Geographic Research and Applications Subactivity

Subactivity	FY 2000 Estimate	Uncontrol. & Related Changes	Program Changes	FY 2001 Budget Request	Change From FY 2000
Mapping Data Collection and Integration	56,330	+228	+10,769	67,327	+10,997
Earth Science Information Management and Delivery	34,270	+641	+2,000	36,911	+2,641
Geographic Research and Applications	**36,117**	**+727**	**[1]+14,200**	**51,044**	**+14,927**
Total Requirements $000	126,717	+1,596	+26,969	155,282	+28,565

[1] See Program Change section for details on Urban Dynamics (+$10,000), Decision Support for Resource Management (+$2,000), Columbia River – Aquatic Resources (+$500), Mojave Desert Initiative (+$400), DOI Science Priorities (+$1,300), Amphibians (+$100), and programmatic decrease (-$100).

Current Program Highlights

USGS Geographic research activities and investigations help advance the understanding of the complex processes that influence the land surface, increase our understanding of the interactions between the physical and human environments, further the applicability of geospatial data and technology, and improve the delivery of information all vital elements to informed decision making and decision support for the Nation. In its three program areas, geographic, cartographic, and information science research, collaborative efforts are encouraged with other mapping organizations, academia, and private industry to maximize research resource utilization, promote technology transfer and technological innovations, and enhance understanding and awareness of geographic science throughout the research community.

Geographic Research

Geographic research is conducted to better understand the biophysical and socioeconomic processes that influence the land surface and near surface, the ways the land surface functions as a component of the earth system, the response of the land surface to natural and human induced forces, and the use of that understanding for the management of our natural resources. It includes identification, acquisition, development, integration, and application of interdisciplinary information that describes the states and changes of the land surface at regional, national, and global scales; international research and applications; support for other government agencies; global change research; and data collection, assessment, integration, and interpretation for multidisciplinary, multi-agency research activities, such as environmental effects on human health.

Cartographic Research

Cartographic research is conducted to develop advanced analytical methods and spatial data integration tools required to design, create, maintain, and visualize national data bases compatible with the NSDI geospatial data framework. Research focuses on the development of geospatial data handling methods and techniques to allow for the integration, revision, and

certification of large holdings of all types of geospatial data, and investigations into the collection processes and testing procedures for components of spatial data quality.

Lake Tahoe Land Exchange

The Tahoe Regional Planning Agency is using USGS expertise and earth science data to relate property values, housing characteristics, neighborhood effects of development, and recreational characteristics to test and implement a building permits auction and land exchange.

Information Science Research

Information science research is conducted to systematically study information and the methods used to find, store and manipulate it. Computer science research is conducted to study those aspects of information science that can be manipulated with computing devices. Being a mathematical discipline, information science relies heavily on symbolic computation to describe and model nature. The goal of research in information and computer science is the discovery of principles that, when applied by the engineering disciplines, assist in the solution of specific geographic research problems.

Key areas of recent geographic research and applications include:

Land Cover Trends

To build a scientific understanding of the rates of change and the driving forces and associated impacts of change, a Land Cover Trends project will document the rates, causes, and consequences of land use and land cover change for the conterminous United States for 1972-2000.

Monitoring, analyzing, and modeling land cover characteristics at multiple scales — The USGS documents and analyzes the geographic variability of land cover and land use at local, regional, national, and global scales using state-of-the-art remotely sensed data and classification strategies. Models are developed to explain: (1) the extent of human modification of the natural environment, (2) how these modifications affect weather formation, storm behavior, wildfire hazards, and atmospheric chemistry, (3) what types of land cover are most dynamic, (4) what the relationship is between land cover change and their environmental factors such as quantity and quality of ground water, health and distribution of various biologic species, and affects of change on the availability of natural resources, (5) how changes affect the potential for compliance with international environmental treaties (e.g., biodiversity and climate change), and (6) what the regional rates of change in land cover and land use change are. Only through developing and applying complex data sets and describing land characteristics can scientists better understand and model land processes, land-atmosphere interactions, and the impacts of landscape change that result from natural and human causes.

