



PROJECT OVERVIEW

Agenda for today!

- **Objective** of the Working Group Africa is to enhance capacities in Africa in the sector of Earth Observation (EO) from Space, **in complement** to other institutional efforts such as GMES & Africa.
- Training of trainer's program in **FR, EN and PT**:
 - Phase 1: 10 modules provided to 30 trainers
 - Phase 2: supporting the trainers to implement a training session in their local communities
- Webinars in FR, EN and PT for **wider dissemination and engagement.**



WORKING
GROUP
AFRICA

Webinar 2: Copernicus services and applications – part I

1. General introduction and webinar objectives

1. The Copernicus Services Part 1

Copernicus Marine Environment Monitoring Service

1. CMEMS overview and use cases in Africa (Fabrice Messal, MOi)
2. Use cases from **GMES & AFRICA**:
 - in GHANA, Kwame Adu Agyekum, University of Ghana
 - in South Africa, Marie Smith, CSIR

Copernicus Land Monitoring Service

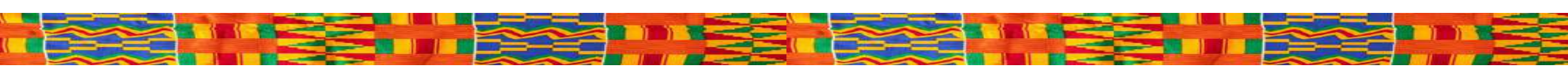
1. CLMS overview and applications (Marco Clerici, JRC)
2. Use cases in Africa - Monitoring the water reservoirs in Burkina Faso (B. Palmaerts, ISSeP)

3. **Meet the trainers** and the plans for the Training phase 2:
Meet the trainer: Brighton Gwamagobe (Tanzania)

3. Other projects: **EO4CEA** – Earth Observation For Central East Africa; Giovanni Laneve (Sapienza University of Rome)

GMES & Africa use cases for WG Africa Webinar

Kwame Adu Agyekum
Project Coordinator, Marine and Coastal Areas
Management in North and West Africa (MarCNoWA)
University of Ghana
kaagyekum@ug.edu.gh



Marine & Coastal Areas Management in North and West Africa (MarCNoWA) Consortium

6 Countries from North Africa

- Algeria
- Egypt
- Libya
- Morocco
- Tunisia
- Mauritania

12 Countries from West Africa

- Benin
- Cape Verde
- Cote d'Ivoire
- Gambia
- Ghana
- Guinea
- Guinea Bissau
- Liberia
- Nigeria
- Senegal
- Sierra Leone
- Togo





Copernicus Programme:

Ensuring access to Earth Observation data

To provide decision-makers with **information and tools that would support effective marine and coastal resources management** in western and North Africa.



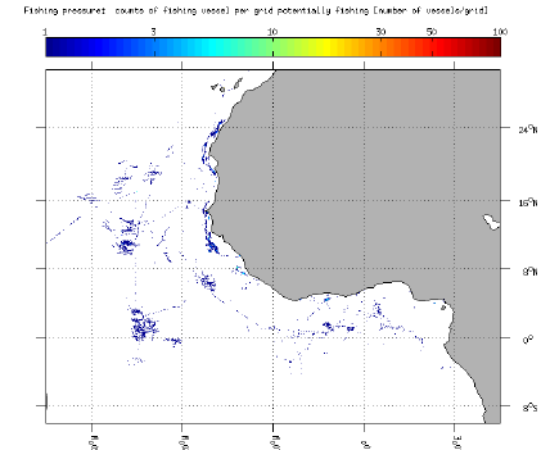
Impact: supporting resource management using EO

Policy Advocacy

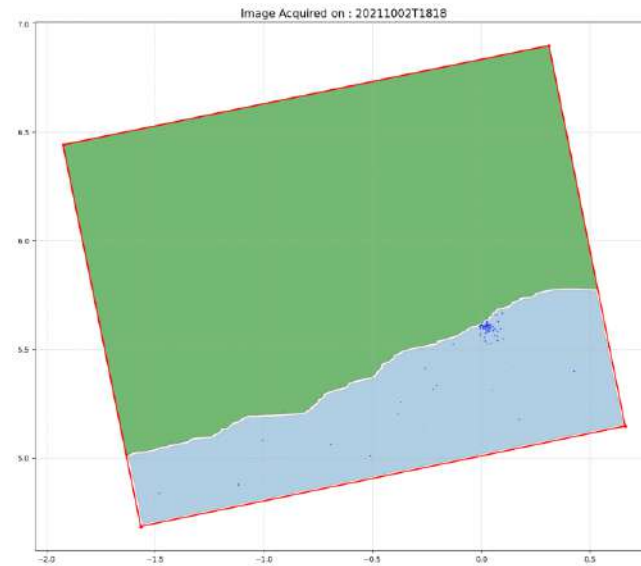
- Raising awareness of geospatial information's role in SDG-aligned policy and decision-making.

Improved Environmental Monitoring

- Satellite monitoring of key ocean processes.
- Tracking fishing vessel traffic to combat IUU fishing.
- Detecting oil spills for cleaner oceans.
- Monitoring changes in coastal ecosystems, etc



Fishing density maps



GMES
AND AFRICA



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OF GHANA

Access to forecast model products

Copernicus Marine Data Store

Home > Marine Data Store

Filters

FREE-TEXT SEARCH
Freetext

FAVOURITES ★ 0

TIME RANGE mm/dd/yyyy mm/dd/yyyy
Covering full interval

WITH DEPTH 37

DEPTH RANGE

UNIVERSE

- Blue Ocean 191
- White Ocean 40
- Green Ocean 78

MAIN VARIABLES

- Carbonate system 19
- Mixed layer thickness 17

Products 277

MOST POPULAR

Global Ocean Physics Analysis and Forecast
GLOBAL_ANALYSISFORECAST_P..._001_024
Models
Global, 0.083° × 0.083° × 50 levels
1 Nov 2020 to 7 Mar 2024, hourly, daily, ...
Mixed layer thickness, salinity, sea ice, sea surface height, temperature, velocity, wave...

Global Ocean Biogeochemistry Analysis and Forecast
GLOBAL_ANALYSISFORECAST_B..._001_028
Models
Global, 0.25° × 0.25° × 50 levels
1 Oct 2021 to 1 Mar 2024, daily, monthly
Carbonate system, nutrients, optics, oxygen, plankton

Global Ocean Physics Reanalysis
GLOBAL_MULTIYEAR_PHY_001_030
Models
Global, 0.083° × 0.083° × 50 levels
1 Jan 1993 to 24 Oct 2023, daily, monthly
Mixed layer thickness, salinity, sea ice, sea surface height, temperature, velocity



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AND AFRICA**



MarCNoWA



**UNIVERSITY
OF GHANA**

Impact: supporting resource management using EO

Enhanced Safety for Fishermen and Communities using Mercator products



- Providing ocean state alerts.
- Monitoring shoreline changes.







Mobile USSD code




SMS Service
Forecasting ocean weather

Advance information on ocean weather on your mobile phone

1  →  Calm

2  →  Rough

3  →  Dangerous

To receive SMS on ocean conditions please contact:  MESA  00233 15201250 Ext: 4502 



GMES
AND AFRICA



Training and other future activities

Training and Capacity Building

- Developing skills EO data processing and visualization
- Developing insitu ocean measuring tools using IoT/Low Cost Sensors



Insitu ocean data collection

- Canoes and fishing nets as platforms to collect temperature, salinity etc.



GMES
AND AFRICA



Our dissemination channels

Thank You



<https://gmes.rmc.africa/>



rmc@ug.edu.gh



[Regional Marine Centre](#)



[@ug_gmes](#)



[Regional Marine Centre](#)



[UG-GMES Regional Marine Centre](#)



**GMES
AND AFRICA**



**African
Union** 



CSIR
Touching lives through innovation

Marine & Coastal Operations for southern Africa and the Indian Ocean (MarCOSIO)

Dr Marié Smith

*Coastal Systems and Earth Observation Research Group
Council for Scientific and Industrial Research (CSIR)*

WG Africa – Training of Trainers Webinar #2

27 February 2024



<https://marcosio.org/>

MARINE AND COASTAL OPERATIONS
FOR SOUTHERN AFRICA AND THE INDIAN OCEAN


MarCOSIO



**GMES
AND AFRICA**



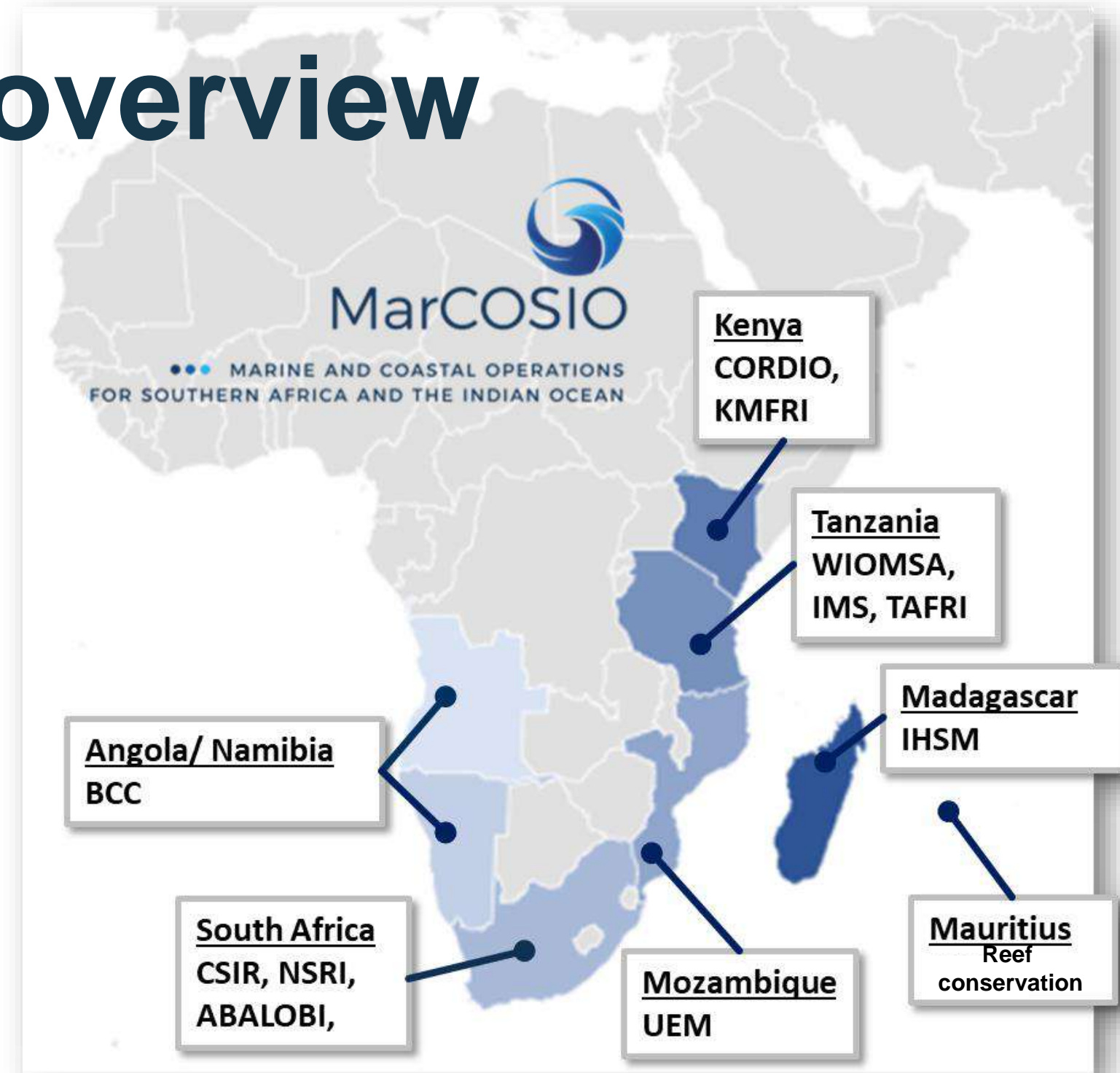
**African
Union**



CSIR
Touching lives through innovation

GMES&Africa MarCOSIO overview

- One of 2 marine consortia within the GMES&Africa programme
- The MarCOSIO project is lead by the CSIR (South Africa)
- The project represents 12 partners in 8 countries in Southern Africa and the Western Indian Ocean (WIO) region





**GMES
AND AFRICA**



**African
Union**



Project pillars

Policy and institutional Frameworks

Data Access

Services

Knowledge Management and Cross Fertilization

Capacity Building

Outreach, Uptake and Dissemination

**Fisheries
and
Aquaculture
Service**



Fisheries



Aquaculture

**Coastal
Service**



Coral Bleaching
Monitoring



Coastal
Ecosystems

**Marine and
Maritime
Service**



Ship Traffic
Monitoring



Sea Rescue



<https://marcosio.org/>

MARINE AND COASTAL OPERATIONS
FOR SOUTHERN AFRICA AND THE INDIAN OCEAN





GMES
AND AFRICA

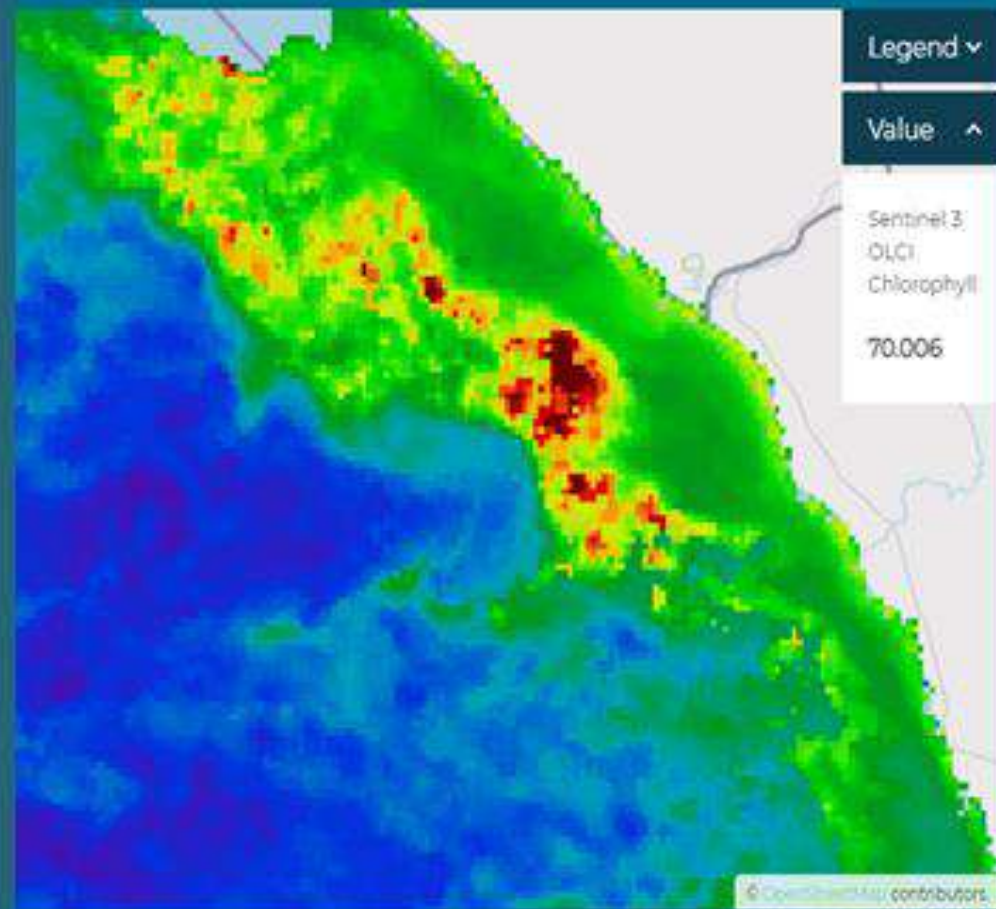
African
Union



MarCOSIO



Aquaculture
Support Service



DATE ON VIEW: 2021-08-25

SEEK TO SPECIFIC DATE:

-1 DAY

+1 DAY

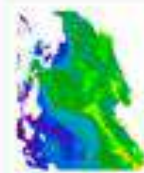
PICK DATE:

2021-08-25



Now viewing:

Sentinel 3 OLCI Chlorophyll



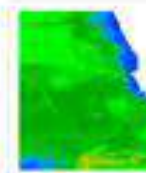
Sentinel 3
OLCI
Chlorophyll



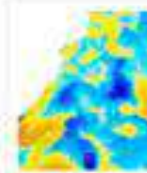
Sentinel 3
SLSTR
SST (AM)



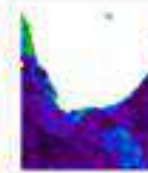
Sentinel 3
SLSTR
SST (PM)



SST



SST
Anomaly



GlobColour
Chlorophyll

Aquaculture Support Service

<https://ocims.csir.co.za/hab/app/#>



<https://marcosio.org/>

MARINE AND COASTAL OPERATIONS
FOR SOUTHERN AFRICA AND THE INDIAN OCEAN

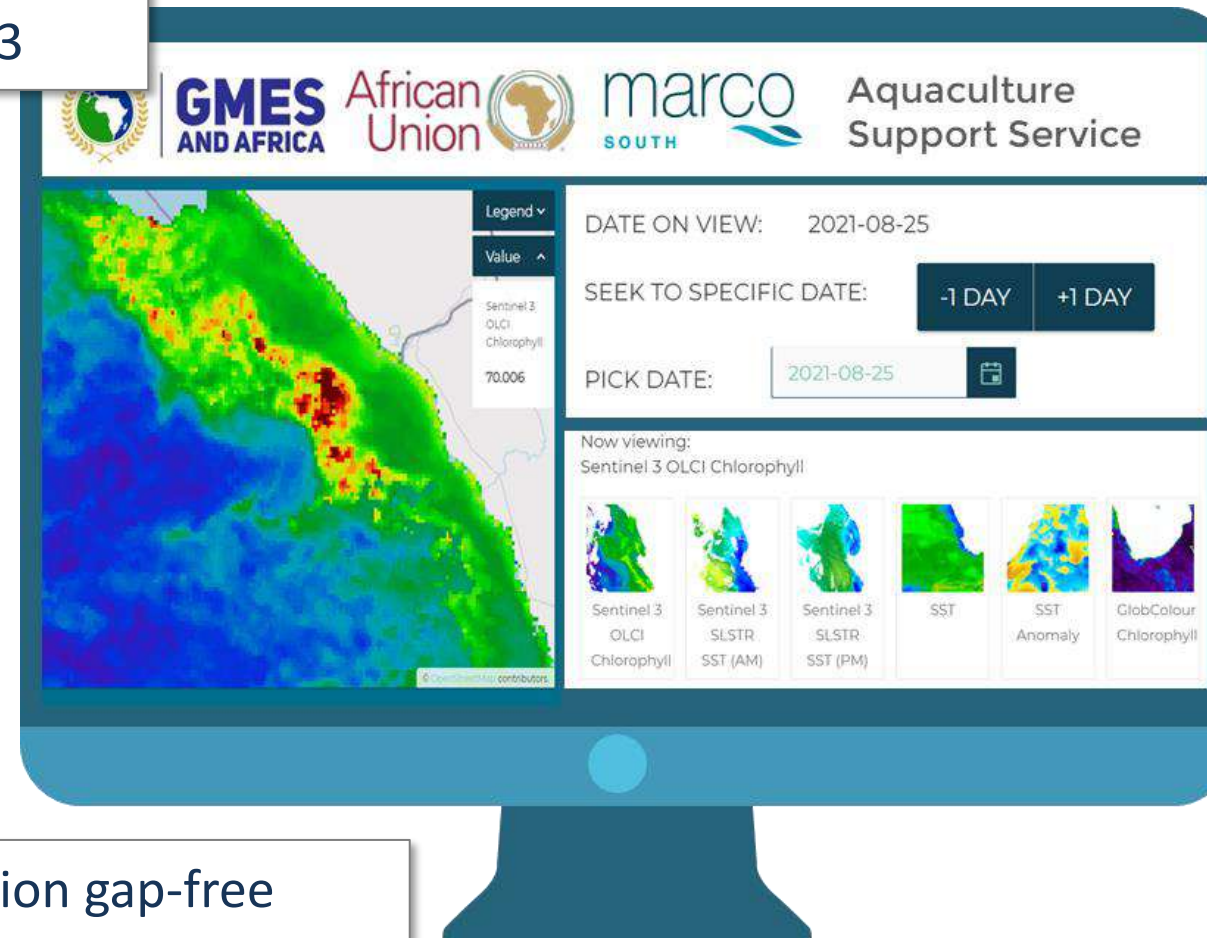
MarCOSIO



The web-based viewers

The Aquaculture support service

High resolution near real time products from Sentinel 3



- Web-based application for Aquaculture and Fisheries support in southern Africa
 - Spatial coverage from north of Angola to Kenya
- Low latency 1km Chl-a & SST products from Sentinel 3
- 1-2 day latency gap-free SST, SST anomaly (5km, OSTIA) and Chl-a (4km, Globcolor) products from CMEMS

Low resolution gap-free products from CMEMS

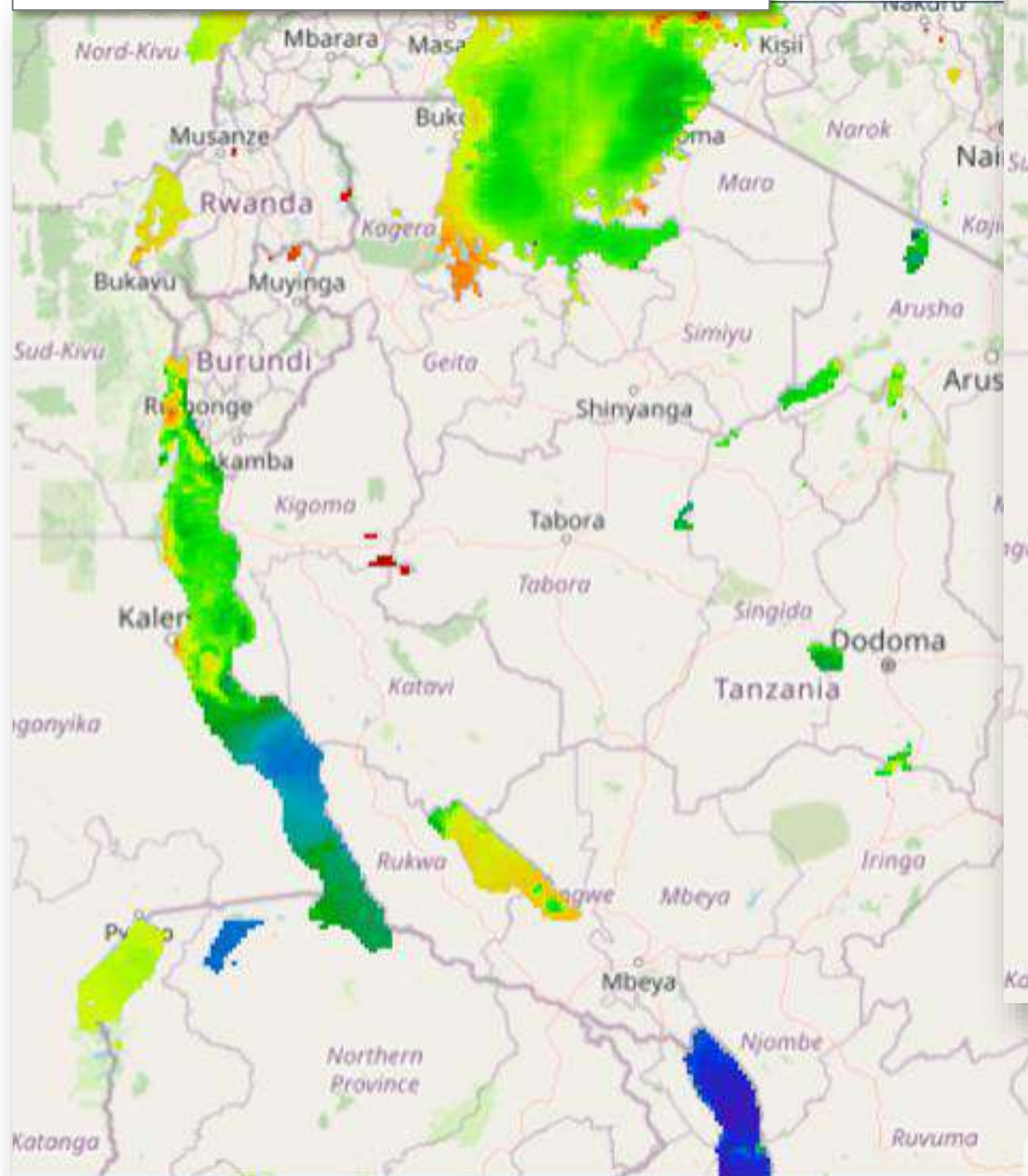
<https://ocims.csir.co.za/hab/app/#>

The web-based viewers

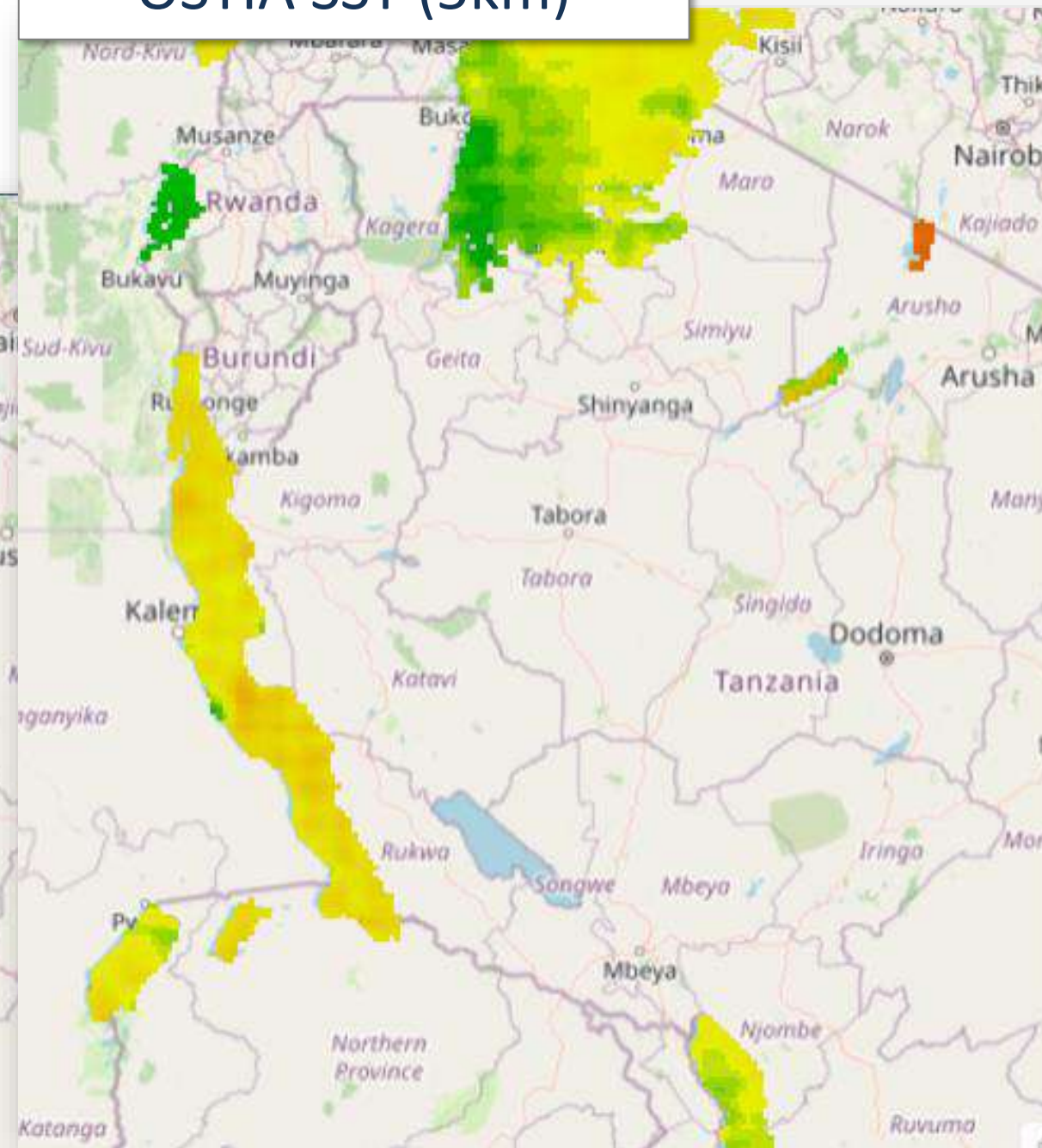
The Aquaculture support service



Globcolor Chl-a (4km)



OSTIA SST (5km)



- Both the low resolution SST and Chl-a products already provide data for the large African lakes

