Towards climate-smart Alpine forests

Milan, 30 September, 2021

Abstracts

Part 1 - Introduction

The new EU Forest Strategy for 2030 and its relevance for Alpine forests by **Marco Onida**, Team Leader Forests, ENV.D1 - Land Use & Management, DG Environment, European Commission, Brussels

The speech focuses on:

- The political background of the new EU Forest Strategy (in particular the European Green Deal and the EU Biodiversity Strategy for 2030) and the process that led to the adoption of the Strategy.
- The main contents of the Strategy: overview of the structure, headlines and planned deliverables. Focus on the enhanced climate and biodiversity ambition and the multifunctional approach to Forests.
- Specific focus on the challenges of Alpine forests and the opportunities in the new EU Forest Strategy

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Speech 1

Climate Change in Mountainous Areas by **Mathias W. Rotach**, Department of Atmospheric and Cryospheric Sciences, University of Innsbruck, Austria

In 2021, climate change is a reality and mankind is facing the challenge, not only to slow it down by drastically reducing the emissions of greenhouse gases, but also to be prepared for adaptation. While the former is a joint task for humanity, the latter concerns our immediate environment – and it is our responsibility to define appropriate strategies. The climate in a mountain range such as the Alps is in many ways special: on the one hand, mountain ranges shape the climate by producing, among other outcomes, orographic precipitation, mountain windstorms or glaciers – on the other hand, they give rise to water storage, recreation spaces, agriculture, renewable energy production, etc. Mountain regions not only have a quite substantially larger climate sensitivity than the rest of the land surface on the globe, they also host particularly fragile ecosystems.
Furthermore, from a climate-science perspective, mountain areas are extremely challenging. Climate scenarios are inevitably based on numerical modeling but climate models are struggling with a number of mountain-specific challenges – the most important of which is resolution (and hence cost). Thus, when addressing the role of forests in a mountain ecosystem and their possible adaptation to a changing climate, the climate community must be able to overcome these challenges in order to provide reliable climate services – to mountain forest managers and hence to mountain societies.

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Speech 2

Mountain forests in a rapidly changing world–why should we worry? by **Harald Bugmann**, Forest Ecology, ETH Zurich, Switzerland

Mountain forests cover a disproportionally large fraction of the mountain area and harbour above-average amounts of carbon. At the same time, they provide a large array of further goods and services to humanity, from timber, across biodiversity conservation, to medicinal plants, cultural heritage, and protection from hazards such as avalanches and rockfall.
Forests develop slowly, and the current stand structure typically has a long legacy effect. This contrasts with the increasing rate of climate change and human demands for forest ecosystem goods and services. Is there reason to suspect that such disequilibrium will jeopardise the provision of ecosystem services by mountain forests?
It is intrinsically difficult to study and predict forest dynamics, which operate over long-time scales and large spatial domains. Yet, empirical evidence as well as modeling results suggest that forests are expanding at upper tree-line; at the "trailing" edge of the forest, i.e., in dry areas, there is increasing evidence for accelerating loss of trees and forest cover. Both trends have strong impacts on ecosystem services and human livelihoods.
Within the forested area, climate-induced changes of forest properties are generally slow as long as large-scale disturbances (e.g., insect attacks, wildfires, pests and pathogens) are disregarded. Thus, the stand-scale perspective is not sufficient, but landscape-scale phenomena must be considered. Recent research has greatly expanded our ability to assess disturbance dynamics in a more and more mechanistic way.
I propose that we should indeed worry given the accumulating empirical evidence and model-based simulations of future trajectories of mountain forests. Specifically, we should take scenarios of the future of mountain forests seriously, although not literally.

