

→ THE ESA EARTH OBSERVATION Φ -WEEK

EO Open Science and FutureEO

12–16 November 2018 | ESA–ESRIN | Frascati (Rome), Italy

Food Security TEP - Supporting Sustainable Food Production from Space

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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](https://foodsecurity-tep.net)



urban
tep



geohazards
tep



forestry
tep



coastal
tep



hydrology
tep

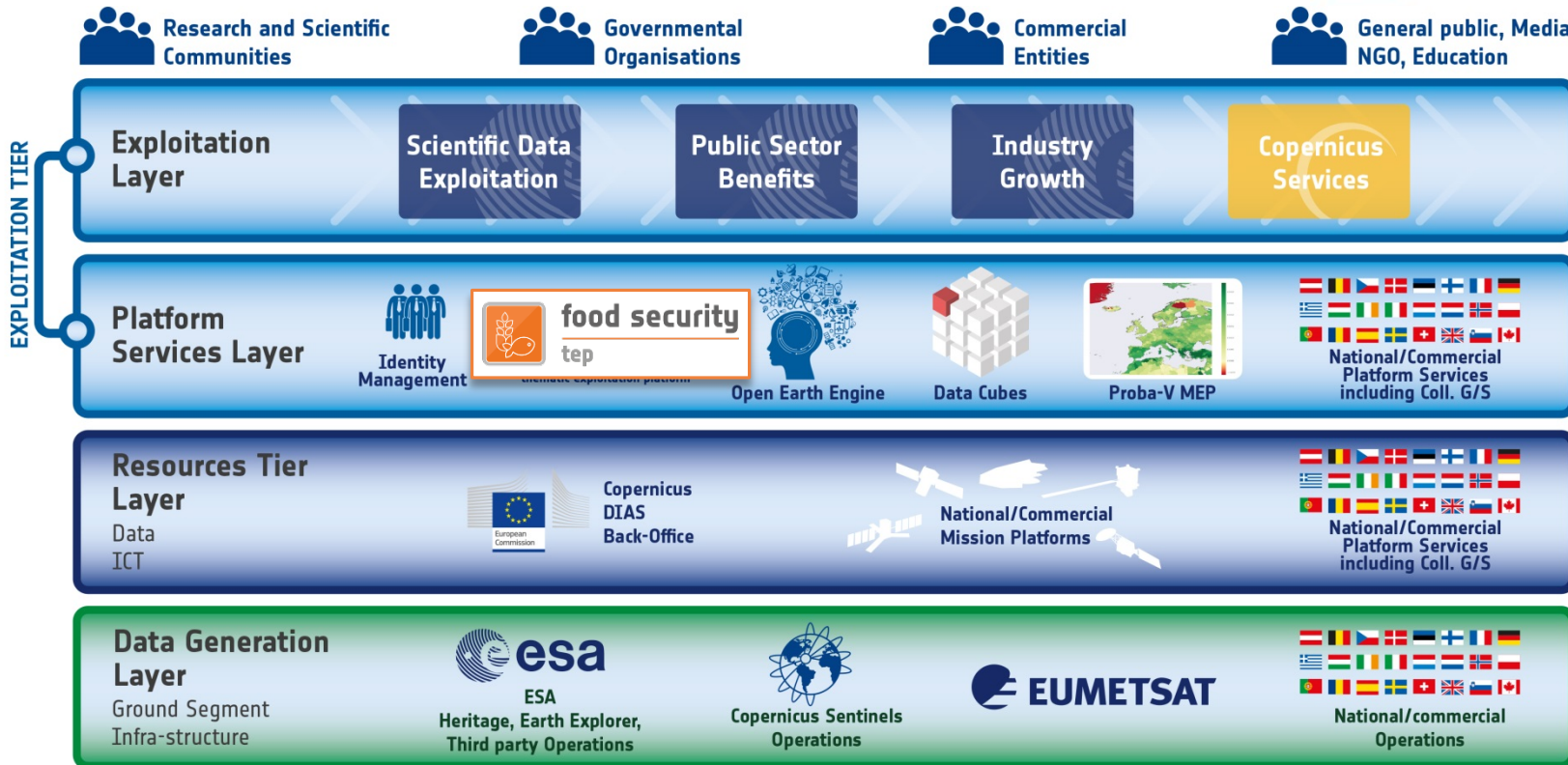


polar
tep

The European EO Ecosystem: Space 4.0 ("the agreed picture")