<https://ocims.csir.co.za/hab/app/#>



Coastal Ecosystems Monitoring Service

<https://online.cyanolakes.com/marcosio/>



<https://marcosio.org/>

MARINE AND COASTAL OPERATIONS
FOR SOUTHERN AFRICA AND THE INDIAN OCEAN



The web-based viewers

Coastal Ecosystems (Water Quality) Monitoring service

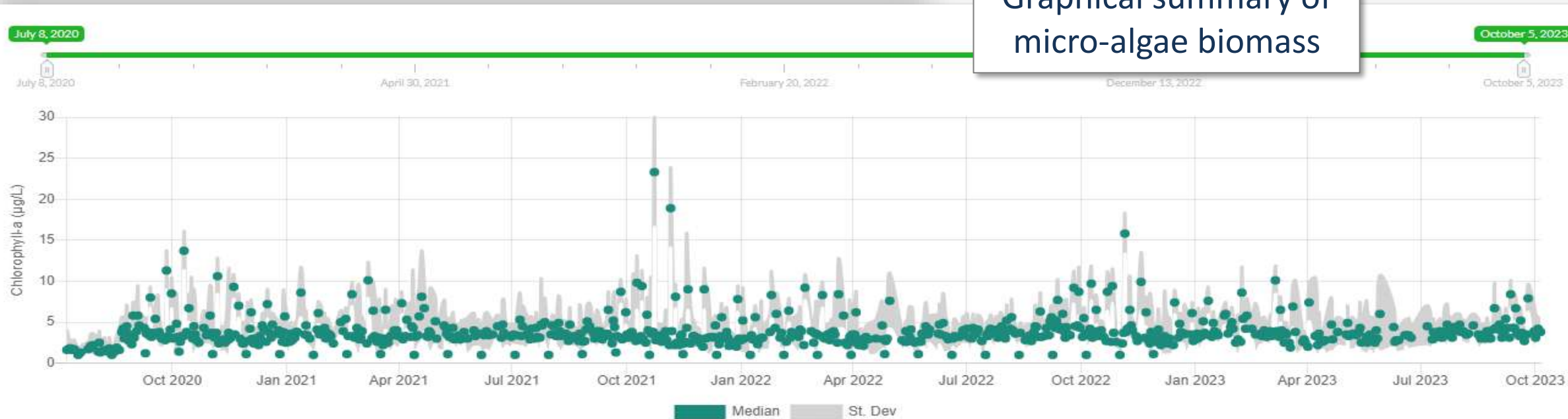
Enhanced vegetation product using Sentinel 2



- In collaboration with CyanoLakes
- 300 m resolution Chl-a, turbidity, cyanobacteria, and floating vegetation products (near-daily) [Sentinel-3]
- 10 m resolution vegetation indicator products and true color images (every 5 days) [Sentinel-2]
- Several locations around Africa, but can scale to other regions

<https://online.cyanolakes.com/marcosio/>

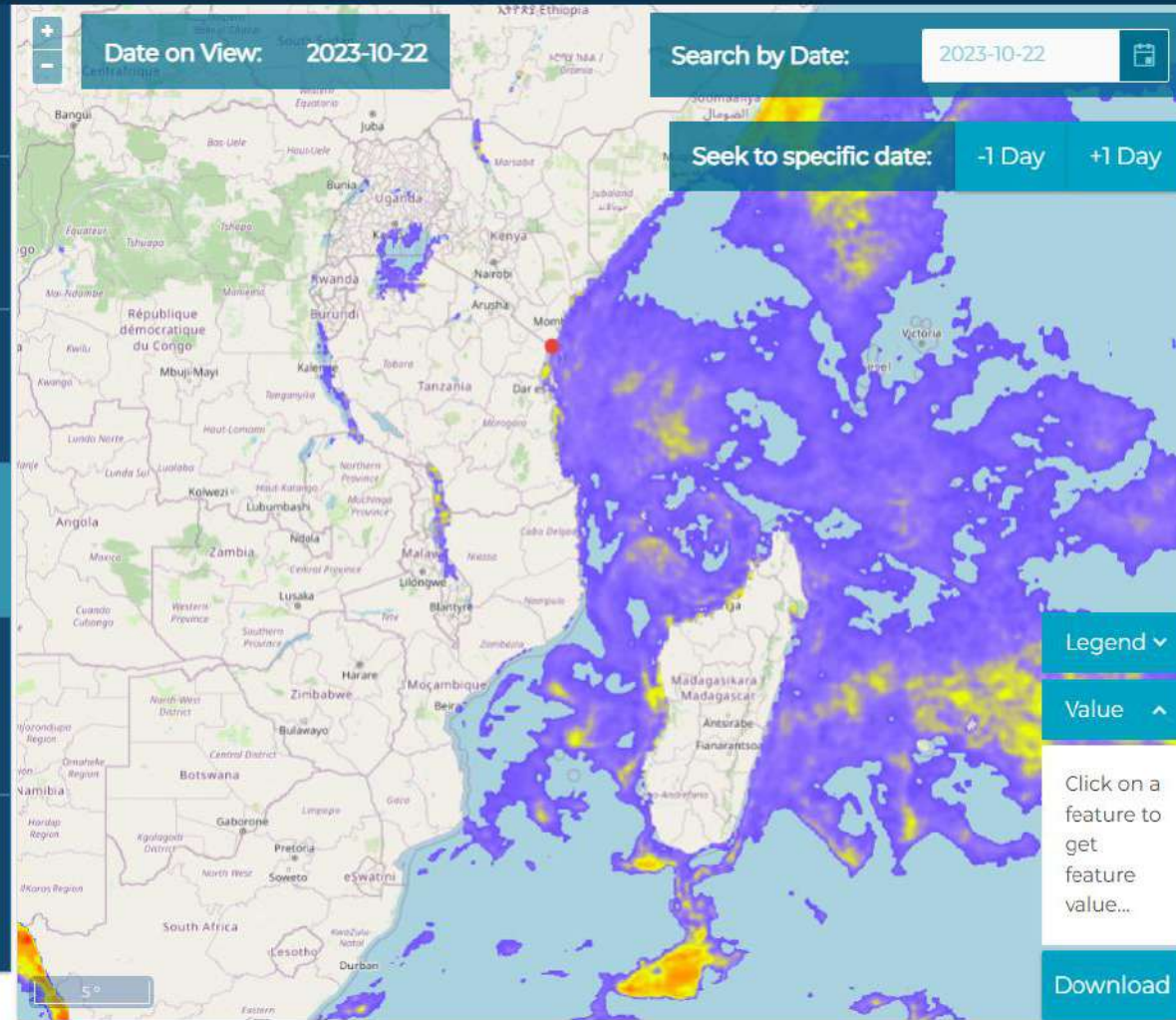
Graphical summary of micro-algae biomass



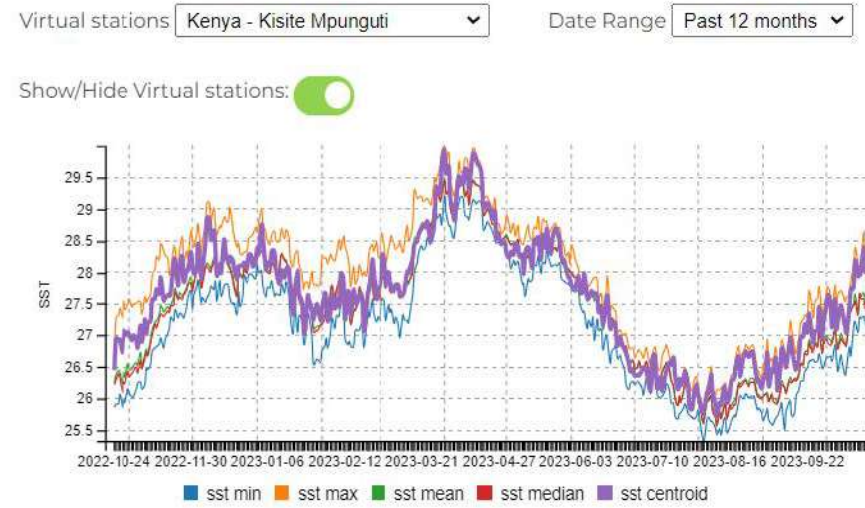
ALGOA BAY
ANGOICHE
BEL OMBRE LAGOON
DELTA ZAMBEZI
LANGEBAAN
LUANDA
LUDERITZ
MOMBASA
NUNGWI
PATE LAMU
PEMBA
SHIMONI
WALKER BAY
WALVIS BAY



Western Indian Ocean Coral Bleaching Monitoring Service



Virtual Stations



In situ bleaching observations



Coral Bleaching Monitoring Service

<https://ocims.csir.co.za/coralbleaching/>



<https://marcosio.org/>

MARINE AND COASTAL OPERATIONS FOR SOUTHERN AFRICA AND THE INDIAN OCEAN



The web-based viewers

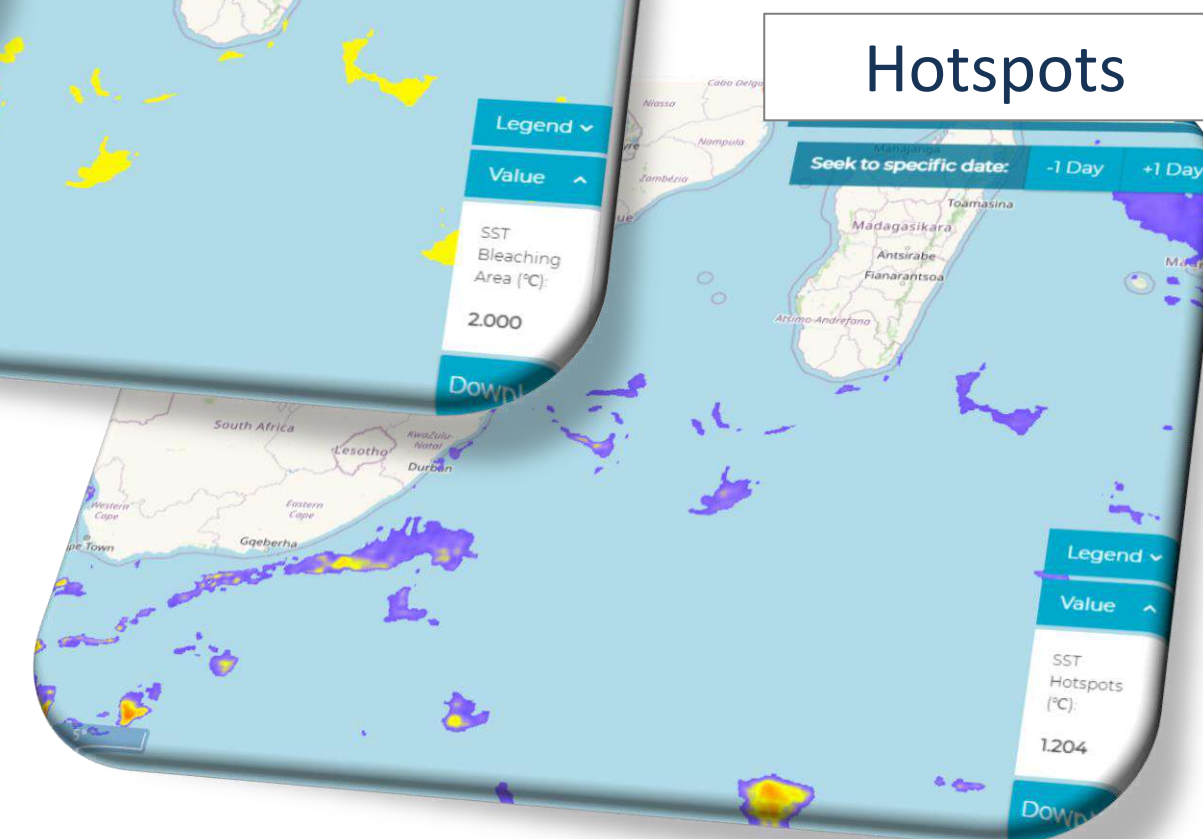
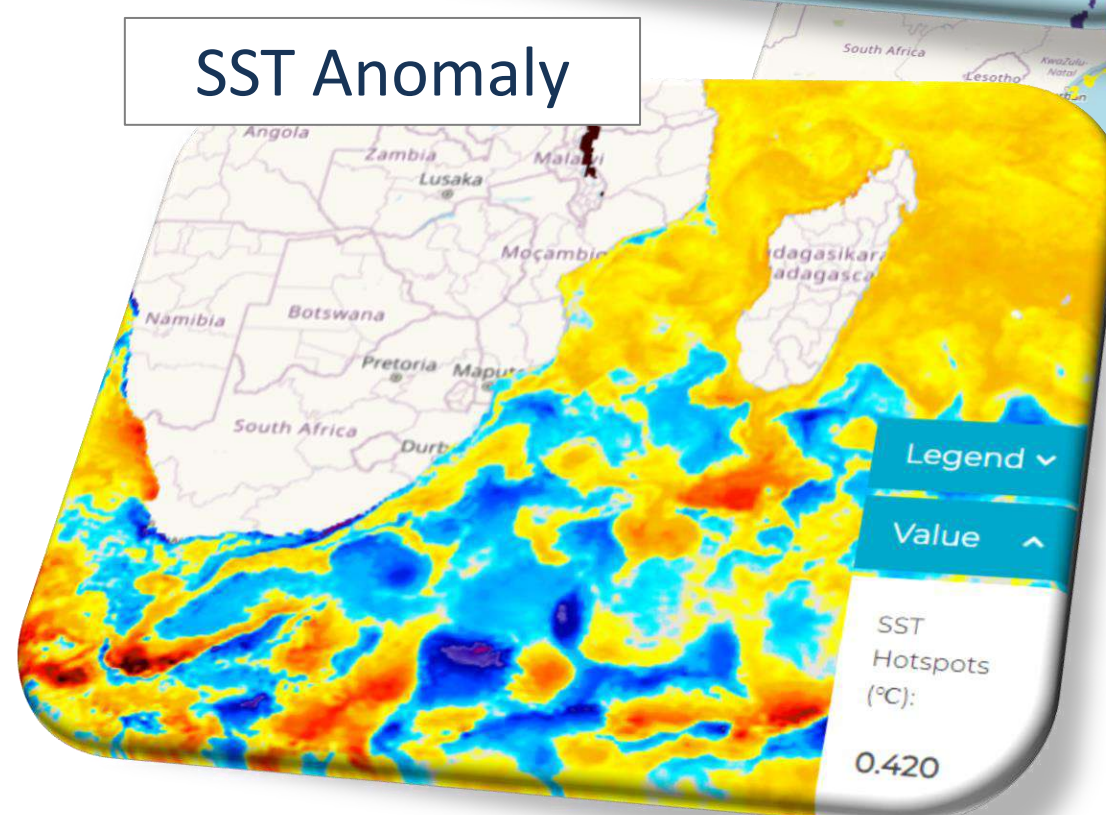
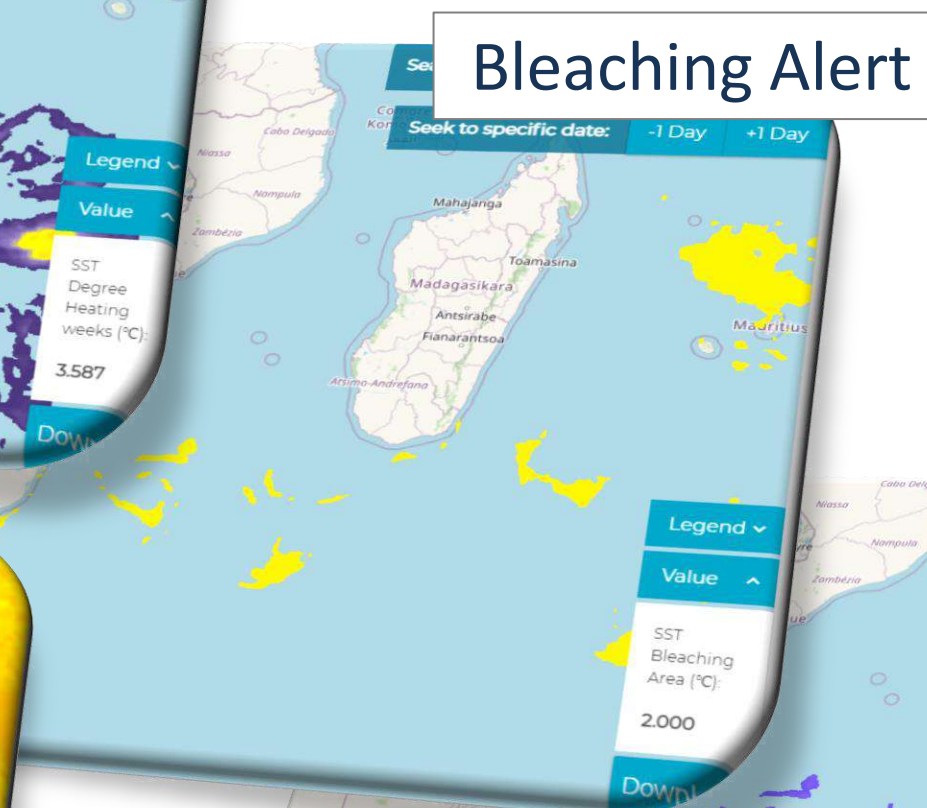
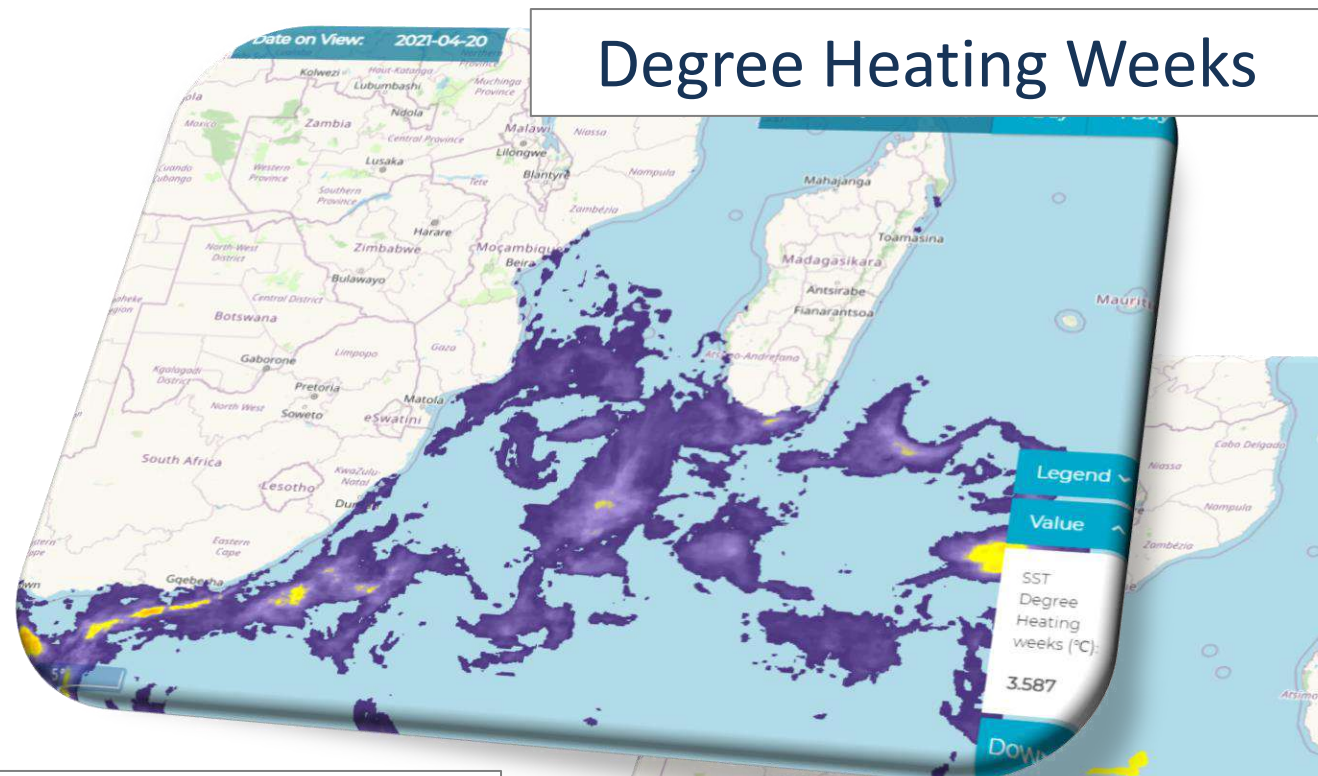
Coral Bleaching Monitoring service

CORDIO
East Africa



<https://ocims.csir.co.za/coralbleaching/>

- Thermal stress products
 - Gap-free satellite products derived from SST (5km resolution), providing information on potential bleaching alerts, immediate and accumulated thermal stress

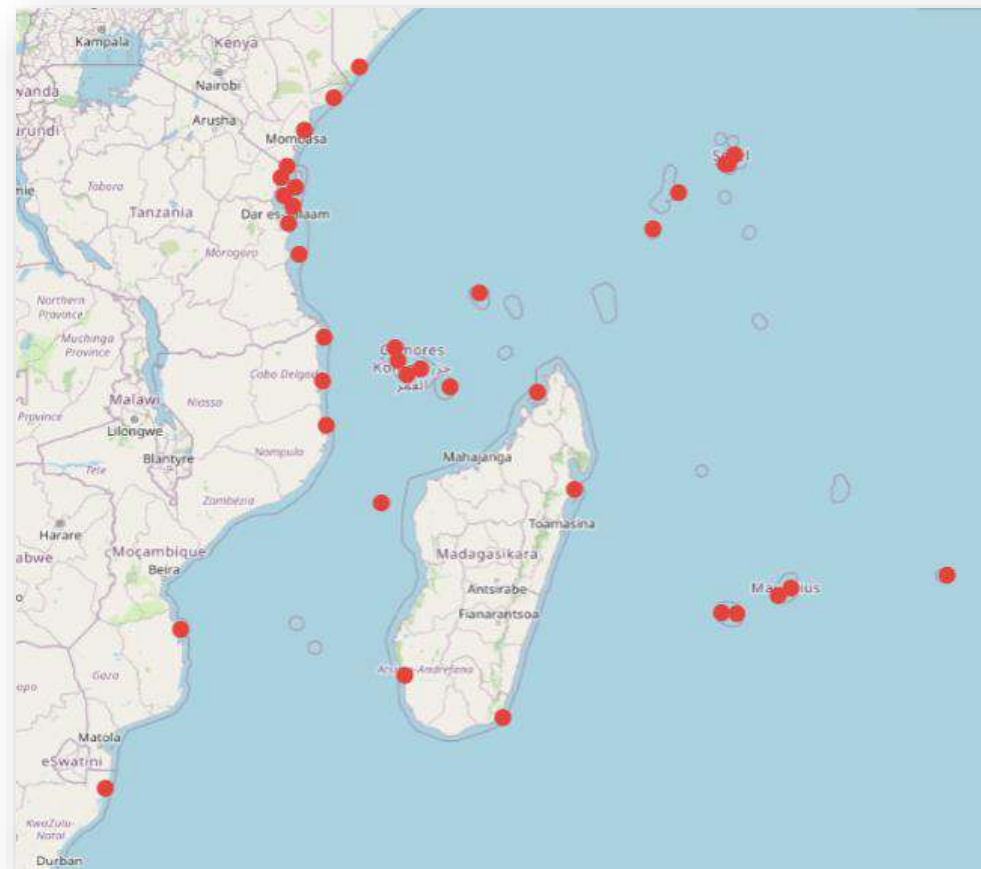


The web-based viewers

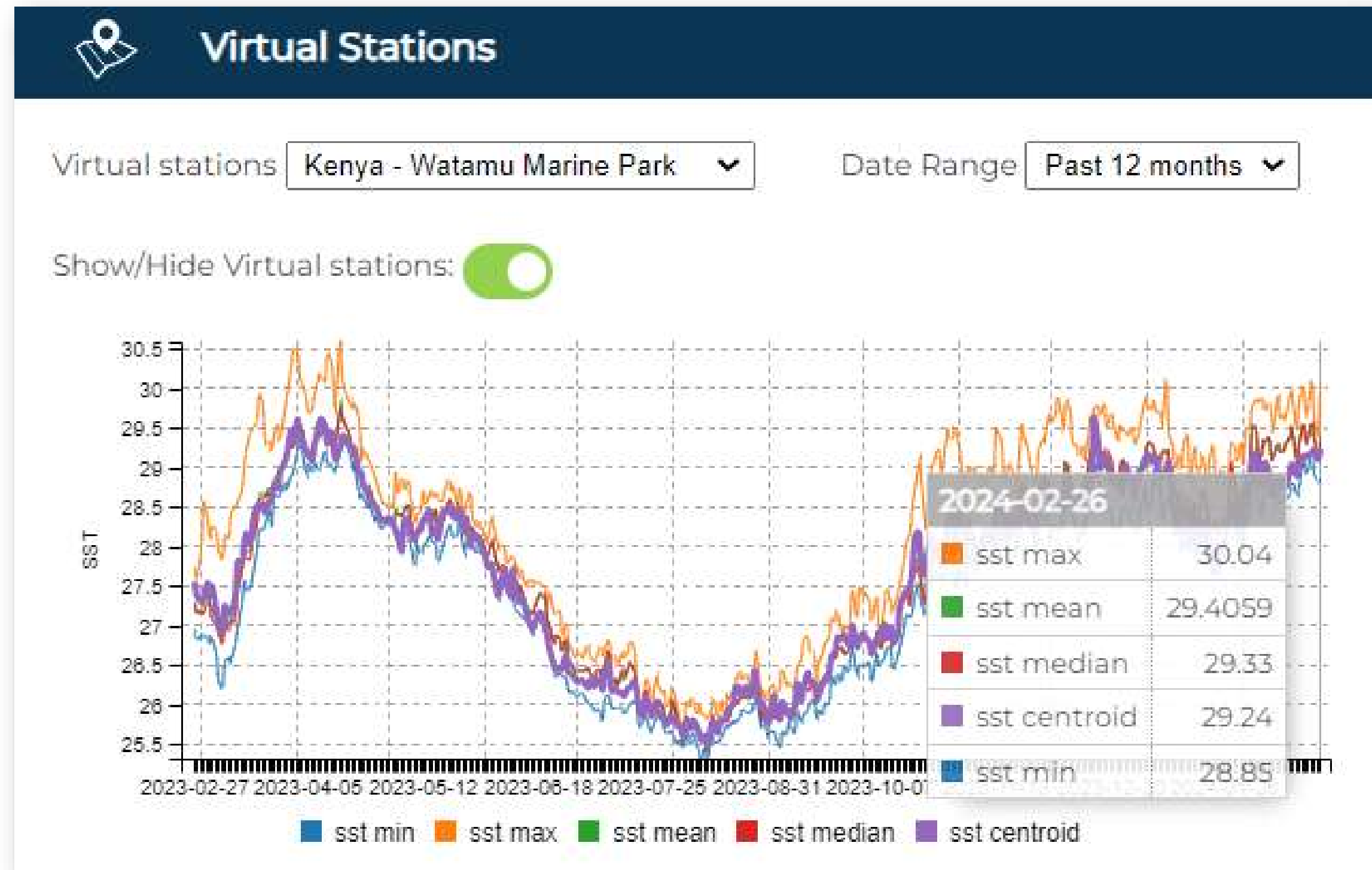
Coral Bleaching Monitoring service

- Virtual stations

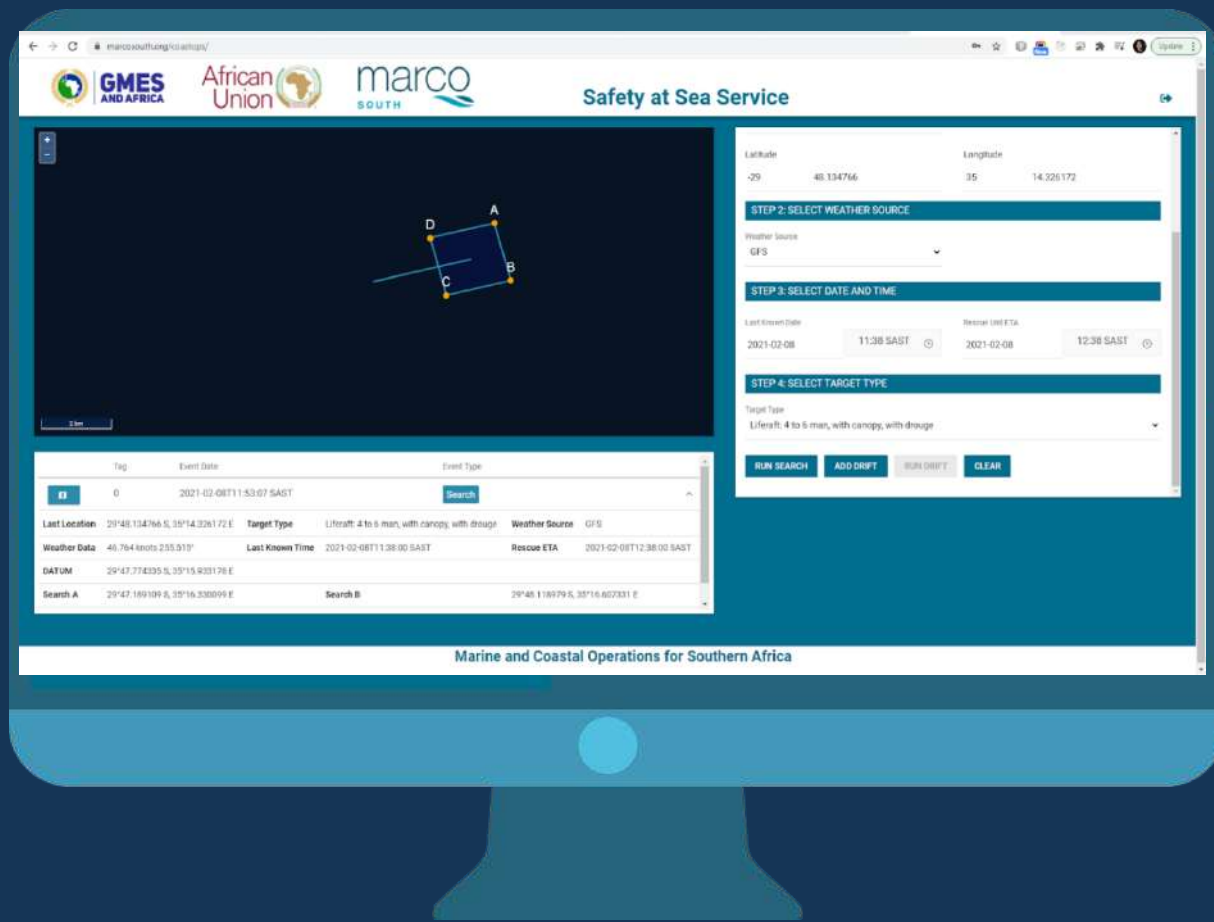
- Interactive graphical presentations of key monitoring sites showing historical information on SST within the past 12 months



