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A STUDY TRENDS OF RAINFALL PATTERN OF MAHARASHTRA STATE BASED ON STATISTICAL TOOLS

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ABSTRACT

Rainfall is an important factor that needs serious attention as Indian agriculture is drastically affected due to change in rainfall pattern. Understanding of rainfall trend is an important tool for future of agriculture. In the present study we see the rain fall is uniformly distributed over the geographical region of Maharashtra state and regression analysis used for the predication model . our study shows rain fall is not uniformly spread over the geographical region of Maharashtra state and the slope parameter estimate regression model in the predication model play an vital role for future prediction of future rain fall.

KEY WORDS: *Graphical Representation, Small Test, Regression analysis , Level of significance.*

INTRODUCTION

The rainfall received in an area is one of the determining factors for the socio-economic activities including agriculture, forestry and bio-diversity, water resources management, industry and tourism of the region. The changes in rainfall pattern may cause heavy floods in some areas while other areas may experience frequent droughts (IPCC, 2007). Due to the possible effects of climate change on rainfall pattern, analysis of rainfall characteristics and its long term variability has got special attention worldwide in recent years. Trend analysis of rainfall is the primary tool to understand its temporal variations. There are several studies in India on the rainfall variability and long term trends (Parthasarathy and Dhar, 1975; Mooley and Parthasarathy, 1984; Sarkar and Thapliyal, 1988; Soman et al., 1988; Thapliyal and Kulshresthra, 1991; Guhathakurta and Rajeevan, 2008; Krishnakumar et al., 2009; Kumar et al., 2010; Bhatla and Tripathi, 2014). Most of these studies investigated the trends in annual and seasonal rainfall series on the country scale or in regional scales. Studies of Mooley and Parthasarathy (1984), Sarkar and Thapliyal (1988), and Thapliyal and Kulshresthra (1991) have concluded that there is no significant trend in average annual rainfall of the country. Kumar et al. (2010) have reported no significant trend for annual, seasonal and monthly rainfall over India. Similarly, there are studies those focused mainly on the trends in intensity of daily rainfall. For example, Rakhecha and Soman (1994), Sen Roy and Balling (2004), Joshi and Rajeevan (2006), Goswami et al. (2006) and Guhathakurta et al. (2010) have studied the trend in extreme rainfall

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over India. On the other hand, there are only a few studies (Deka et al., 2013; Jain et al., 2013; Das et al., 2011; Das and Goswami, 2003) available on the rainfall variability and trends over northeast India. They have concluded that there is no significant trend in annual rainfall for northeast region whereas Rupa Kumar et al. (1992) have reported a decreasing trend in monsoon rainfall over this region. Geographical location of Maharashtra is such that it is subjected to different types of climatic features. Due to varied topographical climatologically features , India Meteorological Departments divided the state into five meteorological sub divisions .The meteorological subdivisions Konkan is to the extreme west coast of India .Due to this topographical feature, the region receives very high rainfall during monsoon season . The vidarbha region is to the extreme east of the state. The mean monsoon or annual rainfall of this region is less than that of konkan but more than the other three sub divisions viz.., Marathwada, Khandesh and northern Maharashtra and Paschim Maharashtra. The rainfall patterns have high interaseasonal variability.

Also there is high spatial variability of rainfall over districts of Maharashtra. Due to the increased no of disaster events and its high impact on the economic and human life, it's necessary for the district administrations to have district rainfall climatology and information about temporal variability of rainfall at the district level for the better disaster management and water resources management and planning. This information is very useful to agriculture and water sectors of this state. The study aims in to find changing patterns of rainfall over Maharashtra in the district scale which may have an impact on increasing extreme rainfall events and floods over Maharashtra. The distribution of rainfall through the season or year plays an important role in recharging the ground water.

OBJECTIVE

- To compare actual rain with normal rain.
- To formulate the prediction model.
- To identify the patterns of rain fall.
- To study difference between the actual and expected rain.
- To study the correlation between Normal rain and Actual rain.
- To study the prediction of actual rain and rainy days.
- To study the total rainfall of all regions is same or not.
- Rainfall is not uniformly distributed.

