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COVER STORY

Power and Potential of Geospatial Infrastructure

CASE STUDY

India-WRIS: Delivering Nationwide Water Information through a Single Window

ARTICLE

Contextualizing Location Intelligence for Smarter Infrastructure

PRODUCT REVIEW

ArcGIS Field Maps

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1st Floor, The PARK, 22, Raj bhavan Road,
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Kolkata - 700091, West Bengal

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CONTENT

FROM MD'S DESK

Agendra Kumar
Managing Director, Esri India

Today, geospatial technology touches virtually every sphere of human activity. GIS has become an integral part of our lives, allowing us to understand and navigate the complexities of our world. Irrespective of the industry sector, both governments and businesses are progressively adopting contextualized intelligence to enhance governance and operational effectiveness.

As India strives to become one of the world's leading economies, there is a dire need for establishing a robust, scalable, and futuristic geospatial infrastructure, which will play a defining role in navigating the complexities of the economy by fostering inclusive, equitable, and sustainable growth.

National Geospatial Policy 2022 has made geospatial data more accessible and easily available. Highlighting geospatial as a "common good" and location as a "common reference frame," the Policy reiterates the societal, economic, and environmental value of geospatial data to foster sustainable national development. It also elucidates the need to strengthen the geospatial infrastructure in the country.

Digital India, PM Gati Shakti National Master Plan, National Infrastructure Pipeline, National Digital Health Mission, National Logistics Policy, and other initiatives exemplify an integrated approach and articulate their intent to leverage digital intelligence by strengthening the infrastructure (Physical and Digital). All these aspirational initiatives have one thing in common - they are multi-sectorial and multi-disciplinary trying to solve complex socio-economic-environmental challenges by harnessing location intelligence, powered by geospatial infrastructure.

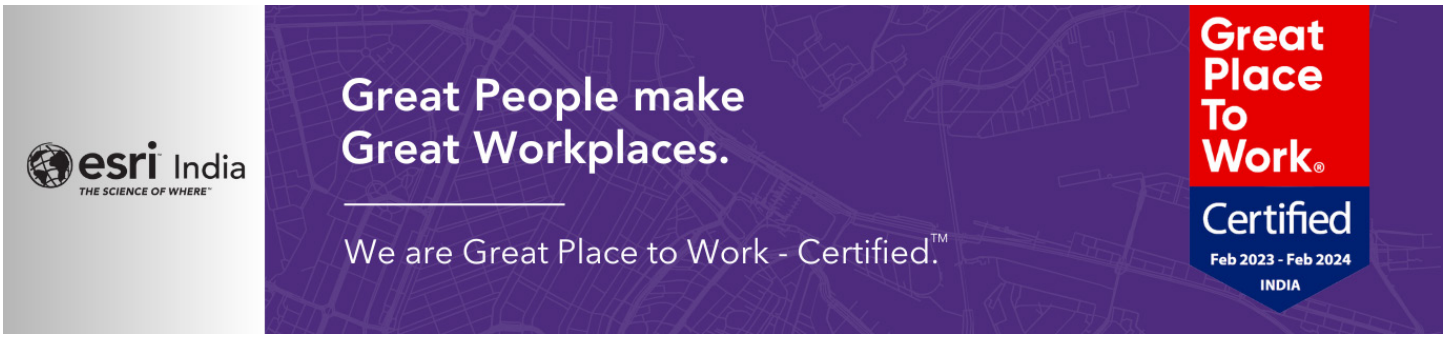
Geospatial infrastructure holds immense potential across different sectors. By leveraging open standards, APIs, licenses, and marketplaces, geospatial infrastructure guarantees smooth integration and connectivity between organizations, surpassing geographical boundaries, legal jurisdictions, and industry sectors. Emerging trends such as cloud computing, Geo-AI, IoT, and big data analytics are further amplifying the benefits of geospatial infrastructure and its potential applications continue to expand. Geospatial Infrastructure empowers us with decision intelligence. In an era where sustainability is of paramount importance, geospatial infrastructure allows us to narrate stories about the present world and envision the future. This becomes even more significant against the backdrop of climate change, global warming concerns, and the unpredictability of geopolitical and economic challenges.

As cloud computing gains popularity, GIS portals are becoming the focal point of geospatial infrastructure. For the last few years, Esri India has been focused on developing India-centric solutions with a view to helping our customers focus on their core activities while we support them with geospatial technology, solutions, and expertise. Integrating all the components of geospatial infrastructure, "Indo ArcGIS" is one such effort.

Powered by ArcGIS, Indo ArcGIS helps you build your own Geospatial Infrastructure in a very short time through world-leading GIS technology and India-specific GIS data and solution products. Indo ArcGIS on Cloud offers extensive capabilities, enabling organizations to gain a deeper understanding of spatial data. Hosted on a secure Ministry of Electronics and Information Technology (MEITY) approved cloud infrastructure, Indo ArcGIS provides an exhaustive repository of out-of-the-box technology and end-to-end workflows.

Deployed and managed by Esri India experts, Indo ArcGIS on Cloud gives you higher utilization at a lower total cost of ownership. Indo ArcGIS is currently available on Railtel Cloud (A "Mini Ratna" Central Public Sector Enterprise) and AWS Cloud. We are working with other service providers to expand these offerings.

For India to be a leading player on the global stage, investing in high-quality infrastructure is essential for accelerating and sustaining economic progress over the long term. Harnessing the potential of geospatial infrastructure will be critical for sustainable, inclusive, and equitable growth.



Esri India gets certified as a Great Place to Work® once again

Esri India achieved the Great Place to Work® certification for the first time in 2021 in the first attempt itself. In 2022, it got certified for the second time in a row with a higher score. It is a phenomenal achievement to get certified for the third consecutive year in 2023 and that too with a significant increase in scores.

Every year, more than 10,000 organizations from across the world participate in the survey and aspire to be certified. This Certification is recognized world over and is considered the 'Gold Standard' in identifying and recognizing Great Workplace Cultures. Even if certified once, very few companies manage to maintain their certified status in subsequent years.

Agendra Kumar, Managing Director, Esri India, shared on the occasion, "Success is No Accident"! We constantly strive to create a meaningful impact in the world we live in, and it is the "Passion" of every Esri'te towards this "Purpose" that makes us what we are. I am proud of Esri'tes for embracing equity, celebrating diversity, caring, connecting, learning from each other, and having fun while solving some of India's biggest problems as "Esri India ONE Team". This defines our unique culture. It gives me immense pride to take this moment to acknowledge and celebrate once again our fantastic team and this inclusive culture that we have built together at Esri India."

Esri India aims to continue pushing forward the boundaries, create delightful customer experiences, and always be not just a 'Great Place to Work' but also an organization that has customer success as a top priority.

Esri India User Conference concludes with high-level of engagement, innovation and collaboration

After a gap of two years, Esri India User conference was back in-person this year. It was held on January 18, 2023 in Delhi and on January 20, 2023 in Kolkata.

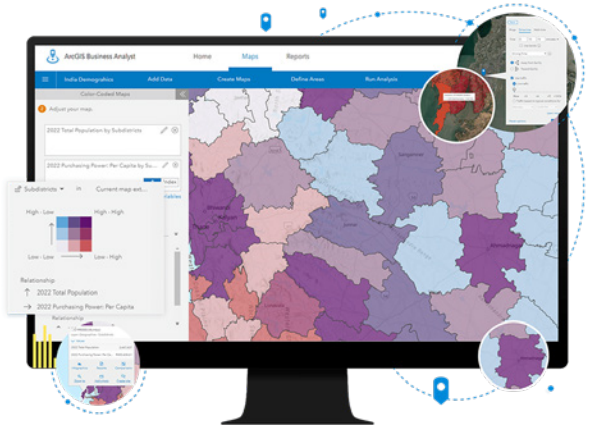
The theme of this year's conference was 'GIS — Transforming Communities'. As our world faces serious threats of climate change, sustainability, and social and economic inequality, communities are transforming themselves by adopting a geographic approach. GIS helps us understand all these interconnected problems holistically through visualization and analysis.

At Esri India UC, user organizations from across the country showcased how GIS is helping them solve some of the most crucial social and business challenges. The event witnessed the presence of more than 1000 geospatial enthusiasts including government officials, geospatial practitioners, researchers, academicians and users.

Agendra Kumar, Managing Director, Esri India shared, "Communities evolve better when they collaborate to solve common problems and GIS is an important enabler here. From uncovering trends and patterns

that eventually bring transformation both in perception and behavior, GIS has the potential to empower us immensely. GIS enables us to make informed and timely decisions for transforming communities in a positive manner. As the GIS community connects at the Esri India User Conference, through networking, sharing stories and learning together, we set stronger grounds for Transforming Communities through GIS." Esri India UC included an extensive range of enriching discussions through engaging Plenary sessions, technology tracks and user presentations on the latest innovations and best practices in the adoption of GIS technologies.

Esri India launches ArcGIS Business Analyst



Esri India has announced the availability of ArcGIS Business Analyst, a location intelligence solution suite designed to aid organizations in making data-driven smart decisions. Some of the target markets for this solution are banking and financial services companies, manufacturing organizations, retail chains, real estate companies, insurance, transportation and logistics, healthcare, hospitality, etc. All such organizations have business data that has a location component attached to it and using ArcGIS Business Analyst they can realize the full value of their data in decisions and gain a competitive advantage.

ArcGIS Business Analyst for India will include a variety of location-based datasets, such as points of interest; road network; accurate boundaries at various levels like village, PIN codes, district, state, etc.; socio-economic and demographic data; and data available from Esri's Living Atlas. Live road traffic information will also be available. The solution can help in the identification of new markets, new sites for stores or outlets, understanding customers' preferences better and getting better visibility about competitors.

Agendra Kumar, Managing Director, Esri India, said, "ArcGIS Business Analyst is a unique solution comprising data, maps, workflows, infographics that will enable businesses to make smarter decisions. Using ArcGIS Business Analyst, businesses can gain invaluable insight into changing population, housing, demographics, consumer spending, competition, etc., and thus make more informed decisions for market planning, site selection, territory management and customer analysis. Such in-depth analysis will help them gain a competitive edge and improve operational efficiency."

The power of location intelligence and analytics is being recognized all over the world. Data availability and sharing are now easier in India. With enabling policies like the National Geospatial Policy and the Geospatial Data Guidelines in place, the availability of geospatial data has improved. Being a leader in providing solutions based on geospatial technologies, Esri India has launched ArcGIS Business Analyst in India to enable Indian businesses optimally utilize Indian datasets for carrying out location-specific analysis and gain a competitive advantage.

Esri India and ideaForge join hands

Esri India has signed a Memorandum of Understanding (MOU) with ideaForge, a market leader in the Indian Unmanned Aircraft Systems. The objective of this partnership is to boost the adoption of drones in India.

The partnership between Esri India and ideaForge will allow users to deploy drone solutions with GIS to solve complex problems in AEC, forestry, agriculture, mining, transportation, utilities, and defence. Drone users in India primarily face the difficulty of working with different firms for meeting their hardware, software, training, and services requirements. Shortage of skilled workforce is another area of concern. This partnership will resolve these challenges to a great extent. The users will also be able to achieve seamless integration of drone videos and photos for advanced GIS applications, establish SOPs and standard workflows, and develop solutions for motion imagery, live streaming, and more.

The partnership will also help enterprises and government agencies to meet their essential drone-based requirements, both in terms of drone flying and GIS. This will reduce the complexity of engaging multiple vendors and foster higher adoption of drones in India, bringing multiple solution components under one umbrella.

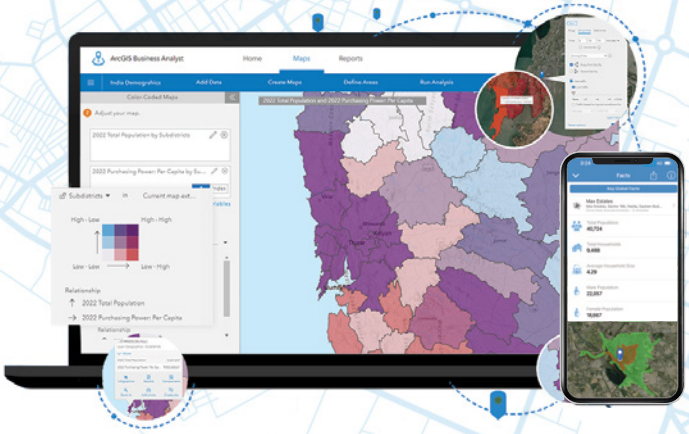
Agendra Kumar, Managing Director, Esri India said, "India is placing great importance on using drone data for effective governance and growth. Several sectors such as forestry, agriculture, insurance, surveying & mapping, among others, are already taking advantage of the liberalized regulations and

adopting drone technology for data collection. As the use of drones increases, there arises a need for integrated solutions that can provide a complete, end-to-end workflow for acquiring and processing drone imagery, processing the data, and gathering useful insights from the same for informed decision-making. Esri India's partnership with ideaForge will help drone users benefit from such integrated solutions, including Drones & GIS, curated by the leaders in their respective fields. The bundled solution will help the users to achieve time and cost-effectiveness in their drone data collection, processing, and analysis efforts. We aim to also provide extensive support in training."

