



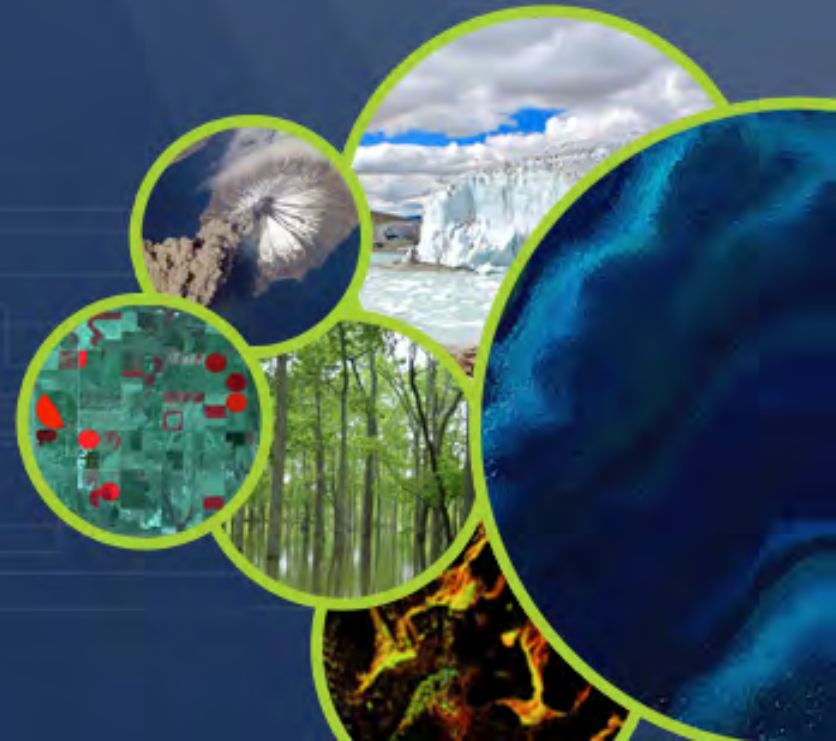
The Africa Regional Data Cube

A webinar hosted by the Africa Open Data Network (AODN)

October 30, 2018

Dr. Brian Killough

CEOS Systems Engineering Office
NASA Langley Research Center

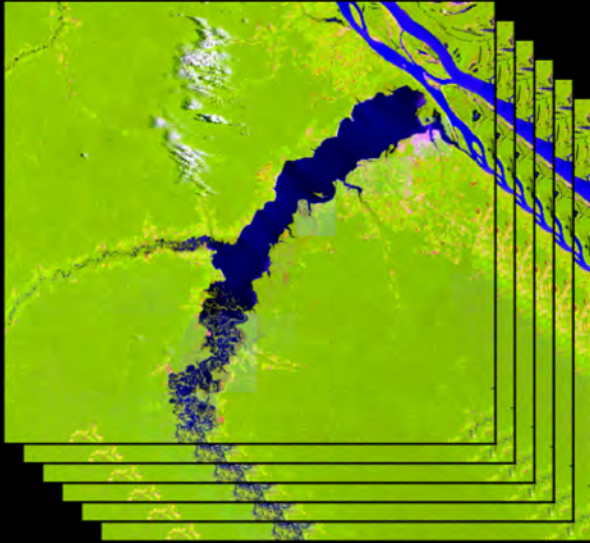


Committee on Earth Observation Satellites (CEOS)

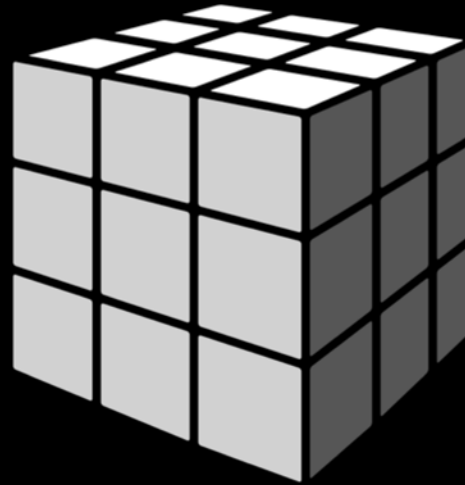


**International coordination of satellite data ...
24 countries, 62 members, 163 active satellites**

What is a Data Cube?



