



Credit: Planet



WORKSHOP: GOOGLE EARTH ENGINE AND COLLECT EARTH ONLINE FOR LAND USE AND COVER

Andréa Puzzi Nicolau

July 17, 2019



Collect Earth Online

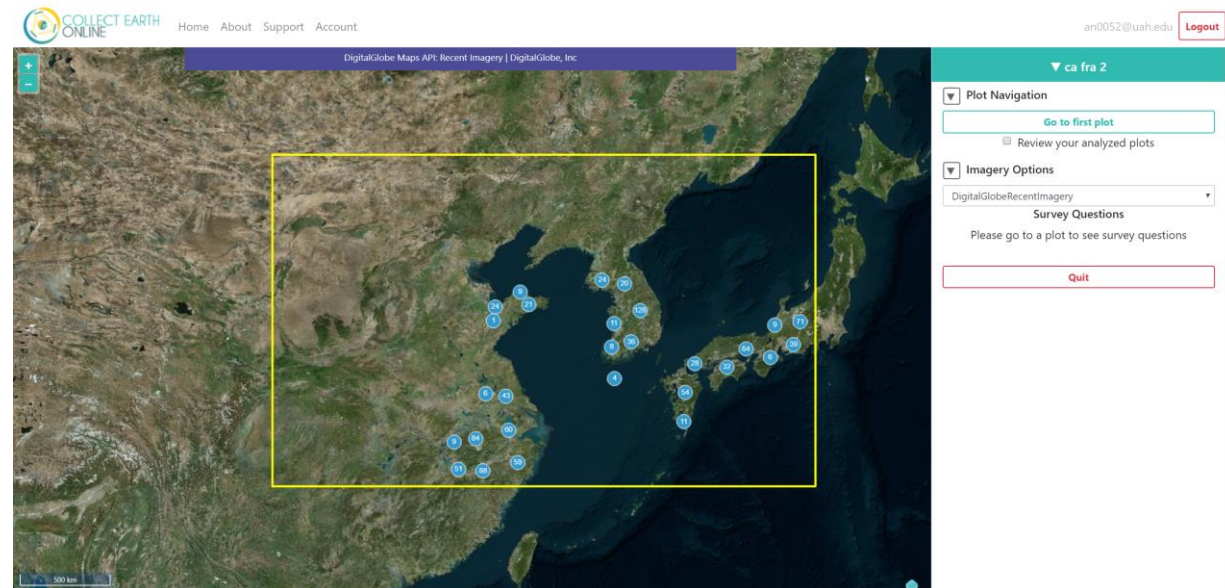




Collect Earth Online



- ▶ Collect Earth Online (CEO): A visual image interpretation system for reference data collection
- ▶ Developed by SERVIR and FAO
- ▶ No installation needed
- ▶ Collaborative mapping



Exercises

- ▶ How to create a project
- ▶ Plot and sample design
- ▶ Survey design
- ▶ Plot navigation
- ▶ Imagery options
- ▶ How to export reference data

Useful links

- ▶ <https://collect.earth/support>
- ▶ https://collect.earth/downloads/CEO_Manual.pdf
- ▶ <https://github.com/openforis/collect-earth-online/issues>
- ▶ <http://www.openforis.org/>

<http://collect.earth>



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Institutions

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FAO-FRA



US Forest Service



Forest Department (Myanmar)



Spatial Informatics Group
(SIG)



Forest Research and Training
Center, Nepal



SERVIR-Mekong Training




Demo

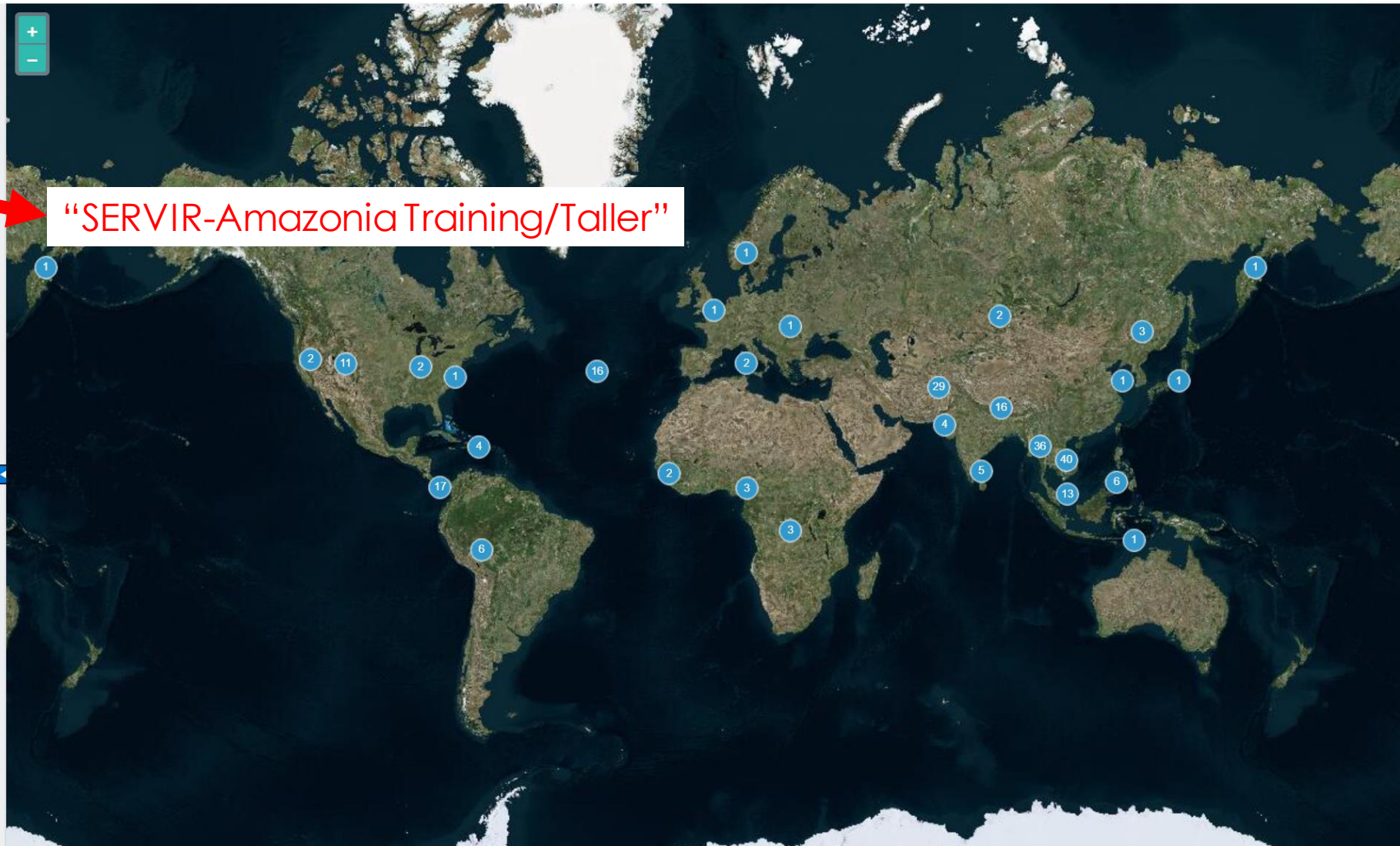


Institutions

[+ Create New Institution](#)



- FAO-FRA ①
- US Forest Service ①
- Forest Department (Myanmar) ①
- Spatial Informatics Group (SIG) ①
- Forest Research and Training Center, Nepal ①
- SERVIR-Mekong Training ①
- Demo ①
- Cambodia Change Detection ①
- Collaborative Forest Landscape Restoration Program (CFLRP) ①
- SERVIR-Mekong ①
- Afghanistan NLCMS ①



“SERVIR-Amazonia Training/Taller”

Collect Earth Online



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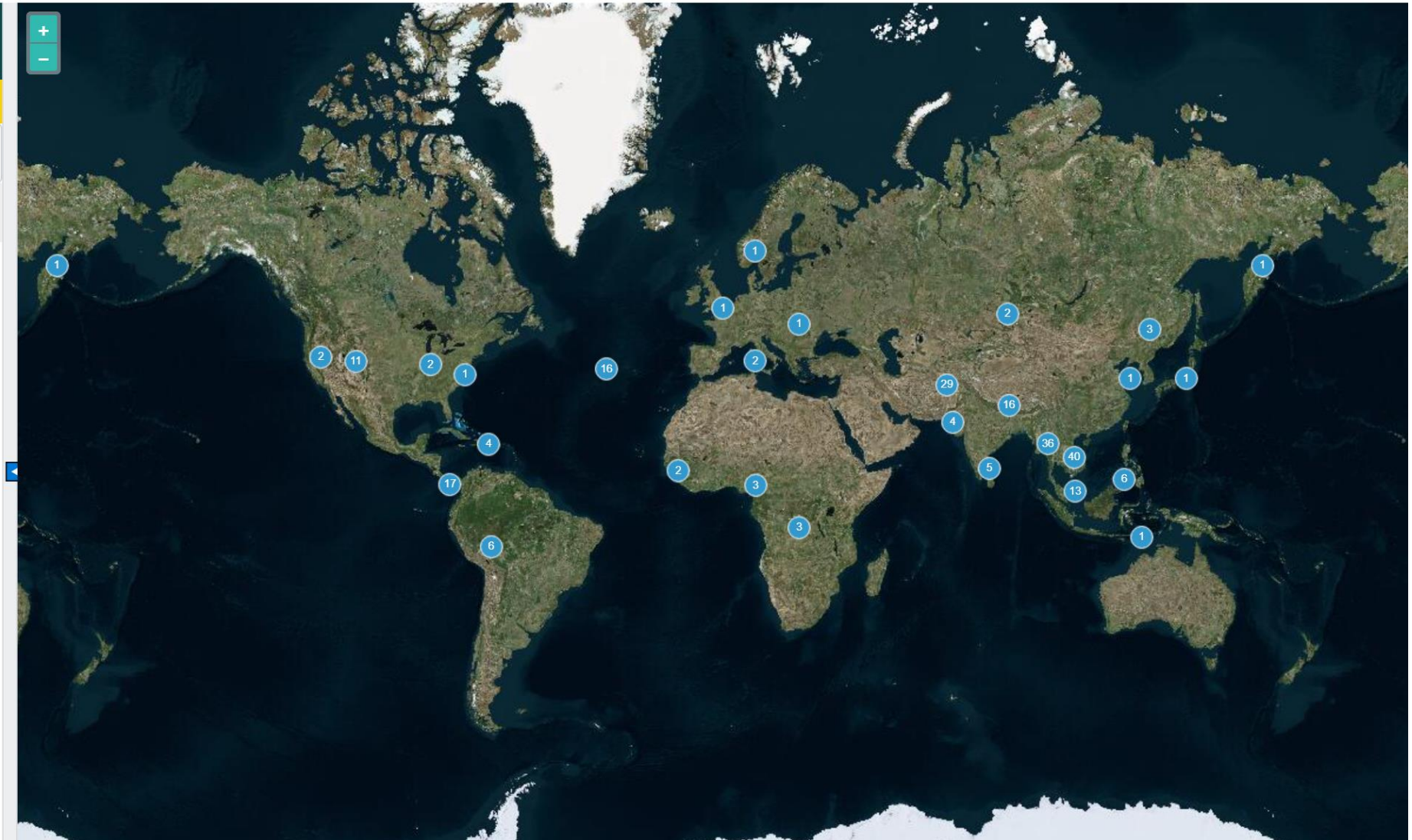
an0052@uah.edu

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SERVIR-Amazonia Training/Taller



Creación de un proyecto



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an0052@uah.edu

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SERVIR-Amazonia Training/Taller

Institution created for trainings on CEO (SERVIR-Amazonia) / Institución creada para talleres sobre CEO (SERVIR-Amazonia)

Edit

Delete

Go to Dashboard

Imagery 5

+ Add New Imagery

DigitalGlobeRecentImagery

DigitalGlobeRecentImagery+Streets

BingAerial

BingAerialWithLabels

DigitalGlobeWMSImagery

Projects 1

+ Create New Project

Institution

Mane de Dios ejemplo



Users 2

Email

+ Add User

an0052@uah.edu

Admin

mealvah@gmail.com

Admin

Create Project

Use Project Template (Optional)

Template Filter (Name or ID)

Select Project

None ▼

Project Info

Name

Description


Privacy Level

Public: All Users: Logged In Users Institution: Group Members Private: Group Admins

Project AOI



Project AOI



5000 km

Hold CTRL and click-and-drag a bounding box on the map

North

West East

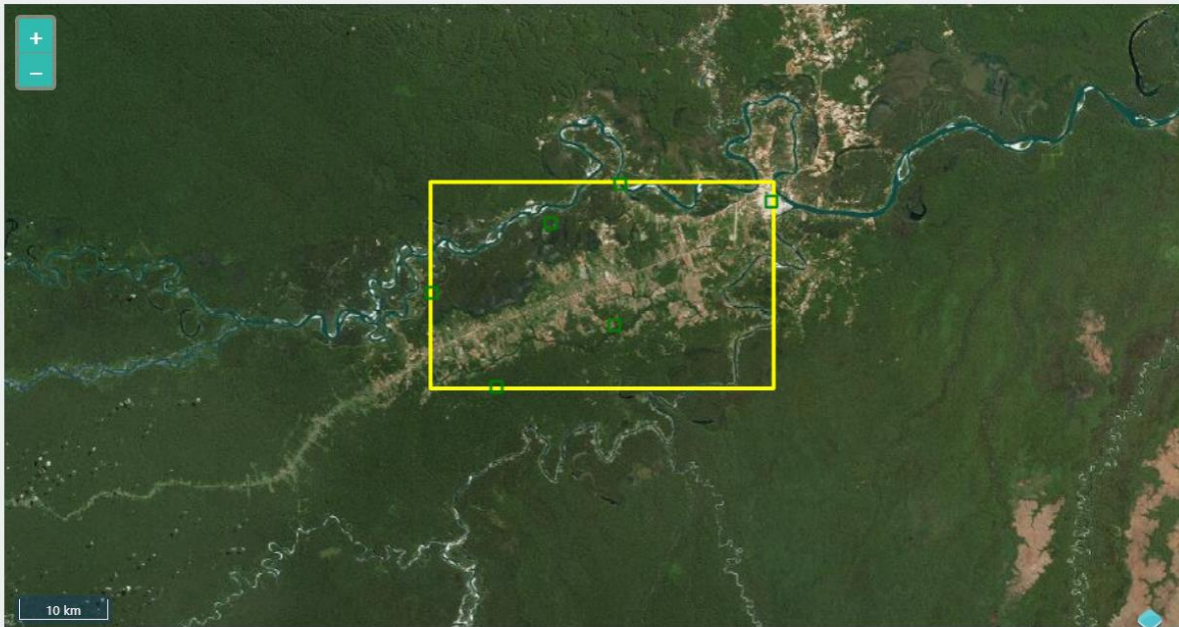
South

Basemap Source

DigitalGlobeRecentImagery

Plot Design

Project AOI



10 km

-12.5745912082845

-69.5420419202322 -69.1863591905305

-12.7837089735666

Basemap Source

DigitalGlobeRecentImagery

Plot Review

Spatial Distribution [csv distribution](#)

Plot Design

Spatial Distribution

Random Gridded

-Plot centers will be randomly distributed within the AOI.

