au service de l'Afrique
serving Africa

AfriCultuReS

Enhancing Food Security in AFRIcan agriCULTUral Systems with the Support of REmote Sensing

Earth Observation for food security in Africa

Earth Observation for food security in Africa - Policy brief/OSS. _ 26p. _ Tunis, August 2022. _

ISBN : 978-9938-933-34-5

AfriCultuReS – Enhancing Food Security in AFRIcan AgriCULTUral Systems with the Support of REmote Sensing. Horizon 2020 - https://cordis.europa.eu/project/id/774652

Sahara and Sahel Observatory - OSS

AfriCultuReS Project
Enhancing Food Security in AFRIcan AgriCULTUral Systems with the Support of REmote Sensing

Earth Observation for food security in Africa

Policy brief

August 2022

Contributions

The present policy brief was developed as part of the AfriCultuReS project, funded by the European Union (H2020), and was produced under the supervision of Mr. Nabil Ben Khatra, Executive Secretary of the Sahara and Sahel Observatory and Mr. Mourad Briki, Watch and Prospective Department Coordinator.

Mr. Louis Evence Zoungrana, the AfriCultuReS project Supervisor was in control of the book editing. He was assisted by Mr. Mustapha Mimouni, Head of the Remote Sensing & GIS Unit, Mr. Amjed Hadjtaieb, Remote Sensing & GIS Expert and Mrs. Kaouther Hamrouni, Biodiversity Expert.

Mrs. Nadia Khammari, Mrs. Lilia Benzid, Mrs. Leila Bennani, Mrs. Asma Ghiloufi, Mrs. Alia Ben Attia and Mr. Ahmed Ben Salah from the OSS Communication Department made a contribution to the release of this book. Mrs. Olfa Othman, helped with the design, iconography and publication monitoring.

We would like to thank all those who have taken part in the production of this work.

Earth Observation for food security in Africa - Policy brief/OSS. _ 26p. _ Tunis, August 2022. _

ISBN : 978-9938-933-34-5

AfriCultuReS – Enhancing Food Security in AFRIcan AgriCULTUral Systems with the Support of REmote Sensing. Horizon 2020 - https://cordis.europa.eu/project/id/774652

Table of contents

Foreword....4
Agriculture at the heart of an operational strategy for food security in Africa....6
Agriculture : a major component of Agenda 2063 and the SDGs....7
Remote sensing and agriculture : an integration that needs to be boosted in Africa....10
Production of useful information for agricultural monitoring....10
Benefits of remote sensing....11
Causes limiting the use of remote sensing in agriculture....13
How to take full advantage of remote sensing in agriculture....16
AfriCultuReS, the project....17
Challenges and prospects for a better valuation of remote sensing by the African public authorities and national organizations....21
Recommendations....22
Bibliography....24
Webography....25

Foreword

Agriculture and food production systems are facing substantial challenges due to climate change, land and water availability and, more recently, the Covid-19 health crisis. These elements put the environmental and economic stability of current and future food supply systems at risk. Thus, scientific and technological innovations are more necessary than ever to make sure sufficient food is available for a rapidly growing world population.

Agriculture is a great job creator and income generator. That is fairly enough to make all efforts to have this sector and natural areas protected and make sure that it remains prosperous for the sustainable development, the preservation and enhancement of local products.

Remote sensing technologies are an efficient tool for assessment and can act as an early warning system, making it possible for farmers to take timely decisions and address potential problems that negatively impact the crop productivity. With recent advancements in geospatial technologies, data management and analysis, several tools are now available to farmers. However, these technologies are still poorly integrated in the agricultural sector due to the lack of knowledge on their relevance, benefits and implementation.

It is, in fact, crucial to popularize and further promote the results of innovations and progress made in the field of space technologies and Earth Observation. This will make it possible to take full advantage of agricultural innovation and precision agriculture.

The dissemination of remote sensing data, the free access to geospatial applications and the drop in installation costs of geospatial resource acquisition systems in recent years, is a true call to fully use these technologies and make them a top instrument for ensuring food security. By doing so, Africa will be able to improve its agriculture and supply its population.

Africa is undeniably home to large and diverse natural capital and ecosystem resource potential. Now, it is up to us to develop its human performance in the production of geospatial solutions and have them valued for a more efficient management of this natural capital and ecosystems. These solutions must be used for the benefit of sustainable agriculture in order to achieve food security in an environment friendly way. For this to happen, a paradigm shift is needed through capacity building, political will, institutional commitment, public-private partnership and positive feedback.

Developed as part of AfriCultuReS, a regional project funded by the European Union (H2020), this book will contribute to improving knowledge on the remote sensing role and usefulness in agriculture and food security.

This book is addressed to all operators, decision-makers, technicians, representatives of the public and private sector - stakeholders in the African agricultural and related sectors. It is a call to take actions and think of how to better value the remote sensing tool in the production chains of agricultural information and statistics in response to the needs of all stakeholders.

Mr Nabil BEN KHATRA

Executive Secretary
Sahara and Sahel Observatory

Agriculture at the heart of an operational strategy for food security in Africa

According to the United Nations Food and Agriculture Organization (FAO), ending hunger and malnutrition is one of the greatest challenges ahead of Africa. The continent has more than half of the world's unused arable land, yet it remains vulnerable to food insecurity. The number of undernourished people has reached 256.5 million (2017), that is 20% of its population (FAO, 2020). Progress has certainly been made in the area of food security over the last years, yet, it has been uneven across countries and regions of Africa. With respectively 31.4% and 26.1%, the most affected areas are the East and Center of the continent. North Africa's rate fell to 5% (except Sudan).

For many Africans, the ability to access enough, nutritious and safe food declined due to a number of natural disasters and epidemics such as the Idai and Kenneth cyclones, the swarms of locusts in East Africa or the droughts in southern and eastern Africa.

In order to properly contend with the drought, climate change, food insecurity and other challenges, Africa needs to have reliable, early (and spatially referenced) information for good management of natural resources and better practice of sustainable agriculture. In this regard, remote sensing can be a top solution for crop monitoring and production improving.

