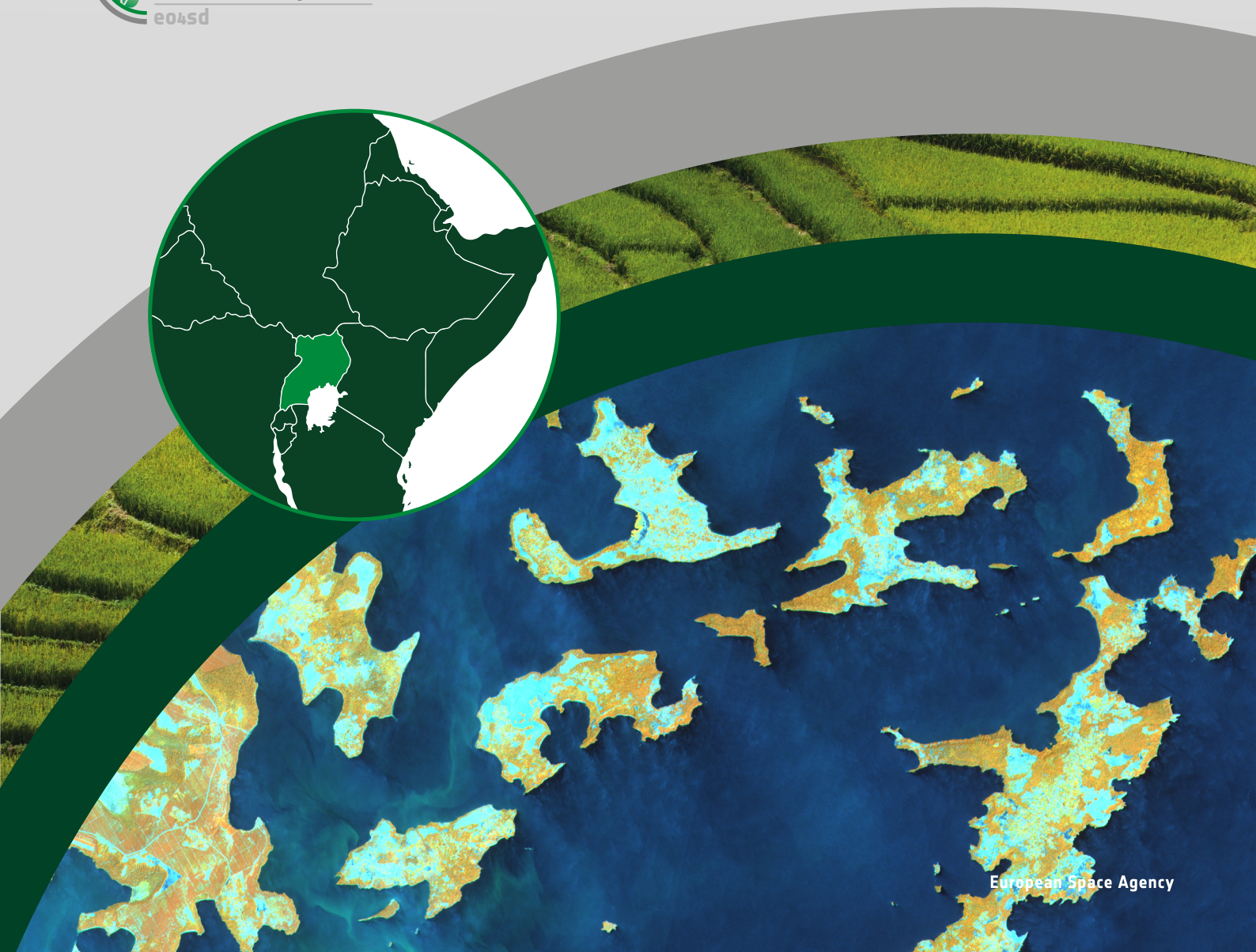
→ EO4SD – EARTH OBSERVATION FOR SUSTAINABLE DEVELOPMENT

Agriculture and Rural Development | Uganda

Agricultural production changes & monitoring environmental impact of palm oil commodities expansion

agriculture and rural development
eo4sd



European Space Agency

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Cover image **Sentinel 2 image over Kalangala District, Uganda, 2016**
Credit: European Space Agency

1. INTRODUCTION

Uganda has an estimated population of 35.8 million, 80% of whom are involved in agricultural production that contributes to about 22% of the total Gross Domestic Product (GDP). Females make up 60-75% of those employed in the mostly rural agricultural sector. While the agriculture sector is significant, currently growth has stagnated partially due to smallholder farmers not being able to have access to extension services that provide agricultural advice on better farming practices and climate resilience, nor to invest in additional inputs such as improved seeds, fertilisers and herbicides/pesticides to improve their yields. Providing farmers the knowledge and the tools to make better informed decisions on basis of information regarding crop and climate status, will impact their way of farm management, and hence impact their productivity and income.

