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Numerical recreation of rainfall and runoff in Namakkal District of Tamil Nadu State, India.

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Abstract - *Rainfall is a natural resource in geo that fulfills the basic human need – universal solution, 'the water'. Rainfall in India is seasonal, even during the season; India receives only a fair amount of precipitation. Hence, agriculturist, farmers are in need of predicting the rainfall for their irrigation and ground recharge purposes. In this article, a simulated equation is suggested based on the previous data that was collected from the meteorological department of India. Using the equation, the rainfall and runoff can be predicted. With the known results, it is an easier job for an agriculturist to plan for irrigation and water recharge. Five places in Namakkal district – Namakkal, Tiruchengode, Sendamangalam, Erumapatti and Rasipuram, were selected for the study. Equations were framed based on the essential data for rainfall and runoff. The strength of the equations is high which implies accuracy in results.*

***Key Words*: Rainfall, Runoff, Wind velocity, Wind pressure, Simulation**

1. INTRODUCTION

Rainfall is liquid precipitation produced by clouds. The rainfall has numerous implications with life on the planet. Life on the planet depends on the precipitation – the rain from clouds. Human life sustenance, Plants and animal sustenance, Human hydraulic inventions, etc., are the major factors that depend on rain. Lag of rain will promote unexpected and severe damages in society. Taking necessary steps such as tree plantings and preserving water bodies will promote the high intensity of precipitation. Sometimes, rainfall will cause ironic situations such as modifying the water quality, dangerous mud slides, flooding, downpours, etc.

Forecasting the rainfall and runoff will help much in planning and preparation to face the risk as well as the credits. Generally, Rainfall in a particular area is measured using rain gauges. There are three types of rain gauges that are available: Standard rain gauge, tipping bucket rain gauge and weighing rain gauge. Rain gauges work under the principles of mechanical systems. This article describes the need for forecasting and its application. Forecasting is considered most technique for avoiding such natural disasters.

1.1. Rain Gauges

Rain gauges are the instruments that are used to measure the rainfall intensity. The instrument was placed at the most suitable place which represents the entire area. The rainfall will be collected in the gauge which reads the quantity of rainfall.

1.1.1. Standard Rain gauge

Standard Rain gauge is also known as funnel rain gauge, which collects the rainfall in the funnel shape and discharge to the measuring tube.

1.1.2. Tipping Bucket Rain gauge

Tipping Bucket rain gauge collects water through the funnel assembly and discharges to small buckets which are then channelized to tipping of the liquid into the outer shell of the gauge. This gauge is widely used in wireless weather stations.

1.1.3. Weighing Rain Gauge

Weighing rain gauge is also known as universal weighing rain gauge. This gauge is found to be more precise in measuring rainfall. This gauge measures the depth and time of collection simultaneously.

1.2. Area

Area in gauge can be measured as depth that occurs over a unit area. Unit area in gauge represents one meter square and the rainfall amount. One millimeter of measure precipitation represents one liter of rainfall per square meter. Rain gauges are generally placed in the place which is free from obstacles and high enough to avoid splashes.

2. DATA STUDY

In this simulation, some of the data are considered to be the major rainfall and runoff determining factors.

a. Average rainfall
b. Time
c. Runoff coefficient

d. Rainfall intensity
e. Wind velocity
f. Wind pressure

2.1. Average rainfall

The quantity of water that is precipitated and recorded in the rain gauge is referred as average rainfall. Precipitations are in the form of snow and rain. Average rainfall is estimated as total amount of precipitation recorded during a calendar or month.

2.2. Time

Time is the deciding factor of the annual rainfall and other factors. Generally, in all the rainfall related equations time are measured in seconds.

2.3. Runoff coefficient

Runoff coefficient is a dimensionless coefficient relating the amount of runoff to the amount of precipitation received. The value of runoff coefficient will be higher for the places where the infiltration is lower and runoff is higher.

2.4. Rainfall intensity

Rainfall intensity is defined as the ratio of the total amount of rain falling during a given period to the duration of the period. It is generally expressed in depth units per unit time. Rainfall intensity is considered to be one of the desirable factor in simulator.

