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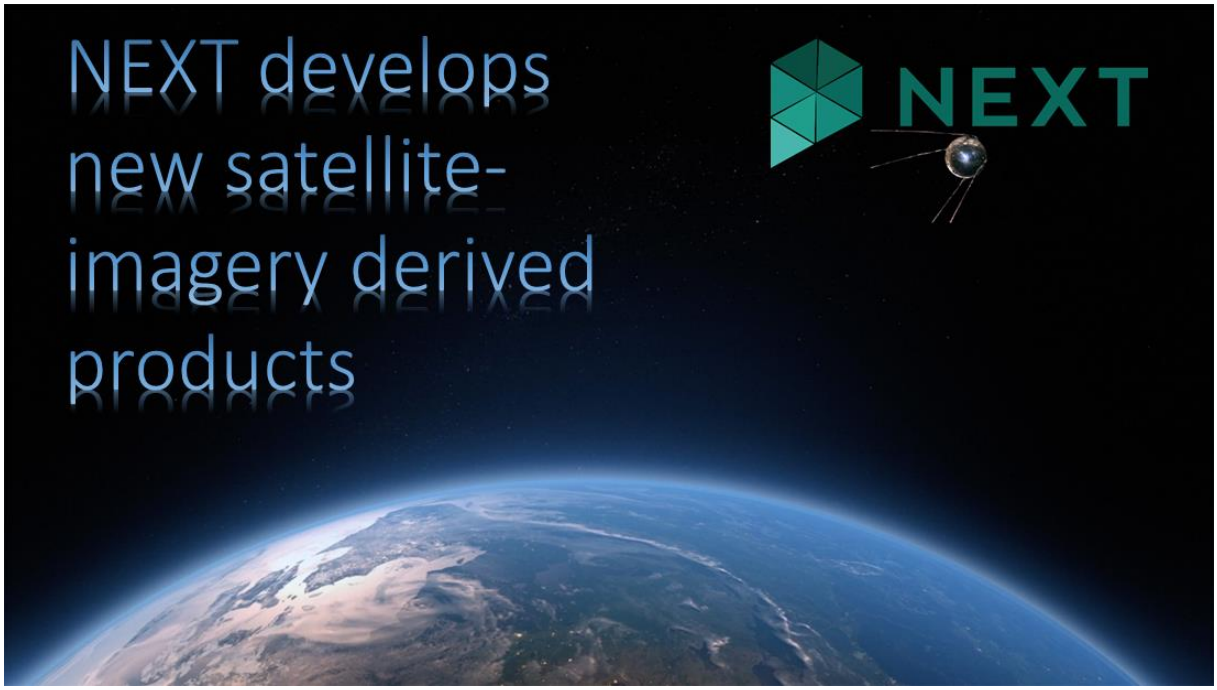

NEXT develops new satellite-imagery derived products for mineral exploration and environmental monitoring

For this write-up, we invited Sebastian Teuwsen, Project Manager in Research and Development; Energy, Mining and Resource Management at EFTAS Remote Sensing and Transfer of Technology GmbH. EFTAS is an SME based in Münster, Germany, which provides geoinformation and IT services based on remote sensing and GIS from a single source. Sebastian is overseeing the remote sensing related research activities in the EU funded Horizon 2020 New Exploration Technologies **(NEXT)** project.

Could you elaborate on the contribution of remote sensing to the ambitions of the NEXT project?

Even before the start of the NEXT project, we gave a lot of attention to how we could help our colleague partners in the consortium with the many tasks foreseen, by building on our experience from previous exploration projects. We foremost took into consideration that a minimal impact on the environment was requested by the Horizon 2020 Call for proposals to which NEXT was submitted. Indeed, the Call specifically expected proposals to develop new and more sensitive environmentally sound exploration technologies and solutions. Furthermore, the Call requested to communicate the added value of a proposal to the local communities around the exploration sites as well as to society at large for improving public acceptance. Thus, one of the primary goals of the Call was to achieve a reduction of the anthropogenic footprint in the field of exploration technologies and thereby strengthen and

increase the acceptance, and in this instance, of the Social License to Explore (SLE) on the part of the public.

