Spatial and Temporal Rainfall Trend Analysis: At Assosa &Bambasi in Assosa Zone,BenishangulGumez Region, Ethiopia

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Abstract
The main aim of this study was investigated the temporal (annual, seasonal, monthly) rainfall and its spatial distribution with in Assosa and BambasiStations. In Ethiopia, rainfall is variable climate element both of them amount and distribution. The assessment used historic climatic data (Rainfall data (1989-2021) were collected from Assosa meteorological service center. Based on the 33 year period rainfall record, analysis was carried out to extract the trends of seasonal and annual rainfall. Correlation of annual rainfall between the two stations in the period of 1989-2021 is around 0.35 that mean medium.They are in the same rainfall regime; the correlation shows that they have positive correlation. The coefficient of variation and standard deviation for 1989 to 2021 ranged from 0.2 to 0.3,respectively, confirming the moderate variability of the mean monthly rainfall over the two stations. This shows that outside of the 4-months rainy period, there are highly variableBelg and Bega. In this result, the mean annual rainfall coefficient of variability Is indicated moderate to high rainfall variability and both variables tend to positive relationship.
Keywords: Trends, Climate change, Rainfall Variability, Benishangul Gumez,Ethiopia
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1. Introduction

Climate change is emerging as one of the main challenges humankind is facing and will have to face for many years to come. It could become a major risk to world food security, as it has a strong effect on food production, access and distribution.Potential impacts of climate change on world food supply have been estimated in several studies (Parry, 2004).Climate variability: Variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events (Fusel and Klein, 2006,). it became due to natural internal processes within the climate system to variations in natural or anthropogenic external forces (external variability) Most of the climate scientists agree that, the current global climate change is due to human activities (Oreskes, 2004).According to IPCC (2007), climate variability refers to (daily, monthly, yearly, inter-annual, several years) variations in climate, including fluctuations associated with, for example tele-connection systems, *El Niño* (warming) or *La Niña* (cooling) events, which is spatial and season specific .Diro et al. in 2011 [2] described the highlands of Ethiopia to exhibit three cycles of seasonalrainfall: spring mid-rainy season (February–May), summer rainy season (June–September), and dryseason (October–January), locally known as Belg, Kiremt, and Bega seasons, respectively .Seasonal rainfall in Ethiopia is driven mainly by the migration of the Inter-Tropical Convergence Zone (ITCZ).(*McSweeneyet al*2010). Osman and Sauer born (2002) determined that summer rainfall (known as Kiremt) in the central highlands of Ethiopia declined in the second half of the 20th century, while Seleshi and Zanke (2004) failed to find such a trend over central, northern, and northwestern Ethiopia. Instead, they found a decline of annual and Kiremt rainfall in eastern, southern, and southwestern Ethiopia since 1982.so, understanding the variations in rainfall both spatially and temporally and improving the ability of forecasting rainfall may help in planning for any purpose e.g.crop cultivation , designing water storages, planning drainage channels for flood mitigation, etc. so that the paper focuses on the trends and seasonal patterns of rainfall on a set of selected weather stations by utilizing statistical techniques. The work was considered monthly and annual rainfall data recorded on 2 stations within a time 33 years. Emphasis was given to find out whether there is any significant change in the rainfall time series records over the years. The study would also address the temporal climate change trend of precipitation and its variation over the two stations.