Collaboration with China

Building on the success of the global land cover database, the USGS and China are producing a global forest cover map and regional ecological zone maps based on specifications from the United Nations Food and Agriculture Organization and in collaboration with the Chinese Academy of Sciences. The map includes a number of climate and topographic variables needed to build an ecological zone map to help China formulate an effective national strategy for forest management.

International Research and Applications — USGS geographic research scientists use remotely sensed data and geographic information systems to help address issues of sustainable development, resource management, land cover change, monitoring, and early warning systems in many countries around the world. Projects are developed on the basis of specific requests from other U.S. agencies, non-governmental organizations, international donors, or host countries. A prime

example is the Pan American Institute of Geography and History (PAIGH) fire activity for which the USGS is developing a fire potential index model for the Mediterranean climate zones found in Argentina, Chile, Mexico, Spain, and Venezuela. This index allows mangers to monitor the fire potential on a regional basis using daily weather data, weekly imagery, and vegetation mapping. Web site: **http://edcintl.cr.usgs.gov/ip/fire/fire.html**.

Land Resources Observation Research — With the launch of Landsat 7, USGS scientists are conducting research to calibrate sensors and determine their effects on a range of applications, including land cover classification, landscape metrics, and land cover/land use change. Sensor calibration validates the utility of measuring and monitoring a wide array of land resources phenomena, such as volcanic activity, flooding, vegetation mapping, geologic assessment, fire fuel potential, and land cover change such as deforestation. New images from the Landsat 7 spacecraft are available for viewing and purchase via the Internet from the USGS and NASA. Web site: **http://landsat7.usgs.gov**.

Earth Science for Decision Making — The overarching goal for the USGS is to create more effective ways for science to be used in decision-making. Through the Center for Science Policy, the USGS is integrating scientific and economic information in a GIS environment with social and political values to achieve balanced solutions to issues. Ongoing efforts include developing stochastic models for environmental risk assessments, teaching adaptive management techniques and quantitative environmental risk modeling, developing tools for environmental bargaining, conflict resolution, and consensus building, and testing and refining negotiation theory.

Hazards Applications — The USGS Center for the Integration of Natural Disaster Information performs research in data integration, analysis, modeling, and decision support that supports the ongoing evolution of the USGS processing and delivery of hazards data. Results include (1) satellite interferometry used to detect volcanic deformation and increase the potential to anticipate eruptions, (2) urban mapping in the Puget Sound basin for analyzing correlations between hazard risk and urban development and growth, (3) scientific support and mapping products to help reduce the vulnerability of Cape Girardeau, Missouri, to earthquakes and floods and to enhance the community's response to these natural hazards, and (4) a USGS national fire fuels map for use by the wildland fire community for their national fire danger rating system and by their scientists in fire behavior models. Web site: **http://cindi.usgs.gov/**.

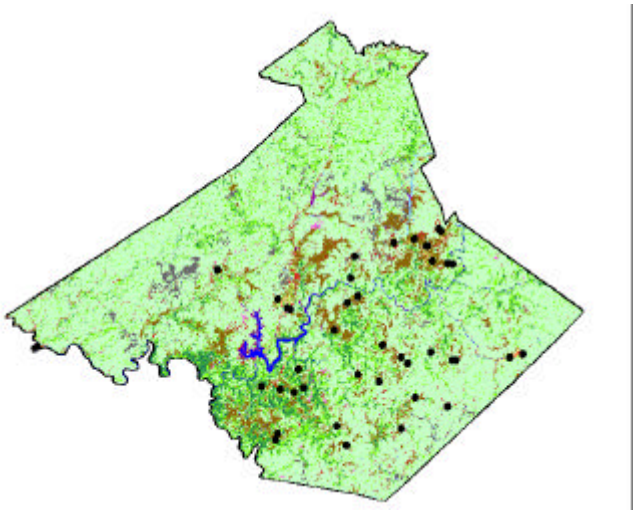
Center for Integration of Natural Disaster Information

New hardware and software capabilities of the USGS Center for Integration of Natural Disaster Information (CINDI) will ensure that information from multiple, disparate sources can be integrated and analyzed quickly to provide the synoptic views of on-the-ground conditions and scenarios that are needed in near-real-time by decision makers and recovery teams responding to disaster events.

