Digital Earth AFRICA

Mapping and monitoring Water Resources in the Digital Earth Africa Platform

National Space Conference
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01

Introduction to Digital Earth Africa

Our Vision

DE Africa will provide a routine, reliable and operational service, using Earth observations to deliver decision-ready products enabling policy makers, scientists, the private sector and civil society to address social, environmental and economic changes on the continent and develop an ecosystem for innovation across sectors.

Open and Free Data

- Interoperability
- Privacy and Integrity

Operational Service

- Continental-scale
- Sustainable
- Domain expertise

Accountability and transparency

- Responsive to African priorities
- Agile, nimble and actions oriented

Diversity and inclusion

- Multi-sector perspectives
- Span data communities
- Foster collaboration

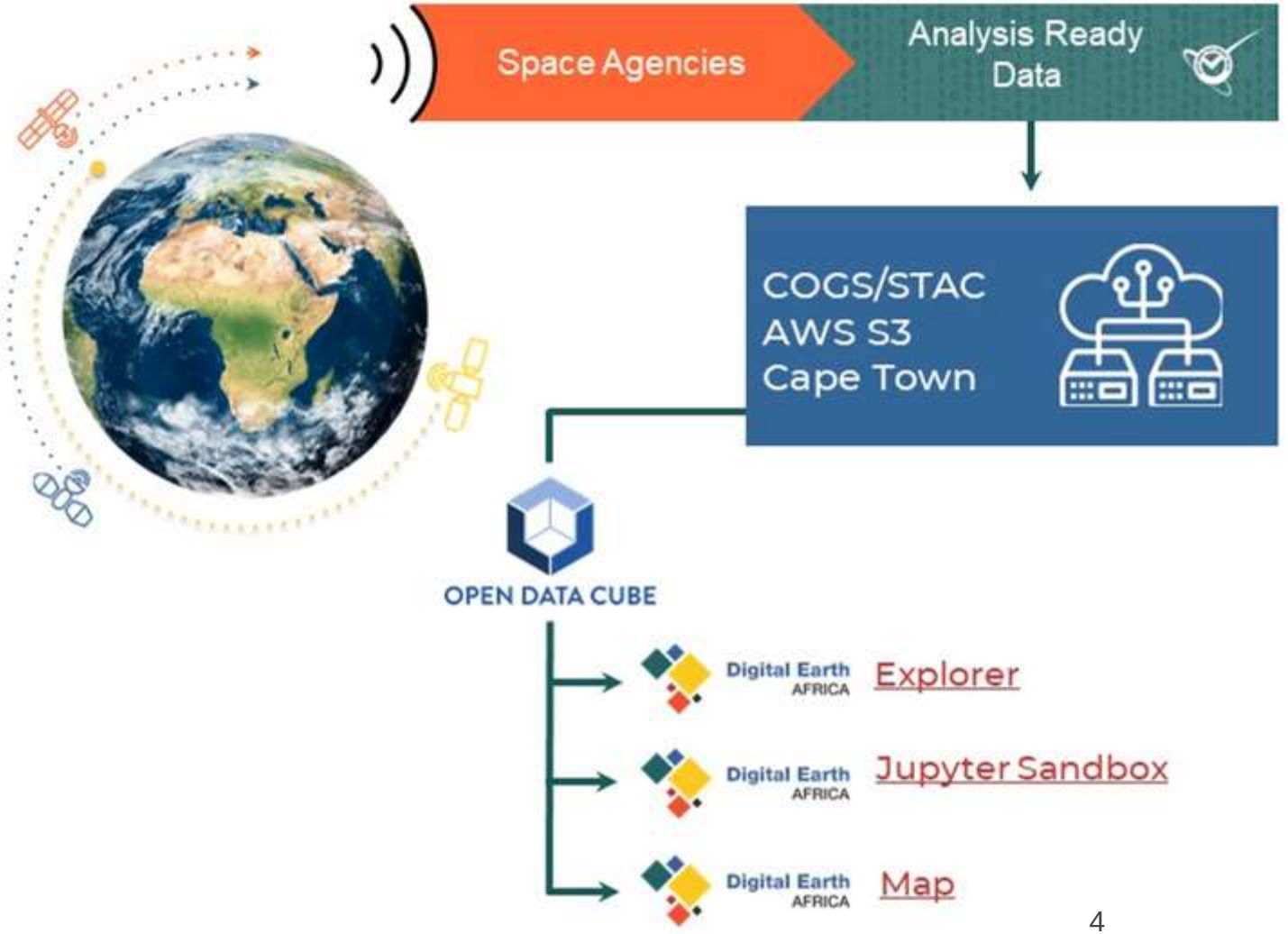
- Land degradation
- Coastline changes
- Urbanisation
- Water resources and flood risks
- Agriculture and food security

Eye of Sahara: Credit: Contains modified Copernicus Sentinel data 2021, processed by Digital Earth Africa.

Satellite data available through

Digital Earth Africa

- Largest global Open Data Cube implementation
- Entirely cloud native in AWS
- Completely free, even for commercial use
- Optimized EO data for web processing
- Complete visibility from the data to the product
- Different interfaces for different needs
- Build complex analyses on your topic in your own environment
- Extensive library of SDG-oriented tools
- Free online learning platform & helpdesk



Datasets and Services

Digital Earth AFRICA

Satellite images

Surface reflectance

Landsat Collection 2 Level-2 Surface Reflectance

Daily satellite images from Landsat 5, 7, 8 and 9.

MORE

Sentinel-2 Level-2A Surface Reflectance

Daily satellite images from Sentinel-2.

MORE

GeoMAD cloud-free composites

Cloud-free mosaics from Landsat and Sentinel-2 satellites.

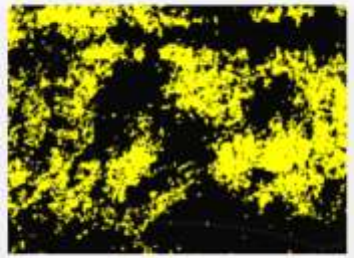
MORE

Land and water

Water Observations from Space

Individual, annual and historic water observations.

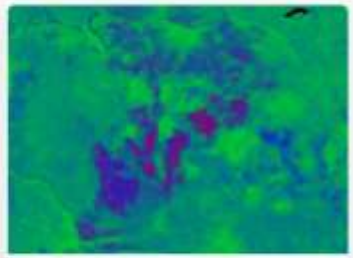
MORE



Cropland extent maps for Africa

Estimated location of croplands.

MORE



Fractional Cover

Green vegetation, non-green vegetation and bare soil for every Landsat image.

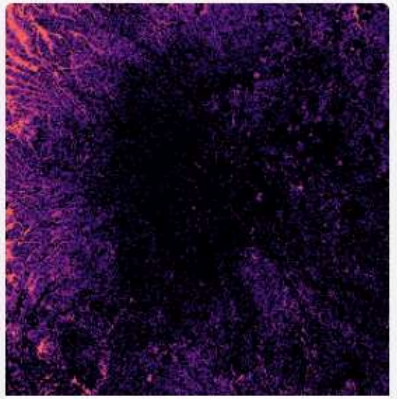
MORE

Elevation

Copernicus DEM (COP-DEM)

Corpenicus Digital Elevation Model with limited worldwide coverage at 30 metres and global coverage at 90 metres spatial resolution.

MORE



Shuttle Radar Topography Mission (SRTM) 1 Arc-Second Global Digital Elevation Model and DEM Derivatives

NASA version 3.0 Shuttle Radar Topography Mission (SRTM) global 1 arc second (~30 metre) DEM and Digital Earth Africa SRTM DEM Derivatives.

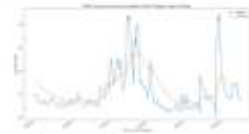
MORE

External Datasets

ERA5 Climate Gridded Data

ERA5 global climate reanalysis product by the Copernicus Climate Change Service (C3S) at the ECMWF.

MORE



Global Root-zone moisture Analysis & Forecasting System (GRAFS)

Global Root-zone moisture Analysis & Forecasting System (GRAFS) by the ANU Centre for Water and Landscape Dynamics.

