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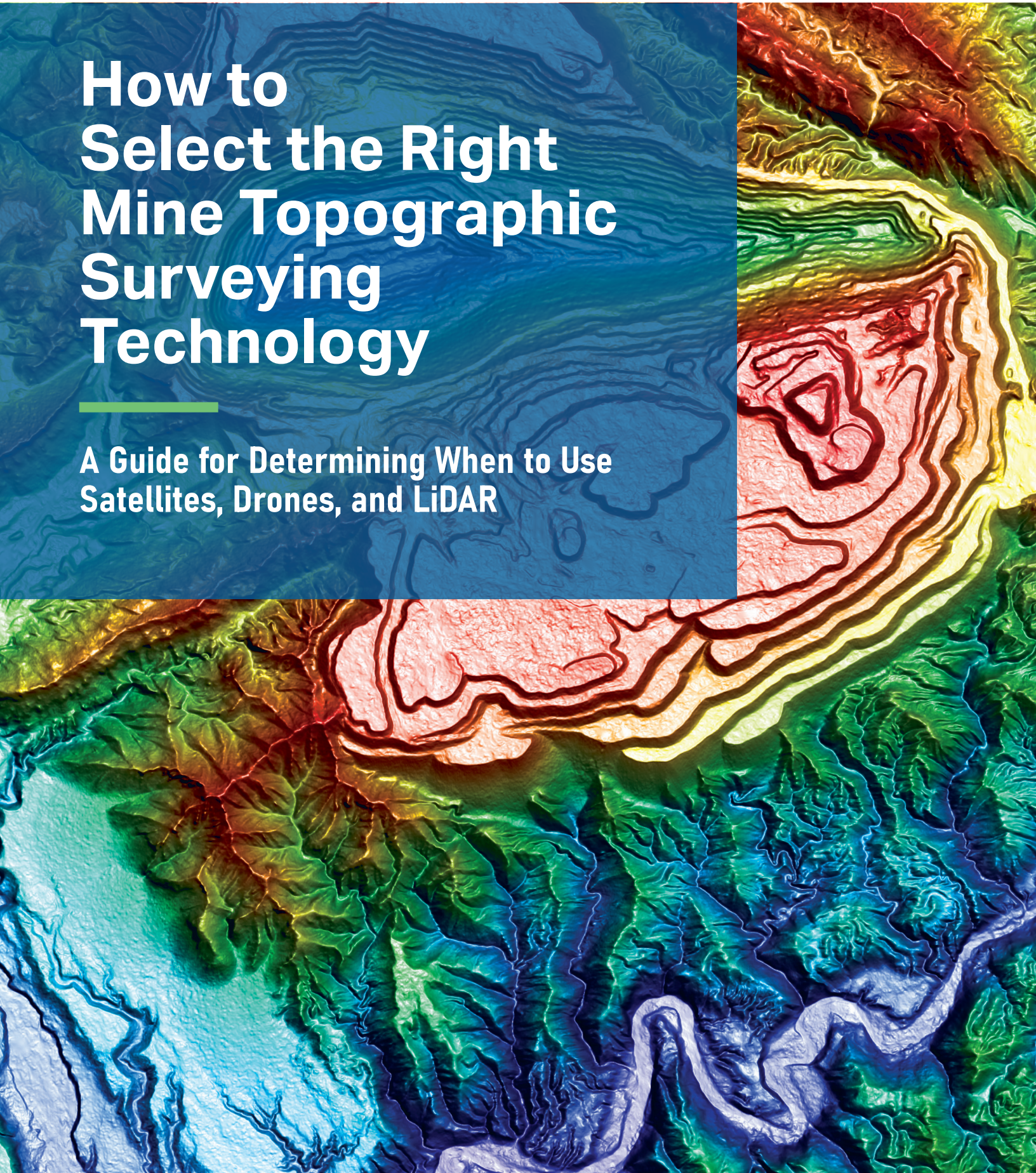
How to Select the Right Mine Topographic Surveying Technology

A Guide for Determining When to Use Satellites, Drones, and LiDAR



INTRODUCTION

Active mine pits, waste dumps, stockpiles, leaching facilities, and tailings storage facilities (TSF) constantly change. Monitoring the shifting dynamics of mining operations and water management is crucial for ensuring a mine site's safety, compliance, and efficiency. Mining professionals need timely, robust topographic survey data to manage their sites responsibly and efficiently.

Traditionally, ground-based surveying teams manually mapped areas at a relatively slow pace of about 10 to 30 km² per day, on average (Hammer Missions, 2022, para. 8), to create low-density maps. However, technologies have advanced and mining operations have grown more complex; this boots-on-the-ground only approach has become inadequate for keeping up with the pace of business decisions and changing regulatory standards.

Now, mining professionals have multiple remote technologies available to measure and monitor the changing topography of their site, including high-resolution and rapid-revisit optical satellites, drones, and Light Detection and Ranging (LiDAR) systems.

Choosing the right technology is critical, as there are so many options to streamline the surveying process.

Understanding the benefits and limitations of each technology is key to selecting the most appropriate data sources—and integrating several solutions into a holistic approach—to optimize your mining operations.

In this guide, we will compare the strengths, limitations, and applications of these technologies to help you choose the best combination of tools for surveying your site.

Comparing Topographic Survey Options

Active mine pits, waste dumps, stockpiles, leaching facilities, and tailings storage facilities (TSF) constantly change.

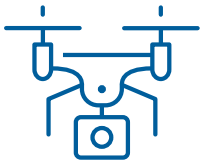
Comparing Topographic Survey Options

Depending on your operational priorities—whether you are looking for a more detailed topographical inspection or a higher-level analysis—each type of surveying technology has unique strengths, limitations, and potential use cases on mining sites.