METHOD OF DATA COLLECTION

Various method of collecting data are employed by social scientist. There are two methods of data collection which are Primary data and Secondary data. The secondary data was taken from the internet and the website is WWW.Maharain.com

STATISTICAL TECHNIQUES

A] Diagrammatical representation

B] Analysis of data

a) Correlation coefficient
b) Testing of hypothesis
b) Simple linear regression

C] Software used

- MS-EXCEL
- R- Software

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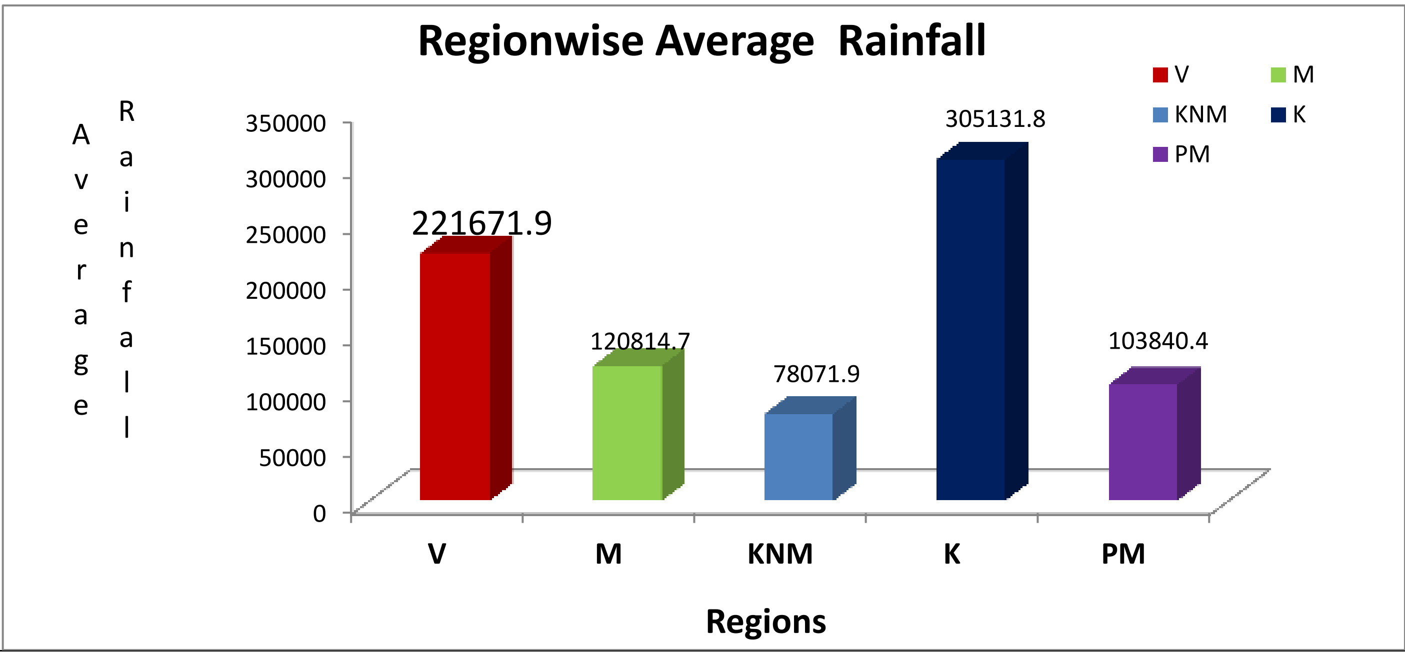
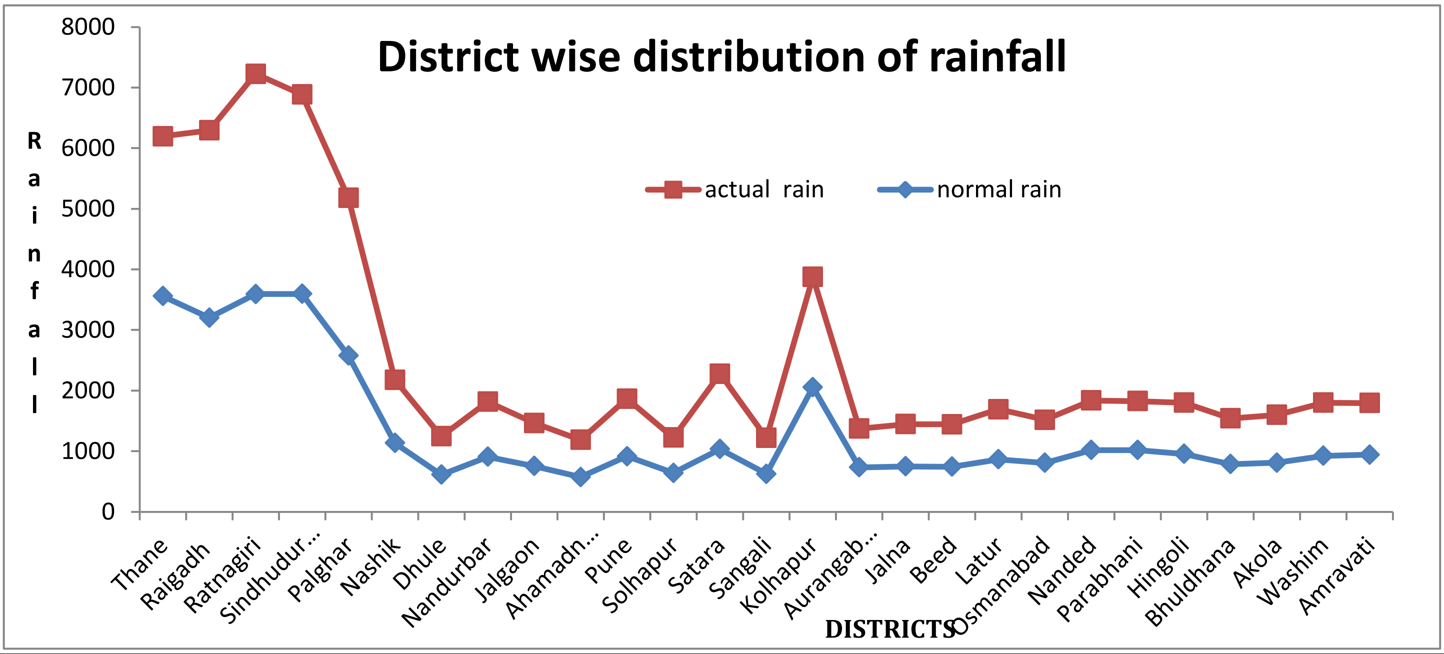
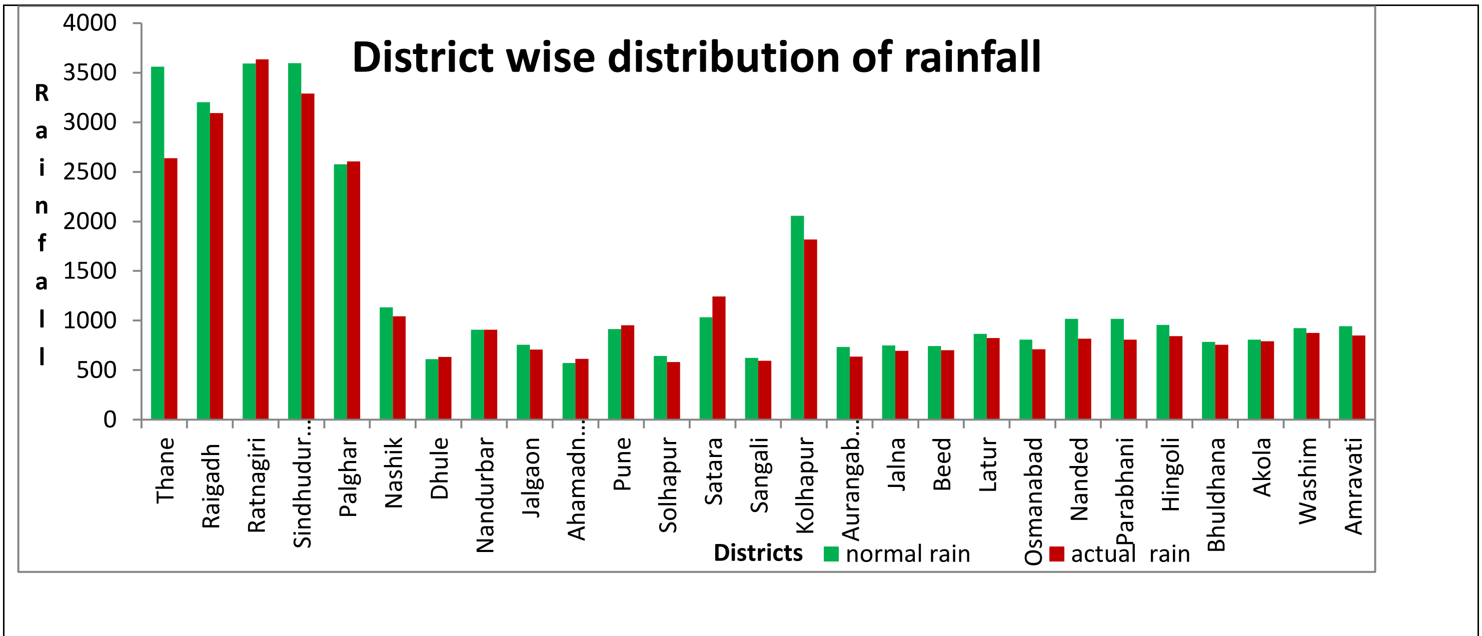
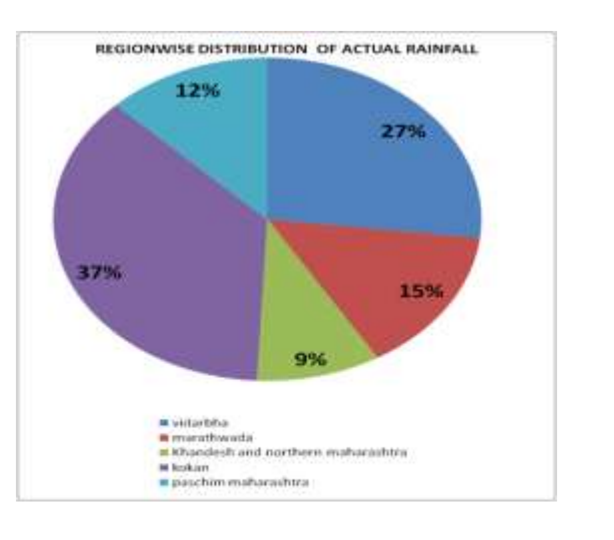
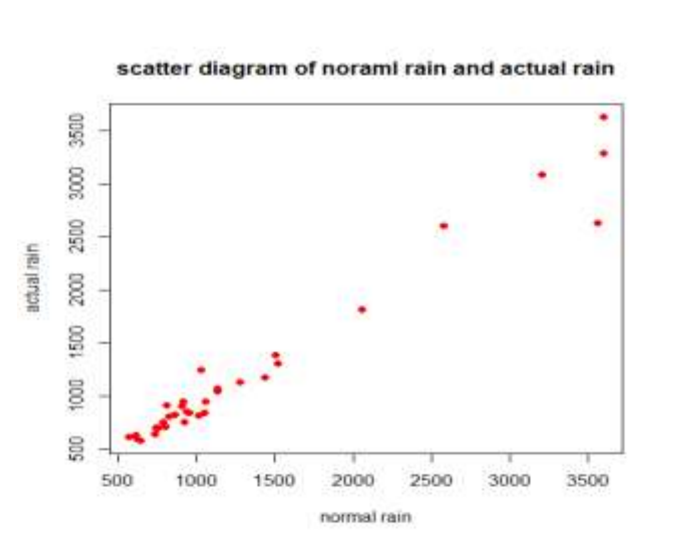





