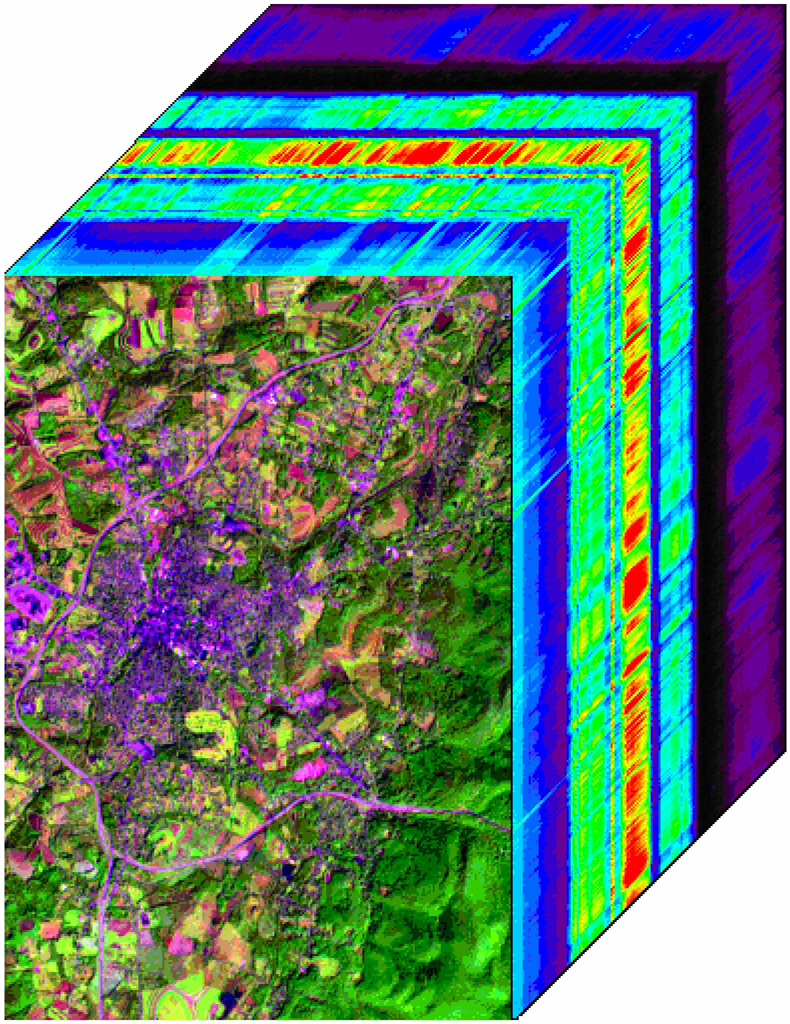
Appalachian Remote Sensing Conference

May 11th, 2005. West Virginia University, Morgantown, WV



SCHEDULE & ABSTRACTS

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Conference at a glance
Mountainlair

8:30	**Registration**	Outside Rhododendron Room
9:00	**Keynote address**	Rhododendron Room
9:50	**Break & Posters**	Mountaineer Room
10:10	**Paper Session 1**	Rhododendron Room
11:50	**Lunch**	Hatfields, Mountainlair
1:20	**Paper Session 2**	Rhododendron Room
3:10	**Break & Posters**	Mountaineer Room
3:30	**Paper Session 3**	Rhododendron Room
4:45	**Closing remarks**	Rhododendron Room
4:50	**Conference ends**	Rhododendron Room

Posters

Mountaineer Room (9:50-10:10 and 3:10-3:30)

Three-dimensional geovisualization techniques for the exploratory analysis of hyperspectral imagery.
Susan J. Bergeron, Department of Geology and Geography, West Virginia University, Morgantown, WV, and **L. Jesse Rouse**, National Geospatial Development Center, West Virginia University, Morgantown, WV.

Mapping of the eastern hemlock (*Tsuga canadensis*) resource in the state of West Virginia.
Stephen Schilling, Division of Forestry, West Virginia University, Morgantown, WV.

Landscape visualization through LiDAR for natural stream channel design.
Edward Watson, Canaan Valley Institute, Canaan Valley Institute, Thomas, WV, and **Janette Bennett**, Canaan Valley Institute, Thomas, WV.

WV statewide addressing and mapping board elevation conversion.
Kurt Donaldson, WV GIS Technical Center, West Virginia University, Morgantown, WV, **Evan Fedorko**, WV GIS Technical Center, West Virginia University, Morgantown, WV, and **Kevin Kuhn**, WV GIS Technical Center, West Virginia University, Morgantown, WV.

Schedule

8:30 Registration: Outside Rhododendron Room, Mountainlair

9:00 Welcome and Keynote Address: Rhododendron Room

Welcome and introduction of Keynote speaker.
Timothy A. Warner, Department of Geology and Geography, West Virginia University, Morgantown, WV, and Principle Investigator, West Virginia View.

Keynote address: *The United States Geological Survey: conducting geospatial science for a changing world.*
Barbara Ryan, Associate Director for Geography, United States Geological Survey National Center, Reston, VA.

