Examples of Earth Observation Based Services for the EU Forestry Strategy

October 2021

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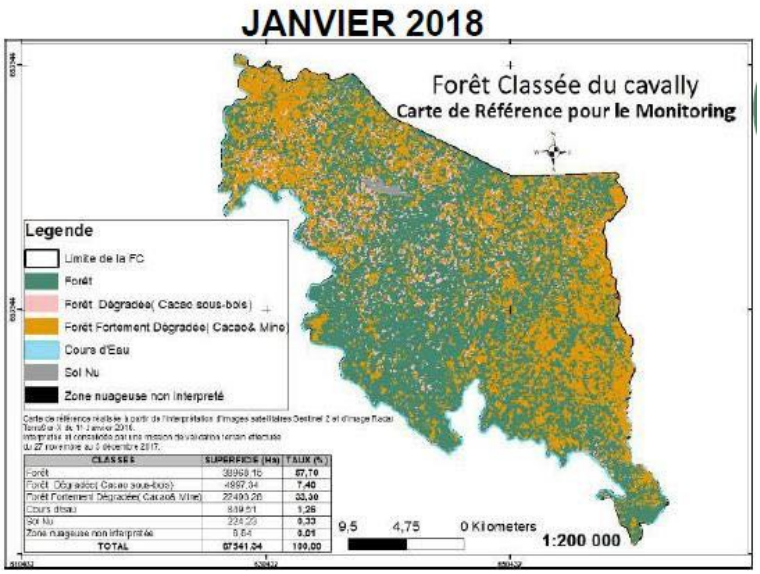
Application of Earth observation for forest management

Description of the use cases

Presentation of the company	
Name	Airbus Defence & Space
Address	5 Rue des Satellite, BP 14359 France – 31030 Toulouse
Website	https://www.intelligence-airbusds.com/markets/forestry-environment/starling/ https://www.earthworm.org/news-stories/the-cavally-forest-is-regenerating-hope-is- allowed
Contact name	Wendy Carrara
Email	Wendy.carrara@airbus.com
Presentation of the use case	
Type of customer	SODEFOR – Société de développement des forêts – Agence de protection et de restoration des forêts Ivoirienne // National agency for forest protection andrestoration of Ivory Coast
Area of interest	Cavally forest – Ivory Coast
Product category	Deforestation monitoring
Product description	The Cavally project began in 2018 when Earthworm, Airbus and SODEFOR joined forces to create a forest monitoring project using Starling technology. The project was to support the Ivorian government's goal of achieving 20% forest cover increase across the country by 2030. Through the project, the aim was to protect and restore the Cavally Forest reserve, to find livelihoods for farmers and communities living in the area and to adapt the model to other forest reserves in Ivory Coast. The approachis based on promoting collaboration between farmers, industry and government to find a protection and development model that works for all. The project has a strong focus on providing technological solutions and capacity building. The objectives of theproject were: - Monitoring early signs of deforestation due to illegal cocoa plantations under canopy - Contributing actively to the protection and restoration of the Cavally Forest: effectiveground monitoring and continuous satellite monitoring alongside community-led restoration of degraded areas. - Empowering farmer and community resilience: building trust and a shared development vision with communities through field studies and participatorymapping. - Extending the approach to other forest reserves: to go beyond the Cavally Forest by applying the model to other Ivorian forest reserves. In order to achieve these goals, SODEFOR used Starling. Starling is a digital solution leveraging Cloud technology, machine learning and satellite technology that combineshigh-resolution optical and radar satellite images. Typically, radar images to allow for unbiased monitoring of forest cover changes. As an example, thanks to the use of radar imagery, monitoring analytics can equally be applied to check activities occurring beneath the canopy, therefore ideal for monitoring the very early stages of e.g. cocoa induced deforestation.
Earth Observation Images used	
Source #1 *Name* *Type of image* *Resolution*	 Airbus Defence & Space radar imagery TerraSarX, SAR satellite, various resolutions

Source #2 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	Copernicus – Sentinel satellites (S1 and S2) Sentinel 1 – SAR satellite, various resolutions : 9, 20, 23, 50, 84 meters Sentinel 2 – 10, 20 or 60 meters resolution depending on the particular spectral band
Add other sources if necessary	Airbus Defence & Space Spot and Pléiades images optical VHR: Pléiades constellation – 50 cm spatial resolution, 4-band spectral resolution 2 meters.SPOT constellation – 1.5 m spatial resolution, 4-band spectral resolution 6 meters
…	NASA Landsat satellites 30 meters (visible, NIR, SWIR); 100 meters (thermal) and 15 meters (panchromatic)
Other data source used	
Source #1 *Name* *Provider* *Access* *Area of interest* *Description* *Usage*	The digital solution developed has a data upload functionality allowing users to incorporate business-specific data into the platform, e.g. boundaries such as cadastralinformation, no go areas or buffer zones, or supply chain data such as certified forest management units as well as supply chain specifics: • Supply chain objects: ○ Suppliers list ○ Mill list ○ Sourcing boundaries list (concession plantation estates, smallholders,etc.) • Connections: ○ The link between suppliers and mills ○ The link between boundaries and mills. Supply chain information can come from different sources: • Data of public origin e.g. open data made available by Starling and accessibleto all users via the portal • Private data, which is user-informed and strictly confidential
Add other sources if necessary	Streaming portal to deliver data to SODEFOR, tailored service
Algorithms and processing tools	
Processing details	Starling is a complete information system dedicated to identifying where natural or productive forest is, and when forest cover change occurs, thereby supporting sustainable forest management. By design, Starling contains an imagery layer, a basemap layer with a 20 year timeseries that identifies key land cover classes and, finally, a monitoring layer with anaytics which displays confirmed forest cover change from forest to non-forest status, by default on a quarterly basis Each image is computed by our internal tool (Overland) to derive from each pixel all

	biophysical parameters and variables which help to characterise cover or vegetation. The advantage of the biophysical parameters is that all the sensors can be analyzed together with in a time series image stack based on our inhouse Geoube technology. The GeoCube, at the core of Starling, is designed to provide a storage infrastructure that is scalable, distributed, able to ingest pre-processed information from a variety of EO systems or external data generating components, and to deliver consolidated, fully aligned information.
Feedback and evaluation	
Reproducibility	With sharp accuracy and detailed resolution, Starling's reference maps differentiate between production forests that include palm plantations, natural forests and otherareas, including other commodities. The method is replicable on other territories. Should the forest type and sensors usedbe different, this may require an adjustment of the learning process to take into account these specificities. The GeoCube solution is designed for the processing of additional heterogeneous data sources e.g. aggregation of data from the BIOMASS mission and of LIDAR data, together with the already available optical and SAR data. Such a system will be capable to serve the scientific community as well as decision makers by giving access to a major playground where to develop and test their models on multiples themessuch as Carbon stocks, Climate Change, Biodiversity assessments, etc.
Accuracy	Using Starling's high resolution satellite and radar images, and regular forest clearance alerts, SODEFOR was able to target their patrolling efforts across the 67,600-hectare forest reserve. From December 2017 to July 2018, Starling establishedan up-to-date reference map of the Cavally Forest. This has made it possible to detect any disturbances in the forest with close to 100% precision. Since then, Starlingprovides regular alerts on any forest clearance. This has allowed SODEFOR to take rapid and targeted action such as increased patrols and clearing the land of illegal plantations. This led to an 83 percent decrease in deforestation between the second quarter of 2018 and the second quarter of 2019. According to the SODEFOR field teams, the decline in deforestation is linked to the precise level of information from Starling alerts.
Feedbacks	*« This is a sign of hope in achieving the objectives of rebuilding the Ivorian forest cover. I look forward and hope that satellite monitoring combined with field missions in the Cavally Forest can be extended to other forests in the country."* **Colonel Mamadou Sangaré, Director General of SODEFOR**
Pictures	

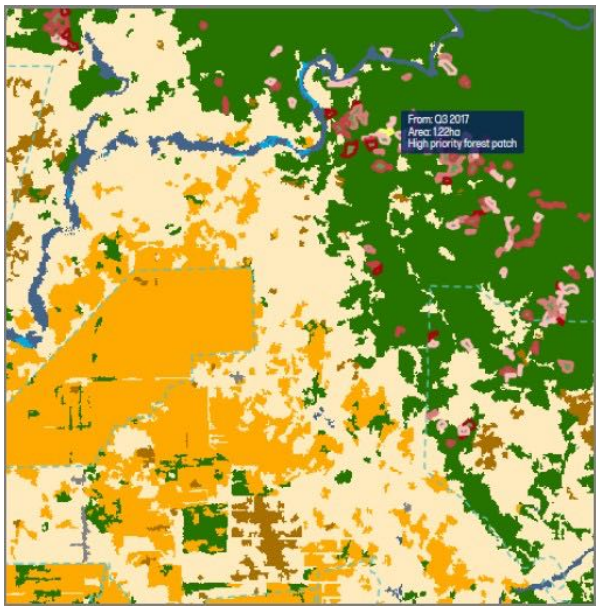
Legend:	 **Starling data is helping the Ivory Coast government rebuild forest cover in the Cavally Forest** Cavally forest is one of the most precious and still intact "Forest Reserve" in Ivory Coast. However, illegal cocoa is developing fast in Cavally forest with subsequent forest loss. To detect illegal cocoa activities at the early days is critical to avoid further deforestation and to also avoid social issues when families settle in the forest. It requires to observe very thin canopy disturbance as things start withclearing of the understory vegetation (beneath the canopy). It is what Starling has done.

Application of Earth observation for forest management

Description of the use cases

Presentation of the company	
Name	Airbus Defence & Space
Address	5 Rue des Satellite, BP 14359 France – 31030 Toulouse
Website	https://www.intelligence-airbusds.com/markets/forestry-environment/starling/ https://www.earthworm.org/news-stories/earthworm-foundation-deeper-deforestation-insights-pave-the-way-for-accelerating-the-fight-against- deforestation-and-call-for-greater-company-action
Contact name	Wendy Carrara
Email	Wendy.carrara@airbus.com
Presentation of the use case	
Type of customer	Multiple : Promoting green development in the Leuser Ecosystem in Indonesia
Area of interest	2.6 million hectares across the Indonesia provinces of Aceh Tamiang and AcehSingkil
Product category	Deforestation monitoring
Product description	The Leuser Ecosystem is one of the more biodiverse places in the world, spanning more than 2.6 million hectares across the Indonesia provinces of Aceh and North Sumatra. Adjacent to Leuser are oil palm plantations, mills and farming communities, who inadvertently put pressure on the surrounding forests. By using Starling, a digital solution leveraging Cloud technology, machine learning and satellite technology that combines high-resolution satellite images, Stakeholders are able to access unbiased monitoring of forest cover changes. Thanks to the development of basemaps and monitoring analytics, checks can be applied and contribute directly to a better understanding of the deforestation dynamics enabling on the timely action to be taken. In the context of the Leuser Ecosystem in Indonesia, by monitoring the area and capturing vast amounts of forest change data, Starling has provided a base from which to develop the landscape-level solutions that are necessary to find the balance between conservation and social development. The data allowed stakeholders such as local governments, businesses, palm oil mills, NGOs andfarmers in Aceh Tamiang to be brought together and to develop an ambitious greendevelopment plan with boots-on-the-ground action.
Earth Observation Images used	
Source #1	
Name	Copernicus –
Type of image	Sentinel satellites (S1 and S2)
Resolution	Sentinel 1 – SAR satellite, various resolutions : 9, 20, 23, 50, 84 meters
Other possible sources	Sentinel 2 – 10, 20 or 60 meters resolution depending on the particular spectralband
Access	
Source #2	
Name	NASA
Type of image	Landsat satellites
Resolution	30 meters (visible, NIR, SWIR); 100 meters (thermal) and 15 meters (panchromatic)
Other possible sources	

Add other sourcesif necessary	Airbus Defence & Space Spot and Pléiades images VHR: Pléiades constellation – 50 cm spatial resolution, 4-band spectral resolution 2 meters. SPOT constellation – 1.5 m spatial resolution, 4-band spectral resolution 6 meters
Other data source used	
Source #1 *Name* *Provider* *Access* *Area of interest* *Description* *Usage*	The digital solution developed has a data upload functionality allowing users to incorporate business-specific data into the platform, e.g. boundaries such as cadastral information, no go areas or buffer zones, or supply chain data such ascertified forest management units as well as supply chain specifics: • Supply chain objects: ○ Suppliers list ○ Mill list ○ Sourcing boundaries list (concession plantation estates, smallholders, etc.) • Connections: ○ The link between suppliers and mills ○ The link between boundaries and mills. Supply chain information can come from different sources: • Data of public origin e.g. open data made available by Starling andaccessible to all users via the portal • Private data, which is user-informed and strictly confidential
Algorithms and processing tools	
Processing details	Starling is a complete information system dedicated to identifying where natural or productive forest is, and when forest cover change occurs, thereby supporting sustainable forest management. By design, Starling contains an imagery layer, a basemap layer with a 20 year timeseries that identifies key land cover classes and, finally, a monitoring layer with analytics which displays confirmed forest cover change from forest to non-forest status, by default on a quarterly basis Each image is computed by our internal tool (Overland) to derive from each pixelall biophysical parameters and variables which help to characterise cover or vegetation. The advantage of the biophysical parameters is that all the sensors can be analysed together with in a time series image stack based on our inhouse GeoCube technology. The GeoCube, at the core of Starling, is designed to provide a storage infrastructurethat is scalable, distributed, able to ingest pre-processed information from a varietyof EO systems or external data generating components, and to deliver consolidated, fully aligned information.

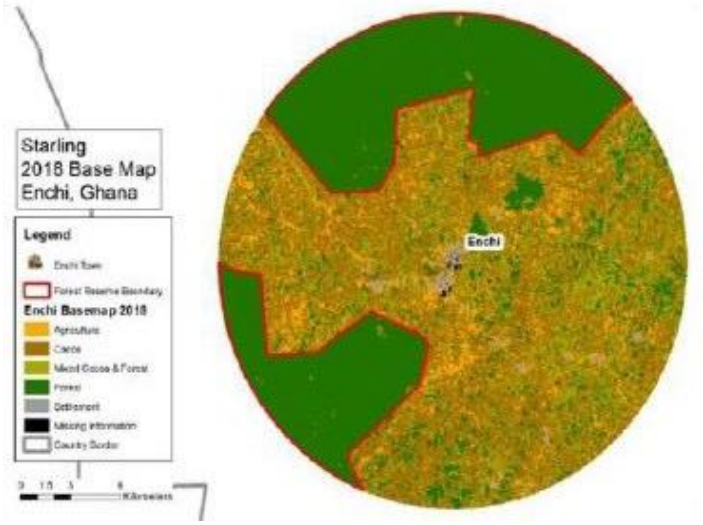
Feedback and evaluation	
Reproducibility	With sharp accuracy and detailed resolution, Starling's reference maps differentiate between production forests that include palm plantations, naturalforests and other areas, including other commodities. The method is replicable on other territories. Should the forest type and sensors used be different, this may require an adjustment of the learning process to takeinto account these specificities. The GeoCube solution is designed for the processing of additional heterogeneous data sources e.g. aggregation of data from the BIOMASS mission and of LIDAR data, together with the already available optical and SAR data. Such a system willbe capable to serve the scientific community as well as decision makers by giving access to a major playground where to develop and test their models on multiplesthemes such as Carbon stocks, Climate Change, Biodiversity assessments, etc.
Accuracy	Data from Starling has shown that deforestation has decreased about 60 percent between 2016 and 2019, along with evidencing that while this is true across lands owned by large plantations, there are still small farmers encroaching into the forestto earn a living
Feedbacks	*Importantly, results provided by Starling globally show a shift in deforestation dynamics as evidenced over Aceh province. While large deforestation events, indicative of large agricultural expansion are still visible, it is rather massive* *levels of smaller scale deforestation events between one to five hectares that are eroding the integrity of critical forest areas.*
Pictures	
Legend :	 **In shades of pink and red: Smallholder encroachment nearby large industrial plantations (Starling, Aceh province)**

Application of Earth observation for forest management

Description of the use cases

Presentation of the company	
Name	Airbus Defence & Space
Address	5 Rue des Satellite, BP 14359 France – 31030 Toulouse
Website	https://www.intelligence-airbusds.com/markets/forestry-environment/starling/
Contact name	Wendy Carrara
Email	wendy.carrara@airbus.com
Presentation of the use case	
Type of customer	Cocoa stakeholders
Area of interest	Ghana
Product category	Deforestation monitoring - Cocoa
Product description	The No Deforestation commitments made by the cocoa sector have largely focusedon existing protected areas and forest reserves. Attention is now focused on identifying High Carbon Stocks (HCS) outside of these legally zoned forest areas where reducing the significant level of deforestation that occurs outside these zones is key. Therefore, assessing these forest areas for HCS value is critical so they are firstly not converted for cocoa production and secondly farmers are appropriately mapped and incentivized to conserve these forests in perpetuity. By using Starling, a digital solution leveraging Cloud technology, machine learningand satellite technology that combines high-resolution satellite images, Cocoa Stakeholders are able to access unbiased monitoring of forest cover changes. They benefit from dedicated analytics identifying Cocoa, thereby differentiating Cocoa from other vegetation, and trees. Thanks to the development of basemaps and monitoring analytics, checks can be applied and contribute directly to a better understanding of the deforestation dynamics enabling on the timely action to be taken.
Earth Observation Images used	
Source #1 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	 Copernicus – Sentinel satellites (S1 and S2) Sentinel 1 – SAR satellite, various resolutions : 9, 20, 23, 50, 84 meters Sentinel 2 – 10, 20 or 60 meters resolution depending on the particular spectralband
Source #2 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	 NASA Landsat satellites 30 meters (visible, NIR, SWIR); 100 meters (thermal) and 15 meters (panchromatic)
Add other sourcesif necessary	Airbus Defence & Space Spot and Pléiades images VHR: Pléiades constellation – 50 cm spatial resolution, 4-band spectral resolution 2 meters.

	SPOT constellation – 1.5 m spatial resolution, 4-band spectral resolution 6 meters
Other data source used	
Source #1 *Name* *Provider* *Access* *Area of interest* *Description* *Usage*	The digital solution developed has a data upload functionality allowing users to incorporate business-specific data into the platform, e.g. boundaries such as cadastral information, no go areas or buffer zones, or supply chain data such ascertified forest management units as well as supply chain specifics: • Supply chain objects: ○ Suppliers list ○ Mill list ○ Sourcing boundaries list (concession plantation estates, smallholders, etc.) • Connections: ○ The link between suppliers and mills ○ The link between boundaries and mills. Supply chain information can come from different sources: • Data of public origin e.g. open data made available by Starling andaccessible to all users via the portal • Private data, which is user-informed and strictly confidential
Algorithms and processing tools	
Processing details	Starling is a complete information system dedicated to identifying where naturalor productive forest is, and when forest cover change occurs, thereby supporting sustainable forest management. By design, Starling contains an imagery layer, a base map layer with a 20 year timeseries that identifies key land cover classes and, finally, a monitoring layer with analytics which displays confirmed forest cover change from forest to non-forest status, by default on a quarterly basis Each image is computed by our internal tool (Overland) to derive from each pixelall biophysical parameters and variables which help to characterise cover or vegetation. The advantage of the biophysical parameters is that all the sensors can be analysed together with in a time series image stack based on our inhouse GeoCubetechnology. The GeoCube, at the core of Starling, is designed to provide a storage infrastructure that is scalable, distributed, able to ingest pre-processed information from a variety of EO systems or external data generating components,and to deliver consolidated, fully aligned information.
Feedback and evaluation	
Reproducibility	With sharp accuracy and detailed resolution, Starling's reference maps differentiate between production forests that include palm plantations, naturalforests and other areas, including other commodities. The method is replicable on other territories. Should the forest type and sensors used be different, this may require an adjustment of the learning process to takeinto account these specificities.

