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# Geospatial Information and Geographic Information Systems (GIS): An Overview for Congress

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# Summary

Geospatial information is data referenced to a place—a set of geographic coordinates—which can often be gathered, manipulated, and displayed in real time. A Geographic Information System (GIS) is a computer data system capable of capturing, storing, analyzing, and displaying geographically referenced information. The federal government and policy makers increasingly use geospatial information and tools like GIS for producing floodplain maps, conducting the census, mapping foreclosures, congressional redistricting, and responding to natural hazards such as wildfires, earthquakes, and tsunamis. For policy makers, this type of analysis can greatly assist in clarifying complex problems that may involve local, state, and federal government, and affect businesses, residential areas, and federal installations.

Examples of how GIS and geospatial data are used within and outside the federal government are growing rapidly. In this report, a few examples are provided that describe the real-time or near real-time data analysis in the case of a California wildfire; policy analysis in support of a Base Realignment and Closure decision in Virginia Beach; and analysis of foreclosure patterns using census and other data for the New York City area. An additional example is provided demonstrating the burgeoning interaction of GIS and social media. In this case, Japanese citizens collected and provided census records, maps, and other information—a variant of "crowd-sourcing"—to a GIS team. The team assembled the information into data layers supporting an interactive map to assist humanitarian organizations working in areas of Japan damaged by the March 11, 2011, earthquake and tsunami.

Office of Management and Budget (OMB) Circular A-16, first issued in 1953, gives direction for federal agencies that produce, maintain, or use geospatial data. OMB Circular A-16 has been revised and updated in 1967, 1990, and 2002. Most recently, the Obama Administration issued supplemental guidance to Circular A-16 that labeled federal geospatial data a capital asset and referred to its acquisition and management in terms analogous to financial assets. How well these "assets" are managed depends, in part, on how the federal government is structured to organize and coordinate its geospatial enterprise. That structure is embodied in the Federal Geographic Data Committee (FGDC), comprising 10 cabinet-level departments and 9 independent agencies. OMB Circular A-16, via its revisions and supplemental guidance, as well as Executive Order 12906, issued in 2004, gives the FGDC primary responsibility for developing the National Spatial Data Infrastructure (NSDI). The NSDI can be thought of as the infrastructure for federal geospatial "assets," or the means by which federal geospatial data are acquired, processed, distributed, used, maintained, and preserved.

The 112$^{th}$ Congress in its oversight role may have an interest in the programs and geospatial assets belonging to most federal departments and agencies within the framework of the NSDI. This report describes some of these programs to give a sense of the breadth and complexity of the federal geospatial enterprise.

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# Introduction

The explosion of consumer demand for geospatial information and tools such as geographic information systems (GIS) to manipulate and graphically display such information has brought GIS into the daily lives of millions of Americans, whether they know it or not. Google Earth and handheld or dashboard navigation systems represent enormously popular examples of the wide variety of applications made possible through the availability of geospatial information.[1] The release of Google Earth in 2005 represented a paradigm shift in the way people understand geospatial information, according to some observers, because it offered multi-scale visualization of places and locations around the globe that was free and easy to use.[2]

This report provides a primer on geospatial data and GIS and provides several examples of their use. It should be recognized that the amount of geospatial data is expanding rapidly, the methods for acquiring geospatial data are growing, and the ways geospatial data are being used are diversifying throughout local and state governments, as well as within the federal government. It is beyond the scope of this report to present the universe of geospatial data and its utility to the federal government. However, the federal government has had and continues to have a major role in the overall framework for geospatial data, including its organization, coordination, and sharing among federal agencies and with state and local entities.

In addition to providing basic information on GIS and geospatial information, this report describes the federal geospatial enterprise and how it is organized. Given the complexity of managing, sharing, and using geospatial data from a variety of sources and across the breadth of the federal government, the 112th Congress in its oversight role may have an interest in the programs and geospatial "assets" belonging to most federal departments and agencies.[3]

CRS Report R41826, *Issues and Challenges for Federal Geospatial Information*, explores geospatial policy issues of interest to Congress, including organization and management, data sharing, coordination, the role of nonfederal stakeholders, and proposals for a national GIS, as well as examples of legislation. CRS Report R40717, *Issues Regarding a National Land Parcel Database*, delves into one specific federal responsibility: the coordination and management of land parcel data for all federal lands. Together, these three reports introduce basic concepts and discuss more complex policy issues regarding the federal geospatial enterprise.

A discussion of classified geospatial information and national security issues is beyond the scope of this report.

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[1] The development and commercial availability of Global Positioning System (GPS) data and the integration of these data with digital maps has led to the popular handheld or dashboard navigation devices used daily by millions.

[2] The National Geospatial Advisory Committee, *The Changing Geospatial Landscape*, January 2009, p. 10, http://www.fgdc.gov/ngac/NGAC%20Report%20-%20The%20Changing%20Geospatial%20Landscape.pdf. Hereinafter referred to as NGAC, *The Changing Geospatial Landscape*, January 2009.

[3] The Obama Administration issued supplemental guidance to OMB Circular A-16 on November 10, 2010, which labeled federal geospatial data a capital asset, and referred to its acquisition and management in terms analogous to financial assets. See Vivek Kundra, Federal Chief Information Officer, *Geospatial Line of Business OMB Circular A-16 Supplemental Guidance*, Office of Management and Budget, November 10, 2010, http://www.whitehouse.gov/sites/default/files/omb/memoranda/2011/m11-03.pdf.

# GIS and Geospatial Data: The Basics

GIS is a computer data system capable of capturing, storing, analyzing, and displaying geographically referenced information—information attached to a location, such as latitude and longitude, or street location.[4] Geographically referenced information is also known as geospatial information. Types of geospatial information include features like highway intersections, office buildings, rivers, the path of a tornado, the San Andreas Fault, or congressional district boundaries. Information associated with a specific location is referred to in GIS parlance as an attribute,[5] such as the population of a congressional district, or amount of movement per year along the San Andreas Fault. Other terms common to geospatial data and GIS analysis are described in the box below.

The power of GIS is the ability to combine geospatial information in unique ways—by layers or themes—and extract something new. For instance, a GIS analysis might include the location of a highway intersection and the average number of vehicles that flow through the intersection throughout the day, and extract information useful for locating a business. GIS might include both the location of a river and the water depth along its course by season, and enable an analysis of the effects of development on runoff within the watershed. Overlaying the path of a severe thunderstorm with geospatial data on the types of structures encountered—homes, stores, schools, post offices—could inform an analysis of what types of building construction can survive high winds and hail.

