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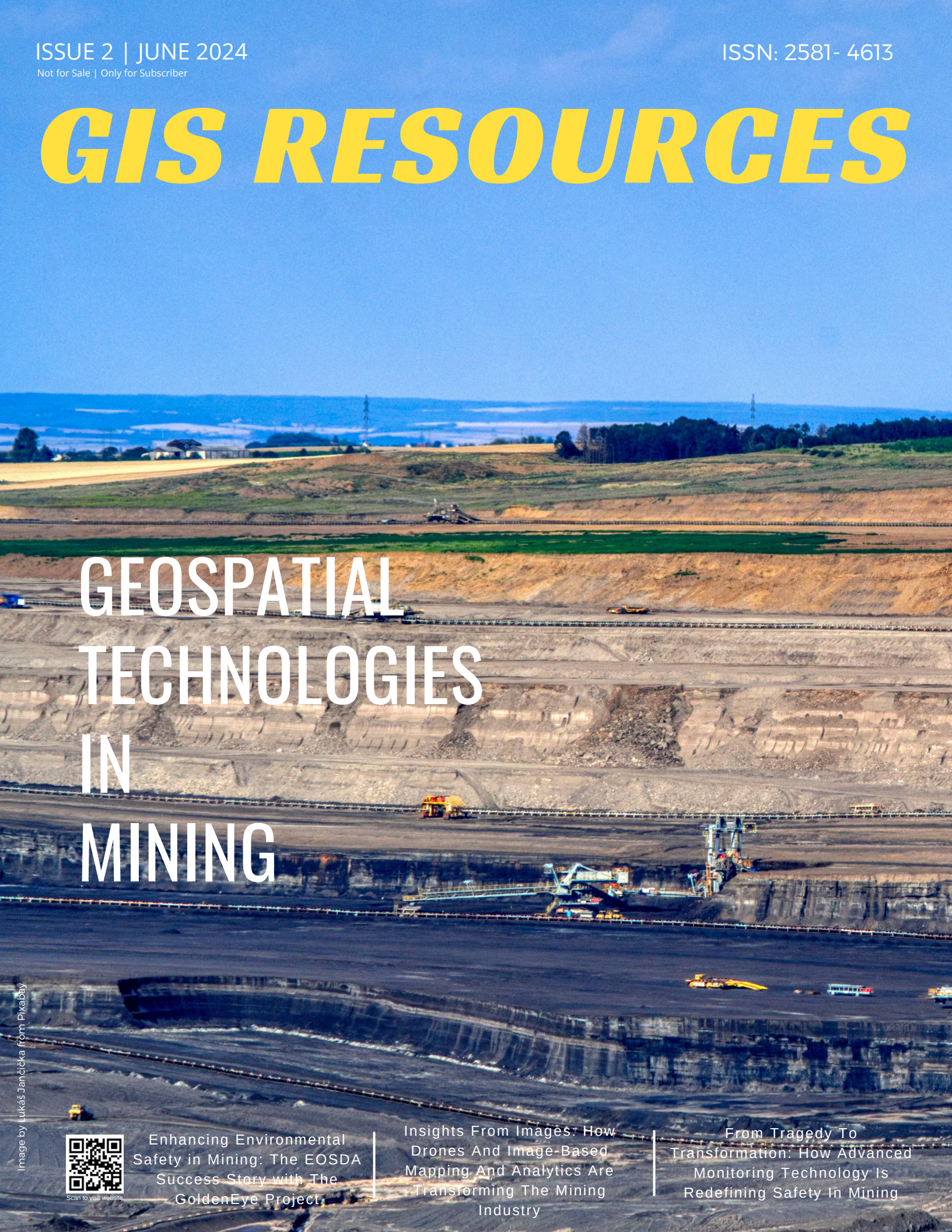

## GEOSPATIAL TECHNOLOGIES IN MINING

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Enhancing Environmental Safety in Mining: The EOSDA Success Story with The GoldenEye Project

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From Tragedy To Transformation: How Advanced Monitoring Technology Is Redefining Safety In Mining

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# Editor's Note

Geospatial technologies are revolutionizing the mining industry by significantly enhancing mine surveying, planning, and safety. These technologies offer unparalleled precision in mapping mining sites, enabling accurate resource estimation and efficient land use. This precision minimizes waste and optimizes extraction processes, ensuring resources are fully utilized.

In planning, advanced spatial analysis tools create detailed models of ore bodies and surrounding terrains. These models inform decisions on infrastructure placement, pit design, and waste management, optimizing transportation routes and reducing environmental footprints.

Safety in mining operations is significantly improved through real-time monitoring using satellite and aerial imagery. This helps detect potential hazards like landslides, allowing for timely interventions and mitigating risks to human lives. Precise positioning data also aids in the safe navigation of autonomous vehicles, reducing accident risks.

Moreover, environmental monitoring is crucial in modern mining. Geospatial technologies track land use and vegetation changes, enabling companies to implement sustainable practices and rehabilitate mine sites effectively post-extraction.

In conclusion, geospatial technologies are essential for modern mining, underpinning precise surveying, meticulous planning, and robust safety protocols. These technologies ensure mining operations are efficient, sustainable, and safe, guiding the industry towards a more responsible and technologically advanced future.

EOSDA's Senior Researcher measures soil moisture with HH2 moisture meter (ML3 ThetaKit) in the field near Boguslav Quarry to later check it against satellite analytics. Image_ EOS Data Analytics.

# Enhancing Environmental Safety in Mining: The EOSDA Success Story with The GoldenEye Project

By Kateryna Sergieieva
Scientist
EOS Data Analytics



Ensuring environmental safety in mining operations is crucial for sustainable development. Through EOS Data Analytics' involvement in the GoldenEye project, part of the Horizon 2020 research initiative, the company has contributed to improving mining safety and minimizing environmental impacts. This article explores their contributions, highlighting the technologies and methodologies employed to safeguard the environment.

**Understanding Horizon 2020**

Horizon 2020 was the European Union's flagship research and innovation funding program, running from 2014 to 2020 with a budget of nearly €80 billion. It aimed to drive economic growth and create jobs by fostering innovation through science, technology, and industrial leadership across Europe.

The primary objectives of Horizon 2020 were to:

1. **Support excellent science**: This included funding for frontier research through the European Research Council (ERC), developing new and emerging technologies, and strengthening human resources through Marie Skłodowska-Curie Actions.
2. **Foster industrial leadership**: The program aimed to boost Europe's industrial capacity and competitiveness through investments in key technologies, access to risk finance, and support for small and medium-sized enterprises (SMEs).
3. **Address societal challenges**: Horizon 2020 targeted seven major societal challenges, including health,

demographic change, food security, energy, transport, climate action, inclusive societies, and secure societies.

By the end of its term, Horizon 2020 had funded over 31,000 projects, involving more than 150,000 participants from universities, research organizations, and businesses across Europe and beyond. Some notable achievements included:

- **Scientific excellence**: The program significantly bolstered scientific research in Europe, with numerous breakthroughs in various fields, including health, energy, and digital technologies.
- **Economic growth**: It contributed to economic growth by supporting innovative projects that led to new products, services, and processes. The Horizon 2020 projects were estimated to generate up to €11 of economic value for every euro invested.
- **Societal benefits**: Projects funded under Horizon 2020 addressed critical societal issues, such as developing renewable energy technologies, improving public health, and advancing climate change mitigation efforts.

Horizon 2020's effectiveness was assessed through comprehensive evaluations. The interim evaluation in 2017 highlighted several successes, such as high participation rates and the positive impact on scientific output and innovation. The final evaluation in 2024 reaffirmed these findings, noting that the program had effectively met its goals and provided substantial added value at the European level.

Horizon 2020 brought together a diverse range of stakeholders, including universities and research institutes, industry and small and medium enterprises, public sector and non-profits, and international partners. The program was open to global participation, fostering international collaboration and knowledge exchange.

Several high-profile projects were funded under Horizon 2020, demonstrating the program's breadth and impact, such as The Human Brain Project aimed to map the human brain, the Graphene Flagship focused on advancing graphene-based technologies, and the European Green Deal to achieve the EU's climate and environmental goals.

Horizon 2020 was a landmark program that significantly advanced European research and innovation. Its comprehensive approach, encompassing scientific excellence, industrial leadership, and societal challenges, ensured that it addressed critical issues while fostering economic growth and job creation. The success of Horizon 2020 set the stage for its successor, Horizon Europe, which aims to build on this legacy and further enhance Europe's research and innovation capabilities.

**The GoldenEye Project Timeline and Milestones**

The GoldenEye project, funded under the Horizon 2020 program, was initiated to develop innovative sensing technologies and data integration methods to enhance the environmental safety and efficiency of mining operations. With a total budget of €10.8 million and spanning three and a half years, the project brought together 17 partners from 11

Figure 1: GoldenEye project team comparing topographic map with the actual terrain.

countries, including research institutions, private companies, and universities.

