GEODESIGN PRIORITIZES CLIMATE RESILIENCY IN DECISION-MAKING

Enhanced Context Drives Sustainable Development and Environmental Stewardship

esri

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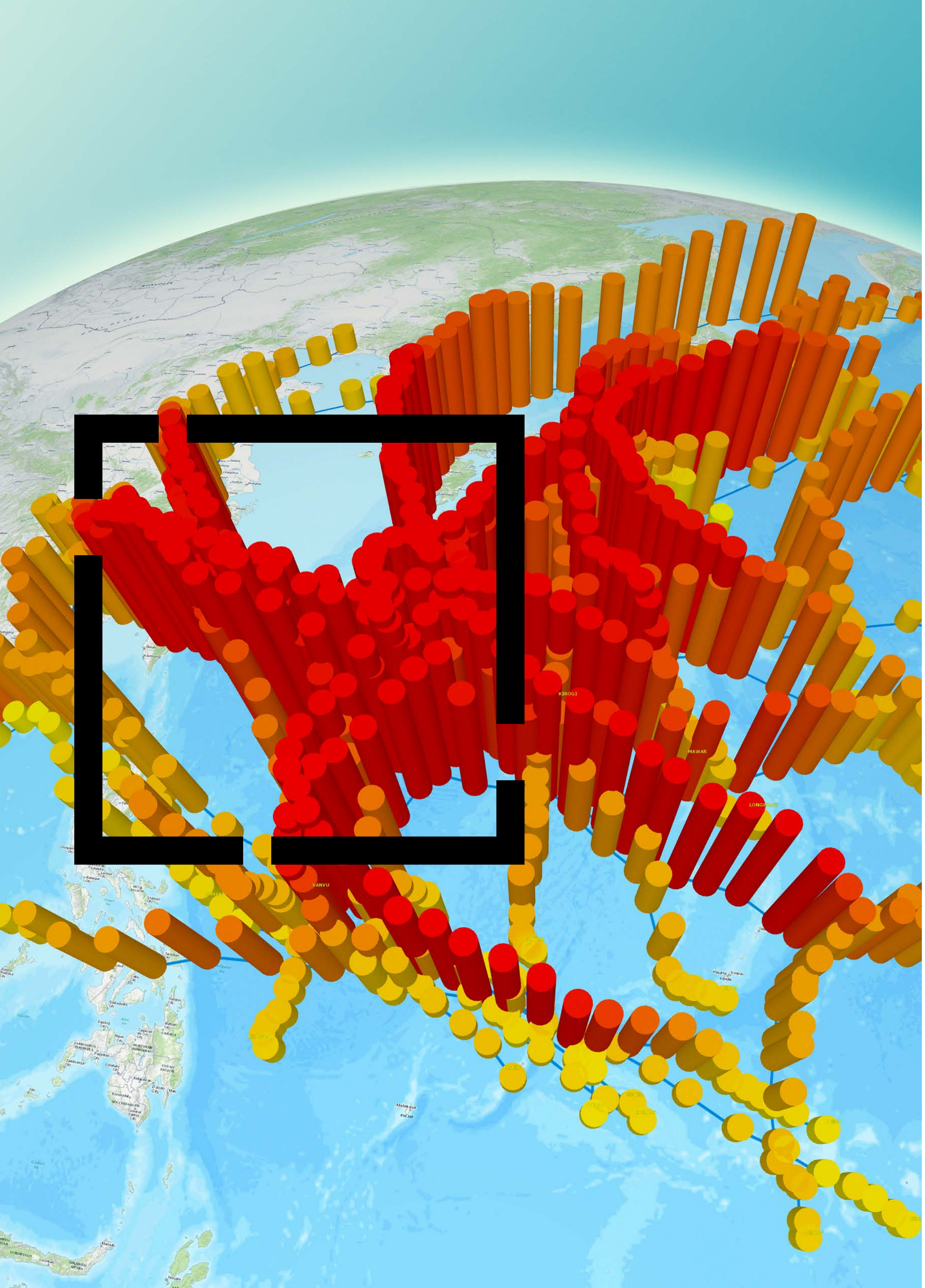


WHAT'S INSIDE

Executive Summary

The Big Idea

It is essential that we design for resiliency from the inception of every project to ensure sustainable infrastructure for future generations. Like all complex problems, designing for a world affected by climate change requires intelligent, data-driven solutions that consider the needs of many different stakeholders—our customers, residents, policy makers, and the planet itself. Geospatial design (geodesign) provides a design framework and supporting technology for professionals to leverage geographic information, resulting in designs that more closely follow natural systems.

Here's Why

According to the US Global Change Research Program's fourth Climate Science Special Report, our climate is projected to continue to change over the rest of this century and beyond. And the effects of climate change are now apparent to the naked eye. Hurricanes are getting stronger and more frequent, historic flooding is occurring every year, droughts and wildfires are increasingly severe, and the Arctic region is predicted to soon be ice-free in the summer months. Governments are taking notice, with an increasing number of countries making ambitious conservation commitments to curb the impacts of climate change.