Ankit Mehta, CEO, ideaForge stated, "We are thrilled to be collaborating with Esri India. This collaboration will assist ideaForge and Esri India in designing an integrated Drone and GIS software solution for the Indian market. Through this collaboration, ideaForge and Esri India can offer GIS software with ideaForge products to various customers in India via integrated solutions."

ArcGIS Business Analyst™

Location-Based Market Intelligence



What Is ArcGIS Business Analyst?

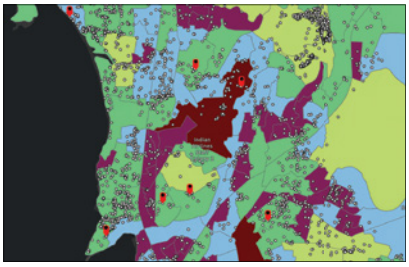
ArcGIS Business Analyst demographic mapping software helps you make smarter decisions for market planning, site selection, and customer segmentation by combining demographic, business, lifestyle, spending, and census data with map-based analytics. Business Analyst helps you identify underperforming markets, pinpoint the right growth sites, find where your target customers live, and share the analysis across your organization as accurate infographics and dynamic presentations.

Available on Any Device, Anywhere, Anytime

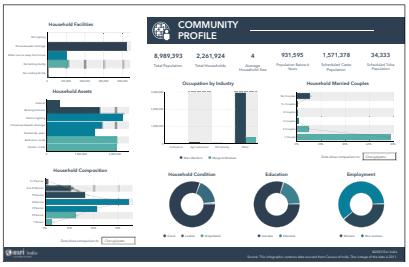
- ArcGIS Business Analyst Web App Access site selection, business analytics, and demographics in the cloud.
- ArcGIS Business Analyst Mobile App Work on projects on iOS and Android devices.
- ArcGIS Business Analyst Pro Perform advanced target marketing, spatial analytics, and territory design.

How It Works

Identify areas for analysis



Analyze areas using a variety of datasets



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esri India

Power and Potential of Geospatial Infrastructure

Introduction

We are living in unprecedented times. Technology is rapidly transforming the world we live in. Influenced by economic and social considerations, the future of technology will depend on what it eventually means to citizens or customers in a defined framework and context influenced by expectations, circumstances, environment, and behavior.

> Geospatial technology allows us to perceive what would otherwise remain invisible, unappreciated, or poorly understood. Through a common language of maps, GIS provides an incredibly powerful framework to communicate, analyze, share, and collaborate.

In today's world, the influence of geospatial technology permeates virtually every sphere of human activity. Its applications extend far beyond mapping, enabling us to solve complex problems, make informed decisions, predict outcomes, and unravel the intricacies of our environmental and social systems.

New age digital transformations are being shaped by a complex interplay of scientific and technological advancements that are driven by innovation on one side and the hyper-local consumer on the other. Artificial Intelligence, Cloud Computing, Internet of Things (IoT), Big Data Analytics, Augmented Reality/Virtual Reality, Blockchain and Quantum computing are some leading-edge technologies that have been able to mark their presence so far. One of the discernable features of these frontier technologies is their ability to either capture location or transform location rich data into spatial insights and contextualized intelligence.

Agnostic to industry sector, governments and businesses are increasingly embracing contextualized intelligence to improve governance and operational efficiencies. Cutting across the governance and business processes, geospatial technologies are aiding in improvement of asset management, operations management, network management, project management, resource management and disaster management. Behind the scenes, it is geospatial infrastructure that endows us with decision intelligence that is contextualized to events, subjects and/or processes.

A robust, scalable, and futuristic geospatial infrastructure will play a defining role in navigating the complexities of economy by fostering an inclusive, equitable and sustainable growth.

Changing Geospatial Landscape

In the past, GIS was confined to desktop computers, offering only a handful of features, and requiring specialized expertise to operate within office settings. In the present day, with versatile functionalities that are tailored and customized, GIS has become easily accessible from any location at any time, empowering individuals from all walks of life to utilize its capabilities.

Today, GIS serves a diverse community ranging from ordinary citizens to administrators, business leaders, scientists, social workers, and many others. It caters to the requirements of individuals, governments, businesses, entire enterprises, and civil society. With geospatial data becoming increasingly ubiquitous, contextualized geo-intelligence has taken a center-stage. Its economic value and benefits across the spectrum, sector-agnostically, are well acknowledged. Here are some ways in which the reach of geospatial technologies has grown:

1. **Increased Accessibility of Geospatial Data:** The availability of geospatial data has greatly improved. Open data initiatives, online platforms, and mapping services have made geospatial data more accessible for a wide range of applications.

2. **Advancements in Mobile Technology:** With proliferation of smartphones and mobile devices, mobile apps and location-based services have empowered individuals to access geospatial information, and engage with location-specific content, contributing to the mainstream adoption of geospatial technology.

3. **Integration with Everyday Applications:** Geospatial technologies have been integrated into everyday applications and services like navigation apps, social media platforms and e-commerce services, making them more user-friendly and relevant to a broader audience.

4. **Emergence of Web-Based Mapping Platforms:** Web-based mapping platforms have democratized access to geospatial information and facilitated community-driven mapping initiatives.

5. **Integration with Internet of Things (IoT):** Geospatial technologies have converged with IoT devices, creating new opportunities for collecting and analyzing spatial data in real-time.

6. **Advancements in Data Analytics:** Big data analytics, machine learning, and artificial intelligence techniques are now being applied to geospatial data expanding capabilities in understanding complex spatial relationships., enabling deeper insights, pattern recognition, and predictive modeling.

7. **Emergence of Cloud-GIS:** Cloud computing for geospatial has volutionized the industry by offering scalability, cost efficiency,

collaboration, and enhanced processing power, enabling them to make informed decisions, streamline workflows, and unlock new insights and opportunities.

These advances have made geospatial technologies more accessible, user-friendly, and relevant in our daily lives, fostering their widespread adoption and impact.

Power of Geospatial Infrastructure

Infrastructure has played a pivotal role in connecting geographies and advancing economic progress from ancient times. The monumental change brought about by digital technologies in the last few decades is not just limited to the physical realm of infrastructure but has also ushered in a new way of understanding and solving problems. Often left out or passingly acknowledged "digital infrastructure" has become an indispensable necessity today.

By augmenting the digital framework behind the scenes, geospatial infrastructure enables contextualized interactions between the physical subjects and the people through technology and data. With sustainability as a new order of the world, geospatial infrastructure lets us tell stories about the world as it is today and the future, we want to see by providing a holistic view of the environment in which we are operating. This gains significance with the climate change and global warming concerns in the backdrop of unpredictable geopolitical and economic headwinds.

In simple terms, geospatial infrastructure is a layer that is integrated with the digital infrastructure to enable acquisition, processing, management and dissemination of spatial data and location information with high precision and accuracy. From a technological perspective, geospatial infrastructure is the foundation that supports the use and implementation of geospatial technologies, such as Geographic Information Systems (GIS), remote sensing, and Global Positioning Systems (GPS). Powered by hardware, connectivity, and software that bridge and facilitate interactions within and outside the ecosystems, value from ever-increasing volumes of data has become a key enabler for integrated approaches and sustainable development. While being able to visualize and assess the subjects more holistically and accurately in real-time, location inclusive digital interventions have enabled cognizance to social and environmental issues that are intricately interleaved with economic and business activities. Armed with smart devices, location aware citizens and consumers are increasingly seeking hyper-localized intelligence that is personalized and prescriptive. After all the human brain is wired to model and create a spatial frame of the things around us and it is natural for humans to desire information that is contextual, accurate, and timely. And this would not have been possible without geospatial infrastructure.

Recent government initiatives like Digital India, PM Gati Shakti National Master Plan, National infrastructure Pipeline and National Logistics Policy echo an integrated approach and articulate their intent to leverage digital intelligence by strengthening the infrastructure (Physical and Digital). All these aspirational initiatives have one thing in common - they are multi-sectorial and multi-disciplinary trying to solve complex socio-economic-environmental challenges by harnessing contextualized decision intelligence powered by the geospatial infrastructure.

Emphasizing geospatial as "common good" and location as a "common reference frame," National Geospatial Policy 2022 reaffirms the societal, economic, and environmental value of geospatial data to enable government systems and services, and sustainable national development initiatives, while elucidating the need and roadmap to strengthen the geospatial infrastructure in the country.

As a "System of Systems," geospatial infrastructure comprises of the systems, processes, and policies that are used to acquire, manage, distribute, and apply geospatial data. By providing accurate and timely geospatial data, geospatial infrastructure:

1. **Provides Valuable Insights:** Geospatial infrastructure helps organizations gain valuable insights about location-based data, allowing them to make informed decisions and optimize their operations.

2. **Improves Efficiency:** Geospatial infrastructure enables organizations to optimize their processes and operations, leading to increased efficiency and productivity.

3. **Facilitates Collaboration:** Geospatial infrastructure enables collaboration across different industries and sectors, leading to the development of new partnerships and opportunities.

4. **Supports Innovation:** Geospatial infrastructure provides a platform for innovation, allowing organizations to develop new products, services, and solutions that leverage location-based data.

These benefits are being further amplified by 4IR technologies (Industry Revolution 4.0) such as Cloud Computing, Geo-AI (Artificial Intelligence), Internet of Things (IoT), and Big Data Analytics. These technologies rely on geospatial infrastructure to hyper-localize outcomes, reduce turnaround times, and lower costs. There is a growing demand for a robust geospatial infrastructure as more organizations recognize its potential value and applications.

Components of Geospatial Infrastructure

Providing specialized capabilities to manage geospatial data, geospatial infrastructure acts as a backbone for all spatial operations including data acquisition, processing, integration, analytics, and dissemination. This infrastructure also facilitates management, sharing and collaboration of geospatial data, information, and knowledge. The components of geospatial infrastructure include elements that collectively enable the capture, management, analysis, and dissemination of geospatial data. Here are the key components:

1. **Geospatial Data:** This component forms the foundation of geospatial infrastructure. It includes satellite imagery, aerial photography, LiDAR (Light Detection and Ranging) data, digital elevation models, land cover datasets, and other spatially referenced information.

2. **Geographic Information Systems (GIS):** GIS software is a principal component of geospatial infrastructure. It allows for the collection, storage, analysis, and visualization of geospatial data. GIS enables users to create maps, perform spatial analysis, generate insights, and make informed decisions based on spatial relationships.

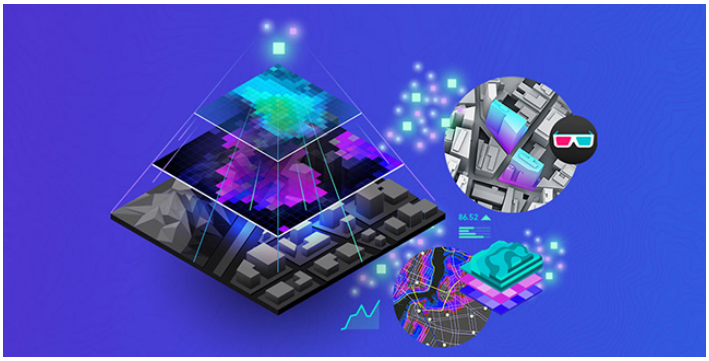
3. **Global Positioning System (GPS):** GPS technology provides accurate positioning and navigation information by utilizing signals from a network of satellites. GPS is vital for capturing real-time location data, enabling precise mapping, surveying, asset tracking, and navigation in various applications.

4. **Remote Sensing:** Remote sensing involves gathering data about the Earth's surface from airborne or satellite sensors. It includes techniques such as capturing multispectral imagery, thermal imaging, and radar sensing.

5. **Spatial Data Infrastructure (SDI):** SDI is a framework that facilitates the sharing, discovery, access, and integration of geospatial data from multiple sources and organizations. SDIs provide standards, protocols, and tools for harmonizing geospatial data across different systems, ensuring interoperability, and facilitating efficient data exchange.

6. **Geospatial Analysis Tools:** These tools enable advanced spatial analysis and modeling, allowing users to extract valuable insights from geospatial data. They include algorithms for spatial statistics, spatial clustering, network analysis, terrain analysis, and other techniques that support decision-making processes.

7. **Geospatial Applications:** Geospatial infrastructure supports a wide range of applications across various sectors, including urban planning, transportation management, environmental monitoring, disaster response, precision agriculture, natural resource management, and many others. These applications leverage the capabilities of geospatial data and tools to address specific needs and challenges.



