Homeland Security
GIS for Community Safety

GIS Software
Creating safer communities and a better world

Since 1969, ESRI has been helping people solve real-world geographic problems. ESRI, a pioneer in geoprocessing tools, is wholly dedicated to geographic information system (GIS) technology. Today more than 100,000 organizations around the world use ESRI® software because it utilizes the leading ideas in technology for geographic information management.

One of the primary responsibilities of any government is providing for the safety and security of its citizens, communities, and assets—the places we call home.

Recent world events have significantly heightened the importance of this responsibility and emphasize the need to understand all of the systems, infrastructure, and design of everything that contributes to our communities, our livelihoods and, ultimately, our safety. Today it is more than natural disasters or catastrophic accidents that require full-scale emergency assessment, mitigation, preparation, response, and recovery. It also includes terrorism, which is now recognized as a global threat of the greatest of magnitudes.

This new reality means rethinking policies and planning; allocation of resources; and partnership strategies among federal, state, local, and private sectors.

For federal, state, and local government officials and private businesses and nonprofit organizations of all sizes, this requires a new, comprehensive approach involving people, processes, and technology to effectively and rapidly plan and respond to new emergencies and threats to our communities. As demonstrated by recent events, GIS technology will be crucial to this security effort.

ESRI GIS software solutions help government and business entities to meet the challenges. Fire, police, public works, public health, building and safety, water, engineering, utilities, and other disciplines have long recognized the value of ESRI GIS software for analysis and planning. They have discovered how traditional tasks can be performed more efficiently and how previously impractical or seemingly impossible tasks can be managed. Benefits of using GIS in homeland security include

- Rapid response capabilities.
- Locate resources.
- Improve planning capabilities.
- Develop training scenarios.
- Improve accuracy.
- Provide timely decision support.
- Develop contingency plans.
- Real-time management of field data.
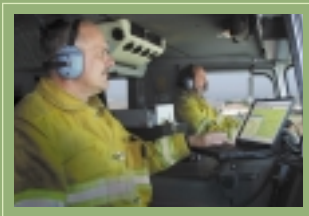
HOMELAND

# Managing the Homeland Security Effort with GIS

Homeland security is focused on three primary objectives. These objectives are protecting life, property, and critical infrastructure. Homeland security efforts require a multitude of critical tasks that incorporate both short- and long-range planning including risk assessment, mitigation, preparedness, response, and recovery. Technology and information are crucial in these efforts.

All emergencies, whether caused by nature or people, begin locally and elevate to regional, state, or national levels depending on severity, complexity, size, and the nature of the event. During these events, emergency managers need the right information at the right time to deploy resources, implement evacuation plans, establish medical aid, and manage events as they unfold.

GIS is the core information and analysis tool that helps manage geographic-based and associated data. GIS has been embraced by professionals in all areas of government and business for conducting day-to-day operations as well as for planning, analysis, and decision making.

GIS can be used to develop a community's emergency response plan by identifying the location of schools, medical centers, staging areas, and evacuation routes. Analysis can identify transportation choke points near bridges or overpasses. During an emergency, GIS can be used to route response vehicles and quickly identify critical infrastructures such as water storage/treatment facilities, communications networks, electric generation facilities, refineries, and more.
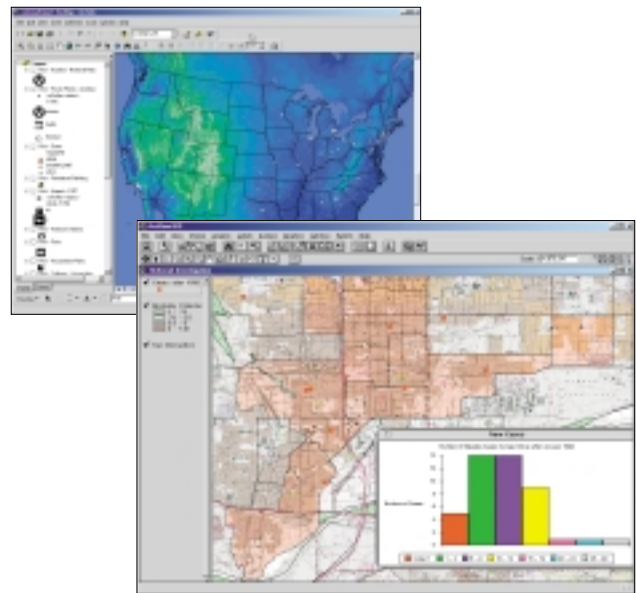
National hazardous risk factors (above) and number of measles cases by age group (below)

