




Deliverable D7.1

Report on the available ground data

V 1.0



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Abstract (for dissemination)	<p>In this report, we have assessed the availability, quality and usefulness of the detailed ground data acquired during past campaigns about land use, crop types, SSM, LAI, biomass and yield, for the main crops in the test sites and surrounding areas.</p> <p>All the SENSAGRI partners have been involved in finding existing and available ground data from 2015, when S1 and S2 were both in operation. This report describes the number of sampling units, of elementary data, the time frequency and the kind of instrumentation used to get this validation data.</p>
Keywords	Ground data, LAI, Land use, soil moisture, validation sites

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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

Europe provides Earth Observation data from Sentinel-1 (S1) and Sentinel-2 (S2) on a free and open data policy basis. In response to the Earth Observation Work programme ‘EO-3-2016: Evaluation of Copernicus Services’, Sentinels Synergy for Agriculture (SENSAGRI) aims to exploit the capacity of S1 and S2 images to develop an innovative portfolio of prototypes agricultural monitoring services, exploiting the synergy of using both types of measurements.

S1-A images are available from October 2014, S1-B images from September 2016, while for S2 the first images were acquired on July 2015.

There is the need of increasing the dataset (both spatially and temporally) for the validation of the services expected from SENSAGRI project, also before the starting date of the project (November 1st 2016) and the beginning of the measurement campaigns (spring of 2017).

Aim of this deliverable is to evaluate the ground data availability in the 2015-2016 period, to validate the proposed SENSAGRI services.

1.2. Notations, abbreviations and acronyms

BIOM	Crop Biomass Amount
LAI	Leaf Area Index
SSM	Soil Surface Moisture
SAR	Spaceborne Synthetic Aperture Radars

2. Available data

The available ground data within the SENSAGRI consortium are classified and grouped in Table 1, according to the types of proposed services indicated in the SENSAGRI project. In this initial phase of the project, previous data availability is especially crucial for the validation of the Prototype Services and therefore the analysis of already available data for these services is the main purpose of this deliverable 7.1. The lack of enough ground data availability for the Advanced Services is no so critical now, since its validation is foreseen for the second half of the project and the necessary data will be collected during the WT 7.2.

SENSAGRI will exploit the synergy of optical and radar measurements to develop three Prototype Services capable of near real time operations: (1) Surface Soil Moisture (SSM), (2) *green* and *brown* Leaf Area Index (LAI) and (3) Crop type mapping. These Prototypes shall provide a baseline for Advanced Services that can boost the competitiveness of the European agro-industrial sector. SENSAGRI proposes four advanced proof-of-concept services: (i) yield/biomass, (ii) tillage change, (iii) irrigation and (iv) advanced crop maps.

Table 1. Correspondence among SENSAGRI services and ground measured variables types

SENSAGRI SERVICES	Ground Measured variables
Prototype Services	
Surface Soil Moisture	Soil Moisture
Green and Brown LAI	LAI (green & brown)
Seasonal Crop Mapping	Crop-Land Use
Advanced Services	
Yield/Biomass	Yield & Biomass
Irrigated/Not Irrigated	Irrigated Fields
Tillage change	Tilled Fields
Advanced Crop Maps	Crop-Land Use

The available 2015-2016 data were obtained in four European agricultural test areas in Spain, France, Italy and Poland, which are representative of the European crop diversity, and in one non-European country (Argentina).


The available data of the French site are furnished by CESBIO; data of the Spanish site are managed from ITACyL; Italian data are given from CREA and CNR-ISSIA; Polish site is managed from IPP and, finally, data from the Argentine site are given from UVEG.

2.1. SOIL MOISTURE

SSM content is of applicative interest for its role in the interactions between water, energy and biochemical fluxes and for a number of land applications ranging from seasonal hydrologic forecasting to drought identification, from irrigation scheduling to yield forecasting. SAR are the most appropriate systems to retrieve SSM at a high spatial resolution (e.g. 100-1000 m), with a data fusion approach combining them with optical data. Available data can improve the quality of validation of the services.

2.1.1. Spain

The available data in Castile and León district (North-Western of Spain, Duero river basin) have been collected by means of 24 continuous Stevens Hydra Probes (impedance-based sensors) placed at the 5 cm soil depth. The probes are located in the cereal, abandoned crops and vineyard crops. Each probe measured the SSM data every ten minutes frequency and then averaged per hour. Data are available since 1 January 2015.

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2.1.2. France

The available data have been collected in the Lamasquère (Seysse city) and Auradé experimental sites (South of France); they consist of 6 continuous measurements (3 points per field of 20 hectare size each) with the Tetha Probe in the 0-5, 5, 10, 30, 50 and 100 cm soil depth, that collect the SSM data at half-hourly frequency. The availability of data is since 1 April 2004.

