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Research Paper
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A Geographical Study of Pre and Retreating Monsoon Pattern – A Case of Selected Region of Sahyadri (Western Maharashtra).

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Abstract
According to International Labor Organization, rainfall plays a very important role in the overall development of a country like India where the agriculture workforce includes more than 50% of the population, of 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 and to mitigate agricultural hazards from pre-monsoon and returning monsoon. This paper is an evaluation of pre-monsoon and returning monsoon rainfall patterns for three districts in the state of Maharashtra in India which are adjoin to the Western Ghats which are known as Sahyadri. Variation in rainfall can be clearly observed through these districts belonging to the same natural division.

Introduction

Physiography of the region is one of the various factors that affect the rainfall pattern of a region. Based on 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 the same physiography. In Satara, Sangli, and Kolhapur, the area under sowing is higher than urbanized areas. Because of having an agro-based economy, which is largely dependent on monsoon, any changes in rainfall pattern will ruin the agricultural conditions, that is why understanding the pre-monsoon rainfall pattern is important as it can be helpful to mitigate the agricultural hazard. Pre-monsoon rainfall is known for its different local names such as Tea showers in Assam, Mango Showers in Kerala, and coastal area of Karnataka, Cherry blossom or coffee showers in Kerala, Loo in Northern India Climate variability refers to short term variation in climate. Climatic fluctuation associated with El Nino Southern Oscillation, La Nina, Indian Ocean Dipole can be studied under the climate variability. Anomalous changes in atmospheric pressure and summer rainfall are climate variability. The present paper analyzes the temporal changes and spatial variations in this climate variability i.e. of pre-monsoon as well as re-treating rainfall to understand whether it is similar or vary among these three districts which belong to the same physiographic division.

Study Area:

This paper includes the study of rainfall pattern in western maharashtra, Krishna River Basin of Satara, Sangli, and Kolhapur district of Western Maharashtra, India. Maharashtra (coordinates 19.75° N, 75.7139° E), which is one of the fastest developing states of India, located at west-central part, spread over 307,713 sqkm. There are 5 natural divisions of Maharashtra. These are i. Konkan ii. Paschim Maharashtra iii. Marathwada iv. Khandesh v. Vidharbha.

Objectives:

1. To find out the changing pattern of pre and retreating monsoon.
2. To study the impact of the rainfall on human activity.

Database And Methodology

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

Normal rainfall: Normal precipitation does not equal "what you should expect." "Normal" precipitation to a meteorologist is an average of the precipitation values over 30 years. (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 the formula, *Rainfall Deviation = (Actual rainfall – Normal rainfall) / Normal Rainfall * 100.*

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Topography: The topography of Maharashtra is all about western Ghats, Deccan Plateau, and the Western Coastal planes. The Western Ghats are known as Sahyadri in Maharashtra. Most of the parts of Western Maharashtra are located at the foothills of the Sahyadri Range and some are part of a Deccan Plateau. Sangli, Satara, Kolhapur are part of a Krishna river basin, which is also one of the major districts of western Maharashtra.

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

Climate: As it is having subtropical monsoon, hot summer and chilly winters can be observed. This study area receives rainfall from the southwest monsoon from June to September. This region experiences scanty rainfall of around 50 cm. The temperature of this place is dry and continental.

Satara:

The only year 2004 (83.4 mm) and 2006 (87.6 mm) has recorded higher actual rainfall in May. 1998 (45.5 mm) and 2015 (42.6 mm) has recorded actual rainfall at around the normal rainfall (93.2 mm). Other years have received rainfall less than normal. An interesting observation is, the year 2015 even after being recorded as an El Nino year, has received more rainfall in May. The same interesting observation is for the years 2004 (83.4 mm) and 2006. Both years have been witnessed El Nino, but the rainfall in May is the highest during this time. On the other side when the year 2005 witnessed La Nina, there is no rainfall this year.