As a combination of hardware, connectivity, and software, geospatial infrastructure serves as a framework that facilitates seamless interactions within and beyond ecosystems. All these work together harmoniously to unlock the potential of geospatial data, enabling informed decision-making, fostering collaboration, and promoting holistic and sustainable development practices. These key functional components are supported by:

1) **Standards and Interoperability**
2) **Data Management and Storage**
3) **Data Processing and Analysis**
4) **Data Visualization and Dissemination**
5) **Policy and Governance**
6) **Capacity Building and Human Resources**

Supporting the entire geo-data lifecycle and binding all the infrastructure components in a user-friendly environment, GIS software plays a key role in facilitating interactions between data, systems, processes, and users.

Integrating all the components of geospatial infrastructure, as a one-stop destination, Esri India's "Indo ArcGIS" helps businesses to build their own geospatial infrastructure at a lower cost of ownership. Hosted on a secure MEITY approved cloud, Indo ArcGIS also provides an exhaustive repository of ready to use India data sets at no additional cost. Indo ArcGIS on Cloud supports organizations and industries of various scales, bringing together distributed information and making GIS accessible to a wide range of users. With its SDI framework, GIS platform for data ingestion, processing, integration, and dissemination, as well as advanced analysis tools and applications, ArcGIS System enables geospatial infrastructure with out-of-the-box technology and end-to-end workflows.

Potential of Geospatial Infrastructure

Using web-GIS technology, an integrated geospatial infrastructure connects various organizations across borders, sectors, and jurisdictions. As cloud computing gains popularity, GIS portals are becoming the focal point of geospatial infrastructure.

By efficiently organizing and providing access to content and capabilities, enabling users to utilize them anywhere and at any time, organizations and communities can lay the rules of engagement to manage spatial data cooperatively and improve engagements. Here are ways in which geospatial infrastructure is adding value to different sectorial applications:

1. **Urban Planning and Development:** Geospatial infrastructure supports urban planning by providing tools for mapping and analyzing land use, infrastructure networks, transportation systems, and population density. It assists in planning, design, 3D modelling, identifying areas for growth and development, and improving urban resilience and sustainability.

2. **Smart Cities and Infrastructure Management:** Geospatial infrastructure forms the backbone of smart city initiatives. It enables efficient management of utilities, infrastructure planning, asset management and GeoBIM. Geospatial data assists in optimizing energy consumption, improving waste management systems, enhancing public safety, and fostering citizen engagement.

3. **Transportation and Logistics:** Geospatial infrastructure facilitates efficient transportation and logistics management. It aids in route optimization, fleet tracking, real-time traffic monitoring, and intelligent transportation systems. Geospatial data enables effective supply chain management, enhances delivery operations, and improves overall transportation efficiency.

4. **Agriculture and Food Security:** Geospatial infrastructure supports precision agriculture, crop monitoring, yield prediction, and soil analysis. It aids in optimizing resource allocation, irrigation management, and pest control. Geospatial data assists in enhancing agricultural productivity, ensuring food security, and promoting sustainable farming practices.

5. **Public Health and Epidemiology:** Geospatial infrastructure aids in public health and epidemiological studies. It enables disease mapping, surveillance, and analysis of health-related data to understand patterns, track the spread of diseases, and inform public health interventions. Geospatial data assists in resource allocation, healthcare planning, and disease prevention strategies.

6. **Disaster Management and Emergency Response:** Geospatial infrastructure plays a critical role in disaster management and emergency response. It supports hazard mapping, risk assessment, early warning systems, and post-disaster recovery efforts. Geospatial data helps identify vulnerable areas, coordinate emergency response activities, and assess damages for effective relief operations.

7. **Natural Resource Management:** Geospatial infrastructure assists in the sustainable management of natural resources. It helps monitor forests, track changes in land cover and land use, manage water resources, and mitigate the impact of natural disasters. Geospatial data enables informed decision-making in conservation, agriculture, forestry, and environmental management.

8. **Environmental Monitoring and Conservation:** Geospatial infrastructure contributes to environmental monitoring and conservation efforts. It facilitates monitoring of biodiversity, habitat mapping, climate change analysis, and ecosystem management. Geospatial data helps identify ecological hotspots, monitor pollution levels, and support conservation planning and decision-making.

9. **Prescriptive Personalized Services:** Geospatial infrastructure enables commercial industry to provide prescriptive personalized services to their customers. With consumer behavior being reshaped towards instantly gratifying personalized experiences, prescriptive hyper localization of geospatial data helps in improving user experience for shopping, travelling, gaming, and navigating with virtual walkthroughs and immersive experiences.

These are just a few examples of the wide-ranging sectorial applications of geospatial infrastructure. As technology continues to advance, its potential applications are expanding across various sectors, driving innovation, and enabling smarter, more sustainable approaches to societal challenges.

Emerging Trends in Geospatial Infrastructure

Geospatial infrastructure is the driving force behind modern Geographic Information Systems (GIS). It assumes responsibility for essential elements like security, privacy, accessibility, identity management, collaborative spaces, and content negotiation. By leveraging open standards, APIs, licenses, and marketplaces, geospatial infrastructure guarantees smooth integration and connectivity between organizations, surpassing geographical boundaries, legal jurisdictions, and industry

sectors. This integrated approach facilitates effective sharing and collaboration, empowering organizations to swiftly connect and cooperate in their geospatial pursuits.

Some notable trends that are emerging and are expected to make a profound impact in the near future include:

1. **Cloud-Based Geospatial Services:** Cloud computing continues to play a significant role in geospatial infrastructure. Cloud-GIS offers scalability, flexibility, and cost-effectiveness. It enables on-demand access to geospatial tools, data storage, processing power, and collaborative capabilities, making it easier for organizations to leverage geospatial infrastructure without heavy upfront investments.

2. **Real-Time Geospatial Data:** The demand for real-time geospatial data is increasing rapidly. Advancements in sensor technologies, IoT, and satellite imagery enable the collection of up-to-date, high-resolution spatial data. Real-time data allows for more accurate and timely decision-making in areas such as transportation management, disaster response, and urban planning.

3. **Artificial Intelligence (AI) and Machine Learning (ML):** AI and ML technologies are being increasingly integrated into geospatial infrastructure. These technologies can automate data analysis, pattern recognition, and predictive modeling, leading to improved spatial analysis and decision support systems. AI and ML algorithms can process large volumes of geospatial data, extract meaningful insights, and enable advanced geospatial applications.

4. **3D Geospatial Visualization:** 3D geospatial visualization is becoming more prevalent in various applications, such as urban planning, architecture, and virtual reality. Technologies like LiDAR, photogrammetry, and 3D modeling enable the creation of detailed, immersive representations of the physical world referred to as metaverse by some. 3D visualization enhances spatial understanding and supports more accurate spatial analysis and simulation.

5. **Geospatial Integration with Internet of Things (IoT):** The integration of geospatial infrastructure with IoT devices and networks is expanding. IoT sensors embedded in infrastructure, vehicles, and environmental systems generate vast amounts of spatially referenced data. By combining geospatial and IoT technologies, organizations can gain deeper insights into spatial patterns, monitor assets in real-time, and optimize resource management.

6. **Open Data and Open Standards:** Open data initiatives and open standards continue to gain momentum in the geospatial domain. Governments, organizations, and communities are embracing open data principles, making geospatial datasets and tools more accessible to the public. Interoperability through open standards allows for seamless data exchange and integration between different systems, enabling collaboration and innovation.

7. **Spatial Data Privacy and Security:** As the amount of geospatial data grows, ensuring privacy and security becomes paramount. Protecting sensitive location information, adhering to data protection regulations, and implementing robust security measures are critical considerations for geospatial infrastructure. Techniques like differential privacy, data anonymization, and secure data sharing protocols are emerging to address privacy concerns.

These emerging trends demonstrate the evolving nature of geospatial infrastructure and its increasing importance in various sectors. Keeping abreast of these trends is critical for us to harness the full potential of geospatial data and technology to drive innovation and informed decision-making.

In Closing

India is emerging as a prominent player in the global economy. The role of infrastructure in driving economic growth cannot be overstated. Investing in high-quality infrastructure is essential for accelerating and sustaining economic progress over the long term. Geography and spatial thinking are essential for successful and all-inclusive growth. Empirical evidence suggests contextual intelligence has become a valuable tool for promoting economic growth and development.

Over the past two decades, the reach of geospatial technologies has expanded multifold, transforming various aspects of our lives. The recognition of GIS as a valuable decision-making tool has led to its integration into various sectors, extending their reach and impact. Geospatial infrastructure becomes a critical component of modern society.

Providing valuable insights, improving efficiency, facilitating collaboration, and supporting innovation in various sectors, geospatial infrastructure is reshaping the way governments, businesses and communities collaborate and interact with spatial data. Harnessing the potential of geospatial infrastructure will be critical for a sustainable, inclusive, and equitable growth.

As National Geospatial Policy 2022 sets the stage for a strong geospatial infrastructure, enabled ecosystems and ease of doing business, it is incumbent on us to take these efforts forward at a faster pace. While we invest in geospatial infrastructure, we should not lose sight of the importance of capacity and expertise.

Delivering Nationwide Water Information through a Single Window

Industry
Water Resources / Government

Organization Profile
The National Water Informatics Centre (NWIC) is a subordinate office under the Ministry of Jal Shakti, Department of Water Resources, RD & GR with a mandate for timely and reliable water resources data acquisition, storage, collation & management and to provide tools for informed decision making for management of water resources of the country.

Solution
Web based Water Geo-Hub on ArcGIS Server and ArcGIS Platforms.

Highlights
Esri India helped NWIC to achieve the following objectives:

- Build a comprehensive "Water Resources Information System" (WRIS) in the public domain towards making it easily available to users.
- Provide authoritative, and consistent data and information on India's water resources and allied themes for planning, development, and management of water resources in the country.
- Development of a decision support system for informed decision making and strengthening the capacity of targeted water resources professionals and management institutions in India.
- Facilitate seamless collaboration with national/ international research institutes and other agencies.

Website
https://indiawris.gov.in/

Project Summary

The management of water resources is a highly complex and tedious task that involves the expertise of multidisciplinary domains and depends on reliable data and information which is accessible to all the stakeholders. Considering the challenges involved in the water resources sector, the Government of India took an initiative for developing a centralized platform to act as a repository of water resources and related data at the national level with administrative granularity up to the smaller units of governance at the state level as well as hydrological levels such as basin and sub basins. The first initiative towards the development of a centralized Water Resources information system under the project titled 'Generation of database and implementation of web enabled water resources information system of India' short named as India-WRIS WebGIS was undertaken in 2008 through collaborative effort of Central Water Commission (CWC) and National Remote Sensing Centre (NRSC). This was a standalone information system built on ArcGIS.

During 2016-17, the Government of India, through Department of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti (erstwhile Ministry of Water Resources, RD & GR) embarked upon a World Bank supported flagship program named National Hydrology Project with the objective of improving the extent, quality, and accessibility of water resources information, decision, basin level resource assessment/planning, development of decision support system and to strengthen the capacity of targeted water resources professionals and management institutions in India. On this foundation, India WRIS was revamped on the latest version of ArcGIS by integrating with the existing Water Information management System (WIMS) on a nationwide centralized database. A revamped and up-scaled India - WRIS was launched on 30th July 2019.

Esri India offered NWIC a Water Geo-Hub solution that encompassed software, application development, training, handholding, and support services. The solution provides nationwide water information to users through a "single window", promoting a free exchange of data among various central and state agencies, while delivering reliable and timely data and insights for comprehensive projections of future water, and facilitating informatics based sustainable development of water resource management along with value added products and services to all stakeholders.

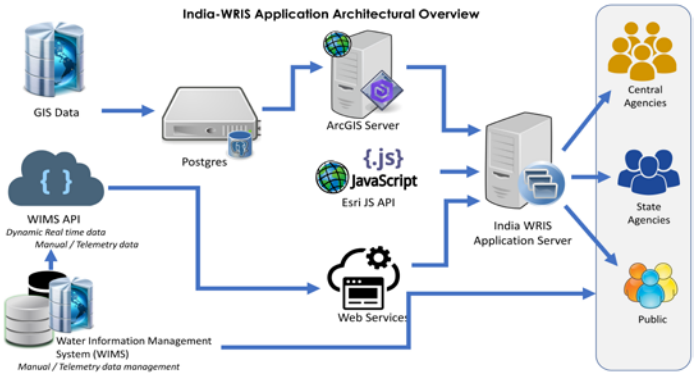
NWIC Mandate

Cutting across demand and supply, water challenges are becoming complex every passing day due to population growth, urbanization, excess withdrawals, and losses, while climate change, extreme weather events, deforestation, and pollution are worsening the situation further. India-WRIS is an important element to address these challenges, bringing all relevant water data on one nationwide platform, making information available to users and creating the basis for better management of our water resources. India-WRIS addresses the following challenges:

- Collection of available data from varied sources, generate new database, organize in standardized GIS format and provide scalable web enabled information system.
- Provision of standardized tools to create value added maps by way of multi-layer stacking of GIS database so as to provide an integrated view of the water resources scenarios.
- Facilitate easier, faster access, sharing of nationally consistent and authentic water resources data through a centralized database and application server to all water resources departments/ organizations.
- Build a foundation for advanced modeling and Spatial Decision Support Systems (SDSS) including an automated data collection system.

