Proceedings of the U.S. Geological Survey Fifth Biennial Geographic Information Science Workshop: March 1–5, 2004, Denver, Colorado

By Stephen J. Char and Jennifer B. Sieverling, Editors

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Contents

Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	0.004047	square kilometer (km^2)
square mile (mi^2)	2.590	square kilometer (km^2)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

°F=(1.8 × °C) +32

NOTE TO USGS USERS: Use of hectare (ha) as an alternative name for square hectometer (hm^2) is restricted to the measurement of small land or water areas. Use of liter (L) as a special name for cubic decimeter (dm^3) is restricted to the measurement of liquids and gases. No prefix other than milli should be used with liter.

Si to Inch/Pound

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
millimeter (mm)	0.03937	inch (in.
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
	Area	
hectare (ha)	2.471	acre
square kilometer (km^2)	247.1	acre
hectare (ha)	0.003861	square mile (mi^2)
square kilometer (km^2)	0.3861	square mile (mi^2)
	Volume	
cubic meter (m^3)	6.290	barrel (petroleum, 1 barrel = 42 gal)
Liter (L)	33.82	ounce, fluid (fl. oz)
Liter (L)	2.113	pint (pt)
Liter (L)	1.057	quart (qt)
Liter (L)	0.2642	gallon (gal)
cubic meter (m^3)	264.2	gallon (gal)
cubic decimeter (dm^3)	0.2642	gallon (gal)
cubic meter (m^3)	0.0002642	million gallons (Mgal)
cubic centimeter (cm^3)	0.06102	cubic inch (in^3)
cubic decimeter (dm^3)	61.02	cubic inch (in^3)
Liter (L)	61.02	cubic inch (in^3)
cubic decimeter (dm^3)	0.03531	cubic foot (ft^3)
cubic meter (m^3)	35.31	cubic foot (ft^3)
cubic meter (m^3)	1.308	cubic yard (yd^3)
cubic kilometer (km^3)	0.2399	cubic mile (mi^3)
cubic meter (m^3)	0.0008107	acre-foot (acre-ft)
cubic hectometer (hm^3)	810.7	acre-foot (acre-ft)
	Density	
kilogram per cubic meter (kg/m^3)	0.06242	pound per cubic foot (lb/ft^3)
gram per cubic centimeter (g/cm^3)	62.4220	pound per cubic foot (lb/ft^3)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:
$°F = (1.8 \times °C) + 32$

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Introduction

The U.S. Geological Survey (USGS) Fifth Biennial Geographic Information Science (GIS) Workshop (USGS–GIS 2004) was held March 1–5, 2004, at the Denver Federal Center in Denver, Colorado. In addition to topics featured in previous workshops—availability and use of national-scope data, GIS system administration, web-based GIS data dissemination, metadata generation, land and water characterization, and GIS-integrated Decision Support Systems—USGS–GIS 2004 featured new topics that include the application of GIS in health sciences, integration of new elevation-data products, nonproprietary GIS software and data formats, advanced cartographic concepts, advanced scientific visualization techniques, and fundamental GIS concepts. These topics were presented in USGS–GIS 2004 through user and vendor presentations, demonstrations, and hands-on technical workshops. Many USGS–GIS 2004 participants submitted abstracts of their presentations for publication in these proceedings.

The keynote speaker at USGS–GIS 2004 was Dr. Michael Goodchild of the University of California, Santa Barbara. Morning plenary sessions, conducted Monday through Thursday, focused on trends in GIS and Remote Sensing, scientific visualization, health, and Federal and USGS-specific GIS policy issues. A new activity introduced in USGS–GIS 2004 was a Tuesday evening "Town Hall" meeting that fostered informal discussion of GIS data and policy issues in the USGS.

Purpose and Scope

These proceedings document the information presented at USGS–GIS 2004. A description of the attendees, participating organizations, and a workshop schedule are included. Abstracts of the presentations are listed alphabetically by primary author. All acronyms used in the Proceedings are explained in the text of each abstract. Specifically, the acronym, "GIS," may refer to "Geographic Information Systems" or "Geographic Information Science."

Summary Description of Attendees

- Total number of attendees: 234
    - USGS employees and contractors: 175
    - USGS Biological Resources Discipline: 20
    - USGS Geographic Information Office: 7
    - USGS Geology Discipline: 39
    - USGS Geography Discipline: 39
    - USGS Water-Resources Discipline: 69

States Represented by USGS personnel at the 2004 GIS Workshop

Alaska
Arkansas
Arizona
California
Colorado
Connecticut
Florida
Georgia
Hawaii
Idaho
Iowa
Louisiana
Maryland
Massachusetts
Mississippi
Missouri
Montana
North Carolina
North Dakota
New Hampshire
Nevada
New York
Oklahoma
Oregon
South Dakota
Texas
Utah
Virginia
Washington
Wisconsin

Participating Organizations

Federal Agencies:

U.S. Geological Survey
U.S. Department of Agriculture Fish and Wildlife Service
National Oceanic and Atmospheric Administration
Coastal GIS Service Center
National Oceanic and Atmospheric Administration
National Geophysical Data Center
Centers for Disease Control and Prevention (CDC)
National Aeronautic and Space Administration

Consortia:

PlaceMatters.com
National Geographic Society

Universities:

Colorado School of Mines
University of California, Santa Barbara
University of Colorado, Boulder

Commercial vendors:

Community Viz
Environmental Systems Research Institute, Inc. (ESRI)
Golden Software, Inc.
Interactive Visualization Systems
Leica Geosystems
Maptek
Microsoft Corporation
Research Systems Inc. (RSI)
Rockware, Inc.
Sanz, Inc.
Trimble Navigation

Review Process

All abstracts in this report have undergone the review procedures mandated as part of the policy of the USGS. In addition to peer review, the abstracts published in this report have undergone editorial review and have been edited, as needed, to ensure consistent formatting and consistent use of acronyms, and to correct grammatical errors.

USGS-GIS 2004 Schedule

Monday, March 1											
Building 810 Auditorium											
8:00 AM - 9:30 AM	Orientation; Jennifer Sieverling, Workshop Coordinator Welcome; Tom Casadevall, Central Region Director ***Keynote; Michael Goodchild, Geographer, University of California at Santa Barbara***										
9:30 AM – 9:45 AM	Break										
9:45 AM - 11:45 AM	Plenary session: Homeland Security and the National Map Mark DeMulder (USGS) Plenary session: What is Going on with the "G" in the GIO Karen Siderelis (USGS) Dan Ashe (FWS), Hank Garie (USGS), Ivan DeLoatch (USGS),										
	Lunch (Hospitality fee) – lunch schedule below										
ROOM	Snowmass	Keystone	Copper	Breckenridge	Loveland	Columbine	John B. Weeks	Corner Annex	ORH Conference	Yucca Mountain Conference	Vendors
11:45 AM - 1:00 PM (LUNCH)				Demo: Microsoft SQL Server	Demo: Community Viz		Demo: Vulcan (Maptek)				
	Hands-on sessions				Lecture sessions						
1:00 PM– 2:55 PM	NHD Tools (ArcView 3) (Jeff Simley, USGS)	Introduction to ArcGIS (ESRI, Denver Staff)	ERDAS IMAGINE Fundamentals (Leica)	SDE (Database-independent) (Mike Jensen, ESRI) (1st offering)	In the News: GIS and Health (1st session)	LIDAR / IFSAR	ArcGIS Desktop Deployment	Cartography	ArcIMS Security, Deployment, and Applications	open	Demos, consultations, and product information
2:55 PM - 3:15 PM	Break										
3:15 PM - 5:10 PM	(continued)	(continued)	(continued)	(continued)	(continued)	(continued)	Data Distribution and Publication	(continued)	(continued)	open	Demos, consultations, and product information
5:30 PM – 7:30 PM	TOWN HALL MEETING at Holiday Inn, Lakewood										

Tuesday, March 2											
Building 810 Auditorium											
8:00 AM - 9:45 AM	Plenary session: GIS Trends Ken Snyder (Place Matters), Anne Hale Miglarese (NOAA Coastal GIS Service Center)										
9:45 AM - 10:00 AM	Break										
10:00 AM - 11:30 AM	Announcements: Carma San Juan, Workshop Planning Committee Plenary session: GIS Trends (cont.) Clint Brown (ESRI) 30 minutes Panel Discussion, Questions, & Answers										
(LUNCH)	**Poster Session** at 810 and 53, (Barb Ray, coordinator) Lunch (Hospitality fee)										
ROOM	Snowmass	Keystone	Copper	Breckenridge	Loveland	Columbine	John B Weeks	Corner Annex	ORH Conference	Yucca Mt Conference	Vendors
	Hands-on sessions				Lecture sessions						
1:00 PM - 2:55 PM	ArcPad (ESRI, Denver Staff) (1st offering)	Raster Display and Analysis in ArcGIS (Al Rea and Curtis Price, USGS and Steve Kopp, ESRI) (1st offering)	Image Analysis for ArcGIS (Leica)	SDE (Database-independent) (Mike Jensen, ESRI) (2nd offering)	GIS Trends: DSS	ArcGIS Data Models (Joe Breman, ESRI) (1st offering)	National Map	Land and Water Character-ization	GIS Fundamentals	open	Demos, consultations, and product information
3:15 PM	Break										
3:15 PM - 5:10 PM	Making Maps with ArcGIS (ArcPress, ArcReader) (ESRI, Denver Staff) (1st offering)	ESRI 3-D Tools (Steve Kopp, ESRI) (1st offering)	(continued)	(continued)	(continued)	(continued)	(continued)	(continued)	(continued)	open	Demos, consultations, and product information
Evening	Birds of a Feather meetings at Holiday Inn Lakewood (ArcGIS Deployment, Spatially-Enabling the Water Data Report)										

Wednesday, March 3											
Building 810 Auditorium											
8:00 AM - 9:45 AM	Plenary session: Trends in EGIS Robert Pierce (USGS, EGIS); Plenary session: Scientific Visualization & Modeling Geoffrey Dorn (CU)										
9:45 AM - 10:00 AM	Break										
10:00 AM - 11:30 AM	Plenary session: Scientific Visualization & Modeling (cont.) Keith Turner (Colorado School of Mines); John Kineman (NOAA-NGDC); 30 minutes Panel Discussion, Questions, & Answers										
	Lunch (not covered by hospitality fee) – lunch schedule below										
ROOM	Snowmass	Keystone	Copper	Breckenridge	Loveland	Columbine	John B Weeks	Corner Annex	ORH Conference	Yucca Mt Conference	Vendors
11:30 AM - 1:00 PM (LUNCH)		BOF: NAWQA All-Hands meeting	Demo: RockWare		Demo: Fledermaus (IVS)		Demo: NGS TOPO! (2 sessions)				
	Hands-on sessions				Lecture sessions						
1:00 PM - 2:55 PM	ArcScan (ESRI, Denver Staff)	Raster Display and Analysis in ArcGIS (Curtis Price, USGS; Steve Kopp, ESRI) (2nd offering)	Advanced Image Processing ERDAS (Leica)	3D Modeling EarthVision (Dynamic Graphics)	Scientific Visualization	ArcGIS Data Models (Joe Breman, ESRI) (2nd offering)	What's New in ArcGIS 9.0 (ESRI, Denver Staff) (1st offering)	Architecture and System Design (Dave Peters, ESRI)	Surface-Water Applications (1st session)	open	Demos, consultations, and product information
2:55 PM - 3:15 PM	Break										
3:15 PM - 5:10 PM	Using Metadata Tools (George Lienkaemper and Peter Schweitzer, USGS)	Surface Interpolation: Concepts, Methods, and Tools (Curtis Price, USGS; Kopp, Kevin Johnston, ESRI)	(continued)	(continued)	(continued)	(continued)	(continued)	Programming and Scripting	(continued)	open	Demos, consultations, and product information
Evening	Birds of a Feather meetings at Holiday Inn Lakewood										

Thursday, March 4											
Building 810 Auditorium											
8:00 AM - 9:45 AM	Plenary session: Future Trends Melissa Massaro (CDC); Dr. Jon Ranson (NASA); Poster awards (Barb Ray)										
9:45 AM – 10:00 AM	Break										
10:00 AM - 11:30AM	Plenary session: Trends in Remote Sensing (cont.) Nick VanDriel (USGS); Jeff Young (Leica Geosystems) 30 minutes Panel Discussion, Questions, & Answers										
	Lunch (not covered by hospitality fee) – lunch schedule below										
ROOM	Snowmass	Keystone	Copper	Breckenridge	Loveland	Columbine	John B Weeks	Corner Annex	ORH Conference	Yucca Mt Conference	Vendors
11:30 AM - 1:00 PM (LUNCH)	Demo: EarthWhere (SANZ)	Demo: Surfer (Golden Software)			BOF: USGS-Geography State Liaisons						
	Hands-on sessions				Lecture sessions						
1:00 PM - 2:55 PM	ArcHydro Data Model and Tools (Dean Djokic, ESRI)	Geostatistical Analyst (Kevin Johnston, ESRI)	GPS / Mobile Mapping (Rick Spengler, USGS)	ENVI (RSI) Introduction	In the News: GIS and Health (2nd session)	Programming / Scripting	What's New in ArcGIS 9.0 (ESRI, Denver Staff) (2nd offering)	GIS Policy Metadata	Project Applications	open	Demos, consultations, and product information
2:55 PM - 3:15 PM	Break										
3:15 PM - 5:10 PM	(continued)	Geoprocessing (ESRI, Denver Staff)	(continued)	ENVI (RSI) Hyperspectral Advanced	(continued)	(continued)	(continued)	GIS Interopera-bility and Standards (ESRI)	Surface Water Applications (2nd session): StreamStats	open	Demos, consultations, and product information
Evening	Birds of a Feather meetings at Holiday Inn Lakewood (ArcGIS 9 Geoprocessing)										

Friday, March 5											
ROOM	Snowmass	Keystone	Copper	Breckenridge	Loveland	Columbine	John B Weeks	Corner Annex	ORH Conference	Yucca Mt Conference	Vendors
	Hands-on sessions				Lecture Sessions						
8:00 AM - 9:55 AM	ArcHydro Data Model and Tools (Dean Djokic, ESRI)	What's New in ArcGIS 9.0 (ESRI, Denver Staff)	RockWorks (Jim Reed, RockWare)	Implementing ArcIMS (ESRI)	GPS / Mobile Mapping Applications	LIDAR / IFSAR	EarthWhere (SANZ)	National Datasets	NGS TOPO! (8:30-9:15)	open	Demos, consultations, and product information
9:55 AM – 10:15 AM	Break										
10:15 AM - 11:40AM	(continued)	(continued)	(continued)	(continued)	(continued)	open	Surfer (Golden Software)	(continued)	Open	open	Demos, consultations, and product information
	Lunch (not covered by hospitality fee) – lunch schedule below										
11:40 AM - 1:00 PM (LUNCH)								BOF: Colorado DRG Development			
1:00 PM - 3:00 PM	Making Maps with ArcGIS (ArcPress, ArcReader) (ESRI, Denver Staff) (2nd offering)	3-D Tools (Steve Kopp, ESRI) (2nd offering)	ArcPad (ESRI, Denver Staff) (2nd offering)	LIDAR / IFSAR	Miscellaneous GIS Lectures	open	GIS Fundamentals (USGS)	open	open	open	Demos, consultations, and product information
3:00 PM	Adjourn										

USGS–GIS 2004 Workshop Abstracts

Topographic Mapping Using GPS Receivers and GIS Software at the Osage–Skiatook Petroleum Environmental Research Sites in Oklahoma

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Survey-grade Global Positioning System (GPS) receivers were used at the two Osage-Skiatook petroleum environmental research sites to obtain data for detailed topographic mapping. A real-time kinematic GPS method was used because it is stable, fast, and accurate (±1 cm horizontal, ±2 sm vertical).