2.1.3. Italy

The available data have been measured in the Capitanata Plain (South-East of Italy); they have been collected by a network of 11 continuous stations, equipped with an EM50 datalogger, recording volumetric SSM values every 15 min by means of two 5TM and two 10HS probes (capacitance/frequency domain) installed horizontally at 2.5cm, 10cm, 20cm and 40cm depths, respectively. Data is available from the 1st of January, 2015. Gravimetric measurements of soil moisture at 0-20 cm and 21-40 cm soil depth on 3 February and 1 April 2015, in 10 points at 120x80m grid size, are available. Finally, gravimetric measurements data in the same area are also available in 10 sampling dates during spring 2016 in 52 points (at 40x20m grid size) at 0-30cm soil depth.

2.1.4. Poland

IPP did not conducted any research on soil moisture in the Agricultural Experimental Station site. Therefore, no SSM are available for the required period.

2.1.5. Argentina

No SSM are available for the required period.

2.2. LEAF AREA INDEX

SENSAGRI project aims to improve the distinction of green (photosynthetic) and brown (senescent) LAI. For the moment no data about brown LAI is available, but only several measurements of green LAI. In the course of project, specific measurement of brown LAI will be carried out.

2.2.1. Spain

LAI data are not available for the required period.

2.2.2. France

The LAI available data have been collected in several areas of South of France by means of hemispherical photographs or destructive measurements:

Barran: 92 points of wheat on 27 June 2016.


Seysse (Lamasquère experimental site):

5 points on maize crop, on 2 June, 1 and 23 July, 6 August and 2 September 2015

10 points on winter barley crop, 7 January, 23 March, 29 April, 9 and 23 June 2015;

Auradé (experimental site):

4 points on winter wheat crop, on 13 January, 24 February, 6 April, 12 and 29 May 2016;

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4 points on sunflower crop, on 9 and 28 June, 21 July, 9 August, 12 September 2016.

OSR Auradé and Lamasqère area

3 points on maize crop, on 7 June, 8 July and 10 August 2016;

4 points on sorghum crop, 1 July, 1 August and 9 September 2016;

3 points on winter wheat crop, on 8 March 2016;

2-12 points on sunflower crop, on 27 May, 17 and 24 June, 4, 8 and 20 July, 2, 10 and 18 August 2016.

2.2.3. Italy

The available LAI data have been measured with LAI-2000 Plant Canopy Analyzer in the Capitanata Plain. There are 89 points in the period 17-20 March 2015 and 93 points in the period 23-24 April 2015. For both periods, the monitored crops were cereals (mainly durum wheat, some fields of barley and oat) and all the plants were green, so this values can be considered as Green LAI data.

2.2.4. Poland

In the years 2015/2016 IPP did not conducted research on Leaf Area Index in this area, so no LAI data are available for the required period.

2.2.5. Argentina

LAI data are not available for the required period.

2.3. CROP/LAND USE

Land use and crop mapping provide decisive information for crop management (irrigation water, crop nutritional status, nitrogen fertilization, crop growth progress), and yield and production modelling for food security. At regional level, crop maps are required for energy, water and carbon balance calculations needed in implementation of climate change mitigation strategies. Accordingly, a high demand exists for improving existing land cover products in order to more precisely describe and classify crop areas.

2.3.1. Spain

An intensive Land use Monitoring campaign was carried out in the Castile and Léon district during 2015/2016 and a very large number of fields (about 1.400.000) is available for SENSAGRI project. The Land Use classification and the degree of details, is the following:

Arable Crops

- Wheat
- Barley
- Maize
- Other cereals
- Sunflower
- Rape seeds
- Green peas
- Other grain legumes
- Sugar Beet
- Other industrial crops
- Potato
- Horticulture
- Aromatic plants
- Alfalfa
- Forage crops

Permanent Crops

- Vineyard
- Fruit trees
- Nuts trees
- Olive grove

Forest and Seminatural Area

- Grassland
- Scrub
- Coniferous forest
- Broad-leaved deciduous forest
- Broad-leaved evergreen forest
- Sheet of water
- Artificial surfaces
- Bare rocks
- Bare soil

2.3.2. France

Intensive Land use Monitoring campaign have been carried since 2006 with approximately 400 plots monitored each year (see yellow and red fields on the map below) and up to 1500 in 2015.

