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A Performance Evaluation of Chirps Satellite Rainfall Data Over Rain Gauge Station Data of Sirsi Taluka, Uttarkannad District

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Abstract: ***Rainfall is most significant processes of hydrological cycle which has its own domain in the nature and also it stands essential for lives above and beneath the earth surface. It is generally recorded by raingauges but in recent days it has been recording through use of satellite. Hence the satellite records comparative or performance check is very important to make use data set for different studies of water resource management. Therefore, in present study CHIRPS satellite records of 20 years period (2002-2022) have been used for performance check over gauge station records of Sirsi taluka, Uttrakannad district. The Sirsi taluka basically contains 10 raingauge stations which are taken in to consideration for the present study. It is observed from linear regression method that CHIRPS satellite records performs good for stations Sirsi and Bandal (R^2= 0.39 to 0.46) as well as quite good for stations Janmane, Karur, Yakkambi, & Hulekal (R^2= 0.20 to 0.40) for both annual & monsoon rainfalls. Also it exhibited poor performance for the stations Hegadekatta, Hebbatti, Bidralli & Mugavalli resulting very minimal value for R^2 in the range of 0.03 to 0.1. As the study is carried out for monsoon and annual rainfall records, initially the performance check for satellite records is carried out using time series analysis. Which is helpful to study the satellite rainfall variations corresponds to gauge station records on the basis of visual interpretation. Then the strength of relationship between the two records is checked using linear regression method. Hence from both the methods CHIRPS data records performed well for stations Sirsi & Bandal.***

Keywords: hydrological cycle, performance, CHIRPS, time series analysis, linear regression

1. Introduction

Rainfall is a one of the very significant processes of hydrological cycle. The entire creation of earth basically depends on rain water to lead life over it. Hence it is essential for different usages namely, drinking, agriculture & irrigational use, power generation, industrial use etc. Therefore, its fluctuation makes life difficult, such as famine conditions threatens lives over earth. The tradition way of recording its amount is with rain gauge stations installed by IMD [Indian Meteorological Department].But in recent days the amount of rainfall is also recording through satellites. Therefore for the proper management of water to different sectors the records of the satellite data needs to be evaluated for the performance check with the ground station records. So as to have dependency over records when no station records are available for water resource management studies. Hence here an effort is made to carryout a performance evaluation of CHIRPS[Climate Hazards Group InfraRed precipitation with station data], developed by the United State Geological Survey (USGS) and the Climate Hazards Group at the University of California, Santa Barbara, with rain gauge station records of Sirsi taluka, Uttarkannada district. A CHIRP incorporates 0.05degree resolution satellite imagery with in-situ station data to create gridded rainfall time series for trend analysis and seasonal drought monitoring. Basically Sirsi is a one of the taluka in Uttarkannada district situated at latitude of 14.61º & longitude of 74.83º. It is also very close to coast line. Therefore it experiences very good amount of rainfall in the monsoon season. It contains totally 10 number of rain gauge stations which are taken in to consideration as a base station to have performance check over CHIRPS data set. The satellite data record is retrieved from web source known as Climate Engine using following website [app.climateengine.com/climateengine] as it is open to public.

2. Literature Survey

T.V. LAKSHMI KUMAR (SRM Institute of Science and Technology) In this study continuous scores were used to access the CHIRPS rainfall estimates against ground based observations on a pixel-to-station basis, during 01 January 1981 to 30 June 2019. Results showed that CHIRPS exhibits better performance in inland regions.

D. A.HUGHES (Rhodes University) this paper reports on a preliminary analysis of the potential for using satellite derived rainfall data through a comparison with available gauge data for basins in the southern Africa region.

M.SHAMKIet.al have investigated two scenarios first by using the Tropical Rainfall Measuring Mission (TRRMM) to generate the satellite precipitation data for the 1998-2009 periods and employ that data to compare with the data from the rain gauge stations available in the basin. The second was accomplished by using the prediction of Worldwide Energy Resource data from the NASA POWER for the 1994-2005 periods.

ATYAF J.M In this research, the validity of two types of satellite data viz., the tropical rainfall measuring mission (TRMM) product 3B43 and NASA Prediction of worldwide energy resource (POWER) are verified, using the ground monitoring stations.

 This paper gives a report on the applicability of the results of the study are in good agreement with the TRMM results obtained in the Western region of the country. Additionally, the NASA POWER data performed better in detecting moderate precipitation, consistent with previous research on CHRPS data.

3. Data

(i)Raingauge Data: The 20 year's monthly rainfall records of raingauge station data ranging from 2002 to 2022 for below 10 stations of Sirsi taluka, Uttarkannad district were collected from district statistical office Karwar. The latitude and longitude details of stations are as given in table 1below.