<https://ocims.csir.co.za/coralbleaching/>

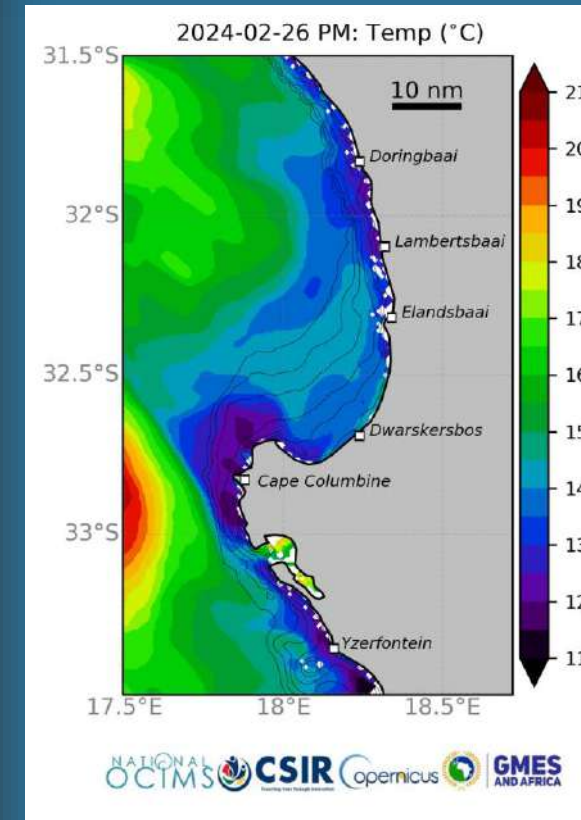


Safety at Sea Service



- ✓ Capability to monitor and predict ocean and sea state variables such as wind, currents and waves
- ✓ Quickly determine a search area for rescue operations
- ✓ Closed system to avoid rescue attempts by ordinary citizens

Abalobi Fisher App



- ✓ Aimed at small-scale fishers
- ✓ Low mobile data draw
- ✓ Provides regional information on sea state, sea temperature and algal blooms

Ship Traffic Monitoring



- ✓ Provides authorised users the capability to monitor co-operative vessels in near real time
- ✓ Derive strategic information on non-co-operative vessels
- ✓ Data sources includes: AIS, Sentinel-1 SAR, VMS, Optical cameras



<https://marcosio.org/>

MARINE AND COASTAL OPERATIONS
FOR SOUTHERN AFRICA AND THE INDIAN OCEAN





GMES
AND AFRICA



African
Union 



CSIR
Touching lives through innovation

Thank you

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MarCOSIO lead : Sives Govender
SGovender5@csir.co.za



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MARINE AND COASTAL OPERATIONS
FOR SOUTHERN AFRICA AND THE INDIAN OCEAN


MarCOSIO



Copernicus

European Union Earth Observation & Monitoring Program

Land Service - Global

Nature Conservation and Observations Unit (D6)
Directorate-General Joint Research Centre (DG JRC)



Copernicus

C O P E R N I C U S I N B R I E F

- **Copernicus, the Earth Observation and Monitoring flagship programme** of the European Union:
 - **Monitors the Earth**, its environment and ecosystems
 - Prepares for crises, security risks and natural or man-made disasters
 - Contributes to the EU's role as a global "soft" power
- Adopts a **full, free and open data policy**
- Is an **operational and sustainable** program
- Is a **tool for economic development** and a driver for the digital economy



COPERNICUS Architecture

FULL, FREE AND OPEN

Copernicus

| | | |
|--|---|--------------------|
| | SENTINEL-1: 4-40m resolution, 6 days revisit at equator | 2 Sats in orbit |
| | SENTINEL-2: 10-60m resolution, 5 days revisit time | 2 Sats in Orbit |
| | SENTINEL-3: 300-1200m resolution, <2 days revisit | 2 Sats in Orbit |
| | SENTINEL-4: 8km resolution, 60 min revisit time | 1st Launch in 2023 |
| | SENTINEL-5p: 7-68km resolution, 1 day revisit | 1 Sat in Orbit |
| | SENTINEL-5: 7.5-50km resolution, 1 day revisit | 1st Launch in 2023 |
| | SENTINEL-6 Michael Freilich: 10 day revisit time | 1 Sat in Orbit |

Sentinels



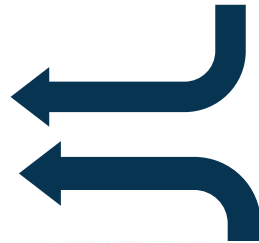
Services using Earth Observation data to deliver core products



Downstream Applications



Contributing missions












Copernicus

THE SENTINELS

Sentinel Mission and Status

| | | |
|---|---|----------------------------|
|  | SENTINEL-1: 4-40m resolution, 6 days revisit at equator | <i>1 Sat in operation</i> |
|  | SENTINEL-2: 10-60m resolution, 5 days revisit time | <i>2 Sats in operation</i> |
|  | SENTINEL-3: 300-1200m resolution, <2 days revisit | <i>2 Sats in operation</i> |
|  | SENTINEL-4: 8km resolution, 60 min revisit time | <i>1st Launch in 2023</i> |
|  | SENTINEL-5p: 7-68km resolution, 1 day revisit | <i>1 Sat in operation</i> |
|  | SENTINEL-5: 7.5-50km resolution, 1 day revisit | <i>1st Launch in 2023</i> |
|  | SENTINEL-6 Michael Freilich: 10 day revisit time | <i>1 Sat in operation</i> |

Key Features

Polar-orbiting, all-weather, day-and-night radar imaging

Polar-orbiting, multispectral optical, high-res imaging

Optical and altimeter mission monitoring sea and land parameters

Payload for atmosphere chemistry monitoring on MTG-S

Mission to reduce data gaps between Envisat, and S-5

Payload for atmosphere chemistry monitoring on MetOp 2ndGen

Radar altimeter to measure sea-surface height globally

FULL, FREE AND OPEN



Copernicus

SATELLITE Data ACCESS

Access to Satellite data from Science Hub to CDSE

FULL, FREE AND OPEN



Main features of Copernicus Data Space Ecosystem

Full Sentinel Data On-line Repository

Data visualisation, custom analysis, and export through an interactive Copernicus Browser

Cloud computing with user-selectable capacity and performance

Copernicus Contributing Missions Data

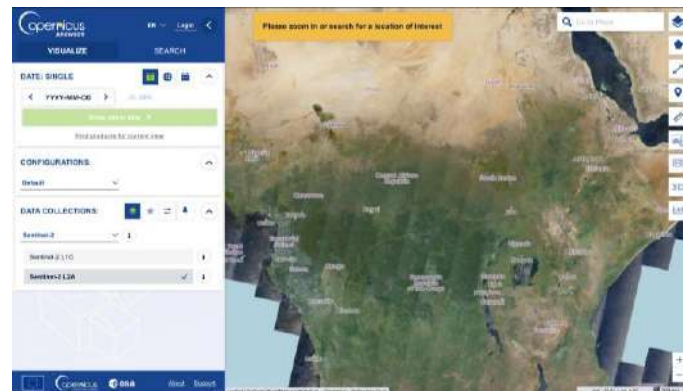
Open and free data access with downloading and processing APIs

Onboard code lab and repositories

Additional EO data

Federation and user identity services

Open ecosystem





Copernicus

COPERNICUS SIX SERVICES





Land
Monitoring

Benefit areas and products examples

Ecosystems

Biodiversity

Agriculture

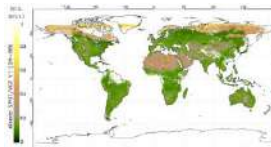
Forestry

Energy

Natural Resources

Water

Urban planning



Global Systematic Monitoring

Global Hot Spot

Pan-European land cover mapping and systematic monitoring

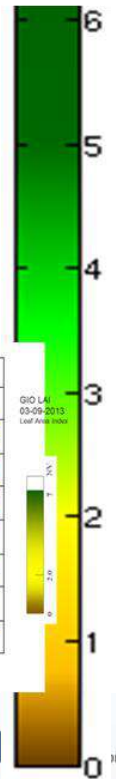
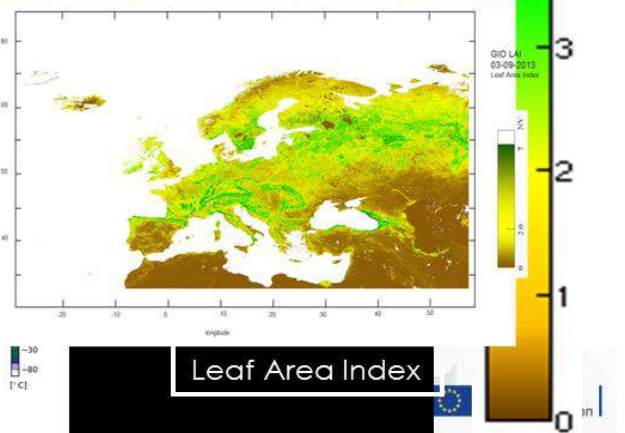
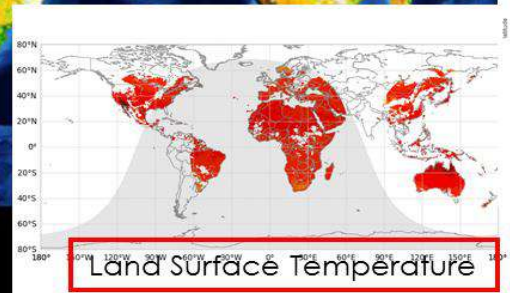
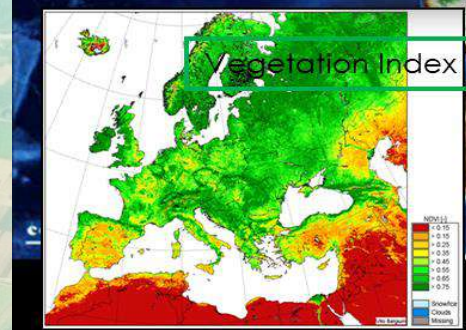
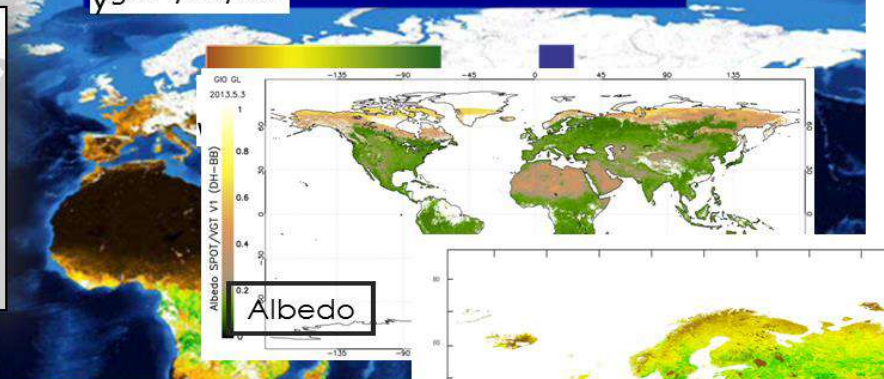
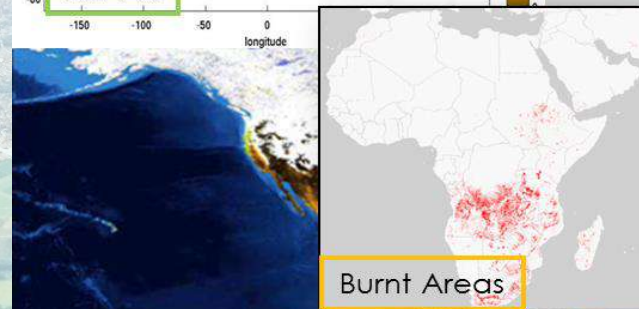
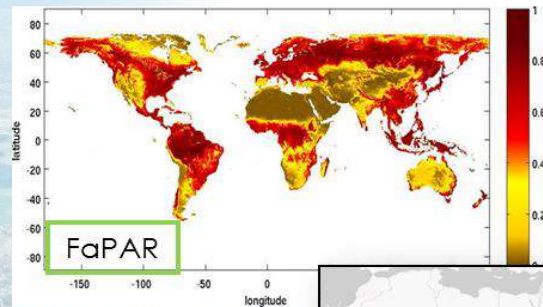
EU Local component

Reference Data & SENTINEL 2 Mosaic



Land
Monitoring

Global Systematic Monitoring Vegetation-Energy portfolio





Biophysical variables - systematic monitoring

From medium to high resolution

| Theme | Variable | Spatial Resolution Moderate 50-100m |
|------------|--------------------|---|
| Vegetation | Land Cover | In production |
| Water | Lake Water Quality | Archive only |
| | Water Bodies | In production |

From coarse to medium resolution

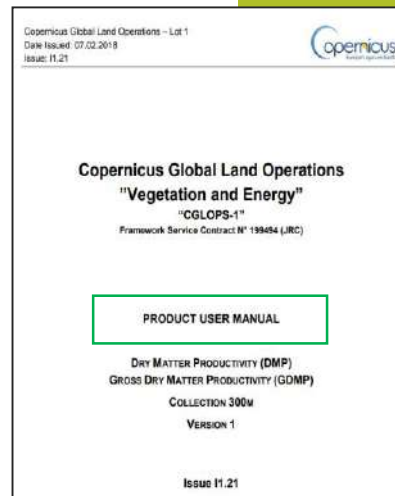
| Theme | Variable | Spatial Resolution | |
|------------|--|--|---------------------|
| | | Coarse >= 1km | Medium 250m-500m |
| Vegetation | Fraction of photosynthetically active radiation absorbed by the vegetation | Archive only, Near-Real Time (NRT) to be resampled from 300m | In production |
| | Fraction of green vegetation cover | Archive only, NRT to be resampled from 300m | In production |
| | Leaf Area Index | Archive only, NRT to be resampled from 300m | In production |
| | Normalized Difference Vegetation Index | Archive only, NRT to be resampled from 300m | In production |
| | Vegetation Condition Index | Archive only | |
| | Vegetation Productivity Index | Archive only | |
| | Dry Matter Productivity | Archive only, NRT to be resampled from 300m | In production |
| | Burnt Area | Archive only, NRT to be resampled from 300m | In production |
| | Soil Water Index | In production | |
| | Surface Soil Moisture | In production | |
| Energy | Land Surface Temperature | In production | |
| | Top Of Canopy Reflectance | In production | |
| | Surface Albedo | Archive only | |
| Water | Water Bodies | Archive only | In production |
| | Lake Surface Water Temperature | In production | |
| | Lake Water Quality | In production | In production |
| | Lake Ice Extent | In production | In production |
| Cryosphere | Snow Cover Extent | In production | In production |
| | Snow Water Equivalent | In production | |

Non-gridded products

| Theme | Variable | Rivers and Lakes |
|-------|-------------|------------------|
| Water | Water Level | In production |

Production global biogeophysical products covers:

21 type products,
3 resolutions,
80+ data collections



Free available
Quality assessed
Peer reviewed
Fully document
Long term commitment



VEGETATION



- Leaf Area Index (LAI)
- Fraction of Absorbed Photosynthetically Active Radiation (FAPAR)
- Fraction of vegetation cover (FCOVER)
- Normalized Difference Vegetation Index (NDVI)
- Vegetation Condition Index
- Vegetation Productivity Index
- Dry Matter Productivity
- Burnt Area
- Greenness Evolution Index
- Phenology metrics
- Mid Resolution Yearly Land Cover

ENERGY



- Top-of-Canopy reflectance
- Surface Albedo
- Land Surface Temperature
- Radiation Fluxes
- Evapotranspiration
- Active Fires
- Surface soil moisture
- Soil Water Index

WATER



- Water Bodies
- Coastal Erosion
- Lake surface water temperature
- Lake and river water level
- Lake surface reflectance*
- Lake turbidity*
- Lake trophic state*
- Lake ice coverage*

CRYOSPHERE

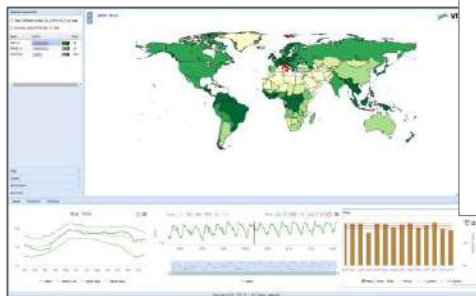
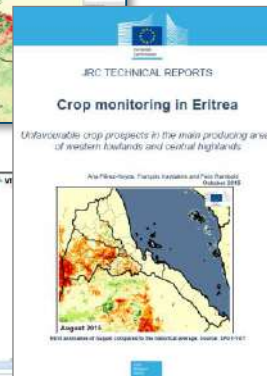
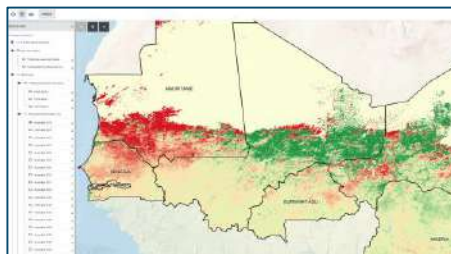
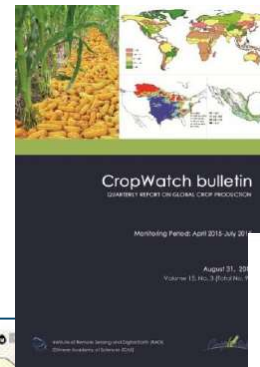
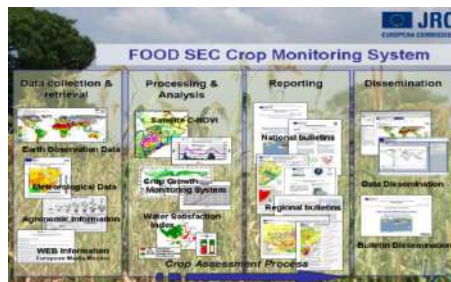


- Snow cover extent*
- Snow water equivalent*



Application fields

- Climate change
 - Carbon flux forecast
- Agriculture
 - Crop monitoring
 - Yield forecasting
 - Biomass conditions
- Monitoring extreme events
 - Droughts
 - Frost conditions
 - Heat waves
- Hydrology
 - Water management
 - River discharge



- Monitoring of fires and burned areas on a daily basis
- Development of indices of fire management and efficiency
- Bulletins developed at



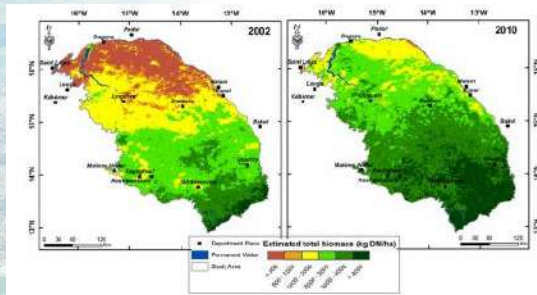


Land
Monitoring

Global - Spotlight on users

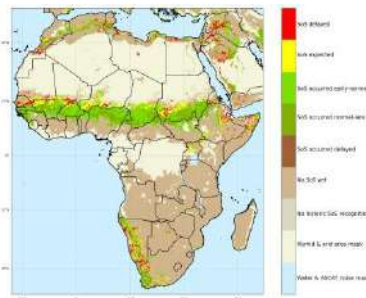
CSE (Senegal) & CREAM (Spain)

Uses FAPAR for biomass estimation for agricultural areas



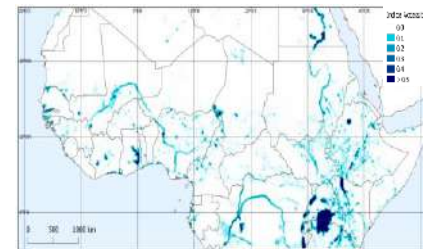
GeoVille GmbH (Austria)

Derives Start of Wet Season (SoS, left) indicators from CGLS Soil Water Index



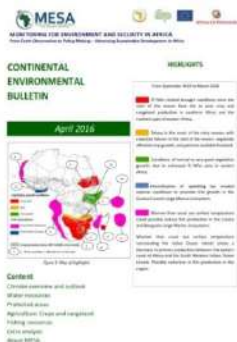
ACF NGO (Spain / West Africa)

Water accessibility index map produced with Hydrogenerator



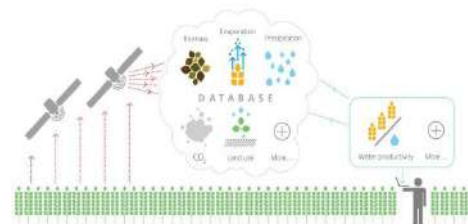
Monitoring for Environment and Security in Africa (African Union)

Pre-cursor to GMES&Africa
Use CGLS products in continental, multilateral and national agro-meteo & environmental bulletins



FAO / eLeaf (UN, Italy)

Use LC100 for water productivity management tool (WaPOR)



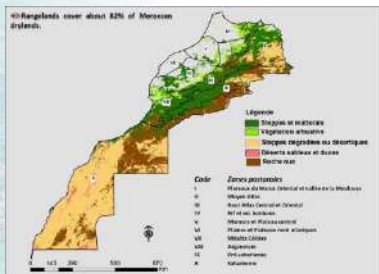


Land
Monitoring

Vegetation & Energy - Spotlight on users

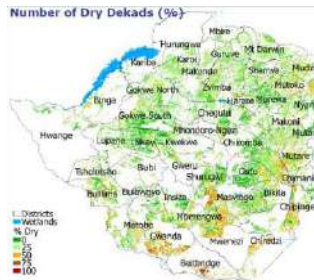
INRA (Marocco)

Uses LAI, fAPAR, NDVI to evaluate monitoring of rangelands



BDMS (Botswana)

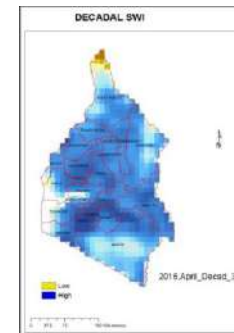
Uses VCI (dry dekads) to predict maize yield in Zimbabwe



<http://hq.mesasadc.org:8080/EMMA/emma>

DSRS (Kenya)

Uses SWI for Agricultural monitoring



I find the Global Land Service products, based on PROBA-V, really useful for developing environmental indicators for decision makers in Namibia. We look forward to the Service going the extra mile and introducing online processing facilities.

Peter Erb, National Director, SASSCAL, Namibia

SASSCAL centres are supported by the Federal Ministry of Education & Research, Germany

We regularly use Global Land's products for evaluating trends and deviations in growing seasons across multiple years. Often combined with Sentinel data for crop classification, monitoring crop phenology, and flooding. For instance in the context of the ESA-funded TIGER project for water resource management in Africa.

C. van der Sande, NEO B.V. (private company), the Netherlands



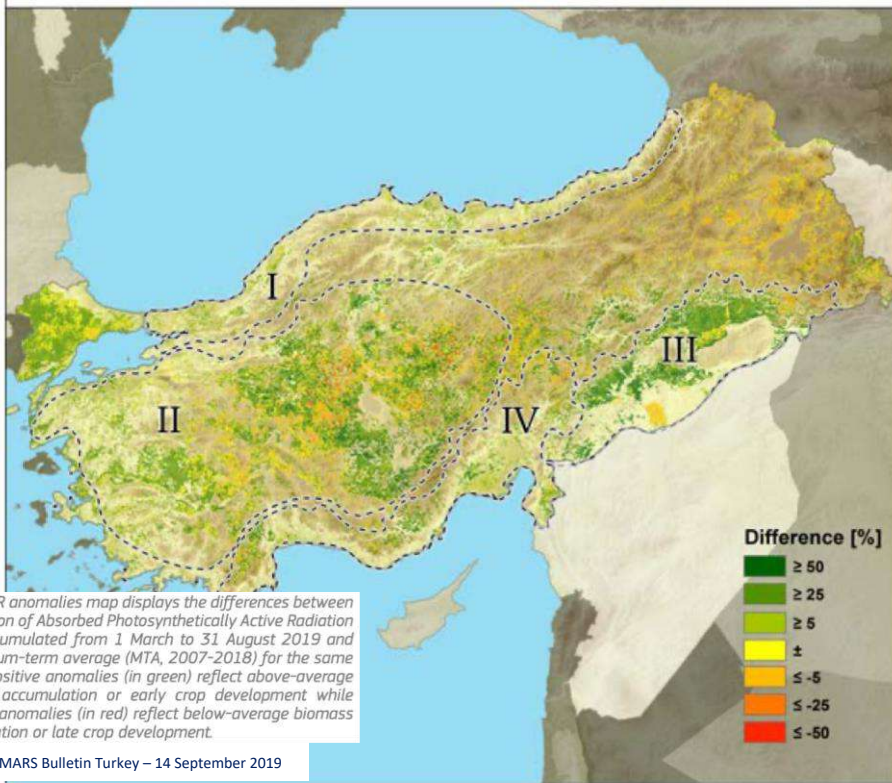


Land
Monitoring

Agriculture monitoring for food security

fAPAR anomalies - Turkey

Current year - Short Term Average (STA / 2014-2018)
Cumulative period: 01 May 2019 - 31 August 2019

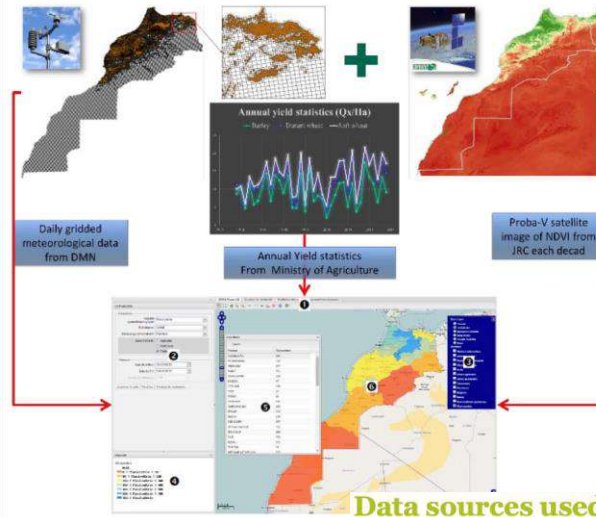


The fAPAR anomalies map displays the differences between the fraction of Absorbed Photosynthetically Active Radiation (fAPAR) cumulated from 1 March to 31 August 2019 and the medium-term average (MTA, 2007-2018) for the same period. Positive anomalies (in green) reflect above-average biomass accumulation or early crop development while negative anomalies (in red) reflect below-average biomass accumulation or late crop development.

DG JRC MARS Bulletin Turkey – 14 September 2019

Data source: MARS remote sensing database / fAPAR smoothed - Copernicus (SPOT-VGT + Proba-V)
Mask: arable land based on Glob Cover 2009

Crop Growth Monitoring System



CGMS-Maroc: mapping system

From the service

- NDVI
- FAPAR
- FCOVER
- LAI





Usage examples: Botswana Drought Assessment

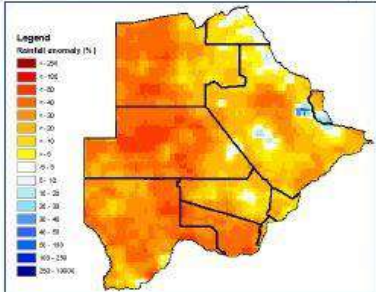
Field work

Two Inter-ministerial teams go on drought assessment tour around the country

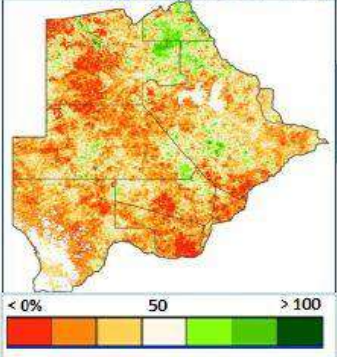


RS Data

Rainfall- Anomaly



Vegetation-VCI



Validating of Drought indices with field work

Report



Report presented to the Ministers at Parliament.

