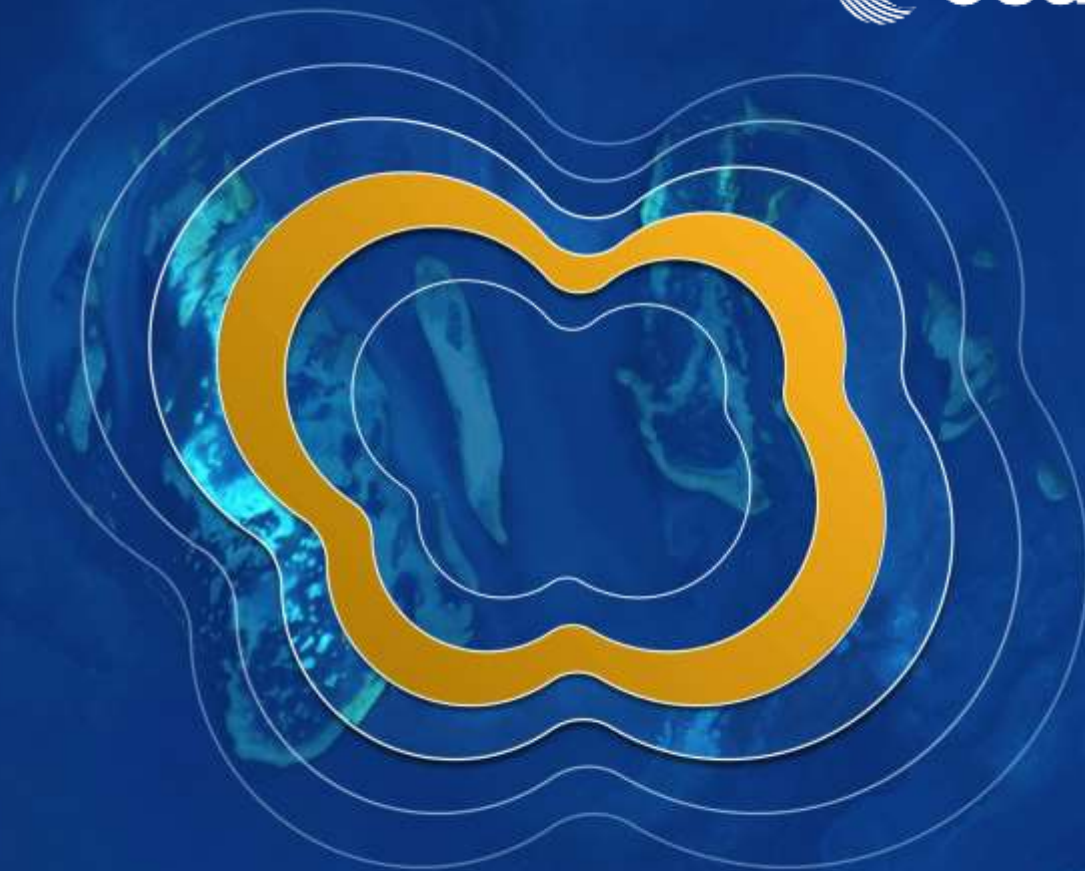


# living planet symposium

MILAN  
13-17 May  
2019



ESA UNCLASSIFIED - For Official Use





CGI



# Operational crop monitoring in Africa using the **Food Security TEP**



**food security**  
tep

Markus Muerth  
Vista GmbH

# Bringing together Food Security and Big Data



**food security**  
tep

## Access to nutritious food is crucial to end hunger and malnutrition

Efficient use of satellite data and spatial information can

- sustainably increase agricultural and aquacultural productivity
- help farmers adapt to global change
- improve early warning initiatives



### ESA's Thematic Exploitation Platforms "Bringing the users to the data"

A collaborative virtual work environment

- providing manifold EO data and tools
- providing processors & ICT resources
- enabling new business models



thematic exploitation platform

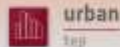
**Start of the project: April 2017 / Platform Release 1.2: Sep. 2018**



**food security**  
tep

- strong focus on users
- agile development
- learning from other TEPs  
- other ESA TEPs started beginning 2015 -

-----> <https://foodsecurity-tep.net>



urban  
tep



geohazards  
tep



forestry  
tep



coastal  
tep



hydrology  
tep



polar  
tep



# The European EO Ecosystem: Space 4.0

("the agreed picture")



