COMPARISON OF RAINFALL INTERPOLATION METHOD FOR DELHI

[1]Mr. SANTHOSH KUMAR MB, [1]Mr. TILAK L N
[1]Assistant Professor, JSS Academy of Technical Education, Noida
[2]Mr. SHIVAM PACHAURI, [2]Mr. SAURABH CHAURASIA
[2]Undergraduate student, JSS Academy of Technical Education, Noida

ABSTRACT-Rainfall is a highly unpredictable and random phenomenon in nature, rainfall interpolation from point measurements is one approach that hydrologists use to account for spatial variation in rainfall. Rainfall is arguably the meteorological phenomena that have the greatest impact on the human activity. However, it remains one of the most elusive elements to predict. Advances in numerical weather prediction models and available computing power have resulted in a steady improvement of short range forecast since 1950. Geographical Information System (GIS) has emerged as a useful tool in carrying out the spatial analysis of rainfall. GIS can handle of large amount of spatial and non spatial data and can provide outputs which can be easily interpreted. Geostatistcs is a study of phenomena that vary in space and time. It can be regarded as a collection of numerical techniques that deal with the characterization of spatial attributes, employing primarily random models in a manner similar to the way in which time series analysis characterize temporal data.In the present study, an attempt is made to predict rainfall using conventional methods such as Theissen polygon method, Inverse distance weightage and geostatistical methods such as kriging and radial basis function for Delhi. The point rainfall data of over 8 rain gauge station have been used in GIS environment.

Geostatistical interpolation methods Kriging and Radial basis function along with theissen polygon method and Inverse Distance Weightage have proved to be comparable approaches in prediction of annually rainfall values. The choice of interpolation method for predicting rainfall depends on the nature of the rain in the regions under study and the quality of observations. From the present study Kriging by linear interpolation and Radial basis function have prove to be satisfactory among other interpolation methods.

***KEYWORDS*-Remote Sensing, GIS, Thiessen Polygon, IDW, Krigging, RBF**

INTRODUCTION

Rainfall is a scarce and an important hydrological variable in dry land areas. The need for water in these areas increases daily due to population growth, economic developments, urbanization, and consequently, water management using all the available resources is becoming increasing crucial. In order to develop an effective management strategy, it is paramount to understand and assess the impact of this resource on the ecosystem. The relation between rainfall, space and time determines the environment and development of the particular region Rainfall is a crucial agro climatological factor in the seasonally arid parts of the world and analyzing an important perquisite for agricultural planning in India. Rainfall is the key factor for determining the sustainability and conservation of living species on the earth. In dry farming areas, where rainfall is the sources of water for crops, changes in both quantity and distribution of rainfall during the year could affect the economy of an area.Climatechange is very likely to have a major impact on hydrological cycle and consequently on available of water resources, flood and draft frequencies, natural and manmade eco-system, society and economy. India is a tropical country and its agricultural planning and utilization of water depends on monsoon rainfall. More than 75% of rainfall occurs during the monsoon season; monsoon rainfall is uneven both in time and space. Therefore it is important to understand and analyze the variations of rainfall both in time and space.

The use of rainfall data is essential and fundamental to the rainfall runoff process. The rainfall data are the driving force in the relationship.To study the hydrological parameters of the proposed area can be done by spatial and temporal analysis.

Precipitation is the major source of fresh water in water cycle. For the accurate information and area wise details of water availability is evaluated from spatial analysis. It helps to study the detailed nature of the areas like vegetation index variability, climatic change during that year, many hydrological features of that area etc.

Temporal Analysis the detailed calculations of rainfall data on the basis of season to season; the process is called temporal analysis. The four seasons of rainfall are,

a) Pre monsoon b) Monsoon c) Post monsoon d) Winter

It helps to study on the field of agriculture, climatic variations, hydrological features of that area, flood analysis etc.

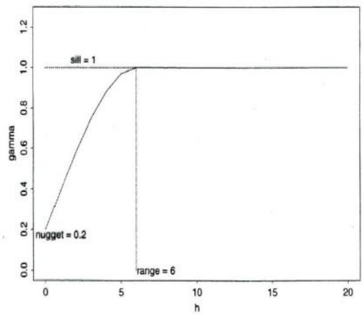

Figure 1: A generic variogram showing the sill and range parameters along with nugget effect

STUDY AREA

Delhi,officially the National Capital Territory of India (NCT), is a city and a union territoryof India.The NCT covers an area of 1,484 square kilometres (573 sq mi).