## Sources and Types of Geospatial Data

Geospatial data may be acquired by federal, state, tribal, county, and local governments, private companies, academic institutions, and nonprofit organizations. The collection and management of geospatial data are considered by many to be the costliest components of a GIS—some experts attribute close to 80% of GIS total costs to data acquisition.[6]

Geospatial data can be acquired using a variety of technologies. Land surveyors, census takers, aerial photographers, police, and even average citizens with a GPS-enabled cell phone can collect geospatial data using GPS or street addresses that can be entered into GIS.[7] The attributes of the collected data, such as land-use information, demographics, landscape features, or crime scene observations, can be entered manually or, in the case of a land survey map, digitized from a map format to a digital format by electronic scanning. Remote sensing data from satellites is acquired digitally and communicated to central facilities for processing and analysis in GIS. Digital satellite images, for example, can be analyzed in GIS to produce maps of land cover and land use. When different types of geospatial data are combined in GIS (e.g., through combining satellite

[4] U.S. Geological Survey, *Geographic Information Systems*, http://egsc.usgs.gov/isb/pubs/gis_poster/#what.

[5] National Research Council, *Successful Response Starts With a Map: Improving Geospatial Support for Emergency Management*, Washington, DC, 2007, p. 15.

[6] New York State Department of Environmental Conservation, Center for Technology in Government, *Sharing the Costs, Sharing the Benefits: the NYS GIS Cooperative Project*, Project Report 95-4, Albany, NY, 1995, p. 7, http://www.ctg.albany.edu/publications/reports/sharing_the_costs/sharing_the_costs.pdf.

[7] For example, thousands of amateur geospatial enthusiasts are forming mapping parties, using personal navigation devices to create their own street maps. See http://www.OpenStreetMap.org. Information derived from such groups is referred to as volunteered geographic information (VGI).

remote sensing land use information with aerial photograph data on housing development growth), the data must be transformed so they fit the same coordinates. GIS uses the processing power of a computer, together with geographic mapping techniques (cartography), to transform data from different sources onto one projection and one scale so that the data can be analyzed together.

### Geospatial and GIS Terminology

*Attribute*: descriptive information about the properties of events, features, or entities associated with a location, such as the ownership of a parcel of land, or the population of a neighborhood, or the wind speed and direction over a point on the ground.

*Bathymetry*: the science of measuring and charting the depths of water bodies to determine the topography of a lake bed or seafloor.

*Cadastre*: the map of ownership and boundaries of land parcels, often used to record ownership and assist in calculating taxes.

*Cartography*: the study and practice of making maps.

*Datum*: a definition of the origin, orientation, and scale of the coordinate system; usually a system of coordinate positions on a surface (horizontal datum) or heights above or below a surface (vertical datum).

*Geocoding*: assignment of alphanumeric codes or coordinates to geographically referenced data. Examples include the two-letter country codes, or the coordinates of a residence computed from its address. The end result is spatial data that can be displayed as features on a map.

*Geodetic control*: horizontal or vertical survey monuments that are primarily intended to serve as reference positions for other surveys or that serve to extend the national geodetic control networks.

*Geographic information system* (GIS): a digital database in which information is stored by its spatial coordinate system, which allows for data input, storage, retrieval, management, transformation, analysis, reporting, and other activities. GIS is often envisioned as a process as much as a physical entity for data.

*Geospatial data*: information that identifies the geographic location and characteristics of natural and constructed features and boundaries on Earth.

*Global Positioning System* (GPS): a navigation system supported by a constellation of 24 satellites owned and operated by the U.S. Department of Defense. The satellites transmit precise microwave signals that enable GPS receivers such as handheld devices or receivers installed in automobiles to determine their location, speed, and direction.

*Hydrography*: the charting and description of bodies of water.

*LIDAR*: acronym for Light Detection and Ranging, a remote sensing technique that uses laser pulses to determine elevation with high accuracy, usually from an aerial survey.

*Map*: a two-dimensional visual portrayal of geospatial data. The map is not the data itself.

*Metadata*: information about the quality, content, condition, and other characteristics of data. It may describe and document how, when, where, and by whom the data was collected, among other types of information.

*Orthoimagery*: An aerial photograph or image from which distortions resulting from camera tilt and ground relief have been removed. An orthophotograph or orthoimage has a uniform scale and can be used as a map.

*Polygon*: a feature in GIS used to represent areas (versus a point, or a line). A polygon is defined by the lines that make up its boundary. On a map, the closed shape representing the area is defined by a connected sequence of coordinates, or x,y pairs.

*Projection*: a mathematical means of transferring information from the Earth's three-dimensional, curved surface onto a two-dimensional map or computer screen.

**Sources**: Environmental Systems Research Institute, Inc., (ESRI), GIS Dictionary, http://support.esri.com/en/knowledgebase/Gisdictionary/browse; Urban and Regional Information Systems Association (URISA), GIS Glossary of Terms, http://www.urisa.org/files/publications/gis_glossary/gis_glossary.pdf.

## Geospatial Data from Local, State, and Federal Governments and the Private Sector

Local and state governments provide geospatial data for use in GIS for a variety of public services such as land records, property taxation, local planning, subdivision control and zoning, and others.[8] Local governments often contract with private-sector companies to acquire more recent and higher-resolution data than what is available to the federal government.[9] Whether and how the most up-to-date and detailed geospatial information is made available to users other than the local government for which the data were acquired are long-standing issues. For example, in the immediate aftermath of a natural disaster, such as Hurricane Katrina in 2005, it may be important for the federal government to acquire the most current and detailed geospatial information about the disaster area. In many instances, however, impediments to data sharing such as lack of interoperability between systems, restrictions on use, concerns about data security, and a lack of knowledge about what data exist and where the data can be found could hinder a timely and effective emergency response.[10]

The federal government sometimes acquires geospatial data for federal needs, such as for updating floodplain maps from paper flood insurance rate maps to a digital format. Assessing the need to update floodplain maps on a periodic basis is required by law,[11] and the Federal Emergency Management Agency (FEMA) has spent over $1.4 billion since FY2003 to convert paper flood insurance rate maps (FIRMs) to digital flood insurance rate maps (DFIRMs) and to produce a format usable in GIS.[12] Simply converting paper maps to digital formats does not necessarily improve their accuracy, which often depends on the resolution of the original data. New techniques for collecting more data, such as Light Detection and Ranging (LIDAR), would help produce more accurate floodplain maps.[13]

Geospatial data are increasingly acquired and provided by the private sector, and many companies as well as professional organizations support and promote the role of private-sector data providers. One organization, the Management Association for Private Photogrammetric Surveyors (MAPPS), bills itself as the only national association exclusively composed of private geospatial firms.[14] MAPPS itself is a member of a larger coalition—the Coalition of Geospatial Organizations (COGO). COGO is comprised of 11 organizations and associations involved in geospatial data and policy issues.[15]

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8 U.S. General Accounting Office (now the Government Accountability Office), *Geospatial Information: Better Coordination Needed to Identify and Reduce Duplicative Investments*, GAO-04-703, June 23, 2004, p. 13. Hereinafter referred to as GAO (2004).

9 GAO (2004).

10 National Research Council, *Successful Response Starts With a Map*, 2007, p. 3.

11 Section 575 of P.L. 103-325 requires the Director of FEMA to assess the need to revise and update all floodplain areas and flood risk zones identified.

12 For more information on the flood map modernization initiative and flood insurance, see CRS Report R41056, *Mandatory Flood Insurance Purchase in Remapped Residual Risk Areas Behind Levees*, by Rawle O. King.