**8000 Landsat
images over
17 years**



**1000 Data Cube
storage units
(1° x 1° x 1 year)
Processed and ready!**



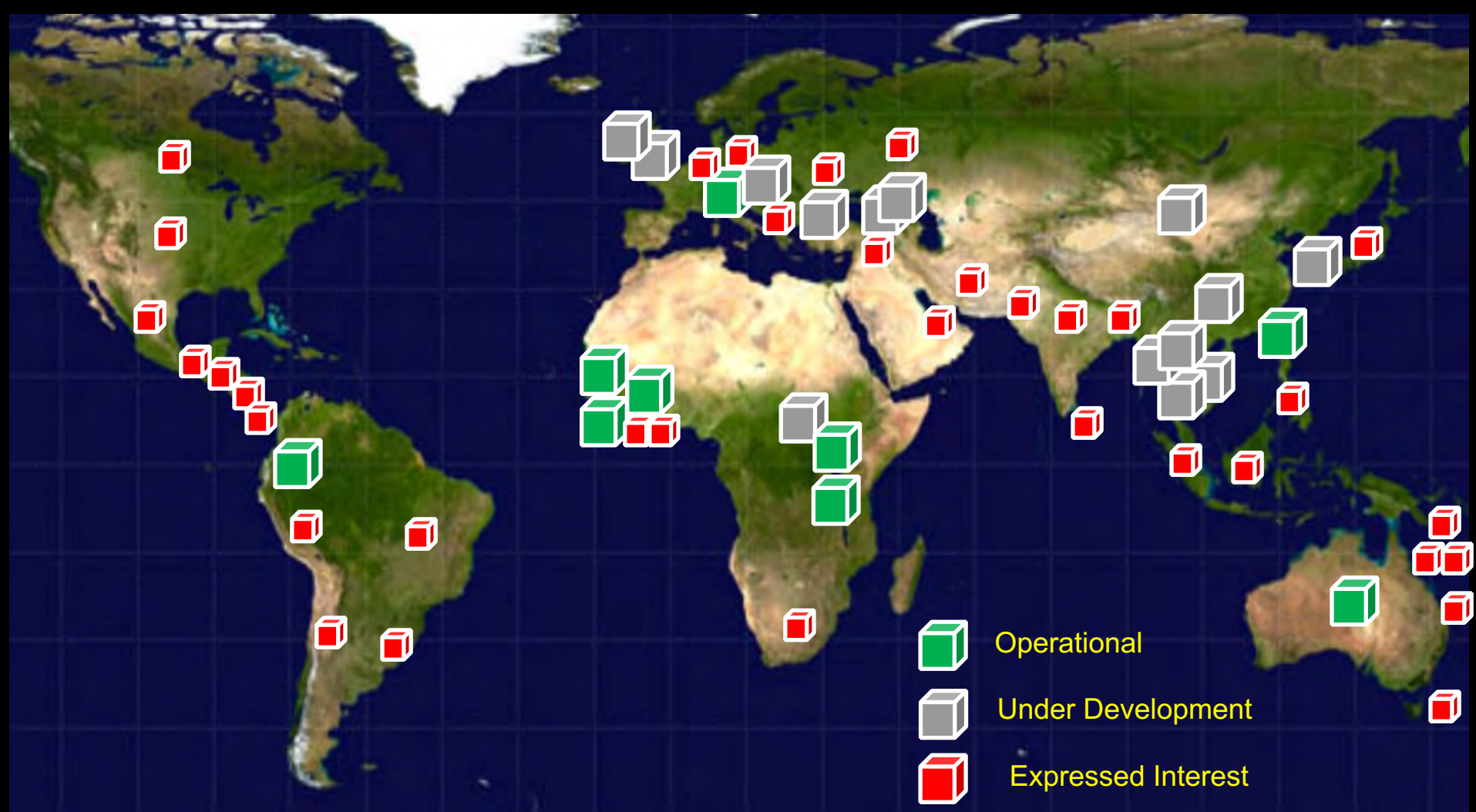
**8x data
compression**

Why do we need Data Cubes?

- Makes it easier to use satellite data by reducing preparation time
- Makes it easier to query data in time and space for powerful application products
- Provides free and open source software and algorithms for the cloud or a local computer
- Allows community development, shared capacity building and organized algorithms
- Enables efficient time series analyses and data interoperability
- Because it works ... just ask Australia and Switzerland!



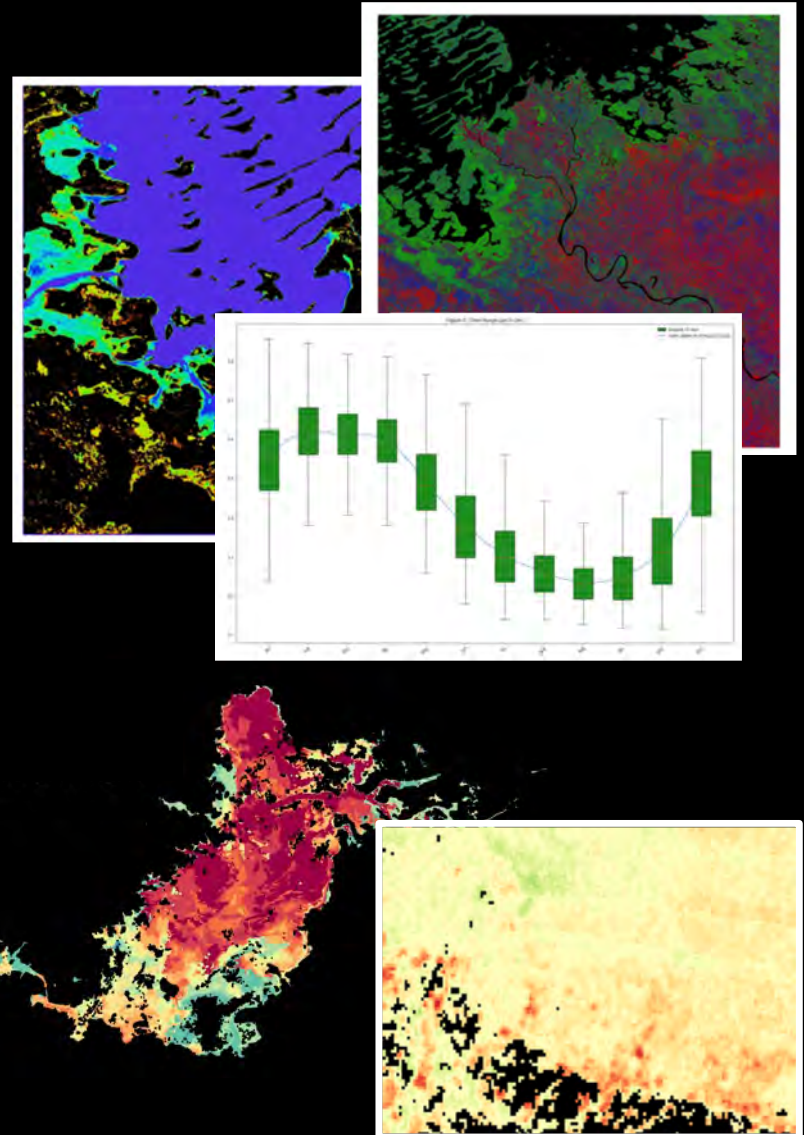
Where are the Data Cubes?



55 countries are interested with 9 in operation and 14 coming soon!

How can we use Data Cubes?

- **Cloud-free Mosaics:** Recent Pixel, Median, Geomedian, Max-NDVI
- **Spectral Indices:** NDVI, NDBI, NDSI, NDWI, SAVI, EVI, Fractional Cover
- **Land Classification:** K-Means, Random Forest
- **Water:** Extent - Landsat WOFS (Australia), Sentinel-1 WASARD (NASA), Quality - Total Suspended Matter
- **Land Change:** PyCCD (USGS), PCA (Colombia), Spectral Anomaly, Sentinel-1 Radar (Deutscher), Coastal Change, Landslide Risk



Africa Regional Data Cube (ARDC)

- Launched in May 2018 for 5 countries (Kenya, Tanzania, Sierra Leone, Senegal, Ghana). Initially based on Landsat, but S1, S2 and ALOS data are coming soon!
- Supported by CEOS (lead + technical support), Amazon (donated cloud services) and GPSDD (training + management support)
- Recent web-based remote training for Ghana (July), Tanzania (August+Oct+Nov), and Sierra Leone (August).
- Initial country use-cases include agriculture, flooding, urbanization, deforestation and illegal mining.

