Sahara and Sahel Observatory

Union Africaine

GMES AND AFRICA

A sustainable of management natural resources in Africa

Sahara and Sahel Observatory - OSS

A sustainable management of natural resources in Africa

November 2023

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What is the state of natural resource in Africa North

Context

North Africa is facing growing climate change challenges. It undergoes episodes of drought and water shortages. Besides, this region witnesses land degradation caused in part by poor land use practices, which negatively affect biodiversity, food security and the well-being of the communities. Consequently, having reliable information on agricultural practices in the region, the extent of land degradation and the impact of degraded land restoration is fundamental to ensure informed decision-making in order to support sustainable land and water management and efficient monitoring of agricultural campaigns.

Earth Observation resources can provide up-to-date and reliable data, products and information to strengthen this decision-making process.

Issue

Agriculture in North Africa: multiple challenges to overcome !

- Rainfall shortage and repeated droughts.
- Need for data on the crop areas and on the yield estimates during the agricultural season.
- Irrational use of water for irrigation.
- Unavailability of reliable, up-to-date and spatially referenced information on land degradation: loss of vegetation, forest fires, coastal erosion, etc.
- Need for early warning tools to prevent drought and anticipate drops in production.

In order to have an effective agricultural campaign, users need efficient tools to monitor a series of important factors:

- The crop health and growth, agricultural yield forecasts.
- Water stress and agricultural drought through an operational early warning mechanism.
- Natural and anthropogenic threats (floods, insects, diseases, etc.).
- Groundwater withdrawal for agricultural use.
- Degraded areas and the impact of restoration actions for a sustainable agriculture.

La télédétection, un outil au service de la gestion durable des ressources naturelles et de la sécurité alimentaire. Ses potentialités et ses atouts couvrent les domaines suivants :

- ◊ Land use mapping and multi-scale change detection.
- ◊ Monitoring the spatiotemporal dynamics of the plant cover and forests.
- ◊ Monitoring the agricultural areas, detection anomalies and forecasting agricultural yields.
- ◊ Near real-time monitoring and management of the risks: forest fires, floods, drought, etc.

Earth Observation is therefore an essential source of useful and relevant information for decision-making. Several initiatives have been put in place to take advantage of space science and technology to support sustainable management of the resources. GMES&Africa - Global Monitoring for Environment and Security and Africa - is one of the flagship programs covering the entire African continent.

GMES&Africa in North Africa

GMES&Africa aims to support decision-making in sustainable land and water management through the provision of products and services based on Earth Observation (EO) data and techniques.

How did we do it?

Identification of end-user needs (agricultural and water resource managers, environmental agencies, farmers and general public)

Definition of technical solutions in response to the needs and conceptualization of methodological approaches

Development and validation of services and implementation of operational platforms

Deployment of the services, testing, taking into account feedback and optimization

Capacity building and ownership; broadcast as community tools

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What is the mission of GMES&Africa

Main ambition

Improve the capacities of African decision-makers, planners, scientists and the private sector to design, implement and monitor national, regional and continental policies, and to promote sustainable management of natural resources through the use of Earth Observation data and derived information.

Boost regional cooperation and promote the sharing of know-how on the sustainable management of natural resources in North Africa.

Further consolidate human and technical capacities of African institutions in order to have a better access and more efficient exploitation of EO-based services.

Raise awareness among beneficiaries and end users for better use and ownership of the Earth Observation derived services and products in response to their needs.

What are the primary objectives of the project?

- Provide EO-derived decision support products and services, to support the monitoring of agricultural campaigns and the conservation of food security.
- Establish an "African Single Window" to promote land degradation monitoring in Africa and its islands.
- Build the capacities of the beneficiaries and end users to take charge of the services and make sure they are adopted by a larger and more diverse community of users.
- Involve stakeholders from academia and the private sector in the production of innovative methodologies, technologies and tools in response to the challenges of sustainable natural resources management.
- Consolidate cooperation and cross-fertilization in order to better capitalize on the achievements, share experiences and optimize resource management actions.

What strategy did the project adopt in North Africa?

In North Africa, the project was fully compliant with the GMES&Africa program vision, whose objective is to contribute to meeting the challenges of the African continent in terms of sustainable management of natural resources and water and adapting to the climate change effects, by using space applications and technologies, as well as the feedback and lessons learned from the project phase I.

Two operational services!

Service 1 - Monitoring seasonal agriculture and water withdrawals for agricultural use, which supports food security by providing reliable information on the evolution of agricultural seasons and drought early warning.

Service 2 - Monitoring land degradation, through the production of information on the extent and severity of the phenomenon, the impact of restoration actions, for better actions and to guide field-interventions.

GMES&Africa Program: what initiative a more sustainable agriculture?