13 Most states do not have comprehensive LIDAR coverage. North Carolina is an exception, having nearly complete coverage because it implemented a statewide LIDAR program, in part to improve the accuracy of state flood plain maps in the wake of Hurricane Floyd in 1999. See http://www.ncfloodmaps.com/pubdocs/FAQs.pdf.

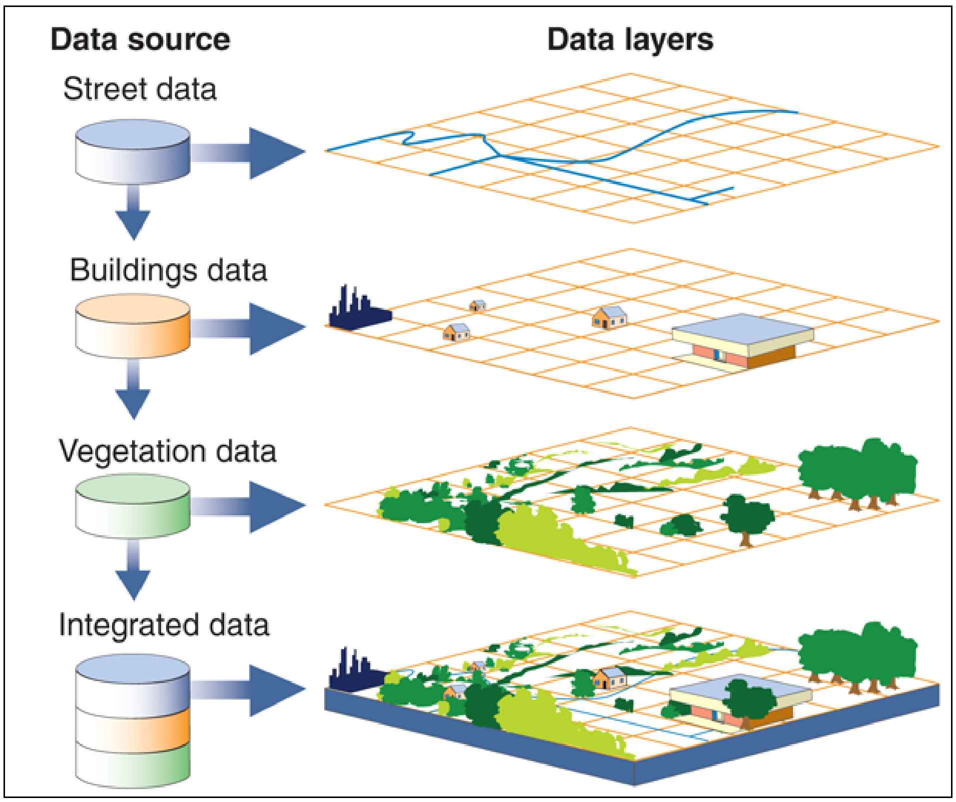
14 See MAPPS, at http://www.mapps.org/.

15 For a list of the COGO member organizations, see http://www.urisa.org/cogo.

## GIS Layers or Themes

The attributes of different types of geospatial data—such as land ownership, roads and bridges, buildings, lakes and rivers, counties, or congressional districts—can each constitute a layer or theme in GIS. (See **Figure 1** for a schematic representation of data layers in GIS.) GIS has the ability to link and integrate information from several different data layers or themes over the same geographic coordinates, which is very difficult to do with any other means. For example, GIS could combine a major road from one data layer as the boundary dividing land zoned for commercial development with the location of wetlands from another data layer. Precipitation data, from a third layer, could be combined with a fourth data layer that shows streams and rivers. GIS could then be used to calculate where and how much runoff might flow from the commercial development into the wetlands. Thus, the power of GIS analysis can be used to create a new way to interpret information that would otherwise be very difficult to visualize and analyze.

**Figure 1. Example of GIS Data Layers or Themes**




**Source:** GAO (2004), p. 5.

# Examples of Why and How Geospatial Information Is Used

## California Wildfires

Timeliness is an important factor for some uses of geospatial information. An example is the southern California wildfires during 2008. One of the worst fires in the region, known as the Sylmar fire, began on the evening of November 14, 2008. It forced the evacuation of 10,000 people and shut down major freeways near the town of Sylmar on the edge of the Angeles National Forest.[16] The speed of the fire's progress made it difficult to know where the fire was heading and to visualize escape routes. In addition, the fire jumped Interstate 210 (I-210) and Interstate 5 (I-5), two major routes of egress, on Saturday, November 15.

To assist in real-time decision making, the fire's progress was posted on the Internet in near real-time by several organizations, using reports from the ground, and the information about the fire was displayed on underlying street maps (showing where the fire crossed I-5 and I-210), terrain maps, and satellite images. (See **Figure 2**.) The Sylmar fire example underscores the informational power available when geospatial information is combined with tools for displaying the information, such as GIS and the Internet. In this instance, timeliness—the ability to post the geospatial information quickly—enhanced its value to the data users, citizens trying to avoid the path of the fire.