9:50 Mountaineer Room, Mountainlair: Tea and Coffee Break & Posters

10:10 Paper Session 1: Rhododendron Room

West Virginia View: an update.
Timothy A. Warner, Department of Geology and Geography, West Virginia University, Morgantown, WV**, Rick E. Landenberger**, Department of Biology & Department of Geology and Geography, West Virginia University, Morgantown, WV, **and Xianfeng Chen,** Department of Geology and Geography, West Virginia University, Morgantown, WV.

Changes in forest condition following the 2003 ice storm in eastern Kentucky.
Christine E. McMichael, Institute for Regional Analysis and Public Policy, Morehead State University, Morehead, KY, and **Jeffrey F. Lewis**, Morehead Ranger District, Daniel Boone National Forest, Morehead, KY.

Mapping the risk of conversion: documenting the changes in the deciduous forest Cumberland Plateau Ecosystem using historical Landsat imagery.
David J. Campagna, Department of Geology and Geography, West Virginia University, Morgantown, WV.

Aerial census of Haleakala silverswords using high spatial resolution color-infrared imagery.
Rick E. Landenberger and **James B. McGraw**, Department of Biology, West Virginia University, Morgantown, WV**,** and **Timothy A.**

Warner and **Tomas Brandtberg**, Department of Geology and Geography, West Virginia University, Morgantown, WV.

Assessing the feasibility of using high spatial resolution hyperspectral data to locate and identify mammals.
Zachary J. Bortolot, Institute for Regional Analysis and Public Policy, Morehead State University, Morehead, KY, and **Philip E. Prater**, Department of Agricultural and Human Sciences, Morehead State University, Morehead, KY.

11:45 Lunch. Hatfields Restaurant (First floor of the Mountainlair). Southwest chicken and beef fajitas buffet & desert. (Included in conference registration).

Lunch keynote address:

The use of high-resolution, active airborne remote sensing technologies to support precision forestry.
Hans-Erik Anderson, Precision Forestry Cooperative, College of Forest Resources, University of Washington, Seattle, WA.

1:15 Paper session 2. Rhododendron Room, Mountainlair

Comparing lineaments derived from Landsat, digital orthophotos, and the NED to well production in Wyoming County, West Virginia.
David D. M. Light, Department of Geology and Geography, West Virginia University, Morgantown, WV.

Monitoring the growth of oil and gas infrastructure using satellite imagery.
John F. Amos, President, SkyTruth, Shepherdstown, WV.

Spatio-temporal analysis of land use change and sinkhole development in the Opequon Creek watershed, West Virginia: 1984-2004.
Lee Stocks, Department of Geography, Kent State University, Kent, OH.

A remote sensing and GIS investigation of urban growth patterns in the Lexington, Kentucky metropolitan region.
Marc Barraclough, Department of Geology and Geography, West Virginia University, Morgantown, WV.

Historical aerial photography as a tool in the identification and evaluation of cultural landscapes: an example from the New River Gorge National River.
Mike Walnoha, Department of Geology and Geography, West Virginia University, Morgantown, WV, **Amy Dawson**, Department of Geology and Geography, West Virginia University, Morgantown, WV, and **Andy Steel**, New River Gorge National River, National Park Service, Fayetteville, WV.

Mapping orchards and vineyards with high resolution panchromatic satellite imagery.
Timothy A. Warner, Department of Geology and Geography, West Virginia University, Morgantown, WV.

3:10 Mountaineer Room: Tea and Coffee Break & Posters

3:30 Paper Session 3: Rhododendron Room

Integrating visible, near infrared and short wave infrared hyperspectral and multispectral thermal imagery for geologic mapping using an expert system.
Xianfeng Chen, Department of Geology and Geography, West Virginia University, Morgantown, WV, **Timothy A. Warner**, Department of Geology and Geography, West Virginia University, Morgantown, WV, and **David J. Campagna**, Department of Geology and Geography, West Virginia University, Morgantown, WV.

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A fuzzy K-nearest neighbor classifier for landcover classification.
Michael Shank, TAGIS Unit, West Virginia Department of Environmental Protection, Charleston, WV.

High Performance Algorithms for LIDAR Data Processing and Visualization.
Mathew T. McMahon and **F. R. Bernal**, The Institute for Scientific Research, Fairmont, WV, and **S. L. Hamilton**, Galaxy Global Corp., Fairmont, WV.

The use of remotely sensed data in formal and informal education.
Hope Childers, Center for Educational Technologies, Wheeling Jesuit University, Wheeling, WV, and **Jodie Hoover**, Center for Educational Technologies, Wheeling Jesuit University, Wheeling, WV.

Building bridges: spatial crime data sharing between a university and police forces.
Thomas R. Mueller, Crime Mapping Center, Department of Earth Sciences California University of Pennsylvania, California, PA.

4:45 Closing Remarks: Rhododendron Room

Monitoring the growth of oil and gas infrastructure using satellite imagery

John F. Amos, President of SkyTruth, Shepherdstown, WV, John@SkyTruth.org

Moderate-resolution satellite images are being applied to monitor the infrastructure of rapidly-growing oil and gas fields in Rocky Mountain basins. Although the percentage of land surface directly disturbed by construction activity is often small (less than 20%), the "footprint" of a typical field is characterized by a dense network of access roads, utility corridors and drill pads that encompasses a large area. Indirect impacts -- including dust deposition, noise, air and water pollution, changes in predation, and the introduction of invasive species -- can affect this broader area. In western Wyoming, SkyTruth is using Landsat and ASTER satellite imagery to illustrate the spread of oil and gas infrastructure. Conservationists and wildlife biologists are correlating that information with data describing wildlife behavior, distribution and reproductive success. This approach is providing land management agencies with quantitative information that will allow them to better evaluate the wildlife impacts of drilling plans.

