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Geospatial Distribution of Rainfall Variability using GIS at Thirumanimuttar River Sub Basin Cauvery River South India

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ABSTRACT: *Rainfall is the major source in the form of precipitation causing stream flow in a majority of rivers in India. In the present study, an attempt has been made to assess the rainfall variation by geospatial distribution in Thirumanimuttar River Sub Basin of Cauvery River, South India. To achieve the aim of rainfall variations during Winter, Summer, Southwest Monsoon and Northeast Monsoon seasons were analyzed for a period of 12 years from 2000 to 2011. The spatial distribution maps were prepared by using GIS. The spatial distribution maps of Southwest- and Northeast monsoon season showed that 1802.78 km^2 and 2033.28 km^2 of the study area received high rainfall during the respective monsoon seasons. Annual average rainfall spatial distribution map for the years 2000-2011 revealed that 74.43 km^2 fell under high rainfall zone in the study area. rainfall is not sufficient for irrigation as well as domestic purposes due to the deforestation. The results suggest that to develop the dense forest in the hilly region.*

Key Words: *Rainfall, Monsoon Season, Variability, Thirumanimuttar, GIS*

INTRODUCTION

Many studies on rainfall variability had been used data at relatively in all resolutions based on global climate models , monthly, seasonal and annual rainfall totals (e.g. Richard and Poccard 1998; Landman *et al.* 2001; Thiamand Singh 2002; Bartman *et al.* 2003). The identification of extreme rainfall is the main function of any rainfall study also to highlight rainfall extremes with the data resolution (Williams *et al.* 2007). Identification of extreme daily rainfall at high spatial resolution is important, because of rainfall variability and extremes have impacts on society. We can see that developing countries suffer more from extreme rainfall events than developed countries because, being environmentally and socio economically vulnerable before the extreme event occurs, developing countries are more sensitive to such disasters. Examining and establishing the availability and accessibility of groundwater under changing boundary conditions is the main work of Integrated Water Resources Management (IWRM) because groundwater is a major drinking water resource and critical for irrigation in many parts of the world (Villholth, 2006; Holman, 2006). The objectives of IWRM namely to provide water in sufficient quantity and quality justifiably to different consumers and at the same time to maintain and guarantee a sustainable qualitative and quantitative status of the groundwater resource itself (Hiscock *et al.* 2002). It is stated that 'good status' of groundwater refers to its role in water supply (drinking water, irrigation water, industrial use, etc.) but it also has a typical role in long term reservoir to cater the need for aquatic ecosystems(wetlands) and to provide a source of discharge in dry seasons.

Geographic Information System is an important technology for geologists (Baker and Case 2000). It has emerged as a powerful technology for many researchers (Openshaw 1991; Longley 2000; Sui and Morrill 2004).

Study Area

The study area, Thirumanimuttar River Sub Basin of Cauvery River, South India lies between the North Latitudes 10^{0}58′ and 11^{0}50′ and East Longitudes 77^{0}53′ and 78^{0}23′covering an area of 2432 km^2. (Figure 1). The study area falls in Salem and Namakkal districts of Tamil Nadu. The major source for recharge of water in this area is rainfall, during monsoon seasons. The average annual rainfall is 737.50 mm based on 12 years average (2000 to 2011). The study area is surrounded by many hills and hillocks and composed of Archean crystalline rocks