Remote sensing, through the use of unmanned aerial vehicles (UAVs) or satellite technology, clearly presents itself as an ideal tool to achieve the goal of reducing the anthropogenic footprint. However, it quickly became apparent that our technology would be of particular interest in new areas identified for exploration and whose viability would normally first be assessed in the field and in the laboratory. The fact that the Finnish study area partly includes an area that is under the guidelines of the EU Natura 2000 directive played a very significant role in this regard.

Could you elaborate on the nature on the remote sensing activities in the Finnish study area?

Throughout the 3-year duration of NEXT, we worked in close cooperation with the mineral exploration company Mawson OY, the permit holder of the Finnish study area. This approach ensured that the methods and approaches used for exploration and monitoring purposes were strictly oriented towards keeping in line with the environmental directives set by the responsible authorities in Finland. This enabled us to develop several methods that can be used in the future and are in full compliance with environmental protection regulations in sensitive natural areas, including Natura 2000 sites. Although this effort required a substantial amount of research, we were very much aware that exploration activities in these sensitive areas are hotly debated not only in Finland but in all such areas around Europe.

Which, if any, particular difficulties did you encounter to test the remote-sensing based technologies?

In fact, from the very outset of NEXT, we faced difficulties to adequately apply our remote-sensing based technologies for the purpose of mineral exploration due to the dense vegetation cover, particularly in the Finnish study area and to a large extent also in the Spanish one. This is mainly because satellite-based remote sensing technology, regardless of which optical sensors are used, can only be applied primarily in arid and sparsely vegetated areas. This is due to the fact that signals from the vegetation cover and the tree canopy hide the signals coming from the open ground or from the outcrops under investigation. Hence the presence of a dense vegetation does not permit investigations with regard to outcropping rocks and their mineralogy. The pros and cons of these test sites had already been a point of discussion among the consortium at the initial meeting in Brussels in November 2016, i.e. at a time when the NEXT research proposal was still being developed. Nevertheless, in the course of the project, together with our colleague partners, we were able to test and develop

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good and, above all, very useful methods and products from the field of satellite remote sensing in these densely vegetated areas.

Could you elaborate on type of satellite sensor data used and how these are linked to the various methodologies you developed in NEXT?

Our methodologies are mainly based on the data collected by the sensors of the Sentinel family of the EU-Copernicus programme, which also corresponds to a primary goal of the Horizon 2020 Call for proposals to which the NEXT project proposal was submitted. However, aside from Sentinel-1 and Sentinel-2 sensors we also relied on LandSat, ASTER and Hyperion satellite imagery. The table below brings an overview of the various methods we developed using the Sentinel-2 and Hyperion sensors for environmental monitoring in general and for mineral exploration in particular.

Table 1: Overview of elaborated methods/datasets for mineral exploration and environmental monitoring

Method	Sensor	Application	Description
Vegetation Type Mapping	Sentinel-2	Environmental Monitoring	Automated classification of vegetation types
Vegetation Change Analysis	Sentinel-2	Environmental Monitoring	Checking vegetation vitality changes over a period of time in the area of interest
Map Check	Sentinel-2	Environmental Monitoring	Automated check, to verify if there are any differences between the outcomes of a field campaign and the remote sensing derived products
Vegetation Structure Analysis	Sentinel-2	Environmental Monitoring	Analysing compensation areas nearby the exploration area to detect areas with similarly valuable environmental stockings
Element Concentrations	Sentinel-2	Mineral Exploration	Analysing principal components of the outcropping rocks in the area of interest
Iron Feature Depth (IFD)	Sentinel-2	Mineral Exploration	Analysing iron contents in the area of interest
Surface Reflectance	EO1-Hyperion	Mineral Exploration	Cluster mapping relating to the spectral reflectance of the bare soils in the area of interest