The use of high-resolution, active airborne remote sensing technologies to support precision forestry.

Hans-Erik Andersen, Precision Forestry Cooperative, University of Washington, Seattle, WA, hanserik@u.washington.edu, *Robert J. McGaughey*, USDA Forest Service Pacific Northwest Research Station, University of Washington, Seattle, WA, and *Stephen E. Reutebuch*, USDA Forest Service Pacific Northwest Research Station, University of Washington, Seattle, WA.

The development and application of advanced digital technologies has enabled the implementation of more precise, site-specific and efficient forest management systems. One of the primary requirements of a site-specific approach to forest management is accurate and detailed three-dimensional spatial data relating to the type and condition of forest stands and characteristics of the underlying terrain surface. A new generation of high-resolution, active remote sensing technologies, including airborne laser scanning (LIDAR) and interferometric synthetic aperture radar (IFSAR) have the capability to provide direct, three-dimensional measurements of forest canopy structure and topography. Airborne laser scanning is an optical remote sensing technology providing high-resolution, precise measurements representing the location of laser reflections from the vegetation and ground surface. LIDAR has been shown to provide highly accurate digital terrain models, even under dense forest canopy. In addition, metrics based upon the LIDAR height distribution are highly correlated with critical forest structure variables, such as dominant height, basal area, and volume. The intensity of near-infrared LIDAR reflections can also be used to classify by species type. IFSAR is a microwave remote sensing technology that is also capable of providing three-dimensional positions of backscattering elements within a forest scene. While IFSAR typically provides measurements of lower resolution and accuracy than LIDAR, it has an all-weather capability and is acquired at a much lower cost per unit area. In addition, the use of multiple-frequency radar systems allows for the collection of information on different scene components. For example, long-wavelength P-band energy penetrates through the canopy and reflects mainly from the terrain surface, while short-wavelength X-band energy reflects from the first reflective surface. Therefore, the difference between the X-band (canopy) surface measurements and the P-band (terrain) surface will yield vegetation height information. This height information, along with other radar observables such as interferometric coherence and backscatter magnitude, has been shown to be highly correlated to critical forest structure variables. In this talk, I will describe the basic principles of these active remote sensing technologies in the context of forest canopy inventory and terrain mapping, and present an example of their application within a Pacific Northwest conifer forest.

A remote sensing and GIS investigation of urban growth patterns in the Lexington, Kentucky metropolitan region.

Marc Barraclough, Department of Geography, West Virginia University, Morgantown, WV, mbarraclough@geo.wvu.edu

In 1958, Lexington, Kentucky became the first city in the nation to implement a growth management strategy that defined the spatial limits of development by restricting access to public services. Now referred to as urban growth boundaries and urban service areas, the use of these containment policies are expanding. This study examines urban growth patterns in the Lexington, Kentucky Metropolitan Region between 1974 and 2000 using remotely sensed satellite images and GIS analysis. Satellite images from 1974 (Landsat MSS) and 2000 (Landsat TM) were classified into urban/built-up, undeveloped, and water classes using ERDAS Imagine. The classified images were then subjected to a post-classification comparison to determine undeveloped to urban/built-up land conversion over the study period. The post-classification comparison image was then subjected to analysis in ArcGIS using County and Urban Growth Boundary polygons. Results of the study indicate that the region is growing internal to existing urban areas, much of the new development within Fayette County has been concentrated within the Urban Service Area, and that the rural character outside the boundary has largely been maintained.

Assessing urban heat islands in Morgantown, WV using Landsat thermal infrared imagery.

Gashawbeza Bekele, Department of Geology and Geography, West Virginia University, Morgantown, WV, gbekele@geo.wvu.edu

Agglomerations of population and economic activities in urban areas and the associated changes in the natural landscape have significant climatic and environmental implications across different spatial scales. There is a growing body of research at present in quantifying the effects of introduction of urban materials on surface energy balance. While there has been an increased interest in analyzing the discrepancy in surface temperature between urban and the surrounding rural areas mainly in metropolitan centers, urban heat island detection in small cities has captured very scant attention. The purpose of this study was, therefore, to examine urban heat islands at a micro scale by taking Morgantown, WV as a case study.

Analysis of surface temperature variations among different land cover types was conducted using a Landsat 5 TM image from 1992 and a Landsat 7 ETM image from 1999. In order to provide a better appreciation of the thermal characteristics of different land cover types, the spectral radiance was converted into surface temperature, which was then color-coded to generate a thermal pattern distribution map. A supervised classification was carried out to make the comparison in temperature differences among various land cover types possible. The thermal energy responses of different landforms in Morgantown indicated that there exists a variation in surface temperature among different surface forms. Examination of the thermal imageries indicated that the commercial and residential areas are places with higher surface temperature relative to vegetation and water, suggesting that modifying the natural environment has an impact in altering the local climate of an area.