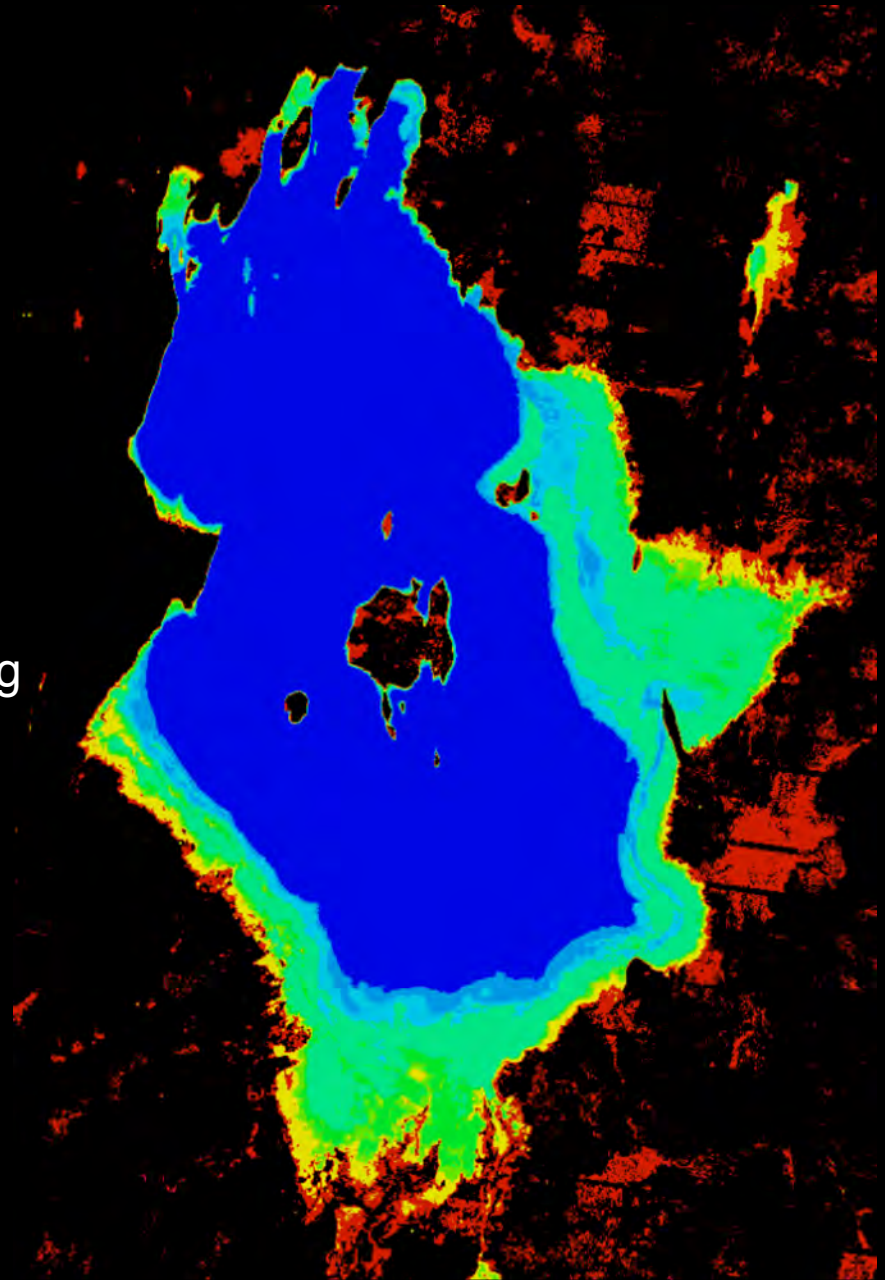
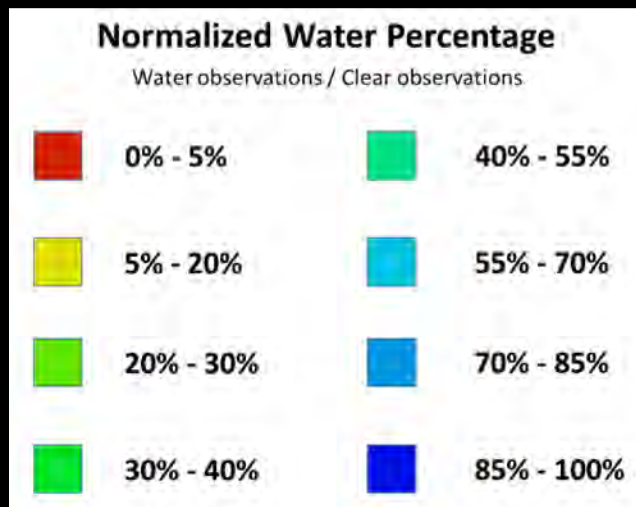


Water Extent

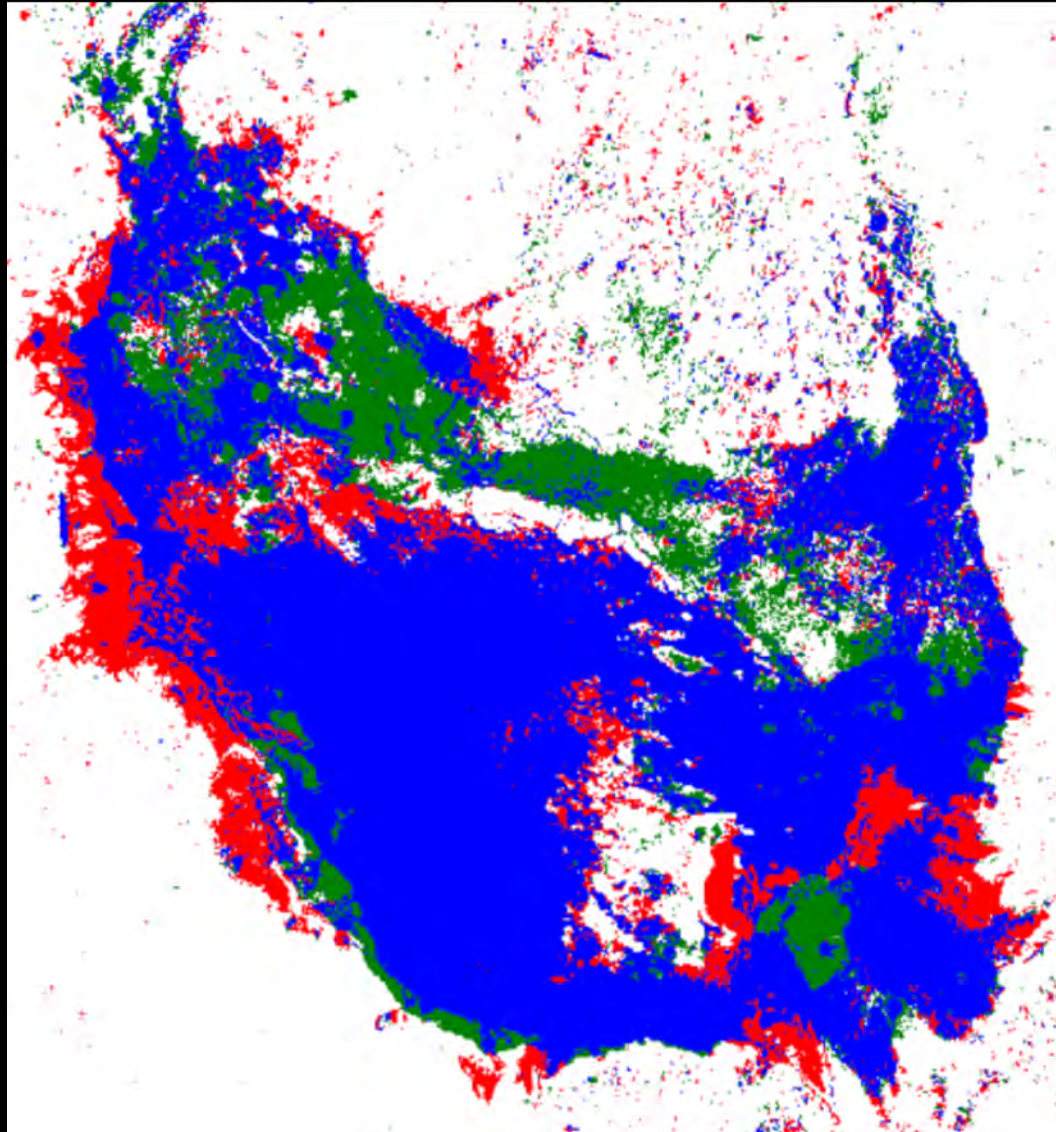
Lake Baringo in Kenya, Africa

A critical habitat and refuge for more than 500 species of birds and fauna. Water levels have been reduced by droughts and over-irrigation and the lake is commonly turbid with sediment.

