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Rainfall Trends And Variability Analysis of Southern Pune District In India

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Abstract

Climate variability and change are among the major environmental challenges of the 21st century. Rainfall and temperature are often used as important climate parameters to determine the changes in global climate. The trend analysis of rainfall, temperature and other climatic variables on different spatial scales will help in the construction of future climate scenarios. The variability of rainfall influences the agricultural operations, cropping pattern, irrigation and productivity are related to variability of rainfall. Therefore, an attempt is made here to study rainfall trends, intensity, and variability of rainfall in the Southern Pune district. The paper is based on secondary data source. To find out trend in rainfall, statistical techniques that is coefficient of correlation and Regression Equation is used. The term intensity of rainfall is used in the context of rainfall received during 24 hours period. The study shows both positive and negative trends of rainfall during the period of 1991 to 2014. The district as whole has over 33 per cent of rainfall variability, so agriculture without irrigation in the region becomes uneconomic.

Key wards: Rainfall, trend, variability, intensity.

Introduction:

Climate variability and change are among the major environmental challenges of the 21st century (Perry et al., 2007). Temperature, rainfall, evaporation, vegetation, crops, cropping pattern, extreme events like flood and droughts are prime indicators of the climate changes. These are the greatest challenges to recognize and understand climate change. Spatial variation in climate may be enormous in different areas. Climatic changes affect agricultural to a great degree, which is main economic activity of more than half of Indian population.

Rainfall and temperature are often used as important climate parameters to determine the changes in global climate (reference). According to the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) (IPCC 2014), water resource has become a prime concern for any development and planning including food production, flood control and effective water resource management. Studies have demonstrated that global surface warming is occurring at a rate of 0.74 ± 0.18 °C over 1906–2005 (IPCC, 2007). Various researchers have contributed to the study of climate change (Dessens and Bucher, 1995; Serra et al., 2001; Marengo, 2004) with long term data. Study of different time series data have proved that trend is either decreasing or increasing, both in case of temperature and rainfall. Human interference is also leading to climate change with changing landuse from the impact of agricultural and irrigation practices (Kalnay and Cai, 2003) (not clear, reframe the sentence).

The trend analysis of rainfall, temperature and other climatic variables on different spatial scales will help in the construction of future climate scenarios (Arijit Ganguly, et al, 2015). Since average annual precipitation in the area is lesser than the overall country precipitation, any rise or fall in trend will have significant impact on watershed management (Agnieszka Rutkowska, 2013). Any rise or fall in annual rainfall in the area leads to stress on annual average stream flow with consequent implications in planning and designing of water resources development projects (A. Serrano, V. L. Mateos et al, 1998). Changes in temperature will impact the various hydrological processes such as rainfall and their sequences (Basistha A, Arya D.S. et al 2008). “There are various methods used to identify hydrometeorological time series” (Duhan and Pandey, 2013). “Trend analysis of rainfall time series includes determination of increasing and decreasing trend and magnitude of trend and its statistical significance" (Jain and Kumar, 2012) by using parametric and non-parametric statistical methods.

The term intensity of rainfall is used in the context of rainfall received during 24 hours' period. It is important as it determines the intensity of soil erosion. More ever the intensity of rainfall determines the water regime and thereby irrigation potentials of the region. In other words, higher the intensity of rainfall higher is the degree of erosion, lower is the water regime and irrigation potentials, and vice versa (Nanaware A.H., 2007).

The variability of rainfall influences the agricultural operations, cropping pattern, irrigation and productivity. Variability of rainfall increases with decreasing mean annual rainfall. Variability in excess of 20 per cent implies great risk to farming (Williamson, 1925). In view of the above, an attempt is made here to study rainfall trends, intensity and variability of rainfall in the Southern Pune district.

The study region:

The study region is the southern part of Pune district in Maharashtra state of India (Fig. 1). Pune district is situated in western part of Maharashtra state in India. The absolute location of the district is in between 17 degree 54' and 19 degree 22' North latitude and 73 degree 24' and 75 degree 14' East longitudes. The geographical area of the Pune district is 15642 Sq. kilometers. It is bounded by Thane district to the Northwest, Raigad district to the West, Satara district to South, Solapur district to the Southeast and Ahmednagar district to the North and Northeast. Pune district lies in the Western Ghats or Sahyadri mountains range and it extend on the Deccan Plateau on the east. The shape of district is triangle with its base in the mountains on the west and its apex in the extreme Southeast corner near the point of confluence of the Bhima and Nira rivers (Gazetteer of the Maharashtra). Pune district receive 600 to 700 mm annual average rainfall. This is usually during the monsoon from July to September. The temperature ranges from 20^{o} to 38^{o} celsius in summer. In the winter season the temperature ranges from 9^{o} to14^{o} celsius. Sometimes lowers up to 3^{o} Celsius. The district has four types of soil i.e. shallw soil, medium soil, medium deep soil, and deep soil.

