Tratamento de Dados Geospaciais em Plataforma de Nuvem

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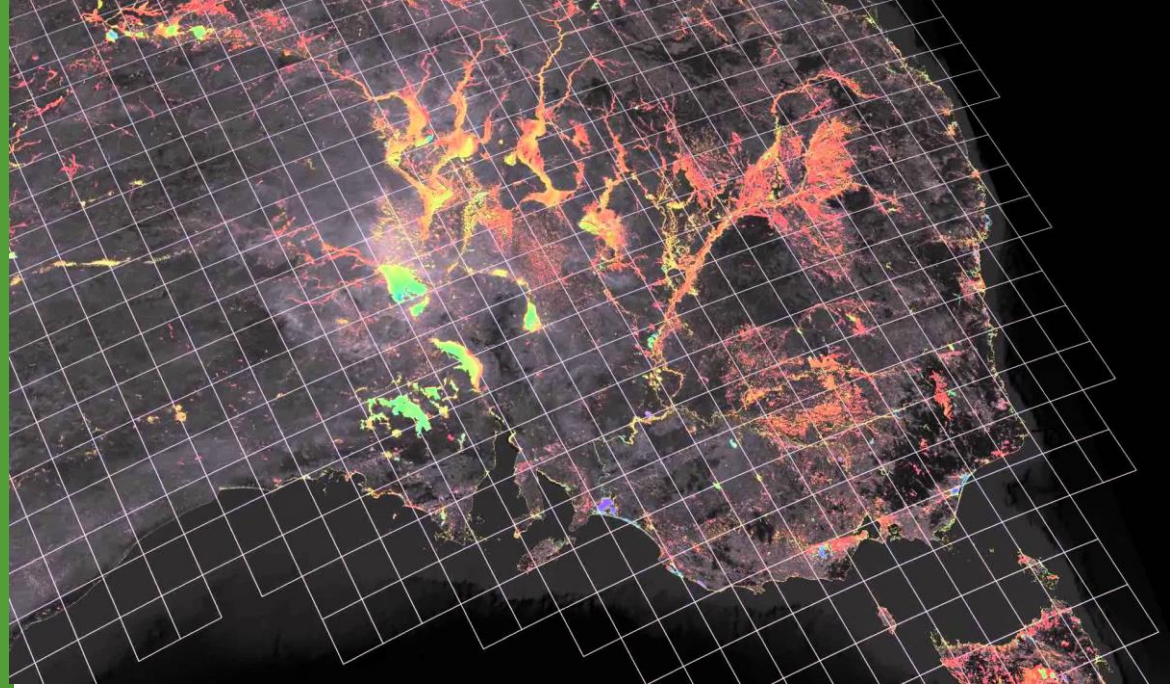
GIADES
GRUPO DE INVESTIGACIÓN AMBIENTAL EN EL DESARROLLO SUSTENTABLE
UNIVERSIDAD POLITÉCNICA SALESIANA

INOVISÃO

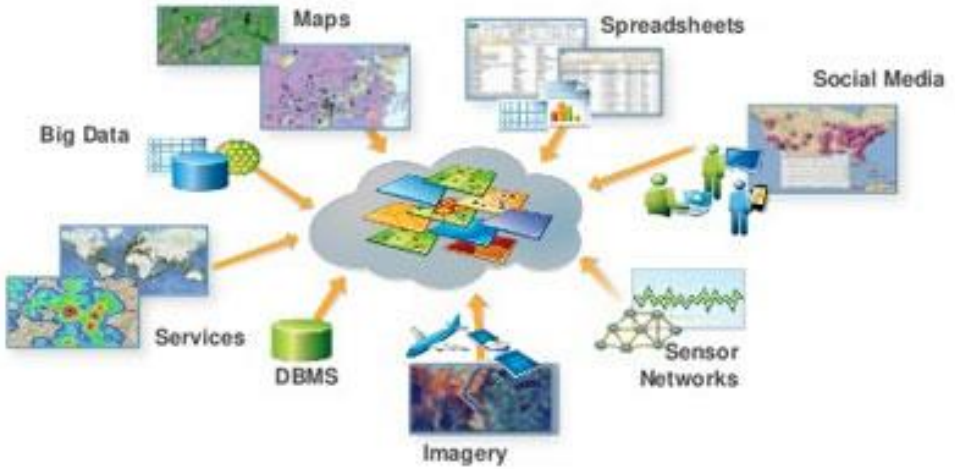
UNIVERSIDAD POLITÉCNICA SALESIANA ECUADOR

UCDB

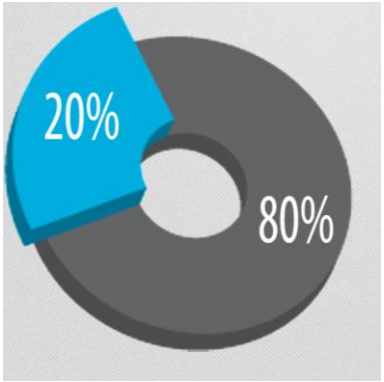


Dados Geoespaciais

Dados geoespaciais, ou geodados, são dados que contêm informações relacionadas a locais na superfície terrestre. É possível mapear objetos, eventos e outros fenômenos do mundo real de uma área geográfica específica identificada por coordenadas de latitude e longitude.



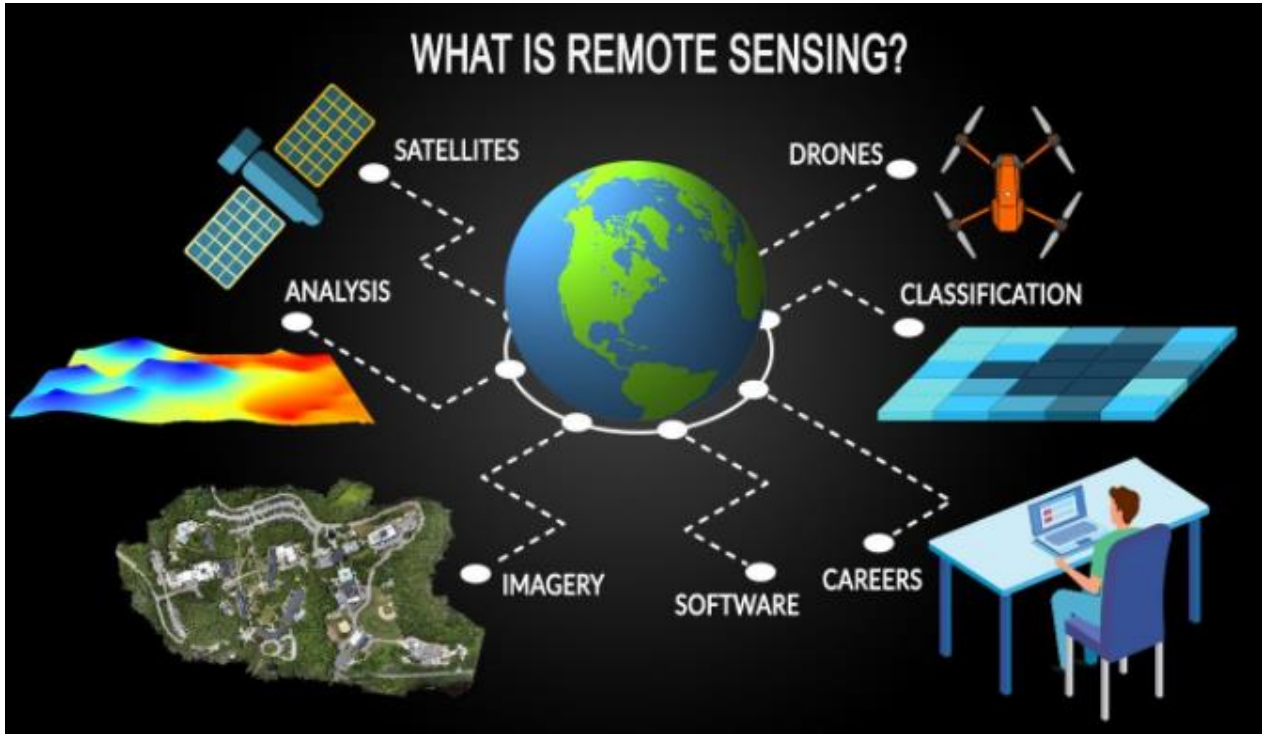
Você sabia que mais de 80% da informação mundial é geográfica?



Tipos de dados geoespaciais

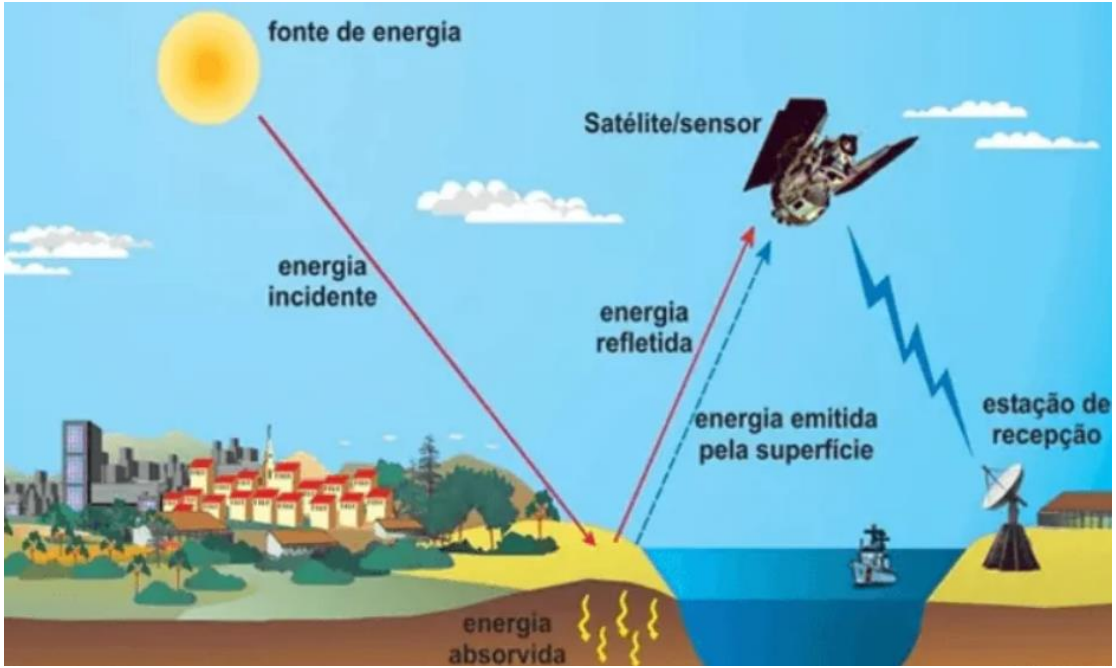
Quem gerencia a informação geográfica consegue organizar o território de forma mais eficaz

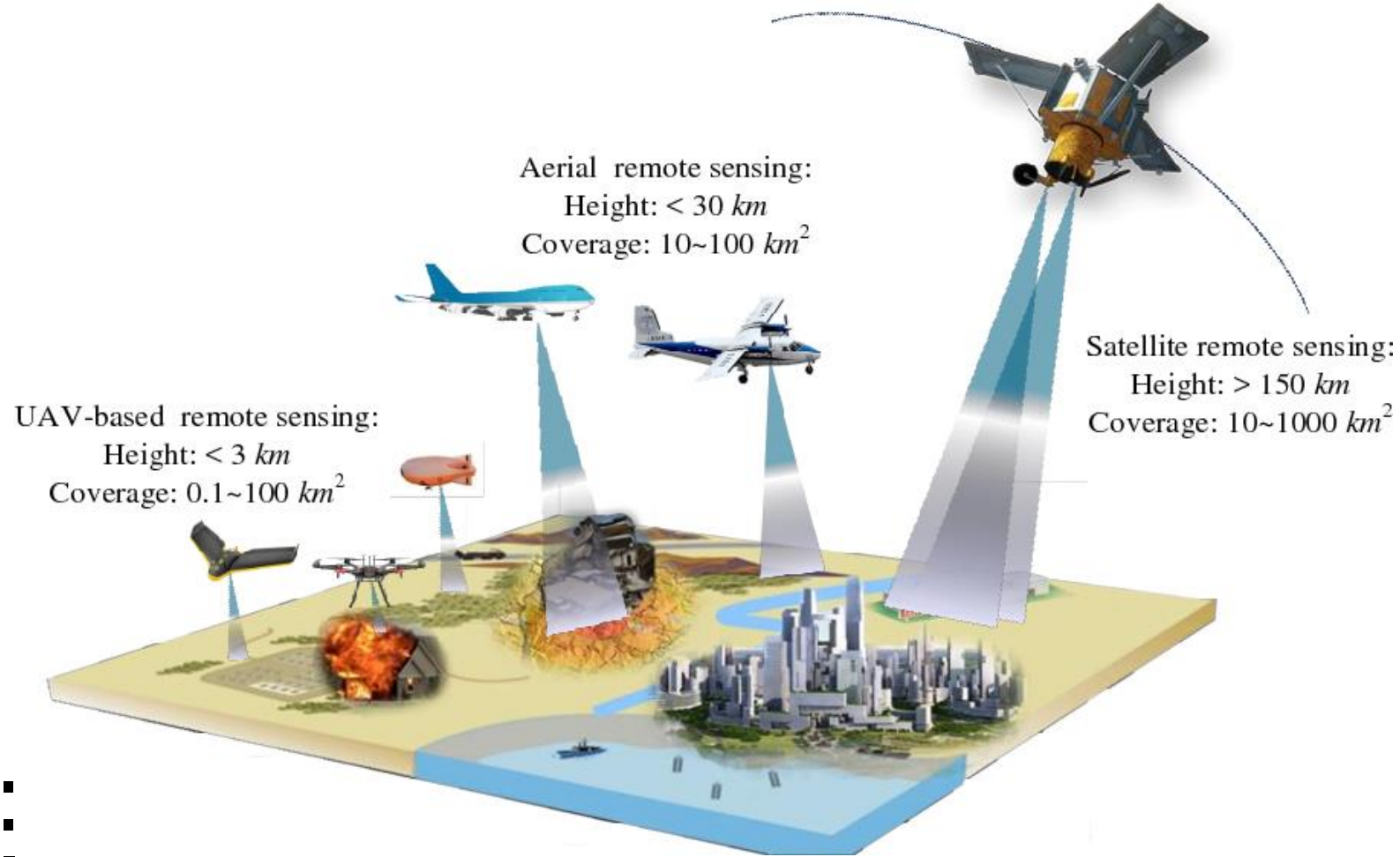
Conceitos de Sensoriamento Remoto



Também conhecido como Sensoriamento Remoto, é um método de obtenção de informações sobre as propriedades de um objeto sem contato físico com ele.

Componentes do Sensoriamento Remoto




Aerial remote sensing:
Height: < 30 km
Coverage: 10~100 km²
UAV-based remote sensing:
Height: < 3 km
Coverage: 0.1~100 km²
Satellite remote sensing:
Height: > 150 km
Coverage: 10~1000 km²

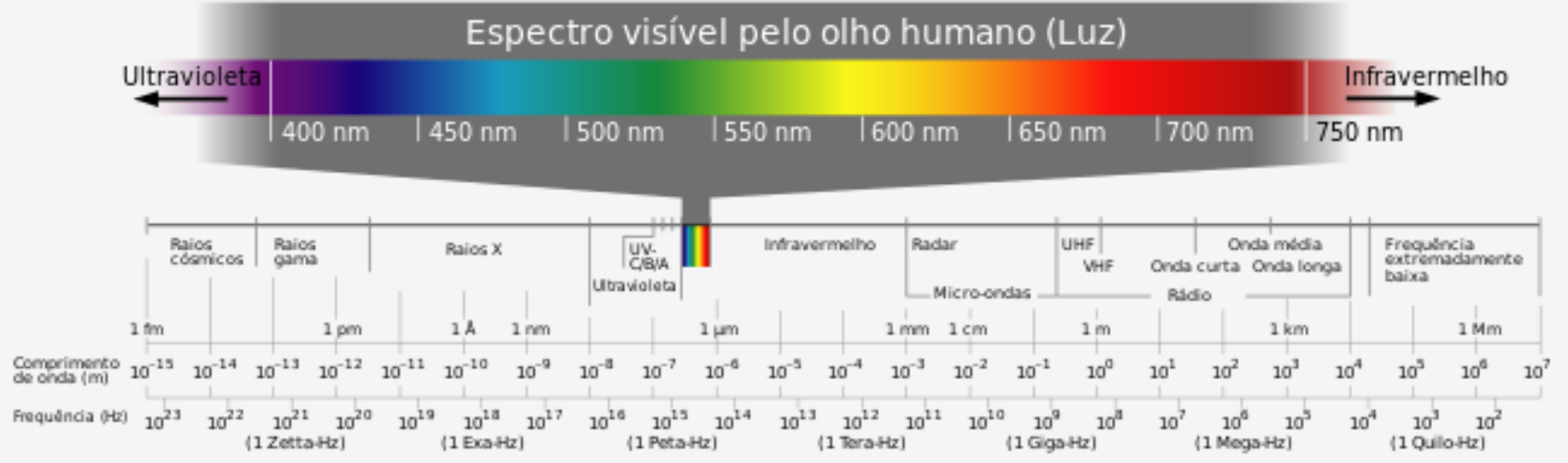
O espectro eletromagnético

A radiação eletromagnética compreende uma ampla variedade de frequências ou comprimentos de onda que vão desde raios gama até ondas de rádio. Todas estas emissões constituem assim o espectro electromagnético.

