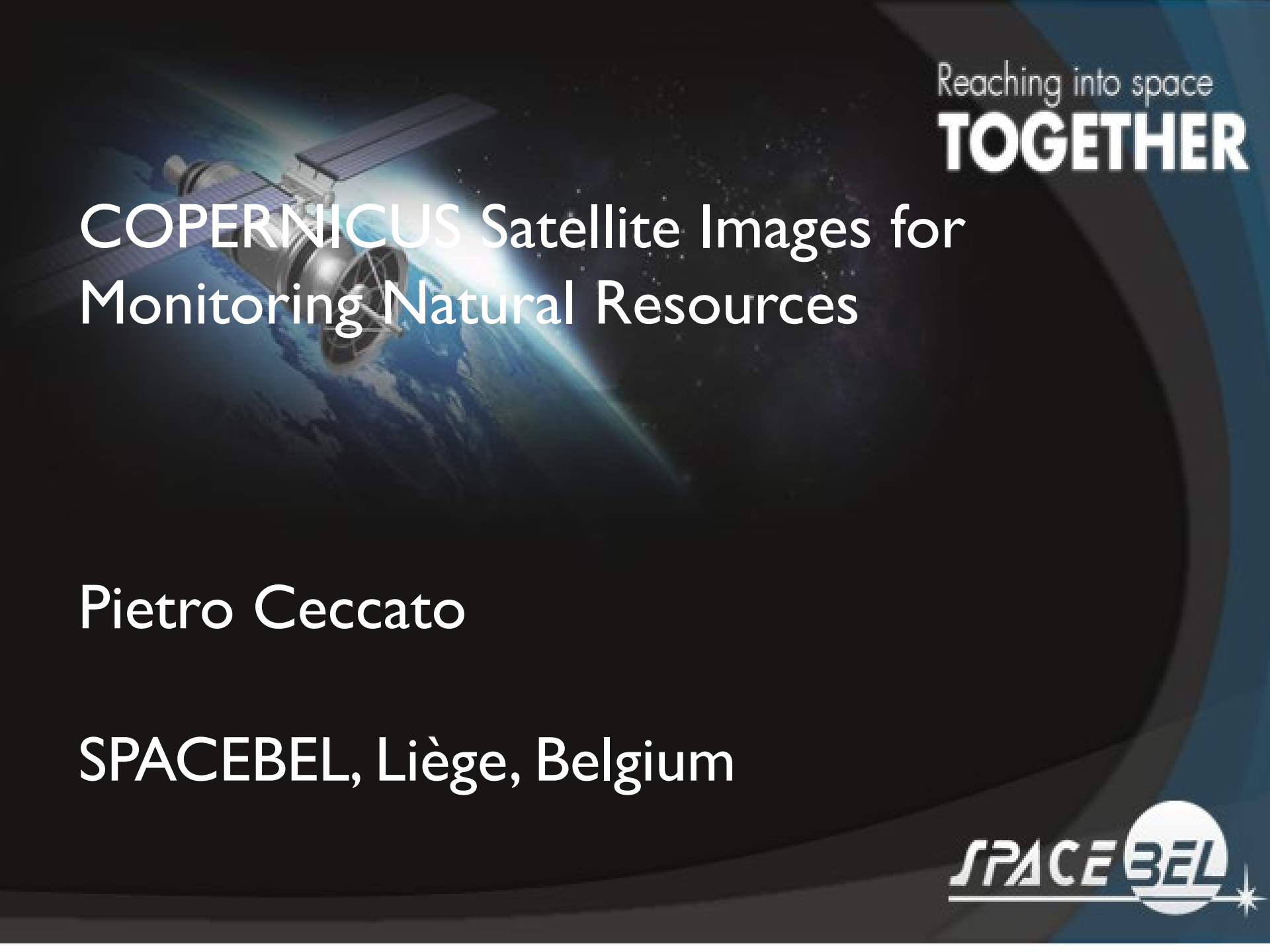




Reaching into space
TOGETHER

COPERNICUS Satellite Images for Monitoring Natural Resources

Pietro Ceccato

SPACEBEL, Liège, Belgium

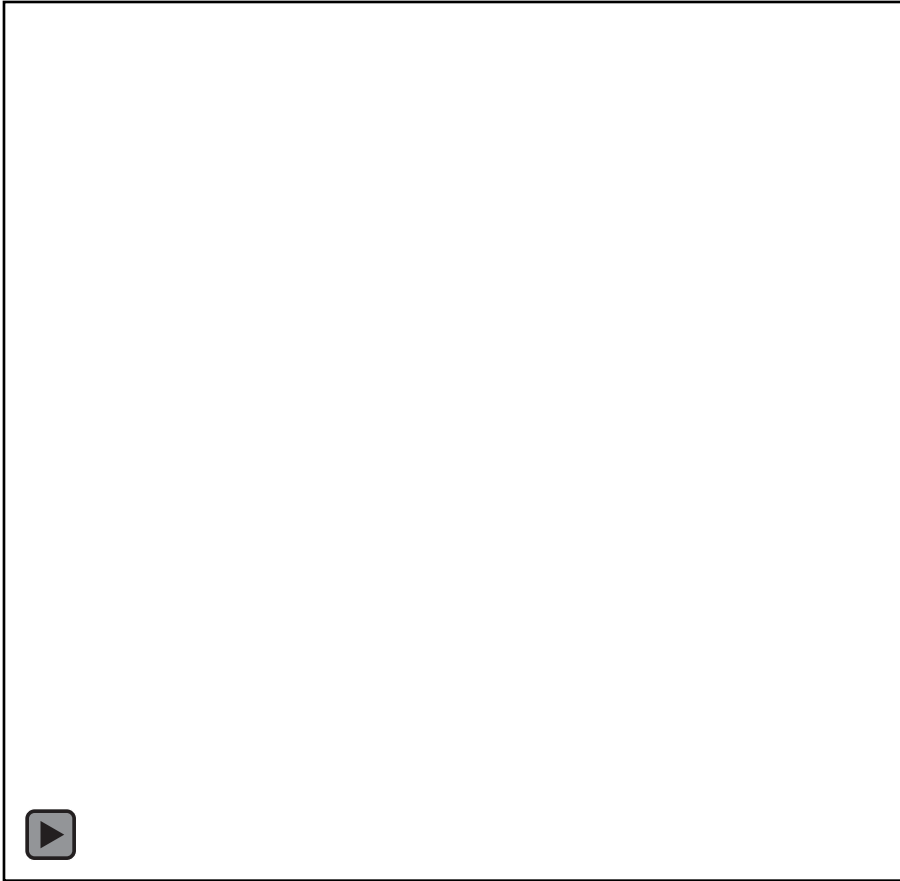


To Obtain Images....

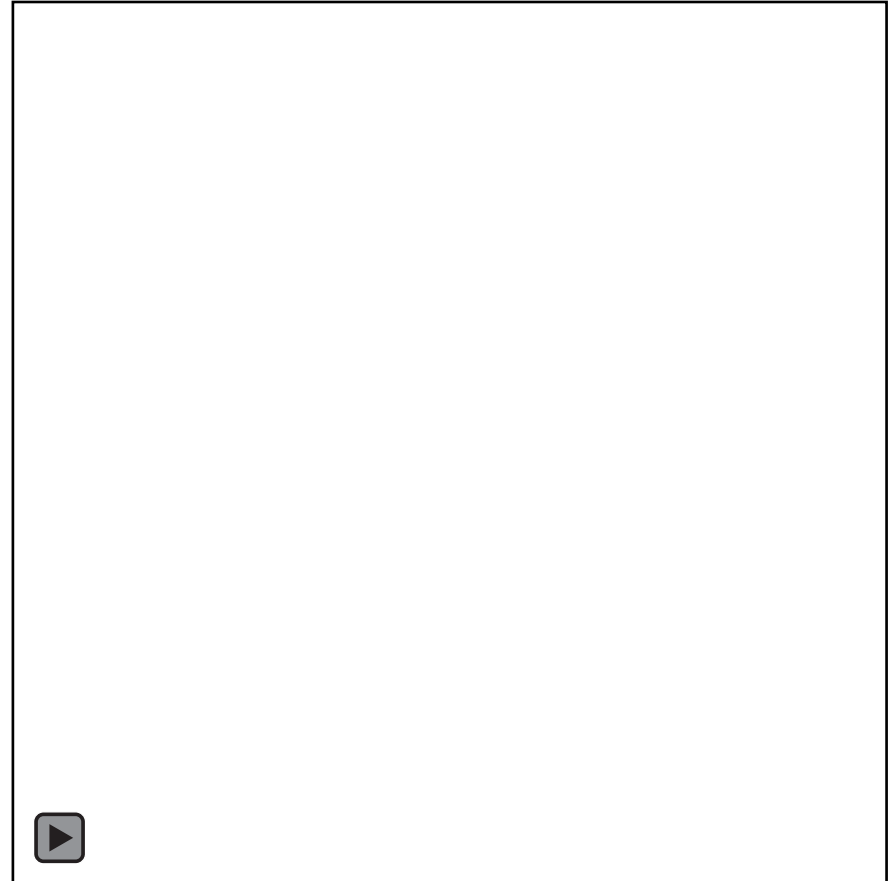
20 Years Ago...



