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Spatial Temporal variability of Rainfall for Kompally Telanagana

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Abstract

Spatiotemporal representation had greater variance and improved the identification of regional heterogeneity of trend and variability compared with gauge station data. The amount of annual rainfall received is higher in the western part of the basin than in the central and southeastern parts of the basin. Rainfall is a crucial component of the hydrological cycle and is severely affected due to Global warming. In the present study, Spatio - Temporal variability of rainfall for Annual, Winter, Summer, Monsoon and Post Monsoon seasons is done for Krishna District, A.P. Spatial interpolation technique (Inverse Distance Weight) for five-year interval (1999-2004, 2004- 2009, 2009-2014, 2014-2019) is considered for the study. It is observed that Upper portion of the district shows higher amount of rainfall as compared to lower. Rainfall occurrence is more in Northeast portion of the district during Monsoon for all years. These findings suggest the importance of selecting the spatial distribution of rainfall magnitudes at the chosen time scales.

Keywords: *Hydrological, Rainfall, Monsoon, Spatial, Temporal.*

INTRODUCTION

The amount of rainfall variability is related to extreme rainfall events occurrence and their intensities. Therefore, the extent of extreme precipitation events in various areas of the area under study is necessary (Agarwal and Kumar 2019). Conducted a study of the spatial variability of extreme precipitation help to identify the high and low value zone of ever extreme precipitation events. In addition, it is very useful to know about the spatial and

temporal variability of extreme precipitation for hydropower planning (Chaitanya et al 2021). For planners and other users an informative regionally based study is practically useful. In the coastal delta areas, mostly Andhra Pradesh has experienced the flood problems because the main reasons are not proper drainage (Agarwal et al 2019).

Effects of precipitation variation closely linked to human activities. In case of global warming the precipitation in each region changes to varying degrees. Precipitation is one of the key climate change factors. Climatic change is increasingly shown to exacerbate rainfall and the frequency of extreme events, such as drought, floods, and hurricanes. Precipitation is characterized by randomness, uncertainty, complexity, and uneven distribution. Therefore, it is essential to study temporal and spatial variability (Ahamed and Agarwal 2019).

Precipitation variation effects closely related to human activities. In case of global warming the precipitation in each region changes to varying degrees. Precipitation is one of the vital factors for climate change. There is increasing evidence that climate change is exacerbating rainfall variability and the frequency of extreme events such as drought, floods, and hurricanes (Parry et al2007). Precipitation is characterized by randomness, uncertainty, complexity, and uneven distribution. Therefore, studying the temporal and spatial variability is crucial.

In India annual rainfall is varying with space and time (Agarwal and Kumar 2020). During Southwest monsoon period (June- Sep) more than 75 percent rainfall received, which results scarcity in many parts of the country in non-monsoon period. The annual rainfall variability has great impact on Irrigation planning, that is why such studies are very important for agriculture planning in India (Gadgil 1986). Climate change will have a significant effect on the future, according to IPCC estimates, which indicate that freshwater supply will be reduced because of climate change. Many Researchers have studied precipitation trend over different parts of the India in different season. Results have shown in some places increasing and some places decreasing, no trend (Agarwal et al 2021a, 2021b).

Andhra Pradesh is a state in India that is vulnerable to natural disasters.(Wu et al 2019) studied the temporal and spatial characteristics of precipitation in the Songhua River Basin. (Goswami et al 2006) used precipitation data from central India to show a significant increase

in extreme precipitation events. The results showed that the annual precipitation in the Songhua River Basin had a decreasing trend(Kumar et al 2019). Mostly Andhra Pradesh experienced has the flood problems for the major causes are no proper drainage in the coastal delta zones (Shakeena 2021).

The evaluation results have showed significant decrease in southwest monsoon and increase in post monsoon season in Indian cardamom hills of Kerala (Sujatha et al 2019). Tamil Nadu showed extreme variation in precipitation pattern over the last hundred years (1905-2004) as well as the humid tropics rainfall climatology (Sivajothi and Karthikeyan 2017). More distributions are fitted for the precipitation, but Gamma distribution is the best fit for wet and dry sequences and obtained good result. The objective of this study is applying geospatial technique to study the temporal and spatial characteristics of precipitation for Krishna districts of Andhra Pradesh state.