food security
tep



Supporting sustainable Food Production from Space



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**

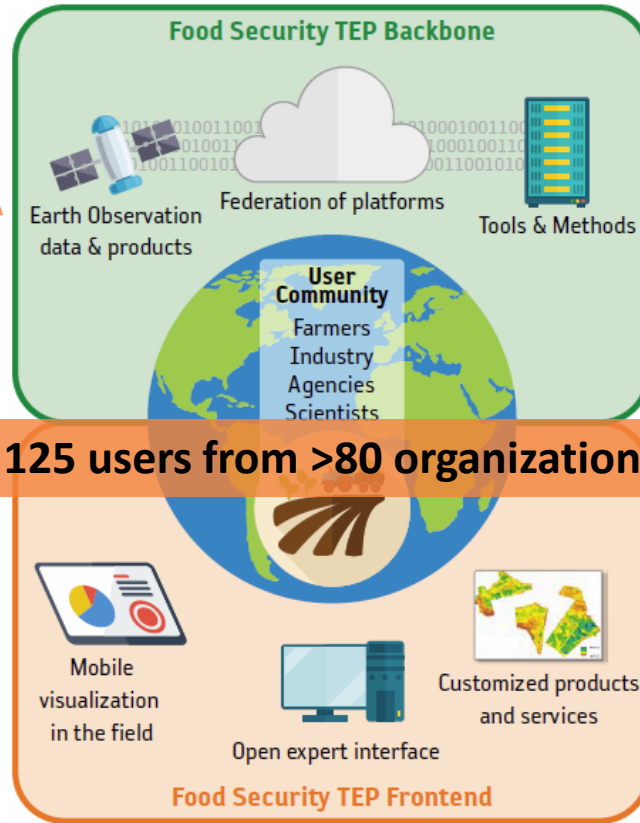
App developers

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

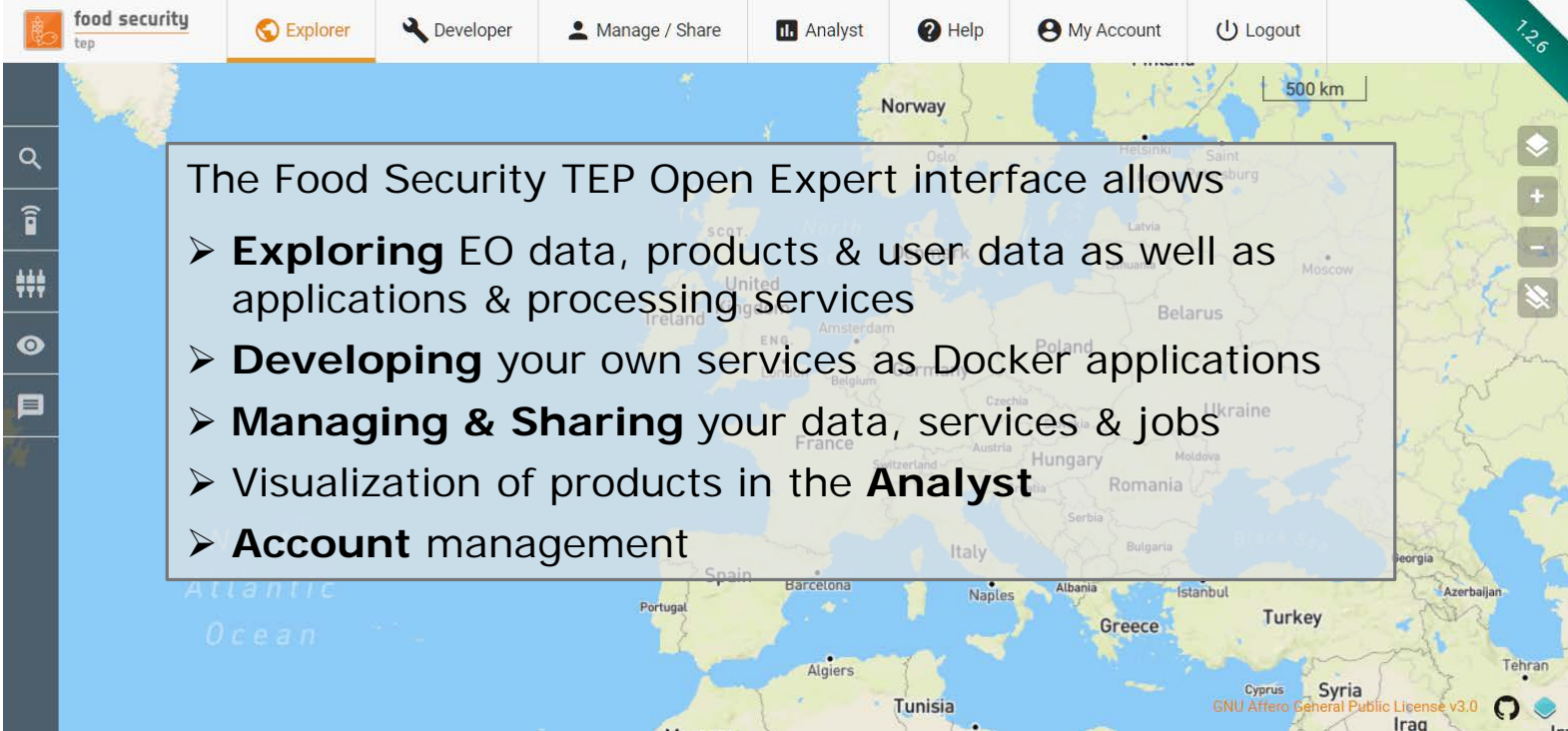
Finance Ind.

