IMPLEMENTING MULTI-SCALE AGRICULTURAL INDICATORS EXPLOITING SENTINELS

USERS REQUIREMENTS

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	11.04.2013	All	First issue after analysis of feedback from users' survey	I1.00
I1.00	04.06.2013	13-16	Add needs of Copernicus Global Land service, and of JRC/LRM team working on MESA project	I1.10
I1.10	17.02.2015	8 11 37 All	Update executive summary Update portfolio according to DoW Issue 2.00 Add ETCSIA and CIAT description Add CIAT needs and update status of sites and local contacts at mid-term of project	I2.00

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1. BACKGROUND OF THE DOCUMENT

1.1. EXECUTIVE SUMMARY

The Copernicus program is the EU response to the increasing demand for reliable environmental data. The objective of the Copernicus Land Service is to continuously monitor and forecast the status of land territories and to supply reliable geo-information to decision makers, businesses and citizens to define environmental policies and take right actions. ImagineS intends to continue the innovation and development activities to support the operations of the Copernicus Global Land service, preparing the use of the new Earth Observation data, including Sentinels missions data, in an operational context. Moreover, ImagineS aims to favor the emergence of downstream activities dedicated to the monitoring of crop and fodder production, that are key for the implementation of the EU Common Agricultural Policy, of the food security policy, and could contribute to the Global Agricultural Geo-Monitoring Initiative (GEOGLAM) coordinated by the intergovernmental Group on Earth Observations (GEO).

The main objectives of IMAGINES are to (i) improve the retrieval of basic biophysical variables, mainly LAI, FAPAR and the surface albedo, identified as Terrestrial Essential Climate Variables, by merging the information coming from different sensors (PROBA-V and Landsat-8) in view to prepare the use of Sentinel missions data; (ii) develop qualified software able to process multi-sensor data at the global scale on a fully automatic basis; (iii) complement and contribute to the existing or future agricultural services by providing new data streams relying upon an original method to assess the above-ground biomass, based on the assimilation of satellite products in a Land Data Assimilation System (LDAS) in order to monitor the crop/fodder biomass production together with the carbon and water fluxes; (iv) demonstrate the added value of this contribution for a community of users acting at global, European, national, and regional scales.

To reach these objectives, ImagineS portfolio has to meet the requirements of user organizations which can exploit the product information for specific environmental applications. Consequently, the identification of potential users and the collection of their needs is the first step in the definition of the ImagineS services. A number of institutions worldwide involved in different applications related to agriculture have expressed their interest for ImagineS high resolution products. The African community gathered in the MESA project is more interested in the medium resolution products while the Copernicus Global Land service expects that the ImagineS medium resolution products can be included soon in its portfolio.

1.2. SCOPE AND OBJECTIVES

The Users Requirements Document compiles the needs expressed by the institutions which are willing to test and use the ImagineS products. In particular, it presents the

requirements of the Copernicus Global Land service which expects that ImagineS contributes to its evolution towards a higher resolution (300m) portfolio.

1.3. CONTENT OF THE DOCUMENT

Chapter 2 recalls the portfolio and the preliminary characteristics of the ImagineS products.

Chapter 3 presents the Copernicus Global Land service and its specific expectations.

Chapter 4 includes the needs of the JRC/Land Resources Management Unit involved in the MESA project. These needs are generic and common to all Regional Implementation Centers (RIC), and valid at continental scale. They will be completed, in a next step, by the specific requirements of each RIC depending on their thematic application.

Chapter 5 lists the institutions identified as ImagineS users. Their detailed description is provided in Annex.

Chapter 6 summarizes the requirements, split in general needs, specific needs for Medium Resolution products, and specific needs for High Resolution products.

Chapter 7 gives an overview on the utility assessment analysis that the users institutions plan to perform.

1.4. RELATED DOCUMENTS

1.4.1. Inputs

Overview of former deliverables acting as inputs to this document.

Document ID	Descriptor
ImagineS_RP_UserSurvey	Survey on the users requirements

1.4.2. Output

Overview of other deliverables for which this document is an input:

Document ID	Descriptor
ImagineS_RP1.2	Specifications of the ImagineS service and products
ImagineS_RP1.3	Users Assessment reports

1.4.3. External Reference Document

1: Global Land Working Group 2010: “GLOB-Land Service”, the Global component of the GMES Land Monitoring Core Service working paper of the working group on the Global component of the GMES Land Monitoring Core Services. V 3.0. http://www.acceptance.ec.europa.eu/enterprise/policies/space/files/gmes/services/global_land_service_en.pdf

2: European Commission: REGULATION (EU) No 911/2010 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 22 September 2010 on the European Earth monitoring programme (GMES) and its initial operations (2011 to 2013). Official Journal of the European Union L 276/1 of 20.10.2010.

3: GCOS. 2006. “Systematic Observation Requirements for Satellite-Based Output data for Climate”. Supplemental details to the satellite based component of the Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC. GCOS-107 (WMO/TD No. 1338)

Link: http://www.wmo.int/pages/prog/gcos/Publications/gcos-107.pdf

Related link: http://gosic.org/ios/MATRICES/ECV/ecv-matrix.htm

2. IMAGINES PORTFOLIO

The ImagineS portfolio contains global and regional biophysical variables derived from multi-sensor satellite data, at different spatial resolutions, together with agricultural indicators, including the above-ground biomass, the carbon and water fluxes, and drought indices resulting from the assimilation of the biophysical variables in the Land Data Assimilation System (LDAS) (Table 1).

ID	Name	EO sensor	Temporal resolution	Spatial resolution	Spatial coverage
01	LAI, FAPAR, FCover	PROBA-V	10 days	333 m	Global
02	Albedo	PROBA-V	10 days	333 m	Global
03	Above-ground biomass	N/A	10 days	16 km (8 km)	Global (Fr,Hu)
04	Drought indicators	N/A	10 days	16 km (8 km)	Global (Fr,Hu)
05	Carbon fluxes (GPP, RE, NEE) and evapotranspiration	N/A	10 days	16 km (8 km)	Global (Fr,Hu)
06	FAPAR per class	PROBA-V	10 days	333 m	Demo sites (25 km²)
08	FAPAR	Landsat-8 + PROBA-V	10 days	30 m	Demo sites
09	Above-ground biomass	N/A	10 days	local simulations	Demo sites
10	Crop map	Radarsat + RapidEye + MODIS	continuous update [1]	10 m	Demo sites

Table 1: Detailed IMAGINES products. [1]: when a new acquisition is available.

The ambition of the project is to provide a full coverage of the globe, at a frequency of 10 days, using PROBA-V data since it became clear that no nominal Sentinel-3 data will be available before the end of the project. The NRT production of LAI, FAPAR, FCover and Albedo is performed in the framework of the Copernicus Global Land service (http://land.copernicus.eu/global/). The demonstration of high resolution (30m) products (Landsat-8 + PROBA-V as proxies of Sentinel-2 + Sentinel-3, respectively) will be done over a selection of demonstration sites of cropland and grassland in contrasting climatic and environmental conditions (Table 2). At mid-term of the project, the initial list of demonstration

sites has been updated: additional sites proposed by different users (Section 6.3, Table 11) were added while some initial sites were replaced by new ones due to changes in motivation of local users for performing utility assessment.

ID	Name	Description	Location
1	South-West, France	Flat cropland with a rotation of wheat, maize, sunflower. Some fields are irrigated.	43° 29' N, 1° 16' E
2	Hegyhatsal, Hungary	Flat cropland where small parcel-based agricultural management is typical of the whole country	46° 57' N, 16° 39' E
3	Las Tiesas Farm, Barrax, Spain	Flat cropland of 65% dry land (barley, wheat) and 35% irrigated crops with large pivots (onion, garlic, sugarbeets, potatoes, maize, alfalfa, sunflower).	39° 02' N, 2° 04' W
4	Tula, Russia	Typical field size is near 100 hectares. Crop types are winter wheat, spring barley, potatoes, maize, rape seeds, and winter rye.	53° 05' N, 37° 14' E
5	Upper Tana Basin, Kenya	Small holder farms where grow tea, coffee, maize and vegetables	0° 55' N, 36° 47' E
6	Merguellil, Tunisia	Flat plain with fields of cereals, vegetables and olive trees, dry and irrigated	35° 45' N, 10° 5' E
7	Free State Province, South Africa	Agriculture and grasslands. Site located in the major grain producing province of South Africa.	28° 25' S 27°4' E
8	Greenbelt Farm, Ottawa, Canada	Agriculture in this region of eastern Canada mainly consists of corn, soybean and spring wheat annual crops adapted to short-season, perennial forage and livestock pasture.	45° 18' N, 75° 45' W
9	San Fernando, Chile	Flat cropland area covered by annual crops such as maize, wheat, alfalfa, sunflowers.	34° 42' S, 71° 0' W
10	25 de Mayo, La Pampa, Argentina	Semi-desertic area with irrigated alfafa pastures	37° 54' S, 67° 44' W
11	Yanco area, Murrumbidgee River catchment, Australia	A gently sloping area containing irrigated croplands and natural rangelands.	34° 45' S, 146° 04' E
12	Comunidad de regantes del campo de Cartagena, Spain	50.000 ha irrigated crops with drip irrigation (vegetables and citrus trees)	37° 48' N, 1° 03' W
13	Cordoba, Spain	Flat cropland area	37° 48'N, 4° 44' W

ID	Name	Description	Location
14	Lambayeque, Peru	Flat cropland area monitored for drought and desertification analysis	6° 47' S, 79° 46' W
15	La Albufera, Spain	Rice fields	39° 16' N, 0° 19' W
16	Rosasco, Milan, Italy	Rice fields	45° 15' N, 8° 33' E
17	Pshenichne, Ukraine	Flat area with winter wheat, spring barley, maize, soybeans, winter rapeseed, sunflower, sugar beet, potatoes, winter rye and spring wheat	50° 4' N, 30° 6' N

Table 2: IMAGINES demonstration site characteristics

France and Hungary are the main areas of interest as the regional LDAS can run at 8 km resolution over these countries.

The feasibility of the crop map merging Sentinel-1, Sentinel-2, and Sentinel-3, using Radarsat, RapidEye and MODIS data as proxies, will be demonstrated over two areas of about 300km x 300km around Tula (Russia) and in the Free State Province, South Africa. Both areas are demonstration sites of the JECAM initiative, developed in the framework of GEO Global Agricultural Monitoring, which enables to share experiment data on proposed sites where regularly field campaigns are organized.

