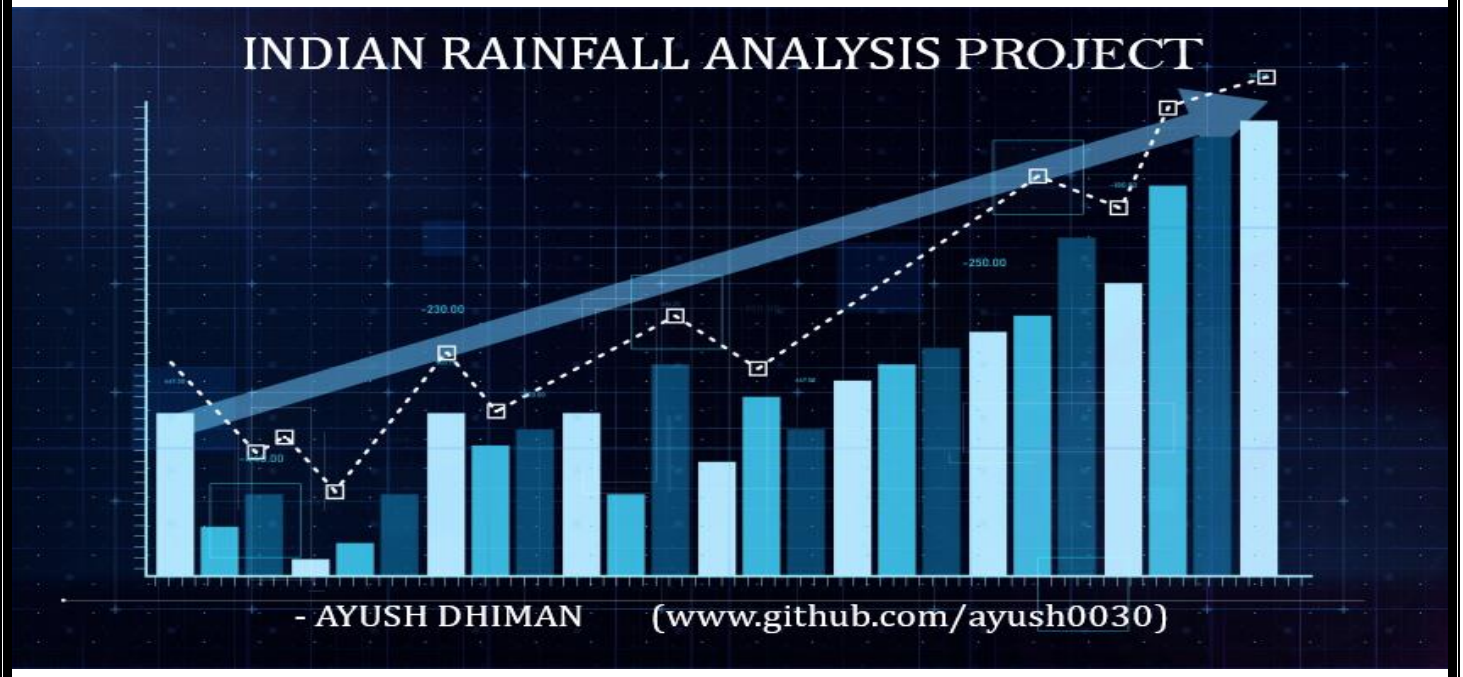

INDIAN RAINFALL ANALYSIS

(PROJECT REPORT)

Submitted By

AYUSH DHIMAN

DEPARTMENT OF COMPUTER SCIENCE - (2019 BATCH)

CHITKARA
UNIVERSITY

ABSTRACT

The data analysis & visualisation techniques are employed for efficient and real time analysis of Weather and Climate data. The main goal of studies on Climate is that users e.g. farmers, Scientist, decision & policy maker etc., from different industries e.g. Agriculture, Scientific, Aerospace etc., is required to understand the importance of various changes in weather and climate parameters like rainfall, humidity, temperature etc. This report provides a better understanding of the weather and climate data using data-visualisation in India, the monsoon months of June to September account for more than 80% of the annual rainfall. During June and July, the number of sub-divisions showing increasing rainfall is almost equal to those showing decreasing rainfall. In August, the number of sub-divisions showing an increasing trend exceeds those showing a decreasing trend, whereas in September, the situation is the opposite. The majority of sub-divisions showed very little change in rainfall in non-monsoon months. For the whole of India, no significant trend was detected for annual, seasonal, or monthly rainfall. Annual and monsoon rainfall decreased, while pre-monsoon, post-monsoon and winter rainfall increased at the national scale. Rainfall in June, July and September decreased, whereas in August it increased, at the national scale.

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ACKNOWLEDGEMENT

I would like to avail this opportunity to thank all of the people who have stood by me, encouraged me, inspired me and have contributed greatly in providing the pleasure of achievement and ecstasy of creative effort experienced all the way through the accomplishment of this project. I would like to place on record my deep sense of gratitude to **TCIL-IT Chandigarh (ICS Group),** for their stimulating guidance, and continuous encouragement**.**

CERTIFICATE

I **Ayush Dhiman**, a student from Computer Science Department of **Chitkara University, Rajpura** having enrolment/roll number **1910990441** would like to bring in notice that I have completed my 6 months industrial training in **Data Science using python** from **TCIL-IT Chandigarh**. I hereby declare that the matter presented in this report has not been submitted by me for the award of any other degree elsewhere.

Yours Sincerely,

Name: AYUSH DHIMAN
Roll Number: 1910990441
Email: ayushdhiman333@gmail.com

www.tcilitchandigarh.com

INTRODUCTION

A change in the climate is a remarkable change in the geographic distribution of weather pattern over periods from decades to thousands of years. With the growing recognition of the possibility of adverse impacts of global climate change on water resources, an assessment of future rainwater availability at various spatial and temporal scales is needed. It is expected that the response of hydrological systems, erosion processes and sedimentation could significantly get altered due to climate change. An understanding of the hydrological response of rainfall under changed climatic conditions would help solve problems associated with floods, droughts and allocation of water for agriculture, industry, hydropower generation, domestic and industrial use. Scenarios of variations in runoff and its distribution depend on the future climate scenarios. In the context of climate change, it is relevant to ascertain whether the characteristics of Indian monsoon also are changing. The Indian monsoon (June to September) rainfall is very crucial for the economic development, disaster management, hydrological planning for the country.

Studies carried out by several investigators have shown that the trend and magnitude of warming over India/the Indian sub-continent over the last century is broadly consistent with the global trend. Changes in rainfall over India have concluded that there is no clear trend of increase or decrease in average annual rainfall over the country. At present there are 748 districts in the country Using only 306 rain gauge stations. A rain gauge is an instrument used by meteorologists and hydrologists to gather and measure the amount of liquid precipitation over an area in a predefined area, over a period of time. It is used for determining the depth of precipitation that occurs over a unit area and thus measuring rainfall amount, it may not be possible to represent all the districts and prepare district-wise rainfall climatology. All the districts are having geographical area more than 100 square km (except Andaman and Nicobar Islands).

Maximum rainfall occurs near the earth's equator because these regions having very high direct sunlight impact with very high temperature which creates high level of vertical uplift or air. The presence of mountains in this region increases the uplift of air. The opposite happens in Polar Regions, where the air is very cold and contains high amount of water level which enable only low level of vertical uplift. This forces the air to descend down preventing from any cloud formation. The major factors which have direct impact on the amount of rain received over a region are humidity, air pressure, region's topography and the type of cloud formed over the region. One of the major driving force towards this wide cultural heritage is the difference in climatic characteristics prolongs through the area. The region covers snow covered Himalayas in the north to tropical rain forests in the south. The types of mountains, rivers and sea shores make India a distinct geographical entity in Asia. It is bound by the Himalayas in the north to tapper between Indian Ocean in south, Bay of Bengal

in the east and Arabian Sea in the south. The climate within India can be mainly classified into four major categories: tropical dry, tropical wet, sub-tropical humid and mountain climate

Rainfall study is mainly known as climatology which includes process of measuring, understanding, and predicting rainfall pattern across the earth surface

The rainfall pattern over the study areas were analysed with data from the csv file. To investigate the changes in rainfall for different seasons, a year was divided into four seasons: winter (January–February), pre-monsoon (March–May), monsoon (June–September), and post-monsoon (October–December). Rainfall analysis was carried out for all the seasons as well as the whole year separately. Note that the post-monsoon season contains only two months, while the monsoon season has four months. For the trend analysis, monthly rainfall series were used to form seasonal and annual series of these variables. Further we have plotted graphs for visual representation & better understanding of the csv file data having Indian Rainfall metrics for various subdivions i.e. 4116 in count (from year 1901 to 2015) and accompanied by more columns such as (“**YEAR**”, ”**JAN**”, “**FEB**”, “**MAR**”, “**APR**”, “**MAY**”, “**JUN**”, “**JUL**”, “**AUG**”, “**SEP**”, “**OCT**”, “**NOV**”, “**DEC**”, “**ANNUAL**”, “**Jan-Feb**”, “**Mar-May**”, “**Jun-Sep**”, “**Oct-Dec**”).

The project is sub-divided following sections, which are as follows:

1. Loading necessary libraries (such as Numpy, Pandas, Matplotlib, Seaborn)
2. Loading Dataset from a CSV file.
3. Summarization of Data to understand Dataset (Descriptive Statistics)
4. Visualization of Data to understand Dataset (Plots, Graphs etc.)
5. Evaluating the result of the visualised data.

DATA

The source of this dataset is Kaggle. The dataset consists of text which is having data from year 1901 till 2015. The dataset has 19 columns and 4116 rows in the dataset where each row corresponds to a subdivision. For the classification problem under consideration we have used ‘subdivisions’ and months as columns. The subdivision column is of string data type whereas the other months are in float data type. The data is classified into subdivisions. However, in some of the rows some

values were missing for some of the values and were ‘NaN’. The data was cleaned in the previous steps before using it for visualising and analysis

Source url: https://www.kaggle.com/rajanand/rainfall-in-india

TOOLS USED

NUMPY	NumPy is very useful for performing mathematical and logical operations on Arrays.
PANDAS	Pandas is a Python library for data analysis
MATPLOTLIB	Matplotlib is a cross-platform, data visualization and graphical plotting library for Python
SEABORN	Seaborn is an open-source Python library built on top of matplotlib. It is used for data visualization and exploratory data analysis

PROJECT PROPOSAL

This project has been made to provide an easy and analytical approach and the trends of the rainfall in India divided upon subdivisions, months and seasons having 4116 rows and 19 columns in a dataframe from the year 1901 till year 2015. The graphs and plots made from this data help a person to easily recognise the trend and relation among the different

year rainfall. All the data that is 4116x19 i.e. 78204 has been represented in the form of graphs and charts.

WORK

Out[2]:

	SUBDIVISION	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	Jan-Feb	Mar-May	Jun-Sep	Oct-Dec
0	ANDAMAN & NICOBAR ISLANDS	1901	49.2	87.1	29.2	2.3	528.8	517.5	365.1	481.1	332.6	388.5	558.2	33.6	3373.2	136.3	560.3	1696.3	980.3
1	ANDAMAN & NICOBAR ISLANDS	1902	0.0	159.8	12.2	0.0	446.1	537.1	228.9	753.7	666.2	197.2	359.0	160.5	3520.7	159.8	458.3	2185.9	716.7
2	ANDAMAN & NICOBAR ISLANDS	1903	12.7	144.0	0.0	1.0	235.1	479.9	728.4	326.7	339.0	181.2	284.4	225.0	2957.4	156.7	236.1	1874.0	690.6
3	ANDAMAN & NICOBAR ISLANDS	1904	9.4	14.7	0.0	202.4	304.5	495.1	502.0	160.1	820.4	222.2	308.7	40.1	3079.6	24.1	506.9	1977.6	571.0
4	ANDAMAN & NICOBAR ISLANDS	1905	1.3	0.0	3.3	26.9	279.5	628.7	368.7	330.5	297.0	260.7	25.4	344.7	2566.7	1.3	309.7	1624.9	630.8
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4111	LAKSHADWEEP	2011	5.1	2.8	3.1	85.9	107.2	153.6	350.2	254.0	255.2	117.4	184.3	14.9	1533.7	7.9	196.2	1013.0	316.6
4112	LAKSHADWEEP	2012	19.2	0.1	1.6	76.8	21.2	327.0	231.5	381.2	179.8	145.9	12.4	8.8	1405.5	19.3	99.6	1119.5	167.1
4113	LAKSHADWEEP	2013	26.2	34.4	37.5	5.3	88.3	426.2	296.4	154.4	180.0	72.8	78.1	26.7	1426.3	60.6	131.1	1057.0	177.6
4114	LAKSHADWEEP	2014	53.2	16.1	4.4	14.9	57.4	244.1	116.1	466.1	132.2	169.2	59.0	62.3	1395.0	69.3	76.7	958.5	290.5
4115	LAKSHADWEEP	2015	2.2	0.5	3.7	87.1	133.1	296.6	257.5	146.4	160.4	165.4	231.0	159.0	1642.9	2.7	223.9	860.9	555.4

4116 rows × 19 columns

The above image has a glimpse of the dataset that is used as a data source in the project. We can see that it has 4116 rows having the subdivisions and 19 columns having the amount of rainfall from the year 1901 till 2015 as in each month and different seasons.

Out[3]:

	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	
count	4116.000000	4112.000000	4113.000000	4110.000000	4112.000000	4113.000000	4111.000000	4109.000000	4112.000000	4110.000000	4109.000000	4105.0(
mean	1958.218659	18.957320	21.805325	27.359197	43.127432	85.745417	230.234444	347.214334	290.263497	197.361922	95.507009	39.8(
std	33.140898	33.585371	35.909488	46.959424	67.831168	123.234904	234.710758	269.539667	188.770477	135.408345	99.519134	68.6(
min	1901.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.400000	0.000000	0.000000	0.100000	0.000000	0.0(
25%	1930.000000	0.600000	0.600000	1.000000	3.000000	8.600000	70.350000	175.600000	155.975000	100.525000	14.600000	0.7(
50%	1958.000000	6.000000	6.700000	7.800000	15.700000	36.600000	138.700000	284.800000	259.400000	173.900000	65.200000	9.5(
75%	1987.000000	22.200000	26.800000	31.300000	49.950000	97.200000	305.150000	418.400000	377.800000	265.800000	148.400000	46.1(
max	2015.000000	583.700000	403.500000	605.600000	595.100000	1168.600000	1609.900000	2362.800000	1664.600000	1222.000000	948.300000	648.9(

The descriptive information about the data set is shown in the above image.

Out[4]:
```
Index(['SUBDIVISION', 'YEAR', 'JAN', 'FEB', 'MAR', 'APR', 'MAY', 'JUN', 'JUL',
       'AUG', 'SEP', 'OCT', 'NOV', 'DEC', 'ANNUAL', 'Jan-Feb', 'Mar-May',
       'Jun-Sep', 'Oct-Dec'],
      dtype='object')
```

The list of columns in the dataset have been extracted in the above image.

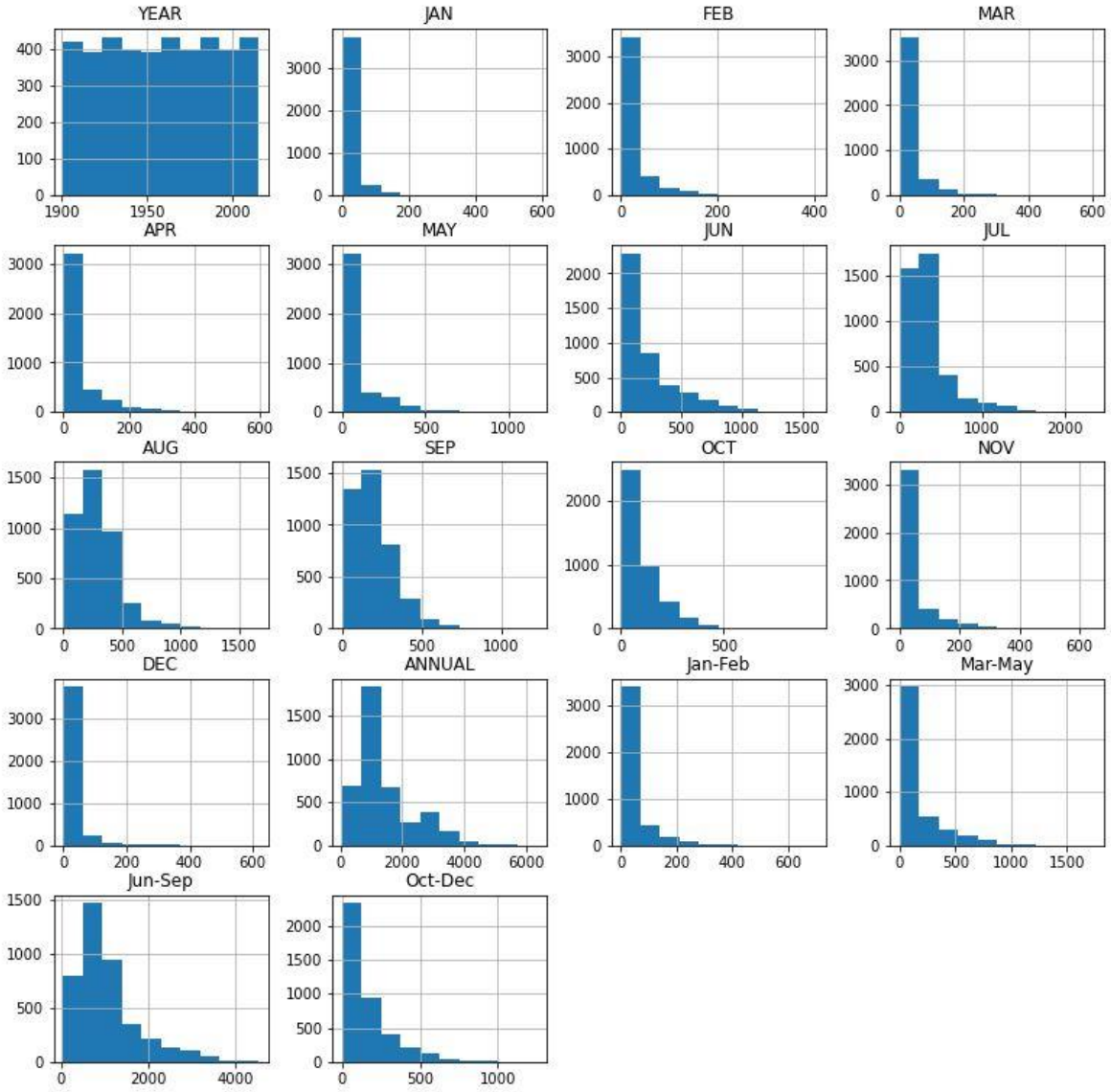
Out[5]:
```
array([['ANDAMAN & NICOBAR ISLANDS', 1901, 49.2, ..., 560.3, 1696.3,
        980.3],
       ['ANDAMAN & NICOBAR ISLANDS', 1902, 0.0, ..., 458.3, 2185.9,
        716.7],
       ['ANDAMAN & NICOBAR ISLANDS', 1903, 12.7, ..., 236.1, 1874.0,
        690.6],
       ...,
       ['LAKSHADWEEP', 2013, 26.2, ..., 131.1, 1057.0, 177.6],
       ['LAKSHADWEEP', 2014, 53.2, ..., 76.7, 958.5, 290.5],
       ['LAKSHADWEEP', 2015, 2.2, ..., 223.9, 860.9, 555.4]], dtype=object)
```

All Values inside the dataset (shown in the above image)

Out[6]:

	SUBDIVISION	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	Jan-Feb	Mar-May	Jun-Sep	Oct-Dec
2327	GUJARAT REGION	1951	0.0	0.0	0.4	0.3	2.1	65.6	218.6	162.6	7.3	13.9	7.3	0.3	478.3	0.0	2.7	454.1	21.5
1765	JAMMU & KASHMIR	1964	126.2	60.7	96.0	134.6	41.3	92.7	167.4	99.4	64.0	1.3	4.6	58.0	946.2	186.9	272.0	423.5	63.9
3333	RAYALSEEMA	1922	36.9	0.0	0.0	12.0	52.0	48.4	64.8	85.0	34.8	120.0	306.3	10.0	770.3	36.9	64.0	233.1	436.3
3029	CHHATTISGARH	1963	0.4	5.4	8.9	44.8	28.2	160.8	349.4	387.7	258.8	91.2	1.2	0.3	1337.2	5.8	82.0	1156.7	92.7
366	NAGA MANI MIZO TRIPURA	1945	68.7	60.9	67.7	170.4	354.2	595.3	573.9	509.7	378.8	205.6	13.3	53.3	3051.9	129.6	592.3	2057.7	272.2

Some random rows from the dataset (shown in the above image)



Out[8]:

```
array(['ANDAMAN & NICOBAR ISLANDS', 'ARUNACHAL PRADESH',
       'ASSAM & MEGHALAYA', 'NAGA MANI MIZO TRIPURA',
       'SUB HIMALAYAN WEST BENGAL & SIKKIM', 'GANGETIC WEST BENGAL',
       'ORISSA', 'JHARKHAND', 'BIHAR', 'EAST UTTAR PRADESH',
       'WEST UTTAR PRADESH', 'UTTARAKHAND', 'HARYANA DELHI & CHANDIGARH',
       'PUNJAB', 'HIMACHAL PRADESH', 'JAMMU & KASHMIR', 'WEST RAJASTHAN',
       'EAST RAJASTHAN', 'WEST MADHYA PRADESH', 'EAST MADHYA PRADESH',
       'GUJARAT REGION', 'SAURASHTRA & KUTCH', 'KONKAN & GOA',
       'MADHYA MAHARASHTRA', 'MATATHWADA', 'VIDARBHA', 'CHHATTISGARH',
       'COASTAL ANDHRA PRADESH', 'TELANGANA', 'RAYALSEEMA', 'TAMIL NADU',
       'COASTAL KARNATAKA', 'NORTH INTERIOR KARNATAKA',
       'SOUTH INTERIOR KARNATAKA', 'KERALA', 'LAKSHADWEEP'], dtype=object)
```

Individual districts in the complete dataset (shown in the above image)