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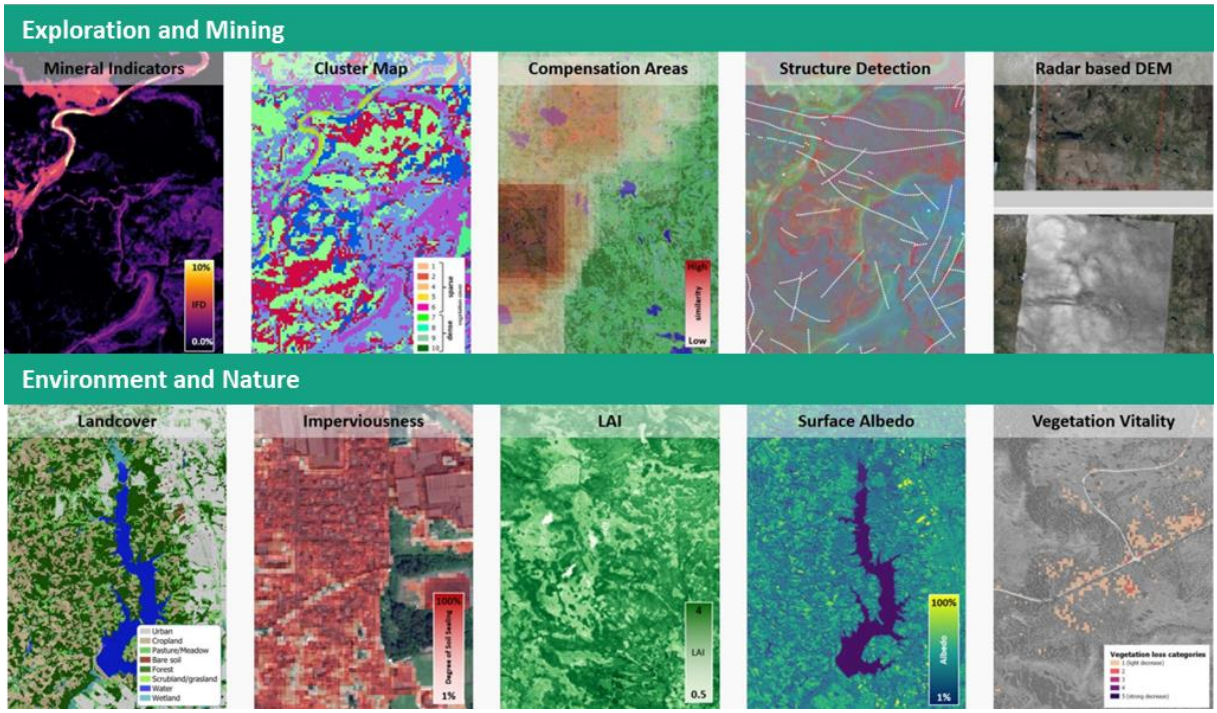
In the figure below, our products derived from the application of these methodologies are grouped, firstly in relation to their application for mineral exploration and mining purposes (top), and then with respect to their usefulness in environmental monitoring (bottom).



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"Many people, including acquaintances, friends and family, ask me how I came to be a geologist, because this profession it is widely considered to be something special or even extraordinary in Germany. I grew up in a tranquil, rural suburb of a medium-sized city in Westphalia. Already as a young boy I was keenly exploring the wonders of nature in the nearby forests and countryside. Later at school, I focused more and more on subjects that are concerned with the natural processes occurring on our planet and how these shape our lives. After completing my secondary education and a year of civilian service I moved to the beautiful city of Münster. There I studied geology/palaeontology and geophysics, and after a few external internships I was lucky to get a job at the company where I still work every day with pleasure and fulfilment. Our application world of energy, mining and resource management is highly multifaceted. Our remote sensing applications range from soil contamination to water management and supply, pore storage projects, ground movement monitoring and mineral exploration projects. The range of activities covered under the umbrella of remote sensing is really incredibly vast!"

Sebastian Teuwsen is Project Manager in Research and Development; Energy, Mining and Resource Management at EFTAS Remote Sensing and Transfer of Technology GmbH, based in Münster, Germany.

More about NEXT: www.new-exploration.tech

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