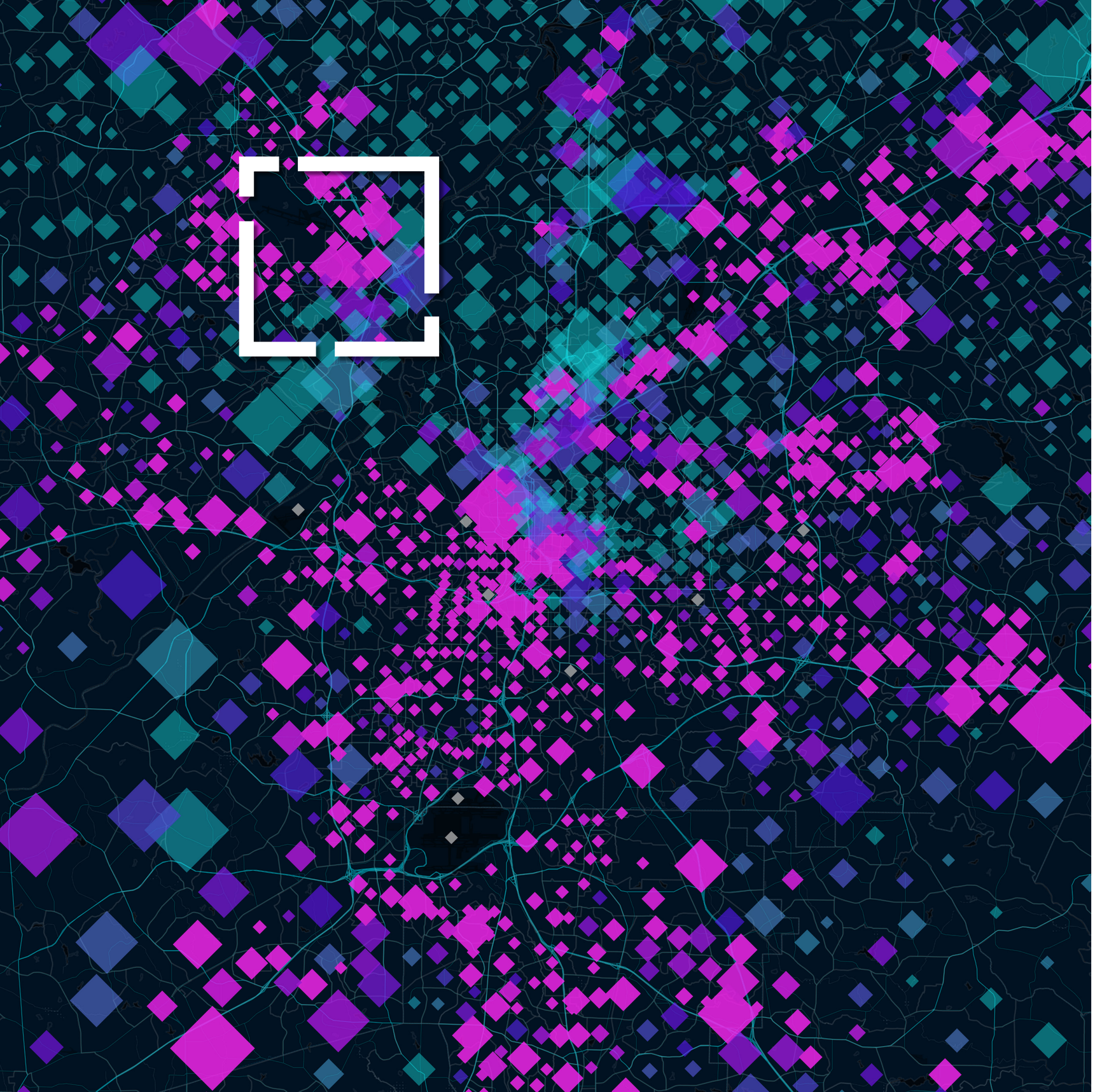
THE RISE OF AI AND LOCATION INTELLIGENCE

How organizations are using the combined power of AI and location intelligence for sustainability, efficiency, and growth

esri®

WHAT'S INSIDE



"The previous generation of GIS technology was built for people, and now we have a GIS built for machines. Automation doesn't mean we're replacing humans; it means humans don't need to do the tedious work that causes a state of boredom. Data scientists can focus on what they're good at, which is innovation, and machines can then take innovations to scale and perfect the readings—focusing on accuracy and outcomes."

—Jay Theodore, CTO, ArcGIS Enterprise Development Lead, Esri

What Makes AI and Location Intelligence Difference-Makers

Machine learning and deep learning are types of artificial intelligence (AI) that involve teaching computers to learn from data to make predictions and guide decisions. They excel at making sense of large volumes of data rapidly. Some of the most compelling uses of these tools involve split-second location decisions as in autonomous driving.

When it comes to location questions, businesses and governments have relied on geographic information system (GIS) technology for decades. Machine learning, deep learning, and location intelligence (powered by GIS technology) are now part of those workflows in automation techniques known collectively as AI and location intelligence.

Decision-makers use AI and location intelligence on problems that involve big datasets and complex patterns that may be difficult for humans to detect. A city, for instance, uses AI and location intelligence to analyze energy usage patterns in buildings and identify opportunities to reduce energy consumption. This could help a city meet its sustainability goals and reduce costs.

AI uses image recognition to tease out answers to complex and high-value questions. With the explosion of imagery coming from satellites, aircraft, and drones—coupled with the urgency to make sense of rapid changes—AI and location intelligence meet this moment by swiftly sifting through all the pixels to find answers to not only *where* but also *where now*.

With AI and location intelligence, decision-makers can tackle high-priority questions such as the following:

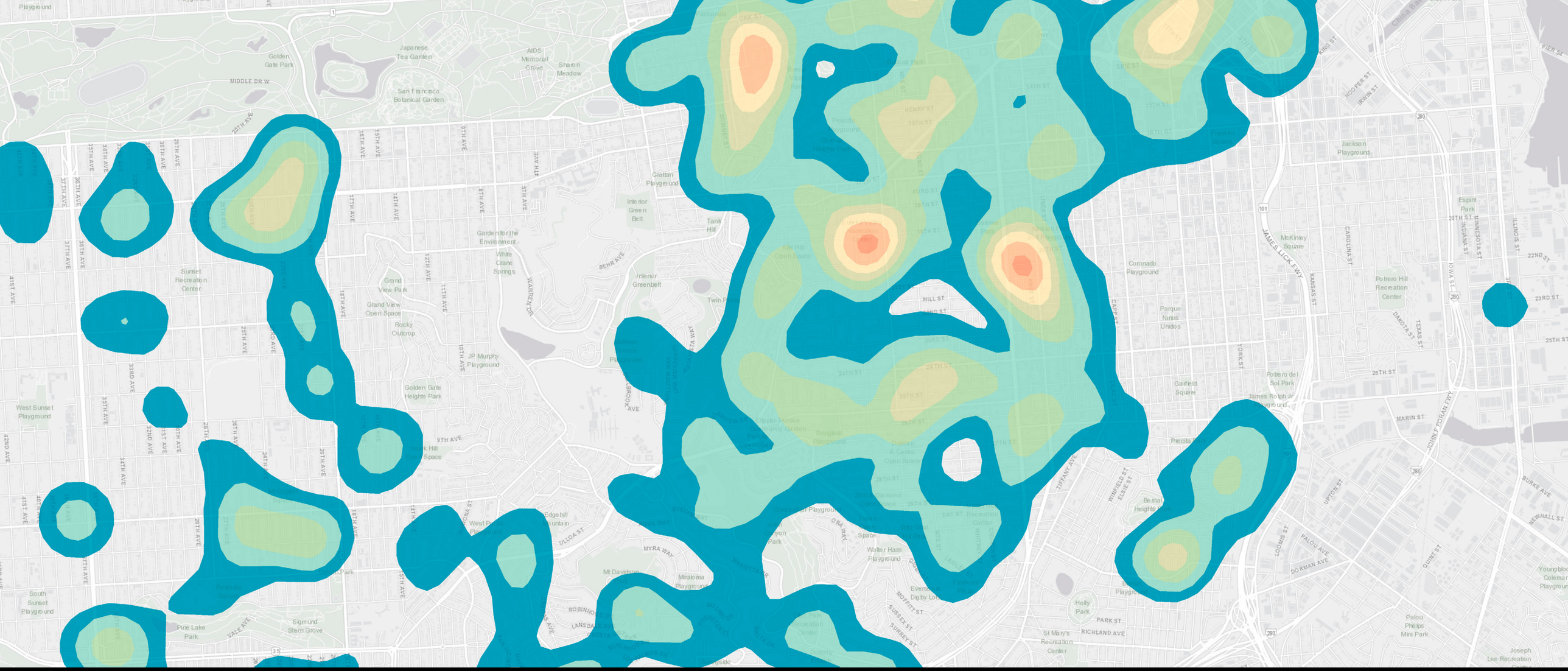
- Where are my assets and locations in danger from that developing storm or from rising seas or other climate risks?
- Where are the resources my company relies on, and how can we operate sustainably with the least impact on the environment and threatened species?
- When should we schedule maintenance on that highway section or shipping channel to ensure the least disruption and lowest cost?
- Where is that ship or train now, and how quickly will it deliver components we need tomorrow to keep the supply chain moving?
- Where do we need to do maintenance on trees near electric transmission lines to avoid catastrophic damage from limbs falling on power lines due to high winds or ice storms?
- Where are our best customers and locations, and where are they likely to be in the future?
- Where should farmers and agriculture producers adjust land use, crops, and livestock to make the best use of their resources?
- Where are the vulnerable populations most likely to be endangered when the next unprecedented flood or wildfire event occurs?

