Smarter Cities

Thought Leadership White Paper

Employing integrated operations for water resources management

IBM

Contents

Water affects almost every aspect of human life. Everything from health and nourishment, to business and commerce, to energy and transportation relies on water. But today, the world's water systems face serious issues including declining water quality and aging and insufficient infrastructures. Pressures from climate change and more frequent extreme wet and dry weather are compounding water-related problems. Without smarter water management, global water systems will not be able to meet the critical needs of people and business in virtually every country of the world. In the past, water managers have typically tackled water management issues in isolation, focusing on traditional physical infrastructure solutions and single-point technology solutions.

As a result, the industry is now dealing with applications and data landscapes that aren't integrated. However, water issues can't be solved by a single organization; they require collaboration among many stakeholders. To help managers make better decisions in the future, cities and water industry professionals need to work together to develop smarter water strategies. The many existing data streams, models and single-purpose solutions must be integrated into a seamless network of water resources information and analytics. IBM can provide the technical foundation to facilitate the flow of information across organizational boundaries, and establish a shared, comprehensive view of the water resources landscape. By improving modeling and engaging the water resources management community and key stakeholders, cities and regions can make better decisions to optimize how they achieve water management objectives for the greater societal good.

Facing water system challenges

Today, 3.3 billion people live in cities, and that number is expected to double by 2050.[1] Many cities lack the resources to keep up with rapid population growth while delivering the services that citizens demand. As shown in Figure 1, the global water system faces several interrelated challenges that lead to critical vulnerabilities:

- Water resources worldwide are diminishing, while demand for those resources is increasing. To reduce the gap between the demand for water and the supply of water, the management of water resources must be improved.
- Water infrastructures are inadequate and aging. Reducing maintenance costs and improving the reliability of the water network requires better asset management.
- Climate change is causing more frequent, more extreme weather—both too dry and too wet. It is important to be able to analyze data to help predict when, where and how severe events will occur to mitigate costs and improve preparedness and incident response.
- Globally, water quality is declining. To improve and maintain water quality, pollution must be monitored and controlled.
- A shortage of workers with the right industry skills exists. It is vital to preserve knowledge and improve the attractiveness of the water industry to young, skilled workers.

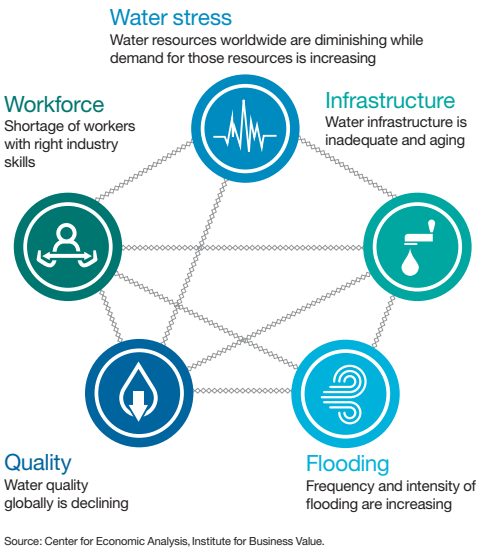
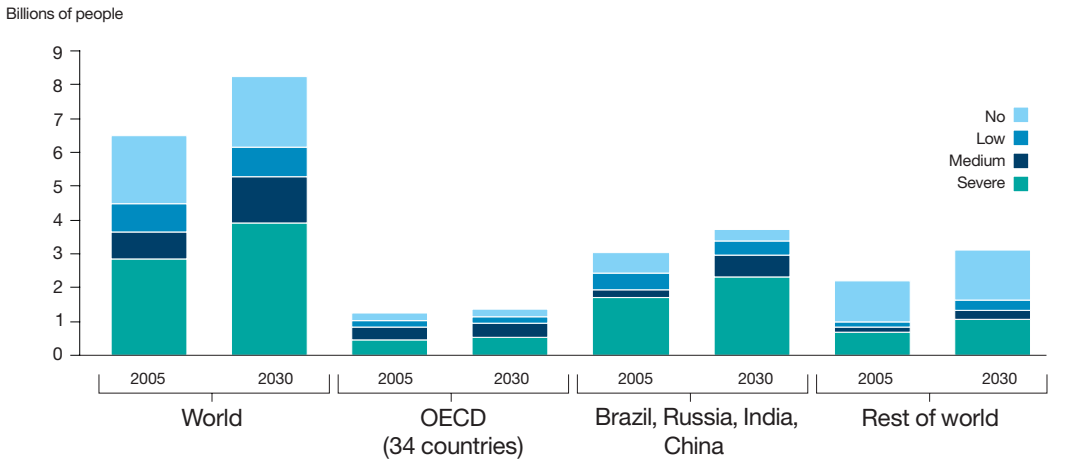