Number of plots

Plot spacing (m)

Plot Shape

Circle Square

Diameter (m)

Sample Design

Spatial Distribution

Random Gridded

-Sample points will be randomly distributed within the plot boundary.

Samples per plot

Sample resolution (m)

Survey Design

	A	B	C
1	LONGITUDE	LATITUDE	PLOTID
2	-69.47329712	-12.78190041	1
3	-69.54019928	-12.68719959	2
4	-69.35099792	-12.71959972	3
5	-69.4178009	-12.61629963	4
6	-69.1882019	-12.59490013	5
7	-69.34559631	-12.5763998	6

PLOTID cannot start at 0

Plot Design

Spatial Distribution

Random Gridded **Upload CSV** **Upload SHP** File: ceo_pts.csv
-Specify your own plot centers by uploading a CSV with these fields: LONGITUDE,LATITUDE,PLOTID.

Number of plots

Plot spacing (m)

Plot Shape

Circle Square

Diameter (m)

Sample Design

Spatial Distribution

Random Gridded **Upload CSV** **Upload SHP**
-Sample points will be randomly distributed within the plot boundary.

Samples per plot

Sample resolution (m)

Survey Design

Plot Design

Spatial Distribution

Random Gridded Upload CSV Upload SHP File: ceo_pts.csv
-Specify your own plot centers by uploading a CSV with these fields: LONGITUDE,LATITUDE,PLOTID.

Number of plots

Plot spacing (m)

Plot Shape

Circle Square

Width (m)

Sample Design

Spatial Distribution

Random Gridded Upload CSV Upload SHP
-Sample points will be randomly distributed within the plot boundary.

Samples per plot

Sample resolution (m)

Survey Design

Plot Design

Spatial Distribution

Random Gridded Upload CSV Upload SHP File: ceo_pts.csv
-Specify your own plot centers by uploading a CSV with these fields: LONGITUDE,LATITUDE,PLOTID.

Number of plots

Plot spacing (m)

Plot Shape

Circle Square

Width (m)

Sample Design

Spatial Distribution

Random Gridded Upload CSV Upload SHP
-Sample points will be randomly distributed within the plot boundary.

Samples per plot

Sample resolution (m)

Survey Design

Plot Design

Spatial Distribution

Random Gridded [Upload CSV](#) [Upload SHP](#) File: ceo_pts.csv
-Specify your own plot centers by uploading a CSV with these fields: LONGITUDE,LATITUDE,PLOTID.

Number of plots

Plot spacing (m)

Plot Shape

Circle Square

Width (m)

Sample Design

Spatial Distribution

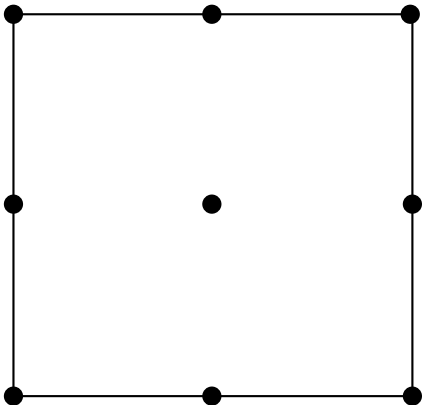
Random Gridded [Upload CSV](#) [Upload SHP](#)
-Sample points will be arranged on a grid within the plot boundary using the sample resolution selected below.

Samples per plot

Sample resolution (m)

Survey Design

40.000 m²



Width (m)

200

Sample Design

Spatial Distribution

Random Gridded [Upload CSV](#) [Upload SHP](#)

-Sample points will be arranged on a grid within the plot boundary using the sample resolution selected below.

Samples per plot

Sample resolution (m)

100

Survey Design

Simple

Advanced

Parent Question:

None

Parent Answer:

Any

New Question:

[Add Survey Question](#)

Project Management

[Create Project](#)

Width (m)

200

Sample Design

Spatial Distribution

Random Gridded [Upload CSV](#) [Upload SHP](#)

-Sample points will be arranged on a grid within the plot boundary using the sample resolution selected below.

Samples per plot

Sample resolution (m)

100

Survey Design

Simple

Advanced

Parent Question:

None

Parent Answer:

Any

New Question:

Uso/Cobertura del Suelo?

[Add Survey Question](#)

Project Management

[Create Project](#)

Survey Design

[Simple](#) [Advanced](#)

- Survey Card Number 1 ▲ ▼

Usos/Cobertura del Suelo

Answers:

- Agua
- Bosque
- Minería
- Pastizal
- Agricultura
- Tala
- Urbano/Artificial
- Otro

Parent Question: ▼

Parent Answer: ▼

New Question:

Project Management

[Create Project](#)

Survey Design

[Simple](#) [Advanced](#)

- Survey Card Number 1 ▲ ▼

Usos/Cobertura del Suelo

Answers:

- Agua
- Bosque
- Minería
- Pastizal
- Agricultura
- Tala
- Urbano/Artificial
- Otro

Parent Question: ▼

Parent Answer: ▼

New Question:

Project Management



Review Project

Project Info

Name

Madre de Dios ejemplo

Description

Madre de Dios ejemplo

Privacy Level

Public: All Users: Logged In Users Institution: Group Members Private: Group Admins

Project AOI



5 km

-12.5745912082845

-69.5420419202322 -69.1863591905305

-12.7837089735666

Basemap Source

DigitalGlobeRecentImagery

Plot Review

Spatial Distribution **csv distribution**

Number of plots **6 plots**

Plot shape **square**

Plot size **200 m**

Sample Design

Spatial Distribution **gridded distribution**

Samples Per Plot **9 /plot**

Sample Resolution **100 m**

Survey Review

- Survey Card Number 1

Uso/Cobertura del Suelo?

- **Component Type:** button - text

Samples Per Plot 9 /plot

Sample Resolution 100 m

Survey Review

- Survey Card Number 1

Uso/Cobertura del Suelo?

- **Component Type:** button - text

Answers:

- Agua
- Bosque
- Minería
- Pastizal
- Agricultura
- Tala
- Otro
- Urbano/Artificial

Rules:

No rules available for this survey

Project Management

Close Project	Update Project
Project Dashboard	Configure Geo-Dash
Download Plot Data	Download Sample Data
Project Stats	

Samples Per Plot 9 /plot

Sample Resolution 100 m

Survey Review

- Survey Card Number 1

Uso/Cobertura del Suelo?

- **Component Type:** button - text

Answers:

- Agua
- Bosque
- Minería
- Pastizal
- Agricultura
- Tala
- Otro
- Urbano/Artificial

Rules:

No rules available for this survey

Project Management

Close Project	Update Project
Project Dashboard	Configure Geo-Dash
Download Plot Data	Download Sample Data
Project Stats	



Project Dashboard

Project AOI



Project Stats

Members	0	Contributors	1
Total Plots	6	Date Created	
Flagged Plots	0	Date Published	
Analyzed Plots	6	Date Closed	
Unanalyzed Plots	0	Date Archived	

Samples Per Plot 9 /plot

Sample Resolution 100 m

Survey Review

- Survey Card Number 1

Uso/Cobertura del Suelo?

- **Component Type:** button - text

Answers:

- Agua
- Bosque
- Minería
- Pastizal
- Agricultura
- Tala
- Otro
- Urbano/Artificial

Rules:

No rules available for this survey

Project Management

Close Project	Update Project
Project Dashboard	Configure Geo-Dash
Download Plot Data	Download Sample Data
Project Stats	



Collect Earth Online

 COLLECT EARTH
ONLINE GEO-DASH



an0052@uah.edu

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[Add Widget](#)

[Geo-Dash Help](#)



Create Widget ×

Type

Please select type ▾

- Please select type
- Image Collection
- Time Series Graph
- Statistics
- Dual Image Collection
- Image Asset
- Image Collection Asset
- SRTM Digital Elevation Data 30m



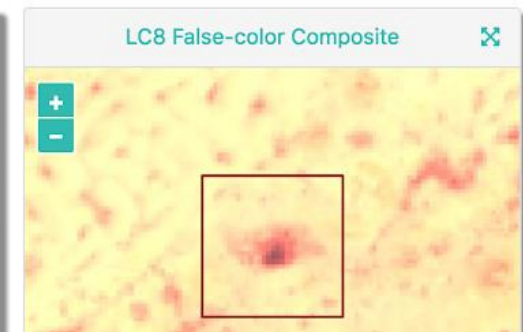
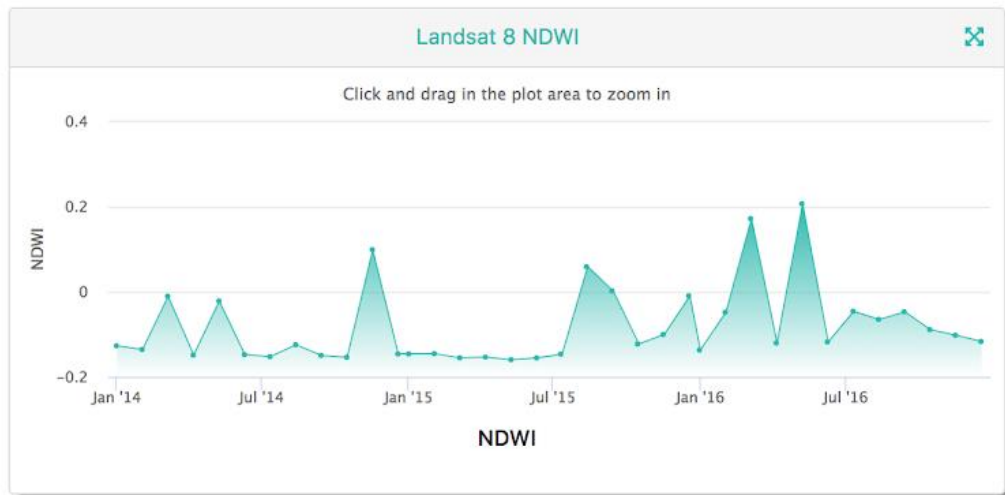
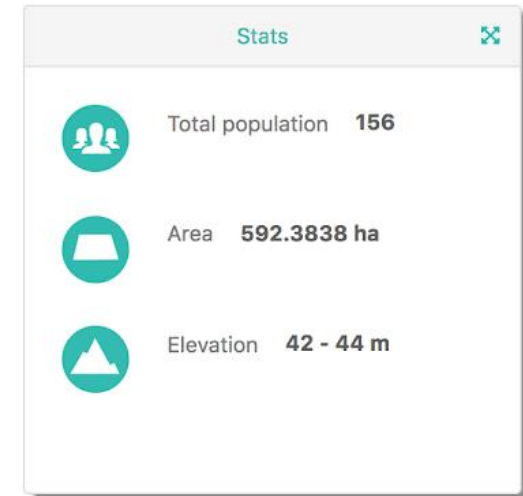
Collect Earth Online



COLLECT EARTH
ONLINE

COLLECT EARTH
ONLINE GEO-DASH

admin@openforis.org [Logout](#)



Links:

<https://collect.earth/geo-dash/geodash-help>

<https://youtu.be/7elvtgDbXw>

<https://youtu.be/7elvtgDbXw>

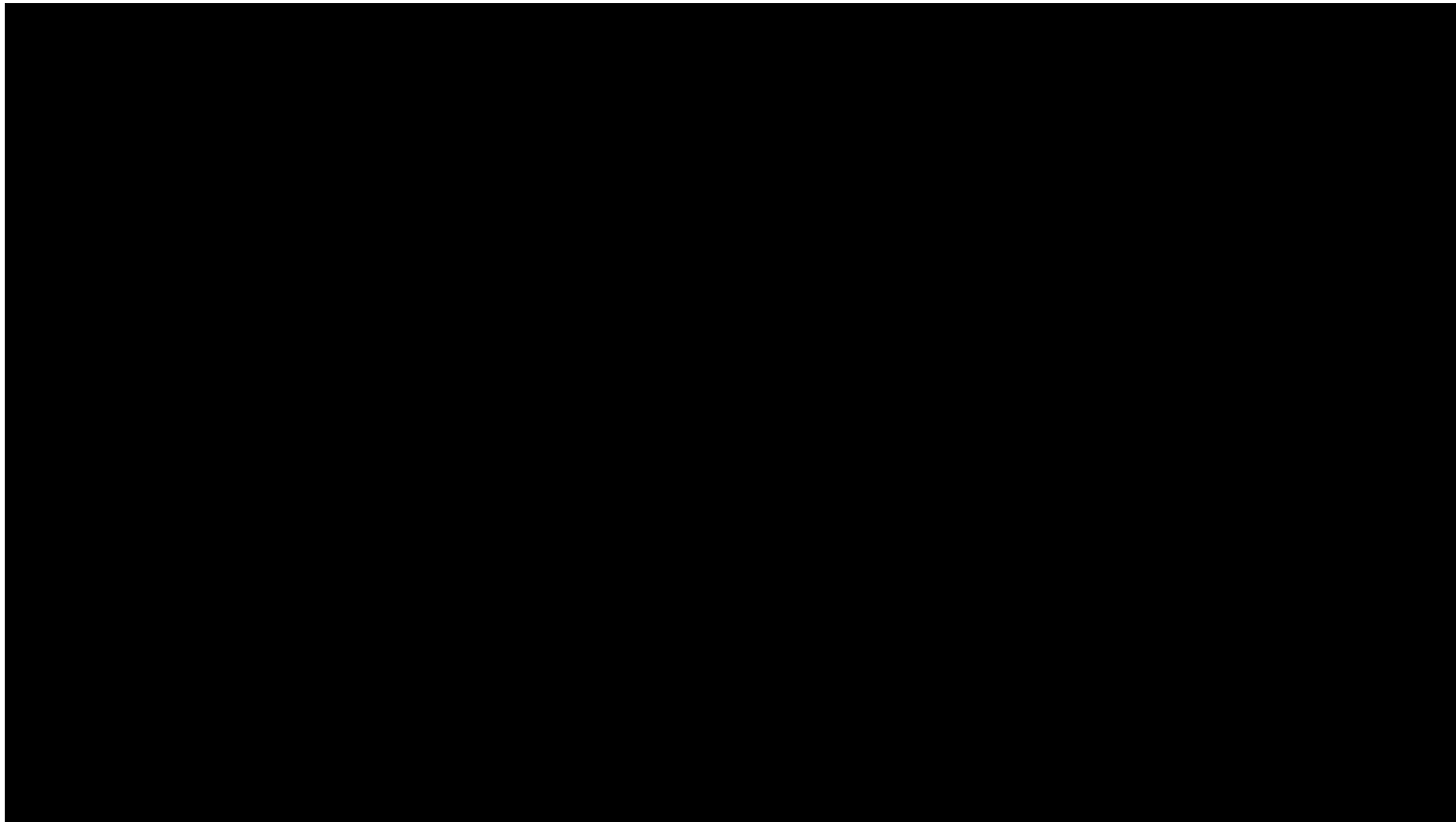


Collect Earth Online



COLLECT EARTH
ONLINE

How to create a Project (https://youtu.be/ecXmOx_kCPU)