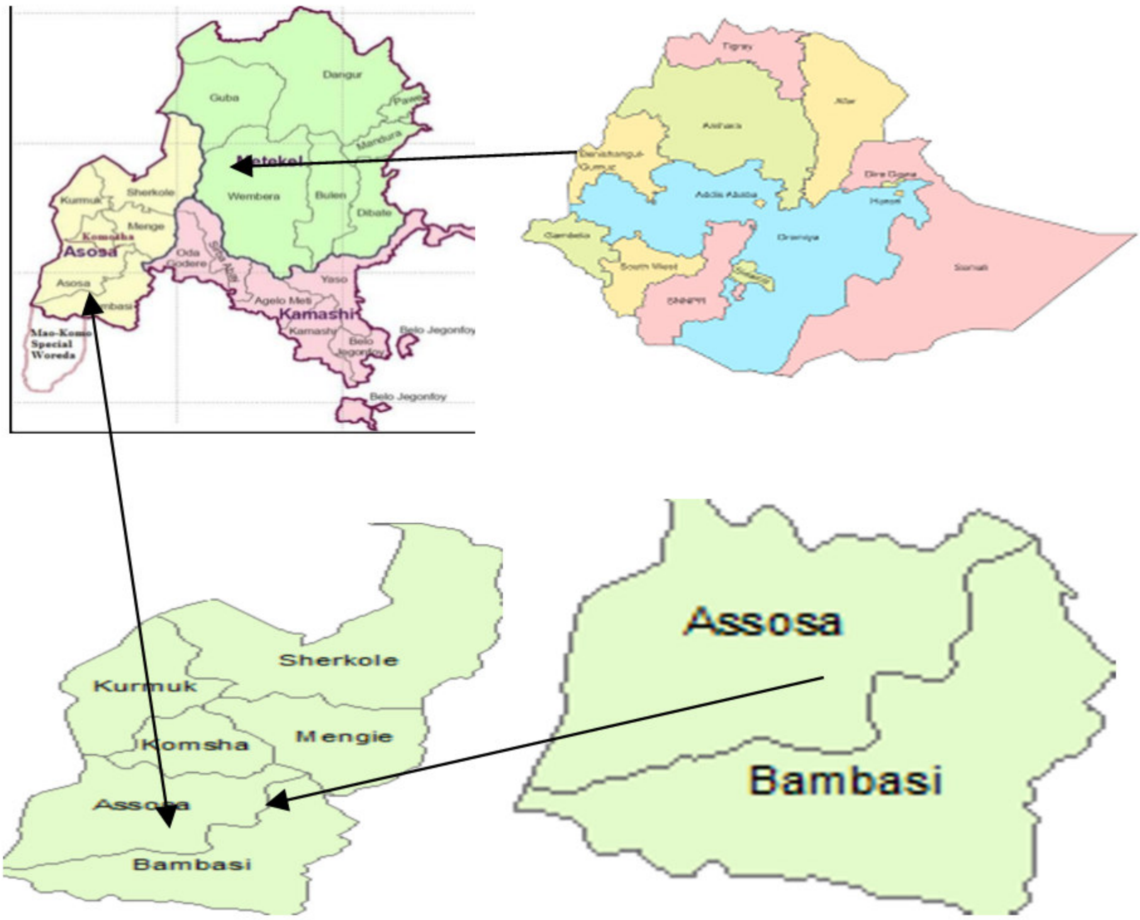
2. Objective

To assess rainfall variability and Investigated the temporal (annual, seasonal, monthly) dynamics of rainfall and its spatial distribution with in Assosa and Bambasi stationsin BenishangulGumuz, Assosa Zone. Changes in rainfall were examined using data from both stations in between 1989-2021. The variability and trends in seasonal and annual rainfall were analyzed with data from all available years.

3. Data and Methodology

3.1.Description Study Area

The study area was connected in assosa zone,at Assosa&Bambasi woreda.Assosa is one of the zone found in Benishangul-Gumuz Region of Ethiopia. This Zone was named after the Assosa Sultanate, which had approximately the same boundaries. Assosa is bordered on the south by the Mao-Komo special woreda, on the west by Sudan, and on the north east by the Kamahi. The largest town in this zone is Assosa. Located in the Assosa Zone, this town has a latitude 10°02' 44.4"N and longitude 34°32' 45.2" E. Bambasi town has longitude34° 43' 44 .3"E, latitude 09° 45' 03.9"N (station History profile of under Benishangul Gumuz Meteorological service center ,2000).The altitude of Assosa 1541and Bambasi 1485 metersabove sea level with Keremt season total rainfall is around 1221.8, Assosa and 1296.9.0 Bambasiamount of rainfall in millimeters. The distance between Assosa and Bambasi is 42 km.



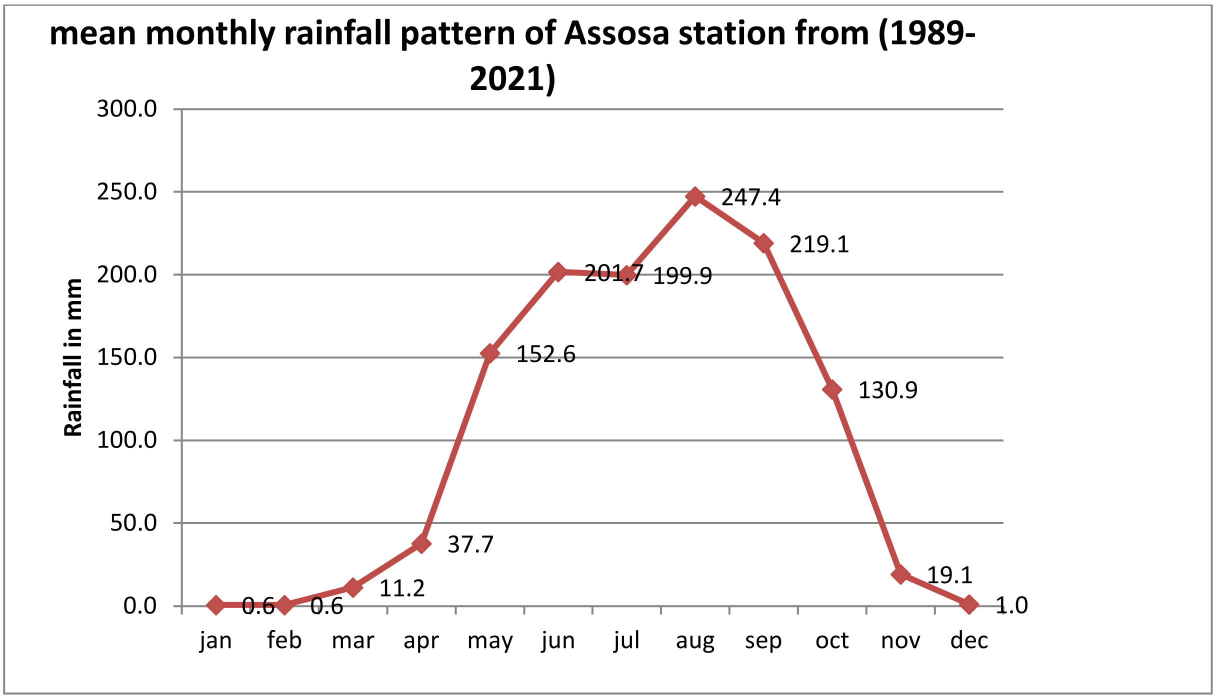
Location Map (Source: Extracted from Ethio-GIS

