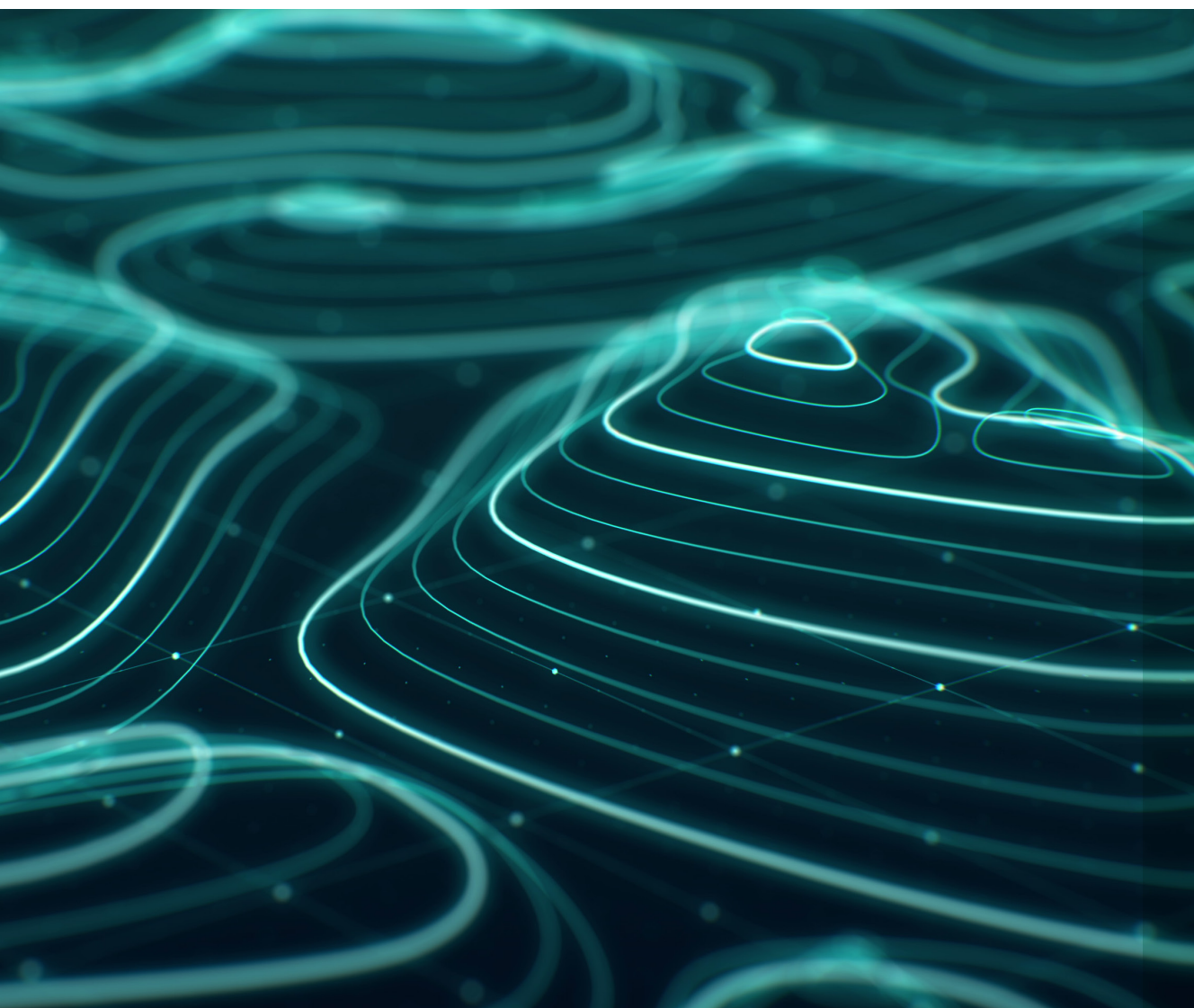


The present and future of GIS in the water sector

The most innovative use cases



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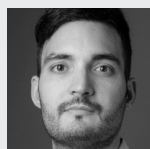
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Introduction

We are certainly living through a time of global change characterized by a volatile, unknown and rapidly shifting environment. In this context, digital transformation has become the backbone of a society in which digital and environmental sustainability are of paramount importance.

These new challenges demand the deployment of operational changes which, in turn, can solve some of the serious challenges facing humanity, such as water supply. Against this backdrop, digital transformation plays a hugely important role. In the case of the water cycle, Geographic Information Systems (GIS) have proved to be one of the most important assets for users.