District wise distribution of rainfall
Rainfall
4000
3500
3000
2500
2000
1500
1000
500
0
Thane
Raigadh
Ratnagiri
Sindhudur...
Palghar
Nashik
Dhule
Nandurbar
Jalgaon
Ahamadn...
Pune
Solhapur
Satara
Sangali
Kolhapur
Aurangab...
Jalna
Beed
Latur
Osmanabad
Nanded
Parabhani
Hingoli
Bhuldhana
Akola
Washim
Amravati
Districts
normal rain
actual rain


REGIONWISE DISTRIBUTION OF ACTUAL RAINFALL
12%
27%
37%
15%
9%
vidarbha
marathwada
khandesh and northern maharashtra
kokan
paschim maharashtra


scatter diagram of norami rain and actual rain
actual rain
500
1000
1500
2000
2500
3000
3500
normal rain

ANALYSIS PART

B] Measure of central tendency and dispersion

We have a Rainfall data of 20 years from 1998 to 2017 of 34 district.the descriptive statistics

OBSERVATION TABLE

District	mean	Var	Sd	c.v	District	Mean	Var	Sd	c.v
Thane	2636	238638	489	19	Latur	825	37847	195	24
Raigadh	3093	322781	568	18	Osmanabad	711	36867	192	27
Ratnagiri	3634	423593	651	18	Nanded	819	56102	237	29
Sindhudurga	3289	403879	636	19	Parabhani	809	54265	233	29
Palghar	2604	187623	433	17	Hingoli	844	59447	244	29
Nashik	1042	58997	243	23	Bhuldhana	756	27887	167	22
Dhule	633	28772	170	27	Akola	792	32027	179	23
Nandurbar	907	82307	287	32	Washim	876	55029	235	27
Jalgaon	708	44240	210	30	Amravati	851	29963	173	20
Ahamadnagar	614	32939	181	30	Yawatmal	842	55768	236	28
Pune	952	77365	278	29	Wardha	951	69100	263	28
Solhapur	583	33854	184	32	Nagpur	1076	55760	236	22
Satara	1244	132720	364	29	Bhandara	1176	70955	266	23
Sangali	596	19739	140	24	Goindia	1308	79134	281	22
Kolhapur	1817	262081	512	28	Chandrapur	1137	96981	311	27
Aurangabad	638	20887	145	23	Gadchiroli	1389	116967	342	25
Jalna	695	34343	185	27					
Beed	701	27364	165	24					

a] Correlation Coefficients:

Let x be a actual rain and y be the normal rain.

$$r = \frac{\text{cov}(x,y)}{\sqrt{(\text{var}(x) * \text{var}(y))}}$$

Observed values are Cov(x,y)=732282.5 **;** var(x) = 812871.2 & var(y)=684328.2

r =0.930802

Testing Part

i] Z test for sample correlation

Test for correlation between normal rain and actual rain:

Hypothesis: H0:ρ=0 H1:$\rho \neq 0$

Level of significance = α % =5 %

Test statistic: $|Z|=\left|\frac{Z-\xi}{\sqrt{\frac{1}{n-3}}}\right| \sim$ N (0, 1)

Where; $z=\frac{1}{2}log\frac{1+r}{1-r}$ and $\xi=\frac{1}{2}log\frac{1+\rho}{1-\rho}$

Observed values are Z=0.722822 and ξ=0

Zcal.=4.024503 ; $Z_{tab} = 1.96$ And $Z_{tab} > Z_{cal}$

ii] Test for correlation between actual rain and rainy days

H0:ρ=0 v/s H1:ρ≠0

Level of significance = α % =5 %

Test statistic:
$|t| = \left|\frac{r*\sqrt{n-2}}{\sqrt{(1-r^2)}}\right|$ $|t|_{cal}$=10.4 and $t_{tab}=t_{n-1}$=2.101 and $|t|_{cal} > t_{tab}$

C] Testing of Hypothesis:

i) Test for uniformity:

Define: Let X be discrete random variable follows uniform distribution then its probability mass function is given by;

$P(x) = \frac{1}{5}$; x=1, 2, 3, 4, 5.

Where; 1= Vidrbha ; 2= Maratrhwada ; 3= Khandesh and northern Maharashtra

4= Kokan 5= Pachim Maharashtra

Expected frequency = E_i = N*P(x);

Where; N = Sum of all frequency

H0 : Rain fall is uniformly distributed over the geographical Regions.

H1 : Rain fall is not uniformly distributed over the geographical Regions.

Level of significance = α % =5 %

Test statistic: $\chi^2 = \sum_{i=1}^{5}\frac{(oi-ei)^2}{ei}$

$\chi^2{}_{calculated} = 217555.9$ & $\chi^2{}_{n-1} = \chi^2{}_4 = 7.827.82$

Therefore ;$\chi^2{}_{calculated} > \chi^2{}_{Table}$

ii) One Way Analysis of Variance

a) Part I: **Total rainfall same or not.**

Ho: The total rainfall is same in all regions.

H1: The total rainfall is not same in atleast two regions.