The challenge of agriculture in North Africa

Agriculture is a key component of the economies of North African countries and takes an important social significance (food, jobs, income, etc.) as it plays a crucial role in territorial development and the fight against poverty, particularly in rural areas. However, agriculture is facing major challenges that compromise optimal crop development and food security.

North Africa is one of the areas most affected by water stress. Increasingly extreme climate conditions, exhaustion and degradation of agricultural soils exacerbated by anthropogenic causes are drivers to reduced natural resources and losses in the agricultural production.

- **Droughts compromise agricultural production:** Increasingly frequent and severe drought episodes are putting agricultural systems under strain, causing water stress, reduced yields and loss of productivity.
- **Rising temperatures, reduced agricultural productivity:** Rising temperatures cause heat stress for crops.
- **Dehydration of crops in saline soils:** The progression of soil salinity, which reduces soil fertility and leads to dehydration of the crops' root system.
- **The increase in production costs:** The costs of agricultural inputs and certain raw materials are increasing, in particular due to geopolitical factors.

Helping farmers make decisions

Decision-makers and farmers need to think out of the box to face these challenges. How is it possible to establish a sustainable agriculture that overcomes all these challenges while being productive and profitable? With this in mind, GMES offers a substantial contribution in terms of innovation. Indeed, the sustainable management of natural resources and the promotion of food security uses innovative technologies and multiple, scaled responses, in which EO plays a fundamental role.

How to take advantage of Earth Observation for the benefit of sustainable agriculture?

Providing decision-makers, agricultural monitoring technicians, water resource managers, farmers, insurance companies, with a range of instruments to inform decision-making in a timely manner and at various (local, national, regional) scales.

Thematic maps: Land use, crop types, land productivity, erosion, land degradation, burned areas, etc.

Alert and dissemination platforms: Access to timely information for monitoring agricultural campaigns and natural resources management (MISLAND, MISBAR and GUETCROP).

Mobile apps: Monitoring agricultural activity, sensing anomalies and agricultural risks (drought, floods, etc.).

Information: Monitoring the state and evolution of crop growth through biophysical indicators of the crops.

Establishment of reference systems with functionalities for the optimal monitoring of natural resources at various scales, monitoring of the crops and forecasting of their agricultural yields.

Building the capacities of end users on the use of tools for better optimization of water use, efficient monitoring of agricultural campaigns in support of food security.

Promotion gender equality: Motivating young people and women, easier access to products and services and EO promoting initiatives (internships, training and technical assistance, scholarships, hackathons, consultation for start-ups, etc.)

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How to assess lan

Land degradation monitoring service in North Africa

Little reliable data is available on the extent and severity of land degradation in Africa. Decision-makers and stakeholders involved in the fight against this phenomenon need reliable information on its state and evolution, in order to come up with efficient strategies and plan land restoration actions.

A decision support system called "Integrated Land Degradation Monitoring System, MISLAND-Africa, accessible via: "http://misland.oss-online.org" has been developed. It uses Earth Observation data to ensure spatiotemporal and multi-scale monitoring of degraded areas. MISLAND-Africa offers an integrated solution for monitoring SDG indicator 15.3.1 on "Proportion of degraded land compared to total land area" in support of land degradation neutrality.

MISLAND-Africa thus contributes to improving spatiotemporal monitoring and estimation of areas affected by different forms of degradation, by highlighting areas of loss (hotspots) and gain (brightspots) of vegetation, changes in forest cover, forest fires and desertification.

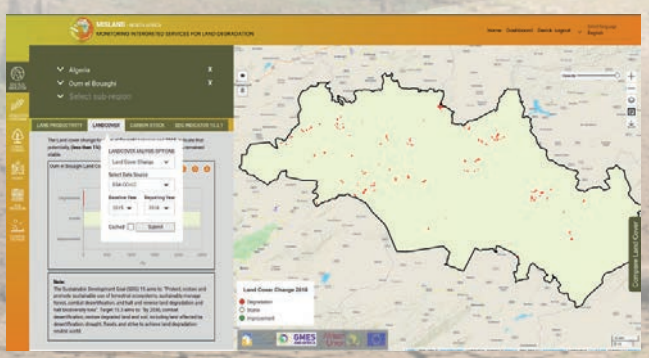
Indicators accessible via the Integrated Surveillance System of land degradation - MISLAND-Africa