Collect Earth Online



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Institutions

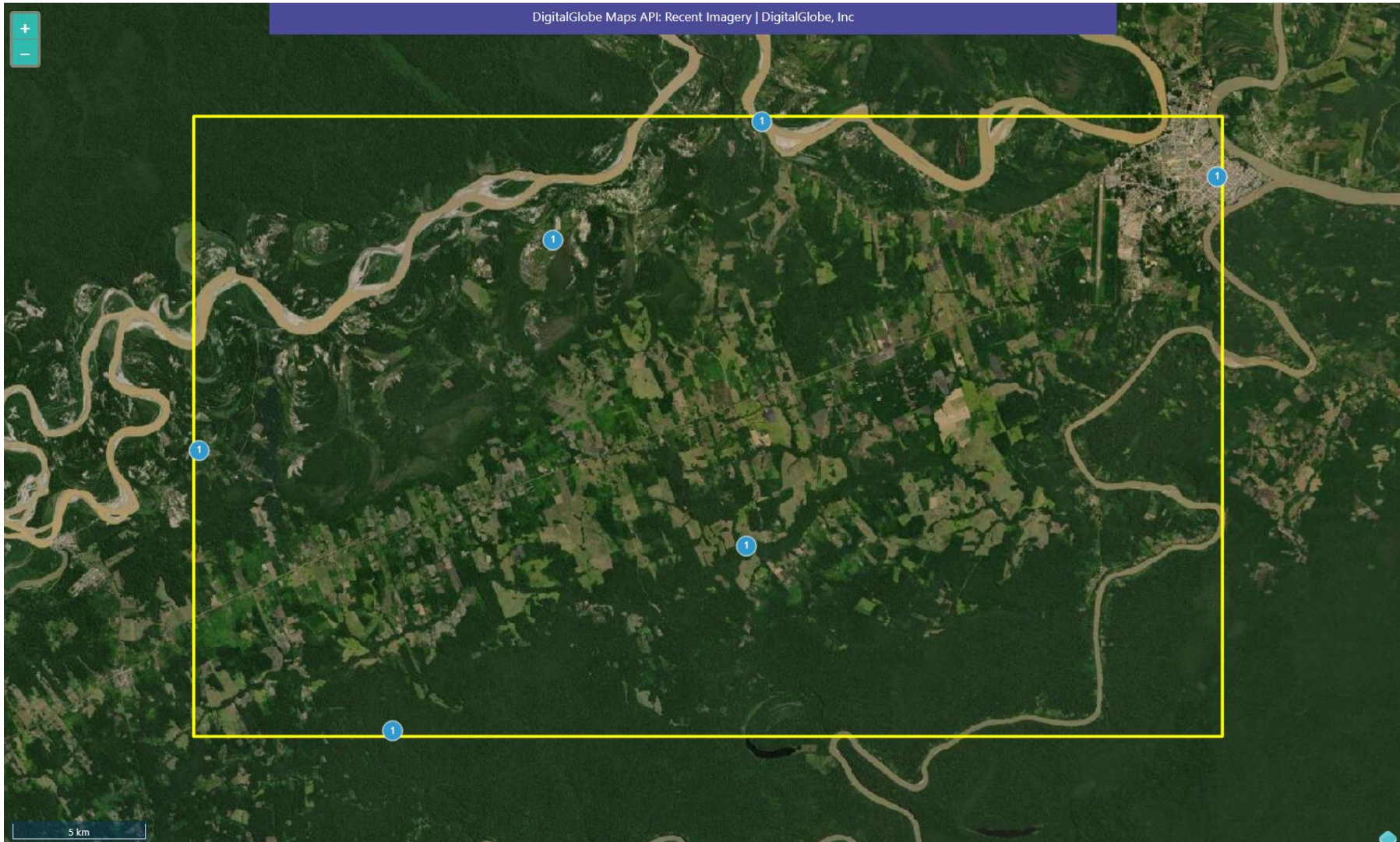
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servir-amaz

SERVIR-Amazonia Training/Taller

Madre de Dios ejemplo





▼ Madre de Dios ejemplo

▼ Plot Navigation

Go to first plot

Review your analyzed plots

▼ Imagery Options

DigitalGlobeRecentImagery

Survey Questions

Please go to a plot to see survey questions

Quit

DigitalGlobe Maps API: Recent Imagery | DigitalGlobe, Inc



▼ Madre de Dios ejemplo

▼ Plot Navigation - ID: 1

Review your analyzed plots

▼ Imagery Options

DigitalGlobeRecentImagery ▼

Unanswered Color Black White
Survey Questions

Uso/Cobertura del Suelo?

<input type="radio"/> Agua	<input type="radio"/> Agricultura
<input checked="" type="radio"/> Bosque	<input type="radio"/> Tala
<input type="radio"/> Minería	<input type="radio"/> Otro
<input type="radio"/> Pastizal	<input type="radio"/> Urbano/Artificial

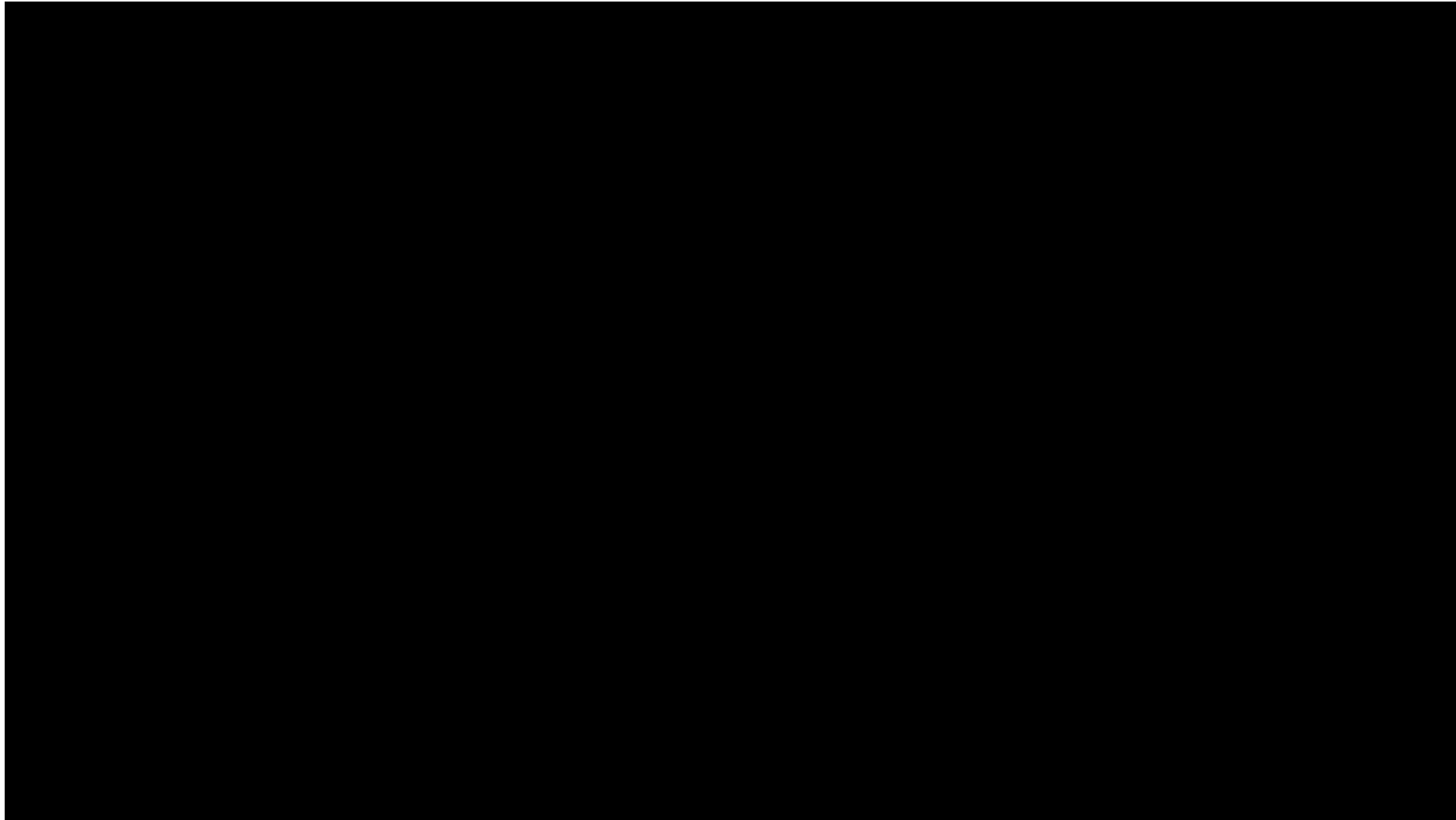


Collect Earth Online



COLLECT EARTH
ONLINE

Plot navigation/data collection (<https://youtu.be/t2D5WgWKhPg>)



Samples Per Plot 9 /plot

Sample Resolution 100 m

Survey Review

Survey Card Number 1

Uso/Cobertura del Suelo?

- **Component Type:** button - text

Answers:

- Agua
- Bosque
- Minería
- Pastizal
- Agricultura
- Tala
- Otro
- Urbano/Artificial

Rules:

No rules available for this survey

Project Management

Close Project	Update Project
Project Dashboard	Configure Geo-Dash
Download Plot Data	Download Sample Data
Project Stats	





