Imagery Delivers New Insights for Smart Communities

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Introduction

Imagery can provide communities with insights into nearly every aspect of their operations, from urban planning and natural resource management to event management and disaster response. The problem is that, until recently, their use of imagery was limited by its cost and availability.

Agencies could tap into various libraries of satellite imagery and other remote sensing data, but they had no feasible way to capture imagery in response to their unique or emerging requirements. So although departments of nearly all disciplines understood the value of imagery, it was simply too cost-prohibitive to use as frequently as they'd like.

But the commercialization of drones and the integration of drone technology and geographic information systems (GIS) have removed those barriers and changed how departments can practically use imagery. Now, they can capture imagery on demand, visualize and analyze it, and integrate it into their everyday workflows, shaping day-to-day decisions and long-term planning alike.

Ultimately, imagery is about building smarter communities – using data and technology to modernize workflows, enable data-driven decisions and improve communications with elected officials and the public. More simply, smart communities aim to improve residents' lives. A smart community has four defining, repeatable technology tenets: planning and engineering, operational efficiency, data-driven performance, and civic inclusion.

To explore this intersection of imagery and GIS, and how it helps governments fulfill visions of becoming a smart community, GovLoop partnered with Esri, a leader in GIS. This report outlines those four tenets, discusses the capabilities that imagery and GIS can provide, and highlights real-world examples from Horry County, South Carolina; Fort Mitchell, Kentucky; Onondaga County, New York; and the National Science Foundation.

How Imagery Makes Communities Smarter

Imagery is a powerful tool for community leaders. The use of remote sensing platforms, such as drones, allows agencies to collect and visualize data more quickly and comprehensively than otherwise possible. The ability to collect the data on demand is critical, enabling agencies to capture data at a specific point in time and to analyze changes and trends across time.

For example, after a severe storm, an emergency management agency can use a drone to calculate the spread and volume of debris and plan recovery efforts. Later, they can analyze imagery from before and after the storm to assess the damage and calculate the cost of repairs.

The key is integrating imagery into GIS, making it possible to visualize, analyze and share the data. That is the foundation of smart community applications. Esri has identified four technology tenets that deliver on the promise of smart:

Planning and Engineering

Any meaningful and lasting endeavor to transform a community begins with proper planning. This tenet spans all departments and, in many ways, is the unofficial first step to embracing smart. The goal is to use the resources currently available – or acquire new ones – to plan for communities that are more livable and inclusive for current and future generations.

Use case: Urban planners can use imagery as the foundation to generate a 3D digital twin. Once created, the planners can design and analyze site specific and regional plans in the context of the existing built and natural environments.

Operational Efficiency

The goal is to enable agencies to collect information in real time and feed it back into performance dashboards for real impact. With GIS, you can quickly visualize and analyze the data drones collect, and share it with decision-makers and other stakeholders.

Use case: A transportation department can use drones to conduct bridge inspections, collecting data on damage and wear and tear to plan current repairs and budget for future ones.

Data-Driven Performance

Smart communities use location as the standard analytical approach to achieving new insights. Increasingly, they rely on smart devices, the Internet of Things and cloud computing to continuously collect data about the locations of people, nature, vehicles and infrastructure.

Use case: To weigh new land planning policies, a department of natural resources could use imagery to analyze current and historic data on tree loss.

Civic Inclusion

Governments and citizens rely on each other to meet the community's needs and shape its future. What occurs in a community is inherently geographically personal – everyone who lives in a place cares about that place. GIS provides a platform through which agencies and their constituents can share information and collaborate on critical decisions.