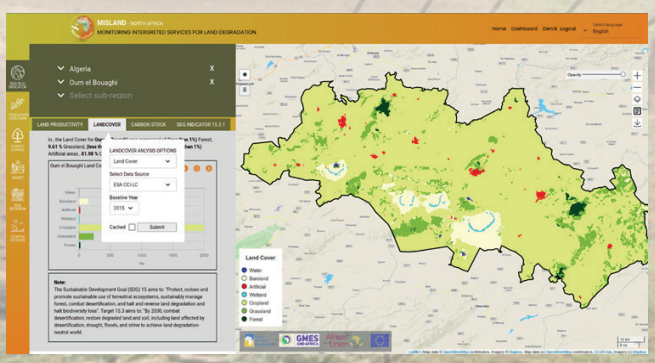
- Vegetation loss/gain trend
- Land degradation indicators monitored service
- Evaluation of forest carbon emissions
- Assessment of soil erosion
- Coastal, wind and water erosion
- Vulnerability to desertification
- Change in forest cover
- Forest fires
- SDG indicator 15.3.1

nd degradation

The land degradation monitoring service is mainly based on a set of reliable reference data sources (ESA-Copernicus, USGS, ECMWF, etc.). This data covers multiple topics including:

- Vegetation indices
- Agroecological areas
- Rainfall
- Soil carbon
- Evapotranspiration
- Moisture and soil quality
- Climate
- Land use





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through fre

The Seasonal Agriculture monitoring Service

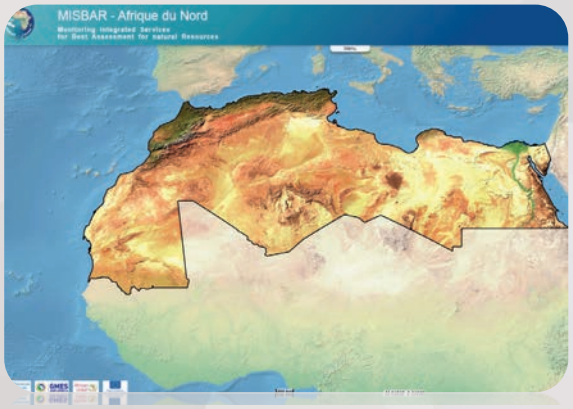
The North African region faces the challenge of food insecurity. Excessive withdrawals and pressure from undeclared agricultural water drilling cause irreversible damage to soil and groundwater resources, worsened by drought and climate change. In a context of high rainfall variability where water is the limiting factor in agriculture, urgent actions are necessary to ensure sustainable management of water resources in North Africa.

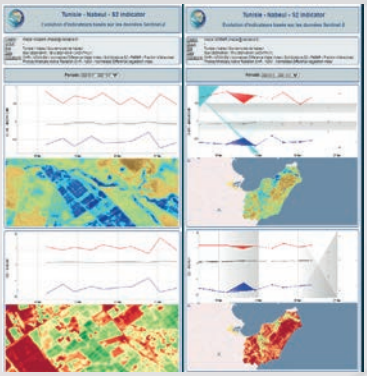
Two decision support systems have been developed to promote timely access to reliable information and data, useful for agricultural monitoring: MISBAR and GUETCROP.

- **MISBAR: Monitoring Integrated Services for Best Assesment of natural Ressources**

MISBAR is a platform that provides useful geospatial resources for monitoring agricultural campaigns. It offers access to a range of data and indicators useful for monitoring crop growth conditions and detecting anomalies and planning field interventions.

Access link:
http://misbar.oss-online.org





ow we can track
paigns in near real time
e satellite images

• GUETCROP : Crop monitoring and early warning in North Africa

GUETCROP is a platform providing regular access (every 10 days) to automatic early warnings of drought and anomalies likely to lead to reductions in production crops and affect the good growth of rangelands in the region and countries of North Africa. This information is reaped from time series of biophysical indicators and weather data.

Access link:
http:/getcrop.oss-online.org

Main indices

- zNDVIc: Normalized score (Z-score) of the cumulative vegetation index
- zNDVI: Normalized score (Z-score)
- FCover : Fraction of vegetation cover
- FAPAR: Fraction of absorbed photo-synthetically active radiation
- NDVI: Vegetation index by normalized difference vegetation index
- MNDWI: Modified normalized difference water index
- RECI: Chlorophyll index
- zWSI: Z-score of the overall water satisfaction index
- SPI1: Normalized precipitation index
- NMDI: Normalized multi-band drought index
- SAVI: Vegetation index adjusted to the soill
- MSAVI2: Vegetation index adjusted to modified soil 2

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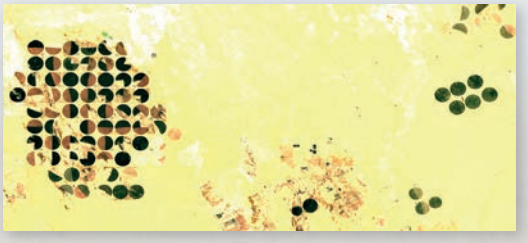
Do you know that crop y

Crop monitoring

Regular monitoring of the cropped plots makes it possible to inform decision-makers and planners about the progress of the agricultural campaign and the growth anomalies observed in the vegetative development of the crops.

