Satellite Image Processing through google earth engine

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Abstract

The Cauvery basin is highly sensitive to the impacts of climate change and experiences recurrent flooding, which affects large agricultural areas and poses a high risk to the population. This project is focused on the recent flood disaster in the Cauvery basin, which mainly affected the regions of Kerala, Tamil Nadu, Karnataka during October,2021. Using the Sentinel-1A Synthetic Aperture Radar (SAR) data, the flood extent was derived in the Google Earth Engine (GEE) platform. The project will provide a holistic spatial assessment of flood inundation in the region due to the combined impact of the Cauvery River basin. The identification of highly flood-prone areas with an estimated impact on cropland and build-up will provide necessary information to decision-makers for flood risk reduction, mitigation activities, and management.

Precipitation is important to life on Earth. It is a predominant process in the global hydrologic cycle and is an indispensable component of water balance analysis. However, in some area like the Southern Karnataka, the information on precipitation is deficient and sometimes difficult to access. In this case, satellite remote sensing coupled with GIS techniques have been applied and considered as a powerful and effective tool in handing precipitation analysis tasks. In short, the application of GEE platform is very effective; it provides a comprehensive tool for managing time-consuming tasks, like precipitation data collection and analysis, and results in reliable outputs.

Introduction

In South India, floods have a recurrent occurrence, where these floods cause an average economic loss of 56,250 crores annually. As the frequency of flood events and their severity has increased, the global concerns are also increasing for lessening the fatalities and other economic losses. The flood inundation extent and frequency information are necessary for evaluating the exposure of society, infrastructure loss, economic loss, crop damage, urban flooding, flood storage volumes, attenuation of flood waves, and the future flood hazards. In recent times, extreme flood events have intensified riverbank erosion and siltation that has negative impacts on agriculture as well as soil fertility. Flood impacts are also adverse particularly in densely populated regions and compact urban structures.

Precipitation is a critical variable in the global hydrologic cycle, and it influences our daily lives (drought, floods, agricultural, irrigation, outdoor activities, etc. However, the accessibility of precipitation data in the Karnataka region is one of limitations to conduct a comprehensive hydrological analysis. In this case, the techniques of satellite remote sensing have been widely used and been considered as a powerful and effective tool in perceiving precipitation. However, massive datasets must be downloaded; satellite image processing with geographic information system (GIS) analysis function is the prerequisite before retrieval of rainfall information. Recently, the Google Earth Engine (GEE) leverages cloud computing services to provide analysis capabilities on over 40 years of Landsat data, and other satellites. As a remote sensing platform, its ability to analyze global data rapidly lends itself to being a useful tool on data visualization.

The **normalized difference vegetation index** (**NDVI**) is a simple graphical indicator that can be used to analyze remote sensing measurements, often from a space platform, assessing whether the target being observed contains live green vegetation. Thus, NDVI was one of the most successful of many attempts to simply and quickly identify vegetated areas and their "condition," and it remains the most well-known and used index to detect live green plant canopies in multispectral remote sensing data. Once the feasibility to detect vegetation had been demonstrated, users tended to also use the NDVI to quantify the photosynthetic capacity of plant canopies. In general, if there is much more reflected radiation in near-infrared wavelengths than in visible wavelengths, then the vegetation in that pixel is likely to be dense and may contain some type of forest.

Research Methodology

There were 3 main aims of this project.

1) Flood mapping
2) Calculating the Rainfall & Rainfall Deviation
3)Vegetation Cover

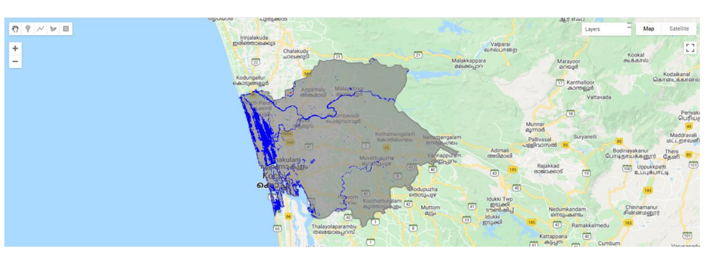
The Datasets that I have used for mapping the floods have been taken from Sentinal-1 SAR Data.

The Sentinel-1 mission provides data from a dual-polarization C-band Synthetic Aperture Radar (SAR) instrument at 5.405GHz (C band). This collection includes the S1 Ground Range Detected (GRD) scenes, processed using the Sentinel-1 Toolbox to generate a calibrated, ortho-corrected product. The collection is updated daily. New assets are ingested within two days after they become available.

