ORIGINAL RESEARCH PAPER

Earth Science

Temporal, Seasonal and Spatial Rainfall Analysis of Dindi Reservoir catchment area using GIS, Mahabubnager and Nalgonda Districts, Telangana, India

KEY WORDS: Spatial, Seasonal, Rainfall, Dindi, Temporal, GIS

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ABSTRACT

Rainfall data of 16 years from the 6 rain gauge stations covering the Dindi river basin such as Midjil, Kalwakurty, Vangur, Uppununtala, Achampet and Balmur mandal were used in this study. Average rainfall over the thirteen years is 613.2 mm. Average highest rainfall i.e. 796.4 mm recorded at Kalwakurthy and lowest rainfall i.e. 529.5 mm received at Vangoor. Over the thirteen years highest rainfall recorded in 2005-06 at Kalwakurthy where as lowest found in 2004-05 at Balmoor. Annual rainfall trend of the study area indicating that decreasing trend was showed in Achampet, Uppunuthala, Midjil, Kalwakurthy, Talakondapalli and Vangoor stations; and increasing trend was evidenced in Balmoor station only. The analysis proved that average monthly highest rainfall in south west monsoon season was received in September, in north east monsoon highest rainfall was experienced in October month and April was the highest rainfall recorded month in summer. Annual rainfall departure is ranged from 48.2% in 2011-12 to 95.9% in 2005-06. 2004-05, 2006-07, 2011-12 and 2015-16 were the drought years in the study area which was received below 75% of the normal rainfall. During south west monsoon highest rainfall (760.8 mm) was received in 2005-06 and lowest was (240.8 mm) received in 2011-12. North east monsoon in 2013-14 highest rainfall (386 mm) as well as lowest (23 mm) was received in 2011-12. In winter only in 2012-13, 22.9 mm and in summer highest rainfall was 156.7 mm of rainfall was recorded. Of the total annual rainfall 71% of the rainfall was recorded in south west monsoon; 20% was received in north east and remaining 9% was received in summer. Spatial distribution of the average annual rainfall, south west, north east and summer seasons over the period of thirteen years shows that central and extreme north of the area received less than average rainfall and remaining area has more than average rainfall.

Introduction:

Agriculture is the backbone of India's economy. Nearly 70% of the working population depends on agricultural activities for their livelihood. The majority of India's population depends on cereal and pulse production for sustenance. Rainfall occurring over India during summer monsoon season (the major rainy season generally starts in June and ends in September) significantly affects the agricultural production of the country by providing water for the two main crop growing seasons, Kharif (summer) and Rabi (winter). Variations in the monsoon rainfall affect the total food grain yield of India and also the country's economy, which largely depends on agriculture [1, 2, 3]. Rainfall is one of the important variables associated with monsoons in any part of world and the quantity of rainfall within a week or month varies widely. The monsoon season is fairly organized spatially over seasons on a large scale but this is not true for smaller scale domains1. The optimum time and space scales for rainfall are not well studied in the local domain and therefore it becomes important for one to understand the dynamics of the rainfall seasonally and annually [4, 5, 6]. Rainfall patterns usually have spatial and temporal variabilities. These variabilities affect the agricultural production, water supply, transportation, the entire economy of a region, and the existence of its people. In regions where the year-to-year variability is high, people often suffer great calamities due to floods or droughts [7, 8, 9]. Precipitation plays a significant role in agriculture and it is a major area in climatological studies. Studying about precipitation is important in (i) identifying precipitation characteristics; occurrence and temporal & spatial variability (ii) statistical modeling and forecasting of precipitation and (iii) resolving the problems such as floods, droughts, landslides, etc [10, 11]. The complete understanding of the range and the likelihood of rainfall amounts received in a certain location can provide the designers, planners and decision makers' useful guides to prepare for and deal with the consequences of precipitation anomalies [12, 13]. Arc map is a product of ESRI (Environmental System Research Institute). It is a powerful GIS tool for spatial visualizing, querying, exploring and analyse spatial data. Arc Map 10.2 provided tools to facilitate our GIS operations as well as strategic updates to existing capabilities. To provide support for datum transformations and range of data projections the It introduced a new shape file projection utility. Arc Map10.2 included significant database access improvements and tools which are helpful in analysing data [14].

