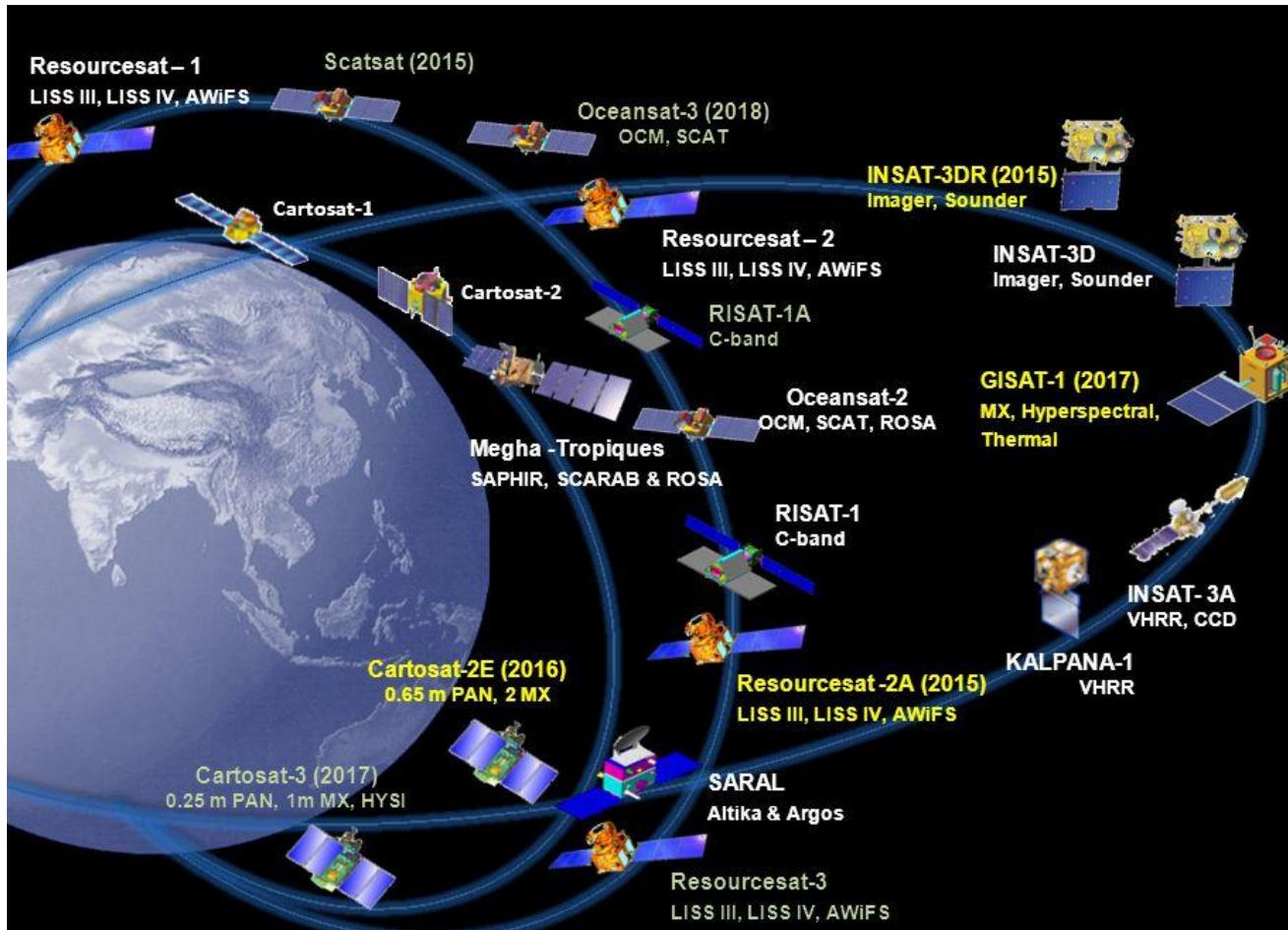


# Introduction to Google Earth Engine



- Large number of data sources e.g. ISRO alone specifies 130 missions (as of 2022)
- 10-20 TB /day
- Requirement for high accuracy of models.
- Requirement for real time analysis.

Source: ISRO website, 2015

# How can we work with the data

- High end PCs/Workstations with multiple cores.
  - Graphics Processing Units
  - HPC, Parallel, clustered or distributed systems
- 
- High costs for installation and maintenance.
  - Not suitable for small organizations or individuals.

**CLOUD COMPUTING:** Scalable, no hassle of downloading data, parallelized set up, pocket-friendly.

Eg: AWS, Microsoft Planetary Computer, Digital Earth, Google Earth Engine



## Google Earth Engine: Planetary-scale geospatial analysis for everyone

Noel Gorelick <sup>a,\*</sup>, Matt Hancher <sup>b</sup>, Mike Dixon <sup>b</sup>, Simon Illyushchenko <sup>b</sup>, David Thau <sup>b</sup>, Rebecca Moore <sup>b</sup>

Google

**Earth Engine:**  
Google's Cloud Platform for Big  
Earth Data Analytics

Image  
courtesy:  
Gennadii  
Donchyts

# The Earth Engine Public Data Catalog



## Landsat 4, 5, 7, 8

Raw, TOA, SR, ...



## MODIS

Daily, NBAR, LST, ...



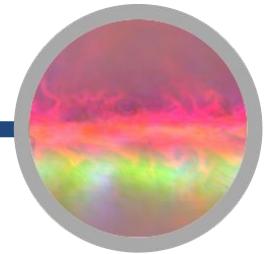
## Terrain

SRTM, GTOPO, NED, ...



## Land Cover

GlobCover, NLCD, ...



## Atmospheric

NOAA NCEP, OMI, ...

... and many more, updating daily!

> 200 public datasets

> 20 million images

> 35 years of data

> 4000 new images every day

> 20 petabytes of data

> 12 quadrillion pixels

*“Often it turns out to be more efficient to move the questions to the data than to move the data to the questions.”* -Jim Gray in the Fourth Paradigm

Stats and Image courtesy:  
Gennadii Donchys, Nick Clinton

# Features of Earth Engine

## Data Types

- **Rasters:** Image, ImageCollection
- **Vectors:**
  - Geometry: Point, Line, Poly
  - Feature: Geometry and attribute information
  - FeatureCollection: set of features
- **Projection:** CRS, transforms. Default is pseudo Mercator EPSG 3857.
- **Model:** Trained ML models
- **Common programming datatypes:** Integer, String, Date, Array, Dictionary etc

