BUILDING A STRONG SCIENCE ENTERPRISE

ADDRESSING SCIENTIFIC CHALLENGES WITH A MODERN APPROACH

Science, regulatory, and statistical organizations face challenges that are more complex and unpredictable than ever before. As data becomes more spatially aware and computationally intensive, these organizations are increasingly pressured to be more interdisciplinary; challenged to analyze greater volumes of data; and in some instances, regulated to share data, research, and results with the public. While traditional intricacies persist, a new set of challenges create an environment where missions and priorities change daily—driven by discrete events involving weather, population growth, and land management. Management of all these ancillary pressures can divert focus from primary mission objectives. As organizations work to mitigate ancillary pressures, it is becoming evident that the workflows and approaches that organizations have relied on for years are often outdated or inadequate to facilitate modern research and critical decision-making, which ultimately affects their daily operations and everyone's quality of life.

Modern challenges require a modern approach to meeting them—including building a science enterprise. A strong scientific enterprise yields new tools for analysis and investigation and increases the capacity to question, learn, and build on previous discoveries. Through science, organizations move toward innovative solutions not only for today's major problems but also for future problems. These solutions provide the foundation for economic growth and development and enhance our quality of life. Today, science, regulatory, and statistical agencies must be able to access data, collaborate to unify operations, and rapidly respond to crises while communicating with the public.

Through the power of geospatial technology, organizations can now adopt an all-encompassing, more integrative approach to science. With the right technology, data, people, and processes, every organization can develop a streamlined approach to creating an environment where the mission remains the focus.

Scientific Challenges of the Twenty-First Century

- Population and Economic Growth
- Clean Air and Water
- Sustainable Energy
- Land and Waste Management
- Food and Water Security
- Environmental Justice
- Climate Resilience
- Ecosystem Preservation and Management
- Chronic and Infectious Disease Control
- Space Exploration and Colonization
- Education Outreach and Accessibility

THE SCIENCE ENTERPRISE VISION

A science enterprise utilizes modern approaches and techniques to empower governments and organizations to meet the scientific challenges of the twenty-first century. It embraces a methodology that fosters collaboration to enhance data collection, analysis, sharing, and usability so that science professionals can make the most of existing resources and domain expertise to ensure success in their missions. It also employs a strategy that lowers mission costs while preserving mission performance, enabling scientists to focus on their critical research.

The science enterprise strives to serve the community by clearly conveying its research results. A successful enterprise also makes every effort to transfer technologies to organizations and cultivate strong and lasting relationships among industries, academia, and governments so that the nation and community gain maximum scientific and economic benefits from the mission. As a result, stakeholders with shared interests can communicate to better understand the data and how to apply it to everyday situations, operations, and research—allowing for a collaborative environment to prepare and deal with known and potential issues.

In a science enterprise, organizations can confidently address the following:

- Communicating scientific results and outcomes in an impactful and easy-to-understand approach
- Providing coordinated and reliable access to information and research products focused on serving the broader community
- Improving the value and use of, as well as access to, scientific data
- Better visualization, analysis, and interpretation of patterns
- Providing ways to share methods, techniques, and knowledge
- Leveraging commercial off-the-shelf (COTS) software, often in collaboration with free and open-source software, to accelerate scientific data exploration and analysis
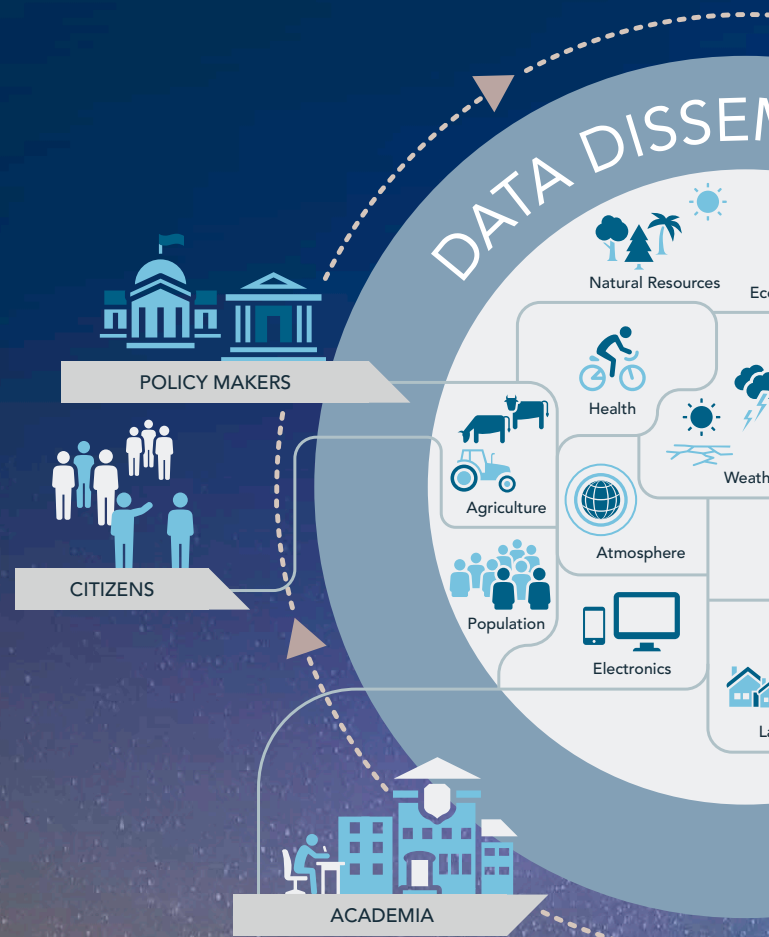
BUILDING A STRONG SCIENCE ENTERPRISE

Organizations around the world are turning to big data analytics, mobile technology, GPS-enabled devices, and live data sensors to develop a capability for delivering better services, accountability, and transparency. The science enterprise concept is built on the idea that technology helps governments and organizations manage the growing complexity of the scientific challenges of the twenty-first century.

Scientists are experts in the skills of the scientific method. They observe, leverage critical and creative thinking, collect data, and perform analysis, and more. A science enterprise builds on the core capabilities of a modern methodology to empower scientists with the following:

- Multiagency, interdepartmental collaboration
- Access to authoritative, actionable data from multiple resources
- Workflows for easily collecting, analyzing, sharing, and consuming data in the field and the office
- Secure, repeatable, reliable, and scalable capabilities
- Complete analysis for understanding and solving problems
- Accurate, data-driven decision-making

DATA DISSEM

POLICY MAKERS

CITIZENS

ACADEMIA

Natural Resources

Health

Agriculture

Atmosphere

Population

Electronics

Weath

THE SCIENCE ENTERPRISE SUPPORTS A RANGE OF DOMAINS AND MISSIONS

Agriculture

- Refine understanding of soil for optimal resource output
- Understand invasive pests' effects on livestock
- Prioritize responsible use of land for optimal output
- Predict events with economic consequences
- Understand weaknesses in infrastructure

Economics

- Understand the impacts of location on trade, tech transfer, supply chains, job creation, and entrepreneurship
- Analyze patterns in economic big data directly related to location
- Go beyond the graph—visualize spatial patterns in compelling, easy-to-build maps
- Help communities become sustainable

Environmental Management

- Monitor the community for impacts of pollution, weather, and hazards
- Create reasonable policy, implement regulations, and manage enforcement
- Help businesses comply effectively with regulations without inhibiting competitiveness or growth
- Devise water scarcity alleviation strategies
- Understand the interdependency of the earth's ecosystems and human impact on the environment

Health and Social Science

- Produce quality statistical data on the population to magnify impact
- Leverage spatial data to highlight a changing cultural landscape to better serve citizen needs
- Establish relevant community services based on trends in economic and social growth