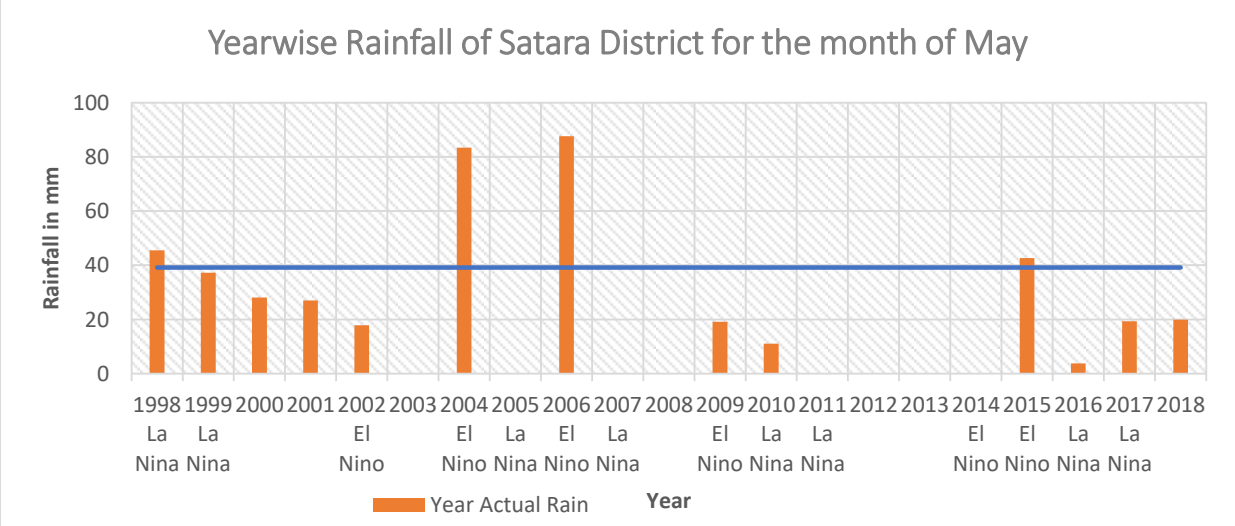

Fig 1 : Year wise Rainfall of Satara districtfor year 1998 - 2018

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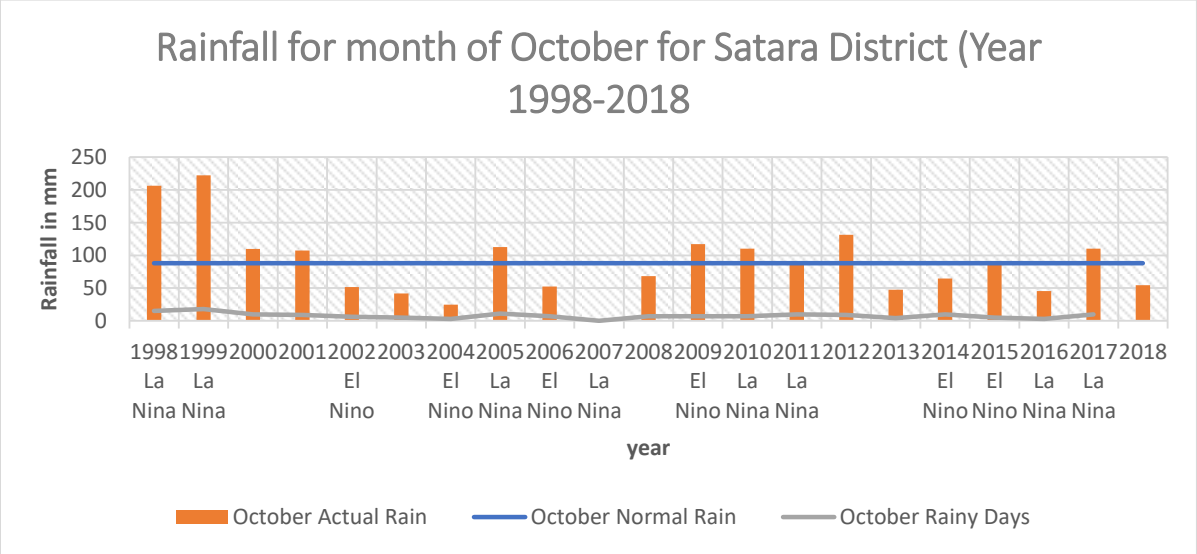

