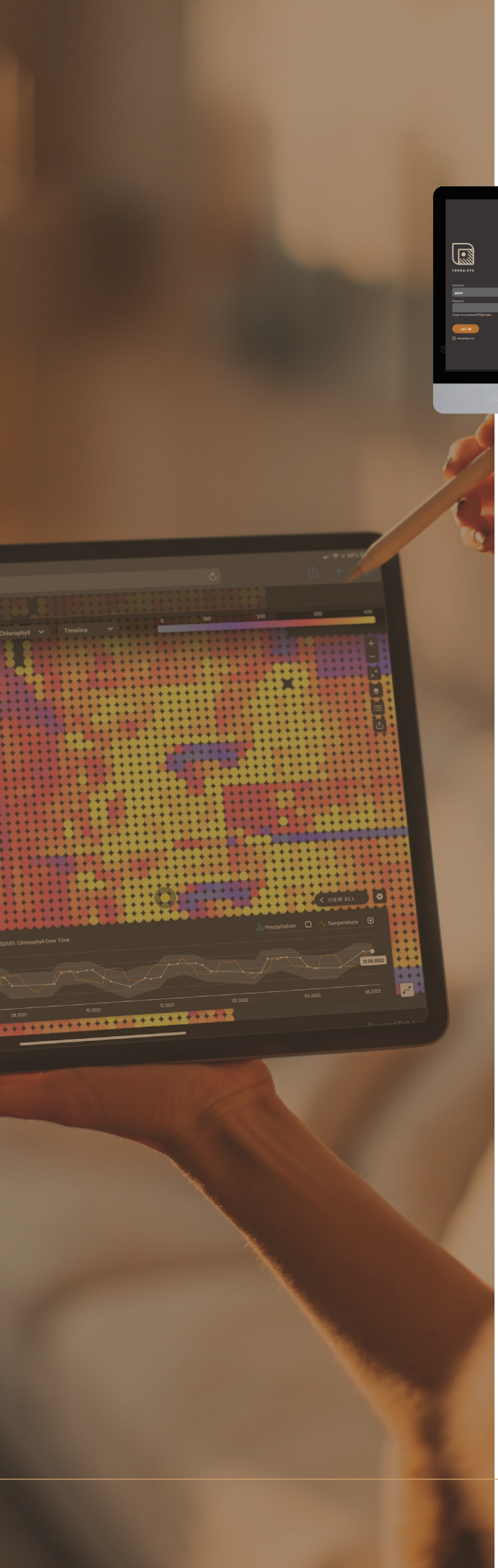
TERRA•EYE

Capabilities of TerraEye System

Monitoring the Environmental Impact of Mining Activities on the Example of PAK KWB Konin Open-pit Mines

REMOTE SENSING
BUSINESS
SOLUTIONS

Maximizing efficiency and accuracy
with AI-powered satellite data processing



TERRA•EYE

TerraEye system is a tool, dedicated to the opencast mining industry, used, among other things, to monitor the impact of opencast mines on the environment. The functionalities we are developing are based on satellite data analysis, with the support of artificial intelligence and machine learning.

The current spatial and temporal resolution makes it possible to quickly and accurately observe the variability of environmental parameters, such as the state and condition of vegetation, water quality, or changes in land use. Based on satellite imagery and machine learning algorithms, the TerraEye system identifies mine components, natural environment elements, water bodies, and agricultural areas. By combining current observations with archival data, it provides an opportunity to observe and interpret the variability of selected environmental features: changes in the surface of the water table and its quality parameters (amount of chlorophyll, dissolved carbon, turbidity), variability of parameters describing the condition of green areas about weather conditions, fragmentation of ecosystems or deforestation.

Moreover, the TerraEye system also works well in monitoring the progress of processes related to mine decommissioning and reclamation activities. In this article, we present selected functionalities relating to environmental impacts, using selected examples of open-pit mines. We have chosen to analyze the mines of PAK KWB Konin.

Due to the specific nature of the satellite data we process, our solutions apply to areas around the world.