Thanks to their connection with the environment, in this case on a map, GIS provide added value as they interconnect everything that happens around us. However, **GIS systems also provide users with information, locating it in a geographical point, and analyzing the data obtained from it, practically in real time.** This is their strong point: analysis, which is where everything lies in geostatistics.

Therefore, GIS systems have become essential tools in the water cycle, as their work leads to infrastructure upgrades, cost savings, detection of pests and sources of contagion, and improvements in water management and water-related assets. In short, they have become key tools for the management of the strategic resource we call water.

What are Geographic Information Systems (GIS)?

In recent years, Geographic Information Systems (GIS) have progressed from being a tool for modelling geographical data to a **platform for understanding and planning the world**.

In today's ever-changing world, convergence and data analysis of the countless sources of information have become a necessity. In this scenario, with the pandemic still in the background, the implementation of Geographic Information Systems is particularly relevant for gathering information to manage resources more effectively and efficiently, such as the detection of leaks and COVID outbreaks in wastewater.

GIS have four basic functions: storing, displaying, checking and analyzing information. As such, GIS are built on a combination of five elements: data (spatial or telematic), technology, analysis processes, procedures, and people. As a result, GIS help to understand patterns, analyze, solve complex problems, uncover relationships between data, monitor changes and comprehend trends.

GIS are thus capable of integrating a variety of data sources, subsequently representing them in maps and 3D visualizations, to analyze the data represented, detect trends and make faster, smarter decisions.

There are four main elements in a GIS, which are essential for their proper functioning:

1 Maps

These are the most visible elements: the graphical representation of geospatial datasets to facilitate their analysis. They can be shared and distributed on multiple platforms, and there are even certain mobile applications that offer this service, collecting and analyzing data on smartphones.

2 Applications

GIS have become central to the digital transformation of companies in the so-called industrial revolution 4.0. They are transversal tools in organizations, as they support business processes and can be used to share data and create maps thanks mainly to landmarks taken from databases, image analysis and graphic design tools.

3 Data

Data is at the heart of these systems and is key to understanding the GIS ecosystem, given that, apart from the visual part of the maps, it is the alphanumeric data that brings together the information and develops the geostatistics.

Each GIS can contain an infinite number of data types and sources, from satellite images, through to sensor information, vector data, and images taken with drones. Therefore, we can talk about two types of data: spatial data, which contains spatial information, such as latitude and longitude, and the attribute data of the represented area. This data, in turn, can be digital or analog, depending on its source.

4 Analysis

However, **the true power of GIS lies in their ability to assess data, predict events, and detect trends and patterns.** Analysis, whether simple or more complex, provides users with a multi-perspective understanding of the data and maps they contain, resolving problems that would otherwise go unanswered. This evaluation and understanding of the data brought by analysis can be performed either on the element location or on the element itself, giving us a more global overview.



Thus, there are at least three advantages of these Geographic Information Systems:

Real-time, available information

As mentioned above, these GIS systems gather real-time information from a variety of sources which is available for consultation at any time.

Good return on investment

Undoubtedly, one of the great advantages of GIS systems lies in the benefits it brings to users, taking into account the investment required. These benefits include streamlining, greater efficiency, control, and resource optimization. In the case of the water sector, for example, having a GIS can help to detect and reduce leaks, decrease cost overruns and, in short, improve decision-making.

Improved operational efficiency and resource managements

Having all the information available in real time means enhanced operational efficiency. Possible inefficiencies that may appear throughout the water cycle must be reduced, since there are thousands of landmarks that must be geolocated, collected, and analyzed for decisions to subsequently be made.

Current GIS technology applications

Today, numerous disciplines and specific fields are leveraging the value of Geographic Information Systems to change the way the world works.

The dynamic GIS market has brought about continuous improvement. This change is already beginning to be seen in organizations such as universities, government, public agencies, telecommunication companies, and utilities. In addition, resource management (electricity, gas, natural resources) and other fields of knowledge, such as education, criminology, national defense, land use planning, urban planning, transportation, and logistics, are benefiting from its capabilities.

The use of GIS has been democratized to such an extent that we use them for everyday tasks, such as locating restaurants, obtaining the fastest route to somewhere we want to go, and even assessing the environmental and socio-cultural characteristics of an area we want to live in. These systems have become part and parcel of our daily lives and are an essential tool on the road to digitally transforming organizations.

Their integration with numerous tools, and their potential to represent and analyze geospatial information, has led to GIS being mainstreamed in a large number of fields, including:

Geomarketing

Geospatial components are used to determine market and customer niches. In addition, they can impact on users through targeted advertising, which is delivered in specific places thanks to reverse geocoding maps.

Human dynamics

The study of the activities carried out by a group of people over a given period of time generates geospatial data that can be analyzed using a GIS.