**food security**  
tep



Food and Agriculture  
Organization of the  
United Nations



**FarmDrive**

EXPLOITATION TIER

**Exploitation  
Layer**

**Scientific Data  
Exploitation**

**Public Sector  
Benefits**

**Industry  
Growth**

**Copernicus  
Services**

**Platform  
Services Layer**



**Resources Tier  
Layer**

Data  
ICT



**Data Generation  
Layer**

Ground Segment  
Infra-structure



ESA  
Heritage, Earth Explorer,  
Third party Operations



Copernicus Sentinels  
Operations



# Supporting sustainable Food Production from Space



**food security**  
tep

Access to key satellite products and ancillary data, backed up by a **scalable processing infrastructure**

**Universities**

Interact with a range of users through a dedicated **forum**

**App developers**

Ability to **easily develop new services**, with the ability to share processors and outputs only with selected user groups

**Service Providers**

**New Business Model** offer for private companies

**Start-Ups**



Access to **tools** to derive **agricultural** and **aquacultural** products

**Researchers**

Technical **support** for platform use

**Public Entities**

Provision on request of **high-accuracy, quality checked** vegetation parameters (LAI, fAPAR, etc), suitable for use in operational scenarios.

**Int. Bodies**

**Finance Ind.**

Access to **ready-to-use products** or customized services

**Farmers**

**Ag & Aquac. Industry**

# The Main User Interface



**food security**  
tep



- Visit the **ESA Data Access Booth** anytime and/or meet us at the booth on Thursday 11:00-13:00
- See our public **Food Security presentation** in the EO4Society Area, Thursday 17:30-18:00

# Tools on Food Security TEP



food security  
tep



Run your scripts in  
parallel mode!





# Food Security Data and Service Portfolio



Public processing services	Spatial res.
SNAP S-2 Band Ratio Processor	yes
SNAP S-2 Normalized Band Difference Processor	yes
SNAP S-2 Red Edge Position Index	yes
SNAP S-2 Modified Chlorophyll Absorption Ratio	yes
SNAP S-2 Brightness Index	yes
SNAP S-2 Generic Graph Processor	(beta)
Generic R Script Processor	(upcoming)
Sen2Cor	(beta)
(+ your contributions that you can share with others!)	

Parallel Processing Services	Public?
VISTA (Green) Leaf Area	(upcoming)
VISTA Reflectance at Bottom of Atmosphere	(upcoming)
VITO Fraction of APAR	(upcoming)
VITO Fraction of Vegetation Cover	(upcoming)
VITO Normalized Difference Vegetation Index	(upcoming)
VITO Leaf Area Index	(upcoming)
Higher level services (VITO, VISTA, Hatfield)	(upcoming)
(+ your services if you like to deploy your algorithm on the Food Security TEP and become an EO service provider on the platform!)	



# Complementary data for analysis



food security

food security TEP FS-TEP products Reference data

Products Reference data

### ALOS Global DEM 1 arcsec

ALOS World 3D - 30m (AW3D30) is a global digital surface model (DSM) dataset with a horizontal resolution of approximately 30 meters (1 arcsec mesh). The dataset is based on the DSM dataset (5-meter mesh version) of the World 3D Topographic Data. More details are available in the dataset documentation.

Data access is available through WCS service:  
[Capabilities document](#)  
[Describe coverage document](#)

### GFSD 1km Cropmask

The NASA Making Earth-System Data Records for Use in Research Environments (MEasures) Global Food Security Support Analysis Data (GFSD) Crop-Mask Global 1 kilometer (km) dataset was created using multiple input data including remote sensing such as Landsat, Advanced Very High Resolution Radiometer (AVHRR), Satellite Probatoire d'Observation de la Terre (SPOT) vegetation and Moderate Resolution Imaging Spectrometer (MODIS), secondary elevation data, climate 50-year precipitation and 20-year temperature data, reference sub-meter to 5-meter resolution ground data and country statistics data.  
<https://pdssec.usgs.gov/node/11140>

Data access is available through WCS service:  
[Capabilities document](#)  
[Describe coverage document](#)

### GFSD 30m Cropmask

Global Food Security support Analysis Data (GFSD) Cropland Extent 30 m, is the highest spatial resolution global croplands map to date. It was created to help support global food and water security studies for nominal year 2013. The global product was derived from 7 continental or very large area cropland extent products. This dataset contains one band, cropland extent, with 0 = Ocean or inland waterbody, 1 = Non-Cropland, 2 = Cropland. The product was created from two machine learning algorithms (MLAs). These were pixel-based supervised: (a) random forest classifications, and (b) support vector machines. The product was further refined using object-based: (c) recursive hierarchical segmentation (RHSeg).

