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Report on the applicability of SENSAGRI services outside Europe

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Project Coordinator	José F. Moreno. IPL – University of Valencia (Spain)		
EU Project Officer	Massimo Ciscato		

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Responsible partner	Universitat de València (UVEG)			
Responsible Author	Name	Antonio Ruiz-Verdú	E-mail	Antonio.Ruiz@uv.es
	Partner	UVEG	Phone	+34 963 543 679
Other authors				

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¹ R = Document, report; DEM = Demonstrator, pilot, prototype; DEC = Websites, patent filings, videos, etc; OTHER; ETHICS = Ethics requirement

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



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1. Introduction

1.1. Scope of the document

This report summarizes the status on the application of SENSAGRI products in sites located outside Europe during the project life, as well as the potential use of these products for agricultural or environmental monitoring in non-European countries.

1.2. Notations, abbreviations and acronyms

CAP	European Union Common Agricultural Policy
CEE	Copernicus Entrusted Entities
CLMS	Copernicus Land Monitoring Service
DoA	Description of the Action
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

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2. Motivation and objectives

2.1. Requests in the H2020 Space Work Programme 2016-17

The main objective of SENSAGRI was to develop and validate prototypes and proof-of-concept for potential new Copernicus pan-European Land services, focused in agricultural applications and making use of the synergy of S1 and S2.

This overarching aim responded to the main request of the H2020 call EO-3-2016: Evolution of Copernicus services, issued in 2015 in the framework of the Space Work Programme 2016-17, which stated that:

“The research and innovation action should aim at demonstrating the technical operational feasibility of a specific service evolution proposal. The proposers are expected to demonstrate at the proposal stage an active link with the Copernicus service by suitable means. The output of these research and innovation project should aim at providing a proof-of-concept or a prototype for a proposed evolution of the Copernicus services, respecting the border between Copernicus services and downstream services. This proof-of-concept or prototype should allow to demonstrate the appropriateness to implement the proposed evolution later on at European level, i.e. potentially with operational Copernicus funding.”

However, in addition to the call, the EC issued a Guidance Document indicating which were the main research needs of Copernicus operational services. This document identified the main questions that the applicants needed to respond in the different application domains. In the “Crop area and crop status monitoring” section, one of the key issues was:

“How can common methodologies in this domain be benchmarked and shared amongst different crop production systems, including those in food insecure countries?”

This specific question was the main driver for proposing a strategy in SENSAGRI for evaluating the potential application of its services outside Europe, as explained in the next subsection.

2.2. Approach in the SENSAGRI proposal

The evaluation of the applicability of SENSAGRI outside Europe was included as one of the objectives of the project. With respect to the specific question in the EC Guidance Document, the approach of SENSAGRI was summarized as follows:

“Although the focus of SENSAGRI is on developing and stimulating European agricultural monitoring services, it will not restrict to European test sites. Apart from the four core European test sites (France, Spain, Italy and Poland) summarized in Table 1.3c the developed services shall be tested against ground-truth data coming from agricultural sites outside Europe. In this respect, the SENSAGRI consortium partners’ Pan-European and global dissemination network will be utilized for obtaining access to agricultural sites across the world, e.g. as part of the JECAM network (<http://www.jecam.org/>) which gather 34 sites located in all the continents. Three of the partners of SENSAGRI manage a JECAM site, namely in France, Italy and Spain. In addition, UPS-CESBIO and its foreign partners manage two JECAM sites located in Morocco and Tunisia. We plan to test SENSAGRI over one or both of these North-African sites. One Argentinian institute, the INTA (Instituto Nacional de

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Tecnología Agropecuaria) has already confirmed its interest in acting as a remote partner. INTA is a technological research and innovation centre in Argentina with a long-term agricultural test sites. Through its involvement in different projects, and notably in ESA’s “Sentinel-2 for Agriculture” project, UPS-CESBIO has also connections with a number of organizations active in Ukraine, South-Africa, Burkina, as well as to international organizations such as the World Food Programme. The inclusion of the INTA and North-African test sites will help to extend the reach of SENSAGRI to the global scale. It will not only tested whether the proposed services are transferrable to outside Europe against their datasets, also it will strengthen the Copernicus monitoring network, as well opportunities to new partnerships and commercial activities within the agricultural sector. Thanks to the connections of the partners with international networks and projects, opportunities exist to extend even further the reach of SENSAGRI.”

The applicability of SENSAGRI services outside Europe, in countries in which the availability of reliable crop data is scarce and access to EO advanced agricultural services is limited, was identified as one of the expected impacts of the project.

For this purpose, the strategy was two-fold:

1. To carry out a set of field campaigns in non-European test sites, for obtaining validation data for the SENSAGRI products. The possibility of using JECAM data obtained outside SENSAGRI was also envisaged.
2. To define a specific Work Task (WT 8.4) within the Exploitation and dissemination WP8, to apply and evaluate the performance of the prototypes on S1 and S2 data from the non-European test sites.

