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On

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Spatio-Temporal Trend Analysis of Rainfall and Rainy Days in Marathwada

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Abstract:

The study of climatic parameters is the need of time, because it changing over a time and place. The climate is directly connected to primary activities and indirectly to secondary and other activities of society. The present research work focused on the rainfall trend over Marathwada region. The region has been located on the south eastern part of Maharashtra state. The rainfall data for 37 years have been grabbed from Indian Meteorological Department, Pune and Hydrological Project Department, Nashik. Trend is one of the method to understand the changing nature of entity over the time. As concern to rainfall trend, there are 72 stations are recorded negative trend of average annual rainfall during 1980 to 2016. It means the average annual rainfall decreases and it ranges from 0.59 to 20.11mm. Whereas 24 stations recorded positive/ increasing trend, and ranges from 0.01 to 6.43mm.

Key Words: Climate, Rainfall, Seasonal, Trend.

Introduction:

Trend is one of the method to understand the changing nature of entity over the time. In the present study, while the studying the scenario of rainfall and temperature over Marathwada, trend analysis is carried out for the period of 37 years (1980 to 2016). The linear regression method is used and the rate of change is computed through the slope of regression line. The trends are variable depending on seasonal and annual pattern and are greatly modified by altitude and location in relation to the sea coast and other geographical features (Pal and Al-Tabbaa 2010). In the present evaluation the position of β represents an increasing trend over a time whereas the negative value of β represents decreasing trend with time constraint.

Study Area:

The study region of the present research work is Marathwada region in Maharashtra state in India. The study region lies in upper Godavari basin which extends from $17^{\circ} 35'$ north to $20^{\circ} 40'$ north latitude and $74^{\circ} 40'$ east to $78^{\circ} 19'$ east longitude. The study region covers 64434 sq. km. which is 20.95% of states area. Population of the region is 1.87 cores (2011). The study region has been divided in eight districts for administrative purpose with 76 talukas. The region characterized by Deccan trap mostly found basalt rock. Major part of region covered by deep black soil, it formed from basalt rock. The climate of study region is typical hot and dries with high temperature. It ranges from 20° C to 40° C some time it goes more than 40° C in summer and also it falls down below 20° C in winter season.

The study region receives 771.80mm. average annual rainfall. It receives from south western monsoon winds. Near about 70% rainfall receives during June to September i.e. monsoon season.

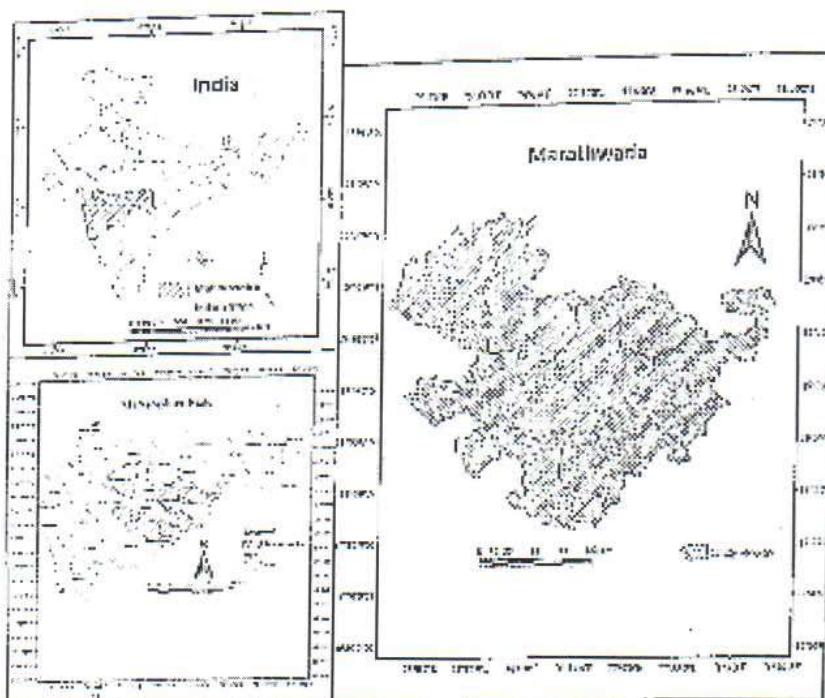


Fig. no. 01 Location of Study Region

Objectives: The main objective of the present study is to assess the Trend of Rainfall and Rainy days in Marathwada region.

Materials and Methods:

1. Trend Analysis Linear Regression

Correlation Regression line has an equation in the form

$$Y = a + bX,$$

Where, X = the explanatory variable and

Y = the dependent variable.

Result and Discussion

Annual trend of rainfall:

The below diagrams illustrates the trend of average annual rainfall of 96 stations in study region. There are 72 stations are recorded negative trend during 1680 to 2016. It means the average annual rainfall decreases and it ranges from 0.59 to 20.11mm/year. Whereas 24 stations recorded positive/ increasing trend, and ranges from 0.01 to 6.43mm/year. The increasing trend is much in less proportion in comparison to decreasing trend. The minimum decreases trend of rainfall is recorded at Majalgaon and maximum at Billoli of Beed and Nanded district accordingly. In concern to the increasing trend, the lowest at Alni and highest at Lohara stations of O'bad district. Overall the study region has found decreasing trend of rainfall by 3.32mm/year during study period.

