GeoTerrace-2025-056

Satellite Monitoring of Technogenically Hazardous Areas in Poltava Region

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SUMMARY

Over the past half-century, Poltava region has undergone significant territorial changes that have affected land use and the state of the environment. The number of areas with a high level of technogenic impact and hazardous geodynamic processes, requiring constant monitoring, has increased. One of the methods for observing technogenically hazardous areas is remote sensing. The study examines technogenically affected territories in Poltava region and methods of remote geomatic monitoring to track changes and enable rapid response to negative trends.

Keywords: remote sensing of the Earth; satellite monitoring; technogenically loaded territories; mining and processing plants.

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Introduction

Poltava region is an important center of industry and agriculture (Historical overview. Home – Poltava Regional Military Administration). The condition of landscapes in this region reflects the interaction of natural and anthropogenic factors, which continue to shape a complex surface structure with potentially hazardous areas. Monitoring such changes is an important tool for territorial planning, contributing to the effective management of natural resources, ensuring ecosystem resilience, and supporting biodiversity conservation. The use of modern methods such as remote sensing, GIS, bioindication, and modeling (Ajaoud et al., 2025) makes it possible to effectively track changes over large areas and promptly respond to negative trends. At the same time, it is important to combine traditional methods with innovative technologies to ensure comprehensive and accurate monitoring, particularly of technogenically hazardous areas, which will help ensure sustainable spatial development and environmental protection.

Method and Theory

The remote sensing method makes it possible to monitor large territories, including remote areas, without the need for fieldwork. Satellite images, with different spectral ranges, allow for the assessment of various parameters. For example: optical images are used to study vegetation cover and land use, making it possible to detect land cover changes, soil degradation processes, and other anthropogenic impacts (Qin & Liu, 2022); radar images allow for the assessment of the water balance, detection of irrigated lands, monitoring of soil erosion processes, and identification of surface deformations (Nesterenko & Mishchenko, 2025); thermal images can be used to detect temperature anomalies, which helps assess changes in climatic conditions in the area (Lee et al., 2018).

Satellite images can be obtained at different times, allowing for the monitoring of seasonal changes or long-term trends. Software enables the analysis of images taken at different periods to identify change dynamics (Tretiak et al., 2023). Satellite imaging data can also be integrated with other information sources, such as meteorological data, to build comprehensive models of the Earth's surface condition.

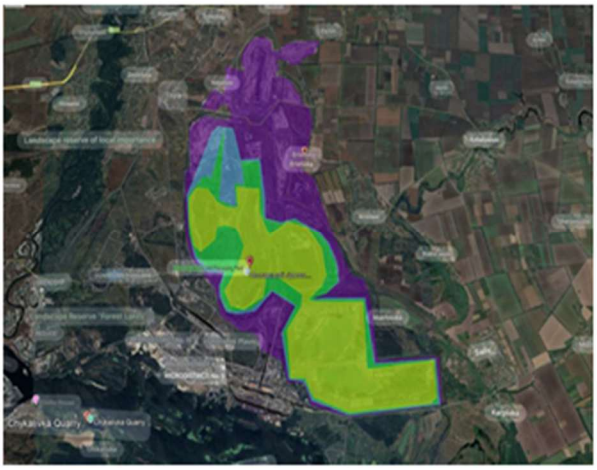
Through remote monitoring, it is possible to analyze the scale of technogenic transformation factors in Poltava region. According to (Regional reports on the state of the environment in Ukraine. Ministry of Environmental Protection and Natural Resources of Ukraine – official website), among the enterprises that exert the greatest technogenic pressure on the environment in this region are oil refining plants (e.g., Kremenchuk Oil Refinery), metallurgy and machine-building enterprises (e.g., Kremenchuk Automobile Plant "AvtoKraz", Kryukiv Railway Car Building Plant). Technogenic threats also include mining and beneficiation complexes, such as the Poltava Mining and Processing Plant, Yeristivskyi Mining and Processing Plant, Bilanskyi Mining and Processing Plant (Ferrexpo Poltava Mining), as well as granite and sand quarries, which disrupt soil structure, contribute to soil erosion, and pollute adjacent areas.

The Kremenchuk Hydroelectric Power Plant is an important infrastructure facility in the region, performing critical functions for energy, water supply, and irrigation. However, its construction and operation have led to significant territorial changes. A total of 735 settlements, as well as large areas of arable land and natural landscapes, were flooded. Today, erosion processes are intensifying in the areas adjacent to the reservoir due to shoreline undercutting. Swampy areas have emerged near the reservoir, limiting agricultural activity. In lowlands, secondary soil salinization occurs as a result of flooding and water evaporation.

The balance between advantages (water supply, energy) and negative consequences (land flooding, changes in hydrology and ecosystems) requires attention and further measures to minimize the harm caused by the hydroelectric power plant. Moreover, constant monitoring of dam deformation processes is necessary to prevent risks associated with its potential destruction.

Results

Using satellite monitoring, territorial changes of technogenically hazardous areas within the Horishni Plavni united territorial community of the Kremenchuk district, Poltava region, were studied. The expansion of the quarries of the Poltava Mining and Processing Plant can be observed through the free resource Copernicus Browser (https://browser.dataspace.copernicus.eu/) and the Google Earth Pro service (https://earth.google.com/web/). Comparing the occupied areas in 1990 and 2025, one can visually see the expansion of the Poltava Mining and Processing Plant by 2.7 times, including due to the development of the Yeristivske deposit in the northern part of the area since 2006 (Figure 1).



