My Sustainable Forest

Earth observation services for silviculture

D4.2 END-USER TRIALS ASSESSMENT REPORT (V1)

OPERATIONAL SUSTAINABLE FORESTRY WITH SATELLITE-BASED REMOTE SENSING

Project no.	776045
Project title	Operational sustainable forestry with satellite-based remote sensing
Project acronym	MySustainableForest
Start date of project	1 November 2017
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TECHNICAL REFERENCES

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Project Title	Operationally sustainable forestry with satellite-based remote sensing
Project Coordinator	Julia Yagüe GMV mjyague@gmv.com
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Workpackage	WP4 - Service Demonstration and Training Program Preparation
Task	T4.1 Pre-Operational Service Planning & Support T4.2 Regulatory Issues T4.3 End-Users Pre-Operational Trials & Critical Assessment T4.4 End-Users Training Preparation T4.5 Business Model Validation
Lead beneficiary	RAIZ
Contributing beneficiary (ies)	**RAIZ**, GMV, CFRI, UFE, FORESNA, FOAL, CNPF, MADERA+, FORA, EFI
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DOCUMENT STATUS SHEET

Version	Date	Pages	Changes
V1	24/04/2019	51	First version of the document

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1. INTRODUCTION

The objectives of the WP4 Service Demonstration and Training Program Preparation are to show how the set of integrated **technologies fulfil the End-Users requirements and support their operational process in an efficient and effective way**; to **develop a training program** for End-Users in order to facilitate MySustainableForest service usage and to **demonstrate the Business Model**. This work package is led by RAIZ with the involvement of all partners (GMV, CFRI, UFE, FORESNA, FOAL, CNPF, MADERA+, FORA, EFI). The activities in the WP4 are divided into five tasks (Table 1-1).

Table 1-1. WP4 tasks and activities.

Task	Activity
T4.1 Pre-Operational Service Planning & Support (**GMV**, RAIZ, CFRI, UFE, FORESNA, FOAL, CNPF, MADERA+)	End-User plan and prepare all needed **logistics and practical arrangements to conduct the validation use cases into their operational environment**. It will ensure that any needed action for providing or configuring the service is properly performed and accurately documented in the service´s guide.
T4.2 Regulatory Issues (**RAIZ**)	Analyze the **potential of the service products to reduce the effort in fulfilling regulatory requirements** such as mandatory local, regional or national reporting, certification regulation or EU Timber Regulation (EUTR)
T4.3 End-users Pre-Operational Trials & Critical Assessment (**GMV**, RAIZ, CFRI, UFE, FORESNA, FOAL, CNPF, MADERA+)	End-User will **run the service in a preoperational mode fully integrated into their workflows as a trial for the project duration to conduct the validation use cases within its operational environments**. Such pre-operational trials will be assessed by End-User with the final aim of deriving an independent critical evaluation of the EO derived products. The pre-operational usage will start with the early version and then will evolve into pilot usages with both the enhanced and advanced versions of the service
T4.4 Develop a Training Program (**GMV**, RAIZ, CFRI, UFE, FORESNA, FOAL, CNPF, MADERA+, FORA, **EFI**)	**Develop a training program for End-Users of the service**. **Training material** will be structured in basic contents (i.e. sustainable forestry, forestry ecosystem services, forestry vulnerability to climate change, remote sensing principles, Copernicus, etc.) to be prepared by EFI and specific material (i.e. examples of services use cases) under GMV responsibility. **Teaching strategies** will combine lectures and practical sessions. It is foreseen to inject the basic contents of End-Users capacity building course to the Stakeholders awareness communication with a **feedback process which will be designed with a methodical approach to elicit, analyze, prioritize and document the End-Users' requirements**. Thus, activities to be executed, in collaboration especially with project partners involved in the pilot demonstrations, will include: **preparing training material**, **delivering training** and **compiling stakeholders feedback**. Three cycles training strategy will be followed in line with the workflow engineering integration plan (early, enhanced and advanced service). **Training elements** will include materials for use both online and in a classroom non-operational setting. The latest includes technical on-site support when delivered as part of a given Stakeholders workshop. Training material will be improved according to attendees´ suggestions and enriched with up-to-date scientific knowledge on the chosen methodological and technological approaches, including relevant aspects of ecosystem functioning and the socio-economic system. **End-Users training feedback** will be collected for an assessment of the service in meeting their particular requirements and next future expectations
T4.5 Business Model Evaluation (**GMV**, RAIZ, CFRI, UFE, FORESNA, FOAL, CNPF, MADERA+, FORA, EFI)	GMV will tune the service products, according to the trials critical assessment. GMV, partners developing models- MADERA+, FORA, EFI- and End-Users will **re-assess the associated business models considering both the End-Users training feedback and their cost/benefit valuation**. The current hypothesis for financial projections (i.e. service recurrent costs, pricing, etc.) needs to be confirmed or modified accordingly. This task will also build the structure for the Service Level Agreements and feed the elaboration of the Business Plan.

Table 1-2. WP4 deliverables and coherence of contents

WP4 Deliverable	Contents
D4.1 Service Getting Started Guide (GMV)	Service Getting Started Guide will describe what the service does and how to use it in a concise, easy to understand by End-Users and comprehensive manner.
D4.2 End-User Trials Assessment Report (v1) (RAIZ)	This End-User Trials Assessment Report will **compile the critical evaluations from End-Users partners about the EO derived products (in Early Service)** provided to each End-User. It will cover at least End-Users´ **operational and financial criteria** in line with Project objectives • i.e. O2. **Smooth and smart integration into End-Users workflow and working environment**, • F3. **Average annual savings in End-Users´ due to forestry operations optimization**.
D4.2 End-User Trials Assessment Report (v2) (RAIZ)	Idem (in Enhanced Service)
D4.2 End-User Trials Assessment Report (v3) (RAIZ)	Idem (in Advanced Service)

1.1. PURPOSE

This document corresponds to Deliverable D22–**D4.2 End-User Trials Assessment Report (v1)** of MySustainableForest H2020 Project. The strategy proposed to address this deliverable is the following:

1. Describe specific forest management problems that could be better addressed using EO images integrated with other data from remote sensing, forest models and field data, in forest decision support.
2. Present the work done to validate the quality of the MSF products proposed to fulfil the problems defined in 1.
3. Start the description of the **Training Program** and the **Business Model.**
4. **Compile the operational critical** evaluations from end-users after the demonstration and training sessions.
5. **Evaluate the Business Model** and collect financial criteria evaluations from end-users about the MSF service.
6. Synthesize feedback for next cycle - Enhanced Service.

In this first deliverable of a series of three defined in WP4 (End-User Trials Assessment), the main objective is to start the definition of the framework and methodology for evaluating the MSF services and products. For this proposed from the six specific forest management problems described in this document, we chose two: Forest Inventory and Pest Control. This two examples fit in three of the six main needs express and described in the deliverable D3 D2.1 End-Users Use Cases "1 - *Better definition of physic characteristics of the forest areas and monitoring their changes…*"; "3 - *Improved accuracy of forest inventories to know the different species of the stand and their dasometric variables…*"; – "5 - *Better definition, detection, and control of potential pests and diseases that may endanger the forest…*". The effective evaluation of all products will be done in the second and third version of the referred series of deliverables.

1.2. SCOPE

This document is structured in the following sections:

- Section 1 (present chapter) defines the purpose of the document, the project overview and the strategy adopted in the elaboration of the deliverable
- Section 2, lists applicable contract documents and acronyms quoted in this document.
- Section 3, describe specific problems of forest management and planning, the potential of OE products to better solve these problems and the validation of these OE products, in line with tasks 4.1, 4.2 and 4.3.
- Section 4, presents the Training Program Plan in line with 4.4.
- Section 5, presents a general Business Model for MSF service in line with task 4.5.
- Section 6, compile the critical economic and operational criteria to evaluate the MSF service and the feedback for the next cycle.

2. APPLICABLE AND REFERENCE DOCUMENTS

2.1. APPLICABLE DOCUMENTS

The following documents, of the exact issue shown, form part of this document to the extent specified herein. Applicable documents are those referenced in the contract or approved by the Approval Authority.

Table 2-1. Applicable Documents

Ref.	Title	Code	Version	Date
[AD.1]	Grant Agreement Nº 776045—MySustainableForest	Ares(2017)5215238	1.0	25/10/2017
[AD.2]	D01_D1.1_Project Plan	D01_D1.1	1.0	30/11/2017
[AD.3]	D03_D2.1_End-users_Use_Cases_20181029	D03_D2.1	1.0	29/10/2018
[AD.4]	D09_D2.2_Service Requirements and Validation of Use Cases	D09_D2.2	1.0	03/09/2018
[AD.5]	D15_D4.1. Service Getting Started Guide	Dxx_D4.1	1.0	16/01/2019
[AD.6]	D19_D6.2_Outreach and Dissemination Plan	D19_D6.2	2.0	28/12/2018

2.2. REFERENCE DOCUMENTS

The following documents, although not part of this document, amplify or clarify its contents. Reference documents are those not applicable and referenced within this document. They are referenced in this document in the form [RD.X]:

Table 2-2. Reference Documents

Ref.	Title	Code	Version	Date
[RD.1.]	Sawyer, G., Dubost, A., & De Vries, M. (2016). Copernicus sentinels' products economic value: a case study of forest management in Sweden. *European Association of Remote Sensing Companies*.		Final	2016
[RD.2.]	Watson, Dal Bosco (2014). Use of Forest Information Technologies & Marketing of Forestry Services and Products. OpenForests, Bonn, Germany		Final	2014
[RD.3.]	Kayaoglu, N. (2013). A Generic Approach for Dynamic Business Model Evaluation. Depositonce.tu-berlin.de		Final	2013
[RD.4.]	Horsti, A. (2007). *Essays on electronic business models and their evaluation*. Helsinki School of Economics.		Final	2007
[RD.5.]	Van Belle, J. P. (2006). A Framework for the Evaluation of Business Models and Its Empirical Validation. *Electronic journal of information systems evaluation*, *9*(1).			2006
[RD.6.]	Van Belle, J. P. (2004, October). A proposed framework for the analysis and evaluation of business models. In *Proceedings of the 2004 annual research conference of the South African Institute of Computer Scientists and Information Technologists on IT research in developing countries* (pp. 210-215). South African Institute for Computer Scientists and Information Technologists.			2004

2.3. ACRONYMS

The following acronyms have been used across this document:

Table 2-3. Acronyms

Acronym	Full term
ALOS	The Phased Array type L-band Synthetic Aperture Radar
ALS	Airborne Laser Scanning
AOI	Area of interest
BMC	Business Model Canvas
BME	Business Model evaluation
CFRI	Croatian Forest Research institute
CIR	Color Infrared aerial photography
CNPF	Centre national de la propriété forestière
CREEA	Compiling and Refining Environmental and Economic Accounts
CREODIAS	Data and Information Access Services. (one of five DIAS)
DEM	Digital Elevation Model
DLR	German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt)
EFI	European Forest Institute
ELB	Eucalyptus Longhorned Borer
ESA	European Space Agency
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EUTR	EU Timber Regulation
EVI	Enhanced Vegetation index
FOAL	Forest Owners Association of Lithuania
FÖRA	föra forest technologies
FORESNA	Asociación Forestal Navarra
FSC	Forest Stewardship Council
GCP	Ground Control Point
GIS	Geographic Information System
GMES	Global Monitoring for Environment and Security
GNDVI	Green Normalized Difference Vegetation Index
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
ICT	Information and communications technology
IFN	National Forest Inventory
JAXA	Japan Aerospace Exploration Agency
LIDAR	Light Detection and Ranging o Laser Imaging Detection and Ranging
LSA	Land Surface Analysis
LULC	Land Use land Cover
MOE	wood Modulus of Elasticity
MSAVI	Modified soil-adjusted vegetation index
MSF	MySustainableForest Project
NBR	Normalized Burn Ratio

Acronym	Full term
NDMI	Normalized Difference Moisture Index
NDVI	Normalized Difference Vegetation Index
NDWI	Normalized Difference Water Index
NGO	Non-Governmental organisation
PALSAR	Phased Array type L-band Synthetic Aperture Radar
PEFC	Programme for the Endorsement of Forest Certification
RGB	Red, Green, Blue
SAF	Satellite Application Facilities
SAR	Synthetic Aperture Radar
SAVI	Soil-adjusted Vegetation Index
SEEA	System of Environmental Economic Accounting
SFM	Sustainable Forest Monitoring
SME	Small and Medium Enterprise
SPOT	Satellite Pour l'Observation de la Terre
SWOT	Strengths, weaknesses, opportunities and threats analysis
TEP	Thematic Exploitation Platform
TERRASAR	imaging radar Earth observation satellite
UAV	Unmanned aerial vehicle
USE	Unión de Selvicultores del Sur de Europa
USGS	United States Geological Survey

3. FOREST MANAGEMENT AND PLANNING - DESCRIPTION OF SPECIFIC PROBLEMS

Forest management is regulated by law, by certification schemes and by strategic, tactical and operational planning. Information up-to-date, precise, low cost and available when needed is critical to support the forest management planning. The use of Geographic Information Systems (GIS), Global, Position Systems (GPS) and aerial photography are general use in the forest sector. Although the recognize potential, the same does not generally happen with the use of satellite images, LiDAR or other remote sensing new technologies. Demonstrating the potential of these IT integrated into the real forest environment and the training of end-users in the use of this IT are crucial tasks. In this process, the quality, the utility the efficiency and the economic value of the service must be noticeable. Also critical is the integration of users and their knowledge in each context, something very relevant in the processes of decision making. Forest managers will evaluate the MSF service information based on their perception that the service will help to solve their real problems and if he could afford for it. In the demonstration and training program, this fact must be considered, as an example, the products Forest Mask and Main Forest Types will be useful to quantify the total forest areas and by main species (ha/acres) is something that they need to report annually. Also from the Business Model, it is critical to evaluate and determine what is the price that the forest manager willing to pay for some packages of information.

In this first version of this series of deliverables, only a few specific examples of forest management needs are describe and only two of them (Forest Inventory and Pest Control) are used to demonstrate the methodology that will be used to evaluate and demonstrate the MSF products and services and train end-users in using it. At this stage, some examples aren´t from the AOIs MSF project because the information isn´t yet available. In the following boxes, each forest management problem/need are described. For these specific examples, we describe briefly the forest management environment: regulatory issues (defined by law, certification process or in strategic, tactical, and operational forestry planning); the silvicultural workflow; the work is done to collect data to validate the products and the potential of satellite imagery to meet the needs of them. Additional we established the link between the main end-users needs identify in the WP2 (D2.1 End-users use cases) and the services/products that MSF service will provide.

FOREST INVENTORY

FOAL 1 and FOAL 2

Current forestry legislation in Lithuania assumes mandatory stand-wise forest inventory for all forests of the country, which is financed by the state. However, such inventory in private estates suffers from serious information gaps, requiring additional inventory to elaborate forest management plan. More, state-financed stand-wise inventories in private forests were stopped since 2018 and the system of compensation mechanisms to private forest owners for providing updated stand-wise forest data to Forest State Cadastre was introduced. eforest.lt is a forest information and management planning platform developed by/for the members of FOAL. However, it lacks functionality for keeping forest stand information up-to-date.

