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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 interpret tolated 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 Mettupalaym 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/15 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 km^2). 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, Lambs 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).

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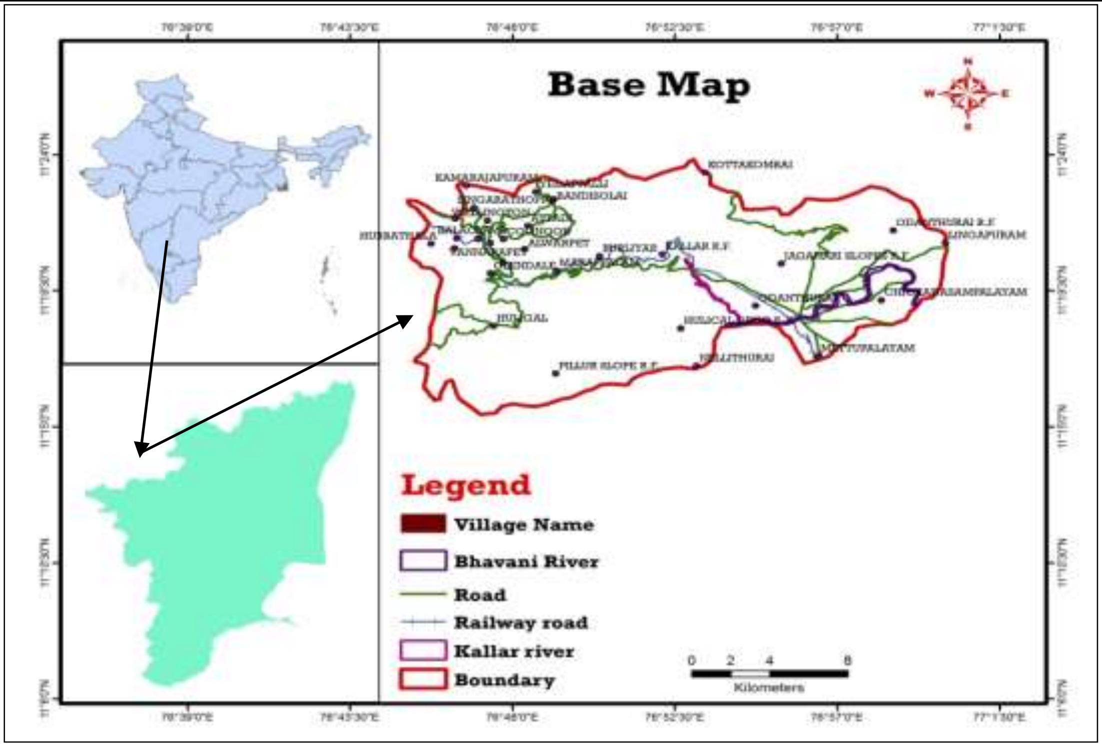

Fig.1: Study Area Base Map

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.

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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.

Table.1: Average occurrences of rainfall during various seasons

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	
HILGROVE	103	397.6	454	625	394.9	
GURRENCY	74	450.8	372	1094	497.7	
ADERLY	52	312	198	481	260.75	
METTUPALAYAM	7	277	107.9	571	240.725	
COONOOR	31.6	131.3	2038.1	662.8	715.95	2007
RUNNEYMEDU	85	143.8	773.8	350.9	338.375	
HILGROVE	166	348	1714.2	413.4	660.4	
GURRENCY	15.8	54	1470	519	514.7	
ADERLY	8	206.1	768.2	528.4	377.675	
METTUPALAYAM	33	96	173	314	154	
COONOOR	352.9	556.5	492.1	509	477.625	2008
RUNNEYMEDU	499	472	178.6	547.2	424.2	
HILGROVE	291.6	329.4	133.7	598	338.175	
GURRENCY	136.4	455.8	125	580.2	324.35	
ADERLY	236	316	172	422.6	286.65	
METTUPALAYAM	44	286	264	300	223.5	
COONOOR	10.2	190.9	371.4	1509.3	520.45	2009
RUNNEYMEDU	0	284	264	1473	505.25	
HILGROVE	0	257	251	541	262.25	
GURRENCY	0	200	142.7	106.4	112.275	
ADERLY	0	172	116.1	84.2	93.075	
METTUPALAYAM	0	249	153	378.7	195.175	
COONOOR	41.6	138.1	342.8	897.9	355.1	2010
RUNNEYMEDU	32	96	161.3	1551	460.075	
HILGROVE	7	117.5	134	709	241.875	
GURRENCY	4	14.8	104.8	438.6	140.55	
ADERLY	4.3	44.7	111.6	147.2	76.95	
METTUPALAYAM	16	159.2	209.20	603.90	247.08	
COONOOR	654.8	262.5	427.5	1239.3	646.025	2011
RUNNEYMEDU	682.8	161.4	273.5	1100.4	554.525	
HILGROVE	762.8	174.8	342	884	540.9	
GURRENCY	175.7	37	95.4	248.8	139.225	
ADERLY	27.2	24.3	24.2	393.1	117.2	