## Algorithms

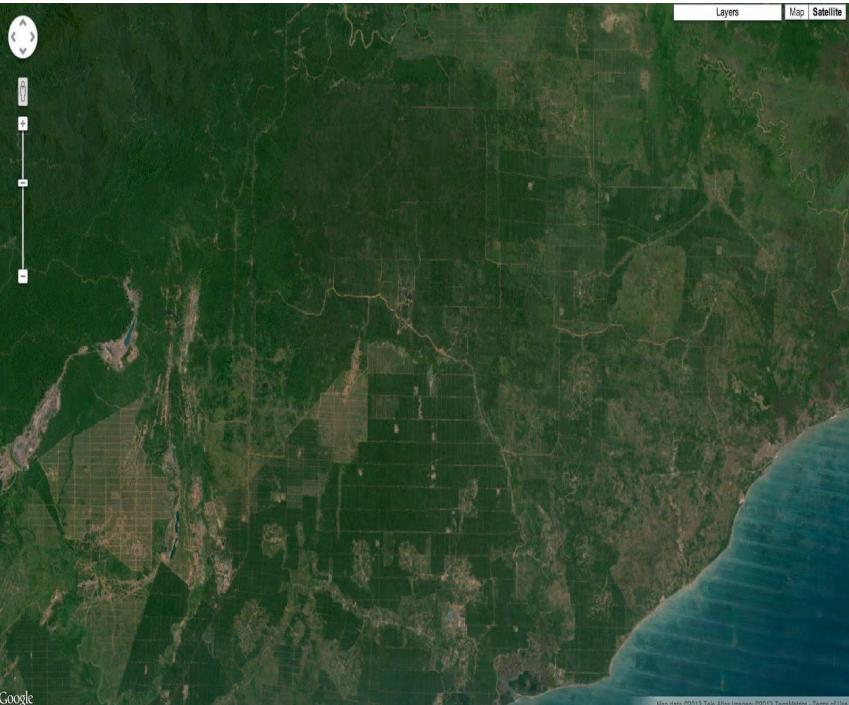
- **Data preprocessing:** Filters, radiance calibration, f-mask filtering, hillshade, slope, aspect
- **Feature Extraction:** Sobel, Roberts, Prewitt, Laplacian
- **ML tools:** CART, Random Forest, Gradient Boosted, SVM, SNIC, K-Means, Accuracy Assessment tools. More from sklearn and TensorFlow.
- **Reducers:** Image collection to image, feature collection to feature/image, Image to number using aggregation such as mean, median, minMax, first, etc.
- **Visualization:** Maps, Charts, UI

# Capabilities of Earth Engine

- Optimized data download via Google Drive/Cloud Storage
- Large-scale time lapse visualization
- Earth Engine Explorer
- JavaScript API emphasis using Code Editor
- Python API to integrate with Machine Learning Workflows
- QGIS integration for mapping and data representation
- Google Earth Engine Apps

# Optimized data download and Earth Engine Explorer

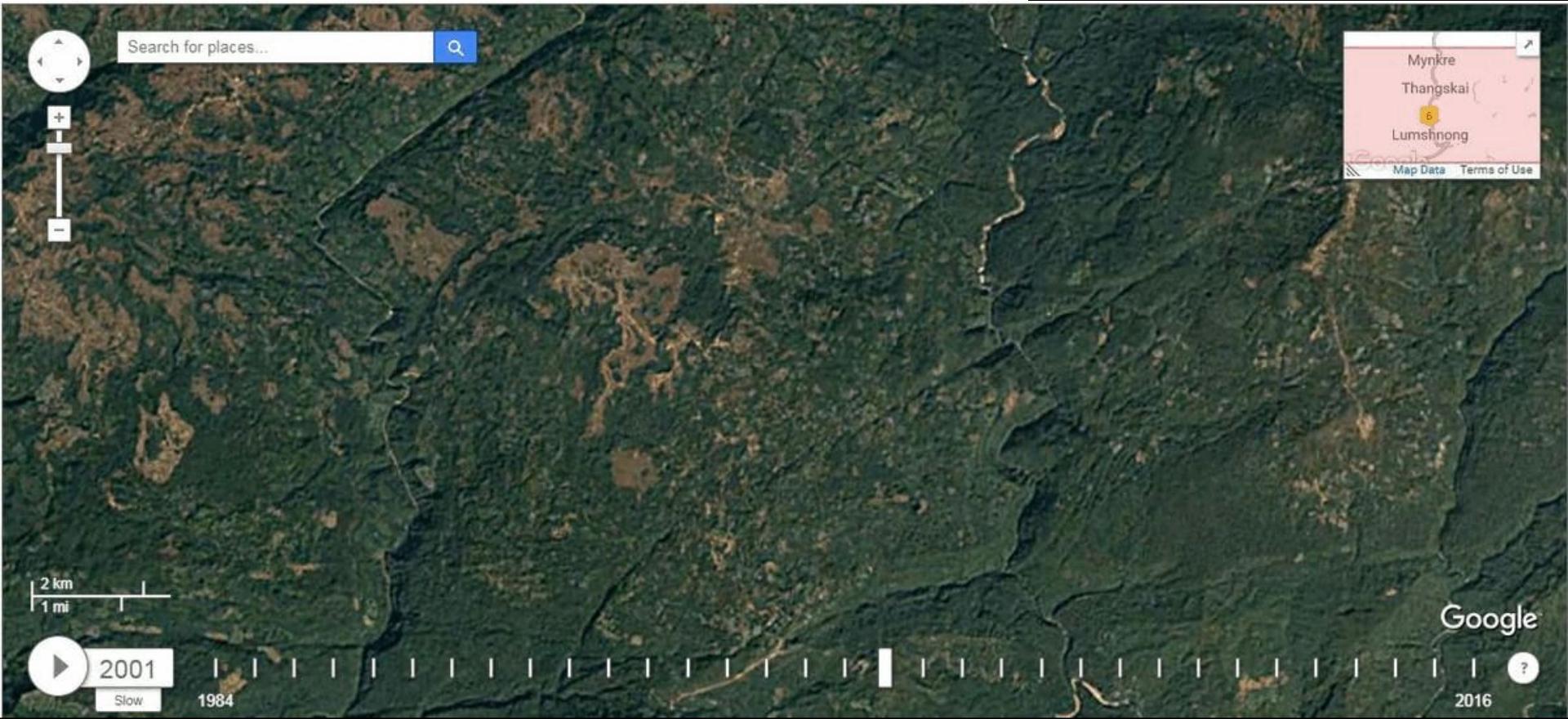
- Access and visualize datasets across locations and time steps desired at varying levels of processing
- Access large number of datasets across the domains
  - Climate and weather
  - Satellite imagery
  - Terrain
  - Land Cover
  - Other geophysical data
- Cloud-free data generation through temporal merging
- Code-free processing tools including classification