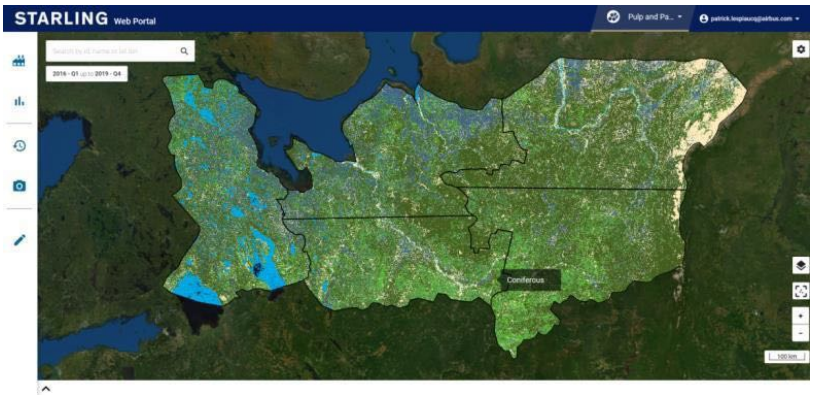
	The GeoCube solution is designed for the processing of additional heterogeneous data sources e.g. aggregation of data from the BIOMASS mission and of LIDAR data, together with the already available optical and SAR data. Such a system willbe capable to serve the scientific community as well as decision makers by giving access to a major playground where to develop and test their models on multiplesthemes such as Carbon stocks, Climate Change, Biodiversity assessments, etc.
Accuracy	Lindt & Sprüngli and the Lindt Cocoa Foundation (hereafter: L&S) are supportingan early mover pilot of scaling HCS and HCV methodologies to a 60,000-hectare landscape in the Western Region, Ghana. In 2018 L&S initiated the pilot with Starling, a service developed by Airbus and Earthworm Foundation that provides access to very accurate up to date land cover maps and near real time monitoring of forest loss. In 2019, L&S have decided to go a further step to assess on the ground the presence or absence of HCV and HCS using the land cover output fromStarling in 2018 (see image). Prior to conducting the HCV/HCS pilot, L&S and Earthworm have secured the support of the World Cocoa Foundation (WCF) and the HCSA.
Feedbacks	*« In 2018, Lindt & Sprüngli used Starling to determine the location of forests and deforestation within a key sourcing area of our supply chain in Ghana. The results are allowing us together with Earthworm Foundation to take targeted action and work directly with suppliers to tackle cocoa-driven deforestation. »* *Piera Waibel, Head Raw Materials & Sustainability of Lindt & Sprüngli*
Pictures	
Legend:	 **Lindt & Sprüngli partnered with Starling in Ghana**

Application of Earth observation for forest management

Description of the use cases

Presentation of the company	
Name	Airbus Defence & Space
Address	5 Rue des Satellite, BP 14359 France – 31030 Toulouse
Website	https://www.intelligence-airbusds.com/markets/forestry-environment/starling/
Contact name	Wendy Carrara
Presentation of the use case	
Type of customer	Multiple customers - Pulp and paper
Area of interest	Russia
Product category	Deforestation monitoring
Product description	Starling is a global forest monitoring service using satellite imagery, developed in partnership between Airbus Defence and Space) and the Swiss based not for profit foundation Earthworm. Starling combines the expertise of both partners in remote sensing, image processing, supply chain knowledge and forest management. Since the 1990's Airbus has been a key provider of high quality satellite imagery and thematic maps to a range of stakeholders to support national policy setting, REDD+ projects and forest management, among other applications. Starling is a service primarily supporting users to identify issues, prioritize action, and verify commitments to responsible forest management. Currently Starling is supporting a diversity of users from the private sector and government to address forest and land management issues linked to the production of key raw materials thathave a forest footprint. Starling is digital solution leveraging Cloud technology, machine learning and satellite technology that combines high-resolution satellite images to allow for unbiased monitoring of forest cover changes. Thanks to the development of basemaps and monitoring analytics, checks can be applied and contribute directly toa better understanding of the deforestation dynamics enabling on the timely action tobe taken. In this specific context, Starling provides a package of solutions over 170 million hectares in temperate regions of the world (e.g. areas in Canada, USA and Russia) where users are focused on improving forest management linked to the harvesting of timber, pulp and biomass.
Earth Observation Images used	
Source #1 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	 Copernicus – Sentinel satellites (S1 and S2) Sentinel 1 – SAR satellite, various resolutions : 9, 20, 23, 50, 84 meters Sentinel 2 – 10, 20 or 60 meters resolution depending on the particular spectral band
Source #2 *Name* *Type of image*	 NASA Landsat satellites

Resolution *Other possible sources* *Access*	30 meters (visible, NIR, SWIR); 100 meters (thermal) and 15 meters (panchromatic)
Add other sources if necessary	Airbus Defence & Space Spot and Pléiades images VHR: Pléiades constellation – 50 cm spatial resolution, 4-band spectral resolution 2 meters. SPOT constellation – 1.5 m spatial resolution, 4-band spectral resolution 6 meters
Other data source used	
Source #1 *Name* *Provider* *Access* *Area of interest* *Description* *Usage*	The digital solution developed has a data upload functionality allowing users to incorporate business-specific data into the platform, e.g. boundaries such as cadastral information, no go areas or buffer zones, or supply chain data such ascertified forest management units as well as supply chain specifics: • Supply chain objects: ○ Suppliers list ○ Mill list ○ Sourcing boundaries list (concession plantation estates, smallholders,etc.) • Connections: ○ The link between suppliers and mills ○ The link between boundaries and mills. Supply chain information can come from different sources: • Data of public origin e.g. open data made available by Starling and accessibleto all users via the portal • Private data, which is user-informed and strictly confidential
Add other sources if necessary	no go areas IFL (Intact Forest Landscape).
Algorithms and processing tools	
Processing details	Starling is a complete information system dedicated to identifying where natural orproductive forest is, and when forest cover change occurs, thereby supporting sustainable forest management. By design, Starling contains an imagery layer, a base map layer with a 20 year timeseries that identifies key land cover classes and, finally, a monitoring layer with analytics which displays confirmed forest cover change from forest to non-forest status, by default on a quarterly basis. Each image is computed by our internal tool (Overland) to derive from each pixel all biophysical parameters and variables which help to characterise cover or vegetation. The advantage of the biophysical parameters is that all the sensors can be analysed together with in a time series image stack based on our inhouse GeoCube technology.The GeoCube, at the core of Starling, is designed to provide a storage infrastructure that is scalable, distributed, able to ingest pre-processed information from a variety of EO systems or external data generating components, and to deliver consolidated, fully aligned information.

Feedback and evaluation	
Reproducibility	With sharp accuracy and detailed resolution, Starling's reference maps differentiate between production forests that include palm plantations, natural forests and otherareas, including other commodities. The method is replicable on other territories. Should the forest type and sensors usedbe different, this may require an adjustment of the learning process to take into account these specificities. The GeoCube solution is designed for the processing of additional heterogeneous data sources e.g aggregation of data from the BIOMASS mission and of LIDAR data,together with the already available optical and SAR data. Such a system will be capable to serve the scientific community as well as decision makers by giving access to a major playground where to develop and test their models on multiples themessuch as Carbon stocks, Climate Change, Biodiversity assessments, etc.
Accuracy	The resulting land cover and monitoring products are then quality controlled through both desktop and field based methodologies to guarantee the highest level ofaccuracy. Following quality control, land cover and monitoring products are loaded into the Starling Web Portal, which is a secure web interface that allows users to view, analyse and extract actionable intelligence.
Feedbacks	Starling is currently bringing a range of benefits to users with a corresponding impact on forest management in many places around the world. Major food and beverage companies use Starling to ensure that their commitment to No Deforestation is being achieved in their palm oil and paper based packaging sourcing regions. With the aid of Starling, they are increasing their levels of verified No Deforestation raw materials and are able to provide their suppliers with actionable intelligence of forest loss within certified and non-certified plantation areas. This has led to significant gains and cost savings in taking action to ensure that deforestation isn't linked to the production of these key raw materials. In Russia, Starling has provided a range of stakeholders with actionable intelligence on the forest status and forest loss within voluntary moratorium areas that are linked to the Dvinsky Intact Forest Landscape. Feedback has been anonymized as per the customer's request.
Pictures	
Legend:	 **Starling Basemap North-East Russia**

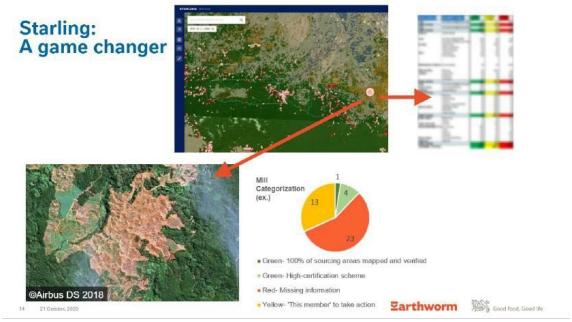
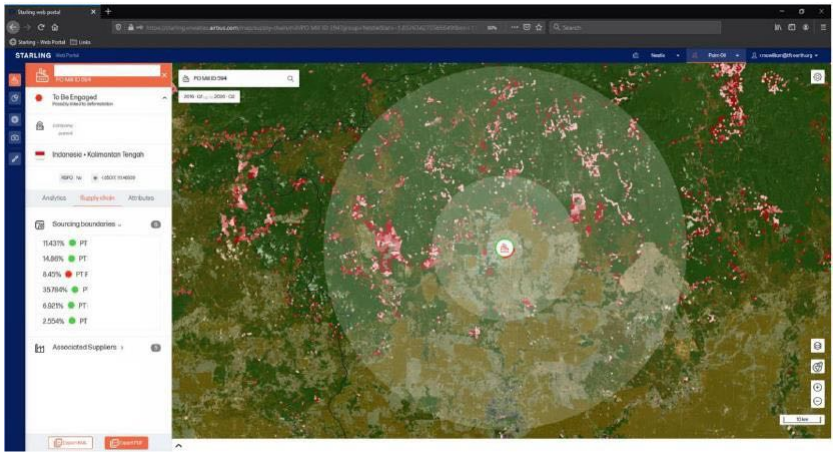
Interactive analysis (deforestation, land cover) on a map view or auser defined AOI drawn on the screen

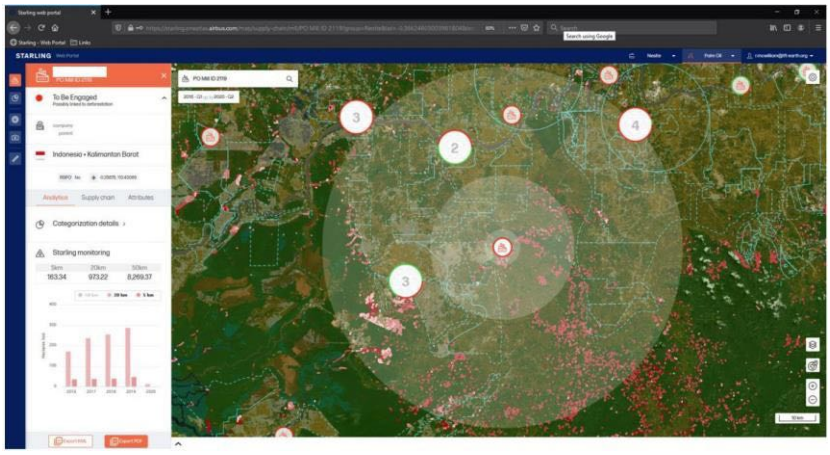
Application of Earth observation for forest management

Description of the use cases

Presentation of the company	
Name	Airbus Defence & Space
Address	5 Rue des Satellite, BP 14359 France – 31030 Toulouse
Website	https://www.intelligence-airbusds.com/markets/forestry- environment/starling/
Contact name	Wendy Carrara
Email	wendy.carrara@airbus.com
Presentation of the use case	
Type of customer	Multiple customers, including e.g. Nestlé
Area of interest	Global – 22 countries
Product category	Deforestation monitoring for Palm oil
Product description	Multiple stakeholders, including multinationals such as Nestle have committed to achieving deforestation-free commodities. Among other actors, Nestlé is supported by Starling to monitor their entire palm oil supply chain using satellite imagery across 22 countries, globally. To help understand the complex deforestation patterns around palm oilproducing areas: where deforestation occurs, what drives deforestation and who is involved. Using alerts, potential deforestation cases and risks can be identified and investigated, in collaboration with suppliers, and action taken to address where they are verified. By using Starling, a digital solution leveraging Cloud technology, machine learning and satellite technology that combines high-resolution satellite images, customers are able to access unbiased monitoring of forest cover changes. They benefit from dedicated analytics differentiating palm oil plantations from other vegetation, plantations and trees. Thanks to the development of basemaps and monitoring analytics, checks can be applied and contribute directly to a better understanding of the deforestation dynamics enabling on the timely action to be taken.
Earth Observation Images used	
Source #1 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	 Copernicus – Sentinel satellites (S1 and S2) Sentinel 1 – SAR satellite, various resolutions : 9, 20, 23, 50, 84 meters Sentinel 2 – 10, 20 or 60 meters resolution depending on the particular spectral band
Source #2 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	 NASA Landsat satellites 30 meters (visible, NIR, SWIR); 100 meters (thermal) and 15 meters (panchromatic)
Add other sources if necessary	Airbus Defence & Space Spot and Pléiades images VHR: Pléiades constellation – 50 cm spatial resolution, 4-band spectral

	resolution 2 meters. SPOT constellation – 1.5 m spatial resolution, 4-band spectral resolution6 meters
Other data source used	
Source #1 *Name* *Provider* *Access* *Area of interest* *Description* *Usage*	The digital solution developed has a data upload functionality allowing users to incorporate business-specific data into the platform, e.g. boundaries such as cadastral information, no go areas or buffer zones, orsupply chain data such as certified forest management units as well as supply chain specifics: • Supply chain objects: ○ Suppliers list ○ Mill list ○ Sourcing boundaries list (concession plantation estates, smallholders, etc.) • Connections: ○ The link between suppliers and mills ○ The link between boundaries and mills. Supply chain information can come from different sources: • Data of public origin e.g. open data made available by Starlingand accessible to all users via the portal • Private data, which is user-informed and strictly confidential
Algorithms and processing tools	
Processing details	Starling is a complete information system dedicated to identifying wherenatural or productive forest is, and when forest cover change occurs, thereby supporting sustainable forest management. By design, Starling contains an imagery layer, a basemap layer with a 20year time series that identifies key land cover classes and, finally, a monitoring layer with analytics which displays confirmed forest cover change from forest to non-forest status, by default on a quarterly basis Each image is computed by our internal tool (Overland) to derive from each pixel all biophysical parameters and variables which help to characterise cover or vegetation. The advantage of the biophysical parameters is that all the sensors canbe analysed together with in a time series image stack based on our inhouse GeoCube technology. The GeoCube, at the core of Starling, is designed to provide a storage infrastructure that is scalable, distributed, able to ingest pre-processed information from a variety of EO systems or external data generating components, and to deliver consolidated, fully aligned information.
Feedback and evaluation	
Reproducibility	The method is replicable on other territories. Should the forest type and sensors used be different, this may require an adjustment of the learning process to take into account these specificities.

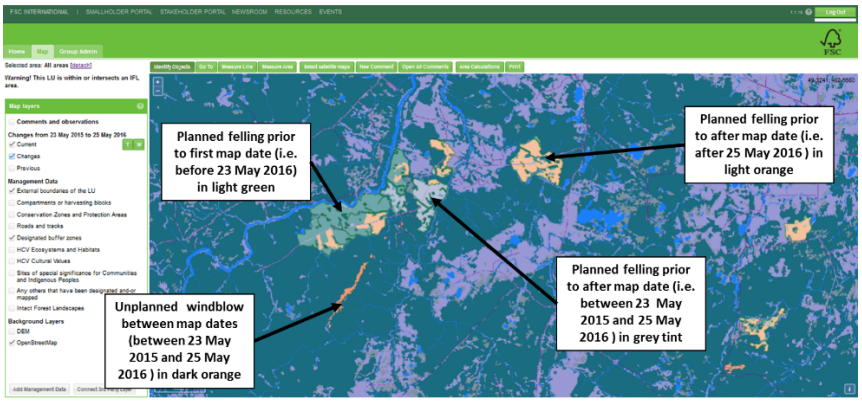
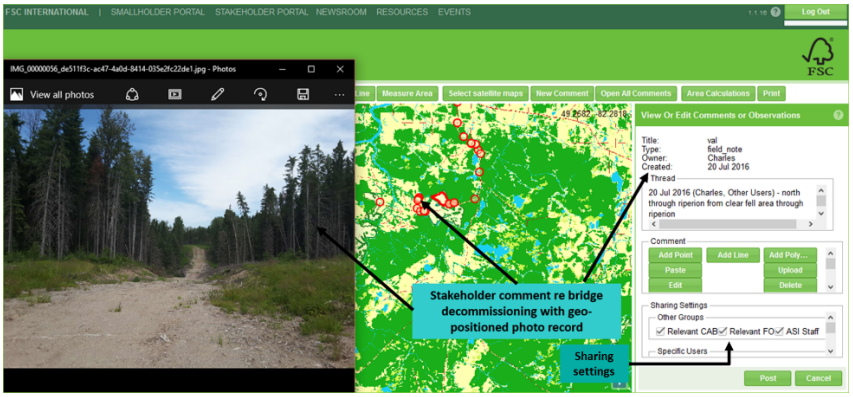
	The GeoCube solution is designed for the processing of additional heterogeneous data sources e.g. aggregation of data from the BIOMASS mission and of LIDAR data, together with the already available optical and SAR data. Such a system will be capable to serve the scientific community as well as decision makers by giving access to a major playground where to develop and test their models on multiples themessuch as Carbon stocks, Climate Change, Biodiversity assessments, etc.
Accuracy	Starling uses a combination of high resolution imagery and radar data inorder to provide monitoring of land cover change, focusing on forest cover loss. It is a private and independent tool that allowing any actor tomonitor the implementation of its No Deforestation policy. Starling usesAirbus's high-resolution SPOT 6 and SPOT 7 satellites as well as other third-party sensors. The data generated is then processed through machine learning algorithms, which are designed for large geographical areas. With sharp accuracy and detailed resolution, Starling's reference maps differentiate between production forests that include palm plantations, natural forests and other areas, including other commodities.
Feedbacks	*Francois Lombard, Director of Intelligence at Airbus Defence and Spacesaid, "Thanks to satellite imagery from space we can offer a powerful tool, bringing extensive, impartial and cost-effective information in near real time, including the ability to differentiate replanting from deforestation. Our technology allows companies to manage their operations and make informed decisions and demonstrate to all stakeholders that they are fully committed."*
Pictures	
Legend:	 

Application of Earth observation for forest management

Description of the use cases

Presentation of the company	
Name	cropix in cooperation with sarmap SA
Address	Kronenbergstrasse 7, 8800 Thalwil, Switzerland
Website	https://cropix.ch/ https://www.sarmap.ch/
Telephone	+41 76 749 22 77
Contact name	Dietrich Heintz
Email	heintz@cropix.ch
Presentation of the use case	
Type of customer	Certification provider
Area of interest	world wide
Product category	Land cover and change maps
Product description	Knowing the origin and life cycle of product constituents is important for both retailers and consumers. Independent certification provides manufacturers with confidence about their environmental and social integrity. The international standard developed by Forest Stewardship Council (FSC) provides a globally accepted route to forest management certification. FSC's mission is to "promote environmentally appropriate, socially beneficial, and economically viable management of the world's forests". However, forest certification has a number of challenges, especially the reliance on limited field inspection and the extrapolation of limited observations to support certification decisions very large forest areas. Increasing either the intensity or frequency of certification audits would be prohibitively expensive and unacceptable to the forestry community. Another solution is required. TransparentForests aims to overcome these limitations, by allowing relevant stakeholders to visualise and share key management data with each other, in the context of independent customised date stamped maps and change maps, where the dates reflect the audit period. It also aims to provide a communication platform allowing stakeholders to create and safely share information. One such client is the Forest Stewardship Council. FSC needs a practical solution to meet the following operational challenges and goals: • Maintain and improve the quality of certificates it issues especially on large forest operations, where physical access for inspection teams are limited due to time constraints and costs • Facilitate continued expansion in the area of FSC certified forests, without reduction in credibility or quality of the certificates issued • Facilitate stakeholder engagement • Increase transparency to enhance and protect brand value Certification Bodies and the Accreditation Body need: • Independent and up to date maps of certified areas to support inspections as they currently rely on data and information provided by Certificate Holders. • Greater global consistency in the information base supporting certification decisions. TransparentForests provides Certificate Holders with a tool that links them directly with the Certification Bodies and stakeholders and facilitates audit preparation and execution. They can also request state of the art map products (e.g. very high resolution land cover maps or products to measure timber volume) to support forest management activities.