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Speech 3

Silviculture for resilience in mountain environments by **Kurt Ziegner**, Land Tyrol/Forest Department, Innsbruck, Austria

Currently the mean annual temperature in the Alpine region is two degrees above the long-term average, with worst-case scenarios estimating changes of up to plus four degrees. Climate change leads to drought stress in trees, making them much more susceptible to pests and diseases.
Approximately 40,000 ha of the Tyrolean forests are in so-called "climate-sensitive forest areas", those forests located in dry, and below 1000 m above sea level, areas. These are the first which need to be rejuvenated and converted into mixed forests.
More than 70% of the Tyrolean woods have a protective function, protecting the environment from avalanches, rockfall and erosion. A healthy protective forest is existentially necessary for life in Tyrol. The long-term goal of the action group "Climate-Smart Tyrolean Mountain Forests" is to adapt the Tyrolean forests to climate change. Furthermore, it aims to sensitise society above all to the consequences of climate change for protective forests and the environment. The motto is**: Diversity above all!** In recent years, many necessary measures have already been initiated. Bundling these activities and promoting focal points in a targeted manner should achieve an even more positive impact on forests.
The benefits for society and forest owners are the long-term protection of the Tyrolean living and economic area from natural hazards and maintaining the profitability of our mountain forests by:
- rejuvenating small areas of old forest and bringing in mother trees;
- actively reforesting with mixed tree species;

- strengthening forest maintenance and thinning;
- offering advanced training courses on professional afforestation and care of mixed forests;
- specifically funding programmes which provide incentives;
- increasing public relations and awareness-raising measures;
- expanding cooperation and networking with natural space partners.

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Speech 4

Natural reproduction and afforestation - Forest reproductive material by **Christian Annewanter**, Land Tyrol/Forest Department, Innsbruck, Austria

The safeguarding of the genetic diversity of the woods as well as the sustainable management of this "green protective shield" are vital for their survival.
Uncontrolled imports of seeds and plants, as well as the afforestation of locally non-adapted planting material, lead to problems in the long term such as the displacement of native tree populations, mixing or loss of locally adapted genetic structures.
The decisive and critical issue for the artificial rejuvenation of the forest is the choice of reproductive material. Wrong decisions burden future forest development due to inadequate adaptation, lead to higher failures, unsatisfactory growth and susceptibility to biotic and abiotic harmful influences. Since the genetic make-up of the seed and seedlings are not recognisable to the forest managers, reproductive material needs to be marked.
The clear and traceable securing and labeling of the identity of forest reproductive material in Austria is regulated in the Forest Reproductive Material Act.

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Speeches 5, 6 and 7

Overview by three panelists - *Soils and erosion in mountain watersheds*

Mountain soils fulfil important ecosystem services in supplying trees with water and nutrients, harbouring an extraordinary diversity of organisms and storing large amounts of carbon. Soils have formed during millennia, but they are at risk due to climatic changes, forest disturbances and exploitive management. In steep mountain areas, soils are particularly vulnerable to loss by erosion and their preservation is therefore of central importance for the sustainable management of forests. Here, we present the role of mountain soils as hot spots for biodiversity, their contribution to carbon sequestration and finally, we discuss how vulnerable mountain soils are to global changes and how they can be managed sustainably.
Forest as a land use should be viewed holistically as a system of plant-soil communities. The condition of the soil is reflected in forest growth, just as forest management is reflected in soil health. As far as forest management is concerned, forest soil and forest plant communities are inextricably linked. Sustainable forest management therefore involves stable, species-rich forest plant communities adapted to climate change and silvicultural practices that, above all, protect forest soils from erosion, compaction by heavy machinery, acidification and contamination. In this way, forests can better fulfil a wide range of ecosystem services, including production, biodiversity, water storage and purification, flood protection and - most importantly from a climate change perspective - a larger and stable carbon sink.

Speech 5

Mountain soils and their importance for ecosystem services by **Colin Campbell**, James Hutton Institute, UK

General introduction to soils - Overview of soil properties, soil diversity - Soil ecosystem services: biomass, food fibre, water, biodiversity & soil biodiversity - Role of soils in global climate, soil carbon storage - global soil carbon budget, carbon sink.

Speech 6

Vulnerability of mountain soils to climate change and disturbances by **Frank Hagedorn**, Federal Institute for Forest, Snow and Landscape Research, WSL Birmensdorf, Switzerland

Carbon storage in mountain soils: elevational patterns - Vulnerability to climate change and disturbances by windthrow - Risk of soil erosion.