GoldenEye aimed to create an advanced platform named Golden AI that integrates new and existing data from mine sites to provide comprehensive monitoring solutions. The project focused on developing new sensing technologies, combining remote sensing and Earth observation data with ground-based measurements and machine learning algorithms. The ultimate goal was to deliver a cloud-based solution that mining companies and authorities could use to monitor and manage mining operations more sustainably and efficiently.

The GoldenEye project officially started in May 2020, with Teknologian Tutkimuskeskus VTT Oy (VTT Technical Research Centre of Finland Ltd) coordinating the efforts. The initial phase focused on setting up the project framework, defining technical requirements, and starting the development of the sensing technologies and data integration platform.

Throughout 2021, the project partners worked on creating and refining various data acquisition and processing technologies. These included hyperspectral imaging, drone-based surveys, and time-gated Raman spectroscopy. Companies like Radai, which specialized in drone-based surveys, and Timegate Instruments, which developed the time-gated Raman spectrometer, played crucial roles in this phase. These technologies were designed to provide high-resolution, real-time data on various environmental parameters at mining sites.

Starting in late 2021 and continuing through 2022, field trials were conducted at several mining sites across Europe. These trials took place in Bulgaria, Germany, Romania, Finland, and Kosovo. The primary goal was to validate the developed technologies and gather comprehensive data to feed into the GoldenEye platform. These trials helped ensure that the sensing technologies could operate effectively in real-world mining conditions.

With data collected from field trials, the next phase involved integrating this data into the GoldenEye platform. The latter was designed to process and analyze large datasets, combining satellite imagery, drone data, and ground-based sensor inputs to provide actionable insights for mining operations.

By late 2022, the Golden AI platform underwent extensive testing and validation. The focus was on ensuring the platform's accuracy, reliability, and user-friendliness, which was achieved through an AI interface that interacts with users in natural human language. The platform's AI-driven analytics capabilities were tested to provide real-time monitoring and predictive insights into environmental conditions and potential safety hazards at mining sites. The successful validation phase demonstrated the platform's potential to revolutionize environmental monitoring in the mining sector.

The final phase of the GoldenEye project involved making necessary adjustments based on feedback from the testing phase and preparing for the project's conclusion. The team ensured that the platform met all technical and operational requirements, providing a robust solution for mining companies and regulators. The project officially concluded in October 2023, leaving a legacy of innovative tools and methodologies for sustainable mining practices.

The GoldenEye project was a collaborative effort involving diverse partners, such as EOS Data Analytics, Sinergise, Radai, Timegate Instruments, and others. It successfully demonstrated the potential of integrating advanced sensing technologies and data analytics to enhance the environmental safety and efficiency of mining operations. Through its innovative platform, the project provided mining companies and regulators with powerful tools to monitor and manage mining activities sustainably. The achievements of the GoldenEye project highlight the importance of interdisciplinary collaboration and technological innovation in addressing the challenges of modern mining.

**Field Trials of the GoldenEye Project**

To better understand the GoldenEye project and its connection to mining safety, let’s take a closer look at their field trials and see the technologies used, the challenges faced, and the measurable benefits achieved.

**Copper Ore Extraction in Bulgaria**: In the Panagyurishte ore district of Bulgaria, the GoldenEye project implemented a combination of infrared (IR) and multispectral drone-supported remote sensing technologies. This area is known for its Cu-Mo-porphyry systems and Cu-Au epithermal deposits. The objective was to produce GIS-based maps of alteration mineral assemblages and conduct predictive mapping of mineral potential. By integrating high-resolution electromagnetic data from drones and satellite imagery, the project significantly enriched the dataset, allowing for precise identification of new mineral targets and improving exploration efficiency.

**Mineral Exploration in Germany**: The Erzgebirge district in Germany, with its 800-year history of mining, was another critical field trial site. This region is rich in minerals such as silver, uranium, tin, tungsten, and lithium. The GoldenEye project focused on integrating high-resolution electromagnetic data from drones, InSAR (Interferometric Synthetic Aperture Radar), and other Copernicus satellite data. The aim was to enhance the mineralogical knowledge of the area and identify

precise drilling targets that were previously undetectable due to the lack of high-resolution data. This approach resulted in more accurate exploration efforts and reduced the environmental footprint of mining activities.

**Open Pit Extraction in Romania**: In the Roşia Poieni district of Romania, the GoldenEye project focused on open-pit copper ore extraction. The integration of satellite remote sensing and ground-based sensor data allowed for comprehensive environmental monitoring. The project utilized drone-based surveys and hyperspectral imaging to monitor land deformation, water quality, and vegetation health. This comprehensive monitoring system enabled the integration of multi-temporal satellite data and drone or ground-based observations to improve mineral predictions and track surface changes in mining areas.

**Underground Mining in Finland**: The Pyhäsalmi mine in Finland, one of the oldest and deepest underground mines in Europe, was another significant site for the GoldenEye project. The mine produces copper, zinc, and pyrite. The project implemented time-gated Raman spectroscopy and drone-based surveys to monitor the underground extraction processes. These technologies provided real-time data on mineral composition and structural stability, enhancing the safety and efficiency of mining operations. The project reported significant improvements in operational efficiency and a reduction in safety incidents.

**Post-Closure Monitoring in Kosovo**: In Kosovo, the GoldenEye project focused on the Trepča Mines Complex, which required post-closure environmental monitoring. The project employed a combination of satellite remote sensing, drone surveys, and ground-based sensors to monitor the stability of tailings dams and detect potential environmental hazards. This integrated monitoring system ensured the safety and stability of the post-closure site, providing critical data to support long-term environmental management and rehabilitation efforts.

These field trials helped extract several key lessons for the successful implementation of geospatial technologies in mining:

1. Combining multiple geospatial technologies provides a comprehensive and accurate monitoring solution.
2. Implementing these technologies can significantly reduce costs and time associated with environmental monitoring and resource estimation.
3. Enhanced monitoring capabilities lead to better safety measures and improved compliance with environmental regulations.
4. Transparent and effective use of geospatial technologies can improve community relations and stakeholder trust.

The successes reached in those five locations provide a roadmap for other mining companies seeking to enhance their environmental monitoring, safety, and operational efficiency through innovative technological solutions.

**The Role of EOS Data Analytics in the GoldenEye Project**

EOS Data Analytics, a global provider of AI-powered satellite imagery analytics, contributed its expertise to enhance the

Figure 2: The team of the GoldenEye project in the Panagyurishte ore district of Bulgaria. Image: EOS Data Analytics.

environmental monitoring and safety of mining operations during the GoldenEye project. As part of the consortium, EOSDA focused on leveraging its advanced remote sensing technologies to provide real-time insights and predictive analytics for sustainable mining practices.

EOSDA's primary responsibility within the GoldenEye project was to process and analyze satellite imagery to support various aspects of the mining operations. By using high-resolution satellite data, EOSDA was able to monitor environmental parameters such as land cover changes, vegetation health, and water quality. These insights were crucial for identifying potential environmental risks and implementing mitigation measures promptly.

One of EOSDA's key contributions was helping develop the Golden AI platform that integrated satellite data with other data sources, such as drone imagery and ground-based sensors. This platform provided a comprehensive view of the mining sites, allowing for continuous monitoring and real-time analysis.

Throughout the project, EOS Data Analytics was involved in several field trials in the above-mentioned locations to validate the effectiveness of its technologies. During these trials, EOSDA's satellite data analytics were used to monitor the environmental conditions of the mining sites and provide valuable insights to support decision-making processes.

"By combining satellite data with ground-based measurements, we can achieve a more accurate and holistic understanding of the environmental impacts of mining activities. This approach allows us to detect and address issues before they become critical."

Kateryna Sergieieva
Scientist at EOS Data Analytics

In Bulgaria, for instance, EOSDA collected ground-based data to compare it against the output of the satellite monitoring technology for the Golden AI platform. In Finland, the EOS Data Analytics team reconstructed soil moisture dynamics over the tailing pond using the Soil Moisture Index.

Another significant aspect of EOSDA's contribution was its role in resource estimation. By analyzing multispectral and hyperspectral satellite imagery, EOSDA could identify mineral deposits and estimate their concentration and distribution. This capability was particularly valuable in reducing the need for invasive ground surveys, thereby minimizing the

Figure 3: The EOS Data Analytics team discusses the samples they found at a copper ore quarry. Image: EOS Data Analytics.

environmental impact of resource exploration. The data provided by the company allowed for more precise and efficient resource estimation, contributing to the overall sustainability of the mining operations.

EOSDA also played a crucial role in the development and validation of the Golden AI platform's predictive analytics capabilities. By applying machine learning algorithms to the integrated data, the platform could predict potential environmental hazards, such as landslides or water contamination, before they occur. This predictive capability was essential for proactive environmental management and ensuring the safety of mining operations.

