Seeing **THROUGH** The **TREES**

Monitoring Agriculture and Forestry
Using Satellite Imagery

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AN OVERVIEW

Agriculture provides us with food, fuel, fibers and raw materials that are imperative to our everyday lives. However, food security in the face of climate change continues to challenge us. Under the 2030 UN Agenda, the FAO has highlighted the need to invest in agriculture including crops, livestock, and forestry. The world's population is rising and is expected to grow to more than 10 billion people by 2050. To accommodate this growth, it is estimated that agricultural production will need to expand to 70% by 2050. Agriculture not only plays a major role in global food security, but can also be used to combat climate change.

Globally the world emits over 36 billion tonnes of CO_2 each year. Forests are an important resource in reducing these emissions. Stopping deforestation, restoring forests and improving forestry practices could cost-effectively remove up to 7 billion tonnes of CO_2 annually. Therefore, forests are a critical factor in combating climate change and a resource that needs protection.

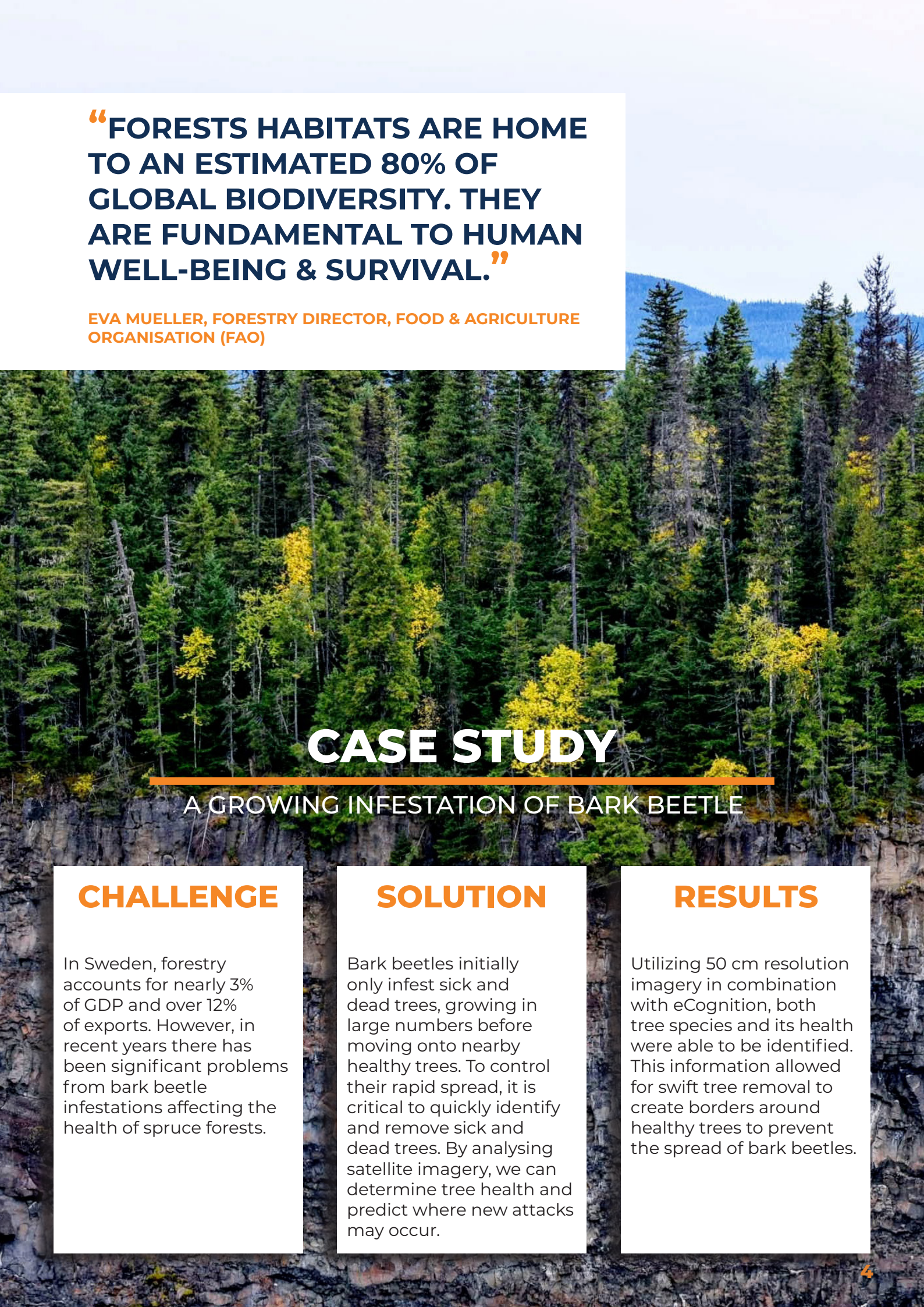
There is a strong requirement for monitoring forests and crops in order to tackle the present challenges within agriculture and forestry. Near real-time monitoring is crucial to react to extreme events - such as climate conditions or pest infestations - and thus minimize their impact, while also optimising management practices - such as precision agriculture - in a sustainable manner.