MATERIAL AND METHODS

The district of Krishna is a coastal district of Andhra Pradesh, having its district headquarters at Machilipatnam. It was once known as the district of Machilipatnam. Later it was renamed as Krishna District after the holy river Krishna, by adding certain Taluks of the abolished Guntur District in 1859. It is located between 15º 43’ 02’’ and 17º 08’ 17’’ of the North latitude and 80º 07’ 24’’ and 81º 34’ 51’’ of East longitude and spreads across 8727 square kilometers, along 88 km of the coast. It was surrounded on the East by Bay of Bengal and West Godavari District, on South by Bay of Bengal on West by Guntur and Nalgonda Districts and on North by Khammam District.

The average annual rainfall of the district is 1011.2 mm, which ranges from nil rainfall in January to March. The mean seasonal rainfall distribution is 700 mm in southwest monsoon (June-September), 241 mm in northeast monsoon (Oct-Dec), 6.3 mm rainfall in winter (Jan-Feb) and 64 mm in summer (March–May). The famous river Krishna is flowing in this district. The average rainfall recorded during the year 2016-17 it is 794.7 mm and in 2017-18 it is 804.0 mm.

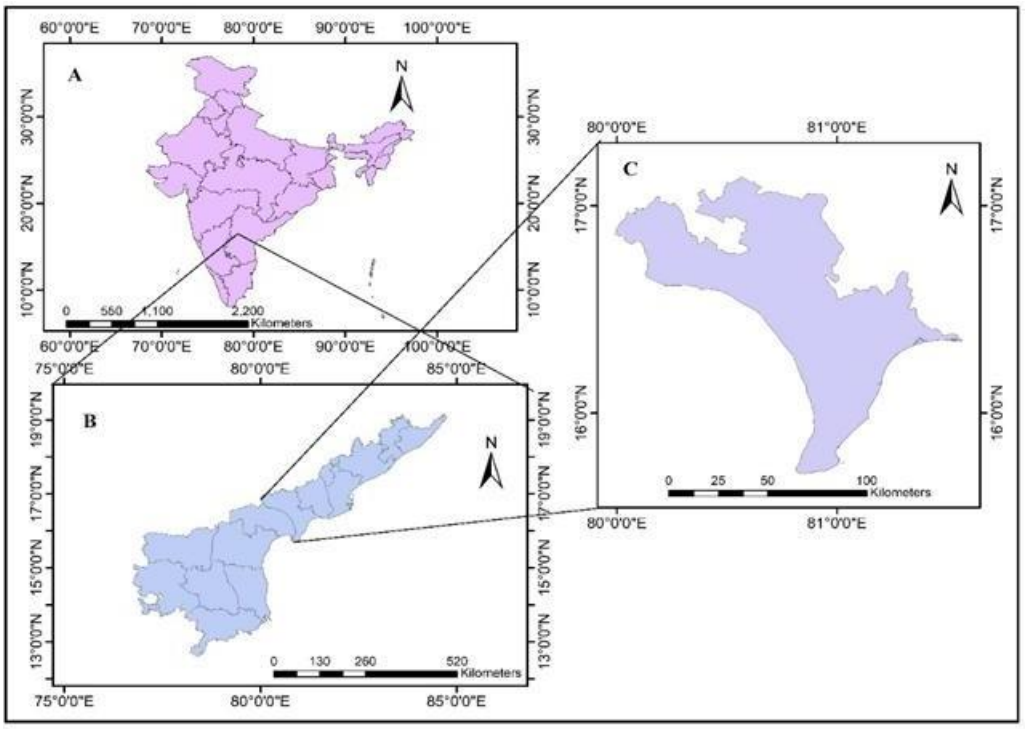

Fig. 3.1 Study area Map

To examine the variability of rainfall using geospatial techniques, Rainfall observed data from 1999 to 2019 is used. The observed rainfall data is clipped to Krishna district shapefile using ARCGIS 10.3. The Spatial interpolation technique (Kriging) is employed to determine the Spatio Temporal variability of rainfall. Ordinary Kriging method is to consider the spatial correlation factors, estimate a general point of a measurement equation.