Seasonal Trend of Rainfall:

The trend of mean seasonal rainfall is also evaluated and trend values are given in the below table. During the winter season mean rainfall trend is observed as positive and negative. There are 91 stations are found as decreasing trend and it ranges from -0.001 to 0.82 mm/year. The lowest decreasing trend is observed at Khuttabad and Latsangyi and highest decreasing trend at Malegaon stations. The positive/ increasing trend observed over 5 stations namely Pishor (0.05), Beed (0.07), Ambad (0.07), Rohina (0.12) and Udgir (0.11). The lowest positive trend at Pishor and highest at Rohina stations of A'bad and Latur districts. The pre-monsoon season considered during March to May month. The average trend of pre-monsoon season also recorded positive and negative. During this season 84 stations are found with decreasing trend, ranges from 0.01mm/year to 1.87mm/year at Pishor and Aurad

Shahjahanji stations. During this season it is observed it decreases from northwest to southeast. The increasing trend is recorded at 12 stations, it varies from 0.02mm/year to 0.80mm/year at —————— mm.

Scatterplot Trend of Rainfall 1980-2016																	
Stations	PM		M		PoSM		Wint		Stations	PM		M		PoSM		Wint	
	RF	RD	RF	RD	RF	RD	RF	RD		RF	RD	RF	RD	RF	RD		
Ajodhia	-0.20	0.31	6.50	0.20	0.54	0.01	0.60	-0.00	Tikka	-0.12	-0.10	0.50	0.00	0.04	0.01	0.35	0.01
Bhadrak	0.35	0.15	1.10	0.20	1.63	0.12	-0.14	-0.00	Tinku	-1.41	-0.36	3.10	0.03	0.77	0.22	0.32	0.05
Bhuban	-0.29	-0.02	8.60	0.88	2.20	0.28	-0.12	0.00	Udige	-0.62	-0.10	1.10	0.34	1.11	0.09	0.11	0.01
Cuttack	0.34	0.11	3.19	0.15	1.26	0.03	-0.18	-0.03	Wadhua	-1.14	-0.13	1.84	0.20	0.73	0.07	0.60	0.09
Dharmapuri	0.41	-0.04	1.09	0.25	1.62	0.07	-0.26	-0.02	Bhadrak	-0.13	-0.01	3.43	0.07	1.35	0.06	0.75	0.06
Gajapati	-0.20	-0.01	5.25	0.13	0.85	0.03	-0.15	-0.01	Dhurur	0.11	0.01	21.65	0.74	0.05	3.41	3.10	0.01
Khandabali	-0.07	-0.35	0.05	0.25	0.65	0.05	0.02	0.00	Janki B.	0.15	-0.01	3.06	0.19	1.00	0.00	0.12	0.08
Lodhagiri	-0.10	0.01	2.31	0.15	1.22	0.10	0.00	-0.01	Kandhamal	-0.65	0.01	4.74	0.26	0.39	38.00	0.12	0.03
Lorikhi	-0.21	-0.01	3.77	0.24	0.56	0.06	-0.12	0.01	Katrapur	-0.67	0.01	4.84	0.05	1.70	0.02	0.20	0.01
Nabarangpur	-0.92	-0.21	5.56	0.32	1.46	0.39	-1.68	-0.17	Katrapur	-0.71	0.10	3.03	0.19	0.37	0.02	0.32	0.08
Paharpur	-0.11	-0.02	3.38	0.30	0.43	0.01	-0.04	-0.01	Luniper	-1.10	-0.20	1.05	0.11	0.38	0.19	0.63	0.05
Phulbani	0.73	-0.04	0.11	0.22	2.55	0.03	0.38	-0.01	Lalgader	-0.52	-0.01	3.93	0.69	0.38	0.05	0.15	0.03
Pipli	-0.07	0.01	1.05	0.15	1.87	0.07	0.05	0.00	Majer	-0.70	-0.06	3.18	0.14	2.24	0.15	0.66	0.02
Sainam	-0.65	-0.05	8.84	0.12	2.06	0.10	-0.65	-0.04	Maligaon	-1.15	-0.14	1.70	0.03	2.34	0.13	0.87	0.06
Sand	0.56	0.07	3.88	0.40	0.59	0.02	-0.05	0.00	Mukher	-0.08	0.01	3.16	0.07	1.53	0.07	0.08	0.01
Sangpur	0.30	0.01	1.77	0.12	0.59	0.01	-0.01	0.00	Nanded	-0.25	-0.09	0.17	0.07	0.33	0.07	0.31	0.07
Vijaypur	-0.07	0.01	0.48	0.28	0.35	0.01	-0.10	-0.03	Panighat N.	-0.94	-0.11	32.72	0.15	1.39	0.13	0.26	0.01