AI and location intelligence allow organizations to ask these questions at a scale and frequency that could only be dreamed of before. They have fast become the most powerful means of gathering information, filling in knowledge gaps about spatial relationships to prioritize *what* needs to happen *where* and *when*.

Today we have the computing power and modern GIS technology that make AI and location intelligence capabilities attainable for all organizations. This ebook contains a wide range of examples that show how organizations use AI and location intelligence to capture reality, simulate scenarios, and anticipate the future.

Organizations are moving quickly to gain a spatial inventory of resources and assets and are creating decision support systems to safeguard against interruptions. AI and location intelligence allow businesses to plan like never before and governments to invest where new infrastructure is needed most to defend against calamities.

AI and location intelligence provide a way to automate tasks that would take combinations of people an exponentially greater number of hours to complete—to make sense of complex situations quickly. ▶



What AI and Location Intelligence Can Do for Decision-Makers

Close observers of AI have noted that as an analytic tool, much of what it accomplishes falls into three main categories in which AI and location intelligence fit seamlessly:

- **Automate tasks and repeat them quickly at scale.** A utility company can use AI and location intelligence, along with drone technology, to examine utility poles and wires, determining where telltale signs suggest repairs are necessary.
- **Look at past patterns to make predictions.** An insurance company can use AI and location intelligence to make sophisticated projections of flood or wildfire damage based on past patterns and weather variables. A logistics or manufacturing company can use AI and location intelligence to optimize supply chains, considering such disparate data as weather forecasts, the likelihood of ship and rail traffic backup, and how many left-hand turns there are on driving routes. The AI and location intelligence program can even factor in the likelihood of social protests by analyzing millions of social media posts to learn if unrest could impede the supply chain.
- **Search for patterns hidden in large amounts of data.** A company determining where to locate retail stores or other physical assets can search and cross-reference data related to customer demographics and geography. The business can even use AI and location intelligence to show transportation patterns to determine how far a potential customer is likely to travel. ▶

Global Awareness of Change Averts the Worst of Climate Impacts

It's been difficult to detect changes as they happen to our planet and to understand their causes. But now, with growing earth observations and tools that identify emitters of greenhouse gases, we can connect causes to outcomes.

With AI and location intelligence, algorithms can be trained to analyze imagery and other data sources to identify patterns and trends in environmental and climate variables. This information can then be visualized on maps and analyzed to inform adaptation and mitigation strategies.

Machine learning techniques have taught computers to learn from data, training models with datasets to answer questions. The leap to deep learning adds further capabilities. With machine learning, you can find all the trees in a massive set of images. With deep learning, you can do that, plus determine tree type and stress level related to climatic conditions to predict the severity of the next fire season.

Today, AI and location intelligence techniques are being applied to provide solutions to environmental problems at a scale, granularity, and speed that have not been possible before.

Organizations around the world are gaining a new understanding of climate risk and taking action where and when it's needed most. With the new awareness of AI and location intelligence, companies are tackling their greatest risks before impacts hit their balance sheets. Governments have gained tools to revitalize urban areas while making them more resilient. And natural resource managers now have the knowledge to mitigate climate impacts on forests and water sources.

Even the largest and most risk-averse organizations are acting with haste when they see change coming and know ahead of time how they can reduce harm. ▶

AT&T—Case Study

AI and Location Intelligence Help Telecommunications Giant Get Ahead of Climate Risk

Situation: Climate change is causing warming temperatures, rising sea levels, and more extreme weather events. Business executives are scrambling to reduce the risk of disruptive events, such as drought, flooding, and resource scarcity. Among forward-looking businesses, a new effort is afoot to navigate disruptions by leveraging data analytics and simulations using location intelligence that forecast climate trends next season or decades into the future. By studying supply chains in detail, companies are quantifying how resilient they are. Where they identify vulnerabilities, they are taking preemptive action.

Challenge: Leaders at AT&T—the world's largest telecom company by market capitalization—are focused on doing their part to mitigate climate damage even as they take steps to adapt their business to its impacts. The company serves as an essential utility to millions, providing connections to home computers, mobile devices, Internet of Things (IoT) sensors, and more. Those services are digital, but the infrastructure that powers them—from cell towers to base stations—is very much part of the physical world and vulnerable to climate impacts. AT&T, which maintains billions of dollars' worth of equipment worldwide, is studying its infrastructure to assess how to mitigate damage from intensifying storms and floods.

Solution: AT&T executives authorized a joint project with Argonne National Laboratory that used big data and location technology to map where climate risk will be for the next 30 years.

Result: With AI and location intelligence, business executives have a new evidence-based ability to predict where supply chain vulnerabilities could emerge months and years in the future. A global awareness, coupled with the ability to test scenarios and see downstream impacts, helps organizations plan like never before. For businesses, this gives them an edge to deliver goods when and where they are needed. For cities, investments are made where new infrastructure is needed most to safeguard against calamities. For risk and insurance, the awareness lets firms pull back from risky scenarios.■

"It's not just AT&T—I'm seeing this more and more in all kinds of industries where companies are saying, 'If this is the reality, then let's prepare for it, let's deal with it.'"

—Antoine Diffloth, Director of Data Insights, Chief Data Office, AT&T

Microsoft—Case Study

Impact Observatory, and Esri—Seeing Near Real-Time Changes on Earth

Situation: Land-cover and land-use maps have been a necessary tool for scientists and governments since the inception of remote sensing and GIS technology. More recently, the objective has gone beyond collecting inventories to documenting climate-related changes and impactful human activity, including deforestation and reforestation, to balance land use for the better health of our planet. However, the lack of global imagery and the computing power to calculate change has hindered a consistent record of change at the worldwide scale.

Challenge: The data and processing challenge meant that environmental assessments and land-cover analysis happened at smaller scales, with infrequent updates. Landscape-scale assessments have happened more frequently for forests and watersheds, but a high-resolution view of land-cover change has been elusive and has taken a great deal of time to model, analyze, and produce a record of change.

Solution: Open data and a partnership between Esri, Impact Observatory, and Microsoft have yielded a repeatable global snapshot of land-cover change. With help from deep learning, the map makes it possible to closely monitor in near real time the impacts of climate change and humanity's footprint. AI and location intelligence underpin the ability to see change and complications clearly. Ten distinct categories of land cover, the physical type of land, show just what's where—such as trees, grass, crops, built areas, wetlands, scrub/shrub, and snow/ice.

Result: Each pixel in the land-cover map represents a 10-by-10-meter block, bringing the slightest detail into view. A repeatable global snapshot of land-cover change helps organizations react even at the far reaches of their operations. Thanks to AI and location intelligence, the ability to monitor global change can be repeated at a scale and frequency that could only be dreamed of before. The capability will lead to answers to pressing questions about climate change and environmental crises for years to come. Everything from conservation planning to food security to hydrologic modeling can be observed. ■

Achieving Automation for Sustainable Business Operations

Given the scale and scope of global change, organizations are moving quickly to gain a spatial inventory of resources and assets. They are creating decision support systems to get a handle on natural resources that underpin operations, such as water, timber, and minerals essential to products, to safeguard against interruptions.

AI and location intelligence inputs are tracing supply chains and monitoring factors that might turn into disruptions, allowing executives to trace delays, shortages, the impact of geopolitical incidents, and other risks. Adding transparency to supply chain vulnerability helps avoid costly delays or even the need to shut down factories and furlough workers because of delayed shipments.