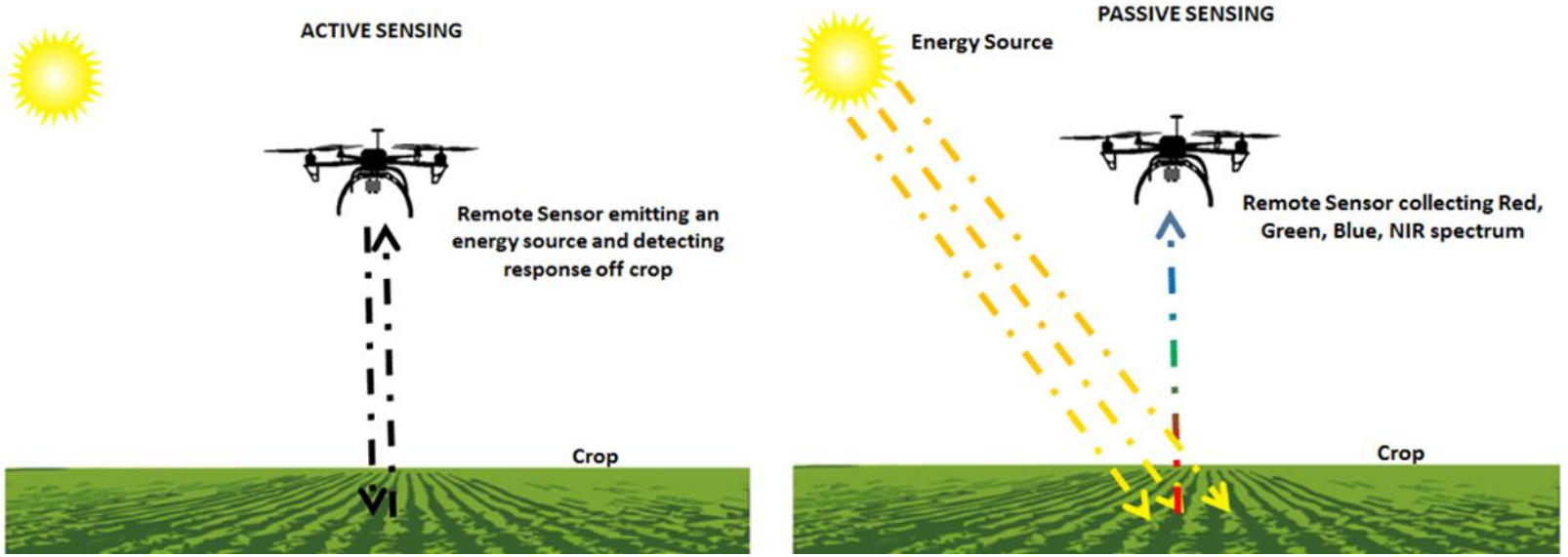
As radiações mais utilizadas em sensoriamento remoto são:

- As microondas são usadas em sensores de radar.
- Radiação infravermelha radiação emitida por corpos quentes.
- O espectro visível (RGB)
- A radiação ultravioleta é o principal componente da radiação solar.

O espectro eletromagnético



Tipos de Sensores

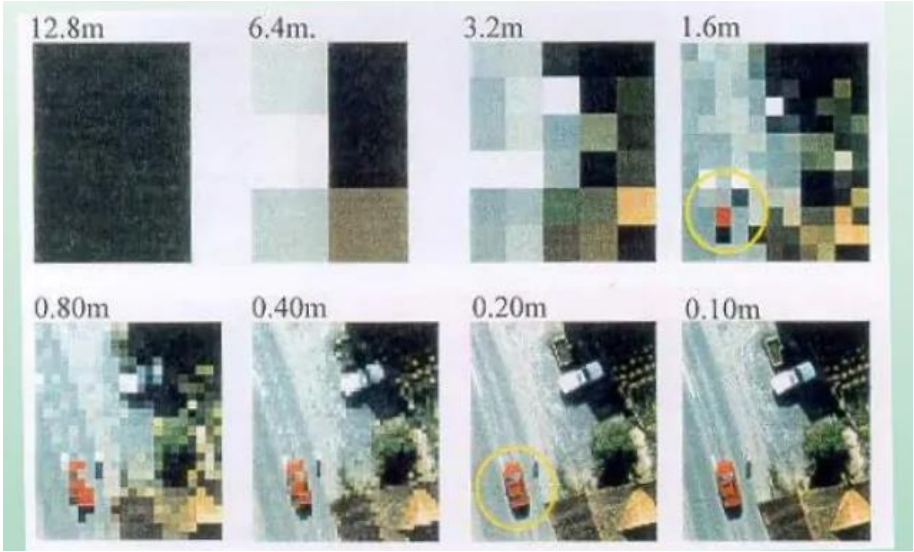


Tipos de resoluções

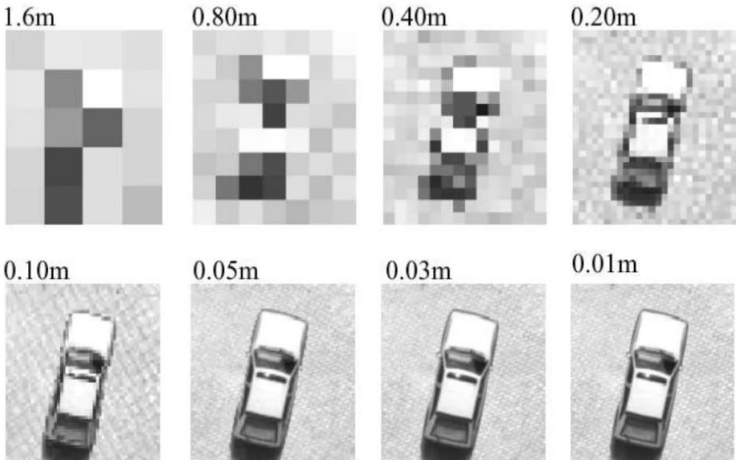
- Resolução Espacial - Geográfica
- Resolução Espectral
- Resolução Radiométrica
- Resolução temporária

Resolução Espacial - Geográfica

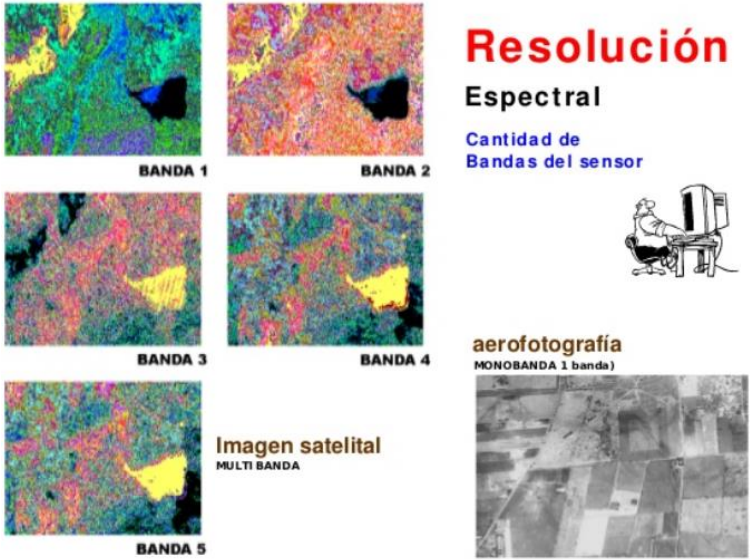
Tamanho que a área abarcada em um pixel corresponde na realidade.

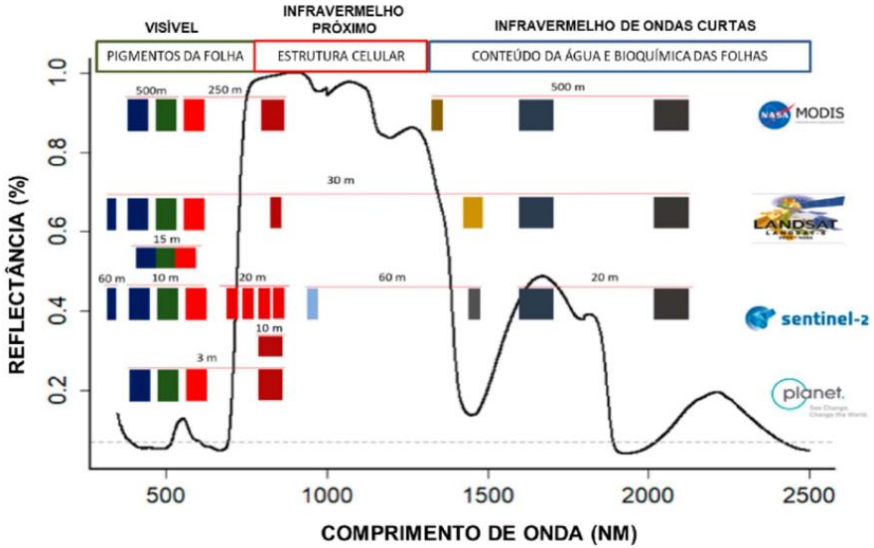


Resolução Espacial - Geográfica

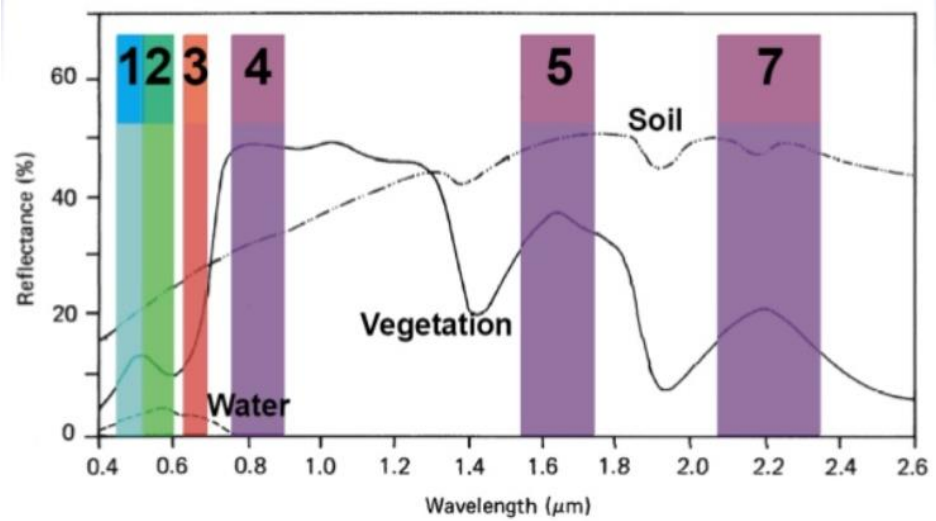


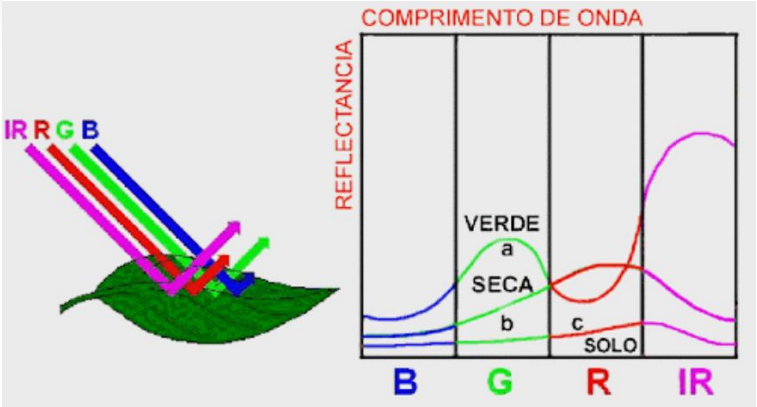
Resolução Espectral





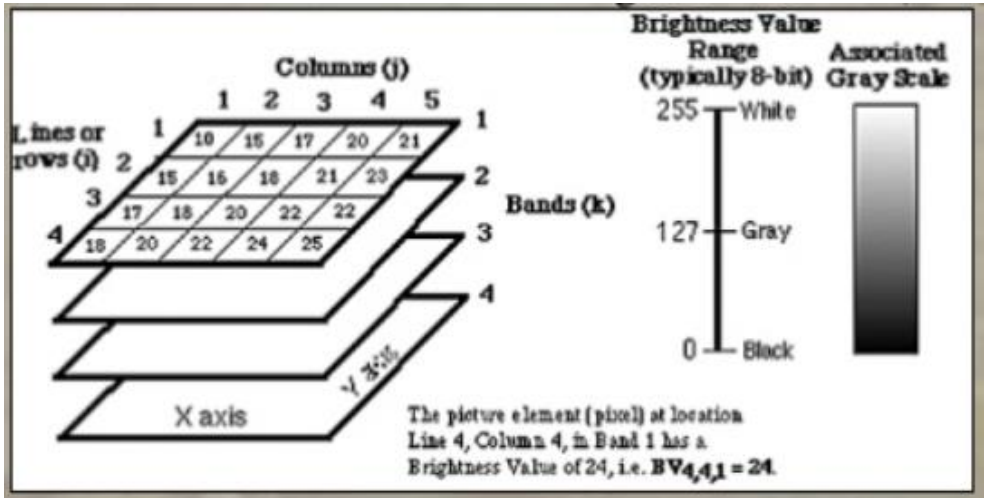
Resolução Espectral - Assinaturas Espectrais



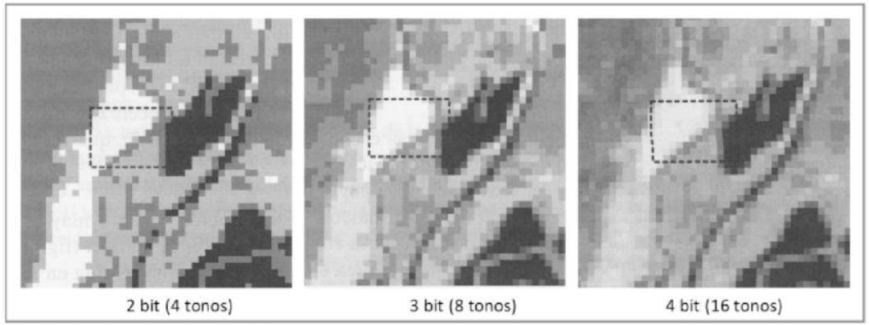


Resolução Radiométrica

Quanto maior o número de níveis que podem ser registrados, maior será a resolução radiométrica do sistema de sensores 8, 12, 16, 24, entre outros.

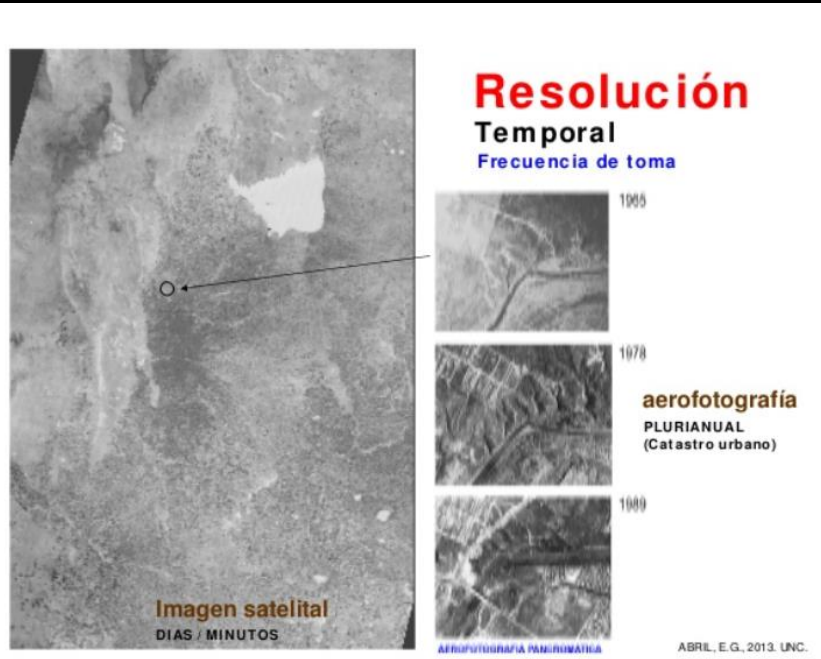


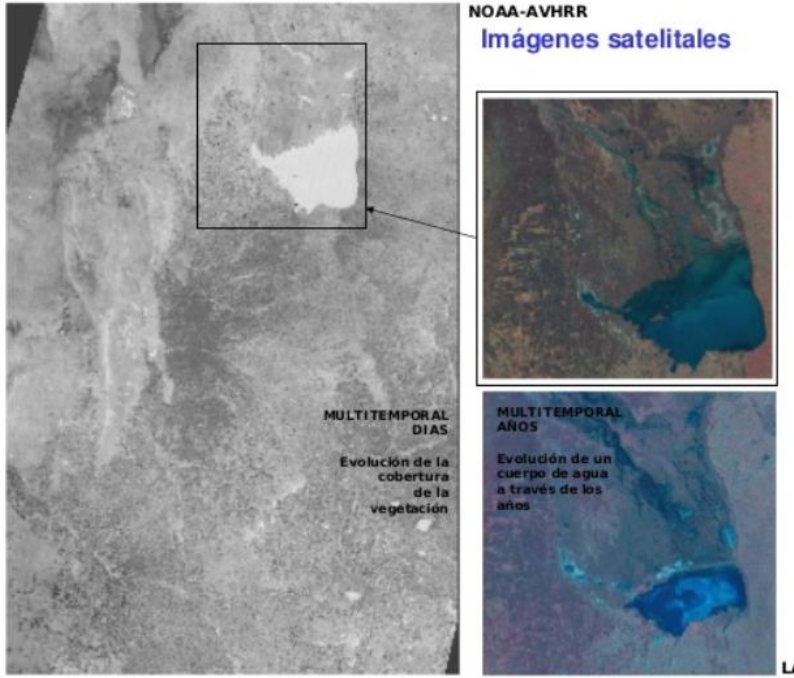
Resolução Radiométrica



Fuente: Adaptado de Chuvieco, 2002

Resolução temporária





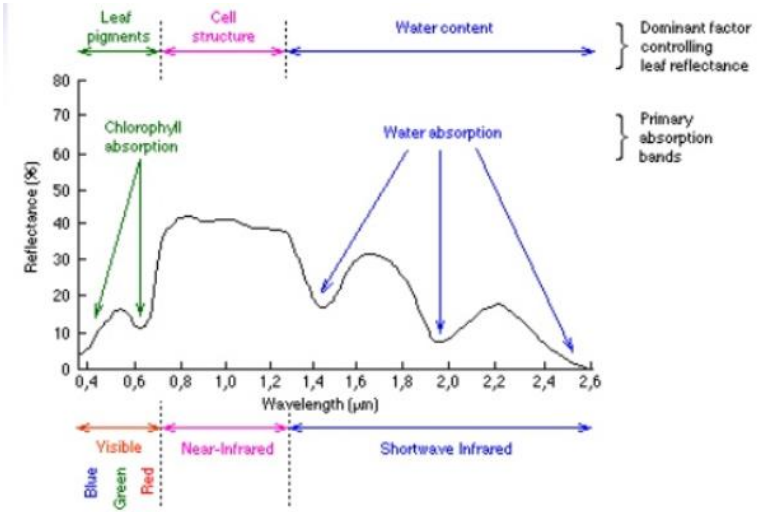
Intervalo de tempo que o satélite leva para voltar a recobrir a área de interesse

Índices multiespectrais

Existe um grande número de índices espectrais que podem analisar diversos aspectos como vegetação, recursos hídricos, neve, solo, fogo, entre outros. Ou seja, destacamos o elemento de interesse na superfície terrestre.