Solution

India Water Resource Information System (India-WRIS) is a web GIS-based application on the ArcGIS Server for scientific assessment of the water resources, development of analytical tools and Decision Support System (DSS) for informed decision making.



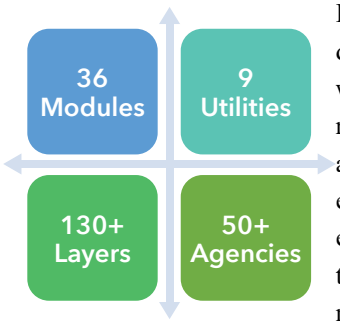
As a national Water Geo-Hub, India-WRIS maps the common ground for sustainable water resource management in the country. By providing nationwide water information to users through a "single window", promoting free exchange of data among various central and state agencies, while delivering reliable and timely data and insights for comprehensive projections of future water, India-WRIS facilities informatics based sustainable development of water resource management along with value added products and services to all stakeholders.

The current version of India-WRIS is in process to be integrated with the Water Information management System (WIMS). With addition of new modules wherein data from automated data acquisition systems established by CWC and CGWB is disseminated along with improvement in the previously existing modules, data through WIMS is fetched in real-time in a handshake mode to disseminate current data in the portal.

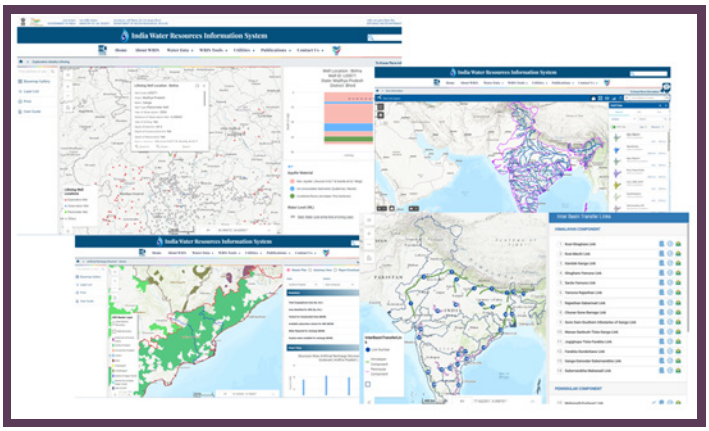
India-WRIS provides access to diverse multiyear datasets (5-100 years) along with a large number of attributes and temporal data sets of various inhouse/agency/archive and allows users to Search, Access, Analyze, Visualize, Understand and Analyse comprehensive and contextual water data for the assessment, monitoring, planning and development of water resources for Integrated Water Resources Management (IWRM).

Water Data

India-WRIS provides comprehensive water data including rainfall, snowfall, geo-morphology, climate, geology, surface water, ground water, water quality, ecology, water extraction and use, irrigated area, glaciers, etc., allied themes along with project information, fostering and promoting an integrated approach to Water Resources Management. Extending geospatial infrastructure capabilities for publishing, Jal IITIHAS is an innovative story telling tool powered by ArcGIS for capturing heritage and cultural references of water structures for increasing public awareness.



In addition to being a repository and dissemination platform of nation's water data, India WRIS also facilitates real time data ingestion and processing along with historical data along with easy to use tools that enhance user experience. Dynamically coupled temporal and spatial information, model linked analytical products such as evapotranspiration and soil moisture at district level and analytical tools on water budgeting, etc. add to the versatility of India-WRIS decision support capabilities.

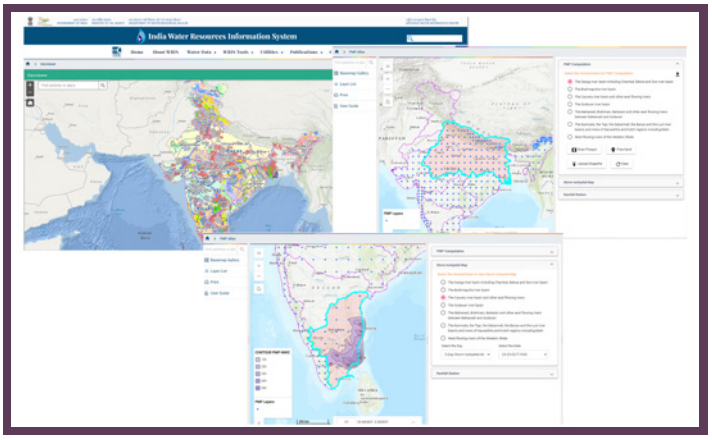


WRIS Tools

Ready to use WRIS tools strengthen collaboration and participatory management of water resources. “Online Feature Editor” enables states to update irrigation projects through secure access to the ArcGIS portal. The “ARS - Editor module” enables states, and central agencies to update and ingest the attribute data related to artificial recharge structures (ARS) under various schemes directly into the India WRIS database while consolidating the nationwide conservation/augmentation efforts made by different agencies at a single location.

Water Utilities

Water Utilities provide users information regarding Data Availability along with dashboards and tools for data/report download, district snapshots and meta data created through ArcCatalog as an XML. Powered by commonly used spatial queries Geo Viewer and PMP Atlas provide intuitive user-friendly visualization of the data sets and analytics.

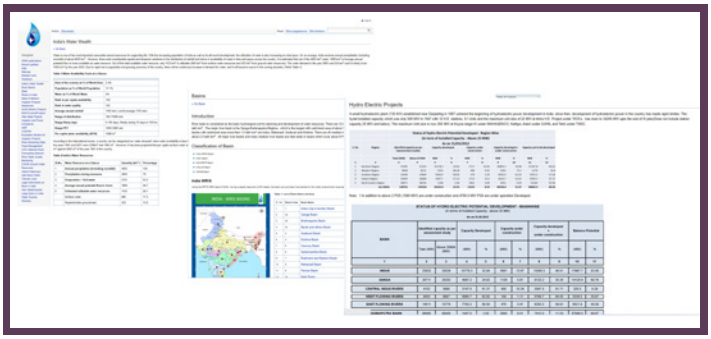


• Rainfall (mm) • Reservoir (Level) • River Points (Level & Discharge) • Ground Water Level (BGL Meter) • Water Quality - Groundwater • Water Quality - Surface water • Water Audit • Evapotranspiration (mm) • Soil Moisture (%) • Minor Irrigation Tanks • Coastal Informative System	Dynamic Modules
• Groundwater Resources • Snow Glacial Lake • Water Resources Project • Minor Irrigation Census • Inland Navigation Waterways • Inter Basin Transfer Links • District at a glance • LULC • Wasteland • Wet Land • Water Tourism	Semi Dynamic Modules
• Data / Report Download (Tabular) • Data Availability • Feedback • GEO Viewer • Artificial Recharge Structure • PMP Atlas Data Entry • WRIS WIKI • Meta Data • Mobile App • Online Editor	Utilities and Tool
• Litholog • Aquifer • Probable Maximum Precipitation Atlas • Reservoir Sedimentation studies • Surface Water Bodies • River Basin System • Socio Economic Census • Extreme Events Flood Inundation / Drought Prone Area Program / Earthquake • Groundwater Prospects • Region Agro Climatic / Agro Ecological • Soil • Land Degradation • Water Logging & Soil Salinity	Static Modules

Modules of India-WRIS

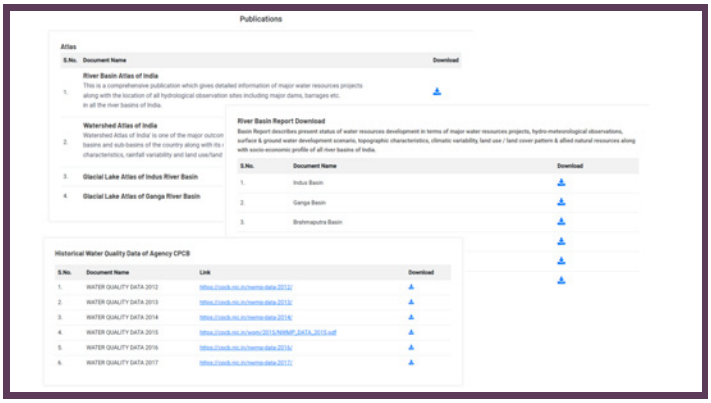
Collaborative Knowledge Platform

As a Collaborative Knowledge Platform sharing updated information regarding the various aspects of the water resources of the nation, WRS Wiki customized on wiki framework provides access to comprehensive water information and knowledge.



Publications

Publications section brings together all the water related literature and publications including Atlas, Basin Reports, Compendium, Groundwater, Pre-generated Maps, Project Documents, Wasteland Distribution Atlas, Waterlogging and Salinity Assessment, NWMP Data of CPCB (2012-2017). A library of various publications of organisations under Ministry of Jal Shakti is displayed under Research and Development section of Publications.



> Esri India presented National Water Informatics Centre (NWIC) with a comprehensive Water Geo-Hub solution that includes software, application development, training, handholding, and support services. This solution offers users nationwide access to water information through a single window, promoting the free exchange of data among various central and state agencies., while delivering reliable and timely data and insights for comprehensive projections of future water, and facilitating informatics based sustainable development of water resource management along with value added products and services to all stakeholders. Esri India played a crucial role in assisting NWIC in achieving its objectives. Additionally, Esri India facilitated seamless collaboration with national and international research institutes and other agencies. Thanks to the efforts of Esri India, NWIC was able to achieve its objectives and establish a robust water resources information system that would benefit the country's water management efforts.
>
> **- Goutam Bhati, Team Lead (GIS development), NWIC**

Benefits

As a one-stop solution for contextualized water resource information management and decision support, India-WRIS provides capabilities for data management, mapping and visualization, analysis, and discovery with automation tools for creating, analysis, managing and sharing of water resource information. India-WRIS acts as a force multiplier to strengthen India's water security and resilience by:

- Acting as a single window information source for decision makers, water managers, experts and the public.
- Mapping a common ground for a common understanding and positive action.
- Providing deeper contextualization of all the factors responsible for understanding the relationships and linkages spatially and temporally.
- Bridging the gaps by connecting data and science to the decision-makers.
- Ensuring collective problems solving by fostering participative management and collaboration.
- Creating public awareness about the crucial issues related to water and attract wider participation in water resource management.

ArcGIS GeoBIM

Collaboration in the Cloud

for Architecture, Engineering, and Construction

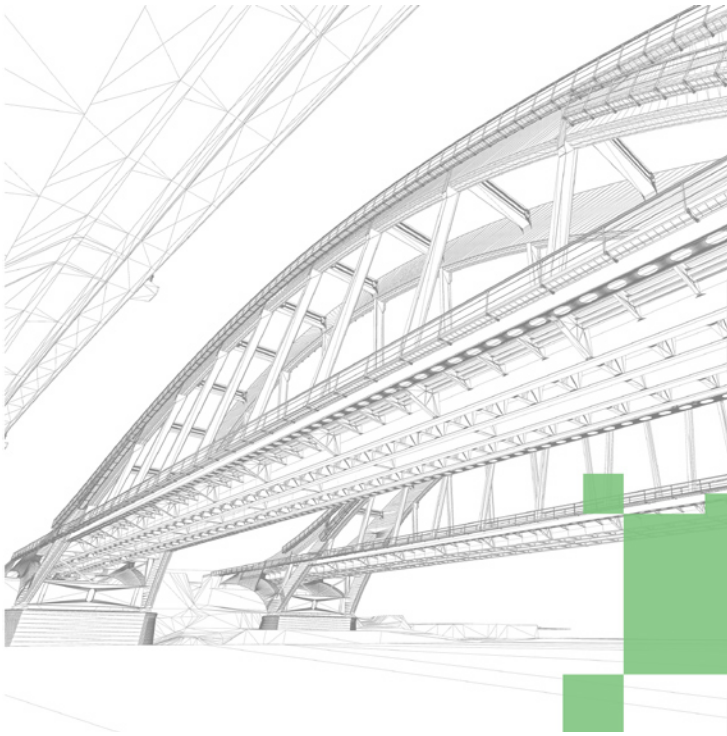
ArcGIS GeoBIM delivers an innovative, easy-to-use web-based experience for teams to explore and collaborate on BIM projects and issues, using data from multiple systems in a geospatial context. AEC and operations teams can easily work with linked data and documentation in configurable web apps to simplify communication and collaboration.