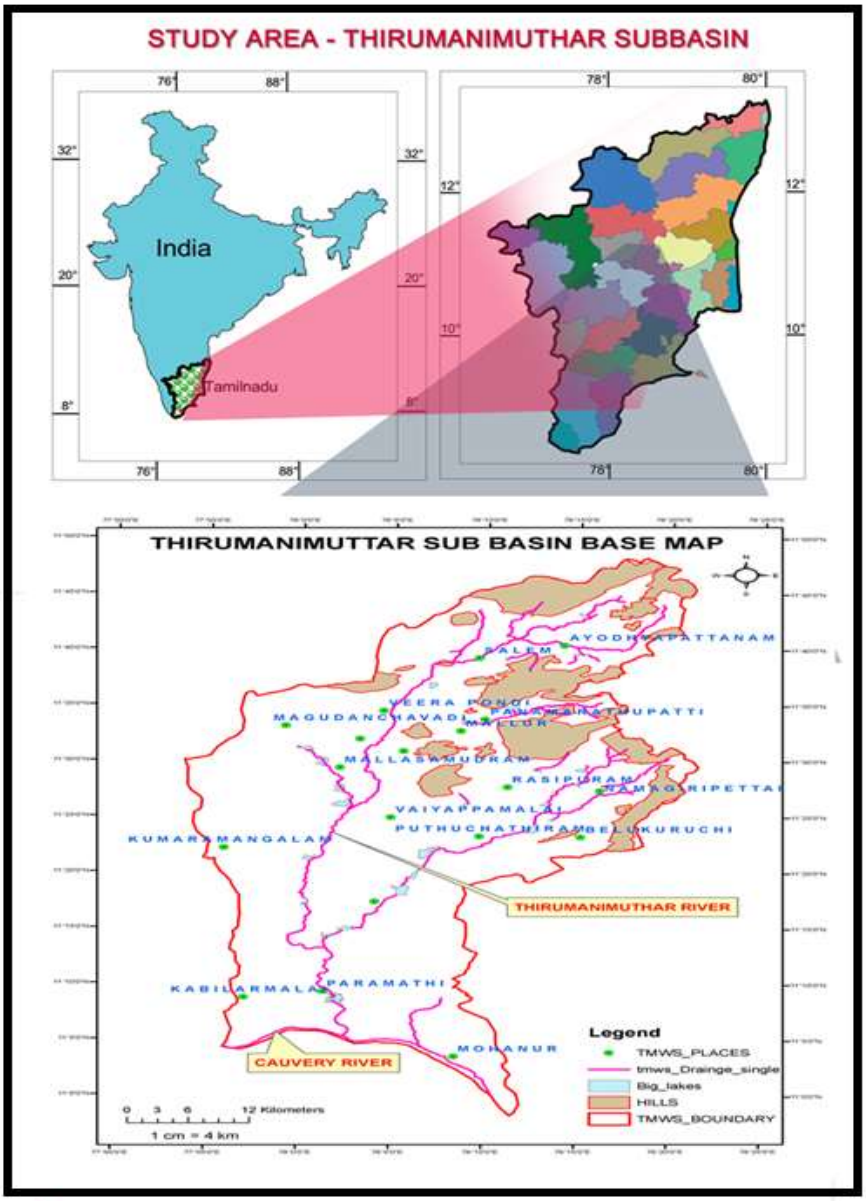

FIG.1-LOCATION MAP OF THE STUDY AREA

MATERIALS AND METHODS

The daily rainfall data obtained from Public Work Department (PWD), Government of Tamil Nadu and used to find out average seasonal rainfall like Winter (January and February), Summer (March, April and May), South West (June, July, August and September), and North East (October, November and December) monsoon rainfall. Finally, the average annual rainfall for the last twelve years was calculated. The 12-year rainfall data (2000 – 2011) were calculated in nine rainfall stations at Salem, Salem Junction, Anaimadvu, and Yearcaud, Valapadi, Namakkal, Mohanur, Rasipuram, Senthamangalam, Paramathivelur, Thiruchencode spread over the study area. By using the daily rainfall data, month wise and seasonal wise average rainfall data were calculated. Finally using the above, the annual average rainfall was calculated and interpreted. ARC GIS 9.3.1 software was employed to find out the spatial distribution of the rainfall variation in the study area,. The corresponding values (Averages of winter, summer, southwest, northeast and annual average rainfall) with all attributes were given as an input to the spatially referenced rainfall locations. By using this data, the interpolated raster maps were classified with respect to our interest and converted into vector maps. Finally all the maps were clipped with the boundary of the study area.

RESULTS AND DISCUSSION

The following stations Salem, Salem junction, Anaimadvu, Valapadi, show a moderate rainfall and the remaining stations namely Mohanur, Rasipuram, Senthamangalam, Paramathivelur, and Thiruchencode show a low rainfall. Where as Yercaud station showed a good response of rainfall because of higher elevation.Using the 12 years (2000 to 2011) data collected from The Public Work Department (PWD) of Government of TamilNadu (Table 1 and

Figure 2) the results were interpreted. The maximum rainfall occurred in 2005, and minimum rainfall occured in 2002. The average Southwest monsoon rainfall is 271.06 mm, and average Northeast monsoon rainfall is 333. 38mm. In summer and winter season, the average rainfall is 8.54 mm and 102 mm. The Table 2 and Figure 3 are used for illustration.

