

**U.S. Department of Energy, National Nuclear Security Agency's
Use of Geographic Information Systems
for Nuclear Emergency Response Support**

Abstract

The U.S. Department of Energy (DOE), National Nuclear Security Agency's (NNSA) Remote Sensing Laboratory (RSL) provides Geographic Information System (GIS) support during nuclear emergency response activities. As directed by the NNSA, the RSL GIS staff maintains databases and equipment for rapid field deployment during an emergency response. When on location, GIS operators provide information products to on-site emergency managers as well as to emergency managers at the DOE Headquarters (HQ) Emergency Operations Center (EOC) in Washington, D.C. Data products are derived from multiple information sources in the field including radiological prediction models, field measurements taken on the ground and from the air, and pertinent information researched on the Internet. The GIS functions as a central data hub where it supplies the information to response elements in the field, as well as to headquarters officials at HQ during emergency response activities.

The NNSA GIS Response

During the emergency phase of a federal response, the NNSA's Consequence Management Response Team coordinates a seventeen multiagency Federal Radiological Monitoring and Assessment Center (FRMAC) comprised of scientists, engineers and emergency planners from the NNSA and the U.S. Department of Energy (DOE) as well as other agencies, e.g., the U.S. Nuclear Regulatory Commission (NRC), U.S. Environmental Protection Agency, Federal Emergency Management Agency, U.S. Department of Agriculture, and Center for Disease Control, to name a few. These agencies collaborate to monitor and assess the contamination resulting from a release of radioactive material. FRMAC officials work closely with state organizations to provide timely recommendations to the state(s) relating to protective actions that should be taken to protect the public in response to a given radiological accident or incident.

Within the NNSA Consequence Management Program, there is a continuing effort to improve the FRMAC data management and communication process. GIS is central to this process, providing both critical data management and product generation tools. Arc/Info and ArcView GIS software provide an integrated platform for the input, archival, query, and analysis of spatially referenced GIS data. The integration of digital images with Arc/Info permits digital map products to be analyzed, registered, and overlaid onto satellite imagery, air photos, and scanned maps. RSL scientists have leveraged the suite of Environmental Systems Research Institute (ESRI) products to develop a deployable GIS capability for handling emergency response activities in the FRMAC as well as providing important response status products to the Lead Federal Agency, State(s), and other appropriate government officials. The system integrates all elements of emergency planning, from the initial protective actions based on models through the emergency monitoring phase, finally ending with the complex reentry and recovery phase.

To support NNSA deployments and field exercises, e.g., FRMAC, a geographic database consisting of transportation, cultural, environmental, business, radiological, aerial photographic, and satellite imagery data is maintained for the United States, with particular attention to areas

around commercial nuclear power plants and DOE facilities. To be prepared for a crisis at any location in the country at any time, it is imperative that all data be maintained on-line and be readily available for field deployment and query by emergency managers. All of RSL's vector "base map" data sets are stored in Spatial Data Engine (SDE) (ver. 8.0.2) for Oracle (ver 8.1.5) as well as on CDROM for rapid deployment. SDE serves as the data backbone for RSL's Intranet mapping capability as provided across the Emergency Communications Network (ECN). The ECN Internet Map Server application gives DOE emergency managers the ability to quickly display and query the wealth of data on the RSL GIS server during a crisis. The centralization of geo-spatial data for emergency response scenarios helps insure consistency of information flow between the FRMAC, field Lead Federal Agency, State(s), home team support, and information products provided to government officials in Washington, D.C.

Raster imagery is also critical to the RSL GIS for response activities. "A picture is worth a thousand words" is a relevant statement to the need for aerial photos of a facility during a response. Photos provide emergency managers with visual information as to facility layouts, environmental conditions, and facility hazards that are relevant to emergency response activities. Such information may not exist in vector layers in the GIS database. Use of scanned map products can also reduce the map labeling preparation time necessary for GIS staff to create final hardcopy products. This help increases the efficiency of GIS scientists to quickly produce products for briefings and dissemination. At this time, digital air photos exist for all DOE and NRC facilities. Satellite data are currently in place for many DOE facilities but for only a few NRC sites. Scanned 1:100,000 United States Geological Survey (USGS) maps are maintained for the entire country. Scanned 1:24,000 USGS maps are maintained for the major United States cities. The library of typical vector and raster base map layers in the RSL GIS includes, but is not limited to, the following data:

<u>Data Layer Theme</u>	<u>Source</u>
Base Map Data:	
State Boundaries	Geographic Data Technologies (GDT)
County and/or Township Boundaries, MSAs	GDT
Roads, Highways, etc	GDT
Railroads	GDT
Utility Corridors	GDT, Pennwell MapSearch
Evacuation Routes	NRC Site Plans
Surface Hydrology	GDT
Emergency Response and Public Facilities Data:	
Emergency Operations Centers (EOC)	NRC and NNSA Files
Decontamination Centers	NRC and NNSA Files
Shelters and Reception Centers	NRC and NNSA Files
Emergency Planning Zones (EPZ)	NRC Regulations
Protective Action Sectors (PAS)	NRC Site Plans
TLD Locations	NRC Site Plans
Schools	Business Point File
Police and Fire Stations	Business Point File
Hospitals and Physicians	Business Point File

Nursing Homes	Business Point File
State Institutions	Business Point File
Major Industries	Business Point File
Small and Large Businesses	Business Point File
Recreation Areas	Business Point File, GDT
Infrastructure (electric, pipelines, etc)	Pennwell MapSearch
Demographics Data	GDT, ESRI, Business Points
Radiation Measurements and Derived Data:	
Exposure Rates	AMS / FRMAC
Deposition Measurements	AMS / FRMAC
Protective Action Recommendations	FRMAC Scientists
Ingestion Pathways	FRMAC Scientists
Baseline Radiation Surveys	Historical AMS
Dispersion Model Output Data:	
RASCAL	NRC
ARAC	DOE (LLNL)
ACRID	DOE (Sandia)
Imagery:	
Satellite Images	Space Imaging, SPOT
Aerial Photographs	NNSA, RSL Surveys
Scanned USGS Maps	SureMaps, LandInfo, other

A variety of source materials (including digital and paper maps, tabular summaries, and imagery) have been collected from federal, state, and commercial sources. Radiation data are entered from hand-drawn maps or from gamma data acquired with the Aerial Measuring System (AMS) operated by Bechtel Nevada. AMS data are provided in a "generate" format (ESRI, 1999) that can be entered directly into the GIS as radiation contours. Most of the remaining data layers are manually automated from existing maps and reports. All data for the United States are currently maintained in latitude-longitude, decimal degree, geographic projection. To prepare and train GIS scientists for emergency response situations, the system is used in all FRMAC exercises and deployments. The GIS system is deployed and used to analyze the available spatial data to help determine the impact of a hypothetical radiological release and aid in development of mitigation recommendations. For this application, both hard-copy and real-time spatial displays are generated and analyzed using the suite of ESRI products.

The ECN is a stand-alone network that connects EOCs around the country for video conferencing, data transmission, e-mail, and to provide the backbone for Intranet applications for emergency management. Ultimately, the ECN provides a network connection of all DOE field offices to DOE/HQ in event of an emergency response. It is the mission of the RSL GIS Team to provide sound solutions for the compilation, analysis, and mapping of geo-spatial information for emergency operations. The ECN GIS team provides mapping support to the DOE Office of Emergency Operations for daily operations and serves as a node on the ECN network from a

deployed FRMAC location. During an emergency response, computers and plotters in Washington, D.C. become nodes on the deployed network of GIS equipment. Information products are sent directly to the DOE/HQ EOC from the field to provide government officials with an overview of response activities. This support includes compilation of map products to support emergency operations such as natural disasters and nuclear emergency response activities and exercises. DOE/HQ support for recent responses such as the fires at Los Alamos, NM, Hanford, WA, and Idaho National Environmental and Engineering Laboratory was provided by the RSL in this fashion.

In conclusion, the RSL GIS is a robust system for the analysis of spatial data for radiological emergency response. Emergency situations require rapid processing of base map data to most effectively provide support for emergency response officials. Data layers should be preprocessed and maintained on-line for quick implementation during the initial response phase of a crisis. Scenario-dependant information and field measurements are entered into the GIS as data become available in the field. As more information is entered into the GIS database, the power of the system for emergency response and as a decision-making tool is systematically enhanced. Because the GIS is integrated into the ECN, deployed GIS emergency responders are able to provide timely and current response status products. The RSL GIS fulfills the needs of deployed radiation scientists and assessment staff, public affairs personnel, and emergency managers, both in the field and in Washington, D.C.

Reference

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