Collect Earth Online



COLLECT EARTH
ONLINE

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	
1	PLOT_ID	SAMPLE_I	LON	LAT	FLAGGED	ANALYSES	USER_ID	COLLECTIC	ANALYSIS	IMAGERY	IMAGERY	STACKING	PL_PLOTIC	USO/COBERTURA DEL SUELO?													
2	1.35E+08	4.8E+08	-69.4742	-12.7828	FALSE	1	an0052@u	49:22.1	104.8	DigitalGlo	2016	Accuracy_	1	Bosque													
3	1.35E+08	4.8E+08	-69.4742	-12.7819	FALSE	1	an0052@u	49:22.1	104.8	DigitalGlo	2016	Accuracy_	1	Bosque													
4	1.35E+08	4.8E+08	-69.4742	-12.781	FALSE	1	an0052@u	49:22.1	104.8	DigitalGlo	2016	Accuracy_	1	Bosque													
5	1.35E+08	4.8E+08	-69.4733	-12.7828	FALSE	1	an0052@u	49:22.1	104.8	DigitalGlo	2016	Accuracy_	1	Bosque													
6	1.35E+08	4.8E+08	-69.4733	-12.7819	FALSE	1	an0052@u	49:22.1	104.8	DigitalGlo	2016	Accuracy_	1	Bosque													
7	1.35E+08	4.8E+08	-69.4733	-12.781	FALSE	1	an0052@u	49:22.1	104.8	DigitalGlo	2016	Accuracy_	1	Bosque													
8	1.35E+08	4.8E+08	-69.4724	-12.7828	FALSE	1	an0052@u	49:22.1	104.8	DigitalGlo	2016	Accuracy_	1	Bosque													
9	1.35E+08	4.8E+08	-69.4724	-12.7819	FALSE	1	an0052@u	49:22.1	104.8	DigitalGlo	2016	Accuracy_	1	Bosque													
10	1.35E+08	4.8E+08	-69.4724	-12.781	FALSE	1	an0052@u	49:22.1	104.8	DigitalGlo	2016	Accuracy_	1	Bosque													
11	1.35E+08	4.8E+08	-69.5411	-12.6881	FALSE	1	an0052@u	50:15.4	135.6	DigitalGlobeRecentImagery			2	Tala													
12	1.35E+08	4.8E+08	-69.5411	-12.6872	FALSE	1	an0052@u	50:15.4	135.6	DigitalGlobeRecentImagery			2	Tala													
13	1.35E+08	4.8E+08	-69.5411	-12.6863	FALSE	1	an0052@u	50:15.4	135.6	DigitalGlobeRecentImagery			2	Bosque													
14	1.35E+08	4.8E+08	-69.5402	-12.6881	FALSE	1	an0052@u	50:15.4	135.6	DigitalGlobeRecentImagery			2	Bosque													
15	1.35E+08	4.8E+08	-69.5402	-12.6872	FALSE	1	an0052@u	50:15.4	135.6	DigitalGlobeRecentImagery			2	Agricultura													
16	1.35E+08	4.8E+08	-69.5402	-12.6863	FALSE	1	an0052@u	50:15.4	135.6	DigitalGlobeRecentImagery			2	Agricultura													
17	1.35E+08	4.8E+08	-69.5393	-12.6881	FALSE	1	an0052@u	50:15.4	135.6	DigitalGlobeRecentImagery			2	Bosque													
18	1.35E+08	4.8E+08	-69.5393	-12.6872	FALSE	1	an0052@u	50:15.4	135.6	DigitalGlo	2016	Accuracy_	2	Otro													
19	1.35E+08	4.8E+08	-69.5393	-12.6863	FALSE	1	an0052@u	50:15.4	135.6	DigitalGlobeRecentImagery			2	Bosque													
20	1.35E+08	4.8E+08	-69.3519	-12.7205	FALSE	1	an0052@u	51:43.3	170.2	DigitalGlobeRecentImagery			3	Bosque													
21	1.35E+08	4.8E+08	-69.3519	-12.7196	FALSE	1	an0052@u	51:43.3	170.2	DigitalGlo	2016	Accuracy_	3	Pastizal													
22	1.35E+08	4.8E+08	-69.3519	-12.7187	FALSE	1	an0052@u	51:43.3	170.2	DigitalGlo	2016	Accuracy_	3	Pastizal													
23	1.35E+08	4.8E+08	-69.351	-12.7205	FALSE	1	an0052@u	51:43.3	170.2	DigitalGlo	2016	Accuracy_	3	Otro													
24	1.35E+08	4.8E+08	-69.351	-12.7196	FALSE	1	an0052@u	51:43.3	170.2	DigitalGlo	2016	Accuracy_	3	Pastizal													
25	1.35E+08	4.8E+08	-69.351	-12.7187	FALSE	1	an0052@u	51:43.3	170.2	DigitalGlo	2016	Accuracy_	3	Pastizal													
26	1.35E+08	4.8E+08	-69.3501	-12.7205	FALSE	1	an0052@u	51:43.3	170.2	DigitalGlobeRecentImagery			3	Bosque													
27	1.35E+08	4.8E+08	-69.3501	-12.7196	FALSE	1	an0052@u	51:43.3	170.2	DigitalGlo	2016	Accuracy_	3	Otro													
28	1.35E+08	4.8E+08	-69.3501	-12.7187	FALSE	1	an0052@u	51:43.3	170.2	DigitalGlo	2016	Accuracy_	3	Pastizal													
29	1.35E+08	4.8E+08	-69.4187	-12.6172	FALSE	1	an0052@u	52:06.0	105	DigitalGlo	2016	Accuracy_	4	Miner?a													
30	1.35E+08	4.8E+08	-69.4187	-12.6163	FALSE	1	an0052@u	52:06.0	105	DigitalGlo	2016	Accuracy_	4	Miner?a													
31	1.35E+08	4.8E+08	-69.4187	-12.6154	FALSE	1	an0052@u	52:06.0	105	DigitalGlo	2016	Accuracy_	4	Miner?a													

ceo-madre-de-dios-ejemplo-sampl



Google Earth Engine



Google Earth Engine

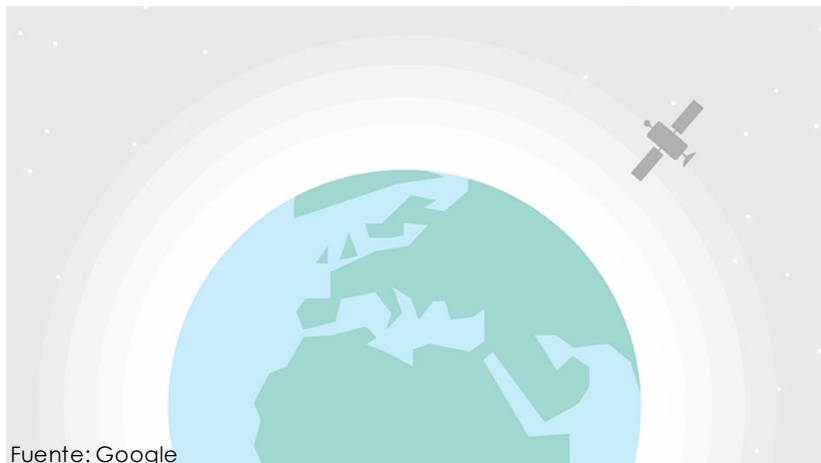


Google Earth Engine



Google Earth Engine

- ▶ Google Earth Engine (GEE): planetary scale cloud platform
- ▶ For access, processing and analysis of multitemporal satellite data from different sources
- ▶ Entire Landsat archive is already there!
- ▶ JavaScript or Python API
- ▶ Easy-to-share scripts
- ▶ Own data upload



Fuente: Google

The screenshot displays the Google Earth Engine web interface. On the left, a sidebar lists various scripts under 'Examples', including 'Image', 'Where Operator', and 'Normalized Difference'. The main area shows a script titled 'Landsat - Phenology Model.js' with the following code:

```

37 // Set up the "design matrix" to input to the regression.
38 function createLinearModelInputs(img) {
39   var tstamp = ee.Date(img.get('system:time_start'));
40   var tdelta = tstamp.difference(start, 'year');
41   // Build an image that will be used to fit the equation
42   // c0 + c1*sin(2*pi*t) + c2*cos(2*pi*t) = NDVI
43   var img_fitting = img.select()
44     .addBands(1)
45     .addBands(tdelta.multiply(2*Math.PI).sin())
46     .addBands(tdelta.multiply(2*Math.PI).cos())
47     .addBands(img.select('NDVI'))
48     .toDouble();
49   return img_fitting;
50 }
51
52 // Estimate NDVI according to the fitted model.
53 function predictNDVI(img) {
54   var tstamp = ee.Date(img.get('system:time_start'));
55   var tdelta = tstamp.difference(start, 'year');
56   // predicted NDVI = c0 + c1*sin(2*pi*t) + c2*cos(2*pi*t)
57   var predicted = ee.Image(meanCoeff)
58     .multiply(tdelta.multiply(2*Math.PI).sin())
  
```

On the right, the 'Inspector' panel shows a line graph titled 'Original and fitted values' comparing 'NDVI' (blue line with dots) and 'fitted' values (red line). The x-axis shows dates from April to October 2014, and the y-axis ranges from 0.00 to 1.00. Below the graph, a map shows a satellite view of a landscape with a color-coded overlay representing the NDVI prediction results.

Fuente: Gorelick et al., (2017)

Exercises

- ▶ CEO reference data as an asset
- ▶ How to filter satellite data
- ▶ How to define your study area / geometries
- ▶ How to plot time series and histograms for LULC
- ▶ How to use packages
- ▶ How to create time series animation
- ▶ Comparison between optical and radar time series
- ▶ How to export results

Useful Links

- ▶ <https://earthengine.google.com/faq/>
- ▶ <https://developers.google.com/earth-engine/>



Google Earth Engine



Google Earth Engine

<http://code.earthengine.google.com>

Google Earth Engine Search places and datasets...

Scripts Docs Assets

Filter scripts... NEW

- Owner (9)
- Writer (1)
- Reader (5)
- Examples
- Archive (2)

New Script

Get Link Save Run Reset

Inspector Console Tasks

Use print(...) to write to this console.

Map Satellite

North Pacific Ocean

North Atlantic Ocean

Google

Map data ©2019 Google, INEGI, ORION-ME | 500 km | Terms of Use



Google Earth Engine



Google Earth Engine

- ▶ To execute the Script, you can either select the *Run* button at the top, or use the keystroke combination *CTRL + Enter*
- ▶ To comment lines use as first characters *//*. You can mark several lines and use the keystroke combination *CTRL + /* to comment/uncomment the block. Alternatively, you can use */** as the first line of the block and **/* as the last line of the block to comment/uncomment the block

Scripts: https://code.earthengine.google.com/?accept_repo=users/an0052/servir-amazonia

- ▶ Script1
- ▶ Script2

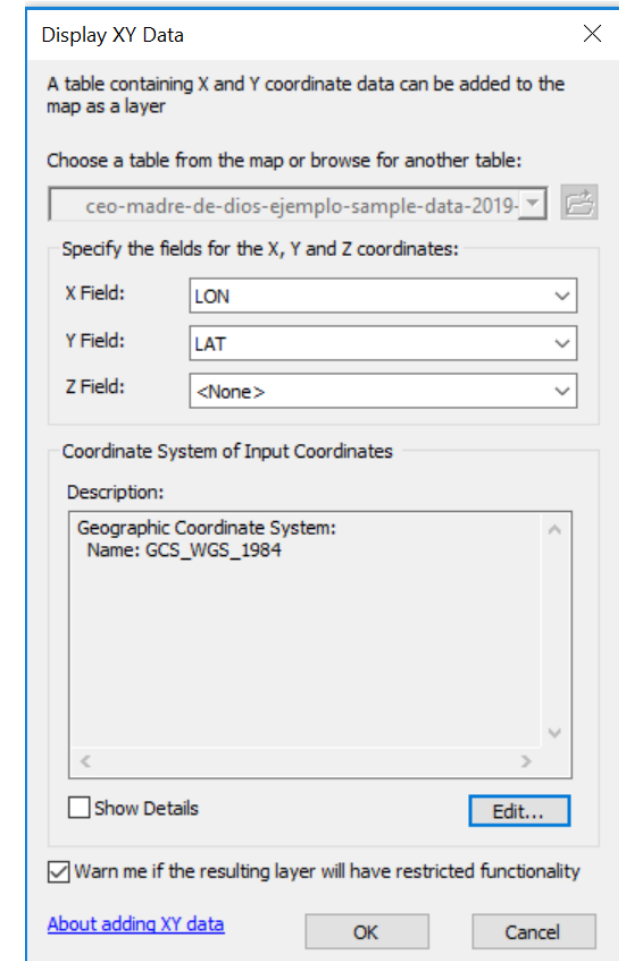
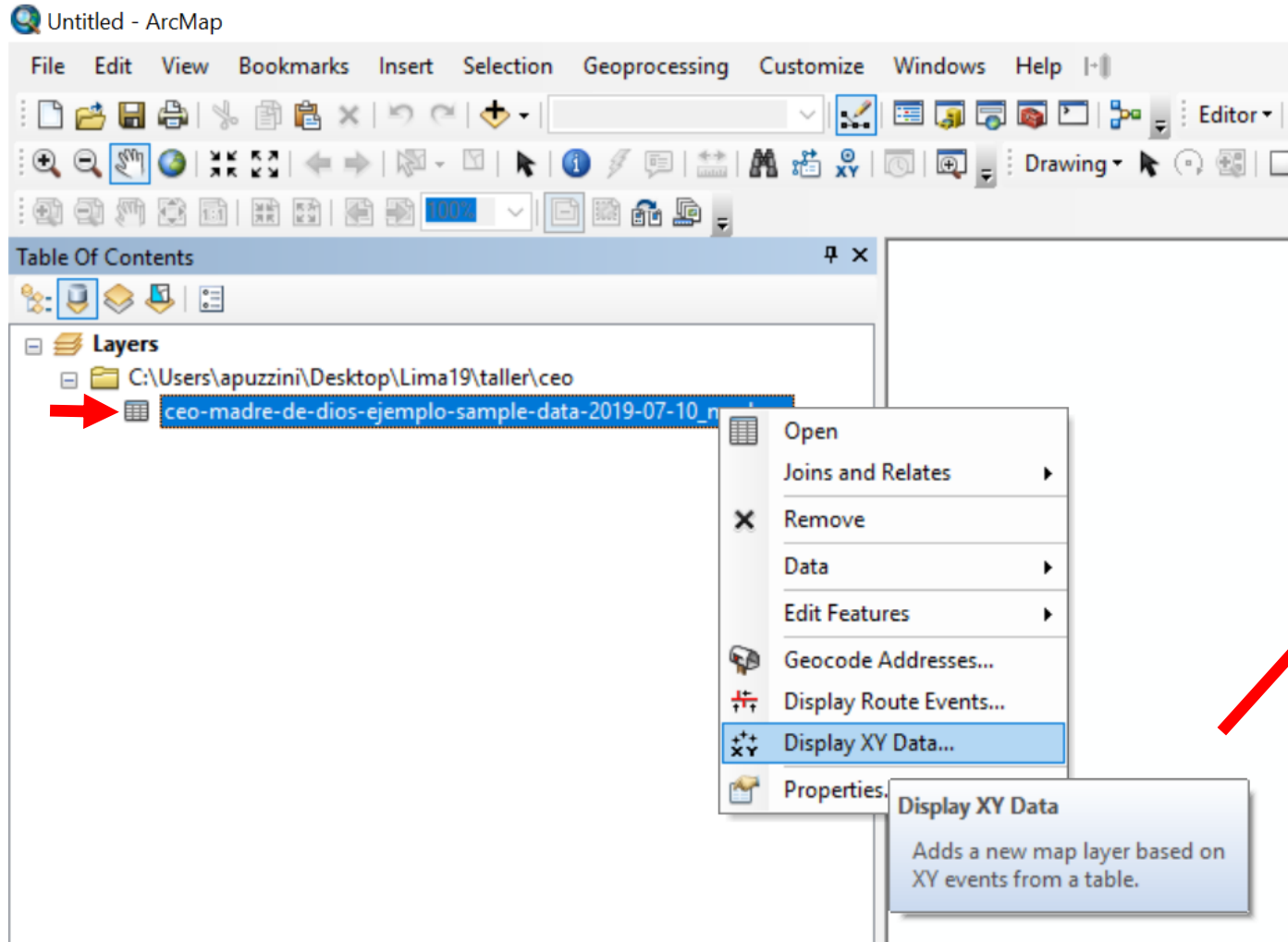
► CEO reference data as an Asset in GEE