We know that most of the financial costs of a disaster are not caused by the event itself. Rather, it's the fragility of infrastructure such as utilities, transportation, and physical structures that require rethinking. From 2014 to 2020, the US alone has experienced more than $595 billion in losses directly from climate-fueled weather disasters, and a shift to designing for resilience is required to reduce these losses. ▸

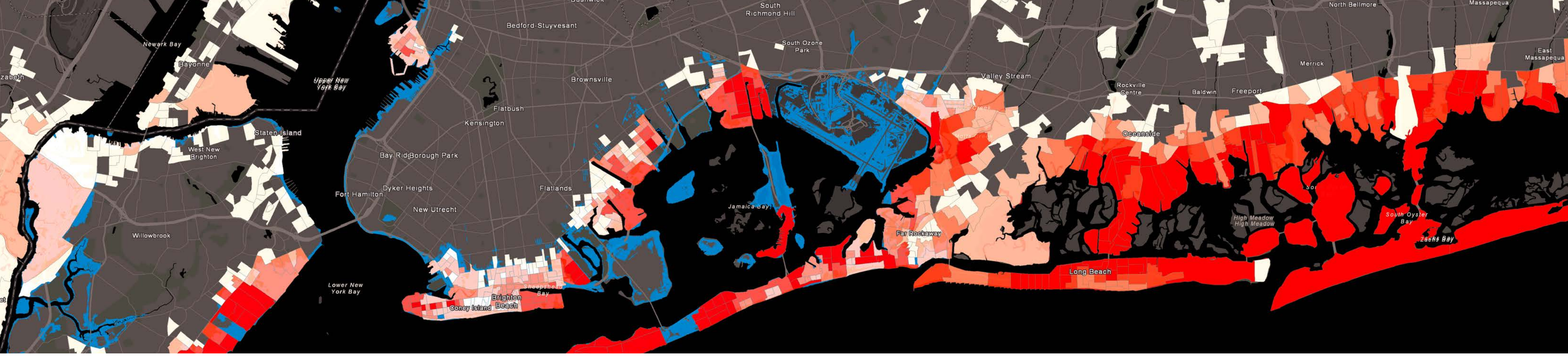
The Details

New levels of contextual awareness let us combine our collective expertise within a decision support system with a deep understanding of place and natural processes. The geodesign toolset takes advantage of advanced technologies like digital twin, [artificial intelligence](#) (AI), spatial analysis, remote sensing, real-time and 3D visualization, and other inputs to ensure that development projects are sustainable.

Geodesign combines geography with design by providing designers with robust tools that support the rapid evaluation of design alternatives as well as the ability to compare the impacts of those designs.

Geodesign infuses design with a blend of science and value-based information to help designers, planners, and stakeholders make better-informed decisions.

The key principals of this approach support a range of business areas including environmental permitting and planning, site assessment and restoration, environmental construction, and environmental management and compliance. ■



SECTION 1

CLIMATE-RESILIENT INFRASTRUCTURE

Climate-related disasters are increasing in both severity and frequency. Global infrastructure losses due to catastrophic climate-related events reached US$210 billion in record-setting 2020, according to global reinsurer Munich Re. In the US, there were 22 separate billion-dollar weather- and climate-caused disasters, shattering the previous record—set in 2017 and tied in 2011—of 16 events in a year.

The built environment has traditionally suffered significantly from these types of disasters, but when climate change is addressed at the inception of a project, a significant shift occurs. Intelligently engineered resilient infrastructure can act as the first line of defense against extreme-weather events. Using sophisticated data analysis and geospatial technology, communities can ensure that infrastructure is prioritized, planned, designed, built, and operated to account for anticipated or experienced climate changes.

Advanced technology is now enabling building information modeling (BIM) to be integrated within a 3D geographic information system (GIS) environment, creating a geographically anchored digital twin of any project or community. Looking at a digital twin, stakeholders can quickly see a project modeled with interrelationships such as terrain and structures (including underground utilities), saving time and avoiding mistakes. Predictive analytics, powered by artificial intelligence and thousands of points of historical and real-time data, allow environmental planners to test thousands of different scenarios on current and proposed infrastructure within the digital environment.

The contextual awareness provided by a digital twin can help ensure that new infrastructure is designed for resiliency. It can also help identify which existing infrastructure needs to be retrofitted, with models and simulations that predict the effects of climate change on that location decades into the future. Since location is a factor in every aspect of resilience planning, adopting tools that improve our collective understanding of a place is critical.

Analyzing a location can also help planners determine where to add new infrastructure that was not previously needed, including engineered solutions like sea walls, as well as green infrastructure that uses nature-based solutions, such as the restoration of wetlands and mangrove forests.

Geodesign offers an iterative design method that uses stakeholder input, geospatial modeling, impact simulations, and real-time feedback to facilitate holistic designs. It gives us a framework for analyzing, understanding, and acting, with the ultimate goal of creating a better future for us all. GIS provides a collaborative work environment to consider change and focus efforts to overcome some of the biggest challenges associated with creating climate-resilient infrastructure projects. ▶