Social networks

The transfer of information and knowledge of users' geographical positions makes social networks a source of interest for studying certain phenomena and creating thematic maps based on them.

Smart cities

GIS are an excellent solution when implementing a smart project, as they interconnect all the components used in smart cities by geolocating services and infrastructures.

Unmanned Aerial Vehicles (UAVs).

Drones, which are becoming increasingly popular, provide high-resolution images using LIDAR technology, which can detect light and range. These images can then be integrated and processed in a GIS.

Outdoor & indoor mapping

Companies are improving their processes by incorporating geographic intelligence and exploiting the data contained in GIS. They are already monitoring the position of objects and people in both open (outdoor mapping) and closed (indoor mapping) environments.

Remote sensing

The acquisition of data from the earth's surface, from sensors installed on space platforms and with alternate data frequency, provides information that is useful in different applications, such as agriculture and forestry.

What are the main use cases in the water sector?

The water resource applications deployed in GIS cover the entire water cycle and its processes. **These systems facilitate more effective and efficient management of water resources in the sector by providing more accurate understanding of the availability and distribution of water resources.** In addition, they can address specific challenges and problems that would otherwise go unanswered.

Some of the use cases include:

- Understanding relationships between the components of a water distribution network and of a hydrological basin (rivers, wetlands, groundwater, etc.).
- Understanding the hydraulic processes taking place in different space and time scales.
- Providing quantitative methods to assess water networks and manage them more effectively.
- Creating advanced water simulation models.
- Assessing risks and resolving uncertainties in the decision-making process of designing water networks.

However, it is important to focus on three areas of daily use, i.e., drinking water supply, wastewater treatment and irrigation management, as these are key points in environmental and digital sustainability.

Drinking water

Leak and alarm management.

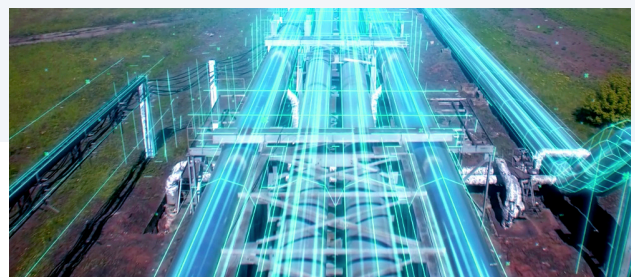
Thanks to GIS, utilities can make decisions to minimize water service interruptions after a leak or planned work in the distribution network. These systems provide information about which pipes and service connections are going to be affected by repair work or a leak, thus providing guidance on which elements, such as valves, need to be closed to minimize the consequences. Users can thus be notified if their water is likely to be cut off at home.

Fault detection and prevention

GIS gather vital information to prevent failures in the distribution network, such as the material pipes are made of or the date they were installed. Geospatial analysis of the pipes, i.e., linking data with the geographical element facilitates inspections. For example, detecting connections that are operational but should no longer be in use.

Geolocation of field work

GIS systems provide field information through real-time mapping of essential data for route setting and tracking, and detailed documentation related to the work performed at a specific location. Therefore, GIS improves water resource management by providing more detailed, up-to-date information.



Wastewater

Analysis of virus incidence in the population

GIS can compile, analyze, and draw up infected population maps or cadastral maps (document with information on location, measurements and/or land surface, etc.), to establish areas of greater or lesser infection, population ratios, ages, etc., based on the information available from the pipes, connections and wastewater pipes that go from each household to the mains sewer, crossed with contagion data. Thus, GIS enable us to carry out critical studies to analyze relationships and behavioral patterns that can provide a more effective response to pandemics.

Flood prevention

GIS systems, in combination with remote sensing, can identify possible blockages in sewers, and show which ones have poor drainage capacity, providing municipalities with alerts to prevent flooding after heavy rainfall events.



Irrigation

Water volume control

Irrigation associations can access information about the amount of water retained in the soil through remote sensing, IoT, satellite imagery and sensors. This means irrigation can be regulated according to the needs of each field, thus optimizing water management and reducing cost overruns.

Early pest detection in crops

Areas that are prone to becoming pest breeding sites can be located thanks to information returned by the GIS, using geo-referenced land maps. Likewise, this real-time information provides other specific data such as pest behavior patterns, management, and prevention.

Failure prevention

GIS systems can detect assets whose life cycle is coming to an end, enabling irrigation associations to replace them before they fail, causing imbalances in the system.



How do GIS help utilities?

A GIS system is a repository housing the water supply and sanitation networks of the different towns and cities run by a utility. Its efficiency partly depends on a robust connection to the rest of the utility's systems and the tools used in daily management.