3. THE COPERNICUS GLOBAL LAND SERVICE

The European Copernicus program provides reliable and up-to-date information on how our planet and its climate are changing. Policy-makers and public authorities (at national level, within the European Commission and in international agencies), the major users of Copernicus, use this information to prepare environmental legislation and policies and to monitor their implementation and assess their effects.

3.1. PRESENTATION

The overall scope, key priorities and the architecture of the Global Land Component of the Copernicus Land service (in short, the Global Land service), including main implementation issues and conditions for its sustainability are described in a consensus working paper discussed during a special session of the 33rd International Conference on Remote Sensing of Environment (ISRSE33) conference in 2009 and revised by the Member States delegates at the GMES Advisory Committee n°14 (GAC) of 12 June 2009[1].

In line with this consensus working paper, the deployment of the Global Component of the Copernicus Land service in the framework of GIO is limited to the operation of " *a multi-purpose service component*" that provides a series of bio-geophysical products on the status and evolution of land surface at global scale: surface albedo, FAPAR, LAI, top of canopy spectral reflectance, Fcover, NDVI, VCI, VPI, DMP, burnt area, land surface temperature, soil moisture, and areas of water bodies. Production and delivery of the variables take place in a timely manner (typically maximum of three days after the data acquisition period) and is complemented by the constitution of long term time series.

The JRC Land Resource Management (LRM) Unit is given the responsibility to implement, on behalf of DG ENTR and through an Administrative Arrangement completed by a Cross-Delegation Agreement between DGs of the European Commission, the Global Land Component of the GIO Land Service, one of the two Copernicus services identified for operational implementation as defined in recital 20 of the preamble of the "GMES Initial Operations" regulation (EU) No 911/2010[2].

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3.2. REQUIREMENTS

Considering the time frame of Copernicus Global Land service activities, which are currently limited in time until end of 2015, but are expected to continue as a Copernicus service in a governance setting still to be defined, and the global and operational nature of the service, two different levels of priorities can be identified with regard to the ImagineS product list (Table 1):

- Variables 1 (LAI/FAPAR/FCover) and 2 (Albedo) can be considered as first and short term priorities as they seem to be quite mature (similar products are already generated with other EO data input than the ones considered by the project: the Copernicus Global Land service generates these variables using SPOT/VEGETATION data).
- The other ImagineS products are still in a R&D level, with uncertainties regarding the underlying assumptions (e. g. simultaneous availability of compatible HR and LR data) or the expected accuracy and reliability (e. g. biomass at global scale).

3.2.1. Technical characteristics of products

- **Spatial coverage:**
  - LR products: global
  - HR products: large ROIs anywhere globally

- **Spatial resolution:**
  - LR products: baseline = 1km with a target to 1/3 – 1/10 km
  - HR products: baseline = 10 – 30m

- **Temporal frequency and coverage:**
  - LR products: baseline = 10-day (1-10, 11-20, 21-end of month), cloud and haze-free everywhere globally
  - HR products: baseline = one cloud free image or artifact-free product every month with a target to every 10 days.

- **Projection and grid:**
  - LR products:
    - geographic projection: lat-lon
    - geodetical datum: WGS84
    - pixel size: 1/112° and fractions of 1/112°, accuracy: minimum 10 digits

        - coordinate position: pixel centre
        - global window coordinates: UL: 180°W-75°N, BR: 180°E, 56°S (if pixel size = 1/112°, then 40320 columns by 14673 lines)
        - pixel alignment between products and pixel sizes (no pixel overlap).
    - HR products: capacity to generate LR compatible products AND local standard projections

- **Format of files:**
    - Hdf4 for EOS (asa HDF-EOS2) + external ZIP compression
    - Hdf5 for EOS (asa HDF-EOS5) with internal compression
    - NetCDF (CF extension)
    - Geotiff or BigTIFF files (i.e. evolution of the TIFF format to support files larger than 4GB).

- **Metadata:**
    - Whenever applicable INSPIRE guidelines on data model, metadata and web services shall be followed (see INSPIRE web site at http://inspire.jrc.ec.europa.eu)
    - Readable with OS viewing tools

3.2.2. Quality Indicators

- Keep quality indicators of input data
- Add quality indicator on algorithm output (i.e. combination of input data quality, ancillary data quality and algorithm possible boundary conditions).
- Provide a synthesis layer based on analysis of quality indicators on a yearly basis (annual proportion of usable products, number of unusable products in a row, …)

3.2.3. Product Accuracy

Baseline: internationally agreed standards such as GCOS[3].

Target: the products should be "*fit for the purpose*", i.e. of sufficient quality to answer the users' needs. The Global Land service does not have yet a quantitative definition of this, also considering the multiple user nature of the service. This means essentially that, for each individual product, the accuracy should be defined (thus also described by the providers!) in terms of:

- Overall quantitative accuracy
- Accuracy by environmental unit (e.g. biomes or land cover classes or eco-climatic regions)

- Accuracy (or adequacy) by geographical scale: global, continental, transnational, national, regional, local, depending on product type and properties (e.g. LR vs. HR)
- Accuracy stability with time: is accuracy stable between products in a time series, depending on location and (a) seasonal effects, (b) multi-annual time series?

In the absence of user specifications, it is necessary to describe these properties so that, during the user uptake phase, the positive or negative user feedback can be connected to the properties.

3.2.4. Miscellaneous

Timeliness: within 3 days after end of period (= constraint on software engineering)

Documentation: ATBD, user manual, validation results, evidence of review meetings

Long-term continuity: required, but not an ImagineS issue

Accessibility and Dissemination: required, but not an ImagineS issue

User support: required, but not an ImagineS issue

4. THE MESA PROGRAM

The MESA program (2013-2018) involves 48 countries, with a budget of 37 M€ from the 10th European Development Fund (IntraACP budget line and five Regional Indicative Programmes).

4.1. PRESENTATION

MESA is built on the heritage of the AMESD program, using Earth Observation data and information products for environment and sustainable development, specifically designed for African users at continental, regional and national levels.

Infrastructure support, including upgrading and maintenance of PUMA and AMESD receiving stations continued under MESA in all Sub-Saharan African countries. The program will also consolidate and further develop information services in the thematic areas addressed by the AMESD program: (i) water resources management; (ii) crop and rangeland management; (iii) agricultural and environmental resource management; (iv) mitigation of land degradation (including forest exploitation) and conservation of natural habitats and; (v) marine and coastal management. MESA expands to new thematic areas and services (such as climate services and forest management). Moreover, systematic efforts are devoted to promote cross-fertilization among the five partner regions and to pursue the continentalisation of services, where appropriate.

The JRC LRM contributes to various aspects of the implementation of the MESA program, in particular through the development and provision of the eStation and various training activities, both in Europe and in Africa. Indeed, LRM's research informs EU environment and development policymaking concerning soils, desertification, ecological restoration and biological diversity and development-aid programming. The unit's research also helps the EC to meet obligations from Multilateral Environmental Agreements, especially the UN Convention to Combat Desertification and the Convention on Biological Diversity. The Unit pays particular attention to the EU and its neighbors plus EU development-assistance priority regions, especially the ACP (Africa, Caribbean and Pacific). The Unit also works closely with UN agencies related to sustainable land resource management, in particular FAO and UNEP.

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4.2. REQUIREMENTS

4.2.1. Technical characteristics of products

- **Spatial coverage and resolution**

Regarding the spatial coverage, there is no problem as the whole Africa is covered. Regarding the spatial resolution, products at 300m are a valuable improvement. But reversely, products at 16Km will not be used because of their coarse resolution, while they are of interest from a thematic point of view. It could be useful to consider the possibility to generate these products at a higher resolution (ideally <1km).

- **Temporal frequency and coverage**

10 days frequency is fine, but at least 10 years of observations is mandatory to allow computing the anomaly products needed for the environmental monitoring. It means that calibration between VGT and S3+ProbaV as well as back processing in case algorithm changes are of prime importance.

- **Projection and grid:** Lat Long / WGS84

- **Format of files:**

A format compatible with popular image processing software's (e.g. ENVI, ERDAS, IDRISI) should be used. In the framework of the MESA (and previously AMESD), all the RS products are automatically converted in GeoTIFF with LZW internal compression and geo-spatial information embedded.

We recommend providing global or continental images instead of tiles.

- **Metadata**

We don't have specific requirement, the usual information should be provided (Projection, geographic extent, date extend, data scaling, algorithm version, production dates…)

4.2.2. Quality Indicator

A quality flag as well as any information allowing making a good use of the proposed information should be associated to each file.

4.2.3. Miscellaneous

Timeliness: a three days delivery time lag (after the last acquisition) should be considered as a maximum. Obviously the provided product should be representative of the last 10 days. This last point should be considered for the choice of the compositing methodology because a near real time processing does not necessarily correspond to the production of a near real time vegetation condition.

The long term continuity is essential as explained above. This is why a back processing is mandatory if an algorithm change that impact the result occurred.

Accessibility and Dissemination: the data should be both available by EUMETCast and by FTP.

Documentation and user support: the Algorithm Theoretical Baseline Document, the Product User Manual as well as the Product Validation Report should be provided. Training material is appreciated, if any.

4.2.4. Specific needs for Medium Resolution products

All the products should be available free of charge for the African users

NDVI is not part of the proposed products, and should be considered as it's of interest for many users in the framework of MESA.

As said above the 16km spatial resolution of products 03 to 05 (Biomass, Drought indicators, Carbon fluxes and evapotranspiration) will prevent their use. The production of a higher resolution should be considered.

4.2.5. Specific needs for High Resolution products

Is it possible to add other test sites in Africa (to be defined), in order to evaluate with our African users, the possibility to develop new services based on HR imagery?

The generation of images for locations agreed with Users (especially in the Eastern Africa Region) would be beneficial for their thematic applications.

5. USER PRESENTATION

This section provides an overall view of the ImagineS user's community and the different applications related to ImagineS products and services. The complete user presentation provided in the survey on user requirements documents is presented in Annex A.