A geographic view adds traceability and an overview of the dependencies between suppliers and plants. The geographic approach creates a tightly tuned system that can track incidents and detect threats and patterns to make organizations more resilient.

When unexpected events occur—or even before they do—planners use these technologies to run what-if scenarios, weighing the outcomes of changing a route, a supplier, or a strategy.

AI and location intelligence can be used in tandem with another GIS technique that displays supply chain relationships in knowledge trees. Such visuals help business leaders understand how an event's effect on one supply tier will ripple to others. Seeing that information in a geographic context can illuminate dependencies among suppliers and strengthen contingency plans.

New climate risk analytics are built on a foundation of spatial data and analytics that inform environmental, social, and governance (ESG) concerns. At the forefront, companies are looking to be more efficient, with a longer-term focus on environmental concerns around carbon reduction.

In many organizations, an AI and location intelligence approach is scaling in the form of collaboration hubs that bring diverse departments together to solve shared challenges. These hubs bring together all stakeholders with shared maps. The new awareness takes companies from sensing and then responding to predicting and intervening proactively.

The whole mentality of operations is changing, with smart maps that quickly communicate where action is needed. Using AI, location intelligence, and science, whole industries are guiding healthy operations with more care for the environment to safeguard and reduce climate impacts. ■

Finnish Forest Centre—Case Study

Robots for Better Forest Management

Situation: Finland's forests cover three-quarters of the country's landscape, and monitoring the maintenance of this vast space falls on the Finnish Forest Centre. Recently, the centre's forestry experts developed an ambitious plan to use robots to autonomously perform the majority of forest maintenance tasks.

Challenge: More than 65 percent of the forests are owned by private owners who live in other cities and rarely visit. Using robots would allow proactive management of forests, a move that would maximize the carbon sequestration of trees, and robots could fill an employment gap due to a lack of interest in forestry jobs.

Solution: The Finnish Forest Centre staff have created a marketplace for forest owners to connect with forest professionals to undertake maintenance work. The site contains forest inventory data based on surveys and a sophisticated AI-driven algorithm that takes imagery and weather and climate data to better predict forest inventory and maintenance needs. The data must be accurate and accessible, with all the data that the robots will need.

Result: For foresters and landowners, the work of AI will give them knowledge about the volumes and species of wood without driving to the land to do a costly, time-consuming inspection. Automation has greatly streamlined the management of Finnish forests. AI and location intelligence fuel the proactive management of forests, focused on optimizing growth and harvest cycles. And, robots are filling an employment gap, working in the cold and the dark to maintain and sustain a whole new level of forest benefits **observed**. ■

"Going to the forest for **12 hours** a day to drive a harvesting machine is lonely work in a dark forest. Some people like that, but there's no queue of people who want to be trained for these jobs. It's a real problem that can't be solved without automation."

—Tapani Hämäläinen, Development Director, Finnish Forest Centre

Data-Driven Sustainable Marine Development

Situation: The Nova Scotia-based brand specializes in luxury seafood including scallops, clams, crab, shrimp, and lobster that it gathers mostly from the seafloor in coastal Canada. Some of Clearwater's catch, such as clams, live *on* the seafloor, creating homes in the silt and mud known as the substrate. Catching these seafloor dwellers not only labor-intensive and expensive. A company like Clearwater needs to know when and where to harvest but also when and where *not* to harvest to protect the resource and the environment.

Challenge: Clearwater needed a precision approach to ensure corporate responsibility and improve sustainability. In Canada, companies are granted rights to a specific fishery to hunt specific species. One of Clearwater's corporate values is to serve as stewards of the ocean through responsible fishing practices.

Solution: Clearwater uses sophisticated assessment models to determine stages of growth and log fishing activities to avoid returning to the same fishing grounds until the appropriate time has passed. This allows Clearwater to further its goals related to sustainability, as well as traceability for food safety, and to convey the origin of each catch. In this way, GIS, coupled with advanced analytics, becomes a four-dimensional tool, cataloging the space and time for the present catch and all past catches.

Result: This new awareness allows Clearwater to factor in weather influences, species biology, and other relevant details to determine the most effective methods of harvesting. With increasing amounts of high-quality data, Clearwater has moved from fishing to harvesting. Rather than going out into the ocean with the thought to catch a certain quota, the company now has data that every ship captain uses to plan their harvest. Each foray captures more fish and more data that AI and location intelligence workflows use to forecast and predict sustainable harvests. ■

"We're really moving the operation to being one of culturing and nurturing. To be able to look at the seafloor and understand population characteristics—these are the tools we need to support the objectives of sustainability."

—Jim Mosher, Director of Harvest Science, Clearwater Seafoods

Pinpointing Predictive Maintenance to Enhance Efficiency and Safety

As funds have become available in the US via federal infrastructure legislation, the country's distressed infrastructure is finally getting the attention it deserves. This provides a unique opportunity for municipalities to not only repair existing transportation and transit infrastructure but to also put in place measures to address and identify problems before they reach crisis levels.

This presents problems of scale. A large city has thousands of miles of roadways. Transportation departments are often forced to wait until problems become serious enough to create visible levels of danger or malfunction. And this goes for all sorts of infrastructure. Old bridges are repaired when the damage becomes apparent. Streetlights receive attention when they go dark.

Many cities are simply always in repair mode. A city might decide to always be in the process of inspecting streetlights. By the time they've all been checked, it's time to start the process over. It's an approach that lacks efficiency and incurs excessive costs, either because repairs only occur when they reach crisis levels or because cities devote large amounts of resources to inspecting everything, all the time.

AI and location intelligence enable transportation departments, and other asset-heavy industries, to remain proactive. Rather than waiting for roads to exhibit enough damage to warrant repairs, these industries use algorithms that can learn to spot warning signs and create maps, allowing them to act before trouble spots become crisis points.

AI and location intelligence also empower transportation agencies to analyze large amounts of geospatial data, creating maps that reveal places where safety and mobility need to be improved. By looking at data spread across months, years, or decades, transportation and supply chain managers are able to make the most informed decisions. AI and location intelligence also forge links between different types of transportation-related data, providing an optimal means to see how mass transit data, for example, is related to traffic data.

"Data gathered from spaceborne sensors has long been used to calculate the degradation of natural landscapes, such as the deforestation of the Amazon Rainforest; but now, powerful machine learning techniques combined with data gathered from spaceborne sensors are forging a path to more robust and resilient data collection and interpretation for monitoring positive interventions."

—David Merren, Assistant Director, Analysis & Geospatial, Deloitte Middle East

Autobahn—Case Study

Bavaria Gains Insights into Roadways with Predictive Maintenance

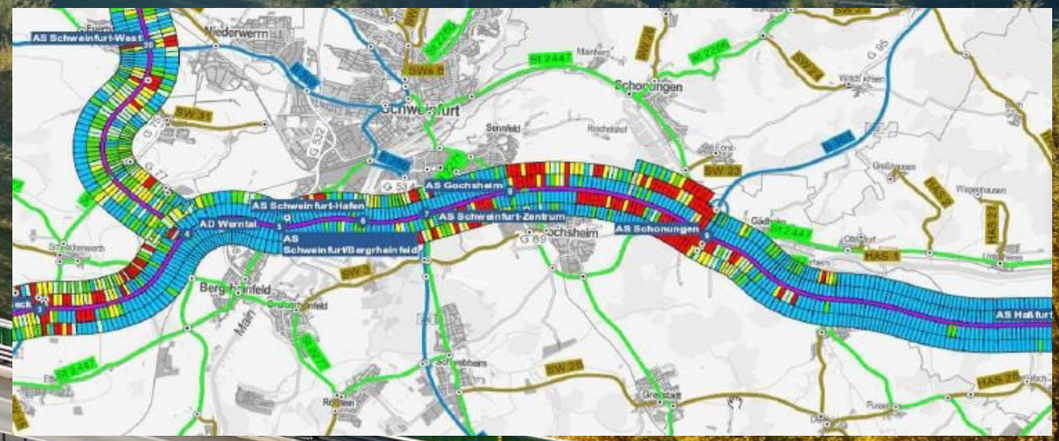
Situation: Bavaria's centralized location in the European Union makes the German state a crossroad to reach several towns in Germany, a common destination for travelers passing through on their way to other countries and an important transit route for goods transport across Europe. The state's 23,000 kilometers of roads (motorways, federal roads, and state roads) represent €40 billion in fixed assets. Due to a reform initiated by the federal government, the previous responsibility for motorways (including planning, building, and operating) was transferred from states like Bavaria to the newly founded Autobahn GmbH at the beginning of 2021.