The GPS antenna was mounted on a modified 2-m measuring wheel because of the need for mobility and to maintain a constant instrument height above the ground. The GPS receiver recorded data points every 1.5 m along traverses of the sites. The traverses initially were spaced evenly across the sites. Traverses then were added where ground features, such as rapid slope changes, needed to be mapped. Approximately 8,600 data points were logged in 30 hours.

The GPS data points were incorporated in a digital elevation model (DEM) using the ARC/INFO® Geographic Information System software. The software uses an interpolation method specifically designed for the creation of DEMs for comparatively small areas that have well-defined elevation. The software assumes a surface-drainage system model on the area. The software uses an iterative finite difference interpolation technique that has been modified to allow the fitted DEM to follow abrupt changes in terrain. This model of an assumed drainage condition produces more accurate surfaces with less input data. The program acts conservatively in removing closed low areas and will not impose the model of an assumed drainage in locations that would contradict the input elevation data.

The GPS data points for the DEM were compared to known ground-level data across the sites for quality assurance and quality control. Thirty-one data points were within 0.5 m of control points. The mean elevation difference between the grid cells and the control points was 4.4 cm, and the 90th percentile confidence interval was 7.2 cm.

The DEMs were computed with a cell size of 0.2 m. The DEMs were used to produce topographic contour maps of the sites with a contour interval of 20 cm. These topographic maps will be used in contaminant-flow and sediment-erosion modeling at the research sites.

GIS Activities in the Central Energy Resources Team: A Model for Expanding GIS Utilization

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A primary objective for the implementation of Geographic Information System (GIS) technologies in the Central Energy Resources Team is to improve access to maps, data, and other geospatial services by U.S. Geological Survey (USGS) personnel and outside stakeholders. Because the utilization of GIS improves the ability of decision makers to analyze layers of disparate data in a common geographic space, our goal is to simplify the ability of our customers and USGS personnel to find and use geospatial data and services.

GIS utilization is enhancing research activities related to project workflow and information access and discovery. GIS technologies serve three major needs of Energy Team projects: (1) efficient, centralized data management and data visualization; (2) ease in sharing of data and interpretations by project personnel; and (3) dissemination of information and products to customers in an easily usable format.

Energy Team GIS activities, including Internet Map Services (IMS) and Metadata Services, also are being leveraged in global networks such as the National Spatial Data Infrastructure (NSDI), the Geography Network, and the GeoSpatial One-Stop that provide the infrastructure needed to support the sharing of geographic information. Technical issues related to application deployment, security, and system architecture are some of the major tasks. Live demonstrations of the National

Assessment of Oil and Gas (NOGA) Online, Gulf Coast Geology (GCG) Online, Gulf Coast Information Access System, and Gateway to Energy applications illustrate how interactive maps and publication services provide ready access to assessment results, Gulf Coast geology, and other Energy Team project data and interpretations.

Developing Decision Support Tools in the Chesapeake Bay Watershed

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The U.S. Geological Survey's (USGS) Chesapeake Bay Studies are using a multidisciplinary approach to provide scientific information to resource managers responsible for the restoration and protection of the Chesapeake Bay and its watershed. One main goal of the USGS Chesapeake Bay Studies is to enhance decision-support tools related to nutrient and sediment delivery to the bay.

In 2000, the Chesapeake Bay, the Nation's largest estuary, was listed as an impaired water body under the Clean Water Act. In an attempt to have the bay removed from the impaired waters list by 2010, the Chesapeake Bay Program (CBP), a multiagency partnership comprised of multiple Federal, State, and local agencies completed Chesapeake 2000, an agreement that focuses restoration efforts on improving water quality, living resources, and ecological habitats.

Accessible and reliable spatial information is critical for resource managers formulating and implementing effective restoration plans that include nutrient-reduction strategies in the bay watershed. The USGS supports these restoration efforts by providing useful tools and information used by resource managers to help develop and revise nutrient-reduction strategies and to evaluate the sources, contributions, and transport of nutrients entering the bay.

One tool available to resource managers is a collection of SPAtially Referenced Regressions On Watershed (SPARROW) attributes. Developed by the USGS, these models use a nonlinear statistical approach to relate nutrient sources and land-surface characteristics to nutrient loads of streams throughout the Chesapeake Bay watershed. Spatial data generated for the models can be used to identify the location of nutrient sources and factors that affect the transport of nutrients, and the models' nutrient estimations can be used to evaluate stream-nutrient load and source percentages contributed locally to each stream reach, as well as percentages of the load that reach Chesapeake Bay.

This information has been disseminated to resource managers and scientists through various media including reports, technical presentations, journal articles, and web sites. Spatial data related to the Chesapeake Bay Studies are currently being accumulated in web-based decision support tools. The USGS is developing an Internet Map Service (IMS) based on The National Map framework. Basic cartographic and geographic data layers will be presented as well as spatial data related to the effects of nutrient enrichment, nutrient and sediment sources, and transport to the bay. Future decision support tools include more application-oriented mapping of nutrient and sediment sources, loads, and trends, and their effects on vital habitat on the Chesapeake Bay and its watershed.

The USGS–NPS Vegetation Mapping Program

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The USGS–NPS Vegetation Mapping Program is a cooperative effort by the U.S. Geological Survey (USGS) and the National Park Service (NPS) to classify, describe, and map vegetation communities in more than 270 national park units across the United States. This landmark program is the first to provide national-scale descriptions of vegetation for a Federal agency and the first to create national vegetation standards for its data products. Its goal is to meet specific information needs identified by the NPS.

The vegetation mapping program is an important part of the NPS Inventory and Monitoring Program, a long-term effort to develop baseline data for all national park units that have a natural resource component. It is jointly managed by the USGS Center for Biological Informatics and the National Park Service's Inventory and Monitoring Program.

Project work is based on a set of standard data collection procedures for classification, mapping, accuracy assessment, and use of existing data. A report of project methods and results is provided at completion of individual projects. Project results include a rich set of data and information for each park project, as follows:

- Spatial data
- Aerial photography
- Map classification
- Map classification description and key
- Spatial database of vegetation communities
- Hardcopy maps of vegetation communities
- Metadata for spatial databases
- Complete accuracy assessment of spatial data
- Vegetation information
- Vegetation classification
- Dichotomous field key of vegetation classes
- Formal description for each vegetation class
- Ground photographs of vegetation classes
- Field data in database format

Products produced by the program are made available on the World Wide Web (http://biology.usgs.gov/npsveg). Examples of data products will be shared with specific emphasis on the Geographic Information System data products.

Mapping the Distribution of a Soil-Borne Human Pathogen: Coccidioides

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Coccidioidomycosis is a public health issue of increasing importance to people in the southwestern United States and in parts of Central and South America. It is caused by Coccidioides, a dimorphic soil-inhabiting fungus. The saprophytic phase of the fungus is characterized by branching segmented hyphae that form a network of mycelium in the upper horizons of soils. As the fungus matures, it produces arthroconidia that can be separated by soil disturbance (natural or anthropogenic) and consequently dispersed by the wind. If airborne arthroconidia are inhaled by an appropriate host, primary infection may occur, and the parasitic phase of the Coccidioides lifecycle is initiated.

Habitat modeling of the saprophytic phase of the Coccidioides life cycle is difficult due to the limited number of known growth sites. This confounds the determination of statistical relations among physical, chemical, and biological habitat parameters. Laboratory and site-specific field studies have determined many of these parameters. The modeling scheme, therefore, must use these parameters as input data and transform them into output that describes the favorableness of soil for hosting Coccidioides at all locations in the study area. The model should be able to deal with data of differing precision and accuracy and should reduce a potentially intractable number of model relations to a smaller modeling framework with reduced dimension. The modeling technique chosen to do this is a fuzzy system. Because this modeling technique will be applied to a large number of spatially distributed cells within a raster Geographic Information System, the approach is referred to as a spatial fuzzy system.

The spatial fuzzy system was applied to 30-m by 30-m cells in Organ Pipe Cactus National Monument, Arizona. The resulting product is a map depicting each cell's favorableness for hosting Coccidioides based on a scale of 0 to 1. The fuzzy system allows modelers to change and update relations between the variables as more is learned about Coccidioides habitat. It also allows dynamic representation of climate-related variables and can be used to predict changes in habitat with changing climate.

In addition, a model of the spread and survival of Coccidioides in soil through wind-borne arthroconidia transport has been completed using public domain, agent-based modeling software. The model results mimic what is seen in nature and indicate that complexity introduced in the model from site favorableness, temperature, moisture, and duration of favorable temperature and moisture conditions is adequate to explain observed distributions of real sites.

The Role of GIS in Addressing a Threat to Everglades' Native Habitat within A.R.M. Loxahatchee National Wildlife Refuge

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The Everglades ecosystem is under threat from invading species. More habitat is lost each year to exotic invasive plants than to human development. One species that is spreading at an alarming rate is Old World Climbing Fern (Lygodium microphyllum). This native of the Paleotropics (Africa to Australia, Asia, and Melanesia) was discovered as a naturalized population in 1965 in South Florida. Today L. microphyllum has destroyed vast expanses of habitat. In the northern region of the Everglades landscape, Arthur R. Marshall National Wildlife Refuge has been greatly affected by L. microphyllum. As of 2003, as much as 48,000 acres were infested at various intensities.

The rapidity of this exotic's invasion can be explained by its efficient reproductive strategies. Spores are released from vines high in the tree canopy and dispersed mainly by wind. L. microphyllum produces tremendous numbers of spores, as each fertile leaf has the potential to produce 20,000 spores. Because a single spore can grow to become a reproducing adult, the ramifications for the Everglades' native habitats are overwhelming.

Several Geographic Information System data layers are being used in the development of an optimal control model. One layer illustrates L. microphyllum spatial distribution and density in a grid cell framework based upon Systematic Reconnaissance Flights (SRF). In addition to estimating infestation density, data from SRFs is being used to develop a sampling strategy for a spore dispersal study. The dispersal study refines the dispersal kernel input into the model. Interpretation of IKONOS (satellite) data provides a finer scale estimate of L. microphyllum infestations. This data layer incorporates habitat information that is lacking in the SRF layer. Both SRF and IKONOS spatial layers are being used to estimate parameter values and to provide a benchmark to evaluate model results. In addition to the spatial layers, another data layer detailing the location of treatment activities, such as cutting, burning, and spraying with herbicides is included in the model.

The optimal control model integrates the GIS data layers with the spore dispersal kernel, treatment costs, and method effectiveness. The development of a user interface will provide managers with a valuable tool that will aid in the allocation of resources in addressing the threat of L. microphyllum to native habitat within the refuge.

From LIDAR Data to Flood Inundation Maps: Methods and Challenges

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An important application of light detection and ranging (LIDAR) data is to produce digital elevation models (DEMs) that can be used for predicting flood-inundation areas. The U.S. Geological Survey (USGS) is working with the North Carolina Flood Mapping Program (NC FMP) to produce flood-inundation maps from steady-flow hydraulic models and topography data. A library of inundation maps is being prepared for 18 USGS streamflow-gaging sites in the Tar River basin of coastal North Carolina. Each map represents a particular stage, ranging from bankfull to the maximum observed stage, and illustrates the water depth and lateral extent of inundation over the mapped reach.

Steps involved in producing the library of maps include (1) input of hydraulic model results into a geographic information system (GIS) as measured locations (linear events) along a stream-reach; (2) creation of a series of water-surface elevation layers representing each flood stage for each gage; (3) use of LIDAR bare-earth elevation data and a digital stream network to create 5-ft by 5-ft resolution DEMs for each reach; (4) generation of maps depicting depth and lateral extent of inundation for each reach at 6-inch incremental stages of the model; and (5) verifying model results by comparing the generated maps to existing digital flood-insurance rate maps, surveyed high-water marks from previous flood events, and stage-discharge ratings.

Methodology challenges included importing model results into a GIS environment, processing large and complex elevation data sets, and verifying model results. Additional tasks required for the project included vertical datum conversion, creating realistic water surfaces in areas of meandering streams, creating continuous flow paths under bridges, correcting errors in LIDAR elevation models (at roads and levees), and gathering enough historical flood-inundation data to verify results.

Effectively Managing and Utilizing Large Terrain Data Sets

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Advances in terrain data collection methods are making feasible the collection of highly accurate elevation data sets that cover large geographic areas. The new collection methods create terrain data with large file sizes that previous software tools are not optimized to manage or utilize. The large file sizes are driving the development of systems to store and access these large terrain data, as well as new methods for converting the raw data into a useful format that can be used in model generation. This session will focus on examples of Environmental Systems Research Institute’s ArcGIS-based tools developed to manage and utilize these data.