CHALLENGES AND HOW GIS CAN HELP

CHALLENGE	HOW GIS CAN HELP
Uncertainty about the future—There are inherent uncertainties in how the climate and other factors affecting infrastructure resilience will evolve.	Building on a strong foundation of GIS technology, geodesign extends our analytical capabilities to automate the calculation of hazards, risk, sensitivity, capacity, proximity, accessibility, vulnerability, and other factors to inform design decisions. Bringing science into the design process without compromising the art of design is enabled by the new tools and enhanced workflows of geodesign. A digital twin powered by advanced modeling and spatial analytics tools can help planners and designers account for a range of possible future scenarios and ensure that infrastructure is being designed to fit what the world will become.
Access to information. Information—such as climate projections–that raises awareness and shows the risks from climate change may not be readily available or recorded in a usable format to inform investment decisions.	Geodesign gives us a powerful new context that includes everything that lies below, on, above, and around the earth, including what exists inside and outside buildings, as well as how things connect and change through time. It aggregates what is known about a place to enable proactive designing and decision-making. Geospatial technology provides evidence-based information about places and proposed projects that can help address uncertainties and alleviate concerns. Complex challenges, such as climate change, can be hypercontextualized with information gathered from a large number of sources and examined visually through a geographic lens.
Benefits not being immediate and/or monetary—Project cost overruns and delays in reaching milestones impede progress. Lengthy approval processes and public distrust of new projects harm progress on important challenges.	Geodesign helps us see connections between geography and society. It's an approach that fosters collaborative decision-making by bringing people together so that participants from different backgrounds and points of view can run what-if scenarios based on their assumptions and assess the consequences of those assumptions. People and stakeholders are often more in agreement than they realize, and discovering this can make reconciling differences a much easier process. The goal is not to wow constituents–or to sink more money into the planning process–but to reach a shared understanding that speeds the improvement of our places, with a focus on what we all value. ▶

Section 1 (continued)

A GIS-based decision support system can facilitate collaboration between many different stakeholders including government departments, community representatives, investors, and infrastructure owners and operators. The shared contextual view of GIS allows all players to examine and understand the tangible and intangible benefits and the necessary steps needed to create community resilience in both the short and long term. The added efficiency of an all-digital process, with shared awareness, eliminates costly change orders.

The future of the architecture, engineering, and construction (AEC) industry will belong to firms that proactively adopt intelligent and resilient geodesign approaches that leverage advanced technologies to consider the impact of development on the natural environment. It's not a question of whether these types of resilient and sustainable approaches will become a requirement of the industry—it's a question of when. ■

CASE STUDY

BOULDER, COLORADO

Boulder County encompasses 741 square miles on the eastern slopes of the Rocky Mountains in north-central Colorado. Boulder County's residents reside in dense urban centers, rural buffer zones, and mountain communities, and its landscape ranges from farmland and rolling grasslands in the plains to the high peaks of the Continental Divide.

In September 2013, a warm front moving in from the south slammed into a lingering cold front, triggering five days of torrential rains and catastrophic flooding in the state's Front Range region, from Fort Collins to Colorado Springs. More than 17 inches of rain fell over Boulder County, eclipsing in one storm the amount of rain the area usually sees in a year. Nine people died; nearly two thousand homes were destroyed; and roads were washed away, cutting off access to mountain communities.

The city of Boulder is the county seat and is surrounded by the famous red rock foothills for which it's named. Twisting between and around the rapidly ascending rock formations are narrow canyons, which serve as gateways to the mountains. They are also the drainage ways, which bring the waters of the North and South St. Vrain, Left Hand, North and South Boulder Creeks to the plains. During the catastrophic storm, those canyon streams became raging rivers, sending massive amounts of water into the populated plains below.

In the aftermath, county officials launched a resiliency study of the area, focused on floodplain management and public infrastructure, which they completed in November 2019. One of the key challenges of the study was the understanding that the weather events of the past do not necessarily predict the severity of those in the future. Climate change increases the likelihood of extreme-weather events, but the unprecedented nature of the climate crisis also makes it difficult to predict the details of these events. ▶

Boulder (continued)

The county looked to Atkins, a multinational engineering and design consultancy, and its City Simulator tool for help. The City Simulator and its sister tool, the Seaport Simulator, use digital twin technology to model urban and regional development to provide a framework for testing alternative scenarios, understanding their impacts, and visualizing their outcomes.

The program considers factors both natural, such as a city's elevation or weather patterns, and social, such as zoning requirements and population trends. An analysis might focus on specific climate change outcomes, including heat waves or droughts. For Boulder County, City Simulator provides a way to understand future storms. The tool pulls data from a GIS, allowing the scenarios to play out in time-lapsed fashion on digital maps.

Since Boulder's resiliency study concerned flooding and infrastructure, the Atkins team made rainfall the focus of the simulation, which imagined how Boulder might look in 2050. The team drove the simulation with a range of future rainfall projections derived from global climate model results. Developed by research centers around the world, these models run greenhouse gas control scenarios set by the United Nations Intergovernmental Panel on Climate Change. Projections factor a range of responses, from depicting a world that seeks to limit greenhouse gas emissions to portraying a world more focused on economic growth.

Among the findings for Boulder, the data suggested that more 2013-level floods in the Front Range were possible in the coming decades and that even infrastructure originally constructed to withstand once-per-century weather events may need upgrades. Armed with the information to predict and understand these extreme events, the city is now able to take the steps necessary to prepare for them. ■