A 17-year time series (2000 to 2017) showing the % time that every pixel has observed water.



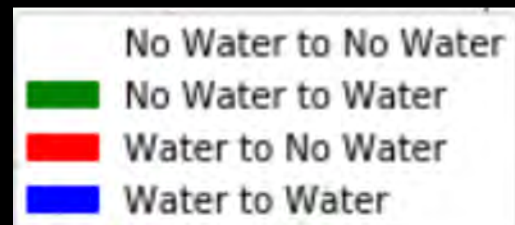
SDG 6.6.1 - Water Extent



Lake Sulunga in Tanzania

From 2014 to 2018, there is a **net loss of 3.8%** of water pixels. This is considered an “Unmodified Natural” change or “Class-A”.

Analysis followed the SDG 6.6.1a indicator methodology (20 Jan 2017) and used the Landsat WOFS water detection algorithm.



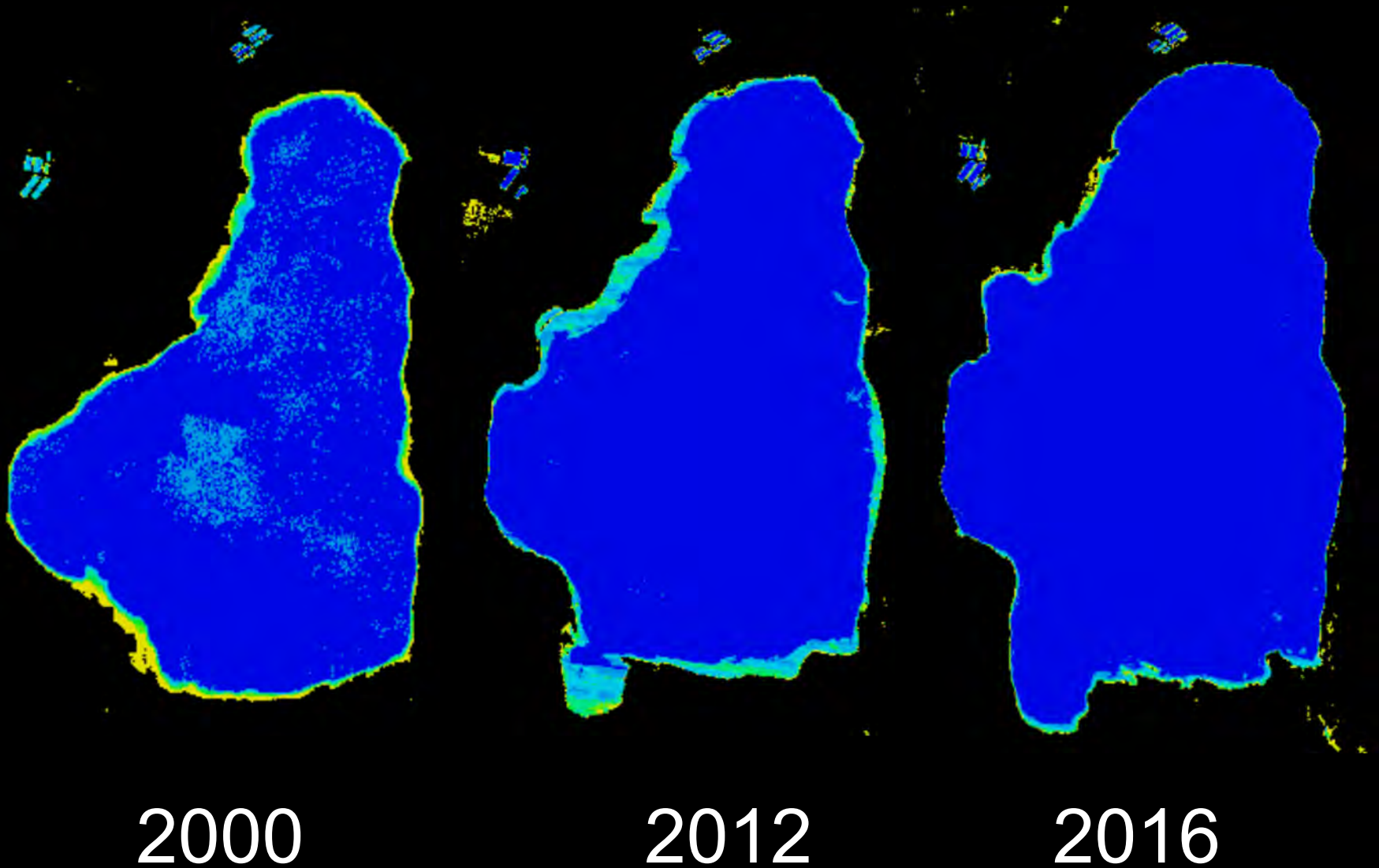
Lake Sulunga, Tanzania

A time series water extent analysis can be used to show relative changes in water depth