Surface-to-Surface Comparison of NED, SRTM, Digital Photogrammetry, and LIDAR-Derived Digital Elevation Models: Implications for Geological Mapping and Geographic Analysis

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There are numerous sources of digital elevation models (DEMs) that are available to scientists for mapping, modeling, and analysis. The accuracy of elevations encoded in DEMs reflect spatial variations, however, and an understanding of the sources and methodologies that created them is essential prior to incorporating DEMs into geological mapping or quantitative topographic analyses. Evaluation of several commonly used sources of elevation data through quantitative surface-to-surface comparisons illustrates the spatial variation of accuracies due to the collection methodology, geomorphologic, and topographic variations in the landscape. Many accuracy tests of DEM data compare a DEM surface to a set of high-resolution Global Positioning System (GPS) observations, such as the National Geodetic Survey’s High Accuracy Reference Network (HARN) sites. These point-to-surface accuracy tests fail to fully account for variations in elevation accuracy throughout the surface because HARN sites and GPS observations often are located in road right-of-ways and in areas of low slope with an unobstructed view of the sky.

Instead, this study compares the National Elevation Dataset (NED), the Shuttle Radar Topography Mission (SRTM), and a photogrammetrically derived DEM to two surfaces derived by Light Detection and Ranging (LIDAR) for a topographically diverse study area within the Shenandoah National Park, Virginia. First, all data are adjusted to a common horizontal and vertical datum. Surface-to-surface comparisons then are conducted using the “first return” LIDAR surface, which incorporates tree canopy, buildings, and other features into the mean elevation value, and the “last return” or “filtered” LIDAR surface, which represents the “bald earth” elevation values.

The results of the study will quantify elevation, slope, and surface-curvature differences among the tested data sets and explain the differences through a discussion of collection methodology, topographic position, and land cover variations. In addition, the scientific implications of the DEM surface accuracy are evaluated in the context of geological mapping, landform studies, and various models that incorporate DEMs.

Web GIS for Water-Use Data: Arkansas Water-Users Report and Browse Water-Use Information Online

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A new U.S. Geological Survey (USGS) web application provides an interactive Geographic Information System (GIS) interface that enables Arkansas water users to report and browse Arkansas water-withdrawal data. The Arkansas Water Science Center of the USGS developed the application to allow remote access to water-use data, reduce data-entry time for Science Center personnel, and increase quality assurance. The data entry and retrieval routines for the Arkansas Water-Use Database System use existing open-source software that provides interactive, web-based GIS capabilities. These capabilities include determining latitude and longitude, hydrologic unit code, township, range, section, and county code for a user defined point, such as a well. The open-source software powering the GIS on the web site is Mapserver (http://mapserver.gis.umn.edu/), which was originally developed by the University of Minnesota ForNet project in cooperation with the National Aeronautics and Space Administration (NASA) and the Minnesota Department of Natural Resources.

The current configuration allows web users three ways to select or create a withdrawal point: create a new withdrawal site on the web-based interactive map; enter a latitude and longitude to produce a new withdrawal site; select existing sites from the database. Once a withdrawal point has been selected or created, information about the withdrawal point is provided, and new data can be entered or modified.

Enhancements are planned that will enable users to determine land-surface altitude and assign aquifer codes to ground-water withdrawal sites. Land-surface altitudes and aquifer codes are determined from the USGS National Elevation Dataset and interpolated data from nearby borehole geophysical logs. These values are selected using Geographic Resource Analysis and Support System (GRASS, http://grass.itc.it/), a program developed by the U.S. Army Corps of Engineers. GRASS allows a query of as many as 14 raster layers per request. The selected values of land-surface and aquifer altitude may be compared to the well depth of the withdrawal point to determine the aquifer codes. Aquifer codes then can be assigned or verified by the user. Well information such as driller logs or geophysical-log information may be used to supplement existing aquifer-altitude data. The new information would be reviewed and, if verified, the surface of the aquifer could be modified accordingly.

Free, Open-Source Solutions in GIS Application Development

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As Geographic Information Science (GIS) matures into the realm of the latest internet technologies, its applications are fast becoming intertwined with enterprise information systems, networks of distributed computing and data dissemination, and the idea of total internet accessibility. Driving this growth, but more often struggling to catch up, is the new GIS software. No longer a single software package to be operated on a workstation by an expert user, the new GIS tools are breaking into smaller components, are becoming programmatically accessible, and can be combined with an arrangement of other interoperable technologies to produce a solution as unique as each application. Standards are driving this interoperability, and users are becoming more able to benefit from work already completed for similar applications.

A familiar application that is now benefiting from recent advances is the Internet map server that links to a spatially enabled database, leveraging GIS capabilities to a non-GIS user through a web browser anywhere in the world. The current, de facto solution involves three software tiers: a map server, a spatial data engine, and a relational database, such as ArcIMS, ArcSDE, and a Relational Data Base Management System such as ORACLE or Microsoft® Structured Query Language.

Because of open-source initiatives, standards, and programmatic interfaces, it is possible to use this application and others like it without buying proprietary software. And as these standards and tools mature together, unique, custom solutions will become easier to develop and deploy.

Digital Geologic Mapping at Yucca Mountain, Nevada

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Digital geologic mapping at a scale of 1:6,000 at Yucca Mountain, Nevada, was more efficient than traditional geologic mapping techniques. Equipment for digital mapping such as a Global Positioning System (GPS) receiver, a Personal Digital Assistant (PDA) loaded with ArcPad mapping software, Digital Orthophoto Quarter Quadrangle (DOQQ) base maps, and digital data-collection forms, all contributed to the improved efficiency.

Using a GPS receiver and the DOQQs led to a high confidence in location accuracy, saving time in the mapping process. The georeferenced DOQQs in this area have a resolution of 1 m, and by combining that amount of precision with a GPS-acquired location greatly improved overall position accuracy to about 3 m. This accuracy is beneficial in locating one's position on the DOQQ and in mapping continuous features while the PDA records the GPS locations along a traverse.

Collecting point data using the GPS improved efficiency of data collection and compilation. During field mapping, geologic observations were recorded onto the PDA by using customized digital data-collection forms created in ArcPad. These forms automated data collection and helped to ensure that all relevant data were collected. Data were more consistently and efficiently collected by using choices from list boxes or combo boxes on the form. Attribute data collected and stored digitally were easily exported into spreadsheets, whereas traditionally, attribute data recorded in field notebooks required time-consuming compilation efforts.

Digitizing line data has traditionally been a time-consuming step in the production of a geologic map. Because data collected with the PDA were recorded digitally in the field, post-mapping digitizing was not necessary; and to minimize any chance of data loss, data were routinely backed-up onto a flash card each day in the field.

Yucca Mountain is an ideal location for digital geologic mapping with a GPS because of the absence of tree cover to interfere with GPS reception and minor multipath error. Multipath error occurs when a satellite signal is interrupted on its path to the GPS receiver, resulting in false recording of position. Minor multipath error was encountered during mapping near cliff faces at Yucca Mountain, but such errors were recognized and locations were corrected using the DOQQs.

Drainage Area Determination Using ArcGIS8 and the Geodatabase

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The Colorado Water Science Center routinely derives basin boundaries to determine drainage areas for stream gages and other surface-water data-collection sites. During 2003, the South Platte River Basin National Water Quality Assessment (NAWQA) project required 83 new basin-area computations. Traditionally, the Science Center has drawn and compiled basin boundaries on paper topographic maps and has recorded basin-area computations as written entries in notebooks. The South Platte River NAWQA's need to quickly compute numerous basin areas led to the creation of a Geographic Information System (GIS) technique that has been approved by the Science Center for delineating basins. The effort began with creating a feature data set to hold digital basin-related information, configuring a geodatabase schema, and developing geodatabase topology rules. It also was necessary to assemble ancillary data sets, such as basin-line sources, elevation data, and digital raster graphics (DRGs). Another aspect of the work included developing procedures and protocols for ongoing basin creation, editing, and review.

In addition to the 83 new NAWQA basins, 40 check basins having known, traditionally derived areas also were delineated. GIS-derived basin areas for the check basins and known areas generated by traditional means had a median absolute difference of 0.38 percent. This accuracy level is consistent with the USGS Office of Surface Water guidelines for reporting drainage areas. Where substantial differences occurred, nearly all were found to be errors occurring in the traditionally derived basin areas.

Using GIS and Spatial Analysis to Guide in the Surveillance and Eradication of Animal Diseases

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U.S. Department of Agriculture's Veterinary Services utilizes geographic information system (GIS) technologies and spatial analysis for tracking animal diseases, predicting disease spread, and guiding surveillance efforts. Two recent animal disease events will be discussed: exotic Newcastle disease outbreak in southern California in 2002–2003, and the bovine spongiform encephalopathy (BSE) or "Mad Cow

Disease" diagnosis of a cow in south-central Washington State late last year.

During the 2002–2003 outbreak of exotic Newcastle disease virus, eight counties in the Los Angeles area were affected. The virus primarily infected backyard birds, pet birds, and commercial poultry facilities, and spread quickly due to the high pathogenicity of the infectious strain. Coordinate data and information on all premises with birds within the quarantine zone were collected by surveillance teams using Global Positioning System (GPS) receivers. The data were entered into the Veterinary Services' Emergency Management Response System (EMRS) database and presented using an Internet map server. All coordinate data were validated using a high-accuracy geocoding database, and spatial models were developed to identify areas of high disease risk. This method was used to create a targeted surveillance strategy that led to the eradication of exotic Newcastle disease in southern California.

The diagnosis of BSE in a cow in Mabton, Washington, prompted trace-back and trace-forward identification of cattle from the original birth herd in Alberta, Canada. An Internet map server was used by veterinarians and epidemiologists in Yakima, Washington, to target areas for quarantine and surveillance and to assign duties for field personnel. Preliminary maps were created for international trading partners showing the location of the index case, density of milk and beef cows throughout the United States, and location of rendering facilities. Additional analyses will be forthcoming.

More Than Just a Pretty Picture—Interactive 3D Visualization

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Recent years have seen remarkable advances in techniques and systems for mapping on land and in the oceans. Light Detection and Ranging (LIDAR) systems for topography and bathymetry, sonar technology, positioning capabilities, and computer processing power have revolutionized the way we image our environment. The new techniques and systems produce massive and diverse data sets that can challenge our ability to process and manage the data. The traditional two-dimensional (2D) approach to presentation and analysis of data is no longer adequate as it nearly always results in the reduction of the data. This limits the variety of information that can be presented and analyzed. The great density of these data, however, offers the opportunity to take advantage of automatic processing combined with interactive three-dimensional (3D) visualization techniques to improve the efficiency and accuracy of processing and reveal a greatly improved perspective of morphology and processes. The seabed presents a particular challenge because it is not visible for verification, and it is in this difficult environment where advantages can be gained from 3D visualization and analysis.

It is essential that 3D tools be designed to facilitate interpretation and analysis of large, complex, multicomponent spatial data sets. If properly georeferenced and processed, these complex data sets can be presented in a natural and intuitive manner that allows the integration of multiple components each at their inherent level of resolution and without compromising the quantitative nature of the data. Artificial sun illumination, shading, and 3D rendering can be used with digital topographic or bathymetric data to form natural looking and easily interpretable, yet quantitative landscapes. Colors representing elevation/depth values or other parameters (backscatter or sediment properties) can be draped over elevation data, or high-resolution imagery can be texture-mapped on a surface generated from elevation data.

The presentation includes an overview of a number of recent project examples where 3D visualization has been used as a key element to the analysis and representation of large and complex geospatial data sets.

Natural Hazards Support System

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The Natural Hazards Support System (NHSS) is being developed by the U.S. Geological Survey (USGS) Rocky Mountain Mapping Center (RMMC) to aid in monitoring and responding to all types of natural hazards. The primary goal of NHSS is to provide a comprehensive view containing all current natural hazard events combined with key geospatial information from The National Map. This web-enabled (http://nhss.cr.usgs.gov) combination of information can aid the federal and emergency response community in planning for response and recovery activities. NHSS currently contains dynamic data feeds from a wide variety of sources such as the National Earthquake Information Center (earthquakes), the National Oceanic and Atmospheric Administration (weather), and the National Interagency Fire Center (wild fires). This application provides an overview of all natural hazards events in a single area and direct access to the appropriate site for more detailed information on each event.

GIS Alligator Tagging Allocation System

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Historically (mid-1900s), the American alligator (Alligator Mississippiensis) was overharvested in Louisiana because of a lack of sufficient population controls and an unregulated harvest. As a result of rapidly declining populations, the Fur and Refuge Division of the Louisiana Department of Wildlife and Fisheries (LDWF) closed the alligator season in 1962 and initiated an aggressive research and enforcement program. As populations began to recover, LDWF developed a harvest program that would provide for a sustained yield harvest. Under this sustained yield alligator program, nearly 500,000 alligators have been harvested since 1972 with more than 1,800 alligator hunters participating annually in the statewide harvest. Since 1990, an average of 26,276 alligators has been harvested annually in Louisiana. In 1986, LDWF initiated the alligator egg collection program and from 1990 to 1996, an average of 238,900 alligator eggs has been collected annually.

The LDWF Alligator Management Program is one of the world's most recognizable examples of a wildlife conservation success story. Louisiana leads the world in production of classic skins (all crocodiles and alligators) with a wild harvest of approximately 35,000 skins in 1999 and a farm harvest of approximately 160,000 in 1999. These harvests result in a combined direct economic benefit of $20 million to the alligator trappers and farmers in the state. Because of the alligator's value, age to sexual maturity, and vulnerability to hunting, detailed regulations were established to provide for harvest of surplus alligators. The most critical component of these regulations was to develop a harvest scheme that equitably distributed the harvest in relation to population levels. Accountability of tag allocations was accomplished through a complex system of applications, licenses, and landowner permission and report forms.

Allocation of tags to an individual landowner is based on the quality and quantity of alligator habitats on the landowner's property. Quality of the habitat is determined by annual alligator nest surveys conducted throughout coastal Louisiana. Classification of habitats was first developed by O'Neil in 1949. Since the initial classification of Louisiana's vast wetlands in 1949, revisions to the map (1968, 1978, 1988, and 1997) have kept vegetation information updated. This classification then becomes the habitat base that LDWF uses to quantify alligator nest surveys, assess populations, and establish wild-alligator and egg-harvest quotas.

The main objective of this project is to create an automated alligator tag allotment system, using ArcView GIS technology, for calculating the number of alligator tags to issue, based on the LDWF's alligator habitat classification, nest survey, and population data.

