

# → E04SD – EARTH OBSERVATION FOR SUSTAINABLE DEVELOPMENT

**Agriculture and Rural Development Cluster**

**Final Report 2019**



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**Cover image** Multi-temporal NDVI image of agricultural fields over San Juan in Bolivia as seen by the Copernicus Sentinel-2 satellite. Each colour on the image represents a variation in crop and growth stage.

Credit: E04SD Agriculture and Rural Development cluster

**Infographic image** Multi-temporal NDVI image of agricultural fields over Oulad Gnaou in Morocco as seen by the Copernicus Sentinel-2 satellite. Each colour on the image represents a variation in crop and growth stage.

Credit: E04SD Agriculture and Rural Development cluster

## 8 THEMATIC AREAS

1. Agriculture and ecosystem services
2. Food security and agricultural risk management
3. Irrigation
4. Land degradation
5. Agricultural production
6. Rural infrastructure
7. Impact of commodities
8. Environmental and social safeguards

## 9 GEOGRAPHIC AREAS

1. Sub-Saharan Africa
2. Uganda
3. Ethiopia
4. Cambodia
5. Burkina Faso
6. Bolivia & Paraguay
7. Syria
8. Morocco
9. Great Green Wall



## THE ECOSYSTEM OF → E04SD – EARTH OBSERVATION FOR SUSTAINABLE DEVELOPMENT



*AIM: to achieve progressive uptake of satellite-based environmental information in the planning and implementation of development projects, programmes and activities of Multilateral Development Banks and their respective client states.*

## STAKEHOLDER ENGAGEMENTS ~60

- 10 Capacity Building events
- 5 InfoSessions for the World Bank, IFAD and ADB
- 3 E04SD side-events at large conferences

OVER 40 STAKEHOLDER INTERACTIONS TO INCREASE UPTAKE OF EO INFORMATION IN THEIR PROJECTS.

### + PARTICIPTED AT VARIOUS EVENTS GLOBALLY

- WB Land and Poverty Conference, 2017 & 2018 & 2019
- GEF IAP Food Security workshops, May 2018 in Kenya, March 2019 in Ghana
- Asia Water Forum, 2018
- AARSE conference, 2018
- ADB Business Opportunities Fair, 2019
- WB Water Week, 2019
- Geospatial World Forum, 2019
- Living Planet, 2019



## DATA UPTAKE

1. FIELDLOOK
2. LIZARD
3. WORLD BANK DATA CATALOGUE
4. CI RESILIENCE ATLAS
5. ICRAF LANDSCAPE PORTAL

## PUBLICATIONS

- How can Earth Observation support agriculture development in rural areas? (2018) A Better World: Vol. 4, pp. 18-25
- Satellites for Syria: New methods for assessing agricultural production in conflict areas to support productivity assessments, rehabilitation efforts, and (post conflict) assistance (2018) Land Governance in an Interconnected World, Annual World Bank Conference on Land and Poverty, Washington DC
- The sky is not the limit: Satellites in support of smallholder farming (2019) Blog post in 2 parts: challenges & opportunities. "What's cooking? Rethinking farm and food policy in the digital age" blog series of the World Bank.
- and many more!



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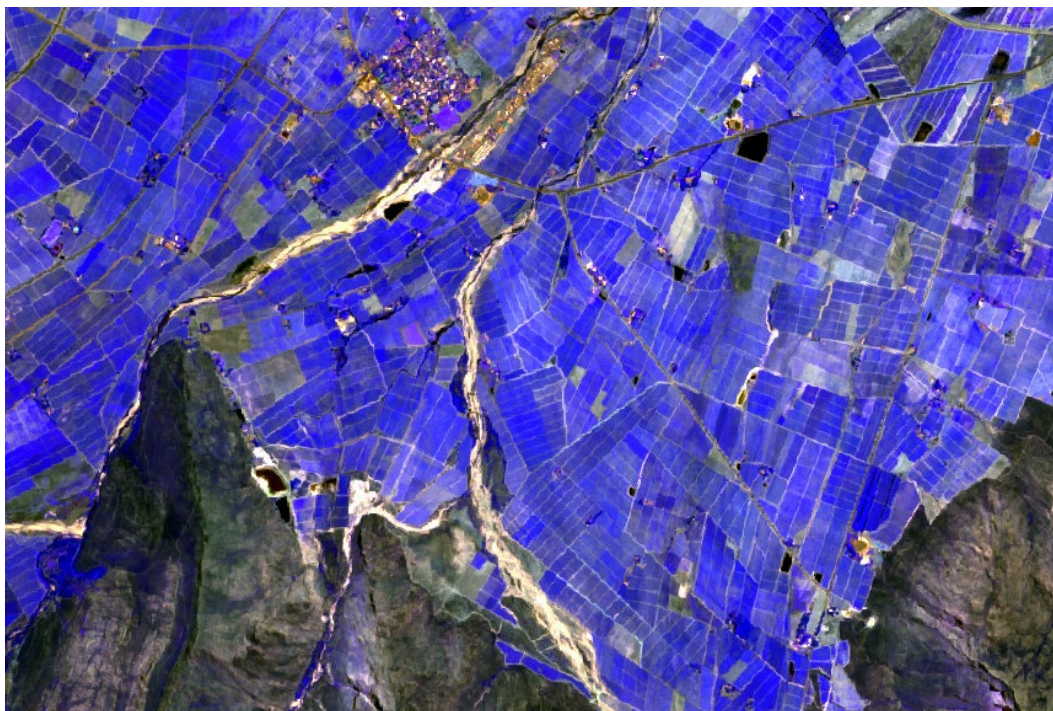


# INTRODUCTION

## International effort to support global sustainable development through Earth Observation for agriculture

Improving the efficiency and sustainability of economic sectors, tackling environmental challenges and fostering societal progress are pivotal in **global development**. Many actors are involved in this endeavour, including the **multilateral development banks** (MDBs) which are international financial institutions (IFIs) providing financial assistance to developing countries in order to encourage and support their **economic and social development**.





**Satellite image** Agricultural fields over South Africa, as seen by the Copernicus Sentinel-2 satellite.

Credit: E04SD Agriculture and Rural Development cluster

Agriculture is critical to the future of sustainable development. Globally, the entire sector is required to produce approximately 56% more food by 2050<sup>1</sup> to feed nearly 10 billion people. All while the environmental sustainability of intensifying production in this sector is scrutinised.

Agriculture currently accounts for 70% of global freshwater withdrawals<sup>2</sup>. Together with forestry and other land use processes, agriculture emits about a quarter of all global greenhouse gases<sup>3</sup>. Some farming practices may also have negative consequences on water quality and impact biodiversity through land clearing and habitat fragmentation.

The central question on the future of global sustainable development is therefore, **how can the expected vast increase in food and agriculture commodity supply be achieved in a sustainable way?** Most of the increase in food production may need to come from greater land and water productivity as well as expansion of arable and irrigated areas. Also, the positive and negative impact of farming systems and rural development need to be addressed.

To do so, governments and development agencies need to **improve agricultural sector diagnostics, development indicators, programme monitoring and service delivery**. This requires access to unbiased quantified information at a large scale. This is now increasingly available because of the **advancements in satellite technology**, such as data obtained from **Copernicus**, the Earth Observation programme of the European Union. Combining EO data with sophisticated analytics, information and other support tools allows decision and policy makers to make more **well-informed decisions** because they now have data at **scales, resolution and frequencies previously unavailable**.

