Leveraging Daily Satellite Imagery for Advanced Geospatial Analytics

Until roughly the last decade, most governmental agencies and commercial entities seeking top-down perspectives of different geographies remained reliant on aerial photogrammetry—or gathering reliable information about objects and environments via photographs, electromagnetic radiant imagery, and similar methods. However, sourcing existing or new aerials came with numerous challenges, resulting in most available solutions proving subpar regarding accuracy, regularity, and cost.

Organizations no longer contend with these challenges when trying to improve their visibility or leverage ground-truth data to guide decisions and operations. The introduction of commercial satellite imagery now enables government and commercial entities to regularly and promptly source current and accurate ground-truth. With these images—often captured daily—and the right technological platform, any organization can leverage geospatial analytics to achieve new insights.

This article will provide an in-depth breakdown of daily satellite imagery, geospatial analytics, geospatial intelligence, and how organizations leverage these resources and processes. With this information, you'll be able to determine the impact geospatial analysis may bring to your organization and how to start implementing it.

Deepen Your Understanding of Geospatial Analytics

Geospatial analytics refers to processing earth observation (EO) data and satellite imagery with data from geographic information systems (GIS) and other sources to produce geospatial intelligence (GEOINT). Organizations reference the compiled GEOINT to inform decision-making and operations (or perform even more extensive analyses).

Ultimately, geospatial analysis and GEOINT provide greater and more granular visibility.

To that end, this discipline resembles other types of analysis now becoming increasingly accessible (and, accordingly, increasingly popular). For example, auditing customer relationship management to optimize personnel structures, process efficiencies, and revenue streams is a relatively new discipline for many organizations, largely facilitated by dedicated software logging and analyzing relevant information. Similarly, geospatial analysis relies on technological innovations that improve data capture.

What sets geospatial analytics apart is how the provided visibility, assessment capabilities, and predictive guidance pertain to observable locations and phenomena on the Earth's surface—geographies, their changes, and related human or environmental

activity. And that's why the introduction of commercial satellite imagery caused a paradigm shift.

GEOINT—Long-Understood Value, Recently Realized Accessibility

Given the benefits, organizations weren't ignoring geospatial analysis because it lacked merit. Rather, traditional barriers rendered it unfeasible for most.

Before commercial satellite imagery, sourcing historical aerial photogrammetry risked receiving images that were too out-of-date and irrelevant, while capturing new images often involved logistical challenges, expert personnel, specialty equipment, and significant expenses, like:

- Pilots
- Photographers
- Specialty cameras and lenses
- Aircraft and fuel
- Outsourcing or in-house employment and equipment maintenance costs

Other legacy data collection methods not using aerial capabilities might struggle with similar challenges—like monitoring waterways' streamflow, which still often requires expert personnel and specialty equipment brought on-site.

However, with satellite imagery, organizations can now easily support geospatial analysis via reliable, regular access to the necessary information. Organizations can request historical images and data from massive repositories on demand, subscribe to receive new images matching configured parameters (e.g., location, subject) as they become available, and task satellites with capturing new images to maintain up-to-date visibility.

Types of Data and Intelligence Informing Geospatial Analysis

Data sources and types of intelligence that organizations may rely on to perform geospatial analysis can be divided into a few standard categories. While these terms often describe defense or military intelligence applications, they still sufficiently distinguish the types of data geospatial analysis leverages:

- Imagery intelligence (IMINT), such as:
    - Satellite imagery
    - Aerial photogrammetry
- Human intelligence (HUMINT) collected by personnel in the field, such as:
    - On-site visits and similar 'reconnaissance'
    - Interviews
- Measurement and signature intelligence (MASINT), such as:
    - Remote sensing
    - RADAR and similar radio frequency detection methods

- Open-source intelligence (OSINT), which serves as an umbrella for publicly available information regardless of which category it belongs to

Depending on the data an organization wants to analyze and the insight they want to gain from it, geospatial data analysis may combine some or all of the intelligence sources above. The discipline may also include signals intelligence (SIGINT) like monitoring communications and other electronic transmissions, but that tends to occur more within dedicated defense and military applications.

Among the different sources and types of data, most government and commercial entities will find IMINT—specifically, daily satellite imagery—and remote sensing the most impactful. This is because today's IMINT capabilities produce high-resolution images with greater regularity and frequency, and remote sensing collects non-visible wavelengths on the electromagnetic spectrum that would go undetected by personnel relying solely on their eyes.

