GIS & DIGITAL WATER

Transforming the Global Water Industry

A research collaboration with

bluefield RESEARCH

CONTENTS

PREFACE

How to Use This Document

POINT OF ORIGIN

This report is a companion piece to *GIS & Digital Water: The Foundational Role of GIS in Digital Water Transformation*, published by Esri and Bluefield Research. While the report focused on the US water, wastewater, and stormwater sector, this version is global in scope, featuring compelling statistics and inspiring customer stories from utilities and their partner organizations around the world.

THE *big* PICTURE

Defining GIS and Its Role in Digital Water Transformation

What Is GIS, *and* What Does It Have to Do with Water?

Location is everything in the water industry. Utilities' core function is the timely, orderly movement of flows of water, wastewater, and stormwater from location to location–from the plant to the tank to the tap, and back to the plant for treatment and discharge.

Utility staff are highly mobile, operating and maintaining a vast network of remote assets across service areas that span hundreds, or thousands, of square miles. Utility data, too, is fundamentally spatial. Though a utility's various datasets are typically housed in separate systems or silos, and used by different teams for different purposes, most share a common link to location–they are tied to specific customers, assets, system events, or processes in discrete, identifiable places.

So where does GIS fit in? What is GIS, *and* what is it not?

- Geographic information system (GIS) technology was originally developed in the 1960s for recording and analyzing geospatial, or locational, information.
- GIS is a tool for location intelligence—for helping organizations of all types and sizes, including water, wastewater, and stormwater utilities, make better decisions using locational data.
- GIS is an ideal foundation for digital transformation in the water industry. GIS facilitates integration, coordination, and analysis of disparate hardware and software, workers and processes, and departments and datasets across space and time, laying the groundwork for more advanced digital initiatives such as big data analytics, machine learning, artificial intelligence, and digital twins.
- GIS is not just a system of record for storing data about a utility's assets—the age and material type of a certain pipe segment, for example, or the maintenance history of a specific valve. GIS also serves as a system of engagement (enabling staff to access core asset data from any location, on any device) and a system of insight (facilitating advanced analysis of key data trends over space and time to support better operations and investment decisions).
- GIS is not just for horizonal assets, like distribution and collection pipe networks. GIS technology has moved indoors, making it equally suitable for managing complex three-dimensional vertical assets like treatment facilities and pump stations.
- GIS is not just for experts. Though GIS professionals play a crucial role in building and maintaining a utility's GIS database, GIS is designed to be used by nonspecialists. Field crews can use it for accessing and updating asset maintenance on-site and in real time, for example, while customer service representatives can use it to identify and communicate with affected households in the event of a main break or network outage. Managers, supervisors, and team leads can use it to help manage and monitor work. GIS can be used to clearly communicate information to key stakeholders; for example, a dashboard can be used to summarize key performance indicators (KPI).

DEFINITIONS

Digital Water
An ecosystem of data and analytics solutions, including hardware, software, and services, which are used to support more informed decision-making across water, wastewater, and stormwater management. Also known as "smart water."

Geographic Information System (GIS)
A framework for gathering, managing, and analyzing data, rooted in the science of geography, which analyzes spatial location and organizes layers of information into visualizations using maps and 3D scenes.

ArcGIS®
The market-leading GIS platform launched by US software company Esri in 1999, used widely in the water, wastewater, and stormwater industry.

Horizontal Assets
Network assets such as system pipes and appurtenances, which are represented as points, lines, and polygons on a GIS map.

Vertical Assets
Buildings and facilities such as treatment plants and pump stations, which are represented as lines, points, polygons, and 3D features on a GIS map.

Why Now?

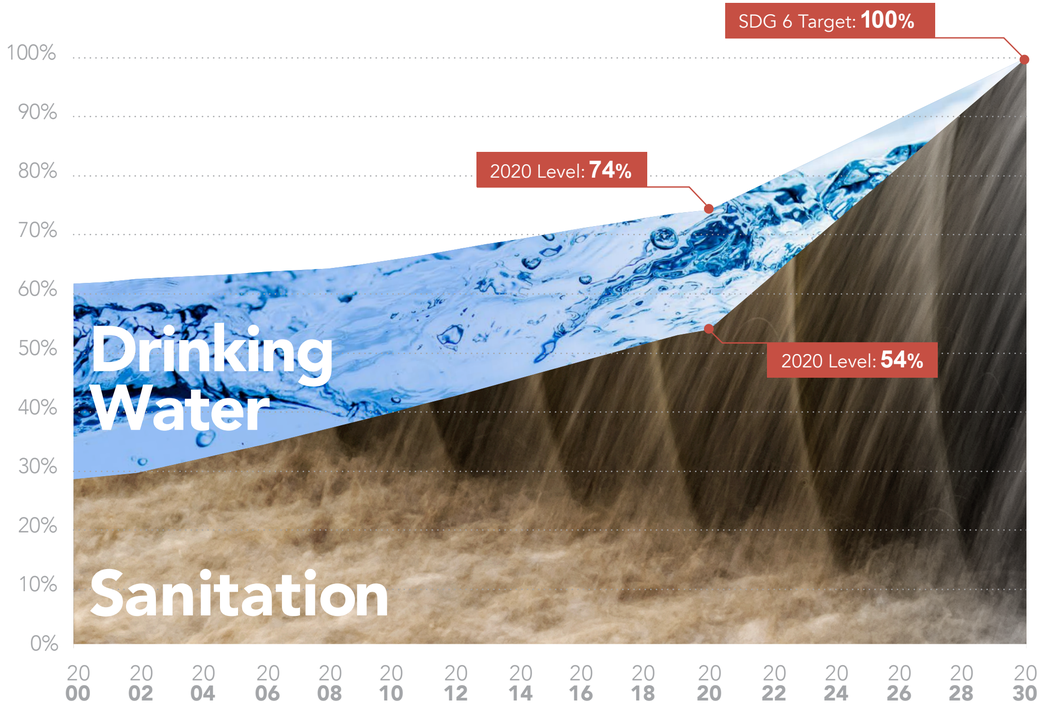
Drivers for Digital Water Transformation

As climate change alters and accelerates the water cycle, effective management of water, wastewater, and stormwater resources and flows has taken on even greater importance for communities across the globe. The United Nations (UN) projects that half of the world's population will live in water-stressed areas as soon as 2030, with regions such as India, Australia, the Middle East and North Africa, Sub-Saharan Africa, and the western United States particularly vulnerable to drought and water scarcity. Meanwhile, the World Meteorological Organization estimates that extreme storm and flood events have caused nearly US$3.1 trillion in economic losses over the past 50 years—more than a third of which occurred in the last decade alone—necessitating greater investment in flood modeling, stormwater monitoring, and green infrastructure.

At the same time, the global water industry continues to face longstanding infrastructural challenges. In some parts of the world, access to drinking water and sanitation infrastructure remains severely limited, with 2 billion people (more than a quarter of the world's population) lacking access to safely managed drinking water, and 3.6 billion people (nearly half of the world's population) lacking access to safely managed sanitation facilities—well short of UN Sustainable Development Goal 6's target of universal global access to clean water and sanitation by 2030. Elsewhere, existing infrastructure is aging, outdated, and deficient. Leaky pipes contribute to global nonrevenue water rates reaching an estimated 30 to 35 percent, and as high as 55 to 60 percent in parts of Europe and Asia, while overloaded wastewater collection systems contribute to major problems with sewer overflows and environmental pollution even in high-income countries like the United States and the United Kingdom. Finally, changing financial and workforce conditions, rapid technological advances, and evolving regulatory regimes in response to emerging contaminants of concern all contribute to a shifting landscape underneath utility managers' feet, requiring agility, flexibility, resilience, and resourcefulness at every turn.

WORLD PROGRESS

on Sustainable Development Goal 6 — Universal Access to Safely Managed Drinking Water & Sanitation



SOURCE: *World Bank, Bluefield Research*

Savvy utility leaders also recognize the opportunities inherent in these challenges–opportunities to tangibly improve public health and customer satisfaction; make their communities more sustainable and resilient; maintain the safety and security of their workers and operations; and maximize the efficiency and productivity of their people, processes, and technologies. But to fully harness these opportunities, utilities need to undergo a digital transformation of their operations and infrastructure. They need to put data at the heart of their decision-making, adopting systems and equipment for collecting and communicating, storing and managing, and visualizing and analyzing that data–in other words, for making that data accessible, actionable, and meaningful.