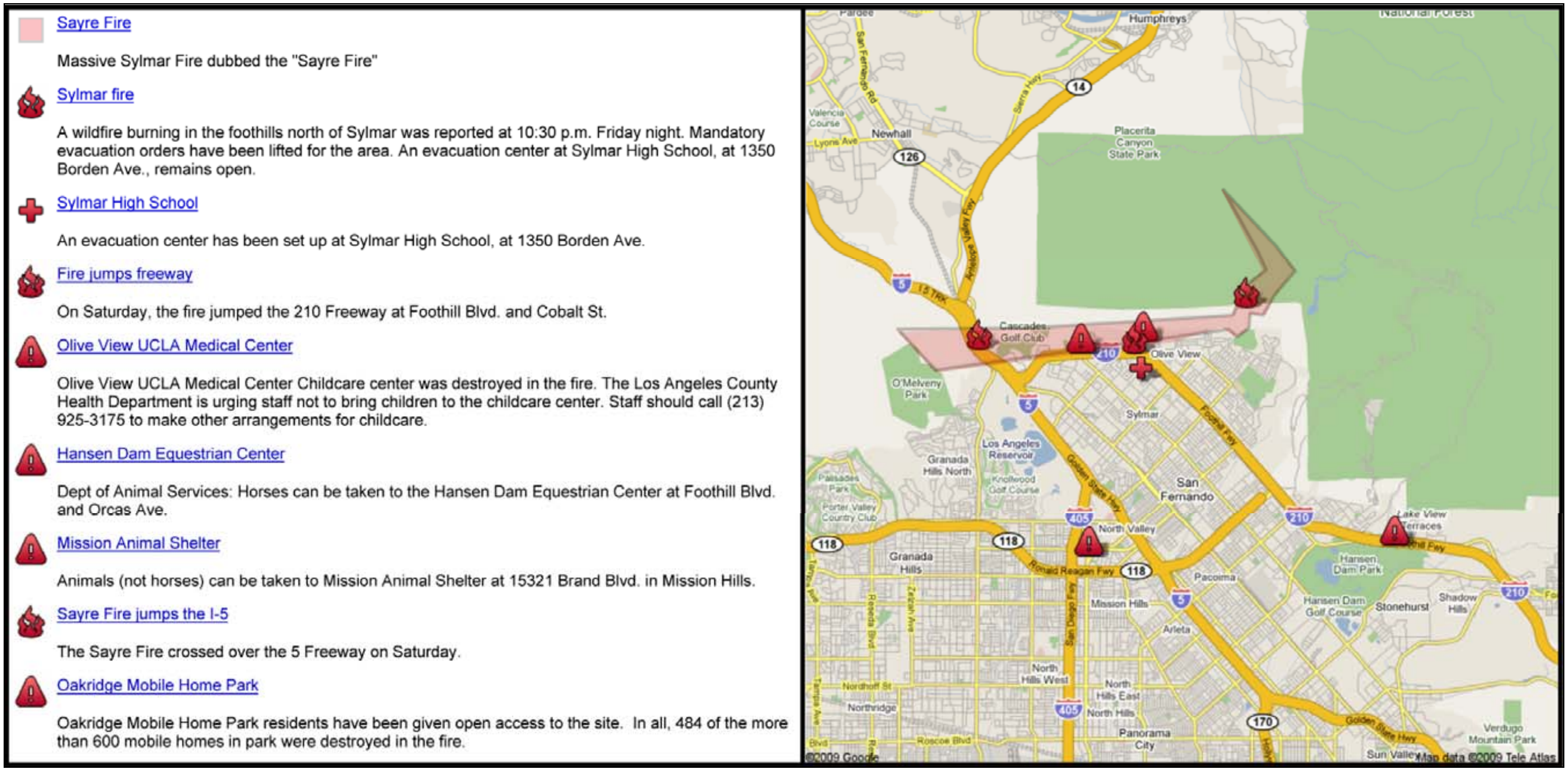
Although timeliness is often important, the analytical power resulting from combining geospatial information with GIS more typically underscores its value to policy makers at all levels. GIS often provides for unique analyses of disparate types of information—linked by their spatial coordinates—to help resolve policy questions. For policy makers, this type of analysis can greatly assist in clarifying complex problems that may involve local, state, and federal government, and may affect businesses, residential areas, and federal installations.

## Base Realignment and Closure (BRAC) Program

The Base Realignment and Closure (BRAC) program is the process by which unneeded military facilities are identified and transferred to other federal agencies or disposed of. The City of Virginia Beach, VA, used GIS in its response to the 2005 BRAC Commission's recommendation to realign Naval Air Station Oceana, located near the population center of the city. The BRAC Commission was concerned that the city's land use was encroaching on the air station; in particular, the city was impinging on the noise zones and accident potential zone (APZ) around the air station. Because the recommended realignment of Oceana would likely cause Virginia Beach to suffer significant economic losses, the city sought to establish a baseline—using GIS—to understand the status of encroachment. In addition, the GIS analysis could inform city leaders about how to modify the municipal land use ordinance to prevent encroachment on the air station and forestall its realignment.

[16] Peter Fimrite, "Wildfires Raging Through Southern California," *San Francisco Chronicle*, November 16, 2008, online article via SFGate, http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2008/11/15/MNC7145F2D.DTL.

**Figure 2. Snapshot of the Path of the 2008 Sylmar Fire Near Los Angeles, CA**

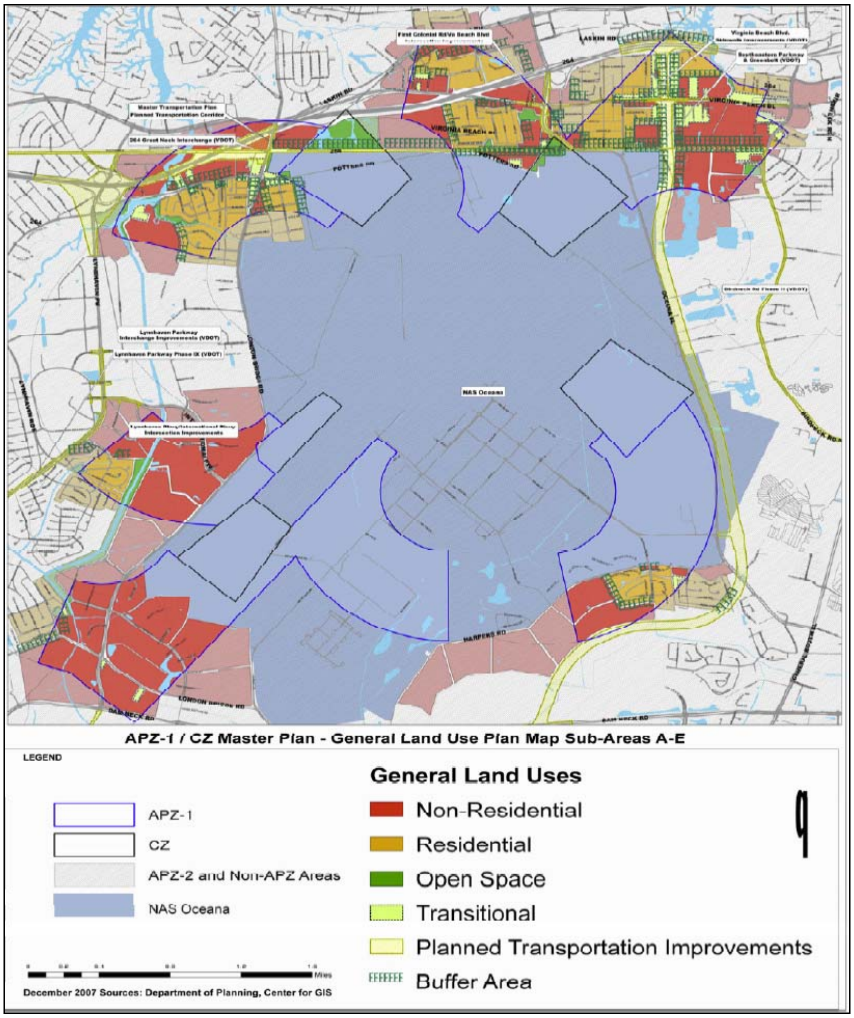



**Source:** ABC Eyewitness News, Sylmar Wildfire, created Nov. 15, 2008, updated Nov. 20, 2008. See http://maps.google.com/maps/ms?hl=en&ie=UTF8&msa=0&msid=100866907082629170478.00045bb5e2170708e9258&t=h&source=embed&ll=34.314638,-118.436834&spn=0.251809,0.528717&z=12. Modified by CRS.

**Notes:** the path of the fire with the annotation is shown with an underlying street map. The original interactive website also allows the user to choose an underlying terrain map or satellite image map.

**Figure 3. GIS Analysis of Naval Air Station Oceana, Virginia Beach, VA**

(example showing city land use encroachment)




**Source**: Office of the City Attorney, Virginia Beach, *Second Progress Report, N.A.S. Oceana Encroachment*, July 1, 2007 – June 30, 2008, Figure 5, p. 19, APZ-1/Clear Zones Master Plan, http://www.vbgov.com/file_source/dept/mcg/WebPage/HotTopics/BRAC/Web%20Page/Documents/nas_oceana_encroachment_2nd_progress_report_2008.pdf.