Such a monitoring becomes possible thanks to the availability of a series of biophysical indices on crops and agrometeorological data making it possible to describe the state of these crops and to act only in areas subject to development anomalies.



Yield forecasting

Estimating crop yields is a fundamental activity in agricultural policy. It allows decision-makers to be "reassured" or "alerted" about the situation of the agricultural campaign and to take the necessary measures.

The yield forecasting activity can be done efficiently by combining qualitative information from satellite data with quantitative information provided by crop growth models.

MISBAR and **GUETCROP** provide valuable information on the agricultural campaign extending from the plot to an entire region or even a whole country. These tools use low, medium and high spatial resolution data, at high temporal frequencies, which makes them very useful for agricultural monitoring and early warning of the agricultural campaign evolution.

t we can estimate ields

Mapping the crop types

Forecasting agricultural yields and estimating production during agricultural campaigns requires data on the cropped areas by type of crop. These data can be estimated from Earth Observation products from the crop plot using innovative technologies such as Artificial Intelligence including Machine Learning and cloud computing.

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Would you like to estima
for agricultural use using

Water stress detection

Earth Observation and its derived products (namely indices) is an effective tool for detecting water stress affecting the crops. Such information is crucial for planning irrigation practices and optimizing water use in this context of water stress. They are accessible via MISBAR and GUETCROP.

The indices accessible via MISBAR and GUETCROP are useful for:

- Monitoring water samples for agricultural purposes.
- Monitoring water availability for crops during the growing season.
- Mapping irrigated areas and their spatio-temporal monitoring.
- Early warning in the event of a water deficit that could lead to poor crop growth.

NDWI-SM: Normalized Water Difference Index - Soil Moisture
NDVI: Normalized Difference Vegetation Index
NDWI-OW: Normalized Water Difference Index (open water)
zWSI: Z-score of the overall water satisfaction index
SPI1: Normalized Precipitation Index 1
SPI3: Normalized Precipitation Index 3

te the volumes of water
Earth Observation data

Estimated volumes for agricultural use

A mobile app. dedicated to irrigation management is expected to be developed as part of this second phase. It will further contribute to better optimize the use of water resources, placing the farmer at the heart of the decision-making process. All the farmer has to do is sending a simple request, he will have the answer on: "When to irrigate" and "How much water to use? »

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MISBAR

Monitoring Integrated Services for Best Assessment of natural Resources

North-Africa Consortium needs

Seasonal agriculture monitoring

- Where do my crops grow ?
- Where/what are my cultivated crops in summer and in winter ?
- I need to have a detailed crop acreage per season
- I need to have an estimation of my agricultural production
- I need to undertake a multi-scale crop monitoring
- I need to analyze the changes of agricultural campaigns over time

Needs

Water abstractions monitoring

- Where are my irrigated parcels?
- How much water is used for irrigation purposes ?
- I need to identify the unauthorized irrigated areas
- I need to evaluate the pressure on groundwater resources
- I need to analyze the changes of irrigated surfaces and assess the trends over time
- I need to assess the impact of climate change on irrigation

Linkages between "Water" and "Agriculture"

Irrigated areas are characterized by high soil moisture and high vegetation index

Indirect estimation of water consumption is done through vegetation indices

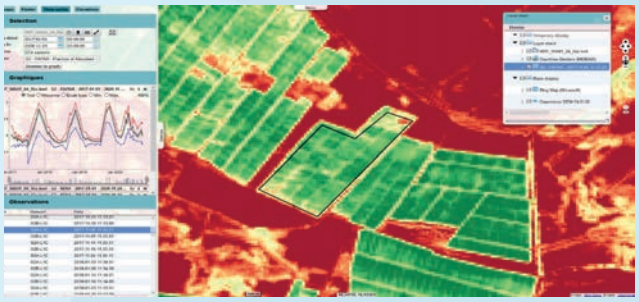
Climate variables (rainfall,etc.) help distinguish between rainfed and irrigated crops

Answers provided by the MISBAR platform

www.misbar.oss-online.org

Multi-scale time-series analysis

Geoservices customization



Data processing relay

Intuitive access to a very wide range of EO data

Systematic production

- Irrigated area maps at monthly basis
- Crop water consumption estimation
- Agricultural crop areas at monthly basis
- Agrometeorological variables (rainfall, etc.)
- Crop monitoring at the parcel / district levels