Amberpetti	-1.21	-0.15	1.89	0.13	1.07	0.08	-0.70	-0.04	Singhan	-0.52	-0.10	3.03	0.48	2.39	0.14	0.09	0.01
Aditi	-0.57	-0.04	0.34	0.10	0.38	0.00	-0.05	-0.01	Sitikanji	-0.50	-0.11	3.47	0.58	0.31	0.19	0.21	0.04
Baxdi	0.02	0.01	2.94	0.03	3.04	0.02	0.07	0.00	Sundarji	-0.68	-0.10	4.57	0.04	0.22	0.11	0.17	0.03
Cesrai	-0.07	-0.01	3.11	0.02	1.25	0.02	-0.17	0.00	Tansa	-1.01	-0.05	10.36	0.39	1.80	0.10	0.38	0.05
Hiranya	-0.35	-0.03	4.15	1.01	1.06	0.23	-0.01	-0.01	Unti	1.11	-0.17	6.86	0.03	1.03	0.06	0.79	0.06
Kupp	-0.73	-0.08	0.68	0.36	0.03	0.01	-0.39	-0.01	Arif	1.35	-0.11	2.04	0.23	0.54	0.20	0.02	0.01
Lakhimpur	0.71	-0.03	4.32	0.40	0.70	0.00	-0.01	0.00	Bilaspur	-0.52	-0.10	3.05	0.48	2.39	0.14	0.09	0.01
Mujipura	-0.02	-0.05	0.90	0.00	0.56	0.05	-0.31	-0.01	Anantnag	0.64	-0.10	3.05	0.69	1.57	0.26	0.32	0.05
Muz	0.50	-0.04	0.37	0.04	1.82	0.03	-0.01	0.00	Berhampur	-1.15	-0.11	1.40	0.18	1.31	0.06	0.77	0.02
Parsia D	-0.65	-0.04	0.16	0.09	3.36	0.04	-0.10	0.00	Bloem	0.28	-0.05	0.53	0.04	0.28	0.11	0.27	0.01
Vida	-1.20	-0.06	0.08	0.34	1.60	0.04	0.12	0.01	Chamling	-0.80	-0.03	1.36	0.19	0.65	0.01	0.21	0.00
Deshbhitar	-1.41	-0.10	3.01	0.07	1.99	0.12	0.40	0.04	Kalamb	0.68	0.00	5.10	0.07	0.50	0.05	0.30	0.01
Teknaf	-1.36	-0.02	4.28	0.33	0.62	0.07	-0.19	-0.01	Karajkeshi O	-0.59	-0.07	3.74	0.09	0.36	0.05	0.53	0.02
Amul	0.34	0.04	1.11	0.25	0.24	0.01	0.07	0.01	Lohara	-0.02	-0.30	3.56	0.00	0.69	0.07	0.39	0.01
Bhadravasdi	-0.93	-0.12	2.71	0.75	1.05	0.09	-0.13	0.07	O'had	-0.76	-0.10	0.36	0.36	0.05	0.05	0.08	0.00
Bokardan	0.17	0.01	0.16	2.31	1.30	0.01	0.01	0.01	Omerta	0.05	0.01	0.35	0.02	1.49	0.05	0.15	0.00
Gobardan	-0.45	0.13	3.45	1.45	0.64	0.02	-0.19	0.05	Padeli	-1.16	-0.13	3.43	0.03	2.00	0.07	0.54	0.00
Jharpad	0.86	-0.12	4.13	0.23	1.61	0.15	0.31	0.07	Paranda	-1.06	-0.03	1.93	0.03	1.69	0.08	0.28	0.04
Patna	-0.14	-0.02	3.11	0.15	0.92	0.05	0.16	0.02	Sorela	-1.81	-0.10	4.48	0.24	2.11	0.04	0.32	0.02
Ranai	-0.28	-0.06	4.23	0.08	0.43	0.10	0.03	0.02	Sringar	-0.05	-0.01	0.77	0.02	2.12	0.10	0.30	0.01
Sahsana	-0.27	-0.02	4.27	0.15	2.46	0.05	0.24	0.01	Sundi	0.17	-0.03	3.40	0.06	1.42	0.04	0.27	0.02
Sitakud	0.06	0.00	5.72	0.35	1.20	0.38	0.08	0.27	Tourisikheda	-1.07	-0.12	5.23	0.27	1.01	0.01	0.18	0.02
Sbewki	-1.12	0.05	6.90	0.10	0.24	0.04	0.45	0.03	Yagnali	-0.77	-0.05	2.60	0.20	1.03	0.08	0.13	0.01
Akashganga	-1.10	0.10	3.71	0.06	1.20	0.04	0.73	0.01	Chandkheda	-0.09	-0.01	0.44	0.13	1.90	0.08	0.07	0.01
Mund Shu	1.87	-0.21	2.26	0.41	1.34	0.07	0.24	0.01	Jitna	-0.75	-0.04	0.79	0.37	1.23	0.11	0.20	-0.05
Ausa	-0.21	-0.10	0.46	0.63	0.36	0.07	0.03	0.03	Kamleshk	-0.84	-0.11	2.70	0.12	0.95	0.11	0.40	-0.05
Jedda	0.71	-0.26	2.50	0.65	3.77	0.23	0.30	0.10	Palan	-0.72	-0.06	3.23	0.45	1.07	0.10	0.32	-0.04
Jorhat	1.09	-0.08	4.27	0.52	2.77	0.01	0.34	0.00	Parbatpur	0.89	0.02	3.51	0.20	0.60	0.08	0.59	-0.01
Koraput	0.76	-0.10	4.90	0.80	1.64	0.08	0.20	0.01	Patur	-1.34	-0.14	0.38	0.40	0.97	0.11	0.38	-0.04
Nira	-0.13	-0.10	3.77	0.28	1.39	0.07	0.18	0.02	Supraman	-0.38	-0.10	1.01	0.44	0.33	0.09	0.27	-0.03
Bhadrak	-0.11	-0.10	0.77	0.56	0.78	0.04	0.12	0.01	Zari	-1.22	-0.10	5.15	0.30	1.02	0.16	0.46	-0.02