MORE

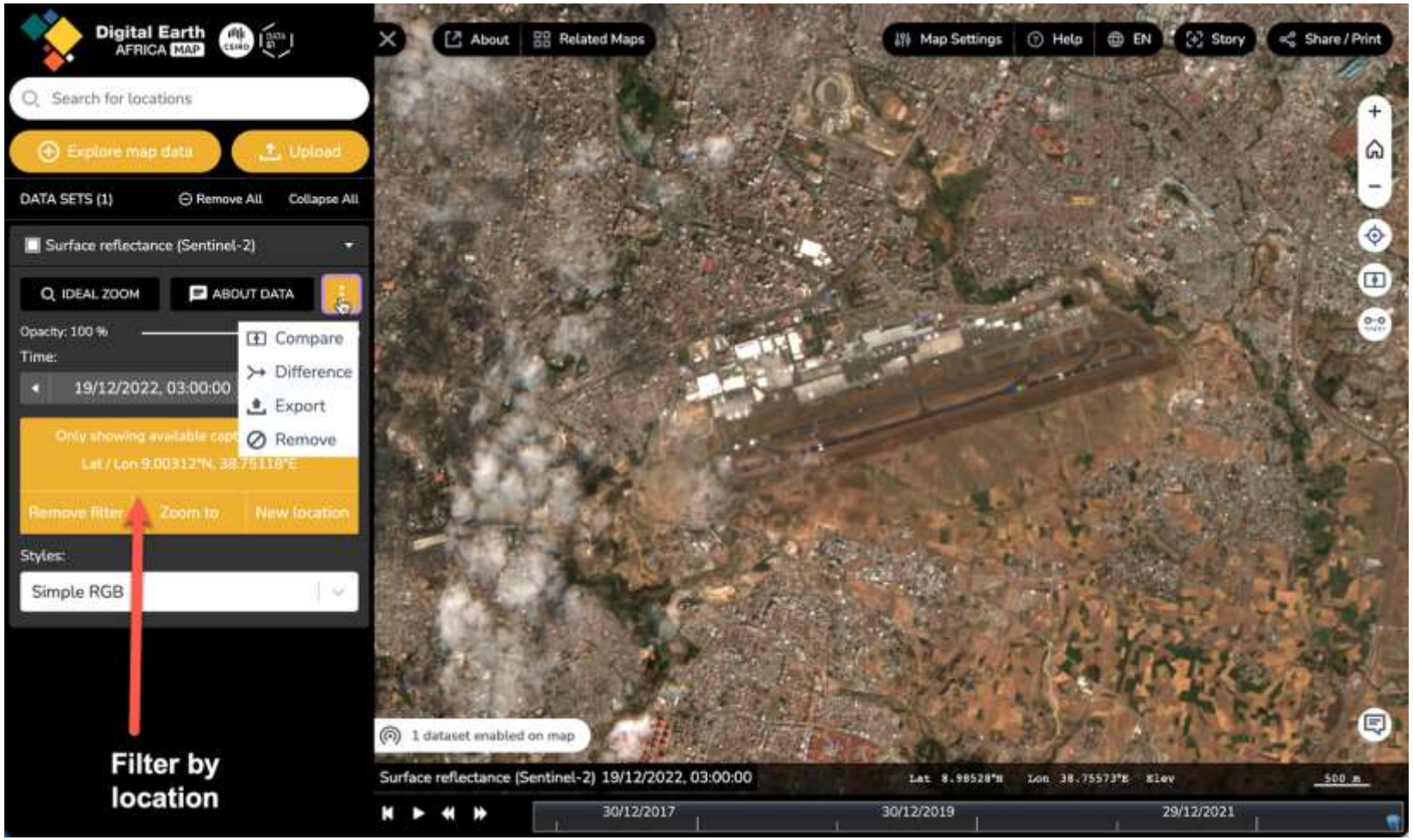
02

Accessing Digital Earth Africa Data and Tools

DE Africa map

The Digital Earth Africa (DE Africa) Map is a website for map-based interaction with DE Africa products and services.

Through the Map we aim to provide users with the tools to explore our data and products and visualise the African continent with satellite images to understand its geographic diversity and how it changes through time.



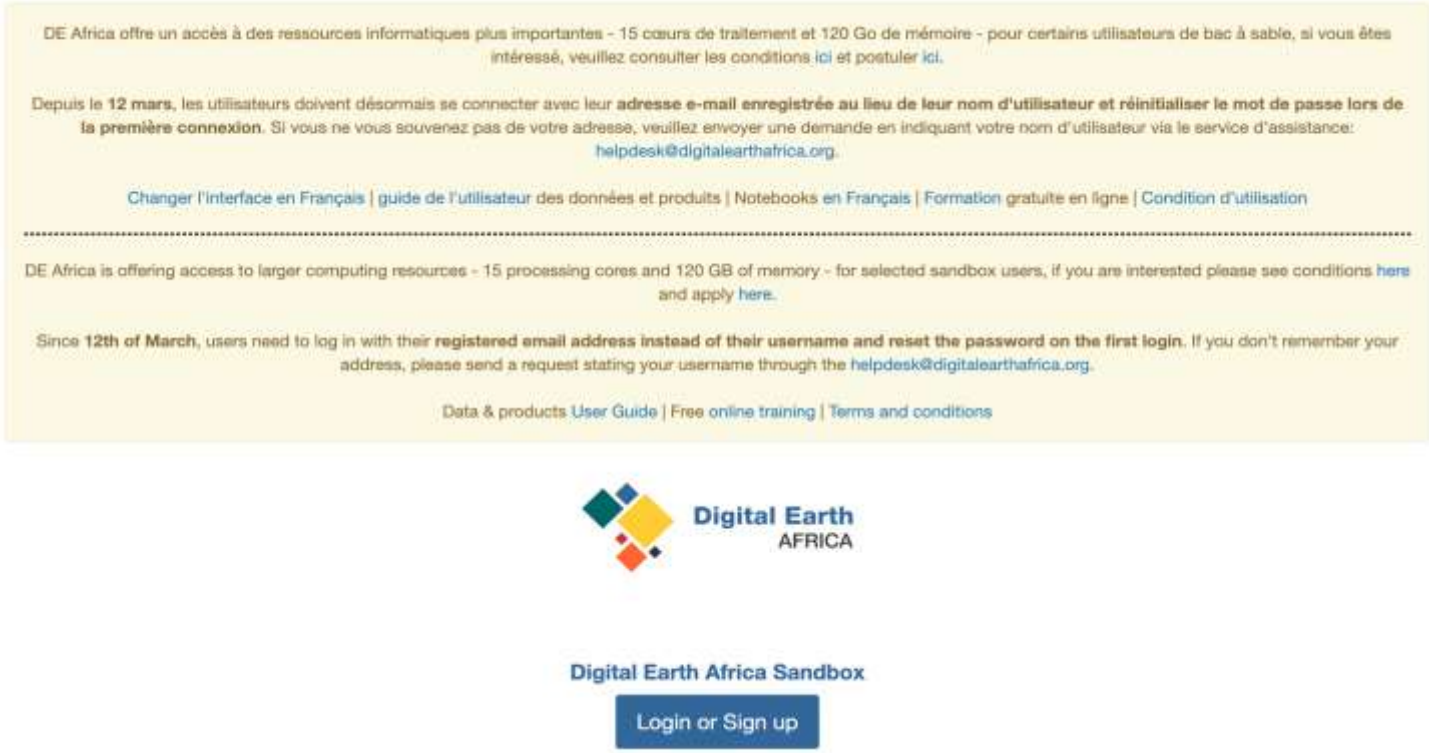
https://maps.digitalearth.africa/

DE Africa Sandbox

The DE Africa Sandbox is a cloud-based computational platform that operates through a Jupyter Lab environment.

It provides a limited, but free compute resource for technical users and data scientists to explore DE Africa data and products.

It enables access to remote-sensing data and analysis tools for ad-hoc report generation and rapid development of new algorithms. This analysis environment is continuously improved to meet the needs of users.