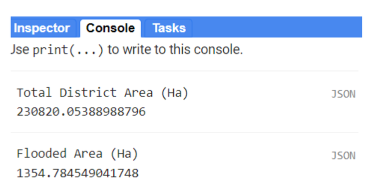
The Datasets that I have used for calculating the rainfall and its deviation have been taken from CHIRPS Pentad data. Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) is a 30+ year quasi-global rainfall dataset. CHIRPS incorporates 0.05° resolution satellite imagery with in-situ station data to create gridded rainfall time series for trend analysis and seasonal drought monitoring.

The Datasets that I have taken for calculating and mapping green vegetation have been taken from MODIS Dataset.
The Normalized Difference Vegetation Index is generated from the Near-IR and Red bands of each scene as (NIR - Red) / (NIR + Red), and ranges in value from -1.0 to 1.0. This product is generated from the MODIS/006/MCD43A4 surface reflectance composites.

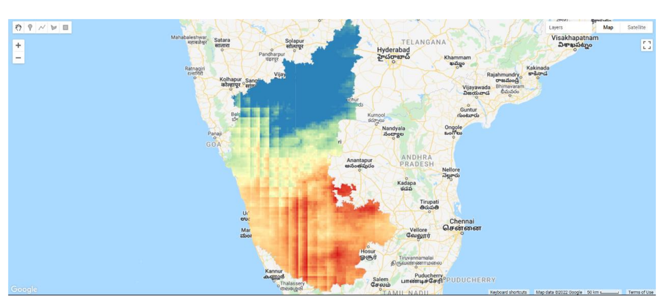
Results & Conclusion



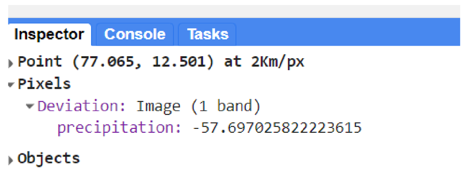
Mapping the flood area of Ernakulam District of Kerala



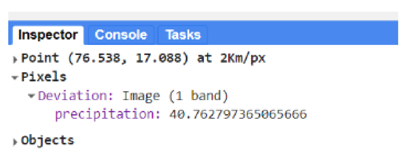
total Flood area of Ernakulam District



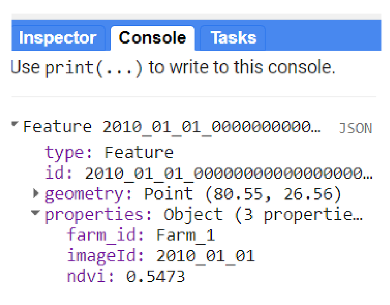
Calculating the Rain Fall and Rainfall Deviation



Southern Karnataka has low Precipitation -57



Whereas Northern Karnataka is experiencing very high precipitation of 40



Calculating the Vegetation Cover

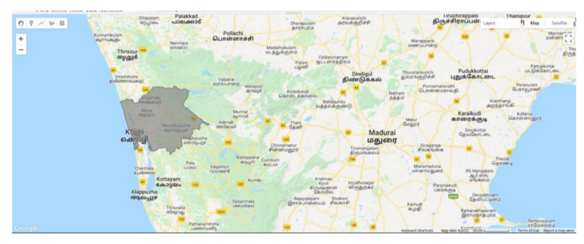
The present comprehensive study provides an insight into the utility of cloud platforms like GEE to process SAR data for mapping inundation over the Cauvery basin. Without the cloud platform, it could have been impossible to map the flood characteristics over such a large area. The key findings can be summarized as floods have occurred over an area of 1354 hectares of land on Ernakulam District.

Coming to the rainfall deviation, Southern Districts of Karnataka state has experienced low precipitation of -57, and Northern Districts of Karnataka state has experienced very high precipitation of more than 40.

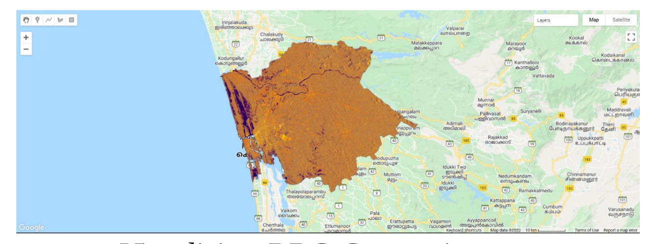
Coming to finding the NDVI values of some selected villages in the state of Uttar Pradesh.

I have found all the NDVI values of all the villages, the values with NDVI values have more green vegetation.