The collaborative nature of the GoldenEye project allowed EOSDA to work closely with other partners, including research institutions, universities, and private companies. This interdisciplinary approach facilitated the exchange of knowledge and expertise,

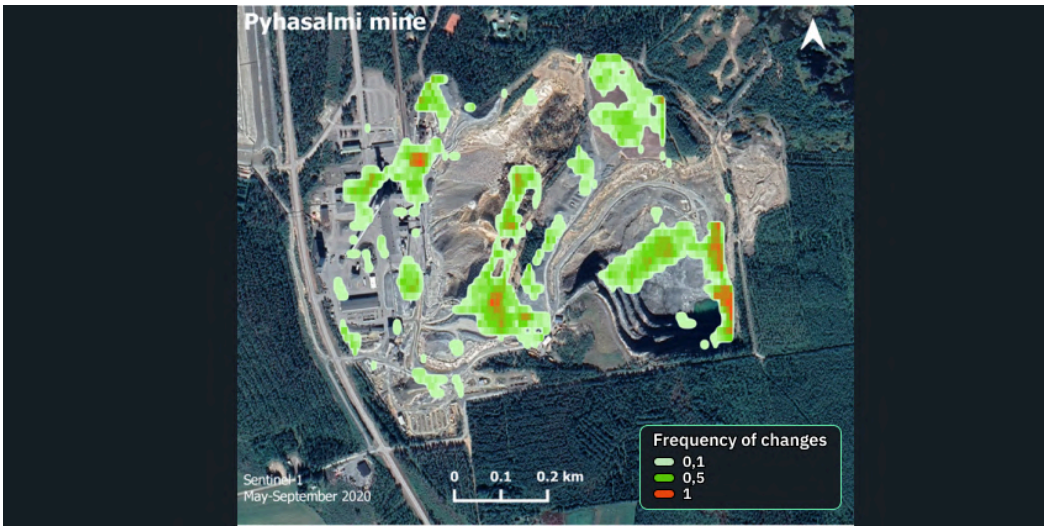



Figure 4: Map of the Temporal Activity Index (TAI) for the Pyhäsalmi mine area in Finland from May to September 2020, calculated using Sentinel-1 SLC data. Constantly operated areas are highlighted in orange. Image: GoldenEye.

"Our ability to accurately estimate resources using satellite data not only improves the efficiency of mining operations but also significantly reduces the environmental footprint. This is a crucial step towards achieving sustainable mining practices."

Kateryna Sergieieva
Scientist at EOS Data Analytics

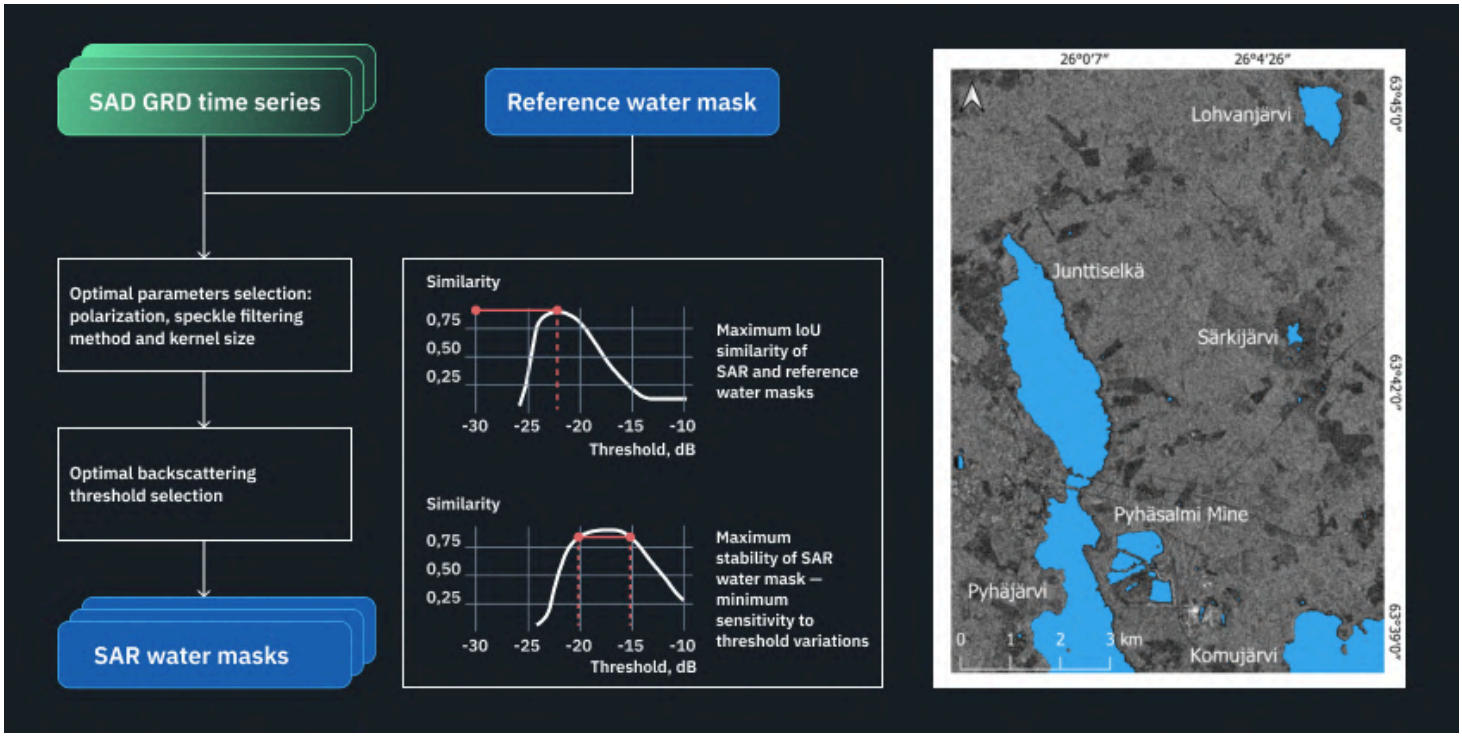



Figure 5: Water bodies mask around the Pyhäsalmi mine as of July 22, 2019, constructed using Sentinel-1 GRD data with a threshold algorithm created by EOS Data Analytics. Image: Water 2022.

enhancing the overall effectiveness of the project. By leveraging the strengths of each partner, the GoldenEye project was able to achieve its objectives and demonstrate the potential of advanced geospatial technologies in promoting environmental safety and sustainability in mining.

Overall, EOSDA's participation in the GoldenEye project showcased the transformative potential of satellite data analytics in the mining industry. Through its innovative technologies and collaborative efforts, EOSDA contributed to the development of a comprehensive monitoring and management solution that enhances environmental safety and supports sustainable mining practices.

**Vision for the Future of Geospatial Technologies in Mining**

The GoldenEye project demonstrates the transformative potential of geospatial technologies in enhancing the environmental safety and efficiency of mining operations. By integrating advanced satellite data analytics, drone-based surveys, and ground-based sensors, the project provided a comprehensive monitoring solution that supports sustainable mining practices.

Looking ahead, the role of geospatial technologies in mining will continue to expand. Future advancements are expected to focus on increasing the resolution and frequency of satellite imagery, enhancing the precision of predictive analytics, and integrating more sophisticated AI algorithms.
These improvements will enable even more accurate monitoring of environmental conditions and faster responses to potential hazards.

EOS Data Analytics envisions a future where mining operations are conducted with minimal environmental impact, leveraging real-time data to ensure safety and sustainability.

Moreover, the collaboration between different stakeholders — research institutions, private companies, and governmental bodies — will be crucial in advancing these technologies. The GoldenEye project has set a precedent for such partnerships, highlighting how diverse expertise can come together to solve complex environmental issues.

As a bottom line, the future of mining lies in the seamless integration of geospatial technologies. Continuous innovation and collaboration will drive the development of more sophisticated tools, enabling the industry to operate more responsibly and sustainably. As we move forward, EOSDA remains committed to leading these efforts, ensuring that mining practices evolve to meet the highest standards of environmental safety and sustainability.

"Today, the integration of geospatial technologies into mining operations is a technological advancement necessary for ensuring the long-term health of our planet. By continuously improving our tools and methodologies, we can make mining safer and more sustainable for future generations."

Kateryna Sergieieva
Scientist at EOS Data Analytics


Figure 6: Water bodies mask around the Pyhäsalmi mine as of July 22, 2019, constructed using Sentinel-1 GRD data with a threshold algorithm created by EOS Data Analytics. Image: Water 2022.


Figure 7: The EOSDA teammeasures the leaf area index using the SunScan device sensors in the field near Boguslav to confirm EOS SAT-1 satellite measurements. Image: EOS Data Analytics.

Cepemar plays a key role in safeguarding tailings dams across Brazil.

# From Tragedy To Transformation: How Advanced Monitoring Technology Is Redefining Safety In Mining

By Rafael Cruz
Senior Commercial Technical Consultant
Hexagon

In 2015 and 2019, Brazil's mining sector was shaken by two devastating events - tailings dams at mines in Minas Gerais collapsed. These structures serve as stores for mining waste resulting from processed rock. Both events released floods of liquefied waste that destroyed local communities, contaminated water supplies and led to many deaths.

These tragedies highlighted the high costs of inadequate safety measures in mining. In response, new laws in Brazil mean that mines now have to closely monitor the structural stability of their dams.

