Group Name: **GeoGlobetrotters**

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Project Number & Name: **5. Amazon Deforestation Time Series Analysis**

Duration Taken: **13/12/2023 – 21/12/2023**

Objectives: To write GEE code to analyze the time series of deforestation in the Amazon rainforest.

The primary objectives of this analysis are to:

1. Load and visualize the Hansen Global Forest Change dataset.
2. Define a region of interest (ROI) covering the Amazon rainforest.
3. Filter the dataset to a specified time frame (2000-2022) and the Amazon region.
4. Calculate and visualize annual deforestation rates.
5. Create a time-series chart illustrating cumulative deforestation over the years.

Interpretation and Analysis:

Cumulative deforestation

First Decade (2000-2010):
Cumulative deforestation: Around 30,000,000 Hectare.
Second Decade (2010-2022):
Cumulative deforestation: Increased from 30,000,000 Hectare to 80,000,000 Hectare.

Yearly Deforestation Areas

Initially it ranged from 2,000,000 to 3,500,000 Hectare.
Increased to 6,000,000 Hectare in 2016-2017.
Subsequently fluctuated, staying around 400,000 Hectare, with a spike to 500,000 Hectare in 2022.

Analysis:

Rate of Deforestation Increase :

The data shows a substantial rise in the rate of deforestation between the two decades. In the first decade, the cumulative deforestation was 30 million Hectare, while in the second decade, it surged to 80 million Hectare. This indicates a more than twofold increase in the rate of deforestation.

a. Significant Increase in 2016-2017: The sharp jump in deforestation from 2-3.5 million Hectare to 6 million Hectare in 2016-2017 is noteworthy. This sudden increase may be indicative of specific events, policies, or economic activities driving higher rates of deforestation during that period.

b. Stability around 400,000 Hectare:Following the peak in 2016-2017, the yearly deforestation areas stabilized around 400,000 Hectare. This period of relative stability could be due to changes in land-use policies, conservation efforts, or economic factors influencing deforestation rates.

c. Increase to 500,000 Hectare in 2022:The uptick in deforestation to 500,000 Hectare in 2022 suggests a renewed increase. Identifying the drivers behind this increase is crucial for understanding whether it is a short-term fluctuation or part of a broader trend.

Analysis of deforestation rate change per year:

a. 2001-2002: The deforestation rate increased from 1,500,000 hectares per year in 2001 to 3,000,000 hectares per year in the following year (2002). This represents a significant and abrupt doubling of the deforestation rate.

b. 2002-2016: After the sharp increase, the deforestation rate remained constant at 3,000,000 hectares per year from 2002 to 2016. This 14-year period indicates a plateau in the rate of deforestation, suggesting a period of stability in the environmental impact.

c. 2016-2022: Starting in 2016, there was a linear increase in the deforestation rate each year, reaching around 350,000 hectares per year by 2022. This represents a departure from the previous stability, indicating a renewed upward trend in deforestation.

Interpretation:-

<u>Cumulative Deforestation (2000-2022):</u>
The twofold increase in cumulative deforestation signals a concerning trend of accelerated environmental degradation over the years.

<u>Yearly Fluctuations:</u>
The sharp increase in 2016-2017 may indicate a specific event or policy change driving higher deforestation rates during that period.
Subsequent stability suggests potential interventions or economic shifts, while the uptick in 2022 requires attention.

<u>Deforestation rate :</u>

Deforestation rates doubled from 2001 to 2002, possibly due to increased demand for agricultural land and logging. From 2002 to 2016, a stable period indicates consistent factors driving deforestation. However, a linear increase from 2016 to 2022 suggests renewed and steady forest loss, possibly influenced by changing economic conditions, policy shifts, or altered land-use patterns.

Possible Drivers:
Economic activities, policy changes, and climate events could be influencing deforestation trends. Identifying and addressing these drivers is crucial for effective conservation.