Looking at the growing global awareness of the environmental impact of companies, it is worth focusing on the mining sector, which is one of the main players responsible for environmental degradation. Open-pit mines cover areas reaching up to several hundred square kilometers, and during the mining process, it is not uncommon for permanent and irreversible changes in nature to be caused, i.e. the transformation of the relief, changes in water relations, fragmentation of ecosystems, etc.

In addition, there is a risk of uncontrolled accidents, which in the past have been the cause of human deaths, loss of property, and massive environmental damage (e.g., the post-mining waste tank accident in Jagersfontein). Continuous monitoring of a mining site can prevent potential damage and allows for supervision of the removal process.

ANALYZED AREAS

1. Tomislawice Open-pit

2. Jóźwin Opencast

3. Drzewce Quarry

To date, as many as 10 lignite open pits have been launched as part of PAK KWB „Konin" operations. This article analyzes the Jóźwin (**2**), Tomisławice (**1**), and Drzewce (**3**) open-pit mines, which are in operation until August 8, 2022. The sites are located in Poland's Greater Poland Province. Due to the nature of the mining method used, the operations of each of the mines analyzed cover a significant area.

Over the past few years, negative changes in water-soil relations have been observed, such as fluctuations in the level of the water table or the formation of a depression funnel, associated with the need to drain the mining area. In addition, within the range of influence of the above open-pit mines is the Powidz Landscape Park (PPK), included in the Natura 2000 program.

The functionality developed by us allows the user to automatically detect and track changes in the land cover classes of mining area.

The functionality of segmentation of elements of mining areas developed in the TerraEye system, depending on the needs of the user, can provide information on the current surface of areas transformed by mining activities. TerraEye, by tracking changes in the surface area of individual elements of open-pit mining operations, addresses the most obvious environmental impact of mining activities, i.e. land consumption. **The machine learning models we are developing are capable of automatically recognizing as many as 15 land cover classes, including the most basic ones - pits and dumps.**

In the future, the capabilities of the TerraEye system envisage integrated operation with autonomous drones, which, based on predictions made based on satellite imagery, will autonomously direct themselves to the location of the survey.

Below are presented examples of predictions of the area of the Drzewce open pit generated automatically by the machine learning model. The status for 2017, 2020, and 2022 is shown (Fig. 1)

