

Spatial and Temporal Analysis of Rainfall Variation in Yadalavagu Hydro-geological unit using GIS, Prakasam District, Andhra Pradesh, India

Umamaheswara Rao B and Sankara Pitchaiah P

Department of Geology, Acharya Nagarjuna University, Guntur, Andhra Pradesh, INDIA

Available online at: www.isca.in, www.isca.me

Received 12th January 2014, revised 24th February 2015, accepted 5th March 2015

Abstract

Rainfall is the one of the most important factor in hydrological cycle as well as climate elements. Amount of rainfall received over an area affects the availability of water resources and cropping pattern of an area. Therefore the present study deals with the rainfall characteristics of the Yadalavagu sub basin of Prakasam district. The analysis includes the seasonal and special variations of rainfall within a basin through different seasons. Six rain fall measuring stations have been established at Chennareddypalli, Buddapalli, Markapur, Bodapapdu, Mannevaripalli and Moddpulapalli of Markapur and Tarlupadu mandals of Prakasam districts, Andhra Pradesh; which has mean rainfall about 612.7 mm. First shower of the rainfall starts in second week of the June. Highest rainfall 885.3 mm recorded in 2005-06; whereas lowest 364 mm is recorded in 2011-12. 52 Percent and 40 percent of the rainfall received in south west monsoon as well as north east monsoon period respectively where as in summer season only 8 percent of the rainfall received. North east part of the hydro-geological unit has received highest rainfall and the foot hill area of Veligonda hill ranges received lowest rainfall.

Keywords: Annual, seasonal rainfall, rainfall variability, special distribution, GIS.

Introduction

Rain fall is the primary source for the world's agriculture. Productivity of the agriculture in a particular year depends on the amount of rainfall received, intensity and distribution of the rainfall over a particular area which indicates the growth of the economy of the state¹. Characteristics of rainfall over an area vary from one part to another. Analysis of the rainfall pattern of sub basin level is important to understand the micro-level variability of the rainfall which in turn useful to planning the agriculture; land and water development activities. The present study made understanding of the rainfall of Yadalavagu sub basin which is tributary of the Gundlakamma River flowing Markapur and Tarlupadu mandals.

Yadalavagu hydro-geological unit is located in western part of Prakasam district, Andhra Pradesh, India shown in figure 1. The geographical area of study area is 143.26 sq.km falls between 15^o47' 01.25" to 15^o35' 47.27" north latitude and 79^o14' 42.57" to 79^o21' 48.92" east longitude. The temperature ranges between 10^oC in the month of January and 34.5^oC in the May. Topographically slope of the study area is gradually decreasing towards north from south. First order drainage of the Yadalavagu starts at Velugonda reserve forest of Nallamallai hill ranges at Magalakunta village flowing through 17 villages and finally reaches Gundlakamma River at Bodapadu Village.

Material and Methods

Daily rainfall data from 6 stations from 2004 to 2014 have been taken into consideration for analysis of onset of monsoon,

monthly, seasonal and annual rainfall pattern. Survey of India toposheets 57M/5 and M/6 has been used for preparation of base map. 10 years daily rainfall data collected from the mandal revenue office (MRO) of Markapur, as well as 5 stations data collected from a non-governmental organization named as Collective Activities for Rejuvenation of Village Arts and Environment (CARVE). Geographical information system is used for preparation of annual, seasonal spatial rainfall distribution maps; the method is found useful in rainfall distribution studies². Microsoft Excel is used for preparation of temporal and seasonal variations of the rainfall.

