Analysis of Forest Area Change in India using GEE

Presented by

RAKESH JADHAV

(1BM20CS122)

Under the guidance of

Vikranth B M

Assistant Professor

Department of Computer Science and Engineering

BMS College and Engineering, Bengaluru

Contents:

Introduction

Overview

- Analyzes forest cover and changes in India from 2000 to 2020.
- Uses Earth Engine API to handle data (boundaries, forest cover), filtering, masking, and visualizing.
- Generates maps showing forest cover percentage, loss areas, and gain areas in the chosen regions.

Introduction

Motivation

- Exploring how forests in sensitive regions like Kashmir and Arunachal Pradesh are changing, to fight deforestation and climate threats.
- Delving into Earth Engine's power to analyze forest changes, paving the way for new research and knowledge in geospatial applications.

Introduction

Objectives

- Conduct a comprehensive analysis of forest cover changes in India from 2000 to 2020.
- Utilize Google Earth Engine and the Hansen Global Forest Change dataset for geospatial analysis.
- Visualize and quantify variations in tree cover, loss, and gain over the specified time period.
- Focus on specific regions, including India, Jammu and Kashmir, Aksai Chin, and Arunachal Pradesh or the Bharat.

Literature Survey

SL.NO	Title and Journal	Methodology	Key Findings
1	Satellite-based monitoring of forest cover change in Indonesia using google earth engine from 2000 to 2016	The paper uses the global forest change data by Hansen et al. to estimate forest cover area in 2000 and its interannual variations, as well as the factors affecting land cover change in Indonesia	The paper finds that GEE is very effective to analyze large amount of remote sensing data quickly, and that Indonesia experienced high rates of deforestation, especially in 2011 and 2015
2	Geospatial analysis of land use change in the Savannah River Basin using Google Earth Engine	The authors used random forest supervised classification to produce land cover maps for four time periods (1999, 2005, 2009, and 2015) with 13 land cover classes.	The authors found that 48.30% of the study area changed over the 16-year period, mainly due to urbanization, agricultural expansion, and forest Management.
3	Time series (2001/2002–2021) analysis of Earth observation data using Google Earth Engine (GEE) for detecting changes in land use land cover (LULC) with specific reference to forest cover in East Godavari Region, Andhra Pradesh, India	Supervised classification with Classification and Regression Trees (CART) algorithm was applied to Landsat 7 ETM+, Landsat 8 OLI/TIRS, and Landsat 9 OLI-2 images to generate LULC maps.	An increase of 375.81 km2 (3.32%) in forest cover was observed from 2001 to 2022, along with positive changes in water, built-up, riverbed, and mangroves classes.
4	Global Forest Cover Mapping using Landsat and Google Earth Engine cloud computing	The paper proposes a forest eco-zoning based classification approach, which divides the globe into 43 sub-regions of similar forest type and spatial continuity, and uses multi-source forest/non-forest sample points to train a random forest classifier for each sub-region.	he accuracy of the forest cover products in three initial zones (Amazon rainforest, South Tibet and Hengduan Mountain, and East Asia) is evaluated using cross-validation and reference data from high resolution imagery. The overall accuracy ranges from 85.67% to 90.93%