Since 2008, the **European Space Agency (ESA)** has worked closely with MDBs and their client states to **harness the benefits of Earth Observation (EO) in global sustainable development**. EO is an irreplaceable tool that provides large-scale, high quality and unbiased data on the physical, chemical and biological systems of our planet. EO data and information can measurably enhance the quality of interventions and financial investments **in the context of global development initiatives**.

1 WRI, 2019. [Creating a sustainable food future. A menu of solutions to feed nearly 10 billion people by 2050](#). World Resources Report.

2 FAO, 2017. [Water for sustainable food and agriculture. A report produced for the G20 Presidency of Germany](#).

3 US Environmental Protection Agency (EPA) [Global Greenhouse Gas Emissions Data](#).



**Satellite image** Agricultural fields over South Africa, as seen by the Copernicus Sentinel-2 satellite.

Credit: E04SD Agriculture and Rural Development cluster

In 2016, ESA launched an initiative: Earth Observation for Sustainable Development (E04SD) with the aim of achieving **progressive uptake of satellite-based environmental information** in projects, programmes and activities of the MDBs and their client states. The E04SD initiative concentrated on thematic areas: agriculture and rural development, water resources management, urban development, climate resilience, disaster risk reduction, marine resources, fragility, conflict and security and Eastern European region.

The E04SD Agriculture and Rural Development Cluster is represented by ESA and a consortium of **eight** organisations specialised in satellite data services, data integration, capacity building and communication. Over three years, from 2016 to 2019, the consortium **demonstrated** how EO-based information and services support agricultural monitoring and management tasks. The consortium also **built capacity** of the project's stakeholders to use satellite imagery for their projects. The consortium included:

- **eLEAF** (the Netherlands, project coordinator and EO service provision)
- **Satelligence** (the Netherlands, EO service provision)
- **Nelen&Schuurmans** (the Netherlands, data integration)
- **ITC** (the Netherlands, capacity building)
- **GeoVille** (Austria, EO service provision)
- **DHI GRAS** (Denmark, EO service provision)
- **Lahmeyer International** (Germany, stakeholder engagement)
- **SpaceTec Partners** (Belgium, promotion and communication).

To facilitate the uptake of this technology within the IFI's, the E04SD Agriculture and Rural Development Cluster demonstrated many of the **benefits of EO-based geoinformation products and services**. The demonstrations showed how EO-based products and services support the entire project cycle of agricultural sustainable development projects.



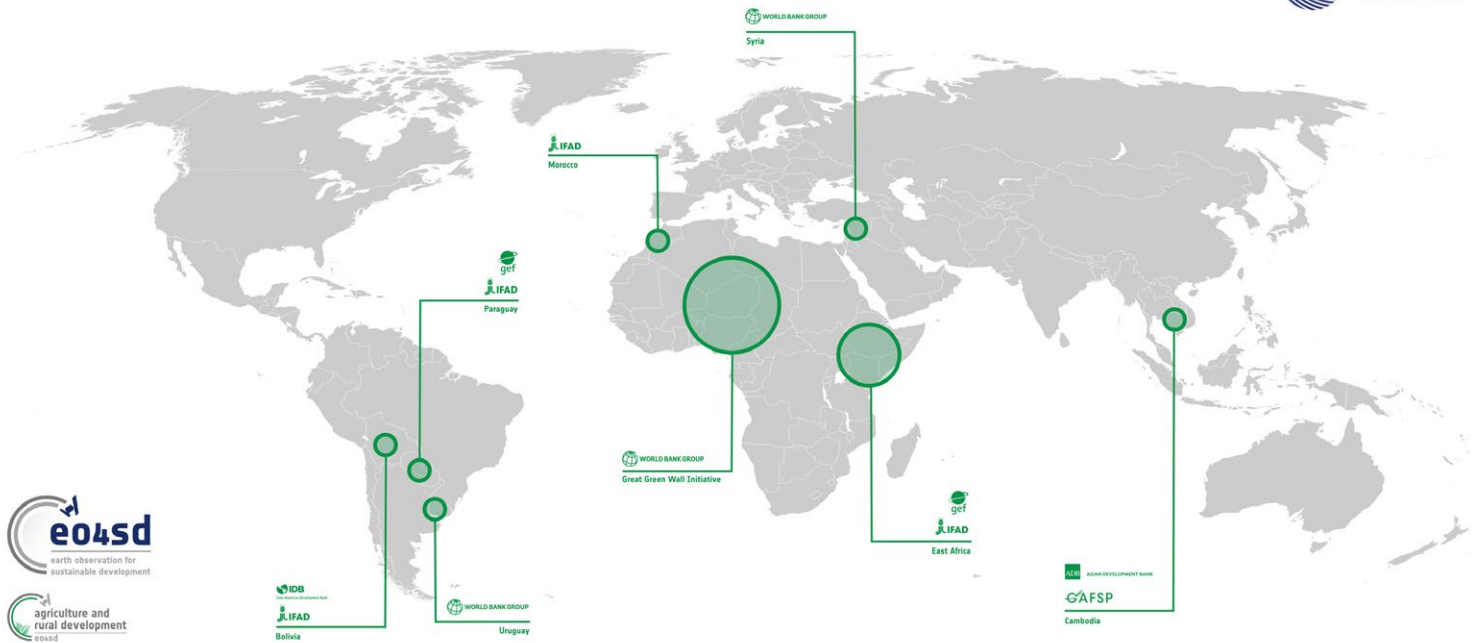


## The results of three year work of E04SD Agriculture and Rural Development cluster

To showcase how EO-based information and services can measurably enhance the effectiveness of the MDBs' investments addressing agricultural and rural development challenges, the Agriculture and Rural Development cluster **collaborated with various international financial institutions** such as the International Fund for Agricultural Development ([IFAD](#)), the Global Environment Facility ([GEF](#)), the World Bank Group ([WBG](#)), the Inter-American Development Bank ([IADB](#)) and the Asian Development Bank ([ADB](#)). **Several local partners and international institutions** contributed to the demonstrations, for instance ministries and governmental agencies working in the areas of agriculture, water and environment; [Conservation International](#), [World Agroforestry \(ICRAF\)](#), [the Sahara and Sahel Observatory \(OSS\)](#), the United Nations [World Food Programme](#), [Food and Agriculture Organisation \(FAO\)](#), and others.

The demonstration was conducted within the context of MDB projects in:

- **Africa** ([Ethiopia](#), [Burkina Faso](#), [Uganda](#), [the Great Green Wall region](#)),
- **North Africa** ([Morocco](#)),
- **Latin America** ([Bolivia and Paraguay](#)),
- **Asia** ([Cambodia](#))
- **Middle East** ([Syria](#)).



The E04SD Agriculture and Rural Development demonstration successfully **identified the needs and requirements of IFIs and their client states**, this served as the basis for the demonstration products and services. The knowledge transfer resulted in **excellent relationships between the demonstration partners and their stakeholders**: from the field up to the head offices. This sparked a wide recognition of the usefulness of the technology, highlighted by the inclusion of EO-derived information in the strategies of the MDBs as presented for example at the World Irrigation Forum 2019 and Business Opportunities Fair 2018 by the ADB. Capacity building materials were made exclusively **to support the transfer of technology and to educate stakeholders** on how to use EO services; from the inclusion of EO capabilities into project and programme terms of references to the background of how satellite images are made.