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Stations	Post-monsoon	Pre-monsoon	SW monsoon	NE monsoon	Average Rainfall	Year
METTUPALAYAM	235	191.30	75.90	593.70	273.97	
COONOOR	14	214	206.6	925.10	339.93	2012
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	2013
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	2014
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	2015
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	

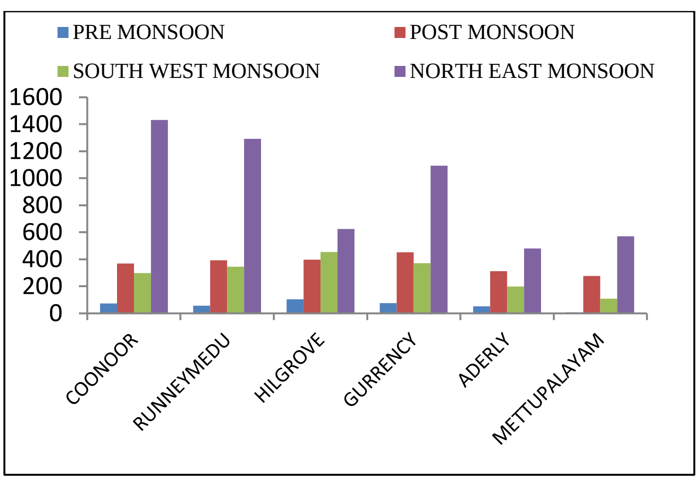

Fig.: 2 Annual Rainfall (in mm) 2006

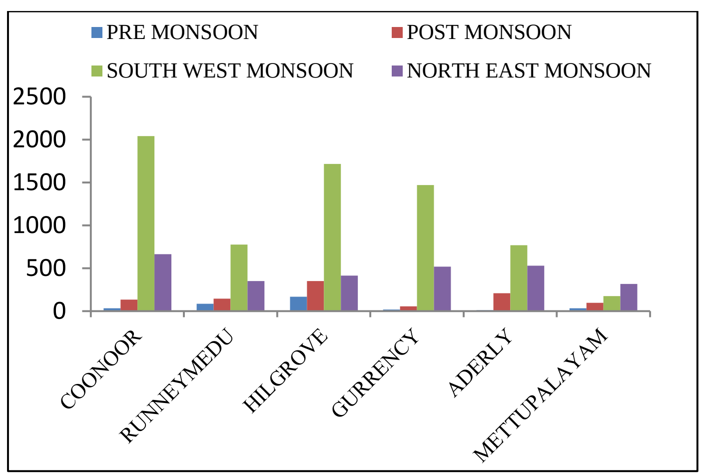

Fig.: 3 Annual Rainfall (in mm) 2007

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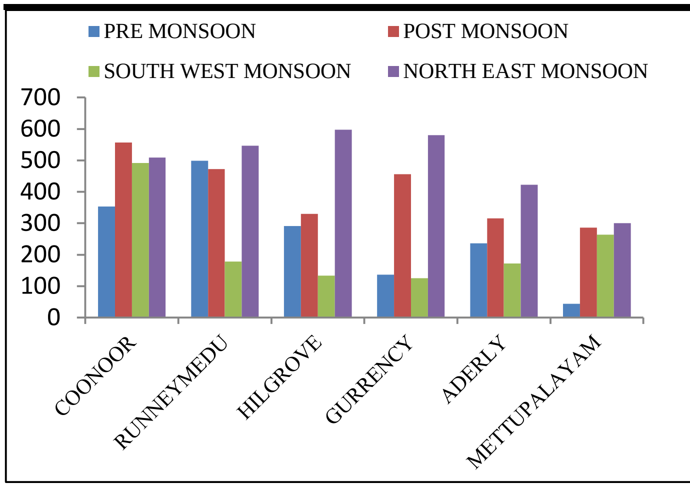

