Impact of Physiography on the Precipitation Pattern – A Case of Sahyadri

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Abstract: ***According to International Labor Organization, rainfall plays a very important role for the overall development of the county like India where agriculture workforce includes the more than 50% of the population, in which 80% is from rural India. Thus, it is necessary to understand the rainfall pattern and to revise it periodically to understand the changes in it, so that necessary changes can be done on agricultural models. This paper is an evaluation of the seasonal (monsoon) rainfall pattern for three districts of state of Maharashtra adjacent to Western Ghats, known as Sahyadri. The focus is on the relationship between rainfall variation and topography of Western Ghats (Sahyadri). These three districts are part of a same natural division of this state, but the varition in rainfall is clearly seen. Impact of broader Western Ghats in Karnataka has been clearly seen in its adjacent district in Maharashtra, whereas narrower Western Ghats resulted into less rainfall in other two districts. Slope of mountains directly affect the possibility of precipitation. Gentle slope of Western Ghats in Kolhapur, and steeper slopes of Satara and Sangli leads to higher rainfall in Kolhapur districts, in comparison to other two.***

I. INTRODUCTION

Physiography of the region is one among the various factors that affect rainfall pattern of a region. On the basis of natural divisions Maharashtra is divided into 5 different parts. These are: i. Konkan ii. Paschim (Western) Maharashtra iii. Marathwada iv. Khandesh v. Vidharbha. Satara, Sangli, Kolhapur are three major districts of Western Maharashtra having same physiography.

In Satara, Sangli, and Kolhapur, the area under sowing is higher than urbanized area. Because of having an agro-based economy, which is largely depend on monsoon, any changes in rainfall pattern will ruin the agricultural conditions, that is why understanding the rainfall pattern is important as it can be helpful to relate and make necessary changes in cropping pattern for coming years. The present paper analyzes the temporal changes and spatial variation of rainfall to understand whether it is similar or vary among these three districts which are belong to same physiographic division. This paper will also analyze the relationship between mountain topography and spatial distribution of rainfall.

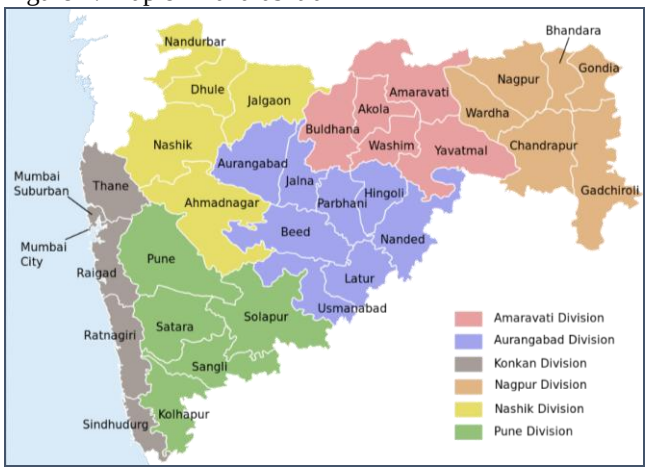
II. DATABASE AND METHODOLOY

Different trends and patterns of rainfall are analyzed by various bar and line graphs, and by calculating mean and rainfall deviation. This study is based on the precipitation data (secondary data) of last 21 years i.e. 1998-2018 collected from Indian Meteorological Department and Department of Agriculture, Maharashtra.

Normal rainfall: Normal precipitation does not equal "what you should expect." "Normal" precipitation to a meteorologist is an average of the precipitation values over a 30-year period. (National Drought Mitigation Center, University of Nebraska). Rainfall deviation is one of the statistical techniques to measure variation in actual rainfall over a period. Rainfall deviation is calculated by formula, Rainfall Deviation = (Actual rainfall – Normal rainfall) / Normal Rainfall * 100.

STUDY AREA

Figure 2: Map of Maharashtra



(souce:https://www.mapsofindia.com/maps/maharashtra/maharashtraphysical.html)

Study area for this paper is Krishna River Basin of Satara, Sangli and Kolhapur district of Western (Paschim) Maharashtra, India. Maharashtra (coordinates 19.7515° N, 75.7139° E),

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one of the fastest developing state of India, located at west-central part, spread over 307,713 sqkm. which is best known for the financial capital of India i.e. Mumbai, Bollywood (film industry), Arabian Sea coast, Sahyadri (part of Western Ghats). [1,6,5]There are 5 natural divisions of Maharashtra. These are: i. Konkan ii. Paschim Maharashtra iii. Marathwada iv. Khandesh v. Vidharbha.

