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TAKING THE PULSE OF OUR PLANET FROM SPACE

ASSESSING CROPLAND ABANDONMENT FROM VIOLENT CONFLICT IN THE SAHEL WITH SENTINEL-2 & GOOGLE EARTH ENGINE

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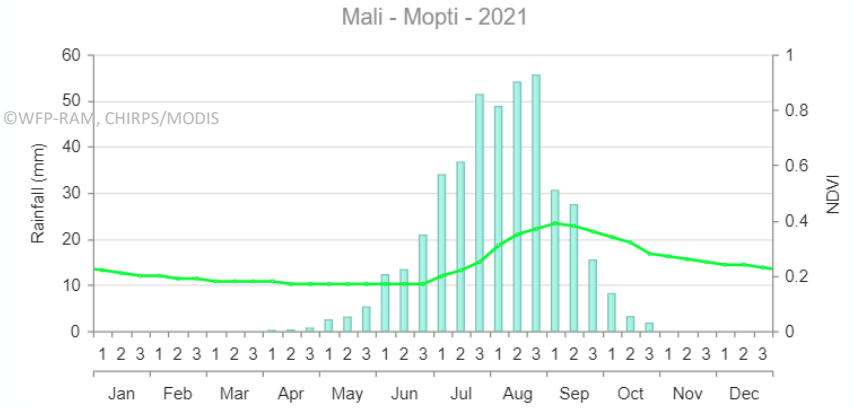
date

Introduction and Context: The Sahel

- Single rainy season with harvest in Sept/Oct
- Ongoing conflict and humanitarian emergency since 2011 - millions of people food insecure in 2021*
- Food assistance estimates rely on in-person agricultural surveys impossible during active conflict

Rainfall

NDVI



* Source : Cadre Harmonisé (2021)

Cropland Abandonment

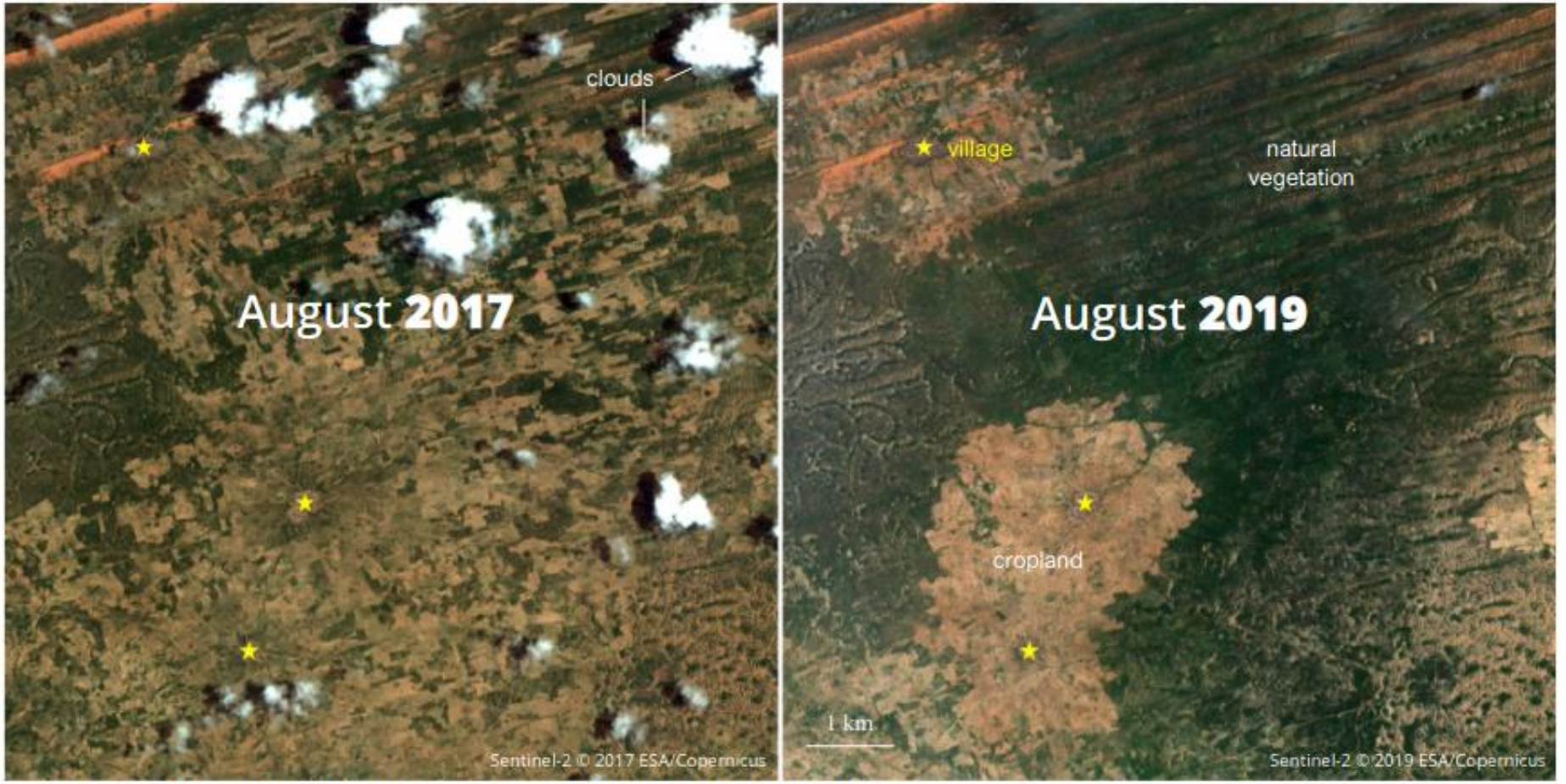
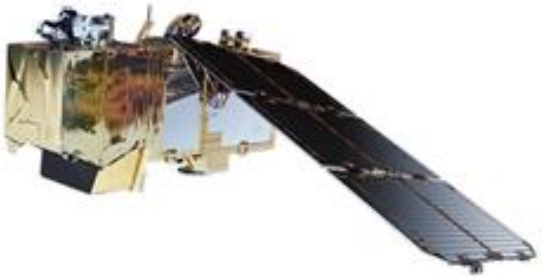