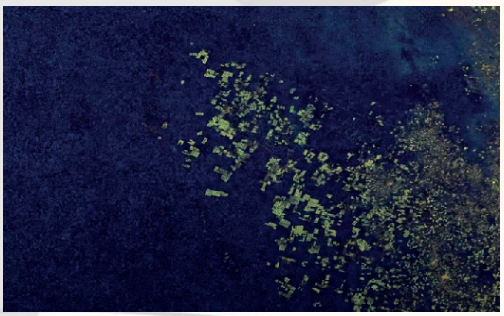
Non-Systematic production

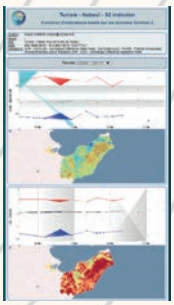
- Unauthorized private irrigated perimeters
- Public irrigated areas intensification rate
- Quantified pressure on groundwater resources
- Crop maps
- Yields forecast

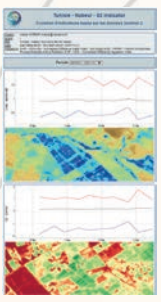
MISBAR main functionalities

- Easy and intuitive access to EO data
- Interactive 2D / 3D visualization
- "Finder" service
- Processing chains for optical and radar image processing
- Views and studies sharing through a simple link
- Time-series analysis of 16 indicators related to water and agriculture
- Easy GEOSERVICES setup, for automatic and real-time application

Responsive design







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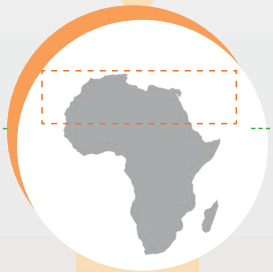
MISLAND

Monitoring Integrated Services for Land Degradation

North-Africa Consortium needs

Needs

- How much forest area is lost due to forest fires?
- Where are my vegetation loss /gain hotspots ?
- Can we monitor urban extension over agricultural lands ?
- Where are my land degradation hotspots?
- Are we achieving land degradation neutrality?
- How does my forest evolve over time? Risk ? Vulnerability?



Capitalization of experiences in North-Africa with respect to land degradation monitoring

End-users needs assessment (national studies, meetings, etc.)

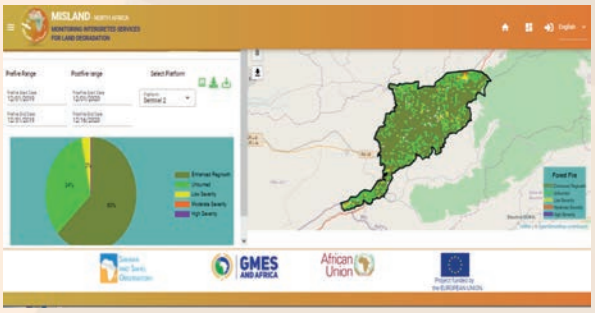
North-Africa specific context (climate, vegetation, etc.)

- SDG 15.3.1 Indicator (land degradation neutrality) according to UNCCD guidelines
- Kit of Indicators to support and complement SDG 15.3.1 indicator
- Integration of high resolution datasets (Landsat 30m and Sentinel-2 10m) to capture a more accurate picture of land degradation / restoration

Answers provided by the MISLAND platform

www.misland.oss-online.org

- Vulnerability to desertification (MEDALUS)
- Forest fire risk assessment
- Assessment of land susceptibility to wind and water erosion



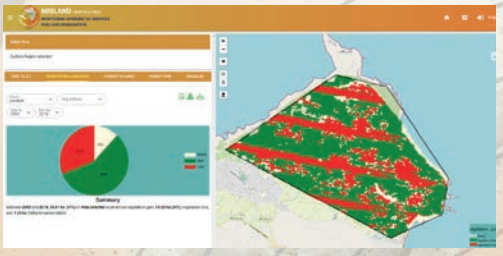
- Assessment of forest carbon emissions
- Evolution of forest cover
- Vegetation loss/gain trends
- Burnt areas quantification
- Assessment of coastal erosion

+Crash courses on the MISLAND use
(+ 12 sessions + 1 000 trained)

MISLAND ADDED-VALUE - NORTH AFRICA

- Disseminates simplified information for decision making, and customizable resources for technical experts
- Guides policies and decisions (design/implementation) in North-Africa and monitors SDGs (especially 15.3.1)
- Integrates Kit of indicators for land degradation / restoration assessment, suitable for the North-Africa context
- Integrates high spatial resolution data (10m, 30m)
- Dynamic feedbacks from end-users : iterative loops for MISLAND operationalization and ownership
- Involves the Joint Research Commission (European Commission) in algorithms reviewing and optimization, training kit (video recording of sessions, online training materials, etc.)