Tampa Bay Interactive Mapping System and Digital Library: Providing Accessible Data and Information for Management and Research

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Providing easy access to data and information is an essential component of science and management. The Tampa Bay Digital Library and Interactive Mapping System (IMS) are two online resources for accessing Tampa Bay information. The Tampa Bay Digital Library is an Internet portal for data, documents, and other products. The library centralizes this information and is designed to be a "one-stop-shop" for data and information on Tampa Bay. In addition, the Tampa Bay portal is an Internet geographic data-viewing system that provides the capabilities of geographic information systems to a wide audience and is a much more dynamic tool than a static map display or paper map. The IMS allows users to view, query, and analyze geographic data, such as land use, seagrass distribution, and temperature. Users can navigate maps, overlay different layers, query databases, and print maps—all through an interactive mapping interface. The Tampa Bay Digital Library and IMS are a combined effort to provide scientists and managers with tools and resources to exchange data and ideas, as well as outreach tools for providing information to the public. Current plans are to populate the digital library with U.S. Geological Survey data and resources, find and create links to other Tampa Bay Internet resources, establish partnerships with local agencies and groups for distribution of their resources and products, and promote the digital library and IMS as tools for scientists, managers, and the public.

Visualization Techniques for Studying Landscape Pattern and Fish Distribution

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Spatially explicit data are needed to quantify habitat relations and evaluate status and trends in the abundance of coastal cutthroat trout (Oncorhynchus clarki clarki). From 1998 to 2003, streams in 48 mid-sized watersheds (500–1000 ha) throughout western Oregon were surveyed in a spatially continuous manner, resulting in the measurement of habitat characteristics and fish abundance for approximately 42,000 channel units (such as pools, riffles, and cascades) in 300 km of stream. A temporal component was added to the study by performing annual surveys in three watersheds. With high-resolution spatial data that cover a broad extent and vary through time, multiple Geographic Information System visualization and mapping techniques are needed for exploratory data analysis and pattern identification. We will discuss geospatial techniques—including dynamic segmentation, kernel density estimation, three-dimensional (3-D) animation, and 3-D scenes with extruded points—that were useful for viewing and analyzing relations between fish distribution and stream habitat at multiple spatial scales.

GIS and USDA's National Tick Survey

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Worldwide, there are approximately 838 tick species. Currently, there are 85 tick species established in the United States, with approximately 56 species belonging to the family Ixodidae (hard ticks) and 29 that belong to the family Argasidae (soft ticks). There are approximately 34 tick species in the United States that are injurious to livestock, equids, and poultry. A National Tick Survey was initiated by the U.S. Department of Agriculture to assess the current distributions of tick species in the United States, to access the potential for the introduction and establishment of new tick species or tick-borne diseases, to determine the environmental factors that might influence the survival and distribution of ticks in the United States, and to disseminate this information to the public using an interactive website, pamphlets, and CD-ROMs.

An increasing number of vector-borne disease studies have used Geographic Information System (GIS) and spatial analysis tools and methods for monitoring, surveillance, control, or risk mapping. The National Tick Survey also uses GIS as a tool to determine what ecological factors might influence the distribution of Dermacentor andersoni, the Rocky Mountain wood tick, and Amblyomma variegatum, the tropical bont tick. D. andersoni is an indigenous species in the United States and an important vector of anaplasmosis. A. variegatum, an important vector of heartwater in Africa, is currently established on several islands in the Caribbean, and has been imported into the continental United States on imported wildlife from Africa.

Initial spatial analyses of the distribution of D. andersoni included overlays of their distributions with annual average precipitation over a 30-year period and with national ecoregions. The Rocky Mountain wood tick appears to inhabit drier regions of the country with an average precipitation from 16.8 to 50.7 mm. Preliminary analyses of ecoregion overlays with each tick distribution indicated that D. andersoni may inhabit a dry domain that is semiarid and mountainous. In contrast, the spatial analysis of the tropical bont tick distribution indicates that this species inhabits regions in Africa that have an annual average temperature of 21 – 27ºC with vegetation types that range from savanna to deciduous broadleaf forest. If introduced into the United States, the tropical bont tick is most likely to inhabit areas with an annual average temperature of 18–22ºC with vegetation types of cropland/woodland mosaic, mixed forest, and deciduous broadleaf forest. Statistical analyses of the data will be performed for each tick species to more accurately define tick habitat characteristics.

Using the National Hydrography Dataset for Water-Quality Modeling of Nutrients in New England Streams

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The New England SPAtially Referenced Regressions On Watershed Attributes (SPARROW) model is an application of the 1:100,000-scale National Hydrography Dataset (NHD). New England SPARROW is a spatially detailed regression model that relates observed phosphorus and nitrogen concentrations in streams to pollution sources and watershed characteristics. These statistical relations then are used to predict nutrient concentrations and loads in unmonitored streams, represented in the NHD as reaches. NHD stream reaches are segmented sections of a river system, typically arranged as confluence-to-confluence features. Watershed catchments, representing the local contributing area for each NHD reach, were delineated by use of the National Elevation Dataset (NED) and the National Watershed Boundary Dataset (WBD). Catchment characteristics from various sources were computed for each NHD reach by using ARC/INFO GRID software. The NHD navigation functionality was used to help derive estimates of streamflow and velocity for each NHD reach. Other useful information, such as total upstream population (U.S. Census), and total developed, forested, and agricultural land area, also was determined by using the catchment characteristics, the NHD navigation tool, and a customized software program written in the Avenue scripting language.

NC OneMap: Developing Partnerships to Build The National Map and OpenGIS Interoperability

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NC OneMap, a vision for geospatial data coordination and distribution for North Carolina, emerged from the convergence of two complementary initiatives. A county, State, and Federal collaborative effort featuring a Web Map Service (WMS)-compliant ArcIMS viewer began as an outgrowth of a Mecklenburg County project under The National Map and 133 Cities urban area effort. Meanwhile, the North Carolina statewide coordinating council was undertaking phase one of planning and policy decisions for a new program intended to organize geospatial data statewide. While presenting the work at the 2003 North Carolina Conference for Geographic Information Systems, other city and county government representatives showed interest for active involvement.

Over the course of several months, the Mecklenburg viewer evolved into the NC OneMap Regional Demonstration Viewer. Currently, four levels of government voluntarily contribute GIS data to the viewer. Participants include the U.S. Geological Survey, four state agencies, eight county governments (including one in South Carolina), and three municipal organizations. Most often, these participants are serving data from their local servers, which are being displayed in the viewer.

Developing this viewer, or portal, is not the only goal of this effort. The purpose of the project is to collaborate in the testing of technology for integration of geospatial data common to both The National Map and NC OneMap. Other objectives include exposing technology, fostering collaboration within the state, providing input into the formal implementation of NC OneMap, and helping identify benefits, obstacles, strengths, and weakness in the collaboration process.

This presentation details the successes, hurdles, and future plans for components common to The National Map and NC OneMap efforts: Partnerships, Policy, Standards, and Technology.

Accessing and Using USGS and Other Base Spatial Data Within ESRI GIS Software

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Confused about the many sources from which to access U.S. Geological Survey (USGS) and other base spatial data for use in Geographic Information Systems (GIS) projects using ESRI software? Join Geographer Joseph Kerski as we explore how to download, format, and examine national, regional, and local sources for USGS imagery, grids, and vector data, including the Geography Network, The National Atlas, The National Map, State data portals, Terraserver, Geode, the Global Land Cover Facility, the USGS Seamless Data Server, the National Hydrography Dataset portal, regional, local, and other data sites. We will explore the scale and format of digital raster graphics, digital orthophotoquads, digital elevation models, land-cover data, Landsat imagery, the National Elevation Dataset, the National Hydrography Dataset, Census transportation, hydrography, and demographic data, Natural Resources Conservation Service soils data, earthquake data, climate data, and many other datasets in this useful workshop. Many of these guidelines are online at <http://rockyweb.cr.usgs.gov/public/outreach/gisguidelines.html>

Remote Sensing of Invasive Species: Leafy Spurge and Cheatgrass

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Remote sensing data have been applied to detected landscape disturbance caused by invasive species. Using spectral differences between the invasive species leafy spurge and surrounding native vegetation, various remote-sensing technologies have been applied to map infestations of leafy spurge in Theodore Roosevelt National Park, North Dakota. Hyperspectral sensors and broadband multispectral sensors collected data over the infested areas from 1999 to 2002. The overall accuracies of all sensors in detecting leafy spurge were near 65 percent. Data from hyperspectral sensors were found to be more accurate but costly to purchase and required specialized expertise to process. Multispectral sensors were found to overestimate the coverage of leafy spurge. By using temporal differences in spring greenup, cheatgrass infestations were detected in Canyonlands National Park, Utah. Normalized Difference Vegetation Index (NDVI) data calculated from spring and summer Landsat Thematic Mapper/Enhanced Thematic Mapper Plus (TM/ETM+) data were used to detect areas infested by cheatgrass. Cheatgrass infestations were easily identified in wet years. Additional research is being conducted to explore the relations between soil texture and geochemistry and vulnerability to cheatgrass invasion.

Post-Fire Characterization of the Land Surface and Vegetation Using Imaging Spectroscopy Data for Cerro Grande, New Mexico, and Left Hand Creek, Wyoming

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Historically, fire has been among the dominant disturbances in the Rocky Mountain Region of the United States. Recent occurrences of large wildfires, due in part to the increased abundance of fuels resulting from the past century of wildfire suppression, necessitate that resource managers acquire information on the post-fire state of the land surface to plan erosion-hazard mitigation strategies and to guide revegetation efforts. This paper reports on the spectroscopic analysis of remotely sensed data collected post-wildfire. Two areas were studied: (1) the May 2000 Cerro Grande fire in Los Alamos, New Mexico, and (2) the Left Hand Creek Bureau of Land Management area in Central Wyoming, which has been subject to wild fires in 2000 and 2001. Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) data collected on September 4, 2000, over the Cerro Grande fire were atmospherically corrected and converted to reflectance by using a single ground calibration site. The spectral signatures in these data were examined in relation to known spectral responses of vegetation, mineral, and post-fire ash materials. The results in this study area indicate that the presence of ash-covered surfaces and bare soil/bedrock surfaces can be identified and mapped. Variations in vegetation absorption features arising from chlorophyll and lignin/cellulose indicate that vegetation within fire perimeters can potentially be discriminated into unburned vegetation, fire-killed nonphotosynthetic needles/leaves, and regenerated vegetation. Hymap™ imaging spectrometer data over the Left Hand Creek study site were collected on July 2, 2002. In conjunction with the remote-sensing data collection, field measurements of vegetation reflectance and surveys of plant species composition were made for 33 sites within the study area. Measurements of vegetation cover and species composition were made in order to assess the effect of fire on vegetation regeneration in this sagebrush ecosystem. Ongoing efforts in both study areas seek to utilize the post-fire characterization of the land surface in conjunction with in situ studies of erosion and vegetation regrowth to develop predictive models of landscape recovery from wildland and prescribed fires.

IFSAR and LIDAR Elevation Data: Getting Started

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Knowledge of the fundamentals of Interferometric Synthetic Aperture Radar (IFSAR) and Light Detection and Ranging (LIDAR) elevation data and intensity/magnitude imagery are important to many scientific programs in the U.S. Geological Survey. Although many researchers have heard of these higher resolution Digital Elevation Model products, a lesser number understand the data characteristics, and even fewer have actual experience using these data. Basic theory and comparisons, potential uses and drawbacks, and some current applications of IFSAR and LIDAR will be presented in this talk under the following topics:

- Introduction to Interferometric Synthetic Aperture RADAR (IFSAR) elevation and imagery
- Introduction to topographic Light Detection and Ranging (LIDAR) elevation and imagery
- Accuracy testing and surface comparisons
- Loading IFSAR/LIDAR data into ArcInfo, ArcGIS, and ERDAS Imagine
- Applications - feature extraction from LIDAR, data fusion processes

LIDAR Toolkit Development: The Advanced LIDAR Exploitation System Consortium

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The U.S. Geological Survey (USGS) has been invited to join the Advanced LIDAR Exploitation System (ALES) Consortium, which primarily consists of Department of Defense government agencies that are interested in collection of, feature extraction from, and other uses of high resolution Light Detection and Ranging (LIDAR) terrain data. This consortium is gathering investment funds from contributing members to apply to a vendor-contracted software development project that will build upon, and supersede, the existing but limited-capacity Rapid Terrain Visualization (RTV) LIDAR Toolkit. In addition to using existing software like the RTV tool, many users of LIDAR at the federal level have been independently developing feature extraction capabilities, but these efforts have been costly and often redundant. The main goal of the ALES Consortium is to consolidate functional software and data extraction requirements from all member agencies and build an ArcGIS extension tool based on these requirements. Currently, the USGS Rocky Mountain Mapping Center is a member of the ALES Consortium. The intent of this presentation is to spark additional interest from other USGS programs and disciplines in order to ensure a full voice for USGS on the consortium member panel.

The Watershed Boundary Dataset

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The Watershed Boundary Dataset (WBD) is a nationally consistent, topographically based set of hierarchical hydrologic unit boundaries coincidental to and computationally integrated with other National data sets such as the National Elevation Dataset (NED), National Hydrography Dataset (NHD), and the Elevation Derivatives for National Applications (EDNA). The WBD will replace the current 1:250,000-scale Hydrologic Unit (HU) data set (subbasins, 4th Level, 8-digit), offering higher resolution delineations based on the 1:24,000 U.S. Geological Survey (USGS) 7.5-minute Digital Raster Graphics (DRG). Responding to the need for a higher resolution and better referenced hydrologic unit delineations for the Nation, the WBD further subdivides the current subbasins into a nested 5th Level (Watersheds, 10-digit), and 6th Level (Subwatersheds, 12-digit). These divisions are based upon size criteria as outlined in the Federal Standards for Delineation of Hydrologic Unit Boundaries. The WBD carries vector as well as polygon attribution that integrate with multi-scale water-resource applications as well as other key seamless National data sets.

A multiagency committee was established to ensure communication and coordination efforts among States, Federal agencies, and private cooperators while creating the WBD. This multiagency coordination effort ensures that all organizations have access to a consistent and nationally accepted set of delineations. This reduces redundancy while encouraging interagency collaboration and the most efficient use of resources. The actual delineation methods vary from state to state, as do the agencies involved in the coordination and the development process. However, with the Federal standards in place, along with direct national involvement, interim reviews, support, and evaluation of methods from regional and national coordinators, the approaches adopted by individual states are transparent within the seamless structure. Direct involvement from the national and regional WBD coordinators has stimulated interest, as well as financial and managerial support throughout the Nation.