Remote sensing is the most cost, time and resources efficient solution for permanent monitoring of private forests, including natural and human-induced change detection, updating stand boundaries and attributes, facilitation of improved forest management advises and fulfilling the requirement by State authorities regarding the sharing of forest inventory information. Additionally, the FOAL is interested in building an objective public image on private forestry and management in private forests, thus, remote sensing is expected to support the development of solutions to inform the public on the status of forestry activities in private forests, to utilize the crowdsourcing opportunities for field data collection and validation. General public opinion is that the forests, especially the private ones, are over-utilized, however, without substantiating such statements. Remote sensing images fused with some maps on forestry activities could support visualization the actual forestry activities improving the image of private forest owner.

RAIZ1 to RAIZ3

The National Forest Inventory (IFN) in Portugal is a statistical and cartographic process, whose objective is to evaluate the abundance, state, and condition of national forest resources. This process is mandatory and financed by the state for all country. IFN is held every 10 years. Forest owners with professional forest management have specific Forest Inventories at stand level (Stand Forest Inventories SFI), in general, and depending on the species are held every 5 years. IFN support the definition of policies and the SFI support the tactical and operational forest management planning. The majority of private forest areas do not have a stand-wise forest inventory. So generally the information about the private forest are scarce, outdated and with low accuracy. The lack of information about resources and their situation is particularity critical for the industry and for regional forest planning. The wood transforming industry has great difficulty in accessing strategic information that allows it to evaluate timber availability for supplying the factories and their environmental sustainability. Information about land use dynamics and updated quantification of standing timber are critical. A huge set of factors (biogeographic and anthropic) determine the enormous variability of environments in the Portuguese Forest areas. EO services, particularly the very high-resolution satellite imagery, should be able to help better characterize these environments and to define increasingly appropriate and specific sustainable forest management plans for each site. EO-based services provide an opportunity in the provision of relevant, current and cost-effective accurate information.

CONTROL of PEST

RAIZ3 - in *Eucalyptus* stands

Eucalyptus Longhorned Borer (Phoracantha spp.) Is an insect that feeds on eucalyptus wood. This insect lays its eggs under the eucalyptus bark. The larvae pierce the wood and create feed rails that interrupt the flow of sap which often leads to the death of trees. The susceptibility to attack by this pest is related to the physiological state of the trees, usually weakened trees due to prolonged periods of drought, which are more prone to attacks. Eucalyptus borer has an annual life cycle, with flying activity and oviposition during spring and summer. Larvae develop inside the trees, where they pupate, emerging as adults the following spring.

The current way of controlling this pest is to identify attacked trees, to cut them and to remove them from the forest before the larvae hatch (Phytosanitary Cuts). A complementary method is to use attractive traps to control the population of insects in their adult state. These control methods are extremely labour-intensive and difficult to plan as there are currently no expedited ways to identify the affected areas and where the attacked trees are. The lack of control of the eucalyptus borer populations leads to an increase in their population levels with an increasingly negative impact on mortality and loss of forest productivity. The increase in periods of extreme drought predicted in the context of climate change could translate into a significant increase in the conditions for the spread of this pest, so more effective plans to control it are urgently needed.

Forest Management needs to control pests in an effective and low-cost way. It's an operational requirement but also a requirement from Forest Certification (FSC and PEFC). The parameters need to support is a decision to control the pest and to report the situation are: number of hectares or percentage of the total area affected and degree of attack (symptoms: dead tree, tree losing is vitality).

Figure 3-1. Symptoms of a settlement attacked with the eucalypt eucalyptus borer (*Phoracantha spp*.) pest and a general view of a stand attack with *Phoracantha spp*.

Others specific user-needs that will be work on the next reports

Ecosystem service assessment

FOAL2

The potential to combine eforest.lt – a forest inventory and management platform by/for members of FOAL – and remote sensing in order to provide conventional functionality related to forest inventory and management planning need to be investigated. The challenge is to develop additional functionality to eforest.lt focusing on other than provisioning ecosystem services. Very often the regulating and cultural services are based on the landscape rather than stand-level forest attributes. The role of remote sensing is to provide information related to the quantification of forest regulative/cultural services and conduct the monitoring of such services. Availability of mapped forest provisioning, regulating and cultural services with implemented solutions to model the dynamics of such services under conditions of different future development scenarios ate the pre-requisites for sustainability-aimed of forest management planning and tasks for improving currently used projection tools by FOAL.

Wood Characterization

MADERA+1: Eucalyptus globulus wood density

Eucalyptus globulus is one of the most important hardwood species used by the pulp and paper industry due to its high pulp yield, high wood density, excellent fibre quality, and good handsheet properties. However, the wood is a highly variable and complex material that has different chemical, physical and anatomical properties that influence its commercial value and industrial processing. The variability of the Wood used by the pulp mills is extremely wide with basic densities of 0.460 to 0.600 g/cm(3). The morphological characteristics of the pulp fibres were also markedly different of low, intermediate, and high wood basic density.

Environmental accounting

EFI - an example of a practical application from Catalonia Region, Spain

An implementation of the environmental accounting guidelines was done in Catalonia Region in the framework of the CREEA (Compiling and Refining Environmental and Economic Accounts) project (Varela et. al, 2013). This assessment aimed to understand the main forests stocks

in a region for which the forestry sector plays a marginal role in economic terms. This assessment thus meant to assess the overall economic value of both existing deciduous and coniferous stands.

The results show that:

***Forest land account**-: Catalonian land use maps were used for establishing a forest land account for Catalonia. The account shows that secondary succession processes (natural afforestation) are the main reason for the increase of forest lands in Catalonia. These processes are mainly triggered by land abandonment or after a forest fire. About 3.5% of the total open forest areas (less than 20% of canopy cover) in 2009 were shrublands in 2005. Further, 3% of the burnt areas in 2005 turned into dense forests (more than 20% of canopy cover) in 2009*

***Monetary timber account**- The opening stock in the cultivated forest is greater than in the natural forests available for wood supply. This comes from the productive and highly valuable species planted in cultivated areas (radiata pine, Douglas fir, poplar, eucalyptus). Although some of these species are not mature in the opening, there is an anticipated value for these species.*

Wind Damages

***CFRI* – Reference to the work: "Possibilities of the application of the medium-resolution Landsat 8 and the high-resolution RapidEye optical imagery in visualization and detection of changes in the forest cover by windthrows"**

Examining the visual and quantitative estimates of wind damages and the renovation of the forest cover following the Theodor storm in November 2013 in Medvednica mountain, North-western Croatia.

3.1. OPERATIONAL ENVIRONMENT AND REGULATORY ISSUES

Independent from age of rotation, species, regime and other particularities of each silvicultural workflow, it is possible to define a general silvicultural workflow in forest management (Figure 3-2). The flow starts with the available land to afforestation (stage 0) that we need to characterize (Stand Characterization - Sc) from the point of view of their soil, climate, among others to decide an afforestation (A) (stage 1), or the start point could be a stand already established (stage 2). Between stage 2 and stage 3 is the period of Maintenance (M), in this period the stands need to be periodical monitoring to evaluate the stage of development and vitality among others. In this period if any event damage the forest like fire or strong winds (stage 3) sometimes it needs to start again from stage 1. Between stage 4 and stage 5 the forest stand reaches the term of exploitability for the volume variable, some information from the stand is needed to define the cut-age (C). At stage 5 the stand is clear-cut or selectively cut trees, depending on the silvicultural regime, and after that, we need some information to evaluate the next decision options (like reforestation or regeneration). The timber collected is transported to woodyard (stage 6) of mills.

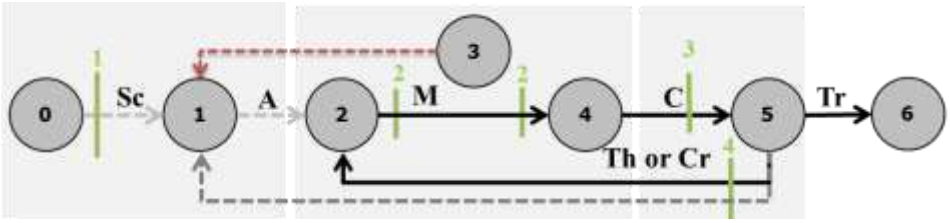


Figure 3-2. General Silvicultural Workflow

Table 3-1 presents for each problem described above a specific moment in the silvicultural workflow where the information is needed and how the information is collected. For the examples of Forest Inventory and Control of Pest above mentioned, we detailed the related regulatory issues, the forest operational environment where the information is needed, the potential of satellite images, the data that was collected to validate the quality of the MSF products and the validation methodology.

Table 3-1. Where the information is required in silvicultural workflow and how is collected.

Forest user need requirement	Information required and collected in the silvicultural workflow
Forest inventory (FOAL1 – FOAL2)	Permanently (in the maintenance period - M), at least once a year for all forests in a specific estate or group of estates: ▪ Segmentation of remotely sensed images utilizing available borders of estates and compartments ▪ Estimating rough forest characteristics for segments ▪ Combining segments into the initial version of forest compartment delineation ▪ Sketch maps for field inventory ▪ Facilitating field estimation of some attributes

Forest user need requirement	Information required and collected in the silvicultural workflow
	▪ Identification of any changes within the area of compartments, stored in eforest.lt ▪ Identification of the type of impact on the forest ▪ Constructing new borders of compartments ▪ Characterization of adjusted compartments ▪ Validating and updating attributes neighbouring the updated compartments ▪ Validating and updating attributes for all other compartments
Forest Inventory (RAIZ1- RAIZ3)	NFI at least once a year (Land use land cover dynamics and support yield estimation). SFI at least once a year. Between stage 2 and stage 4 (monitoring - Land use land cover dynamics and productivity evaluation) or between stage 4 and stage 5 (support yield estimation and decision to cut).
Pest and disease control (RAIZ3)	Between stage 2 and stage 4. Monitoring stands in regions with medium to high risk of attacks with the pest *Phoracantha*. The risk of an attack of *Phoracantha* is related to the drought regions or particular drought event. ▪ The product "Drought estimation" is requested between May and September after detection of drought by the meteorological station. The output is the forest area affected by drought event. ▪ For the areas detected in (1) is request the product "Forest Vitality" between October and January. The objective is detected trees or areas that lose their vitality or even dead. ▪ Field Confirmation of Problem Cause ▪ Decide where and how to implement phytosanitary cuts and with witch priority.
Assessment of ecosystem services (FOAL2)	Data on forest compartments originating from upgraded forest inventory used as the main source of information. However, as some Ecosystem Services are possible to evaluate at the landscape level (contrary, the forest inventory is estate based), one needs simplified information, however for larger areas. The periodicity could be less than the one for forest inventory. The focus on the estimation of the following characteristics first (assumed as the source data to quantify the ES): ▪ Land cover types ▪ Dominant tree species ▪ Standing volume ▪ Mean age ▪ Site productivity
Wood traits characterization	Between stage 3 and 4 the product wood quality will be applied to detected areas with a desirable wood quality attribute. Spatial characterization of variation in a desirable wood quality attribute, such as density, or Modulus Of Elasticity enhances the possibility for value chain optimization, which could allow the forest industry to be more competitive through efficient planning management. That aid the segmentation of forest masses and later management plans, based on basic wood properties, in order to optimize the sustainable management and the exploitation of resources in woodlands.

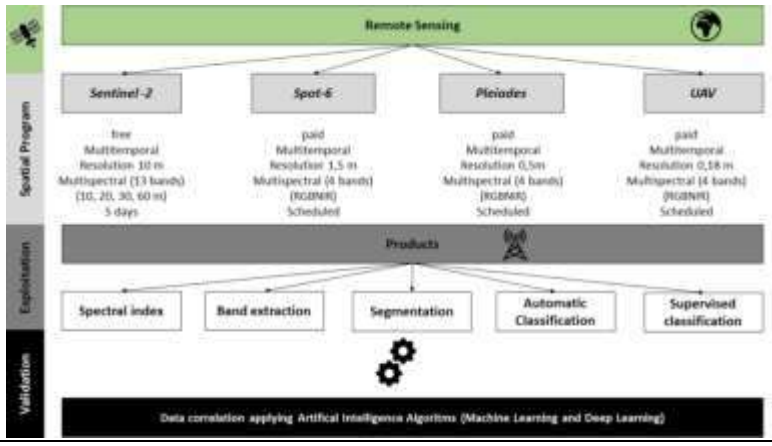
The EO images could help the forest manager to support better his decisions, continuing with our example:

Forest Inventory
FOAL1 – FOAL2 *The potential of satellite imagery has always been considered as relatively low in Lithuania, much because of the requirements for stand-wise forest inventory data. Very high-resolution satellite images have never overtaken the advantages of conventional CIR aerial photography due to higher costs and very limited availability of suitable weather conditions for image acquisition. However, the use of satellite images has always been considered as a replacement for aerial photography. Subsequently, the methods to work with satellite images used to be borrowed from the field of aerial photography application. Within this project, the approach for using satellite imagery is changed, i.e. alternative processing approaches are tested to deliver conventional forest inventory data.* **RAIZ1 - RAIZ3** *Satellite imagery (optical and radar) has considered an alternative with an effective cost, especially when other types of information aren't available for all the territory, like LiDAR data. But is questioned and recognized the great variability of the Portuguese Territory and the need to have more data for algorithms training.*

Pest Control

RAIZ3 in Eucalyptus stands

Trees with signs of loss of vitality may be a first initial indicator of the probability of being attacked. The symptoms of the attack are visible in the crowns, which dry progressively. These symptoms are likely to alter the reflective properties of the tree when compared to its normal state and eventually detected through the lowest reflectance observed in images collected with remote sensing technologies in the near infrared and medium infrared bands. The use of high to very high-resolution images collected by satellites or unmanned aerial vehicles is an opportunity to make monitoring of areas and trees under attack more efficient and expeditious.



Others specific user-needs that will be work on the next reports

Assessment of Ecosystem services

FOAL2

Satellite imagery is considered as an additional data source to conventional forest resource information to deliver standardized and referring to one-time point estimates of ES. It is expected, that the satellite information (also medium resolution) is suitable to provide generalized information for ES evaluation at the landscape level.

Wood traits characterization

Madera+1, Raiz1, Raiz2, CFRI1,CFRI2

Basic wood properties are involved in forest tree response to environmental variation, nutritional state, and forest management. Some factor like temperature determines the period of growth or the percentage of latewood produced. The number of trees/ha and the dominant height or diameter are also related to wood properties and can be determined by LiDAR data. Many aspects like phenological characteristic and chlorophyll content can be eventually detected through the lowest reflectance observed in images collected with remote sensing technologies in the near infrared and medium infrared bands. The use of climatological data, LiDAR data and satellites images is an opportunity to make a spatial characterization of variation in a desirable wood quality attribute, such as density, or Modulus Of Elasticity. Wood density is also correlated with cavitation resistance and participate indirectly in water transport. (Drought risk detection?)

Services based on EO have the potential to reduce the effort in fulfils regulatory requirements in the specific forest management cases presented in the item above. Table 3-2 synthesizes the type of requirement; criteria to fulfil the requirement; parameter that we need to collect; entities involved; and the current situation in forest management and the potential of using EO data to fulfil the requirement. Regarding the previous work in the WP2, we also stabilized the link between main user requirements and the services that MSF will provider.