Out[9]:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	Jan-Feb	Mar-May	Jun-Sep	Oct-Dec
0	49.2	87.1	29.2	2.3	528.8	517.5	365.1	481.1	332.6	388.5	558.2	33.6	3373.2	136.3	560.3	1696.3	980.3
1	0.0	159.8	12.2	0.0	446.1	537.1	228.9	753.7	666.2	197.2	359.0	160.5	3520.7	159.8	458.3	2185.9	716.7
2	12.7	144.0	0.0	1.0	235.1	479.9	728.4	326.7	339.0	181.2	284.4	225.0	2957.4	156.7	236.1	1874.0	690.6
3	9.4	14.7	0.0	202.4	304.5	495.1	502.0	160.1	820.4	222.2	308.7	40.1	3079.6	24.1	506.9	1977.6	571.0
4	1.3	0.0	3.3	26.9	279.5	628.7	368.7	330.5	297.0	260.7	25.4	344.7	2566.7	1.3	309.7	1624.9	630.8
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4111	5.1	2.8	3.1	85.9	107.2	153.6	350.2	254.0	255.2	117.4	184.3	14.9	1533.7	7.9	196.2	1013.0	316.6
4112	19.2	0.1	1.6	76.8	21.2	327.0	231.5	381.2	179.8	145.9	12.4	8.8	1405.5	19.3	99.6	1119.5	167.1
4113	26.2	34.4	37.5	5.3	88.3	426.2	296.4	154.4	180.0	72.8	78.1	26.7	1426.3	60.6	131.1	1057.0	177.6
4114	53.2	16.1	4.4	14.9	57.4	244.1	116.1	466.1	132.2	169.2	59.0	62.3	1395.0	69.3	76.7	958.5	290.5
4115	2.2	0.5	3.7	87.1	133.1	296.6	257.5	146.4	160.4	165.4	231.0	159.0	1642.9	2.7	223.9	860.9	555.4

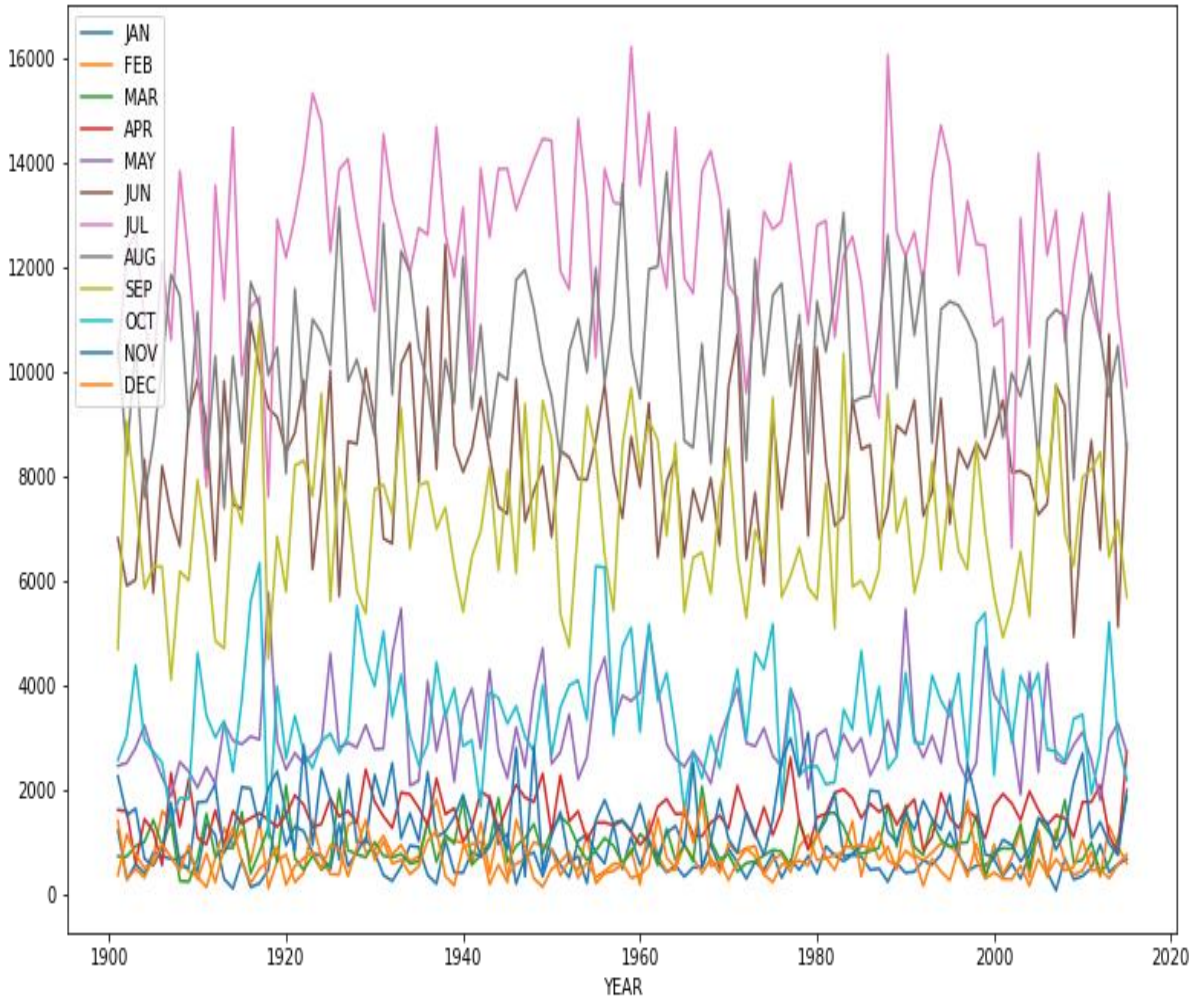
4116 rows × 17 columns

Only float values from the dataset (shown in the above image)

Out[10]:

SUBDIVISION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ANDAMAN & NICOBAR ISLANDS	5790.1	3079.4	3437.0	7800.1	38919.2	50930.7	43204.6	43205.1	47024.6	31348.6	25244.4	16388.5
ARUNACHAL PRADESH	4540.6	8747.2	14585.1	25592.1	34776.7	62147.9	66676.3	48037.3	41917.0	18495.2	3391.2	2327.7
ASSAM & MEGHALAYA	1952.1	3615.8	9088.1	23358.3	39277.0	58668.6	56936.8	46528.2	35734.5	17493.6	3097.9	1029.4
BIHAR	1539.4	1655.3	1164.3	1945.6	6104.4	20046.3	37310.8	34459.0	24999.2	7253.6	825.5	424.9
CHHATTISGARH	1633.8	2214.8	1755.7	1928.9	2420.6	22800.6	45836.4	44835.4	25044.7	7320.9	1353.8	603.6
COASTAL ANDHRA PRADESH	860.6	1486.2	1520.5	3075.2	7193.2	14224.8	19989.8	20231.2	20896.4	21333.8	8958.9	1313.3
COASTAL KARNATAKA	220.9	174.6	731.1	3555.4	14120.6	98752.5	129608.3	82066.1	34460.0	21223.5	7314.9	1450.6
EAST MADHYA PRADESH	2231.2	2149.8	1568.3	826.7	1066.4	16218.4	42708.5	42477.4	22337.2	4563.9	1461.1	966.5
EAST RAJASTHAN	738.6	623.0	519.4	361.6	1129.3	7290.9	25685.0	25101.9	11267.5	1651.5	560.5	419.9
EAST UTTAR PRADESH	1841.4	1825.5	1024.4	739.5	1979.3	12731.9	33415.4	31695.6	21228.0	4935.9	527.9	664.3
GANGETIC WEST BENGAL	1448.5	2582.0	3345.4	5161.8	12395.6	28427.6	37533.4	35809.0	28256.7	13310.8	2481.6	654.4
GUJARAT REGION	205.4	137.0	140.4	128.4	668.1	13947.7	40125.9	29807.2	17116.8	2365.0	796.8	154.0
HARYANA DELHI & CHANDIGARH	1942.3	2004.9	1487.6	877.9	1671.4	5592.0	17251.8	17346.7	10155.3	1474.7	375.4	826.4
HIMACHAL PRADESH	9681.8	10452.9	11631.8	7179.3	6688.0	10490.4	32232.7	31502.3	14975.2	3597.0	1920.0	4587.7
JAMMU & KASHMIR	11733.5	13276.8	15108.5	10775.8	7759.8	7387.0	20501.5	20811.9	10268.3	3929.2	2751.2	6318.5
JHARKHAND	2026.5	2781.4	2118.7	2227.2	5556.5	22377.7	38752.2	37435.3	26153.5	9201.8	1371.2	568.0
KERALA	1408.4	1782.1	4233.7	12716.0	26436.4	75244.8	80609.6	48527.4	28246.2	33824.1	18809.4	4594.3
KONKAN & GOA	145.2	62.9	158.1	490.6	3854.3	79185.5	123398.5	78517.0	40224.7	13039.5	2837.2	519.4
LAKSHADWEEP	3079.4	1789.3	1607.3	5058.3	18356.1	36694.3	31294.1	23295.3	18111.9	18506.8	13482.8	6689.2
MADHYA MAHARASHTRA	351.3	168.8	413.6	1051.9	2638.5	16954.0	28632.7	21205.7	18080.5	8072.4	2983.7	672.6
MATATHWADA	575.1	511.0	817.1	873.4	1799.4	15750.1	20774.6	19145.7	20524.8	6736.7	2580.2	839.8
NAGA MANI MIZO TRIPURA	1612.9	4215.0	8877.9	19634.3	33446.5	51247.9	50448.7	47297.4	36150.3	20125.7	5385.9	1425.9
NORTH INTERIOR KARNATAKA	346.5	364.8	819.2	2794.6	5409.1	11614.2	15931.1	13737.8	16438.2	11004.2	3358.9	727.7
ORISSA	1417.9	2267.7	2430.5	3928.4	7461.9	24249.0	40384.9	40869.0	27761.4	13063.1	3215.6	640.3
PUNJAB	2903.3	3080.5	2719.9	1455.9	1625.7	5343.7	19430.8	18189.3	9980.8	1591.2	476.1	1459.9
RAYALSEEMA	1134.8	653.2	928.8	2278.0	5804.7	7445.4	11049.4	12363.8	15147.8	15562.7	11805.2	3939.9
SAURASHTRA & KUTCH	131.0	185.8	149.1	136.1	536.2	8552.7	22421.6	13658.6	8673.1	1668.7	701.1	127.5
SOUTH INTERIOR KARNATAKA	336.8	478.8	1090.8	4862.3	10591.5	16263.0	26606.3	20037.5	15791.1	16001.5	6259.6	1324.5
SUB HIMALAYAN WEST BENGAL & SIKKIM	1619.6	2642.1	4960.6	12728.4	30951.5	61856.4	74336.3	59887.8	48454.3	16519.3	1850.2	696.9
TAMIL NADU	2739.2	1543.6	2239.7	5174.5	8040.9	5986.5	8201.2	11027.1	12833.7	21067.6	20343.9	9330.8
TELANGANA	885.8	1114.2	1450.7	2091.3	2918.0	16344.5	28462.4	24731.8	20182.9	8536.1	2328.8	591.3
UTTARAKHAND	6186.7	7297.0	6586.3	4044.1	6363.9	18693.4	44930.3	43932.7	22551.1	4493.5	941.6	2534.1
VIDARBHA	1214.8	1378.0	1365.3	1085.1	1328.4	19961.5	37884.3	32884.2	20176.7	5997.1	1791.1	911.7
WEST MADHYA PRADESH	1062.8	719.1	594.9	273.2	880.6	12854.9	34843.0	33132.5	18534.4	3230.0	1419.2	724.1
WEST RAJASTHAN	382.7	567.0	458.4	410.7	1086.0	3293.3	10944.7	10873.9	4639.4	589.7	191.7	218.8
WEST UTTAR PRADESH	2031.6	2057.8	1318.1	719.1	1415.2	8923.7	28349.8	28899.4	16819.3	3309.4	456.1	818.2

Subdivision wise rainfall metrics (shown in the above image)



Rainfall of all subdivisions of all years and all months except season (shown in the above image)

```
Out[13]: JAN    36
         FEB    36
         MAR    36
         APR    36
         MAY    36
         JUN    36
         JUL    36
         AUG    36
         SEP    36
         OCT    36
         NOV    36
         DEC    36
         dtype: int64
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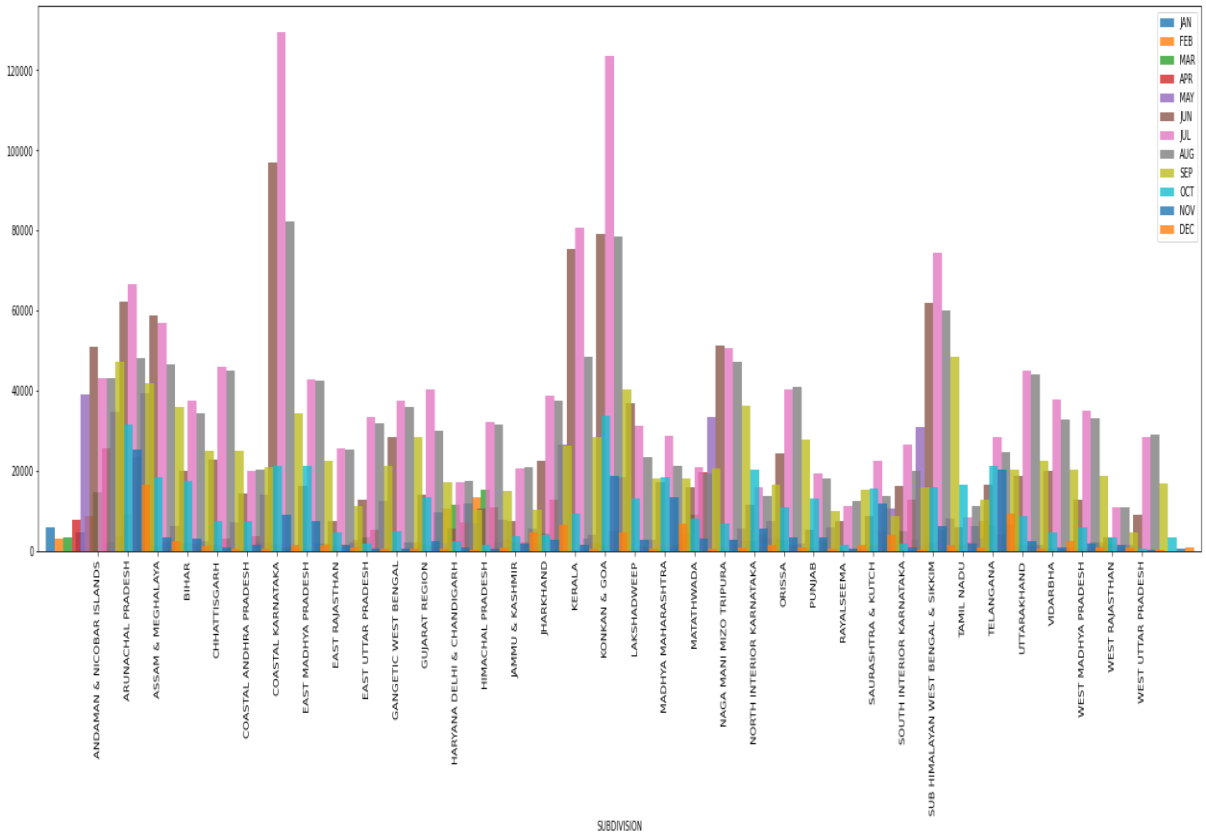
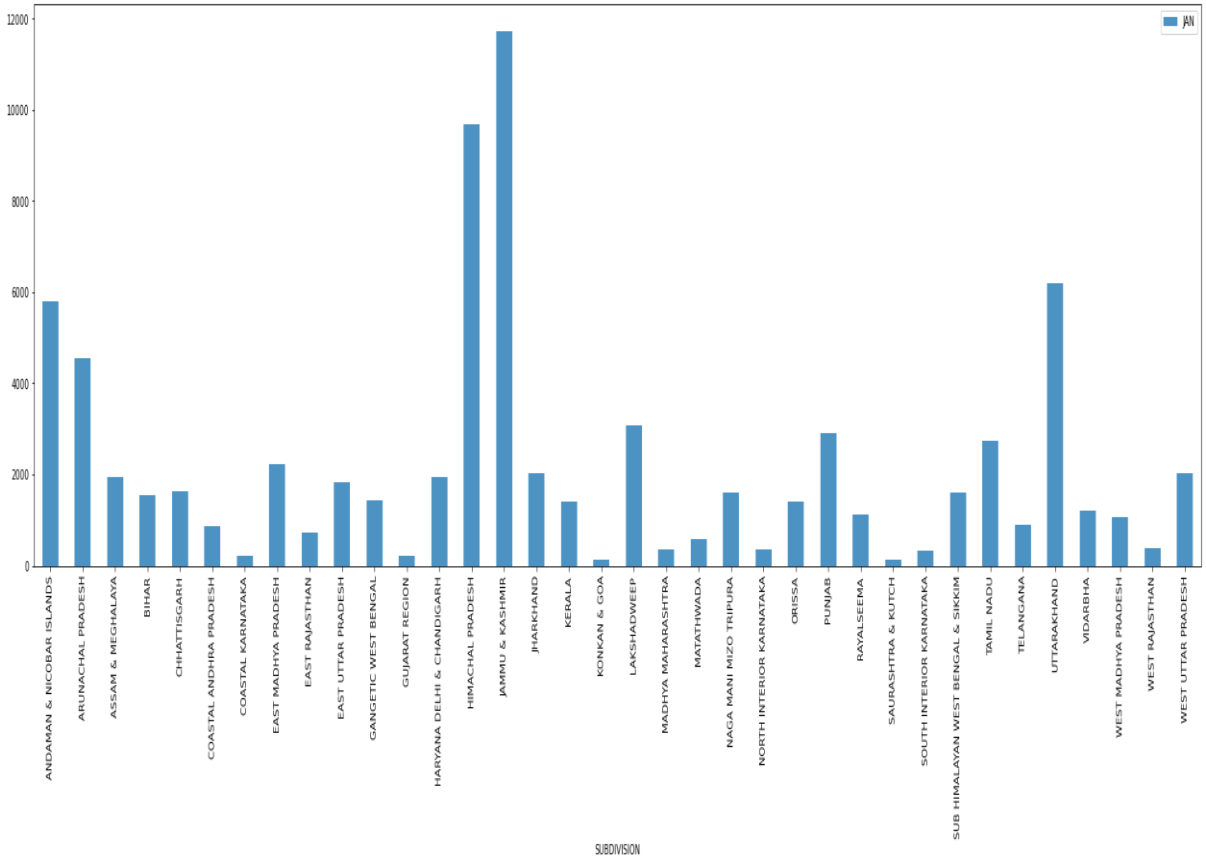


Bar graph representation of all subdivisions rainfall of all months and all years (shown in the above image)



All subdivisions rainfall of all years but of only “JAN” month (shown in the above image)

Out[19]:

SUBDIVISION	Jan-Feb	Mar-May	Jun-Sep	Oct-Dec
ANDAMAN & NICOBAR ISLANDS	8869.6	49460.7	182615.6	72269.6
ARUNACHAL PRADESH	13288.0	73880.2	215785.1	23924.3
ASSAM & MEGHALAYA	5567.5	71724.1	197867.9	21621.8
BIHAR	3194.3	9214.8	116815.4	8504.7
CHHATTISGARH	3848.2	6105.6	138517.6	9277.6
COASTAL ANDHRA PRADESH	2346.5	11789.3	75341.3	31606.1
COASTAL KARNATAKA	384.3	18405.9	342886.1	29989.2
EAST MADHYA PRADESH	4380.9	3461.1	123742.1	6992.0
EAST RAJASTHAN	1361.3	2011.1	69344.8	2632.1
EAST UTTAR PRADESH	3667.1	3743.7	99070.9	6128.8
GANGETIC WEST BENGAL	4029.9	20903.1	130025.6	16447.1
GUJARAT REGION	342.4	938.6	100998.9	3316.0
HARYANA DELHI & CHANDIGARH	3948.1	4037.9	50345.5	2676.1
HIMACHAL PRADESH	20134.5	25498.6	89201.4	10105.2
JAMMU & KASHMIR	25010.5	33643.5	58758.8	12991.4
JHARKHAND	4808.1	9901.0	124718.7	11141.3
KERALA	3190.0	43384.2	232626.7	57228.2
KONKAN & GOA	208.5	4503.6	321325.0	16396.6
LAKSHADWEEP	4717.5	24620.5	108191.0	38381.8
MADHYA MAHARASHTRA	520.5	4104.6	84872.9	11728.4
MATATHWADA	1086.6	3490.5	76195.3	10156.7
NAGA MANI MIZO TRIPURA	5827.0	61958.5	185143.3	26937.6
NORTH INTERIOR KARNATAKA	711.2	9023.0	57721.7	15090.7
ORISSA	3685.5	13821.2	133264.0	16919.1
PUNJAB	5983.5	5800.6	52945.1	3527.0
RAYALSEEMA	1787.7	9011.2	46006.7	31307.8
SAURASHTRA & KUTCH	316.5	821.2	53306.7	2497.6
SOUTH INTERIOR KARNATAKA	815.1	16544.1	78698.9	23585.8
SUB HIMALAYAN WEST BENGAL & SIKKIM	4262.0	48641.4	244535.0	19067.2
TAMIL NADU	4282.5	15454.4	38047.5	50742.0
TELANGANA	2000.6	6459.9	89721.5	11456.4
UTTARAKHAND	13483.9	16994.0	130107.3	7970.2
VIDARBHA	2592.6	3777.9	110906.4	8700.3
WEST MADHYA PRADESH	1782.8	1750.0	99365.0	5373.3
WEST RAJASTHAN	949.4	1955.7	29751.4	1000.6
WEST UTTAR PRADESH	4088.8	3453.0	82992.8	4583.7

All subdivisions data of all four seasons and of all years i.e from 1901 till 2015 that can be in the columns names (shown in the above image)