Administratively the Pune district is divided in 14 tahsils. These tahsils are Junnar, Ambegaon, Maval, Khed, Mulshi, Velhe, Bhor, Haveli, Purandar, Pune city, Indapur, Daund, Baramati and Shirur. Present study region is the southern part of Pune district and it includes eight tahsils. These are Mulshi, Velhe, Bhor, Haveli, Purandar, Indapur, Daund and Baramati tahsils. The geographical area of southern Pune tehils is 9011 sq. kilometer. The Population of southern Pune district is 4276157 according to 2011census.

Objectives:

1. The main objective of the present study is to analyze trends of rainfall in South Pune district.
2. To study of rainfall intensity and variability in South Pune district.

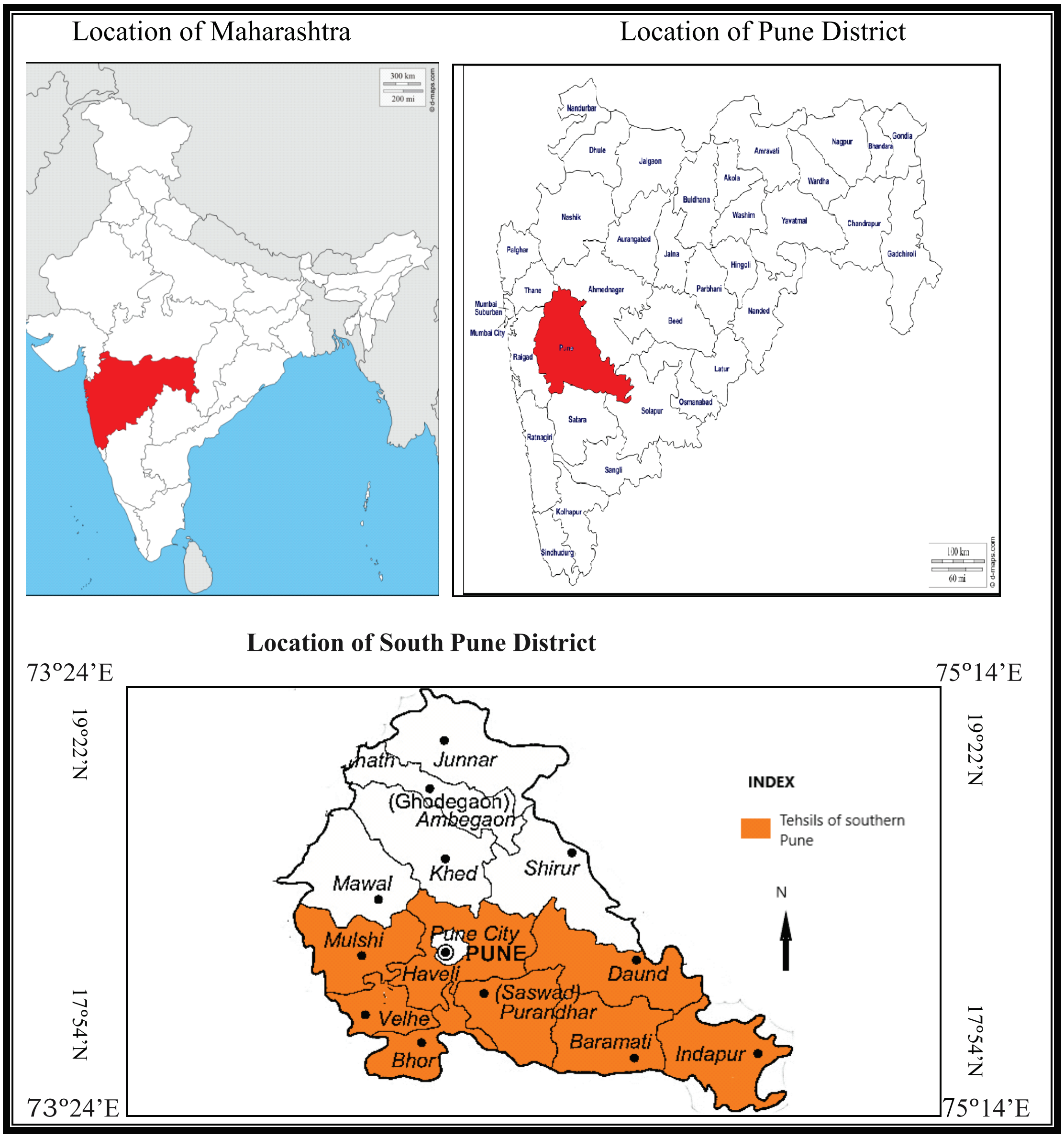
Data collection and Methodology:

To fulfill the objectives, data regarding rainfall is obtained from Socio Economic Review and District Statistical Abstract of Pune District for the period of 1991 to 2014. Other information is collected from Gazetteer of Pune district. The collected data is processed and (??). To find out trend in rainfall, statistical techniques that is coefficient of correlation and Regression Equation that is Y= a + bx is used. For this calculation computer work in excel is done. On the basis of statistical techniques the result and conclusions are drawn. Rainfall variability is measured by the co-efficient of variation of average rainfall of 31 years. The higher the co-efficient of variability, the lower is the assurance of rainfall. The Co-efficient of rainfall variability is calculated by the following formula.

$$\text{Co-efficient of Rainfall variability} = \frac{S.D}{\overline{X}} \times 100$$

Where, S.D = Standard Deviation

X = the arithmetic mean of rainfall during the 31 years



Result and Discussion:

1. Rainfall trend: The table No. 1 and figure no. 2 indicate that region as a whole has negative trend of rainfall in South Pune district. the co-efficient of correlation in this regard is i.e.s 'r' value is -0.0188 which reveals light negative trend. Co-efficient of determination in this regard is 0.00035 percent. Regression Coefficient indicates that an increase of one year period causes decrease of rainfall by 6.43 MM. during the period of investigation.

Table No. 1: Trends in rainfall of South Pune District.

Tahsil	Trends in Rainfall duing 1991-2014		
	R	r2	Y= a+bx
Bhor	0.005297952	3.00E-05	y = 0.0249x + 704.7
Baramati	0.019210189	0.000369031	y = 0.681x - 854.5
Haveli	0.033342782	0.001111741	y = 1.160x - 1545.
Indapur	-0.040816545	0.00166599	y = -1.361x + 3268.
Mulshi	0.183133167	0.033537757	y = 12.51x - 23357
Daund	-0.144765485	0.020957046	y = -3.518x + 7537
Purandar	-0.360727556	0.13012437	y = -17.07x + 34898
Velhe	0.005986705	3.58406E-05	y = 0.911x + 746.1
Region	-0.018871058	0.000356117	y = -6.438x + 21399

Source: Compiled by Researcher on the basis of Socio-economic Review and District Statistical Abstract of Pune District (1990-2014)

Table No.1 and figure 3 shows that tahsil wise trends in rainfall. Both the positive and negative trends of rainfall are found during the period of 1991 to 2014. The tahsils of Bhor, Baramati, Haveli, Mulshi and Velhe shows light positive trend of rainfall. Among these Mulshi tahsils shows highest positive trend, which is amounted to +0.1831 'r' value and 0.03353 'r2' value. The 'b ' Coefficient indicates that an increase of one year period causes and increase of rainfall by 12.51 MM. While lowest positive trend is found in Bhor tahsil, which is amounted by + 0.0529 'r' value. Regression equation indicates that increase of one year period causes and an increase rainfall by 0.0249 MM. per year. The tahsils of Baramati, Haveli, Velhe and Bhor also shows positive trend of rainfall during the period of investigation, 'r' value in this regard is 0.0192, 0.0333, 0.0059 and 0.0052 respectively.