In this context, tools and services using Earth Observation (EO) data have the opportunity to prove their value and impact on food security in the country. EO technology is starting to become widely accepted and utilised, within the community of growers of large cooperatives and businesses, as valuable assets to monitor and evaluate the food production cycle. The resulting testing, validation and maturity of the technology now makes it feasible to deploy services for the benefit of smallholders, as well as for NGO's, donors and (non)governmental organisations that strive to improve the livelihood of the farmers.

ESA's Earth Observation for Sustainable Development (EO4SD) initiative leverages and contributes to a number of ongoing operations carried out in Uganda by different national and multilateral donor organizations, and their local stakeholders.

The International Fund for Agricultural Development (IFAD) currently provides financial and technical assistance to a number of projects. The 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.

Another two initiatives of relevance funded by IFAD are the Vegetable Oil Development Project (VODP) and National Oil Palm Programme (NOPP), implemented under the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). The VODP2 (in its second phase) is about to close and the NOPP is about to start. Building on the results and experience of VODP and VODP2, the Government of Uganda sees NOPP as an immediate priority and long-term strategy for the development of the vegetable oil sub-sector. Further support to a national oilseeds program is considered under IFAD's next lending cycle (2019-21), based on the actual results achieved at the end of VODP2 (completing in December 2018).

In addition, a project under the Netherlands Space Office (NSO) G4AW programme, supported by the National Agricultural Research Organisation (NARO) and under the name Market-led User-owned ICT4Ag Enabled Information Service (MUIIS) was actively working in Uganda to bring Earth Observation services to smallholders in the country. This project ended in 2019 but was converted into a business (https://muiis.com/) that reached more than 800,000 stakeholders with Earth Observation based insurance services and agronomic tips and a significant increase in crop productivity was reached.

This proofs that Earth Observation-based technology is exceptionally well suited to support the implementation of long-term and large-scale development programs resolving the data and information gaps concerning the status and change in land use, vegetation cover, agricultural production and water productivity. With the launch of the European Space Agency's (ESA) Sentinel satellites - carrying both optical and radar sensors and providing images at multiple spatial scales - an unprecedented amount of free and open-access data has become available. This will not only remove the barriers related to previously inadequate access to timely information but will also to solve the obstacles related to the operational adoption of information provision for various reporting obligations, especially if coupled with appropriate ground information and on-site validation using hierarchical field survey and sampling protocols.

2. OBJECTIVES

EO4SD (Earth Observation for Sustainable Development) "Agriculture and Rural Development Cluster" is a European Space Agency (ESA) initiative developed to encourage the uptake of Earth Observation information and services in international development projects on a large scale. In the context of Uganda the projects PRELNOR, VODP, and NOPP, funded by IFAD, have obtained training and data showcasing the effectiveness of Earth Observation for the MDB's technical assistance interventions and financial investments. This demonstrated that the agriculture sector can be measurably enhanced by using EO-derived information.

The EO4SD project contributed to the programmes by providing information on crop biomass production, agricultural water productivity, water consumption and deficit for monitoring sustainable agriculture, as well as land cover change and deforestation monitoring of the environmental impact of palm oil commodity.

The demonstration activities also involved the Ugandan initiative under the name Market-led, User-owned ICT4Ag-enabled Information Service (MUIIS) which was an innovative project that harnesses the power of satellite data to support extension and advisory services to farmers in Uganda, now turned into a successful public-private partnership. This MUIIS business is supported by the National Agricultural Research Organisation (NARO) and coordination between the project and the EO4SD – Rural and Agriculture Development Cluster ensured that experiences and uptake of technologies are shared in Uganda, and IFAD and WB were informed on the existing operational services in Uganda that may support their programs.

