Kansas
LTAP Fact Sheet
A Service of The University of Kansas Transportation Center for Road & Bridge Agencies

LiDAR Provides Advantages to Local Public Works Agencies in Kansas

By Pat Weaver

What is LiDAR? Can it work for you?

Looking for lower-cost but accurate ways to collect data to support local road construction, maintenance and operations is of critical importance at a time when resources are short. Technologies that promise to save us time, or give us more and more accurate data, or save us money, don't always live up to that promise. However, LiDAR is a technology whose time has come, and it is proving itself in the field to support public works functions. The purpose of this article is to provide a bit of an overview about LiDAR and its capabilities, describe some of the advantages and disadvantages over traditional photogrammetric and surveying techniques, and provide some case examples of how Kansas counties are putting the technology to good use.

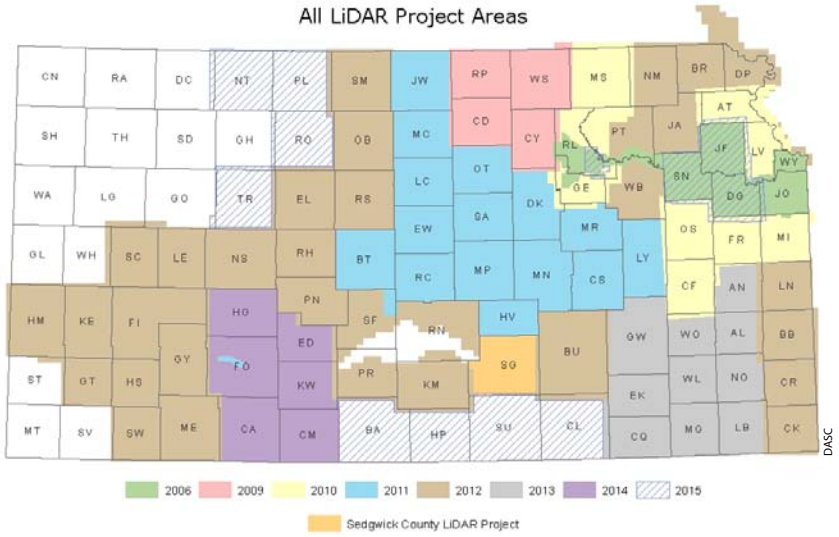


Figure 1. *This map shows counties that have been mapped with LiDAR since 2006. Eight more will be mapped this year.*

First, what is LiDAR?

LiDAR is an acronym for Light Detection and Ranging (pronounced LIE-dar). LIDAR is a technique for remotely sensing the shape of surfaces, typically using lasers. It produces high-resolution maps, measuring distance by illuminating a target with the laser. In the context of GIS, LiDAR refers to data collected using specialized equipment and airplanes to measure the elevation of the ground over a geographic area. The resulting elevation data creates a 3D model of the area, adding a "z" height value to the x, y coordinate pair.

Typical uses of elevation data in public works

LiDAR has been used for public works applications in a number of way, and the list is growing as datasets become more and more available. In a study conducted in 2012, Bryan Young found that "LiDAR survey data may not replace traditional ground-based survey for applications that require centimeter or sub-centimeter accuracy," but is still very good for many public works applications. Examples include hydraulic modeling for floodplain mapping, earthwork calculations for preliminary route planning, and line-of-sight distance analysis.

The Kansas GIS Policy Board reports several examples of LiDAR applications that have been used in Kansas. For example, the Jefferson County Road and Bridge Department requests maps with contour data to plan bridge and culvert repair to depict slope and drainage areas.

Data collection with LiDAR

According to the Kansas Data Access and Support Center (DASC), there have been five projects collecting LiDAR data in the state of Kansas since 2006. The majority of the state has been mapped, as shown in Figure 1. All but 15 counties have been mapped (or will be by the end of 2015). Files are available for download from DASC, provided that you are logged in to a DASC account. Example formats available for download include TIFF, LAS idar, Interactive Map, DEM, and File Geodatabase. You can find information on these files at http://www.kansasgis.org/resources/lidar.cfm.

integrating LiDAR data with GIS

ArcGIS supports LiDAR data provided as LAS—an industry-standard binary format for storing airborne LiDAR data that includes the set of LAS files plus additional surface feature files. Two additional types of datasets (terrain and mosaic) also can be used to manage and work with your LiDAR data in ArcGIS, depending on your needs.

Advantages of LiDAR mapping?

The advantages typically mentioned in the use of LiDAR include the speed and accuracy with which data can be collected, and the potential for cost savings due to quicker data collection.