Challenge: One of the important routes in Bavaria is the motorway Bundesautobahn 70 (A 70). The heavy car volume and the high percentage of truck transport take a toll on road conditions. The Bavarian State Ministry of Housing, Building, and Transport launched a pilot project to make road maintenance on A 70 motorway efficient by predicting when and where it will soon be needed.

Solution: The Ministry used a deep learning program trained to notice and process indicators of road conditions. Working with a team of data scientists, the Ministry provided data on road conditions from different measurement campaigns and traffic history. The A 70 motorway was divided into 4,800 segments, each 100 meters long. A GIS program served two functions: it provided a way to visualize the data and perform preprocessing functions. Using the data, a deep learning model was developed that could detect when road sections would need repairs by analyzing features such as thickness and road conditions.

Result: The pilot project has proven that these approaches are capable of realistically forecasting changing road conditions. With the application of AI deep learning, several road condition variables can be meaningfully connected, and thus, interdependencies of different parameters can be included in the forecast.

With AI and location intelligence, the task of combing through reams of data, which would've taken analysts hundreds of hours to pore over, could now be done swiftly and automatically as part of ongoing workflows. ■



A visualization of the input dataset containing features for 4,800 road sections (each 100 meters long) describing road conditions and traffic density on the A 70.

US Army Corps of Engineers—Case Study

Predicting Where to Dredge to Save $100 Million per Year

Situation: Dredging US waterways is the largest item in the US Army Corps of Engineers (USACE) civil works budget. The need to keep ports and channels at a specific depth for ships and barges requires constant attention. USACE spends around $1.5 billion each year on dredging for hundreds of navigation projects across the country. A typical dredging project goes through several phases, including project planning, bidding, contract award, placement, inspection, and project completion. At each point, there's room for more input to improve awareness of conditions of the country's 12,000 miles of inland and intracoastal waterways, 13,000 miles of deep-draft coastal channels, 400 ports, and more.

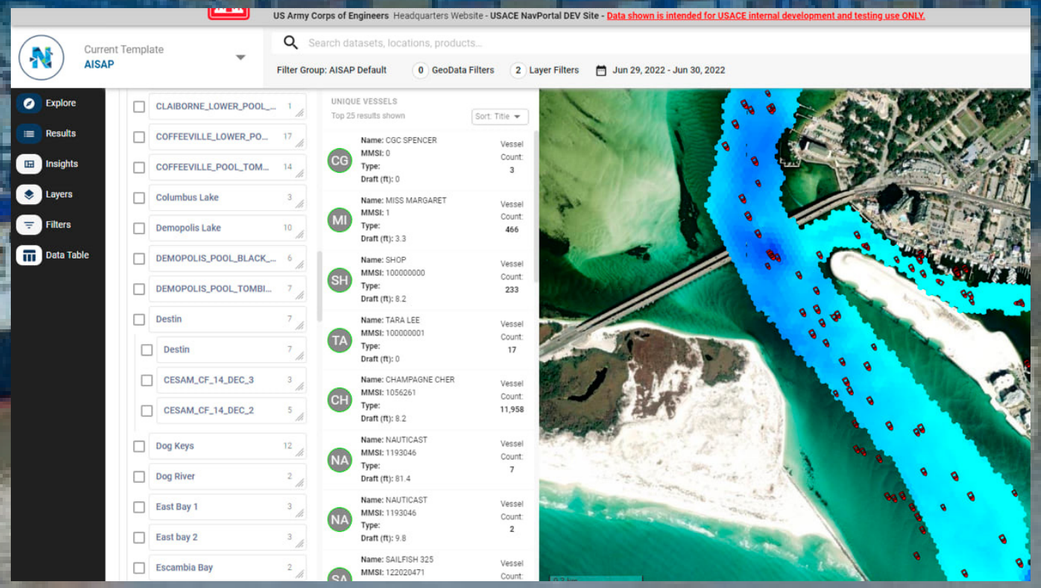
Challenge: Surveyors have greatly improved techniques to assess depth and understand dredging requirements, but the complexity and scale of the work sometimes make it difficult to distinguish between needs and practices that have simply become routine. USACE required a way to rigorously and repeatably determine the most efficient and effective way to conduct maintenance dredging. And the solution needed to scale across hundreds of projects nationwide.

Solution: The US Army Corps of Engineers combines inputs from three systems that deliver a real-time understanding of the conditions of America's waterways into one Nav Portal view to see vessel traffic and channel constraints, ensuring that commerce keeps moving through ports. This data fusion site is made possible in part by the capacity of AI and location intelligence to crunch the millions of Automatic Identification System (AIS) vessel tracking pings to show clearly where barges and container ships are slowing down due to building sediment.

Result: The new system pinpoints exactly where dredging should happen, eliminating significant reactive costs while fueling proactive workflows. It also addresses project sequencing, with attention paid to coordinating the next project nearby to reduce travel time and costs. With increased ship sizes and growth in shipping, the number and scope of dredging projects will continue to rise. With AI and location intelligence assistance on where and how to dredge, USACE estimates it can save as much as $100 million per year. ■

"We're able to do more with the same amount of money and reduce the long-standing maintenance backlog. They also give us the ability to adjust and adapt to the unexpected through more efficient use of the industry dredging fleet."

—Dr. Ned Mitchell, Research Civil Engineer, US Army Engineer Research and Development Center.



Keeping Supply Chains Movings

Supply chains have reached a complexity unheard of even a few years ago. In a truly globalized world, any consumer good has a multitude of origins. Pieces of it may be manufactured in different countries; assembly might occur in another. Distribution is handled in different segments, via ocean, rail, and road.

The functioning of every segment depends on the smooth functioning of every other segment. It is imperative that supply chain operators have a complete sense of how things are proceeding along every individual part of the chain and along the chain as a whole.

Companies and logistics support supervisors already augment supply chain management software with GIS technology. Mapping allows them to see the whole supply chain in context, to see how one segment functions in relation to others. Dashboards and other apps provide a way to link the whole map with figures and statistics regarding the status of moving parts. At a glance, anyone can see what's going on.

Visualization and contextualization are crucial, but they are not enough. The complexity of supply chains demands that managers be able to spot problems before they occur—to see what's over the horizon.

AI and location intelligence provide this extended view.

AI and location intelligence can note weather patterns in various parts of the world and compare them to historical weather patterns to get a sense of whether an incoming storm front is likely to lead to catastrophic flooding. An AI and location intelligence system can scan through millions of social media messages, conducting open-source intelligence to understand unraveling political unrest. It can gather AIS signals from fleets of cargo vessels to know the traffic volume and anticipate backlogs at ports.

This real-time contextual awareness is all the more important as the world tries to deal with the various disturbances—from travel restrictions to increased shipping costs to pent-up demand—that have troubled supply chains in the post-COVID-19 era. AI and location intelligence can relate complex combinations of factors to help us understand the new normal we can expect in today's volatile world.

FedEx—Case Study

Location Intelligence Helps Keep Shipments on Time

Situation: FedEx's global logistics operation relies on extreme precision to function effectively. This includes ensuring that the mechanics who work on the company's fleet of airplanes have the replacement parts they need. In a given year, FedEx's fleet of planes might experience nearly a quarter-million flights, with less than 1 percent failing to take off within 15 minutes of the scheduled departure, usually attributed to late arrival. To keep these planes on time, FedEx relies on a sophisticated GIS system to track its fleet.

Challenge: The company wanted to explore ways to wring even more efficiency out of their operation. The managers who oversee the flights wondered if there was a way to determine when a plane would need parts or maintenance.

Solution: AI and location intelligence helped the company achieve this efficiency. The existing GIS system was augmented with AI's predictive capability. The company's vice president of airline technology described the setup as "almost the holy grail for a maintenance operation."

Result: FedEx is expanding its use of AI as a key component of the company's operations. A package analytics system provides extra tracking and monitoring for packages that are time-sensitive or may require extra security or visibility. Sensor data, accessible by the customer, provides information pertaining to such factors as location, temperature, and humidity. The collected data is also used to train the system's machine learning program to consider more time and place variables to continually increase efficiency. ■

Utilities Inspect Assets and Reduce Network Loss with Insights from AI

Electric and water utilities have embraced the power of AI and location intelligence to increase operational efficiency. Network operators use AI and location intelligence to inspect and manage assets, such as power lines and pipes.

Predictive maintenance is a huge area of improvement for utility operations. It uses data from sensors and other sources to alleviate issues before they cascade. This work is taking place to understand the performance of the network, such as leaks in a water system, as well as conditions around the assets, such as monitoring tree growth to enhance vegetation management around utility lines. With AI and location intelligence, utilities are improving the reliability and sustainability of their operations.