Table 1: Tamilnadu Average annual rainfall data in mm (2000 – 2011)

YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AVERAGE RAINFALL (mm)	847.50	774.70	748.40	867.80	1126.27	1386.22	956.37	1018.58	1251.94	982.48	1190.07	1062.87

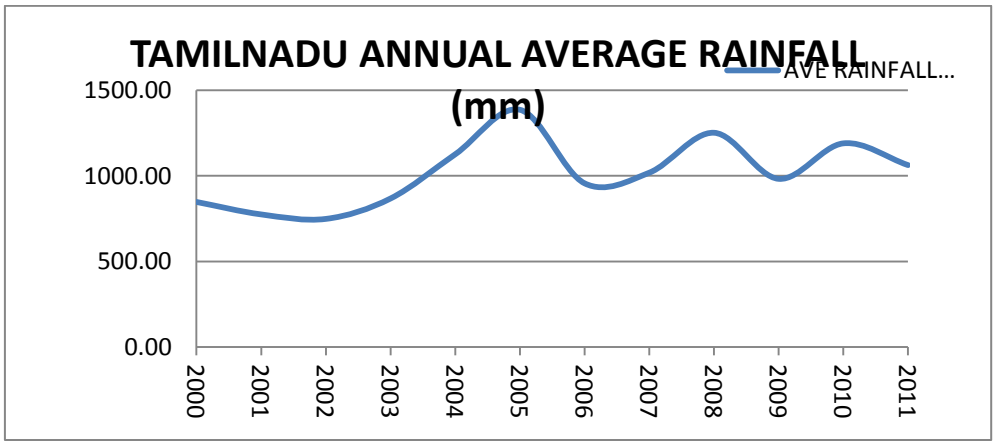

FIG.2-TAMILNADU ANNUAL AVERAGE RAINFALL

Table 1a: Average annual rainfall data in the Study area in mm (2000 – 2011)

YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AVERAGE RAINFALL (mm)	680.76	617.52	474.48	718.37	851.31	1152.26	776.69	719.64	715.57	487.68	874.93	780.80

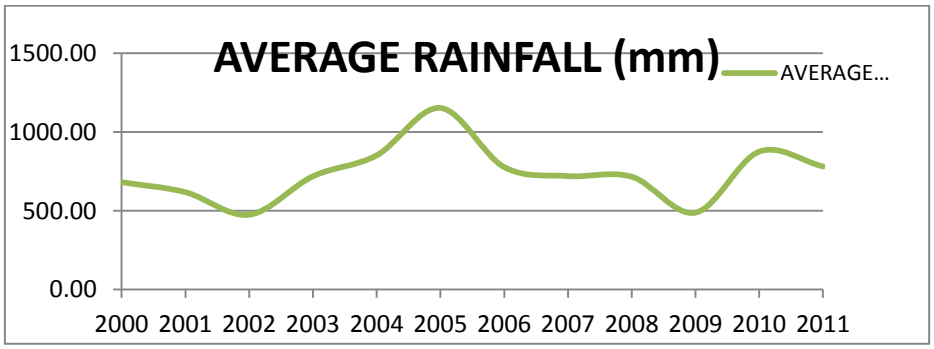

FIG.2a - ANNUAL AVERAGE RAINFALL OF THE STUDY AREA

Table 2: 12 years (2000-2011) Average annual seasonal rainfall data in mm

Stations	Winter season	Summer season	South west monsoon	Northeast Monsoon
Salem	3.86	154.23	268.56	405.64
SALEM JUNCTION	17.98	197.53	273.44	272.73
ANAIMDVU_RES	3.58	140.50	273.44	390.35
YERCAUD	16.62	243.56	420.00	616.42
VALAPADI	1.78	106.62	198.88	337.20
NAMAKKAL	7.73	175.00	305.95	285.49
MOHANUR	4.30	131.33	194.73	323.33
RASIPURAM	23.87	171.03	351.99	224.73
SENTHAMANGLM	6.92	114.77	294.44	250.43
PARAMATHIVLR	2.83	90.63	155.36	248.76
TIRUCHENGODE	4.50	161.93	244.92	312.07
AVERAGE	8.54	153.37	271.06	333.38

