The Open Data Cube

Africa Regional Data Cube
Remote Training Workshop for Tanzania

October 9, 2018

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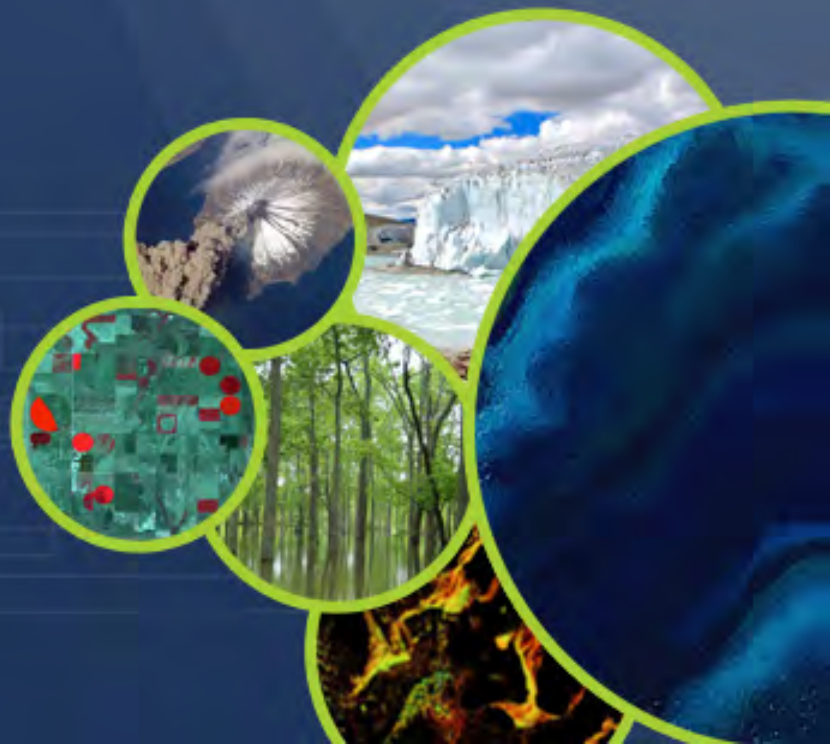
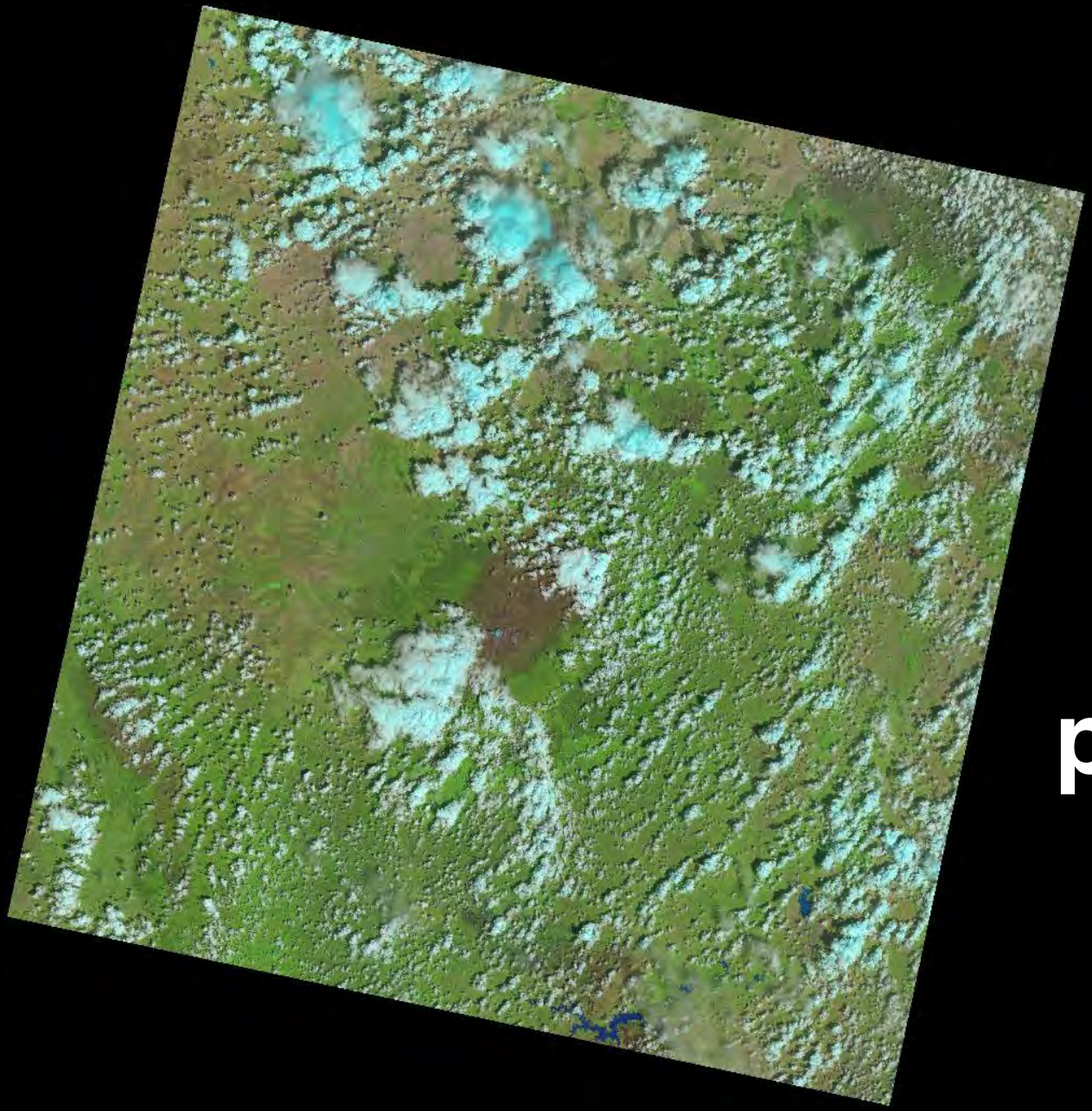


Committee on Earth Observation Satellites (CEOS)

International coordination of satellite data …
22 countries, 60 members, 137 active satellites



