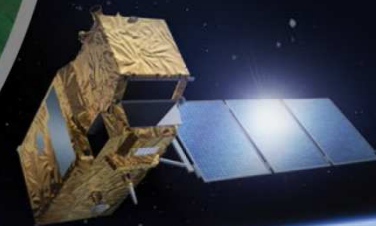


→ SENTINEL-2 FOR AGRICULTURE

Towards the exploitation of Sentinel-2 for local to global operational agriculture monitoring



Newsletter 2 - October 2014

On the track towards system development

After 8 months of work and the completion of all the activities related to user requirements consolidation which are presented in this issue, the Sentinel-2 for Agriculture project is currently entering a new stage.

It is time now to go on and focus on the specification of the Earth Observation based products to be delivered, as well as the selection and assessment of underlying image processing algorithms, which are the key success factors for the implementation of the future system.

There is still some way to go before the latter is fully operational, but exchanges with end users show we are moving in the right direction.

Staying tuned with the worldwide agriculture monitoring user community

In the context of the ESA Data User Element, the Sentinel-2 for Agriculture project is following a user-driven approach, meaning that a dedicated user community will closely interact with the consortium throughout the whole project. The interactions, initiated in 2012 through an ESA User Consultation meeting, went on during the project **1st User Workshop** held on May 19 at FAO in Rome. More than 50 people, coming from 20 different institutions, attended to discuss the user requirements, from which will be derived the products specifications.

The workshop offered each participant the possibility to take the floor. ESA and the consortium introduced the project and its objectives. The Champion Users exposed their key work linked with the project and their specific expectations. The managers of the sites that would be used in the project presented the corresponding areas in terms of agro-ecological context and their activities with regard to in-situ data collection.

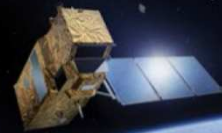
In addition to the definition of clear technical expectations for 4 products, a key output was the discussions and agreement about a cropland definition suitable for all actors. As a conclusion, all attendees expressed their interest and their intention to be actively involved in the project. So let's meet in future conferences to discover more about it and, at the latest, in 2015 for the 2nd User Workshop!



One step further with the JECAM network

The first **JECAM Science Meeting** gathered more than 40 scientists from around the world in Ottawa from 21 to 23 July. Our project, presented as one of the very first across JECAM sites initiatives, was actively represented thanks to the participation of several site managers.

The cropland definition discussed during the 1st User Workshop was proposed for final examination and endorsement by the JECAM network. This process is currently going on, with the possibility to update the definition based on later experimental evidence. In support to this definition, FAO just completed an overall cropland nomenclature compliant with its Land Cover Meta Language ISO standard, allowing to scope precisely the different targets considered in Sentinel-2 for Agriculture,

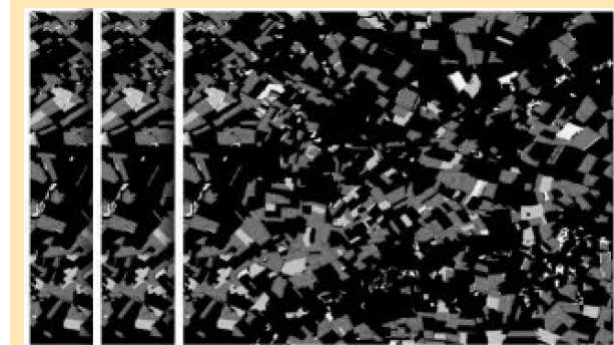
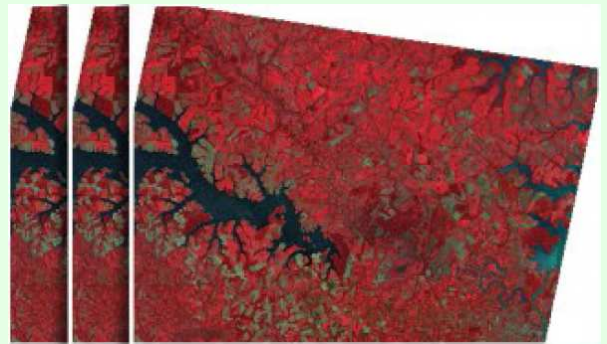


A comprehensive portfolio of products endorsed by all the project partners

The consolidation of users requirements, a well as the conclusions of the 1st User Workshop, resulted in the definition of a portfolio including 4 items to be supplied by the future **Sen2-Agri system**. These products will be demonstrated during the last year of the project with Sentinel-2 data over 3 national and 5 local sites that are still to be selected. A open-source toolbox will then be released at the end of the project, to allow any user generating its own Sentinel-2 for Agriculture products.