Study area

Geographically the study area is located longitude between 78°19'31.2"E and 78°54'35.8"E to latitude between 16°50'40.6"N and 16°11'24.9"N; covering survey of India toposheet numbers 56L/5, 56L/6, 56L/7, 56L/10, 56L/11, 56L/14, 56L/15. Figure 1 shows the location map of study area. The study area lies at the north and south of Dindi reservoir covering part of Dindi River catchment which is tributary of Krishna River. Geographical area of the study area is 14, 840 sq.m. Administratively it could be found in Mahabubnagar district of Telangana state, India which is about 115 kilometers by the road from the Hyderabad to Kalvakurthy at Dindi Village, boarder of Nalgonda district on east.

Material and methodology

Thirteen years i.e. from 2006-2016, monthly rainfall data of Telakapally, Midjil, Kalwakurthy, Vangoor, Uppunuthala, Achampet and Balmoor maldals of project area has been collected from the Statistics department, Government of Telangana State. This data was used for analysis of monthly, annual, seasonal variations and trend analysis. Linear trend graphs has been prepared in Microsoft excel as well as Spine spatial interpolation tools in Arc map 10.2 was used to generate the rainfall spatial maps of the study area.

Results and Discussions

Average annual rainfall: The data represents the seven mandals such as Achampet, Uppunuthala, Kalwakurthy, Vangoor, Balmoor, Midjil and Talakondapalli which is falling in the project area. Average rainfall of the study area over the 13 years i.e., from 2003 to 2016 hydrological year is 613.2 mm.

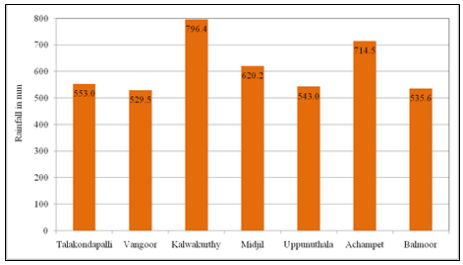

Figure 1: Average annual rainfall of 2013 to 2016

Above figure 1 shows that average highest rainfall (796.4 mm) recorded at Kalwakurthy, followed by Achampet (714.5 mm), Midjil (620.2 mm), Talakondapalli (553 mm), Uppanuthala (543 mm), Balmoor (535.6 mm) and Vangoor (529.5 mm). Four stations such as Balmoor, Uppunuthala, Vangoor and Talakondapalli was received less than average rainfall where as three stations like Kalwakurthy, Achampet and Midjil was received more than average.

Annual rainfall: Figure 2 reveals that highest rainfall recorded in 2005-06 at Kalwakurthy where as lowest found in 2004-05 at Balmoor.

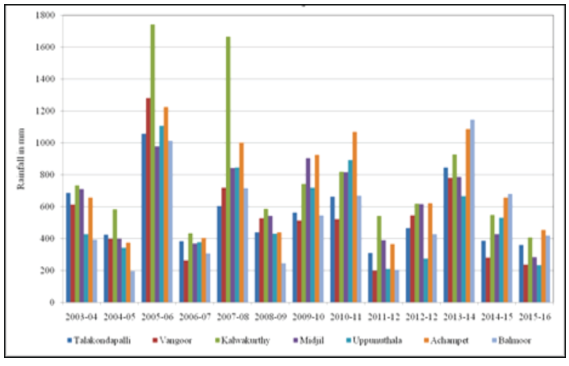

Figure 2: Annual Rainfall of study area

Annual rainfall trend: At Achampet highest rainfall (1225 mm) was recorded in 2005-06 where as lowest (367 mm) was received in 2011-12 which shows the decreasing trend over the 13 years (figure 3). Highest rain fall (1108 mm) recorded in 2005-06 where as lowest (211 m) measured in 2011-12 that shows the decreased trend in Uppunuthala.