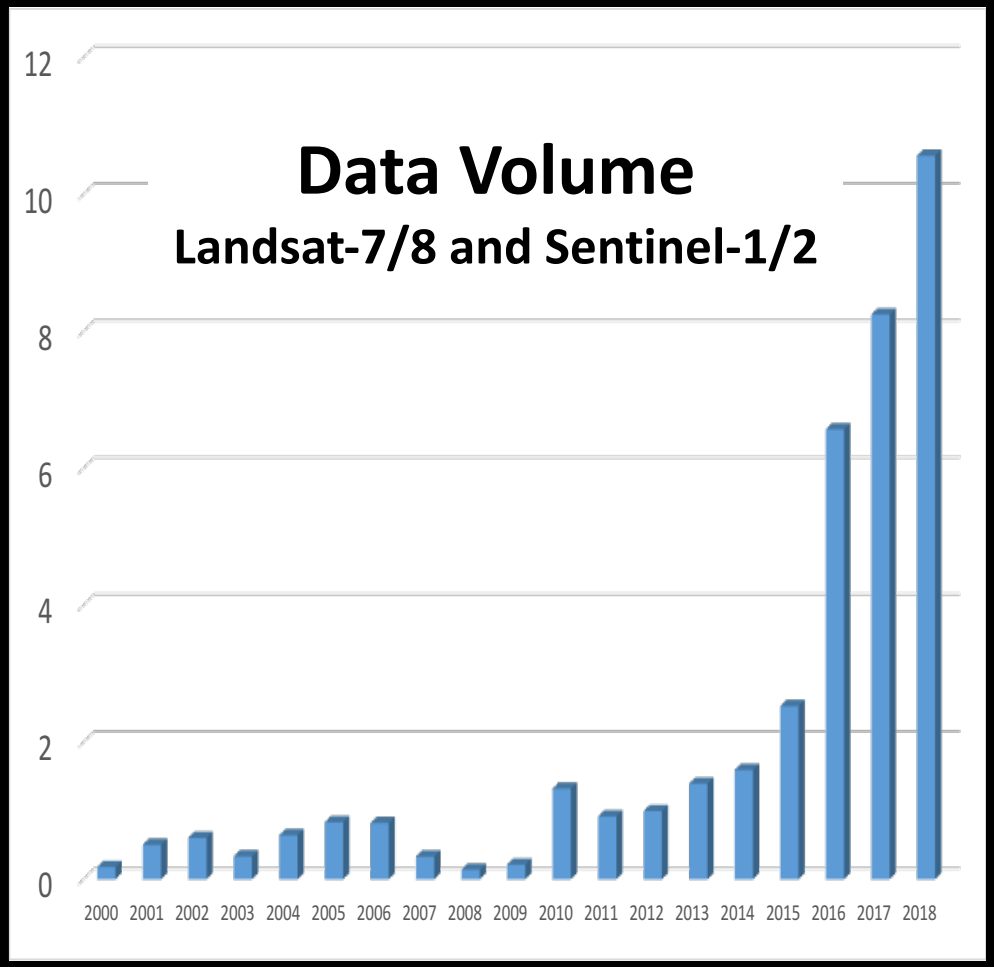
Landsat
$600
per scene
in 2007

34 scenes to cover Kenya

$918,000 per year

Now it is FREE!

The Big Data Problem



- Free data has **increased data volumes** by 10x in the last 5 years.
- Many countries **lack the expertise, infrastructure, and resources** to access and use the data to create products.
- Countries have requested help ...

The Latest Trends

Free and Open Resources

- Abundant Satellite Data
- Open Source Software and Tools

Global Engagement

- Improved communication
- Increased cooperation and collaboration

Global Philanthropy

- Google Earth Engine, Earth on AWS
- Governments, World Bank, Others (GPSDD)