Radiância é o fluxo radiante emitido, refletido, transmitido ou recebido por uma determinada superfície, por unidade de ângulo sólido por unidade de área projetada.

A refletância é a razão entre a radiância refletida e a produção total de energia.

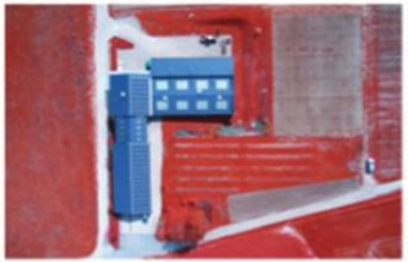


NDVI

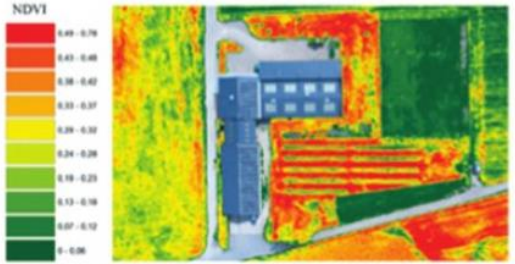
O Índice de Vegetação por Diferença Normalizada (NDVI) é um índice de vegetação utilizado para estimar a quantidade, qualidade e desenvolvimento da vegetação com base na medição da intensidade de radiação de determinadas bandas do espectro eletromagnético.

$$NDVI = \frac{NIR-RED}{NIR+RED}$$

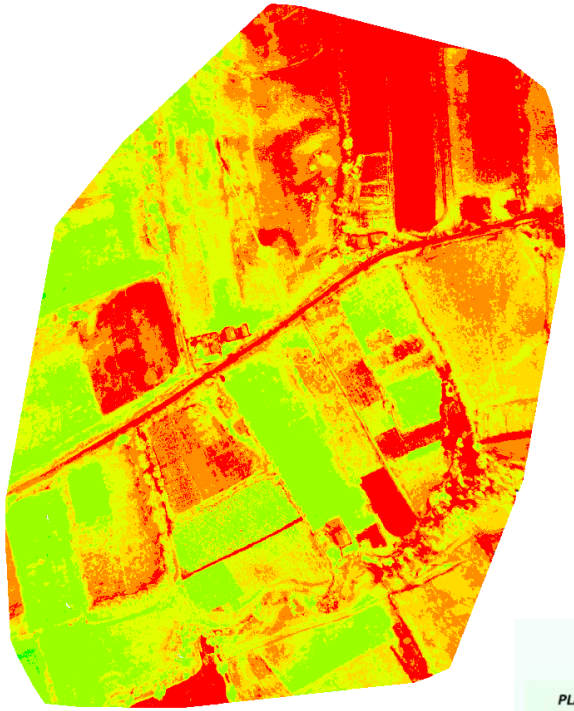
Résultat classique pour comparaison.

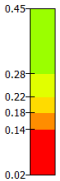


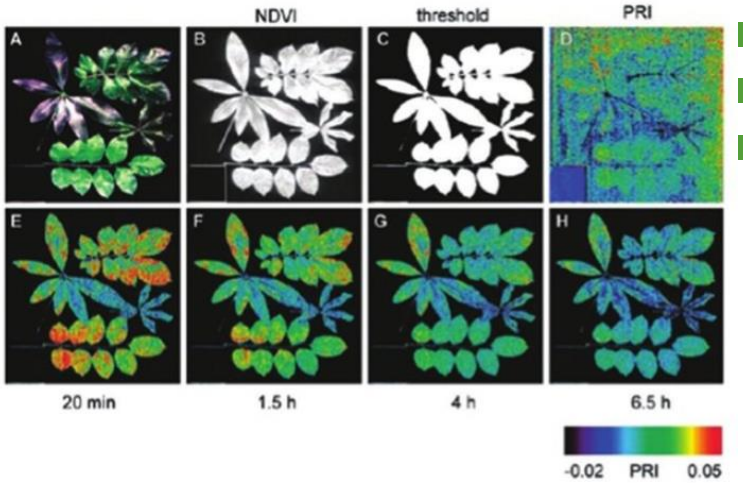
Cliché brut.

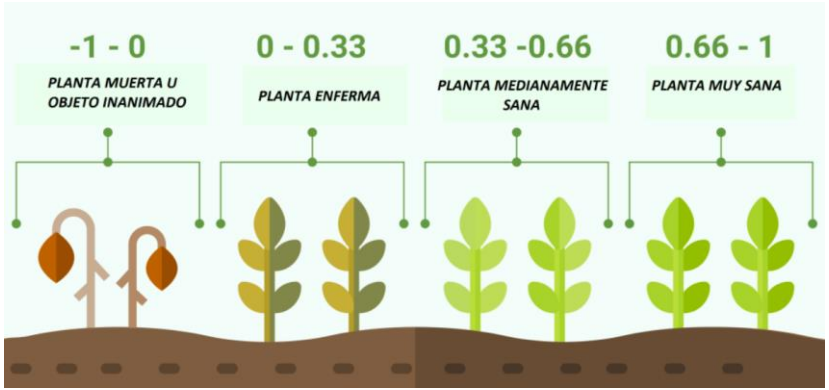


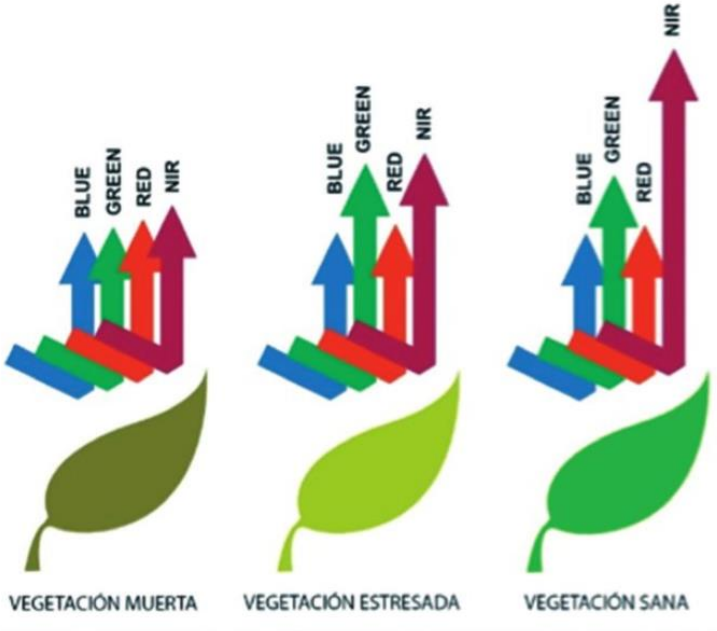
Carte d'activité végétale NDVI obtenue à partir du cliché brut.

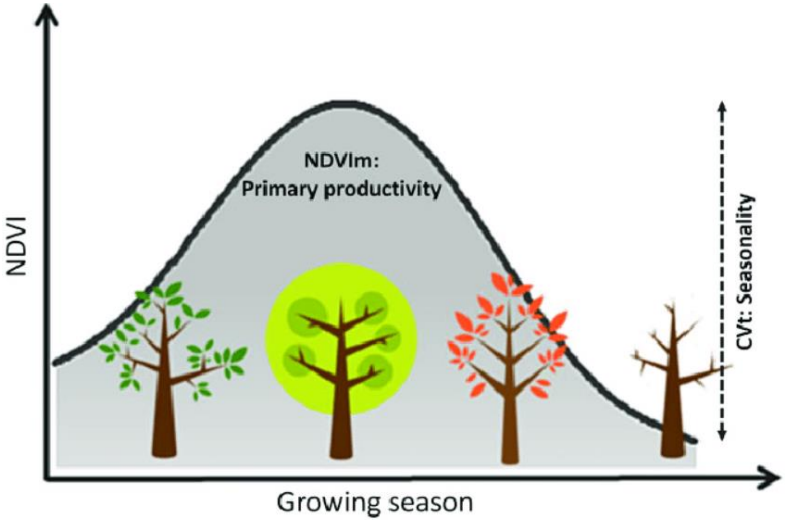


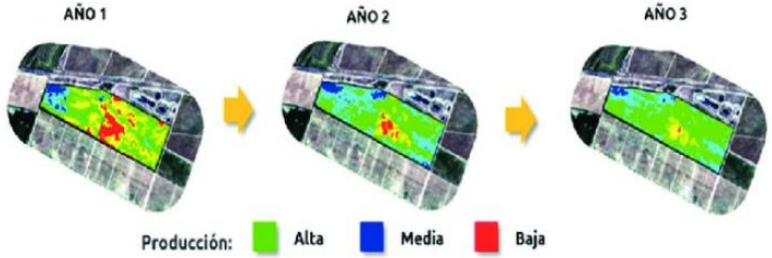

0.45
0.28
0.22
0.18
0.14
0.02


NDVI
threshold
PRI
A
B
C
D
E
F
G
H
20 min
1.5 h
4 h
6.5 h
-0.02
PRI
0.05


-1 - 0
PLANTA MUERTA U OBJETO INANIMADO
0 - 0.33
PLANTA ENFERMA
0.33 -0.66
PLANTA MEDIANAMENTE SANA
0.66 - 1
PLANTA MUY SANA


BLUE
GREEN
RED
NIR
VEGETACIÓN MUERTA
VEGETACIÓN ESTRESADA
VEGETACIÓN SANA

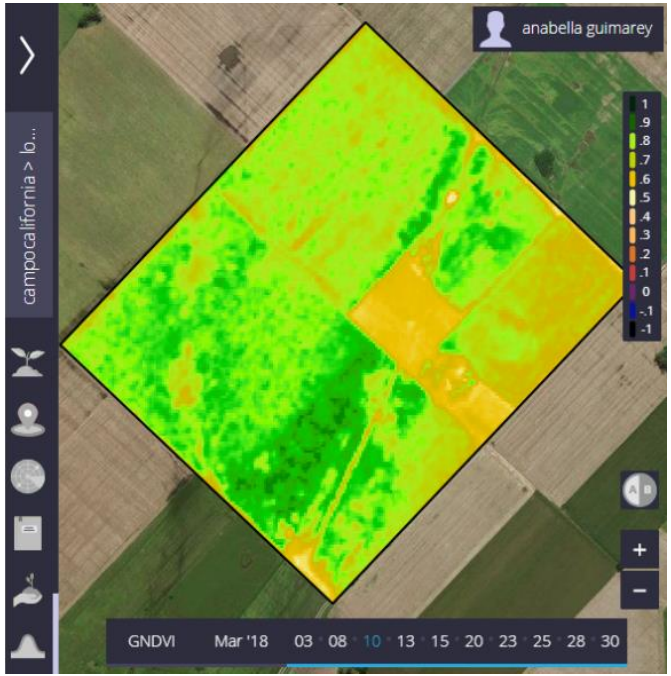

NDVI
NDVIm:
Primary productivity
CVt: Seasonality
Growing season


AÑO 1
AÑO 2
AÑO 3
Producción:
Alta
Media
Baja

GNDVI

O Índice GNDVI (Green Normalized Difference Vegetation) é um índice de "verdura" da planta ou atividade fotossintética. É um dos índices de vegetação mais utilizados para determinar a absorção de água e nitrogênio na copa das culturas.

$$GNDVI = \frac{R_{NIR} - R_{Green}}{R_{NIR} + R_{Green}}$$

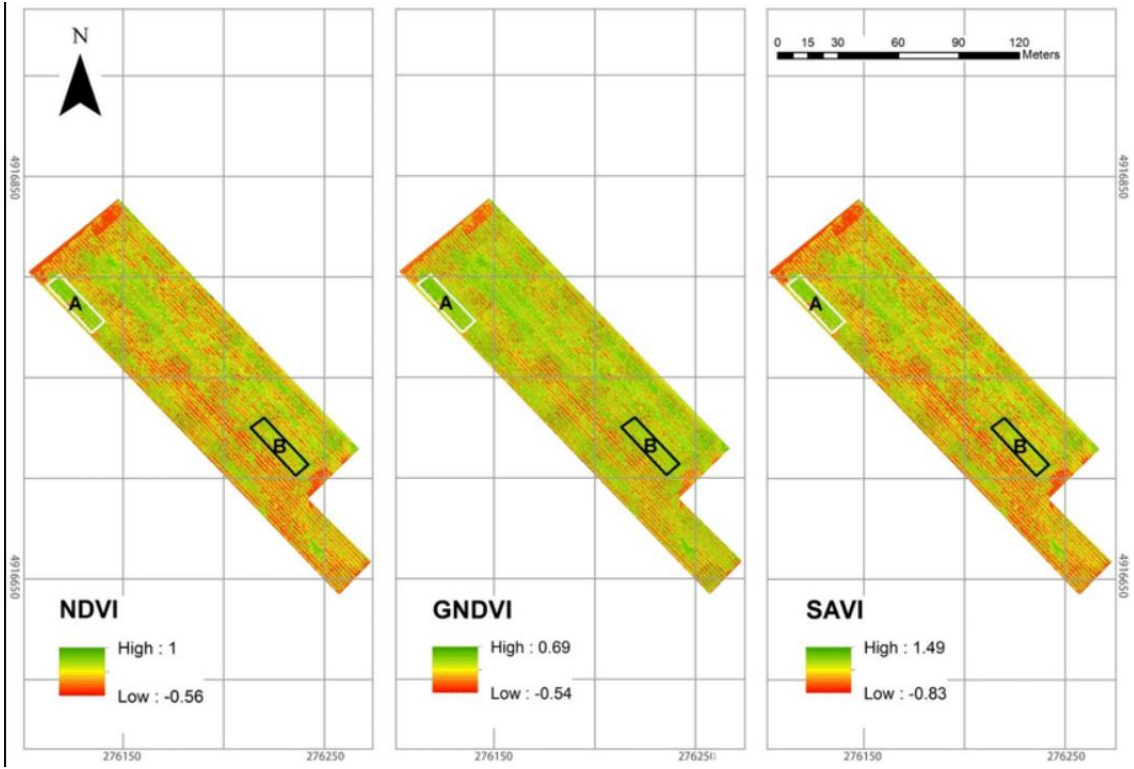


SAVI

$$\mathrm{SAVI} = \frac{(1 + \mathrm{L})(\mathrm{NIR} - \mathrm{Red})}{(\mathrm{NIR} + \mathrm{Red} + \mathrm{L})}$$

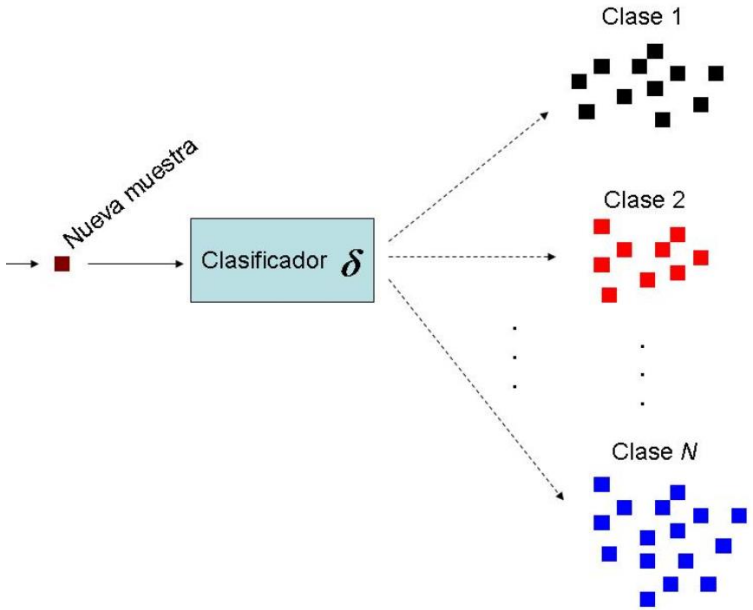
O SAVI (Índice de Vegetação Ajustado ao Solo) apresenta uma ligeira variação em relação à fórmula tradicional do NDVI para evitar distorções nos valores de análise quando a vegetação é encontrada em solos expostos. Condições como temperatura ou umidade podem influenciar as faixas de trabalho analisadas e, portanto, os resultados oferecidos pelo indicador. Neste caso, o índice de vegetação SAVI tentará evitar esta influência do solo nos resultados adicionando um fator adicional (L) na equação NDVI que permitirá trabalhar em cenários onde o desenvolvimento das plantas é incipiente.