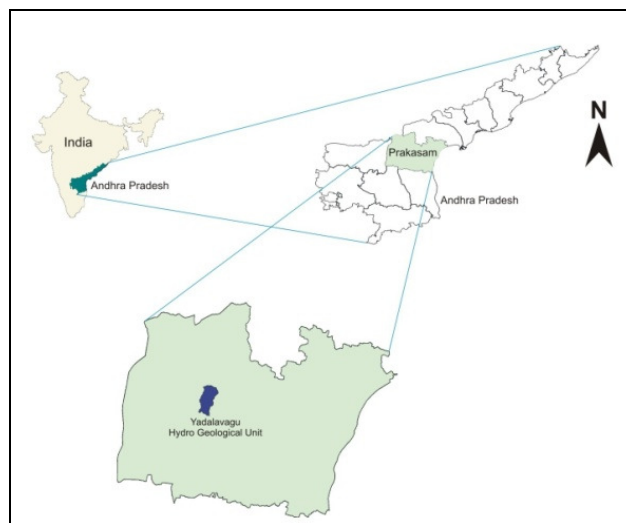


Figure-1
Location map of the Yadalavagu sub-basin

Results and Discussion

From the rainfall data monsoon arrival date, mean annual, seasonal and spatial distribution are observed and presented here.

Onset of monsoon: According to the Indian meteorological department, monsoons arrives this area by 2nd week of June. It is experienced from the figure 2, that south west monsoon arrived at the study area from July 9th to June 2nd. During 2005-06 monsoon hit on 9th July, followed by 2009-10 and 2012-13 have received 3rd week of June. Of the 10 years, remaining 7 years (70 percent) received 1st week of June².

Variations of monthly rainfall: Highest average rainfall, 136.7 mm received in October as shown in figure3. Similarly, early north east monsoon period impact on this region is significant than south west monsoon. Trend of the north east monsoon decreased from October to February³. Average monthly rainfall of 10 years (2004-2014) for 6 rain gauge stations in the Yadalavagu sub-basin indicates that mean received rainfall is increased from June to October³. In summer (March –May) no trend observed in rainfall. It is also revealed that no impact of

north east monsoon on this region after November. During south west monsoon highest mean rainfall received during September (106.8 mm) followed by August (83.9 mm), July (69.3 mm) and June (59.1 mm). During north east monsoon 92.8 mm rainfall received in November, 4.4 mm in December, 1.5 mm in January and 5.1 mm in March. During summer season 15.7 mm of rainfall received in March, 14.2 mm in April, and 13.7 mm in May. The data indicate the climatic shifts in the area.

Mean Annual rainfall: General trend of the mean annual rainfall of the Yadalavagu is increased. From table-1 mean annual rainfall of the Yadalavagu sub basin is 612.7 mm based on the 10 years consequent data 6 rain gauge stations established in the Yadalavagu. Years 2004-05, 2006-07, 2008-09, 2009-10, 2011-2012 recorded below mean rainfall and remaining five years viz., 2005-06, 2007-08, 2010-11, 2012-13 and 2013-14 received above mean rainfall. Figure-4 reveals that minimum rain fall (364 mm) received during the period 2011-12 and highest rainfall experienced in 2005-09 (885.3mm); followed by 2013-14 (798.7 mm); 2010-11 (720.3 mm); 2007-08 (636.4 mm); 2012-13 (634.7 mm); 2009-10 (565.6 mm); and 2008-09 (520.1 mm).