GIS is uniquely suited to serve as the foundation for digital water transformation, for a number of reasons. GIS is built to be used by anyone, from anywhere, and on any device across a utility organization. GIS can intake, display, and analyze data from all manner of digital hardware and software, from flow meters and water quality monitors to billing and work order management systems. Finally, GIS is already in use at many water, wastewater, and stormwater utilities around the world, making it an ideal point of departure for new digital water investments and initiatives. Whether you are with a large urban utility serving millions of people or a small rural or suburban provider serving thousands, GIS can support your journey of digital transformation at every step of the way.

Water industry analysts Bluefield Research view GIS as one of the top growth areas for global digital water investment, on par with other key segments such as SCADA human machine interface (HMI), enterprise asset management, and hydraulic modeling. Water utility investments in GIS software are projected to see nearly 8 percent growth annually over the next decade, as utilities around the world harness GIS as the bedrock of their digital transformation initiatives.

DEFINITIONS

Nonrevenue Water (NRW)

Water that is pumped or produced but not billable, due primarily to leakage, inaccurate meter readings, or unauthorized consumption.

Customer Information System (CIS)

Software platform for managing key customer data, including account and billing information.

Human Machine Interface (HMI)

Software component of a SCADA system that enables operators to monitor and control devices and processes.

Computerized Maintenance Management System (CMMS)

Software platform for managing maintenance programs, with functionality related to scheduling maintenance tasks, managing work orders and inventory, and facilitating communication around maintenance activities.

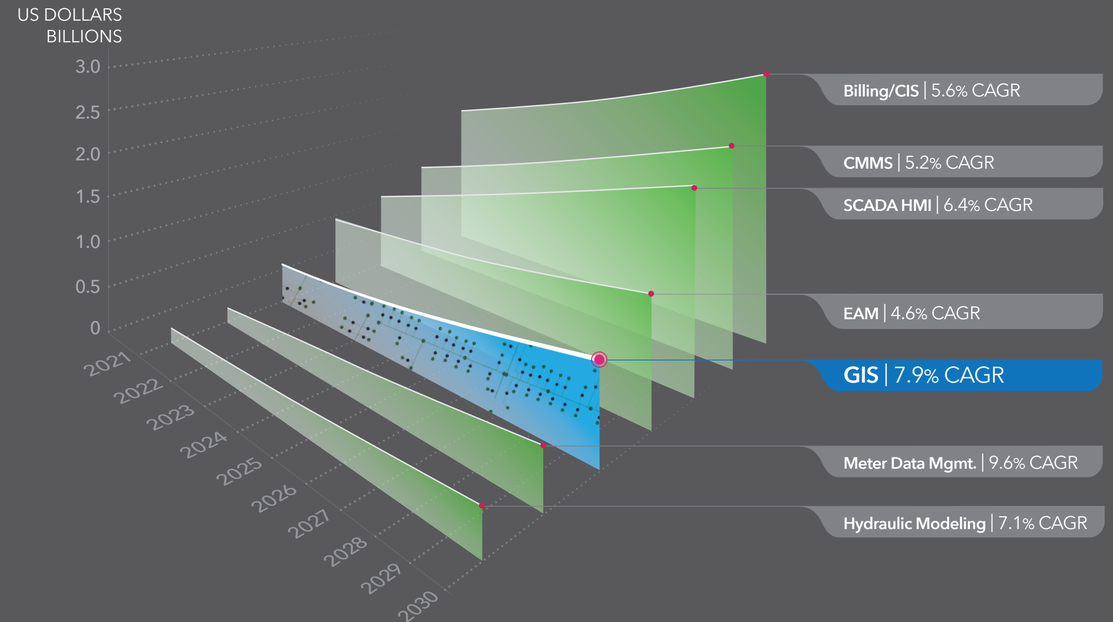
Enterprise Asset Management (EAM) Software

More advanced software for managing enterprise assets, which often includes CMMS modules and draws from CMMS data, but extends into predictive maintenance, asset life cycle planning, and financial analysis.

Supervisory Control Data Acquisition (SCADA)

A control system architecture comprising computers, networked data communications and graphical user interfaces for high-level supervision of machines and processes.

GLOBAL Utilities' Projected Digital Water Software Investments *by Product Type* | 2021–2030



SOURCE: *Bluefield Research*

plotting

A COURSE FOR THE DIGITAL WATER JOURNEY WITH GIS

Mapping the Points of Opportunity

The sections that follow highlight several ways in which a robust, well-configured GIS can be used as the cornerstone for ambitious digital transformation initiatives. With pioneering water, wastewater, and stormwater utilities from across the globe as your guides, you will learn how GIS can be harnessed for three key digital water project types:

- **Network Management**
  Updating and integrating network data to better model and manage network performance and behavior and the relationships between disparate network assets.
- **Coordinated Operations**
  Putting utility data in the hands of all staff members—field crews, customer service representatives, engineers, and financial planners—to ensure that every member of the organization has access to up-to-date information when, where, and how they need it.
- **Real Time**
  Integrating, visualizing, and analyzing real-time data from various sources—SCADA systems, Internet of Things devices, weather forecasts, and even social media—to help utilities understand what is happening at all times, and all places, in their service areas.

In the process, you will learn about Esri® ArcGIS cutting-edge features and advanced functionality, which support data-driven decisions and sustainability planning now and into the future. These include the following:

- **Digital Twin**
  Providing a framework for creating and integrating digital twins—dynamic digital replicas of physical objects, processes, relationships, and behaviors—which are grounded in precise, up-to-date real-world data.
- **Location Intelligence/Analytics**
  Leveraging embedded, industry-specific analytics to help utility staff make data-driven operational, planning, and investment decisions.
- **Facilities and Vertical Assets**
  Extending GIS mapping, modeling, and location intelligence capabilities to indoor facilities—like treatment plants and pump stations—to enhance utilities' vertical asset management programs.

You will also learn how GIS has evolved from a system of record to a system of engagement and a system of insight. These interlocking, interoperable capabilities make GIS an indispensable part of digital transformation for utilities of all types, shapes, and sizes.

DEFINITIONS

Internet of Things (IoT)

A network of internet-connected objects and devices embedded with sensors and software that collect, process, and transmit data on their physical surroundings.

Digital Twin

A virtual representation of the real world, including physical objects, processes, relationships, and behaviors. GIS creates digital twins of the natural and built environments and uniquely integrates many types of digital models.

GLOBAL
WATER *and* WASTEWATER
Asset Base

17 MILLION
kilometers of water pipe

142,000
wastewater treatment plants

184,000
water treatment plants

390,000
water storage tanks and towers

900,000
pump and lift stations

$7.7 TRILLION
worth of assets

81 MILLION
fire hydrants

67 MILLION
maintenance holes

10 MILLION
kilometers of wastewater pipe

SOURCE: *Bluefield Research*

Network Management

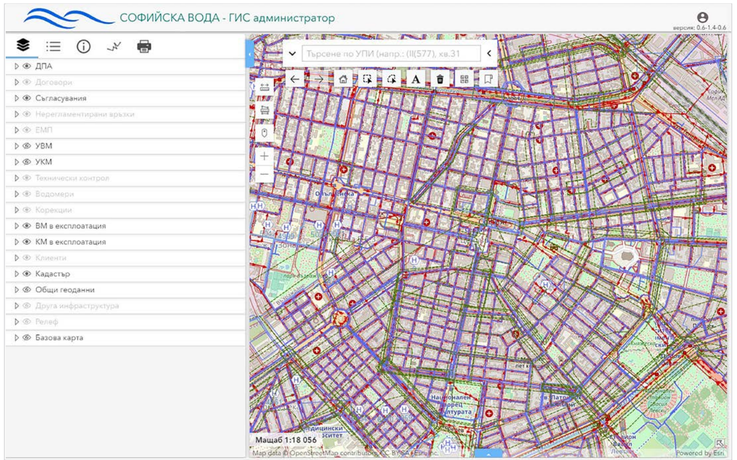
Global utilities collectively manage over US$7.7 trillion worth of water and wastewater assets, including an estimated 27 million kilometers of distribution and collection pipe, more than 300 million network assets (valves, hydrants, and maintenance holes), and nearly 1.7 million vertical assets (treatment plants, storage tanks, and pump and lift stations). Mapping these assets and recording their key attributes–size, age, material type, etc.–are among the core functions of a GIS platform.

