

**UNIVERSITY GRANTS COMMISSION
WESTERN REGIONAL OFFICE
GANESHKHIND, PUNE - 411007**

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File Nos-47-534/12(WRO)

The Accounts Officer
University Grants Commission
Ganeshkhind, Pune-411007.

29 MAR 2013

**Subject: Financial assistance to college teachers for undertaking Minor Research Projects -
Release of first installment during XIIth Plan.**

Sir/Madam,

The UGC on the recommendations of the Expert Committee has approved the Minor Research Project in the subject of Statistics entitled "Statistical Modeling of Rainfall Data in Sangli-Dist." to be undertaken by Dr. Patil M. K. of **PADMABHUSHAN VASANTRAO DADA PATIL MAHAVIDYALAYA, KAVATHE MAHANKAL, SANGLI-416 405**. The financial assistance of the UGC would be limited to Rs. 145000/- (Rupees Only) for a period of two years. An amount of Rs. 117500/- (Rupees Only) is presently being sanctioned as the first installment.

Non-Recurring Grant for Two years	Amount (Rs)	Recurring grant	1 st Year Amount	2 nd Year Amount	Head of a/c
Books & Journals	15000	Contingency	10000	10000	4(ii)b (For General)
Equipment	75000	Special Need	0	0	1.B(i)h(i)b (For SC)
		Travel/Field work	12500	12500	1.B(i)h(i)b (For ST)
		Chemicals & Glassware	0	0	
		Others	5000	5000	
Total (Rs.)	90000		27500	27500	

Total amount for the project: Rs. 145000/-

The grant is subject to the terms and conditions as mentioned below.

1. A Certificate of Acceptance of the conditions governing the research project should be sent immediately to this office.
2. The amount of the grant shall be drawn by the Accounts Officer (D.D.O), University Grants Commission on the grant-in-aid bill and shall be disbursed to and credited to the above-mentioned institute through D.D./ RTGS Confirmation No/ NEFT/ Transfer No.
3. The sanctioned amount is debatable to the Major Head 4(ii)b (For General), 1.B(i)h(i)b (For SC), 1.B(i)h(i)b (For ST) and is valid for payment during the financial year 2012 -2013 only.
4. The grant is subject to adjustment on the basis of Utilization Certificate in prescribed proforma submitted by University/College/Institute.

NOTE:

1. The grant shall not be used self-financial/non-grant/unaided courses & teachers.
2. Teacher already availing other Fellowship/Project from UGC/ other agency.
3. Date of implementation will be the date of sanction of first installment.

Dept Of P.V.P. Mahavidyalaya, K. Mahankal
Dist-Sangli

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4. The researcher is required to submit an Acceptance Certificate of the project in the enclosed format to the affiliating university, which would then be sent to UGC (WRO) in a bunch by the University.
5. Please send one copy of the project completion report to Director, INFLIBNET, Gujarat University Campus, Navrangpura, Ahmedabad for record.
5. The statement of expenditure incurred and brief academic progress report relating to the above project is to be sent in the prescribed format to this office after completion of one year. Audited utilization certificate of full-allocated amount, audited statement of expenditure and final project report be submitted immediately after completion of the project.
6. The assets acquired wholly or substantially out of UGC grant shall not be disposed off or encumbered or utilized for purposes other than those for which the grant was given, without proper sanction of the UGC, Western Regional Office, Pune-07 and should at any time the college cease to function, such assets shall revert to U.G.C.
7. A register of the assets acquired wholly or substantially out of the grant shall be maintained by the University/College in the prescribed form.
8. The University/College shall strictly follow all the instructions issued by the Govt. of India from time to time with regard to reservation of posts for SC/ST/OBC.
9. The interest earned by the University/College/Institute will be treated as additional grant and it is required to be incorporated in the U.C./Statement of Expenditure submitted to UGC, (WRO).
10. The University/College shall fully implement the office Language Policy of the Union Govt. and comply with the official Language Act, 1963 and Official language (use for official purposes of the Union) Rules, 1976 etc.
11. The sanction issues in exercise of the delegation of powers vide Commission office order No.5/92 dated may 01, 1992.
12. The funds to the extent are available under the scheme.
13. The grantee institution shall ensure the Utilization of grants-in-aid for which it is being sanction /paid. In case non-utilization/ part utilization, simple interest @ 10% per annum amended from time to time on unutilized amount from the date draw/to date of refund as per provisions contained in general financial Rules of Govt. of India will be charged.

PRINCIPAL

Padmabhushan Vasantodada Patil
Mahavidyalaya, Kavathe Mahankal.
Dist-Sangli.

Yours faithfully

(Dr. G. Srinivas)
Joint Secretary

Copy to:

1. THE PRINCIPAL
PADMABHUSHAN VASANTRAO DADA PATIL MAHAVIDYALAYA,
KAVATHE MAHANKAL, SANGLI -416 405.
2. DR. PATIL M. K., PADMABHUSHAN VASANTRAO DADA PATIL
MAHAVIDYALAYA, KAVATHE MAHANKAL, SANGLI -416 405.
3. DIRECTOR (BCUD) SHIVAJI UNIVERSITY, VIDYA NAGAR,
KOLHAPUR- 416004
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5. ACCOUNTANT GENERAL, MAHARASHTRA STATE, MUMBAI
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HEAD

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(Dr. G. Srinivas)
Joint Secretary

Socio Economic Status of Sangli District

1.0 Introduction:

The Sangli district is situated in the southern part of Maharashtra and is a part of Deccan plateau. It is endowed with the gift of fertile black soils in the central parts. The eastern part of Sangli district has a scanty drought prone belt of the state. Thus there are regional disparities. The central part of Sangli district is cultivable area. The eastern part includes *Jath, Kavathe Mahankal, Atpadi* tahsils. These tahsils are drought prone area and has insignificant irrigation facilities. The northern part of Sangli district is also rain shadow area. There is always acute shortage of drinking water. The Sangli district consists of ten tahsils, namely *Walwa, Shirala, Atpadi, Khanapur, Tasgaon, Miraj, Jath, Kavathe Mahankal, Kadegaon and Palus*. Topographically the region has large diversified surface. Climatically the region falls under the rain shadow region of Sahyadri Mountain ranges. Temperature increases from west to east and rainfall decreases from west to east. Climatically, the region shows four seasons, namely monsoon, post-monsoon, cold season and hot season. The region is drained by river Krishna and its tributaries as Yerala and Agrani.

1.1 History

There is not much evidence about the historical aspects of the district Sangli, thus the history of Sangli suffers from huge lacunae. Of the ancient historical records available during 1024 there is a mention of an area called Sangli under the control of the *Gonk king Shilahar*, who was the ruler of *Karad* region falling under the area of *Mirinch* which is currently known as *Miraj* and *Karhtak*. The first notable evidence about the existence of Sangli is found in the Sanskrit poem *Shiv-Bharat* composed during the regime of Maratha ruler Maharaja Shivaji. His courageous warrior Netaji Palkar had captured the areas of *Sangli, Miraj* and *Brhamnal* from the Adilshah in 1659.

Apart from this there are several other myths about the origin of Sangli. According to one belief there were six (6) *Gallies* i.e., lanes or streets on the bank of the Krishna River and hence the name "SANGLI" originated. The second one is that, the name of the village was *Sangalki* in Kannad language so in Marathi it became SANGLI. Another belief is that the confluence of Warna and Krishna rivers is near Sangli village. The word for confluence in Marathi is '*Sangam*' and the SANGLI is the distorted version of the word 'Sangam'. Apart from this there is not much relevant evidence about the district Sangli.

1.2. Location and Geology

Location

The Sangli District is one of the important districts of state of Maharashtra. It is situated between the latitudes 16°45' N and 17°33' N and longitudinal of 73°42' East and 74°40' East. Its east-west length is 205 km and north-south breadth is only 96 km. Satara district was divided in two parts, viz. North and South, and formed two districts named as North Satara and South Satara during 1949. South Satara district was formed by carving *Tasgaon, Khanapur, Walwa & Shirala* tahsils from erstwhile Satara district and erstwhile Miraj & Jath states. Thus there were 6 tahsils in South Satara district. Later on, on 21st November, 1960 South Satara district was renamed as Sangli district. During 1965 *Kavathe Mahankal* tahsil was carved out from *Miraj* tahsil and *Atpadi* tahsil from *Khanapur*. Thus Sangli district was consists of eight tahsils from 1965. Palus and Kadegaon are the two newly formed tahsils. Now Sangli district consists of ten tahsils.

The district is bounded by Satara district on the North western side. Southern is boarded by Belgam and Bijapur district of Karnataka State. East Kolhapur district and the Ratnagiri district lies on west of Sangli district. The total area of the district, according to 2011 census, is about **8602** Sq.km

According to 2011 census the population was 28,22,143 of which male and female were 14,35,728 and 13,86,415 respectively and the literacy rate is about 81.48%. If things are looked out at gender wise, the male and female literacy were

88.22 and 74.59. For 2001 census, same figures stood at 86.26 and 66.73 in Sangli district. Total literacy in Sangli district was 20,49,467 of which male and female were 11,21,550 and 9,27,917 respectively. With regards to sex ratio in Sangli, it stood at 996 per 1000 male compared to 2001 census figure of 957. The district is divided in to five Administrative sub-divisions mainly *Khanapur, Walwa, Miraj, Tasgon, Palus*. The *Shirala* and *Walwa* Tahsil was included in *Walwa* sub-division. The *Miraj* Sub- division Comprises of *Jath, Kavthe-Mahankal* and *Miraj*. The *Khanapur* Sub-division includes *Atpadi* and *Khanapur* and *Palus* Sub-division includes *Kadegaon* and *Palus*.

Figure 1.1 gives the location of study area.

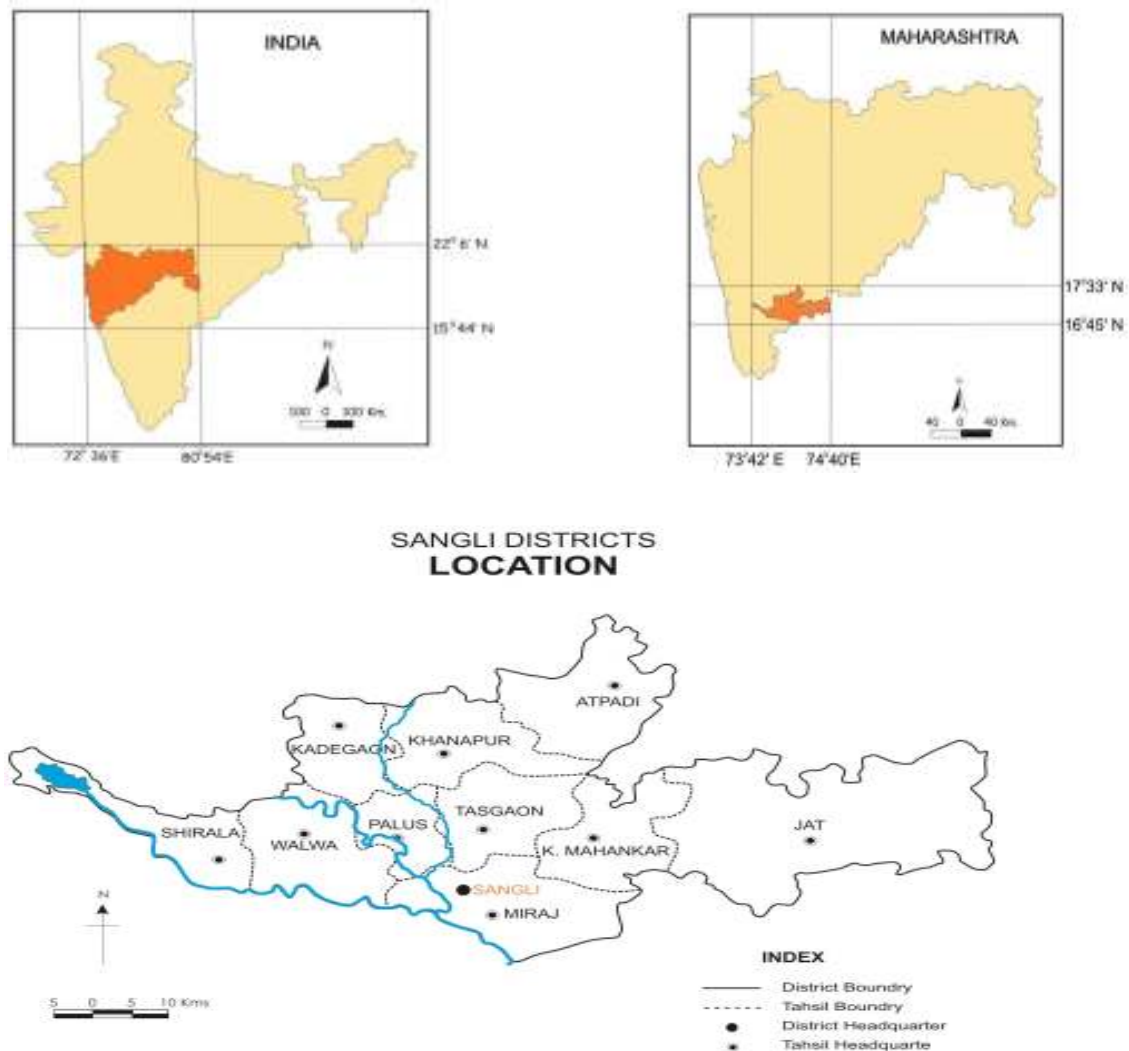


Figure1.1 : Location of Study Area

Area & Administrative Divisions: Area of Sangli district is **8602** sq. km. and it is twenty first in Maharashtra state so far as area is concerned. Rural area of

Sangli district is 8303 sq. km. while the urban area is 299 sq. km. There are 727 villages (2 deserted) and 10 urban locations in Sangli district. There are 646 village Panchayats as on 31st March, 1991 and 6 Municipal councils.

There were two Revenue sub-divisions viz. *Walwa* and *Miraj*. Each sub-division has the area of 4 tahsils. But during 1992, one more sub-division was created by taking out two tahsils, viz. *Khanapur & Atpadi* from *Walwa* and was named as *Khanapur* sub-division. Thus now there are three sub-divisions having their headquarters at *Islampur, Miraj & Vita* in Sangli district.

Geology

The Deccan traps, which cover almost major portion of Maharashtra state, were erupted as horizontal lava sheets during the Cretaceous– Eocene times and is supposed to have welled out from the long and the narrow fissures in the earth crust. These formations are termed ‘traps’ because of their step like terraced appearance, a characteristic and a common feature in the scenery of the Traps Deccan. The chief varieties of the Traps are hard, compact Basalt and vesicular Traps. The Sangli district is a part of Deccan plateau. Basalt is the main rock in the Sangli district. The geological formation of Sangli district is only the Deccan trap. The Deccan lava flows are found usually in the form of horizontally bedded sheets. They are more or less uniform in composition corresponding to basalt. These are dark gray or greenish gray in colour. Some parts of the Sangli district particularly the river valley are occupied by the typical black soil. These soils are formed from the Deccan trap. The black soil contains high alumina and carbonates of calcium and magnesium with variable amount of potash, low nitrogen and phosphorous.

1.3 Overview of Sangli District

Salient Physical Features and Land Use Patterns: This district falls partly in Krishna basin and partly in Bhima basin. Consequently, it is divided into different drain systems. The whole district can be divided into three different parts on the basis of topography, climatology and rainfall viz.

1. Western hilly area of Shirala tahsil with heavy rainfall.
2. The basin area of Krishna, Warna & Yerala rivers, comprising of Walwa, Tahsil & western part of Tasgaon and Miraj tahsils with medium rainfall.
3. Eastern drought prone area which comprises of eastern part of Miraj, and Tasgaon tahsils, north-eastern part of Khanapur tahsil and whole of Atpadi, Kavathe Mahankal & Jath tahsils.

The climate gets hotter and drier towards the east and humidity goes on increasing towards the west. The maximum temperature is 42° C while the minimum temperature is 14° C. The climate in the district is fairly tolerable throughout the year. The winter is pleasant from December to February. The summer season starts from mid February to May. June to September is the months of normal rainy season. July and August are the months of heavy rainfall.

The western part of *Shirala* tahsil gets heavy rainfall on an average over 1004 mm in a year. The central and eastern parts receive annual rainfall about 900 mm in a year. The north-eastern portion receives the lowest rainfall in the district only 300 mm in a year. Due to this lowest rainfall, the tahsils of *Atpadi*, *Jath*, *Kavathe Mahankal*, *Miraj (East)*, *Tasgaon (East)* and *Khanapur (East)* are drought prone areas.

Soil : Soil is different in different parts of the district. In western part comprising *Shirala* tahsil soil cover is reddish and yellow-reddish. It is 7.37% of the total area of the district. Central part i.e. Entire *Walwa* tahsil and western part of *Miraj* and *Tasgaon* tahsils i.e. Warna, Krishna and Yerala river basins have deep black soils which makes up 26.18% of the total area of the district. In the remaining part of the district i.e. eastern part, the soil is faint gray accounting for 66.45% of the total are of the district.

Land Use Patterns

The geographical area of Sangli district is 8,61,065 Hectares and it is under different use as shown in the **Table 1.1**

Table 1.1 Geographical area of Sangli District under different use.

Type of Land Use	Area in Hectares	Percentage
Forest	47314	5.49
Not available for cultivation	69906	8.12
a. NA area	32044	3.73
b. Not cultivable	37862	4.39
Area not cultivated	69018	8.02
a. Cultivable but not in use	34526	4.01
b. Permanent Pastures and Grazing lands	19094	2.22
c. Trees, Orchards	15398	1.79
Fallow Lands	80204	9.31
a. Current	42985	4.99
b. Other	37219	4.32
Net Cultivated Area	594623	69.06
Total	861065	100.00

Socioeconomic Features

Demographic Features

The demographic features of Sangli district according to the 2011 Census are as follows

Total Population	: 28,22,143
Total male population	: 14,35,728
Total female population	: 13,86,415
Sex Ratio	: 996
Urban Population	: 5,02,000
Rural Population	: 16,96,000
Percentage of urban population to total population	: 23%
Population Density	: 256 / sq. km.
Literacy rate	: 81.48 %.

Male Literacy rate	:	64.57%
Female Literacy rate	:	45.69%
SC/ST		
SC Percentage	:	12.56%
ST Percentage	:	0.49%
Occupational Profile	:	
Workers	:	36.87%
Agriculturists	:	43%
Agricultural Labourers	:	24%
Trade and commerce	:	7%
Marginal Workers	:	7%
Others	:	2%

1.4 Rain gauge Centers in Sangli District

The Department of Agriculture, Maharashtra state initiated the project for recording daily rainfall in the state in year 1998. Initially rainfall data was recorded at tahsil level and from 2013 as Government of Maharashtra has installed rain gauge station at every circle. Circle officer send daily rain data using mobile through SMS. In addition to SMS rain data can be entered directly on the web portal. There are 60 rain gauge centers in Sangli district. **Table 1.2** gives the list of the rain gauge centers in Sangli district.

Table 1.2 : Rain gauge centers in Sangli district

Sr. No.	Tehsil	Rain gauge Centers
1	Shirala	Shirala, Kokrud, Shirshi, Mangale, Sagav, Charan
2	Islampur	Islampur, Walwa, Koregaon, Kurlap, Tandulwadi, Takari, Peth, Bahe, Aashta, Kameri

3	Tasgaon	Tasgaon, Manjarde, Visapur, Yelavi, Manerajuri, Savalaj
4	Khanapur / Vita	Khanapur, Vita, Karanje, Lengare, Bhalwani
5	Miraj	Miraj, Budhagaon, Aarag, Sangli, KasbeDigraj, Malgaon, Kavalapur
6	Kavathe Mahankal	K Mahankal, Dhalgaon, Deshing, Kuchi, Hingangaon
7	Jath	Jath, Sankh, Madgyal, Muchundi, Daflapur, Kumbhari, Umadi, Shegaon
8	Palus	Palus, Bhilawadi, Kundal, Ankalkhop,
9	Kadegaon	Kadegaon, Wangi, Nevari, Chinchni, Shalgaon
10	Atpadi	Atpadi, Diganchi, Kharsundi,

River Systems and Dams

The main rivers of Sangli district are Krishna and Warna. The Krishna is one of the three largest sacred rivers of southern India. Approximately 105 kms. of the river course falls inside the district. Morna, Yerla, Manganga, Agrani, Nanni and Bor are small feeder rivers of Krishna. Warna is the largest tributary of the Krishna in the district.

- Krishna with its tributaries Warna and Yerla flows through the western part of the district.
- Warna flows from west to east along the southern boundary of the district and joins the Krishna at Haripur near Sangli town.
- Yerla flows from north-west to south-east and after traversing the western parts of Khanapur and Tasgaon tahsils joins Krishna near Brahmanal
- These rivers are the lifelines of the western half of the district and serve as source for large irrigation schemes.

- Agrani, Man and Bor constitute the drainage system for the eastern part of the district. The water resources from these rivers are limited and they remain dry for most part of the year.
- There is only one major dam - Warna - at Chandoli on the Warna River. Besides there are two major lift irrigation schemes on the Krishna River.
- There are five Medium Irrigation Projects, namely Morna, Shindewadi, Bassappawadi, Doddanala and Sankh.
- There are 66 minor irrigation projects, 462 percolation tanks, 353 masonry dams and 11 Kolhapur type Bandharas.

1.5 Agriculture and Cropping Pattern in the District

- Net cultivated area is 594623 hectares, while double crops area is 59743 hectares. Thus gross cropped area is 654366 Hectares. Net cropped area is 82% as compared to the total cultivable area.
- Major crops include Paddy, Jowar, Bajra, Groundnut, Wheat, Gram, sugarcane, Soybean, Grapes, Pomegranate, and Bor.
- Out of the net cultivable area, 46% is under Jowar and 16% under Bajra. Jowar (Kharif) is sown in Walwa, Miraj, Tasgaon, tahsils while Jowar (Rabi) is taken in Miraj (east), Khanapur, Atpadi, Jath and Kavathe Mahankal tahsils. Bajra is grown in Jath, Atpadi and Kavathe Mahankal tahsils.
- Paddy is taken in Shirala and Walwa tahsils. Sugarcane is taken in all the tahsils where there is assured source of water.
- Grapes are taken in Tasgaon, Khanapur and Kavathe Mahankal tahsils. Tasgaon grapes are famous in India and the Middle East.

• Pomegranates and Bor are taken in Jath and Atpadi tahsils while Soyabean is cultivated in Walwa, Miraj, Tasgaon and Khanapur Tahsils. These tahsils also cultivate groundnut crop. Table 1.3 gives cropping pattern in Sangli district.

Table 1.3 : Cropping pattern in Sangli district

Crop Types	Names	Cropping Period in Months	Market (District State Export)
Major Crops (Irrigated)	1) Sugarcane 2) Grapes	12 & 18 months 12 months	Sugar factories in Sangli dist.
Major Crops (Non-irrigated)	1) Hy. Jowar 2) Bajra 3) Soybean 4) Groundnut	4 to 5 months --- '' --- --- '' --- --- '' ---	District / State --- '' --- --- '' --- --- '' ---
Major Cash crops	1) Sugarcane 2) Grapes 3) Ber 4) Pomegranate	12 months 12 months 12 months 6 months	Sugar factories Dist./ State, India, Foreign Dist./State State /India
Major Plantations	Mango, Guava, Pomegranate, Coconut	12 months 6 months 6 months	District State, India District

1.6 Industries

• Though Sangli district is not backward in industrial development, it cannot be said to be advanced. Some industries are concentrated at Sangli, Miraj, Madhavnagar, Kupwad, Islampur, Palus, Kirloskarwadi, Chikhali, Atpadi, Walwa, Kavathe Mahankal and Thurchi Phata. In rest of the district there is no industrialization

• There are 692 registered factories of which 594 are working. Capital invested amounts to Rs.301 Crores and working capital amounts to Rs.146 Crores. There are 36,000 workers.

• There are 9 sugar factories, 22 cotton spinning mills, one engineering factory at Kirloskarwadi and one bulb factory at Nerle.

- There are five Industrial Estates and another five in the co-operative sector
- There are 3038 small industries employing 17754 workers.
- Miraj town is famous for Sitar manufacturing.

1.7 Chapter wise summary

This project consists of 4 chapters. Chapter one provides introduction to the problem and socio economic status of Sangli district. Chapter two is devoted to Rainfall Data and Exploratory Analysis. This chapter consists of availability of data, Rainy days, Dry days, percentage of rainy days and Percentage of dry days. Season wise Mean rainfalls over the stations of Sangli district are provided. Distribution of coefficient of variation of rainfall over the Stations of Sangli District for four seasons and annual rainfall is also obtained. Probability Analysis of Dry and Wet Spells at different Stations of Sangli District is also studied. The consecutive Dry and week probability analysis of Sangli District is also carried out. Chapter three is devoted to Seasonality index of rainfall for Sangli district. In this chapter seasonality index for all months is computed using *Walsh and Lawler (1981)* index. Rainfall is purely seasonal; therefore seasonality index is obtained for monsoon and other than monsoon months. Chapter four is devoted to analysis of trend in rainfall for Sangli district. MATLAB code is provided to estimate *Sen's estimator* and *Mann-Kandall test*. Chapter five ends with findings, conclusion and references.