Big Earth Observation Data



Sentinel - 1



Sentinel - 2

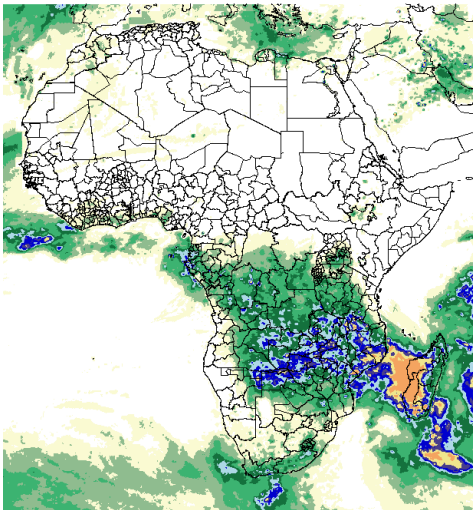
Connecting Space



To Village



Dissemination of Information to Local Communities

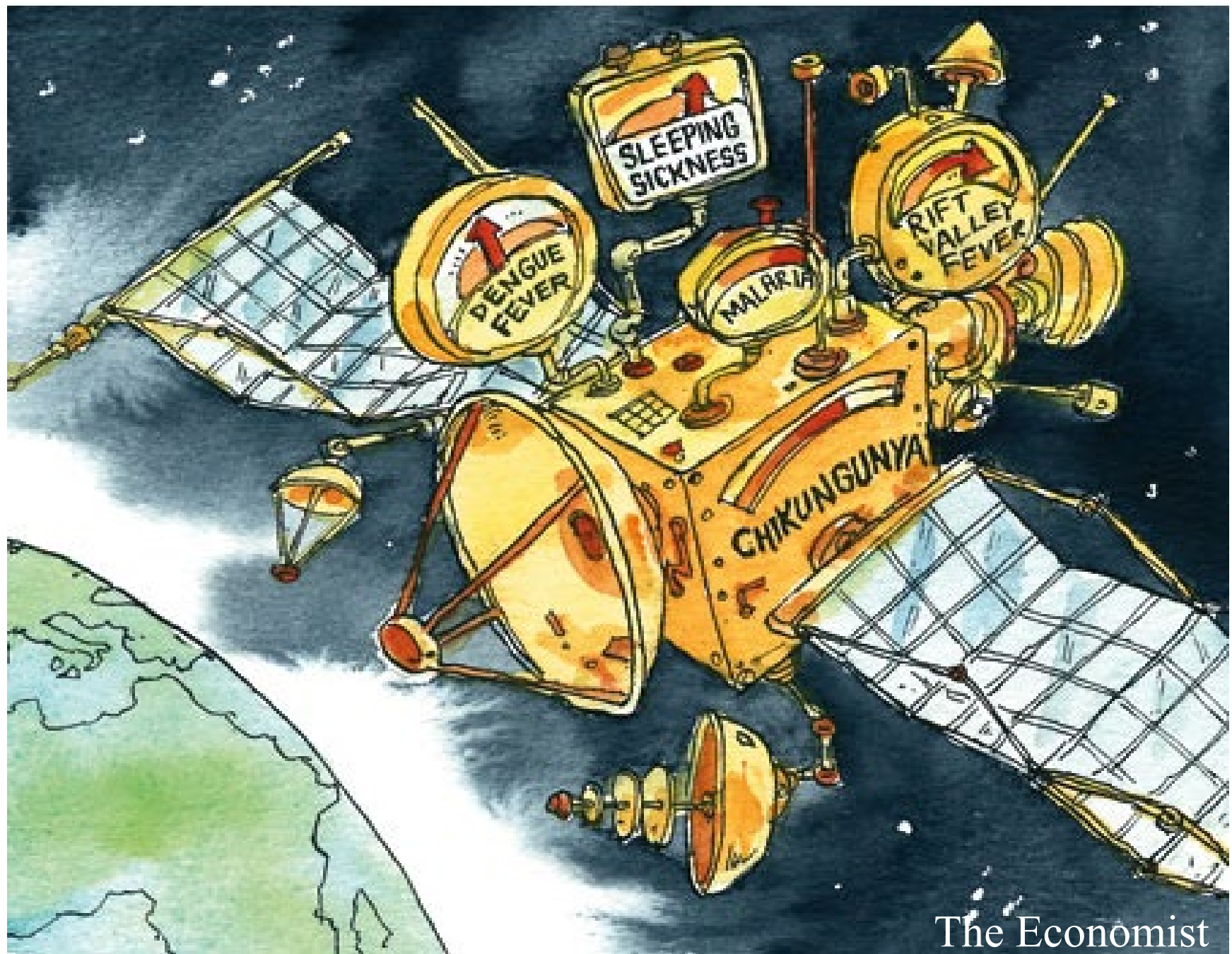


1-10 Jan 2014



IRI Data Library:

<http://iridl.ideo.columbia.edu/maproom/>



The Economist

Natural Resources from Satellites

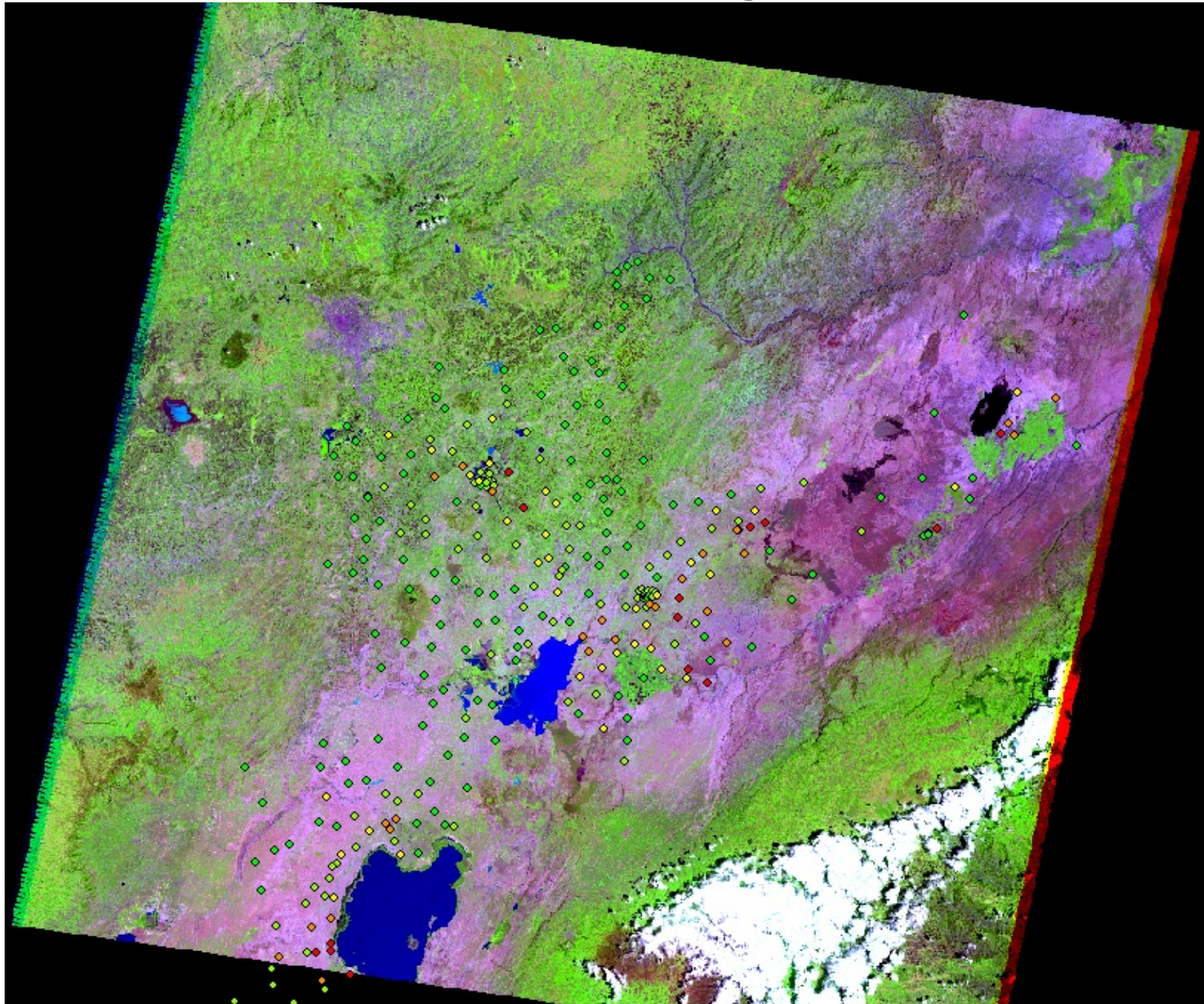
Vegetation



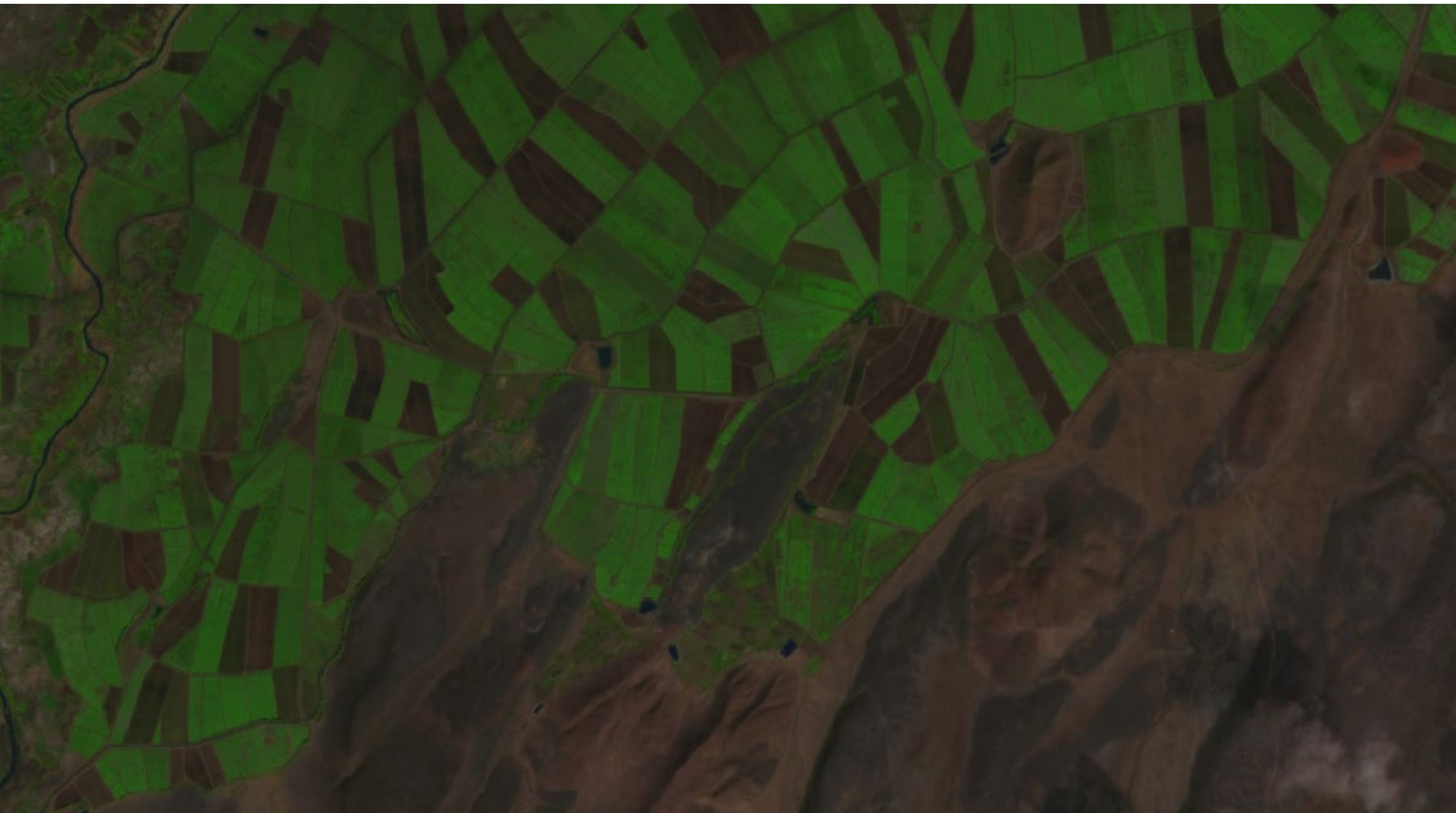
Water Bodies/Floods



Water Bodies from Sentinel 2 images and Malaria

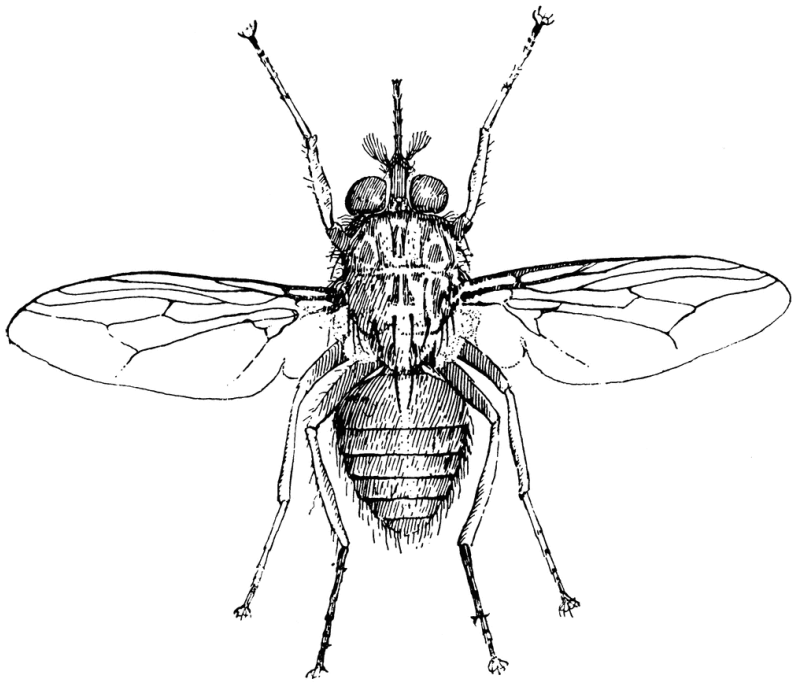






Trypanosomiasis

Collaborations with:
Nelson Mandela University

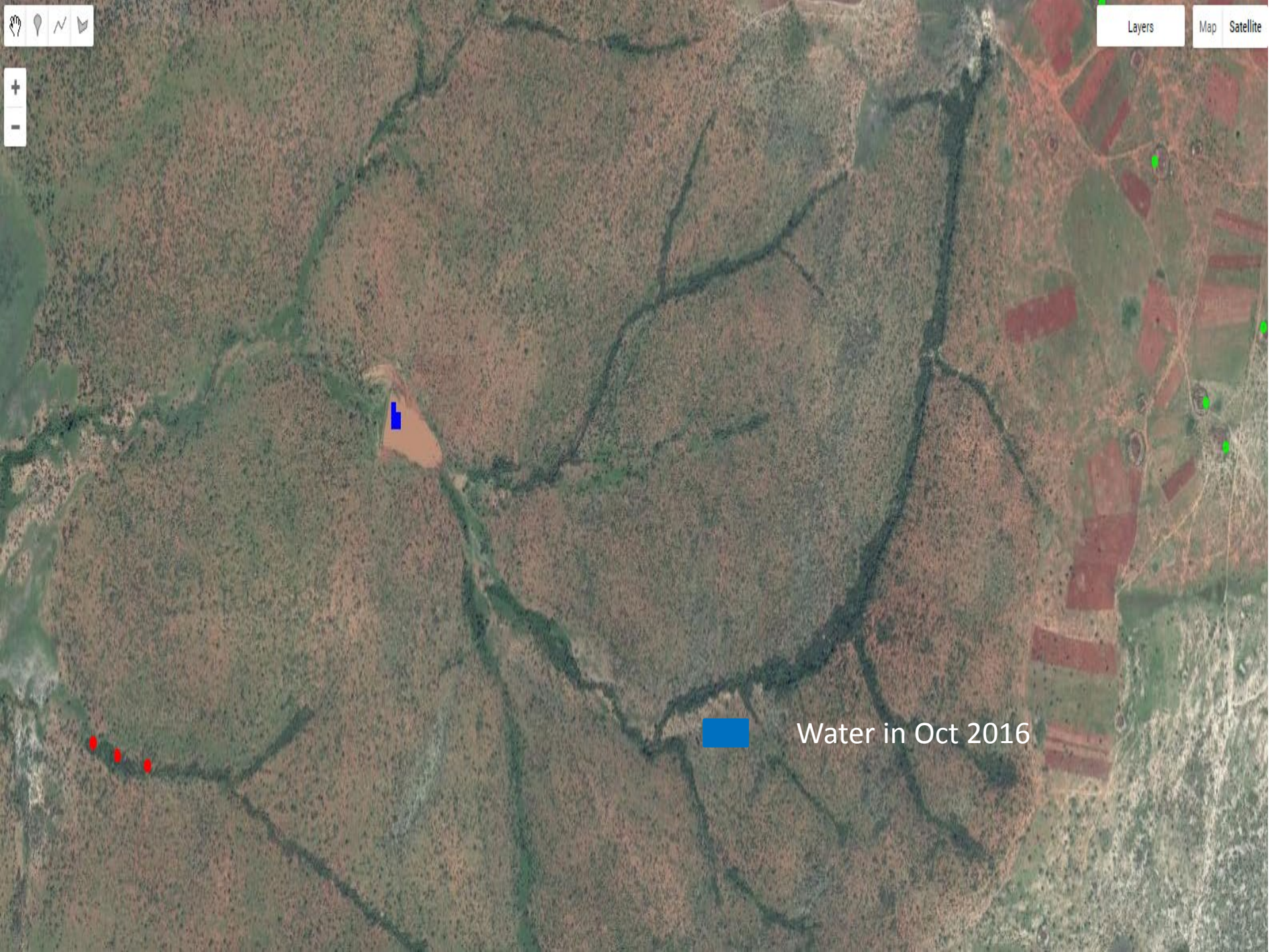


Masai village in Tanzania affected by trypanosomiasis

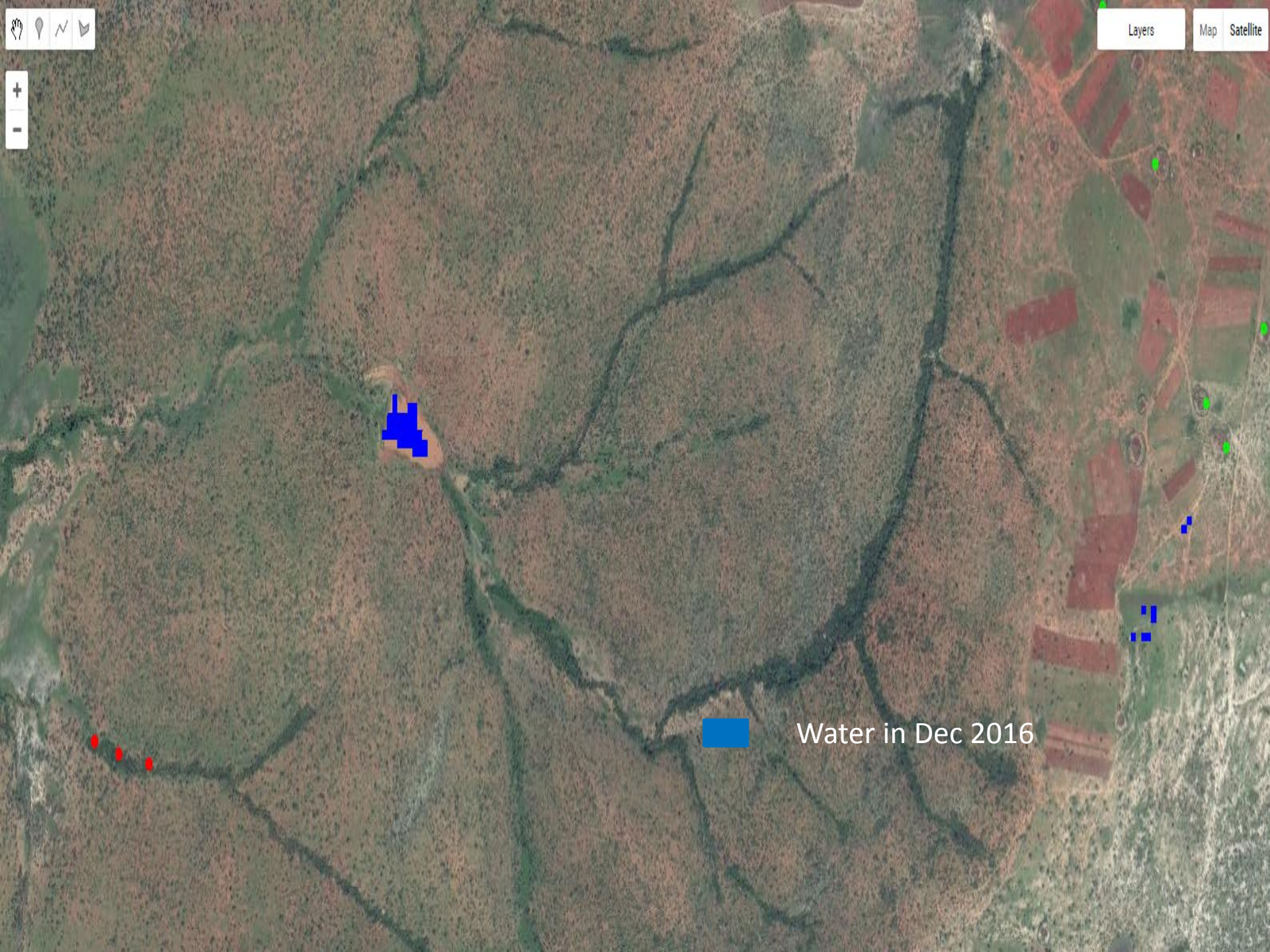


John Hargrove providing expertise on tsetse fly

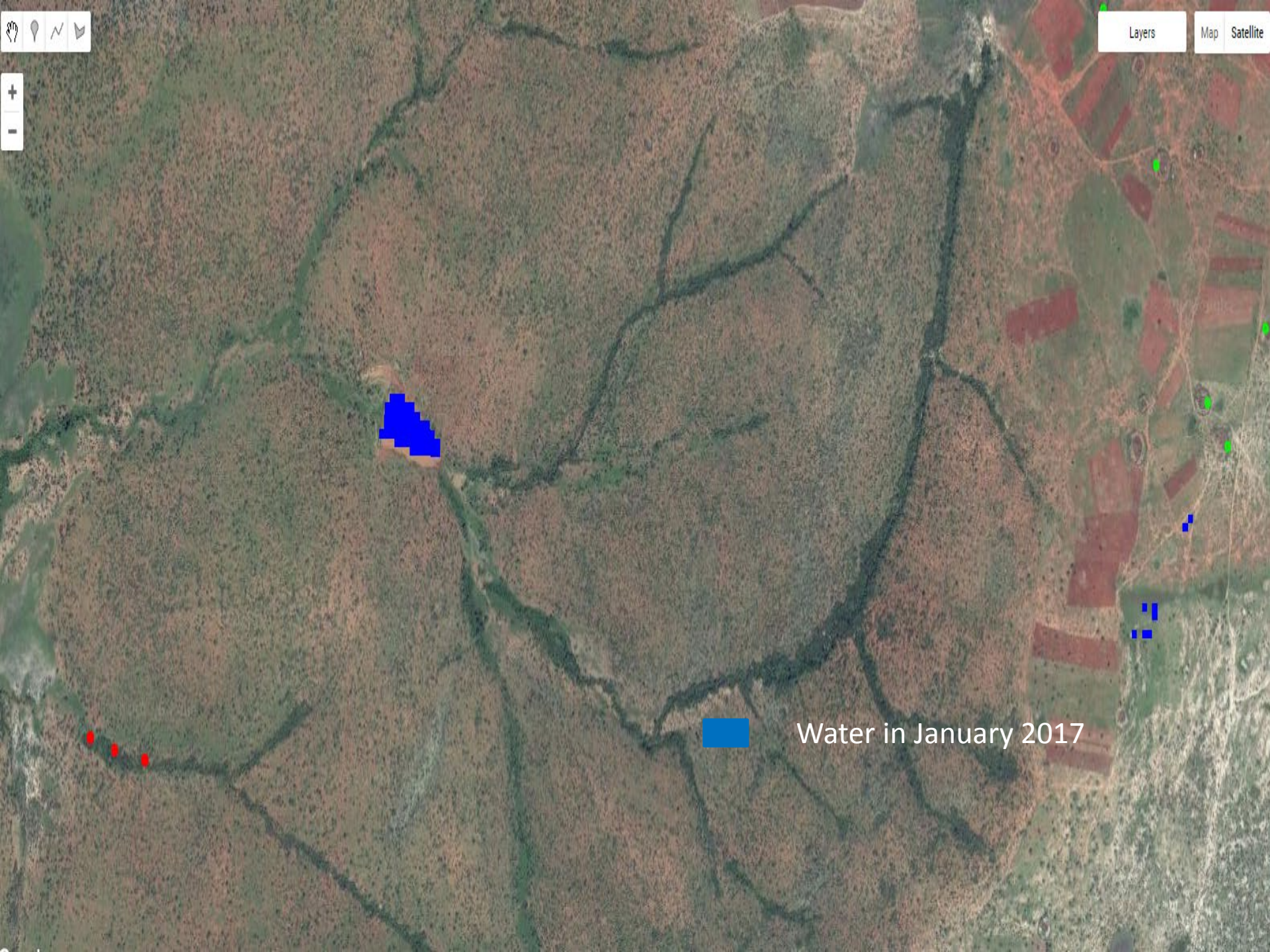




Water in Oct 2016



Water in Dec 2016



Layers

Map

Satellite



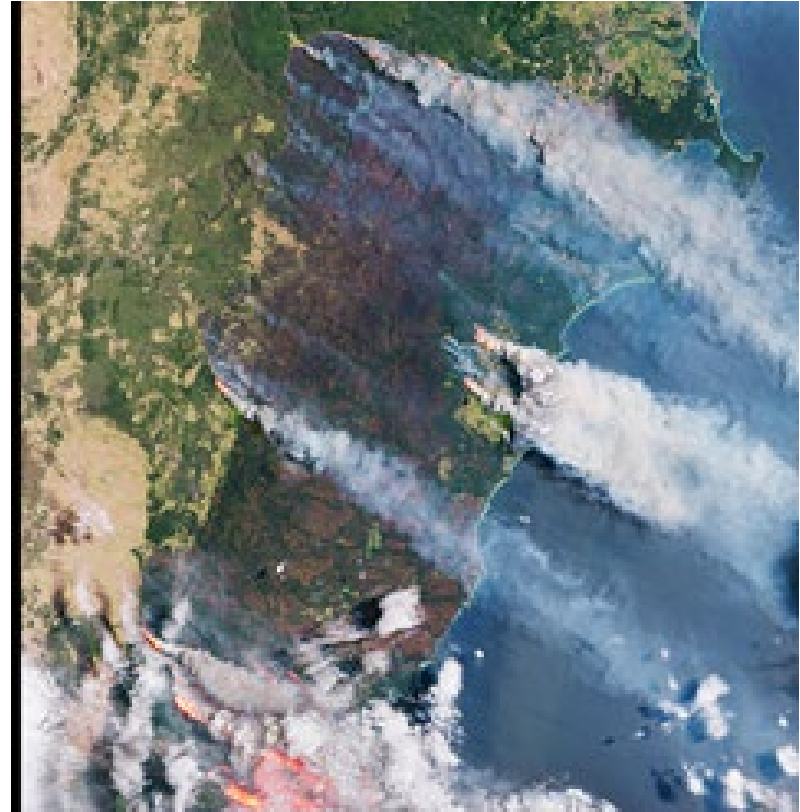
Water in January 2017



Examples of Applications: Fire Management

Forest Fires in Australia

The Copernicus Sentinel-2 mission has been used to image the fires. The Sentinel-2 satellites each carry just one instrument – a high-resolution multispectral imager with 13 spectral bands. The smoke, flames and burn scars can be seen clearly in the image shown here, which was captured on 31 December 2019. The large brownish areas depict burned vegetation and provide an idea of the size of the area affected by the fires here – the brown ‘strip’ running through the image has a width of approximately 50 km and stretches for at least 100 km along the Australian east coast. Credit: Contains modified Copernicus Sentinel data (2019), processed by ESA, CC BY-SA 3.0 IGO



Flasse, S., Ceccato, P. (1996). A Contextual Algorithm for AVHRR fire detection. International Journal of Remote Sensing 17 (2) 419-424.