5.1. THE INSTITUTION AND ITS MANDATE

A total of 20 institutions from 11 countries of Europe, North America, South America, Africa and Oceania and 3 European or international organizations provided us their contributions to the survey on user's requirements. Five different categories of users are identified: (1) European and international organizations (Table 3), (2) National Services (Table 4), (3) National Agriculture Research Institutes (Table 5), (4) Regional Agriculture Research Institutes (Table 6), (5) Universities and research laboratories (Table 7).

ID	User	Country	Institution	Mandate
1	MARS /JRC	EU	Monitoring Agriculture ResourceS Unit – Joint Research Center	MARS serves to Agriculture and Food policies of the EU
2	ETCSIA/UMA	EU	European Topic Centre for Spatial Information Analysis – European Environment Agency / University of Malaga	Monitoring temporal changes of land use and environment
3	CIAT/CGIAR	International	International Centre for Tropical Agriculture / Consultative Group for International Agricultural Research	Research aimed at increasing the eco-efficiency of agriculture

Table 3: IMAGINES Users and its mandate: European and International Organizations

ID	User	Country	Institution	Mandate
4	Meteo-France	France	End-user Service Department on agro-meteorology	Interface between operational services of Meteo-France and agriculture users
5	IGN / PNT	Spain	National Geographic Institute ~ Ministry of Public Works	Responsible for the National Remote Sensing Program (PNT) among others.

Table 4: IMAGINES Users and its mandate: National Services

ID	User	Country	Institution	Mandate
6	Agri-Food	Canada	Agriculture and Agri-Food Canada ~ Dpt. of Agriculture of Canada	R&D to achieve environmental sustainable agriculture, agri-food and agri-based products.
7	ARC	South Africa	Agricultural Research Council (ARC) lead consortium	R&D and transfer to promote agriculture and industry; facilitate/ ensure natural resource conservation
8	INTA	Argentina	National Institute of Agricultural Technology ~ Dpt. of Agriculture	Research and innovation to improve sustainable rural development
9	INIA	Chile	National Institute of Agro-fishery ~ Dpt. of Agriculture	Transfer knowledge for improving competitiveness in the agri-food sector

Table 5: IMAGINES Users and its mandate: National Agriculture Research Institutes

ID	User	Country	Institution	Mandate
10	IMIDA	Murcia, Spain	Institute of Agricultural and Food Research ~ Department of Agriculture of Murcia	Research into agriculture, forestry, food, fishing, shell-fish culture
11	ITAP	Albacete, Spain	Provincial Agronomic Technical Institute	Transfer science and technology to farmers in Albacete
12	IFAPA	Andalusia, Spain	Agricultural Research and Training Institute ~ Department of Agriculture and Environment of Andalusia	R&D to develop and transfer solution to agriculture.

Table 6: IMAGINES Users and its mandate: Regional Agriculture Research Institutes

ID	User	Country	Institution	Mandate
13	CESBIO	France	Centre d'Etudes Spatiales de la BIOsphere. UPS-CNRS-CNES-IRD	R&D on biosphere functioning based on EO data.
14	UChile	Chile	Laboratory for Research in Environmental Sciences - University of Chile	Applied research in agro-meteorology and agriculture.
15	BCA	Bostwana	Botswana College of Agriculture ~ University of Bostwana	Research and innovation in agriculture and related disciplines.
16	ELU	Hungary	Eötvös Loránd University	Science and education
17	UCLM	Spain	Remote Sensing and GIS Unit, University Castilla-La Mancha	Remote Sensing and GIS in support of regional development

ID	User	Country	Institution	Mandate
18	UVEG	Spain	Remote Sensing Unit-University of Valencia	R&D on remote sensing of land surfaces
19	LABTEL	Peru	Remote Sensing Laboratory ~ Universidad Nacional Mayor de San Marcos	Application of Remote Sensing techniques to agriculture and water resources management
20	U. Monash	Australia	Monash University	Science and technology to improve environmental sustainability across all aspects of life

Table 7: IMAGINES Users and its mandate: Universities and Research Laboratories

5.2. THE APPLICATIONS RELATED TO IMAGINES

Users are involved in different applications related to agriculture including among others fodder production, food insecurity (drought monitoring), crop monitoring, irrigation or water resources management needs (Table 8).

User	Applications
MARS /JRC	AGRI4CAST action is centered on the JRC's crop yield forecasting and crop production biomass. FOODSEC action is focused on the analysis of food insecure (Drought monitoring) regions mainly African countries.
UMA / ETCSIA	EEA Simplified Ecosystem Capital Accounts (SECA), environment, biodiversity, water, carbon EEA Ecosystem Assessment ~ EU biodiversity strategy 2020
CIAT / CGIAR	Upper Tana Water Fund Project (Kenya): mitigate sedimentation and erosion in upstream agricultural zone to provide good quality and adequate quantity of water for downstream urban dwellers.
Meteo-France	Fodder production over France (ISOP system) Modelling corn crop water needs to estimate real water consumption of irrigated crops (OSIRIS)

User	Applications
IGN / PNT	Centralize the distribution of satellite images and products for all the Spanish Public Users (national departments, regions, universities)
Agri-Food	Crop biomass and yield. Monitor crop growth using remote sensing, micrometeorology and modelling Verify process-based land surface and crop growth models through data assimilation
ARC	Crop Yield Modeling. Crop Area monitoring. Irrigation and Water use efficiency assessments. Drought monitoring. Vegetation condition assessment.
INTA	National System for pastures monitoring Agriculture and floodings in the Pampas & Chacos (Argentina & Paraguay)
INIA	Crop coefficient for irrigation, evapotranspiration Agro-meteorological monitoring
IMIDA	Space assisted irrigation advisory services in the SUDOE space (TELERIEG) Sustainable drought-adapted Irrigation Management. Water Observatory.
ITAP	Agriculture advisory Services for farmers at regional scale.
IFAPA	Crop coefficient for irrigation, evapotranspiration Agro-meteorological monitoring
CESBIO	Site 1 (South-West, France): evaluation of agro-meteorological models , water needs and water supply for water resource management Site 2 (Tunisia): Validation of SVATs models, drought indices, soil moisture estimation based on synergy between optical and microwave
LARES	Improve irrigation water use in agriculture. Develop an irrigation (ET, water management) EO advisory system for agriculture
BCA	Crop monitoring and yield forecasting; Forest and Rangeland resources management; Landcover and landcover changes; Drought monitoring

User	Applications
ELU	Greenhouse gases and carbon dioxide exchange Crop identification, Light Use Efficiency (FAPAR)
UCLM	Space assisted irrigation advisory services (www.sirius-gmes.es) .Crop monitoring in test areas worldwide.
UVEG	Retrieval of vegetation products and Net Primary Production in the LSA SAF project. Environmental monitoring over Spain (carbon fluxes in forest areas, drought indicators)
LABTEL	Vegetation monitoring; Desertification and Drought. Land cover/use. Crop monitoring
U. Monash	Land Surface Modelling (assimilation of vegetation conditions) Water Resources management for agriculture and environment Hazard mapping (Fire prediction)

Table 8: Users applications related to IMAGINES

6. USER REQUIREMENTS

6.1. GENERAL NEEDS

This section includes the most frequent answers to the survey on user's requirements. Table 9 summarizes all the answers provided by the users.

6.1.1. Technical characteristics of products

- **Spatial resolution:** According to the portfolio (Table 1).

- **Temporal frequency:** 10-days is fine for most of the users, whereas three of them (IGN, UCLM, U. Monash) requested a higher frequency (7-days), in particular during growing seasons. For CIAT, monthly data over the study site would be more appropriate.

- **Projection and grid:**

  For the European window, ETRS89, compliant with the INSPIRE on Geographical Grid Systems – Guidelines (http://goo.gl/wHvsT). ETRS89-LAEA 52°N 10°E (http://goo.gl/nXKUI) is the EEA reference grid. Transverse Mercator projection, UTM (ETRS89-TMzn) and/or geodetic coordinates (ETRS89-GRS80) using the Grid_ETRS89-GRS80 proposed in Annex II of INSPIRE is proposed by the IGN (National Geographic Institute, Spain).

  For the Global window a regular latitude/longitude grid in WGS84; the standard parallel is the equator (plate carrée)

- **Format of files:** GeoTiff or HDF or binary file with its associated header file. Header file should reflect ENVI files type and contains the following fields:

  description = description of the image content
  samples = number of columns
  lines = number of lines
  bands = number of bands
  header offset = offset of the header (should be 0 always)
  file type = file type (e.g. ENVI standard)
  data type = data type
  interleave = type of interleave
  projection info = standard information about the projection used
  values = range of values and scaling coefficients
  flags = flagged values if any
  date = date associated to the image
  days = type of time composite
  sensor type = sensor

comment =any relevant comment
program = program and program version used for creating the file

- **Metadata:** Compliance with INSPIRE metadata regulation: INSPIRE Metadata Implementing Rules based on EN ISO 19115 and EN ISO 19119.

6.1.2. Quality Indicator

Quality flags are expected including algorithm performance indicators, number of valid observation in the compositing window, a synthetic quality indicator summarizing the expected quality of the observation. Moreover, a map of the accuracy associated to the products and associated validation reports are expected. Other quality indicators expected are the positional accuracy, cloud coverage or information on previous rain.

6.1.3. Timeliness

Near real time is mandatory for agriculture applications, thus the required timeliness ranges from 0 to 2 days after the acquisition.

Long-term continuity is essential for planning future operational use of ImagineS products. The products are expected to contribute to existing monitoring systems which are designed to analyze trends and changes over time. Therefore, datasets from different years must be comparable among them with simple subtraction. These change layers must make sense from the thematic point of view.

6.1.4. Accessibility and Dissemination

Data accessibility via SDI with downloaded capability is foreseen. If not possible to download using SDI, simple FTP is expected. Dissemination via EUMETCast is also desirable for African users (BCA).

Products should be available in composite windows and not (or not only) in tiles.

For MARS Unit: The data to be delivered should be pre - defined through a formal agreement. Through FTP automated routines the data provider should send to JRC the defined set of images and windows. Global window should have the format of an image with the sea pixels removed. Status images that describe the original position of the land pixel should be provided.

6.1.5. Documentation and user support

Standard documentation including User Manual, ATBD (Algorithm Theoretical Basis Document), producer verification documents, and validation reports are expected.