EO4SD - Agriculture and Rural Development Cluster project aimed to demonstrate the benefits of EO-based geo-information products and services to support agricultural monitoring and management tasks including:

- agriculture production assessment,
- land degradation monitoring,
- deforestation-free commodity monitoring, and
- identifying food security

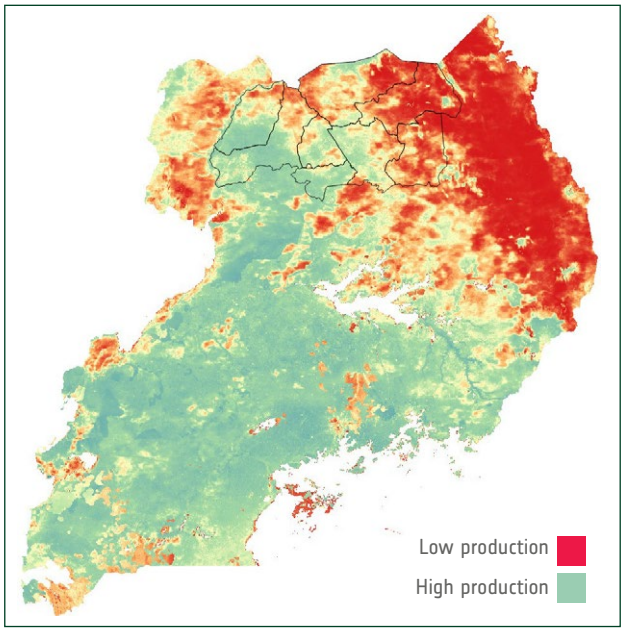


Figure 1 Biomass production of Uganda at 250m spatial resolution.
Credit: EO4SD Agriculture Cluster (eLEAF for ESA/IFAD/WB, 2017).

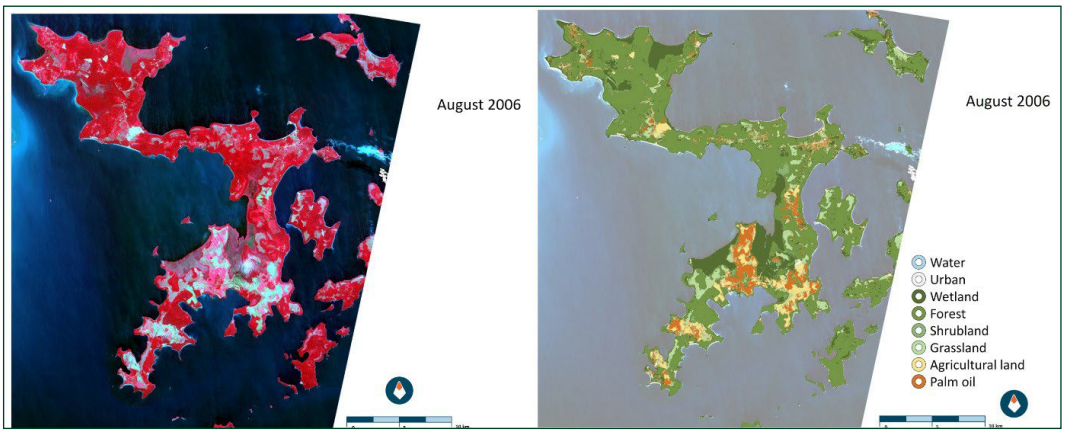


Figure 2 Left: Aster satellite image. Right: example land cover baseline production for Kalangala island, Uganda, at 20m spatial resolution.
Credit: EO4SD Agriculture Cluster (Satelligence for ESA/IFAD, 2017).

3. RESULTS

EO4SD provided in collaboration with the MUIIS project and local partners Conservation international (CI) and the world agroforestry center (ICRAF) and the World Food Program (WFP) a large number of datasets to be used by the stakeholders for the monitoring the agricultural and environmental impact of the project areas such as the palm oil commodities expansion. As such, EOSD provided a base line and monitoring information in the form of mapping, monitoring tools. The full set of data provided is listed in table 1 below.

Service level	Data	Spatial coverage	Temporal coverage	Spatial resolution	Description
Regional to national	Water consumption and deficit	National	January 2017- May 2019	250m	Water consumption by evapotranspiration and water deficit over time, in mm per hectare per week
	Leaf Area Index (LAI)	National	January 2017 - May 2019	250m	Canopy cover index, per hectare per bi-weekly interval
	Basic land cover	Kalangala, Buvuma, Mainland	2000, 2016	10-30m	Land cover baselines, with classes including forest, wetland, agriculture etc.
	Deforestation	Continental Africa	2000 – May 2019 Jan 2018 – May 2019	10-30m	Deforestation on an annual basis for impact monitoring, on a weekly basis for recent years for environmental enforcement
	Water consumption and deficit	Customised	January 2018 - May 2019	10-30m	Water consumption by evapotranspiration and water deficit over time, in mm per hectare per week
	Leaf Area Index (LAI)	Customised	January 2018 - May 2019	10-30m	Canopy cover index, per hectare per bi-weekly interval
	Agricultural monitoring	Karamoja	Customised	10-30m	Sentinel-2 for Agriculture tool (Sen2-Agri) experiment in partnership with WFP/EODC (monthly composites, dynamic cropland mask, crop type map and leaf area index (LAI)

The datasets where created for two specific themes, multi-scale agricultural monitoring and monitoring of the environmental impact of expansion of palm oil commodity production.