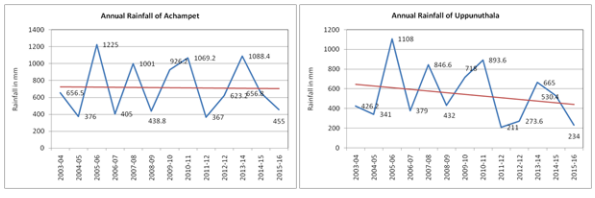

Figure 3: Annual rainfall and trend of Achampet and Uppunuthla mandal

In Blamoor highest rainfall (1145.8 mm) was recorded in 2013-14 where as lowest (196.5 mm) was found in 2004-05 that sows the increasing trend. In Midjil highest rainfall (977 mm) was recorded in 2005-06 where as lowest (282.2 mm) was found in 2015-16 that shows the decreasing trend.

Figure 4: Annual rainfall and trend of Balmoor and Midjil mandal

In Kalwakurhy highest rainfall (1744 mm) was recorded in 2005-06 where as lowest (406.2 mm) was found in 2014-15 which shows the decreasing trend. In Vangoor highest rainfall (1281 mm) was recorded in 2005-06 where as lowest (235 mm) was found in 2015-16 that shows the decreasing trend. In Talakondapally highest rainfall (1058.8 mm) was recorded in 2005-06 where as lowest (310.4 mm) found in 2011-12 that shows Graph 2.4 the decreasing trend.

Figure 5: Annual rainfall and trend of kalwakurthy, Talakondapalli and Uppunuthla mandal

Average monthly rainfall: Graph 6 shows that average highest amount rainfall (141.8 mm) received in the month of September followed by August (118.6 mm), July (107.2 mm), October (101.2 mm), June (63.9 mm), November (20.9 mm), April (27.6 mm), May (18.1 mm), March (10.2 mm), February (2.0 mm), December (1.6 mm) and no rainfall in January.

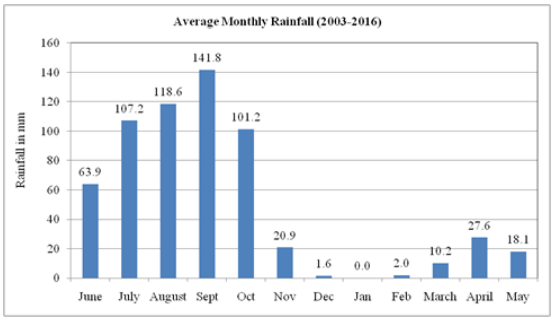

Figure 6: Average monthly rainfall distribution of study area

Annual rainfall departure: Annual rainfall departure over the thirteen years ranged from -48.2 % in 2011-12 to 95.9 % 2005-06. Departure in 2007-08 is 49 % followed by 45.4 % in 2013-14, 27.1 % in 2010-11, 14.5 % in 2009-10, -1.7 % in 2003-04, -16.7 % in 2012-13, 18.3 % in 2014-15, -25.2 % in 2008-09, -36.7 % in 2004-05, -40.8 % in 2006-07 and -44.3% in 2015-16. Four years such as 2004-05, 2006-07, 2011-12 and 2015-16 were drought years that received less than 75 % of the normal rainfall in the study area.

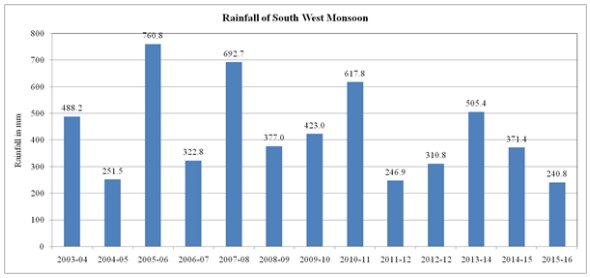

Figure 7: Rainfall of south west monsoon of study area

Rainfall of south west monsoon: Figure 7 depicts that during south west monsoon (June to September) highest amount of rainfall (760.8 mm) was received in 2005-06 followed by 2007-08 (692.7 mm), in 2010-11 (617.8 mm), in 2013-14 (505.4 mm), in 2003-04 (488.2 mm), in 2009-10 (423mm), in 2008-09 (377 mm), in 2014-15 (371.4 mm), in 2006-07 (322.8 mm), in 2012-13 (310.8 mm), in 2004-05 (251.5 mm), in 2011-12 (246.9 mm) and minimum (240.8 mm) found in 2015-16.