Information Science — Understanding the basic principles of information science and technology allows the USGS to anticipate technology-induced change and take advantage of new opportunities such change creates. Information technology has advanced to such a degree that commercial-off-the-shelf solutions are available for many problems. Investigations of the basic principles underlying the technologies lead to the discovery of new knowledge that results in many-fold increases in productivity, new scientific discoveries, and the creation of new products. Key research in information science includes investigations of the architectures and uses of parallel computing environments and the distribution of tasks across wide-area networks. These investigations are expected to produce intelligent software agents that can

solve problems in the geographic sciences by performing tasks on behalf of a researcher without the direct supervision of the researcher. The agents will provide a mechanism for researchers to access many NSDI clearinghouse nodes or other repositories of spatial data and retrieve information in a reproducible and efficient manner.

Geography and Environmental Effects on Human Health — Using geographic information systems (GIS), remote sensing, and spatial analysis tools, scientists are defining geographic distributions of disease cases and their relationships to environmental factors; developing and testing models designed to predict disease activity and transmission rates; characterizing the human population at risk; and devising ecology-based prevention and control measures. Spatial analysis of health data using GIS is an innovative approach that improves the understanding of the geographic distribution of disease outbreaks. Scientists at the USGS and the Centers for Disease Control and Prevention (CDC) are examining the environmental influences on transmitted diseases, such as Lyme disease, plague, and viral encephalitis.



Human cases of LaCrosse Encephalitis in Nicholas County, West Virginia.

Information Systems Development and Maintenance — To ensure effective operation of the National Mapping Program (NMP), the Information Systems Development and Maintenance (ISDM) effort develops systems for collecting, integrating, archiving, and maintaining geospatial data and procures and maintains computer equipment and software. Specific activities include the operation, maintenance, design, development, expansion, enhancement and acquisition of geographic information systems, digital cartography, image processing, information management and business computer systems, and digital telecommunications networks utilized nationwide. This activity also provides support for systems issues within the bureau and the Department of the Interior, as well as across the Federal Government, partnering with the private sector and with academia.

The ISDM has historically depended upon internal government staff for most of the systems integration work and much of the unique software development required to support the NMP. However, there has been dramatic growth over the past several years in the breadth of commercially available software with advanced mapping and information management functions. Emphasis has accordingly been shifted to employing and adapting more commercial-off-the-shelf solutions and to developing stronger partnerships with the private sector to meet NMP systems and software needs.