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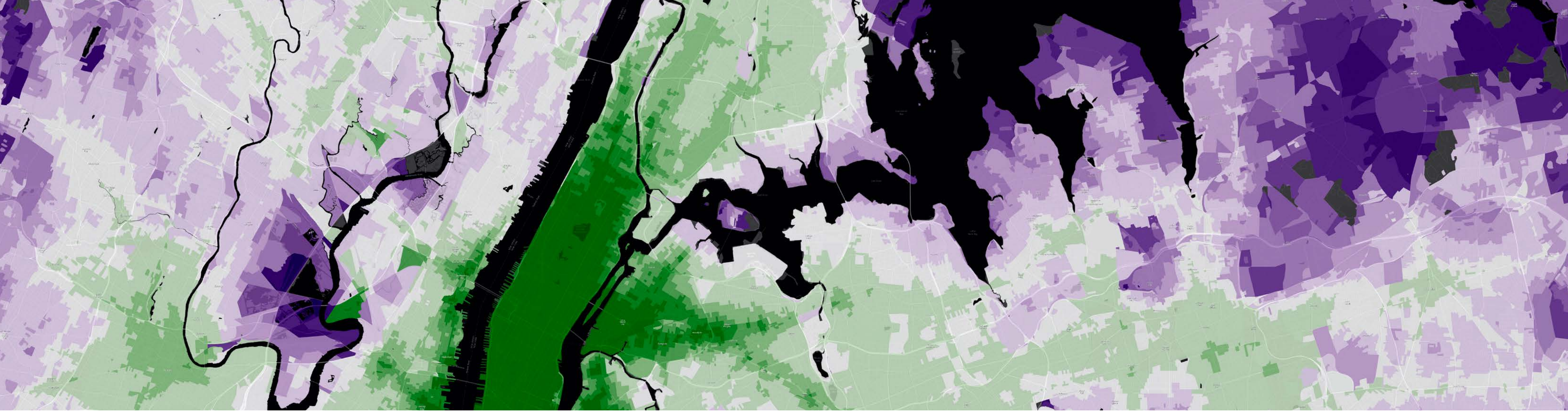


SECTION 2

NEW MOBILITY AND THE 15-MINUTE CITY

A global effort to curb the effects of climate change is prioritizing low-impact mobility projects. One such effort is the 15-minute city concept, which advocates access to essential urban services within a 15-minute walk or bike ride for all city residents. The COVID-19 pandemic accelerated these efforts in many urban centers as residents were encouraged to stay close to home. Banning vehicles from certain streets allows cities to reallocate that space for outdoor dining as well as walking, bicycling, and other low-impact and active modes of transportation. Some experts suggest that this momentum, gained for cities where cars are treated as guests, should continue. They envision a future where sidewalks are expanded, bike lanes reign, green spaces abound, and social services offices are set up in areas convenient to pedestrians.

In these so-called carless cities, traditional methods of planning a business location, including analyzing customer drive times, will remain important. But new metrics—like walking distance, daytime foot traffic, and space created for low-impact vehicles like scooters and electric skateboards—will also need to be accounted for. Some experts predict that cities will ultimately move away from being large employment centers surrounded by residential neighborhoods, instead transforming into a collection of smaller city villages. It's a reality that forward-thinking planners, designers, and city officials will need to consider as residents demand a more localized living experience.

Thankfully, the increasing volume of accessible data is helping planners, designers, and engineers to better reflect how our cities operate. Transportation planning has shifted toward multimodal people moving, instead of car-centric construction. An improved understanding—together with technologies to sense and report change—is transforming our society into smart communities to help us address the fast pace of global change.

The era of the carless city is closer than many people may imagine. In 2018, the city of Madrid created a 472-hectare zone free of nearly all vehicles. The city has opened space to pedestrians, bicyclists, and businesses and even improved air quality. An attempt by a more conservative city government to dismantle the program was thwarted after thousands of residents rallied in support of the car-free environment. ▶

Section 2 (continued)

In 2020, Paris residents expressed their support of the 15-minute city concept when they reelected Mayor Anne Hidalgo, who ran on a campaign of four major principles: proximity, diversity, density, and ubiquity. Hidalgo has overseen a major mobility transformation in Paris since her election in 2014, and that transformation is a testament to the financial investment major cities are willing to make in the 15-minute city concept. More than 50 kilometers of bike routes, known as *coronapistes*, have been added since the pandemic began, and the city just completed a pedestrian-friendly renovation of the Place de la Bastille as part of a €30 million redesign of seven major squares. Hidalgo has pledged a further €1 billion per year for the maintenance and beautification of streets, squares, and gardens.

As cities rethink mobility, geospatial technology can help planners and government leaders envision what-if scenarios on proposed locations for housing, shops, public services, and restaurants as well as the infrastructure that will serve them. For instance, GIS-based maps showing daily foot traffic data—gathered anonymously from cell phones—reveal how patterns of mobility are shifting in certain communities as well as which locations are becoming more or less popular with certain demographics.

Data-driven analysis can help provide clarity on equity-related issues such as how becoming a carless city may affect residents, employees, and visitors. Is a store or office situated close enough to public transportation options? Are there fresh food options available for residents in every village community? Is internet and cell service universally accessible and affordable for all residents? The insights revealed by GIS can help planners address these and other important concerns as cities embrace a new reality. ■

CASE STUDY

LONDON

Public health is a top priority of Mayor Sadiq Khan's 2018 Transport Strategy, with the goal that, by 2041, 80 percent of trips around London will be taken via public transit, on foot, or by bicycle. Though the goal is ambitious, experts in the city believe it can be done by developing situational awareness built on a foundation of GIS. The technology keeps people moving through the city by delivering real-time understanding of traffic patterns, transportation demand, and incidents, allowing planners to create and communicate route and mobility options for locals and visitors via mobile apps.

Transport for London (TfL) is well-equipped to meet Khan's goal, thanks to a pioneering GIS transportation system originally developed for the 2012 Olympic Games, when 600,000 new customers needed to use London's public transportation system. The need to move visitors around to the many venues while maintaining mobility for residents and businesses provided an opportunity for TfL to implement new technologies. Preparation included standing up the Games Playbook, a comprehensive traffic management tool that served as a central information source to visualize mobility and communicate mobility options with commuters.