Moreover, many organizations now leveraging or considering geospatial analytics generally do so because the logistics and costs (e.g., number of qualified experts employed, equipment availability, number of sites to be assessed) associated with acquiring sufficient HUMINT prove too challenging or inefficient to manage.

Sources of Satellite Imagery

Different sources of satellite imagery may be used for geospatial analysis depending on how regular and rigorous an organization must be. However, each comes with their own trade-offs:

- **Free satellite imagery** – Primarily sourced from government image repositories and various governments' currently orbiting satellites, free satellite imagery provides a basic entry point for organizations looking to adopt geospatial analysis. However, as with most free platforms, they may not support the resolution quality or update frequency required for regular analysis. Additionally, data exports may not be seamless without dedicated APIs.

- **Commercial satellite imagery** – This industry is largely driven by a few leading companies that launch and maintain satellite "constellations" in low Earth Orbit (LEO) (i.e., under altitudes of 1,200 mi. or 2,000 km). While partnerships and subscriptions do carry some cost, they provide organizations with the optimal blend of near real-time ground-truth:

    - Commercial constellations often contain many satellites, which considerably expands the global surface area captured per pass. For example, the Dove satellites in the [REDACTED] constellation capture 300 million km^2 daily.

    - Higher-resolution images (e.g., 3.7 m, 50 cm) and different spectrums (e.g., 8-band, panchromatic) will be more widely available.

    - Commercial entities tend to launch their satellites more frequently, meaning they're more likely to be equipped with the latest technology. For example, [REDACTED] has launched 463 satellites in total, currently maintaining a constellation of about 200 Doves.

    - Satellites in LEO complete rotations nearly every 90 minutes, providing up-to-date information.

    - "Tasking" capabilities execute image capture requests for specific locations to ensure organizations can access the specific visibility they need. Tasking in particular separates commercial capabilities from freely available imagery.

- **Non-satellite alternative imagery** – Aerial photography captured via legacy methods described above or via unmanned aerial vehicles (UAVs or "drones") still holds significant value for augmenting other Earth observation data and imagery when performing geospatial analysis. However, the same limitations that existed prior to daily satellite imagery's emergence remain. UAVs provide a far better solution to manned aerial reconnaissance if requiring regular image capture but still involve considerable investment and experienced personnel to operate and maintain.

Applications of Daily Satellite Imagery in Geospatial Analytics

Daily satellite imagery provided by commercial entities often proves the most impactful input for geospatial analysis—especially for compliance monitoring and stewardship applications that fall under many government agencies' purview. This is because imagery captured with such regularity helps ensure the most accurate analyses and conclusions, as well as provides organizations with the most timely notice regarding changes.

Particularly for broad area land management applications like those explored below, the achieved outcomes wouldn't have been possible without regular, reliable satellite imagery.

Agriculture Practice Verification

Government agencies tasked with monitoring compliance for agricultural practices and land-use often cannot procedurally perform on-site assessments for every tract—at least,

not in a timely manner or without considerable tax dollar expenditures. Either the agency falls behind on its workload or overlooks some citizens or entities.

For example, one Slovenian agency (ARSKTRP) struggled with adopting the 2023 reforms to the Common Agricultural Policy (CAP)—the European Union's (EU) agricultural regulations for fair food prices, farmer subsidies, and environmental sustainability. Although the EU improved general efficiency by transitioning from in-person "on-the-spot-checks" (OTSC) to "Checks by Monitoring" (CbM), ARSKTRP discovered the Copernicus Sentinel satellites and other EO data used to support the new assessment method wouldn't work for roughly 25% of Slovenia's 174 million agricultural hectares.

Farmland marked by smaller, irregular property boundaries couldn't be assessed properly by the Area Monitoring System (AMS). The Copernicus Sentinel satellites couldn't produce reliable time series data for narrow fields, struggled to identify recent agricultural activity on permanent grasslands and extended orchards, and occasionally produced images with cloud cover obscuring visibility.

However, after ARSKTRP and its service provider (Sinergise) incorporated [REDACTED] data into the geospatial analysis, they managed to reduce the number of parcels previously deemed inconclusive by 73%. The reduction in OTSC visits reclaimed €1 million. Additionally, any OTSC visits still necessary also leverage the same [REDACTED] satellite data timelapse and other geospatial analysis derived from it to perform most on-site assessments in roughly 30 seconds—saving another €70,000.

