Sentinels Synergy for Agriculture

Deliverable D5.7

Synergy with Sentinel-3 to improve crop mapping algorithms

V 1.0

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Abstract (for dissemination)	This report summarizes the foreseen and actual exploitation of the S3 data for crop classification in SENSAGRI, explaining the causes of the deviations.
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[1] R = Document, report; DEM = Demonstrator, pilot, prototype; DEC = Websites, patent fillings, videos, etc; OTHER; ETHICS = Ethics requirement

[2] PU = Public; CO = Confidential (Consortium and Commission Services); EU-RES = Restreint UE; EU-CON Confidentiel UE; EU-SEC = Secret UE (Commission Decision 2005/444/EC)

Table of Contents

1. Introduction

1.1. Scope of the document

This report summarizes the foreseen and actual exploitation of the S3 data for crop classification in SENSAGRI, explaining the causes of the deviations.

1.2. Notations, abbreviations and acronyms

CAP	European Union Common Agricultural Policy
CEE	Copernicus Entrusted Entities
CLMS	Copernicus Land Monitoring Service
EC	European Commission
EE	Entrusted Entities
EEA	European Environmental Agency
EEAB	External Experts Advisory Board
ESA	European Space Agency
EU	European Union
GA	Grant Agreement
GAM	General Assembly Meeting
IACS	Integrated Administration and Control System
JRC	Joint Research Centre
PO	Project Officer
REA	Research Executive Agency
S1	Sentinel-1
S2	Sentinel-2
S3	Sentinel-3
WP	Work Package
WPL	Work Package Leader
WT	Work Task

2. Use of S3 data within SENSAGRI

2.1. Use foreseen in the proposal

The work programme topic (EO-3-2016; Evolution of Copernicus Services) requested the ground be prepared for the innovative exploitation of European space data, for new upstream data products and analysis methods for subsequent integration into applications and services. Special emphasis was demanded on providing proof-of-concepts or prototypes for a proposed evolution of the Copernicus agricultural monitoring services, respecting the border between Copernicus services and downstream services. As a result, RD&I as well as commercial and operational exploitation of S1, S2 and eventually S3 data will be fostered, hence promoting Europe's leadership in space-enabled agricultural monitoring services.

SENSAGRI addressed specifically the research needs indicated in the section 5.2.5 of the EO-3-2016 Guidance Document regarding **crop area and crop status monitoring** within the Pan-European Land component of Copernicus.

One of the key questions indicated in the 5.2.5 section of that guidance document of EO-3-2016 was:

How does the synergetic use of S1 and S2 imagery enhances the derivation of temporal crop parameters from lower resolution instruments, in particular those of Sentinel-3?

In the proposal and in the subsequent Description of the Action, we proposed to explore in SENSAGRI the possibilities of using S3 as suggested in the Guidance Document. We already had previous experiences in this type of fusion methods. However, we warned on the uncertainties of this approach, taking into account that S3-A was still at the commissioning phase at the moment of writing the proposal. The processing tools and quality of S3 data was still unknown. The text in the proposal stated the following:

The potential for the synergies between S2 and Sentinel-3 (S3) were already investigated by UPS-CESBIO in a simulation study (Inglada et al., 2013) in which different methods for merging Proba-V and S2 data were tested and its impact in crop classification was evaluated. The results indicated that a modified STARFM algorithm (Spatial and Temporal Adaptive Reflectance Fusion Model) gave the best results for seasonal classification where all the images of the series are available. The results of this simulation study probably still hold when merging S3 and S2, but it has to be demonstrated with actual data. This will be specifically addressed in WT 5.6, in which S3 images will be used to improve the proposed multi-temporal crop mapping algorithms.