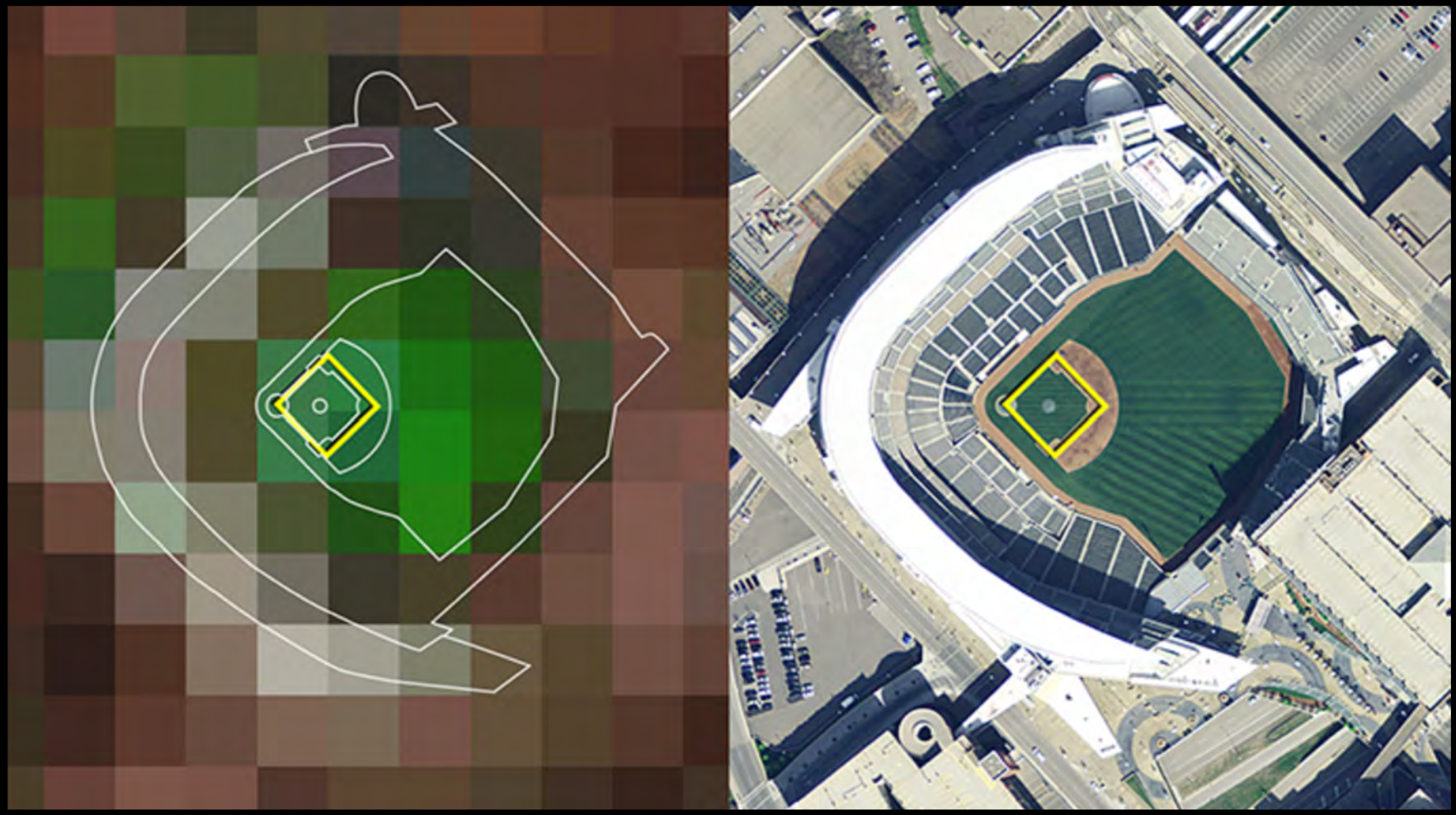
Improved Technology

- Cloud Storage and Computing
- Data Cubes

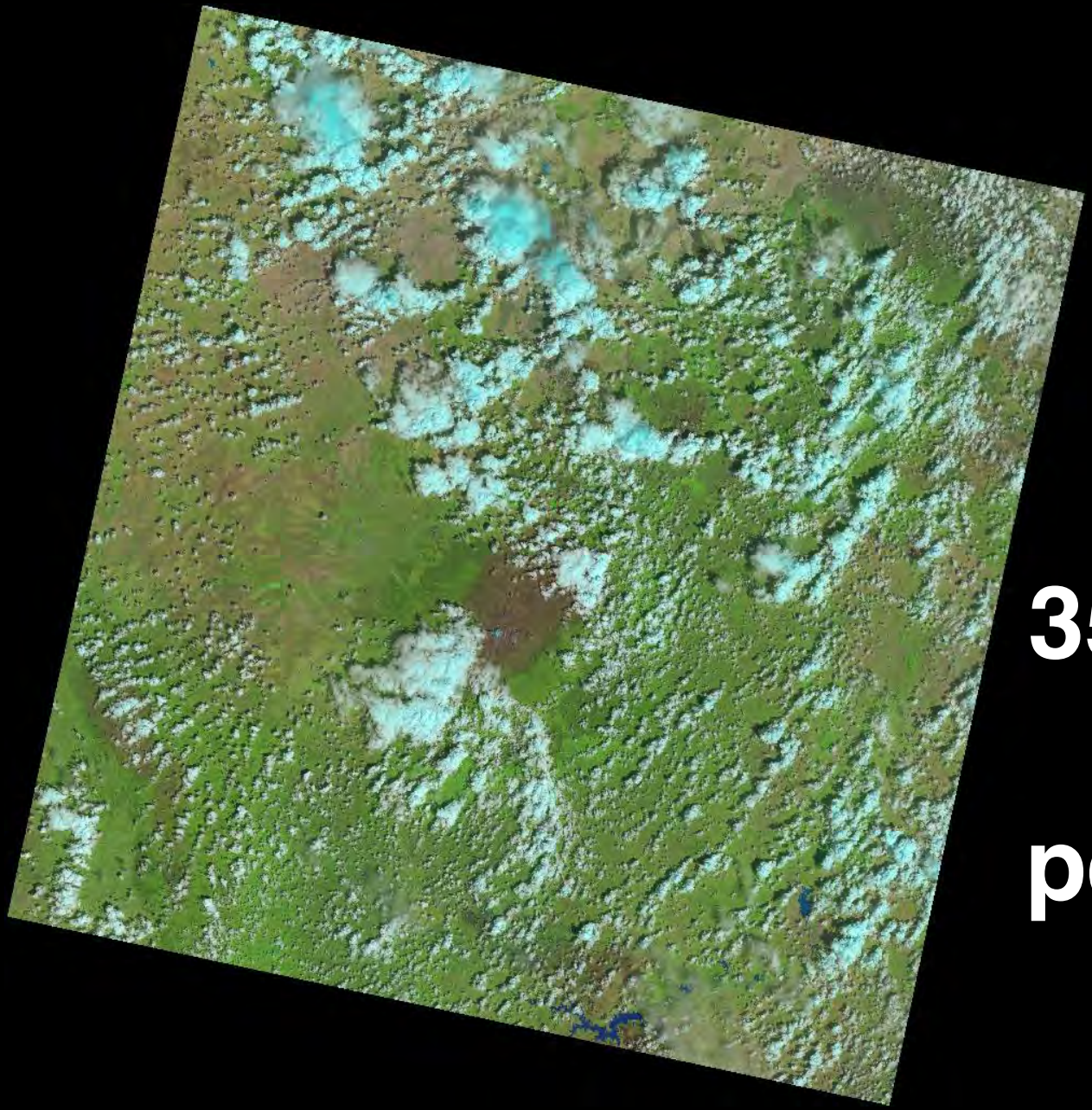
Everything is in place ...
Why doesn't the world use satellite data?

- It requires science knowledge to understand what data is needed … optical or radar
- It is hard to access and download
- It is hard to prepare … atmospheric correction, grid formats, pixel alignment, cloud filtering
- It requires capacity building and training