Support to the user in order to understand the thematic content of the outputs is also a major asset (i.e. measurement units of the different units)

User	Spatial	Temporal	Projection/Grid	Format	Metadata	Quality Indicator	Timeliness	Dissemination
MARS	Table 1	Table 1	Plate carrée; INSPIRE	binary with header	xlm	quality flags	2 days	FTP
ETCSIA	Europe, Table 1	Monthly	ETRS89-LAEA 52N10E	GeoTiff, ESRI, ENVI	ISO 19115	quantitative	No need	SDI or FTP
CIAT	Upper Tana Basin, Table 1	Monthly	WGS84 UTM 37S	GeoTiff	yes	N/A	N/A	N/A
Meteo-France	France	N/A	N/A	N/A	N/A	N/A	N/A	N/A
IGN	Spain, Table 1	7 days	UTM (ETRS89-TMzn)	jpeg2000, TIFF, ecw	ISO 19115	Positional accuracy	N/A	Online, free
Agri-Food	Table 1	Table 1	UTM18 / WGS84	GeoTiff or HDF	HTML	quality flags	few days	web server
ARC	Table 1	Table 1	N/A	GeoTiff	N/A	cloud cover	1 day	N/A
INTA	Table 1	Table 1	N/A	N/A	N/A	N/A	N/A	N/A
INIA / U. Chile	Table 1	daily	WGS84	TIFF	ascii	N/A	N/A	web
IMIDA	N/A	N/A	ETRS89 / WGS84	GeoTIff	ISO 19115	N/A	N/A	FTP, web
ITAP	Barrax area	N/A	ETRS89	N/A	N/A	N/A	N/A	N/A
IFAPA	Table 1	Table 1	N/A	N/A	N/A	N/A	1 day	N/A
CESBIO	N/A	N/A	Lambert-93	HDF	N/A	N/A	N/A	N/A
BCA	Table 1	Table 1	WGS84	GeoTiff	yes	N/A	N/A	FTP, EUMETCast
ELU	N/A	N/A	Plate carrée	NetCDF, HDF, binary	yes	Positional accuracy	N/A	N/A
UCLM	Castilla-la-Mancha	7 days	ETRS89	IMG, HDF, GeoTiff	calibration	absolute error	1-2 days	FTP, web
UVEG	N/A	Table 1	N/A	N/A	N/A	N/A	N/A	N/A
LABTEL	Peru, Table 1	Table 1	Plate carrée	Tiff, HDF, binary	yes	yes	N/A	FTP
U. Monash	Table 1	< 10 days	N/A	N/A	calibration	errors, cloud cover	N/A	FTP, push

Table 9: Summary of User Requirements: general needs

6.2. SPECIFIC NEEDS FOR MEDIUM RESOLUTION PRODUCTS

Table 10 compiles the specific needs for medium resolution product expressed by the users. Only answers different than Table 1 are compiled.

User	Specific MR needs
MARS /JRC	We recommend maintaining the simple and pragmatic NDVI product in the ImagineS portfolio. We would like to access to NDVI because i) some of our customer (especially in Africa) developed expertise and processing chains based on NDVI, and ii) we consider it useful to have the option to access a remote sensing indicator more attached to actual satellite observations.
UMA / ETCSIA	LAI and Fcover at 300m are welcome. Comparability with existing products (i.e. MODIS datasets) is required for the user to understand the pros and cons of moving from existing datasets to upcoming ones.

User	Specific MR needs
IGN / PNT	LAI, FAPAR, FCover. Drought Indicators, Carbon Fluxes and Biomass over Spain at a higher spatial resolution (1200m) are desirable.
Agri-Food	300 m products whenever available; covering experiment site and possibly eastern Ontario, surface reflectance is desirable.
INTA	LAI, FAPAR, FCover and Albedo to the national level will be an excellent opportunity for temporal and spatial comparison among forage resources.
INIA/ U. Chile	Albedo, LAI, FPAR, FCover, Surface Reflectance, Biomass, Crop map

Table 10: Specific needs for medium resolution products

6.3. SPECIFIC NEEDS FOR HIGH RESOLUTION PRODUCTS

Table 11 compiles the specific needs for high resolution product where several users proposed new demonstration sites for HR products. Only answers different than Table 1 are compiled.

User	Specific HR needs
MARS /JRC	FAPAR (10m) products are of interest for classification purposes. We would appreciate adding a test site for the crop map over Europe (France?) given the importance of the monitoring of the European Agriculture for MARS. Furthermore, we would appreciate to indicate an additional demo site when ImagineS will be ready to start the production.
UMA / ETCSIA	Large description of the products with special attention to “Biomass” and “crops” is expected. They are not well known products by the users as FAPAR, Fcover or LAI products are. Fcover and LAI at High Resolution are very welcome in some demonstration sites (if possible) in order to explore the suitability for monitoring and reporting mechanisms at European level.
IGN / PNT	LAI, FAPAR, FCover. Surface reflectance, biomass and crop map.

User	Specific HR needs
INIA	Biomass
IMIDA	Surface reflectance, FAPAR, Biomass, Crop map. An additional demonstration site is proposed for evaluation purposes. The area corresponds to the Irrigation Community of Cartagena croplands (CRCC, in Spanish). 50.000 ha irrigated crops with drip irrigation (vegetables and citrus trees). Location: 37° 48' N, 1° 03' W
IFAPA	A new demonstration site is proposed in Córdoba (Andalusia): Location: 37º 48'N, 4º 44'W
LABTEL	A demonstration site is proposed in Lambayeque. Location: -6.78° S, Lon 79.76° W. This area is of primary interest for high resolution products as it is our study area for our Proyecto Cátedra, in collaboration, among others, with a private agro-industrial company, which is providing field data (soil conductivity, texture, pH, sugar cane production) over more than 11000 ha, collected during 2008 and 2010. Topographically, the region is almost flat and is located in northern coast of Peru. A second site, Ayacucho, is of interest in the southern Andean region (Lat -13.15°S, Lon -74.12° W)
UCLM	Ortho-rectified images: thermal and optical channel, reflectances and temperature. Vegetation Index and color composition, daily, in a rush service at full spatial resolution.

Table 11: Specific needs for high spatial resolution products

7. USER EVALUATION

This section describes the user evaluation of ImagineS products and services as it is envisaged by the users. Five different categories are identified:

- **Validation with ground truth:** Most of the users corresponding to demonstration sites (Table 2) are willing to perform direct comparisons of ImagineS products with ground data collected in their study site. In particular, CESBIO, ITAP, INTA, IFAPA, ELU, UCLM and U. Monash will participate in this evaluation.
- **Inter-comparison with similar products:** Several users will perform inter-comparison with existing products, which are being currently used into their working environments (e.g. Land-SAF, INIA system, ISOP products, MARSOP). In particular, ETCSIA, INTA, UCLM, Météo-France, UVEG, ARC, U. Monash will be involved in this activity.
- **Assessment of scientific relevance:** This category includes the evaluation of LDAS outputs to contribute to the seasonal forecasting of biomass production, or the relevance of LAI, FAPAR products for monitor crops status or to improve performance for biomass and yield prediction. MARS, ETCSIA, CIAT, IGN, Agri-Food, CESBIO, ELU, and Meteo-France will participate in this evaluation.
- **Usability in operational systems**: This includes the test of formal aspects on format, timeliness, data access, etc, mainly oriented to agriculture advisory operational systems. MARS, IGN, Meteo-France, IFAPA, IMIDA, INIA/U. Chile, CESBIO, UCLM, ITAP will participate in this activity.
- **Promotion/Dissemination**: The IGN through the Spanish remote sensing program (PNT) is willing to distribute to Spanish regional administrations and scientific community the ImagineS products, and collect their feedbacks.

User	Evaluation
MARS /JRC	Test of formal aspect of user requirements on product usability (format, timeliness, absence of artifacts, etc.)
UMA / ETCSIA	1) To distribute among thematic experts (i.e. agriculture and forestry), 2) To assess the products in comparison with existing datasets used in the monitoring system (i.e. NDVI, FAPAR). 3) To assess the use of ImagineS products as proxy for applying 32symmetric disaggregation mapping techniques based on EO data → based of the ecosystems accounting and services activities.
CIAT / CGIAR	LAI, FAPAR and FCover (300m) depending on the temporal coverage (2001 – current) will be used to estimate how primary productivity has changed in relation to land cover change across the Upper Tana Basin. Biomass (10m) would provide important measures of productivity of the landscape and would be related to land use.

User	Evaluation
Meteo-France	To evaluate to what extent the LDAS can contribute to the seasonal forecasting of biomass production.
IGN / PNT	Products would be disseminated at national level by ftp download, monitoring the download size for each agency and specific application (applications are collected in the registration process). Through regular meetings and working groups would gather information about the usefulness and scientific relevance of each product.
Agri-Food	Direct validation with spectra of targets to assess radiometric integrity. Direct validation of higher level products (FAPAR). INRA will provide equipment for continuous FAPAR monitoring. Assessment of scientific relevance for 1) monitor crop growth status, such as cover fraction, LAI and crop stresses; 2) investigate the seasonal dynamics; and 3) improve performance of process-based models for biomass and yield prediction, soil-plant-atmosphere interactions through data assimilation.
ARC	Assessment the utility of ImagineS products/services for crop growth monitoring, crop conditions assessment, crop yield prediction and vegetation (pasture/grazing) conditions assessment. Direct validation with field observations.
INTA	The utility of ImagineS products/services will be continuously monitored through INTA website in which INTA will distribute and integrate the products delivered by ImagineS together with others permanent products generated from NOAA-AVHRR, GOES and MODIS own information. Direct validation with ground truth.
INIA	Usability for an operation system for agronomy and irrigation water management.
IMIDA	Usability for an EO-based irrigation advisory system.
ITAP	Direct validation. Usability for an agriculture advisory service for farmers.
IFAPA	Agreement of ImagineS products with: 1) field observations of original variables when and where available (FCover, biomass), 2) data provided by other sensors and 3) measurement of variables obtained using ImagineS product (yield, water consumption). Operative issues such as timeliness, data selection and ordering procedures, downloading or data access system, requirements of additional processing, etc.
CESBIO	For both sites: direct and indirect validation of LAI, FAPAR , FCOVER

User	Evaluation
	at high spatial resolution.
LARES	Improve irrigation water use in agriculture. Develop an irrigation (ET, water management) EO advisory system for agriculture
ELU	ELU plans to use ImagineS products as research tool, not as operational application. Upon availability of the products/services ELU will seek for a PhD student or undergraduate student who will start working with the data.
UCLM	The surface reflectance will be evaluated using similar sensors when they coincide on time, such as Deimos for high resolution and others. The quality of the reflectance can be checked as input in the satellite-assisted soil water model and validated with ground measurement such as lysimeter or meteorological stations when field campaigns in the area are carried out.
UVEG	Inter-comparison with the Land-SAF products. Biomass comparison as compared with Forest National Inventories. Drought indicators will be compared with drought maps obtained from the Spanish meteorological stations (AEMET).
LABTEL	Comparison with field data.
U. Monash	The Yanco area has a number of spectral sensors permanently installed at a grassland site and also has soil moisture/temperature as well as weather data available. In addition, regular destructive samples are already being collected. Those will then be compared to the data supplied by the ImagineS project. The land surface modeling aspect will compare climatologies currently used in the land surface models against real data and a comparison of the LSM after using ImagineS data will be studied. Similarly. The hazard mapping will use different types of input data and compare the performance of those simulations against historical events.