Figure 2

DATA USED

The point rain fall data are collected from the National Centre for Weather Forecasting, Noida.The rainfall data are obtained from about 25 rain gauge stations distributed across the study area.

Table 1: Rain gauge Stations along with their Locations

S. No.	Raingauge Stations	Lattitude (degree)	Longitude (degree)
1	NAJAFGARH	28.601	76.989
2	RASHTRAPATI BHAVAN	28.614	77.199
3	OKHLA	28.560	77.291
4	SHAHDARA	28.752	77.210
5	MEHRAULI	28.521	77.122
6	NANGLOI	28.689	77.063
7	ALIPUR	28.752	77.261
8	NARELA	28.838	77.107
9	DHANSA	28.734	77.004
10	DELHI SADAR	28.657	77.212
11	SAFDAR JUNG	28.569	77.191
12	BADLI	28.7324	77.144
13	DELHI UNIVERSITY	28.584	77.163
14	PALAM	28.590	77.088
15	CHANDRAWAL	28.549	77.203
16	NEW RAJENDRA NAGAR	28.640	77.185
17	CORONATION PILLA	28.722	77.196
18	KESHOPUR	28.638	77.073
19	CHIRAG DELHI	28.533	77.210
20	GURMANDI	28.544	77.180
21	KHANJAWALA	28.734	77.004
22	DELHI RIDGE	28.644	77.216
23	AYA NAGAR	28.472	77.132

Table 2: Annual Rainfall Data of Rain gauge Stations

S. No.	Rain Gauge Station	RF_2012	RF_2013	RF_2013	RF_2014	RF_2015
1	RASHTRAPATI BHAVAN	321.0	867.9	477.0	630.0	713.0
2	OKHLA	331.0	337.0	396.0	545.0	615.0
3	SHAHDARA	197.0	287.0	376.0	441.0	322.0
4	ALIPUR	505.9	753.0	221.9	655.5	460.5
5	MEHRAULI	596.4	653.8	569.0	997.4	657.8
6	NAJAFGARH	444.0	752.8	332.8	847.5	688.1
7	NANGLOI	222.0	563.0	652.9	667.2	672.3

COMPUTATIONAL RESOURCESUSED

The software's are used for analysis are MicrosoftWord, Bhuvan 2D,ArcGIS ,MicrosoftExcel

METHODOLOGY

The present study includes analysis of rainfall data over the last 5 years collected

from statistical department over the study area. The collected data is in the form of point rain gauge readings from 8 rain gauge stations spread across the study area. The point rain gauge data are handled using MS EXCEL spreadsheets in order to calculate yearly rainfall and other statistical parameters. The analysis is carried out using GIS technique with the help of MS Word, ARCGIS and MS Excel software. Spatial analysis of the rainfall data is carried out to predict rainfall of 12 rain gaugestations.

Spatial analysis of the rainfall is carried out as described in the subsequentsections.

There theoretical values calculated from each ofmethods

a) Theissen polygonmethod
b) Inverse distance weightingmethod
c) Kringmethod
d) Radial base functionmethod

