Chapter 2
Know Your Daily Rainfall in Any Location in India- A Web-Based Approach Developed in Google Earth Engine

R. Boopathi, Madhavi Ganesan, and V. Naresh

Abstract Urban planners, farmers, academicians, researchers, and students particularly in agricultural and water resources field require daily rainfall information for their study or project preparation. To make this information available for them, a web-based application was developed using Google Earth Engine (GEE). GEE is a tool for analysing geospatial information and a cloud-based computing system. A java script code is compiled in the GEE platform in conjunction with the Climate Hazards group Infrared Precipitation with Stations (CHIRPS) dataset which is used in the application as a base to download the daily rainfall for any region in India with a resolution of 5.5 × 5.5 km. The methodology adopted is used to derive daily rainfall information for certain coastal locations and other major cities in India. Chennai city receives 60% of Annual Rainfall during October, November, and December with an average annual rainfall of 1440 mm whereas Mumbai city receives 97% of Annual Rainfall during the months of June, July, August, and September with an average annual rainfall of 2837 mm. The information for rainfall estimation will be useful to farmers for estimation of farm pond storage capacity, practicing irrigation engineers of government body to determine the check dam storage levels etc., CHRIPS data is however 75–80% precise to the actual measured rain gauge readings due to bias. If bias correction is carried out, then one would be able to get an accurate estimation of rainfall.

Keywords Google Earth Engine · Rainfall · Web application · Monsoon · Flood

R. Boopathi · V. Naresh (✉)
Water and Effluent Treatment IC, Larsen and Toubro Construction Ltd, Chennai, India
e-mail: boopathir@lntecc.com; naresh-v@lntecc.com

M. Ganesan
Centre for Water Resources, Anna University, Chennai, India

V. S. Kanwar et al. (eds.), *Proceedings of International Conference on Innovative Technologies for Clean and Sustainable Development (ICITCSD – 2021)*,
https://doi.org/10.1007/978-3-030-93936-6_2

2.1 Introduction

Due to continuing COVID'19 pandemic situation, researchers and college students find it extremely difficult to undertake field visit to the site or project region for their data collection. One primary data for Water Resources Engineering researchers and students is the daily rainfall information, which forms the basis for the study and analysis of water resources. To make this information available for the people who is in need of daily rainfall, a web-based application was developed using Google Earth Engine which is described below. The Google Earth Engine (GEE) is an online domain with java script providing earth spatial-temporal series satellite imagery and vector data, cloud-based computing, and access to software modelling and procedures for processing such data. The current era of digitalization and data driven for all scientific aspects will help a common man in understanding the pattern of rainfall and importance of harnessing the rainfall at the place to make use of it for the utilization of rain water. In this way, the paper will be very great importance to all the people who are dependent on the rainfall for their source.

The data source is a collection of over 40 years of satellite imagery for the entire geographical location of earth, with many places having repetitive data for the whole period or once in two weeks, and with a sizeable group of daily and sub-daily information as well. The data available in the GEE platform is from multiple satellites, such as the complete Landsat series; Moderate Resolution Imaging Spectrometer (MODIS); National Oceanographic and Atmospheric Administration Advanced very high-resolution radiometer (NOAA AVHRR); Sentinel 1, 2, and 3; Advanced Land Observing Satellite (ALOS) etc. As a water resources professional , one can use GEE tool for varied applications such as to determine the Cropping Intensity (Single, Double and Multiple), Water Body Mapping to calculate area and seasonal changes, Crop pattern change and Productivity, Assessment of Land Use and Land Cover Change, Water budgeting (Rainfall, Evaporation from Water, Interception loss, Evapotranspiration from Vegetation), Watershed Mapping – up to micro watershed level, Flood Modelling, Deriving Normalized Difference Vegetative Index (NDVI) and Normalized Difference Water Index (NDWI) calculations and Preparation of Contour maps of the watershed.