Beed and Parbhani. During the monsoon season there are 60 stations have recorded decreasing trend from 1680 to 2016. The lowest decreasing trend is observed at Patoda station of Beed district by 0.05mm/year and highest decreasing trend is noted at Billeli of Nanded district by 21.66mm/year. On the other hand 36 stations are found with increasing trend. It ranges from 0.08mm/year to 12.72mm/year at Pathri of Parbhani district and Patoda of Nanded district. The post monsoon season has observed that 88 stations noticed decreasing trend and 8 stations increasing trend of average seasonal rainfall. The decreasing trend varies from 0.03mm/year to 2.77mm/year at Kuppa and Jawalabik station of Beed and Latur district. Whereas 8 stations observed increasing trend, ranges from 0.04 mm/year to 1.37mm/year at Taka and Palam stations of Latur and Parbhani district.

Annual Trend of Rainy days: As like rainfall trend, the trend of rainy days also significant for agriculture and other sectors which are directly or indirectly depends on climate of region. The trend of mean annual rainy days is evaluated and increasing and decreasing trend is observed. The entire Marathwada region has recorded decreasing trend during study period. As concern to station wise trend, 70 stations are recorded decreasing trend, it varies from 0.01 to 2.03 days/year. The lowest trend is recorded at Lonikh. Station of A'bad district and highest decreasing trend is at Golpaongri of Jalna stations. The increasing trend in rainy days also observed over 27 stations. It varies from 0.01 to 0.77 days/year over Beed and Kasarshirsi stations of Beed and Latur districts.

Seasonal Trend of Rainy Days:

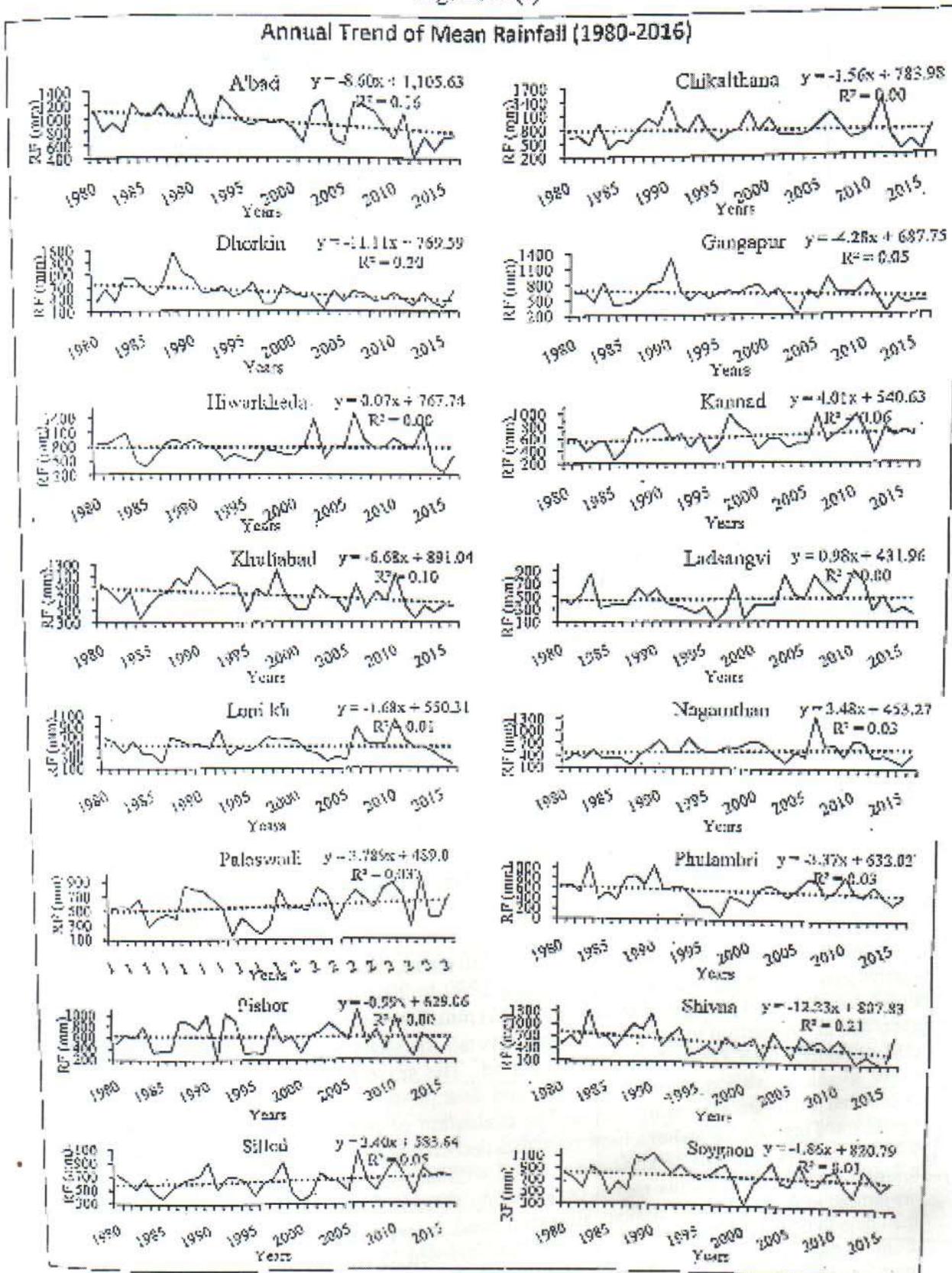
The mean seasonal trend of rainy days is computed and reported. The winter season is recorded decreasing trend at 89 stations and four stations namely Daborkin, Khultabad, Sillod and Beed are recorded <0.001 days/year and Parbhani has recorded by 0.21 days/year. Whereas 7 station have observed increasing trend. Out of them Pishor, Golpangri and Patoda stations have noticed <0.001 day/year and Shahagad recorded 0.27 days/year, it is highest positive trend during this season in Marathwada. During the pre-monsoon season, the increasing and decreasing trend is observed. The negative trend is varies from <0.001 to 0.34 days/year at Shahagad and Awadshirpur stations of Jalna and O'bad districts. Whereas the increasing trend is found at 14 stations. The 5 stations, Vaijapur, Beed, Bhokardan, Mkhed and Omanga are recorded <0.01 days/year and Kinwat of Nanded district has found highest positive change by 0.10 days/year during this season. The monsoon season is also found with positive and negative trend. There are 55 stations have noticed decreasing trend, ranges from <0.001 to 1.45 mm/year. On the other hand 41 stations are observed positive change with varies from 0.02 to 2.31 days/year, recorded at Sutalgao and Bhokardan stations of O'bad and Jalna districts.

Post monsoon season is considered during October to December. The trend of rainy days is computed and observed as 86 stations with decreasing and 10 stations with increasing trend. The decreasing trend varies from <0.01 to 38.0 days/year. There are four stations, Gangapur, Ashti, Limbagarsh and Degloor are having <0.001 days/year and Jamb blc. of Nanded district recorded highest negative or decreasing trend of rainy days. Whereas the positive or increasing trend varies from 0.01 to 0.11 days/year during the season. The Palaswadi, Soygarn, Ambad, Taka and Kinwat stations are recorded lowest increasing trend and Pathri has recorded the highest positive trend.

Conclusion:

It is observed that as far as concern to rainfall trend, there are 72 stations are recorded negative trend of average annual rainfall during 1980 to 2016. It means the average annual rainfall decreases and it ranges from 0.59 to 20.11 mm. The increasing trend is much in less proportion in comparison to decreasing trend. Overall the study region has found decreasing trend of rainfall by 3.32 mm during study period. The seasonal trend of rainfall is during winter season 91 stations have decreasing and 5 stations namely Pishor, Beed, Ambad, Rohina and Udgir are increasing nature. The evaluation of trend of rainy days is also most significant. There are 70 stations have recorded decreasing trend of rainy days, ranges from 0.01 to 2.03 days/year. The 26 stations are found with increasing trend and varies from 0.01 to 0.77 days/year in Marathwada region during study period. During winter season 89 stations are noticed as declined and 7 stations increased trend. In pre monsoon season it ranges from 0.34 days to 0.10 days. The monsoon season has observed 55 stations decreasing trend ranges from <0.001 to 1.45 days where as 41 stations observed positive trend. During the post monsoon 86 stations and 10 stations found negative and positive trend accordingly.