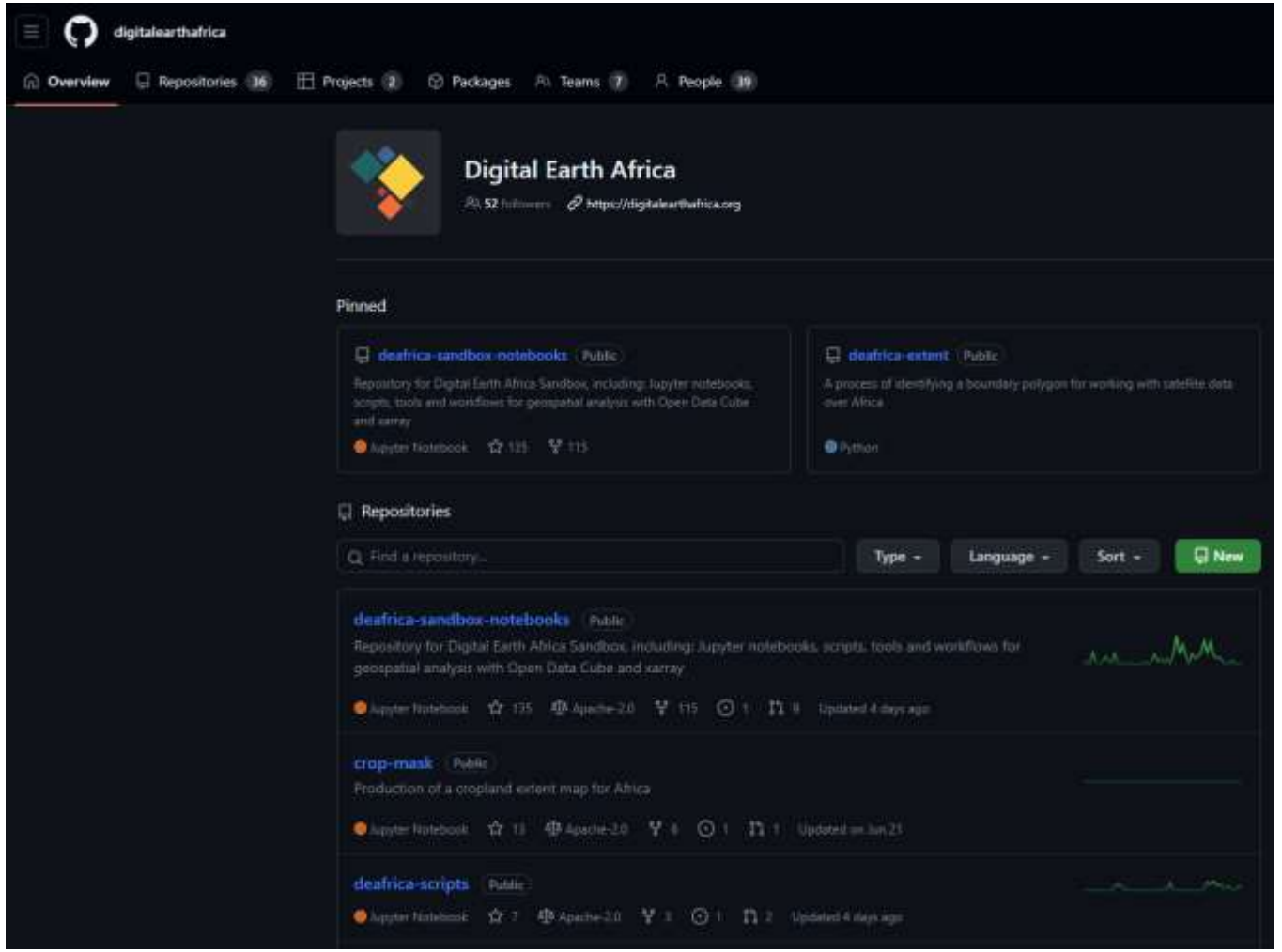
https://sandbox.digitalearth.africa/

Notebook Repository

A repository of readily available notebooks (user computational workflows and code) will allow users to use, interact and engage with the DE Africa Sandbox.

Available from the GitHub and loaded by default in the Sandbox, users will be able to use these notebooks to readily load, process, analyse and visualise DE Africa datasets.

The repository grows continuously as new notebooks are developed by DE Africa team and the user community.



https://github.com/digitalearthafrica

Notebook Repository

Digital Earth AFRICA

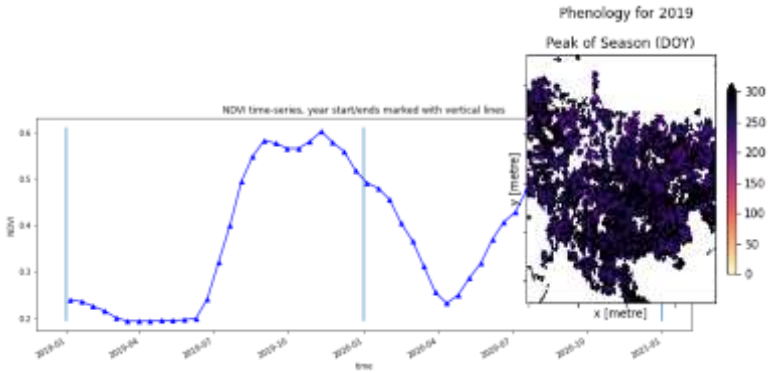
100 Open-source notebooks

7 Main Topics

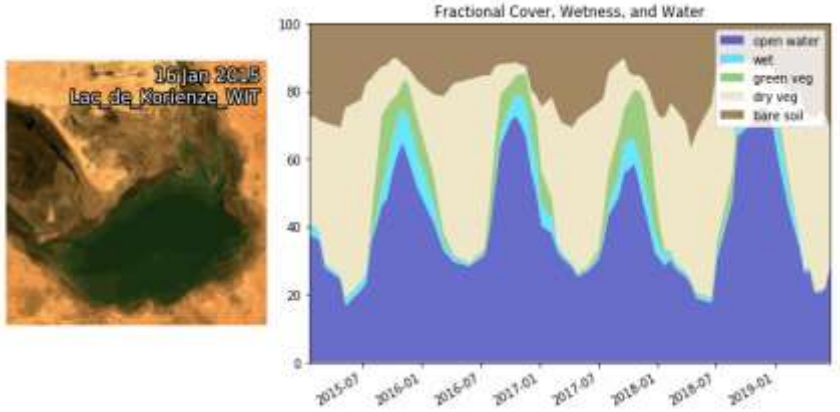
7 SDG Indicators Supported

From beginners to advanced users

- Agriculture and food security
- Water resources and flood risk
- Vegetation
- Urbanisation
- Land degradation, land cover and accounting
- Coastal and marine environment
- EO data, ML & Open Data Cube



Crop and vegetation phenology using optical and radar data



DE Africa Wetland Insight Tool - an interactive notebook

Monitoring coastal erosion along Africa's coastline

Other Access

DE Africa Metadata Explorer

The DE Africa Metadata Explorer is a website that uses existing Open Data Cube infrastructure to inspect metadata for DE Africa services and underlying datasets. It includes a time-picker and coverage map to help users find datasets. The explorer can be used to locate and download individual data files from DE Africa. https://explorer.digitalearth.africa/products

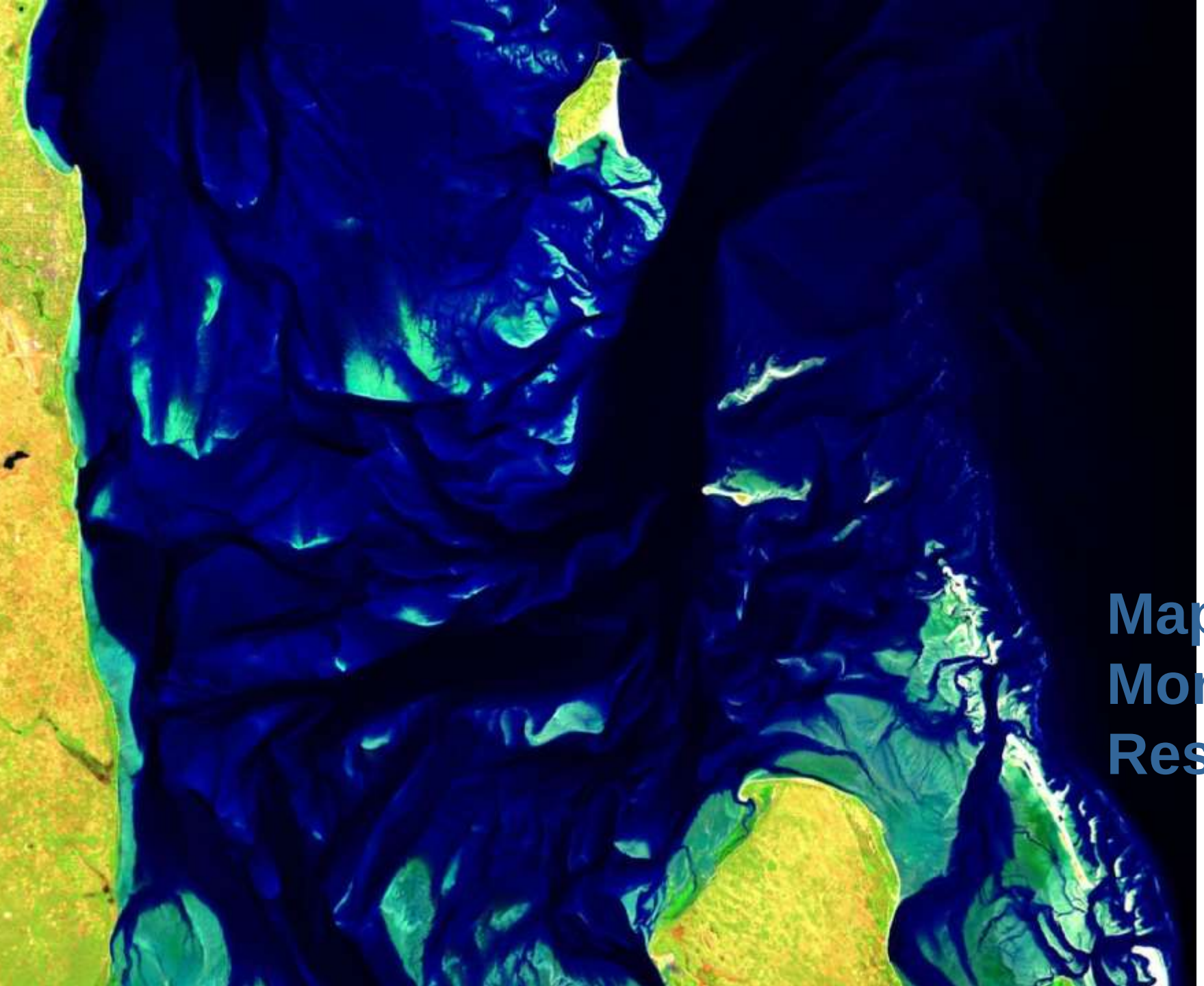
Open Geospatial Consortium (OGC) Web Services

