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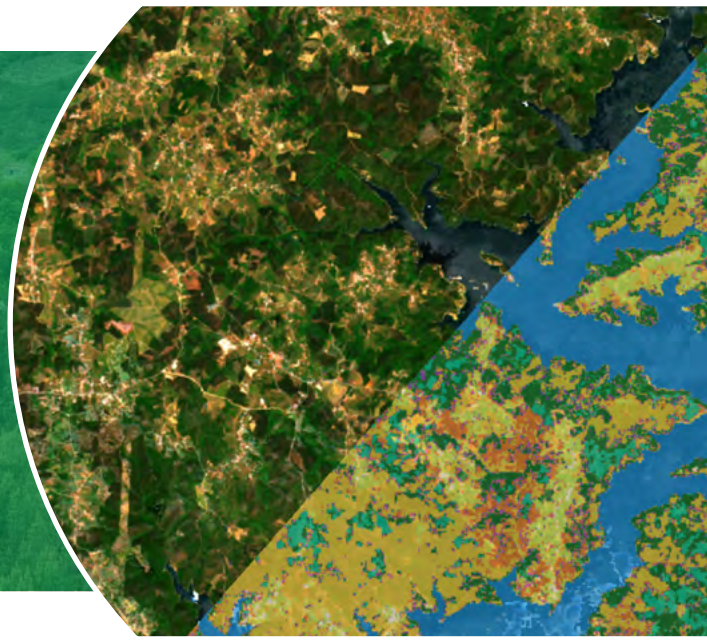
FOREST MONITORING IN PORTUGAL

Copernicus Sentinel data and AI are being used to provide continuous forest inventories in Portugal, identify land use (changes) as well as check upon the health status of trees in support of forest managers and the pulp & paper industry.



THE CHALLENGE

You may not be aware, but the pulp and paper industry has a very high importance to the Portuguese economy! The main players of the processing industry directly manage around 200,000 ha of (mainly eucalyptus) forests and tree plantations in Portugal, covering c. 20% of the industry's demand for wood – the basis for the huge pulp and paper production facilities. The remaining is coming from both the domestic market including small-scale forest owners (55%) and imports (25%). As the tree plantations are dispersed all over the country, it is expensive and time-consuming to monitor their lifecycle growth. On top of that, in recent years, Portugal has been home to an increasing number of wildfires that, additionally to their dramatic human cost, are presenting a risk to plantations and to the constant supply of raw materials for the pulp and paper mills. Regulations imposed by the government on some of the production forests, namely eucalyptus, demand new tools and more information to manage the forest actively and sustainably.

In this context, CELPA, the Portuguese pulp and paper industry association, and its member companies have started a collaboration with Tesselo. This Lisbon-based European start-up delivers continuous forest inventories powered by AI, allowing to monitor tree health status, identify land use and land use changes all over the country to monitor forest dynamics and understand more effectively market gaps and import needs. As such, the service is provided to CELPA as well as to its various members, most of which are leaders of the global pulp and paper market and make up 90% of the Portuguese paper industry. In times of the Covid pandemic and associated counter-measures that came along with it especially, the solution provided by Tesselo helped users "keep a holistic eye" on the plantations throughout the country, monitor tree growth and understand where wildfires might have ravaged trees, necessitating further action.

More information on
www.earsc.org/sebs

HOW SATELLITES CAN HELP

Forest management and inventory is, traditionally, an extremely demanding work for forest managers, necessitating frequent field inspections and/or aerial surveys of the plantations on a regular basis to keep information updated. Because of its extensive workload and associated cost, the Portuguese National Forest Inventory for instance is only updated every 5 years. By contrast, **optical satellite imagery**, acquired in this case from Sentinel-2, **coupled with AI models**, provides extremely useful information about land use (changes) and status of the tree plantations over the whole of Portugal on a weekly basis.

In light of these benefits, Sentinel-2 data was chosen to form the backbone of the service provided by Tesselo. Being able to access a great database of historical in-situ measurements provided by CELPA and the individual member companies, Tesselo was in the position to draw from excellent training and verification data i.e. field data and develop AIbased algorithms that are able to process the vast amount of EO data and determine tree health, land use and land cover, environmental threats and many more features that ultimately deliver the actionable insights to the users that make the solution so powerful. The diversity and geographical spread of CELPA members was invaluable to build high-quality samples to train and test models. In addition, the close collaboration led to a better understanding of market needs and finer calibration of the Tesselo services and in turn impacted on their strategic R&D planning.