Examples of Applications: Pest Management

Desert Locust



Solitary



Gregarious

Desert Locust Swarms



Swarm Invasions



Cairo, Egypt

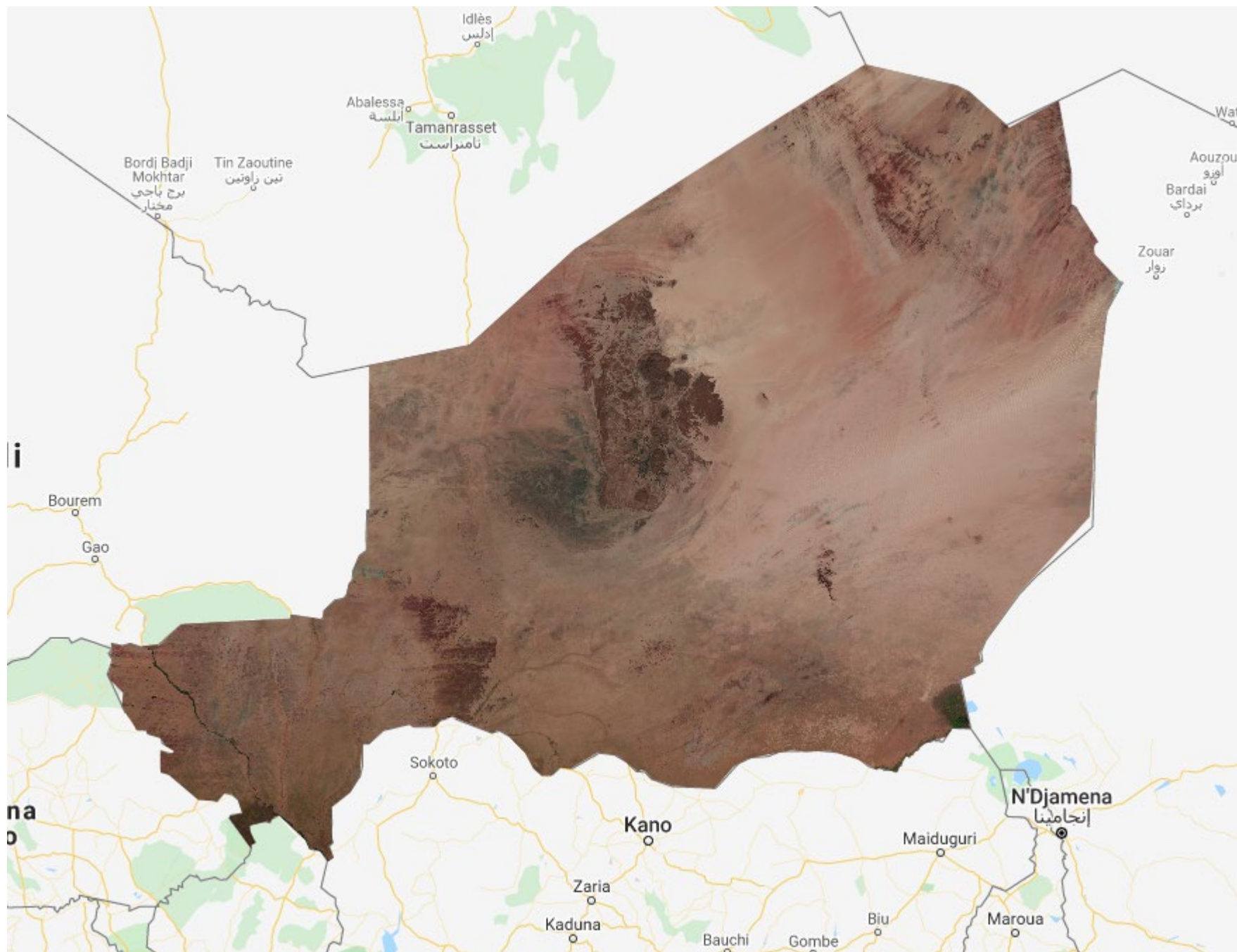


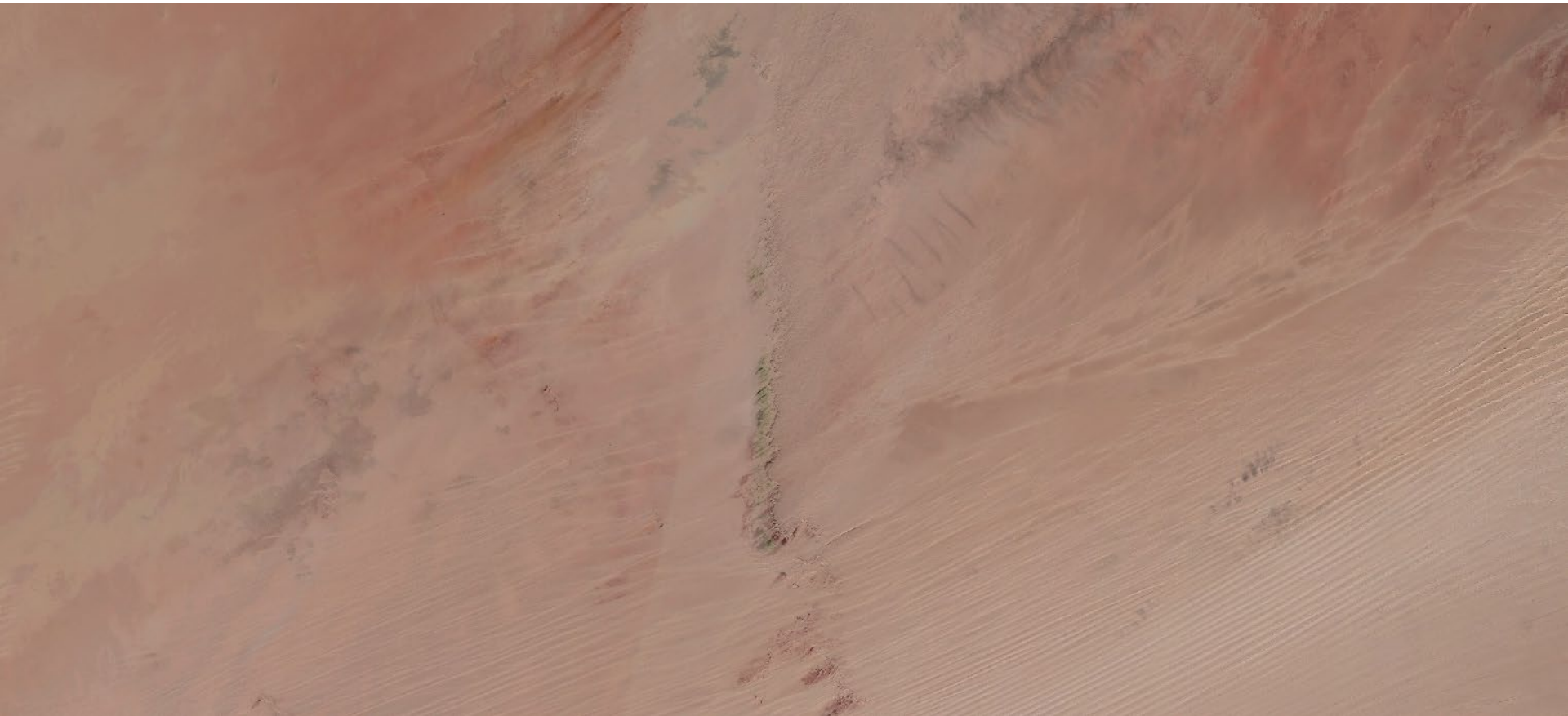
Nouakchott, Mauritania

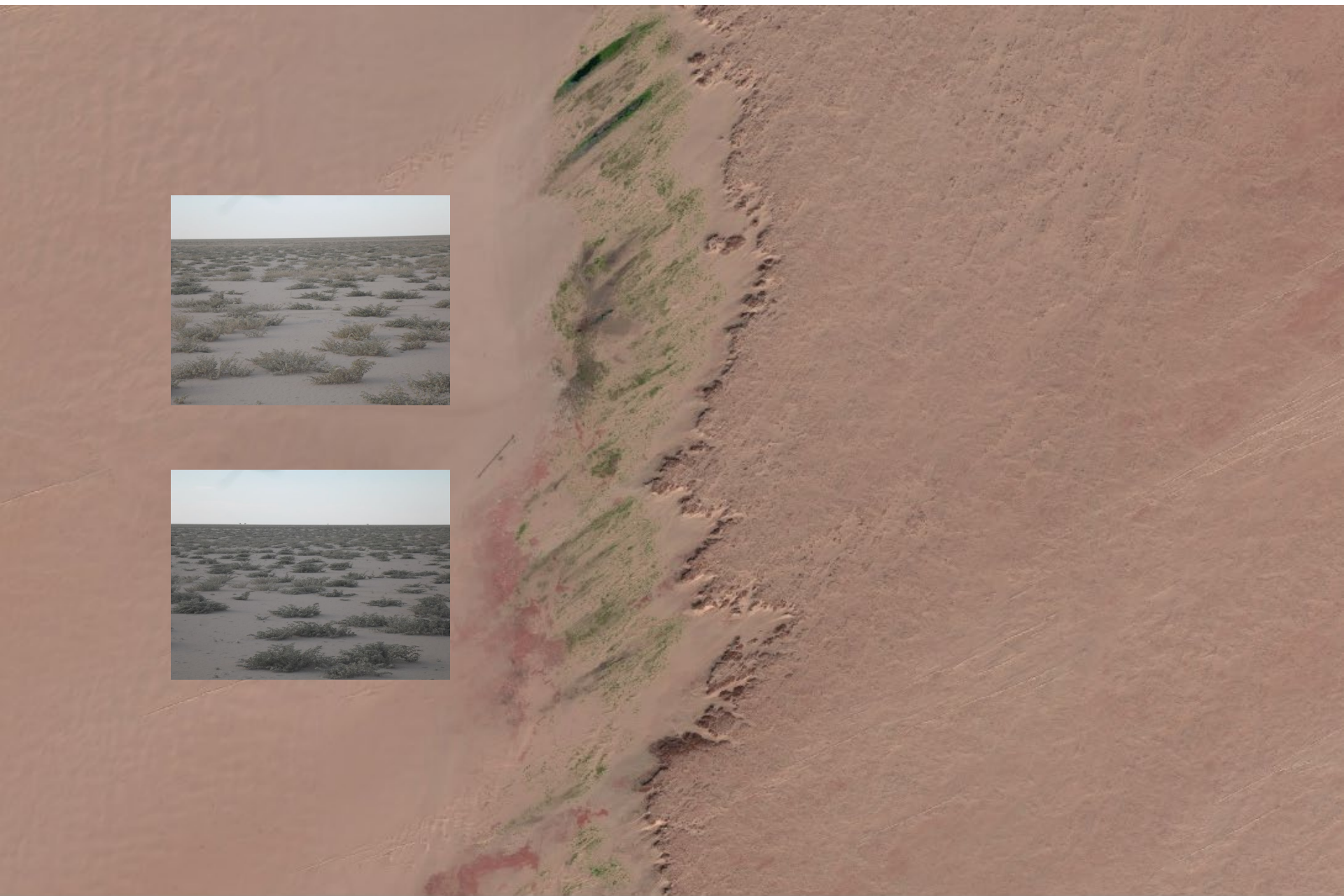
Monitoring Desert Areas: e.g. in Niger, Africa



Area equivalent to State of Texas or France





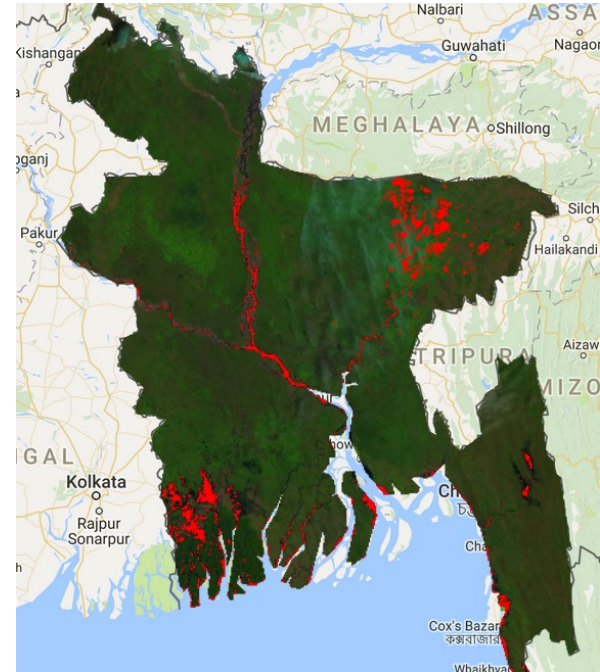


Examples of Applications: Natural Disasters
Floods (Index Insurances)

Assess Impacts of Flood Events



Sentinel 1 SAR, 20m spatial resolution

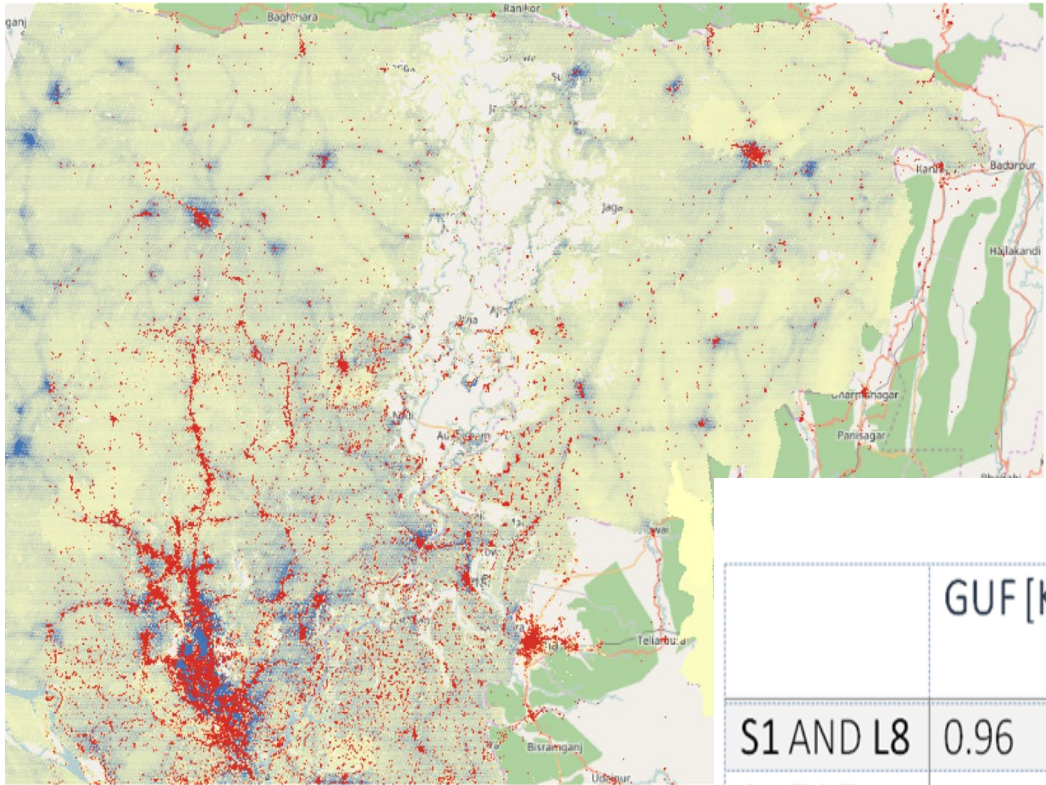


LANDSAT 8, optical 30m spatial resolution

Cian, F., Marconcini, M., Ceccato, P. (2018) Normalized Difference Flood Index for rapid flood mapping: Taking advantage of EO big data. *Remote sensing of environment* 209, 712-730