Speed and accuracy. LiDAR offers several advantages in the area of speed and accuracy over traditional surveying techniques. LiDAR sensors can be operated in any weather, and are not affected by low sun angles. LiDAR allows for the inclusion of larger areas for analysis than can be effectively surveyed, saving both time and money. It creates a 3D model directly from the returns. And finally, safety is improved since objects are measured remotely, eliminating operations such as measuring roadways under traffic.

Cost savings. "What does it cost?" and "Can it save me money?" are generally the first two questions about any new technology or process. Without LiDAR, obtaining accurate elevation measurements involved employing a survey crew averaging about $200 an hour, according to estimates from Shawnee County (Kansas GIS Policy Board, 2010). Surveys, especially in highly vegetated areas, can be expensive since the land must be cleared prior to surveying. LiDAR data significantly reduces the cost of the project and avoids impacts of clearing vegetation to survey.

LiDAR applications in Barton County

Barton County Public Works has made use of LiDAR data for the past four years. Mapped in 2011 under a Kansas DASC project, Barton County under County Engineer Clark Rusco's direction has made use of LiDAR data for flood management and for road construction cost estimation. The first use of the data was for flood management. LiDAR data provided much better detail than previous maps, with contour lines every one foot of elevation instead of every five to 10 feet of elevation, a big help to projecting flood events in varying rainfall conditions. Rusco said that LiDAR helped them identify the source of flooding near Ellinwood, despite previous flood studies that had not detected drainage swales as the source of the problem.

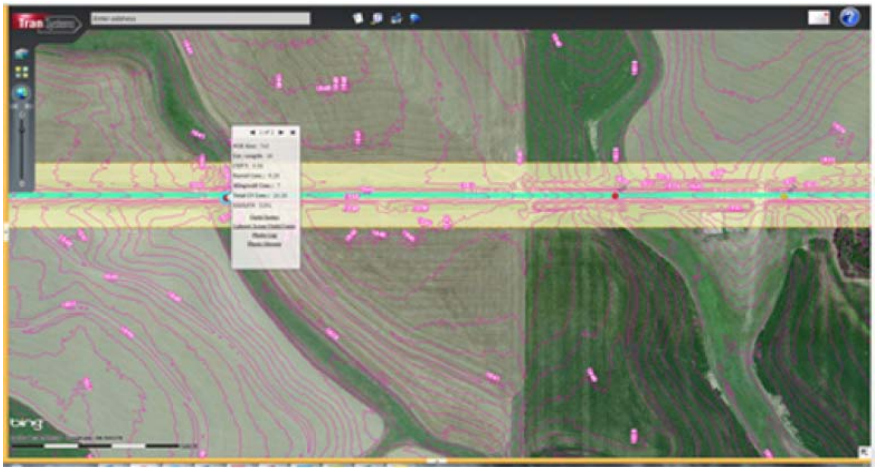
The second application Rusco is very excited about is in cost estimation for local road construction in the county. According to Rusco, the county's previous estimates for dirt and concrete work costs in grant applications have been based on very rough estimates, often overestimated somewhat to ensure adequate resources for the projects. Using LiDAR allows quicker and more accurate estimating for materials. One example he shared was of a grant application under the KDOT's High-Risk Rural Road Program in which modifications were proposed for work on multiple Reinforced Concrete Box Culverts (RCBs). Just by looking at the maps provided through LiDAR, and with some measurement using the LiDAR map, he was able to estimate dirt and concrete needed for the project. Surveying each site would have been cost-prohibitive.

Under contract with Barton County, TranSystems developed a model using the LiDAR map layers within ESRI™ to provide additional functionality to the inventory of RCBs. The layers include field notes, the Culvert Scour Field Form, photo log and viewer, right of way, traffic counts, and a cost-benefit model to prioritize projects—still in final stages of agreement with KDOT on the underlying assumptions. See Figure 2 on page 3.

Since most of these projects are primarily culvert extensions, they plan to use the LiDAR to develop a grading plan at each, according to Slade Engstrom, Professional Engineer at TranSystems. They will import the point cloud (the data produced from LiDAR based on XYZ coordinate geometry) into Microstation™ and develop an existing surface which can be used to show proposed grading.

