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RESEARCH ARTICLE

The High/Low Rainfall Fluctuation Mapping through GIS Technique in Kodaikanal Taluk, Dindigul, District, Tamil Nadu.

Dr. M. BAGYARAJ, M. BHUVANESWARI and B. NANDHINI PRIYA

Department of Civil Engineering, Gnanamani College of Engineering, NH-7, A.K Samuthiram, Pachal, Namakkal - 637 018

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*Corresponding Author

Dr. M. BAGYARAJ

Abstract

The study of rainfall pattern is very important for the agricultural planning of any region. Monsoon depressions and cyclonic storms are the most important synoptic scale disturbances which play a vital role in the space – time distribution of rainfall over India. In the present study, an attempt has been made to understand the rainfall fluctuation study through GIS Technique in Kodaikanal Taluk, Dindigul Dist. Tamil Nadu. The study area highlights the rainfall variation with respect to spatial distribution for the GIS. The rainfall data for the period of 2005 to 2014 were collected in the Statistical Department wing (PWD) Govt. of Tamil Nadu. The rainfall data were assessed for all the seasons. These results were taken into GIS platform to prepare the spatial distribution maps. Winter, Summer, Southwest and Northeast monsoon seasons spatial distribution maps result reveals that 996.13 km², 969.97 km², 1004 km² and 983.39 km² area falls in high rainfall received shadow zone respectively. Last 10 years (2005 to 2014) annual average rainfall spatial distribution map result reveals that 993.71 km² areas fell under high rainfall shadow zone with more than 261 mm rainfall. It shows the annual average rainfall distribution is very high in the study area. The high rainfall domain occupies 84.9 % of the study area.

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INTRODUCTION

The study of rainfall pattern is very important for the agricultural planning of any region. Monsoon depressions and cyclonic storms are the most important synoptic scale disturbances which play a vital role in the space – time distribution of rainfall over India (Sikka, 1977). Water is the renewable resource and the per capita availability in India is fairly good. Present study area receives only two seasonal rains but sometimes the seasonal rainfall becomes inadequate. During such times the domestic, agricultural and industrial requirements are met by increased in sub-surface water. Since groundwater is a major drinking water resource and critical for irrigation in all parts of the world, evaluating and predicting the availability and accessibility of groundwater under changing boundary conditions is one of the central tasks in integrated water resources management (IWRM) (Villholth, 2006; Holman, 2006). IWRM with respect to groundwater has two main objectives namely to provide water in sufficient quantity and quality equitably 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). A 'good status' of groundwater refers to its function in water supply (drinking water, irrigation, industrial use etc.) but also to its role as a long term reservoir to sustain aquatic ecosystems (wetlands) and to provide a source of discharge in dry periods. India is a tropical country its agricultural planning and utilization water is depends on monsoon rainfall, more than 75% of rainfall accruing during the monsoon season; Monsoon rainfall is uneven both in time and space, so it is important

factors to evolving the rainfall analysis. Jagannadhasarma (2005) has analysed the rainfall pattern of the coastal zone of Krishana Godavary River Basin Andhra Pradesh, India. He has made analysed the annual, monsoon and monsoon rainfall and spatial and frequency distribution of rainfall intensity and G.Vennila (2007) has analysed rainfall variation analysis of Vattamalaikarai subbasin, Tamil Nadu, India. He has interpreted monthly, seasonal variation, intensity and frequency of rainfall.

Climate plays a dominant role in agriculture having a direct impact on the productivity of physical production factors, for example the soil's moisture and fertility. Adverse climate effects can influence farming outputs at any stage from cultivation through the final harvest. Even if there is sufficient rain, its irregularity can affect yields adversely if rains fail to arrive during the crucial growing stage of the crops (Smith and Skinner, 2002; Molua and Lambi, 2007; Rudolf and Hermann, 2009).

According to Oloaoye (1999), regular occurrence of drought as a result of erratic rainfall distribution and/or cessation of rain during the growing season reduce Nigeria's capability for increased crop production. Sdoodee and Rongsawat (2012) concluded that high rainfall tended to decrease tapping days per year. From the results, it was suggested that climate change and climate variability in Songkhla province tends to reduce latex yield because of an increase of rainfall leading to a reduction of tapping days.

