LiDAR Surface Topography of Will County, Illinois

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Illinois County Geologic Map
ICGM Will-ST

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LiDAR Elevation Data

This surface topography map was created from enhanced elevation data acquired using airborne LiDAR (light detection and ranging) technology. This active remote sensing technique uses a pulsating laser sensor to scan the Earth's surface, and the intended application determines the sensitivity of the laser sensor used for data acquisition. For terrestrial applications such as topographic mapping, the principal wavelength selected for most airborne laser sensors is 1,064 nm, which is within the near-infrared band of the electromagnetic spectrum.

The first object contacted by a laser pulse and reflected back to the sensor is designated as a "first return," which may be a hard target, such as a building rooftop or the ground surface, or a soft target, such as vegetation. When a laser pulse encounters a soft target, e.g., a tree, a portion of the laser beam continues downward and reflects from the underlying branches and trunk, providing additional returns recorded by the laser sensor (Fig. 1). The reflected light pulses are detected by instruments that record the accurate location of each return pulse in three dimensions—(x) and (y) horizontal coordinates and (z) elevation values. The processed returns, which number in the billions for a typical county area, are termed a "point cloud."

A portion of the processed returns represent the ground surface and are referred to as the "bare-earth" point cloud. To maximize the probability of acquiring sufficient ground returns in vegetated terrain, LiDAR is collected in the Midwest during the leaf-off portion of the year when deciduous tree canopies are barren, crops are absent, and most other vegetation types are dormant. However, wherever filtered daylight can pass through vegetated canopy, a portion of the laser pulses reach the surface and produce ground returns.

The bare-earth point cloud, comprising only ground returns, was processed to create a digital terrain model (DTM), which was used to produce the *LiDAR Surface Topography of Will County, Illinois*. The extraordinary feature detail contained in the DTM is illustrated in the 1:6,000-scale enlargements of the longwall mine and cloverleaf features in Figures 2A and 3B, respectively. In contrast, processing all the returns in the LiDAR point cloud produces a digital surface model (DSM) that characterizes the remaining landscape features for the same area (Fig. 3A). Wooded areas, buildings, and other structures are all apparent on the DSM. The returns representing these aboveground features are filtered from the all-returns point cloud to create a DTM. The airborne LiDAR data collected for Will County and the surrounding counties (Fig. 4) average at least one return for each square meter of land surface. This point density, coupled with the exceptional vertical accuracy of LiDAR enhanced elevation data, meets the National Standard for Spatial Data Accuracy for the creation of 2-foot contours (Fig. 2B).

References

Mangold, R., and J. Van Sickle, 2008, Points of light, *in* Point of beginning, February 1, 2008, http://www.pobonline.com/articles/91662-points-of-light (accessed March 30, 2014).

U.S. Geological Survey, 2014, The National Map Viewer and Download Platform, http://viewer.nationalmap.gov/viewer/ (accessed March 30, 2014).

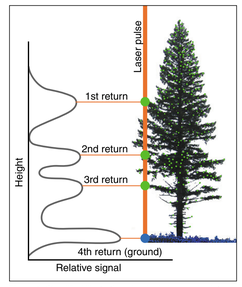

Figure 1 Simplified illustration of a single laser pulse interacting with a soft target (the tree). A maximum of four returns are possible from each pulse, and current airborne systems can emit more than 150,000 pulses per second. The waveform data collected from the target are processed into a LiDAR point cloud (colored dots), which is used to generate a three-dimensional representation of the target (revised from Mangold and Van Sickle 2008).

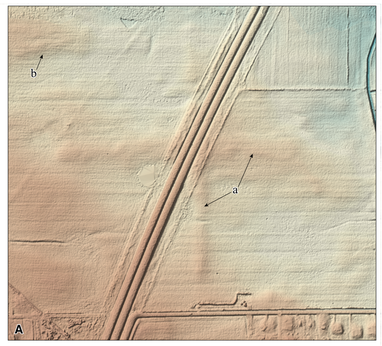

Figure 2 The cross-shaped feature revealed on this digital terrain model (DTM) on Figure 2A (a) is a remnant of an abandoned, underground longwall coal mine referred to as the Diamond Mine (T32N, R9E). A DTM represents only the ground surface and is extracted from airborne LiDAR data using automated filtering methods to produce what is commonly referred to as a "bare-earth" point cloud. Located near Braidwood in Will County Illinois, the Diamond Mine began operations in February 1883. During the intervening period of 131 years, it has been estimated that approximately 2 feet of ground subsidence has occurred because of this type of hand-mining operation (unpublished manuscript by Robert A. Bauer 2008). This DTM defines not only the belowground structures associated with these mines, such as the supporting pillars or "haulageways" (a), but also the extent of these underground mine operations (b). The 2-foot contours depicted on Figure 2B confirm that at least 2 feet of subsidence has occurred. Contours are shown at 2- and 5-foot intervals. Scale is 1:6,000 (1 in. = 500 ft).

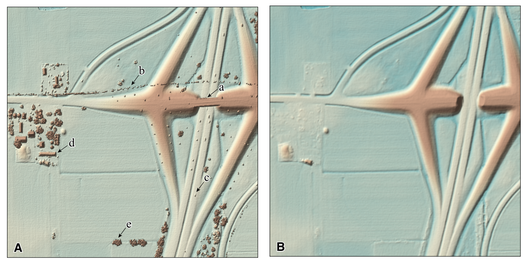

Figure 3 The feature shown is a cloverleaf structure associated with I-55 located at the Will County boundary (T32N, R9E). Figure 3A is a digital surface model (DSM), whereas Figure 3B is a DTM of the same area. In contrast to a DTM, which represents only ground features, a DSM portrays all aboveground features. For example, the roadway overpass (a) shown on the DSM has been removed on the DTM because the elevated roadway is not considered part of the ground surface. Likewise, the patterns of scattered points at (b) on the DSM represent the cables of an aboveground transmission line, which have been removed on the DTM. Vehicles moving along I-55 (c), building structures (d), and trees and other vegetation (e), all of which are visible on the DSM, have been removed on the DTM. Scale is 1:6,000 (1 in. = 500 ft).

Surface Elevation
(feet above mean sea level)

800
750
700
650
600
550
500
450

Road Classification

Interstate Route
U.S. Route
State Route

SCALE 1:62,500

1 0 1 2 3 4 5 MILES
1 0 1 2 3 4 5 6 7 KILOMETERS

1½°
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 2014

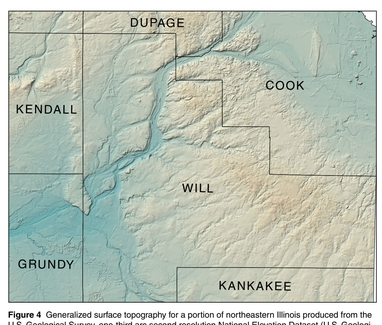

Figure 4 Generalized surface topography for a portion of northeastern Illinois produced from the U.S. Geological Survey, one-third arc second resolution National Elevation Dataset (U.S. Geological Survey 2014).

2008 LiDAR data for Will County, Illinois, made available through the U.S. Geological Survey, the Will County GIS Department, and the Illinois Height Modernization Program (http://www.isgs.illinois.edu/nsdihome/webdocs/ilhmp/). Universal Transverse Mercator, zone 16. North American Datum of 1983 (NSRS2007), North American Vertical Datum of 1988. Vector base data from 2013 TIGER/Line Shapefiles provided by the United States Census Bureau.

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