Annual surveys of power lines and pipes collect massive amounts of data, and it has taken staff thousands of hours in the past to sort through the data and images to craft maintenance plans. Getting past the manual labeling of images and the tedious job of visiting every asset in virtual form holds great promise for staff who must maintain thousands of miles of network infrastructure.

An AI and location intelligence deep learning approach can detect wires and other representative components of networks, assess their condition, and discern pain points.

Overall, AI and location intelligence can help utilities increase the efficiency and reliability of their operations by collecting and analyzing conditions quickly to spot potential problems. This in turn reduces downtime and maintenance costs and improves the performance of all assets. ■

Nob Hill Water Association—Case Study

Replacing Old Water Mains after AI Analysis

Situation: Utilities around the world struggle to deal with water loss due to broken pipes. Deteriorating water infrastructure not only impacts customers but can also erode roads and damage property. Nob Hill Water Association in Yakima, Washington, faced the familiar challenge of aging infrastructure. Frustrated customers were experiencing more service disruptions and higher water bills, while Nob Hill was dealing with higher repair costs and increased water loss from broken pipes.

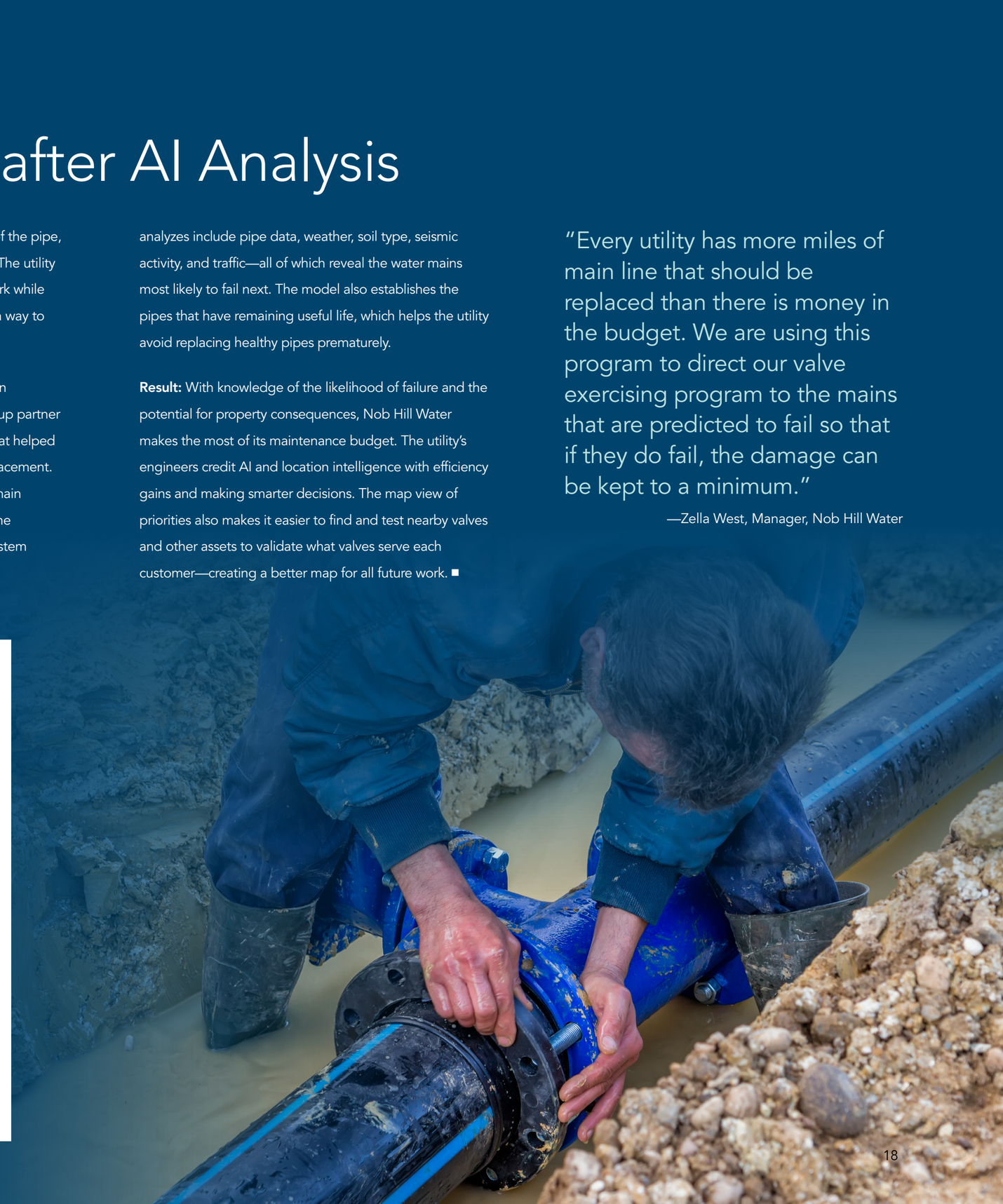
Challenge: Preventing loss by proactively replacing water pipes is not an easy task. The utility needed a system to select the right pipes to replace at the right time that would factor in such considerations as the age of the pipe, its failure history, and the material it is made of. The utility needed a system to inform it of the required work while maintaining service to its customers. It needed a way to avoid water loss and stay on budget.

Solution: Nob Hill Water used an AI and location intelligence deep learning model from Esri startup partner VODA.ai to conduct a conditions assessment that helped it pinpoint the water mains most in need of replacement. The machine learning model ranks each water main segment by the likelihood of failure, as well as the consequences of that failure. Factors that the system analyzes include pipe data, weather, soil type, seismic activity, and traffic—all of which reveal the water mains most likely to fail next. The model also establishes the pipes that have remaining useful life, which helps the utility avoid replacing healthy pipes prematurely.

Result: With knowledge of the likelihood of failure and the potential for property consequences, Nob Hill Water makes the most of its maintenance budget. The utility's engineers credit AI and location intelligence with efficiency gains and making smarter decisions. The map view of priorities also makes it easier to find and test nearby valves and other assets to validate what valves serve each customer—creating a better map for all future work. ■

"Every utility has more miles of main line that should be replaced than there is money in the budget. We are using this program to direct our valve exercising program to the mains that are predicted to fail so that if they do fail, the damage can be kept to a minimum."

