How do agencies in Kentucky leverage Orthophotography and LiDAR data products?

National Geodetic Survey

The goal of the Kentucky Height Modernization project is to "provide a reliable and accurate infrastructure for elevation data that meets the needs of a broad spectrum of users and applications." Our first achievement in reaching this goal was to build a network of Continuously Operating GPS Reference Stations (KY-CORS). KY-CORS provides the framework for LiDAR to accurately reference flight paths and perform data calibration. LiDAR is a mature technology. A modern geodetic control network is in place. With these tools we now have the ability to create an accurate elevation model, meeting the needs of the Commonwealth.

Kentucky Department of Fish & Wildlife Resources

Having access to current aerial imagery along with accurate elevation information are important spatial data components needed to develop products for both public users and professional biologist staff. We produce maps of Wildlife Management Areas for public use and incorporate aerial photographs and topographic features into these maps. Showing recent images allows the public to see where open fields, forest, and water features are located before coming to the area. Also, using hill-shading and slope for on-line applications like the internet mapping service hosted by DGI will allow WMA users to visualize landscape features that is impossible to do without these data sets. These same data sets are invaluable to our professional biologists in determining potential habitat use for many species. We have struggled to develop accurate habitat models for elk and black bear in eastern Kentucky because the existing elevation data is not accurate. Similarly, developing habitat models for non-game species such as songbirds requires a combination of elevation, slope, aspect, and recent aerial imagery.

Kentucky Infrastructure Authority

The development of high-resolution leaf-off imagery and accompanying elevation data will be of tremendous benefit to projects for which the Kentucky Infrastructure Authority provides funding resources. Imagery data, particularly of reasonable accuracy, resolution and vintage, can be used for planning, reconnaissance, and in many cases design purposes for most civil engineering projects including water and wastewater infrastructure. Current elevation data derived from LIDAR technology will be of the resolution and accuracy required to support all but the most demanding planning, design and construction purposes. With respect to water projects elevation data can be used to model variations in water line pressure due to topography, thus facilitating optimum locations for pressure reducing valves and pumping stations, as well as determining critical design parameters for water tanks. On the wastewater side elevation data plays a critical role in determining optimum locations and alignments for gravity based sewer lines and appurtenances.

The resolution and accuracy proposed for statewide imagery and elevation data will essentially zero-out costs that are currently being incurred for each water and wastewater project, particularly those involving distribution/collection line replacement and/or expansions. This will also eliminate the lag time incurred while survey and mapping data is collected and compiled for each project, thus expediting the entire design and construction process.

Finally, having this data in a single standardized coordinate system will facilitate the development of CAD drawings that can easily be incorporated into the WRIS geographic information system. Currently, most information provided by engineers to KIA has not been developed in a standardized coordinate system meaning a great deal of time and effort must be expended to bring as-built data into the WRIS geospatial database while maintaining a reasonable, or even quantifiable degree of positional accuracy.

Kentucky Parks

Obtaining new imagery and elevation data is vital to the personnel of State Parks. Many of our in-house park engineers and architects are working on numerous projects throughout our "off the beaten path" state park system. It is extremely difficult to see or even visualize existing structures as well as proposed facilities at all of the fifty-two parks. The ability to have accurate elevations will provide the answer to many common questions and will increase workflow as projects develop. For example, accurately mapping an elevation for a new water front cabin within the confines of U.S. Corps of Engineers elevation regulations.

Clear and high accuracy aerial imagery would give both central office and park staff the ability to monitor changing conditions throughout the park. Since many of our parks lie in rural settings we have a common problem managing encroachment within our 55,000 acres. Updated leaf-off color imagery is the best source to manage this problem. This data would also greatly improve our flora and fauna management efforts while working with other agencies. Furthermore, we could produce high quality static and interactive website maps for hikers, bikers, and equestrian enthusiasts.