Speech 7

Towards sustainable management of forests and their soils by Borut **Vrščaj** - Agricultural institute of Slovenia KIS Lubiana, Slovenia and Aleš **Poljanec** - Slovenia Forest Service.

Inseparable forest & forest soils: holistic approaches – Sustainable-forest and forest soil management - Changing strategies and practices - Strategies and measures to limit soil degradation, especially erosion and soil compaction - Adaptation of forest structure and tree species composition to site conditions, also taking climate change into account - Strategies to safeguard soil and forest ecosystem services.

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Speech 8

Drought and bark beetles by **Sigrid Netherer**, Institute of Forest Entomology, Forest Pathology and Forest Protection, University of Natural Resources and Life Sciences, BOKU Vienna, Austria

Since 1900, mean growing season air temperatures have constantly risen, while climatic water balance, i.e., the difference between precipitation and potential evapotranspiration, has significantly decreased. The year 2018 was characterised by the most severe and long-lasting heat wave and summer drought ever recorded. This “hotter drought” event resulted in increased mortality and severe signs of drought stress such as premature leaf shedding and exceptional low foliar water potentials of main Central European tree species. Impaired physiological recovery of deciduous and conifer trees made them highly vulnerable to secondary damage by fungal pathogens and forest pest insects. A number of bark beetles on Scots pine show the potential of mass outbreaks given warm and dry weather conditions. The Eurasian spruce bark beetle, *Ips typographus*, has been in epidemic phase more or less constantly since the 1990 storm events. The probability of infestation of this aggressive scolytid species increases with the share of Norway spruce, stand age, very low and high stand density. Main drivers of mass outbreaks are temperature conditions, allowing for fast generation development as well as summer drought, as shown in a study conducted for the Austrian Federal Forests. A high proportion of years with two or more bark beetle generations is predicted for the main area of Norway spruce distribution in Europe for the coming decades.

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Speech 9

Diapause and voltinism in the spruce bark beetle 'Ips typographus' by Martin Schebeck, Nina Dobart, Gregory J. Ragland, Axel Schopf and Christian Stauffer. A research paper presented by **Martin Schebeck**, BOKU, Vienna, Austria.

The bark beetle *Ips typographus* is the most destructive pest in Norway spruce-dominated forests in Europe. It can produce multiple generations per year; this trait contributes to rapid population growth and severe outbreaks. The voltinism (i.e., the number of generations per year) of *I. typographus* is strongly driven by ambient temperature, but also affected by its diapause expression. *Ips typographus* enters diapause in the adult stage, in order to match its life cycle with fluctuating environmental conditions, characterised by an arrest of development and reproduction, and by an increase in stress resistance, as a response to cold winters; *Ips typographus* enters a facultative, photoperiod-regulated diapause. Moreover, it expresses an obligate diapause that is independent of photoperiodic induction. The diapause phenotype affects the beetle's voltinism, as obligate diapausing individuals establish only one generation per year. Intraspecific variation for diapause expression most likely is an adaptation to synchronize life cycles with ambient conditions across the species' range. As the diapause phenotype influences *I. typographus* voltinism, our findings form the basis for understanding outbreak patterns. Finally, the effects of climate change on diapause and voltinism under altering environmental conditions in mountainous regions are discussed.

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Speech 10

The role of bacteria and fungi in the population dynamics of the European spruce bark beetle by Hannes Schuler, Jessica Dittmer, Moussa Abdelhameed, Patrizia Elena Vannucchi, Martin Schebeck, Massimo Faccoli, Andrea Battisti and Christian Stauffer. A research paper presented by **Hannes Schuler**, Freie Universität Bozen, Italy