Apr 2013



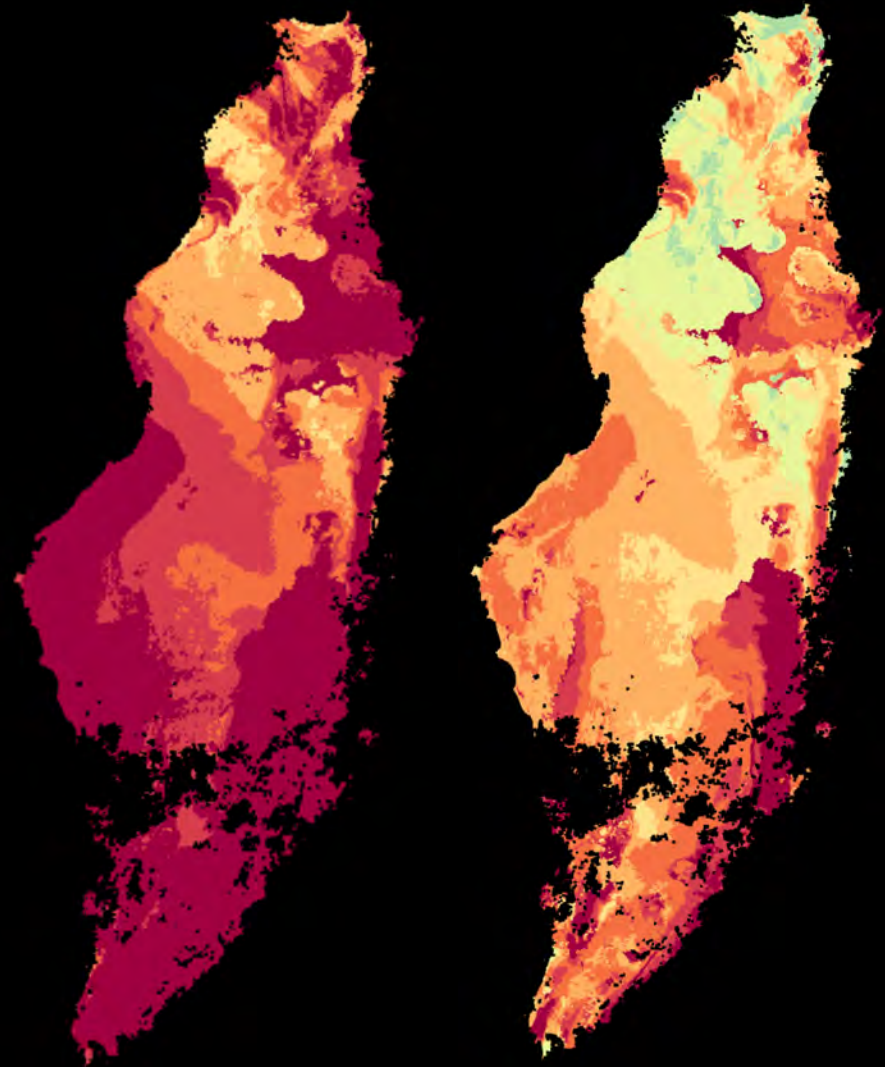
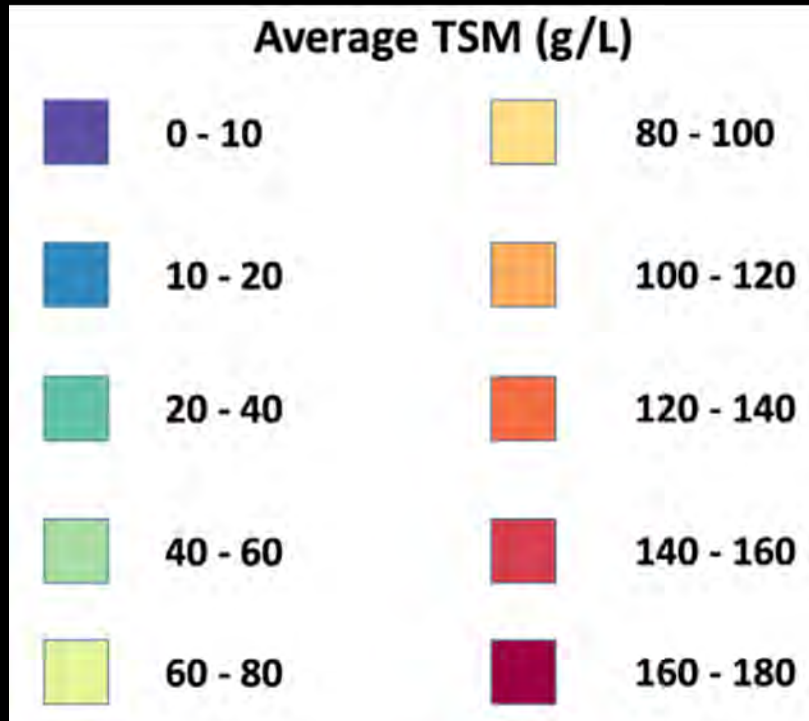
Lake Nakuru, Kenya: Water History



SDG 6.3.2 - Water Quality

Lake Manyara in Tanzania
Feb 2013 to Dec 2016

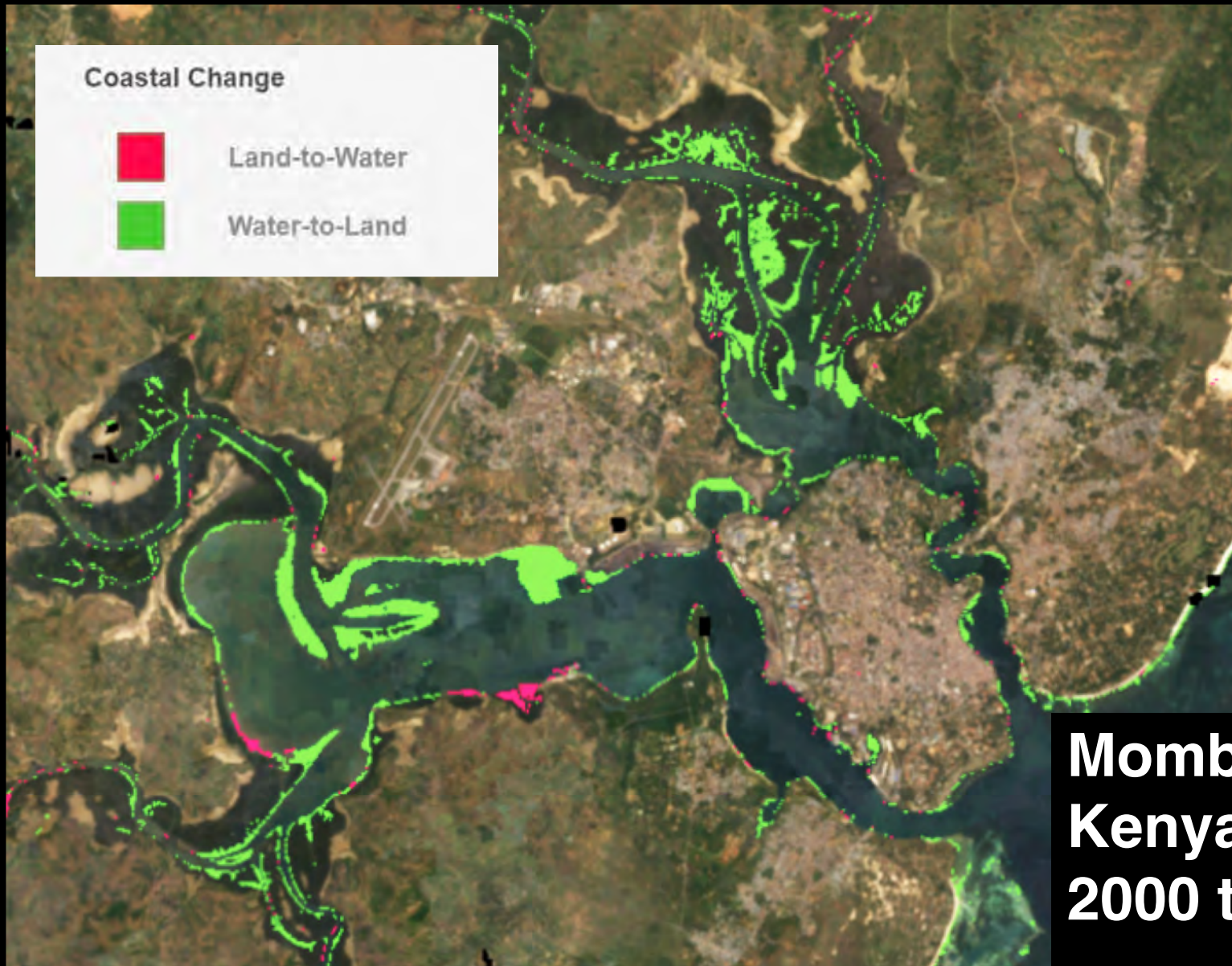
Total Suspended Matter (TSM)