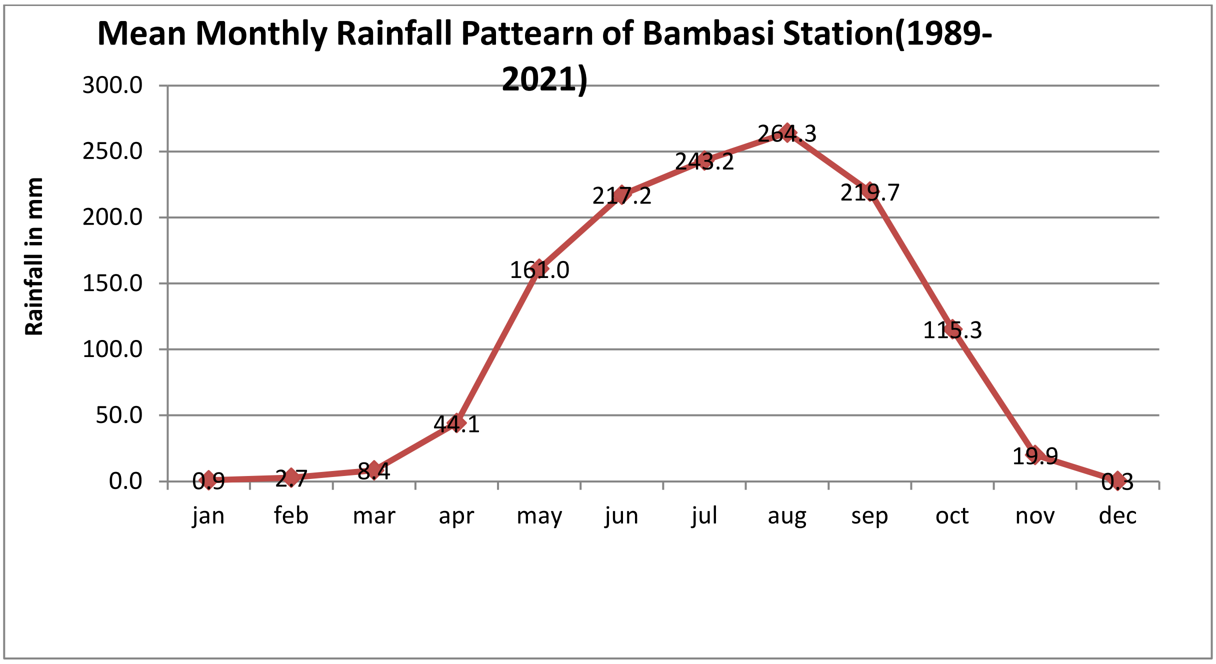
3.2. Method of data analysis

For the study of rainfall variation in annual and seasonal basis with available data for both stations are selected and used in the analysis, which have less number of missing data. But According to Stern *et al*. (2006), missing data was filled with mean values. The record period 1989-2021 are taken as the common periodwhere statistical test is applied to detect and measure trend. This 33 year period is selected to see change ofrainfall variation recently in the areas. The procedure is prepared on MS-Excel worksheet andthe computation is finished on the worksheet.