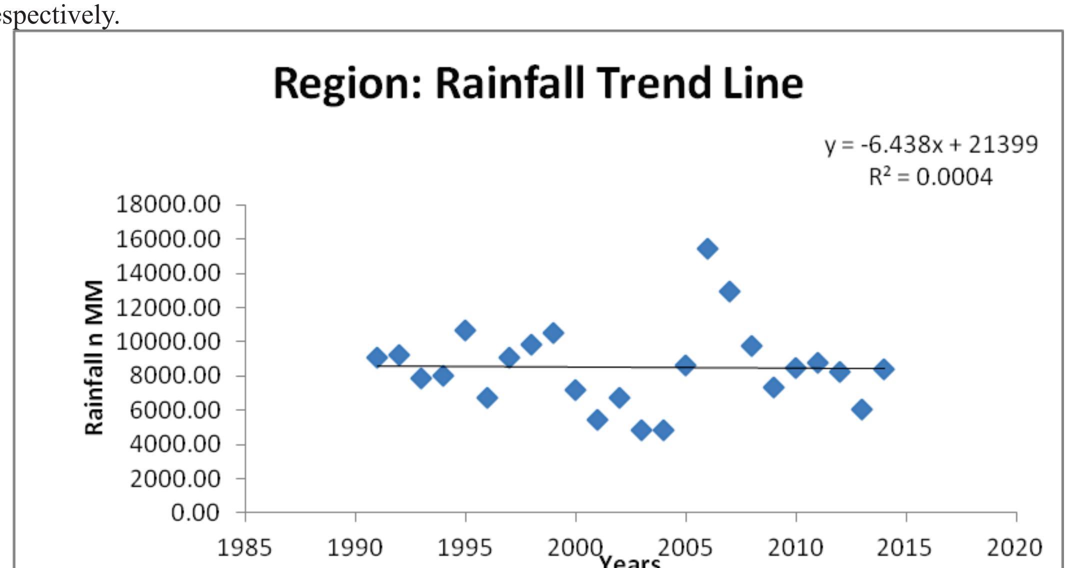
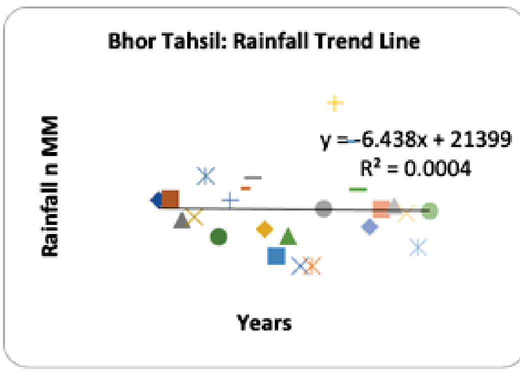
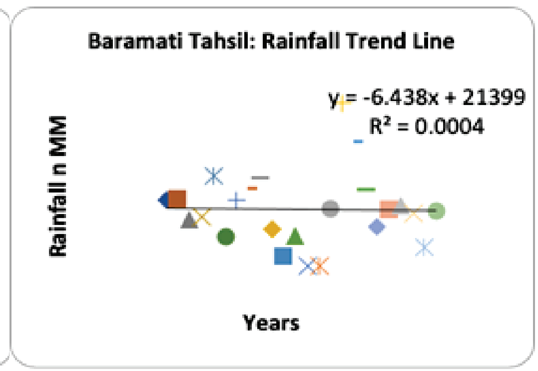
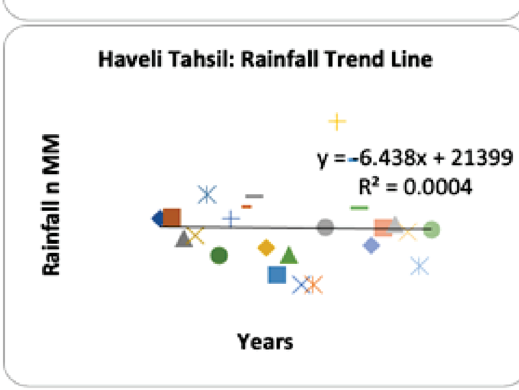