Three-dimensional geovisualization techniques for the exploratory analysis of hyperspectral imagery.

Susan J. Bergeron, West Virginia University, Department of Geology and Geography, West Virginia University, Morgantown, WV, sue.bergeron@mail.wvu.edu, and L. Jesse Rouse, National Geospatial Development Center, West Virginia University, Morgantown, WV, jesse.rouse@mail.wvu.edu

This poster will explore the use of geovisualization techniques, such as 2.5D and 3D display of data layers, as a tool for exploratory analysis of hyperspectral remotely-sensed data. The role of such visualization techniques in traditional remote sensing software has been to display results obtained from standard classification and analysis. However, geovisualization can be used as a tool in preliminary data analysis. For example, by generating 2.5D displays of individual hyperspectral bands, using the DN value as the elevation, and exploring visualizations of various band combinations, it may be possible to identify areas which exhibit absorption features at fairly specific wavelengths, a technique used in the identification of minerals. As a case study, this poster uses data from a single AVIRIS image taken of a portion of the Cuprite Mining District in Nevada, and available for free download from NASA's AVIRIS website (aviris.jpl.nasa.gov). Individual bands were imported into ESRI's ArcScene software, and the DN values were used as elevation values to generate a surface. The result is a visualization in which the areas characterized by absorption features take on the color of the layer below, creating a strong contrast and highlighting the absorption features.

Assessing the feasibility of using high spatial resolution hyperspectral data to locate and identify mammals.

Zachary J. Bortolot, Institute for Regional Analysis and Public Policy, Morehead State University, Morehead, KY, z.bortolot@moreheadstate.edu and *Philip E. Prater*, Department of Agricultural and Human Sciences, Morehead State University, Morehead, KY, p.prater@moreheadstate.edu

An assessment of the feasibility of using high spatial resolution shortwave infrared hyperspectral data to locate and identify mammals was conducted using data collected with a portable spectroradiometer. Reflectance data were collected between 450 and 2500nm for four livestock species (cattle, horses, hogs, and sheep) as well as two grass species (orchard and sorghum-Sudan). Animal measurements were collected from sunlit portions of eight examples of each species, with a sensor declination angle ranging between 0 and 45º. Spectra from 100 examples of each plant species were collected at a similar range of declination angles. Each plant was measured at four orientations and the spectra were averaged to yield a single spectrum. Pixels from a hyperspectral sensor with a spatial resolution of 2.5m were simulated by estimating the fraction of a pixel a single animal would take up, assuming that the rest of the pixel consists of grass, and then using the fractions to calculate the weighted average of a plant spectrum and an animal spectrum. 1000 pixels (200 pure grass, and 200 for each animal species) were created by randomly combining plant and animal spectra (no duplicate pixels existed). The pixels were then divided into 200 model development pixels and 800 testing pixels. To assess the utility of these data in discriminating among animal and non-animal targets and among animal species, the following procedure was used: The spectral resolution of the data between 1150 and 2400nm was reduced from 11.5nm to 23nm, the reflectance values were converted to absorption values using Beer's law, the first difference of the spectra was taken, and discriminant analysis was used to create discriminant functions. Results suggest that shortwave infrared hyperspectral data can be used to discriminate among animal and non-animal targets, and among different animal species with high accuracy. When assessing the separability of pixels containing animals from pixels without animals, we obtained user's accuracies of 82.5% for pixels without animals, and 86.5% for pixels with animals. When discriminating among animals we obtained user's accuracies of 100% for cattle, 79.3% for horses, 91.5% for hogs, and 68.1% for sheep. Based on the success of this project, we plan to extend this technique to wildlife and hope to conduct a similar analysis using data from an aircraft-borne sensor.

Mapping the risk of conversion: Documenting the changes in the deciduous forest Cumberland Plateau Ecosystem using historical Landsat imagery.

David J. Campagna, Department of Geology and Geography, West Virginia University, Morgantown, WV, david@campagna-associates.com

Native hardwood forests of the eastern United States are currently undergoing dramatic changes due to clearing and growth of pine plantations. The Cumberland Plateau in Tennessee contains some of the largest remaining tracts of privately owned, contiguous temperate deciduous forest in North America consisting predominately of a mixture of oak (*Quercus* spp.) and hickory (*Carya* spp.) species. Since the area is privately-held, conservation is being pursued by buying large tracts of land by such groups as the Nature Conservancy. The problem then becomes which tracts to purchase that would provide the most value for the money being spent. Geospatial analytical techniques provide the basis to develop a spatial decision support system (SDSS) that will ultimately allow planners and stakeholders to map the risk of regional changes in land-use/cover structures, and assess the appropriate response to the risk of conversion. The SDSS will be developed from: a) an ecosystem-wide analysis of land-use/cover changes, b) a comparison between forward models that predicts regional landscape changes with theoretically developed drivers and an empirical model that identifies biological, geomorphic, and economic drivers, and c) a working SDSS model that will map the risk of conversion. This presentation will discuss the first stage of identifying the pattern of change in the Cumberland Plateau ecosystem in the state of Tennessee. Beginning with Landsat MSS data from 1975, Landsat data is chosen every five years in both leaf-on and leaf-off conditions for a total of six image pairs (1975-2000). The images were then classified using the maximum likelihood supervised classification with classes that conform to a modified Anderson Level II system. Leaf-on and leaf-off images are used to delineate deciduous, evergreen and mixed forests as well as to determine agricultural areas from barren zones. The imagery provide clear evidence for an approximately 15% conversion of native deciduous forest cover to large tracts of pine plantation.