The creation of an enterprise homeland security GIS database enables emergency managers to

- Assess risks to community and infrastructure.
- Establish specific mitigation/protection plans.
- Determine the scale of the emergency.
- Estimate rate of spread or progression.
- Identify and evacuate at-risk populations.
- Expedite and direct rescue efforts.
- Provide accurate damage assessment.
- Prioritize recovery efforts.

GIS Applications in Emergency Management

Emergencies can impact all or any number of government departments or agencies and can escalate from local to national scope. There are common elements of emergency management planning that are also critical to homeland security. GIS is a powerful tool in each of these processes and provides critical information for critical decision support.

Surveillance and Detection

GIS is a critical technology for detection, intelligence gathering, and surveillance. These GIS capabilities include

1. Understanding the spatial relationships of subjects/suspects as they move through a country or area

2. Locating where telephone calls are made from and to whom

3. Understanding the clustering of subjects or conversely the dispersion of a group of potential subjects

4. Understanding and mapping incidents or seemingly unconnected actions by suspects to aid in the understanding and identification of an intended event and its location as well as who may be suspects

5. Displaying the locations of reported incidents that may indicate a chemical or biochemical problem including the tracking of chemicals or toxins used in the manufacture of these types of weapons

Terrorism and criminal activity require funding, people, materials, and logistics. The connections among these involve patterns in time and space. GIS techniques can be used to correlate apparently disconnected events to see the big picture emerge from huge volumes of data. The key is the fusion of data from disparate sources into a common spatial framework. As a growing range of sensors are deployed to gather information concerning suspicious activities and possible biochemical attacks, GIS can be used to integrate information into a meaningful common picture with surveillance and detection activity coordinated through the medium of a dynamic map. GIS provides powerful analysis tools that can detect pending events, allowing government officials to implement actions that will prevent acts of destruction from occurring.
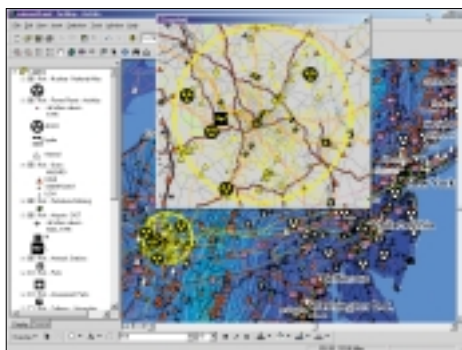
Planning

Homeland security programs begin with understanding the problem. This involves strategic and tactical planning to locate and identify potential emergency management problems and, using GIS, pinpointing these hazards and evaluating the consequences of potential attacks, emergencies, or disasters. They can identify obvious hazards (chemical storage, nuclear plants, flood zones, earthquake faults) as well as evaluate less obvious hazards such as critical resources (forests, water, food supplies), critical infrastructure (utilities, waterlines, etc.), and other potential hazards or targets. The hazard data can be viewed with other map data (population density, streets, pipelines, power lines, etc.) to develop a risk assessment. With ESRI GIS, tools, lives, property, and critical infrastructures at high risk from potential attack or emergency are much easier to identify.

Mitigation

Once the risk assessment has been completed, GIS analysis can easily determine adjoining structures, utilities, and affected population areas to the hazard. It can identify facilities that require reinforced construction or relocation. Other mitigation efforts may target hazardous material storage, establishing security buffers around high-risk structures or environmental health monitoring. Mitigation involves understanding potential hazards to human life, property, infrastructure, the environment, and many other areas at risk from these emergencies, and targeting them for protective and/or preventive action.