The use of space and satellite technologies in the agricultural field provides the advantage of quickly collecting reliable information on the state of crops by highlighting spatial and temporal variability and by making it possible to establish a substantial assessment helping take timely decisions and make field actions. A wide variety of satellite imagery as well as the operational tools for having it processed have been disseminated, in order to have the necessary information for decision-making.

However, the potential of remote sensing is still underevaluated and undervalued, which significantly limits its use. The private and public sectors' investments in the development of applications using remote sensing are still lagging behind. Even though an adequate understanding and ownership would contribute to providing suitable responses to the crop growth monitoring, the production forecasting and the need to come up with strategies for agriculture, self-sufficiency and food security.

For a better investment and valuation of Earth Observation resources and products, to reach food security in Africa, it is important to highlight the challenges to be met, the opportunities to be taken and prospects to consider.

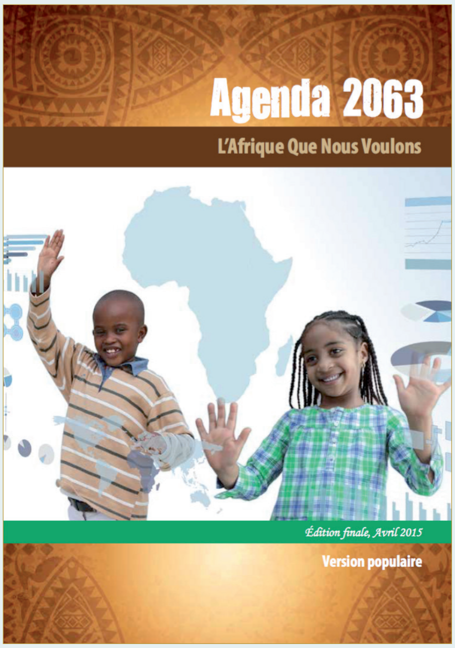
Food safety logo
(FAO, 2020)

Agriculture: a major component of Agenda 2063 and the SDGs

Only a few African countries have managed to achieve sustainable food security, as almost 20% of the African population is prone to mulnutrition (World Bank 2018; FAO, 2020).

Food security is thus one of the mainstays of the African Union (AU) Agenda 2063 and of the 17 Sustainable Development Goals (SDGs) of the United Nations, both adopted in 2015.

Agenda 2063 aims to achieve "A prosperous Africa based on inclusive growth and sustainable development". For this ambition to be achieved, one of the main Goals (Goal - 5) is to develop "Modern agriculture for increased productivity and production". This goal is in line with SDG-2 which calls for "Ending hunger, achieving food security, improving nutrition and promoting sustainable agriculture by 2030".



Agenda 2063 defining key programs and initiatives identified as crucial to speed up Africa's economic growth and development.

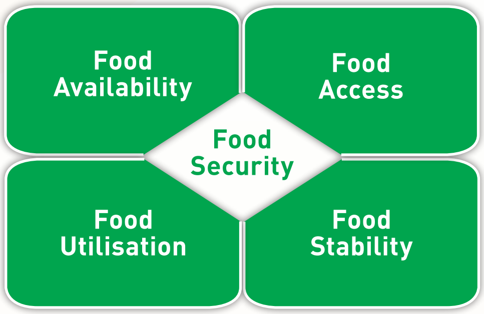
The 17 SDGs, with emphasis on SDG no2 which brings together "hunger, food and nutritional security, sustainable agriculture" in the same Goal

Agenda 2063 and the SDGs

What is food security?

Food security at the individual, family, national, regional and global levels is when all human beings have, at all times, physical and economic access to sufficient and healthy food meeting their energy needs and food preferences to have a healthy and active life. (FAO, Rome Declaration on World Food Security and World Food Summit Plan of Action, 1996. Rome).

Food security is a concept that covers four main dimensions: (i) availability of food in sufficient quantity; (ii) stability of supply; (iii) physical and economic accessibility of food products; and (iv) food quality and safety.



Main dimensions of food security (FAO, 2020 ; Intellivoire, 2015)

The use of remote sensing to strengthen food security in Africa is becoming a must!

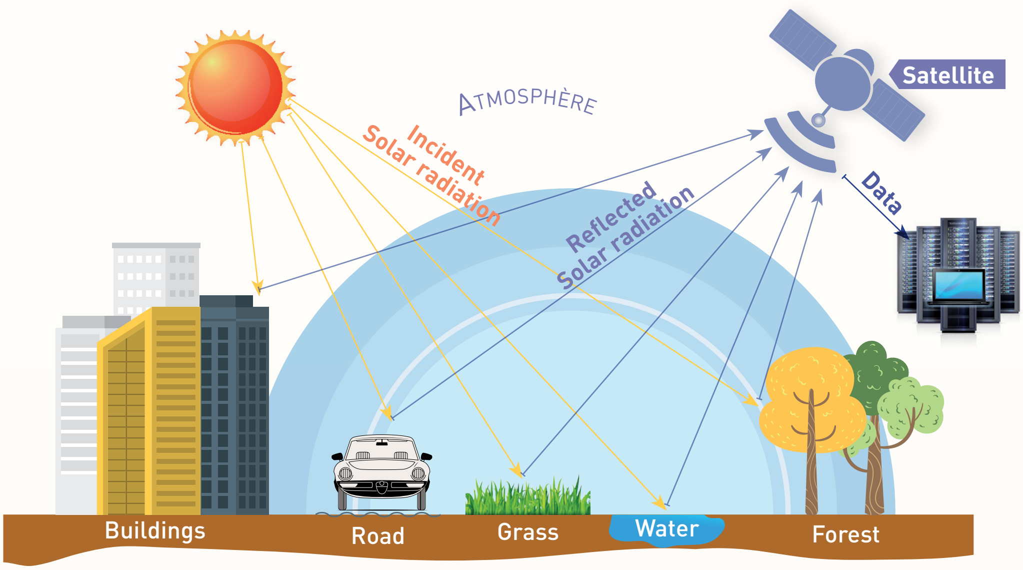
Remote sensing has been used in agriculture since the 1980s, with the establishment of the first Earth Observation satellites. The satellite image is the main resource coming from remote sensing and being the potential source of information for agricultural monitoring. The main benefit of using these satellite images is that they provide a better understanding of the agricultural production and crop features related to current and past agricultural campaigns. As for the crop campaigns in current years, such data helps predict whether they will be "good" or "bad" by comparing them to other seasons or to average situations. There are currently different types of satellite images used at various scales (local, national and regional) for the production of surface biophysical products (data on vegetation indices, evapotranspiration, soil moisture, etc.) and climate products (rainfall, radiation, etc.), making it possible to monitor the vegetation, the water cycle, the energy balance, and the topography identification around the globe (Begué et al, 2006).