The application itself is accessible through an automated web platform – through API and WMTS – while reports are provided to CELPA and its member companies on a monthly basis. Whilst R&D is continuing in close cooperation with CELPA and further features will be added in the near future, the Sentinel-based application currently provides the following information features for end users:

- Classification of (national) land use: classification of the whole country land into customizable classes (agriculture, forest, shrubs etc.) and monitoring of change over time
- Identification of tree species (eucalyptus, cork oak, holm oak and 3 categories of pines)[1]
- Tree characterisation: age (and soon timber volume)
- Life cycle monitoring: continuous detection and measurement of new plantations, harvested areas & burnt areas to optimize forest management operations
- Tree health: flagging of health anomalies by monitoring of leaf moisture, leaf area index and chlorophyl level

1. Through previous projects, Tesselo is also skilled in detecting and monitoring other vegetation/crop/tree species including pepper fields (in Brazil), mangrove (in Madagascar), Almond trees (in Costa Rica), sugar cane (in India), sandalwood (in Australia).

The satellite data:

Sentinel-2 carries an innovative wide swath highresolution multispectral imager with 13 spectral bands. The combination of high resolution, novel spectral capabilities, a swath width of 290 km and frequent revisit times provides unprecedented views of Earth. Sentinel-2 images can be used to determine various plant indices such as leaf area, chlorophyll and water content, providing information useful for agricultural and forestry practices and for helping manage food security. Sentinel-2 also provides information on pollution in lakes and coastal waters.

Images of floods, volcanic eruptions and landslides contribute to disaster mapping and help humanitarian relief efforts.

Copernicus Sentinels data are available under an open and free data policy.

Sentinel-1 data can be accessed at https://scihub.copernicus.eu

More info: https://sentinels.copernicus.eu

Certainly, one of the main advantages of using the Sentinel satellites is its frequent global coverage and thus the provision of fresh data and updated insights over the Portuguese tree plantations every 5 days; a frequency that could never be achieved with other remote sensing methods, let alone field visits, at this low cost per hectare and with this regularity. The ability to have easily accessible frequent and synoptic views over the plantations is a great advantage that provides timely and full information matching the specific needs of CELPA and its members. CELPA in itself is interested in rather large-scale market developments in Portugal in support of its market analyses while individual member companies are seeking timely and efficient information at parcel level. Furthermore, thanks to satellite data archives (Sentinel-2 goes back to 2015, but can be complemented with Landsat data going back decades), companies can look up historical information of the tree plantations. Since the majority of Portugal`s tree plantations are non-industrial privately owned, historical knowledge and experience may be lacking. Historical satellite data can shed light on which potential areas can provide the biggest timber volumes and thus return of investment. Moreover, using satellite data is a non-intrusive method of retrieving information i.e. in-situ data and field inspections are not permanently necessary, while seasonal and long-term trends can be monitored.

With relation to the health status of trees and pest prevention, satellite data is able to provide insights days before the forest manager would have observed any stress or disease. Because Sentinel-2 sensors cover a wider electromagnetic spectrum than the human eye, with the help of AI, Tesselo can uncover more details and information about tree health than otherwise possible. As a result, forest managers are able to step in days in advance and focus on plantations where their care is most needed. The temporal resolution, i.e. frequency of fresh imagery, is sufficient to monitor changes and take appropriate measures in a timely manner.