Total hospital admissions in hospital service areas


Citywide risk assessment and planning
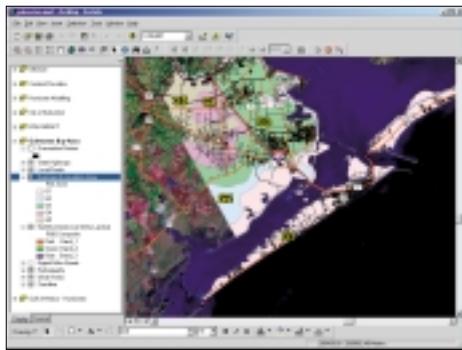
Hurricane evacuation risk areas

Preparedness

Preparedness includes those activities that prepare for actual emergencies. These activities include contingency planning, model building, and training. In a given emergency, GIS can be used to answer questions such as the following:

- Where should first responder teams be staged to support incident operations?
- Where should fire stations be located if a five-minute response time is expected?
- How many ambulances are required, and where should they be staged?
- What are the best potential evacuation routes?
- Where are my medical and public health assets?
- Will the road networks handle the evacuation or rescue traffic?
- What facilities will provide evacuation shelters?
- What critical assets have I lost?
- What quantity of supplies will be required at shelters based on expected evacuees?
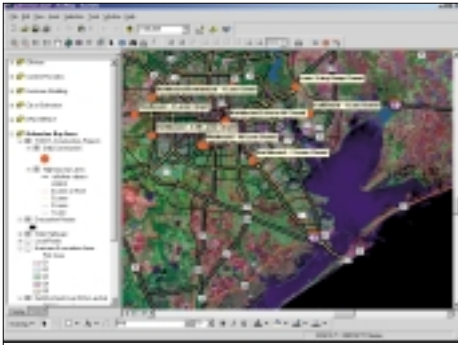
Emergency evacuation route monitoring

Response

Critical activities occur immediately following a terrorist event, emergency, or disaster. These begin with the immediate rescue, evacuation, and safekeeping of people and management of life-threatening situations such as fire, explosions, or collapse of structures. Managers seek to stabilize the situation and reduce the probability of secondary damage (for example, shutting off contaminated water supply sources, cordoning off affected areas to prevent further injury, preventing looting or other problems) as well as to speed up other emergency operations for victims (search and rescue, emergency shelter, medical care, mass feeding). GIS is critical to understanding the scope, complexity, and severity of the emergency as well as understanding available assets and those lost or no longer available. The full range of GIS capability can be utilized in assigning rescue personnel and equipment, organizing medical support, monitoring environmental problems (toxic plumes, etc.) and evacuation routes, providing logistical support, and hundreds of other uses.

Hurricane Mitch event and impacts (above) and dams located near nuclear hazards (below)

Recovery

Recovery efforts begin when the immediate threat to life, property, and critical infrastructures is over. Recovery efforts are often in two phases: short term and long term.

- **Short-Term Recovery**

  Supplies, such as food, water, and clothing, can be allocated to emergency shelters based on population displacement and type of damage in each area. The immediate recovery efforts can be visually displayed and quickly updated. This "visual status map" can be accessed and viewed from remote locations by critical decision makers. This is particularly helpful for large emergencies or disasters where multiple efforts are ongoing at different locations.

- **Long-Term Recovery**

  Long-term recovery means restoring all services to normal or better. Long-term recovery, such as replacement of buildings, water systems, and streets, can take several years and cost billions of dollars. GIS can be used during this period to identify facilities, assess damage, and establish prioritization for major restoration projects. As funds are allocated for repairs, accounting information can be recorded and linked to each location.

Who Is Part of the Homeland Security Effort?

Effective homeland security will require a coordinated implementation of policies and planning, allocation of resources, and partnership strategies among federal, state, and local government as well as the private sector. Within these organizations are divisions and departments that manage data about people, places, and things…information that is critical in planning for, or responding to, an emergency situation.