What is precision agriculture?

Precision agriculture involves the use of geospatial technologies to map spatial variations in crop and soil conditions, matching inputs - such as water, fertilizer, pesticides and seeds - to those variations by applying them at variable rates. From this data, zone maps and prescription maps can be created. Zone maps highlight the difference between healthy and stressed plants, whereas prescription maps determine how much input to apply to each management zone. The ultimate goal is to make farming as sustainable as possible to minimise inputs and maximise outputs.

Very High Resolution (VHR) optical satellite imagery can be an essential tool to respond to threats against agriculture and forestry as it offers a non-destructive means of proving recurrent information from both a local and global scale. By combining data sources with artificial intelligence and machine learning, further insights can be gained autonomously and in a timelier manner. Advances in these technologies are becoming more affordable for most users, making the exploitation of remotes sensing reliable and profitable.

Other areas whereupon VHR optical satellite imagery can provide benefits includes land use & land cover, vegetation behaviour and mapping, species identification, biodiversity and land degradation.



> "FORESTS HABITATS ARE HOME TO AN ESTIMATED 80% OF GLOBAL BIODIVERSITY. THEY ARE FUNDAMENTAL TO HUMAN WELL-BEING & SURVIVAL."

EVA MUELLER, FORESTRY DIRECTOR, FOOD & AGRICULTURE ORGANISATION (FAO)

CASE STUDY

A GROWING INFESTATION OF BARK BEETLE

CHALLENGE

In Sweden, forestry accounts for nearly 3% of GDP and over 12% of exports. However, in recent years there has been significant problems from bark beetle infestations affecting the health of spruce forests.

SOLUTION

Bark beetles initially only infest sick and dead trees, growing in large numbers before moving onto nearby healthy trees. To control their rapid spread, it is critical to quickly identify and remove sick and dead trees. By analysing satellite imagery, we can determine tree health and predict where new attacks may occur.

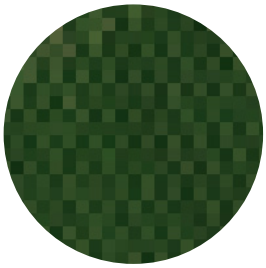
RESULTS

Utilizing 50 cm resolution imagery in combination with eCognition, both tree species and its health were able to be identified. This information allowed for swift tree removal to create borders around healthy trees to prevent the spread of bark beetles.

WHAT IS VHR SATELLITE IMAGERY?

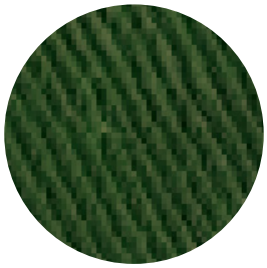
Very High Resolution (VHR) satellite imagery are images of Earth taken from space in sub-meter resolution – that is every pixel of the image is under one metre in width and height. VHR imagery can be delivered in different combinations of multispectral bands allowing the user to see more detail than possible with the human eye.

EUSI utilises the WorldView Constellation from their ground station in Munich, Germany to acquire imagery at 30 – 50 cm resolution with rapid revisit. Rapid revisit refers to the ability of the satellites to collect imagery over the same area within a short time frame.