Fig 2 : Year wise Retreating Rainfall of Satara districtfor year 1998 – 2018

Higher rainfall in October in the year 1998 (206.1 mm) and 1999 (202.2 mm) can be related to the La Nina. The year 2015 was recorded the lowest annual and seasonal rainfall in the last two decades but still, the rainfall in October in this year had very less deviation. The year 2004, 2005, 2006, and 2007 were having higher rainfall during monsoon months, and even in May, but these years have recorded less rainfall in October.

Sangli:

This graph of rainfall of Sangli district for May for the year 1998-2018 shows that year 2004 has received highest rainfall i.e. 101.4 mm in last 2 decades followed by the year 2006 (89.7 mm). Normal rainfall for this region for this month is considered as 43.2 mm. The only year 2004, 2006, 2015 (58 mm), 2009 (46.8 mm), 1999 (45.5 mm) has received rainfall above normal. Other 15 years have received less than normal rainfall in this month in Sangli.

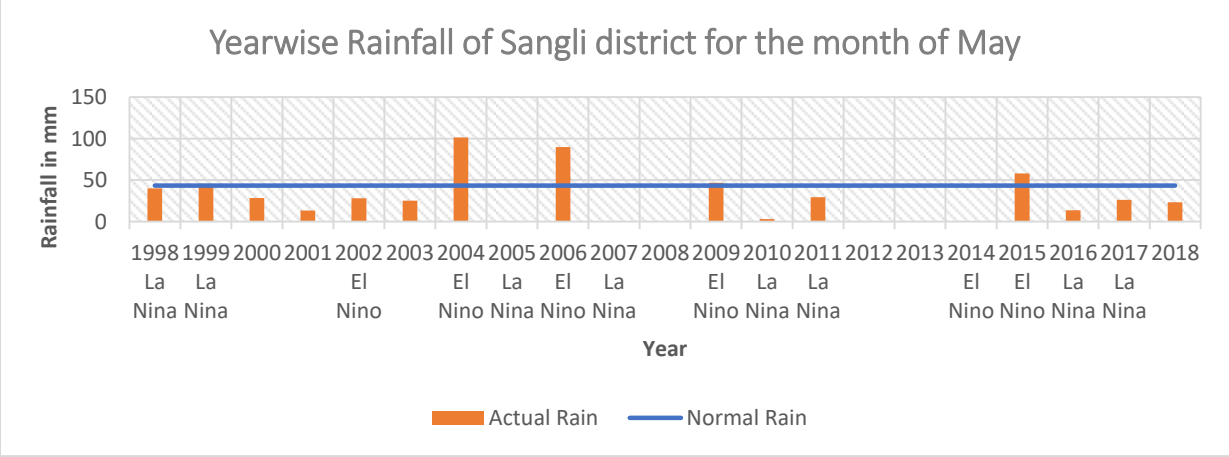