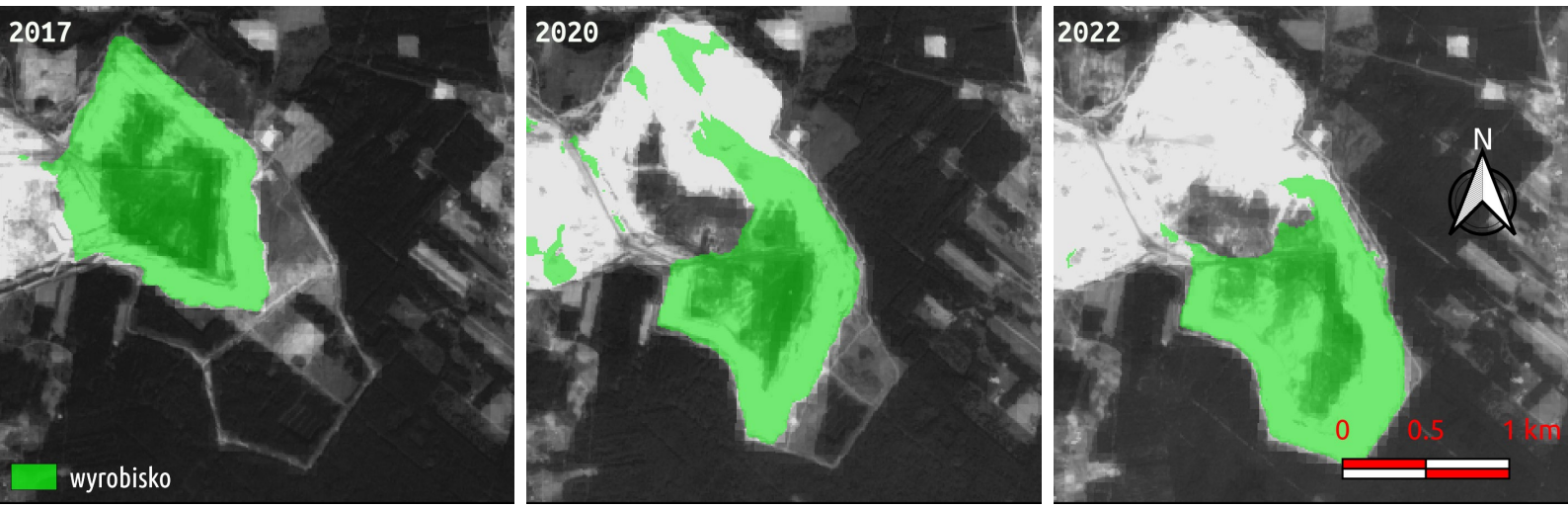


Fig. 1 Summary of changes in the area of the Drzewce open pit made by the machine learning model in 2017, 2022 and 2022

The water detection functionality being developed allows the user to monitor both the changing surface of water bodies and selected water quality indicators.

Mining activities can affect surface water in two ways: to be the cause of water loss in a water body and to be the cause of water pollution. Very often, in the process of mining a deposit, the level of groundwater is lowered, leading to the drying up of surrounding surface reservoirs. Monitoring changes in the level and surface of the water table allows for mitigating this phenomenon. Fig. 3 shows examples of changes in the surface of the water table, which have been detected based on satellite imagery processed in the TerraEye application.

At the same time, it is possible to monitor the growth of the surface and level of the water table, for example, in the processes of reclamation or repair of damage, as is the case with the Słaboludz Reservoir.