However, S2 and S3 fusion techniques are not offered from the beginning of the project as a core part of the prototypes, since at this moment is impossible to assess whether all aspects of the ground processing of S3 will be running smoothly. The first of the two S3 satellites has just been successfully launched at the very moment of this writing (16/02/2016). In the next months, the satellite will go through the commissioning phase. This means that currently S3 data exploitation is not possible yet, although it is expected that by the take-off of SENSAGRI first OLCI images will be ready to be delivered. We shall closely follow up the S3 image acquisition and pre-processing progress of S3, since the synergy with S3 is of special interest for increasing the temporal resolution of some of the services.

SENSAGRI thus proposed to explore the use of S3 images to improve the proposed multi-temporal crop mapping algorithms. This was expected to be attempted in the WT 5.6 (text below):

WT 5.6. Use of Sentinel-3 images to improve the proposed multi-temporal crop mapping algorithms (UPS-CESBIO) [M22-M34]

Due to cloud cover and even to some rapid changes, a higher temporal resolution may be needed for mapping crops in some landscapes. One of the ways to improve the temporal resolution of the data used in the classification system is to merge S1-S2 time series with higher temporal resolution systems such as S3. However, the directly exploitation of S3 with S1-S2 images is not feasible due to its low spatial resolution. For this reason, this WT will aim at exploring how the very high temporal resolution of S3 can be used in previous presented classification algorithms.

2.2. Causes for deviations

- Although the objective of exploring the use of S3, mainly as a gap-filling option for the Seasonal Crop Mapping prototype, was kept during all along the project life, at the moment of activating WT 5.6, all the effort of CESBIO, the main responsible, were still put in the main priority of WP5, which was the synergy of S1 and S2 in the crop mapping processor, as well as in the investigation on the algorithmic approach for an early in the season classification without data on the current year.
- The delays in the availability of some of the field data for classification, as well as problems in the computing facilities at CESBIO, added delays to the main purpose of testing and validating the SCM and to produce the maps datasets at all core test sites.
- In addition, the experiment proposed by the reviewer in the interim review at M24, which was adopted in SENSAGRI as a very good way to evaluate the impact of using different datasets and legends in the crop classification accuracy, increased the effort in the CESBIO persons eventually in charge of the exploration of S3 use. The experiment, described in D5.6, produced interesting results for the project, but require a notable coordination effort between the CESBIO and ITACyL team. This prevented starting with WT 5.6 during the first semester of 2019, still put as a less priority task.
- The results of the SCM validation showed that the addition of S1 does not significantly improve the accuracy with respect to the classification using only S2 optical data. An immediate conclusion could be that the high effort in pre-processing of S1 data and ingesting it in the algorithm could not be worthwhile. But, on the contrary, the conclusion was that S1 data is essential as gap-filling information for cloudy dates / areas. The SCM processor will rely on S1 data in Central and Northern Europe areas, were cloud cover is an issue. And in Southern Europe, S1 is also very important early in the season, were cloudiness is more frequent.
- The conclusion is that S1 is already a sufficient gap-filling data source for crop classification, adding useful information in cloudy periods and ensuring that the time series for the crop mapping algorithm are continuous and dense enough.
- This conclusion diminished the need for exploring the use of S3 in the crop mapping algorithm. Although the temporal frequency of S3-A together with S3-B ensures almost daily acquisitions, this data is also affected by clouds and it has the drawback of its much coarser spatial resolution and the different band settings with respect to S2.

With all those issues on the table, at M32 the CESBIO team realized that it was going to be impossible to attempt the integration of S3 in the SCM processing chain. At that time, all the effort was put in the production of the SCM map outputs, including those of the joint experiment with ITACyL. It was not possible to allocate expert personnel for that task.

As a consequence, and taking the opportunity of a still opened GA amendment, CESBIO formally asked for the removal of D5.7.

However, the SENSAGRI Project Officer responded that this non-compliance with the GA should be considered as a deviation and that the D5.7 should be kept.

Following the indication of the Project Officer, this D5.7 is submitted containing the causes and explanations for this non-compliance with one of the project objectives.