4. Results and Discussion

4.1 Rainfall Statistics





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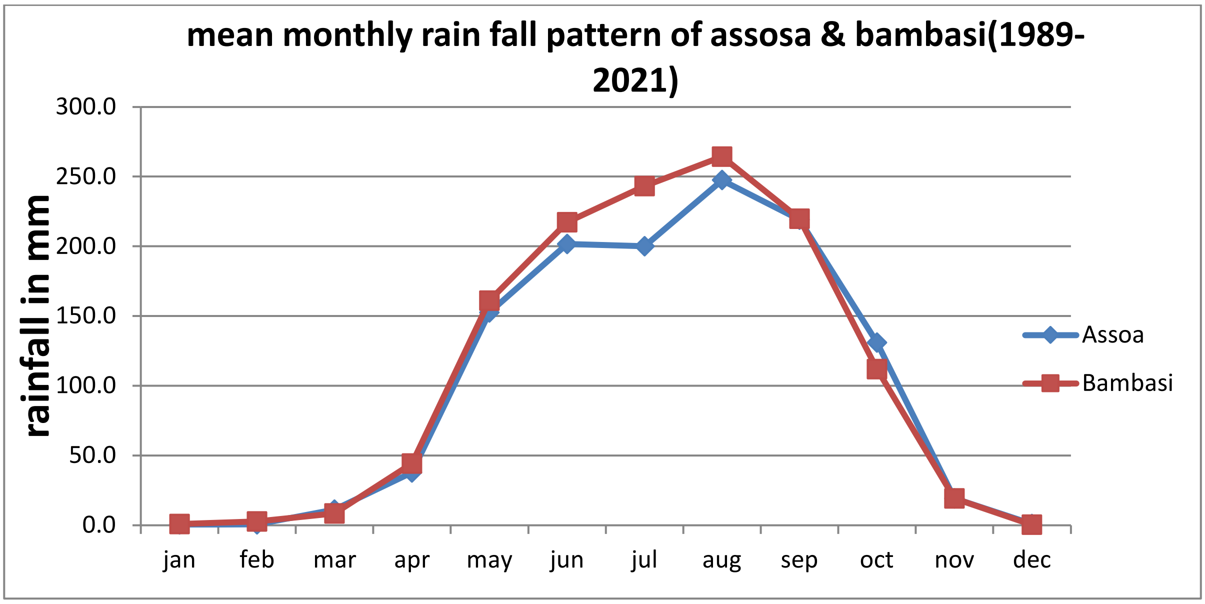
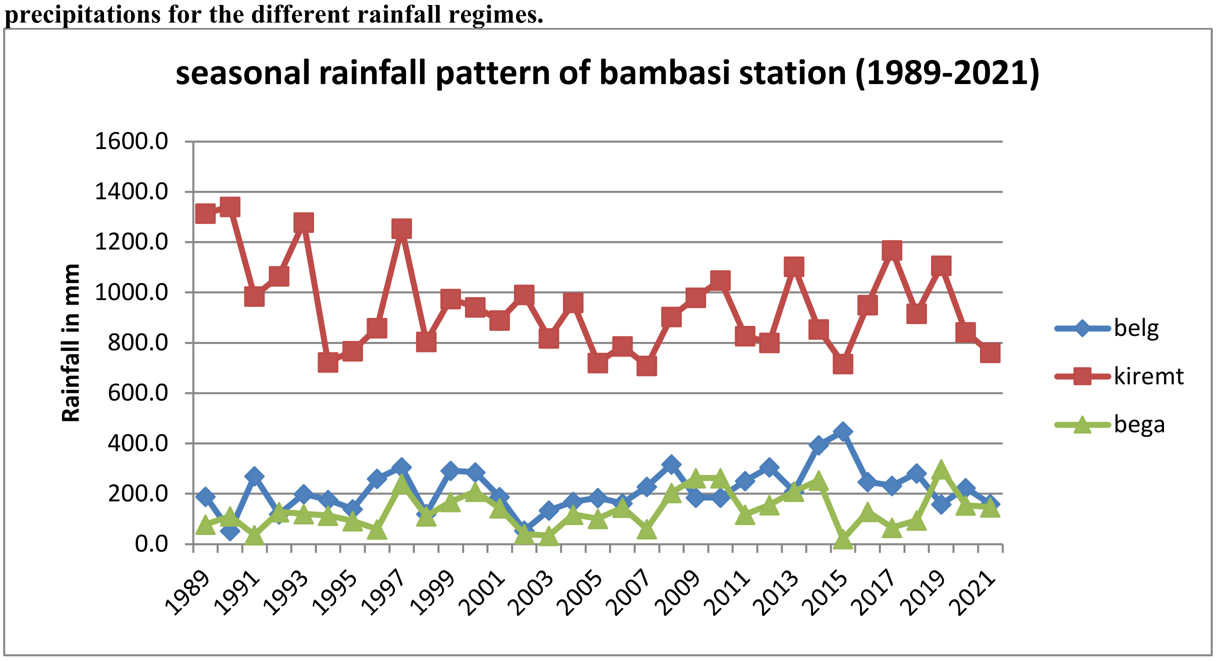
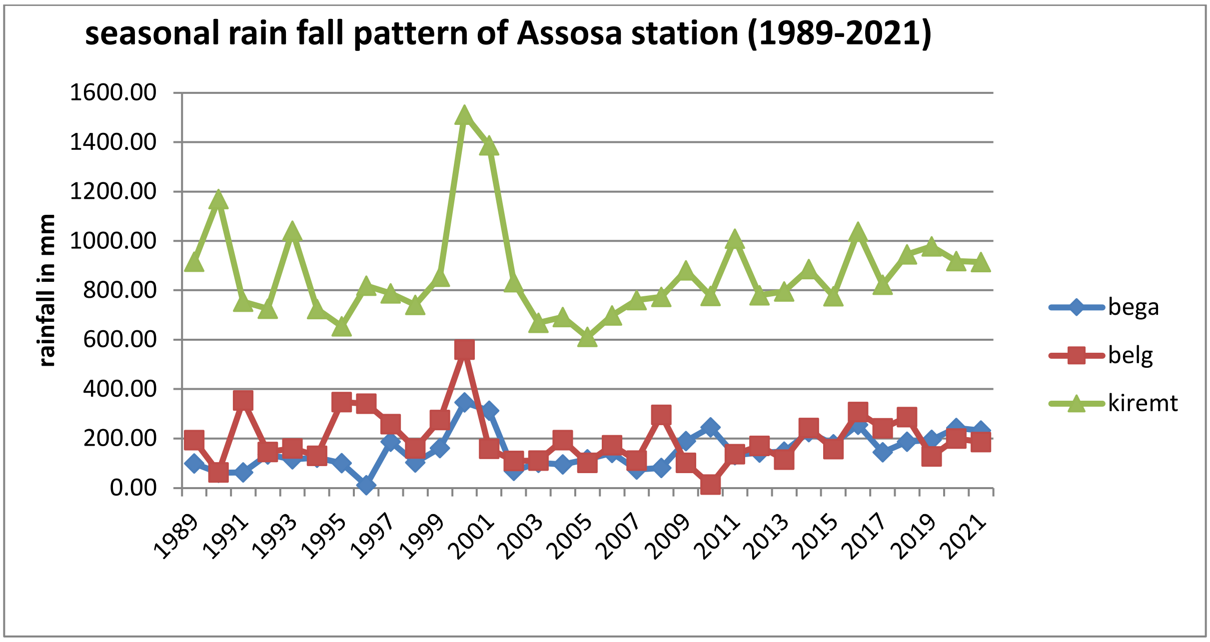


When we compare both station, Aug had more rainfall distribution than the other months. When monthly rainfall was mapped over the areas, it was found to vary from one location to another and the total Monthly rainfall recorded in Bambasi is much greater in amount than Assosa. Generally, Kiremt rainfall condition was satisfactory andsingle maxima type for both of them temporally or spatially.