The European spruce bark beetle *Ips typographus* is the most important forest pest in Europe. In autumn 2018, the storm 'Vaia' caused severe damage to spruce forests in the Alpe-Adria region. In addition, heavy snowfalls caused further damage in autumn 2019 and winter 2020. These affected areas provided ideal conditions for the development and population growth of *I. typographus,* leading to enormous ecological and economic damage in the region.
Bacteria and fungi associated with *I. typographus* can significantly affect the aggressiveness of the beetle, as they help to overcome tree defenses or are involved in pheromone production. Moreover, they might provide nutrients and detoxify host defense chemicals. Therefore, the existence of microorganisms is a substantial factor influencing the biology and behaviour of this important pest species. Moreover, environmental conditions, and especially climate change, besides acting directly on the beetles, might impact also the composition and structure of their microbiome and therefore indirectly affect beetle fitness and outbreak dynamics.
Here we provide new insights into the association of *I. typographus* with symbiotic bacteria and fungi and present their role in the current dynamics of bark beetles and their distribution in the Dolomites.

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Part 2 - Introduction

The contribution of the forest sector to climate change mitigation: challenges and trade-offs by **Giacomo Grassi**, Scientific officer, project leader**,** Joint Research Centre, Directorate D – Sustainable Resources – Bio-Economy Unit, European Commission, Brussels

Within the EU's plan to reach climate neutrality in 2050, the importance of the forest CO2 sink will increase over time. However, forests can deliver more than just the CO2 sink: a wise use of wood products may also help fight climate change. Open questions remain and trigger a polarised debate. What is better for the climate: should forests be harvested more or less? Should wood be used in energy or in construction? This talk discusses trade-offs among different options and the challenge to reconcile mitigation and adaptation in order to achieve resilient and multifunctional forests.

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Speech 11

Regole d'Ampezzo collective property woodlands by **Michele Da Pozzo**, Regole d'Ampezzo, Ampezzo Dolomites Natural Park, Italy

The *Regole d'Ampezzo* are a collective property, that, for centuries, have managed 15,400 hectares of forestry-farming assets in the Ampezzo Dolomites. The main purpose of the *Regole* woods is currently landscape-environmental, as half of them are attributed to the Regional Natural Park and visited every year by millions of hikers. 6,400 hectares of the total extension are considered in the management plan as production and landscape woods, with annual felling of about 1 m3 / ha / year on average; 2,100 hectares are protection forests. Fertility is scarce and the annual felling is still less than the annual increment. The average felling cycle in a single forest unit is between 12 and 18 years.
The woods are mixed, uneven-aged and multi-layered, with six main building species; the articulated structure is the result of centuries of management with selection systems, aimed at obtaining high quality assortments, satisfying, firstly, the primary needs of the local community, and secondly, commercial objectives that complete the economic cycle of the forestry chain. On many sides of the Ampezzo valley, especially in recent years, the hydrogeological stabilisation function of the protection forests has also been of fundamental importance.
In addition to their extraordinary landscape and naturalistic qualities, these woods in fact perform diversified functions, are rich in biodiversity and deadwood and are, on average, rather aged, also due to low growth rates. They produce good quality assortments and unique environmental and tourism services. They have also proved to be rather resilient to climate change, as they have suffered below-average damage compared to those of the north-eastern Alps impacted by storm Vaia, heavy snowfall and bark beetle attacks.

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Speech 12

Managing for complexity: sustaining Ecosystem services in a context of climate change by **Emanuele Lingua**, Department TESAF, University of Padua, Italy

Mountain forests provide several ecosystem services, and, in the last few decades, some of them have been considered of greater importance compared to their productive function. The multifunctional management of forest stands calls for a comprehensive approach in order to implement interventions

for achieving the different goals. Today's challenge is to sustain timber production while maintaining or enhancing the biodiversity, protective function, aesthetic and recreational value of managed stands. In a context of climate change and natural disturbance regime alterations, new silvicultural approaches should be implemented and old (local) good practices rehabilitated.