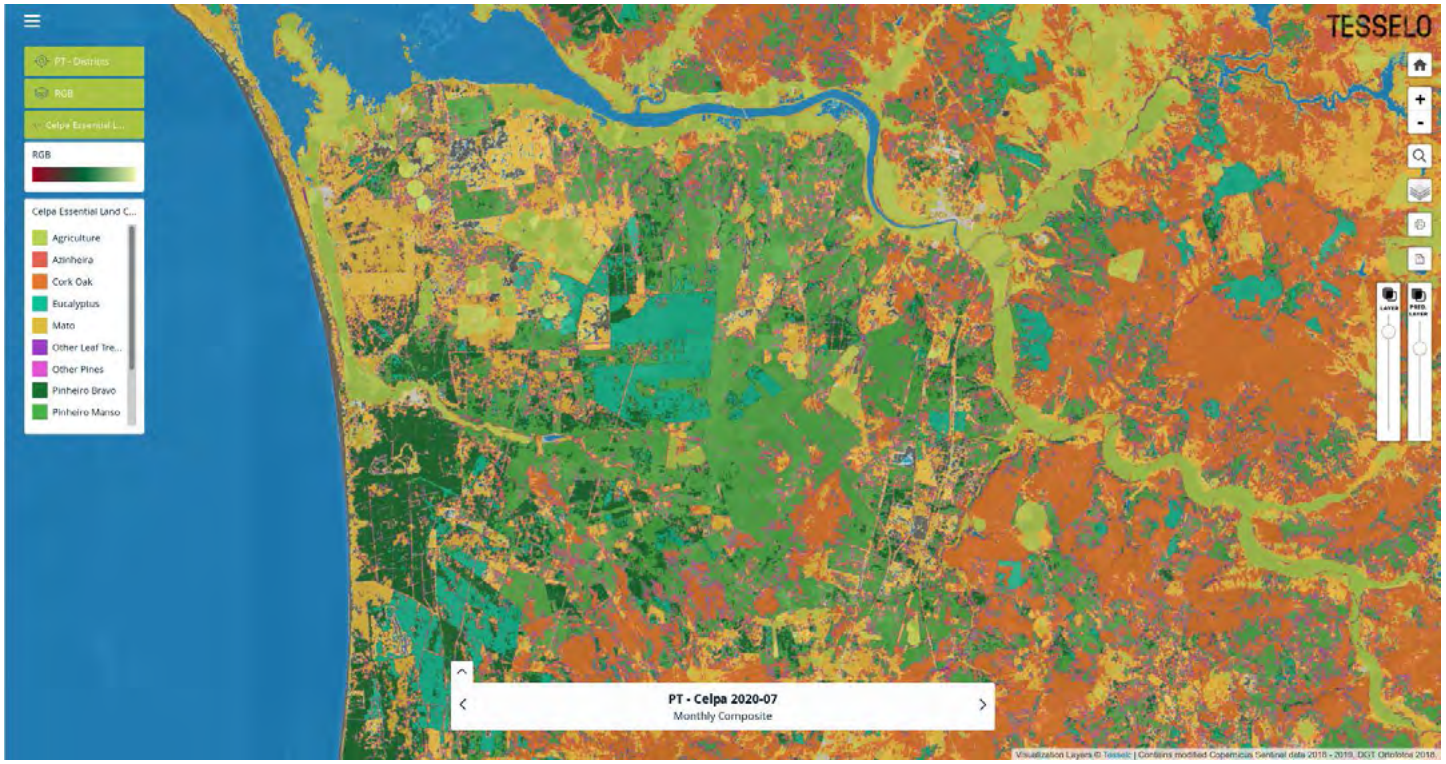
The Service Provider

Tesselo, an innovative start-up from Lisbon, Portugal, is an environmental technology firm specialised in spatial intelligence. Founded in 2017, the multilingual team spread over three continents engaged in a 2-year R&D collaboration process with CELPA and has been supported by grants coming from ESA and EC i. a. Working solely with open spatial data from the Copernicus program, Tesselo is able to deliver costeffective solutions for any natural resource stakeholders.