Topography: Presence of Western Ghats and Deccan Plateau is one of the most important topographical features of the Maharashtra. Part of the Western Ghats in Maharashtra is called as Sahyadri. Most of the part Western Maharashtra are located at the foothills of Sahyadri Range and some of are part of a Deccan Plateau.[2,8,9] Sangli, Satara, Kolhapur are one of the major districts of western Maharashtra and also a part of a Krishna River Basin.

River Basins: Krishna is the fourth largest river of India. These three districts of western Maharashtra region lies in Krishna river basin which includes tributaries like Bhima, Mulsi, Venna, Koyana, Panchganga, Tungbhadra.

Climate: Climate of this region is subtropical monsoon. Hot summer and chilly winters. Receives rainfall from southwest monsoon in month of June to September. This region experiences scanty rainfall of around 50 cm. Temperature of this place is dry and continental.

Land use: Land use pattern helps us to understand the anthropogenic interference in a region. In Satara, Sangli, and Kolhapur the area under sowing region is higher than urbanized area. Basically, agriculture is a major[112,8,] economic activity in this region. Influence of man in any region can be determined by the pattern of land use in that region.

Soil and Soil Slope: Soil profiles are necessary for understanding hydrological character of the basin. One can find laterite soil and black soil. Laterite soil is poor in organic matter and it is covered by forest land. Soil profile also determined the penetration level of water into the soil.

III. RAINFALL PATTERN

SATARA

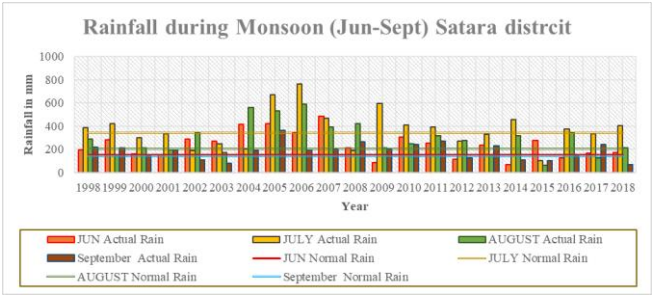

Fig 3.1: Month wise Seasonal (Monsoon) Rainfall in Satara District for year 1998-2018

If we calculate mean actual rainfall throughout the monsoon season during from 1998-2018, July (371.93 mm) month has received more actual rainfall followed by August (291.49 mm), June (238.84 mm), September (184.27 mm). The same sequence is for rainy days. July month has received rainfall more days (23.35 days) followed by August (21.1 days), June (15.95 days), and September (15.3 days).

Through this graph it can be analyzed that seasonal rainfall (June to September) in Satara district is above its normal limit i.e. 834.2 mm. Year 2003 (765.5 mm) and year 2015 (539.5 mm) has received rainfall less than normal. Year 2015 can be considered as a rainfall deficit year. And when we analyze the data of rainfall in a year, then along with 2003, and 2015, year 2000, 2012, 2017 have received actual rainfall less than normal.

SANGLI

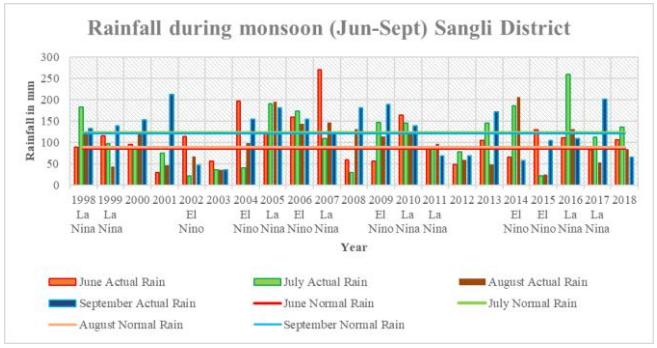

Figure 3.2: Month wise Seasonal (Monsoon) Rainfall in Sangli District for year 1998-2018

There is not much variation between rainfall for the month of June and August. Mean difference of normal rainfall between June and August is only 4.6 mm. With the mean difference of 1.2 mm, the difference between normal rainfall for month of July and August is lesser. Normal rainfall for month of September is second highest, but on an average this month has received actual rainfall only about 65.1 mm. Highest actual rainfall (on an average) has recorded for July (112.72 mm), followed by June (107.67 mm), August (99.1 mm) and the lowest is in September (65.1 mm). Though September has witnessed lowest mean actual rainfall, the number of rainy days is highest in this month, followed by July (11.45 days), June (10.32 days), and August (9.9 days). Seasonal rainfall is nothing but the mean rainfall for the month June to September i.e. monsoon season. Year 2005 (689.3 mm) has received highest seasonal rainfall followed by year 2007 (652.7 mm), 2006 (418.4 mm).