ArcCatalog Metadata Extensions

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Metadata development has been greatly improved with the implementation of the metadata tools in ArcGIS ArcCatalog. Users now may generate spatial metadata directly from data set properties and use a metadata editor to enter other metadata elements. Several extensions have been developed to streamline metadata entry, improve metadata quality, and manage metadata records. In a 1-hour hands-on workshop, extensions to the ArcCatalog metadata development tools will be introduced and used in practice. Using sample metadata records, attendees will make use of the Contacts Database sample extension to add contact information to metadata records from an Access database instead of keying in the information multiple times. Attendees also will use the National Park Service ArcCatalog Metadata Extension to perform several metadata management functions—metadata records will be imported into ArcCatalog in batch; a spelling checker will be used to correct spelling errors found in sample metadata records; the metadata parser will be run on a metadata record and errors will be examined; metadata will be exported to a variety of output file types that are compliant with Federal Geographic Data Committee Standards; and a metadata database will be created and searched. At the end of this workshop, users will know how to access, install, and use these extensions.

ArcIMS Website for District Projects and NWIS Sites

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An ArcIMS website (http://co.water.usgs.gov/Website/Projects) has been created for displaying U.S. Geological Survey Colorado Water Science Center Project information and NWIS (National Water Information System) data-collection sites in Colorado. Project areas are displayed as polygons and NWIS sites as points and are coded with different symbols based on whether they are active or inactive. NWIS sites are categorized by site type and data-collection type (for example, streamgages, spring-water-quality sites, continuous ground-water water-level monitoring sites, precipitation quantity sites, and so forth). Data-collection summaries can be viewed for each site, and links are provided to project description web pages and to NWISWeb data-download web pages. An automated method that uses TSQL (Trival Structured Query Language) and ArcObjects VBA (Visual Basic for Applications) has been developed to periodically refresh the NWIS data-collection site information. USGS scientists, cooperators, and the general public find the website useful for quickly determining where the U.S. Geological Survey has done work in Colorado.

Urban Geochemistry and Health: Approaches to Understand Potential Human Health Consequences of Metals and Other Substances in Local Environments

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Introduction. Urban brownfields represent the next generation of hazardous waste and more broadly, environmental challenges across America's urbanizing areas. Unfortunately, little is known about the potential chemical and physical hazards associated with past uses of urban land and the consequences for communities living on or near these lands. Moreover, information on the health and socioeconomic status of communities living near these sites is limited. State and local cleanup, redevelopment, and planning decisions require rational methods to evaluate related hazards and the potential risks to affected neighborhoods.

Methods. Using primary and secondary data, we will present a practical framework for evaluating urban environmental hazards drawing on our experiences in Baltimore, Maryland, Boston, Massachusetts, and Pueblo, Colorado. We will briefly present screening techniques used for Baltimore, where primary data were not available, and soil collection strategies used for Boston and Pueblo, where the intent was to establish an urban geochemical baseline for urban communities. Geographic Information Systems and statistical models were developed to spatially and statistically examine environmental geochemical conditions and potential associations with human health.

Results. The results of these analyses demonstrate that urban environmental conditions are not benign and require more intensive study of potential human exposures and consequent health effects over the short- and long-term. The implications are particularly timely in light of intensive urban redevelopment efforts that require knowledge of baseline environmental conditions when setting cleanup standards, identifying appropriate future land uses, and improving conditions in aging neighborhoods.

Digital Atlas of Lake Texoma

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Investigations are underway on Lake Texoma, a U.S. Army Corps of Engineers lake on the Oklahoma and Texas border, to develop decision-support tools and information to evaluate the transport attenuation of contaminates and stressors in a lake ecosystem. Access to spatial data sets that can be used in a Geographic Information System (GIS) is an important part of a decision support system. The U.S. Geological Survey, U.S. Environmental Protection Agency, and U.S. Army Corps of Engineers developed a Digital Atlas of Lake Texoma to aid in the decisionmaking process.

The Digital Atlas of Lake Texoma contains 29 digital map data sets covering Cooke and Grayson Counties in Texas, and Bryan, Carter, Johnston, Love, Marshall, Murray, and Pontotoc Counties in Oklahoma. The Digital Atlas of Lake Texoma includes ArcExplorer Version 2 software, which allows basic viewing of GIS data sets. The data sets on this compact disc include:

- 2000 census block boundaries with selected demographic data; county commissioner boundaries
- County boundaries
- Land-surface elevation contours, elevation points, and digital elevation models
- Watershed boundaries and hydrologic unit codes
- Latitude and longitude lines

- Geographic names
- Rivers and lakes
- Indexes of U.S. Geological Survey 1:24,000, 1:100,000, and 1:250,000-scale topographic quadrangles
- Roads and railroads
- Administrative boundaries and school districts
- Locations of U.S. Geological Survey streamgages
- Locations of weather stations
- Soil properties
- Land-survey information (separated by state)
- Surficial geology and geologic faults
- Land-use information

Public Health GIS Application: The Power of Place

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The National Center for Environmental Health/Agency for Toxic Substances and Disease Registry (NCEH/ATSDR) at the Centers for Disease Control and Prevention (CDC) houses a program using a state-of-the-art Geographic Information System (GIS). The program, known as the Geospatial Research, Analysis, and Services Program (GRASP), is a functional area under the direction of the chief medical officer. This multidisciplinary team includes more than 20 individuals, including medical geographers, cartographers, social scientists, data specialists, applications developers, toxicologists, nurses, and doctors. The team applies the concepts and practices of the field of medical geography, spatial analysis, and cartography to the area of public health. This presentation will showcase the work that is being done at NCEH/ATSDR and CDC with the help of GIS.

ATSDR staff first utilized GIS in the 1990s in conjunction with the agency's work at Superfund sites and other environmental hazard sites. GRASP originally was one section within ATSDR's Division of Health Assessment and Consultation, and staff provided assistance with environmental health investigations. GRASP has since evolved into a program area that exceeds the organizational boundaries of one agency. Tools and spatially enabled data have been applied to other activities within CDC and the Department of Health and Human Services. To facilitate the evolving needs of a growing customer base, GRASP has been organized into three interconnected functional subunits: Rapid Response and Emergency Preparedness Support (RREPS); GIS Systems and Applications Consultation and Integration (GSACI); and Applied Geospatial Support, Research, and Training (AGSRT).

RREPS assists the CDC Director's Emergency Operations Center with investigations involving emergency events. RREPS also is the main contact for providing GIS support, locally or in the field, within NCEH/ATSDR's areas of terrorism preparedness and emergency response. GSACI's role includes developing and providing customized applications, web services, and managing the geospatial data used in the program and other program areas within CDC. AGSRT is the primary source for the myriad of technical GIS products and services using socio-demographics, environmental research, health resources, and health outcome data. AGSRT also coordinates GIS training opportunities and sets the groundwork for in-house research and collaborative research with other activity areas.

Use of Satellite Imagery and GIS Modeling to Derive Agricultural Chemical Exposure Metrics for Use in Human-Health Studies

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Exposure to agricultural chemicals has been associated with diseases such as cancer, adverse reproductive outcomes, and neurological disorders. Epidemiologists have been hampered in their research by the lack of information on historical environmental exposure for rural populations in particular. Traditional methods used by epidemiologists to assess historical exposures include questionnaires and biological sampling. However, these approaches do not provide useful information about historical exposures to agricultural pesticides among the general population. Unless actively involved in farming, most rural residents do not know what agricultural chemicals were applied to crop fields near their home.

We are studying the use of Remote Sensing and Geographic Information Systems (RS/GIS) technology to develop historical environmental exposure metrics for use in understanding the relation between agricultural chemical exposure and health outcomes. Collaborators on this research include the National Cancer Institute, U.S. Geological Survey, and the Environmental Health Advanced Systems Laboratory at Colorado State University. Specifically, we are using satellite imagery to create historical crop maps that then are linked to historical crop-specific chemical-use data. GIS modeling can be used to integrate meteorological and other data to predict chemical concentrations in ground water or the extent of pesticide drift near residences. Rare diseases like cancer must cover large geographical regions and span many decades to determine statistically significant relations between environmental exposures and disease occurrence; therefore, cost-effective classification methods are essential to utilize remote-sensing imagery to characterize agricultural landscapes.

We will present a summary of our research, to date, using three case studies in eastern Nebraska, the Platte River Valley (Colorado and Nebraska), and Iowa. Our data show promising results as well as challenges that still exist to the effective use of RS/GIS technology for epidemiological studies.

Migration Path to ArcGIS Version 9

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Over the last 4 years, the U.S. Geological Survey (USGS) has successfully migrated its primary Geographic Information System (GIS) software base from a combination of ArcInfo and ArcView to ArcGIS version 8 from Environmental Systems Research Institute, Incorporated (ESRI). The migration effort was simplified by restructuring software licensing from a per license method to a Department of Interior (DOI)-wide enterprise license method.

In 2004, ESRI will release ArcGIS version 9, which will include the ArcGIS version 8 model, as well as incorporate spatial data serving, database, enhanced cartography, and many other new software extensions and functionality. Federal government licensing of the ESRI product line also will undergo migration during this period mandated by an Office Management and Budget (OMB) and General Services Administration (GSA) Information Technology (IT) procurement program called SmartBUY. For the USGS and DOI to migrate effectively to ArcGIS version 9, a thorough examination of licensing alternatives and costs under SmartBUY, as they relate to functionality, will be essential. This examination is currently being performed by the Enterprise GIS (EGIS) unit of the USGS Geographic Information Office (GIO), with input from GIS users at various field sites of USGS and other DOI Bureaus. This examination will result in advice and guidance for USGS and DOI Bureau field offices to ensure all GIS functionality needs are met at the most reasonable costs.

GIS and Childhood Lead Poisoning in Cleveland, Ohio

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The city of Cleveland, Department of Public Health, is developing a Geographic Information System (GIS) that will allow its health supervisors and city program manager responsible for administering the Childhood Lead Poisoning Prevention Program access to information on childhood lead poisoning cases in the city of Cleveland in a spatial context. Spatial analysis of health data on lead poisoning using GIS technology allowed the city's health officials to identify wards and neighborhoods most affected by lead poisoning, such as Glenville, Fairfax, St. Clair-Superior, and Tremont-West in the city of Cleveland. This will help the city health officials in focusing their resources, time, and efforts in addressing the factors that most contribute to the problems of lead poisoning.

Occurrence of childhood lead poisoning is directly related to location of low-income housing units. Conditions in low-income housing that could cause lead poisoning include housing code violations, nuisance complaints, drug activities, and poor housing and sanitation.

The Department of Public Health believes that the data on housing, environmental health, and socioeconomic conditions from a spatiotemporal perspective will help evaluate the effectiveness of the lead-abatement program. Through knowledge/data sharing with Cleveland Housing Network (CHN), neighborhood development corporations, and Federal agencies such as U.S. Department of Housing and Urban Development (HUD), U.S. Environmental Protection Agency (EPA), and U.S. Geological Survey (USGS), public health officials are using GIS technology to address a major human health issue.

The city of Cleveland has seen decreases in overall lead levels in housing units; however, children in most of the homes inspected and treated for lead continue to show higher than national average elevated blood lead levels (EBLL) (>25 µg/dL). This leads to the conclusion that there are "Hot Spots" within the city, areas where levels continue to be elevated in spite of the fact that these housing units had been tested year-after-year through the HUD Lead Grantee program. The two contributing factors responsible for EBLL in children could be household paint dust and soil. Because housing data have been spatially analyzed, further evaluation of soil sample data is warranted to understand the causes of EBLL in the "Hot Spots."

GIS has been a useful tool in understanding the spatial relationships between housing, health, and environmental, socioeconomic, and housing data for identifying the EBLL "Hot Spots." It has helped city officials evaluate the effectiveness of the Lead-Abatement Program for the city of Cleveland.

Linking Health Effects to NAWQA Data

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Background. Linking adverse health effects to potential environmental contaminants is an important step in understanding how environmental conditions impact human health.

Objective. To explore possible relations between nitrite/nitrate in the ground water and hospitalization rates for cardiovascular disease (CVD) in Georgia. .

Methods. Nitrite/nitrate concentrations and locations of various wells were extracted from the U.S. Geological Survey (USGS) National Water-Quality Assessment Program (NAWQA) Data Warehouse. Hospital discharge data were spatially referenced using patient zip codes. Environmental Systems Research Institute's (ESRI) Geostatistical Analyst extension was used to create a surface of estimated nitrite/nitrate concentrations in ground water for the Apalachicola-Chattahoochee-Flint (ACF) river basin in eastern Georgia, United States, from averaged multiyear station values. The surface then was displayed with a choropleth map of the CVD rates. The spatial relation between the two layers was explored using geospatial and statistical tools.

Results. In this presentation, we explore how a GIS can be used to link nitrite/nitrate concentrations in ground water in the ACF river basin to rates of cardiovascular disease in the same region. We discuss some issues arising from linking the health data and water-quality maps.

Conclusion. The NAWQA Data Warehouse provides useful data for exploratory analyses of potential relations between human disease and water-quality conditions. Future studies will explore combinations of other analytes and disease states, as well as temporal changes in the variables.

The GAP Analysis Program and NLCD

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The U.S. Geological Survey (USGS) Gap Analysis Program (GAP) has been a long-time collaborator of the Multi-Resolution Land Characteristics Consortium (MRLC). Originally, the coordination served GAP well by providing a cost-effective venue for the acquisition of satellite imagery critical to our biodiversity mapping. Today, we find that our programs, GAP and National Land Cover Dataset (NLCD), have evolved in a way that complements each other. Numerous GAP projects discovered that stratifying states or regions ecologically lends itself to more efficient mapping and image processing. The classification protocols developed for the NLCD 2001 effort provide GAP mappers with useful tools for conducting such a stratification consistently across the United States. In essence, this provides a first cut of broad vegetation categories that can be further classified into the finer, ecologically based units. This finer, more detailed classification can be used to do biodiversity assessments on vegetation patterns and to model habitat relations for vertebrate species, thus, completing our biological database. Newly initiated GAP projects are coordinating with the USGS Earth Resources

Observation Systems (EROS) Data Center to incorporate methodologies and to add these interim data layers to the NLCD dataset. Our program benefits from the coordination with other agencies, the expertise of the remote sensing staff at EROS, and the standardization of the outputs. Inevitably, we find ourselves in a better position to focus more on analysis and applications that can better inform land-management decisions.

The Role of GIS in Logistic Regression Modeling of Ground-Water Vulnerability

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ArcGIS Desktop and Arc Workstation were used to extract significant information from various geospatial data sets for input into a statistical model of ground-water vulnerability. The product of this effort was a probability map that identified areas of vulnerability to ground-water contamination. This information is of interest to a variety of water professionals because it allows for educated decisionmaking regarding the ground-water resources of the High Plains aquifer.