We are confident that the momentum will continue and IFIs **are stimulated to allocate funds** that would allow their client states to procure EO-based services in support of the IFI's projects.

What further steps and effort would help sustain and multiply the successful results of the project? Over the past three years, E04SD managed to accomplish **a consolidation of requirements and stakeholder engagement** reaching a new level of cooperation between partners. As a result, the E04SD framework has raised significant interest of the IFI stakeholders to continue exploring the long term adoption of EO-based information, including under their own strategic financing. In this context, ESA's **objective to carry out the relevant technical developments and demonstrations** in the future will continue to be supported by the continuing programmatic dialogue with the IFIs to stimulate the development of this new, global user domain.



## What information does this document provide and how can it be used?

This **information package provides** an overview of the state-of-the-art EO-based services that have been demonstrated in the context of the Earth Observation for Sustainable Development (E04SD) initiative of the European Space Agency. This document consists of four parts:

- (1) Description of Earth Observation services relevant for agriculture and rural development
- (2) Description of demonstrations of services performed in several countries located in three continents
- (3) Overview of capacity building material available
- (4) List of service providers and partners.

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USER FEEDBACK:  
MOROCCO



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Mellal province

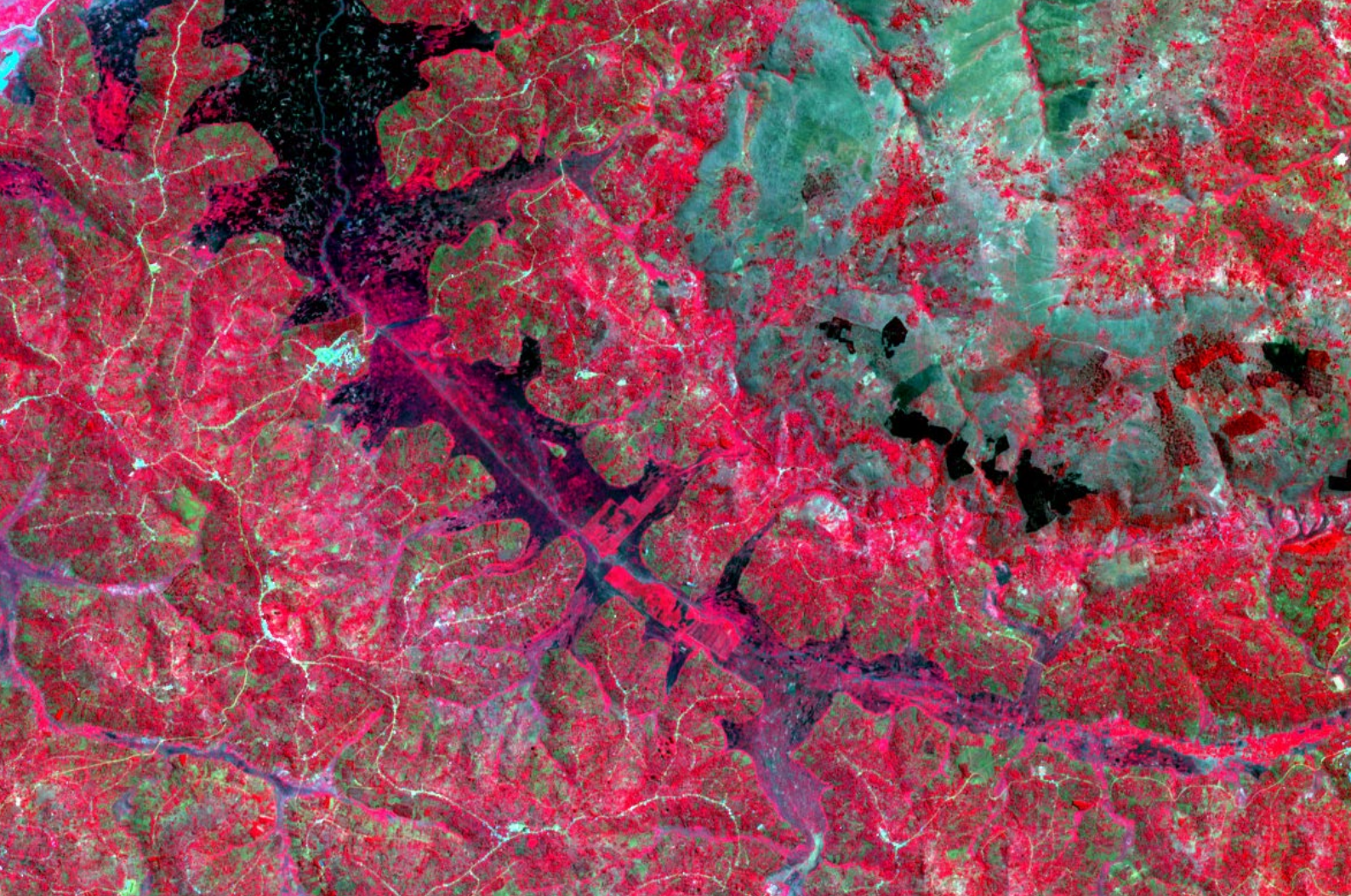
### → E04SD – EARTH OBSERVATION FOR SUSTAINABLE DEVELOPMENT

The E04SD workshop helped us acquire different skills and tools to work on **groundwater resource management** and **irrigation management** in the Beni Mellal area using open source software.

**Informative, very connected,  
interactive!**

**Satellite data and information** have a wide field of application, and they have proven to be **efficient in resource management**, thanks to their performance in geo-referencing or for drip irrigation management.





**Satellite image** Smallholder farming in the Republic of Burundi as seen by the Copernicus Sentinel-2 satellite.

Credit: E04SD Agriculture and Rural Development cluster

# EARTH OBSERVATION SERVICES FOR AGRICULTURE AND RURAL DEVELOPMENT

Agriculture and ecosystem services

Food security and agricultural risk management

Irrigation management

Land degradation

Agricultural production

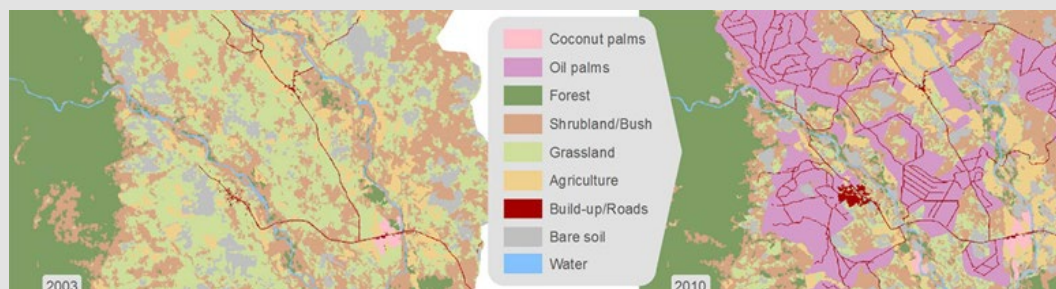
Rural infrastructure

Impact of commodities on deforestation

Environmental and social safeguards







## **Agriculture and ecosystem services**

Understanding the environmental services that the agriculture sector can provide, such as absorbing carbon, managing watersheds and preserving biodiversity, is gaining important momentum in development programmes implementation. Earth Observation data supports integrated ecosystem management by determining the spatial extent and condition of ecosystems, associated trends and changes over time.