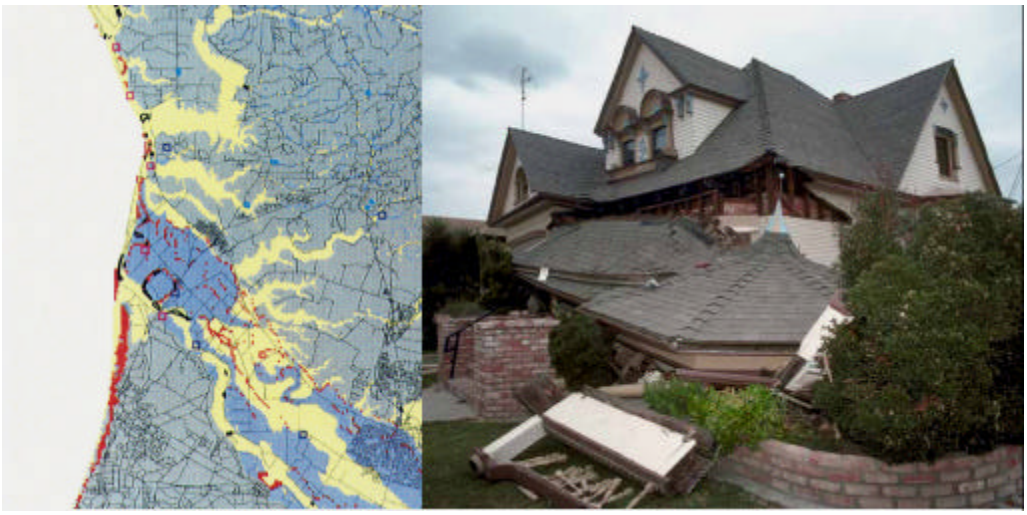
Analysis of Dynamic Urban Environments — Retrospective data of urban land use change has been compiled for several urban regions around the Nation to include Wilmington-Philadelphia, New York City, Portland-Vancouver, and Chicago-Milwaukee. Analysis of the rates, patterns, and trends of change is being conducted to analyze and model the dynamic urban landscape and apply the resulting understanding to regional problems of societal concern. Applications include the following activities: (1) understanding the role of land use change in ground water recharge and quality and coastal aquifer susceptibility to saltwater infiltration, (2) investigating the role of urban growth in fragmenting ecosystems, and (3) evaluating constraints to resource accessibility imposed by urban development.

Amphibians

Research and monitoring for amphibians requires the compilation and analysis of geospatial data to characterize habitats in areas of demonstrated amphibian loss and model development enabling the use of spatial analysis techniques to predict potential amphibian loss. Geographic analysis and mapping techniques are being developed and tested for measuring changes through space and time in amphibian habitat and determining contaminant transport pathways.