Declare drought / No drought





Land Monitoring

Agriculture monitoring for food security



À PROPOS DE NOUS | RAPPORTS ET DOCUMENTS | PAYS | TELECHARGER LES DONNÉES | GUIDES ET TUTORIELS | CONTACT

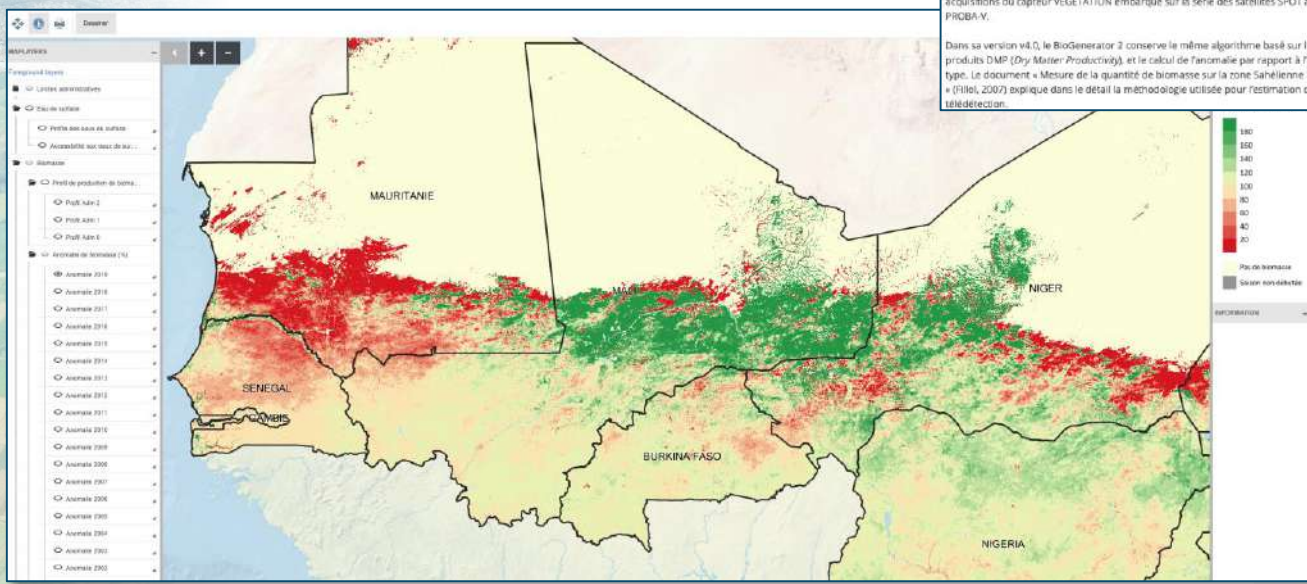
BioGenerator – Introduction

BioGenerator 2 (v4.0) est un outil capable de générer des cartes annuelles de la quantité de production de biomasse et d'anomalies de quantité de production de biomasse à partir des données issues des acquisitions du capteur VEGETATION embarqué sur la série des satellites SPOT auxquels succède le satellite PROBA-V.

Dans sa version v4.0, le BioGenerator 2 conserve le même algorithme basé sur le cumul annuel des produits DMP (Dry Matter Productivity), et le calcul de l'anomalie par rapport à l'année moyenne ou année type. Le document « Mesure de la quantité de biomasse sur la zone Sahélienne Mali-Niger par télédétection » (Tilley, 2007) explique dans le détail la méthodologie utilisée pour l'estimation de la biomasse par télédétection.

CARTES INTERACTIVES

Accéder à l'information sur la biomasse, les eaux de surface, la surveillance pastorale et la veille multisectorielle.



Dry Matter Productivity
Amount (weight) of dry matter (DM) produced per surface unit and per time unit expressed in kilograms of dry matter per hectare per day (kgDM/ha/day).
Derived from FAPAR.

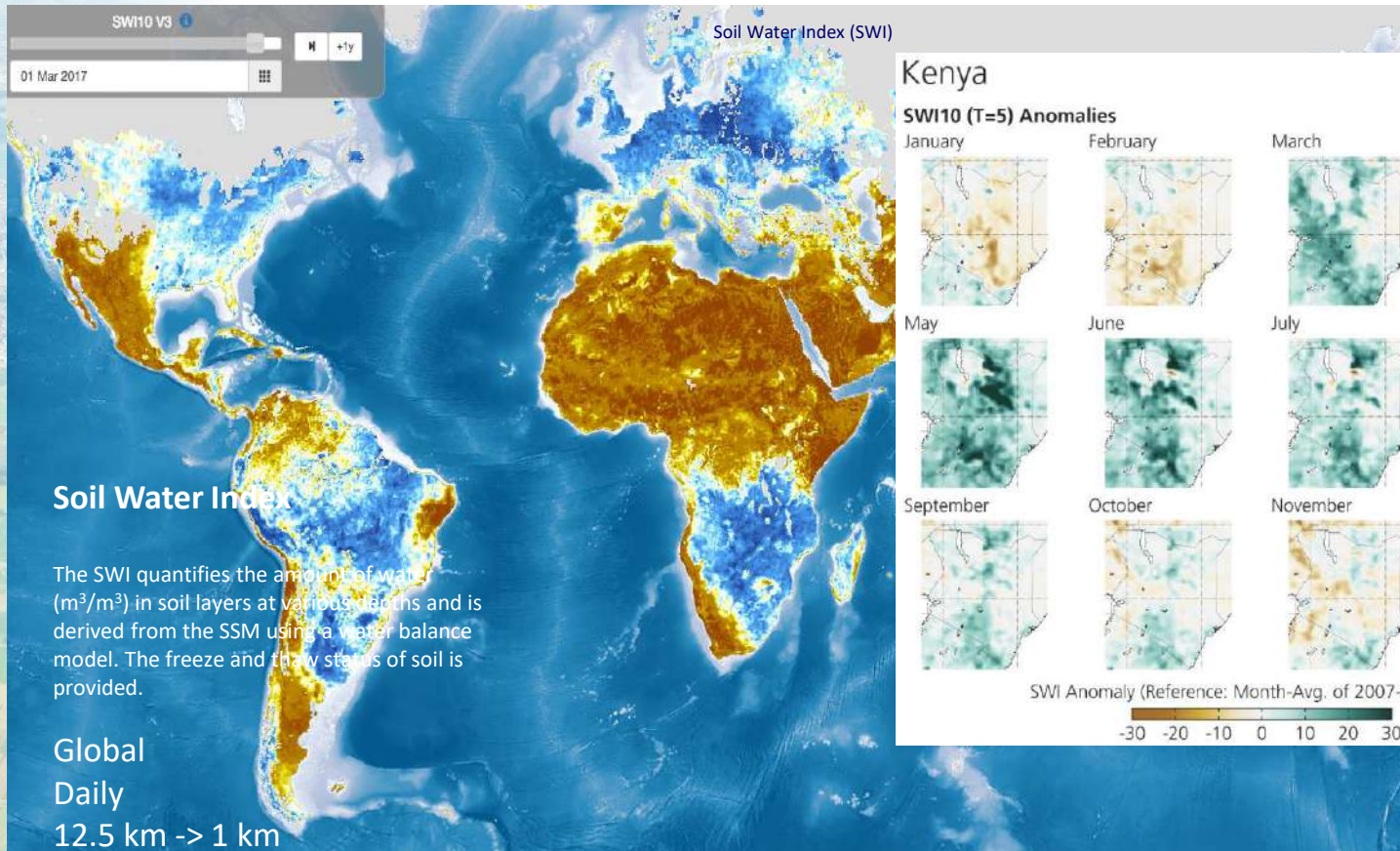
Global
Ten day (from 1999)
1km - 300m





Land
Monitoring

Soil Moisture and Soil Water Index



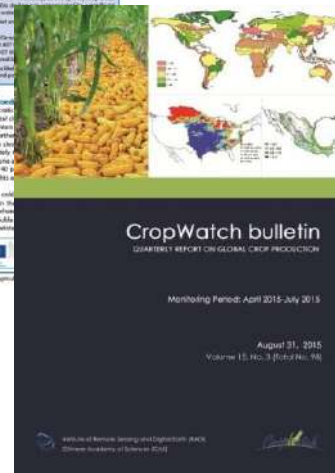
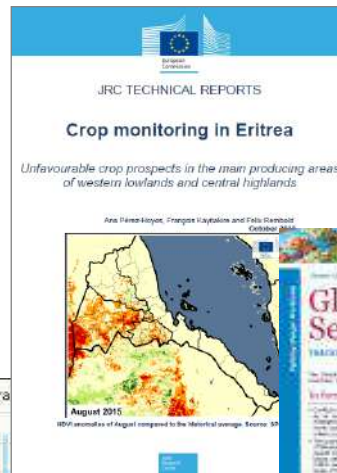
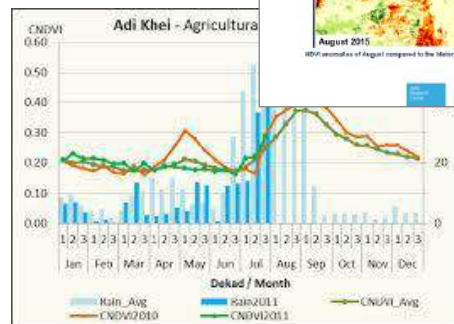
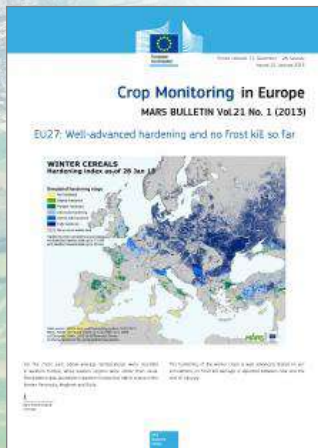


Land
Monitoring

GLOBAL LAND Systematic Monitoring Agriculture applications

Agriculture

- Crop monitoring
- Yield forecasting
- Biomass conditions



Some agriculture users (from our download records) : INRA France, FAO, WFP, MESA (AUC-Africa), Action Contre la Fam (NGO), CONAB Brazil, EMBRAPA Brazil, MARS JRC, Chinese Academy of Agricultural Sciences, INRA Morocco, SRI Ukraine, Wageningen University, ISRO India, ARC South Africa, CIRAD France ...



CLMS Global Agriculture



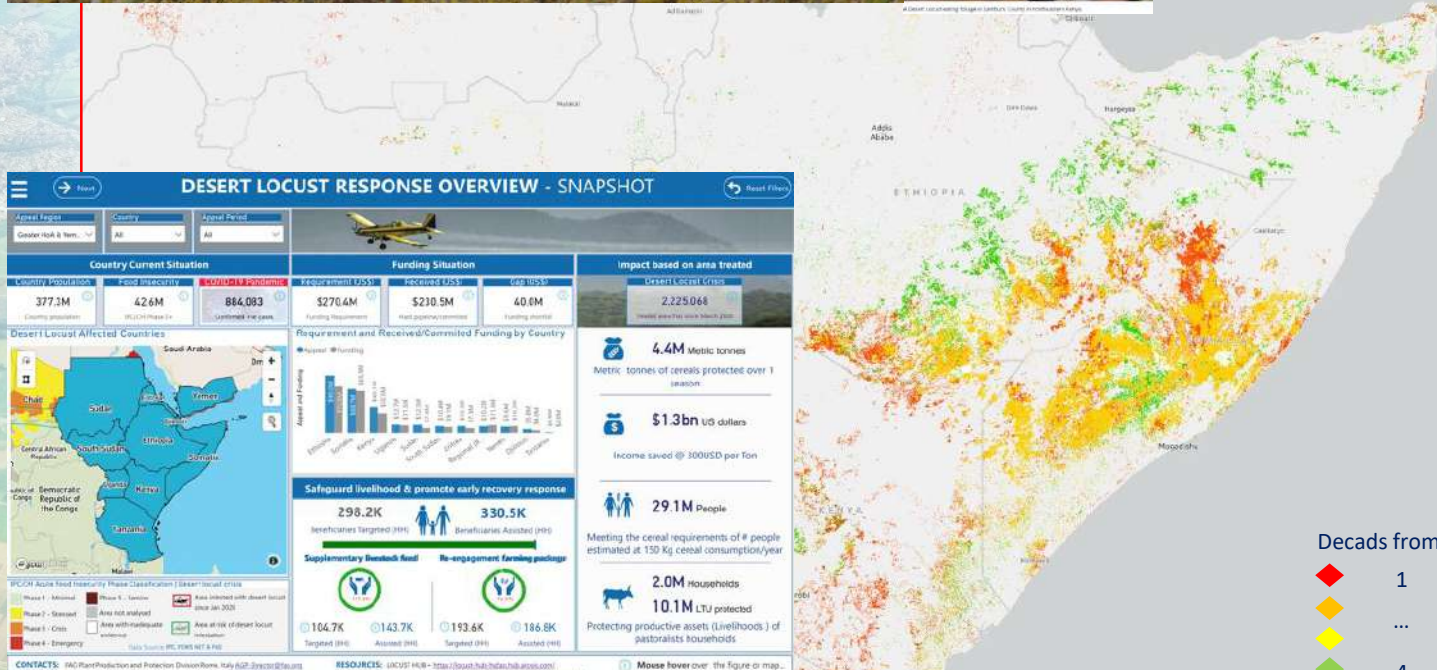
Locust Hub UPDATED: Locust Watch

Locust Hub

An Initiative of the Food and Agriculture Organization of the United Nations



Greenness product (time of green vegetation since onset in Locust breeding areas) based on Global Land 1km NDVI and being transferred to Sentinel 3 300m; now routinely delivered to FAO



- ◆ 1
- ◆ ...
- ◆ 4
- ◆ >= 5

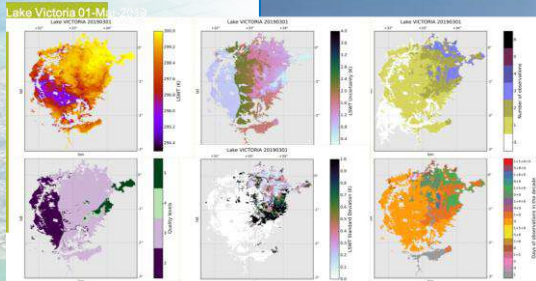


Land
Monitoring

Inland Water related variables

Cryosphere and Inland Water

Lake Surface Temperature



Freshwater Ecosystems Explorer

Leverage the best available science to track, monitor, and improve the health of freshwater ecosystems.

Lake Ice Extent

Snow Cover Extent

Snow Water Equiv.

Lake Surf. Water Temp.

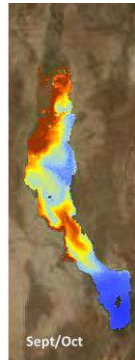
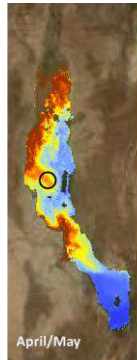
Lake Water Quality

Water Bodies

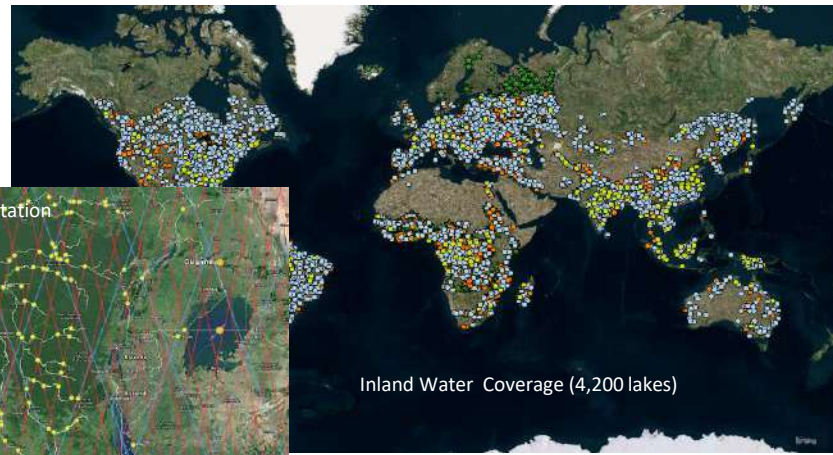
Water Level

Turbidity data over 10 years seasonal trends

Lake Turkana



NRT Turbidity data

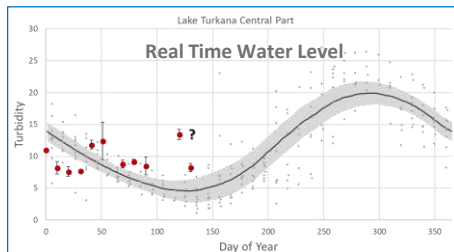
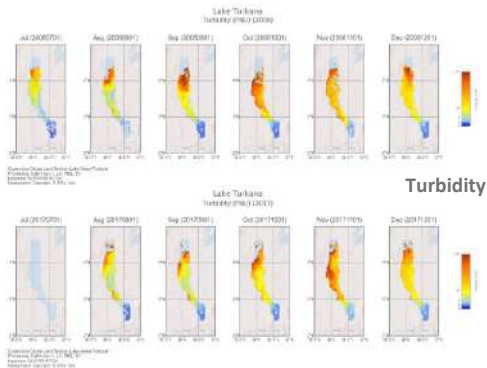




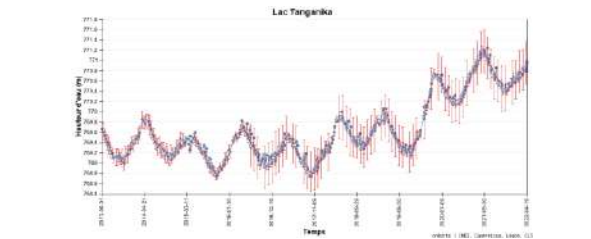
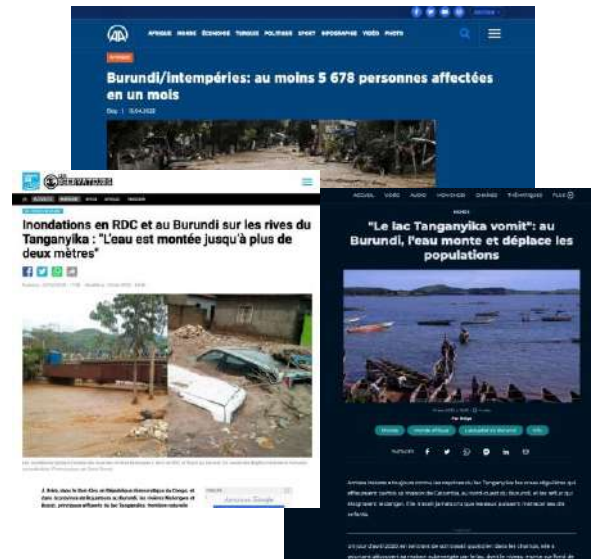
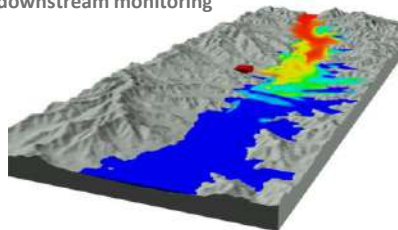
Land
Monitoring

Inland Water related variables – Turkana - Tanganyika

Gibe III dam on the Omo River in Africa's biggest dam (since 2016), will make possible large-scale commercial irrigation schemes in the Lower Omo



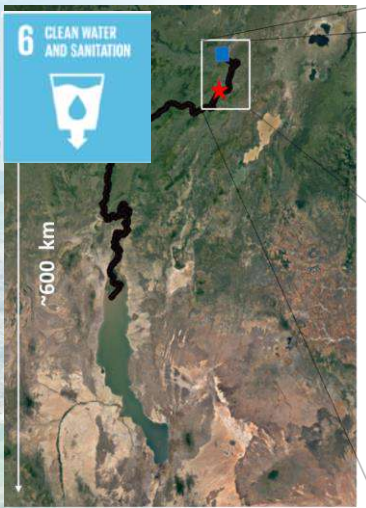
Hydrologic models for upstream and downstream monitoring





Land Monitoring

Water Quality for SDG 6 – Turkana, Kenya

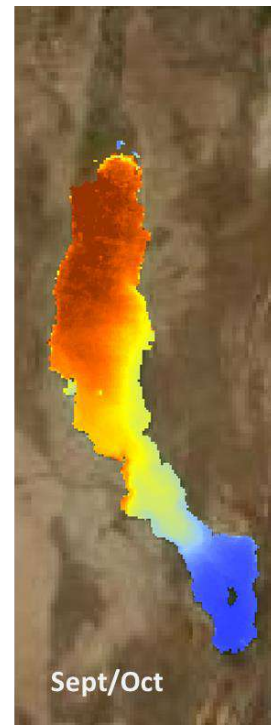
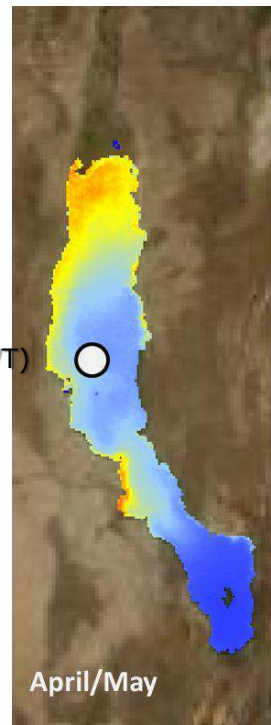


- Lake Surface Water Temperature (LSWT)
- Turbidity (TUR)
- Trophic State Index (TSI)

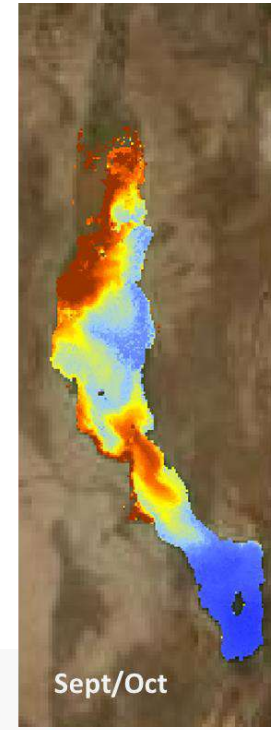
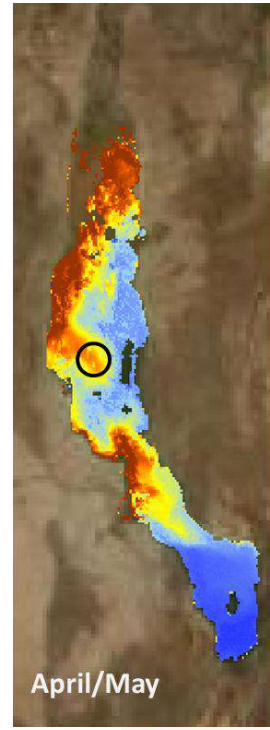


Water Quality product: +-4500 lakes at 300m (turbidity, trophic state, reflectance)

Turbidity data over 10 years
seasonal trends



NRT Turbidity data - 2018



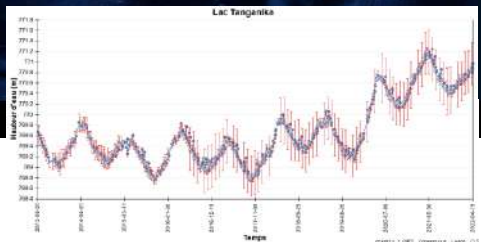
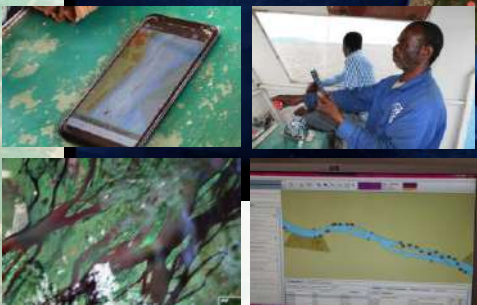
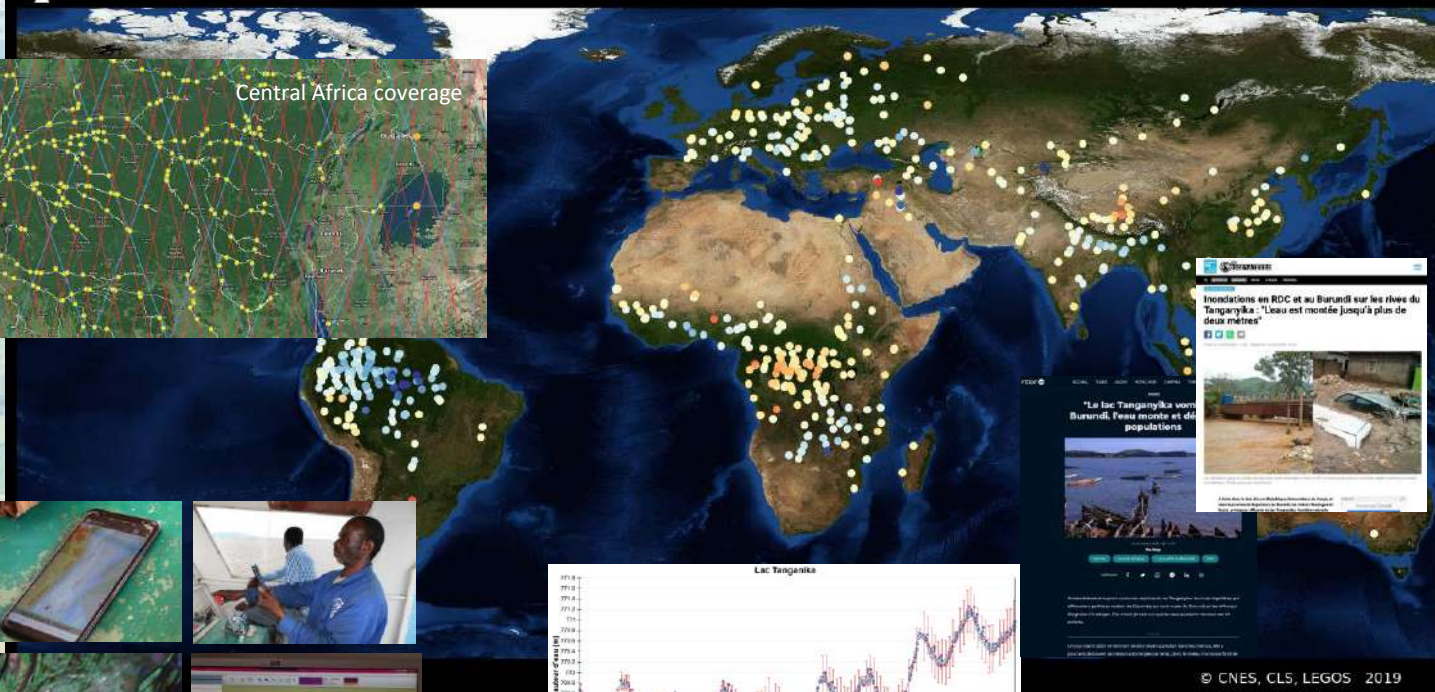


Land Monitoring

Monitoring water sources, levels, quality

World Water Level Variation from Copernicus Global Land Water Level product

2016 2017 2018 2019 2020



© CNES, CLS, LEGOS 2019

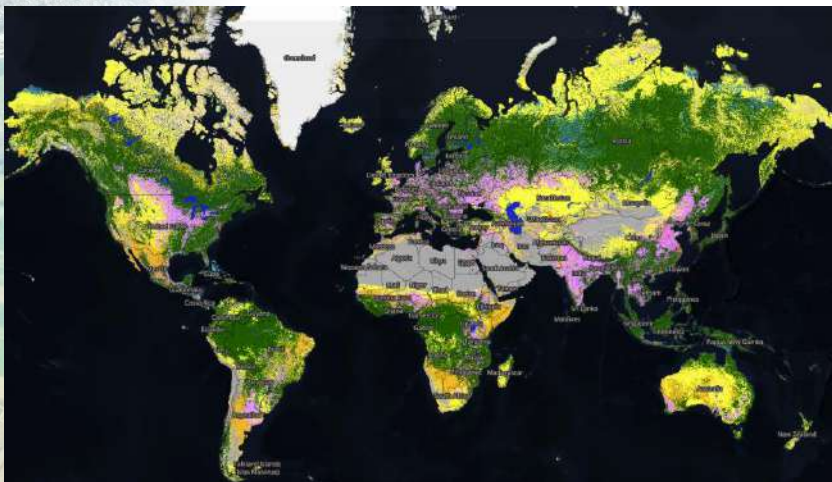


Land
Monitoring

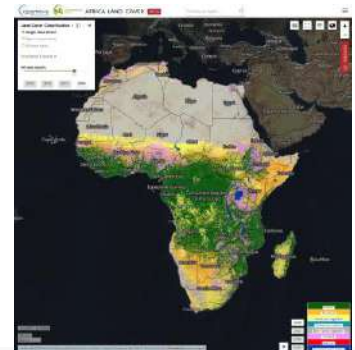
Global Land Cover Product

Also used by the UN Biodiversity Lab platform to provide key information on Aichi Biodiversity targets and nature-based Sustainable Development goals.

Peer reviewed publication on the final adopted methodology for global land cover characteristics mapping.