Table 3-2. Potential of the MSF services and products to reduce the effort in fulfils requirements (regulatory and others) (PT example)

Forest user need requirement		Type of requirement	Criteria	Parameter to collect	Entities	Current Situation	With EO data	Service/Product
1 - Better definition of physic characteristics of the forest areas and monitoring their changes, also the existing infrastructures for its management and the administrative limits for law enforcement. **3 - Improved accuracy of forest inventories** to know the different species of the stand and their dendrometric variables for better management of biomass and wood stocks and to know the value of them for assurance purposes.	**Forest Inventory** (RAIZ1- RAIZ3)	Law / Legislation	Forest Statistics: assessing the abundance, status, and condition of national forest resources	Total forest areas and by main species (ha/acres) Stand yield of the main forest species (m3) Age class area by main species (%) Above ground Biomass for the main species (ton) Quantity of CO2 - carbon fixed by the main species (ton)	State forest service	Update LULC Sampling methods and tree measurement techniques are used, these processes are usually time-consuming, costly and the information collected is not enough accurate and rapidly outdated. Update frequency: NFI (every 10 years), Companies Inventories (every 5 years)	Forest inventory periodically available up-to-date and more precise. Update frequency: Every year.	**Forest Characterization (S1)** • **Forest mask** (S1 P1) • **Stand delineation** (S1 P2) • **Forest infrastructures** (S1 P3) • **Main Forest Types** (S1 P4) • **Stand height** (S1 P5) • **Forest age** (S1 P6) • **Burn scars** (S1 P7) • **Clear cuts** (S1 P8) • **Site Index (S1 P12)** • **DEM**, altitude, slope, aspect (S1 P9-11) **Biomass and CO2 (S3)** • **Above Ground Biomass** (S3 P1) • **CO2 stock** (S3 P2)
		Forest Certification	Maintenance and enhancement of forest resources and their contribution to global carbon cycles		Certifications entities			
		Tactical and Operational forest management planning			Forest owners, companies providing services to forest owners and managers			
	Forest Inventory (FOAL1-FOAL2)	Law / Legislation	Updating of Forest State Cadastre	Updated compartment information to be uploaded to Forest State Cadastre	State forest service	State financed stand-wise forest inventory to update Forest State Cadastre was stopped since 2018, however, the forest owner is obliged to provide updated data on forest compartments with an opportunity to be reimbursed for expenses Inventory to elaborate forest management plans for private forest owners is much based on field estimations	Improved accuracy of inventory data and better forest management plans, permanent updating of information, including updates of Forest State Cadastre	
		Tactical and Operational forest management planning	Conducting stand-wise forest inventory to enable sustainable forest management planning	Forest delineation into compartments (Borders) and characteristics of forest compartments (or adjusting of available borders of forest compartments from previous stand-wise forest inventories) Forest characteristics for compartments (above 100 attributes by species) Silvicultural treatment suggestion for a compartment	Forest owners, companies providing services to forest owners and managers			

Forest user need requirement		Type of requirement	Criteria	Parameter to collect	Entities	Current Situation	With EO data	Service/Product
5 - Better definition, detection, and control of potential pests and diseases that may endanger the forest, as well as the evolution of invasive alien species and adaptation to climate change linked with forest management.	**Pest and disease control** (RAIZ3, RAIZ4)	Law/Legislation	NA	NA	NA	NA	NA	
		Forest Certification	Maintaining the health and vitality of forest ecosystems	The area with symptoms (discolouration, defoliation)	Certification Entities: PEFC, FSC, Citizens	*Eucalyptus* stands have to be fully monitored to identify areas and/or trees with symptoms - this process is costly, time-consuming and not efficient.	Efficient and early detection of symptoms in areas or trees affected by pest and diseases.	**Forest Protection** (S4) • Biotic damages (S4 P1) • **Drought Estimation** (S4 P2) • **Forest vitality** (S4 P5)
		Strategic, tactical and Operational Planning	Maintaining the health and vitality of forest ecosystems	The area with symptoms (discolouration, defoliation)	Forest manager Private owners and their organizations			
4 - Better definition of forest conditions for the surveillance and development of different forests species (type of soil, nutrients, water availability, isolation) and the potential habitat for wildlife	Evaluation and communication of forest management externalities: soil, water, biodiversity protection (FOAL2)	Forest Certification The tactical and operational forest management plan	Maintenance, conservation and appropriate promotion of biological diversity in forest ecosystems Maintenance and appropriate promotion of protective functions in forest management (mainly soil and water)	The average number of flora species Number of plots with riparian galleries Plots with evidence of erosion (no.% Total plots)	Forest manager Private owners and their organizations Certification Entities: PEFC, FSC, Citizens	Parameters that are extremely difficult to collect at a high cost and difficult to recognize the value and function in their monitoring	Efficient characterization of ecosystem vulnerabilities: soil, water, biodiversity	**Ecosystem Vulnerabilities** (S5) • Watershed delineation (S5 P1) • Stream network (S5 P2) • Biodiversity indicator (S5 P3) • Habitat fragmentation indicator (S5 P4) • Fire risk indicator • Soil erosion risk indicator
	Assessment of ecosystem services (FOAL2)	Strategic, tactical and Operational Planning	Supply of additional information to enhance sustainable forest management planning	Additional information on ES and the dynamics of ES Land Cover Types Dominant tree species Standing volume	Forest owners, companies providing services to forest owners and managers, investors	Practically no additional information on ecosystem services is provided (even though it may be deducted from conventional forest inventory data)	Improved image of private forestry, better planning decisions	

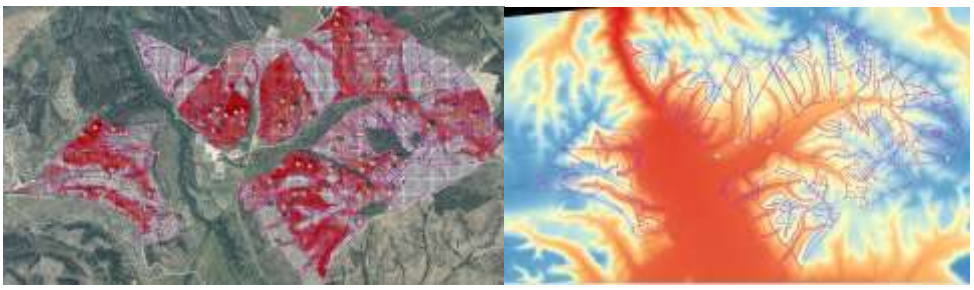
Forest user need requirement		Type of requirement	Criteria	Parameter to collect	Entities	Current Situation	With EO data	Service/Product
		Forest Certification		Mean age Site productivity Carbon balance	Certifications entities			**Biomass and CO2** (S3) • **Above Ground Biomass** (S3 P1) • **CO2 stock** (S3 P2) Ecosystem Vulnerabilities • Watershed delineation (S5 P1) • Stream network (S5 P2) • Biodiversity indicator (S5 P3) • Habitat fragmentation indicator (S5 P4)
2 - Better definition of the properties of the wood from the different species of trees for more appropriate use in the production or industrial process	Evaluate Wood quality traits to incorporate in forest inventory (MADERA+1, CFRI1, CFRI2	Law/Legislation				Wood quality traits as wood density in *Eucalyptus globulus* or dynamic modulus of elasticity in conifers	Forest inventory periodically available up-to-date and more precise. Update frequency: Every year.	**Wood Characterization (S2)** • **Wood density ranking** (S2 P1) • **Wood stiffness** (S2 P2) • **Strength class** (S2 P3)
		Forest Certification						
		The tactical and operational forest management plan	Strategic business industry decisions before proceeding with clear-cuts, More efficient planning management. Forest-wood chain cost-effectiveness	Estimates of stand-level variation in various wood and fibre attributes Wood density prediction in *Eucalyptus* Stands Dynamic modulus of elasticity prediction in *Pinus* stands Wood density prediction in *Quercus robur* stand	Forest / Wood companies / owners			

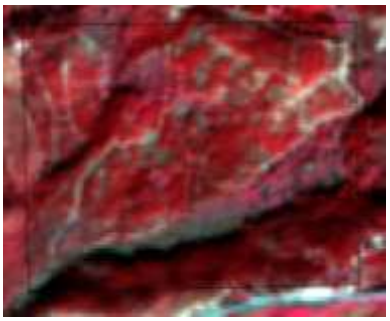
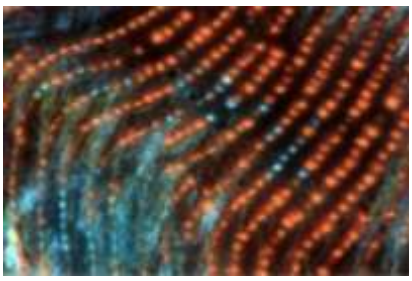
Forest user need requirement		Type of requirement	Criteria	Parameter to collect	Entities	Current Situation	With EO data	Service/Product
6. Improve the economic performance of forestry work and all industries associated with the wood cycle	(EFI, Foresna)	Environmental Accounting	Environmental accounting guidelines provide a framework for conceptualizing the interaction of the economy and the environment (i.e the forest resources), bringing forest estimations and their relationships with the economy within official statistics.	Fluxes of forested lands between two reference periods Fluxes of timber (m3) between two reference periods Prices of timber and market values in the two reference periods	State forest service /Authorities Forest / Wood companies / owners			**Environmental and Economic Accounting** (S6) • Physical wood accounts (S6 P1) • Monetary wood accounts (S6 P2) • Land Physical Asset Accounts (S6 P5)

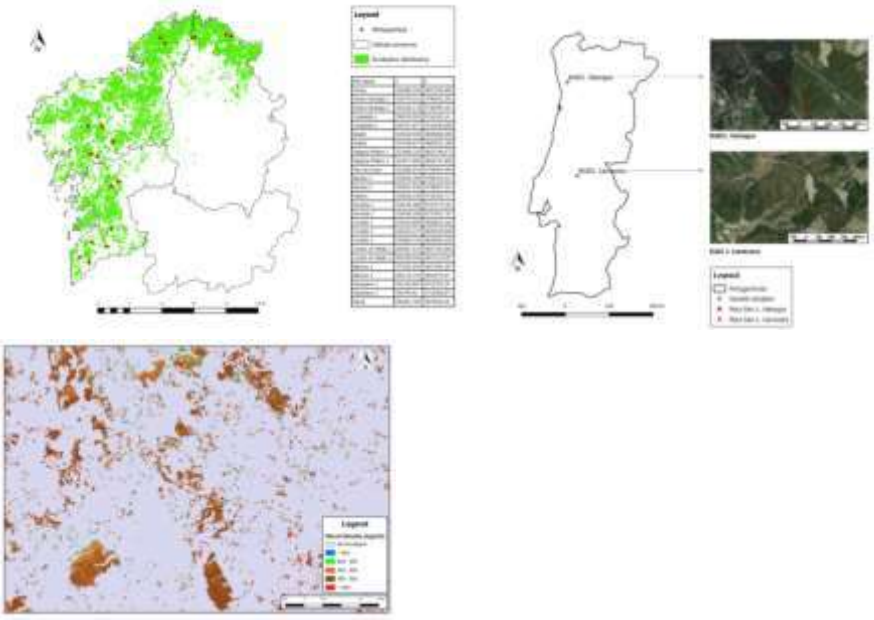
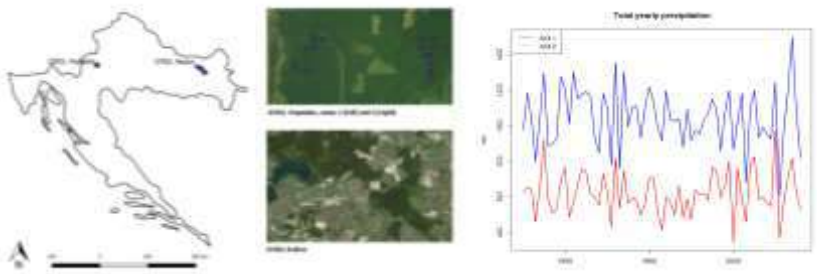
3.2. DATA COLLECTED AND THE VALIDATION PROCESS

End-users planned and prepared all needed logistics and practical arrangements to conduct the validation use cases into their operational environment, namely, they collected data and information from AOI's for training and validation of the MSF products in the services. The training data was shared with the provider's partners to training the algorithms that generate the products and data for validation will be used to validate the precision or level of agreement with the reality or resolution need to characterize the product. Also, geodatabases were prepared for the training and demonstration phase, and to demonstrate the level of integration in the end-users workflow.

Table 3-3. Work done by the stakeholders to conduct the validation and demonstration of the MSF services.

Problem	AOI - Site	Work was done
Forest Inventory	RAIZ 1 – RAIZ3	• Defined the AOI – representing the main types of Eucalyptus plantation in Portuguese territory • Collected ground control points • Collected forest inventories and cadastre at stand level data from 2015 to 2018 • Delineate, implement and measure a network of forest inventory plots • Estimate forest stand parameters (density, dominant height, Basal Area, Total Volume, Total Biomass Above Ground) • Shared with providers 70% of data to training algorithms • Used 30% of data to validate MSF products (at the moment: Forest mask and Main Forest Types) • Validated the precision of the products Forest Mask and Main Forest Types in site RAIZ3 (collected about 500 points to validate LULC).  **Figure 3-3. AOI RAIZ3 – Points where data was collected to validate Forest mask and Main Forest Types products.** • RAIZ Purchased an Airborne Laser Scanning (ALS) flight. FÖRA process DEM and Forest Inventory for Eucalyptus stands. RAIZ validate the DEM and Forest stand variables.  **Figure 3-4. Products derived from ALS data in RAIZ3 AOI. Left: Forest Inventory and Right: DEM.**
	FOAL 1 FOAL 2	• Defined the AOI • Collected available information on forest resources and other remote sensing materials • Fieldwork to adjust stand-wise forest inventory data for validation at FOAL1 • Preliminary assessment of MSF platform suggested products

Problem	AOI - Site	Work was done
Pest Control	RAIZ3	• Defined the AOI - representing the main types of Eucalyptus plantation in Portuguese territory • Collected ground control points (GCP) • Georeferenced trees and areas affected by the pest (*Phoracantha*) for training and validation purposes. Additional data was collected in other management units to increase the data available for training algorithms. • Some satellite images available (sentinels and others) are explored to extract relevant information. Bought SPOT and Pleiades images because of unavailable quota in MSF project or access of data with an adequate temporal resolution to describe the problem. Additionally, it was collect data with a drone. • Fieldwork was performed to evaluate the level of concordance between the information of processed satellite images and the areas affected or number of trees affected (hectares, %) **Reference work (in progress): "Eucalyptus Longhorned Borer attack assessment in industrial plantations using very high-resolution images in Portugal central region"** Abstract: The Eucalyptus Longhorned Borer (ELB) is an insect that attacks several species of *Eucalyptus*. This pest has caused significant economic damages in the last years. The severe drought that has reached the hottest regions of mainland Portugal has promoted the proliferation of this pest. Monitoring of affected areas, including dead trees or trees with symptoms of decline, is a very expensive and difficult task by traditional methods. Control is only effective when outbreaks are detected in an early stage and the infected trees are promptly removed from the stand to reduce pest populations. On the other hand, when large areas are already infested, clearcutting may be required. The main goal is to evaluate the location and extent of pest attacks through satellite images with different spatial and temporal resolutions as a decision-making tool for forest technicians and producers. Images from the Sentinel-2A / B, Spot-6/7, and Pleiades-1A / B satellites were used on areas where the pest attack has already been identified to validate models. Firstly, the analysis was performed by spectral vegetation index differences. Secondly, the COntinuous monitoring of Land Disturbance (COLD) using Sentinel time series was applied. Finally, the use of machine learning or deep learning techniques was tested to identify affected areas. The expected outcome is a methodology based on satellite images that could detect affected areas or individual trees in an early stage, thus providing better support to forest managers. **Sentinel-2 (10 m)**  **Spot (1.5 m)**  **UAV (0.18 m)**  **Pleiades (0.5)**  