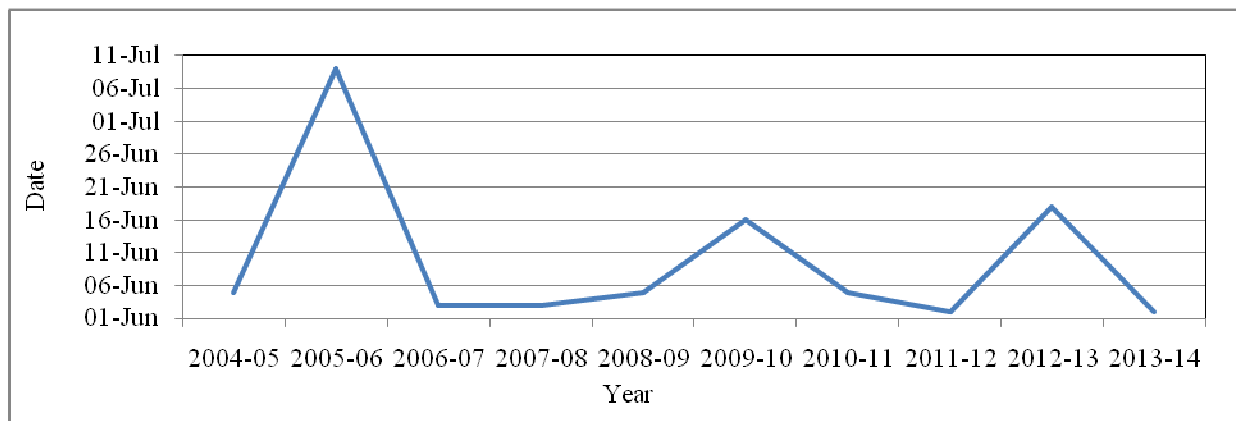


Figure-2
 Onset of monsoon during 2004-14 in Yadalavagu sub-basin

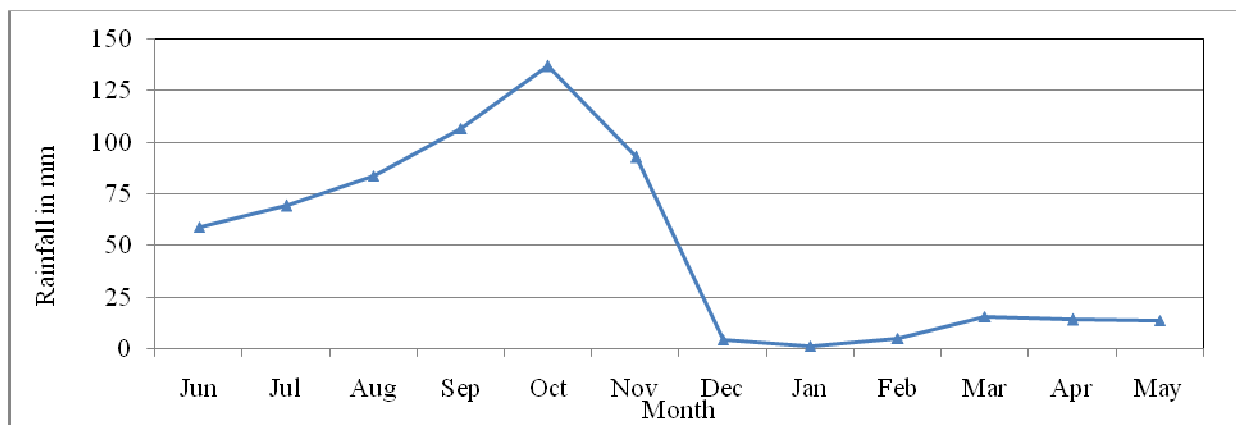


Figure-3
 Mean monthly rainfall during 2004-14 in the Yadalavagu sub-basin

Mean south west rainfall: General trend of the mean south west rainfall of the Yadalavagu is increased. From table-2 mean south west rainfall of the Yadalavagu sub basin is 319.2 mm. The years 2004-05, 2006-07, 2008-09, 2009-10, 2011-2012 and 2012-13 recorded below mean rainfall and remaining four years viz., 2005-06, 2007-08, 2010-11 and 2013-14 received above

mean rainfall. Figure-5, reveals that minimum rainfall (162.3 mm) received in the 2008-09 as well as highest rainfall experienced in 2013-14 (513.4 mm); followed by 2007-08 (422.9 mm); 2005-06 (399.6 mm); 2010-11 (326.8 mm); 2009-10 (290 mm); 2012-13 (275.1 mm); and 2011-12 (218.8 mm).