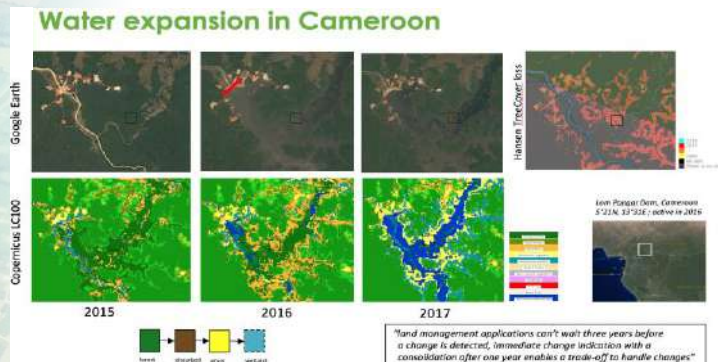
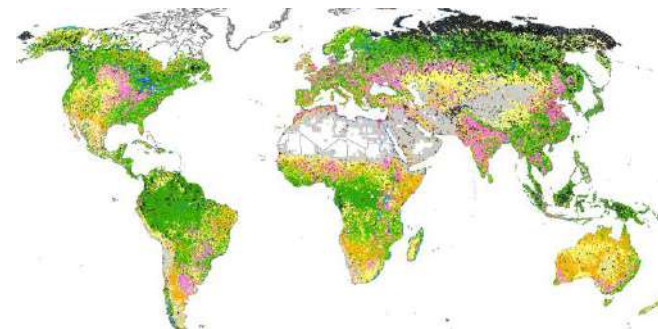
Proba-V since 2015
100m Global / Yearly
Sentinel 2 / 100m and 10m
23 classes & Fractions
Global accuracy >80%





Global Land Cover Product (new contract)

- Production of land cover and land cover change maps at high and mid resolution – 10m - 100 m
- New LCFM Contract to move to Sentinel 1 and 2 at 10m
- Including a specific Tropical Tree Cover component to derive Forest cover maps and FC change maps to support the World Forest observatory of the EU Deforestation Regulation



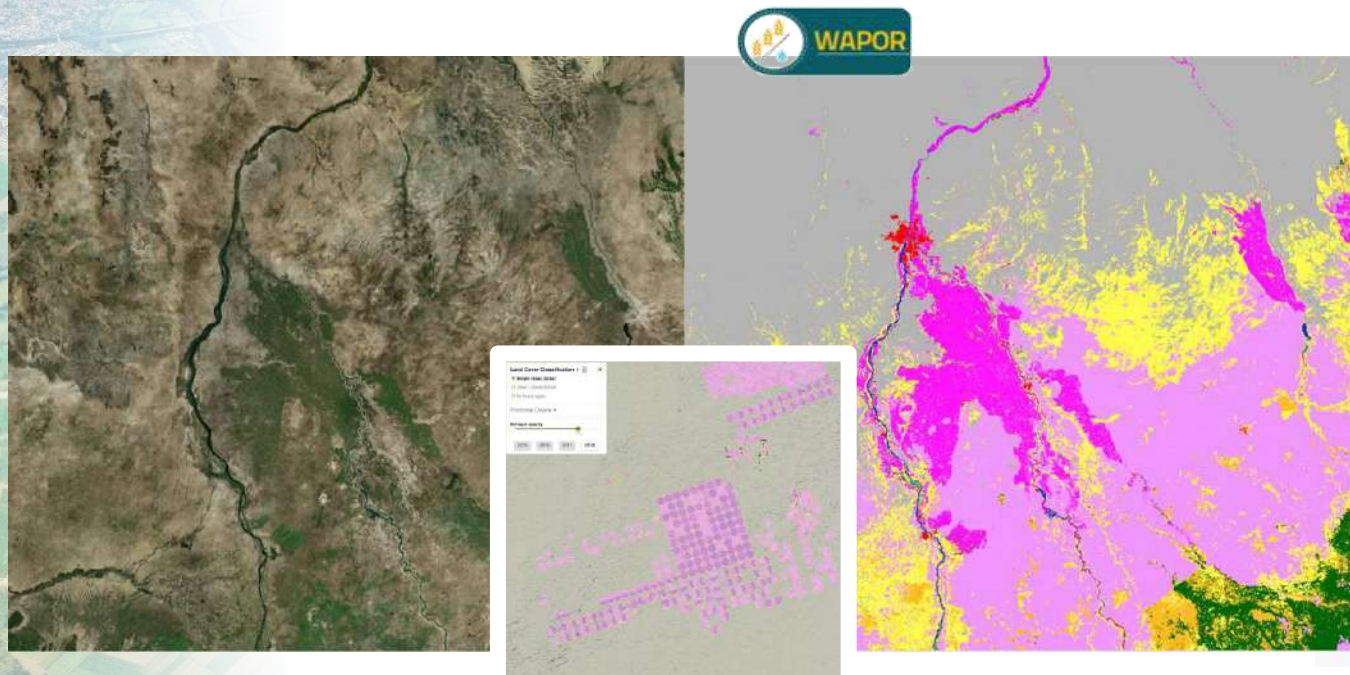


Land
Monitoring

FAO uses The CLMS Global land Cover map



FAO WAPOR USES OUR LAYERS & ALGORITHM TO MONITOR WATER PRODUCTIVITY AND EVEN ADD OWN DATA FOR IRRIGATION MAPPING



Khartoum region, Sudan

-  Forest
-  Shrubs
-  Herbaceous vegetation
-  Cropland rainfed
-  Cropland irrigated
-  Built-up
-  Bare / sparse vegetation
-  Snow & ice
-  Permanent Water Bodies
-  Herbaceous Wetland
-  Sea
-  Unknown (no data)

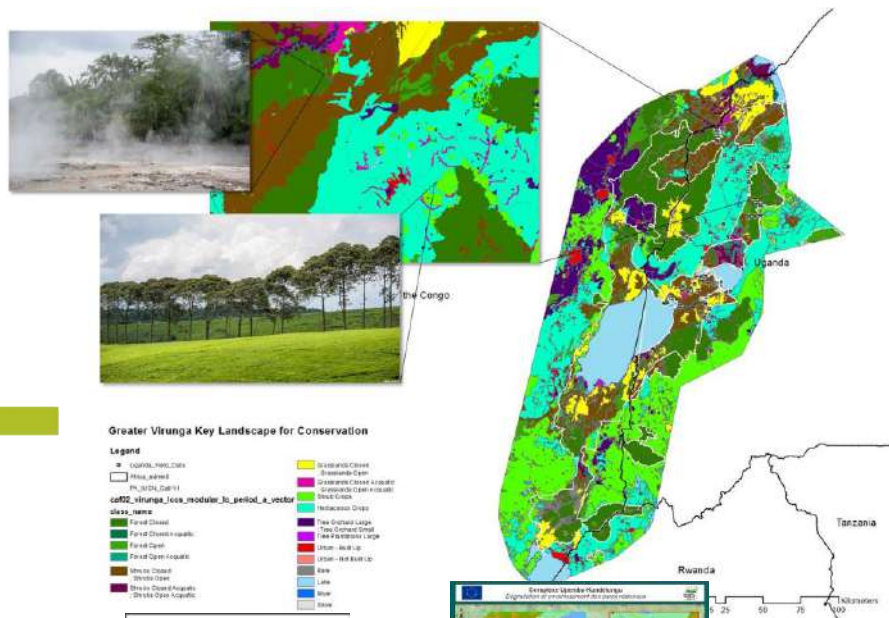
<http://wapor.apps.fao.org>



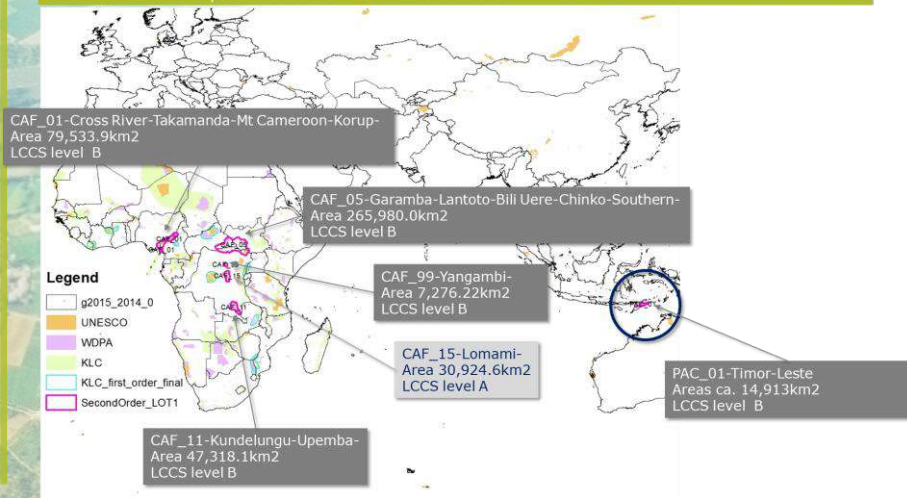
Land
Monitoring

GLOBAL Hot Spot component - Biodiversity

Provide detailed land cover information on specific areas of interest for EU outside the European Union, particularly in the domain of the sustainable management of natural resources.



Second Specific Contract – AOI



Greater Virunga Key Landscape for Conservation

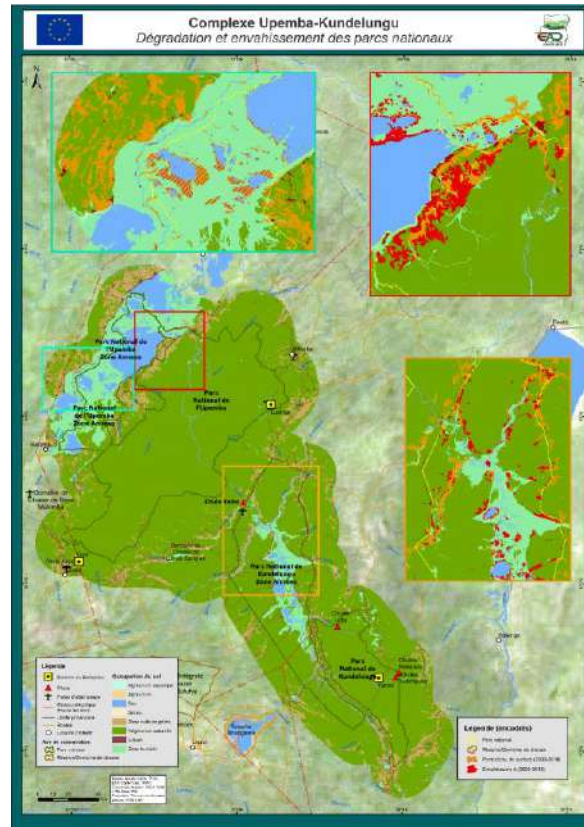
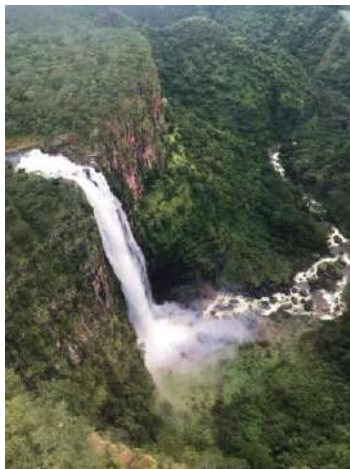




Upemba-Kundelungu complex (Democratic Republic of Congo)

The HSM Land Cover map

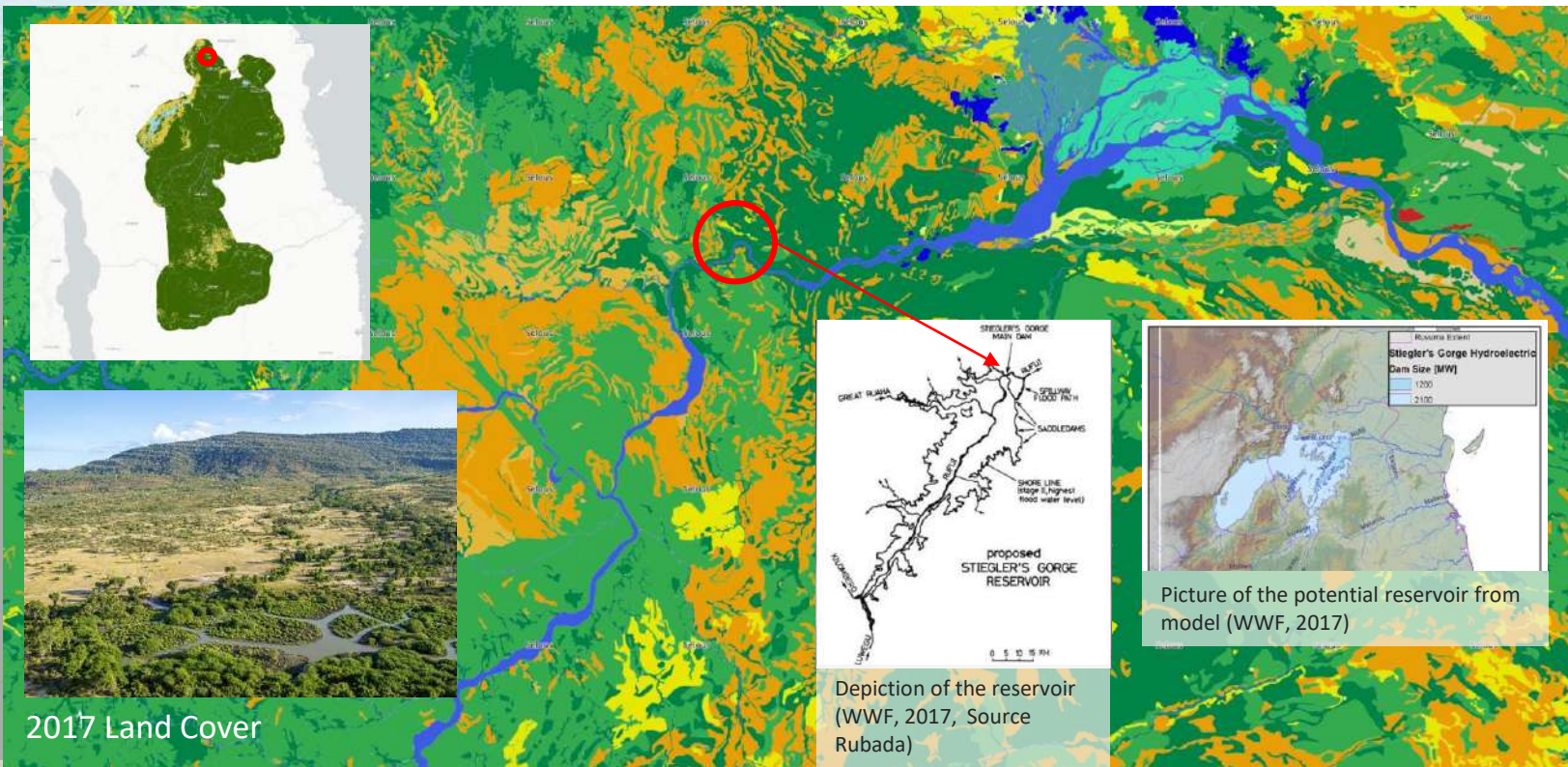
- (i) highlights the **threats and pressures** on the wetlands and the last population of elephants in the Katanga province and the wetlands which is one of the biggest RAMSAR site in the world (since 2017),
- (ii) supports to **prioritize the actions of EU funds** in the complex and the management plan of the complex and
- (iii) brings some leverage in **negotiations** between EU/national agency in charge of the PAs and the private sector.





Land Monitoring

Selous Game Reserve – Hydropower Dam Project (Tanzania)



2017 Land Cover

Depiction of the reservoir (WWF, 2017, Source Rubada)

Picture of the potential reservoir from model (WWF, 2017)

Infrastructure Impact Assessment

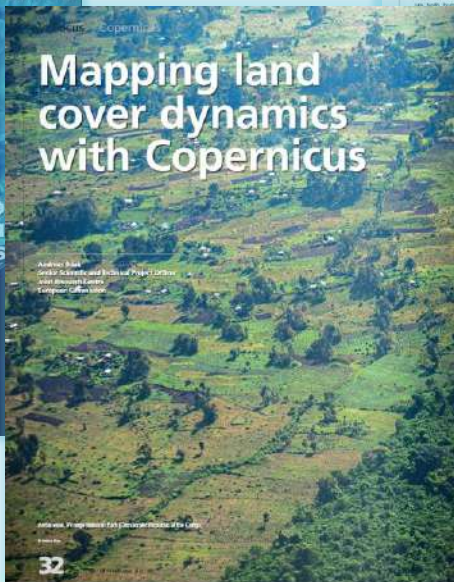


Land
Monitoring

GLOBAL Hot Spot component — Biodiversity COM UNESCO

★ Journal contribution:

- World Heritage Journal, N.98. Article: “Mapping land cover dynamics with Copernicus”, April 2021.



In Focus Copernicus

Mapping land cover dynamics with Copernicus

Sub-Saharan Africa has known unprecedented land cover and land use changes over the past decades, affecting urban, agriculture and fisheries, and causing degradation and loss of biodiversity. The most dramatic changes are in the drylands, where a massive loss of natural vegetation has occurred, leading to a decline in soil fertility and a decrease in water availability. This has led to a significant increase in land degradation, which is a major threat to the livelihoods of the population living in these areas. The Copernicus Land Monitoring Service (CLMS) provides a comprehensive and up-to-date view of land cover changes across the globe, allowing for a better understanding of the complex interactions between land cover, climate change, and human activities. This article explores the use of Copernicus data to monitor land cover dynamics in sub-Saharan Africa, highlighting the challenges and opportunities associated with this task.

What is Copernicus?

Copernicus is the European Union's Earth Observation programme, providing our planet with environmental information. Copernicus delivers data on Earth observation through satellites and in situ ground-based data. The programme is based on a number of satellites and ground-based stations (Copernicus) in cooperation with partners such as the European Space Agency (ESA) and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT).

The programme's main objective is to provide a comprehensive view of the Earth's environment, including land cover, climate, and oceans. The data is used for a wide range of applications, from monitoring natural resources to assessing the impact of human activities. The programme is a key component of the European Union's efforts to address the challenges of climate change and sustainable development.

Hot Spot Monitoring in sub-Saharan Africa in detail

In the drylands of sub-Saharan Africa, the loss of natural vegetation is a major threat to the livelihoods of the population living in these areas. This is due to a combination of factors, including climate change, human activities, and land degradation. The Copernicus Land Monitoring Service (CLMS) provides a comprehensive and up-to-date view of land cover changes across the globe, allowing for a better understanding of the complex interactions between land cover, climate change, and human activities. This article explores the use of Copernicus data to monitor land cover dynamics in sub-Saharan Africa, highlighting the challenges and opportunities associated with this task.

World Heritage J. 98

IN FOCUS

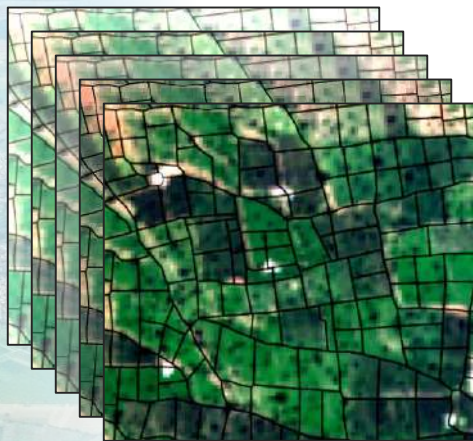




Land Monitoring

GLOBAL Hot Spot component – Agriculture capacity

Sentinel-2 time series (5-day revisit)



500 crop polygons in situ



Cotton

Maize

Mil

Sorgho

Machine learning



| Accuracy (F1-score) | |
|------------------------------|------|
| Coton | 0,93 |
| Maïs | 0,87 |
| Mil | 0,82 |
| Sorghum | 0,45 |
| Overall acc. = 85.5 % | |

(Lambert et al., RSE2018)

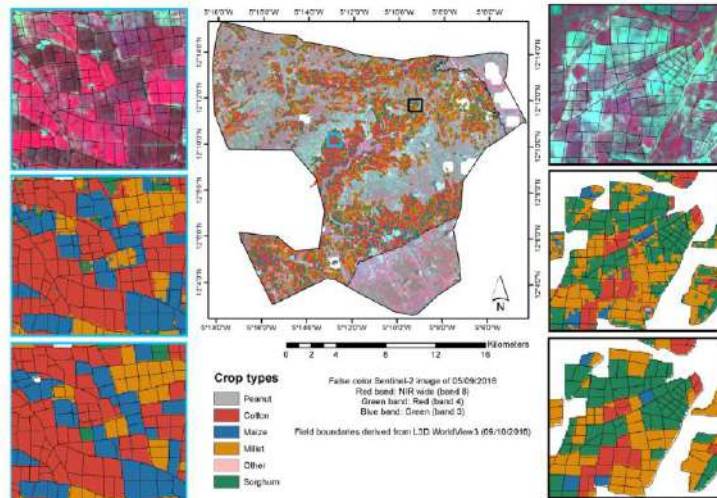
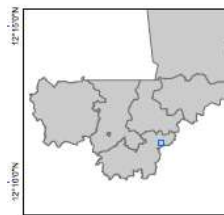
Digital Globe



Sentinel-2



PROBA-V



sen4cap
common agricultural policy

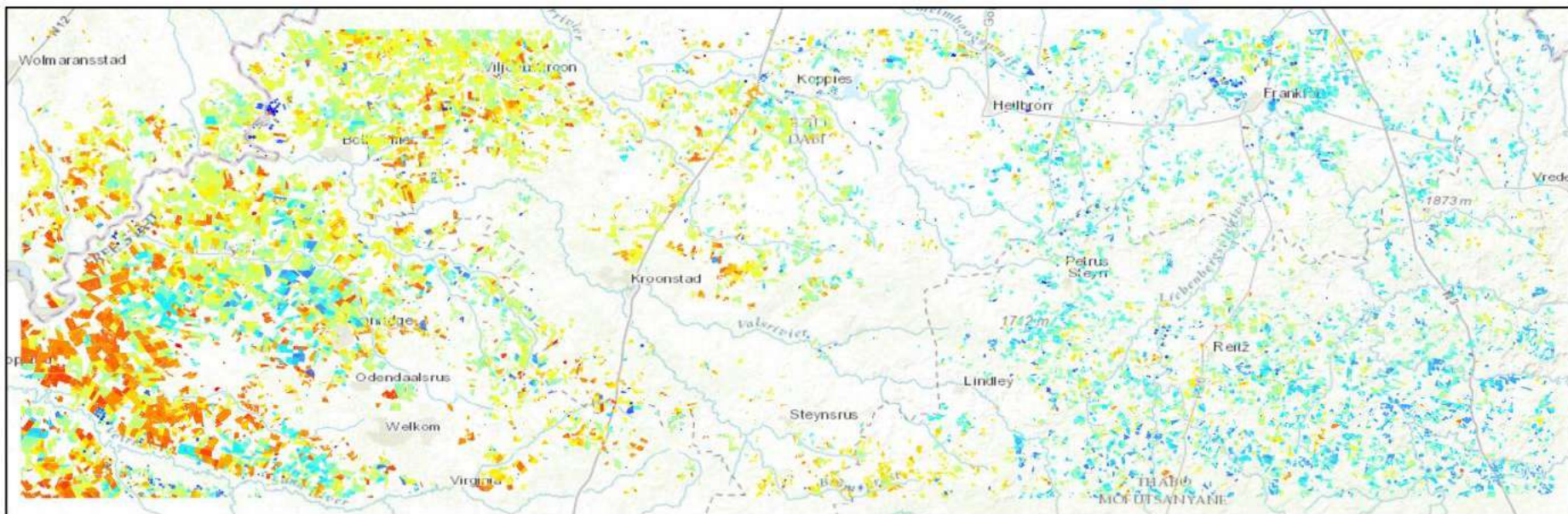


Land Monitoring

Maize emergence date map at field level, Free State, South-Africa

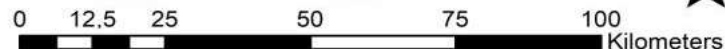


H2020 ECoLaSS project



Emergence date

| | | | | | | | | | | | | | |
|--|---------------|--|---------------|--|---------------|--|---------------|--|---------------|--|---------------|--|---------------|
| | 10-05 - 10-11 | | 10-24 - 10-28 | | 11-06 - 11-09 | | 11-18 - 11-21 | | 12-02 - 12-06 | | 12-17 - 12-21 | | 01-03 - 01-20 |
| | 10-12 - 10-18 | | 10-29 - 11-01 | | 11-10 - 11-13 | | 11-22 - 11-26 | | 12-07 - 12-11 | | 12-22 - 12-26 | | 01-21 - 02-18 |
| | 10-19 - 10-23 | | 11-02 - 11-05 | | 11-14 - 11-17 | | 11-27 - 12-01 | | 12-12 - 12-16 | | 12-27 - 01-02 | | |





Land Monitoring

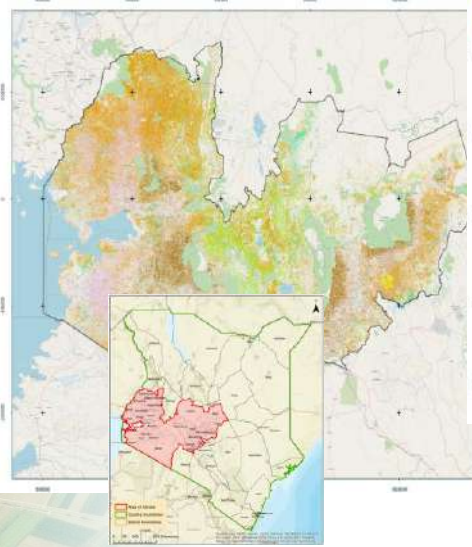
GLOBAL Hot Spot component - Agriculture



| Country | Field campaign | In-season mapping | End-of-season mapping |
|----------|--|-------------------|-----------------------|
| Tanzania | First - completed Second – to start | Completed | Completed |
| Kenya | First – completed Second – to start | Completed | Completed |
| Uganda | First – completed Second – to start | Completed | Completed |

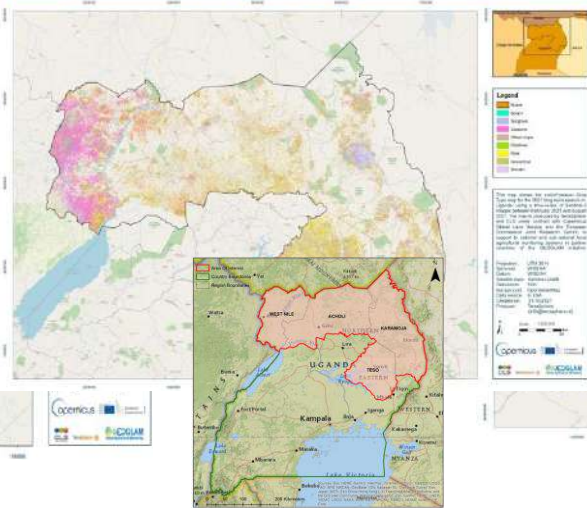
Crop Mapping

Copernicus4GEOGLAM - In-Season Crop Type Map - long rains season 2021 - Kenya



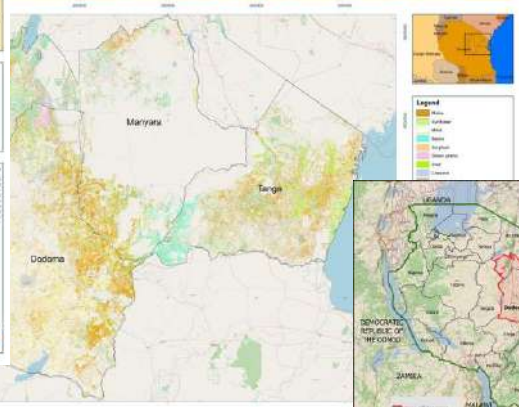
Kenya (98 687 km²)

Copernicus4GEOGLAM - End-Of-Season Crop Type Map - long rains season 2021 - Uganda



Uganda (89 296 km²)

Copernicus4GEOGLAM - End-Of-Season Crop Type Map - long rains season 2021 - Tanzania



Tanzania (116 190 km²)



Land Monitoring

GLOBAL component – Tropical Forest monitoring – 2023



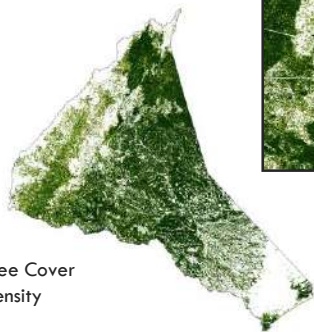
GLASGOW LEADERS' DECLARATION ON FORESTS AND LAND USE



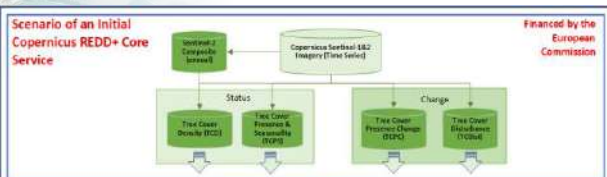
Annual Composite



Tree Cover Density



Tree Cover Presence Change



Global Environmental and Forestry Themes

| | | | | | |
|--|-------------------------------|----------------------------------|---|--|--|
| REDD+ National Forest Management System (NFMS), Drivers of Deforestation & Degradation | Sustainable Forest Management | Coastal Ecosystems and Mangroves | Forest Landscape Restoration/Forest Restoration | Protected Areas Support for integrated management and monitoring of Protected Areas including MLD, Biodiversity... | Community Based Forest Monitoring/Management |
|--|-------------------------------|----------------------------------|---|--|--|

Process & Products



2018



2020



Change

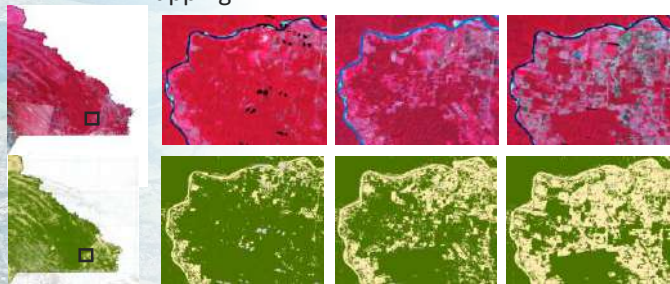


Land
Monitoring

Forest Monitoring

Forest monitoring (Mexico, Central African Republic)