Homeland security, at every level, will mean having the people, procedures, and technology in place for secure data management with the flexibility to establish an effective, shared environment when needed. GIS supports this requirement, providing managers with the necessary tools to manage data for planning and daily operations and the power to deploy critical data in an emergency that can help save lives and minimize damage to property and vital structures. Anyone who uses GIS will be able to support homeland security.
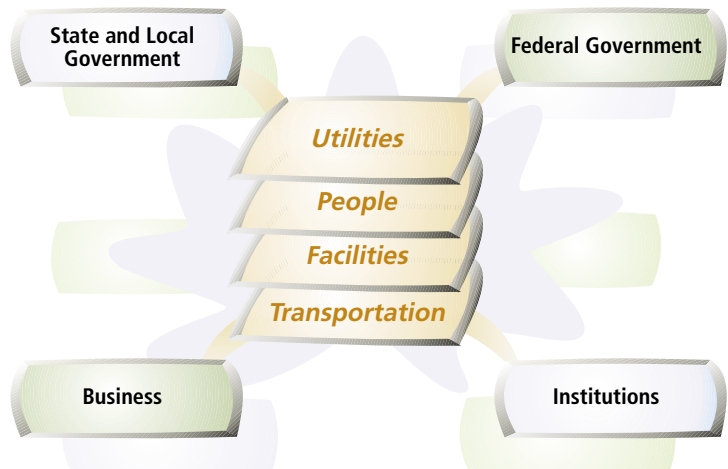
GIS enables a distributed knowledge base in which geodata is collected, managed, and served by many organizations to create a mosaic of geographic information.

GeoMAC wildfire tactical planning and monitoring (above) and earthquake tracking, modeling, and incident support (below)

All Organizations Can Support Homeland Security.

State and Local Government
- Fire
- Police
- Public Health
- Building and Safety
- Planning Departments
- Water Agencies
- Public Works
- Mass Transit
- Office of Emergency Management
- Environmental

Businesses
- Electric
- Gas
- Telecommunications
- Cable
- Airlines/Bus
- Railroads
- Health Care

Federal Government
- The Office of Homeland Security
- Federal Emergency Management Agency (FEMA)
- National Imagery and Mapping Agency (NIMA)
- Federal Aviation Administration (FAA)
- Centers for Disease Control and Prevention (CDC)
- Department of Justice
- Department of the Treasury
- Defense Threat Reduction Agency
- Environmental Protection Agency
- Department of Transportation
- Department of Agriculture
- Department of Health and Human Services

Institutions
- Universities
- NGOs
- Associations
- Schools
- Libraries
- Museums
- Hospitals

Getting Started

GIS Implementations

Project GIS · Departmental GIS · Enterprise GIS · Citizen GIS

Homeland Security
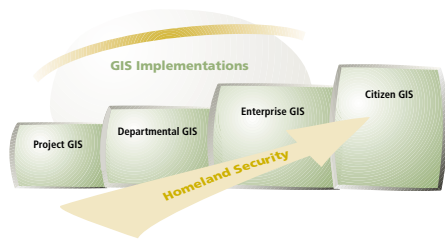
Project GIS

Departmental GIS
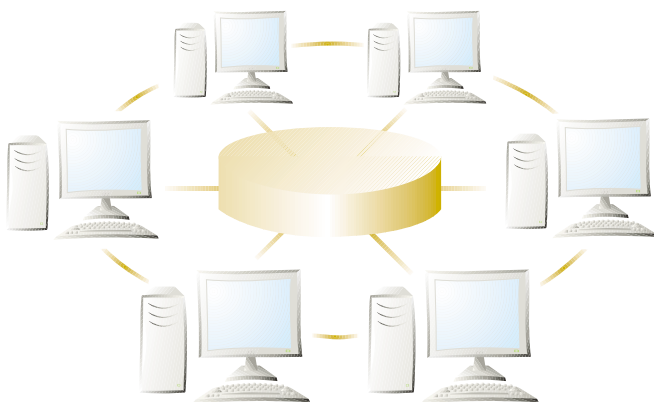
Enterprise GIS

Citizen GIS

GIS software tools allow users to collect, organize, analyze, display, and model information. These tools easily integrate with related technologies such as global positioning systems (GPS) so that real-time data can be collected or served in the field for emergency operations. An easy-to-use development environment enables users to customize applications and serve up integrated data views for decision makers. Web tools extend capability to publish relevant information and maps on Intranets and the Internet. GIS solutions are robust and support any and all aspects of data management and data sharing for homeland security.

