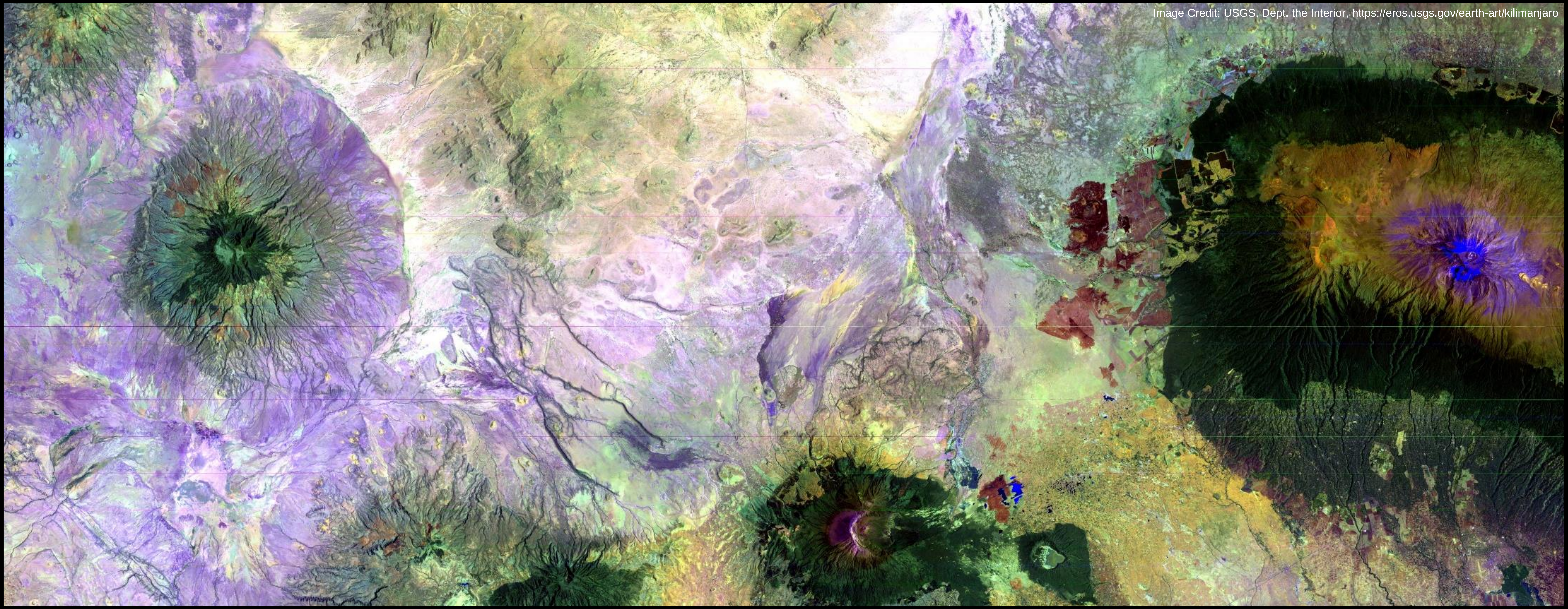
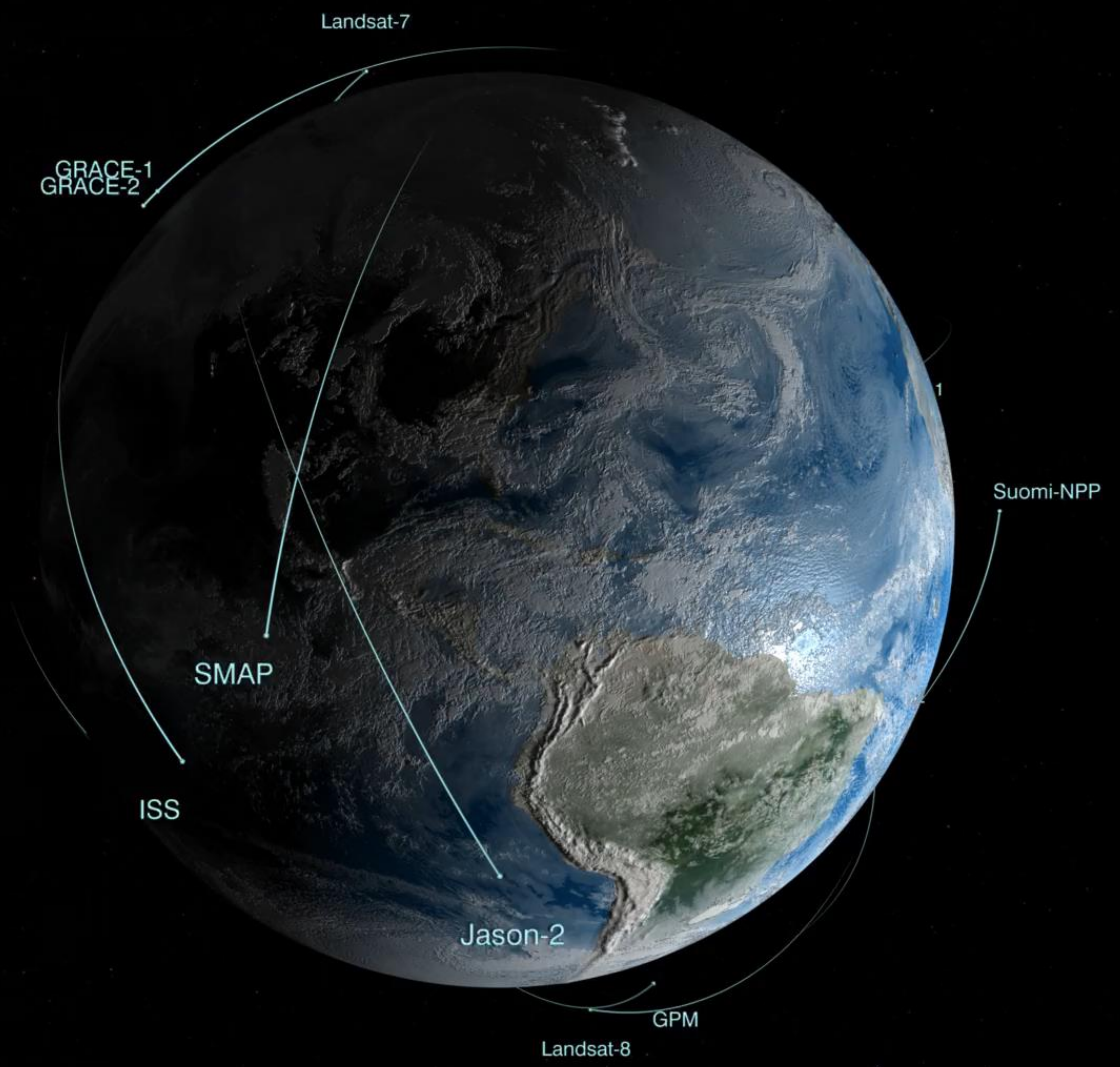
Using Earth Observation Technologies to Support Sustainable Development in Developing Countries