Table 12: User evaluation of ImagineS products

8. CONCLUSIONS

This document compiles the requirements of the institutions which have expressed an interest for testing and using the ImagineS products.

The Copernicus Global Land service and the MESA program expect that the 300m products will contribute to ensure the evolution of the service, and will help the African users for their environmental applications, respectively. In addition, a number of institutions from eleven countries have provided their requirements to achieve researches and to deal with various applications related to agriculture at different scales, from local to global.

ANNEX A: USER PRESENTATION AND APPLICATIONS RELATED TO IMAGINES

1) MARS - INSTITUTE FOR THE ENVIRONMENT AND SUSTAINABILITY. JOINT RESEARCH CENTRE

The MARS unit of which the two actions AGRI4CAST and FOODSEC have compiled this questionnaire is part of the European Commission, Joint Research Centre, Institute for the Environment and Sustainability.

The MARS Unit (Monitoring Agricultural Resources) itself is focusing on crop production, agricultural activities and rural development, the MARS Unit provides timely forecasts, early assessments and the scientific underpinning for efficient monitoring and control systems. The work serves the Agriculture and Food policies of the European Union, their impact on rural economies and on the environment, encompassing the global issues of food security and climate change.

The AGRI4CAST action is centered on the JRC's crop yield forecasting system aiming at providing accurate and timely crop yield forecasts and crop production biomass for the union territory and other strategic areas of the world. The System contributes to the evaluation of global productions in support to CAP management decision. In view of providing support to a reviewed CAP for the next 10 years and the Climate Change policy agenda of the EC, studies on changing production scenarios based on climate change impact on agriculture are implemented.

The FOOSEC action is focused on the analysis of food insecure regions of the world (mainly African countries in the Horn of Africa and the Sahel). North African countries and North Korea are also covered by the action upon request of various DGs.

Both actions deal with the monitoring of crop status and thus requiring updated information at a high temporal frequency and in near real time. Estimation of crop yield and pasture biomass based on optical remote sensing products (mainly NDVI and FAPAR) is performed using statistical approaches when ground measurements are available, and using anomaly indicators in the absence of ground reference data. In both cases, long-term time series of remote sensing products are needed.

MARS is currently using SPOT-VGT products (1998-today) (global), NOAA-AVHRR and METOP-AVHRR (both only Europe) as well as MODIS data (Europe, African window) maintained by VITO under the MARSOP3 framework contract.

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The applications related to ImagineS

AGRI4CAST

- crop yield forecasting at country and regional level (annual crops & pastures)
- Phenological calibration of crop growth models at regional level
- Estimate crop calendars

FOODSEC

- Drought monitoring and early warning;
- Regional and country level food security analysis;
- Index Based Insurance using meteorological and remote sensing data.

As a general remark we point out that both MARS actions make use of "long-term" archives of remote sensing data (currently 15 years of SPOT-VGT) for their operational monitoring of crops and pastures. Since there is no capacity to ingest directly a new remote sensing product, ImagineS imagery will not be used for operational application at this stage. However, we are interested in testing the products in view of the future availability of an archive. Testing of ImagineS imagery will be facilitated when more than one year of observations will be available.

2) EUROPEAN TOPIC CENTRE FOR SPATIAL INFORMATION AND ANALYSIS.

University of Málaga – European Topic Centre for Spatial Information and Analysis.

The applications related to ImagineS

ENVIRONMENTAL ACCOUNTING

European Environmental Agency (EEA) launched the **Simplified Ecosystem Capital Accounts** (SECA), which aims at supplementing the UN SEEA (System of Integrated Environmental and Economic Accounting) and SNA (System of National Accounts) with information on the environment and natural capital.

SECA considers the ecosystem as capital which delivers a bundle of services to people, some of which are appropriated and incorporated into products, accumulated and/or consumed. Evaluating the ecosystems means to know about the land, the biodiversity, the water and the carbon content.

Related to ImagineS, not only information related to the **carbon account** across Europe is very significant but also datasets derived from EO sensors (i.e. LAI and FAPAR) allowing the establishment of monitoring systems. The characteristic indicators considered for ecosystem capital carbon/biomass accounts are:

- **Net Primary Production (NPP) and heterotrophic respiration**
- Carbon content and carbon flows related to **agriculture, forestry and cities development**

ECOSYSTEM ASSESSMENT AND EVALUATION OF ECOSYSTEM SERVICES

In 2012, the EEA has established its internal implementation strategy for Ecosystems – Ecosystem services Assessments that draws EEA´s conceptual framework, building blocks, objectives, activities and roadmap to support the implementation of the EU biodiversity strategy 2020 (European Commission 2010)

Within this strategy 1, target 2 aims at maintaining and restoring ecosystems and their services by 2020, by establishing a green infrastructure and restoring at least 15% of degraded ecosystems. In its supporting action 5, that targets improving the knowledge on ecosystems and their services, this action pins down that "Member States, with the assistance of the Commission, will map and assess the state of ecosystems and their services in their national territory by 2014, assess the economic value of such services, and promote the integration of these values into accounting and reporting systems at EU and national level by 2020" (European Commission 2011 a). Particularly, Europe 2020 flagship initiative for a resource-efficient Europe provides a long-term framework for actions in many policy areas, supporting policy agendas for climate change, energy, transport, industry, raw materials, agriculture, fisheries, biodiversity and regional development (European Commission 2011 b). This is to increase certainty for investment and innovation and to ensure that all relevant policies factor in resource efficiency in a balanced manner.

Common implementation of the EU level ecosystem assessments work in four phases:

I. Biophysical baseline mapping and assessments of the state of major ecosystems;
II. Biophysical baseline mapping and assessments of defined ecosystem services;
III. Alignment of ecosystem service assessments with scenarios of future changes;
IV. Valuation of ecosystem services for baseline and contrasting scenarios and integration into environmental and economic accounting.

Related to ImagineS, it is expected that the developments in HR and MR Terrestrial Essential Climate Variables will improve the establishment of phases I and II. Through these developments, a number of datasets will be shaped via a pre-operational services which could answer these two questions:

- What datasets and information are available at the global and EU levels that can be used in biophysical mapping to understand the status and trends of European ecosystems?
- What types of information and data are / will be available that will secure and improve the continued update of ecosystems assessment?

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3) INTERNATIONAL CENTRE FOR TROPICAL AGRICULTURE (CIAT)

The mission of CIAT (http://ciat.cgiar.org/) is to reduce hunger and poverty, and improve human nutrition in the tropics through research aimed at increasing the eco-efficiency of agriculture

As a member of CGIAR, CIAT's research agenda is built upon four development aims - reduced rural poverty, stronger food security, improved human nutrition and health, and better management of natural resources. As a centre, CIATs research on tropical agriculture focuses on selected crops and research areas, complementing the research of other organizations working on tropical agriculture. CIAT develops technologies, methods, and knowledge that better enable farmers, mainly smallholders, to enhance eco-efficiency in agriculture i.e. make production more competitive and profitable as well as sustainable and resilient through economically and ecologically sound use of natural resources and purchased inputs. CIAT is currently involved in developing strategic partnerships with key development actors to widen the impact of our research in addition to strengthening scientific capacity through closer ties with advanced research institutes. In sub-Saharan Africa CIATs research concentrates on large-scale application of new knowledge to key tasks, such as closing crop yield gaps, restoring degraded agricultural landscapes and fostering climate-change adaptation.

The applications related to ImagineS

THE UPPER TANA WATER FUND PROJECT (KENYA):

In partnership with The Nature Conservancy, and other private and government organizations, CIAT is engaged in a project to mitigate sedimentation and erosion in the predominantly rural upstream watersheds of the Upper Tana River Basin while providing good quality and adequate quantity of water for downstream urban dwellers of Nairobi. The current challenge is that upstream dynamics are contributing to increased sedimentation and degraded water quality in the streams that supply downstream urban dwellers. The Upper Tana provides 90% of water to Nairobi, and contributes to 66% of Kenya's power supply through downstream hydropower generation. It is a high-potential agricultural zone and is

densely populated, predominantly by small holder farmers who grow tea, coffee, maize and vegetables. Upstream land users do not have the resources to implement wide scale interventions targeted at reducing sedimentation but a benefits sharing scheme where downstream users contribute to a fund to initiate upstream interventions may address this (The Water Fund). Interventions include sustainable land management (SLM) options such as riparian afforestation, terraces, grass strips and agroforestry.

CIAT is using a number of GIS tools and field studies to investigate (1) costs and benefits associated with different SLM interventions and (2) how intervention investments may be targeted across the landscape to improve livelihoods and natural resource management. The above approaches are based on remote sensing information in addition to field studies. The higher resolution ImagineS products would add a great deal of value to the project. Specifically they could be used to investigate how interventions are being taken up across the landscape and how this impacts crops production:

LAI, FAPAR and FCover (300m) and FAPAR (10m) could be used to predict primary productivity and crop growth which could be linked to field measures of soil fertility to examine soil fertility-productivity linkages across the landscape. They can provide important information on the condition of crops.