Fig 3: Pre-Monsoon Rainfall (May) in Sangli District from year 1998-2018

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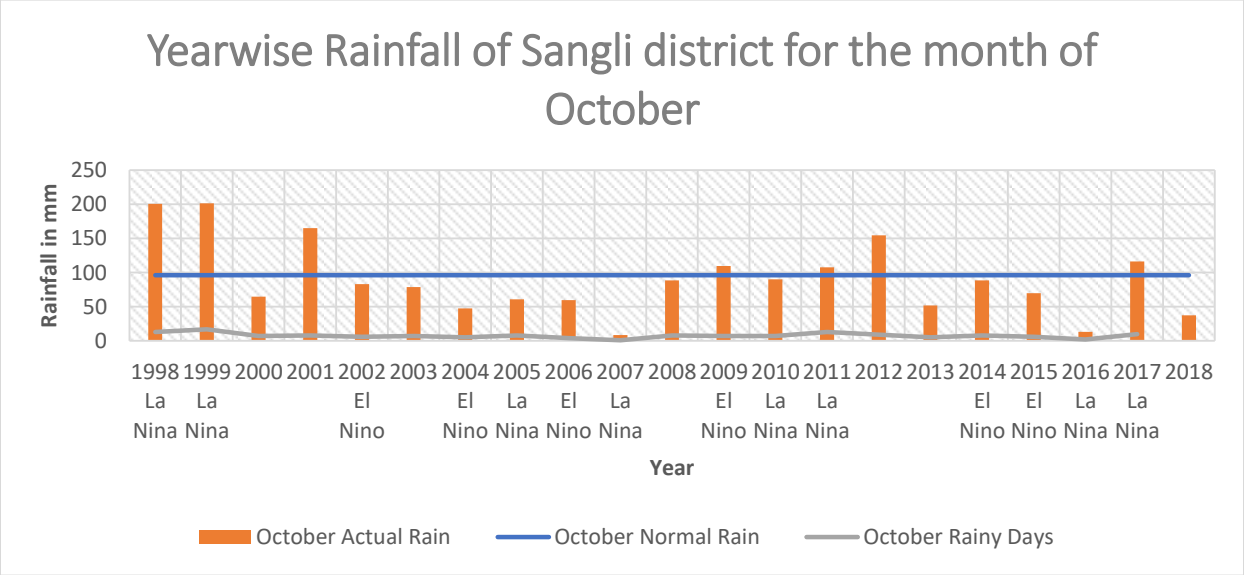

Fig 4: retreating monsoon i.e. October Rainfall in Sangli District from year 1998-2018

Rainfall in October in Sangli district has followed the same pattern as of Satara. The year 2007 was recorded La Nina, but rainfall was less in October. The year 1999 (201.4 mm), and 1998 (200.6 mm) was received higher rainfall in October and both were La Nina years, whereas the years 2007 and 2016 had the lowest rainfall in this month even after being recorded as La Nina year.

Kolhapur:

From this graph, it can be observed the pre-monsoon rainfall of Kolhapur from year 1998-to 2018. Normal rainfall during this period is 70 mm. Even during El Nino, the Year 2006 has witnessed very high rainfall (195.4 mm) during this month which is nearby to the normal rainfall of September. The year 2006 and 1999 (100.5 mm) has received rainfall higher than normal