A Geographic Information System (GIS) was used to efficiently extract spatial data from 15 individual layers for each of 6,416 wells throughout the study area. The layers were vector and raster and included information about depth to water, saturated thickness, precipitation, percent irrigated/agricultural land, nitrogen/phosphorous/pesticide applications, soil characteristics, and water use. For categorical data and certain continuous data sets (precipitation, depth to water, saturated thickness, chemical applications, soil characteristics, water use, and lithology), the data were extracted directly from the layer at the location of each well using a series of identity overlays. For other data sets where information needed to be related to a well (percent irrigated land around a well, land-cover information, irrigation well density, and playa lakes), buffers of varying sizes were created around each well, and the information was inventoried for the buffer areas by using vector union techniques and raster map algebra techniques.

The extracted data were used as variable input for an iterative series of statistical calculations (using logistic regression) that determined which of the variables (layers) or combination of variables were significantly correlated with the observed water-quality conditions. The variables became part of an equation defining the probability of a dissolved constituent in the ground water to be above a specified limit. Once the probability equation was defined, the appropriate GIS layers were converted to raster data sets to utilize the map algebra capabilities of ArcGIS. The equation and its various coefficients for each layer were fed back to the GIS, and, using map algebra, the probability surface was calculated and then easily visualized using the GIS.

Comparison of Urban Structure Extraction Technologies with LIDAR and High-Resolution Imagery

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Urban structure delineation remains a high priority for emergency responders after the September 11, 2001, terrorist attack. However, this data theme remains one of the most problematic and costly to produce. Presently, Light Detection and Ranging (LIDAR) data, along with aerial high-resolution photography of urban areas, are being evaluated for feature extraction. This research explores different methods and available software that may be suitable for structure extraction with LIDAR, and high-resolution imagery. We compare structure-delineating automated feature extraction software.

Estimating Drainage Areas Using Thiessen Catchments for the National Hydrography Dataset

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The National Hydrography Dataset (NHD) does not currently contain information relating to the landscape through which the stream network flows. The effort described in this presentation is an initial step to develop catchment areas and other characteristics for each NHD network segment. A catchment is defined here as the area that contributes overland flow to a stream segment.

Thiessen catchments are defined based on distance to the nearest NHD stream and do not take terrain elevation information into consideration. Thus, they provide only an approximation of the true catchment area.

Because this technique is computationally efficient, we can use Thiessen catchments with regression equations to quickly compute rough estimates of mean annual streamflows for millions of NHD drainage network segments nationwide.

Data Preparation for the StreamStats Web Application

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StreamStats is a web-based application that allows users to interactively delineate basin boundaries, compute basin characteristics, and estimate a variety of streamflow statistics. This session will provide an overview of the StreamStats application and a brief introduction to Geographic Information System (GIS) data requirements and preparation. Specific topics covered will include Digital Elevation Model (DEM) preparation, loading data into ArcHydro, building the global database, and computing basin characteristics.

Indexing Stream Gages to the National Hydrography Dataset

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The National Hydrography Dataset (NHD) is a comprehensive set of digital, geospatial data that contains information about surface-water features such as lakes, ponds, streams, rivers, and springs. The NHD also contains information on flow relations between the features, which allows users to determine what is upstream or downstream from a point of interest on the NHD flow network. The National Water Information System (NWIS) is the repository for streamflow data collected by the U.S. Geological Survey (USGS) for approximately 20,000 currently active and historical stream gages. Currently, there is no direct linkage between the NHD and NWIS. A pilot project is underway to index the locations of the NWIS stream gages, which are expressed in latitude and longitude, to addresses on the NHD reaches, which are expressed with a reach code and measure. An automated snapping process, followed by a comprehensive review by local USGS Water Science Center personnel, will ensure that gages are indexed to the correct NHD reaches. An overview of the process and a discussion of the results will be presented.

Preparation and Management of Digital Raster Graphics for ArcMap and ArcIMS

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Digital Raster Graphics (DRGs) are scanned, georeferenced, digital images of U.S. Geological Survey topographic maps that can be used in Geographic Information System (GIS) software. Although DRGs are one of the most useful GIS data sets available and are available for the entire United States, they can be difficult to manage. This session will describe a process for efficiently managing large collections of DRGs by using techniques available under a standard ArcInfo license. Tasks required in the process will be explained, and programs to automate the tasks will be available. Tasks include:

- Clipping the map collars.
- Applying a spatial reference to DRGs.
- Building image catalogs.
- Using DRG image catalogs in ArcView 3.x, ArcMap 8.x, and ArcIMS.

This session will not cover managing DRGs with the Spatial Data Engine (SDE).

RockWorks/2004: Subsurface Data Management, Analysis, and Visualization

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RockWorks is an integrated collection of Windows-based geological programs for environmental, hydrological, mining, petroleum, and civil-engineering applications. Initially developed in 1983, RockWorks has undergone a 20-year evolution. The latest version, RockWorks/2004, includes new features for processing information based on subsurface data from boreholes. The input data include lithology, stratigraphy, geochemistry, geophysics, water levels, fractures, and geotechnical parameters. The output includes base maps, contour maps, strip logs, cross sections, fence diagrams, solid models, block models, and volumetric calculations. The three main design considerations for RockWare are value, ease-of-use, and adaptability.

Specific new features include:

- New ReportWorks program for easy page layout of RockWorks diagrams, bitmaps, legends, logos, and more.
- Easy time animation (solid model morphing) in RockPlot3D given a list of existing models, with Audio Video Interleave (AVI) movie export.
- Multipanel profiles of lithology, stratigraphy, geochemistry/geophysics, fracture, and aquifer data.
- Line contours on color-filled geochemistry/geophysics or fracture profile and section panels.
- Geology maps representing lithology or stratigraphy models where they intersect a designated surface.
- Automatic section/fence location maps.
- Contour disabling at clipping boundaries.
- Automatic strip log management for all Borehole Manager solids, fences, profiles, and sections.
- New fracture modeling: solids, profiles, sections, and fences.
- Ability to right-click on any map location to retrieve data records.
- Two-dimensional (2D) plan maps of lithology, stratigraphy, I-data, P-data, and fracture models.
- Clip logs to display a user-specified elevation range.
- Easier borehole ground-surface modeling for mapping, model filtering, and more.
- Automatic project dimensions settings for model and images.
- Fully scriptable program operation (RCL)—all program operations.
- Revamped Microsoft® Excel Spreadsheet format (XLS) file transfer in and out of RockWorks for much faster processing.
- Revamped bitmap handling in 2D and 3D images —much faster.
- Faster borehole handling prior to processing with additional user control over temporary file creation.

Three-Dimensional Geological Visualization: Eye-Candy or Indispensable Tool?

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Historically, three-dimensional geological diagrams have been used as a tool for conveying geological concepts to non-geologists. The assumption holds that geologists are able to examine two-dimensional diagrams and intuitively conceptualize three-dimensional relations within their brains. This is why geologists were recruited during World War II as submarine commanders. It has even been speculated that geologists actually have a fundamentally different brain structure than the more typical "linear thinkers." As a consequence, computer-generated, three-dimensional geological visualization has been perceived by some as a wasted endeavor that oversimplifies the geology and degrades the geologist. In some cases, there may be some truth to all of this. On the other hand, today's higher-paced work environments do not allow the geologist to spend the time that is necessary in order to convert two-dimensional data into three-dimensional conceptual models. Instead, the data must be rapidly converted into whatever format will allow the geologist to make an informed decision. The effort that is required to evaluate a complex, multivariate, subsurface dataset that changes over time (such as contaminant plume migration, reservoir depletion, and so on) has telescoped from years to days.

As an example, consider a contaminated site with 40 monitoring wells that have been sampled on a quarterly basis for 3 years. The downhole data include lithology, stratigraphy, multielement geochemistry, geophysics (gamma and resistivity), fractures, and water levels. The task is to compute the amount of contaminated material that is subject to remediation. The final report will include planimetric maps, strip logs, cross sections, fence diagrams, time-based three-dimensional animations, and volumetric reports for all data sets. In the past, this would represent a 1-year project. In this example, however, the report is due in 48 hours. Although useful, the two-dimensional diagrams (such as contour maps and cross sections) do not provide enough information to adequately depict, understand, and quantify the geology. The fact that the three-dimensional diagrams look pretty is just icing on the cake of geological understanding.

The National Atlas of the United States Map Maker: Delivering Maps by Using MapObjects and ArcIMS

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A reliable summary of national-scale geographic information is currently available on the World Wide Web through the Map Maker of the National Atlas of the United States®. By using the Map Maker, visitors can select any combination of more than 2,000 data layers to create a custom map. The Web site, http://nationalatlas.gov, delivers approximately 35,000 custom maps daily. Its mapping engine was developed in the Microsoft® Visual Basic development environment by using ESRI MapObjects 2.2 and ArcIMS 4.0 technology. MapObjects is a set of developers Object Linking and Embedding customized extension (OCX) controls that can be used in a variety of development environments to provide mapping functionality and Web communication in Microsoft® Windows applications. ArcIMS provides request/response control between the Windows application and the Web server. The National Atlas of the United States® mapping engine has undergone two major revisions since it was made available to the public in 1998. The first revision included moving much of the embedded JavaScript and Hypertext Markup Language (HTML) out of the mapping engine code; the second revision included replacing the MapObjects Image Map Server with an ArcIMS Image Map Server and upgrading the graphical user interface based on the results from usability studies. Along with tips and techniques for using MapObjects with ArcIMS, you will get a preview of what is new with The National Atlas of the United States of America®.

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Natural Science Web-based Applications

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Rocky Mountain Mapping Center has developed a wide range of web-based applications that support scientific studies and investigations. Each of these applications combines easy access to geospatial data, site-specific scientific information, and unique functionality to help address and answer scientific questions.

U.S. Environmental Protection Agency (EPA) Region VIII Oil Response applications, Dynamic Atlas, and U.S. Department of Housing and Urban Development Colonias Initiative are just a few of the specific applications that have been developed and deployed.

Spatial Analysis of Very Low Birth-Weight Risk

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This presentation illustrates the utility of combining Geographic Information Systems (GIS) with spatial statistics in health-risk analysis. We present results from a case-control study designed to estimate the risk of a very low birth-weight baby associated with exposure to ambient particulate matter that is 10 microns in diameter or smaller (PM10). The exposure estimates are obtained from an atmospheric transport model that is used to predict ambient PM10 concentrations at geographically known, but unmonitored residences. Spatial statistics and GIS are used to assess potential clusters of elevated risk and link exposure data to the health outcome. We demonstrate the power of GIS for visualization and mapping, examine the value of observing the elements of “space” and “exposure” on a map, combine it with the probabilistic framework afforded by spatial statistics, and show that both aspects can be important components of health-risk studies.

The Latest Developments in LIDAR Software

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This presentation discusses the latest developments in Light Detection and Ranging (LIDAR) data software. LIDAR is rapidly becoming the terrain-modeling solution of choice. In the past, users have had little to no ability to reliably perform quality assurance, manipulate data, and render the large data sets associated with a LIDAR project. MARS™ (Merrick Advanced Remote Sensing software) provides users with a fast, reliable tool suite to perform all of these functions. Unique MARS™ tools/processes will be demonstrated including classification, breakline generation, and on-the-fly contour interpolation. Specific topics will include binary data formats, calibration, classification, LIDAR Digital Elevation Model (DEM) ortho rectification requirements, LIDAR DEM breakline requirements for contours, storage, data export to Geographic Information Systems and Computer-Aided Drafting packages, and end-user quality control.

Overview of the LIDAR Acquisition and Processing in Support of the North Carolina Floodplain Mapping Program: Lessons Learned and Advancements in LIDAR Technology

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This presentation will begin with an overview of Light Detection and Ranging (LIDAR) acquisition and processing performed by EarthData International in support of Phase I and Phase II of the North Carolina Floodplain Mapping Program. To date, the work performed by EarthData for this program encompasses approximately 32,000 square miles and includes varied terrain from the coastal plains to the Smoky Mountains. The overview will be followed by discussion of the technological advancements in LIDAR sensors and processing that have occurred since the project was begun in 2001, intensity imagery, the use of elevation histograms for final quality assurance of the bare earth Digital Elevation Model, and semiautomated generation of three-dimensional hydro breaklines. The presentation will conclude with brief discussion and illustrations of ancillary uses and value-added products that can be produced from LIDAR data, including land-use classification data from the analysis of multiple-return LIDAR data, which can be used to calculate the “Manning’s N” values for hydrology and hydraulics modeling.

GeoPro: Technology to Enable Scientific Modeling

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Development of the ground-water flow model for the Death Valley Regional Ground-Water Flow System (DVRFS) required integration of numerous supporting hydrogeologic investigations. The results from recharge, discharge, hydraulic properties, water level, pumping, model boundaries, and geologic studies were integrated to develop the required conceptual and three-dimensional (3-D) framework models, and the flow model itself. To support the complex modeling process and the needs of the multidisciplinary DVRFS team, a hardware and software system called GeoPro (Geoscience Knowledge Integration Protocol) was developed.

A primary function of GeoPro is to manage the large volume of disparate data compiled for the 100,000-square-kilometer area of southern Nevada and California. The data are primarily from previous investigations and regional flow models developed for the Nevada Test Site and Yucca Mountain projects. GeoPro utilizes relational database technology (Microsoft® Structured Query Language ServerTM) to store and manage these tabular point data, ground-water flow model ASCII data, 3-D hydrogeologic framework data, 2-D and 2.5-D Geographic Information System (GIS) data, and text documents. Data management consists of versioning, tracking, and reporting data changes as multiple users access the centralized database.

GeoPro also supports the modeling process by automating the routine data transformations required to integrate project software. This automation also is crucial to streamlining pre- and post-processing of model data during model calibration.

Another function of GeoPro is to facilitate the dissemination and use of the model data and results through web-based documents by linking and allowing access to the underlying database and analysis tools. The intent is to convey to end users the complex flow model product in a manner that is simple, flexible, and relevant to their needs.

GeoPro is evolving from a prototype system to a production-level product. Currently, the DVRFS pre- and post-processing modeling tools are being reengineered to improve their versatility, ease-of-deployment, and integration with GeoPro and current GIS technology. For instance, a Microsoft® Access application used to analyze and develop model head observations from water-level data is being reengineered to use Microsoft® SQL Server™ and ArcMap.