Biomass (10m) would provide important measures of productivity of the landscape which could only otherwise be achieved by an extensive field campaign. We could validate this product by comparing satellite information with on the ground measurements. Agroforestry and riparian are both important interventions to reduce erosion and Biomass (10m) could be used to examine uptake of these measures across the landscape.

Crop map, if used here, to monitor crop biomass and carbon and water fluxes would indicate how uptake of sustainable land management is impacting livelihoods i.e. does crop production/carbon/water increase or decrease with SLM and over what time scale? This, combined, with household surveys would allow trade-off analysis of different SLM options.

OTHER PROJECTS:

CIAT is about to initiate research in two smallholder farming landscapes with high rates of poverty and natural resource degradation in Tanzania and Malawi. We will be examining the costs and benefits of adopting SLM practices and how this, and other factors, constrains the adoption of SLM practices. ImagineS products could be useful here for examining how SLM options impact primary productivity and biomass. We have the expertise to ground truth these products in these regions and so could provide important validation information for these products.

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4) METEO-FRANCE – AGRO-METEOROLOGY DEPARTMENT

Meteo France is the French national weather and climate service. The end-user department on agro-meteorology expertise of Meteo-France / Direction de la Production is in charge of the interface between the operational production services of Meteo-France and the agriculture users, co-ordination of agro-meteorological activities in Météo-France and agro-meteorological software conception, development and production. Several operational chains are operated:

- estimation of the fodder production over France in order to provide objective information to estimate real farmers losses (ISOP system)
- Modeling of corn crop water needs in order to estimate real water consumption of irrigated crops in France (OSIRIS system)
- Fire meteorological indices production for Civil Protection in the context of prevention, early warning and surveillance of forest fires

The applications related to ImagineS

- We are interested in using the land data assimilation systems (LDAS) developed by the project for the monitoring of crops and grasslands over **France**.
- The LDAS developed over France by CNRM, a partner of the project, could be integrated, after the end of the projects, in our processing lines. Assessing to what extent the LDAS could be extended outside France would be useful.
- The existing ISOP product dedicated to the monitoring of fodder production over France will be made available to CNRM, for benchmarking purposes. Also, we plan to evaluate to what extent the LDAS can contribute to the seasonal forecasting of biomass production. We will participate to the definition of the user needs.
- We are also interested in evaluating the potential of soil wetness indicators in comparison to the Météo France operational product.

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5) INSTITUTO GEOGRÁFICO NACIONAL (IGN)

The Insti**tuto Geográfico Nacional (IGN),** or National Geographic Institute, is a Spanish government agency, dependent on the Spanish Ministry of Public Works. It is the national mapping agency for Spain. The IGN is the body responsible for **National Remote Sensing Program (PNT)**, which provides periodic coverage (annual, monthly and weekly) of the entire national territory via high and medium resolution satellite images. And for National Program for Aerial Ortho-photography (PNOA), which provides periodic coverage (from two to three years) of the national territory with very high resolution aerial ortho-photography, (10 - 50 cm) and digital terrain models with LIDAR sensors.

On the other hand, the IGN is the National Reference Centre in Land Cover and Use (EIONET´s National Reference Centre for Soil, by mandate of the National Focal Point, the Spanish Environment Ministry); according to this mandate, IGN must coordinate the information in Spain related to Land Cover and Use. The IGN also coordinates the Spanish SDI.

The applications related to ImagineS

ImagineS may be used in the **Spanish National Remote Sensing Program (PNT)** frame that provides regular coverage of the Spanish territory with current and historical satellite imagery. This imagery is processed once with geometric and radiometric processing agreed by experts of Spanish scientific community.

Thanks to Spanish Remote Sensing National Program (PNT), it has been promoted the massive use of satellite images on multiple projects and jobs for all the Spanish Public Administration, Universities and Public Investigation Agencies.

Spanish imagery is structured in three levels of spatial and temporal resolution:

High resolution: Images from 2 to 10m of spatial resolution in panchromatic mode and from 10 to 30m in multispectral mode. It is planned to acquire a complete coverage every year with summer images. From 2005 to nowadays SPOT5 HRG (Simultaneous panchromatic 2,5m and multispectral 10m) satellite is selected to provide that type of resolution.

The main applications of these images are: to obtain land cover cartography (project SIOSE and project CORINE land cover of the European Union), updating cartographic

database of medium and small scales, to obtain environmental and agricultural information, etc. It also may be obtained “Image Cartography” (Ortho-imagery and Cartho-imagery).

Medium resolution: Images from 10 to 15 m of spatial resolution in panchromatic mode and from 20 to 50 m in multispectral mode. It was planned to acquire at least four coverages every year, but since January 2008 all Landsat5 imagery (Thematic Mapper, multispectral 30 m) captured over Spain were acquired. In 2011 and 2012 has been acquired Deimos 1, 20 m. En the future, Sentinel II will be the best option.

The repetitive captured of information of the same zone is carried out with the aim to allow the multi-temporal monitoring (intra and inter-annual) of environment and territory evolution, It is also useful for environmental management, design of plans and policies of prevention and emergency according to natural catastrophe, risky places, control of environmental quality, etc, in which remote sensing is combined with tools like Geographical Information Systems. Other applications are land cover automatic classification, crop identification, irrigated land detection, forest information, biophysical parameters, etc.

Low resolution: Multispectral images from 50 to 1000 m of spatial resolution, with a periodicity of 1 or 2 days. Sentinel 3 will be the main source of this type of resolution.

Low resolution data are used mainly to analyze the evolution of phenomena which change quickly along time, through the creation of biophysical parameters. The daily availability of the images of these sensors and of derivate parameters of them, facilitate the monitoring in nearly real Earth time, directed to the analysis of environmental variables.

So, main applications of the low resolution images are the extraction of the biophysical and environmental parameters (indexes of vegetation, temperatures, quantity of combustible materials, and risk of fire...) theses parameters can facilitate the obtaining of standard environmental index by different world organizations.

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6) AGRICULTURE AND AGRI-FOOD CANADA (AAFC)

Agriculture and Agri-Food Canada (AAFC) is the department of agriculture of the federal government of Canada, with a mandate in providing information, research and technology, policies and programs to achieve a competitive, innovative and environmentally sustainable agriculture, agri-food and agri-based products sector. The Science and Technology Branch is made of 19 research centers distributed across Canada.

Dr. Elizabeth Pattey is the leader of the micrometeorology laboratory at the Eastern Cereal and Research Centre (ECORC) of Ottawa (Ontario). She is a senior research scientist, who led several major remote sensing initiatives co-funded by Canadian Space Agency and AAFC. She has expertise in quantifying trace gas and particular matter fluxes, verifying process-based models such as soil-crop models, which might include remote sensing data assimilation, and in developing remote sensing applications. The micrometeorology lab is in charge of a micrometeorological flux site located in the greenbelt experimental farm (Ottawa, ON) of the Canadian Food Inspection Agency and has the capability to install roving micrometeorological sites. Historical datasets were accumulated over the past decade at the permanent flux site, which is equipped to carry out research involving in situ monitoring of soil-plant-atmosphere interactions for refining models and remote sensing applications.

The following research aspects can benefit from ImagineS products and services:

1) Quantify crop biomass and yield and monitor crop growth in response to climate and soil conditions using remote sensing, micrometeorology and modeling;
2) Verify process-based land surface and crop growth models through data assimilation;
3) Incorporate remote sensing information and technologies in agri-environmental indicators

Contact point:
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7) AGRICULTURAL RESEARCH COUNCIL (ARC)

An Agricultural Research Council (ARC) leads consortium, the SA-GEO Agricultural Community of Practice will co-ordinate the activities for the site in South Africa. Currently the team involved in the site includes the ARC (Coordinating organization); The Crop Statistics Consortium (NCSC) comprising ARC, GTI and SIQ; The Provincial Department of

Agriculture, Free State (PDA); The National Department of Agriculture, Forestry & Fisheries; and various academia (at the University of Kwazulu-Natal, University of the Free State, University of Stellenbosch); Co-operatives and organized industry will also become involved.

The Agricultural Research Council (ARC) is the principal agricultural research institution in South Africa. The objectives of the ARC are to conduct research, drive research and development, drive technology development and transfer (dissemination) in order to:

- promote agriculture and industry;
- contribute to better quality of life; and
- facilitate/ ensure natural resource conservation
- alleviate poverty

The organization performs its functions through ten (10) Research Institutes that are predominantly commodity based and are strategically distributed throughout the country. These research campuses can be clustered into five business divisions, namely, Animal Health, Animal Production, Grain and Industrial Crops, Horticulture, and Natural Resources and Engineering. Research at these facilities is complemented by on field experimental sites distributed throughout every province of South Africa. In addition, selected farm fields are utilized to study the performance ARC research technologies under actual farm production environments. The ARC plays a pivotal role in the economy of South Africa and contributes to improvements in the quality of life of people. This is supported by various studies that have been published on the impact of investments into agricultural research and development conducted by the ARC.

The ARC-ISCW resides within the Natural Resources and Engineering business division. The ARC-Institute for Soil Climate and Water (ISCW) acquires its mandate as an operational unit within the ARC. ARC-ISCW is subservient to the policies, strategies, and business plans of the ARC and committed to the mission and strategic imperatives of the ARC. ARC-ISCW promotes the effective and efficient development and implementation of expertise and technology for sustainable agricultural and natural resources management through research, technology development, technology transfer, and scientific services. The six current research and development programmes of the ARC-ISCW are Soil and Water Science, Pedometrics, Soil Health and Remediation, Agroclimatology, Earth Observation, and Geoinformatics.

The applications related to ImagineS are:

- Crop Yield modeling.
- Crop Area monitoring using EO data and PICES system
- Crop type mapping (Field level).
- Soil Moisture monitoring.

- Irrigation and Water use efficiency assessments (dependent on resources).
- Rangeland production and Condition assessment (dependent on resources).
- Invader vegetation monitoring (Slangbos).
- Drought monitoring
- Vegetation conditions assessment studies.