Problem	AOI - Site	Work was done
		Figure 3-5. Satellite and UAV images analyzed and extraction of areas and trees affected by the pest. Some exploratory studies that was perform in this project (Figure 3-3 and reference work above mentioned) demonstrate that even with VHR data with 0.5 meters the detection of a tree affected with a pest (dead or losing their vitality) is extremely difficult, but with more data could be possible to get good results even with 10 m resolution of sentinels, so we need to continually work to achieve better results.
Eucalyptus Wood density characterization	Madera+1 RAIZ 1 RAIZ 3	▪ Define the MADERA+1 AOI ▪ Collected ground control points ▪ Georeferenced areas with different clones and site condition. ▪ Additional data was collected in RAIZ for training and validation purposes. ▪ Some satellite images available (sentinels and other) and climatological data, physiographic data and age data are explored to extract relevant information. Satellite: values for all bands and five Index (EVI, GNDVI, NDVI, NDWI, and SAVI) were collected for Sentinel II and Lansat8 on the months of May to September during the period of 2013 to the 2018 year. For radar (Sentinel I) values of backscattering coefficients from the same dates where selected. Follow some images related to the work already done. 
Quercus robur wood density characterization	CFRI 1 CFRI 2	Collected ground control points and trees in sites with different drought conditions. Additional data related to wood density profile variation was obtained in each tree to study drought symptoms into the wood. Some satellite images available (sentinels and other) and climatological data, physiographic data and age data are explored to extract relevant information. 
Wind-Damages	CFRI	**Reference to the work: "Possibilities of the application of the medium-resolution Landsat 8 and the high-resolution RapidEye optical imagery in visualization and detection of changes in the forest cover by windthrows"** *ABSTRACT. This paper presents a comparison of the satellite information of medium (Landsat 8, 30 m) and high (RapidEye, 5 m) resolutions for the purpose of examining the visual and quantitative estimates of wind damages and the renovation of the forest cover following the Theodor storm in November 2013 in Medvednica mountain, North-western Croatia. 3D visualization of the whole Medvednica area was derived from the Landsat 8 RGB channels of the visible part of the spectrum, pan-sharpened with the pan-chromatic channel on 15 m spatial resolution for visual forest damages detection. The spatial sensitivity of different satellite indices (NDVI, SAVI, MSAVI, NDMI, NBR, NBR2), based on Landsat 8 imagery, as a quantitative measure of the state of the*

Problem	AOI - Site	Work was done
		vegetation cover, was investigated throughout the whole Medvednica area. From the investigated indices, the best detection of the changes in the forest cover was achieved by soil corrected indices such as SAVI and MSAVI in relation to the standard NDVI index. Indices based on the infra-red part of the spectra (NDMI, NBR, NBR2) showed quite good performance in detection of the damages of the forest cover. By the comparative assessment on the chosen pilot area with severe windthrows near Bliznec, a significant advantage of the high-resolution RapidEye imagery in comparison with Landsat 8, was confirmed for the potential purpose of the more precise silvicultural subgroups delineation and monitoring of the success of the restoration of the young forest cover. Based on the obtained results, substantial possibilities of medium and high-resolution satellite imagery have been identified, both for the purpose of damages assessment after natural disasters and for the monitoring of the reforestation on these surfaces, which will be confirmed in the further course of this research. This research is performed as a part of the ongoing activities in the Horizon2020 project "My Sustainable Forest" with support of the Croatian science foundation projects GEMINI and 3D Forinvent.

4. TRAINING PROGRAM PREPARATION

In this section, we present the plan delineated to the Training Program.

4.1. OBJECTIVE

Contextualization within the project: as the project develops its services, they are getting closer to an operational stage. Therefore, at that point, the project is able to show to the end-users what the products are able to perform in order prepare them for the final release of the MySustainableForest platform and, at the same, time collect feedback from them in order to deliver a platform that can respond to their needs. The partners mainly responsible for this activity are EFI and GMV. Other partners will be asked for contribution as specified below.

Purpose of the activity: this activity is to develop a training program, deliver it and compile stakeholders' feedback. The aim of the training program is to facilitate MySustainableForest's services usage to end-users. It will cover the six services that MySustainableForest project offers. At the end of this activity, this training material will remain accessible and play the role of "user's manual" for the MySustainableForest platform.

4.2. RECIPIENT

Project deliverables to which the activity contributes: the training sessions will be held during the three stakeholders workshops (months 14, 27, 34). From these workshops, Deliverables 6.11, 6.12 and 6.13 will be produced (due in months 15, 28 and 36 respectively). These three deliverables should include the training material as well as the feedback provided by end-users in order to improve the following training material.

Agents: in previous deliverables, the term "end-users" refers to the engaged project partners responsible for the chosen Areas of Interests in the various participating countries (RAIZ, CFRI, UFE, FORESNA, FOAL, and CNPF), and their associated or federated stakeholders. For Task 4.4. End-users Training Preparation, an "end-user" is any person susceptible to use the services of the platform. End-users are mostly forestry or natural sciences practitioners. Therefore, they should have basic knowledge of forest management.

Collaboration expected from the agents: project partners considered end-users (RAIZ, CFRI, UFE, FORESNA, FOAL, and CNPF; see D2.1. End-User Use Cases) must mobilize the stakeholders to attend the Stakeholders workshops (WP4) and, within the workshop, the training session. After the training session, attendees must provide feedback to the training organizers.

4.3. OUTPUTS

Training materials: training elements will include materials for use both online and in a classroom non-operational setting. The latest includes technical on-site support when delivered as part of a given Stakeholders workshop (organized within WP6).

Feedback: training material will be 1) improved according to attendees' suggestions and 2) enriched with up-to-date scientific knowledge on the chosen methodological and technological approaches, including relevant aspects of ecosystem functioning and the socio-economic system. End-users/stakeholders training feedback will be collected for an assessment of the service in meeting their particular requirements and next future expectations. This feedback collection will happen in both online (self-learning) and in classroom (in-person) training sessions.

4.4. METHODOLOGY

It is foreseen to inject the basic contents of end-users capacity building training to the stakeholders awareness communication with a feedback process which will be designed with a methodical approach to elicit, analyze, prioritize and document the end-users' requirements. Thus, activities to be executed, in collaboration especially with project partners involved on the pilot demonstrations (end-users project partners: RAIZ, CFRI, UFE, FORESNA, FOAL, CNPF), will include preparing training material, delivering training and compiling stakeholders feedback, according to this cycle:

Table 4-1. Activities to be executed in the preparation of the training program.

Activities	Source of information	Months

Users' needs identification for S2 training and the first proposal of a Table of contents	D2.1 & end-users project partners	16-17
Preparing training material for S2, including feedback questionnaire	End-users project partners & scientific literature	18-26
Deliver training in S2: In-person (January 2020) On-line (January 2020 to July 2020, passive) In D.6.12	-	 27 27-33 28
Collect and compile stakeholders feedback from S2	stakeholders	27-33
Preparing S3 training material, recycling S2 training material, by: Incorporating feedback Enriching with progress towards Advanced service (S3) made in the project	stakeholders project partners & scientific literature	 28-33 28-33
	-	34 34-36
Collect and compile stakeholders feedback from S3	stakeholders	34-36
Preparing final training material, recycling S3 training material, by: Incorporating feedback	stakeholders	 35-36
Deliver final training (replacing previous S3 training material) On-line only (from October 2020 onwards) In D6.13	-	 36 36

S1 training session already took place in month 13 (November 2018) during the workshop organized by CFRI in Zagreb (Croatia).

S2 training material will be replaced by the S3 training material, and the later by the final training material (each version is an improved version of the previous, as enhanced service is an improved and more complete version of the advanced service). The final training material will only differ from the S3 training material by the incorporation of feedback from stakeholders. No additional up-to-date scientific knowledge from project partners will be incorporated because 1) the last scientific update will be done in month 33, so there is little chance that significant scientific updates happen since then until the end of the project in month 36, and 2) there will only be a period of two months between the delivery of the S3 training material (M34) and the end of the project (M36).

The training material will consist of six lessons, each one corresponding to one of the six services that the project will develop:

- Forest Characterization
- Wood Characterization
- Biomass and CO2 stocking
- Forest Condition
- Ecosystem Vulnerabilities
- Environmental and Economic Accounting

In each lesson, one of the several end-users needs, as listed in D2.1, will be used as a topic and working material. By doing so, the training will also show how a given service can solve a given problem or need. The six lessons will have the same structure, with five chapters:

1. **Scope of the problem**: this first section will make users reflect that they may have a problem (one of the user's needs) to solve and that they need a solution. It will not present the technology directly but the ecological and managerial fundaments of forestry to tackle this given problem.
2. **A sample case of the solution**: the second section will present a real example where the aforementioned problem (one of the user's needs) can be solved, completely or partially, using remote sensing technology. Here the technological bases of the solution will be presented.
3. **Practical exercise**: the users will have access to a downloadable dataset of files to practice with the sample case in GIS software (the exercise will be executable in most of the open-source GIS platforms, any required add-on will be listed). This section will include the instructions to perform the exercise and the expected results.

4. **Conclusions**: this section will present the conclusions about the solution, including the list of user's needs that could be solved with the products of the My Sustainable Forest's service presented in that lesson.
5. **Feedback form**: at the end of the lesson, there will be an online questionnaire where the user will evaluate the lesson and provide feedback (only for cycle S2 and S3). The questionnaire will be the same in all lessons and will be used to improve the next cycle training (S2 feedback to improve S3, and S3 to improve the final version).

Each lesson will be 2-3 pages long maximum, with straightforward messages. It is expected to be completed by the user in one hour or less.

EFI and GMV will be the partners developing the training material. EFI will be in charge of the content related to ecological and managerial fundaments of forestry, and GMV will be in charge of the content related to the technological solution of the problem. Therefore, EFI will play the main role developing the sections "Scope of the problem" and "Feedback form", while GMV will play the main role developing the sections "Sample case solution" and "Practical exercise". The section "Conclusions" will be under the shared responsibility of EFI and GMV. EFI and GMV will keep in contact with project partners, as they'll provide the material for the sample cases and the dataset for the practical exercises.

4.5. FORMATS

Teaching strategies: teaching strategies will combine lectures and practical sessions (for in-person training as well as for online training). This material will be available online for self-learning (eventually uploaded in the project's website or MySustainableForest platform). Therefore, training material will have a format suitable for both in-person and self-learning. Table 4-2 presents the documents to be produced.

Table 4-2. Documents to be produced.

Cycle	In-person training material	On-line training material	Deliverable
S2	Any documents and formats usually required in this kind of training	As stand-alone material in the project website (6 lessons, one per service)	Text, images, and references will be included in D6.12 (due in M28, one month after S2 training)
S3	Any documents and formats usually required in this kind of training	As stand-alone material in the project website (6 lessons, one per service)	It will not be published in any deliverable, final training material will be done instead
final	NA	As stand-alone material in the project website (6 lessons, one per service)	Text, images, and references will be included in D6.13 (due in M36, two months after S3 training)

S2 and S3 training material questionnaires will be online and will concentrate only on the training material content (not on the teaching skills). The questionnaires will be the same for the in-person and the self-learning material.

The in-person training session will not be recorded.

In-person training requirements: a room will be required with WiFi internet connection, a projector and workspace for the attendees to use their own laptops with a GIS software installed. In-person training sessions will include a time slot at the end of the training to allow attendees to provide feedback immediately through the "feedback form" (in order to increase chances of response). Each lesson will last one hour, so the total "in-person" training, per service, will last six hours (without considering the pauses).

On-line training requirements: on-line training will be passive, self-learning with no support from a trainer. Most of the material will be in text, but videos may be recorded for the most complex steps of the exercises. On-line material for self-learning will be hosted on the project's website and be available as long as the website is operative. S2 training material will be replaced by the S3 training material, and the later by the final training material. Each lesson is expected to last one hour.

Language: English will be the only language of the training.

4.6. TIMELINE

Three cycles training strategy will be followed in line with the workflow engineering integration plan (early, enhanced and advanced service).

Timeline: see Table 4-1 in the Methodology section.

Deadlines: here are the deadlines of other tasks and deliverables related to this task:

Table 4-3. Calendar of Stakeholders workshops, Training Program, and End-User Trials Assessment.

Engineering integration plan (services)		Training (WP4)	Stakeholders workshops (WP6)			End-User Trials Assessment Report (WP4)	
Cycle	Date	Date	Date of the workshop	Deliverable	Date of the deliverable	Deliverable	Date of the deliverable
Early service (S1)	Nov 2018 (M13)	Dec 2018 (M14)	Dec 2018 (M14)	D6.11 (v2)	Jan 2019 (M15)	D.4.2 (v1)	Mar 2019 (M17)
Enhanced service (S2)	Aug 2019 (M22)	Jan 2020 (M27)	Jan 2020 (M27)	D6.12 (v3)	Feb 2020 (M28)	D.4.3 (v2)	Dec 2019 (M26)
Advanced service (S3)	Apr 2020 (M30)	Aug 2020 (M34)	Aug 2020 (M34)	D6.13 (v4)	Oct 2020 (M36)	D.4.4 (v3)	Aug 2020 (M34)

4.7. END-USER NEEDS TO BE USED IN THE TRAINING AS SAMPLE CASES

Select the most appropriate product of each service to be used as sample case (Table 4-3). The "Recommended end-user needs to be used in the training as sample cases" are selected because they:

- represent one on the most "popular" end-users need,
- they are more different from products in other services,
- they are more innovative and less available from other sources/platforms.

Per service (and lesson), there are at least two "Recommended end-user needs to be used in the training as sample cases". This allows a choice according to the availability of sample cases and the technical availability of the service at the moment of the first training. Note: once a product has been chosen as a sample case S2 training lesson, it has to be maintained for the S3 training and the final version of the training.

Choosing the "Recommended end-user needs to be used in the training as sample cases" allows diversification of end-users typologies as trainees: authorities, forest owners & forest companies, and environmental purposes.

From D2.1, pg. 73:

> Also, group and harmonize EO products, improving the access to satellite data through a sustainable automated system, harmonization of mapping products and statistics, easy and quick access to EO and in situ forest data, and better access to remote sensing tools are transversal needs that have to be solved for all the stakeholders for a proper use of those applications.

Will this need be treated in the training?