Fig. no. 1.(1)



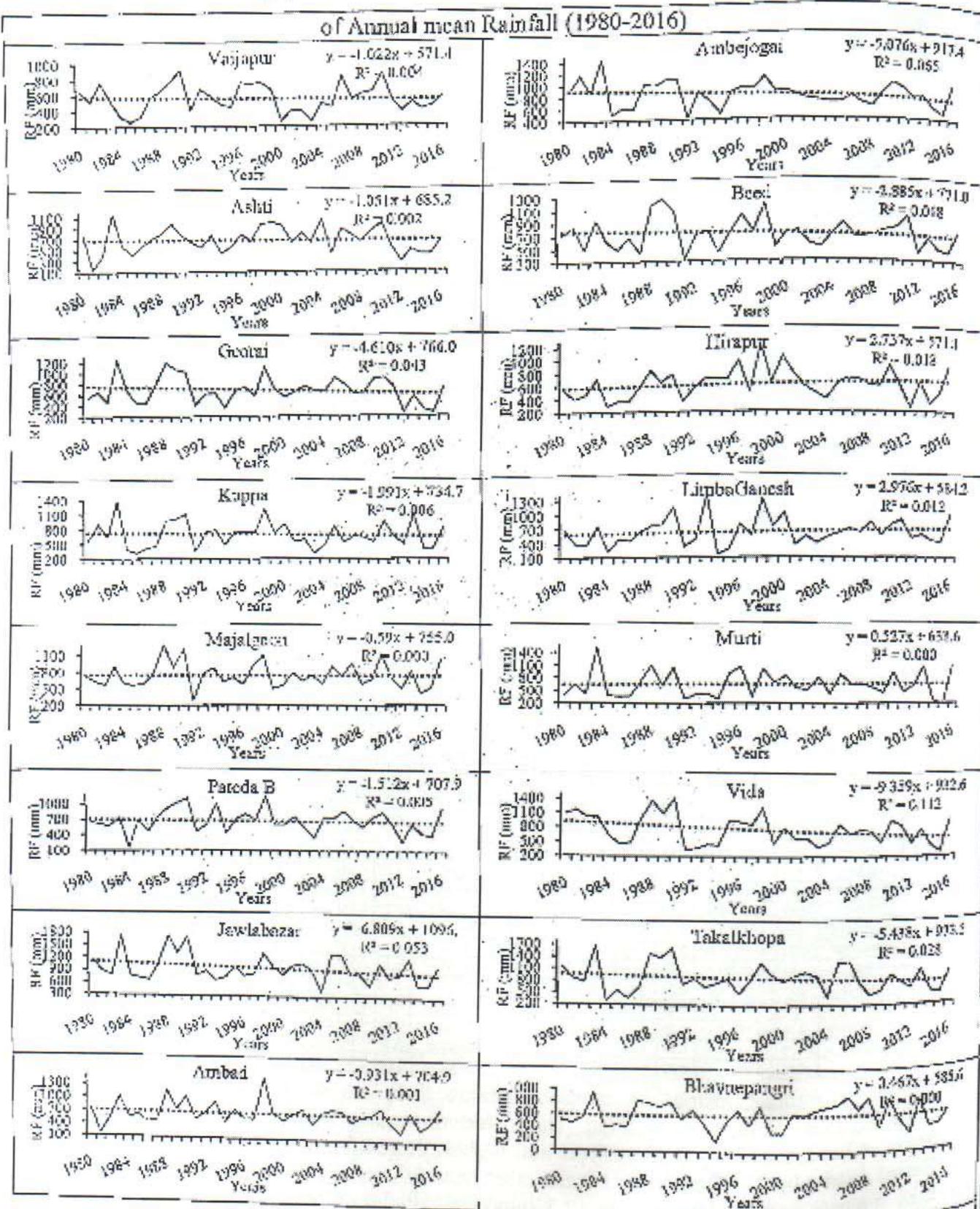


Fig. no. 01 (II)