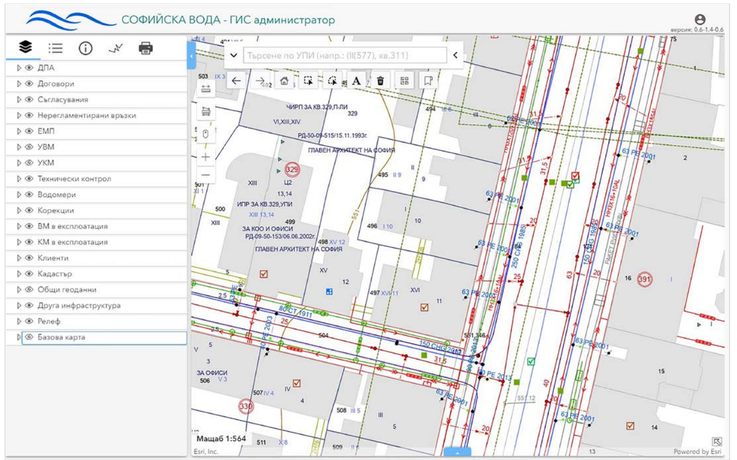
Effective management of utility infrastructure requires operators to think about their networks as a whole rather than as individual assets–they need to understand not just where their critical assets are, but also the connections and relationships between those assets. In the event of a water main break, which valves should be closed to ensure that service disruptions impact the fewest customer households and businesses? In the event of a power outage at a wastewater lift station, which maintenance holes are at greatest risk for a sanitary sewer overflow? When catastrophic weather impacts a water treatment plant, how do the power, communications, heating, and water networks interact and influence each other to help head off cascading effects?

perspectives

"[ArcGIS network management] represents a significant upgrade to our data quality—ensuring that we have a full representation of our water network that is fast and scalable."

— ***Tim Cover***
Former ICT Project Manager | North East Water (Australia)





LEFT:
Map overview within the new web GIS.

RIGHT:
Additional detail becomes visible depending on the map scale.

This is where Esri's advanced network management and modeling tools come into play. Web-based networking capabilities are available via the desktop and accessible from mobile devices. With ArcGIS, utilities have access to a dynamic system of record that fully captures the intricacies of real-world water networks, using both industry-standard and utility-specific logic to model, visualize, and analyze the performance of individual assets, groups of related assets, and the network as a whole. These tools extend to complex infrastructure with multiple subcomponents, such as pump stations, which contain several pieces of interrelated equipment that must be operated and managed in tandem. ArcGIS network management tools are designed to work as well on a field foreperson's smartphone as they do on a GIS professional's desktop computer, enabling access by anyone, from anywhere, in the organization.

For example, Sofiyska voda (part of Veolia)—the water and sewerage service provider for Bulgaria's capital city of Sofia—wanted to upgrade its legacy GIS software in 2019 in response to evolving staff and organizational needs, such as improved network management capabilities and next-generation functionality. After a successful pilot with Esri Bulgaria, Sofiyska voda decided on a full-scale modernization of its network model, which included migrating all existing GIS data to the ArcGIS Utility Network data model, implementing mobile GIS apps, and integrating GIS with other IT systems (e.g., customer care and billing, enterprise resource planning, CMMS, and asset management).

The upgraded system has produced many benefits for Sofiyska voda. Staff have access to a highly efficient and scalable model of their network, which gives a comprehensive view of their infrastructure and can represent large numbers of objects on a map without cluttering. Sofiyska voda has increased data consistency and reduced data entry errors by imposing multiple validation and verification rules and providing advanced analytical capabilities, including through dynamic network models. As an added benefit, staff can model the connectivity and interrelationships of infrastructure components across multiple utility networks, including water, sewer, and electrical. Ultimately, the implemented ArcGIS solution has enabled Sofiyska voda to work faster and smarter in terms of infrastructure operations and management, and to provide higher-quality service to city residents.

perspectives

"The implementation of ArcGIS Utility Network allows us to even better manage our physical assets as well as to take full advantage of the ArcGIS technologies that are solving current problems with a vision for the future."

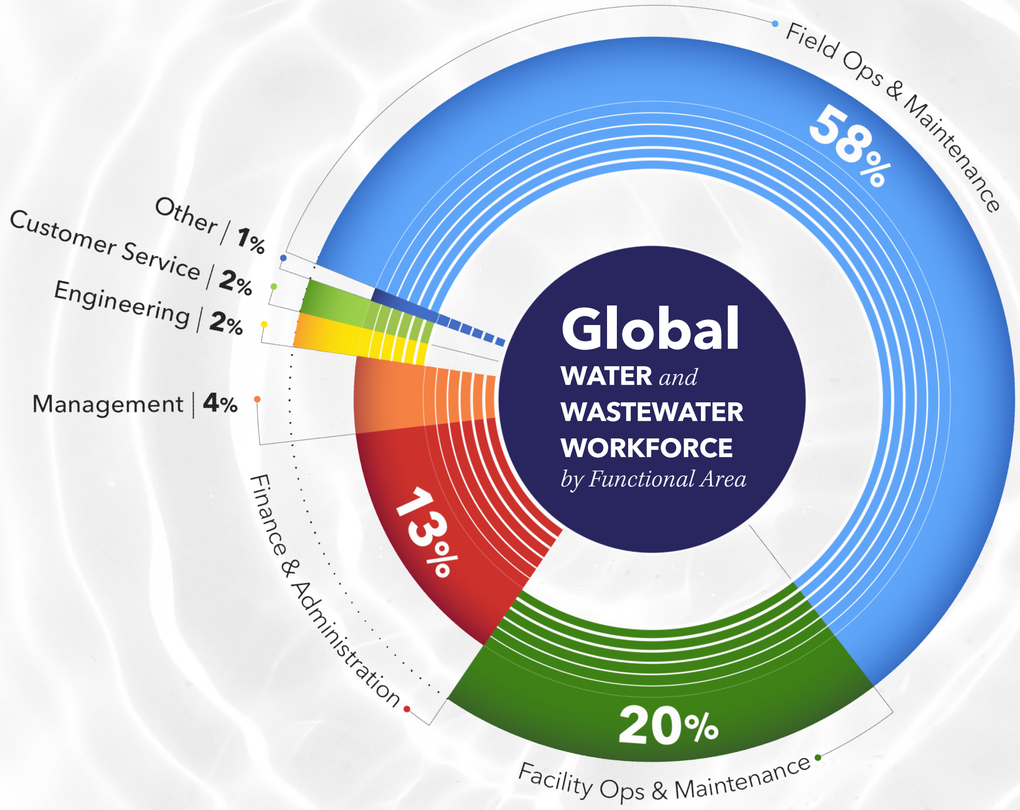
— ***Milko Velichkov***
Head of Asset Management | Sofiyska voda, Part of Veolia (Bulgaria)