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Level of Significance= α= 5%

Observation table:

Groups	Count	Sum	Average	Variance
V	11	221671.9	20151.99091	16787520.29
M	8	120814.7	15101.8375	2402570.974
KN	5	78071.9	15614.38	13937338.96
K	5	305131.8	61026.36	76964736.79
PM	5	103840.4	20768.08	105942405.5

ANOVA Table :

Source of Variation	*SS*	*D.f.*	*MS*	*F*	*P-value*
Between Region	8049488902	4	2012372225	60.03551906	0.00000000000013
Within Region	972071124.7	29	33519693.96		
Total	9021560027	33			

b) Part II: Mean rainfall same or not

Ho: The mean rainfall is same in all regions.

H1: The mean rainfall is not same in atleast two regions.

Level of Significance= α= 5%.

Observation table:

Groups	*Count*	*Sum*	*Average*	*Variance*
V	11	11153.03	1013.912	46734.75
M	8	6040.735	755.0919	6006.427
KN	5	3903.595	780.719	34843.35
K	5	15256.59	3051.318	192411.8
PM	5	5192.02	1038.404	264856

One way ANOVA:

Source of Variation	*SS*	*D.f.*	*MS*	*F*	*P-value*	*F critical-value*
Between Regions	20094537	4	5023634	58.79539	2E-13	2.701399
Within Regions	2477837	29	85442.66			
Total	22572375	33				

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ii)Two way Analysis of Variance:

Ho: There is no significance difference between average rainfalls in all years.
H o1: There is no significance difference between average rainfalls in all regions.

Level of Significance = α= 5%

Analysis of variance:

Source of Variation	*SS*	*D.f.*	*MS*	*F*	*P-value*	*F crit*
Rows	1.81E+09	4	4.53E+08	271.6799	3.51E-44	2.492049
Columns	1.48E+08	19	7803778	4.67887	6.35E-07	1.725029
Error	1.27E+08	76	1667876			
Total	2.09E+09	99				

Here p-value is less than alpha

iii) Regression analysis for prediction:

For the prediction of the trend in rainfall we use the following relationship;

$$Y=a+bx$$

Where a = intercept, b= slope and x=t-a; t=2007 (fixed value), 'a' is predicted year.

For Vidarbha region we calculate the model to predict the rainfall for whichever year one wants.

Observation table:

Year	actual rain	X=t-a	x^2	x*y	Trend	Year	actual rain	X=t-a	x^2	x*y	Trend
1998	1020.3	-9	81	9183	942.68	2009	788.98	2	4	1578	1029.74
1999	1173.8	-8	64	9391	950.6	2010	1313.7	3	9	3941	1037.66
2000	1028.8	-7	49	7202	958.51	2011	921.12	4	16	3684.5	1045.57
2001	1127.6	-6	36	6766	966.42	2012	1072.5	5	25	5362.6	1053.49
2002	944.94	-5	25	4725	974.34	2013	1413.7	6	36	8482	1061.4
2003	1016.0	-4	16	4064	982.25	2014	749.75	7	49	5248.2	1069.31
2005	1221.4	-2	4	2443	998.08	2015	912.57	8	64	7300.6	1077.23
2006	1177.4	-1	1	1177	1006	2016	994.49	9	81	8950.4	1085.14
2007	1141.1	0	0	0	1013.9	2017	702.2	10	100	7022	1093.06
2008	839.20	1	1	839.2	1021.8		1013.9	10	670	5302.8	1100

Prediction model to predict the future of rainfall for Vidarbha is

$$Y=1013.91+7.91456*x$$

Similarly predictions models for to predict the future or past of rainfall of the regions Marathwada is Y=510.9132+1.6265*x and Khandesh and Northern Maharashtra Y= 780.719+3.854*x Konkan is Y=3051.4+3.69221*x and Paschim Maharashtra is Y=1038.4+3.69221*x.

MAJOR FINDINGS

The correlation between actual rain and rainy days is 0.9267.The Simple linear regression model between actual rain and rainy days is Y=38.7*x-1490.4 . rainfall is consistently falls in the Palghar district but it is is not uniformly distributed ore all the districts or region. The total rainfall as well as average rainfall is not same in at least two regions.The estimate slope parameter is play vital role in the prediction of future rain model.

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