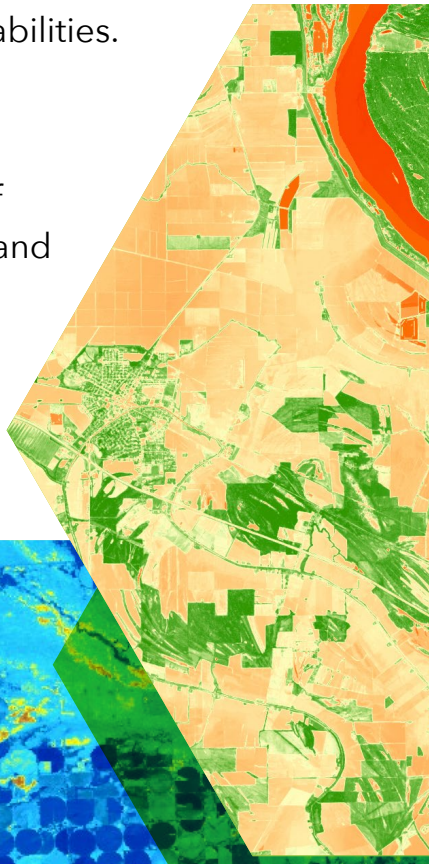
Use case: The commercial boom in drone technology has democratized imagery collection. Civic leaders can recruit private drone pilots to become citizen scientists, gathering imagery that can be fed into the community's GIS for visualization and analysis.

Next, we will share government success stories and best practices that reflect the value of these tenets.

The Intersection of Imagery and GIS

GIS and imagery provide a powerful view for organizations. But until recently, they had not existed in one integrated and complete system. Users had one system for GIS and another for image processing.

These two separate threads are now interwoven in Esri's ArcGIS, resulting in a far-reaching expansion of imagery applications within the world of traditional vector-focused GIS. ArcGIS, which works with satellite, aircraft and drone imagery, offers a wide array of imagery and remote sensing capabilities.



Key capabilities include:

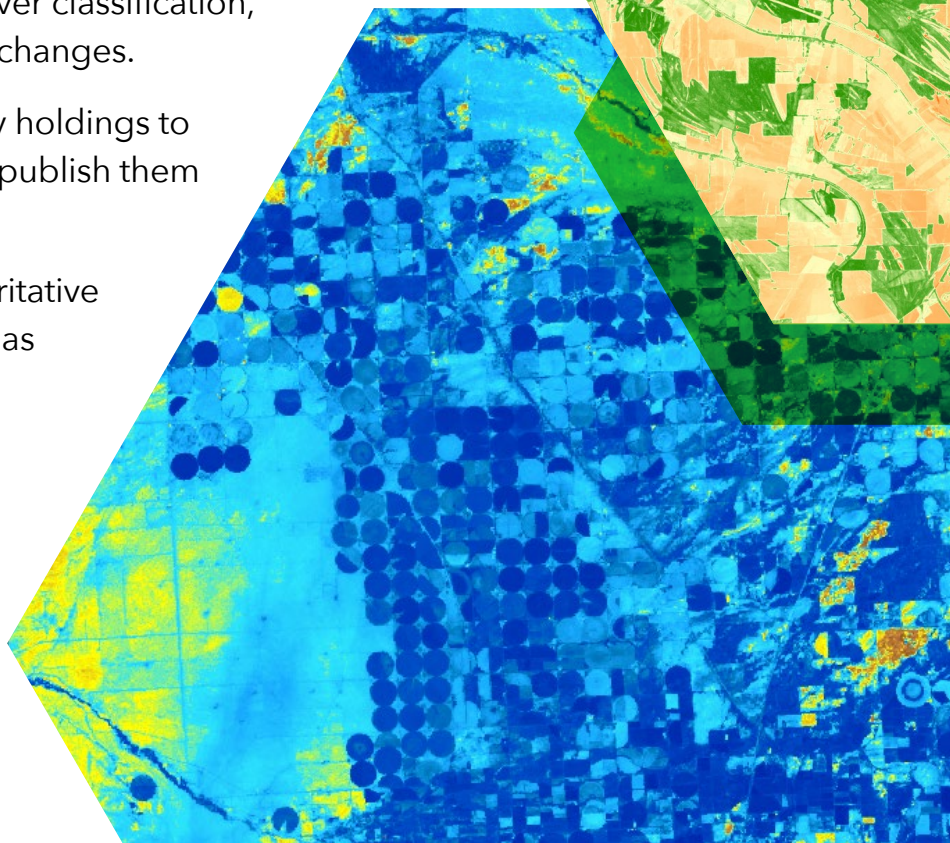
Content: ArcGIS provides the world's largest online collection of imagery, terrain and geospatial information layer to add insight and context to your work.