KOLHAPUR

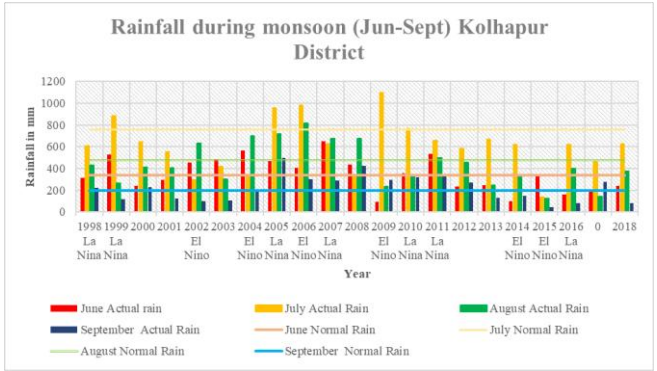

Figure 3.3: Month wise Seasonal (Monsoon) Rainfall in Kolhapur District for year 1998-2018

According to data above, if we calculate the mean, July month

(611.44 mm) has received more actual rainfall (on an average), followed August (436.77 mm), June (349.49 mm), September (217.6 mm). Mean of actual rainfall in the month of July and August is less than that of normal rainfall. Difference between actual and normal rainfall is huge for the month of July. At other side, month of June and September received actual rainfall more than normal rainfall. But the actual rainfall received for these two months (i.e. June and September) is more than the mean of actual rainfall of July and August. Though, July and August month has received more rainfall than June and September, but still it is lower than its normal limit, thus these months (July and August) can be considered as a rainfall deficit month. Number of rainy days follows the sequence of actual and normal rainfall. Thus, it can be concluded that number of rain days are directly proportional to rainfall received which is not seen with the case of other two previous districts.[11,6,9,4] Year 2005 (2639 mm) has witnessed highest rainfall during monsoon season followed by 2006 (2503.6 mm), 2007 (2234.7 mm). According to obtained data, it can be observed that seasonal rainfall is decreasing from last one decade. Year 2015 has recorded lowest actual seasonal rainfall (634.9 mm) which was the lowest in two decades which is 137.5 mm less than normal actual seasonal rainfall (1772.4 mm). Last decade has received less rainfall than decade of 1998-2008. From year 2012, this region has continuously witnessed less actual rainfall than normal seasonal rainfall.

IV. CONCLUSION

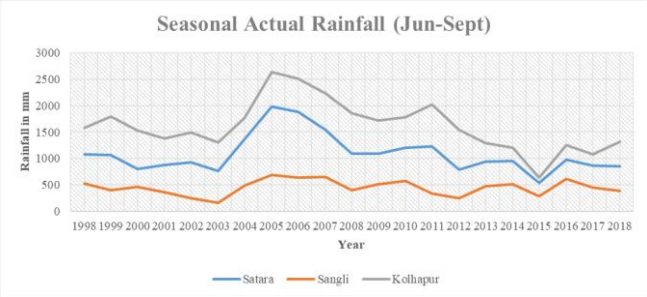

Figure 4.1: Seasonal Actual Rainfall for Satara, Sangli, and Kolhapur

By calculating the mean for all months of monsoon i.e. from June to September for all sample years i.e. from last 21 years i.e. from year 1998-2018, it can be observed that rainfall is higher in Kolhapur than other two districts, followed by Satara and Sangli. If we analyze the location of these three districts then from south to north it is Kolhapur, Sangli and Satara but the rainfall pattern from higher to low is Kolhapur, Satara and then Sangli. If we see the deviation in rainfall, we can further understand how much the rainfall is deviated from its normal limit. Rainfall deviation is one of the statistical techniques to measure an actual rainfall variation from time to time. Bar towards the negative deviation determines the rainfall deficiency, which further determines the intensity of drought conditions prevailing over an area. Rainfall deviation is calculated by following formula: Rainfall Deviation = (Actual rainfall – Normal rainfall) / Normal Rainfall * 100.