Rainfall is usually the main element that impacts the crop development in arid and semi-arid regions and is therefore the first indicator to monitor. The classic techniques used for sensing and monitoring drought conditions are, of course, based on data provided by networks of weather stations. However, these networks proved to be unrepresentative enough and often located in unsuitable areas. This led to the use of remote sensing data to calculate specific indicators including the Vegetation Condition Index (VCI) and the Temperature Condition Index (TCI) ; the good correlation of these two indices with the Standardized Precipitation Index (SPI) having been demonstrated in periods of drought (Beaudin, 2006).

Today, new advances in Remote Sensing make it a key tool for developing a variety of decision support products and services for agricultural policies in Africa.

What is remote sensing?

Also called "Earth Observation", remote sensing is all the techniques that, through the acquisition of images, make it possible to have information on the earth's surface (including the atmosphere and the oceans), without direct contact with it. Remote sensing includes the whole process of receiving and recording the energy of emitted or reflected electromagnetic radiation, processing and analyzing the information it represents, and then having it applied.



Simplified illustration of the remote sensing concept

Remote sensing and agriculture : an integration that needs to be boosted in Africa

Agriculture is more than ever, at the heart of the world's political, economic, societal and environmental challenges. Limited land and water resources, climate change and extreme events are also a serious threat to agriculture and food security.

In order to address these concerns shared by all African countries, it is very important to focus on the production, dissemination and use of reliable, objective and up-to-date information on agriculture.

The appearance of new technological solutions for data acquisition and processing (workstations, storage servers, tablets and mobiles), makes information collection and sharing much easier for agricultural management assistance.

Nevertheless, Africa still suffers from the lack of geospatial information because of the weak synergies between the traditional national statistical systems and the mapping agencies. Besides, non-specialists are still having trouble acquiring satellite data.

In addition, the expertise necessary for the production of successful products and relevant information, requiring the different data sources to be merged, is not available in sufficient quantity. To meet this demand, Africa has become aware of the need to come up with enough technicians, professionals and researchers who have a perfect command of the technology and above all, to develop and maintain applications adapted to its environment.

It is worth noting that today, it has become necessary to overcome the under-use of remote sensing by public agricultural policies in Africa and to carry out awareness-raising actions with universities, governments, development agencies and the private sdector for the benefit of geospatial technologies.

Production of useful information for agricultural monitoring

Over the past decade, governments, international institutions, donors and the private sector have taken renewed interest in agricultural issues in Africa. This interest was led by the pressing need for training, for agricultural campaign-monitoring related decision-making.

The fragile national statistical systems lie behind the lack or inadequacy of basic data. In fact, these systems lack financial and material shortcomings, technical failures, the complexity of the culture and, possibly, the farmers reluctance. They are most often based on conventional methods that generally rely on periodic surveys, so the agriculture statistical data are most often not as reliable as they should be.

The lack of reliable and timely baseline information is thus a real issue that needs to be addressed, and makes it necessary to go for any approach that can streamline monitoring and improve existing systems (Bégué et al, 2020).

Benefits of remote sensing

Comprehensiveness and reliability of remote sensing

Given its ability to observe the Earth at local, regional and global scales from different points, remote sensing is a powerful tool that can help streamline monitoring and improve the existing systems to support decision-making. Despite the complexity of the process that makes satellite imagery data influence agricultural decision-makers, remote sensing remains a highly important technology for the production of geospatial information – going from farm to continental scale - useful for land and agricultural policies.