(1) multi-scale agricultural monitoring

For the multi-scale agricultural monitoring daily data was collected for the whole of Uganda, starting January 2017. A few interesting statistics are already observed. A clear regional trend is visible, where the crop growth, or the biomass productivity, in the regions Mukono and Luwero is being high on average while in the region Kitgum and Ngora the productivity is lower.

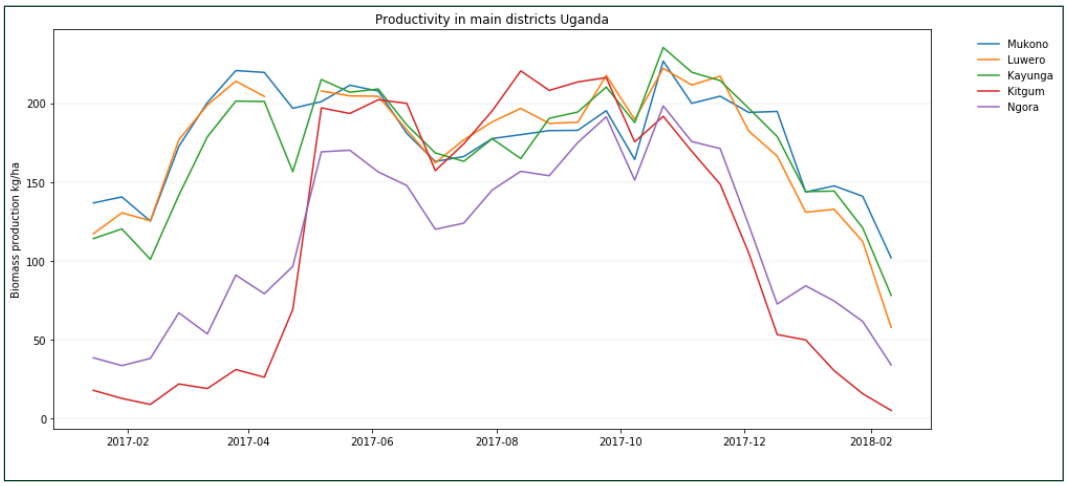


Figure 4 Comparison of satellite derived biomass productivity of crops for a few sample regions based on data provided
Credit: EO4SD Agriculture Cluster (eLEAF/MUIIS for IFAD, 2018)

When comparing between seasons, we observed that production in the first season of 2018 started late when compared with the first season of 2017. In the below image of the Luwero region this is seen by the high productivity observed in the northern and central area of Luwero in 2017 while in the same week in 2018 productivity has not peaked yet, thus requiring an updated schedule of agronomic activities. The information is used at the basis of the MUIIS agronomic tips, and can be used as baseline measurements for Monitoring & Evaluation.