### **Agriculture ecosystem mapping and monitoring**



## **Food security and agricultural risk management**

Organisations concerned with food security require timely information on predicted and actual crop production statistics at different stages in time, to assess, for example, the market situation or act upon food scarcity and drought events. Traditional crop statistics are often unreliable or take a long time to be published, making comparisons between systems difficult.

EO services provide valuable information on crop biophysical, soil and climate characteristics, but also on the occurrence, duration and intensity of natural disasters such as heat stress, droughts and floods that strongly influence production statistics for large areas. EO services can be provided globally, also in remote and/or locations that are inaccessible, for example by conflict. Archives store data obtained by satellites as far back as 25 years, allowing historical comparisons and analysis of historical and current trends. The latest EO satellites, such as the EU's Copernicus Sentinel satellites, offer the opportunity to establish an effective, near real-time and large-scale agricultural monitoring system which helps government agencies and international organisations collaborate and coordinate their response.

Another fast growing and accepted application is index based drought or flood insurance, where insurance premiums and indemnity pay-outs are based on a pre-determined index derived from EO data rather than on actual crop and livestock losses. Index insurance is used as a risk management tool in agriculture, food security and disaster risk reduction and helps stabilise income for smallholders when yields are affected by weather.

### **Food Security: early warning, monitoring and understanding**

#### **Index insurance service**



## **Irrigation and irrigation systems management**

Higher food production levels can be achieved with irrigation. Globally, there is an interest for the expansion of irrigated areas or enhancement of irrigation performance through optimising water distribution (rehabilitation of the physical irrigation infrastructure) and by improving irrigation water management (sufficient and timely application).

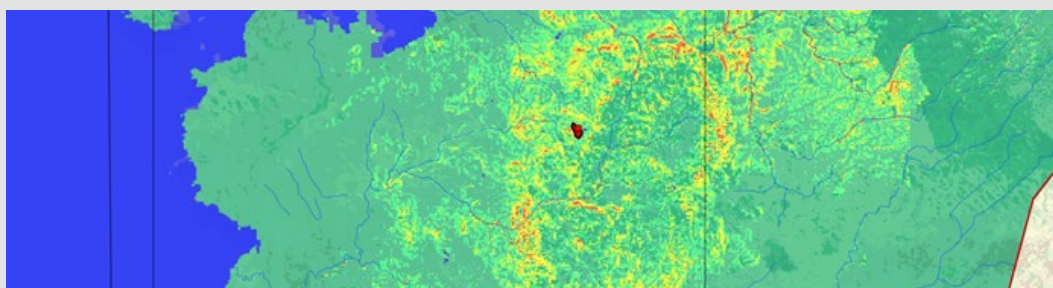
EO services can be used for the exploration of irrigation potential of new schemes (by looking at land suitability, identifying constraints for development and quantifying the impact on the water balance i.e. addressing the water consumption required versus that available, by water accounting); the identification of areas in need of rehabilitation (by assessing irrigation performance, water distribution and water productivity); the operation of irrigation (by providing on- and off-farm tooling for crop required water management, as well as optimising water inputs); assess the efficiency and profitability of irrigation schemes (by quantifying the irrigated area, water consumption, yield and water productivity) and the monitoring of legislation and agreed water rights (by water auditing: a tool that compares actual crop water consumption by transpiration with agreed water permits).

**Irrigation system design**

**Irrigation system operations**

**Irrigation development service**

**Irrigation performance service**



## **Assessing land degradation and environmental condition**

The status, changes and fluctuations of environmental conditions and ecosystem functions can be monitored using EO in a synoptic, continuous and homogeneous way. This can rapidly reveal where change has happened in a consistent and repeatable manner and therefore supports land use planning and natural resource management. EO information can map land degradation status and its drivers, as such can be used to map areas with higher susceptibility of land degradation, for example by soil erosion risk.

**Land status indicators**

**Land degradation monitoring**

**Land degradation assessment**

**Soil erosion mapping**





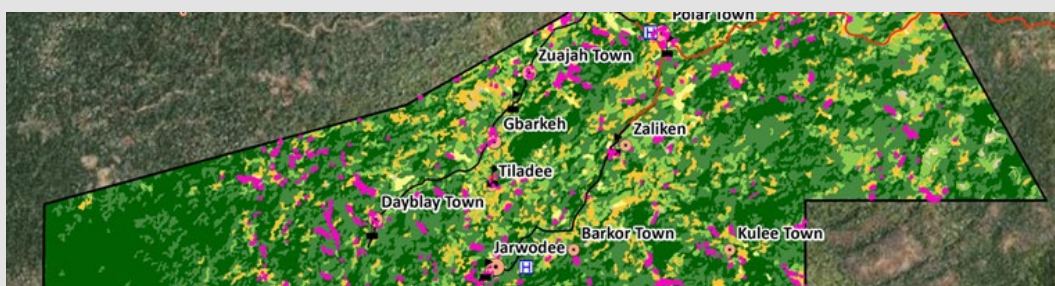
## **Multi-scale monitoring to assess agricultural production**

Satellite Earth Observation (EO) is a powerful technique for continuously assessing the status of agricultural production on a wide range of spatial and temporal scales. It provides historical to current global data on cultivated areas (crop, type, acreage, irrigation supply and other basic crop parameters) and can rapidly reveal where change has happened in a consistent and repeatable manner.

Timely information on crop distribution, status and productivity indicators help to assess the impact of project interventions, assisting the final programme or project evaluation. Near real-time yield prognosis statistical information is used as a tool to optimise production. Information on expected crop yields during a growing season is of great importance to the public and private sector.

### **Agriculture production mapping and monitoring service**

#### **Crop yield prognosis**



## **Rural infrastructure investments**

Sustainable rural development planning requires knowledge on the rural infrastructure assets and physical supply chain structures, such as the road network and other transport infrastructure, storage facilities, markets and irrigation schemes. Further analyses provide information on travel times to markets and other resources or support emergency planning in case of natural hazards, such as floods.

Earth Observation can be used to map rural infrastructure assets and physical supply chain infrastructures such as the road network and other transport infrastructure, storage facilities, markets and irrigation schemes. It supports planning, project design and impact assessment of rural infrastructure investments. Furthermore, it answers various land management questions to estimate the future land use demand and manage potential land use conflicts.

### **Rural infrastructure and supply chain mapping**

#### **Land suitability mapping**



## **Impact of agriculture commodity production on deforestation and ecosystem health and sustainability**

Commodity sectors (palm oil, soybean and beef) have an important role in food security, energy supply and economic development, but also have significant environmental and social impacts. Information from Earth Observation is very well suited to help assess and reduce risks associated with the environmental and social impacts of commodity (palm oil, soy, beef etc.) production.

This includes land titling, the location and extent of industrial and smallholder production areas versus other land use, in particular vulnerable ecosystems (peatlands, wetlands, natural grassland), trends and patterns of deforestation and ecosystem loss and degradation.