Here is a brief overview of each solution:

High-resolution optical satellites offer the unparalleled ability to collect detailed imagery over large areas. These satellites can survey an entire mine site in a single, instantaneous snapshot, offering excellent data consistency, repeatability, and precision. Satellite imagery provides a cost-effective solution with quick delivery times, offering archived historical data and ongoing surveys to provide a complete timeline of time-stamped records.

Rapid-revisit optical satellites cover a much smaller collection area and are less accurate than their high-resolution counterparts. But as the name suggests, they can provide rapid collection times by leveraging a larger constellation of satellites.



Drones (UAVs) offer excellent on-demand flexibility and accessibility for capturing detailed imagery and topography, although they require on-site operators. Since they fly at lower elevations than traditional crewed aircraft, drones can avoid some atmospheric conditions, capturing higher resolution imagery with vertical accuracy down to centimeter levels. But adverse weather, such as high winds, rain, fog, and extreme temperatures, can affect their flight stability. Their limited flight times lead to smaller collection areas, which can cause challenges when merging data from multiple flights, leading to potential offsets in the resulting data and requiring additional time to acquire and process data over an entire site.

LiDAR has become the benchmark for accurate surveys because it captures detailed elevation data, creating topographic surveys of an area to establish a baseline with high absolute accuracy in a single flight. Its ability to penetrate vegetation gives it an edge over other imaging tools. However, since LiDAR requires long processing times and crewed aircraft, it faces constraints related to accessibility, expense, and the flexibility of revisit intervals.

Why about InSar? InSar is not a topographic surveying technology, unlike the other solutions listed above. Since it detects ground movement and displacement, rather than generating elevation grids, it has vastly different applications than the other four technologies we compare in this guide. As such, it has been excluded from this analysis and the chart on the following page.

Technology	Strengths	Limitations	Best Mining Use Cases
High-Resolution Optical Satellites 	· Wide coverage range of hundreds of sq.km. or more · Frequent updates and historical archives for long-term monitoring · Does not require site access	· Lower pixel and elevation grid resolution than drones or LiDAR · Affected by cloud cover and other atmospheric conditions	· Full-site topographical surveys · Tailings management · Long-term monitoring
Rapid-Revisit Optical Satellites 	· Utilizes extensive satellite networks for frequent mine site topography, potentially weekly · Offers rapid data processing	· Compared to other technologies, this option exhibits lower overall resolution and accuracy	· Frequent monitoring (e.g., monthly or weekly) of tailings storage facilities (TSF), stockpiles, waste dumps, and other facilities
Drones 	· High-level pixel resolution (cm level) and relative accuracy with ground control · Flexible on-demand deployment · Cost-effective, especially as part of an internal program	· Limited coverage, typically covering up to 4 km² per flight · Affected by weather and airspace regulations · Requires on-site operation	· Detailed, localized surveys · Tailings dam inspections · Stockpile management
LiDAR 	· Extremely high absolute accuracy (5-15 cm) · Penetrates vegetation to reveal the ground surface	· Expensive operation · Long processing times · Requires flight permits · Affected by weather conditions, particularly rain	· Detailed terrain mapping · Baseline topographic survey

When to Use Which Technology

A single technology might not be the best solution for complex, dynamic mine site scenario. Selecting the right tool for the job requires understanding the specific problem you are trying to solve, the type of data needed to solve it, and your constraints in terms of budgets and timelines.

Below are some common scenarios that might point you toward one surveying technology over another.

Choose high-resolution optical satellites when:

- Your project involves a large-scale elevation survey, requiring extensive coverage in a single shot
- Your project requires regular updates and historical surveys for long-term monitoring
- You need to passively survey remote, hard-to-reach areas without requiring site access or aircraft permits

Choose rapid-revisit optical satellites when:

- Projects require regular (e.g., monthly or weekly) monitoring of tailings storage facilities, stockpiles, waste dumps, and similar sites, where a high level of absolute accuracy may not be necessary.

Choose drones when:

- You have a small project area, or you are focused on targeted, localized surveying
- Your site demands rapid deployment or on-demand flexibility

Choose LiDAR when:

- You want a baseline survey of your site
- Your project involves a large-scale elevation survey requiring extensive coverage in a single flight
- You have a larger budget that can accommodate the higher costs of crewed aircraft
- You need a detailed analysis, and you have a longer timeline for complex processing
- You need to survey ground elevations obstructed by vegetation

Best Practices for Technology Integration

No two mine sites are identical, and each location faces unique challenges that affect the planning and implementation of an effective elevation survey program. Choosing a topographic surveying technology is not an either/or, one-size-fits-all decision, but a dynamic consideration requiring a holistic approach.

Integrating data from complementary technologies empowers mining operators to overcome the limitations of each tool while enhancing the overall accuracy and completeness of various surveys to provide a more comprehensive picture of their site's topography. For example, by combining the full-site baseline survey from optical satellite imagery with the detailed, targeted data from a drone survey, operators can merge multiple data sets to create a more complete picture of their mine site, making both data sets more valuable when working together than alone.

By harnessing the collaborative potential of these solutions, operators can access the full scope of data they need to safely and efficiently manage mining operations, water management, tailings storage facilities, waste dumps, stockpiles, and leaching facilities.

To learn more about leveraging optical satellite imagery to generate or complement topographic surveying data on your mine site, request a quote from PhotoSat.

Sources
1. Hammer Missions. (2022, September 12). How drone technology is changing the mining industry: Drones for Mining. https://www.hammermissions.com/post/how-drone-technology-is-changing-the-mining-industry

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