2017 1st week February

2018 1st week February

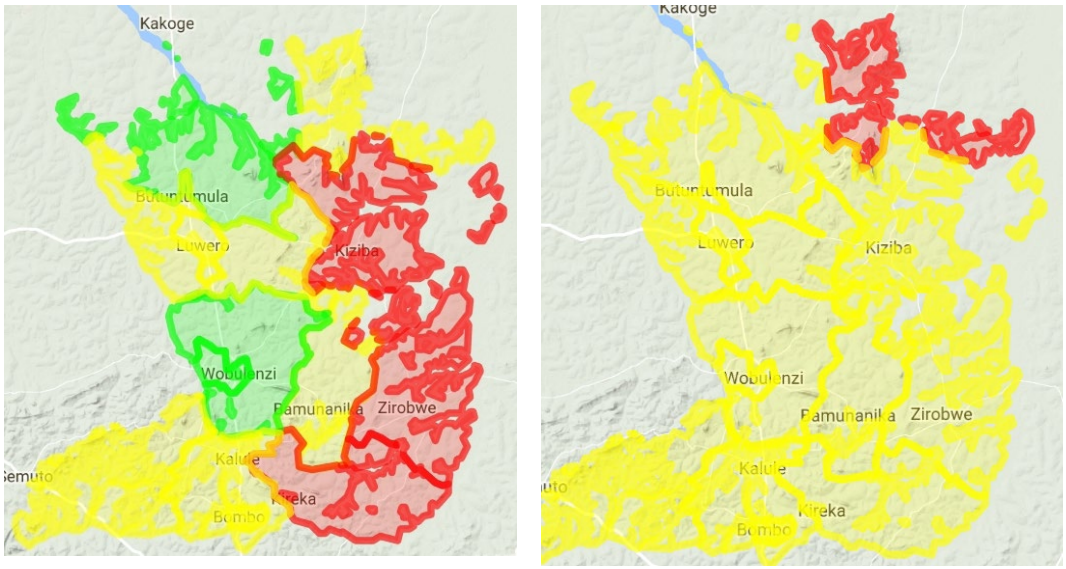
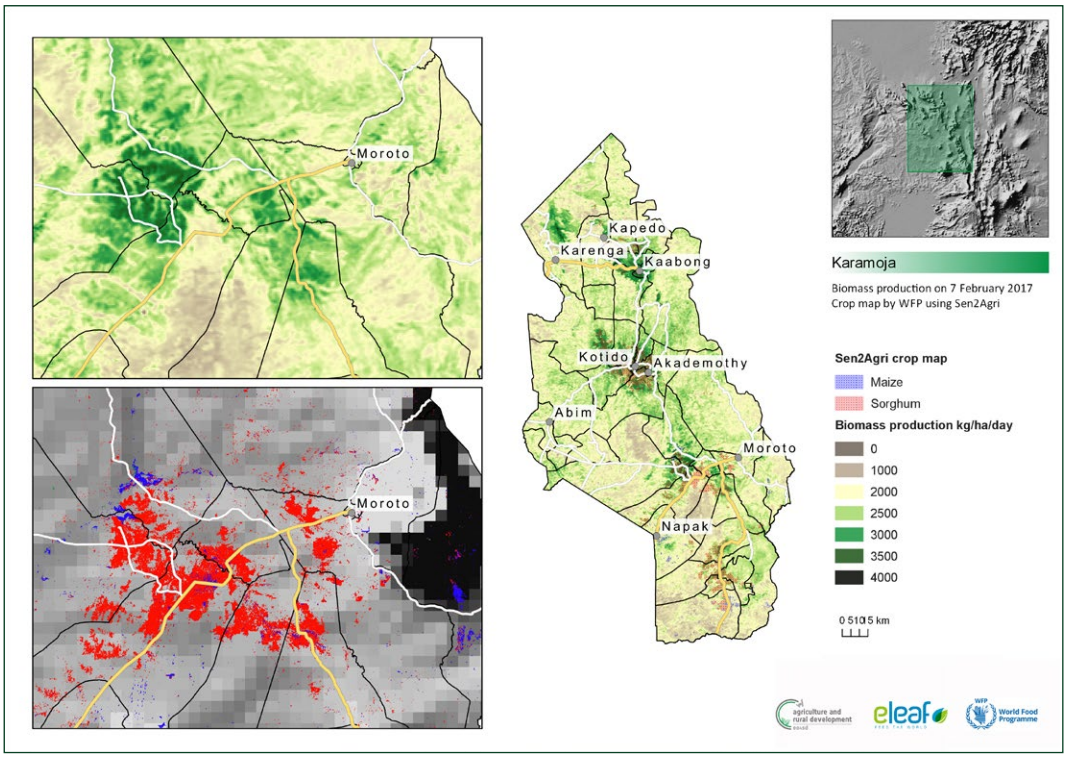


Figure 5 Productivity of cropland in Luwero, based on Satellite derived productivity and the ESA CCI land cover map, where yellow shows normal productivity, red low and green high when compared to the regional average. Updated weekly, this gives a good indication of the production near-real time
Credit: EO4SD Agriculture Cluster (eLEAF/ESA/MUIIS for IFAD, 2018)

Zooming in further to the field level, the information is telling us the status of growers' fields and allows for grower specific advice and evaluation. Knowing the field locations, the data allows field production to be compared with regional and seasonal production to determine whether this is in the line of expectation, and previous seasons to determine its potential yield. Below and example is presented that combined satellite derived productivity and the Sentinel derived crop map from the World Food Programme into an exert of a crop productivity map for Karamoja.