Responsive design



Intuitive, interactive and easy to use

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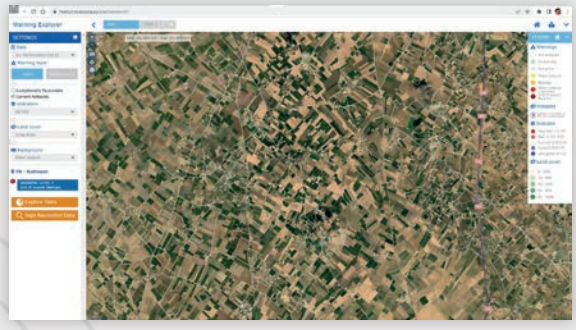
GUETCROP

CROP MONITORING AND EARLY WARNING IN NORTH-AFRICA

A multi-dashboard service for agriculture monitoring and better decision making

GuetCrop is a Decision Support System which provides timely early warning information on agricultural production based on Earth Observation and agro-climatic data.

It is an open access and easy to use online platform composed of 2 main environments:

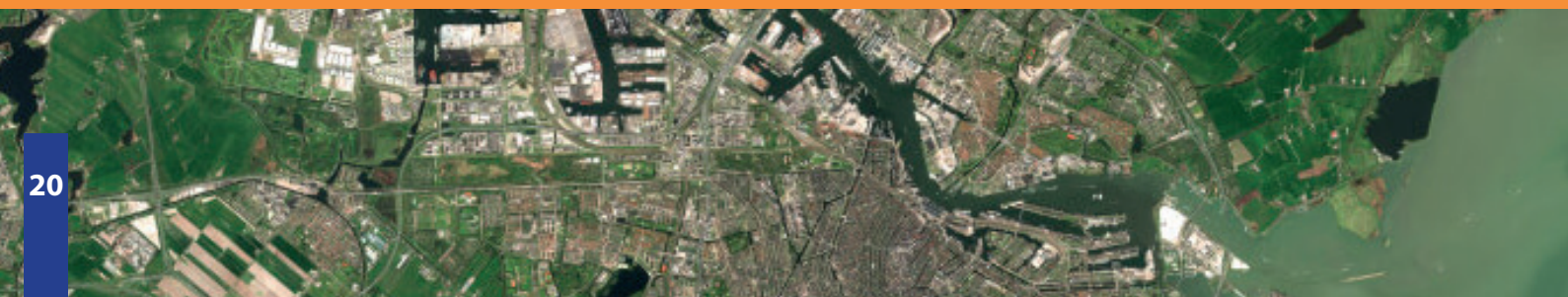


The Warning Explorer | A web-GIS for visualizing automatic warnings, agriculture-relevant global indicators and a dashboard showing statistics aggregated at the first sub-national administrative level

The High-Resolution Viewer | A user-friendly interface serving high spatial resolution data (Copernicus Sentinel-1 and Sentinel-2) which can be easily visualized and processed to provide real-time information at the local level

Guetcrop *is the fruit of a close collaboration between the European Commission Joint Research Center (JRC) and the North Africa Consortium within the framework of GMES&Africa.*

The platform is inspired from the Anomaly hotSpots of Agricultural Production (ASAP) tools.



Why GuetCrop?

GuetCrop provides EO-based maps, interactive graphs and statistics:

- To support various stakeholders in early detecting and preventing food security crises.
- To plan and undertake necessary actions to respond to these security crises.

Who are the end users of this service?

- GuetCrop informs national services on the status and conditions of crops and rangeland in near real-time, and contributes to support crop import & agriculture/water management services in better planning their activities.

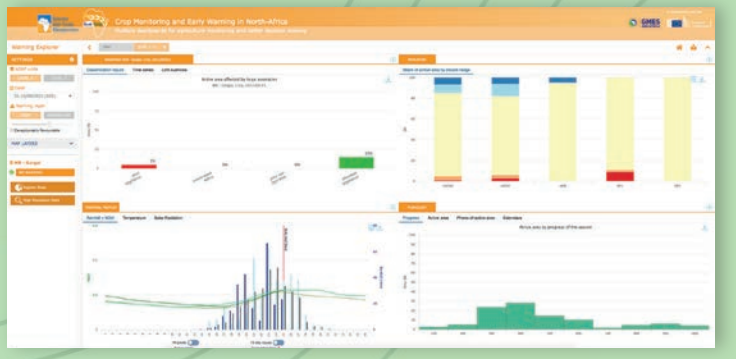
GuetCrop is targeting audiences from 3 main groups

- North-African decision-makers
- Agriculture, Water & natural resources managers
- General & public users

Improvement and dissemination

- A synergic approach was set up to elaborate a scientific paper which highlights the improvements newly implemented in ASAP and GuetCrop systems to keep it synchronized with the users' needs.

- Free online decision support system for early warning about hotspots of agricultural production anomaly
- Operational system that provides automatic 10-day warnings



- Near real-time information on crop growing conditions Multi-scale analysis

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Capacity building is one of the pillars of GMES&Africa

The North Africa Consortium is aware of the fundamental role of capacity building actions for the proper ownership and effective use of Earth Observation products and services.