In the present paper we discuss on how to download the web-based rainfall information for any region inside India as a CSV or PNG file format and its allied applications. Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) is a global rainfall dataset with 30+ year which has been used in this analysis. CHIRPS incorporate 0.05 degree resolution (5.5 km approx.) satellite imagery with ground-based station data to create gridded rainfall time series suitable for seasonal pattern and seasonal drought monitoring. Using CHIRPS as a baseline data, a Java script is written in the Google earth engine to download the rainfall data for the last 11 years from January 2009 to March 2021which can be used to download rainfall for any region or location in India.

2.2 Materials and Methods

Earth Engine is a web domain for scientific study and conception of geospatial datasets, for academic, non-profit organizations, business and government users. The difference between Google Earth and Google Earth Engine is that while Google Earth enables you to explore about the world by interacting with a simulated globe image and can view satellite images, maps, topography, 3D buildings, and much more, the Google Earth Engine on the other hand is a tool for analysing geospatial information. Once you have signed up with your google account in the following address https://earthengine.google.com/, the screenshot pop ups as shown in Fig. 2.1, where you can write the Java script you would like to work on. In our study, using CHRIPS dataset that is available in the global dataset directory of google earth engine, the daily rainfall web application script was written and using geometry tool the boundary is clipped to Indian administrative boundary; after running the code the output data will be shown as a chart file for the region selected, from where we can download the chart file as CSV (comma-separated values – MS-Excel file) or as an image in PNG (Portable Network Graphics). The methodology adopted is shown below (Fig. 2.2).

2.3 Results and Discussion

The two coastal cities of India (Mumbai and Chennai) which receives two different seasonal rainfall was taken for analysis. Mumbai receives its rainfall mostly from South West Monsoon during June to September and Chennai receives its bulk of rainfall from North East Monsoon during October to December. Using the web

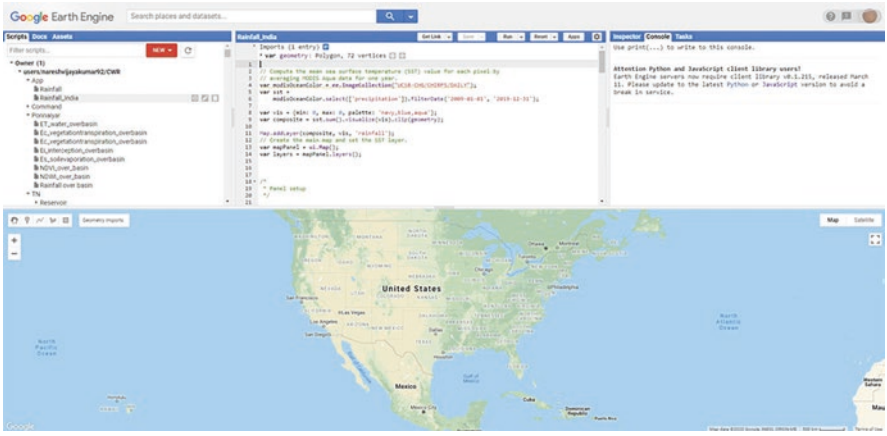

Fig. 2.1 Google Earth Engine platform. (Source: Author)

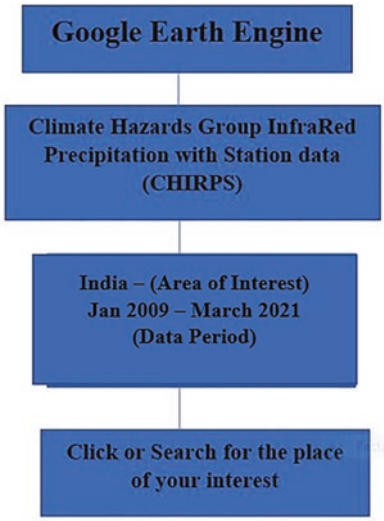

Fig. 2.2 Methodology flowchart. (Source: Author)

application, the daily rainfall for the above two locations was downloaded and analyzed. Also, for some mega cities in India, the daily rainfall was downloaded, and the daily data was converted into monthly average over the period (2009–2020) and the results were analyzed as monthly average as shown below.