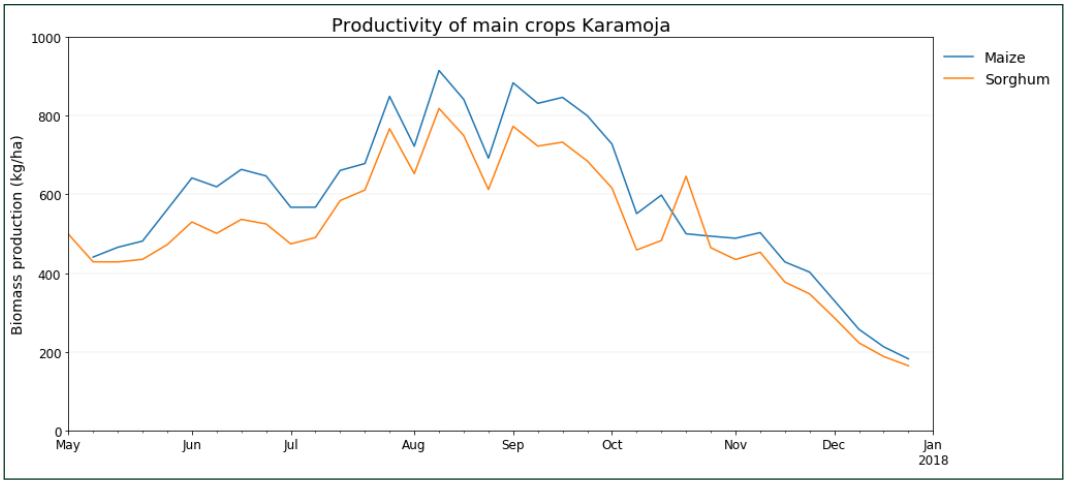


Figure 6 Satellite derived crop and productivity map for sorghum and maize in Karamoja (top) and seasonal productivity 2017 (bottom).
Credit: EO4SD Agriculture Cluster (eLEAF/WFP/MUIIS for IFAD, 2018)

In this way, the satellite information aids project managers, agronomists and growers with unbiased and frequent information they use to send out tips that increase the productivity of the growers.

The datasets are made available to the stakeholders using different platforms. The Vital Signs Food Security and Resilience atlas (https://foodsecurityiap.resilienceatlas.org) and world agroforestry center Landscape portal (http://landscapeportal.org/projects/11) exposed the dataset to the GEF Integrated Approach Pilot stakeholders and general public.

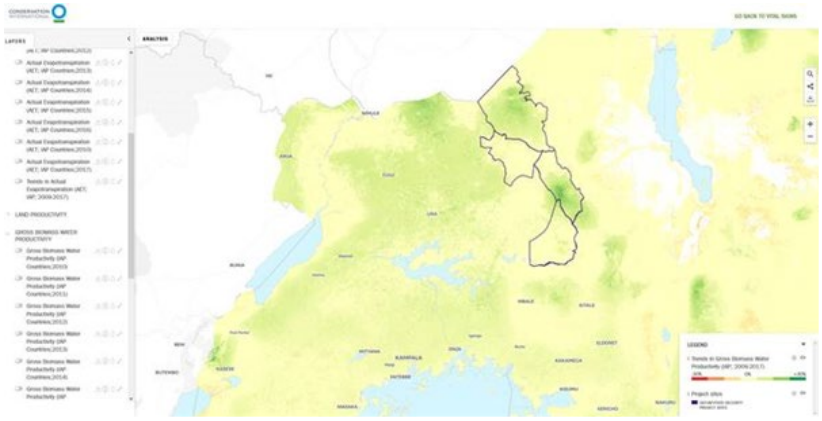


Figure 7 Vital Signs Food Security and Resilience atlas
Credit: Conservation International and EO4SD Agriculture Cluster (eLEAF)

