How KGS Uses LiDAR

KGS established its Digital Earth Analysis Laboratory in 2017 to support research on innovative LiDAR solutions to benefit the commonwealth. DEAL contains high-end computer workstations capable of working with large LiDAR files, a high-capacity server containing 14 TB of Kentucky LiDAR data, an 80-inch touchscreen display to facilitate collaboration, and a variety of specialized mapping and analysis software.

DEAL
Digital Earth Analysis Lab

Abandoned oil and gas wells—KGS DEAL scientists are using airborne LiDAR data to identify the land-surface signatures of approximately 14,000 known locations of wells across the state abandoned prior to 1960, which can pose safety and environmental hazards (Fig. 1).

Our scientists are training computers to distinguish features associated with known abandoned well locations, and will use their results to search for previously unknown abandoned wells. A collaborative pilot project in the Daniel Boone National Forest is currently underway.

Figure 1. An abandoned wellhead in the Daniel Boone National Forest. LiDAR data may help identify the locations of many such abandoned wells.

Topographic roughness—Another DEAL project focuses on variations in topographic roughness across Kentucky at scales ranging from 5 meters to 5 kilometers (Fig. 2). Comparing roughness at different scales will elucidate what surface processes are controlling the different parts of the Kentucky landscape and help KGS geologists better understand sinkholes, landslides, and earthquake hazards.

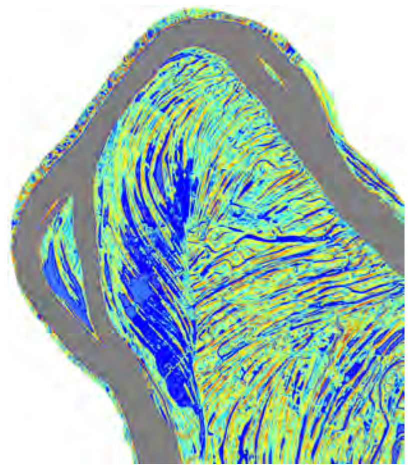

Figure 2. A 15-meter surface roughness map highlights bar and swale topography resulting from the migration of the Ohio River, near Henderson, Ky.

River systems and flood research—Geologic mappers at KGS are using LiDAR data to help them understand Kentucky's river systems. They are processing parts of the LiDAR digital elevation model along river valleys to more accurately correlate fluvial terraces along the lengths of major rivers. Once this process is complete, groups of terraces can be compared to help quantify long-term changes in stream gradient. Combined with geochronologic studies, the timing of the stream gradient changes will be correlated with long-term climate variations. Analysis of terraces within a group will give insight into the potential scale of flooding, how it has changed through time, and how to plan for future floods.

Landslide occurrence and susceptibility—Airborne LiDAR is an invaluable tool for landslide mapping in heavily forested areas (Fig. 3). KGS scientists are using LiDAR data to map landslides in Kentucky at a level of detail not previously possible. Features such as landslide scarps and toes, as well as characteristically irregular terrain, stand out in LiDAR images and derivative maps.

Kentucky Geological Survey

For more information contact
Jason Dortch, (859) 323-0547
jason.m.dortch@uky.edu

uky.edu/kgs

The LiDAR digital elevation model has also shed light on previously unknown landslides in valley fills associated with mountaintop-removal coal mining in eastern Kentucky. KGS geologists are using the statewide LiDAR DEM in computer models that combine the physics of landslide initiation with elements of probability theory to produce cutting-edge landslide-susceptibility maps that can take into account factors such as the effects of climate change and human activities. Adding information about infrastructure and critical facilities to the landslide model will allow KGS to also evaluate possible losses and contribute to effective risk mitigation strategies.