	Stakeholders (NGOs, Indigenous Peoples, Forest Communities and the general public) can use TransparentForests as a new channel to engage and provide critical input on social and environmental issues. TransparentForests has to have global coverage as FSC certified forests are all over the world.
Earth Observation Images used	
Source #1	
Name	Sentinel-1
Type of image	SAR
Resolution	20x20 m
Other possible sources	
Access	
Add other sourcesif necessary	Sentinel-2 Landsat-8
Other data source used	
Source #1	
Name	GNSS
Area of interest	World-wide
Description	Positioning System
Feedback and evaluation	
Accuracy	Successfully approved
Pictures	
Legend :	 

Application of Earth Observation for Forest Management

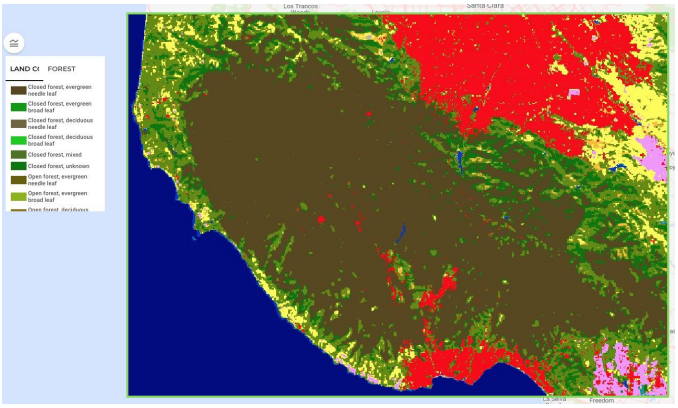
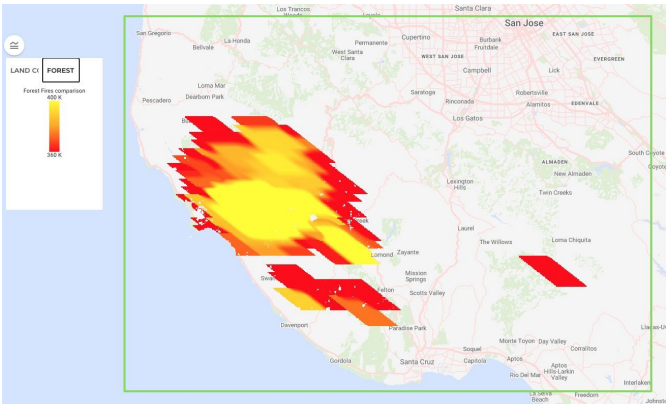
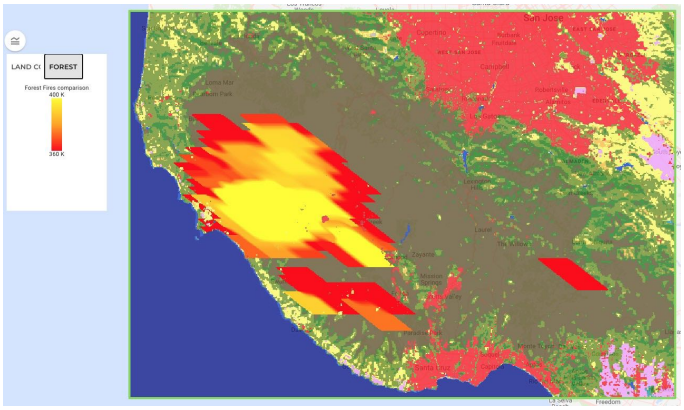
Description of the Use Cases

Presentation of the company	
Name	Earth Blox
Address	6 Redheughs Rigg, Edinburgh, Scotland, EH12 9DQ
Website	www.earthblox.io
Contact name	Sam Fleming
Email	s.fleming@earthblox.io
Presentation of the use case	
Type of customer	Insurance
Area of interest	Environmental Risk Assessment
Product category	Software as a Service (SAAS)
Product description	Earth Blox is a web-based application that is accessed via browser software. Its purpose is to perform analysis of geospatial data hosted on the Google Earth Engine (GEE) platform. The application itself is hosted on systems operated by Quosient Ltd – this is the registered name of the company that trades as Earth Blox. Typically, users of Earth Blox create analyses by visually assembling (dragging anddropping) blocks of high-level instructions that together select the data source, time period, other processing steps, and the presentation method. It is possible to store repeatable analyses methods, known as workflows, on the Earth Blox system so that they can be repeatedly reused as required by different users. The results of analyses can be downloaded to local user systems as required. **ForestRe Needed to Improve Risk Modelling** UK-based insurer, Globe Underwriting, has been dedicated to supplying insurancebrokers with first-class underwriting services at a global scale since 2008. ForestRe represents one of Globe's five key product lines - a worldwide portfolio of forestry insurance serving a wide range of customers in over 26 countries, including community forestry investment, organisations owning forests, and timber investment management organisation. ForestRe has over 25 years of knowledge on tree type vulnerability, forests, forest management, and fire behaviour. It uses this knowledge to calculate frequency, severity and, above all, the Probable Maximum Loss (PML) value of forest assets.Once the rate of loss is determined, ForestRe insures forests based on the likelihood of environmental risks, such as severe flooding, fires, and hurricanes. In recent years, largely because of climate change, ForestRe saw a greater demandfor clarity on the provenance of the data and relevant risk assessment data. More than ever, the underwriters at ForestRe needed accurate, historic data to assess risk. As a result, ForestRe searched for a research-based solution to improve the

	speed of data collection, accuracy of analysis, and quality of modelling within theirrating process. ForestRe quickly identified remotely collected Earth Observation (EO) data as a suitable alternative to their existing data sources. Unlocking a world of rapid geospatial insights would empower ForestRe to plan, prioritise, and manage environmental risks to forests. A more accurate risk assessment of their insured plantations would deliver many benefits to their business. Whilst the team at ForestRe are forest asset experts, they cannot use EO tools that typically require advanced coding ability. They surveyed the market looking for an application thatwould process EO data in a simple, fast, and effortless manner. ForestRe chose Earth Blox to meet their needs. **Earth Blox is Quick and Easy to Use** Earth Blox gives ForestRe an easy-to-use, web-based platform for near real-time geospatial analytics using Google Earth Engine (GEE) as a primary data source. It simplifies access to many petabytes of planetary-scale satellite intelligence covering forests globally. The intuitive interface attracted ForestRe users who don't have deep domain EO knowledge. Earth Blox worked with ForestRe to develop custom workflows for their specific needs including functionality to analyse forest burn scars, wildfires, and drought indices. Earth Blox continues to work closely with ForestRe risk analysts as they explore the benefits that advancedEO insights can deliver. **Earth Blox Delivers Many Business Benefits** As a result of using Earth Blox, ForestRe is competing more effectively in forest insurance internationally and is seeing excellent business growth. Earth Blox provides ForestRe with an accurate, transparent process for measuringrisk from evidentially robust EO data, removing reliance on client-based loss data,poor client data, or, in some cases, no data at all. As Earth Blox enables ForestRe to access quality data within a wider geographical spread where field research would have been impossible to carry out, an improved portfolio performance helpsForestRe generate more consistently positive and reliable underwriting results, giving the underwriting team credibility for all its markets. Head of Forestry Phil Cottle noted that thanks to Earth Blox, ForestRe is able to develop the first ever rigorous burn scar map of the world which he considers extremely valuable to investors and forest managers. Earth Blox frees up the underwriters' precious time, empowering them to increase daily efficiencies in delivering the most comprehensive risk analysis possible. This will naturally extend ForestRe's client base and help them retain existing clients, whose loyalty will grow. With a greater conversion of risk clients to buyers of insurance comes a better awareness, confidence and trust in ForestRe's insurance services, leading to a growth in commissions. In turn, ForestRe's already respectedreputation within the forestry industry can only improve.

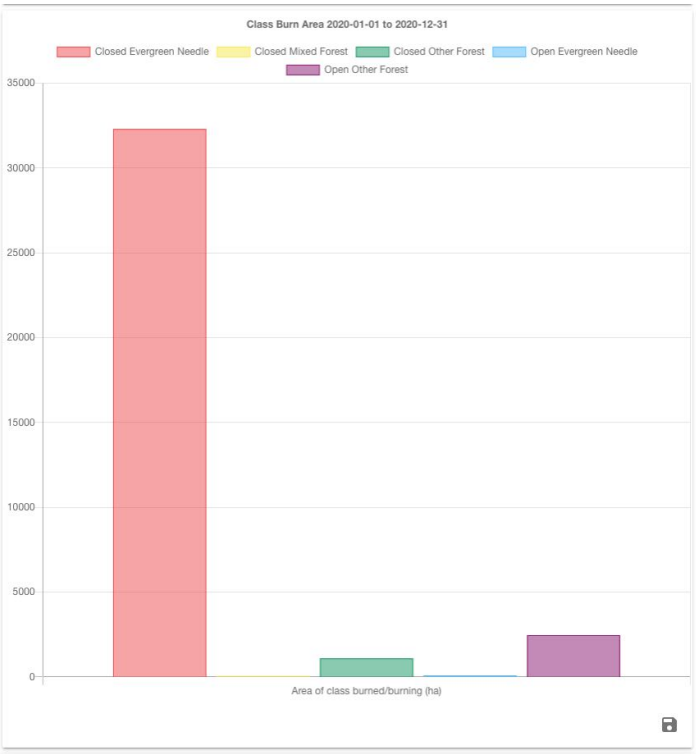
	Head of Forestry, Phil Cottle, remarks that Earth Blox is always on: "We engaged with Earth Blox just in time… because the rate of fire loss within the world means that re-insurers are running for the hills when it comes to forest fire insurance and we want to send data which is rigorous and repeatable and so on… to give them data that they can believe in and to give them more confidence so thatthey can enter or stay in this glass of business." Phil also emphasised the time-saving benefits: "(Getting results would take) easily a day before Earth Blox. And, now you could do it on Earth Blox in 45 minutes with no concerns, you just know what you're doing, and we're getting consistent results. As we use it, we learn more and moreabout how we can use it."
Earth Observation Images used	
Source #1 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	FIRMS: Fire Information for Resource Management System The Earth Engine version of the Fire Information for Resource Management System (FIRMS) dataset contains the LANCE fire detection product in rasterized form. The near real-time (NRT) active fire locations are processed by LANCE using the standard MODIS MOD14/MYD14 Fire and Thermal Anomalies product.Each active fire location represents the centroid of a 1km pixel that is flagged by the algorithm as containing one or more fires within the pixel. The data are rasterized as follows: for each FIRMS active fire point, a 1km bounding box (BB) isdefined; pixels in the MODIS sinusoidal projection that intersect the FIRMS BB are identified; if multiple FIRMS BBs intersect the same pixel, the one with higherconfidence is retained; in case of a tie, the brighter one is retained. Accessed via the Earth Blox platform from Google Earth Engine.
…	The above data source is just one of the most commonly used by our customers for Forestry related activities. However, we are able to provide commercial access to the world's largest repository of satellite imagery, Google Earth Engine. The Google Earth Engine catalogue can be browsed here – https://developers.google.com/earth-engine/datasets
Other data source used	
Source #1 *Name* *Provider* *Access* *Area of interest* *Description* *Usage*	Copernicus Global Land Cover Layers: CGLS-LC100 Collection 3 Copernicus Land Service Accessed via the Earth Blox platform from Google Earth Engine.Global The Copernicus Global Land Service (CGLS) is earmarked as a component of the Land service to operate a multi-purpose service component that provides a seriesof bio-geophysical products on the status and evolution of land surface at global scale.

	The Dynamic Land Cover map at 100 m resolution (CGLS-LC100) is a new product in the portfolio of the CGLS and delivers a global land cover map at 100 mspatial resolution. The CGLS Land Cover product provides a primary land cover scheme. Next to these discrete classes, the product also includes continuous field layers for all basic land cover classes that provide proportional estimates for vegetation/ground cover for the land cover types. This continuous classification scheme may depict areas of heterogeneous land cover better than the standard classification scheme and, as such, can be tailored for application use (e.g. forest monitoring, crop monitoring, biodiversity and conservation, monitoring environment and security in Africa, climate modelling, etc.). These consistent Land Cover maps (v3.0.1) are provided for the period 2015-2019 over the entire Globe, derived from the PROBA-V 100 m time-series, a database ofhigh quality land cover training sites and several ancillary datasets, reaching an accuracy of 80% at Level1 over al years. It is planned to provide yearly updates from 2020 through the use of a Sentinel time-series.
...	The above data source is just one of the most commonly used by our customers for Forestry related activities. However, we are able to provide commercial access to the world's largest repository of satellite imagery, Google Earth Engine. The Google Earth Engine catalog can be browsed here – https://developers.google.com/earth-engine/datasets
Algorithms and processing tools	
Processing details	Earth Blox provides rich functionality for performing detailed analysis of satellite imagery by leveraging the processing power and capabilities of Google Earth Engine. Users create their own workflows to process and analyse the data in a way that is customised to their specific needs. In this use case the ForestRe use Earth Blox to select Active Fire data for the location and time period of their choice. They then cross-reference this with the Copernicus Land Cover dataset to understand the fire impacts on different types offorest in their area of interest. The Land Cover dataset is used to mask out land covers which are not forest, and therefore not of interest. This information is then tabulated to provide the statistical information aboutfires in the area of interest.
Feedback and evaluation	
Reproducibility	Earth Blox enables users to save and share workflows, meaning that analyses canbe easily repeated and reproduced. This provides benefits to our users as they donot need to store and retain results, and can quickly and easily produce outputs when required.
Accuracy	Google Earth Engine is the world's largest satellite data repository and we will provide commercial access to all 38 petabytes of datasets to its users and its agents for humanitarian and environmental purposes. Earth Blox is a web-based application that is accessed via browser software. Its purpose is to perform analysis of geospatial data hosted on the Google Earth Engine (GEE) platform.

Pictures	
Legend:	  

Class Burn Area 2020-01-01 to 2020-12-31

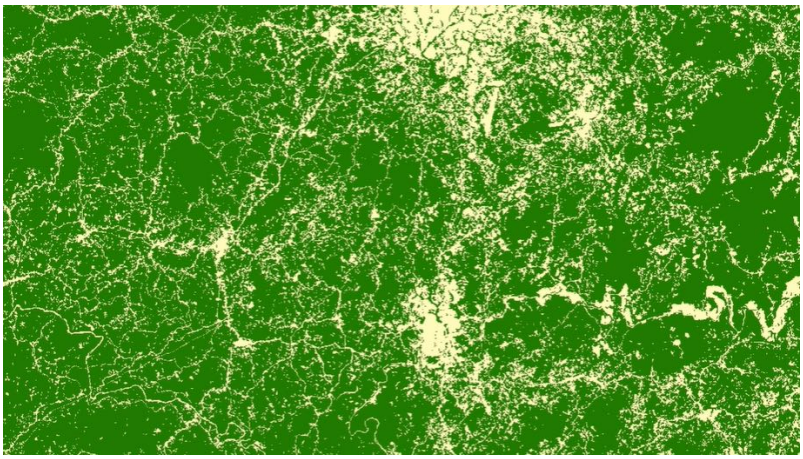
	Area of class burned/burning (ha)
Closed Evergreen Needle	32303.8
Closed Mixed Forest	52.5
Closed Other Forest	1090.6
Open Evergreen Needle	86.7
Open Other Forest	2455.7



Application of Earth observation for forest management

Description of the use cases

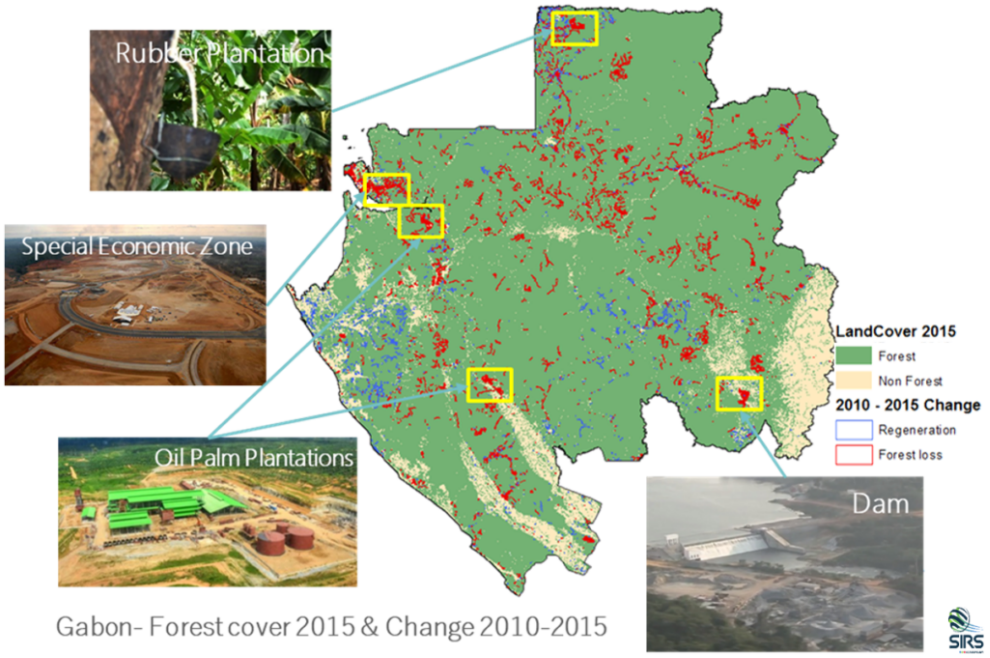
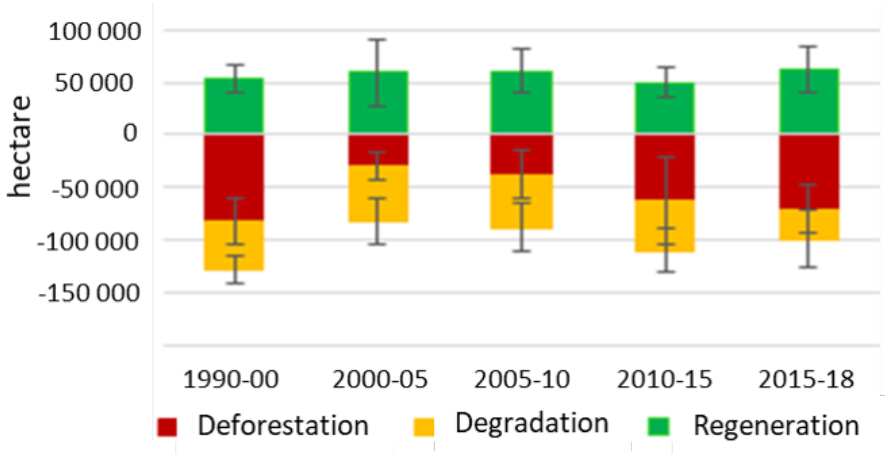
Presentation of the company	
Name	GAF AG
Website	https://www.gaf.de/
Presentation of the use case	
Type of customer	Stakeholders with activities related to: • forest management • forest restoration • REDD+ • land-use planning (as it offers an accurate calculation of the spatial extent and location of forested areas and changes within those areas) Furthermore as input for: • Assessment of Activity Data for REDD+ • Analysis of Degradation and Deforestation • Sustainable Forest Management (SFM) • Forest Landscape Restoration (FLR) • Identification of High Carbon Stock (HCS) forests • Forest management/ planning • Input variable to spatially explicit modelling of forest biomass and change
Area of interest	Regional, National, Sub-national and Local
Product category	Forest Area and Change
Product description	The Forest Area and Change products form the basis for determining gross deforestation rates and for the detection of forest regrowth or replanting. They are used as the benchmark for deforestation/disturbance detection byearly warning systems. There are two related capabilities: • The **Forest Area Status** shows the extent of the forest at a given point in time. This product takes into account country-specific forest definitions, such as the minimum area of a forest patch and minimum canopy cover density. All forest types are consolidated into a single 'forest' category; other land cover types are aggregated into a 'non-forest' category.The **Forest Area Status** product is derived from high resolution (HR) satellite data. • The corresponding **Forest Change** product is derived by a direct time series image classification approach to identifystable and non-stable forest areas.

Earth Observation Images used	
Source #1 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	High Resolution (HR) satellite data, (e.g. Sentinel-1 and Sentinel-2) with 10 m resolution from 2016 onwards; historic Landsat Missions data with 30 m resolution from around 1990.
Feedback and evaluation	
Reproducibility	High
Accuracy	Status products: > 90% Change products: > 80% Positional accuracy: < 1 pixel of source imagery
Pictures	
	 **The animated image example above shows an example of Forest Area change mapping at 20m spatial resolution.**

Application of Earth observation for forest management

Description of the use cases

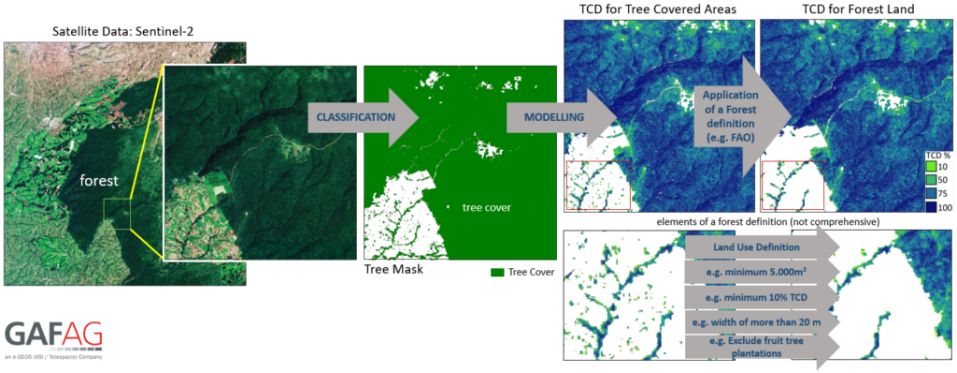
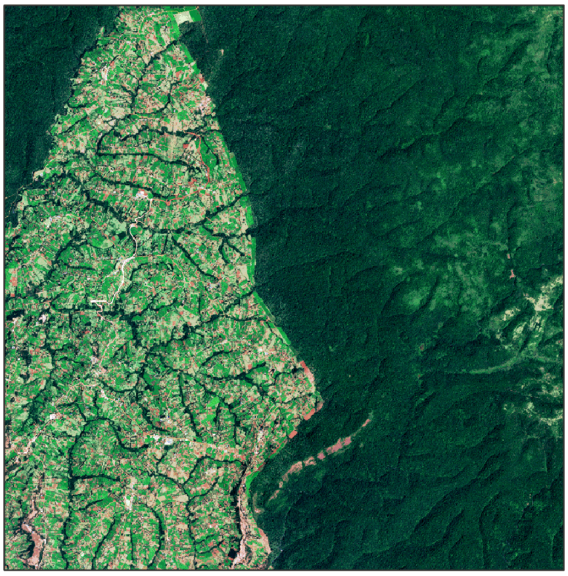
Presentation of the company	
Name	GAF AG
Website	https://www.gaf.de/
Presentation of the use case	
Type of customer	Stakeholders with activities related to: • accurate assessment of forest extent, loss and gain • identification of areas of deforestation. • also in combination with emission factors (EF) to assess the greenhouse gas (GHG) emissions associated with land and forest change Furthermore: • Assessment of Activity Data for REDD+ • Analysis of Degradation and deforestation • Sustainable Forest Management (SFM) • Forest Management / planning • Planning of Forest Landscape Restoration (FLR)
Area of interest	Regional, National, Sub-national, Local
Product category	Land Use / Land Cover Change
Product description	The Land Use /Land Cover and Change products present the status of, and changes in, land use andland cover. The information is derived from high resolution (HR) satellite data of a spatial resolution between ten and thirty meters. The **Land Use/ Land Cover Status** product uses a (hierarchical) land use/ land cover classificationscheme, where land cover and/or functional use of land is presented at a granularity level that matches that of the satellite data. The **Land Use/ Land Cover Change** product shows the conversion of land use/ land cover from oneclass to another between two points in time. The classification scheme for a status and a change product can be adapted to user requirements. Land use/ land cover and change maps provide fundamental base information for a wide variety offorest monitoring and spatial planning tasks.
Earth Observation Images used	
Source #1 *Name*	High resolution (HR) satellite data e.g. Sentinel-2 with 10m resolution. Historic Landsat data with 30m resolution.