A New Solution ... **Data Cubes**

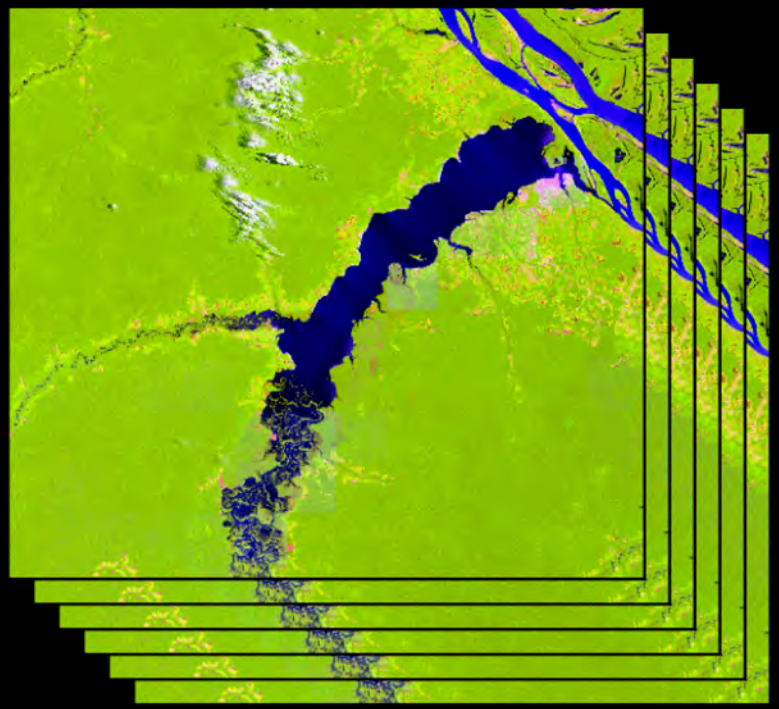


1 pixel = 30 meters square

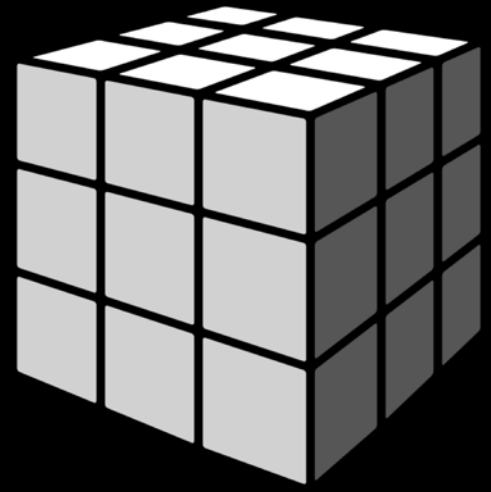


35 million pixels per scene

What is a Data Cube?



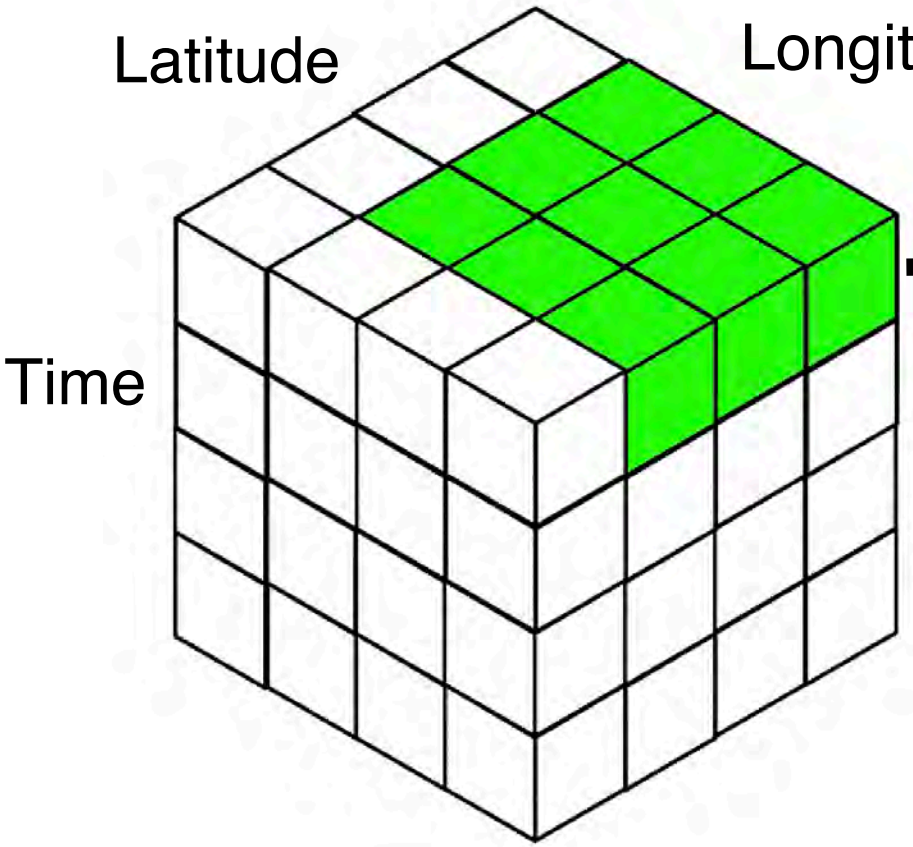
8000 Landsat scenes
(17 years of data)



1000 Data Cube storage units (1° x 1° x 1 yr)

8x data compression

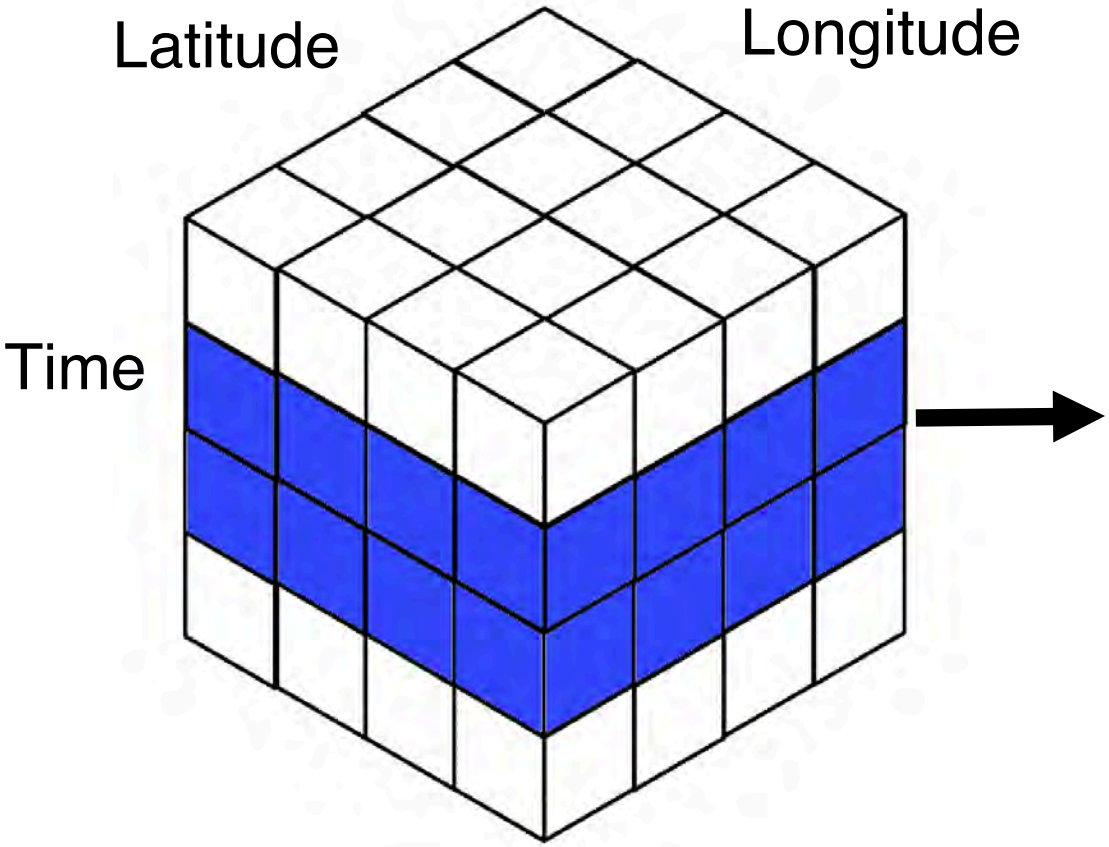
Sampling a Data Cube



A single time slice, similar to a standard “scene” can be used to assess a single point in time