Environmental Implications:
Deforestation, even during periods of stability, has environmental consequences, including habitat loss and ecosystem disruption. The cumulative impact underscores the urgency of sustainable land management.

Policy and Conservation Efforts:
The data highlights the need for robust policies and conservation measures. Understanding the effectiveness of existing interventions and adapting strategies to address emerging challenges is essential.

Continuous Monitoring:
Regular monitoring of deforestation trends is crucial for adaptive management. It enables policymakers to respond to changing conditions and implement targeted interventions.
In Conclusion, the data paints a picture of increasing cumulative deforestation with notable yearly fluctuations. Understanding the drivers behind these trends and implementing effective policies and conservation efforts are essential for mitigating the environmental impact and promoting sustainable land management.

Challenges (team faced):

- Resolution and Scale:
  Balancing the trade-off between spatial resolution and computation time while analyzing large-scale deforestation patterns.

- Integration of Multipolygon Shapefile:
  The integration of a multipolygon shapefile, representing the Amazon Basin, posed challenges in terms of handling complex geometries and ensuring accurate spatial filtering.

New ideas to extend the work:

- Predictive Modeling for Early Warning:

Develop machine learning models to predict deforestation, offering early warnings for proactive conservation planning and preventing biodiversity loss.

- Interactive Visualization for Public Awareness:
  Create a web tool for real-time deforestation updates, historical trends, and educational resources to increase public awareness and support sustainable initiatives.

- Carbon Emission Estimation and Offsetting:
  Extend analysis to estimate carbon emissions from deforestation, contributing to climate change mitigation. Explore carbon offset projects through reforestation or conservation efforts.

- Land Cover Change Classification:
  Expand analysis to classify various land cover changes beyond deforestation, providing a comprehensive understanding of land-use alterations.

- Community Engagement and Socio-Economic Analysis:
  Integrate socio-economic data, engage local communities for on-the-ground insights, and understand the human dimension of deforestation. Collaborate on sustainable practices and policies with stakeholders.

Code :