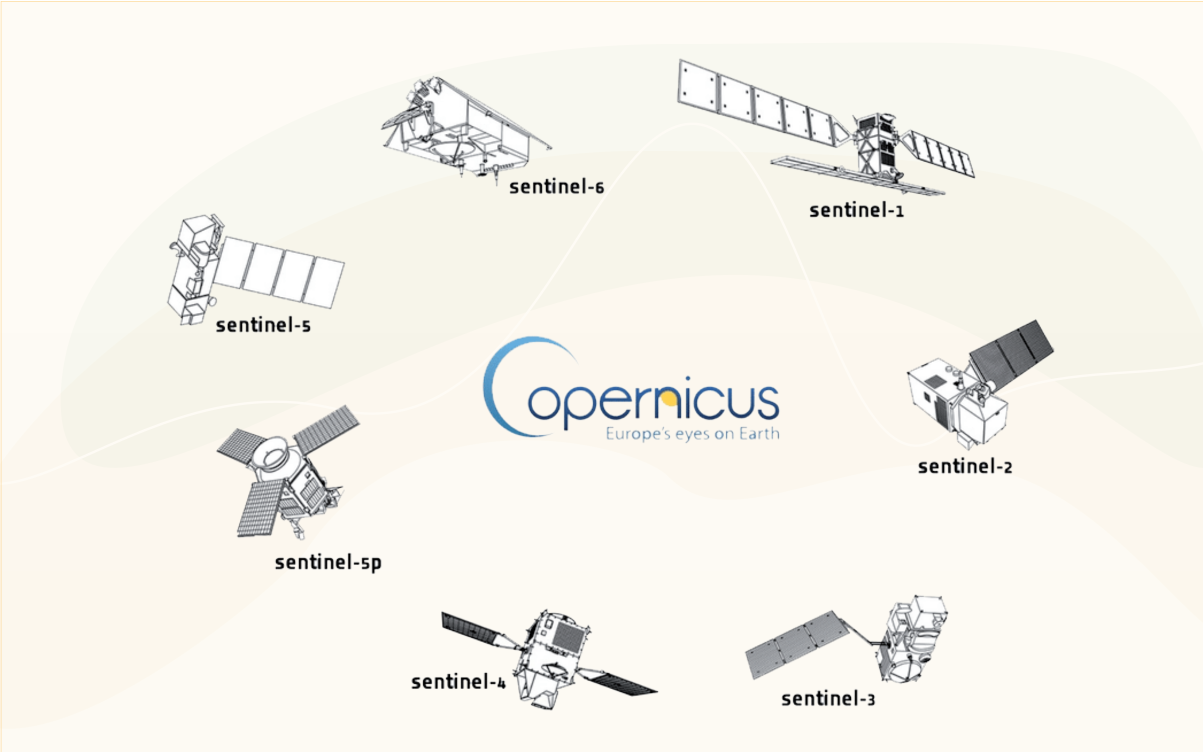
Dissemination of satellite images

The availability of satellite images has very often times been considered to be the main obstacle slowing down the development and enhancement of remote sensing in Africa. Today, these satellite images are being widely disseminated leading to better accessibility. Notwithstanding the existence of several specialized centers, remote sensing remains underused and undervalued, even though it is the most appropriate tool given the benefits it provides in terms of cost and time. These benefits are all the more attractive and important to consider, as the territories to consider, cover vast areas and are rarely the subject of updated mapping data.

The Copernicus program and the Sentinel satellites constellation

Copernicus is the European Commission Earth Observation program around the world. It is implemented in partnership with ESA, EUMETSAT, ECMWF, Mercator Ocean and the Member States. Copernicus is one of the most ambitious Earth Observation programs, providing free and open access to data from a set of dedicated satellites (the Sentinel families) and contributing satellites (existing public and commercial satellites). Since Sentinel-1A was launched in 2014, the European Union initiated the process of placing a constellation of almost 20 satellites to be orbiting before 2030. The program already has six families of satellites:

- **Sentinel 1 -** Day and night radar observation of land and oceans.
- **Sentinel 2 -** Medium-resolution optical observation of land surface.
- **Sentinel 3 -** XS optics, infrared and altimetry observation of oceans and land.
- **Sentinel 4 -** UV spectrometer and IR sounder - study of air pollution.
- **Sentinel 5 -** Study of the air chemistry from the Metop satellite low orbit.
- **Sentinel 6 -** Real-time monitoring of sea and ocean level rise.



Constellation of Sentinel satellites already launched or being launched

Drones: an innovative solution

Since 2014, satellite remote sensing has been accompanied by the appearance of drones for public and commercial use. The use of drones is very popular with farmers in Western countries. Indeed, they provide the huge benefit of being able to overcome the two satellite mapping constraints : cloud cover and the speed of updating. That being said, experts disagree on their relevance, due to major shortcomings in terms of economies of scale. This technology could now be considered as a complementary instrument to satellites and therefore a tool that needs to be prioritized in Africa.

Multiplicity of by-products useful for agricultural monitoring

The main useful products for agricultural public policies, developed via remote sensing can be classified into 3 categories:

- **Base maps,** produced at different scales (from 1:50,000 to 1:200,000) using satellite images of various types and resolutions.
- **Land cover/use maps,** produced at different scales (from national to continental) and regularly updated, in order to monitor changes at land cover units (evaluation, prospective).

- **Bio-geophysical products,** generally covering continental and global scales. These ready-to-use products are classified according to: land use, the state of vegetation (vegetation index, productivity, leaf area index, fires, etc.), the water cycle (rainfall, evapotranspiration, soil humidity, etc.), energy balance (albedo, reflectance and radiation), topography indices, etc.

Causes limiting the use of remote sensing in agriculture

Several causes lie behind the poor valuation of the remote sensing potential and its integration in agricultural monitoring in Africa:

- **The significant spatial and temporal disparity of the cropping systems :** with the exception of Southern Africa, the Maghreb, Egypt and a few West African coastal countries, small-scale agriculture is the most predominant type in Africa (Dixon et al, 2001 ; Samberg et al, 2016). The spatial disparity of agricultural land is often exacerbated by the presence of trees within crop plots (parks in West Africa) and/or intercropping (Félix et al, 2018). Crop-fallow rotation is also widely practiced in small-scale agriculture as a way for restoring soil fertility, but until recently, it was poorly detected by remote sensing (Tong et al, 2020). In Africa, land surface phenology can be difficult to capture, for:
    - **In the humid tropics,** changes in land surface phenology are not related to climate, but to cultivation practices.
    - **In the dry tropics,** the rainy season is short and the crops and the natural vegetation have an almost synchronized vegetative growth.
    - **Mixed cropping systems** may have intercrops with a very short cycle, "scrambling" the primary crop signal. (Bégué et al 2020).
- **Adverse weather conditions :** heavy cloud cover during the rainy season is a major constraint for monitoring rainfed crops that reign over the African cropping systems. Studies (Whitcraft et al, 2015a & b) have pointed out that a 1-3 day revisit period in August is necessary to have 8-day composite images — with 70% of agricultural land under clear sky conditions in Sub-Saharan Africa. The European Space Agency (ESA) Copernicus Sentinel-2 constellation, with a 5-day revisit period, provides an appropriate revisit frequency to cover the entire growing season.
- **The lack of ancillary data, with limited accessibility :** the processing and analysis of satellite images require ancillary data of various kinds : topography, type of soil, climate or agricultural statistics useful for the evaluation of the resulting products. However, the quality and quantity of these resources are sometimes inadequate for a proper assessment of the indicators generated from remote sensing data, as well as the methods that led to their development (Becker-Reshef et al, 2020), besides the disparity of high-resolution satellite archives such as the incomplete galleries of images generated by the Landsat satellite. Moreover, the SPOT satellite imagery galleries are very heterogeneous depending on the region and the periods considered. As for the recently acquired Sentinel-2 satellite images (2015 and 2017), they provide good prospects, particularly in terms of dry season images.