Fig.: 4 Annual Rainfall (in mm) 2008

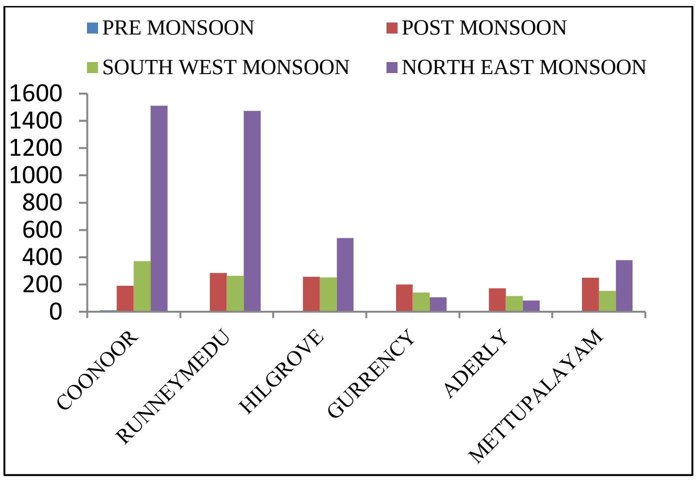

Fig.: 5 Annual Rainfall (in mm) 2009

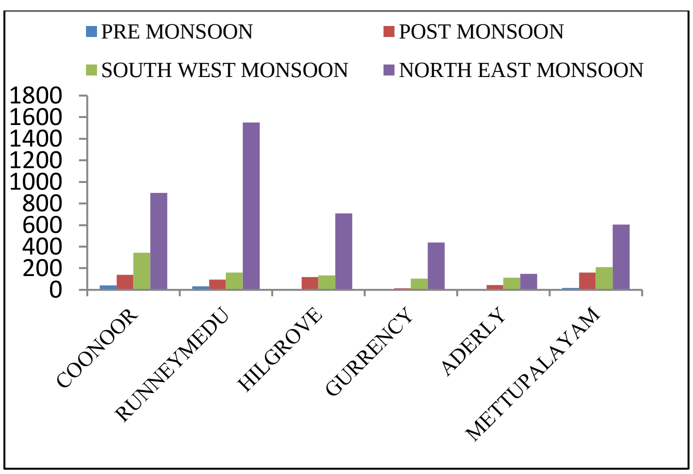

Fig.: 6 Annual Rainfall (in mm) 2010

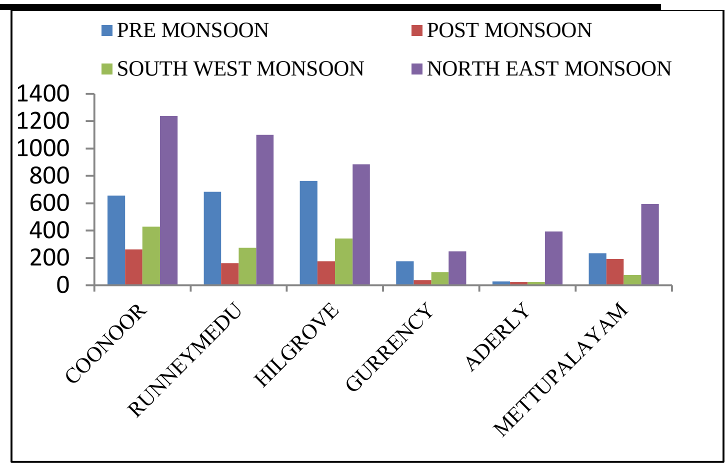

Fig.: 7 Annual Rainfall (in mm) 2011

