

Satellite imagery access and analysis in Python & Jupyter notebooks

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Abstract—Among the most common and destructive natural catastrophes, floods frequently cause significant harm to human lives, agriculture, and urban infrastructure. Effective catastrophe management and mitigation depend on quick and accurate flood detection. The Normalized Difference Water Index (NDWI), Which is calculated from satellite imagery, is used in this study's offline flood detection method. The suggested system, which is fully implemented in Python using Jupyter Notebook, enables users to submit satellite photos, process them interactively, and view areas that are dominated by water without using cloud-based tools like Google Earth Engine (GEE). In order to evaluate flooded areas, the proposed model was applied to the Bangalore region, Producing NDWI maps, Flood masks and histograms. The findings show that offline NDWI computation is a practical and effective way to monitor and analyze floods at the local level.

I. INTRODUCTION

Due to uncontrolled growth, Fast urbanization and climate change, Floods have become more frequent in recent years. Flash floods are a common occurrence in many quickly expanding urban areas during periods of high rainfall. Effective emergency response and sustainable city development depend on the identification and study of flood prone areas. Conventional flood mapping frequently uses cloud-based tools like Google Earth Engine (GEE), Which call for technical know-how and an internet connection. This project focuses on creating an offline, Interactive Python based system that directly processes satellite imagery on a local computer in order to overcome these difficulties. The model provides an effective, Self-contained method for flood detection by identifying and highlighting water bodies

and flooded areas in satellite images using the Normalized Difference Water Index (NDWI).

II. METHODOLOGY

There are five primary phases for flood detection and analysis in this Jupyter Notebook. The workflow is depicted in the related block diagram below.

Input



Image Preprocessing



NDWI Calculation



Thresholding / Flood Detection



Result Visualization (Flood Map)

Data Collection

The study made use of publicly accessible satellite photos of the Bangalore area. Instead of using online APIs or distant datasets, these photos were manually put into the Jupyter Notebook for analysis.

Preprocessing

The relevant bands, Usually the Green (G) and Near Infrared (NIR) bands, were chosen by preprocessing of uploaded photos. Since water reflects green light while absorbing NIR light, these bands are crucial for determining the NDWI index.

NDWI Calculation

The following formula was used to determine the Normalized Difference Water Index.

$$NDWI = (Green - NIR) / (Green + NIR)$$

This technique reduces background noise from vegetation and soil while enhancing water features.

The average range of NDWI values is -1 to +1, With values greater than 0.3 commonly denoting water bodies or flooded areas.

Thresholding and Flood Mask Generation

To identify flooded areas, the NDWI output was subjected to a threshold value. Some pixels were labeled as "Non-water" While those that above the threshold were categorized as "water/flooded." Color coded output was used to show the resulting flood mask, Such as:

Blue or cyan tones indicating water

Yellow or green representing dry regions

Visualization

Several interactive visual outputs were produced by the Jupyter Notebook, Including:

NDWI Map: Showing how water bodies are distributed geographically.

Flood Mask: Emphasizing areas that are flooded.

Histogram: Displaying the NDWI pixel value distribution.

Give users the option to select where to save the findings locally.



Figure 1: Satellite Image (Courtesy of [Digital Globe])