Study Area

Study area (Fig. 1) is located in the Dindigul district of Kodaikanal hill, which is a mountainous terrain in the Western Ghats of Tamil Nadu, with an area of 1039.46 km². It is geographically located between 77° 14' 26" and 77° 45' 28" E longitudes and 10° 6' 25" and 10° 26' 54" N latitudes. In the survey of India toposheet, it forms part of 58 F/7, 8, 11 & 12 on 1:50,000 scale. It is widely hailed as the "Princess of Hill Stations" owing to the popularity it gained during British Raj. The climatic condition of the study area is characterized by humid conditions. Relative humidity is high during retreating north-east monsoon season (October to mid December). The mean temperature of Kodaikanal taluk is 15.930 C with a mean summer (June, July and August) temperature of 17.290 C and mean winter (December, January and February) temperature of 14.100 C. The average annual rainfall is 993.71 mm. The study area is fully covered by hills. The plain area forms a small part. The hilly area is in the form of undulating terrain and slope towards south-southeast and east. The maximum elevation is 2517 m, located in the southwest portion. The study area is rich in biodiversity and has variety of endemic Shola forests. The settlements are created on the manmade terraces and are densely populated in isolated pockets. Geologically the area covered under charnockite, granitic gneiss, laterite and anorthosite among these rock types, the charnockite are found over large area in 837.90 km². The granitic gneisses cover less area in (195.58 km²) and observed in the southeastern portion. The other rock types namely anorthosite (3.59 km²) and laterite (2.34 km²) are distributed over very small areas and observed in the northeastern portion of the study area.

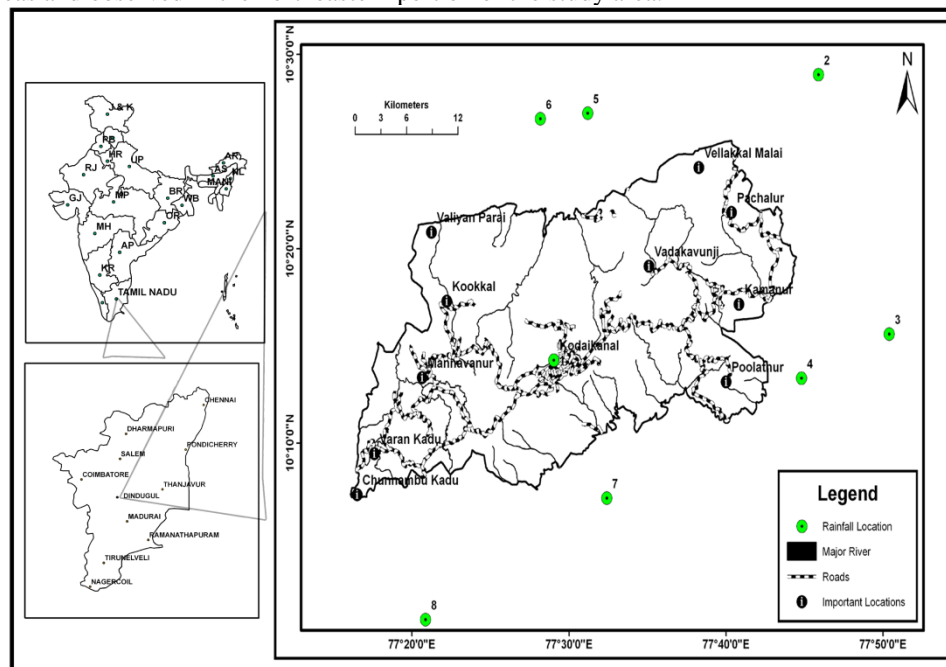


Figure 1: Study Area

The lineaments of the study area were assigned for satellite data product. The study area is crisscrossed by major and minor lineament. They vary in length from a few meters to kilometers, 586 lineaments were identified in the study area. General trend of the lineaments present in the study area are oriented in NE-SW and NNE-SSW directions.