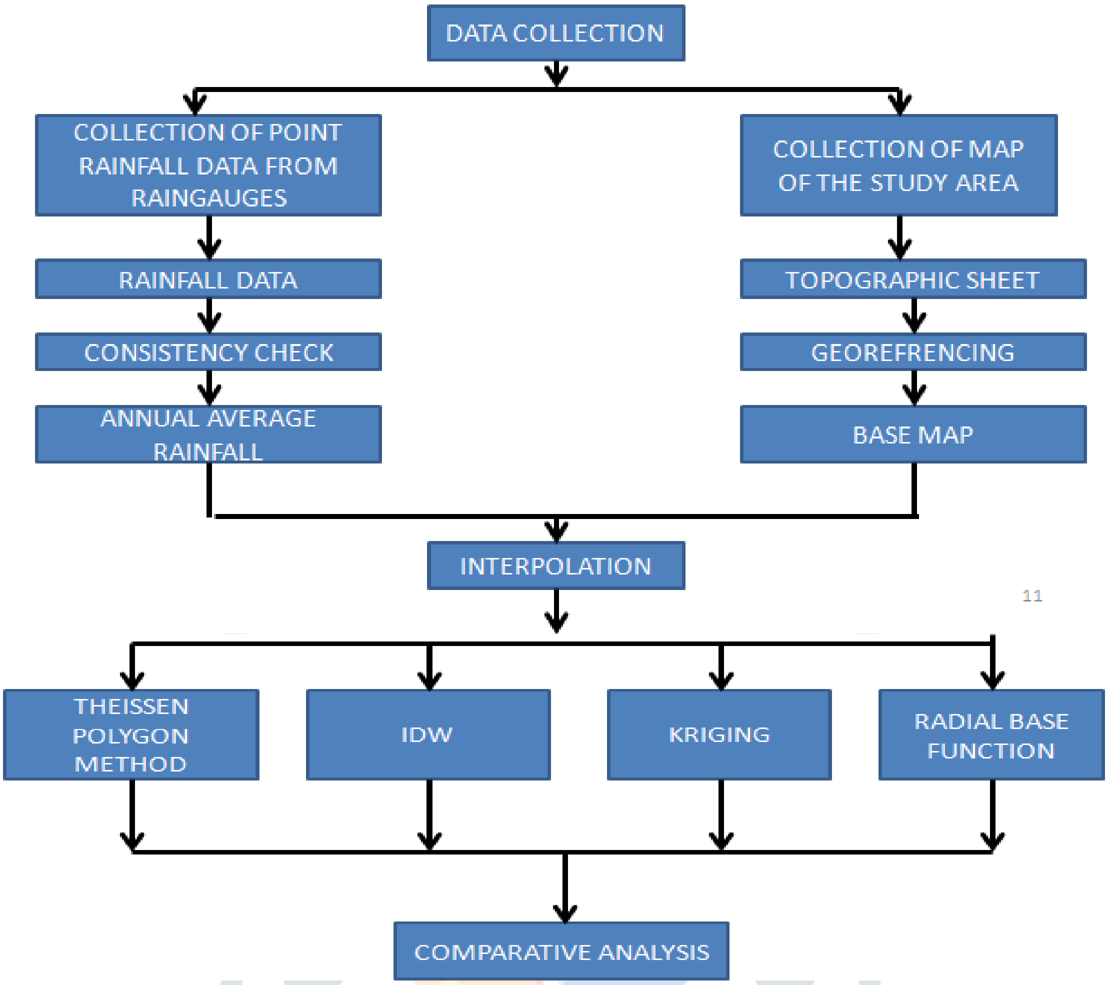

Figure 3: Methodology Chart

RESULTS AND SHAPE FILES OF THE STUDY AREAUSING DIFFERENT GEOSTATISTICALMETHOD

1.INVERSE DISTANCEWEIGHTAGE

2. THIESSEN POLYGON METHOD 3.LINEARKRIGING

4. RADIAL BASIS FUNCTION

1. RESULTS OF SPATIAL INTERPOLATION OF THE RAINFALL USING INVERSE DISTANCE WEIGHTAGE

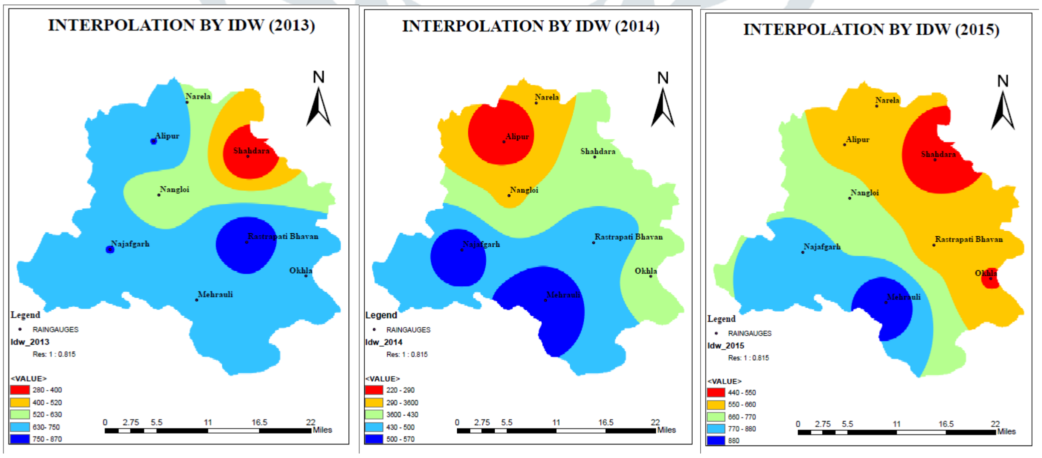

Figure:4

Table 5: Comaparative analysis of actual and predictive value of observation station (NARELA) by IDW method.