Land Management

New Mexico's State Land Office provides another example of the common challenges faced by government agencies tasked with broad area land management. The 9 million surface acres and 13 million mineral acres the agency manages simply prove too large an area to effectively monitor without the increased visibility of satellite imagery aiding personnel.

NMSLO knew it was missing out on the considerable revenue it would normally generate from leasing land to entities for various commercial applications (and from fines assessed for trespassing on that land without those leases). But roughly one year on from implementing satellite imagery and incorporating it into compliance monitoring and geospatial analysis models, NMSLO managed to:

- Identify 58 trespassers
- Establish 22 new leases
- Collect $4.3 million in total.

Brazil's Federal Police similarly uses satellite imagery to identify crimes occurring in the Amazon Rainforest.

Disaster Recovery

Satellite imagery updated daily provides one of the most valuable sources of data for disaster recovery, response, and impact analysis applications. For example, satellite imagery enabled researchers to better visualize and analyze the Lahaina fires that devastated Maui in 2023.

In seeking to better understand the scope and scale of the wildfire's impact, the team at Microsoft's AI for Good Research Lab collected recent and historical satellite imagery from the [REDACTED] library. They found that using a machine learning (ML) model to analyze building damage better established stark, before-and-after comparisons to help government officials and researchers respond to disasters and communicate their impacts.

Caleb Robinson—one of the leading Microsoft researchers on the project—later published a paper detailing this process and how it was later used in conjunction with the American Red Cross. Following a 2023 tornado in Mississippi, the joint team used the geospatial analysis model to rapidly assess structure damage, informing and optimizing first responders' efforts.

Tools and Techniques for Geospatial Analytics

Since the very first true GIS technology was developed in 1963 by Roger Tomlinson, these geospatial technology platforms have steadily grown to dominate the geospatial analysis and GEOINT fields. Today, the two most popular GIS platforms for analyzing and displaying geospatial data remain ArcGIS and QGIS.

Satellite imagery imported into a GIS platform generally utilizes a desktop, API, or streaming integration.

GIS Software—Comparing ArcGIS and QGIS

Both GIS platforms will provide the essential satellite data applications and functionality professionals need, but each will suit specific circumstances better. For example:

- **ArcGIS** – As paid-for, proprietary software only compatible with Windows machines and potentially requiring additional licenses for some tools, ArcGIS presents a greater barrier to entry. However, it remains the industry standard—providing:
    - Myriad tools
    - Remote access to desktop versions via mobile devices
    - Flexible data entry (i.e., float, text, and integers)

    - Professional technical support

- **QGIS** – The open-source alternative, QGIS, presents users with the customary benefits of free software: minimal barrier to entry and support for multiple OS. But organizations looking to utilize more advanced capabilities may encounter some challenges:

    - No professional support, official resources, or central repository for plugins and extensions
    - Little to no remote access capability
    - No field data entry (i.e., text or numeric only)

Data Integration

Integrating satellite imagery and geospatial information from various sources with your GIS mapping platform enables more robust analyses and more detailed visualizations. For example, ARSKTRP's solution for CAP management involves integrating both [REDACTED] imagery and data with that collected by the Copernicus Sentinel satellites.

Depending on the implemented platform and additional technology resources, an organization will choose to integrate with GIS via:

- **Desktop integration** – Connect vendor-provided libraries directly with GIS platforms to facilitate image search, access, and importation for analysis.

- **APIs** – Although these integrations may require more technical know-how to connect with ArcGIS, QGIS, open-source, or other software, they provide some of the fastest data pipelines when built and configured properly.

- **Streaming Web Service** – Platforms that support Open Geospatial Consortium (OGC) WMS or WMTS standards will allow satellite imagery to be streamed from a vendor-provided library.

Just remember to clean, construct, integrate, and formulate your data beforehand:

- Eliminate or correct unnecessary and incomplete fields
- Make sure you derive any new fields from existing fields and layer properties.
- Add data from other sources to enrich your information and analysis.
- Organize and format fields consistently.

Future Trends in Geospatial Analytics—Led by [REDACTED]

The most exciting future trend in geospatial analytics will be the broader adoption of these methodologies and resulting insights. With commercial satellite imagery now

available, organizations can take on new projects, approach varied analyses differently, and keep discovering more applications for EO data.

As one of the leading commercial satellite partners, [REDACTED] provides government and commercial organizations with some of the broadest Earth coverage and highest-resolution images available. Contact [REDACTED] today to learn more about the new insights and analysis-backed guidance your organization can achieve with commercial satellite imagery.

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