Coordinated Operations

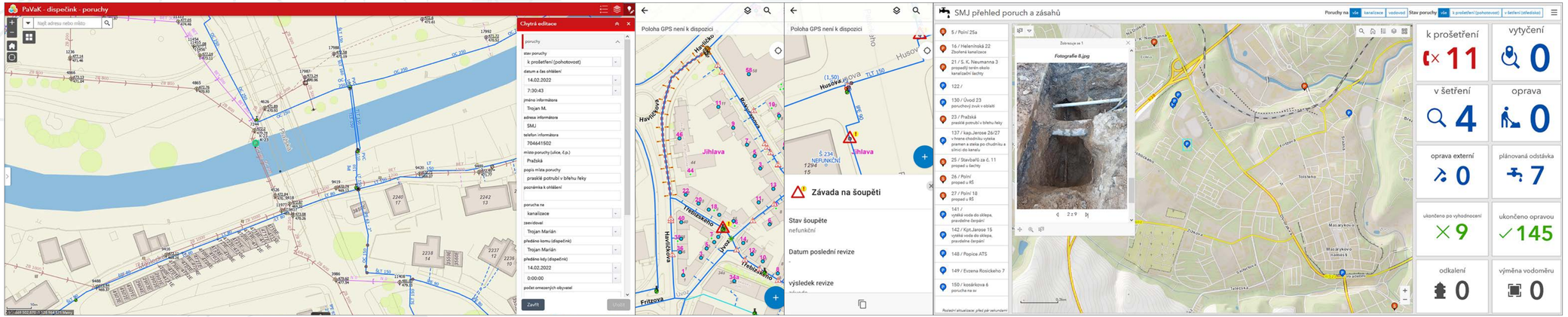
Bluefield estimates that the global water, wastewater, and stormwater utility sector directly employs between 5.5 million and 7.5 million people, with another 8 million to 11.5 million positions (e.g., consultants, contractors, and supply chain partners) supported indirectly. Roughly 75 percent of these utility professionals serve in on-site or field-based roles, with only a quarter working in office-based positions. Such a mobile, distributed workforce makes communication and coordination a significant challenge. How can utility managers ensure that all of their staff members, contractors, and consultants have the same access to accurate, up-to-date, authoritative organizational information—as-builts, maintenance records, open work orders, etc.—regardless of whether they are in the back office or working at a jobsite?

GIS is an ideal solution, serving as a system of engagement that facilitates coordination, collaboration, and data sharing in real time across all teams and departments—from field crews and plant operators to customer service representatives and financial planners. Esri's synchronized mobile and desktop applications open a two-way channel of communication between the field and the office. Field staff can quickly and easily collect or update data while they work via smartphone or tablet, with changes immediately reflected in back-office maps and operational dashboards. Meanwhile, office-based dispatchers and customer service representatives can push assignments out to field teams with the click of a button, leveraging either Esri's internal task management tools or its deep integrations with third-party work order management software platforms (e.g., EAM and CMMS), many of which are built directly on top of ArcGIS.

The benefits of better coordination and data sharing across functional areas are clear. With all the data they need at their fingertips, field crews can eliminate frequent trips back to the office to review paper maps and files, saving significant time—not to mention labor and fuel costs. Functioning as a single source of truth, GIS can empower utility staff, contractors, and other external stakeholders to make better, more data-driven decisions in the field and avoid costly or even dangerous mistakes resulting from inaccurate or out-of-date information. Esri's ArcGIS is also an ideal repository for the institutional knowledge of veteran operators, making nuanced information about the condition and performance of network assets readily available for the next generation of utility staff. Built-in data visualization and analytics capabilities give utility managers greater visibility and transparency into their teams' performance, enabling them to track progress against key organizational targets, goals, and KPIs.



SOURCE: *US Bureau of Labor Statistics, Brookings Institution, Bluefield Research*



The City of Jihlava uses GIS applications in various ways, including desktop applications for office staff and mobile applications for field staff.

perspectives

"ArcGIS software is a powerful [system] to support the entire organization and enable different departments to improve their efficiency and productivity. This requires commitment from the utility for a sustainable implementation."

— Lilian Maserele

Expert Engineer | WaterWorX Project ARUSHA (Tanzania)

perspectives

"Managing the water and wastewater network requires a fast and comprehensive operational picture, both for office and construction workers or when searching for malfunctions in the field. We also expect the need to manage large data in one place. This technology allows us to do all of this. Furthermore, it helps us to do our work more efficiently and allows our ideas to evolve."

— Libor Göth

Head of Water Supply and Sewerage Division | Jihlava City Services (Czech Republic)

For example, Jihlava—a city of 51,000 inhabitants in the Czech Republic—took over the ownership of the water infrastructure in its territory in 2021, requiring city staff to build a functional water infrastructure management system almost from scratch. The city chose to use Esri's ArcGIS as one of its main information systems, which enabled city staff to respond quickly and flexibly to evolving data requirements and to provide all employees with a clear and comprehensible user environment. The GIS system functions as a central data portal, processing and displaying a variety of disparate input sources such as nonspatial customer and supply point data and CAD files.

From this one central data source, city staff have created web maps and thematic map applications in ArcGIS for all business units and specific key users (e.g., water supply and sewerage division, customer center, and technical department). For instance, customer and call center staff are able to access and input information about customers, parcels, and network incidents on a map, which is automatically shared with field staff responsible for verifying and resolving customer issues. GIS-based data and applications are also shared with external suppliers and the public to facilitate better communication and collaboration between city staff and external stakeholders. Overall, city staff from a wide range of occupational, educational, and technical backgrounds have adapted to the new platform quickly and smoothly, and the city plans to expand its use of GIS in the near future.

DEFINITIONS

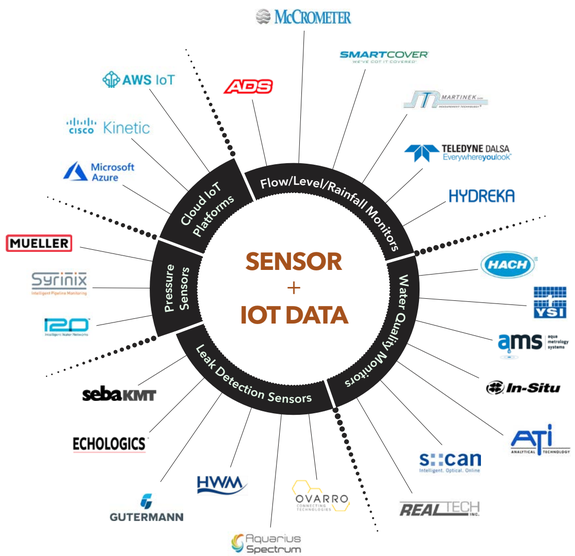
Computer-Aided Design (CAD)

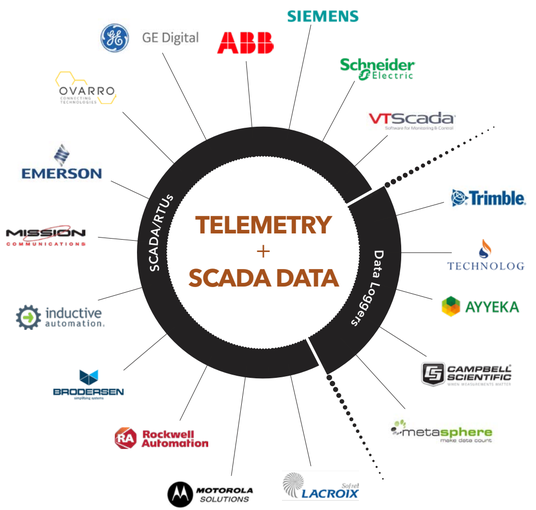
A computer-based system for the design, drafting, and display of graphical information to support engineering, planning, and illustrating activities.

Real Time

In our increasingly digital world, utilities have greater access than ever to real-time information on the operating conditions, performance, and health of their infrastructure, enabling more efficient operations and planning decisions, more proactive response to network events, and more preventive or predictive maintenance of critical assets. This data can come from a wide range of sources—SCADA platforms, Internet of Things devices, automatic vehicle location systems, weather forecasts, and social media. For example, Bluefield estimates that more than 10 percent of the world's nearly one billion total metered water connections are equipped with advanced metering infrastructure (AMI) radios, generating billions of time-stamped data points each day.