Image 1. Cropland abandonment detected from space for three villages in Koro cercle
In 2017 (left), cultivated fields are visible (in beige) as far as 10 kilometres away from habitations (star), singling out from the surrounding natural vegetation in dark green. In 2019 (right), cultivated fields are considerably reduced and concentrated in proximity to habitations due to movement restrictions imposed by armed actors.

Overview

- New method to analyse inter-annual cropland change;
  - Easy identification of **cropland abandonment**: assist humanitarian action/ decision-making in hard to reach areas of the Sahel
  - thousands of villages with cropland losses, most of which were **not identified by other humanitarian actors** or early warning systems.
- 3-period timescan:
  - S2-derived product reflecting vegetation evolution during a full growing season,
  - yearly composite of max-NDVI values (beginning, middle and end of growing season),
  - stacked into one RGB image used to s**ingle out cultivated land for each season**.
- Target audience / end users are humanitarian actors;

Methodology - data & tools

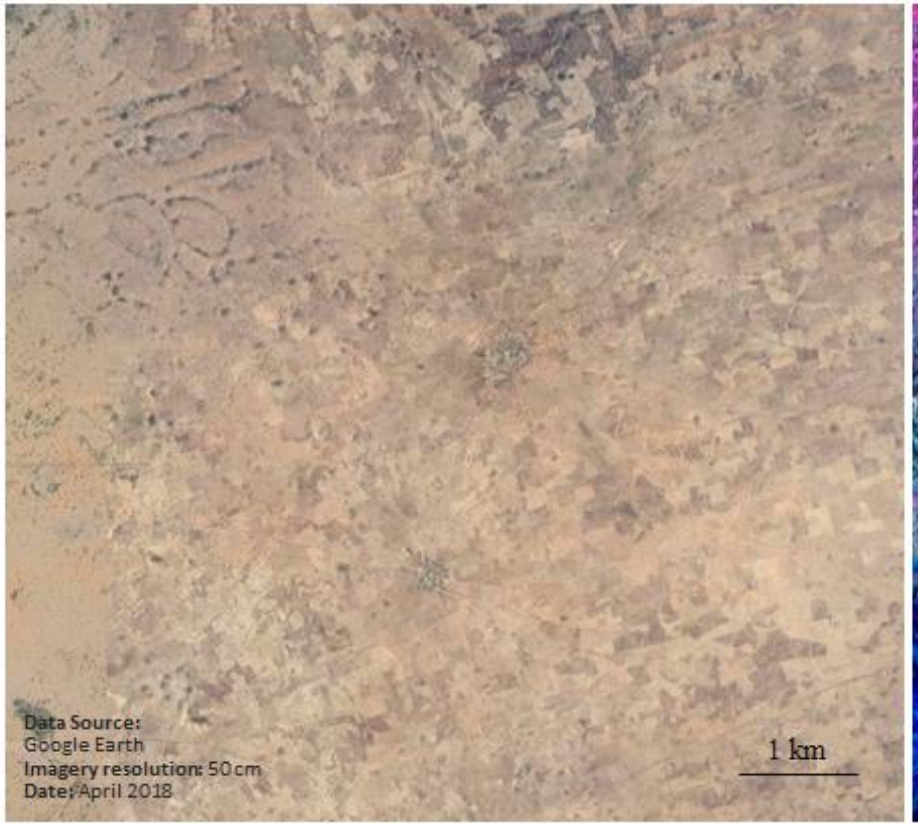


- Sentinel-2
  - Combines most adequate characteristics to detect agricultural fields over the AOI.
- Google Earth Engine
  - Given the amount of S2 images processed, the most appropriate tool to run analyses.

```
29  };
30  // FUNCTION to create new bands to the collection
31  var GREEN_s = 'B3';
32  var RED_s = 'B4';
33  var NIR_s = 'B8';
34  var SWIR_s = 'B11';
35
36  var addIndices = function(image) {
37    var ndvi = image.normalizedDifference([NIR_s, RED_s]);
38    return image.addBands(ndvi.rename('NDVI'));
39  };
40  //var s2016 = sentinel2(2016).map(addIndices);
41  //print('Sentinel collection 2016', s2016);
42  var s2017 = sentinel2(2017).map(addIndices);
43  print('Sentinel collection 2017', s2017);
44  var s2018 = sentinel2(2018).map(addIndices);
45  print('Sentinel collection 2018', s2018);
46  var s2019 = sentinel2(2019).map(addIndices);
47  print('Sentinel collection 2019', s2019);
48  var s2020 = sentinel2(2020).map(addIndices);
49  print('Sentinel collection 2019', s2020);
50
51  // 3-PERIODS PRODUCTS
52  // Visualize RGB from different max-NDVI values from three distinct periods of the year
53  var p1 = s2017.filter(ee.Filter.dayOfYear(t1, t2)).select('NDVI').max();
54  var p2 = s2017.filter(ee.Filter.dayOfYear(t2+1, t3)).select('NDVI').max();
55  var p3 = s2017.filter(ee.Filter.dayOfYear(t3+1, t4)).select('NDVI').max();
56
57  var min_values = p2.reduceRegion('min', region, 100).values().getInfo();
```