Feedback and evaluation	
Reproducibility	High
Accuracy	Overall thematic accuracy: > 85 – 90%. Positional accuracy: < 1 pixel of source imagery.
Pictures	
Legend :	 

Application of Earth observation for forest management

Description of the use cases

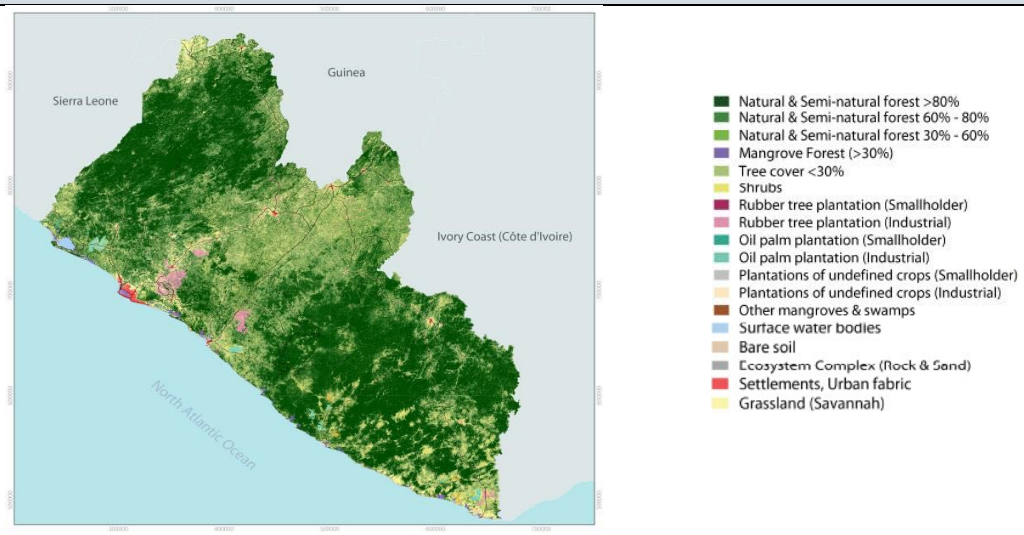
Presentation of the company	
Name	GAF AG
Website	https://www.gaf.de/
Presentation of the use case	
Type of customer	Stakeholders with activities related to: • Assessment of Activity Data for REDD+ • Analysis of Degradation and Deforestation • Sustainable Forest Management (SFM) • Forest Landscape. Restoration (FLR) • Identification of High Carbon Stock (HCS) forests • Forest management/ planning • Input variable to spatially explicit modelling of forest biomass and change
Area of interest	Regional, National, Sub-national and Local.
Product category	Tree Cover Density (TCD) and Tree Cover Change
Product description	The **Tree Cover Density (TCD) product** is directly derived from high resolution(HR) satellite data and provides information on the proportional canopy coverage per satellite pixel in a range of 0 to 100%. When the TCD assessment is based on the Copernicus Sentinel-2 satellite imagery, then the information can be provided in a 10m by 10 m resolution on a regular basis in a spatially explicit wall-to-wall representation. The TCD product is a key input/ precursor for deriving forest maps following a specific forest definition, e.g. FAO definition, national definition. By applying geo-spatial operations with key parameters of forest definitions, like minimum area, minimum width and minimum canopy cover density, very accurate forest area maps can be achieved. A **Tree Cover Change** product is derived by combining satellite data from two points in time for a direct classification of stable tree covered areas, stable non tree covered areas and change areas (tree cover loss and tree cover gain). The Tree Cover Densities are then modelled on the Tree Cover Change product based on the later point in time.
Earth Observation Images used	
Source #1 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	 High Resolution (HR) satellite data, e.g. Sentinel-2 with 10 m resolution, historic Landsat data with 30 m resolution.

Feedback and evaluation	
Reproducibility	High
Accuracy	Overall thematic accuracy: > 85 – 90%. Positional accuracy: < 1 pixel of source imagery
Pictures	
Legend:	  Copernicus Sentinel-2 Image

Application of Earth observation for forest management

Description of the use cases

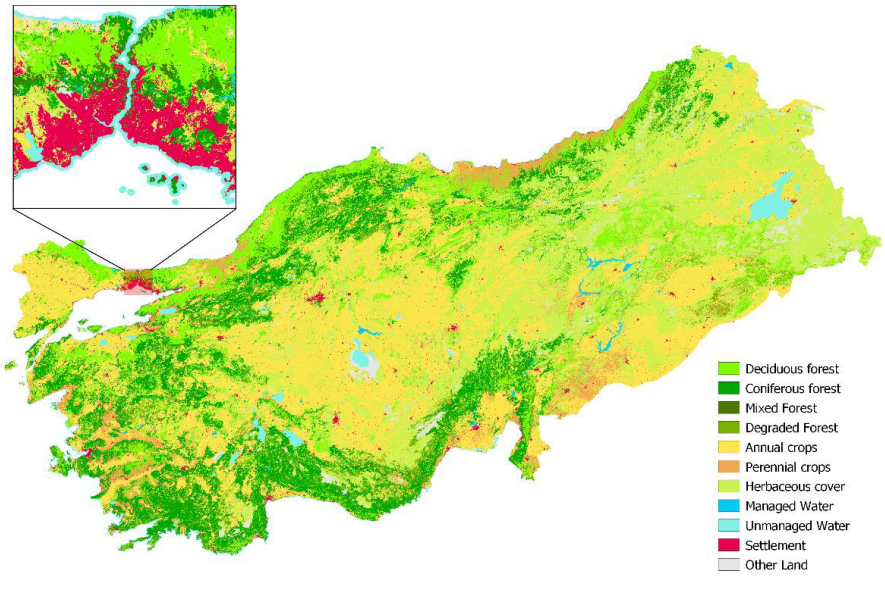
Presentation of the company	
Name	GeoVille
Address	Sparkassenplatz 2, 6020 Innsbruck, Austria
Website	www.geoville.com
Telephone	+43 512 562021-0
Contact name	Jürgen Weichselbaum
Email	weichselbaum@geoville.com
Presentation of the use case	
Type of customer	Public authorities : Forest Development Authority of Republic of Liberia, funded byWorld Bank
Area of interest	111,369 square kilometers
Product category	Detection of forest areas, REDD+ monitoring
Product description	Production and update of the Liberia Land Cover and Forest Map as a compliant baseline for assessment of Liberia's natural resources and specifically for land degradation activity monitoring as well as biomass and emission estimations for MRV in REDD+
Earth Observation Images used	
Source #1 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	 Sentinel-2 Multispectral 10/20m
Add other sourcesif necessary	Sentinel-1 SAR, 10m Landsat, Multispectral, 30mRapidEye, Multispectral, 6m
Other data source used	
Source #1 *Name* *Provider* *Access* *Area of interest* *Description* *Usage*	 Concession boundaries, mangrove survey, primary & secondary roads, on-site reference data acquired during field campaign FDA, LISGIS Liberia Various reference data for calibration/validation Partly open access
Algorithms and processing tools	
Processing details	Time-series based image classification for reference year 2016 and update for 2018 Modification of nomenclature to new Liberian forest definition, incl. a separate mapping of oil palm and rubber tree plantations
Feedback and evaluation	
Reproducibility	The method is fully replicable to all REDD+ countries. Cloud coverage of opticalimagery must be mitigated through the use of SAR imagery.

Accuracy	Minimum mapping unit between 0,5ha (forest and urban/rural classes) to 1ha(plantations) Overall thematic accuracy validated by independent field data: 92,6%
Feedbacks	Need for training data for the models. Specificity and diversity of forest types to betaken into account on the same territory.
Pictures	
REDD+ forest & land cover map for Liberia, 2018	

Application of Earth observation for forest management

Description of the use cases

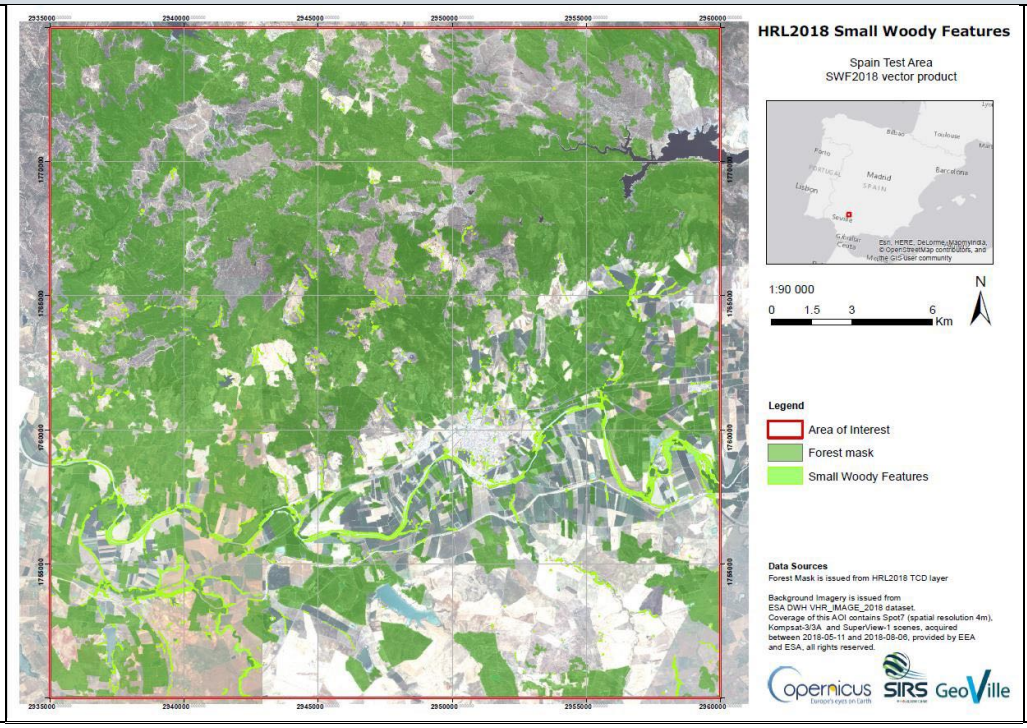
Presentation of the company	
Name	GeoVille
Address	Sparkassenplatz 2, 6020 Innsbruck, Austria
Website	www.geoville.com
Telephone	+43 512 562021-0
Contact name	Jürgen Weichselbaum
Email	weichselbaum@geoville.com
Presentation of the use case	
Type of customer	*Contractor*: Central Finance and Contracts Unit (CFCU), Undersecretariat of Treasury ofthe Prime Ministery *Benificiary*: Ministry of Environment and Urbanization (MoEU), Turkey
Area of interest	783,356 km2
Product category	Historic LULUCF detection and change monitoring and reporting
Product description	Three annual Landcover/Landuse maps and statistical information on the annual changes and transitions from one landcover/landuse to another for the 26-year period from 1990 until 2015 (incl.). The class definitions and transitionperiods are in line with the LULUCF reporting requirements put forth by the UNFCCC.
Earth Observation Images used	
Source #1	
Name	Landsat 4-8
Type of image	Multispectral
Resolution	30m
Other possible sources	Sentinel 1 & 2 for future implementations
Access	Open
Other data source used	
Source #1	
Name	Copernicus HR layers (Forest, Imperviousness, Water, Grassland)Copernicus
Provider	Programme
Access	Online Copernicus Land Monitoring Portal
Area of interest	Turkey
Description	Various reference data for calibration/validation
Usage	Open access
Source #2	
Name	Copernicus Corine Landcover
Provider	Copernicus Programme
Access	Online Copernicus Land Monitoring Portal
Area of interest	Turkey
Description	Various reference data for calibration/validation
Usage	Open access

Algorithms and processing tools	
Processing details	Time-series based image classification for the 26 year-period between 1990 and 2015. Annual maps were produced for 1990, 2000, and 2015 while all annual changes are derived from a change vector analysis of the intermediateLandsat time series to produce quantified annual changes for each calendar year.
Feedback and evaluation	
Reproducibility	The method is documented and fully replicable. The historic assessments arebased on Landsat archive data and future implementations shall be based on the higher resolved Sentinel data streams, including Sentinel 1 SAR imagery.
Accuracy	Minimum mapping unit of 1ha Overall thematic accuracy of the annual LULUCF maps: 88% - 90%.
Feedbacks	The products were accepted and integrated into Turkey´s national emissions reporting system to the UNFCCC.
Pictures	
Legend: LULUCF mapfor the base year 1990 with a snapshot for Istanbul.	

Application of Earth observation for forest management

Description of the use cases

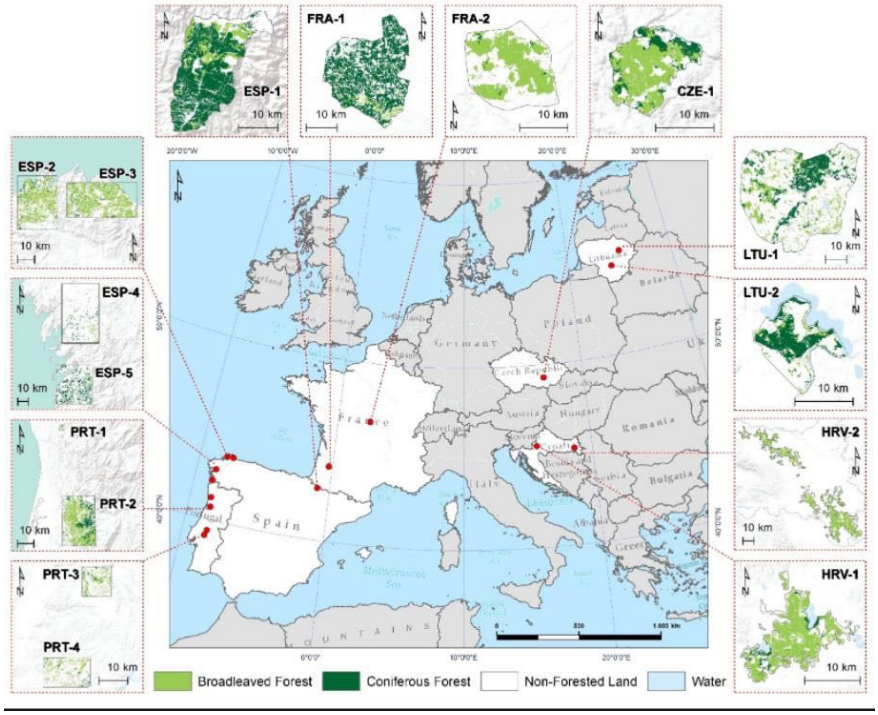
Presentation of the company	
Name	GeoVille
Address	Sparkassenplatz 2, 6020 Innsbruck, Austria
Website	www.geoville.com
Telephone	+43 512 562021-0
Contact name	Christian Schleicher
Email	schleicher@geoville.com
Presentation of the use case	
Type of customer	European Environment Agency - EEA
Area of interest	6.002.096 square kilometers
Product category	Copernicus Land monitoring services High Resolution land cover characteristics for the 2018 reference year
Product description	Update and production of the Small Woody Feature (SWF) High Resolution layer for the 2018 reference year, and new change products between the reference years 2015 and 2018. Small woody landscape features (i.e. linear structures and isolated patches of trees, hedgerows and scrubs) are important vectors of biodiversity and provide information on the fragmentation and connectivity of habitats, especially considering the importance of Green Infrastructure and hazard protection contributing to monitor and evaluate the SDGs, the Green Deal initiative and CAP greening.
Earth Observation Images used	
Source #1	
Name	VHR (VHR_IMAGE_2018/ VHR_IMAGE_2018_ENHANCED) Pléiades 1A & 1B, PlanetScope, SuperView-1, Kompsat-3/3A
Type of image	Multispectral
Resolution	2-4 m
Other possible sources	SPOT6/7, TripleSat
Access	ESA CSCDA
Source #2	
Name	VHR (VHR_IMAGE_2015) Pléiades 1A & 1B, PlanetScope, SuperView-1, Kompsat-3/3A, SPOT6/7,TripleSat
Type of image	Multispectral1 to 2-4 m
Resolution	
Other possible sources	ESA CSCDA
Access	
Other data source used	
Source #1	
Name	HRL TCD 2018
Provider	EEA
Access	Copernicus land monitoring
Area of interest	EEA39
Description	Tree Cover Density product consists of the status layers showing the level of treecover density in a range from 0-100%, for the 2012, 2015 and 2018 reference years
Usage	Sample points, masking
Source #2	
Name	HRL SWF 2015
Provider	EEA

Access	Copernicus land monitoring
Area of interest	EEA39
Description	The HRL Small Woody Features provides harmonized information on linear structures such as hedgerows, as well as patches of woody features across the EEA39 countries
Usage	Sample points, Change product
Algorithms and processing tools	
Processing details	• Fully operational SWF pre-classification processing chain based on state-of-the-art Machine Learning algorithm • Additional post-processing approach to improve the connectivity ofcontiguous SWF • Processing chain relies on open-source tools and algorithms implemented ina dedicated cloud environment and thus fully reproducible • Cloud infrastructure for the pre-classification of SWF was selected for its scalability and customization capabilities, as part of the ongoing EU wide GAIA + initiative for a federated European data infrastructure.
Feedback and evaluation	
Reproducibility	Reproducibility is ensured by the use of these standards, the provision of technical specifications during the development and production phases and through the detailed description of the processing environment.
Accuracy	80 % for Overall thematic Accuracy, User's Accuracy and Producer's Accuracy. For the linear elements no MMU is applied. For patchy structures of trees andscrub the MMU is > 200 m2 (size limit of 50 000m2). The MMW for linear structures/elements is >= 30m. The MML for linear structures/elements is of <= 30 m length. For Patchy structures no MML is applied. The positionalaccuracy is less than 5 m.
Feedbacks	Product accepted by EEA and integrated in CLMS portfolio.
Pictures	
Copernicus Land Monitoring Service: SmallWoody Features 2018 Vector product	