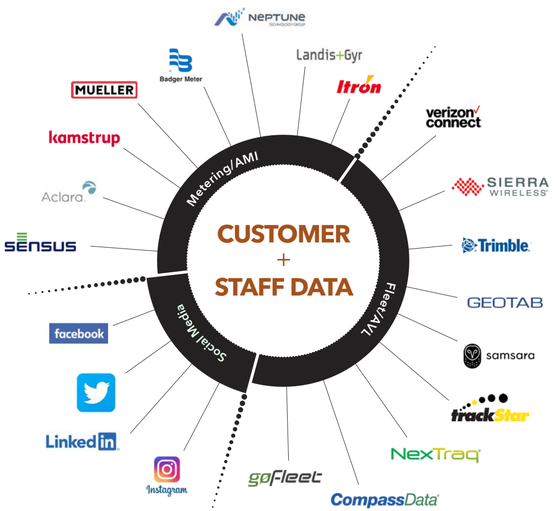
This deluge of data can be overwhelming, quickly becoming "dark data," which is gathered and stored but not used in any meaningful way—particularly when it is generated from multiple sources or systems and stored in departmental silos that do not communicate with one another. Esri's real-time data integration capabilities are designed to bridge this gap, adding a crucial locational component to utilities' time-based data. Functioning as a powerful system of insight, ArcGIS allows operators to visualize and analyze real-time data across both time and space, regardless of source, providing an at-a-glance view of where individual data feeds are in relation to each other, to customers and assets, and to network processes and events. This much-needed context makes previously dark data more meaningful and actionable.





SOURCE: *Bluefield Research*

Real-Time DATA PROVIDERS *by Type*



perspectives

"With [ArcGIS], data turns into shareable knowledge and live visuals, promoting awareness and understanding of projects by [utility] staff."

— James Galley
Principal Administrative Analyst | St. Johns County Utilities (United States)

The value of a dynamic, holistic view of network conditions cannot be overstated. During outages, extreme weather events, and other emergency situations, ArcGIS can serve as a crucial platform for monitoring conditions in real time and mounting a proactive, coordinated response. Meanwhile, Esri's embedded analytics capabilities and third-party partner machine learning applications can be trained on the real-time and historical data feeds captured by ArcGIS, providing robust optimization and prediction tools to support operations, maintenance, and investment planning decisions. In all cases, Esri's ArcGIS Living Atlas of the World provides a valuable enhancement to a utility's own data generated across its service territory. ArcGIS Living Atlas of the World is the foremost collection of geographic information from around the globe. It includes maps, apps, and data layers to support your work. Utilities can take advantage of demographics data to support equity initiatives, soils data for corrosive analysis, and real-time weather and traffic data for planning activities.

For example, Vitens—the largest drinking water company in the Netherlands—relies on the real-time data integration capabilities of ArcGIS to monitor and manage water supply and demand. Vitens collects 11 billion data points annually from sensors and meters across its service territory, providing complete visibility into its systems. To turn all of this rich, real-time data into actionable insights that support decision-making and daily operations, Vitens uses the PI System (from Esri partner OSIsoft) to aggregate disparate datasets and ArcGIS for data mapping and visualization.

On the demand side, Vitens created a GIS dashboard to monitor real-time water consumption data from the utility's smart metering network, particularly for heavy industrial users. The dashboard also provides valuable information on meter connectivity and battery life, enabling staff to identify nonperforming devices or network outages at a glance. On the supply side, Vitens uses the PI System to provide dynamic predictions of reservoir levels based on real-time inflows and outflows and then visualizes the predictive data in ArcGIS to help staff pinpoint and respond proactively to potential supply shortages. Looking forward, Vitens is experimenting with new real-time data visualization and analytics tools that harness the power of both ArcGIS and the PI System, including for historical pipeline maintenance and incident information, as well as network pressure data.

perspectives

"ArcGIS brings our data to life. Displaying historical data, real-time data, and predictive data on the map keeps us in control, helps us discover relationships, and leads to new insights. The PI System then allows us to zoom in to the data. Being able to navigate from the map to the underlying data in just a few clicks makes our work more efficient and more enjoyable."

— René Kersten
Senior Business Analyst | Vitens (Netherlands)

Looming water shortages are instantly spotted using the Resttijden Reservoirs dashboard.

DEFINITIONS

Automatic Vehicle Location (AVL)
A system for tracking and monitoring a fleet of vehicles, including location, speed, and stops, using GPS satellite technology.

Advanced Metering Infrastructure (AMI)
A system for collecting meter read data remotely in near real time.

Dark Data
Data that is collected and stored by an organization but is beyond the organization's capacity to process, interpret, use, or make actionable in any meaningful way.

Machine Learning
A subset of artificial intelligence in which machines use algorithms to analyze and learn from data to make predictions or improve decision-making.

Esri ArcGIS Living Atlas of the World
A vast geospatial database of geographic, demographic, and real-time information, such as flood gauge readings and soil maps, which is available to all ArcGIS users.

Digital Twins Leverage Network Management for Coordinated Operations

perspectives

"We use Esri technology to upload project content, site surveys and photos, [and] site constraints and blend it with design content, providing a single source of truth for Scottish Water."

— ***Dave Dukes***
BIM Manager, AECOM | Caledonia Water Alliance (United Kingdom)

Though it has a long history in other industries, the concept of the digital twin has recently become popular in water, evoking ideas of futuristic monitoring and control platforms used by highly sophisticated, tech-savvy organizations. In reality, most utilities already have a strong foundation for a digital twin of their critical infrastructure in the form of their GIS. GIS is an ideal framework for creating and integrating the various digital models at the core of a utility digital twin, including models of assets and networks, buildings and facilities, and cities and landscapes. ArcGIS also incorporates real-time data from a wide range of sources, turning static engineering and design models into dynamic replicas of real-world objects and processes, which can in turn be used for optimizing asset management and investment decisions, monitoring real-time operational performance, and simulating network events and scenarios for planning and training purposes.

Aljarafesa, a water and wastewater company serving several municipalities of the Aljarafe region of Seville, Spain, recently completed a pilot project with Esri Spain to create a 3D digital twin of a large storm tank in the municipality of Tomares. For the project, mobile mapping and laser scanning technologies were used to create a point cloud of the tank in a matter of minutes, resulting in a three-dimensional building information model (BIM) of the asset with centimeter accuracy. Esri's ArcGIS was used to complete the digital twin, adding elements of the surrounding geospatial context such as nearby buildings and vegetation, and a web application was developed to allow Aljarafesa to share asset data with internal users and third-party partners.

The pilot project has provided Aljarafesa with a dynamic, interactive model of the Tomares storm tank, bringing valuable BIM data from the engineering and design phase of the asset life cycle into the maintenance and management phase. The ArcGIS software-based web application allows measurement, calculation, and analysis within the digital twin model; facilitates rapid access to and sharing of information across internal and external stakeholders; and ultimately enables better understanding and decision-making for Aljarafesa staff.

perspectives

"With the combination of BIM and GIS, it has meant taking the project to a higher level of detail, which allows us to talk about the present to a virtual reality, where we can create a remote assistance system—and in the future, we will talk about the incorporation of the metaverse."

— ***Antonio Jesús Merina Cárdenas*** | *Jefe del Área de Sistemas de Información, Aljarafesa (Spain)*

ALJARAFESA

For video

Aljarafesa uses ArcGIS data to provide the geospatial context for its storm tank digital twin, with 3D representations of nearby buildings and vegetation.

DEFINITIONS

Building Information Modeling (BIM)
Software used for creating and managing 3D representations of physical structures (e.g., buildings and infrastructure) and their functional characteristics.

Light Detection and Ranging (lidar)
A remote sensing method that uses laser pulses to generate precise three-dimensional data about the shape and makeup of physical objects.

Visualization and Analytics Leverage Real-Time Data for Decision Support

perspectives

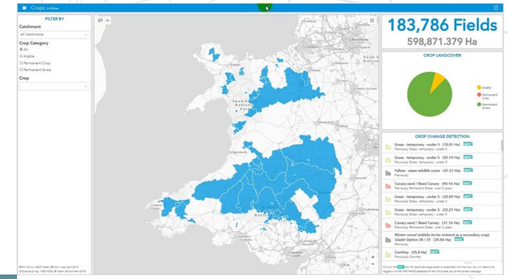
"Because of these analyses [in ArcGIS], we are able to make better choices when it comes to investments. It's efficient and insightful. We now use the time we saved to enhance our analyses with more data for better insights."