See all your project activity on one map

Keep your project and asset data organized

Minimize costly model conversions by connecting to the source

Communicate project information easily and securely



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Rourkela City, the steel city of Odisha, located on the banks of river Koyal and Brahmani was shortlisted as one of the SMART Cities under the Government of India's SMART City Mission. Under this Mission, Rourkela is required to prepare a SMART City Plan and formulate its own unique vision and strategies through active consultation of its citizens and all stakeholders.

As Rourkela Smart City Limited (RSCL) plans to transform Rourkela into a smart city in phases using smart technologies such as surveillance systems, traffic analytics, e-Governance, and solid waste management, GIS becomes a key enabler.

Let's understand the role of GIS in transforming Rourkela from a steel city to a smart city through a conversation with Ram Mohan Mishra, Town Planner, Rourkela Smart City Limited.

What's the Mission of Rourkela Smart City Limited (RSCL)?

The mission of RSCL is to provide the people of Rourkela a healthy and hygienic life in the city. We are making efforts to provide a smart solution to every problem of the people of Rourkela. We are addressing all issues from A to Z - such as traffic management, sewage, drainage, firefighting, solid waste management, electricity distribution, and restructuring/ redevelopment of old buildings, as well as the construction of the new infrastructure.

Is it advantageous to use GIS in city development planning (CDP)?

Yes, definitely, there are many advantages. Location plays a crucial role in every aspect of city development planning. To better the quality of life of the citizens, GIS provides an IT infrastructure where all the stakeholders are involved in every activity starting from planning and conceptualization to development, monitoring, and maintenance.

I experienced this when I was preparing the CDP for Rourkela. Earlier, whatever we were doing, we were doing manually. So, I have prepared Master plans for the cities manually as well as in digital mode. i.e., using the GIS platform. The use of GIS has expedited the process significantly. Earlier we used to take four to five years to prepare one Master plan but now that can be done within four to six months. This was beyond imagination for us.

How is GIS aiding in the transformation of Rourkela from a steel city to a smart city?

Rourkela is among India's oldest planned cities and the third largest urban agglomeration in the eastern state of Odisha after Bhubaneshwar and Cuttack. The city is known for India's first integrated public sector steel plant, set up in the 1960s with German collaboration and technical expertise. The township in the vicinity of the steel plant city was also designed by German planners. This is one of the reasons why that area is better developed than adjoining localities. While the infrastructure available in the steel township is very good, the infrastructure of the civil township is not at par. It is not as planned as the steel township. There is a discrepancy in the facilities available as well.

Using the latest technologies, we are trying to address this gap. We want to ensure that equal facilities are available for all the citizens of the city. There's no disparity.

Geospatial data plays a vital role here. With the help of GIS, planners collect the required data, tally it with the grievances/queries, build capacity to address the needs, and develop infrastructure based on the demands and requirements.

Esri India has done good work in Bhubaneswar and Varanasi. We also aim to achieve excellence in our smart city efforts and thus are using Esri India's technology in our urban infrastructure projects, smart city projects and other Rourkela Municipal Corporation projects.

> "We are using Esri India's Urban Management Solutions to provide the people of Rourkela a healthy and hygienic life in the city. GIS is helping in addressing all issues from A to Z."

Contextualizing Location Intelligence for Smarter Infrastructure

Driven by Capital, Creativity, and Customer (3Cs), Indian Architecture, Engineering and Construction (AEC) industry has a defining role to play in steering India's '$5 trillion economy' vision.

But AEC industry is faced with complex challenges. Infrastructure projects are not restricted to construction alone. Landscape, access, utilities, amenities, natural resources and their impact on the local environment and ecology are integral aspects. Increasingly AEC industry is being tasked to strike the right balance between the economic, social, and environmental factors revolving around infrastructure projects.

As one of the most disaster-prone nations in the world, disaster risk to projects due to natural hazards is considerably high. Infrastructure projects are not just capital intensive with 30% wastage, 40% rework and significant schedule overruns, the industry also accounts for 39% of energy consumption and is responsible for 19% of GHG emissions.

As digital interventions make their way into the AEC sector, activities can no longer be carried out in isolation. Being myopic to the construction sites alone is no longer tenable. The need for contextual understanding to demystify the interdependencies and linkages in the infrastructure environs is greater than ever. Geo-enabling the AEC value chain provides builders with better control over their outcomes while ensuring the right balance between social, economic and environmental aspects.

Integrating GIS with building information management (BIM) facilitates better contextualization of the infrastructure and its environs. Breaking down the data silos and unifying all the information on a common platform by contextualizing location can radically transform AEC workflows, helping builders to deliver projects in a timely and cost-efficient manner, while taking cognizance of the disaster risks and other safeguards.

One Platform for AEC

Esri India's AEC solutions provide firms with a "single-point-of-truth" through one platform for managing the entire AEC lifecycle. Not just improving efficiency and productivity, it also aids in demystifying the complexities and unearthing cost leaks and redundancies. By mapping a common ground, ArcGIS AEC portfolio enables all AEC stakeholders to harness the power of location intelligence for insights that are timely and actionable for smarter decisions.

Supported by intelligent mapping and data capture tools for Geodesign, intuitive visualization for enhanced situational awareness, advanced geospatial analytics for operational intelligence that is actionable, and multi-mode dissemination for sharing and collaboration among stakeholders, ArcGIS AEC solutions foster transparency, efficiency, and cost optimization across the value chain.

Bringing GIS and BIM Together

With advancement in 3D modeling and simulations, Digital Twins are increasingly assuming greater significance in the AEC workflows. Proliferation of IoT sensors and devices is providing accurate insights for enhanced location awareness and response. Smart applications streaming real-time insights into ArcGIS enable seamless monitoring and administration of the construction processes, facility management, and environmental monitoring.

The power of using BIM data within ArcGIS expands beyond incorporating BIM content from multiple disciplines, sources, and applications into various asset lifecycle workflows. Bringing together environmental, demographic, political, and social data on ArcGIS ensures that due importance is given to these sensitive factors and ensures sustainability and resilience at every stage.

ArcGIS GeoBIM enables organizations to provide rich geospatial context to architecture, engineering, construction, and facility management projects. By bringing GIS and BIM data together, ArcGIS GeoBIM allows users to incorporate and use data from multiple systems, access project data from a common experience, explore GIS and BIM data side by side, collaborate and share information with stakeholders, and minimize costly data conversions. AEC Project Delivery subscription enables professional service companies to extend internal GIS content and context to resources outside of the organization allowing them to collaborate and share information directly with stakeholders.

Data Capture and Integration

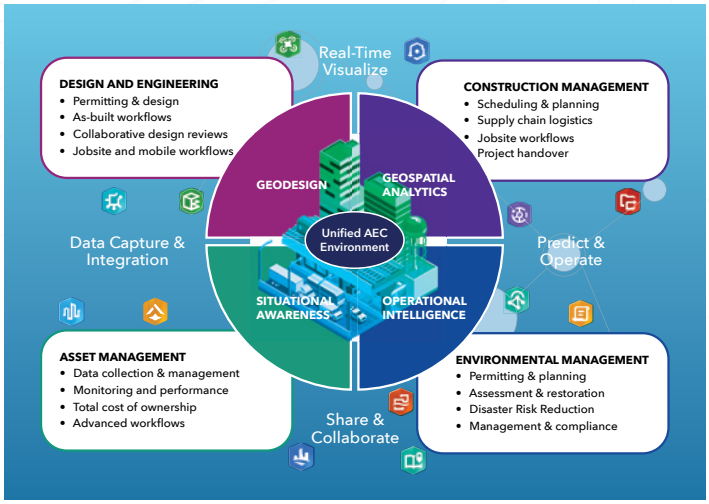
Site Scan for ArcGIS is a cloud-based drone mapping software designed to revolutionize imagery data collection, processing, and analysis for smaller sites. ArcGIS CityEngine is an advanced 3D modeling software used for creating massive, interactive, and immersive urban environments based on real-world geographic information system (GIS) data with the potential to showcase a fictional city of the past, present, or future. ArcGIS Utility Network provides a comprehensive framework of functionality for the modeling of utility systems such as electric, gas, water, stormwater, wastewater, and telecommunications. It allows you to build real-world behavior into the network features you model.

Visualization

ArcGIS GeoPlanner is a web-based planning tool that empowers you to rapidly design city, regional and landscape-scale scenarios in a collaborative, iterative environment. ArcGIS Urban applies GIS technology to urban planning to streamline plan creation, analyze the impact of plans, visualize current projects, and facilitate public engagement. In addition to helping you design, manage, and measure urban developments. ArcGIS Indoors, as a complete indoor mapping system for smart building management, organizes computer-aided design (CAD), building information modelling (BIM), site scans, and operational datasets into floor-aware indoor maps to support estates, facilities, workplace and maintenance operations, and other various use cases. ArcGIS Insights fuses location analytics with open data science and business intelligence

Share and Collaborate

ArcGIS Hub organizes people, data, and tools through information-driven initiatives for community engagement. With ArcGIS Hub, organizations leverage their existing data and technology and work together with internal and external stakeholders to track progress, improve outcomes, and create vibrant communities. ArcGIS Experience Builder is a highly configurable solution for building compelling web apps without writing code. It helps you to choose a template and create an immersive web experience for your audience by unifying web maps, apps, pages, interconnected widgets, and both 2D and 3D data through a flexible drag-and-drop interface. ArcGIS StoryMaps is a story authoring application that allows you to share your maps in the context of narrative text and other multimedia content.



Predict and Operate

ArcGIS Workforce is a mobile app solution that uses the power of location to coordinate the field workforce. It integrates work management to reduce reliance on paper and provides everyone with access to the authoritative data they need. ArcGIS GeoEvent Server enables real-time event-based data streams to be integrated as data sources in enterprise GIS and alert personnel when specified conditions occur, all in real-time.

In Closing

Right data available at the right time in the right hands is critical for the success of infrastructure projects. Using BIM information in a comprehensive manner, ArcGIS helps improve decision making, and creates true digital twins for facility design, project delivery and operations. While allowing you to build site context with the environment, it provides you with capabilities to sense site change with every phase of development. Designing and visualizing the real world in 3D and integrating with IoT sensors helps you optimize infrastructure operation intelligence.

By contextualizing a BIM model with local and regional environs, ArcGIS AEC portfolio provides efficient design, project management, and improved coordination and collaboration among stakeholders while addressing sustainability and resilience.

ArcGIS Field Maps

The all-in-one app for mobile work

ArcGIS Field Maps is an all-in-one app that uses data-driven maps to help fieldworkers perform mobile data collection and editing, find assets and information, and report their real-time locations. Because it is built on ArcGIS, everyone - whether in the field or the office - will benefit from using the same data.

ArcGIS Field Maps brings together the functionality of ArcGIS Collector, ArcGIS Explorer, and ArcGIS Tracker to give users the ability to collect data, view maps, and track locations all within a single mobile app.

ArcGIS Field Maps has two components, a mobile app and a web app. The mobile app is powered by maps created with ArcGIS and configured using the Field Maps web app. The web app streamlines map configuration and deployment by bringing together the experiences throughout ArcGIS that support offline capabilities - including configuring feature templates, form capabilities for data capture, and editing in the field - in one place.

Mobile personnel who use Field Maps benefit from map-centric workflows that make it easy to explore a map of a work area, search within the map to find assets or places of interest, and record location tracks. Data that they edit or capture feeds directly into the organization's ArcGIS system, where it's available for others to use in near real time. Field Maps works seamlessly in disconnected environments, too. It retains collected data on the mobile device until connectivity is available, and then it syncs with the organization's ArcGIS.

Simple, Intuitive Design Empowers Mobile Workers

Members of a mobile workforce are often experts in their industries but may not be in GIS. For this reason, Field Maps has been designed to be intuitive and simple to use. And as mobile operations evolve, so do the capabilities of Field Maps - especially in the areas of location sharing, mapping utility networks, and indoor use.

Location Sharing

Keeping workers safe, following regulations, and synchronizing field based and office work are primary reasons that organizations require mobile employees and contractors to share their locations. This capability is an integral part of Field Maps, and it works whether users are in a connected environment or in remote areas where coverage isn't readily available.

Utility Networks

Accessing digital utility records has traditionally been limited to desktop environments. But now that Field Maps supports ArcGIS Utility Network, comprehensive data about utility assets and networks can be accessed in the field from mobile devices. This enables engineers, for example, to query a digital twin of utility assets as they view easements and encroachments—all on the same map, all while on-site completing their tasks.

Indoor Mobile GIS

Increasingly, people want to be able to use mobile GIS inside buildings. This growing demand is encouraged by the wider availability of building information modelling (BIM) data and indoor positioning systems (IPS).

