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PRINCIPAL PARAMETER IDENTIFICATION FOR RAINFALL DURING SUMMER SEASON

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ABSTRACT
Life on earth is due to the presence of water, one significant source of water is rain. Rainfall maintains the water cycle and agriculture in most of the areas are dependent on it. Trichirapalli in Tamilnadu, India is drought hit during summer with scanty ground water table. Rainfall during summer improves the ground water and as well the climate of the region. Parameters such as Mean Temperature, Dew point, visibility, precipitation, maximum, minimum temperature, Gust etc., were used to analyze the possibilities of rainfall during summer. Principal Component Analysis was deployed to identify the important parameters for rainfall.
Keywords: PCA, weather parameters, Dew point, Precipitation, Rainfall, summer

INTRODUCTION

Varsha means rain which is life generating and a major source of water that is required for all human beings on earth. Two monsoons in India viz: South _ West from Kerala during May or June and another North_ East during December in Tamilnadu provide the required rain. Trichirapalli is the central region that usually experiences dry winters and very hot summers. Summer rainfall usually improves the ground water table but it does not favor the farmers as it affects the samba crop.

Rainfall can be predicted before 48 hours using the parameters such as dew point, temperature, precipitation, visibility and windspeed[1-2]. Online forecast of weather with temperature and solar forecast for 24 hours has found to be accurate.[3] Faster approach for predicting rainfall is required hence the parameters for prediction should be minimized.

Principal Component Analysis is a dimension reduction method that uses the covariance of the dimensions to identify the principal parameters from multiple parameters. As weather has several parameters, dimensionality reduction can be employed using PCA.[4-5] Our aim is to identify the principal parameters for faster prediction of rainfall in a region[6].

EXPERIMENTAL

Data Collection

Trichirapalli, Tamilnadu, India is taken for rainfall identification during summer. The region is on the banks of River Cauvery with agriculture being a major occupation. It is located at 10.8050° N, 78.6856° E.Weather Data for summer season [01/05/2013 to 30/05/2013] may month for Trichirapalli , Tamilnadu, India was downloaded from NOAA –National Oceanic and Atmospheric Administration to identify Rainfall prediction. It was during this year [2013 may] in summer Trichirapalli experienced rain up to 44mm. Hence it is appropriate to take up this data for prediction modeling.

Weather Parameters

The daily weather data contains the following parameters : station number (433440 – Trichirapalli), WBAN -Weather Bureau Air Force Navy number, Year month date, Dew point, Temperature, Mean Sea Level Pressure, Mean Station Pressure, Mean Visibility, Mean Wind Speed and Sustained Speed, Maximum Wind Gust, Maximum and Minimum Temperature, Total Precipitation, snow depth , FRSHTT (fog, rainfall, snow, hail, thunder, tornado indicator).

Preprocessing

The weather data had missing values so the data was initially preprocessed. All the missing values in certain parameters, indicted by 9999.9 like sea level pressure, snow depth were not applicable for the region as the region is not near the coastal area and it never experienced any snow fall. Those parameters were removed and finally 10 parameters were considered for evaluation as given in Table.1.

Table-1: Weather Parameters for Trichirapalli, Tamilnadu, India (Courtesy: NOAA)

TEMP	DEWP	VISIB	WDSP	MXSPD	GUST	MAX	MIN	PRCP	FRSHTT
91.5	74.3	4.6	5.2	13	999.9	104.4	81.3	0	0
92.3	74.1	3.8	4.7	15	999.9	105.8	82.4	0	0
92.5	74.6	3.8	6.6	15	999.9	106.3	82.9	0	0
92.9	72.7	4.2	5	9.9	999.9	106.7	84.2	0	0
92.4	74.6	4.4	4.7	9.9	999.9	106.7	83.3	0	0
90.5	74.6	3.8	4.5	13	999.9	103.3	83.5	0	0
89	75.7	4.2	3.4	8	999.9	104.4	80.6	0.01	10
92.4	73.7	4.5	6.2	15	999.9	107.6	81.9	0	0
93.7	72	4.3	7.8	15	999.9	109	83.3	0	0
92.9	70.2	3.7	7.4	14	999.9	109.4	84.2	0	0
93.7	71.8	4.2	8.4	13	999.9	109	83.7	0	0
93	70.6	4	10.9	19	999.9	109	84.9	0	0
88.5	73.5	3.6	5.1	12	999.9	103.8	80.6	0	0
92	70.6	3	9.5	15.9	999.9	102.2	81.5	0	0
93.2	70	3.5	9.4	16.9	999.9	106.2	82.2	0	0
92.3	71	3.9	9.3	20	999.9	106.2	82.2	0	0
93.1	71.9	4.2	6.7	12	999.9	109.4	81.9	0	0
92.8	72.8	4.6	7.3	15	999.9	109.2	80.6	0	0
92.5	73.5	4.7	5.6	12	999.9	108.5	82.8	0	0
92.8	73.2	4	7	12	999.9	107.4	82.4	0	0
91.5	71.4	4.3	6.8	12	999.9	106.9	79.9	0	0
93.3	71.8	4.5	6.9	12	999.9	108.3	82.4	0	0
94.4	72.4	4.7	7.7	12	999.9	108.3	83.8	0	0
90.9	71	4.6	9.9	15.9	25.1	107.6	77	0	10010
90.3	71.2	4.1	12	29.9	999.9	106.7	78.8	0.01	10110
89.7	70.6	5	9.1	12	20	106.2	79	0.71	0
90.3	71.7	5.3	9.5	15	20	101.8	81.9	0	10000
90.9	71.5	4.7	11.3	15	999.9	104.2	80.2	0	0
92.3	70.8	5.1	9.8	13	999.9	104.2	82.4	0	0
86.8	73.7	4.1	7.2	15	999.9	104.2	77	0.94	10010
86	73.8	4	6.5	12	20	103.8	77.2	0.01	10000