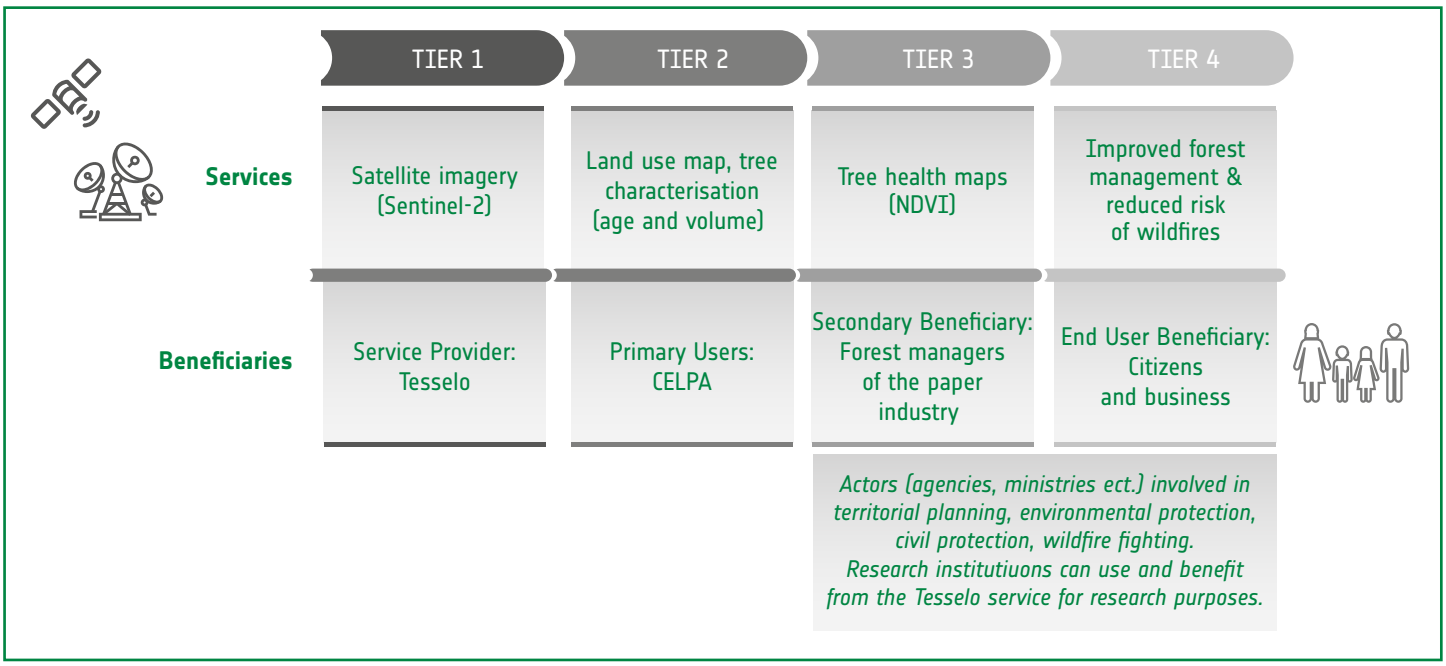
The company's core business rests on the augmentation of open satellite imagery with artificial intelligence. Their main target markets are the forestry, infrastructure and insurance.

TESSELO

www.tesselo.com



Land use classification interface *©Tesselo*



Schematic representation of the main beneficiaries along the value chain, including the corresponding services and benefits provided

WHO IS CONCERNED?

CELPA (Associação da Indústria Papeleira) is the association of the Portuguese pulp and paper industry and represents the interests of its member companies Altri, DS Smith, Renova and The Navigator Company. It also promotes relations with other industry sectors and looks out for new technologies that may be of interest to the sector such as satellite Earth Observation. Its members produce 100% of the Portuguese pulp and some 90% of the Portuguese paper. To monitor national forests, as a source of raw material, CELPA needs as much information on the eucalyptus and maritime pine plantations as possible to plan strategically and support its members.

This information can be drawn from analysing Sentinel-2 images through which developments such as tree extent, cut/burnt areas, distance to settlements etc. can be provided. Reports are produced by Tesselo on a quarterly basis, a frequency often enough to understand changes in these parameters.

The forest managers of the paper companies usually spend their time out in the forests. Their picture of the situation of the plantations can however never be complete as the plantations can be in remote regions and there are simply too many to have a holistic picture. Experience, knowledge, and intuition has to tell them where to go next. To make more informed decisions, the application provides them with updated information on tree health updated every few days so that field inspections can be prioritised according to where their work is needed the most. The application, moreover, gives the forest managers an idea about the potential of new plantations and how a newly leased plantation has been doing in the past.

The Primary Users

CELPA, the trade association of the Portuguese pulp and paper producers, was founded in 1993 from the merger between ACEL (pulp) and FAPEL (paper and board). The members of CELPA are 14 industrial and forestry companies and together they produce 100% of the national virgin fibre paste and about 90% of all paper and board. CELPA's members directly manage 193,200 hectares of forest in their own and leased properties.