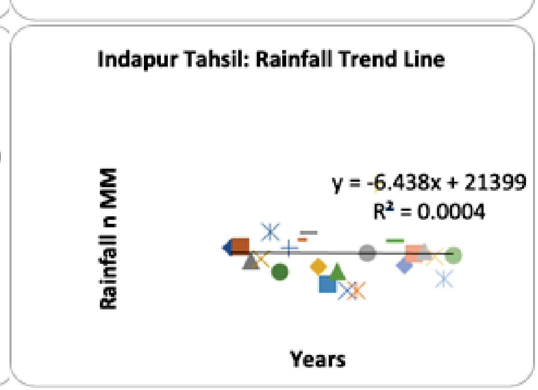
Fig. No. 2

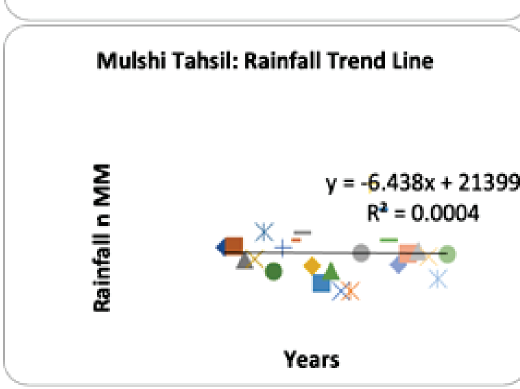
The tahsil of Purandar, Daund and Indapur shows negative trend of rainfall. The highest negative trend of rainfall is found in Purandar tahsil. The 'r' value in this regard is -0.3607 and 'r2' value is 0.1301. The regression equation in this regard is Y = 34898 + (-17.07). The b Coefficient indicates that increase of one year time period causes decrease of rainfall by 17.07 MM. The lowest negative trend of rainfall is recorded in the Indapur tahsil. The Co-efficient of correlation in this regard is -0.0408 and the coefficient of determination is 0.0016. Regression equation in this regard is Y = 3268 + (-1.361). The b Co-efficient indicates that an increase of one year period causes decrease of rainfall by 1.361 MM. Daund tahsil also shows negative trend of rainfall during the span of 24 years. The 'r' value in this regard is -0.1447 and 'r2' value is 0.02095. The coefficient of determination indicates that the influence of time period on rainfall is 2.09 percent. The regression equation in this regard is Y=7537 + (-3.518). The coefficient b indicates that increase of one year time period causes decrease of rainfall by 3.518 MM.

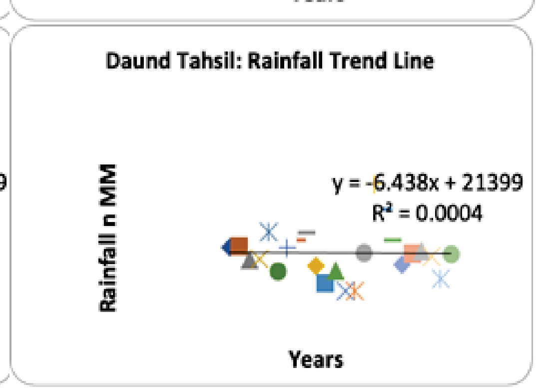












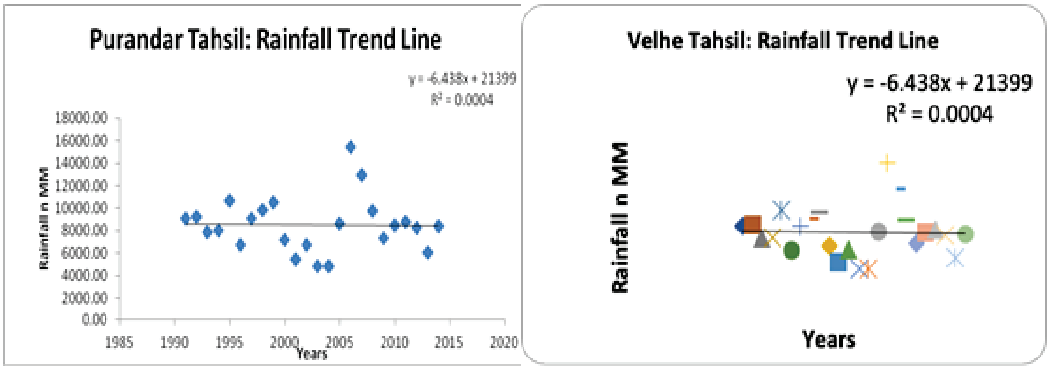


Fig.no.3

Intensity of Rainfall:

The South pune district as a whole has 20.21 intensity of rainfall, but the spatial distribution of intensity of rainfall varies from tahsil to tahsil. The low intensity of rainfall i.e. < 21 is found in Bhor, Baramati, Haveli, Indapur and Daund tahsils. The moderate intensity of rainfall is observed in Mulshi and Purandar tahsils i.e.21 to 25, whereas it is high only in Velhe tahsil i.e. > 25.