### **Agriculture commodity production risk monitoring service**



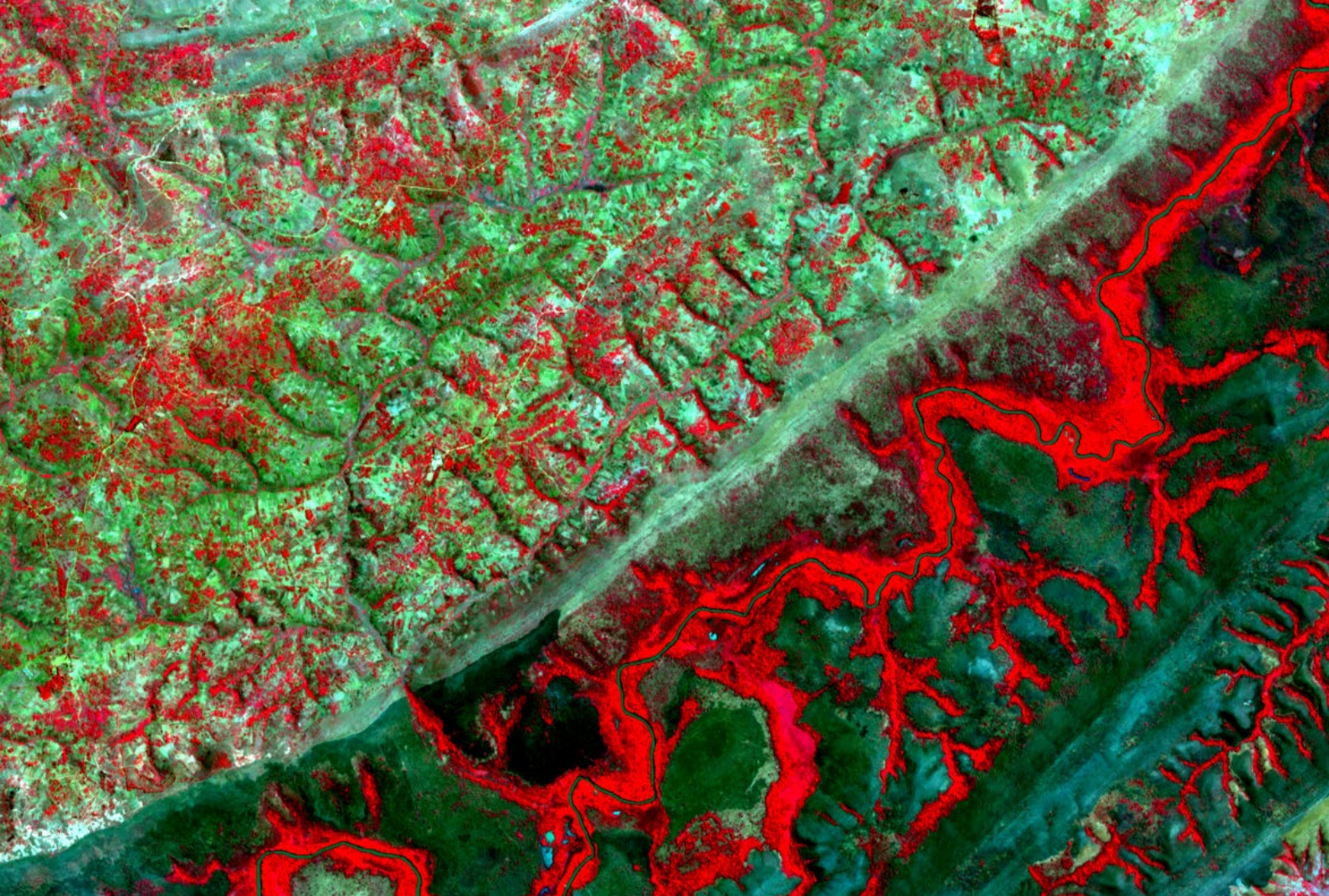
## **Supporting environmental and social safeguards frameworks**

Environmental impact assessment (EIA) or strategic environmental assessment (SEA) both attempt to predict the likelihood of environmental impacts emanating from development proposals. EO provides the biophysical baseline existing in a given geographic space which is a necessary pre-condition for effective SEA and EIA. The more commonly employed baseline data types used in safeguard assessments such as elevation, land cover and use, meteorology, hydrology and geology, can either be derived directly from EO satellite data or extrapolated efficiently. Satellite EO helps defining the biophysical baseline existing in a given geographic space and for assisting with the monitoring component of environmental management plans (EMPs).

### **Environmental impact assessment and strategic environmental assessment**

### **Monitoring and evaluation for environmental and social safeguards**





## DESCRIPTION OF SERVICE DEMONSTRATIONS PERFORMED

Satellite image Smallholder farms and river bed in the Republic of Burundi as seen by the Copernicus Sentinel-2 satellite.

Credit: E04SD Agriculture and Rural Development cluster

### **Sub-Saharan Africa: The Global Environment Integrated Approach Pilot (IAP) programme on sustainability and resilience for food security**

“Sustainable and Resilience for Food Security in sub-Saharan Africa – An Integrated Approach” is a Global Environmental Facility flagship programme with specific focus on natural resources. It is led by IFAD in coordination with six other GEF Agencies and involves twelve sub-Saharan countries located in dryland regions where the threats of environmental degradation and food insecurity are greatest. E04SD has developed a range of land information services that have been delivered to the IAP Food Security stakeholders in the form of mapping and monitoring tools and training activities. E04SD contributed to the programme's Resilience Atlas with high resolution layers including land cover/ land use, biomass production, agricultural water productivity and soil erosion risk assessments. The E04SD team participated in several programme workshops, to inform and build awareness among workshop participants of the use, benefits and potential constraints of using Earth Observation information services in programme operations.

**Country brochure:** *Sub-Saharan Africa*



## **Uganda: Agricultural production changes & monitoring environmental impact of palm oil commodities expansion**

The agricultural sector in Uganda employs 80% of the population and contributes to about 22% of the total Gross Domestic Product (GDP). Providing farmers with the knowledge and tools to make more well informed decisions regarding crop and climate status, will impact their way of farm management, and hence impact their productivity and income. ESA's Earth Observation for Sustainable Development (E04SD) initiative contributed to:

- The IFAD Project for Restoration of Livelihoods in the Northern Region (PRELNOR) implemented partly under the responsibility of the Food and Agriculture Organisation of the United Nations (FAO) aims to increase sustainable production, productivity and climate resilience of smallholder farmers and provide increased and profitable access to domestic and export markets.
- The IFAD Vegetable Oil Development Project (VODP) and National Oil Palm Programme (NOPP), implemented under the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). The Government of Uganda sees NOPP as an immediate priority and long-term strategy for the development of the vegetable oil sub-sector.

**Country brochure: *Uganda***



Credit: Muhammad Mahdi Karim

## **Ethiopia: Supporting sustainable land management and food security**

In Ethiopia, E04SD initiated partnerships with three country projects implemented by IFAD, United Nations Development Programme (UNDP) and World Bank, respectively. The collaboration led to the production of a series of EO data products covering the Ethiopian project areas, including land cover/ land cover change, long-term vegetation trends, biomass production, water productivity, soil erosion risk assessment as well as irrigation suitability maps for various crops. To strengthen the local technical capacities and to demonstrate the opportunities and benefits of using EO-based information services for project M&E, two capacity trainings were conducted in the framework of E04SD with in total almost 60 attendees from various institutions. This resulted in the implementation of an EO-based monitoring system for the UNDP- implemented project on Food Security Ecosystem Resilience.

**Country brochure: *Ethiopia***

## **Cambodia: Land-use and infrastructure planning for rural development**

Around 85% of Cambodians depend on agriculture and non-timber forest extraction for a major part of their livelihoods, although these activities account for only about one-third of the national GDP. Key issues affecting agriculture and rural development in Cambodia include low cropping intensity and low yields, poor siting of agricultural production areas, roads and bridges, and high vulnerability of agricultural and urban areas to flooding and other climatic factors.