Data access is available through WCS service:  
[Capabilities document](#)  
[Describe coverage document](#)

### Copernicus Pan-European High Resolution Layers

Pan-European High Resolution Layers (HRL) provide information on specific land cover characteristics, and are complementary to land cover / land use mapping such as in the CORINE land cover (CLC) datasets. The HRLs are produced from satellite imagery through a combination of automatic processing and interactive rule-based classification. Since the production of the 2015 reference year the production is increasingly based on time series of satellite images from a number of different sensors, including the combination of optical and radar data. The main source are the Sentinel Satellites (in particular Sentinel-2 and Sentinel-1). In addition to high resolution (HR) data, since 2015, we also use very high resolution (VHR) imagery for some of the products.

Data access is available through WCS service:  
[Capabilities document](#)  
[Describe coverage document](#)

### ESA CCI Global Landcover

Land cover maps break down the different types of material on Earth's surface, such as bodies of water, ice cover, crops, forests, grasslands and artificial surfaces. This information is important for monitoring changes in land use, conserving biodiversity, managing natural resources and understanding climate change. The European Space Agency Climate Change Initiative Land Cover (ESA-CCI-LC) project delivers consistent global land cover maps at 300 m spatial resolution on an annual basis from 1992 to 2015.

Data access is available through WCS service:  
[Capabilities document](#)  
[Describe coverage document](#)

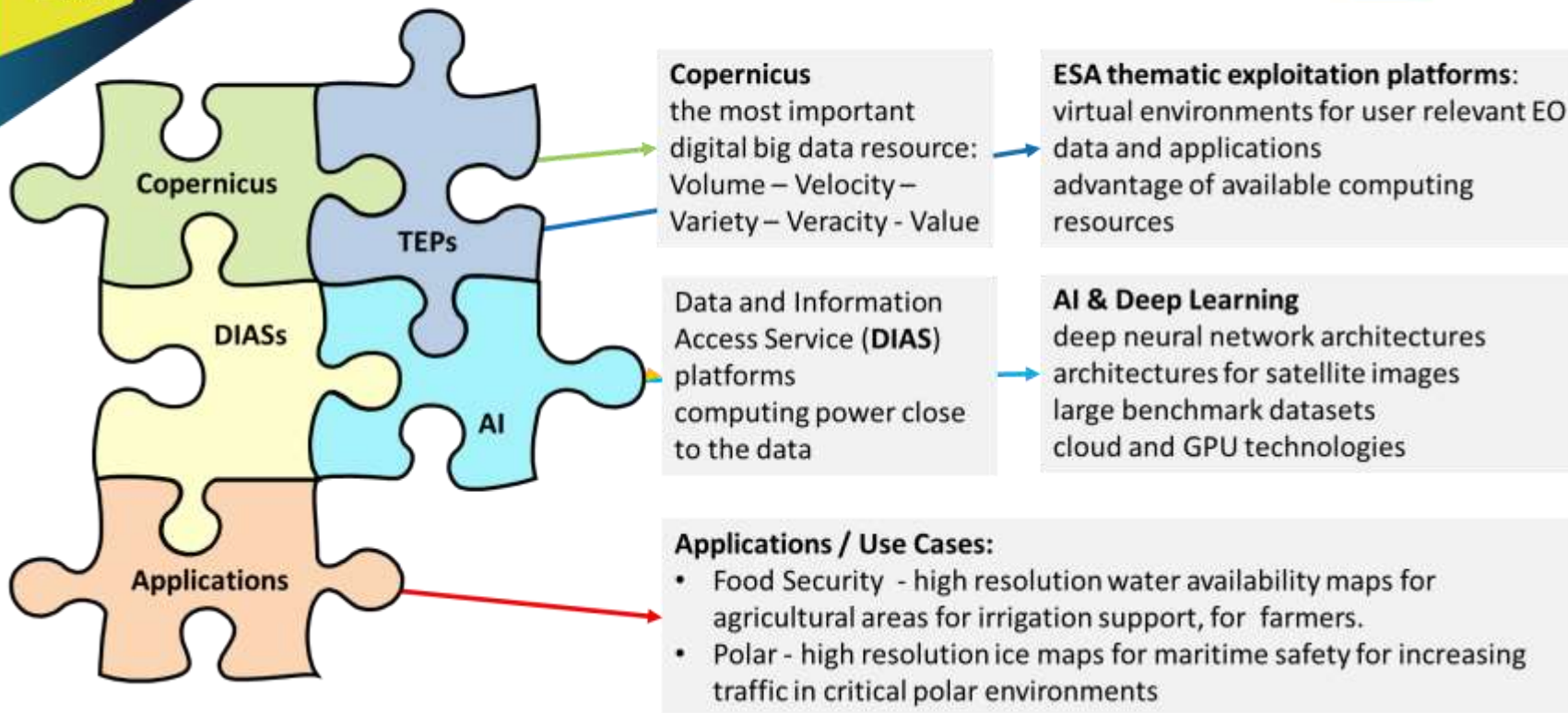
### Global Administrative Boundaries

GADM wants to map the administrative areas of all countries, at all levels of sub-division. We use a high spatial resolution, and of a extensive set of attributes. This is a never ending project, but we are happy to share what we have. You can write us with questions and suggestions, using this contact form: [http://data.gadm.com/contact/gadm\\_contact\\_form](http://data.gadm.com/contact/gadm_contact_form)