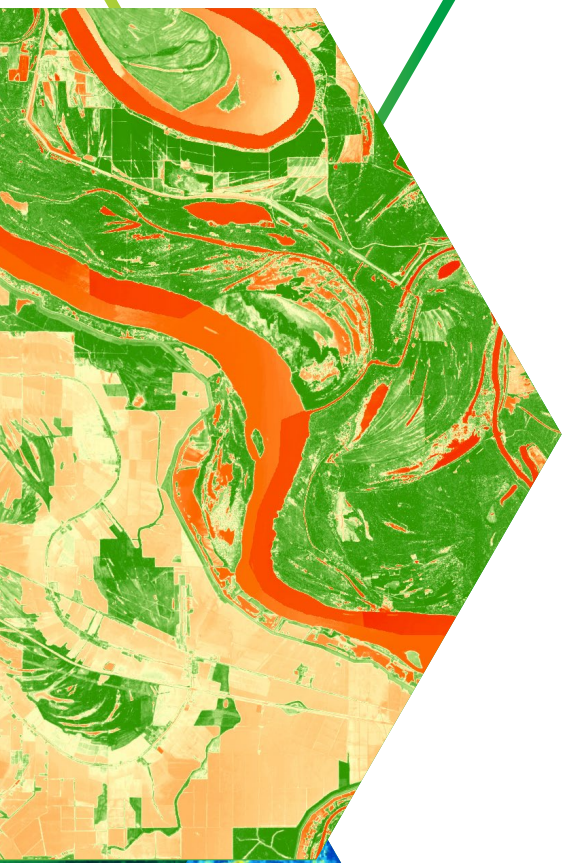
Visualization and Exploitation: Use dynamic desktop, web and mobile applications that enable informed decision-making.

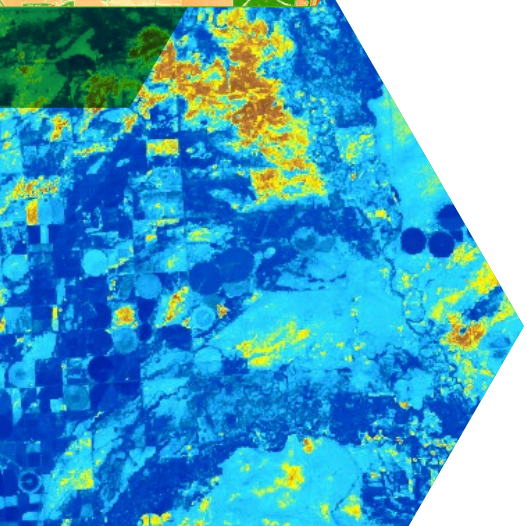
Analysis: Extract location-based information from geospatial data such as land-cover classification, objects and features, and Earth changes.

Management: Catalog imagery holdings to efficiently and securely store or publish them as web services.

Map production: Create authoritative imagery-derived products such as orthomosaics, digital elevation models, 3D meshes and topographic maps.







IMAGERY IN ACTION

Planning and Engineering

Horry County Mitigates Beach Erosion Costs

The Challenge

When Hurricane Matthew hit Myrtle Beach, South Carolina, it dumped 10 to 17 inches of rain and generated a storm surge that reached levels not seen since Hurricane Hugo in 1989, resulting in severe beach erosion all along the coast.

For Horry County, the impact of beach erosion can be severe. The coast, home to 60 miles of white sand and countless businesses catering to tourists, is known as "The Grand Strand." It is the heart of the county's tourism industry and essential to the region's economy. Closed beaches mean lost revenue.