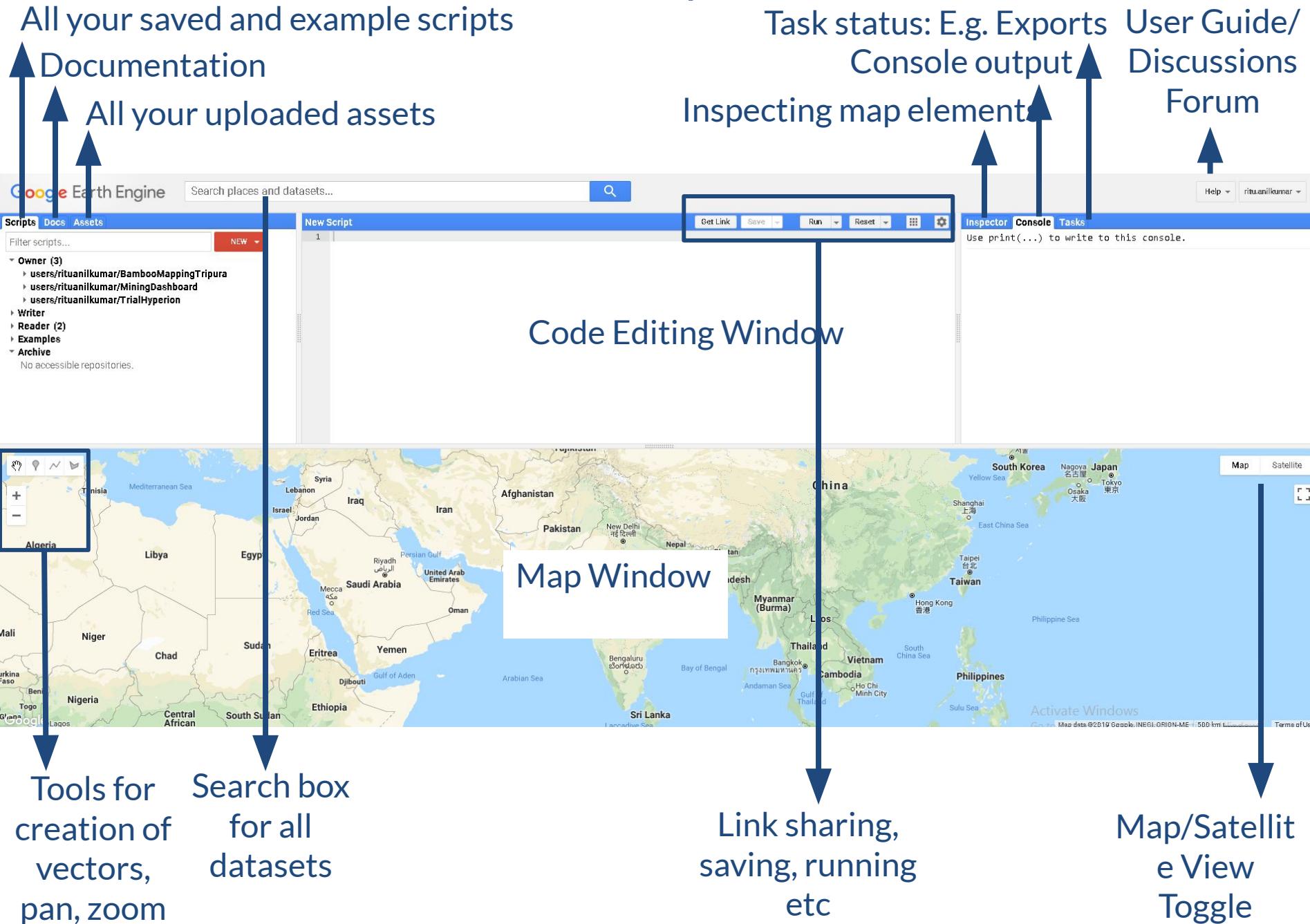
# Large-scale time lapse visualization

**Right:** GIF of monthly mean NDVI visualization for NER from 2018 to 2019

**Bottom:** Quarry land time lapse at Lumshnong, Meghalaya

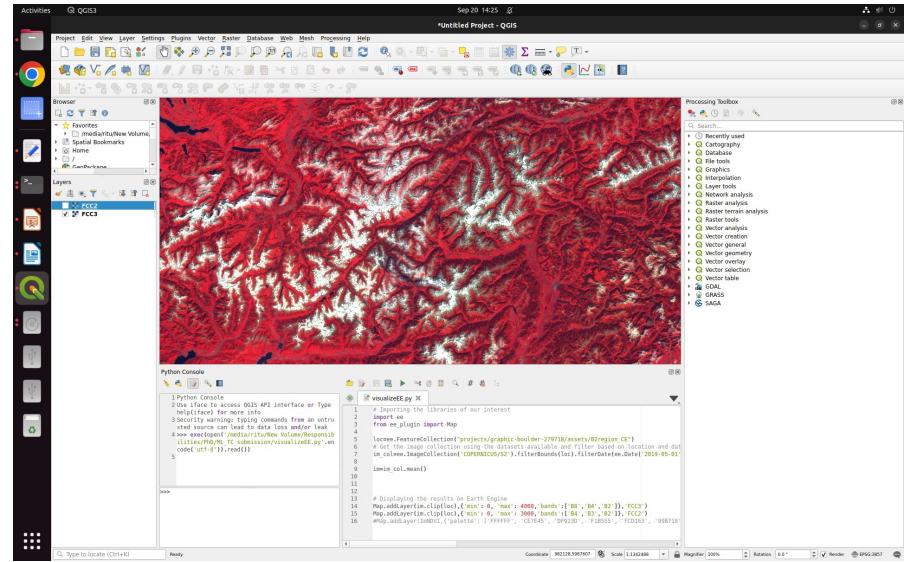


# JavaScript API



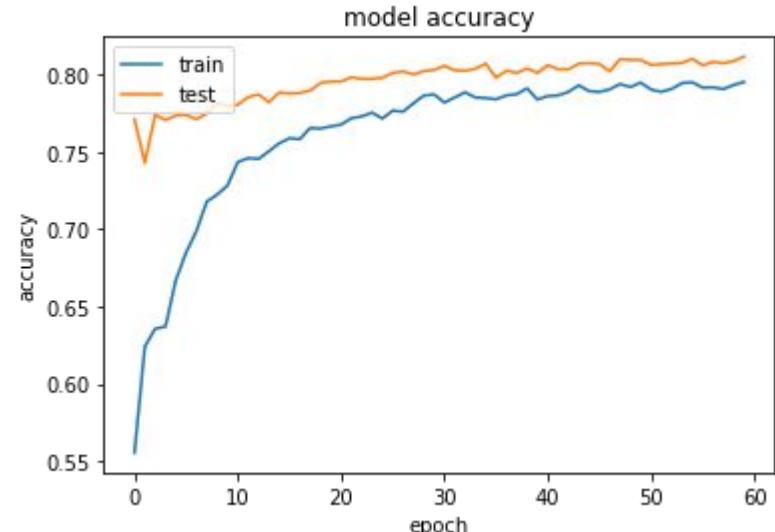
# Python API and Integration with GIS Tools

- Visualize and create maps on QGIS using Python interface and Earth Engine plugin
- Example project: forest fire burnt patch estimation with automated buffering and quantile derived thresholding.



# Python API and Integration with ML Libraries

- Integration with other Python statistical and machine learning libraries
- Tested with TensorFlow for the DTDI project extended with Sentinel 2 and PROBA V datasets