Integrating visible, near infrared and short wave infrared hyperspectral and multispectral thermal imagery for geologic mapping using an expert system.

Xianfeng Chen, Department of Geology and Geography, West Virginia University Morgantown, WV, xchen@geo.wvu.edu, *Timothy A. Warner*, Department of Geology and Geography, West Virginia University, Morgantown, WV, tim.warner@mail.wvu.edu, and *David J. Campagna*, Department of Geology and Geography, West Virginia University, Morgantown, WV, david@campagna-associates.com

Visible, near infrared (NIR), and short wave infrared (SWIR) hyperspectral data have been widely used for geological mapping because distinctive, narrow absorption features can potentially be used to discriminate minerals and rocks. In particular, iron oxide, hydroxyl, and carbonate minerals exhibit absorption features in the visible, NIR, and SWIR regions. In contrast, multispectral thermal infrared (TIR) data have demonstrated great potential to discriminate oxide, silicate, and carbonate minerals. Previous research has shown that integrating hyperspectral visible, NIR, and SWIR data with multispectral TIR data can lead to improved mineral and rock identification. However, inconsistent results were found regarding the relative accuracies of different classification methods for dealing with the integrated data set. In this study, we investigated a knowledge-based expert system for integration of visible, NIR, and SWIR hyperspectral data with TIR multispectral data for geological mapping at Cuprite, Nevada. A geological map and sample spectral measurements were used to develop a generalized knowledge base for analysis of both spectral reflectance and spectral emissivity. The characteristic absorption features, albedo of rocks, and the location of absorption feature emissivity were taken into account to construct the decision tree. In the expert system, a continuum removal algorithm was used to identify absorption features from visible, NIR, and SWIR hyperspectral data only; spectral angle mapper (SAM) and spectral feature fitting (SFF) algorithms were used to estimate the most likely rock type. The expert system was found to achieve a higher performance than SAM, SFF, minimum distance, and maximum likelihood classification methods on their own.

The use of remotely sensed data in formal and informal education.

Hope Childers, Center for Educational Technologies, Wheeling Jesuit University, Wheeling, WV, hope@cet.edu, *Jodie Hoover*, Center for Educational Technologies, jhoover@cet.edu, and *Jane Neuenschwander*, Center for Educational Technologies, Wheeling Jesuit University, Wheeling, WV, jneuen@cet.edu

The Center for Educational Technologies® at Wheeling Jesuit University provides learning tools and remotely sensed data for K-12 students, their teachers, and the public. Many of the center's projects focus on problem-based learning and electronic simulations. In the online program Exploring the Environment®, students investigate scientific, social, and political aspects of authentic environmental problems. It also introduces students to remote sensing as an essential resource. Many of the program's 25 modules and activities describe or use SONAR, satellite imagery, aerial photography, and even radio tracking of wild animals. Students download, view, and manipulate images and maps to complete an investigation. Global Perspectives takes students on a tour of some of the world's political hotspots: the Middle East, South Asia, the Balkans, Central America. Students tackle real-world problems in these troubled areas. Remotely sensed images and other geospatial information reveal multiple aspects of an event such as war, natural disaster, or economic change. The online geospatial information conveys concepts that involve global- and regional-scale patterns. STORM-E, a distance learning simulation, is designed to culminate any classroom weather unit. It focuses on the possibility of a storm front developing. Students try their hand at predicting the weather for an air show in Ohio or the New Year's Eve celebration in New York City. They take on the roles of meteorologists; form teams to analyze maps, graphs, data, and satellite images; and decide whether to hold or cancel outdoor events. One of the center's recent collaborations is the Coal Impoundment Project. Funded through the U.S. Mine Safety and Health Administration, the project uses the Internet to educate residents of coal impoundments, related emergency evacuation plans, safety issues, and alternatives for impounding coal waste and sludge in West Virginia. The web site features online mapping tools to create custom maps and data queries for coal impoundment locations. Through the Center for Educational Technologies both children and adults experience geospatial tools and data while experiencing the advances in technology and connectivity that have changed the way people of all ages learn.

Aerial census of Haleakala silverswords using high spatial resolution color-infrared imagery.

Rick E. Landenberger, Department of Biology, West Virginia University, Morgantown, WV, rlanden@mail.wvu.edu, *James B. McGraw*, Department of Biology, West Virginia University, Morgantown, WV, jmcgraw@wvu.edu, *Timothy A. Warner* Department of Geology and Geography, West Virginia University, Morgantown, WV, tim.warner@mail.wvu.edu, and *Tomas Brandtberg*, Department of Geology and Geography, West Virginia University, Morgantown, WV.