CELPA
Associação da Indústria Papeleira

www.celpa.pt

WHAT ARE THE BENEFITS?

CELPA considers that the use of AI-powered Sentinel data is a "gamechanger" to the pulp and paper industry in Portugal and that its use has been facilitating and benefiting the industry considerably already in the short time it has existed. While Tesselo's R&D activities are continuing in close cooperation with CELPA and further features will be added in the near future to the platform, it is already delivering valuable insights that otherwise would have been difficult to materialise.

CELPA is now in the position to monitor land use throughout Portugal, and specifically the national eucalyptus and maritime pine forests in a much more cost-effective way. To check and monitor forests and tree health and care, CELPA and member companies 25% on average in trips to often remote areas all over the country. This type of monitoring can be done now from a mobile device or laptop. This freed-up time can be used in a more productive way (and long trips are saved). Knowing monthly accurate forest information gives companies an effective tool and "strategic intelligence" to do their planning and logistics more effectively for pulp and paper production.

The key benefits are:

Economic

- increased employment (tier 1)
- efficiency gains and cost savings due to needs-based field inspections by at least 25% (tier 2/3)
- increased revenues due to better tree care and maintenance increasing the yield (tier 3)
- increased revenues due to early warning system in the future (tier 3)

Environmental

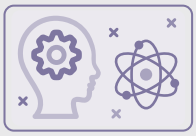
- reduced pollution due to decreased use of fertilizer/pesticides (tier 3)
- reduced pollution due to 25% less car trips (tier 2/3)

Regulatory

- improved monitoring of protected/at-risk forest areas (tier 2/3)

Innovation & Entrepreneurship

- creation of a new, profitable business (tier 1)
- changed, more efficient business practice (tier 2/3)

