

EO Africa // ARIES



Project Description

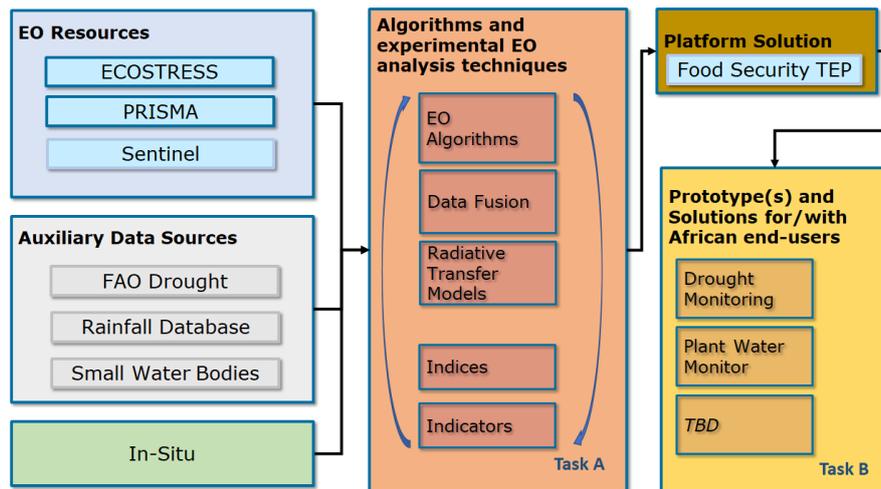
EO AFRICA (African Framework for Research Innovation, Communities and Applications) is a research and development initiative by ESA. It focuses on building African-European R&D partnerships and the facilitation of the sustainable adoption of Earth Observation and related space technology in Africa.

Within “ARIES” experimental EO analysis techniques will be developed and validated, addressing water management and food security in Africa. Those techniques, algorithms and prototype solutions will be based on a new generation of upcoming operational EO data: thermal and hyperspectral. The utilization of hyperspectral (PRISMA) and thermal data (ECOSTRESS) will deliver important information for the design of future missions (CHIME, LSTM). Additionally, algorithms that can be used on such data and tools for its efficient processing will be developed. Doing this in an African setting means, that future services will take into account the needs of African users.

“ARIES” aims to create more detailed and timely information about drought conditions and crop water stress for African land use stakeholders. Thus, helping them navigate changing climatic conditions with unreliable rainfall patterns, that threaten food security. On an individual field or farm level this could e.g., take the form of more timely irrigation. On a larger scale the information that will be generated aims to inform drought policy frameworks in the respective regions.

The proposed research is going to be carried out by three European research groups (VISTA, VITO and LIST) in collaboration with several African partners and research groups. The proposed approach builds on the team’s 20+ years of experience in analysis of thermal and hyperspectral as well as Copernicus and ancillary data.

VISTA, VITO and LIST will acquire a diverse set of data: ECOSTRESS and PRISMA data, Sentinel data, meteorological data, in-situ data etc. With the regular input of African partner organizations, useful data products will be determined and algorithms building on the available data for defined pilot areas will be developed and validated. All processing will happen on the already existing online platform “Food Security TEP”. This is also where all data and algorithms will be freely available to all even after the end of the project.



Conceptual overview of the proposed workflow and steps

To ensure the products developed within the project serve the needs of future users we will work closely together with African Early Adopters. We already reached out to key organizations in Africa and identified five partner organizations that are willing to participate within our project. These five organizations are covering east (AfriGeo, EO research group within the Regional Centre for Mapping of Resources for Development in Kenya & the Regional Centre for Mapping of Resources for Development in Kenya itself), west (AGRHYMET Regional Centre and AAH Action Against Hunger in Niger) and southern (Zambian Agricultural Knowledge and Training Centre LTD in Zambia) Africa. Thereby the developed algorithms and approaches can be validated, tested and evaluated in different geographic regions with different climatic conditions and agricultural practices.

We already identified several information products that can be derived from ECOSTRESS and PRISMA data that serve the defined use case. In some cases, additional data sources are required for the creation of the product. These additional data products are mainly multispectral data of Sentinel 2, thermal data of Sentinel 3 and meteorological data.

Green leaf area

The green plant leaf area will be derived PRISMA data (30m spatial resolution). Green leaf area will be derived in physical units, in this case in m^2/m^2 . This will allow users to get detailed information about the current development of their crop stands. The green leaf area will be used as input to the canopy water content Level 4 product.

Leaf water content

Leaf water content will be derived from Level 2 PRISMA data (30m spatial resolution). Leaf water content will be derived in physical units, in this case in $\mu g/cm^2$ of leaf area. The green leaf area will be used as input to the canopy water content Level 4 product.

Ecosystem water stress

Ecosystem water stress will be derived from the information of ECOSTRESS LST and air temperature (70m resolution). There will be three metrics to represent ecosystem water stress, namely, crop water stress index, evaporative fraction,

and scaled ecosystem drought index. Data fusion between ECOSTRESS data and Landsat 8 will be investigated as a potential way to further increase temporal frequency of the thermal observations.

High resolution crop water stress

High-resolution Land Surface Temperature and evapotranspiration time series (10m – 20m resolution) will be generated through the fusion of daily, low resolution Sentinel-3 thermal imagery with high-resolution Sentinel-2 optical data. We will investigate to what extent high-resolution ECOSTRESS data can be used to finetune the thermally sharpened LST data to generate a high quality daily LST product. Thermally sharpened Sentinel-3 LST data is fused with plant structural and physiological characteristics derived from Sentinel-2 data, the Copernicus Digital Elevation Model (DEM), land cover information and meteorological data from ECMWF ERA-5 and is the basis for creating high-resolution evapotranspiration maps.

Drought susceptible area

Drought susceptibility pockets in the study area will be estimated through a rapid change index. The rapid change index will be derived from the shortwave transformed reflectance using SWIR band information of Sentinel-2.

Canopy water content

The canopy water content will be derived from the PRISMA Level 3 products Leaf Water content and Green Leaf Area (39m resolution). It is given in a physical unit: $\mu\text{g}/\text{m}^2$. The canopy water content can be used as an independent variable to crosscheck the crop water stress derived from ECOSTRESS / S2 / S3 data fusion. While the variables are not synonymous, their patterns should be similar, with higher canopy water contents coinciding with less water stress.

All developed services and products will be made available to the Early Adopters and potential other future users via the Food Security Platform (TEP). The Food Security TEP host almost all relevant data necessary to deliver the proposed products. At the moment, ECOSTRESS data as well as data from Sentinel-2 and Sentinel-3 are already available on the Food Security TEP. PRISMA data is not yet available on the TEP but can be uploaded.

The Consortium will follow agile development methods and engineering best practices in order to develop the proposed products and implementation of first prototypes on the Food Security TEP. The developed algorithms and created products during project time will be maintained long-term and be publicly available on the Food Security TEP.

Generation of new products after the project time will be enabled by making available toolboxes and services for product generation on the Food Security TEP that will allow users to generate products developed within the project after the end of the project. The calculated products will be stored in collections on the Food Security TEP and will thereby be made easily deployable to third parties. The data can either be further utilized within the TEP or be downloaded from the Food Security TEP for offline analysis.

To ensure efficient knowledge-sharing to the wider community we will organize two public webinars with potential future users of the service. We will also identify policy needs and capture the major findings and the policy relevance of the project in Policy Highlights material.

The project runs from October 2022 until April 2024.