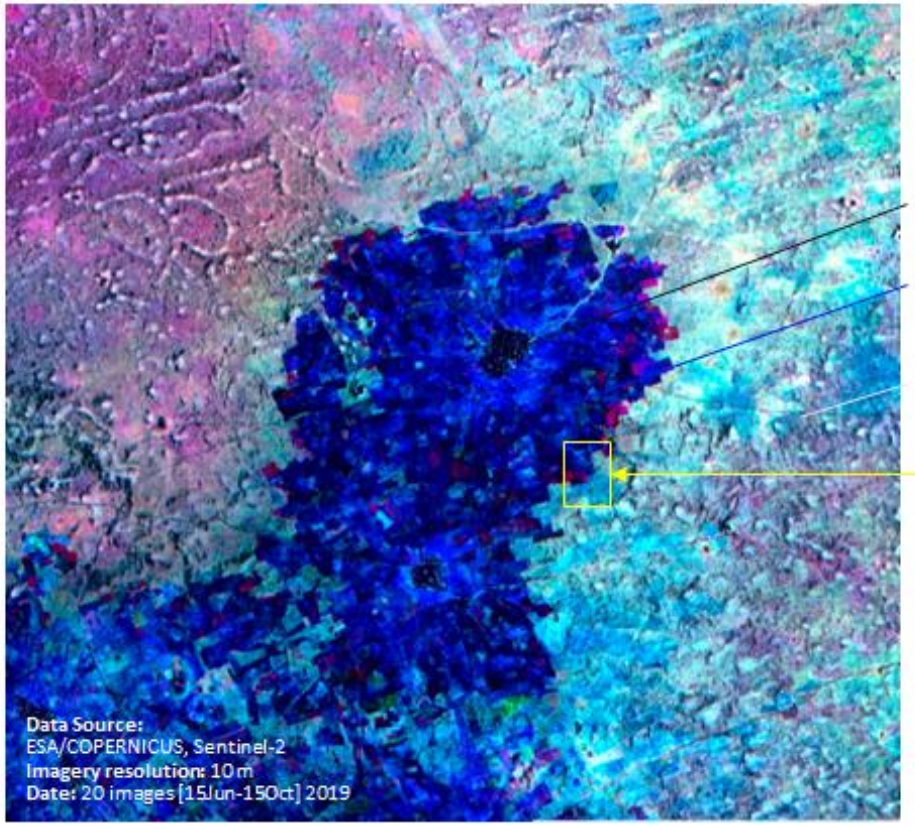
Methodology - 3-period timescan

Image available on Google Earth



A. Single-date satellite image (source : Google Earth)

Composite image (timescan) derived from Sentinel-2



B. 3-period timescan : RGB composite derived from imagery acquired between **15 Jun** and **15 Oct**