Table-1
Received rainfall in six rain gauge stations of Yadalavagu sub-basin (2004-2014)

S. No.	Year	Bodapadu	Moddulapalli	Mannevaripalli	Buddapalli	Chennareddypalli	Markapur	Average
1	2004-05	613	581.7	165.9	517.8	614.65	685.9	529.8
2	2005-06	833.2	996.3	841.8	657.7	917.5	1065	885.3
3	2006-07	422.8	531.6	530.2	390.82	323.6	633.6	472.1
4	2007-08	665.5	571.4	458.3	628.3	687.5	807.2	636.4
5	2008-09	367.5	399.6	516.6	609.9	516.7	710.6	520.1
6	2009-10	578.5	538.5	545.8	560	396.7	774.1	565.6
7	2010-11	713.6	733.9	696.5	669.9	712	795.8	720.3
8	2011-12	356.5	375.2	311.3	339.2	391.7	410.2	364.0
9	2012-13	647.2	653.5	622.9	606.3	509.2	769.2	634.7
10	2013-14	616.6	655.9	829.4	848	906.1	936.2	798.7
Average		581.4	603.8	551.9	582.8	597.6	758.8	612.7

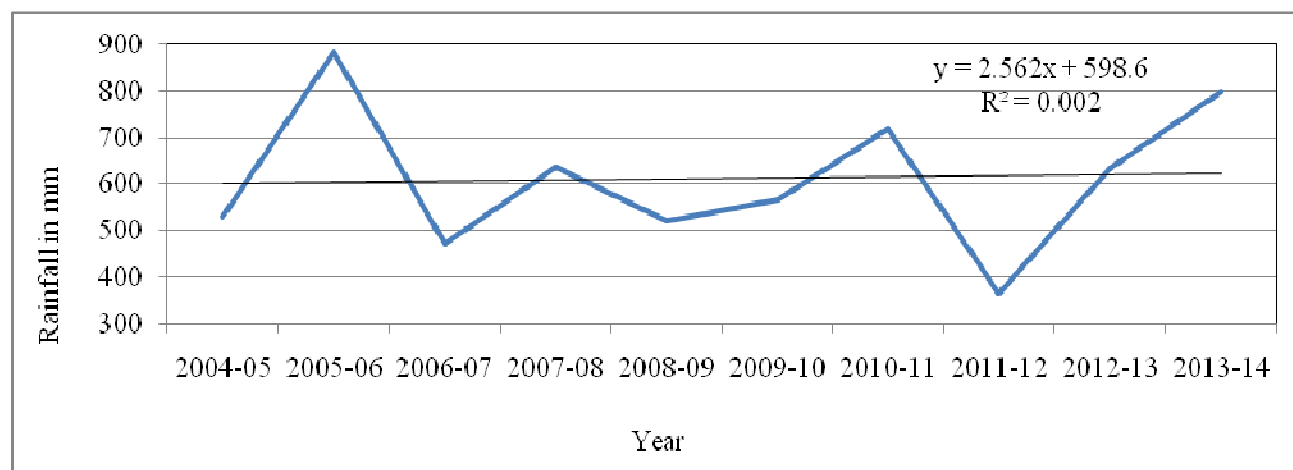


Figure-4
Mean annual rainfall pattern in Yadalavagu sub-basin (2004-14)

Table-2
Annual and seasonal rainfall variability from 2004 to 2014 of Yadalavagu sub-basin

S. No.	Rain gauge station name	South west monsoon	North east monsoon	Summer	Annual
1	Bodapadu	300.8	236.8	43.9	581.4
2	Moddulapalli	306.8	235.3	61.7	603.8
3	Mannevaripalli	285.8	231.9	34.1	551.9
4	Buddapalli	296.1	239.3	47.4	582.8
5	Chennareddypalli	324.8	214.5	58.2	597.6
6	Markapur	400.8	292.8	65.3	758.8
Average		319.2	241.8	51.8	612.7