SL.NO	Title and Journal	Methodology	Key Findings
5	Mapping Vegetation and Land Use Types in Fanjingshan National Nature Reserve Using Google Earth Engine	The paper uses multi-seasonal Landsat image composites, spectral vegetation indices (SVIs), elevation ancillary layers, and machine learning classifiers to generate vegetation and land use maps for two study periods: 2011 and 2016.	Vegetation and land use maps: The authors generate vegetation and land use maps for two study periods, 2011 and 2016, using the optimal image input and classifier combination.
6	Mapping mangrove forest cover using Landsat-8 imagery, Sentinel-2, Very High Resolution Images and Google Earth Engine algorithm for entire Cambodia	The paper applies Random Forest Classifier, a supervised classification technique, to three Landsat-8 images collected in December 2014, February 2015 and April 2015, and uses 63 field plots as ground truth data.	The paper estimates the total area of mangrove forest cover in Cambodia at 73,240 ha, with the highest density in Koh Kong province, followed by Preah Sihanouk, Kompot and Kep.
7	Google Earth Engine for large-scale land use and land cover mapping: an object-based classification approach using spectral, textural and topographical factors	Uses Landsat-8 time series, texture information, spectral indices, and topographic factors as input variables, and apply principal component analysis (PCA) and simple non-iterative clustering (SNIC) for image segmentation. They use the Random Forest (RF) algorithm for image classification and accuracy assessment	An overall accuracy of 91.7% for the LULC map and an identification of the most important input variables for class separation
8	China Forest Cover Extraction Based on Google Earth Engine	The paper divides China into five forest partitions according to the bioeconomic, and trains different random forest classifiers for each partition using samples selected from Google Earth software	The paper reports that the proposed method achieves an overall accuracy of 89.08% and a kappa coefficient of 0.7503,

SL.NO	Title and Journal	Methodology	Key Findings
9	Global high-resolution mountain green cover index mapping based on Landsat images and Google Earth Engine	The paper proposes a new global high-resolution mountain green cover index (MGCI) mapping method based on Landsat-8 images and Google Earth Engine (GEE)	The green vegetation cover extraction method achieves an overall accuracy of 95.56% and can effectively discriminate vegetation from non-vegetation classes in mountain areas
10	Classification of Indian cities using Google Earth Engine	Methodology: The paper uses Google Earth Engine to classify land cover in 10 Indian cities from Landsat imagery,	The paper finds that the global model produces accuracies greater than individual models, with an overall classification accuracy greater than 80% for each city.

Methodology

1. **Data Selection:**
    - Utilizes the Hansen Global Forest Change dataset (2019 version) from Google Earth Engine, specifically focusing on bands such as 'treecover2000,' 'loss,' and 'gain.' The Hansen et al. (2019) Global Forest Change dataset in Earth Engine represents forest change, at 30 meters resolution, globally, between 2000 and 2019.
2. **Region of Interest (ROI) Selection:**
    - Defines a region of interest (ROI) that includes India, Jammu and Kashmir, Aksai Chin, and Arunachal Pradesh.
3. **Data Visualization:**
- The code includes visualization techniques to map forest cover, loss, and gain using a color-coded palette. Visualization is crucial for interpreting spatial patterns and changes over time.
4. **Image Masking:**
    - Applies masking techniques to focus on specific features, such as tree cover, and distinguish them from other land cover types.