Abandoned Mine Lands

At AML, we currently get individual overflights done to get high resolution imagery of complaint generated project sites. Traditionally this was done at low elevation to provide imagery for our engineers to design their projects on top of. Coupled with traditional surveys, they generate countours of the existing topography and use this as baseline information. We also used to get higher elevation imagery to scout for potential waste areas and get more coverage. The 2006 2' imagery was good enough that we were able this year to stop flying the higher elevations, and stick with lower elevation flights over more potential project areas. So, newer high-resolution ortho imagery could further lessen our need for additional overflights.

Having an updated Bare Earth Model that Lidar would provide could save time and money on our traditional surveying. I know for our GIS work, just updated the DEM would change our ability to geofererence our aerial imagery and orthorectify our project areas. It came up at our meeting that the DEM we use now could be 40 years old in some instances, being based on our topo maps. I have asked for our engineers to comment on the impact LIDAR would have on our design process and will forward to you when I get them.

But, at the base level, every project we send out is put on top of georeferenced aerial imagery. Every project is either surveyed traditionally or an orthorectified map is generated for us by using aerial photography + control points on the ground. So high-resolution orthos + lidar could help every project we design.

Kentucky Division of Water

The Kentucky Division of Water leverages the Commonwealth's geospatial data holdings on a daily basis in order to carry out a wide variety of regulatory, planning, and monitoring functions. Having access to updated imagery and better topographic information would benefit the following activities:

Floodplain determination – Stream cross sections for hydraulic analyses – Dam inundation mapping – National Hydro Dataset (NHD) rectification – Non-point source runoff modeling – Waste Load Allocation (WLA) modeling – Elevation-based biological assessment – Exceptional waters identification – Sinkhole identification and delineation – Spring identification – General geomorphology – Stream morphology – Assessment of watershed changes (development, mining, etc) – TMDL hydrologic modeling – HUC delineation – Delineation of subwatersheds for 401 certification

USDA - Natural Resources Conservation Service:

NRCS uses current aerial imagery on a daily basis in our many local, area, and state offices. More accurate elevation data (such as LIDAR) are a priority need for our agency statewide. We would utilize LIDAR immediately in 2 of our primary program activities: (1) Soil Survey mapping - LIDAR would give us accurate elevation data to delineate slope classes for compiling/updating our digital Soil Survey Program statewide. (2) Flood Protection/Breech Analysis - we would utilize LIDAR for performing flood hazard/breech analysis on approximately 100 high-hazard dams statewide built thru the PL-566 Small Watershed Program.

Kentucky Transportation Cabinet

Aerial Photography Benefits - Almost all areas of the Transportation Cabinet depend on aerial photography to perform their business. At one time the Cabinet flew county level aerial surveys to support its business needs. With the efficient sharing of GIS imagery from DGI, KYTC focuses its aerial purchases to project specific areas.

From the early phases of planning a new road project, to assisting local communities maintain public airports, to the maintenance of our properties, we need current and older imagery to evaluate changes and make decisions of how to best serve the people of the Commonwealth.

Current aerial imagery acts as a common base map that everyone uses as a reference to then apply their specialized data to. This promotes effective communication internally as well as with other state and local agencies and with the public. Current photography also reduces the number of field visits required by KYTC personnel, thereby saving time and travel costs. They can just pull up desktop GIS or web mapping, analyze their problem, make a decision and move their project forward.

By working in partnership with other entities, the Cabinet does not have to shoulder all the costs for imagery it needs. It can devote its precious resources to more efficiently to deliver the safe, efficient transportation network the public expects and needs.

LIDAR Benefits - A LIDAR-based elevation model is a key pillar in the Transportation Cabinet's effort to update and streamline our project development business. With a detailed elevation model, the Transportation Cabinet can save significantly in the initial project design phase and have much more accurate cut and fill estimates. It can also be used in environmental areas for development of improved viewshed analysis of National Register properties and probability models for threatened and endangered species.