Pixels in the Data Cube are processed, aligned, and compressed and ready for data analysis

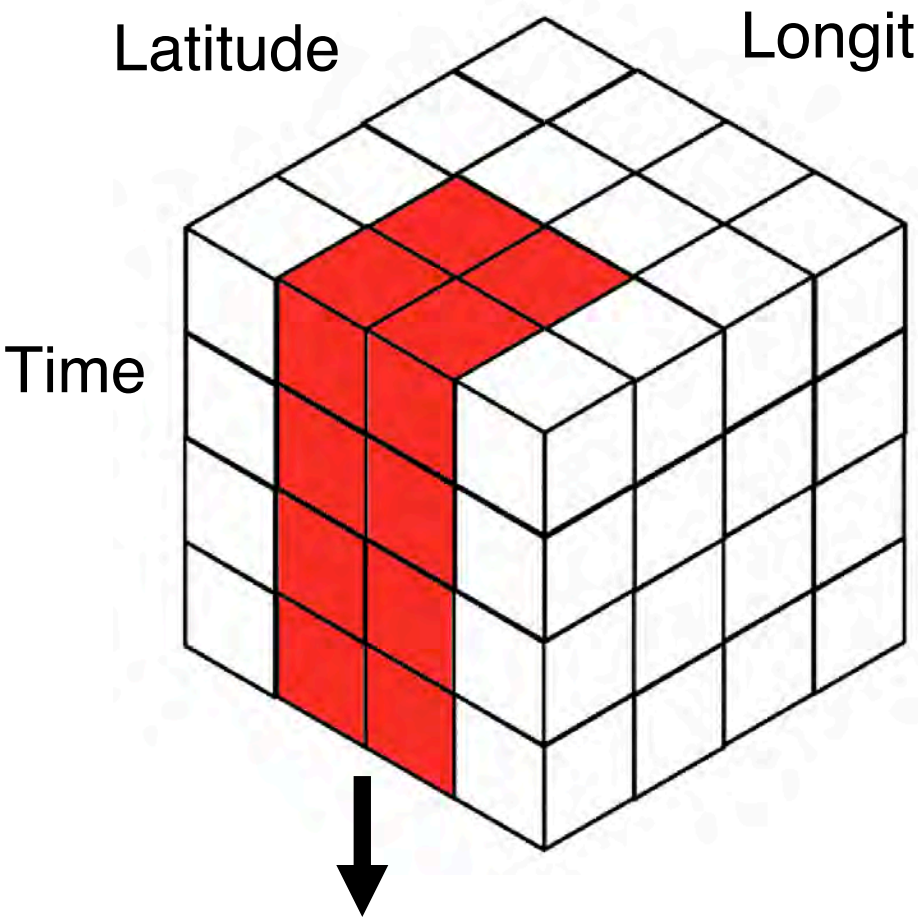
Sampling a Data Cube



Several time slices can be combined into one to form a "**Mosaic**". This is often used to reduce clouds or create seasonal or annual images.

Typical Mosaics ... Most Recent Pixel, Median, Max NDVI

Sampling a Data Cube



Examples of **Time Series** analyses include: Land Change or Water Change

Time Series analyses consider the variation of data over time to assess change

Benefits of Data Cubes

- Expanded use of satellite data
- Reduced data preparation
- Enables data interoperability and efficient time series analyses
- Free and open access
- Flexible deployment (local or cloud) using a common architecture
- Community development and sharing
- Proven concept ... Australia, Colombia, Switzerland, Taiwan **and now Africa!**

The Data Cube Vision

A solution supporting priority objectives …

- Build capacity of users to apply CEOS satellite data
- Support GEO and United Nations agendas