Figure 1. Interrelated challenges in the global water system are creating critical vulnerabilities.

By 2030, the world's population is expected to grow to over 8.2 billion people and the number of people living in areas affected by severe water stress is expected to increase to over 3.9 billion.[2] "Water stress" occurs when the demand for water exceeds the amount of water available. Today, water stress is a global issue that affects all regions (see Figure 2). Water stress also creates further negative impacts on the quantity and quality of water.[3] As the number of people living in areas of severe water stress increases, water stress will become even more pervasive.

Stress on water resources and infrastructures affects nearly every dimension of a city's economic development roadmap. Today, cities must innovate to get more from their limited resources. Even though cities are expanding steadily, the resources on which their growth depends are finite. Going forward, sustainability will be essential, particularly in some areas of the world where up to 50 percent of the water supply in urban areas is lost as a result of infrastructure leaks.[4]



Note: Water stress is based on the ratio of water withdrawal to annual water availability and uses the following thresholds: <10 percent = low; 10-20 percent = moderate, 20-40 percent = medium, >40 percent = severe.
Source: OECD, OECD Environmental Outlook 2030, 2007.

Figure 2. Populations living in areas of water stress, 2005 and 2030.

Declining quality is adversely affecting water supplies in many parts of the world.[5] The amount of water use is also rising. Water use increased at twice the rate of population growth between 1900 and 1995[6] and global water demand is projected to increase by 55 percent between 2000 and 2050.[7]

Even more alarming is the estimated investment that will be required to modernize obsolete infrastructures to meet these ever-expanding water demands. A report by Booz Allen Hamilton estimates that from 2005 - 2030, modernizing and expanding urban infrastructures would require approximately USD41 trillion. Of that, USD22.6 trillion would be needed for water infrastructure enhancements.[8]

Intelligently managing resources

Whether in emerging cities where populations are growing rapidly, or in mature cities where leaders deal with economic challenges and population changes, city leaders must face the harsh realities of scarce water resources and overwhelming demands. Leaders must make decisions related to water management that not only help the city survive, but transform to drive enhanced innovation, economic development, community engagement and overall sustainability.

Despite their enormous diversity, water resources management challenges everywhere are identical in one respect: integrated decision-making across systems of systems is the key to success. Water resources management encompasses storm water management and flood control, aquifer recharge, water reuse, catchment basin water quality management, and the balance between energy production (including hydroelectric power), agricultural irrigation, and domestic and industrial consumption. Complex and deeply interdependent, these systems produce equally complex and interdependent challenges that demand innovative thinking. Until recently, city leaders and water managers have approached technology solutions for water management in isolation.

In order to address and avoid water management problems, governments and local water authorities have focused on traditional physical infrastructures and isolated technology solutions. Water managers in these organizations must work with many different vendors, regulators and industry and research organizations. If they do not, they are locked into working with a small set of vendors who are financially motivated to exclude others.