High resolution remote sensing offers largely untapped potential for censusing and monitoring rare plant populations. The Haleakala silversword is a federally listed threatened species whose natural range is restricted to the highest elevations on Maui. With its distinctive foliage set against the volcanic background, the species provides an excellent test of the capabilities of color infrared remote sensing to provide a spatially explicit, individual-based approach to monitoring. We used a helicopter-mounted, high spatial resolution digital camera with a color-infrared filter to image a series of permanent census plots. Ground-based censuses from 2001 were compared to photointerpretation and automated computer classification of super high resolution (3-5 cm GSD) color-infrared images. Errors of omission and commission occurred in both methods, although at low rates. Photointerpreters and automated classification accuracy estimated silversword size in aerial images, with higher accuracy in the larger size classes. Although imperfect, both manual and automated methods effectively differentiated between living and dead individuals. Relative to photointerpreters, flowering individuals presented challenges for the classification. Although not as accurate as localized ground-based censuses,, high resolution aerial censuses provide a rapid partial population census over larger areas, which may be adequate for monitoring rare plants that exist in barren landscapes.

Comparing lineaments derived from Landsat, digital orthophotos, and the NED to well production in Wyoming County, West Virginia.

David D. M. Light, Department of Geology and Geography, West Virginia University, Morgantown, WV, dlight@mix.wvu.edu

As early as the late 1800s, scientists began mapping linear features on the earth's surface. These features included outcrop patterns and fracture traces. The addition of aerial photography (and later satellite imagery) provided scientists with vertical perspectives that allowed large areas of the earth's surface to be viewed at one time. Linear features on imagery were termed lineaments and were recognized to have local to regional extents. Further research indicated the lineaments often develop coincident with areas of the surface that are highly fractured or fracture zones. Fracture zones when not sealed are areas of relatively high permeability and are expected migration pathways for oil and gas as well as ground water. Lineaments then should represent areas of relatively high production for oil and gas wells and water wells. Lineament mapping was conducted on imagery of Wyoming County, West Virginia. Lineaments were mapped on a Landsat 7 scene, high-resolution digital orthophotos, and a digital elevation model from the National Elevation Dataset. The mapped lineaments were then compared to well locations and averaged production values. Visually, gas production does not appear to be well correlated to lineaments, however a statistical analysis is necessary to verify this conclusion. Well completion data including the depth, formation, and initial productions for the wells will also improve the analysis.

High performance algorithms for LIDAR data processing and visualization

Mathew T. McMahon, The Institute for Scientific Research, Fairmont, WV, *F. R. Bernal*, The Institute for Scientific Research, Fairmont, WV, and *S. L. Hamilton*, Galaxy Global Corp., Fairmont, WV.

While there has been a steady increase in the resolution and size of LIDAR datasets, there has been an associated increase in demand for full-resolution interactive processing and visualization of this data. The requirements of this processing create a computational bottleneck, suggesting the application of High Performance Computing (HPC) resources to improving performance. The work described here focuses on developing parallel algorithms for the processing of very large LIDAR datasets. Triangulation and rasterization algorithms were designed as proof of concept for the HPC infrastructure. A brief discussion is given of the issues, tradeoffs, and performance results for these algorithms. The core computational engine for HPC use has general applicability on a standalone workstation without access to HPC resources (serial computation versus parallel computation). This work spawned exploration of ways to facilitate development of additional LIDAR processing algorithms. Although applied to smaller datasets than those used with the HPC infrastructure, the computational engine provides an environment for facile creation of new algorithms and scripting of LIDAR data processing tasks by chaining algorithms together. Examples of LIDAR algorithms developed using the programming model, applied to feature classification in LIDAR data. Some examples are presented of the application of the LIDAR processing engine to several feature identification and classification tasks (e.g., bare earth classification, building identification). Results for a simple flood-plain simulation algorithm are given as well.

Changes in forest condition following the 2003 ice storm in eastern Kentucky.

Christine E. McMichael, Institute for Regional Analysis and Public Policy, Morehead State University, Morehead, KY, c.mcmichael@moreheadstate.edu, and *Jeffrey F. Lewis*, Morehead Ranger District, Daniel Boone National Forest, Morehead, KY, jefflewis@fs.fed.us

A devastating ice storm occurred in eastern Kentucky in February, 2003, depositing up to two inches of ice on tree limbs across the region - damaging stems and branches and uprooting some trees completely. This study investigates the utility of multi-temporal Landsat data (June 2002, September 2002, June 2003 and September 2003) for detecting ice storm related damage in a portion of the Daniel Boone National Forest in eastern Kentucky using the Multi-temporal Kauth-Thomas (MKT) transform. Specifically, we examine the relationships between MKT change components (change in brightness, change in greenness and change in wetness) and four levels of ice storm damage (no, low, moderate and severe damage) interpreted from post-storm aerial photography. Results show that MKT can be used to detect ice storm damage in temperate hardwood forests, that damage classes may be differentiated using MKT greenness and wetness change components and that the magnitude of MKT change components varies with the 'season' of image acquisition (June vs. September).

Building bridges: spatial crime data sharing between a university and police forces.