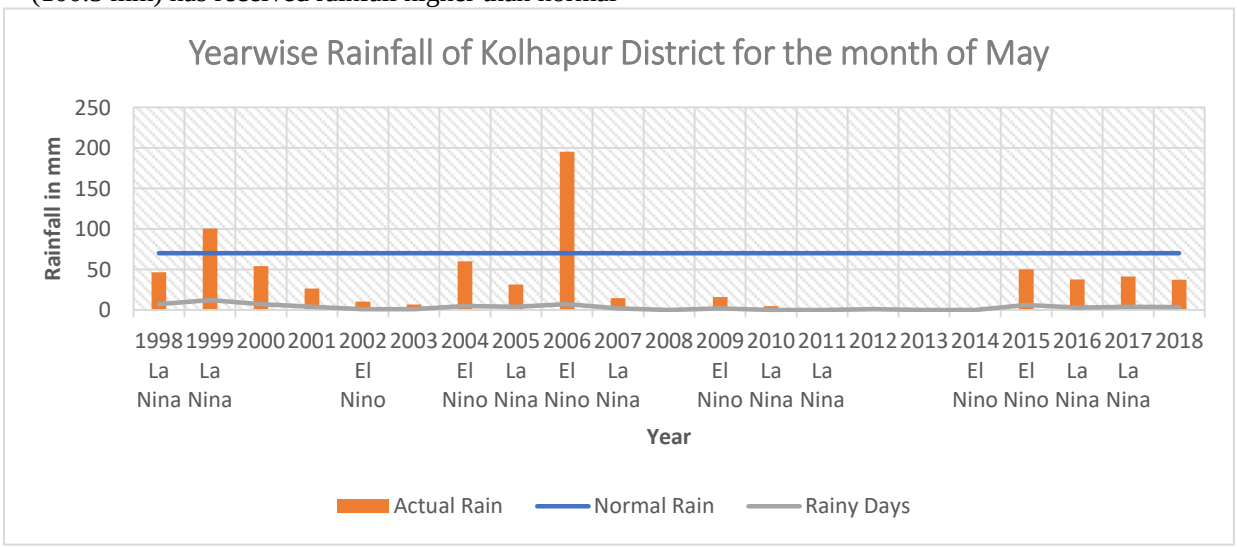

Fig 5: Pre-monsoon Rainfall (May) in Kolhapur District from year 1998-2018

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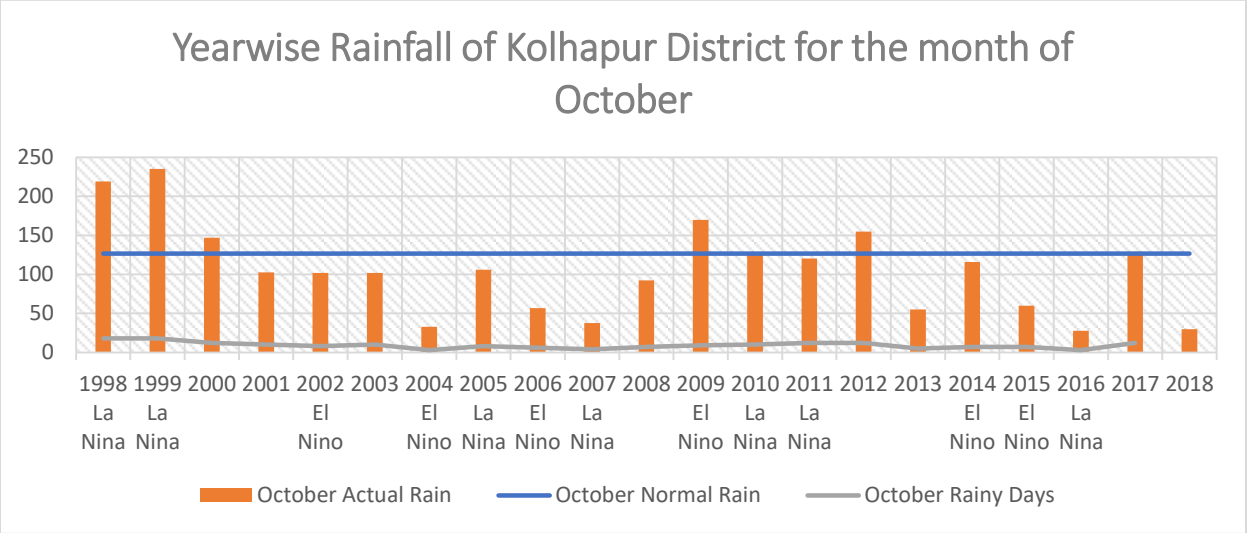


Fig 6: Retreating monsoon i.e. October Rainfall in Kolhapur District from year 1998-2018

In a Kolhapur district, the intensity of the retreating monsoon is more than the other two i.e. Satara and Sangli. The impact of La Nina can be seen in the years 1998 and 1999. The year 2009 has witnessed higher actual rainfall in October even it has been recorded as an El Nino year. The year 2014-15 were recorded 2 consecutive years as a drought year and both were recorded El Nino but the rainfall in October during these years was higher than some other years which have recorded La Nina before and after. Hence, it has been proved once again that the impact of La Nina and El Nino is less in this region.