Village

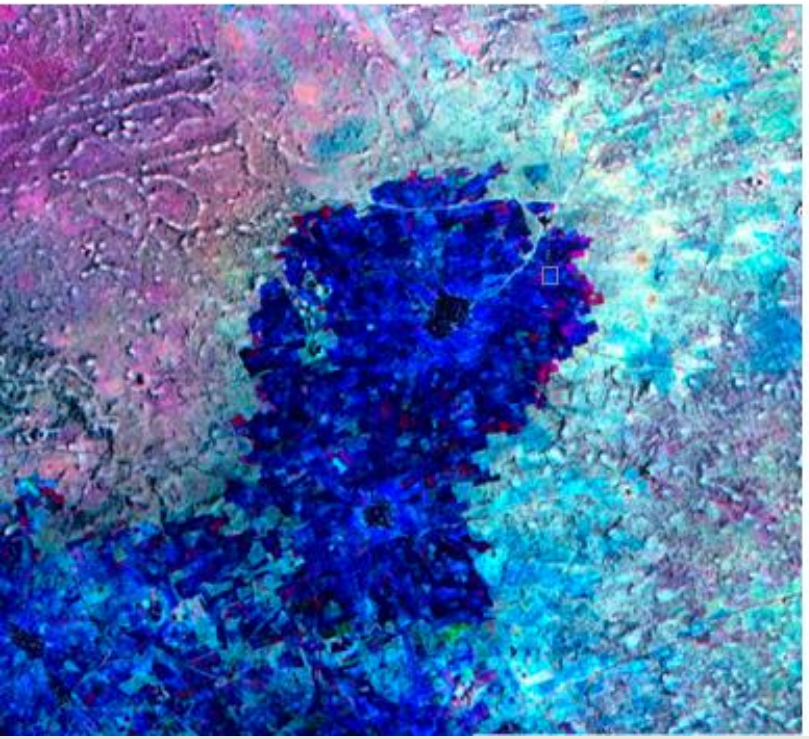
Cropland

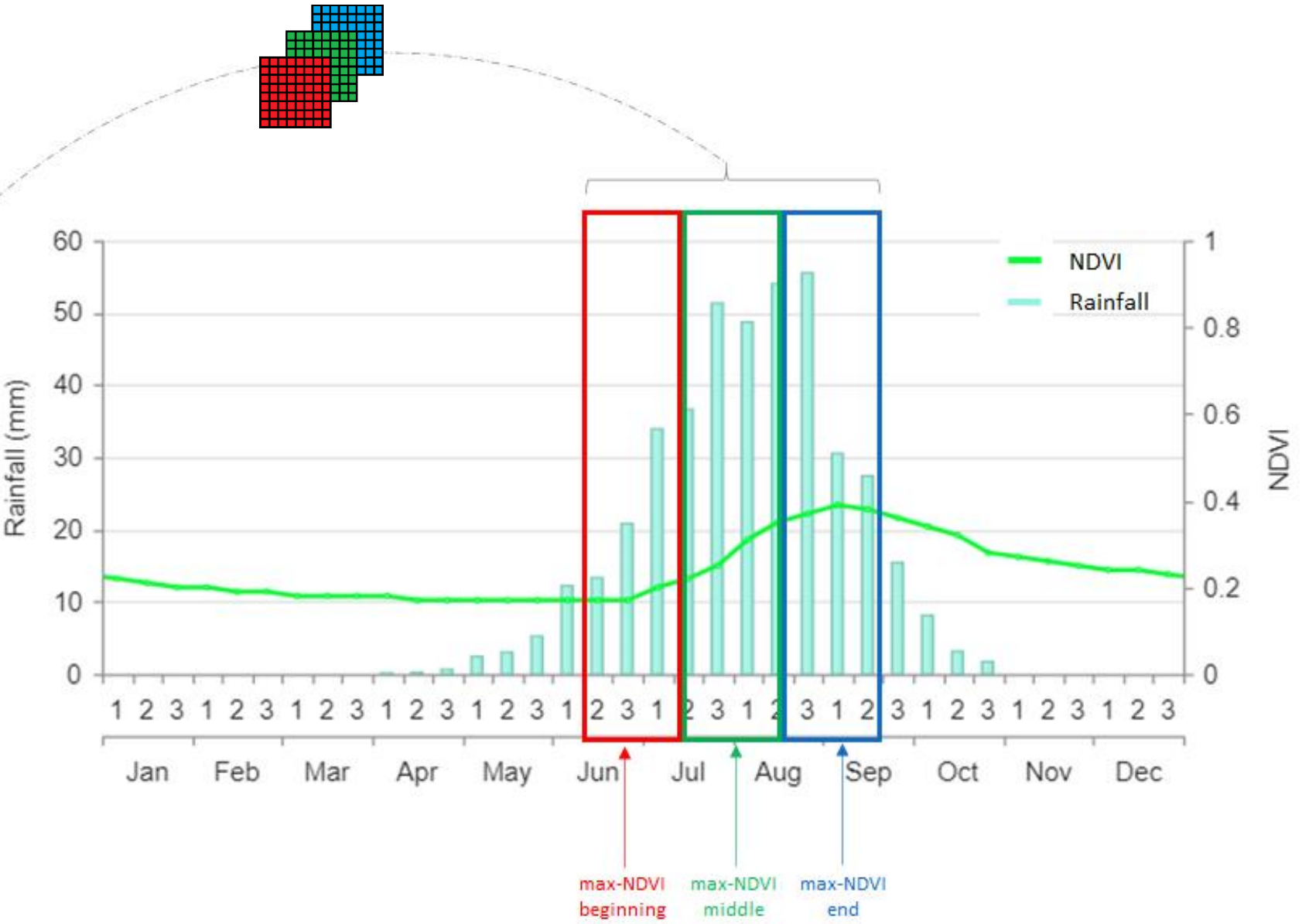
Natural vegetation

Field validation

Methodology

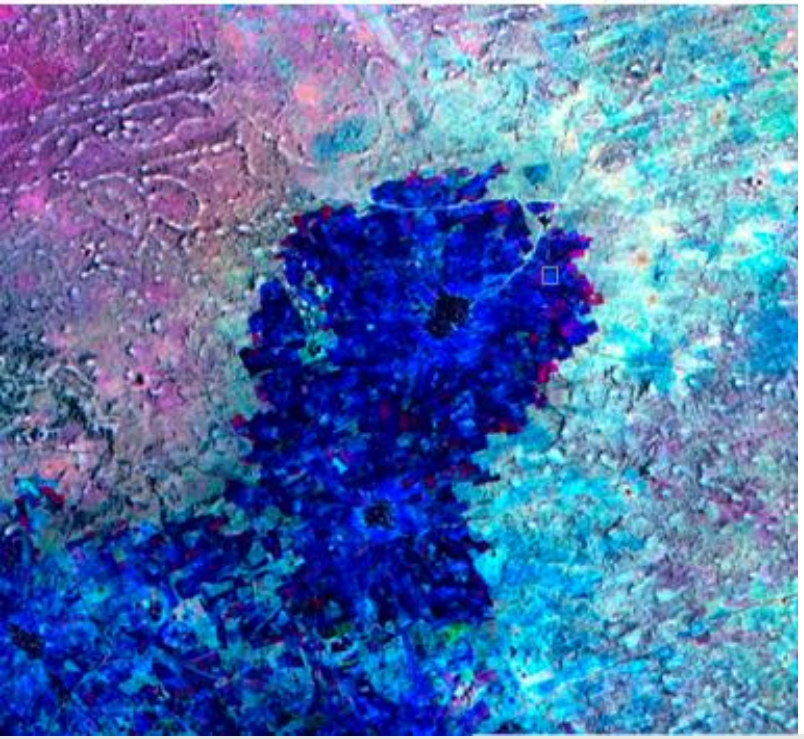
3-period timescan = a **RGB** composite of NDVI values along the agricultural season

