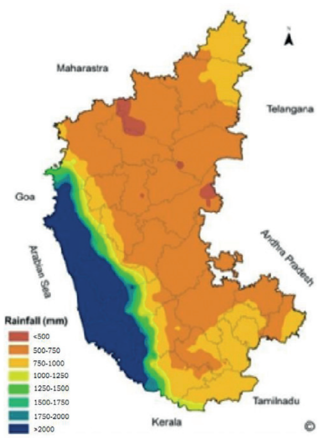

Figure 1: Annual rainfall in Karnataka

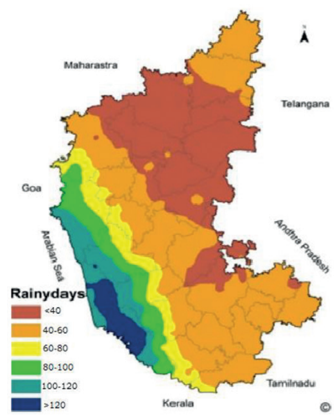

Figure 2: Annual rainy days in Karnataka

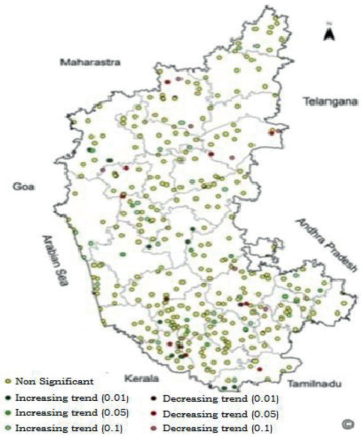

Figure 3: Trends in annual rainfall in Karnataka

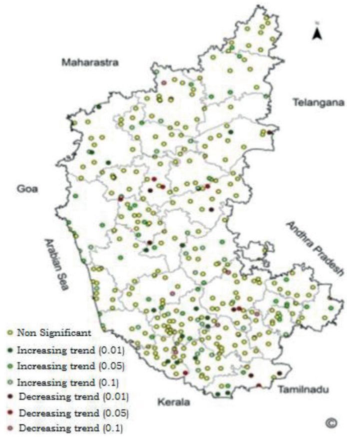

Figure 4: Trends in annual rainy days in Karnataka

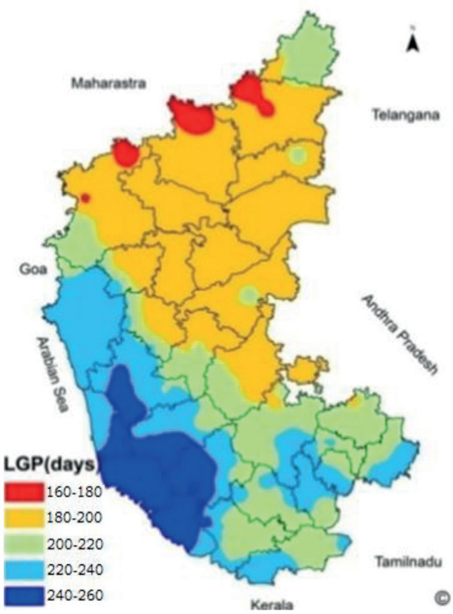

Figure 5: Length of growing period (LGP) in Karnataka

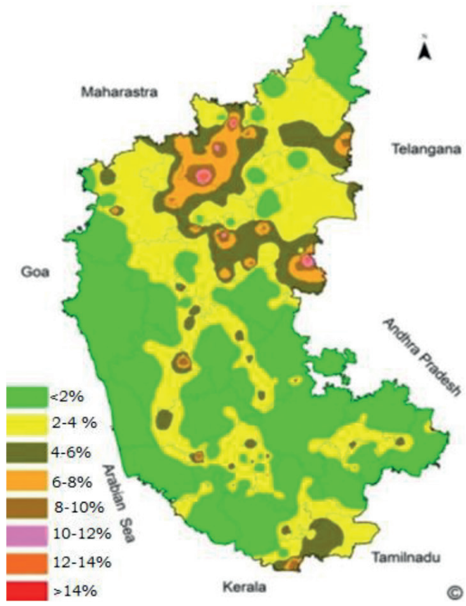

Figure 6: Probability of occurrence of severe meteorological drought in Karnataka

Out of the stations with positive trend, 50 % showed significance at 10 per cent, 28 % shown significance at 5 per cent and 22 % stations shown significance at 1 per cent. This indicates that the increasing trend was slower at 50 % of stations (PT-10%), and it was greater at other stations (PT- 5% & 1%). Out of the stations with negative trend, 38%

shown significance at 10%, 48% of stations shown significance at 5% and 14% of stations shown significance at 1 per cent. Thus, the negative trend observed was greater at more number of stations.

Annual rainy days: Of the remaining 113 stations, 89 stations showed positive trend (23% of total stations), while 24 stations showed negative trend (6% of total stations) for annual rainy days. An interesting point was noticed during the north east monsoon that none of the stations showed decreasing trend in annual rainy days while only 9% of the stations showed increasing trend indicating the shift in the wetness in October, November and December.

Length of growing period (LGP)

The spatial distribution of LGP is depicted in Figure 5. The length of growing period varies between 168 days in Aland Taluk of Kalburagi district to 259 days in Beltangadi taluk of Dakshina Kannada district. Fifty one %of taluks (88) in Karnataka has LGP between 180-210 days, and 31% of taluks (54) has LGP between 210-240 days.

While 13% of taluks (22) have LGP of more than 240 days (all are located in south Karnataka). According to LGP, the Karnataka has been delineated into agro-climatic zones and sub zones. There are ten agro-climatic zones in Karnataka, each having 2-4 sub zones divided based on LGP.

Meteorological drought

Meteorological drought occurs in all climatic regions of Karnataka, but its intensity differs from region to region. Around 97% of the stations in the state showed probability of < 10% of occurrence of severe droughts (Figure 6). The remaining three % of stations come in the category of 10-20% probability. Drought prone areas have been defined for Karnataka based on LGP concept (Naidu *et al*., 2003).

Conclusion

Recently, real time drought occurrence and drought affected areas are being announced for the state of Karnataka based on the rainfall deficiency and LGP based indices developed. Trends noted and present LGP becomes the base for re-delineation of present agro-climatic zones of Karnataka into new sub zones.

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