Maximum

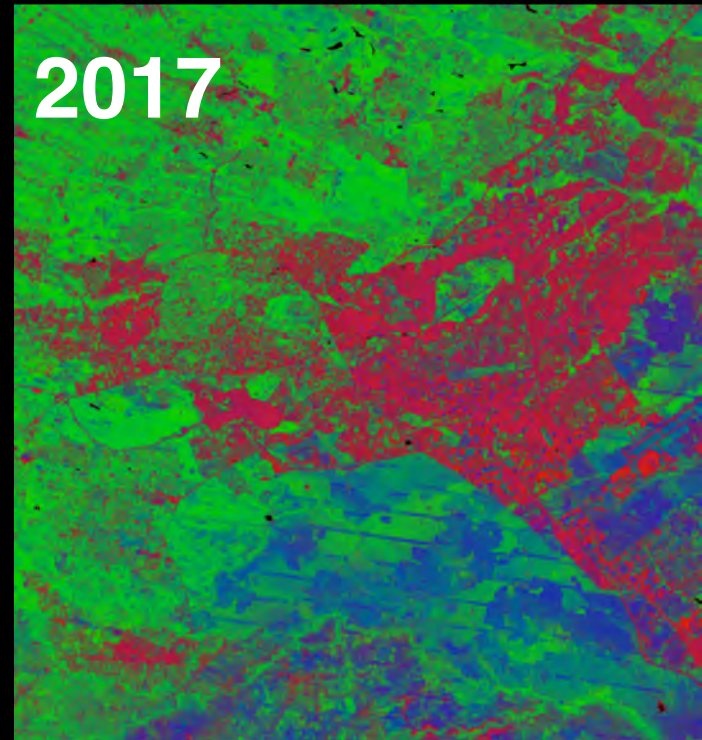
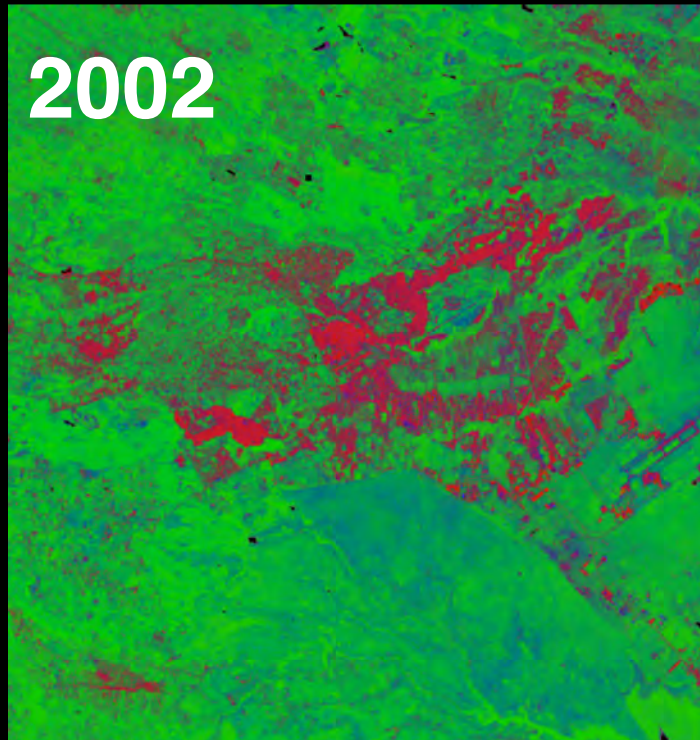
Variability

Coastal Change



**Mombasa,
Kenya
2000 to 2015**

SDG 11.3.1 - Urbanization



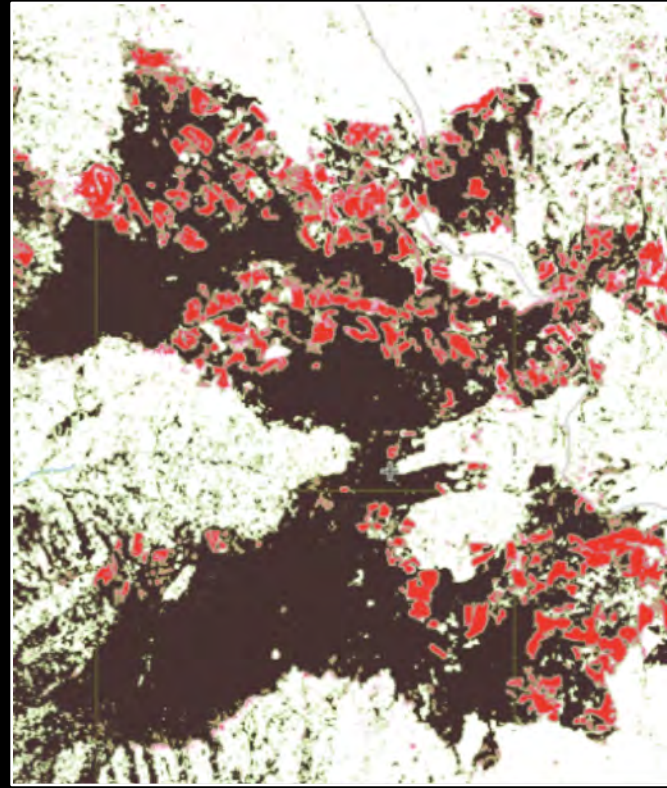
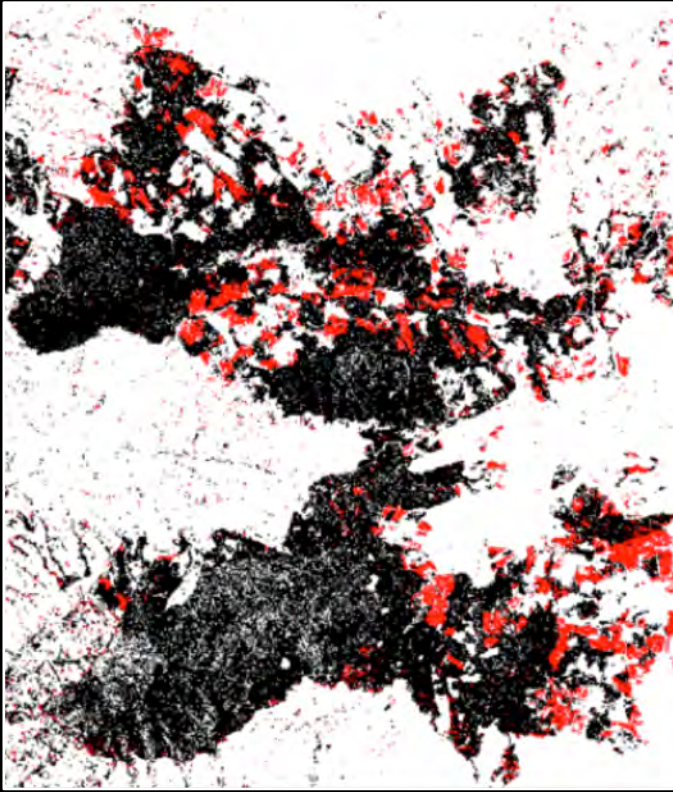
Urbanization in Nairobi, Kenya – 2002 to 2017 (15 years)

Urban Area Growth = 6.7% per year (Landsat-7 Fractional Cover, 0.6 threshold)

Population Growth = ~ 4 % per year (according to several web sources)

What does this tell us? Nairobi is rapidly expanding its urban footprint at a rate that is 1.7x faster than the population is growing. Is this population growth and urban area expansion sustainable and what are the impacts?