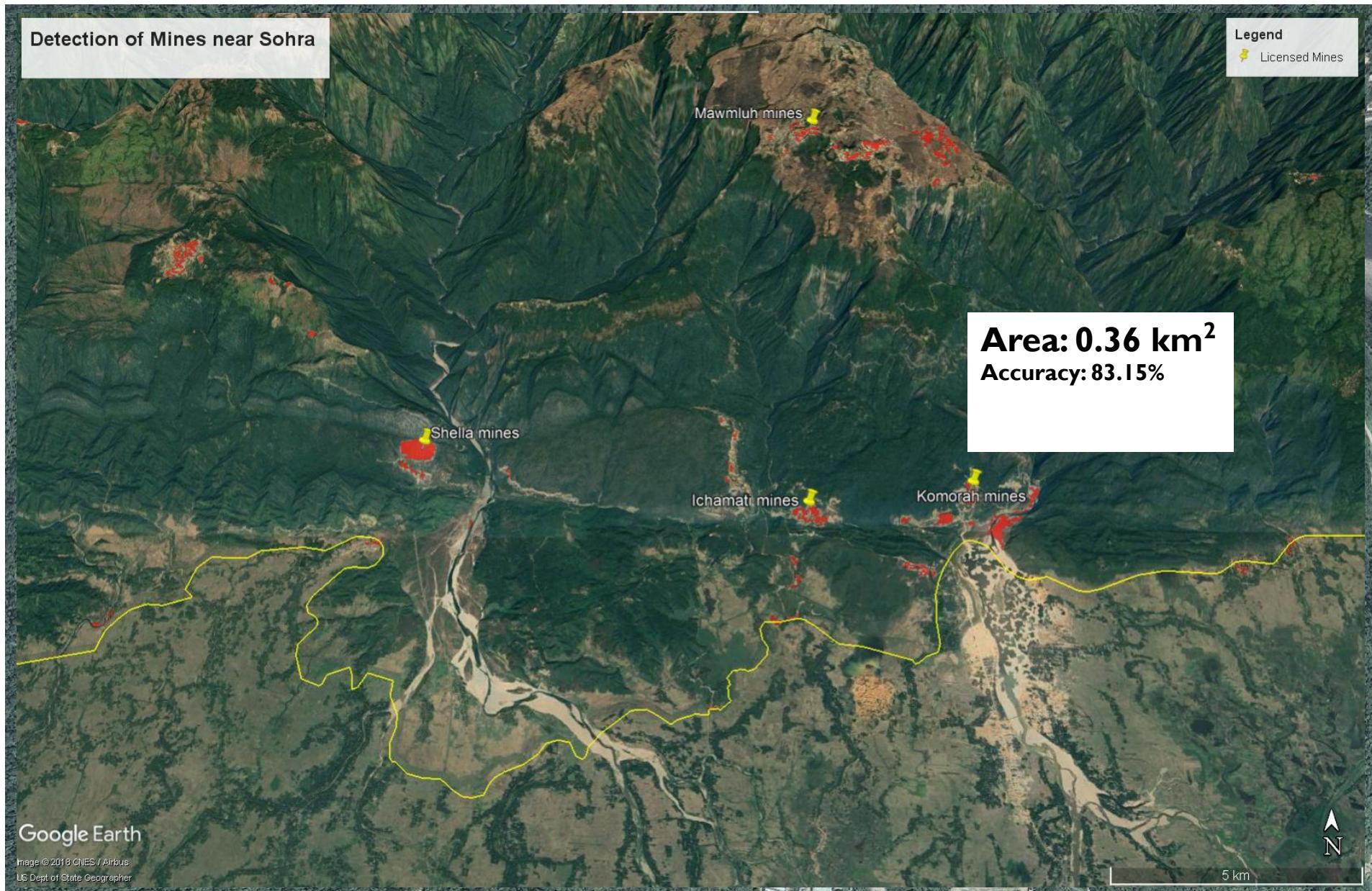
# Projects Implemented

1. Open Cast Mine Identification in Meghalaya
2. Vegetation loss associated with Coal and Limestone Mining, Jaintia Hills
3. Monitoring of Strip Mining activity in Saleki PRF, Assam
4. Burnt area assessment for Manipur
5. Pan-NE Forest Loss Studies
6. Glacier change studies, Sikkim
7. Identification of permanent river islands in Assam
8. LULC mapping for parts of Assam
9. Bamboo dominated area mapping for Tripura
10. Flood mapping using Sentinel 1

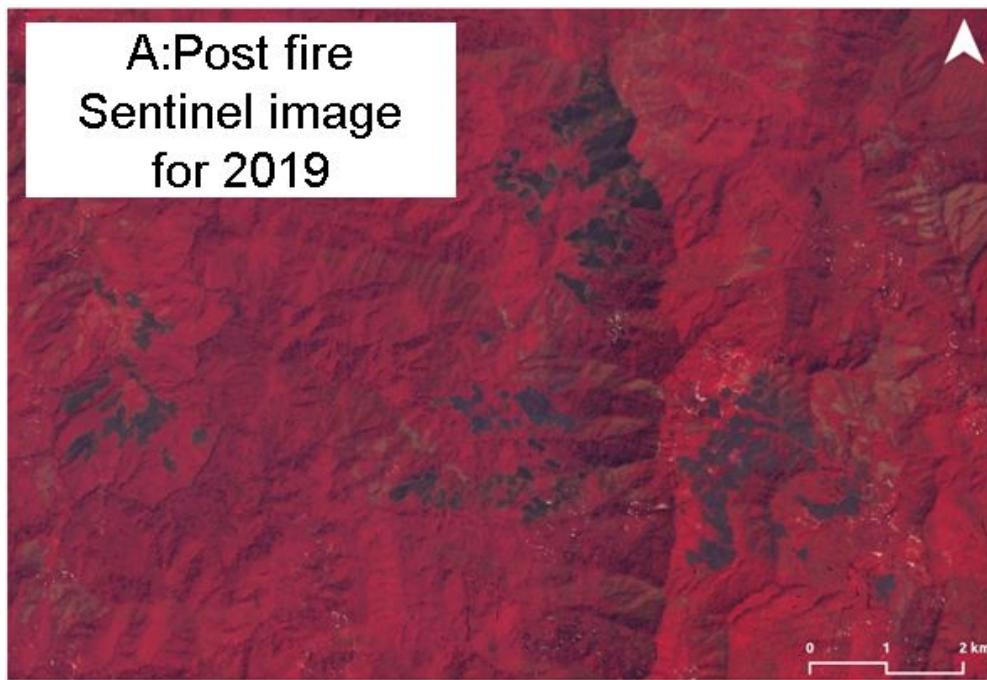
## Techniques Implemented

- Cloud free composite generation
- Landsat 7 desriping
- Classification (incl ML pipelines using Python)
- PCA based dimensionality reduction
- Textural features using GLCM and OBIA image segmentation
- Charting and time series visualization