2.5. Wind velocity

Wind velocity is the velocity that is measured at pedestrian level which is 2m above the ground level. Wind speed along with wind directions defines the weather patterns and climatic fluctuations in the earth.

2.6. Wind pressure

Wind pressure related the weather, high pressure indicates a fair weather and low pressure indicates the rain. Wind blow towards the los pressure area and air rises to the atmosphere. When the air rises it met with water vapour further condenses and make precipitation.

3. SIMULATIION

Simulation is a practice which reflects or predicts the results with the past observed data. Simulation analysis are performed based on the statistical distribution of input data. Predicting rainfall and runoff is an essential way to avoid the losses and can take preventive measures to meet out the disaster. Simulation analysis shall be framed on the sensitivity and scenario concepts.

Mathematical modelling of extremely hydrological events such as droughts or floods, also for evaluating surface and subsurface water sources and the quality.

3.1. Steps in Simulation Analysis

Step 1 - General Procedure
Step 2 - Planning the Study
Step 3 - System definition
Step 4 - Model building
Step 5 - Experimentation
Step 6 - Analysing
Step 7 - Reporting

3.2. Concept

Simulation can be stated as the imitation of real world process over time. It requires use of models, which represents key characteristics or behaviour of system over time.

Basic elements of a model are the state – describes the properties of system, along with set of rules – strings.

Simulation can be treated as the valuable tools for statistical research, evaluation of methods and comparison of alternative methods.

3.3. Advantages

Simulation allows us to explore the question of 'what if' without undergoing any experiments. It helps in identifying the best answer for the question that can be asked in the real time world. It gives an insight about the advantages and disadvantages of a particular problem.

3.4. Regression

Regression is form of simulating analysis which creates a relationship between targets and predictors. It ensures the strength of the relation. It rounds off the variation that takes in target relation in selecting predators.

3.5. Types of regression

Regression can be classified into

1. Linear regression
2. Logistic regression
3. Lasso regression
4. Polynomial regression
5. Ride regression

3.6. Linear regression

The basic regression analysis that a beginner can do is linear regression. It has a predictor and dependent variable which is related to each linearly.

3.7. Logistic regression

Discrete values are taken as the dependent variable then logistic regression is the best way to model a function. Logistic regression uses sigmoid curve for predicting models.

3.8. Lasso regression

It is a regular technique which is used to minimize the complexity of the model. Lasso regression is used for feature selection

3.9. Ridge regression

Ridge regression is highly used in a place where high correlation is expected between the predictor and variables. This regression reduces the complexity of the model

3.10. Benefits of regression analysis

1. Identification of errors
2. Increase in operational efficiency
3. Better forecasting
4. Data informed decision making
5. Fresh perspectives

4. RESULTS

Following are the values taken and results forecasted from the simulated model,

Equations for Runoff

Tiruchengode

Y = 0.0667x + 25.1

Namakkal

Y = 0.074x + 24.285

Sendamangalam

Y = 0.0825x + 3.445

Erumaipatty

Y = 0.0731x + 13.729

Rasipuram

Y = 0.0674x + 22.127

Table-1: Rainfall intensity at Tiruchengode

S. No.	Year	Rainfall (mm)	Time (hours)	Rainfall Intensity
1	2009	698.8	3.0	232.93
2	2010	717.8	4.0	179.45
3	2011	632.2	3.0	210.73
4	2012	314.9	3.0	104.97
5	2013	209.9	2.0	104.95
6	2014	348.7	3.0	116.23
7	2015	232.9	2.0	116.45
8	2016	237.5	2.5	95.00
9	2017	554.9	4.0	138.73
10	2018	668.6	4.0	167.15