```
Out[20]: Index(['ANDAMAN & NICOBAR ISLANDS', 'ARUNACHAL PRADESH', 'ASSAM & MEGHALAYA',
       'BIHAR', 'CHHATTISGARH', 'COASTAL ANDHRA PRADESH', 'COASTAL KARNATAKA',
       'EAST MADHYA PRADESH', 'EAST RAJASTHAN', 'EAST UTTAR PRADESH',
       'GANGETIC WEST BENGAL', 'GUJARAT REGION', 'HARYANA DELHI & CHANDIGARH',
       'HIMACHAL PRADESH', 'JAMMU & KASHMIR', 'JHARKHAND', 'KERALA',
       'KONKAN & GOA', 'LAKSHADWEEP', 'MADHYA MAHARASHTRA', 'MATATHWADA',
       'NAGA MANI MIZO TRIPURA', 'NORTH INTERIOR KARNATAKA', 'ORISSA',
       'PUNJAB', 'RAYALSEEMA', 'SAURASHTRA & KUTCH',
       'SOUTH INTERIOR KARNATAKA', 'SUB HIMALAYAN WEST BENGAL & SIKKIM',
       'TAMIL NADU', 'TELANGANA', 'UTTARAKHAND', 'VIDARBHA',
       'WEST MADHYA PRADESH', 'WEST RAJASTHAN', 'WEST UTTAR PRADESH'],
      dtype='object', name='SUBDIVISION')
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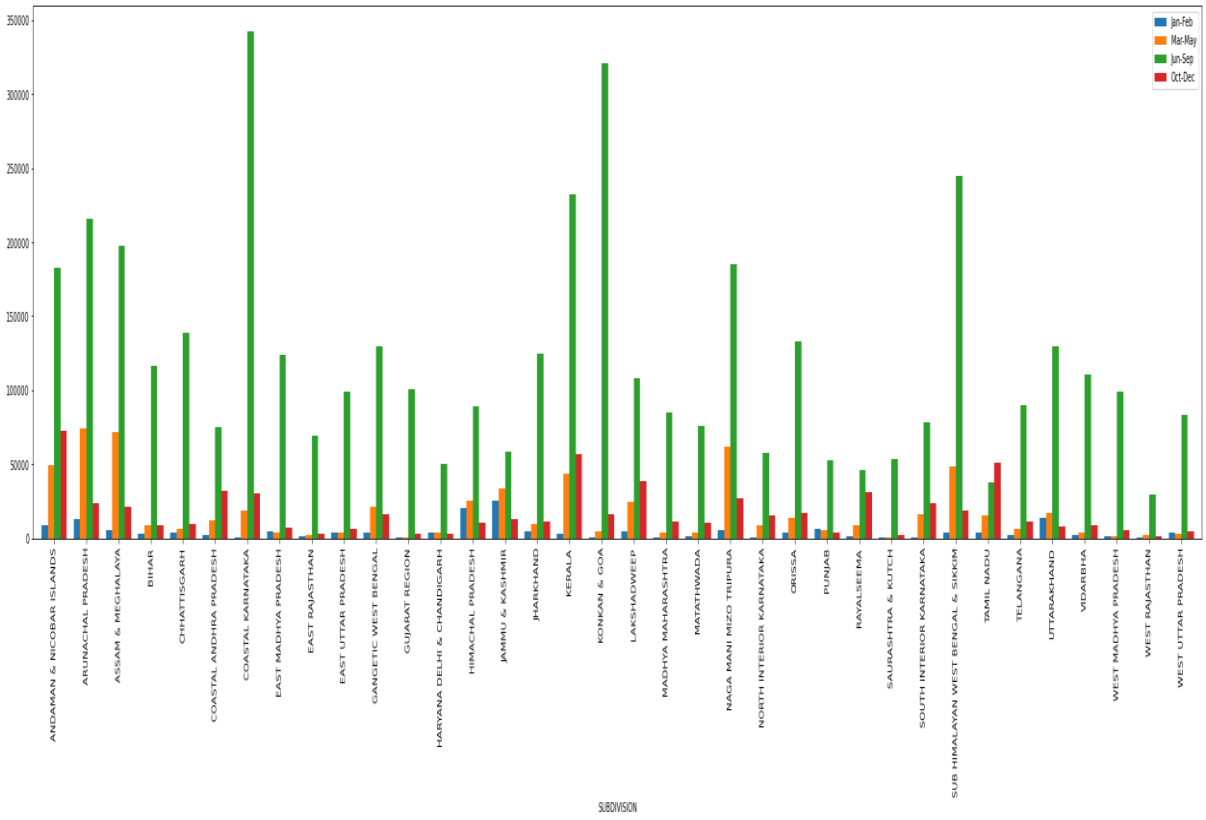
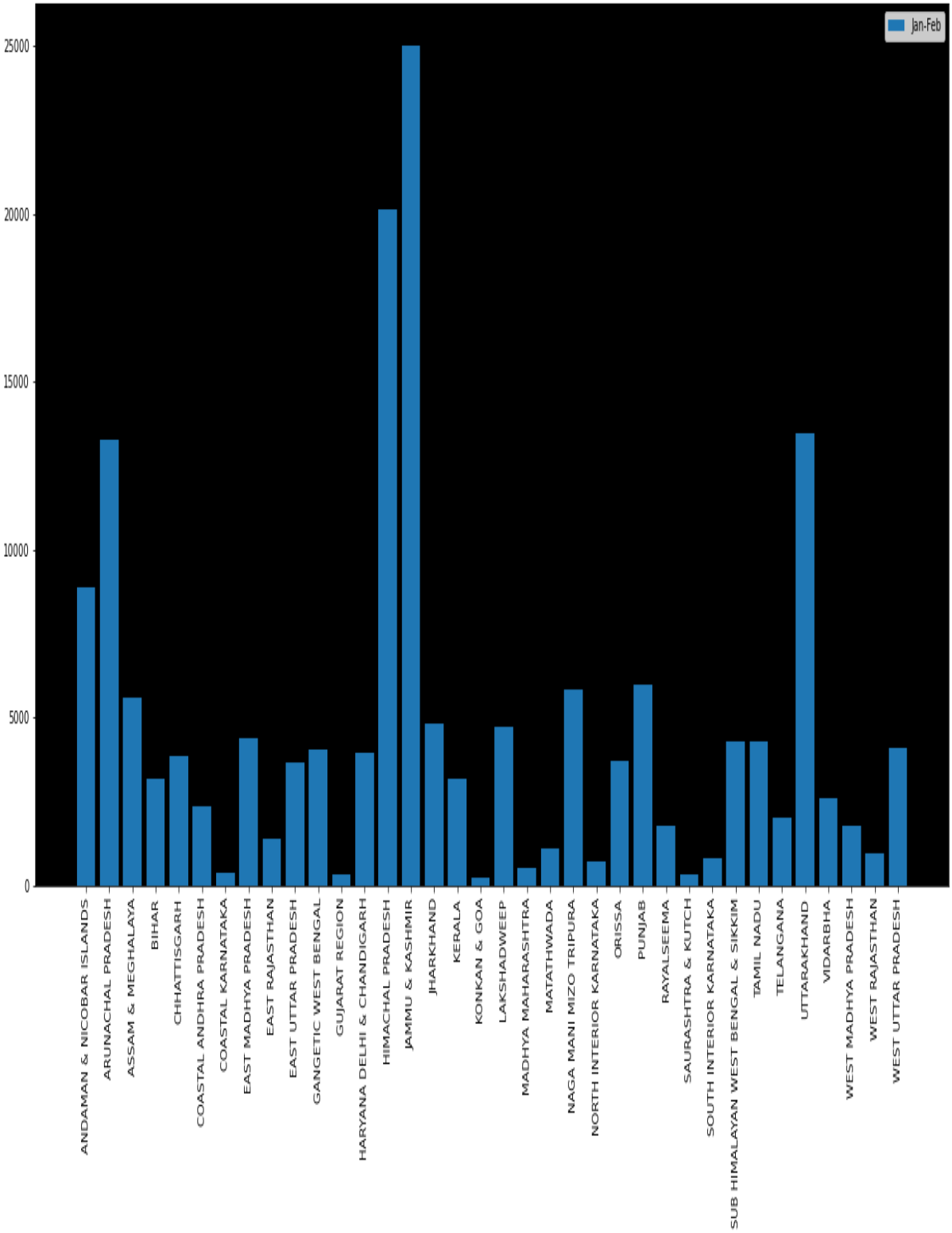
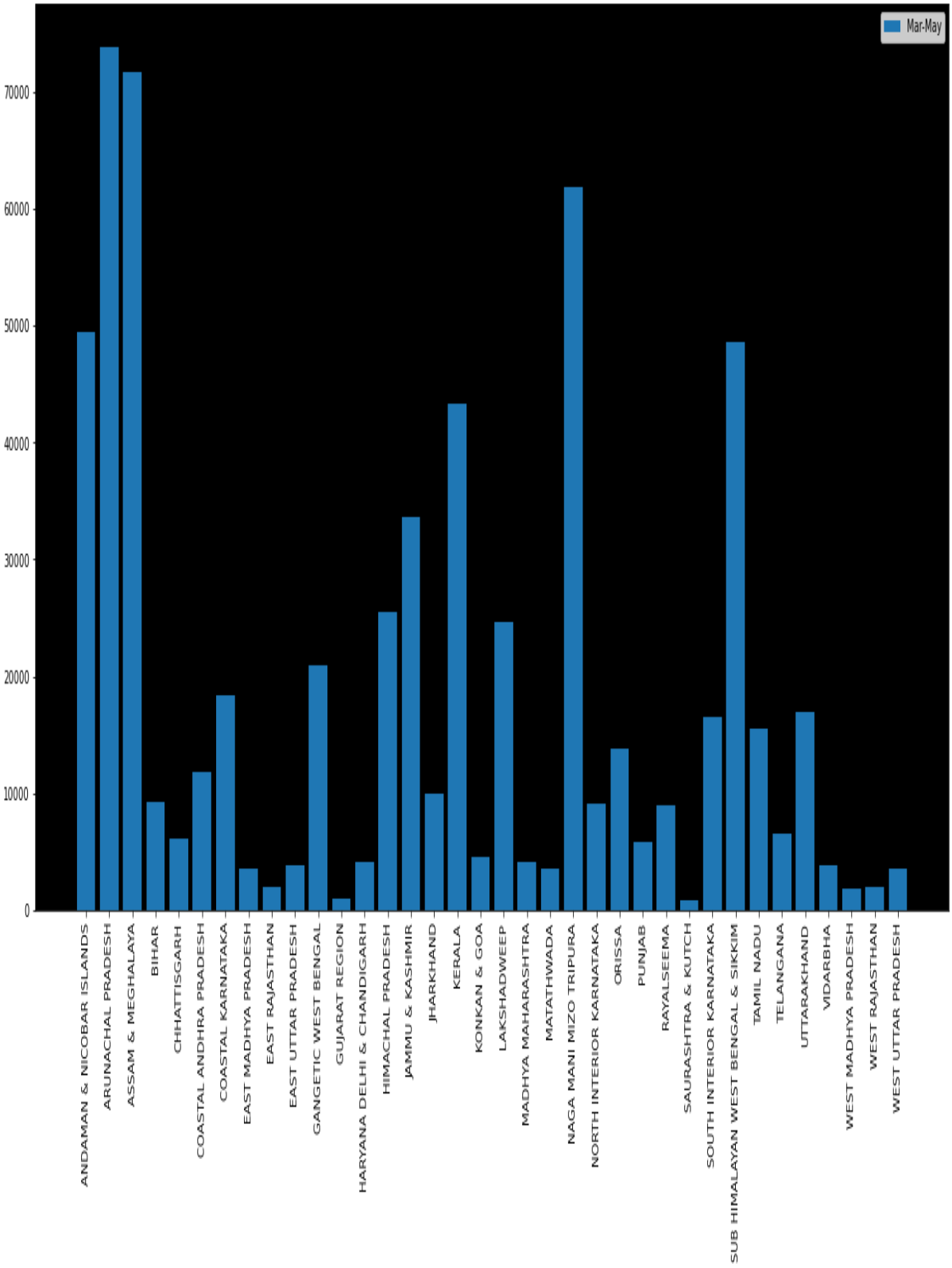


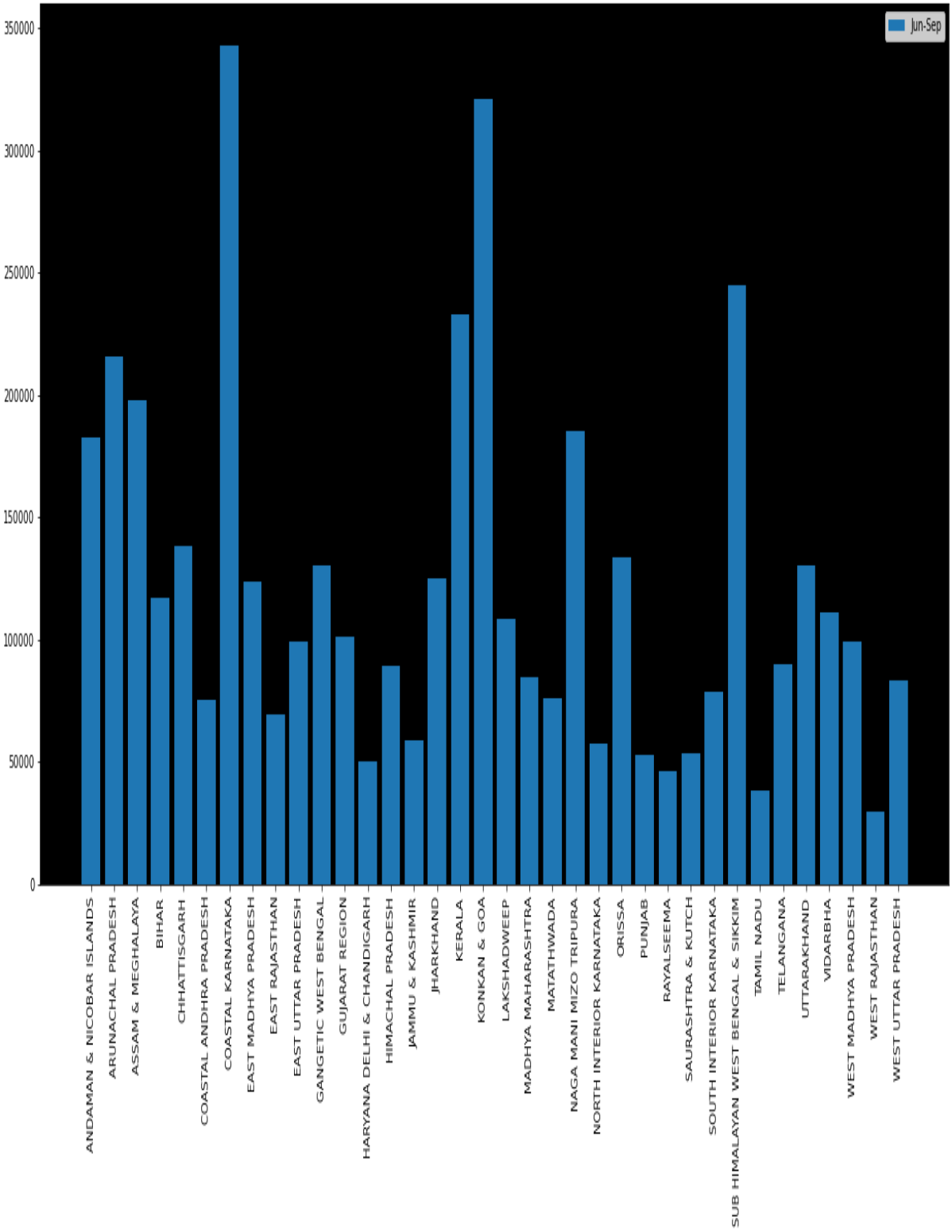
Bar graphs for visualising the seasonal rainfall in all districts of India since the year 1901 till year 2015 (shown in the above image)



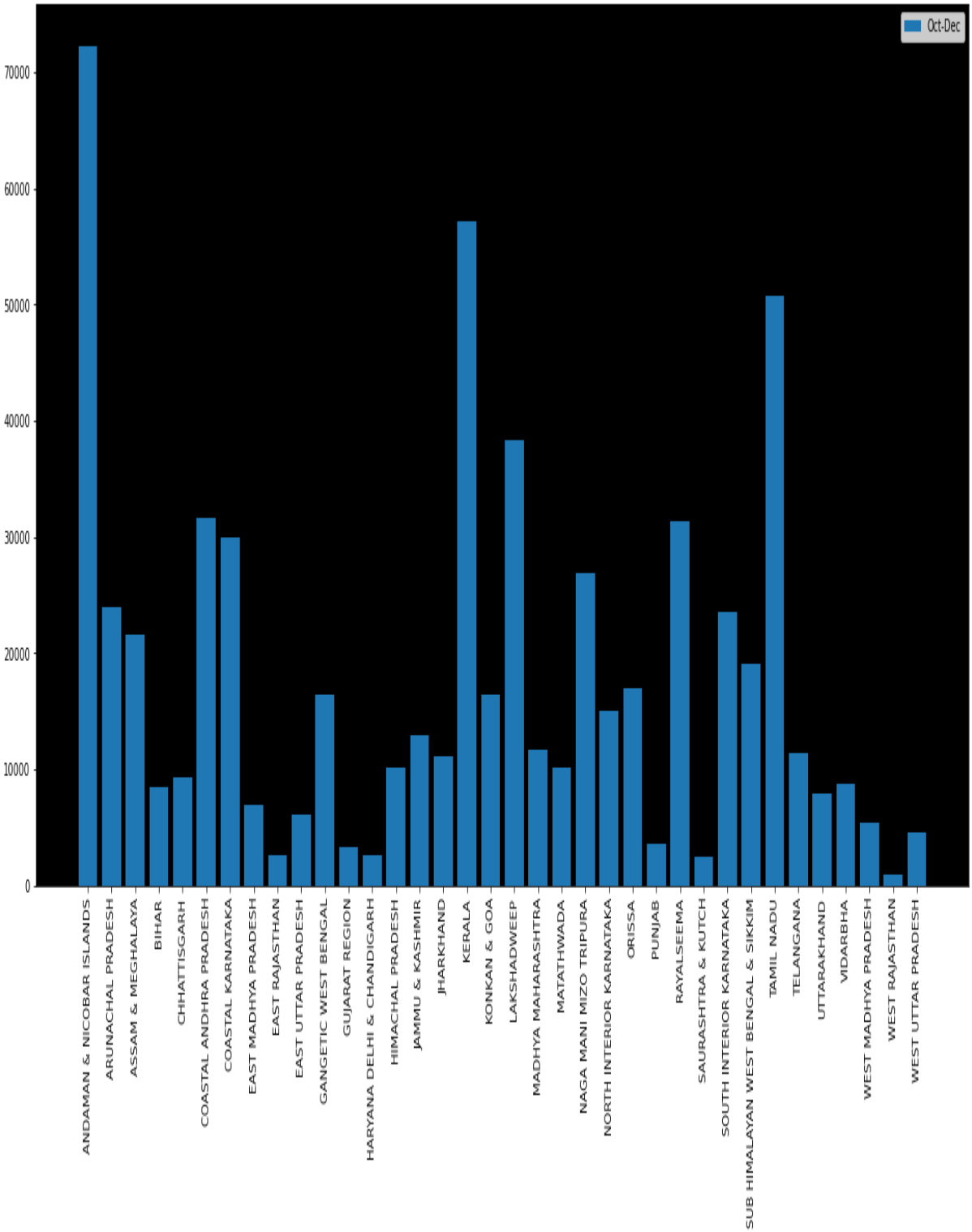
First season rainfall in all districts of India since the year 1901 till year 2015 (shown in the above image)



Second season rainfall in all districts of India since the year 1901 till year 2015 (shown in the above image)



Third season rainfall in all districts of India since the year 1901 till year 2015 (shown in the above image)

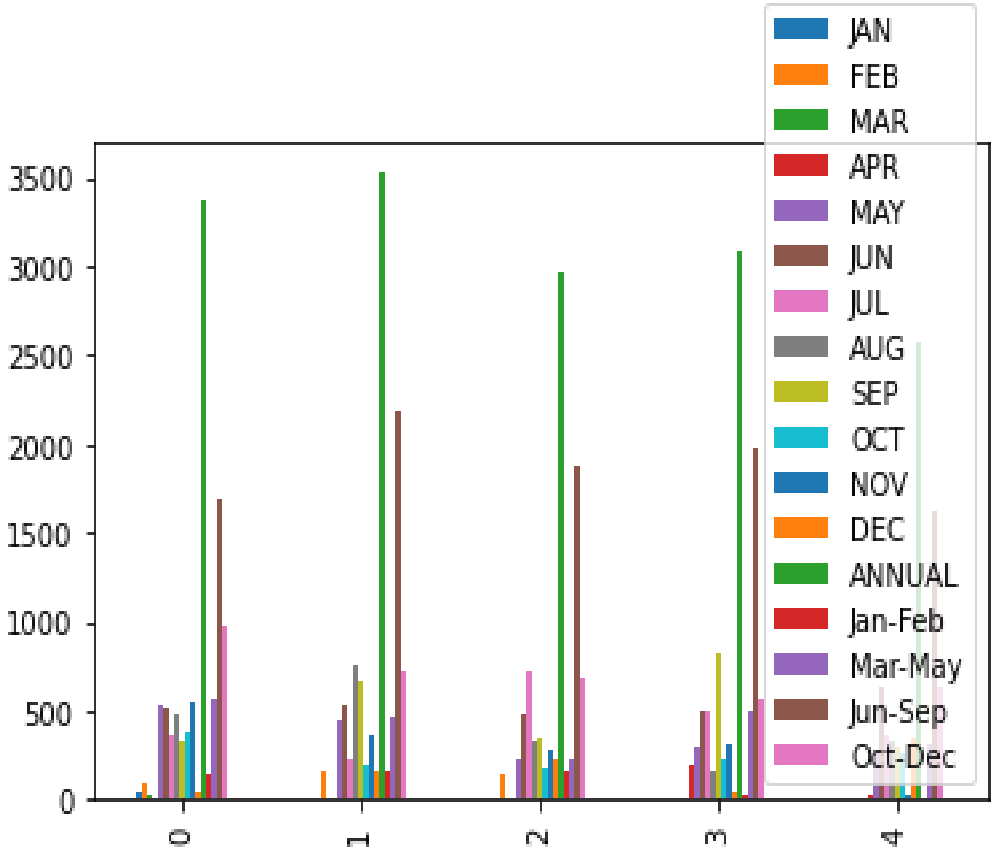


Fourth (Last) season rainfall in all districts of India since the year 1901 till year 2015 (shown in the above image)

Out[22]:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	Jan-Feb	Mar-May	Jun-Sep	Oct-Dec
0	49.2	87.1	29.2	2.3	528.8	517.5	365.1	481.1	332.6	388.5	558.2	33.6	3373.2	136.3	560.3	1686.3	980.3
1	0.0	159.8	12.2	0.0	446.1	537.1	228.9	753.7	666.2	197.2	359.0	160.5	3520.7	159.8	458.3	2185.9	716.7
2	12.7	144.0	0.0	1.0	235.1	479.9	728.4	326.7	339.0	181.2	284.4	225.0	2957.4	156.7	236.1	1874.0	690.6
3	9.4	14.7	0.0	202.4	304.5	495.1	502.0	160.1	820.4	222.2	308.7	40.1	3079.6	24.1	506.9	1977.6	571.0
4	1.3	0.0	3.3	26.9	279.5	628.7	368.7	330.5	297.0	260.7	25.4	344.7	2566.7	1.3	309.7	1624.9	630.8
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4111	5.1	2.8	3.1	85.9	107.2	153.6	350.2	254.0	255.2	117.4	184.3	14.9	1533.7	7.9	196.2	1013.0	316.6
4112	19.2	0.1	1.6	76.8	21.2	327.0	231.5	381.2	179.8	145.9	12.4	8.8	1405.5	19.3	99.6	1119.5	167.1
4113	26.2	34.4	37.5	5.3	88.3	428.2	298.4	154.4	180.0	72.8	78.1	26.7	1426.3	60.6	131.1	1057.0	177.6
4114	53.2	16.1	4.4	14.9	57.4	244.1	116.1	468.1	132.2	169.2	59.0	62.3	1395.0	69.3	76.7	958.5	290.5
4115	2.2	0.5	3.7	87.1	133.1	298.6	257.5	148.4	180.4	185.4	231.0	159.0	1642.9	2.7	223.9	860.9	555.4