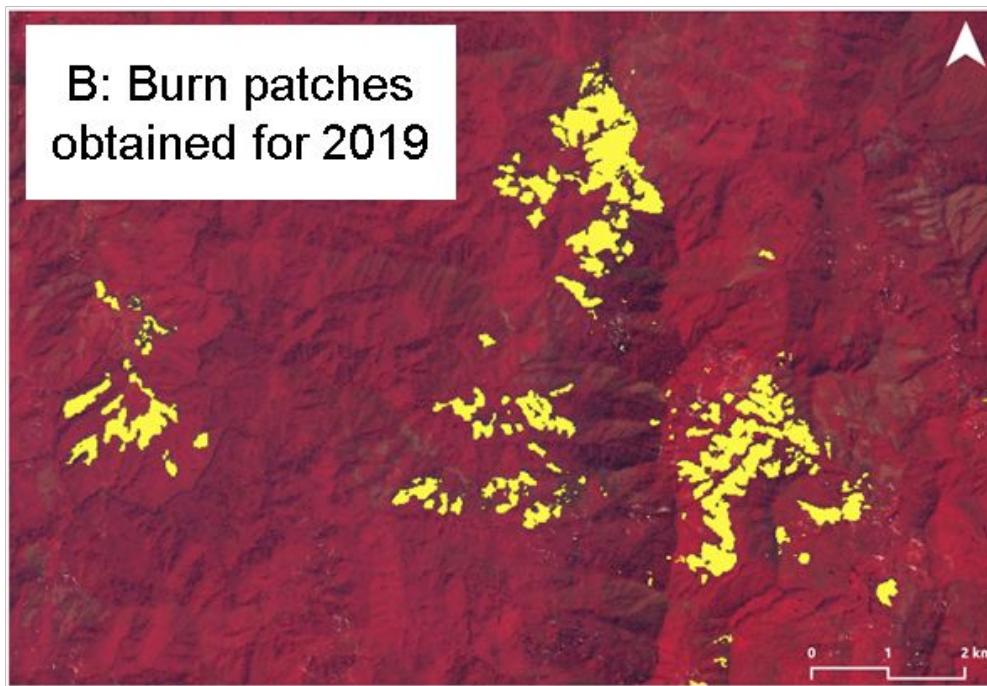
# Mining in Meghalaya



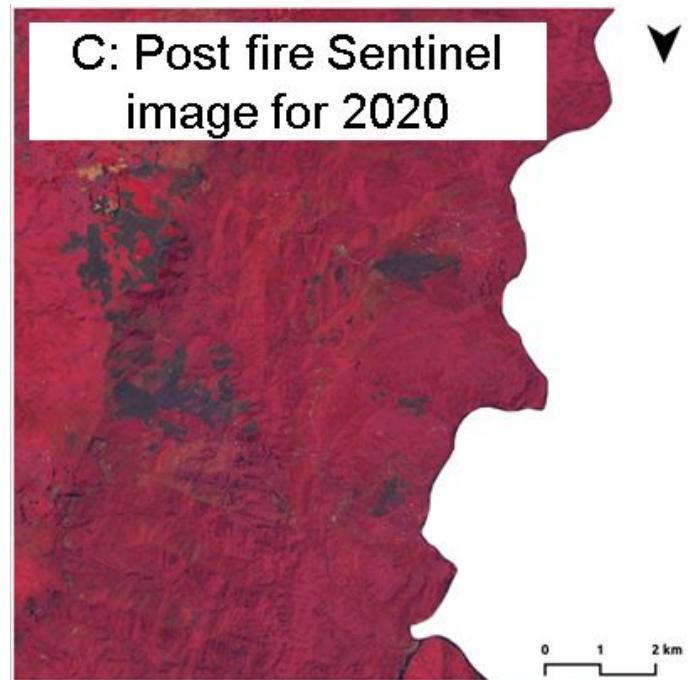
A: Post fire  
Sentinel image  
for 2019