Rainfall Data and Exploratory Analysis

2.0 Introduction:

In chapter 1, focus was to shed lights on the Socio Economic Status and history of Sangli District. This chapter is devoted to the study the exploratory data analysis of Sangli district. The rainfall data of Sangli district is obtained from India Metrological Department, Pune. Day wise rainfall data for 32 years is obtained for the period 1981 to 2012. Data is recorded at ten stations of Sangli district, namely Shirala, Islampur, Kasegaon, Sangli, Miraj, Tasgaon, Jath, Kavathe Mahankal, Palus and Atpadi. The mean rainfall values of all ten stations were considered to represent the rainfall of the Sangli district.

2.1 Data availability and Descriptive Statistics

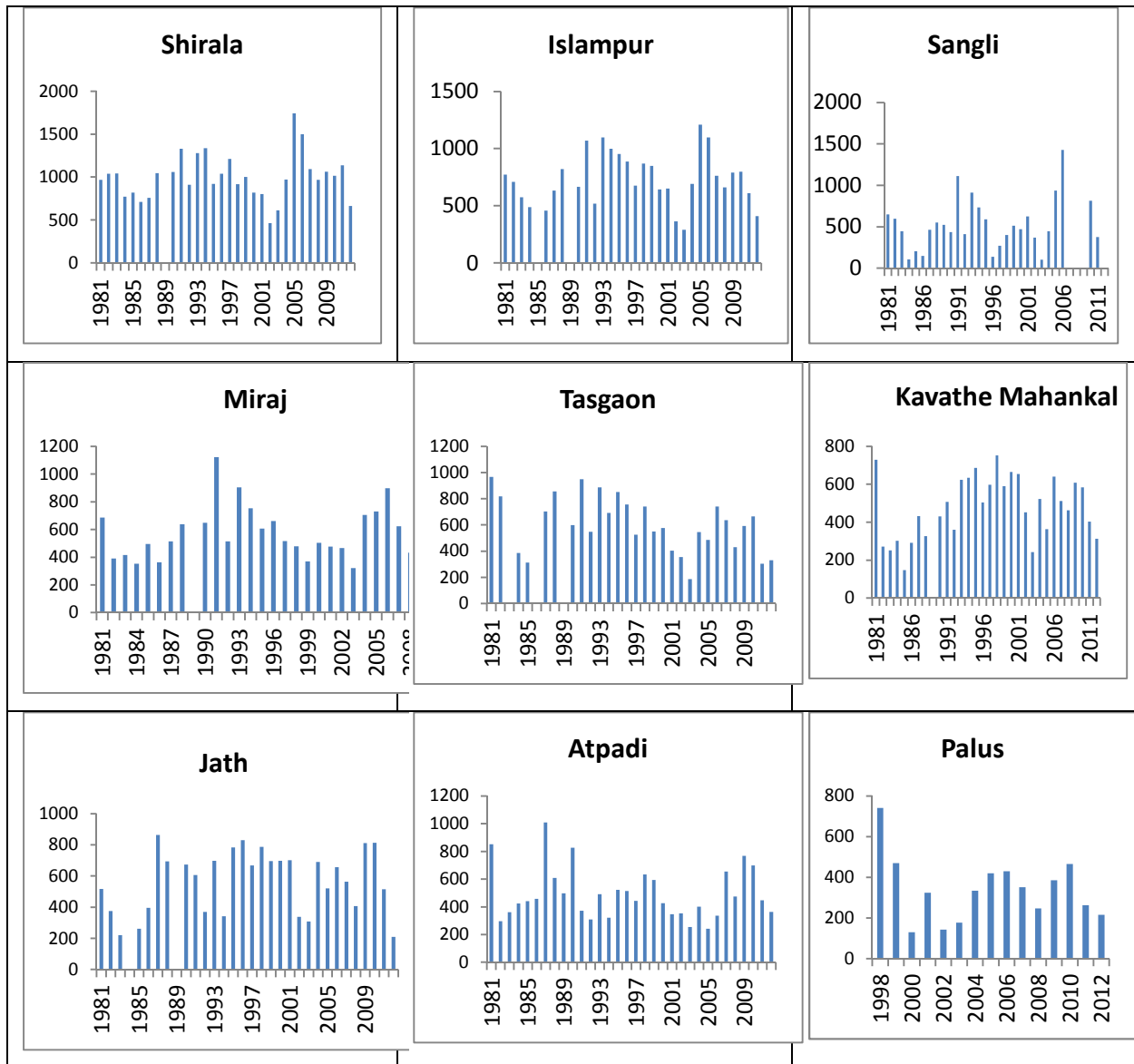
Table 2.1 gives the availability of station-wise Rainfall data of Sangli district for the construction and analysis is as given below.

Table 2.1: Station wise Data availability of rainfall for Sangli district

Sr. No.	Station	Availability	Missing Year
1	Shirala	1981-2012	1989
2	Kasegaon	2006-2012	----
3	Islampur	1981-2012	1985,1989
4	Tasgaon	1981-2012	1983,1986,1989
5	Miraj	1981-2012	1989,2007
6	Sangli	1981-2012	2008,2009,2012
7	Jath	1981-2012	1984, 1989
8	K Mahankal	1981-2012	1989
9	Palus	1998-2012	---
10	Atpadi	1981-2012	1989

From the available data, we obtain the average rainfall for of all stations of Sangli district. **Figure 2.1** gives the average rainfall of nine stations of Sangli district.

Figure 2.1: Average rainfall for nine stations of Sangli district



Rainy days play important role in the study of rainfall data. In the present study, it is assumed that if it receives 2.5mm or more rainfall in a day is a rainy day, otherwise dry day. In Sangli district the percentage of dry days is more as compared to rainy days. Therefore, descriptive statistics were obtained for **rainy days** of the ten stations. It includes average rainfall per rainy days, average median

rainfall per rainy days, average maximum rainfall per rainy days, average minimum rainfall per rainy days, average total rainfall and average number of rainy days and coefficient of variation of rainfall over these stations.

Table 2.2: Average Descriptive Statistics (in mm) of 32 years (1981-2012) for rainy days only for all stations

Sr. No.	Station	Average Rainfall per rainy day	Minimum Rainfall per rainy day	Maximum Rainfall per rainy day	Median Rainfall per rainy day	Average Rainy Days	Total rainfall
1	Shirala	15.37	3.00	85.03	8.94	62.84	1000.4
2	Kasegaon	12.36	3.00	50.71	6.89	51.57	678.61
3	Islampur	14.64	3.00	73.17	8.93	47.03	653.02
4	Tasgaon	12.99	2.91	62.20	7.89	43.52	597.20
5	Miraj	14.71	2.97	69.17	8.75	38.29	590.23
6	Sangli	13.00	2.80	71.69	7.85	37.04	528.01
7	Jath	15.63	2.83	77.03	9.04	34.97	569.53
8	K Mahankal	13.26	2.90	58.36	8.24	34.84	469.84
9	Palus	9.21	2.99	31.93	6.66	32.60	339.51
10	Atpadi	14.10	3.10	55.38	9.67	28.35	498.19

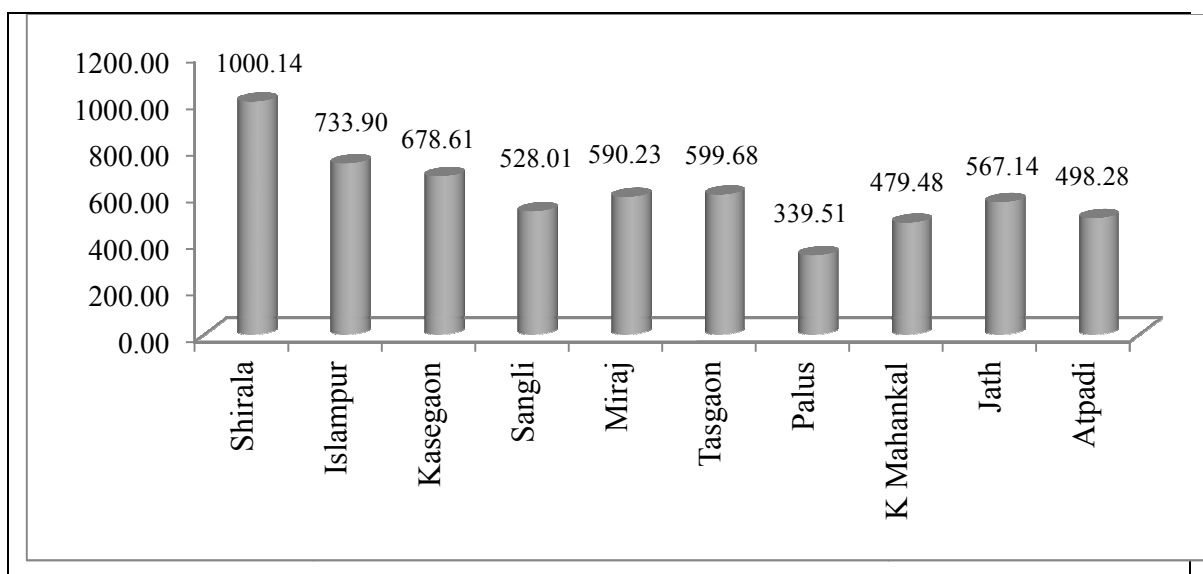


Figure 2.2: The station wise average rain fall in mm per year

From the **Table 2.2** it is observed that the average rainfall for the Shirala station is 1000.4 mm per year and it is maximum among all stations, where as Palus station has average rainfall 339.51 mm per year and is minimum among all stations. Average rainfall lies in the range 1000.4 mm to 339.51mm for different stations of Sangli district. There is lot of variation within these stations. The **Figure 2.2** shows average rain fall in mm per year for all the stations under study with the help of bar diagram.

2.2 Rainy days and Dry days

The number of rainy days and dry days play important role in the study of rainfall data. The availability of water is dependent on rainy days. If there are more rainy days then there is low scarcity of water. If numbers of dry days are more then there is scarcity of water. Here we have computed number of dry days, number of rainy days, percentages of dry days and rainy days for all stations under study.

Table 2.3 gives station wise dry days, percentages of dry and rainy days. It is observed that the average rainy days for the Shirala station is 63 days, whereas Atpadi station has only 28 days. On an average, 28 to 63 rainy days were observed at the stations of Sangli district. The number of dry days for all stations of Sangli district is considerable, which indicates scarcity of water.

Table 2.3 : Station wise average number of dry days, percentage of dry days, rainy days and percentage of rainy days.

Sr. No.	Station	Dry days	Dry days in %	Rainy Days	Rainy Days in %
1	Shirala	302	82.78	63	17.22
2	Kasegaon	313	85.87	52	14.13
3	Islampur	318	87.08	47	12.92
4	Tasgaon	323	88.18	42	11.82
5	Miraj	327	89.57	38	10.43
6	Sangli	328	89.93	37	10.07

7	Jath	330	90.45	35	9.55
8	K Mahankal	331	90.57	34	9.43
9	Palus	333	91.11	32	8.89
10	Atpadi	337	92.21	28	7.79

From the **Table 2.3** we observe that the percentage of rainy days varies from 7.79 to 17.22. The maximum percentage of rainy days is observed at the Shirala station, which is 17.22, whereas the percentage of rainy days at the Atpadi station is just 7.79. The percentage of dry days varies from 82.78 to 92.21. The **Figure 2.3** gives station wise percentage of rainy days and percentage of dry days.

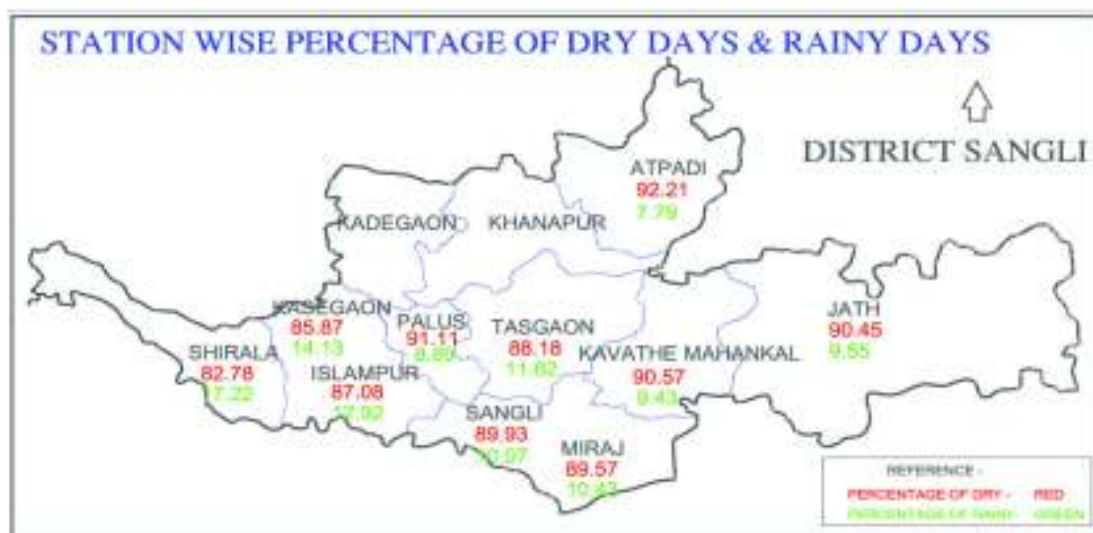


Figure 2.3: Station-wise percentage of dry days and percentage of rainy days.

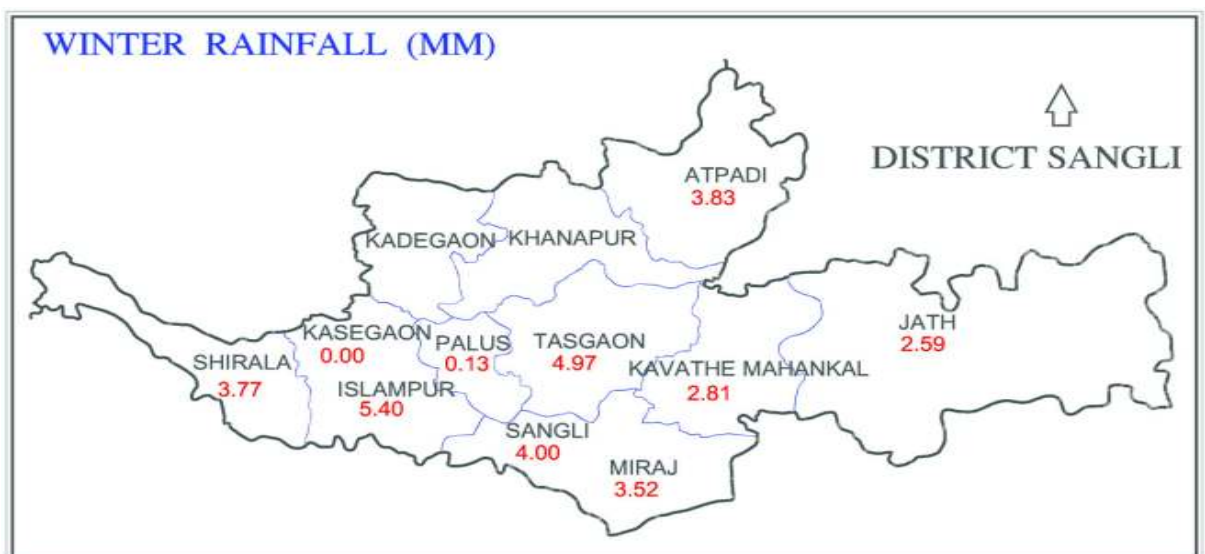
As rainfall is purely seasonal, we classify the rainfall data according to four seasons, namely winter season (January- February), pre-monsoon (March- May), Monsoon (June- September) and post monsoon (October-December). Most of the rainfall occurs in the monsoon season. During winter season all the stations of Sangli district receives very low rainfall (even much less than 6 mm). During pre-monsoon season maximum rainfall occurs at the Miraj station and it receives 64.48mm (10.98%) on an average whereas Palus station receives only 14.37mm (4.22%) rainfall on an average, which is lowest among all the stations. Most of the rain occurs in the Monsoon season. Shirala station receives 823.75mm rainfall on

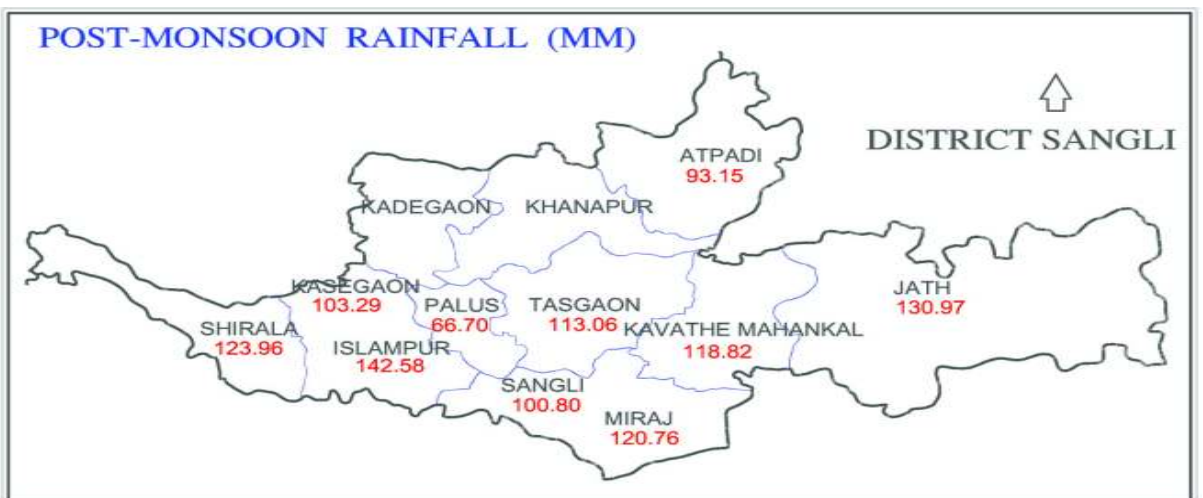
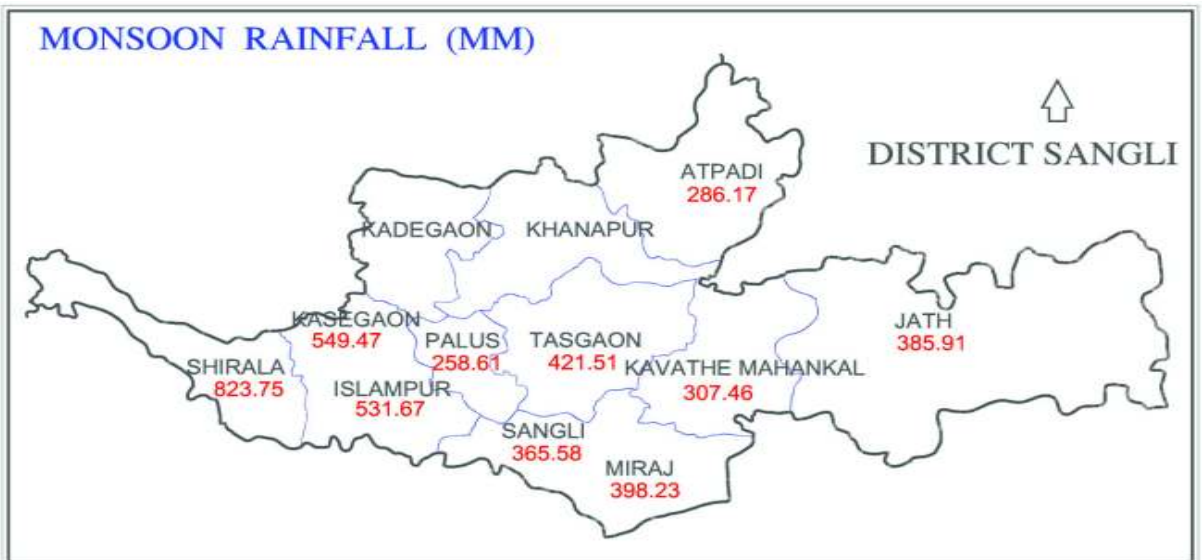
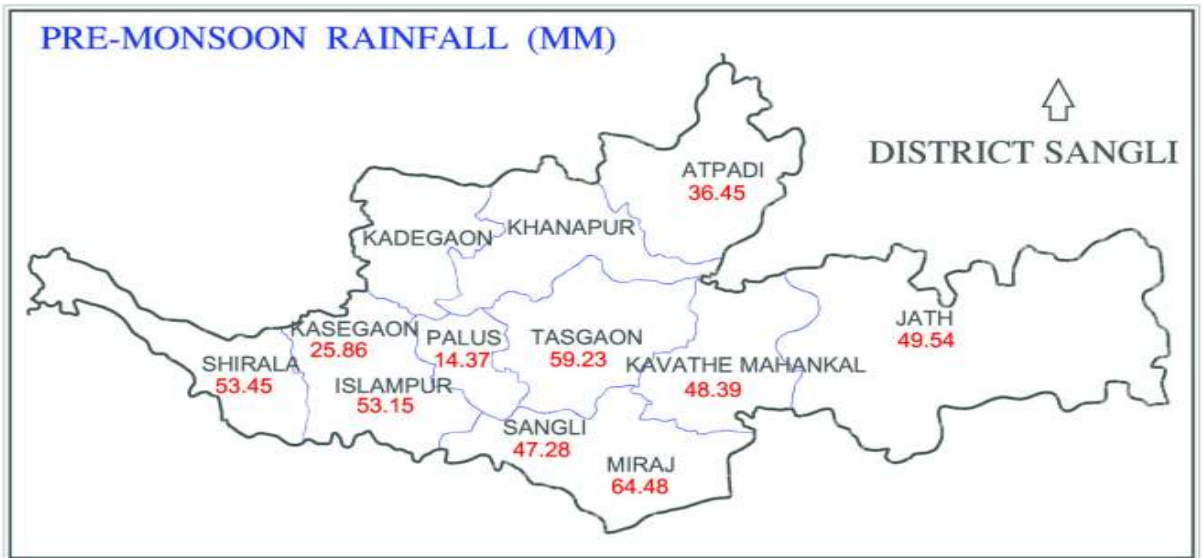
an average in Monsoon which is 81.97% to the total rainfall. In Monsoon season, Palus station receives on an average only 258.61 mm, which is 76.10% to the total rainfall. In Post-Monsoon season Islampur station receives on an average 142.58mm rainfall which is 19.45%, where as Palus station only 66.70mm rainfall in Post-Monsoon season which is 19.62% to the total rainfall. The following **Table 2.4** gives season wise average rainfall with percentage for all the stations of Sangli district.

Table 2.4: Season wise Mean rainfall (mm) over the stations of Sangli district (Bracketed quantities are in %)

Sr. No.	Station	Winter	Pre-Monsoon	Monsoon	Post Monsoon	Average Rainfall
1	Shirala	3.77(0.37)	53.45(5.31)	823.75(81.97)	123.96(12.33)	1004.94
2	Kasegaon	0.00(0.00)	25.86(3.81)	549.47(80.96)	103.29(15.22)	678.61
3	Islampur	5.40(0.73)	53.15(7.25)	531.67(72.55)	142.58(19.45)	732.80
4	Tasgaon	4.97(0.83)	59.23(9.89)	421.51(70.39)	113.06(18.88)	598.77
5	Miraj	3.52(0.59)	64.48(10.98)	398.23(67.84)	120.76(20.57)	587.00
6	Sangli	4.00(0.77)	47.28(9.13)	365.58(70.62)	100.80(19.47)	517.66
7	Jath	2.59(0.45)	49.54(8.70)	385.91(67.82)	130.97(23.01)	569.01
8	K. Mahankal	2.81(0.58)	48.39(10.13)	307.46(64.39)	118.82(24.88)	477.48
9	Palus	0.13(0.03)	14.37(4.22)	258.61(76.10)	66.70(19.62)	339.81
10	Atpadi	3.83(0.91)	36.45(8.68)	286.17(68.19)	93.15(22.20)	415.61

Figure 2.4 shows season wise and annual rainfall for all stations.