—Zella West, Manager, Nob Hill Water



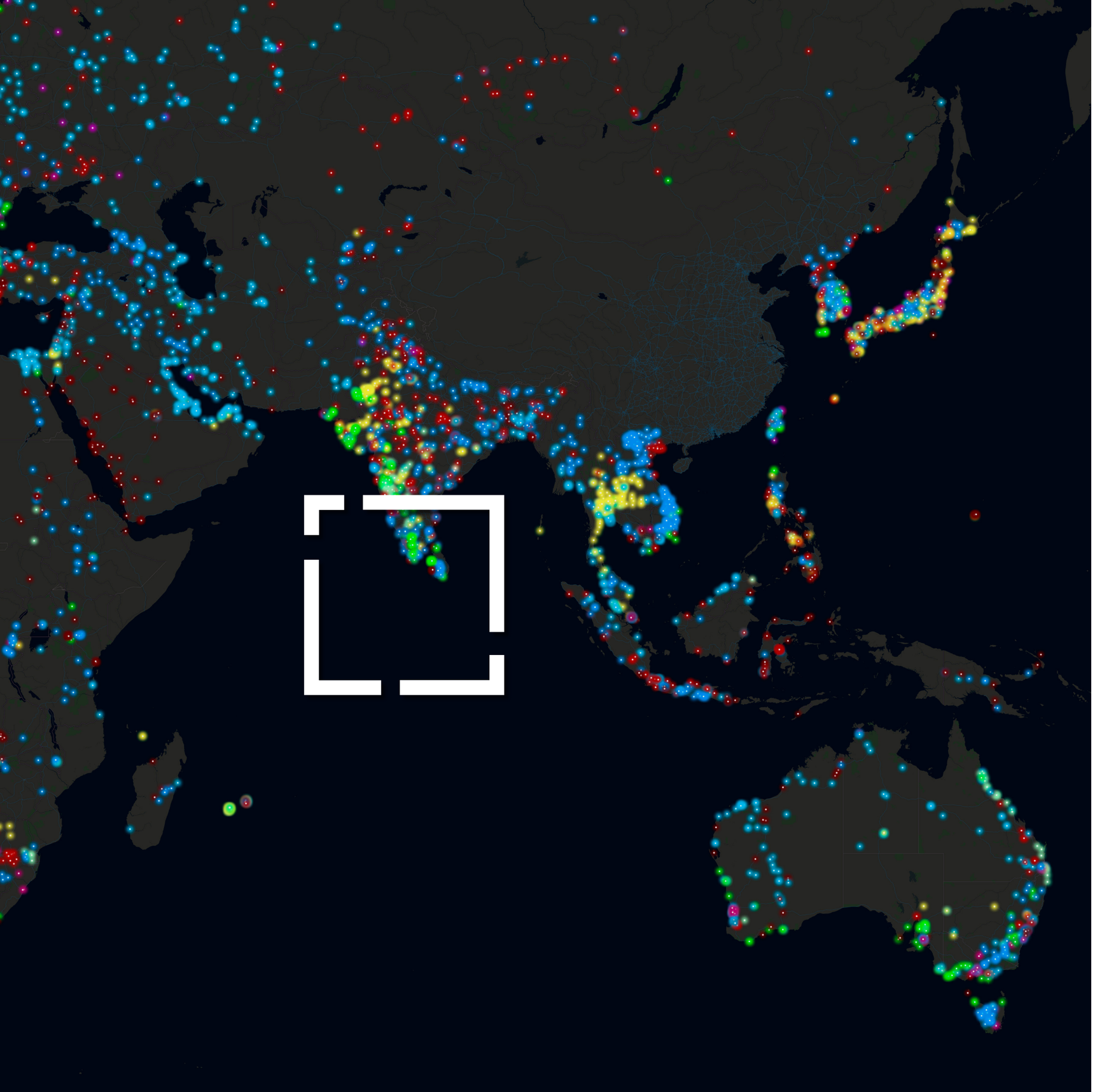
Side Bar

Rethinking Utility Vegetation Management with AI and Location Intelligence

Power lines require regular vegetation management to eliminate encroachments that can lead to power outages and, in the worst cases, wildfires. Using an AI and location intelligence deep learning approach, vegetation encroachment analysis can be conducted at scale. The workflows not only help identify encroachment sites but also help prioritize them based on whether vegetation growth is above the wire, below the wire, or intertwined with the distribution wires.

Inspecting and identifying places that need work take a great deal of time, money, and resources—costs that are compounded when tackling trimming work. AI and location intelligence workflows automate the analysis of satellite and drone imagery and lidar data—classifying the condition of distribution wires and poles in relation to trees.

The AI and location intelligence workflows save costs and optimize the process of vegetation management for utility companies—ensuring a more thorough assessment. With the clean energy revolution underway, the resilience of power lines is growing in importance. Automation ensures that these processes can be repeated regularly to add resilience with pinpoint precision.



"We can, for the first time in history, quickly and easily layer together data from a vast array of sources that can tell us all kinds of important stories about both the natural world and our human world. This geographic approach is collaborative; it can bring people together regardless of economics or nationalities. And it can give us what we need: common ground, an entirely new understanding."

—Jack Dangermond,
Cofounder and President, Esri

Spotting Unseen Expansion Opportunities

Businesses need to know where their customers are, but that's not the only relevant question. An even better one is, Where will their *future* customers be? And how does the customer base in one region differ from those in others?

The science of answering these questions has grown more complex. Demographic data lets companies examine a customer base in minute detail. What is the specific, most promising demographic of a city? Where are they? What are their interests? What are their occupations? What are their spending and investment priorities?

Companies can dig even deeper into consumer habits. Where do people like to pay by credit card? How many take mass transit? What is the average travel time someone would be willing to endure to visit a new location?

These are all critical business questions, and they are all geographic questions. They involve the relationship between people and place.

But these relationships are complex, involving many variables. AI and location intelligence provide a common meeting ground for disparate data from many sources, from human movement data derived from anonymized cell phone signals to American Community Survey analyses of census blocks.

Answering the relevant questions means searching for hot spots hidden amid all the data sources.

These same principles do not merely apply to companies seeking to retain customers and attract new ones—they hold true for locating any kind of new physical assets. If a company is looking to site a new corporate headquarters, the investment requires due diligence. This can include anything from whether a coastal location might become problematic as climate change intensifies to an analysis of where the employees it wants to attract desire to live.

AI and location intelligence are key to finding such answers.

Side Bar

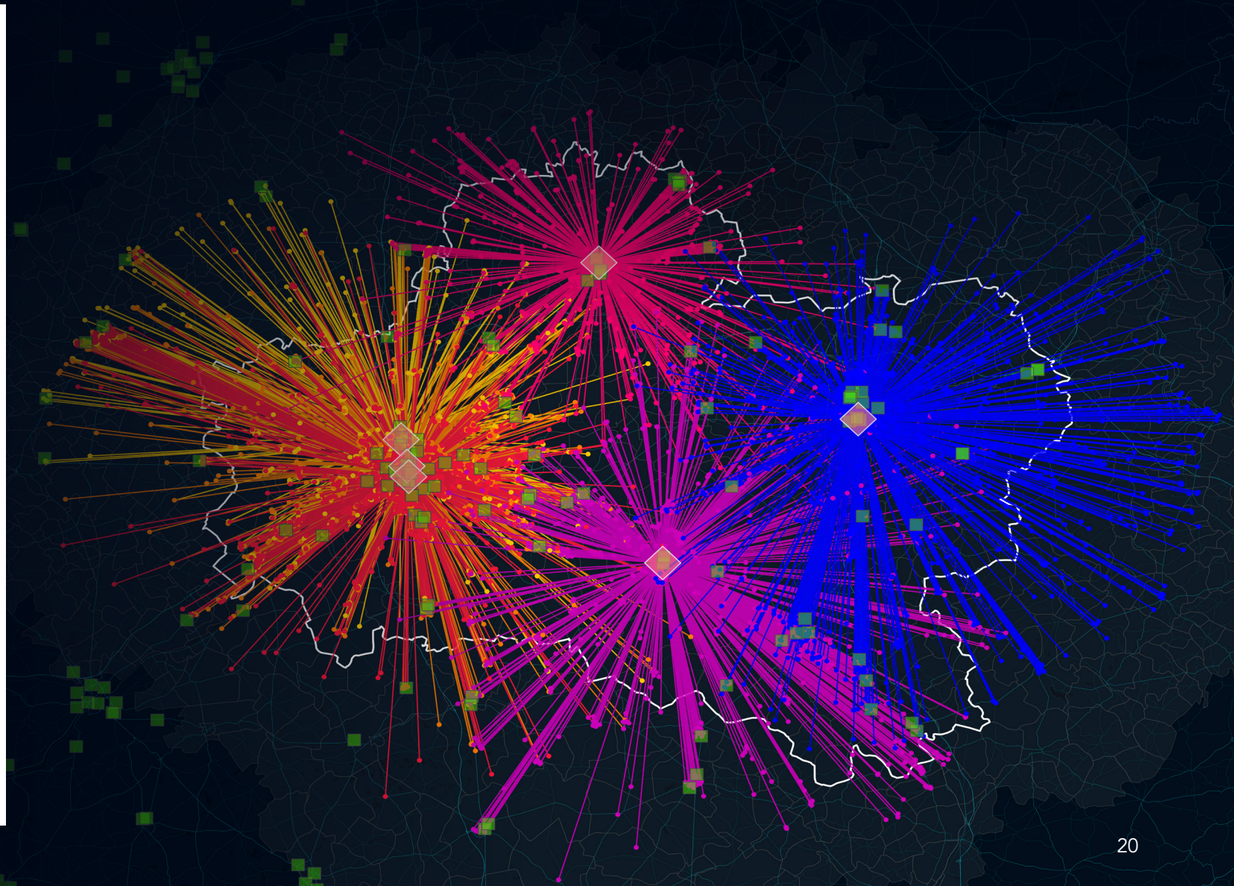
Halo Forecasting with AI: A Major Leap in Retail Planning

Over the last several years, large retailers have noticed that online sales do not necessarily detract from sales made in a chain's brick-and-mortar store. On the contrary, digital sales often increase in geographic areas near a store's physical location. The industry calls this mutually beneficial relationship the *halo effect*.

The halo effect is not a sure thing. Retailers need a way to create the optimal halo effect by deciding where to site stores. That means considering many types of factors, including data on the company's in-store and online sales, detailed demographic data, and the complex spatial relationships between a proposed store site and surrounding consumers.

Effective halo forecasting requires the judicious application of AI and location intelligence. The first step is to use GIS to "quantify proximity." Using information such as drive-times from surrounding locations, supplemented by demographic and consumer preference data, the company can determine expected revenue from various possible store locations. The company then uses AI and location intelligence to perform a close analysis of consumer spending that yields an accurate forecast of online sales. The results are displayed on a map, showing the company which physical locations will maximize both in-store and online sales.