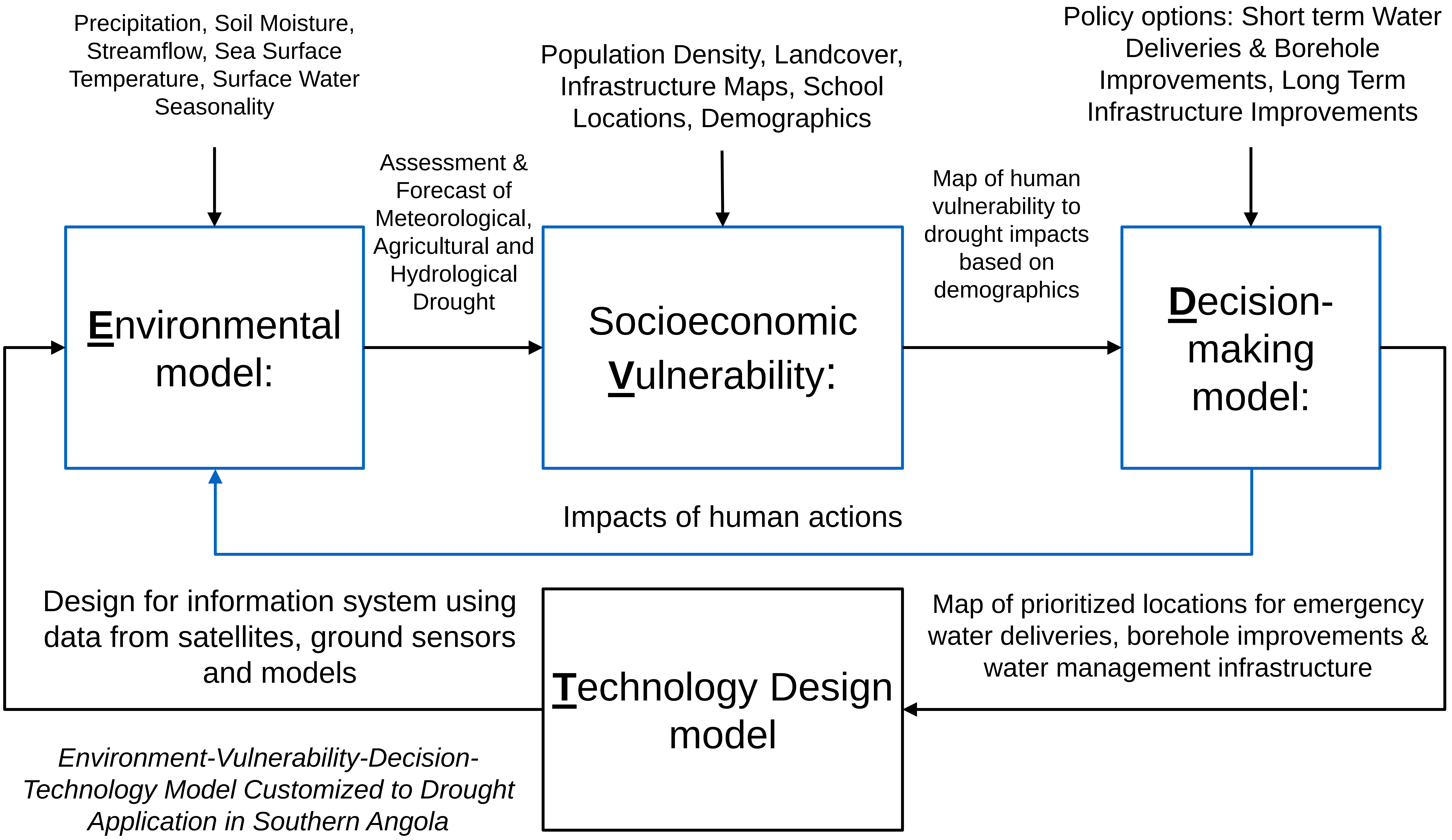


Sharif Islam
Media Lab, MIT



https://svs.gsfc.nasa.gov/vis/a000000/a004500/a004558/final_earth_obs_fleet06_1080p60.mp4


1 NO POVERTY
2 NO HUNGER
3 GOOD HEALTH
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 RENEWABLE ENERGY
8 GOOD JOBS AND ECONOMIC GROWTH
9 INNOVATION AND INFRASTRUCTURE
010
011
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE AND JUSTICE
17 PARTNERSHIPS FOR THE GOALS
THE GLOBAL GOALS
For Sustainable Development


Precipitation, Soil Moisture, Streamflow, Sea Surface Temperature, Surface Water Seasonality
Population Density, Landcover, Infrastructure Maps, School Locations, Demographics
Policy options: Short term Water Deliveries & Borehole Improvements, Long Term Infrastructure Improvements
Assessment & Forecast of Meteorological, Agricultural and Hydrological Drought
Map of human vulnerability to drought impacts based on demographics
Environmental model:
Socioeconomic Vulnerability:
Decision-making model:
Impacts of human actions
Design for information system using data from satellites, ground sensors and models
Technology Design model
Map of prioritized locations for emergency water deliveries, borehole improvements & water management infrastructure
Environment-Vulnerability-Decision-Technology Model Customized to Drought Application in Southern Angola

EVDT Projects

1. Coastal erosion hazard in Bangladesh.
2. Assessment of agricultural drought vulnerability in Angola
3. Estimation of Methane gas emissions
4. Deforestation due to mining in Ghana
5. Integrated water resources management in Benin

Coastal Erosion Hazard in Bangladesh

Background Information

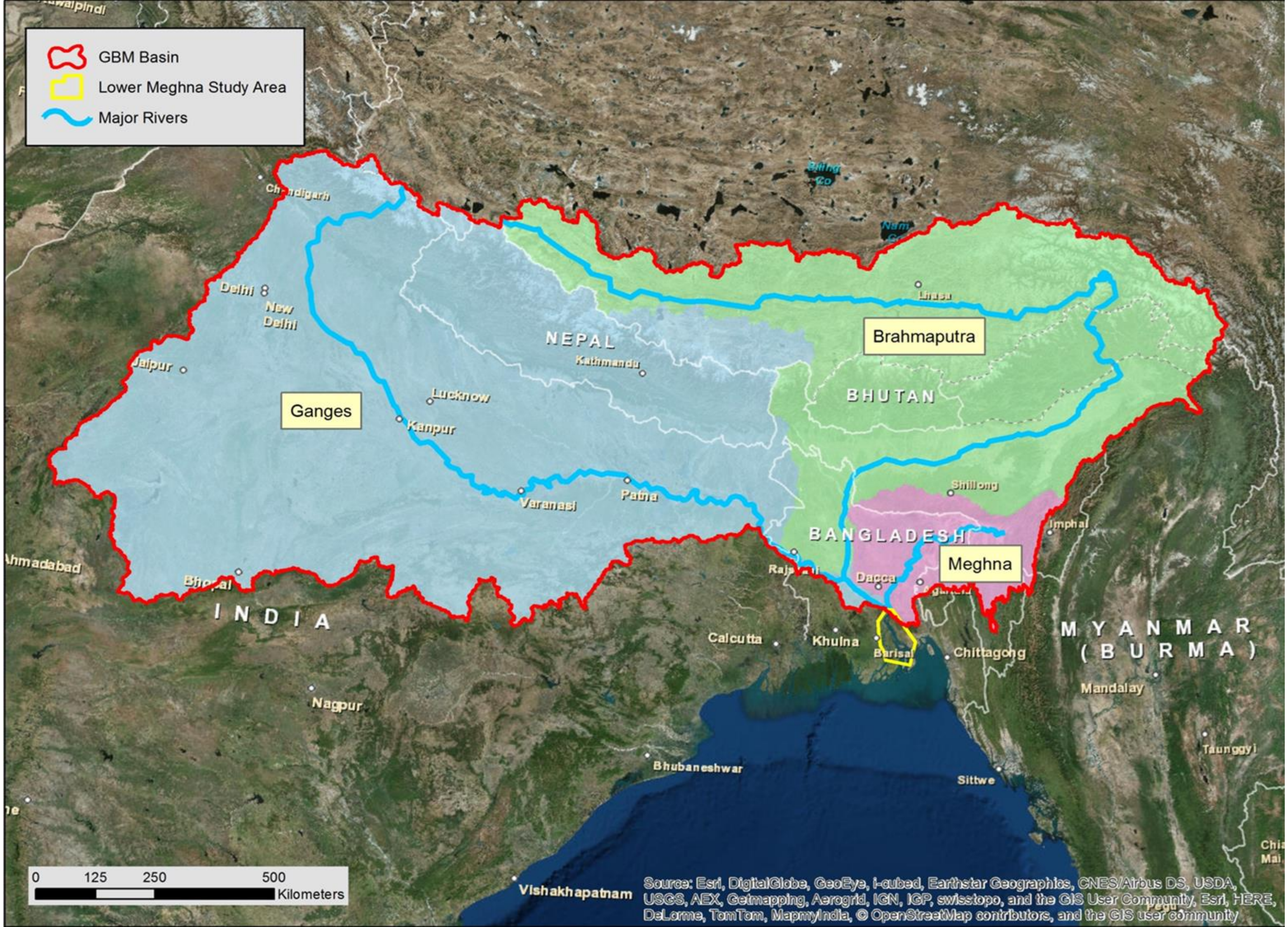
- Floods, cyclones and storm surges, riverbank/coastal erosion are common natural hazards in Bangladesh.
- Coastal erosion is **one of the major natural disasters** that occurs regularly.
- Erosion rates are among the **highest** in the world.
- Erosion causes numerous problems including **loss of households, productive lands and infrastructure, displacement of population**, and most importantly **loss of livelihoods**.