Data access is available through WCS service:  
[Capabilities document](#)  
[Describe coverage document](#)

Upcoming:

- HWSD and ESDB Soil maps
- Population data
- Precipitation data documentation



# Pre-processed products



food security  
tep

food security tep FS-TEP products User controls

Products / FS-TEP products

**LAI (VISTA)**



Leaf Area Index (LAI) measures the amount of leaf material in an ecosystem, which imposes important controls on photosynthesis, respiration, rain interception, and other processes that link vegetation to climate. Consequently, LAI appears as a key variable in many models describing vegetation-atmosphere interactions, particularly with respect to the carbon and water cycles.

**Cab (VISTA)**



Leaf chlorophyll content (Cab) is an indicator for crop nutrition status and photosynthetic capacity. Remote sensing of Cab plays an important role in crop growth monitoring, pest and disease diagnosis, and crop yield assessment.

**FAPAR (VITO)**



The Fraction of Absorbed Photosynthetically Active Radiation (FAPAR, sometimes also noted FAPAR or IPAR) is the fraction of the incoming solar radiation in the Photosynthetically Active Radiation spectral region that is absorbed by a photosynthetic organism, typically describing the light absorption across an integrated plant canopy. This biophysical variable is directly related to the primary productivity of photosynthesis and some models use it to estimate the assimilation of carbon dioxide in vegetation.

**FCOVER (VITO)**



The Fraction of Vegetation Cover (FCover) corresponds to the fraction of ground covered by green vegetation. Practically, it quantifies the spatial extent of the vegetation. Because it is independent from the illumination direction and it is sensitive to the vegetation amount, FCover is a very good candidate for the replacement of classical vegetation indices for the monitoring of ecosystems.

**LAI (VITO)**



Leaf Area Index (LAI) measures the amount of leaf material in an ecosystem, which imposes important controls on photosynthesis, respiration, rain interception, and other processes that link vegetation to climate. Consequently, LAI appears as a key variable in many models describing vegetation-atmosphere interactions, particularly with respect to the carbon and water cycles.

**NDVI (VITO)**



The normalized difference vegetation index (NDVI) is a simple graphical indicator that can be used to analyze remote sensing measurements, typically but not necessarily from a space platform, and assess whether the target being observed contains live green vegetation.

06°24'10"N 009°30'51"W 2018-11-15

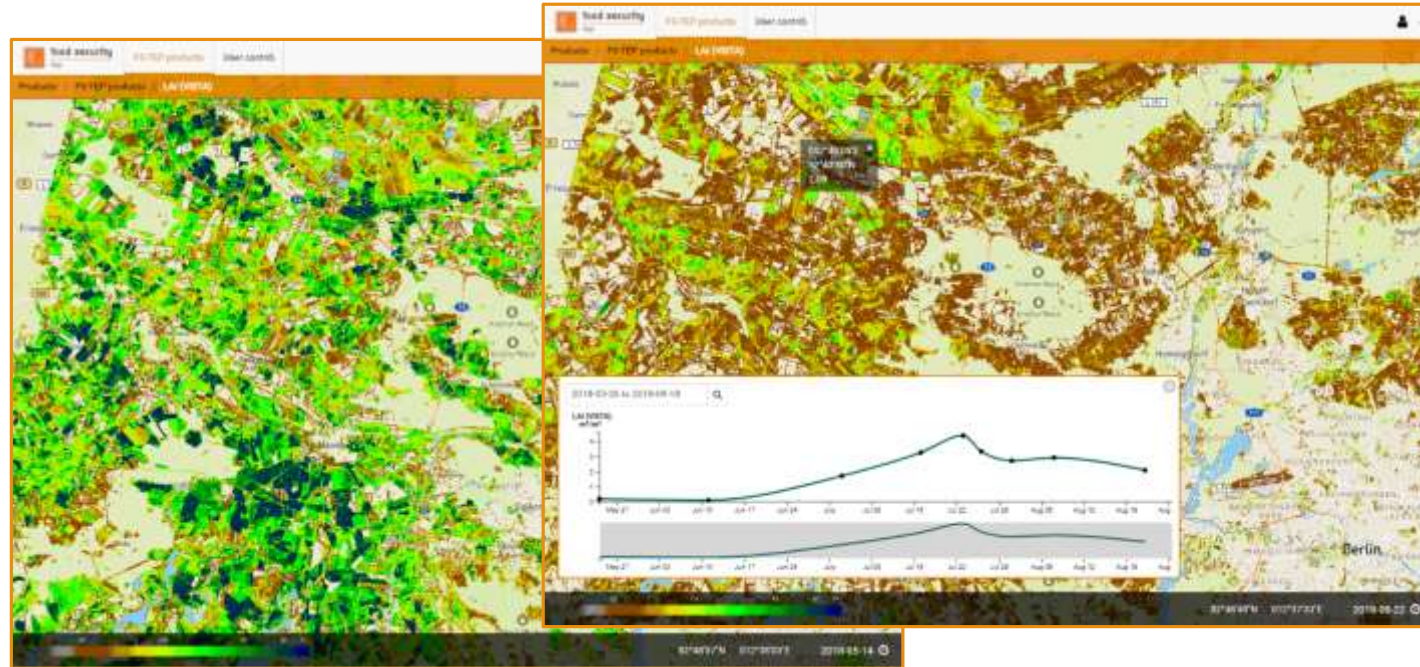
**Product collections of commercial and public service providers provide analysis ready data sets**