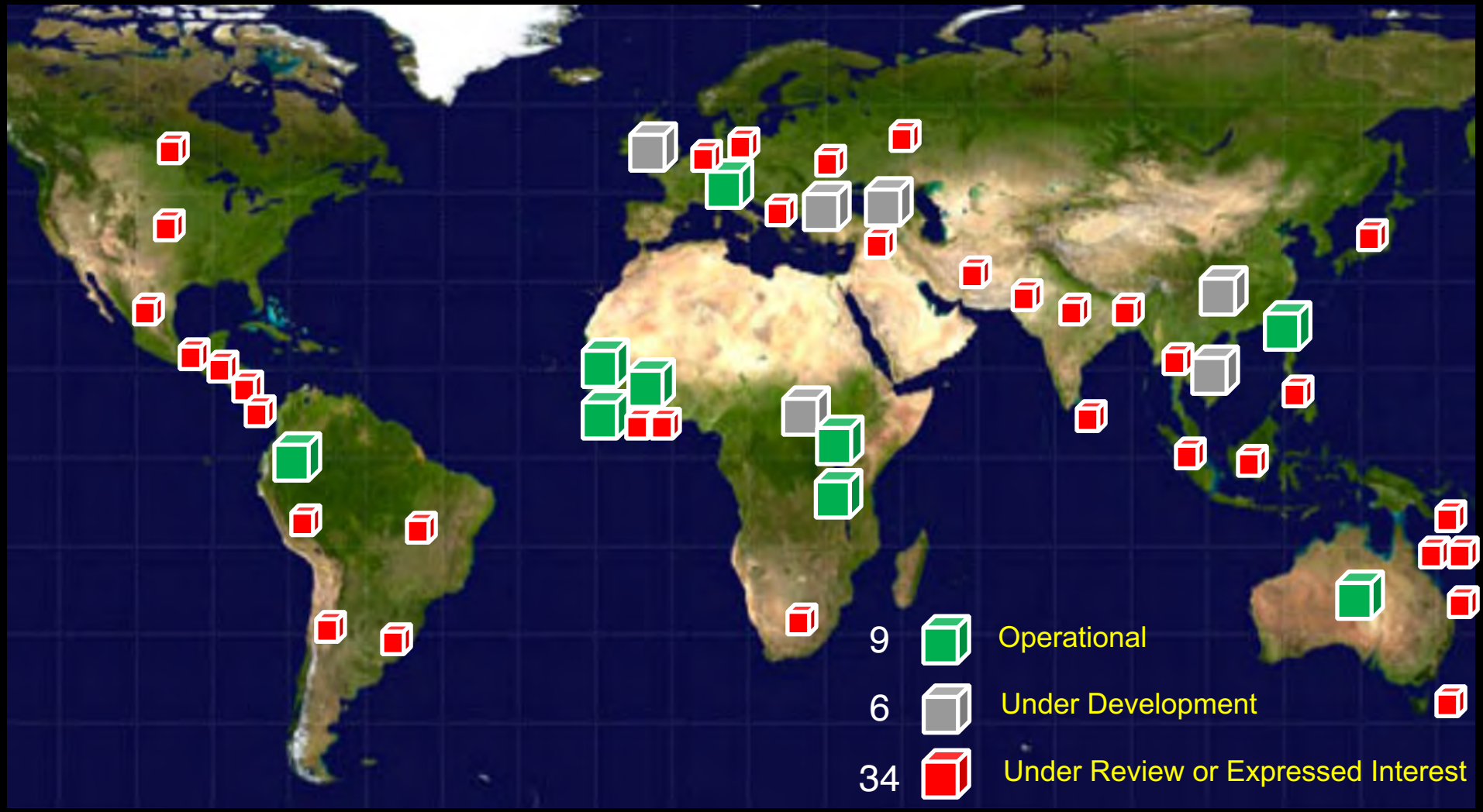
Customer focused …

- Easy to install and maintain with training materials
- A brand that people know and trust

Scalable solution …

- Operational Data Cubes in **20 countries by 2022**
- Partnerships with … Google, Amazon

49 countries in 20 months

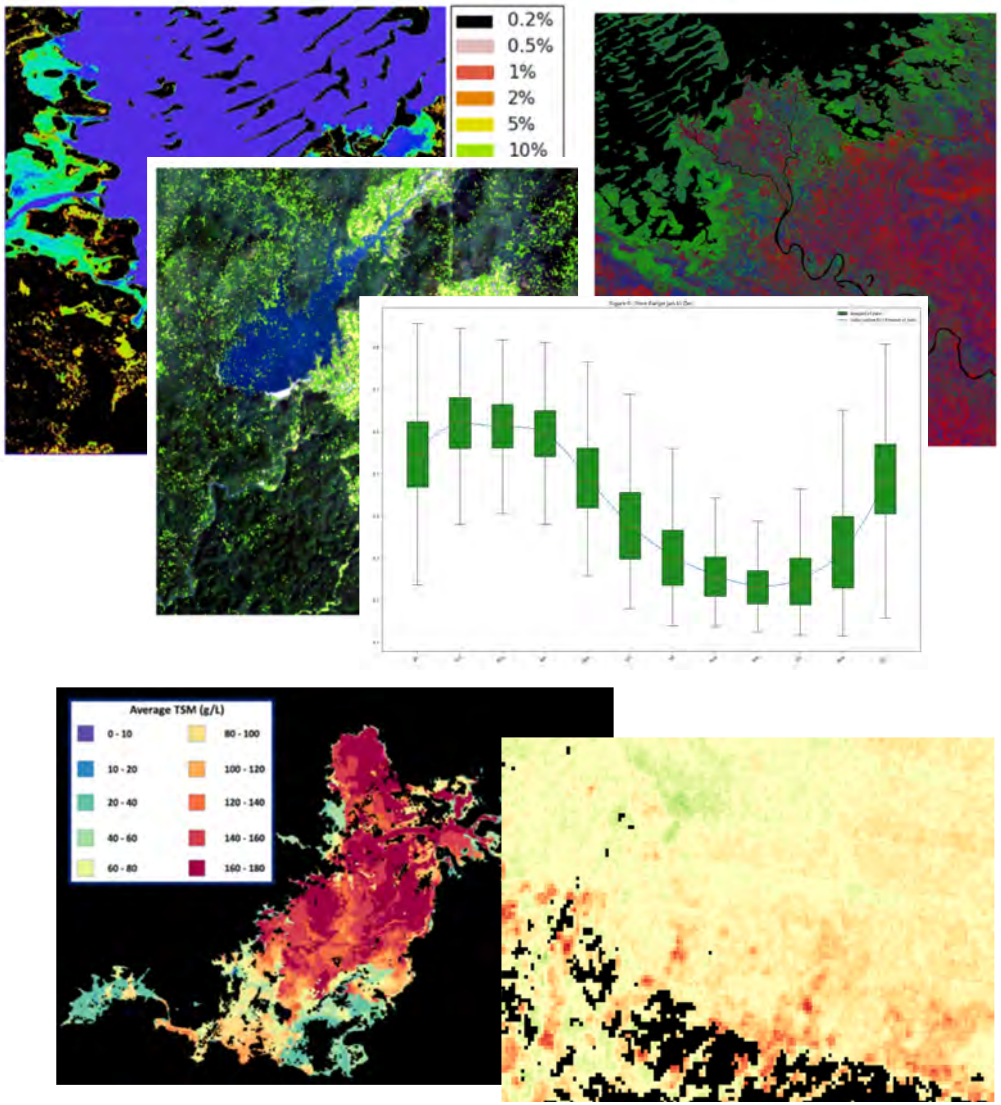


Operational: Australia, Colombia, Switzerland, Taiwan, Kenya, Tanzania, Ghana, Sierra Leone, Senegal

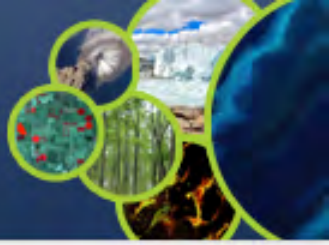
Application Products

20+ algorithms

- **Cloud-free Mosaics:** Recent Pixel, Median, Geomedian, Max-NDVI
- **Spectral Indices:** NDVI, EVI, NDBI, NDSI, NDWI, FC, TCT
- **Land Classification:** K-Means, Random Forest, Snow (from Swiss)
- **Water:** WOFS (from Australia), WASARD (radar), Total Suspended Matter (TSM)
- **Land Change:** PyCCD (from USGS), PCA (from Colombia), NDVI Trend (Vogelmann), NDVI Anomaly, S1 Radar (Deutscher), Coastal Change, SLIP-Landslides (NASA GSFC)



Data Cube Use-Cases

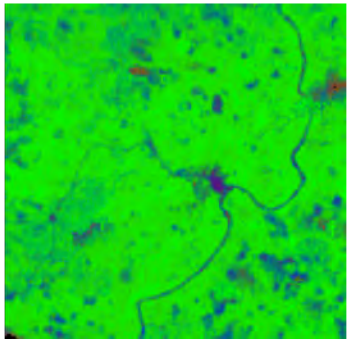


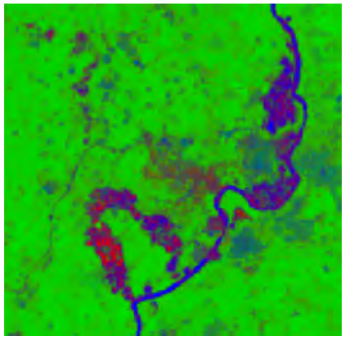
Data Cubes are having a global impact ...