UNB
UNITED NEWS OF BANGLADESH

Meghna erosion devours lands and displaces thousands in Lakshmipur

UNB NEWS PUBLISH- AUGUST 28, 2021, 09:45 AM
MD KAWSAR - UNB LAXMIPUR CORRESPONDENT UPDATE- AUGUST 29, 2021, 12:40 PM

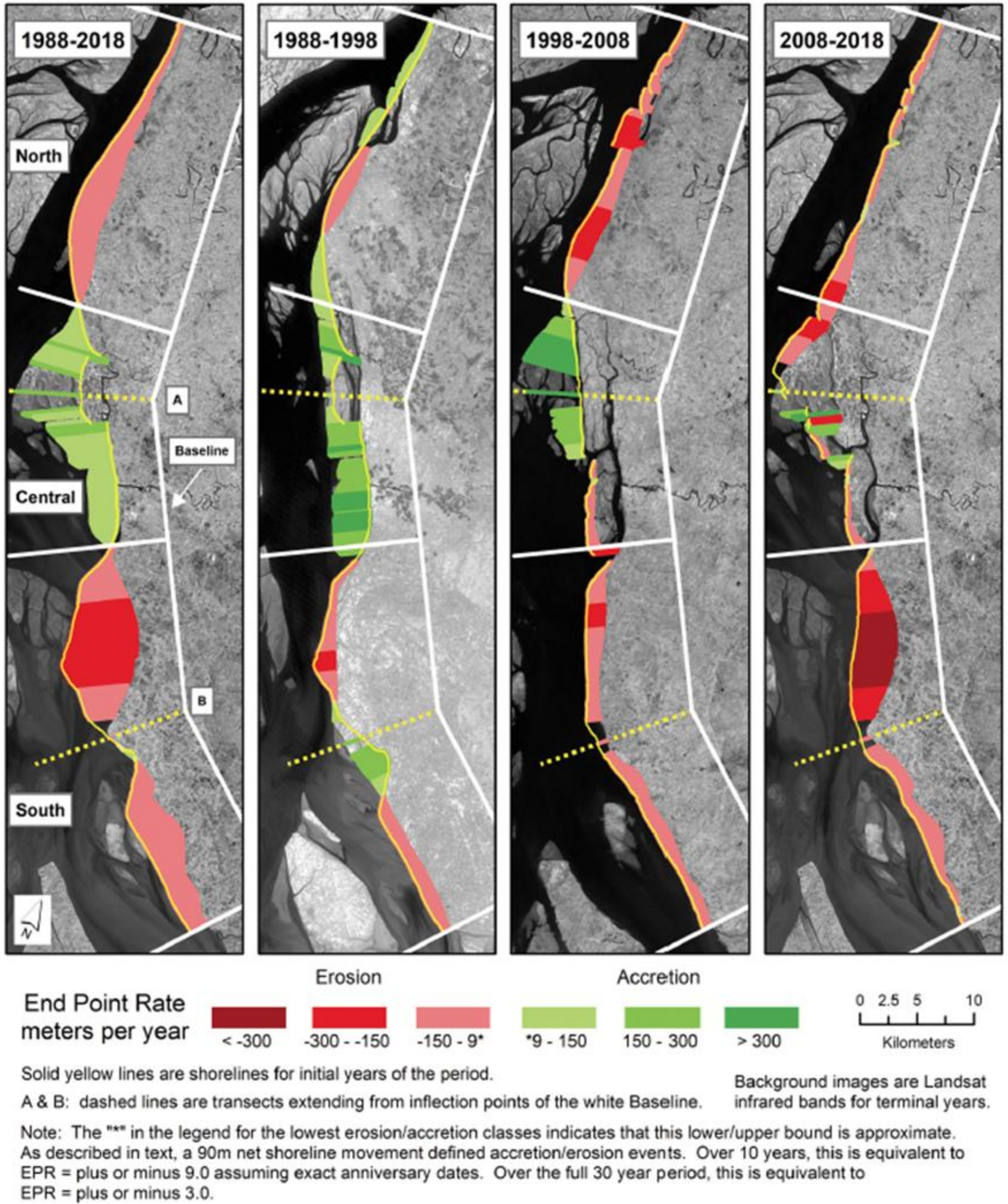
Erosion along the banks of the Meghna River in Lakshmipur


GBM Basin
Lower Meghna Study Area
Major Rivers
Ganges
Brahmaputra
Meghna
NEPAL
BHUTAN
BANGLADESH
INDIA
MYANMAR (BURMA)
Delhi
New Delhi
Jaipur
Lucknow
Kanpur
Varanasi
Patna
Kathmandu
Lhasa
Shillong
Imphal
Dacca
Calcutta
Khulna
Barisal
Chittagong
Mandalay
Nagpur
Bhopal
Ahmadabad
Bhubaneshwar
Sittwe
Vishakhapatnam
Taunggyi
0 125 250 500 Kilometers
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Esri, HERE, DeLorme, TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