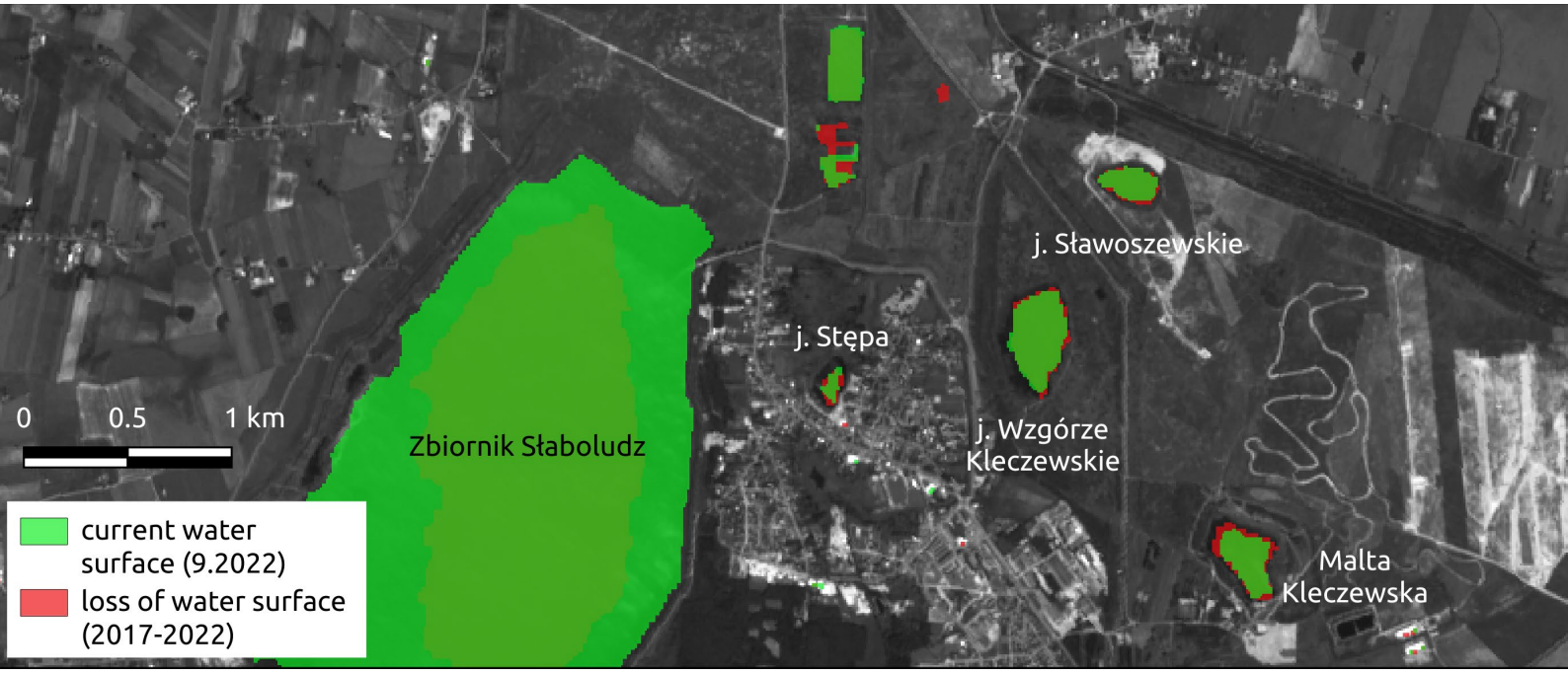


Fig. 2: Changes in the surface area of the water table in the surrounding natural and artificial reservoirs over the years 2022 and 2017.