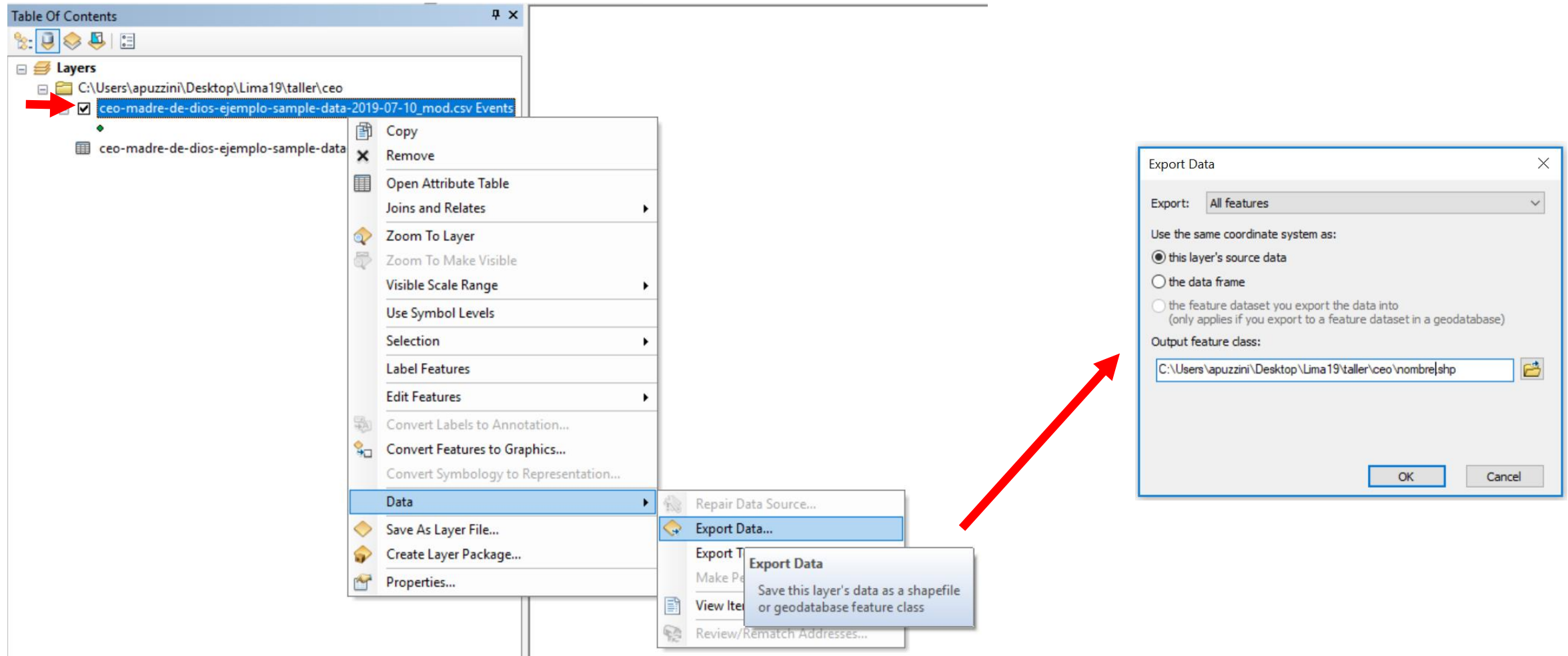
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	1	A	B	C	Y	Z	
	PLOT_ID	SAMPLE_	LON	LAT	FLAGGED	ANALYSES	USER_ID	COLLECTI	ANALYSIS_	IMAGERY_	IMAGERY	STACKING	PL_PLOTI	USO/COBERTURA	DEL SUELO?						2	LON	LAT	LULC			
2	1.35E+08	4.8E+08	-69.4742	-12.7828	FALSE	1	an0052@u	49:22.1	104.8	DigitalGlo	2016	Accuracy_	1	Bosque							2	-69.4742	-12.7828	2			
3	1.35E+08	4.8E+08	-69.4742	-12.7819	FALSE	1	an0052@u	49:22.1	104.8	DigitalGlo	2016	Accuracy_	1	Bosque								3	-69.4742	-12.7819	2		
4	1.35E+08	4.8E+08	-69.4742	-12.781	FALSE	1	an0052@u	49:22.1	104.8	DigitalGlo	2016	Accuracy_	1	Bosque								4	-69.4742	-12.781	2		
5	1.35E+08	4.8E+08	-69.4733	-12.7828	FALSE	1	an0052@u	49:22.1	104.8	DigitalGlo	2016	Accuracy_	1	Bosque								5	-69.4733	-12.7828	2		
6	1.35E+08	4.8E+08	-69.4733	-12.7819	FALSE	1	an0052@u	49:22.1	104.8	DigitalGlo	2016	Accuracy_	1	Bosque								6	-69.4733	-12.7819	2		
7	1.35E+08	4.8E+08	-69.4733	-12.781	FALSE	1	an0052@u	49:22.1	104.8	DigitalGlo	2016	Accuracy_	1	Bosque								7	-69.4733	-12.781	2		
8	1.35E+08	4.8E+08	-69.4724	-12.7828	FALSE	1	an0052@u	49:22.1	104.8	DigitalGlo	2016	Accuracy_	1	Bosque								8	-69.4724	-12.7828	2		
9	1.35E+08	4.8E+08	-69.4724	-12.7819	FALSE	1	an0052@u	49:22.1	104.8	DigitalGlo	2016	Accuracy_	1	Bosque								9	-69.4724	-12.7819	2		
10	1.35E+08	4.8E+08	-69.4724	-12.781	FALSE	1	an0052@u	49:22.1	104.8	DigitalGlo	2016	Accuracy_	1	Bosque								10	-69.4724	-12.781	2		
11	1.35E+08	4.8E+08	-69.5411	-12.6881	FALSE	1	an0052@u	50:15.4	135.6	DigitalGlobeRecentImagery			2	Tala								11	-69.5411	-12.6881	3		
12	1.35E+08	4.8E+08	-69.5411	-12.6872	FALSE	1	an0052@u	50:15.4	135.6	DigitalGlobeRecentImagery			2	Tala								12	-69.5411	-12.6872	3		
13	1.35E+08	4.8E+08	-69.5411	-12.6863	FALSE	1	an0052@u	50:15.4	135.6	DigitalGlobeRecentImagery			2	Bosque								13	-69.5411	-12.6863	2		
14	1.35E+08	4.8E+08	-69.5402	-12.6881	FALSE	1	an0052@u	50:15.4	135.6	DigitalGlobeRecentImagery			2	Bosque								14	-69.5402	-12.6881	2		
15	1.35E+08	4.8E+08	-69.5402	-12.6872	FALSE	1	an0052@u	50:15.4	135.6	DigitalGlobeRecentImagery			2	Agricultura								15	-69.5402	-12.6872	4		
16	1.35E+08	4.8E+08	-69.5402	-12.6863	FALSE	1	an0052@u	50:15.4	135.6	DigitalGlobeRecentImagery			2	Agricultura								16	-69.5402	-12.6863	4		
17	1.35E+08	4.8E+08	-69.5393	-12.6881	FALSE	1	an0052@u	50:15.4	135.6	DigitalGlobeRecentImagery			2	Bosque								17	-69.5393	-12.6881	2		
18	1.35E+08	4.8E+08	-69.5393	-12.6872	FALSE	1	an0052@u	50:15.4	135.6	DigitalGlo	2016	Accuracy_	2	Otro								18	-69.5393	-12.6872	8		
19	1.35E+08	4.8E+08	-69.5393	-12.6863	FALSE	1	an0052@u	50:15.4	135.6	DigitalGlobeRecentImagery			2	Bosque								19	-69.5393	-12.6863	2		
20	1.35E+08	4.8E+08	-69.3519	-12.7205	FALSE	1	an0052@u	51:43.3	170.2	DigitalGlobeRecentImagery			3	Bosque								20	-69.3519	-12.7205	2		
21	1.35E+08	4.8E+08	-69.3519	-12.7196	FALSE	1	an0052@u	51:43.3	170.2	DigitalGlo	2016	Accuracy_	3	Pastizal								21	-69.3519	-12.7196	5		
22	1.35E+08	4.8E+08	-69.3519	-12.7187	FALSE	1	an0052@u	51:43.3	170.2	DigitalGlo	2016	Accuracy_	3	Pastizal								22	-69.3519	-12.7187	5		
23	1.35E+08	4.8E+08	-69.351	-12.7205	FALSE	1	an0052@u	51:43.3	170.2	DigitalGlo	2016	Accuracy_	3	Otro								23	-69.351	-12.7205	8		
24	1.35E+08	4.8E+08	-69.351	-12.7196	FALSE	1	an0052@u	51:43.3	170.2	DigitalGlo	2016	Accuracy_	3	Pastizal								24	-69.351	-12.7196	5		
25	1.35E+08	4.8E+08	-69.351	-12.7187	FALSE	1	an0052@u	51:43.3	170.2	DigitalGlo	2016	Accuracy_	3	Pastizal								25	-69.351	-12.7187	5		
26	1.35E+08	4.8E+08	-69.3501	-12.7205	FALSE	1	an0052@u	51:43.3	170.2	DigitalGlobeRecentImagery			3	Bosque								26	-69.3501	-12.7205	2		
27	1.35E+08	4.8E+08	-69.3501	-12.7196	FALSE	1	an0052@u	51:43.3	170.2	DigitalGlo	2016	Accuracy_	3	Otro								27	-69.3501	-12.7196	8		
28	1.35E+08	4.8E+08	-69.3501	-12.7187	FALSE	1	an0052@u	51:43.3	170.2	DigitalGlo	2016	Accuracy_	3	Pastizal								28	-69.3501	-12.7187	5		
29	1.35E+08	4.8E+08	-69.4187	-12.6172	FALSE	1	an0052@u	52:06.0	105	DigitalGlo	2016	Accuracy_	4	Miner?a								29	-69.4187	-12.6172	6		
30	1.35E+08	4.8E+08	-69.4187	-12.6163	FALSE	1	an0052@u	52:06.0	105	DigitalGlo	2016	Accuracy_	4	Miner?a								30	-69.4187	-12.6163	6		

- 1 – Water
 2 – Forest
 3 – Logging
 4 – Agriculture
 5 – Pasture
 6 – Mining
 7 – Urban

Delete unnecessary columns and add unique numbers for each class

In ArcGIS (o QGIS), open the csv table, right click on the table and select "Display XY Data":
X Field is the longitude, Y Field is the latitude (check your table), and the Coordinate System is "GCS_WGS_1984"

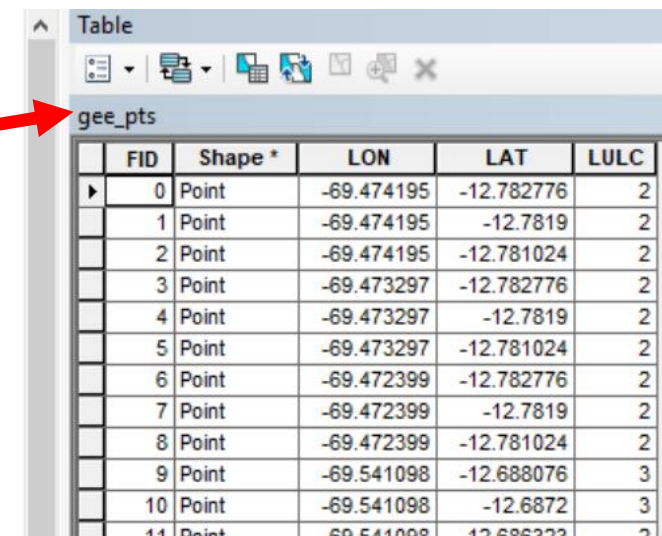
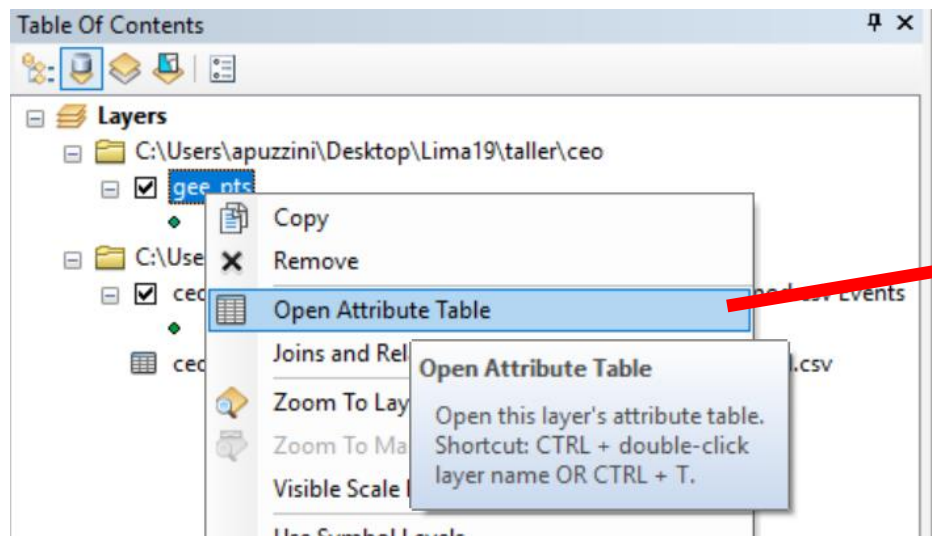




The screenshot shows the Google Earth Engine interface. In the 'Table Of Contents' panel, a layer named 'ceo-madre-de-dios-ejemplo-sample-data-2019-07-10_mod.csv Events' is selected. A right-click context menu is open over this layer, with the 'Data' option highlighted. The 'Export Data...' option is also highlighted, and a tooltip explains: 'Export Data: Save this layer's data as a shapefile or geodatabase feature class'. A red arrow points from this menu to the 'Export Data' dialog box. The dialog box has 'Export: All features' selected. Under 'Use the same coordinate system as:', the radio button for 'this layer's source data' is selected. The 'Output feature class' field contains the path 'C:\Users\apuzzini\Desktop\Lima19\taller\ceo\nombrelshp'. The 'OK' button is highlighted.