$$z_0 = \sum_{x=1}^{s} z_x W_x$$

In above equation, Z0 is the estimated value, Zx is the known value of point x, Wx is the weight of x, and s is the number of points used to estimate the sample. Kriging assumes that the distance or direction of the sampling points represents a spatial correlation which is used to explain surface variation. The tool fits a numerical function to specific points, or all points within radius, to determine output location value. Kriging is a multistep process; it includes exploratory statistical analysis of the data, variogram modelling, creating the surface, and (optionally) exploring a variance surface. Kriging is most appropriate when you know there is a spatially correlated distance or directional bias in the data. It is often used in soil science and geology.

RESULT AND DISCUSSIONS

The Spatial interpolation technique (Inverse Distance Weight) is employed to determine the Spatio Temporal variability of rainfall using ArcGIS 10.3. Spatial maps were generated on five-year interval (1999-2004, 2004-2009, 2009-2014, 2014-2019). It is observed that Upper portion of the district shows higher amount of rainfall as compared to lower portion.

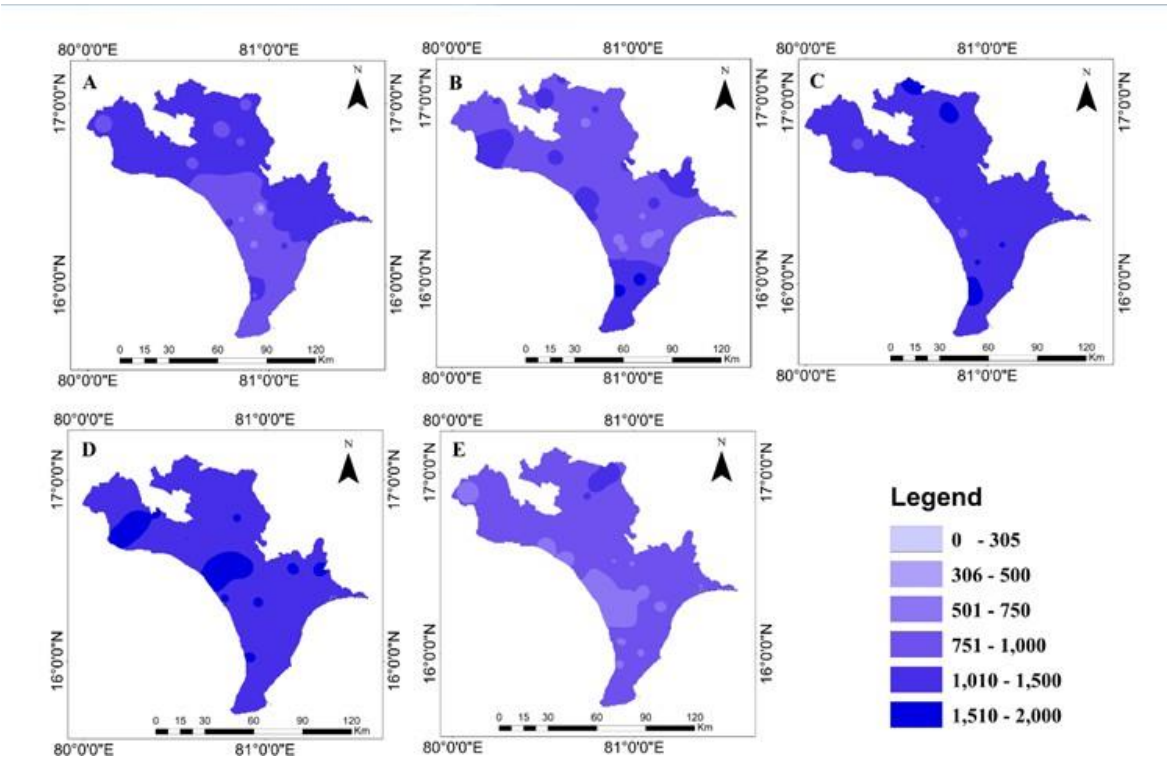

Fig.1Spatio Temporal Variability of Annual Rainfall (A=1999, B=2004, C=2009, D=2014, E=2019)