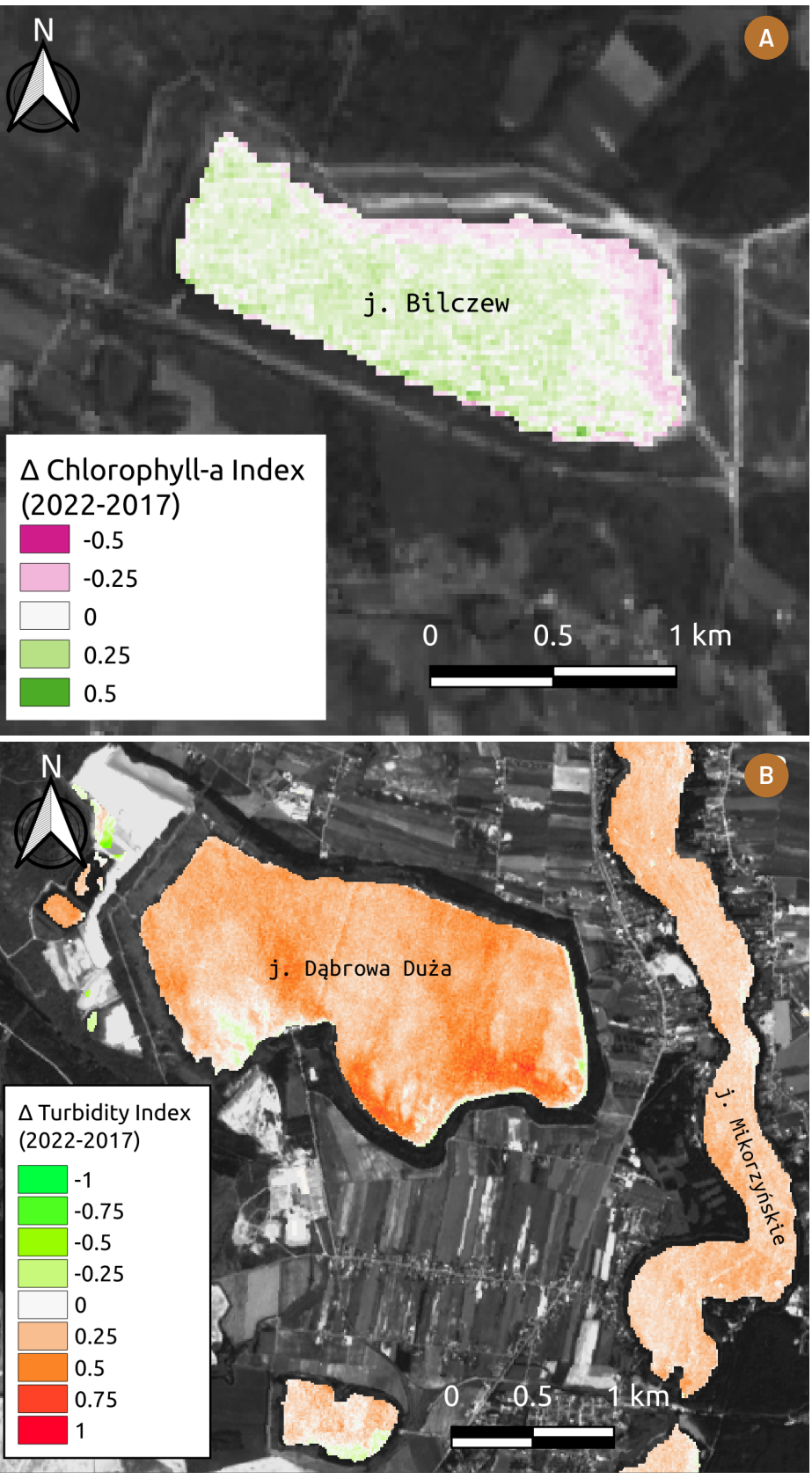


Fig. 3. Examples of detection of changes in water quality parameters on the example of lakes Bilczew and Dabrowa Duża

In the course of mining operations, mines may discharge industrial wastewater or pit water into surrounding water bodies. Such practices, combined with ongoing climate change and lowered water levels, can lead to rapid changes in livelihood conditions, and thus to a climate catastrophe such as that on the Oder River in 2022.

Based on satellite imagery and the indicators calculated from it to assess chlorophyll and dissolved organic matter content, the TerraEye system alerts users to changes in reservoirs that may require additional action.

Figure 3 shows examples of indicators for water quality assessment. In the case of Lake Dabrowa Duża, locally large increases in water turbidity were observed (**3B**).

In the case of Lake Bilczew, on the other hand, there was an increase in the overall chlorophyll content of the water (**3A**), which may be due to an algal bloom, and which may consequently lead to the release of toxins harmful to animals and humans.

The developed functionality of greenery detection is used to inventory the vegetation cover in the area affected by mining activities, by indicating the extent of each class of vegetation cover.

The developed greenery detection functionality makes it possible to record the vegetation cover in the area of mining activity and its surroundings. For this purpose, 11 land cover classes (such as grasses, shrubs, trees, or cultivated fields) are used, which are distinguished using a machine learning model we have developed.

The following graphics (Fig. 4) show the use of greenery detection in the example of losses in vegetation cover in the areas of the Drzewce and Jóźwin opencast. The TerraEye system allows calculating the acreage of degraded land for selected classes and comparing it with previous years.