Climate and Floods: Assessing Economic Impacts

Difference between GHSL-POP and WorldPop



Assessing population impacted by floods in Bangladesh based on three data set: Global Urban Foot Print (DLR), WorldPop and Joint Research Center Data set

Population Affected - July 2015

	GUF [KM^2]	WORLDPOP [MILLION PEOPLE]	JRC – GHSL-POP [MILLION PEOPLE]
S1 AND L8	0.96	0.131628	0.310658
S1 TOT	7.89	0.377555	1.780534
L8 TOT	38.77	0.403508	2.789170
S1+L8	45.7	0.649435	4.259047

Google Earth Engine to Analyze Big Data

The screenshot displays the Google Earth Engine web interface. At the top, the Google Earth Engine logo is on the left, a search bar with the text "Search places and datasets..." is in the center, and a user profile dropdown for "pietro.ceccato" is on the right. Below the search bar, the interface is divided into three main sections: Scripts, Docs, and Assets. The Scripts section is active, showing a list of scripts under "Private" with "Pietro Tests" selected. The main editor area is titled "LANDSAT Pietro Niger" and contains a JavaScript script. The script starts with an import of the "GeometryCollection" dataset. It then contains several commented-out lines of code, including a line to convert Landsat SWIR/NIR/red composite to HSV and a line to isolate the soil and vegetation. The script is followed by a console output area showing the message "Use print(...) to write to this console." Below the script editor, a map of Niger is displayed, showing the Niger River and surrounding regions. The map includes a "Layers" panel on the left and a "Map" panel on the right. The map shows a satellite view of the Niger River and surrounding regions, with a cyan-colored line representing the river. The map includes a scale bar and a "Terms of Use" link.

Google Earth Engine

Search places and datasets...

Help | pietro.ceccato

Scripts Docs Assets

Filter scripts...

Private

- Pietro Tests
 - Cloud detection Noel - Pietro
 - LANDSAT B4B3B2 Pietro
 - LANDSAT Crop Uruguay
 - LANDSAT Forest Malawi

LANDSAT Pietro Niger

Get Link Save Run Reset

Inspector Console Tasks

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

Geometry Imports

Layers Map Satellite

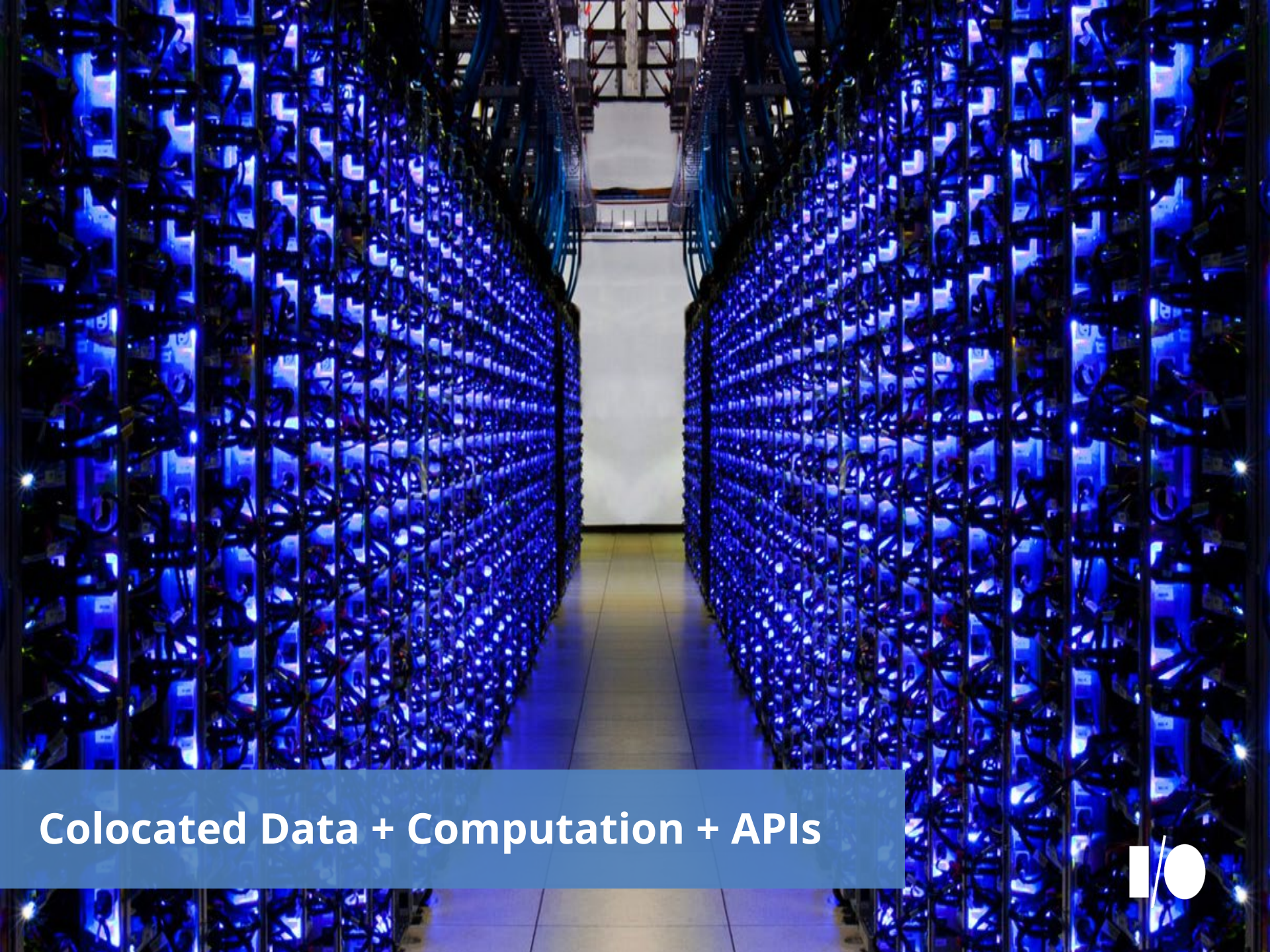
Man data ©2016 Google 20 km Terms of Use

How to Access Google Earth Engine?

Please sign up using the following URL:

<https://signup.earthengine.google.com>

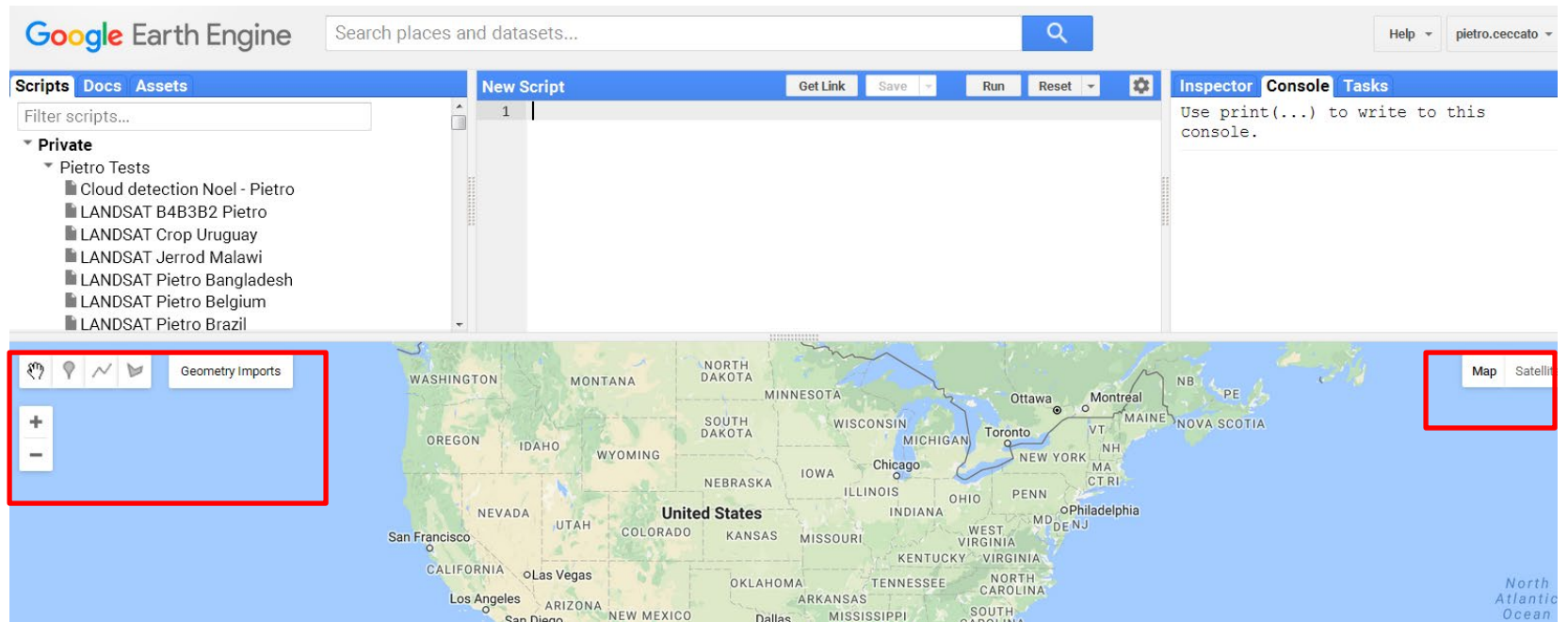
Using your gmail account (*i.e.*@gmail.com)



Colocated Data + Computation + APIs



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



Save Scripts and Get URL

The screenshot displays the Google Earth Engine web interface. At the top, the 'Google Earth Engine' logo is on the left, and a search bar with the text 'Search places and datasets...' is in the center. On the right, there are links for 'Help' and the user 'pietro.ceccato'. Below the search bar, the 'Scripts' tab is active, showing a list of scripts under the 'Private' folder. A red box highlights this list, which includes 'Pietro Tests' and several 'LANDSAT' scripts. In the center, the 'New Script' editor is open, showing a single line of code: `var geometry: GeometryCollection`. A red box highlights the top right of the editor, containing buttons for 'Get Link', 'Save', 'Run', and 'Reset'. On the right side, the 'Inspector' and 'Console' tabs are visible, with the 'Console' tab showing the instruction: 'Use print(...) to write to this console.' At the bottom, a map of the United States is shown, with a red polygon highlighting a region in the Northeast. The 'Geometry Imports' panel on the left of the map shows a checked box for 'geometry (1 pt, 1 poly)' and a '+ new layer' button.