Particular attention was paid to building the capacities of national partners and end users according to their needs.

What is the reinforcement capacities by GMES & Africa

The interest of partners and participants from different backgrounds and geographical areas in Africa is a living proof to the success of the strategy and action plan put in place and implemented by the Consortium.

The strategy and action plan used by the Consortium to improve and build the capacities according to different audiences

Training of trainers

04 training

- OT for agricultural monitoring
- OT for monitoring water withdrawals
- OT for restoration / evaluation land degradation
- OT for prediction yields (JRC-EC)

Target

Regional and national EO experts and national remote sensing agencies
The new trainers will be responsible for training end users and duplicating training at their level.

Results

04 training sessions organized

+200 trainers trained

Training on the use of services

Responsible : the OSS and the private sector in charge of the services developing

Target

National and regional partners and various end users

Results **+2100** trained users

Training on administration and maintenance of the services

Responsible : the OSS and the private sector

Target

IT and thematic experts, including Consortium partners

Results **+30** trained

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What is the long-term vision

Improving the decision-making process, by providing Earth Observation information, to reach a sustainable management of natural resources!

Launched in March 2022, the second phase of GMES&Africa was initiated based on the experiences and lessons learned from the first phase, taking into account feedback from end users and key stakeholders.

It will mainly build on the achievements and accomplishments of the first phase in terms of EO derived operational services in support of the sustainable management of natural resources, in compliance with the national policies and strategies of the North African countries.

Optimization of the potential and process of continuous production of information in support of sustainable land and water management in the following areas:

- The ongoing awareness of stakeholders and decision-makers
- The coordinated and effective management of information and data
- Ownership of the products, platforms, and services developed within the project framework
- The integration of updated EO data and information in natural resources management processes and political planning strategies.

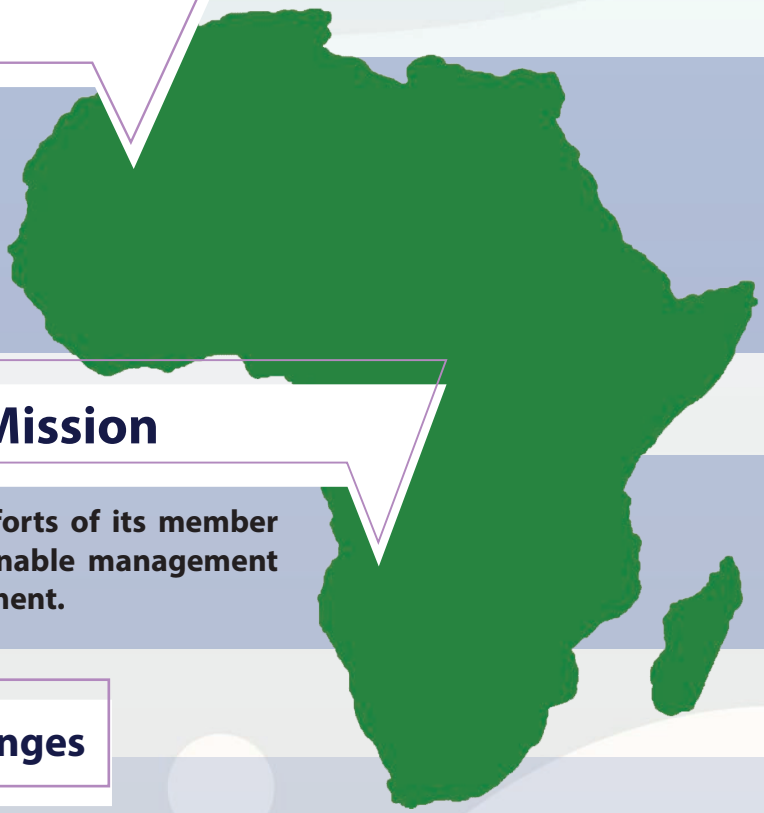
Training, information, and awareness are based on a concrete and evolving need. This results in the sustainable use of products and services arising from the project. Indeed, maintenance and updates are ongoing and will be ensured by the OSS.

The Sahara and Sahel Observatory

Created in 1992 and based in Tunis (Tunisia) since 2000, the Sahara and Sahel Observatory (OSS) is an international scope organization with an African vocation.

Action area

The Sahara and Sahel Observatory operates in the arid, semi-arid, sub-humid and dry zones of Africa. The main topics covered relate to the **(Water, Land, Climate and Biodiversity)** challenges facing the continent.



Mission

The mission of the OSS is to support the efforts of its member and partner countries in the areas of sustainable management of natural resources and sustainable development.