After the storm, the county was eligible for federal assistance to fund beach restoration. The application requires documentation of damage impact, which typically involves sending crews to survey the damage and develop cost estimates. When dealing with 60 miles of coast, it can take months to assess and repair storm damage, delaying beaches' and businesses' reopening.

The Solution

Before the hurricane hit, the Horry County IT/GIS department had used drones to take pictures of its coastline. Now the drones took on a whole new mission: documenting and analyzing the storm damage.

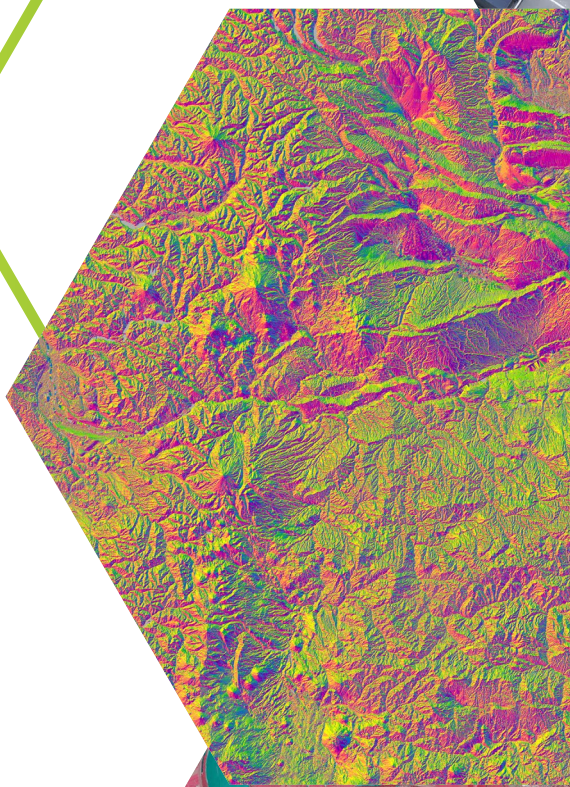
Using ArcGIS to process those images, the county could capture the contours of beaches, making it possible to measure erosion and document loss much more accurately than surveyors could have done with traditional methods. Also, the county was able to submit its Federal Emergency Management Agency application in just two days.

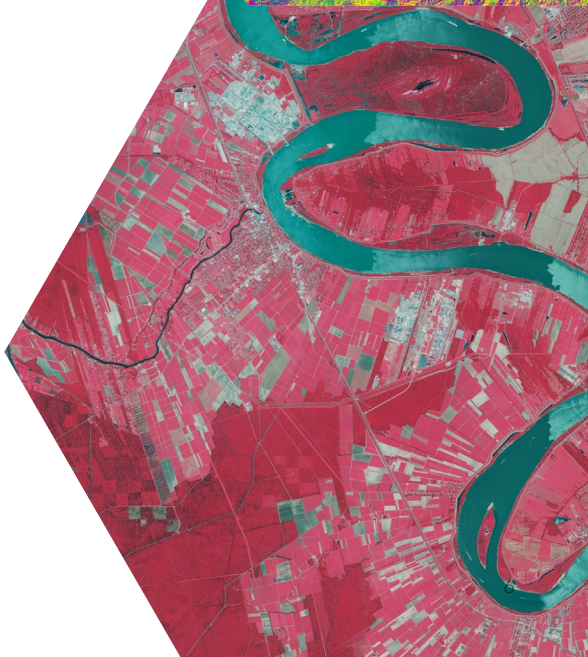
The county also used the drone and GIS to note the location and size of debris piles, which helped the county plan its recovery efforts.

In preparation for future storms, Horry County officials decided to conduct another fly-over once the beaches were restored, establishing a new baseline for future estimates. The images, capturing the area between the dunes and the low-tide line, will serve as "before" pictures that they can compare to images taken "after" the next storm.