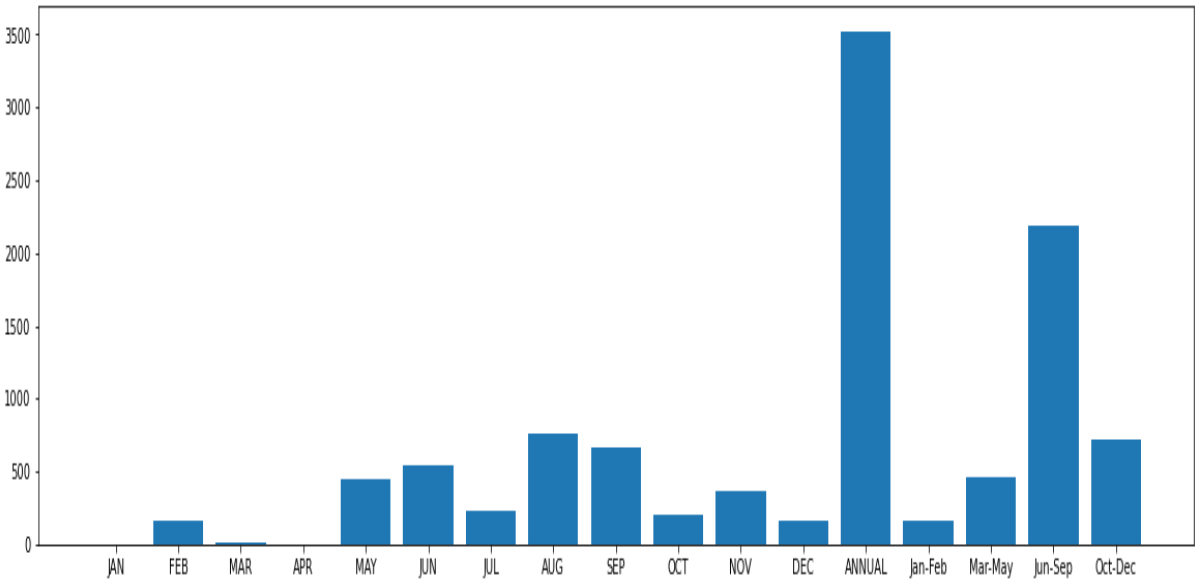
4116 rows × 17 columns



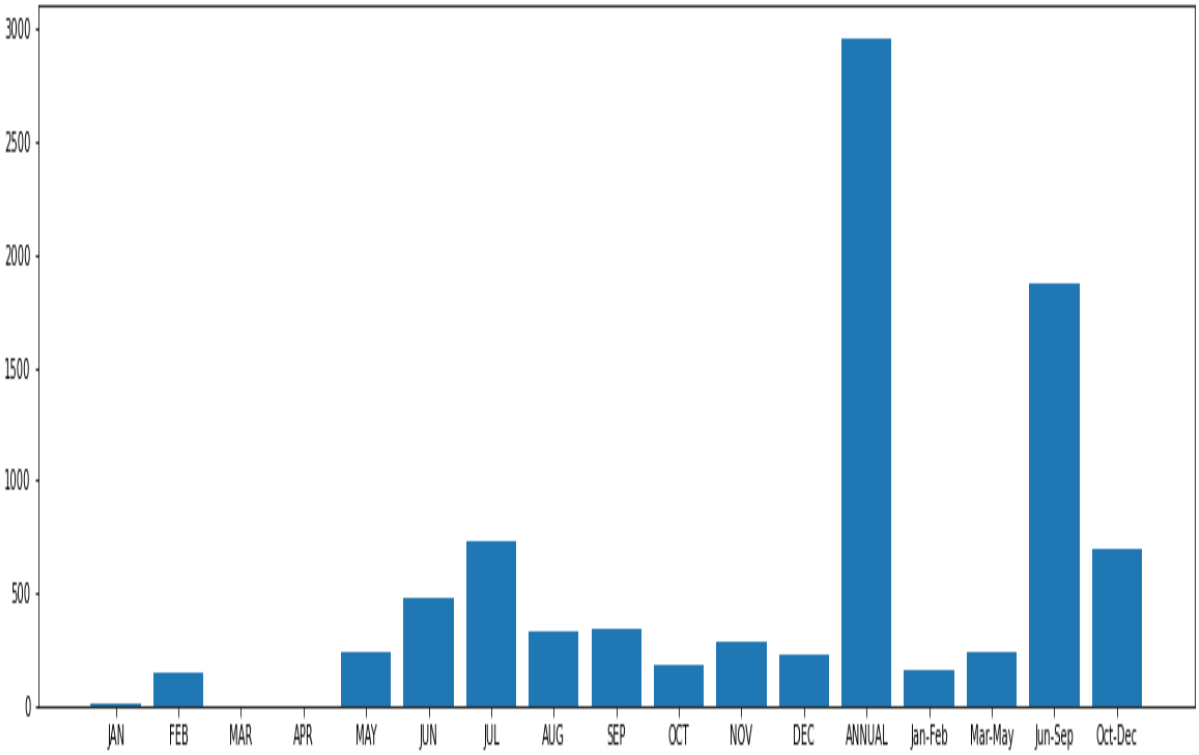
Out[26]:

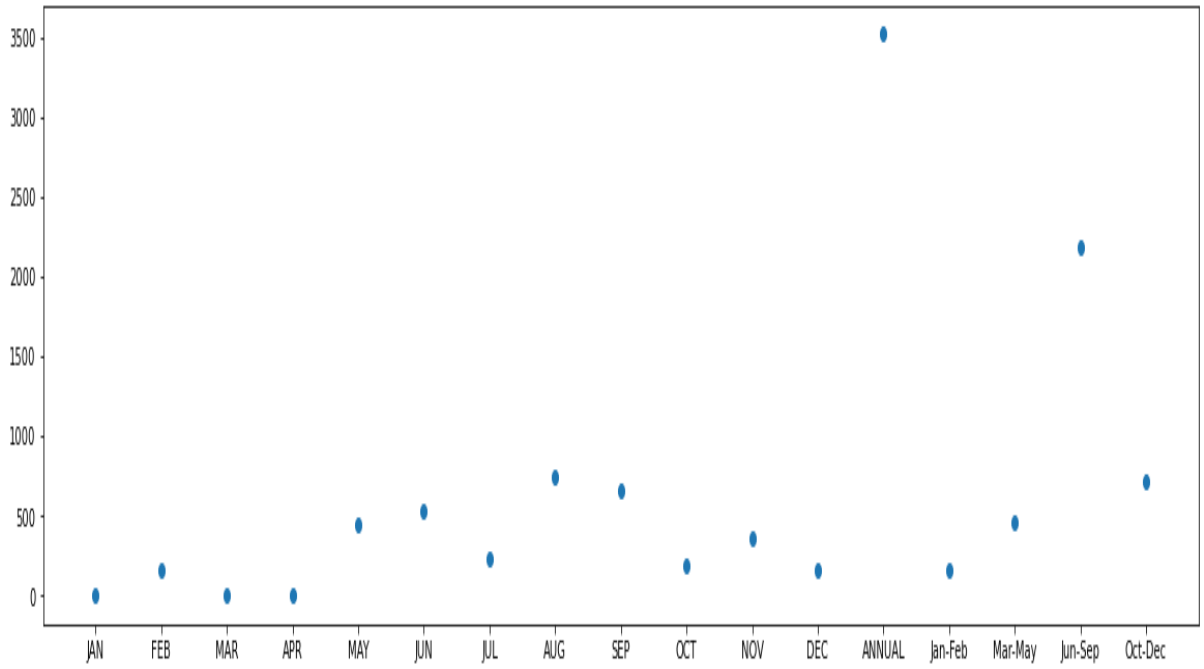
SUBDIVISION	RAYALSEEMA
YEAR	1922
JAN	36.9
FEB	0
MAR	0
APR	12
MAY	52
JUN	48.4
JUL	64.8
AUG	85
SEP	34.8
OCT	120
NOV	306.3
DEC	10
ANNUAL	770.3
Jan-Feb	36.9
Mar-May	64
Jun-Sep	233.1
Oct-Dec	436.3

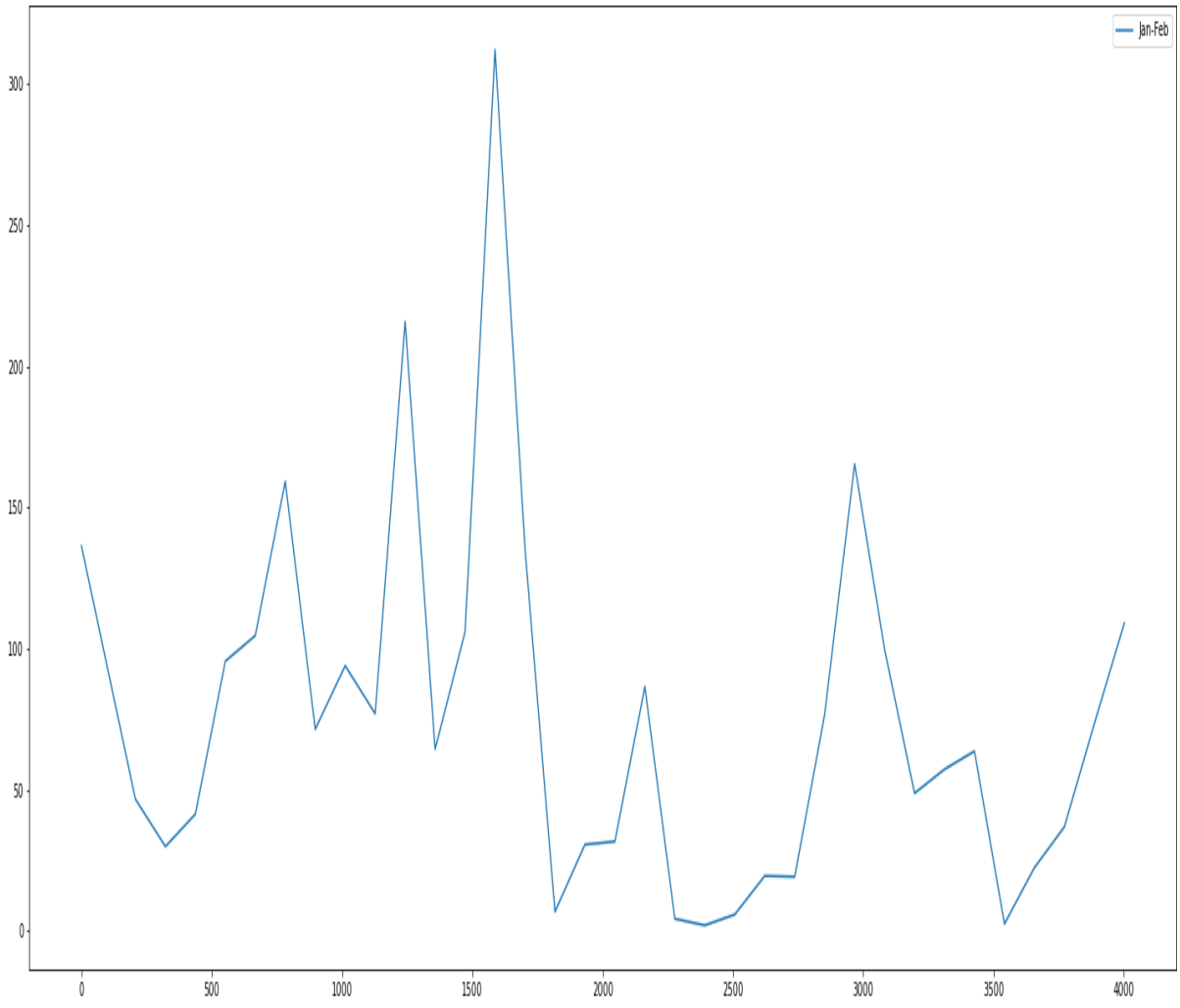
Name: 3333, dtype: object

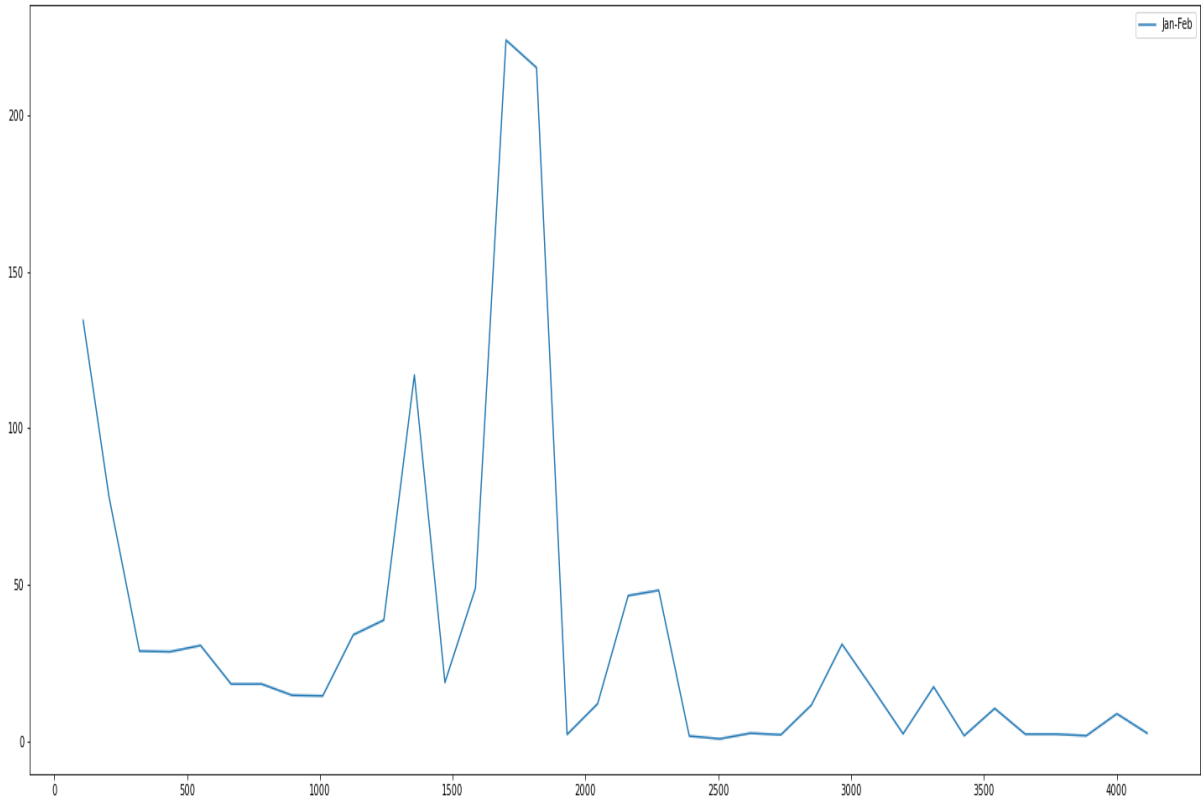


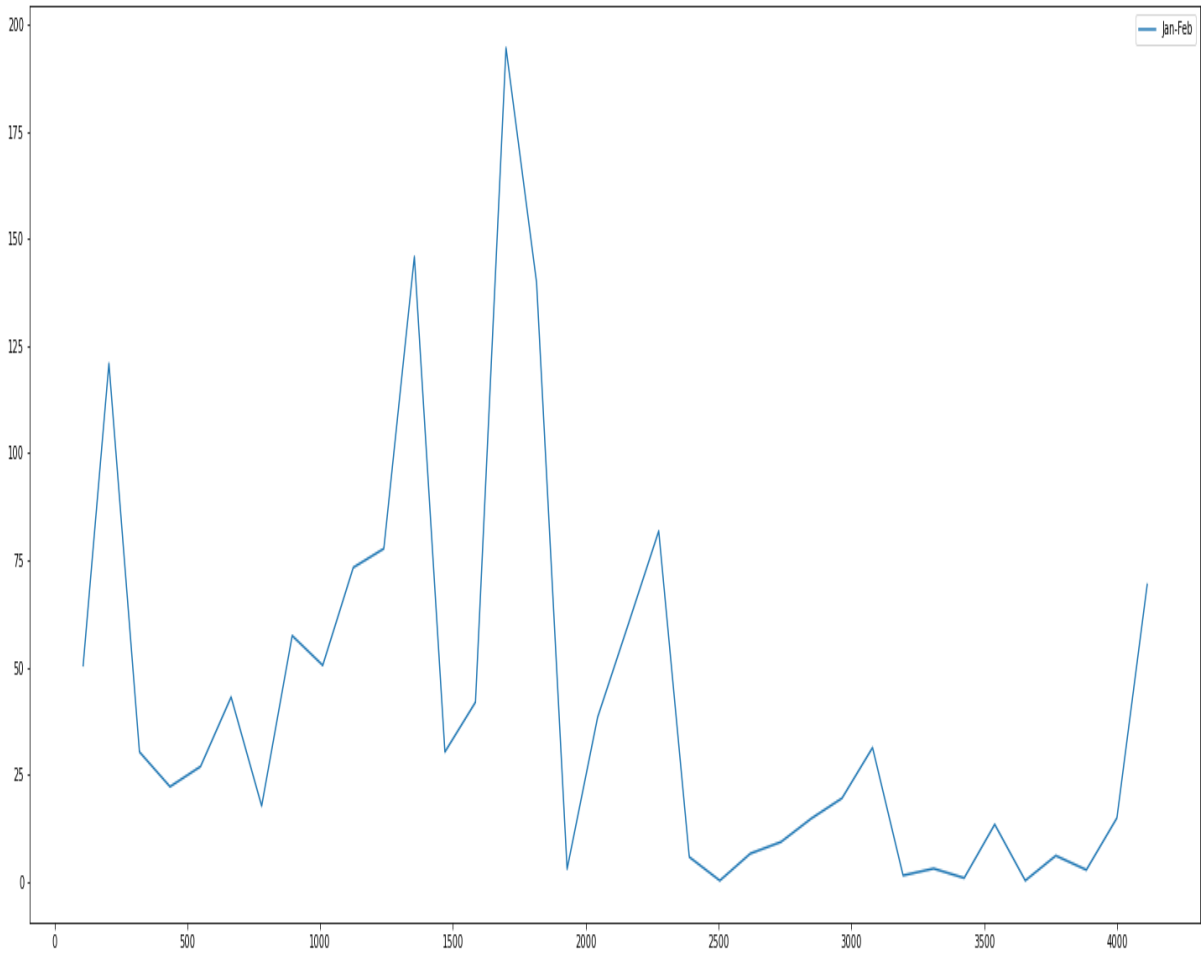
All months and all seasons rainfall bar graph for the subdivision “RAYALSEEMA” having row index as “3333” (shown in the above image)

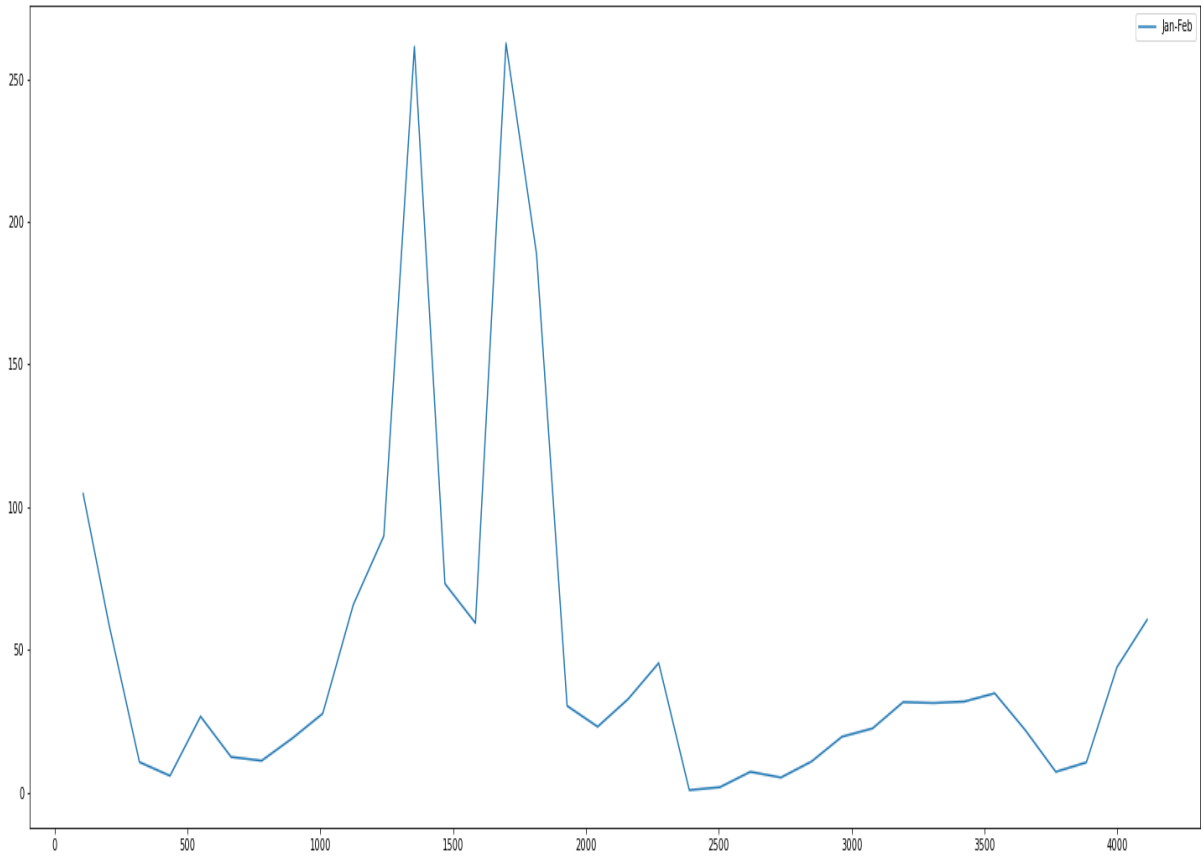


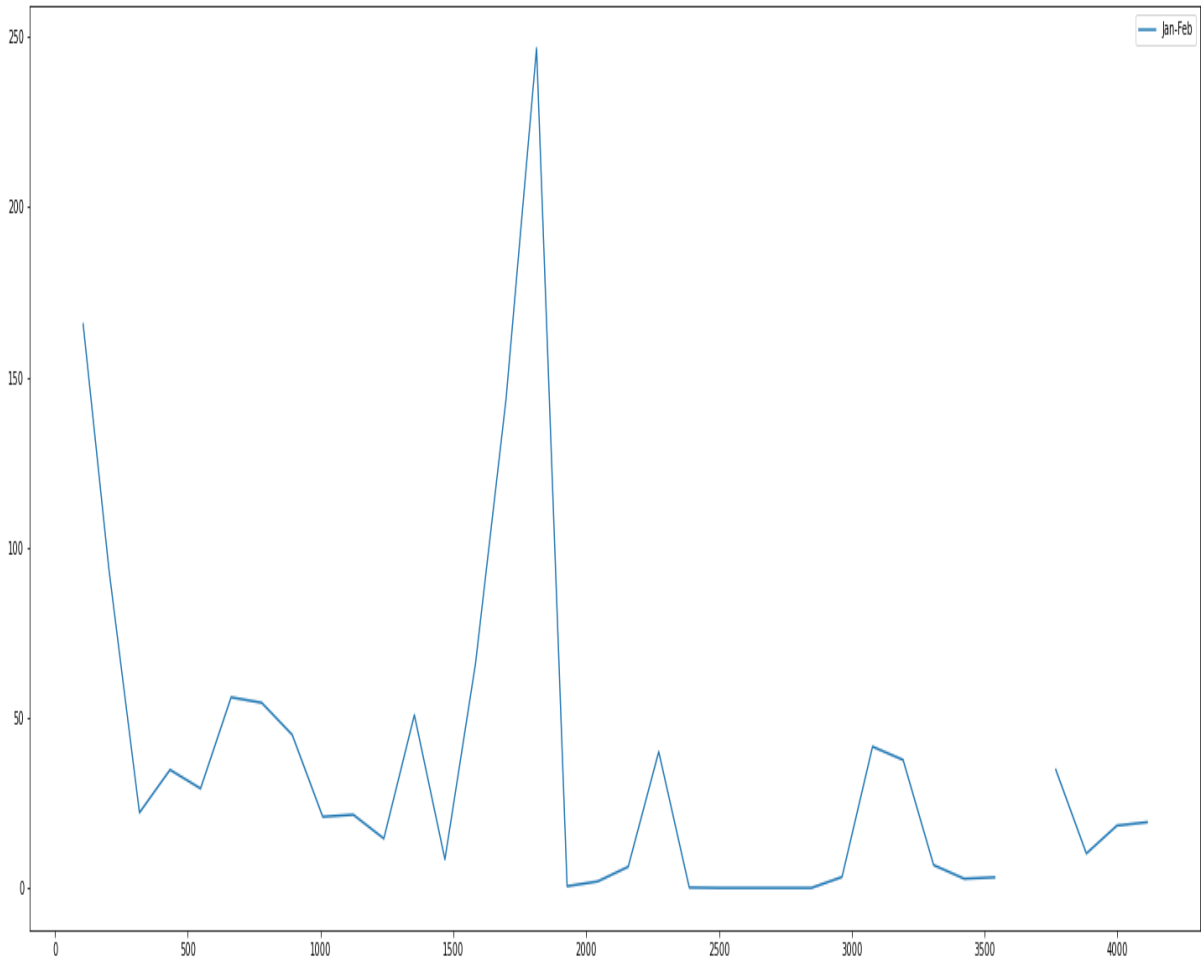

3500
3000
2500
2000
1500
1000
500
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
ANNUAL
Jan-Feb
Mar-May
Jun-Sep
Oct-Dec