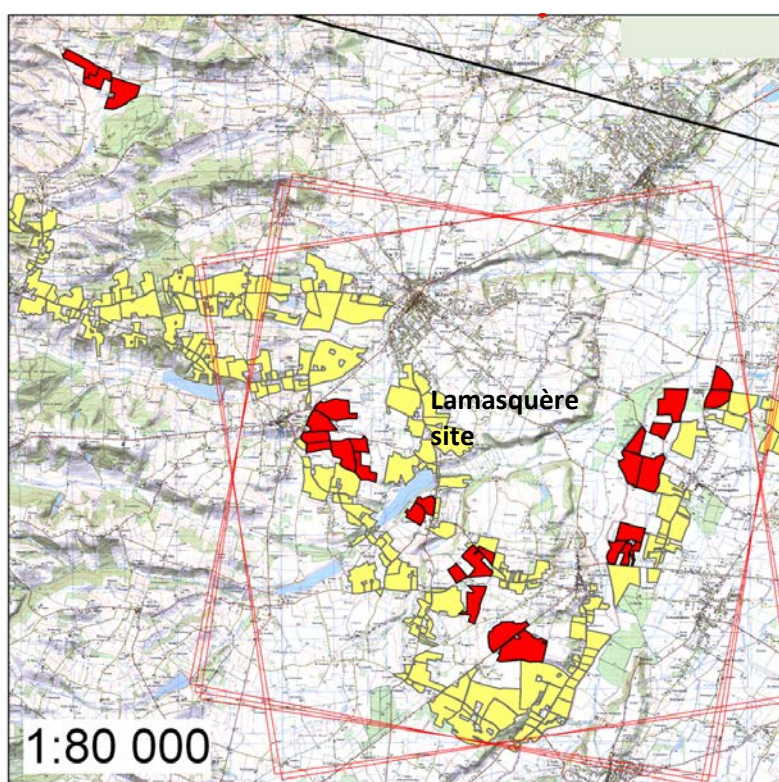


Figure 1. Crop map of 2015-2016 in the Auradé site (France).

2.3.3. Italy

In the Capitanata Plain, the land use data were collected in the two periods 15 March 2015 and 20 May 2015. The number of fields were about 90 with a large prevalence of wheat (70% of the area), other crops (chickpea and field bean for a 10%), other cereal crops (barley, oat and emmer for a 5%); secondly, several fields were fallow (bare soils) or with spontaneous weeds before the cultivation of the following processing tomato (15%).

2.3.4. Poland

For the Agricultural Experimental Station in Winna Gora, the relative share of crops during the season 2015/2016 is shown in the figure below. A total of 19 plots were surveyed:


- 2 plots of Maize Silage (10 % of the total area)
- 5 plots of Winter Oilseed Rape (28 % of the total area)
- 2 plots of Winter Triticale (5 % of the total area)
- 1 plot of Charlock (1 % of the total area)
- 4 plots of Winter Wheat (27 % of the total area)
- 1 plot of Beet (5 % of the total area)
- 4 plots of Maize (24 % of the total area)

Legenda

- Maize_Silage
- Maize
- Winter_Oilseed_Rape
- Winter_Triticale
- Winter_Wheat
- Winter_Wheat+Maize
- Winter_Oilseed_Rape+Maize
- Winter_Wheat+Beet
- Charlock+Winter_Oilseed_Rape+Winter_Wheat
- Other



Figure 2. Crop map of 2015-2016 in the IPP Winna Gora site (Poland).

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2.3.5. Argentina

The monitored area is Villarino - Patagones area, in central Argentina (south of Buenos Aires). Crop and Land Use data have been collected in the two periods, Jan-March 2016 with 113 fields and Nov-Dec 2016 with 1200 fields. Of these last fields, 700 fields were irrigated while 500 were not-irrigated.

The crop list is the following: Maize, Onion, Alfalafa, Tall wheatgrass, Natural pastures, Fallow land.

2.4. YIELD & BIOMASS

Estimation of biomass accumulation during crop cycle and final yield production are interesting issues to evaluate and forecast phenological status, plant growth and development and, finally, crop commercial yield.

2.4.1. Spain

In the Land use Monitoring network a number of 710 fields have been measured for crop yield during 2015 and 2016, for all the main arable crops reported in the 2.3.1 section.

2.4.2. France

In this test sites the available data about crop BIOM during the crop cycle and at harvest, and Yield at harvest, are the following:

Barran: 18 points of wheat (BIOM and Yield), 27 June 2016;

Lagardère: 120 points of grapevine (BIOM and Yield), 21 september 2016;

Lapouyade: 26 points of grapevine (BIOM and Yield), 28 september 2016;

Seysse (Lamasquère experimental site):

5 points on maize crop, on 2 June, 1 and 23 July, 6 August and 2 September 2015;

10 points on winter barley crop, 7 January, 23 March, 29 April, 9 and 23 June 2015;

Auradé (experimental site):


4 points on winter wheat crop, on 13 January, 24 February, 6 April, 12 and 29 May 2016;

4 points on sunflower crop, on 9 and 28 June, 21 July, 9 August, 12 September 2016.