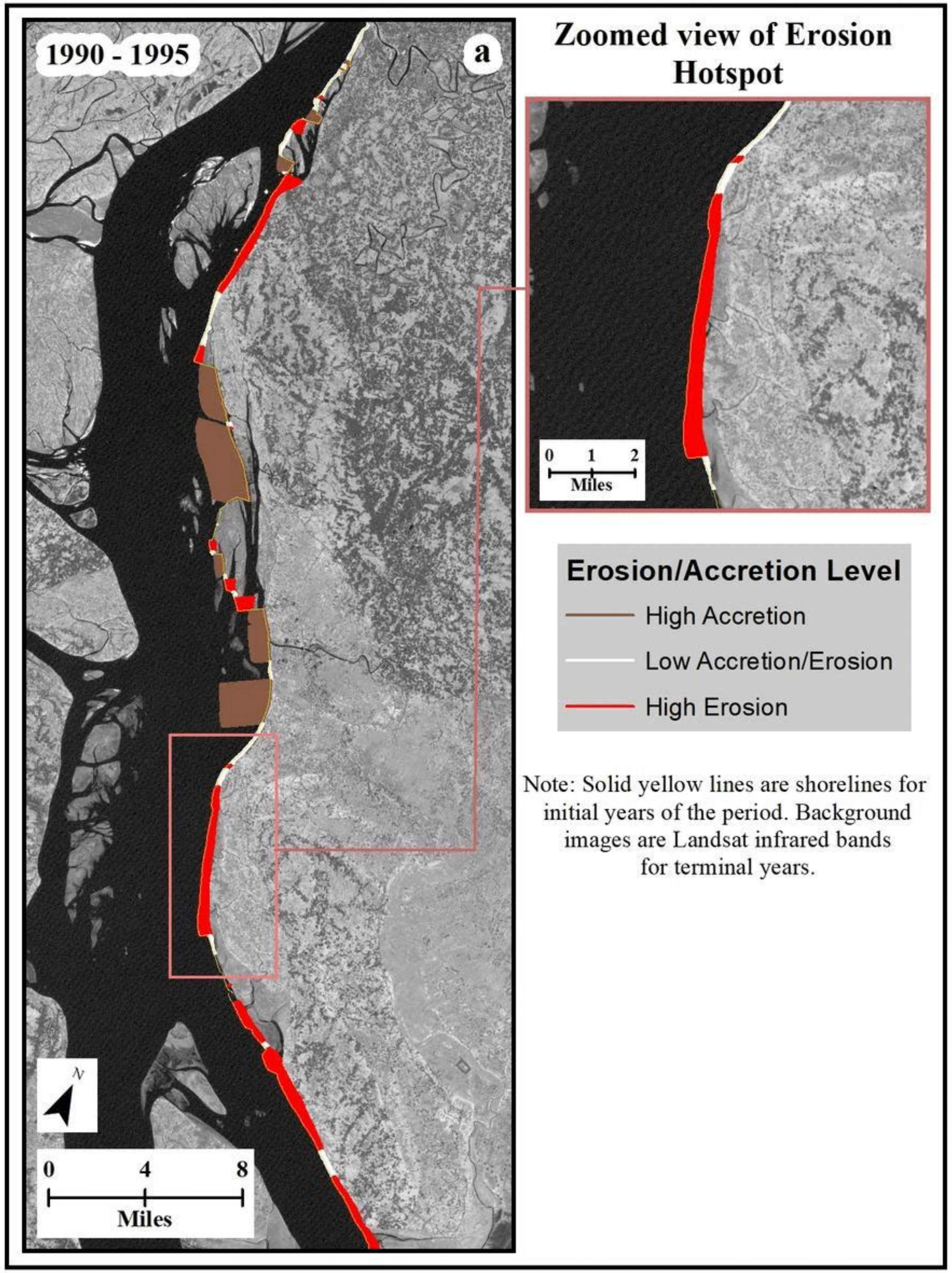
Historical shoreline movement

Decadal shoreline movement in the Lower Meghna River region

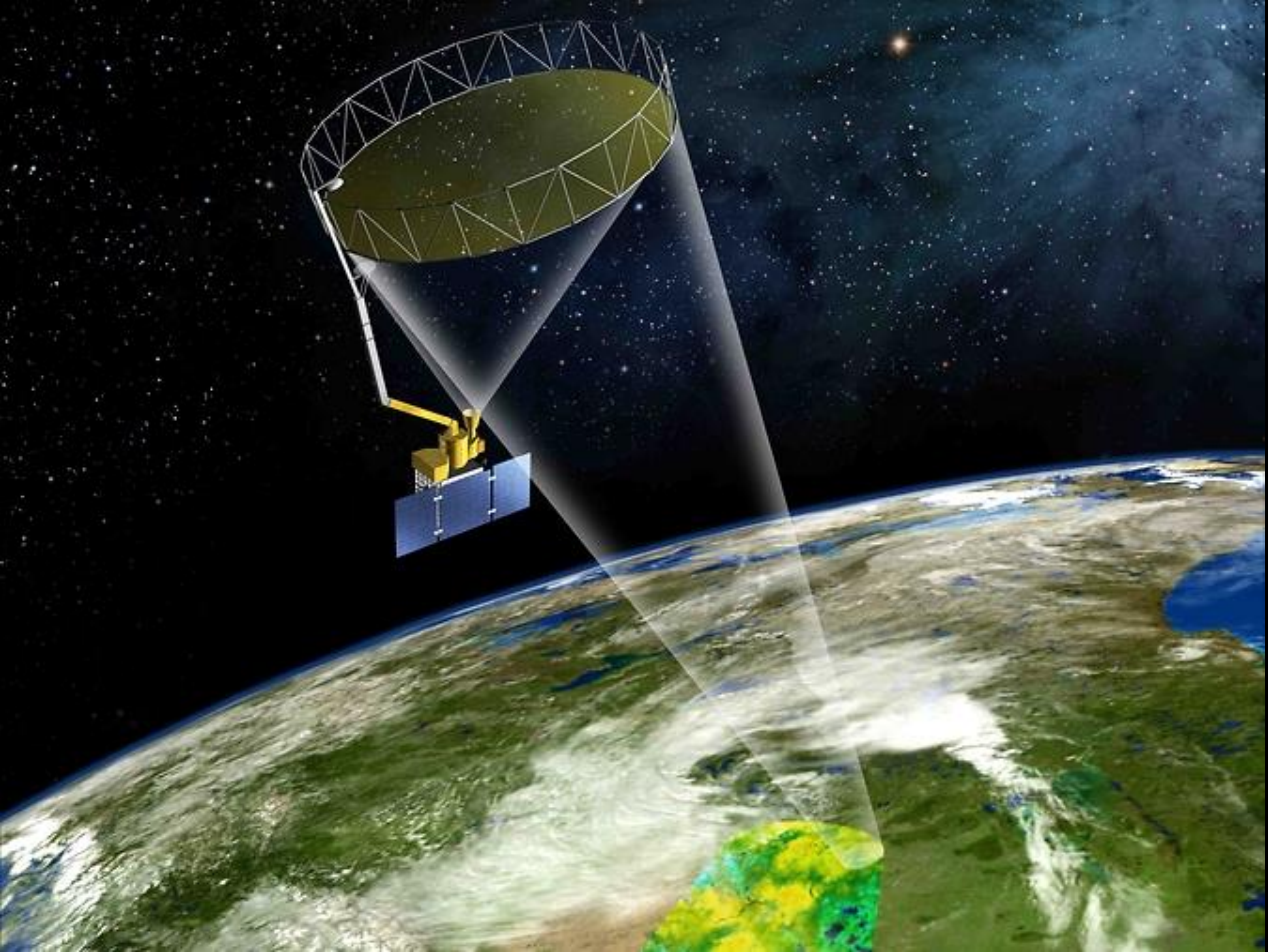
Erosion rates are among the highest in the world causing loss of productive land resources and disruption to households.



Coastal Erosion in Bangladesh



Supporting Drought Management in Angola using Integrated Modeling of the Environment, Vulnerability, Decision Making and Technology (EVDT)



NASA has a satellite called SMAP that has a sensor that can measure the microwaves that reflect from the earth. This allows the sensor to measure water in the soil.

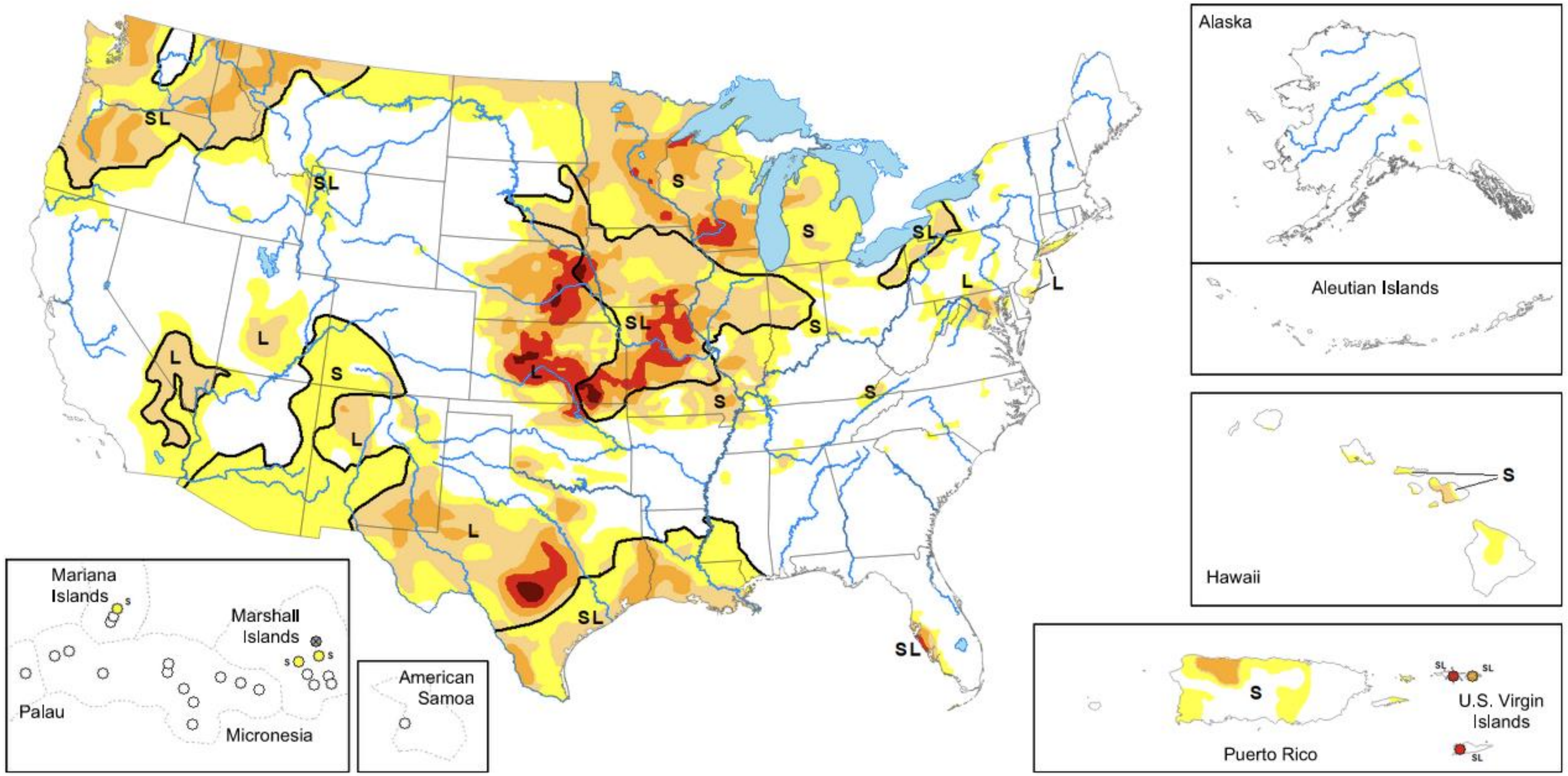
U.S. Drought Monitor

Current | Maps | Data | Summary | About | Conditions & Outlooks | Ag in Drought | En Español | NADM

Map released: July 27, 2023

Data valid: July 25, 2023

☐ View grayscale version of the map



United States and Puerto Rico Author(s):
Brian Fuchs, National Drought Mitigation Center

Pacific Islands and Virgin Islands Author(s):
Brad Rippey, U.S. Department of Agriculture

More maps and statistics:

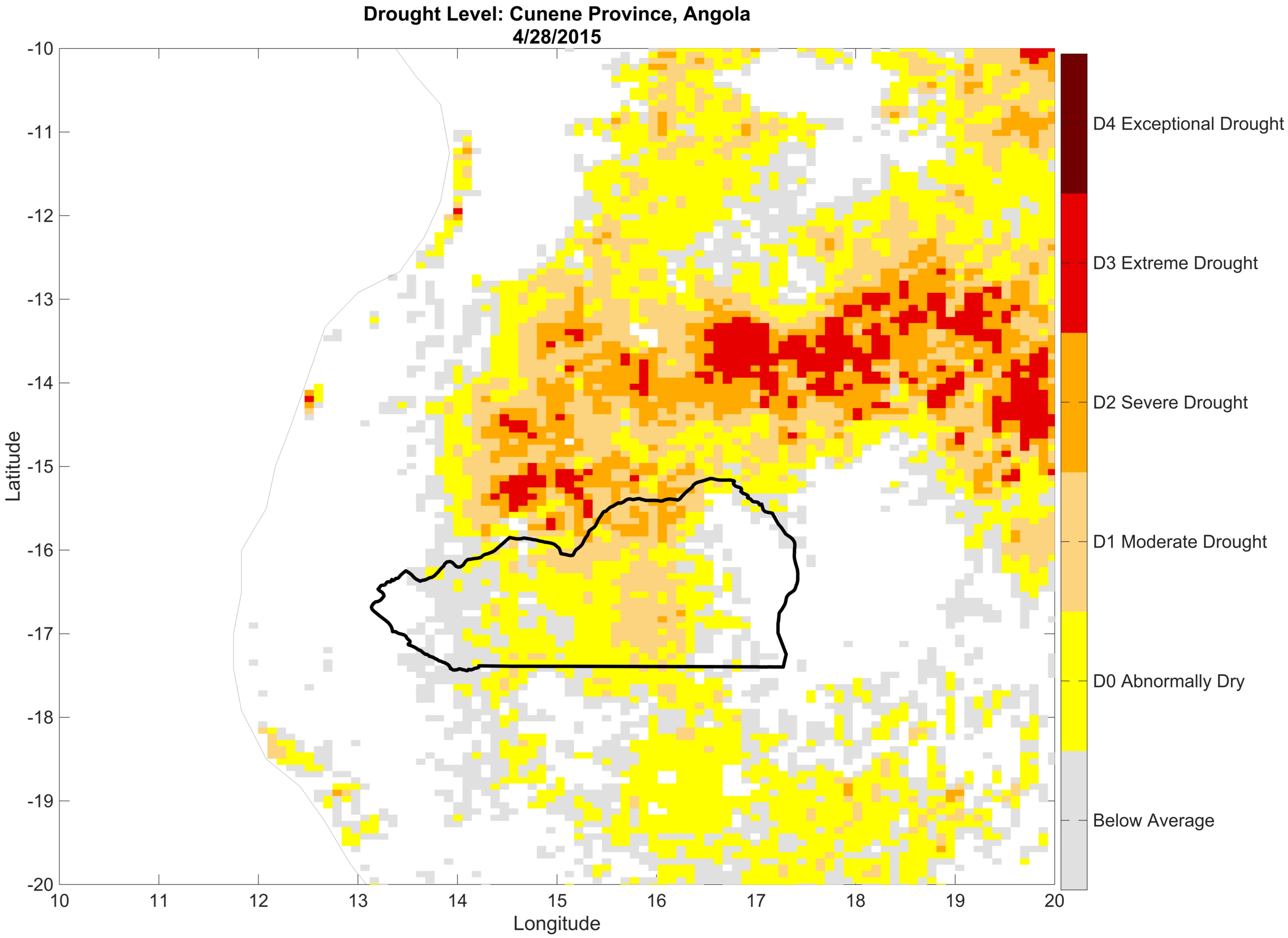
U.S. States and Puerto Rico | Continental U.S. | Regions ▾

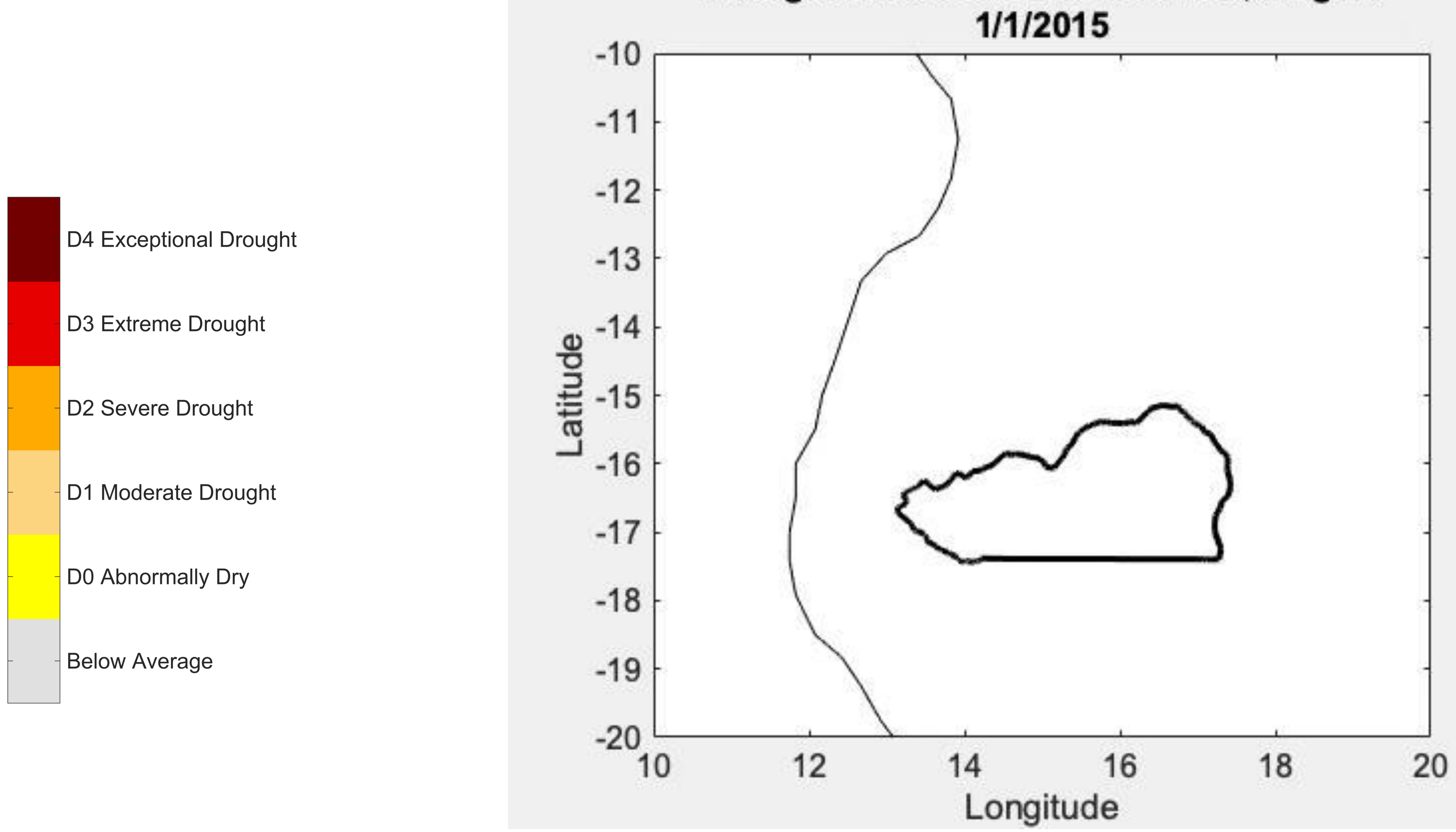
The data cutoff for Drought Monitor maps is each Tuesday at **8 a.m. EDT**. The maps, which are based on analysis of the data, are released each Thursday at **8:30 a.m. Eastern Time**.

Intensity and Impacts

- **None**
- **D0** (Abnormally Dry)
- **D1** (Moderate Drought)
- **D2** (Severe Drought)
- **D3** (Extreme Drought)
- **D4** (Exceptional Drought)
- **No Data**

This project maps the level of drought intensity in Angola for multiple years using data from SMAP. Dark red means very dry soil.