The Olympics effort was deemed a success—90 percent of journeys were completed on time despite record numbers of riders. The London Tube alone had 4.5 million riders on one day of the games as well as 30 percent more riders than usual over the course of the event.

In addition to catalyzing the use of powerful traffic-awareness technology, the Olympics kicked off a series of citywide initiatives to make healthy, sustainable travel options more accessible. Boris Johnson, the then mayor of London, pledged to maintain key elements of the walking, cycling, and public transit infrastructure created to support the games. TfL reinforced its GIS in 2014, delivering GIS as a service and creating the Surface Playbook. ▶

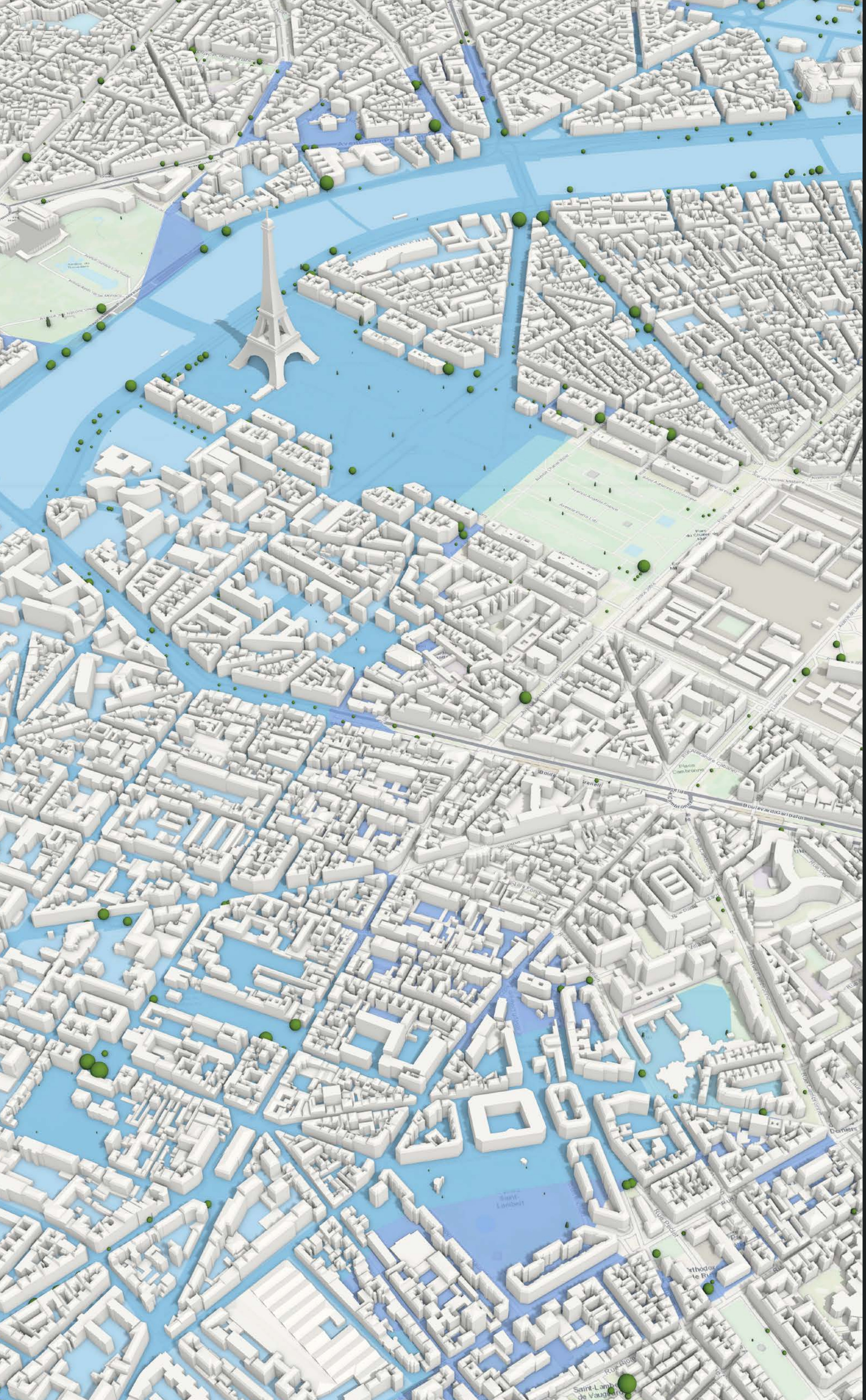
London (continued)

Since the emergence of the COVID-19 pandemic in early 2020, TfL has faced a new challenge in supporting London's goals for active, sustainable transportation. Instead of seeking routes to funnel additional people throughout the city, there has been the need to create more space for fewer people.

Using maps created in the Surface Playbook, TfL rolled out Streetspace for London. The program encompasses several connected projects, including widening walkways, creating temporary bicycle lanes, and restricting car traffic near schools and in designated low-traffic neighborhoods. Streetspace projects have been built out citywide on the 360 miles of roads managed by TfL, as well as through funding provided to London's boroughs—all in an effort to increase the public's confidence to walk or bike during the pandemic.

Streetspace has leveraged the expertise of the GIS and spatial data team to help determine where new schemes like wider walkways could be located for greatest impact. Since there's a limited amount of space in London, the team created maps visualizing city data to identify at-risk and high-demand areas. As a whole, the maps conveyed a clear picture of where streets were likely to be crowded—and where additional space was needed the most for safe and socially distant activity.