In 1999, the annual rainfall is higher for upper portion and eastern region. The result of the analysis for 2004 indicates remarkable improvement particularly in the low rainfall areas. Compare to preceding year low rainfall variation is observed in this year. For 2009 and 2014 rainfall is increasing in all parts of the district. In 2009 the rainfall is varying 1904 mm to 808 mm and 1860 mm to 1000 mm for the year of 2014. The spatial distribution of annual precipitation is not uniform throughout the region. In 2019, the rainfall is decreasing compared to preceding years.Statistical analysis of annual rainfall in Krishna district is performed, mean annual rainfall is varied from 815.2 mm (2019) to 1386.9 mm (2014) and it is decreasing 20.07 % from 1999 to 2019. Standard deviation of annual rainfall is varied from

129.1 mm for 2019 to 222 mm for 2014. Coefficient of variation is less 14.2% for 2014

compared to all years. During the year 2014, annual rainfall was exceeded by 7% and no drought conditions were prevailed in the entire state.

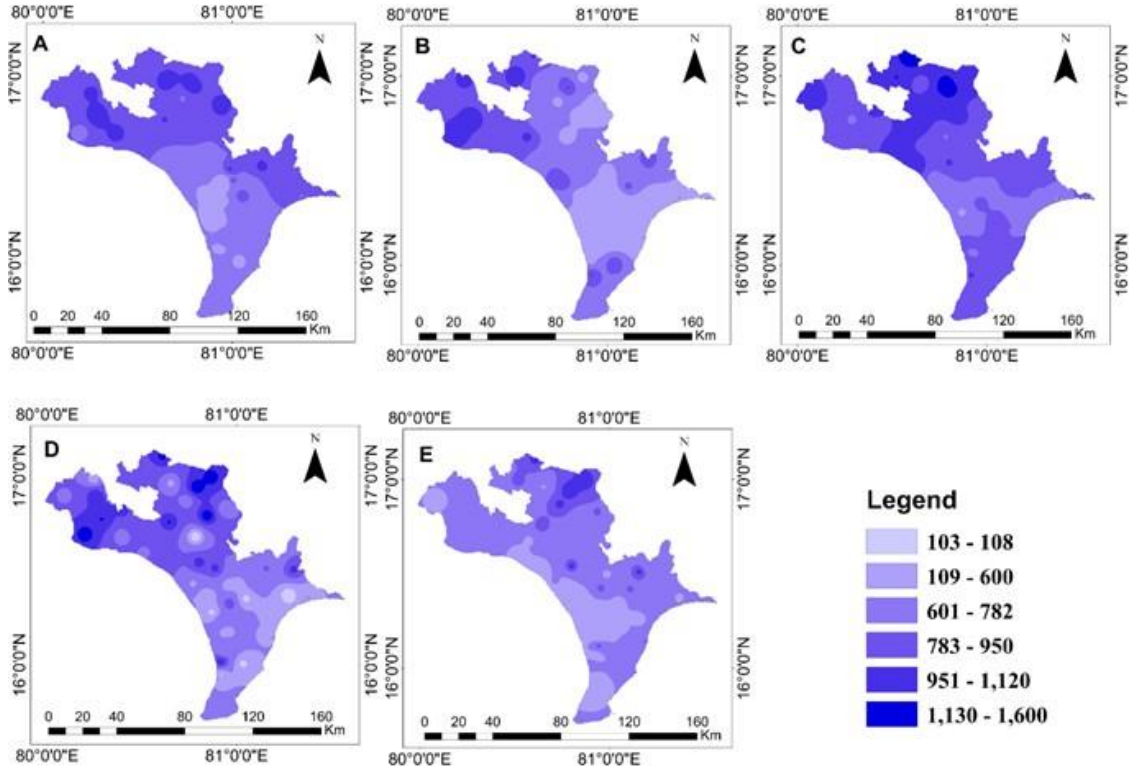

Fig.2Spatio Temporal Variability of Rainfall during Monsoon (A=1999, B=2004, C=2009, D=2014, E=2019)

The spatial distribution characteristics of rainfall in the monsoon season (June, July, August and September) is shown in Figure 5.2. For 1999 and 2004 less rainfall variability is observed in the region. Rainfall occurrence is more in Northeast portion of the district during Monsoon for all years. Less rainfall variability is observed in 2019 but the annual mean rainfall is varied from 643.3 mm for 2019 to 905.9 mm for 2009. The Monsoon rainfall is decreasing from 1999 to 2004, increasing from 2004 to 2009 and again decreasing from 2009 to 2019. The mean annual rainfall of Krishna district showed increasing and decreasing trends between these intervals. Annual Mean rainfall is decreasing 17.20% from 1999 to 2019. Standard deviation of monsoon rainfall is varied from 114.2 mm for 2019 to 193.1 mm for 2009.