Right click on "...csv Events" and select "Data > Export Data", choose a name for the shapefile, "OK"

Right click on the shapefile and select "Open Attribute Table":



FID	Shape *	LON	LAT	LULC
0	Point	-69.474195	-12.782776	2
1	Point	-69.474195	-12.7819	2
2	Point	-69.474195	-12.781024	2
3	Point	-69.473297	-12.782776	2
4	Point	-69.473297	-12.7819	2
5	Point	-69.473297	-12.781024	2
6	Point	-69.472399	-12.782776	2
7	Point	-69.472399	-12.7819	2
8	Point	-69.472399	-12.781024	2
9	Point	-69.541098	-12.688076	3
10	Point	-69.541098	-12.6872	3
11	Point	-69.541098	-12.686333	2



Google Earth Engine



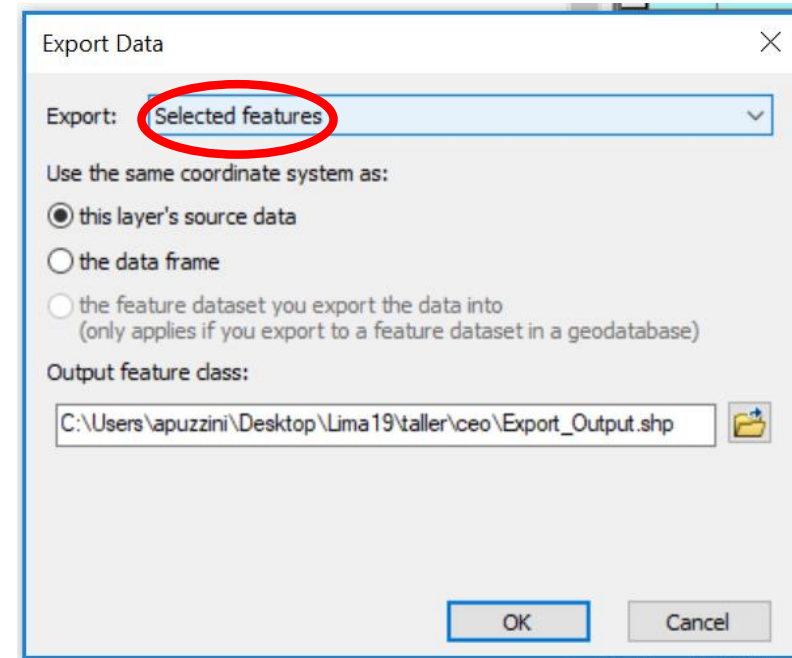
Google Earth Engine

Double click on "LULC" column to organize it in numerical order:

FID	Shape *	LON	LAT	LULC
45	Point	-69.346495	-12.577277	1
46	Point	-69.346495	-12.5764	1
47	Point	-69.346495	-12.575523	1
48	Point	-69.345596	-12.577277	1
49	Point	-69.345596	-12.5764	1
50	Point	-69.345596	-12.575523	1
51	Point	-69.344698	-12.577277	1
52	Point	-69.344698	-12.5764	1
53	Point	-69.344698	-12.575523	1
0	Point	-69.474195	-12.782776	2
1	Point	-69.474195	-12.7819	2
2	Point	-69.474195	-12.781024	2
3	Point	-69.473297	-12.782776	2
4	Point	-69.473297	-12.7819	2
5	Point	-69.473297	-12.781024	2
6	Point	-69.472399	-12.782776	2
7	Point	-69.472399	-12.7819	2
8	Point	-69.472399	-12.781024	2
11	Point	-69.541098	-12.686323	2
12	Point	-69.540199	-12.688076	2
15	Point	-69.539301	-12.688076	2
17	Point	-69.539301	-12.686323	2
18	Point	-69.351896	-12.720476	2
24	Point	-69.3501	-12.720476	2
9	Point	-69.541098	-12.688076	3
10	Point	-69.541098	-12.6872	3
13	Point	-69.540199	-12.6872	4
14	Point	-69.540199	-12.686323	4
19	Point	-69.351896	-12.7196	5
20	Point	-69.351896	-12.718723	5
22	Point	-69.350998	-12.7196	5
23	Point	-69.350998	-12.718723	5
26	Point	-69.3501	-12.718723	5
27	Point	-69.418699	-12.617176	6
28	Point	-69.418699	-12.6163	6
29	Point	-69.418699	-12.615423	6
30	Point	-69.417801	-12.617176	6
31	Point	-69.417801	-12.6163	6
32	Point	-69.417801	-12.615423	6

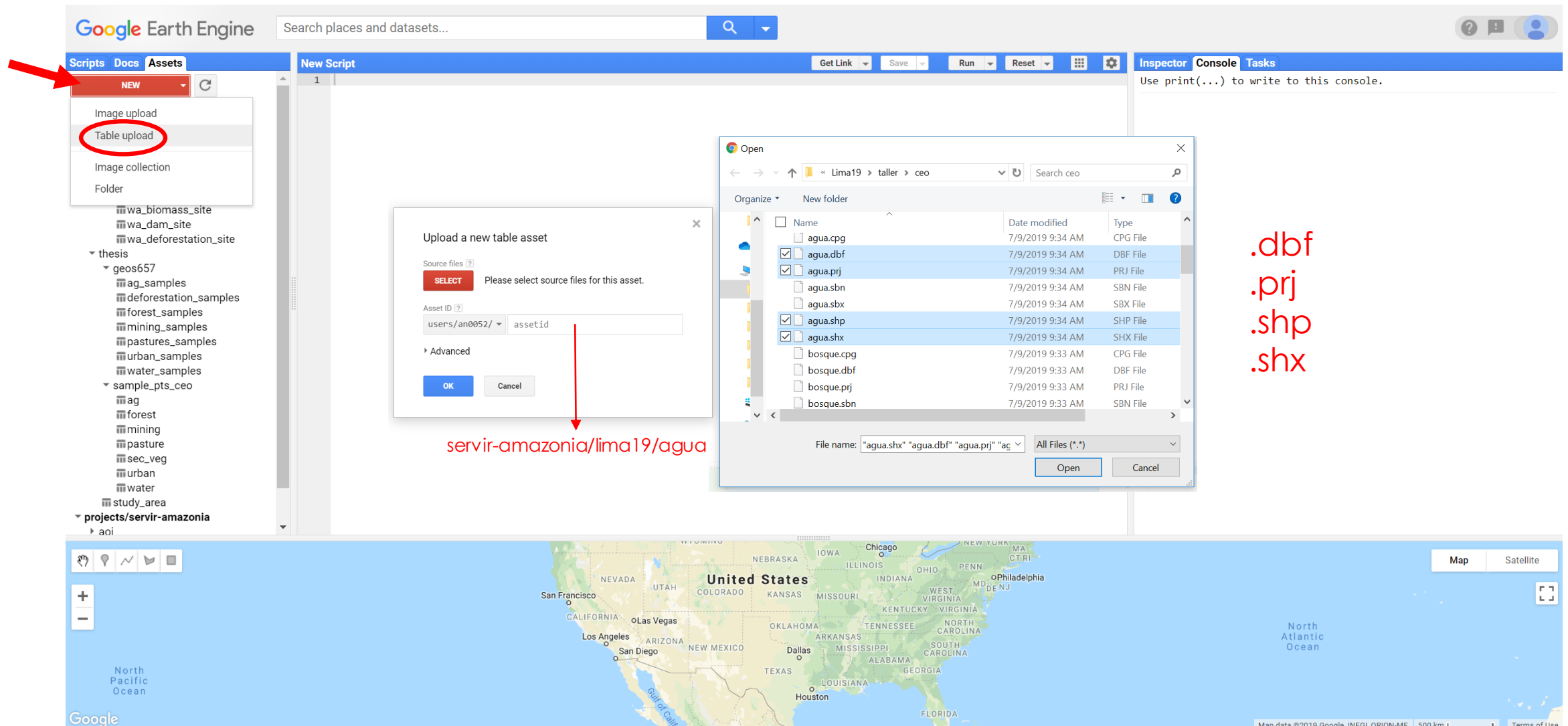
Select each class rows and export them as unique shapefile (Data>Export Data):

FID	Shape *	LON	LAT	LULC
45	Point	-69.346495	-12.577277	1
46	Point	-69.346495	-12.5764	1
47	Point	-69.346495	-12.575523	1
48	Point	-69.345596	-12.577277	1
49	Point	-69.345596	-12.5764	1
50	Point	-69.345596	-12.575523	1
51	Point	-69.344698	-12.577277	1
52	Point	-69.344698	-12.5764	1
53	Point	-69.344698	-12.575523	1
0	Point	-69.474195	-12.782776	2
1	Point	-69.474195	-12.7819	2
2	Point	-69.474195	-12.781024	2
3	Point	-69.473297	-12.782776	2
4	Point	-69.473297	-12.7819	2
5	Point	-69.473297	-12.781024	2
6	Point	-69.472399	-12.782776	2
7	Point	-69.472399	-12.7819	2
8	Point	-69.472399	-12.781024	2
11	Point	-69.541098	-12.686323	2
12	Point	-69.540199	-12.688076	2
15	Point	-69.539301	-12.688076	2
17	Point	-69.539301	-12.686323	2



The same for each class(1 to 7)

► CEO reference data as an Asset in GEE



The screenshot displays the Google Earth Engine web interface. The 'Assets' tab is active, and the 'NEW' dropdown menu is open, with 'Table upload' circled in red. An 'Upload a new table asset' dialog box is shown, with a red arrow pointing to the 'Asset ID' field containing the text 'servir-amazonia/lima19/agua'. An 'Open' file dialog is also visible, showing a directory structure with files like 'agua.dbf', 'agua.prj', 'agua.shp', and 'agua.shx' selected. To the right of the file dialog, the file extensions '.dbf', '.prj', '.shp', and '.shx' are listed in red text. The bottom of the interface shows a map of the United States.

Google Earth Engine

Search places and datasets...

Scripts Docs **Assets** New Script

NEW

- Image upload
- Table upload**
- Image collection
- Folder

- wa_biomass_site
- wa_dam_site
- wa_deforestation_site
- thesis
 - geos657
 - ag_samples
 - deforestation_samples
 - forest_samples
 - mining_samples
 - pastures_samples
 - urban_samples
 - water_samples
 - sample_pts_ceo
 - ag
 - forest
 - mining
 - pasture
 - sec_veg
 - urban
 - water
- projects/servir-amazonia
 - aoi

Upload a new table asset

Source files ?

SELECT Please select source files for this asset.

Asset ID ?

users/an0052/ assetid

Advanced

OK Cancel

servir-amazonia/lima19/agua

Open

Name	Date modified	Type
<input type="checkbox"/> agua.cpg	7/9/2019 9:34 AM	CPG File
<input checked="" type="checkbox"/> agua.dbf	7/9/2019 9:34 AM	DBF File
<input checked="" type="checkbox"/> agua.prj	7/9/2019 9:34 AM	PRJ File
<input type="checkbox"/> agua.sbn	7/9/2019 9:34 AM	SBN File
<input type="checkbox"/> agua.sbx	7/9/2019 9:34 AM	SBX File
<input checked="" type="checkbox"/> agua.shp	7/9/2019 9:34 AM	SHP File
<input checked="" type="checkbox"/> agua.shx	7/9/2019 9:34 AM	SHX File
<input type="checkbox"/> bosque.cpg	7/9/2019 9:33 AM	CPG File
<input type="checkbox"/> bosque.dbf	7/9/2019 9:33 AM	DBF File
<input type="checkbox"/> bosque.prj	7/9/2019 9:33 AM	PRJ File
<input type="checkbox"/> bosque.sbn	7/9/2019 9:33 AM	SBN File

.dbf
.prj
.shp
.shx

Map Satellite

Google

Man data ©2019 Google, INEGI, ORION-MF 500 km L Terms of Use



Google Earth Engine



Google Earth Engine

► CEO reference data as an Asset in GEE

The screenshot displays the Google Earth Engine web interface. On the left, the 'Assets' panel shows a tree structure under 'users/an0052' with a sub-folder 'servir-amazonia' containing a sub-folder 'lima19' and several asset folders: 'agricultura', 'agua', 'bosque', 'mineria', 'pastizal', 'tala', and 'urbano'. A red box highlights the 'lima19' folder, and a red arrow points from it to the script editor.

The main editor shows a script named 'lima19/script2' with the following code:

```
Imports (9 entries)
var sentinel1: ImageCollection "Sentinel-1 SAR GRD: C-band Synthetic Aperture Radar Ground Range Detected, log scaling"
var aoi: Polygon, 4 vertices
var agricultura: Table users/an0052/servir-amazonia/lima19/agricultura
var agua: Table users/an0052/servir-amazonia/lima19/agua
var bosque: Table users/an0052/servir-amazonia/lima19/bosque
var mineria: Table users/an0052/servir-amazonia/lima19/mineria
var pastizal: Table users/an0052/servir-amazonia/lima19/pastizal
var tala: Table users/an0052/servir-amazonia/lima19/tala
var urbano: Table users/an0052/servir-amazonia/lima19/urbano

1 // ----- Colección Sentinel-1 -----
2
3 // Filtrar colección Sentinel-1 de acuerdo con la área de interés y otras propiedades
4 var s1Col = ee.ImageCollection(sentinel1
5   .filterBounds(aoi)
6   .filterDate('2016-01-01', Date.now())
7   .filterMetadata('orbitProperties_pass', 'equals', 'DESCENDING')
8   .filter(ee.Filter.listContains('transmitterReceiverPolarisation', 'VH'))
9   .filterMetadata('relativeOrbitNumber_start', 'equals', 127));
10 // .filterMetadata('instrumentMode', 'equals', 'IW')
11 // .filterMetadata('resolution_meters', 'equals', 10)
12
13 // Imprimir la colección filtrada
14 print('Colección Sentinel-1', s1Col);
15
16 // Adicionar colección al mapa
17 // Map.addLayer(s1Col, {bands: 'VV', min: -15, max: -5}, 'Colección Sentinel-1')
18
19 // Centrar el map en el punto de interés
20 Map.centerObject(aoi, 10);
21
22 // Como algunas imágenes son de la misma fecha (ejemplo 02/01/2016):
23 Map.addLayer(ee.Image('COPERNICUS/S1_GRD/S1A_IW_GRDH_1SDV_20160206T101415_20160206T101440_009824_00E617_D79A'), {bands: 'VV', min: -15, max: -5}
24 Map.addLayer(ee.Image('COPERNICUS/S1_GRD/S1A_IW_GRDH_1SDV_20160206T101440_20160206T101505_009824_00E617_C31E'), {bands: 'VV', min: -15, max: -5}
25
26 // Tenemos que crear mosaicos con el código abajo:
27 var comienzo = ee.Date('2016-01-01');
28 var termino = ee.Date(Date.now());
29 var fechas = ee.ImageCollection(ee.Array(s1Col.filterDate(comienzo, termino).aggregate_array('system:time_start')).toList().map(function(t)
30   var fechaCompleta = ee.Date(t);
31   var fecha = ee.Date.fromYMD(fechaCompleta.get('year'), fechaCompleta.get('month'), fechaCompleta.get('day')).millis();
32   return ee.Image().set('system:time_start', fecha);
33
```

The bottom of the interface shows a map of the region, with labels for 'Boca Colorado', 'Las Pircas', 'Puerto Maldonado', and 'Puerto Heath'. The map is currently in 'Map' mode, with 'Satellite' mode also available.