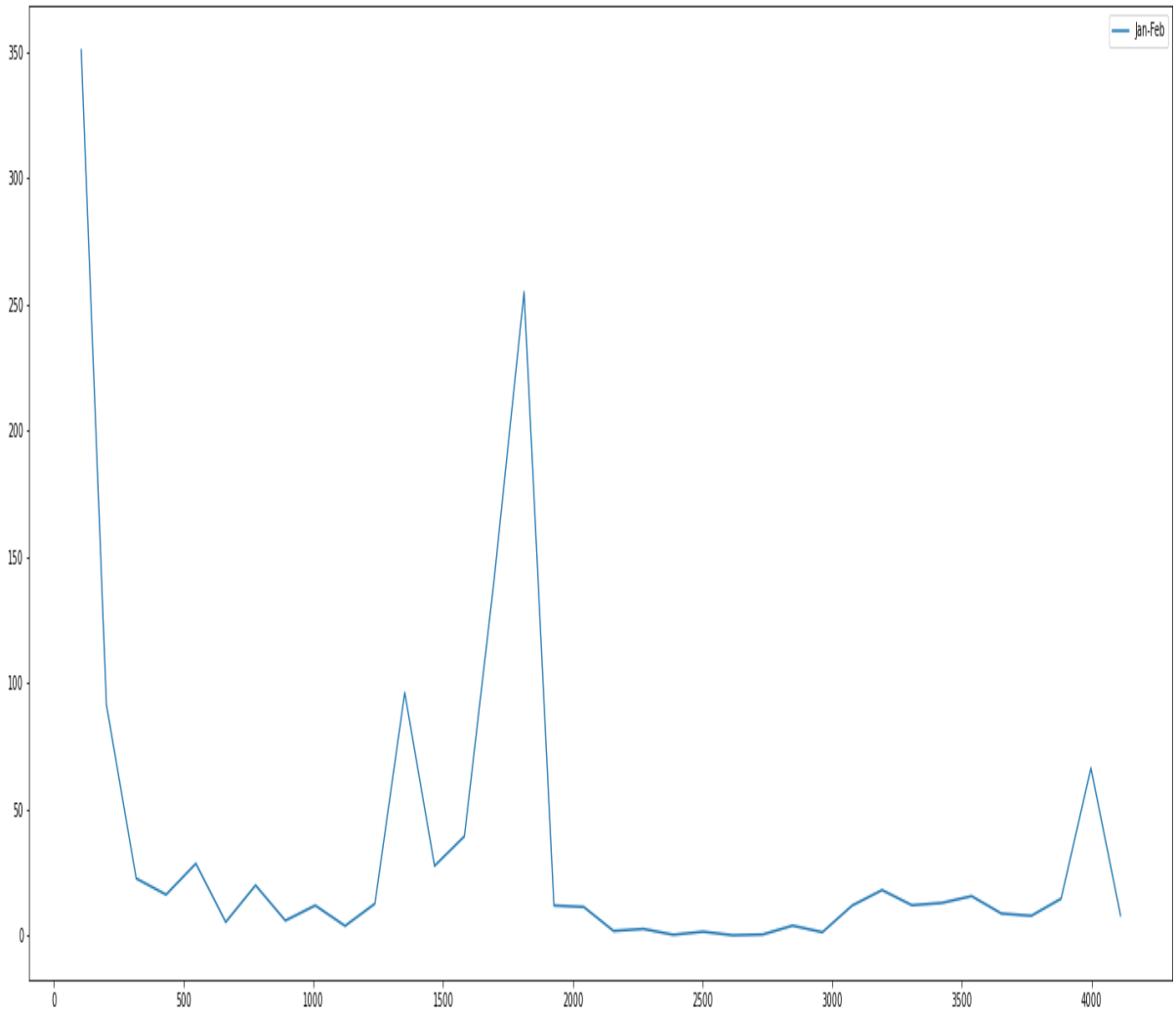

Jan-Feb
300
250
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
3500
4000


Jan-Feb
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
3500
4000


Jan-Feb
200
175
150
125
100
75
50
25
0
0
500
1000
1500
2000
2500
3000
3500
4000


Jan-Feb
250
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
3500
4000


Jan-Feb
250
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
3500
4000


Jan-Feb
350
300
250
200
150
100
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500
1000
1500
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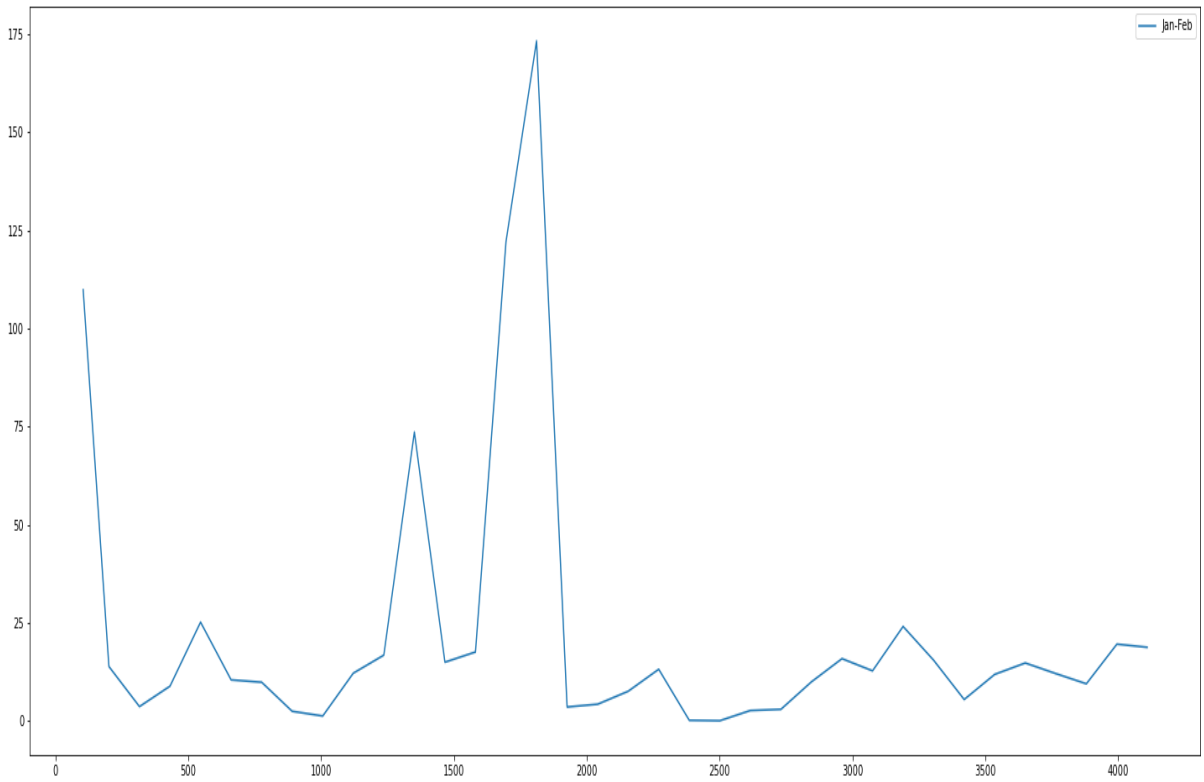
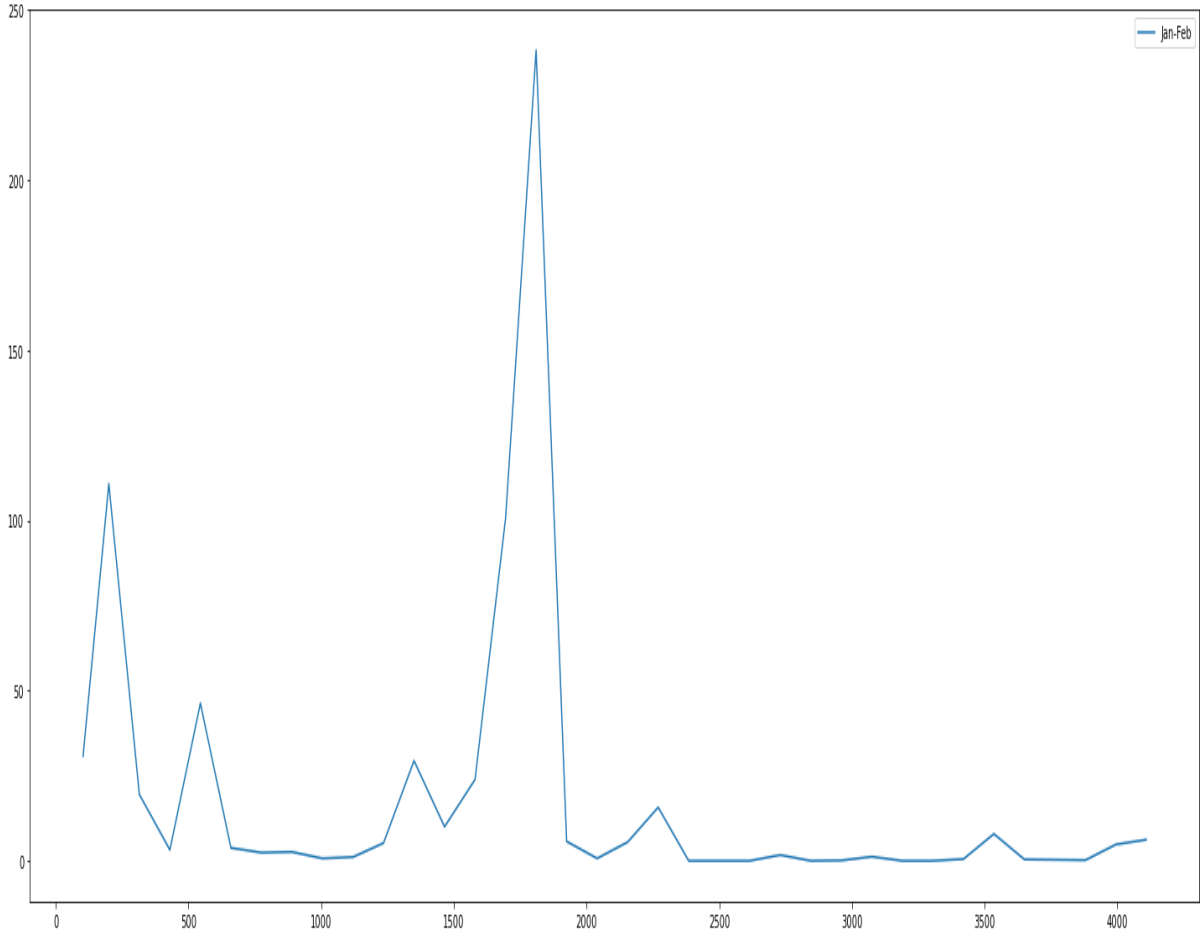
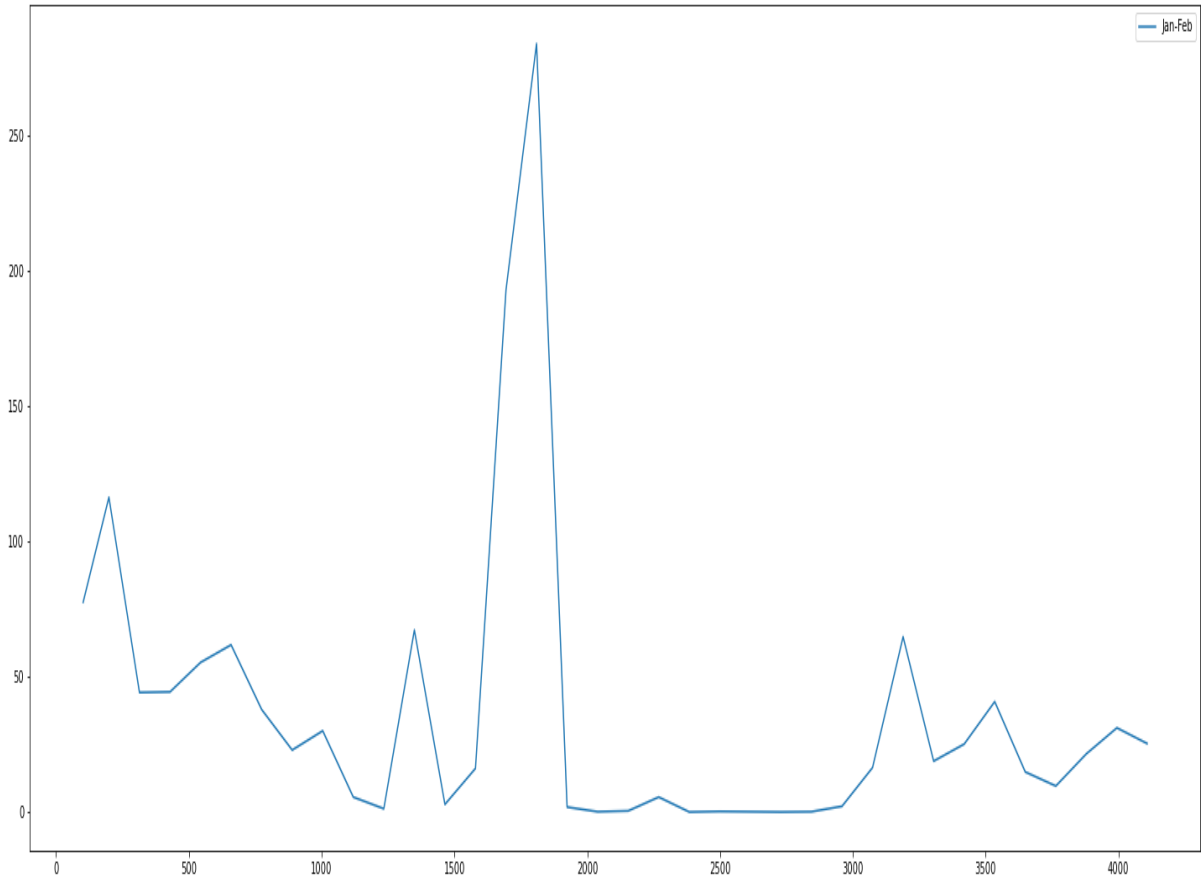
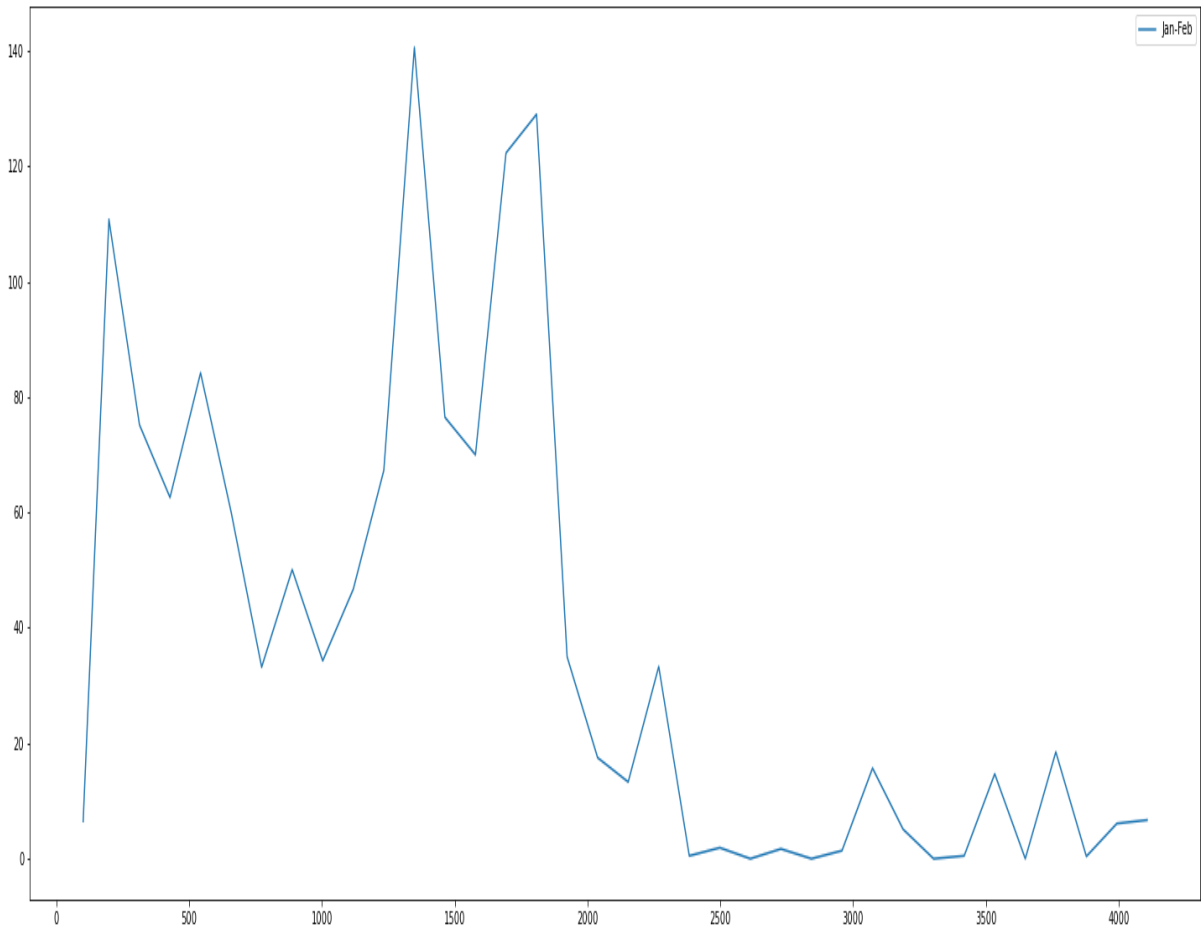
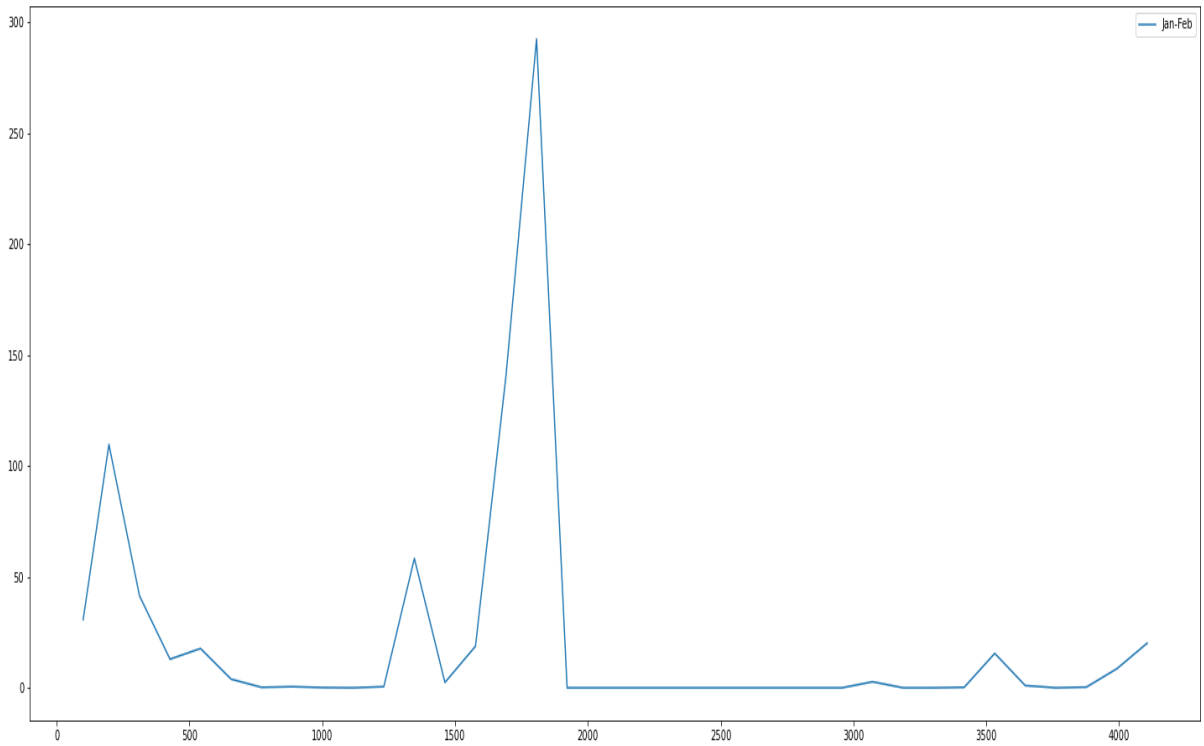
2500
3000
3500
4000