METHODOLOGY

The Dindigul District monthly rainfall data were collected from the Public Works Department (PWD), Surface and Groundwater Division, Govt. of Tamil Nadu. The monthly rainfall data are converted into yearly and annual average seasonal like winter (January and February), summer (March, April and May), southwest (June, July, August and September), and northeast (October, November and December) monsoon based on India Meteorological Department (IMD), Chennai. From this, the annual rainfall for the last ten years (2005 – 2014) was calculated. The rain gauge stations of the Kodaikanal, Chettiankotai, Ayyampalayam, Oddanchatram, Palani, Neykkarappatti, Periyakulam and Bodinayakkanur. To find out the spatial distribution of the rainfall variation in the study area, GIS was employed. The rainfall (GPS Location) location was digitized and the corresponding values (Annual Average, winter, summer, southwest, and Northeast Monsoon Rainfall) of its attributes are added and analyzed in ArcGIS version 9.3 software. Spatial analysis tools were used for the preparation of interpolation raster map. The maps were interpolated in raster format by using inverse distance methods. Subsequently, these maps were classified with respect to more than mean (High rainfall shadow zone), less than mean (low rainfall zone) and moderate category is between less than mean and more than mean. These raster maps were converted into vector maps. These maps were clipped with the boundary to derive within the boundary of the study area. The rainfall data interpretation work flow and rain gauge stations map was given below in Fig. 2

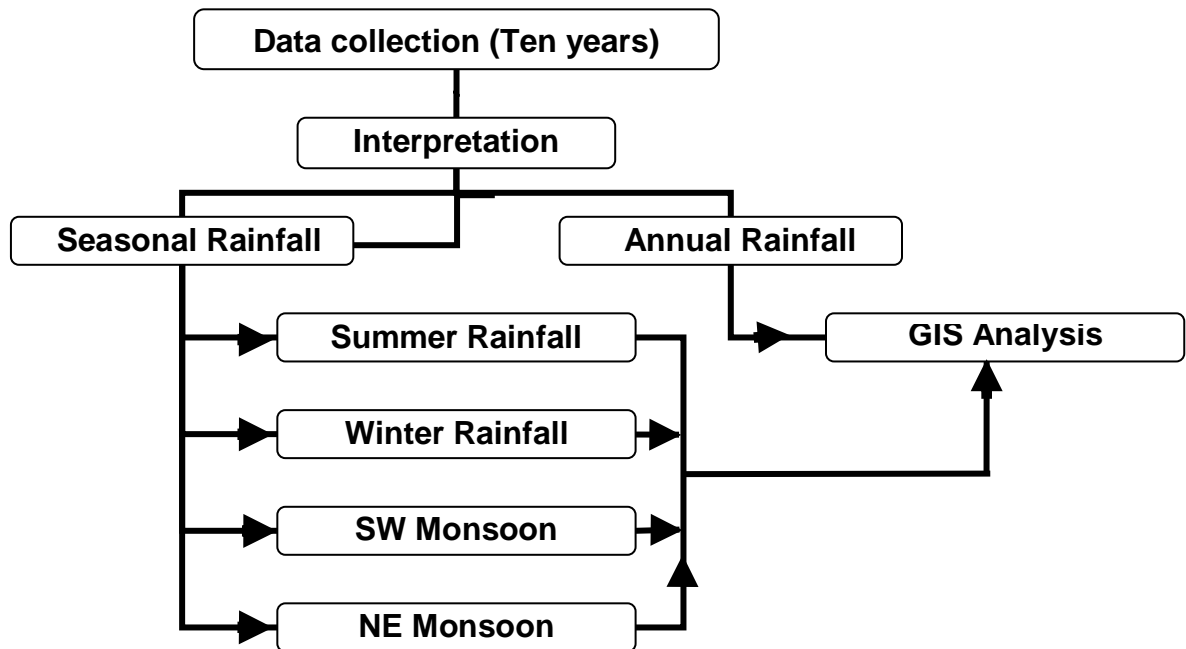


Figure 2: Flow Chart - Methodology Adopted for Rainfall Data Assessment

Result and discussion

10 years (2005 – 2014) data interpretation results are shown in Table 1 and Fig 3. High rainfall is noticed in the year 2011, low rainfall noticed in the year 2009. The average Northeast monsoon rainfall is 404.9 mm, and average Southwest monsoon rainfall is 189.4 mm. In summer and winter season, the average rainfall is noticed as 150.4 mm and 21.7 mm respectively. Average annual rain fall is of 191.6 mm (Table 2 and Fig 4).