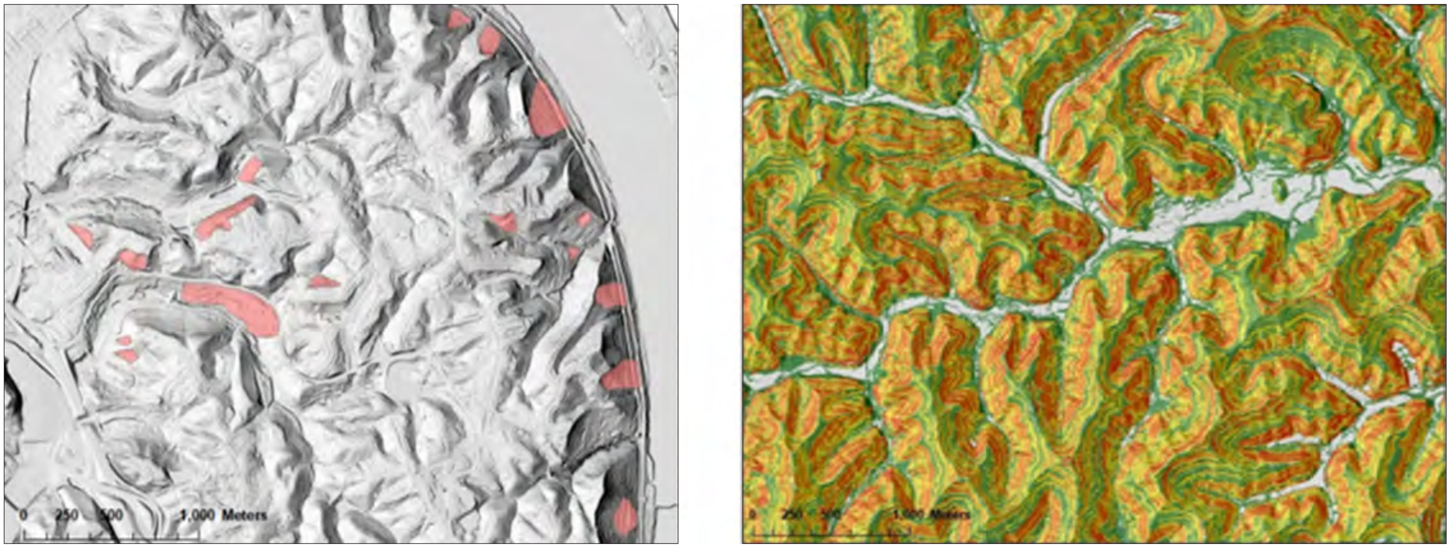

Figure 3. Example of mapped landslide deposits in northern Kentucky (left) and a landslide-susceptibility map of eastern Kentucky (right). The susceptibility map shows the probability that the slope factor of safety is less than 1. Reds and oranges are high probability and yellows and greens are lower probability. These types of maps are useful for land-use planners, engineers, geologists, emergency management officials, and others needing landslide hazards information.

Sinkhole mapping—Since 2014, KGS geologists have been using LiDAR data to map far more sinkholes than were known from older data (Fig. 4). As of February 2019, KGS has produced LiDAR-based sinkhole maps for 17 of the state's counties, adding thousands of sinkholes to the KGS database. The sinkhole mapping team has also been using machine-learning techniques to help automate and expedite the process. The results of mapping in 10 counties are already available through the online KGS Geologic Map Information Service and maps for the remaining counties will be added soon.

Change detection—In areas where at least two sets of LiDAR data are available, LiDAR-based change detection can establish the timing of landslides, document the extent of damage caused by flooding or extreme rainfall, evaluate the progress of land subsidence, and quantify the impact of human activities such as surface mining. Ongoing KGS research includes development of techniques to calculate changes between laser-accurate LiDAR DEMs and far less accurate DEMs created decades ago.

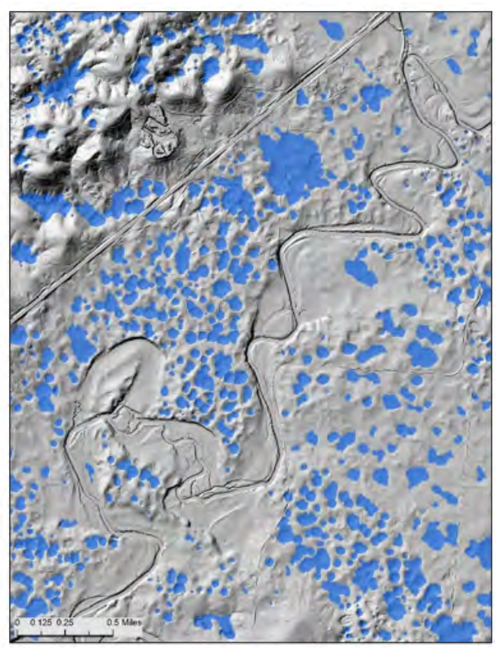

Figure 4. Sinkholes delineated by LiDAR (blue) in an area of Hardin County.