Application of Earth observation for forest management

Description of the use cases

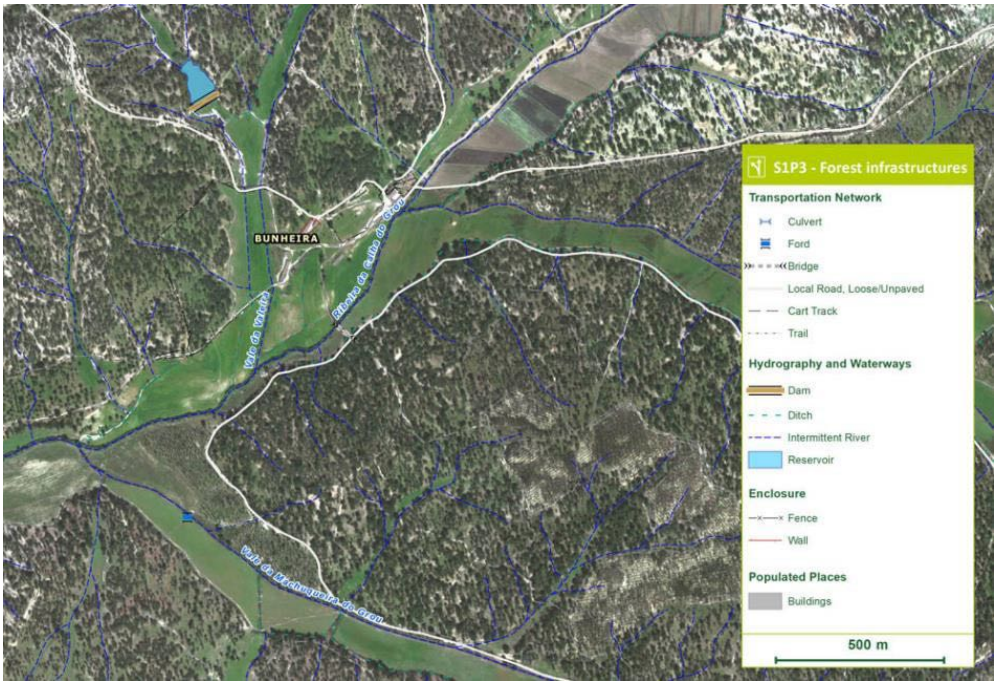
Presentation of the company	
Name	GMV
Address	Isaac Newton, 11 P.T.M. Tres CantosE- 28760 Madrid
Website	www.gmv.com
Telephone	Tel. +34 91 807 21
Contact name	Ana Sebastián / María Julia Yagüe
Email	asebastian@gmv.com / mjyague@gmv.com
Presentation of the use case	
Type of customer	Institutional (public), private, NGO
Area of interest	Dominican Republic, Croatia, Lithuania, Czech Republic, Portugal, France, Spain
Product category	**Forest Characterization Service**: provides facts on the status and condition of predefined forest properties: forest extension, stand delineation, forest infrastructures, main forest types, stand variables (dominant height, stand age, stand density), forest disturbances (clear cuts, fire scars), topography (DEM, slope, aspect). Example in this template: **Forest Mask product**
Product description	**The Forest Mask** is a binary product identifying the forest lands. This product is the basis for other products such as forest type classification or vegetation stress monitoring. The product adapts to the definition of forest valid in each country. Temporal coverage: several images are required to include seasonal foliage conditions in the same reference year. Final product is a binary forest /non-forest classification that has 10 m or 2 m resolution data, depending on the source image, with a 0,1 ha or 0,004 MMU, respectively, and it is delivered in TIFF format with metadata (TXT). Spatial coverage: it can be generated anywhere in the world.
Earth Observation Images used	
Source #1 *NameType of imageResolution Other possible sources Access*	Two options: - Sentinel 2 data - Multispectral - 10/20 m - Not applicable. - Open source - ESA Hub
Add other sources ifnecessary	- Optical VHR imagery (e.g. RapidEye, WorldView…), depending on the need, availability and quality
Algorithms and processing tools	

Processing details	The Forest Mask classification is performed using a supervised Machine Learning algorithm trainedwith more than 2500 samples across Europe.
Feedback and evaluation	
Reproducibility	The product, both at 10m or at 2m spatial resolution, is reproducible anywhere in the world.It has also been derived in other countries, such as Mozambique or Dominican Republic.
Accuracy	Accuracy = 96.3%, Omission Error = 2.4%, Commission Error = 4.5%See details in https://www.mdpi.com/2072-4292/12/19/3159 *Designing a Validation Protocol for Remote Sensing Based Operational Forest Masks Applications.Comparison of Products Across Europe. Remote Sensing. 2020 12(9)* https://doi.org/10.3390/rs12193159 *by A. Fernandez-Carrillo et al.*
Feedbacks	According to end-users, main applications of this mask are: • Forest Inventory • Forest and Natural Resources Management • Land Use Land Cover Planning and Dynamics monitoring • Environmental Impact Assessment • Deforestation and Degradation analyses • Biomass estimation and carbon offsets projects • Canopy cover fraction • Biodiversity conservation • Forest fire-fighting plans
Pictures	
Legend:	

Application of Earth observation for forest management

Description of the use cases

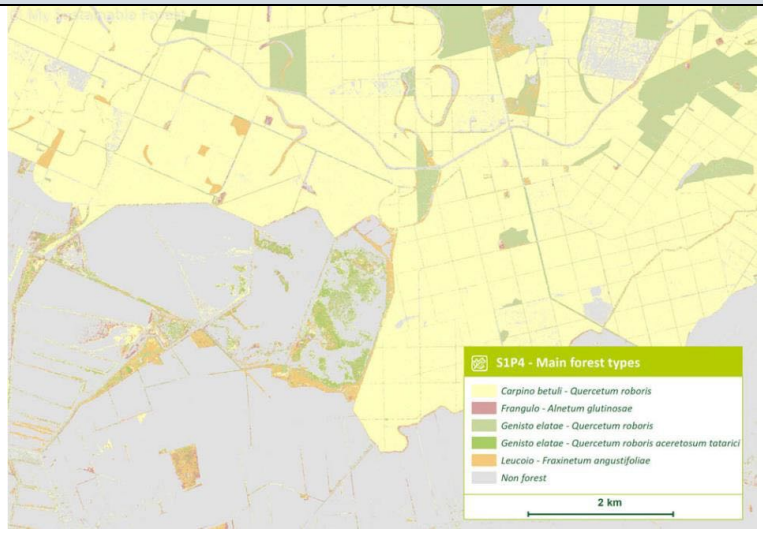
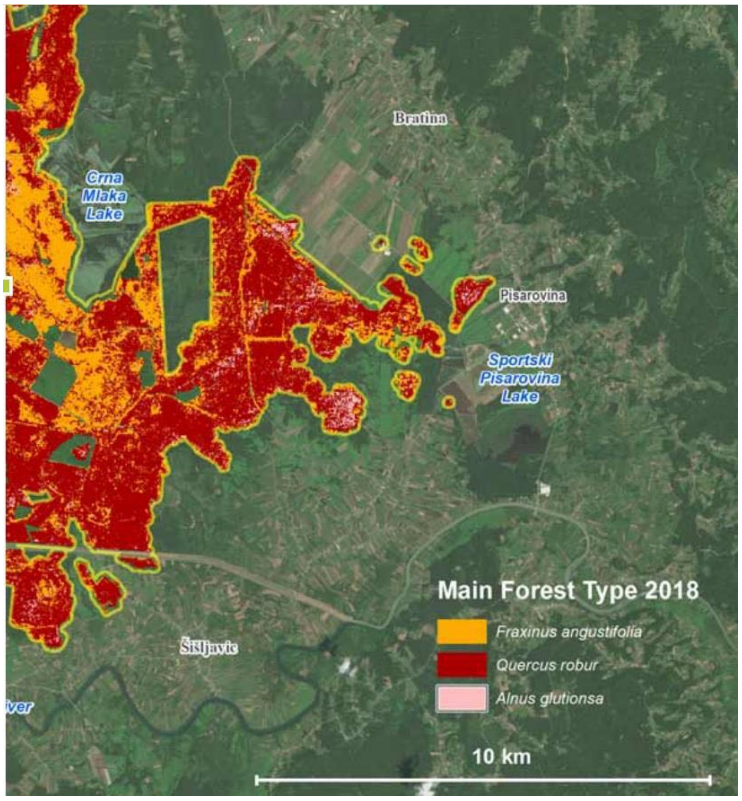
Presentation of the company	
Name	GMV
Address	Isaac Newton, 11 P.T.M. Tres CantosE- 28760 Madrid
Website	www.gmv.com
Telephone	Tel. +34 91 807 21
Contact name	María Julia Yagüe
Email	mjyague@gmv.com
Presentation of the use case	
Type of customer	Institutional (public), private (several forest owners associations)
Area of interest	Croatia, Lithuania, Czech Republic, Portugal, France, Spain
Product category	**Forest Characterization Service**: provides facts on the status and condition of predefined forestproperties: Forest extension, stand delineation, forest infrastructures, main forest types, stand variables (dominant height, stand age, stand density), forest disturbances (clear cuts, fire scars), topography (DEM, slope, aspect). Example in this template: **Forest Infrastructures**
Product description	Geo-database of forest infrastructures, adapted from the international cartographic standard MGCP.Working scale 1:5,000. Thematic classes of features: transportation networks, hydrology, populated places, industry, energy and LULC. Features are attributed with descriptive data for consultation. INSPIRE standards apply. Spatial coverage: this product can be generated anywhere in the world
Earth Observation Images used	
Source #1 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	Very High Resolution (VHR) imagery Pleiades, Worldview, … depending on availability
Add other sources if necessary	Hybrid SRTM and ASTER GDEM (25m)
Algorithms and processing tools	
Processing details	Features are manually extracted by experts following the Multinational Geospatial Co-productionProgram (MGCP) protocols. Extraction scale is set to 1:2,000.
Feedback and evaluation	
Reproducibility	The product is reproducible anywhere in the world thanks to the MGCP standard

Accuracy	Geometric accuracy: 99% Thematic accuracy: 95%; rms max : 1m
Feedbacks	Main applications of this product are: • Infrastructures Access and Maintenance • Forest Inventory and Management Plan • Land Use Land Cover Dynamics • Environmental Assessment The representation scale is Representation: 1:5,000; whereas feature are extracted at 1:2,000MMU, and it is delivered in Tiff format with metadata (.txt)
Pictures	
Legend:	

Application of Earth observation for forest management

Description of the use cases

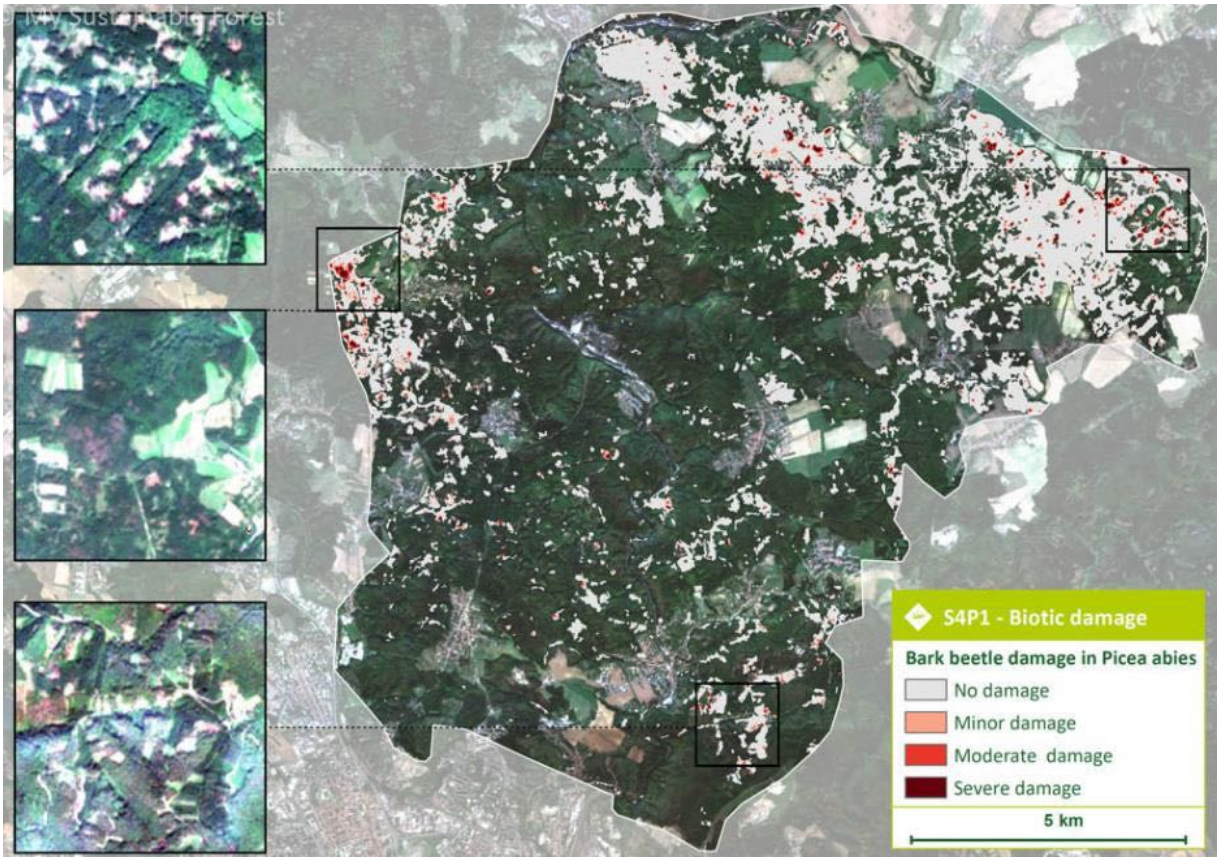
Presentation of the company	
Name	GMV
Address	Isaac Newton, 11 P.T.M. Tres CantosE- 28760 Madrid
Website	www.gmv.com
Telephone	Tel. +34 91 807 21
Contact name	Ana Sebastian / Maria Julia Yague
Email	asebastian@gmv.com /mjyague@gmv.com
Presentation of the use case	
Type of customer	Institutional (public), private (Forest owners association), NGO
Area of interest	Croatia, Lithuania, Czech Republic, Portugal, France, Spain
Product category	**Forest Characterization Service**: provides facts on the status and conditionof predefined forest properties: forest extension, stand delineation, forest infrastructures, main forest types, stand variables (dominant height, stand age, stand density), forest disturbances (clear cuts, fire scars), topography (DEM, slope, aspect). Example in this template: **Main Forest Types and VHR Main Forest Types**
Product description	Map showing the spatial distribution of the dominant species. It also identifiesthe probability of co-occurrence of species within an area. The current product has been tested over 50 species (e.g. *Abies alba, Pinus pinea, Populus tremula, Acacia dealbata, Eucaliptus globulus,* etc.) - Spatial resolution: 10 m or 2 m (VHR); - Minimum Mapping Unit (MMU): 0,1 ha or 0,004 ha - Spatial coverage: calibrated for forests in Europe, but could be extrapolated toother areas if ground data to re-train the classifier is available. -Temporal coverage: Several images are required to include seasonal foliageconditions in the same reference year
Earth Observation Images used	
Source #1 *Name* *Type of image* *Resolution* *Other possible sources Access*	- Sentinel-2 imagery - Multispectral - 10/20 m - Not applicable. - Open source
Add other sources if necessary	- Diverse Very High Resolution (VHR) imagery - Commercial access
Other data source used	
Source #1 *Name* *Provider* *Access* *Area of interest* *Description* *Usage*	 Forest species ground truth samples End-user/National Forest Inventory/ Forest Management Plans Samples are needed to characterize dominant species within an areaThis data is used to train the algorithm
Algorithms and processing tools	
Processing details	Different supervised Machine Learning algorithms are combined to produce themaps. A preliminary desk study of dominant species or forest communities is required

Feedback and evaluation	
Reproducibility	The product, both at 10m or at 2m spatial resolution, is reproducible anywhere inthe world
Accuracy	85-90%, tested in 16 sites across Europe
Feedbacks	According to the end-users, main applications of this product are: • Infrastructures Access and Maintenance • Forest Inventory and Management Plan • Land Use Land Cover Dynamics • Environmental Assessment• Species probability maps can be used to estimate potential biodiversity
Pictures	
Legend : Main Forest Types in Valle del Roncal (Navarra, Spain) and in Pokupsko BasinForest, Karlovac, Croatia	 

Application of Earth observation for forest management

Description of the use cases

Presentation of the company	
Name	GMV
Address	Isaac Newton, 11 P.T.M. Tres CantosE- 28760 Madrid
Website	www.gmv.com
Telephone	Tel. +34 91 807 21
Contact name	María Julia Yagüe / Ana Sebastian
Email	mjyague@gmv.com /asebastian@gmv.com
Presentation of the use case	
Type of customer	Institutional (public), research : University Forest Enterprise Masaryk Forest Křtiny of MendelUniversity in Brno
Area of interest	Croatia, Lithuania, Czech Republic, Portugal, France, Spain
Product category	**Forest Condition Service:** The Forest Condition Service monitors and measures forest healthcondition, identifying stressed vegetation, due to drought, plagues or any other hampering cause. Example in this template: **Biotic Damage Product**
Product descriptio n	This product detects the occurrence of a pest outbreak or disease, estimates the forest loss and the areaaffected, eventually updating the Forest Mask- - Spatial resolution: 10 m; - Minimum Mapping Unit (MMU): 0,1 ha - Spatial coverage: The model was developed in mixed forests in the Czech Republic. It can however be adapted to other areas in Europe. -Temporal coverage: Several images are required to perform a monitoring of pest outbreaks and diseases. *More detail in: Fernandez-Carrillo, A.; Patočka, Z.; Dobrovolný, L.; Franco-Nieto, A.; Revilla- Romero, B. Monitoring Bark Beetle Forest Damage in Central Europe. A Remote Sensing Approach Validated with Field Data. Remote Sens. **2020**, 12, 3634. https://doi.org/10.3390/rs12213634 https://www.mdpi.com/2072-4292/12/21/3634/htm*
Earth Observation Images used	
Source #1 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	- Sentinel-2 imagery - Multispectral - 10/20 m - Not applicable. - Open source
Other data source used	
Source #1 *Name* *Provider* *Access Area of interest* *Description* *Usage*	*Ground Truth Data:* Records of salvage cutting and records of clear-cuts These ground truth data were used to build the ground truth dataset, together with a forest stand mapderived from forest management plan (valid for the period 2013–2022).

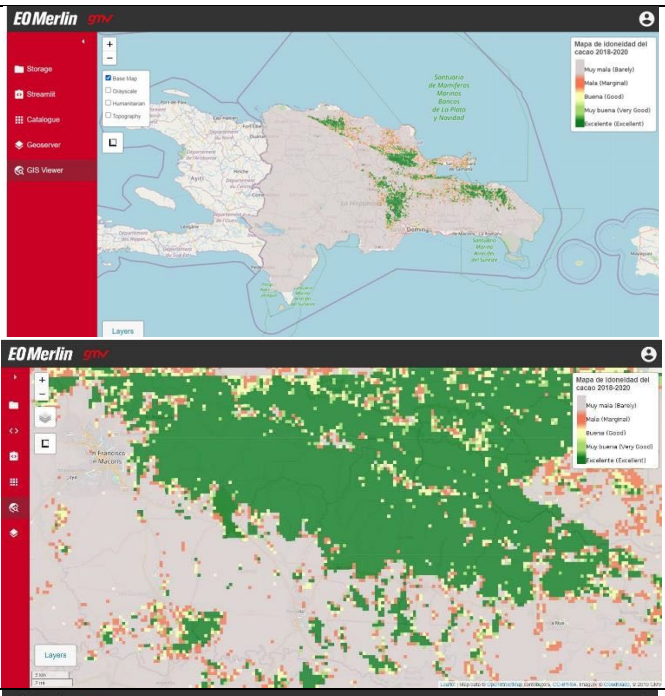
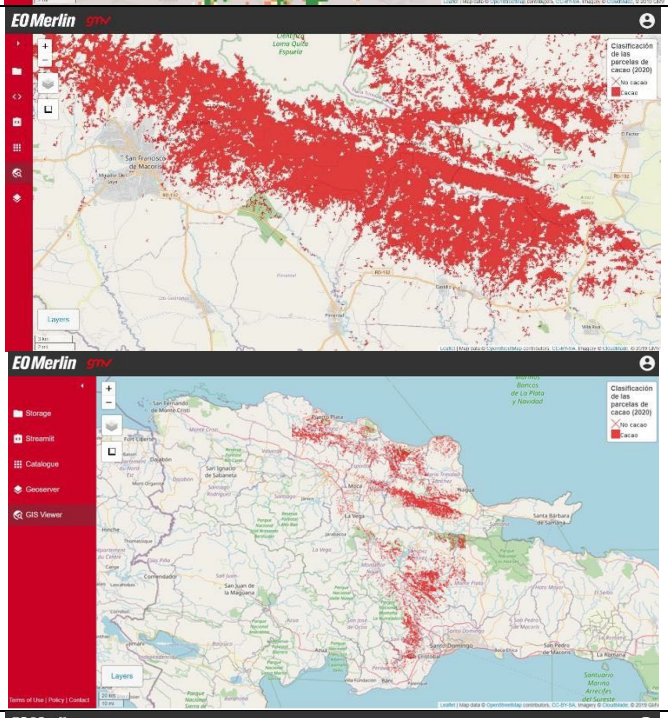
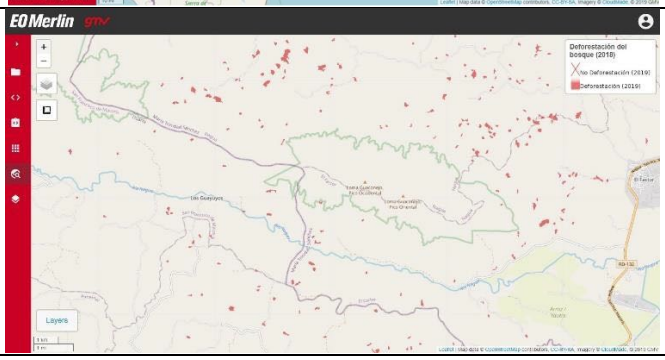
Algorithms and processing tools	
Processing details	Algorithms make a multi-temporal evaluation of vegetation condition based on Sentinel 2 data and detect changes along time. Different Machine Learning algorithms are used to identify anomalies invegetation condition.
Feedback and evaluation	
Reproducibility	The biotic damage products based on Sentinel-2 can be set up for any location to derive regular forestvitality maps and inform of early pest damage.
Accuracy	Always above 80%
Feedbacks	According to the end-users, main applications of this product are: • Near-Real Time Pest and Diseases Damage Assessment • Environmental Impact Assessment • Forest restoration plans • Firefighting prevention management **On accuracy**: Products were validated with in situ data. All the maps showed high accuracies (acc > 0.80). Accuracy was higher than 0.95 and F1-score was higher than 0.88 for areas with high severity, with omission errors under 0.09 in all cases. This confirmed the ability of all the models to detect barkbeetle attack at the last phases. Areas with no damage or low severity showed more complex results. The no damage category yielded greater commission errors and relative bias (CEs = 0.30–0.42, relB = 0.42–0.51). Similar results obtained for 2020 leaving out clear-cuts and dead trees proved that the proposed methods can be used to help forest managers in the Czech Republic fight bark beetle pests.
Pictures	
Legend : Map of bark beetle damage in an AoI in the Czech Republic	