Table 4-4. Recommended end-user needs to be used in the training as sample cases

Services	Conclusions	Products	End-users needs (from D2.1, section 6.2. END USER NEEDS)	Recommended end-user needs to be used in the training as sample cases	Main end-users typologies*
1. Forest Characterization	Forest site and stock characterization: are the main needs due to the importance of knowledge about the resource being managed, its quantity and factors affecting its production.	Forest / no forest mask Stand delineation Forest infrastructures Main forest types Forest Age Stand height Burnt scars Clear Cuts DEM, altitude, slope, and aspect	1 - Better definition of **physic characteristics of the forest areas** and **monitoring their changes**, also the **existing infrastructures** for its management and the **administrative limits** for law enforcement. 3 - Improved accuracy of **forest inventories** to know the different **species** of the stand and their **dasometric variables** for better management of biomass and wood stocks and to know the value of them for assurance purposes.	"Physic characteristics", "existing infrastructures" and "administrative limits" are mostly already available from other sources. "**Stand delineation**", "**Main forest types**", "**Forest Age**", "**Stand height**" are more changing conditions that may require more frequent updates from remote sensing.	Authorities Forest/wood companies/owners Environmental
2. Wood Characterization	Wood characterization: identified as a new market opportunity demanded by the industry.	Site index Wood density ranking Wood stiffness Strength class Stand density	2 - Better definition of the **properties of the wood** from the different species of trees for more appropriate use in the **production or industrial process**.	"**Wood density ranking**", "**wood stiffness**" and "**strength class**" are wood properties requested for timber production or industrial processes, users need about wood characterization. Use one of them as a sample case. Do not use "site index" or "stand density" because they are more related to Service 1.	Forest/wood companies/owners
3. Biomass and CO2 stocking	Forest site and stock characterization: are the main needs due to the importance of knowledge about the resource being managed, its quantity and factors affecting its production.	Site index Above ground biomass CO2 stock	3 - Improved accuracy of forest inventories to know the different species of the stand and their dasometric variables for better management of **biomass and wood stocks** and to know the **value** of them for **assurance** purposes.	As "**CO2 stock**" is more complex than "above-ground biomass", I suggest to the user the first one as a sample case. If "above ground biomass" is used as a proxy to calculate CO2 stock through allometric equations, then both products will appear in the sample case. Do not use "site index" because they are more related to Service 1.	Authorities Environmental
4. Forest Condition	Forest condition and ecosystem vulnerabilities: are key needs for establishing risk factors affecting forest continuity in the context of climate change.	Biotic damages Drought estimation Wind damages Snow damages Forest vitality Frost damages	4 - **Better definition of forest conditions** for the surveillance and development of different forests species (type of soil, nutrients, water availability, isolation) and the potential habitat for wildlife 5 - Better definition, **detection, and control of potential pests and diseases** that may endanger the forest, as well as the **evolution of invasive**	All products are "on demand", when the disturbance takes place, except Forest vitality. Maybe the lesson on this service could have 2 sample cases: 1. One sample case on selected **damage**: I would choose **biotic damage** because, even if caused by different agents, it's a common damage type across Europe, while the 4 abiotic damages are restricted to certain areas, so less appealing to a pan-European trainee	Forest/wood companies/owners

Services	Conclusions	Products	End-users needs (from D2.1, section 6.2. END USER NEEDS)	Recommended end-user needs to be used in the training as sample cases	Main end-users typologies*
			alien species and **adaptation to climate change** linked with forest management.	2. One sample case on **forest vitality**: it responds to the need "a better definition of forest conditions"	
5. Ecosystem Vulnerabilities	Forest condition and ecosystem vulnerabilities: are key needs for establishing risk factors affecting forest continuity in the context of climate change.	Watershed Delineation Stream Network Biodiversity Indicator Habitat Fragmentation Indicator Flood Risk Indicator Fire Risk Indicator Soil Erosion Risk Indicator	4 - Better definition of forest conditions for the surveillance and development of different forests species (**type of soil, nutrients, water availability, isolation**) and the **potential habitat for wildlife**	"Watershed delineation", "stream network", "flood risk indicator", "fire risk indicator" and "soil erosion risk indicator" are mostly already available from other sources. I suggest using "**Habitat Fragmentation Indicator**" or "**Biodiversity Indicator**" as products for sample case and more related to the need "potential habitat for wildlife", and are less broadly available.	Authorities Environmental
6. Environmental and Economic Accounting	Socio-economic functions: the socio-economic link to forest management is relevant for all partners to establish their viability and underscore the value of their products.	Physical land accounts Physical wood accounts Monetary wood accounts Physical supply and use of wood Monetary supply and use of wood	6 - Improve the **economic performance of forestry** work and all industries associated with the wood cycle	"Physical land accounts" and "physical wood accounts" are mostly already available from other sources, even if updated less frequently that MSF could offer. I suggest using "**Monetary wood accounts**", "**Physical supply and use of wood**", "**Monetary supply and use of wood**" are more innovative and related to the users need "economic performance of forestry".	Authorities Forest/wood companies/owners

5. BUSINESS MODEL

In this section, we started the description of the Business Model (BM). As start exercised the BM was described for the all MSF service, with four entities providers of the service (GMV, FÖRA, Madera+, and EFI). In the next deliverables Business Models can also be described for each service provider: GMV provider of service based on satellite images; FÖRA provider of service based on LiDAR; Madera+ provider of service of wood characterization and EFI provider of service of social-economical accounting. Other options will describe the BM for each service or based on a specific Value Proposition for a group of stakeholders needs (e.g. Forest Inventory, Pest control). Many Business models could be generated to stand out different aspects of the Business. A BM describes the rationale of how an organization creates, delivers, and captures values (Osterwalder et al. 2010). In this deliverable, the BM was described and synthesized based in the Canvas Model, nine basic building blocks that show the logic of how a company intends to make money. The nine blocks cover the four main areas of a business: customers, offer, infrastructure, and financial viability (Osterwalder et al. 2010). Follow the description of the BM, during the course of the project and based on product evaluation, feedback from end users and market analysis this information will be updated.

5.1. COMPANY DESCRIPTION

In this item, we present the Business the Company property (consortium) that will be responsible for the deliverable of the service/products. We also include a hypothetical Value Chain for the deliverable of the services/products between EO and Forest management.

5.1.1. BUSINESS PRESENTATION

Table 5-1. Objectives of the MSF services

Items	Description
Service objective	■ Integration of EO based information into the daily decision making, protocols, and operations of silvicultural stakeholders, end-users working environment, ICT infrastructures and operational workflows considering any needed End-User customization. ■ Integration of EO information with socio-economic data. ■ Integrating advanced EO processing with meteorological information, in-situ data and customized forestry models to conduct sustainable forestry in the context of the forest industry needs ■ Find the right combination of different data sources to fulfil End-Users needs while fostering a collaborative open space for further transnational collaborative research, experimentation, and future co-development within the forestry community. ■ Services shall combine satellite data, meteorological information (ground stations or EUMETSAT LSA-SAF) in situ forest data (volume, biomass, and carbon, wood quality) and socio-economic models

In general, an integrated value chain between EO services and Forest management could be delineated like in Figure 5-1. The Value Chain starts with the provision or sale of satellite images or service by Copernicus program (ESA), other contributing missions from ESA; Landsat (USGS) and LiDAR airborne laser scanning. The images accessed or purchased are processed in the MSF service by technological companies (GMV, FÖRA, Madera+, EFI). Entities from the forest sector, namely: Forest Owners, their organizations and forest managers in companies responsible for the forest production; forest managers responsible for the wood mill supply; public administration responsible for the regulation of the sector; insurance companies that are critical in support and share the forest risk, and the researchers in the Researches institutions responsible for the research in new solutions and development of new functionalities, are potential clients of the MSF service and products with different objectives. Forest owners and managers want to maximize production and preserve environmental and social values. The Industry wants sustainable access to raw materials all over the timing and with some quality requirements. Insurance clients want active and quality management and production that ensure an adequate risk to share with the private owners. And the research institutions want information with quality and quantity to perform their research and help the sector with innovation.

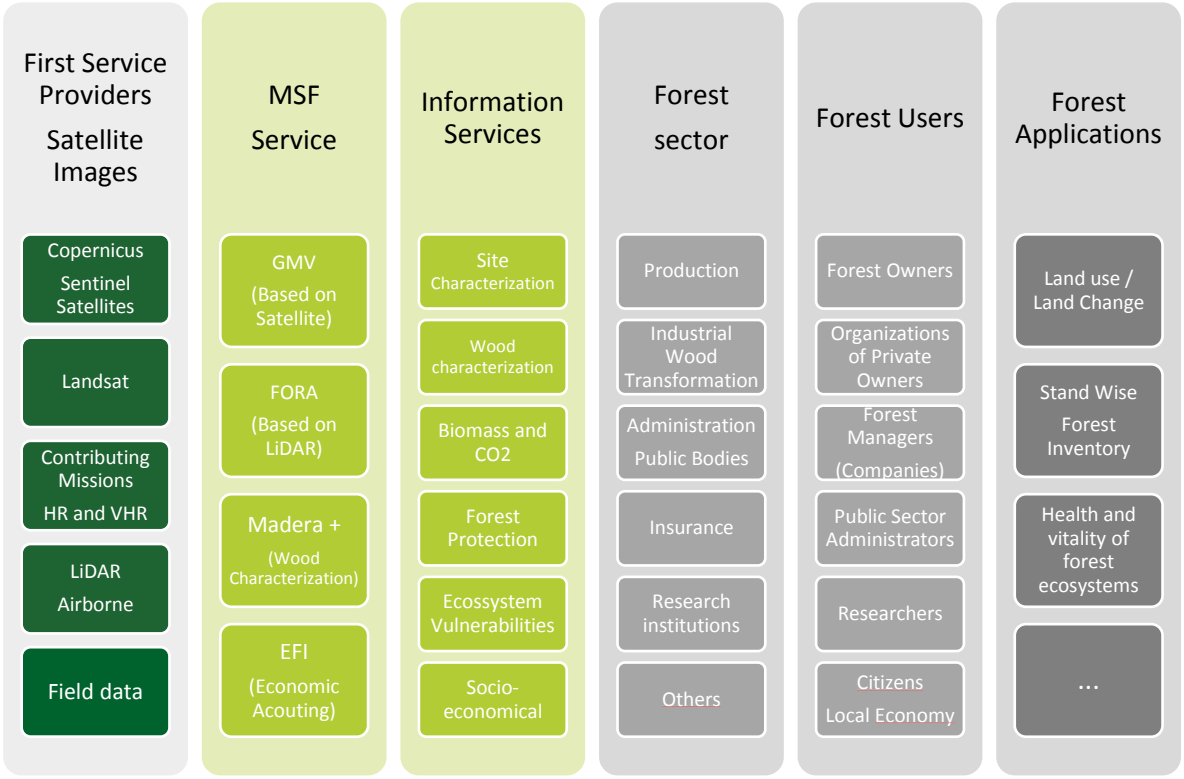


Figure 5-1. Integrated Value Chain between services based on EO and Forest management and planning.

5.1.2. COMPANY PROPERTY

Table 5-2 describes the companies' providers of the MSF services to the forest sector.

Table 5-2. Providers of the service

Providers	Description
GMV Aerospace and defence	GMV Aerospace and Defence S.A.U. (GMV) is a wholly owned subsidiary of GMV Innovating Solutions S.L. (www.gmv.com), a privately-owned, technology multinational founded in 1984 and headquartered in Madrid (Spain), with affiliates and offices around the world. GMV is present in the space industry with technologies, systems, and services in the areas of remote sensing data processing and exploitation, and the development of GNSS systems and application. GMV has actively involved in the Copernicus (former GMES) program, within European Commission framework programs, and is one of the pioneering companies in Spain in the development and implementation of the Galileo program.
FORA FOREST TECHNOLOGIES	FÖRA forest technologies (FÖRA) is an SME based in Soria and Barcelona (Spain) and founded by PhDs in forest modelling with a wide background in research and strong links with universities and research centres. FÖRA is focused on technifying the forest sector through technology transfer, forest innovation, and specialized education. The main working areas are: i) assessment of forest resources: development of forest models (growth and yield, site index, taper, etc.), innovative forest inventories using LiDAR technology, and new tools for modern forest planning and management, among others, ii) forests and global change: carbon footprints, forest carbon budgets, carbon offsets through forests, carbon consulting, etc., iii) technological innovation: sensorization in forests and industry, new tools and apps for enhanced forest management, forest visualization with drones, etc., iv) training and technological transfer: specialized forest education (forest modelling, LiDAR, statistics, carbon footprint, etc.) and technology transfer to stakeholders and partners in research projects.
MADERA PLUS Calidad Florestal	MADERA PLUS CALIDAD FORESTAL is a technology-based company that aims at achieving enhancement of forestry and local timber, commitment to innovation and quality. We characterize the quality of the wood from the tree standing and logs by end performance in the industry. We use different non-destructive technologies and silvicultural parameters. MADERA PLUS CALIDAD FORESTAL S.L. provides scientific and technical services to the forest and wood chain for better-assessing wood quality. It is an SME with Headquarters in Galicia (North West region of Spain).

Providers	Description
European Forest Institute (EFI)	The European Forest Institute (EFI) is a pan-European international organization. It has 28 Member Countries and c. 110 member organizations from 37 different countries working in diverse research fields. EFI provides forest-related knowledge around three interconnected and interdisciplinary themes: bioeconomy, resilience, and governance. With a staff of over 100 experts in several offices across Europe, EFI is in a unique position to generate, connect and share knowledge at the interface between science and policy. EFI puts increasing emphasis on cross-sectoral approaches in its research and development activities. It is thus in a good position to have efficient access to social, economic and environmental expertise covering all of Europe's bio-geographical regions. The work in the field of policy support includes enhanced support for decision makers and policy makers. For example, the high-level forum on forests, ThinkForest, brings together high-level policy makers and leading European forest scientists to generate science-policy dialogue on strategic forest-related issues. EFI is quickly becoming a leading science-policy platform providing forest-related knowledge to build a sustainable future: connecting knowledge to action. www.efi.int.

5.2. PRODUCTS AND SERVICES MARKED

In this item, we describe the products and services that will be marked under the MSF general service, the competitive advantages and disadvantages of the service, the raw materials, and the technology.

5.2.1. PRODUCT AND SERVICE DESCRIPTION

Based on the evaluation of end-user needs defined in the WP2 the providers defined six services of products for the forest sector. Products are grouped in six services based on the main provider: Service 1 (GMV) (Table 5-3), Service 2 (Madera+) (Table 5-4), Service 3 (FÖRA) (Table5-5), Service 4 (GMV) (Table5-6), Service 5 (GMV) (Table 5-7) and Service 6 (EFI) (Table 5-8). Products of the Service 1 are related to the characterization of the site. Products of the Service 2 are related to the characterization of the wood. Products of the Service 3 are related with Quantification of biomass above ground and Carbone storage. Products of Service 4 are related to the forest condition (e.g. pest and disease attack). Products of the Service 5 are related to the ecosystem vulnerabilities (e.g. soil and water protection). Finally, the products of Service 6 are related to socio-economic accounting. All the products are described in the following tables.

Table 5-3. Service 1 – Forest Site Characterization.