Monthly cloud-free surface reflectance composite

- ❖ Surface reflectance values in all the Sentinel-2 bands at sensor full spatial resolution (4 bands at 10 m and 6 at 20 m)
- ❖ Suitable for visualization or as classification and/or segmentation algorithm inputs to handle data gaps in image time series

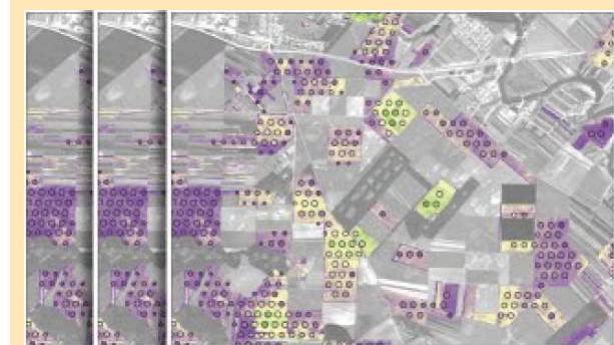
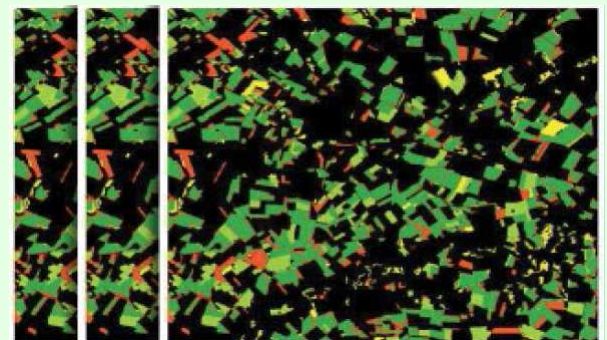


Dynamic annual cropland mask

- ❖ Binary map provided on a regular grid at 10 meter resolution
- ❖ Temporal resolution of 1 month, each mask being derived from a 12 month moving window of input data
 - ❖ Annual cropland defined as *“a piece of land of minimum 0,25 ha actually sowed/planted and harvestable at least once within the 12 months after the sowing date, which produces an herbaceous cover possibly combined with a tree cover”*

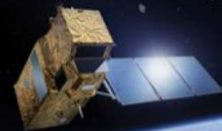
Cultivated crop type map and early crop area indicator

- ❖ Map of the 5 main crop types delivered twice a year (first half and end of the season) on a regular grid at 10 meter resolution
- ❖ 5 main crops defined as those covering each one a minimum area of 5% of the annual cropland and as a whole a cumulated area higher than 75%
- ❖ Early crop area indicator delivered as the crop type proportion inside a 1 km² pixel



Vegetation status indicators

- ❖ Maps of NDVI and LAI showing the evolution of the green vegetation corresponding to crop vegetative development delivered at 20 meter resolution on a 7-day basis (once the whole Sentinel-2 constellation is available)
- ❖ NDVI metrics (start date and length of the season, amplitude) delivered from the first half of the season



The benchmarking exercise: the road from in-depth research to an operational system

The benchmarking exercise is dedicated to the testing of algorithms for the development of the proposed products. For each of them, a minimum of **5 algorithms**, previously identified from the state of the art of literature, will be analysed and compared in order to select the most relevant processing strategies.

In practical terms, the benchmarking exercise can be viewed as composed of:

- ❖ An **input dataset**, including Sentinel-2 like time series made of Spot 4, Landsat 8 and RapidEye imagery, as well as in-situ data;
- ❖ A set of **alternative processing algorithms**;
- ❖ Different **output products** to compare;
- ❖ A **methodology for comparison** involving specific criteria, along with appropriate validation in-situ information.

This activity should contribute to improve the understanding of the considered algorithms and will result in the assessment of their performance towards a list of objective criteria, as well as the appraisal of products quality.

Benchmarking is therefore an essential step in the project development to ensure that the implemented system fulfils the user requirements to a maximum extent. Our Champion Users are also deeply involved in this process as they not only took part to the selection of the 12 sites taken into account, but will also provide the in-situ data requested for validation and actively participate to the final product assessment.



A few facts and figures

In order to prepare the Sen2-Agri system operational use, the requirements consolidation process also included the definition of an **Exploitation Scenario** for an agricultural monitoring scheme at national scale.