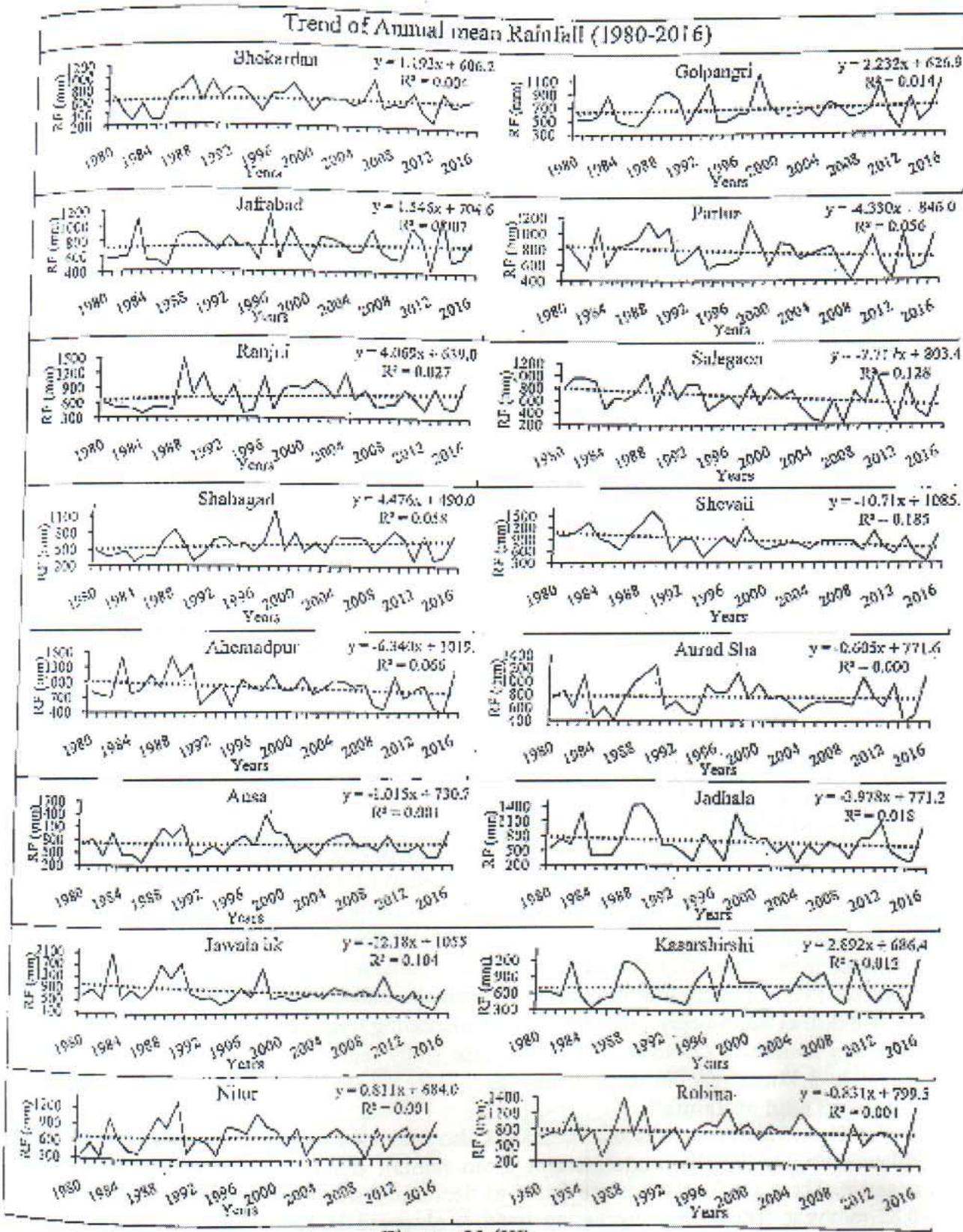


Fig. no. 01 (III)