SERVICE 1: FOREST SITE CHARACTERIZATION	The Forest Site Characterization service provides facts on the status and condition of predefined forest components, such as forest extension, stand delineation, forest infrastructures, main forest types, stand variables (i.e: dominant height, stand age, stand density), forest disturbances (clear cuts, fire scars), topography (DEM, slope, aspect).
Product 1 - FOREST MASK	A forest mask classifies forest/non-forest land coverages. The forest mask product is the basis for other products such as forest type classification or vegetation stress monitoring.
Product 2 - STAND DELINEATION:	Stand delineation defines homogeneous forest management units on account of given criteria (dominant species, age and/or trees density). Stand delineation also highlights property boundaries and management units (stands). This product is the baseline for forest type classifications and other forestry products.
Product 3 - FOREST INFRASTRUCTURES	Forest infrastructures product describes geographically the forest cartographic features. The forest cartographic features can be point features (i.e. logging machinery / equipment, road infrastructures), linear features (i.e. forest trails, forest roads, streams, contour levels, forest boundaries, road infrastructures) and polygon features (i.e. fire scars, logging infrastructures, plot location, stand location, ownership and rights, wetlands, riparian zones, rivers).
Product 4 - MAIN FOREST TYPES:	This product provides a supervised image classification of the main forest type's found in the AOI.
Product 5 - STAND HEIGHT:	The stand height product provides the dominant tree heights for each forest management sector.
Product 6 - FOREST AGE	Forest age product is only necessary when the forest management plan does not specify the stands dominant ages. Forest age is calculated by management stand using a multi-temporal analysis of historical satellite data.

SERVICE 1: FOREST SITE CHARACTERIZATION	The Forest Site Characterization service provides facts on the status and condition of predefined forest components, such as forest extension, stand delineation, forest infrastructures, main forest types, stand variables (i.e: dominant height, stand age, stand density), forest disturbances (clear cuts, fire scars), topography (DEM, slope, aspect).
Product 7 - BURNT SCARS:	Burnt scar detection is a multi-temporal product: it starts with the production of a baseline (forest mask) which is reviewed in each iteration to detect the changes in the forest due to wildfires. Burnt scars could be executed in a stand-alone product (the identification of the burnt areas of a given date) or in a surveillance product updated in fixed temporal intervals (i.e. six months).
Product 8 - CLEAR CUTS:	The clear cuts product informs of the forest surface from which every tree has been cut down and removed. It is a multitemporal product in so far as it requires a baseline forest mask for a given initial time (T0 mask) which is reanalyzed in subsequent iterations, to detect forest changes due to logging.
Product 9 - DEM-ELEVATION:	DEM-Elevation product consists of a sampled array of elevations for a number of ground positions at regularly spaced intervals.
Product 10 - DEM-SLOPE:	The dem-slope product can be generated from DEM data from any source: LIDAR, optical images, SAR, third-party DEM. The slope product provides contains the incline of the terrain in each pixel and expressed in grades.
Product 11 - DEM-ASPECT:	The dem-aspect product can be generated from DEM data from any source: LIDAR, optical images, SAR, third-party DEM. The aspect product provides the orientation of the terrain in each pixel and expressed in grades from the geographic north.
Product 12 - SITE INDEX:	Site index is an indicator of the forest biological productivity; this indicator is a baseline for many forest management activities such as forest inventory. The site index can be obtained only if two consecutive LIDAR flights are available together with information on site index curve.

Table 5-4. Service 2 – Wood density Ranking

SERVICE 2: WOOD CHARACTERIZATION:	The Wood Characterization service consists of modelling and mapping wood fibre attributes linked to the wood product potential and performance (i.e. pulp yield, density, strength and stiffness of lumber). Data handled by the wood characterization models are: remote sensing (LIDAR) data, environmental parameters, and timber attribute field measurements. Thereafter, wood characteristics are extrapolated to larger forest areas.
Product 1 - WOOD DENSITY RANKING:	The goal of this product is to obtain the wood density at the stand level, which will be measured by extracting cores from the trees as ground truth, using satellite data, LIDAR and climatic data. A predicted value for wood density at the tree level will be calculated according to a mathematical model. Wood density is a key wood quality, most relevant for the pulp industry: when density increases, raw wood demands are lower and yields are higher. Wood density is also related to drought resistance. Wood characterization product will try to find a predicting parameter for drought susceptibility.
Product 2 - WOOD STIFFNESS:	The goal of this product is to obtain a reliable approach to the wood stiffness at the stand level. It is a good indicator of wood quality for structural uses. This is determined by the wood Modulus of Elasticity (MOE). A mathematical model predicting MOE will be built using satellite, LIDAR and climatic data.
Product 3 - STRENGTH CLASS:	Each strength class has defined by a minimum value for each factor and the limiting factor (the factor with the lower value of resistant class). The limiting factor for coniferous is always the wood stiffness, so strength class will be based on the results of MOE.
Product 4 - STAND DENSITY:	Stand density is a measure of how many trees are growing per unit area. Stand density is typically predicted with a moderate degree of precision from LIDAR cloud metrics.

Table 5-5. Service 3 – Biomass and CO2

SERVICE 3: Biomass and CO2:	The Biomass and CO2 stocking service provide estimations of the living volume of trees in a forest and its CO2 stock. These products are key for the forest biomass industry and carbon accounting.
Product 1 - ABOVE GROUND BIOMASS:	Above ground, biomass provides a measurement of the forest biomass per surface unit. Above ground, biomass can be a survey product or a multi-temporal product. Survey product consists of a single reference date calculation of the above-ground biomass. The multi-temporal product consists of the calculation of the above-ground biomass increment or decrease between two or more reference dates. Above ground biomass product can be produced from three types of EO input data: optical satellite images, SAR satellite images, and LIDAR.
Product 2 - CO2 STOCK:	CO2 stock can be a survey product or a multi-temporal product. Survey product consists of a single reference date calculation of the CO2 stock. The multi-temporal product consists of the calculation of the CO2 stock increment or decrease between two or more reference dates. CO2 stock is related to the above-ground biomass calculation. The relation between biomass and CO2 stock is established with measurements of wood carbon content

Table 5-6. Service 4 – Forest Condition

SERVICE 4: FOREST CONDITION:	The Forest Condition Service monitors and measures forest health condition, identifying stressed vegetation, due to drought, frost, plagues or any other hampering cause.
Product 1 - BIOTIC-DAMAGES:	**Biotic damages is an on-demand product. It is produced when the activation is raised because of the concurrence of a pest** or disease outbreak. The objective is detecting the forest loss due to the catastrophic event by analyzing an image just after the event and an image just before the event. The output of this product is the forest area affected by the biotic damages and an actualized forest mask after the event.
Product 2 - DROUGHT ESTIMATION:	Drought estimations is an on-demand product. It is produced when the activation is raised because of a drought event which was detected by meteorological stations. The objective is detecting the forest loss due to the catastrophic event by analyzing an image just after the event and an image just before the event. The output of this product is the forest area affected by the drought event and an actualized forest mask after the event.
Product 3 - WIND-DAMAGES:	Wind-damages is an on-demand product. It is produced when the activation is raised because a fast wind event which was detected by meteorological stations. The objective is detecting the forest loss due to the catastrophic event by analyzing an image just after the event and an image just before the event. The output of this product is the forest area affected by the wind event and an actualized forest mask after the event.
Product 4 - SNOW-DAMAGES:	Snow-damages is an on-demand product. It is produced when the activation is raised because a snow which was precipitation event detected by meteorological stations. The objective is detecting the forest loss due to the catastrophic event by analyzing an image just after the event and an image just before the event. The output of this product is the forest area affected by the snow event and an actualized forest mask after the event.
Product 5 - FOREST VITALITY	Forest vitality index is a multi-temporal product. It detects changes in the vegetation pigmentary indexes (carotenoid, anthocyanin, chlorophyll) that are related to the tree health and vitality status. The input images of this product must be acquired in the day of the year with the peak activity of the vegetation to avoid seasonal effects (leaf fall) that produce false positives or mask vitality changes.
Product 6 - FROST-DAMAGES	Frost-damages is an on-demand product. It is produced when the activation is raised because a frost event which was detected by meteorological stations. The objective is to detect the forest loss due to the catastrophic event by analyzing an image just after the event and an image just before the event. The output of this product is the forest area affected by the frost event and an actualized forest mask after the event.

Table 5-7. Service 5 – Ecosystem Vulnerabilities

SERVICE 5: ECOSYSTEM VULNERABILITIES:	The Ecosystem Service provides information on an array of ecosystem descriptors and vulnerabilities, namely: watershed extent, hydrologic network, biodiversity indicators, habitat fragmentation, floods, and soil erosion.
Product 1 - WATERSHED DELINEATION:	Watershed delineation seeks to provide a detailed map of limits between drainage basins in a given study area. These limits between drainage basins will help to estimate the flood risk in the study area.
Product 2 - STREAM NETWORK:	The stream delineation seeks a database capable of estimating the flood-prone areas along the stream banks. The stream network is most important to monitor the health condition of riparian forests.
Product 3 - BIODIVERSITY INDICATOR	Biodiversity provides a measurement of the richness of forest types or tree species in a certain study area. This measurement is the main factor to take in consideration the environmental forest management.
Product 4 - HABITAT FRAGMENTATION INDICATOR	Habitat fragmentation indicator is a categorization of the types of spatial relationships between the different, habitats, forest types or tree species. Fragmentation categories are from total isolations (patches) to total connection (interior). Fragmentation results are provided in a resume table (with fragmentation types by each forest class) and a raster to provide a spatial overview of forest fragmentation.
Product 5 - FLOOD RISK INDICATOR	The flood risk indicator is provided with a spatial dataset that delimits the extension of potential floods in the study. This risk methodology type is a deterministic approach rather than a probabilistic approach in which the risk parameter is the distribution of the total flood risk.
Product 6 - SOIL EROSION RISK INDICATOR	Soil erosion risk provides a quantification of the total soil and terrain lost per year by study pixel. Working units in this product are regular pixels because the calculation has better accuracy and continuity in raster spatial analysis because many factors came from DEM data.

Table 5-8. Service 6 – Socioeconomic functions and conditions

SERVICE 6: SOCIOECONOMIC FUNCTIONS AND CONDITIONS:	Environmental and Economic Accounting provides analytics based on the System of Environmental Economic Accounting (SEEA) proposed by United Nations; SEEA integrates economic and environmental data to provide a comprehensive view of the relationships between economy and environment.
Product 1 - PHYSICAL WOOD ACCOUNTS	Physical wood accounts will compute the differences between the opening and closing stocks of timber resources, and the additions and reductions will be discriminated. This task works on the basis of homogeneous management forest units based on forest types. Hence, the data is needed at the homogeneous forest unit level, both for the beginning and end of the period.
Product 2 - MONETARY WOOD ACCOUNTS:	This product consists of the assignment of a monetary value to productive forest items (natural available and cultivated) that were obtained in product S6 P1 Physical Wood Accounts. This task works on the basis of homogeneous management forest units based on forest types. Hence, the data is needed at the homogeneous forest unit level, both for the beginning and end of the period.
Product 3 - PHYSICAL SUPPLY AND USE OF WOOD	This product focuses on timber variations occurred during the studied period (generally 10 years. This product can be only developed for a regional or national level because of the nature of the required data. It can be applied to lower scales if the data is available at such an administrative level. Most data stems from non-EO sources. Products deliveries consist of four output tables: overall supply table, overall use table, and detailed supply and detailed use tables.
Product 4 - MONETARY SUPPLY AND USE OF WOOD	This product assigns a monetary value to the items of the product S6 P3 Physical Supply and Use of Wood.
Product 5 - LAND PHYSICAL ASSET ACCOUNT	Physical asset accounts for forest and other wooded lands (land accounts) describe the area of land and related changes over an accounting period. This product is developed for land covers derived from forest and other wooded land data obtained from satellite and LIDAR images. The reporting unit is Ha.

5.2.2. COMPETITIVE ADVANTAGES AND DISADVANTAGES

In this item, we describe the competitive advantages and disadvantages between the service/products marked and the products already available in the market (competitors).

Table 5-9. Competitive advantages and disadvantages of the MSF services

Competitive Advantages	Competitive disadvantages
✓ Some products unavailable in other services/platforms ✓ Synergy with other remote sensing data (LiDAR) ✓ Synergy with field data (e.g. meteorological stations) ✓ Synergy with models (wood quality, economic)	✓ The functionality of products by competitors is higher ✓ Technologically more advanced products are not requested by key forestry stakeholders ✓ Products may go beyond traditional forestry concepts and requirements for input date

Environmental accounting products are thought to be designed for regional/national policy-making and national accountability systems. The competitive advance of integrating EO data into environmental accounting can be appraised only once the first products will be generated.

5.2.3. RAW MATERIALS

Earth Observation data, both airborne and satellite are the key input for the pilot Service demonstrations. Also, LiDAR data are a key input for the MSF service. MySustainableForest will prioritize EU's Copernicus satellites-Sentinel's data spatial resolution; revisit and quality will enable demonstrating a high number of forest products. Nonetheless, for some specific products, the spatial, and sometimes the radiometric resolution of Sentinel data is not enough. Those products, which constitute what will be defined as a "premium" service will be demonstrated using VHR and HR satellite data, which opposite to the Sentinel data, has a cost that has to be considered in the Service price when operative.

Environmental accounting products can be based both on LIDAR and SENTINEL data. Additionally, a dataset of wood prices, management practices, and forest ownership maps are needed. These data are publicly available (e.g. census data) or available in national/regional databases.

Table 5-10. Raw materials of MSF service: products of information of different spatial programs and Airborne Laser Scanning (ALS). (To complete if relevant).

Company	EO Input Data	type	Timeline	Revisit day	resolution	Resolution (m)	Min Area (km2)	Cost (€/km2)
USGS	Landsat 4, 5, 7, 8	optical	1982 - 2019			15 - 120		0€
Planet	Rapideye	optical		5.5	High resolution	4 - 10		
Planet	Doves	optical		variable	Very High resolution	1 -4		
Astrium	SPOT 6/7	optical		1	Very High resolution	1.5	500	4.6
Astrium	Pléiades	optical		1	Very High resolution	0.5	100	17.7
Digital Globe	Worldview-2	optical		1.1				
Digital Globe	Worldview-3	optical		1				
Digital Globe	Worldview-4	optical		1		<0.5		
JAXA (Japanese)	ALOS-2	SAR		14	High resolution	4 - 30		
JAXA (Japanese)	PALSAR-2	SAR			High resolution	4 - 30		
DLR (German)	TERRASAR-X	SAR		11	Very High resolution	2 - 256		
	ALS	LiDAR						100

5.2.4. TECHNOLOGY

GMV: Described in D09_D2.2_Service Requirements and Validation of Use Cases_20180903

FÖRA: Described in D09_D2.2_Service Requirements and Validation of Use Cases_20180903

Madera+: Described in D09_D2.2_Service Requirements and Validation of Use Cases_20180903

EFI: Environmental accounting is based on the classifications, methodologies, and standards used in standard environmental accounting (UN, 2014; The World Bank, 2017) with the following references:

- The World Bank 2017. *Forest Accounting Sourcebook. Policy applications and basic compilation.* Washington, DC, pp: 37-114.
- UN 2014. *System of Environmental-Economic Accounting 2012—Central Framework*. pp: 173-198.

5.3. MARKET AND COMPETITIVE ANALYSIS

In this item, we describe the target market of the MSF services. Table 5-11 presents the main target market segments for the MSF service.

Table 5-11. Description of the target market segments.