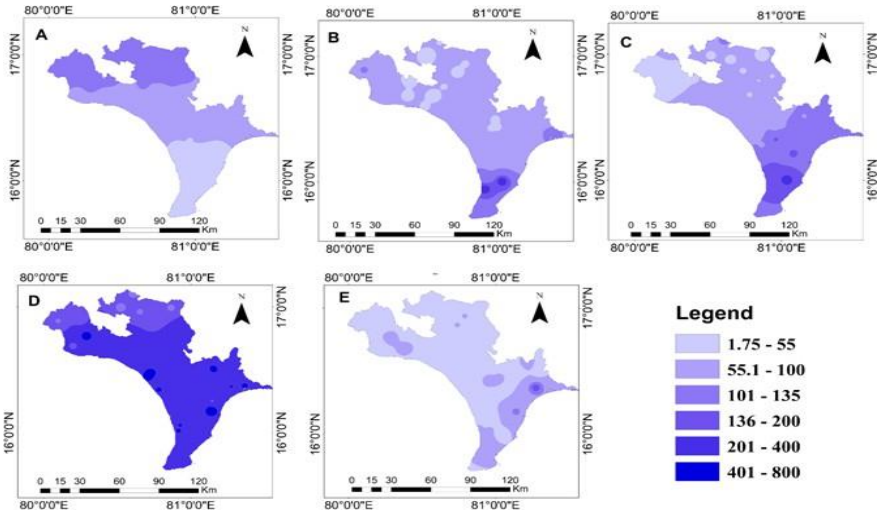

Fig.3Spatio Temporal Variability of Rainfall during Post Monsoon (A=1999, B=2004, C=2009, D=2014, E=2019)

The post monsoon (October and November) spatial variability of rainfall is shown in Figure 5.3. The analysis shows less rainfall variability in all years except 2014. Lower part of the districts shows high amount of rainfall as compared to upper portion for 2004 and 2009. The mean annual rainfall is varying from 45.4 mm for 2019 to 478.9 mm for 2014. Mean annual rainfall is decreasing from 1999 to 2009 and 2014 to 2019 while increasing from 1999 to 2014. Standard deviation of post monsoon rainfall is varied from 31 mm for 2019 to 120.6 mm for 2014 and coefficient of variation is less, 25.2% for 2014.

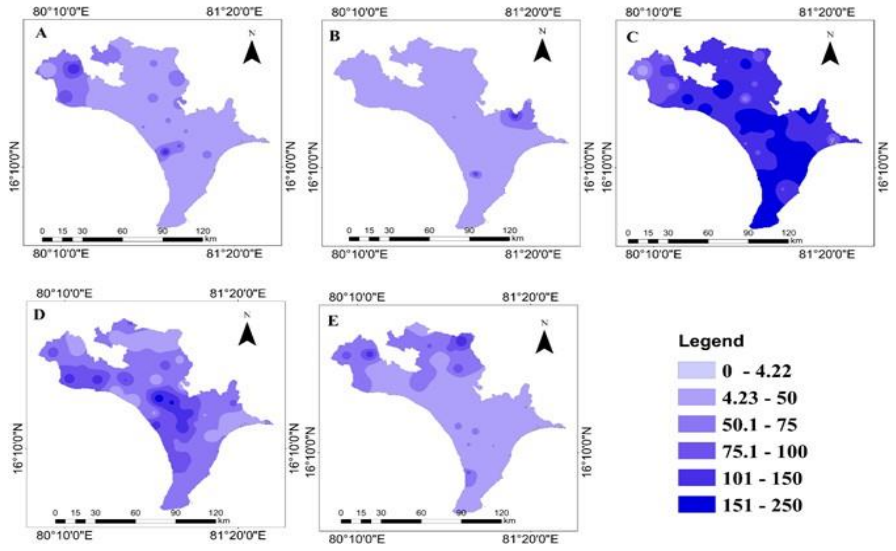

Fig.4Spatio Temporal Variability of Rainfall during Summer (A=1999, B=2004, C=2009, D=2014, E=2019).