THE POWER OF GEOGRAPHY
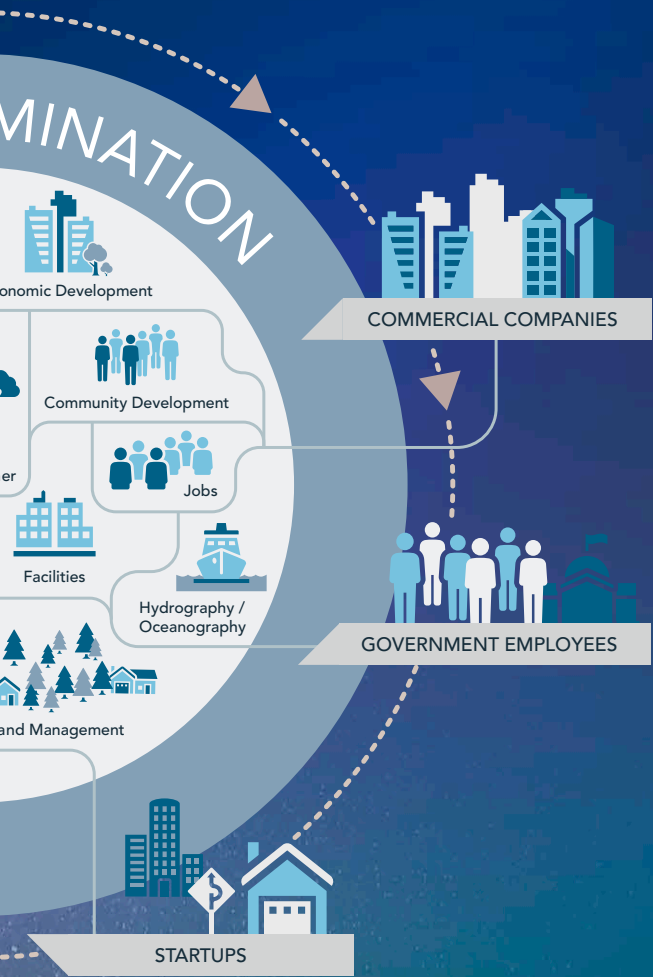
Geography is the study of the world and all that is in it: its people, land, air, water, plants and animals, and relationships among each. What differentiates geographic science is location and space. Geographic thinking is based on understanding where something is and how that location influences its characteristics and relationships with other things.

Geographic information system (GIS) technology is expanding the application of scientific data for problem solving. With a single collection of tools, GIS is able to bridge the gap between curiosity-driven science and practical problem solving. A core skill of a scientist is to make observations, and GIS helps expand the usability of valuable research to a broader range of users.

Maps are the preeminent means of recording and communicating information about location and spatial characteristics of the natural world, society, and culture. A mapcentric theme evolves at each stage, combining itself with other information layers, as well as the expertise of others, to result in a story. Maps gain value and inform others in three ways:

- By collecting and storing information
- By allowing users to analyze and revealing locational distributions and spatial patterns
- By presenting information and communicating findings

Governments, businesses, and society as a whole must capture and curate large quantities of information about the environment and the location of natural resources and phenomenon, capital assets, and people. Maps are a means to recognize spatial distributions and relationships and make it possible to visualize and conceptualize patterns and processes that operate through space. They convey information and findings that are difficult to express verbally.

GIS provides the unique ability to use location and maps as a way to fuse diverse data and systems and bring everything into a common view. Ultimately, it enables agencies to collaborate and share data through dynamic maps and online applications. At a glance, leaders can see the status of an incident or visualize patterns that may not have been seen before and direct an appropriate response. Maps provide an intuitive way to understand complex situations. When everyone operates from the same information, responders can best coordinate and unify their actions to complete the mission.

Diagram labels

MINATION

...onomic Development

Community Development

...er

Jobs

Facilities

Hydrography / Oceanography

...and Management

COMMERCIAL COMPANIES

GOVERNMENT EMPLOYEES

STARTUPS

Hydrography and Oceanography

- Understand and mitigate the factors that are harmful to marine and coastal environments as well as lakes, rivers, and groundwater
- Adopt responsible management practices while still making a profit in fisheries
- Conduct surveys to support fish restoration goals in both freshwater and saltwater environments
- Design communities that withstand storms, tsunamis, sea level rise, population growth, and ocean chemistry changes

Natural Resources

- Improve inventory and land administration, evaluate conditions, and support sustainable forest planning and timber sales
- Identify new opportunities for mining and mineral exploration
- Produce sustainable energy
- Manage and mitigate hazards

Weather, Atmosphere, and Climate

- Detect anomalies in weather patterns
- Map atmosphere in real time and better predict uncertainty
- Identify the trend in climatic shifts and their impacts on industry
- Help communities become resilient to natural weather phenomena

ArcGIS®
ONE PLATFORM, MANY MISSIONS

A strong science enterprise leverages advancements in science and data acquisition to give data stewards an effective means to manage the high velocity, volume, and variety of earth observation data for mission support.