— Wilfried Martens
Department Head of Distribution Infrastructure | Brabant Water (Netherlands)

The advancement of digital water technology has provided utilities with ever more data—on the needs and behaviors of their customers, the condition and performance of their critical assets and systems, and the day-to-day problems and pain points they face in operating and maintaining their networks. For that data to be truly valuable, it needs to be accessible, understandable, and usable. GIS broadens operational awareness by integrating customer, climate, and other datasets with a utility's own data on infrastructure health and performance, providing utility professionals with a clear picture of patterns and trends over space and time to help them find better solutions to enduring problems. ArcGIS spatial analytics capabilities, built on deep industry-specific domain knowledge, take the analysis a step farther, guiding utility operators and managers to the insights they need to make the right operational, planning, and investment decisions for their customers and communities.

Dŵr Cymru Welsh Water's Catchment team manages 136 catchments that feed 61 water treatment works, delivering safe drinking water for over three million customers in a service area that covers more than half of Wales. The company has little control over how land is used across these catchments, necessitating proactive, data-driven engagement with a range of external stakeholders (e.g., farmers and private landowners) to safeguard the quality of raw water reaching its treatment facilities and minimize pollution from pesticides, fertilizers, and other contaminants. Dŵr Cymru Welsh Water's catchment spatial risk analysts decided to use ArcGIS to develop a "one-stop shop" portal for sharing and managing data both internally and externally. The application was initially trialed and then quickly adopted as a business-critical system, utilizing the out-of-the-box functionality of their existing ArcGIS software with no new licensing costs.

For Dŵr Cymru Welsh Water, ArcGIS serves to collate, analyze, and manage disparate datasets and provides predictions of key issues affecting raw water quality. The platform also enables offline data access and collection in remote, isolated locations and supports department efforts ranging from regulatory compliance reporting to administering tree planting programs with farmers to reduce soil erosion and runoff. Ultimately, the ArcGIS portal has made Dŵr Cymru Welsh Water better equipped to work collaboratively with external stakeholders to protect raw water quality, which will reduce the need for chemicals and energy to treat the water, thereby decreasing operating costs while safeguarding the environment. Meanwhile, staff are able to work more efficiently, accurately, safely, and confidently in response to rapidly changing environmental conditions, with vital business intelligence and powerful spatial analytics available for users and teams across the organization.



Dŵr Cymru Welsh Water uses an online application to better understand and communicate how crops in Wales might impact water quality.

perspectives

"Water from catchment areas reaching our treatment works needs to be of manageable and expected quality. Where situations are often unpredictable, new means and ways of working with spatial data are critical for us in our work, so we can produce tailored web and mobile apps within hours."

— Shaun Lewis
Customer Acceptability and Compliance Performance Manager | Dŵr Cymru Welsh Water (United Kingdom)

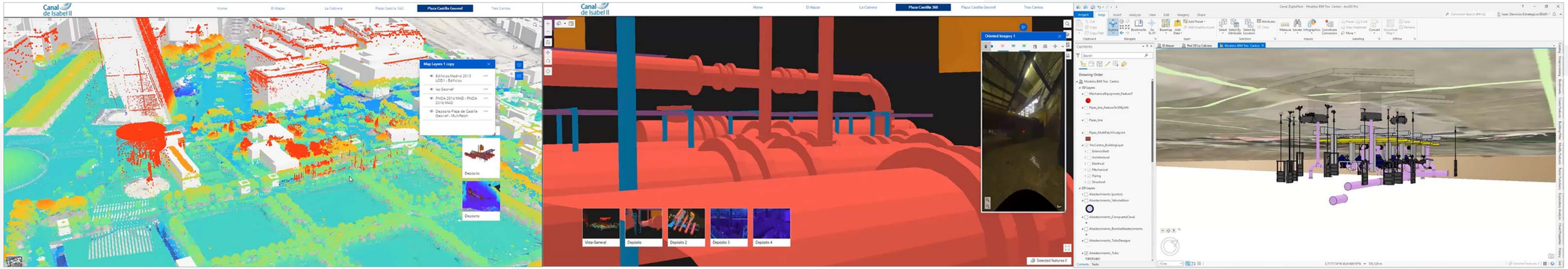
Optimizing Facility and Vertical Asset Management

GIS has traditionally been used to manage two-dimensional linear assets, like water, wastewater, and stormwater pipe networks. Esri is taking ArcGIS inside facilities as well, with a suite of tools for mapping, modeling, and managing three-dimensional vertical assets, such as treatment facilities and pump stations. By integrating design and engineering models (e.g., CAD and BIM) and real-time sensor and control system data, providing easy access to maintenance records and wayfinding guides, and delivering lifelike visualizations of facilities and their interconnected assets, GIS enables better understanding of complex 3D systems, structures, and assemblies at any point in the vertical asset life cycle, from design and construction to operations and maintenance.

Canal de Isabel II—the water and wastewater service provider for the Spanish capital city of Madrid—recently carried out four pilot projects to develop 3D models of different types of critical infrastructure assets, leveraging ArcGIS to integrate a range of datasets such as point clouds, CAD, BIM, and data collected in the field. The assets chosen for the projects included several vertical assets, such as a dam intake tower, an elevated reservoir, and a sewer lift station. For example, the dam intake tower was modeled in 3D and populated with technical data on facility equipment, historical maintenance information, and asset failure data, thereby taking a step forward in the integration of BIM design and engineering information with the ongoing operations and maintenance of the asset. For the elevated reservoir tower pilot, a laser scan was conducted to create a point cloud of the facility, enabling the development of a three-dimensional model that is accessible in ArcGIS.

Ultimately, Canal de Isabel II hopes to create a single view of the integrated water cycle across its entire infrastructure base, including vertical assets and facilities, by capturing all relevant data to make it available for internal staff, external collaborators, and the general public. The pilot projects have demonstrated several tangible benefits of ArcGIS vertical asset modeling and management capabilities, including creating attractive, modern data visualizations that capture maximum detail for users; improving data governance across all phases of water management, from collection and treatment to distribution and sanitation; and furthering the digital transformation of Canal de Isabel II as a whole by making 3D the standard for infrastructure models and data moving forward.

La Cabrera water distribution network visualized in 3D.



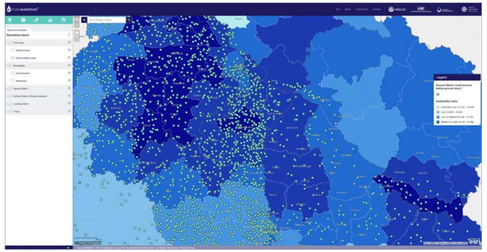
LEFT:
At Plaza Castilla a laser scan was conducted with a point cloud to support a three-dimensional model.

CENTER:
Canal de Isabel II has developed a 360 degree view of assets using a point cloud, three-dimensional modeling and images using oriented imagery tools.

RIGHT:
Tres Cantos BIM integrated with ArcGIS Pro.

For video

GIS in the Developing World

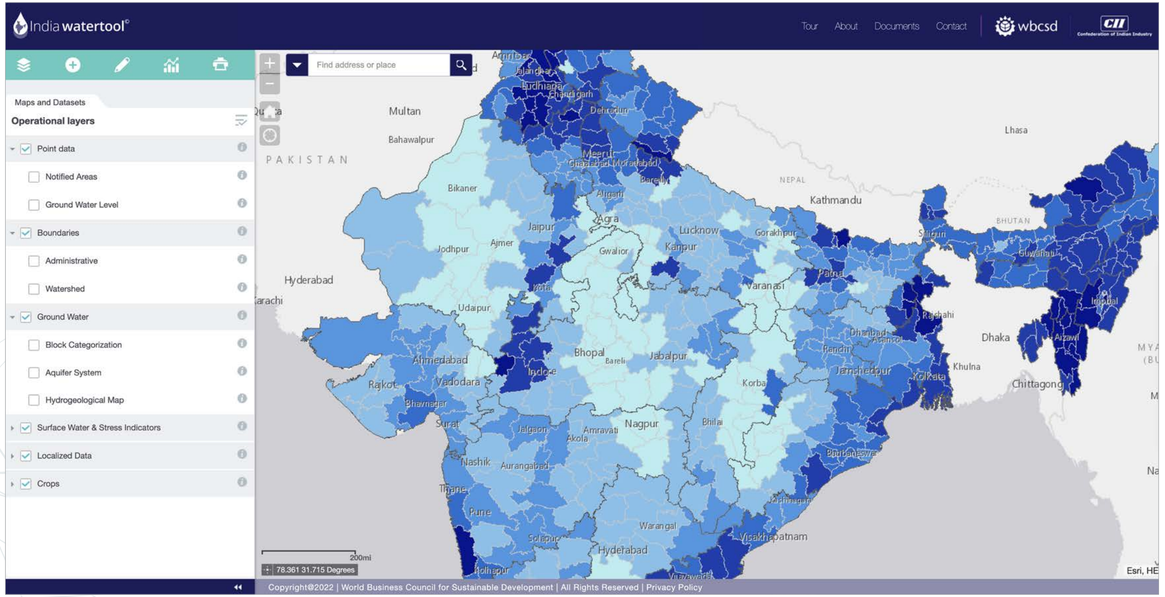


The India Water Tool provides GIS mapping and analytics to help companies and investors understand water risk and plan water management interventions.

perspectives

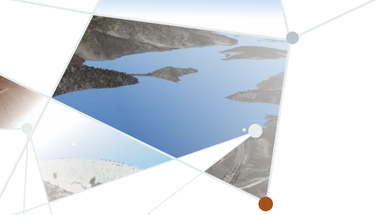
"Geospatial technologies can be a force multiplier in [water] and sewerage management, including planning, design, and management."