Operational Efficiency

Onondaga County Reaps Savings on Water Tank Inspections





The Challenge

The Onondaga County, N.Y., Water Authority (OCWA) oversees 2,200 miles of water mains – that is, primary water pipes – and 58 water storage facilities. The system, which serves about 350,000 customers in portions of five counties in central New York, delivers 39 million gallons of water each day, drawing water from Lake Ontario and Otisco Lake.

Until recently, OCWA's process for inspecting the water tanks was slow and inefficient. One of the basic challenges was geography: There was no quick way to survey 58 tanks spread across so much territory. And the inspections themselves took time and were risky, with crews having to climb up and repel down each tank. And once the inspections were complete, the field staff needed to make their reports.

Geography also presented challenges in other areas, such as monitoring the lakes' water quality.

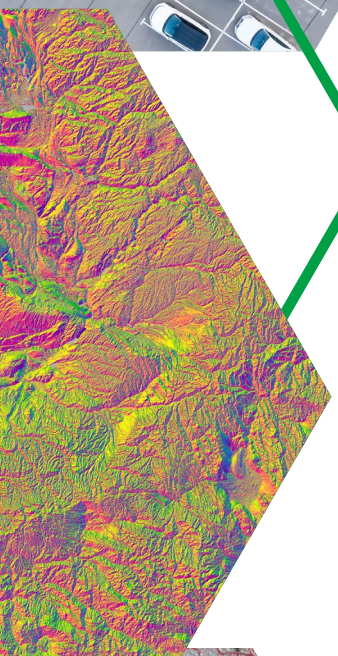
The Solution

OCWA decided to modernize its systems and workflows to increase efficiencies, mitigate risks and share information, beginning with the workflow methods for tank inspections. Above all, they wanted to reduce the time and labor needed to inspect the tanks. The first part of the solution was drone technology.

Using a drone to inspect tanks, they could complete each inspection much faster and safer. They also found that they could gather more information because the drones, equipped with high-resolution cameras, can see more details than a human can. The drones can capture imagery on every inch of even the largest tanks in less than 20 minutes.

The second part of the solution is the software: Drone2Map for ArcGIS, which captures the images for analysis. Because the software connects to OCWA's mapping portal, the agency can visualize and share the data with various stakeholders through web maps and apps. Altogether, OCWA says that it now saves $6,500 per tank inspection.

Finally, drones provided OCWA with a new way to assess water quality at the lakes. The high-resolution camera can peer 10 to 12 feet beneath the surface of the lakes to look for algal blooms or invasive species. As with water tank inspections, conducting drone-based inspections is much more cost-effective than sending out an OCWA crew, especially for parts of the lakes that are difficult to access.



Data-Driven Performance

Fort Mitchell Shapes New Parking Strategy

The Challenge

As part of a 2018 Historic Business District Economic Development Study, Fort Mitchell officials asked Planning and Development Services of Kenton County to identify the needs and usage of parking lots in the downtown business district.

City officials know that the supply and management of off-street parking are important elements of a thriving business district. From task force meetings and interviews with key stakeholders, they realized that many people believed that there was a parking shortage in the area. Rather than acting on perceptions, however, city officials wanted data.

One way to gauge parking demand was to map out the businesses in a given area, assess the potential parking requirements of each and compare that to the available on-street parking spaces.

Although such calculations would provide a good benchmark, they could not account for the daily rhythms of downtown streets. Parking demand varies at different times of day depending on the types of businesses – restaurants vs. banks vs. grocery stories.

The Solution

Traditionally, teams of people walk the parking lots counting cars. But this process is time-consuming and potentially inaccurate, with errors in counting or recording counts and no way to double-check the work.

The task force realized that a drone would make the work much easier and more accurate. A drone could fly the 7-acre study area in less than 10 minutes, creating updated aerial imagery showing when and where off-street parking spaces were in use.

The task force and city officials identified the day and time of flight observations based on their knowledge of parking demand in the area, while also ensuring that they captured data at different times on weekdays and weekends.

The study provided nuanced data-driven insights that informed the task force's recommendations.