Target Market Segments	Description
Private Owners and their organizations	Public and private forest owners. The demands of the system ultimately fall on the owners of the forests, who are the ones who have to manage the forests more and more precisely in order to respond to the needs of society.
Industry	Wood, fibre and other products industry. Ensuring a continuous and adequate supply of products of sufficient quality to the different industries requires new and more precise management techniques to ensure the sustainability of the system.
Public bodies	European Commission, state governments, local authorities, certification bodies, NGO. All these entities regulate and condition forest management by enacting laws or regulations that must be complied with, generating important needs for obtaining and managing detailed and periodic information in order to comply with their requirements.
Insurance Companies	Insurance Companies interested in Forest Insurance products. The existence of a risk-sharing mechanism that compensates the forestry producer in the event of a casualty event, making it possible to compensate for economic and financial losses, is an opportunity for the forestry sector to boost investment and forest management.
Research Institutes	Universities, research and development centres. The advancement of science for better management of renewable resources, the fight against climate change and the search for new applications for forest products generates new needs for high-precision management.
Investors	Investment funds, private investors Need actual value of forest real estates to make the decision for long term investments and monitoring

Stakeholders representing all these target market segments identify six main groups of user needs (WP2 D3 - D2.1 End-user needs):

- 1 - Better definition of physic characteristics of the forest areas and monitoring their changes, also the existing infrastructures for its management and the administrative limits for law enforcement.
- 2 - Better definition of the properties of the wood from the different species of trees for more appropriate use in the production or industrial process.
- 3 - Improved accuracy of forest inventories to know the different species of the stand and their dendrometric variables for better management of biomass and wood stocks and to know the value of them for assurance purposes.
- 4 - Better definition of forest conditions for the surveillance and development of different forests species (type of soil, nutrients, water availability, fragmentation) and the potential habitat for wildlife
- 5 - Better definition, detection and control of potential pests and diseases that may endanger the forest, as well as the evolution of invasive alien species and adaptation to climate change linked with forest management.
- 6 - Improve the economic performance of forestry work and all industries associated with the wood cycle.

In a study about the use of information technologies of forestry services and products (Dal Bosco, 2014) satellite imagery, airborne imagery and LiDAR services are already very important technologies currently in use and they are in increasingly demanding in the future (Figure 5-1).

Figure 5-2. Comparison of the importance of information services which currently help and which would help to achieve the work goals if they would be available (Fonte: Watson, Dal Bosco (2014). Use of Forest Information Technologies & Marketing of Forestry Services and Products. OpenForests, Bonn, Germany).

5.4. SECTOR ANALYSIS

In this item, we describe the channels of distribution and sales of MSF service, the key factors in sales and the main competitors already in the market.

5.4.1. DISTRIBUTION AND SALE

In a study about the use of information technologies of forestry services and products (Dal Bosco, 2014) the five main channels of distribution and sale are word of mouth, company website, networking, Conferences and social media (Figure 5-3).

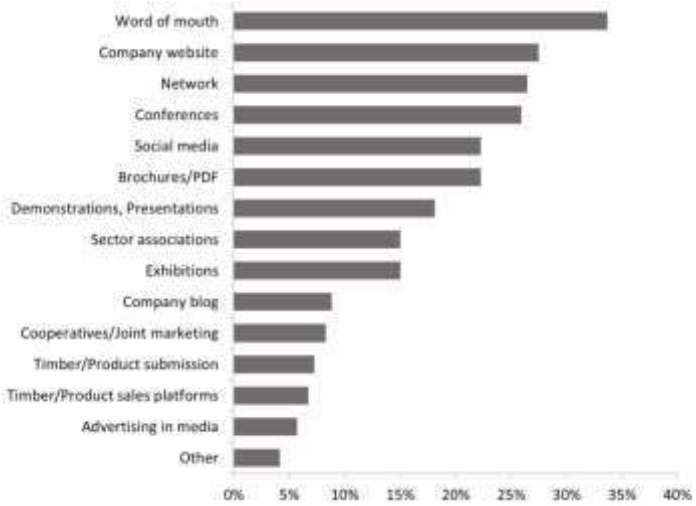


Figure 5-3. Importance of promotion opportunities for services and products (Fonte: Watson, Dal Bosco (2014). Use of Forest Information Technologies & Marketing of Forestry Services and Products. open forests, Bonn, Germany).

5.4.2. KEY FACTORS IN SALES

Table 5-12 presents some product acquisition criteria. The lowest price under required technical conditions are met is the first of these criteria. The technical requirements include among others the quality of the product, the accessibility, and support on using it.

Table 5-12. Product acquisition criteria.

Key factors in sales	Description
Price	Lowest price under required technical conditions are met
Quality	The quality of the service/product (accuracy, precision, suitable product)
Accessibility	Easy to use, integrated into the operational work environment
Customer Support	Training and Demonstration - Suitable to the end users
Frequency	Up-to-date data

5.4.3. COMPETITORS

Table 5-13 describe the main competitors of MSF service so far identify in the market. The competitor could be divided into direct or indirect respectively if the product is developed for general use or specially applied to Forest management. The study of competitors, however preliminary, reveals the good positioning of MySustainableForest Portfolio and Platform. Some critical products for forest management aren't available in these platforms or aren't available in a format easily usable by the forest end-user. During the course of the project and based on product evaluation and feedback from end users this information will be updated

Table 5-13. Description of the potential competitors.

Competitor	Description	Direct	Indirect
Sentinel Hub	Sinergise is a software development company focused on large-scale GIS for agriculture and land administration, with a long track record in cloud GIS. Sentinel Hub is a service that hides the complexity of archiving, processing and distributing satellite imagery behind a set of standard web services which can be easily integrated into any desktop, web or mobile mapping application. Get satellite data through a web application or within the GIS. Unique features of Sentinel Hub: global coverage; efficient access to imagery at any scale; preconfigured EO products; multi-temporal processing; custom scripting		X
Forest TEP	Forestry Thematic Exploitation Platform (Forestry TEP) enables commercial, governmental and research users in the forestry sector globally to efficiently access satellite data based processing services and tools for generating value-added forest information products. Via the platform, the users can also create and share their own processing services, tools, and generated products.	X	
Terramonitor	Terramonitor is a Finnish company whose mission is to make space data reachable for anyone, anywhere and anytime. Is the world's first unified and up-to-date, global, enriched map produced by artificial intelligence. Terramonitor can be integrated into existing map services. The service contains over 100 million streaming images that update automatically every day. They can always provide customers with an up-to-date view of the globe. With this service, businesses and organizations can take advantage of spatial data in their browser or by integrating Terramonitor to their own systems. The goal is to help companies and individuals make better decisions.	X	
Others	https://giovanni.gsfc.nasa.gov/giovanni/ http://landcover.org/research/portal/gfcc/index.shtml (está em reconstrução mas podes aceder a alguma informação) https://www.globalforestwatch.org/		

5.5. STRATEGIC ANALYSIS

In this item, we characterize the internal strengths, the weakness and external opportunities and threats of the general MSF service based on SWOT analysis.

My Sustainable Forest Services

	POSITIVE	NEGATIVE
INTERNAL	**Strengths** ✓ Companies with expertise and experience in technology critical to the service (e.g. satellite and LiDAR data) ✓ Integration of different solutions of information and technology into the forest value chain (smart integration into the end-users working environment) ✓ Innovative service: combines socio-economic models, with EO and weather information ✓ Robust applicable background – gmv eoforest technology ✓ Deliverable conventional forest products that are perceived and integrated into the silvicultural workflow	**Weaknesses** ✓ Lack of capacity to respond to a huge demand of end-users ✓ Uncertainty in the development of algorithms to provide the specific services and products that end-user needs. ✓ Proposed technological innovation not matching End-Users demands or expectations. ✓ Performance results from validation results do not allow operational savings that justify service fee. ✓ Limited awareness of actual end-user needs. ✓ The strong dependence of forest governance on command and control thus leading to stagnant legislation and expert opinion of established stakeholders. (e.g. could be against the innovations including remote sensing).
EXTERNAL	**Opportunities** ✓ Lack of information from private forest owners. Information is needed but not available ✓ Lack of updated and sufficiently accurate data from forest inventories suitable for SFM ✓ The growing importance of climate change related impacts ✓ Available satellite data: Copernicus and other contribute missions ✓ Help fulfil forest regulatory issues ✓ The support EU strategy for forests ✓ Monitoring on real-time all forest changes ✓ Thematic interactive maps for all citizens to know about the forest importance ✓ No strong competitors in the area at the moment	**Threats** ✓ Technology stage not enough to characterize the sites at stand or tree level ✓ Resistance to change - traditional use of high-quality aerial images (processed manually by qualified personnel) ✓ Willingness to pay (what criteria: Cost, quality, operationalization, easy to use?) ✓ Competitors with products with a similar or better value to the end-user ✓ Small and fragmented customer bases. ✓ Lack of forest management (with economic viability) ✓ A huge amount of users accessing the platform ✓ Availability of VHR EO imagery: impossible generate the product

Figure 5-4. SWOT Analysis for the MSF Services

5.6. SALES STRATEGY

In this section, we describe the communication channels for the promotion of the MSF service, the pricing strategy, and sales forecasting.

5.6.1. PROMOTION AND POSITIONING

MySustainableForest will produce a range of different communication products and will organize several communication activities aiming to bring project information and results to the target groups (WP6, D04- D6.1 Outreach and Dissemination Plan). Table 5-14 describe the main communication channels for products and services.

Table 5-14. Description of communication channels for products and services.

Communication Channels, products and activities	Description
WEB SITE	www.mysustainableforest.com is the place to find all the public information produced by the consortium: news, press releases, general information, newsletters, brochures, policy briefs, stakeholder workshops, and any other activities/events.
SOCIAL MEDIA	In order to support the rest of communication actions, it will engage with its target audiences through LinkedIn and Twitter. It will encourage the project partners and other stakeholders to make use of suggested hashtags linked to the project activity.
NEWSLETTER	It will be produced a newsletter twice a year, that include updates on project activities and will promote any upcoming ones. The newsletter will mainly include the last news items and events published on the website.
PARTNER NETWORKS	Project partners will actively contribute to the communication of the project using their usual tools. GMV and EFI are the partners with wider networks and together have more than 26 000 followers on social media.
MEDIA LISTS	Consortium partners will be briefed on how to interact with their local media, as well as with the promotion of stakeholder workshops and study cases.
TEMPLATES	Templates for documents, presentations, posters and any other communication needs from the project partners will be produced and distributed by WP6.
BROCHURE	A generic brochure will include general and introductory information for broad distribution to wide potential audiences.
VIDEOS	Short videos with testimonials will be produced taking advantage of the stakeholder workshops and any other relevant activities taking place during the project's lifespan.
PUBLICATIONS	MySustainableForest will produce between 15 and 30 publications.
POLICY BRIEF	A policy brief will be a synthesis of policy recommendations at the EU and national scales on improved sustainable forest management using EO services.
STAKEHOLDER WORKSHOPS	A minimum of four stakeholder workshops will be conducted through the project's lifespan with different aims according to the project progress and the status of the service.

5.6.2. PRICING STRATEGY

In general, the initial objective will be to attract customers, as such one of the immediate advantages that the EO platform can assure will be the reduction of prices with an innovative system. One strategy will be the quantity discount, the larger the number of customers, the lower the price of the product. The entire process, from the collection of the basic information, to the availability of the services/products, must be optimized in order to confer a competitive advantage to the company, allowing competing with any competitors that are already deployed but with less adequate technology and services to the user.

In this first deliverable of a series of three, we focus the analysis in two end-user needs examples described in section 3 (Forest Inventory and Pest Control) and in a preliminary analysis of the main competitors of the MSF service.

Among the main competitors (Table 5-15) analyzed only two products could be currently competitive with the MSF service/products, namely: deforestation and land use land cover (LULC). The "deforestation" competes with the MSF product "clear-cut" and the LULC compete with the following products: Forest mask, Main Forest Types, among others. Products like Drought estimation and Forest Vitality are not currently available in the competitors market analyzed so far.

Table 5-15. Preliminary analysis of main competitors. Competitor, product description and price per month

Competitor	Product Description	Price
Sentinel Hub	✓ Deforestation /clear-cuts ✓ Land Use land cover	500 €/month
Forest TEP	✓ Deforestation /clear-cuts ✓ Land Use land cover	NA
Terramonitor	✓ Deforestation /clear-cuts ✓ Land Use land cover	499 €/month
Others		

Table 5-16 presents the economic evaluation of alternatives to get equivalent information that could be providing by MSF service. Follow we describe the economic evaluation for the RAIZ3 example of Pest control.

Example Pest Control (RAIZ): The forest manager current doesn't have an expedited way and low-cost methodology to monitor forest pest attack. Frequently he detected the problem in an advanced stage and applies immediately a plan of action based on very few information about the real situation. To get equivalent information that could be acquired from satellite data he has to alternatives: (1) hire specialized human resource in pest and disease monitoring; (2) Hire a specialized service to collect data with UAV. Considering that the forest manager has 20 000 hectares to monitor each year it's possible to estimate a cost of 465 000 €/year in the first alternative and 100 000 €/year in the second alternative. These values are impossible to support in the general forest management plan. Although, at the moment we don't know if the competitors have a service or product that fulfil this specific need of the forest manager, the price of their service it's current about 6000 €/year, so the willingness to pay of a forest manager will be less than this market value, and for a package of information.

Table 5-16. Evaluation of alternatives to get equivalent information that could be provided by MSF service.

Parameter	Service	Method (example)	Price (€ / year)
Pest Control The area with symptoms (defoliation, discolouration)	Alternative 1: MSF Forest Protection (S4) Drought estimation (P2) Forest Vitality (P5)	Monitoring annually affected Area (20000 ha)	??
	Alternative 2: Hire a specialized human resource in pest and disease monitoring	Annually affected Area (20000 ha) One field work monitor 5 ha per day, with expenses of stay nearby and travel to the forest stands	e.g. 465 000 € / year
	Alternative 3: Hire a specialized service to collect data with UAV	Flight and processing data 1250 € / 250 ha	e.g. 100 000 €/ year
Forest Inventory LULC and forest parameters	Alternative 1: MSF Site Characterization and Biomass and CO2 Forest Mask (Service 1, Product 1) Forest Main Types (Service 1, Product 4) Stand Height (S1, Product 5) Forest Age (S1, Product 6) Above Ground Biomass (S3, P1) CO2 Stock (S3, P2)	Annual updating of products	??
	Alternative 2: Photo-interpretation and stand-wise forest	An annual number of forest management plans for private forest owners in Lithuania is about 3000. The minimum area which requires a forest management plan is 3ha.	e. g 10€/ ha/ year in Lithuania assuming that total area is above 100 000 ha
	Alternative 3: *Airborne Laser Scanning* (ALS)	e.g. Flight and processing data 1 € / ha	e.g. more than 100 000 € /year

Parameter	Service	Method (example)	Price (€ / year)
Wood characterization	Alternative 1: Hire a specialized human resource wood traits characterization Alternative 2: MSF wood characterization Wood density product Strength class products	One field monitor 2-3 stand (<1ha) per day with expenses of stay nearby and travel to the forest stands	e.g 500-750 €/ stand 20-50 €/ stand

In the next deliverable of this series, with more data available, a Cost-benefit analysis should be performed by each specific forest problem to address. It was expected that Forest owner's benefits from having better information (in quality and quantity) to support their decisions (e.g. management to improve productivity).