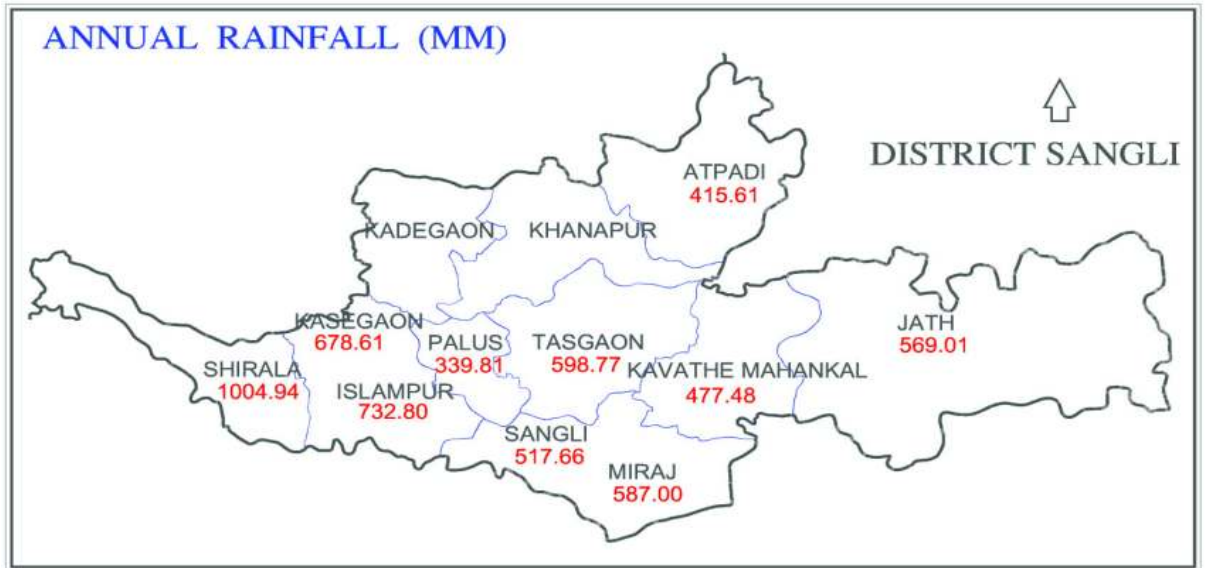


Figure 2.4: Season wise and annual rainfall for all stations of Sangli district

2.3 Coefficient of variation

Here we study the distribution of coefficient of variation of rainfall for four seasons and coefficient of variation for annual rainfall. **Table 2.5** Shows the distribution of coefficient of variation for four seasons and the coefficient of variation for annual rainfall. From the **Table 2.5**, it is observed that very less amount of rainfall is being received during the winter season and the variability is very high in all the stations of Sangli district. Maximum variability (387.30%) is over Palus and the lowest variability (199.46%) is over Kavathe Mahankal. Variability decreased as the monsoon set in and again it increased in the post-monsoon season. During monsoon season, in spite of very high rainfall, coefficient of variability of monsoon rainfall is very high in Sangli (58.73%). At the same time the coefficient of variation is low in Shirala (31.44%). During monsoon season, western part of Sangli district get excessive rain due to strong westerlies from Arabian Sea and the presence of offshore through whereas eastern parts of Sangli district get comparatively less rain.

Table 2.5: Distribution of **coefficient of variation (%)** of rainfall over the Stations of Sangli District for four seasons and annual rainfall

Sr. No.	Station	Winter	Pre-Monsoon	Monsoon	Post Monsoon	CV for Mean rainfall of 32 years
1	Shirala	278.79	91.32	31.44	60.39	25.20
2	Kasegaon	NA	92.53	33.25	64.58	29.00
3	Islampur	276.16	122.20	38.32	64.93	31.25
4	Tasgaon	345.10	83.22	38.54	66.77	35.04
5	Miraj	267.83	104.19	41.86	71.28	32.61
6	Sangli	266.58	119.26	58.73	109.71	60.77
7	Jath	312.88	97.97	38.19	77.29	34.45
8	K Mahankal	199.46	83.77	41.01	65.89	34.15
9	Palus	387.30	123.90	43.48	88.48	46.45
10	Atpadi	210.82	86.27	55.07	72.21	45.52

Figure 2.5 shows the distribution of coefficient of variation for the four seasons while **Figure 2.6** shows the distribution of coefficient of variation for annual rainfall.



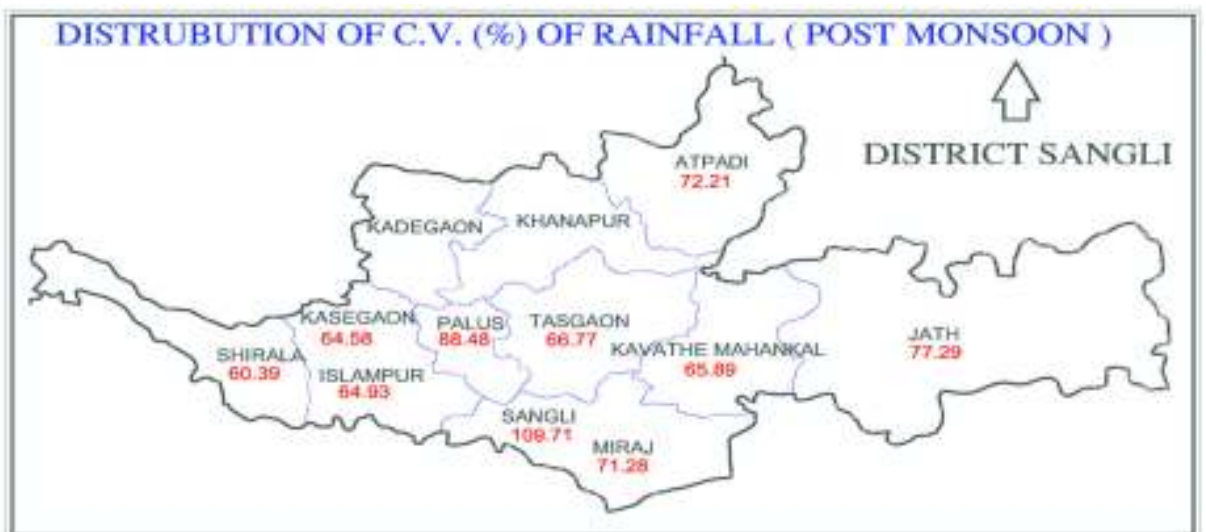
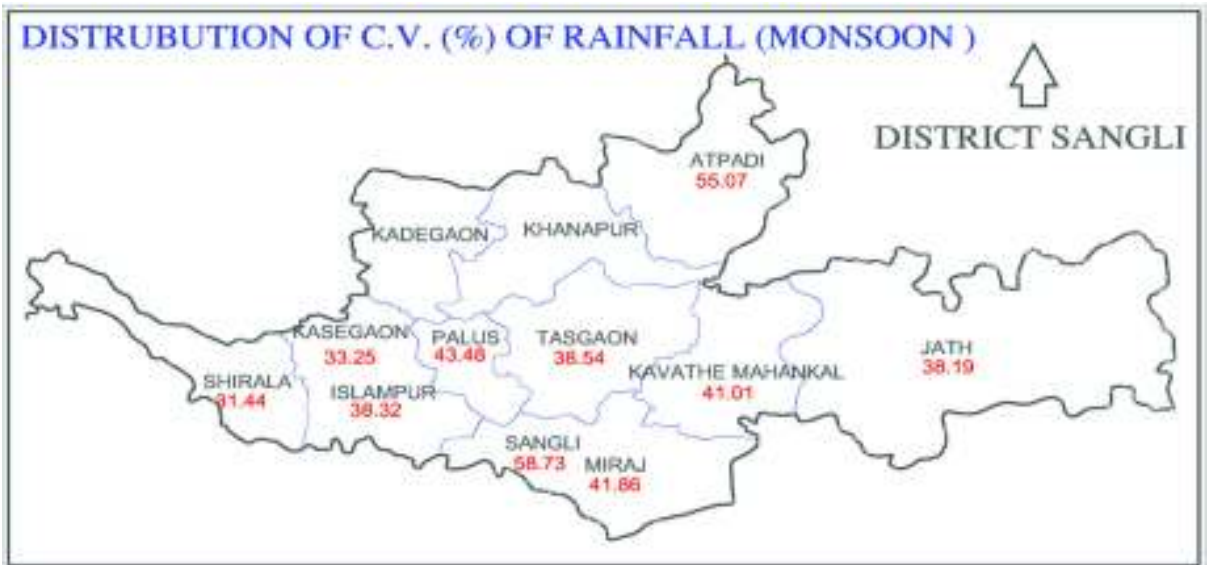
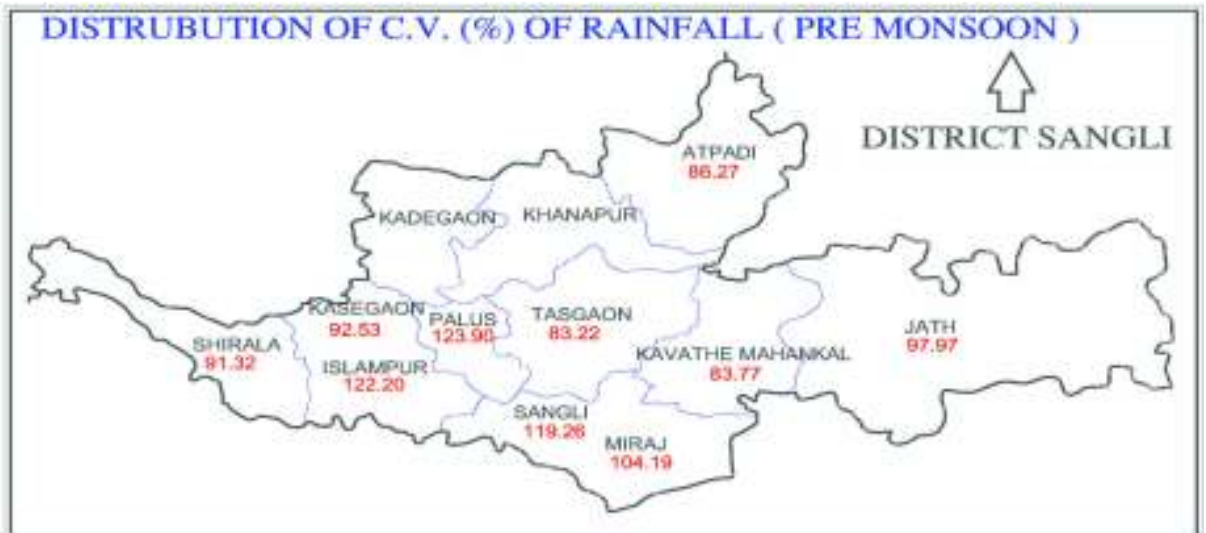


Figure 2.5: Distribution of coefficient of variation for the four seasons

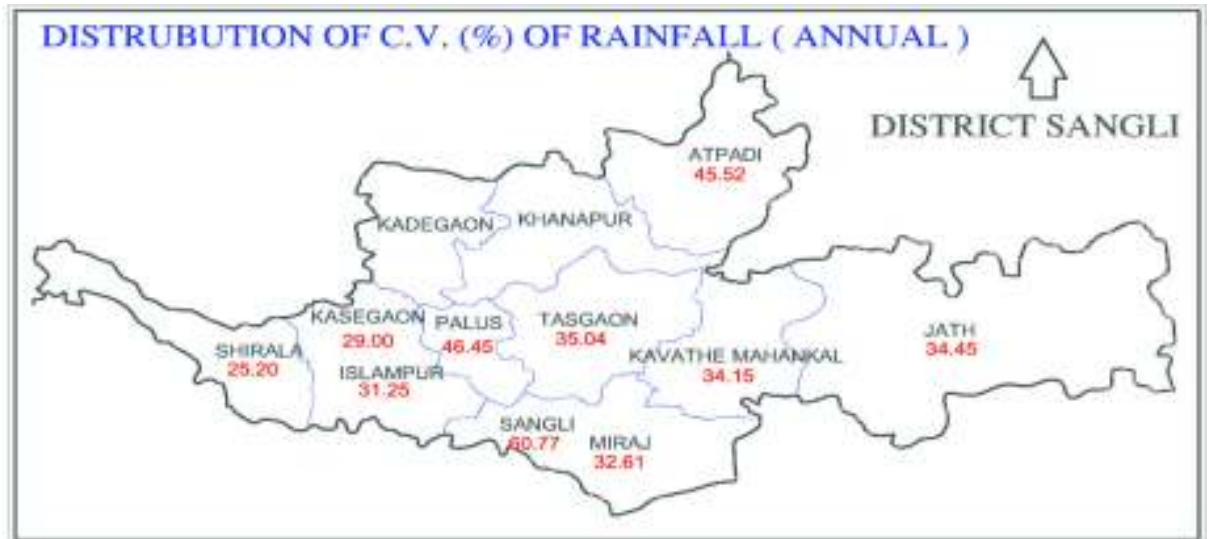


Figure 2.6: Distribution of coefficient of variation for annual rainfall.

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2.4 Probability Analysis of Dry and Wet Spells

The Markov chain probability model [Pandharinath (1991)] has been used for drought and wet frequencies during rain periods. Pandharinath (1991) and Das & Senapati (1992) have taken 20mm or more rainfall in a week as a wet period and less than 20mm a dry period. In the present study, based on Das and Senapati (1992), it is assumed that if it receives 20mm or more rainfall it is wet week, otherwise dry week. The formulae used in this study are

$$P(d)=F(d)/N$$

$$P(w)=F(w)/N$$

Where, P(d) = Probability of the week being dry.

F(d)=Frequency of dry weeks, N= Total number of years of data being used.

P(w)= Probability of the week being wet.

F(w)=Frequency of wet weeks

The consecutive dry and wet probabilities are defined as under

$$P(2D)=P(dw1)*P(ddw2)$$

$$P(3D)= P(dw1)*P(ddw2)*P(ddw3)$$

Where, P(2D)= Probability of 2 consecutive dry weeks

P(dw1)= Probability of the first week being dry

P(ddw2)=Probability of the 2nd week consecutive dry week given the preceding week being dry

Table 2.6: Standard Meteorological Weeks

MW	Calendar Month	Dates From-To	MW	Calendar Month	Dates From-To
1	January	01-07	27	July	02-08
2	"	08-14	28	"	09-15
3	"	15-21	29	"	16-22
4	"	22-28	30	"	23-29
5	"	29-04 February	31	"	30-05 August
6	February	05-11	32	August	06-12
7	"	12-18	33	"	13-19
8	"	19-25	34	"	20-26
9*	"	26-04 March	35	"	27-02 September
10	March	05-11	36	September	03-09
11	"	12-18	37	"	10-16
12	"	19-25	38	"	17-23
13	"	26-01 April	39	"	24-30
14	April	02-08	40	October	01-07
15	"	09-15	41	"	08-14
16	"	16-22	42	"	15-21
17	"	23-29	43	"	22-28
18	"	30-06 May	44	"	29-04 November
19	May	07-13	45	November	05-11
20	"	14-20	46	"	12-18
21	"	21-27	47	"	19-25
22	"	28-03 June	48	"	26-02 December
23	June	04-10	49	December	03-09
24	"	11-17	50	"	10-16
25	"	18-24	51	"	17-23
26	"	25-01 July	52**	"	24-31

*MW. No. 9 is of 8 days in leap year.

**MW. No. 52 is of 8 days

P(3D)=Probability of 3 consecutive dry week.

P(ddw3)=Probability of 3rd week being dry given the preceding week being dry.

In a similar way P(w/d), probability of wet week preceded by dry week; P(d/d), probability of dry week preceded by another dry week; P(d/w), probability of dry

week preceded by wet week; $P(w/w)$, probability of wet week preceded by another wet week; $P(2W)$, probability of 2 consecutive wet weeks; and $P(3W)$ =probability of 3 consecutive wet weeks are computed. For the computation of forward and backward accumulation of rain water, the weekly rainfall are added from the week onward to evaluate the corresponding week number in which the cumulative rainfall has reached a sum total of 75 mm and 200mm. Likewise the weekly rainfall of 52nd week is added backwards to evaluate 100mm, 200mm and 300mm total rainfall and the corresponding week numbers are noted. **Table 2.6** gives the standard meteorological weeks

The initial and transitional probabilities for all the stations of Sangli district under study are obtained by using the above formulae and they are tabulated in the **Table 2.7**

Table 2.7: Initial and Transitional probabilities for all stations under study in the Sangli District

Atpadi						
Week	Initial Probabilities (%)		Transitional Probabilities (%)			
	P(w)	P(d)	P(w/w)	P(d/w)	P(d/d)	P(w/d)
1	0.00	100.00	0.00	0.00	100.00	0.00
2	0.00	100.00	0.00	0.00	100.00	0.00
3	0.00	100.00	0.00	0.00	100.00	0.00
4	0.00	100.00	0.00	3.23	96.77	0.00
5	3.23	96.77	0.00	0.00	96.77	3.23
6	0.00	100.00	0.00	3.23	96.77	0.00
7	3.23	96.77	0.00	0.00	96.77	3.23
8	0.00	100.00	0.00	0.00	100.00	0.00
9	0.00	100.00	0.00	0.00	100.00	0.00
10	0.00	100.00	0.00	0.00	100.00	0.00
11	0.00	100.00	0.00	3.23	96.77	0.00
12	3.23	96.77	0.00	3.23	93.55	3.23
13	3.23	96.77	0.00	0.00	96.77	3.23
14	0.00	100.00	0.00	3.23	96.77	0.00
15	3.23	96.77	0.00	3.23	93.55	3.23
16	3.23	96.77	0.00	0.00	96.77	3.23
17	0.00	100.00	0.00	12.90	87.10	0.00
18	12.90	87.10	0.00	6.45	80.65	12.90
19	6.45	93.55	0.00	6.45	87.10	6.45
20	6.45	93.55	3.23	19.35	74.19	3.23

21	22.58	77.42	3.23	16.13	61.29	19.35
22	19.35	80.65	3.23	19.35	61.29	16.13
23	22.58	77.42	38.71	19.35	58.06	16.13
24	25.81	74.19	3.23	22.58	51.61	22.58
25	25.81	74.19	9.68	6.45	67.74	16.13
26	16.13	83.87	3.23	12.90	70.97	12.90
27	16.13	83.87	0.00	16.13	67.74	16.13
28	16.13	83.87	0.00	9.68	74.19	16.13
29	9.68	90.32	3.23	12.90	77.42	6.45
30	16.13	83.87	3.23	6.45	77.42	12.90
31	9.68	90.32	3.23	6.45	83.87	6.45
32	9.68	90.32	3.23	12.90	77.42	6.45
33	16.13	83.87	3.23	16.13	67.74	12.90
34	19.35	80.65	6.45	19.35	61.29	12.90
35	25.81	74.19	6.45	16.13	58.06	19.35
36	22.58	77.42	12.90	29.03	48.39	9.68
37	41.94	58.06	25.81	16.13	41.94	16.13
38	41.94	58.06	29.03	32.26	25.81	12.90
39	61.29	38.71	32.26	29.03	9.68	29.03
40	61.29	38.71	25.81	9.68	29.03	35.48
41	35.48	64.52	12.90	9.68	54.84	22.58
42	22.58	77.42	6.45	12.90	64.52	16.13
43	19.35	80.65	3.23	3.23	77.42	16.13
44	6.45	93.55	0.00	3.23	90.32	6.45
45	3.23	96.77	0.00	6.45	90.32	3.23
46	6.45	93.55	0.00	0.00	93.55	6.45
47	0.00	100.00	0.00	3.23	96.77	0.00
48	3.23	96.77	0.00	3.23	93.55	3.23
49	3.23	96.77	0.00	3.23	93.55	3.23
50	3.23	96.77	0.00	0.00	96.77	3.23
51	0.00	100.00	0.00	3.23	96.77	0.00
52	3.23	96.77	0.00	0.00	96.77	3.23

Islampur						
Week	Initial Probabilities (%)		Transitional Probabilities (%)			
	P(w)	P(d)	P(w/w)	P(d/w)	P(d/d)	P(w/d)
1	0.00	100.00	0.00	3.33	96.67	0.00
2	3.33	96.67	0.00	0.00	96.67	3.33
3	0.00	100.00	0.00	0.00	100.00	0.00
4	0.00	100.00	0.00	3.33	96.67	0.00
5	3.33	96.67	0.00	0.00	96.67	3.33
6	0.00	100.00	0.00	0.00	100.00	0.00
7	0.00	100.00	0.00	0.00	100.00	0.00
8	0.00	100.00	0.00	0.00	100.00	0.00

9	0.00	100.00	0.00	0.00	100.00	0.00
10	0.00	100.00	0.00	0.00	100.00	0.00
11	0.00	100.00	0.00	3.33	96.67	0.00
12	3.33	96.67	0.00	0.00	96.67	3.33
13	0.00	100.00	0.00	0.00	100.00	0.00
14	0.00	100.00	0.00	0.00	100.00	0.00
15	0.00	100.00	0.00	3.33	96.67	0.00
16	3.33	96.67	0.00	10.00	86.67	3.33
17	10.00	90.00	0.00	3.33	86.67	10.00
18	3.33	96.67	0.00	10.00	86.67	3.33
19	10.00	90.00	3.33	13.33	76.67	6.67
20	16.67	83.33	13.33	23.33	60.00	3.33
21	36.67	63.33	13.33	10.00	53.33	23.33
22	23.33	76.67	6.67	33.33	43.33	16.67
23	40.00	60.00	23.33	36.67	23.33	16.67
24	60.00	40.00	40.00	10.00	30.00	20.00
25	50.00	50.00	13.33	16.67	33.33	36.67
26	30.00	70.00	13.33	36.67	33.33	16.67
27	50.00	50.00	23.33	16.67	33.33	26.67
28	40.00	60.00	26.67	33.33	26.67	13.33
29	60.00	40.00	43.33	16.67	23.33	16.67
30	60.00	40.00	36.67	10.00	30.00	23.33
31	46.67	53.33	23.33	26.67	26.67	23.33
32	50.00	50.00	26.67	10.00	40.00	23.33
33	36.67	63.33	20.00	20.00	43.33	16.67
34	40.00	60.00	20.00	16.67	43.33	20.00
35	36.67	63.33	10.00	16.67	46.67	26.67
36	26.67	73.33	10.00	20.00	53.33	16.67
37	30.00	70.00	26.67	26.67	43.33	3.33
38	53.33	46.67	36.67	13.33	33.33	16.67
39	50.00	50.00	33.33	20.00	30.00	16.67
40	53.33	46.67	23.33	23.33	23.33	30.00
41	46.67	53.33	16.67	10.00	43.33	30.00
42	26.67	73.33	10.00	23.33	50.00	16.67
43	33.33	66.67	0.00	3.33	63.33	33.33
44	3.33	96.67	0.00	16.67	80.00	3.33
45	16.67	83.33	3.33	3.33	80.00	13.33
46	6.67	93.33	0.00	3.33	90.00	6.67
47	3.33	96.67	0.00	0.00	96.67	3.33
48	0.00	100.00	0.00	6.67	93.33	0.00
49	6.67	93.33	0.00	3.33	90.00	6.67
50	3.33	96.67	0.00	0.00	96.67	3.33
51	0.00	100.00	0.00	0.00	100.00	0.00
52	0.00	100.00	0.00	0.00	100.00	0.00

Jath						
Week	Initial Probabilities (%)		Transitional Probabilities (%)			
	P(w)	P(d)	P(w/w)	P(d/w)	P(d/d)	P(w/d)
1	0.00	100.00	0.00	0.00	100.00	0.00
2	0.00	100.00	0.00	3.33	96.67	0.00
3	3.33	96.67	0.00	0.00	96.67	3.33
4	0.00	100.00	0.00	0.00	100.00	0.00
5	0.00	100.00	0.00	0.00	100.00	0.00
6	0.00	100.00	0.00	0.00	100.00	0.00
7	0.00	100.00	0.00	0.00	100.00	0.00
8	0.00	100.00	0.00	0.00	100.00	0.00
9	0.00	100.00	0.00	0.00	100.00	0.00
10	0.00	100.00	0.00	0.00	100.00	0.00
11	0.00	100.00	0.00	3.33	96.67	0.00
12	3.33	96.67	0.00	3.33	93.33	3.33
13	3.33	96.67	0.00	3.33	93.33	3.33
14	3.33	96.67	0.00	0.00	96.67	3.33
15	0.00	100.00	0.00	0.00	100.00	0.00
16	0.00	100.00	0.00	0.00	100.00	0.00
17	0.00	100.00	0.00	10.00	90.00	0.00
18	10.00	90.00	0.00	6.67	83.33	10.00
19	6.67	93.33	6.67	13.33	80.00	0.00
20	20.00	80.00	13.33	10.00	70.00	6.67
21	23.33	76.67	3.33	20.00	56.67	20.00
22	23.33	76.67	16.67	40.00	36.67	6.67
23	56.67	43.33	23.33	16.67	26.67	33.33
24	40.00	60.00	3.33	20.00	40.00	36.67
25	23.33	76.67	10.00	20.00	56.67	13.33
26	30.00	70.00	6.67	6.67	63.33	23.33
27	13.33	86.67	3.33	26.67	60.00	10.00
28	30.00	70.00	6.67	10.00	60.00	23.33
29	16.67	83.33	6.67	13.33	70.00	10.00
30	20.00	80.00	3.33	16.67	63.33	16.67
31	20.00	80.00	3.33	16.67	63.33	16.67
32	20.00	80.00	3.33	10.00	70.00	16.67
33	13.33	86.67	6.67	26.67	60.00	6.67
34	33.33	66.67	13.33	13.33	53.33	20.00
35	26.67	73.33	13.33	23.33	50.00	13.33
36	36.67	63.33	23.33	30.00	33.33	13.33
37	53.33	46.67	36.67	13.33	33.33	16.67
38	50.00	50.00	36.67	30.00	20.00	13.33
39	66.67	33.33	40.00	16.67	16.67	26.67
40	56.67	43.33	20.00	16.67	26.67	36.67
41	36.67	63.33	16.67	16.67	46.67	20.00