SDG 15.1.1 – Forest Area

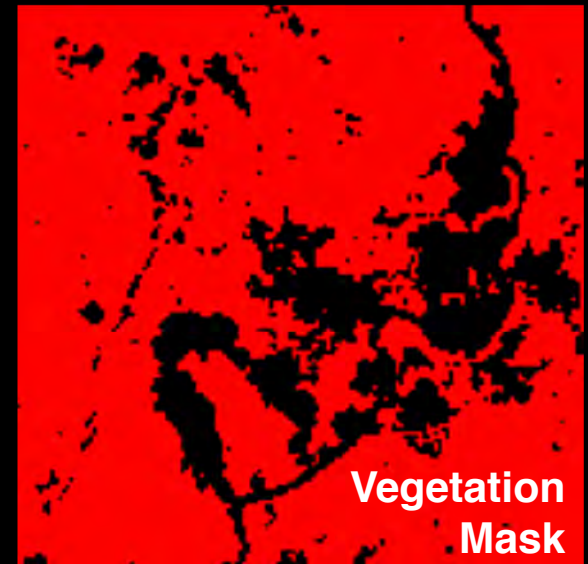
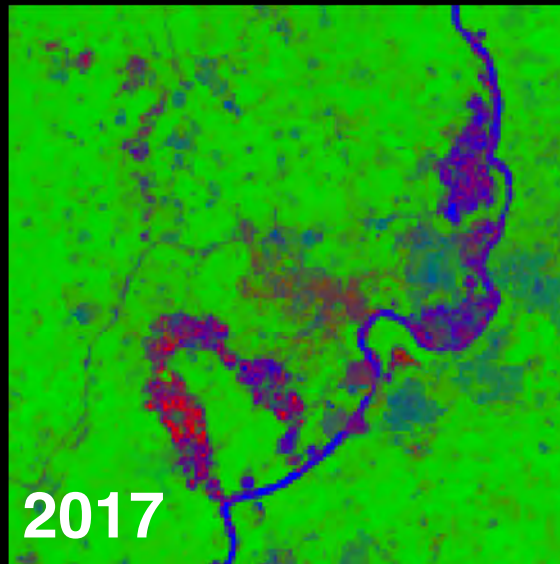
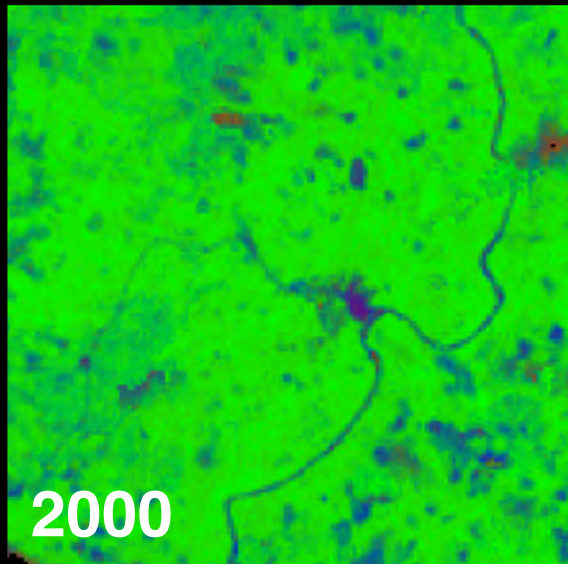


Mau Forest in western Kenya

Results from Data Cube (left) closely compare well with the Global Forest Watch (<https://www.globalforestwatch.org/>) product (right).

Using an EVI threshold approach, there is a **loss of 5.7%** of the land to devegetation (likely deforestation) from 2002 to 2017.