Linear Referencing

When inspecting assets along roads, railways, and utility lines, mobile workers often need to describe where the infrastructure is located by taking measurements from a fixed point using a linear referencing system. Now, Field Maps can find the measurement nearest to a mobile worker's location or search for locations anywhere along a line. Found measurements like this can be captured by mobile workers when collecting information. They can also be used as destinations for navigation using a compass.

Integration Capabilities Generate Smoother Workflows

A part of the appeal of using Field Maps is that it is agile and can be integrated easily with other technologies, high-accuracy devices and within wider business systems.

5 Key Capabilities in One App

1. Map Viewing
2. Map Markup
3. Data Collection
4. Asset Inspection
5. Location Tracking

ArcGIS Velocity

Analyze real-time and big data

ArcGIS Velocity is a cloud-native add-on capability for ArcGIS Online. It enables users to ingest data from the Internet of Things (IoT) platforms, message brokers, or third-party APIs. It also helps users process, visualize, and analyze real-time data feeds; store those feeds as big data; and perform fast queries and analysis. This software as a service (SaaS) IoT application helps in better leveraging your real-time spatial data for essential operational decisions such as remote monitoring of assets, predictive maintenance, and process optimization.

What is ArcGIS Velocity?

High-velocity event data can be filtered, processed, and sent to multiple destinations, allowing users to connect virtually any type of streaming data and automatically alert personnel when specified conditions occur. Users can also design analytic models to process high-volume historical data and gain insights into patterns, trends, and anomalies.

ArcGIS Velocity tools can be used for various spatial analysis approaches: analyze patterns, find locations, manage data, summarize data, use proximity, and data enrichment. Whether one needs to perform geofencing, detect incidents, run regression analysis on multiple datasets, or find areas of data clustering, there are many options to explore data.

Getting started with ArcGIS Velocity

1. Integrate real-time data

- Ingest data from connected devices by configuring a feed that can be used as a live map layer.
- Integrate real-time data with historical data via stream and feature layers to analyze change over time.
- Process massive volumes of spatial data at very high speeds with the highly scalable Kubernetes-based architecture of ArcGIS Velocity.

2. Monitor critical assets

- Get precise locations and insights on all of your assets for 24/7 visibility.
- Track dynamic assets that are constantly changing location, such as vehicles, aircraft, and vessels.
- Track stationary assets, such as weather and environmental monitoring sensors.

3. Unlock spatial insights

- Make more informed decisions with IoT spatial intelligence analysis.
- Access a range of powerful real-time and big data tools to analyze information from a variety of data feeds and sources.
- Leverage a visual analytic model builder that enables you to design complex analysis and automate workflows, saving time and effort.

4. Trigger alerts

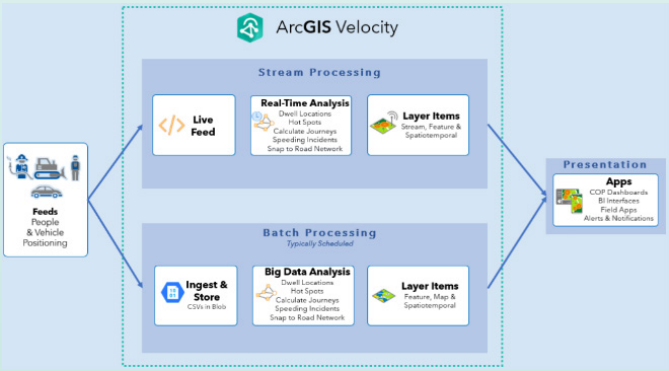
- Act on events of interest including storage, alerting, and actuation.
- Display and share your findings to others in your organization with the help of dashboards.
- Gain operational, tactical, and strategic efficiencies that save time and money.

Tip: ArcGIS Velocity provides us with tools to generate on-demand analytical products.

How it works:

Connect

Connect to real-time, streaming IoT data from multiple feeds and visualize directly in maps.



Analyze

Speed up your analysis and get answers faster when you set up analytical models in the cloud.

Alert and actuate

Take action with your analyses. Share the results and alert stakeholders when it matters.

Real-time analysis using ArcGIS Velocity

Real-time analytics perform processing on data ingested via a feed, analyzing each message as it is received. Real-time analytics are used especially for transforming data, geofencing, and incident detection. Analytics conclude with one or more outputs such as storing data in a feature layer or sending an email alert.

Examples of real-time analysis

- As an emergency operations manager, you track and archive the current locations of your field crews in real-time, send alerts if crew is inside a restricted zone, and calculate the distance of the field crews from their assigned base of operations.

- As a supply chain analyst at an oil and gas company, you connect to an Automatic Identification System (AIS) data stream to monitor your vessels, calculate expected arrival information, and understand when vessels are either inside or outside areas of interest.

- As an environmental scientist managing a large number of sensors, you archive observations for later processing in a big data analytic.

Data sources in a real-time analytic are only used as a secondary dataset in applicable tools such as Join Features, Filter by Geometry, Calculate Distance, and more.

ArcGIS Velocity provides us capability to keep the main feature layer relatively refreshed, to give it an interval that we provide, and archive data as it rolls over. That way, we can continue to do analytics on it.

Components of a real-time analytics

There are four components of a real-time analytics:

- **Feeds:** A feed is a real-time stream of data coming into ArcGIS Velocity. Feeds typically connect to external sources of observational data such as Internet of Things (IoT) platforms, message brokers, or third-party APIs.

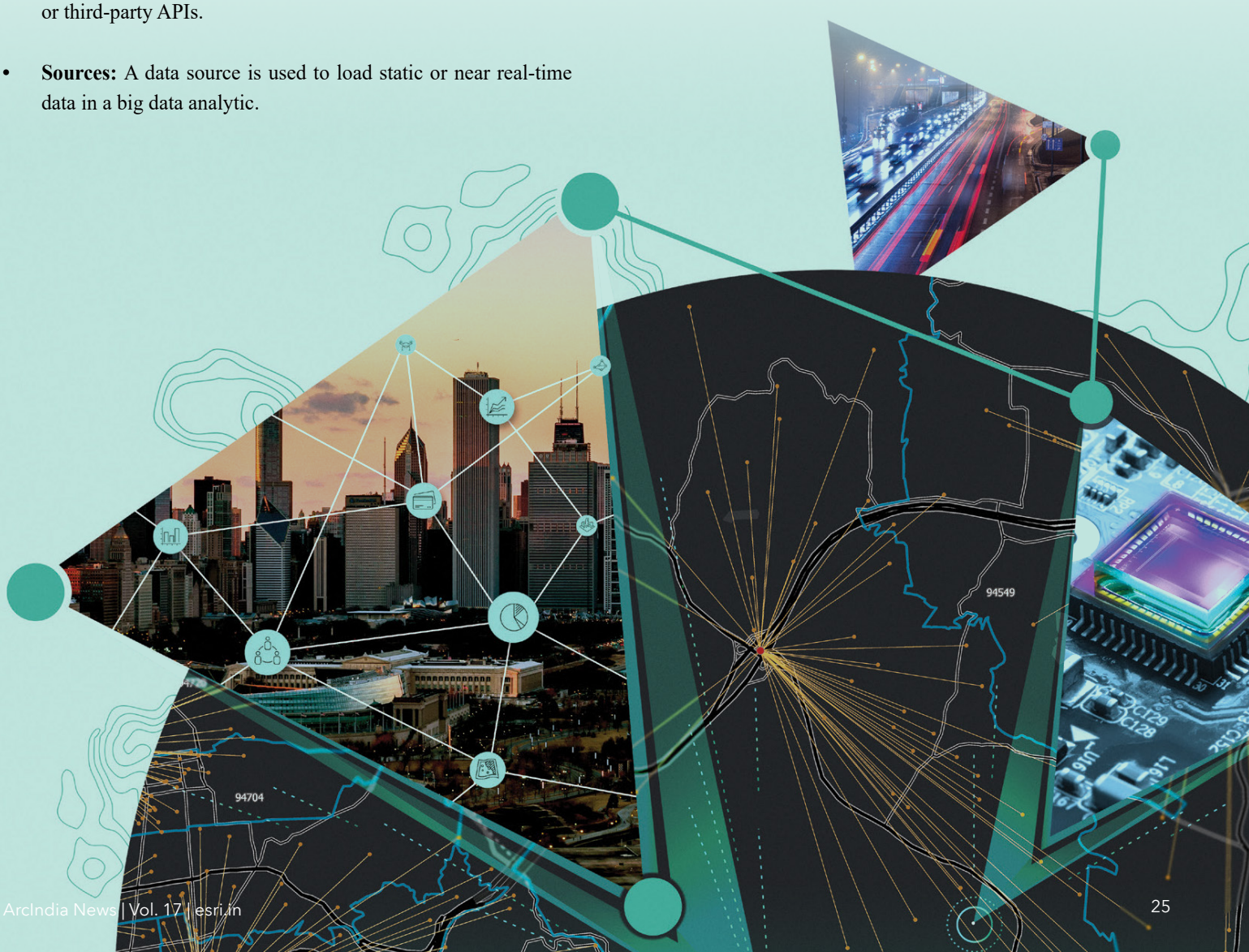
- **Sources:** A data source is used to load static or near real-time data in a big data analytic.

- **Outputs:** An output defines what should be done with each event as it is processed by a real-time analytic.

- **Tools:** Tools process or analyze events coming in from feeds. Include none or multiple tools in a real-time analytic depending on the use case.

ArcGIS Velocity for real-time analytics

Tip: One of the most powerful uses of real-time analysis is the ability to be alerted when something changes. You may want a notification when a tracked delivery vehicle enters the perimeter around a shipping facility, or when an aircraft suddenly loses airspeed or altitude. This ability to compare current observations to previous ones in real-time is referred to as stateful processing.



Strengthening the Geospatial Infrastructure of the Country: How important is Geospatial Education and Skill Development?

"Geospatial Education and Skill Development is the most important component to consider before we move forward in the direction of strengthening the Geospatial Infrastructure of India. Without a skilled workforce, it will be difficult to meet the growing demand for geospatial to leverage geospatial data and technology and build and maintain large geospatial infrastructures. Geospatial Education and Skill Development can help prepare professionals to address complex socio-economic challenges and promote innovation in various sectors." **- Dr. Shaily Gandhi, Ph.D., Deputy Center Head, CAG, CRDF & Program Chair, M.Tech Geomatics, Faculty of Tech. CEPT University.**

"Geospatial education and skill development are crucial components in strengthening the geospatial infrastructure of a country because they provide the necessary knowledge, expertise, and human resources needed to effectively manage and utilize geospatial data, which can lead to improved decision-making, economic growth, and job creation. The right education and training can help in improving the country's ability to manage the geospatial infrastructure in a much better way." **- Dr. Raaj Ramsankaran Ph.D., Associate Professor, Remote Sensing Division, Department of Civil Engineering, IIT Bombay.**

"With the development of technologies like big data, artificial intelligence, the Internet of Things, etc. smart mapping has now reached a new level. Using mobile and satellite technology, new technologies regularly produce large amounts of complicated data, most of which have a geographical component. Formally educated and skilled individuals in the field of geospatial technology have the potential to handle and analyze such technical processes that employ computer processing, engineering, and statistical ideas, as well as spatial modelling. Without such kind of human force, it is difficult to imagine any country's geospatial infrastructure." **- Dr. T.P. Singh, Director, Symbiosis Institute of Geoinformatics.**

"India is on a Geospatial expressway at the moment and the present generation stands to benefit from dynamic job opportunities with skills in geospatial technologies. Being a geologist in an engineering department, I can see how every aspect of engineering can be enhanced by GIS. Students today will be the backbone of tomorrow's infrastructure and what better way to prepare them than to equip them with geospatial skills." **- Dr. Sunayana Sarkar, Assistant Professor, Department of Civil Engineering, Mukesh Patel School of Technology Management and Engineering.**

"Very few institutes are offering Geo-informatics courses at the undergraduate level and post-graduate levels. We must increase the number of institutes providing such courses and also create job opportunities in the government and private sectors. This will help in making India a world leader in global space and develop new innovations in geospatial technologies." **- Dr. Ishtiyaq Ahmad, Assistant Professor, Civil Engineering, NIT Raipur.**

"Geospatial technologies and spatial thinking are fundamental components of human capacity in nation building. Geospatial Infrastructure has and will lead nation building and the need for skill development at all levels in society, starting from students in school. Higher education remains the only hope to develop indigenous GeoICT of India." **- Dr. Sumit Sen, GISP, PMP, CSM, Chief Executive - GISE Hub, IIT Bombay.**

How Industry-Academia Partnership can Help?