Thomas R. Mueller, Crime Mapping Center, Department of Earth Sciences
California University of Pennsylvania, California, PA, Mueller@cup.edu

Cal U Crime Mapping Center needs cooperation of police forces in the community to be successful. There is a paradoxical relationship between universities and their regional areas. Universities help their regional area through jobs and capital, whereas a regional service area helps a university by offering the essential infrastructure needed to run efficiently. However there are also many "town - gown tensions" between these two entities. For example, towns are upset by increasing taxes, perceived crime, traffic, etc. While universities are upset being the lightening rod for any problems in the area (i.e. if something is wrong it must be the universities' fault). The Cal U Crime Mapping Center is being built to offer students a role in the Monongahela River Valley area by having students produce crime mapping reports for the local area. This presentation will examine the data sharing issues facing the Cal U Crime Mapping Center in regards to positives, problems and evaluations.

The United States Geological Survey: conducting geospatial science for a changing world.

Barbara Ryan, Associate Director for Geography, United States Geological Survey National Center, Reston, VA, bryan@usgs.gov

The USGS has a long history of discovery at the cutting edge of science and technology. Currently the Survey's primary mission involves conducting science for a changing world. USGS Geography monitors the changes that occur on the land surface using remote sensing, studies the connections between people and those changes, and then provides individuals and society with information they can use to cope with the consequences of those changes. As all of us in the geospatial and natural resource sciences know, land changes can be very gradual or sudden. They can be natural, such as forest regrowth after a lightning-caused fire or a volcanic eruption, or they can also be caused by human action such as converting forestland to residential land. Sometimes, the consequences of natural processes are significantly magnified because of human action such as when debris flows that might have harmed a forest, now harm a neighborhood. These increasingly common situations create particularly difficult challenges for citizens, emergency services personnel, and land-use planners. Given the dynamic nature of our earth and the increasing human population, the USGS's Geography Program's main challenges are: (1) to understand coupled human environmental systems in the face of land change; and (2) to deliver pertinent information on the vulnerability and resilience of these systems for decision-making.

Each of the three Geography programs of the USGS addresses different parts of the geographic knowledge spectrum. **Geographic Analysis and Monitoring (GAM)** conducts research to understand the rates, causes, and consequences of landscape change over time and uses that understanding to model change processes for predicting future conditions. The program demonstrates the value of *The National Map* through case-study applications that concern specific environmental, natural resource, and economic issues. **Land Remote Sensing (LRS)** is the Nation's portal to the largest archive of remotely sensed land data in the world. Working with NASA, NOAA, commercial satellite companies, State and local governments, and international programs, the LRS Program collects, maintains, and distributes millions of images acquired from satellite and aircraft sensors. From such images scientists and land managers, both public and private, derive information about natural resources, hazards, and long-term changes to the landscape. Through advancements in data archive and processing technology and through the operation and maintenance of satellites such as Landsats 5 and 7, the LRS Program provides continuous access to worldwide land images that can be used in mankind's effort to sustain the ever-changing Earth. **Science Impact** is an effort to improve and expand the use of USGS science information to support decision-making at the Department of the Interior, other Federal, State, and local government organizations, and by the public.

Mapping of the eastern hemlock (*Tsuga canadensis*) resource in the state of West Virginia.

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Eastern hemlock (*Tsuga Canadensis*) was once widely distributed across eastern North America, but was reduced dramatically in abundance following the early logging era (ca. 1850 – 1910). Although slowly beginning to recover in the mountainous areas of the eastern US, it is now under attack by an exotic insect, the hemlock wolly adelgid (*Adelges tsugae*) whose range is expanding rapidly through West Virginia. I will use of remote sensing and GIS to locate and map hemlock stands greater than 10 acres with at least a 20% basal area. The methodology involves the use of remotely sensed data (aerial photos, Landsat images, Hyperion images) combined with ground reference data to train and then assess pixel classification accuracy. Nicholas County, WV is one training area because of the existing large hemlock resource. GIS with other ancillary data (aspect, slope position, soil type, fire history, etc.) may play a role in helping to classify hemlock stands.

A fuzzy K-nearest neighbor classifier for landcover classification.

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A supervised classification method is presented that uses the K nearest samples from a prototype set to calculate fuzzy class membership values for an unknown. The contribution of each neighbor is inversely weighted according to its distance from the unknown in the classification space. Because the algorithm uses no summary statistics or assumptions regarding class shape, it can create complex, even disjoint, partitions of classification space. Two parameters-maximum radius, and fuzzy threshold-were built into the classifier to improve classification results. Maximum radius restricts the classification to pixels that fall relatively close to existing prototypes, thereby revealing areas in the scene that are not adequately represented by the existing prototype set. The fuzzy threshold parameter can be used to identify pixels with a maximum class membership below a selected threshold. These pixels can be treated as uncertain cases due to class overlap, or intermediate positioning between clusters. Thus the classifier can be implemented to limit classification to unambiguous cases, while setting aside unresolvable cases for further processing. An example of second stage processing is presented which incorporates class values of neighboring pixels to determine final categorical membership. The classifier is applied to a subset of a Quickbird scene depicting large scale surface mining operations in Southern West Virginia. A nine-class product is produced and compared to a maximum likelihood classification using the same prototype set.

Spatio-temporal analysis of land use change and sinkhole development in the Opequon Creek watershed, West Virginia: 1984-2004.

