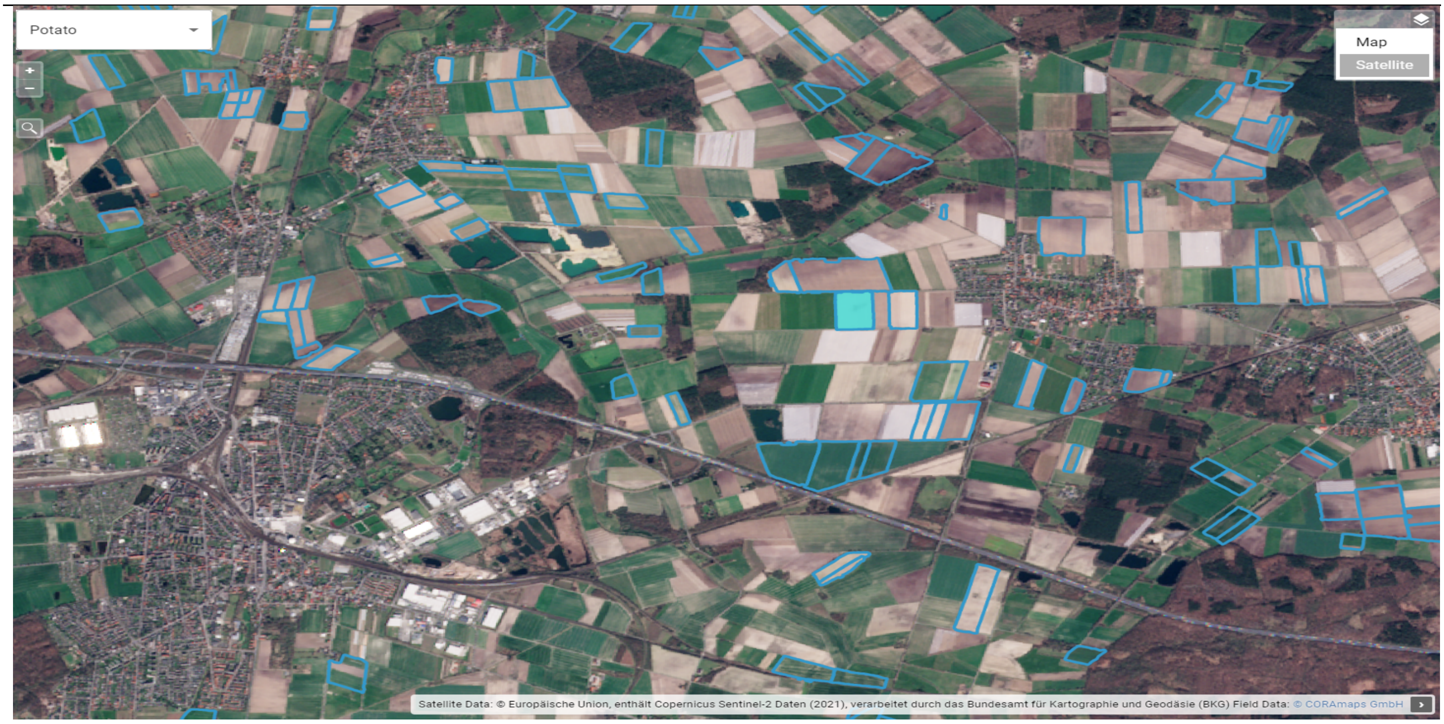
OBSERVER: Revealing hidden land patterns with AI and Copernicus



Artificial Intelligence (AI) is not just a futuristic concept; it's a critical tool shaping the present, especially in the field of Earth Observation (EO). This is particularly evident in Copernicus, the Earth Observation component of the EU Space Programme, where, more and more, AI algorithms are employed to process the extensive data streams from Copernicus satellites. This marriage of machine intelligence and big satellite data is enabling a wide range of applications across various domains. From rapidly identifying environmental changes like deforestation or urban expansion to monitoring air quality and ocean temperatures for climate research, the use of Copernicus data with AI is transforming our understanding of the Earth's surface in unprecedented ways.

Quicker processing of data

Copernicus generates around 25 terabytes of data every day. Sifting and sorting this data, let alone performing meaningful analytics from it would be near-impossible by hand. AI can be used to mine and manipulate data far more efficiently.

Software can be used to transform Copernicus data from raw- into application-ready form, while AI algorithms can identify patterns, anomalies, and changes in the environment. This brings added value to the end-user, who may at that point use the AI-derived insights for decision-making and better monitoring.

Improving crop monitoring

Earth Observation holds great promise for agriculture, and AI adds an exciting boost to these prospects. AI-powered EO helps farmers track crop health and optimise irrigation and fertiliser use.