The WT 8.4 was described in the Annex I of the DoA as:

WT 8.4: Demonstration of the prototypes applicability outside Europe (UVEG, UPS-CESBIO, ITACyL) [M24-M36]

In this WT, the prototypes will be applied for generating SSM, LAI and seasonal crop maps in several agriculture areas outside Europe. One site is located in Argentina (an area of 2,440,000 ha managed by the national agronomic institute INTA), and two JECAM sites, which will be in Morocco and Tunisia. The institutions managing these areas agree to supply the ground data necessary for the validation of the prototypes at no cost for the SENSAGRI project. The produced maps will be validated with the available datasets, using the methodology described in the Work WT 8.3 The results will be discussed together with the local responsible personnel of the test sites, in order to evaluate the improvements of the SENSAGRI prototype services with regard to the currently available crop information.

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3. Evaluation procedure

3.1. Hypothesis

The validation of the Soil Surface Moisture (SSM), Leaf Area Index (LAI) and Seasonal Crop Mapping (SCM) prototypes, is based on the core European sites at Southern France, Italy, Spain and Poland. Taking into account the relative weight of the different sites, even from the beginning of the project, it was evident a certain bias in the validation dataset towards central-continental and especially Mediterranean agricultural landscapes.

It was hypothesized that the validation could ensure a reliable and accurate enough application in countries with similar crop types, soil conditions and climate. In this respect, the initial choice of the additional test sites in Morocco and Tunisia had this intention, being at the same time similar as Mediterranean countries, but with a different level of development on the agricultural monitoring systems. The site in Argentina also presented similarities to the Southern European SENSAGRI core test sites.

3.2. Means for verification

The field campaigns in non-European sites, carried out within SENSAGRI, plus the potential use of JECAM data, were the means foreseen for verifying the hypothesis of an applicability of European-validated SENSAGRI products.

3.3. Deviations and delays

The field campaigns in Argentina started at a good pace already in 2017, as reported in D7.5. Centered in San Antonio de Areco (Buenos Aires province), a small area (20x 20 km) was selected where high frequency crop and environmental monitoring was performed. A total of 370 fields were monitored in 2017.

This test site provided data at no cost for SENSAGRI project. The data was obtained in the framework of an ongoing cooperation between the Argentinian National Institute for Agronomic Technology (INTA) and the University of Valencia.

On the contrary, the campaigns in Morocco and Tunisia, which were planned to be subcontracted to local partners of CESBIO (20 K€ budgeted), could not start immediately. During the first months, up to March 2017, the reasons were internal to the Toulouse University (UPS), legal representative of CESBIO in the project, due to a rearrangement of the accounting system that prevented budget expenses. But once this issue was unblocked, the Moroccan partners of CESBIO declined to participate in SENSAGRI. CESBIO offered a JECAM site in Ukraine as an alternative and they started contacts with the site managers (*Space Research Institute of National Academy of Sciences of Ukraine and State Space Agency of Ukraine*).

A similar situation occurred with the Tunisian site, which was also discarded for several reasons in February 2017. CESBIO proposed as alternative a site in South Africa.

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The site in South Africa belongs to the JECAM network and is managed by Terry Newby, from the Agricultural Research Council (Institute for Soil, Climate and Water: ARC-ISCW). It is located in the Freestate province and has a continuous cropping season that includes both winter (wheat, barley) and summer crops (maize, sunflower, sorghum, soya and dry beans). Most SENSAGRI services could be tested and validated in this site.

The site in Ukraine is also a JECAM site, managed by Space Research Institute NASU-SSAU under the direction of Nataliia Kussul. The site is in a totally safe area and has a large variety of crops (wheat, barley, maize, rapeseed, sunflower...) with a phenology and agricultural practices similar to those of Central and Eastern European countries. They had a previous satisfactory experience with CESBIO in the Sen2Agri project and they were able to carry on most of the measurements required for the validation of SENSAGRI services.

Ukraine is a European country and the JECAM site is fully representative of Central-Northern Europe continental agriculture. Therefore, this site cannot be considered for testing the applicability outside Europe. However, is a non-UE country and it could be considered as an example of limited availability of agricultural monitoring data, in which EO-based systems could be very valuable.

Once the change of sites was accepted by the SENSAGRI Project Officer, CESBIO initiated the procedure for subcontracting the field work at both sites. However, this procedure took more than one year and a half. Until July 2018 the contract was not formalized, with the field campaigns foreseen for April-December 2018.

The important deviation in the start of the field campaigns also affected the availability of data. In March 2019, only a small set of LAI data was available from the Ukraine site. The bulk of the data arrived to SENSAGRI in July and August 2019.

At that time, the validation work of most deliverables was very advanced and it was not possible to set and run the processing chains for S1 and S2 data in dates concomitant to those of the field data campaigns. It is important to recall that the activities of WT 8.4 were foreseen for the period M24-M36, based on the assumption that the field data from non-European sites was available before M24. The actual availability dates were M33-M34.