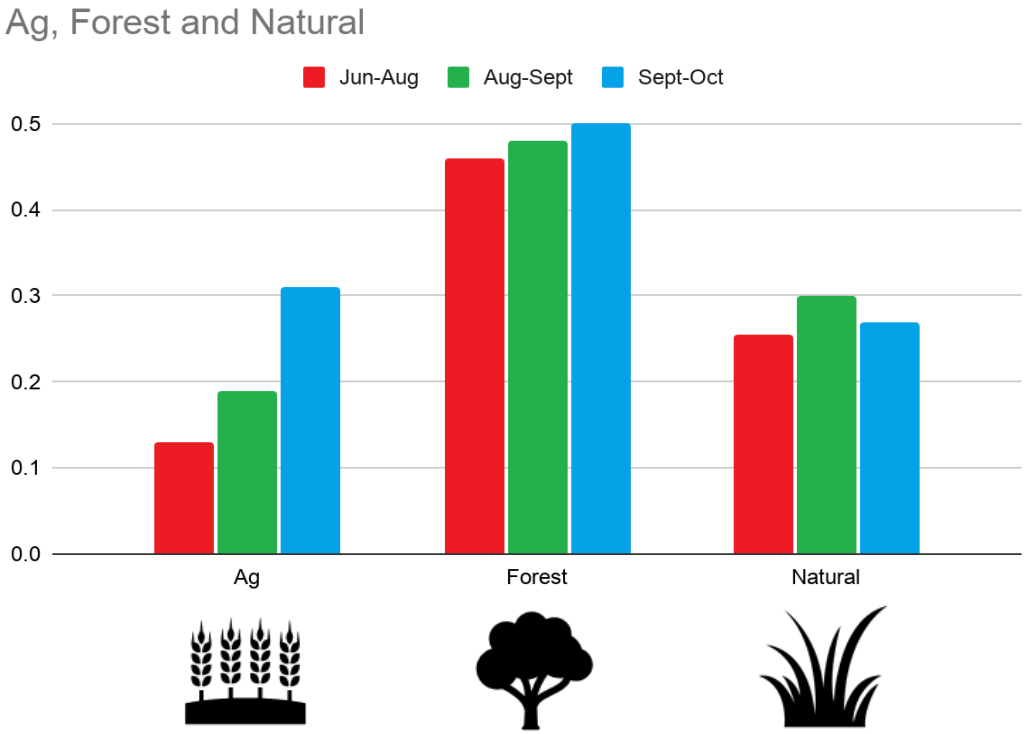




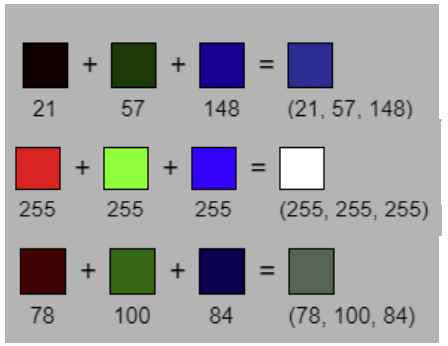
Methodology

Different land cover types are associated with specific colours, revealing patterns that are easy to interpret