"Students emerging from most geospatial courses have certain amount of skills and competencies. There is however a need to be current with knowledge about cross-domains, and emerging tech trends. Fostering innovations requires collaboration across sectors especially sustained collaboration between academia and industry. Strong industry-academia collaboration is a game changer in this sector. Today Universities are mandated to set up incubation centres to support entrepreneurship and this is a win - win situation for both parties concerned. This enables research innovations. Esri India has been a key player in fostering industry-academia collaboration." **- Dr. Shamita Kumar, Vice Principal, Institute of Environment Education and Research, Bharati Vidyapeeth University.**

"Industry-academia partnership is a crucial element of India's geospatial growth story because it helps in bridging the gap between theoretical knowledge and practical application of geospatial technology. Leaders like Esri India have been playing a significant role in building the geospatial infrastructure of the country by providing innovative solutions and services that cater to the needs of various industries and sectors. Esri India has also been collaborating with prestigious institutions to promote research and development in geospatial technology." **- Dr. B Prithvi Raj, Asst. Professor (Digital Technology), School of Planning & Architecture.**

"Industry-academia partnership is a crucial element of India's geospatial growth story as it can help bridge the gap between industry requirements and academic curriculum, promote research and innovation, and create a skilled workforce. CEPT University has been leveraging this with Esri India from the very initial days of teaching the Geomatics course at the University, since 2001. Industry players like Esri India have been playing a key role in building the geospatial infrastructure of the country by providing cutting-edge technology solutions and software, supporting capacity building initiatives, and promoting the adoption of geospatial technology across various sectors." **- Dr. Shaily Gandhi, Ph.D., Deputy Center Head, CAG, CRDF & Program Chair, M.Tech Geomatics, Faculty of Tech. CEPT University.**

"Academia and industry relationship is very important in terms of updated curriculum development and to provide industry ready individuals. Without this it will be difficult to achieve the vision stated in National Geospatial Policy." **- Dr. T.P. Singh, Director, Symbiosis Institute of Geoinformatics.**

"Industry-academia partnership is an important element of India's geospatial growth story. The partnership helps in enabling the exchange of knowledge, skills, and resources between the two sectors, leading to the development of innovative solutions to complex geospatial problems. The collaboration is particularly useful in bridging the gap between academic curriculum and industry practices. Further, it is important to state that this kind of partnership is highly essential so that the education and training efforts are directed towards the societal needs and applications for the growth of India. **- Dr. Raaj Ramsankaran Ph.D., Associate Professor, Remote Sensing Division, Department of Civil Engineering, IIT Bombay.**

Application of GIS Tools for Groundwater Management under Atal Bhujal Yojana

Neety Nagi[1], U.S. Balpande[2], Pratul Saxena[3], Jitesh Tatiwal[4], Vivek Tiwari[5]
National Program Management Unit, Atal Bhujal Yojana, New Delhi

Introduction

Water is a fundamental resource for life. Groundwater has become an increasingly important natural resource catering to the freshwater requirements of various sectors in India. Sustainable development and efficient management of this scarce resource has become a challenge. Groundwater has steadily emerged as the backbone of India's agriculture and drinking water security. The contribution of groundwater is nearly 62% in irrigation, 85% in rural water supply and 50% in urban water supply. Groundwater is an annually replenishable resource but its availability is non-uniform in space and time (CGWB, 2022). Water is a scarce and precious national resource to be planned, developed, conserved and managed as such, and on an integrated and environmentally sound basis, keeping in view the socio-economic aspects and needs of the States. It is one of the most crucial elements in developmental planning. As the country has entered the 21st century, efforts to develop, conserve, utilize and manage this important resource in a sustainable manner, have to be guided by the national perspective (National Water Policy 2012).

In recent years, there have been several promising attempts at groundwater management with community participation in different parts of the country. These include the Andhra Pradesh Farmer Managed Groundwater Systems (APFAMGS); and Water budget-based holistic water management in Hiwre Bazaar village in Maharashtra. These pilot initiatives have demonstrated how demand for groundwater can be reduced if timely information on groundwater availability is provided to communities, multiple agencies work together and communities are engaged in the planning process. Most of these success stories of participatory groundwater management are community driven. With time, the government and the policymakers have recognized the potential of the community in groundwater management and the need to institutionalize such initiatives through convergence of Government initiatives with emphasis on demand side management and behavioural change for ensuring long term sustainability of groundwater in the country. Atal Bhujal Yojana is a major step in this direction.

Atal Bhujal Yojana (Atal Jal)

The Atal Bhujal Yojana was inaugurated on the 95th birth anniversary of Bharat Ratna Shri Atal Bihari Vajpayee and is under implementation since April 2020. The duration of the scheme is for five years from 2020-21 to 2024-25. The total outlay of the scheme is Rs. 6000 Crores, funded by the Government of India and the World Bank. The scheme is being implemented in 8220 Gram Panchayats (GP) of 229 Blocks in 80 districts of the select water stressed areas of seven states viz. Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh.

Objective

The goal of Atal Bhujal Yojana is to demonstrate community-led sustainable groundwater management which can be taken to scale. The major objective of the scheme is to improve the management of groundwater resources in select water stressed areas in identified states. The scheme is targeted at sustainable groundwater management, mainly through convergence among various ongoing schemes with the active involvement of local communities and stakeholders. This will ensure that in the scheme area, the funds allocated by the central and state governments are spent judiciously to ensure long-term sustainability of groundwater resources. The convergence of funds, aided by a strong data base, scientific approach and community participation shall further result in incentives to state governments for suitable investments. It also aims at bringing about behavioral change at the community level through awareness programs and capacity building for fostering sustainable groundwater management in the participating states. It offers a complete techno-managerial and social solution for the availability of water to the villagers/local community. A core aspect of the program is centered around community participation to prepare the water budget of the gram panchayat resulting in the formulation of the Water Security Plan. Atal Bhujal Yojana aims at making the states responsive in creating an enabling environment for a paradigm shift in groundwater management.

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Areas under Atal Jal

The states for implementation of the scheme, viz. Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh have been selected according to a number of criteria, including degree of groundwater exploitation and degradation, established legal and regulatory instruments, institutional readiness, and experience in implementing initiatives related to groundwater management. The districts, blocks and gram panchayats for implementation of the scheme in the identified states have been finalized by the respective States. Atal Bhujal Yojana attempts for de-mystification of science wherein the complex scientific knowledge of hydrology and hydrogeology is made simple and easy to understand by the community.

Components of Atal Jal

The Atal Jal scheme has two components, viz. Institutional Strengthening and Capacity Building (IS&CB) and the Incentive Component.

Institutional Strengthening and Capacity Building (IS&CB)

The IS&CB component is aimed at strengthening the groundwater governance mechanism in the participating states. It strengthens the institutional arrangements and capacity in the states for enabling them to sustainably manage their groundwater. The various components under IS&CB include training and capacity building activities to enhance institutional capacity for effective groundwater management at all levels, engagement of District Implementation Partners (DIPs) viz. community-based organizations (CBOs)/ non-governmental organizations/etc, to establish monitoring & evaluation (M&E), engaging the independent verification and other program management components. The District Implementation Partners (DIPs) consist of one or more NGOs / CBOs hired by the SPMU and shall facilitate handholding of the GPs in various aspects of the scheme, including the development of water budgets and Water Security Plans (WSPs); community mobilization; formation/ strengthening of Water User Associations (WUAs); data collection; information, education, and communication (IEC) activities.

Incentive Component

The Incentive Component is aimed at rewarding/incentivizing the states for various measures aimed at ensuring the long-term sustainability of groundwater resources. Through a combination of institutional strengthening, community mobilization, convergence among ongoing schemes and incentivization of good performance, the scheme aims to bring synergy among various ongoing schemes and ensure benefits and dividends at minimal cost in the identified ground water stressed areas. Under this component, funds are disbursed for incentivizing or rewarding the states that achieve certain pre-defined targets against the identified Disbursement Link Indicators (DLIs).

Disbursement Linked Indicators (DLIs)

These are result indicators linked to the disbursement of funds under the Incentive component of the scheme. Funds are disbursed subject to the achievement of the result indicators by the implementing agencies. Selection of DLIs has been guided by (i) activities that need to be done for sustainable management of groundwater, (ii) measurability and ease of verification and (iii) capacity of stakeholders to achieve the results. Taken together, these DLIs, while focusing on the objective of the scheme, provide incentives for achieving key milestones towards the ultimate goal of the scheme i.e. improving groundwater management with community participation. Five DLIs have been selected out of which the first four DLIs incentivize the activities leading to sustainable management of groundwater while the fifth DLI is related to the outcome of the four DLIs. The DLIs have been defined as below:

1. Public disclosure of groundwater data/information and reports (DLI#1)
2. Preparation of Community-led Water Security Plans (DLI#2)
3. Public financing of approved Water Security Plans through the convergence of ongoing/new schemes (DLI#3)
4. Adoption of practices for efficient water use (DLI#4)
5. Improvement in the rate of decline of groundwater levels (DLI#5)

To support and strengthen the groundwater monitoring mechanism on groundwater quantity and quality, various works and equipment are procured under Atal Bhujal Yojana. These include the construction of piezometers and installation of Digital Water Level Recorders, procurement of Water Quality Testing Kits, Water Flow meters, Water Level Indicators/sounders and Rain Gauges.

Data Repository under Atal Jal

A dedicated web portal including Management Information System (MIS) and Mobile Application has been developed under the Atal Bhujal Yojana for progress monitoring, data capture and preparation of Water Security Plans at the level of Gram Panchayats. The Atal Jal portal and Mobile application is hosted on NIC Cloud.

Key features of MIS & Mobile application are:

- Capturing demographic data at gram panchayat level
- Separate MIS module for the preparation of gram panchayat-wise WSPs
- Modules to capture details about Social & Environmental safeguard tools, along with monitoring the physical and financial progress of the scheme.

- Online facility for registration and management of various training and capacity building programs being organised under the scheme.
- GIS-based "Map view" for dissemination & display of data at a public level.
- Collection of information at the field level viz., groundwater monitoring, rainfall monitoring, geo-tagging of artificial recharge & water conservation structures, and social events through mobile application (both Android & iOS).
- Dissemination of data for public view through mobile app and decision making at the user level.

ArcGIS tools are being used extensively for several activities under Atal Bhujal Yojana, ranging from the data management and visualization under DLI#1, preparation of maps and locating possible sites for interventions in the Water Security Plans under DLI#2, Cumulative Impact assessment studies, etc. This paper, however, focuses on the utility of the ArcGIS application in building a user friendly platform for disclosure of data to the public, and has been elaborated in the next section.

Public Disclosure of Groundwater Data/ Information and Reports

Atal Bhujal Yojana has collated the data related to groundwater level as well as quality being monitored and maintained by various agencies viz., Central Ground Water Board (CGWB) & State Ground Water Department in the seven participating States. One of the key aspects of Atal Jal is to bring in behavioral changes in the community, from the prevailing attitude of consumption to conservation & smart water management. It is imperative that this message is driven across all levels, especially at the grass-root level, so that the objectives of the scheme are achieved.

Additionally, to bring the groundwater data to the masses, in the form of information, it is imperative to showcase the outcomes of a scheme on a single click. ArcGIS has evolved to collate and manage huge database over time by providing user friendly features. Using the ArcGIS platform, it has been attempted to publish and disseminate more than 3000 water level observations, 1500 water quality observations, 60000 existing artificial recharge structures & water conservation structures and 7 lakh existing wells in the gram panchayats falling under the participating states for Atal Bhujal Yojana. Other than the groundwater data, various other parameters viz., Rainfall, groundwater resource comparison, block-level hydrogeological reports have been disclosed through the additional features provided by ArcGIS Enterprise version.

GIS Application for Dissemination of Data

A dedicated web GIS application, using ArcGIS Enterprise, has been developed for the disclosure of data in public domain (Fig.1).

The application can be accessed through https://ataljal-arcgis.mowr.gov.in/GIS. The application offers various features to view, analyze and download data with respect to the groundwater level & quality, artificial recharge structures & water conservation structures, and interventions proposed for groundwater management in selected gram panchayats under Atal Bhujal Yojana.

Features of the GIS Application

The GIS application offers various features to visualize and perform analytical operations to obtain the desired results. The key features are elaborated below:

Map View

This interface offers multiple tools to visualize and download the data within a selected frame or area of interest such as:

1. Location of ground water level observation wells, water quality observation wells, existing artificial recharge structures & water conservation structures, wells inventoried and registered through Atal Jal mobile application.
2. Zoom to layer with statistical summary at zoom extent.
3. Locate incidents, area calculation and buffer zone analysis (Fig.2)
4. Query analysis within area of interest
5. Data search and download report

Charts & Graphs

This interface redirects the application to analyze the groundwater resource information for selected administrative boundary (Fig. 3), such as

1. District wise rainfall report (Actual, Normal & Deviation)
2. Block-wise groundwater availability and withdrawal
3. Well hydrographs (Pre & Post-monsoon water level for a specified period)

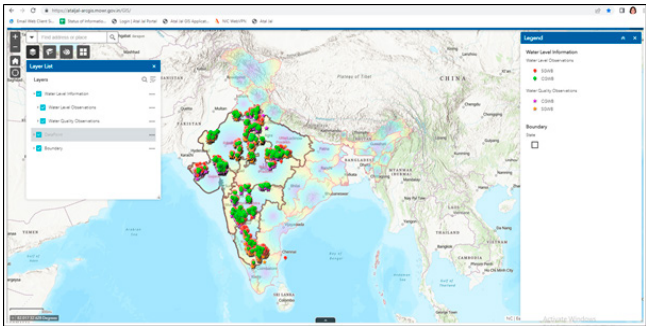

Fig: 1. Web-GIS application for Atal Bhujal Yojana

Dashboard

Dashboard offers a summary statistic to view the significant details of the achievements of the scheme so far (Fig. 4). The numbers are also reflected as the point locations on the map. The statistics can be obtained for a specific area through selection of state, district, block and gram panchayat.