42	33.33	66.67	3.33	13.33	53.33	30.00
43	16.67	83.33	0.00	3.33	80.00	16.67
44	3.33	96.67	0.00	10.00	86.67	3.33
45	10.00	90.00	0.00	3.33	86.67	10.00
46	3.33	96.67	0.00	6.67	90.00	3.33
47	6.67	93.33	0.00	0.00	93.33	6.67
48	0.00	100.00	0.00	3.33	96.67	0.00
49	3.33	96.67	0.00	3.33	93.33	3.33
50	3.33	96.67	0.00	0.00	96.67	3.33
51	0.00	100.00	0.00	0.00	100.00	0.00
52	0.00	100.00	0.00	0.00	100.00	0.00

Kasegaon						
Week	Initial Probabilities (%)		Transitional Probabilities (%)			
	P(w)	P(d)	P(w/w)	P(d/w)	P(d/d)	P(w/d)
1	0.00	100.00	0.00	0.00	100.00	0.00
2	0.00	100.00	0.00	0.00	100.00	0.00
3	0.00	100.00	0.00	0.00	100.00	0.00
4	0.00	100.00	0.00	0.00	100.00	0.00
5	0.00	100.00	0.00	0.00	100.00	0.00
6	0.00	100.00	0.00	0.00	100.00	0.00
7	0.00	100.00	0.00	0.00	100.00	0.00
8	0.00	100.00	0.00	0.00	100.00	0.00
9	0.00	100.00	0.00	0.00	100.00	0.00
10	0.00	100.00	0.00	0.00	100.00	0.00
11	0.00	100.00	0.00	14.29	85.71	0.00
12	14.29	85.71	0.00	0.00	85.71	14.29
13	0.00	100.00	0.00	0.00	100.00	0.00
14	0.00	100.00	0.00	0.00	100.00	0.00
15	0.00	100.00	0.00	0.00	100.00	0.00
16	0.00	100.00	0.00	0.00	100.00	0.00
17	0.00	100.00	0.00	0.00	100.00	0.00
18	0.00	100.00	0.00	0.00	100.00	0.00
19	0.00	100.00	0.00	0.00	100.00	0.00
20	0.00	100.00	0.00	28.57	71.43	0.00
21	28.57	71.43	14.29	0.00	71.43	14.29
22	14.29	85.71	0.00	42.86	42.86	14.29
23	42.86	57.14	14.29	28.57	28.57	28.57
24	42.86	57.14	14.29	28.57	28.57	28.57
25	42.86	57.14	28.57	0.00	57.14	14.29
26	28.57	71.43	28.57	14.29	57.14	0.00
27	42.86	57.14	28.57	0.00	57.14	14.29
28	28.57	71.43	14.29	14.29	57.14	14.29
29	28.57	71.43	14.29	28.57	42.86	14.29

30	42.86	57.14	28.57	42.86	14.29	14.29
31	71.43	28.57	42.86	14.29	14.29	28.57
32	57.14	42.86	28.57	0.00	42.86	28.57
33	28.57	71.43	0.00	28.57	42.86	28.57
34	28.57	71.43	14.29	42.86	28.57	14.29
35	57.14	42.86	28.57	28.57	14.29	28.57
36	57.14	42.86	28.57	28.57	14.29	28.57
37	57.14	42.86	57.14	14.29	28.57	0.00
38	71.43	28.57	28.57	28.57	0.00	42.86
39	57.14	42.86	42.86	0.00	42.86	14.29
40	42.86	57.14	28.57	42.86	14.29	14.29
41	71.43	28.57	0.00	14.29	14.29	71.43
42	14.29	85.71	14.29	0.00	85.71	0.00
43	14.29	85.71	0.00	0.00	85.71	14.29
44	0.00	100.00	0.00	28.57	71.43	0.00
45	28.57	71.43	14.29	0.00	71.43	14.29
46	14.29	85.71	0.00	0.00	85.71	14.29
47	0.00	100.00	0.00	0.00	100.00	0.00
48	0.00	100.00	0.00	0.00	100.00	0.00
49	0.00	100.00	0.00	0.00	100.00	0.00
50	0.00	100.00	0.00	0.00	100.00	0.00
51	0.00	100.00	0.00	0.00	100.00	0.00
52	0.00	100.00	0.00	0.00	100.00	0.00

Kavathe Mahankal						
Week	Initial Probabilities (%)		Transitional Probabilities (%)			
	P(w)	P(d)	P(w/w)	P(d/w)	P(d/d)	P(w/d)
1	0.00	100.00	0.00	0.00	100.00	0.00
2	0.00	100.00	0.00	0.00	100.00	0.00
3	0.00	100.00	0.00	0.00	100.00	0.00
4	0.00	100.00	0.00	0.00	100.00	0.00
5	0.00	100.00	0.00	0.00	100.00	0.00
6	0.00	100.00	0.00	0.00	100.00	0.00
7	0.00	100.00	0.00	0.00	100.00	0.00
8	0.00	100.00	0.00	0.00	100.00	0.00
9	0.00	100.00	0.00	0.00	100.00	0.00
10	0.00	100.00	0.00	0.00	100.00	0.00
11	0.00	100.00	0.00	3.23	96.77	0.00
12	3.23	96.77	0.00	0.00	96.77	3.23
13	0.00	100.00	0.00	3.23	96.77	0.00
14	3.23	96.77	0.00	6.45	90.32	3.23
15	6.45	93.55	0.00	6.45	87.10	6.45
16	6.45	93.55	0.00	3.23	90.32	6.45
17	3.23	96.77	3.23	12.90	83.87	0.00

18	16.13	83.87	0.00	3.23	80.65	16.13
19	3.23	96.77	0.00	9.68	87.10	3.23
20	9.68	90.32	3.23	16.13	74.19	6.45
21	19.35	80.65	9.68	19.35	61.29	9.68
22	29.03	70.97	19.35	16.13	54.84	9.68
23	35.48	64.52	12.90	16.13	48.39	22.58
24	29.03	70.97	9.68	16.13	54.84	19.35
25	25.81	74.19	9.68	9.68	64.52	16.13
26	19.35	80.65	9.68	9.68	70.97	9.68
27	19.35	80.65	0.00	25.81	54.84	19.35
28	25.81	74.19	6.45	9.68	64.52	19.35
29	16.13	83.87	6.45	16.13	67.74	9.68
30	22.58	77.42	3.23	12.90	64.52	19.35
31	16.13	83.87	3.23	19.35	64.52	12.90
32	22.58	77.42	0.00	6.45	70.97	22.58
33	6.45	93.55	3.23	12.90	80.65	3.23
34	16.13	83.87	3.23	6.45	77.42	12.90
35	9.68	90.32	0.00	22.58	67.74	9.68
36	22.58	77.42	9.68	35.48	41.94	12.90
37	45.16	54.84	19.35	25.81	29.03	25.81
38	45.16	54.84	29.03	29.03	25.81	16.13
39	58.06	41.94	35.48	16.13	25.81	22.58
40	51.61	48.39	25.81	12.90	35.48	25.81
41	38.71	61.29	22.58	16.13	45.16	16.13
42	38.71	61.29	6.45	16.13	45.16	32.26
43	22.58	77.42	0.00	9.68	67.74	22.58
44	9.68	90.32	0.00	6.45	83.87	9.68
45	6.45	93.55	0.00	9.68	83.87	6.45
46	9.68	90.32	0.00	3.23	87.10	9.68
47	3.23	96.77	0.00	0.00	96.77	3.23
48	0.00	100.00	0.00	0.00	100.00	0.00
49	0.00	100.00	0.00	0.00	100.00	0.00
50	0.00	100.00	0.00	0.00	100.00	0.00
51	0.00	100.00	0.00	0.00	100.00	0.00
52	0.00	100.00	0.00	0.00	100.00	0.00

Miraj						
Week	Initial Probabilities (%)		Transitional Probabilities (%)			
	P(w)	P(d)	P(w/w)	P(d/w)	P(d/d)	P(w/d)
1	0.00	100.00	0.00	0.00	100.00	0.00
2	0.00	100.00	0.00	3.23	96.77	0.00
3	3.23	96.77	0.00	0.00	96.77	3.23
4	0.00	100.00	0.00	3.23	96.77	0.00
5	3.23	96.77	0.00	0.00	96.77	3.23

6	0.00	100.00	0.00	3.23	96.77	0.00
7	3.23	96.77	0.00	0.00	96.77	3.23
8	0.00	100.00	0.00	0.00	100.00	0.00
9	0.00	100.00	0.00	0.00	100.00	0.00
10	0.00	100.00	0.00	0.00	100.00	0.00
11	0.00	100.00	0.00	3.23	96.77	0.00
12	3.23	96.77	0.00	3.23	93.55	3.23
13	3.23	96.77	0.00	3.23	93.55	3.23
14	3.23	96.77	0.00	6.45	90.32	3.23
15	6.45	93.55	0.00	9.68	83.87	6.45
16	9.68	90.32	0.00	0.00	90.32	9.68
17	0.00	100.00	0.00	19.35	80.65	0.00
18	19.35	80.65	3.23	0.00	80.65	16.13
19	3.23	96.77	0.00	9.68	87.10	3.23
20	9.68	90.32	3.23	25.81	64.52	6.45
21	29.03	70.97	12.90	9.68	61.29	16.13
22	22.58	77.42	9.68	35.48	41.94	12.90
23	45.16	54.84	19.35	19.35	35.48	25.81
24	38.71	61.29	9.68	22.58	38.71	29.03
25	32.26	67.74	3.23	25.81	41.94	29.03
26	29.03	70.97	3.23	19.35	51.61	25.81
27	22.58	77.42	6.45	19.35	58.06	16.13
28	25.81	74.19	9.68	25.81	48.39	16.13
29	35.48	64.52	16.13	25.81	38.71	19.35
30	41.94	58.06	22.58	19.35	38.71	19.35
31	41.94	58.06	19.35	19.35	38.71	22.58
32	38.71	61.29	9.68	12.90	48.39	29.03
33	22.58	77.42	9.68	25.81	51.61	12.90
34	35.48	64.52	9.68	9.68	54.84	25.81
35	19.35	80.65	12.90	12.90	67.74	6.45
36	25.81	74.19	6.45	19.35	54.84	19.35
37	25.81	74.19	16.13	32.26	41.94	9.68
38	48.39	51.61	19.35	32.26	19.35	29.03
39	51.61	48.39	41.94	16.13	32.26	9.68
40	58.06	41.94	32.26	16.13	25.81	25.81
41	48.39	51.61	16.13	12.90	38.71	32.26
42	29.03	70.97	3.23	16.13	54.84	25.81
43	19.35	80.65	0.00	0.00	80.65	19.35
44	0.00	100.00	0.00	16.13	83.87	0.00
45	16.13	83.87	3.23	3.23	80.65	12.90
46	6.45	93.55	0.00	6.45	87.10	6.45
47	6.45	93.55	0.00	0.00	93.55	6.45
48	0.00	100.00	0.00	0.00	100.00	0.00
49	0.00	100.00	0.00	0.00	100.00	0.00

50	0.00	100.00	0.00	0.00	100.00	0.00
51	0.00	100.00	0.00	0.00	100.00	0.00
52	0.00	100.00	0.00	0.00	100.00	0.00

Palus						
Week	Initial Probabilities (%)		Transitional Probabilities (%)			
	P(w)	P(d)	P(w/w)	P(d/w)	P(d/d)	P(w/d)
1	0.00	100.00	0.00	0.00	100.00	0.00
2	0.00	100.00	0.00	0.00	100.00	0.00
3	0.00	100.00	0.00	0.00	100.00	0.00
4	0.00	100.00	0.00	0.00	100.00	0.00
5	0.00	100.00	0.00	0.00	100.00	0.00
6	0.00	100.00	0.00	0.00	100.00	0.00
7	0.00	100.00	0.00	0.00	100.00	0.00
8	0.00	100.00	0.00	0.00	100.00	0.00
9	0.00	100.00	0.00	0.00	100.00	0.00
10	0.00	100.00	0.00	0.00	100.00	0.00
11	0.00	100.00	0.00	0.00	100.00	0.00
12	0.00	100.00	0.00	0.00	100.00	0.00
13	0.00	100.00	0.00	0.00	100.00	0.00
14	0.00	100.00	0.00	0.00	100.00	0.00
15	0.00	100.00	0.00	0.00	100.00	0.00
16	0.00	100.00	0.00	0.00	100.00	0.00
17	0.00	100.00	0.00	6.67	93.33	0.00
18	6.67	93.33	0.00	6.67	86.67	6.67
19	6.67	93.33	6.67	0.00	93.33	0.00
20	6.67	93.33	0.00	0.00	93.33	6.67
21	0.00	100.00	0.00	13.33	86.67	0.00
22	13.33	86.67	0.00	6.67	80.00	13.33
23	6.67	93.33	6.67	33.33	60.00	0.00
24	40.00	60.00	6.67	13.33	46.67	33.33
25	20.00	80.00	13.33	6.67	73.33	6.67
26	20.00	80.00	0.00	20.00	60.00	20.00
27	20.00	80.00	6.67	13.33	66.67	13.33
28	20.00	80.00	6.67	13.33	66.67	13.33
29	20.00	80.00	13.33	13.33	66.67	6.67
30	26.67	73.33	13.33	13.33	60.00	13.33
31	26.67	73.33	13.33	20.00	53.33	13.33
32	33.33	66.67	0.00	0.00	66.67	33.33
33	0.00	100.00	0.00	13.33	86.67	0.00
34	13.33	86.67	0.00	13.33	73.33	13.33
35	13.33	86.67	13.33	6.67	80.00	0.00
36	20.00	80.00	6.67	26.67	53.33	13.33
37	33.33	66.67	20.00	13.33	53.33	13.33

38	33.33	66.67	6.67	26.67	40.00	26.67
39	33.33	66.67	26.67	13.33	53.33	6.67
40	40.00	60.00	26.67	20.00	40.00	13.33
41	46.67	53.33	6.67	6.67	46.67	40.00
42	13.33	86.67	0.00	0.00	86.67	13.33
43	0.00	100.00	0.00	0.00	100.00	0.00
44	0.00	100.00	0.00	0.00	100.00	0.00
45	0.00	100.00	0.00	6.67	93.33	0.00
46	6.67	93.33	0.00	0.00	93.33	6.67
47	0.00	100.00	0.00	0.00	100.00	0.00
48	0.00	100.00	0.00	0.00	100.00	0.00
49	0.00	100.00	0.00	0.00	100.00	0.00
50	0.00	100.00	0.00	0.00	100.00	0.00
51	0.00	100.00	0.00	0.00	100.00	0.00
52	0.00	100.00	0.00	0.00	100.00	0.00

Sangli						
Week	Initial Probabilities (%)		Transitional Probabilities (%)			
	P(w)	P(d)	P(w/w)	P(d/w)	P(d/d)	P(w/d)
1	0.00	100.00	0.00	0.00	100.00	0.00
2	0.00	100.00	0.00	0.00	100.00	0.00
3	0.00	100.00	0.00	0.00	100.00	0.00
4	0.00	100.00	0.00	0.00	100.00	0.00
5	0.00	100.00	0.00	3.57	96.43	0.00
6	3.57	96.43	0.00	0.00	96.43	3.57
7	0.00	100.00	0.00	3.57	96.43	0.00
8	3.57	96.43	0.00	0.00	96.43	3.57
9	0.00	100.00	0.00	0.00	100.00	0.00
10	0.00	100.00	0.00	0.00	100.00	0.00
11	0.00	100.00	0.00	0.00	100.00	0.00
12	0.00	100.00	0.00	0.00	100.00	0.00
13	0.00	100.00	0.00	0.00	100.00	0.00
14	0.00	100.00	0.00	3.57	96.43	0.00
15	3.57	96.43	0.00	3.57	92.86	3.57
16	3.57	96.43	0.00	0.00	96.43	3.57
17	0.00	100.00	0.00	10.71	89.29	0.00
18	10.71	89.29	0.00	3.57	85.71	10.71
19	3.57	96.43	0.00	10.71	85.71	3.57
20	10.71	89.29	7.14	14.29	75.00	3.57
21	21.43	78.57	14.29	14.29	64.29	7.14
22	28.57	71.43	21.43	17.86	53.57	7.14
23	39.29	60.71	21.43	21.43	39.29	17.86
24	42.86	57.14	10.71	17.86	39.29	32.14

25	28.57	71.43	7.14	21.43	50.00	21.43
26	28.57	71.43	14.29	14.29	57.14	14.29
27	28.57	71.43	7.14	28.57	42.86	21.43
28	35.71	64.29	21.43	21.43	42.86	14.29
29	42.86	57.14	32.14	7.14	50.00	10.71
30	39.29	60.71	17.86	10.71	50.00	21.43
31	28.57	71.43	14.29	25.00	46.43	14.29
32	39.29	60.71	14.29	7.14	53.57	25.00
33	21.43	78.57	7.14	14.29	64.29	14.29
34	21.43	78.57	0.00	14.29	64.29	21.43
35	14.29	85.71	7.14	14.29	71.43	7.14
36	21.43	78.57	14.29	14.29	64.29	7.14
37	28.57	71.43	17.86	21.43	50.00	10.71
38	39.29	60.71	25.00	14.29	46.43	14.29
39	39.29	60.71	21.43	21.43	39.29	17.86
40	42.86	57.14	17.86	21.43	35.71	25.00
41	39.29	60.71	17.86	7.14	53.57	21.43
42	25.00	75.00	3.57	10.71	64.29	21.43
43	14.29	85.71	3.57	0.00	85.71	10.71
44	3.57	96.43	0.00	14.29	82.14	3.57
45	14.29	85.71	0.00	3.57	82.14	14.29
46	3.57	96.43	0.00	7.14	89.29	3.57
47	7.14	92.86	0.00	0.00	92.86	7.14
48	0.00	100.00	0.00	0.00	100.00	0.00
49	0.00	100.00	0.00	3.57	96.43	0.00
50	3.57	96.43	0.00	0.00	96.43	3.57
51	0.00	100.00	0.00	0.00	100.00	0.00
52	0.00	100.00	0.00	0.00	100.00	0.00

Shirala						
Week	Initial Probabilities (%)		Transitional Probabilities (%)			
	P(w)	P(d)	P(w/w)	P(d/w)	P(d/d)	P(w/d)
1	3.23	96.77	0.00	6.45	90.32	3.23
2	6.45	93.55	0.00	0.00	93.55	6.45
3	0.00	100.00	0.00	0.00	100.00	0.00
4	0.00	100.00	0.00	0.00	100.00	0.00
5	0.00	100.00	0.00	0.00	100.00	0.00
6	0.00	100.00	0.00	0.00	100.00	0.00
7	0.00	100.00	0.00	0.00	100.00	0.00
8	0.00	100.00	0.00	0.00	100.00	0.00
9	0.00	100.00	0.00	3.23	96.77	0.00
10	3.23	96.77	0.00	0.00	96.77	3.23
11	0.00	100.00	0.00	3.23	96.77	0.00
12	3.23	96.77	0.00	3.23	93.55	3.23

13	3.23	96.77	0.00	3.23	93.55	3.23
14	3.23	96.77	0.00	3.23	93.55	3.23
15	3.23	96.77	3.23	0.00	96.77	0.00
16	3.23	96.77	3.23	12.90	83.87	0.00
17	16.13	83.87	3.23	9.68	74.19	12.90
18	12.90	87.10	0.00	6.45	80.65	12.90
19	6.45	93.55	0.00	9.68	83.87	6.45
20	9.68	90.32	3.23	22.58	67.74	6.45
21	25.81	74.19	12.90	19.35	54.84	12.90
22	32.26	67.74	16.13	19.35	48.39	16.13
23	35.48	64.52	22.58	41.94	22.58	12.90
24	64.52	35.48	48.39	22.58	12.90	16.13
25	70.97	29.03	41.94	12.90	16.13	29.03
26	54.84	45.16	41.94	19.35	25.81	12.90
27	61.29	38.71	41.94	12.90	25.81	19.35
28	54.84	45.16	45.16	35.48	9.68	9.68
29	80.65	19.35	58.06	19.35	0.00	22.58
30	77.42	22.58	54.84	12.90	9.68	22.58
31	67.74	32.26	48.39	19.35	12.90	19.35
32	67.74	32.26	54.84	19.35	12.90	12.90
33	74.19	25.81	38.71	16.13	9.68	35.48
34	54.84	45.16	25.81	16.13	29.03	29.03
35	41.94	58.06	35.48	16.13	41.94	6.45
36	51.61	48.39	19.35	9.68	38.71	32.26
37	29.03	70.97	16.13	32.26	38.71	12.90
38	48.39	51.61	29.03	19.35	32.26	19.35
39	48.39	51.61	32.26	19.35	32.26	16.13
40	51.61	48.39	25.81	25.81	22.58	25.81
41	51.61	48.39	12.90	9.68	38.71	38.71
42	22.58	77.42	3.23	9.68	67.74	19.35
43	12.90	87.10	3.23	6.45	80.65	9.68
44	9.68	90.32	3.23	12.90	77.42	6.45
45	16.13	83.87	3.23	6.45	77.42	12.90
46	9.68	90.32	0.00	0.00	90.32	9.68
47	0.00	100.00	0.00	3.23	96.77	0.00
48	3.23	96.77	3.23	0.00	96.77	0.00
49	3.23	96.77	0.00	3.23	93.55	3.23
50	3.23	96.77	0.00	0.00	96.77	3.23
51	0.00	100.00	0.00	0.00	100.00	0.00
52	0.00	100.00	0.00	3.23	96.77	0.00

Tasgaon						
Week	Initial Probabilities (%)		Transitional Probabilities (%)			
	P(w)	P(d)	P(w/w)	P(d/w)	P(d/d)	P(w/d)
1	0.00	100.00	0.00	3.45	96.55	0.00
2	3.45	96.55	3.45	0.00	96.55	0.00
3	3.45	96.55	0.00	3.45	93.10	3.45
4	3.45	96.55	0.00	0.00	96.55	3.45
5	0.00	100.00	0.00	0.00	100.00	0.00
6	0.00	100.00	0.00	3.45	96.55	0.00
7	3.45	96.55	0.00	0.00	96.55	3.45
8	0.00	100.00	0.00	0.00	100.00	0.00
9	0.00	100.00	0.00	0.00	100.00	0.00
10	0.00	100.00	0.00	0.00	100.00	0.00
11	0.00	100.00	0.00	3.45	96.55	0.00
12	3.45	96.55	0.00	0.00	96.55	3.45
13	0.00	100.00	0.00	0.00	100.00	0.00
14	0.00	100.00	0.00	3.45	96.55	0.00
15	3.45	96.55	0.00	0.00	96.55	3.45
16	0.00	100.00	0.00	6.90	93.10	0.00
17	6.90	93.10	0.00	13.79	79.31	6.90
18	13.79	86.21	0.00	6.90	79.31	13.79
19	6.90	93.10	3.45	13.79	79.31	3.45
20	17.24	82.76	10.34	20.69	62.07	6.90
21	31.03	68.97	20.69	17.24	51.72	10.34
22	37.93	62.07	20.69	20.69	41.38	17.24
23	41.38	58.62	17.24	24.14	34.48	24.14
24	41.38	58.62	10.34	20.69	37.93	31.03
25	31.03	68.97	10.34	13.79	55.17	20.69
26	24.14	75.86	10.34	27.59	48.28	13.79
27	37.93	62.07	3.45	27.59	34.48	34.48
28	31.03	68.97	20.69	34.48	34.48	10.34
29	55.17	44.83	31.03	10.34	34.48	24.14
30	41.38	58.62	17.24	24.14	34.48	24.14
31	41.38	58.62	17.24	17.24	41.38	24.14
32	34.48	65.52	3.45	17.24	48.28	31.03
33	20.69	79.31	6.90	24.14	55.17	13.79
34	31.03	68.97	3.45	17.24	51.72	27.59
35	20.69	79.31	6.90	20.69	58.62	13.79
36	27.59	72.41	13.79	34.48	37.93	13.79
37	48.28	51.72	31.03	27.59	24.14	17.24
38	58.62	41.38	34.48	17.24	24.14	24.14
39	51.72	48.28	31.03	24.14	24.14	20.69
40	55.17	44.83	27.59	24.14	20.69	27.59
41	51.72	48.28	17.24	13.79	34.48	34.48

42	31.03	68.97	3.45	10.34	58.62	27.59
43	13.79	86.21	0.00	0.00	86.21	13.79
44	0.00	100.00	0.00	10.34	89.66	0.00
45	10.34	89.66	3.45	6.90	82.76	6.90
46	10.34	89.66	0.00	3.45	86.21	10.34
47	3.45	96.55	0.00	0.00	96.55	3.45
48	0.00	100.00	0.00	3.45	96.55	0.00
49	3.45	96.55	0.00	6.90	89.66	3.45
50	6.90	93.10	0.00	0.00	93.10	6.90
51	0.00	100.00	0.00	0.00	100.00	0.00
52	0.00	100.00	0.00	0.00	100.00	0.00

2.5 Results and Discussion

For the comparisons we consider only two stations Shirala and Atpadi. Shirala station receives more rainfall whereas Atpadi station receives comparatively less rainfall. We make the comparison of probabilities of dry week, wet week, wet given wet, wet given dry, dry given wet and dry given dry weeks between Shirala and Atpadi station. Above table shows the probability of occurrence of dry week is very high until the end of 23rd week. The range of probability of occurrence of dry week from 1st to 23rd week is from 64.52 % to 100% for Shirala station. At the same time, for Atpadi station the same probability of occurrence of dry week from 1st to 23rd week is from 77.42 % to 100%. The probability of occurrence of dry week preceded by another dry week and that of dry week by another wet week from 1st to 23rd week vary from 22.58 % to 100% and 0% to 41.94% for Shirala station. The same probability for Atpadi station varies from 58.06% to 100% and 0% to 22.58% respectively.