GIS is then used to examine suitable locations within these preferred areas. To further narrow the choice, the company can use the map to see the locations of available parcels zoned for commercial activity. It can then add further attributes, such as the location of high-traffic intersections.



Providing an Enhanced Awareness for Sustainable Carbon Farming Practices

Businesses are under a microscope like never before. No longer is it enough for them to deliver products their customers want. Today, they must also deliver transparency.

An increasing number of customers want to know where their products are coming from. They want to know that the businesses that make them are responsible corporate citizens. They want to make sure products are sustainable and ethically made. If a company makes sustainability commitments, consumers want to be sure there's no deceptive advertising.

Organic food brands, for example, have rigorous practices in place to ensure sustainability practices. Consumers of organic products expect no genetically modified plants, no growth hormones or antibiotics, and no synthetic fertilizers or pesticides. And when these brands want to take it a step further, it's this very framework that gives them something to build on. Optimum soil health sits at the foundation of sustainable organic farming to retain moisture and carry nutrients to plants effectively.

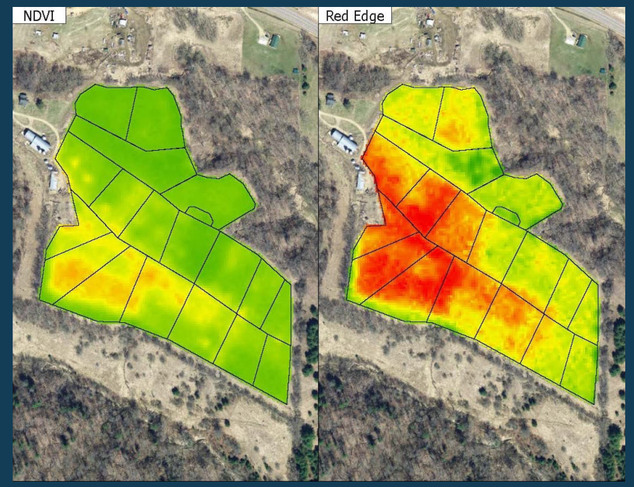
AI and location intelligence help sort through the data explosion brought on by precision farming. Farmers now gather data from equipment that plants, fertilizes, weeds, and harvests. Many use drones to analyze plant vigor or satellite imagery that can be downloaded on a daily basis. Weather is another critical variable in every aspect of operations. All of these inputs roll up into big data that requires AI and location intelligence to analyze it.

In high-value crops, such as grapes in vineyards, there's almost no limit to what is sensed and what inputs are applied. Artificial intelligence is used to correlate weather information with soil sensor networks to make recommendations on water needs. Drones gather daily data that AI and location intelligence analyze for signs of disease, the wine world's biggest problem.

These micropractices also work at the macro level for larger fields of crops. Farmers who have applied predictive modeling point to labor and cost savings that ensure there's no going back to traditional methods. With AI and location intelligence, agriculture has a way to aggregate all inputs for smarter and more automated processes, leading to higher productivity, profitability, and sustainability.

Organic Valley—Case Study

Improving Pasture Vigor with Insights Derived from Daily Satellite Imagery

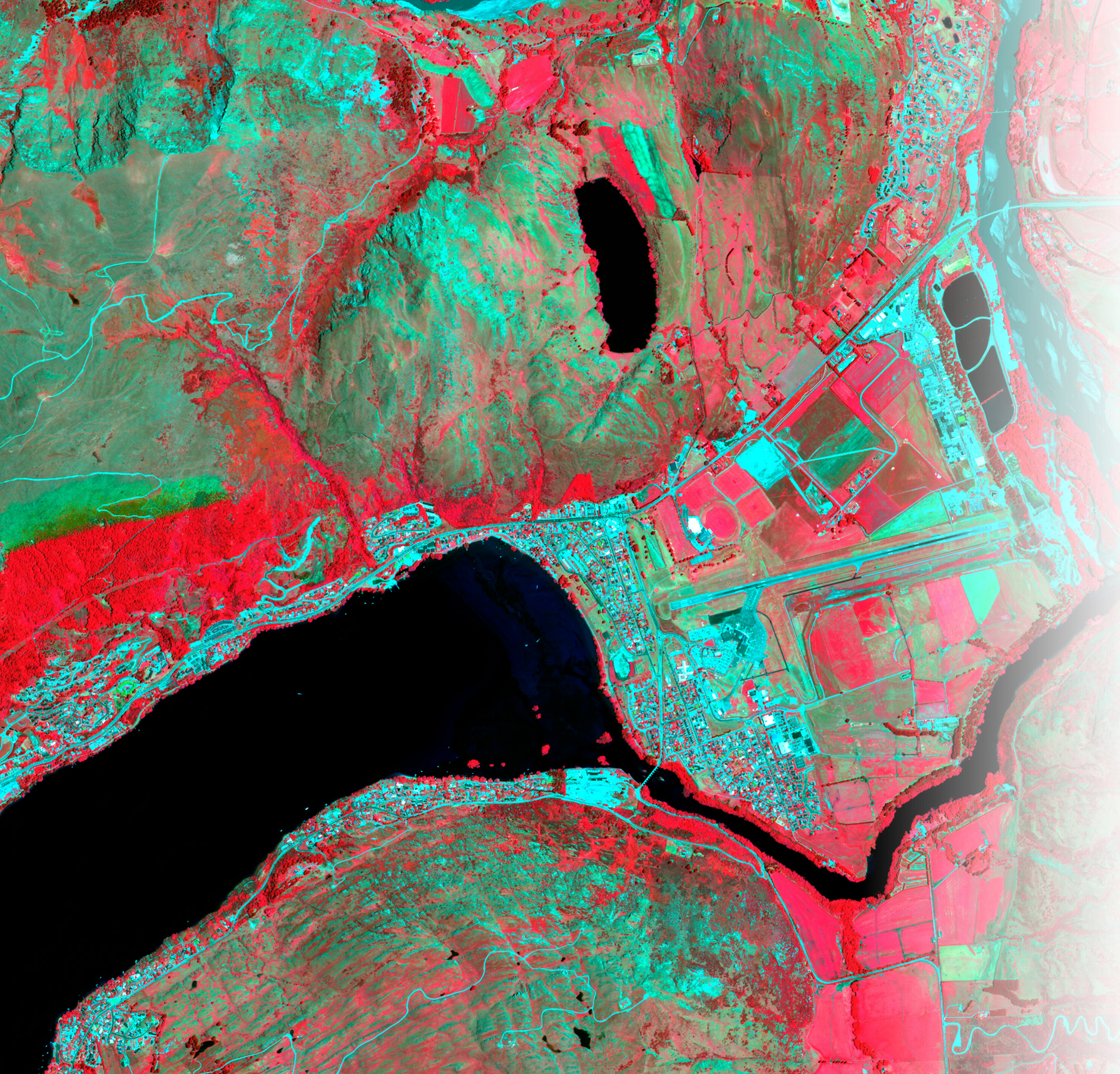


Situation: Organic Valley, a national organic brand and family farm cooperative, prioritizes smart grazing practices, determining optimal methods for rotating cows across pastures.

Challenge: As many as 200 different types of plants can grow on an Organic Valley farm. A careful rotation results in the maintenance of a critical balance of grasses and legumes. Farmers were accustomed to painstaking measures for determining grazing rotation. To determine the amount of biomass on a pasture, a farmer would walk through the paddocks with a plate meter to measure the height of grass, recording figures in a notebook. For the more than 40 percent of Amish or Mennonite farmers in the cooperative, a high-tech solution would need to be hands-off because they don't use computers.

Solution: Organic Valley now uses custom mapping products to create pasture condition reports. AI and location intelligence algorithms are applied to daily satellite imagery passes to produce insights regarding which paddocks should be grazed, cut, or left to grow by measuring such variables as the amount of chlorophyll in an area. AI and location intelligence automate the process, generating reports sent to farmers. A critical component of these reports is the "grazing wedge" that shows the estimated biomass availability for each paddock.

Result: The system produces better analysis with less effort on the part of individual farmers. There are also important ancillary benefits. The AI and location intelligence capability behind the imagery analysis is sophisticated, but the reports themselves are simple. The data generated by the program, combined with GIS-based routing systems, helps determine what farms to visit to fill each truck. The same data workflow also measures carbon sequestration, an important potential revenue stream with growing interest in carbon farming.



Locating the Most Important Targets Quickly, with Urgency

In business and government, there are moments when time is the factor. When decisions deal with life and death, the need for trustworthy information acquires a new urgency.