Contact persons:
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8) NATIONAL INSTITUTE OF AGRICULTURAL TECHNOLOGY (INTA)

The National Institute of Agricultural Technology (INTA) is a decentralized government agency with operational and financial autarky, under the Ministry of Agriculture, Livestock and Fisheries of the Nation. It was created in 1956 and since that year the Institute has been developing research and technological innovation to improve the competitiveness and sustainable rural development in the country. Its efforts are aimed at innovation as an engine for development and integration capabilities to promote interagency cooperation, generate knowledge and technologies and make them available to the agricultural sector through their extension, information and communication systems.

The applications related to ImagineS

- PIP CONICET 2012-112-201101-00217. Agriculture and floodings in the Pampas. Adaptations to eco-hydrological changes in Pampa and Chaco Region.la Pampa y el 2012-2015.
- National System for pastures monitoring. IPCVA. Participants: FAUBA-MINAGRI-AACREA-INTA. 2011-2013
- Flatness, farming and flooding: Adapting to eco-hydrological changes in the Pampas & Chaco (Argentina-Paraguay). IDRC – Canadá – 1/10/2011 – 1/10/2014. PI: Dr. Esteban Jobbágy. CoPI: Carlos Di Bella y otros

Contact point:
Dr. Carlos M. Di Bella, Instituto de Clima y Agua – CIRN – INTA Castelar
Los Reseros y las Cabañas s/n (1712), Castelar, Buenos Aires, Argentina

9) INSTITUTE OF AGRICULTURAL AND FOOD RESEARCH AND DEVELOPMENT OF MURCIA (IMIDA)

The Institute of Agricultural and Food Research and Development of Murcia (IMIDA, in its Spanish acronym) is an autonomous, state-funded research institute, as established by the Spanish Law 8/2002.The Institute, which is situated in La Alberca (Murcia), comes under the aegis of the Regional Department of Agriculture and Water, and carries out research into agriculture, forestry, food, fishing, shell-fish culture and marine aquaculture in general.

IMIDA is run by the Director and the Board of Institute, whose functions are to direct, co-ordinate and oversee the individual sections of the centre, that is, the Financial and Administrative Department, the different research departments and the Office for the Transfer of Research Results. The Research and Development Departments plan, co-ordinate, direct and control their respective research teams, who are responsible for carrying out the research into the already mentioned fields of agriculture and aquaculture. The Office for the Transfer of Research Results plans and co-ordinates the diffusion of results to the interested sectors outside the Centre, organizes the regional network of experiments, the System of Agricultural Information, the Network of Co-operative Experimental Farmland GIS and remote sensing team- SIGyT.

The applications related to ImagineS

- TELERIEG, The remote sensing use for irrigation practice recommendation and monitoring in the SUDOE space. **Coordinator**
- AOSUDOE, Observatorio del agua en el espacio SUDOE. **Coordinator (Proposal)**
- HYDROCLIM, EVALUACIÓN DE VARIABILIDAD HIDROCLIMÁTICA DESDE COMBINACIONES MULTIMODELO CLIMÁTICAS REGIONALES
- Land Use/Land Cover State and Changes: SIOSE: 2005, 2009 AND 2011
- Land Use/Land Cover State and Changes: CORINE: 2006 AND 2012

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10) INSTITUTO TÉCNICO AGRONÓMICO PROVINCIAL (ITAP)

Instituto Técnico Agronómico Provincial (ITAP) is a public company created by the local administration in 1986, as a model of more effective management of the Agricultural Services. We work for the agricultural and food sector in the province of Albacete (Spain).

The main purpose of ITAP is the transfer of technology to farmers, providing knowledge and technological progress, as a way to connect the scientific and agricultural worlds.

The applications related to ImagineS

The main applications ImagineS products should be focus on add value and improve our agriculture advisory service for farmers at regional scales.

We are interested in biophysical parameters like FPAR, cover fraction, potential crop yield, surface reflectance. Even some reflectance index related with nitrogen and water management in crops.

Contact point:
Horacio López Córcoles: Phd Agronomic Engineer Responsable of R&D
Fernando de la Cruz Tercero: Agronomic Engineer

11) AGRICULTURAL RESEARCH AND TRAINING INSTITUTE (IFAPA)

The Agricultural Research and Training Institute (IFAPA) of the Andalusian Agriculture, Environmental and Fisheries Department conducts research to develop and transfer solutions to agricultural problems of high priority in the region and provide information access and dissemination to sustain a competitive agriculture economy and to enhance the natural resource base and environment. Earth observation is one of the technologies that we implement to monitor agrosystems at different spatiotemporal scales.

The applications related to ImagineS

There are two particular applications, being developed in the framework of different projects, which could make use of ImagineS products and services, depending on the spatial resolution of the available data:

- Medium/low resolution data (10^2-10^3 m) could be used to monitor pastures at regional scale. Product as FCover and FPAR, with 10-day resolution, may aid the assessment of pasture growth along the season, allowing the estimation of its carrying capacity and supporting management decisions concerning stocking rates, rotational grazing, etc.. Other products as biomass, evapotranspiration or drought indices would be of great interest for this application, provided that the spatial scale is similar to 01-02

products (table 1).We currently participate in a project aiming to develop policies and tools for biodiversity conservation and management in *dehesa* ecosystems (LIFE+11/BIO/ES/000726 bioDEHESA), which is a highly valuable agro-forestry system with an important presence in Southern Europe. This demonstration project will apply and disseminate appropriate technology to manage a large group of dehesa farms. ImagineS products 01 could provide useful information to that end.

- High resolution data ($<10^2$m) could be integrated in an on-line tool, currently under development, to help farmers and farm managers to achieve the most efficient and sustainable exploitation of their crop by providing technical knowledge and customized recommendations in real time about: (a) varieties and sowing techniques, (b) fertilization, (c) irrigation needs and (d) risk of plagues, diseases and weeds for each specific area. The integration of airborne and satellite data at plot scale is planned in the project to estimated potential yield, water consumption and nitrogen deficit, all of them connected to variables provided by ImagineS project. The availability of these products for some of the pilot areas defined in the project (one in each of the five Spanish participant regions: Castilla-LaMancha, Andalucía, Navarra, Pais Vasco y Cataluña) would be of great interest.

Contact Point:

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Agronomy research scientist
IFAPA-Natural Resources Area
Andalusia Department of Agriculture, Fisheries and Environment

12) CENTRE D'ETUDES SPATIALES DE LA BIOPHERE (CESBIO)

The CESBIO is a laboratory of the University Paul Sabatier (Toulouse, France) that depends on four institutions: University, CNRS, CNES and IRD, The research activities focus on the biosphere functioning with the help of remote sensing data. The CESBIO leads several spatial missions (SMOS, Venμs), but also participates in the specification of new space missions (Biomass, Mistigri, Sentinel-2…), and in CAL/VAL activities.

The CESBIO has also developed an expertise on the measurements (Béziat et al. 2009, Solignac et al. 2009) and simulations of land surface fluxes at different time and spatial scales. It is in charge of the Observatoire Spatial Régional supported by INSU-CNRS. It is involved in several programs with industrial partners focusing in the water resource management. The aim of the OSR is to deliver to the scientific and users' community the remote sensing products elaborated thanks to the different research programs.

The applications related to ImagineS

Two sites are proposed to the cal/val activities corresponding to site n°1 and n°6 of table 2.

Site n°1: We propose to evaluate the high spatial and temporal (10 days) products: FAPAR, biomass and crop maps. The evaluation could be done at both local (field) and image scale.

Local scale: measurements of GAI, FAPAR and Biomass are performed since 2006, on two study sites belonging to the CarboEurope-IP Regional and IKOS experiments. These sites are located on the southwest of France. Measurements are performed over winter and summer crops: wheat, corn, soybean and sunflower. These measurements will be performed simultaneously to the Sentinel 2 data acquisitions.

Image scale: since 2006, validation of GAI and Biomass maps are also performed using the VALERI protocol combined with the use of BVNet Tool and the use of an agro-meteorological model (SAFY). The production of GAI and Biomass maps will be done using in-situ data and would be compared with the Imagine products.

Site n°6: The Merguellil site is situated in central Tunisia (9°30'E-10°15'E, 35°N, 35°45'N) (Fig. 1). The climate in this region is semi-arid, with an average annual rainfall of approximately 300 mm per year, characterized by a rainy season lasting from October to May, with the two rainiest months being October and March. As is generally the case in semi-arid areas, the rainfall patterns in this area are highly variable in time and space. The mean temperature in Kairouan City is 19.2 °C (minimum of 10.7 °C in January and maximum of 28.6 °C in August). The mean annual potential evapotranspiration (Penman) is close to 1600 mm.

The landscape is mainly flat. The vegetation in this area is dominated by agriculture (cereals, olive trees, and market gardens). Crops are various and their rotation is typical of semi-arid regions.

In Merguellil site, different applications could be based on ImagineS products:

- Validation of SVAT models (ICARE, SETHYS)
- Validation of irrigation SAMIR model
- Development of drought indices
- Development of remote sensing methodologies for soil moisture estimation based on synergy between optical and microwave data.

Since the end of 2008, ground-truth measurements have been carried out over different test fields, simultaneously to different satellite acquisitions (SPOT/HRV, ASAR/ENVISAT-TERRASAR-X, ASCAT measurements). We consider different types of measurements:

- Moisture measurements made using a handheld Thetaprobe, and by means of gravimetric measurements at depths between 0 and 5 cm. Thetaprobe measurements are calibrated with gravimetric measurements.
- Roughness measurements made using a pin profiler.
- Soil texture measurements

In order to characterise the cereal vegetation covers, we consider three types of measurements:

- Leaf Area Index data (more than 8 times per year over more than 15 test fields)
- Vegetation water content (VWC) data (two times per year)
- Height of vegetation (more than 8 times during vegetation cycle).

Contact point:
For Site n°1 : Valérie Demarez, valerie.demarez@cesbio.cnes.fr
For Site n°6 : Mehrez Zribi, mehrez.zribi@ird.fr

13) UNIVERSITY OF CHILE (LARES) / AGRICULTURAL RESEARCH INSTITUTE (INIA)

We are made up of two institutions:

1. Laboratory for Research in Environmental Sciences, Faculty of Agricultural Sciences (LARES), University of Chile: Our goal is applied research in agro-meteorology and environmental science in agriculture.
2. Agricultural Research Institute (INIA), Center for Advanced Studies in Fruticulture (CEAF): Our goal is to develop scientific and technological products to support the fruit industry and improving the scientific competitiveness of the Region of El Libertador Bernardo O´Higgins, Central Zone of Chile.