The Asian Development Bank (ADB) country strategy aims at reducing poverty and promoting inclusive growth with an integrated approach to rural development. E04SD Agriculture and Rural Development Cluster supports the ADB and its efforts to improve the agricultural sector through three projects all focused on rural provinces surrounding the Tonle Sap lake.

**Country brochure:** *Cambodia*



## **Burkina Faso: Effective management and evaluation of rural development and sustainable land and forestry projects**

Burkina Faso is a landlocked sub-Saharan country with limited natural resources. Its agroecological conditions are impacted by climatic deterioration and increasing human pressure. Economically agriculture is the most important sector, providing 80% of employment of the active population. However, as most of the agriculture is rainfed, changes in rainfall patterns and droughts severely affect the country's income and livelihoods. It has been estimated that besides natural factors, agricultural pressure (such as the overexploitation of the already limited natural resources through agricultural intensification of crop and livestock) increases environmental degradation.

The E04SD Agriculture and Rural Development Cluster provided the World Bank, IFAD and their local stakeholders with up-to-date geoinformation based on satellite data that can guide land management decisions in order to ease land degradation, safeguard natural resources and improve agricultural productivity and food security. This showed the potential of satellite EO technology to effectively manage and evaluate sustainable land and forestry management under the Integrated Approach Pilot Program on Food Security (IAP), the Sahel and West Africa Program (SAWAP) and the Forest Investment Program (FIP). It furthermore raised awareness and demonstrated to MDBs and their local stakeholders in Burkina Faso the added value of the state-of-art EO-based geo-spatial data products and services geared to information and capacity building requirements of the World Bank's and IFAD's programmes.

**Country brochure:** *Burkina Faso*



## Bolivia and Paraguay: Agriculture expansion impact on deforestation

Deforestation and land degradation are threatening areas like the Chaco dry forest in the South of Bolivia and Eastern part of Paraguay. The region is an important wilderness area and is experiencing one of the highest deforestation rates in the world. Providing policymakers at the Multilateral Development Banks (MDBs) and government agencies, as well as farmers with the knowledge and tools to make better informed decisions on the basis of historical to current information of habitat quality, deforestation and crop distribution and performance, can help design more sustainable policies and raise productivity and income in existing agricultural areas.

E04SD provided Earth Observation (EO) technologies and services supported projects in Bolivia and Paraguay:

- IDB Rural Land Regularisation and Titling Program (Land Administration Program II – IDB BOL1113). This project supports setting up an environmental cadastre to address land tenure control issues resulting from unbridled soy and livestock expansion causing deforestation and ecosystem degradation. Improving the estimation and availability of land pricing information and informed land allocation can help promote sustainable agricultural expansion in less vulnerable areas.
- GEF Taking Deforestation out of Commodity Supply Chains (Integrated Approach Pilot (IAP) Commodities program), implemented by UNDP's Green Commodities Programme. This program promotes an integrated supply chain approach to tackle the underlying root causes of deforestation from agriculture commodities, such as beef in Paraguay.

**Country brochure:** *Bolivia and Paraguay*

## Syria: Satellite-derived information to assess the consequences for armed conflict on the agriculture sector

Despite the need to understand the consequences of armed conflicts on economy and population, agricultural statistics in conflict affected countries are often not available, or of questionable accuracy due to the high risk and difficulty of acquisition. However, timely and reliable information on agricultural production is needed to plan preventive interventions by building resilience prior to the conflict, target humanitarian aid during the conflict and focus rehabilitation actions after the conflict ends.

Satellite Earth Observation (EO) is a powerful and cost-effective technique to assess agricultural production in areas with no or limited access. It provides historical and near-real time operational data to rapidly identify changes in a consistent and repeatable manner.

The example of Syria demonstrates that satellite Earth Observation is an excellent tool to assess agricultural production in areas under conflict, not only to monitor the impact of conflict on the agricultural sector, but also to map its dynamics, resilience, coping and adaptive mechanisms over time.

**Country brochure:** *Syria*

## Morocco: The Atlas Mountains Rural Development Project under the Green Morocco Plan

Agriculture is a strategic sector in Morocco, economically and socially. Agriculture production represents almost 15% of Morocco's GDP and as such, it plays a major role in terms of food security, employment, and stabilisation of livelihoods of rural residents, which makes up almost 40% of the total population. The poverty rate in rural areas has dropped in recent years, but remains four or five times higher than that of urban areas, with provinces in mountainous areas being among the poorest. Economic growth in Morocco is particularly volatile due to changes in agricultural production, which is highly dependent on climatic conditions, among other factors.

Morocco is characterised by two types of agriculture, a modern, highly productive agriculture in irrigated areas covering about 20% of cultivated land and a traditional food-producing agriculture for the remaining 80%, localised in disadvantaged, rain fed farmland, and mountain and oasis areas. IFAD's Atlas Mountains Rural Development Project (Projet de développement rural des montagnes de l'Atlas, PDRMA) aims at reducing poverty in areas of the Atlas mountains and increasing agricultural production. The project covers three provinces of Ouarzazate, Tinghir and Beni Mellal. The potential of EO-based geo-information products and services to contribute in an effective way to the consolidation of a sustainable agriculture sector in Morocco was demonstrated to IFAD, supporting the Atlas Mountains Rural Development Project (PDRMA).

**Country brochure:** *Morocco*



Credit: Stefan Swanepoel

## The Great Green Wall: the SAWAP program and the BRICKS project

Land degradation and desertification are major development barriers in the Sahel and threaten the livelihood of its population, which heavily depends on agriculture and the natural resources, particularly soil, water and vegetation. Yet, concrete evidence on the extent, severity and its drivers is frequently weak. The World Bank Sahel and West Africa (SAWAP) programme supports the Great Green Wall to combat land degradation and desertification, to boost food security, and support climate change adaptation.

E04SD supported the BRICKS project and country projects in Burkina Faso and Ethiopia under SAWAP. The E04SD project provided data, information and methods designed for monitoring land degradation/regeneration as well as desertification and land use trends, including multi-scale agricultural monitoring, tools to assess land degradation and environmental conditions and support to rural infrastructure.

**Country brochure:** *The Great Green Wall*





## DATA SHARING

For the demonstrations, most datasets were made available through a dedicated online viewer: [eo4sd.lizard.net](https://eo4sd.lizard.net). To ensure the data remains available after the demonstrations, the datasets produced under E04SD were **shared with the following partners**:

- World Bank: inclusion of 15 datasets including timeseries information in their [data catalogue](#)
- Conservation International: hosting of 55 datasets on the [Resilience Atlas](#)
- ICRAF: storing of 10 datasets including timeseries on the [Landscape Portal](#)

An **index/catalogue of data and services**, including **metadata** can be found through the E04SD [Lizard Portal](#). The data can also be requested through the relevant demonstration partners listed on [page 7](#).

**Satellite image** Agricultural fields over the Western Cape province in South Africa as seen by the Copernicus Sentinel-2 satellite.

Credit: E04SD Agriculture and Rural Development cluster







## CAPACITY BUILDING

Satellite image Agricultural fields over South Africa as seen by the Copernicus Sentinel-2 satellite.

Credit: E04SD Agriculture and Rural Development cluster

The **capacity building activities** organised under the E04SD umbrella **demonstrated the opportunities and benefits of EO-based services** so that these become embedded in the planning, operational, monitoring and evaluation phases of international development projects.