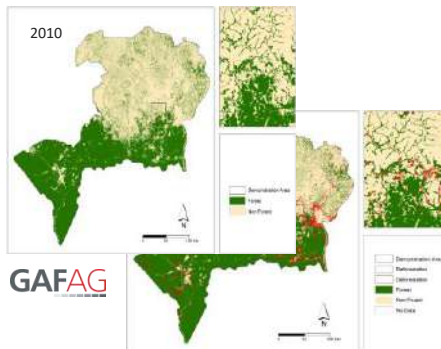
- High and Very High Resolution Forest cover, Forest change and Biomass mapping



1990

2000

2010



GAFAG

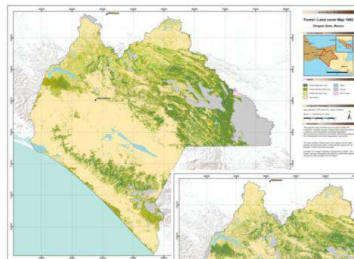
Logging Concessions Monitoring (DRC)

- Road Network

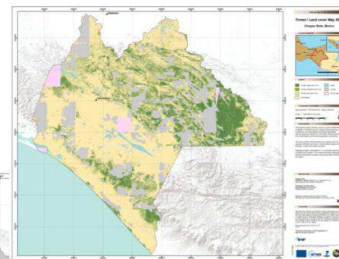


VTT

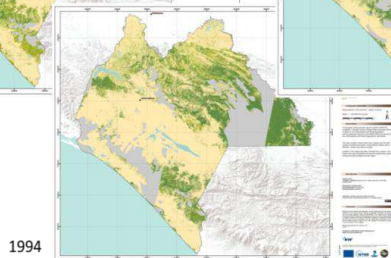
Biomass



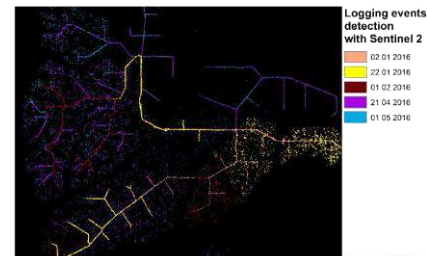
1992



2009



1994



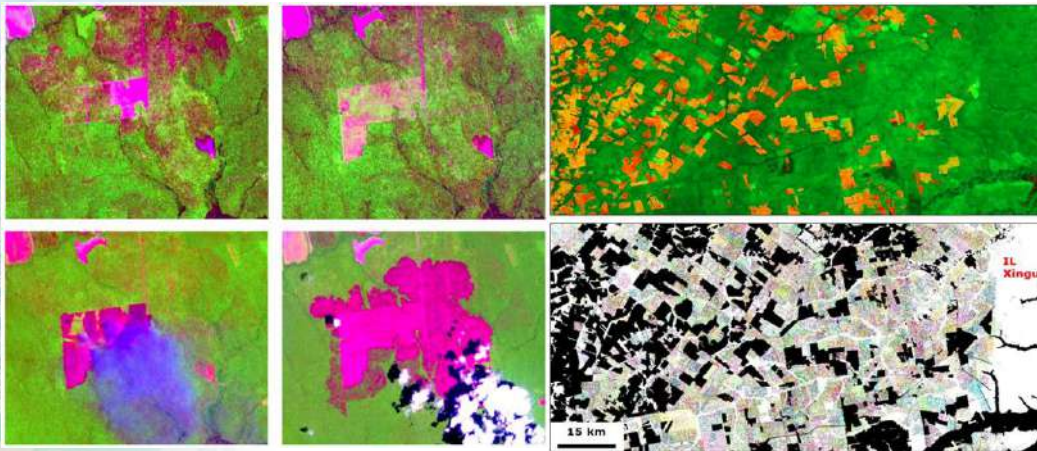
Logging events
detection
with Sentinel 2

- 02 01 2016
- 22 01 2016
- 01 02 2016
- 21 04 2016
- 01 05 2016



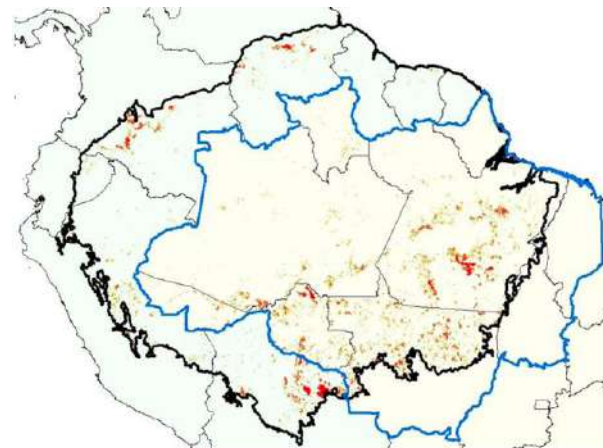
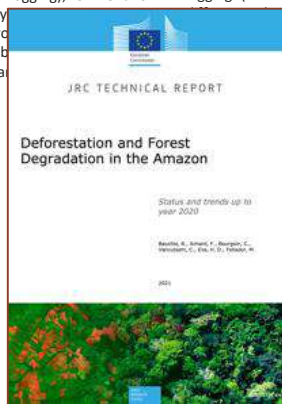
CLMS Global Forest

Land
Monitors

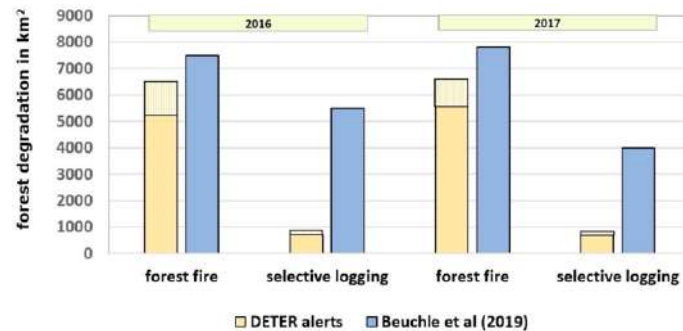


UL: start of deforestation activities in 2014 (image from 14th October 2014), with degraded forest nearby (and signs of selective logging); UR: end of deforestation activities in 2015 (image from 8th July 2015), with active fire burning of the newly deforested areas in 2015 (image from 15th November 2015). Image width: ca. 12 km

Sentinel-2 imagery of 2018 (above) and mapped 23 years of selective logging (1996- 2018) in Northern Mato Grosso State (below), with all remaining forest areas 2018 outside the Xingu (IL Xingu) and (IL Xingu) have been selectively logged at least once in this time period. Black areas represent non-forest in 2018, NPE. Image width: ca. 160 km



Distribution of JRC-TMF forest disturbances (in red) in the Pan-Amazon humid forest in 2020.

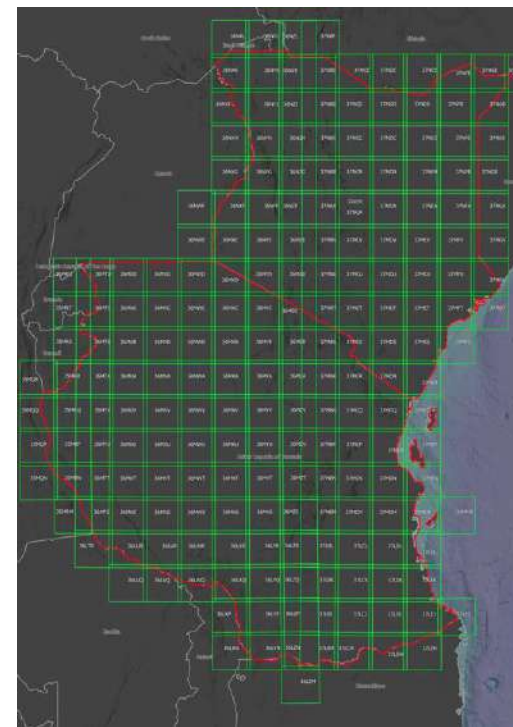
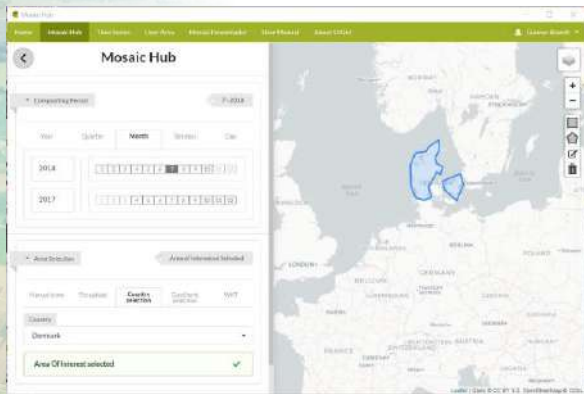




Sentinel 2 Global mosaics tool – S2GM

Analysis Ready Data (ARD)

- Composites from time-series of Sentinel-2 Multi-Spectral Instrument (MSI) surface reflectance observations
- In three spatial resolutions (10m, 20m and 60m) and from different compositing periods
- Interactive Mosaic Hub





Land
Monitoring

SERVICE PRODUCT ACCESS

The screenshot shows the CLMS homepage with a navigation bar containing 'CLMS portfolio', 'Dataset catalogue', 'Data viewer', 'Use cases', and 'About us'. The main content area features a large image of a forest with a text box stating: 'Copernicus Land Monitoring Service (CLMS) We provide geographical information on land cover and its changes, land use, ground motion, vegetation state, water cycle and earth surface energy variables for both Europe and the entire globe. All products are free of charge and can be used for any purpose.' Below this, there is a section for 'CLMS General Assembly 3-5 June 2024 - SAVE THE DATE' and a grid of service categories: 'Land Cover and Land Use Mapping', 'Priority Area Monitoring', 'Bio-geophysical Parameters', 'Ground Motion Monitoring', 'Satellite Data', and 'Reference and Validation Data'. A cookie consent banner is visible at the bottom.

The screenshot shows the Copernicus Global Land Service website. The header includes the Copernicus logo and the tagline 'Europe's eyes on Earth'. The main navigation bar lists 'Home', 'Products', 'News', 'Product Access', and 'Viewing'. A central image of the Earth is accompanied by three prominent buttons: 'Vegetation', 'Water', and 'Energy'. The 'Home' section contains introductory text about the service and a 'Latest news' section with several news items, including 'First SWI Time Series product available' and 'Release of three SWI static layers'. A statistics box at the bottom left shows '125 sq kilometres' of land in Australia, '1100th user registered', and '8.7 TB downloaded'. A 'User support corner' link is also present.

<http://land.copernicus.eu>



Thank you



Monitoring the water reservoirs in Burkina Faso

Benjamin PALMAERTS
ISSeP, Belgium

WG Africa – 2nd webinar
27.02.2024



WORKING
GROUP
AFRICA

CONTEXT

- Work achieved by David van Rossum – intern at ISSeP in 2023
- Goal: Development of a free and open-source method to remotely monitor water reservoirs in Burkina Faso
- Study site: Nakambé watershed



CONTEXT

Around **900 reservoirs** in the Nakambé watershed

- Small dams, walls
- < 20 ha
- Shallow => large variations of water volume and risk of drying-out
- Annual precipitation: 500-900 mm



CONTEXT

Usages:

- Agricultural production, including irrigated
- Vegetable growing
- Livestock watering
- Fishing
- Drinking water supply



CONTEXT

Issues:

- High dependence on weather
- Silting of watercourses and reservoirs due to erosion from the whole watershed
- Overexploitation
- Pollution by phytosanitary products
- Conflicts between users



OBJECTIVES

Monitoring water resources in each reservoir

Challenges:

- Computer infrastructures of the potential users
- Large amount of data
- Short-scale variations of the reservoir level
- Surface \neq Volume
- Clouds

OBJECTIVES

Monitoring water resources in each reservoir

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- Large amount of data
- Short-scale variations of the reservoir level
- Surface \neq Volume
- Clouds

**Sentinel-2 data in the Copernicus Data Space Ecosystem
Processing in the JupyterLab**

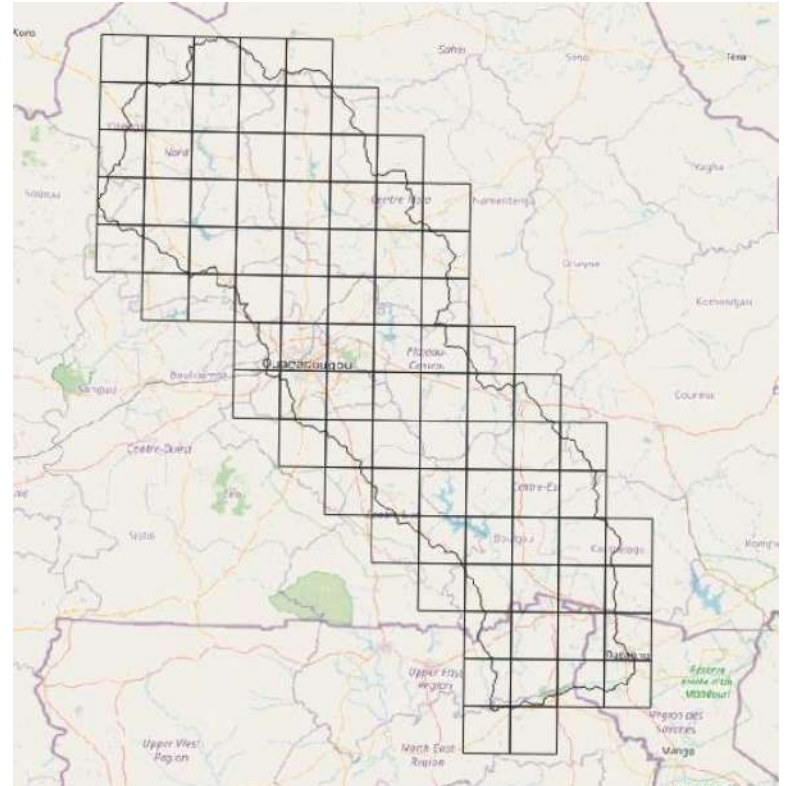
METHODOLOGY

Downloading Sentinel-2 data

- Subdivision of the watershed into a grid
- openEO API
- Data loading
 - > temporal extent
 - > spatial extent
 - > S2 bands
 - > max cloud cover
 - > coordinate system

```
# Connexion à l'API openEO
connection = openeo.connect(url="openeo.dataspace.
connection.authenticate_oidc()

# Charger la collection Sentinel-2 avec Les coordo
temporal_extent = ("2022-09-01", "2022-09-30")
s2_cube = connection.load_collection(
    "SENTINEL2_L2A",
    temporal_extent=temporal_extent,
    spatial_extent={
        'west': -0.166208030000000,
        'south': 11.825353154999900,
        'east': 0.083791970000000,
        'north': 12.075353154999900,
        "crs": "EPSG:4326",
    },
    bands=["B04", "B03", "B02", "B08", "SCL"],
    max_cloud_cover=50,
)
```



METHODOLOGY

Cloud mask

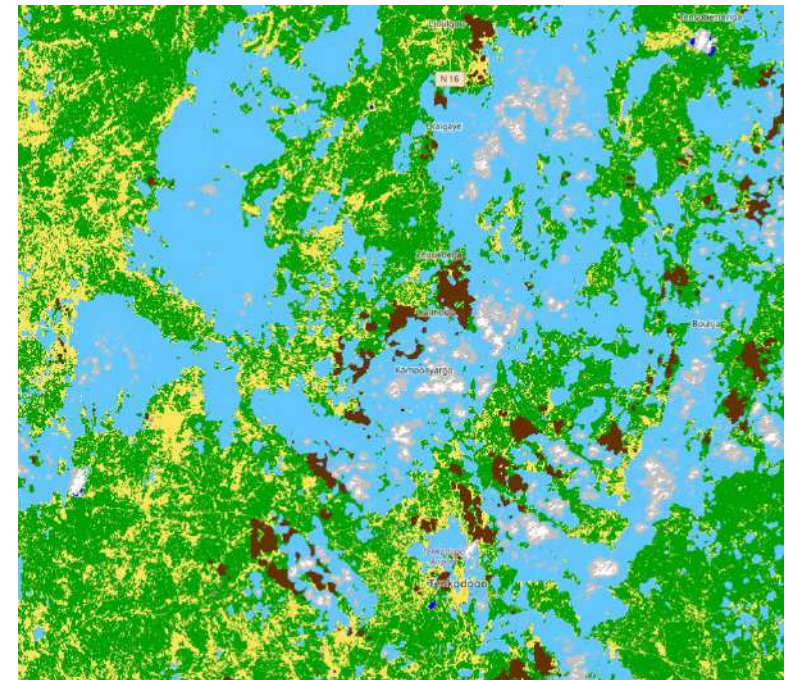
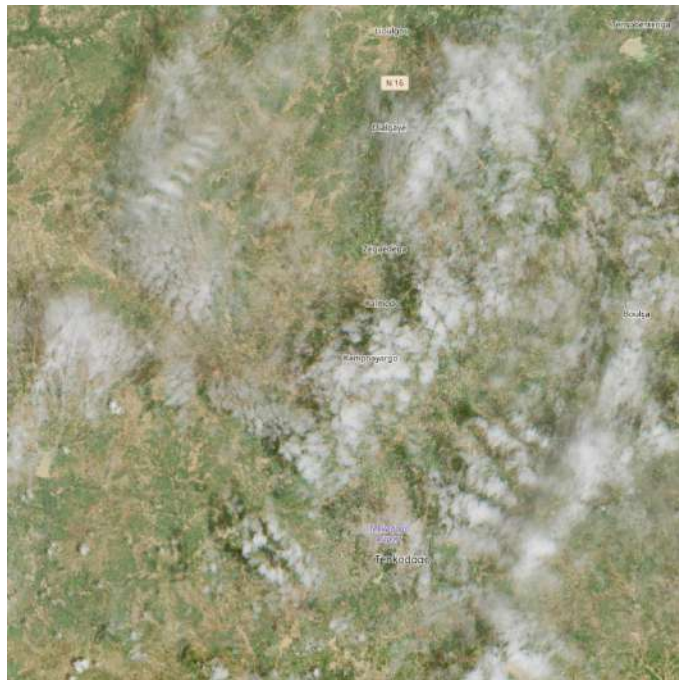
- SCL = Scene Classification Layer

```
# construit et applique le masque
```

```
scl_band = s2_cube_resampled.band("SCL")
```

```
cloud_mask = (scl_band == 3) | (scl_band == 9) | (scl_band == 10)
```

| Label | Classification |
|-------|--------------------------|
| 0 | NO_DATA |
| 1 | SATURATED_OR_DEFECTIVE |
| 2 | DARK_AREA_PIXELS |
| 3 | CLOUD_SHADOWS |
| 4 | VEGETATION |
| 5 | NOT_VEGETATED |
| 6 | WATER |
| 7 | UNCLASSIFIED |
| 8 | CLOUD_MEDIUM_PROBABILITY |
| 9 | CLOUD_HIGH_PROBABILITY |
| 10 | THIN_CIRRUS |
| 11 | SNOW |



METHODOLOGY

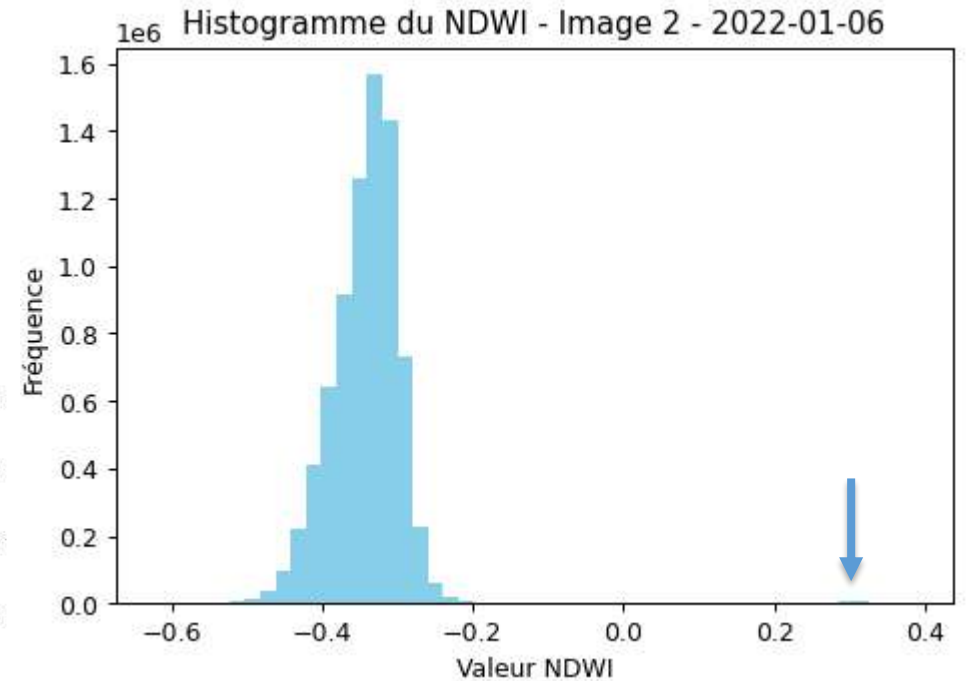
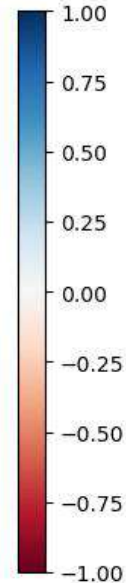
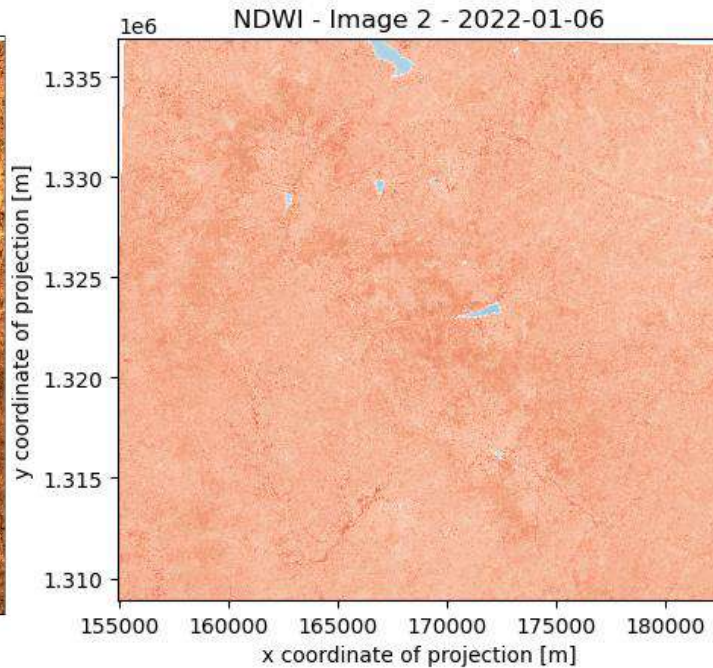
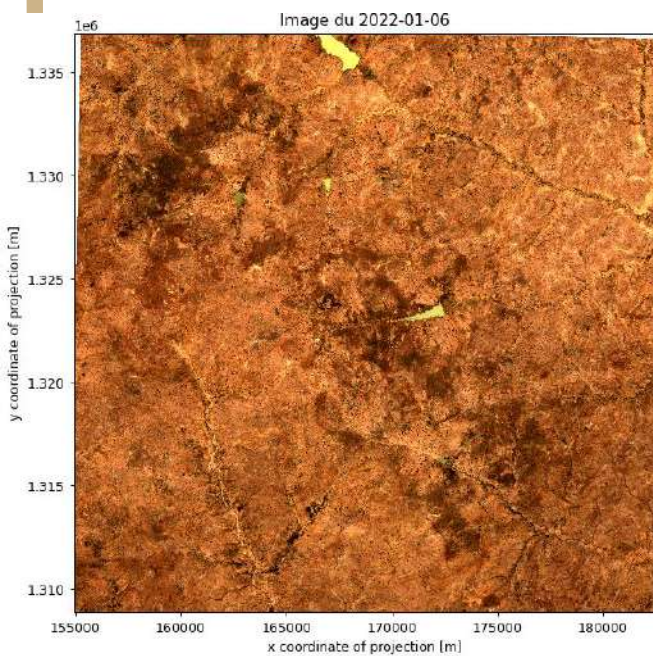
NDWI

- Normalized Difference Water Index

Calcul du NDWI

```
green = data_resampled.sel(t=t, bands="B03")  
nir = data_resampled.sel(t=t, bands="B08")  
ndwi = (green - nir) / (green + nir)
```

$$\text{NDWI} = \frac{\text{Green} - \text{NIR}}{\text{Green} + \text{NIR}}$$

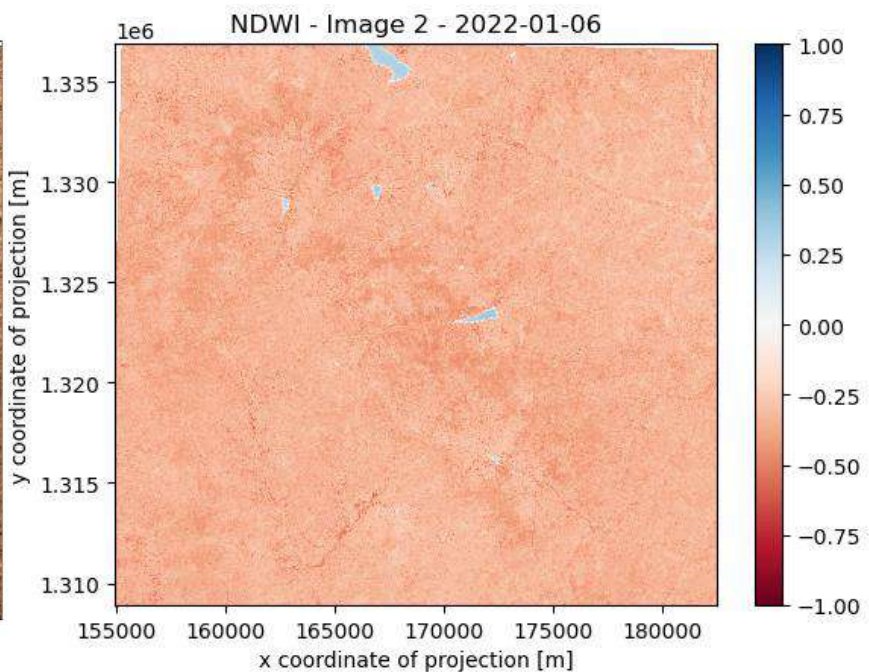
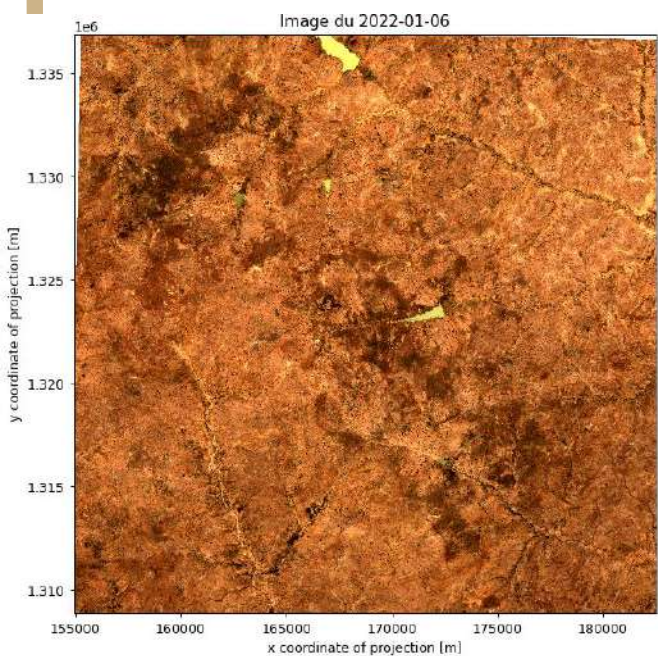


METHODOLOGY

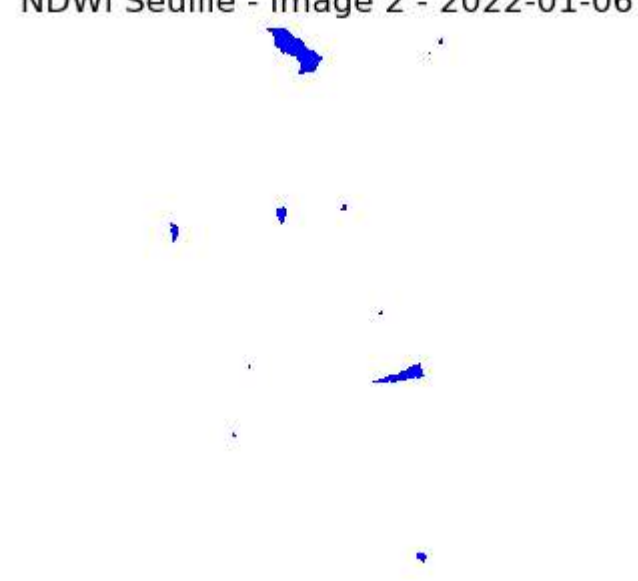
NDWI

- Normalized Difference Water Index
- Water if $NDWI > -0.2$

```
# Afficher l'image du NDWI seuillé en binaire  
segmentation_binaire_1 = ndwi > seuil_ndwi
```