— Agendra Kumar | *Managing Director* | *Esri India*



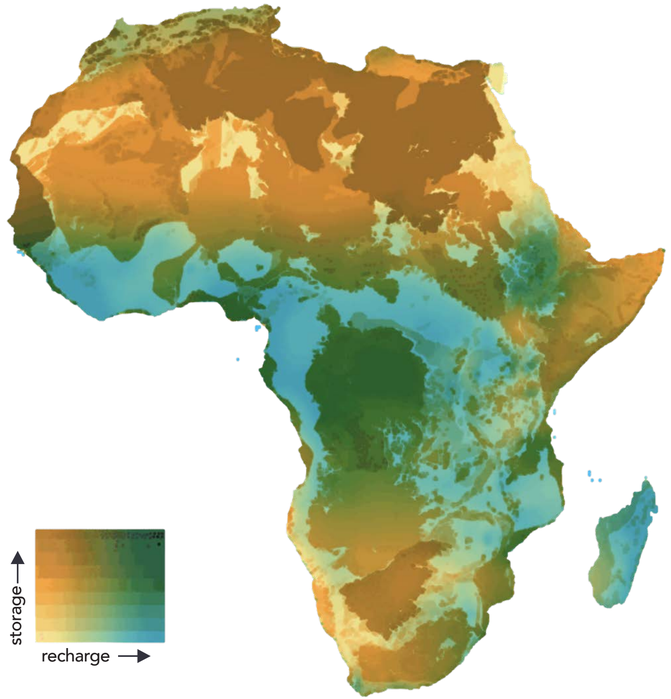
Digital water technology may seem to be limited to the economies of North America and Europe, with little relevance or applicability in emerging markets where universal access to safe drinking water and sanitation remains elusive. In fact, GIS is a powerful, versatile, and affordable platform for addressing a wide variety of water challenges and has been used successfully by utility operators and water resource managers throughout the the developing world, including India and the African continent. GIS can support efforts to map and monitor source water, model and manage new infrastructure, and evaluate service population behavior and demographics, even in relatively low-technology contexts.

India, for example, ranks 13th out of the 17 countries facing extremely high water stress, with more a than a third of the country's population living in water-stressed areas, and recent projections indicating that it will have only half the water it needs by 2030 if current consumption trends continue. At the same time, a significant share of the Indian population lacks access to safe, reliable drinking water and sanitation infrastructure, necessitating an integrated water resources management (IWRM) approach to the country's water challenges. ArcGIS technology has been used by both national and municipal agencies to provide critical geospatial context and insights for these efforts, ranging from basic data collection, management, and visualization to advanced modeling and forecasting, predictive analytics, and situational awareness. For example, the municipality of Thrissur in Kerala, India, has leveraged ArcGIS for its Water Efficient Thrissur (WET) campaign, integrating spatial information with real-time smart meter and IoT data to help reduce leakage and water theft, geoenable billing and customer feedback systems, reduce response time to outages, and run advanced modeling and simulations to forecast demand and supply dynamics. Meanwhile, a consortium of national and international companies and agencies used ArcGIS as the core of the India Water Tool, a public data visualization and decision-support tool developed to help businesses and investors understand water risk and plan water management interventions across the country's watersheds.

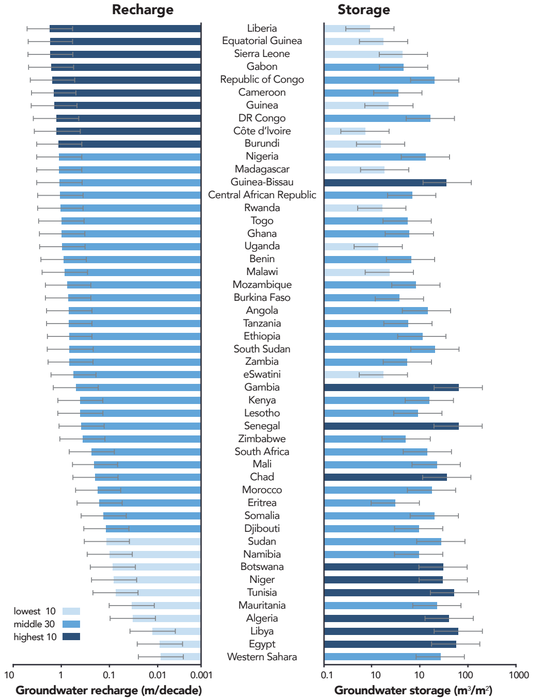


BGS map indicating the location, recharge rate, and storage potential of African groundwater resources.

GIS technology can also play an instrumental role in helping governments, academics, and nongovernmental organizations (NGOs) model and manage water resources in the developing world. In Africa, for instance, GIS was used in a recent international study led by the British Geological Survey (BGS) on the distribution and sustainability of groundwater resources across the African Continent, challenging a longstanding misperception that African societies are dry, arid, and entirely dependent on seasonal rainfall for agriculture and economic activity. By aggregating and analyzing a variety of spatial datasets (e.g., climate, precipitation, land cover, vegetation health, and soil type), the BGS team has produced maps that highlight the location, storage capacity, and recharge rate of groundwater resources throughout Africa. These maps have proven invaluable for government planners and NGOs in highlighting countries and regions with plentiful, sustainable groundwater reserves to support local communities, agricultural activity, and public health.



British Geological Survey © UKRI 2021



perspectives

"If you do get a map that people are really going to look at and use, you want to make sure that you're giving them information that is useful to them and is a gateway to more information."

— Alan MacDonald

Managing Director | IMP3 Research Scientist and Head of Groundwater Resilience, British Geological Survey (United Kingdom/Africa)

DEFINITIONS

Integrated Water Resources Management (IWRM)

An approach to water and land management that takes a holistic view of the water cycle, including water, wastewater, and stormwater flows across municipal, agricultural, and industrial sectors.


TAKING THE
next steps
ON THE DIGITAL
WATER JOURNEY

perspectives

"GIS is the foundation for our digital transformation. It's our building block that can branch off into different areas of the organization, from customer care and operations, to finance and administration, to external stakeholder engagement."

— Mark Bowen
Former GIS and CMMS Manager | Lehigh County Authority (United States)

You Are Here:

Getting Started on the Path to Transformation

Recent industry surveys suggest that time, rather than cost, is the biggest barrier to digital transformation in the water utility sector. Utility managers fear getting entangled in long, arduous digital initiatives that will monopolize their team's time, attention, and budget for months or years before producing any tangible benefits for customers and staff.

It doesn't have to be this way. Many of the most successful digital water innovators in the industry are those who have learned one simple, but essential, lesson: the best place to start is where you already are. Most utilities have already made significant investments in data and digital systems across departments and functional areas, and starting from scratch, or trying to tackle everything at once, is both unwise and unnecessary. The key is to find ways to maximize the value of existing investments first and to build incrementally from there—learning, adjusting, and improving as you go.