From 24th to 41st week the probability of wet week increases. It varies from 29.03% to 80.65% for Shirala station. The same probability for Atpadi station varies from 9.68% to 61.29%. In the same period the probabilities of dry week varies from 19.35% to 70.97 for Shirala station. The same probability for Atpadi station varies from 38.71% to 90.32%. The probability of occurrence of dry week preceded by another dry week and that of dry week by another wet week from 24th to 41st week vary from 0 % to 41.94% and 9.68% to 32.26% for Shirala station. The

same probability for Atpadi station varies from 9.68% to 8.087% and 6.45% to 32.26% respectively.

2.6 The Consecutive Dry and Wet probabilities

In the following we compute two Consecutive Dry Probabilities (CDP) in percentage, three Consecutive Dry Probabilities, two Consecutive Wet Probabilities (CWP) and three Consecutive Wet Probabilities for all stations of Sangli district and are tabulated in **Table 2.8**. For the purpose of comparison we consider the CDP and CWP for Atpadi and Shirala Station.

Table 2.8 The consecutive Dry and Wet probabilities in percentage

Atpadi				
Week No.	CDP (%)		CWP (%)	
	P(2D)	P(3D)	P(2W)	P(3W)
1	100.00	100.00	0.00	0.00
2	100.00	100.00	0.00	0.00
3	100.00	96.77	0.00	0.00
4	96.77	96.77	0.00	0.00
5	96.77	93.55	0.00	0.00
6	96.77	96.77	0.00	0.00
7	96.77	96.77	0.00	0.00
8	100.00	100.00	0.00	0.00
9	100.00	100.00	0.00	0.00
10	100.00	96.77	0.00	0.00
11	96.77	93.55	0.00	0.00
12	93.55	93.55	0.00	0.00
13	96.77	93.55	0.00	0.00
14	96.77	93.55	0.00	0.00
15	93.55	93.55	0.00	0.00
16	96.77	83.87	0.00	0.00
17	87.10	80.65	0.00	0.00
18	80.65	77.42	0.00	0.00
19	87.10	70.97	0.00	0.00
20	74.19	61.29	3.23	0.00
21	61.29	45.16	3.23	3.23
22	61.29	51.61	3.23	3.23
23	58.06	41.94	6.45	0.00
24	51.61	45.16	3.23	0.00
25	67.74	54.84	9.68	3.23
26	70.97	58.06	3.23	0.00

27	67.74	61.29	0.00	0.00
28	74.19	61.29	0.00	0.00
29	77.42	74.19	3.23	0.00
30	77.42	70.97	3.23	0.00
31	83.87	70.97	3.23	3.23
32	77.42	61.29	3.23	0.00
33	67.74	51.61	3.23	0.00
34	61.29	48.39	6.45	0.00
35	58.06	32.26	6.45	3.23
36	48.39	35.48	12.90	6.45
37	41.94	22.58	25.81	19.35
38	25.81	6.45	29.03	16.13
39	9.68	6.45	32.26	16.13
40	29.03	25.81	25.81	9.68
41	54.84	45.16	12.90	3.23
42	64.52	61.29	6.45	0.00
43	77.42	74.19	3.23	0.00
44	90.32	83.87	0.00	0.00
45	90.32	90.32	0.00	0.00
46	93.55	90.32	0.00	0.00
47	96.77	93.55	0.00	0.00
48	93.55	90.32	0.00	0.00
49	93.55	93.55	0.00	0.00
50	96.77	93.55	0.00	0.00
51	96.77	96.77	0.00	0.00
52	96.77	93.55	0.00	0.00

Jath				
	CDP (%)		CWP (%)	
Week No.	P(2D)	P(3D)	P(2W)	P(3W)
1	100.00	96.67	0.00	0.00
2	96.67	96.67	0.00	0.00
3	96.67	96.67	0.00	0.00
4	100.00	100.00	0.00	0.00
5	100.00	100.00	0.00	0.00
6	100.00	100.00	0.00	0.00
7	100.00	100.00	0.00	0.00
8	100.00	100.00	0.00	0.00
9	100.00	100.00	0.00	0.00
10	100.00	96.67	0.00	0.00
11	96.67	93.33	0.00	0.00
12	93.33	90.00	0.00	0.00
13	93.33	93.33	0.00	0.00
14	96.67	96.67	0.00	0.00

15	100.00	100.00	0.00	0.00
16	100.00	90.00	0.00	0.00
17	90.00	83.33	0.00	0.00
18	83.33	73.33	0.00	0.00
19	80.00	70.00	6.67	3.33
20	70.00	53.33	13.33	0.00
21	56.67	26.67	3.33	3.33
22	36.67	23.33	16.67	6.67
23	26.67	23.33	23.33	0.00
24	40.00	26.67	3.33	0.00
25	56.67	50.00	10.00	3.33
26	63.33	43.33	6.67	3.33
27	60.00	50.00	3.33	0.00
28	60.00	50.00	6.67	0.00
29	70.00	56.67	6.67	0.00
30	63.33	46.67	3.33	0.00
31	63.33	53.33	3.33	0.00
32	70.00	46.67	3.33	0.00
33	60.00	46.67	6.67	6.67
34	53.33	33.33	13.33	3.33
35	50.00	26.67	13.33	6.67
36	33.33	20.00	23.33	16.67
37	33.33	13.33	36.67	26.67
38	20.00	6.67	36.67	20.00
39	16.67	10.00	40.00	10.00
40	26.67	16.67	20.00	6.67
41	46.67	36.67	16.67	0.00
42	53.33	50.00	3.33	0.00
43	80.00	76.67	0.00	0.00
44	86.67	83.33	0.00	0.00
45	86.67	83.33	0.00	0.00
46	90.00	90.00	0.00	0.00
47	93.33	90.00	0.00	0.00
48	96.67	93.33	0.00	0.00
49	93.33	93.33	0.00	0.00
50	96.67	96.67	0.00	0.00
51	100.00	100.00	0.00	0.00
52	100.00	100.00	0.00	0.00

Kavathe Mahankal				
	CDP (%)		CWP (%)	
Week No.	P(2D)	P(3D)	P(2W)	P(3W)
1	100.00	100.00	0.00	0.00
2	100.00	100.00	0.00	0.00
3	100.00	100.00	0.00	0.00
4	100.00	100.00	0.00	0.00
5	100.00	100.00	0.00	0.00
6	100.00	100.00	0.00	0.00
7	100.00	100.00	0.00	0.00
8	100.00	100.00	0.00	0.00
9	100.00	100.00	0.00	0.00
10	100.00	96.77	0.00	0.00
11	96.77	96.77	0.00	0.00
12	96.77	93.55	0.00	0.00
13	96.77	90.32	0.00	0.00
14	90.32	83.87	0.00	0.00
15	87.10	83.87	0.00	0.00
16	90.32	77.42	0.00	0.00
17	83.87	80.65	3.23	0.00
18	80.65	70.97	0.00	0.00
19	87.10	70.97	0.00	0.00
20	74.19	61.29	3.23	0.00
21	61.29	45.16	9.68	6.45
22	54.84	41.94	19.35	9.68
23	48.39	38.71	12.90	3.23
24	54.84	48.39	9.68	0.00
25	64.52	61.29	9.68	9.68
26	70.97	48.39	9.68	0.00
27	54.84	48.39	0.00	0.00
28	64.52	48.39	6.45	3.23
29	67.74	58.06	6.45	0.00
30	64.52	48.39	3.23	3.23
31	64.52	61.29	3.23	0.00
32	70.97	61.29	0.00	0.00
33	80.65	74.19	3.23	0.00
34	77.42	54.84	3.23	0.00
35	67.74	35.48	0.00	0.00
36	41.94	25.81	9.68	9.68
37	29.03	16.13	19.35	12.90
38	25.81	19.35	29.03	12.90
39	25.81	12.90	35.48	19.35
40	35.48	25.81	25.81	16.13
41	45.16	32.26	22.58	6.45

42	45.16	38.71	6.45	0.00
43	67.74	64.52	0.00	0.00
44	83.87	74.19	0.00	0.00
45	83.87	83.87	0.00	0.00
46	87.10	87.10	0.00	0.00
47	96.77	96.77	0.00	0.00
48	100.00	100.00	0.00	0.00
49	100.00	100.00	0.00	0.00
50	100.00	100.00	0.00	0.00
51	100.00	100.00	0.00	0.00
52	100.00	100.00	0.00	0.00

Palus				
Week No.	CDP (%)		CWP (%)	
	P(2D)	P(3D)	P(2W)	P(3W)
1	100.00	100.00	0.00	0.00
2	100.00	100.00	0.00	0.00
3	100.00	100.00	0.00	0.00
4	100.00	100.00	0.00	0.00
5	100.00	100.00	0.00	0.00
6	100.00	100.00	0.00	0.00
7	100.00	100.00	0.00	0.00
8	100.00	100.00	0.00	0.00
9	100.00	100.00	0.00	0.00
10	100.00	100.00	0.00	0.00
11	100.00	100.00	0.00	0.00
12	100.00	100.00	0.00	0.00
13	100.00	100.00	0.00	0.00
14	100.00	100.00	0.00	0.00
15	100.00	100.00	0.00	0.00
16	100.00	93.33	0.00	0.00
17	93.33	86.67	0.00	0.00
18	86.67	86.67	0.00	0.00
19	93.33	93.33	6.67	0.00
20	93.33	80.00	0.00	0.00
21	86.67	80.00	0.00	0.00
22	80.00	53.33	0.00	0.00
23	60.00	46.67	6.67	0.00
24	46.67	40.00	6.67	6.67
25	73.33	60.00	13.33	0.00
26	60.00	46.67	0.00	0.00
27	66.67	53.33	6.67	0.00
28	66.67	53.33	6.67	6.67
29	66.67	53.33	13.33	6.67

30	60.00	46.67	13.33	13.33
31	53.33	53.33	13.33	0.00
32	66.67	60.00	0.00	0.00
33	86.67	73.33	0.00	0.00
34	73.33	66.67	0.00	0.00
35	80.00	53.33	13.33	0.00
36	53.33	46.67	6.67	6.67
37	53.33	33.33	20.00	0.00
38	40.00	26.67	6.67	6.67
39	53.33	40.00	26.67	20.00
40	40.00	40.00	26.67	6.67
41	46.67	46.67	6.67	0.00
42	86.67	86.67	0.00	0.00
43	100.00	100.00	0.00	0.00
44	100.00	93.33	0.00	0.00
45	93.33	93.33	0.00	0.00
46	93.33	93.33	0.00	0.00
47	100.00	100.00	0.00	0.00
48	100.00	100.00	0.00	0.00
49	100.00	100.00	0.00	0.00
50	100.00	100.00	0.00	0.00
51	100.00	100.00	0.00	0.00
52	100.00	100.00	0.00	0.00

Shirala				
Week No.	CDP (%)		CWP (%)	
	P(2D)	P(3D)	P(2W)	P(3W)
1	90.32	90.32	0.00	0.00
2	93.55	93.55	0.00	0.00
3	100.00	100.00	0.00	0.00
4	100.00	100.00	0.00	0.00
5	100.00	100.00	0.00	0.00
6	100.00	100.00	0.00	0.00
7	100.00	100.00	0.00	0.00
8	100.00	96.77	0.00	0.00
9	96.77	96.77	0.00	0.00
10	96.77	93.55	0.00	0.00
11	96.77	93.55	0.00	0.00
12	93.55	90.32	0.00	0.00
13	93.55	90.32	0.00	0.00
14	93.55	93.55	0.00	0.00
15	96.77	83.87	3.23	3.23
16	83.87	74.19	3.23	0.00
17	74.19	67.74	3.23	0.00

18	80.65	70.97	0.00	0.00
19	83.87	64.52	0.00	0.00
20	67.74	51.61	3.23	3.23
21	54.84	35.48	12.90	9.68
22	48.39	16.13	16.13	9.68
23	22.58	6.45	22.58	16.13
24	12.90	6.45	48.39	29.03
25	16.13	9.68	41.94	29.03
26	25.81	16.13	41.94	29.03
27	25.81	6.45	41.94	32.26
28	9.68	0.00	45.16	25.81
29	0.00	0.00	58.06	41.94
30	9.68	3.23	54.84	41.94
31	12.90	3.23	48.39	45.16
32	12.90	3.23	54.84	25.81
33	9.68	6.45	38.71	12.90
34	29.03	25.81	25.81	19.35
35	41.94	32.26	35.48	9.68
36	38.71	16.13	19.35	12.90
37	38.71	25.81	16.13	6.45
38	32.26	19.35	29.03	12.90
39	32.26	12.90	32.26	16.13
40	22.58	19.35	25.81	6.45
41	38.71	35.48	12.90	3.23
42	67.74	64.52	3.23	0.00
43	80.65	67.74	3.23	3.23
44	77.42	74.19	3.23	0.00
45	77.42	77.42	3.23	0.00
46	90.32	87.10	0.00	0.00
47	96.77	96.77	0.00	0.00
48	96.77	93.55	3.23	0.00
49	93.55	93.55	0.00	0.00
50	96.77	96.77	0.00	0.00
51	100.00	96.77	0.00	0.00
52	96.77	90.32	0.00	0.00

Islampur				
	CDP (%)		CWP (%)	
Week No.	P(2D)	P(3D)	P(2W)	P(3W)
1	96.67	96.67	0.00	0.00
2	96.67	96.67	0.00	0.00
3	100.00	96.67	0.00	0.00
4	96.67	96.67	0.00	0.00
5	96.67	96.67	0.00	0.00
6	100.00	100.00	0.00	0.00

7	100.00	100.00	0.00	0.00
8	100.00	100.00	0.00	0.00
9	100.00	100.00	0.00	0.00
10	100.00	96.67	0.00	0.00
11	96.67	96.67	0.00	0.00
12	96.67	96.67	0.00	0.00
13	100.00	100.00	0.00	0.00
14	100.00	96.67	0.00	0.00
15	96.67	86.67	0.00	0.00
16	86.67	83.33	0.00	0.00
17	86.67	76.67	0.00	0.00
18	86.67	73.33	0.00	0.00
19	76.67	53.33	3.33	3.33
20	56.67	46.67	13.33	6.67
21	50.00	26.67	16.67	3.33
22	43.33	16.67	6.67	6.67
23	26.67	16.67	20.00	10.00
24	30.00	13.33	36.67	6.67
25	33.33	16.67	10.00	3.33
26	33.33	26.67	10.00	3.33
27	33.33	16.67	23.33	13.33
28	26.67	10.00	26.67	20.00
29	23.33	13.33	43.33	26.67
30	30.00	16.67	36.67	20.00
31	26.67	20.00	23.33	13.33
32	40.00	30.00	26.67	6.67
33	43.33	30.00	16.67	10.00
34	46.67	33.33	20.00	3.33
35	50.00	30.00	10.00	3.33
36	53.33	30.00	6.67	3.33
37	43.33	33.33	26.67	13.33
38	33.33	16.67	33.33	23.33
39	33.33	13.33	33.33	13.33
40	20.00	20.00	23.33	10.00
41	43.33	26.67	16.67	6.67
42	53.33	53.33	10.00	0.00
43	63.33	46.67	0.00	0.00
44	76.67	73.33	0.00	0.00
45	76.67	73.33	3.33	0.00
46	90.00	90.00	0.00	0.00
47	96.67	90.00	0.00	0.00
48	93.33	90.00	0.00	0.00
49	90.00	90.00	0.00	0.00
50	96.67	96.67	0.00	0.00
51	100.00	100.00	0.00	0.00
52	100.00	96.67	0.00	0.00

Kasegaon				
	CDP (%)		CWP (%)	
Week No.	P(2D)	P(3D)	P(2W)	P(3W)
1	100.00	100.00	0.00	0.00
2	100.00	100.00	0.00	0.00
3	100.00	100.00	0.00	0.00
4	100.00	100.00	0.00	0.00
5	100.00	100.00	0.00	0.00
6	100.00	100.00	0.00	0.00
7	100.00	100.00	0.00	0.00
8	100.00	100.00	0.00	0.00
9	100.00	100.00	0.00	0.00
10	100.00	85.71	0.00	0.00
11	85.71	85.71	0.00	0.00
12	85.71	85.71	0.00	0.00
13	100.00	100.00	0.00	0.00
14	100.00	100.00	0.00	0.00
15	100.00	100.00	0.00	0.00
16	100.00	100.00	0.00	0.00
17	100.00	100.00	0.00	0.00
18	100.00	100.00	0.00	0.00
19	100.00	71.43	0.00	0.00
20	71.43	71.43	0.00	0.00
21	71.43	28.57	14.29	0.00
22	42.86	14.29	0.00	0.00
23	28.57	14.29	14.29	0.00
24	28.57	28.57	14.29	0.00
25	57.14	42.86	28.57	28.57
26	57.14	57.14	28.57	14.29
27	57.14	42.86	28.57	14.29
28	57.14	28.57	14.29	14.29
29	42.86	14.29	14.29	0.00
30	14.29	0.00	28.57	14.29
31	14.29	14.29	42.86	14.29
32	42.86	14.29	28.57	0.00
33	42.86	14.29	0.00	0.00
34	28.57	0.00	14.29	0.00
35	14.29	0.00	28.57	14.29
36	14.29	0.00	28.57	28.57
37	28.57	0.00	57.14	14.29
38	0.00	0.00	28.57	28.57
39	42.86	14.29	42.86	28.57
40	14.29	14.29	28.57	0.00
41	14.29	14.29	0.00	0.00
42	85.71	85.71	14.29	0.00
43	85.71	57.14	0.00	0.00
44	71.43	71.43	0.00	0.00
45	71.43	71.43	14.29	0.00
46	85.71	85.71	0.00	0.00

47	100.00	100.00	0.00	0.00
48	100.00	100.00	0.00	0.00
49	100.00	100.00	0.00	0.00
50	100.00	100.00	0.00	0.00
51	100.00	100.00	0.00	0.00
52	100.00	100.00	0.00	0.00

Miraj				
Week No.	CDP (%)		CWP (%)	
	P(2D)	P(3D)	P(2W)	P(3W)
1	100.00	96.77	0.00	0.00
2	96.77	96.77	0.00	0.00
3	96.77	93.55	0.00	0.00
4	96.77	96.77	0.00	0.00
5	96.77	93.55	0.00	0.00
6	96.77	96.77	0.00	0.00
7	96.77	96.77	0.00	0.00
8	100.00	100.00	0.00	0.00
9	100.00	100.00	0.00	0.00
10	100.00	96.77	0.00	0.00
11	96.77	93.55	0.00	0.00
12	93.55	90.32	0.00	0.00
13	93.55	87.10	0.00	0.00
14	90.32	80.65	0.00	0.00
15	83.87	83.87	0.00	0.00
16	90.32	74.19	0.00	0.00
17	80.65	80.65	0.00	0.00
18	80.65	70.97	3.23	0.00
19	87.10	64.52	0.00	0.00
20	64.52	54.84	3.23	3.23
21	61.29	32.26	12.90	6.45
22	41.94	32.26	9.68	9.68
23	35.48	22.58	19.35	6.45
24	38.71	22.58	9.68	0.00
25	41.94	29.03	3.23	0.00
26	51.61	38.71	3.23	0.00
27	58.06	35.48	6.45	3.23
28	48.39	25.81	9.68	3.23
29	38.71	25.81	16.13	9.68
30	38.71	29.03	22.58	12.90
31	38.71	32.26	19.35	6.45
32	48.39	32.26	9.68	3.23
33	51.61	45.16	9.68	0.00
34	54.84	45.16	9.68	6.45
35	67.74	48.39	12.90	3.23
36	54.84	29.03	6.45	6.45
37	41.94	19.35	16.13	9.68
38	19.35	9.68	19.35	12.90
39	32.26	16.13	41.94	22.58

40	25.81	22.58	32.26	16.13
41	38.71	29.03	16.13	0.00
42	54.84	54.84	3.23	0.00
43	80.65	67.74	0.00	0.00
44	83.87	80.65	0.00	0.00
45	80.65	77.42	3.23	0.00
46	87.10	87.10	0.00	0.00
47	93.55	93.55	0.00	0.00
48	100.00	100.00	0.00	0.00
49	100.00	100.00	0.00	0.00
50	100.00	100.00	0.00	0.00
51	100.00	100.00	0.00	0.00
52	100.00	100.00	0.00	0.00

Sangli				
Week No.	CDP (%)		CWP (%)	
	P(2D)	P(3D)	P(2W)	P(3W)
1	100.00	100.00	0.00	0.00
2	100.00	100.00	0.00	0.00
3	100.00	100.00	0.00	0.00
4	100.00	96.43	0.00	0.00
5	96.43	96.43	0.00	0.00
6	96.43	92.86	0.00	0.00
7	96.43	96.43	0.00	0.00
8	96.43	96.43	0.00	0.00
9	100.00	100.00	0.00	0.00
10	100.00	100.00	0.00	0.00
11	100.00	100.00	0.00	0.00
12	100.00	100.00	0.00	0.00
13	100.00	96.43	0.00	0.00
14	96.43	92.86	0.00	0.00
15	92.86	92.86	0.00	0.00
16	96.43	89.29	0.00	0.00
17	89.29	85.71	0.00	0.00
18	85.71	78.57	0.00	0.00
19	85.71	71.43	0.00	0.00
20	75.00	60.71	7.14	3.57
21	64.29	50.00	14.29	7.14
22	53.57	35.71	21.43	10.71
23	39.29	28.57	21.43	3.57
24	39.29	32.14	10.71	3.57
25	50.00	39.29	7.14	3.57
26	57.14	35.71	14.29	3.57
27	42.86	28.57	7.14	3.57
28	42.86	39.29	21.43	14.29
29	50.00	42.86	32.14	14.29
30	50.00	32.14	17.86	7.14
31	46.43	42.86	14.29	7.14

32	53.57	46.43	14.29	7.14
33	64.29	53.57	7.14	0.00
34	64.29	53.57	0.00	0.00
35	71.43	60.71	7.14	3.57
36	64.29	46.43	14.29	7.14
37	50.00	39.29	17.86	7.14
38	46.43	32.14	25.00	10.71
39	39.29	21.43	21.43	10.71
40	35.71	35.71	17.86	7.14
41	53.57	42.86	17.86	0.00
42	64.29	64.29	3.57	0.00
43	85.71	75.00	3.57	0.00
44	82.14	78.57	0.00	0.00
45	82.14	75.00	0.00	0.00
46	89.29	89.29	0.00	0.00
47	92.86	92.86	0.00	0.00
48	100.00	96.43	0.00	0.00
49	96.43	96.43	0.00	0.00
50	96.43	96.43	0.00	0.00
51	100.00	100.00	0.00	0.00
52	100.00	100.00	0.00	0.00

Tasgaon				
Week No.	CDP (%)		CWP (%)	
	P(2D)	P(3D)	P(2W)	P(3W)
1	96.55	96.55	0.00	0.00
2	96.55	93.10	3.45	0.00
3	93.10	93.10	0.00	0.00
4	96.55	96.55	0.00	0.00
5	100.00	96.55	0.00	0.00
6	96.55	96.55	0.00	0.00
7	96.55	96.55	0.00	0.00
8	100.00	100.00	0.00	0.00
9	100.00	100.00	0.00	0.00
10	100.00	96.55	0.00	0.00
11	96.55	96.55	0.00	0.00
12	96.55	96.55	0.00	0.00
13	100.00	96.55	0.00	0.00
14	96.55	96.55	0.00	0.00
15	96.55	89.66	0.00	0.00
16	93.10	79.31	0.00	0.00
17	79.31	72.41	0.00	0.00
18	79.31	72.41	0.00	0.00
19	79.31	62.07	3.45	0.00
20	62.07	48.28	10.34	6.90
21	51.72	37.93	20.69	6.90
22	41.38	24.14	20.69	10.34
23	34.48	24.14	17.24	3.45
24	37.93	27.59	10.34	3.45

25	55.17	37.93	10.34	6.90
26	48.28	24.14	10.34	0.00
27	34.48	10.34	3.45	3.45
28	34.48	24.14	20.69	10.34
29	34.48	13.79	31.03	6.90
30	34.48	24.14	17.24	13.79
31	41.38	24.14	17.24	3.45
32	48.28	37.93	3.45	0.00
33	55.17	37.93	6.90	3.45
34	51.72	41.38	3.45	0.00
35	58.62	31.03	6.90	3.45
36	37.93	17.24	13.79	10.34
37	24.14	13.79	31.03	17.24
38	24.14	10.34	34.48	17.24
39	24.14	10.34	31.03	13.79
40	20.69	13.79	27.59	13.79
41	34.48	27.59	17.24	0.00
42	58.62	58.62	3.45	0.00
43	86.21	79.31	0.00	0.00
44	89.66	82.76	0.00	0.00
45	82.76	79.31	3.45	0.00
46	86.21	86.21	0.00	0.00
47	96.55	93.10	0.00	0.00
48	96.55	89.66	0.00	0.00
49	89.66	89.66	0.00	0.00
50	93.10	93.10	0.00	0.00
51	100.00	100.00	0.00	0.00
52	100.00	96.55	0.00	0.00

2.7 Conclusion

For the purpose of analysis and comparison, we consider only two stations, Atpadi and Shirala. The analysis of consecutive dry and wet spells reveals that there are 58.06% to 100% chances that two consecutive dry weeks will occur within the first 23rd weeks of the year for Atpadi station and the same probability for Shirala station is 22.58% to 100%. Similarly, the probability of occurrence of three consecutive dry weeks is very high from 41.94% to 100% in the first 23rd weeks of the year for Atpadi station and the same probability for Shirala station is 6.45% to 100%. The corresponding values of 2 and 3 consecutive wet weeks from 1st to 23rd week are very low 0% to 6.45% and 0% to 3.23% for Atpadi station. The same probabilities for Shirala station are 0% to 22.58% and 0% to 16.13%.