For example, drone observations showed that one choke point was a block that had both a bar and a restaurant with similar peak parking times. However, plenty of spaces were available in the parking lots of adjacent businesses that were closed in the evening. The study showed the task force that more parking spaces weren't the answer. A simpler solution was a shared parking site.

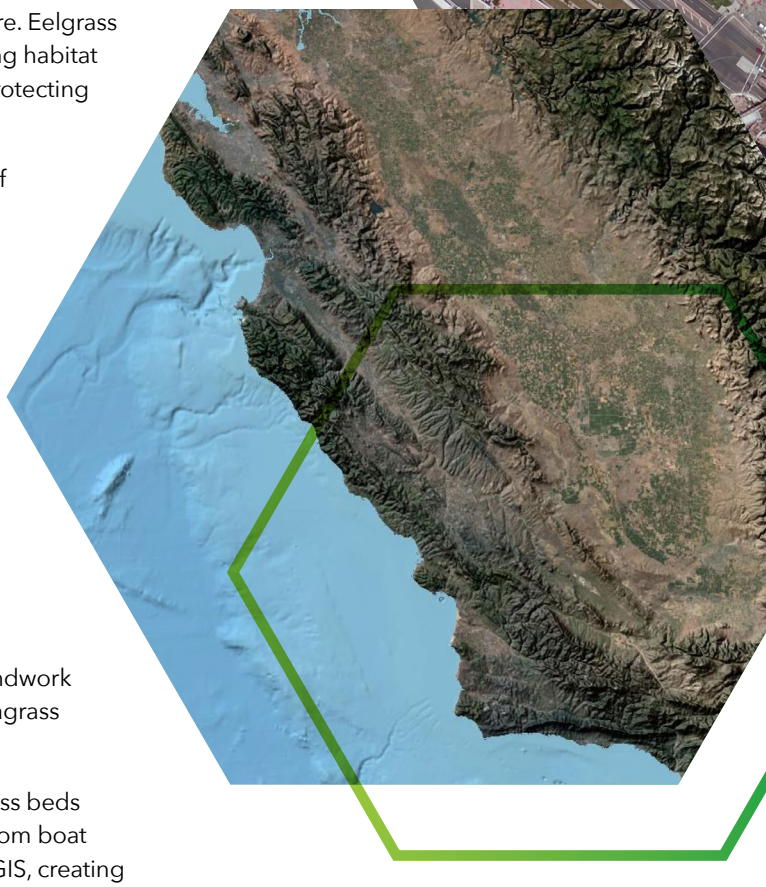
Civic Inclusion

Citizen Scientists Fill in the Gaps for Marine Research

The Challenge

Funded by a $1.3 million grant from the National Science Foundation, a team of marine biologists, geologists and other scientists has undertaken a multiyear, multidisciplinary effort to better understand the dynamics of coastal ecosystems along the West Coast.

Their efforts focus on eelgrass, the most prevalent seagrass there. Eelgrass and other seagrasses are a vital part of that ecosystem, providing habitat to sea creatures, contributing nutrients to the food chain and protecting against erosion.



But in recent years, a wasting disease has led to a loss of 7% of eelgrass each year. Scientists want to determine both the root cause of the disease and its potential impact on the larger coastal ecosystem.

They face considerable challenges. Coastal ecosystems are both complex and immense, making it difficult to identify all variables that might be involved. The project is looking at sites from California to Alaska, studying how the spread and impact of the disease varies based on temperature variability, location and changes in the animal community.

The Solution

A combination of drone imagery and GIS has helped the teams accelerate their work. At each site, scientists have laid the groundwork for their research by using drones to capture imagery of the seagrass beds and take GPS measurements.

Teams use that initial imagery to assess the extent of the seagrass beds and the impact of wasting disease and to document damage from boat propellers. That imagery is processed with Drone2Map for ArcGIS, creating a map used to track all subsequent research efforts.