2.4.3. Italy

Intensive durum wheat plant BIOM sampling have been carried out in 2015, in 1 field on 21 April 2015 with 48 points at a grid size of 9x4m. At harvest on 15 June 2015, 1 wheat field of 9 hectares was harvested with a precision harvester (grid size of 6x5m).

In the 2016, 104 BIOM points were collected on 1 April and on 13 May at a grid size of 20x20m; 48 points at a grid size of 9x4m and 104 points at a grid size of 20x20m have been collected on 13-14 May. Wheat grain yield data at harvest, in 10 points at 120x80m grid size and about 3.000 points at a grid size of 6x5m, are available.

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2.4.4. Poland

In the years 2015/2016 no biomass data was acquired in this area. However, yield data was collected in the entire area. The the average yield per hectare was calculated for 19 plots (reported below). Biomass data are not available for the required period.

2 plots of Maize Silage (50.0 t ha⁻¹)

5 plots of Winter Oilseed Rape (3.1 t ha⁻¹)

2 plots of Winter Triticale (6.5 t ha⁻¹)

1 plots of Charlock (1.1 t ha⁻¹)

4 plots of Winter Wheat (5.9 t ha⁻¹)

1 plots of Beet (72.3 t ha⁻¹)

4 plots of Maize (11.4 t ha⁻¹)

2.4.5. Argentina

Yield and Biomass data are not available for the required period.

2.5. IRRIGATED & TILLED FIELDS

2.5.1. Spain

There are not available data.

2.5.2. France

There are not available data. Further information could be available from the sites that are concerned yet over the 400 sites that are monitored each year. Same for tillage, cover crops, crop spontaneous regrowth.

2.5.3. Italy

Information about tilled fields and the time of tillage (plowing) are available in 3 points in autumn 2016.

Information about irrigated fields in 2016 will be required to local Irrigation Consortium.

2.5.4. Poland

There are not available data.

2.5.5. Argentina

Data about 700 irrigated and 500 not-irrigated fields are available in 2016.

Table 2. Overview of Available Ground Data about SOIL SURFACE MOISTURE

Country	Location	Data	Number of Points
Spain	Castile and Leon	Continuous	24
France	Seysse and Auradé	Continuous	6
Italy	Foggia	Continuous	11
		Two dates in 2015	10
		One date in 2015	52
		Ten dates in 2016	52
Poland	--	--	--
Argentina	--	--	--

Table 3. Overview of Available Ground Data about LEAF AREA INDEX


Country	Location	Data	Number of Points
Spain	--	--	--
France	Barran	27 Jun 2016	92
	Seysse	5 dates in 2015	15
		5 dates in 2016	8
	OSR Auradé and Lamasqère	3 dates in 2016	7
		1 date in 2016	3
		9 dates in 2016	2-12
Italy	Foggia	17-20 Mar 2015	89
		23-24 Apr 2015	93
Poland	--	--	--
Argentina	--	--	--

Table 4. Overview of Available Ground Data about CROP/LAND USE

Country	Location	Data	Number of Points
Spain	Castile and Leon	2015 and 2016	About 1.400.000
France	Barran	2016	92
	Lagardère	2016	120
	Lapouyade	2016	26
	Seysse	2015	23
Italy	Foggia	15 Mar 2015	90
		20 May 2015	90
Poland	Winna Góra	2015/2016	19
Argentina		Jan-Mar 2016	113
		Nov-Dec 2016	1200

Table 5. Overview of Available Ground Data about BIOMASS & YIELD

Country	Location	Data	Number of Points
Spain	Castile and Leon	2015 and 2016	710
France	Barran	27 Jun 2016	18
	Lagardère	21 Sep 2016	120
	Lapouyade	28 Sep 2016	26
	Seysse	5 dates in 2015	23
Italy	Foggia	21 Apr 2015	48
		15-16 June 2015	Field of 9 ha (about 3.000 points)
		1 Apr 2016	104
		13 May 2016	256
		Wheat harvest	10
Poland	Winna Góra	2015/2016	19
Argentina	--	--	--

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3. Data Format

All the data are georeferenced and stored in MS Office Excel files

4. Additional web data sources

Additional ground data source could be available from different validation networks, as:

- JECAM (<http://www.jecam.org/>)
- FLUXNET (<http://fluxnet.ornl.gov/>)
- OLIVE (<http://calvalportal.ceos.org/cvp/web/guest/olive>)
- ENVIRONET (<http://www.envir-net.org/>)
- ISMN (<http://ismn.geo.tuwien.ac.at/ismn/>)

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.

These networks furnish free available data on different crops and sites.