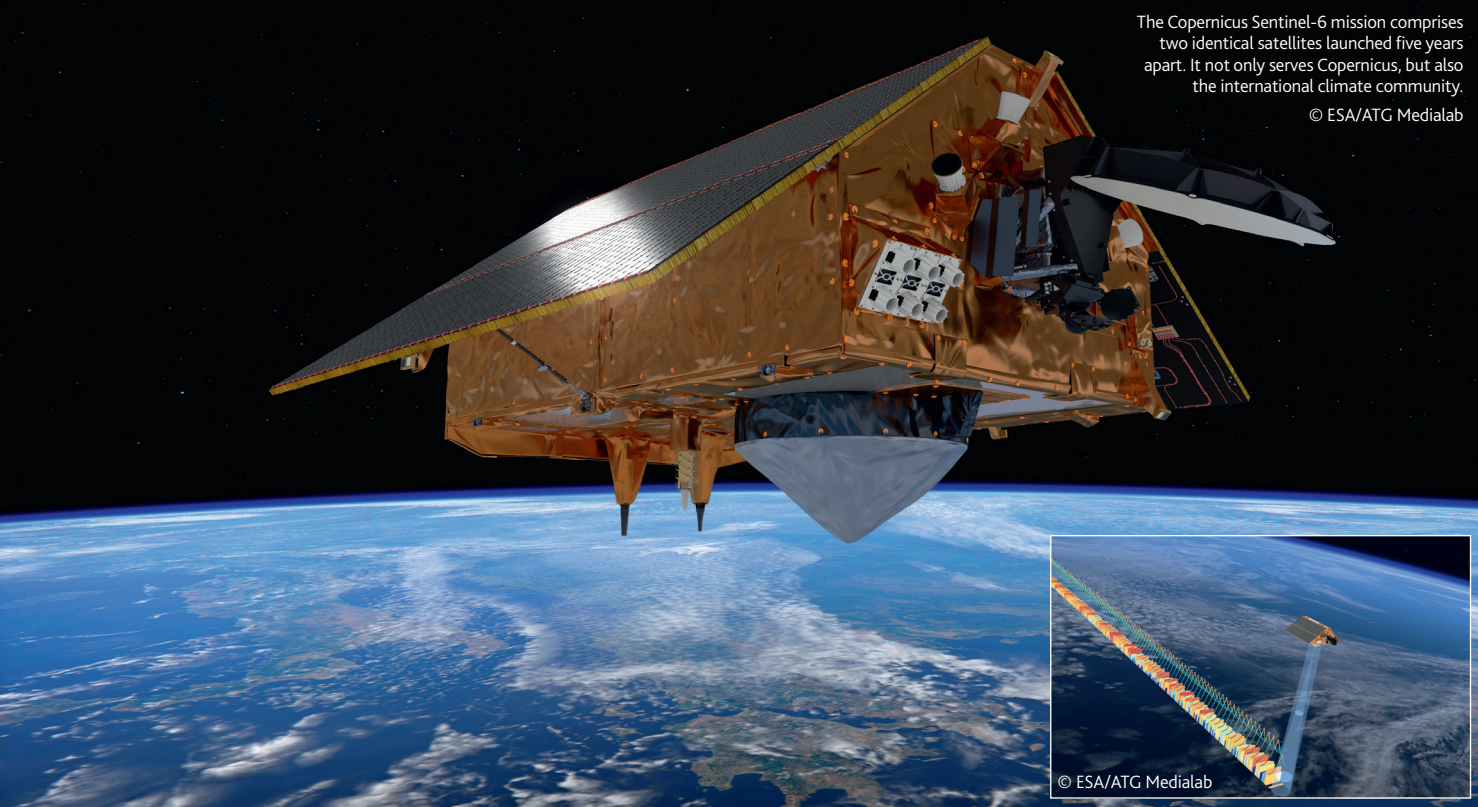
Harnessing the power of earth observations



The Copernicus Sentinel-6 mission comprises two identical satellites launched five years apart. It not only serves Copernicus, but also the international climate community.