D4 Exceptional Drought
D3 Extreme Drought
D2 Severe Drought
D1 Moderate Drought
D0 Abnormally Dry
Below Average
1/1/2015
Latitude
Longitude
-10
-11
-12
-13
-14
-15
-16
-17
-18
-19
-20
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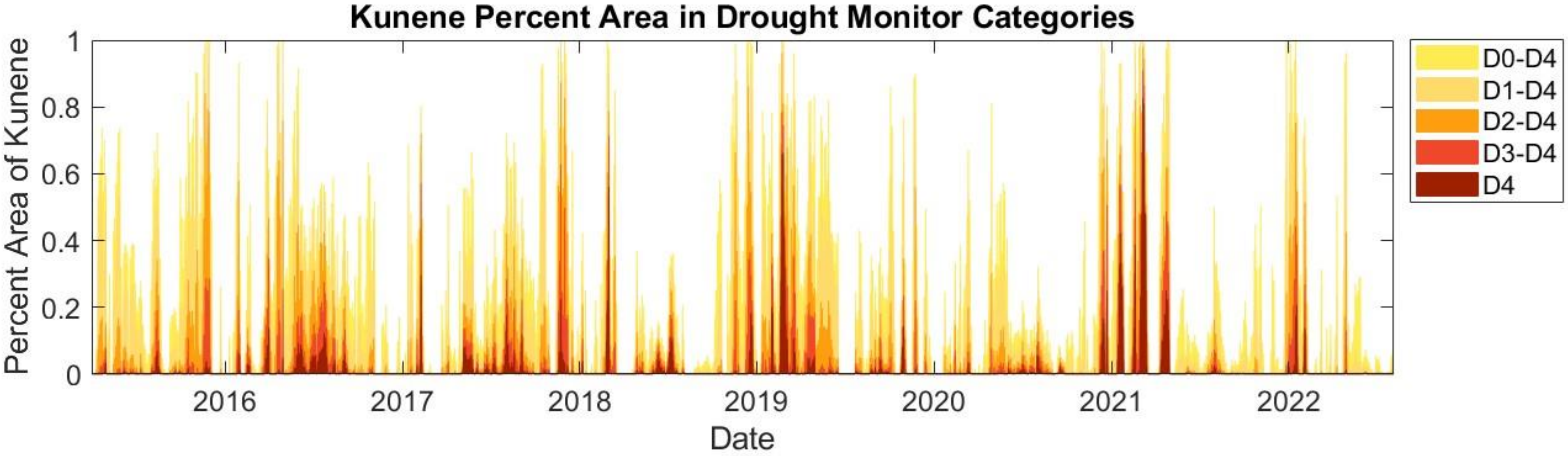
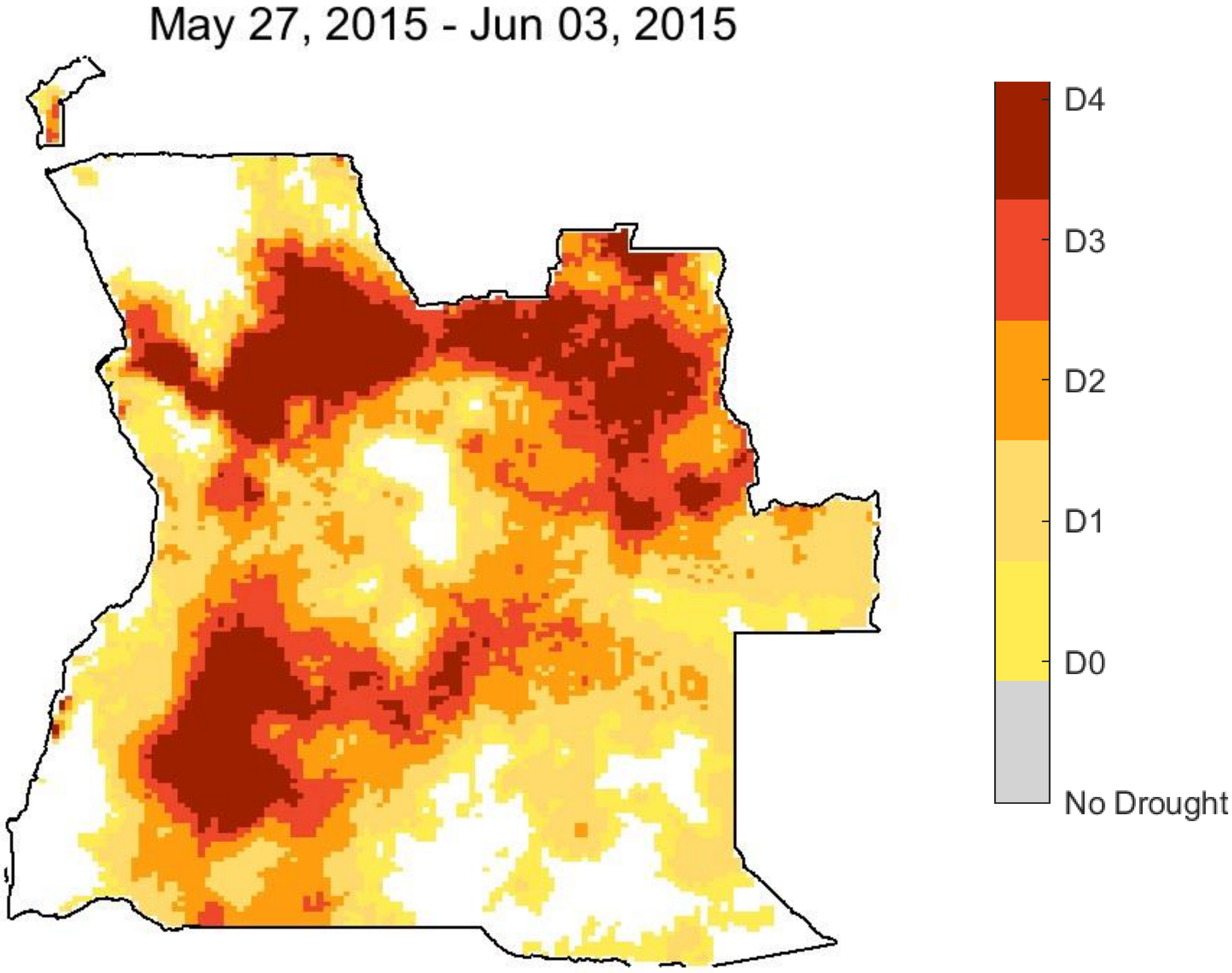
20

Drought time series



This video shows the changing Drought level indicators in Angola from 2015 – 2023. The images show filtered soil moisture data with 8 day averages which are used to estimate the Drought Level. The dates show the middle day in the 8 day period.



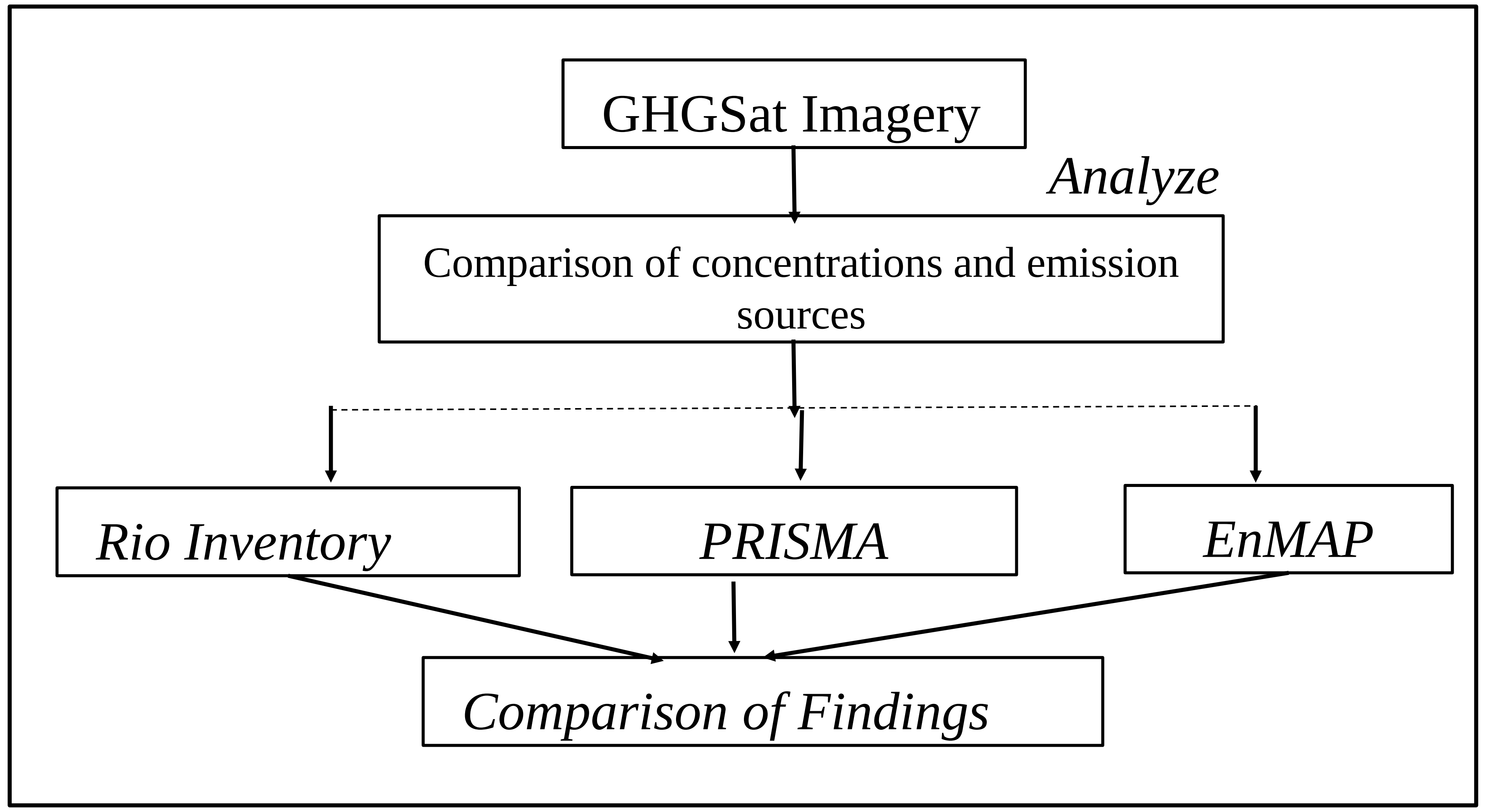
Assessing Accuracy of Greenhouse Gas Emission Inventories in a Multi-Municipality Metropolitan Area

CSDA Onramp #3 GHGSat Evaluation

Assessing Accuracy of Greenhouse Gas Emission Inventories in a Multi-Municipality Metropolitan Area

Description and Objectives

To assess the potential of high-resolution greenhouse gas emissions imagery to supplement standard emissions inventories, this study is using GHGSat data to identify and characterize point sources across the Rio de Janeiro metropolitan area. Objectives: 1) Supplement the Rio de Janeiro GHG emissions inventory process, 2) Provide emissions data that is both timely and geolocated to enable more targeted interventions, and 3) building capacity so that this methodology can be adopted by other cities that use the GPC methodology.