At present, GeoPro improves the modeling process by (1) reducing data-discovery time, (2) automating routine data manipulations, and (3) integrating and sharing analysis and visualization tools. When fully developed, it is envisioned that GeoPro also will (1) provide consistency among reports, databases, models, and archives, and (2) provide a means to develop and share best work practices with future projects.

High Availability Web Services

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The High Availability Web Services (HAWS) is Rocky Mountain Mapping Center's (RMMC) primary user interface for the public to access all of the RMMC hosted websites/applications that have a 24/7 requirement. HAWS provides 24/7 operational capability with a combination of dynamic load balancing, redundant servers, automated monitoring, and 24/7 system administrative support.

Environmental Pollutants and Adverse Human Health Effects: Hazard Identification by Using Interregion Comparisons

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Background. Associations between adverse health effects and environmental exposures are difficult to study because exposures may be widespread, low-dose in nature, and common throughout the study population. Therefore, individual risk-factor epidemiology may not be the right tool. A better method is provided by a series of multidisciplinary studies, starting with a hazard identification study, such as an interregion comparison. This presentation shows how existing databases routinely collected by federal agencies can be used for the purpose of hazard identification.

Objective. Spring and durum wheat grown in the United States are produced primarily in Minnesota, Montana, North Dakota, and South Dakota. Chlorophenoxy herbicides are the predominant herbicides used on these crops. Because information on chlorophenoxy herbicide use per county is not available, wheat acreage per county was used as a surrogate exposure measure. Associations of cancer mortality and birth malformation rates with wheat acreage per county were investigated.

Method. Cancer mortality for 1980–1989 and birth malformations for 1995–1997, in rural agricultural counties of Minnesota, Montana, North Dakota, and South Dakota, were extracted from existing databases maintained by the National Center for Health Statistics. Agricultural information for the selected counties was obtained from the U.S. Department of Agriculture. Analyses were performed based on individual or grouped counties, depending on the levels of adverse health outcomes.

Results. With increasing wheat acreage per county, increased mortality rates were observed for the following cancer types: stomach, rectum, pancreas, larynx, cervix, ovary, prostate, thyroid, bone, brain, leukemia, eye, nasal cavity, and oral cavity. With respect to birth malformations, increased rates of circulatory/respiratory and musculoskeletal/integumental malformations were observed in counties with a large wheat acreage.

Conclusions. The results may be relevant because chlorophenoxy herbicides are among the most widely used herbicides in the United States. Subsequent studies based on different disciplines need to confirm the observed effects.

Disclaimer. This abstract does not necessarily reflect U.S. Environmental Protection Agency policy.

Mapping Land-Cover Change at the National Level

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Establishing a strategy for mapping land-cover change for large areas such as the United States inevitably must deal with issues such as applications requirements, methodological philosophies, mapping methods, and source data. Processes to provide an assessment of the characteristics of 1973–2000 conterminous United States land-cover change are being implemented; specifically, a strategy is being developed in which the national rates and causes of contemporary land-cover change are being built, ecoregion by ecoregion, using probability-based random sampling. A series of 10 square-kilometer samples of Landsat data from 1972, 1980, 1986, 1992, and 2000 are selected for each ecoregion. Each sample is interpreted manually to estimate the rates of land-cover change. The estimates of the rates of change are combined with field observations and corollary socioeconomic variables to document the complex geography of change in each ecoregion. This strategy provides statistical summaries of change per land cover category and also the generation of an expression of the spatial extent of change. This spatial information is particularly useful for assessing the environmental consequences of change.

A Brief Look At The National Hydrography Dataset

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The National Hydrography Dataset (NHD) began as a cooperative effort between the U.S. Geological Survey (USGS) and the U.S. Environmental Protection Agency (USEPA) to develop a complete, networked hydrography data set for the United States at 1:100,000-scale content. Having completed this milestone in 2001, and with more than 3 million USEPA water-quality events now linked to the NHD, efforts are now underway by the USGS to develop a 1:24,000-scale database for the entire United States, an effort currently focused on covering U.S. Forest Service lands in addition to several specific States. The NHD is designed to allow continuous navigation paths throughout the entire hydrologic network and to provide an addressing scheme to link attributes to hydrography. The NHD also provides an easy-to-use toolkit of hydrography-specific GIS functions and is designed for continuous maintenance by local data stewards. The NHD has become the standard for hydrography coverage for most Federal agencies and in more than 40 states. The data are easily accessible from the web and ready-to-use in the ArcView environment. The NHD is now being converted to a Geodatabase format for use in ArcGIS.

USS Arizona Drawings and Underwater GPS Surveys Linked by ArcIMS

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The USS Arizona, a National Historic Landmark (NHL)—the highest level of national historic significance—is among the most recognized and visited war memorials in the Nation. Currently more than 1.5 million people annually visit the USS Arizona Memorial, tomb of more than 900 United States sailors and the most visible warship lost in World War II. The National Park Service (NPS) needs baseline data for understanding the complex corrosion processes affecting Arizona's hull, both internally and externally, and modeling and predicting the nature and rate of structural changes. The primary project focus was to develop an attributed Geodatabase of the eight layers of the ship from as-built engineering drawings. These data layers were georeferenced with control points taken by an NPS team of researchers. The geodatabase layers, related photographs, and results from archeological fieldwork were displayed in a Web interface by using ArcIMS and a Microsoft® SQL Server™ database.

Bakerville, Colorado: A Recently Established Under-Canopy Site for Performance Testing of Handheld GPS Receivers

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Through a cooperative effort among the U.S. Geological Survey, the National Park Service, and U.S. Department of Agriculture Forest Service, a site was established to test performance of handheld Global Positioning System (GPS) receivers under partially obscured sky conditions. Similar conditions are commonly encountered in vegetation-mapping projects, forest-resource inventories, and fire-suppression events. Using conventional survey techniques, six control stations were constructed under a moderate to dense canopy of dominantly lodgepole pines on a north-facing slope near Interstate 70 at Bakerville, Colorado, approximately 50 miles west of Denver. Both commercial- and military-grade GPS receivers, as well as internal and external manufacturer-designed antenna configurations, commonly used for GPS data collection by the cooperating Federal agencies, have currently been tested at the new site. Where applicable, receiver systems with dual capabilities were tested in autonomous and real-time differential (National Differential GPS—NDGPS) modes. Testing was performed by mounting either GPS receivers or their external antennas on leveled bipods and downloading real-time data in National Marine Electronics Association communications protocol (NMEA 0183) to personal digital assistant (PDA) data-storage devices.

Preliminary under-canopy results indicated that all tested receivers and antenna configurations had mean horizontal position accuracies between 1 and 3 meters and twice-distance root-mean-square (2DRMS) values from 6 to 16 meters. Receivers with a mean accuracy of 1 meter and 2DRMS values of less than 10 meters included the Trimble ProXR, and GeoXT NDGPS pack systems, the 3-D Marketing Garmin V NDGPS pack system, and the Rockwell PLGR+96 using the internal quad-helix popup antenna. Several receivers were tested in autonomous mode and had significantly lower 2DRMS values with their internal antennas than with their external antennas.

Digital Field Mapping of Landslide Features near Golden, Colorado

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A digital field system, composed of a Global Positioning System (GPS) receiver with external antenna, ArcPad software (ESRI version 6.0.2), and handheld computer with outdoor display capabilities was used to map and inventory geologic, hydrologic, and vegetation features associated with landslide deposits near Golden, Colorado. Important elements of pre-field, field, and post-field phases of digital field mapping are identified.

The pre-field phase included collecting and preparing three types of georeferenced digital data: (1) a preliminary composite shapefile of landslide polygon features, digitized from previously published geologic quadrangle maps, (2) a detailed electronic data-entry form to describe landslide attributes, and (3) a collection of digital backdrops of Digital Orthophoto Quadrangles (DOQs), Digital Raster Graphics (DRGs), multispectral imagery, and grids of slope morphologic characteristics to aid with onsite identification of field relations. Because computing resources of handheld devices can be severely strained while displaying large raster files, geographic extents of these files were clipped to reduce the time needed to refresh the display in the field.

Onsite revision of the landslide shapefile and entry of data into the electronic attribute form were performed during the field phase. GPS positioning tools provided an effective means for navigating to known or suspected landslide deposits as well as to confirm or revise landslide boundaries. Accuracies were commonly within less than 10 meters using stand-alone GPS receivers or within less than 5 meters using real-time differential GPS receivers.

During the post-field phase, advanced editing tools in ArcGIS Desktop (such as “clipping”) were needed to enforce shared polygon-topology rules, particularly where younger landslide deposits occur as outgrowths of older unstable slopes and share common boundaries. Even after customization, the ArcPad software package does not accommodate these necessary editing functions in the field.

Although traditional and digital mapping methods require pre- and post-field phases, digital mapping methods appear far superior for several reasons. They include: (1) increased accuracy of spatial positions; (2) decreased time spent documenting field observations; (3) enhanced flexibility in identifying field relations through onsite interchanging of digital georeferenced backdrops of morphologic, hydrologic, and vegetation properties; and (4) reduced time and effort to accurately transform line work from the field into map products.

Batch Processing With the National Hydrography Dataset

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The Massachusetts-Rhode Island Water Science Center of the U.S. Geological Survey (USGS) recently developed a batch processing procedure that uses logistic regression with the National Hydrography Dataset (NHD) to determine the point on a drainage network where an intermittent stream in Massachusetts transitions to a perennial stream. The procedure was developed to accomplish two major steps: (1) step through all first-order streams, and (2) move up and down a selected first-order stream until a transition point is found (if not found, move down to the second-order stream, continuing down the stream network until the transition point is found). The NHD provides the logical environment for these programming steps.

Flow relations, coded in the NHD, allow for the use of navigation tools developed for the data set. Navigation of the NHD can be set up in batch mode for a number of diverse applications. The applicability of this tool is further enhanced when surrounding elevation data are modified to recognize the NHD as the drainage network (this procedure has been called “drainage enforcement” or “burning in streams”), because batch processing then can include a watershed-delineation step. This allows for batch calculation of typical watershed characteristics such as slope, land cover, or population.

Other uses of batch processing with NHD could include variations to the following examples:

- Summarize watershed characteristics for a selected set of sampling locations;

- Find and delineate all upstream watersheds that are 5 square miles in area and have 30–50 percent forest cover;

- Find all upstream reaches that have 30 percent agricultural cover within a 100-foot buffer zone; or
- Find and delineate all upstream watersheds that have a population density greater than 500 people per square mile.

These tools also could be used as a cost-effective method for selecting surface-water, ground-water, and water-quality locations on the basis of watersheds meeting predetermined characteristic criteria.

The Monitoring of Landscape Change with Temporal Land-Use and Land-Cover Information

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The demand for land-use and land-cover (LULC) data has increased recently, especially in rapidly growing metropolitan areas. Many Federal, State, regional, and local planning agencies require LULC information for various applications, including modeling urban growth, determining land suitability for future development, monitoring how land-use changes affect the environment, natural resources and wildlife habitats, understanding land-use patterns, and developing policies that could encourage or discourage certain land-use zoning. In response to these increasing demands, the U. S. Geological Survey (USGS) has initiated the National Landscape Change Research Program. The purpose of this program is to interpret, monitor, predict, and understand the driving forces and consequences of landscape change through the mapping of historical and contemporary LULC.

A critical part of the program's success will rely on the efficient acquisition and integration of temporal LULC information. Currently, the USGS is mapping temporal LULC at 1:24,000-scale for Douglas County, Colorado, using historical aerial photographs for the 1930s, 1950s, and 1970s, and digital orthoimages for the 1990s and 2000s time periods. USGS will use the temporal LULC for supporting the geographic research of the Colorado Comprehensive Urban Ecosystems Study (CUES). Specifically, the Colorado CUES Project will demonstrate the utility of The National Map to address landscape change and its impact on the environment and society along the Colorado Front Range. In addition to the Colorado CUES Project, LULC will or has been created for USGS watershed, aquifer, and urban growth studies in such areas as San Antonio, Texas; Albuquerque, New Mexico; and Denver, Colorado.

The general procedures involved in compiling the temporal LULC data include (1) obtaining historical aerial photographs, digital orthophoto quadrangles (DOQ), and ancillary data for the collection, interpretation, and classification of the land-surface activity; (2) scanning, georeferencing, and mosaicking historical aerial photographs using image processing software; (3) compiling the LULC data by 7.5-minute USGS quadrangles using USGS-developed software; (4) paneling the 7.5-minute quadrangles into one seamless data set; (5) checking positional accuracy, LULC classification, and quadrangle edges for each temporal period; and (6) performing accuracy assessments where possible. Currently, USGS is developing new procedures to achieve the highest efficiency in acquiring and integrating the necessary LULC data that likely will change the existing procedures in the near future.

USGS–NPS Vegetation Mapping Program

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The U.S. Geological Survey (USGS) is cooperating with the National Park Service (NPS) to produce detailed, computerized maps of the vegetation of approximately 250 National Park units across the United States. Through this undertaking —the USGS/NPS Vegetation Mapping Program http://biology.usgs.gov/npsveg—a variety of data and information on vegetation are being made available to Internet users through the National Biological Information Infrastructure (NBII) website, http://www.nbii.gov.

Integration of High-Resolution LIDAR Elevation Data into The National Map

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The National Map provides a seamless, continuously maintained, nationally consistent set of base geographic data in the public domain. The National Elevation Dataset (NED), a U.S. Geological Survey (USGS) seamless raster product, provides the elevation information for The National Map. The NED uses a multiresolution approach to equip users with the "best available" elevation data for a given area, based on the characteristics of current source data sets. National coverage of the NED at a spatial resolution of 1-arc-second (approximately 30 meters) is derived from USGS 7.5-minute quadrangle-based elevation models. Additionally, coverage of the NED at 1/3-arc-second resolution (approximately 10 meters) is approaching 40 percent of the conterminous United States. To meet the requirements of The National Map for best available elevation data, the USGS is now updating the NED by incorporating new high-resolution, high-accuracy elevation data from Light Detection and Ranging (LIDAR) from various sources. Where these new data support it, the NED is being produced at a resolution of 1/9-arc-second (approximately 3 meters), which is spatially nested within the lower resolution 1/3- and 1-arc-second NED layers. A key aspect of this activity is the USGS partnering with other Federal agencies (through the National Digital Elevation Program), as well as with State and local entities, to integrate their elevation data for presentation to a broader user community. Recent efforts have focused on integration of LIDAR collections in the Puget Sound area and North Carolina.