The OGC Web Services delivers DE Africa data through standard Application Program Interfaces (APIs). It offers users freely available and interoperable data via services that are compatible with international open standards, allowing users to visualise and analyse data with Geographic Information System (GIS) clients.

Reference

https://docs.digitalearthafrica.org/en/latest/platform_tools/explorer.html

https://docs.digitalearthafrica.org/en/latest/platform_tools/web_services_gis.html



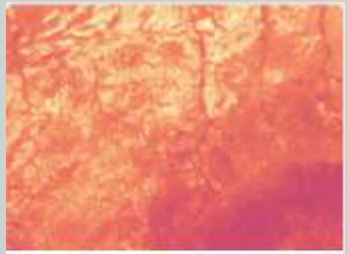
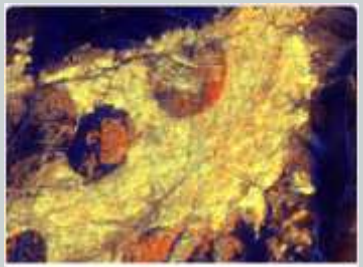
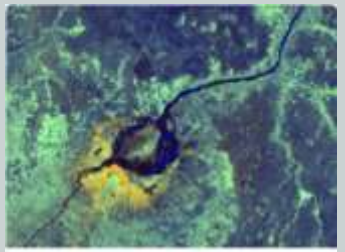
03

Mapping and Monitoring Water Resources

Satellite Images

Digital Earth Africa provides over three decades of satellite imagery across the entire continent of Africa.

- Satellite data from the NASA/USGS Landsat program allow us to produce fortnightly images of Africa's diverse natural and artificial landscapes at any time since 1984.
- More recently, the Copernicus Sentinel-2 mission has provided even higher resolution imagery as frequently as every 5 days since 2017.

Surface Reflectance			Surface Temperature	Radar Backscatter	
					
Landsat Collection 2 Level-2 Surface Reflectance Daily satellite images from Landsat 5, 7, 8 and 9.	**Sentinel-2 Level-2A Surface Reflectance** Daily satellite images from Sentinel-2.	**GeoMAD cloud-free composites** Cloud-free mosaics from Landsat and Sentinel-2 satellites.	**Landsat Collection 2 Level-2 Surface Temperature** Surface Temperature from Landsat 5, 7, 8 and 9.	**Sentinel-1 Normalised Radar Backscatter** Synthetic Aperture Radar from Sentinel-1.	**ALOS PALSAR, ALOS-2 PALSAR-2 and JERS-1 SAR Annual Mosaic** Synthetic Aperture Radar annual mosaics from JAXA.

Analysis Ready Data

The open and free data provided by Digital Earth Africa is dependent on what is called Analysis Ready Data (ARD). This is Earth observation data that has been processed according to a set of requirements that allow immediate analysis.

Preparing data for analysis is a major hurdle to the uptake of satellite images. **Traditionally 80% of project time could be taken up in accessing, pre-processing and organising satellite images. Analysis ready data is a game-changer and is critical if Earth observation infrastructures are going to be efficient, and sustainable.**

Currently, Digital Earth Africa uses open and free ARD provided by international satellite programs, including:

- *Landsat (USGS)*
- *Sentinel-2 (ESA)*
- *Sentinel-1 (ESA)*

GeoMAD cloud-free composites

GeoMAD is the Digital Earth Africa (DE Africa) surface reflectance geomedian and triple Median Absolute Deviation data service. It is a cloud-free composite of satellite data compiled over specific timeframes.
The GeoMAD service spans all of Africa and is currently available in three timeframes:

- **Annual**: observations from one calendar year are summarised into one set of measurements
  - Sentinel-2 Annual GeoMAD *(2017 – current)*
  - Landsat 8 Annual GeoMAD *(2013 – 2020)*
  - Landsat 5 & 7 Annual GeoMAD *(1984 – 2012)*
  - Landsat 8 & 9 Annual GeoMAD *(2021 – current)*

- **Semiannual**: observations are summarised for each half of the calendar year, giving one set of measurements for January–June, and one for July–December
  - Sentinel-2 Semiannual GeoMAD *(2017 – current)*

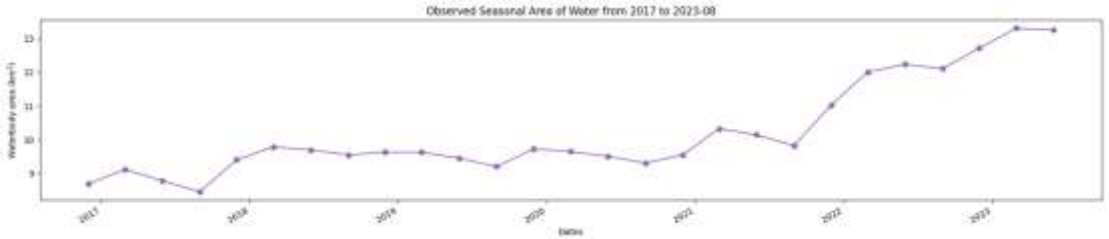
- **Rolling monthly**: observations are summarised over rolling three-month periods starting on the first day of each calendar month, giving a set of new measurements each month e.g., Jan-Mar, Feb-Apr, Mar-May and so on.
  - Sentinel-2 Rolling Monthly GeoMAD *(2019 – current)*