The result has been analyzed to reach certain conclusions and to give an effective solution to the problem

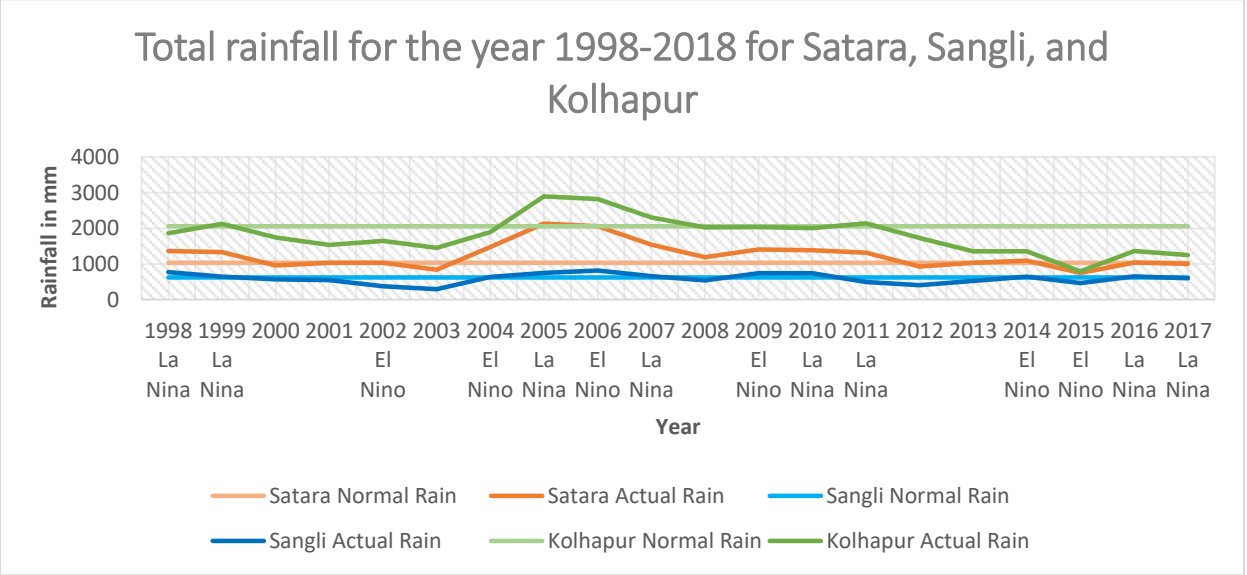


Fig 7: Total rainfall for the year 1998-2018

Through this graph, one can observe that the rainfall difference in these three districts is huge. Normal rainfall is higher in Kolhapur (1033.4 mm), followed by Satara (1033.4 mm), and Sangli (623.9 mm), Same difference is seen in between actual rainfall. The highest is in Kolhapur followed by Satara and Sangli. The location of Sangli is the reason for its low rainfall. Among these three districts, Sangli is towards the east, and Satara and Kolhapur are towards the west. Thus, the impact of rain shadow plays a very vital role in the Sangli district. Higher rainfall in Kolhapur than Satara is because of its short distance from Karnataka. Kolhapur shares it with Karnataka. In Karnataka western Ghats are broader but discontinuous resulting in the prolonged

and higher rainfall in the region of the eastern margin of western Ghats of that region as discontinuity helps the clouds to pass through mountains rather than blocking it.

Conclusion:

The highest seasonal rainfall, as well as annual rainfall, is observed in Kolhapur followed by Satara and Sangli. The same pattern can be seen for Pre-monsoon showers as well as retreating monsoon. But in 2019, in which these three districts experienced heavy floods, rainfall was more than normal as well as the average of the last 21 years. If rainfall is 10% less than normal and covers an area of about 20-40%, it is called Deficient Year and when it covers more than 40% of an area, it is called Severe Drought Year which was previously known as All India Drought Year. By calculating the Rainfall deviation of the respective region, we can understand the flood and drought cycle in that region. *Rainfall deviation* is the expression of actual rainfall in percentage deviation from normal rainfall. Normal rainfall is simply a long period average of the actual rainfall. Hence, it can be observed that though these three districts belong to the same natural division, still there is a rainfall variation during pre-monsoon and re-treating monsoon.