Índices multiespectrais

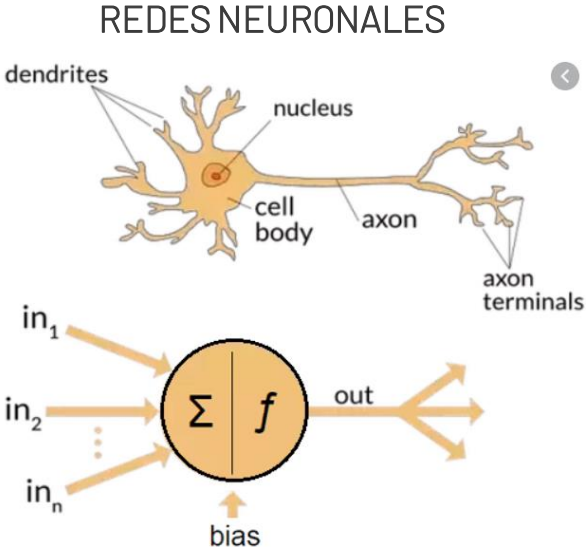


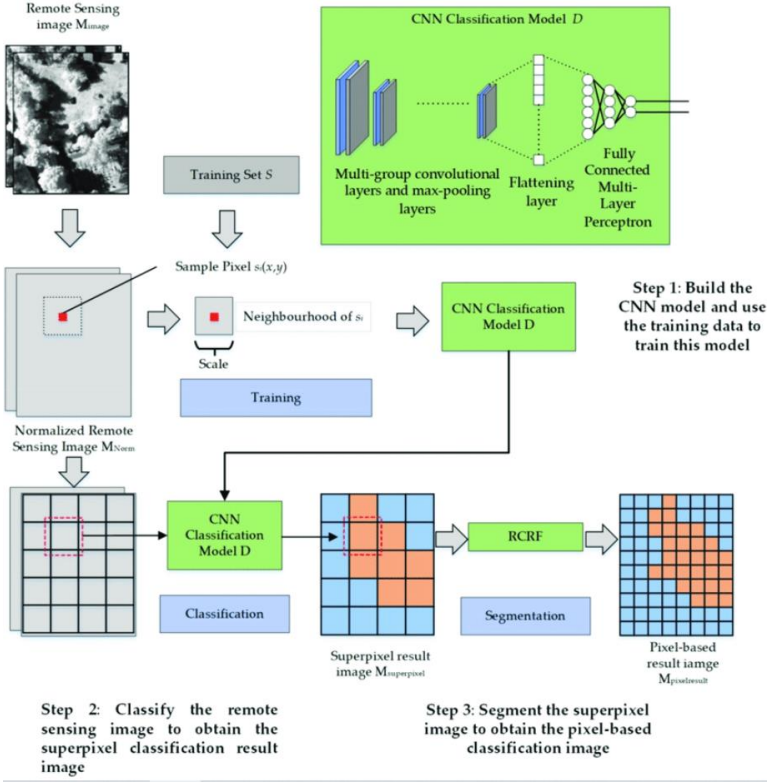
Classificação Supervisionada

A classificação supervisionada exige que você insira regiões de interesse (ROIs) para cada classe de cobertura do solo. São polígonos desenhados sobre áreas homogêneas que se sobrepõem a pixels pertencentes à mesma classe de cobertura do solo.

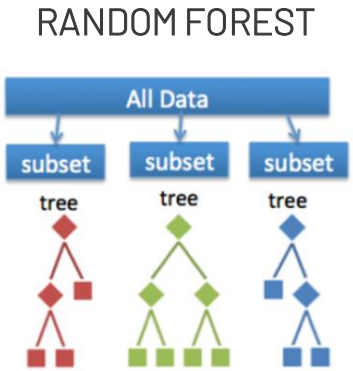


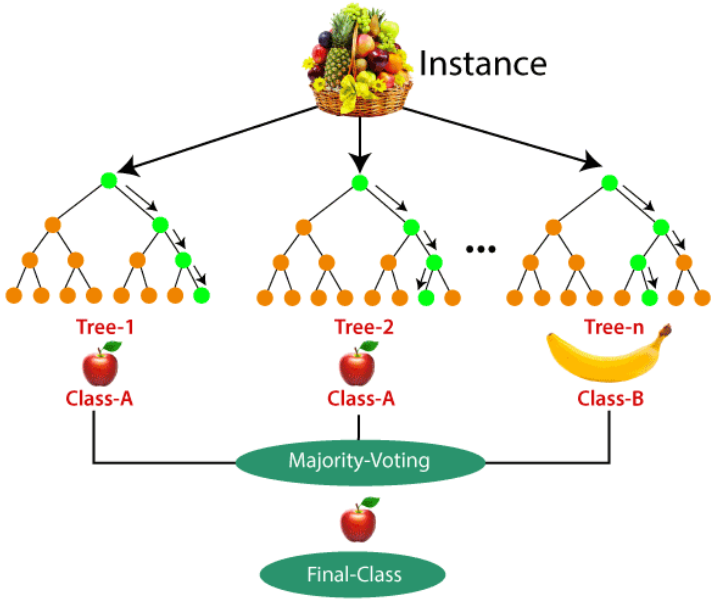
Classificação Supervisionada – Métodos



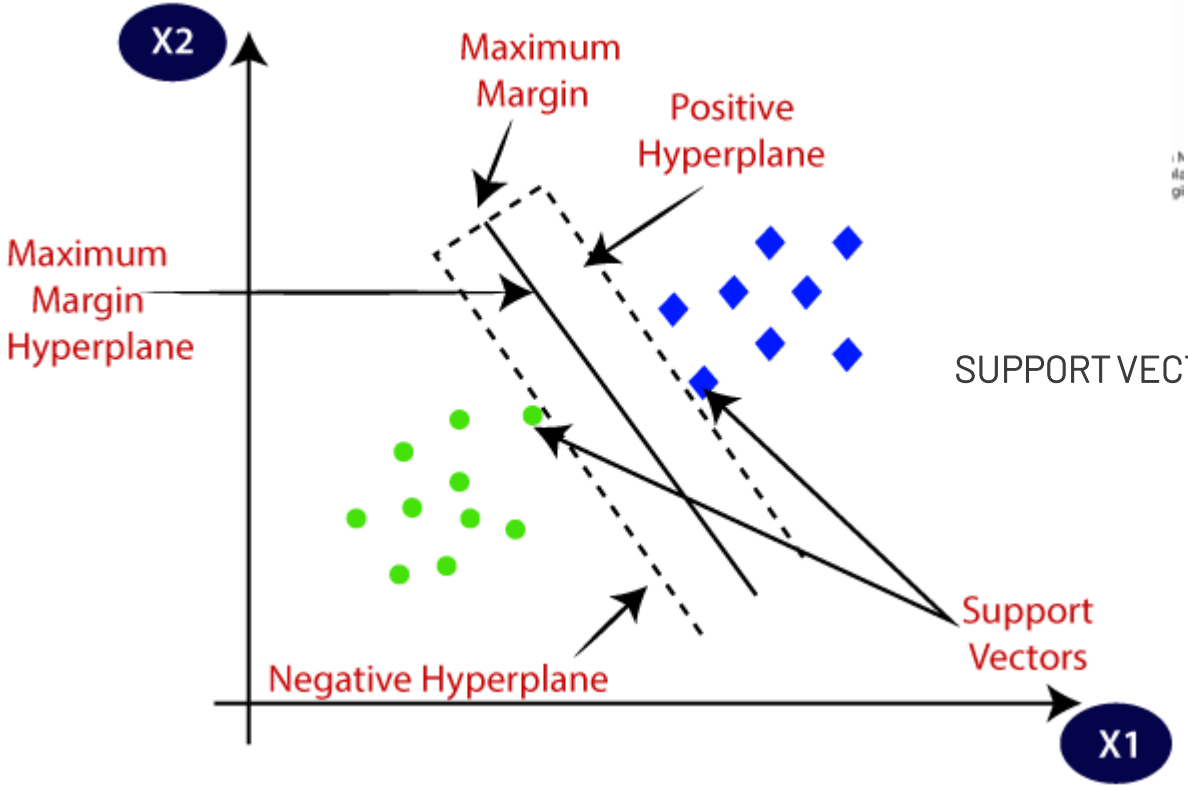


Classificação Supervisionada – Métodos





Classificação Supervisionada – Métodos



SUPPORT VECTOR MACHINE (SVM)

Google Earth Engine (GEE)

Google Earth Engine (ou simplesmente Earth Engine ou GEE), é uma plataforma em nuvem para análise científica e visualização de dados geoespaciais. O Google a define como “A plataforma de processamento geoespacial baseada em nuvem mais avançada do mundo!”

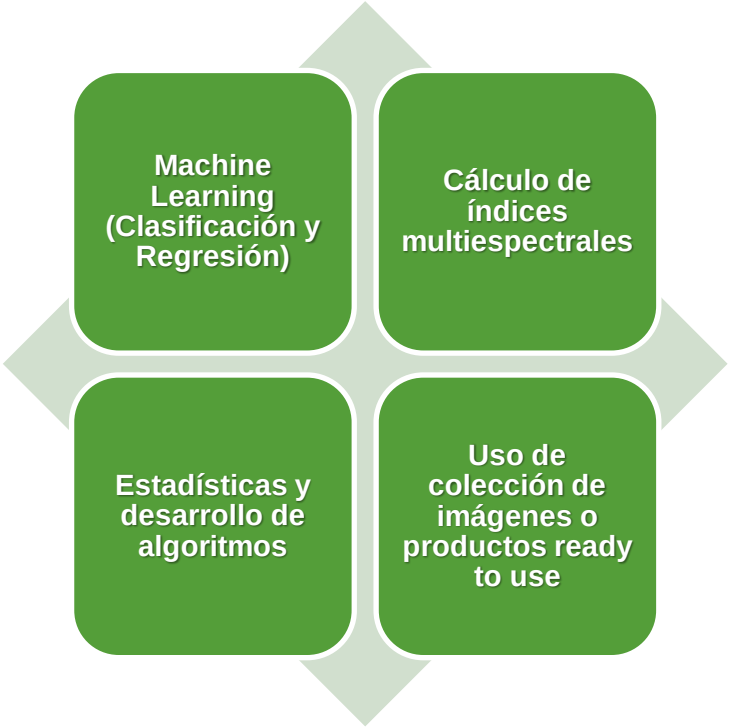
Vantagens de usar o GEE

- Carregue seus próprios dados raster e vetoriais (por exemplo, arquivos GeoTIFF ou Shapefile) para análise.
- Acesso a um catálogo de dados, que inclui todo o catálogo Landsat, MODIS, Sentinel, dados de temperatura, entre outros.
- Você pode exibir os resultados da análise no Google Maps ou em qualquer outra plataforma de mapeamento, como ArcGIS ou QGIS.
- O Earth Engine é gratuito para pesquisa, educação e uso sem fins lucrativos. Para aplicações comerciais, a avaliação do Earth Engine é permitida.
- Não é necessário baixar as imagens para realizar a análise, reduzindo assim os tempos de processamento**.**

Onde podemos usar o Google Earth Engine (GEE)?

- GEE Javascript
- Earth Engine (EE) Python API
- rgee package R
- Google Earth Engine Complemento - QGIS

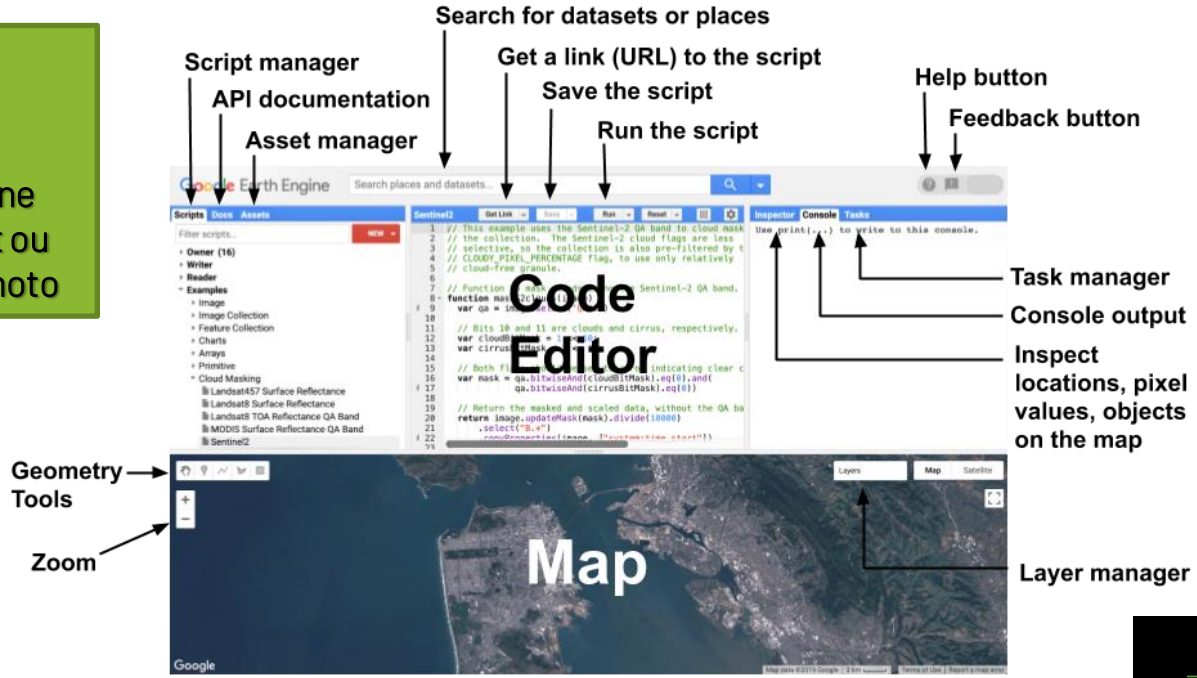
Qué podemos hacer en Google Earth Engine?



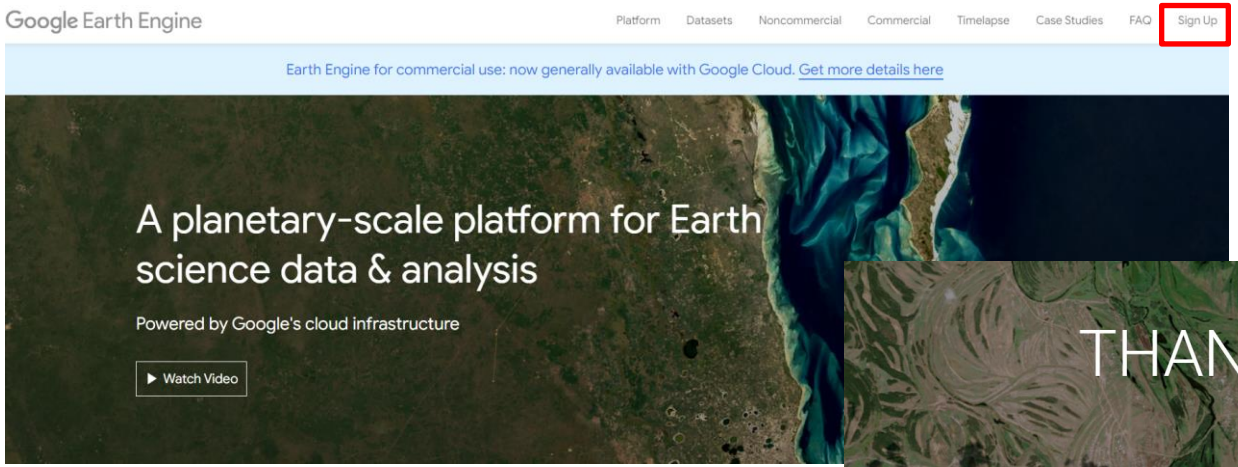
Serviço de geoprocessamento em nuvem – Google Earth Engine

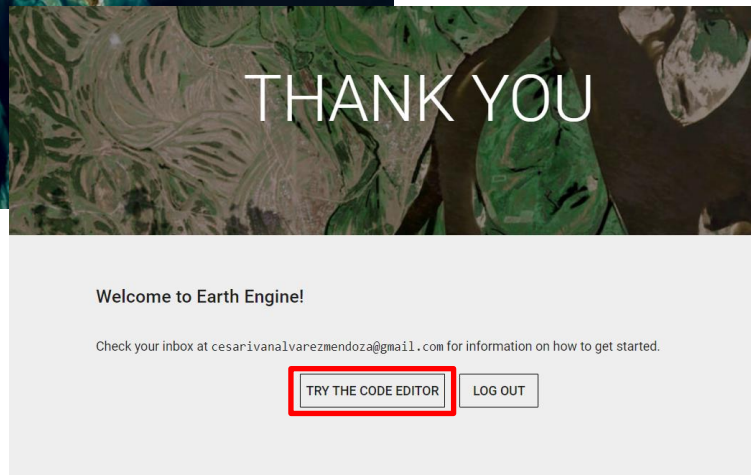
O que eu preciso?