Approach

- Task 1: Reviewing known emissions sources from city of Rio de Janeiro team and reviewing GHGSat catalog
- Task 2: Comparing expected versus measured emissions patterns
- Task 3: Comparison to methods and insights from EnMAP & Prisma
- Task 4: Comparison with the Global Protocol for Community-Scale (GPC) Inventory with City of Rio de Janeiro

Collaborators

- MIT: Danielle Wood, Jack Reid, Sharif Islam, Priscilla Baltezar, Frederick Ajisafe
- IPP, Brazil: Felipe Mandarino, Patricia Carvalho

Issues or Weaknesses of the data

- Low temporal resolutions compared to some existing data products (e.g., Sentinel has high revisit and lower resolution) but this is improving as their constellations grows
- There is uneven geographic coverage with some regions having limited data in the catalog
- The data in the catalog does not cover several of the sites within Rio that we hoped to study

Benefits or Strengths of the data

- GHGSat has higher resolution imagery compared to some existing data products (e.g., Sentinel).
- GHGSat calculated values cohere with previously trusted sources of data

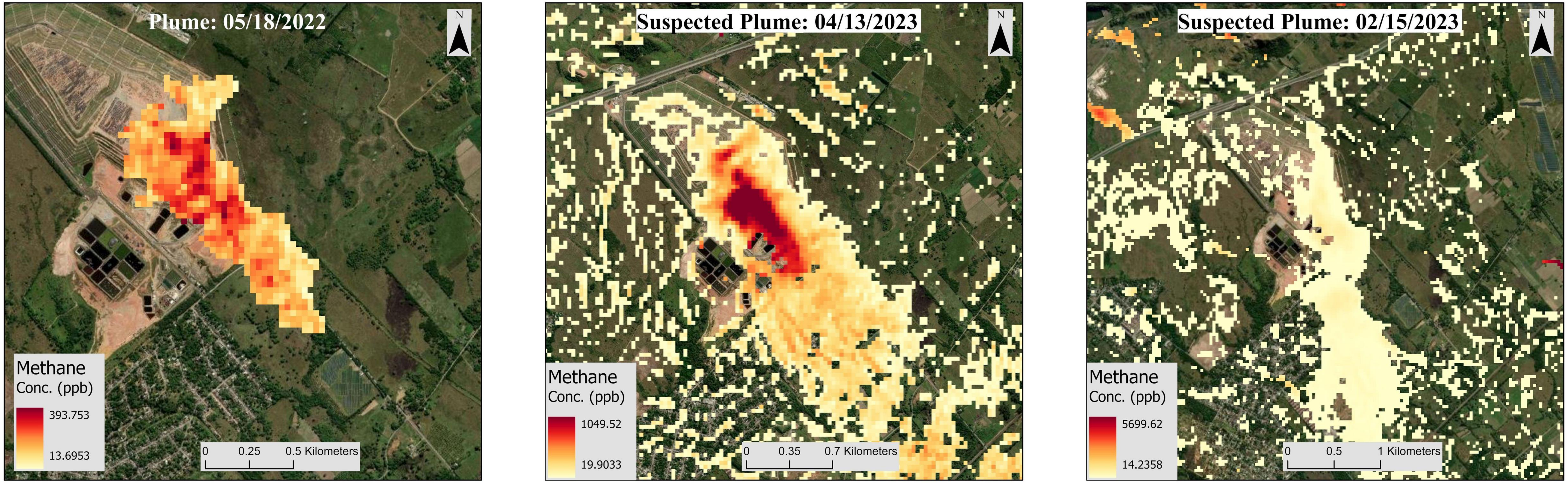
Key Findings

- For a major landfill in Rio de Janeiro, we calculated the emission source rate of a plume and found a rate within 3% of GHGSat (~4200 kg/hr)
- For the same major landfill in Rio de Janeiro, we found general agreement (within 10%) between GHGSat and the IPCC based model used by the city government to estimate annual methane emissions
- As new methane data analysts, we learned how to distinguish between the insights to be gained from area mappers like TROPOMI and point source mappers like PRISMA. The team plans to update our PRISMA analysis to use the matched filter method in order to make a more valid comparison with GHGSat. We will also assess the opportunity to compare with ENMAP data

Utility of GHGSat Data

- High resolution to characterize sources more precisely than historically available satellite-based methane datasets
- Direct methane abundance values bypasses the difficulty of hyperspectral retrievals
- Low spatial and temporal coverage limits the ability to draw robust conclusions about the methane emissions of a potential source

Summary



We found one plume in agreement with GHGSat, and a few other potential plumes that they did not characterize as such. We are gathering historical ground-based wind data that will tell us more about these potential plumes.

Estimator	Method	Wind Speed (m/s)	WS Data Source	Emission Rate (kg/hr)
City of Rio De Janeiro	IPCC			4574
GHGSat	IME	3.2	GEOS-FP	4225
Space Enabled	IME	2.44	MERRA-2	4344

Our estimates of emission rate for the confirmed plume agreed with both GHGSat’s calculation and municipal IPCC-derived estimates.

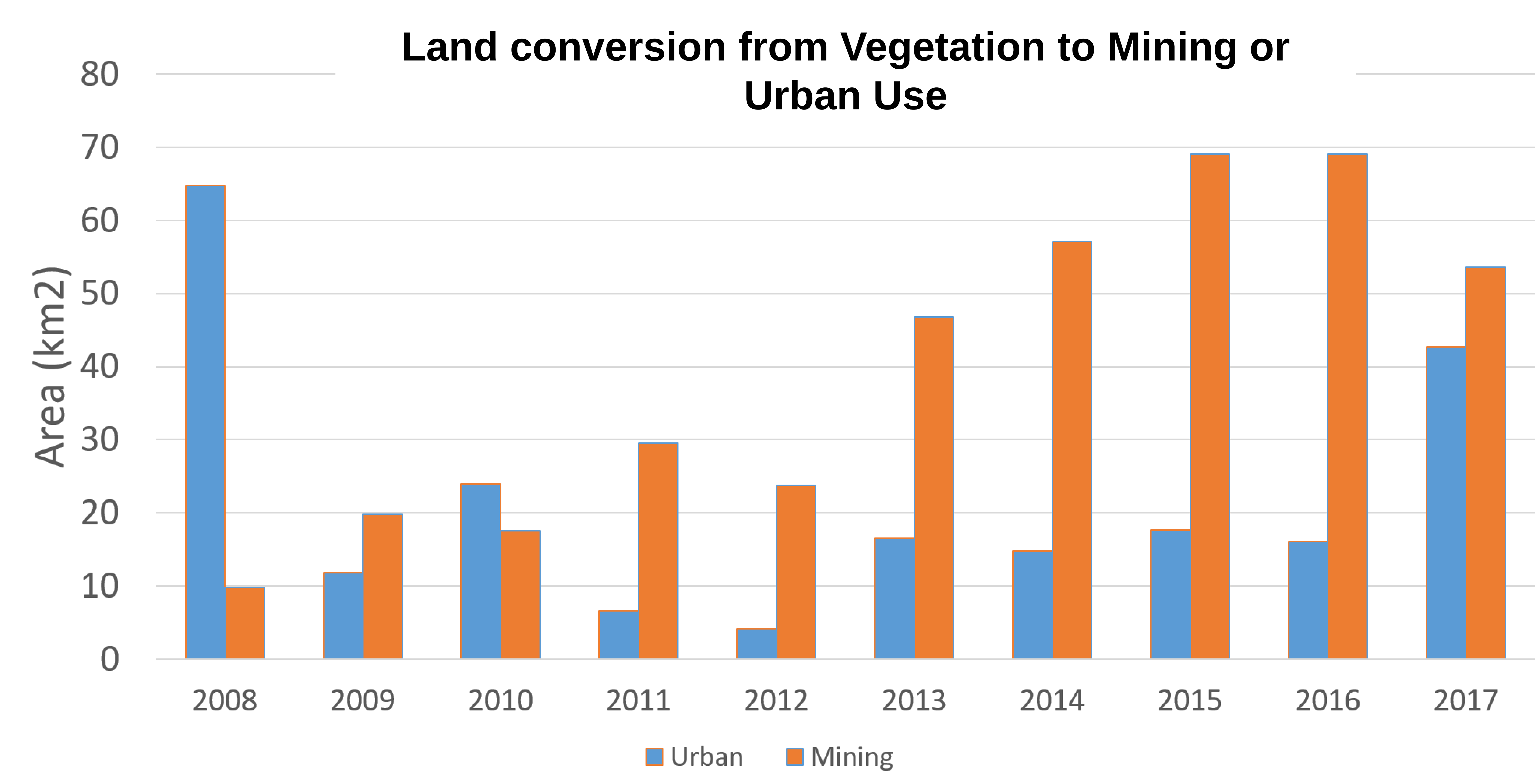
Analysis of deforestation due to artisanal mining in Southwestern Ghana