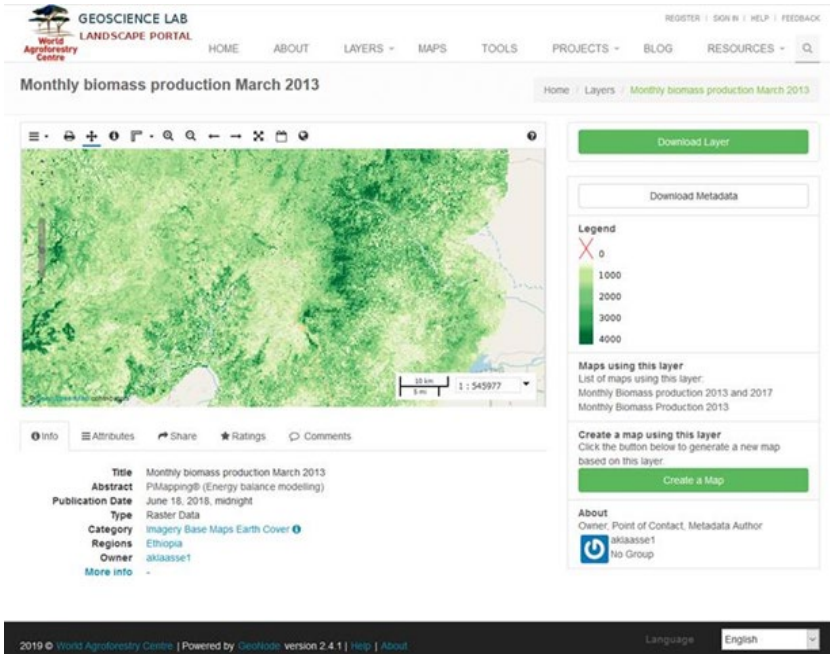


Figure 8 world agroforestry center (ICRAF) Landscape portal
Credit: World agroforestry center (ICRAF)and EO4SD Agriculture Cluster (eLEAF)

The fieldlook.com platform (figure 5) was used to provide the data on a daily basis to the FAO as IFAD project stakeholder.

The FAO Water Productivity Open-access database – WaPOR (https://wapor.apps.fao.org/) - which provides open access to the water productivity database and underlying map layers such as the Above Ground Biomass Production (AGBP) product was used as input for the relevant data portals

(2) monitoring of the environmental impact of expansion of palm oil commodity production.

Satelligence produced an oil palm baseline map (see figure 2 above) based on Sentinel 1, Sentinel 2 and Landsat imagery for 2017. From then on deforestation change maps were made every quarter and shared with the IFAD project. Based on that input, the committee decided to move forward with the project funding and is now in the process of setting up institutional and human resources to kick off.

Satelligence was invited as a mission member to prepare for the National Oil Palm Programme.

Satelligence will coordinate with the local and international experts to discuss the proper institutional framework, work processes, needs, opportunities and cost for scaling the monitoring system

to Buvuma.

4. CAPACITY BUILDING

The amount of free and open-access satellite data has increased dramatically with the commissioning of the Sentinel satellites. However many organisations lack the capacity to develop and use the data for monitoring and reporting activities. Therefore, under the EO4SD umbrella tailored information services and capacity building activities where provided to build up decision-making capabilities as well as knowledge in EO data exploitation.

The training under the EO4SD umbrella was aimed at demonstrating the opportunities and benefits of using EO-based information services so that they become an integral part of the planning, operational, monitoring and evaluation phases of projects.