# Food Security TEP Analyst View: Browser based visualization



food security  
tep



*Green leaf area of agricultural areas near Berlin, Germany showing the decrease of plant health during the summer drought 2018*

# Food Security TEP Service Pilots

Food Security TEP Customized is **demonstrated** in three **service pilots**.

Pilot 1 'Agriculture' (**VISTA** – VITO)

*Central Europe &  
Southern Africa*



Pilot 2 'Agriculture' (**VITO** – VISTA)

*Kenya*



Pilot 3 'Aquaculture' (**Hatfield**)

*Tanzania*



Food and Agriculture  
Organization of the  
United Nations



## Service Pilot 2: Micro-credits



FarmDrive



food security  
tep

- Agriculture employs 2/3 of Africa's population and contributes 1/3 of its GDP. Yet only **1% of commercial loans** go to the agricultural sector, and very little of that reaches SHFs (**Small Holder Farmers**).
- SHFs are often denied loans because they **lack credit profiles** and lenders have no efficient methods to assess the risks lending to SHFs.
- Additionally, lenders **lack visibility** (i.e. data) into SHFs' agri-businesses and use inflexible lending systems not applicable to the needs of SHFs.
- Lenders therefore either refrain from lending to SHFs or have a high effort which results in exorbitantly **high interest rates**.
- This results in a **agricultural funding gap** (\$450 billion globally) leaving farmers underserved and creating a hole in lenders' client base



# FarmDrive's VP



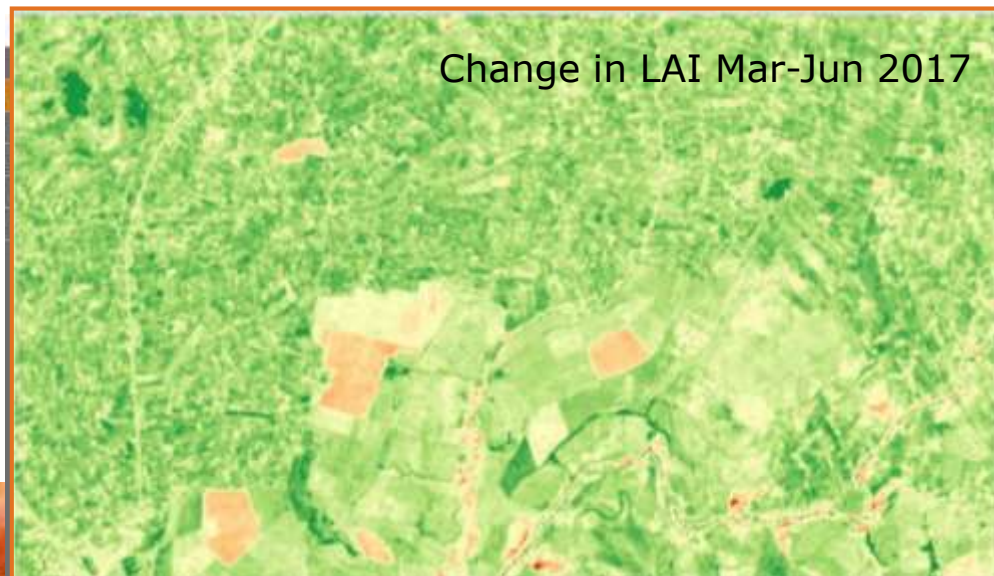
FarmDrive provides tailored mobile loans to SHFs by using innovative credit assessment, data analytics and operational efficiencies. FarmDrive's goal is to efficiently drive capital to smallholder farmers.