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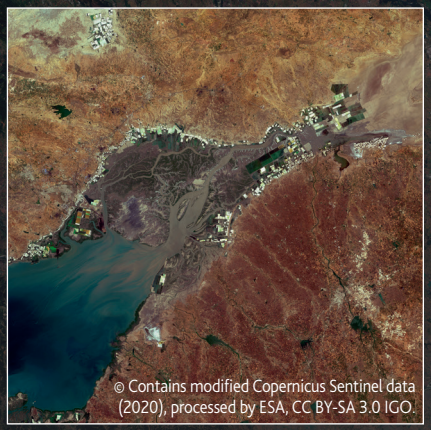
Satellites continuously orbit the earth and gather huge amounts of data, which can be highly relevant for decisions in areas like flood risk assessment and food security. We spoke to **Dr Guido Vingione** and **Maria Gabriella Scarpino** about the EOPEN project's work in developing an open platform to enable non-expert users to make full use of satellite data.

The Copernicus programme systematically monitors the globe through a constellation of satellites named Sentinels, which continuously acquire imagery and data on our planet. This data is enormously relevant in areas like flood risk assessment, food security and climate change mitigation, yet it must be presented in an accessible way if it is to meet the needs of end-users, a topic central to the EOPEN project. "EOPEN is essentially a platform targeted at non-expert users who want to easily access this big volume of Copernicus data," says Dr Guido Vingione, the project's coordinator. Three use cases have been identified, where satellite data could help inform decision-making on the ground. "The first is flood risk assessment and prevention in an area under the Eastern Alps Water District Authority, partner in the project, particularly focussed over Vicenza, in the Veneto region. When there is a heightened flood risk, satellite data can provide mapping and information," outlines Dr Vingione. "The second use case is about demonstrating that satellite data can be useful to entities in South Korea managing food resources and food security."

A third use case centres around using both non-earth observation datasets and (satellite) earth observation to mitigate the impact of climate change in Finland and adapt to its effects, which differs in nature from the first two use cases. With the climate change use case, the emphasis is more on identifying longer-term patterns. "With climate change, it's a matter of processing time series, to produce global maps. It's different in terms of volumes and complexity, it's about processing a huge volume of data," explains Dr Vingione. The focus in this specific use case is on monitoring the extent of climate change in the Arctic, as well as assessing its likely impact on regional infrastructure. "The Finnish Meteorological Institute aim to support the national transport agency in road maintenance operations and future planning, as well as to support Finnish Lapland communities. Reindeer herders are on the frontline of climate change," says Maria Gabriella Scarpino, a researcher at Serco who is also closely working on the project. "The aim with the EOPEN platform is, among others, to provide users, stakeholders, with the tools they need to process data of various typologies. In this use case, that's weather forecast, climate projections, observation of snow covers and time series of temperature and precipitation, to support particularly reindeer herders and reindeer researchers."

Earth Observation data

The end-users in the different use cases may not necessarily be experts in interpreting satellite data, yet nevertheless it can provide important insights and help them work more effectively. The platform is targeted at those staff members with a degree of authority, people who are called upon to make decisions based on the information available to them. "In the case of flood risk assessment, it is the civil protection authority in Italy who need to know the area which is likely to be affected by flooding. That



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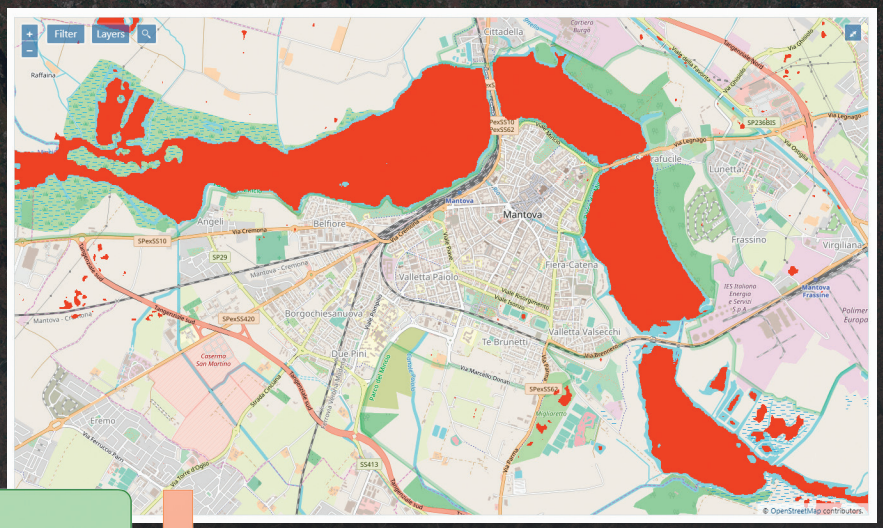
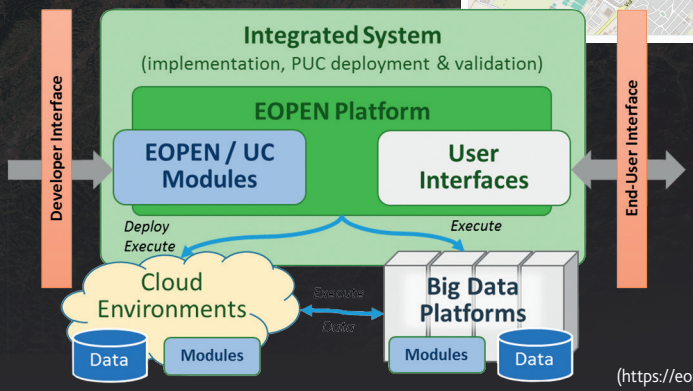