Table 1: Latitude & Longitudinal details of 10 raingauge stations

Station name	Latitude	Longitude
Sirsi	14º37'	74º53'
Karur	14º20'	74º40'
Yakkambi	14º42'	74º53'
Bidralli	14º32'	74º54'
Hebbatti	14º35'	75º00'
Mugavalli	14º35'	75º00'
Hegadekatta	14º36'	74º49'
Bandal	14º32'	74º40'
Janmane	14º77'	74º24'
Hulekal	14º42'	74º46'

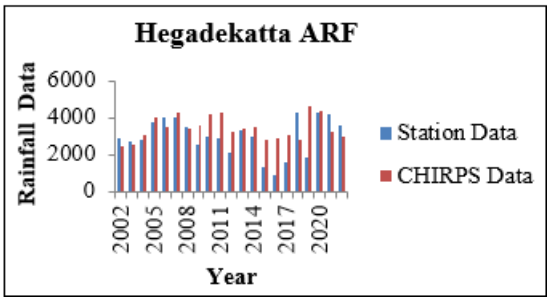
(ii) Satellite Data: The CHIRPS daily rainfall data of above mentioned 10 raingauge stations for 20 year's period ranging from 2002 to 2022 were collected from following climate engine website [app.climateengine.com/climateengine]. Further the values of daily records are converted in to monthly & yearly to carryout the study.

4. Methodology

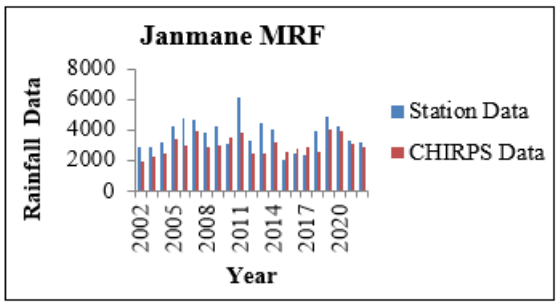
The best approach to evaluate the satellite rainfall data may be to make comparisons between the rain gauge stations and satellite data. This is done by applying the performance check of CHIRPS data records with rain gauge station records of above 10 base stations for a period of 20 years, both for monsoon & annual rainfalls. To estimate the strength of relationship between the two records the linear regression method y=mx+c were adopted to calculate the values of simple statistics (R, R^2& slope). Where x & y stands for independent and dependent variables, m represents line slope and c represents the line intercept. The time series analysis was also carried out for visual interpretation to compare observed (station) data records with satellite data records.

5. Results & Discussion

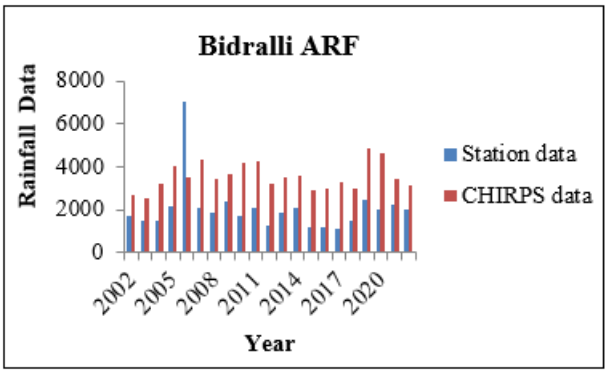
The time series analysis for CHIRPS data set has not shown much variation in rainfall amount respect to the ground station records both for monsoon & annual rainfalls at stations Hegadekatta & Janmane. While in other 8 stations Sirsi, Karur, Yakkambi, Bidralli, Hebbatti, Mugavalli, Bandal & Hulekal it exhibited quite good variations in rainfall amount both for monsoon & annual rainfalls. This is evident from following graphs.



Graph 1: Time series analysis between gauge station & CHIRPS data for annual rainfall (ARF)



Graph 2: Time series analysis between gauge station & CHIRPS data for monsoon rainfall (MRF)



Graph 3: Time series analysis between gauge station & CHIRPS data for annual rainfall (ARF)

It is also evident from below basic statistical parameters table that the rainfall has not much variation in amounts at many stations. But has more variations in the few stations. Especially more in the station Hegadekatta.

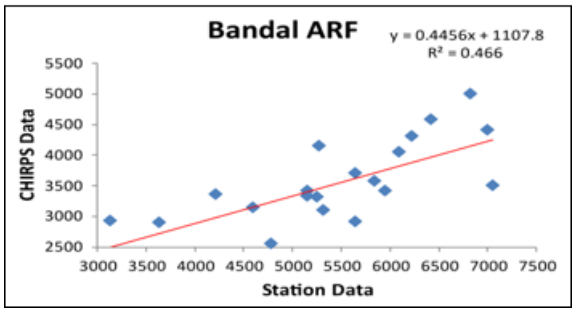
Table 2: Basic statistical parameter values of gauge stations data

Sl. No	Stations	Annual rainfall	Standard deviation	Coefficient Variation
1	Sirsi	2708.60	549.61	0.20
2	Karur	2574.93	608.93	0.24
3	Yakkambi	1901.44	444.85	0.23
4	Bidralli	2040.4	1215.02	0.59
5	Hebbatti	1356.25	435.53	0.32
6	Mugavalli	2211.72	1079.55	0.49
7	Hegadekatta	3007.46	999.10	0.33
8	Bandal	5438.84	1026.16	0.19
9	Janmane	3974.15	1008.24	0.25
10	Hulekal	2661.91	590.63	0.22