Likewise, **GIS systems are the core of the geospatial information about a utility's assets, where the maintenance of the infrastructures' geospatial information and their technical characteristics is carried out.**

Some of their key features include:

- Advanced network inventory queries
- Generation of thematic maps
- Printing of maps using dynamic templates
- Generation of longitudinal profiles of the networks and management of discharge basins
- Links to documentation, photographs, sketches, etc.
- Real-time information queries on mobile devices
- In recent years, some of the most advanced utilities have chosen to locate elements by integrating them with GPS systems, as well as connecting them with mathematical models (EPANET).



What does a GIS specialist do?

A GIS specialist basically brings together knowledge about cartography, geospatial analysis and data management.

The main skills that a GIS specialist requires are as follows:

- They must have good geospatial orientation to interpret data. This is essential because their ability to observe data hinges on this.
- They must know how to create topological rules which, when linked to the world of water, are extremely generic in certain respects.
- They must be familiar with Building Information Modelling (BIM) which is one of the existing trends that focuses on real-time knowledge of the condition of infrastructures and/or buildings.
- They must have sound knowledge of the water cycle and its constituent elements.

Trends

New technologies are key to the success of digital transformation. Although they were developed years ago, the upsurge in the use of GIS systems has been relatively recent, leading some authors to include them in the New Technologies category.

In any event, these GIS systems have adapted to digital transformation in different ways:

Cloud GIS

Just as it is becoming increasingly common to save files in the cloud, GIS cloud applications are also available. This brings major benefits, as they operate without their own server or database manager, reducing costs and improving data access.

Autonomous vehicles

In a few years' time, the existence of autonomous cars will be a reality. GIS play an important role in this type of projects, as they are used throughout the entire process from mapping the vehicle's routes to the actual driving of the vehicle using LIDAR technologies, including the creation of maps that are transferred to the car so that it is aware of the surrounding environment.

Building Information Modeling (BIM)

Creating scenarios that are highly realistic is a significant advantage, and this is one of the clearest trends in GIS. There are multiple applications for this, one of which is Building Information Modeling (BIM). This system provides real-time visualization of the conditions of an infrastructure or building, thus facilitating more efficient, ongoing maintenance.

Virtual reality

Virtual reality is becoming increasingly common in our lives, such as in the management of a city's distribution networks. This information is particularly helpful to the employees who are in charge of the daily maintenance of these networks.

Big Data and IoT

We can now collect and process huge amounts of data in real time. This information is produced by all kinds of devices. Geospatial artificial intelligence systems play a relevant role in this field, as they feature machine learning systems that work with the information provided. These data-driven prediction systems have multiple applications, from serving public agencies for better city management to assisting private-sector companies in optimized data-driven decision-making.

5G Technology

Real-time information on what is happening in a water network and in any of its hydraulic elements will become a reality thanks to 5G connectivity. Data visualization and interpretation will become faster thanks to the speed of 5G, thus benefiting statistical and functional calculations and algorithms. The potential for interconnection between various elements, for example, also adds value.



Conclusions

Current scenarios call for measures, solutions and technologies that can live up to the circumstances. The fight against climate change and water scarcity implies a paradigm shift that also affects operations. **Digital transformation is a means to drive this paradigm and must also be used in the water sector.**

However, this transformation is not optional. It is the only way forward if we are to tackle today's challenges. According to the latest UN data, water leaks and over-consumption are major issues: **non-revenue water accounts for the equivalent of supplying water to nearly 200 million people. It is therefore crucial to find effective solutions to this problem and improve people's quality of life.**

In this context, in which digital transformation is not a trend but a reality, data has become an intangible value of capital importance, both to analyze historical data and to detect trends and resolve future situations. Geographic Information Systems (GIS) can map data by cross-referencing it with various sources and exploring different alternatives.

Therefore, and although it is true that they predate digital transformation, GIS systems play a fundamental role in this process thanks, precisely, to their compatibility with other data sources and the information they deliver. In addition, the importance of reducing our water footprint, improving natural resource management, increasing response speeds to leaks and outages, and reducing cost overruns make Geographic Information Systems a highly valuable tool for users.

The gradual implementation of digital transformation elements, such as GIS, in different processes, together with expert advice, are essential to face the challenges posed by everyday reality, in order to apply sustainable measures that help to face the future with realistic optimism.



About Idrica

Idrica is a leading company specializing in water cycle management. Its unique value proposition is based on the efficiency and quality of its services and on the GoAigua technological solution used for the digital transformation of the industry.

Contact us for an analysis of the challenges facing your organization and learn how the GoAigua technology is helping its customers in the water industry.

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