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While there have been studies dealing with urban growth impacts on watershed hydrology and geomorphology, very little has been done to analyze the spatial character and composition of such growth using remote sensing and geographic information system technology, particularly in karst watersheds. Karst watersheds are those that have distinctive landforms found on limestone and dolostone bedrock, characterized by sinking streams, sinkholes, caves, karren, and dolines. Karst watersheds are more sensitive to environmental change than typical watersheds because soils are characteristically thin and water has relatively short residence times in underlying aquifers. This research addresses a portion of the Opequon Creek Watershed, an urbanizing karst subwatershed of the Potomac River in West Virginia. Opequon Creek lies approximately 60 miles from both Washington, D.C. and Hagerstown, Maryland and has experienced irregular, urban growth patterns and a subsequent population boom over the last 10 years, while sinkholes have become more frequent. LandSat 7 imagery and digital orthophoto quadrangles between (1984-2004) are utilized to quantify land use change, and sinkhole frequency and density within the watershed. Ecognition software is used to classify and quantify land use and sinkholes temporally through spectral and morphometric analysis. The spatial relationship between these variables is explored using FragStats, a categorical map pattern spatial analysis program that enables exploration of quantitative data at various scales. Interpretation of the statistical relationship between land use change and sinkhole development offers enormous potential in mitigating negative impacts of urban growth and sinkhole hazards in these sensitive watersheds.

Historical aerial photography as a tool in the identification and evaluation of cultural landscapes: an example from the New River Gorge National River.

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The New River Gorge National River is historically a culturally rich area. By integrating historical aerial photography with remote sensing software, it is now possible to identify and study cultural landscapes that may now be completely altered. Historical aerial photography is an invaluable resource, in some cases dating as far back as the late 1930s, and can provide significant information about historical landscapes. This study utilizes a series of historical photographs of the New River area captured between 1945 and 1947. While historical photography provides considerable insight in cultural landscapes, a number of issues arise in the use of these images. Data preparation, especially georeferencing and orthorectification, is often difficult due to the low resolution of historical photographs (1:20,000), and the high resolution of modern reference images. However, even though some drawbacks are present, these historical images are an irreplaceable resource in the study of historical cultural landscapes.

Mapping orchards and vineyards with high resolution panchromatic satellite imagery.

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High spatial resolution satellite data usually has only a single band, and is consequently often labeled as panchromatic imagery, in the sense that it is spectrally similar to a black and white photograph. Remote sensing has a long and successful tradition of analysis of multispectral data, but the automated classification of single band data is much more challenging. Classification of single band data necessarily requires the analysis of spatial patterns, instead of multispectral patterns. This paper presents a method for classifying orchards and vineyards from single band imagery. Orchards and vineyards have a repeating spatial pattern that makes them particularly well-suited to spatial analysis. The autocorrelogram of orchards and vineyards shows a distinctive sequence of negative and positive autocorrelation values that indicates the presence of a repeating pattern. The distance between the peaks of the autocorrelogram can be used to estimate the distance between the trees or vines. In a test application of the method at Granger, Washington, using IKONOS panchromatic imagery, the spatial autocorrelation based classification resulted in an estimated accuracy of 0.954 and a kappa of 0.900. Errors of omission for orchards and vineyards were slightly higher than errors of commission (11-14% vs. 3-6%). By comparison, a maximum likelihood classification of 32 gray level co-occurrence texture bands had a lower accuracy (0.865), with a kappa of 0.701, and errors of omission and commission as high as 35% and 57%, respectively.

West Virginia View: an update.

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West Virginia View (wvview.org) is a consortium of organizations that have an interest in promoting remote sensing in West Virginia. West Virginia View was formed in 2002 as a partnership between West Virginia University (WVU) Department of Geology and Geography, WVU Department of Biology, the WV GIS Technical Center, WV Department of Environmental Protection and the Canaan Valley Institute. The goals of the consortium focus on cooperation and sharing of data and equipment, outreach activities, and supporting student education through graduate research and internships. West Virginia View is a founding member of AmericaView (www.americaview.org), a national umbrella organization of state consortia, sponsored by the USGS. Over the past three years, West Virginia View has developed an internet archive of approximately 100 Landsat images of West Virginia available for free download, making the site the premier location for West Virginia satellite imagery. In addition to the full-frame Landsat data sets focused on remote sensing professionals, for the general public smaller images of each of the 55 counties are available in common desktop publishing form. West Virginia View has appointed an advisory board, as well as a general manager. Current activities focus on outreach activities in order to expand West Virginia View to additional academic institutions, and to promote remote sensing education and research at those institutions.

Landscape Visualization through LiDAR for Natural Stream Channel Design

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The airborne terrain mapping technology known as Light Detection and Ranging (LiDAR) has many uses. LiDAR data as well as survey data were acquired for Mouth of Seneca, West Virginia in November of 2003, for the purpose of facilitating Natural Stream Channel Design (NSCD) work. Triangulated Irregular Networks (TINs) and GRIDs were produced from the LiDAR data and cross sections and longitudinal profiles were created from the survey data. The surfaces are used for applications such as visual, qualitative examination of floodplains, illustrating abandoned fluvial features as well as quantitative analyses such as cut and fill estimates for construction. Flood modeling with LiDAR permits highly accurate flood inundation mapping as well as many other visualization products.