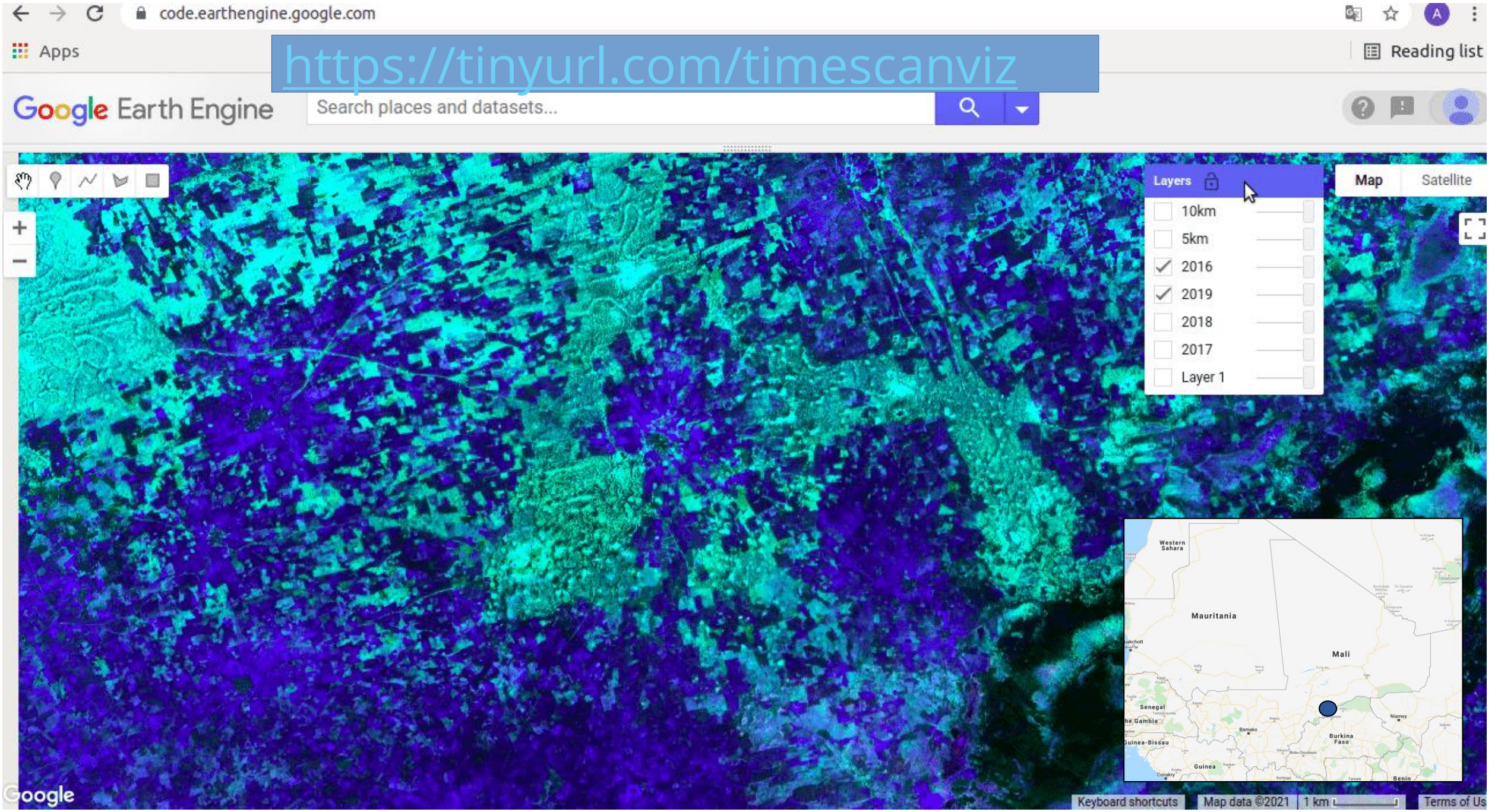
RGB Color Mixing



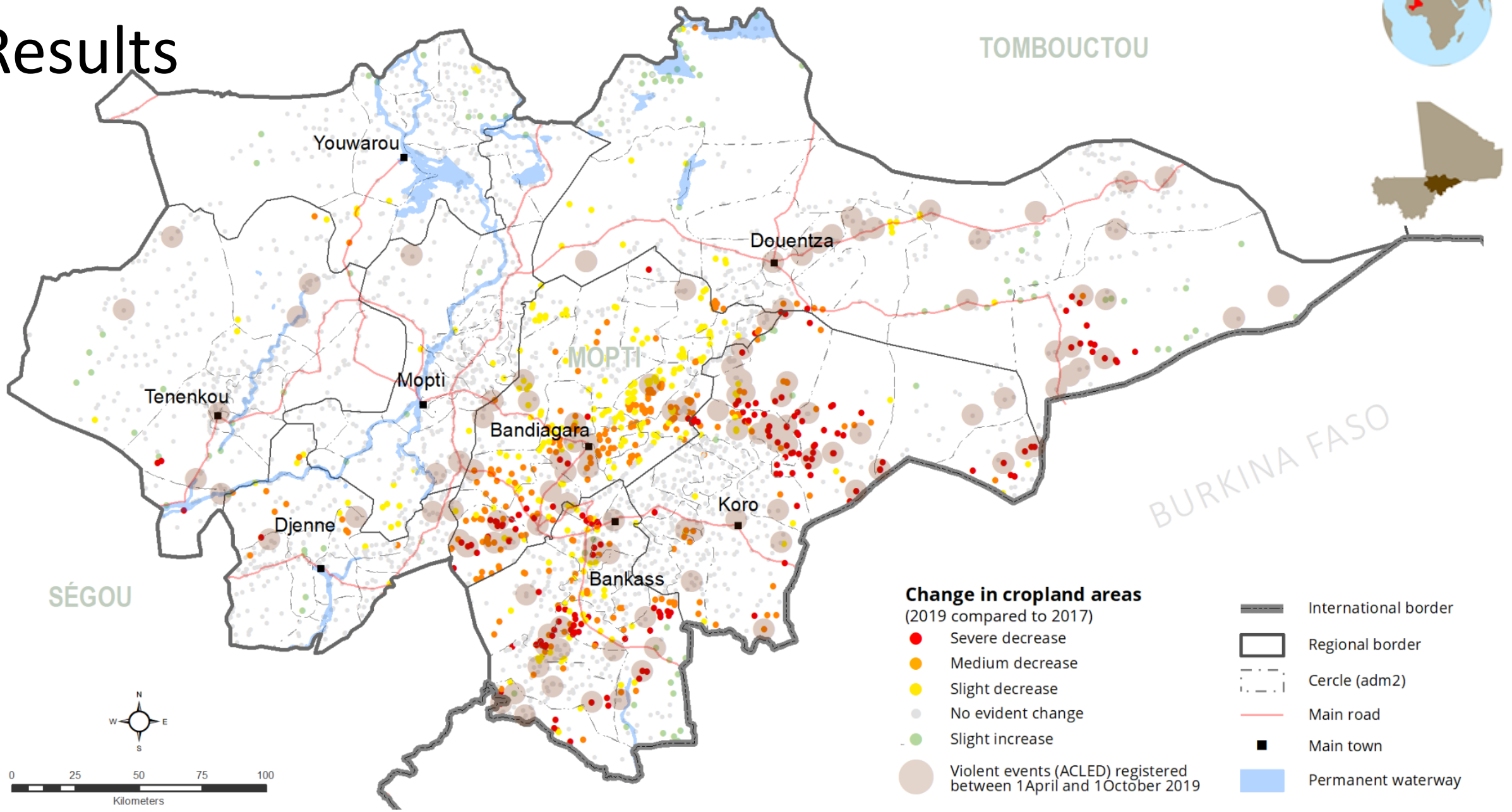
Ag

Forest

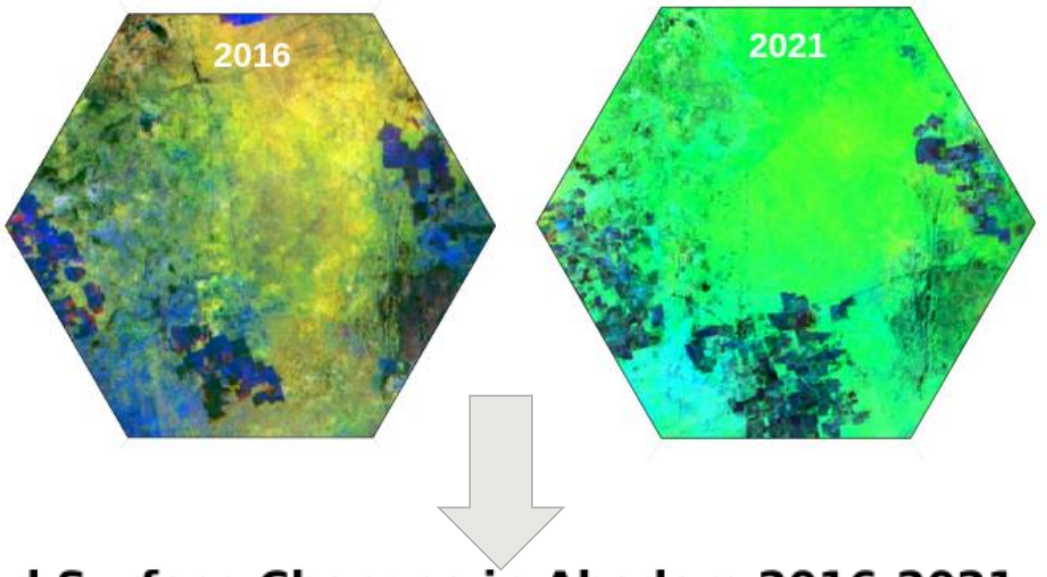
Natural


code.earthengine.google.com
Apps
https://tinyurl.com/timescanviz
Reading list
Google Earth Engine
Search places and datasets...
Layers
10km
5km
2016
2019
2018
2017
Layer 1
Map
Satellite
Western Sahara
Mauritania
Mali
Senegal
Gambia
Guinea-Bissau
Guinea
Bamako
Burkina Faso
Niamey
Benin
Google
Keyboard shortcuts
Map data ©2021
1 km
Terms of Us