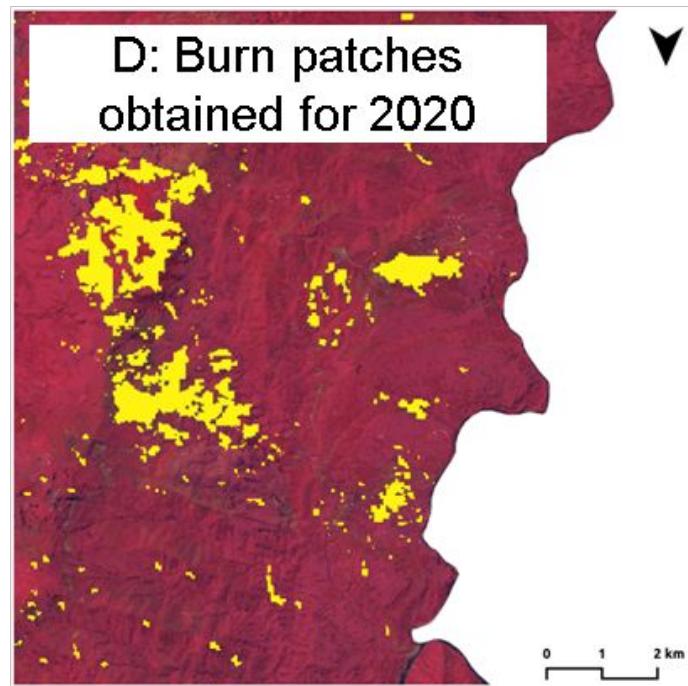
B: Burn patches  
obtained for 2019



C: Post fire Sentinel  
image for 2020



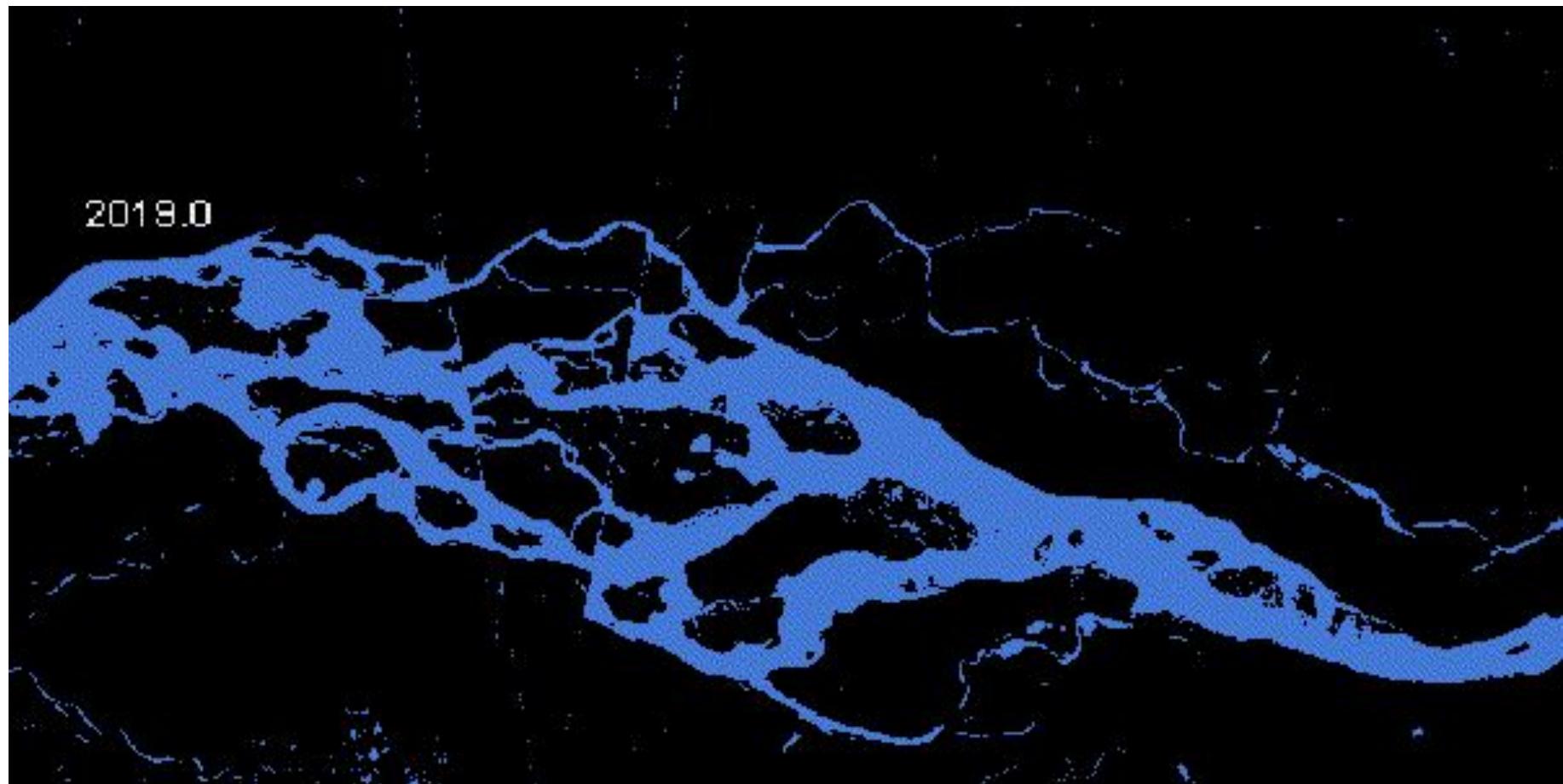
D: Burn patches  
obtained for 2020



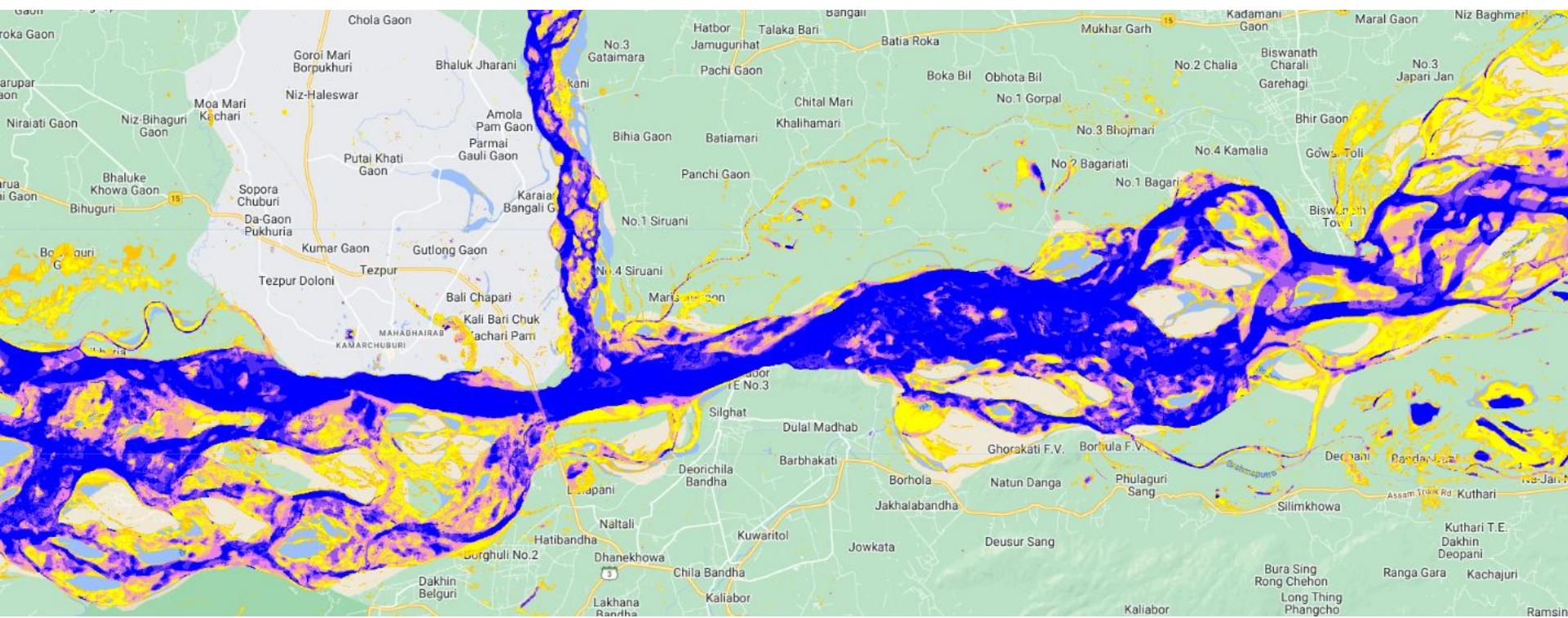
# Inter-annual time series



# Inter-annual time series: Extracted waterbody



# Our Model Seasonality



4 months



12 months

JavaScript Hands on: [Click Here](#)

Python Hands-on: [Click Here](#)

Some Resources: [Click Here](#)

[Here](#)

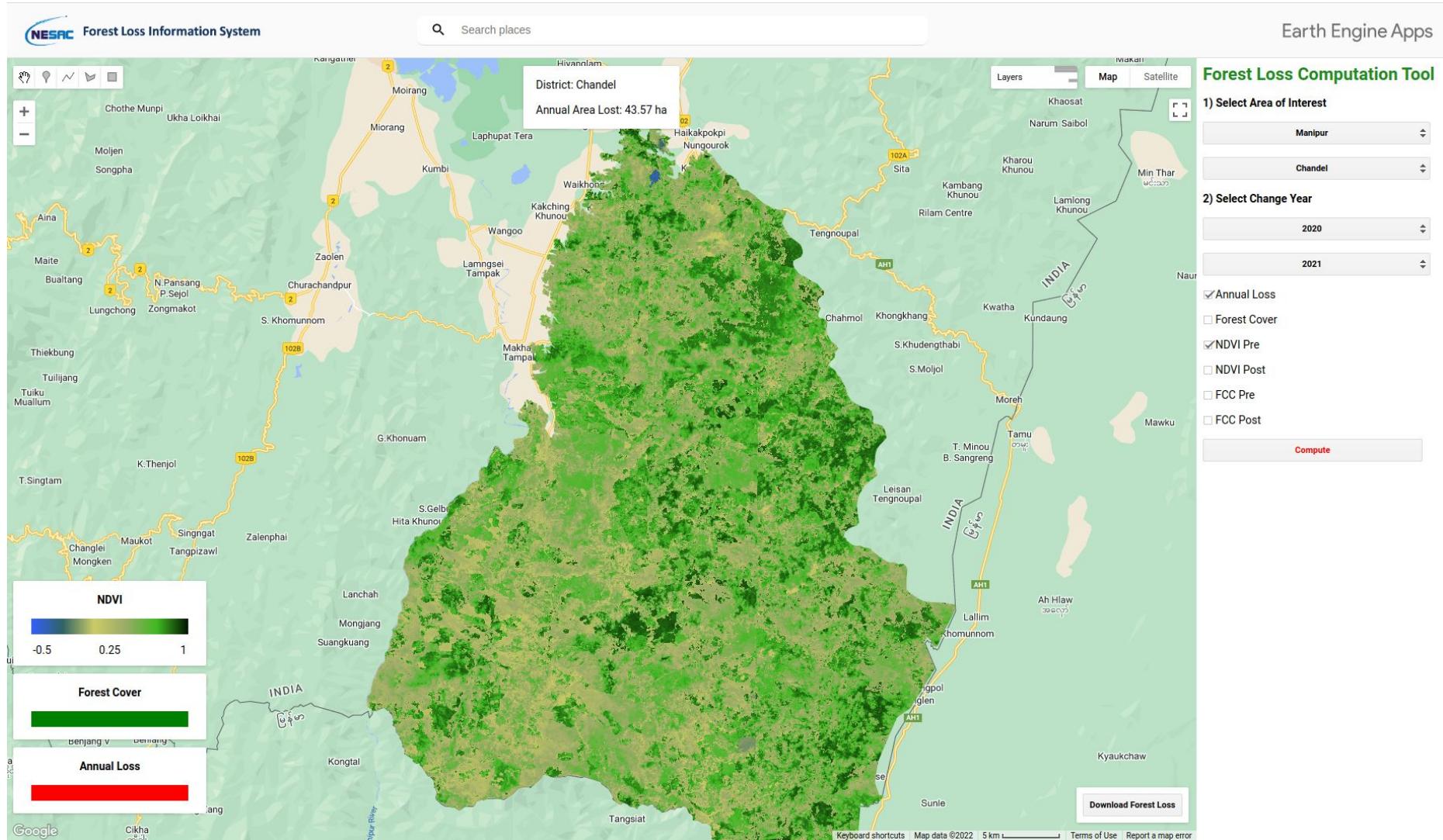
[Here](#)

[and here](#)

<https://github.com/RituAnilkumar>

# SOME COMMON STUDIES USING EARTH ENGINE

# Web Apps using App+Earth Engine



Forest Loss: <https://nilaynishant.users.earthengine.app/view/forest-loss>

# Global Forest Watch

GLOBAL FOREST WATCH MAP DASHBOARD TOPICS BLOG ABOUT HELP ENGLISH MY GFW MORE

## Global

### ▼ Select country

In 2010, the world had **3.92Gha** of tree cover, extending over **30%** of its land area. In **2021**, it lost **25.3Mha** of tree cover.

SUMMARY LAND COVER FOREST CHANGE FIRES CLIMATE

Explore interactive charts and maps that summarize key statistics about global forests. Statistics and global rankings – including rates of forest change, forest extent and drivers of deforestation – can be customized, easily shared and downloaded for offline use.