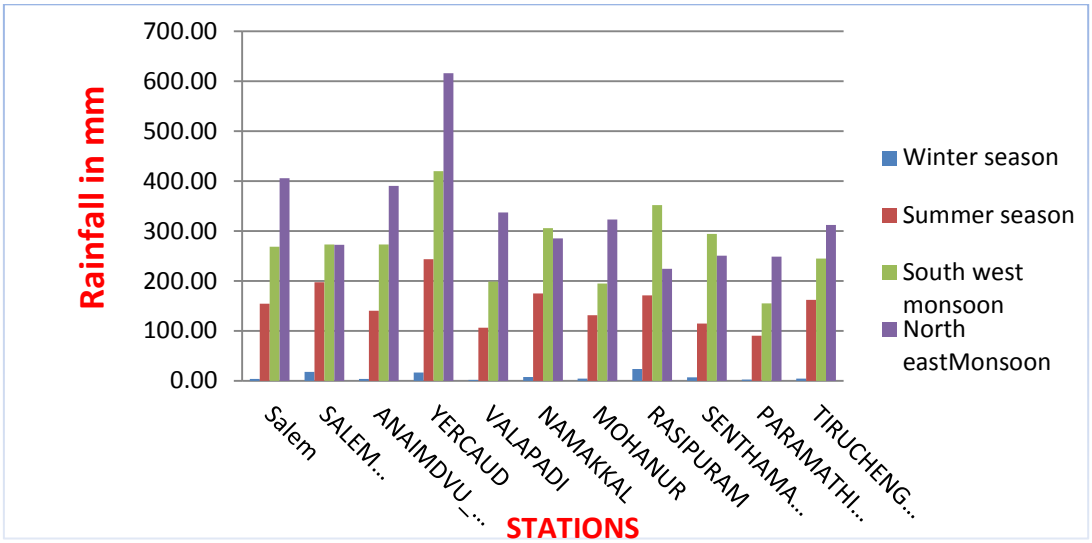

FIG.3 Season wise graph of rainfall for the period of 12 years from 2000 to 2011

GIS Results

The modern Geographic Information Systems are chracterised by more analytical techniques and tools to integrate the study of locations with their spatial dimension and their associated attributes like table analysis, classification, polygon classification and weight classification. As described above The Winter, Summer, Southwest monsoon Northeast monsoon and Annual average rainfall thematic maps have been prepared and converted into raster form considering 30m as cell size to achieve considerable accuracy. These were then reclassified and assigned suitable weightage and spatial distribution results (Table 3). The spatial distribution maps show The results of winter season, summer season, southwest monsoon season, northeast monsoon and average annual rainfall data for the period 2000-2011. GIS spatial distribution maps with their results are shown in Figure 4 to 8 and given Table 3.

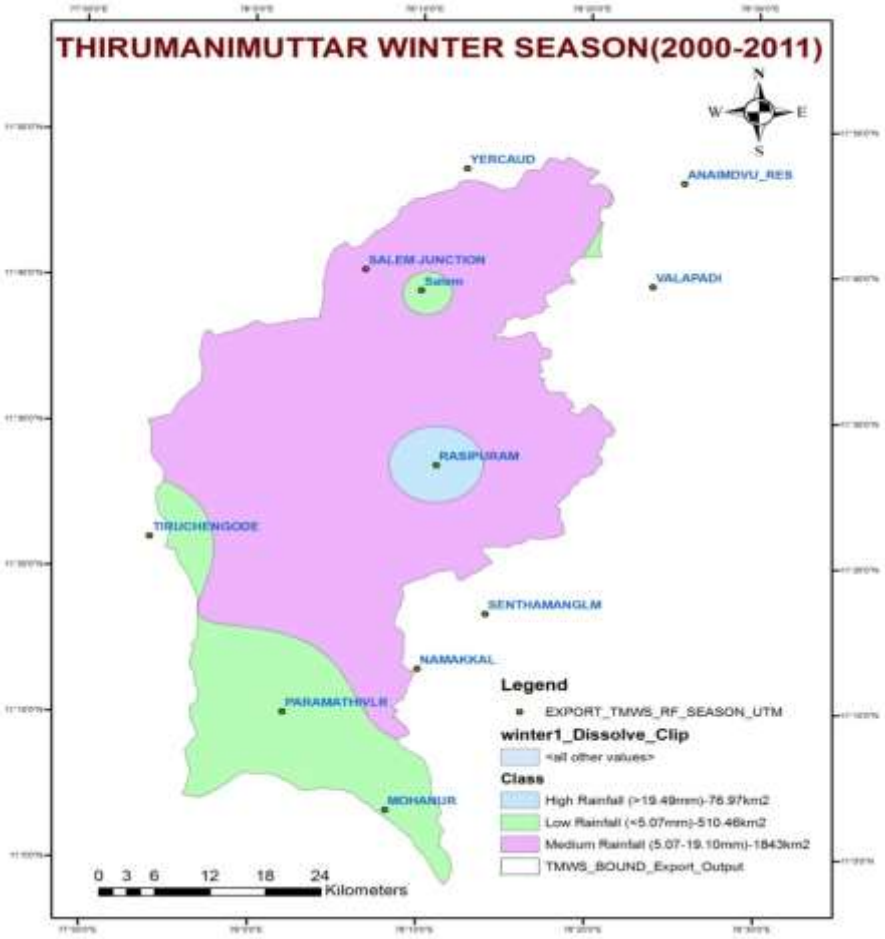

Figure 4: Annual average rainfall Winter Season – Spatial Distribution Map

The spatial distribution map of winter season shows that 76.97 km^2 fell in the high rainfall zone and 1843km^2 area falls in a medium rainfall zone (Figure 4). The high rainfall area is located in near to the elevated hill and forest.