Eight rainfall stations were noticed; out of eight stations, two stations i.e. Kodaikanal and Palani received good rainfall. Two stations namely Chettiankotai and Ayyampalayam received a moderate rainfall, as the other four stations, namely Oddanchatram, Neykkarappatti, Periyakulam and Bodinayakkannur received a poor rainfall.

Table 1 Average Annual Rainfall Data in mm (2005 - 2014) for Kodaikanal Taluk

Years	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Rainfall in mm	879.85	990.08	1031.82	1170.32	232.233	860.859	1056.91	763.163	945.325	804.003

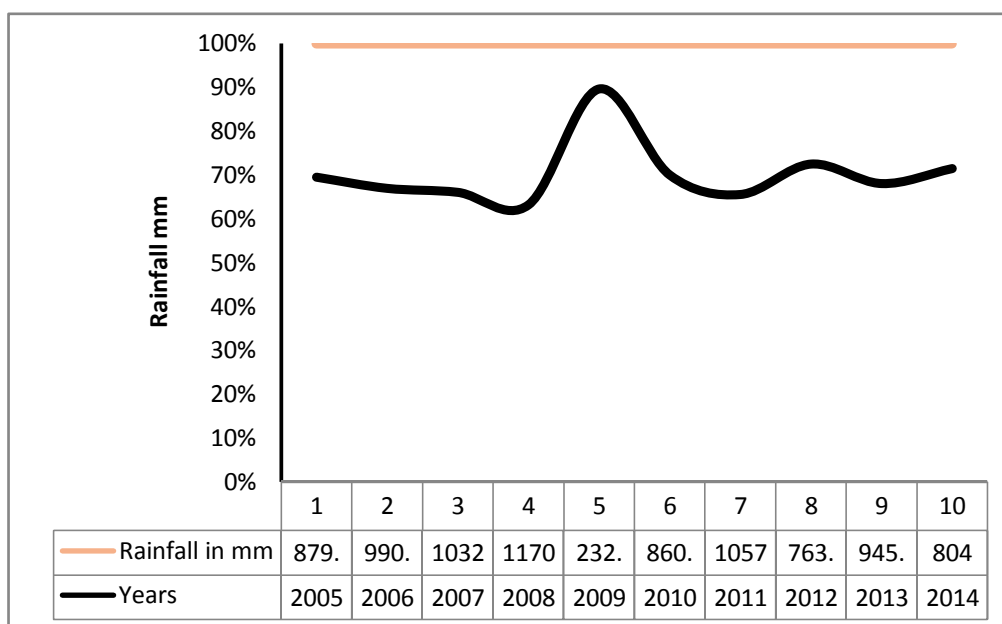


Figure 3: Fluctuation graphs of rainfall data for the Period of 2005 – 2014 In Kodaikanal Taluk

Table 2 Average Seasonal Rainfall (mm) received in the rainfall station of the Study Area in (2005 –2014)

Stations/Season	Winter	Summer	Southwest Monsoon	Northeast Monsoon	Average Annual Rainfall
Kodaikanal	64.1	311.7	451.2	659.1	371.5
Dindigul	33.6	152.3	212.3	498.1	224.1
Nilakkottai	7.7	185.0	217.9	416.0	206.7
Oddanchatiram	12.9	77.6	125.1	274.7	122.6
Palani	21.5	187.0	177.5	583.3	242.3
Udumalaipettai	26.9	120.4	108.2	304.5	140.0
Periyakulam	1.6	78.8	85.7	260.7	106.7