1. Bangalore
2. New Delhi
3. Kolkata
4. Hyderabad
5. Trivandrum

Chennai receives 60% of Annual Rainfall during October, November, and December largely from the North East Monsoon and the average annual Rainfall for Chennai works out to 1440 mm. The maximum single day rainfall was recorded on 16th November 2015 with 191 mm. November 2015 is recorded as the wettest month of the last 100 years with 1113.80 mm of rainfall. Way back in 1918 Chennai has received 1088.40 mm which remains maximum till date. Normal life affected due to high rise of water level in Coovum river, Adyar river, Buckingham Canal and Kosasthalaiar river basin which passes through the Chennai city as a result of surplus water released from Chembarambakkam, Redhills and Poondi reservoir during 17.11.2015 and 01.12.2015 which are the water bodies for Chennai drinking water supply (Figs. 2.3, 2.4, and 2.5).

Mumbai receives 97% of Annual Rainfall during the months of June, July, August, and September predominantly from the South West Monsoon. The average annual Rainfall for Mumbai works out to 2837 mm. The maximum single day rainfall in Mumbai was recorded as 355 mm on 01st July 2019 followed with the second highest single day recorded rainfall on 23rd July 2014 with 255 mm. The monthly average rainfall for other few cities is shown below (Tables 2.1 and 2.2).

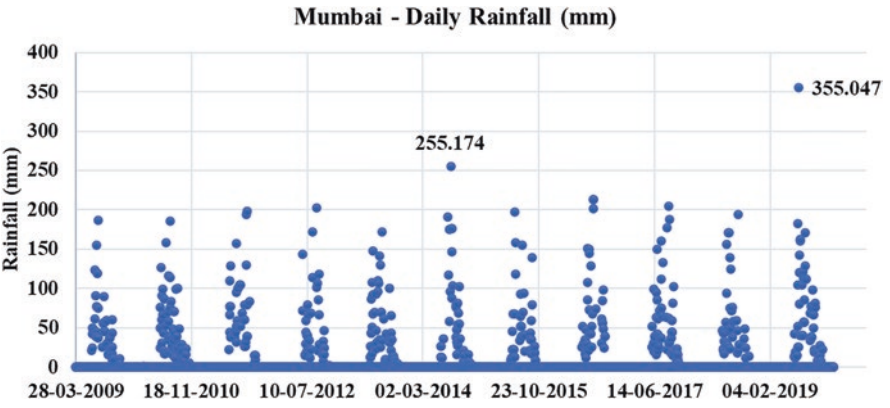

Fig. 2.3 Mumbai daily rainfall chart. (Source: Author)

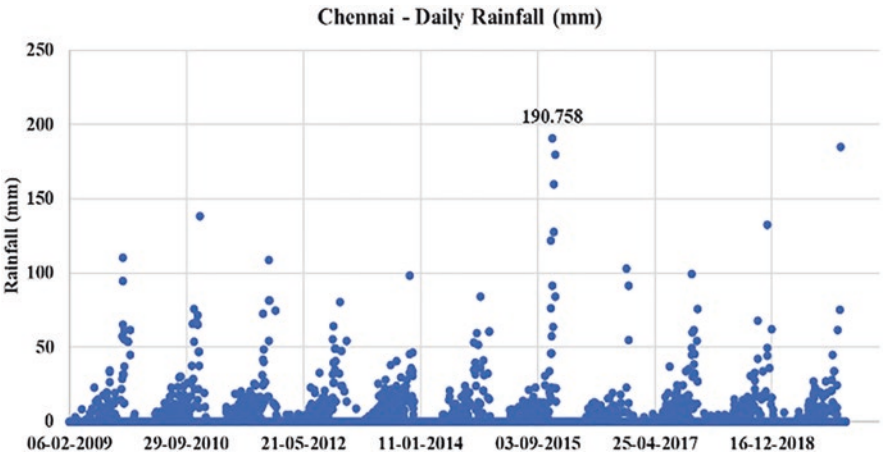

Fig. 2.4 Chennai daily rainfall chart. (Source: Author)