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

Farmers

Ag & Aquac. Industry

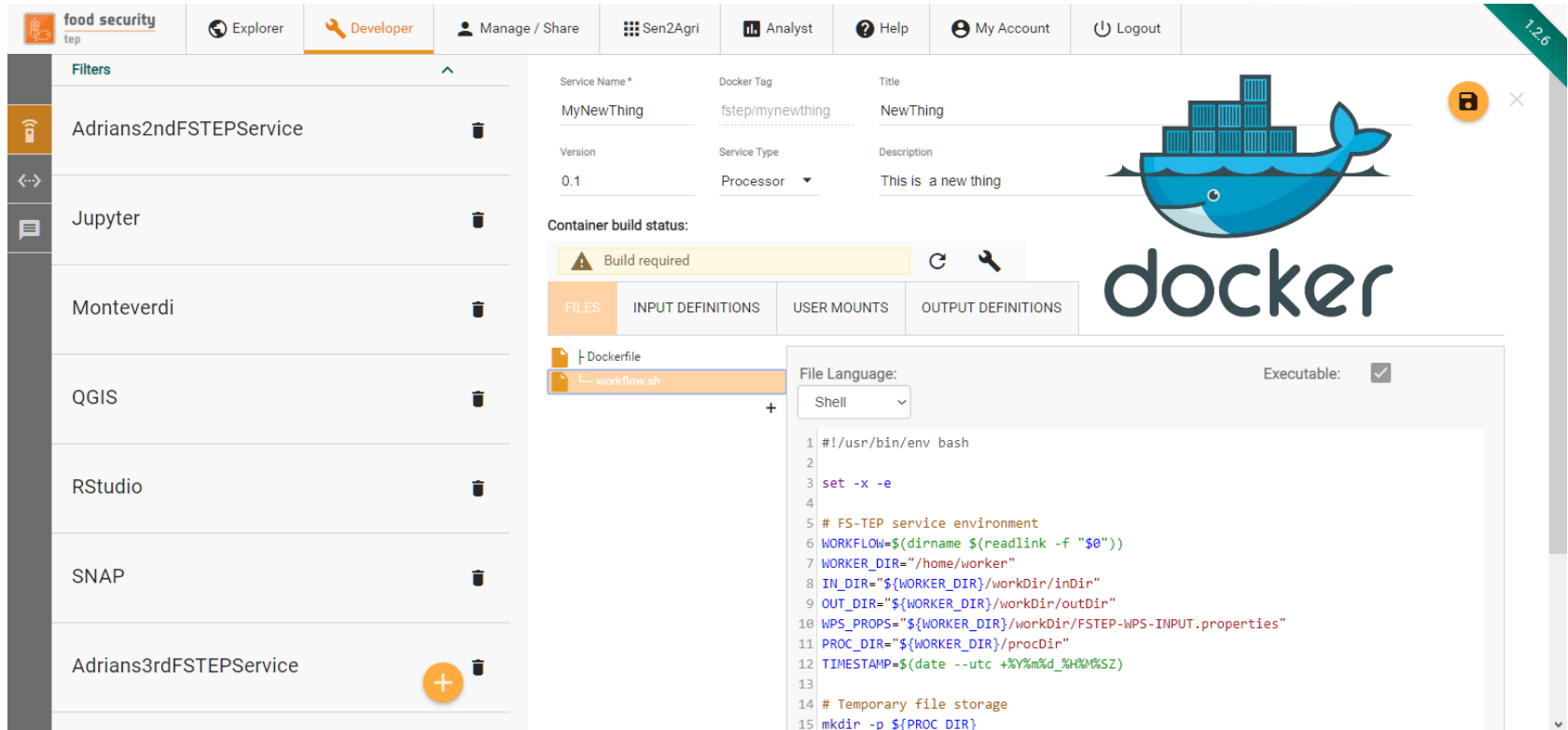
The Main User Interface



The Food Security TEP Open Expert interface allows

- **Exploring** EO data, products & user data as well as applications & processing services
- **Developing** your own services as Docker applications
- **Managing & Sharing** your data, services & jobs
- Visualization of products in the **Analyst**
- **Account** management

Developing new processing services



The screenshot shows the 'food security tep' web interface. The top navigation bar includes 'Explorer', 'Developer' (active), 'Manage / Share', 'Sen2Agri', 'Analyst', 'Help', 'My Account', and 'Logout'. A sidebar on the left lists services: Adrians2ndFSTEPService, Jupyter, Monteverdi, QGIS, RStudio, SNAP, and Adrians3rdFSTEPService. The main content area displays the configuration for 'MyNewThing' with fields for Service Name, Docker Tag, Title, Version, Service Type, and Description. Below this is the 'Container build status' section with a 'Build required' warning and tabs for 'FILES', 'INPUT DEFINITIONS', 'USER MOUNTS', and 'OUTPUT DEFINITIONS'. The 'FILES' tab is active, showing a file named 'workflow.sh' with a 'File Language' dropdown set to 'Shell' and an 'Executable' checkbox checked. The Dockerfile content is as follows:

```
1 #!/usr/bin/env bash
2
3 set -x -e
4
5 # FS-TEP service environment
6 WORKFLOW=$(dirname $(readlink -f "$0"))
7 WORKER_DIR="/home/worker"
8 IN_DIR="${WORKER_DIR}/workDir/inDir"
9 OUT_DIR="${WORKER_DIR}/workDir/outDir"
10 WPS_PROPS="${WORKER_DIR}/workDir/FSTEP-WPS-INPUT.properties"
11 PROC_DIR="${WORKER_DIR}/procDir"
12 TIMESTAMP=$(date --utc +%Y%m%d_%H%M%S)
13
14 # Temporary file storage
15 mkdir -p ${PROC_DIR}
```