Integrated Analysis and Data Sharing, One Community's Experience

Maricopa County, Department of Transportation, Phoenix, Arizona

The Maricopa County Department of Transportation GIS (MCDOT-GIS) created the maps for the Maricopa County Department of Emergency Management for use in the Emergency Operation Center (EOC) and by all assigned field personnel.

The Palo Verde 10-Mile Emergency Planning Area map is one of a series that includes maps of various sizes covering an area ranging from a 10-mile radius divided into sectors out to a 50-mile radius.

The maps are provided to numerous agencies including federal, state, county, and local governments; the Arizona Public Service; private agencies; and numerous volunteers. By providing the same map and data to all the agencies, decision making has become more effective. Through the cooperative efforts of MCDOT-GIS, Maricopa County Flood Control-GIS, and other County departments, the maps specifically dealing with the nuclear plant evacuation plan have been developed into an application for Emergency Management to use in its EOC. The application is diversified and user-friendly, using all the data in static paper maps, and provides the user with additional spontaneous real-time data to heighten the level of analysis.

The application displays emergency response resources and easily organizes events as they happen. It enables EOC personnel to interactively place or remove barricades and deploy sheriff's deputies to locations. They also can display contamination plumes, aerial photography, U.S. Geological Survey (USGS) maps, and population data; zoom to an address; and send JPEG files via the Internet.

The application has a range of uses from managing floods and hazardous spills to managing large events. The application continues to meet the needs for evacuation planning by dealing not only with incidents specific to the generating station but also with any type of evacuation.

GIS Software Solutions

Communities and organizations that already use ESRI GIS tools can build on their experience to dramatically improve their capability to plan for and reduce the consequences of terrorist attacks, disease outbreaks, or emergencies. Those who are new to, or are considering, GIS can leverage the extensive geodata resources that currently exist to help their organizations implement homeland security strategies.

ArcGIS Solutions for Homeland Security

Clients

- ArcExplorer
- Java
- HTML Browser
  - • Map Viewing
  - • Public Services
- ArcView — Incident Management
- ArcEditor
- ArcInfo — Map Production
  - • Surveillance/Detection
  - • Risk Assessment
  - • Mitigation
  - • Preparedness
  - • Recovery

Homeland Security Network

- ArcPad — Field GIS
- ArcObjects — Administration
- Mobile Devices — Response
- ArcIMS
- ArcSDE — **Servers** Departmental, Corporate Information Technology
- Database — **Geodatabases**

The ArcGIS software suite offers industry-strength GIS tools that provide vital scalability and performance for deployment throughout the homeland security enterprise.

ArcInfo

ArcInfo™ is a professional geographic information system with capabilities for automation, modification, management, analysis, and display of geographic information.

ArcEditor

ArcEditor™ includes all the functionality of ArcView® and adds the power to edit features in a multiuser geodatabase or coverage. Additional functionality includes support for multiuser editing, versioning, custom feature classes, feature-linked annotation, dimensioning, and rasters in a multiuser geodatabase.

ArcView

ArcView, the world's most popular desktop mapping and GIS software, is a powerful tool for the management, display, query, and analysis of spatial information. The usability and intuitive interface of ArcView means users can get up and running quickly.

ArcIMS

ArcIMS® software is the foundation for distributed GIS data and applications on the Internet. It is the pathway for shareable, distributed databases in a homeland security application. For more information, visit www.esri.com/arcims.

ArcSDE

ESRI's ArcSDE™ is client/server software that allows you to store, manage, and quickly retrieve spatial data from leading commercial database management systems. With ArcSDE, a shareable, distributed information system can be deployed to multiple users for a number of emergency and response activities.

ArcObjects

ArcObjects™, the COM-based framework of ArcGIS™, is open to users and developers, meaning geographic mapping and analysis can be easily integrated into large-scale information technology infrastructures for homeland security. Customized information architectures can be developed to meet users' needs. Developers can create their own features and functions to be used in conjunction with other systems in the homeland security enterprise—for instance, network performance and real-time network replication.

ArcExplorer

ArcExplorer™ is a lightweight GIS data viewer. This freely available software offers an easy way to perform basic GIS functions.