https://code.earthengine.google.com/349b4b05936a77786f0ebf0b5c839db5

```
// Load the Amazon region geometry
var amazonRegionGeometry = ee.FeatureCollection("projects/ee-
sanjeevanilakade25/assets/amazon_basin").geometry().dissolve({'maxError': 1});
print('Amazon Region Geometry:', amazonRegionGeometry);

// Add the Amazon region geometry to the map for visualization
Map.addLayer(amazonRegionGeometry, {color: 'blue' }, 'Amazon Rainforest Geometry', true, 0.5);

// Load the Hansen Global Forest Change dataset
var forestChangeImage =
ee.Image("UMD/hansen/global_forest_change_2022_v1_10").select(['lossyear']).clip(amazonRegionGeometry);
print('Forest Change Image:', forestChangeImage);

// Center the map on the region of interest
Map.centerObject(amazonRegionGeometry, 4);

// Display the forest loss image on the map
```

```
Map.addLayer(forestChangeImage, {bands: ['lossyear'], palette: ['FF0000']}, 'Forest Loss');

// Define the years of interest
var yearsOfInterest = ee.List.sequence(0, 22);

// Map over the years and calculate deforestation area
var deforestationAreas = yearsOfInterest.map(function(year) {
  var lossYearMask = forestChangeImage.eq(ee.Number(year)).selfMask();
  var pixelAreaImage = lossYearMask.multiply(ee.Image.pixelArea());
  var areaStats = pixelAreaImage.reduceRegion({
    reducer: ee.Reducer.sum(),
    geometry: amazonRegionGeometry,
    scale: 200,
    maxPixels: 1e14
  });

  // Convert the image value to a Number
  var lossArea = ee.Number(areaStats.get('lossyear'));

  // Multiply pixel area by loss area (assuming 'lossyear' represents loss area)
  var deforestationArea = lossArea.multiply(0.0001);

  return lossYearMask.set('area', deforestationArea)
    .set('year', ee.String(ee.Number(year).add(2000).toInt()));
});

// Create an ImageCollection from the mapped result
var deforestationImageCollection = ee.ImageCollection.fromImages(deforestationAreas);
print('Deforestation Image Collection:', deforestationImageCollection);

// Aggregate the results for charting
var yearsList = deforestationImageCollection.aggregate_array('year');
var deforestationAreasList = deforestationImageCollection.aggregate_array('area');
var deforestationData = ee.Dictionary.fromLists(yearsList, deforestationAreasList);
print('Deforestation Data:', deforestationData);

// Create an area chart for deforestation
var deforestationChart = ui.Chart.array.values({
  array: deforestationData.values(),
  axis: 0,
  xLabels: deforestationData.keys()
}).setChartType('AreaChart').setOptions({
  title: 'Deforestation Over the Years',
  hAxis: {title: 'Year'},
```

```
  vAxis: {title: 'Deforestation Area (in hectares)'}
});

// Print the deforestation chart
print('Deforestation Chart:', deforestationChart);

// Function to calculate cumulative sum with modified logic
var cumulativeSum = function(element, accumulator) {
  accumulator = ee.List(accumulator);
  return accumulator.add(ee.Number(element).add(accumulator.get(-1)));
};

// Apply cumulative sum function to the list
var cumulativeDeforestationList = deforestationAreasList.iterate(cumulativeSum, ee.List([0]));
print('Cumulative Deforestation List:', cumulativeDeforestationList);

// Convert the cumulative list to a dictionary with years as keys
var cumulativeDeforestationDict = ee.Dictionary.fromLists(yearsList, ee.List(cumulativeDeforestationList).slice(1));
print('Cumulative Deforestation Dictionary:', cumulativeDeforestationDict);

// Create an area chart for cumulative deforestation
var cumulativeDeforestationChart = ui.Chart.array.values({
  array: cumulativeDeforestationDict.values(),
  axis: 0,
  xLabels: cumulativeDeforestationDict.keys()
}).setChartType('AreaChart').setOptions({
  title: 'Cumulative Deforestation Over the Years',
  hAxis: {title: 'Year'},
  vAxis: {title: 'Cumulative Deforestation Area  (in hectares)'}
});

// Print the cumulative deforestation chart
print('Cumulative Deforestation Chart:', cumulativeDeforestationChart);

// Function to calculate deforestation rate
var calculateDeforestationRate = function(value, accumulator) {
  accumulator = ee.List(accumulator);
  var index = accumulator.size();

  // Calculate deforestation rate
  var deforestationRate = ee.Number(value).divide(index);

  return accumulator.add(deforestationRate);
};
```