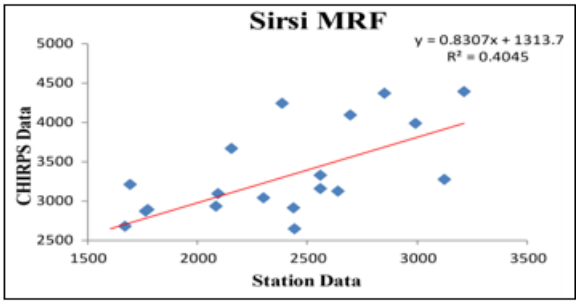
Table 3: Basic statistical parameter values of CHIRPS data

Sl. No	Stations	Annual rainfall	Standard deviation	Coefficient Variation
1	Sirsi	6785.92	654.60	0.09
2	Karur	6765.48	634.72	0.09
3	Yakkambi	6439.51	641.01	0.09
4	Bidralli	6746.249	631.07	0.09
5	Hebbatti	1931.10	669.90	0.12
6	Mugavalli	3722.51	440.91	0.12
7	Hegadekatta	6535.70	635.15	0.97
8	Bandal	6742.08	669.89	0.09
9	Janmane	6484.42	634.67	0.09
10	Hulekal	6499.32	603.43	0.09

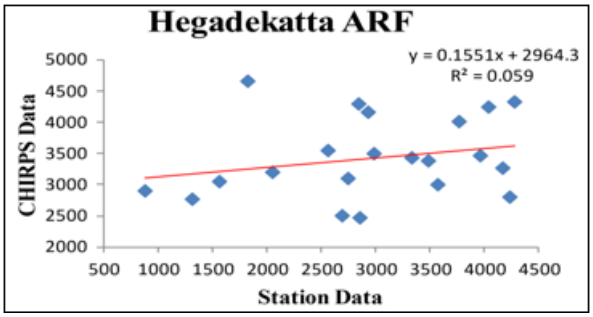
The results of linear regression have shown that the CHIRPS satellite data records performs good for station Bandal & Sirsi, resulting coefficient of correlation value R^2 = 0.39 to 0.46 & R^2 = 0.40 to 0.36 respectively for monsoon and annual rainfalls. Also, quite good for stations Janmane, Karur, Yakkambi, & Hulekal resulting R^2 value in the range of 0.20 to 0.40. But at the remaining stations Hegadekatta, Hebbatti, Bidralli & Mugavalli the strength of relationship shown very weak with R^2= 0.03 to 0.1. This means at some stations the records are under biased and at some stations it is over biased. The resulting graphs are as shown below.



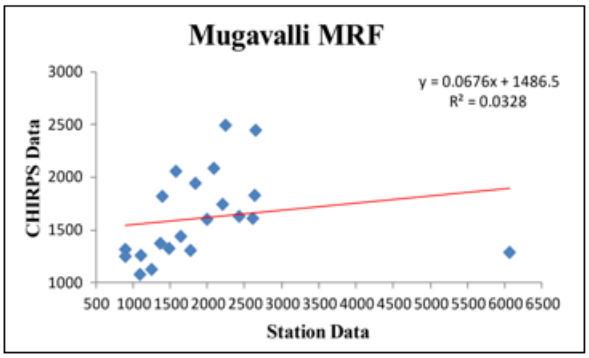
Graph 4: Scatter plot between station & CHIRPS data for annual rainfall (ARF)



Graph 5: Scatter plot between station & CHIRPS data for monsoon rainfall (MRF)



Graph 6: Scatter plot between station & CHIRPS data for annual rainfall (ARF)



Graph 7: Scatter plot between station & CHIRPS data for monsoon rainfall (MRF)

6. Conclusion

It is concluded from the study that the CHIRPS satellite records performs better for the stations Sirsi & Bandal giving good strength of relationship value (R^2=0.4) for both monsoon and annual rainfalls.. Also it performs quite well for stations Janmane, Karur, Yakkambi, & Hulekal, R^2 closer to 0.4. But has poor performance for the stations Hegadekatta, Hebbatti, Bidralli & Mugavalli from both the time series analysis & linear regression methods. Hence the CHIRPS satellite records can be made used at good performed stations including stations shown quit good strength of relationship, in the absence of ground station records during the period of need at above stations. Importantly to run the hydrological model & other water resource management studies at basin area covering the above stations.

7. Future Scope

The same study further can be continued taking in to consideration of other types of satellite records namely GPM, CMORPH, NASA POWER, PERSSIAN data etc. Also the same study can be carried out on daily; monthly data set records to have in detailed performance check for satellite records corresponds to gauge station records. It can also be extended over other coastal belt regions to have gross performance check over entire region.

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