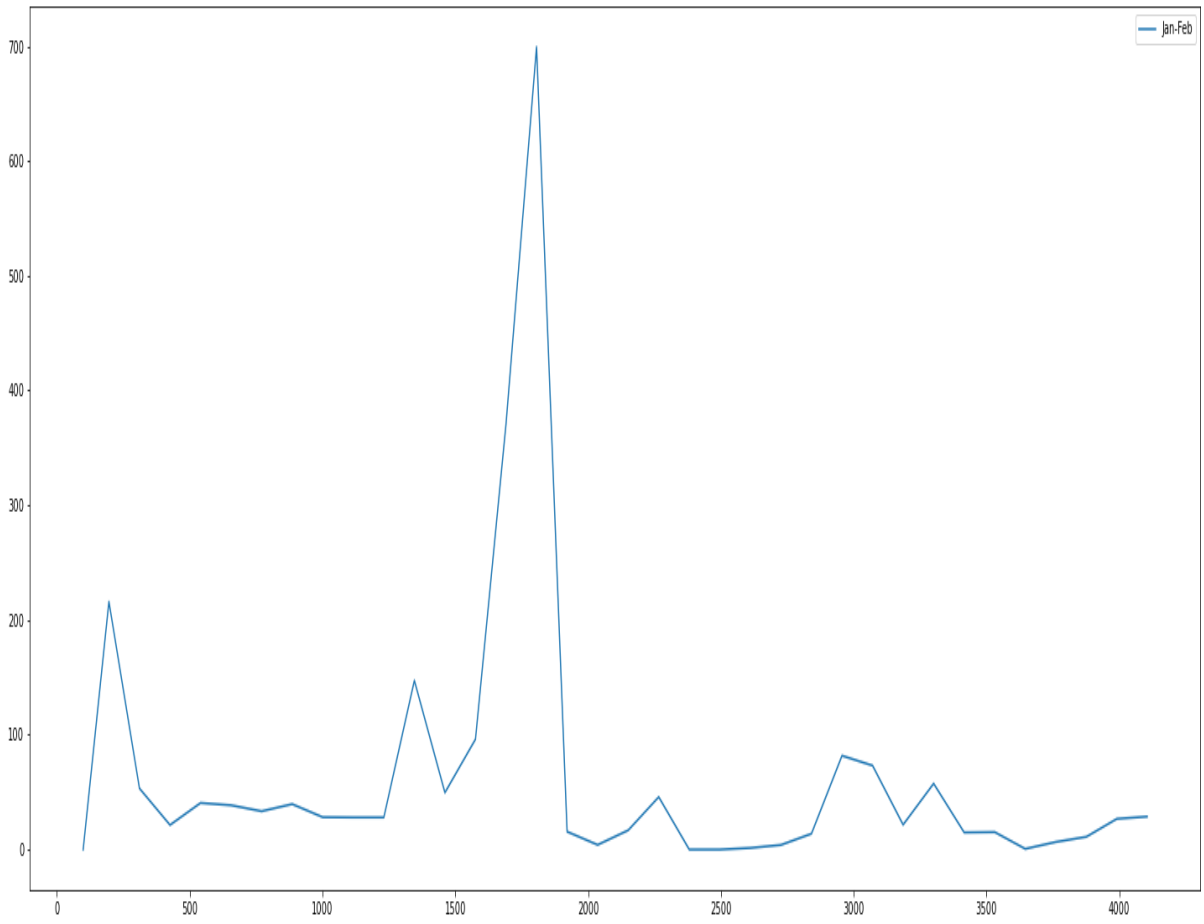

Jan-Feb
175
150
125
100
75
50
25
0
0
500
1000
1500
2000
2500
3000
3500
4000

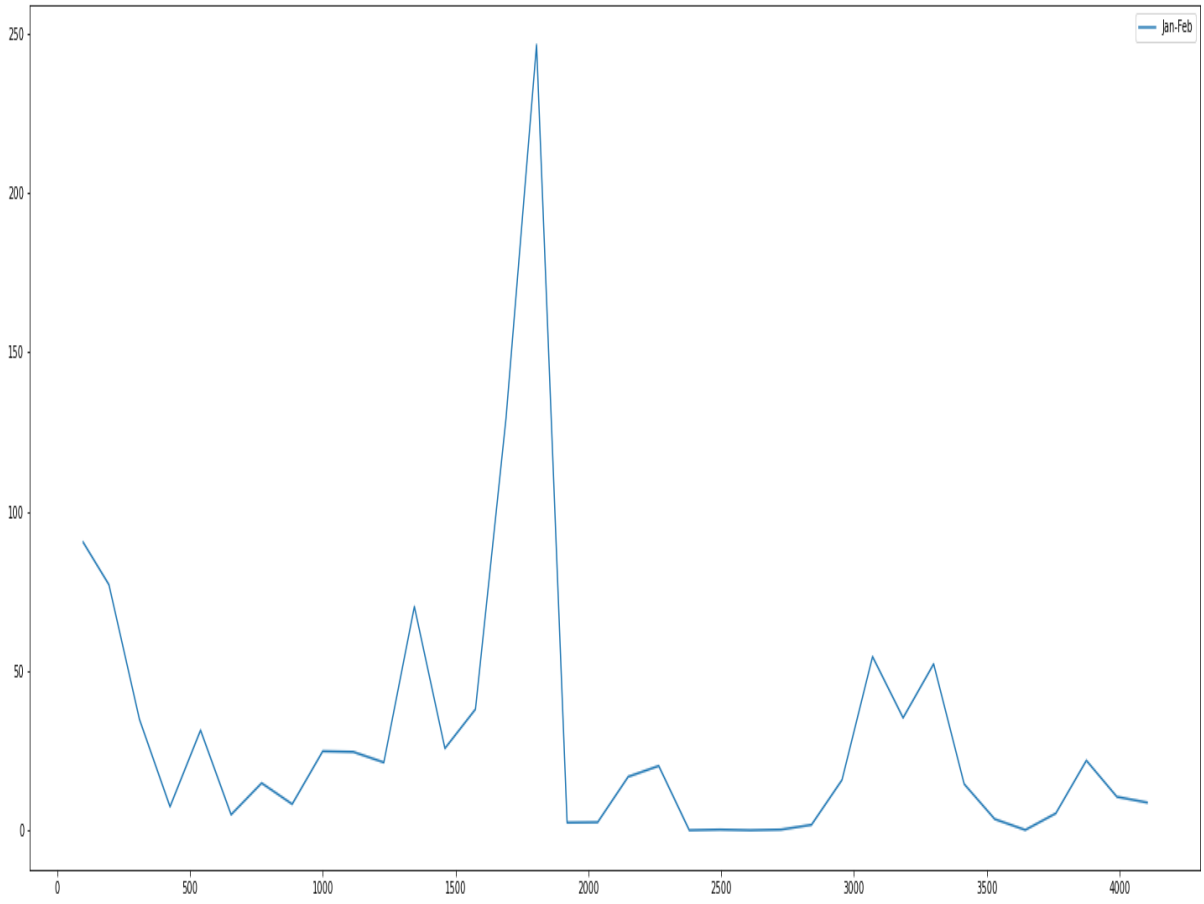

Jan-Feb
250
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
3500
4000

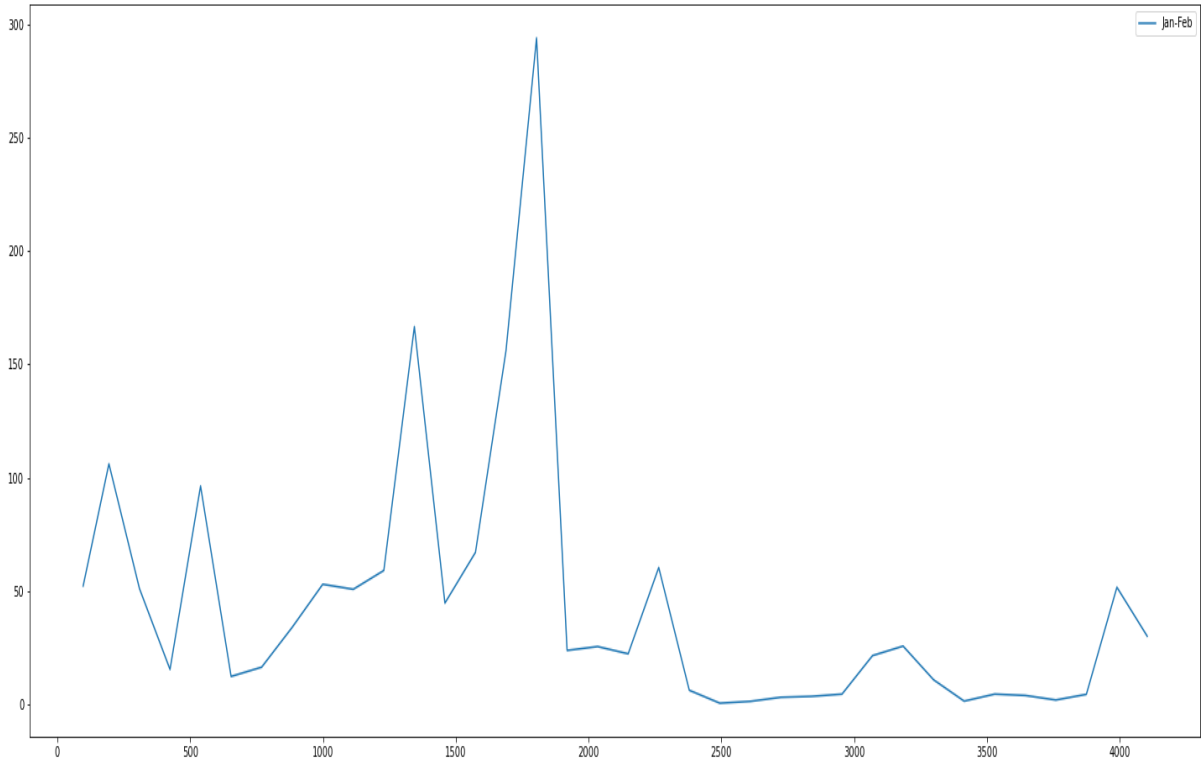

Jan-Feb
250
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
3500
4000

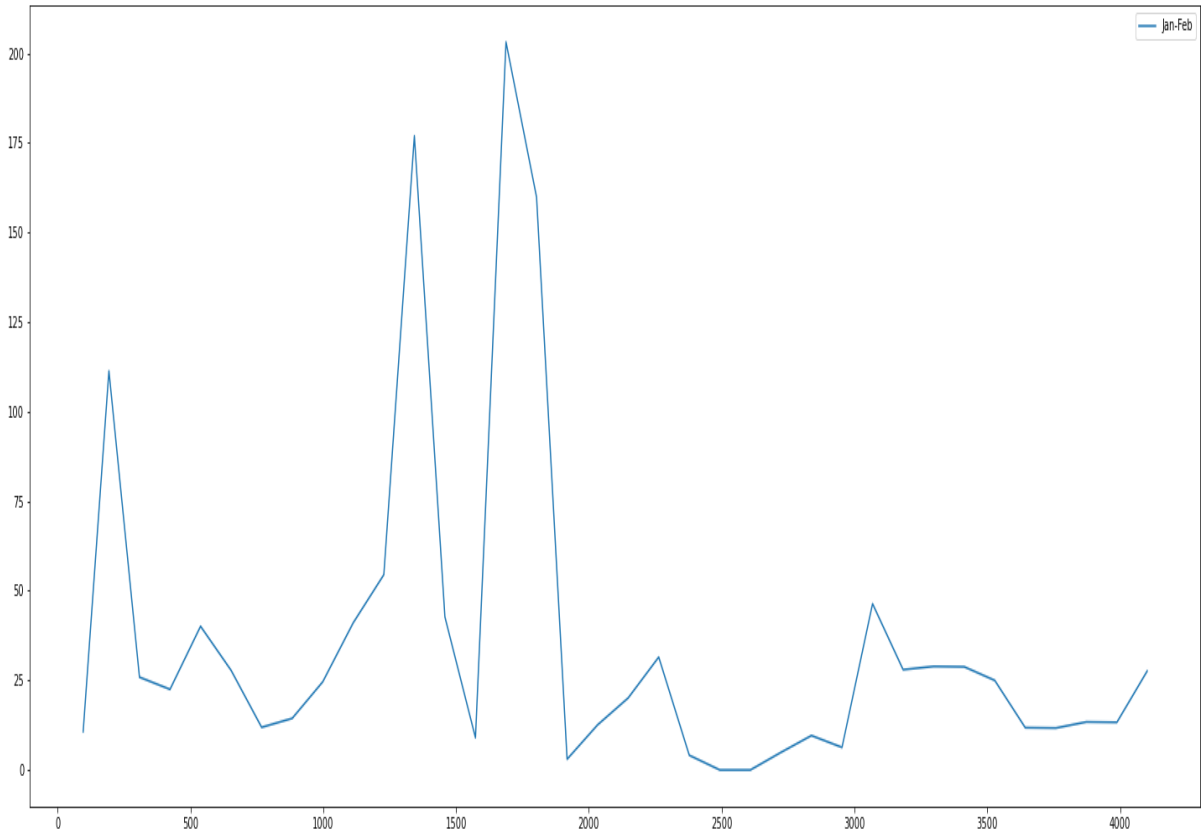

Jan-Feb
140
120
100
80
60
40
20
0
0
500
1000
1500
2000
2500
3000
3500
4000


Jan-Feb
300
250
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
3500
4000


Jan-Feb
700
600
500
400
300
200
100
0
0
500
1000
1500
2000
2500
3000
3500
4000


Jan-Feb
250
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
3500
4000


Jan-Feb
300
250
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
3500
4000


Jan-Feb
200
175
150
125
100
75
50
25
0
0
500
1000
1500
2000
2500
3000
3500
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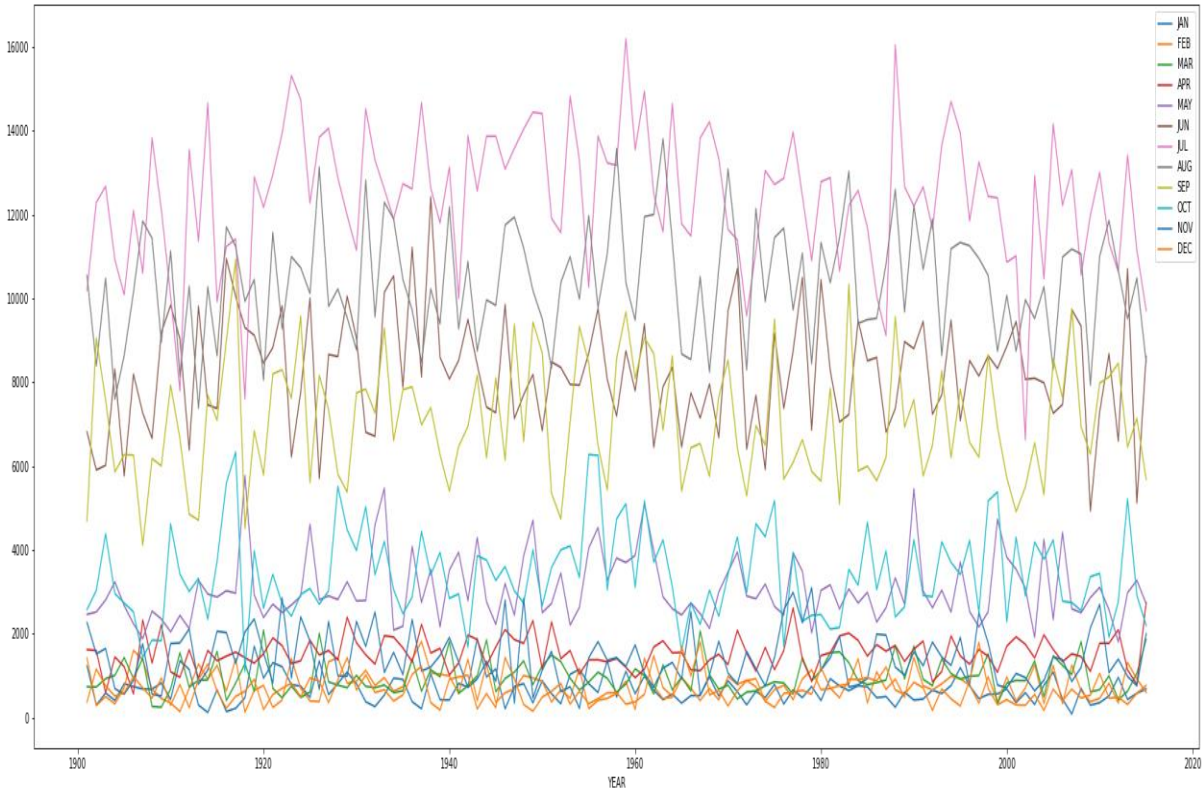
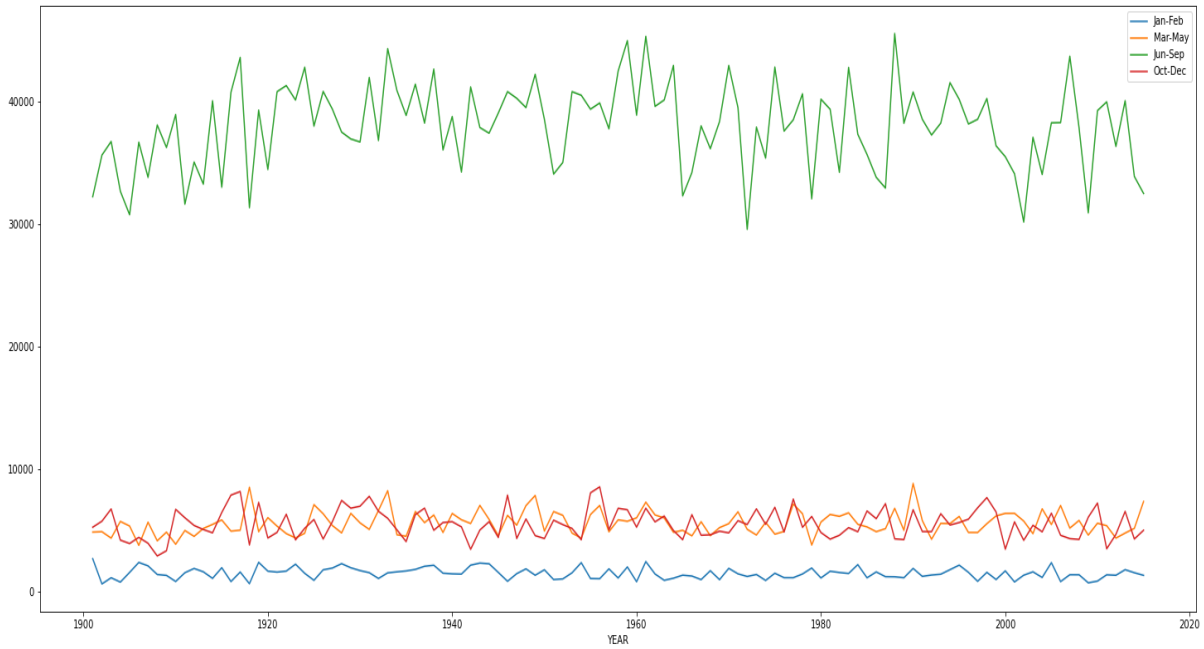
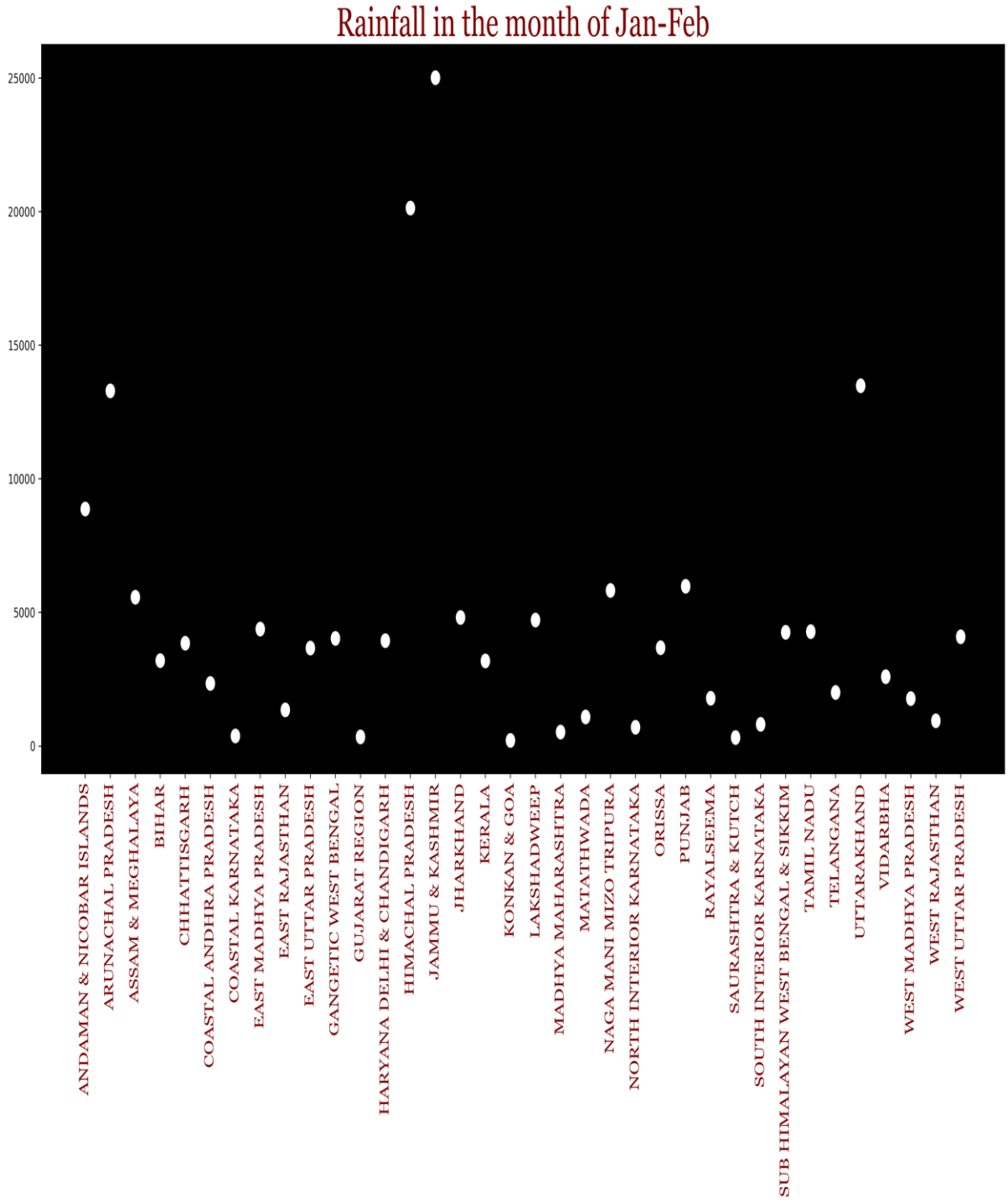