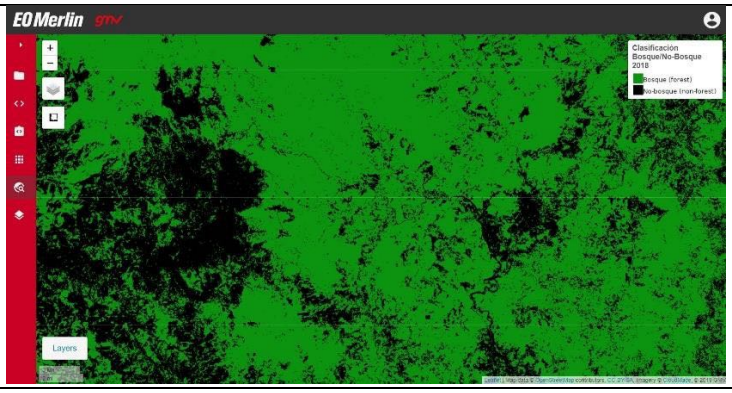
Application of Earth observation for forest management

Description of the use cases

Presentation of the company	
Name	GMV
Address	Isaac Newton, 11 P.T.M. Tres CantosE- 28760 Madrid
Website	www.gmv.com
Telephone	+34 91 807 21 00
Contact name	Ana Sebastián López
Email	asebastian@gmv.com
Presentation of the use case	
Type of customer	Institutional : Ministry of Environment, Ministry of Agriculture-Cocoa Department), Private: DR Cocoa Foundation, Cocoa National Commission
Area of interest	Dominican Republic
Product category	**MRV for Commodities – Sustainability monitoring in the cocoavalue chain**
Product description	• **Land Suitability Map**: Identification of the most suitable land to growcocoa, without losing sight of the natural protected areas. • **Forest loss Monitoring System**: to monitor forest loss, in particular,around the current cocoa farms. • **Cocoa agroforestry systems classification** to support managementand market strategy planning. • **Agricultural Drought Index**. • Interoperable App providing access to the geospatial data and enabling theuser to maintain relevant layers.
Earth Observation Images used	
Source #1 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	**Cocoa agroforestry systems classification**: • Sentinel-2 imagery • Multispectral • 10/20 m • Not applicable. • Open source
Add other sources if necessary	**Forest loss product**: • Sentinel-1A C-band SAR • Interferometric Wide Swath mode (IW, 250 km swath width) • 15 m • Open source
Other data source used	
Source #1 *Name* *Provider* *Access* *Area of interest* *Description* *Usage*	• **Cocoa agroforestry systems classification**: sample of cocoa farms. Source: Ministry of Environment And Natural Resources (MENR) and DR Cocoa Foundation. Ground truth data was used to train, validate and test thecocoa farms classifier model. • **Forest loss product**: forest mask matching the resolution of the Sentinel-1 imagery (MENR), used to constrain the forested areas.
Add other sources if necessary	**Land suitability Map:** • **Bioclimatic Variables:** Derived from monthly Temperature and Rainfallvalues represent annual trends (e.g., mean annual temperature), seasonality (e.g., annual range in precipitation) and extreme or limiting environmental factors (e.g., temperature of the coldest month). Source:

	https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-land-monthly-means?tab=overview • **Soil Variables**: Spatial predictions of soil's chemical properties and physical properties, like texture and density. Source: https://soilgrids.org/**.** • **Topographic Variables**: Digital Elevation Model and derived attributes.Represent terrain elevation (i.e., DEM) and terrain characteristics (e.g., slope). Source: https://lpdaac.usgs.gov/products/nasadem_hgtv001/.
Algorithms and processing tools	
Processing details	• **The cocoa agroforestry classifier** is a machine learning algorithm thatuses Sentinel 2 bands, spectral indices, texture indices and DEM derived parameters. • **The Agricultural Drought Index** (ADI) is based on satellite-derived vegetation indices and in-situ station data. The - Sentinel-2 NDVI anomaly,the Soil Moisture Index Anomaly (SMIa), and the Precipitation- Evapotranspiration Anomalies (SPEI) are were combined to generate the ADI. Depending on the values, the environmental conditions are classified as: watch, danger and alert. • **The forest loss monitoring system** is based on an algorithm that is able to correct for seasonality, identifies early warning of forest loss before it expands to a larger area and allows the user setting a specific threshold value to confirm a forest cover loss event which can be fine-tuned based on the monitoring requirements of the user. In the future, availability of a longer and denser historical time-series for the training period will improvethe robustness of the approach. Training period: from: 13/03/2017 to 21/12/2018, monitoring period: 02/01/2019 -28/12/2019.
Feedback and evaluation	
Reproducibility	The products are reproducible in other areas of cocoa production providing thatground truth data is available to retrain the models (cocoa agroforestry systems classification and land suitability map)
Accuracy	• **Cocoa agroforestry systems classification**: 0.89 (F1 score for cocoaclass). • **Forest loss monitoring system**: area-adjusted producer's accuracy(0.93) and user's accuracy (0.86) (forest loss class). • **Land suitability for cocoa**: 93.3% ± 0.2.
Feedbacks	With MRV4C, GMV has generated a series of geospatial products/services that, by providing geospatial insights underpin the sustainable management of cocoa in Dominican Republic. GMV has: - Mapped cocoa agroforestry areas with improved accuracy. - Identified potential new areas suitable for growing cocoa. - mapped and provided statistics of forest extent; Additionally, GMV implemented: - A deforestation mapping service to support monitoring of zero-deforestation value chain. - A forest/non forest mapping service suitable for supporting forest management. - A drought monitoring system to generate periodic actionable evidenceto track events which could have an impact on cocoa production. - A web-based platform and application to extract actionable informationfrom the products. The users expressed their satisfaction with the products during a demonstrationin the closing event hosted by the World Bank.
Pictures	

(A) Land suitability map	
(B) Cocoa agroforestry system classification	
(C) Forest loss product	

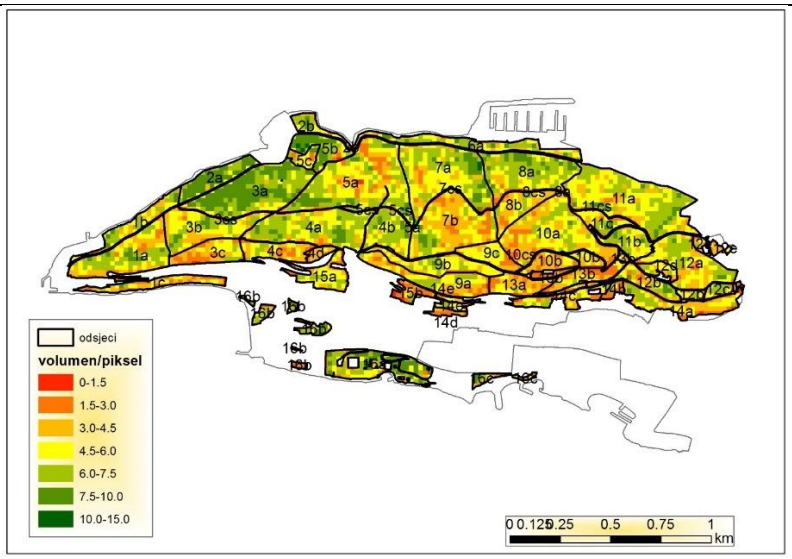
(D) Forest/non-forest mask	

Application of Earth observation for forest management

Description of the use cases

Presentation of the company	
Name	Oikon Ltd. – Institute of Applied Ecology
Address	Trg senjskih uskoka 1-2, 10000 Zagreb, Croatia
Website	https://oikon.hr/
Telephone	+385 91 2363 280
Contact name	Dalibor Hatić
Email	dhatic@oikon.hr
Presentation of the use case - 1	
Type of customer	Ministry of Tourism and Environment of Albania
Area of interest	Berat Municipality, Malesi e Madhe Municipality
Product category	Integrated Forests and Pastures Management Plans
Product description	Development of forest and pastures management plans for two municipalities in Albania, Berat and Malesi e Madhe. The project included terrestrial measurements of forest measurement parameters and modelling of forest measurement parameters based on Earth Observation data for areas of difficult accessibility.
Earth Observation Images used	
Source #1	
Name	Sentinel 1 GRD
Type of image	SAR data10 m
Resolution	Commercial SAR systems
Other possible sources	
Access	Copernicus Open Access Hub, ASF Vertex
Source #2	
Name	Sentinel 2
Type of image	Multispectral images
Resolution	10 m – 60 m
Other possible sources	MODIS, Landsat, Commercial MS systems
Access	Copernicus Open Access Hub
Other data source used	
Source #1	
Name	LiDAR data
Provider	Ministry of Tourism and Environment of AlbaniaNo
Access	public access
Area of interest	Berat Municipality and Malesi e Madhe Municipality, AlbaniaOfficial
Description	national LiDAR data
Usage	Vegetation height data extraction
Add other sources if necessary	Field measurement data
Algorithms and processing tools	
Processing details	Land cover mapping for forest management units through applied MachineLearning and Object-Based classification Use of modelling algorithms for extraction of forest stand parameters:

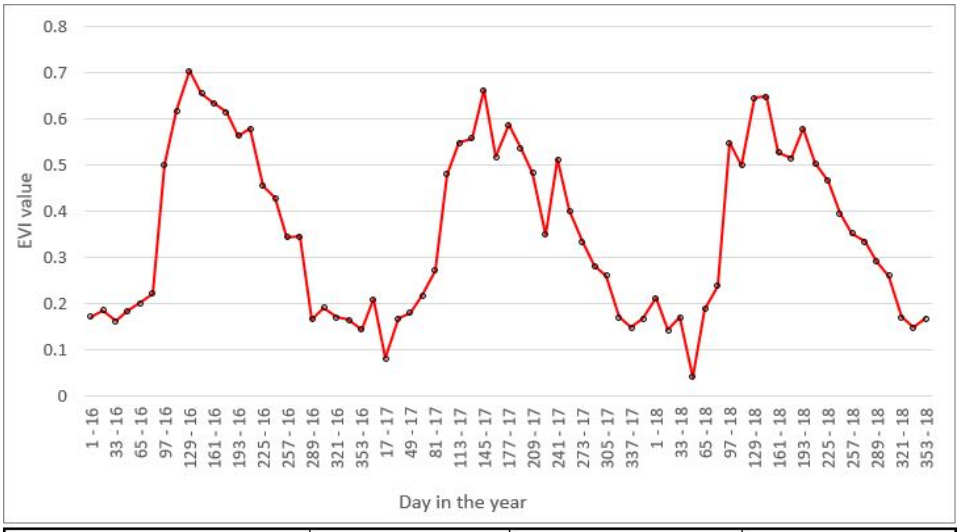
	- Linear regression - Random forest - kNN - SVM The model trained on the data from field measurementsUse of data mining software
Feedback and evaluation	
Reproducibility	High
Accuracy	78% - 93%
Feedbacks	Positive feedback from the client. Results used in the creation of the Forest Management Plans.
Pictures	
Legend :	N/A
Presentation of the use case - 2	
Type of customer	City of Split, Croatia
Area of interest	Park forest Marjan
Product category	Biomass assessment
Product description	Assessment of biomass in area of the Forest park Marjan, based on the data acquired through UAV LiDAR survey. LiDAR data was used in correlation with the data acquired during field forest measurements.
Earth Observation Images used	
Source #1 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	 N/A
Other data sources used	
Source #1 *Name* *Provider* *Access* *Area of interest* *Description* *Usage*	 LiDAR data Subcontractor No public access Forest park Marjan UAV LiDAR data Biomass assessment and modelling
Add other sources if necessary	Field measurement data
Algorithms and processing tools	
Processing details	Point cloud density calculation, noise removal, point cloud classification, vegetation metrics extraction, correlation of LiDAR data and field measurements, biomass calculation
Feedback and evaluation	
Reproducibility	High
Accuracy	89%
Feedbacks	Positive feedback from the client. Data successfully used for the control of theforest harvesting process
Pictures	

Legend : Biomass assessment for forest management sub-parcels. Volume [m3] / Pixel	
Presentation of the use case - 3	
Type of customer	Ministry of the Sea, Transport and Infrastructure, Croatia
Area of interest	Spačva basin
Product category	Forest ecosystem monitoring
Product description	Monitoring of the forest ecosystem on the area of the future multipurpose channelDunav-Sava for the monitoring period 2018-2019. The project included a wide variety of monitoring methodologies. Earth Observation data was applied to the analysis of time series to determine phenological parameters of the ecosystem, monitoring the health of the forest ecosystem and ecosystem productivity parameters.
Earth Observation Images used	
Source #1	
Name	MODIS
Type of image	Multispectral 16-day composites, MOD13Q1
Resolution	250m
Other possible sources	Other MS EO systems
Access	NASA Earthdata search portal
Source #2	
Name	LANDSAT 8
Type of image	MS imagery
Resolution	30m
Other possible sources	Other MS EO systems
Access	NASA Earthdata search portal
Other data source used	
Source #1	
Name	N/A
Provider	
Access	
Area of interest	
Description	
Usage	
Add other sources if necessary	Field measurement data, meteorological data, groundwater data

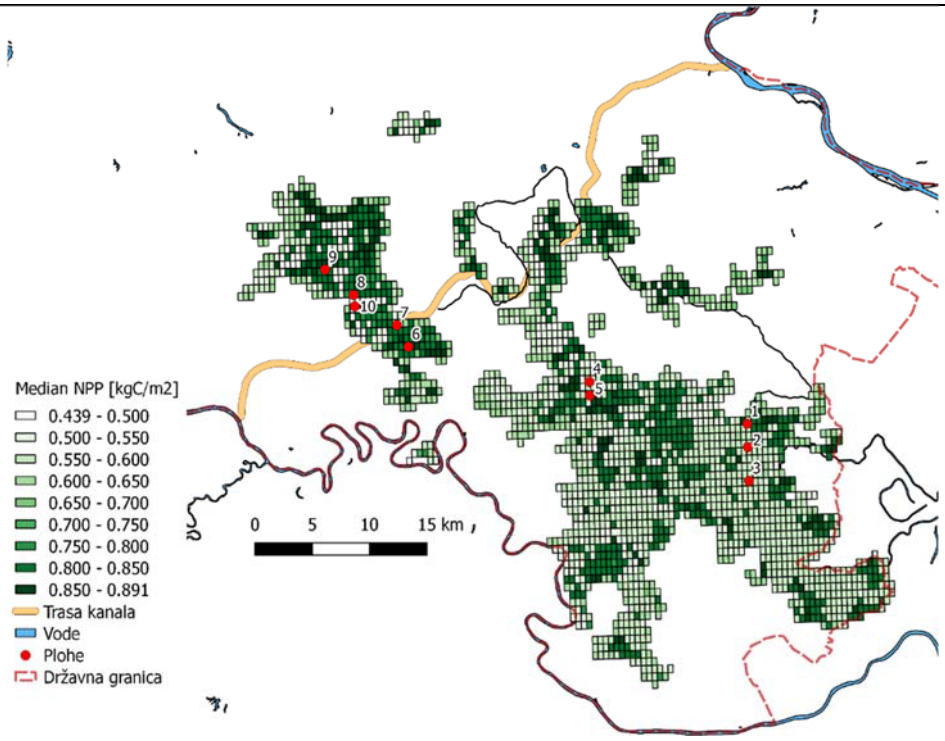
Algorithms and processing tools	
Processing details	Image stacking, EVI index value extraction, time series analysis, phenologicalparameter analysis, regression analysis of EO data
Feedback and evaluation	
Reproducibility	high
Accuracy	N/A
Feedbacks	Positive feedback from the client. Product provided valuable insight into the health of the ecosystem. Results enabled the monitoring of the spread of an invasive species, the Oak lace bug.
Pictures	

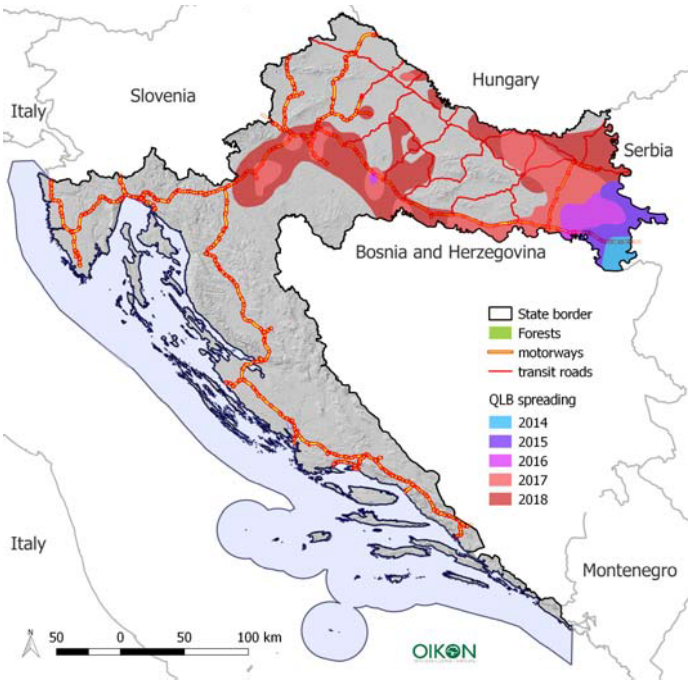
Legend :

1. EVI dynamics and phenology on one of the research plots
2. Net Primary Production derived from EO data
3. Oak lace bug spreading dynamics

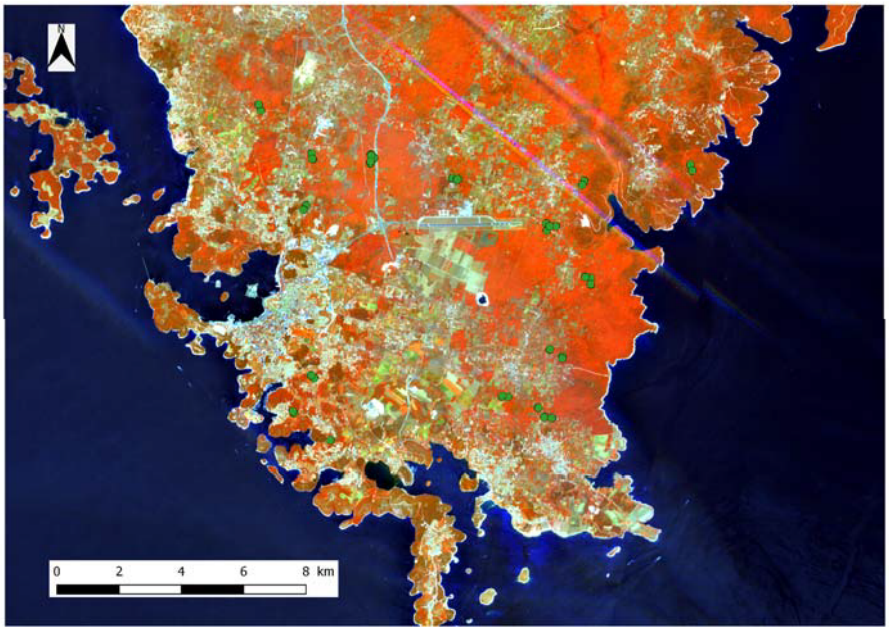


Season	2016	2017	2018
Start of the season [DIY]	102.76	99.08	95.88
End of the season [DIY]	243.40	277.16	263.88
Mid season [DIY]	155.08	164.84	160.52
Season lenght [days]	140.64	178.08	168.00
Base length	0.1489	0.1392	0.1242
Peak value	0.7179	0.6135	0.6134
Season amplitude	0.5690	0.4743	0.4892
Rate of increase at BOS	0.1327	0.1104	0.1154
Rate of decrease at EOS	0.0540	0.0469	0.0421
Large seasonal integral	5.9710	6.4230	5.9390
Small seasonal integral	4.3330	4.6130	4.4480
Value at BOS	0.4309	0.3837	0.3689
Value at EOS	0.4359	0.3690	0.3686





Presentation of the use case - 4	
Type of customer	Ministry of Agriculture, Croatia
Area of interest	The Mediterranean and Submediterranean forest stands in Croatia
Product category	Assessment of productivity and age of stands in unevenaged private forests inCroatian Mediterranean and Submediterranean.
Product description	Use of multispectral EO data for the assessment of productivity and age of Holmoak (Quercus ilex L.) and Pubescent oak (Quercus pubescens Wild.) stands in

	private forests. The main goal was the determination of the age of those standsand create yield tables regarding site indexes revealed through analysis of yearly radial increments.
Earth Observation Images used	
Source #1	
Name	Sentinel 2
Type of image	Multispectral images
Resolution	10 m – 60 m
Other possible sources	Landsat 8, MS EO systems with similar resolution
Access	Copernicus Open Access Hub
Other data sources used	
Source #1	
Name	N/A
Provider	
Access	
Area of interest	
Description	
Usage	
Add other sources if necessary	Field measurement data
Algorithms and processing tools	
Processing details	Atmospheric correction, VI calculation, data modelling, data mining, statisticalanalysis
Feedback and evaluation	
Reproducibility	High
Accuracy	62% - 97%, depending on the species of interest and selected parameters
Feedbacks	Successful application of the methodology in forest management
Pictures	
Legend : False colour composite of one of the areas of interest and field research plots	