**Notes**: APZ is accident potential zone; CZ is clear zone.

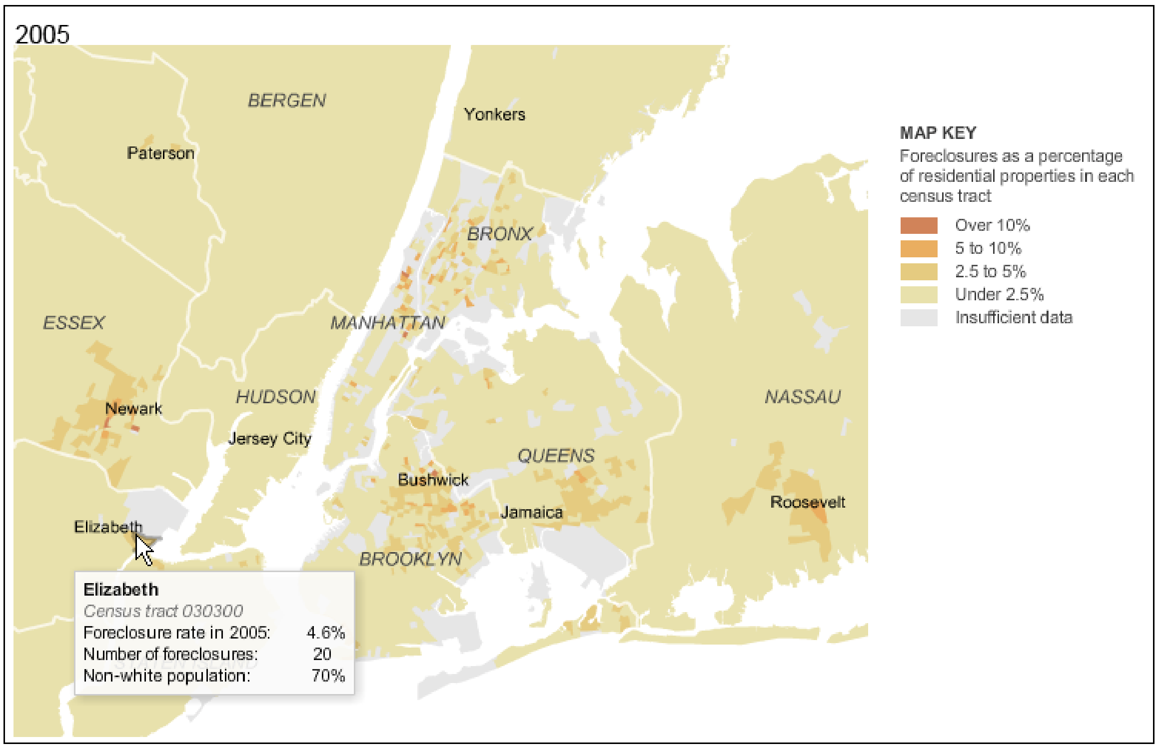
To establish a baseline, city planners and GIS analysts overlaid noise zones and APZ, property, land use, zoning, and other sets of geospatial data—known as attributed boundary layers—to determine current land use and development. Within the GIS analysis, these sets of geospatial data were joined with land parcel information, and with various external databases held within the planning, real estate assessor's, and commissioner's offices. By combining geospatial data with non-spatial data, the GIS analysts helped land planners determine how the land around the air station was being used, and therefore its compatibility with the Navy's requirements. (See **Figure 3**.) The GIS analysis also enabled the city to summarize property values and acreage by its use: undeveloped, commercial, or residential.

GIS helped the Virginia Beach city planners to identify on one map all of the land use around the air station (**Figure 3**). GIS analysts also provided a model of underdeveloped land—land that had additional existing by-right development capacity—but which if developed could exacerbate the encroachment problem for the Navy. As a result of the GIS analysis, city planners recommended a change to the municipal land ordinance to prevent potential future incompatible development. Naval Air Station Oceana has not been relocated from Virginia Beach.

## Mapping Foreclosures

On May 15, 2009, the *New York Times* published an online interactive map showing foreclosures as a percentage of residential properties in each census tract in the New York City region.[17] The map showed census tracts coded by color to represent the foreclosure rate. Moving the cursor over each census tract showed a pop-up window disclosing the foreclosure percentage, the number of foreclosed residences, and the percentage on the non-white population in each tract. In addition, the map allowed the reader to compare foreclosure rates for each year since 2005. **Figures 4** and **5** are snapshots from the map for the years 2005 and 2008.

**Figure 4. Snapshot of Interactive Map Showing Foreclosure Percentage by Census Tract in the New York City Area, 2005**

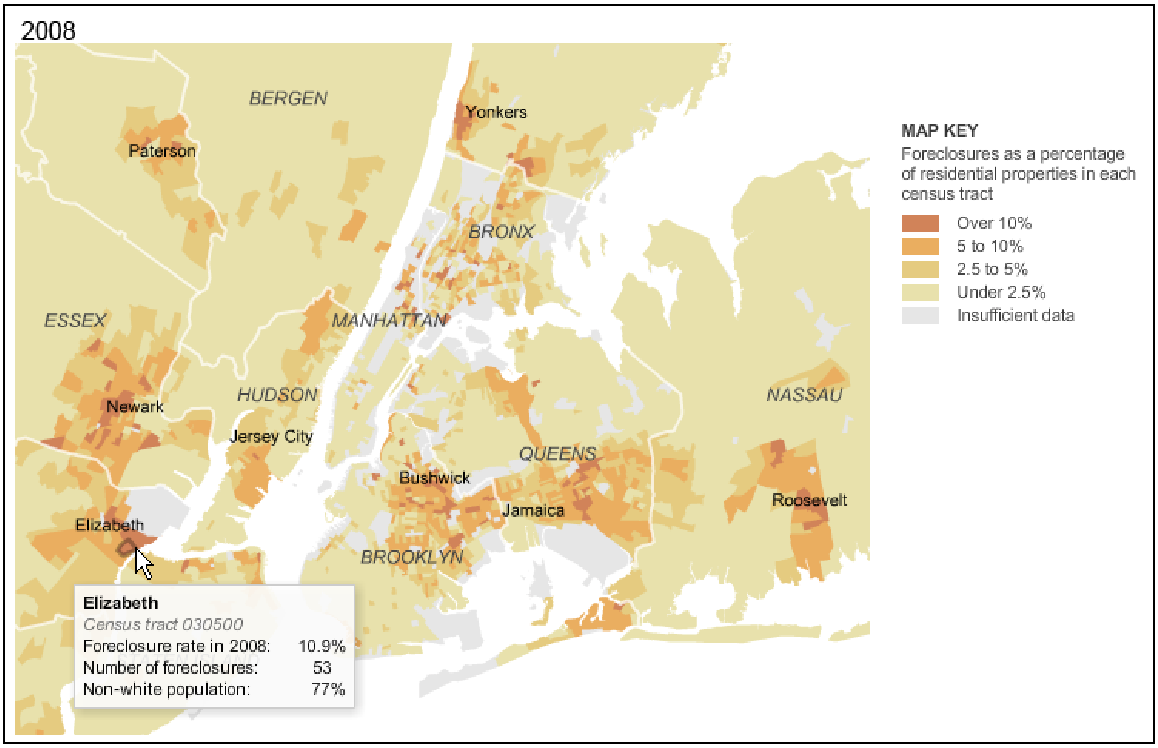



**Source:** *New York Times*, May 15, 2009, at http://www.nytimes.com/interactive/2009/05/15/nyregion/0515-foreclose.html. Modified by CRS.