Nowadays, mining companies worldwide are implementing modern monitoring technologies. These systems now play a big role in upholding safety standards, detecting structural instabilities, providing early warning systems, and guiding preventive measures.

**The Necessity of Monitoring Tailings Dams**

Tailings dams are earthwork structures that grow over time as mining activities generate more and more waste. Since these dams may also contain hazardous materials, they need to be closely observed for any deformations that could lead to collapse.

As a result of the new laws in Brazil, monitoring these structures has become a mandatory safety protocol for mining companies. Tailings dams pose different levels of

risk depending on their construction. Their individual level of risk determines how often they need to be measured and what type of monitoring should be used, either continuous and automated or campaign monitoring. Continuous monitoring provides real-time data through automated sensors that observe the dam's movements and stability, while campaign monitoring involves taking measurements at scheduled intervals.

Two companies seeking to improve safety in Brazil's mining sector are Mineração Morro do Ipê (MMI) and Cepemar. Their monitoring solutions ensure compliance with new regulations while protecting miners, nearby communities, and the environment.

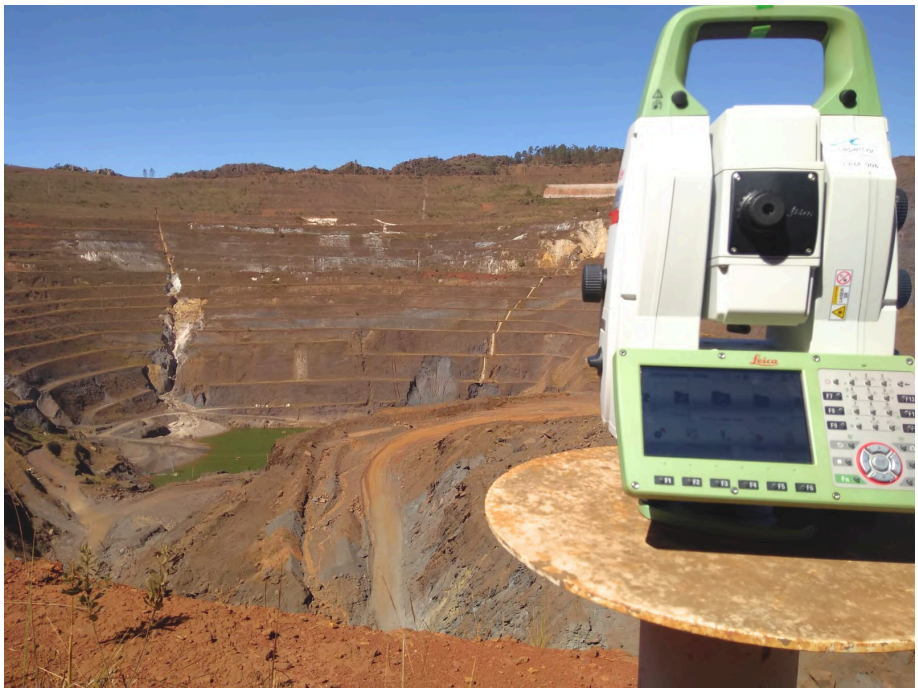


Figure 1: The Leica TM60 facilitates enhanced field workflows and automated data capture processes.

**MMI's Real-time Monitoring of the Ipê and Tico-Tico Mines**

MMI oversees deformation monitoring at the Ipê and Tico-Tico mines in Brazil's Serra Azul region. The mines required an all-encompassing system that unified geodetic, geotechnical, and radar measurements to ensure round-the-clock monitoring and provide alerts for any sudden events – a "Total Monitoring" solution.

Figure 2: A Leica TM60 is used to observe the precise measurements of the tailing dam embankments.

To achieve this, MMI installed advanced monitoring systems at each site, designed in collaboration with Hexagon. A Leica TM60 is used to observe the precise measurements of multiple points situated along the tailing dam embankments. The process is fully automated and controlled remotely via GeoMoS software, which manages the total stations and analyses the measurements. Operating continuously, the software captures and processes data, generating automated alerts to MMI when measurements surpass defined thresholds. User-friendly data analysis and visualisation tools enable the easy generation of graphs, tables, maps, and automatic reports, allowing MMI to effortlessly distribute data and streamline review processes.

MMI also deployed RockSpot – an interferometric and Doppler radar solution from IDS GeoRadar, part of Hexagon. RockSpot is a real-time device that detects rockfalls and activates sirens in urgent situations. It detects sudden surface changes by recording line-of-sight velocity, travel paths, rockfall surface sizes, and other critical data. MMI technicians review this detection data live via a web portal, cross-referencing it with streamed images of the dams. The radar system continuously monitors an extensive area, building a a comprehensive database that logs all rockfall incidents. By identifying areas prone to rockfalls, MMI can effectively counter operational hazards and geotechnical risks.

"Our goal was to make geodetic surveys and field inspections faster and safer, with more information to meet internal standards with high quality in less time."

Rodrigo Oliveira
Geotechnical Manager at MMI

To further enhance their monitoring capabilities, MMI set up a GNSS reference base station that provides round-the-clock corrections to any GNSS survey-grade rover operating on the mine site. This allows MMI to conduct various surveys with high accuracy. For instance, they utilise GNSS for cadastral surveys of boreholes, marking mining plans, and site measurements, with positioning data corrected by the base station. When carrying out aerial surveys, they employ a UAV that leverages the base station's corrections, eliminating the need for ground control points. Additionally, GNSS monitoring points can tap into this base station to deliver precise real-time deformation data.

The geodetic and topographic data captured is processed and integrated within Leica Infinity surveying office software. This centralised platform facilitates post-processing workflows like calculating stockpile volumes from multiple sensor inputs. Additionally, MMI utilises Cyclone 3DR Survey Edition point cloud modelling software to compare surface models, inspect localised ground movements, generate updated contour lines, and maintain current 3D visualisations of the site. Implementing this suite of technologies allows MMI to uphold stringent quality standards more efficiently while prioritising operational safety.

MMI's solution now provides comprehensive monitoring of the tailings dams at Ipê and Tico-Tico, along with land and aerial surveys to track site operations and movements. The Total Monitoring approach provides essential data on movements, aiding in operational organisation and informed decision-making. Adopting this automated mine monitoring system allows MMI to implement proactive mitigation measures and respond swiftly to incidents.

**Cepemar's Precise Campaign Monitoring Workflows**

While MMI focuses on continuous monitoring at two sites, Cepemar plays a key role in safeguarding tailings dams across Brazil through campaign monitoring. As the country's largest provider of environmental survey and monitoring services, Cepemar collects geophysical and geospatial data to perform impact studies and evaluate risks. They conduct periodic monitoring campaigns across the country, gathering measurement data on a daily, weekly, or monthly basis from surface landmarks present at dams, dikes, mining pits, and cliff faces.

Previously, Cepemar relied on basic total stations for manual data collection - a labour-intensive process where technicians had to locate and measure each prism individually, which was both time-consuming and presented higher possibilities for error. To improve accuracy while enabling more efficient and expedited data gathering, Cepemar upgraded its monitoring technology which now features integrated automation capabilities.

Cepemar opted for specialised total stations from Leica Geosystems engineered with dedicated monitoring functionalities, like the Leica TM60. Cepemar wanted to transition towards automated data acquisition - so they needed long-range automatic target recognition, sub-second automatic aiming precision, advanced imaging capacities, and unparalleled continuous operational duration. These capabilities streamlined measurement workflows from initial setup through data collection and subsequent analysis, enabling semi-automated campaign monitoring when integrated with Leica's GeoMoS Monitoring software.

"The goal was to provide the end customer with greater accuracy, data quality and assurance in our campaign monitoring processes."

Frilson Mateus V Netto
Cepemar's Project Manager


Figure 3: MMI oversees deformation monitoring at the Ipê and Tico-Tico mines.

Another benefit is the TM60's self-learning capability. Because of the constantly varying weather in Brazil, Cepemar needed technology that could adapt to environmental conditions, adjusting parameters for factors like fog and rain to maximise successful measurement rates. The solution also takes automated measurements of learnt targets - expediting data collection and reducing errors.

For Cepemar's campaign monitoring applications, the TM60 is equipped with a dedicated TPS Monitoring application that facilitates enhanced field workflows and automated data capture processes. This improves quality control measures while simultaneously reducing the workload and demands placed on technicians during field operations. The acquired data can be reviewed manually by Cepemar on-site or uploaded for subsequent in-depth analysis. Integrating the TM60 with Leica's GeoMoS Monitor software unlocked 24/7 automated measurement capabilities for the team, including scheduled data collection, movement analysis, threshold breach detection, comprehensive reporting, alert generation, and system operational telemetry.

This approach allows Cepemar to obtain key data for performing comparative analyses over time to identify any movements of objects or structures. The detection of such movements indicate potential deformation has occurred. Cepemar then processes and presents these findings in the form of tables, charts, and visualisations that depict the surface movements observed within the monitored areas. These comprehensive reports and visual representations provide Cepemar's clients with valuable insights into the structural integrity of the sites. Having access to this critical information enhances overall site safety empowers their clients to make informed decisions regarding any necessary interventions or remedial actions, and assists them in maintaining compliance with relevant regulations.