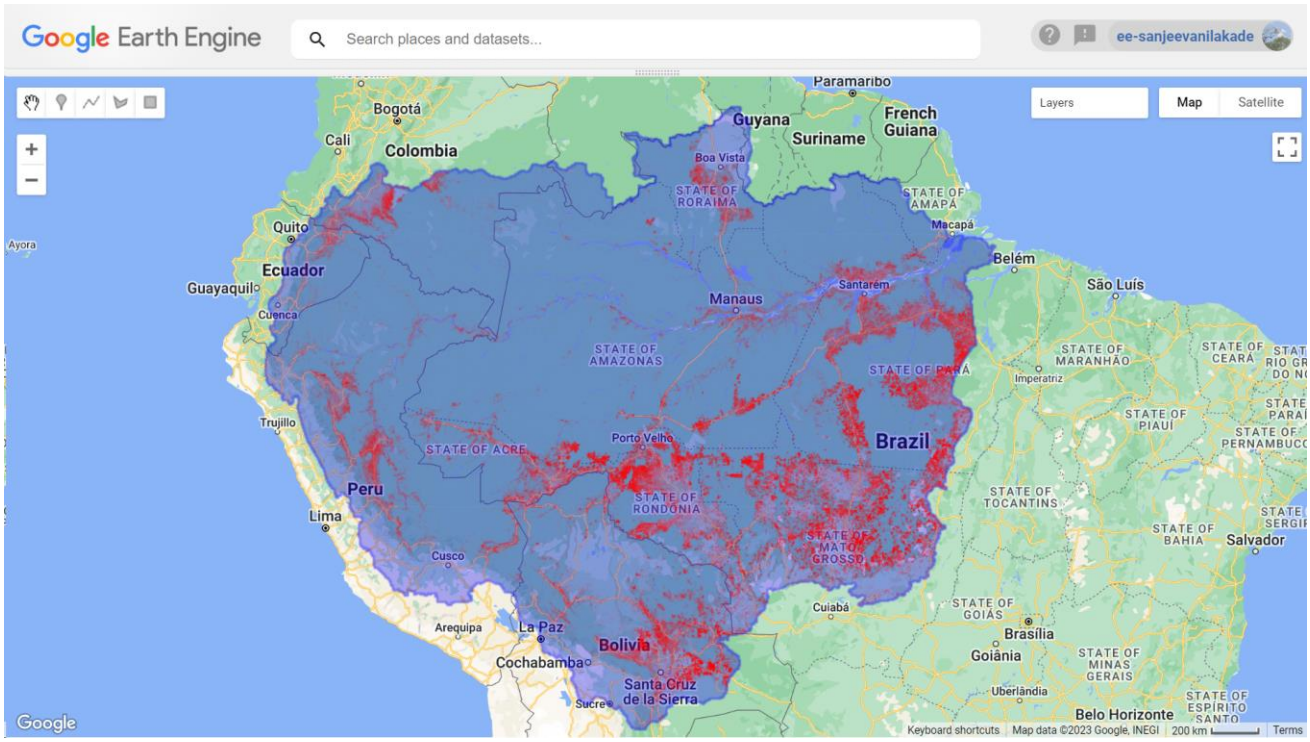
```
// Apply the function to cumulativeDeforestationList using iterate
var deforestationRateList = ee.List(ee.List(cumulativeDeforestationList).iterate(calculateDeforestationRate, ee.List([])));

// Print the result
print('Deforestation Rate List:', deforestationRateList);

var deforestationRateDict = ee.Dictionary.fromLists(yearsList, deforestationRateList.slice(1));
print('Deforestation Rate Dictionary:', deforestationRateDict);

// Create an area chart for cumulative deforestation
var deforestationRateChart = ui.Chart.array.values({
  array: deforestationRateDict.values(),
  axis: 0,
  xLabels: deforestationRateDict.keys()
}).setChartType('AreaChart').setOptions({
  title: 'Deforestation Rate Chart',
  hAxis: { title: 'Year' },
  vAxis: { title: 'Deforestation Rate (in hectares / year)' },
  pointSize: 5,
  lineWidth: 2,
  series: {
    0: { pointShape: 'circle' }
  }
});
// Display the chart
print(deforestationRateChart);
```