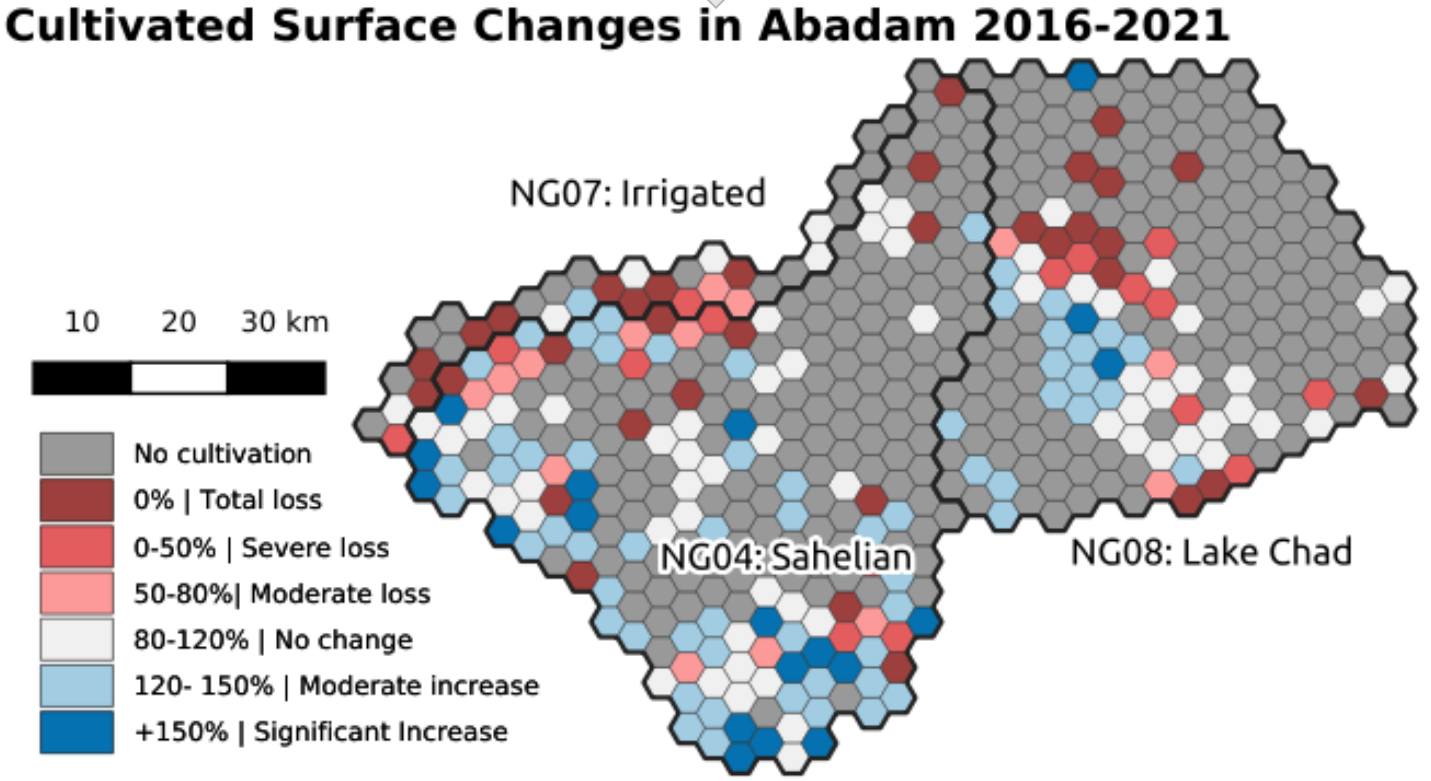
Results


Cropland change in Mopti region in 2019 compared to pre-conflict years
TOMBOUCTOU
Youwarou
Douentza
MOPTI
Mopti
Tenenkou
Bandiagara
Koro
Djenne
Bankass
SÉGOU
BURKINA FASO
N
W
E
S
0
25
50
75
100
Kilometers
Change in cropland areas
(2019 compared to 2017)
Severe decrease
Medium decrease
Slight decrease
No evident change
Slight increase
Violent events (ACLED) registered between 1April and 1October 2019
International border
Regional border
Cercle (adm2)
Main road
Main town
Permanent waterway