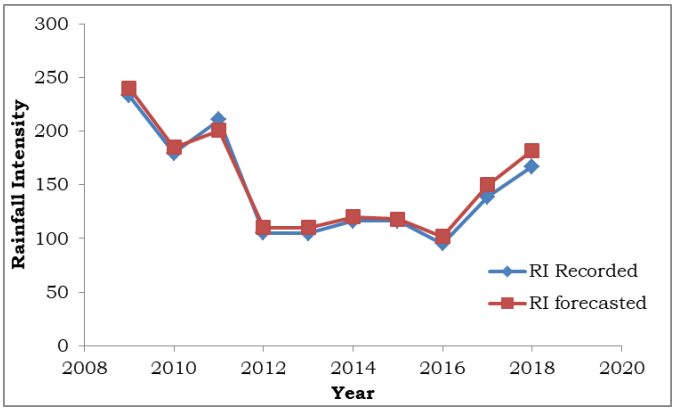

Chart – 1: Rainfall intensity at Tiruchengode

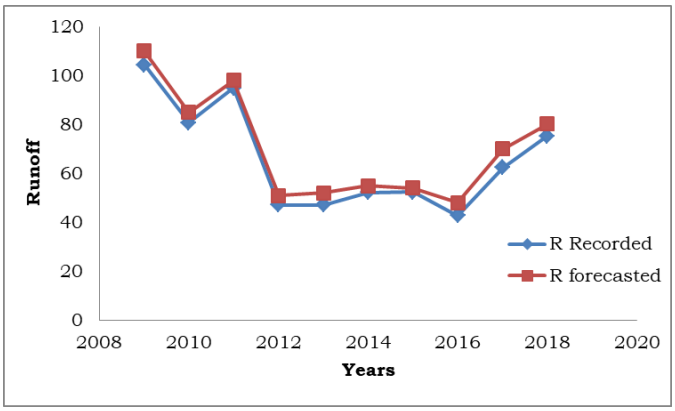

Chart - 2: Runoff at Tiruchengode

Chart 1 and Chart 2 represents the recorded and forecasted values of rainfall intensity and runoff at Tiruchengode area. The study on the chart infers that from 2012 to 2016 the rainfall was found to be minimal when compared to the other years.

The forecasted values were found very similar to that of the recorded observations. After 2018 the same equation was imposed for the preceeding years, for which the values are found to similar to that of the recorded values. The equation Y = 0.0667x+25.1 holds a r square value of 95.6%, which is considered to be a strengthened equation.

Table-2: Rainfall intensity at Namakkal

S. No.	Year	Rainfall (mm)	Time (hours)	Rainfall Intensity
1	2009	537.0	4.0	134.3
2	2010	982.5	3.0	327.5
3	2011	835.5	2.0	417.8
4	2012	502.0	3.0	167.3
5	2013	514.5	4.0	128.7
6	2014	654.8	3.0	218.3
7	2015	731.0	2.0	365.5
8	2016	324.0	4.0	81.0
9	2017	911.0	3.0	303.7
10	2018	581.3	3.0	193.8