Supplemental Dataset	Spatial res.
ALOS Global Digital Surface Elevation Model	30 m
Copernicus Pan-European High Resolution Layers	20 m
GFSAD30 Global Cropland Extent	30 m
Harmonized World Soil Database (HWSD)	30 arcsec
European Soil Database Derived Data	1 km
CHIRPS global meteorological data	0.05°
FAO-UN Global Administrative Unit Layers (GAUL)	(vector)
ESA CCI Global Landcover	300 m
Gridded Population of the World	30 arcsec

Additional Data Services

- **Copernicus Global Land data**, Proba-V and CHIRPS precipitation data will be accessible by **federation with Proba-V MEP**
- The **federation with Coastal TEP** will provide several datasets relevant for aquacultural services
- **Global Yield and Water Use Efficiency Maps** will be provided in collaboration with the Virtual Water Values (ViWa) project

Tools on Food Security TEP



Pre-processed products

food security tep | FS-TEP products | User contrib

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 fPAR) 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)



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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

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

06°24'10"N 009°30'51"W 2018-11-15

Food Security TEP Analyst View: Browser based visualization



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*

BayWa

belgapom

Pilot 2 'Agriculture' (VITO – VISTA)

Kenya



FarmDrive

Pilot 3 'Aquaculture' (Hatfield)

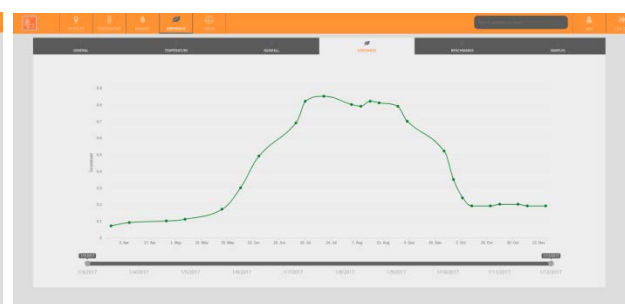
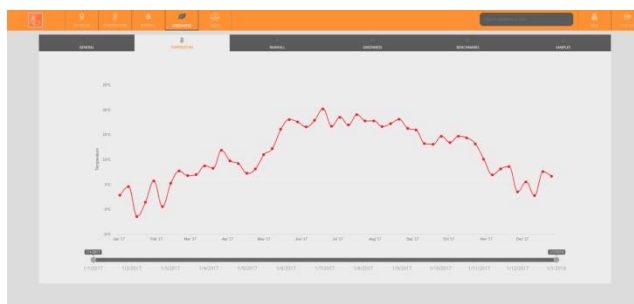
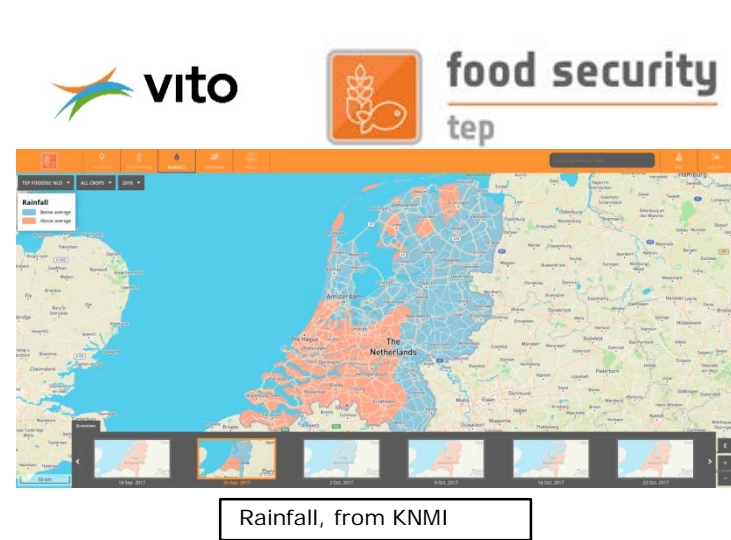
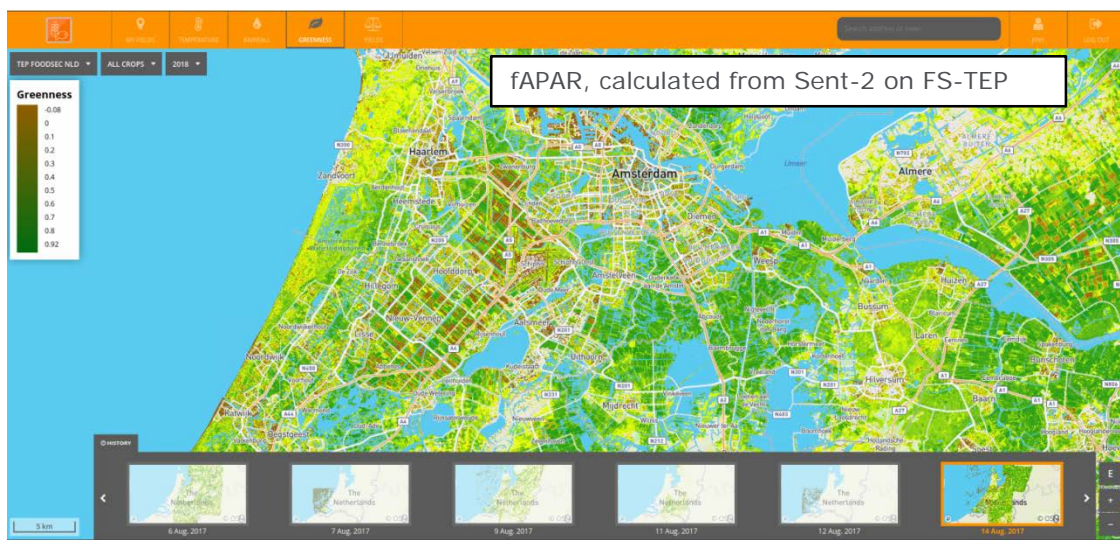
Tanzania