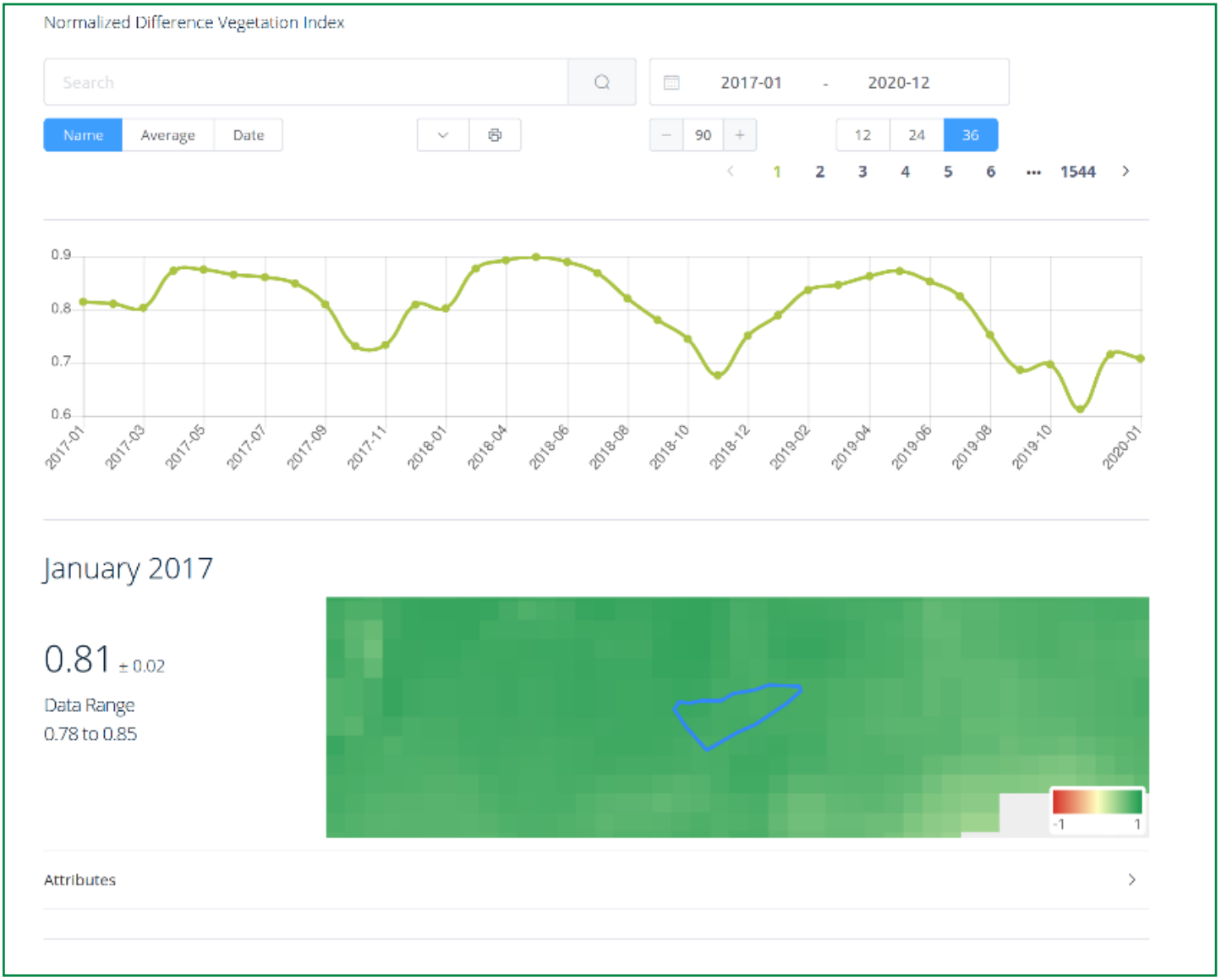


Science & Technological Research

- increased student research on EO due to partnership between Tesselo and universities (tier 3/4)

Societal

- contribution to the sustainability of the forests and of the pulp and paper industry (tier 3)
- contribution to secure a competitive advantage for the Portuguese pulp and paper industry (tier 3)



NDVI time series provided in the application ©Tesselo

EXTENDED IMPACT

This type of satellite image analysis is not interesting only to industrial players and trade associations. Governments and public agencies may well be interested in forest inventories, tree classifications, automatic checks of environmental regulation compliance or deforestation alerts.

Furthermore, the data and analytical techniques used in this case are applicable globally. Sentinel images provide global, periodic coverage and the need for forest monitoring, land use changes or tree health monitoring are becoming ever more important given the need for environmental protection and the relevance of forests in the fight against climate change. After calibration, the application of the algorithms to other geographic regions have already shown high performances and could thus be used in regions where for instance forest monitoring is an important issue.

Building on the work done and with the integration of further features, Tesselo has started to apply its vegetation and forestry expertise to other user markets challenged by natural resource management such as utilities for vegetation management around critical infrastructure and insurance companies, targeting climatic risk-related lines of business. Aiming for a full self-service platform in the future, the distribution of Tesselo's services will be greatly facilitated.

ABOUT THE PROJECT

The Sentinel Benefits Study (SeBS) is conducted by EARSC (European Association of Remote Sensing Companies) with partners The Greenland, IIASA (International Institute for Applied Systems Analysis) and Evenflow on behalf of the European Space Agency (ESA). It has the goal to study 20+ full cases by analysing the impact of the use of Sentinel data along a valuechain.

This short-case has been prepared where there has been an interesting use made of Sentinel data, but it has not (yet) been possible to conduct a full case. It tells the story of the use of Sentinel data without going deeply into the economic or environmental benefits.

> ***For the Portuguese pulp, paper and cardboard industry, it is extremely important to know exactly the areas and stocks of the eucalyptus and pine forests on a national scale, pointing to the need for constant updated forest information. The development of a service for monitoring the evolution of the national forest in mainland Portugal, based on the automatic classification of satellite images from Sentinel-2 is a major breakthrough for the industry because today there is, on a regular and periodic basis, access to up-to-date information on the evolution of land use, i.e. new forests, harvested and burned areas.***
>
> *Francisco Goes, Forest & Statistics, CELPA*

We acknowledge that the understanding of the case was supported by discussions with Rémi Charpentier and Marine Utgé-Royo from Tesselo as well as Francisco Goes from CELPA. We thank them for their valuable insights and availability.

Do you know an interesting case demonstrating the benefits derived from the use of Sentinels data?

Email info@earsc.org

More Information on Sentinels Benefits Studies:

www.earsc.org/sebs

The Sentinels Benefits Study is funded by the EU and ESA.
The views expressed in this study cannot be taken to reflect the official position of the EU or of ESA.