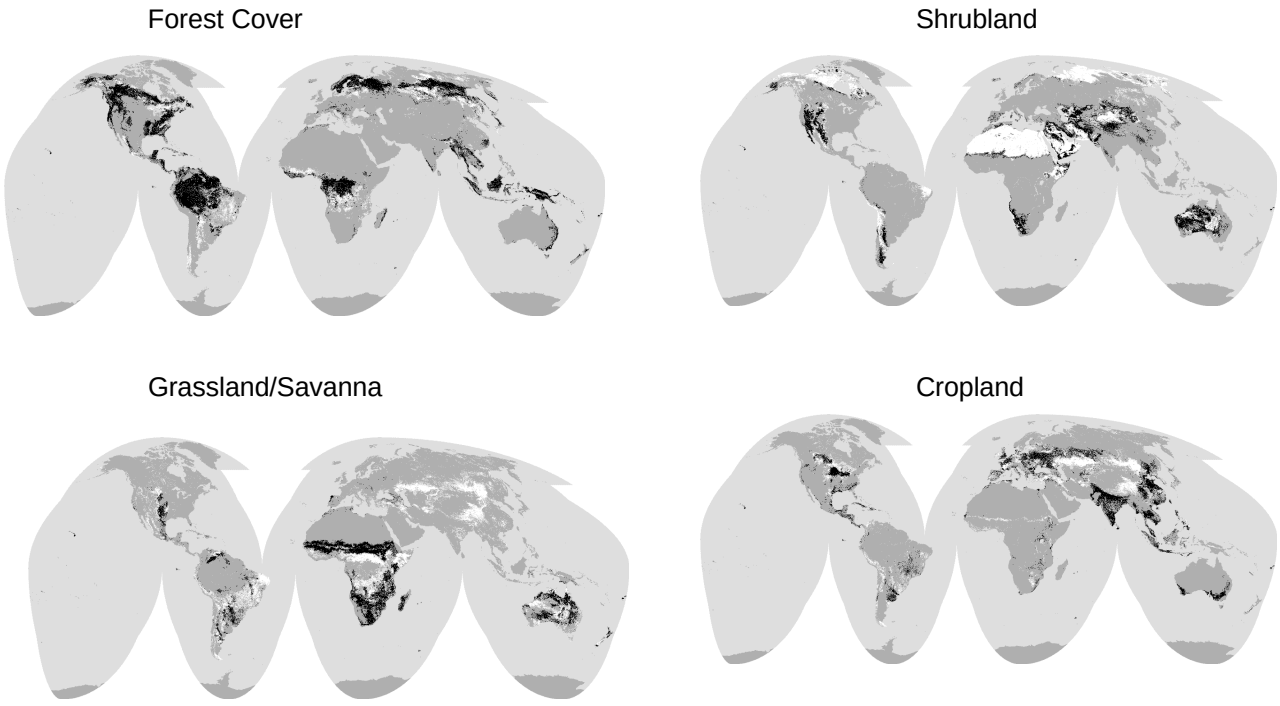
Recent Accomplishments

Center for Science Policy — The USGS has established the Center for Science Policy to investigate and create more effective ways for earth science to be used effectively in decision-making. Three complementary program components are (1) the INtegrated-science and Community-based values in Land Use DEcision making (INCLUDE), (2) the Risk and Environmental Analysis for Decision Information and Implementation (READII), and (3) the Geographic Analysis Team. The Center investigates how policy is set and how policy can be improved with better scientific information, takes the results of integrated scientific assessments and models and translates them into more accessible forms such as environmental-risk maps, and works with disciplinary experts from across the USGS and other organizations to integrate multidisciplinary science and models into geographic decision support systems.



The Loma Prieta earthquake caused extensive damage in the community of Watsonville, California. Working with the California State Geologist and Santa Cruz County and Watsonville officials, the USGS Center for Science Policy translated geologic hazard assessments into environmental-risk maps that help property owners evaluate their exposure and potential losses to future earthquakes.

Global Land Cover Characterization — The global land cover database developed for the International Geosphere-Biosphere Program (IGBP) is the first and only global land cover database to have a statistically based accuracy assessment. Using Landsat and SPOT satellite images as reference, expert international interpreters rigorously evaluated and determined the classification accuracy of the database to be 74 percent - an extremely high level of accuracy given the 1-kilometer resolution of the source imagery. The validation results provide scientists and users with unprecedented accuracy information and make this global land cover database an historic contribution to global mapping. Accurate global information enhances the value of activities such as global change research, weather forecasting, fire danger assessments, resource development planning, and establishment of air quality standards. (See the September 1999 issue of the *Journal of the American Society for Photogrammetry and Remote Sensing* for articles on global land cover data set validation.)



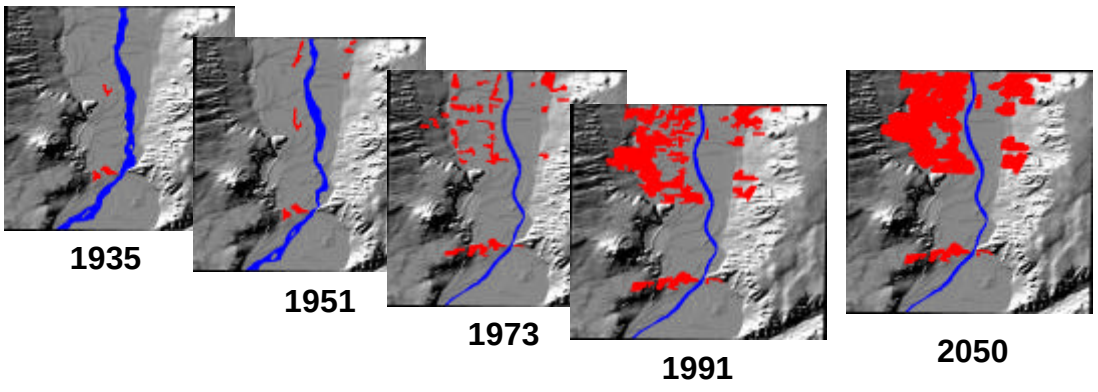
Global land cover has numerous uses in scientific research and modeling. These data are crucial to understanding the interaction of the land surface with the atmosphere and oceans. They are being used in environmental and carbon cycle modeling, wildfire assessment and management, weather and storm forecasting, snow cover and water supply mapping, drought assessments, crop production forecasting, infectious disease assessment, and aviation weather/volcano ash cloud tracking.