In Summer (March, April and May), the maximum rainfall occurred is 236 mm which is observed in 2009. The distribution of rainfall in summer is characterized by decreasing pattern for the South, East and West part of the district except for the year 2009 and 2014. The occurrence of rainfall in the North East and Central part is greater than the North West part for 2009. The middle part of the district is having uniform rainfall distribution during Summer. Mean annual rainfall is varied from 23.1 mm for 2004 to 137.1 mm for 2009. The rainfall is decreasing from 1999 to 2009 and 2014 to 2019. Mean annual precipitation is increasing from 1999 to 2009 and Standard deviation is varied from 23.3 mm for 2019 to 47.5 mm for 2009.

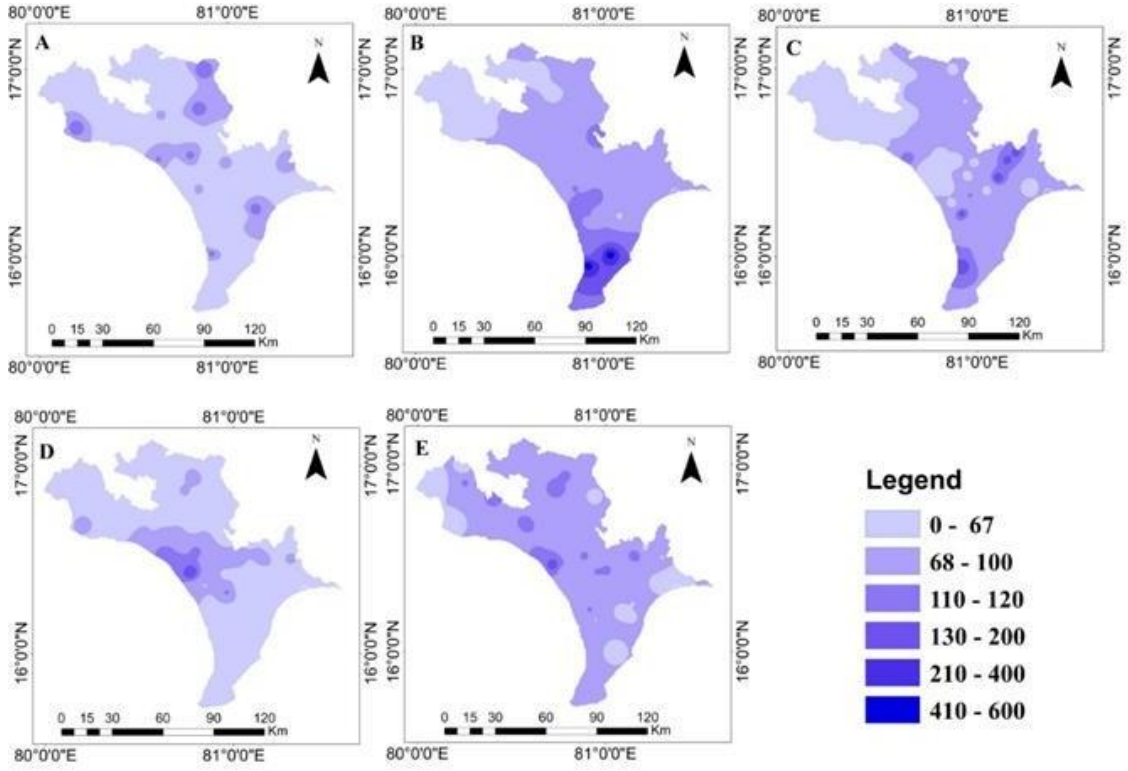

Fig.5Spatio Temporal Variability of Rainfall during winter (A=1999, B=2004, C=2009, D=2014, E=2019)

In winter (December, January and February), the maximum rainfall is 548 mm which is observed in 2004. All most uniform rainfall is observed for all years during Winter season. Mean annual precipitation is varied from 6.5 mm for 1999 to 161 mm for 2004. The mean annual rainfall is increasing from 1999 to 2004 and decreasing from 2009 to 2019. The coefficient of variation is high for 1999 as compared to rest of the years.