From 24th to 41st week, the chances of occurring 2 and 3 consecutive dry weeks are only within 9.68% to 83.87% and 6.45% to 74.19% respectively for the Atpadi station. The same probability for Shirala station is within 0% to 38.71% and 0% to 35.48%. Further, the weeks will get sufficient rain with 2 consecutive wet weeks with the chance of 0% to 32.26%, whereas 3 consecutive wet weeks will have chance of deficit rain within 0% to 19.35% for Atpadi station. The same probability for Shirala station is within 12.90% to 58.06% and 3.23% to 45.16% during 24th to 41st week. The study further reveals that the weeks 42nd onwards would remain under stress due to the chance that occurrences of 2 and 3 consecutive dry weeks are very high in the range of 64.52% to 96.77% and 61.29% to 96.77% for Atpadi station. The same probability for Shirala station is within 67.74% to 100% and 64.52% to 96.77%.

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In chapter 3 we study the change in seasonality index of rainfall in Sangli district.

Change in Seasonality Index of Rainfall in Sangli District

3.0 Introduction

Rainfall seasonality is related to the temporal distribution of rainfall on a monthly basis. Rainfall seasonality can be estimated by the **Walsh and Lawler (1981)** index. The method aims to characterize the distribution of precipitation throughout the year and to classify the climate of an area. For example the climate of an area can be characterized as rather seasonal with a short dry season or marked seasonal with a long dry season, depending on the distribution of rainfall during the year.

3.1 Seasonality Index

The calculation of rainfall seasonality requires climatic data. Therefore, the spatial scale of the index requires regionalization according to the method proposed for the raw climatic data. A period of at least 30 years data is necessary. Data required for the calculation of the rainfall seasonality index are: (a) average monthly rainfall, and (b) average annual rainfall.

Rainfall seasonality index is a critical environmental factor affecting the evolution of natural vegetation. The seasonality index classifies the type of climate in relation to water availability. The higher the seasonality index of a region the greater the water resources variability and scarcity in time, the more vulnerable the area to desertification.

The proposed method is very simple with few data required for calculation. However, since meteorological data are point observations the seasonality index has to be regionalized based on the Thiessen method. A period of at least 30 years of rainfall data are required to describe the prevailing rainfall seasonality index of an area. Seasonality index helps in identifying the rainfall regimes based on the monthly distribution of rainfall. In order to define the seasonal contrasts, the seasonality index (*SI*) (Walsh and Lawer 1981; Kanellopoulou 2002), which is a

function of mean monthly and annual rainfall, is computed using the following formula:

$$SI_i = \frac{\sum_{n=1}^{12} \left| X_{in} - \frac{R_i}{12} \right|}{R_i}$$

Where, X_{in} is the mean rainfall of month i of the year n and R_i is the total annual rainfall for the year n . Theoretically, the SI can vary from zero (if all the months have equal rainfall) to 1.83 (if all the rainfall occurs in one month). Since we have rainfall data of 32 years, a long term mean is calculated as

$$\overline{SI}_i = \frac{\sum_{n=1}^{32} SI_{ij}}{32}$$

If for some station rainfall is available for 31 years then a long term mean is calculated as

$$\overline{SI}_i = \frac{\sum_{n=1}^{31} SI_{ij}}{31}$$

Another seasonality index \overline{SI} was calculated in order to estimate the mean seasonality over the study period by using long- term average monthly rainfall data directly as:

$$\overline{SI} = \frac{1}{\overline{R}} \sum_{n=1}^{12} \left| X_n - \frac{\overline{R}}{12} \right|$$

Where, \overline{R} is the mean annual rainfall and X_n is the mean rainfall of month n

3.2 Rainfall regimes

Table 3.1 shows the different class limits of SI (Seasonality Index) and representative rainfall regimes (Kanellopoulou 2002). Though the method uses the distribution of rainfall for all the 12 months, the index as table identifies the seasonal pattern when the value is more than 0.6. To investigate the changes in

rainfall pattern we have computed the seasonality index for the ten stations of Sangli district for the periods 1981-2012. The rainfall data for Palus and Kasegaon stations is available during 1998-2012 and 2006-2012 respectively. Therefore the seasonality index is computed only for the available data.

Table 3.1: Seasonal rainfall regimes indicated by the SI_i

SI_i	Rainfall regime
< 0.19	Rainfall spread throughout the year
0.20-0.39	Rainfall spread throughout the year, but with a definite wetter season
0.40-0.59	Rather seasonal with a short drier season
0.60-0.79	Seasonal
0.80-0.99	Markedly seasonal with a long dry season
1.00-1.19	Most rainfall in less than 3 months
> 1.20	Extreme seasonality, with almost all rainfall in 1–2 months

Table 3.2: Seasonality Index, Mean rainfall, Standard deviation and Coefficient of variation for different stations in the Sangli district for all months (1981-2012)

Sr. No.	Station	SI for all years	Mean	SD	CV
1	Shirala	1.0124	1004.94	253.26	25.20
2	Islampur	0.9444	732.80	228.99	31.25
3	Tasgaon	0.8983	598.77	209.79	35.04
4	Miraj	0.8776	587.00	191.41	32.61
5	Sangli	0.8973	517.66	314.60	60.77
6	Jath	0.9091	569.01	196.03	34.45
7	K. Mahankal	0.8812	477.48	163.07	34.15
8	Atpadi	0.9031	419.61	191.01	45.52
9	Palus	1.0470	339.81	157.85	46.45
10	Kasegaon	1.0227	678.61	196.82	29.00

Figure 3.1 shows the Seasonality Index and Average Total Rainfall for Sangli District.

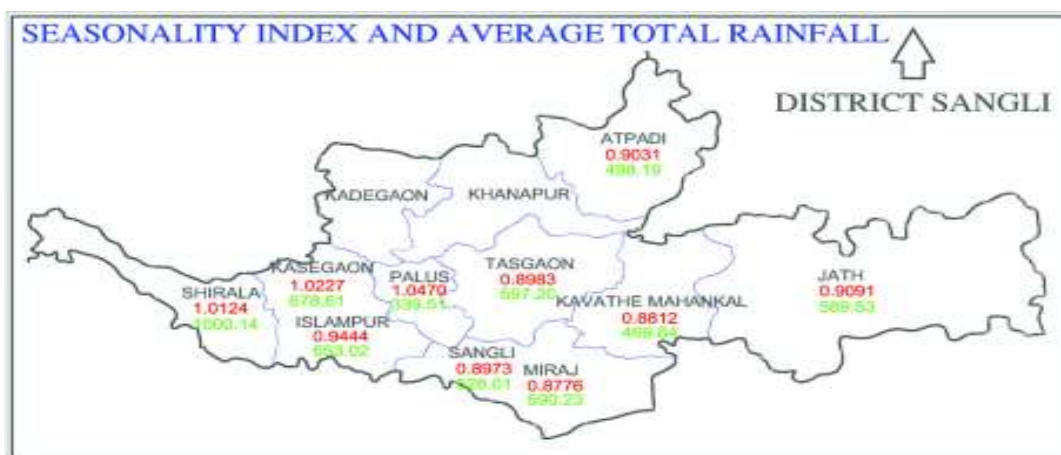


Figure 3.1 : Seasonality Index and Average Total Rainfall for Sangli District.

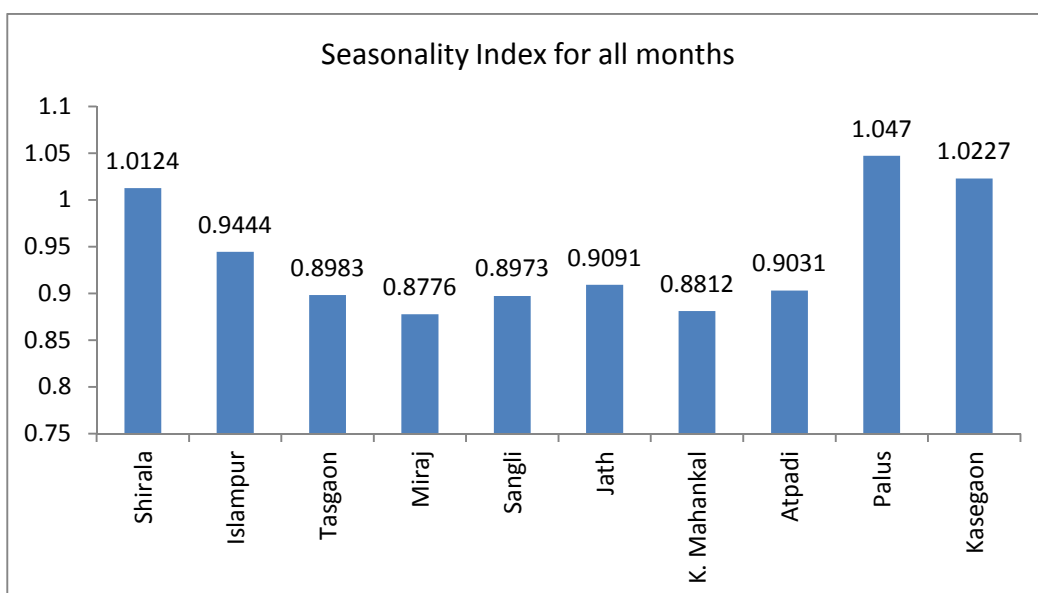


Figure 3.2: Seasonality Index for all months

Table 3.3: Seasonality Index, Mean rainfall, Standard deviation and Coefficient of variation for different stations in the Sangli district for **Monsoon** (June- September-1981-2012)

Sr. No.	Station	SI (June-September)	Mean	SD	CV
1	Shirala	0.1912	823.75	259.00	31.44
2	Islampur	0.0833	531.66	203.74	38.32
3	Tasgaon	0.1549	421.51	162.45	38.54
4	Miraj	0.1200	398.22	166.70	41.86

5	Sangli	0.1294	365.58	214.70	58.73
6	Jath	0.2641	385.90	147.36	38.18
7	K. Mahankal	0.3015	307.46	126.09	41.01
8	Atpadi	0.3529	286.17	157.60	55.07
9	Palus	0.1184	258.60	112.44	43.48
10	Kasegaon	0.0665	549.47	182.70	33.25

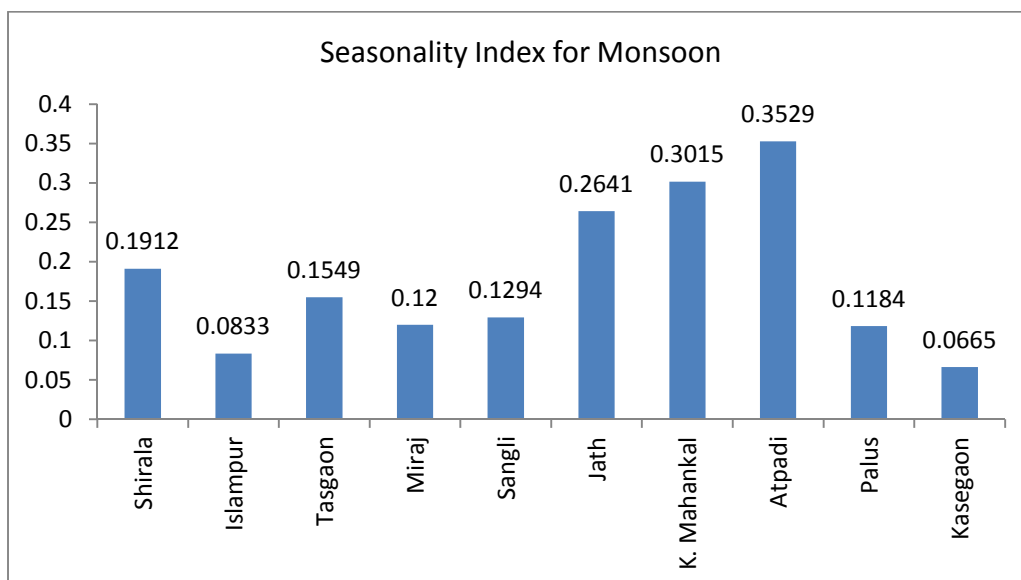


Figure 3.3 : Seasonality Index for Monsoon

Table 3.4: Seasonality Index, Mean rainfall, Standard deviation and Coefficient of variation for different stations in the Sangli district for **other than Monsoon** (January-May and October -December)

Sr. No.	Station	SI (January-May and October-December)	Mean	SD	CV
1	Shirala	1.1255	181.18	85.69	47.29
2	Islampur	1.1985	201.13	113.22	56.29
3	Tasgaon	1.0610	177.26	104.33	58.86
4	Miraj	1.1237	188.76	110.02	58.28
5	Sangli	1.0276	152.07	141.30	92.91
6	Jath	1.1231	183.10	118.33	64.63
7	K. Mahankal	1.0500	170.01	89.56	52.67
8	Atpadi	1.1725	133.43	82.00	61.45
9	Palus	1.2479	81.20	69.23	85.26
10	Kasegaon	1.1084	129.14	80.11	62.03

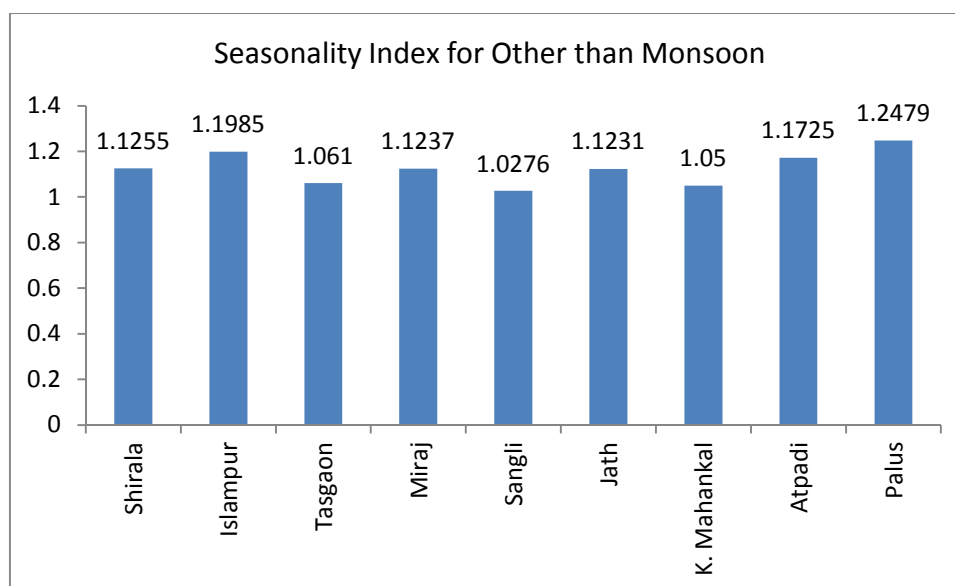


Figure 3.4 : Seasonality Index other than Monsoon

3.3 Result and conclusion

The seasonality index has been computed for all the stations of the Sangli district. We compute the seasonality index for all 32 years data. From the **Table 3.1** it is observed that lower seasonality index value indicates better distribution of monthly rainfall among the months of the year. From **Table 3.2**, we observe that the mean seasonality index for the stations of Sangli district is in the range 0.8776 to 1.0470. This indicates that rainfall is markedly seasonal with a long dry season and most rainfall occurs in less than 3 months.

The lower value of mean seasonality index was over Tasgaon, Miraj, Jath, Kavathe Mahankal, Atpadi and Sangli and was in the range 0.8-0.99. This indicates that only at these stations rainfall was purely seasonal and was evenly distributed in four months though the mean monsoon rainfall was less compared to other stations. The higher value of mean seasonality index was over Shirala, Palus Kasegaon, and Islampur and was in the range (1.0 - 1.19). This indicates that most rainfall occurs in less than three months. An increasing trend in seasonality index is thus an indicator of alarming situation for the agriculture. Therefore analysis of seasonality index helps to have an idea about the distribution of the rainfall among the months.

For Shirala station the average maximum rainfall is 1004.94 and the coefficient of variation of rainfall is low and is given by 25.20%. The Sangli station has average rainfall is 517.66 and the coefficient of variation is high among the all stations and is given by 60.77%. The coefficient of variation varies from 25.20% to 60.77%.

The rainfall is purely seasonal. Most of the rain occurs in Monsoon. Therefore we compute the seasonality index for only Monsoon season (June to September) for the period 1981-2012. For the same period, we compute average rainfall, standard deviation and coefficient of variation and is presented in the **Table 3.3**.

From **Table 3.3**, we observe that all the stations receive most of the rainfall in Monsoon period. The seasonality index varies from 0.0665 to 0.3529. From rainfall regimes, we see that rainfall spread throughout the Monsoon but with a definite wetter season. The mean rainfall varies from 258.60mm to 823.75mm in the monsoon season. In the monsoon season, Palus station receives only 258.60mm mean rainfall, whereas Shirala station receives 823.75mm mean rainfall. The coefficient of variation for Monsoon period is low as compare to coefficient of variation for all month's data. It varies from 31.44% to 58.73%.

In the months of January to May and October to December, very less rainfall occurs. The **Table 3.4** shows the Seasonality index, average rainfall, standard deviation and coefficient of variation for the above period. The seasonality index for this period varies from 1.0276 to 1.2479. This means that there is extreme seasonality in the rainfall and most of the rain occurs within three months. The coefficient of variation is more as compare to Monsoon and is varies from 47.29% to 92.91%.

With above discussion we come to the following conclusion

- Lower seasonality index value indicates better distribution of monthly rainfall among the months of the year.

- Mean seasonality index for the stations of Sangli district is in the range 0.87776 to 1.0470. This indicates that rainfall is markedly seasonal with a long dry season and most rainfall occurs in less than 3 months.
- An increasing trend in seasonality index is thus an indicator of alarming situation for the agriculture.
- Analysis of seasonality index helps to have an idea about the distribution of the rainfall among the months.

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In chapter 4, Non-parametric statistical tools such as *Sen's* estimator of slope and *Mann-Kendall* trend test are used to study the detection of trend in rainfall data.

DETECTION OF TREND IN RAINFALL DATA

4.0 Introduction

In the present study, exploratory analysis of rainfall data is performed. This study aims to determine trends in winter, pre-monsoon, monsoon, post-monsoon seasons and annual at nine stations of Sangli district. The data used consists of season wise and station wise rainfall for the period 1981-2012. Non-parametric statistical tools such as *Sen's* estimator of slope and *Mann-Kendall* trend test was used to estimate the magnitude of trend. The post-monsoon time series of rainfall in Jath and Kavathe- Mahankal stations were observed to be statistically significant ($p < 0.10$, $p < 0.15$). The downward trends are observed at the Atpadi and Tasgaon stations, but these trends were statistically insignificant.

Sangli district falls partly in Krishna basin and partly in Bhima basin. Consequently, it is divided into different drain systems. The whole district can be divided into three different parts on the basis of topography, climatology and rainfall viz.

1. Western hilly area of Shirala tahsil with heavy rainfall.
2. The basin area of Krishna, Warna & Yerala rivers, comprising of Walwa, tahsil & western part of Tasgaon and Miraj tahsils with medium rainfall.
3. Eastern drought prone area which comprises of eastern part of Miraj, and Tasgaon tahsils, north-eastern part of Khanapur tahsil and whole of Atpadi, Kavathe-Mahankal and Jath tahsils.

The climate gets hotter and drier towards the east and humidity goes on increasing towards the west. The maximum temperature is 42° C while the minimum temperature is 14° C. The climate in the district is fairly tolerable

throughout the year. The winter is pleasant from December to February. The summer season starts from mid February to May. June to September is the months of normal rainy season. July and August are the months of heavy rainfall. The average rainfall of Sangli district is 400-450 mm per year.

The purpose of present study is to investigate the variations in the rainfall in different seasons of Sangli district by detecting the precipitation changes in the temporal and spatial structure for the period 1981 to 2012. The present paper consists of five sections. The first section introduces the paper and motives of the work. The second section deals with survey of literature with special reference to trends in rainfall data. The third section describes study area, methodology and statistical techniques used for analysis. The fourth section discusses results and its discussion while the fifth one outlines concluding remarks.

4.1 Survey of Literature

Climatic studies aim to identify and determine the climatic changes in various contexts. Here, we take brief review of some of the research studies conducted in the context of trend analysis of Indian monsoon rainfall data. Time-series of annual rainfall, number of rainy-days per year and monthly rainfall of 10 stations were analyzed by **Zende et al. (2014)** to assess climate variability in semi-arid region of Western Maharashtra. They have reported that results showed mixed trends of increasing and decreasing rainfall, which were statistically significant only for Koregaon and Palus stations by the Mann–Kendall test. Also, with the exception of Vita and Vaduj stations there was no statistically significant trend in the mean number of rainy-days per year. Increasing and decreasing monthly rainfall trends were found over large continuous areas in the study region. These trends were statistically significant mostly during the winter and spring seasons, suggesting a seasonal movement of rainfall concentration. Results also showed that there is no significant climate variability in the semi-arid environment of Western Maharashtra. **Kumar and Jain (2010b)** have conducted study to determine trends in annual and seasonal rainfall and rainy days over different river basins across India. Among 22 basins studied by them, 15 showed a decreasing trend in annual rainfall; only one

basin showed a significant decreasing trend at 95% confidence level. Most of the basins have shown the same direction of trend in rainfall and rainy days at the annual and seasonal scale. Rainfall is subject to strong seasonality in tropical monsoonal climate. **Kumar et al. (2010a)** studied monthly, seasonal and annual trends of rainfall using monthly data series of 135 years (1871–2005) for 30 sub-divisions (sub-regions) in India. Half of the sub-divisions showed an increasing trend in annual rainfall, but for only three (Haryana, Punjab and Coastal Karnataka), this trend was statistically significant. Similarly, only one sub-division (Chhattisgarh) indicated a significant decreasing trend out of the 15 sub-divisions showing decreasing trend in annual rainfall. They have also reported that during June and July, the number of sub-divisions showing increasing rainfall is almost equal to those showing decreasing rainfall.

There are spatial and temporal variations in various attributes of the rainy season such as starting date, ending date, durability, etc. Numerous notions of rainy season exist in the real world and the literature, e.g. green season, growing season, wet season, monsoonal rainy season and wet period. **Krishnakumar et al. (2009)** have studied temporal variation in monthly, seasonal and annual rainfall over Kerala, during the period from 1871 to 2005. Their analysis revealed significant decrease in southwest monsoon rainfall while increase in post-monsoon season over the State of Kerala which is popularly known as the ‘Gateway of summer monsoon’. **Ranade et al. (2008)** have studied a hydrological wet season by taking into consideration important parameters such as starting and ending dates and duration, seasonal rainfall/rainwater and surplus rainfall/rainwater potential. They have performed analysis for the 11 major and 36 minor rivers basins as well as the West Coast Drainage System and the whole country using highly quality-controlled monthly rainfall from well spread network of 316 rain-gauge stations from earliest available year up to 2006. They have observed declining tendency in the rainfall/rainwater and surplus rainfall over most of the minor basins. The state-wise analyses of rainfall have also been reported in the literature.

As it can be seen from the above survey, previous studies have been conducted either river basin wise or state-wise. None of the study deals with month-

wise and/or meteorological region-wise analysis of Indian rainfall data. **Shesabhare and Kalange (2012)** have studied the trends in the time series of rainfall data for more than 100 years. They have reported the results of the trends monsoon month-wise as well as meteorological region-wise. As far as Indian economy is concerned, district is considered as smallest unit of the nation and accordingly policies are worked out. Thus, geographical location like district is playing a crucial role in the formulation of policy. This aspect along with others motivated us to undertake the study of rainfall with study area limited to Sangli district.

4.2 Methodology

4.2.1 Material and Methods

The data used for this study is secondary data. The data is obtained from the Indian Meteorological Department, Pune. The data include the records of daily rainfall recorded at nine meteorological stations in Sangli district. The rainfall records include observations spanning from 1981 to 2012 and cover a period over 32 years. For the said purpose we consider four series of season-wise data namely winter season (January and February), pre-monsoon season (March, April and May), Monsoon season (June, July, August and September), post-monsoon season (October and November) and fifth series as annual rainfall data for all stations. The period of time series is long enough to carry out statistical analysis. As many hydrological time series data are not normally distributed, non-parametric tests were preferred over parametric tests. We have adopted methodology used by previous studies such Abdul-Aziz et al. (2013), Jain and Kumar (2012), Shesabhare and Kalange (2013), etc.