Food and Agriculture
Organization of the
United Nations

„**Customized Service**“ using pre-processed products: **Country-wide monitoring of potatoes from space**

- VITO products transferred from Food Security TEP to VITO hosted Proba-V MEP (federation of platforms) → Powerful data analytics engine
- Pilot integration on Food Security TEP:
 - Service with **Web UI for end-users** on Food Security TEP itself providing access to
 - EO derived information crop growth & development, processed on Food Security TEP
 - Information on weather conditions (rainfall, temp), made available on Food Security TEP
 - Model based yield estimates, developed on Food Security TEP



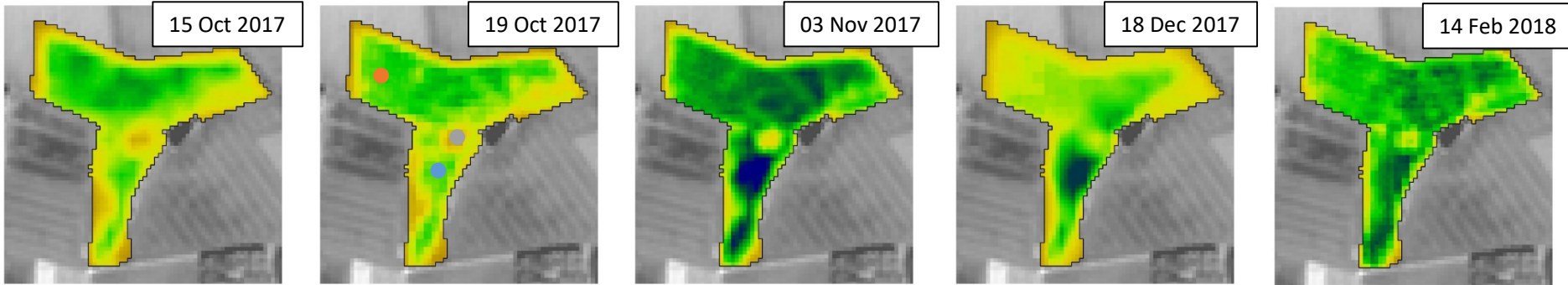
Temperature – Rainfall – fAPAR: time profile for a specific potato field