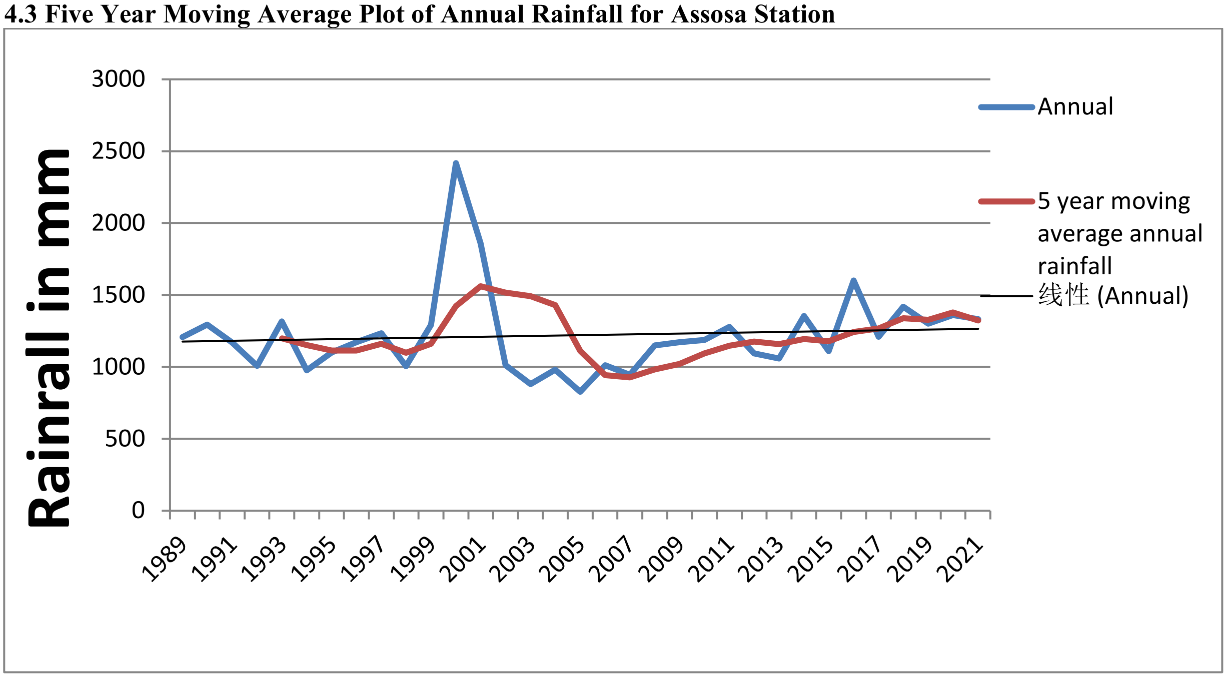
4.2 Observations of mean spatial distribution of seasonal Kiremt (JJAS), Belg (FMAM) and Bega (ONDJ precipitations for the different rainfall regimes.