Identification of Principal Components

The weather data was input to PCA using SPSS tool. Three principal components were identified with Dew point as first component , gust,max,min,temp,maxspd as the second component and FRSHTT, Visibility, precipitation, Wind speed as third component. The component plot is shown below as Fig.-1.

The first component is Dew point, measured as temperature where the air reaches 100% saturation; hence if dew point is lower the air is drier. When dew point reaches near 70 degrees, indicates a humid and an uncomfortable condition. Fog is seen when the dew point and temperature are within few degrees. Dew point greater than 75 indicates higher value and a possibility of rainfall.

The second component related to the mean temperature, maximum and minimum temperature and gust. Gust is the sudden increase in the speed of wind.

The third components are wind speed, visibility, precipitation; FRSHTT .Wind speed is the movement of air from high pressure to low pressure areas. Wind speed is one of the fundamental weather predictor and it determines weather prediction, growth of plants, navy and aircraft operations etc., .Wind speed from 5.2 to 10 favors rainfall. Precipitation is the condensed water vapor that falls due to gravity, the value greater than zero indicates rain, drizzle or snow in the region. Visibility is the clarity of air in the region, from 4

to 7 indicates rainfall in the region. FRSHTT is the parameter that predicts fog, rainfall, snow, hail, thunder or tornado. The total variance extracted from each of the component determines the principal components for the given data. The total variance for rainfall prediction is shown in Table-2.

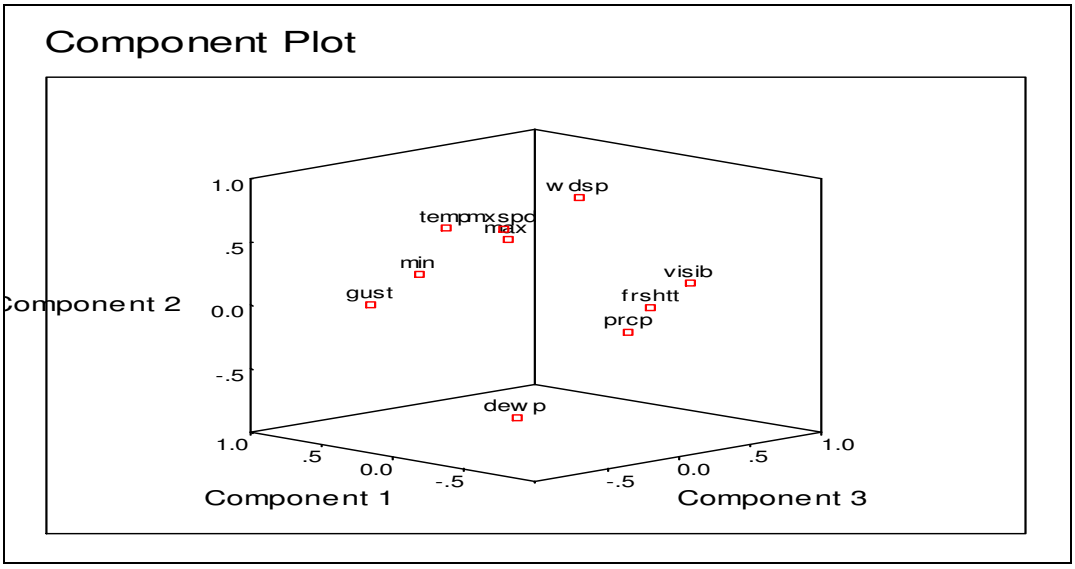

Fig.-1: Component plot for weather data for Trichirapalli Region

Table-2: Variance Explained for Weather Data using Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.491	34.906	34.906	3.491	34.906	34.906
2	2.455	24.553	59.459	2.455	24.553	59.459
3	1.334	13.340	72.799	1.334	13.340	72.799
4	.859	8.588	81.387			
5	.689	6.894	88.281			
6	.531	5.312	93.593			
7	.305	3.046	96.639			
8	.157	1.568	98.207			
9	.103	1.027	99.234			
10	7.658E-02	.766	100.000			

Extraction Method: Principal Component Analysis.