Rusco is a big believer in the benefits of LiDAR to save time and resources and provide much more accuracy in projects than using more traditional approaches. Engstrom qualifies his enthusiasm for the technology a bit, stating "speed is the big reason to use LiDAR.…The data is very accurate, [but] the point clouds generated by the LiDAR data are somewhat cumbersome, and you have to be careful when working with the huge number of points because depending on when the data was

Do you have a DASC account? If not, here's how to get one — and it's free! The GIS resources from the Kansas Data Access and Support Center (DASC) can be a great assistance, and they are all free. You just need to register in order to download GIS data, receive notification of newly published data, and be able to communicate with GIS professionals across the state. Just go to http://www.kansasgis.org/members/index.cfm and enter your contact information and create a user name and password. It's as easy as that. DASC resources aren't limited to just GIS files, but a number of other data resources are available as well. Check out their free resources at http://www.kansasgis.org/catalog/index.cfm.



TranSystems

Figure 2. *This LiDAR map shows a road segment in Barton County with 1 ft contours. The layers, developed by TranSystems, include the ROW shown in yellow and culverts shown as red dots on the road. Data attached to the culverts include size, characteristics, scour form, and a photo log. A cost-benefit analysis is under development to help prioritize projects.*

collected, often if there is crop cover or prairie grass that is a foot or more above the actual ground. This causes the point cloud to include points for these features, which are "higher" than existing ground. Caution should definitely be used with the data to make sure these points get filtered, or additional hard survey is completed in these areas…." For earthwork or emergency repair projects," as applied in Barton County, "the data generally works pretty well," he said.

Jefferson County's recent experiences with LiDAR

DASC reported in 2010 that Jefferson County was requesting maps to plan bridge and culvert repair. Bill Noll, Jefferson County Road Supervisor, provided us an update on LiDAR uses in his county. He said that the county is still using the LiDAR contours for all projects that require the replacement of culverts or box structures that have an opening wider than 48 inches. Since Jefferson County does not employ a licensed engineer, most of those services are contracted to Finney and Turnipseed for bridges, and to McAfee Henderson Solutions for culverts and box structures, to complete the designs and obtain the necessary permits. The consultants obtain the LiDAR contour information from the Jefferson County GIS Department.

Jefferson County has used the contours to get elevations for all the bridge decks in the county. From his previous experience as a licensed surveyor for the county, Noll has found the contours to be accurate to within +- 0.5 ft 95 percent of the time, with no errors found to be greater than 0.8 ft.

Noll also has used the contour maps as an aid in floodplain management and for preliminary plats that did not have any interior developed roads or structures other than houses. He has found the contours to be accurate and easy to use to find large drainage acreage quantities. The disadvantage, according to Noll, is that the contour file is large so that he typically uses only the 5 ft or 10 ft contours.

LiDAR mapping resources in Kansas

The Data Access and Support Center (DASC) was created by the State of Kansas Geographic Information Systems (GIS) Policy Board. Established in 1989, DASC has responsibility to develop Kansas GIS technology management policies and direct the Kansas GIS Initiative. Cooperation between agencies in Kansas has led to the development of a sizable core database. (http://www.kansasgis.org/resources/lidar.cfm). Download of the files from the DASC site is straightforward. "GIS is pretty seamless, but to bring [the data] into Microstation you have to filter the points and convert to other files," Engstrom said.

Conclusion

Public works agencies are just beginning to benefit from the advantages of LiDAR data to meet their needs for surveying and inventory. However, we already have good examples in Kansas of how the LiDAR data has benefitted counties and those examples are expected to grow. The Kansas DASC site and the work of the GIS Policy Board are great resources to keep you up to date on latest development and to provide support for future application.

For more information on downloading files from DASC, call (785) 864-2000 or email dasc@kgs.ku.edu. ■

Reprinted from the Spring 2015 issue of the *Kansas LTAP Newsletter*, a publication of the Kansas Local Technical Assistance Program (LTAP) at the Kansas University Transportation Center.

Sources:

- Engstrom, Slade, Professional Engineer, TranSystems, Wichita, Kansas. Email interview April 29, 2015
- Rusco, Clark, Barton County County Engineer, Great Bend, Kansas. Phone interview April 27, 2015
- Use of LiDAR Technology in Local Government, Kansas GIS Policy Board, Fact Sheet No. 2, February 16, 2010. http://www.kansasgis.org/resources/_lidar/rpt_LiDAR_Local_Government_FS_022510_tr.pdf
- Young, C. Bryan (February 2013) Assessing LiDAR Elevation Data for KDOT Applications, Final Report. Report No. K-TRAN: KU-10-8. Topeka, Kansas: Kansas Department of Transportation. http://ntl.bts.gov/lib/47000/47100/47160/KU-10-8_Final.pdf