Because regional water management requires collaboration among many stakeholders, water management issues cannot be solved by a single organization. The issues are complex and varied, including:

- The need for more investments in reservoirs, dikes, tunnels and dams at the same time budgets have been lowered due to economic circumstances.
- No single strategy exists to unify information and create a common operating picture for an entire water system. Shipping, flood risk, drought, water quality and emergency response are generally dealt with as separate domains.
- Multiple, incompatible, inconsistent and dispersed assets from a range of vendors are owned by disparate entities and managed from remote facilities with their own unique applications.
- Large portfolios of proprietary solutions and applications are used to manage water processes.
- Physical assets, such as pumps and sensor systems, and data and information systems may be poorly protected, which can lead to security issues.

Enabling smarter systems

Water resources management is quickly becoming as much of a big data problem as a water problem. New solutions will not only involve more concrete and physical infrastructure but require more integrated and interoperable water management decision-support systems as well. For a city and region to become more agile, efficient and responsive, data must be

shared and exchanged among departments, agencies, partners and citizens. The current fragmented technology landscape prevents cities and regions from reaching higher levels of efficiency and effectiveness. In many cases, data might exist that could lead to new insights or innovation, but often it cannot be found, is difficult to access or is unreliable. The water industry needs robust and comprehensive platforms that facilitate integrated operations, enable collaborative research and knowledge transfer, and provide advanced modeling capabilities and predictive analytics.

Water managers and their financial counterparts need to become aware of the costs of managing water and develop strategies for lowering those costs. New platforms for interagency collaboration are required to enable the vast number of agencies and organizations that have complementary missions in water science, observation, management and prediction to share water resources information, products and services. By developing a common operating picture, they can improve interoperability between systems, exchange data and information, and gain the flexibility to support better operations and planning.

Looking ahead

To manage water operations and infrastructures to drive optimization, efficiency and conservation, stakeholders will need to harness large amounts of data. Gaining the right insights and identifying the right patterns can help prevent problems, improve preparedness and response, and promote sustainability. Moving forward, it will be essential for stakeholders to:

- Consolidate disparate data sources to improve situational awareness.
- Enhance decision-making with collaboration and predictive insights.
- Keep operators informed with customizable rules-based alerts.

Case study: Digital Delta

The Dutch Water Authorities needed to integrate vast and disparate data sets to protect citizens and businesses from the risk of flooding and drought, ensure water quality, and allow shipping over Dutch waterways. The national water authority, Rijkswaterstaat, initiated the "Digital Delta" program to experiment with the integration of data from a wide range of sources and applications. They wanted to enable the different stakeholders to optimize national, regional and city water management in all its aspects. By integrating data from sensors, forecasting models, applications and historical sources with analytics and visualization tools, operators can anticipate problems in real time. In addition, experts can improve response and enhance the efficiency of the entire system. They also reduced the costs of managing water by as much as 15 percent.

Collaboration among different departments such as water management, asset management, IT and finance, will be required so everyone involved is focused on improving the way water is managed and understands how changes will affect the system as a whole. Systems need to be put in place that offer:

- Advanced data management and visualization.
- Collaboration capabilities and reporting tools with customized key performance indicators (KPIs).
- Operations and device monitoring.
- Sensor-based detection and data collection.

Any new platform must also include workflow and advanced water and weather modeling, and simulation tools so water authorities can make informed decisions. Accurately modeled scenarios can maximize preparedness, so authorities can recommend the most effective allocation of limited resources during routine operations and emergencies. Modeling and simulation tools can help highlight ways to optimize the operation of water infrastructure assets, such as gates and pumps, which can considerably improve operational efficiency and reduce risk. With simulation tools, authorities also can predict how adverse events will unfold. They can evaluate and optimize responses to events such as flooding and drought by running a range of scenarios, calculating evacuation routes and potential damage, and testing and strengthening emergency plans.

Implementing new water management systems can offer substantial benefits for both city and regional leaders and citizens. City and regional leader benefits include:

- Improved system-wide visibility and crisis management capabilities.
- Reduced water use and management costs.
- A reduction of water quality events and easier mitigation if events do occur.
- Improved flood control.
- Extended lifespan of existing infrastructures.