Results

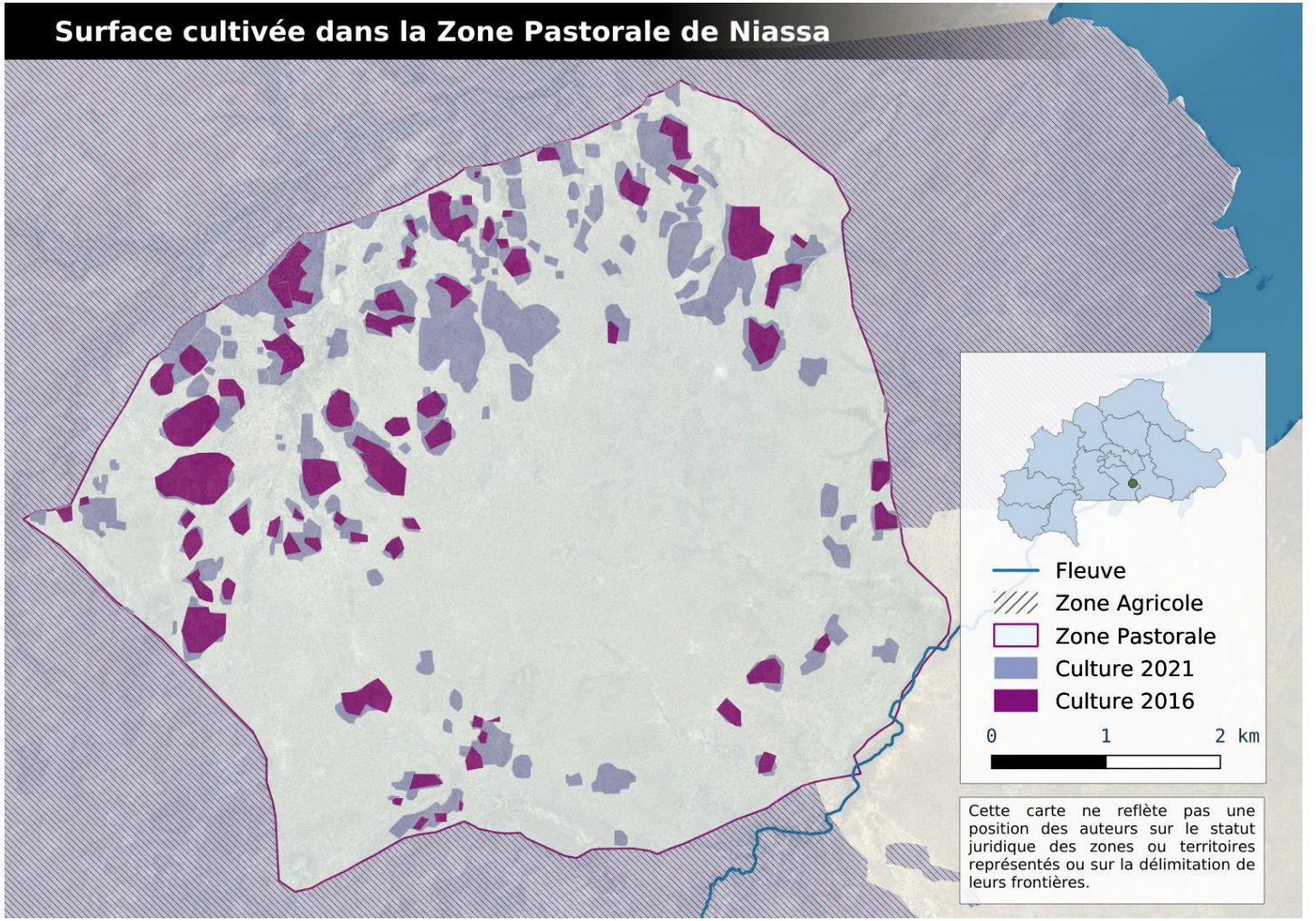


Abadam		Abadam	
		Affected Pop	**Zones**
No cultivation	NA	**42%**	**58%**
Total loss	0%	**16%**	**7%**
Severe loss	0 - 50%	**4%**	**3%**
Moderate loss	50 - 80%	**5%**	**3%**
No change	80 - 120%	**20%**	**13%**
Moderate increase	120 - 150%	**8%**	**12%**
Significant increase	>150 %	**5%**	**4%**



Operational Uses

- Integrated into **national food security analysis** - to inform in hard-to-reach areas where field surveys cannot be conducted;
- Currently used by humanitarian actors for **geotargeting assistance** in their early response planning.
- Monitoring **agricultural encroachment** into protected areas
- **Validation data** for landcover analyses



Try it yourself !

Github (GEE + PyQGIS) https://github.com/oren-sa/3PTS

GEE App (No code needed)

https://tinyurl.com/timescanviz

Thank you !

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Boudinaud, L. and Orenstein, S. A.: Assessing cropland abandonment from violent conflict in central Mali with Sentinel-2 and Google Earth Engine, 2021, *Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci.*, XLVI-4/W2-2021, 9–15, https://doi.org/10.5194/isprs-archives-XLVI-4-W2-2021-9-2021