„**Customized Service**“ using pre-processed products: **On-demand generation** of oil rapeseed **N-uptake maps** at field scale from S-2 leaf area

- VISTA processing chain to derive atmospheric corrected Sentinel-2 data and LAI and chlorophyll products over Germany in 10m.
- **Fertilization** is a central task for each farmer. It determines yield formation, implies costs and can have negative environmental impact (groundwater pollution) when applied inadequately.
- For demonstration of sustainable intensification, **winter oil rapeseed** is a good candidate, since the biomass development over the winter season is input to nitrogen application advice.
(Oil rapeseed is a very important crop in Germany, covering 1.4 Million ha.)

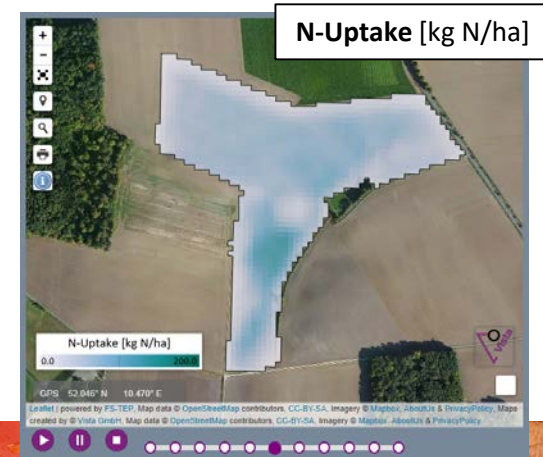
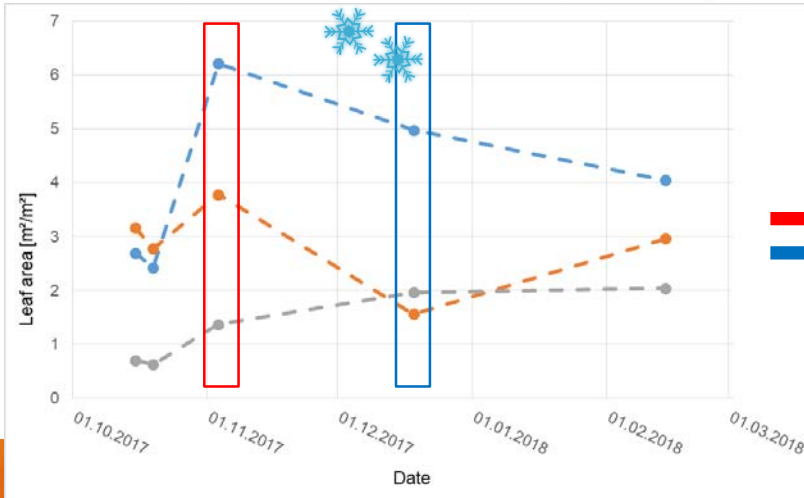
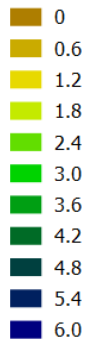
Pilot 1: Oil Rapeseed – Using satellite data for calculating site-specific N-Uptake