Bodinayakkanur	5.3	90.2	137.1	242.6	118.8
Average	21.7	150.4	189.4	404.9	191.6

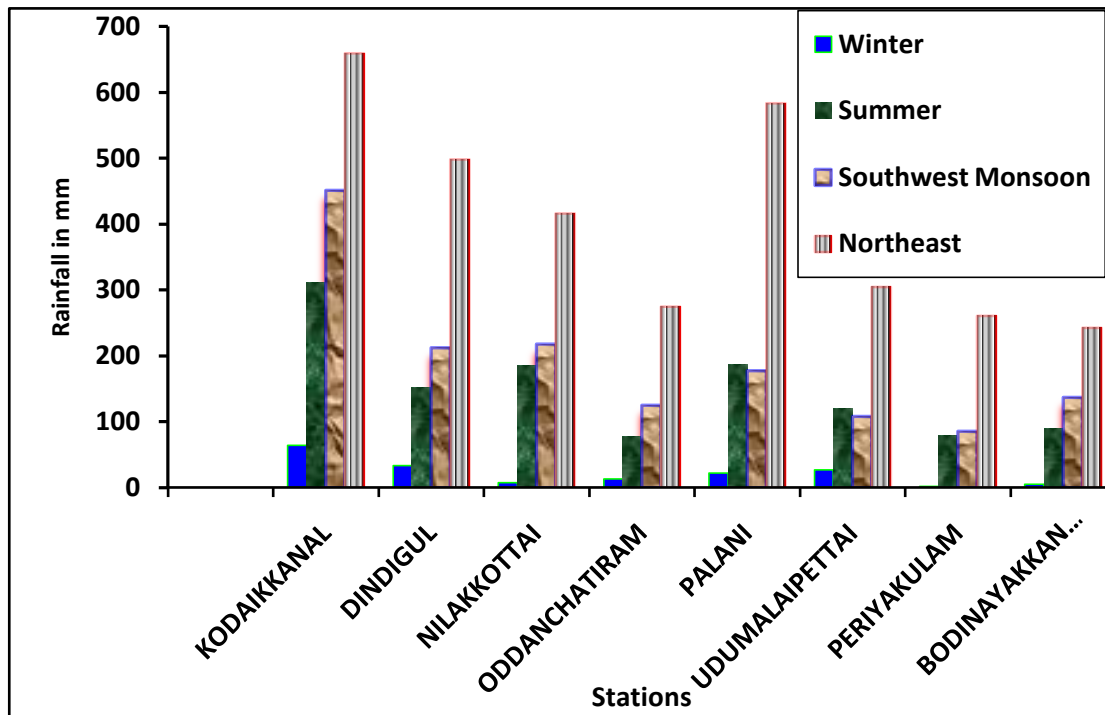


Figure 4: Season wise graph of rainfall for the period of 2005 to 2014

It is an analytical technique associated with the study of locations of geographic phenomena together with their spatial dimension and their associated attributes (like table analysis, classification, polygon classification & weight classification). The winter, summer, southwest monsoon, northeast monsoon and annual average rainfall thematic maps as described above have been 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 results of winter season, summer season, southwest monsoon season, north east monsoon and average annual rainfall data for the period 2005-2014 were used and the spatial distribution maps. GIS spatial distribution maps and Village-level integration map result are given in Fig.5 to 15 and in Table 3. The winter season GIS map reveals that spatially 894.99 Km² area falls in the high rainfall shadow region and village integration map reveals that, 16 villages fall in the high rainfall shadow zone (Fig. 5 and 6).

Table 3 Average Seasonal Rainfall Data Spatial Distribution Results for Decision Support System

Sl.No.	Rainfall Seasons	Class Category	Range of Rainfall in mm	Area in km ²	Area in Percentage	Number of Villages
1	Winter	High	> 22	996.13	95.84	16
		Medium	10 - 22	43.28	4.16	7
		Low	< 10	-	-	-
2	Summer	High	> 150	969.97	93.32	16
		Medium	92 - 150	69.44	6.68	7

		Low	< 92	-	-	-
3	Southwest Monsoon	High	> 189	1004	96.65	16
		Medium	127 - 189	34.79	3.35	5
		Low	< 127	-	-	-
4	Northeast Monsoon	High	> 405	983.39	94.61	16
		Medium	271 - 405	56.02	5.39	7
		Low	< 271	-	-	-

Summer's season GIS image reveals that, spatially 969.97 Km² area falls in the high rainfall shadow region and village integration map reveals that, 16 villages fall in a high rainfall shadow zone (Fig. 7 and 8). The southwest monsoon GIS map and village integration map (Fig. 9 and 10) reveals that, spatially 1004 Km² area falls in the high rainfall shadow region and village integration map reveals that, 16 villages fall in a high rainfall shadow zone. Northeast monsoon GIS map and village integration map (Fig. 11 and 12) reveals that, spatially 983.39 Km² area falls in the high rainfall shadow region and village integration map reveals that, 16 villages fell in a high rainfall shadow zone. Average annual rainfall spatial distribution map and village integration map (Fig. 13 and 14) result shows that spatially 993.71 Km² areas are under high rainfall shadow zone and village integration map reveals that, 16 villages are under high rainfall shadow zone.