NDWI Seuillé - Image 2 - 2022-01-06



METHODOLOGY

Water surfaces

- Surface calculation
- Water surfaces rejected if < 4 ha
- Export in shapefile

```
# Calculer les superficies de chaque polygone en mètres carrés
gdf['area_sqm'] = gdf.geometry.area

# Convertir les superficies en hectares
gdf['area_ha'] = gdf['area_sqm'] / 10000

# Spécifier le type de données "réel double" pour les colonnes de surfaces
dtypes = {'area_sqm': 'float64', 'area_ha': 'float64'}

# Filtrer les polygones ayant une superficie supérieure à 4 hectares et raster_val égal à 1
gdf = gdf.query('area_ha > 4 and raster_val == 1')
```

| | geometry | area_sqm |
|---------|---|-----------|
| POLYGON | ((166205.919 1336881.990, 167065.919 1... | 1681800.0 |
| POLYGON | ((169425.919 1329941.990, 169465.919 1... | 44400.0 |
| POLYGON | ((166955.919 1329811.990, 167085.919 1... | 185300.0 |
| POLYGON | ((162575.919 1329231.990, 162595.919 1... | 174000.0 |
| POLYGON | ((172275.919 1323741.990, 172305.919 1... | 618500.0 |
| POLYGON | ((172335.919 1316341.990, 172355.919 1... | 104400.0 |

METHODOLOGY

Water surface evolution

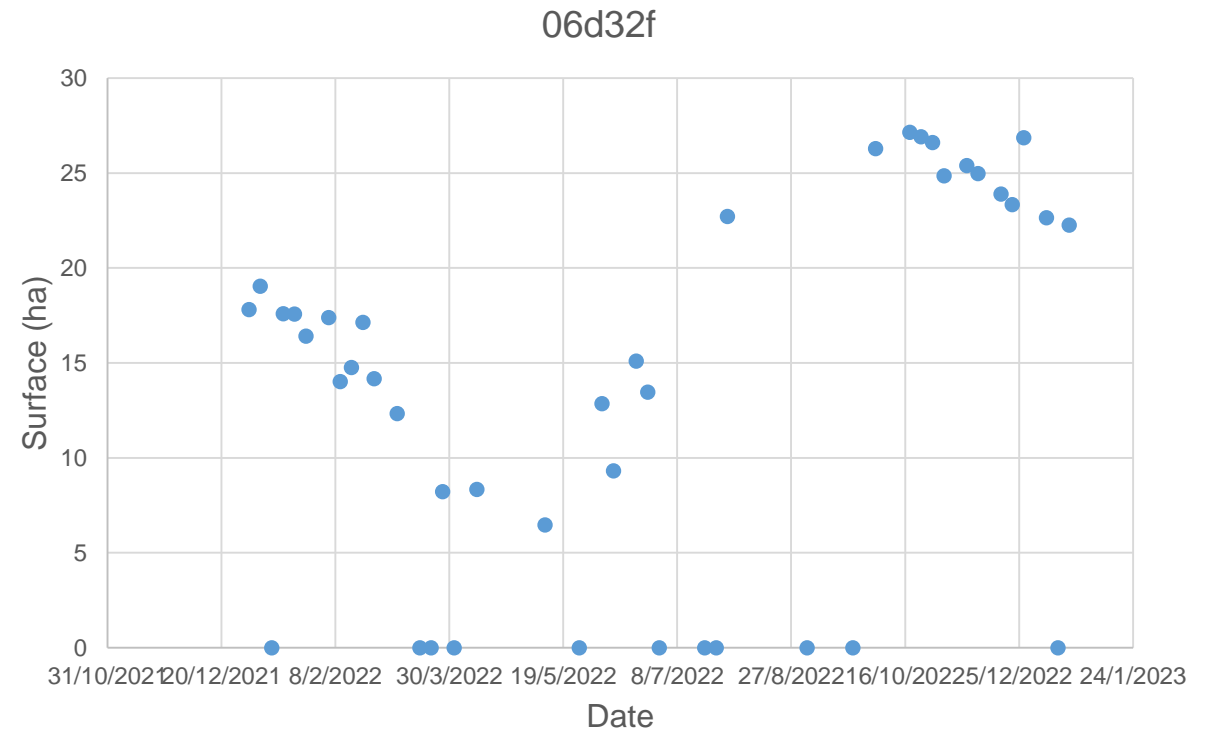
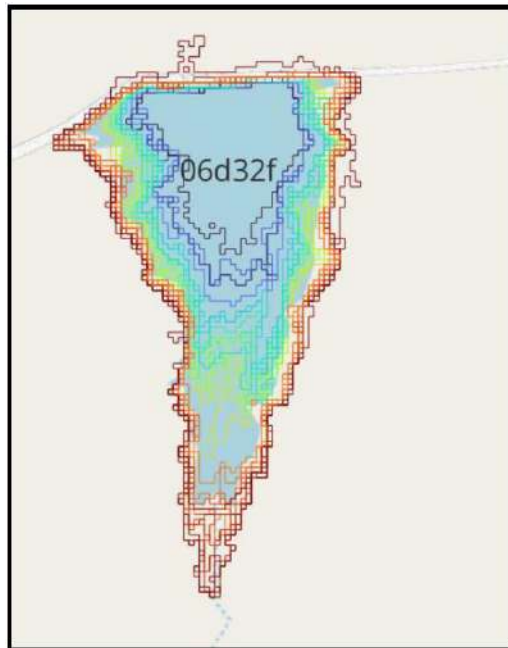
- Temporal evolution over 1 year
- Exclusion of surfaces if intersection with cloud mask
- Export in SHP and CSV

| | A | B | C | D | E | F | G | H | I |
|---|--------------|----------|----------|----------|----------|----------|----------|----------|----------|
| 1 | ShortBufferI | 01-01-22 | 06-01-22 | 11-01-22 | 16-01-22 | 21-01-22 | 26-01-22 | 05-02-22 | 10-02-22 |
| 2 | b0e9e5 | 164.20 | 169.51 | 0.00 | 164.35 | 165.06 | 160.99 | 166.66 | 151.10 |
| 3 | 8acaa0 | 4.42 | 4.57 | 0.00 | 4.18 | 4.11 | 0.00 | 0.00 | 0.00 |
| 4 | 06d32f | 17.81 | 19.04 | 0.00 | 17.59 | 17.58 | 16.41 | 17.39 | 14.03 |
| 5 | 470fd7 | 17.21 | 17.71 | 0.00 | 16.99 | 16.80 | 16.12 | 16.25 | 12.85 |
| 6 | 4aac59 | 60.11 | 62.82 | 0.00 | 59.90 | 60.67 | 58.47 | 61.69 | 51.69 |
| 7 | 4b26fc | 10.14 | 11.14 | 0.00 | 11.18 | 11.43 | 10.67 | 11.16 | 6.87 |

RESULTS

Water surface evolution

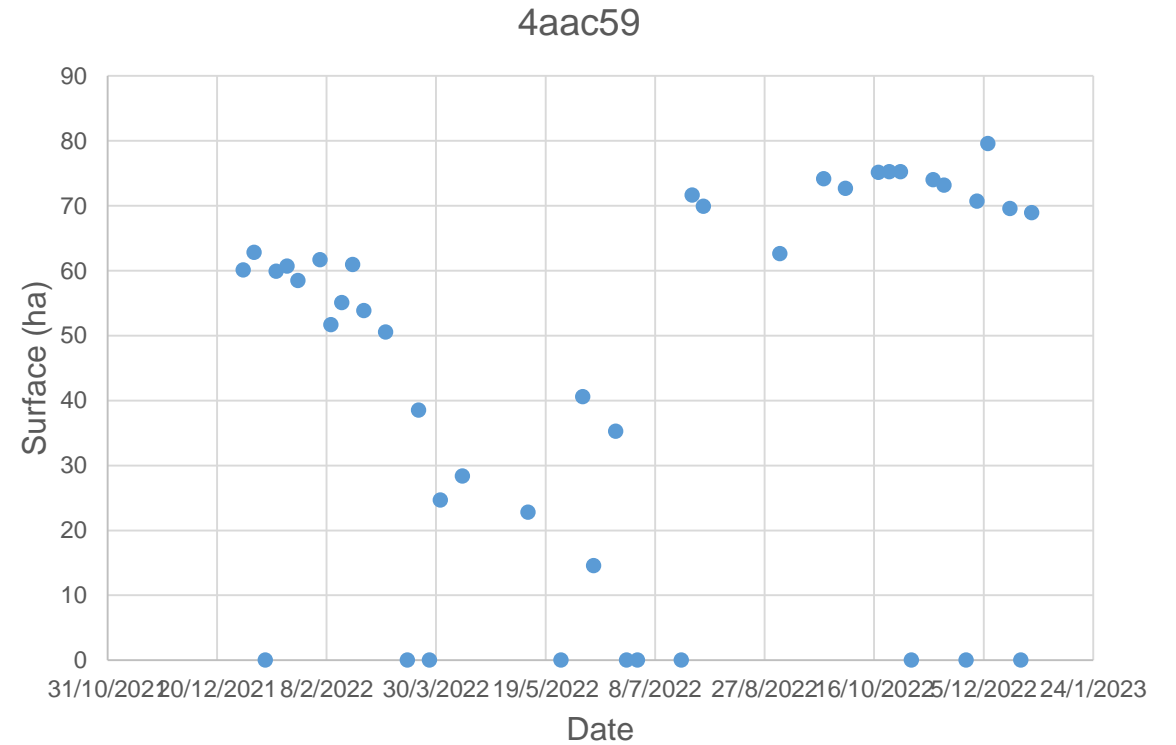
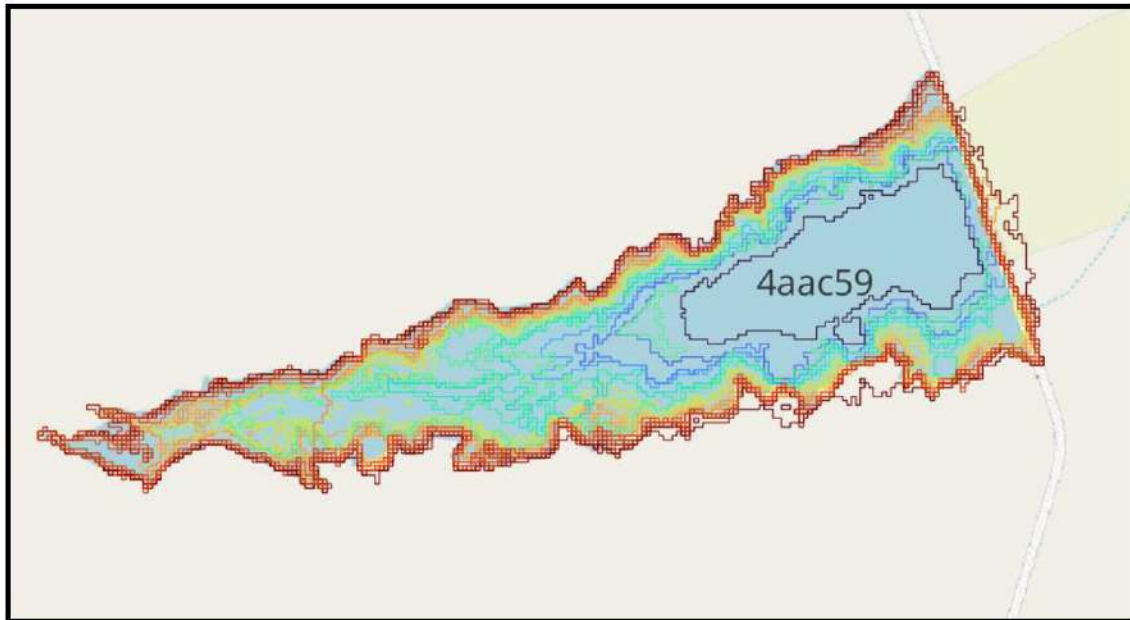
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RESULTS

Water surface evolution

- Temporal evolution over 1 year
- Exclusion of surfaces if intersection with cloud mask
- Export in SHP and CSV



CONCLUSIONS

Monitoring water reservoirs

- First promising results
- Easy implementation on Copernicus Data Space Ecosystem
- Good temporal coverage with Sentinel-2
- Surface \neq Volume
- Operationalisation and automation over large areas



Thank you!

Working Group Africa ToTs Program

Training Feedback: English Speaking Group

WG Africa Trainer: Dr. Brighton Gwamagobe

27 FEB, 2024



**WORKING
GROUP
AFRICA**

Background

- The English group comprised of 10 participants from 5 countries;
 - 4 from Kenya,
 - 3 from Tanzania,
 - 1 from Ghana
 - 1 from Rwanda
 - 1 from Nigeria
- One in common was our background in the application of remote sensing and GIS in various fields
- Our knowledge gap was high on Copernicus services, QGIS, application SNAP software, SAR and AI, and machine learning in earth observation.
- Widely diversified in different thematic experiences and interests



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Training Structure

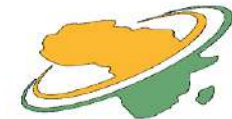
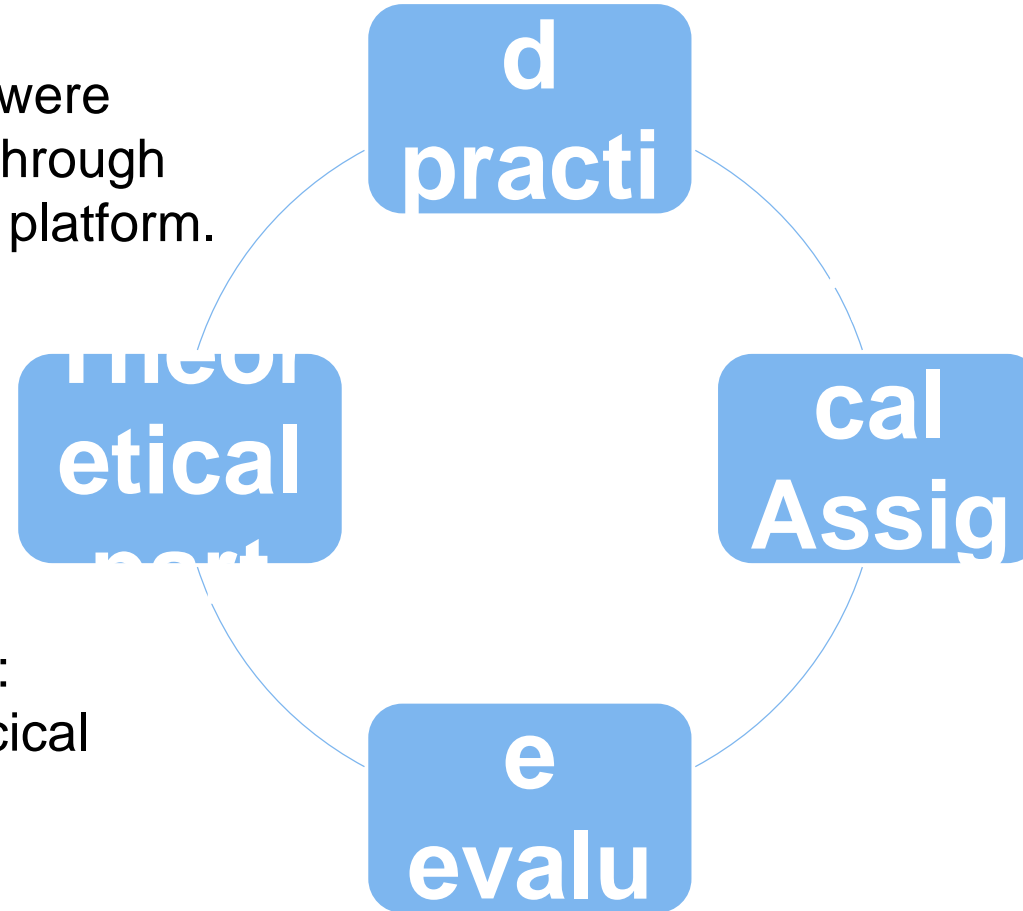
- The WG Africa ToTs training was implemented for 10 weeks stretching from June - November 2023
- More than 25 courses were organized;
- 8 core courses;
 - Pedagogy
 - QGIS
 - Remote sensing
 - Python application
 - SAR applications
 - Copernicus services
 - AI and ML application
 - Mapping and web-making
- 17 thematic/optional course



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Learning Environment

- Training sessions were conducted online through the BigBlueButton platform.
- Training approach: Lecturing and practical demonstration



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Going Forward

- In 2024, each trainer (10 in English) will organize own local training in his/her country/university/region.
- My local training will be addressed to the students and/or local government, and NGOs- scheduled from the end of June to early July 2024.
- Training project to be organized in two weeks: the 1st week for training sessions and 2nd week dedicated for undertaking wildfire research.
- A minimum of 20 trainees will be selected for the training

Tentive Schedule: Training project

Training WK 1: 26th June -4th July 2024:

WK 2 July 5-13, 2024

Remote sensing

- Mapping and accuracy assessment
- Sent2 Image analysis in QGIS
- SARI image analysis in SNAP

Python app

- GEE and colab in EO
- AI and ML for image classification and segmentation
- Map creation

Corpenicus services

- Corpenicus and data access ecosystem
- Exploring sentinel 3 & 5 using SNAP application

Diseaster management

- Application of RS and QGIS in wildfire management
- Wildfire assessment, Monitoring & Mapping



WORKING GROUP AFRICA



RECOMMENDATION

- Due to persistent network, electricity, and participation issues, I propose considering the integration of both online and physical training approaches in future designing the same training project.



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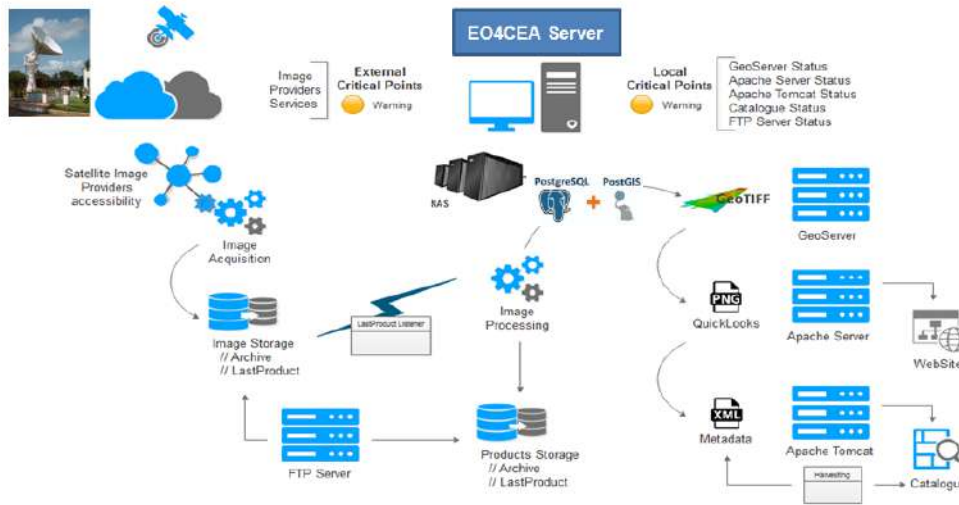


ASANTE SANA

Thank you



**WORKING
GROUP
AFRICA**



WG Africa – Training of Trainers WEBINAR: Copernicus Services and Use Cases

EO4CEA – Earth Observation For Central East Africa

ACCORDO QUADRO tra ASI e Sapienza Università di Roma N. 2015-1-Q.0.

G. Laneve, P. Marzialetti & team
Sapienza Università di Roma – Scuola di Ingegneria Aerospaziale

27-02-2024

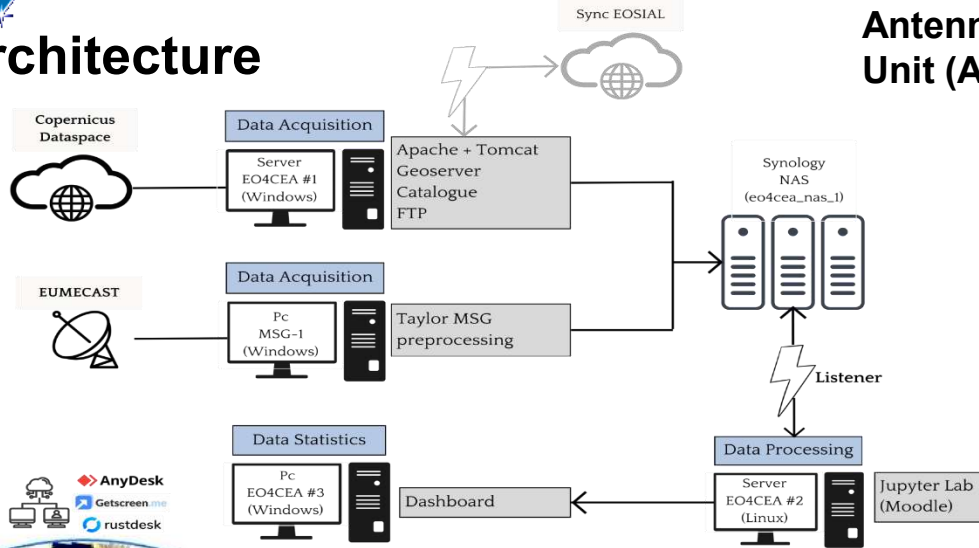
web.uniroma1.it/scuolaingegneriaaerospaziale/

- Objective:** implementation of a system for processing, distributing, analyzing and testing products and services based on satellite images to support the monitoring of indicators for the *Sustainable Development Goals* (SDGs) in Central-Eastern Africa (www.eo4cea.eu).

| Objective | Description |
|--|---|
| Remote Sensing Station up-grade (Malindi, Kenya) | Enhance the receiving station capabilities in order to increase the level of automation and acquisition possibilities. |
| Implementation of products and services | Develop/implement an interface for consulting and analyzing value-added products generated by the processing system and integration with products developed with the support of researchers and students belonging to local institutions , also. The interface allows the user, among other things, to browse and download data, view, analyze and consult metadata. A storage area will store all data including metadata, raster data and any data in vector format. |



Architecture



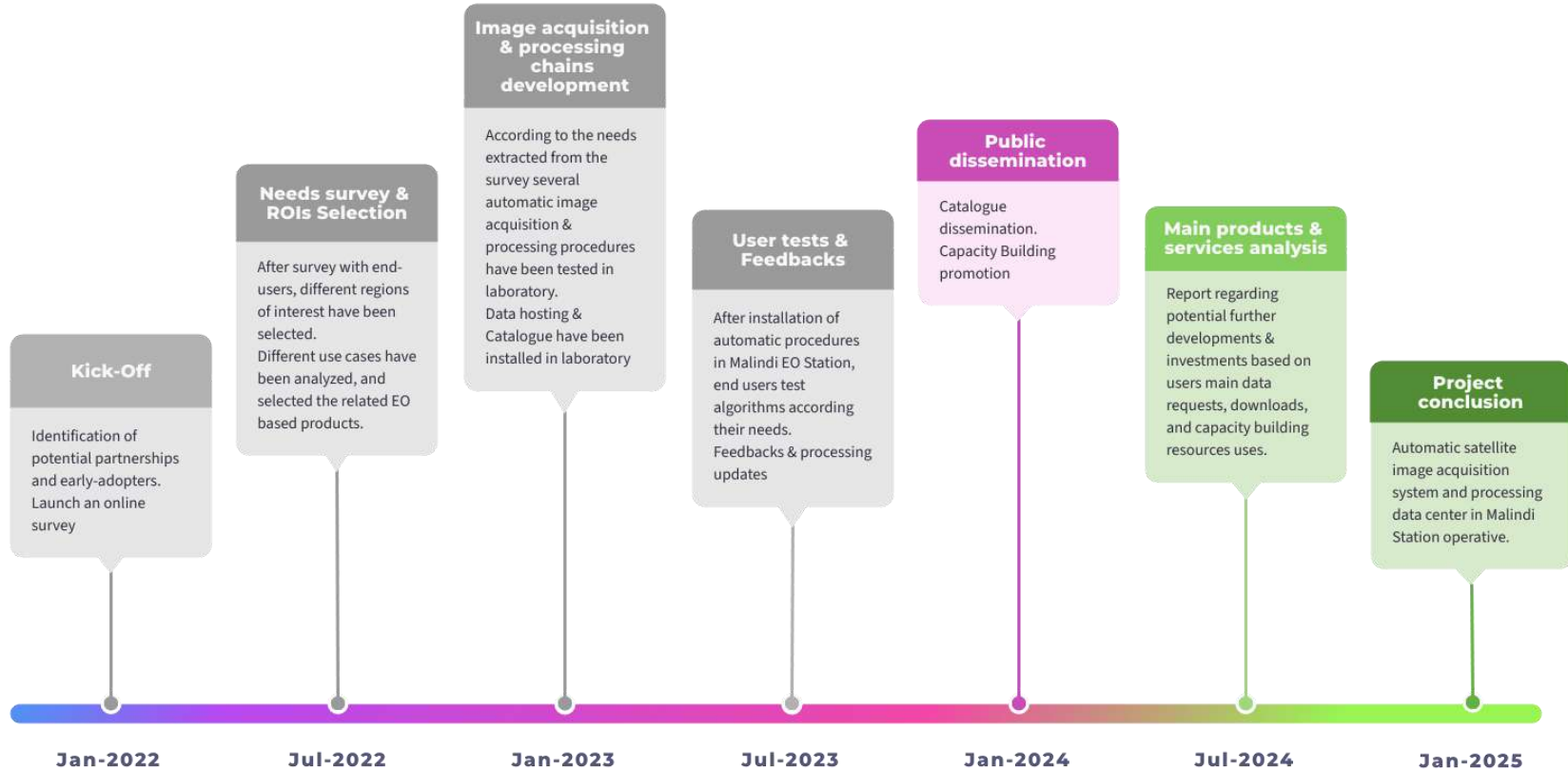
Antenna Control Unit (ACU)



Broglio Space Center, Malindi, Kenya



Objective #2: Implementation of Products & Services timeline





about You

And how are your fields of interest distributed ?

Are you using Meteorological data ?

Are you interested on Crop Anomalies Detection ?

How often do need to monitor the fields?

Are you interested on Crop Pest Detection ?

Preferred Data formats ?

To which segment do you belong?

Are you a user of satellite-based information?

How would you like to access the data?

Which crops are you currently monitoring (or would you like to monitor)?

Which is the dimension of your fields of interest ?

Which are your main spheres of interest ?

about Satellite missions

Do you know the portfolio of Products and Services offered via the Copernicus Climate Data Store ?

Please evaluate the usefulness (or potential usefulness) of data and products of Copernicus Programme and ASI missions in your daily work

Which services offering access to data and products of Copernicus Programme do you know ?

In case you have already accessed to Copernicus Datasets, please valuate its accessibility

Are you already using data and products of Copernicus Programme

In case you have already accessed to ASI Datasets, please valuate its accessibility

In case you would introduce Copernicus and ASI datasets in your activities, please indicate the purposes

Do you know Italian Space Agency (ASI) missions ?

Which other missions do you work with ?

about Image Processing

Do you know image processing techniques ?

Have you worked with Image processing tools ?

Are you interested in receiving training materials concerning Copernicus Programme and ASI missions ?

Do you have the required data storage & image processing infrastructure ?

In what form would are you interested to get knowledge ?

In what kind of knowledge are you mostly interested ?