Color	Date	Area, km²
	1990	22,7
	2000	29,9
	2010	34,9
	2025	61,2

Figure 1. *Territorial changes of the Poltava Mining and Processing Plant (Ferrexpo Poltava Mining) on Google Earth satellite images for the period 1990–2025*

During the period 1985–2024, significant territorial changes occurred in the Kremenchuk district, including the area where the villages of Ostaptsi, Vasylenky, and Bondari were located until recently. However, due to the development of the Bilanivskyi Mining and Processing Plant, these villages disappeared from the map of Poltava region, and their inhabitants were resettled. According to the territorial planning scheme for the construction of the Bilanivskyi Mining and Processing Plant, the relocation of 14 villages is planned (Analytical report on the results of urban planning monitoring for 2023). Yet, this is not only a problem for the residents of the villages designated for resettlement.

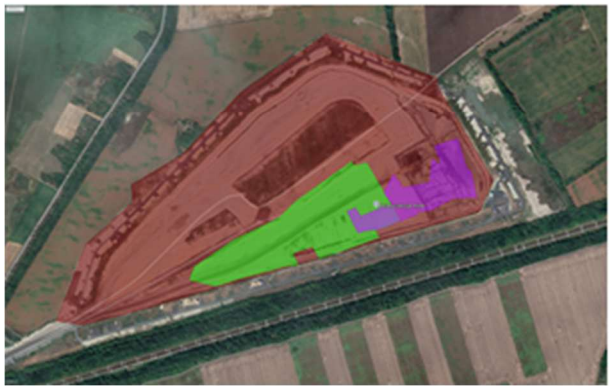
The mining industry poses a major threat to other nearby areas as well. Ore extraction at the Bilanivske deposit is carried out by open-pit mining, which has a considerable impact on the environment. In areas of open development, deforestation and vegetation disturbance occur due to stripping operations, with waste rock being deposited on the soil surface.

Large areas of land suitable for agricultural use are being consumed. The Bilanivskyi quarry is the deepest in Poltava region, meaning that a vast amount of rock is extracted and moved to the surface. The areas occupied by dumps exceed the quarry area several times over. Mining activities lead to increased discharge of mine waters carrying a significant amount of pollutants: chloride compounds, sulfuric acid, soluble salts of iron, manganese, copper, and others.

The surface disturbances negatively affect its biological, erosion, and aesthetic characteristics. Open-pit mining, in particular, exerts the greatest geotoxicological impact of mining on human health.
Remote monitoring shows that the activities of Ferrexpo Poltava Mining are accompanied by serious environmental consequences. The use of the “True color” combination on Sentinel-2 L2A imagery makes it possible to observe the extent of quarry development at the Bilanivskyi Mining and Processing Plant over the period 2017–2025 (Figure 2).

Analyzing the scale of quarry expansion across different periods using Google Earth, we observe active territorial changes: a 2.4 - fold increase during 2011–2017 and a 6.4 - fold increase during 2017–2025.

04.06.2017, Sentinel–2 L2A *07.06.2025, Sentinel–2 L2A*



Color	Date	Area, km²
	2011	0,046
	2017	0,11
	2025	0,70

Figure 2 *Territorial changes of the Bilanivskyi Mining and Processing Plant (Ferrexpo Poltava Mining) on Copernicus satellite images with the True color band combination (a–b) for 2017–2025, and on Google Earth (c) for the period 2011–2025*

As a result of mining activities, serious environmental disturbances have emerged and continue to expand: the withdrawal of large land areas for the construction of dumps for waste rock storage, tailing ponds for beneficiation waste, and reservoirs for highly mineralized mine and quarry waters; fracturing of rocks due to blasting, alteration of the terrain, deforestation, and land surface deformation; changes in reserves, flow regime, quality, and level of groundwater; progressive development of land flooding processes; pollution of surface water bodies and underground aquifers; atmospheric contamination with dust and gas emissions; alteration of the composition and properties of the atmosphere and hydrosphere (acidification, salinization, water and air pollution); degradation of soil properties; as well as noise pollution and ground vibration.

The harmful impact can be monitored using various remote sensing methods: deformation mapping is carried out by the satellite interferometry method InSAR; vegetation cover and dynamics of water bodies can be monitored with Landsat, Sentinel-2, and MODIS imagery; monitoring of water surfaces, urban areas, and individual structures can be conducted based on SAR images processed in SNAP software; atmospheric pollution can be analyzed on EO-Browser or Giovanni platforms using Sentinel-5P satellite data (Dovhyi et al., 2020).

Conclusion

Observations of technogenically stressed regions using satellite methods make it possible to monitor large areas at national and international scales. This is especially important for extensive potentially hazardous territories, where traditional ground-based monitoring can be costly and labor-intensive.

Importantly, satellite imagery enables near real-time monitoring, analysis of different time periods, and subsequent forecasting of changes.

The intensity of technogenic pressure on the landscapes of Poltava region requires the urgent implementation of sustainable land-use practices. The integration of modern monitoring technologies with ecological approaches will help minimize negative consequences, preserve soil fertility, and safeguard the region's natural wealth.

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