One of the difficulties with incorporating LIDAR data into The National Map is that formal processing techniques are still under development. Research being conducted at the USGS Earth Resources Observation Systems (EROS) Data Center involves incorporating high-resolution LIDAR data into the National Elevation Dataset by using varying techniques. This presentation will demonstrate how EROS is processing raw LIDAR data collected from a variety of sources and converting them into 1/9-arc-second resolution elevation models for incorporation into the NED.

Volume Visualization of LIDAR Data for The National Map

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In recent years, technological advances in computer hardware have provided highly improved, yet inexpensive memory chips, which have revolutionized computer graphics. As a result, visualization of three-dimensional (3D) data has become an effective way for scientists and managers to view data and answer questions related to topography. The two most popular methods of 3D visualization are to create surfaces using raster grids and triangulated irregular networks (TINs). Although these methods are excellent in representing continuous surfaces, they are fundamentally flawed in representing vertical vegetation information (such as trees) collected by multiple-return Light Detection and Ranging (LIDAR) sensors or representing discontinuous surfaces, such as some types of buildings and structures. Surface representations generate the surfaces of 3D objects only as viewed from a given direction, but they do not render the interior of 3D objects, such as vegetation and some types of structures.

A potential solution to this is the use of volumetric pixels, or voxels, as the atomic representation of information derived from LIDAR data. A voxel is the cubic unit of volume centered at an integral point. Representing a unit of volume, the voxel is the 3D counterpart of the 2D pixel, which represents a unit of area. Each voxel is associated with a numerical value, which represents some measurable properties or independent variables (such as color, opacity, density, material, intensity, return number, elevation, and so on). The advantages of using voxels rather than surfaces are that voxels are (1) insensitive to scene and object complexity, (2) independent of viewpoint, (3) representative of sampled and simulated datasets, (4) representative of interior information and amorphous phenomena such as clouds and smoke, and (5) supportive of various block operations. Disadvantages of voxels include (1) the need to store data in discrete form, (2) the loss of geometric information, and (3) the required memory and processing power. To date, voxels have not been used in the analysis and visualization of commercial LIDAR data.

The EROS Data Center currently is conducting research on voxels as the atomic representation of high-resolution multiple-return LIDAR data for visualizing forests and urban areas for The National Map. New software merges the high-resolution orthophotography and LIDAR data to provide photo-realistic 3D renderings of forests and urban areas, as well as proper visual representations of the interactions between the laser pulse and the target. This conversion from points to voxels, using new software, compresses extremely large data sets and facilitates interactive 3D views that will be available online.

Rapid Assessment of an Urban Hazard: Spectroscopy of the World Trade Center Dust

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On September 16th, 2001, 5 days following the collapse of the World Trade Center Towers, hyperspectral data were collected over ground zero with the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS). Our intent was to rapidly assess the asbestos hazards of the dust that blanketed a large portion of lower Manhattan. Within 2 days of the overflight, a two-person team had collected ground samples of the dust and airfall debris from 35 sites within a 1-km radius of the collapse site including samples from two indoor locations unaffected by rainfall and samples of insulation from two steel beams at ground zero. Spectral measurements of dust-free cement pavement on the top level of a parking garage in New Jersey, located 3 km west of ground zero, were used to calibrate the AVIRIS data prior to spectral mapping with the U.S. Geological Survey Tetracorder spectral identification algorithm. The dust and beam insulation samples were analyzed for a variety of mineralogical and chemical parameters using reflectance spectroscopy, scanning electron microscopy, X-ray diffraction analysis (XRD), and chemical leach tests.

AVIRIS mineral maps do not show widespread distribution of chrysotile or amphibole asbestos above the few percent detection limit of the instrument at the ground surface, but do show a few isolated pixels of potentially asbestiform minerals. AVIRIS images also were used to locate hot spots in the debris pile hidden from view by smoke, thus allowing firefighters to more effectively battle the fires. Delivery of this information to emergency managers within 2 weeks of the collapse demonstrated how rapidly these urban hazards could be assessed on a spatially comprehensive scale with imaging spectroscopy. Spectral and XRD analysis of the field samples took several weeks longer and revealed that trace levels of chrysotile were present in two-thirds of the dust samples but at concentrations lower than 1wt%, well below the sensitivity level of AVIRIS. The field data indicate that trace levels of chrysotile were distributed with the dust radially in westerly, northerly, and easterly directions, perhaps to distances greater than 0.75 km from ground zero. The lack of chrysotile at levels above the detection limits of both methods in all but one sample collected south of ground zero may indicate that chrysotile was not distributed uniformly during the collapse.

Applications Development Utilizing High Resolution National Hydrography Dataset and Elevation Products in North Carolina

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The U.S. Geological Survey (USGS) and the North Carolina Center for Geographic Information and Analysis (NC CGIA) have been working together to produce a high-resolution (1:24,000-scale) National Hydrography Dataset (NHD) statewide. The collaboration has included innovative partnership agreements between USGS Eastern Region Geography and NC CGIA, as well as NHD production by USGS Eastern Region Water Resources personnel. In addition, under the North Carolina Floodplain Mapping Program, Light Detection and Ranging (LIDAR)-derived elevation products will be generated statewide. Due to this investment in creating high-resolution NHD and elevation data, the need for the development of applications utilizing NHD became apparent.

A team has been formed in North Carolina to develop applications using the NHD. The team consists of members from USGS Geography and Water Resources Disciplines, NC CGIA, North Carolina Department of Environmental and Natural Resources, and the North Carolina Department of Transportation. The team's objective is to develop applications combining the NHD with existing State data sets, to demonstrate capabilities to various stakeholders. The initial application development focuses on utilizing the NHD tool set created for use in ArcView such as reach indexing, watershed tools, and navigate, to demonstrate capabilities of the data model. This initial application uses State of North Carolina data sets, including 305b use-support stream classifications, locations of bridges, National Pollutant Discharge Elimination System (NPDES) sites and ambient monitoring sites. USGS data sets include digital orthophotography, digital raster graphics, land cover, and stream-gage locations with near real-time stream-level information available through a web link. Current application developments include incorporating high-resolution elevation data.

Parcel-Attribute Analysis: Integrating Socioeconomic Data into Decision- and Planning-Support Systems

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The U.S. Geological Survey's Geographic Analysis and Monitoring program studies changes in the Nation's landscape, using an interdisciplinary approach with an emphasis on policy relevance. One of the major drivers of such change is transfer of ownership and development of land parcels across the country. Conservation biologists increasingly need to incorporate anthropogenic processes into models and tools that can be used for biodiversity conservation and recovery. A pilot project, conducted in Napa County, Calif., integrated socioeconomic data into Geographic Information System (GIS)-based land-use-planning algorithms being developed for a software application by the nongovernmental organization NatureServe.

Parcel data are a rich source of public information collected by county assessor offices across the nation for taxation purposes. For the Napa County study, these data provided input variables for socioeconomic models that document and forecast human behavior from a landscape perspective. Current market value, a necessary input for exploring development versus preservation decisions about individual land parcels, was projected for the parcels in the 506,000-acre study area, using hedonic valuation, an econometric-regression technique that estimates the relative contribution of each parcel's structural and locational attributes to the parcel's total market value. This GIS data layer provided the basis for tradeoff analyses that assessed different scenarios of biodiversity conservation for the pilot project's client, the Land Trust of Napa County.

TCEQSWAP–DSS—A Decision Support System for Source-Water Susceptibility Assessment in Texas

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The 1996 Amendments to the Safe Drinking Water Act require that each State prepare a source-water assessment for all public water systems (PWS) regulated by the State to determine whether a drinking-water source might be susceptible to natural or anthropogenic contamination.

In 1998, the U.S. Geological Survey, in partnership with the Texas Commission on Environmental Quality (TCEQ), began development of a scientifically defensible methodology for assessing susceptibility of Texas PWS to contamination. Subject-matter experts from both agencies worked to develop a definition of susceptibility for assessment purposes, to formulate evaluation criteria, and to determine indicators (attributes of spatial and nonspatial databases) to represent and assess susceptibility within a computer-model framework. A primary product of this ongoing project is the Texas Commission on Environmental Quality Source-Water Assessment and Protection Decision Support System (TCEQSWAP-DSS), a decision support system for source-water susceptibility assessment. During 2003, staff used the software, installed on 10 TCEQ computers, to assess susceptibility of more than 6,200 PWS, which represent more than 18,000 individual source assessments, to as many as 227 contaminants.

Considering the broad scope of the problem and the number of data sets, attributes, indicators, ratings, and decision rules, a component-based assessment methodology was developed. Assessment components and representative software components address (1) physical integrity of the PWS; (2) intrinsic characteristics; (3) potential nonpoint and point sources of contaminants; (4) area of primary influence activity; (5) contaminant occurrence; and (6) system susceptibility components. The software implements decision rules that operate on indicator values to produce indicator ratings that form the basis of component and summary susceptibility ratings. As many as 75 spatial or nonspatial databases are queried to determine approximately 195 assessment attribute or indicator values.

TCEQSWAP-DSS is Windows 2000+ compatible and consists of one executable (.exe) file and two supporting dynamic link library (.dll) files. Object-oriented software is written in Visual Basic and contains more than 120,000 lines of source code. The software is Component Object Model (COM)-compliant and implements several licensed commercial COM components. Environmental Systems Research Institute, Inc. (ESRI) MapControl and ArcObjects components are implemented for spatial query, analysis, and display. Microsoft® ActiveX® Data Objects Extensions (ADOX) technology is implemented to create, manage, and query Access format databases. Other commercial components are implemented to provide user interface, printing, and reporting objects. Current work involves user interface and assessment method enhancement, conversion of source code to Microsoft® .NET technology, and preparation for implementation of ESRI ArcEngine components.

National Land-Cover Database 2001

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The U.S. Geological Survey (USGS), as part of the Multi-Resolution Land Characteristics (MRLC) Consortium, is developing the second National Land Cover Database (NLCD) using Landsat-7 satellite data and improved methods. The MRLC Consortium, MRLC 1992, is a group of Federal agencies that joined in 1992 to purchase Landsat imagery for the Nation and to develop a land-cover data set. This effort produced the NLCD 1992, which has been in use since 1996 satisfying a variety of requirements for environmental, land management, and modeling applications. Beginning in 1999, the Consortium again pooled their resources to create a new Landsat-7 Image Database and a second national land-cover database, NLCD 2001. The USGS NLCD 2001 project is compiling land-cover data across all 50 States and Puerto Rico using Landsat-7 Enhanced Thematic Mapper Plus data. NLCD 2001 is a cooperative effort involving several Federal agencies: USGS, U.S. Environmental Protection Agency, U.S. Forest Service, and National Oceanographic and Atmospheric Administration. The key component of this land-cover mapping effort is a database approach, which provides flexibility in developing and applying suites of independent data layers. These independent standardized data themes will be used in both the land-cover classification and as stand-alone data components for other applications. NLCD 2001 methods have been carefully planned and developed to offer users flexibility in derivative products for a wide range of applications.

Mapping Vegetation Type and Structure for LANDFIRE

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The LANDFIRE project is a joint effort between U.S. Department of Agriculture Forest Service and Department of the Interior agencies to provide the spatial data and predictive models required for characterizing fuel conditions and fire regimes and for helping to evaluate fire hazard status. A significant component of the research involves development of detailed vegetation type and structure data layers that can be used in conjunction with other spatial data layers for input to various fire fuels and fire characterization models.

In this presentation, we describe an ongoing remote sensing project in which 30-m resolution data layers of natural vegetation type and structure variables are being generated as part of the LANDFIRE project. The project consists of the following components: (1) linkage with the U.S. Geological Survey National Land Cover Dataset Program's Landsat data acquisition and processing, (2) access to high quantity and quality of field reference data, (3) incorporation of mapped biophysical data layers and potential vegetation type, and (4) use of supervised classifiers that are flexible and that enable integration of a variety of spatial information with field data. Work to date has concentrated on prototype study areas in Utah and western Montana. Data sets have been produced for the Wasatch Range and Uinta Mountains of central Utah and include a 28-class vegetation data layer and percent canopy cover and vegetation height data layers for forest, shrub, and grassland communities.

National Overview Road Metrics—Euclidean Distance (NORM–ED): A National Environmental Indicator

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The Geographic Analysis and Monitoring (GAM) program has developed the first National Overview Road Metrics (NORM) indicator for the lower 48 States. This indicator is Euclidean Distance to the nearest road (NORM–ED). It shortly will be viewable and downloadable from The National Map web portal as a 30-meter resolution product registered to the National Land Cover Data (NLCD) and Elevation Derivatives for National Applications (EDNA) databases, in Albers equal-area projection. NORM metrics, like other environmental indicators, quantitatively express differing conditions across location and time. ED is the first member of the NORM family of metrics; we are developing the processing methods for ED's first sibling.

Roads affect their surroundings. A preliminary estimate suggests that 22 percent of the land area of the lower 48 States is affected ecologically by a nearby road. Effects include canopy interruption, sediment production, drainage alteration, noise, dust, road kill, exotic species introduction, and many more. Availability of a uniform national ED metric will help in refining estimates of areas subject to these effects.

Roads also play a central role in shaping spatial patterns of land use, and land-use change has occurred on more than

30 percent of presettlement grass- and shrub-lands, 30 percent of forestlands, and 50 percent of wetlands. We have not yet demonstrated the value of NORM statistics as leading indicators of changing ecological conditions, but this is a priority research area. The scarcity of multitemporal descriptors of roads, land use and cover, and other environmental conditions presents a significant challenge for investigations of their dynamics.

We illustrate lower-resolution (510 m and 990 m) statistical derivatives of NORM–ED. These discriminate urban, suburban, agricultural, interstate corridor, and backcountry areas. There are numerous opportunities to apply NORM–ED to USGS scientific investigations at scales ranging from sample plot to national.

National Hydrography Dataset

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The National Hydrography Dataset (NHD) is a consistent, seamless database of surface-water features. Features are assigned unique, permanent identifiers that can be applied to data exchange, referencing events, multiscale representations, and lineage tracking. The network features form a Nationally interconnected flow system for hydrologic analysis. This flow network, in combination with referencing capabilities tied to reaches, provides upstream and downstream connectivity to discover information tied to surface-water features. Initially built at a scale of 1:100,000 over the lower 48 States and Hawaii, the high-resolution data are now about 50 percent complete over the whole United States. These data will be released shortly in a new geodatabase format that will include several value-added characteristics in support of user applications.