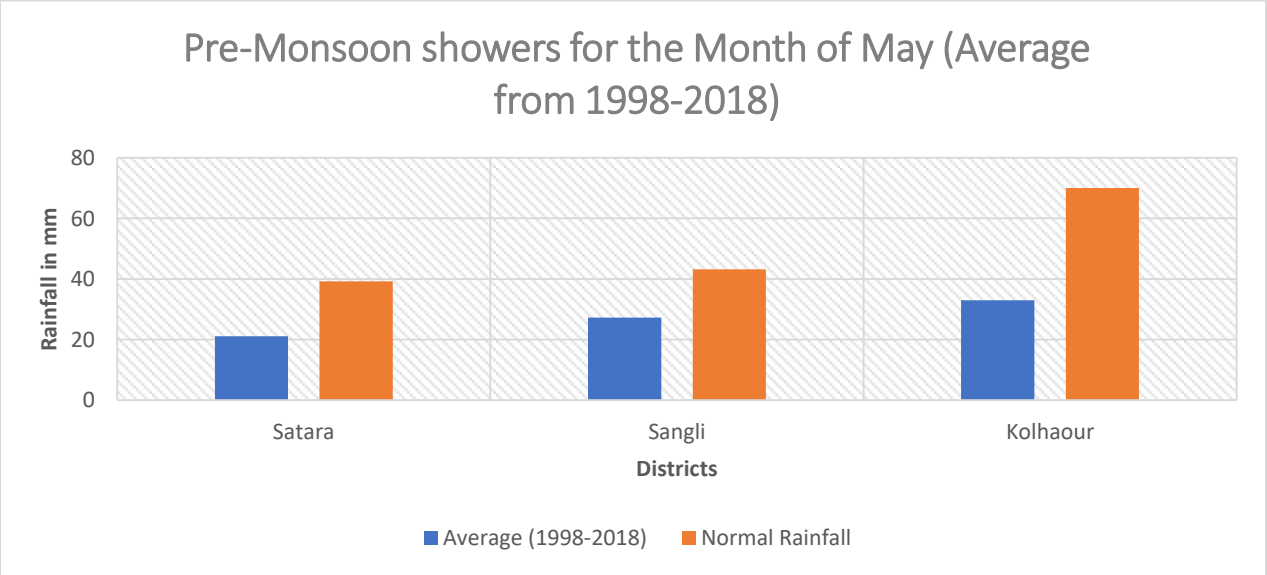


Fig 9 : Pre-monsoon showers for May (Avg 1998-2018)