Objective #2: Implementation of Products & Services timeline

SATELLITE IMAGES TO BE PROCESSED



WEEKLY
> 100
+ 1,344 (MSG)

STATUS IMAGE PROCESSING CHAIN



| | | | |
|---|---|---|--|
| <p>1 Kenya</p> <p>SENTINEL-2 : > 100 ROI SENTINEL-1 : 1 ROI SENTINEL-3 : ADMIN LEVEL 0 SENTINEL-5 : ADMIN LEVEL 0</p> <p>MSG-SEVIRI : ADMIN LEVEL 0 MODIS : ADMIN LEVEL 0</p> | <p>2 Djibouti</p> <p>SENTINEL-2 : 1 ROI SENTINEL-1 : --- SENTINEL-3 : ADMIN LEVEL 0 SENTINEL-5 : ADMIN LEVEL 0</p> <p>MSG-SEVIRI : ADMIN LEVEL 0 MODIS : ADMIN LEVEL 0</p> | <p>3 Ethiopia</p> <p>SENTINEL-2 : 1 ROI SENTINEL-1 : --- SENTINEL-3 : ADMIN LEVEL 0 SENTINEL-5 : ADMIN LEVEL 0</p> <p>MSG-SEVIRI : ADMIN LEVEL 0 MODIS : ADMIN LEVEL 0</p> | <p>4 Somalia</p> <p>SENTINEL-2 : 1 ROI SENTINEL-1 : --- SENTINEL-3 : ADMIN LEVEL 0 SENTINEL-5 : ADMIN LEVEL 0</p> <p>MSG-SEVIRI : ADMIN LEVEL 0 MODIS : ADMIN LEVEL 0</p> |
| | <p>5 Uganda</p> <p>SENTINEL-2 : 1 ROI SENTINEL-1 : --- SENTINEL-3 : ADMIN LEVEL 0 SENTINEL-5 : ADMIN LEVEL 0</p> <p>MSG-SEVIRI : ADMIN LEVEL 0 MODIS : ADMIN LEVEL 0</p> | <p>6 Eritrea</p> <p>SENTINEL-2 : 1 ROI SENTINEL-1 : --- SENTINEL-3 : ADMIN LEVEL 0 SENTINEL-5 : ADMIN LEVEL 0</p> <p>MSG-SEVIRI : ADMIN LEVEL 0 MODIS : ADMIN LEVEL 0</p> | <p>7 Tanzania</p> <p>SENTINEL-2 : 1 ROI SENTINEL-1 : --- SENTINEL-3 : ADMIN LEVEL 0 SENTINEL-5 : ADMIN LEVEL 0</p> <p>MSG-SEVIRI : ADMIN LEVEL 0 MODIS : ADMIN LEVEL 0</p> |
| | <p>8 Malawi</p> <p>SENTINEL-2 : 1 ROI SENTINEL-1 : --- SENTINEL-3 : ADMIN LEVEL 0 SENTINEL-5 : ADMIN LEVEL 0</p> <p>MSG-SEVIRI : ADMIN LEVEL 0 MODIS : ADMIN LEVEL 0</p> | <p>9 Mozambique</p> <p>SENTINEL-2 : 1 ROI SENTINEL-1 : --- SENTINEL-3 : ADMIN LEVEL 0 SENTINEL-5 : ADMIN LEVEL 0</p> <p>MSG-SEVIRI : ADMIN LEVEL 0 MODIS : ADMIN LEVEL 0</p> | <p>10 Madagascar</p> <p>SENTINEL-2 : 1 ROI SENTINEL-1 : --- SENTINEL-3 : ADMIN LEVEL 0 SENTINEL-5 : ADMIN LEVEL 0</p> <p>MSG-SEVIRI : ADMIN LEVEL 0 MODIS : ADMIN LEVEL 0</p> |

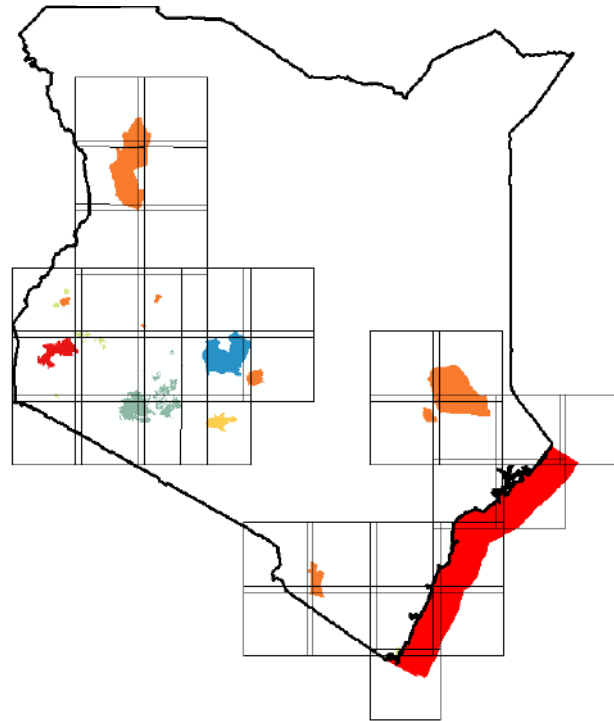
Objective #2: Implementation of Products & Services timeline

Needs survey & ROIs Selection

After survey with end-users, different regions of interest have been selected. Different use cases have been analyzed, and selected the related EO based products.

Image acquisition & processing chains development

According to the needs extracted from the survey several automatic image acquisition & processing procedures have been tested in laboratory. Data hosting & Catalogue have been installed in laboratory



Objective #2: Implementation of Products & Services timeline

Needs survey & ROIs Selection

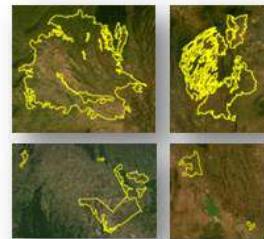
After survey with end-users, different regions of interest have been selected. Different use cases have been analyzed, and selected the related EO based products.

Image acquisition & processing chains development

According to the needs extracted from the survey several automatic image acquisition & processing procedures have been tested in laboratory.

Pest monitoring (Wheat Aphid)

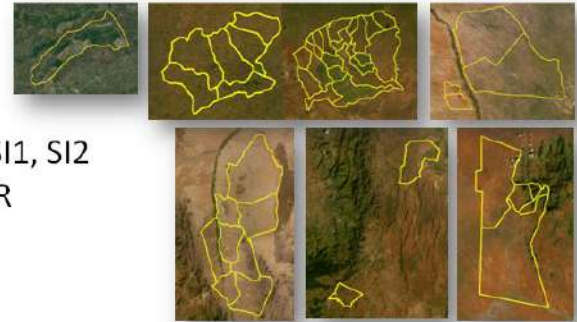
- NDVI, NDWI, LAI, EVI
- SAVI, NDSI, SIPI1, SIPI2
- MCARI, SR
- historical products
- + capacity building



Salinization process

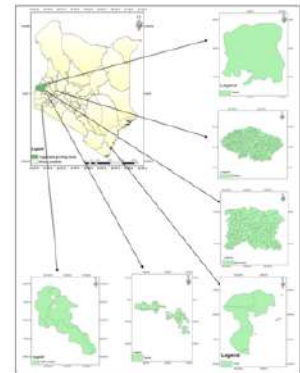


- NDVI, NDSI, VSSI, BI, SI, SI1, SI2
- SI3, SI4, RVI, Int1, Int2, SR
- SAVI, SSSI1, SSSI2
- historical products
- + capacity building

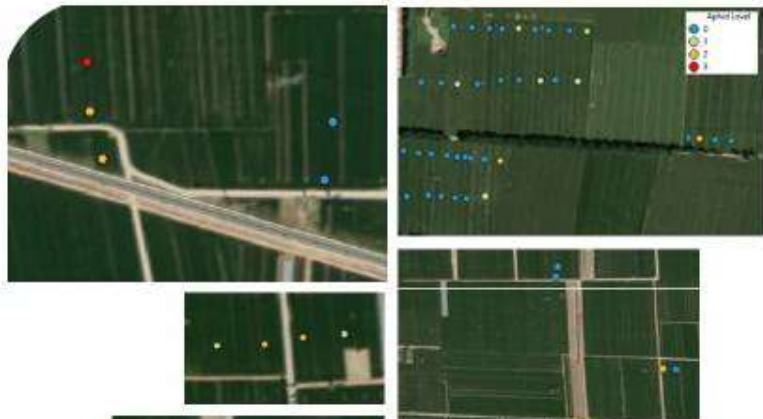


• Sugarcane

- Growth monitoring (from establishment to post-harvesting)
- NDVI, NDWI, LAI, EVI
- historical products
- + capacity building



Objective #2: Implementation of Products & Services timeline



Impact of wheat aphid

in Kenya this illness has been first identified in several fields in 1995. It spread quickly to all the wheat growing areas of the country and it is nowadays the most important pest of wheat and barley.



Kenya

Sugarcane
growth anomaly

(researchers, agricultural services)

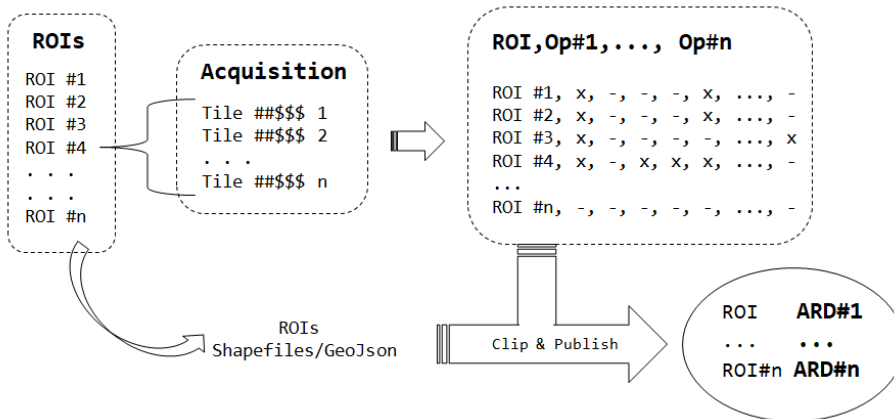
salinity



> 100
fields

Objective #2: Implementation of Products & Services timeline

Sentinel -2 processing chain

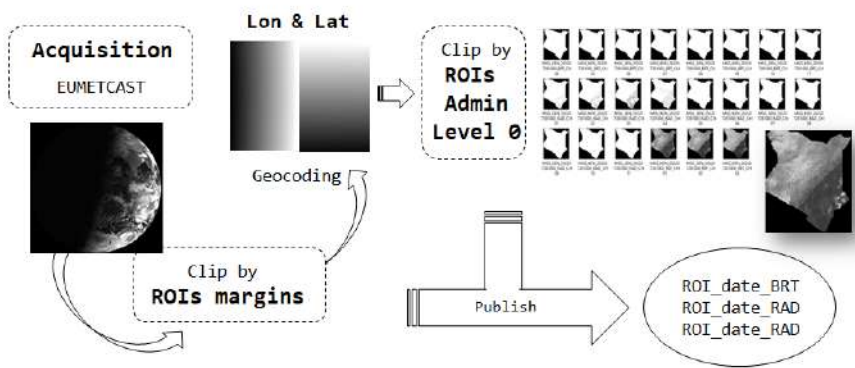


ESA SNAP Tools and Workflows (depending on availability of S2 RAW data)

This block shows the ESA SNAP Tools and Workflows interface. On the left, there are screenshots of the software's graphical user interface, including a map view and a workflow graph. On the right, there is a detailed view of a workflow graph with nodes like **Read**, **S2Resampling(2)**, **BandMaths(2)**, **Write(2)**, and **BandMerge**. Below the screenshots, there is a code block showing XML code for a workflow, which is used to launch the process via GCP command line.

Access to EO4CEA repository (RAW + ARD)
 + Pre-defined 25 workflows graph model
 + .xml to be launch by GCP command line (GCP: Graph Processing Tool)

MSG image processing chain



Objective #2: Implementation of Products & Services timeline

Data collections included:

For ROIs: (Spatial resolution: 20 mt. / Temporal resolution: 5 days)

Arvi, Ireci, Mcari, Ndw, Nbr, Tndvi, Tsavi, Ndpi, Ci, Bi, Ri, Lai, Fapar, Cab, Cwc, Fvc, Ndti, Mndwi, Pssra, Dvi, Reip, Gndvi, Wdvi, Evi, Cdom, Chl, Nsmi, Vnri

Country coverage:

MSG_dataset (Spatial resolution: 3 km / Temporal resolution: 15')

Brightness temperature, Radiances, Reflectances

+ Third party (covering full country): (Spatial resolution: 250 mt / 1000mt / Temporal resolution: 10 days) **Based on CLMS**

Crop: CREW, CRPA, LAI, VCI,

Land: LULC, LCCA, BAcc, LCBA, XXBA,

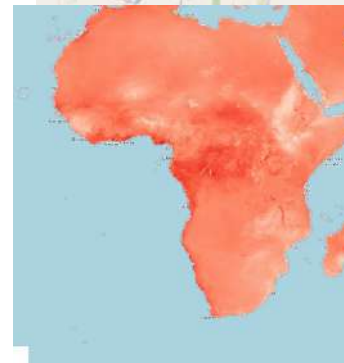
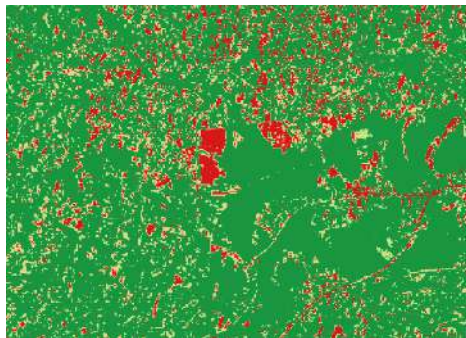
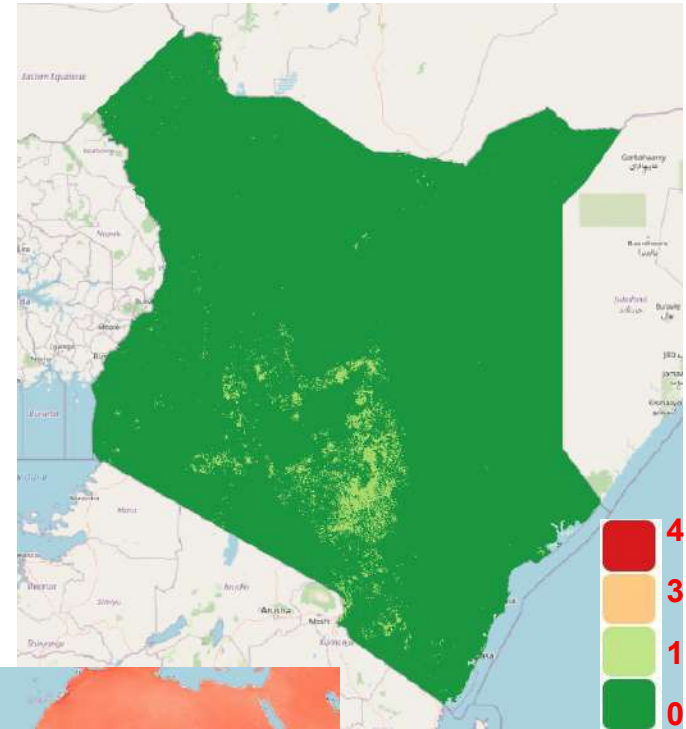
Water: XLWQ, XSWM, SWACI, SWCI, SWI10,

Portfolio for data promotion 

Crop early warning (CREW): high spatial resolution



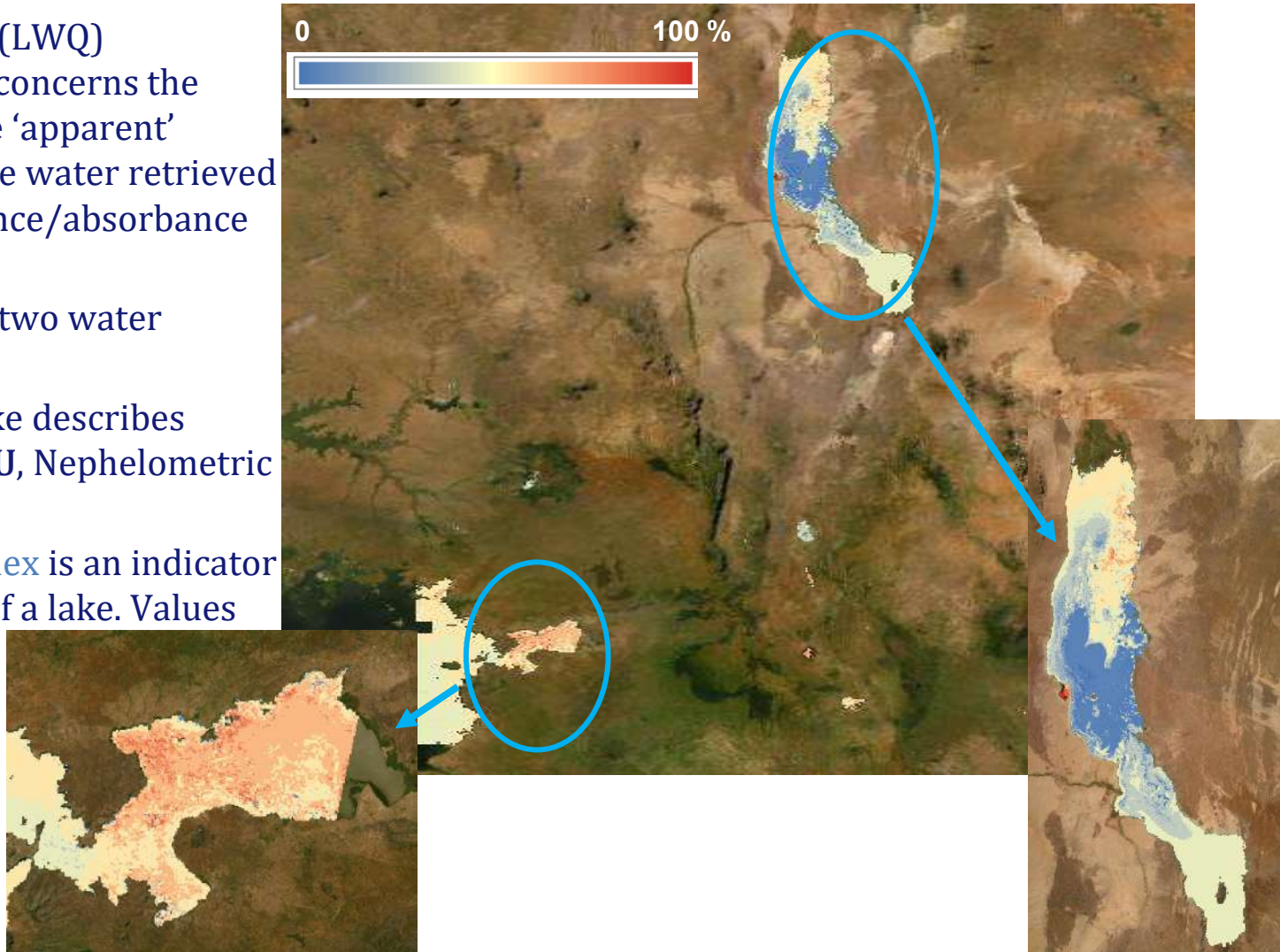
| Indicator name | Explanation |
|----------------|---|
| VCI | VCI time series based on last 7 years of Sentinel-2 images |
| TAI | Temperature anomalies time series computed from the time of the crop growth starting season |
| Rain | Precipitation shortage cumulative value starting from one month in advance with respect the crop growth starting season |

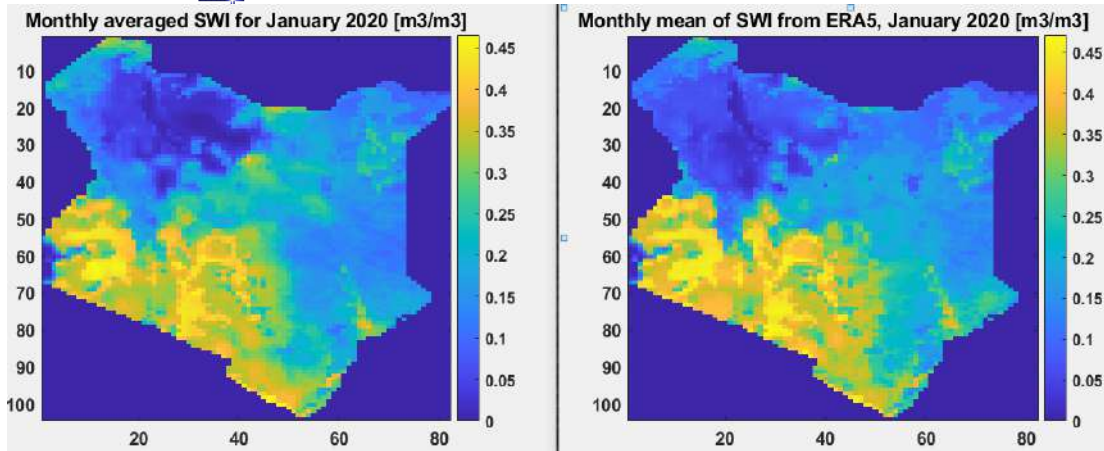


CREW

Lake water quality

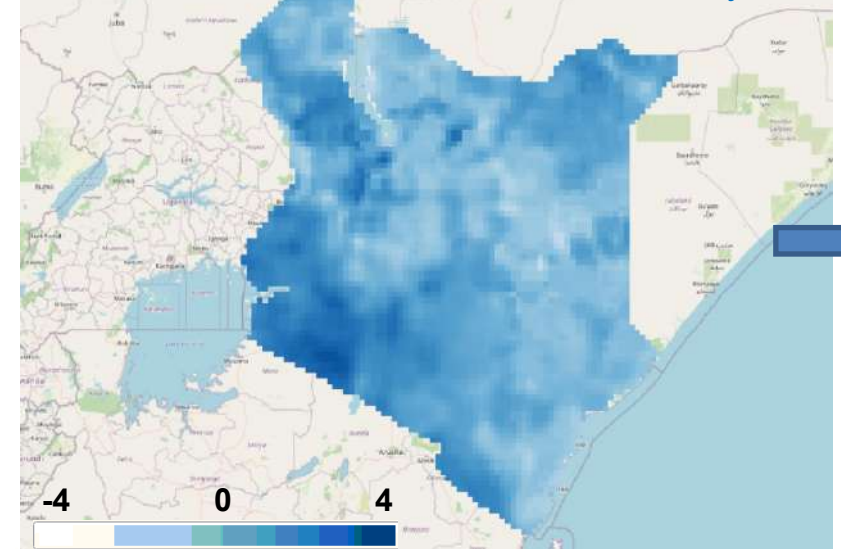
- Lake water quality (LWQ) monitoring service concerns the measurement of the 'apparent' characteristics of the water retrieved through its reflectance/absorbance characteristics.
- The data consist of two water quality parameters:
- The *turbidity* of a lake describes water clarity (in NTU, Nephelometric Turbidity unit).
- The *trophic state index* is an indicator of the productivity of a lake. Values range: 0 – 100%





- The maps provide the moisture condition at various time intervals (8) from which the depths in the soil can be retrieved, one for each layer.
- It's defined as the amount of water contained in soil layers identified according to their depth measured from top surface.
- Changes in soil moisture have a serious impact on agricultural productivity, forestry and ecosystem health.
- The product have a frequency of 10 days and a resolution on 10 km.

Soil Water Condition Index of 21th February 2022











- **Soil Water Condition Index (SWCI)** is based on the Soil Water monitoring (SWI). It allows to compare the actual values of Soil Water Index, the *averaged* and the *standard deviation* computed for the same days of the year in the *previous 10 years*. SWCI values **lower then 0** means conditions worst then the historical mean value, and SWCI values **greater then 0** means conditions better then the historical mean value.
- Therefore, the maps allow to detect any significant changes in soil moisture (for different soil depths) compared with previous years.
- The resolution is 10 km.



Objective #2: Implementation of Products & Services timeline

E-learning platform



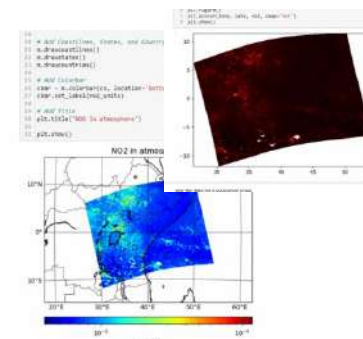
| | | | |
|--|---|--|---|
| <p>Space Missions and Earth Observation Data Systems</p> <p>Topics covered:</p> <ul style="list-style-type: none"> • Introduction to space missions • Introduction to remote sensing • Elements of remote sensing physics • Earth observation systems <p>Teacher: Giovanni Laundy</p> |  | <p>Introduction to Copernicus Programme</p> <p>Topics covered:</p> <ul style="list-style-type: none"> • The Copernicus System • Copernicus Services Catalogue • Copernicus Users Cases • Data Access <p>Teacher: Riccardo Orsi</p> |  |
| <p>Introduction to Geographic Information Systems</p> <p>Topics covered:</p> <ul style="list-style-type: none"> • GIS System • Data formats • Spatial Analysis • Spatial databases <p>Teacher: Paolo Mazzoldini</p> |  | <p>Sugarcane monitoring</p> <p>Topics covered:</p> <ul style="list-style-type: none"> • Satellite phenology • Modeling sugarcane yield • Pest surveillance • Tracking false stems <p>Teacher: Romy Mulenga</p> |  |
| <p>Oil Spill detection</p> <p>Topics covered:</p> <ul style="list-style-type: none"> • Introduction, True & False Alarms • Remote Sensing, SAR products • Image processing & Feature extraction • Classification <p>Teacher: Paolo Mazzoldini</p> |  | <p>Burn Area Detection</p> <p>Topics covered:</p> <ul style="list-style-type: none"> • Burn Indices Background • Normalized Burn Ratio (NBR) calculation • Burn severity • Burn Size Vectorisation <p>Teacher: Sarah Basso Morici</p> |  |
| <p>Earth Observation for Agriculture</p> <p>Topics covered:</p> <ul style="list-style-type: none"> • Vegetation & Soil indices • Crop growth monitoring • Drought detection • Pest monitoring <p>Teacher: Paolo Mazzoldini Teacher: Simone Scudato</p> |  | <p>Soil Salinity Mapping</p> <p>Topics covered:</p> <ul style="list-style-type: none"> • TSD • TSD • TSD • TSD <p>Teacher: Calisto Tanzi Orsini</p> |  |

(based on fixed samples)

MSG-Seviri
RGB Composites



Sentinel-2
ARD Workflows





DATA PIPELINE

Quick view of satellite data acquisition, processing & dissemination status

WORKFLOW

a glimpse to the status of each step of the processing chain



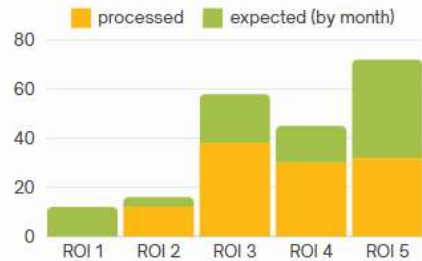
DOWNLOAD SPEED

Data acquisition performance



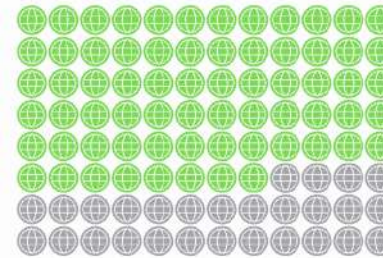
ROI PROCESSING

Expected data processed by ROI vs effectively done

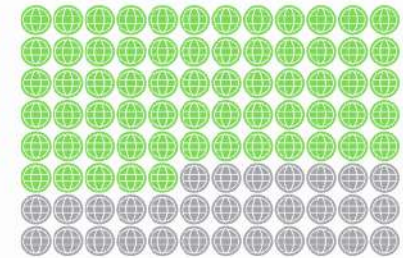


MSG SEVIRI

RAW Data

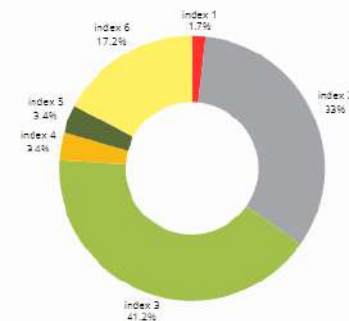


Crop KENYA

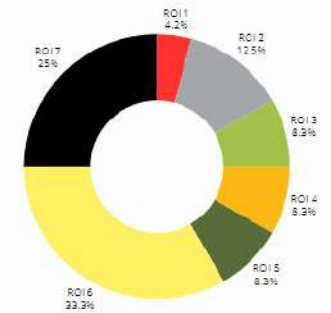


DATA DISSEMINATION

Dissemination by EO based Index



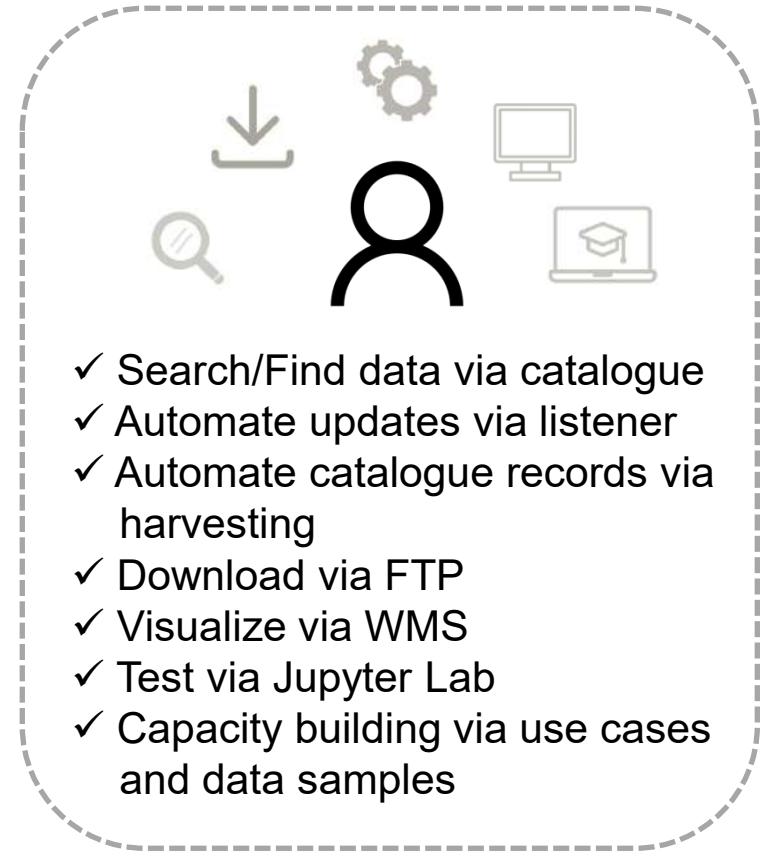
Dissemination based on the Region of Interest



EO4CEA goals

Guarantee FAIR principles

- D** * Findable: GeoNetwork & STAC (Spatio Temporal Asset Catalogs)
- A** * Accessible: Catalogue, FTP, and WMS/WFS
- T** * Interoperable: .geotiff, .csv, .shp, .xml, .json, .sld
- A** * Reusable: Metadata & Data well describe (INSPIRE & RNDT2.0 complaint)



- ✓ Search/Find data via catalogue
- ✓ Automate updates via listener
- ✓ Automate catalogue records via harvesting
- ✓ Download via FTP
- ✓ Visualize via WMS
- ✓ Test via Jupyter Lab
- ✓ Capacity building via use cases and data samples



Earth Observation Satellite Images Application Lab. (EOSIAL)

web.uniroma1.it/eosial/en

www.eo4cea.eu

Thank you

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