The Future of Mining Safety and Sustainability

The tragic dam collapses in Brazil have brought in a new era of mining safety and environmental responsibility. With advanced monitoring technologies at their core, companies like MMI and Cepemar are turning data into protection and prevention.

The integration of geodetic and radar monitoring systems provides the data clarity necessary for informed decisions, preventative actions, and rapid responses to hazards. This approach upholds a commitment to safeguarding local communities and ecosystems impacted by mining operations.

For more information about monitoring solutions for mines, read here.

Figure 4: Cepemar collects geophysical and geospatial data to perform impact studies and evaluate risks.

Figure 5: Cepemar opted for specialised total stations from Leica Geosystems.

3D Model of a Mine.

# Insights From Images: How Drones And Image-Based Mapping And Analytics Are Transforming The Mining Industry

By Pix4D Content Team
Content Marketing
Pix4D

The mining industry is being challenged by the macroeconomic environment. Some of the issues include stagnant global demand, weaker prices, increased volatility, and reduced access to resources which themselves are declining in quality. In light of these trends, the C-suite is turning to technology to guide them through these challenges ahead and to help them to consider environmental factors, while still providing increased value to stakeholders.

These challenges require businesses to mine smarter. Rethinking traditional mining models is needed to survive and to address financial and business processes. By capitalizing on automation and digitization, business capabilities can improve productivity, reduce costs, and remain competitive.

**Growing Digital Trends**

Digital disruption is challenging current business models at every point in the value chain. The mining industry is seeing a growing trend in the Industrial Internet of Things (IoT), automation and robotics (including drones), artificial intelligence, machine learning, and augmented reality (AR).

Contrary to common fears, artificial intelligence, machine learning, and augmented reality are not things to be afraid of, but tools that add speed, accuracy, and value to user tasks. With algorithms that surpass human capabilities, AI

can be used to vastly improve professional workflows.

By leveraging automation, algorithms empower users to achieve greater productivity and efficiency in daily work. Algorithms are important because they automate repetitive, manual tasks. What is more, they often do these tasks faster and more accurately than a human.

However, the real game changer is not these technologies in isolation. The true benefit comes from intelligently combining these technologies. It is the sweet spot at which these technologies interact that makes them powerful.

**Streamlining Business Processes**

Globalization means that mining companies must innovate to survive. Technology can help miners streamline their operations by automating repetitive processes, reducing the number of employees needed to run the mine, and finding more cost-effective and accurate exploration methods. This can reduce unnecessary business processes and better systematize their operations.

The digitization of mines is helping businesses run more efficiently on many levels from managing supply chains, inventories, and services. Technology is automating every stage in the mining process faster than ever before. This helps the business be leaner and generate a higher return on investment (ROI). Additionally, more efficient operating practices due to technology and digitization are reducing waste and lowering emissions, which benefits the environment.

**Deliver Critical Information, Faster**

Automated data collection through image-based technologies with drones and photogrammetry can deliver data straight to decision-makers and stakeholders, ready for analysis and interpretation. What used to take days can now be completed in hours. Reducing manual work maximizes productivity and efficiency.

Automated systems and technology can perform tasks with higher accuracy and consistency than humans, reducing errors and rework. This sort of precision is crucial

in mining operations where even small mistakes can be costly and dangerous. As mining is inherently hazardous (cave-ins, explosions, exposure to harmful substances) automating tasks reduces the need for human workers to be in these dangerous environments. Data-driven decision-making can optimize operations, predict maintenance needs, and enhance productivity.

### Update Production Progress And Forecasts Frequently

Details matter in mining. Photogrammetric results, for example, produce more precise 3D stockpile models with highly accurate volume measurements than ones interpolated from simplified shapes. And with tools such as PIX4Dcloud's timeline tool, measurements can be tracked and monitored over time.

Not only are automatic calculations of reserves based on geospatial data incredibly accurate, but they also provide faster communication as well as real-time updates on production progress and forecasts, stockpile sizes, and composition.

### Improves Productivity

Both workforce and management can be more productive due to tighter processes and clearly defined automated workflows. Data collection, automation, and new photogrammetric workflows – such as drones, machine learning, and automatic scene classification – reduce human intervention and make critical information available faster.

### Integrated Image-Based Solution

The rise of image-based technology enables digital mining enterprises to be more efficient, profitable, innovative, and safer.

### De-Risking Mining: Improve Safety Monitoring And Hazard Prediction With Drones And Image-Based Software

Digitized, automated mines are helping to minimize risk. Central command centres – where mining machinery and tools are operated remotely using sensors, artificial intelligence, and robots – provide safer working environments. Personnel is safeguarded from dangerous conditions, particularly in areas of high toxicity. Where miners are on site, wearable technology with connected sensors and monitors can alert issues and report hazardous conditions to them.

Real-time monitoring applications such as drones and photogrammetry software can provide an overall hazard estimation to help better understand risks, such as rock bursts, water inflows, and slope stability.

### Commercial Feasibility

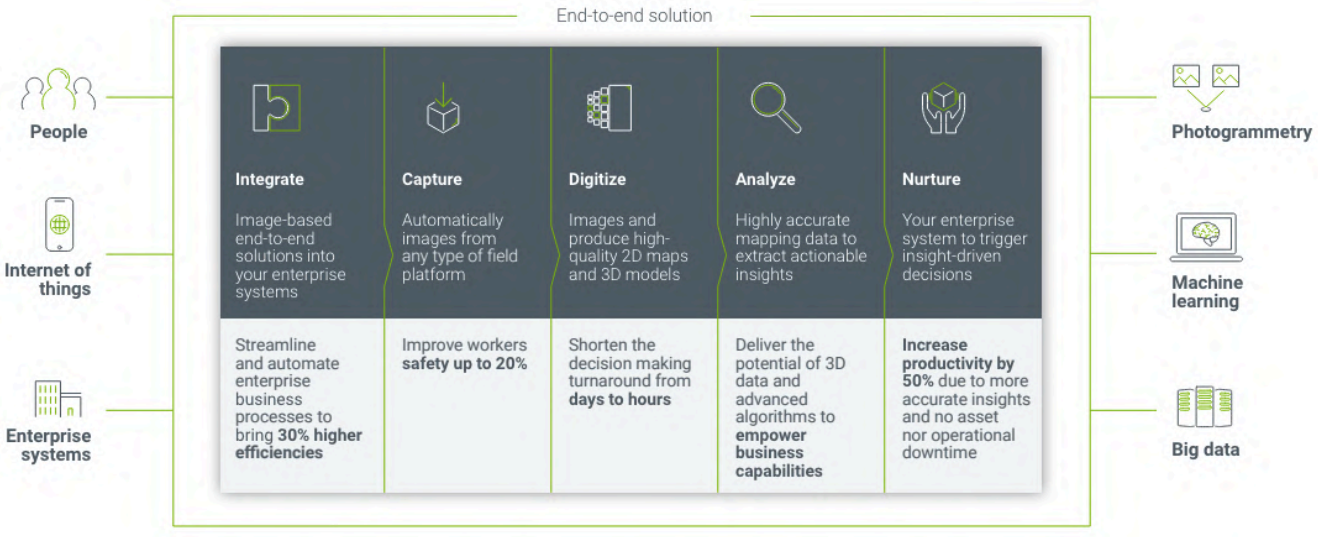
In addition to the safety aspect, technology also provides greater commercial opportunities, including mining in previously untenable locations such as underwater and harsh environments.

And while technology is de-risking mining at every stage of the value chain, it is particularly beneficial in exploration where drones and photogrammetry provide accurate data, faster to aid the decision-making process regarding commercial feasibility of the site.

### Strategic Insights

Photogrammetry and artificial intelligence leverage algorithms to process data from sources within and beyond the traditional value chain, providing real-time data-driven insights, valuable for future projections.

Simulation scenarios, using geospatial information, apply



what-if style analysis and build cartographic-oriented reports that make the location a driver to predict and improve the efficiency of mine operations.

This new and effective process of generating up-to-date information allows for continuous monitoring and well-structured decision-making for any area of mining sites. Results are traceable over time too for compliance with environmental standards.

These innovative business processes help create more sustainable yet agile business practices from an operational and commercial stance. They also help to facilitate collaboration between stakeholders across the whole supply chain.

Large volumes of geospatial-related data can be merged into a comprehensive, digital 3D environment and analyzed for trends, insights, and new business opportunities.

**Driving Profitability**

As a commodity business, costly fixed-asset operations combined with machinery maintenance and depreciation can have a huge impact on output, operating costs, and ongoing capital expenditures. Competition from emerging markets with a cheaper workforce also weighs heavily on the bottom line.

**Smart Technology**

However, the ability to tighten business processes, de-risk the business, and provide better decision-making tools – or indeed, to redefine business models – requires smart technology. It makes the management of extraction activities and environmental protection issues easy to handle and cost-effective, without exposing workers to dangerous conditions.