Synthetic Aperture Radar (SAR)

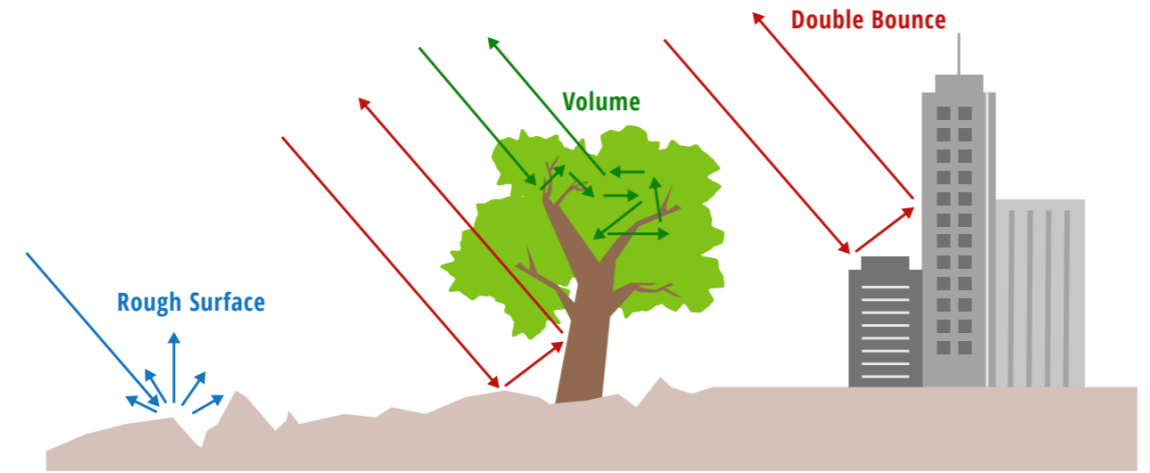
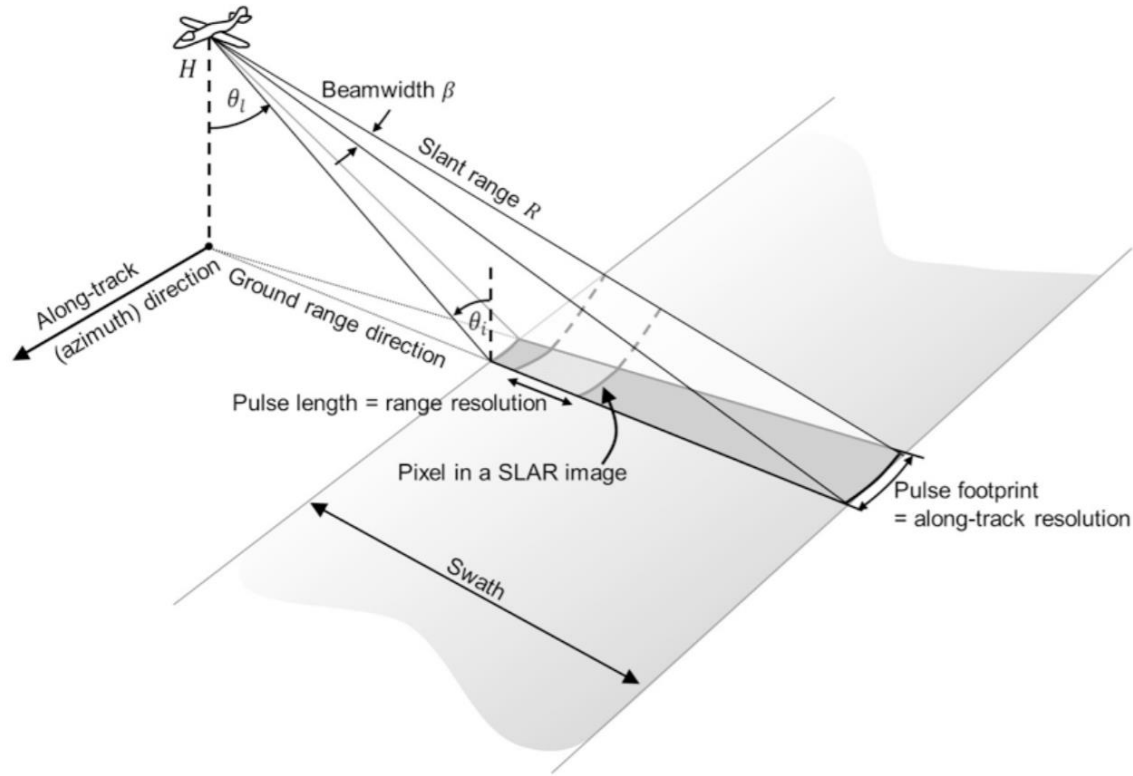
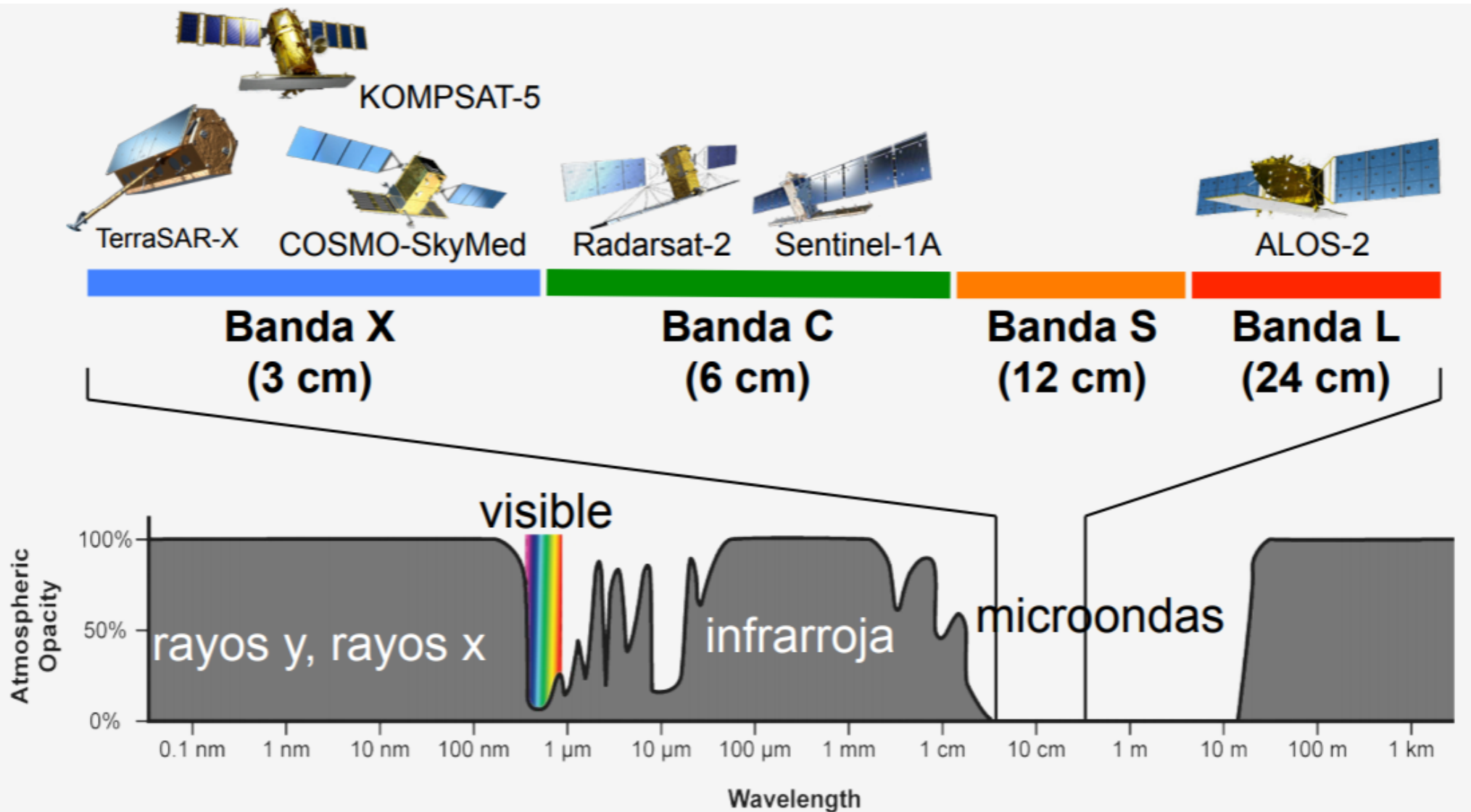


Figure 2.9 Schematic sketch of the three main scattering types considered for SAR data.

Figure 2.1 Observation geometry of a SLAR imager. The radar flies along a straight line at altitude H and observes Earth at an oblique look angle θ_l . Instead of the look angle, sometimes the incidence angle $\theta_i = (90^\circ - \theta_l)$ is annotated. The size of the illuminated footprint is defined by the antenna beamwidth β and the distance between satellite and ground R . Note that the radar beam is wide in range direction but narrow in azimuth. The generation of an image is facilitated by the forward motion of the airborne platform.

Synthetic Aperture Radar (SAR)



Synthetic Aperture Radar (SAR)

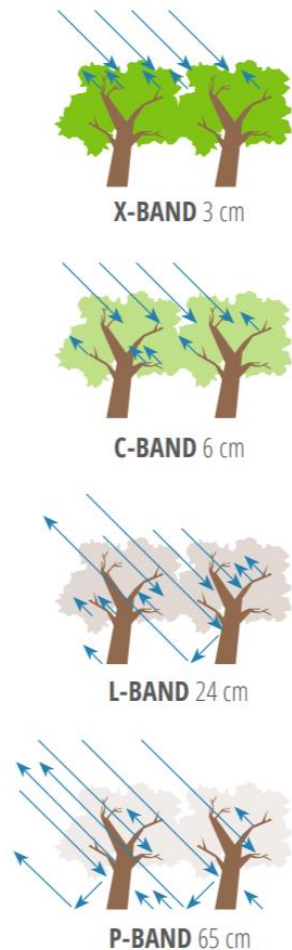


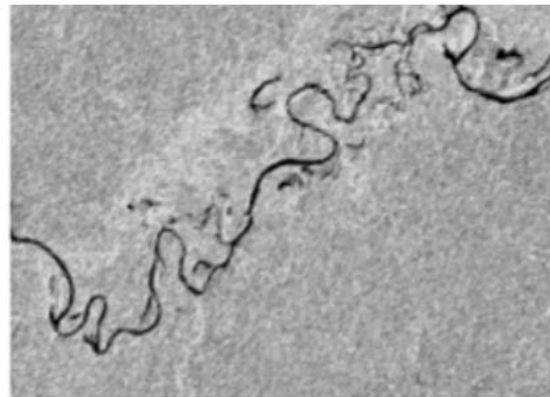
Figure 5.10 Sensitivity of SAR measurements to forest structure and penetration into the canopy at different wavelengths used for airborne or spaceborne remote sensing observations of the land surface.



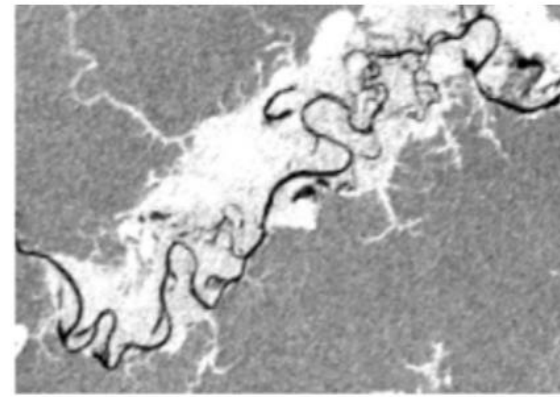
Dry Season



Wet Season



JERS-1 HH (Dry Season)