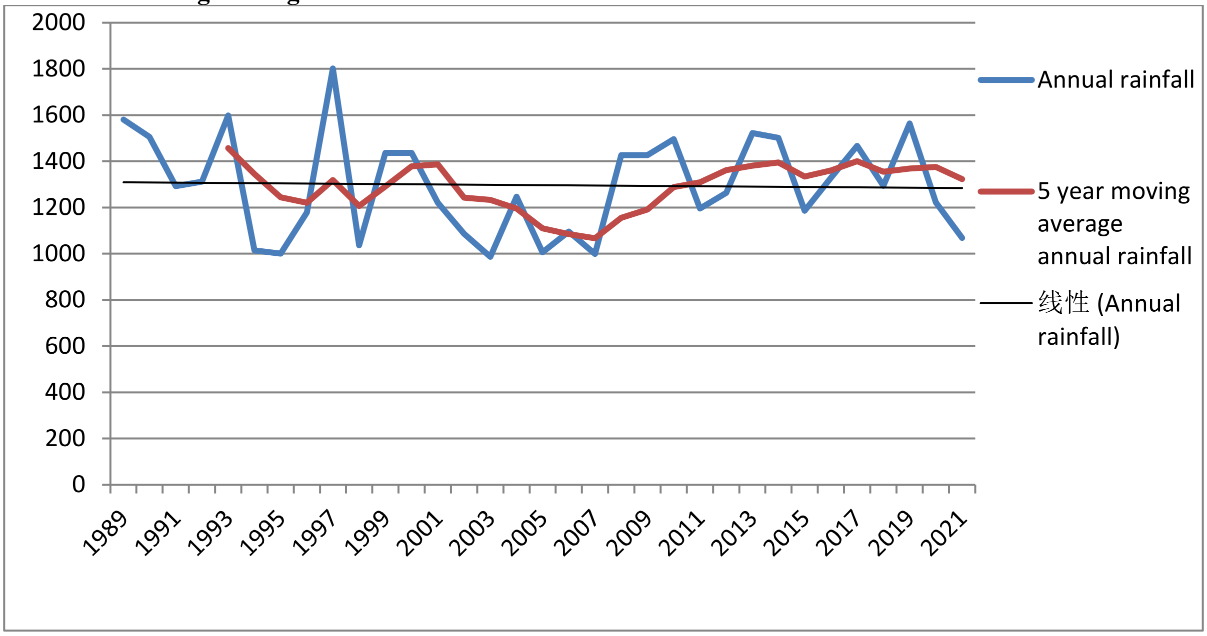


In Kiremt season occur high rain fall amount and the remaining occurs in the Belg season, less rainfall also occurs in Bega. The annual Rainfall is increases towards the Kiremt and has been found to range from 200 to 1400 mm for Bambas and from 200 to 1500 and above for Assosa. The Kiremt rain in both station shows that there is moderate variability since coefficient of variance is between 0.2-0.3. Bambasi station kiremt seasoncoefficient of variance is 0.19when it is close 0.20 and assosa kiremt season coefficient of variance is 0.225so,Theyhave moderate variability both season& annual rainfall. Result of annual coefficient of variance for Assosa=0.245 &for bambasi station annual coefficient of variance = 0.165 When it is close0.20.

4.3 Five Year Moving Average Plot of Annual Rainfall for Assosa Station



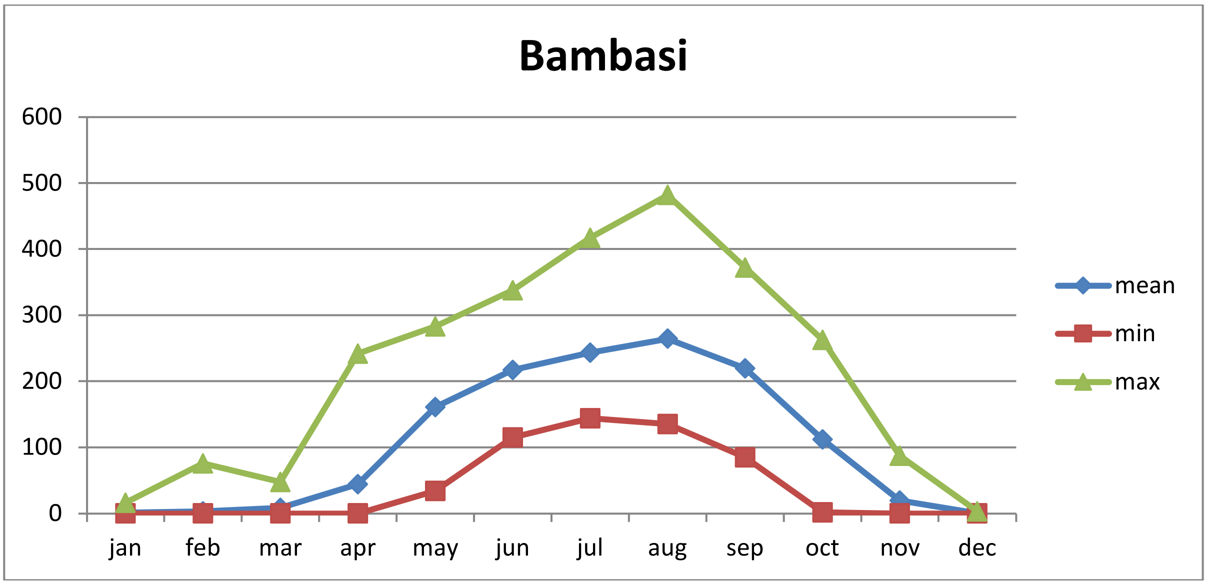
Five Year Moving Average Plot of Annual Rainfall for bambasi Station



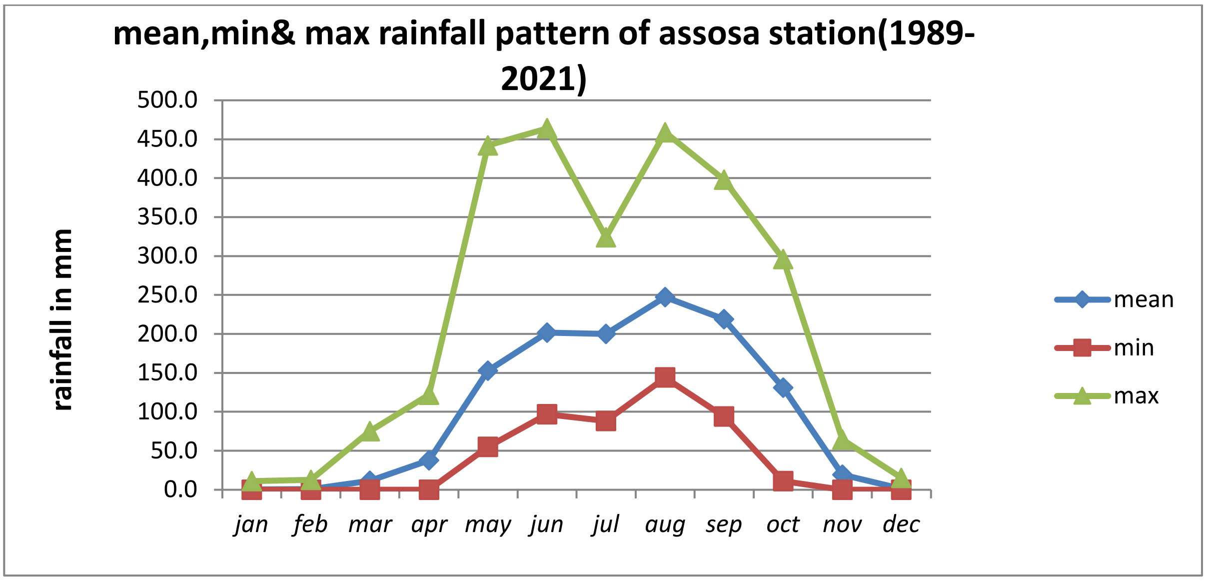
The cyclic nature of the monthly rainfall follows systematic down ward or upward turn. like 1998-2004for Assosa and 192-1998 for bambasi are marked by high cyclic index values. It seems that there is medium time oscillations embedded in long time oscillations in the cyclic components. As the time step in the data is annual and have to be calculated 5-years moving averages