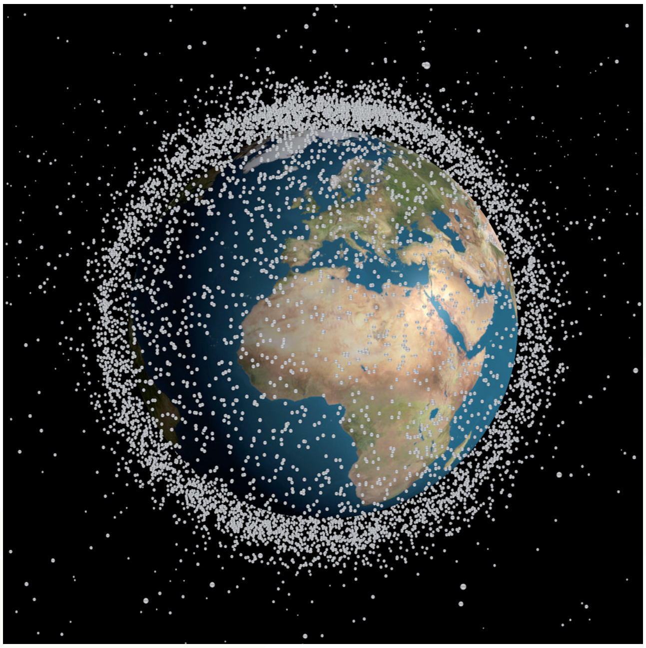
- **Capacity building needs :** the lack of skills is often one of the main constraints to the development of remote sensing tools in Africa.
  It is true that remote sensing specialized centers had some of their managers and technicians trained on the use of this tool, still, all staff members will have to see their skills and knowledge improved, upgraded and updated. It is also important to point out that the training needs of these centers must go beyond the technical side and cover communication and marketing abilities. They must comply with the new needs of potential customers in terms of innovative applications using cloud computing (example of Google Earth Engine : currently one of the cloud computing platforms for processing satellite images and other EO reference), as well as new approaches to marketing and multi-source data and generated information dissemination.

Satellite data : between adequate availability, free access, and the need for powerful processing capacities

More than 780 Earth Observation satellites are currently orbiting and provide data at various spatial resolutions, from 30 centimeters to several kilometers, with multiple revisit periods (hourly, daily, fortnightly, etc.), and varied and complementary spectral bands.

Easy access to satellite data is provided by national and international initiatives that give open access data, such as those of the French Data and Services Center for Continental Surfaces (THEIA), the European Commission with Copernicus, the US National Aeronautics and Space Administration (NASA), etc.

Before, access to images and processing tools was hard to achieve, now, the true challenge is the volume of data to be processed. A first response is provided by computer technologies such as "cloud computing", which give remote access to image computing and processing resources, and by free image processing and Geographic Information Systems (GIS) software. However, these technologies require increasingly sophisticated equipment, knowledge and skills, as well as a good Internet connection. The democratization of access to data and tools is tangible, but their use is linked to a complex and a rapidly-evolving technology.



View of the 7,500 satellites orbiting around the Earth.

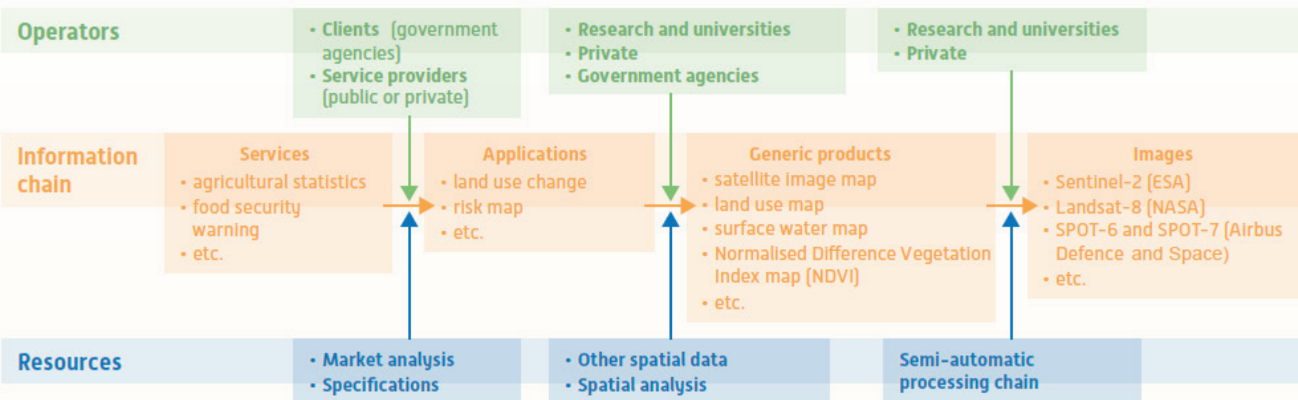
In September 2021, nearly 7,500 satellites were already orbiting, according to the United Nations Outer Space Objects Index defined by the United Nations Office for Outer Space Affairs, UNOOSA).

These satellites belong to governments and private companies and play a variety of roles: GPS for location and navigation, communication (telephone or television signal relay, Internet access), weather forecasting, defense and military, science and agriculture, health, etc.

Focus on some Earth Observation satellites illustrated by the Global Observation System (NOAA Satellite and Information Service).

How to take full advantage of remote sensing in agriculture

- Bridge the gap between the offer of remote-sensing based solutions and the real need for simplified information for decision-makers and end users : despite the implementation of a number of national/regional projects , there is a significant gap between the operational offers in terms of supply of inputs to other fields by remote sensing (environment, weather service, agriculture, etc.) and the demand or expectations of end users.
- Create an environment that is suitable for the development of services that meet the priority needs of the agricultural sector stakeholders. Such an environment must support three main elements: (i) access to images, data and tools, (ii) training and capacity building and (iii) the definition and implementation of national/regional strategies.
- Interact with end users : it is necessary to go for an information product and service co-development approach. For this to achieve, national and regional mapping and remote sensing centers, including the private sector, must put forward a set of activities involving research (to overcome a number of methodological obstacles), the support of intermediate operators and end users (institutions responsible for developing and implementing land management policies, agricultural sector and agricultural producers support structures, etc.).