Mean north east rainfall: General trend of the mean North - East rainfall of the Yadalavagu is increased. Mean north east rainfall of the Yadalavagu sub-basin is 241.8 mm. In the years viz., 2005-06, 2008-09, 2010-11, 2012-2013 and 2013-14 recorded above mean rainfall and remaining six years viz., 2004-05, 2006-07, 2007-08, 2009-10 and 2011-12 received below mean rainfall. Figure-6, reveals that minimum rain fall (107.9 mm) received in the 2007-08 as well as highest rainfall experienced in 2005-06 (411.2 mm); followed by 2012-13 (348.1 mm); 2010-11 (344.3 mm); 2008-09 (333.1 mm); 2013-14 (284.2 mm); 2009-10 (191.1 mm); 2004-05 (147.4); 2006-07 (140.1 mm); 2011-12 (110.5 mm); and 2007-08 (107.9 mm).

Mean summer rainfall: General trend of the mean summer rainfall of the Yadalavagu is decreased. Mean summer rainfall of the Yadalavagu sub-basin is 51.8 mm. In five years viz., 2004-05, 2005-06, 2006-07, and 2009-10 recorded above mean rainfall and remaining five years viz., 2008-09, 2010-11, 2011-12, 2012-13 and 2013-14 received below mean rainfall. Figure 7, reveals that minimum rain fall (1.1 mm) received in the 2013-14 as well as highest rainfall experienced in 2007-08 (105.5 mm); followed by 2009-10 (84.5 mm); 2005-06 (74.5 mm); 2004-05 (67.1 mm); 2006-07 (64.4 mm); 2010-11 (49.3 mm); 2011-12 (34.8); 2008-09 (24.8 mm); and 202-13 (11.6 mm).

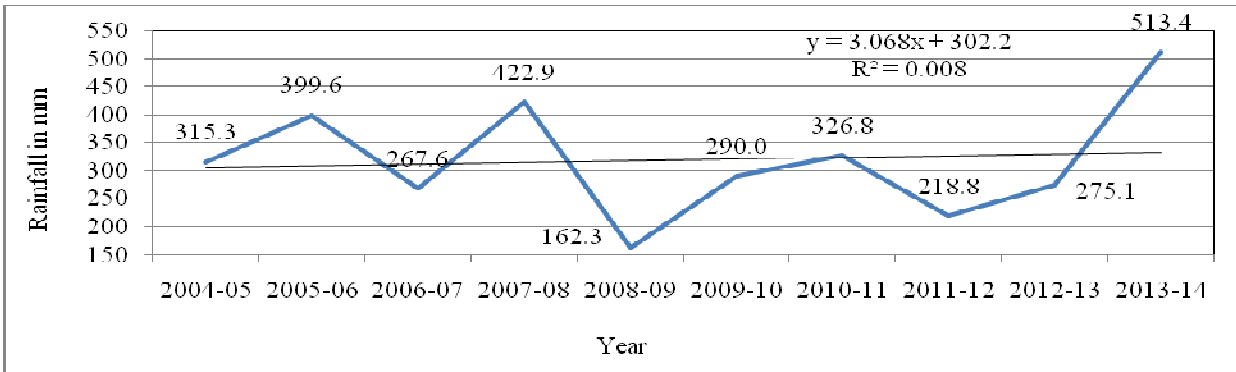


Figure-5
 Mean south west rainfall pattern in Yadalavagu sub-basin (2004-14)