SAR (Sentinel 1) and DEM data fusion, based on Deep Convolutional Neural Network (AI/DCNN)



EOPEN Team (https://eopen-project.eu/team/)

user has to decide how to deploy resources over the affected area," says Dr Vingione. A satellite image of the extent of a flood holds clear relevance in these terms, providing a snapshot of the situation at a particular point in time, while a satellite also provides images of the same area over extended periods, allowing researchers to assess the extent of any changes. "The sentinel satellites have a reconnaissance cycle (repeat-cycle) of between 7-10 days, depending on the mission. So, they pass over the same area, at the same local time, every 7-10 days," says Dr Vingione.

The EOPEN platform itself has been designed with the needs of these users firmly in mind, with researchers developing a set of software and applications which can be run on different platforms, thus tackling interoperability. EOPEN is an open platform, agnostic of both the programming language and the platform in which processes are running (federated platforms execution framework), and is capable of integrating algorithms from users, consumers, and third parties, as well as of integrating more data from other sources. "We have a high computing capability, with the ability to process huge volumes of data, and to deal with different typologies of data," explains Dr Vingione. The satellite data is currently mainly acquired from sentinel 1 and 2, but the EOPEN platform is agnostic of the data, and Dr Vingione says it is possible to include data from other sources. "If there is an application which requires sentinel 3 data, then we can inject that in our working environment, and we can build algorithms to deal with that information," he outlines.

This satellite imagery is combined with data from other sources in the platform, including weather forecasts and tweets from social media users, which can help to build a deeper picture of the situation on the ground. A social media user may send a tweet about the weather in their region for example, yet it is not easy to combine this with information from satellite images. "Satellite data is well-structured, whereas a tweet may be classified as non-structured data. There may be text accompanying an image, but the text may not be relevant to the image, so it is not structured data," explains Dr Vingione. Researchers are applying big data analytics methods, in particular machine learning techniques, to detect the relevant (anonymized) tweets as well as filter out the unwanted ones. "We try to gather information from these tweets and deliver it to the consumers of the platform," says Dr Vingione. "This process is automatically managed through an algorithm based on machine learning."

Decision-making

The wider aim here is to support a prompt reaction to a potential flood event. Shortly after the weather forecast is issued, layers showing maximum expected precipitation amounts in each municipality at various times are available in the platform, with a frequency of update which can be set to 1-4 times a day. In addition, a warning email is sent to relevant people when the precipitation is expected to exceed given thresholds in the following 48 hours. If an event occurs, geo-localized tweets can complement the information derived from satellite-based maps. Also, on an event occurrence, the Water District Authority is using the platform resources to generate an advanced early warning flood forecast product which would take tens of hours to be produced on its systems. This information can help staff involved in flood risk management