Flood Inundation Analysis Tool — The USGS is combining digital map data, discharge hydrographic data from rainfall-runoff models, and model-generated flood elevations to determine the extent of the flood elevations during 100-year rainfall events. The extent of floods is usually the result of downstream flow constriction, such as a culvert or bridge. Through analysis, scientists successfully calculated water levels upstream from downstream constrictions in a step-by-step process to compute water surface profiles along Cape La Croix Creek in Missouri.

USGS Collaboration to Connect High Speed Internet2 Networks-- Internet2 is a collaborative effort to develop advanced Internet technology and applications vital to research agencies and educational institutions. This collaboration includes more than 160 U.S. universities, private sector partners, and other government agencies interested in enabling applications such as digital libraries and virtual laboratories that are not possible with the technology underlying today's Internet. The outcome of the Internet2 effort is extremely important to the core mission of the Survey that requires the availability of its vast data holdings and results generated by USGS research. The importance of this activity will increase as more of our customers demand rapid interactive access to USGS products and services. Through research such as the High Speed Internet2 Networks, the USGS can guide and develop networking technologies to empower our customers and better support bureau activities.

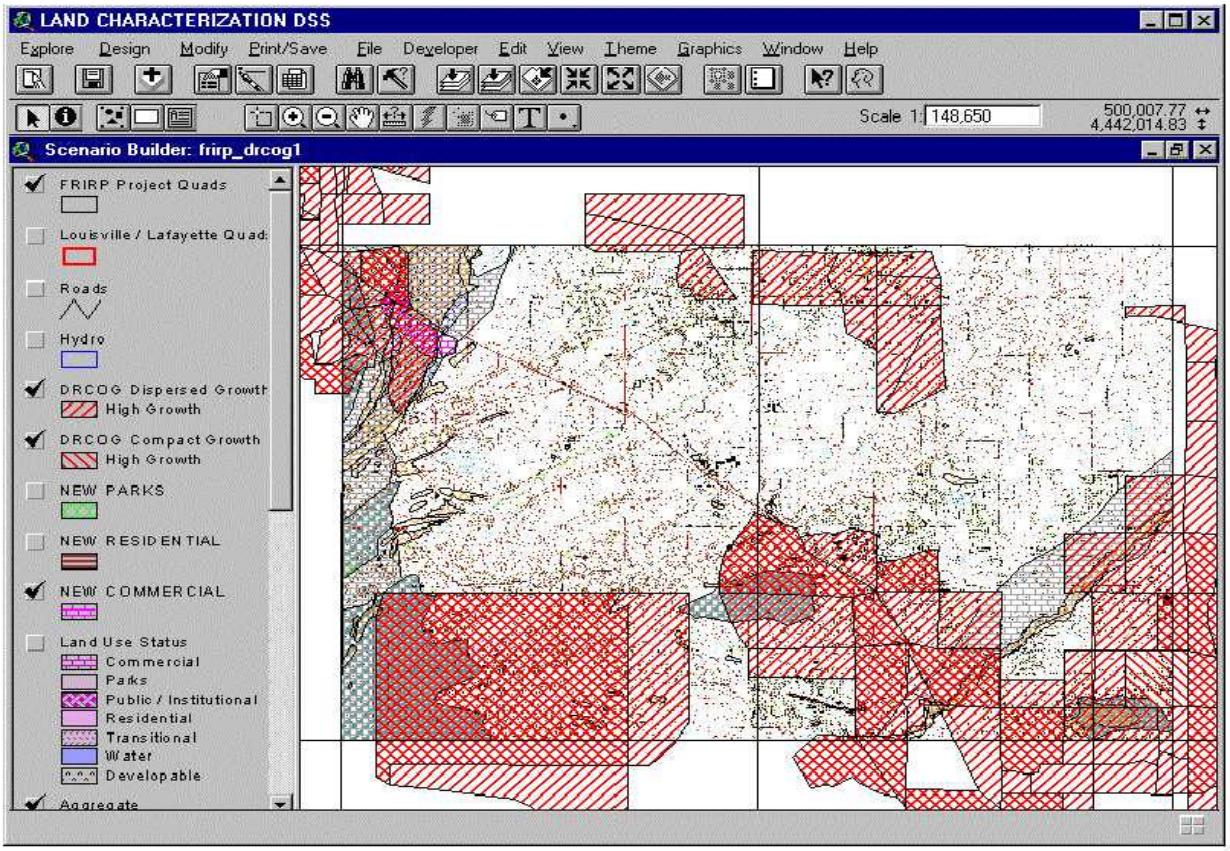
USGS Assisting the Center for Disease Control in Tracking West Nile Virus Outbreak in New York City — USGS scientists are assisting colleagues at the Division of Vector Borne Diseases, Center for Disease Control and Prevention, in responding to the outbreak of West Nile encephalitis in the New York City area. USGS scientists responded by incorporating epidemiological and epizootilogical data on the outbreak into a geographical information system for display and analysis. Graphical displays and animations show the pattern and spread of the outbreak. Additional analysis is being performed to detect clusters of infections and possibly the geographic origin of the outbreak.