Delhi receives 86% of Annual Rainfall during the months of June, July, August, and September predominantly from the South West Monsoon. The average annual Rainfall for Delhi works out to 1440 mm. Hyderabad receives 89% of Annual Rainfall during the months of June, July, August, September, and October from the South West and North East Monsoons and the average annual rainfall for Hyderabad works out to 812 mm. Bangalore receives 86% of Annual Rainfall during the months of May, June, July, August, September, and October from the South West Monsoon and as well as from the North East Monsoon and the average annual Rainfall for Bangalore works out to 1061 mm. Kolkata receives 76% of Annual Rainfall during the months of June, July, August, and September predominantly from the South West Monsoon and the average annual Rainfall for Kolkata works out to 1750 mm. Trivandrum receives 87% of Annual Rainfall during the months of May, June, July,

Fig. 2.5 Chennai flood condition. (Source: Author, Dec 2015)

Table 2.1 Monthly average rainfall (mm)

M	D	K	T	H	B
Jan	20.29	10.22	12.2	4.91	0
Feb	23.49	27.2	18.03	4.35	1.56
Mar	18.17	25.29	22.63	7.21	14.86
Apr	11	50.74	115.86	25.3	65.93
May	28.53	154.97	198.79	29.52	153.08
Jun	91.17	262.84	332.82	114.91	101.77
Jul	229.97	409.65	171.17	165.51	122.8
Aug	276.7	365.59	166.17	184.42	177.59
Sep	179.13	290.63	180.53	159.13	213.24
Oct	15.4	125.32	310.16	98.95	145.67
Nov	1.75	14.84	236.64	14.4	50.51
Dec	8.76	12.24	62.05	2.9	14.3

M month, *D* Delhi, *K* Kolkata, *T* Trivandrum, *H* Hyderabad, *B* Bangalore

August, September, October, and November both from the South West Monsoon and North East Monsoon and the average annual Rainfall for Trivandrum works out to 1827 mm. As can be seen, the rainfall pattern namely the start and ending follows closely the monsoonic movement within the country and the cities located near the coast getting more rains than those which are located far inland.

Table 2.2 Average annual rainfall (mm)

Places	Annual rainfall (mm)
Delhi	904.36
Kolkata	1749.53
Trivandrum	1827.06
Hyderabad	811.5
Bangalore	1061.29

2.4 Application of Daily Rainfall

Daily rainfall data can be used for a number of different applications as stated above. Herein, its application to two typical cases are detailed:

1. To determine the Rainwater harvesting structure capacity for a House or any type of building:

Download the chart of daily rainfall data developed for the area of interest; from the chart the single day maximum daily rainfall in millimetres for 12 years could be determined. From this maximum 11 values, determine the maximum of maximum of rainfall and let us assume this as 100 mm. Calculate the area of the catchment of the house or the roof top area, assume it to be 2400 ft^2 or 223 m^2. The total runoff generation will then be 22.3 m^3; taking 10% as interception and flow losses, the balance is 20 m^3. This water can be stored in a well. Locate the well at the lowest elevation level of the house or building so that the runoff from the rainfall naturally drains into the well. Assuming the depth of the well to be 3 m, based on the capacity the diameter of the well calculated to be 3 m.

2. To construct a dugout farm pond which will be a potential source of water harvesting structure in the low rainfed areas.

The maximum of maximum daily rainfall in millimetres could be determined using the chart for the area of interest as described above. Let us assume this to be 80 mm; let us assume the area of the farm to be 1 acre or 4047 m^2. The total potential rainfall from the farm area will be 324 m^3; taking 40% as infiltration or seepage losses, the net available runoff for pond storage will be 194 m^3. If we assume the depth of the pond to be 2.5 m, and width of the pond is half the size of its length, the calculated length works out to be 12.5 m and width as 6.25 m.

2.5 Conclusion

The downloaded daily rainfall for the last 12 years doesn't restrict its use only to the above applications; it could be used widely by the researchers and the students for their own need-based analysis; the CHRIPS data is however 75–80% precise to the

actual measured rain gauge readings. One who uses this web application for their scientific purpose should do an error or bias correction with the rain gauge station data available at that location.

2.6 Web Application Link

https://nareshvijayakumar92.users.earthengine.app/view/rainfall-indiawebapp

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