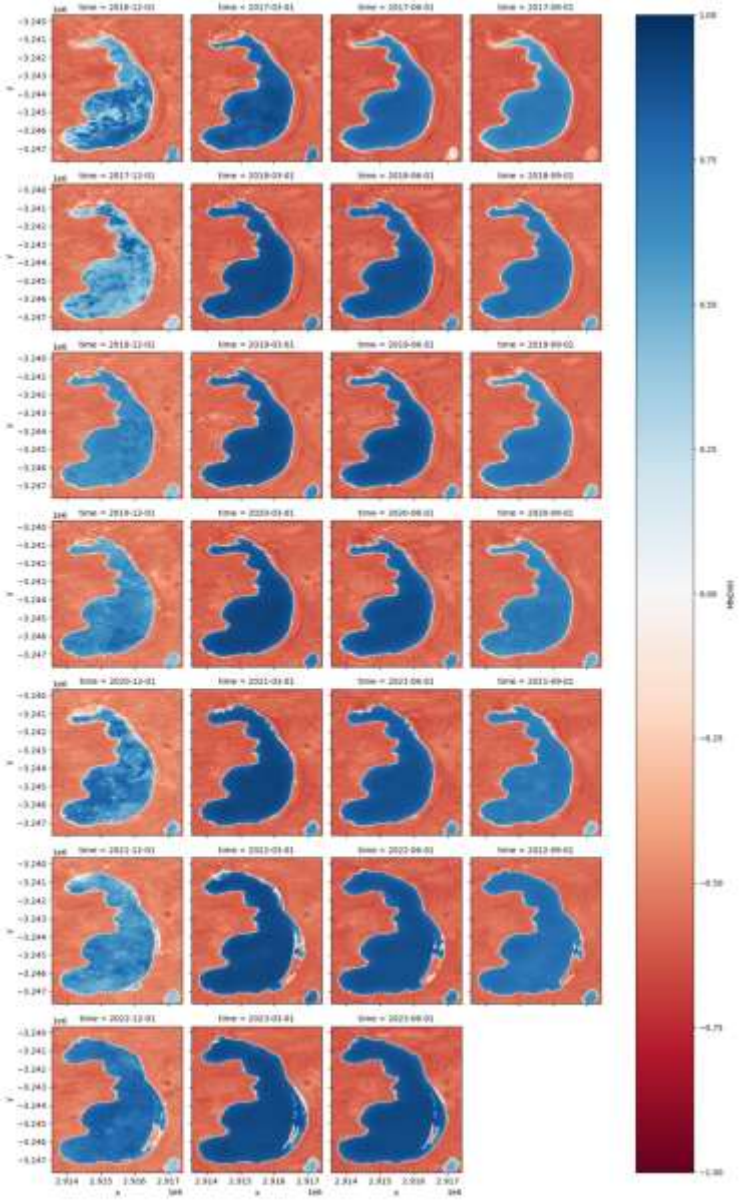
Determining seasonal extent of waterbodies with Sentinel-2

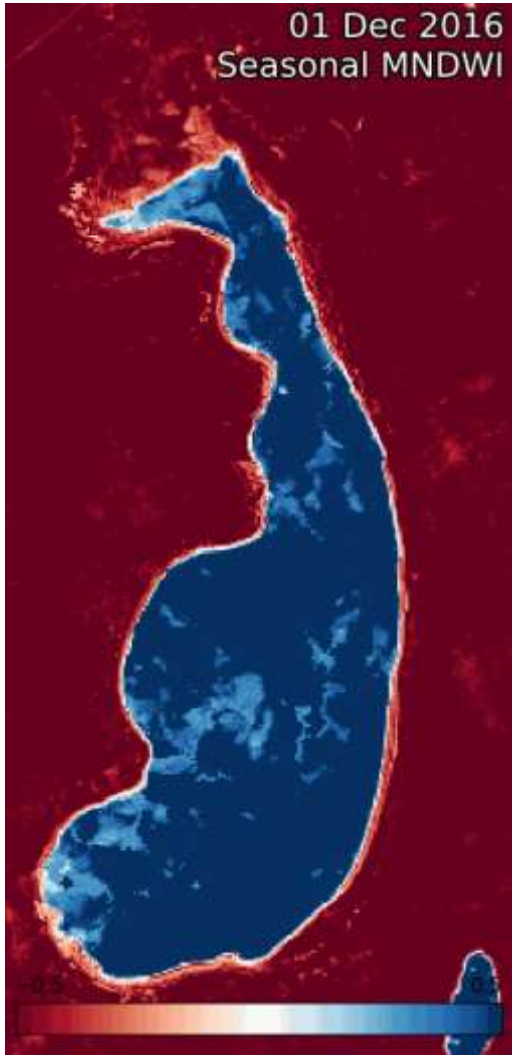
- Lake Chrissie (Chrissiesmeer), Mpumalanga

- The shallow lake is one of the largest freshwater lakes in the country. It's 9 km long and 3 km wide and renowned for its birdlife – around 80 different aquatic birds and 180 other species have been spotted in the area.

- Modified Normalised Difference Wetness Index (MNDWI)
  - quarterly starting in December







Water Observation from Space (WOfS)

- Water Observations from Space (WOfS) is a service that draws on satellite imagery to provide historical surface water observations of the whole African continent.

- Allows users to understand the location and movement of inland and coastal water present in the African landscape.
    - It shows where water is usually present; where it is seldom observed; and where inundation of the surface has been observed by satellite.

- ***WOfS can be used to understand the extent of water available on the surface which can be useful for analysis into flood risk assessment, understanding the change of water extent over time, observing the effect of major weather on a water system and more.***

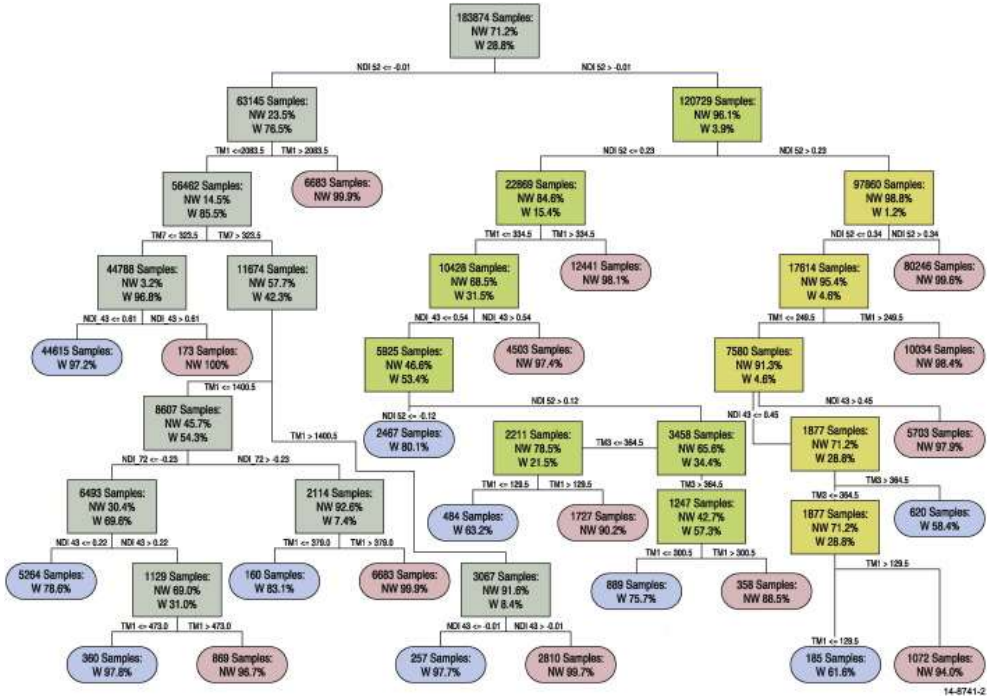
WOfS classification algorithm - work of Norman Mueller, Geoscience Australia, and Dr Dale Roberts, Australian National University.

Mueller et al. (2016) Water observations from space: Mapping surface water from 25 years of Landsat imagery across Australia.

Water Observation from Space (WOfS)

The Water Observations from Space Detection Algorithm uses a decision tree method using both spectral band measurements and derived indices as input datasets.

- Landsat archive
- Shuttle radar topographic mission digital surface model (SRTM DSM)
- Pixel quality
  - Pixel saturation
  - Band contiguity
  - Clouded or cloud shadow
  - Terrain shadow
- Ancillary data and products
  - Multi-resolution valley bottom flatness (MrVBF)
  - Slope
  - Open water likelihood (OWL)



Mueller et al. (2016) Water observations from space: Mapping surface water from 25 years of Landsat imagery across Australia.

Water Observation from Space (WOfS)

There are several WOfS products available for the African continent, as listed below:

- WOFLs (WOfS Feature Layers): Water and non-water classification generated per scene
- WOfS Annual Summary: The ratio of wet to clear observations from each calendar year
- WOfS All-Time Summary: The ratio of wet to clear observations over all time

The WOfS summaries are calculated as the ratio of clear wet observations to total clear observations.