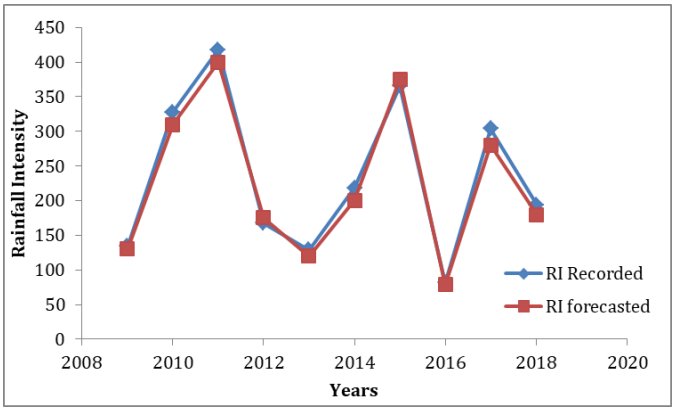

Chart-3: Rainfall Intensity at Namakkal

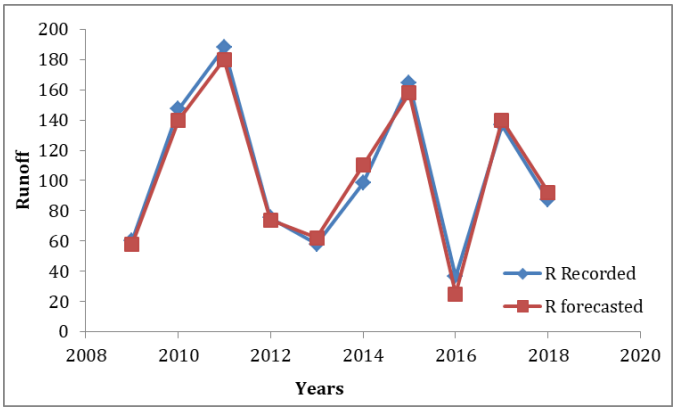

Chart-4: Runoff at Namakkal

Table-3: Rainfall intensity at Sendamangalam

S. No.	Year	Rainfall (mm)	Time (hours)	Rainfall Intensity
1	2009	776.5	4.0	194.1
2	2010	1161.2	3.0	387.1
3	2011	909.8	4.0	227.5
4	2012	1491.8	3.0	497.3
5	2013	88.9	3.0	269.6
6	2014	616.8	4.0	154.2
7	2015	1002.6	2.0	501.3
8	2016	450.0	3.0	150.0
9	2017	709.6	4.0	177.4
10	2018	715.8	2.0	357.9

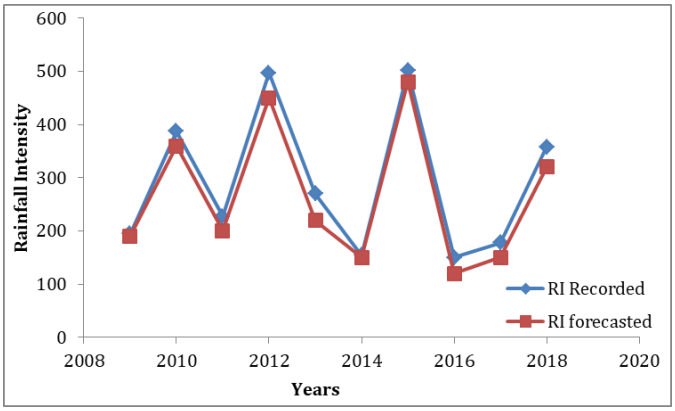

Chart-5: Rainfall Intensity at Sendamangalam

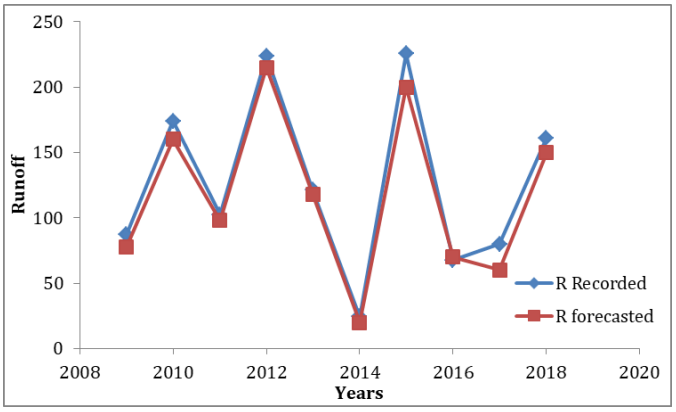

Chart-6: Runoff at Sendamangalam

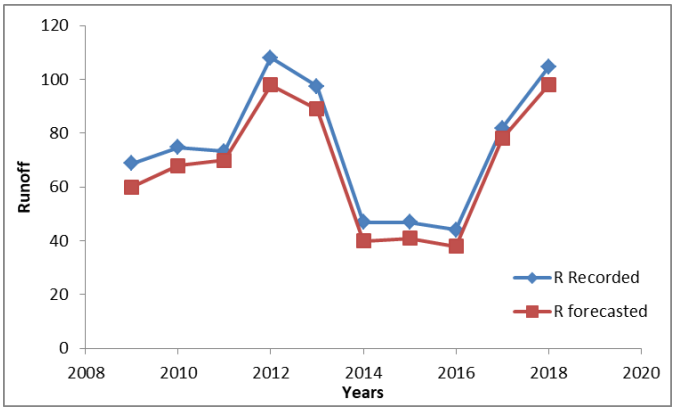

Chart-8: Runoff at Erumapatti

Table-4: Rainfall Intensity at Erumapatti.