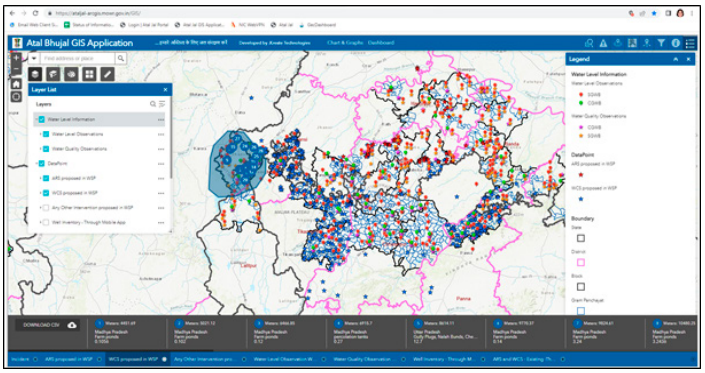

Fig: 2. Locate, visualize, count and download information within a desired incident (polygon)

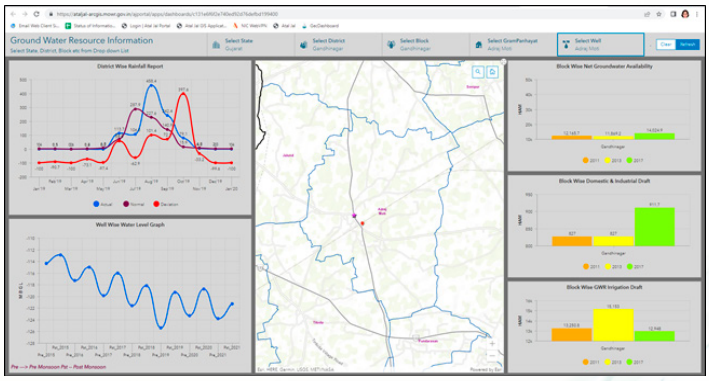

Fig: 3. Ground water resource information including charts & graphs

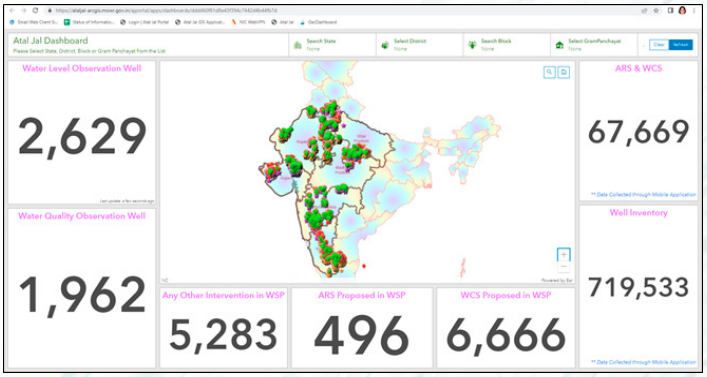

Fig: 4. Atal Jal Dashboard

Conclusion

The scheme is expected to result in multiple benefits including i) improvements in sustainability of ground water resource in target areas, ii) positive contributions to the sustainability component of Jal Jeevan Mission, and to the goal of doubling farmers' income and iii) Inculcation of behavioral changes in the community to foster improved ground water management. Some realistic future expectations of the scheme are Informed & participative decision making, Community mobilization & empowerment leading to behavioral change, which can only be achieved once the stakeholders are well informed about the criticalities in the ground water science. Any decision, at any level, can be taken through practical analysis of the scenarios. Through this paper, an attempt has been made to widely publicize the Atal Bhujal Yojana and sensitize the users about the ground water scenario, for effective management of ground water resources by the stakeholders. The application is dynamic in nature and the information is updated on a frequent basis. The development and enhancement of the application will be done on a continuous basis to make it more user friendly as well as providing advance analytical features for information extraction and planning process.

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Geospatial Infrastructure at Its Best

York Region is located north of Toronto, the provincial capital of Ontario. It encompasses nine fast-growing cities and towns— the City of Markham, City of Vaughan, City of Richmond Hill, Town of Newmarket, Town of Aurora, Town of Georgina, Town of Whitchurch-Stouffville, Town of East Gwillimbury, and Township of King as well as two district school boards and two conservation authorities. With 1.2 million residents, the region is one of Canada's largest municipalities.

Although the region was being honored for a new project, the York Data Co-op, York Region has long recognized the value of GIS for improving government. In 1996, it formed the YorkInfo Partnership to help all its constituent entities benefit by collectively investing in GIS technology, data, and the people who apply both to improve government processes and services.

According to John Houweling, Director of the Data, Analytics and Visualization Services Branch at York Region, "Enabling data access and sharing has been our core direction for years. Building trust in the data adds confidence in decision-making and ultimately results in more effective services. The York Data Co-op takes this further by enabling partners to share apps and tools. This increases collaboration in common business areas."

The sharing aspect of York Data Co-op has been especially important for smaller municipalities that lacked the resources to support the adoption of spatial technologies. The Data Co-op provides a virtual Marketplace in which partners can locate digital assets using a familiar online shopping experience. GIS has been adopted by all service areas in the region and supports governance, housing, transportation, environmental protection, land use, forestry, economic development, public health, and water and wastewater management.

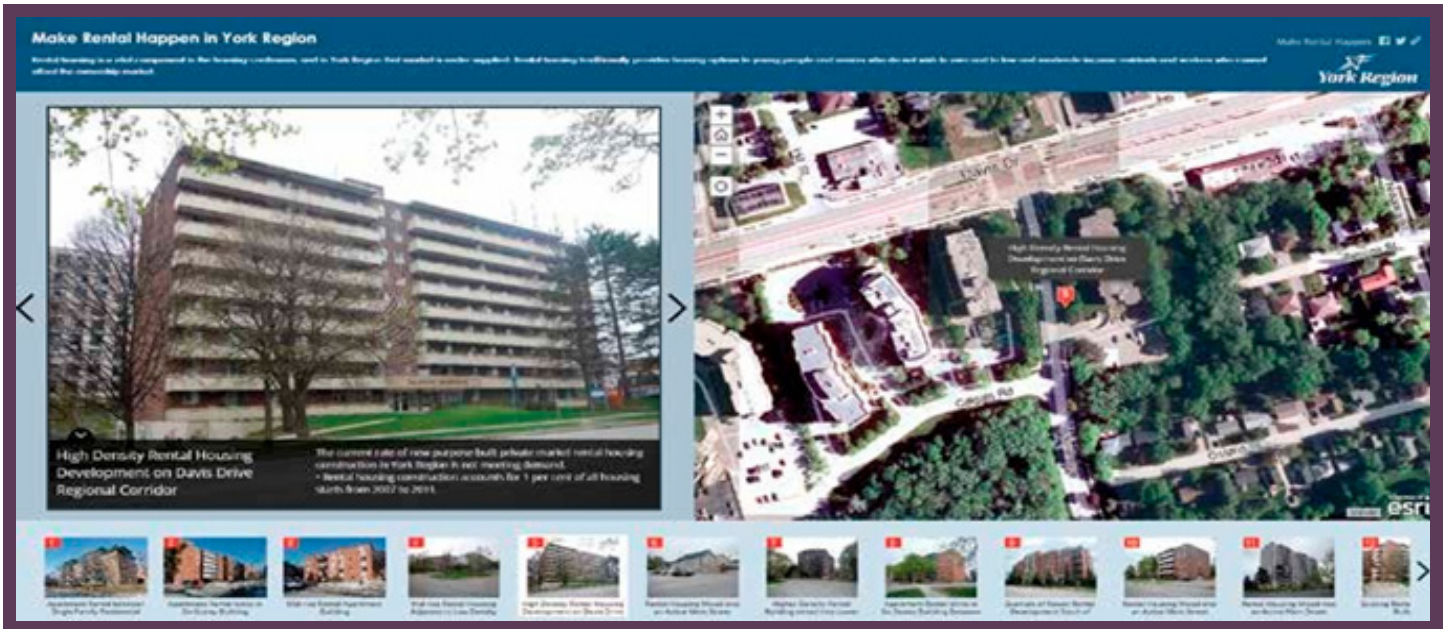
This effort was guided by a vision that would connect the various partners' GIS implementations, allowing access to digital assets to be controlled by those partners. This led to the adoption of a truly federated model—a system of systems— in which no partner is the central owner or distributor of assets. Sharing can occur between any partner, using Esri technology to facilitate collaboration.

This federated platform for sharing was built using ArcGIS Enterprise portal and ArcGIS Online, Esri's cloud-based data sharing, mapping, and analysis service, which gave partners a low-cost entry point to quickly and easily develop solutions.

"The ArcGIS Online development enviroment is so straightforward that we've literally been working things out on a whiteboard in the morning and then looking at a proto- type online that afternoon," said Brendan Coles, GIS project specialist for York Region. "Everyone gets excited when they see how quickly we can make things real."

The York Region Open Data portal and the Marketplace were built using ArcGIS Hub. Partners publish the digital assets that they wish to share by registering them with the York Data Co-op. These assets aren't physically copied into a central server. They remain behind each partner's firewall, where they are maintained so that assets are always current. The assets needed for a specific use are easy to locate because they are grouped based on function rather than asset owner. A defined legal and governance framework controls the use of YorkInfo Partnership resources.

Not only does this structure greatly enhance opportunities for collaboration but it improves accuracy while saving time and eliminating the costs associated with maintaining redundant assets. Users never



Partner data can be pulled into a variety of apps such as this ArcGIS StoryMaps story that promotes the region's rental market.

The York Data Co-op makes data from across the region available to drive better decisions.

have to wrestle with determining which of many versions from many sources is the most current and authoritative.

The York Data Co-op provides a common infrastructure for delivering services, whether within cities, towns, and districts or across the region. This is enormously useful in situations that require municipalities to jointly manage operations such as water and wastewater management. Access to the most authoritative data also promotes data-based decisions by ensuring accuracy and currency. This system provides one window into all the data and a single source of truth. Each asset—whether it is a dataset, script, app, or workflow—is documented with metadata identifying its source, extent, timeliness, and other information so that it can be used knowledgeably by other partners.

Providing the Marketplace has another powerful benefit. Partners can incorporate the work already done by others, rather than replicating it, then build on that work to accomplish more. This support improves productivity and scalability for municipal GIS departments, whether those are single-person shops or departments with many staff members.

This is especially valuable for smaller partners that have more limited resources that may lack the internal capabilities to develop these assets. This also makes deploying new apps more doable and less risky and enables larger cooperative activities between partners, such as using common data models.

Partner data can be pulled into a variety of apps via APIs or into ArcGIS StoryMaps, used in ArcGIS Online maps and analyses, or pulled into work on the desktop using ArcGIS Pro. This approach supports the operations of individual municipalities by letting them choose how they use technology so that it works with, rather than disrupts, existing business processes.

This enables innovation, not for innovation's sake, but to improve processes and services that benefit residents of York Region. This includes a federated Open Data portal that provides York Region businesses and residents with access to government data. Although not all partners' open data has been connected yet, eventually any data shared by partners will be accessible and usable.

YorkInfo Partnership will continue to grow. There are plans for incorporating other municipal service providers, additional levels of government, and organizations in the private sector, although that will require some legal and governance changes.

"The data sharing that they've undertaken lays down a solid foundation for leveraging new technology. Because this works well in such a diverse environment as York Region, it will encourage others to follow their path. It becomes a lighthouse for other municipalities," said Alex Miller, president of Esri Canada.

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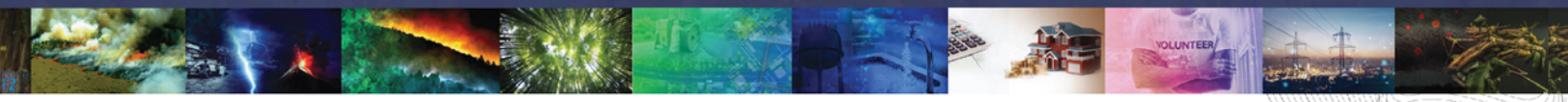

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