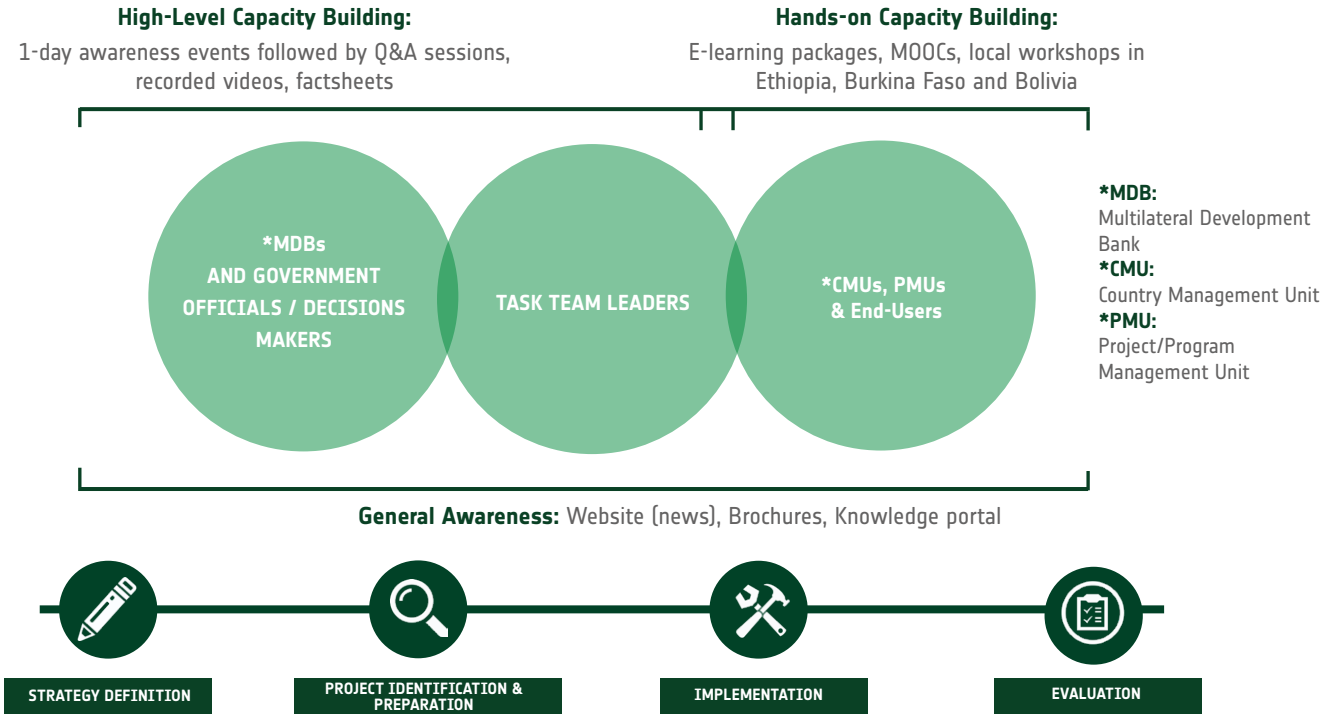


Figure 9 EO4SD capacity building plan.

On the 6th of December 2017 the EO4SD Agriculture and Rural Development cluster organised a workshop in Uganda at the office of the African Forum for Agricultural Advisory Services (AFAAS) in Kampala. The workshop was organised to not only present the state-of-art Earth Observation (EO) capabilities for the agriculture and rural development sector to the invited ministries and development organizations, but also to discuss the way forward towards the development of a roadmap that leads to an integrated approach on the development of indicators in a Monitoring and Evaluation Framework using Earth Observation. Invited partners showed a lot of interest, and the first steps towards the sharing and combination of data has taken place since, adding even more value.

Additional training was provided at the IAP-FS "Regional Hub" project capacity building workshops.

in 2018 in Nairobi, Kenya, over 100 government and development sector experts attended the second general workshop of the GEF-funded Integrated Approach Programme on Fostering Sustainability and Resilience for Food Security in sub-Saharan Africa (II GEF-IAP-FS Workshop). This was part of a regular series of Programme meetings which bring together country projects, the regional cross-cutting hub project and partners, offering systematic opportunities for knowledge exchange and peer learning. The workshop was a great platform for EO4SD to promote the services for customized high quality project M&A which was also acknowledged by CI-Vital Signs. The integration into

the resilience atlas provided visibility to a large group of stakeholders. There was great interest in geospatial data, also expressed by the many participants in the dedicated data session. With the selected EO4SD products we could highlight the quality of customized data, raise awareness with concrete examples and at the same time communicate that high quality data comes with some cost.

In 2019 in Bolgatanga, Ghana, the EO4SD team supported by UNDP Ethiopia provided an infosession on "Earth Observation for sustainable agricultural development" that informed and build awareness among IAP FS workshop participants of the utility, benefits, and potential constraints of using Earth Observation information services in IAP FS operations. Based on practical examples from Burkina Faso, Ethiopia, Niger and Uganda the focus of this session was on harnessing Earth Observation (EO) information services as demonstrated under the ESA Earth Observation for Sustainable Development (EO4SD) initiative. The presentations were organized according the project cycles: design, operation and impact. After each presentation, the country teams were asked a number of questions related to current use and future needs of EO data. Presentations where given by the EO4SD partners eLEAF and DHI GRAS and by the IAP Ethiopia representative from UNDP. He gave an overview on how Earth Observation aided him in his project work and presented the EO-based monitoring system currently under implementation in Ethiopia. Roughly 30 representatives from various country teams and organisations participated in this infosession.

During the workshops, the various portals were presented to access information. The feedback received from the participants emphasizes that EO products should be made available to all teams via the HUB project revealed the following data: land cover/land use maps incl. crop types, status of vegetation cover and forest resources, biomass productivity, degree of land degradation, soil fertility, water availability, biodiversity cover and rainfall/seasonal trends.

This confirmed again the need and usefulness of Earth observation based data and services for agriculture and rural development concluding a successful Uganda demonstration.

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