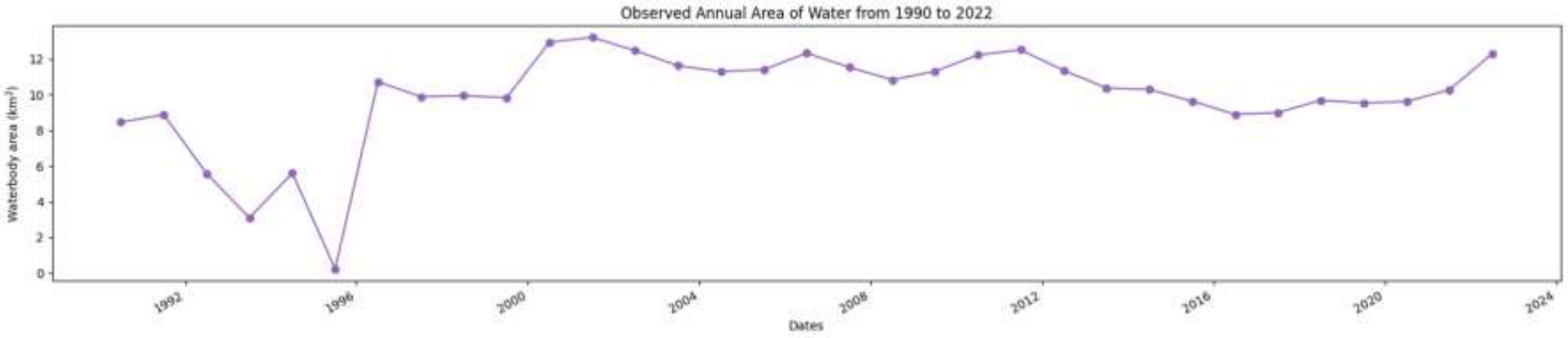
$$\text{WOfS Summary (Frequency)} = \frac{\text{Number of Clear and Wet Observations}}{\text{Number of Clear Observations}}$$

Mueller et al. (2016) Water observations from space: Mapping surface water from 25 years of Landsat imagery across Australia.

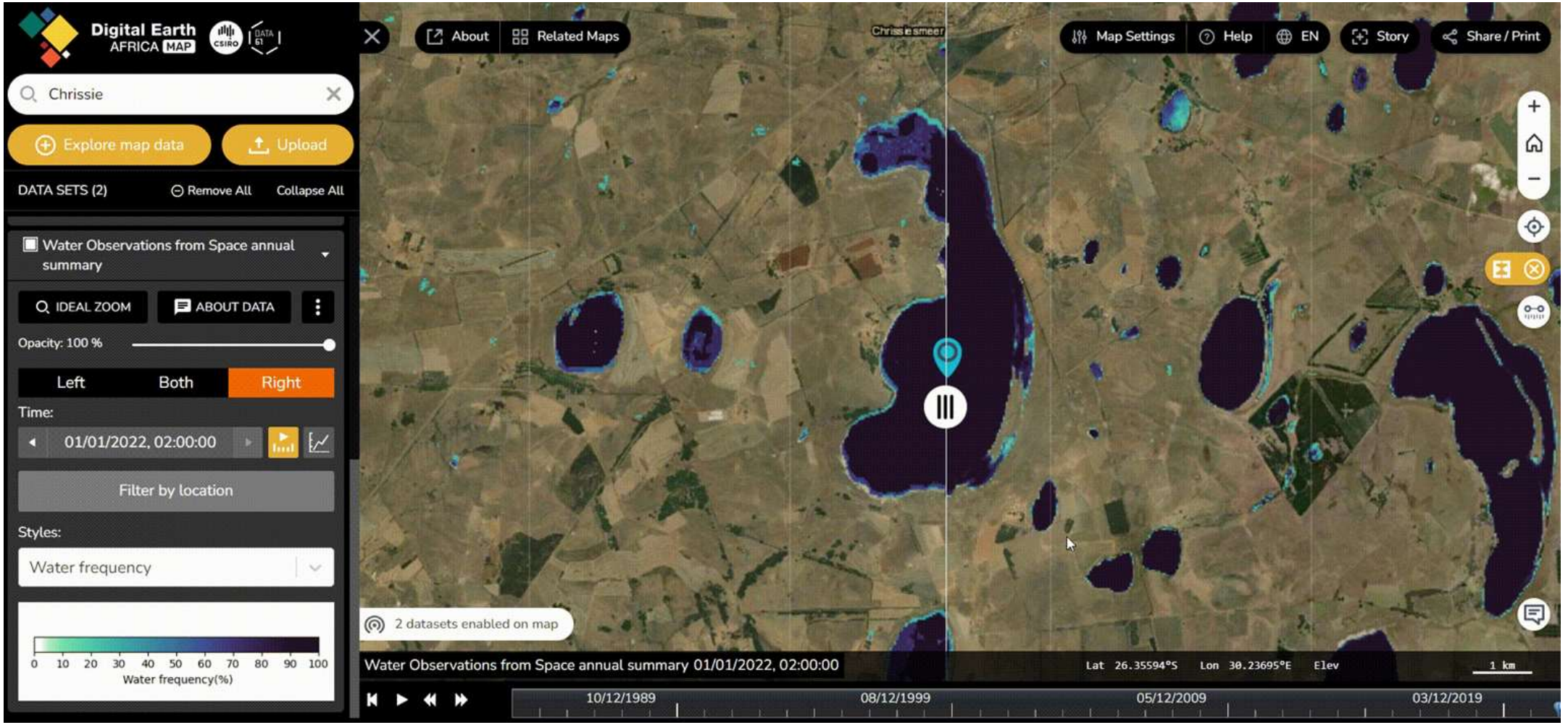
Mapping longer-term changes in water extent with WOfS

- WOfS Annual Summary: The ratio of wet to clear observations from each calendar year

- WOfS annual summary product to gather insights into the longer-term extent of water bodies. It provides a compliment to the Water_extent_sentinel_2 notebook which focuses on more recent water extents at seasonal time intervals.



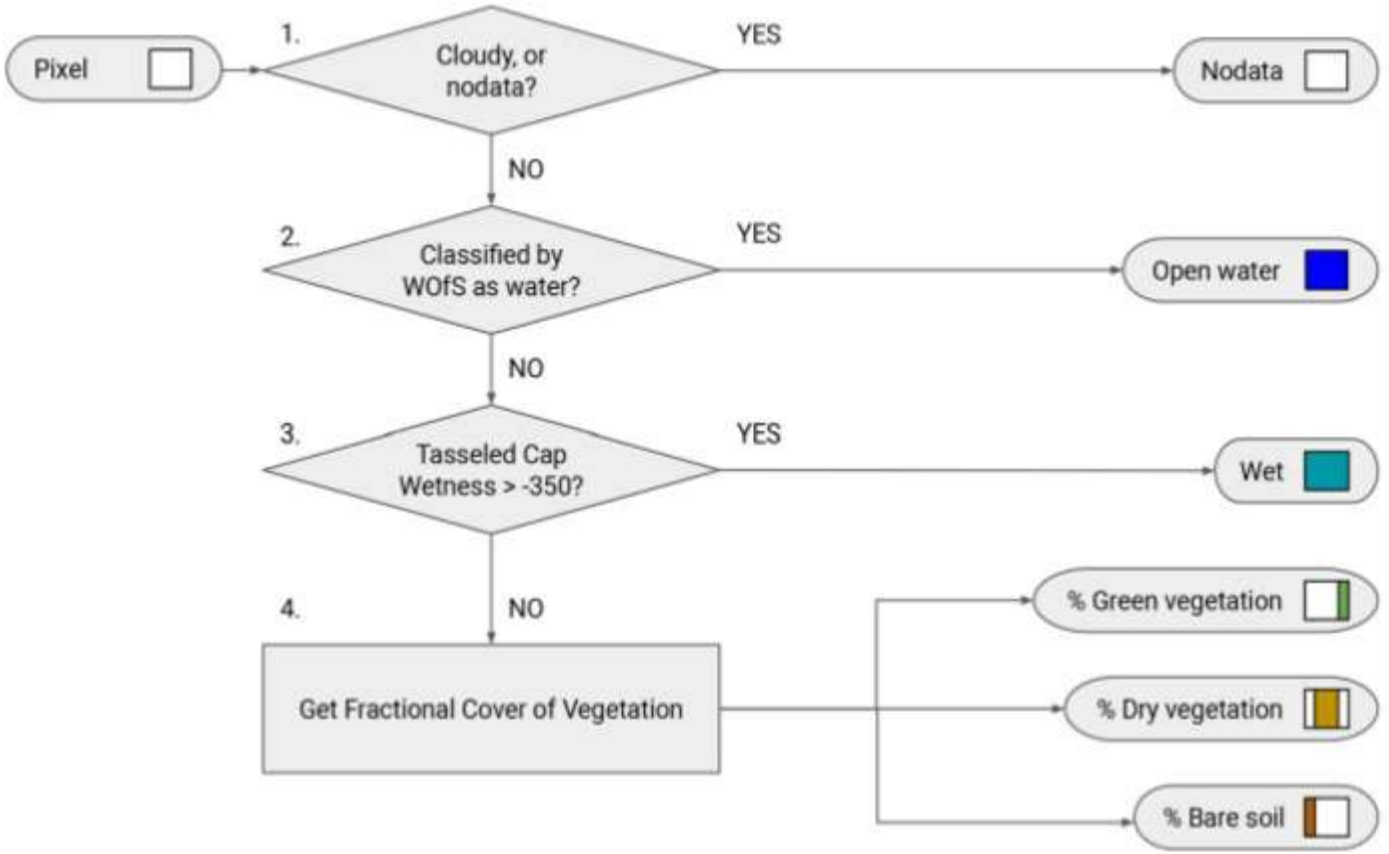
Water Observation from Space (WOfS)