Leaf Area Oil Rapessed

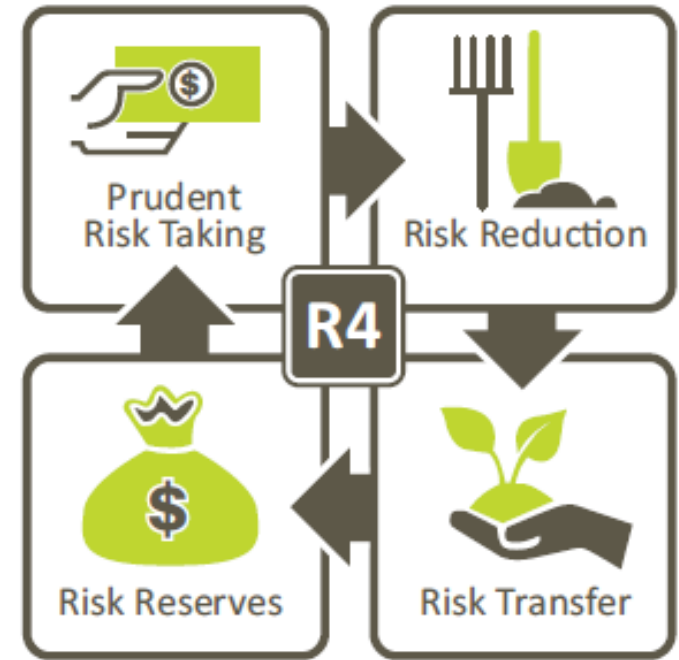
Field boundary

Leaf Area [m^2/m^2]



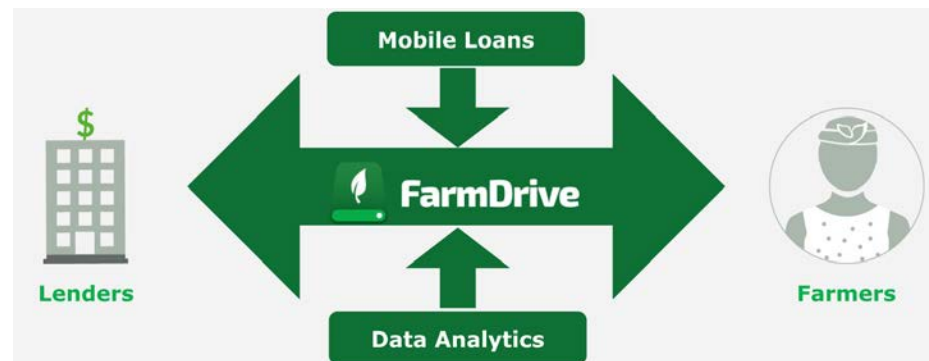
Trial service for Improved crop insurance hedging climate risks (ongoing)

- Use of vegetation indices from high resolution satellite data (Sentinel-2) to improve inter-region **field heterogeneity**
- Supporting the **WFP Rural Resilience Initiative (R4)** which currently reaches nearly 40,000 farmers (about 200,000 people) in Ethiopia, Senegal, Malawi and Zambia
- Pilot application is focused on **Kenya**



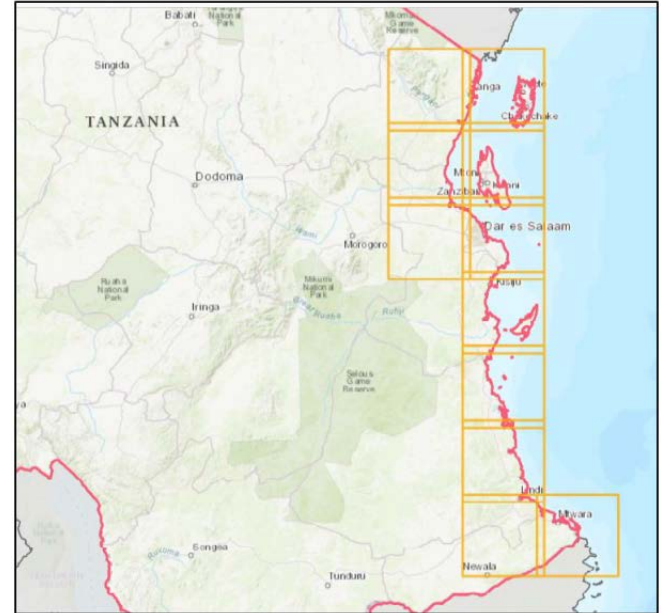
Trial service to support improved access to credits for smallholder farms (ongoing):

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



Trial services for aquaculture practice and management along the Tanzanian coastline:

- **Site suitability assessments** for current and future aquaculture developments (use case seaweed production)
- Inventory and status of aquaculture – supporting the **mapping and attribution** of coastal aquaculture sites and mangrove habitats, which may be affected by clearance for fish, prawn and crab production.





CGI



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