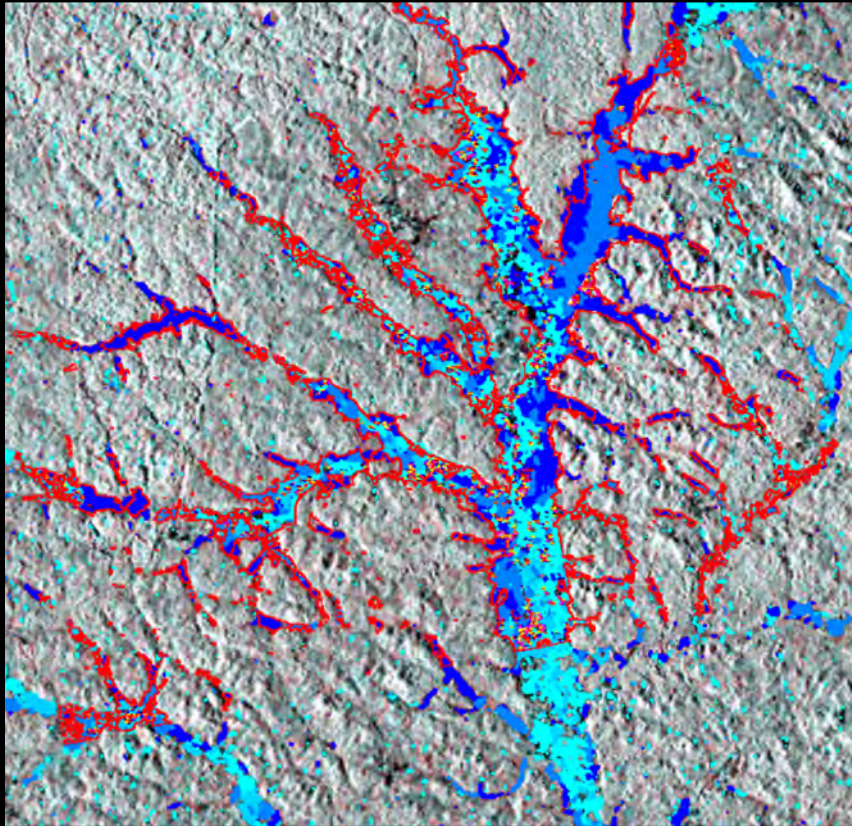
SDG 15.3.1 – Land Degradation



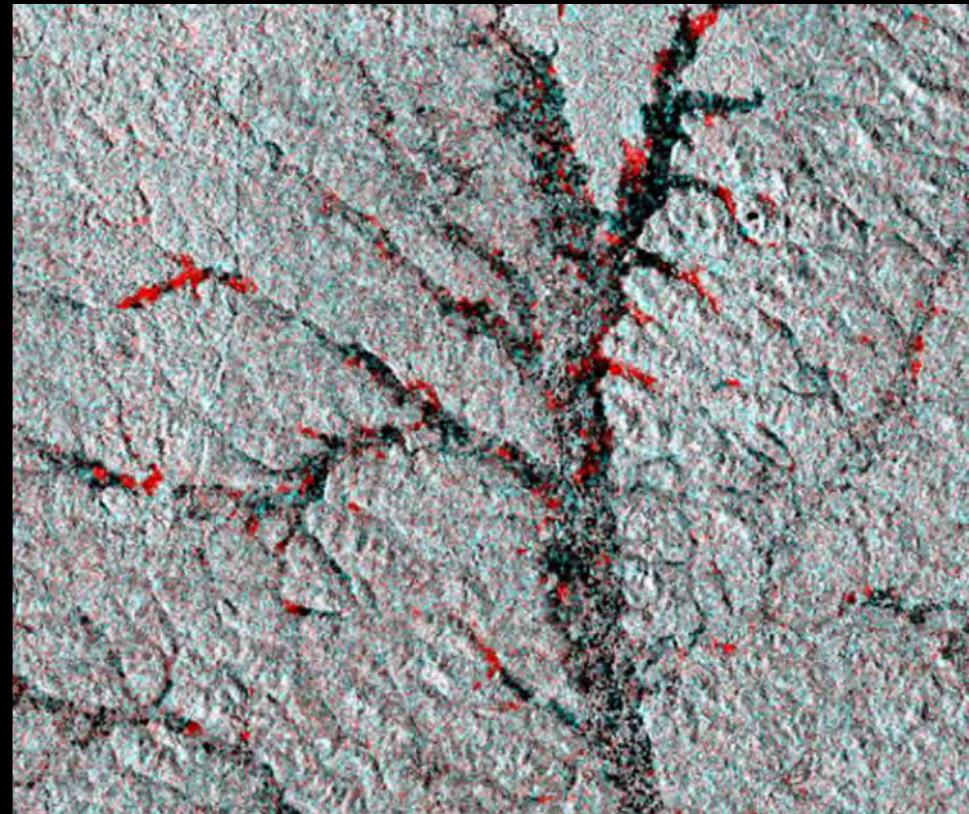
Mining along the Ankobra River in Ghana

There is a 13% loss in dense vegetation from 2000 to 2017. These illegal mines have a significant impact to land and water resources.

Sentinel-1 C-Band Radar



2015-2018 Land Change (RED)



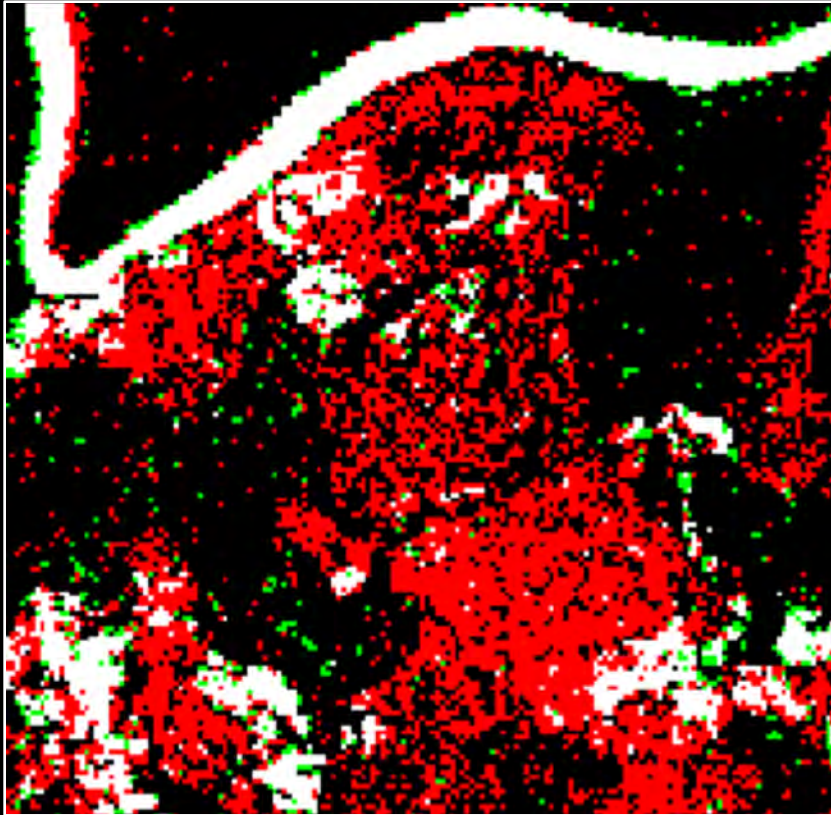
Feb-Nov 2018 Land Change (RED)

Land Change (likely illegal mining) in Ghana

Testing sample pre-processed Sentinel-1 datasets that can be used in the data cube for operational land change detection.

ALOS L-Band Radar

Caqueta, Colombia



Open Data Cube Results

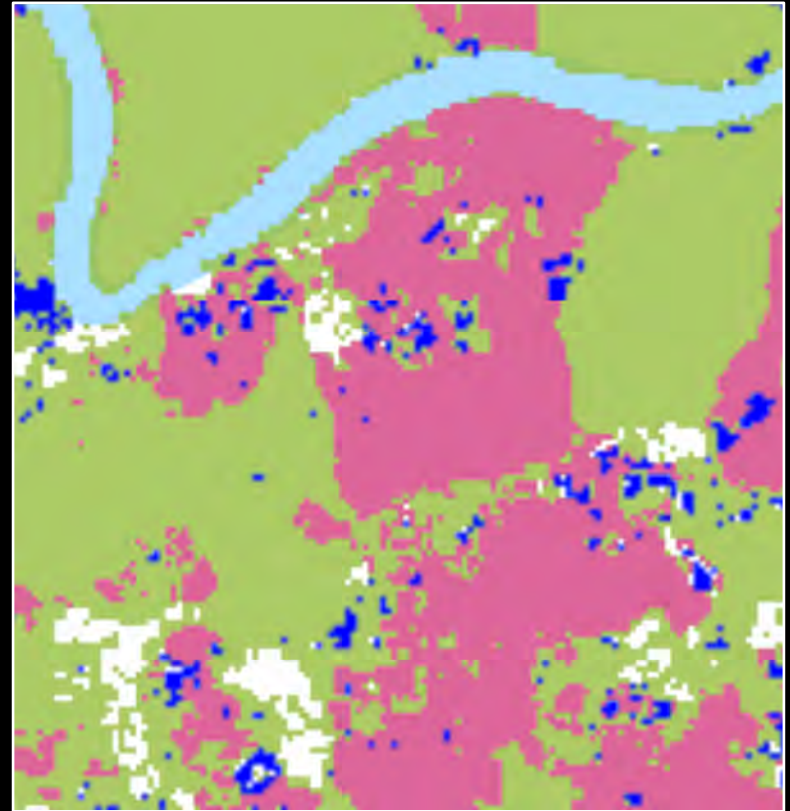
HV Threshold Change from 2010 to 2016

RED = Vegetation Loss

GREEN = Vegetation Gain

WHITE = Non-Forest Mask

BLACK = No Land Change



Global Forest Watch Results

Deforestation from 2010 to 2016

GREEN = Forest mask

RED = Forest Loss

BLUE = Forest Gain

WHITE = Non-forest

The Future



- Add Sentinel-1 (radar), Sentinel-2 (optical, similar to Landsat) and ALOS (radar) data by early 2019. Also update the current Landsat data.
- Improve ARDC operations and scaling of Amazon Cloud resources to accommodate more users and improve performance
- GPSDD is hiring a new technical lead to help support the ARDC
- Develop an organized Application Library to share the latest algorithms
- Develop an organized ODC Learning Center with training products (Tutorials, Videos, Case Studies)

THANK YOU

Web: opendatacube.org

Twitter: [@opendatacube](https://twitter.com/opendatacube)

ARDC Web Tool: tinyurl.com/ardc-tool