Presentation of the use case - 5	
Type of customer	Public institution: Nature Park Biokovo
Area of interest	Nature Park Biokovo - 2005
Product category	Forest type mapping
Product description	Mapping of different forest type areas on the territory of the Nature Park Biokovo through the use of multispectral EO data.
Earth Observation Images used	
Source #1	
Name	ASTER
Type of image	Multispectral imagery
Resolution	15m - 90m
Other possible sources	Other multispectral EO systems. The choice was limited in 2005
Access	
Other data source used	
Source #1	
Name	N/A
Provider	
Access	
Area of interest	
Description	
Usage	
Add other sources if necessary	Topographic maps 1 :5000 and 1 :25000
Algorithms and processing tools	
Processing details	Orthorectification, reclassification to the resolution of 20 m, pansharpening, Uncontrol classification, identification of forest types using ground truth data
Feedback and evaluation	
Reproducibility	high
Accuracy	85%
Feedbacks	Maps were used for the definition of forest management units, compartments andforest stands in forest management
Presentation of the use case - 6	
Type of customer	Minister of Agriculture, Forestry and Waterworks
Area of interest	Senj, Osijek and Vinkovci Forest Administration areas
Product category	National Forest Inventory, 2005 - 2007
Product description	Part of the project was dedicated to the use of Earth Observation in the NationalForest Inventory
Earth Observation Images used	
Source #1	
Name	IRS
Type of image	Multispectral imagery
Resolution	20m
Other possible sources	Other multispectral EO systems available at that time
Access	

Other data source used	
Source #1 *Name* *Provider* *Access* *Area of interest* *Description* *Usage*	 USGS service Determination of forest types, age of stands, crown closure
Add other sources if necessary	Topographic maps 1 :25000 Forestry maps 1 :10000
Algorithms and processing tools	
Processing details	Orthorectification, unsupervised and supervised classification
Feedback and evaluation	
Reproducibility	high
Accuracy	84% - 88%
Feedbacks	Positive feedback from the client. Results used in LULUCF for Croatia
Presentation of the use case - 7	
Type of customer	Croatian Forest Administration
Area of interest	Highlands and the Mediterranean part of Croatia (2/3 of area)
Product category	EO data acquisition and processing for downstream applications - 2005
Product description	Data acquisition, orthorectification and pansharpening of all spectral channels tothe resolution of 15m. Prepared data was used for the assessment of forest stand parameters in private and unmanaged forests
Earth Observation Images used	
Source #1 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	 ASTER Multispectral imagery 15m - 90m Other multispectral EO systems. Limited choice in 2005
Other data source used	
Source #1 *Name* *Provider* *Access* *Area of interest* *Description* *Usage*	 N/A
Add other sources if necessary	Topographic maps in scale 1:25000
Algorithms and processing tools	
Processing details	Orthorectification, reclassification to the resolution of 20 m, pansharpening ofeach channel, data fusion
Feedback and evaluation	

Reproducibility	high
Accuracy	N/A
Feedbacks	Methodology successfully adopted and used by the client

Application of Earth observation for forest management

Description of the use cases

Presentation of the company	
Name	Planet GmbH
Address	Kurfürstendamm 22, 10719 Berlin, Germany
Website	www.planet.com
Contact name	Agnieszka Lukaszczyk
Email	agnieszka@planet.com
Presentation of the use case	
Type of customer	Analytic consulting firm for Utilities
Area of interest	Southern Europe, US To date, Overstory has analyzed 500M hectares of land in 64 countries, and has analyzed 155cities.
Product category	Insights on vegetation for wildfire risk mitigation, including tree height, species, health,damage, and proximity to power lines
Product description	Real-time intelligence about vegetation powered by artificial intelligence and satellite data. The product uses machine learning to interpret satellite imagery, including high spatial and temporal resolution imagery, SAR, and video.
Earth Observation Images used	
Source #1 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	 Plan etSc ope VNIR (4ba nd) 3.77 m/px
Add other sources if necessary	 SkySat VNIR (4ba nd) 3.77 m/px
Other Sources	SAR
Other data source used	
Source #1 *Name* *Provider* *Access Area of interest* *Description* *Usage*	 Hyperspectral
Algorithms and processing tools	

Processing details	Overstory uses machine learning to interpret satellite imagery and climate data. By extractinginsights from Planet data, Overstory is able to provide real-time information to its utility customers based on high spatial and temporal resolution satellite data, including multi- and hyperspectral imagery, SAR, and video. Moreover, by applying AI algorithms specialized in trees and vegetation, Overstory helps customers to predict grow-in and fall-in risks based on species, growth, weather, climate, and vitality. By facilitating predictive planning, tracking and verifying trimming cycles by contractors, and offering timely reports on vegetation management KPIs, customers can make informed decisions and take action. The fusion of diverse spatial, spectral and temporal resolution powered by Planet imageryallows for realtime and predictive insights for informed vegetation management. This information is fed into algorithms that provide insights that are accessed securely via the Overstory platform or can be easily integrated into existing tools and utility workflows through the risk tracker.
Feedback and evaluation	
Reproducibility	Reproduceable but may require tailored training and/or auxiliary data.
Pictures	
Overstory AI uses PlanetScope's frequent coverage to monitor the timing of changes in vegetation near power lines, and SkySat's high resolution to determine the precise condition of the right of way. © 2021, Planet Labs Inc. All Rights Reserved.	

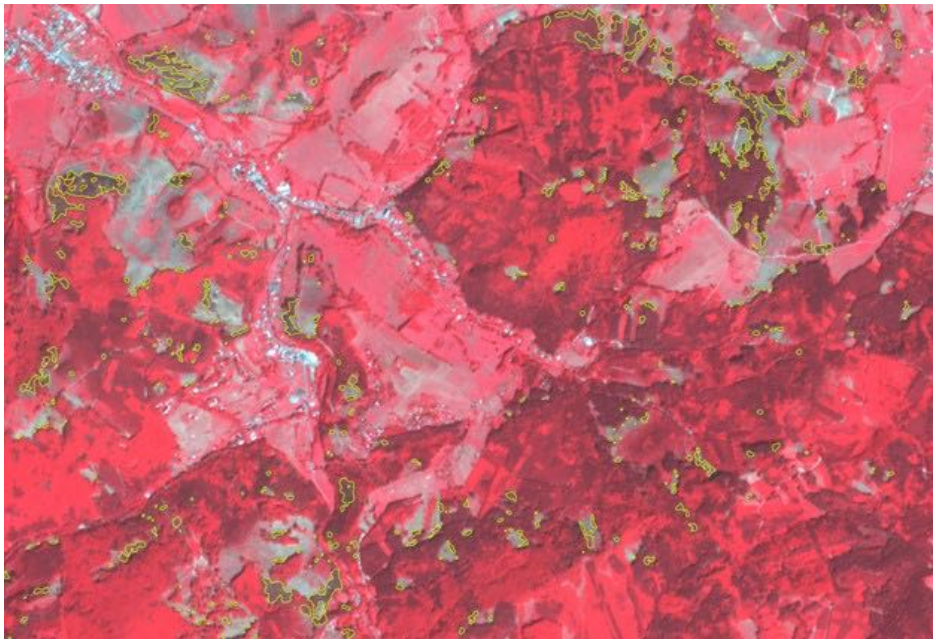
"Our mission is to help solve the climate crisis by providing real-time information about the Earth's vegetation. The availability of the combination of PlanetScope and SkySat images makes it a perfect fit for us and how we envision the future to have more data to analyze andimprove decision-making. It has the frequency, level of detail, and scalability we need," said den Bakker.

https://www.planet.com/pulse/taming-wildfires-with-vegetation-management/

Application of Earth observation for forest management

Description of the use cases

Presentation of the company	
Name	Planet GmbH
Address	Kurfürstendamm 22, 10719 Berlin, Germany
Website	www.planet.com
Contact name	Agnieszka Lukaszczyk
Email	Agnieszka@planet.com
Presentation of the use case	
Type of customer	Government
Area of interest	Czech Republic
Product category	Forest health mapping and monitoring. Early detection of pest outbreak.
Product description	Conducting national-scale vegetation analyses in high spatial and temporal resolutions todetect and classify dead forest stand in order to intervene to stop spread of pest.
Earth Observation Images used	
Source #1 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	 Plan et Scop e VNIR (4Ba nd) 3.77m/px
Add other sources if necessary	Sentinel-2 (Derived tree species layer)
Other data source used	
Source #1 *Name* *Provider* *Access Area of interest* *Description* *Usage*	 National Aerial Inventory
Algorithms and processing tools	
Processing details	Data derived from Sentinel-2 (tree species layer) and the Czech national aerial inventory (tree height) were used to identify candidate tree areas, which were mostly matureNorway Spruce trees and to exclude deforestation from previous years. FMI combined this dataset with a countrywide mosaic created from Planet's

	RGB and NIR data, to conduct vegetation analyses and ultimately identify dead forest standand sanitary logging.
Feedback and evaluation	
Reproducibility	Yes, combination of Planet and Sentinel-2 derived tree data is reproduceable in othergeographies
Feedbacks	"Planet saved FMI considerable time and resources," Lukeš says, "allowing us to achieve our goal at unprecedented speed… "What's really significant is how our data can inform the Ministry of Agriculture sothey can discern affected areas and decide where finances should be allocated for reforestation going forward."
Pictures	
Locating infested forest stands in high spatial and temporal resolution VNIR Planet data	

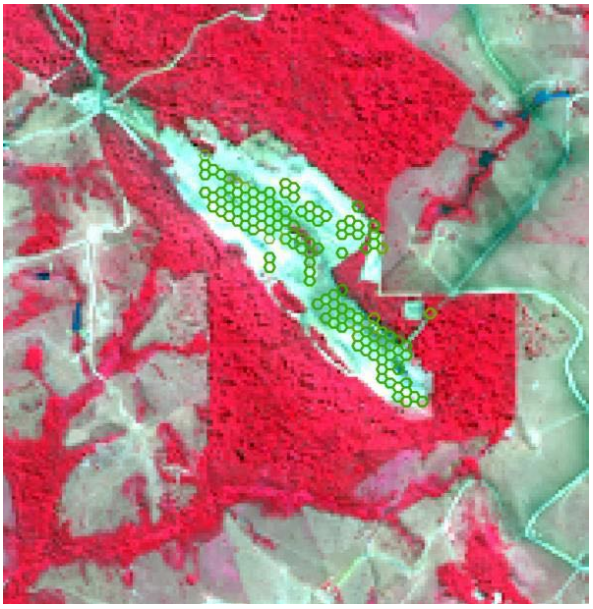
https://www.planet.com/pulse/bark-beetles-are-decimating-forests-satellite-data-can-help/

"Historically, a lack of recent data on a broad scale made it difficult for government to mitigate and understand the full scope of change and destruction,"says Peter Lukeš, a remote sensing scientist at FMI. "But thanks to Planet's data, frequent observation in high spatial resolution allows us to monitor the spread ofthe bark beetle in real time, and provide objective information that is key for decision makers."

Application of Earth observation for forest management

Description of the use cases

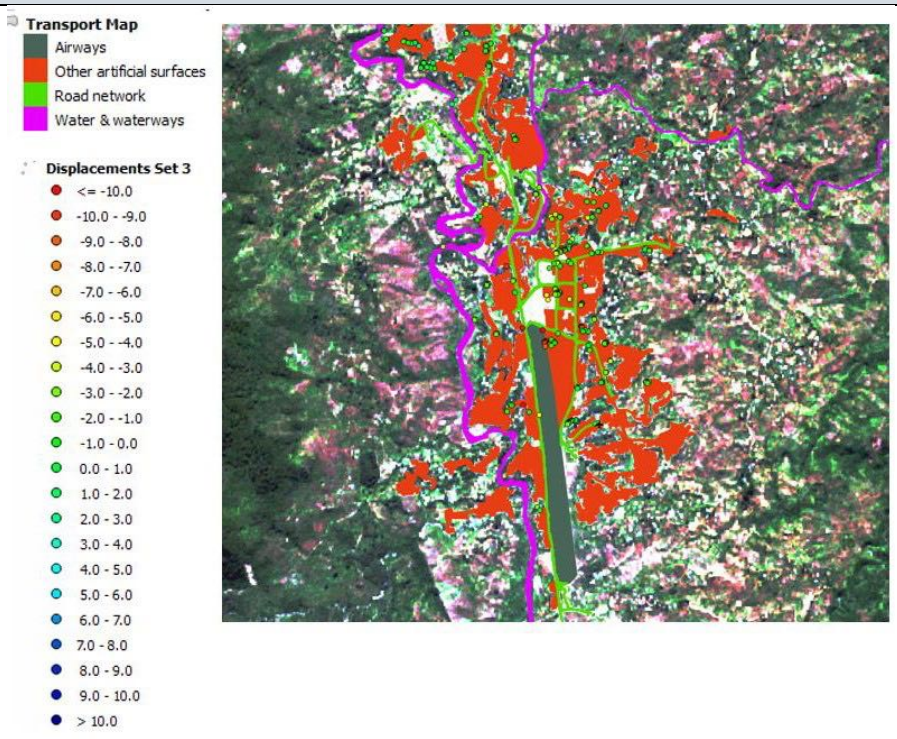
Presentation of the company	
Name	Planetek Italia
Address	via Massaua, 12 – 70132 Bari – Italy
Website	www.planetek.it
Telephone	+39 080 96 44 200
Contact name	Daniela Iasillo
Email	iasillo@planetek.it
Presentation of the use case	
Type of customer	Mining companies, Law Enforcement, Environmental Agencies
Area of interest	270 km^2 (Brazil)
Product category	Detection of illegal mining activities in forested areas in Brazil
Product description	The objective was to detect the occurrence of mining activities in forest and nearbyareas in two different scenarios: mining activities where it is forbidden, mining activities outside the allowed area. The areas of interest were in the State of Parà and in the State of Cearà in Brazil. The areas are extremely cloudy during all the year, so it was important to define a methodology able to provide change alarms in reliable and timely way.in time. Using Sentinel-1 and – when available – Sentinel-2 images, a configurable and completely automatic operational tool was implemented to provide every 2 or 3 months change alarms related to mining activities.
Earth Observation Images used	
Source #1	
Name	ESA Sentinel-1
Type of image	GRDH
Resolution	12m
Other possible sources	
Access	Open access
Source #2	
Name	ESA Sentinel-2
Type of image	L1C or L2A
Resolution	10m
Other possible sources	Open access
Access	
Algorithms and processing tools	
Processing details	The area is initially clustered in forest, other vegetation and no vegetation zones. The changes from the first type were detected using monthly Sentinel-1 coherenceand re-clustering the area every 3 months when enough Sentinel-2 images are available. A set of rules combines the two information to provide change alarms. The challenge was in the definition of such set of rules that derives from thepreliminary analysis of the area, to configure the tool.

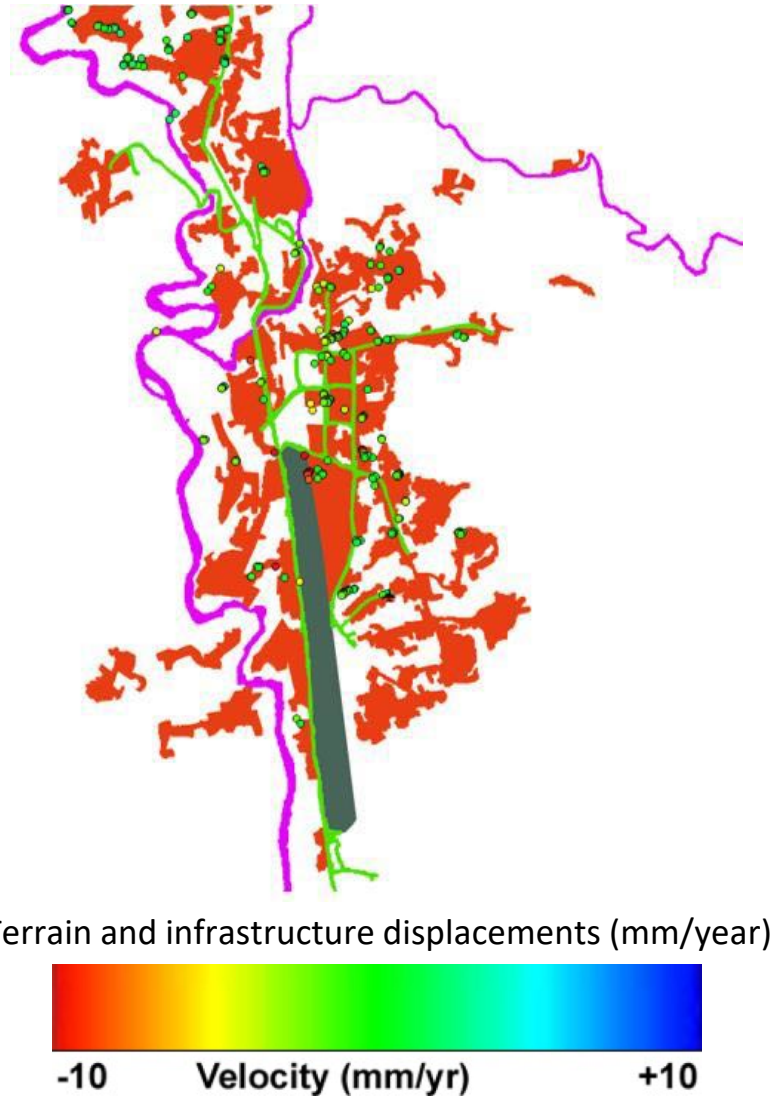
Feedback and evaluation	
Reproducibility	The methodology is applicable to zones forested or with a prevalence of naturalareas. It requires an initial analysis of the area to setup the tool.
Accuracy	100% of the changes related to the mining activities triggered a change alarm, witha delay of maximum 3 months from the occurrence. Very few false change alarms occurred, always far from the area of study.
Feedbacks	Due to the inaccessibility of many forested areas in Brazil, it was very useful for theuser to receive change alarms in order to trigger further actions, like a VHRacquisition by satellite or drone or an inspection.
Pictures	
Sentinel-2 images before and after a forested area was substituted by a mine. Green cells indicate the change alarms detected from June 2019 to July 2020.	 6th May 2019  24th July 2020

Application of Earth observation for forest management

Description of the use cases

Presentation of the company	
Name	Planetek Italia
Address	via Massaua, 12 – 70132 Bari – Italy
Website	www.planetek.it
Telephone	+39 080 96 44 200
Contact name	Daniela Iasillo
Email	iasillo@planetek.it
Presentation of the use case	
Type of customer	Ministry of Transport, Ministry of Economic Development
Area of interest	~26 000 km² (Papua New Guinea)
Product category	Detection of mangroves
Product description	The objective was to make an inventory of existing transport network in the densely forested and lowly populated province of Highlands. The transport network included roads and navigable rivers. This inventory was needed by theMinistries of Transports and of Economic Development for definition of rulesfor the sustainable development of infrastructure in the country. To further support this planning on some test sites also an inventory of landslides and products related to the evaluation of landslide and infrastructure stability wereprovided. High resolution optical and SAR images was used to map the transport network over the whole area, without holes due to cloud coverage. Interferometric time series of SAR images were used to evaluate the terrain motion (stability) and the landslide risk on the test sites.
Earth Observation Images used	
Source #1	
Name	RapidEye
Type of image	Optical 5m
Resolution	
Other possible sources	
Access	ESA TPM
Source #2	
Name	ESA ERS-1/2
Type of image	
Resolution	30m
Other possible sources	
Access	ESA TPM
Source #2	
Name	Radarsat-2
Type of image	Scansar Fine
Resolution	7m
Other possible sources	
Access	ESA TPM
Other data source used	
Add other sources if necessary	USGS SRTM DEM