GLOBAL PRIMARY FOREST LOSS

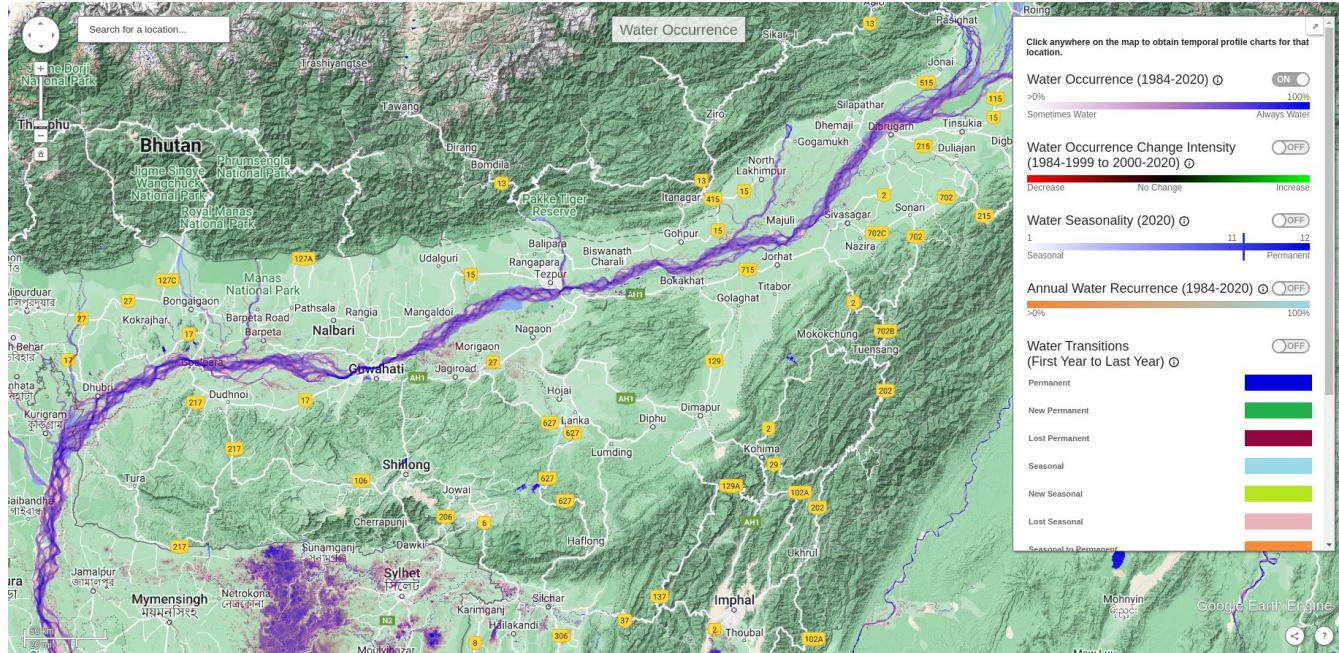
From 2002 to 2021, there was a total of **68.4Mha** humid primary forest lost **globally**, making up **16%** of its total tree cover loss in the same time period. Total area of humid primary forest decreased **globally** by **6.7%** in this time period.

Year	Primary Forest Loss (Mha)
'02	~2.5
'03	~2.8
'05	~3.2
'07	~2.8
'08	~2.5
'10	~3.0
'11	~2.8
'12	~3.2
'13	~2.5
'14	~3.0
'15	~2.8
'16	~6.0
'17	~5.0
'18	~3.8
'19	~3.5
'20	~4.0
'21	~3.5

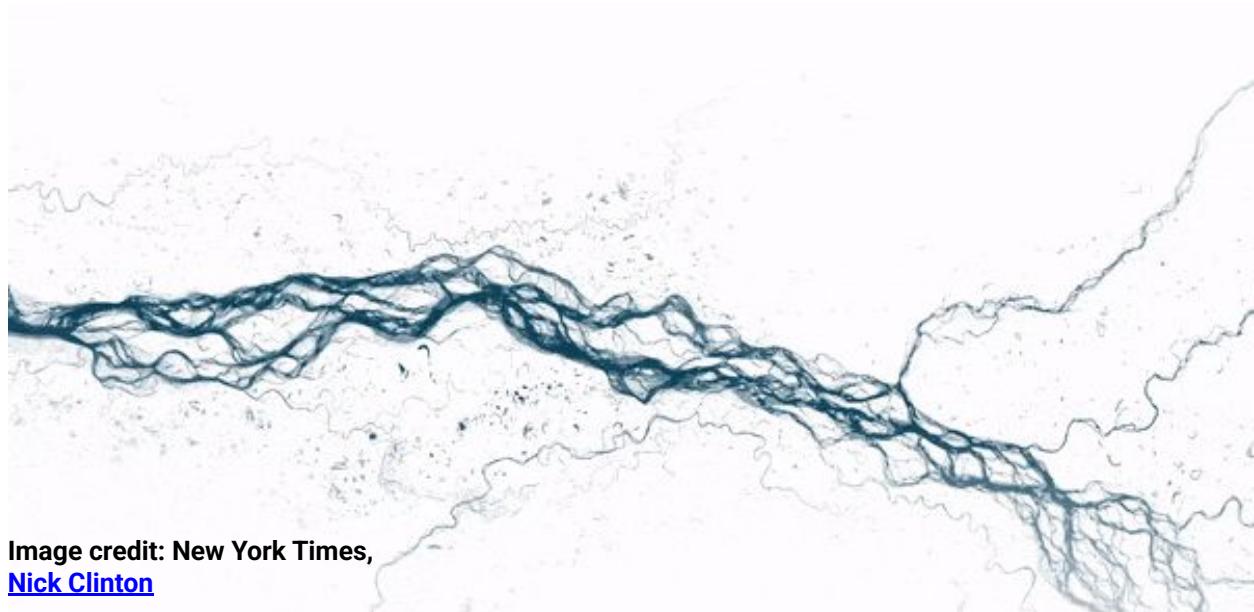
PLANET SATELLITE IMAGERY (TROPICS)

- Forest loss statistics and visualization globally or by country
- Webpage: <https://www.globalforestwatch.org/>

# Global Surface Water



- View water bodies and understand their seasonal behaviour
- Webpage: <https://global-surface-water.appspot.com/map>



# Map of Life



Please provide [feedback](#) to help improve the new interface.

Contact Login Register en de es fr zh

Species

Locations

Indicators

Patterns

Species Home

Summary Map

Detailed Map

Habitat Distribution

Reserve Coverage

Habitat Trends

Projection

Search for a species

Tiger-Striped Leaf Frog

*Phyllomedusa tomopterna*



- Local inventories 4
- Point observations 423
- Expert range maps 1
- Regional checklists 710

[Download species data](#)



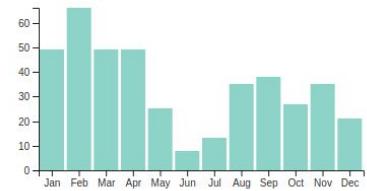
## Temporal Filters

Filters apply to selected point observations and movement layers.

Filter months by selecting bars.

Filter years by clicking and dragging.