**Notes:** The online interactive version allows the reader to point and click on any census tract in the region. Census tract 030300 is shown here for illustration purposes.

[17] Mathew Bloch and Janet Roberts, "Mapping Foreclosures in the New York Region," *New York Times*, May 15, 2009, at http://www.nytimes.com/interactive/2009/05/15/nyregion/0515-foreclose.html.

**Figure 5. Snapshot of Interactive Map Showing Foreclosure Percentage by Census Tract in the New York City Area, 2008**




**Source:** *New York Times*, May 15, 2009, at http://www.nytimes.com/interactive/2009/05/15/nyregion/0515-foreclose.html. Modified by CRS.

**Notes:** The online interactive version allows the reader to point and click on any census tract in the region. Census tract 030500 is shown here for illustration purposes.

Using the zoom tool provided with the map allows the reader to zoom in on specific residential properties, represented by red dots, along with street names. This type of visualization, combining detailed geospatial information with demographic and financial data, lends itself to further analysis such as understanding foreclosure patterns and whether proximity to foreclosed properties has an effect on property values. Some researchers call this the "contagion effect" of foreclosed properties. One report documented how this effect discounted property values as a function of distance from foreclosed homes, and showed that the discount effect dropped off sharply with distance.[18] This type of spatial analysis of foreclosure effects, with the visualization provided by GIS maps such as the *New York Times* example, can help inform policy makers about the nature and extent of foreclosure patterns, if the underlying data are reliable.

## Social Media and GIS: The March 11, 2011, Japanese Earthquake and Tsunami

Within 36 hours of the March 11, 2011 magnitude 9.0 earthquake off Japan's northeast coast, a small team of GIS experts began a project for a volunteer group called GISCorps. The group

[18] John P. Harding, Eric Rosenblatt, and Vincent W. Yao, "The Contagion Effect of Foreclosed Properties," *Social Science Research Network Working Paper*, July 15, 2008.

intended to gather critical geospatial information to help humanitarian organizations working in areas damaged by the earthquake and tsunami.[19] The project was developed in partnership with Crisis Commons, a social media organization that "seeks to advance and support the use of open data and volunteer technology communities to catalyze innovation in crisis management and global development."[20] According to a source, the project was part of a request from the U.N. Office for the Coordination of Humanitarian Affairs to provide current information for aid missions in Japan.[21]

Within a few days, the team developed an interactive map to display real-time information about evacuation shelters, flooded areas, water distribution centers, cleared roads, and other types of geospatial data of immediate use to citizens and humanitarian workers. Further, several members of the team contacted friends and colleagues in Japan to assist in gathering census records and maps and posting them in GIS layers. This type of information gathering, using on-the-ground sources, is one variant of "crowd-sourcing," or public data collection efforts. In this case, the information was vetted through the team of experts and included as GIS data layers in the interactive map. Crowd-sourcing, also referred to as participatory mapping and sensing, or volunteered geographic information, is becoming increasingly popular as demand for location information increases. As with other examples of participatory data gathering efforts, such as Wikipedia, the accuracy and authoritativeness of the volunteered information is sometimes questionable.

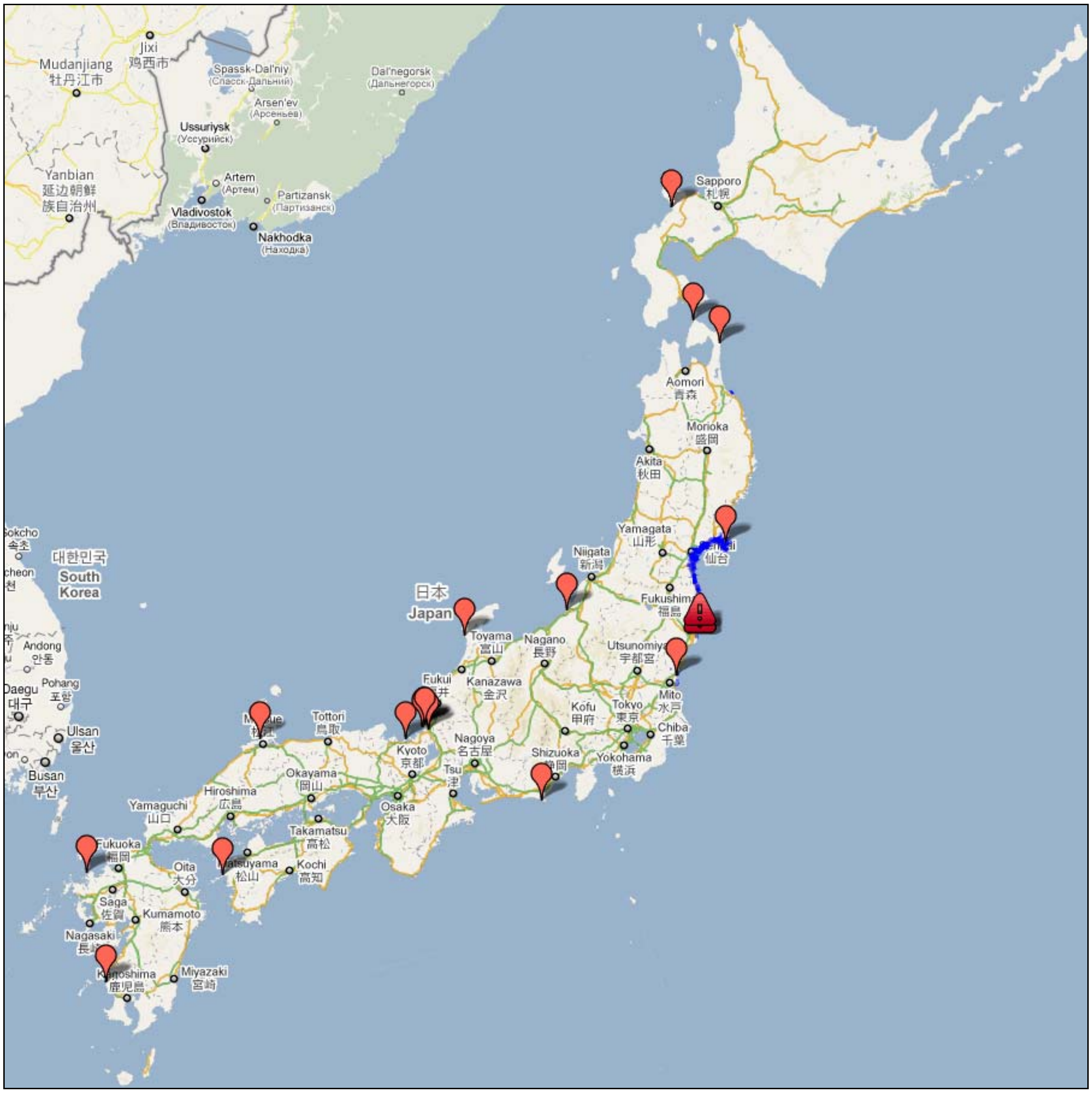
**Figure 6** shows the GISCorps/CrisisCommons interactive map with two data layers turned on: the area flooded by the tsunami, and the location of Japan's nuclear power plants, including the damaged Fukushima I plant.