Rainfall of North East monsoon: Figure 8 depicts that during north east monsoon (October to December) highest amount of rainfall (386 mm) received in 2013-14 followed by 2005-06 (283.6 mm), in 2009-10 (238.5 mm), in 2007-08 (132.1 mm), in 2012-13 (127.3 mm), in 2010-11 (86.1mm), in 2004-05 (84.6 mm), in 2003-04 (73.1 mm), in 2014-15 (55.1 mm), in 2008-09 (53 mm), in 2006-07 (40 mm), in 2015-16 (26.1 mm) and minimum (23 mm) found in 2011-12.

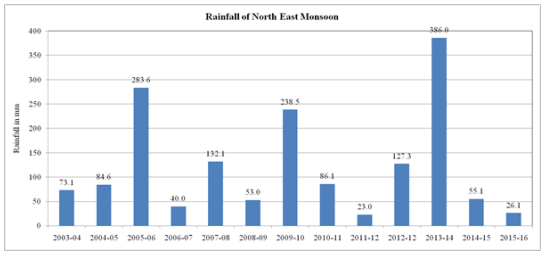

Figure 8: Rainfall of North East monsoon of study area

Rainfall of the winter season: Graph 9 depicts that during winter (January and February) highest amount of rainfall (22.9 mm) received in 2012-13 followed by 2007-08 (2.7 mm) and minimum amount of rainfall received in 2003-04; and remaining years there is no rainfall.

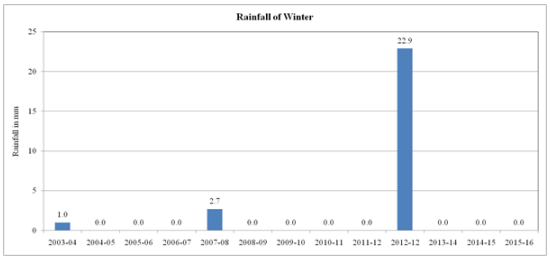

Figure 9: Rainfall of winter of study area

Rainfall of summer: Graph 2.9 depicts that during summer (March to May) highest amount of rainfall (156.7 mm) received in 2005-06 followed by 2007-08 (85.9 mm), in 2010-11 (75.4 mm), in 2014-15 and in 2015-16 (74.8 mm), in 2004-05 (52.2 mm), 2012-13 (49.5 mm), in 2011-12 (47.6 mm), in 2009-10 (40.7 mm), in 2003-04 (40.3 mm), in 2008-09 (28.9 mm) and remaining years 2006-07 and 2013-14 there is no rainfall.

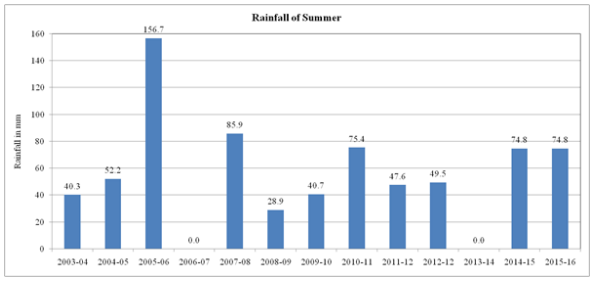

Figure 10: Rainfall of summer of study area

Seasonal distribution of rainfall: Graph 2.10 describes that over the period of thirteen years (2003-16) during south west monsoon 431.5 mm of rainfall has been received that is 71 percent of total average rainfall. During North West monsoon 123.7 mm of rainfall (20%) and during summer 55.9 mm of rainfall i. c., 9 % and during winter season only 2 mm of rainfall has been received in the study area.

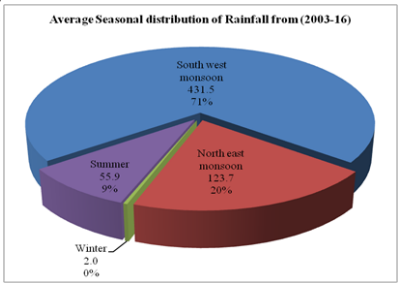

Figure 11: Seasonal distribution of rainfall

Spatial distribution: Thematic maps of annual average rainfall, south west monsoon, North east monsoon, winter and summer has been prepared in Geographic Information System (Ishappa Muniyappan Rathide et al, 2009; Sukumar S, et al, 2001). In all season's distribution of the rainfall has been divided based on the average rainfall of particular season.