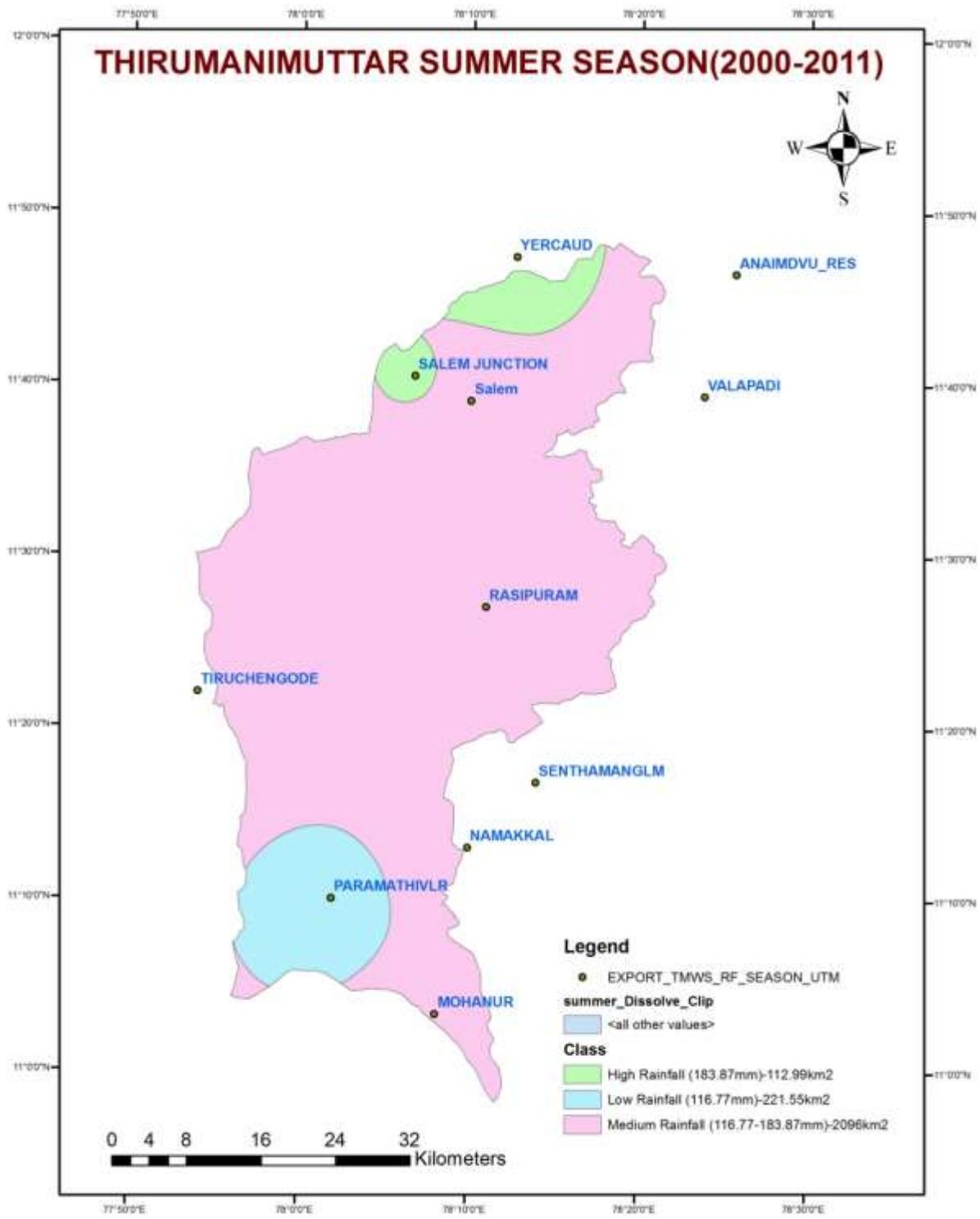

Figure 5: Annual average rainfall Summer Season – Spatial Distribution Map

The spatial distribution of Summer season reveals that nearly 112.99 km^2 fell in the high rainfall area and 2096 km^2 area falls in the medium rainfall category zone (Figure 5). The high rainfall area is located in Yercaud hills.