[19] WAMU 88.5 American University Radio, broadcast of April 21, 2011, http://wamu.org/news/11/04/21/university_of_maryland_professor_helps_digitize_disaster_relief.php.

[20] CrisisCommons, http://crisiscommons.org/about/.

[21] Japan Tohoku Earthquake GISCorps/CrisisCommons collaboration, http://gis.ats.ucla.edu/japan/.

**Figure 6. Example of Interactive Map of Region Affected by the March 11, 2011, Japanese Earthquake and Tsunami**




**Source:** Japan Tohoku Earthquake, CrisisCommons collaboration with GISCorps, http://gis.ats.ucla.edu/japan/.

**Notes:** Two of seven available data layers have been switched on for this display: nuclear power plants (red balloons); and flood areas (shown as the blue band). The red triangle at the bottom of the blue band indicates the Fukushima I power plant that was damaged by the tsunami.

# How Geospatial Data Is Managed at the Federal Level

## The Federal Geographic Data Committee (FGDC)

OMB Circular A-16 was first issued in 1953 to ensure that federal surveying and mapping activities met the needs of federal and state agencies and the general public and to avoid duplication of effort.[22] In 1967, the circular was revised and included a section on responsibilities for coordination among three federal departments: Department of the Interior, Department of Commerce, and Department of State. In 1990, the circular was revised again and expanded beyond just surveying and mapping to include related geospatial data activities. The 1990 revision also established the Federal Geographic Data Committee (FGDC). The purpose of the FGDC was to promote the coordinated use, sharing, and dissemination of geospatial data nationwide.[23]

Under the revised Circular A-16, 19 members comprise the FGDC. (See **Table 1.**) The U.S. Geological Survey, Department of the Interior, provides administrative support through the FGDC Secretariat.[24] According to Circular A-16, all federal agencies responsible for geospatial data themes (discussed below) are required to be members of the FGDC.

**Table 1. Members of the Federal Geographic Data Committee (FGDC)**

| | |
|---|---|
| Dept. of Agriculture | Environmental Protection Agency |
| Dept. of Commerce | Federal Emergency Management Agency |
| Dept. of Defense | General Services Administration |
| Dept. of Energy | Library of Congress |
| Dept. of Health and Human Services | National Aeronautics and Space Administration |
| Dept. of Housing and Urban Development | National Archives and Records Administration |
| Dept. of the Interior (Chair) | National Science Foundation |
| Dept. of Justice | Tennessee Valley Authority |
| Dept. of State | |
| Dept. of Transportation | Office of Management and Budget (Co-Chair) |

### FGDC Coordination Group

In September 2009, the FGDC Steering Committee chartered a Coordination Group, which is charged with identifying, prioritizing, implementing, coordinating, and overseeing strategies and tasks required to support the National Spatial Data Infrastructure (NSDI, discussed in the next section).[25] One of its objectives is to advance intra- and inter-government coordination to ensure implementation of NSDI and to enhance the management of the federal geospatial enterprise and

[22] OMB Circular A-16, Appendix C.

[23] GAO (2004), p. 11.

[24] See the USGS National Geospatial Program, at http://www.usgs.gov/ngpo/index.html.

[25] See FGDC Coordination Group Charter, at http://www.fgdc.gov/participation/coordination-group/coordination-group-charter.

national geospatial data sets. The other objectives appear to align with the goal of improving coordination within the federal government, to meet the responsibilities outlined in Circular A-16. The members of the Coordination Group include agency and department members of the FGDC (**Table 1**), and 11 additional members (two non-voting) representing agencies of the federal government. Individual members of the Coordination Group are responsible for coordinating their agencies' Circular A-16 responsibilities, according the Coordination Group charter.

## The National Spatial Data Infrastructure (NSDI)

OMB Circular A-16 also called for development of a national digital spatial information resource to enable the sharing and transfer of spatial data between producers and users, linked by criteria and standards. This national digital spatial information resource became what is now known as the National Spatial Data Infrastructure (NSDI).[26] In an August 19, 2002, revision, Circular A-16 affirmed the NSDI as "the technology, policies, standards, human resources, and related activities necessary to acquire, process, distribute, use, maintain, and preserve spatial data."

Circular A-16 directs the FGDC to lead and support the NSDI strategy, spatial data policy development, management, and operational decision making. As the overall coordinating entity for the NSDI, the FGDC has broad responsibilities that include all spatial data and GIS activities financed directly or indirectly, in part or in whole, by federal funds.

The FGDC facilitates the NSDI in cooperation with organizations from state, local, and tribal governments, the academic community, and the private sector. As specified in Circular A-16, cooperation is necessary to realize the overall vision of the NSDI: to assure that spatial data from multiple sources—not just federal sources—are available and easily integrated to enhance the understanding of our physical and cultural world. There are five components[27] of the NSDI: (1) data themes; (2) metadata; (3) National Spatial Data Clearinghouse; (4) standards; and (5) partnerships. (Refer to the box above for definitions of common geospatial and GIS terms.)

### *Data Themes*

Data themes are electronic records and coordinates for a topic or subject, such as elevation or vegetation. Themes that are the core group of the most commonly used set of base data are known as framework data, which are (1) geodetic control, (2) orthoimagery, (3) elevation and bathymetry, (4) transportation, (5) hydrography, (6) cadastre, and (7) governmental units.

### *Metadata*

Metadata are information about the data, its content, source, accuracy, method of collection, and other descriptions that help ensure the data are used appropriately. They help ensure that the data are authoritative, and that any resulting analysis is credible. OMB Circular A-16 specifies that all spatial data collected or derived directly or indirectly using federal funds will have FGDC metadata.

[26] On April 11, 1994, President Clinton issued Executive Order 12906, which specified that the FGDC shall coordinate development of the NSDI.

[27] These descriptions are drawn from Circular A-16 Revised, August 19, 2002, at http://www.whitehouse.gov/omb/circulars_a016_rev/.

### *National Spatial Data Clearinghouse*

The Clearinghouse is an electronic service providing access to documented spatial data and metadata from distributed data sources. The Clearinghouse is intended to provide access to NSDI for spatial data users. According to Circular A-16, all spatial data collected by federal agencies will be made available through the Clearinghouse.