Search Data Set

Link de167a4dbaea1ddac4608b9 x New Script - Earth Engine Code E x +

code.earthengine.google.com

Google Earth Engine

Script Editor

Filter scripts... NEW

Owner (1)

- users/pietroceccato/default
 - Pietro Tests
 - Cloud detection Noel - Pietro
 - LANDSAT B4B3B2 Pietro
 - LANDSAT Crop Uruguay
 - LANDSAT Jerrod Malawi
 - LANDSAT Pietro Bangladesh
 - LANDSAT Pietro Brazil
 - LANDSAT Pietro Brazil July 20

Search: Sentinel 2

PLACES

RASTERS

- Sentinel-2 MSI: MultiSpectral Instrument, Level-2A
- Sentinel-5P OFFL NO2: Offline Nitrogen Dioxide
- Sentinel-2 MSI: MultiSpectral Instrument, Level-1C
- Sentinel-5P NRTI NO2: Near Real-Time Nitrogen Dioxide
- Sentinel-5P OFFL SO2: Offline Sulphur Dioxide
- Sentinel-5P NRTI SO2: Near Real-Time Sulphur Dioxide
- Sentinel-3 OLCI EFR: Ocean and Land Color Instrument Earth Observation Full Resolution
- Sentinel-5P NRTI O3: Near Real-Time Ozone
- more »

View Data Catalog

Suggest a dataset

Inspector Console Tasks

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

Map Satellite

United States

Mexico

Google

Honolulu Hilo

Map data ©2020 Google, INEGI, ORION-ME 500 km Terms of Use

18:07 01/03/2020

Import Data Set

The screenshot shows the Google Earth Engine web interface. A modal dialog box is open, displaying information about the Sentinel-2 MSI dataset. The background interface includes a search bar with 'Sentinel 2' entered, a left sidebar with a script list, and a map view showing the North Atlantic Ocean. The Windows taskbar is visible at the bottom.

Sentinel-2 MSI: MultiSpectral Instrument, Level-1C

Sentinel-2 is a wide-swath, high-resolution, multi-spectral imaging mission supporting Copernicus Land Monitoring studies, including the monitoring of vegetation, soil and water cover, as well as observation of inland waterways and coastal areas.

The Sentinel-2 data contain 13 UINT16 spectral bands representing TOA reflectance scaled by 10000. See the [Sentinel-2 User Handbook](#) for details. In addition, three QA bands are present where one (QA60) is a bitmask band with cloud mask information. For more details, [see the full explanation of how cloud masks are computed](#).

Each Sentinel-2 product (zip archive) may contain multiple granules. Each granule becomes a separate Earth Engine asset. EE asset ids for Sentinel-2 assets have the following format: COPERNICUS/S2/20151128T002653_20151128T102149_T56MNN. Here the first numeric part represents the sensing date and time, the second numeric part represents the product generation date and time, and the final 6-character string is a unique granule identifier indicating its UTM grid reference (see [MGRS](#)).

The Level-2 data produced by ESA can be found in the collection

Data availability (time)
Jun 23, 2015 - Feb 29, 2020

Provider
[European Union/ESA/Copernicus](#)

Tags
[eu](#), [esa](#), [copernicus](#), [sentinel](#), [msi](#), [radiance](#)

ImageCollection ID
COPERNICUS/S2

Buttons: CLOSE, **IMPORT**

New Variable

The screenshot shows the Google Earth Engine web interface. The browser address bar displays 'code.earthengine.google.com'. The main header includes the 'Google Earth Engine' logo and a search bar containing 'Sentinel 2'. Below the header, the interface is divided into several panels:

- Left Panel (Scripts):** Displays a list of scripts under the user 'users/pietroceccato/default'. A 'NEW' button is visible at the top.
- Center Panel (New Script):** Shows a new script being created. A red box highlights the first line of code: `var imageCollection:ImageCollection "Sentinel-2 MSI: MultiSpectral Instrument, Leve..."`. The script is titled 'New Script' and has a 'Get Link' button.
- Right Panel (Inspector/Console):** The 'Console' tab is active, showing the message: 'Use print(...) to write to this console.'
- Bottom Panel (Map):** A map of the United States and Mexico is displayed. The map includes state and country names, major cities, and geographical features like the Gulf of Mexico and Gulf of California. A scale bar indicates 500 km.

The Windows taskbar at the bottom shows the system clock as 18:08 on 01/03/2020, along with various application icons.

How to Visualize Sentinel 2 Images using Google Earth Engine

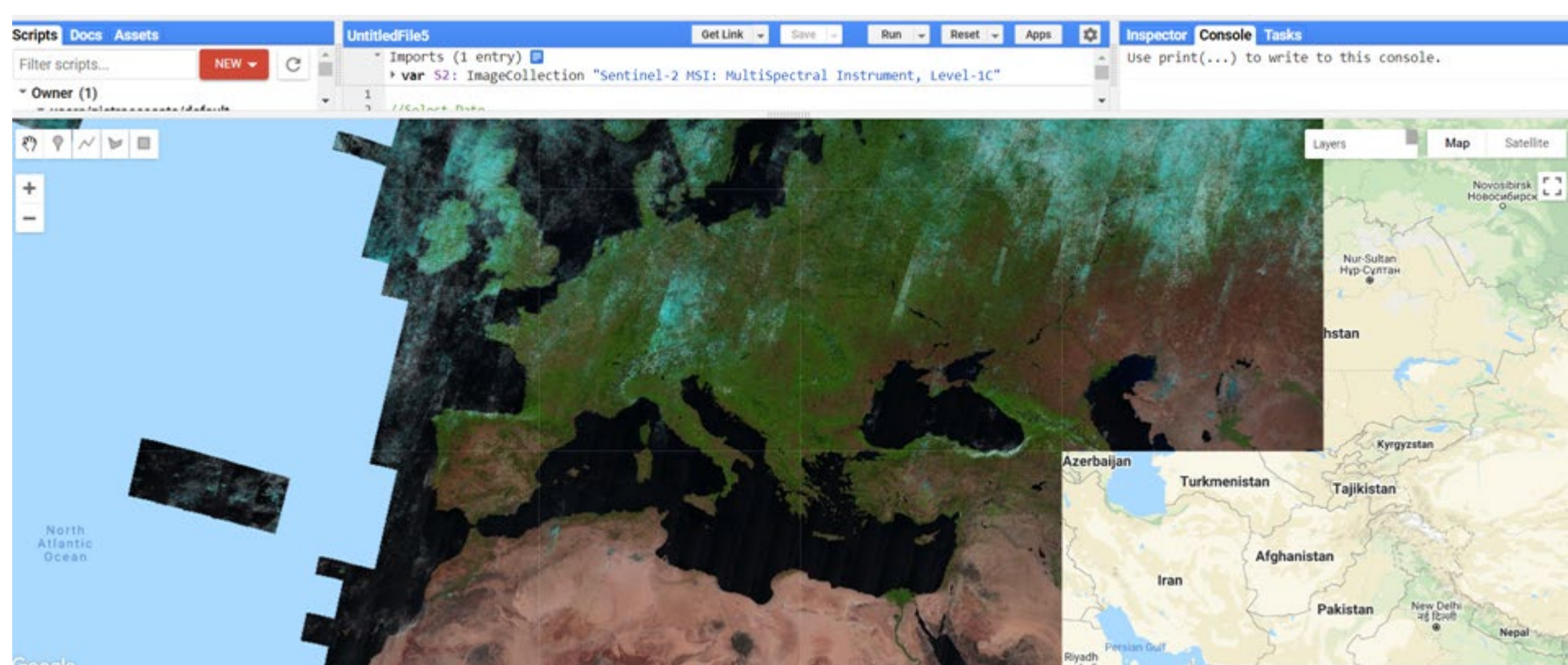
How to Access Sentinel Images

<https://code.earthengine.google.com/fc85ddf8091baed8c3ea4fba462b651e>

```
Imports (1 entry)   
  var S2: ImageCollection "Sentinel-2 MSI: MultiSpectral Instrument, Level-1C"  
  
1  
2 //Select Date  
3  
4  
5 var aug = S2.filterDate('2019-08-01', '2019-08-31');  
6  
7 //Select Bands True Color  
8 var augClip = aug.select('B4', 'B3', 'B2').median();  
9 var viz = {bands:['B4','B3','B2'], min: 0, max: 10000};  
10  
11 Map.addLayer(augClip, viz, 'S2 Aug 2017 True color');  
12  
13 //Select Bands False Color  
14 var augClip1 = aug.select('B11', 'B8', 'B4').median();  
15 var viz = {bands:['B11','B8','B4'], min: 0, max: 10000};  
16  
17 Map.addLayer(augClip1, viz, 'S2 Aug 2017 False Color');  
18
```