- conta GMAIL
Acesse o Google Earth Engine
Conhecimento de Javascript ou Python e Sensoriamento Remoto



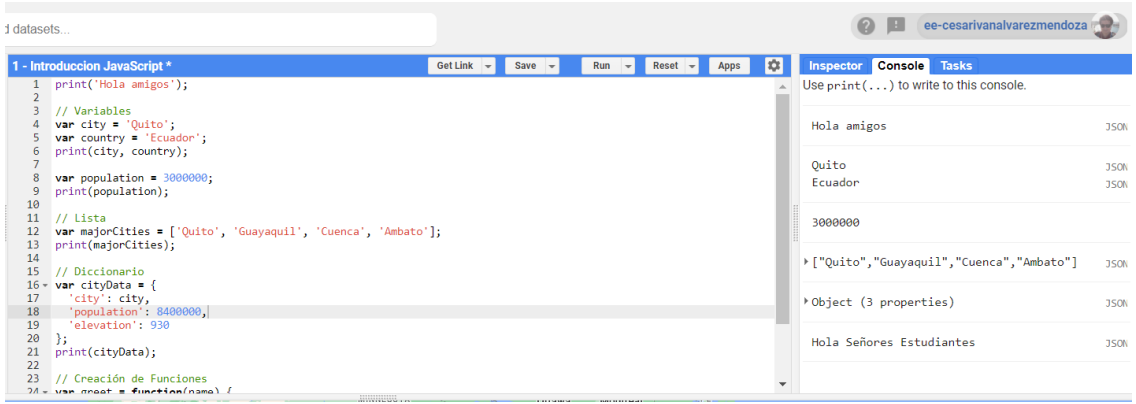
Entre no Editor de Código GEE





01 – Alguns conceitos de Javascript

```
print('Hola amigos');

// Variables
var city = 'Quito';
var country = 'Ecuador';
print(city, country);

var population = 3000000;
print(population);

// Lista
var majorCities = ['Quito', 'Guayaquil', 'Cuenca'];
print(majorCities);

// Diccionario
var cityData = {
  'city': city,
  'population': 8400000,
  'elevation': 930
};
print(cityData);

// Creación de Funciones
var greet = function(name) {
    return 'Hola ' + name;
};
print(greet('Señores Estudiantes'));

// Escritura de Comentarios
```



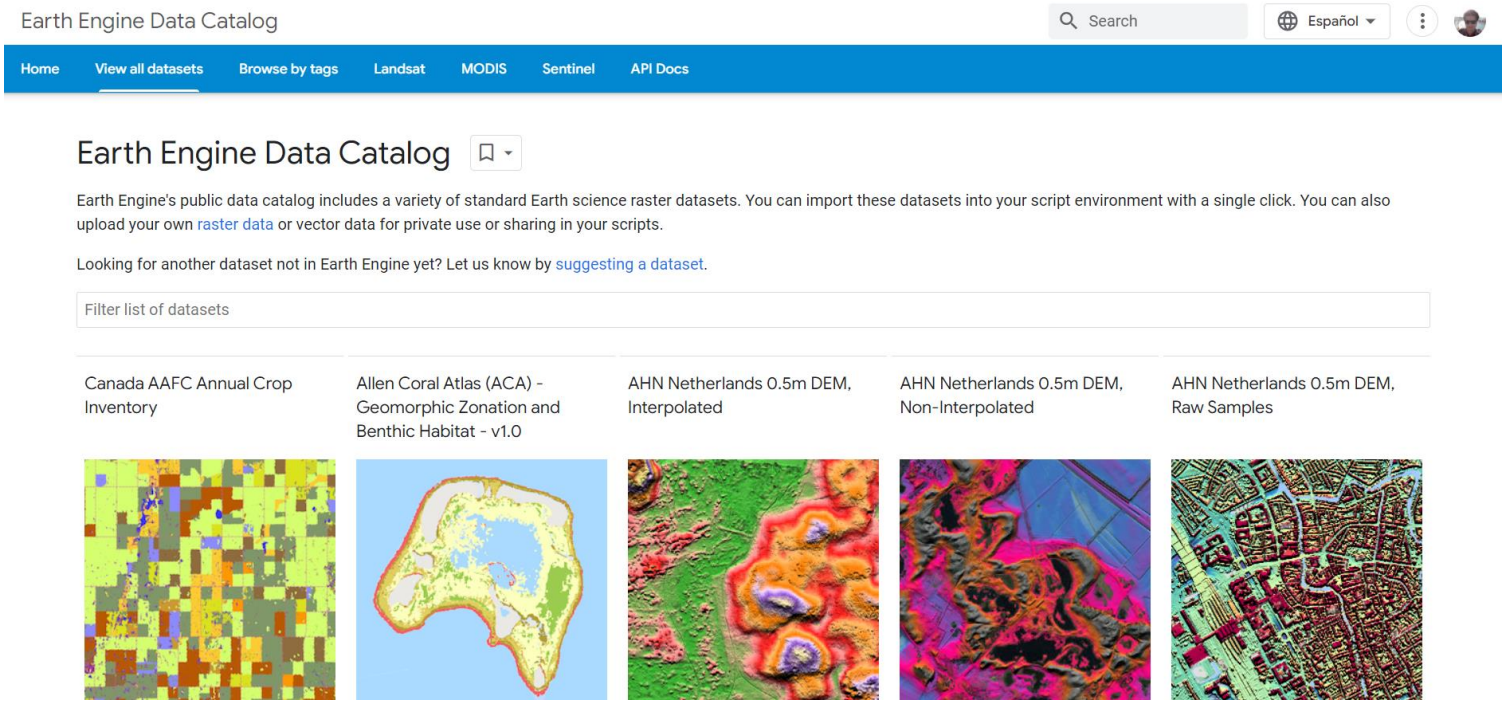
01 – Alguns conceitos de Javascript

JS code editor	Python

`var myFun = function(img) {`
`  return img;`
`};`
	`# Define a function`
	`def my_fun(img):`
	`  return img`

`// Define a variable`
`var myVar = "var";`
 	
`// Logical operators`
`var match = this.and(that);`
`var match = this.or(that);`
`var match = this.not(that);`
	`# Define a variable`
	`my_var = "var"`
	
	`# Logical operators`
	`match = this.And(that)`
	`match = this.Or(that)`
	`match = this.Not(that`

02 - Acesso ao catálogo GEE



https://github.com/osoivan/GEEExercises

02 – Trabalhar com coleta de imagens

variable

Función ImageCollection

Catálogo

```
var dataset =
ee.ImageCollection('LANDSAT/LC09/C02/T1_L2')
  .filterDate('2022-08-01', '2022-10-01');
```

Librería ee

Función para filtrar por fechas

Fecha Inicio

Fecha Fin

Creación de una función llamada applyScaleFactors, donde se requiere de entrada la variable image

Comentario

Función selección de todas las bandas que empiezan con SR_B

```
// Applies scaling factors.
function applyScaleFactors(image) {
  var opticalBands = image.select('SR_B.').multiply(0.0000275).add(-0.2);
  var thermalBands = image.select('ST_B.*').multiply(0.00341802).add(149.0);
  return image.addBands(opticalBands, null, true)
              .addBands(thermalBands, null, true);
}
```

Función multiplicar

Función sumar

Que dará como resultado aplicar esta función

02 – Trabalhar com coleta de imagens

```
dataset = dataset.map(applyScaleFactors);

var visualization = {
  bands: ['SR_B4', 'SR_B3', 'SR_B2'],
  min: 0.0,
  max: 0.3,
};

Map.setCenter(-78, 0.01, 7);

Map.addLayer(dataset, visualization, 'True Color (432)');
```

A quién se aplicará la función

Función o algoritmo a aplicar

Función map, aplica un algoritmo sobre una colección de imágenes

Se crea una variable de visualización con las 3 bandas con colores en un mínimo y máximo

Variable Map por defecto (Mapa a visualizar)

Coordenadas de donde vamos a centrar la imagen y su zoom para visualización

Función addLayer, permite agregar al mapa a visualizar las características requeridas

03 – Filtrar imagem por coordenadas e máscaras

```
var geometry = ee.Geometry.Point([-78.5, 0.02])

/ Function to mask clouds using the Sentinel-2 QA band

function maskS2clouds(image) {
  var qa = image.select('QA60');

  // Bits 10 and 11 are clouds and cirrus, respectively.
  var cloudBitMask = 1 << 10;
  var cirrusBitMask = 1 << 11;

  // Both flags should be set to zero, indicating clear conditions.
  var mask = qa.bitwiseAnd(cloudBitMask).eq(0)
      .and(qa.bitwiseAnd(cirrusBitMask).eq(0));

  return image.updateMask(mask).divide(10000);
}
```

Variable vectorial tipo geometría de punto

Función para enmascarar nubes y sombras Sentinel-2 usando la banda QA

Que retornará la función de enmascarar nubes

03 – Filtrar imagem por coordenadas e máscaras

```
var dataset = ee.ImageCollection('COPERNICUS/S2_SR_HARMONIZED')
                  .filterDate('2020-01-01', '2020-03-30')
                  // Pre-filter to get less cloudy granules.
                  .filter(ee.Filter.lt('CLOUDY_PIXEL_PERCENTAGE',20))
                  .map(maskS2clouds)
                  .filter(ee.Filter.bounds(geometry));

var visualization = {
  min: 0.0,
  max: 0.3,
  bands: ['B4', 'B3', 'B2'],
  //bands: ['B5', 'B4', 'B3'],
};

Map.centerObject(geometry, 10)
//Map.addLayer(dataset.mean(), visualization);
Map.addLayer(dataset.mean(), visualization, 'RGB');
```

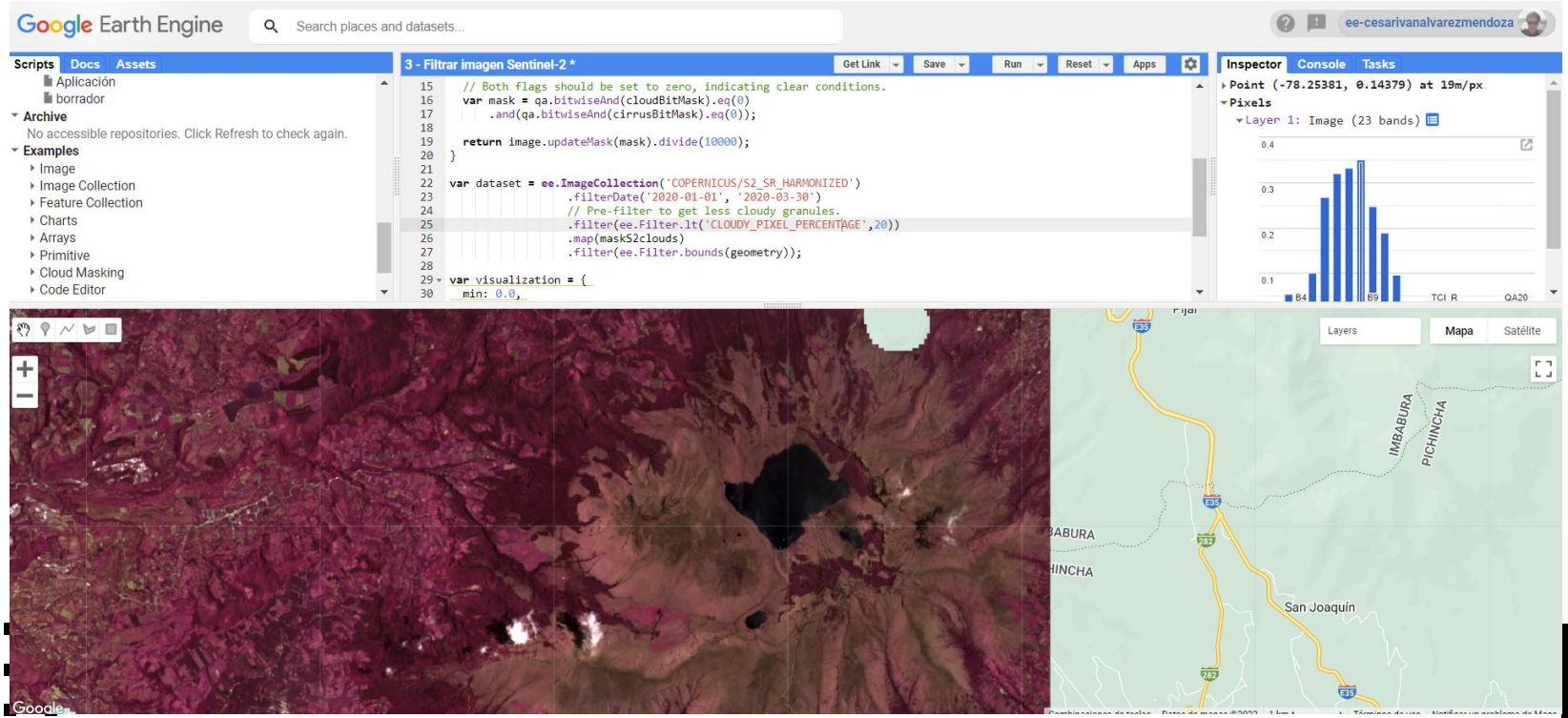
Filtrar con la función maskS2clouds

Filtrar con la capa Cloudy Pixel

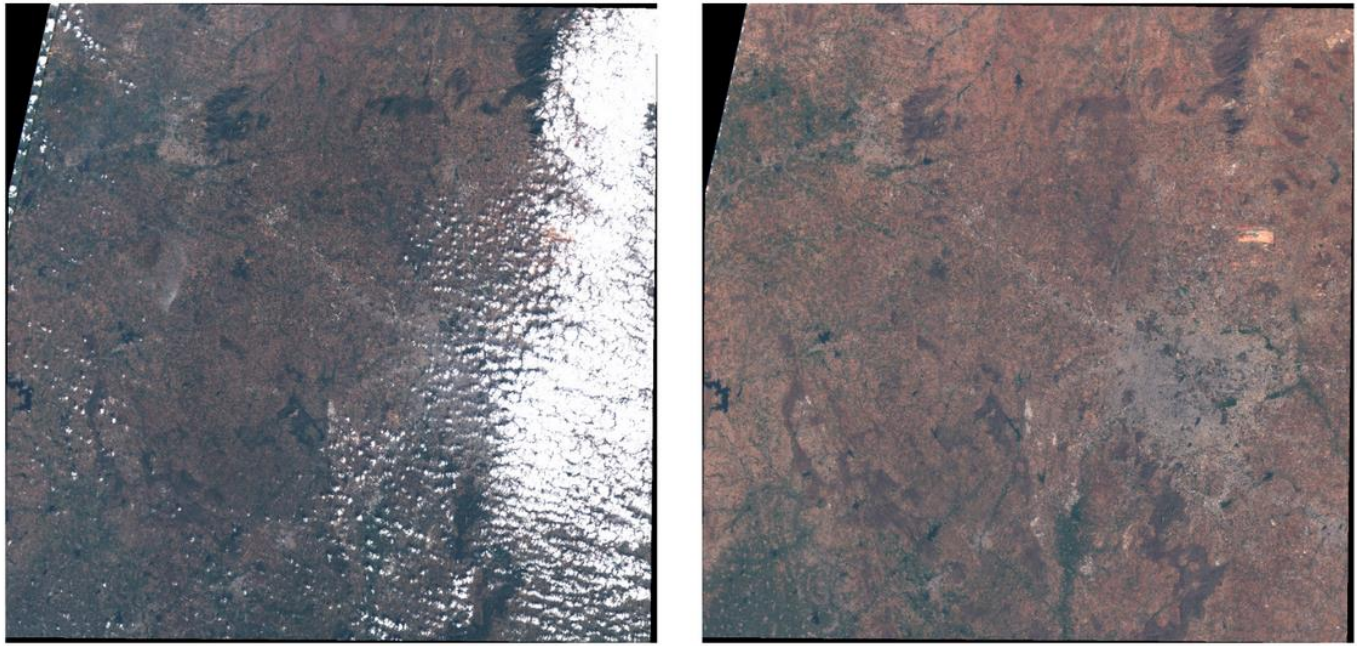
Filtrar con geometría

Se aplica la función media, para que nos genere una imagen con la media de pixeles de las fechas filtradas

03 – Filtrar imagem por coordenadas e máscaras



04 – Criação de mosaicos e composições



MOSAIC

MEDIAN COMPOSITE

Mosaic vs. Composite

04 – Criação de mosaicos e composições

```
var geometry = ee.Geometry.Point([-78.5, 0.02])

var filtered = ee.ImageCollection('COPERNICUS/S2_SR_HARMONIZED')
                  .filterDate('2020-01-01', '2022-01-01')
                  // Pre-filter to get less cloudy granules.
                  .filter(ee.Filter.lt('CLOUDY_PIXEL_PERCENTAGE',20))
                  .filter(ee.Filter.bounds(geometry));

var mosaic = filtered.mosaic() //Crea un mosaico con los últimos pixeles de la
colección encontrados

var medianComposite = filtered.median(); //Genera una mediana de pixeles entre
fechas
```

Función mosaico

Función mediana

04 – Criação de mosaicos e composições

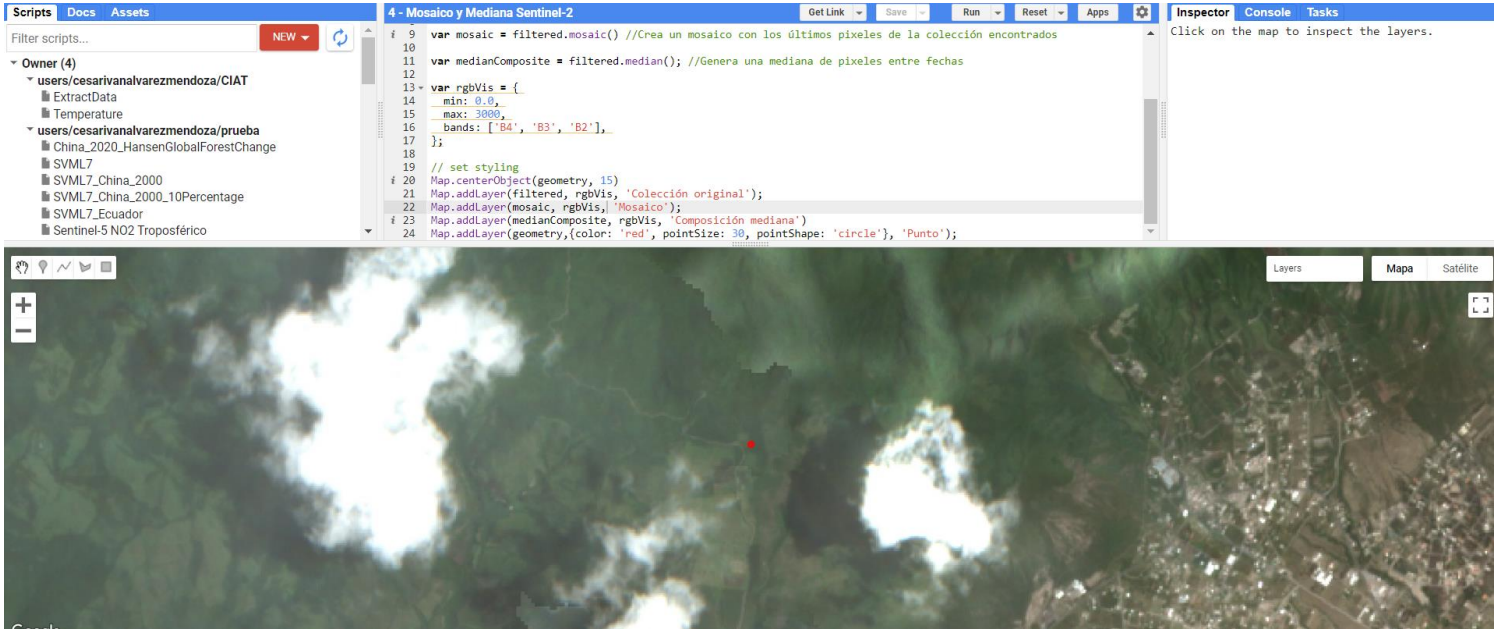
```
var rgbVis = {
  min: 0.0,
  max: 3000,
  bands: ['B4', 'B3', 'B2'],
};

// set styling
Map.centerObject(geometry, 15)
Map.addLayer(filtered, rgbVis, 'Colección original');
Map.addLayer(mosaic, rgbVis, 'Mosaico');
Map.addLayer(medianComposite, rgbVis, 'Composición mediana')
Map.addLayer(geometry,{color: 'red', pointSize: 30, pointShape: 'circle'}, 'Punto');
```