Height Modernization make quality LIDAR possible. A new elevation model would enable KYTC and it's consultants to provide highly accurate and consistent design models for machine control highway construction projects. Other states using digital plans and machine control are seeing a 5% savings in construction costs on major earth moving projects. This would translate into millions of dollars saved annually for the Cabinet.

Division of Conservation

Current imagery and LiDAR datasets could be of great use and add critical value to several of our division's programs. Examples of areas of particular benefit are: watershed structures (dams) breach analysis as it affects life, property and communities downstream from these aging structures, management of watershed districts, delineations and urban growth modeling of agricultural districts, prime farmland protection, and purchases of conservation easements, land use detection with conservation easements properties and below watershed structures, and impact and cost-benefit analysis of best management practices for agriculture water quality and conservation implemented through the state cost-share program.

Kentucky Office Surface Mining

Division of Mine Permits - Topographic maps, elevation models and aerial photography are critical elements for the evaluation of mining and reclamation plans reviewed and regulated by Division of Mine Permits. The review process incorporates aerial digital imagery and topographic maps into a GIS and checks for applicants to meet state and federal standards as required by the federal Surface Mining Control and Reclamation Act of 1977 (SMCRA). Reviewers verify land uses and conditions by quickly utilizing at their desktops presently available 2006 and 2008 ortho-imagery. This makes future, periodic acquisitions of imagery a very important element in maintaining efficiency in the review process. The modernization of out-of-date elevation data with statewide LiDAR is vital for developing mine plans and the continuous update of topographic maps and other elevation products. New infrared data would be coupled with digital aerial imagery to even further assess existing land use and verify against data submitted in the mining permit application.

Division of Mine Reclamation and Enforcement - The Division of Mine Reclamation and Enforcement is responsible for inspecting all surface and underground mining permits in the state, as well as non-coal mining; limestone, sand, gravel, clay, shale. During the inspection process aerial imagery and elevation models are used in the evaluating the success of mining and reclamation plans followed by the operators. Newer imagery would make the checking for compliance quick and cost effective using GIS already in place. Coupled with updated, highly accurate LiDAR-based elevation models our inspectors could accurately determine if the mines are being reclaimed and mined according to their approved plans. Digital aerial imagery, possibly including infrared information could be used in the Kentucky Coal Fields to assess rates and intensity of mining as well as progress made in reclamation and revegetation to ensure performance standards are always met.

Division of Forestry

Remotely sensed data and associated technology are clearly the most cost effective tools for constructing an assessment of Kentucky's forestland so that the best strategic planning for economic, aesthetic, and environmental outcomes can be realized. Currently the Division of Forestry relies upon a combination of aerial photography, landcover datasets, and ground-truthing by field personnel to conduct assesements. However, existing data has serious limitations in scope and accuracy, and not only needs to be updated, but should be supplemented with more powerful, and more revealing types of data for two primary reasons: First, there is an urgent national thrust to find clean alternative energy supplies, and secondly, budget restrictions and subsequent personnel cutbacks have rendered numbers of field staff to the barest minimum. The addition of LiDAR data holds the most promise for the Division of Forestry to be able to measure forest canopy heights and subcanopy as aboveground biomass, as well as providing critical information about the function and productivity of the state's forest. The most immediate need for these data is revealed in the intent of nation's pursuit of biomass as a potential fuel source. The American Clean Energy and Security Act of 2009 will include a Renewable Electricity Standard requiring that a minimum percentage of electricity come from "renewable sources," which include "renewable biomass." For Kentucky's forests to be included in this percentage (as woody biomass), they must be classified as "renewable biomass". Another area of surging interest is a the relatively new concept of carbon credits, whereby landowners who manage their forest may be eligible to earn income from selling their forest's ability to store atmospheric carbon. Carbon credits are a commodity that is traded on the Chicago Climate Exchange, and a number of Kentucky landowners are already participating. The acquisition of LiDAR and co-registered high-resolution aerial photography (including a crucial fourth near infrared band) data for Kentucky would be essential to the Division of Forestry for providing metrics to the public, so that both sustainable forest practices and renewable energy from woody biomass could be accomplished. The LiDAR data should include multiple returns, and be of large footprint, to be able to model canopy structure.