Compared to traditional surveying technology that is labour, skill, and cost-intensive, automatically produced orthomosaics, DSMs and point clouds of open-pit mines, quarries, and pits increase safety, efficiency, and accuracy while keeping cost and labor to a minimum.

**The Future of Digital Mining**

For today's mining, organizations greater productivity and operational efficiency are within reach; from automation and real-time planning to optimizing mining operations and better asset lifecycle management.

Accurate, digitized 3D site reconstructions available on private or cloud servers connect global operations and can align corporate processes and reporting. For example, you can track, monitor, and document site progress with PIX4Dcloud with a shared URL, facilitating easy collaboration between stakeholders.

Georeferenced digital site maps and models, accessible to stakeholders at all levels lead to better decision-making and increased engagement throughout the supply chain, creating a sustainable, safer industry with the opportunity for greater profits.

The future of mining will go to those who are prepared to embrace this technological revolution. Those who survive – and thrive –will be the ones who are prepared to innovate, invest, and reshape their business model to fit the modern mining environment.

**Use Case: Mapping in the Underground Mining Industry**

The benefits of drones in the mining industry have been proven again and again in opencast mines. However underground mines present a unique set of challenges. The narrow passageways - sometimes barely wider than a person's shoulders - make it almost impossible to fly. Traditional inspection methods involve lowering a camera or inserting it into the area on a pole. However, these methods are limited and do not provide the full picture.

Luckily advances in drone technology have led to the development of specialized drones designed specifically for these conditions. Inspection is vital in underground mines. After blasting rocks and minerals, loose material remains behind and can slip without warning. With rocks as large as a small car balanced precariously on a stope, personnel must have an overview of the site.

The Elios 2 and Elios 3 drones from Flyability are reliable tools for confined, indoor spaces. In a use of ours from the Golden Sunlight Mine in Montana, United States, the Elios 2 drone was successfully flown in a confined shaft less than 3 meters in diameter. The images captured by the drone were then processed using Pix4D software.

"My job is to make sure that the underground workings are stable and they don't fall down on the miners... the main challenges are going into these areas where we don't have very much information and trying to figure out if they're stable or if they are going to cause problems - possibly release material onto our equipment or onto our miners."

Ryan Turner
Geotechnical Engineer
Barrick Gold Corporation

As well as danger to personnel, shifting material is hazardous to mining equipment: each machine costs upwards of a million dollars and can be destroyed by a slip. Finally, waste material can dilute valuable ore, or cause it to be missed entirely, impacting the bottom line. To avoid these issues, the Barrick Gold Corporation wanted to create a detailed 3D photogrammetric map of a stope.

Turner describes the process: “We flew into a stope we wanted to investigate how much overbreak had occurred when we flew with the Elios 2, we were able to see a lot of the structures that are releasing material. Particularly on the western rib where a large slab had come out.”

The next day, the flight was repeated, as material can shift over time and as adjacent areas are blasted. By comparing the two photogrammetric models, the team can see where an overbreak has occurred, and calculate the danger to miners, the risk to equipment and the potential loss of ore.

Figure 1: Watching the drone flight live onscreen.

**Accurate Results for a Safer Working Environment**

Drones in mining are often used to calculate stockpile volume, but in this case, a visual inspection was just as important as taking measurements - something that was available with the Elios 2’s live feed.

Turner commented: “With the Elios 2 we were able to see where the structures were releasing material. The imagery looked good. Back above ground, the team loaded the data from the Elios 2 into Pix4D’s software.


Figure 2: The drone flight can be watched live, allowing operators to respond to evolving situations.

The team did not work with ground control points as the stope’s relative accuracy was more important. Using the generated 3D model, Turner and the Barrick Gold team were able to make more informed decisions about their work in the mine, and identify any potential hazards.

As well as allowing Turner and the team a better overview of the mine, 3D models provide a record of the mine and can create valuable learnings for the future as rockfall can be accurately tracked after a blast.

A full 3D inspection of the difficult-to-access underground mine means safer working conditions for the miners and a positive impact on the company’s bottom line.


# Effortless Geospatial Data Downloads with Galileo

By Mitch Davis
GISDATA.io

Downloading geospatial data can be cumbersome if you do not have an extensive GIS or programming background. For this reason, we have decided to make it super easy for users of Galileo to download feature layers. With a click of a button users can download the datasets, removing the need to use external tools or expensive hardware saving them valuable time and money.

**How Are We Solving These Problems?**

At GISDATA.io, we've designed solutions to tackle the two main challenges in geospatial data handling: finding the data and getting it onto your computer or server. Our Geospatial Data Search Engine Galileo makes it simple to find data from thousands of sources in one place. Now we would like to introduce our solutions for downloading data so that you can begin using it.

**Browser-Based Data Downloading with Geodata Downloader**

The tool I created years ago is Geodata Downloader, which operates directly in your browser using GDAL compiled to WebAssembly. This approach offers several advantages:

- Accessibility: By offloading the CPU cost to the user's machine, ensuring that there's nothing to install and no account required. The browser can run WebAssembly code directly on the user's device, making the service highly accessible.

- Cost-Effectiveness: This method enables this service to be free since the heavy lifting is done on the user's machine rather than our servers.

**Robust Server-Side Downloads with Galileo**

The next iteration of this, designed for more demanding tasks, Galileo, our powerful server-side downloading tool built alongside the geospatial data search platform. Here's why Galileo stands out:

- Reliability and Performance: By using GISDATA.io cloud infrastructure, Galileo eliminates the common issues associated with browser-based downloads. If a user accidentally closes their browser tab, they won't lose hours of downloading progress. Additionally, server-side downloads bypass the RAM and CPU limitations of user devices, ensuring consistent performance even for large datasets.
- User-Friendly for All: For users with slower or older computers, server-side downloads with Galileo provide a seamless experience without taxing their local resources. This is particularly beneficial for those dealing with extensive geospatial data that would otherwise be cumbersome to handle on personal machines.

**Galileo Downloads Feature Overview**

With the Galileo search engine, downloading geospatial data has never been easier. Each search results now features a convenient download button, making data acquisition quick and straightforward.

Here's how it works:

1. **Select Your Data**: Click the download button next to your desired search result.
2. **Choose File Type**: A prompt will appear for you to select your preferred file format.
3. **Initiate Download**: Submit the download request to schedule the data retrieval.
4. **Track Progress**: You'll be redirected to the Downloads tab in the Galileo application, where you can monitor the progress in real time.
5. **Access Your Data**: Once the download is complete, you can access and manage your datasets from the Downloads tab. Here, you can also view all your previous downloads.

This user-friendly process is a significant improvement over previous solutions, which often required multiple steps and lacked seamless integration. By centralizing everything within the Galileo application, we've made it easier and more efficient for users to obtain the geospatial data they need. Currently, the Data Download feature supports feature layers, catering specifically to those data requirements.