Capacity building events (workshops and InfoSessions) were tailored to the specific needs of the stakeholders. The workshops were hands on and engaging. They consisted of lectures and practical exercises, describing both **commercial** and **free and open access Earth Observation data** (e.g. the Copernicus programme), **software** (e.g. QGIS, SNAP and ILWIS), **platforms and applications** (e.g. Sen2Agri, Trends.Earth, Lizard, FieldLook, etc.) and the services of the various service providers involved. Generally, stakeholders were invited to attend two workshops: one directly after the demonstration phase **to verify the data delivery**, and one after the service delivery to **evaluate the service**. The workshops were complemented by **awareness events** (InfoSessions) aimed at building capacity at **higher organisational levels** via lectures and panel discussions. The E04SD team organised capacity building events in:

- Ethiopia
- Morocco/Burkina Faso
- Bolivia
- Cambodia
- Uganda
- Washington DC (World Bank)
- Rome (IFAD)
- Manila (Asian Development Bank)



Related capacity building materials can be found through the [EO4SD – Knowledge portal](#) and the [Service Portfolio](#). The Knowledge Portal summaries present **knowledge on the potential uses of Remote Sensing (RS) technology in agricultural systems**. The materials specifically aim at:

- Providing an overview of the different services that are available commercially and open source
- Providing an overview of relevant suppliers of services and capacity training where more information can be requested
- Providing readers with a better understanding of why remote sensing technology has not been used widely in smallholder systems
- Sharing remote sensing-based work streams that produce improved information for a number of regional or national use cases where the demand for such information has been identified for specific stakeholders
- Elaborating on recent technological advancements in the field of remote sensing (e.g. the use of Sentinel-originated satellite data and the use of unmanned aerial vehicles) that can improve agricultural management in smallholder systems for increased productivity, or in monitoring changes in the natural environment
- Providing insight into the equipment and survey instruments that are required for crop performance monitoring, their usage and limitations, or in the monitoring of natural vegetation trends
- Providing readers with a better understanding of the essential treatments that are required for remote sensing data prior to information retrieval.

Moreover, the **recording of the InfoSessions** (awareness building events) organised at the World Bank can be accessed at [World Bank Open Learning Campus](#). This recording contains a three-series course on Earth Observation for sustainable agriculture development.

The series has three components (excerpt from <https://olc.worldbank.org/about-olc/theory-practice-using-earth-observation-sustainable-agriculture-development>):


- Introduction and Impact introduces EO concepts and terminology and highlights how EO can be used for enhanced agricultural productivity, improved agricultural water management, and sustainable land management. We see how EO is applied in two examples: assessing agricultural production in Syria and monitoring water productivity of agriculture investments.
- Successes, Challenges, and Lessons features a lively discussion among Bank Task Team Leaders and practitioners about the challenges and lessons of applying EO services. Topics include anticipating and overcoming constraints in Bank projects, the EO services that have been the most useful, and further opportunities for EO application.
- Applications and Demonstrations uses lightning talks, satellite data, open source solutions, and demonstrations to illustrate how EO tools can be accessed and applied across the development landscape and in Bank operations. This bite offers an interactive, hands-on training for different EO portals.

## → EO4SD – EARTH OBSERVATION FOR SUSTAINABLE DEVELOPMENT

### USER FEEDBACK: BURKINA FASO

#### SOUMAÏLA BERNARD TOUGMA

*In charge of the Geographic Information System at the Forest Investment Program*



We use **satellite data** for planning **reforestation** activities, calculation of **carbon equivalents** of investments and development of **thematic maps**.

Through the **EO4SD capacity building workshop**, we acquired useful information of how to **access higher resolution satellite imagery** as well as **new skills** to better identify the degraded or deteriorating zones and to implement protection actions.

An **enabling objective for sustainable development in Burkina Faso** is to develop access to newer generation hardware and internet connection.





Satellite image Agricultural fields over the Western Cape province in South Africa as seen by the Copernicus Sentinel-2 satellite.

Credit: E04SD Agriculture and Rural Development cluster

# E04SD AGRICULTURE AND RURAL DEVELOPMENT IMPLEMENTATION TEAM





## **[www.eLEAF.com](http://www.eLEAF.com)**

Established in 2000, eLEAF is a Netherlands-based high-tech company that provides EO-based applications and data to optimise crop production and water management. eLEAF's mission is to be the global reference for operational and reliable high-quality quantified data and solutions for crop growth and yield, (water) productivity and water use, to increase food production, support sustainable water management and protect environmental systems worldwide.

The core of eLEAF's technology is called Pixel Intelligence Mapping (PiMapping®). It generates detailed time series of, among others, biomass production, crop water consumption, crop water stress and water productivity using Energy Balance Modelling, a technology that was originally developed and operationalised by eLEAF (SEBAL) and now further developed into the next generation algorithm ETLOOK.

eLEAF product offering is targeted at the entire agri-business value chain ranging from farmers to food processors as well as non-profit organisations, public institutions and governments. Examples of eLEAF's data and services are [WaPOR](#) - FAO's portal to monitor Water Productivity through open-access of remotely sensed derived data, the [FieldLook](#) and [FruitLook](#) precision agriculture application portals. eLEAF is specialised in using EO to determine water productivity, field profitability and provide services in water accounting, water auditing and index based drought insurances.

Within E04SD, eLEAF was leading the E04SD Agriculture and Rural Development cluster project and provided services related to irrigation management, agricultural production and land degradation.



## **[www.dhi-gras.com](http://www.dhi-gras.com)**

DHI GRAS is the leading remote sensing company in Denmark specialised in satellite image analysis and geodata processing to support decision making within water and land domains, urban planning, energy and more. DHI GRAS handles the entire data flow from the reception and processing of satellite images to the delivery of the requested final information product. The company was established in 2000 and has completed projects and delivered services in over 75 countries worldwide. Activities have historically been tied up to both research and development, with clients from national entities and authorities in Denmark, international organisations, NGOs as well as private sector companies. DHI GRAS works closely with universities, research institutions and space agencies to develop innovative and cost-effective services.

Examples of services are [satellite-derived bathymetry](#), agricultural control and CAP monitoring for the Danish Agricultural Agency or large scale image processing for the Copernicus Land Monitoring Service.

DHI GRAS is fully owned by DHI and acts as the knowledge hub of DHI's remote sensing activities on a global scale. DHI is a self-owned and not-for-profit (no shareholders), and every year a considerable part of its resources is invested in R&D.

Within E04SD, DHI GRAS was leading the Stakeholder Engagement Review and coordinating the Ethiopia country case as well as the IAP Food Security regional demonstration. E04SD information services were provided with focus on the land degradation thematic. DHI GRAS was also heavily involved in the capacity training activities in Africa.



**[www.geoville.com](http://www.geoville.com)**

GeoVille is an internationally operating company providing consultancy services and products related to EO, geo-information and geographic information systems (GIS). GeoVille's mission is to offer end-to-end EO-solutions with a particular emphasis on providing dedicated geo-information products tailored to customer needs.

Through a wide range of R&D projects as well as operational implementations, GeoVille is experienced in agricultural applications and a longstanding expertise in Africa, Central and South America as well as Asia/East Europe/North Africa and Middle East. Through the organisation's track record of over 450 successful projects, in over 135 countries worldwide, it has established a solid network of partners and clients.