Esri's ArcGIS® software provides a proven geospatial platform to stand up a science enterprise. ArcGIS provides an efficient way to quickly enable users to leverage massive volumes of data to solve a variety of scientific questions and, ultimately, publish results. Esri® technology is used to capture, manage, analyze, and share big data for faster and more impactful decisions.

Collect and Manage

Empower field staff to view and collect mission-critical data directly from their mobile devices. Likewise, engage citizen scientists to collect observations on biodiversity, hazards reporting, and field validation. Users can quickly create map-driven forms for everything from documenting damaged buildings and collecting soil samples to executing census surveys. Users can capture data and video along with their GPS location and push updates even if collection activities take them out of network range. ArcGIS tools include Collector for ArcGIS, Survey123 for ArcGIS, Navigator for ArcGIS, and Workforce for ArcGIS.

As the twenty-first century progresses, organizations are increasingly augmenting field workflows with streaming earth observation data from multiple sources such as UAS. Cost effective management of big multidimensional data (including LAS, netCDF, and HDF) is possible with ArcGIS. ArcGIS greatly reduces the time it takes to go from data collection to analysis and sharing. ArcGIS tools include Drone2Map™ for ArcGIS, Esri GeoPortal™ Server, and spatiotemporal big data store.

Analyze

Integrate advanced computing and scientific modeling environments with GIS by using ArcGIS plug-ins for open-source statistical packages like the R Suite and ArcGIS API for Python automation and interoperability. Employ ArcGIS for applications in change monitoring, feature extraction, suitability analysis, and predictive and anomaly analysis. Conduct vector-based spatial and raster-based image analysis, interpolate missing data, forecast conditions based on spatial patterns, and automate advanced workflows.

Organizations and governments use ArcGIS Desktop, ArcGIS Enterprise, ArcGIS Image Server, Raster Analytics, ArcGIS GeoEvent Server, and ArcGIS GeoAnalytics Server

software-based analytics to bring the analysis to data too big to move, while delivering timely insight and actionable information in 2D and 3D. These components are routinely the foundation of a strong science enterprise because of their ability to be quickly configured and to scale in the cloud for large-scale analysis, thus eliminating costly customization and maintenance.

Communicate

Combine authoritative data with narrative text, images, graphs, and multimedia content using Esri Story Maps to tell your story and communicate key information in an easy-to-understand way. Monitor, track, and report incidents in real time with Operations Dashboard for ArcGIS. From managing day-to-day activities to coordinating response to a crisis, Operations Dashboard provides focused views of live data that enable leaders to rapidly understand resources, activities, and issues and thus direct response. Lastly, transform executive briefings, environmental success stories, and complex scientific phenomena with compelling presentations geared to multiple audiences. Whether highlighting collections from a citizen science engagement or providing a summary of a completed study, ArcGIS—as part of the science enterprise—gives organizations a powerful tool for keeping peers, partners, and the public informed.

Incorporate real-time data from many sensors

Monitor the situation through real-time tracking, routing, and communications

Gather, fuse, analyze, and share data

Maintain and share the common operational picture

Formulate and disseminate plans

ArcGIS

Manage the data

GETTING STARTED

For almost 50 years, Esri has worked with the science community at all levels of government, academia, and industry. Our global team of dedicated professionals has decades of experience empowering people with geospatial technology to support various disciplines from atmospheric, environmental, oceanographic, and energy sciences. We provide more than just software and solutions—we partner with organizations to ensure that they have the science enterprise they need to succeed now and in the future.