Output:-


Google Earth Engine
Search places and datasets...
ee-sanjeevanilakade
Layers
Map
Satellite
Paramaribo
Bogotá
Cali
Colombia
Guyana
Suriname
French Guiana
Boa Vista
STATE OF RORAIMA
STATE OF AMAPÁ
Macapá
Belém
São Luís
Quito
Ecuador
Guayaquil
Cuenca
Ayora
Santarém
Manaus
STATE OF AMAZONAS
STATE OF PARÁ
STATE OF MARANHÃO
STATE OF CEARÁ
Imperatriz
STATE OF PIAUÍ
Trujillo
Porto Velho
STATE OF ACRE
Brazil
Peru
Lima
STATE OF RONDÔNIA
STATE OF TOCANTINS
STATE OF BAHIA
Salvador
Cusco
STATE OF MATO GROSSO
Cuiabá
STATE OF GOIÁS
Brasília
Goiânia
Arequipa
La Paz
Bolivia
Cochabamba
Santa Cruz de la Sierra
Sucre
STATE OF MINAS GERAIS
Uberlândia
Belo Horizonte
STATE OF ESPÍRITO SANTO
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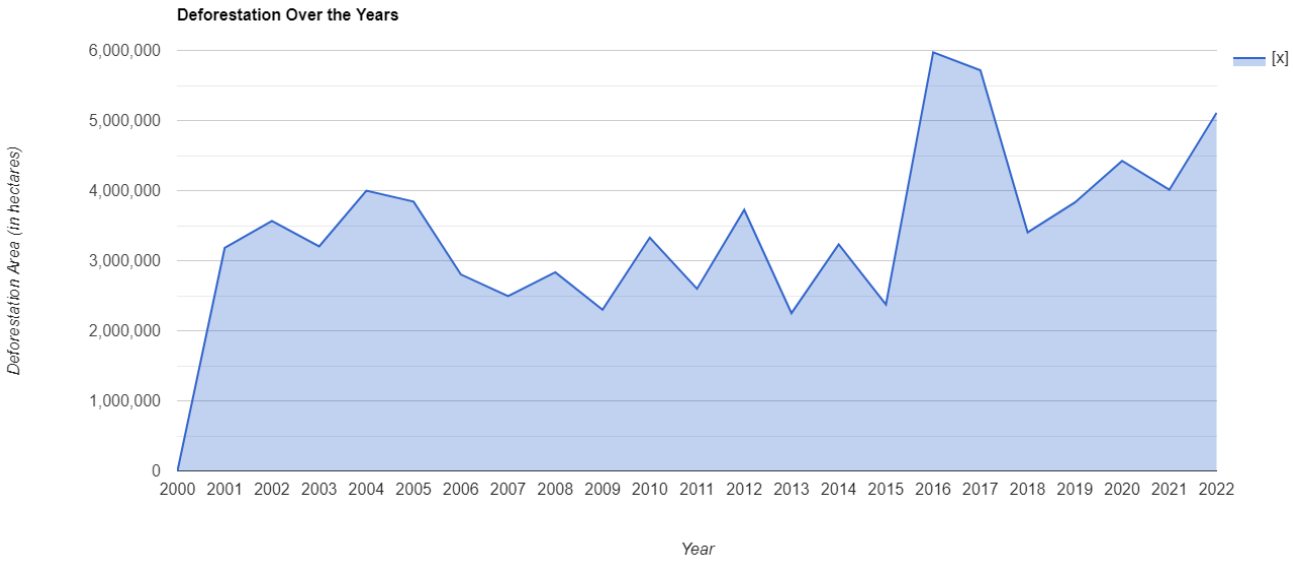
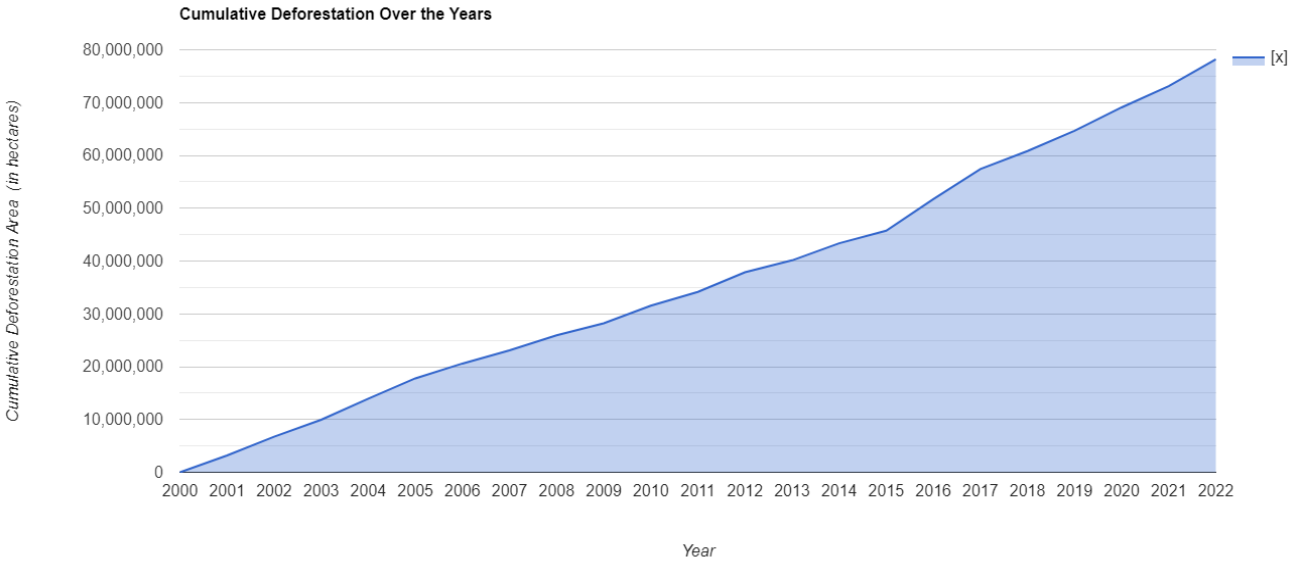
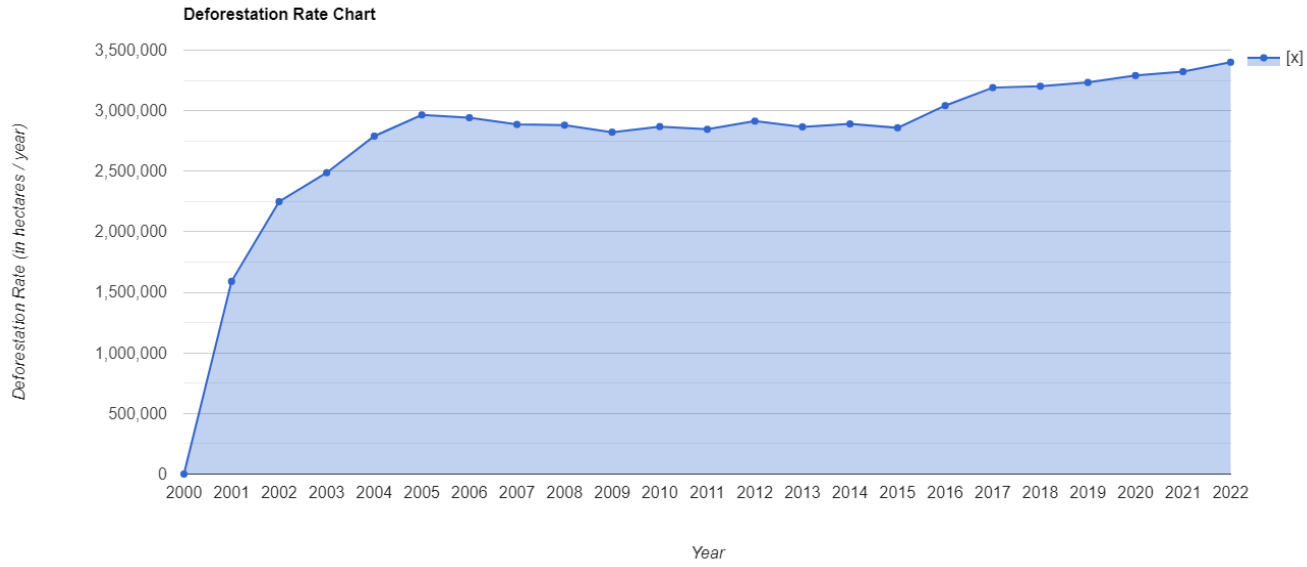

Deforestation Over the Years
[x]
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
Deforestation Area (in hectares)
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022
Year





References:

https://daac.ornl.gov/LBA/guides/CD06_CAMREX.html

https://daac.ornl.gov/cgi-bin/dsviewer.pl?ds_id=1086