ArcPad

ESRI's ArcPad™ software is a mobile GIS technology for field or remote homeland security functions. ArcPad provides database access, mapping, GIS, and GPS integration to users out in the field via handheld and mobile devices.
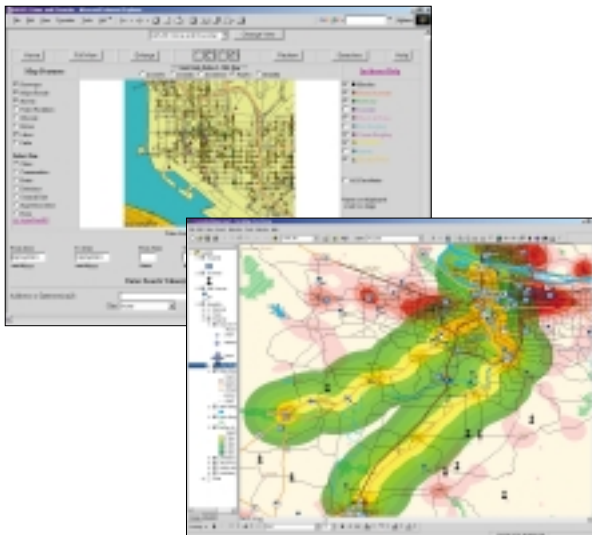
Data Sources

Data acquisition using the Geography Network

United States geodata resources are very extensive. Geographic databases are built by local communities, cities, counties, special districts, states, federal agencies, military services, utilities, commercial companies, and many other organizations. Man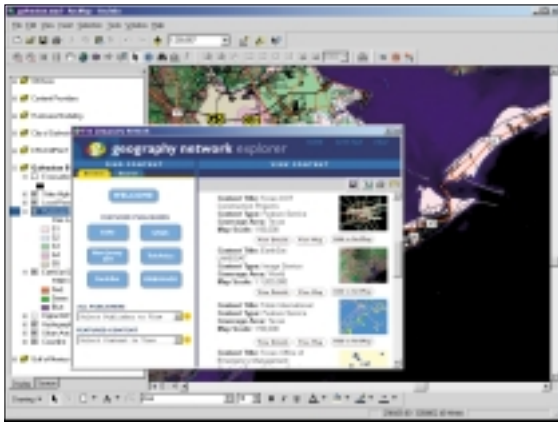y of the businesses and organizations that use geodata already work together and have done so for years or decades. Many define standard data models that facilitate data integration and promote data sharing, and they share their resources and data in various ways, especially during emergencies.

Municipal Data
- Land Base
- Parcels
- Roads
- Waterlines
- Facilities
- Toxic Sites

Commercial Data
- Third Party (ArcData™)
- Internet Conversion Vendors
- Data Conversion Vendors

Government Sources
- Federal Agencies
- State Agencies
- Councils of Government
- State Clearinghouses
- Local Government Agencies

Data Sharing

Sharing data among departments is a core, enabling concept of GIS and geodatabases. Most local government users of GIS have established processes for accessing and sharing data not only among departments but across agencies. The logical extension of this process is a framework for sharing data with other organizations. The Federal Geographic Data Committee (FGDC) has defined key data types for national geographic assets.

- Transportation
- Hydrography
- Elevation
- Orthoimagery
- Government Boundaries
- Geodetic Control
- Cadastral (Public Lands)

The framework represents the best available data for an area, certified, standardized, and described according to a common standard. It provides a foundation on which organizations can build by adding their own detail and compiling other data sets.

Through the leadership of the FGDC, the USGS, and many other organizations, efforts are under way to build the framework data for the United States. However, this task is far from complete. In addition, recent experience shows us that these seven framework layers are just a small fraction of what data is ultimately needed to manage incidents like the World Trade Center attacks and other homeland security issues.

The Geography Network

www.geographynetwork.com

The Geography Network™ is a global network of geographic information users and providers. It provides the infrastructure needed to enable the sharing of geographic information among data providers, service providers, and users around the world. The Internet is used to deliver geographic content to the user's browser and desktop. Through the Geography Network, you can access many types of geographic content including live maps, downloadable data, and more advanced services. The Geography Network content is distributed at many locations around the world, providing you with access to the latest information available directly from the source.