Maps provide a powerful, visual basis of understanding of the space available and a strong platform to plan projects, prioritize them, and make improvements. GIS technology has given TfL a chance to understand how street space can be reimagined for London's residents—whether the challenge is to use the space efficiently for more people, or to use it safely for fewer. ■



SECTION 3

GREEN INFRASTRUCTURE FOR BETTER EXTREME WEATHER MANAGEMENT

The Organisation for Economic Co-operation and Development (OECD) recently modeled the potential impacts of a major flood in Paris and found that 30–55 percent of the direct flood damages would be suffered by the infrastructure sector. New nature-based approaches to infrastructure apply the ecosystem services of natural environments. One example is green infrastructure that acts as a highly efficient buffer against extreme-weather events—absorbing and recycling stormwater far more effectively than human-made systems.

Green infrastructure can range in scale, from site-specific integrations such as rain gardens and green roofs to regional planning approaches that prioritize conservation of large tracts of land. In conjunction with hard infrastructure (also known as gray infrastructure), interconnected networks of green infrastructure can enhance community resiliency by increasing water supplies, reducing flooding, combating the effects of urban heat islands, and improving water quality.

Green infrastructure planning is fundamentally a spatial problem. Data about the natural world and built environments—from many sources, in a variety of formats, and at a range of scales—can be combined and modeled to uncover patterns and perceive relationships.

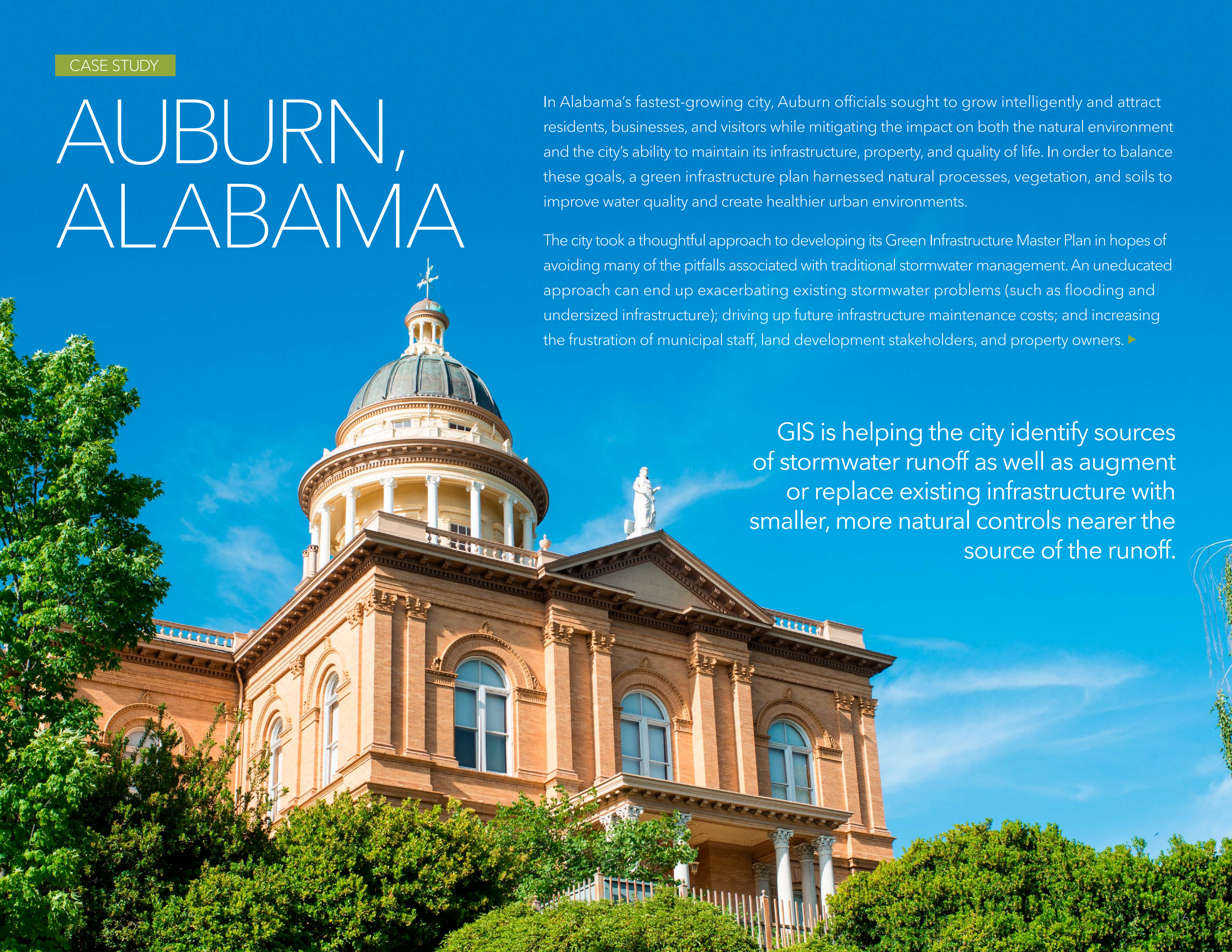
Often, green infrastructures are considered individually, while their design should be more integrated within comprehensive planning and design. Geodesign methods and technology support integrated strategic territorial planning, applying systems thinking to factor in relationships and consider process outcomes when creating comprehensive plans. ▸

Section 3 (continued)

The Green Infrastructure Center in Charlottesville, Virginia, recommends these six steps for creating and implementing a plan for green infrastructure:

1. **Set goals–**Are there particular assets and resources that your community values? Set goals that will improve your specific community's quality of life.
2. **Review data–**Assemble and review all existing data for your local area. Combine local and regional data to connect to the larger national network.
3. **Map ecological and cultural assets–**Once you have assembled all the existing data and collected additional data, it is time to create a natural assets map.
4. **Assess risks–**Once you have created your natural assets map, it is time to assess the assets most at risk. Which areas are zoned for development, and do they overlap key natural assets?
5. **Rank assets and identify opportunities–**Given your objectives and goals, are there risks that need to be addressed more quickly than others? What action should be taken to avoid future risks?
6. **Implement opportunities–**Based on how you have ranked the key natural assets in your area and which assets are at risk, you may need to implement new projects, policies, or zoning laws to ensure that your objectives are met.

Communities are using GIS in tandem with other advanced technologies to identify valuable local landscapes, prioritize which ones to protect, and plan connections within and beyond their boundaries. By applying geodesign, community planners can understand the true cost of development before it happens. ■



CASE STUDY

AUBURN, ALABAMA

In Alabama's fastest-growing city, Auburn officials sought to grow intelligently and attract residents, businesses, and visitors while mitigating the impact on both the natural environment and the city's ability to maintain its infrastructure, property, and quality of life. In order to balance these goals, a green infrastructure plan harnessed natural processes, vegetation, and soils to improve water quality and create healthier urban environments.

The city took a thoughtful approach to developing its Green Infrastructure Master Plan in hopes of avoiding many of the pitfalls associated with traditional stormwater management. An uneducated approach can end up exacerbating existing stormwater problems (such as flooding and undersized infrastructure); driving up future infrastructure maintenance costs; and increasing the frustration of municipal staff, land development stakeholders, and property owners. ▶

GIS is helping the city identify sources of stormwater runoff as well as augment or replace existing infrastructure with smaller, more natural controls nearer the source of the runoff.

Auburn, Alabama (continued)

Auburn has used GIS to develop innovative ways of controlling and monitoring stormwater, which is part of its Green Infrastructure Master Plan. Traditionally, stormwater runoff generated from impervious surfaces has been addressed by using gray infrastructure, moving stormwater quickly off sites and out of roadways with little or no water quality treatment. GIS is helping the city identify sources of stormwater runoff as well as augment or replace existing infrastructure with smaller, more natural controls nearer the source of the runoff.

In another example, Auburn requires a tiered buffer alongside all streams in the community. The city's GIS division created a solution that shows all the city waterways on a smart map and automatically delineates the required buffer zone.

The integrated system is also used to inform the public about water management and changes to the landscape. A watershed management tool inputs data on water quality across the community and displays it in a dashboard that's accessible internally or externally. Users can compare water quality both over time and across geographic areas to ensure that green infrastructure is improving water quality as promised.

SECTION 4

NEXT-GENERATION REMEDIATION

Prior to the late 20th century, human development progressed at the expense of the environment. A corporation shopping for manufacturing locations with the least amount of government oversight was commonplace. Feedlots, sewage plants, tanneries, paper factories, and landfills would freely pollute waterways, the air, and the ground around their facilities.

Though environmental standards have dramatically improved since then, there is still work to be done to protect some of the world's most ecologically rich environments. For example, 10 percent of the world's population lives near coastal wetlands. These fragile ecosystems are vital in the fight against climate change and can store five times as much carbon as tropical forests over the long term—but only if they are restored and protected from sea level rise. Restoring these incredible natural places—supporting the water cycle, conserving soil, and protecting habitat and pollinators—can yield great benefits: providing food and medicine, and giving people safe and open places to live and play.

Governments around the world are recognizing the important role healthy natural environments play in the overall health of the planet and the people who live on it—and these governments are committed to resilience and restoration.

Geodesign technologies allow environmental engineers to gain an improved understanding of contaminated sites. GIS can gather and analyze remarkable volumes of environmental data, allowing users to observe, measure, and monitor restoration sites with incredible detail and precision. That data can be displayed visually on maps and dashboards that facilitate collaboration among all project stakeholders to respond quickly to areas in need of remediation. Users are empowered to craft innovative solutions that consider the entire restoration site as well as nearby urban areas, businesses, and residents, with strategies that match the specifics of each place. ■

CASE STUDY

CHESAPEAKE BAY

The Chesapeake Bay is home to more than 18 million people and 3,600 species of plants and animals. The watershed—spanning over 64,000 square miles and covering parts of Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia, and the District of Columbia—faces many complex challenges. The results of a five-year, federally funded study identified excess nutrient pollution as the main source of the bay's degradation. These nutrients, mostly from animal waste and nitrogen used in farming and livestock management and phosphorus used in detergents, find their way into tributaries to the bay and create conditions harmful to aquatic life. In the 1980s, Congress recognized the bay's pollution crisis and Chesapeake Bay became the nation's first estuary targeted by Congress for restoration and protection.

Restoration of the Chesapeake Bay watershed is a collaborative effort among stakeholders. One group, Chesapeake Conservancy, works closely with national, state, and local partners to pilot new, data-driven approaches to maximize the effectiveness of restoration practices and improve the health of the bay. The results of a five-year, federally funded study identified excess nutrient pollution as the main source of the bay's degradation. These nutrients—mostly from animal waste and nitrogen used in farming and livestock management, and phosphorus used in detergents—find their way into tributaries to the bay and create conditions harmful to aquatic life.