Total records by Month



Total records by Year



Layers

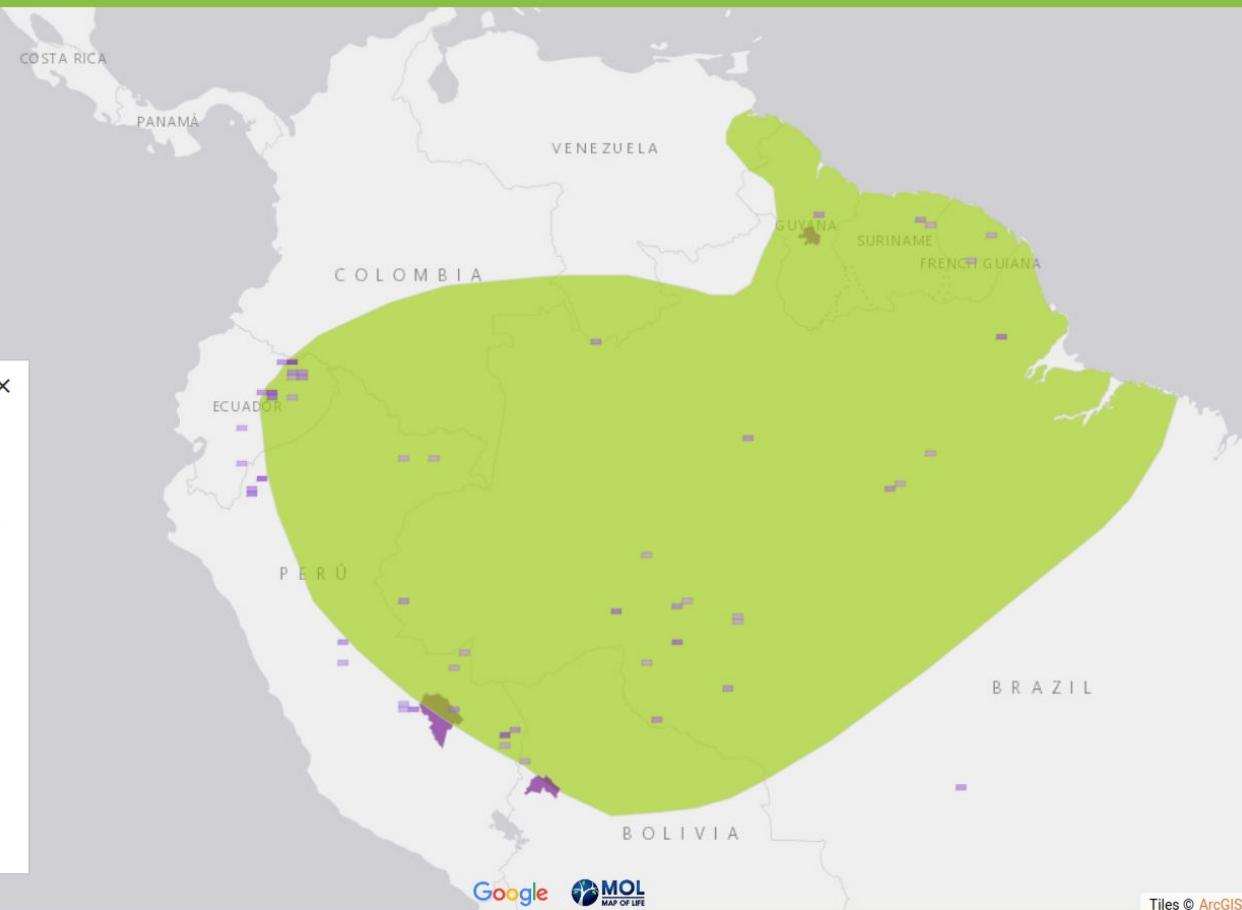
### Legend:

Expert range maps  
Resident  
Breeding  
Non-breeding  
Passage  
No range data available

Point observations  
1  
2 - 6  
7 - 19  
20 - 53  
54 - 147  
148 - 402  
403 - 1095  
1096+

Local inventories  
Presence  
Regional checklists  
Presence  
Gridded surveys  
Presence

500 km

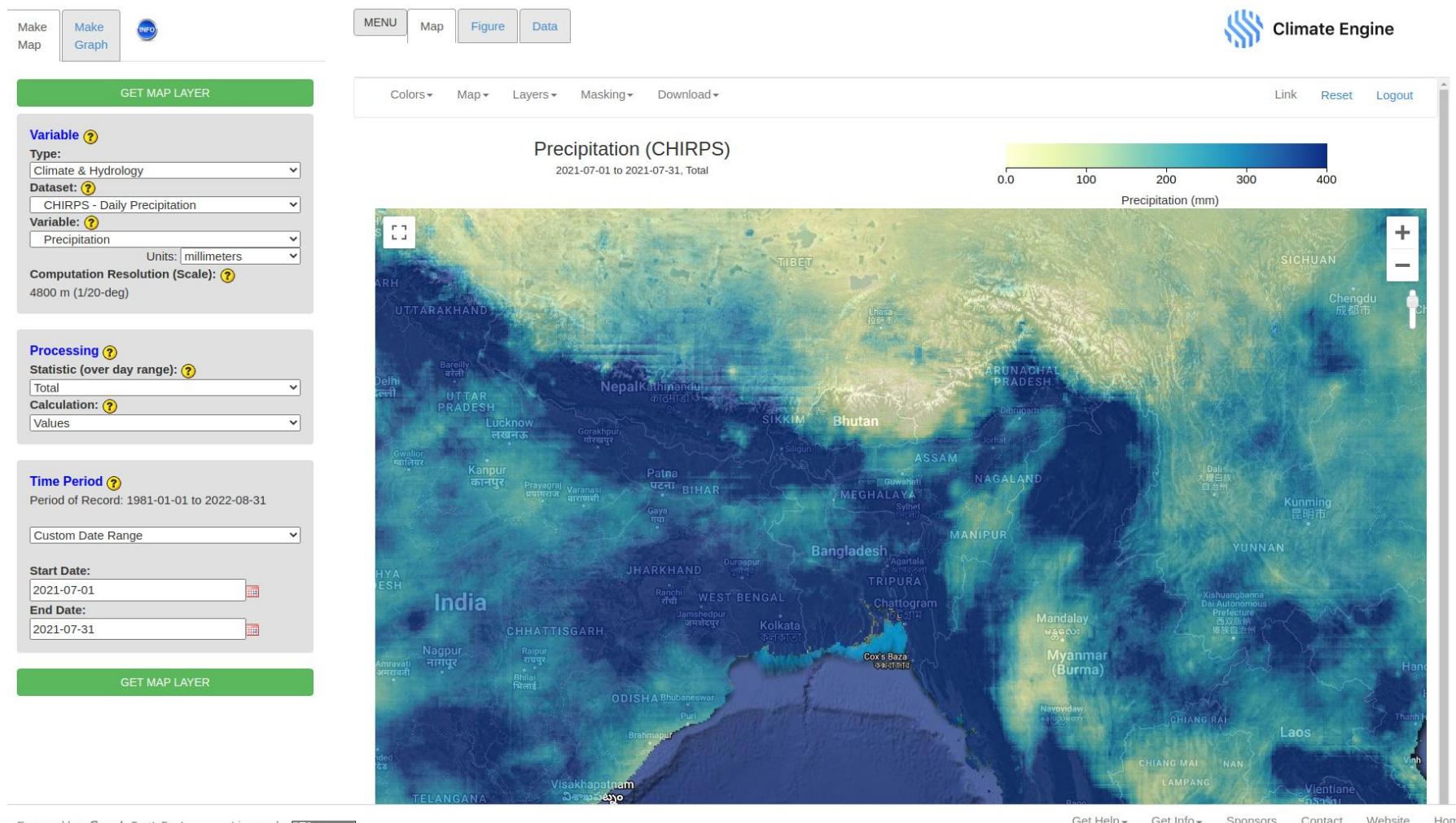


Google MOL  
MAP OF LIFE

Tiles © ArcGIS

- View details of species distribution, status and sightings
- Webpage: <https://mol.org/species/>

# Climate Engine



- View weather datasets and perform basic time series analysis
- Webpage: <https://app.climateengine.com/climateEngine>

THANK YOU