This results in increased crop yields and more sustainable agriculture practices.

One player in the field of using AI for agricultural information is [CORAmaps](), a German startup company. Their focus lies in harnessing AI-based interpretation of satellite radar data to provide insights on land conditions. Their specialisation extends to detailed and rapid assessment of agricultural areas, providing critical information such as crop types, quantities, and quality. Take this delineation of potato crops near the town of Lehrte, Germany, as an example:

Combination of optical and radar data to portray the delineation of potato crops in Germany, in 2022. Credit: CORAmaps

Moreover, by leveraging radar data from Copernicus Sentinel-1 and combining it with extra data streams, CORAmaps can produce large-scale crop maps — a great resource to monitor food supply.

Detecting land cover change

Seeing how land changes from space can be tricky. Satellite images often show significant variations between different acquisitions. Many factors can cause these variations, such as seasonal shifts in vegetation and alterations caused by meteorological conditions. These fluctuations pose a challenge when we want to look for genuine land cover changes (like deforestation) with single-pixel time series data.

To address this, [VITO Remote Sensing]() developed a detection algorithm using deep neural networks. These are a class of artificial networks with multiple layers, designed to model and solve complex large scale problems by simulating human neurons.

VITO's algorithm extracts compressed image features to identify areas with changing land cover. To build it, the team adapted an existing algorithm called Tile2Vec to ensure the separation of seasonal (change of foliage colour and other natural-occurring changes) from structural information (deforestation caused by fires, for example). This enables better land cover change detection. The team trained the algorithm on a set of 500 000 image patches from the Copernicus Sentinel-2 mission as well as Planet Fusion imagery making it so that it is not affected by seasonal effects. The resulting algorithm is capable of detecting land cover changes while ignoring naturally occurring ones.

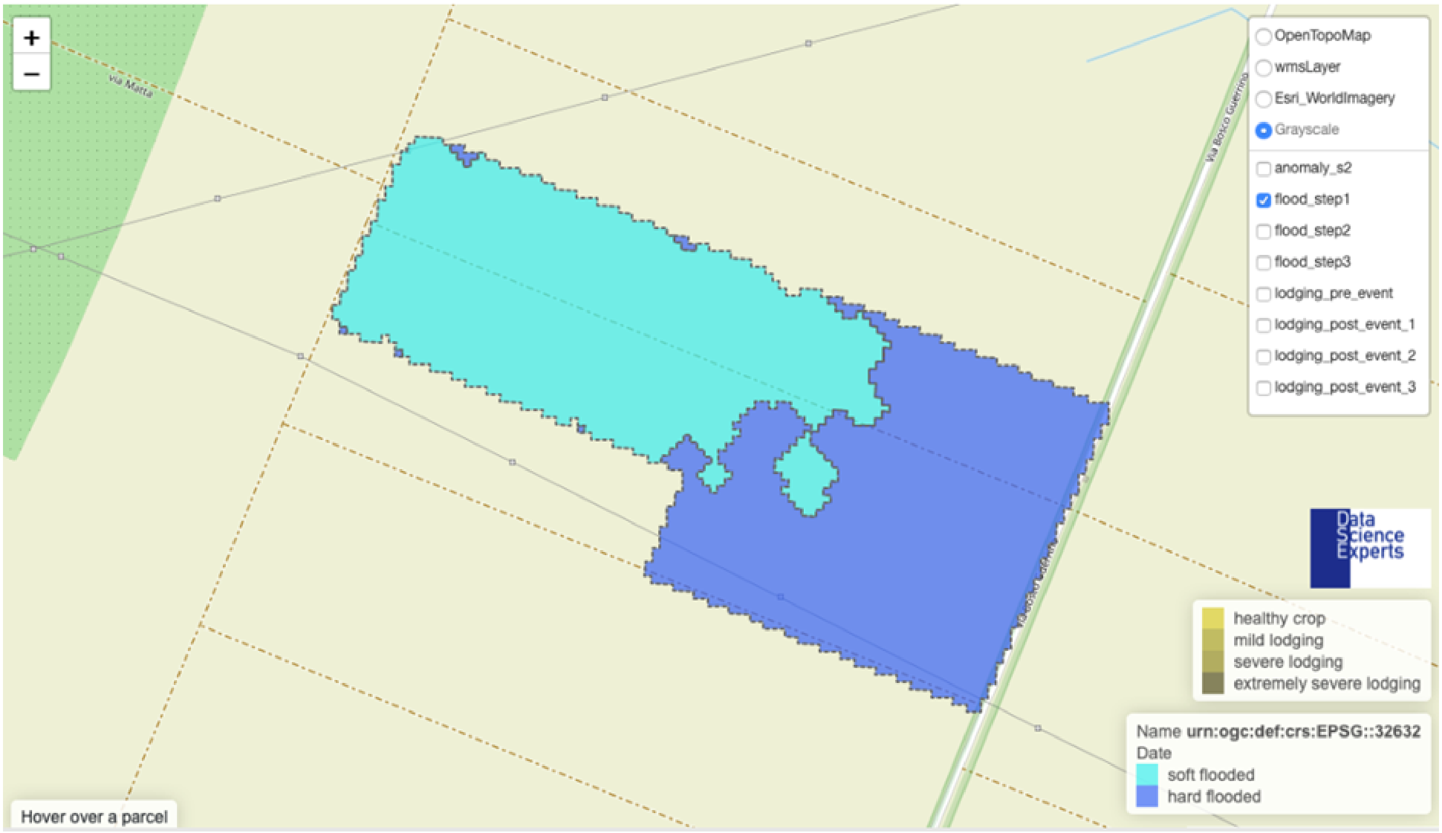
A change detection algorithm revealing alterations over time in a forested region in Portugal. The animation illustrates forest loss during three distinct periods: February 2019, June-July 2019, and June-July 2020. The algorithm identifies these changes, which are highlighted with a red square and ignores other ones, such as the change in vegetation colour. Credit: Vito Remote Sensing