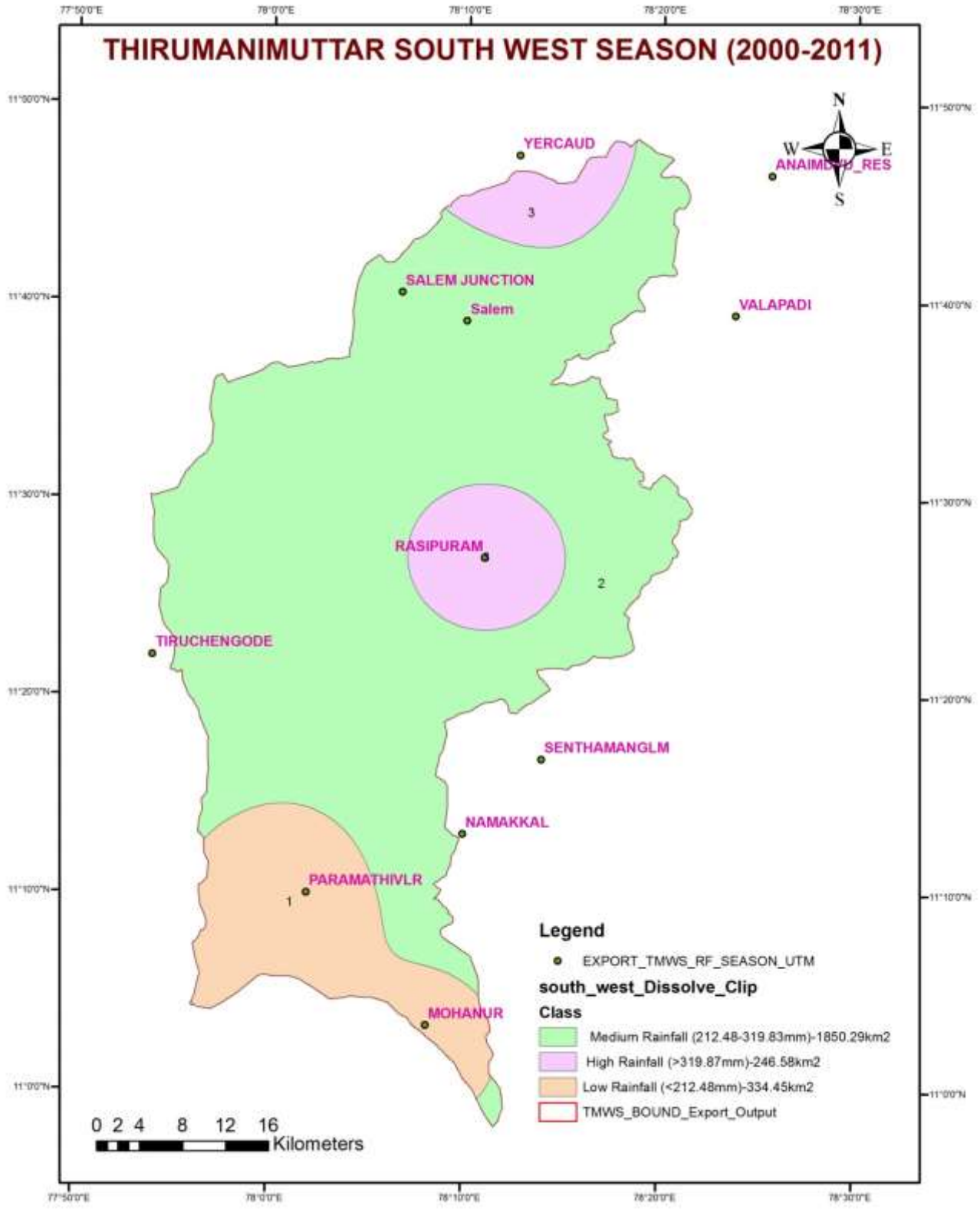

Figure 6: Annual average rainfall Southwest Monsoon Season – Spatial Distribution Map.

The spatial distribution of southwest monsoon (Figure 6) reveals that nearly 1850km^2 area falls in the high rainfall zone , 246.58 km^2 area falls in medium rainfall zone and 334.45km^2 falls in the low rainfall zone . The high rainfall zone is including Yercaud and Rasipuram areas,