The applications related to ImagineS

We are working to improve irrigation water use in orchards. Our lines of development are

Agro-meteorological monitoring

Dynamics of soil water

Water balance in the soil

Water Use Efficiency

Evapotranspiration

Estimation crop coefficients for irrigation

Contact point:
Luis Morales-Salinas: Head of LARES, lmorales@renare.uchile.cl.
Manuel Pinto-Contreras: Head of CEAF-INIA, mpinto@inia.cl.

Note: At mid-term of the project, the demonstration site initially identified has been replaced by a new one (San Fernando, Table 2) more appropriate and monitored by the Laboratory of the Analysis of the Biopshere (LAB) of University of Chile. The new contact point is:

Dr. Cristian Mattar

Email: Cmattar.lab@gmail.com

14) BOTSWANA COLLEGE OF AGRICULTURE (BCA)

Botswana College of Agriculture (BCA) is a Botswana Government funded Tertiary institution with a mandate to provide training and carryout research in agriculture and related disciplines. The College was founded in 1967 and became an associate institute of the University of Botswana and a Parastatal in the Ministry of Agriculture in 1991 through Parliament Act No. 9 of 1991. BCA offers academic programmes at diploma, degree and graduate levels.

The applications related to ImagineS

As part of the agricultural products applications in training and research, BCA offers academic programmes that include courses in Geographical Information Systems, Remote Sensing, Hydrology, Range Ecology and Management, Forestry, etc.... The staff and graduate students will carry out research projects using the products to find out new areas of application, Therefore, the ImagineS products will primarily be used for;

- Academic teaching of both theory and applications on remote sensing and GIS applications
- Research on crop monitoring and yield forecasting
- Forest and Rangeland resources management
- Landcover and landcover changes assessments
- Hydrological studies
- Drought monitoring

Contact point
Dr Mataba Tapela
Deputy Dean, Faculty of Agriculture
Coordinates: (24^0 35’ 30” S, 25^0 56’ 30”E)

Note: since this user did not show any more motivation for ImagineS project (no reply to contact), the Botswana demonstration site has been replaced by the Upper Tana Basin site in Kenya monitored by CIAT

15) EÖTVÖS LORÁND UNIVERSITY (ELU)

Eötvös Loránd University (ELU), the longest continuously serving university of Hungary, was founded in 1635 in the city of Nagyszombat (today Trnava, Slovakia) by Cardinal Péter Pázmány, Archbishop of Esztergom. It serves the interests of high quality education and

research, building upon the best European traditions. The mission of ELU is to preserve and enrich national and universal culture, to cultivate science and to pass on academic knowledge, as well as to shape and satisfy the real, long-term needs of Hungarian society and of mankind.

The applications related to ImagineS

The Department of Meteorology, Eötvös Loránd University – together with the Hungarian Meteorological Service – operates a tall tower site in Western Hungary (Hegyhátsál, 46°57'N, 16°39'E, 248 m asl) for the monitoring of greenhouse gases and for the long term measurement of biosphere/atmosphere carbon dioxide exchange. The products of the IMAGINES project could potentially help the Department to provide better insight into the biogeochemical processes of the Hegyhátsál region with medium and high resolution satellite data and vegetation indices. Satellite based vegetation indices and other data could possibly help the spatial extrapolation of the tower based data. Satellite data provided by the IMAGINES project could be useful for automated crop type identification already performed at the Department of Meteorology based on MODIS data. FAPAR data provided by ImagineS will help to improve our approach for Light Use Efficiency (LUE) based Gross Primary Production (GPP) estimation combined with advanced footprint modeling already performed by our group based on data from the Hegyhátsál tall tower (using MODIS data).

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16) UNIVERSIDAD CASTILLA LA MANCHA (UCLM)

The applications related to ImagineS

The remote sensing group is in charge of monitoring crops in test areas worldwide. To make the remote sensing information available to the water managers we developed a web-gis online called spider (http://www.sirius-gmes.es/). This monitoring includes color composition display in real time, vegetation index, crop map, crop coefficient and evapotranspiration, including also other soil water balance components. In particular, the imagines biophysical variables available will be useful in the area of Barrax for precision farming; in order to include the reflectance to display RGB in real time in the satellite constellation used (Deimos, Formosat-2, Landsat). The farmers find this visual information useful because as water managers they are interested in the diagnostic of the irrigation quality in the plots. Moreover, they are able to understand the NDVI as indicator of crop health in order to take decisions for farm managing.

The research group is in charge of developing a land use map in La Mancha every year, for the aquifer extension, and it is very useful for water managers in large areas.

The evapotranspiration and the water balance components are estimated with a satellite-assisted soil water balance, at high resolution (20 m pixel size) (www.hidromore.es). The key inputs for the calculations are remote sensing optical data (surface reflectance and crop map) and meteorological field observations.

Remote Sensing and GIS group
University of Castilla-La Mancha
02071 Campus of Albacete, Spain

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17) UNIVERSITY OF VALENCIA. REMOTE SENSING UNIT

The Remote Sensing Unit of the University of Valencia (UIT) has executed numerous projects related with the subject of IMAGINES (EFEDA, MEDALUS, HISPASED, TEDECVA, IDEAS, DULCINEA, ARTEMIS, LSA SAF, RESET CLIMATE, DeSurvey). It is active in the development of advanced techniques for assimilation and processing of remotely sensed data, estimating core biophysical indicators and state variables (vegetation cover, LAI, FAPAR, C fluxes) at different scale levels from remotely sensed data.

The applications related to ImagineS

ImagineS products will contribute to the validation of the LSA SAF vegetation products (LAI, FAPAR, FCover) and assess the feasibility of new LSA SAF products (Gross and Net Primary Production, Canopy Water Content) against similar carbon and water fluxes. This will help to improve the algorithms (e.g. correcting some bias in problematic regions).

A secondary objective will be to explore the potential of SENTINEL data for environmental applications over Spain (carbon fluxes in forest areas, developing drought indicators), a region in which we have a significant amount of expert knowledge.

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18) LABORATORIO DE TELEDETECCIÓN (LABTEL), UNIVERSIDAD NACIONAL MAYOR DE SAN MARCOS

Laboratorio de Teledetección (LABTEL). Physics Faculty, Universidad Nacional Mayor de San Marcos, Lima, Peru.

LABTEL's activities involves 1) the application of remote sensing techniques to studies pertaining to agriculture, land and water resources management and monitoring of ecosystem services, among others; 2) capacity building and 3) tool development for supporting decision and policy making. Since the beginning of its activities, LABTEL has led/collaborated in about 50 research projects, which involved national and/or international institutions. The projects involved the study of drought and frost events, land degradation, deforestation, glacier retreat, water sources, estimation of precipitation rates, El Niño events, spatial and temporal variation of land and sea surface temperature and sea coloration, among others, using as main input free access satellite images. We have experience in the analysis of AVHRR, MODIS, LANDSAT, ASTER and GOES images, among others. For the case of AVHRR images, we have implemented our own software for analyzing images ("Pacha Ricaj"), programmed in C++, which is being improved for other sensors (e.g. LANDSAT). The research activities have led to several publications, participation in conferences and thesis work.

Concerning capacity building, we have a permanent study group in the application of remote sensing techniques, which is open to students from everywhere. In addition, the research staff is involved in teaching activities, both at the under and post-graduate level, and in seminars/workshops imparted within and outside the San Marcos University.

Currently, LABTEL is grouping all its activities and projects within two main initiatives; namely, the implementation of a satellite based national monitoring system and a centre of excellence in geosciences.

The applications related to ImagineS

The ImagineS products can be used in the following projects surrounding extreme events (hydrological and agricultural droughts and frosts) and land degradation processes in several parts of Peru.

1. Proyecto Cátedra CONCYTEC "Teledetección de la Desertificación y Sequia", (2012-2014). La institución responsable es la UNMSM-Lima, las instituciones colaboradoras son UNPRG, EAI POMALCA. Este proyecto es financiado por el CONCYTEC – PERU.

2. Proyecto de Investigación “Evaluación de la Vegetación y Estado del Suelo de la Región de Ayacucho mediante datos de Satélites (2013). La institución responsable es la UNSCH-Ayacuho, las instituciones colaboradoras son UNMSM y UNPRG. Este proyecto es financiado por el FOCAM.

3. Proyecto de Investigación “Centro de Información e Investigación Ambiental para el Desarrollo Regional Sostenible”, CIIADERS-UNASAM-FCAM (2010-2015).La institución responsable es la UNASAM, las instituciones colaboradoras son UNMSM y UNPRG. Este proyecto es financiado por el FCAM.

Specifically, we’re interested in, but not limited to:

1. Validation of drought indicators
2. Land cover use/change monitoring
3. Biomass evolution monitoring
4. Crop monitoring

Contact:
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URL: http://labtel.fisica.unmsm.edu.pe/
Coordinates: UTM 18L 0273220 E, 8666228 S (-12.057,-77.083)
(Centre of the University’s stadium)

19) MONASH UNIVERSITY

Monash University has as its core mandate the development of science and technology to improve environmental sustainability across all aspects of life. The Civil Engineering department at Monash University is the leading authority in Australia in terrestrial remote sensing and its applications. The aim is to further knowledge in all fields of environmental monitoring, in particular in water resources and related fields. Among those fields are water resource management, hazard predictions (in particular flood and fire), as well as climate impact on Antarctica.

The applications related to ImagineS

The imagines project has three main applications:

1. Land surface modeling: For land surface models with active vegetation components, it is important to assimilate vegetation conditions on a regular basis. These conditions may be quantified/qualified through LAI (fAPAR), albedo and biomass. At Monash work is currently under way to assimilate those quantities/indices into an LSM.
2. Water Resources management: Australian agriculture and environment management relies heavily on water allocations. Through the use of vegetation conditions maps the

water allocation system may be made more efficient. Through the use of regular vegetation indices, the vegetation dynamics can be better observed and, in conjunction with a water resource management framework, water can be better allocated.

3. Hazard mapping: Fire prediction skills are significantly affected by inaccurate information of the vegetation. Regular updates of the hazard maps, in particular through the use of biomass, will increase those predictive skills, as it allows a better quantification of the fire fuel content of the environment and its state.

Contact point:

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