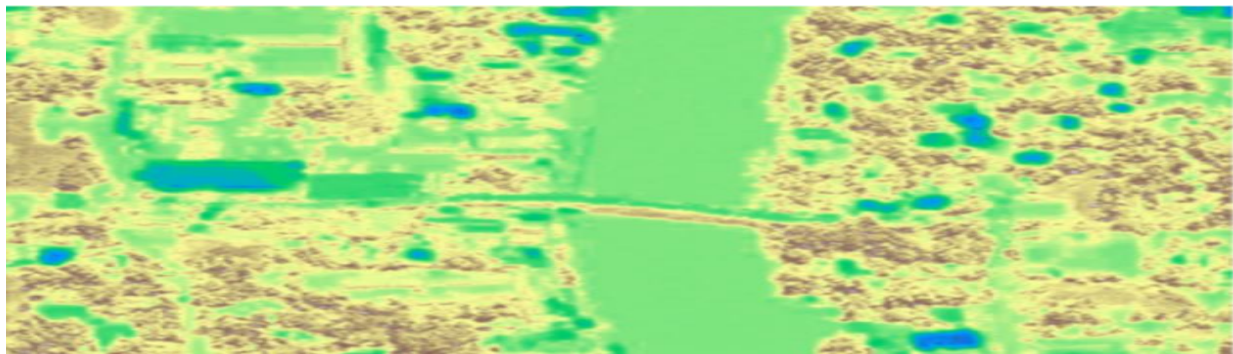


Figure 2: NDWI Calculation

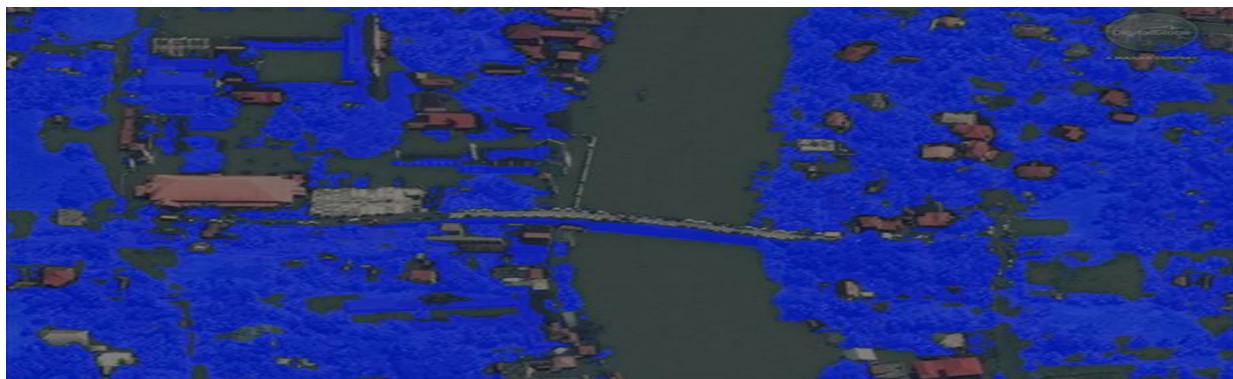


Figure 3: Flood Map Visualization

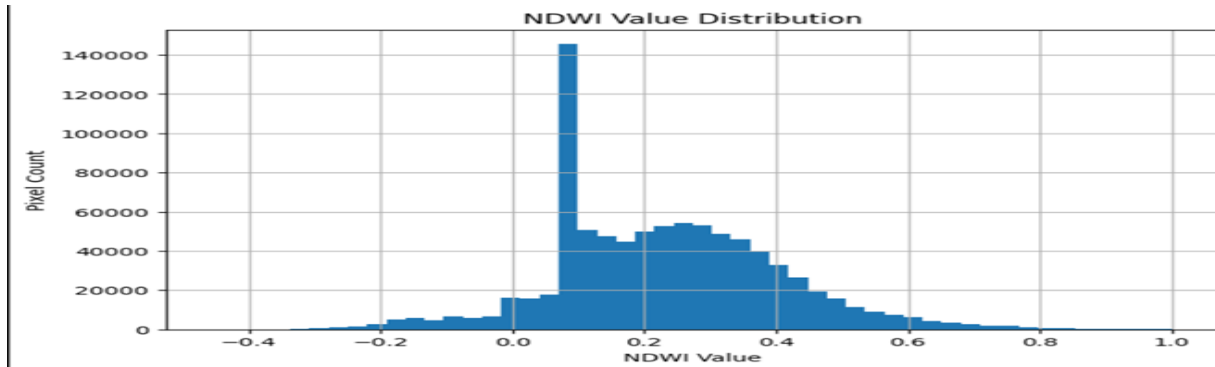


Figure 4: NDWI Value Distribution Histogram

III. RESULTS

Using the NDWI method, the offline flood detection system was able to locate and map flooded regions in Bangalore. Water-dominated areas were easily differentiated from vegetation and populated areas on the generated NDWI maps. Users were able to assess the degree of waterlogging by using the threshold-based flood mask, which offered a visual assessment of the flood extent.

The interactive Jupyter Notebook approach turned out to be effective and user friendly. It illustrated the usefulness of local processing in flood analysis applications by requiring few system resources and functioning without an internet connection.

VI. DISCUSSION

The findings confirm that NDWI is a dependable and computationally efficient technique for identifying floods in urban and semi urban settings. More flexibility is made possible by the system's offline nature, particularly in situations when cloud-based technologies are prohibited or unavailable.

However, there are certain drawbacks, Such as reliance on image resolution and meteorological factors influencing spectral readings. To increase accuracy and automation, future developments might incorporate time series analysis, Automated flood percentage estimation and machine learning classification.

V. CONCLUSION

Using Jupyter Notebook and Python, this study successfully created an offline NDWI based flood detection system. Using locally stored satellite images,

the model effectively detected flooded areas and water bodies within the research region. The experiment shows that offline analysis may provide independence, Data protection and accessibility while matching cloud-based techniques in accuracy. Particularly in areas with poor internet connection, educational institutions, Local planners and non-governmental organizations involved in disaster management may find these technologies useful.

This system may be expanded in the future to include:

- Automatic estimation of the flood percentage.
- Tracking floods over time using multiple pictures.
- Integration with IoT devices and rainfall databases.

This effort helps to improve local capacity for disaster resilience and democratize flood analysis by offering an open, offline and simply executable platform.

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