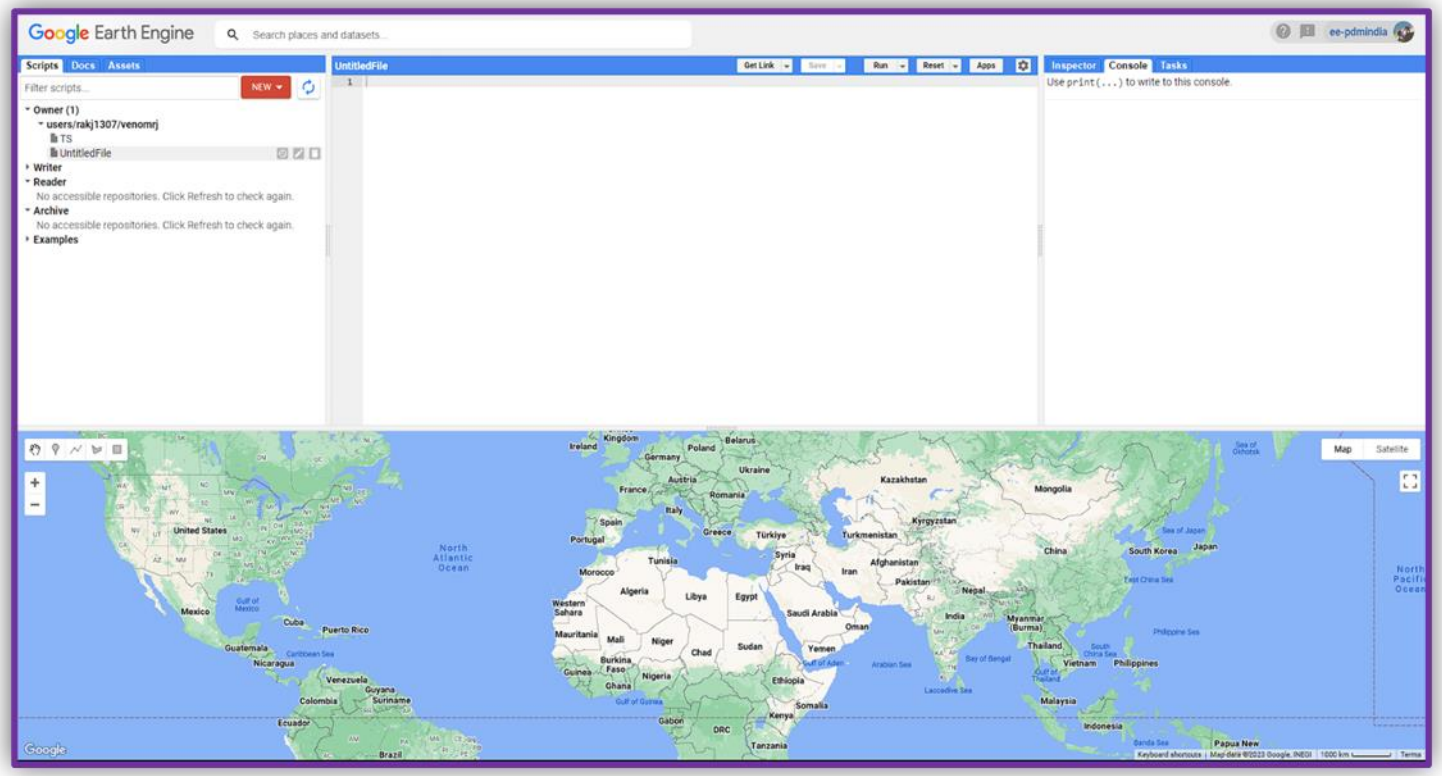
Methodology

5. **Layer Stacking:**
   - Selects and stacks specific bands from the dataset to create composite images for better interpretation and analysis.
6. **Geospatial Analysis:**
   - Utilizes geospatial analysis tools provided by Google Earth Engine for tasks such as region filtering, image clipping, and visualization.
7. **Visualization Enhancements:**
   - Incorporates enhancements such as interpretation of the color-coded maps.
8. **Time Series Analysis:**
   - If data for multiple years is available, time series analysis techniques can be implemented to observe temporal trends in forest cover changes.
9. **Change Detection:**
   - Although not explicitly shown, the project involve change detection to identify significant changes in forest cover over the specified time period.

Tools Used

1. **Google Earth Engine:**

- A cloud-based geospatial processing platform provided by Google, offering a vast archive of satellite imagery and a variety of geospatial analysis tools. It allows for scalable and efficient processing of large-scale remote sensing data.



Tools Used

2. **Hansen Global Forest Change Dataset:**

- The Hansen et al. (2019) Global Forest Change dataset in Earth Engine represents forest change, at 30 meters resolution, globally, between 2000 and 2019.

3. **JavaScript Programming Language:**

- The code is written in JavaScript, the scripting language supported by Google Earth Engine for developing geospatial applications and analyses.