4.4 Climatological data as total monthly rainfall in millimeters (mm) and monthly minimum and maximum RF in mm the above mentioned for the years

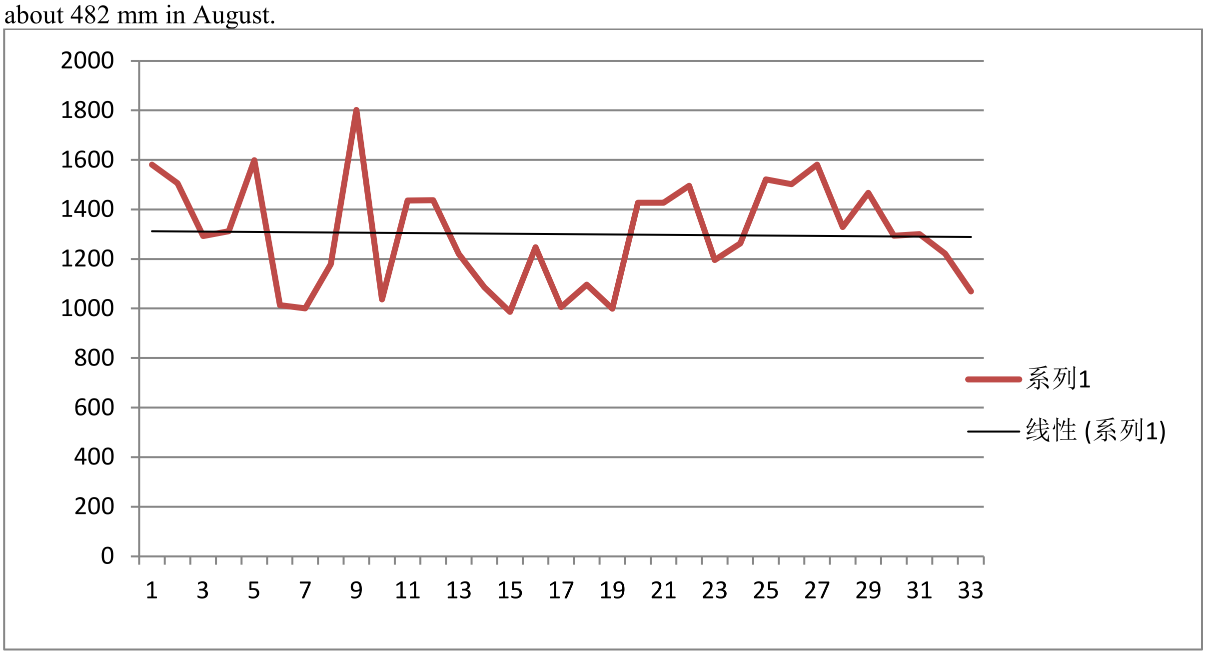
bambasi	Jan	fib	mar	par	may	Jun	jug	au	seep	cot	nova	Dec
mean	0.9	2.7	8.4	44.1	161.0	217.2	243.2	264.3	219.7	111.8	19.3	0.3
min	0.0	0.0	0.0	0.0	34.0	114.8	144.0	135.0	85.0	1.3	0.0	0.0
max	15.8	75.8	47.4	241.7	283.0	337.7	417.0	482.0	372.0	262.4	87.0	3.1