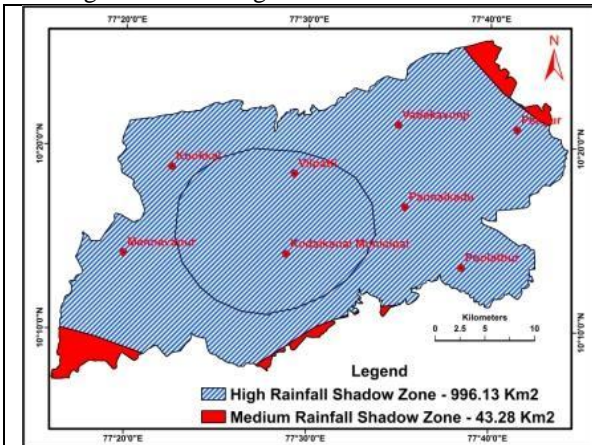


Figure 5: Annual average rainfall Winter Season – SDSS Map

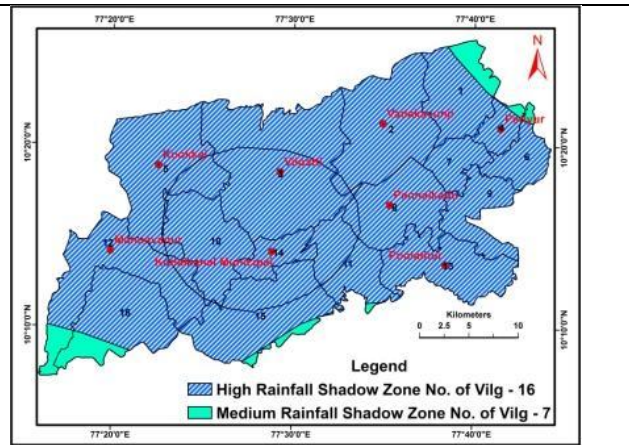


Figure 6: Village Level Annual average rainfall Winter Season – SDSS Map

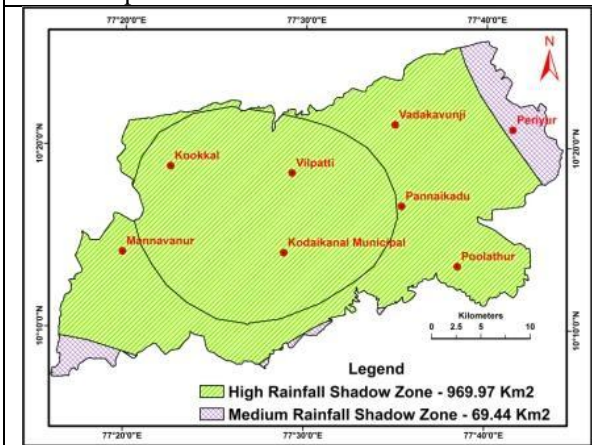


Figure 7: Annual average rainfall Summer Season – SDSS Map



Figure 8: Village Level Annual average rainfall Summer Season – SDSS Map

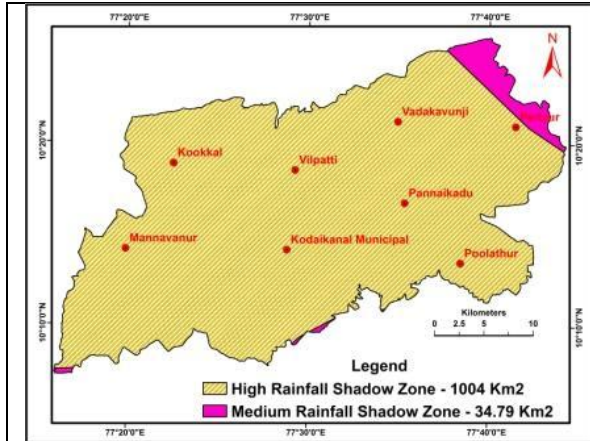


Figure 9: Annual average rainfall Southwest Season – SDSS Map

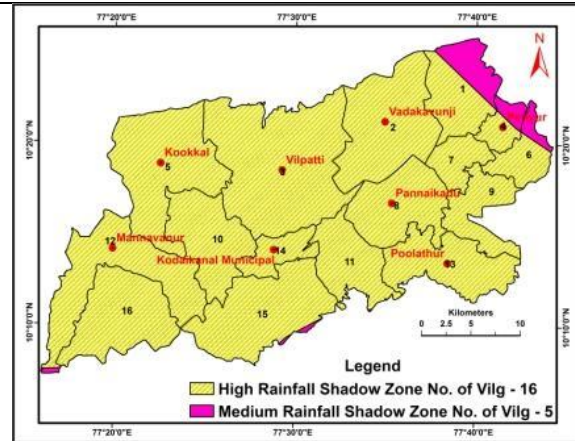


Figure 10: Village Level Annual average rainfall Southwest Season – SDSS Map

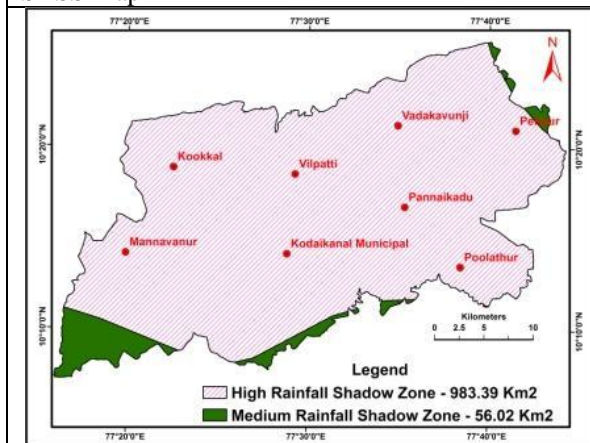


Figure 11: Average Rainfall Northeast Season – SDSS Map