CONCLUSIONS

This paper has outlined the key components required for analysis of spatio temporal variability of rainfall.It has emphasized the critical role of accurate and well-understood data, ofusing exploratory data analysis as a key part of the study.The Spatial interpolation technique (Inverse Distance Weight) is used to make rainfall maps for the study area.It is observed that mean annual rainfall is varied from 815.2 mm (2019) to 1386.9 mm (2014) and it is decreasing 20.07 % from 1999 to 2019.The annual rainfall was exceeded by 7% and no drought conditions were prevailed in the entire state during year 2014.Further work is required before it is possible to unequivocally attribute thevariation of rainfall due to climatic change.

REFERENCES

1. Shakeena M, Panda SK and Agarwal S 2021. GIS-based Integrated Approach for Sustainable Management of Ecology and Environment with Green and Blue Spaces. Indian Journal of Ecology 48(3): 931-938.
2. Sivajothi R and Karthikeyan K 2017. Spatial and temporal variation of precipitation trends in Andhra Pradesh, India. In IOP Conference Series: Materials Science and Engineering 263(4): 042146.
3. Sujatha M, Satyanarayana T and Asadi SS 2019. Spatial Distribution Analysis on Groundwater Quality of Sarada River Basin, Visakhapatnam, AP India. International Conference on Advances in Civil Engineering 7(6C2):747-751.
4. Wu J, Zhang F, Pan Y, Li W, Cao G and An Y2019. Spatio-temporal trend analysis of precipitation in Guizhou province based on GIS technology. In IOP Conference Series: Earth and Environmental Science 21(2):052033.
5. Agarwal S and Kumar S 2019. Applicability of SWMM for Semi Urban Catchment Flood modeling using Extreme Rainfall Events. International Journal of Recent Technology and Engineering 8(2):245-251.
6. Agarwal S, Patil JP, Goyal VC and Singh A 2019. Assessment of Water Supply–Demand Using Water Evaluation and Planning (WEAP) Model for Ur River Watershed, Madhya Pradesh, India. Journal of The Institution of Engineers (India): Series A 100(1): 21-32.

7. Agarwal S and Kumar S 2020. Urban Flood Modeling using SWMM for Historical and Future Extreme Rainfall Events under Climate Change Scenario. Indian Journal of Ecology 47(11):48-53.
8. Agarwal S, Kumar S and Singh UK 2021a. Intensity Duration Frequency Curve Generation using Historical and Future Downscaled Rainfall Data. Indian Journal of Ecology 48(1):275-280.
9. Agarwal S, Suchithra AS and Singh SP 2021b. Analysis and Interpretation of Rainfall Trend using Mann-Kendall's and Sen's Slope Method. Indian Journal of Ecology 48(2): 453-457.
10. Chaitanya TP, Singh UK and Agarwal S 2021. Forest Fire Monitoring of Wildlife Sanctuary using Geospatial Techniques. Indian Journal of Ecology 48(3): 681-685.
11. Gadgil A 1986. Annual and weekly analysis of rainfall and temperature for Pune: a multiple time series approach. Institute of Indian Geographers 8(1):4-20.
12. Goswami BN, Venugopal V, Sengupta D, Madhusoodanan MS and Xavier PK 2006. Increasing trend of extreme rain events over India in a warming environment. Science 314(5804):1442-1445.
13. Kumar MR, Naveen M, PravallikaMS and Kumar S 2019. Variability and time series trend analysis of rainfall over Krishna District of Andhra Pradesh: A case study. International Journal of Recent Technology and Engineering 7(6C2):720-726.
14. Parry M, Parry ML, Canziani O, Palutikof J, Van der Linden P and Hanson C 2007. Climate change 2007-impacts, adaptation and vulnerability: Working group II contribution to the fourth assessment report of the IPCC. Cambridge University Press.