https://maps.digitalearth.africa/

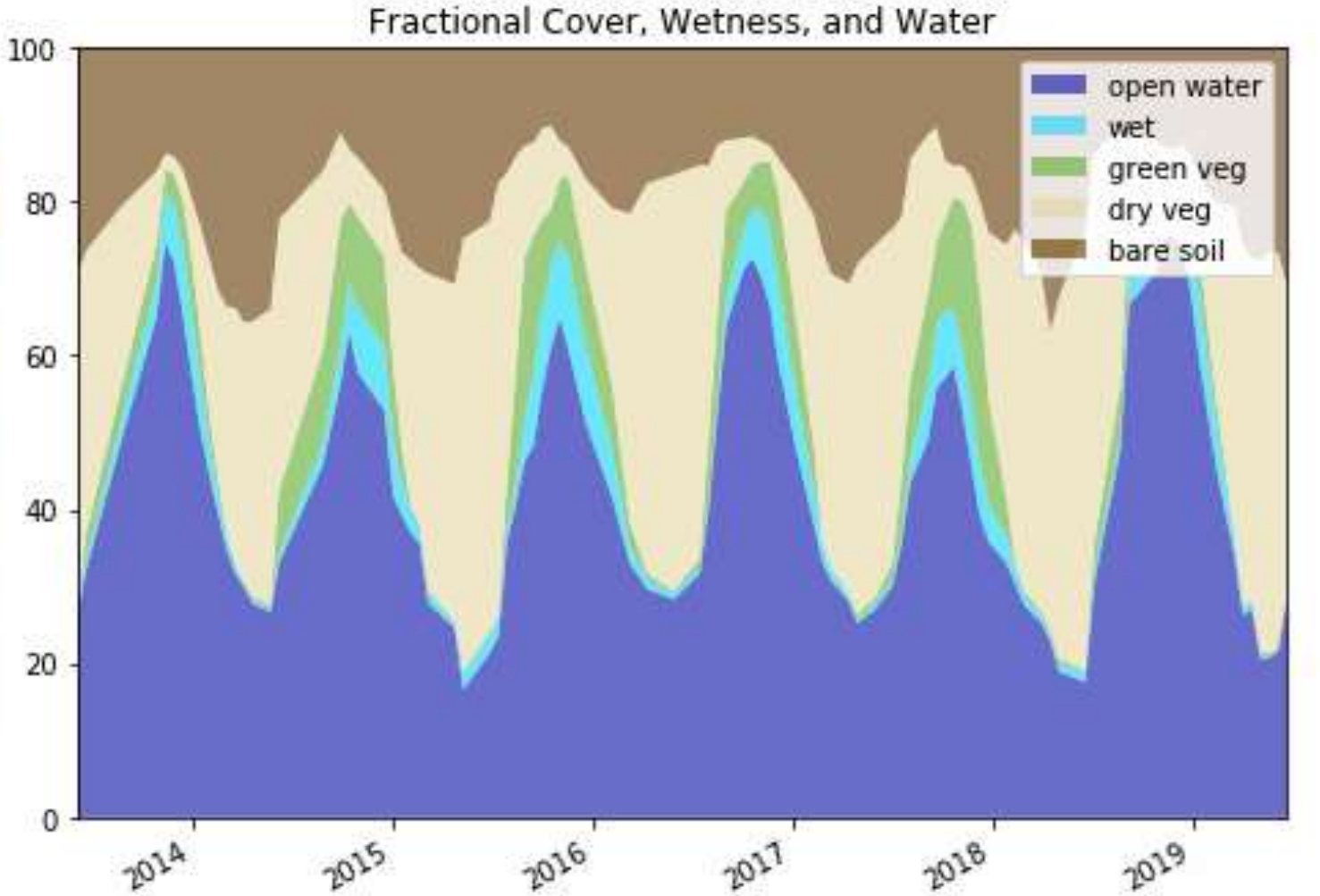
Wetland Insight Tool (WIT)

- Wetlands_insight_tool notebook
- The Wetlands Insight Tool (WIT) provides insights into a wetland's seasonal and interannual dynamics.
- WIT is a spatiotemporal summary of a wetland that combines multiple datasets derived from the Landsat archive held within DE Africa.
- WIT is a spatiotemporal summary of a wetland that combines multiple datasets derived from the Landsat archive held within DE Africa:
  - Vegetation fractional cover
  - Water Observations from Space
  - Landsat surface reflectance



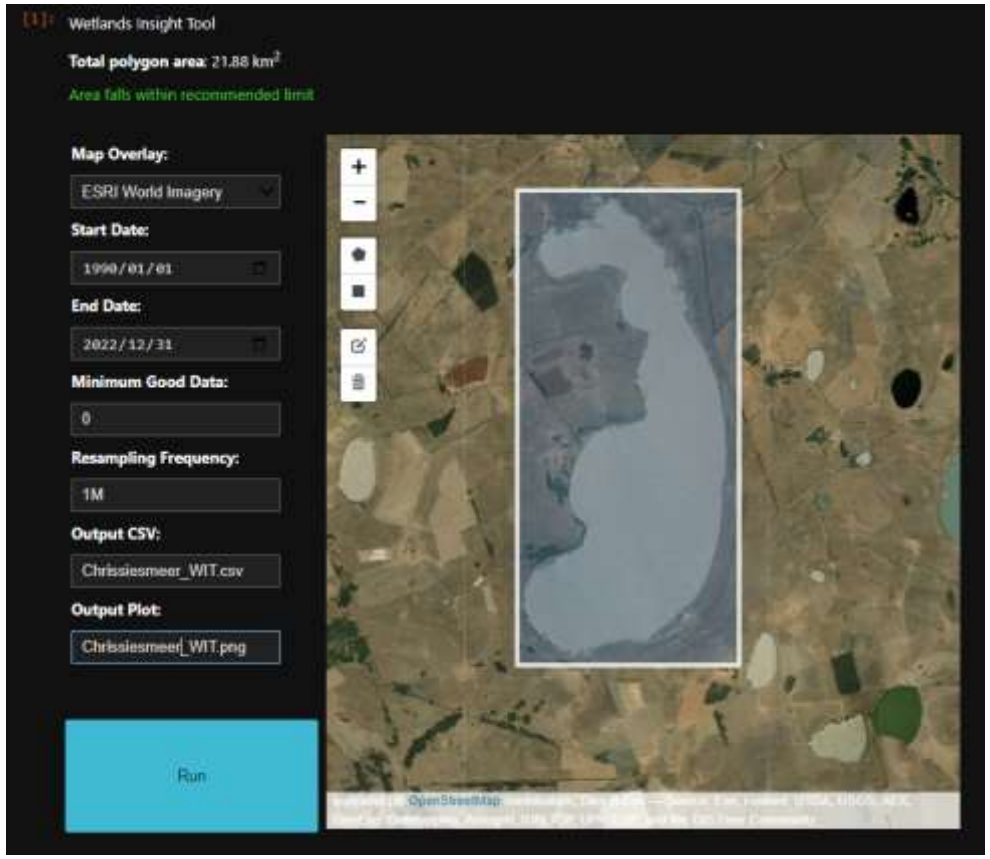
Dunn et al. (2019) Developing a Tool for Wetland Characterization Using Fractional Cover, Tasseled Cap Wetness And Water Observations From Space

Wetland Insight Tool (WIT)