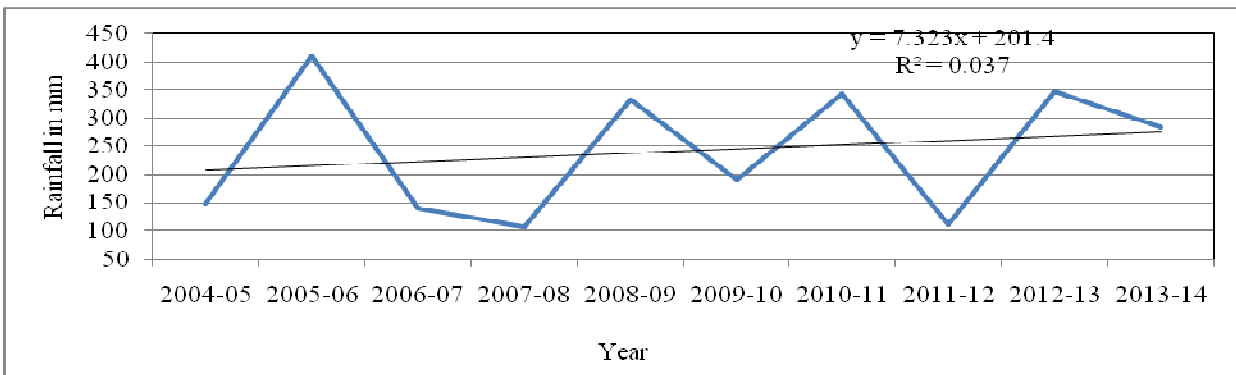


Figure-6
 Mean north east rainfall pattern in Yadalavagu sub-basin (2004-14)

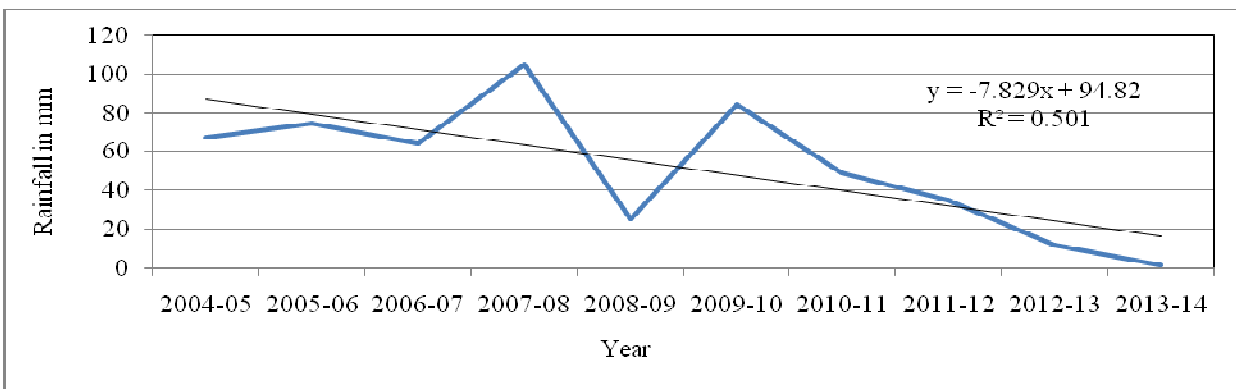


Figure-7
 Mean summer rainfall pattern in Yadalavagu sub-basin (2004-14)

Mean rainfall distribution: Figure-8 reveals that out of ten years rainfall, 52% (391.2 mm) received during north east monsoon; 40% (241.8 mm) during south west monsoon and remaining 8% (51.8 mm) in summer season^{4,5}.

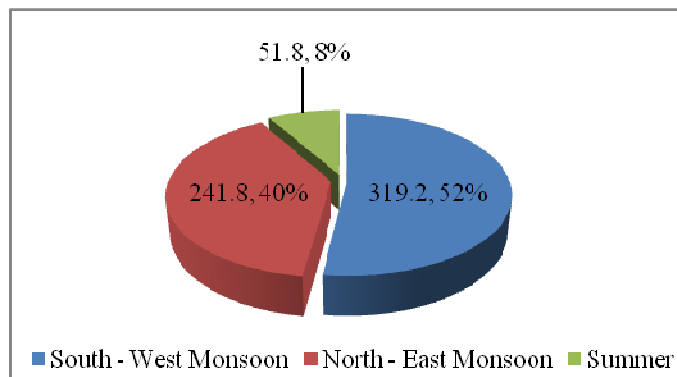


Figure-8
 Mean rainfall distribution of Yadalavagu sub basin
 (2004-14)

Spatial distribution of rainfall: Spatial distribution of mean annual rainfall: Most part of the Yadalavagu sub basin received rain fall range between 545 mm to 575 mm as shown in Figure-9. Southern and central northern portion received 516 mm to 545 mm rainfall. Extreme north east part received 630 mm to 658 mm of rainfall. The mean annual rainfall distribution reveals that north east of the study area has got more than normal annual rainfall (612.7 mm) decreasing to south. It indicates that Southern uplands had received less rainfall than plain lands of northern part of the study area.