10 M

Suitable for large land area coverage but will not provide any detailed area – for example, different crop species are not at all identifiable



1 M

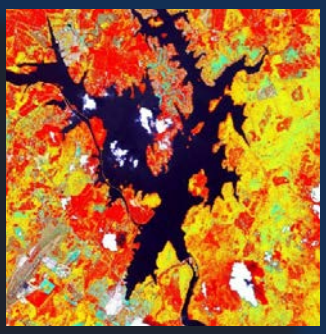
Provides some level of detail but will hinder detection and identification objectives – markings such as a crop and forestry boundaries are not legible nor will measurements be accurate

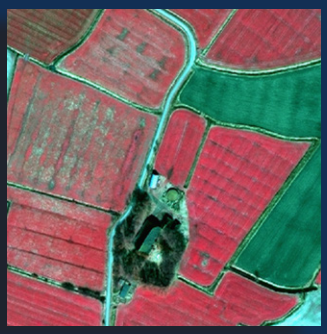
30 CM

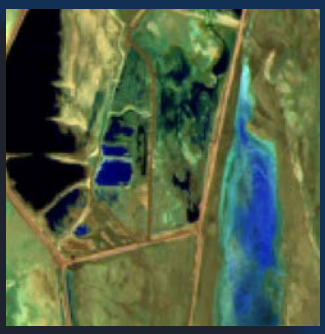
The highest amount of detail commercially available and necessary for projects relating to object identification

What can multispectral bands do for me?

The WorldView satellite constellation has 16 multispectral spectral bands that are focused on a part of the light spectrum and sensitive to a particular feature on the ground. By arranging these multispectral bands in various combinations, additional information can be extracted that is invisible to the human eye, such as soil moisture, vegetation identification and health, as well as estimating yields for future growth profits.







WHAT SOLUTIONS CAN SATELLITE IMAGERY PROVIDE?

The power of 30 cm resolution imagery in combination with frequent revisits and rapid delivery can be critical to making strategic decisions to decrease inputs while increasing profitability within agriculture and forestry. Landcover can be vast and by comparison trees and crop species are small.

Both farms and forests are areas of land that can stretch for hectares long. It is challenging to get an accurate picture of the overall health of both, however this challenge can be tackled with VHR imagery. This data is extremely useful for repetitive timeline-based data collection such as that which is used in precision agriculture methods, allowing for the right tools to be implemented at the right time to increase overall efficiency.

Monitoring agriculture in real time to react to adverse effects from climate conditions allows decision makers to detect trouble areas and optimise scouting efforts which increases profitability. Furthermore, satellite imagery is a powerful tool for monitoring forest cover change as it provides an abundance of spatial information relating to species diversity, forest productivity and health as well as nutrient cycling.

Land Use & Land Cover

Large-scale monitoring of land to review change detection over time for both urban and rural areas. Assist planning, decision making and management to ensure sustainable development

Food Security

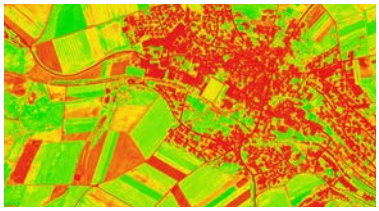
Ability to measure agriculture productivity at both smallholder and large scale farming. Rapid revisit allows analysis of soil fertility and the optimisation of drenching methods to maximise crop yield

Forest Management

Determine the health of forests, differentiate between tree species, detect illegal logging, create canopy height models, calculate carbon stocks and estimate loss after natural disasters

Biomass Estimation

VHR imagery can provide spatial information on forest ecosystems allowing the extraction of forest structural parameters that can be ingested into allometric models to indicate biomass estimates.



Normalised Difference Vegetation Index

The use of NDVI index from satellite imagery can reveal the degree of disturbance of vegetation cover, measure biomass, quantify forest supply and measure leaf area index (LAI).

Vegetation Health

Monitor the growth rates of crops and forests to determine exactly when and where to intervene. Allows for precision agriculture, yield estimates and more effective decision making in the future.

OPTIMISING WINE

With data from space

During a growing season, the maturity and quality of grapes vary across a region and even within a single vineyard. Winemakers must carefully monitor the grapes throughout the season to determine when nutrients, pesticides and additional water should be applied to optimise growth. As the harvest nears, the winemakers examine grapes for signs of maturation and sugar content to select the precise time for picking.

Optical satellite imagery can be used to capture vines during the Véraison period. Monitoring crop vigour at this stage gives the winemaker time to modify management of individual vines with the goal of optimising the harvest.

When compared to traditional methods such as ground-based measurements, the value of satellite imagery is clear. It allows for larger areas of the vineyard to be covered in a shorter amount of time providing increased cost and time savings.

Why not just use Google?

Google Maps is one of the most widely used services on the internet and allows high quality data free of charge. Google Earth has significantly lowered the barriers to accessing high resolution satellite images, however it does come with limitations.