Process of creating information services based on spatial data using a co-development chain
Source : Tonneau et al 2019.

The identified needs are translated into specifications. For a service to be developed, thematic applications and existing products are adapted or new products are developed, using the generic products of image processing. The co-development process implies a set of adjustments and iterations on the design brief if it proves impossible or too costly to have it fully observed.

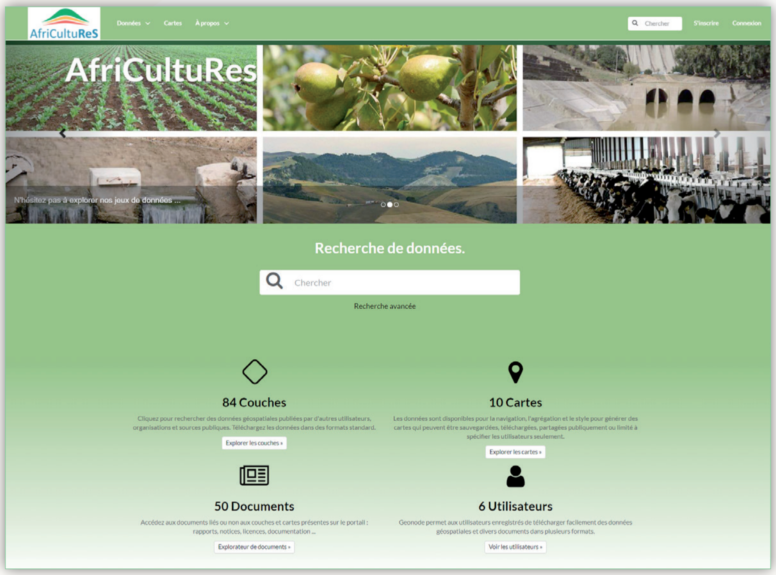
AfriCultuReS, the project

AfriCultuReS *« **Enhancing food security in African agricultural systems with the support of remote sensing** », is a regional project funded by the European Union (H2020). It aims to set up an integrated surveillance and early warning system to support decision-making in the areas of agriculture and food security.*

In Tunisia, the project is jointly implemented by the OSS and remote sensing and research national institutions : the National Center for Mapping and Remote Sensing (CNCT), the National Institute for Research in Rural Engineering, the Water and Forests (INRGREF), the National Observatory for Agriculture (ONAGRI) and the Regional Commissioners for Agricultural Development (CRDAs)

Development of instruments for national institutions

- A 10-m spatial resolution land cover map over the size of Tunisia
- Governorate-scale seasonal maps of crop types
- An agricultural model adapted to strategic crops for production estimate
- A geoportal, interactive mapping services and geospatial databases.



ONAGRI Geoportal

Regional platform for decision support on agriculture in Africa

Remote sensing and land cover

Land Cover Map (LCM) : role and usefulness

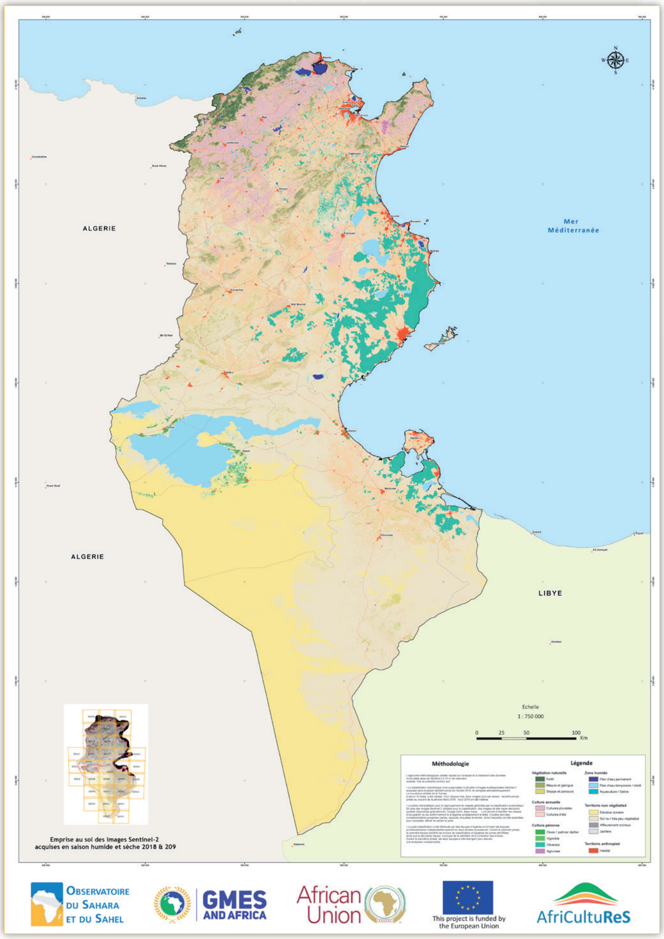
The LCM is a planning support for the strategies and actions to be carried out and a monitoring-evaluation tool of their impacts, it gives an up-to-date vision on the state of ecosystems and their resilience to environmental changes.

The Land Cover Map (LCM) of Tunisia

- *A development approach that optimizes processing time and cost*

  The LCM was developed by the OSS based on Sentinel-2 type satellite images and a methodological approach that combined 2 techniques:
  - Multi-date automatic classification of multi-spectral satellite images.
  - Photo-interpretation for pooling classes generated by automatic classification.
- *Ownership and use cases acquired by end users*
  - Crop identification and statistical information collection.
  - Planning of actions and relay with farmers.
- *Teachings from the development of Tunisia's LCM*

  The appropriate understanding and adoption of remote sensing products and services largely depend on the early strong involvement of the main institutions and users and on the stages of their development and final validation.