Figure 12: Village Level Annual average rainfall Northeast Season – SDSS Map

Conclusion

The present study reveals that the use of GIS in spatial analysis for rainfall variation. It shows that higher amount of rainfall for southwest and northeast monsoon seasons spatial distribution is 96.65 and 94.61%. The rest of the region i.e 3.35 and 5.59% for the southwest & northeast monsoon season falls in medium rainfall class category. The study concludes that the Kodaikanal and Palani receives meager amount of rainfall over the last ten years.

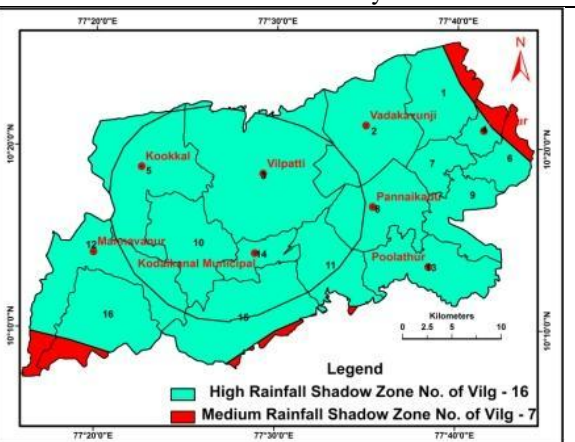
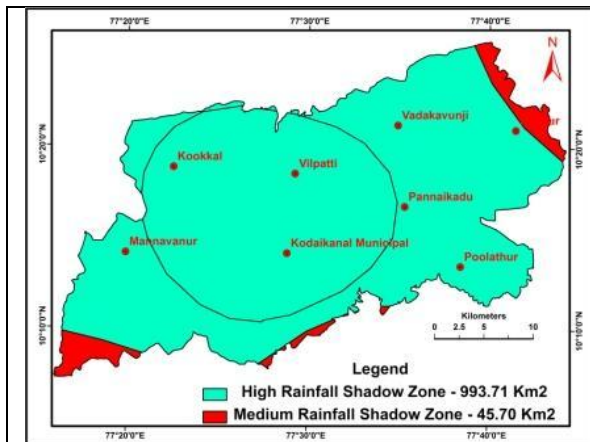


Figure 13: Annual Average Rainfall– SDSS Map	Figure 14: Village Level Annual Average Rainfall– SDSS Map
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