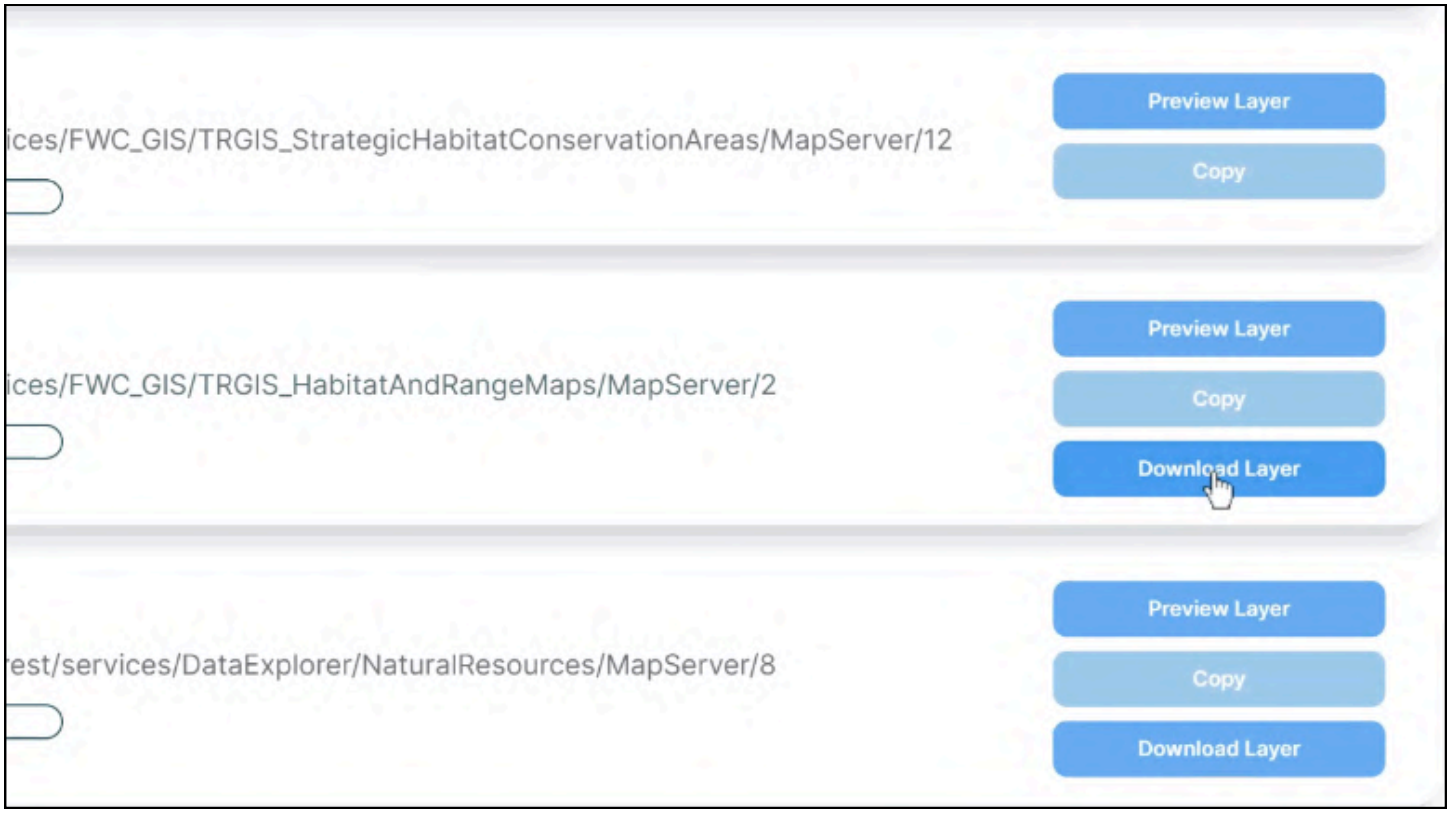



Figure 1: Download the layer.

### What's Next for Galileo?

The server-side implementation of downloads opens up a world of possibilities for the future of Galileo. Here are some exciting features and capabilities we plan to introduce:

- **Custom Pre-Download Queries**: Before initiating a download, Galileo will soon allow you to perform custom queries to refine your data selection. This means you can extract only the necessary data, reducing download times and storage requirements.
- **Scheduled Downloads**: Imagine having your data ready when you need it, without having to initiate the process manually every time. Scheduled downloads will allow you to set specific times for your data to be downloaded automatically. This is perfect for regularly updated datasets or for users who want their data ready for analysis at the start of their workday.
- **Bring Your Own Database**: Galileo will soon support the integration of your own databases. This means you can link Galileo directly to your existing database infrastructure, allowing you to directly sync the data you find into your own database. We initially plan to support PostgreSQL with PostGIS databases.

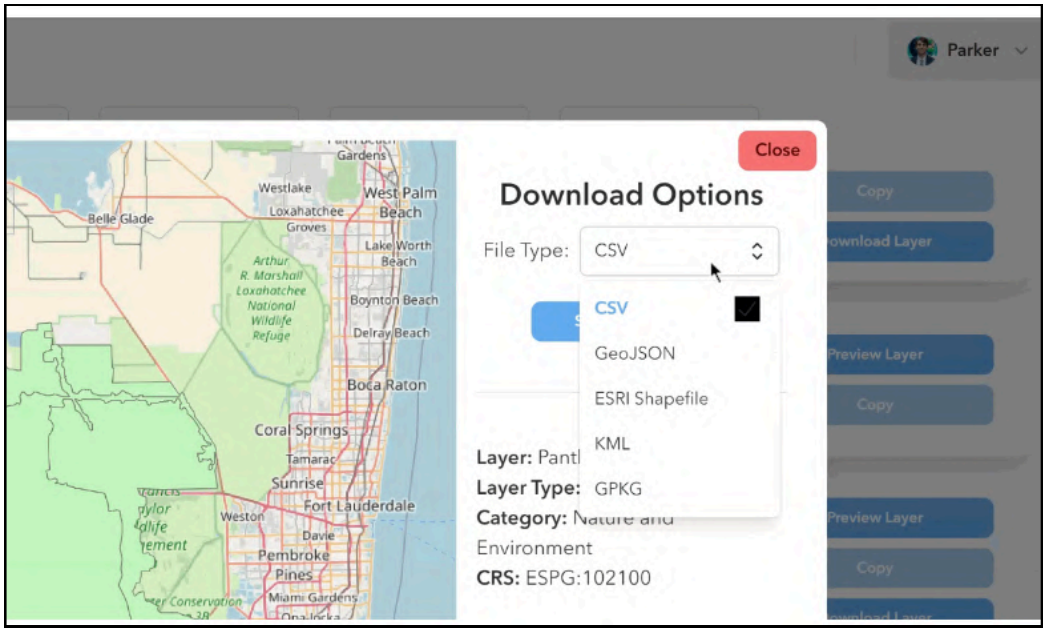



Figure 2: Select the file type.

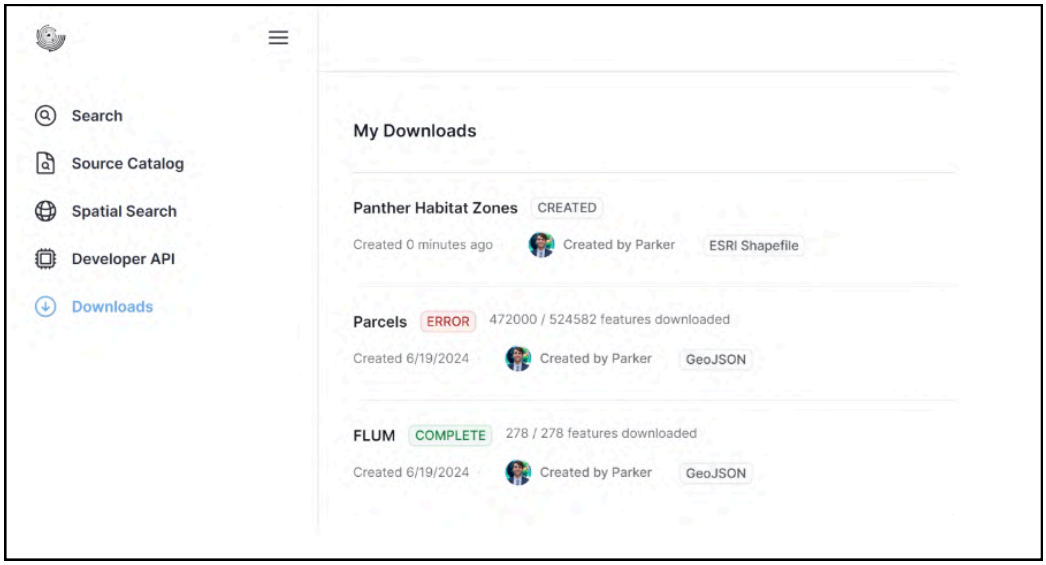



Figure 3: Download page to monitor the status of your downloads.

### Conclusion

The introduction of the Data Downloads feature marks a significant milestone for GISDATA.io Galileo. By simplifying the process of accessing geospatial data, we are empowering our users to focus on what truly matters: leveraging data for impactful decision-making and innovative projects.

This feature is just the beginning. As we continue to enhance and expand our capabilities, we look forward to providing even more powerful tools that cater to your geospatial data needs.

We are committed to making geospatial data accessible and usable for everyone, regardless of technical background. With server-side processing, the potential for larger datasets, and the ability to bypass hardware limitations, Galileo is poised to become the go-to platform for all your geospatial data requirements. Future updates will bring even more exciting features such as scheduled downloads, database syncing, and custom pre-download queries.

We encourage you to explore the new Galileo Data Downloads feature and experience the ease and efficiency it brings to your workflow. We need your feedback too! What do you think about the company? What do you think about our vision? How can we make our product better? What features would you pay for? What features should be free?

# GEO NEWS

March 21 - June 20, 2024

## US DoD Requests $1.5 Billion for PNT Resiliency Programs

In response to global jamming and GPS interference, the U.S. Defense Department is requesting $1.5 billion for positioning, navigation, and timing (PNT) resiliency in its 2025 budget. This is part of a $33.7 billion request for space programs, including $4.2 billion for resilient satellite communications. However, $17 million will be cut from the U.S. Transportation Department's PNT/GNSS/GPS activities. Dana Goward, president of the Resilient Navigation & Timing Foundation, noted that nearly all PNT users in the U.S. are non-military, making PNT vital to technology and infrastructure.

## Galileo Second Generation Satellites Greenlighted by ESA

The first 12 second-generation (G2) satellites for the European Galileo navigation system have been approved. Two review boards confirmed the satellites meet mission and performance requirements, with Thales Alenia Space's design reviewed in April and Airbus Defence and Space's in May. ESA states the G2 satellites will enhance positioning, navigation, and timing capabilities with electric propulsion, digital navigation payloads, a more powerful navigation antenna, inter-satellite link capacity, and an advanced atomic clock. ESA has 30 first-generation Galileo satellites in orbit and plans to launch an additional eight, with two in September and six next year.