Land cover map of Tunisia, 10m resolution

Africa-wide geospatial information management : An action plan of the United Nations and the Economic Commission for Africa

The 2030 Agenda for Sustainable Development (2030 Program), adopted by the UN General Assembly in September 2015, and the Agenda 2063, endorsed by the African Union in January 2015, are both initiatives that emphasize the need for a mechanism to ensure global coordination of geospatial information management.

The United Nations Global Geospatial Information Management Initiative (UN-GGIM), was launched in 2011 by the Secretariat of the United Nations (UN), with a view to establishing a formal mechanism for Member States to review and coordinate their geospatial information management activities. The initiative put forward an action plan for Africa called "African Action Plan for the 2016-2030 period". This action plan should be conducted in four key areas: (i) geospatial information policies and governance, (ii) common framework and tools, (iii) capacity building and knowledge transfer, (iv) international coordination and collaboration in response to regional and global needs.

This action plan also targets a specific field of action: the geospatial and statistical information integration, with a view to providing decision-makers with information products and services which, by relying on national statistical and spatial frameworks, shall achieve the UN Sustainable Development and African Union's Agenda 2063 Goals.

Importance of ancillary and in situ data in agricultural monitoring and food security

Earth Observation makes it possible to perform observations in near real time in a given area. But on its own, it does not have the capacity to accurately foretell certain phenomena such as the agricultural campaigns yield, food production or the water balance in this area.

In order to efficiently meet the complexity of African Earth systems, a variety of ancillary and in situ data must be collected and recorded. In addition, to develop operational products and services adapted to national contexts that best meet the needs of end users, it is important to have in situ data. Example, in order to be able to develop crop growth models in a given area, it is important to have in situ data related to the following points: soils, crop cycles, water needs, extreme performance, etc.

The production and access to ancillary and *in situ* data faces a number of challenges

- The need for funding to carry out field missions.
- As such, carry out awareness-raising actions for decision-makers and project managers on the need to provide (financial and human) resources for regular and continuous *in situ* data collection missions.
- The need to establish inter-institutional synergies between African countries, in order to have in situ data to be collected regularly.
- The need to find alternatives to make the in situ data collection process automated via crowd-sourcing operations.

Challenges and prospects for a better valuation of remote sensing by the African public authorities and national organizations

Challenges to meet

- **Capacity-building of a critical mass of technicians, professionals and researchers,** so that all African countries have a perfect command of EO technologies and benefit from services in line with their socio-economic and geographic environment. For this to happen, the African governments need to invest in initial and vocational training and increase the number and quality of training sessions. Such a capacity building program shall target the majority of national public or private institutions, NGOs stakeholders, etc.
- **The definition and enforcement of national and/or regional geospatial strategies,** to bring together data, human and material investments, and to avoid redundant investments. These strategies can define a regulatory framework for the production and use of geospatial data and information and ensure the technical and economic sustainability of services.

Prospects

Institutional prospects

- Optimize technical skills in remote sensing at the national level, to better guide strategies for its development.
- Strengthen synergies between national remote sensing specialized centers, institutions and stakeholders in the agricultural sector for better consideration of the needs.
- Promote closer collaboration between national and regional remote sensing centers for more sharing of experiences and data.

Country level prospects

- Build the capacities of technical departments of national institutions in the use of the remote sensing tool, when:
  - Mapping strategic crops (subsistence and speculation).
  - Estimating crop yields.
  - Developing agricultural statistics.
- Better equip national institutions with high-performance computing solutions for more efficient handling of large volumes of satellite data.
- Promote innovative technologies such as cloud computing and artificial intelligence.

Recommendations

For better valuation of the remote sensing tool in the production of information and agricultural statistics adapted to the needs of decision-makers and end users, it is necessary to:

- Combine the remote sensing tool with traditional means (surveys, polls, expert opinion, etc.) used by national institutions in their information/statistical data production processes.
- Consolidate the hardware (equipment) and build the technical (expertise) capacities of strategic institutions in the production and use of agricultural spatial data and information.
- Take advantage of the skills and know-how of centers of excellence and regional institutions specialized in the remote sensing product development for the benefit of agriculture (CILSS/AGRHYMET and AFRIGIST in West Africa, RCMRD in East and South Africa, the OSS and CRASTE-LF in North Africa, etc.).
- Promote the partnership and collaboration between the existing space agencies and national mapping centers for a more efficient contribution in the agricultural monitoring spatial data production and management.
- Prioritize the production of annual agricultural maps by national experts, including the private sector, based on remote sensing data, on 1:25,000 and 1:100,000 scales.
- Promote the partnership between the public and private sector for a more effective participation in the production and management of spatial data.
- Integrate the benefits of remote sensing in the monitoring, evaluation and adjustment of country national indicators in order to achieve the food security targets defined in the 2030 and 2063 agendas.

African space initiatives and programs

The African Union, (headquarters in Cairo, Egypt), initiated, in April 2019 the creation of the African Space Agency (ASA) to coordinate the African space strategy. The ASA focuses on four mainstays : Navigation and Positioning, Telecommunications, Earth Observation and Astronomy and Space Science. These components comply with the African Union's Agenda 2063 goals and the roadmap for African development. The ASA will make it possile to establish a common space policy for all African countries. It will also serve as a space for dialogue between international entities and the continent.

The African space industry is experiencing significant growth. In 2019, nearly 41 African satellites were orbiting, launched by South Africa, Algeria, Angola, Egypt, Ethiopia, Ghana, Kenya, Morocco, Nigeria, Rwanda and Sudan. The data provided should make it possible to improve knowledge of the agricultural, forestry and mining resources of each country, but also to contribute to a better contend wih climate disasters.