Implementation and Results

1. Modules Implemented

1. Earth Engine (EE) API:

- Purpose: Provides the core functionality for interacting with Earth Engine's data, algorithms, and map interface.
- Key Functions Used:
  - ee.FeatureCollection(): Loads feature collections from Earth Engine's data catalog.
  - ee.Image(): Loads images from Earth Engine's data catalog.
  - Image.clip(): Clips an image to a specific region.
  - Image.select(): Selects specific bands from an image.
  - Map.addLayer(): Adds layers to the map visualization.
  - Map.centerObject(): Centers the map on a specified object.

Implementation and Results

1. Modules Implemented

2. Feature Collection:

- Purpose: Represents a collection of geographic features, each with its own geometry and properties.
- Key Operations:
  - Loading a feature collection from Earth Engine's data catalog.
  - Filtering features based on their properties.

3. Image:

- Purpose: Represents an image in Earth Engine, which can contain multiple bands of data.
- Key Operations:
  - Loading an image from Earth Engine's data catalog.
  - Selecting specific bands from an image.
  - Creating masks to focus on specific areas.
  - Visualizing images on the map.

Implementation and Results

1. **Results**

1. **Map Visualization:** The code creates a map visualization with four layers:

- Selected: Shows the selected countries (India, Jammu and Kashmir, Aksai Chin, Arunachal Pradesh) in lavender color.
- Forest Cover Masked: Shows the forest cover percentage in green, masked to the selected countries.
- Loss: Shows forest loss areas in red.
- Gain: Shows forest gain areas in blue.

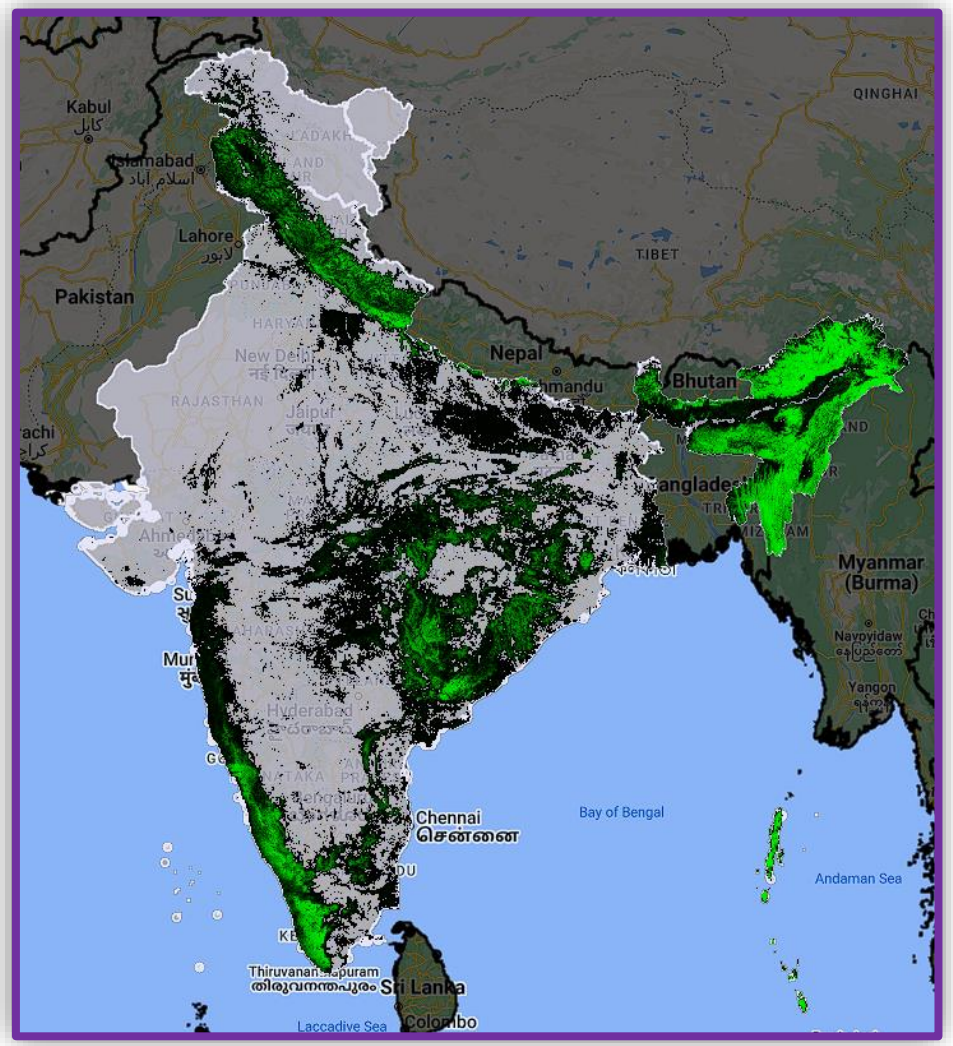
2. **Image Variables:** The code also creates three image variables:

Implementation and Results

1. Results

- **treeCover:**

An image containing only the treecover2000 band from the gfc2019 image.

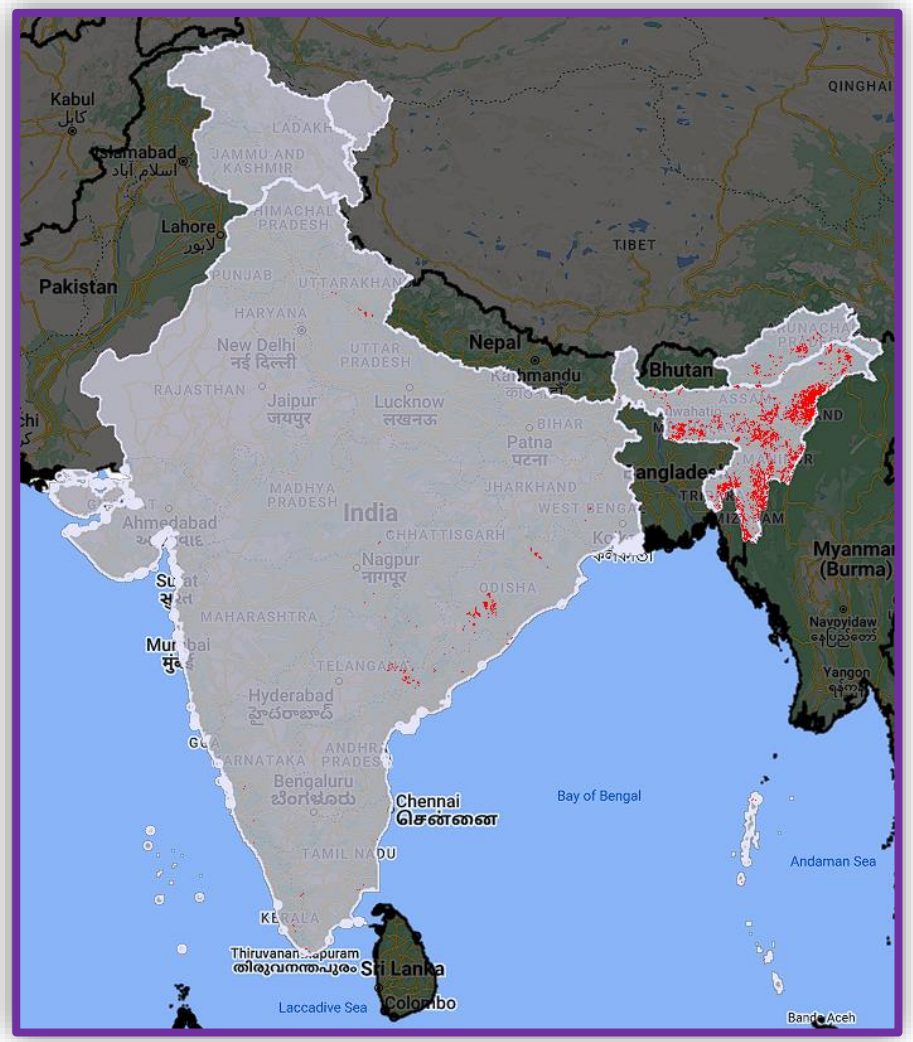


Implementation and Results

1. **Results**

- **lossImage**:

An image containing only the loss band from the gfc2019 image.