In the 1980s, Congress recognized the bay's pollution crisis, and Chesapeake Bay became the nation's first estuary targeted by Congress for restoration and protection.

One of the conservancy's initiatives focuses on the Susquehanna River, the bay's largest source of freshwater, pouring an estimated 20 billion gallons of freshwater into the bay daily. The organization's geospatial team, the Conservation Innovation Center (CIC), is implementing new data analytics tools to guide conservation and outreach efforts at the heart of the Susquehanna River watershed in central Pennsylvania. ▶

Chesapeake Bay (continued)

One type of restoration project of particular interest is the planting of riparian forest buffers. These areas of trees, shrubs, and grasses adjacent to water bodies are the last defense to intercept and treat sediment- and nutrient-laden runoff before it enters nearby streams. The analysis conducted by the CIC sought to use data to identify areas where riparian forest buffers were lacking, and prioritize them for restoration based on their potential to reduce pollution and improve water quality.

To accomplish this, the team developed high-resolution land-cover and hydrography datasets that were analyzed within GIS, which allowed them to see exactly where trees were present and, more importantly, where trees were absent from areas adjacent to waterways. The team also used GIS to assess the upslope landscape to get an idea of just how much and where pollution is coming off the landscape.

All this information helped the CIC create a system that prioritized parcels for possible restoration opportunities based on criteria like pollution-reduction potential and cost-effectiveness of planting trees. However, after scoring over 6,000 parcels in the region, the CIC was still left with hundreds of parcels that were a high priority for restoration.

To narrow these down and develop achievable restoration goals, the CIC turned to Esri's ArcGIS Insights. The app allows the team to leverage spatial and statistical analyses to focus on the highest-priority parcels, connect with landowners interested in restoration, and summarize the data for landowners in a meaningful way.

The intelligent geospatial platform allowed the team to quickly and easily make sense of the prioritized restoration opportunity data. The ability to summarize the data in different ways—like by county or region of interest—enabled them to explore the options further. The summarization and reporting features in ArcGIS Insights help the CIC quantify the potential impact of restoration projects and communicate this to partner group Precision Conservation as well as track progress toward goals. ■

SECTION 5

SAFE AND CLEAN INDOOR ENVIRONMENTS

Though much of this ebook has focused on the natural environment, indoor spaces must also be considered part of an environmentally responsible strategy, especially in light of the COVID-19 pandemic. As employees return to the workplace, managers will be more attuned to using indoor space—and to monitoring its dynamics.

A detailed interior model, coupled with sensors that track movement, can improve facility security, employee efficiency, and contact traceability. Using advanced technologies, operations managers can learn indoor-movement patterns to enhance workplace operations, communication, and productivity, while systems with sensors help companies achieve efficiency goals and lower carbon footprints.

Real-time asset management gives administrators and executives indoor location awareness by creating a digital twin of the workplace on an interactive smart map. Empowered by GIS, operations leaders can monitor any asset in real time—whether it's a shopping cart, a fire extinguisher, or a piece of equipment—and get it where it needs to be.

A digital twin can also help create a more energy-efficient and safer indoor environment. Occupancy-based lighting and HVAC (heating, ventilation and air conditioning) systems automatically conserve electricity when a space is vacant. In another scenario, a facilities manager might consult a campus map to see where the company's security cameras are located, then remotely reposition one for a better view of an unfolding incident. ▶

Section 5 (continued)

As part of a postpandemic back-to-work strategy, companies can use Esri's ArcGIS Indoors to gain important insight into how spaces and resources are used, how practices like social distancing are working, and what safety and efficiency improvements managers might make. The software allows users to aggregate, visualize, and analyze indoor spatial data on 2D and 3D maps, apps, and dashboards, creating a new level of transparency when it comes to facility operations.

For example, operations managers can employ Space Planner, a browser-based app, to better understand employee seating arrangements. Managers can see where there are social distancing conflicts, such as desks that are grouped too closely together, and reorganize people's work spaces to ensure compliance with safety regulations. Space Planner also allows analysts to model various social distancing parameters so that they can visualize areas of concern and map out safe seating assignments.

Here are some of the ways an indoor positioning system (IPS) like ArcGIS Indoors can be used across various industries:

Transportation

Big transport hubs such as airports or train stations are using IPS solutions to improve passenger flow by offering mobile wayfinding via an app. Passenger flows and queues can be managed more efficiently if analytical insights are available. Critical resources such as assets and personnel can be allocated and assigned to tasks more easily with a transparent, location-based facility and operations management system in the background.

Office Buildings

Indoor positioning makes collaboration easier via location sharing, but it also empowers employees to interact with their physical space in a smart and efficient manner. Instant booking for meeting rooms as well as real-time navigation to different areas of corporate campuses, colleagues' offices, and other points of interest—all this helps save time and trouble.

Health Care

The breakthroughs in real-time asset management translate into greater efficiency and productivity. For example, a health system in northern Illinois calculated that time wasted by staff searching for assets like wheelchairs and hospital beds in a 395-bed facility costs $4,000 a day. A smart map of the building could supply the needed information instantly. Hospitals can also benefit from mobile wayfinding apps for visitors and staff. ■

Learn More

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 more than 350,000 organizations globally and in over 200,000 institutions in the Americas, Asia and the Pacific, Europe, Africa, and the Middle East, including Fortune 500 companies, government agencies, nonprofits, 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 information technology, Esri engineers the most innovative solutions for digital transformation, the Internet of Things (IoT), and advanced analytics.

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