Still, even with the help of drones, the scientists can cover only so much territory, so the project includes citizen scientists – people without extensive formal training in the science who can help collect data. The drone team is training local citizen scientists to use the technology and assigning them sites to survey. Involving citizen scientists extends the reach of the project and provides links to the local communities.

Drone-Based Imagery Toolbox for Smart Communities

The ability to use drone-based imagery requires close integration between drone technology and an enterprise GIS platform. Beyond simply capturing imagery, the solution should provide agencies with image management, map production, analysis and visualization capabilities.

ArcGIS Drone Collections can help government agencies begin using imagery data quickly. It provides a pre-packaged configuration of ArcGIS products specifically tailored for drone projects. It includes ArcGIS Online, Drone2Map for ArcGIS and Site Scan for ArcGIS which offers capabilities to collect, process, analyze, manage and share intelligence for informed business decisions.

The key capabilities include:

- **Drone image capture:** Optimizing flight planning, processing drone imagery and automating 2D/3D mapping outputs.
- **Drone image analysis:** Optimizing image analysis with deep learning tools, enhancing field operations with auto capture to Google Cloud Platform and generating authoritative mapping products.
- **Cloud-based analysis:** Enabling analysis on any device, with on-demand scalability.

Here are the major components of Drone Collections:

Drone Mapping Collection

Turn drone data collections into authoritative images and 3D models in minutes. The professional photogrammetry suite, powered by Pix4D, helps you do more in less time.

Drone Mapping and Analysis Collection

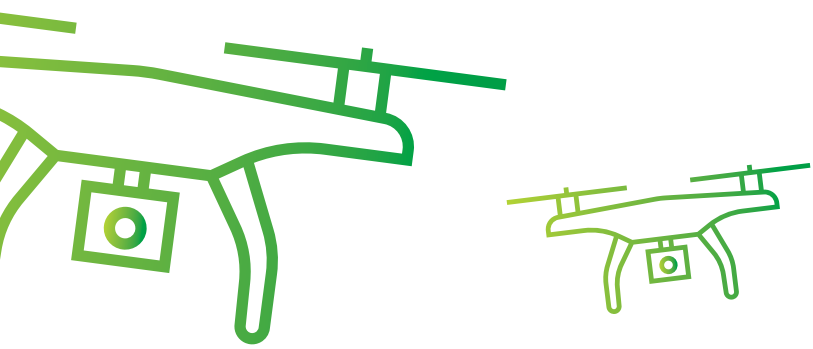
Generate optimal orthomosaics, 3D meshes and crystal views, and perform intelligent spatial analysis that saves time and minimizes analysis costs.

Online Drone Mapping Collection

With software-as-a-service, you can work with your drone data anytime, anywhere – cutting the time it takes to derive intelligence to your infrastructure and the cloud.

Enterprise Drone Mapping and Analysis Collection

Catalog your imagery holdings to efficiently and securely store or publish them as web services. Access, scale and unlock the information.



Conclusion

The combination of imagery and GIS forms a powerful platform for communities looking to improve the efficiency of their operations and the quality of their services – becoming smart communities.

Agencies can tap into a variety of resources, including satellite-, airplane- and ground-based sensors. But the emergence of commercial drone technology makes it easier than ever for those agencies to capture the imagery they need when they need it.

By taking advantage of GIS solutions tailored to work with drone imagery, they can significantly reduce the time it takes to process, visualize, analyze and share imagery data. This data can provide civic leaders and constituents with a new perspective on challenges and actionable intelligence to drive decision-making.

To learn more: go.esri.com/smart-imagery

When Esri was founded in 1969, we realized even then that geographic information system (GIS) technology could make a difference in society. Working with others who shared this passion, we were encouraged by the vast possibilities of GIS.

Today our confidence in GIS is built on the belief that geography matters - it connects our many cultures and societies and influences our way of life. GIS leverage geographic insight to ensure better communication and collaboration.

Explore our website to discover how our customers have obtained the geographic advantage by using Esri software to address social, economic, business, and environmental concerns at local, regional, national, and global scales. We hope you will be inspired to join the Esri community in using GIS to create a better world.