Optional ArcGIS Extensions

The ArcGIS architecture supports a series of extensions for specialized planning and emergency operations.

- ArcGIS Spatial Analyst—Advanced GIS spatial data analysis using raster and vector data
- ArcGIS 3D Analyst™—Surface creation and topographic, analysis, and three-dimensional visualization
- ArcGIS Geostatistical Analyst—Advanced data exploration and interpolative modeling solutions
- ArcGIS StreetMap™ USA—Advanced address matching and street map displays
- ArcPress™ for ArcGIS—High-performance printing
- MrSID™ Encoder for ArcGIS—Efficiently uses large georeferenced images in ArcGIS

ESRI

ESRI, founded in 1969, is the world leader in GIS, with more than 100,000 client sites worldwide. ESRI is a privately held company dedicated to research and development of the most powerful and comprehensive geoprocessing tools available. ESRI also offers professional services to help users plan, implement, and grow their GIS applications. ESRI software is prominently used for emergency planning and response and is the ideal solution for homeland security applications at local, state, and federal levels.

ESRI Software Users

- FEMA
- Department of Justice
- City of Phoenix, Arizona
- City of Honolulu, Hawaii
- City of Dallas, Texas
- City of Sacramento, California
- Winston–Salem, North Carolina
- Visalia, California
- Cook County, Illinois
- Illinois State Police
- Agency for Toxic Substances and Disease Registry (ATSDR)

ESRI

For more than 30 years ESRI has been helping people manage and analyze geographic information. ESRI offers a framework for implementing GIS technology in any organization with a seamless link from personal GIS on the desktop to enterprisewide GIS client/server and data management systems. ESRI GIS solutions are flexible and can be customized to meet the needs of our users. ESRI is a full-service GIS company, ready to help you begin, grow, and build success with GIS.

Corporate

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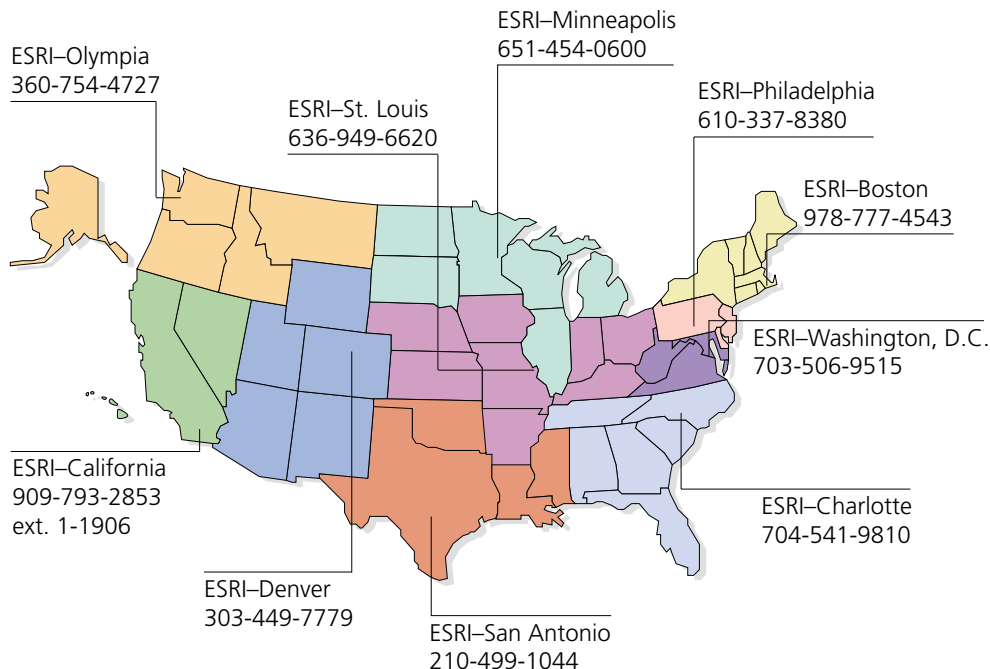call ESRI at

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