Agrega cada elemento como una capa en el visualizador

Propiedades del Vector

Cambiar nombre de capa

04 – Criação de mosaicos e composições



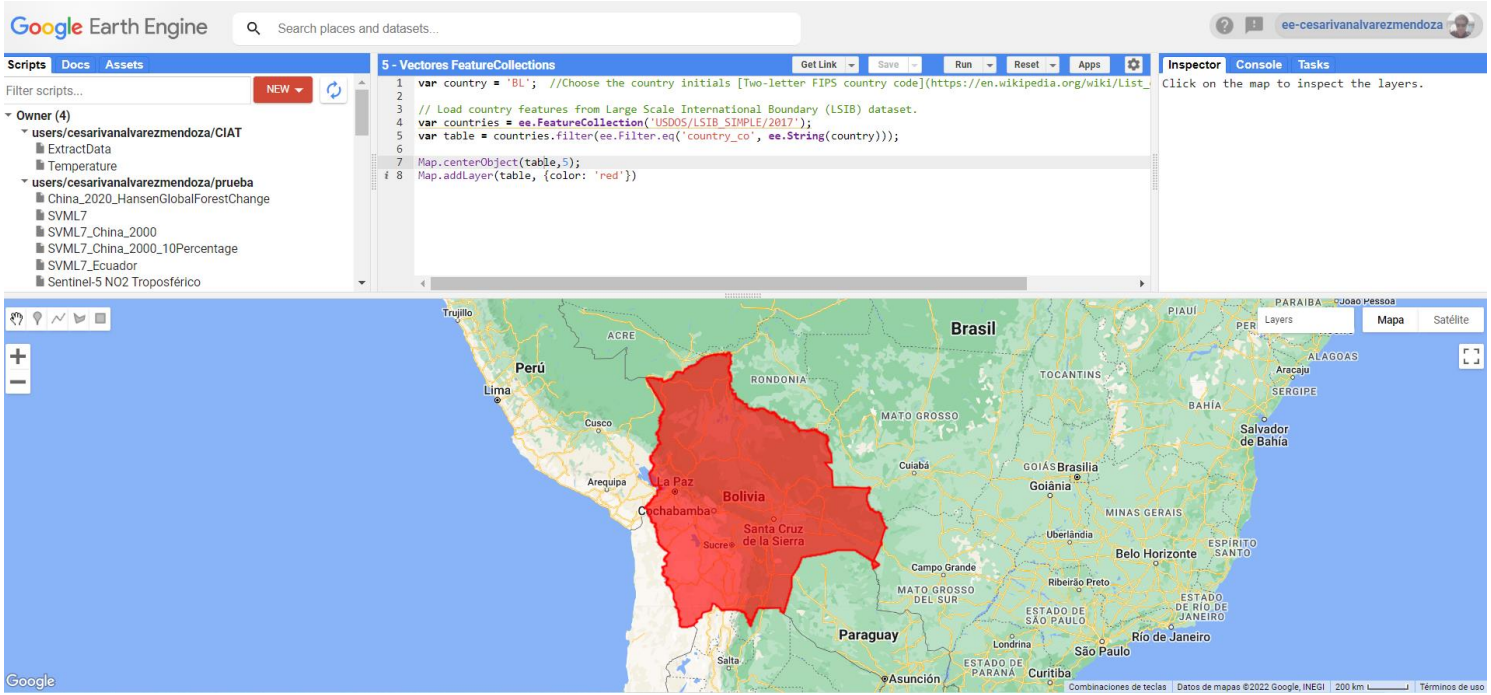
05 – Coleções de vetores (coleções de recursos)

```
var country = 'BL';  //Choose the country initials [Two-letter FIPS country code]
https://en.wikipedia.org/wiki/List_of_FIPS_country_codes

// Load country features from Large Scale International Boundary (LSIB) dataset.
var countries = ee.FeatureCollection('USDOS/LSIB_SIMPLE/2017');
var table = countries.filter(ee.Filter.eq('country_co', ee.String(country)));

Map.centerObject(table,5);
Map.addLayer(table, {color: 'red'})
```

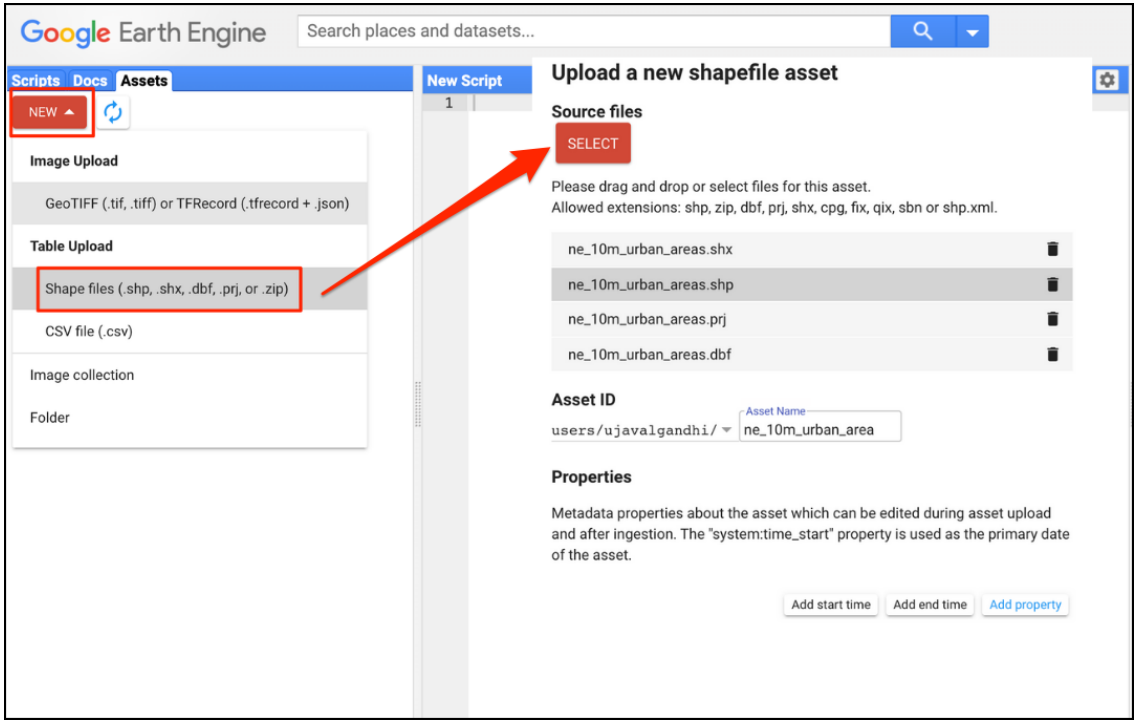
Feature collection disponible en GEE de límite de países

Agregar al mapa en color rojo

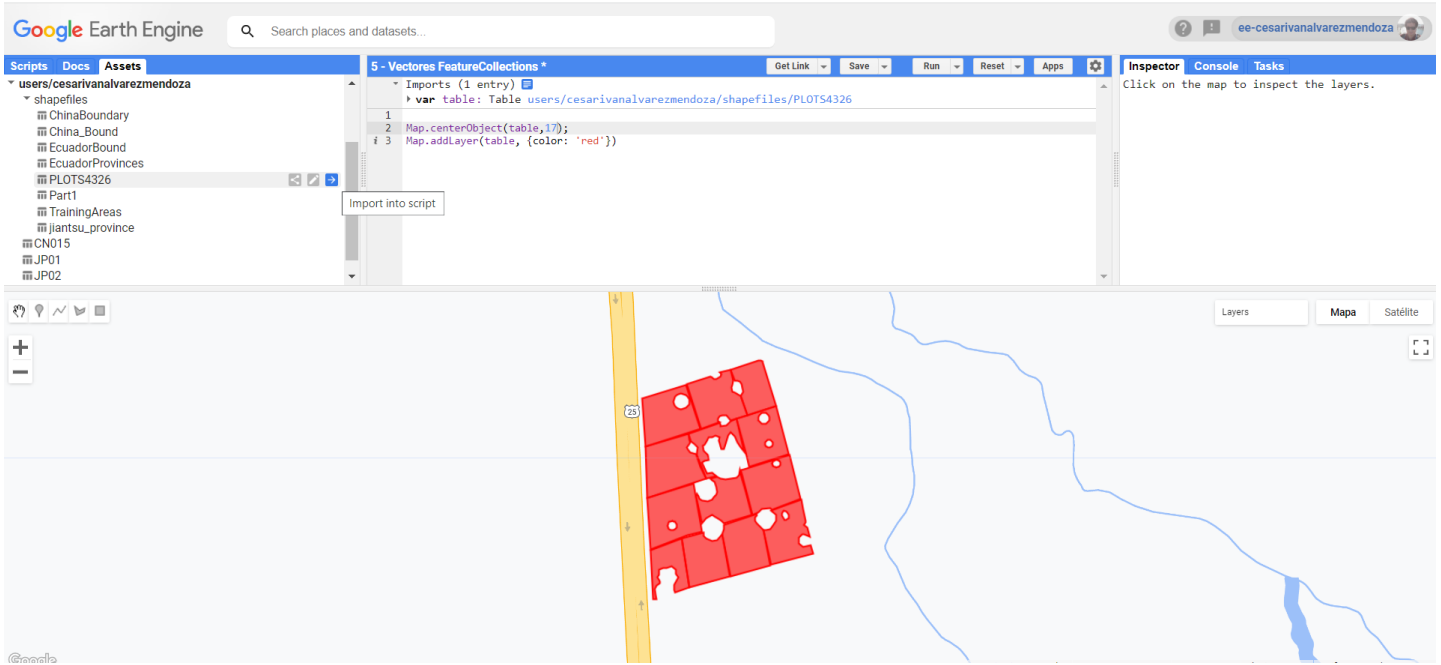
05 – Coleções de vetores (coleções de recursos)



06 – Importar dados (Shapefiles, Geotiff, CSV)



06 – Importar dados (Shapefiles, Geotiff, CSV)



07 – Clipe de Coleção de Imagens

```
var s2 = ee.ImageCollection('COPERNICUS/S2_SR_HARMONIZED')
var urban = ee.FeatureCollection("users/cesarivanalvarezmendoza/shapefiles/PLOTS4326")

var geometry = urban.geometry()

var rgbVis = {
  min: 0.0,
  max: 3000,
  bands: ['B4', 'B3', 'B2'],
};
var filtered = s2.filter(ee.Filter.lt('CLOUDY_PIXEL_PERCENTAGE', 30))
  .filter(ee.Filter.date('2021-01-01', '2022-01-01'))
  .filter(ee.Filter.bounds(geometry))
```

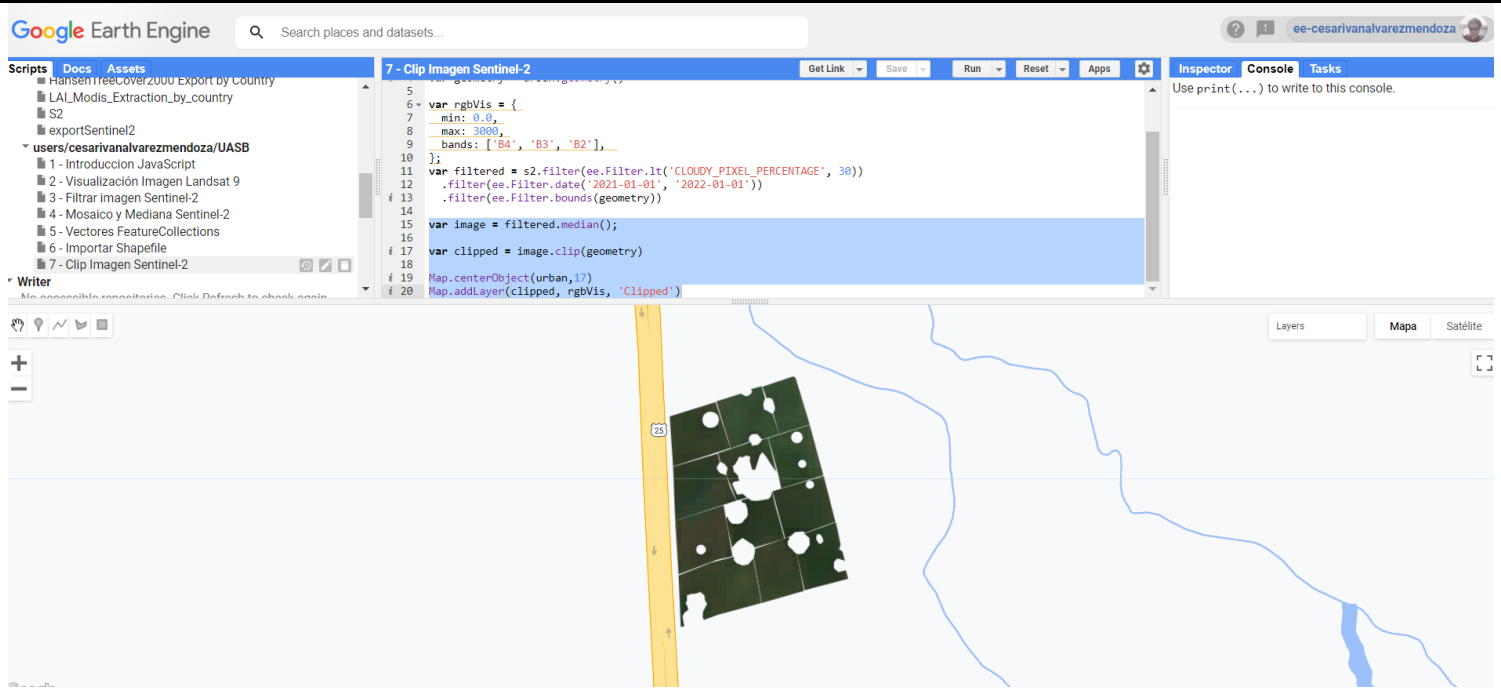
Generar la variable del polígono desde el featurecollection

07 – Clipe de Coleção de Imagens

```
var image = filtered.median();

var clipped = image.clip(geometry)

Map.centerObject(urban,17)
Map.addLayer(clipped, rgbVis, 'Clipped')
```

Función cortar imagen en base a geometría

07 – Clipe de Coleção de Imagens



08 – Exportar imagens

```
var country = 'BL';  //Choose the country initials [Two-letter FIPS country code]
https://en.wikipedia.org/wiki/List_of_FIPS_country_codes

// Load country features from Large Scale International Boundary (LSIB) dataset.
var countries = ee.FeatureCollection('USDOS/LSIB_SIMPLE/2017');
var table = countries.filter(ee.Filter.eq('country_co', ee.String(country)));

// Make the clip boundary.
var clipToCol = function(image){
  return image.clip(table);
};

var collection = ee.ImageCollection('COPERNICUS/S5P/OFFL/L3_NO2')
  .select('NO2_column_number_density')
  .filterBounds(table)
  .filterDate('2019-03-16', '2019-03-31')
  .map(clipToCol);
```

Función para realizar clip

08 – Exportar imagens

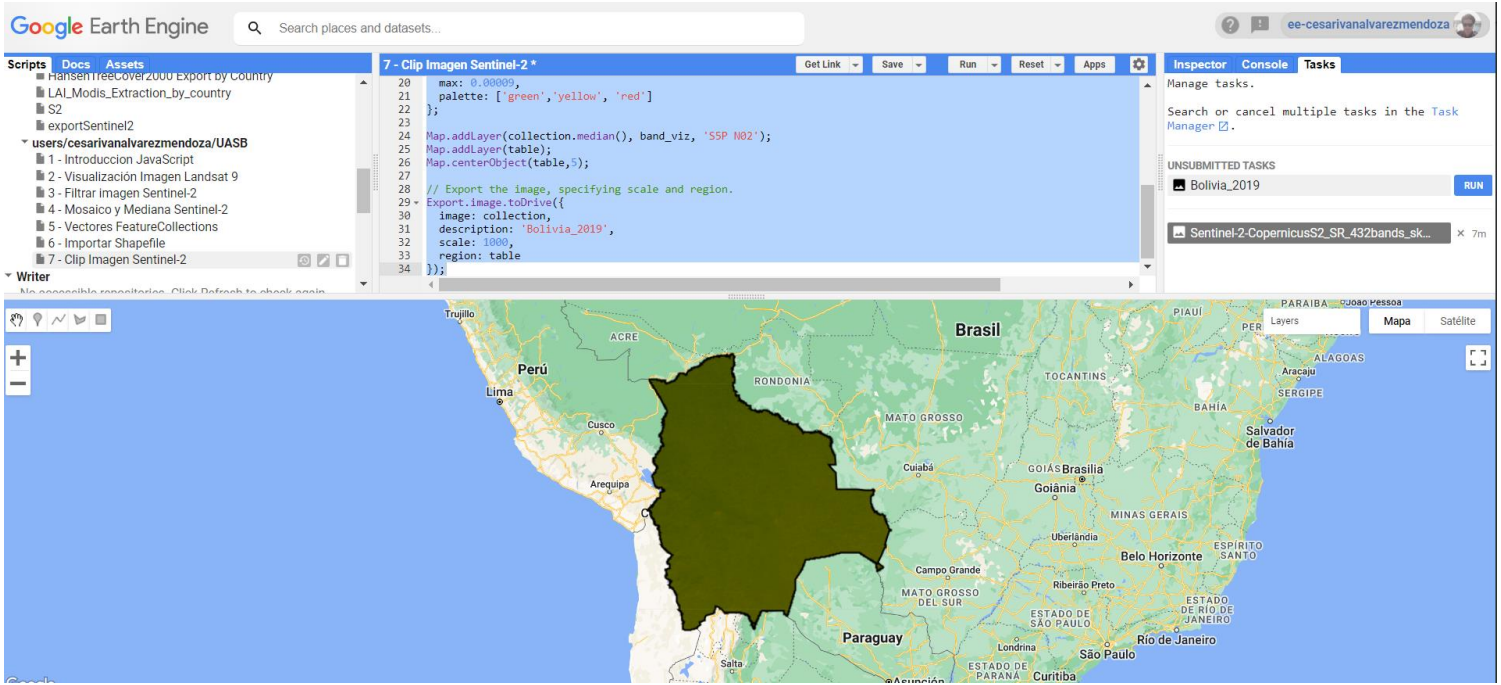
```
var band_viz = {
  min: 0,
  max: 0.00009,
  palette: ['green','yellow', 'red']
};

Map.addLayer(collection.median(), band_viz, 'S5P N02');
Map.addLayer(table);
Map.centerObject(table,5);
print(collection.size())

// Export the image, specifying scale and region.
Export.image.toDrive({
  image: collection.median(),
  description: 'Bolivia_2019',
  scale: 1000,
  region: table
});
```