GIS plays a key role in this process. Esri's ArcGIS is uniquely designed to integrate with a wide variety of devices, business systems, and data feeds across all corners of the water industry, providing crucial locational context that gives value and meaning to dark and disparate data. Likewise, ArcGIS is built to be used by anyone, regardless of role or location—providing everyone in the organization with the tools and information they need to make better operational and planning decisions, communicate and collaborate with one another more effectively, and solve problems more efficiently for their customers, coworkers, and communities.

So get out there, find your first problem, and see firsthand what GIS can do as the foundation for digital transformation at your organization.

Recommendations and Best Practices from Utility Pioneers

STILL NOT SURE WHERE TO BEGIN?
Leading Esri water, wastewater, and stormwater utility clients offer these words of wisdom to their peers:

- Be clear about your goals and vision for your GIS program—focus on the "why" before the "what" or "how," and align your objectives with your organization's core values and strategic priorities.
- Put yourself in your team members' shoes—try to understand staff's key objectives, workflows, and pain points, and find ways to leverage GIS and other technologies to make their lives easier.
- Start with quick and easy wins to better showcase the value of GIS to your team—if a picture is worth a thousand words, a useful, functional application is worth a million.
- Find a champion in each department who can help demonstrate the value of the system to their friends and colleagues.
- Make sure your GIS staff have access to the resources and training they need to get the maximum value out of your GIS and your other digital investments.
- Democratize your organization's data—let your team members see their own data, and give them the tools to update and maintain it over time.
- Patience and positivity are key for success in communicating the value of the new, especially new technology.

perspectives

"Yes, it's a change in tooling, but more so [it's] an organizational change that impacts the people. Take enough time to educate your employees and help them get used to the new way of working. Using [GIS] is not a onetime implementation; it's a [continual] process."

— Wilfried Martens
Department Head of Distribution Infrastructure | Brabant Water (Netherlands)

WHO IS esri® IN THE WORLD OF DIGITAL WATER?

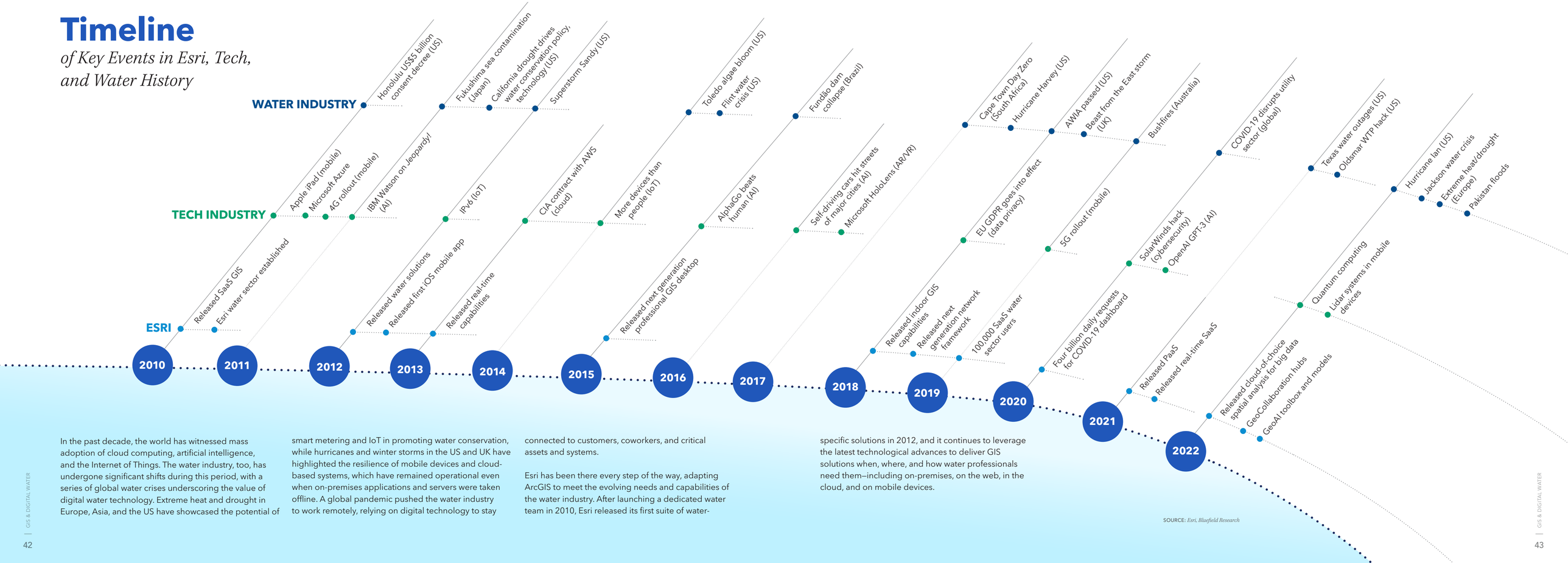
Gartner's *Vital Digital Technology Investments for Water Utilities* report identifies GIS as a key part of water utility enterprise information management (EIM) strategies and an enabler of advanced asset and operations analysis and service delivery functionality. Integration with enterprise asset management, work management, network analysis, spatial planning, and operations management provides utilities with answers to critical water business and operational performance questions.

You may not be familiar with Esri, but chances are, you've come across its software. Esri's ArcGIS is the leading GIS platform in use by water utilities around the world. The *Geographic Information Systems Global Market* report by ARC Advisory Group lists Esri as the market leader of GIS technology, accounting for more than 45 percent of the global market. ARC Advisory Group describes Esri's GIS technology as a true platform that has evolved from a mapping program to a mapping system that developed into a location platform enabling users to access, use, and analyze location information from any device around the globe.

Based in Redlands, California, Esri was founded in 1969 as a land-use consultancy and launched the first commercial GIS software program 12 years later. Esri has continued to evolve along with the rest of the tech industry, pushing GIS to new heights with each successive technological revolution.

Timeline

of Key Events in Esri, Tech, and Water History



In the past decade, the world has witnessed mass adoption of cloud computing, artificial intelligence, and the Internet of Things. The water industry, too, has undergone significant shifts during this period, with a series of global water crises underscoring the value of digital water technology. Extreme heat and drought in Europe, Asia, and the US have showcased the potential of smart metering and IoT in promoting water conservation, while hurricanes and winter storms in the US and UK have highlighted the resilience of mobile devices and cloud-based systems, which have remained operational even when on-premises applications and servers were taken offline. A global pandemic pushed the water industry to work remotely, relying on digital technology to stay connected to customers, coworkers, and critical assets and systems.

Esri has been there every step of the way, adapting ArcGIS to meet the evolving needs and capabilities of the water industry. After launching a dedicated water team in 2010, Esri released its first suite of water-specific solutions in 2012, and it continues to leverage the latest technological advances to deliver GIS solutions when, where, and how water professionals need them—including on-premises, on the web, in the cloud, and on mobile devices.

SOURCE: *Esri, Bluefield Research*

ESRI PARTNERS & DISTRIBUTORS

Esri has built a robust ecosystem of partners that extends to all regions of the globe. This ecosystem includes third-party digital water hardware, software, and service providers whose products are built on top of, or integrate easily with, ArcGIS. There is also a global network of distributors that support customers all over the world.

UNLOCK THE FULL POTENTIAL OF GIS

Esri partners with leading technology firms to help the water industry harness the power of location intelligence across a range of critical applications, including mobile workforce management, regulatory and compliance management, asset condition inspection, and system optimization. Meanwhile, Esri's service partners and distributors—both leading global engineering firms and dedicated GIS specialists—can provide utility operators with the technical support they need to integrate their systems and data, optimize their workflows and processes, and maximize the value of their GIS and other digital water investments.

In other words, ArcGIS can do so much more for your organization than simply mapping your water, wastewater, and stormwater infrastructure—from facilitating better coordination and collaboration between field and office staff, to visualizing and analyzing real-time data from across your service area, to providing more precise, granular models of the performance and behavior of your critical plant and network assets. With a bit of strategic planning and configuration, your GIS platform can serve as the cornerstone for all of your digital transformation initiatives. GIS can help you derive greater value from your new and existing digital water investments across departments and domains, whether they be smart metering rollouts, SCADA modernization projects, or business systems integrations.

esri® | THE SCIENCE OF WHERE®