- Data is not current and Google has no publicly available schedule of updates
- Populated areas are imaged more frequently than rural or coastal areas
- It is not possible to download geo-referenced images from Google
- Multispectral band combinations cannot be changed to reveal additional insights

HOW DO I GET VHR IMAGERY?

Traditionally VHR satellite imagery could be obtained via an order processing system whereby a user contacts an Earth Observation company. The user either requests a specific area of interest and date from the catalogue or order satellite tasking for a future image to be collected.

This method of obtaining data is useful for users who require infrequent data or who need new collections. For more demanding users who need continuous access to the whole archive catalog, SecureWatch is the smarter and more cost-effective option.

EUSI offers both traditional and cloud-based imagery delivery options combined with personal customer support to guide users to the perfect image.

Traditional Order Processing

- Search the catalogue dating back to 1999 or request a new image collection
- Pay for each image upon delivery
- Global coverage – no geographical restrictions, simply define area of interest from available global coverage
- Average delivery in less than 48 hours
- Ability to order imagery with different processing methods (band combinations, pan-sharpening and atmospheric compensation)
- Satellite Tasking – the ability to request a new image collection at specific location
- Smarter model for tailored projects or if new collections are needed

SecureWatch: Cloud-based

- Stream full resolution imagery dating back to the year 1999
- Subscription based service – a yearly price to view, stream and download
- Global coverage – no geographical restrictions, simply define area of interest from available global coverage
- Instant access to imagery via a user friendly web interface or API
- Ability to enhance imagery on screen (band combinations, atmospheric compensation, adding layers and making annotations)
- Set alerts that notify you when new data is collected in your area of interest
- Perfect for customers who need a regular access to archive imagery or integration into software solutions

APPLICATIONS

Livestock Welfare

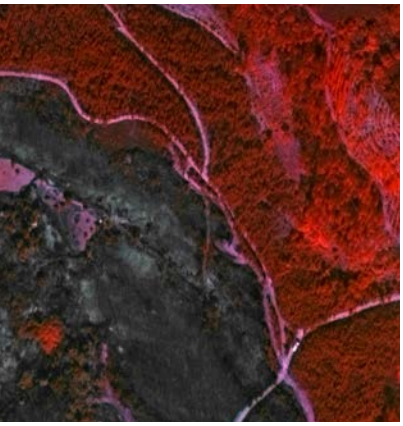
Monitoring livestock autonomously provides valuable opportunities to enhance and refine on-farm management decisions, increase efficiency and lower operating costs. In the past this has been done manually, however more accurate results can be achieved by combining satellite imagery with AI to automatically count and record livestock and monitor movements via map-based systems. This methodology allows for large geographical areas to be covered without human intervention, reducing the need for physical inspection. Additionally, it can improve the prevention and management of disease outbreaks.

Smarter Irrigation

Food is a basic human need, and the production of this food primarily comes through agricultural practices. Agriculture is the main user of water worldwide, accounting for 70% of total water withdrawals. As water resources are a precious commodity, Water Use Efficiency (WUE) is crucial to agricultural sustainability. The goal is to produce more with less and that is where satellite imagery can provide solutions. By imaging areas using certain multispectral bands, estimates of biomass production, evapotranspiration levels, soil moisture, leaf area index, vegetation index and surface temperatures can be calculated. These variables can then be used to calculate the WUE of the agricultural area.

Carbon Storage Estimation

Forests act as one of the biggest carbon sinks of terrestrial ecosystems. With CO_2 emissions currently rising to critical levels, it is now more important than ever to map and monitor carbon stocks in forests in order to combat climate change. Satellite data can be used to estimate several parameters that relate to carbon sequestration including ground biomass, seasonal productivity, leaf area index (LAI) and photosynthetically active radiation (PAR). Additionally, remote sensing technology can be carried out at a global scale to observe vegetation and carbon cycle. When this data is combined with machine learning, the opportunities are endless.



Monitor Forest Operations

Through satellite imagery, a range of forest operations are able to be monitored to ensure operators are up to date with the latest developments crucial to strategic decision making. It allows easy identification of illegal logging, the ability to track harvest progress including forest health and to proactively monitor disease outbreaks. Additionally, satellite imagery can be used to assess the impact of the many disasters that affect forests such as wildfires, flooding and hurricanes directly after the event. This allows for immediate implementation of crisis response tactics to restore the vitality of the forest and thereby lower the disasters influence on profitability.