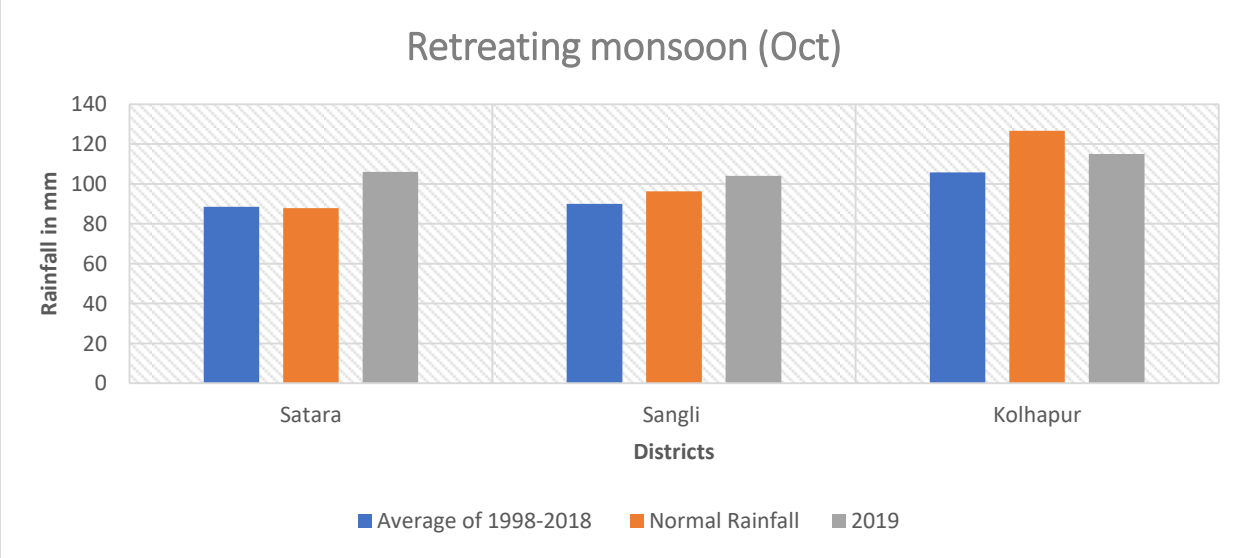
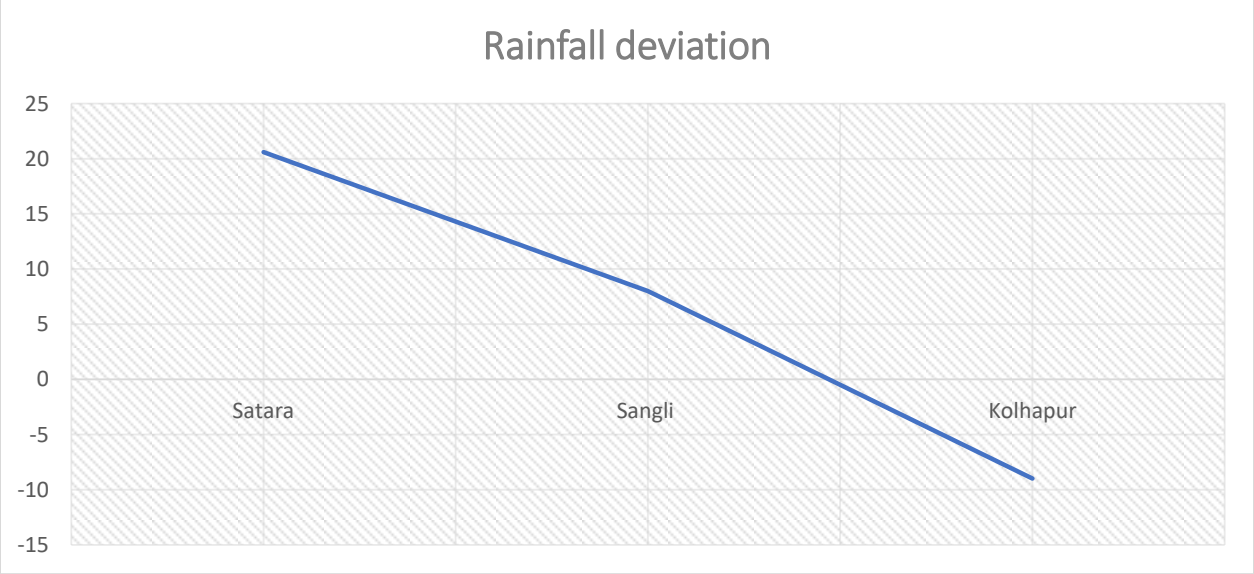


Fig 9 : Re-treating monsoon for Oct (Avg 1998-2018)



Satara and Sangli have witnessed deviation of 20.59 % and 7.99 % respectively. Kolhapur has witnessed a negative deviation of 9% in Oct month. Huge positive deviation in Satara and Sangli resulted in heavy floods. Thus, these three districts not only received heavy showers during the monsoon season but also re-treating monsoon in Oct resulted in heavy rainfall. Satara was the lowest rainfall received among these three districts, but deviation was much in Satara in comparison to the other two i.e. 20.59%. Though the rainfall Satara received is less than the other two districts, because of the more deviation than the other two, Satara can be classified as a heavy flood-prone area based on meteorological data. Based on, impact analysis, the results might change, because impact analyzes are mostly depended on the mitigation capacity of any region. Thus, there is a scope of research for impact analysis i.e. empirical studies to understand and compare the actual impacts of floods in these three districts which belong to the same natural division. Meteorological variation is seen among these three districts, hence empirical variations should be combined for further analysis.

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