S. No.	Year	Rainfall (mm)	Time (hours)	Rainfall Intensity
1	2009	458.4	3.0	152.8
2	2010	498.0	3.0	166.0
3	2011	651.7	4.0	162.9
4	2012	720.6	3.0	240.2
5	2013	433.1	2.0	216.5
6	2014	416.8	4.0	104.2
7	2015	356.6	3.0	118.8
8	2016	392.0	4.0	98.0
9	2017	545.2	3.0	181.73
10	2018	697.0	3.0	232.3

Table-5: Rainfall Intensity at Rasipuram

S. No.	Year	Rainfall (mm)	Time (hours)	Rainfall Intensity
1	2009	627.8	4.0	156.9
2	2010	968.4	3.0	322.8
3	2011	714.2	3.0	238.1
4	2012	588.5	2.0	294.3
5	2013	385.5	3.0	128.5
6	2014	579.6	4.0	144.9
7	2015	755.9	3.0	251.2
8	2016	621.3	3.0	207.1
9	2017	640.2	2.0	320.1
10	2018	544.4	3.0	181.5

Chart-7: Rainfall Intensity at Erumapatti

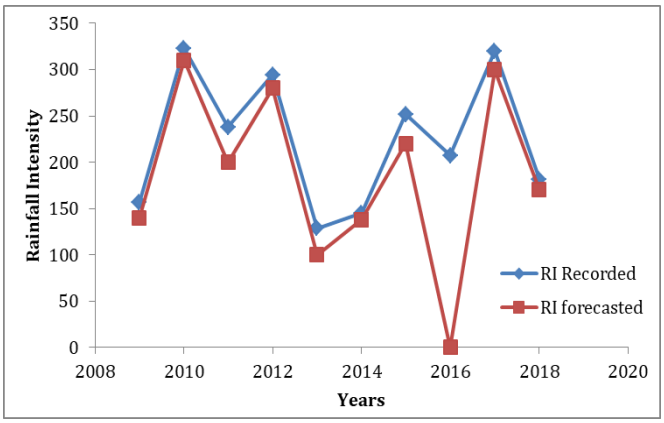

Chart-9: Rainfall Intensity at Erumapatti

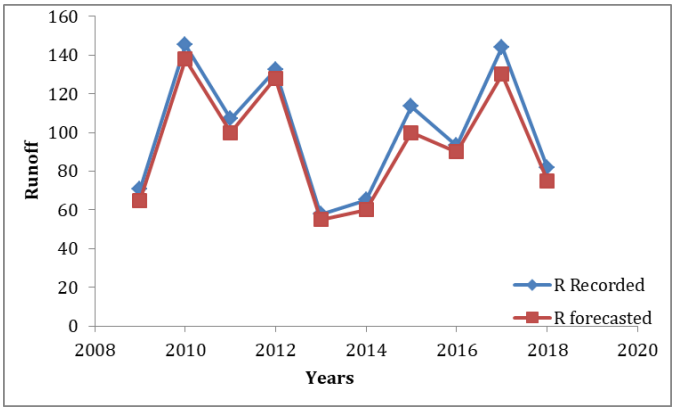

Chart-10: Runoff at Rasipuram

Table-6: Rainfall Intensity at Kumarapalayam

S. No.	Year	Rainfall (mm)	Time (hours)	Rainfall Intensity
1	2009	627.8	4.0	156.9
2	2010	968.4	3.0	322.8
3	2011	714.2	3.0	238.1
4	2012	588.5	2.0	294.3
5	2013	385.5	3.0	128.5
6	2014	579.6	4.0	144.9
7	2015	755.9	3.0	251.2
8	2016	621.3	3.0	207.1
9	2017	640.2	2.0	320.1
10	2018	544.4	3.0	181.5