The 2030 strategy, the main challenges

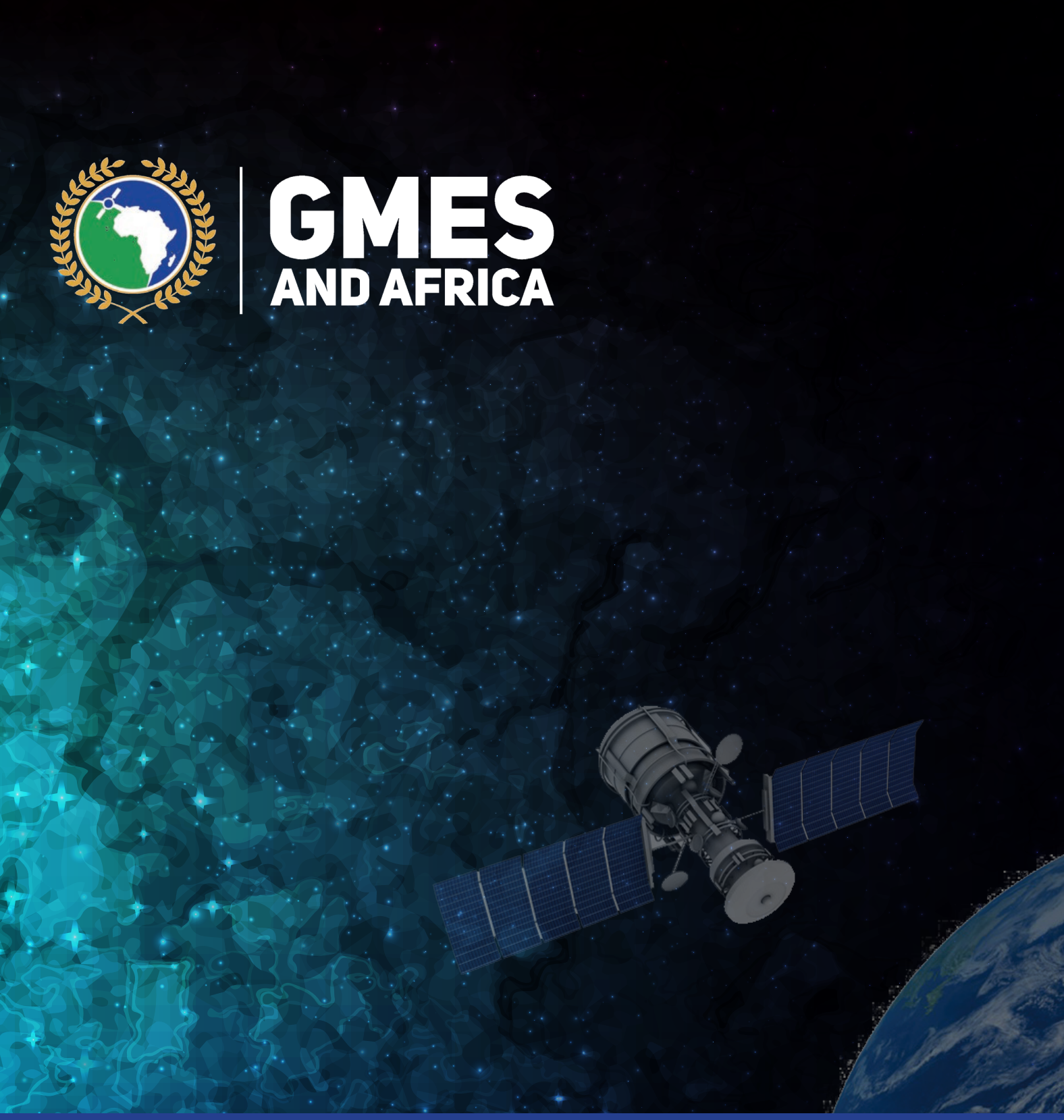
- La sécurité hydrique
- La promotion et le suivi des efforts d'aménagement, la conservation et la restauration des sols
- La gestion des risques climatiques
- L'accès à la finance climat
- La prise en compte de la biodiversité dans les stratégies nationales et régionales
- L'amélioration de la circulation de l'information
- Le transfert de connaissances
- L'inclusion du genre

33 Member States:

- **26 African countries:** Algeria, Benin, Burkina Faso, Cameroon, Cape Verde, Côte d'Ivoire, Djibouti, Egypt, Eritrea, Ethiopia, Gambia, Guinea-Bissau, Kenya, Libya, Mali, Morocco, Mauritania, Niger, Nigeria, Uganda, Central African Republic, Senegal, Somalia, Sudan, Chad, and Tunisia.
- **7 non-African countries:** Germany, Belgium, Canada, France, Italy, Luxembourg, and Switzerland..

13 Member Organizations:

GMES AND AFRICA



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