Geospatial Technology Based Rainfall Precipitation Assessment with Landslides in Mettupalayam – Aravankadu Highway, Tamilnadu

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Abstract— The present study reveals that the relation between rainfall Precipitation with landslides was carried out. The Precipitation data were collected from IWS (Institution of Water Studies) and analyzed for annual and season wise for the period from 2006 to 2015. The Precipitation data were interpreted through spatial distribution methods in GIS and correlated with existing landslide locations. The spatial output of rainfall contour shows that larger area of rainfall is covered with higher amount in Northeast Monsoon when compared to other seasons. However, an almost equal amount of rainfall was noticed in Southwest Monsoon. The above data were taken into a GIS. Using this data, spatial interpolation maps were prepared. It clearly reveals that, high amount of rainfall and existence of landslides occurs throughout the Coonoor region and Wellington and Moderate amount of rainfall and existence of landslides in Kothagiri and Ooty region. This paper highlights the application of GIS in spatially locating the relation between precipitation and landslides.

Keywords— Geospatial Technology, Aravankadu Highway, IWS.

I. INTRODUCTION

A landslide is an event of nature that leads to sudden disruption of normal life of society, causing damage to property of nations, to such an extent those normal, social and economic mechanisms available are inadequate to restore normalcy. Landslides are defined as the mass movement of rocks, debris or earth along a sliding plane. They are characterised by almost permanent contact between the moving masses and sliding plane (Butler, 1976; Crozier, 1984; and Smith, 1996). Landslides cause substantial economic, human and environmental losses throughout the world. Examples of devastating landslides at a global scale include the 1972 Calabria landslide in Italy, the 1970 Hauscaran landslide in Peru (McCall, 1992), the 1966 Aberfan landslide in Wales, and the 1985 Armero landslide in Colombia (Alexander, 1993). It is estimated that in 1998, 180,000 avalanches, landslides, and debris flow in different scales occurred in China, estimated at 3 billion dollars’ worth of direct economic losses (Huabin et al., 2005).

II. STUDY AREA

The study area is the Nilgiris district, which is located in Tamilnadu state. The Mettupalayam to Aravankadu ghat section of length 273.30 km² has taken as the study area to identify the landslide prone areas. It lies in the toposheet Nos. 58 A/11 of survey of India and located in between 76° 48’ 8.34” and 76°54’ 2.48” E longitudes and 11° 17’ 41.25” and 11° 17’ 47.48” N latitudes with an area of (273.30 km²). The study area is blessed with deltaic system with different active and inactive distributaries and shown in figure 1. The proposed study area is covered include villages like Mettupalayam, Odanthurai, Adatturai, Burliyar, Hulical Drug, Kallar, Killpilur, Marrapalam, wellington, Aravankadu, Lamb's rock and Tiger hill.

III. METHODOLOGY

The base map is prepared from Survey of India (SOI) Toposheets 58A/11 &15 at a scale of 1: 50000. In the present study, the average monthly rainfall of a ten years period (2006 - 2015) have been collected from five rain gauge stations and variation diagrams are prepared. Rainfall contour map has been prepared of rainfall variation is found at all the rain gauge stations. The spatial variability of mean annual precipitation depends upon the topographic factors such as exposure of station to the prevailing wind, elevation, orientation and slope of the mountain (Basist A and Bell G.D., 1994).
Arithmetic mean is used for measurements of selected duration at all rain gauges are summed and the total divided by the number of gauges. Arithmetic method is the simplest objective methods of calculating the average rainfall over the area (Basavarajappa et al., 2015a).

Thiessen polygon method provides the individual areas of influence around each set of points. Thiessen (1911), an American engineer adopted the polygon method for rainfall measurements at individual gauges as first weighted by the fractions of the catchment area represented by the gauges, and then summed. Thiessen polygons are the polygons whose boundaries are mathematically define the area (perpendicular bisectors) that is closest to each point relative to all other points (Basavarajappa et al., 2015 a).

Iso-hyetal method is a line drawn on a map connecting points that receive equal amounts of rainfall. It is one of the convenient methods that views continuous spatial variation of rainfall areas. The main aim of the method, to draw lines of equal rainfall amount (isohyets) using observed amounts at stations (Reed W.G and Kincer J.B., 1917). In iso-hyetal map, the x-axis represents East Longitude, while y-axis represents North Latitude (Basavarajappa et al., 2015 a).

IV. RESULTS AND DISCUSSION
The results of post-monsoon, pre-monsoon, southwest, northeast and average annual rainfall data for the period 2006- 2015 were used for the preparation of spatial distribution contour map using geospatial technology and the data’s are given in figures 2 to 11 and in table.1.

Pre monsoon Season
During the pre-monsoon season, study area recorded an average rainfall of 453.83 mm. During this Season, the highest rainfall of 148.78 mm was recorded in Runneymedu station and the lowest rainfall of 43.79 mm was recorded in Gurrency station.

Post monsoon Season
During the post monsoon season, study area recorded an average rainfall of 1231.04 mm. During this Season, the highest rainfall of 347.22 mm was recorded in Coonoor station and the lowest rainfall of 162.43 mm was recorded in Gurrency station.