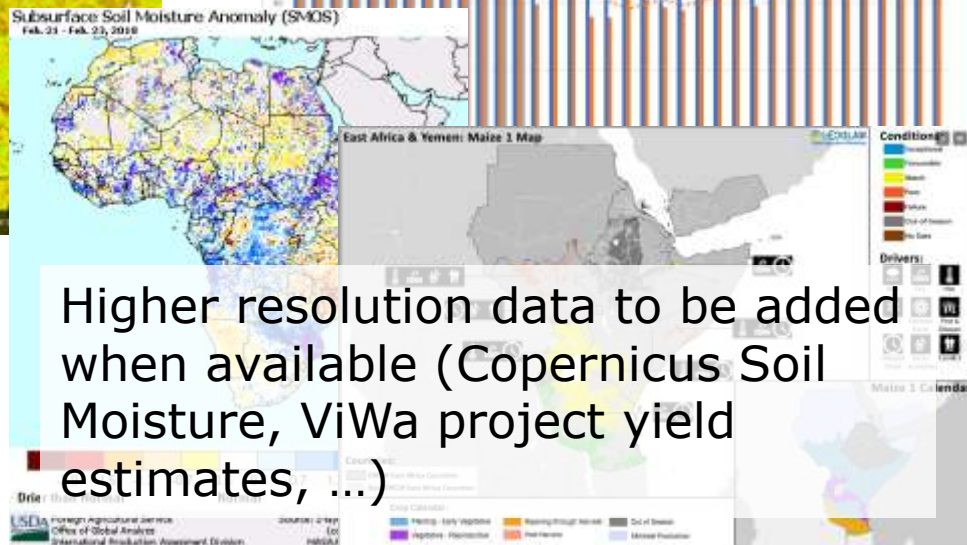
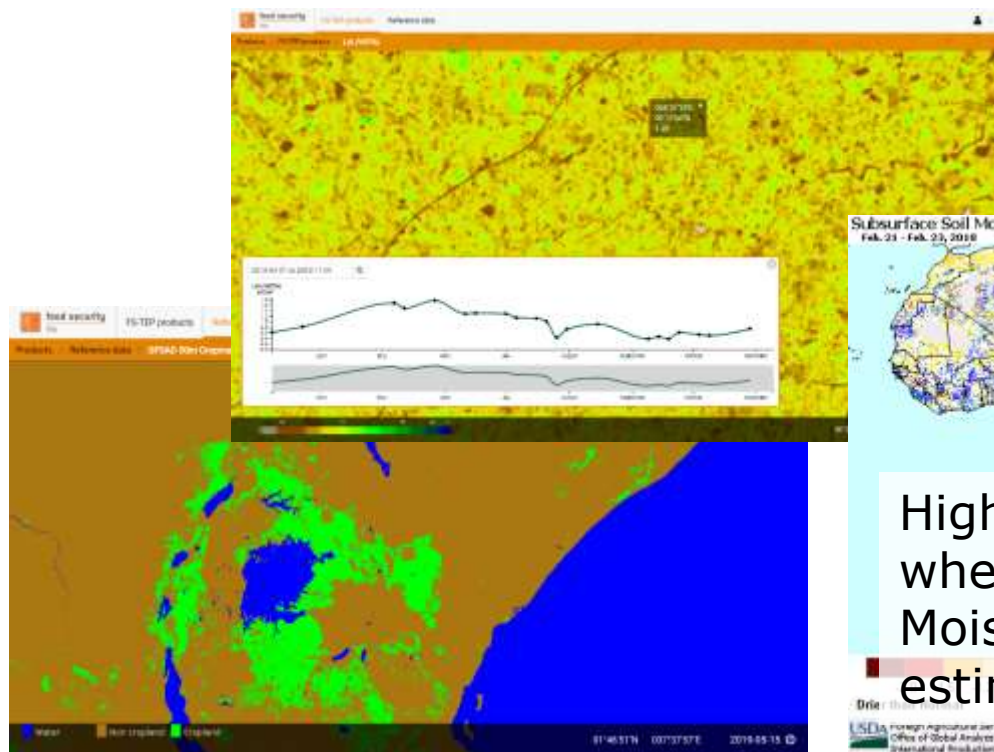