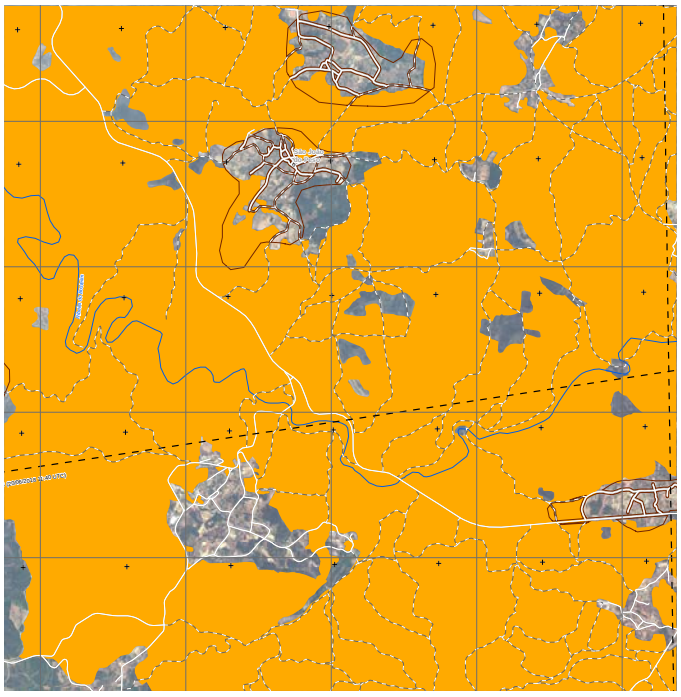
RAPID DELIVERY OF SATELLITE IMAGERY

To assess damage of Portugal Forest Wildfires

On 20 July 2019, multiple forest fires began near Castelo Branco, Portugal, under suspicious circumstances. Within hours the Copernicus Emergency Management Services Rapid Mapping Module was activated to provide First Estimate Product and Delineation maps to the National Command for Relief Operations - National Authority for Civil Protection in Portugal.

Just after midnight on 22 July a satellite tasking order was placed with EUSI to capture the affected areas. The ability to receive overnight orders allowed the fast collection of the data the very next day.

Partnering with GAF AG, delineation maps were rapidly created to provide an assessment of the fire's impact and extent. Both the imagery and maps were delivered within 24 hours from image collection allowing authorities to target their firefighting efforts in order to more efficiency extinguish the blaze.



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CONCLUSION

Seeing The Big Picture From Space

By remotely sensing from their orbits high above the Earth, satellites provide us with much more information than would be possible to obtain solely from the ground.

In particular, Very High Resolution satellite images offer a unique view of what lays in, on and around our forests and agricultural lands. They provide a cost-effective and simple method of monitoring wide areas both locally and globally, as opposed to exhaustive ground measurements, and are an indispensable tool for managing the actions and events that impact forest management, food security and precision agriculture.

From this data you can gain insights into vegetation health, land use & land cover, biodiversity, land degradation, livestock welfare, crop management and so much more.

The Future of Satellite Imagery

In recent years there has been a surplus of satellite imagery available. Advances in technology have seen data analytics leverage the power of Artificial Intelligence (AI), cloud computing and machine learning.

These advances have a huge potential to disrupt traditional business and provide enormous benefits in the long term. Ultimately the future lies in cloud based multi-source data platforms that have high powered analytics integrated within. SecureWatch is an example of a satellite imagery platform incorporating features pertinent to Earth Observation and providing the user with a tremendous array of analytical tools at their fingertips.

In the past we only had traditional methods of ordering imagery from Earth Observation companies, however the future of satellite imagery lies in the cloud – that is delivery of images via web browser or API.

This interface provides the user with instant access to satellite imagery that can be immediately analysed and manipulated. This is especially important for time sensitive projects. Of course, there will always be a need for traditional data ordering whereupon a project has specific needs and requires direct satellite tasking.

Arming yourself with the right tools is the first step for any agriculture or forestry company and one of those tools should be VHR satellite imagery.

About European Space Imaging (EUSI)

Since the launch of the first commercial VHR satellite, we at EUSI have committed ourselves to providing much more than the world's highest quality satellite imagery.

We provide solutions. Utilising our multi-mission ground station at the German Aerospace Center, the team of geospatial experts at EUSI are able to bring together unique partnerships, innovative techniques and tailored services to achieve results for any project.

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