Managing and dealing with natural disasters

You already know that Copernicus helps with emergency response with its Copernicus Emergency Management Service (CEMS), but AI can boost these efforts. Currently, with each emergency activation, CEMS teams provide maps of the disaster sites in a semi-automated process — they analyse Earth Observation datasets manually but also with the help of some AI algorithms. This can become a demanding process, especially when we consider that, in the future, the increasing frequency of natural disasters due to climate change will create even larger datasets. Automated data processing at scale can assist these teams, allowing them to harness Earth Observation data to its maximum potential.

But AI's assistance doesn't end here; this technology also plays a crucial role in quantifying the aftermath of natural disasters.

[DSE](#) (Data Science Experts), a company from France, developed [AIperion](#), a system that evaluates agricultural damage caused by natural disasters. Leveraging AI and Earth Observation data, AIperion identifies flooded and burned areas, quantifies drought impact, and assesses damage to agricultural fields. The system integrates meteorological data from the Meteosat Second Generation (MSG) mission and relies on data from the Copernicus Sentinel-1 and Sentinel-2 missions to calculate vegetation indices. This approach not only provides valuable insights into crop health and the causes of damage but also supports insurance companies in determining premiums for crop losses attributable to natural disasters.



Flooded crop with different levels of damage. Credit: DSE Data Science Experts, AIperion

Filling in the marine gaps

AI has proven itself very useful to the Copernicus Marine Service (CMEMS) too. The service has implemented machine learning in a recent project known as 3DA. Ocean observations obtained primarily from satellites often have gaps in them. 3DA helps fill in these gaps.

Within the project, a machine learning programme was trained on sets of historical data, reinforcing the expected structure of Copernicus' information. Its learnings were then applied to patch data in the 'gappy', as well as to predict its evolution through time; a feature not available using previous technologies. CMEMS uses AI in other ways and you can check other strategies the service is implementing here.

The AI4Copernicus project

Another project already in place is the AI4Copernicus. At its core, the initiative uses the AI4EU AI-on-demand platform to establish a digital environment for Copernicus data users, including researchers and innovators.

The project has three main goals: firstly, integrating the vast resources and extensive Earth Observation data from existing providers, alongside training materials and expertise, enriching the AI4EU resources catalogue. Secondly, it strives to stimulate diverse communities within AI4EU and Copernicus, encouraging them to collaboratively tackle real-world challenges through a series of open calls. Lastly, AI4Copernicus aims to propel the advancement, adoption, and profound impact of the platforms involved, particularly AI4EU and the Copernicus Data Access platforms.

What lies ahead

In this article, we've only scratched the surface of how AI can supercharge Copernicus. But what's on the horizon is nothing short of thrilling. As we venture deeper into the uncharted territory of AI, the possibilities for harnessing massive amounts of satellite data are boundless.

Entities like the European Space Agency (ESA), the European Centre for Medium-Range Weather Forecasts (ECMWF), and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), armed with Copernicus data, are embarking on the European Commission's Destination Earth initiative (DestinE). This visionary endeavour will craft a digital twin of our planet, a complete virtual model of Earth's dynamic systems — the atmosphere, oceans, and land. With this digital twin at our fingertips, we can meticulously monitor and better comprehend climate change, biodiversity loss, and the myriad impacts of human activity, all grounded in real-world data. It's a bold leap into Earth's future, made possible by blending modern AI with Copernicus' full, free, and open data.

Useful Links

Destination Earth on YouTube