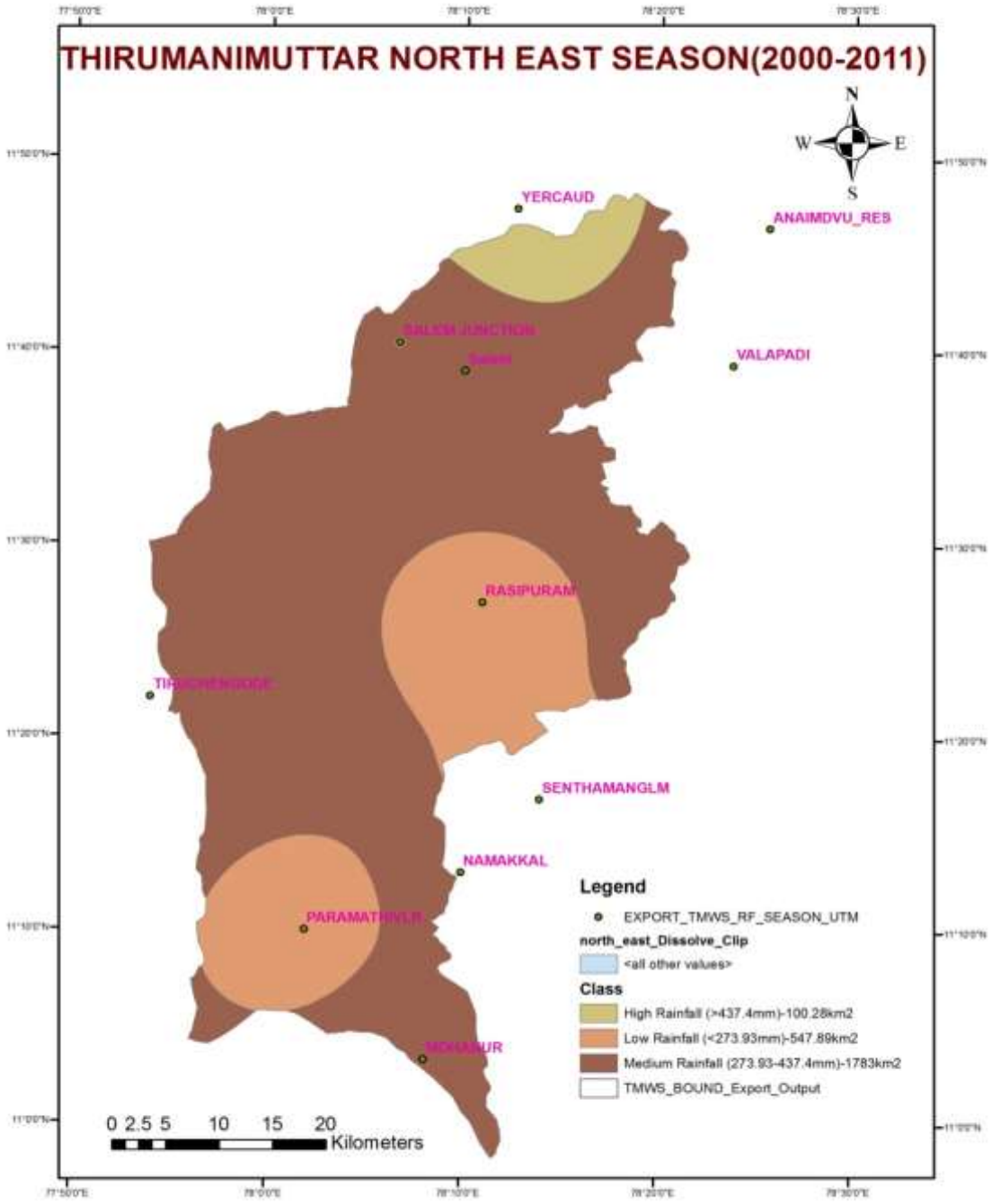

Figure 7: Annual average rainfall Northeast Monsoon Season – Spatial Distribution Map

The spatial distribution of Northeast monsoon reveals that 100. 28km^2 falls in the high rainfall zone, 1783 km^2 area falls in medium rainfall zones and rest of the area 547 km^2 falls in low rainfall zones.

Table 3: 12 years (2000-2011) Average seasonal rainfall data spatial distribution results

SI.NO	Rainfall Seasons	Class Category	Area in km^2	Area in %
1	Winter	High Rainfall	76.97	3.16
		Medium Rainfall	1843.89	75.84
		Low Rainfall	510.46	20.99
2	Summer	High Rainfall	112.99	4.64
		Medium Rainfall	2096.77	86.25
		Low Rainfall	221.56	9.11

3	SW Monsoon	High Rainfall	246.58	10.14
		Medium Rainfall	1850.29	76.11
		Low Rainfall	334.45	13.75
4	NE Monsoon	High Rainfall	100.28	4.12
		Medium Rainfall	1783.15	73.35
		Low Rainfall	547.89	22.53
5	ANNUAL AVERAGE	High Rainfall	144.03	5.92
		Medium Rainfall	1891.20	77.79
		Low Rainfall	396.10	16.29