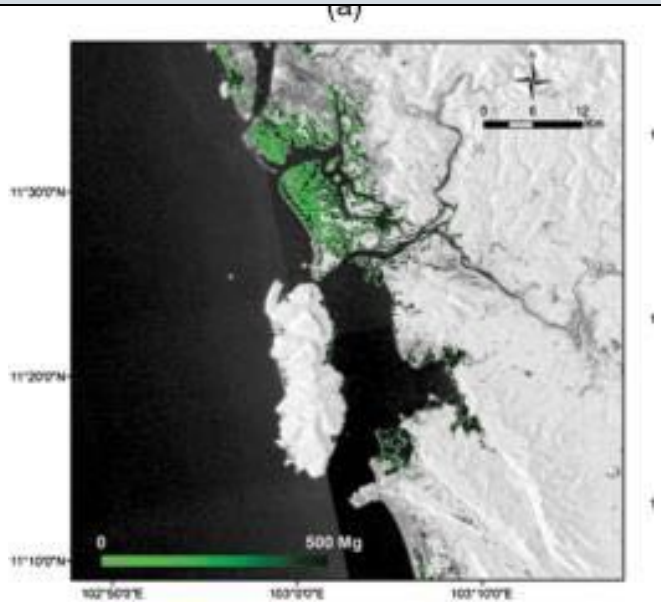
	Open access
Algorithms and processing tools	
Processing details	Transport network mapping: pre-processing of RapidEye imagery including topographic normalization, followed by an automatic classification to identifythe classes of interest. A visual photo interpretation followed in order to verify and improve quality of the map. When RapidEye images were not available, the same process is adapted to use Radarsat-2 imagery. Landslide inventory: photo-interpretation of RapidEye imagery from a geologist expert of remote sensing. Landslide and infrastructure stability: permanent scatterers interferometric technique applied to a stack of ERS-1/2 images from 1992 to 2000.
Feedback and evaluation	
Reproducibility	The methodology for the transport network map is very flexible and applicable to similar highly forested with low anthropic presence. The application of permanent scatterers was difficult due to low coherence in forested areas, however the areas of higher interest – that is landslides and infrastructures – usually show a higher coherence with respect to forest and so it was possible to apply such technique successfully.
Accuracy	The accuracy of the transport network map was verified by random stratified sampling and resulted very high (>85%).
Feedbacks	Very positive feedback was expressed by the local authorities. A lesson learnedwas that a good quality DEM is required to achieve a good normalization of theoptical imagery.
Pictures	
Example of transport map and displacement points. With RapidEye image in background (top), without background (bottom)	

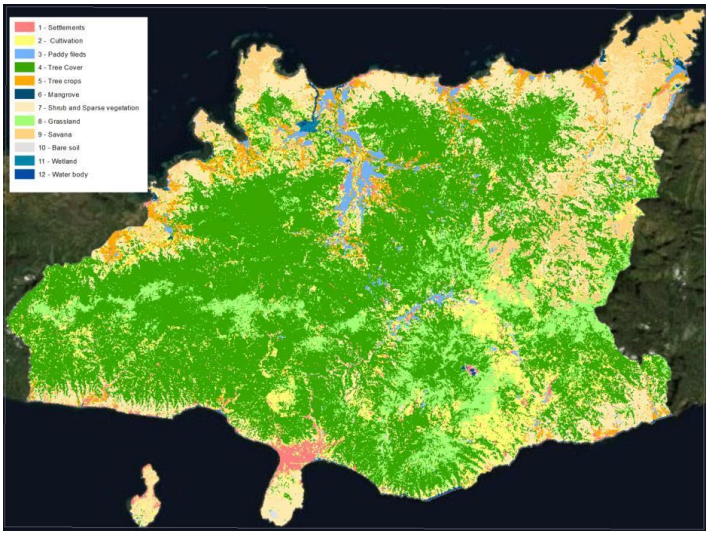

Terrain and infrastructure displacements (mm/year)
-10
Velocity (mm/yr)
+10

Application of Earth observation for forest management

Description of the use cases

Presentation of the company	
Name	Planetek Italia
Address	via Massaua, 12 – 70132 Bari – Italy
Website	www.planetek.it
Telephone	+39 080 96 44 200
Contact name	Daniela Iasillo
Email	iasillo@planetek.it
Presentation of the use case	
Type of customer	Environmental Agencies; Ministry e.g. of Fishery, of Environment, of Economic Development;
Area of interest	~10 000 km^2 (Cambodia)
Product category	Detection of mangroves
Product description	The objective was to detect and quantify the mapping of mangrove extension and its change with time considering the years 2016 and 2021. The area mapped covered the coastal area up to 10 km inland of the following provinces in Cambodia: Koh Kong, Kampot, Kep, and PreahSihanouk. The challenge was to use only Sentinel-1 being the area very often covered by cloud, exploiting the few available optical data from Sentinel-2 to make the process more robust in particular for the training of the AI algorithms. The mapping process was all automatic.
Earth Observation Images used	
Source #1	
Name	ESA Sentinel-1
Type of image	GRDH
Resolution	12m
Other possible sources	
Access	Open access
Source #2	
Name	ESA Sentinel-2
Type of image	L1C or L2A
Resolution	10m
Other possible sources	
Access	Open access
Other data source used	
Source #1	
Name	Global Land Cover
Provider	ESA
Access	Open access
Area of interest	Cambodia
Description	Global Land Cover map produced by the ESA GlobCover project (http://due.esrin.esa.int/page_globcover.php)
Usage	Masking of forested areas

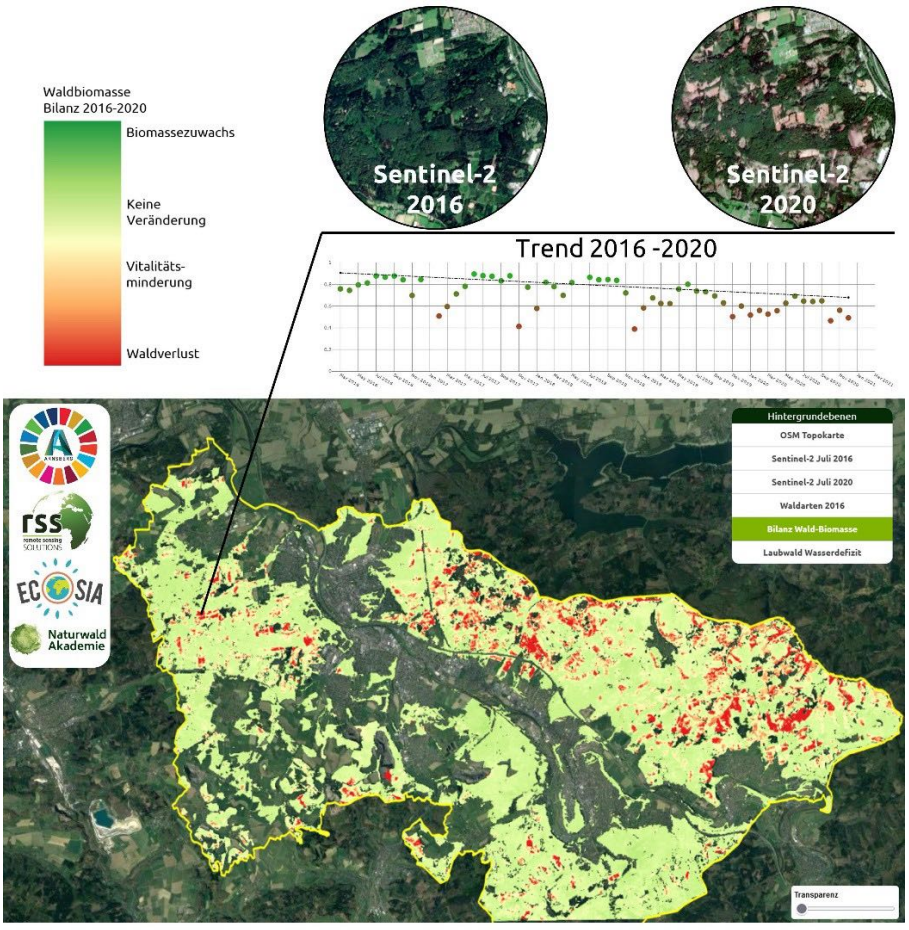
Algorithms and processing tools	
Processing details	Combination of Machine learning and Deep learning methods applied to atime series of Sentinel-1 images: 12 monthly images for each epoch (2016 and 2021). A separate classification was obtained providing probability formangrove presence. Then the probability was combined to obtain the finalmap. The training samples was taken by photo interpretation of Sentinel-2 images and from Google Earth images. Part of the training samples wereused for training of the AI algorithms and part for the final check and validation of the resulting maps. All available Sentinel-2 images was also processed to L2A in order to use the water and forest layers to mask such areas in the final classification of mangroves.
Feedback and evaluation	
Reproducibility	The methodology is applicable on other coastal areas, but it requires a new training process to take into account the available imagery (SAR and/or optical) and of the coastal area to be mapped.
Accuracy	The accuracy was very good, ranging between 75% and 85% within the various provinces. The spatial resolution of the Sentinel-1 proved to be not enough in particular complex areas where the tidal excursion was larger and/or were mangroves and forests were mixed alongside the main rivers. For the latter the use of a forest mask obtained from Sentinel-2 improved the accuracy.
Feedbacks	The collection of training samples is the most time consuming process and it is important to achieve a good accuracy. Land cover maps to mas other features (e.g. forests) are useful to take into account specificity of theterritory.
Pictures	
Spatial distribution of mangrove forests in an area of Koh Kong Province, Cambodia. (S. Darmawan et al 2019)	

Land cover classification including mangroves and other natural classes	

Application of Earth observation for forest management

Description of the use cases

Presentation of the company	
Name	Remote Sensing Solutions GmbH
Address	Dingolfinger Str. 9, 81673 Munich, Germany
Website	www.remote-sensing-solutions.com
Telephone	+49 (0)89-48 95 47 66
Contact name	Dr. Jonas Franke
Email	franke@rssgmbh.de
Presentation of the use case	
Type of customer	Public bodies
Area of interest	Europe
Product category	Continuous monitoring of forest trends in regard to biomass and droughtstress
Product description	Forests store carbon, contribute significantly to the formation of new groundwater, provide cooling and are home to a wide variety of species. However, the last years of drought in some parts of Europe (e.g. Germany) have shown how vulnerable many forest areas are. Large areas of damage have occurred due to the influence of heat, pests and other calamity factors, especially in conifer monocultures. Forest owners (public bodies or private) who manage their forests in a climate-friendly and near-natural way should be rewarded, as they ensure that carbon is stored in wood and soils, biodiversity is preserved and the water balance is improved. RSS offers methods for digital verification of forests that meet the criteria of different sustainability standards. Therefore, we combine the latest technologies such as artificial intelligence and high- resolution Earth observation satellites to transparently, cost-effectively andindependently evaluate whether biomass in forests is building up or degrading. This digital verification also allows for an estimation of theeconomic impact of near-natural management in terms of CO2- and sustainability certificates. On the basis of a 5-year time series of Sentinel-2 satellite data, all forest areasin Germany were for the first time digitally measured for changes in vitality. The satellite-based system is available as a prototype and can be expanded quickly in order to quantify the regeneration of forest areas across Europe quickly, inexpensively and independently. https://map3d.remote-sensing-solutions.de/waldmonitor-deutschland/#
Earth Observation Images used	
Source #1 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	 Sentinel-2

Other data source used	
Source #1 *Name* *Provider* *Access* *Area of interest* *Description* *Usage*	Optionally: High resolution Layer Forest of the Copernicus Land Monitoring Service
Algorithms and processing tools	
Processing details	5 years trend analysis based on monthly aggregated Sentinel-2 vegetation indices
Feedback and evaluation	
Reproducibility	Can be reproduced in any other European country
Accuracy	>90% in regard to forest damage or losses
Feedbacks	RSS implemented the approach at various administrative units. One example is the city of Arnsberg, who integrated the system in their forest administration, who also uses the system for the monitoring of forest restoration activities. The forestry department was intensively involved in the development and provided feedback along the development line.
Pictures	
Legend :	

Application of Earth observation for forest management

Description of the use cases

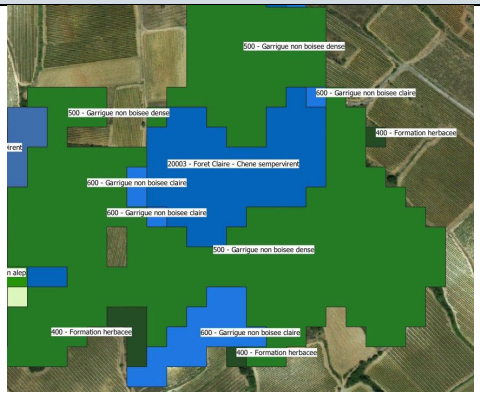
Presentation of the company	
Name	TerraNIS
Address	12 Avenue de l'Europe, 31520 Ramonville France
Website	www.terranis.fr
Telephone	+33 5 32 10 84 80
Contact name	Guillaume Rieu
Email	guillaume.rieu@terranis.fr
Presentation of the use case	
Type of customer	Public authorities; Département de l'Hérault
Area of interest	6 224 km^2 (Hérault)
Product category	Detection of forest areas
Product description	The objective was to detect and quantify the forest areas and to update existing dataand gain accuracy. One of the challenges was to detect Mediterranean type forests composed of sparse vegetation, trees and bare soil (rock, earth, etc.).
Earth Observation Images used	
Source #1 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	 Airbus Defence & Space Spot and Pléiades images VHR: 2m and 70cm
Add other sourcesif necessary	BD Ortho (IGN) - Aerial photography Multispectral 20 centimeters Pleiade or Spot Open access
Other data source used	
Source #1 *Name* *Provider* *Access* *Area of interest* *Description* *Usage*	 BD Foret (Forest Data Base) IGN (France) Open Access (free) France Location of forest areas in France and species typology Learning and validation
Algorithms and processing tools	
Processing details	Deep learning model applied on the RGB image of the aerial image. The training was carried out from the Forest database (BD Foret) with a manual quality control. Once processed, the layer was checked and modified in photointerpretation to ensure the quality of the results
Feedback and evaluation	

Reproducibility	The method is replicable on other territories but requires a new learning processto take into account the specificities of the image (acquisition date, sensor, etc.) and of the forest type.
Accuracy	The tool has given good results and has been able to take into account the specificities of the forests on this territory. Indeed, in this Mediterranean area, the forests are clear and composed of trees, shrubs and rocks. An analysis by pixel is not sufficient because it is this mixture that corresponds to the class "forest". An analysis by patch with a window allowed to obtain efficient results.
Feedbacks	Need for training data for the models. Specificity and diversity of forest types to betaken into account on the same territory.
Pictures	
Legend : Presentation of a result with identified forest areas in green	

Application of Earth observation for forest management

Description of the use cases

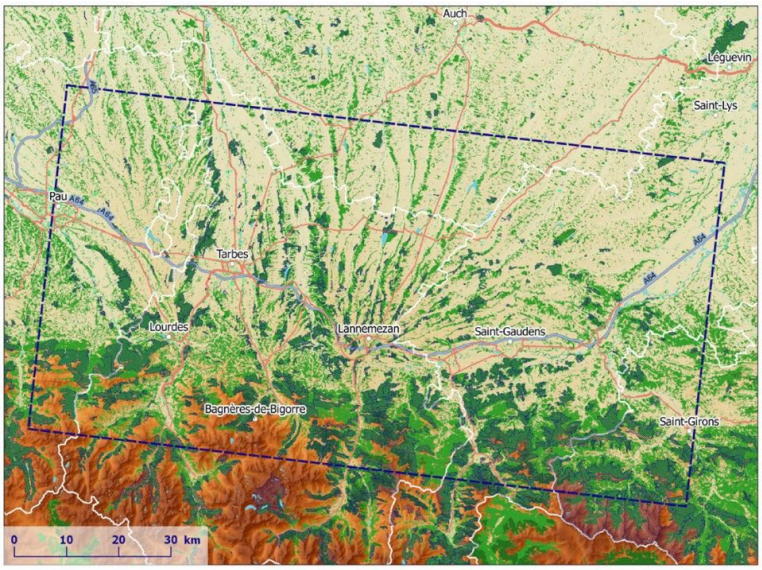
Presentation of the company	
Name	TerraNIS
Address	12 Avenue de l'Europe, 31520 Ramonville France
Website	www.terranis.fr
Telephone	+33 5 32 10 84 80
Contact name	Guillaume Rieu
Email	guillaume.rieu@terranis.fr
Presentation of the use case	
Type of customer	Public authorities
Area of interest	6 224 km^2 (Hérault)
Product category	Forest typology (classification of tree species)
Product description	The objective was to classify tree species to update existing public data and gain accuracy. The challenges was to classify tree species into 13 class (oak, chestnut, beech, etc.) and then create forest typologies (mixture of species, pure species, clear forest, denseforest, etc).
Earth Observation Images used	
Source #1	
Name	Sentinel-2 time series (10 images)
Type of image	Multispectral
Resolution	10 meters (RGB and NIR band were used)
Other possible sources	-
Access	Open access
Other data source used	
Source #1	
Name	BD Foret (Forest Data Base)
Provider	IGN (France)
Access	Open Access (free)
Area of interest	France
Description	Type of tree species
Usage	Learning and validation
Algorithms and processing tools	
Processing details	Random forest model is applied on satellite image time series to attribute one class of tree species for each pixel. Decision rules ona window of 9 pixels (3x3 pixels) is then used to define the forest typology (mixed, mono species, clear, dense, etc...) The training was carried out from the Forest database (BD Foret). Once processed, the layer was checked and modified thanks to thematic expertise (e.g. impossible to have beech trees in the south part of the area because the altitude is too low so the pixel isredefined as oak) to ensure the quality of the results.
Feedback and evaluation	
Reproducibility	The method is replicable on other territories but requires a new learning process to take into account the specificities of the image

	time series (acquisition dates) and of the forest type. The need for thematic expertise is important to validate the layer and correct errors.
Accuracy	The level of precision varies according to several criteria (number and type of classes in particular). In general, it seems to be quite difficult to separate forest species in a fully automatic way. It is necessary to cross-reference other data sources and thematic expertise. Indeed, it is really challenging to define as many classes as there aretree species, so this leads to errors. In addition, there are many mixtures of species in this area which are difficult to take into account in the model. Finally, each species is quite heterogeneous depending on the soil, the altitude, the localization, the slope, etc. This will create difficulties in the classification process.
Feedbacks	Classification requires field data and thematic expertise to validate / reclassify species. The choice of the classes is crucial; the deciduous-coniferous classification is quite good but obtaining details (e.g. conifer type) is difficult.
Pictures	
Legend : Presentation of a result with forest typology	

Application of Earth observation for forest management

Description of the use cases

Presentation of the company	
Name	TerraNIS
Address	12 Avenue de l'Europe, France
Website	www.terranis.fr
Telephone	+33 5 32 10 84 80
Contact name	Guillaume Rieu
Email	guillaume.rieu@terranis.fr
Presentation of the use case	
Type of customer	Public authorities; Region Occitanie
Area of interest	300 000 ha of forests over a zone of 825 000 ha (see below)
Product category	Forest typology (classification of tree species)
Product description	The objective was to classify tree species to update existing public dataand gain accuracy. The challenges was to classify tree species into 13 class (oak, chestnut, beech, etc.) and then create forest typologies (mixture of species, pure species, clear forest, dense forest, etc.....).
Earth Observation Images used	
Source #1 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	 Sentinel-2 time series (10 images) Multispectral 10 meters (RGB and NIR band were used) - Open access
Add other sources if necessary	Copernicus Forest mask
Other data source used	
Source #1 *Name* *Provider* *Access* *Area of interest* *Description* *Usage*	 BD Foret (Forest Data Base) IGN (France) Open Access (free) France Type of tree species Learning and validation
Algorithms and processing tools	
Processing details	Random forest model is applied on satellite image time series to attribute one class of tree species for each pixel. Decision rules on a window of 9 pixels (3x3 pixels) is then used to define the forest typology(mixed, mono species, clear, dense, etc...) The training was carried out from the Forest database (BD Foret). Once processed, the layer was checked and modified thanks to thematic expertise.
Feedback and evaluation	
Reproducibility	The method is replicable on other territories but requires a new learning process to take into account the specificities of the image time series (acquisition dates) and of the forest type. The need for thematic expertise is important to validate the layer and correct errors.

Accuracy	The level of precision varies according to several criteria (number and type of classes in particular). In general, it seems to be quite difficult to separate forest species in a fully automatic way. It is necessary to cross- reference other data sources and thematic expertise. Indeed, it is really challenging to define as many classes as there are tree species, so this leads to errors. In addition, there are many mixtures of species in this area which are difficult to take into account in the model.Finally, each species is quite heterogeneous depending on the soil, the altitude, the localization, the slope, etc. This will create difficulties in the classification process.
Feedbacks	Classification requires field data and thematic expertise to validate / reclassify species.
Pictures	
Legend : Area of interest	

Application of Earth observation for forest management

Description of the use cases

Presentation of the company	
Name	European Space Imaging & Terranor
Address	Arnulfstrasse 199
Website	www.euspaceimaging.com
Telephone	+498913014211
Contact name	Pascal Schichor
Email	Pschichor@euspaceimaging.com
Presentation of the use case	
Type of customer	Swedish Forest Owner
Area of interest	10.000km²
Product category	Detection of forest health / Bark Beetle infection
Product description	The objective was to detect sick and dying trees infected by the bark beetle.
Earth Observation Images used	
Source #1 *Name* *Type of image* *Resolution* *Other possible sources* *Access*	 European Space Imaging / TerranorGeoEye VHR: 40cm data
Algorithms and processing tools	
Processing details	Manual assessment at that time (2016), but recent test with other partners showed good results, if in-situ data is provided. SW: Ecognition
Feedback and evaluation	
Reproducibility	It is reproducible to forestry worldwide, but you need data from the ground toassess the data captured by the satellite.
Accuracy	Single detection of infected trees

Pictures	
Legend : Green: healthy trees Violet: Infected trees