Under basic hypotheses (a 6 month crop season, a 5 day revisit cycle, no image rejected because of cloud cover), running the system at this level (i.e. over an area of 500 000 km²) would:

- ▶ Ingest around **710 Gb** of Sentinel-2 L1c input data;
- ▶ Request more than **3500 Gb** of disk space to store intermediate products generated during processing;
- ▶ Deliver more than **800 Gb** of final products.

These figures led our consortium to think a dedicated **system architecture** capable of meeting the corresponding challenges.

To reach this objective, several approaches are under consideration (high-performance computer, local or external cluster or external cloud computing resources) and the next system design phase will help to select the most relevant one.

Sentinel-2 for Agriculture benchmarking sites and related sites managers

Let's talk about it

- ▶ The **4th RAQRS Symposium**, held in Valencia, Spain, from **22 to 23 September**, gave the Sentinel-2 for Agriculture consortium the opportunity to present various aspects of the project to the scientific community through 2 oral communications and 3 posters. The corresponding abstracts can be retrieved from the symposium Web site (<http://ipl.uv.es/raqrs>) and the final proceedings will be available soon.
- ▶ The next **GEOGLAM Implementation Plan Review meeting** will take place between **October 20 and 22** in Beijing, China. During this event, an update will be made about on-going projects which are expected to deliver significant results for the production and dissemination of relevant, timely and accurate forecasts of agricultural production, and the current status of Sentinel-2 for Agriculture will be presented. More information can be found at http://www.earthobservations.org/geoglam_me.php.



Sentinel-2 for Agriculture at a glance

Achieving sustainable food security for all people is a priority highlighted during the Millennium Summit of the United Nations in 2000, which defined the eradication of extreme poverty and hunger as one of the eight Millennium Development Goals. In response to such growing pressure, the development of agriculture applications is becoming a strategic target for the remote sensing community.

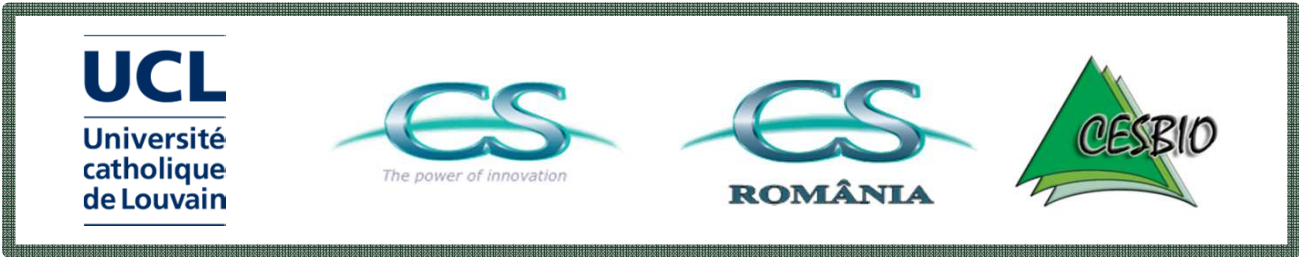
In this context, **ESA** has launched the **Sentinel-2 for Agriculture** project, as a major contribution to the R&D component of the GEOGLAM initiative and to the JECAM network activities. This 3-year project aims at demonstrating the benefit of the Sentinel-2 mission for agriculture across a range of crops and agricultural practices. The intention is to provide the international user community with validated open source algorithms and software to process Sentinel-2 data in an operational manner and derive Earth Observation products relevant for crop monitoring in the major worldwide representative agriculture systems.

The project is carried out in close collaboration with 18 organizations, centers, universities or companies belonging to the agriculture monitoring communities. They are our Champion Users, involved in the project since its very beginning.

The activities are split into several steps for coming to national and local demonstration:

- ▶ During **Phase 1**, user requirements will be collected and consolidated to set up relevant products and system specifications. Simulated test datasets representative of future Sentinel-2 imagery will be acquired over 12 test sites to benchmark algorithms and design the system.
- ▶ **Phase 2** will be devoted to the development of an open source processing system and the generation of prototype products based on the Phase 1 outcomes.
- ▶ Starting right after the Sentinel-2 commissioning phase, **Phase 3** will demonstrate and validate the developed system with actual Sentinel-2 time series, with the additional objective to transfer the system to the Champion Users at operational level.

The Sentinel-2 for Agriculture project is carried out by a consortium led by the **Université Catholique de Louvain** (BE) and involving the **Centre d'Études Spatiales de la Biosphère** (FR) and the companies **CS - Systèmes d'Information** (FR) and **CS Romania** (ROU).



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