The variance explained by the first component (Dew point) is 34%, second components are (59 %) and for the third components is 72%. As the variance for the third component is more the parameters (FRSHTT, Visiblity, precipitation, windspeed) can be considered for prediction. Dew point which is the only parameter in first component attributes to 34% hence for principal component dewpoint along with FRSHTT, Visiblity, precipitation, windspeed can be used. Rainfall prediction algorithm can be written by considering the following parameter condition-

i. Dew point > 75
ii. Precipitation > 0
iii. Visibility from 4 to 7
iv. Wind speed 5.2 to 10

v. FRSHTT – fog, rain, snow, hail, thunder, tornado. (fog, rain, thunder is applicable to the region)

The conditions can be combined to model rainfall prediction during summer.

Validation

The above parameters were tested for the month of May 2014 (01/05/2014 to 30/05/2014). Analyzing FRSHTT, it is the parameter that indicates the fog, rainfall, thunder etc. Hence for validation, the above parameter can be used for verification of results, in the prediction algorithm only Dewpoint, precipitation, visibility, windspeed parameters and their conditions were used. The results of validation are given in Table-3.

Table-3: Rainfall Validation for 01/05/2014 to 30/05/2014 trichirapalli region.

Date	DEWP	VISIB	WDSP	PRCP	FRSHTT	Prediction
01-05-2014	70.9	4	3.9	0	0	no
02-05-2014	73.7	4.3	5	0	0	no
03-05-2014	74.2	3.8	5.2	0	0	no
04-05-2014	74.6	4.1	6.6	0	10000	no
05-05-2014	75.7	2.6	4.2	0.08	10000	Yes
06-05-2014	76.4	2.7	5.7	0.12	10000	Yes
07-05-2014	76.1	1.9	4.1	0	10010	no
08-05-2014	75.6	2.2	3.7	1.93	10000	Yes
09-05-2014	76.4	2.6	2.8	0.35	10000	Yes
10-05-2014	75.7	3.9	5.1	0.04	0	Yes
11-05-2014	75.7	3.3	4.2	0	0	no
12-05-2014	74.2	3.4	4.8	0	10	no
13-05-2014	74.8	2.9	5.5	0	0	no
14-05-2014	73	3.1	7	0	0	no
15-05-2014	71.2	3.7	7.2	0	0	no
16-05-2014	71	3.8	7.1	0	0	no
17-05-2014	69.9	3.4	7.7	0	0	no
18-05-2014	74.5	3.4	4.9	0	0	no
19-05-2014	75.6	3.4	4.3	0	0	no
20-05-2014	75.2	2.9	4.4	0	10010	no
21-05-2014	74.3	3.5	6.1	1.26	0	no
22-05-2014	72.7	3.9	7.1	0	0	no
23-05-2014	73.4	3.7	7.9	99.99	10010	no
24-05-2014	73.6	3	8.9	0.02	10010	no
25-05-2014	75.1	3.5	7.8	0.71	0	Yes
26-05-2014	74.9	3.8	5.2	0	0	no
27-05-2014	76.5	3.9	4.4	0	0	no
28-05-2014	72.8	3	5.6	0	10010	no
29-05-2014	75.3	3.8	4.5	0	0	no
30-05-2014	74.3	3.8	6	0	0	no

The prediction result “Yes” indicates the possibility of rainfall and no indicates that parameters are not favorable for rain. FRSHTT parameter 1 followed by zero indicates fog; similarly 1 in second field indicates rainfall. Comparing our result “Yes” and FRSHTT, in most cases fog filed is 1, which is also a form of rainfall. Prediction result has shown Yes for 6 days and FRSHTT parameter coincided for 4 days.

CONCLUSION

Rainfall predictions with five parameters viz dew point, precipitation, windspeed, visibility and FRSHTT can be done. The chances of rainfall are more when all the conditions are satisfied. On analyzing the data and the condition, the results were correct as Trichirapalli region received sharp summer shower nearly 44

mm rainfall during that year. The work can be extended to include more regions data to create a model for rainfall prediction during summer.

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