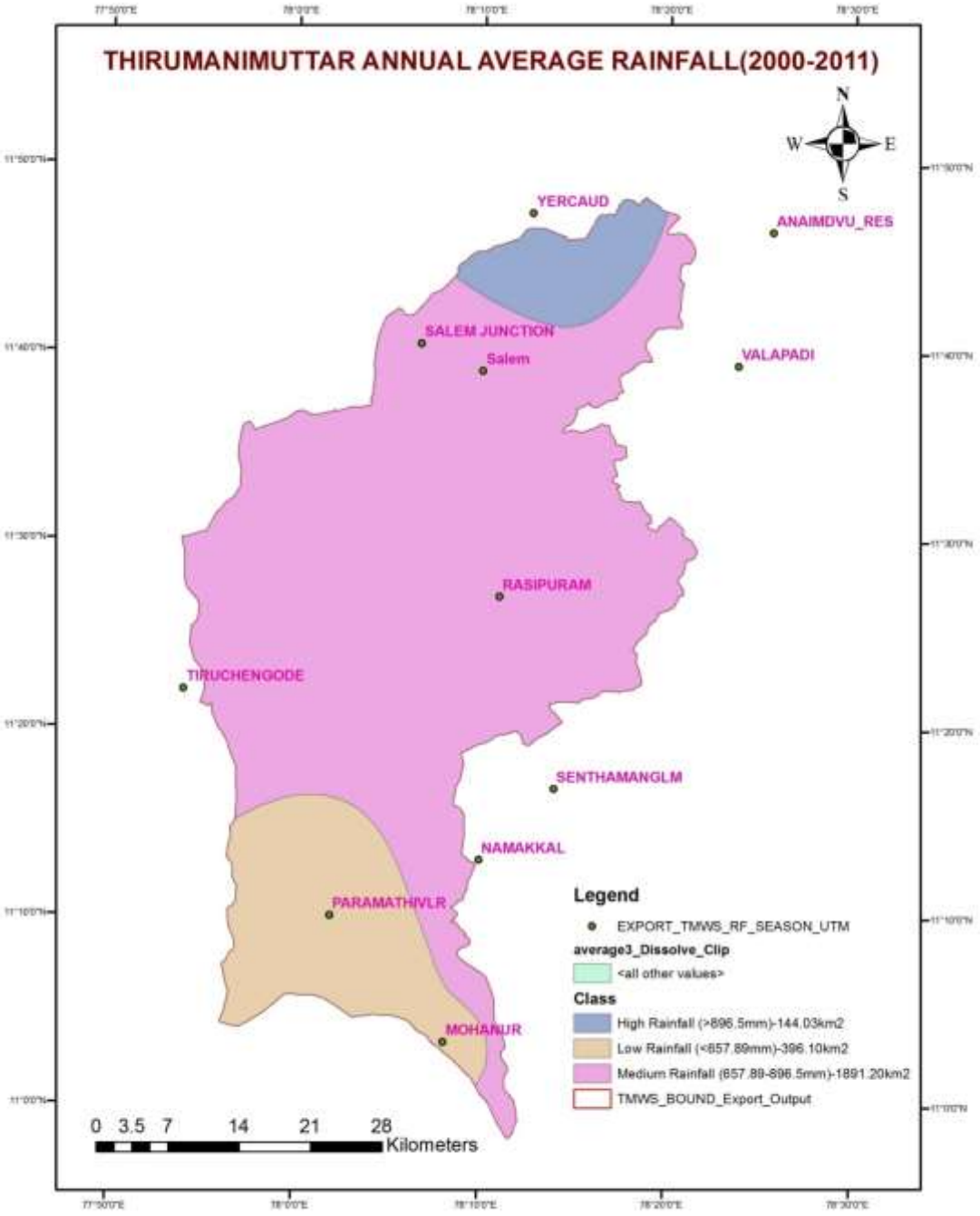

Figure 8: Annual average rainfall– Spatial Distribution Map

The spatial distribution of Average annual rainfall result shows that spatially 144.03 km^2 area falls in high rainfall zones and 1891.20 km^2 area falls in moderate rainfall zones and the remaining area of 396.10 km^2 falls in low rainfall zones. High rainfall spatially occupied by hilly region of Northern part of the study area.

CONCLUSION

In this study the advanced Tools and analytical techniques of modern Geographic Information System are highly useful to delineate the zones of rainfall variability with three categories like High ,Medium and Low rainfall zones. We can understand that, the spatially distributed 1850.29 km^2 received higher amount of rainfall during Northeast monsoon season and they witnessed the precipitation for 76.11%. The study has also seen the high amount of rainfall water received only during monsoonal season. The Non-monsoonal season has seen only a meager amount of rainfall. We have found that this study area is devoid of rainfall and it is not sufficient for irrigational as well as domestic purposes. It is suggested that the study area should develop forest along the hilly regions for more precipitation in the future.

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