Reference to the work (running): Evaluation of very high-resolution remote sensing technologies in delivering information to Forest Management Planning of Eucalyptus stands in Portugal

Context: Forest managers frequently plan their activities based on little data and information at stand and tree levels. Products of information with high and very high resolution from EO, combined with data from other remote sensing technologies and field data, could help the forest manager to improve their tactical and operational management planning. But, different combinations of data collecting systems could provide data with a different value and more information has a cost and it is difficult for the forest manager to perceive and quantify the benefits in their decision process. Aims: We aim to define what system or combination of sources of information increases the value of forest information and better fulfil the needs of information to support decisions in forest management planning. Methods: Different alternatives for accessing and integrating Eucalyptus stands data in Portugal will be explored. The following data sources shall be considered in the analysis: conventional field methods, data collected with UAV's and data produced and available within the MySustainableForest Project (satellite and LiDAR data). Data and information will be used to support specific and relevant forest problems like control pests and estimate forest yield in Eucalyptus stands. The alternatives will be evaluated on their accuracy and precision, operational utility and efficiency and economic value. The alternatives will be evaluated using the Multi-criteria analysis. We will consider the users and their knowledge in each context, something very relevant in the processes of decision making. Expected Results: Demonstrate and quantify the benefits for the forest manager of use of products based on EO combined with field data and collected with other remote sensing technologies to support forest management planning.

Also would be evaluating the positive externalities (e.g. simultaneous monitoring of other species and other events in the field, reduce the ecological footprint by the reduction of a number of trips to the property with diesel car).

5.6.3. SALES FORECASTING

Information not available yet: Estimating future sales (Sales Forecasting).

5.7. ORGANIZATIONAL STRUCTURE

Information is not available yet: Management Team; Human Resources.

5.8. FINANCIAL PLAN

Information not available yet: the need for funding; Loss / Revenue Forecast (Income Statement); Break Even Analysis; Cash flow evolution forecast (Map of Operational Cash Flows); Indicators for investment assessment; financial projections (two years):

Table 5-17. Description of direct cost and revenue

Description of direct cost	Value (€)	Description of revenue	Value (€)
Image cost (VHR images)		Clients / year	
Use of platform CREODIAS		Price/service or product	
Cloud		Price / customization	
HR (Maintenance, Customization…)			

Marketing and publicity			

5.9. SYNTHESIS OF THE GENERAL BUSINESS MODEL OF MSF SERVICES

Follow we present a synthetizes of the Business Model using the Canvas Model described in (Osterwalder et al. 2010).

Table 5-18 Business Model Synthetizes (Canvas Model)

<table>
<tr><th colspan="5">BRAND EXPERIENCE</th></tr>
<tr><th colspan="2">INFRASTRUCTURES</th><th>OFFER</th><th colspan="2">CUSTOMER</th></tr>
<tr><th>PARTNER NETWORK</th><th>KEY ACTIVITIES</th><th>VALUE PROPOSITION</th><th>CUSTOMER RELATIONSHIP</th><th>CUSTOMER SEGMENTS</th></tr>
<tr>
<td rowspan="2">Key partners:
GMV, FORA, Madera+, EFI
Key suppliers:
ESA (Copernicus, contributing missions)
Airborne LiDAR data
Satellite images
Key resources acquiring from partners:
Models: process satellite and LiDAR data, wood density and socio-economic models
Key activities do partners perform:
Services
Motivations for partnerships:
Optimization and economy
Reduction of risk and uncertainty
Acquisition of particular resources and activities</td>
<td>Distribution channels:
EO Merlin Platform
Key activities do our value propositions require:
Production
Platform</td>
<td rowspan="2">Value delivered to the customer:
Cost reduction
Accessibility
Usability
Newness
Performance
Customization
Risk reduction
Customer’s problems helping to solve:
Information up-to-date, effective cost and precise to improve support decision on forest management and planning
Customer needs satisfying:
Information needs
Bundles of products and services offering to each customer segment:
Forest Site Characterization
Wood Characterization
Biomass And Co2 Stocking
Forest Condition
Ecosystem Vulnerabilities
Socioeconomic Functions And Conditions</td>
<td>Type of relationship does each of our customer segments expect us to establish and maintain with them:
Automated Services
Personal assistance</td>
<td rowspan="2">Creating value for whom:
Segmented market
Private Owners and their organizations
Industry
Forest public administration
Insurance Companies
Research institutions
Most important customers:
Forest Managers</td>
</tr>
<tr>
<td>KEY RESOURCES
Physical
Financial
Intellectual
Human</td>
<td>DISTRIBUTION CHANNELS
Website
Social Media
Newsletter
Partner Networks
Media Lists
Templates
Brochure
Videos
Publications
Policy Brief
Stakeholder Workshops</td>
</tr>
<tr><th colspan="3">COST STRUCTURE</th><th colspan="2">REVENUE STREAMS</th></tr>
<tr>
<td colspan="3">Image cost (VHR images)
Use of platform CREO DIAS
Cloud
Human Resources (Development, Maintenance, Customization)
Marketing and Publicity</td>
<td colspan="2">Value our customer's segment really willing to pay?
For services and products
To customize services
Ways to generate revenue streams: Subscription fees
Pricing Mechanisms: Fixed Menu Pricing</td>
</tr>
</table>

5.10. BUSINESS MODEL EVALUATION

Regularly assessing a Business Model (BM) is an important management activity that allows evaluates the health of the position of the organization in the market and adapt accordingly. In scientific research, some frameworks for Business Model evaluation (BME) are proposed (Kayaoglu 2013). In this deliverable, we propose evaluating BM combining SWOT analysis and Business Model Canvas (BMC) (Osterwalder et al. 2010). Simplicity is an advantage of this method. The method consists of asking questions for each building block of the Business Model Canvas (BMC) and give quantitative values from +5 to -5 to the individual strength and weakness points. Also, quantify their importance to the BM and the certainty of evaluation between 1 to 10. But it is not explicit how this should be done.

We present in Table 5-19 an example of the application of this method for the Building block "Value Proposition" of the MSF service BMC proposed above (Table 5-18).

Table 5-19. MSF Business Model Evaluation (BME) – Method using SWOT analysis and Business Model Canvas to the Building Block Value Proposition

Value Proposition Assessment

		Strengths +		**Weakness** –	
Importance to the BM 10	Our Value Propositions are well aligned with customer needs.	**5** 4 3 2 1	**1** 2 3 4 5	Our Value Propositions and customer needs are misaligned	The certainty of evaluation 8
	Our Value Proposition have strong network effects	**5** 4 3 2 1	**1** 2 3 4 5	Our Value Propositions have no network effects	
	There are strong synergies between our products and services	**5** 4 3 2 1	**1** 2 3 4 5	There are no synergies between our products and services	
	Our customers are very satisfied	**5** 4 3 2 1	**1** 2 3 4 5	We have frequent complaints	

Value Proposition Threats	–	**Value Proposition Opportunities**	+
Are substitute products and services available?	1 **2** 3 4 5	Could we generate recurring revenues by converting products into services?	1 2 3 4 **5**
Are competitors threating to offer better price or value?	1 **2** 3 4 5	Could we better integrate our products or services?	1 2 3 4 **5**
		Are additional customer needs could we satisfy?	1 2 3 4 **5**
		Are possible complements to or extensions of our Value Proposition?	1 2 3 4 **5**
		Could we do other jobs on behalf of customers?	1 2 3 4 **5**

The Value Proposition (VP) is the building block of the BM Canvas where the products and services that create value for a specific customer segment is described. In the MSF service, the VP is well aligned with customer needs because delivered conventional forest products that are perceived and integrated into the silvicultural workflow. The VP has a strong network effect in that stakeholder satisfied with the products will propagate the use of them to other stakeholders in the forest sector. Some products or combination of products due to their importance to Forest management could generate more services, as for example, DEM and Biomass Above Ground among others could potentially generate a specific service to fire prevention, or LiDAR and optical satellite data products could be combined to better characterize levels of forest defoliation associated with pest attack. This synergy could generate recurring revenues. Simple and critical products based on EO and LiDAR data could incredibly improve forest management and leave the customers very satisfied. At the moment there isn't available products and services that could substitute the MSF service in price and value.

6. END-USERS CRITICAL ASSESSMENT OF MSF PRODUCTS

In this section, we compile and analyse the end-users critical assessment of the MSF products delivered by the provider partners to the end-user partners. The sources of information are the validation of product and services performed by the end-users partners; the operational feedback given by the stakeholders after each demonstration and training session and the evaluation of the Business Model. The criteria for evaluation are operational and financial. In operational criteria, we considered the quality (precision and accuracy), the utility and effectiveness of the MSF products. In financial criteria, we usually considered final price and cost opportunity. The price depends on what the forest manager is willing to pay. However, he needs to consider his opportunity cost. As an example in pest control, more up-to-date information could help to act faster to prevent future economic losses.

6.1. OPERATIONAL CRITERIA

End-users partners validate the products with data collected in each AOIs and give feedback about the level of accuracy and precision of the products. Products with levels of accuracy upper than 80% will be used in the demonstration and training program. An Online Quest will be prepared and end-users are invited to answer some questions about the MSF Service and products integrated into their work environment. The questions need to considerate at least the collecting of the following information:

- Characterization of the end-user: type: private owner, forest manager, managed area, etc; age-class; country; industry, production; organization.
- Characterization of the MSF service and products delivered to the end-users.

Examples of Questions: this information is useful for your activity; the information is easy to access in the platform? The information is available? Also so include some financial criteria in this quest like What is the willingness to pay for this service of information (answer in a class of value)?

It should be used a simple and expedite way of answers the questions, i.e. using a score of stars from 1 to 5. Additional end-users could give a final comment or recommendations about the products.

Table 6-1 synthesizes the validation of the MSF products available to RAIZ in the early stage and related to the Forest Inventory.

Table 6-1 Synthesis of validation of the products available in the early stage (only for RAIZ).

User Type	Name	Service/Product	Synthesis of Evaluation	Recomendations
Partner	RAIZ3	Forest Site Characterization: Forest Mask Main Forest Types	**Evaluate Quality**: The validation of two MSF's products, Forest Mask and Main Forest Types, was carried out in the study area Site 3. For this purpose, there were taken 528 field samples. After fieldwork, accuracy assessment was conducted through a confusion matrix. Results showed an accuracy of 62% for Forest Mask product and 25% for the Main Forest Type product. In remote sensing, it is usually accepted the accuracy of 80% as the minimum value for considering the classification was successful. Since obtained accuracy percentages were below this threshold, it must be considered Forest Mask and, especially, Main Forest Types products classification was not correctly conducted and, therefore, an improvement in the classification process should be explored.	Improve *Quercus spp.* classification. In general, there was an overall confusion between *Pinus spp*. and *Quercus spp*. categories, as many areas occupied by cork oak were classified as a pine forest. Change *Fraxinus spp*. category to Generic Broadleaves category. In general, areas occupied by this category represent riparian forests where, besides ashes, many broadleaves such as Salix spp., *Populus spp.* or *Arbutus unedo* species are present
	RAIZ3	Forest Characterization: Stand Heigh DEM	**Evaluate Quality:** These products are derived from ALS data (2 pts/m^2). Stand Height with high accuracy. DEM with a resolution of 1 meter with high accuracy.	

Table 6-2 and Table 6-3 present the model that will be used to collect the feedback of end-users about the MSF products (in this deliverable only for two end-user needs: Forest Inventory and Pest Control and RAIZ stakeholders).

Table 6-2. Syntheses of product evaluation of MSF products for Forest Inventory – in the early stage

Requirement	Criteria	Parameter	Products available	Status	Score 1-10
Forest Inventory	Quality	Product Precision and Accuracy Product Documentation/metadata Correct thematic nomenclature Product timeliness Data readability (cartographic elements) Interoperability	S1 P1 Forest Mask	Improve	5
			S1 P4 Main Forest Types	Improve	3
			S1 P5 Stand height	Final	10
			S1 P6 Forest age	NA	
			S3 P1 A G Biomass	NA	
			S3 P2 CO2 Stock	NA	
	Utility (it is useful?)	The use of the product is clearly identified in the end user's silviculture workflow The product is easy integration of into end-user data sets (shapefile, kml) Easy of use/user-friendly	S1 P1 Forest Mask	Improve	5
			S1 P4 Main Forest Types	Improve	5
			S1 P5 Stand height	Final	10
			S1 P6 Forest age	Improve	5
			S3 P1 A G Biomass	NA	
			S3 P2 CO2 Stock	NA	
	Effectiveness (achieves the objectives?)	Increase the temporal resolution? Increase spatial resolution? Increase precision and accuracy?	S1 P1 Forest Mask	Improve	5
			S1 P4 Main Forest Types	Improve	5
			S1 P5 Stand height	Final	10
			S1 P6 Forest age	Improve	
			S3 P1 A G Biomass	NA	
			S3 P2 CO2 Stock	NA	
	Early stage: Corrective Actions, improvements, suggestion:				
	A similar product in the past • User-friendly • Low updating • Low accuracy		**MSF products (in early stage)** • Not user-friendly; Not easy access; Difficulties to find specific dates of satellite images. • Incomplete layer legend information. Metadata is not available yet • Partial accuracy of products; Improvements of algorithms process due to the short-term rotation of eucalyptus forest. • Incomplete layer legend information; Not possibility to access to RAW files; Nomenclature is not available yet.		

Table 6-3. Syntheses of product evaluation of MSF products for Pest Control – in the early stage

Requirement	Criteria	Parameter	Products available	Status	Score 1-10
Pest Control	Quality	Product Precision and Accuracy Product Documentation/metadata Correct thematic nomenclature Product timeliness Data readability (cartographic elements) Interoperability	S4 P1 Biotic Damages	NA	
			S4 P2 Drought Estimation	NA	
			S4 P5 Forest Vitality	NA	
	Utility (it is useful?)	The use of the product is clearly identified in the end user's silviculture workflow The product is easy integration of into end-user data sets (shapefile, kml) Easy of use/user-friendly	S4 P1 Biotic Damages	NA	
			S4 P2 Drought Estimation	NA	
			S4 P5 Forest Vitality	NA	
		Increase the temporal resolution? Increase spatial resolution? Increase precision and accuracy?	S4 P1 Biotic Damages	NA	
			S4 P2 Drought Estimation	NA	
			S4 P5 Forest Vitality	NA	

Requirement	Criteria	Parameter	Products available	Status	Score 1-10
	Early stage: Corrective Actions, improvements, suggestion:				
	A similar product in the past (NA)	**MSF products (NA)**			

6.2. FINANCIAL CRITERIA

Although in section 5 of this document, we already started the definition of pricing strategy, namely by evaluating alternatives to get equivalent information that could be provided by MSF service and analysing MSF service competitors prices, a deeper analyse must be performed to accomplish the opportunity cost of MSF service to forest management and planning.

In the next deliverable of this series, we intend to demonstrate the costs and benefits of using the MSF platform solution compared to the traditional methodologies for monitoring and managing forest. The economic value of the use of the MSF will be determined concerns the expected value of the information to make better decisions. In addition to the economic value, could be considering the value of other benefits (operational, social and environmental) and costs.

6.3. FEEDBACK FOR NEXT CYCLE - ENHANCED SERVICE

General feedback/recommendations:

1. Improve and speed up the development and deliverable of MSF products
2. Start the development and deliverable of VHR MSF products
3. To strength technical-operational collaboration between employees working on the development of products (providers) and those responsible for the validation and evaluation of products (end users)

Work plan to the next deliverables of this series:

1. Improve validation and evaluation of MSF products; the Training Program and the Business Model.
2. Improve the cost-benefit analysis of MSF products to the end-users

END OF DOCUMENT

My Sustainable Forest

Earth observation services for silviculture

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