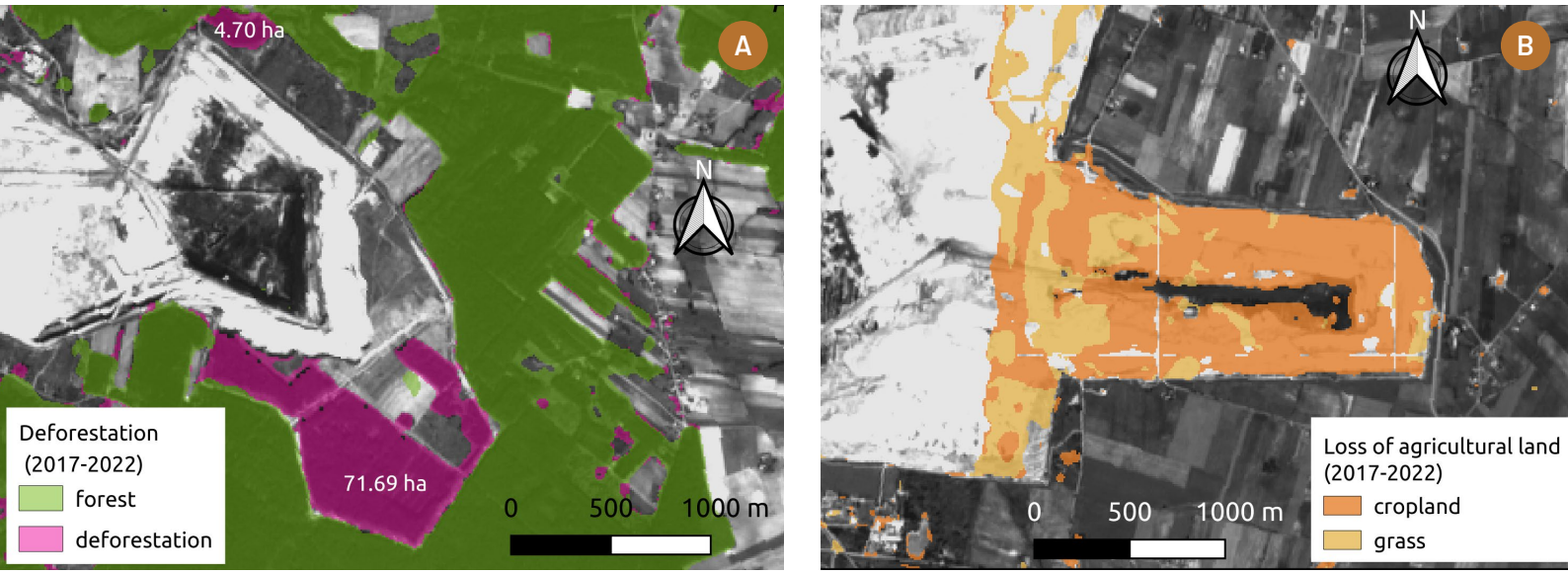


Fig. 4. Forest and agricultural land losses (including grasslands) resulting from mining activities in the Drzewce and Jóźwin opencast areas in 2017-2022