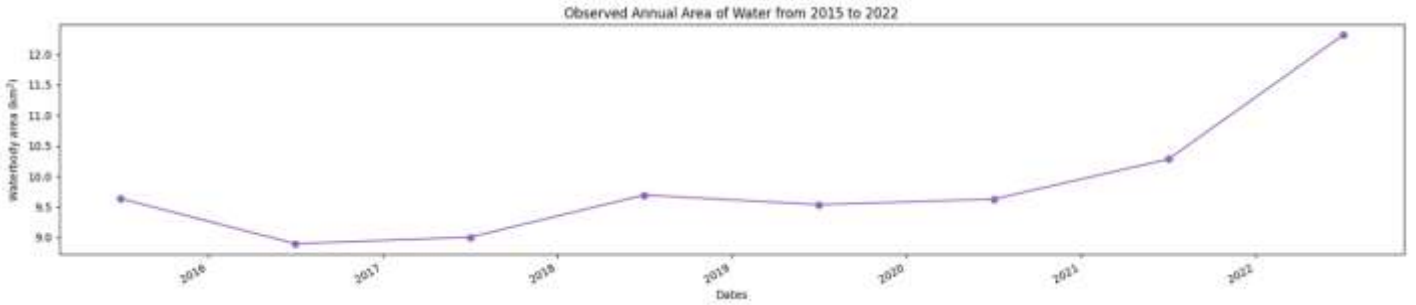


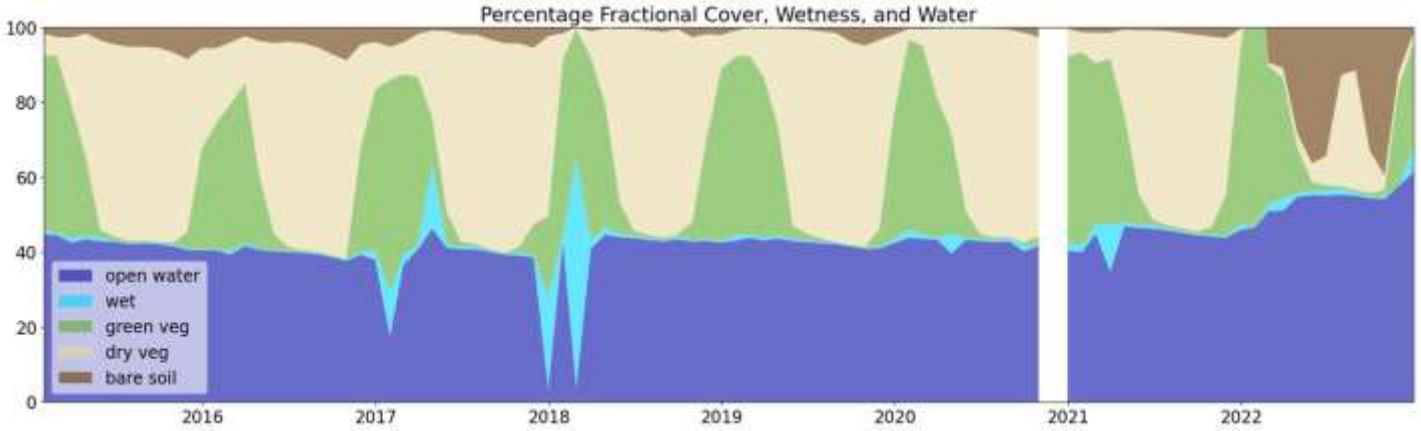
Wetland Insight Tool (WIT)

Digital Earth AFRICA



From WOfS





04

Learn more about Digital Earth Africa

How can I learn more about DE Africa?

- A link to our website https://www.digitalearthafrica.org
- The opportunity to subscribe to the DE Africa community to receive quarterly newsletters and invitations to attend events https://helpdesk.digitalearthafrica.org
- How to sign up to the DE Africa weekly Live Learning Sessions: every Wednesday at 11am, GMT zero) - ask questions and connect:

  https://zoom.us/j/5890793425

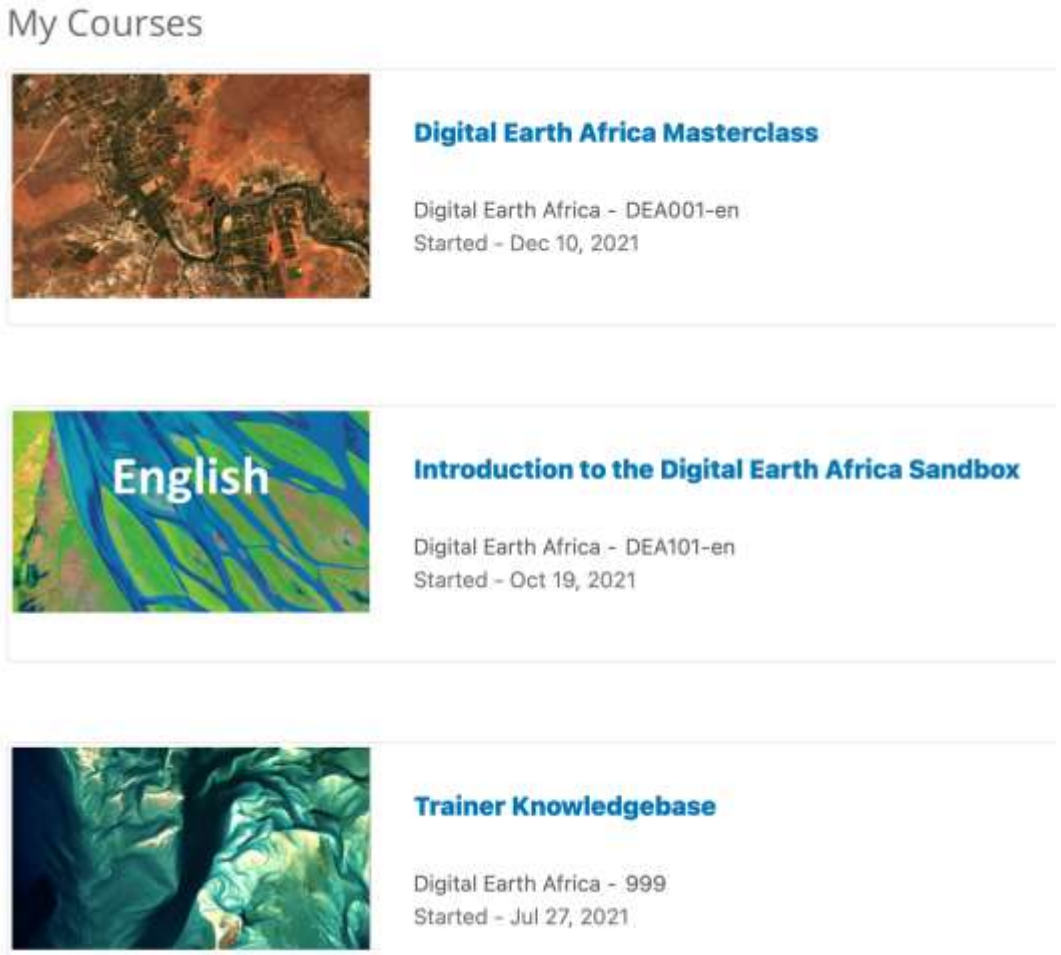
- Email address info@digitalearthafrica.org

DE Africa training course

- **Sign up! (details to be provided)**
- **Enrol in “Intro to Sandbox”, “Master Class”**
- **Self-paced, free-to-access, fully online:**
  - Videos, recorded tutorials, manuals
  - Hands-on exercises
  - English and French versions
- **Certificate of Completion is awarded upon completion of exercises**

https://learn.digitalearthafrica.org/

Email: training@digitalearthafrica.org



https://learn.digitalearthafrica.org/

Acknowledgements

Digital Earth AFRICA

Australian Government
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GEO Group on Earth Observations

United Nations Economic Commission for Africa

RCMRD

CILSS AGRHYMET

sansa South African National Space Agency

Global Partnership for Sustainable Development Data

Ghana Statistical Service

AFRIGIST

Sahara and Sahel Observatory

Université d'Antananarivo

Thunderbird School of Global Management

CSE Centre de Suivi Ecologique

Bill & Melinda Gates foundation

esri

aws

dLab Tanzania Data Lab

COOi studios

World Economic Forum

CEOS Committee on Earth Observation Satellites

Open Data Cube

ITC

IWMI International Water Management Institute

Element 84

SINERGISE

NADMO Ghana

FRONTIER SI

KARTOZA Open Source Geospatial Solutions

Radiant Earth Foundation Earth Imagery for Impact

UENR University of Energy & Natural Resources

Thank you Merci obrigada

Asante. E ṣeun. Murakoze.

Amesegnalaw. Weebale.

Jërëjëf. Kea leboga. meda wo ase

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