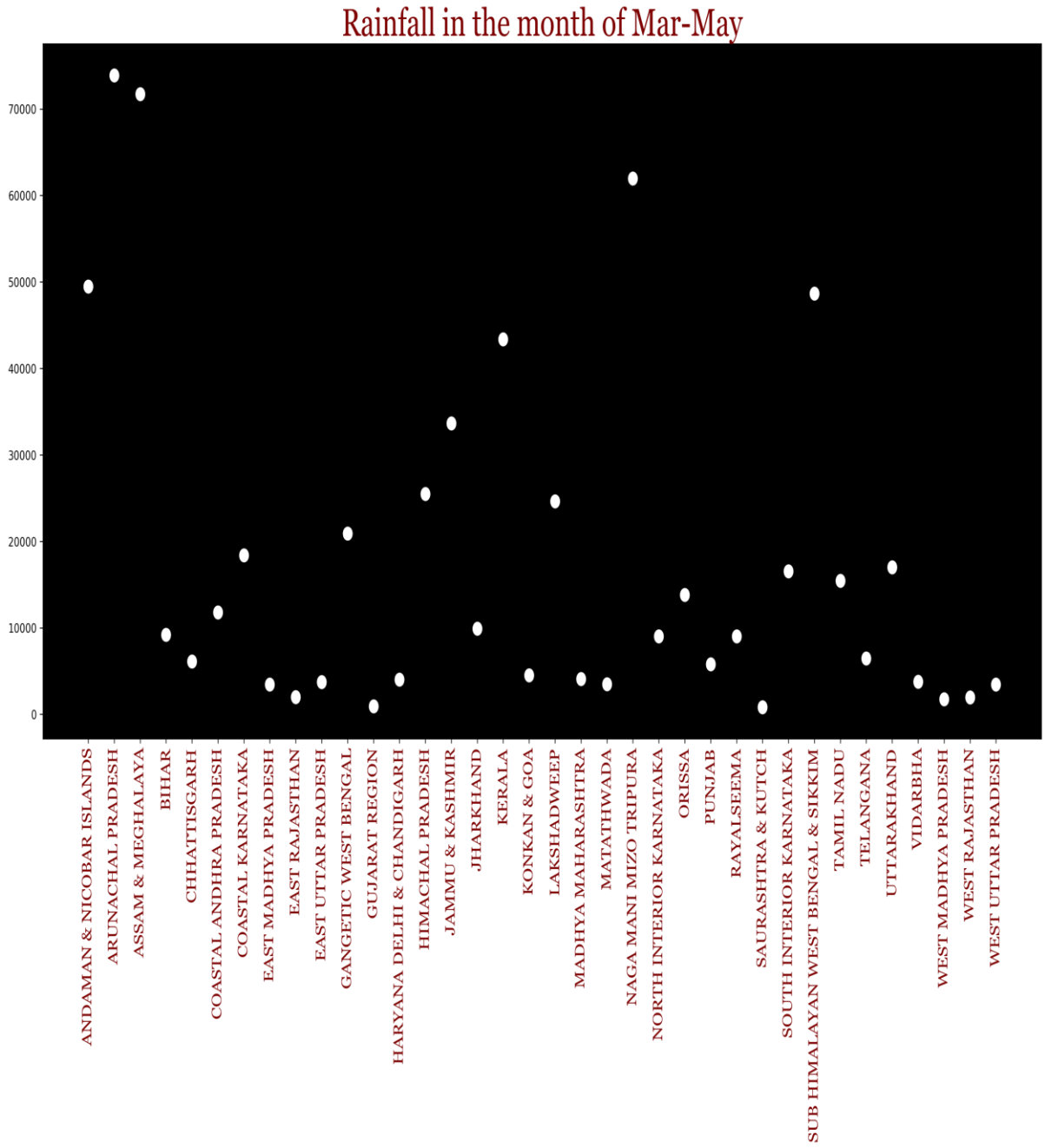
Line graph for visualising all 12 months rainfall for all seasons and for all years that is from 1901-2015 (shown in the above image)



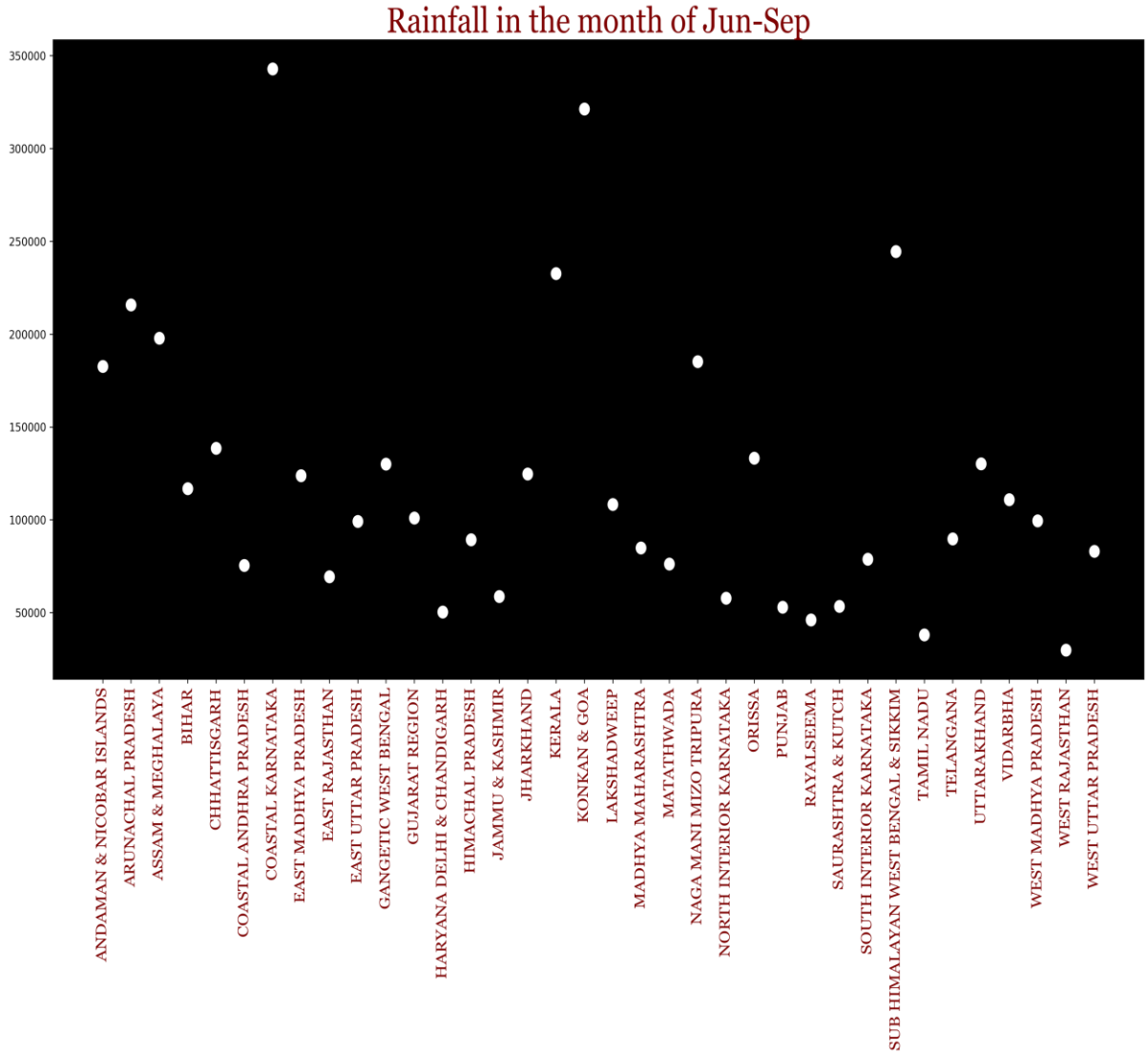
Line graphs for visualising all seasons rainfall for all districts for all seasons and for all year i.e from 1901-2015 (shown in the above image)



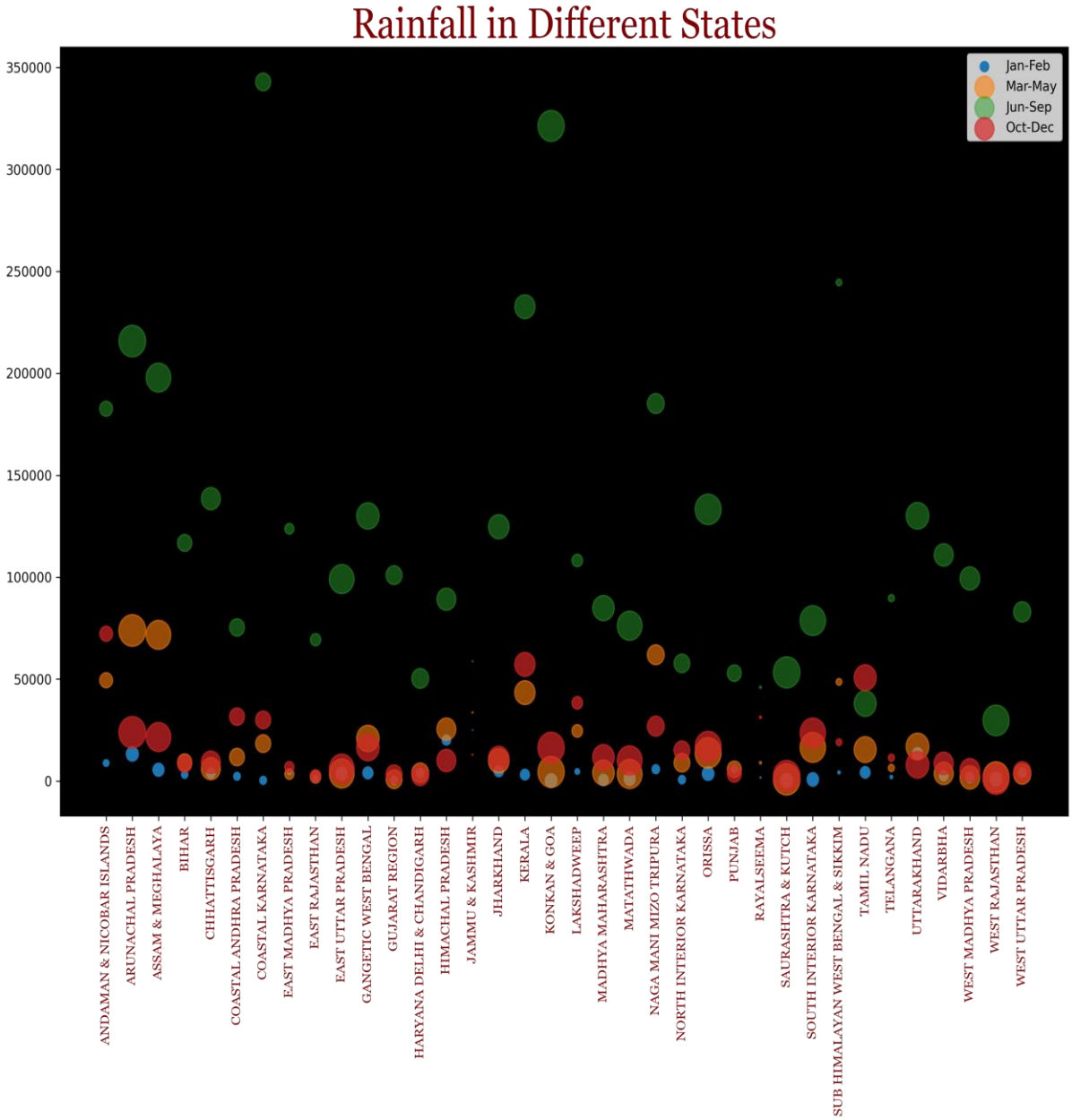
Rainfall for all districts combined and sum of all “JAN-FEB” rainfall entries (shown in the above image)



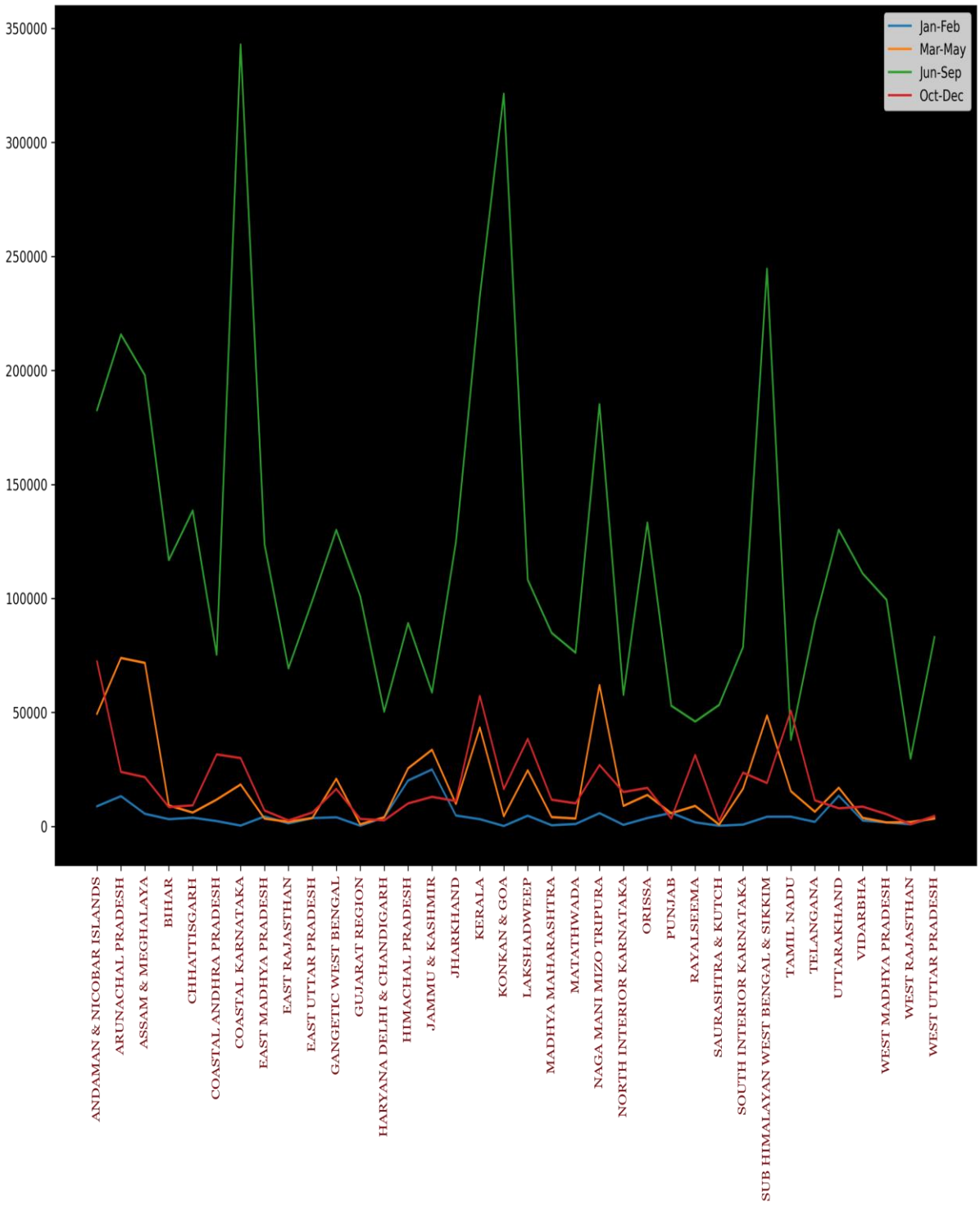
Rainfall for all districts combined and sum of all “MAR-MAY” rainfall entries (shown in the above image)



Rainfall for all districts combined and sum of all “JUN-SEP” rainfall entries (shown in the above image)



Rainfall for all districts combined and all seasons rainfall entries (shown in the above image)



Rainfall for all districts combined and all seasons rainfall entries (shown in the above image)

```
Grouped_data
```

Out[22]:

SUBDIVISION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ANDAMAN & NICOBAR ISLANDS	5790.1	3079.4	3437.0	7800.1	38919.2	50930.7	43204.6	43205.1	47024.6	31348.6	25244.4	16386.5
ARUNACHAL PRADESH	4540.6	8747.2	14585.1	25592.1	34776.7	62147.9	66676.3	48037.3	41917.0	18495.2	3391.2	2327.7
ASSAM & MEGHALAYA	1952.1	3615.8	9088.1	23358.3	39277.0	58668.6	56936.8	46528.2	35734.5	17493.6	3097.9	1029.4
BIHAR	1539.4	1655.3	1164.3	1945.6	6104.4	20046.3	37310.8	34459.0	24999.2	7253.6	825.5	424.9
CHHATTISGARH	1633.8	2214.8	1755.7	1928.9	2420.6	22800.6	45836.4	44835.4	25044.7	7320.9	1353.8	603.6
COASTAL ANDHRA PRADESH	860.6	1486.2	1520.5	3075.2	7193.2	14224.8	19989.8	20231.2	20896.4	21333.8	8958.9	1313.3
COASTAL KARNATAKA	220.9	174.6	731.1	3555.4	14120.6	96752.5	129608.3	82066.1	34460.0	21223.5	7314.9	1450.6
EAST MADHYA PRADESH	2231.2	2149.8	1568.3	826.7	1066.4	16218.4	42708.5	42477.4	22337.2	4563.9	1461.1	966.5
EAST RAJASTHAN	738.6	623.0	519.4	361.6	1129.3	7290.9	25685.0	25101.9	11267.5	1651.5	560.5	419.9
EAST UTTAR PRADESH	1841.4	1825.5	1024.4	739.5	1979.3	12731.9	33415.4	31695.6	21228.0	4935.9	527.9	664.3
GANGETIC WEST BENGAL	1448.5	2582.0	3345.4	5161.8	12395.6	28427.6	37533.4	35809.0	28256.7	13310.8	2481.6	654.4
GUJARAT REGION	205.4	137.0	140.4	128.4	668.1	13947.7	40125.9	29807.2	17116.8	2365.0	796.8	154.0
HARYANA DELHI & CHANDIGARH	1942.3	2004.9	1487.6	877.9	1671.4	5592.0	17251.8	17346.7	10155.3	1474.7	375.4	826.4
HIMACHAL PRADESH	9681.8	10452.9	11631.8	7179.3	6688.0	10490.4	32232.7	31502.3	14975.2	3597.0	1920.0	4587.7
JAMMU & KASHMIR	11733.5	13276.8	15108.5	10775.8	7759.8	7387.0	20501.5	20811.9	10268.3	3929.2	2751.2	6318.5
JHARKHAND	2026.5	2781.4	2118.7	2227.2	5556.5	22377.7	38752.2	37435.3	26153.5	9201.8	1371.2	568.0
KERALA	1408.4	1782.1	4233.7	12716.0	26436.4	75244.8	80609.6	48527.4	28246.2	33824.1	18809.4	4594.3
KONKAN & GOA	145.2	62.9	158.1	490.6	3854.3	79185.5	123398.5	78517.0	40224.7	13039.5	2837.2	519.4
LAKSHADWEEP	3079.4	1789.3	1607.3	5058.3	18356.1	36694.3	31294.1	23295.3	18111.9	18506.8	13482.8	6689.2
MADHYA MAHARASHTRA	351.3	168.8	413.6	1051.9	2638.5	16954.0	28632.7	21205.7	18080.5	8072.4	2983.7	672.6
MATATHWADA	575.1	511.0	817.1	873.4	1799.4	15750.1	20774.6	19145.7	20524.8	6736.7	2580.2	839.8
NAGA MANI MIZO TRIPURA	1612.9	4215.0	8877.9	19634.3	33446.5	51247.9	50448.7	47297.4	36150.3	20125.7	5385.9	1425.9
NORTH INTERIOR KARNATAKA	346.5	364.8	819.2	2794.6	5409.1	11614.2	15931.1	13737.8	16438.2	11004.2	3358.9	727.7
ORISSA	1417.9	2267.7	2430.5	3928.4	7461.9	24249.0	40384.9	40869.0	27761.4	13063.1	3215.6	640.3
PUNJAB	2903.3	3080.5	2719.9	1455.9	1625.7	5343.7	19430.8	18189.3	9980.8	1591.2	476.1	1459.9
RAYALSEEMA	1134.8	653.2	928.8	2278.0	5804.7	7445.4	11049.4	12363.8	15147.8	15562.7	11805.2	3939.9
SAURASHTRA & KUTCH	131.0	185.8	149.1	136.1	536.2	8552.7	22421.6	13658.6	8673.1	1668.7	701.1	127.5
SOUTH INTERIOR KARNATAKA	336.8	478.8	1090.8	4862.3	10591.5	16263.0	26606.3	20037.5	15791.1	16001.5	6259.6	1324.5
SUB HIMALAYAN WEST BENGAL & SIKKIM	1619.6	2642.1	4960.6	12728.4	30951.5	61856.4	74336.3	59887.8	48454.3	16519.3	1850.2	696.9
TAMIL NADU	2739.2	1543.6	2239.7	5174.5	8040.9	5986.5	8201.2	11027.1	12833.7	21067.6	20343.9	9330.8
TELANGANA	885.8	1114.2	1450.7	2091.3	2918.0	16344.5	28462.4	24731.8	20182.9	8536.1	2328.8	591.3
UTTARAKHAND	6186.7	7297.0	6586.3	4044.1	6363.9	18693.4	44930.3	43932.7	22551.1	4493.5	941.6	2534.1

SUB HIMALAYAN WEST BENGAL & SIKKIM	1619.6	2642.1	4960.6	12728.4	30951.5	61856.4	74336.3	59887.8	48454.3	16519.3	1850.2	696.9
TAMIL NADU	2739.2	1543.6	2239.7	5174.5	8040.9	5986.5	8201.2	11027.1	12833.7	21067.6	20343.9	9330.8
TELANGANA	885.8	1114.2	1450.7	2091.3	2918.0	16344.5	28462.4	24731.8	20182.9	8536.1	2328.8	591.3
UTTARAKHAND	6186.7	7297.0	6586.3	4044.1	6363.9	18693.4	44930.3	43932.7	22551.1	4493.5	941.6	2534.1
VIDARBHA	1214.8	1378.0	1365.3	1085.1	1328.4	19961.5	37884.3	32884.2	20176.7	5997.1	1791.1	911.7
WEST MADHYA PRADESH	1062.8	719.1	594.9	273.2	880.6	12854.9	34843.0	33132.5	18534.4	3230.0	1419.2	724.1
WEST RAJASTHAN	382.7	567.0	458.4	410.7	1086.0	3293.3	10944.7	10873.9	4639.4	589.7	191.7	218.8
WEST UTTAR PRADESH	2031.6	2057.8	1318.1	719.1	1415.2	8923.7	28349.8	28899.4	16819.3	3309.4	456.1	818.2