Ver resolución de la imagen

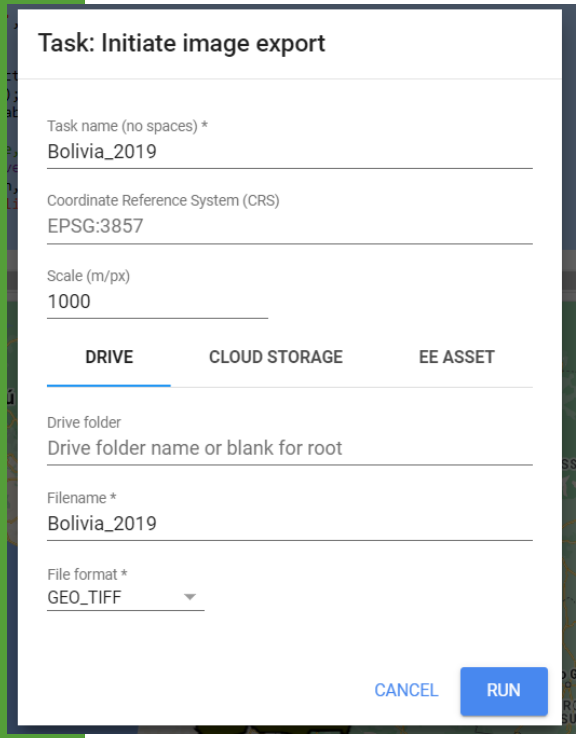
Exportar a Google Drive como GeoTIFF

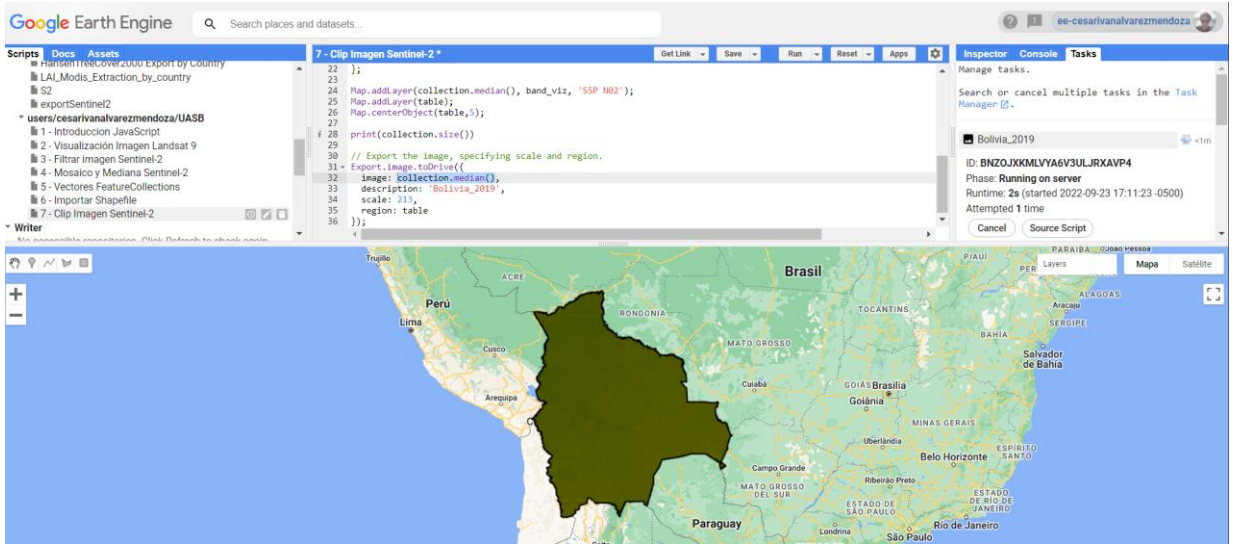
Exportar la mediana del image collection

08 – Exportar imagens



08 – Exportar imagens





09 – Cálculo de índices - NDVI

```
var s2 = ee.ImageCollection("COPERNICUS/S2_SR_HARMONIZED");
var country = 'EC';
var countries = ee.FeatureCollection('USDOS/LSIB_SIMPLE/2017');
var table = countries.filter(ee.Filter.eq('country_co', ee.String(country)));
var geometry = table.geometry()

var rgbVis = {min: 0.0, max: 3000, bands: ['B4', 'B3', 'B2']};

var filtered = s2.filter(ee.Filter.lt('CLOUDY_PIXEL_PERCENTAGE', 30))
  .filter(ee.Filter.date('2021-01-01', '2022-01-01'))
  .filter(ee.Filter.bounds(geometry))

var composite = filtered.median().clip(geometry)
Map.addLayer(composite, rgbVis, 'RGB Ecuador')
```

Generar una imagen compuesta por la mediana

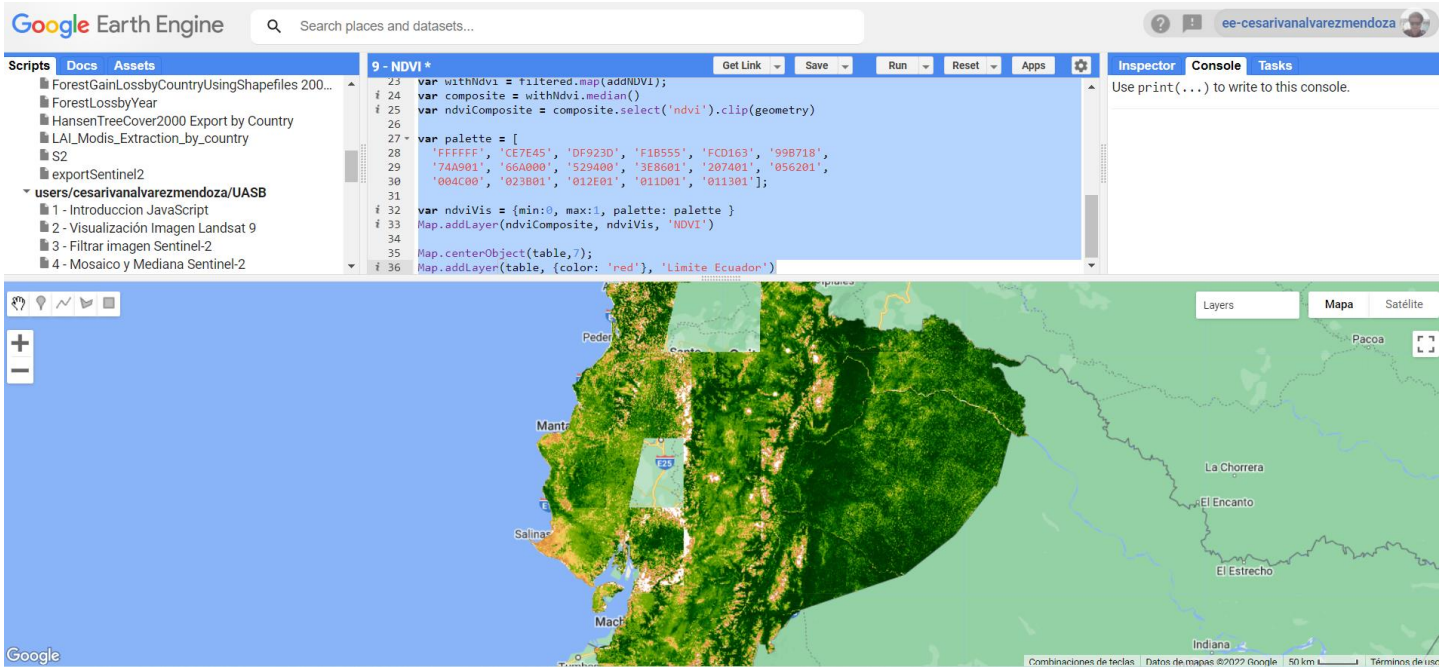
09 – Cálculo de índices - NDVI

```
// Write a function that computes NDVI for an image and adds it as a band
function addNDVI(image) {
  var ndvi = image.normalizedDifference(['B8', 'B4']).rename('ndvi');
  return image.addBands(ndvi);
}

// Map the function over the collection
var withNdvi = filtered.map(addNDVI);
var composite = withNdvi.median()
var ndviComposite = composite.select('ndvi').clip(geometry)

var palette = [
  'FFFFFF', 'CE7E45', 'DF923D', 'F1B555', 'FCD163', '99B718',
  '74A901', '66A000', '529400', '3E8601', '207401', '056201',
  '004C00', '023B01', '012E01', '011D01', '011301'];

var ndviVis = {min:0, max:1, palette: palette }
Map.addLayer(ndviComposite, ndviVis, 'NDVI')

Map.centerObject(table,7);
Map.addLayer(table, {color: 'red'}, 'Limite Ecuador')
```

Función NDVI

Paleta de colores NDVI

09 – Cálculo de índices - NDVI



10 – Reductores (Reducers)

```
//Forest loss between 2000 to 2020
var year = 20; //Choose the year between 2000 (00) to 2020 (20)
var country = 'EC';  //Choose the country initials [Two-letter FIPS country
code](https://en.wikipedia.org/wiki/List_of_FIPS_country_codes

// Load country features from Large Scale International Boundary (LSIB) dataset.
var countries = ee.FeatureCollection('USDOS/LSIB_SIMPLE/2017');
var selected = countries.filter(ee.Filter.eq('country_co', ee.String(country)));

// Make the clip boundary.
var clipToCol = function(image){
  return image.clip(selected);
};

var gfc2020 = ee.Image('UMD/hansen/global_forest_change_2020_v1_8');

// Canopy loss during the selected year
var loss = gfc2020.select(['lossyear']).eq(year).clip(selected) //ClipGeometry can any geometry or feature or
shapfile
```

Catalog Global Forest

Filtrar por año

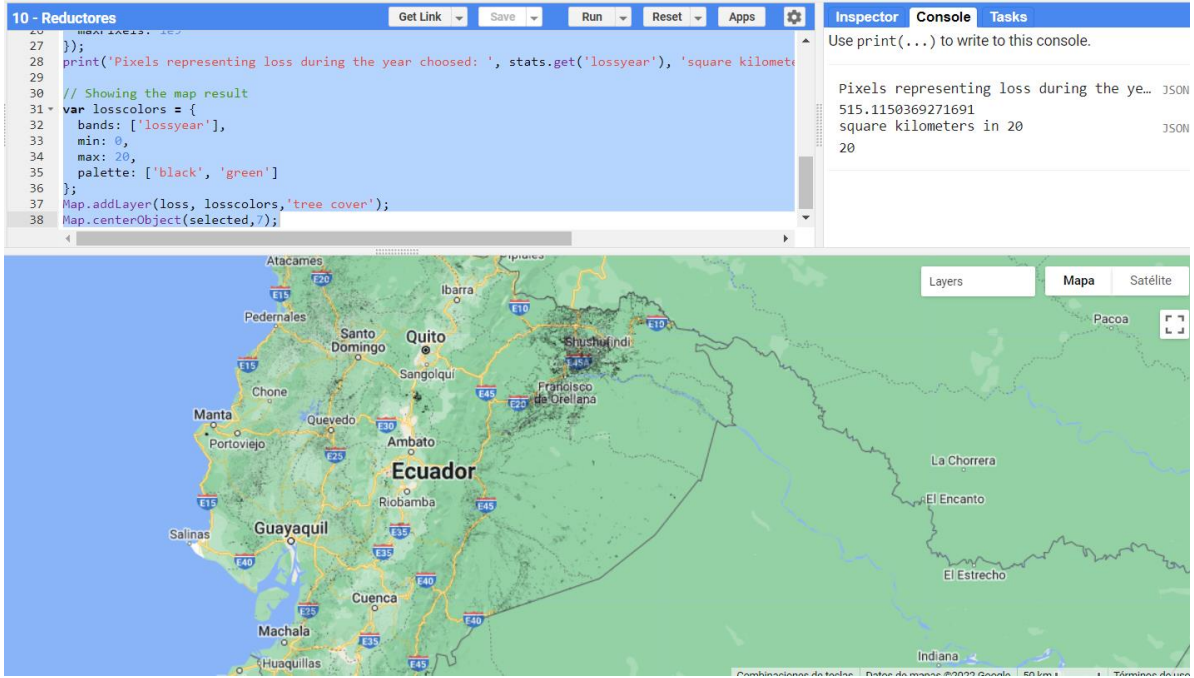
10 – Reductores (Reducers)

```
// Get the forest loss in square kilometers.
var areaImage = loss.multiply(ee.Image.pixelArea()).divide(1000000);

var stats = areaImage.reduceRegion({
  reducer: ee.Reducer.sum(),
  geometry: selected,
  scale: 30,
  maxPixels: 1e9
});
print('Pixels representing loss during the year choosed: ', stats.get('lossyear'), 'square kilometers in 20', year);

// Showing the map result
var losscolors = {
  bands: ['lossyear'],
  min: 0,
  max: 20,
  palette: ['black', 'green']
};
Map.addLayer(loss, losscolors,'tree cover');
Map.centerObject(selected,7);
```

Suma los píxeles dentro del polígono de featurecollection

Función get

10 – Reductores (Reducers)



11 – Serie de Tiempo

```
var s2 = ee.ImageCollection("COPERNICUS/S2_SR_HARMONIZED");
var geometry = ee.Geometry.Polygon([[
  [82.60642647743225, 27.16350437805251],
  [82.60984897613525, 27.1618529901377],
  [82.61088967323303, 27.163695288375266],
  [82.60757446289062, 27.16517483230927]
]]);
Map.addLayer(geometry, {color: 'red'}, 'Farm')
Map.centerObject(geometry)
var rgbVis = {min: 0.0, max: 3000, bands: ['B4', 'B3', 'B2']};

var filtered = s2.filter(ee.Filter.date('2017-01-01', '2022-01-01'))
  .filter(ee.Filter.lt('CLOUDY_PIXEL_PERCENTAGE', 30))
  .filter(ee.Filter.bounds(geometry))

// Write a function for Cloud masking
function maskS2clouds(image) {
  var qa = image.select('QA60')
  var cloudBitMask = 1 << 10;
  var cirrusBitMask = 1 << 11;
  var mask = qa.bitwiseAnd(cloudBitMask).eq(0).and(
             qa.bitwiseAnd(cirrusBitMask).eq(0))
  return image.updateMask(mask)//.divide(10000)
      .select("B.*")
      .copyProperties(image, ["system:time_start"])
}
```

Creando un polígono de estudio o ROI (Region of Interest)

11 – Serie de Tiempo

```
var filtered = filtered.map(maskS2clouds)
// Write a function that computes NDVI for an image and adds it as a band
function addNDVI(image) {
  var ndvi = image.normalizedDifference(['B8', 'B4']).rename('ndvi');
  return image.addBands(ndvi);
}

// Map the function over the collection
var withNdvi = filtered.map(addNDVI);

// Display a time-series chart
var chart = ui.Chart.image.series({
  imageCollection: withNdvi.select('ndvi'),
  region: geometry,
  reducer: ee.Reducer.median(),
  scale: 10
}).setOptions({
      lineWidth: 1,
      title: 'Serie de Tiempo NDVI',
      interpolateNulls: true,
      vAxis: {title: 'NDVI'},
      hAxis: {title: '', format: 'YYYY-MMM'}
    })
print(chart);
```

Función NDVI

Gráfico Serie de Tiempo

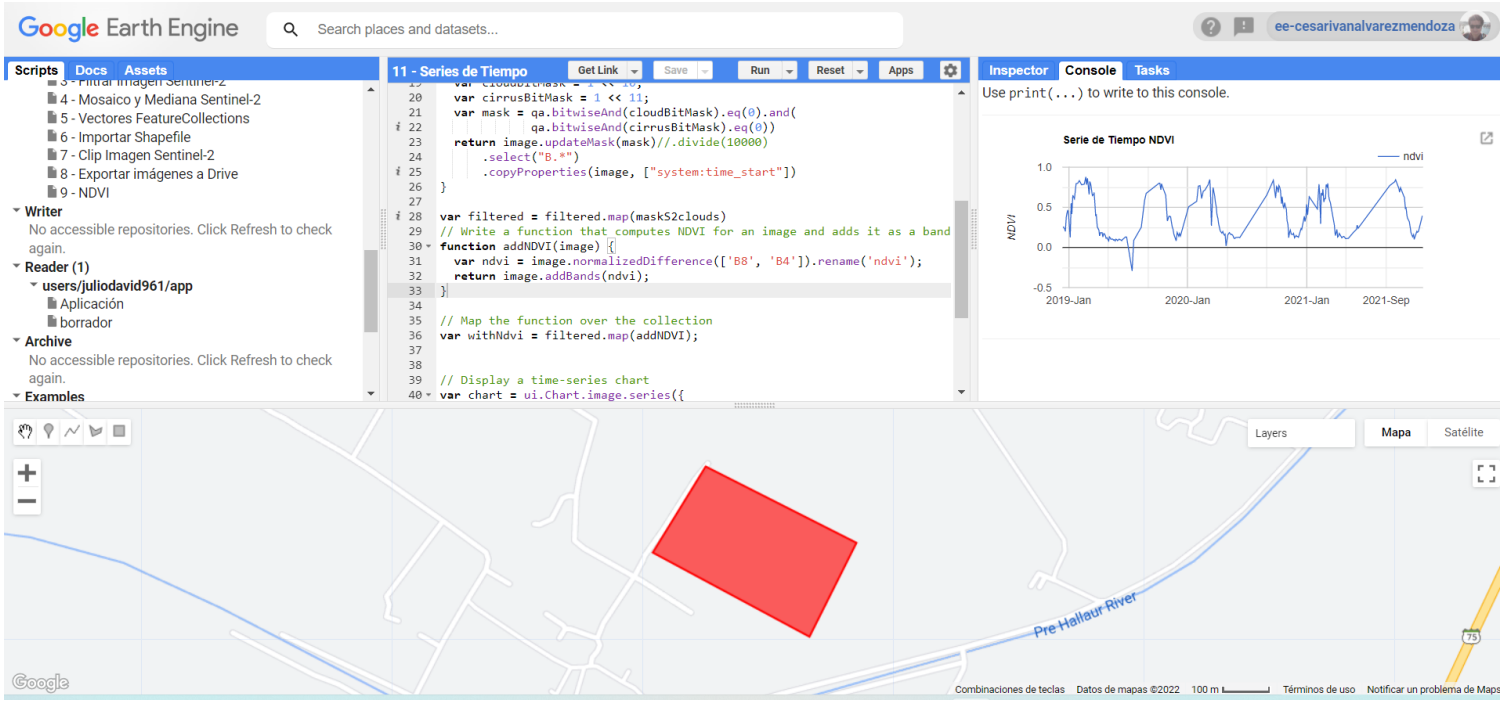
11 – Serie de Tiempo

```
var withNDVI = withNdvi.select('ndvi')
var withNDVI = ee.ImageCollection(withNDVI).toBands();

// Get Zonal Statistics
var reduced = withNDVI.reduceRegions({
  collection: geometry,
  reducer: ee.Reducer.mean(),
  scale: 100,
});
print(reduced);

// the resulting mean is a FeatureCollection
// so you can export it as a table
Export.table.toDrive({
    collection: reduced,
    description: 'NDVIpolygons',
    fileNamePrefix: 'NDVIpolygons',
    fileFormat: 'CSV'
})
```