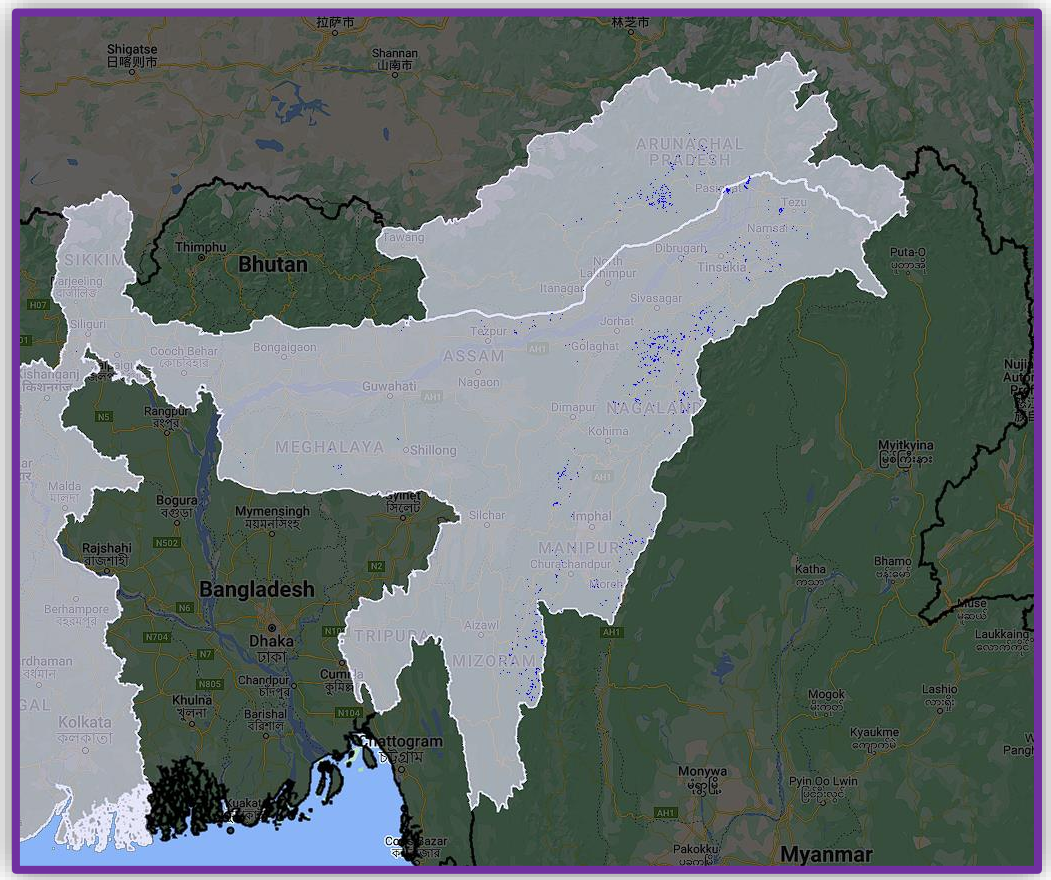


Implementation and Results

1. Results

- **gainImage:**

An image containing only the gain band from the gfc2019 image.



Conclusion

1. The project reveals temporal trends, regional variations, and hotspots in forest cover changes across India from 2000 to 2020.

2. The analysis provides valuable data for evidence-based decision-making by policymakers and conservationists..

3. Future research could delve into detailed investigations of drivers behind forest cover changes, integrating additional environmental variables for more accurate assessments.

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Thank You