**Trial service to support improved access to credits for smallholder farms (ongoing):**

- **continuous monitoring** of agricultural crops and soils with high resolution data at the regional scale **adding weather and yield estimation data**
- Supporting the local **Kenyan SME FarmDrive** by providing additional information for their portfolio management
- Focus on north-western **Kenya**, where most of FarmDrive's customers are located



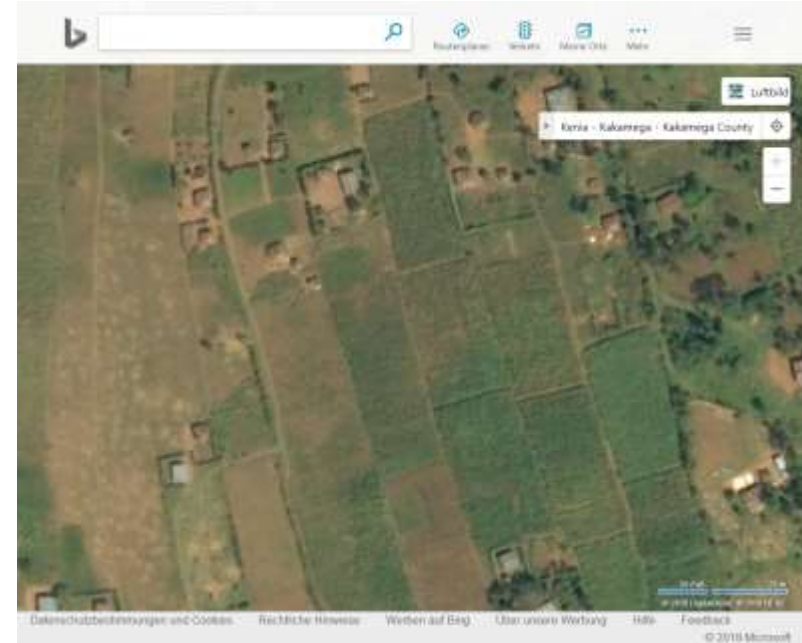
# Monitoring using multiple data sets

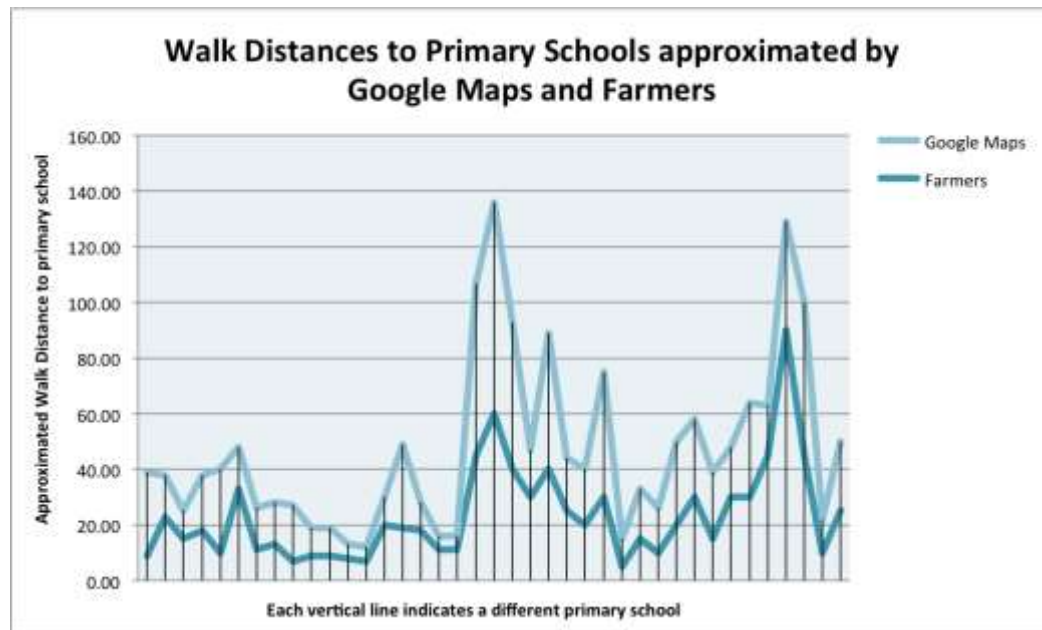


Higher resolution data to be added when available (Copernicus Soil Moisture, ViWa project yield estimates, ...)