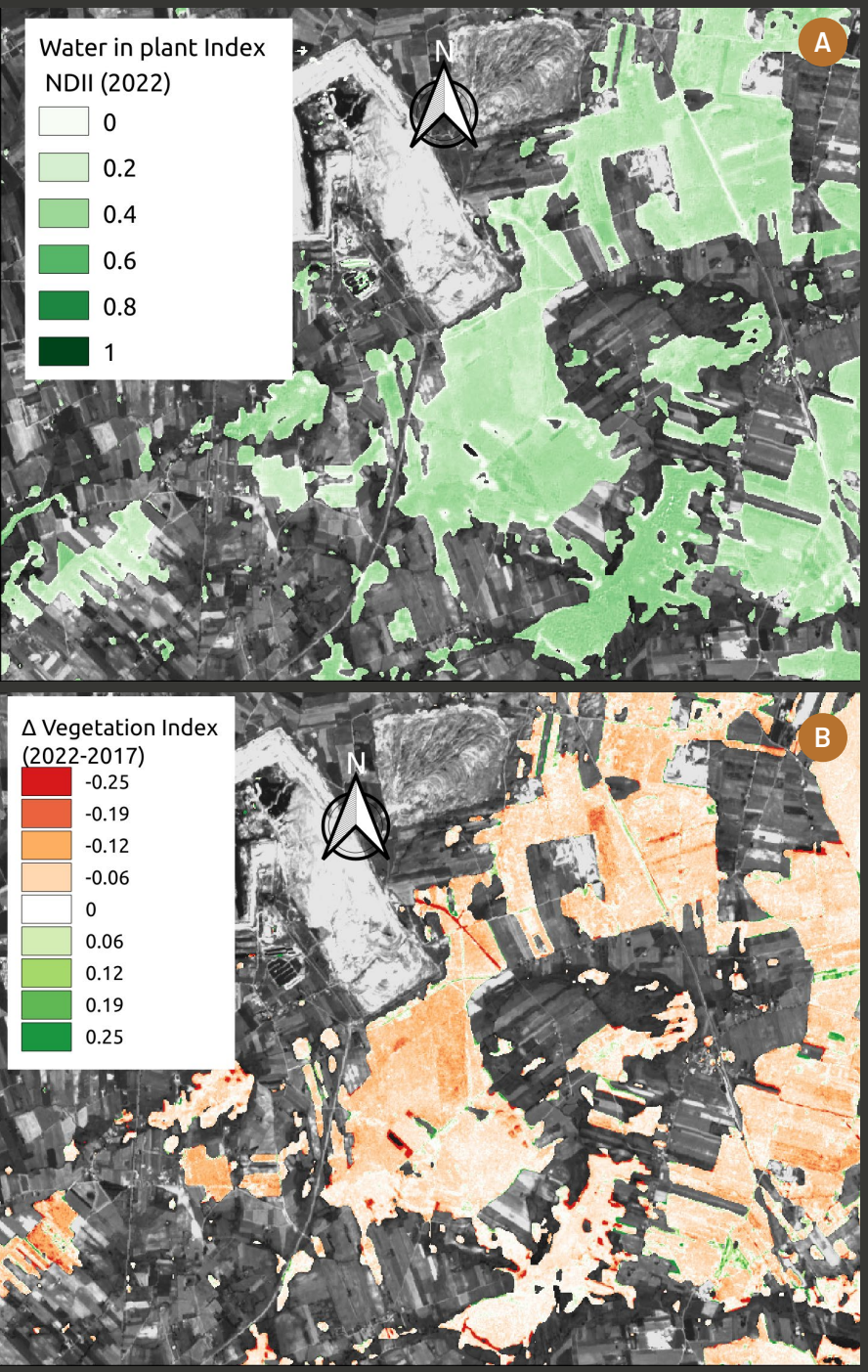


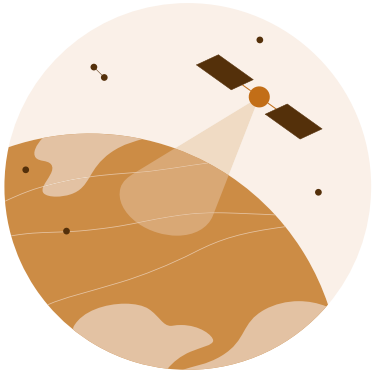
Fig. 5. NDII index values in 2022 (A); change in NDVI index values between 2017-2022 (B).

An important function of our system is the ability to calculate normalized greenery quality indicators for a single pixel (NVDI, NDRE, NDII). The NVDI index allows for assessing the condition and developmental status of vegetation, NDRE the chlorophyll content, and NDII the water content of foliage (Fig. **5A**).

These data can be presented in terms of the difference between years, which provides a simple and efficient way to indicate the locations of the greatest changes, thereby streamlining the way important information is read. As an example, the following shows the changes in the values of NVDI indices between the years 2017-2022 in the vicinity of the Tomislawice open pit (Fig. **5B**).

Our concept for critical sites monitoring

With a wide range of customers we understand the need for data in different ranges and different detail. To provide those types of information we aim to integrate with all types of technologies for data gathering.



THE BIG PICTURE

Satellite imagery provides the most diverse and up to date information:

- Every 2-3 days new multispectral images are available;
- Every 12 days new radar data is acquired for ground displacement information;
- Access to hyperspectral imagery data allows for more complex analysis.

A CLOSER LOOK

Drones (UAV) can be deployed to further supplement satellite data and to get more specific information about a region or a site:

- When better resolution is needed;
- When clouds obscure specific location;
- In case validation of sat data is needed.

IN-SITU DETAILS

Accessing granular information via additional sensors and physical sample gathering.

- Used to create and confirm analysis results.
- Gathering samples in specific locations in case of specific events or to acquire more insight for a planned future project.

PARTNERSHIP

To achieve the highest quality of presented information and constantly improve our machine learning algorithms, we cooperate with the experts:

- Working on data from optical constellations (including Pléiades Neo, Pléiades, SPOT DMC Constellation, Vision-1) through cooperation with Airbus, SentinelHub, ESRIC, Maxar, SatRev, Pixxel and SkyWatch.
- Cooperating with Prometheus S.A. as part of the implementation of drone flights and data acquisition.
- Cooperating with the Faculty of Geology of the University of Warsaw and the Wrocław University of Science and Technology to improve our algorithms.
- Supporting by Microsoft, PWC and ESA in developing our system.
- Receiving funding from the National Centre for Research and Development.

AIRBUS MAXAR esric

sentinelhub pixxel SATREV

Microsoft PROMETHEUS pwc

esa UNIWERSYTET WARSZAWSKI Politechnika Wrocławska

SKYWATCH NCBR Narodowe Centrum Badań i Rozwoju

ABOUT US

Our mission is to reduce the environmental impact of opencast mines by means of new technological innovations. Helping mining professionals make smarter decisions with data, satellite imaging and analytics.

There is no tool on the market that in easy and simple way can assess environmental impact, production bottlenecks and monitor productivity.

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