**EO MAJI**

**EO Africa explorers**

**State of The Art Review**

V1

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# Introduction

## Project objective

This project aims to implement a prototype for irrigation mapping and crop yield estimation using inputs from the scientific ECOSTRESS and PRISMA missions. The final aim is to develop workflows, in collaboration with the African Early Adopters and EO partner(s), that support African irrigation and food security management, as well as transfering these R&D learnings and results to African end-users and stakeholders. More specifically the project objectives in this project can overall be listed as:

* Exploration of the capabilities for future operational Copernicus missions (LSTM+CHIME) to estimate ET and crop water stress.
* Investigate the potential of PRISMA hyperspectral observations and thermal-based crop stress metrics to improve crop yield/biomass estimations to support agricultural monitoring
* Complement the ET retrievals with crop yield, in order to acquire a better understanding of water use efficiency (WUE) of cultivated landscapes.
* Direct involvement of Africal Early Adopters, in order to secure the usefulness and applicability of the prototype.
* Publish the findings in a freely available code repository and as scientifically peer-reviewed papers, as well as to promote the codes through other outreach activities such as development of digital notebooks.

All activities are to be carried out within the duration of the project lifetime from 1 December 2022 to 30 November 2024.

## Scope of Document

This document presents the characterisation of the involved African Early Adopters, understanding their mandate, technical capacity and working practices. In this document we will identify the benefits that the innovative EO analysis techniques could bring to the involved African Early Adopters. This report consists thus in four sections:: i) User Requirements; ii) Product Specifications; iii) System Requirements; iv) Operational Requirements.

## Reference documents

|  |  |
| --- | --- |
| REF-1 | Statement of Work: ESA-EOP-SD-SOW-0250 – EO AFRICA EXPLORERS |
| REF-2 | EO MAJI proposal dated 18/02/2022 |
| REF-3 | Clarification request from ESA dated 06/06/2022 |
| REF-4 | Response to clarification dated 22/06/2022 |
| REF-5 | Contract No. 4000139395/22/I-DT |
| REF-6 | Deliverable 3: State-of-the-Art |

# User Requirements

## Burkina Faso

## Botswana

## South Africa

# Product Specifications

Three main products related to food security are going to be developed are irrigation delimitation, irrigation accounting and crop yield. For additional information about the proposed solutions please refer to the State-of-the-Art document [REF-6].

The three objective products share basically the same input data sources, mainly ET from ECOSTRESS+PRISMA+Sentinel and crop phenology/biophysical traits, but each product will have slightly different specifications due to different user needs and foreseen retrieval approach. These specifications are summarized in Table 1.

Table 1: Product specifications

|  |  |  |  |
| --- | --- | --- | --- |
|  | Irrigation delimitation | Irrigation accounting | Crop yield |
| Physical unit | Binary (Presence/absence) | mm/ha or m³ | kg/ha |
| Spatial Coverage | Regional | Regional | Regional, provided for a given crop |
| Spatial Resolution | 20 m | 100 m | 20 m |
| Temporal Coverage | 2021-2023 | 2021-2023 | 2021-2023 |
| Temporal Resolution | Annual | Monthly | Annual or 2 per year |

All products will have a regional coverage as defined by the Areas of Interest (AOI) submitted for PRISMA acquisitions, the extension of these AOIs are described in Table 2. However, for the crop yield product, within each AOI, only yield information will be provided for the crop of interest (Table 2). Furthermore, since rice in Burkina Faso is cropped twice a year, during the wet and dry seasons, the temporal resolution in this case will consist of two maps per year.

Table 2: Site-specific product specifications, including the spatial coverage for the Areas of Interest of the three African sites and the crop of interest.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Burkina Faso | Botswana | South Africa |
| Minimum Longitude | -4.45 | 28.4 | 26.7 |
| Minimum Latitude | 11.35 | -22.6 | -26.9 |
| Maximum Longitude | -4.35 | 29.4 | 27.7 |
| Maximum Latitude | 11.45 | -21.6 | -25.5 |
| Crop of interest | Rice | Potato | Maize |

The spatial resolution for each product depends mainly on the foreseen sensitivity of the input products. Both irrigation accounting and crop yield would be as sensitive to phenology (shortwave region) as to evapotranspiration (ET, thermal region), and thus 20m resolution could be considered as the goal. However, irrigation accounting is much more sensitive to ET and meteorological data (e.g. rainfall to force the water balance required in the proposed algorithm [REF-6]) and thus we consider delivering a product with a goal of 100m spatial resolution. This is also in line with the user need requirements, since irrigation accounting is useful for water resources planning (I.e. irrigation district level), and water licensing (i.e. parcel level).

# System requirements

# Operational requirements

The operational requirements (timeliness, uncertainty and precision) for the prototypes of irrigation delimitation, accounting and crop yield are summarized in Table 3. Timeliness in this set of products in not critical as these are meant for planning activities. Therefore there is no need to produce near-real-time products and a 1-3 months not-time critical timeliness is targeted. Since irrigation accounting requires running a water balance model, we consider 4 months timeliness in order to use ERA5 reanalysis rainfall data to ensure a better quality. Nevertheless, a short-time critical product for both irrigation accounting and crop yield could also be considered, in order to provide actual irrigation accounting for enforcing water licensing as well as to forecast crop yield before harvesting.

Table 3: Operational requirements

|  |  |  |  |
| --- | --- | --- | --- |
|  | Irrigation delimitation | Irrigation accounting | Crop yield |
| Timeliness | 1 month after the end of the season | 4 months after the end of the season | 1 month after the end of the season |
| Uncertainty | 5% overall accuracy | 100 mm/ha or 20 % relative error | 500 kg/ha or 10% relative error |
| Precision | 20 m | 1 mm/ha | 1 kg/ha |

The precision also differs between products. Since irrigation delimitation is a binary mask produced at 20m spatial resolution (Table 1), its precision can be considered as well as 20m. On the other hand, the precision for both irrigation accounting and crop yield, as scale variables, are influenced by the input data and the standard reporting units.