Kentucky Geological Survey

Geologic Mapping Section has been receiving funding for several years through the USGS STATEMAP Program to produce new digital geologic maps for the Commonwealth. The information from these maps can be applied to address a wide array of issues, including water-supply assessment, geotechnical planning, environmental management, and hazard analysis. The new maps focus on areas of high priority for these issues where the existing geologic maps are not adequate to address these current societal needs. The primary issue in the production of these new maps is delineation and characterization of unlithified sedimentary deposits and the associated geotechnical parameters of the engineering soils. Better tools for delineation of young landforms will enable faster, more efficient, and more accurate geologic mapping by the limited field personnel available.

Detailed topographic data such as that available through LiDAR technology would provide a fundamental advancement in our ability to delineate landforms and identify subtle or large landforms in circumstances where access in limited. Likewise, aerial imagery is a key tool for identifying and extrapolating landscape patterns: leaf-off imagery is necessary for this tool to be most useful, because much of what we need to map is typically obscured by warm-season vegetation canopies. Both of these tools will enable more accurate and confidant identification and delineation of the landforms and sedimentary deposits we are mapping. In addition, we are developing a landslide

inventory for Kentucky. Additionally, combined application of LiDAR and leaf-off imagery would enable more efficient population of the inventory database through faster and more accurate landslide identification, and thus help to produce a more comprehensive landslide inventory.

LiDAR & Landslides - There is an increasing demand for utilizing information from LiDAR, especially in geologic applications, because of its exceptional accuracy over other elevation and terrain model data sets. The Kentucky Geological Survey can use LiDAR for highly detailed virtual inspection of slope geomorphology and landslide activity for landslides hazards mapping.

Landslides comprise a major geologic hazard to the country, affecting thousands of people and costing billions of dollars in damages. Providing the public, local government and state offices with information about slope stability, existing landslide activity, highly susceptible areas, and high risk areas because of slope movement, is vital in landslide hazard mitigation.

LiDAR uses laser scanning technology to obtain high resolution spot elevations (x, y, z) that results in extremely accurate models of earth's terrain. Accurate elevation models are even possible through trees and other vegetation. Using this technology would not only provide data on existing landslide features, but also would be able to document any sequential changes in slope movement over short periods of time and aid in the design of effective solutions.

Louisville/Jefferson County Information Consortium (LOJIC)

LOJIC acquires six-inch resolution color aerial imagery of Jefferson, Oldham and Bullitt Counties on a three-year cycle. For its Spring 2009 imagery acquisition, an approximate one-meter LiDAR was also acquired to provide a new DEM for production of one-foot resolution orthoimagery and to support the generation of two-foot contours. Updated orthoimagery, which is made available to local users through the LOJIC GIS, provides a timely and easily interpreted basemap for a wide range of local agency business processes such as land records management, E911, utility and transportation infrastructure management, address assignment, stormwater modeling, public access web services, and a host of others.

The Spring 2009 LiDAR data points will be classified into bare-earth, low-medium-high height vegetation, buildings, non-ground data, and default points not in any other classification. The classified LiDAR data will be used to model 3-D terrain and buildings as well as tree masses and other vegetation cover.

Aerial imagery also serves as the basis for photogrammetric updates to the LOJIC planimetric/topographic vector database. Prior to a photogrammetric update, old and new imagery and vector data are compared to identify areas of significant change due to development. Areas of potential map update are delineated and prioritized based on the type and magnitude of change and serve as the basis for a more targeted and cost effective update of the LOJIC planimetric/topographic map data.