4.2.2 Study Area

This study is conducted considering nine stations of Sangli district as a study area. The mean rainfall values of all ten stations were considered to represent the rainfall of the Sangli district. We study the season-wise rainfall trend at nine stations of Sangli district.

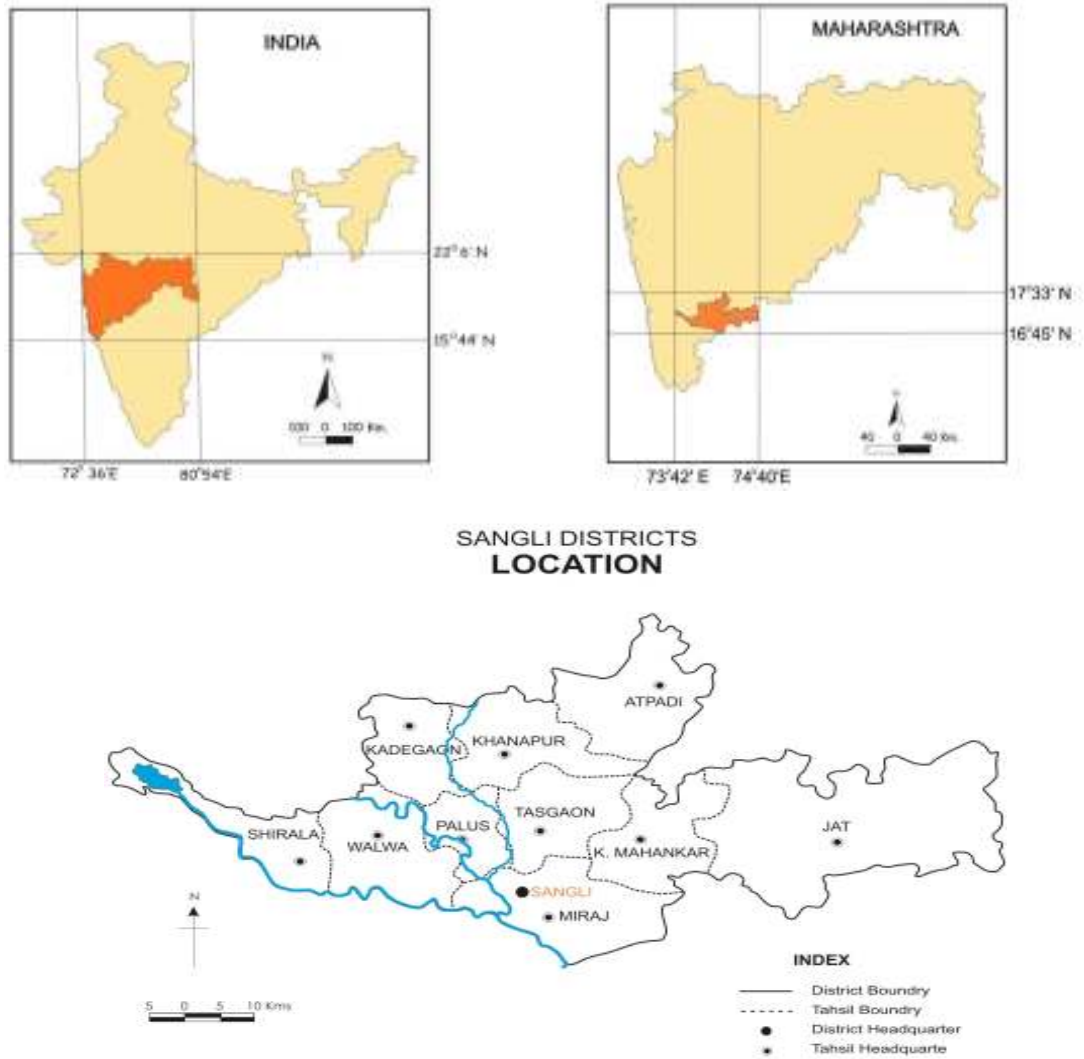


Figure 4.1: Location of Study Area

Table 4.1: Rainfall Gauging Stations

Sr. No.	Station	Elevation (masl*)	Mean Annual Rainfall (in mm)
1	Atpadi	552	419.61
2	Islampur	590	732.80
3	Jath	567	569.01
4	Kavathe-Mahankal	627	477.48
5	Miraj	562	587.00
6	Palus	570	339.81
7	Sangli	549	517.66
8	Shirala	1040	1004.94
9	Tasgaon	585	598.77

*masl: Meters Above Sea Level

4.3 Sen's slope Estimator:

Previous studies have used different methodologies for trend detection. Trend analysis of a time series consists of the magnitude of trend and its statistical significance. In general, the magnitude of trend in a time series is determined either using parametric tests such as regression analysis or using non-parametric method such as Sen's estimator method. Both these methods assume a linear trend in the time series. Sen's slope estimator has been widely used for determining the magnitude of trend in hydro-meteorological time series. In this method, the slopes (T_k) of all data pairs are first calculated by

$$T_k = \frac{x_j - x_i}{j - i} \quad \text{for } k = 1, 2, \dots, N$$

where, X_j and X_i are data values at time j and i ($j > i$)

The median of these N values of T_k is Sen's estimator of slope which is calculated as:

$$\beta = \begin{cases} T_{\frac{N+1}{2}} & N \text{ is odd} \\ \frac{1}{2}(T_{N/2} + T_{(N+1)/2}) & N \text{ is even} \end{cases}$$

A positive value of β indicates an upward (increasing) trend and a negative value indicates a downward (decreasing) trend in the time series.

4.4 Mann-Kendall Test:

The MK test checks the null hypothesis of no trend versus the alternative hypothesis of the existence of increasing or decreasing trend. i.e., H_0 : There is no trend in the data values versus H_1 : There exists trend in the data values.

The statistics (S) is defined as:

$$S = \sum_{i=1}^N \sum_{j=i+1}^{N-1} \text{sgn}(x_j - x_i)$$

Where, N is the number of data points. Assuming $(X_j - X_i) = \theta$, the value of $Sgn(\theta)$ is computed as follows

$$sgn(\theta) = \begin{cases} 1 & \text{if } \theta > 0 \\ 0 & \text{if } \theta = 0 \\ -1 & \text{if } \theta < 0 \end{cases}$$

For large N, the test is conducted using normal distribution with mean and variance as follows:

$$E(S) = 0 \quad \text{and}$$

$$Var(S) = \frac{N(N-1)(2N+5) - \sum_{k=1}^n t_k(t_k-1)(2t_k+5)}{18}$$

Where, n is the number of tied groups and t_k is the number of data points in the k^{th} tied group. The Standard Normal Variate (S.N.V.) is then computed as:

$$Z = \begin{cases} \frac{S-1}{\sqrt{var(S)}} & \text{if } S > 0 \\ 0 & \text{if } S = 0 \\ \frac{S+1}{\sqrt{var(S)}} & \text{if } S < 0 \end{cases}$$

If the computed value is greater than critical value i.e., $|Z| > Z_{\alpha/2}$, the null hypothesis H_0 is rejected at α level of significance, where $0 < \alpha < 1$. The positive value of S indicates an ‘upward trend’, while a negative value indicates ‘downward trend’.

4.5 Results and Discussion

As for the identification of time series changing points, a preliminary graphical inspection is highly instructive and meaningful. All time series histograms show skewed nature of the distribution of data for all nine meteorological stations in Sangli district. Due to space constraint, histograms of only Atpadi and Shirala stations are illustrated in the **Figure 4.2**

Figure 4.2: Rainfall at Atpadi Station

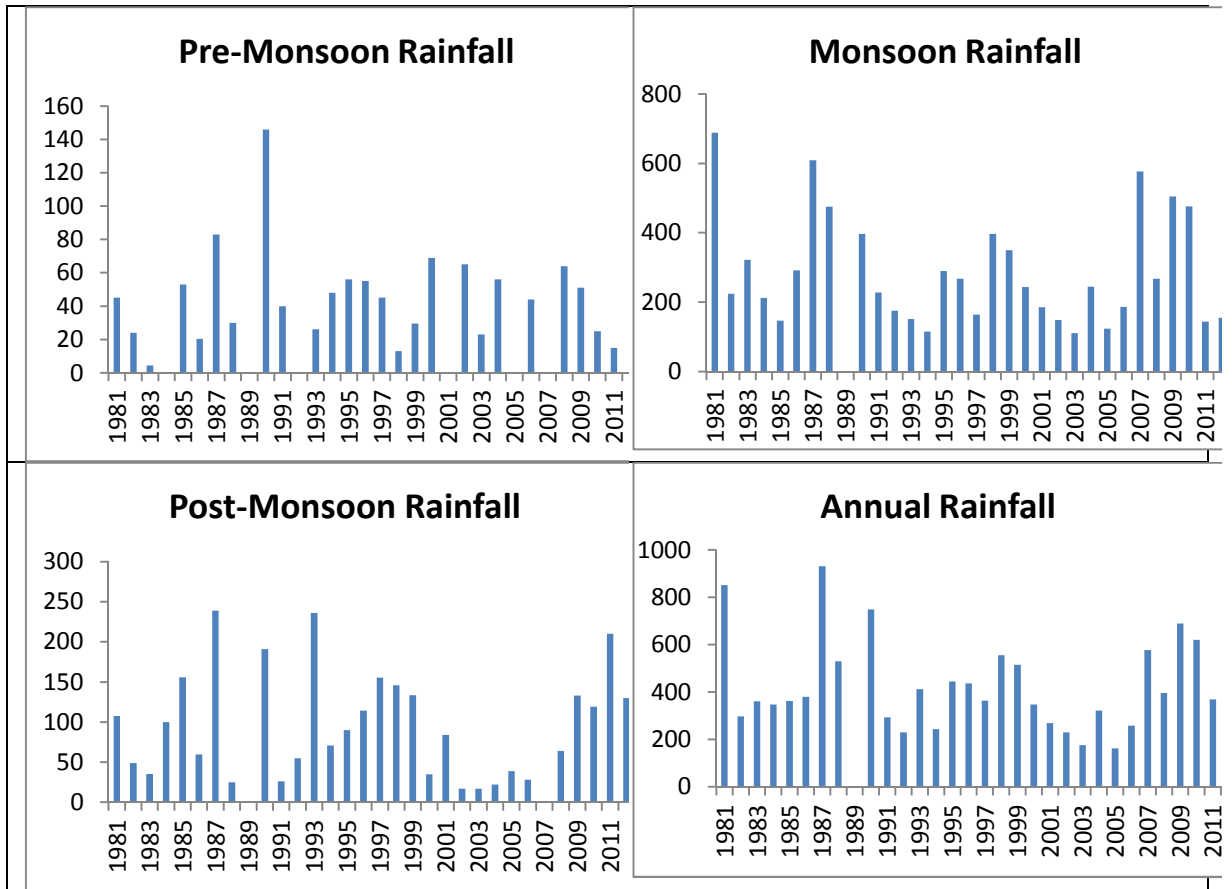
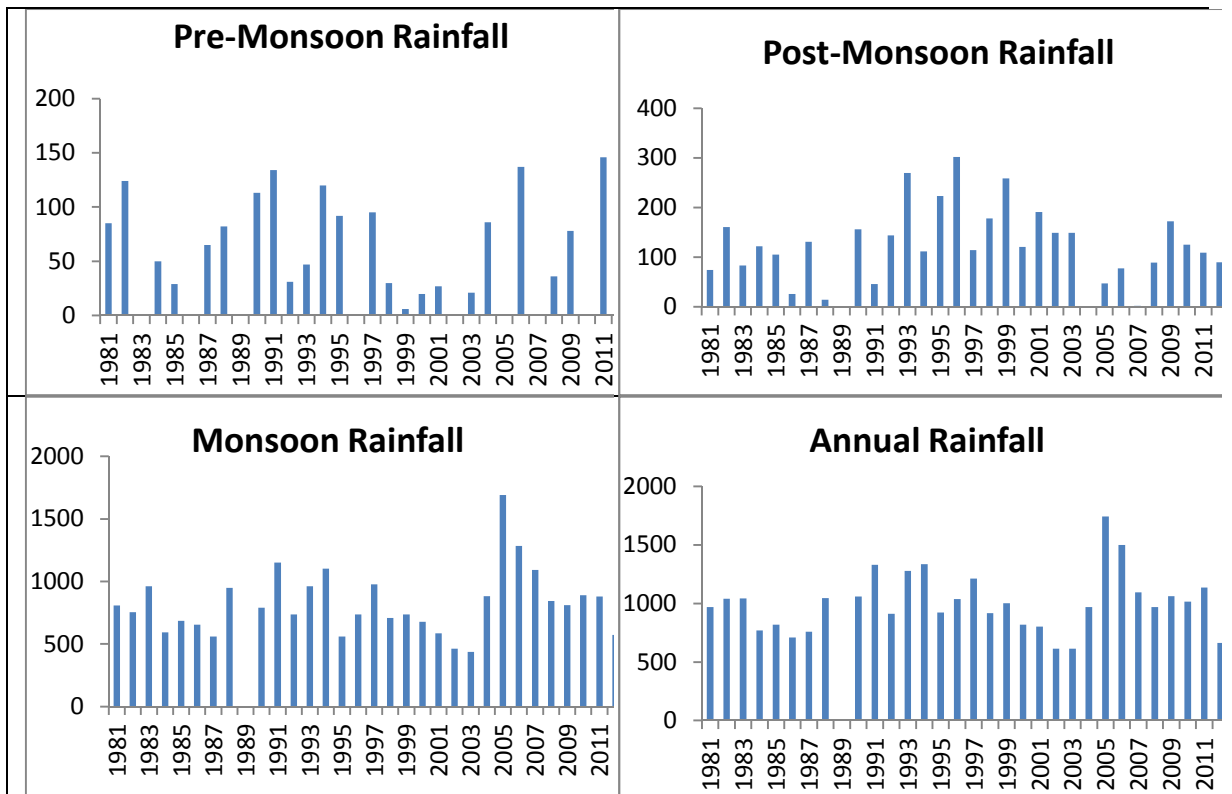


Figure 4.3: Rainfall at Shirala Station



A trend is a significant change over time exhibited by a random variable, detectable by statistical parametric and non-parametric procedures. Onoz and Bayazit (2003) showed that the parametric t -test has less power than the non-parametric Mann–Kendall test when the probability distribution is skewed, but in practical applications, they can be used interchangeably, with identical results in most cases. With the aim of trend detection and cross verification, non-parametric statistical procedures are applied to the rainfall time series data. The rainfall time series are aggregated in the annual and also in seasonal time series (pre-monsoon, monsoon and post-monsoon) to further observe potential changes at the seasonal scale.

Table 4.2: Results of Mann-Kendall Test for Trend Detection

Rainfall Totals	Atpadi			Islampur			Jath		
	S-value	Z-value	P-value	S-value	Z-value	P-value	S-value	Z-value	P-value
Pre-monsoon	-19	-0.2945	0.7684	-89	-1.4338	0.1516	53	0.8507	0.3949
Monsoon	-49	-0.7784	0.4363	57	0.9081	0.3638	65	1.0379	0.2993
Post-monsoon	-16	-0.2432	0.8078	63	1.0056	0.3146	108	1.7352*	0.0827*
Annual	-26	-0.4054	0.6852	33	0.5189	0.6038	71	1.1352	0.2563
	Kavathe-Mahankal			Miraj			Shirala		
	S-value	Z-value	P-value	S-value	Z-value	P-value	S-value	Z-value	P-value
Pre-monsoon	32	0.5037	0.6144	-48	-0.7656	0.4439	-43	-0.6871	0.492
Monsoon	87	1.3946	0.1631	68	1.0865	0.2773	33	0.519	0.6038
Post-monsoon	113	1.8162*	0.0693*	75	1.2	0.2301	11	0.1622	0.8712
Annual	92	1.4757#	0.14#	80	1.2811	0.2002	45	0.7135	0.4755
	Palus			Sangli			Tasgaon		
	S-value	Z-value	P-value	S-value	Z-value	P-value	S-value	Z-value	P-value
Pre-monsoon	13	0.6055	0.5449	-98	-1.6359	0.1019	-97	-1.5639#	0.1178#
Monsoon	-9	-0.3959	0.6922	-82	-1.3145	0.1887	-13	-0.1946	0.8457
Post-monsoon	-16	-0.7423	0.4579	-5	-0.0675	0.9462	-10	-0.146	0.8839
Annual	-3	-0.099	0.9212	-84	-1.3469	0.178	-73	-1.1678	0.2429

* Statistically significant at 90% confidence level # statistically significant at 85% confidence level

Rainfall time series data were analyzed with Mann-Kendall test for all nine meteorological stations in Sangli district taking annual and also seasonal rainfall data. **Table 4.2** provides the calculations of Mann-Kendall Statistics and significant values. P-values are also provided. The downward trends in the annual as well as

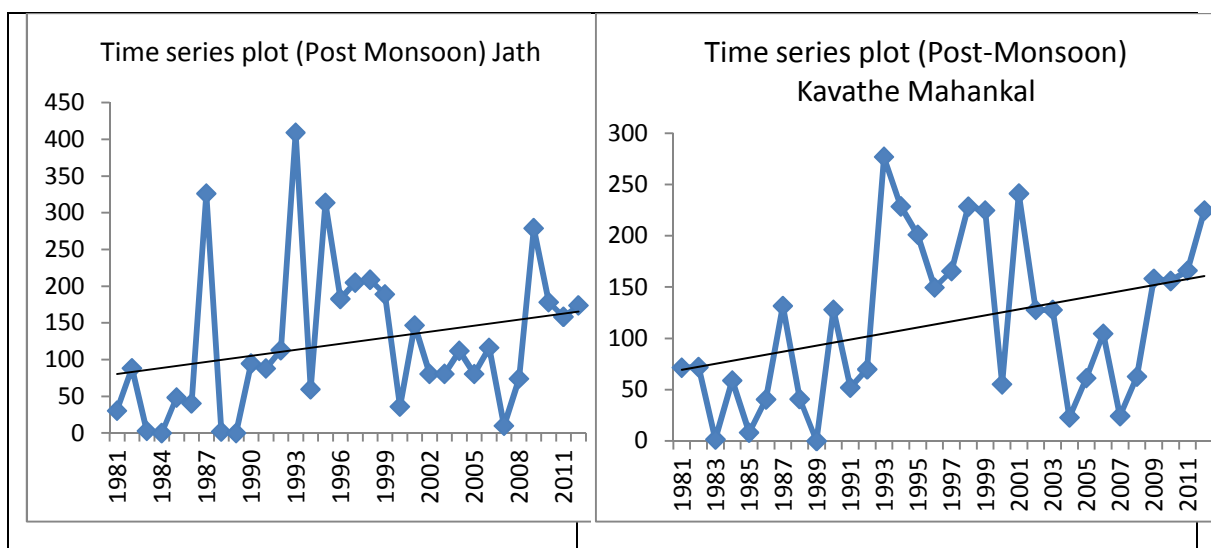
seasonal rainfall were exhibited for Atpadi, Sangli and Tasgaon stations, but these trends are statistically non-significant. For the Kavathe-Mahankal and Jath stations, a weak upward trend is observed. The trends in the post-monsoon rainfall data for both of these stations, taking highest and second highest values, are observed statistically significant at 90% and 85 % confidence levels.

Table 4. 3: Sen’s slope estimate (mm/period)

Station	Sen’s slope estimate (β)			
	Pre-monsoon	Monsoon	Post-monsoon	Annual
Atpadi	0.0000	-2.3650	-0.3804	-1.7458
Islampur	-1.0000	4.7735	1.7947	3.1149
Jath	0.4657	3.8478	3.3100*	5.3612
Kavathe-Mahankal	0.3935	4.4171	3.1805*	6.0431
Miraj	-0.4255	3.6912	2.0450	4.7525
Palus	-0.4722	2.8722	0.1529	3.1554
Sangli	0.3333	-5.8545	-2.9000	-5.6000
Shirala	-0.6250	-6.8792	-6.8792	-7.0742
Tasgaon	-1.2156	-0.6352	-0.6588	-7.1511

* indicate statistically significant at 90% confidence level

Figure 4.4: Time plots of Seasonal Time series for Jath and Kavathe-Mahankal Stations



As it can be seen from the **Figure 4.4**, an increasing trend in the post-monsoon rainfall data series for Jath and Kavathe-Mahankal stations were observed.

Sen's slope estimator was also used to figure out the change per unit time of the trends observed in seasonal as well as annual time series. The computations of the Sen's slope estimator for all nine meteorological stations are presented in the **Table 4.3**, where a negative sign indicate downward slope and a positive sign an upward one. For seasonal time series data, statistically significant trend observed at Jath and Kavathe-Mahankal stations. The MATLAB code to estimate *Sen's* slope estimator and *Mann-Kendall* test statistics is provided in Appendix 1

4.6 Conclusions

The application of trend analysis revealed that upwards trend for some stations while downward for other stations. The continuous downward for Atpadi and Tasgaon stations while continuous upward trends for Kavathe-Mahankal and Jath stations were observed. The trends observed at all stations were statistically insignificant, except post-monsoon time series of Kavathe-Mahankal and Jath stations. These results also indicated that for the analyzed time-period, there was no significant climate change in the study area. The results also suggest the need for further investigation on local environmental issues, which could be one of the major causes of climate change.

(The above work is published in "Review of Research" Volume - 4, Issue-6, March-2015 (ISSN 2249-894X))

In chapter 5, we list the findings in the study of rainfall data of Sangli district.

Findings

5.0 Introduction

There are many findings in the study of rainfall data of Sangli district during 1981 to 2012. There are many lacunas in the data set. For Sangli station rainfall data for many days are not available. Palus and Kasegaon stations are newly established. Rainfall data for Palus station is available during 1998 to 2012, where as Kasegaon station is available during 2006 to 2012. Statistical analysis is made for the available data. For rainfall data analysis at least thirty years data should be available. In spite of the shortcomings of the available data, rigorous analyses have been done. Here we list some of the findings of analysis of rainfall data of Sangli district.

5.1 Findings (Rainfall Data and Exploratory Analysis)

1. Shirala station receives maximum rainfall among all stations of Sangli district and the average rainfall of Shirala station is 1004.94 mm.
2. Palus station receives minimum rainfall among all stations of Sangli district and the average rainfall of Palus station is 339.81 mm.
3. The average rainfall of Sangli district is 400-450 mm.
4. Average rainy days for Shirala station are 63(17.22%). Shirala station has maximum number of rainy days. Average rainy days for Atpadi station are only 28(7.79%).
5. Average dry days for Shirala station are 302 (82.78%) where as average dry days for Atpadi station are 337 (92.21%).
6. Rainfall is purely seasonal. Most of the rain occurs in monsoon season. Shirala station receives 823.75 mm (81.97%) rainfall in monsoon, where as Atpadi station receives 286.17 mm (68.19%)

rainfall in monsoon. Remaining rainfall of the total rainfall occurs in winter, pre-monsoon and post-monsoon season. During winter season all the stations of Sangli district receives very low rainfall (even much less than 6 mm). During pre-monsoon season maximum rainfall occurs at the Miraj station and it receives 64.48mm (10.98%) in average where as Palus station receives only 14.37mm (4.22%) on an average which is lowest among all the stations.

7. Very less amount of rainfall is being received during the winter season and the variability is very high in all the stations of Sangli district. Maximum variability (387.30%) is over Palus and the lowest variability (199.46%) is over Kavathe Mahankal. Variability decreased as the monsoon set in and again it increased in the post-monsoon season. During monsoon season, in spite of very high rainfall, coefficient of variability of monsoon rainfall is very high in Sangli (58.73%). At the same time the coefficient of variation is low in Shirala (31.44%). During monsoon season, western part of Sangli district get excessive rain due to strong westerlies from Arabian Sea and the presence of offshore through, whereas eastern parts of Sangli district get comparatively less rain.

5.2 Findings (Probability Analysis of Dry and Wet Spells)

1. The probability of occurrence of dry week is very high until the end of 23rd week. The range of probability of occurrence of dry week from 1st to 23rd week is from 64.52 % to 100% for Shirala station. At the same time for Atpadi station the same probability of occurrence of dry week from 1st to 23rd week is from 77.42 % to 100%.
2. The probability of occurrence of dry week preceded by another dry week and that of dry week by another wet week from 1st to 23rd week vary from 22.58 % to 100% and 0% to 41.94% for Shirala station.

The same probability for Atpadi station varies from 58.06% to 100% and 0% to 22.58% respectively.