- The **dominant crops** of the Northern Rift region around Eldoret are maize, wheat, beans and potatoes
- There is a **variety of maize grown** by SHFs, most of them take up to 9 months to harvest, the main cropping period is from February to November
- Typically, **mixed cropping** on small fields ( $\sim 0.1$  ha) does not allow field-scale monitoring with Sentinel-2 data





SHFs can only be located by cell phone towers, so **no clear georeferencing** can be made. Thus, FarmDrive is working on their own geolocation algorithm based on school distances

*Both Google Maps and farmer approximations follow a similar trend across 39 different primary schools, but farmers appear to walk faster than google Earth estimations*

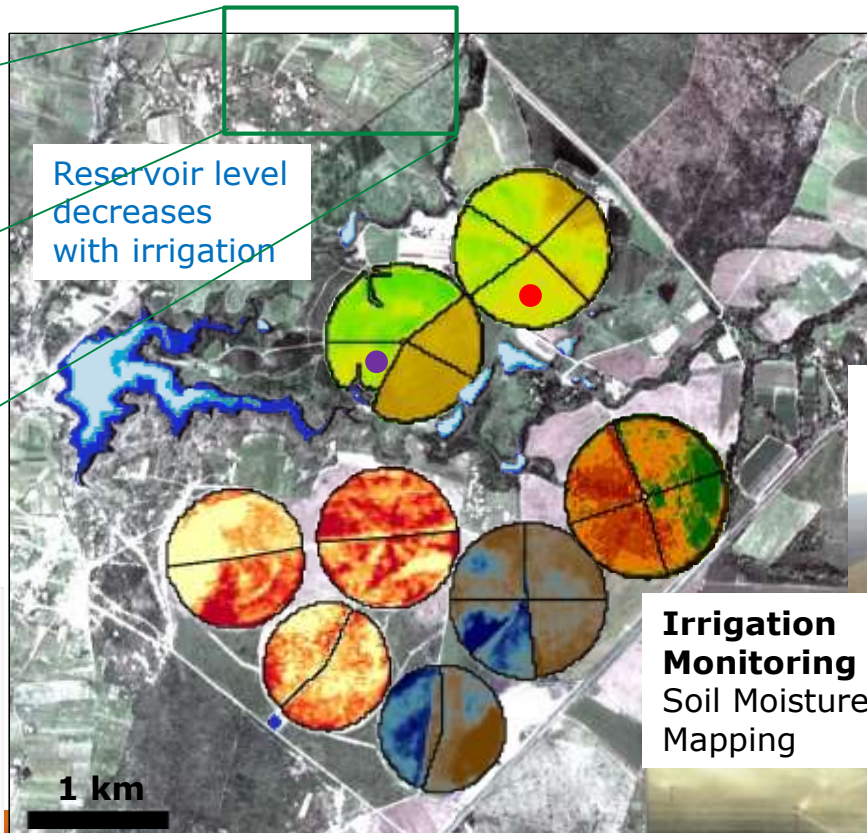
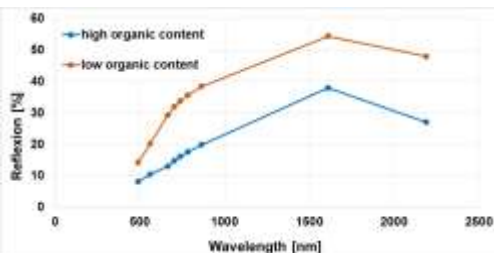
## Food Security

Spatial resolution of S-2 now also allows monitoring of small holder farms.

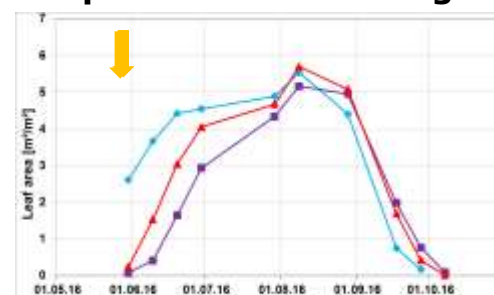


## Soil Quality / Degradation

Mapping of organic content based on spectral features



## Crop Growth Monitoring



## Leaf Chlorophyll

Indicating nitrogen stress and yield losses



## Irrigation Monitoring

Soil Moisture Mapping







CGI



More on Food Security TEP during LPS19:

- Visit the **ESA Data Access Booth** anytime and/or meet us there on Thursday 11:00-13:00
- See our public **Food Security presentation** [EO4Society Area, Thursday 17:30-18:00]
- “**Extreme Earth**– Extreme Data Analytics to Manage an Extremely Dynamic Planet” [*AI and Data Analytics: Technologies and Applications*, Thursday 14:45, Amber 7+8]



**food security**  
tep

Visit us!  
<https://foodsecurity-tep.net>