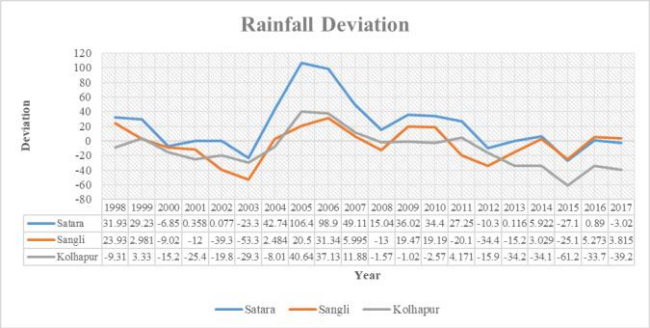

Figure 4.2 : Rainfall deviation from actual rainfall for Satara, Sangli, and Kolhapur

In Satara district of this region, rainfall is more fluctuated, followed by Sangli and Kolhapur, which is completely contrast with the amount of seasonal actual rainfall. Thus, for this region, relation between actual seasonal rainfall and rainfall deviation is inverse. But from year 2011, the deviation for Kolhapur district is cautiously falling, leading towards the sign of drought i.e. rainfall deficit, though the amount of actual rainfall is higher in Kolhapur in these years comparing to other two, the situation is quite alarming.

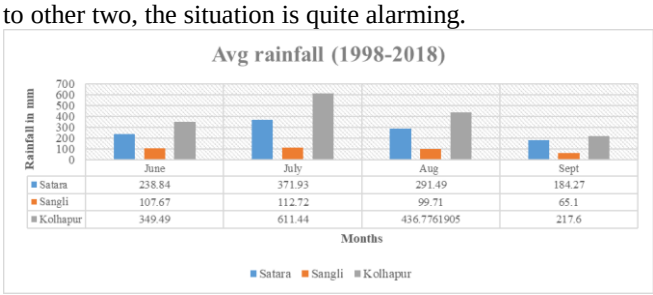

Figure 4.3: Average monthly rainfall during monsoon season for Satara, Sangli, and Kolhapur

Through this data, it can be observed that in all three-district rainfall in month of July is highest followed by August, June and September. Thus, the monthly seasonal rainfall pattern is similar in all three districts. Though, the pattern is similar, but the distribution of rainfall varies that too on larger extent. Kolhapur district receives higher rainfall than other two, followed by Satara and Sangli. The differences are much higher. Number of rain days are directly proportional to rainfall received which is not seen with other two previous districts.

Effect of variation in topography of western ghats is clearly seen for this region. For windward side, Narrower Western Ghats of Maharashtra results into less rainfall in Maharashtra, whereas Karnataka receives more rainfall. In contrast, leeward side of Maharashtra receives more rainfall than the leeward side of Karnataka. Narrower mountain range of Maharashtra allows moisture to pass through it resulting into well distribution of rainfall at both windward and leeward side. Whereas, broader mountain of Karnataka, creates hurdle, resulting into more rainfall at windward and less at leeward. Kolhapur district is adjacent to Karnataka; [11]thus, it acts as a transition zone for the changing topography of Western Ghats from Maharashtra to Karnataka i.e.

from narrower to broader. That is why, Kolhapur receives higher rainfall than Satara and Sangli. Sangli is located at inner margin as compare to other two, thus the rainfall here is less than Satara and Kolhapur. Even changing nature of slope affects the orographic rainfall. Gentle slope results into the higher rainfall, where as steep slope results into less rainfall.

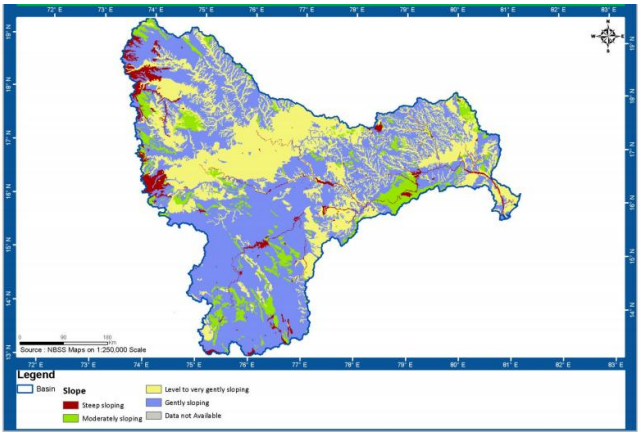

Figure 4.4: Map of Krishna Basin Soil Slope
Source:
http://www.india-wris.nrsc.gov.in/Publications/BasinReports/Krishna%20Basin.pdf

When slope is gradual, air parcel retains its energy and move further for a longer time. Enough vertical motion because of these gradual slops of ghats in Kolhapur, helps cloud droplets to grow by collision-coalescence process and further results into precipitation. For greater convection greater area for sunlight absorption is provided by gentle slope of Kolhapur as compared to an abrupt and steepy slope of Ghats in Satara and Sangli. which results into higher precipitation in Kolhapur than Satara and Sangli.

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