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Speech 13

Managing conservation conflicts: a vital component to tackle the climate crisis by **Chris R J Pollard**, Forest Research, Northern Research Station, Midlothian, Scotland, UK

Expanding realisation of human-mediated impacts on planetary systems has increased tensions between building social foundations for living a good life (such as social equality, clean water, food security, peace, and livelihoods) and limiting processes which cross planetary boundaries (such as biodiversity loss, climate change, and land conversion). Decision-making will inevitably involve trade-offs between varied individual and societal objectives including biodiversity conservation, carbon sequestration, food production, housing, and energy production. A vital area requiring action is land use. In the UK for example, efforts include new government set targets to increase both total tree cover and the percentage of land in protected areas. Disagreements about how to achieve these targets specifically and other conservation aims more generally can descend into conflict, where parties disagree about management objectives and, at least, one party asserts, or is perceived to assert, its interests at the expense of another. Conflicts can slow or stop crucial actions required to meet environmental targets, and stifle the cooperation needed to tackle complex climate and biodiversity crises. Here I discuss what we can learn from instances of conservation conflict and the efforts for its management, to tackle the current and future trade-offs facing Europe in a time of climate crisis.

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Speech 14

Building resilient mountains and mountain food systems by **Rosalaura Romeo**, Mountain Partnership Secretariat, FAO

Mountain people globally face high rates of food insecurity and malnutrition. As of 2017, one in two rural mountain people in developing countries lived in areas where the local food availability risked falling below the minimum threshold to ensure healthy lives.
Protecting mountains through sustainable food systems is a prerequisite to lift mountain communities out of food insecurity and marginalisation.
Agriculture and food production are important economic and development drivers in mountain areas, where six out of ten people live in rural areas. They contribute to sustaining the livelihoods of 1.1 billion people living in the mountains as well as those in the lowlands who depend on healthy mountain ecosystems for freshwater and the conservation of biodiversity.
Farming, according to agroecological principles as well as maintaining traditional and indigenous agricultural knowledge, increases the resilience of mountain agroecosystems and supports the stability of local food production.

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Speech 15

Risk to mountain forest Ecosystem services due to natural disturbances by **Ana Stritih**, Planning of Landscape and Urban Systems, ETH Zurich, Switzerland

Mountain forests are experiencing an increasing rate of natural disturbances, including severe windthrow events, forest fires and bark beetle outbreaks. Homogeneous spruce forests that developed during the 20th century on former agricultural land are particularly susceptible to these extreme events, and management interventions in these forests can even increase the risk of a severe disturbance. These disturbances affect not only wood production and carbon sequestration, but also other ecosystem services provided by mountain forests, such as protection from natural hazards. To better cope with these risks and prioritise areas for management, it is important to understand how these ecosystem services are distributed in space. Increasingly available Earth Observation data can help us model and map ecosystem services as well as the risks due to natural disturbances.

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Speech 16

Wrap up - Policy framework and sustaining of Ecosystem services by **Giorgio Vacchiano**, Department of Agricultural and Environmental Sciences, Milan State University, Italy

The talk summarises the existing EU framework on forest management for climate mitigation and adaptation, starting from recent and upcoming documents from the Green Deal package, such as the EU forest strategy, the Biodiversity strategy, the LULUCF regulation and the Fit for 55 climate package. I highlight pathways and opportunities to increase forest resistance and resilience to climate change, manage forest carbon sinks, and improve ecosystem services provided by forests such as hydrogeologic protection. Finally, I describe markets for carbon credits and other ecosystem services, and the current regulatory framework available to generate them for public and private stakeholders

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Speech 17

Remote detection of spruce bark beetle infestations in the Italian Alps by Aurora Bozzini and Massimo Faccoli, Department of Agronomy, Food, Natural Resources, Animals and the Environment, University of Padua, Italy. Research paper presented by **Aurora Bozzini**.

As previously mentioned, the European spruce bark beetle (*Ips typographus*) is the most important pest affecting Norway spruce in Europe. Mass outbreaks of this insect often occur after abiotic disturbances, such as the storms and snowfalls that took place in autumn 2018, 2019 and 2020 throughout the Alps, which created ideal conditions for the quick growth of pest populations. Extreme events are solicited by climate change, which also impacts bark beetle biology and the whole forest ecosystem. Developing effective monitoring systems and management strategies to contain *I. typographus* infestations is therefore essential for preserving spruce forests. Remote sensing techniques can be valid tools to detect promptly new bark beetle infestations and their spatial distribution as well as to locate those areas most susceptible to new future colonisations.
Within the Interreg project “DolomIps”, we are exploring the potential of satellite imagery analysis to locate and assess sites with tree mortality following *I. typographus* infestations. We also investigate the

application of this technique in alpine territories and how landscape features can affect the analysis outcome.
The improvement of early-detection methods, together with thorough knowledge of pest biology and ecology, can help develop effective control strategies aimed at preventing large-scale outbreaks mitigating both ecological and economic damage.