## Leica Geosystems launches Leica iCON gps 120

The new Leica iCON 120 Machine Smart Antenna is integrated into the existing Leica MC1 solution platform. Thanks to its flexibility, scalability and modularity, it extends the machine control solution offering to more applications and machine types. Construction machines like compaction rollers, which usually require only sub-metre accuracy without heading, can now be equipped with a tailor-made Leica MC1 machine control solution. This allows streamlined operations and consistent workflows between heavy construction equipment that vary in application requirements. Using the Leica MC1 machine control solution enables more accurate and quicker task completion, significantly enhanced fleet efficiency, reduced waste and more environmentally friendly operations.

## Trimble Releases R980 GNSS System for Geospatial Professionals

Trimble has introduced the Trimble R980 GNSS system, the newest addition to its Global Navigation Satellite System (GNSS) receiver portfolio. Building upon premium features available on Trimble's latest receiver models, including the Trimble ProPoint® positioning engine, the new R980 adds several new elements including upgraded communication capabilities to support uninterrupted field operations. The Trimble R980 brings together several top Trimble GNSS technologies to create an indispensable tool for land surveying, transportation infrastructure, construction, energy, oil and gas, utilities and mining projects. Well-established features include Trimble's unrivaled ProPoint GNSS positioning engine and Inertial Measurement Unit (IMU)-based tilt compensation using Trimble TIP™ technology. These features make it possible to work in dense urban environments and under tree canopy, removing the need to level the pole when capturing data points.

## U.S. Congress Derails Funding for Space Force's R-GPS Constellation

The U.S. House Appropriations defense subcommittee is skeptical of the Space Force's plan to use small GPS satellites, called Resilient GPS (R-GPS), for increased resiliency. They declined to fund the $77 million requested for this in the fiscal 2025 budget, doubting that 20 small satellites transmitting core GPS signals would significantly enhance signal resilience. "The committee has concerns about the R-GPS plan, questioning how 20 small satellites transmitting core GPS signals would improve resilience against jamming compared to other DoD alternatives," the House committee stated in their report.

## LabSat Releases New LabSat4 GNSS Simulator

Labsat is a UK-based company specializing in GNSS technology. The flagship product is the LabSat GNSS Simulator. Compact, lightweight, and battery-powered, LabSat simulators enable efficient capture of detailed real-world satellite data, which can then be replayed in controlled environments. The LabSat 4 stands out as the most cost-effective option available, offering full constellation simulation capabilities for GPS, GLONASS, BeiDou, Galileo, and Navic /IRNSS systems. This makes it an accessible choice for companies engaged in GNSS design, testing, or production. It features external data integration, saveable custom record settings, and easy configuration and operation via a user-friendly web interface. LabSat device will support the frequencies: GPS: L1 / L2 / L5; GLONASS: L1 / L2 / L3; BeiDou: B1 / B2 / B3; QZSS: L1 / L2 / L5; Galileo: E1 / E1a / E5a / E5b / E6; IRNSS: L1 / L5 / S-Band; SBAS: WAAS, EGNOS, GAGAN, MSAS, SDC.

### Intelpol by IGNESA Recognized for Excellence in Geospatial AI at Indian Icon Awards

IGNESA INDIA SOLUTIONS PRIVATE LIMITED, an innovative startup specializing in AI-driven geospatial solutions, has received a significant accolade at the Indian Icon Awards 2024. Their flagship product, IntelPol, was honored with the prestigious Best Technology Startup Award for its excellence in geospatial AI solutions. This esteemed award ceremony was held at the Lalit Ashok in Bengaluru on May 4, 2024. IntelPol stands out as a pioneering geospatial AI solution that focuses on crime prediction. By leveraging advanced location intelligence and artificial intelligence technologies, IntelPol provides a cutting-edge approach to addressing crime.

### TRISHNA Mission to Revolutionize High-Resolution Thermal Imaging

TRISHNA Mission, a collaborative endeavour between the Indian Space Research Organisation (ISRO) and the French space agency CNES, is set to revolutionize the monitoring of Earth's surface temperature. TRISHNA (Thermal Infra-Red Imaging Satellite for High-resolution Natural Resource Assessment) is engineered to deliver high-resolution spatial and temporal data on surface temperature, emissivity, biophysical, and radiation variables, enabling comprehensive surface energy budgeting from regional to global scales. TRISHNA will provide unprecedented data crucial for understanding and mitigating the effects of climate change, ensuring more efficient use of natural resources. This groundbreaking collaboration between India and France underscores the importance of international partnerships in tackling global environmental issues.

### TSAT-1A India's First Privately-Built Satellite with Sub-Metre Resolution

Developed by Tata Advanced Systems Limited (TASL) in collaboration with Satellogic, TSAT-1A is a state-of-the-art geospatial satellite launched on SpaceX's Falcon 9 rocket in April 2024. The satellite is designed to provide high-resolution imaging capabilities for a variety of applications, primarily focusing on military and strategic uses. It is a Low Earth Orbit (LEO) satellite. Capable of capturing images of Earth's surface with a resolution sharper than one meter, the satellite provides unparalleled detailed views crucial for military applications.

### IAI Introduces High-Tech Jam-Resistant GNSS System

IAI's new jam-resistant GNSS system incorporates advanced anti-jamming technologies designed to ensure reliable signal reception even in highly contested environments. The system is compact and lightweight, making it suitable for a wide range of aerial platforms, from unmanned aerial vehicles (UAVs) to manned aircraft. It weighs 1.1 kilograms (2.4 pounds), has a size of less than 110 by 140 millimetres (4 by 5.5 inches), and consumes less than 25 watts.

### Northeast Frontier Railway (NFR) to Conduct Airborne LiDAR Survey

The Indian Railway's Northeast Frontier Railway (NFR) zone is set to conduct an Airborne LiDAR Survey on the Lumding to Badarpur hill section. This advanced survey will take place during and after the monsoon season to assess the geological and soil conditions, which is often affected by landslides and track damage due to heavy rains. The survey will help to analyze the region's soil strata, slope stability, natural faults, water accumulation, and hill toe stability.

## GEO EVENTS

**July 15 -19, 2024**
**Esri User Conference**
San Diego, CA, USA
*https://www.esri.com/en-us/about/events/uc/overview*

**August 14-16, 2024**
**CPGIS'2024 – The 31st International Conference on Geoinformatics**
Toronto, Ontario, Canada
*https://www.cpgis.org/*

**August 24-30, 2024**
**International Geographical Congress**
Dublin, Ireland
*https://igc2024dublin.org*

**September 3 - 5, 2024**
**Commercial UAV Expo**
Las Vegas, USA
*www.expouav.com*

**September 16-20, 2024**
**ION GNSS+ 2024**
Baltimore, Maryland, USA
*https://www.ion.org/*

**September 24-26, 2024**
**INTERGEO 2024**
Stuttgart, Germany
*https://www.intergeo.de*

**October 7-10, 2024**
**GIS-Pro 2024: URISA's 62nd Annual Conference**
Portland, Maine
*https://urisa.org/page/GIS-Pro2024*

**December 2 - 5, 2024**
**GeoSmart India 2024**
Hyderabad, India
*https://geosmartindia.net/2024/index.html*

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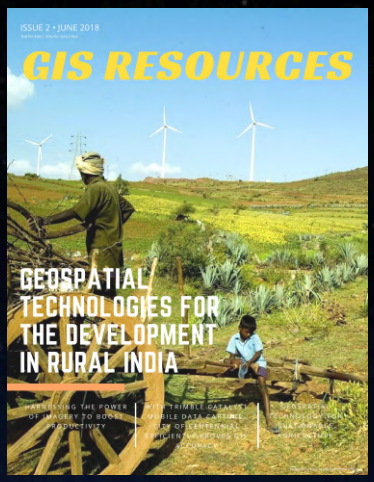


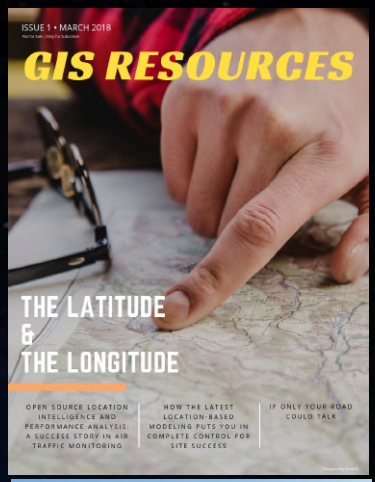





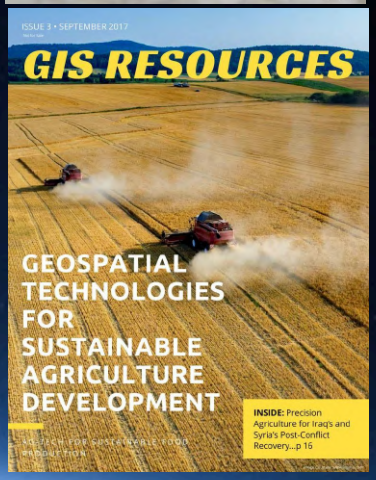


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