3. From 24th to 41st week the probability of wet week increases. It varies from 29.03% to 80.65% for Shirala station. The same probability for Atpadi station varies from 9.68% to 61.29%. In the same period the probabilities of dry week varies from 19.35% to 70.97 for Shirala station. The same probability for Atpadi station varies from 38.71% to 90.32%.
4. The probability of occurrence of dry week preceded by another dry week and that of dry week by another wet week from 24th to 41st week vary from 0 % to 41.94% and 9.68% to 32.26% for Shirala station. The same probability for Atpadi station varies from 9.68% to 8.087% and 6.45% to 32.26% respectively.
5. The analysis of consecutive dry and wet spells reveals that there are 58.06% to 100% chances that two consecutive dry weeks will occur within the first 23rd weeks of the year for Atpadi station and the same probability for Shirala station is 22.58% to 100 %.
6. The probability of occurrence of three consecutive dry weeks is very high from 41.94% to 100% in the first 23rd weeks of the year for Atpadi station and the same probability for Shirala station is 6.45% to 100%. The corresponding values of 2 and 3 consecutive wet weeks from 1st to 23rd week are very low 0% to 6.45% and 0% to 3.23% for Atpadi station. The same probabilities for Shirala station are 0% to 22.58% and 0% to 16.13%.
7. From 24th to 41st week, the chances of occurring 2 and 3 consecutive dry weeks are only within 9.68% to 83.87% and 6.45% to 74.19% respectively for the Atpadi station. The same probability for Shirala station is within 0% to 38.71% and 0% to 35.48%. Further, the weeks will get sufficient rain with 2 consecutive wet weeks with the chance

of 0% to 32.26%, whereas 3 consecutive wet weeks will have chance of deficit rain within 0% to 19.35% for Atpadi station. The same probability for Shirala station is within 12.90% to 58.06% and 3.23% to 45.16% during 24th to 41st week.

8. The study further reveals that the weeks 42nd onwards would remain under stress due to the chance that occurrences of 2 and 3 consecutive dry weeks are very high in the range of 64.52% to 96.77% and 61.29% to 96.77% for Atpadi station. The same probability for Shirala station is within 67.74% to 100% and 64.52% to 96.77%.

5.3 Findings (Seasonality Index of Rainfall in Sangli District)

1. Lower seasonality index value indicates better distribution of monthly rainfall among the months of the year.
2. Mean seasonality index for the stations of Sangli district is in the range 0.87776 to 1.0470. This indicates that rainfall is markedly seasonal with a long dry season and most rainfall occurs in less than 3 months.
3. An increasing trend in seasonality index is thus an indicator of alarming situation for the agriculture.
4. Analysis of seasonality index helps to have an idea about the distribution of the rainfall among the months.
5. We observe that all the stations receive most of the rainfall in Monsoon period. If we obtain seasonality index for monsoon only then it varies from 0.0665 to 0.3529. From rainfall regimes we see that rainfall spread throughout the Monsoon but with a definite wetter season.
6. Very less rainfall occurs in the months of January to May and October to December. The seasonality index for this period varies from 1.0276

to 1.2479. This means that there is extreme seasonality in the rainfall and most of the rain occurs within three months.

5.4 Findings (Detection of trend in rainfall data)

1. The rainfall time series are aggregated in the annual and also in seasonal time series (pre-monsoon, monsoon and post-monsoon) to further observe potential changes at the seasonal scale.
2. Rainfall time series data were analyzed with Mann-Kendall test for all nine meteorological stations in Sangli district taking annual and also seasonal rainfall data. The downward trends in the annual as well as seasonal rainfall were exhibited for Atpadi, Sangli and Tasgaon stations, but these trends are statistically non-significant.
3. For the Kavathe-Mahankal and Jath stations, a weak upward trend is observed. The trends in the post-monsoon rainfall data for both of these stations, taking highest and second highest values, are observed statistically significant at 90% and 85 % confidence levels.
4. Sen's slope estimator was also used to figure out the change per unit time of the trends observed in seasonal as well as annual time series. Negative sign indicate downward slope and a positive sign an upward one. For seasonal time series data, statistically significant trend observed at Jath and Kavathe-Mahankal stations.
5. The trends observed at all stations were statistically insignificant, except post-monsoon time series of Kavathe-Mahankal and Jath stations. These results also indicated that for the analyzed time-period, there was no significant climate change in the study area. The results also suggest the need for further investigation on local environmental issues, which could be one of the major causes of climate change.

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MATLAB Code

To compute Mann-Kendall statistic (S), the *Sen's* slope estimator (β), Standard Normal Variate Z and P value we write MATLAB Code. The MATLAB code and output is provided in the following.

MATLAB code to compute Mann-Kendall Statistic

```
function f=mktest(x)
n=length(x);
s=0;
t=zeros;
tie=0;
for k=1:n-1
    t(k)=0;
    for j=k+1:n
        if (sign(x(j)-x(k))==0)
            t(k)=t(k)+1;
        end
        s=s+sign(x(j)-x(k));
    end
end
for k=1:n-1
    if (t(k)>0)
        tie=tie+((t(k)-1)*t(k)*(2*(t(k)+1)+5));
    end
end
v=(n*(n-1)*(2*n+5)-tie)/18;
if (s > 0)
    z=(s-1)/sqrt(v);
elseif (s==0)
    z=0;
else
    z=(s+1)/sqrt(v);
end
if (z < 0)
    P=2*normcdf(z,0,1);
else
    P=2*(1-normcdf(z,0,1));
end
f=[s z P];
```

MATLAB code to compute Sen's Estimate of Slope Statistic

```
function g=sen_estimator(x)
n=length(x);
T=zeros;
k=1;
```

```

for i=1:n-1
for j=i+1:n
T(k)=(x(j)-x(i))/(j-i);
k=k+1;
end
end
g=median(T);

```

MATLAB code including data to execute M-K test and Sen's Estimate of Slope Statistics

```

%Atpadi

pm1=[45 24 4.4 0 53 20.3 82.9 30 0 146 40 0 26 48 56 55 45 13 29.5
69 0 65 23 56 0 44 0 64 51 25 15 0];
m1=[688.5 224 321.7 212.7 147 291.8 609.1 475 0 397 228 175 151 115
290 267.5 163.9 397 350 243.3 185.2 148.6 110.5 244.4 124 186 577 268
505 476 144 155];
pom1=[107.5 49 35.5 100 156 59.6 238.7 25 0 191 26 55 236 71 90
114.5 155.5 146 133.5 35 84 17 17 22 39 28 0 64 133 119 210 130];
all1=[851 297 361.6 347.2 362 379.9 930.7 530 0 749 294 230 413 243 445
437 364.4 556 515 347.3 269.2 230.6 175.5 322.4 163 258 577 396 689 620
369 285];
n=length(pm1);
s11=mktest(pm1);
se11=sen_estimator(pm1);
s21=mktest(m1);
se21=sen_estimator(m1);
s31=mktest(pom1);
se31=sen_estimator(pom1);
s41=mktest(all1);
se41=sen_estimator(all1);
Atpadi_mk=[s11 s21 s31 s41 ]
Atpadi_sen=[se11 se21 se31 se41]

%Islampur

pm2=[90 254 0 42 0 27 118.4 63 0 76 201 2 9 138 71 2 3 63 32 2
23 8 43 95 0 159 0 33 22 1 17 0];

```

```

m2=[623 296 538 327 0 392 337 660 0 397 825 451 793 685 542 537 519 567
481 470 407.1 254.9 143 541 1129.6 801.5 757.3 505.2 513 683.4 495
279];
pom2=[45 159 37 99 0 38 178 99 0 194 43 65 295 176 268 348 134 238
335.5 170 220 69 69 55 79 137 5 122 256 114 99 131];
all2=[773 709 575 488 0 457 633.4 822 0 667 1069 518 1097 999 952 887
675 868 848.5 642 650.1 331.9 291 691 1209.6 1097.5 762.3 660.2 791
798.4 611 410];
n=length(pm2);
s12=mktest(pm2);
se12=sen_estimator(pm2);
s22=mktest(m2);
se22=sen_estimator(m2);
s32=mktest(pom2);
se32=sen_estimator(pom2);
s42=mktest(all2);
se42=sen_estimator(all2);
Islampur_mk=[s12 s22 s32 s42 ]
Islampur_sen=[se12 se22 se32 se42]

%Jath
pm3=[16.5 29.5 0 0 0 16.4 71.4 117.1 0 87 122.7 3.3 20.5 38.1
44.1 15.8 72.1 29.9 95.6 76 67.5 48.1 37 184.3 0 28 0 22.2
92.4 2.4 148.2 0];
m3=[465 257.3 218.5 0 213.4 334.8 465.6 575.4 0 491.2 396.5 253.4
267.6 243.5 382 631.8 389.1 547.6 411.6 585 478 189.3 182.9 394 439.5
512.8 553.4 309.9 440.3 632.5 208.4 106.9];
pom3=[30.5 88.3 2.9 0 48.4 40.4 326.2 2 0 94.7 88 113 409.2 59.7
313.8 182.8 205 208.8 189 36 146.7 80.6 80.6 112 80.5 116.3 10 74.1
279 178.3 158.4 173.9];
all3=[517 375.1 221.4 0 261.8 396.6 863.2 694.5 0 672.9 607.2 369.7
697.3 341.3 783.5 830.4 667.8 786.3 696.2 698.6 701.2 323 307.5
690.3 520 657.1 563.4 406.2 811.7 813.2 515 280.8];
n=length(pm3);

```

```

s13=mktest(pm3);
se13=sen_estimator(pm3);
s23=mktest(m3);
se23=sen_estimator(m3);
s33=mktest(pom3);
se33=sen_estimator(pom3);
s43=mktest(all3);
se43=sen_estimator(all3);
Jath_mk=[s13 s23 s33 s43 ]
Jath_sen=[se13 se23 se33 se43]

%Kavathe-Mahankal
pm4=[69.1 64 13 17.9 22.3 10 33.8 29.6 0 52.7 72.4 17.5 32.3
140.1 70.6 30 49.4 24.4 58.2 93.2 0 46.8 29 108.8 0 95.2 0
163.2 67.4 24.2 65 0];
m4=[573.6 136 237 218.5 117 240.1 267.5 256.4 0 235.1 382.2 273.6
313.7 252.2 394.6 325 382 498.8 307.7 506.7 413.4 211.5 83.6 390.6
302.2 441.4 486.9 237 382.4 404.3 172.4 87.9];
pom4=[71.5 72 1.5 59 8.2 40.5 131.7 40.8 0 128 52.1 69.9 277 228.6
201.1 149.6 165.6 228.5 224.8 55.3 241.2 127.8 127.8 22.9 61.3
104.6 24.3 62.8 158.3 156 166.1 224.6];
all4=[729.2 272 251.5 302.9 147.5 291.1 433 326.8 0 430.8 506.7 361
623 633.9 686.2 504.6 597 751.7 590.7 664.6 654.6 390.9 242.4 522.3
363.5 641.2 511.2 463 608.1 584.5 403.5 312.5];
n=length(pm4);
s14=mktest(pm4);
se14=sen_estimator(pm4);
s24=mktest(m4);
se24=sen_estimator(m4);
s34=mktest(pom4);
se34=sen_estimator(pom4);
s44=mktest(all4);
se44=sen_estimator(all4);
Kavathe_Mahankal_mk=[s14 s24 s34 s44 ]

```

```

Kavathe_Mahankal_sen=[se14 se24 se34 se44]

% Miraj
pm5=[42.4 91.4 5.4 4 132 27.5 81.5 31 0 270.1 182.2 61.6 78 126.5
70.3 105.5 0 0 12 5 0 60.4 43 137.2 0 206.2 0 79.3 35 55.5 51
5];
m5=[622.7 203.2 394.2 215.1 312 278.2 297 572.8 0 256 827.7 362.7
514.5 353.4 263.1 381.8 302.3 307 201.5 488.7 357.7 267.5 107.4
519.8 668.3 638 617.6 284.2 550.2 482.6 354.5 343.4];
pom5=[17.9 96.7 16 105.8 51.5 51.3 135 34.7 0 119 113 90.8 310.7
272.7 235.2 173.5 213.2 172.6 156.5 10.2 110.2 137.5 48.5 48.5
61.8 53.4 5.2 70.1 237.8 201.5 108.3 284.6];
all5=[685.3 391.3 415.6 353.9 495.5 362.5 513.5 638.5 0 645.1 1122.9
515.1 903.2 752.6 606.9 660.8 515.5 479.6 370 503.9 476.9 465.4
223.9 705.5 730.1 897.6 622.8 433.6 823 739.6 513.8 633];
n=length(pm5);
s15=mktest(pm5);
se15=sen_estimator(pm5);
s25=mktest(m5);
se25=sen_estimator(m5);
s35=mktest(pom5);
se35=sen_estimator(pom5);
s45=mktest(all5);
se45=sen_estimator(all5);
Miraj_mk=[s15 s25 s35 s45 ]
Miraj_sen=[se15 se25 se35 se45]

%Shirala
pm6=[85 124 0 50 29 0 65 82 0 113 134 31 47 120 92 0 95 30 6 20 27
0 21 86 1 137 0 36 78 0 146 2];
m6=[809 755 960.6 592.6 685.7 654.6 561 948 0 790 1151 736 962 1103
560 736 976 708 736 678 585 463.8 438 882.6 1691 1285 1092.5 843 811
889 881 572];
pom6=[74 161 83 122 105 26 131 14 0 156 46 144 270 112 223 302 114 178
259 121 191 149 149 1 47 77.8 2 89 172 125 109 90];

```

```

all6=[968 1040 1043.6 770.6 819.7 709.6 757 1044 0 1059 1331 911
1279 1335 921 1038 1212 916 1001 819 803 612.8 613 969.6 1743
1499.8 1094.5 968 1061 1014 1136 664];
n=length(pm6);
s16=mktest(pm6);
se16=sen_estimator(pm6);
s26=mktest(m6);
se26=sen_estimator(m6);
s36=mktest(pom6);
se36=sen_estimator(pom6);
s46=mktest(all6);
se46=sen_estimator(all6);
Shirala_mk=[s16 s26 s36 s46 ]
Shirala_sen=[se16 se26 se36 se46]

%Palus
pm7=[61 0 0 4 0 18 21.6 2 40 0 11 9 23 26 0];
m7=[455 326.6 90 222.4 109.2 119 294 393.7 364.2 347.8 205.5 277.7
330 186 158];
pom7=[225 142.8 40 97 37.6 37.6 19 24.5 26 3 30 99 112 50 57];
all7=[741 469.4 130 323.4 146.8 176.6 334.6 420.2 430.2 350.8 246.5
385.7 465 262 215];
n=length(pm7);
s17=mktest(pm7);
se17=sen_estimator(pm7);
s27=mktest(m7);
se27=sen_estimator(m7);
s37=mktest(pom7);
se37=sen_estimator(pom7);
s47=mktest(all7);
se47=sen_estimator(all7);
palus_mk=[s17 s27 s37 s47 ]
palus_sen=[se17 se27 se37 se47]

```

```

% Sangli
pm8=[25.2 182.7 3 46.8 0 20.2 84.4 15 20.2 0 184.5 32 77.6
143.2 25.6 6.6 0 114.3 0 38.9 24 15.2 0 34.5 0 133 0 0 0 86 11
0];
m8=[591.1 346.2 384.9 20 206 128.4 273.3 502.4 466 297.6 834.9 282
522.6 421.3 362.3 131.2 122.5 157.7 368.5 341.5 463.3 166 102.9
286.5 788.8 771.5 0 0 0 614.1 282.8 0];
pom8=[33.3 69.2 59.2 0 0 0 105.6 32.2 38.2 139.7 91.6 97.9
313.5 166.6 175.8 0 147.8 129.8 145.7 88.6 134.3 0 0 22.4 144.1
524.3 0 0 0 113.1 49.4 0];
all8=[649.6 598.1 447.1 107.2 206 148.6 464.8 549.6 524.4 437.3 1111
411.9 913.8 732.7 589.6 138 270.3 401.8 514.2 470.8 625.1 181.2
102.9 343.4 935.1 1428.8 0 0 0 813.5 377.6 0];

n=length(pm8);
s18=mktest(pm8);
se18=sen_estimator(pm8);
s28=mktest(m8);
se28=sen_estimator(m8);
s38=mktest(pom8);
se38=sen_estimator(pom8);
s48=mktest(all8);
se48=sen_estimator(all8);
Sangli_mk=[s18 s28 s38 s48 ]
Sangli_sen=[se18 se28 se38 se48]

% Tasgaon
pm9=[65.6 111 0 20 47 0 93 104 0 142 159 18.3 75.9 195 74.8 34 28
61 84.1 22.5 18.2 37 25.2 85.3 0 91.6 0 43.8 46.1 17.4 17.9
0];
m9=[791.3 593.6 0 270 232 0 410 669 0 255 721 462 468.3 404.2 476.6
494.4 343.3 455 322.9 495.7 292.2 230.9 98.3 438.9 436.7 525.1
625.6 336.7 397 515.1 251.9 211.1];

```

```

pom9=[108.2 113 0 74.3 34 0 178 83 0 201 70 67 342.4 93.7 211.7
228.8 145.4 225 142.8 57.4 94.2 60.1 60.1 21 48.6 123.8 10 49.2
148.2 133.5 34.3 120];
all9=[966.1 817.6 0 385.3 313 0 702 856 0 598 950 547.3 886.6 692.9
852.5 757.2 525.5 741 549.8 575.6 404.6 328 186.6 545.2 485.3 740.5
635.6 429.7 591.3 666 304.1 331.1];

n=length(pm9);
s19=mktest(pm9);
se19=sen_estimator(pm9);
s29=mktest(m9);
se29=sen_estimator(m9);
s39=mktest(pom9);
se39=sen_estimator(pom9);
s49=mktest(all9);
se49=sen_estimator(all9);
Tasgaon_mk=[s19 s29 s39 s49 ]
Tasgaon_sen=[se19 se29 se39 se49]

```

```

A=[Atpadi_mk; Islampur_mk ;Jath_mk; Kavathe-Mahankal_mk; Miraj_mk;
Shirala_mk; Palus_mk; Sangli_mk; Tasgaon_mk]
B=[Atpadi_sen; Islampur_sen; Jath_sen;Kavathe-Mahankal_sen;
Miraj_sen;Shirala_sen;Palus_sen;Sangli_sen;Tasgaon_sen]

```

Output

Atpadi_mk =

```

-19.0000 -0.2945 0.7684 -49.0000 -0.7784 0.4363 -16.0000 -0.2432
0.8078 -26.0000 -0.4054 0.6852

```

Atpadi_sen =

```

0 -2.3650 -0.3804 -1.7458

```

Islampur_mk =

```

-89.0000 -1.4338 0.1516 57.0000 0.9081 0.3638 63.0000 1.0056
0.3146 33.0000 0.5189 0.6038

```

Islampur_sen =

-1.0000 4.7735 1.7947 3.1149

Jath_mk =

53.0000 0.8507 0.3949 65.0000 1.0379 0.2993 108.0000 1.7352
0.0827 71.0000 1.1352 0.2563

Jath_sen =

0.4657 3.8478 3.3100 5.3612

Kavate_Mahankal_mk =

32.0000 0.5037 0.6144 87.0000 1.3946 0.1631 113.0000 1.8162
0.0693 92.0000 1.4757 0.1400

Kavate_Mahankal_sen =

0.3935 4.4171 3.1805 6.0431

Miraj_mk =

-48.0000 -0.7656 0.4439 68.0000 1.0865 0.2773 75.0000 1.2000
0.2301 80.0000 1.2811 0.2002

Miraj_sen =

-0.4255 3.6912 2.0450 4.7525

Shirala_mk =

-43.0000 -0.6871 0.4920 33.0000 0.5190 0.6038 11.0000 0.1622
0.8712 45.0000 0.7135 0.4755

Shirala_sen =

-0.4722 2.8722 0.1529 3.1554

Palus_mk =

13.0000 0.6055 0.5449 -9.0000 -0.3959 0.6922 -16.0000 -0.7423
0.4579 -3.0000 -0.0990 0.9212

Palus_sen =

0.3333 -5.8545 -2.9000 -5.6000

Sangli_mk =

-98.0000 -1.6359 0.1019 -82.0000 -1.3145 0.1887 -5.0000 -0.0675
 0.9462 -84.0000 -1.3469 0.1780

Sangli_sen =

-0.6250 -6.8792 -6.8792 -7.0742

Tasgaon_mk =

-97.0000 -1.5639 0.1178 -13.0000 -0.1946 0.8457 -10.0000 -0.1460
 0.8839 -73.0000 -1.1678 0.2429

Tasgaon_sen =

-1.2156 -0.6352 -0.6588 -7.1511

A =

-19.0000 -0.2945 0.7684 -49.0000 -0.7784 0.4363 -16.0000 -0.2432 0.8078 -
 26.0000 -0.4054 0.6852
 -89.0000 -1.4338 0.1516 57.0000 0.9081 0.3638 63.0000 1.0056 0.3146
 33.0000 0.5189 0.6038
 53.0000 0.8507 0.3949 65.0000 1.0379 0.2993 108.0000 1.7352 0.0827
 71.0000 1.1352 0.2563
 32.0000 0.5037 0.6144 87.0000 1.3946 0.1631 113.0000 1.8162 0.0693
 92.0000 1.4757 0.1400
 -48.0000 -0.7656 0.4439 68.0000 1.0865 0.2773 75.0000 1.2000 0.2301
 80.0000 1.2811 0.2002
 -43.0000 -0.6871 0.4920 33.0000 0.5190 0.6038 11.0000 0.1622 0.8712
 45.0000 0.7135 0.4755
 13.0000 0.6055 0.5449 -9.0000 -0.3959 0.6922 -16.0000 -0.7423 0.4579 -
 3.0000 -0.0990 0.9212
 -98.0000 -1.6359 0.1019 -82.0000 -1.3145 0.1887 -5.0000 -0.0675 0.9462 -
 84.0000 -1.3469 0.1780
 -97.0000 -1.5639 0.1178 -13.0000 -0.1946 0.8457 -10.0000 -0.1460 0.8839 -
 73.0000 -1.1678 0.2429

B =

0 -2.3650 -0.3804 -1.7458
 -1.0000 4.7735 1.7947 3.1149
 0.4657 3.8478 3.3100 5.3612
 0.3935 4.4171 3.1805 6.0431
 -0.4255 3.6912 2.0450 4.7525
 -0.4722 2.8722 0.1529 3.1554
 0.3333 -5.8545 -2.9000 -5.6000
 -0.6250 -6.8792 -6.8792 -7.0742
 -1.2156 -0.6352 -0.6588 -7.1511

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|| Published Papers ||

- 1) Change in Seasonality Index of Rainfall in Sangli District. ***“Indian Streams Research Journal” Volume-5, Issue-1***, Feb-2015 (ISSN 2230-7850, Impact Factor : 3.1560(UIF))

 - 2) Statistical Analysis of Rainfall Data of Sangli District. ***International Multidisciplinary Research Journal “Golden Research Thoughts”*** Vol 4/ Issue 8/ Feb 2015 (ISSN:2231-5063, Impact Factor: 3.4052 UIF)

 - 3) Probability Analysis of Dry and Wet Spells at Sangli District. ***International Multidisciplinary Research Journal “ Golden Research Thoughts”*** Vol 4/ Issue 9/ March 2015 (ISSN:2231-5063, Impact Factor: 3.4052 UIF)

 - 4) Detection of Trend in Rainfall Data: A Case Study of Sangli District. ***Review Of Research*** Vol. 4 | Issue. 6 | March. 2015 (ISSN:-2249-894X, Impact Factor : 3.1402 (UIF))
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F. No. 47-534/12 (WRO)

27 NOV 2019

October 2019

THE PRINCIPAL,
PADMABHUSHAN VASANTRAO DADA PATIL
MAHAVIDYALAYA,
KAVATHE MAHANKAL,
SANGLI, PIN- 416405.

Subject: NOC/finalization of Minor Research Project awarded to Dr. Patil M. K. in the Subject of Statistics.

Sir/Madam,

Please refer to your letter no. 170/19-20 dated 19.10.19, regarding the Minor Research Project awarded to Dr. Patil M. K. of your College in the subject of "Statistics". I am to inform you that the account of Minor Research Project titled "Statistical Modeling of Rainfall Data in Sangli Dist." sanctioned by the UGC (WRO), may be treated as finalized and settled as per final report /utilization certificates submitted by the College.

Heads	UGC Allocation	I st & II nd Inst. Grants already released	Total Exp. Incurred (as reported by College)	Grants proposed to be released as Final Inst/ Adjustment
Non-Rec:				
Books/ Journals	15000	15000	15054	0
Equipment	75000	75000	75750	0
Total- I	90000	90000	90804	0
Rec:				
Contingency	20000	10000	20135	10000
Special Needs	0	0	0	0
Travel	25000	12500	26220	12500
Chemicals	0	0	0	0
Other	10000	5000	10000	5000
Total- II	55000	27500	56355	27500
All Total I & II	145000	117500	147159	27500*

*As the Audited UC/SE was not submitted within six months from the date of completion of the project. Hence the balance amount is not admissible as per UGC Guidelines.

It would be highly appreciated if you kindly submit the Feedback Form enclosed herewith.

Yours faithfully,

R. Manoj Kumar
(Dr. R. Manoj Kumar)
Joint Secretary

Encl: As Above

Copy to:

1. DR. PATIL M. K.,
PADMABHUSHAN VASANTRAO DADA PATIL MAHAVIDYALAYA,
KAVATHE MAHANKAL, SANGLI, PIN- 416405.
2. REGISTRAR, SHIVAJI UNIVERSITY, VIDYA NAGAR, KOLHAPUR, PIN-416004.
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Vinod Singh Yadav
(Vinod Singh Yadav)
Education Officer

Sr. No.	१४
P.T.	NIL