Study Area: Analysis of deforestation due to mining in Southwestern Ghana

+ Ghana is the 7th Largest producer of gold worldwide

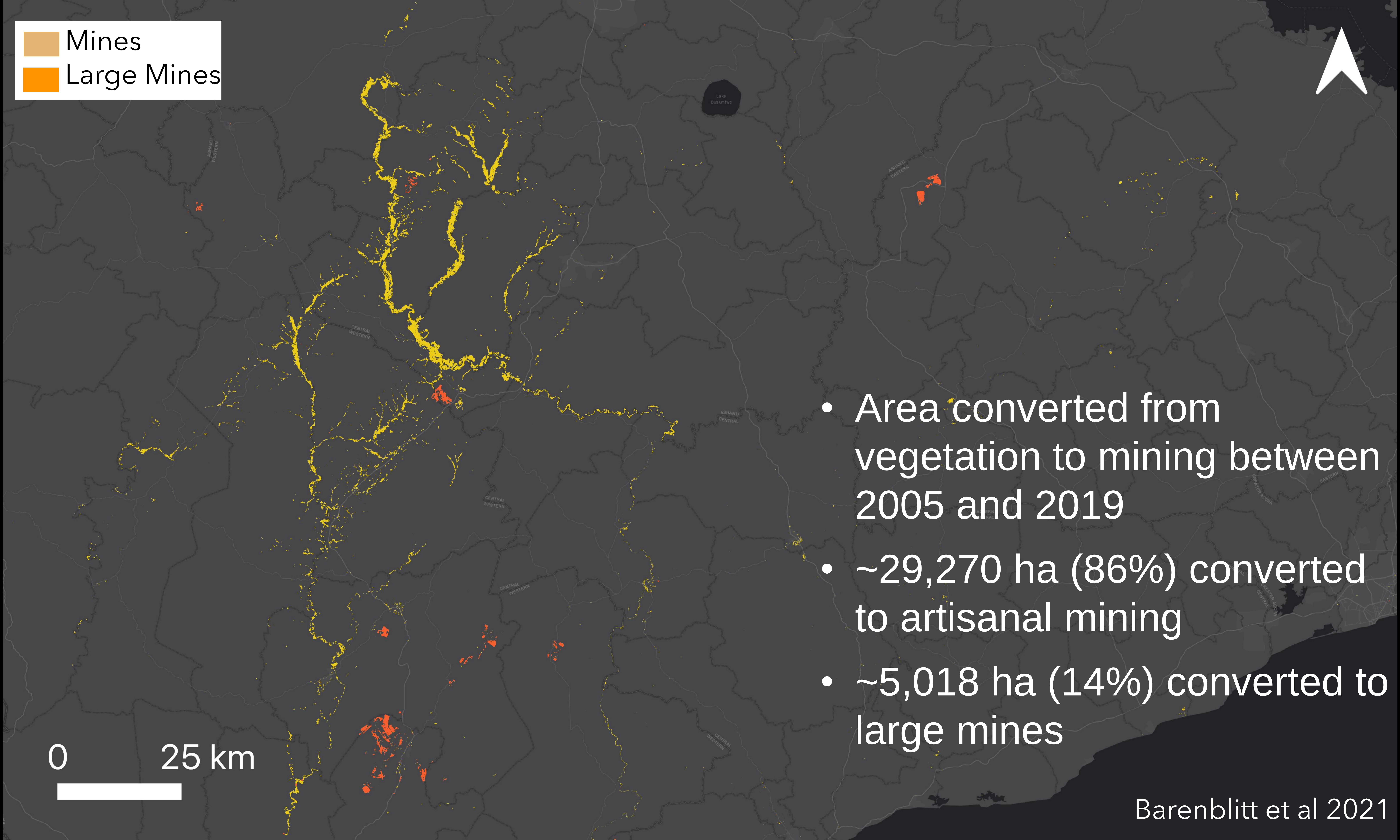
+ Artisanal Mining has increased from 5% of gold production in 1990 to 30% in 2012

+ Artisanal mining causes deforestation and produces Mercury pollution in the environment



The analysis used Landsat 7 and 8 Imagery (Bands 4 to 7). The observational period was 2008-2017. Land was classified into four classes: Water, Urban, Mine and Vegetation

https://assets.bwbx.io/images/users/iqjWHBFdfxIU/iCk5guosUGns/v2/1000x-1.jpg



- Area converted from vegetation to mining between 2005 and 2019
- ~29,270 ha (86%) converted to artisanal mining
- ~5,018 ha (14%) converted to large mines

Barenblitt et al 2021

Designing a Decision Support Tool to support Integrated Water Resource Management and Biodiversity in Lake Nokoue, Benin

440000
460000
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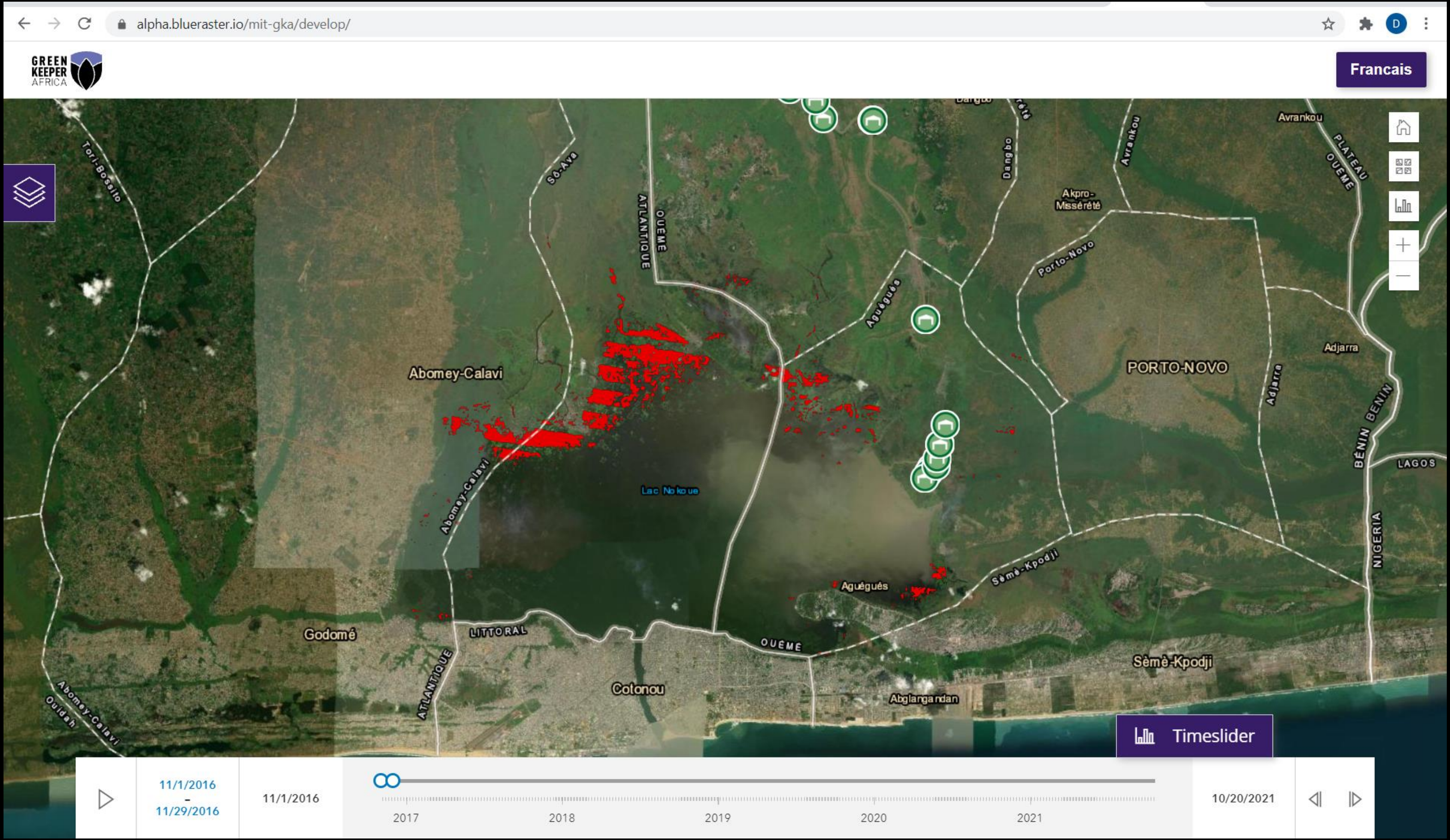
Sô RIVER
SO-AVA
Ouémé
PORTO NOVO
LAGOON
PORTO-NOVO
ABOMEY CALAVI
NOKOUE LAKE
SEME
COTONOU
ATLANTIC OCEAN
0 3 6 12 Km
Legend
Main town
Local government
Stream
Water body

Lake Nokoue


alpha.blueraster.io/mit-gka/develop/
GREEN KEEPER AFRICA
Francais
Avrankou
Dangbo
Akpro-Missérété
Porto-Novo
Aguégués
Adjarra
PORTO-NOVO
PLATEAU
OUEME
ATLANTIQUE
Sô-Ava
Tori-Bossito
Abomey-Calavi
Lac Nokoue
LAGOS
BENIN
NIGERIA
Sèmè-Kpodji
Godomé
LITTORAL
Cotonou
Abglangandan
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2021
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