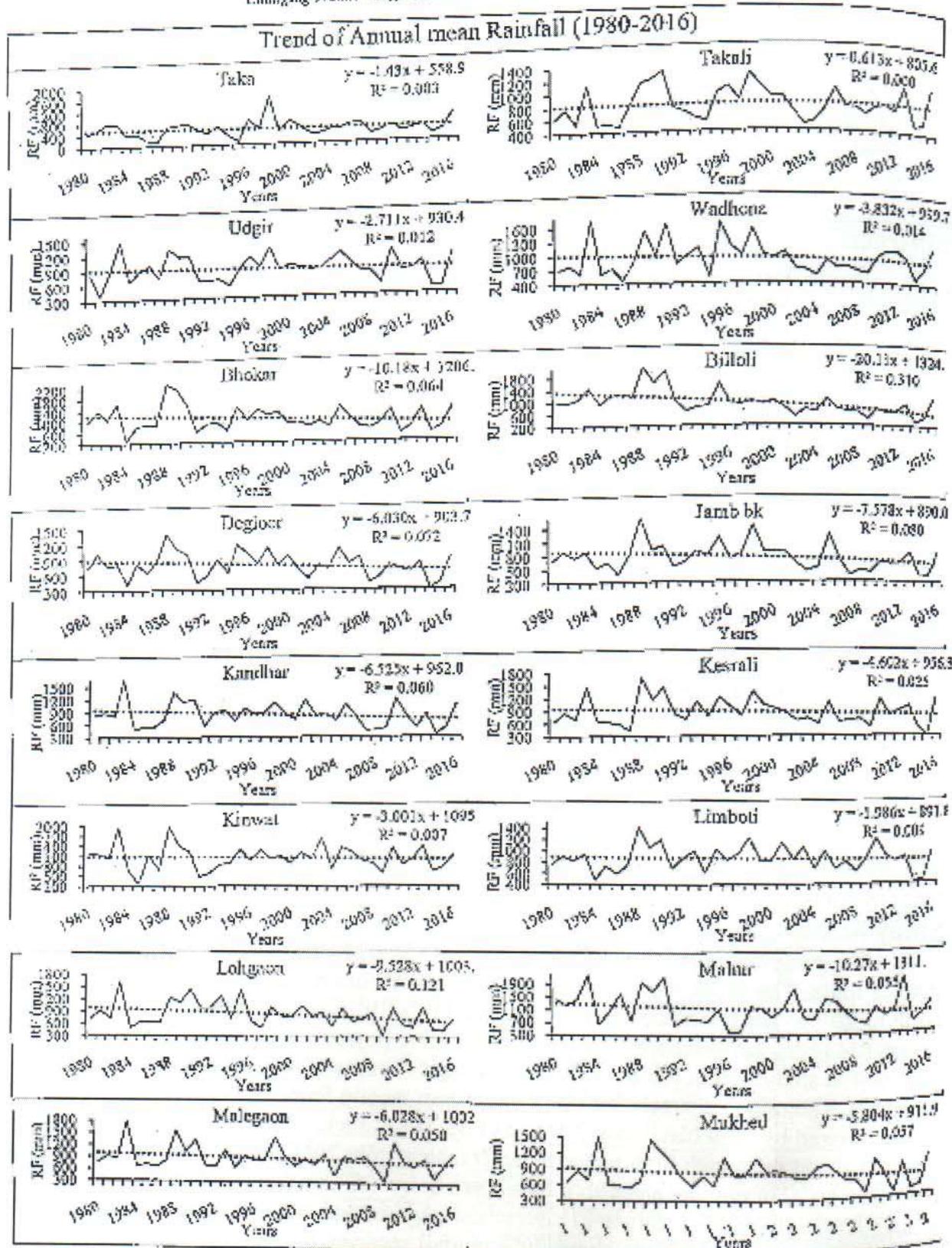


Fig. no. 01.(IV)



Fig. no. 01.(V)

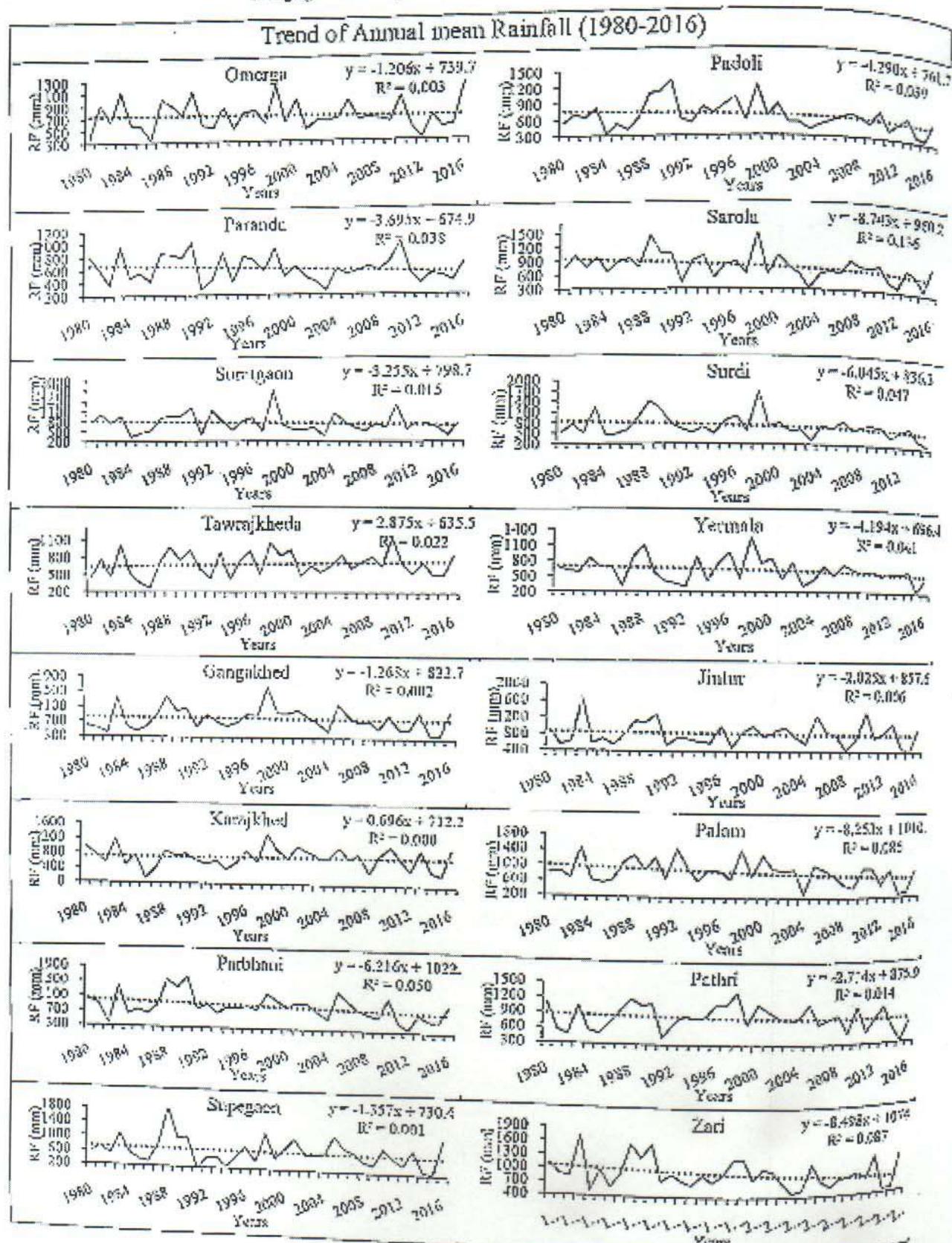


Fig. no. 01 (VI)

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