How to Access Sentinel Images

<https://code.earthengine.google.com/fc85ddf8091baed8c3ea4fba462b651e>



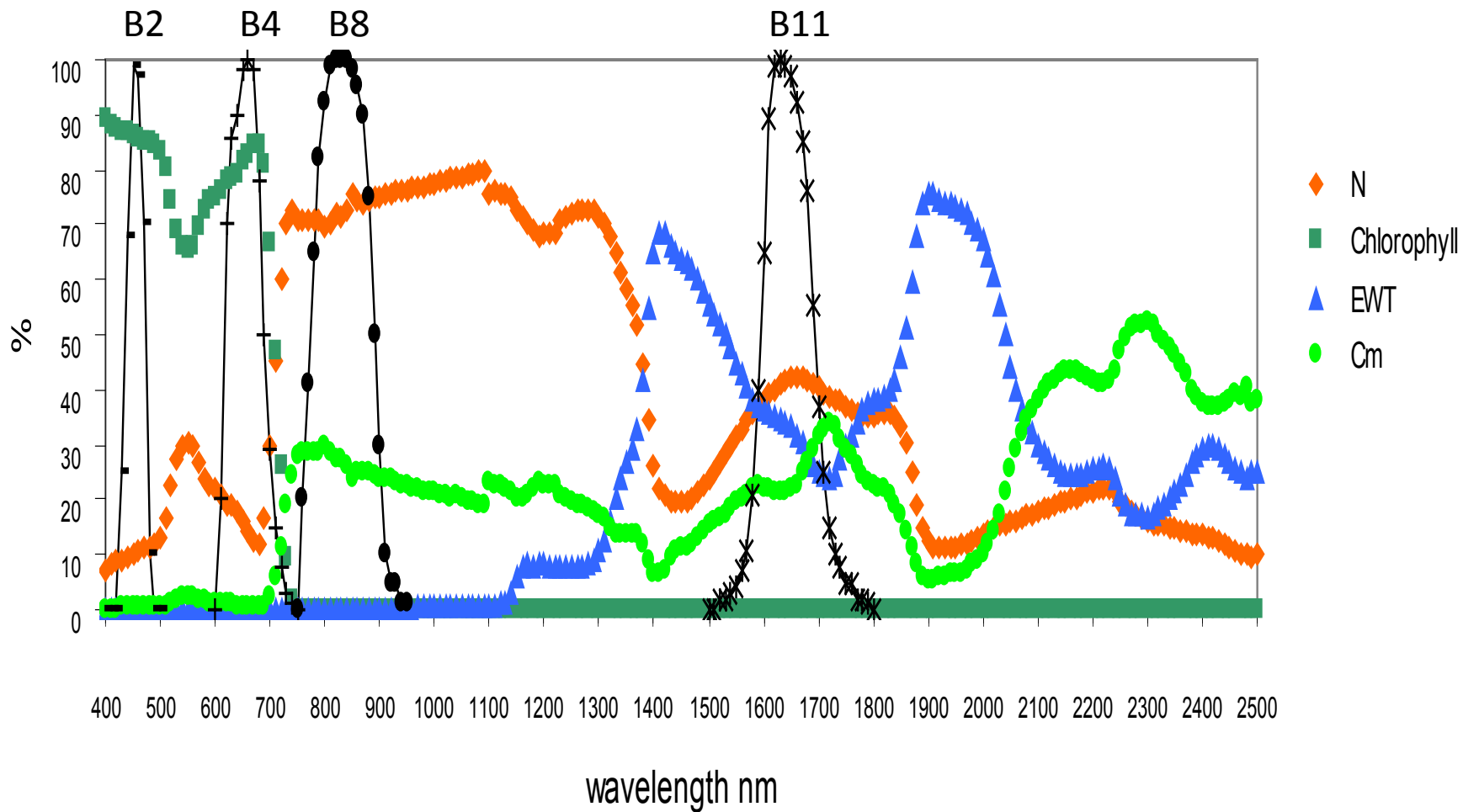
<https://code.earthengine.google.com/fc85ddf8091baed8c3ea4fba462b651e>

Different ways to display the data with color combinations:

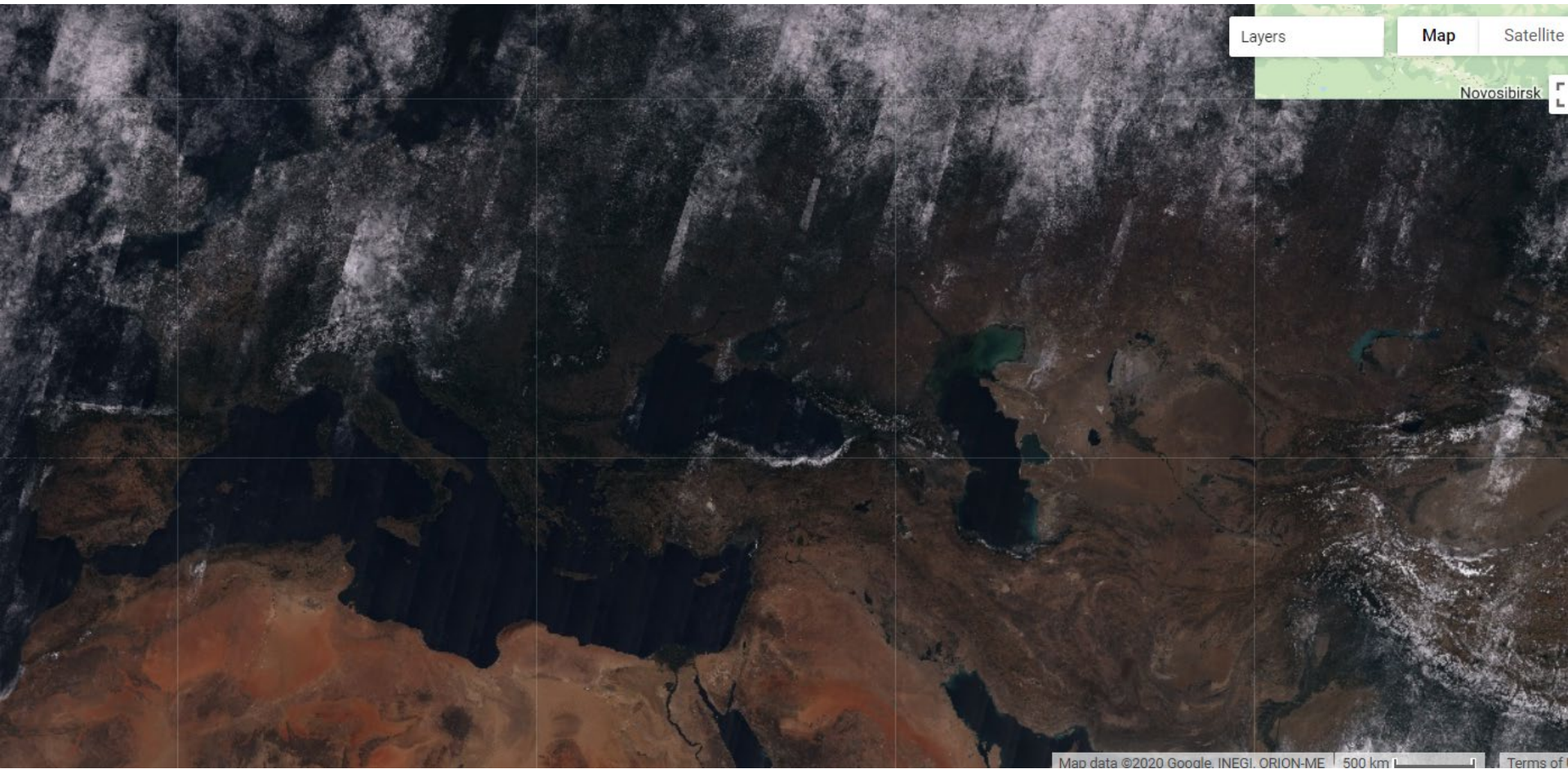
RED GREEN BLUE Color Combination for

B4 (Red Channel), B3 (Green Channel), B2 (Blue channel): True Color

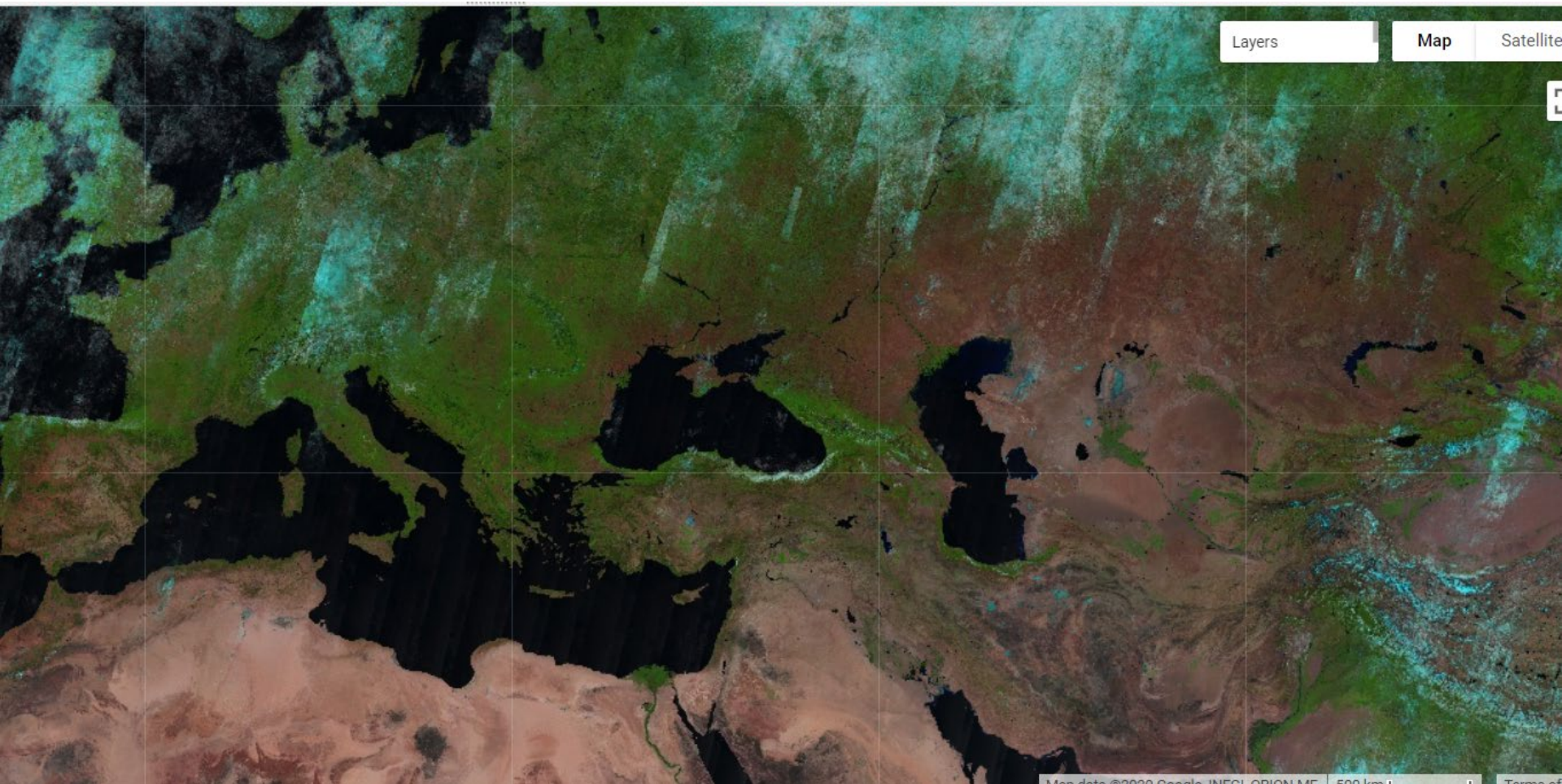
B11 (Middle Infrared Channel), B8 (Near Infrared Channel), B4 (Red Channel): False Color



True Color Composite B4 B3 B2



False Color Composite B11 B8 B4





Reaching into space
TOGETHER

Pietro Ceccato, Business Development Manager
Spacebel - Liège

Rue des Chasseurs Ardennais 6
LIEGE Science Park
B-4031 ANGLEUR

Pietro.Ceccato@Spacebel.be