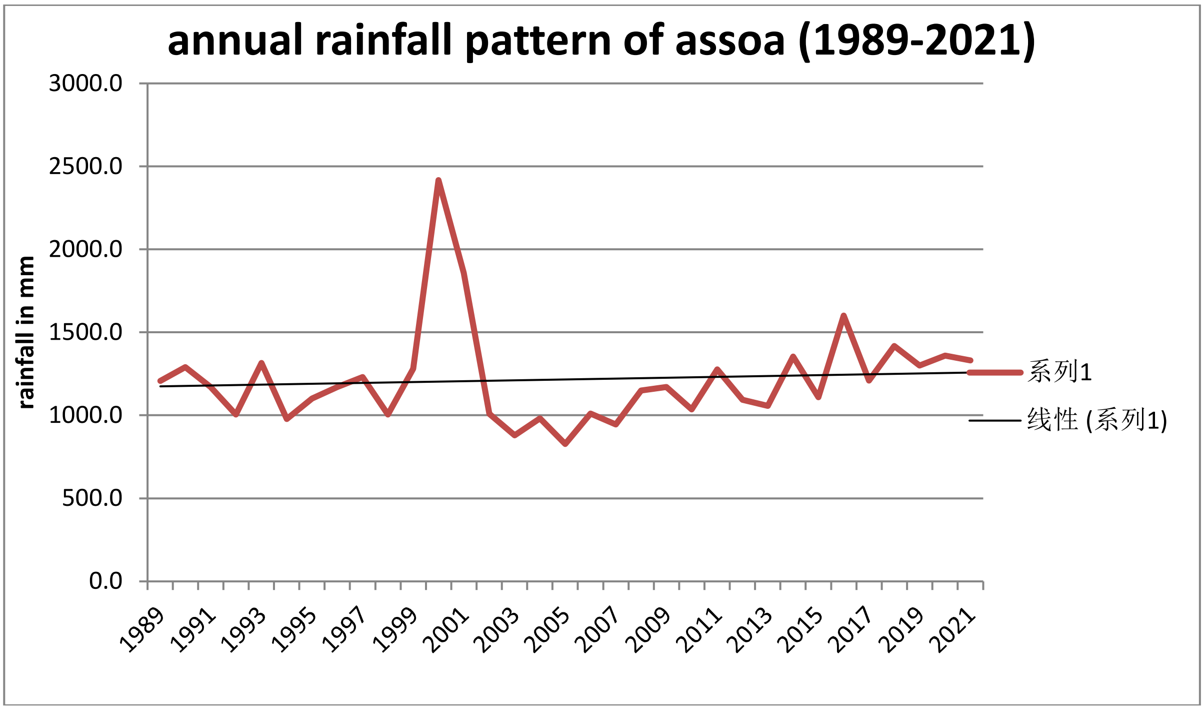


assosa	Jan	fib	mar	par	may	Jun	jug	au	seep	cot	nova	Dec
mean	0.6	0.6	11.2	37.7	152.6	201.7	199.9	247.4	219.1	130.9	19.1	1.0
min	0.0	0.0	0.0	0.0	55.0	97.0	88.4	144.0	94.0	11.0	0.0	0.0
max	11.0	12.5	75.2	122.0	442.0	464.0	324.0	459.0	398.0	296.0	64.5	15.0



In Bega and Belg season have been Monthly minimum RF about 0 mm in the both stations without may. Monthly maximum RF recorded in Kiremt.from both stations the highest amount of rainfall recorded atbambasi about 482 mm in August.





Assosa and Bambasi are found in the same rainfall regime called Monomodal; the analysis demonstrates that bambasi stations are shown slight decreasing trend in rainfall magnitude as shown in the Fig. above. Correlation coefficient of annual rainfall between the two stations in the period of 1989-2021 is around 0.35, which is medium.Bothstations have positive relationship.but the correlation shows that they may not be subjected to the same climatic change influence.

NB- I used Pearson Product moment to calculate the cross-correlation of the annual rainfall of both\stations.

i.e.

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n(\sum x^2) - (\sum x)^2]\,[n(\sum y^2) - (\sum y)^2]}}$$

=0.35 there is positive relationship between both stations.There is covariance in climatic variables that affect the trend.

4.6 Statistical summary of areal rainfall data (1989-2021)

	Assosa				Bambasi			
month	Mean	Stdv	Cv	Skew	Mean	Stdv	Cv	Skew
Jan	0.6	2.01	3.23	4.66	0.88	3.14	3.57	3.26
Feb	0.6	2.2	3.53	5.21	2.7	13.18	4.89	5.69
Mar	11.2	20.95	1.87	2.25	8.44	12.96	1.54	1.44
Apr	37.7	20.95	0.56	1.2	44.14	47.94	1.09	2.63
May	152.6	77.03	0.5	1.67	161.05	57.5	0.36	-0.09
Jun	201.7	79.59	0.39	1.72	217.24	56.04	0.26	0.2
Jul	199.9	58.84	0.29	0.26	243.2	56.7	0.23	0.75
Aug	247.4	70.44	0.28	1.36	264.25	76.21	0.29	0.86
Sept	219.1	77.45	0.35	0.46	219.72	65.27	0.3	0.34
Oct	130.9	68.28	0.52	0.68	115.21	62.34	0.54	0.39
Nov	19.1	19.9	1.04	0.94	19.84	23.44	1.18	1.27
Dec	1.0	2.87	2.94	4.49	0.32	0.86	2.73	2.8
ANNUAL	1221.8	299.1	24.5	2.3	1296.9	214.4	16.5	0.2

The statistical summary of rainfall data from 1989 to 2021 considering monthly, mean, standard deviation and coefficient of variance rainfall data from selected station. In this table we can identify which have high variation of rainfall data by comparing the values of coefficient of variance and provides a measure of year-to-year variation in the data series. Which is calculated, dividing the standard deviation by the mean of the areal rainfall data. NMSA (1996) documented that CV lessthan 0.20 is less variable, CV between 0.20 and 0.30 is moderately variable and CV greater than 0.30 is highlyvariable. in the kiremt season, there is moderate variability, as observed from both station. The coefficient of variation and standard deviation for 1989 to 2021 ranged from 0.3 to 0.2,confirming the moderate variability of the mean monthly rainfall over the two stations.

5. Conclusions

There is no any significant change in the area of belg total rainfall trend.The mean of rainy month's or kiremt rainfall total shows moderate significant change and variability at both stations.in otherwise totals Annual rainfall show very less Significant change at both of them.The moving average plot shows that there appears to be cyclic tendency in annual rainfall.The amount of annual rainfall is positive correlated with the monthly rainfall of May-October and the Annul total rainfall trend shows slight decrees for both stations. Without kiremt season have high variability in both station that means Belg and Bega.

6. References

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