Annual rainfall: Figure 12 shows that in the study area average annual rainfall (613.2 mm) over the period of thirteen years distributes at central and extreme north of the area and remaining area has more than average rainfall.

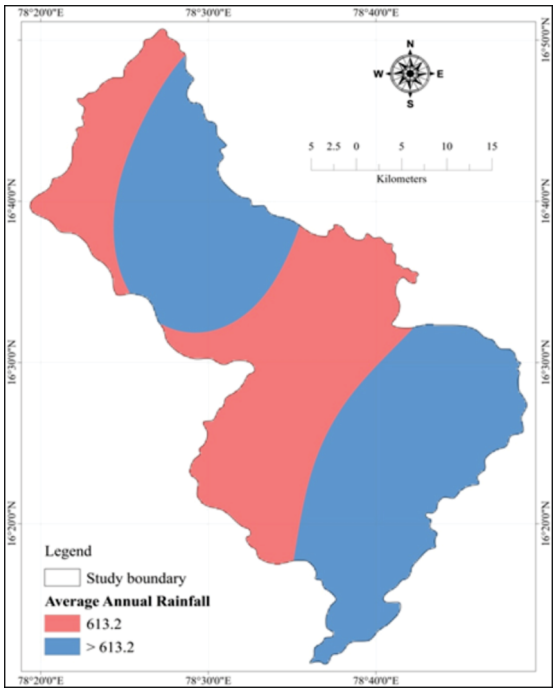

Figure 12: Distribution of average annual rainfall

South West Monsoon: Figure 13 reveals that in the study area average rainfall in south west monsoon (431.5 mm) experienced at central and north edge where as remaining are has more than average in south west monsoon.

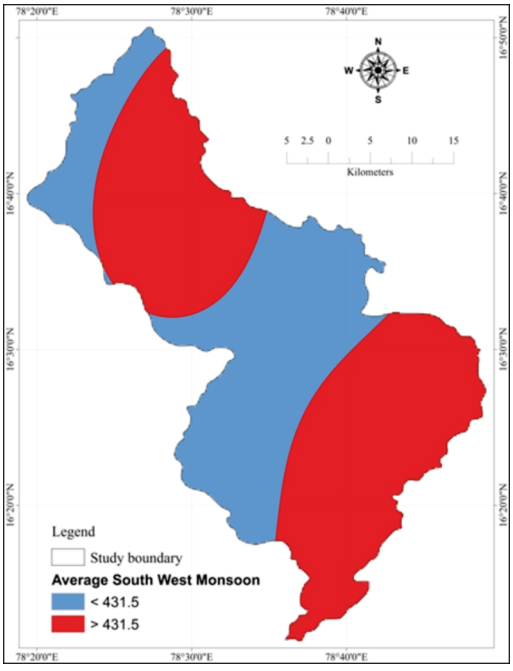

Figure 13: Distribution of average south west monsoon

North East Monsoon: Figure 14 described that below or with in average rainfall experienced in east and remaining are has more than average rainfall.