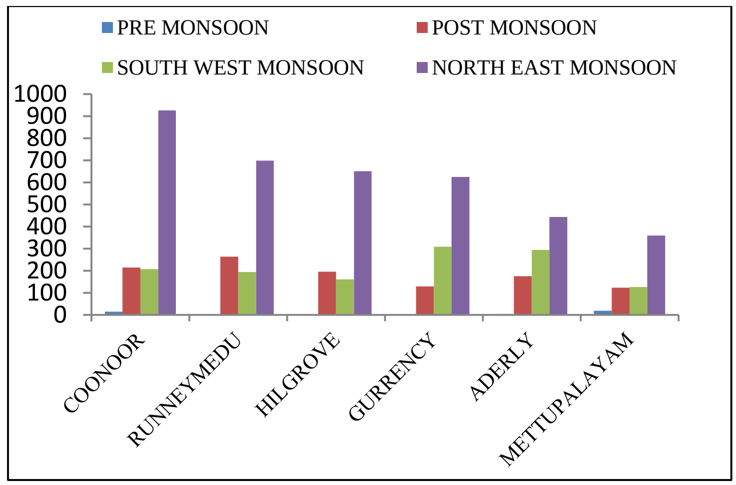

Fig.: 8 Annual Rainfall (in mm) 2012

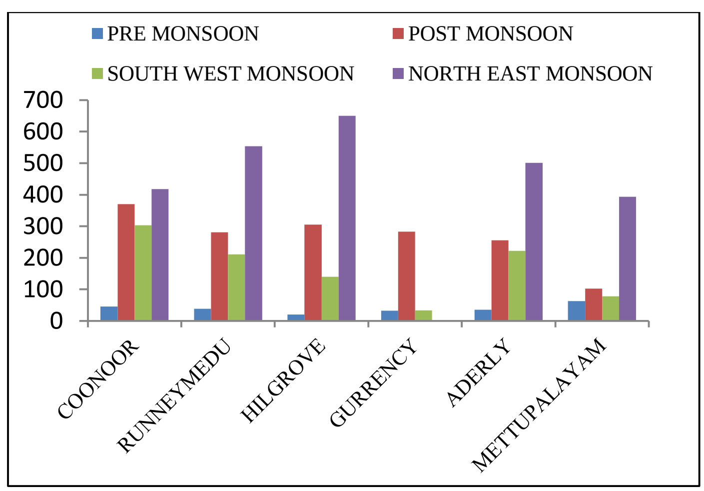

Fig.: 9 Annual Rainfall (in mm) 2013

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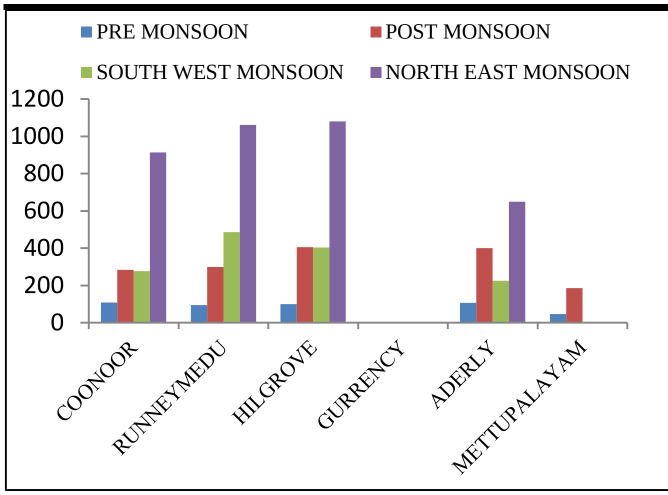