Citizen benefits include:

- More consistent water availability.
- Real-time usage information and leak alerts.
- Faster, more proactive and less disruptive service.
- Reduced health risk from poor water quality.
- Increased transparency and engagement.

The IT environment for water resources management is complex, and in many situations solutions already exist. A new platform must integrate with existing systems and enable them to become more effective to provide solutions more quickly and affordably.

Case study: Ireland's Marine Institute

In Ireland, the Marine Institute wanted to better use their marine and coastal research data. Previously, they had collected this data from six buoys in a local estuarine bay and stored it in a local database. Compiling this data to perform trend analyses or draw conclusions was complicated. After the information was compiled, it was reported across multiple sites, so outside parties struggled to view it. The Marine Institute deployed a number of new sensor platforms in the bay to gather and distribute near-real-time data about environmental conditions, pollution levels and marine life. The new water resource management solution is based on an open architecture that integrates sensor data with other sources such as geographical information systems. Now researchers, the harbor master, and other users can access compiled data through customizable portals that support trending and modeling. They also can set alarms to notify them when certain conditions arise, such as a potential flood or sudden increase in pollution. The information now supports a broad range of activities from climate change research to commercial fishing.

Getting smarter about water management

The IBM solutions for water resources management enable integrated operations that facilitate the flow of information across departmental and organizational boundaries. By enabling a unified view of water-related operations, combined with analytical, visualization and reporting tools, IBM can help you

better balance water supply and demand, manage water quality, improve flood control, maintain critical infrastructure assets and drive multi-stakeholder collaboration. Working with IBM, you can develop capabilities to help you:

- Support seamless data exchange across disparate systems and stakeholders, which improves the delivery of water resources data to help planners make more informed decisions.
- Integrate the many individual solutions that may already be in use by enabling system interoperability with collaborative tools and workflows that facilitate information flow, new application development and deployment across systems.
- Enable the effective monitoring and analysis of water systems using a common operating picture.

Case study: Bangalore Water Supply and Sewerage Board

As the city of Bangalore grew, rapid urbanization put pressure on the Bangalore Water Supply and Sewerage Board (BWSSB) to provide equitable water supplies to all citizens. The agency replaced outdated infrastructure assets such as pipes, pump motors and water treatment equipment, but it lacked instrumentation in the distribution network and real-time visibility into the flow of water through its systems. IBM worked with the BWSSB to create an operational dashboard that serves as a "command center" for monitoring, administering and managing the city's water supply networks. By taking advantage of big data and predictive analytics technology, the BWSSB can better manage their complex water distribution system. BWSSB engineers can now modify the control valve settings and get real-time feedback on the changes to the water supply elicited by their actions.

Why IBM?

Cities everywhere are reinventing themselves. They are reimagining essential systems, infrastructure and service delivery to promote growth, sustainability and enhanced quality of life. Cities are better integrating across functions, capitalizing on new insights, creating system-wide efficiencies and collaborating in new ways to turn challenges into opportunities while building the strong, differentiating identities that attract new citizens and businesses. As the global demand for water increases and water quality concerns are at the forefront of citizen's minds, governments need to evaluate ways to meet these challenges within existing constraints. Smarter integrated water management approaches require intelligent systems to deal with systemic water stress, infrastructure issues, the impact of natural disasters and other issues.

Combining world-class business, industry and technology expertise, IBM provides the integrated solutions that help visionary leaders achieve their objectives. Drawing on thousands of client engagements and proven strength across the breadth of city operations, only IBM offers the experience that today's challenges demand.

For more information

To learn more about IBM solutions for integrated water resources management, please contact your IBM representative or IBM Business Partner, or visit: **ibm.com**/smartercities

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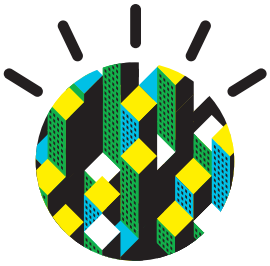

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