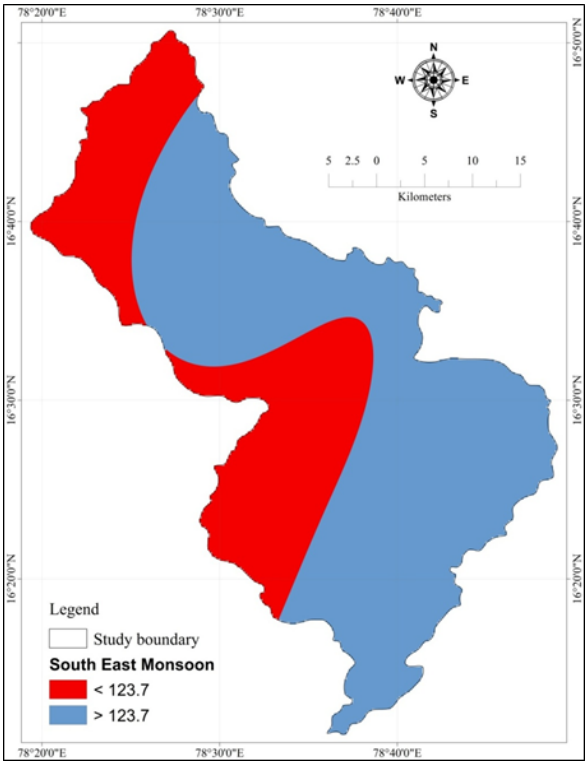

Figure 14: Distribution of north east monsoon

Winter: Figure 15 reveals that Average with in average rainfall experienced in central part of the study area and remaining area has more than average rain fall.

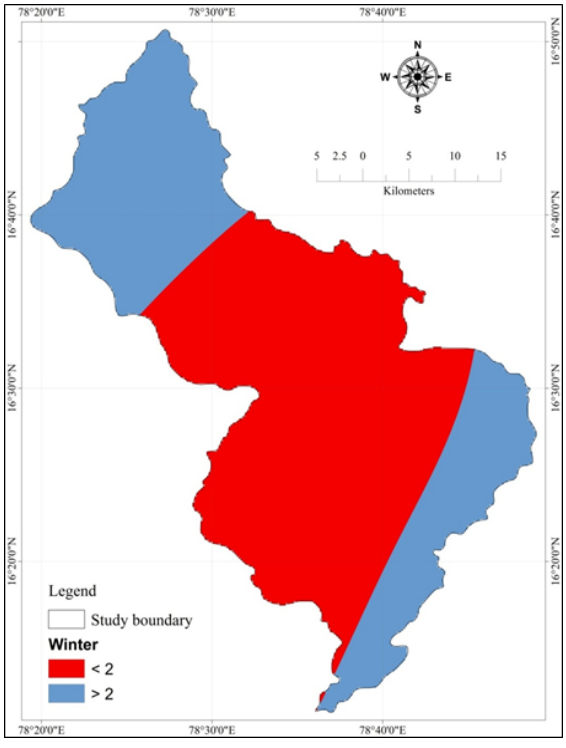

Figure 15: Distribution of winter season

Summer: Figure 16 describes that in the study area average summer rainfall (613.2 mm) over the period of thirteen years distributes at central and extreme north of the area and remaining area has more than average

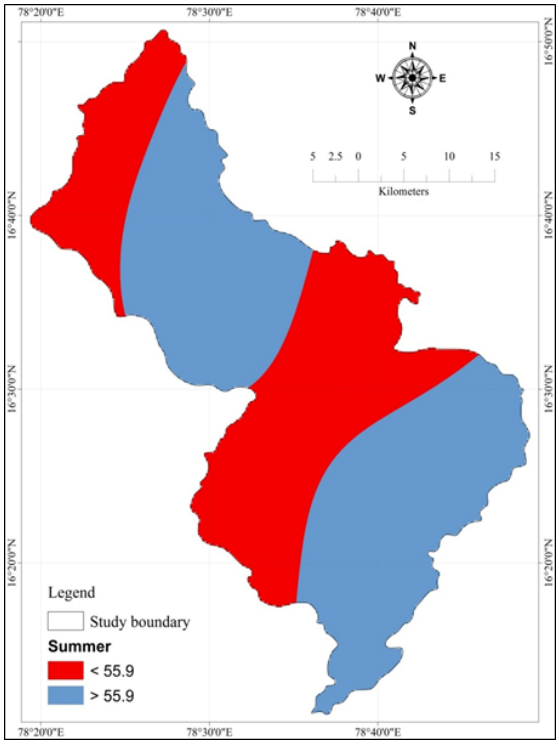

Figure 16: Distribution of summer season

Conclusions

Decreasing trend of the rainfall in the study area is indicating to be focus on the rainfall harvesting structures. Rainfall in the summer could be helpful to the farmers for starting of sowing at right time in which this period has been received about 9 % of the total rainfall. More than normal rainfall in all seasons including annual and seasonal had been received at southern and middle of the northern of the study area indicating at high altitudes has been received more rainfall than other parts.

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