Fig.: 10 Annual Rainfall (in mm) 2014

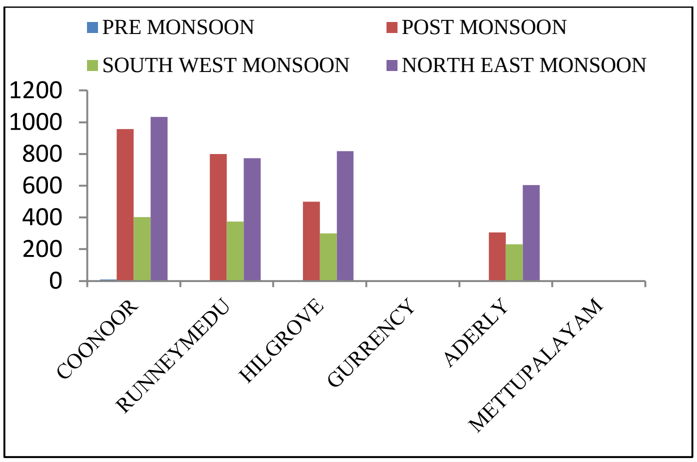

Fig.: 11 Annual Rainfall (in mm) 2015

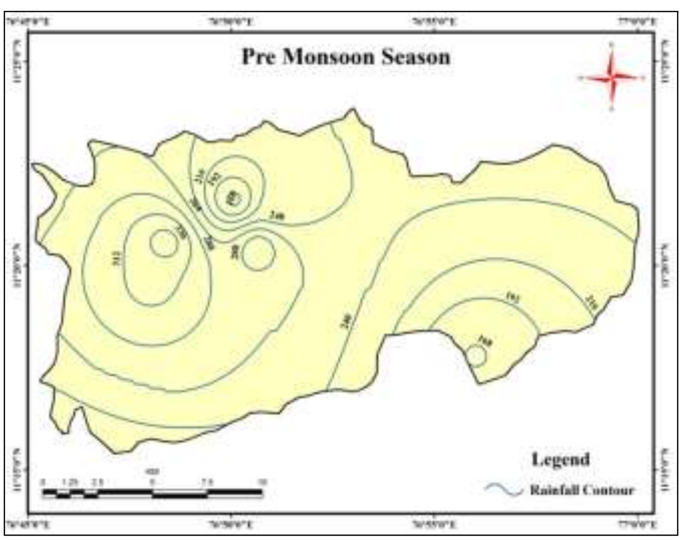

Fig.: 12 Rainfall contour Pre monsoon

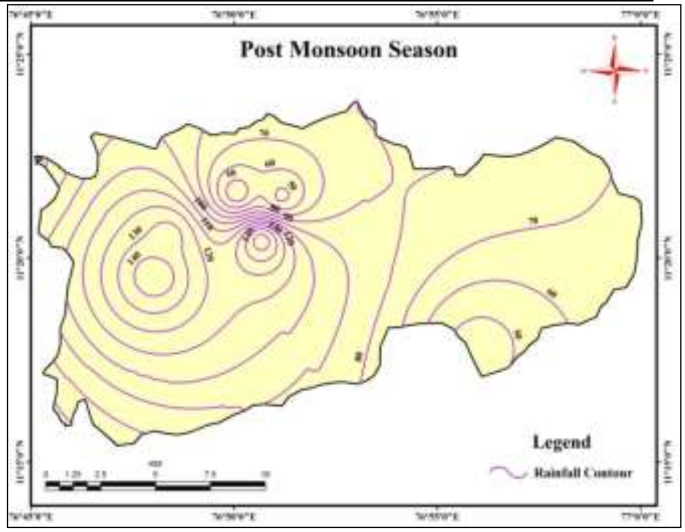

Fig.: 13 Rainfall contour Post monsoon

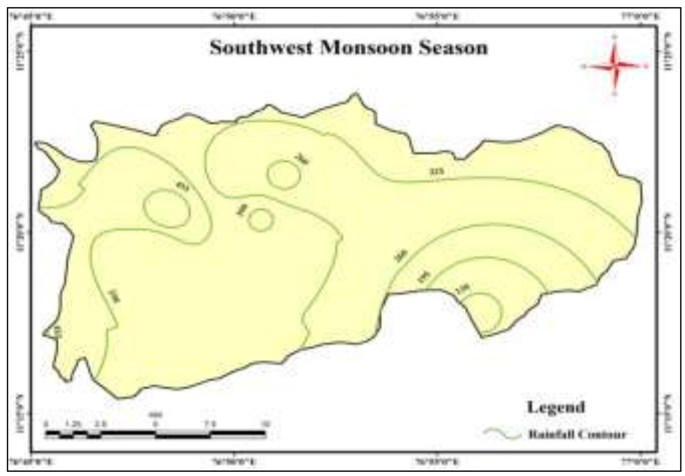

Fig.: 14 Rainfall contour south west monsoon

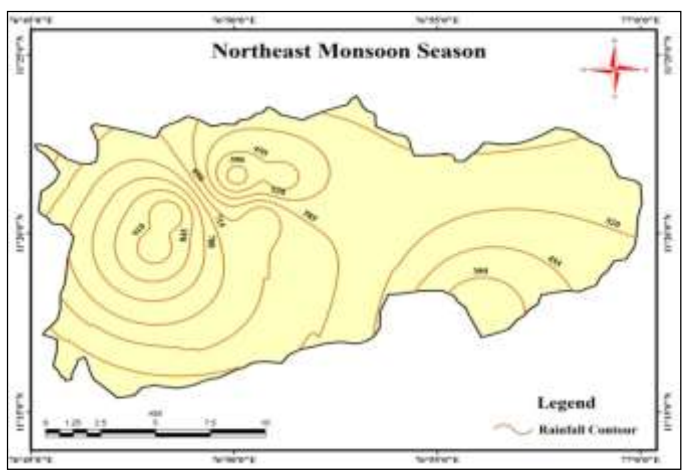

Fig.: 15 Rainfall contour north east monsoon

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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