Recognized as the global leader in geospatial technology with distributors worldwide, Esri is joined in supporting our customers' science enterprises by over 2,000 industry partners that specialize in niche research and operational fields to guarantee our customers' success. No matter where you're located, you'll find a wealth of subject matter experts that can help your science vision become a reality.
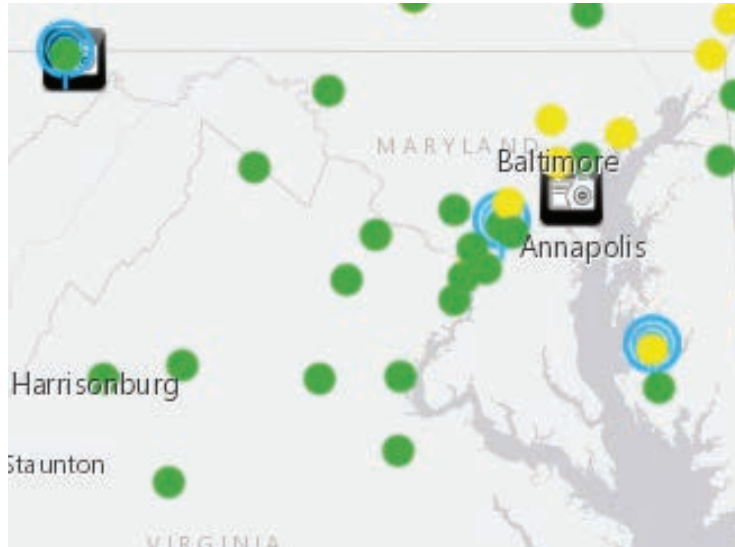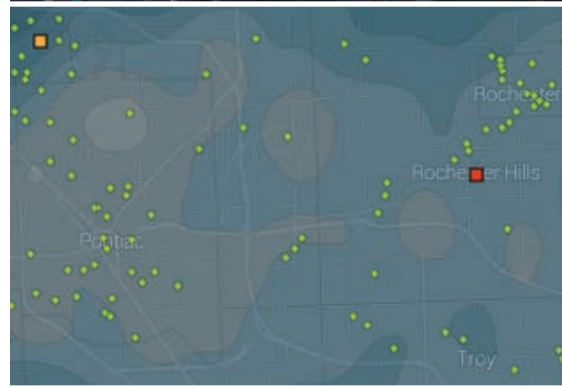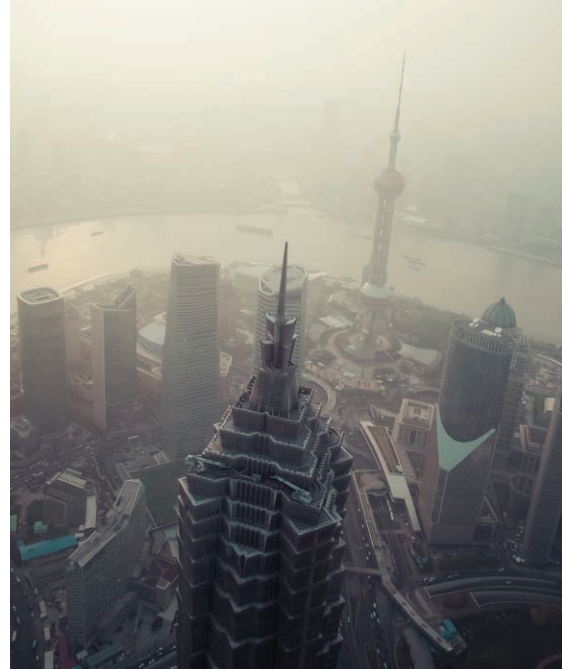
Visit esri.com/federal for more details on the topics outlined in this document.

If you would like to engage in learning more about topics outlined in this document, send an email to an Esri team member at science@esri.com.

Esri inspires and enables people to positively impact their future through a deeper, geographic understanding of the changing world around them.

Governments, industry leaders, academics, and nongovernmental organizations trust us to connect them with the analytic knowledge they need to make the critical decisions that shape the planet. For more than 40 years, Esri has cultivated collaborative relationships with partners who share our commitment to solving earth's most pressing challenges with geographic expertise and rational resolve. Today, we believe that geography is at the heart of a more resilient and sustainable future. Creating responsible products and solutions drives our passion for improving quality of life everywhere.

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