Cálculo de estadísticas NDVI

Exportar a CSV

11 – Serie de Tiempo



12 – Clasificación Supervisada - SVM

```
var country = 'CH';
var countries = ee.FeatureCollection('USDOS/LSIB_SIMPLE/2017');
var table = countries.filter(ee.Filter.eq('country_co', ee.String(country)));

// Make the clip boundary.
var clipToCol = function(image){
  return image.clip(table);
};

// Make a cloud-free Landsat 7 TOA composite (from raw imagery).
var l8 = ee.ImageCollection('LANDSAT/LE07/C01/T1')
                    .map(clipToCol);

var image = ee.Algorithms.Landsat.simpleComposite({
  collection: l8.filterDate('2000-01-01', '2000-12-31'),
  asFloat: true
});

// Use these bands for prediction. We only used the multiespectral bands
var bands = ['B1','B2', 'B3', 'B4', 'B5', 'B7'];

// Manually created polygons. Only I add two polygons to each category forest or non-forest
var forest1 = ee.Geometry.Rectangle(106.024466, 28.470375,106.114408, 28.385354);
var forest2 = ee.Geometry.Rectangle(123.926517, 52.129826,  124.431256, 51.743099);
var nonForest1 = ee.Geometry.Rectangle( 82.564232,40.174726, 85.900993, 38.822149);
var nonForest2 = ee.Geometry.Rectangle(100.003374,37.005547,100.315863,36.751742);
```

Landsat 7 TOA

Bandas para la clasificación

Área de Entrenamiento

12 – Clasificación Supervisada - SVM

```
// Make a FeatureCollection from the hand-made geometries.
var polygons = ee.FeatureCollection([
  ee.Feature(nonForest1, {'class': 0}),
  ee.Feature(nonForest2, {'class': 0}),
  ee.Feature(forest1, {'class': 1}),
  ee.Feature(forest2, {'class': 1}),
]);

// Get the values for all pixels in each polygon in the training.
var training = image.sampleRegions({
  // Get the sample from the polygons FeatureCollection.
  collection: polygons,
  // Keep this list of properties from the polygons.
  properties: ['class'],
  // Set the scale to get Landsat pixels in the polygons.
  scale: 1000
});
```

Reclasificación de categorías

Áreas de entrenamiento en una sola variable

12 – Clasificación Supervisada - SVM

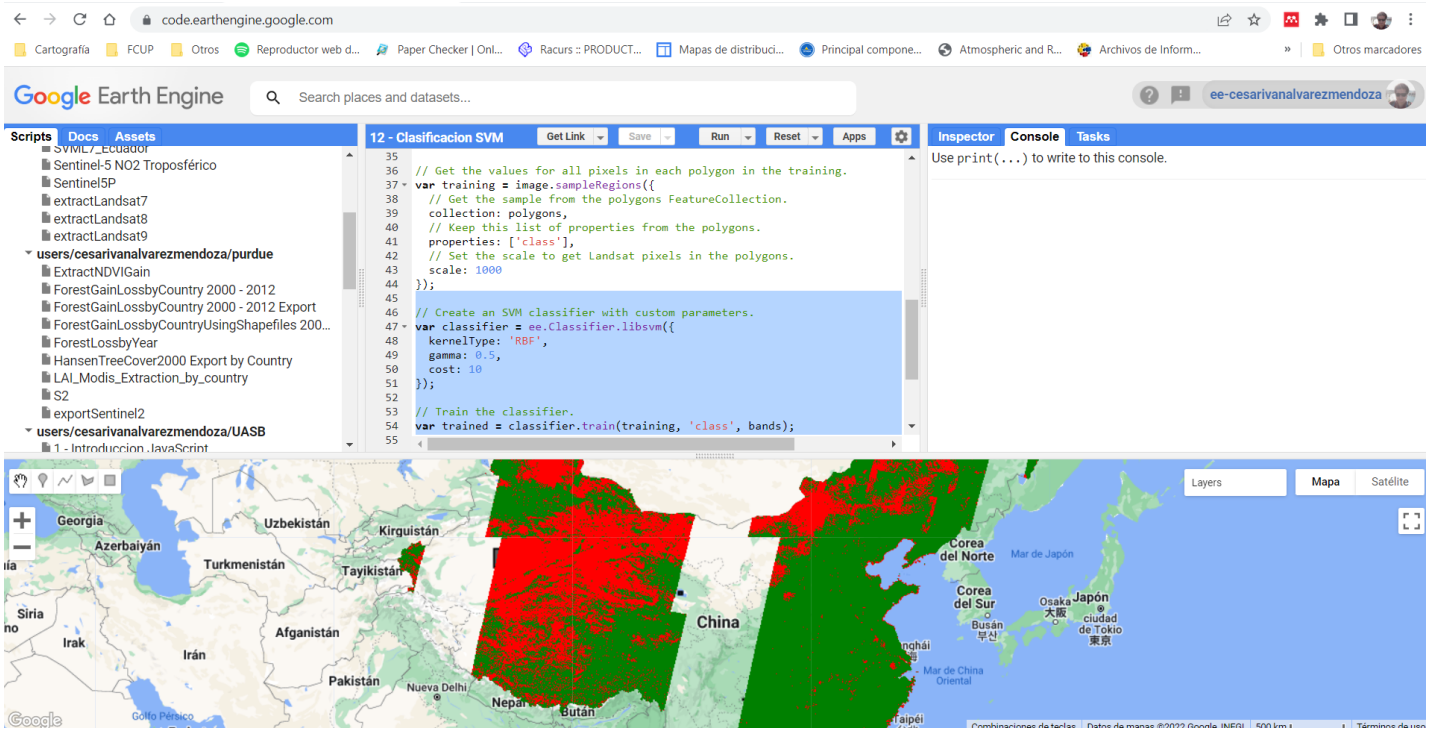
```
// Create an SVM classifier with custom parameters.
var classifier = ee.Classifier.libsvm({
  kernelType: 'RBF',
  gamma: 0.5,
  cost: 10
});

// Train the classifier.
var trained = classifier.train(training, 'class', bands);

// Classify the image.
var classified = image.classify(trained);

// Display the classification result and the input image.
Map.centerObject(table,4);
Map.addLayer(polygons, {}, 'training polygons');
Map.addLayer(classified,
            {min: 0, max: 1, palette: ['red', 'green']},
            'deforestation');
```

Algoritmo de Machine Learning SVM

Áreas de entrenamiento

Clasificación

12 – Clasificación Supervisada - SVM



13 – Clasificación Supervisada Matriz de Confusión – Random Forest

```
// A Sentinel-2 surface reflectance image, reflectance bands selected,
// serves as the source for training and prediction in this contrived example.
var img = ee.Image('COPERNICUS/S2_SR/20210109T185751_20210109T185931_T10SEG')
            .select('B.*');

// ESA WorldCover land cover map, used as label source in classifier training.
var lc = ee.Image('ESA/WorldCover/v100/2020');

// Remap the land cover class values to a 0-based sequential series.
var classValues = [10, 20, 30, 40, 50, 60, 70, 80, 90, 95, 100];
var remapValues = ee.List.sequence(0, 10);
var label = 'lc';
lc = lc.remap(classValues, remapValues).rename(label).toByte();

// Add land cover as a band of the reflectance image and sample 100 pixels at
// 10 m scale from each land cover class within a region of interest.
var roi = ee.Geometry.Rectangle(-122.347, 37.743, -122.024, 37.838);
var sample = img.addBands(lc).stratifiedSample({
  numPoints: 100,
  classBand: label,
  region: roi,
  scale: 10,
  geometries: true
});
```

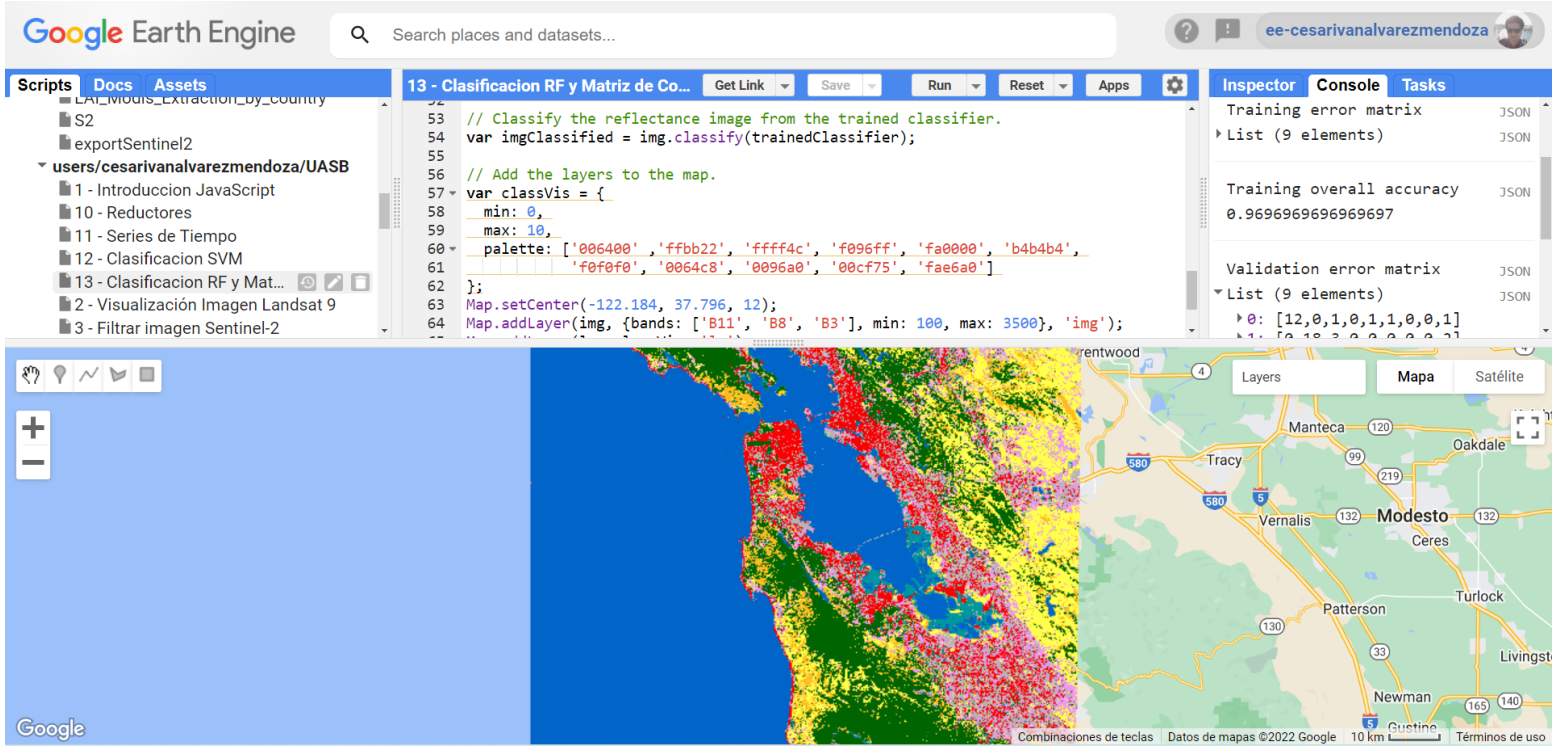
13 – Clasificación Supervisada Matriz de Confusión – Random Forest

```
// Add a random value field to the sample and use it to approximately split 80%
// of the features into a training set and 20% into a validation set.
sample = sample.randomColumn();
var trainingSample = sample.filter('random <= 0.8');
var validationSample = sample.filter('random > 0.8');

// Train a 10-tree random forest classifier from the training sample.
var trainedClassifier = ee.Classifier.smileRandomForest(10).train({
  features: trainingSample,
  classProperty: label,
  inputProperties: img.bandNames()
});

// Get information about the trained classifier.
print('Results of trained classifier', trainedClassifier.explain());

// Get a confusion matrix and overall accuracy for the training sample.
var trainAccuracy = trainedClassifier.confusionMatrix();
print('Training error matrix', trainAccuracy);
print('Training overall accuracy', trainAccuracy.accuracy());
```

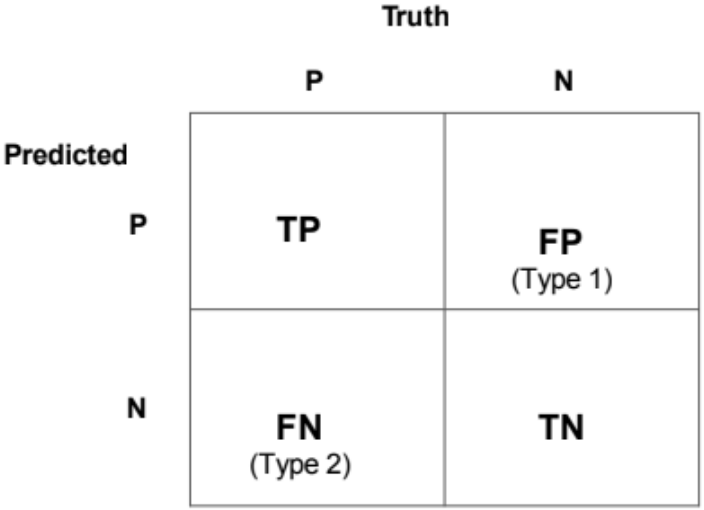
13 – Clasificación Supervisada Matriz de Confusión – Random Forest

```
// Get a confusion matrix and overall accuracy for the validation sample.
validationSample = validationSample.classify(trainedClassifier);
var validationAccuracy = validationSample.errorMatrix(label, 'classification');
print('Validation error matrix', validationAccuracy);
print('Validation accuracy', validationAccuracy.accuracy());

// Classify the reflectance image from the trained classifier.
var imgClassified = img.classify(trainedClassifier);

// Add the layers to the map.
var classVis = {
  min: 0,
  max: 10,
  palette: ['006400' ,'ffbb22', 'ffff4c', 'f096ff', 'fa0000', 'b4b4b4',
            'f0f0f0', '0064c8', '0096a0', '00cf75', 'fae6a0']
};
Map.setCenter(-122.184, 37.796, 12);
Map.addLayer(img, {bands: ['B11', 'B8', 'B3'], min: 100, max: 3500}, 'img');
Map.addLayer(lc, classVis, 'lc');
Map.addLayer(imgClassified, classVis, 'Classified');
Map.addLayer(roi, {color: 'white'}, 'ROI', false, 0.5);
Map.addLayer(trainingSample, {color: 'black'}, 'Training sample', false);
Map.addLayer(validationSample, {color: 'white'}, 'Validation sample', false);
```

13 – Clasificación Supervisada Matriz de Confusión – Random Forest



Matriz de Confusión – Accuracy and Kappa Coefficients



Accuracy = TP + TN / TP + TN + FP + FN

Matriz de Confusión – Accuracy and Kappa Coefficients

		Truth P	Truth N
Predicted	P	0	0
	N	10	$10^9 - 10$

Out of 1 Billion People there are 10 terrorists

Accuracy = $10^9 - 10 / 10^9$
= $1 - 10^{-8}$
= 0.99999
or 99.9999%

Matriz de Confusión – Accuracy and Kappa Coefficients

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Matriz de Confusión – Accuracy and Kappa Coefficients

Classification results are evaluated based on the following metrics

- **Overall Accuracy**: How many samples were classified correctly.
- **Producer's Accuracy**: How well did the classification predict each class.
- **Consumer's Accuracy (Reliability)**: How reliable is the prediction in each class.
- **Kappa Coefficient**: How well the classification performed as compared to random assignment.

Ground Truth (Actual)	Classification (Predicted) 0	1	2	3	Producer's Accuracy
0	41	4	0	0	*0.91*
1	3	43	0	0	*0.93*
2	0	0	48	3	*0.94*
3	0	0	0	37	*1.00*
	0.93	*0.91*	*1.00*	*0.93*	*0.94*

Consumer's Accuracy

Overall Accuracy

Accuracy Assessment

Matriz de Confusión – Accuracy and Kappa Coefficients

		Reference test information					
	Class	Road	Building	Green	Bare	Row total	User's Accuracy
Remote sensing classification	Road	101	0	25	20	146	69.18%
	Building	0	128	0	17	145	88.28%
	Green	10	0	104	1	115	90.43%
	Bare	2	4	2	105	113	92.92%
	Column total	113	132	131	143	519	
	Producer's accuracy	89.38%	96.97%	79.39%	73.43%		

Overall accuracy = 84.4%, Kappa coefficient: 0.825.

Muito obrigado pela sua atenção

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