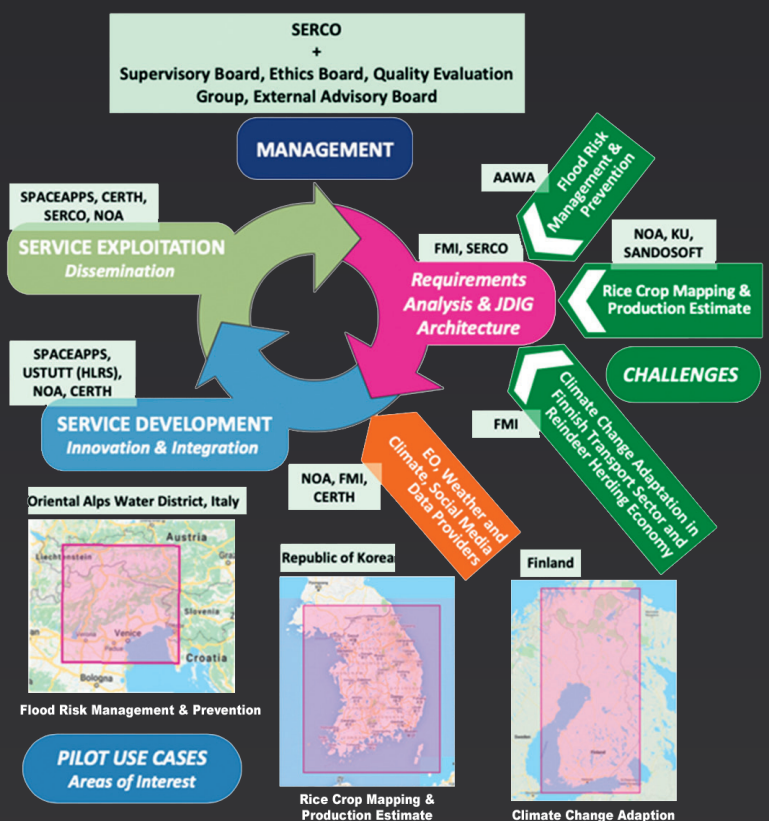
A typical **EOPEN user** can even build a **new application**, re-using **EOPEN data** and available algorithms, and **complement it** with **other sources** of information, like for example **data of restricted usage**

to make more effective decisions. "We can provide an early assessment, which is extremely important for the authority managing the risk." says Dr Vingione.

A different use case may have different requirements, for example the food security use case requires big data management, distributed processing, low dependence on ground truth information, and a highly generalised machine learning modelling. In these cases, solutions can be provided which encompass high performance computing, semi-supervised machine learning, model generalisation and interoperability, in line with the EC call which funded the EOPEN platform. "A typical EOPEN user can even build a new application, re-using EOPEN data and available algorithms, and complement it with other sources of information, like for example proprietary data (e.g. field data)," says Dr Vingione.

A lot of progress has been made over the course of the project in terms of developing new tools and software, and with the funding term nearing its end, researchers are now looking to bring their findings to wider attention. Several events have been organized to collect feedback from use case stakeholders at which wider possibilities in terms of the potential of the platform will be explored. "An event targeting both, stakeholders and policy makers is being organized by the EC Project Officer. It will involve all projects funded under the same call, to see how these platforms can be used to address current social problems and challenges," says Scarpino. There is also the possibility of commercial exploitation, with Dr Vingione looking to provide the EOPEN platform to other parties who may benefit from the ability to combine different sources of data. "Our intention is to start commercialising services based on EOPEN capabilities," he outlines. "There is also the possibility to use the platform to build other applications, so this means EOPEN not as a provider of information, but as a working environment."

The EOPEN platform is able to provide a context or working environment, allowing the user to build a specific application. "So, if the user has specialised knowledge, they can derive all the applications they want, based on the satellite data that is available through EOPEN," says Dr Vingione. The project consortium partners are currently exploring possible business models to sell the EOPEN services more widely, and Dr Vingione believes this versatility is an important attribute. "We're developing a local platform that allows users to inject more detail if they choose to," he explains. "We are also agnostic from the infrastructure hosting EOPEN, we are not constrained by a specific cloud provider. We want to be interoperable with other platforms, so our software and applications, can be run on different platforms."



Application-Service full life cycle support.

EOPEN

Open interoperable platform for unified access and analysis of Earth Observation data

Project Objectives

The objective of EOPEN is to ensure scalability of the data standardisation, fusion and exchange methods, combining also non-EO data and metadata annotation. EOPEN combines mature ICT solutions and scalable processing techniques, building on top of existing European High Performance Computing (HPC) infrastructure. The project's team consists of large service industry, specialised SME, public research centres and university.

Project Funding

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Project Partners

https://eopen-project.eu/consortium/

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Dr Guido Vingione is the EMEA Space Business Development Director for Serco. He gained his PhD in Space Science and Technologies from the University of Naples and joined Serco in 2006, before taking up his current role in 2018. He has authored a number of publications in reviewed journals and has participated in several EC-funded projects.

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