### *Standards*

These are common and repeated rules, conditions, guidelines or characteristics for data, and related processes, technology, and organization. OMB Circular A-16 specifies that international standards and protocols must be used for NSDI, to broaden the global use of federal data and services. The FGDC is responsible for developing and promulgating the standards after receiving broad input from data users and providers. Also, Circular A-16 directs FGDC to adopt national and international standards in lieu of federal standards whenever possible.

### *Partnerships*

OMB Circular A-16 directs federal agencies to promote and use partnerships that promote cost-effective data collection, documentation, maintenance, distribution, and preservation strategies that leverage the federal resources. In addition to federal, state, and tribal governments, these partnerships are to include private-sector geographic, statistical, demographic, and other business information providers and users.

Most recently, OMB issued supplementary guidance to Circular A-16 on November 10, 2010.[28] The supplemental guidance labels geospatial data as a capital asset, and refers to its acquisition and management in terms analogous to financial assets to be managed as a National Geospatial Data Asset Portfolio. (See CRS Report Rxxxxx for a discussion of the most recent supplemental guidance to Circular A-16.)

# Other Activities and Components of FGDC and NSDI

## The National Map

Introduced in 2001, the National Map is envisioned as a consistent framework for geographic knowledge nationwide, and will be available as an online and interactive map service, according to the USGS.[29] The National Map is the future product—the next generation—that would supplant the paper versions of topographic maps that the USGS has produced for decades. Topographic maps are probably the USGS product most familiar to the majority of Americans. The USGS plans to replace all of the current topographic maps for the conterminous 48 states over the next three years with a new map product: "US Topo.[30]

[28] Office of Management and Budget, *Geospatial Line of Business OMB Circular A-16 Supplemental Guidance*, November 10, 2010.

[29] See USGS, *The National Map*, at http://nationalmap.gov/index.html.

[30] USGS Budget Justification for FY2011, p. I-38.

The National Map would allow users to combine geographic information from other sources with the USGS topographic foundation data. The National Map would provide information such as high-resolution digital imagery from satellites and aerial photographs, high-resolution surface elevation data, land cover data, geographic names, and other features. Currently, the National Map is in an initial stage that can provide nationwide coverage at limited resolutions for transportation, hydrography, elevation, land cover, and cultural features. According to the USGS, the National Map will capture and integrate data in a process of continuous update, rather than by regularly scheduled cycles of review and revision. The National Map will face challenges, however, in integrating data from a variety of sources, perhaps at different scales and different resolutions, and in managing inconsistent or incomplete metadata.

## Geospatial One-Stop

The Geospatial One-Stop portal is the official means of accessing metadata resources, published through the National Spatial Data Clearinghouse and managed in NSDI. [31] Geospatial One-Stop focuses on the discovery and access of geospatial information.[32] The Geospatial One-Stop is described as one of the three national geospatial initiatives that share the goal of building the NSDI along with FGDC itself and the National Map. These three components have different foci: the FGDC focuses on policy, standards, and advocacy; and the National Map focuses on integrated, certified, base mapping content. In FY2010, according to the USGS, Geospatial One-Stop focused on integration with the Obama Administration's Open Government initiative through Data.gov.[33] (Data.gov is discussed further below.)

## USGS Geospatial Liaison Network

The USGS Geospatial Liaison Network consists of USGS employees who serve as liaisons in NSDI partnership offices across the country.[34] The liaisons are intended to represent and coordinate the National Geospatial Program (NGP)[35] initiatives in state and local agencies, in addition to other federal agencies, in support of NSDI, The National Map, and Geospatial One-Stop. The liaisons work with statewide coordinating councils and seek partnerships with not-for-profit organizations, the private sector, universities, and consortia to support the goals of NSDI. According to the USGS, each liaison is the "local face" of the USGS, NSDI, and NGP.

Each state is assigned a liaison under the network, although some liaisons may cover more than one state. The liaisons commonly work with the formal state GIS coordinators or councils, or with other individuals or regional groups in states where a formal GIS or geospatial coordinator

[31] USGS. Citied in the FGDC 2009 Annual Report, p. 31, http://www.fgdc.gov/library/whitepapers-reports/annual%20reports/2009/2009-AR.pdf.

[32] The website is called geodata.gov and is available at http://gos2.geodata.gov/wps/portal/gos.

[33] FGDC 2010 Annual report, at http://www.fgdc.gov/library/whitepapers-reports/annual%20reports/2010/web-version/index_html.

[34] A description of the program, and a link to a list of the liaisons, is provided at http://www.usgs.gov/ngpo/ngp_liaisons.html#. Additional information about the broader geospatial partnerships is provided at http://liaisons.usgs.gov/geospatial/.

[35] The USGS National Geospatial Program (NGP) organizes, maintains, and publishes the geospatial baseline of the nation's topography, natural landscape, and built environment, including transportation features. The National Map is a subcomponent of the NGP within the USGS organizational structure. See the USGS Budget Justification, pp. I-29 to I-48 for a fuller description of NGP.

or council does not exist. A large portion of the liaison's efforts is devoted to coordinating with state-level and other stakeholders on geospatial data acquisition and data maintenance. In states with large federal land holdings, such as some western states, geospatial liaisons may devote relatively more time to coordinating with federal land management agencies such as the Forest Service, National Park Service, Fish and Wildlife Service, or Bureau of Land Management.[36]

## Data.gov

Data.gov was launched in 2009 under the Obama Administration with the primary goal of improving access to federal data generated by the Executive Branch.[37] During its first year, Data.gov expanded its accessible raw data to over 270,000 records, 90% of which were geospatial data.[38] Geospatial records in Data.gov are shared with Geospatial One-Stop. Although Data.gov is not exclusively an activity under FGDC and NSDI, its prominence under the Obama Administration's Open Government initiative together with its preponderance of geospatial data make it a growing location for access to and coordination with geospatial elements managed under FGDC.

[36] Ibid.

[37] See Data.gov at http://www.data.gov/about.

[38] FGDC 2010 Annual report.

# Appendix. List of Acronyms

| | |
|---|---|
| ARRA | American Recovery and Reinvestment Act of 2009 |
| APZ | Accident Potential Zone |
| BLM | Bureau of Land Management |
| BRAC | Base Realignment and Closure |
| COGO | Coalition of Geospatial Organizations |
| CZ | Clear Zone |
| DFIRMs | Digital Flood Insurance Rate Maps |
| FEMA | Federal Emergency Management Agency |
| FGDC | Federal Geographic Data Committee |
| FIRMs | Flood Insurance Rate Maps |
| GAO | Government Accountability Office |
| GIS | Geographic Information Systems |
| GPS | Global Positioning System |
| IFTN | Imagery for the Nation |
| LIDAR | Light Detection and Ranging |
| MAPPS | Management Association for Private Photogrammetric Surveyors |
| NGAC | National Geospatial Advisory Committee |
| NGP | National Geospatial Program |
| NILS | National Integrated Land System |
| NRC | National Research Council |
| NSDI | National Spatial Data Infrastructure |
| NSGIC | National States Geographic Information Council |
| OMB | Office of Management and Budget |
| USGS | U.S. Geological Survey |
| USFS | U.S. Forest Service |
| VGI | Volunteered Geographic Information |

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