GeoVille was coordinating the overall service provision in EO4SD and leading the Burkina Faso and Morocco country cases. For all other country cases, dedicated services were provided with a focus on detailed land cover mapping, rural development and value chain mapping, soil moisture monitoring and overall M&E.



**[www.utwente.nl/itc](http://www.utwente.nl/itc)**

The Faculty of Geo-Information Science and Earth Observation (ITC) is part of the University of Twente, an enterprising university that prepares young people for the future. This is accomplished through innovative, attractive and future-focused education and through fulfilling a global function in technological and social research. The scientists and other professionals at the University of Twente work together on cutting-edge research, innovations with real-world relevance and inspiring education.

The principal mission of ITC is to provide international postgraduate education, research and project services in GIS and EO to developing countries and emerging economies. ITC's approach is application-oriented, directed at finding solutions for and strengthening civil society in addressing issues of local, national and global dimensions such as the multifunctional use of scarce resources, including space, the effects of climate change and environmental security.

ITC was responsible for capacity building as part of the EO4SD project.



## [www.satelligence.com](http://www.satelligence.com)

Satelligence is a social enterprise providing actionable information on changes in forest and land cover, agriculture and water world-wide, using satellite and other geodata.

With a combined experience of over 55 years and expertise in advanced radar imaging that can 'see' through persistent cloud cover, Satelligence provides continuously updated mapping and monitoring of land and water dynamics over large areas at high spatial detail (250, 30 and 5 m).

The information provided by Satelligence is reliable and unbiased. The company achieves transparent and sustainable supply chains and local engagement with independent facts. The algorithms Satelligence works with are developed and verified by world leading Wageningen University scientists in cooperation with World Resources Institute.

Satelligence was a service provider for E04SD countries and leading the Bolivia and Cambodia country cases.

## Nelen & Schuurmans



## [www.nelen-schuurmans.nl](http://www.nelen-schuurmans.nl)

Nelen & Schuurmans is a Water & IT consulting company offering creative solutions for water management and agricultural issues. Innovation, knowledge development where the client's needs are key values for the company. Its mission is to provide state-of-the-art and cost-effective solutions, in close consultation and cooperation with its clients.

Nelen & Schuurmans has expertise in the field of water management, spatial planning, remote sensing, system integration, water legislation, institutional aspects and smart agriculture. Its department of information technology has extensive experience with GIS, large databases (big data) and integrated web-based solutions. Some examples of software products that are developed by combining its expertise of water and information technology are 3Di and Lizard.

Within E04SD, Nelen & Schuurmans was the partner in charge of the data management, sharing, compilation and for data demonstration within the E04SD Agriculture and Rural Development cluster project. For this purpose, Nelen & Schuurmans used its online platform to demonstrate the services developed and through their API connect with stakeholders for data sharing.



**Satellite image** Agricultural fields over Paraguay as seen by the Copernicus Sentinel-2 satellite.

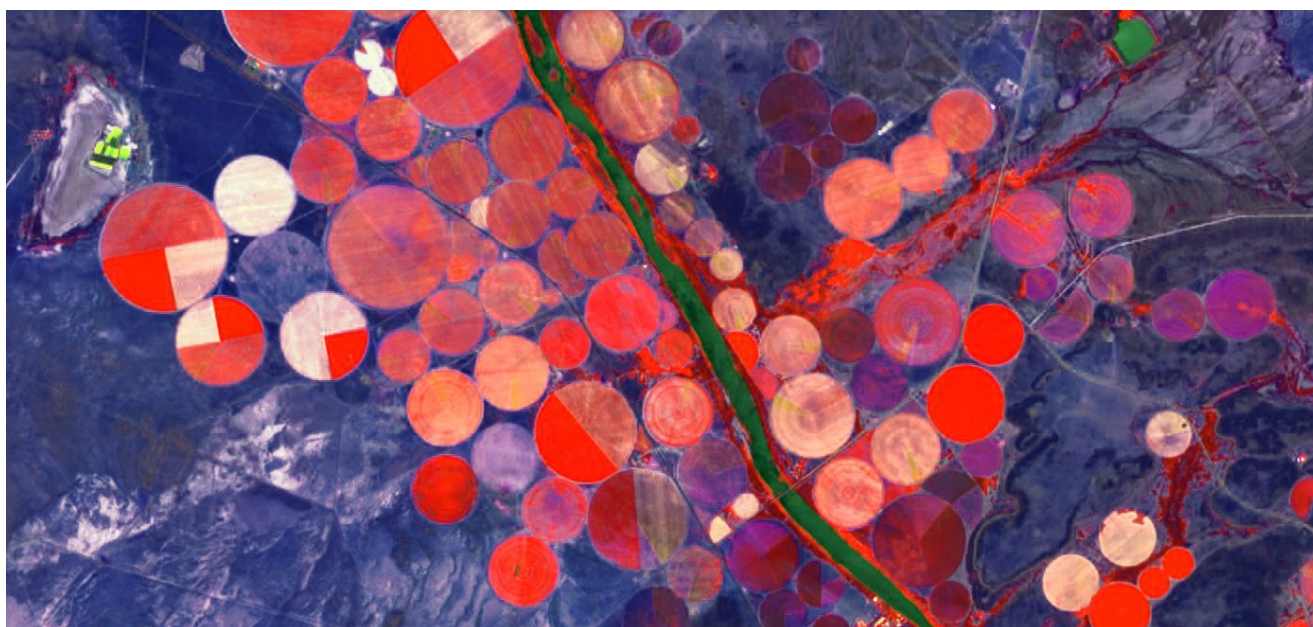
Credit: E04SD Agriculture and Rural Development cluster

## [www.spacetec.partners](http://www.spacetec.partners)

SpaceTec Partners is a consultancy with in-depth expertise of the space industry. SpaceTec Partners assists its clients with management consulting, market development and innovation advisory. SpaceTec Partners' service portfolio includes strategy and technology consulting, communication activities, and interdisciplinary project management mainly for public institutions (e.g. European Commission, European Space Agency, European GNSS Agency, European Parliament, National Ministries, etc.) in the space and space applications domain. SpaceTec Partners further engages in venture capital and provides business coaching for start-ups and SMEs.

SpaceTec Partners' areas of activity include space (Earth Observation, navigation, satellite communications, exploration and situational awareness), geo-information, security & defence, transportation & aviation, mobile & mobility, and energy.

The role of SpaceTec Partners within the E04SD initiative was the promotion of the project and communications.



**Satellite image** Agricultural fields over South Africa as seen by the Copernicus Sentinel-2 satellite.

Credit: E04SD Agriculture and Rural Development cluster



## [www.lahmeyer.de](http://www.lahmeyer.de)

Lahmeyer International offers a wide range of planning, management and consultancy services, primarily for complex infrastructure projects. The main fields of activity are in energy, hydropower and water resources, water supply and wastewater management, as well as in the building and transportation sectors. Dating back to its origins in 1890, the company has developed in more than 45 years since its founding in 1966 into one of the leading international engineering companies with projects in 165 countries around the globe. Today, Lahmeyer International is one of the major international engineering companies operating in the energy and infrastructures sectors.

Lahmeyer supported the stakeholder engagement in the set-up phase of E04SD.



## Partners of the EO4SD Agriculture and Rural Development cluster

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Nelen & Schuurmans



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**[eo4sd.esa.int/agriculture](http://eo4sd.esa.int/agriculture)**