South-West Monsoon Season
During the South–West Monsoon season, study area recorded an average rainfall of 1435.73 mm. During this Season, the highest rainfall of 403.19 mm was recorded in Hilgrove station and the lowest rainfall of 236.31 mm was recorded in Aderly station.
North-East Monsoon Season
During the North-East Monsoon season, study area recorded an average rainfall of 2934.07 mm. During this Season, the highest rainfall of 953.93 mm was recorded in Coonoor station and the lowest rainfall of 351.38 mm was recorded in Mettupalayam station.

| Stations          | Post-monsoon | Pre-monsoon | SW monsoon | NE monsoon | Average Rainfall | Year |
|-------------------|--------------|-------------|------------|------------|------------------|-----|
| COONOOR           | 72           | 368         | 297.4      | 1430.6     | 542              | 2006|
| RUNNEYMEDU        | 56           | 392         | 346        | 1292       | 521.5            | 2007|
| HILGROVE          | 103          | 397.6       | 454        | 625        | 394.9            | 2008|
| GURRENCY           | 74           | 450.8       | 372        | 1094       | 497.7            | 2009|
| ADERLY            | 52           | 312         | 198        | 481        | 260.75           | 2010|
| METTUPALAYAM      | 7            | 277         | 107.9      | 571        | 240.725          | 2011|

Table 1: Average occurrences of rainfall during various seasons
| Stations       | Post-monsoon | Pre-monsoon | SW monsoon | NE monsoon | Average Rainfall | Year |
|---------------|--------------|-------------|------------|------------|------------------|------|
| METTUPALAYAM  | 235          | 191.30      | 75.90      | 593.70     | 273.97           | 2012 |
| COONOOR       | 14           | 214         | 206.6      | 925.10     | 339.93           |      |
| RUNNEYMEDU    | 0            | 264         | 194        | 698.6      | 289.15           |      |
| HILGROVE      | 0            | 196         | 161        | 650.2      | 251.80           |      |
| GURRENCY       | 0            | 128.9       | 309        | 625        | 265.73           |      |
| ADERLY        | 5            | 175.5       | 294.4      | 443.5      | 229.60           |      |
| METTUPALAYAM  | 18.40        | 123.70      | 126.50     | 359.60     | 157.05           |      |
| COONOOR       | 45.80        | 370.20      | 303.20     | 417.70     | 284.22           |      |
| RUNNEYMEDU    | 39.00        | 281.00      | 211.00     | 554.00     | 271.25           |      |
| HILGROVE      | 20.00        | 305.00      | 140.00     | 650.20     | 278.80           |      |
| GURRENCY       | 32.00        | 283.00      | 33.20      | 0.00       | 87.05            |      |
| ADERLY        | 36.00        | 255.50      | 222.00     | 501.00     | 253.63           |      |
| METTUPALAYAM  | 63.10        | 102.40      | 78.40      | 393.00     | 159.22           |      |
| COONOOR       | 108.20       | 283.40      | 277.60     | 913.20     | 395.60           |      |
| RUNNEYMEDU    | 94.00        | 299.00      | 486.40     | 1061.00    | 485.10           |      |
| HILGROVE      | 100.00       | 406.00      | 403.00     | 1080.00    | 497.25           |      |
| GURRENCY       | 0.00         | 0.00        | 0.00       | 0.00       | 0.00             |      |
| ADERLY        | 107.50       | 401.00      | 225.10     | 648.80     | 345.60           |      |
| METTUPALAYAM  | 46.40        | 185.30      | 0.00       | 0.00       | 57.92            |      |
| COONOOR       | 9.00         | 957.30      | 402.00     | 1034.40    | 600.68           |      |
| RUNNEYMEDU    | 0.00         | 800.50      | 374.00     | 774.00     | 487.13           |      |
| HILGROVE      | 0.00         | 500.00      | 299.00     | 818.30     | 404.33           |      |
| GURRENCY       | 0.00         | 0.00        | 0.00       | 0.00       | 0.00             |      |
| ADERLY        | 0.00         | 305.50      | 231.50     | 604.00     | 285.25           |      |
| METTUPALAYAM  | 0.00         | 0.00        | 0.00       | 0.00       | 0.00             |      |

**Fig.: 2 Annual Rainfall (in mm) 2006**

**Fig.: 3 Annual Rainfall (in mm) 2007**
Fig.: 4 Annual Rainfall (in mm) 2008

Fig.: 5 Annual Rainfall (in mm) 2009

Fig.: 6 Annual Rainfall (in mm) 2010

Fig.: 7 Annual Rainfall (in mm) 2011

Fig.: 8 Annual Rainfall (in mm) 2012

Fig.: 9 Annual Rainfall (in mm) 2013
It is observed from the figures 12 to 15 that the isohyetal maps of pre-monsoon is lesser than post monsoon. In these maps, the increasing order of intensity is noticed towards the coonoor rain gauge station. However, in NE monsoon isohyetal map shows that scenario is quite high with compare to other monsoons. Though the contribution of pre monsoon rainfall is too low, the intensity increases towards NE in the basin.

The rainfall is considered as one of the prime triggering mechanism. Mostly the landslides that are happening in this region as triggered by rainfall so as in any landslides in Tamilnadu. The high hills with steep slopes are controlled by newer evolution of the plateaus probably tectonic plateaus, bounded by N S- N E and SW lineaments. These differently oriented lineaments make the slope of the plateaus very much vulnerable to landslides. Moreover the plateaus are highly dissected, may be as a result of cumulative effects of all the tectonic events in this region. Higher degree of deformation and recrystallization makes the rocks break easily and ready to slide.

V. CONCLUSION

Monthly rainfall analysis concludes that the highest intensity of rain showers is recorded during the month of October, while the lowest intensity is usually recorded during January at all the six rain gauge stations. Analysis of seasonal rainfall concludes that the percentage contributions of rainfall during various monsoon periods are in the following order: NE monsoon (52.34%) > SW monsoon (23.66%) > Post-monsoon (16.70%) > Pre-monsoon (7.30%). Spatial distribution pattern of rainfall indicates that the intensity of rainfall increases towards NE monsoon. Lesser intensity was found in pre-monsoon with compare post-monsoon season.

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