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Speech 18

Opportunities and limits of Unmanned Aerial Systems ("Drones") for Environmental Monitoring by **Gernot Paulus**, FH Kärnten - Carinthia University of Applied Sciences, Engineering & IT, Spatial Information Management, Austria

Climate change poses a critical threat to the Alpine ecosystem, resulting in more and more rapid changes in space, time and scale of the biotic and abiotic environment and the related socio-economic structures. Unmanned Aerial Systems (UAS, "Drones") provide a "missing link", in terms of scale, between space- and airborne remote sensing and ground-based observations for high resolution environmental monitoring. UAS are capable of providing flexible "on-demand" data acquisition for collaborative environmental monitoring, automated change detection, spatial decision support, environmental impact assessment and risk management. Multidimensional spatio-temporal sensor fusion, data integration, machine learning, spatio-temporal analysis and dynamic visualisations are key challenges for developing "all-inclusive" scalable environmental service solutions.

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Speech 19

The Copernicus EMS Rapid Mapping Service in dealing with the consequences of the "Vaia" storm by **Lucia Luzietti**, e-Geos, Italy

Since 2012, e-GEOS has provided on-demand tailored Geo-Information mapping and monitoring services based on satellite data, with provision of maps and analytics and is the group leader of the Consortium that is providing the Copernicus EMS Rapid Mapping Service with continuity since the operational phase.
The Copernicus Emergency Management Service (EMS) uses satellite imagery and other geospatial data to provide mapping services to address natural disasters, human-made emergency situations and humanitarian crises throughout the world. In particular, the Rapid Mapping service provides geospatial information, within hours, from its activation in support of emergency management activities immediately following a disaster.
In October 2018, the Rapid Mapping Service was triggered by the Italian Civil Protection (https://emergency.copernicus.eu/mapping/list-of-components/EMSR334) for mapping the damage made by the "Vaia" storm. Indeed, extreme meteorological events are important causes of damage even in the Alpine environment, characterised by strong winds that can damage infrastructures and alter intensively vegetation. The Rapid Mapping service was requested for the same event also in Austria (https://emergency.copernicus.eu/mapping/list-of-components/EMSR340). The aim of both activations was a fast mapping of the affected areas with the identification of the loss of trees cover over a huge area. This quantitative analysis was relevant for understanding the magnitude of the event and for identifying the most impacted areas where the attention of decision makers needed to be focused on immediately after the event.

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Speech 20

How artificial intelligence and big data platforms can deliver new end-user services for forest management by Laurent Clergue, Atos France, CTO Office Public Sector and Domenico Pugliese, Atos Italy, Public Sector & Defence. Presentation by **Laurent Clergue**.

Thanks to the Mundi platform*, led by Atos and built, in partnership with different European companies such as e-Geos, GAF, Thales Alenia Space, T-system and other little expert companies, we have created a range of services based on Earth Observation dedicated to sustainable development. One priority is linked to climate change and its impact on human societies and the environment.
The satellites of the Copernicus programme provide access to the monitoring of each part of the Earth every week, with precision of up to ten meters, allowing the creation of efficient monitoring surveillance.
To provide reliable and robust services, the Atos R&D team, specialised in Earth Observation (EO) combined with Artificial Intelligence, High Performance Computing and Cloud Platforms, implements partnerships with scientific laboratories and thematic experts to provide services tailored to user needs with a high level of scientific validity.
In this way, our product roadmap addresses forests through different perspectives: carbon sinks, biodiversity reservoirs, sustainable use of forests and forest health policy.
The capabilities of EO associated with AI, HPC and Cloud Platforms deliver new assets which can provide end-user services, dedicated to forest management, anywhere in the world and in real time.

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