- **Switzerland** is using their Data Cube to develop new snow detection algorithms and develop time series snow coverage maps.
- UK-Rhea (commercial company) is using the Data Cube to develop a drought monitoring system for **Uganda**
- UK-Catapult is leading the “Common Sensing Project” to monitor climate change resilience in the **Pacific Islands** using a Data Cube.
- **Taiwan** is using the Data Cube to monitor forest and vegetation restoration in landslide areas. They are also developing an algorithm for the detection of Pine Beetle outbreaks.
- **Uruguay** Is using the Data Cube to adjust their water sampling approach to coincide with satellite overpasses in order to improve water quality data in their reservoirs.
- The **Gates Foundation** is using water extent time series data from the Lake Chad Data Cube to compare with their population density maps to strategically supply polio vaccines to small villages around the lake. Many of these villages become "isolated" during the rainy season and are only accessible for a small portion of the year.

Africa Regional Data Cube

- Launched in May 2018 for 5 countries (Kenya, Tanzania, Sierra Leone, Senegal, Ghana). Initially based on Landsat ARD, with S1, S2 and ALOS coming soon!
- Supported by Amazon (donated cloud services) and GPSDD (training)
- Recent web-based remote training for Ghana (July 31), Tanzania (August 16 and October 9-12), and Sierra Leone (Aug 24).
- Initial support has been focused on algorithms to support desired use-cases for each country. These include ...



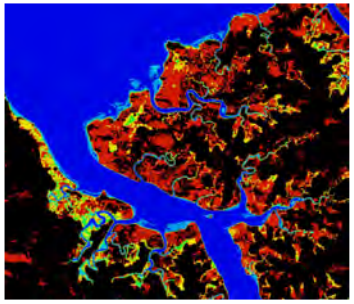


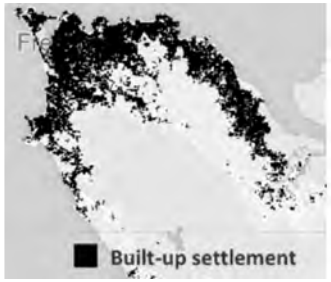
Kenya: Dadaab Refugee Camp expansion, deforestation and vegetation extent, livestock rangelands

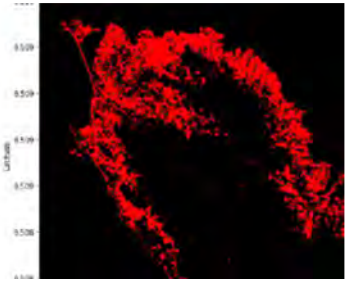
Tanzania: Chenene Forest Reserve deforestation and agriculture phenology

Ghana: Illegal mining (on right)

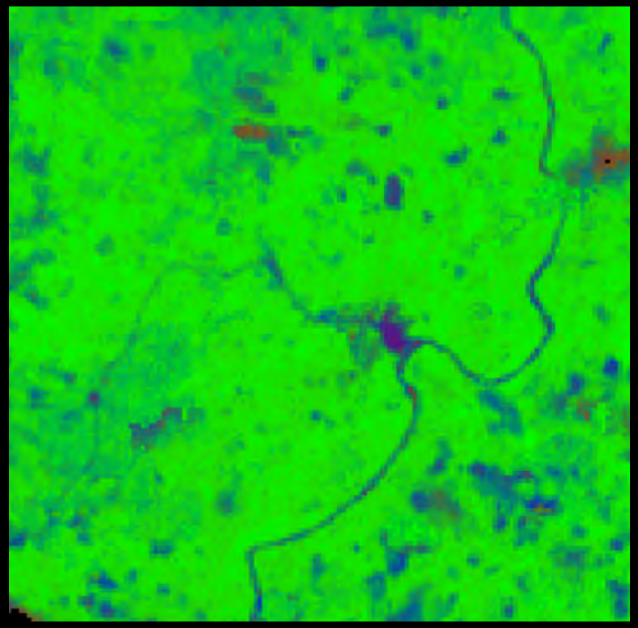
Sierra Leone: Flooding and urbanization (below)