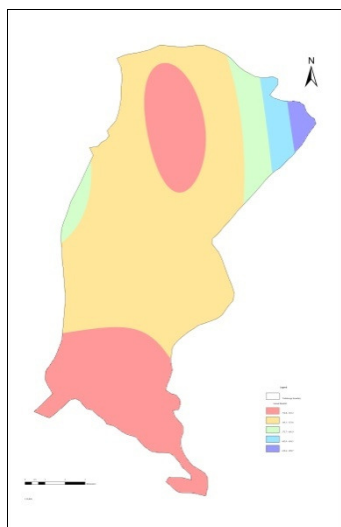


Figure-9
 Spatial distribution of mean annual rainfall in Yadalavagu sub-basin (2004-14)

Spatial distribution of mean south west monsoon: Amount of rainfall received over a one decade for the South west monsoon indicates that rainfall is decreasing from east to west except

extreme north east part as shown in figure-10⁷. Lowest rainfall received at extreme south east part and the highest received at western part; same amount of range of rainfall occurs in the north and south also.

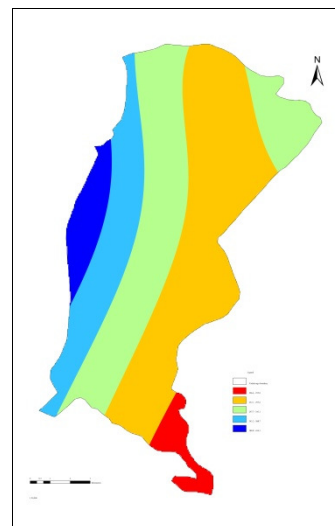


Figure-10
 Spatial distribution of mean south west monsoon
 (2004-14)

Spatial distribution of mean north east monsoon: Amount of rainfall received over a one decade for the north east monsoon indicates that rainfall is decreasing from east to west expect extreme north east part of the study area as shown in figure 11. Lowest rainfall received at extreme south east part as well as highest received at western part of the area⁸.

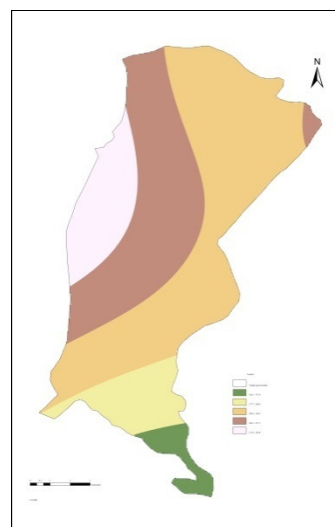


Figure-11
 Spatial distribution of mean north east rainfall
 (2004-14)

Spatial distribution of mean summer rainfall: Most part of the Yadalavagu sub-basin received rain fall range between 30

mm to 54 mm as shown in figure 12. Extreme north east and west part received 66 mm to 90.7 mm of rainfall. Extreme north east part of the study area got rainfall of 90.7 mm^{9,10}.