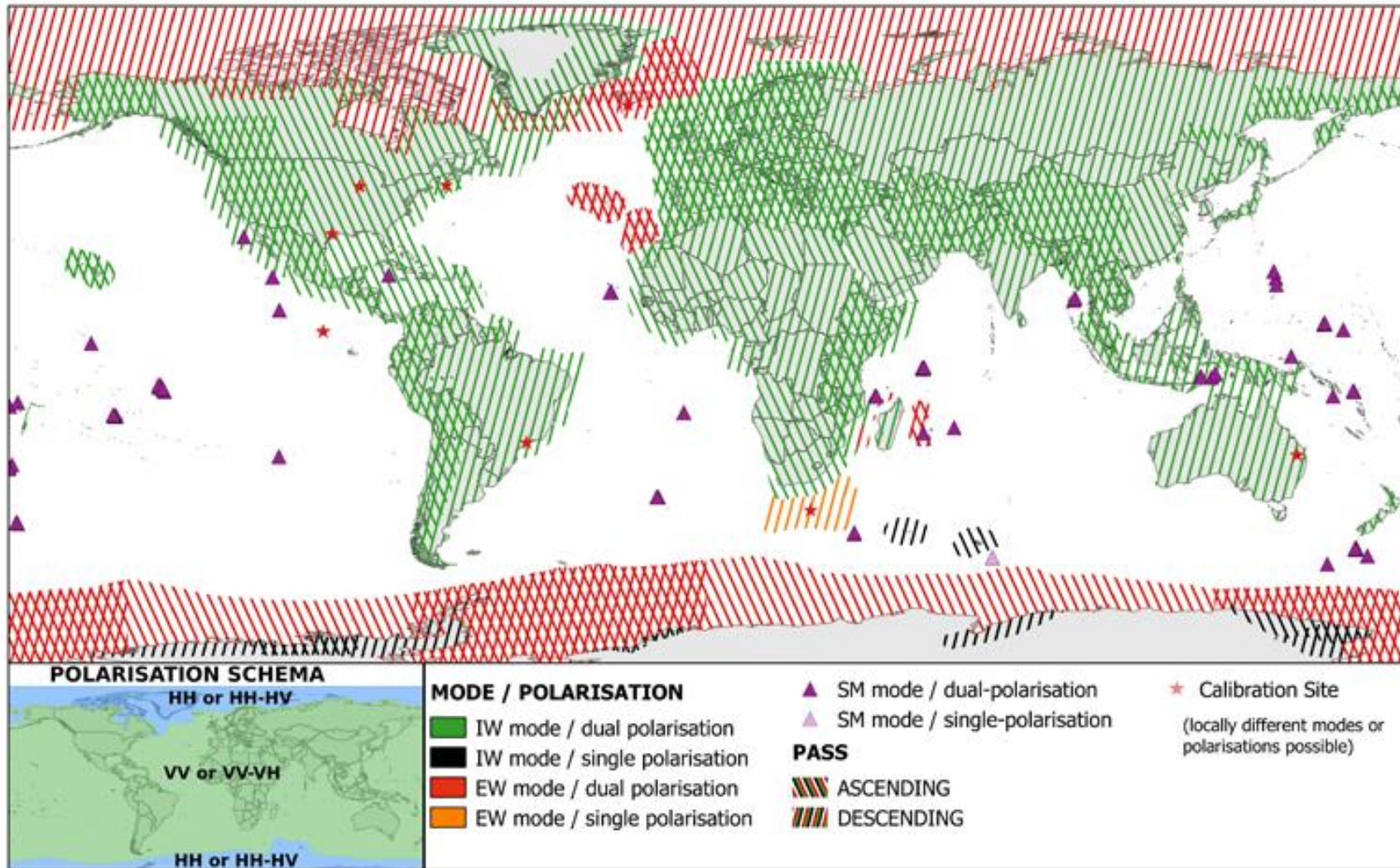


JERS-1 HH (Wet Season)

Figure 5.15 Changes of SAR backscatter in wetland forests acquired during the dry and wet seasons showing large backscatter difference due to inundation and an increase in the surface-volume scattering interaction in HH polarization.

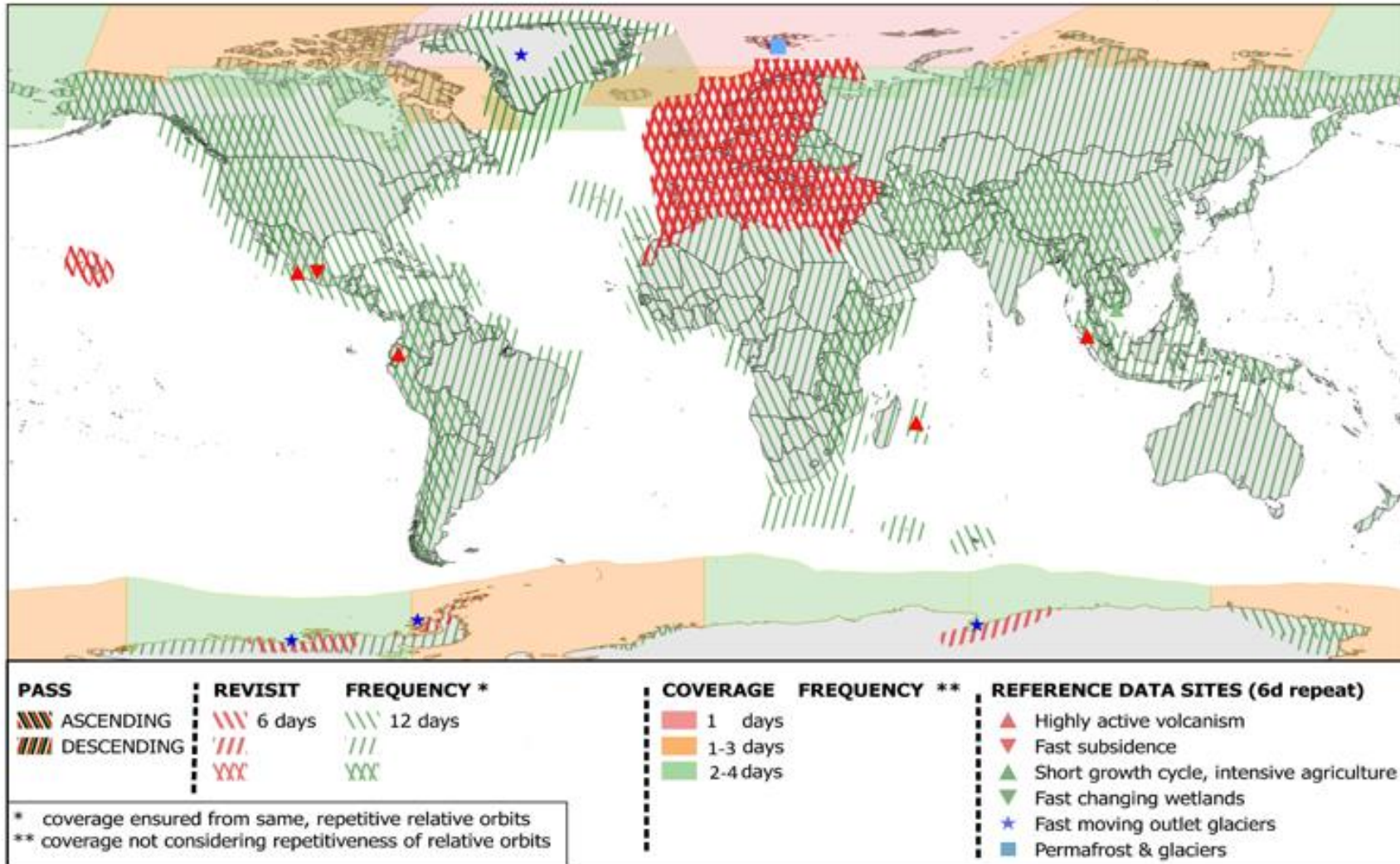
Synthetic Aperture Radar (SAR)

Sentinel-1 Constellation Observation Scenario: Mode - Polarisation - Observation Geometry

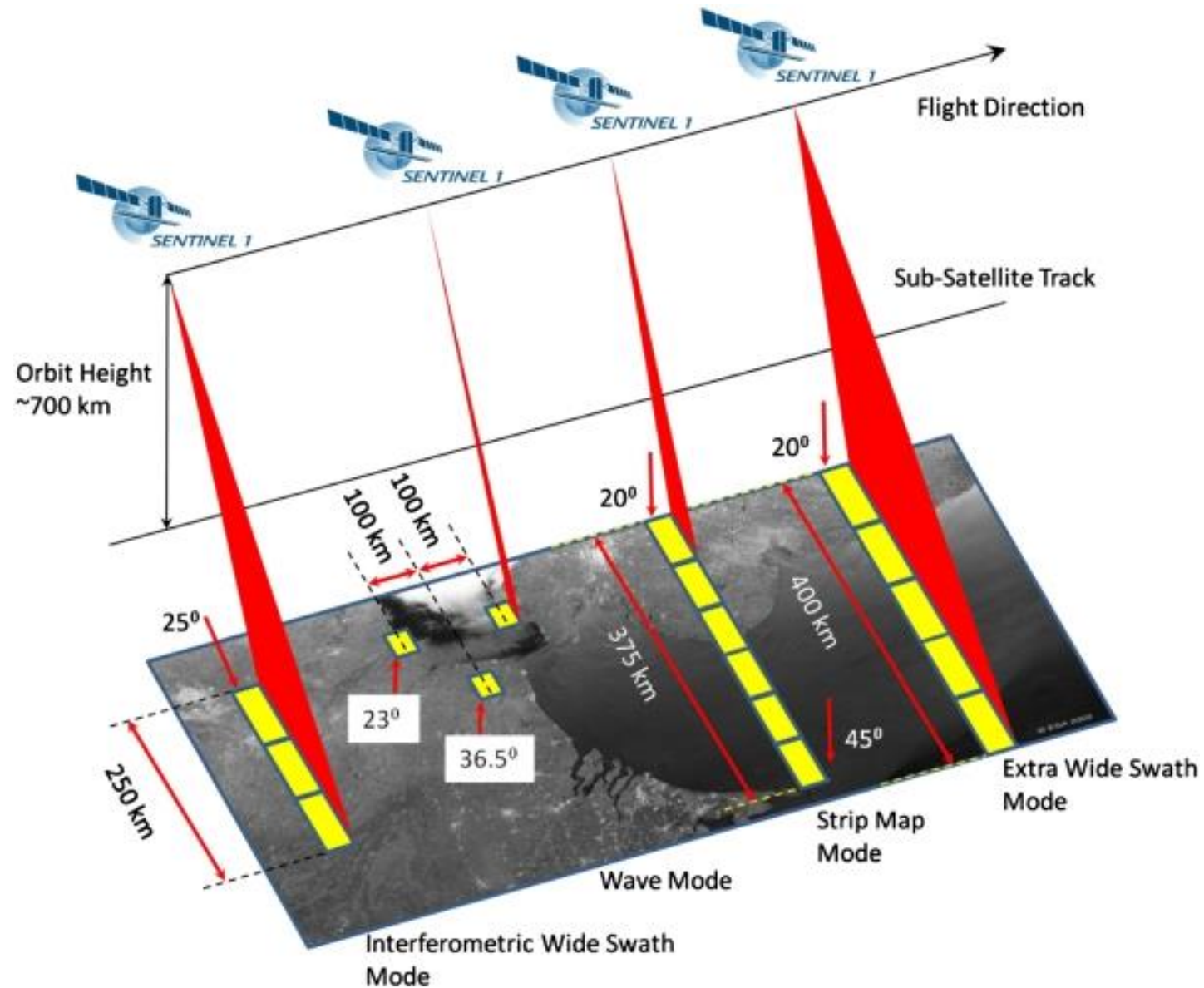


Synthetic Aperture Radar (SAR)

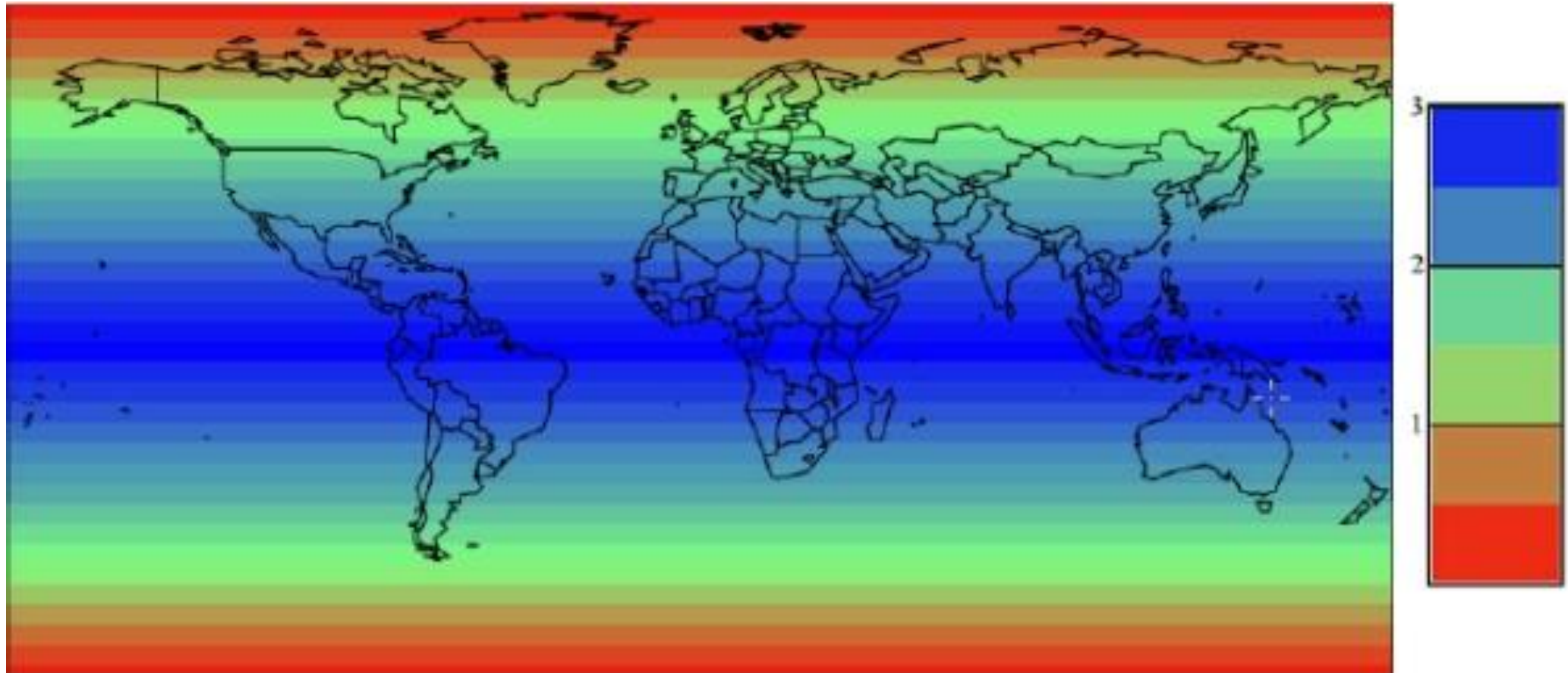
Sentinel-1 Constellation Observation Scenario: Revisit & Coverage Frequency



Synthetic Aperture Radar (SAR)



Synthetic Aperture Radar (SAR)



- ✓ Two satellites in a 12 day orbit
- ✓ Repeat frequency: 6 days (important for coherence)
- ✓ Revisit frequency: (asc/desc & overlap): 3 days at the equator, <1 day at high latitudes (Europe ~ 2 days)

Thank you!



Questions?

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