RAINFALL	RAINFALL YEAR				
	2012	**2013**	**2014**	**2015**	**2016**
Actual Value	377.1	614.9	230.5	640.5	405.4
Predicted Value	390.95	643.74	315	630	497.3
% ERROR	3.3	4.6	36.6	1.6	22.5

Cumulative Mean Error in IDW = 13.72%

RAINFALL	RAINFALL YEAR				
	2012	**2013**	**2014**	**2015**	**2016**
Actual Value	377.1	614.9	230.5	640.5	405.4
Predicted Value	390.95	644.84	306.75	616.9	489.81
% ERROR	3.6	4.8	33	3.6	20.7

Cumulative Mean Error in Kriging = 13.14%

RAINFALL	RAINFALL YEAR				
	2012	2013	2014	2015	2016
Actual Value	377.1	614.9	230.5	640.5	405.4
Predicted Value	383.71	605.5	224.5	646.9	411.3
% ERROR	1.75	1.5	2.5	1	1.38

Cumulative Mean Error in Radial Base Functio =1.352%

Table 8: Comaparative analysis of actual and predictive value of observation station (NARELA) by Thiessen Polygon Method.

RAINFALL	RAINFALL YEAR				
	2012	**2013**	**2014**	**2015**	**2016**
Actual Value	377.1	614.9	230.5	640.5	405.4
Predicted Value	505.9	753.0	221.9	655.5	460.5
% ERROR	34.8	22.4	3.7	2.3	13.5

Cumulative Mean Error in Thiessen Polygon Method = 15.2%

COMPARISON OF DIFFERENT RAINFALL INTERPOLATION METHOD

According to our study:-

The error occurred while using different interpolation methods are presented in ascending order as follows,
RBF < KRIGING <IDW<THIESSEN POLYGON
1.352% 13.14% 13.72% 15.2%

CONCLUSIONS

In this study the rainfall measurements of Union Territory Delhi was studied. Conventional methods such as Thiessen polygon method, Inverse distance weightage and geostastistical methods such as Kriging and Radial basis function were used for prediction of rainfall. A comparative analysis was carried out and the following conclusions have been drawn.

- Geostatistical interpolation methods (Kriging and Radial Basis Function) along with Thiessen polygon method and IDW have proved to be satisfactory in the prediction ofrainfall.
- The choice of interpolation method for predicting rainfall depends on the quality of rainfall data and spatio temporal variation of rainfall in theregion.
- From the present study, Kriging (linear interpolation) and Radial Basis Function have predicted rainfall values better than Thiessen polygon method and inverse distance weightedmethod.

REFERENCES

- B. Mahalingam , Amin Noorie , M.Vinay ; Analysis of selected spatial interpolation techniques for rainfall data.
- Chen Tao , RenLiliang , Yuan Fei , Yang Xiaoli , 11 May 2017; Comparision of spatial interpolation schemes for rainfall data and application in Hydrological modelling .
- D.Han ,M.Bray November 2006, ;Automated Thiessen Polygon Generation (Vol-42, Issue -11).
- Goovaerts P (2000) ,"Geostatistical approaches for incorporating elevation into the spatial interpolation ofrainfall".
- IshappaMuniyappaRathod ,Aruchamy.S (2010), "Spatial Analysis of Rainfall Variation in Coimbatore District Tamil Nadu usingGIS".
- KC Lam, RG Bryn, J.Wainright ,August 2015; Application of spatial interpolation methods foe estimation the spatial variability of rainfall (Vol-6 , No.4 S3).
- L Mitas and H Mitasova (1996), "Spatial Interpolation".
- Marc G. Genton and ReinhardFurrer (1998), "Analysis of Rainfall Data by Robust SpatialStatistics usingSPATIALSTATS".
- N. Q. Hung, M. S. Babel, S. Weesakul, and N. K. Tripathi (2009)' "An artificial neural network model for rainfall forecasting in Bangkok,Thailand".
- S. Ly, C. Charles2, and A. Degr´e (2011)' "Geostatistical interpolation of daily rainfall at catchment scale,the use of several variogrammodels in the Ourthe and Ambleve catchments,Belgium.
- SarannLy , Catherine Charles , AuroreDegré (2012), "Different methods for spatial interpolation of rainfall data for operational hydrology and hydrological modeling at watershedscale".
- Tao Tao ,Chocat Bernard , Liu Suiqing, 2009 ; Uncertanityanalysisofinterpolation method in rainfall spatial distribution – A case of small catchment Lyon (1,50-58).