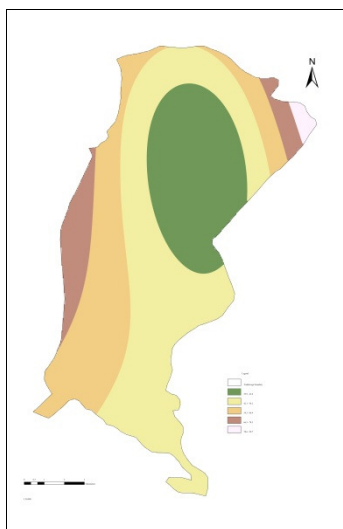


Figure-12
Spatial distribution of mean summer rainfall
(2004-14)

Conclusion

The study area 70% years received monsoon before second week of the June. Highest mean monthly rainfall (136.7 mm) is received due to retreating winds in October, 2004-05, 2006-07, 2008-09, 2009-10 and 2011-12 received less than dependable rainfall (75 percent of the normal- 612.7 mm). South west and north east monsoon showing increasing trend and during the summer it shows the decreasing trend. Lowest rainfall in the southern part is due to the Veligonda hill ranges of south, which acting as rain shadow area. Highest rain fall received at the extreme north east part of the sub basin. Highest deficit (40.6%) experienced in 2011-12; followed by 2006-07 (22.9%); 2008-09 (15.1%); 2004-05 (13.5%) and lowest recorded in 2009-10 (7.7%). In 2005-06 recorded more than 44.5% of dependable rainfall followed by 2013-14 (30.4%); 2010-11 (17.6%); 2007-08 (3.9%) and 2012-13 (3.6%).

References

1. Jones F. Agwata, Spatial Characteristics of Drought Duration and Severity in the Upper Tana Basin, Kenya, *Int. Res. J. Environment Sci.*, **3(4)**, 18-26 (2014)
2. Atef Al-Mashagbah and Mohammad Al-Farajat, Assessment of Spatial and Temporal Variability of Rainfall Data Using Kriging, Mann Kendall Test and the Sen's Slope Estimates in Jordan from 1980 to 2007, *Research Journal of Environmental and Earth Sciences*, **5(10)**, 611-618 (2013)
3. Manickam Valli, Kotapati Shanti Sree and Iyyanki V Murali Krishna, Analysis of Precipitation Concentration Index and Rainfall Prediction in various Agro-Climatic Zones of Andhra Pradesh, India, *Int. Res. J. Environment Sci.*, **2(5)**, 53-61 (2013)
4. Ishappa Muniyappan Rathide, Aruchamy.S, Spatial analysis of rainfall variation in Coimbatore District Tamilnadu Using GIS, *International journal of Geomatics and geo sciences.*, **1(2)**, 106-118 (2010)
5. X. Lana, A. Burgue, M. D. Martinez and C. Serra., A review of statistical analyses on monthly and daily rainfall in Catalonia, *Journal of Weather and Climate of the Western Mediterranean*, *Tethys*, **6**,15-29 (2009)
6. Neeraj Bhargava, Ritu Bhargava, Prakash Singh Tanwar and Ankit Sharma, Rainfall Spatial Analysis using GIS, *International Journal of Advanced Research in Computer and Communication Engineering*, **2(5)** 2198-2200 (2013)
7. Tirkey Anamika Shalini, Pandey A.C. and Nathawat M.S., Groundwater Level and Rainfall Variability Trend Analysis using GIS in parts of Jharkhand state (India) for Sustainable Management of Water Resources, *Int. Res. J. Environment Sci.*, **1(4)**, 24-31 (2012)
8. Deshpande N. R., Kulkarni B.D., Verma A.K. and Mandal B.N., Extreme rainfall analysis and estimation of Probable Maximum Precipitation (PMP) by statistical methods over the Indus river basin in India, *Journal of Spatial Hydrology*, **8(1)**, (2008)
9. Mohamad nooh hassani and Roger D. Stern, A Simple Method for Analyzing Daily Rainfall Data, *a Case Study for Kota Bharu. Pertanika*, **11(1)**, 101-106 (1988)
10. Sharma Manish, Mishra Sunil K. and Tyagi Shuchi, The Impact of Torrential Rainfall in Kedarnath, Uttarakhand, India during June, 2013, *Int. Res. J. Environment Sci.*, **2(9)**, 34-37 (2013)