Implementation and Discussion



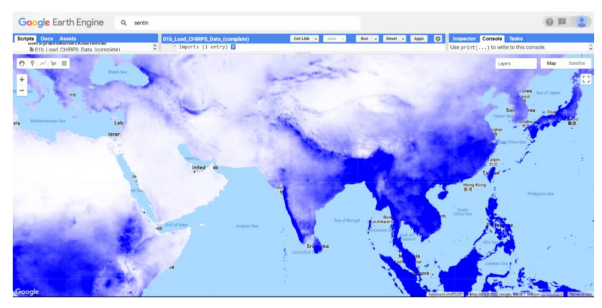
Loading and filtering Sentinel-1 SAR Data



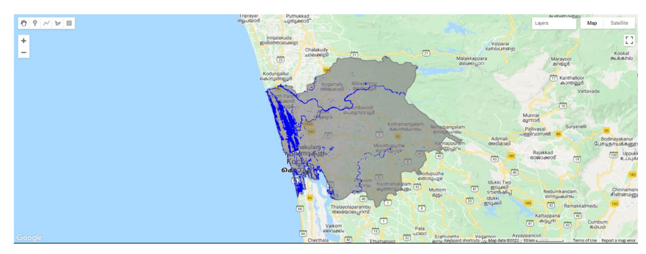
Visualizing RBG Composites

Now Applying Speckle filter

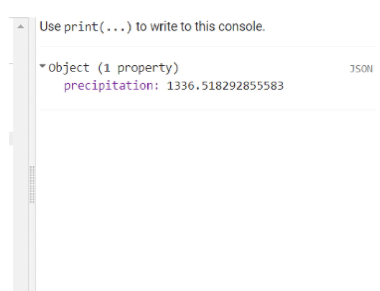
Apply a threshold

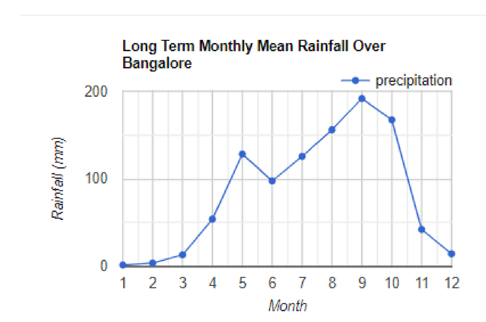


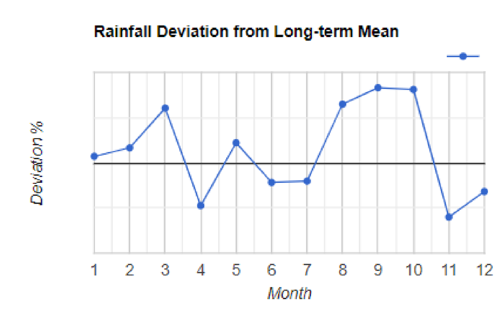
Loading CHIRPS PENTAD DATA



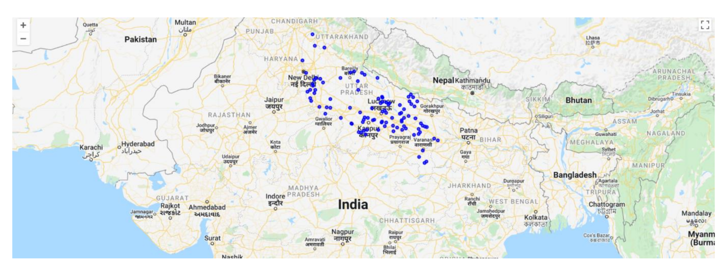
Upon Applying Masks



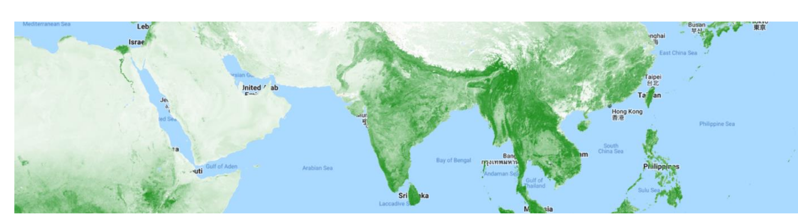




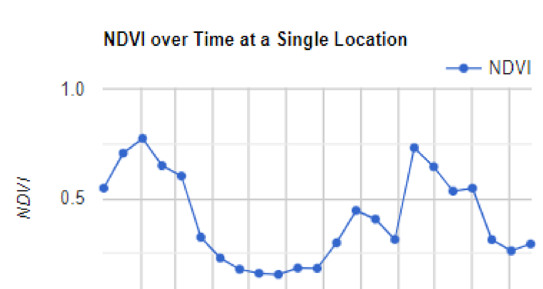
Now Calculating the Vegetation Cover through Normalized Difference Vegetation Index (NDVI)



Uploading Farm locations



Visualization with Date range



Scaling the collection and chart time series for a single point This is done through NDVI over a time at a single location.

References

Google Earth Engine-Based Identification of Flood Extent and Flood-Affected Paddy Rice Fields Using Sentinel-2 MSI and Sentinel-1 SAR Data in Bihar State, India | SpringerLink

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