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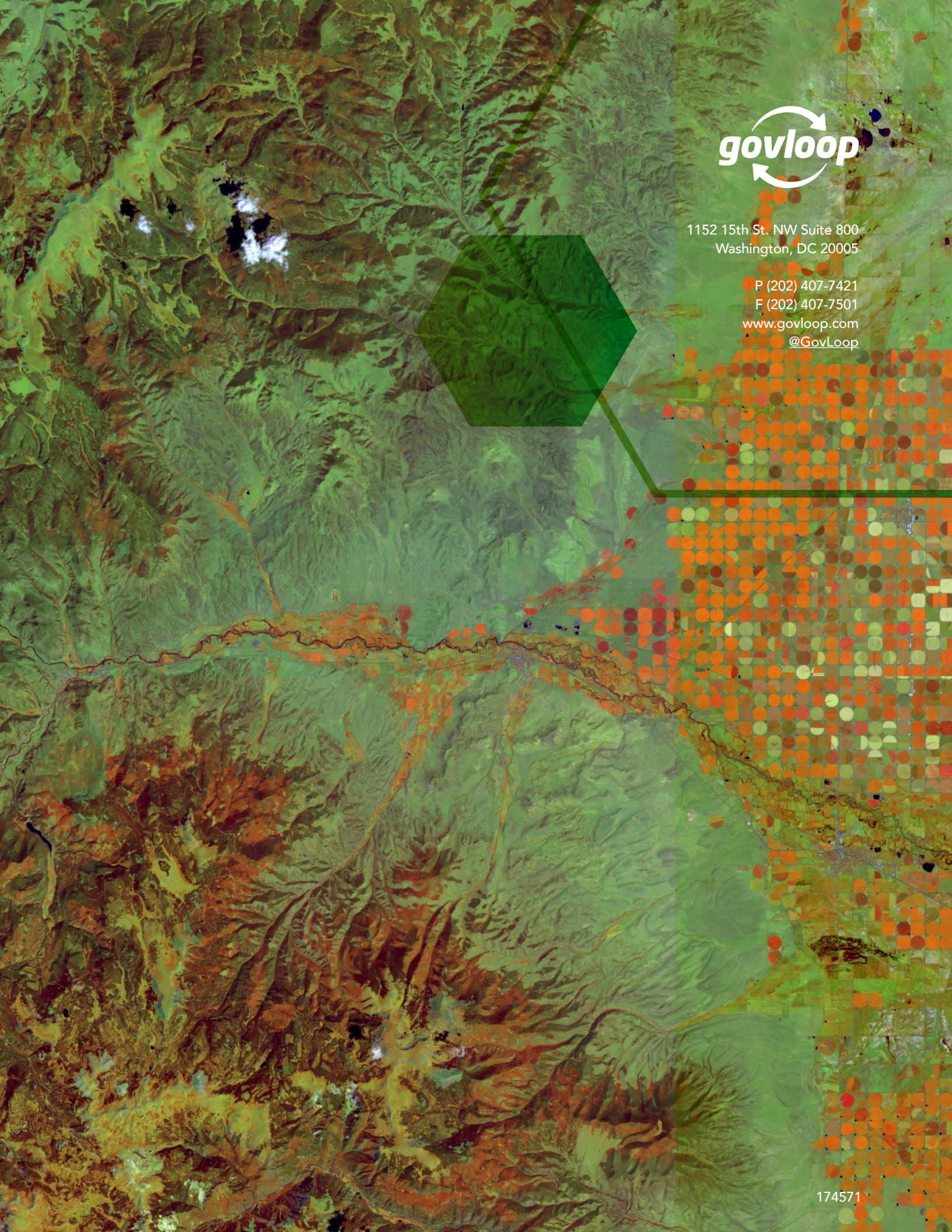

1152 15th St. NW Suite 800
Washington, DC 20005

P (202) 407-7421
F (202) 407-7501
www.govloop.com
@GovLoop

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