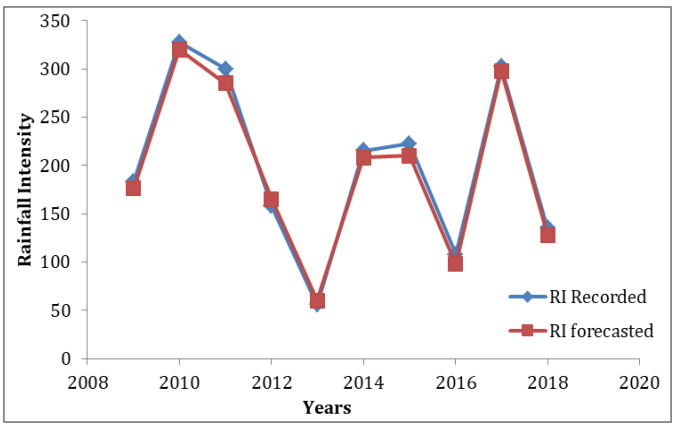

Chart-11: Rainfall Intensity at Kumarapalayam

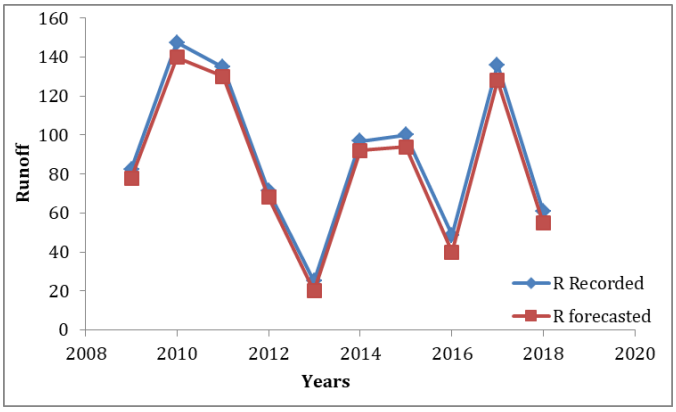

Chart-12: Runoff at Kumarapalayam

Chart 3 and Chart 4 represents the rainfall intensity and runoff at Namakkal. Namakkal being the centre of the district found to have low precipitation from 2012 to 2014. But from 2015 the precipitation found to be sufficient in meeting the demands. The forecast equation for Namakkal district found to be fit with the observed results. For the equation it holds a r square value of 94%, which defines the strength of the equation.

Chart 5 and Chart 6 represents the rainfall intensity and runoff at Sendamangalam. Sendamangalam being located 12kilometers from Namakkal found to have the maximum precipitation in Namakkal district. Since near to Sendamangalam Kolli Hills is situated, maximum precipitation in a year can be expected at Sendamangalam. The forecast equation provides suitable results to that of observed one. The r square value of the equation was found to be 90%.

Chart 7 and Chart 8 represents the rainfall intensity and runoff at Erumapatti. Erumapatti is located 18kilometers from Namakkal in Thuraiyur road. The precipitation generally in Erumapatti found to be low when compared to other areas of Namakkal District. The suggested equation produced good results to that of observed one. The r square value found to be 88%.

Chart 9 and Chart 10 indicates the rainfall intensity and runoff at Rasipuram. Rasipuram is located 30kilometers from Namakkal. The fair precipitation was observed to that of other receiver points. The suggested equation holds a r square value of 90% which produce a good result when compared to that of observed one.

Chart 11 and Chart 12 indicates the rainfall intensity and runoff at Kumarapalayam. The receiver point Kumarapalayam is located at 38kilometers from Namakkal at river banks of river Cauvery. The precipitation was found to be good enough for the year. The r square value found to be 93% which indicates that it produced the best fit relations between the observed and the forecasted observations.

5. CONCLUSIONS

Following are the conclusions arrived from the present study,

- Precipitations at different receiver stations found to be drastically changing in relevance with the topography of the place. 2012 to 2016 in all the receiver unit low or varying precipitation was observed due to high change in the climatic conditions.
- The suggested runoff equation in stations such as Tiruchengode, Namakkal, Sendamangalam, Erumapatti, Rasipuram, Kumarapalayam – suggested the best fit results from the observed data.
- The forecast equation can be used to found out the precipitation for the upcoming years which shall facilitate various fields such as agriculture, farming, etc., to take good decision.
- The forecasted results and observed results found to be similar in most of the receiver units.
- Overall Precipitation in Namakkal district in Tamil Nadu state was found to be insufficient for the peoples, so the total water demand of the district is depending on the river Cauvery.
- Runoff ratio when compared to the rainfall intensity found to be very high. Which infers that ground water recharge found to be low in Namakkal District.

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