Acronyms and abbreviations

AfriCultuReS	Enhancing Food Security in AFRIcan AgriCULTUral Systems with the Support of REmote Sensing
AFRIGIST	African Regional Institute for Geospatial Information Science and Technology
AGRHYMET	Regional Training Centre for Agrometeorology and Operational Hydrology
ASA	African Space Agency
CILSS	The Permanent Inter-State Committee for Drought Control in the Sahel
CNCT	The National Center for Mapping and Remote Sensing - Tunisia
CRASTE- LF	Regional Centre for Space Science and Technology Education – in French Language
CRDA	High Commissioner for Agricultural Development
INRGREF	National Institute for Research in Rural Engineering, Water and Forests
FAO	Food and Agriculture Organization of the United Nations
ESA	European Space Agency
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
ECMWF	European Centre for Medium-Range Weather Forecasts
NASA	National Aeronautics and Space Administration
SDGs	Sustainable Development Goals
ONAGRI	National Observatory of Agriculture - Tunisia
OSS	Sahara and Sahel Observatory
EO	Earth Observation
RCMRD	Regional Centre for Mapping of Resources for Development
RS	Remote Sensing
THEIA	French Data and Services Center for Continental Surfaces
UN-GGIM	United Nations Initiative on Global Geospatial Information Management
UNOOSA	United Nations Office for Outer Space Affairs

Bibliography

BEAUDIN, I., 2006. Potentiel de la télédétection pour le suivi et la caractérisation des conditions de sécheresse en milieu méditerranéen. Programme M.Sc. en sciences géomatiques, faculté de foresterie et géomatique, Université Laval.

BÉGUÉ A, Leroux L, Soumaré M, Faure J-F, Diouf AA, Augusseau X, Touré L and Tonneau J-P, 2020. Remote Sensing Products and Services in Support of Agricultural Public Policies in Africa: Overview and Challenges. Front. Sustain. Food Syst. 4:58. doi: 10.3389/fsufs.2020.00058

BERNARD J.P., 2016. Indices de Télédétections et agronomie Application de la télédétection pour la réalisation de diagnostics agronomiques sur peuplement végétal. Agricultures et territoires. Chambre d'agriculture Charente-marine.

DAILLE F., 1991. Cartographie de l'utilisation du sol en Tunisie. Centre de Télédétection, FAO, Rome.

FAO. 2020. L'état de la sécurité alimentaire et de la nutrition dans le monde 2020. Transformer les systèmes alimentaires pour une alimentation saine et abordable. Rome, FAO.

FAO, Déclaration de Rome sur la sécurité alimentaire mondiale et Plan d'action du SMA. Sommet Mondial de l'alimentation13-17 Novembre 1996. Rome.

FAO-AQUASTAT, 2015. Profil de Pays - Tunisie. FAO, Italie.

OSS, 2017. «Atlas des cartes d'occupation du sol » - projet MENA-DELP.

OSS, 2019. « Enquête sur les besoins des utilisateurs finaux – Télédétection » - Projet AfriCultuReS.

OSS, 2019. « Estimations statistiques de la production agricole en Tunisie » - Projet AfriCultuReS.

OSS, 2019. « Systèmes agricoles en Tunisie - Risques socio-économiques » - Projet AfriCultuReS.

OSS, 2020. « Modélisation de la croissance des cultures (du blé) » - Projet AfriCultuReS.

Pissaloux, R., 1951. Cartes d'occupation du sol, Tunisie. Bulletin économique et social - Tunisie. N°54

Tsendbazar, N.-E., Herold, M., de Bruin, S., Lesiv, M., Fritz, S., Van De Kerchove, R., et al. (2018). Developing and applying a multi-purpose land cover validation dataset for Africa. Remote Sens. Environ. 219, 298–309. doi: 10.1016/J.RSE.2018.10.025

Tonneau, J.-P., Bégué, A., Leroux, L., Augusseau, X., Faure, J.-F., Mertens, B., et al. (2019). "Geospatial information for African agriculture: a key investment for agricultural policies," in Perspective 51, eds P. Caron and C. Fovet-Rabot (Montpellier: CIRAD), 3.

UNECA (2017). Geospatial Information for Sustainable Development in Africa - African Action Plan on Global Geospatial Information Management 2016-2030. Addis Ababa: United Nations Economic Commission for Africa, (UNECA).

Webography

https://www.eo4idi.eu/news/eo4sd-world-bank-agricultural-productivityagricultural-watermanagement-and-sustainable-land

http://africultures-platform.eu/

http://www.africultures.eu/

https://cropmonitor.org/

https://www.copernicus.eu/

http://gmes4africa.blogspot.com/

http://eo4sd.esa.int/

https://servirglobal.net/

http://www.snv.org/project/stamp-building-success

http://www.snv.org/project/mobile-data-moving-herd-management-andbetter-incomesmodhem

https://www.france24.com/fr/20191220-l-essor-de-l-industrie-spatiale-africaine-une-chance-pour-le-d%C3%A9veloppement-du-continent

https://au.int/sites/default/files/treaties/36198-treaty-statute_african_space_agency_f.pdf

https://www.lemonde.fr/economie/article/2019/04/26/l-afrique-a-la-conquete-de-l-espace_5455038_3234.html

https://www.nesdisia.noaa.gov/globaleocoordination.html

Earth Observation for food security in Africa - Policy brief

Agriculture is a key contributor to food security and the economy in Africa. In a context of climate change and variability, accurate, early and spatially referenced agricultural information, has become vital for decision-making.

Their production and dissemination is a real challenge that the relevant authorities must take on in order to provide the various stakeholders (decision-makers, planners, researchers, producers, exporters, etc.) with reliable agricultural data and information.

The UN 2030 Agenda for Sustainable Development and the African Union's Agenda 2063 have both shown the need to value geospatial technologies and Earth Observation in order to have reliable information at various scales and at lower cost. The efficient integration of geospatial technologies in decision-making processes depends on the analysis of the challenges, opportunities and prospects likely to make African countries invest more in Earth Observation.

ISBN : 978-9938-933-34-5

Boulevard du Leader Yasser Arafat
P.O. Box 31 1080 Tunis Carthage, Tunisia
Phone: (+216) 71 206 633/634
Fax: (+216) 71 206 636
Email: boc@oss.org.tn
www.oss-online.org

@OSS_Comms
@osscommunity
@company/osscommunity