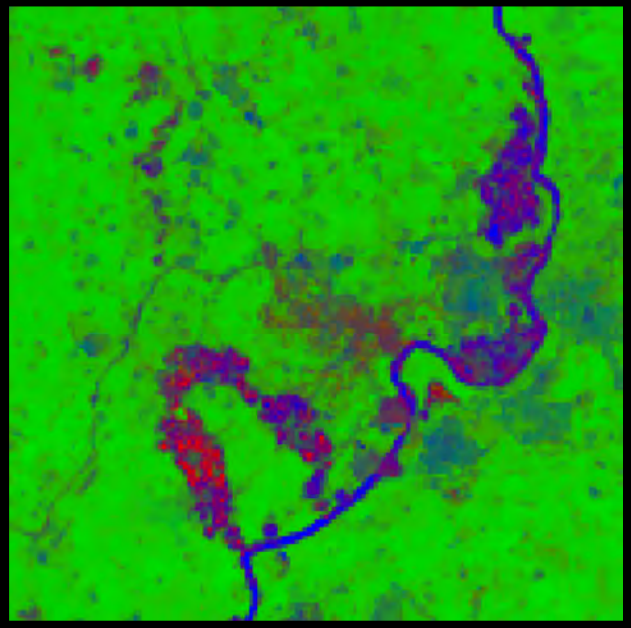




Illegal Mining on the Ankobra River in Ghana



Year 2000

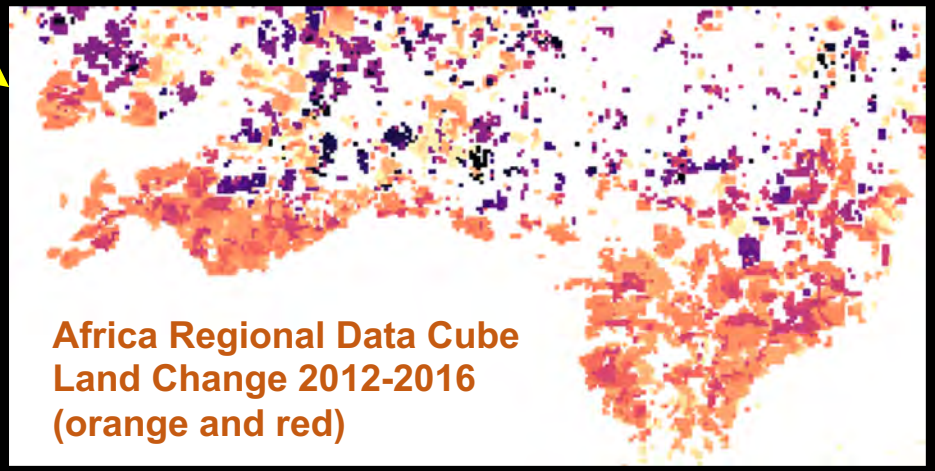


Year 2017

Google Earth 2017

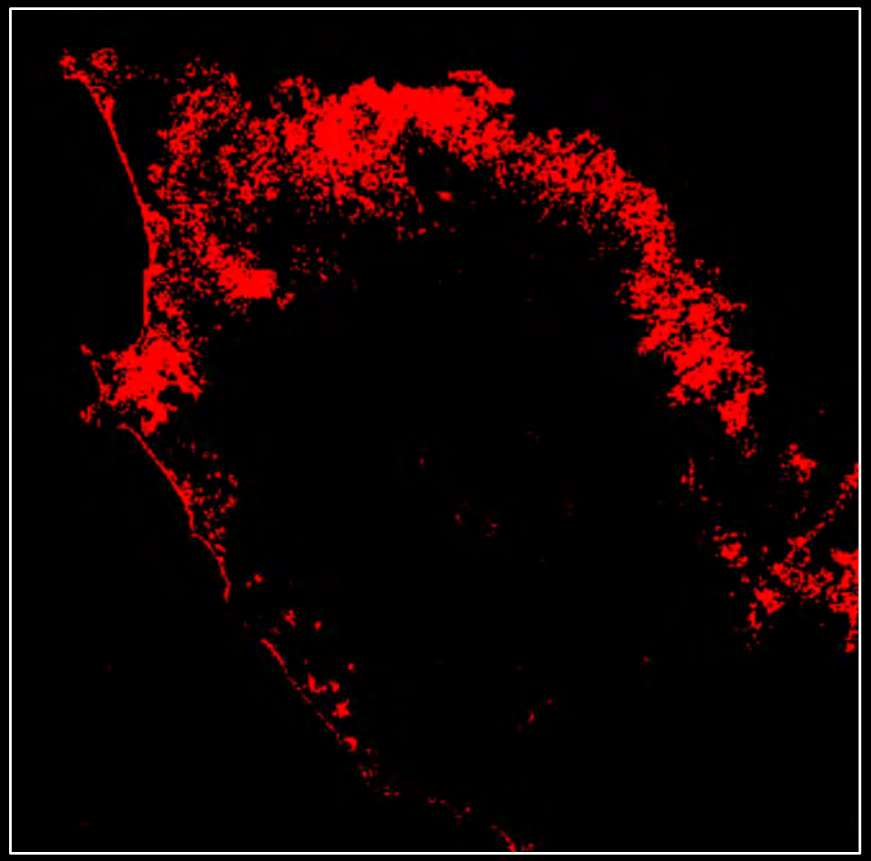
- A Fractional Cover (FC) analysis (GREEN images) showed a 13% loss in dense vegetation along the river
- A Google Earth image in 2017 (far right) shows the known locations of illegal mining, provided by the Ghana Government.

Deforestation and Settlements along the East Chenene Forest Reserve in Tanzania

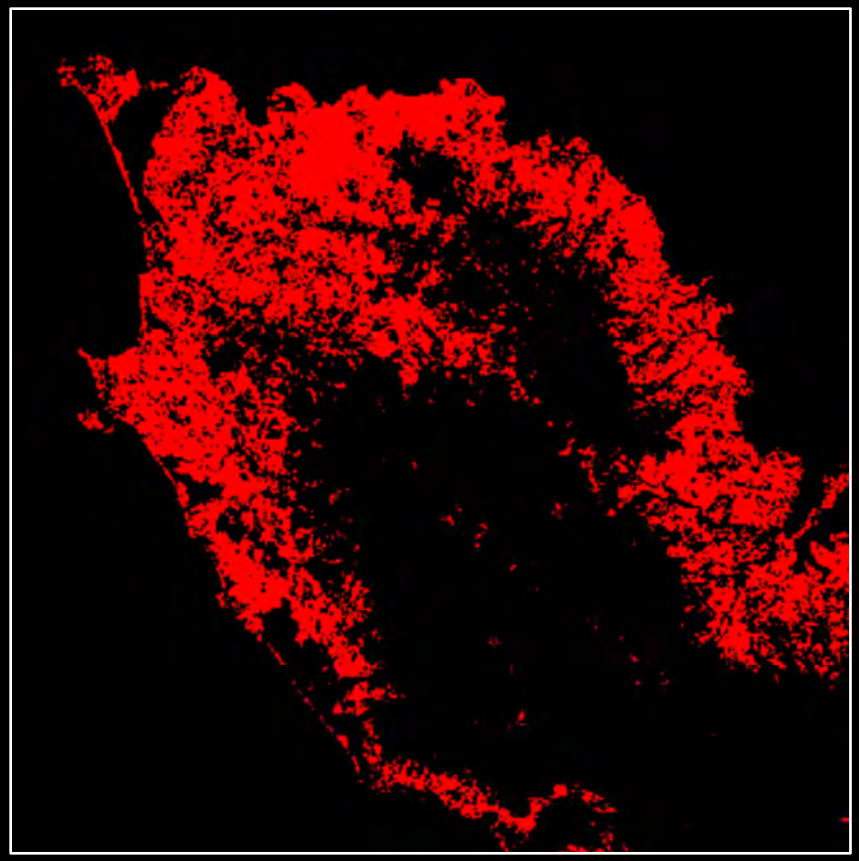


The PyCCD Land Change Algorithm (orange/red – bottom figure) compares well with the Global Forest Watch results (pink – top figure) for deforestation detection.

Urbanization in Freetown, Sierra Leone



Year 2000



Year 2017

Urban extent has grown 11.4% over 10 years.

** Analyses based on the NDBI index using the Africa Regional Data Cube*

THANK YOU

Web: opendatacube.org
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