What that often requires is distilling clarity from the chaos. In a complex environment, what are the things we need to address now? Which are most important, and how do they connect? Only then can we formulate a dependable plan of action.

Natural disasters and humanitarian crises offer the starkest examples, but these requirements are not limited to split-second life-or-death situations.

Effective business decisions often require a quick assessment of the situation, and this includes physical assets. AI and location intelligence provide a way to automate tasks that would take a combination of people an exponentially greater number of hours to complete. A trained AI model can gather useful intel to make sense of a complex situation quickly.

AI and location intelligence are especially important today, given the large volume of imagery and other data streams. A satellite image of a large area may offer a wellspring of information, but without an effective means to identify relevant structures, objects, or landmarks, it's little more than an interesting aerial photo.

The ability of AI and location intelligence to identify and sort objects, and even prioritize actions, means they are the ideal partners in chaotic situations. When floods, fires, or earthquakes are rearranging the physical environment, AI and location intelligence not only show you where things are now but can also quickly sense levels of damage so you know where the most help is needed.

The ability to automate targets for action is not merely convenient. It supports making the right decisions. AI and location intelligence impose order on a dynamic world, but they are also itself dynamic. A well-trained model can learn to adapt to different situations, and what the model finds can be fed back into it as information, preparing it for future situations. AI and location intelligence are equipped for uncertainty, even crisis.

Aiding Flood Victims before and during Disasters with Drone Imagery

Situation: In 2019, two cyclones destroyed more than 800,000 hectares of farmland in Mozambique during harvest season, leaving two million people facing acute food insecurity. The United Nations World Food Programme (WFP) responded quickly, using two helicopters to ferry supplies and rescue stranded people.

Challenge: The flooded roads made the air support crucial, but it was not nearly enough to both distribute food and find stranded people. The dimensions of the flooded areas were in constant flux, further complicating efforts by pilots to understand where help was most needed. And the people could only tread water or cling to trees for a time.

Solution: Drones were put to the task of searching for survivors, freeing up helicopter pilots to conduct rescue and supply missions. And now, that workflow involves advanced AI and location intelligence algorithms to search through drone imagery to identify flood victims. The human eye has trouble with this task, and there's not enough time to both collect and review each image. AI and location intelligence can quickly identify people surrounded by flood waters and quantify damage to buildings and infrastructure to help responders know what resources are needed and where.

Result: Coupling drones with AI and location intelligence workflows has greatly improved disaster assessments and reduced the time it takes to instruct the population to leave flood zones for safe zones. That used to take 72 hours, and now, the alerts happen well in advance of floodwaters. That leap has come in part from the use of drone imagery to construct intricate hazard maps for watersheds, using AI and location intelligence to process imagery with a focus on preparedness. WFP is now spreading AI and location intelligence advancements from Mozambique worldwide.

"We combine science, technology, and local knowledge to prepare the communities and local governments in a participatory manner. Every year we are seeing more frequent flooding, and that has motivated us to innovate."

—Antonio Jose Beleza, Deputy Director, Mozambique National Emergency Operations Center

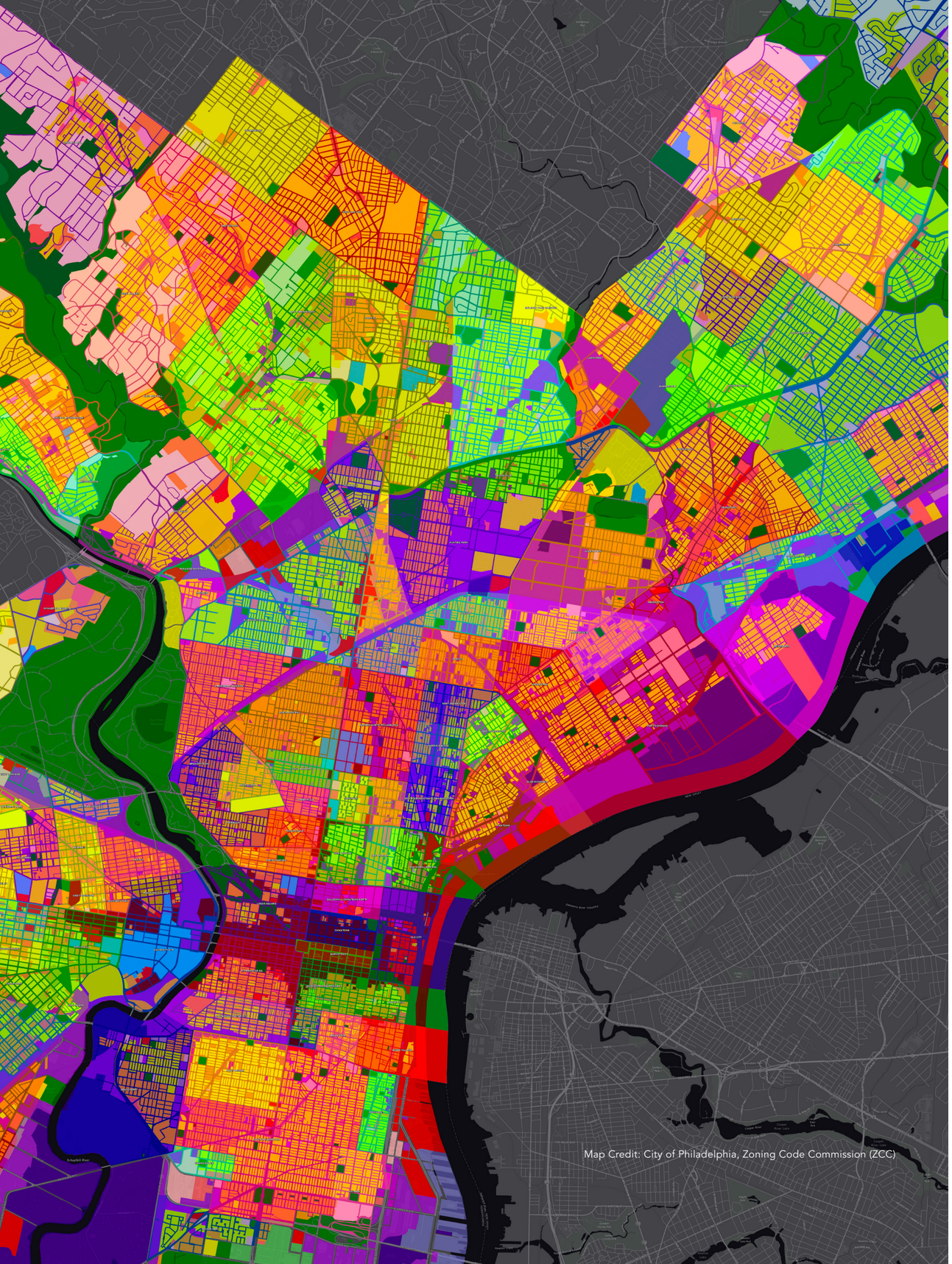
Conclusion

As the influence of AI and location intelligence continue to grow across all sectors of society, claims made on their behalf can easily shade into hyperbole. It is important to understand that AI and location intelligence are not only transformative tools but are also capable of harnessing the power of human intelligence. They provides the means to tackle even the most complex problems by empowering people to craft solutions using a geographic approach.

As humanity's understanding of place has grown over the millennia, the maps people create have grown more complex. Even in an age of turn-by-turn directions, the concept of the map prevails for one simple reason: maps are useful manifestations of the way we see our world and our position within it.

The map concept is endlessly expansive. The petabytes of data with a spatial component generated around the world require maps of massive numbers of inputs. The resultant maps expose vulnerabilities and where work must be done, quickly conveying actionable information that might otherwise stay hidden.

AI and location intelligence are potent means to make sense of complex situations and our data deluge in the service of greater understanding. This is what AI and location intelligence offer organizations—not simple solutions but ways to visualize challenges, sharpen analysis, and help deliver well-considered strategies that factor in all relevant measurements. AI and location intelligence are not replacements for human intelligence. After all, they are products of human intelligence—and powerful partners for us as well.



Map Credit: City of Philadelphia, Zoning Code Commission (ZCC)

About Esri

Esri, the global market leader in geographic information system (GIS) software, location intelligence, and mapping, helps customers unlock the full potential of data to improve operational and business results. Founded in 1969 in Redlands, California, USA, Esri software is deployed in hundreds of thousands of organizations globally, including Fortune 500 companies, government agencies, nonprofit institutions, and universities. Esri has regional offices, international distributors, and partners providing local support in over 100 countries on six continents. With its pioneering commitment to geospatial technology and analytics, Esri engineers the most innovative solutions that leverage a geographic approach to solving some of the world's most complex problems by placing them in the crucial context of location.

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