Table No.2 Intensity of Rainfall and Co-efficient of rainfall variability (1990-2014)

Sr. No.	Tahsils	Average Annual Rainfall (in m. m.)	Rainy Days	Intensity Of Rainfall	Co-efficient of Rainfall Variability (in %)
1	Bhor	1204.14	65.00	18.53	27.64
2	Baramati	541.24	29.00	18.66	42.63
3	Haveli	778.96	47.63	16.36	31.60
4	Indapur	541.08	30.71	17.62	43.60
5	Mulshi	1666.31	73.04	22.81	25.01
6	Daund	491.64	29.33	16.76	34.96
7	Purandar	879.58	40.92	21.50	35.05
8	Velhe	2520.08	85.64	29.43	25.96
	Region	1077.88	50.16	20.21	33.31

Source: Compiled by Researcher on the basis of Socio-economic Review and District Statistical Abstract of Pune District (1990-2014)

3. Rainfall Variability:

The table No.2 and Fig. no. 2 show that the spatial pattern of average rainfall variability in the region. The district as a whole has 33.31 percent rainfall variability but the spatial distribution varies from tahsil to tahsil. The low rainfall variability is observed in Bhor, Velhe and Mulshi tahsils i.e. < 31.21 percent due to their location in western ghat. It is moderate in Haveli, Daund and Purandar tahsils i.e. 31.21 to 37.41, whereas it is high in Baramati and Indapur tahsils i.e. > 35 percent as they are situated in draught prone area.

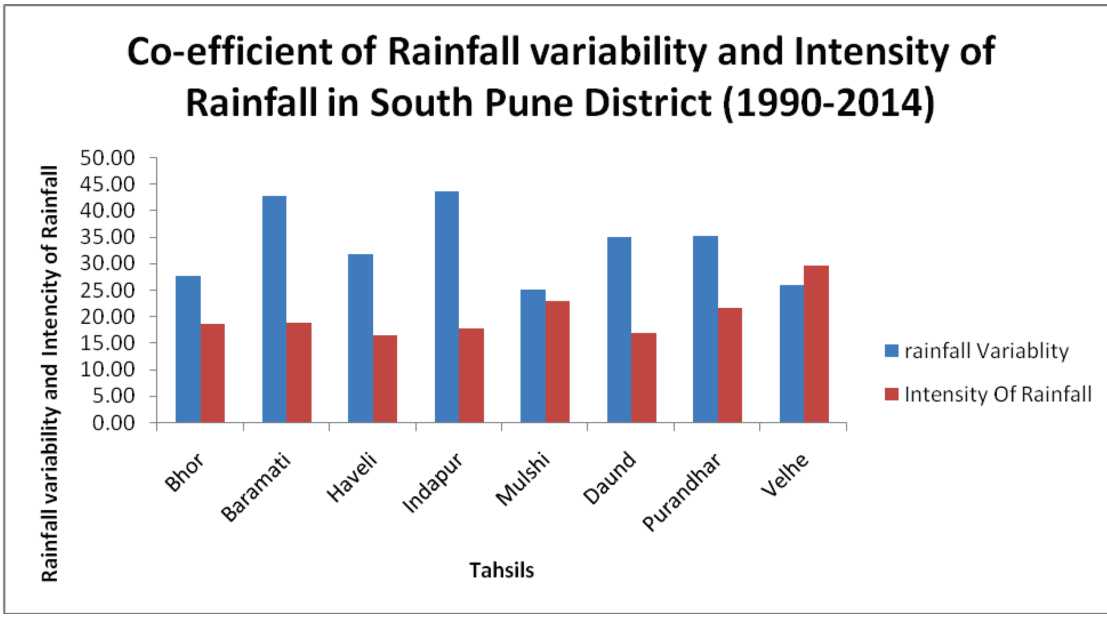


Fig.no.4

Generally, rainfall variability increases from west to east in the study region. Therefore, rainfall reliability is low in western part in relation to Eastern part of the region. District as whole has over 33 per cent of rainfall variability, so agriculture without irrigation in the region becomes uneconomic.

Conclusion:

The study reveals that the region as a whole has marginal negative trend of rainfall in South Pune district, which indicates gradual change in climate due to human interfere in environment. The tahsils of Bhor, Baramati, Haveli, Mulshi and Velhe shows light positive trend of rainfall, where as the tahsil of Purandar, Daund and Indapur shows negative trend of rainfall as they are suited in rain shadow region. The high intensity of rainfall in Velhe tahsil indicates more attention should be paid on soil conservation wok. The study also reveals that the district as whole has over 33 per cent of rainfall variability, so agriculture without irrigation in the region becomes uneconomic.

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