Urban Growth Collaboration — An historical assessment of urban growth in the Central Valley of **California** was requested by the Great Valley Center, a non-profit corporation addressing economic, social, and environmental issues in the Valley. The study includes collaboration among the USGS, the California State University at Stanislaus, the Institute for Environmental Health, the California Department of Conservation, and the National Aeronautics and Space Administration Ames Research Center. In addition to new collaborations, a review of urban modeling activities was conducted at the Environmental Protection Agency and time-series images of urban growth were generated for the ten study areas for which retrospective databases were available.



Simulation models predict urban growth based on historical trends. In this example urban growth is modeled in the Middle Rio Grande River Basin from 1935-2050 (Darkest gray highlights urban and).

Decision Support System Prototype for Regional Planners — To aid the Denver Regional Council of Governments and the regional members of the National Stone Association, the USGS developed a prototype model for decision support useful in addressing land resource management issues. The interactive, computer-based system provides resource managers with a tool for land use planning in urban environments and was developed, in part, to support the USGS Front Range Infrastructure Resource Initiative. The decision support system uses a commercial product to create a decision environment for resource planners to integrate and analyze complex earth science information. Initial testing of the system received positive reviews from regional government and industry collaborators.



In studying resources important for the development of society's infrastructure, NMD researchers are working with commercial software products to build a decision support capability to help planners determine the consequences of different actions on the growth of a region. This interactive display allows the planner to incorporate land use, geologic, and other information (defined in the left hand scroll box) in building alternative development scenarios.

Alaska Geospatial Data User Community — On behalf of the Alaska Geographic Data Committee (AGDC) the USGS has been responsible for the development and management of an advanced web-based geospatial data clearinghouse that provides the Alaska resource management and science community with real-time access to digital maps and geographically

referenced resource information for the entire State. The AGDC is a broad-based, statewide organization comprised of nearly all Federal, State, local, and native government entities operating within the state, as well as universities, private industry and non-governmental organizations. The AGDC is committed to the joint development and sharing of spatial data and mapping products, the development of coordinated methods and standards, and communication and education within the Alaska community of the Federal Geographic Data Committee's standards and policies. USGS development of the AGDC Clearinghouse and its continuing research into improvements in web and data serving technologies has resulted in tremendous efficiencies for the Alaska user community in terms of sharing in the development of expensive, Statewide data bases and open access to the data holdings of the entire community.