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Index: 36 entries, ANDAMAN & NICOBAR ISLANDS to WEST UTTAR PRADESH
Data columns (total 12 columns):
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---  ------  --------------  -----  
 0   JAN     36 non-null     float64
 1   FEB     36 non-null     float64
 2   MAR     36 non-null     float64
 3   APR     36 non-null     float64
 4   MAY     36 non-null     float64
 5   JUN     36 non-null     float64
 6   JUL     36 non-null     float64
 7   AUG     36 non-null     float64
 8   SEP     36 non-null     float64
 9   OCT     36 non-null     float64
 10  NOV     36 non-null     float64
 11  DEC     36 non-null     float64
dtypes: float64(12)
memory usage: 3.7+ KB
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Total number of entries for each subdivision is 12 (shown in the above image)

```
Total Count of Entries in month JAN after grouping and adding
4112

Total Count of Entries in month FEB after grouping and adding
4113

Total Count of Entries in month MAR after grouping and adding
4110

Total Count of Entries in month APR after grouping and adding
4112

Total Count of Entries in month MAY after grouping and adding
4113

Total Count of Entries in month JUN after grouping and adding
4111

Total Count of Entries in month JUL after grouping and adding
4109

Total Count of Entries in month AUG after grouping and adding
4112

Total Count of Entries in month SEP after grouping and adding
4110

Total Count of Entries in month OCT after grouping and adding
4109

Total Count of Entries in month NOV after grouping and adding
4105

Total Count of Entries in month DEC after grouping and adding
4106
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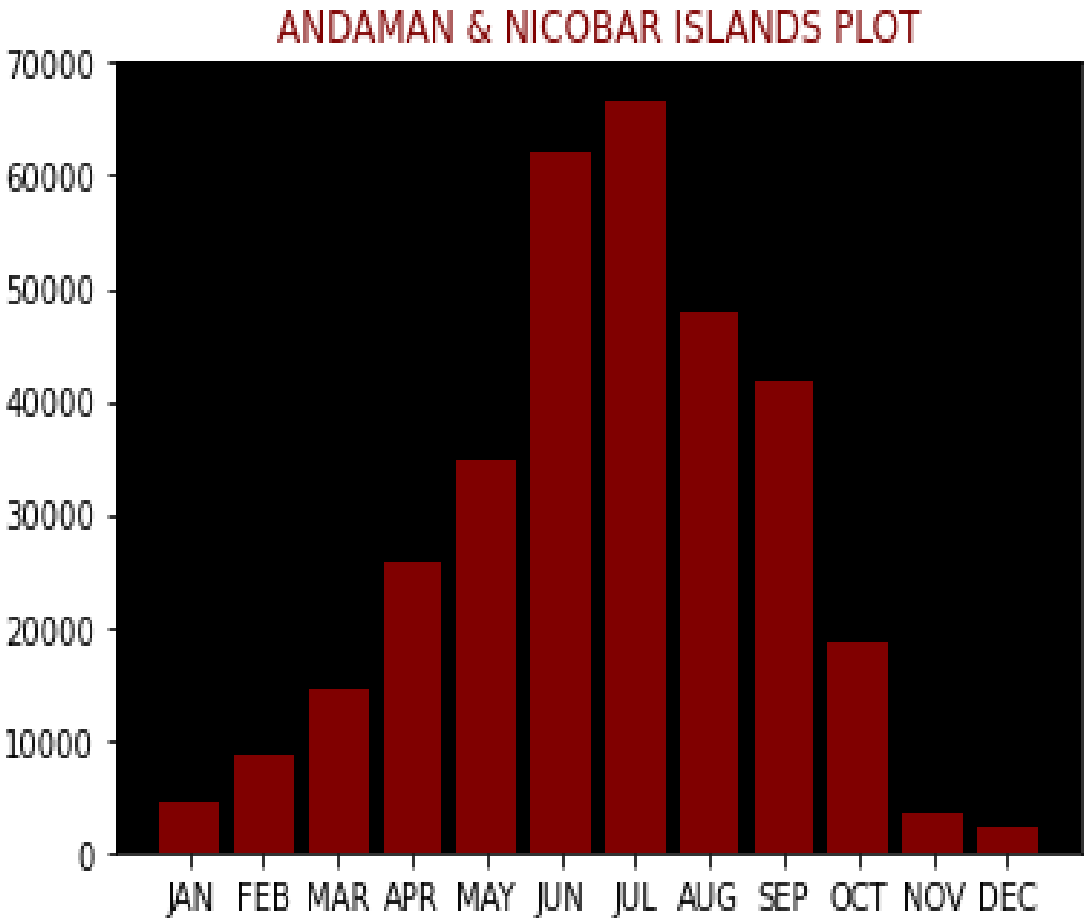
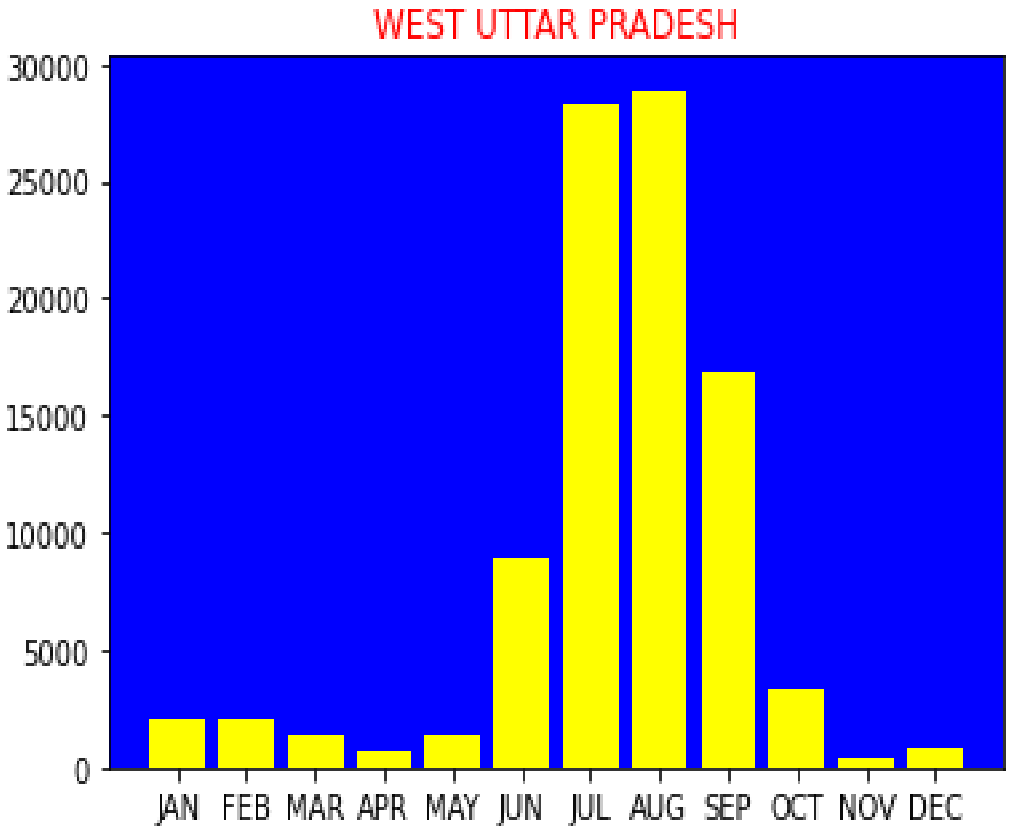
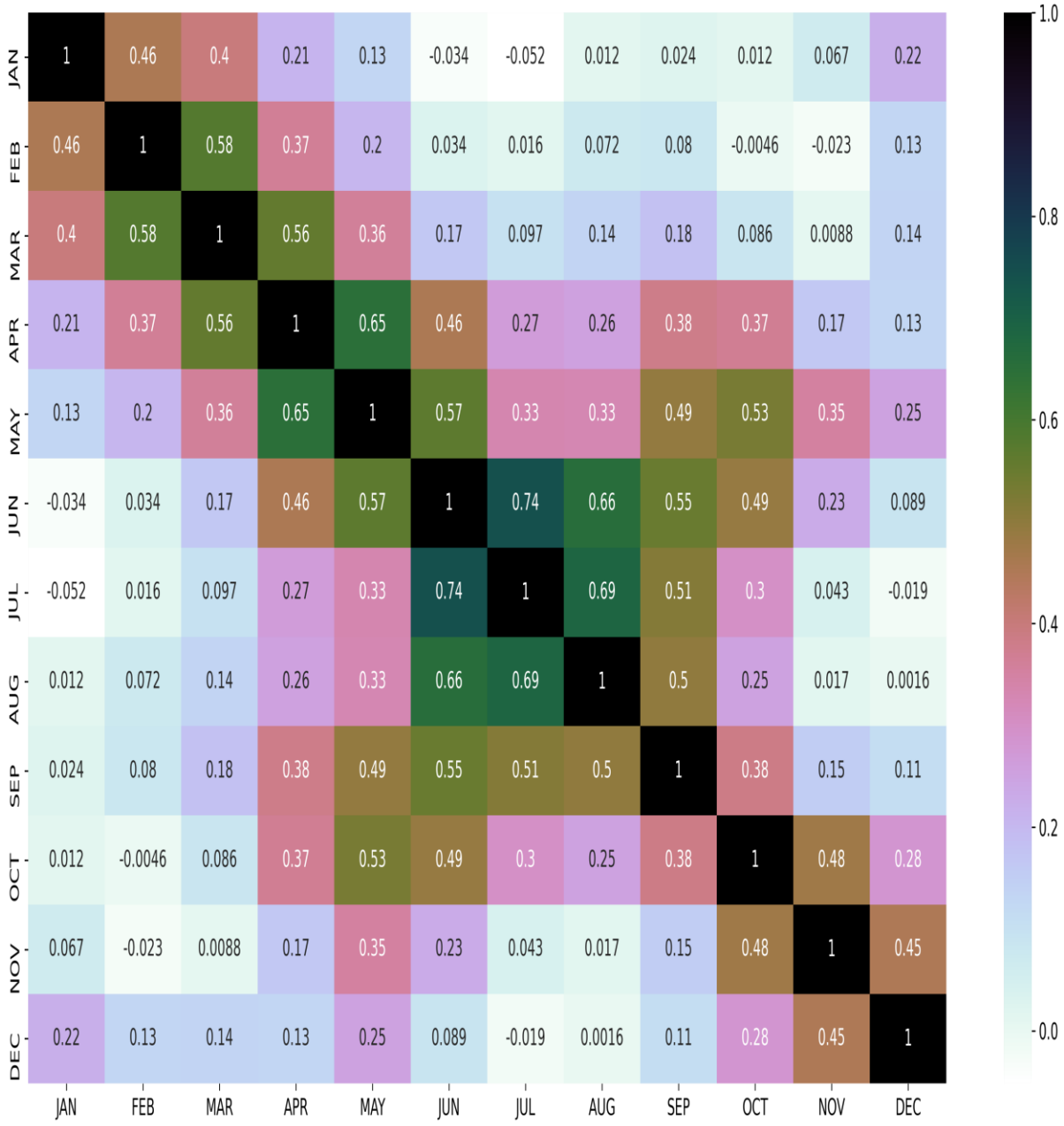
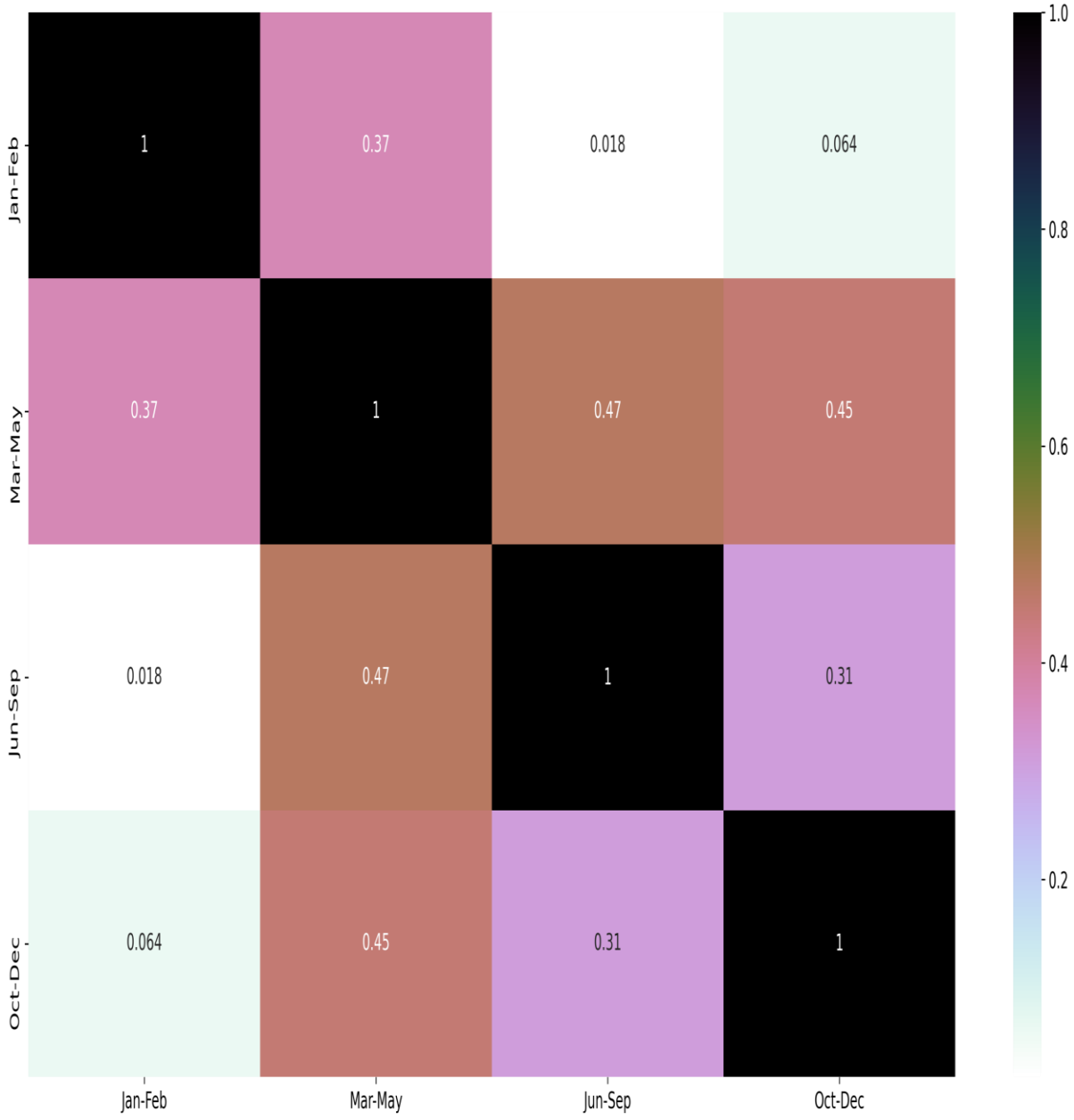

ANDAMAN & NICOBAR ISLANDS PLOT
70000
60000
50000
40000
30000
20000
10000
0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

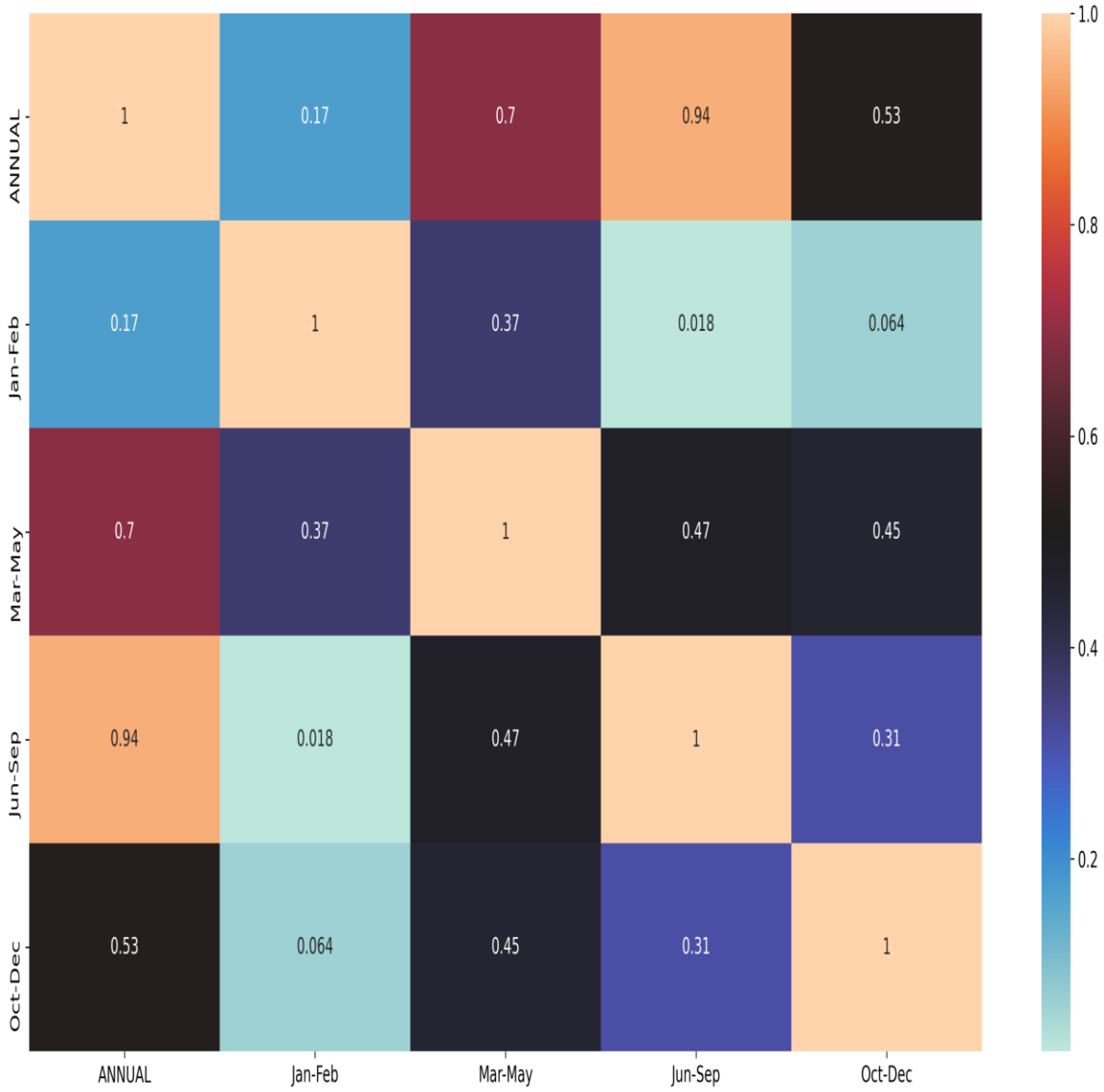

WEST UTTAR PRADESH
30000
25000
20000
15000
10000
5000
0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC



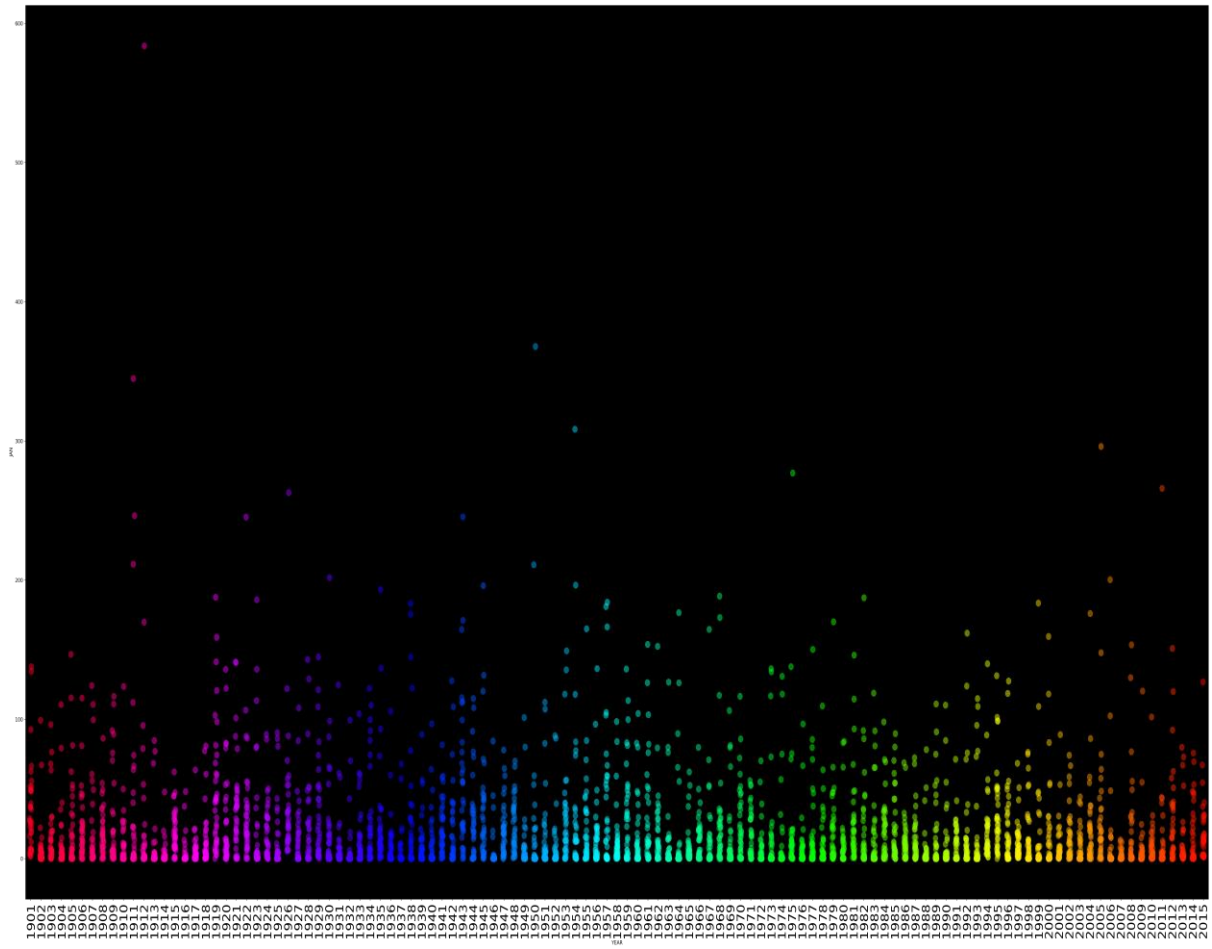
Heatmap visualisation for all districts and all years since 1901 till 2015 for all months (shown in the above image)



Heatmap visualisation for all districts and all years since 1901 till 2015 for all seasons (shown in the above image)



Heatmap visualisation for all districts and all years since 1901 till 2015 for Annual Rainfall and All Seasons (shown in the above image)



CONCLUSION

Data visualization communicated a data set clearly and effectively by using graphics. The best visualizations made it easy to comprehend data at a glance. It took complex information and broke it down in a way that made it simple for the target audience to understand and on which to base their decisions. The essential test of design was to how well it assisted in the understanding of the content, not how stylish it was.

Data visualizations, especially, adhered to the idea. The goal was to enhance the data through design, not draw attention to the design itself. Keeping these data visualization in mind simplified the process of designing infographics that were genuinely useful to the audience.

Through the visualisation of the data in this project we could clearly see the rainfall trend in different districts of India according to months, seasons and annual category, made it really easy to understand the large amount of data at such a great ease.