For the LAI prototype, the data from Argentina was tested, but finally discarded in the validation, after failing the quality checks. The same occurred with SSM field data, due to differences in sampling date and S1 acquisition dates. The SCM was not applied with training / validation data from Argentina, due to an overload in the queue management system of the CESBIO's server.

The general delays in the processing of the core sites (France, Italy, Spain) at CESBIO, impeded the processing of the less priority data from Ukraine and Argentina.

4. Status at M36 and planned work

As reported and discussed in the Final Review meeting, held in Madrid (Spain) on October 16th 2019 (see deliverable D1.17), the important delays in the availability of the validation data has impeded the evaluation of the applicability of SENSAGRI prototypes outside Europe.

4.1. Available data

The summary of available data is shown in the tables below.

Table1. Validation data from Argentina

Argentina						
Land Cover	2017	2018	2019	Total	FA or BS	FALLOW or BARE SOIL
Period	Aug-Nov	Aug-Nov	Aug-Nov		WW	WINTER WHEAT
Number of observed fields (n)	916	1534	1050	3500	TO	TOMATO
Surface (ha)	26000	34000	28000	88000	FB	FABA BEAN
Number of LC classes (n)	10	10	10		MA	MAIZE
SSM	2017	2018	2019	Total	SU	SUNFLOWER
ESU with gravimetric method (n)		80	50	130	SB	SUGAR BEET
Continuous probes (n)					BA	Barley
Main crops		ON,MA,SU	ON,MA,SU		RS	Rapeseed
LAI	2017	2018	2019	Total	LG	Leguminous
Number of ESU (n)		73	52	125	CH	Chick peas
Main crops			WW,CP,TO,AM		PE	Peas
Biomass & Yield	2017	2018	2019	Total	LE	Lentils
Period						
Number of ESU (n)						
Main crops						
Tilled fields	2017	2018	2019	Total		
Period						
Number of observed fields (n)						
Surface (ha)						
Number of Till. classes (n)						
Irrigated fields	2017	2018	2019	Total		
Period		Ago-May	Ago-May			
Number of observed fields (n)		21	30	51		
Surface (ha)		200	280	480		
Number of Irrigation system fields (n)						

Table2. Validation data from Ukraine

Ukraine						
Land Cover	2017	2018	2019	Total	FA or BS	FALLOW or BARE SOIL
Period		Mar-Sep			WW	WINTER WHEAT
Number of observed fields (n)		520		520	TO	TOMATO
Surface (ha)					FB	FABA BEAN
Number of LC classes (n)					MA	MAIZE
SSM	2017	2018	2019	Total	SU	SUNFLOWER
ESU with gravimetric method (n)					SB	SUGAR BEET
Continuous probes (n)					BA	Barley
Main crops					RS	Rapeseed
LAI	2017	2018	2019	Total	LG	Leguminous
Number of ESU (n)		126	20	146	CH	Chick peas
Main crops		WW,MA,SU,SB	WW		PE	Peas
Biomass & Yield	2017	2018	2019	Total	LE	Lentils
Period						
Number of ESU (n)						
Main crops						
Tilled fields	2017	2018	2019	Total		
Period						
Number of observed fields (n)						
Surface (ha)						
Number of Till. classes (n)						
Irrigated fields	2017	2018	2019	Total		
Period						
Number of observed fields (n)						
Surface (ha)						
Number of Irrigation system fields (n)						

Table 3. Validation data from South Africa

South Africa

Land Cover	2017	2018	2019	Total
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Period	Nov-Dec	Jan-Dec		
Number of observed fields (n)	1500	750		2250
Surface (ha)				
Number of LC classes (n)	5	5		

SSM	2017	2018	2019	Total
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ESU with gravimetric method (n)				
Continuous probes (n)				
Main crops				

LAI	2017	2018	2019	Total
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Number of ESU (n)		30		30
Main crops				

Biomass & Yield	2017	2018	2019	Total
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Period				
Number of ESU (n)				
Main crops				

Tilled fields	2017	2018	2019	Total
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Period		Jan-Dec		
Number of observed fields (n)		131		131
Surface (ha)				
Number of Till. classes (n)				

Irrigated fields	2017	2018	2019	Total
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Period				
Number of observed fields (n)				
Surface (ha)				
Number of Irrigation system fields (n)				

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4.2. Planned work

In the Final Review meeting, the reviewers considered that these deviations in the validation activities at non-European sites, do not imply mitigation actions requiring an extension of the project life or a rejection of deliverables. However they would like to see a reaction of the consortium in this respect in the near future (i.e. already in the Final Review period, ending on December 31st). In particular, the consortium must work in the following directions:

- The Biomass and yield processor should use LAI inputs from the project prototype and/or field data.
- The prototypes should make use of data not used so far, especially from Ukraine and South Africa.

The SENSAGRI consortium is going to work in that direction. The results and conclusions will be included in the Final Report.