

The 3D Elevation Program—Supporting the Kansas Economy

Introduction

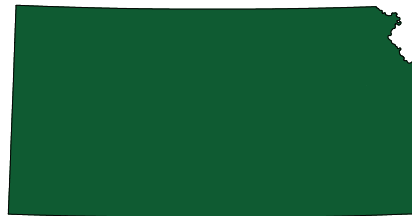
High-resolution elevation data for Kansas inform decision making to improve the State's economy. Existing elevation data coverage is used to support State water planning initiatives, facilitate infrastructure management, and improve resilience to natural disasters. The expanding availability of current and more accurate elevation data helps better support natural resources conservation, agriculture and precision farming, flood risk management, water supply planning, infrastructure and construction management, and geologic resource assessment and hazard mitigation. Critical applications that meet the State's management needs depend on light detection and ranging (lidar) data that provide a highly detailed three-dimensional (3D) model of the Earth's surface and aboveground features.

The 3D Elevation Program (3DEP; refer to [sidebar](#)) is managed by the U.S. Geological Survey (USGS) in partnership with Federal, State, Tribal, U.S. territorial, and local agencies to acquire consistent lidar coverage at quality level 2 or better ([table 1](#)) to meet the many needs of the Nation and Kansas. The status of available and in-progress 3DEP baseline lidar data in Kansas is shown in [figure 1](#). 3DEP baseline lidar data include quality level 2 or better, 1-meter or better digital elevation models, and lidar point clouds, and must meet the Lidar Base Specification version 1.2 (<https://www.usgs.gov/3dep/lidarspec>) or newer requirements. The National Enhanced Elevation Assessment (Dewberry, 2012) identified user requirements and conservatively estimated that availability of lidar data would result in at least \$14.41 million in new benefits annually to the State. The top nine Kansas business uses for

Table 1. Data quality levels, pulse spacing, and pulse density. Quality level 2 or better lidar data meet 3DEP requirements.

[Specifications for quality level 0 (QL0) are from Heidemann (2012, p. 3 and table 1); for quality levels 1 and 2, specifications are from Sugarbaker and others (2014, table 1). In the quality level column, QL0 represents the highest level of quality. RMSE_z, root mean square error in the elevation (z) dimension; cm, centimeter; m, meter; pls/m², first return pulses per square meter; ≤, less than or equal to; ≥, greater than or equal to]


Quality level	RMSE _z (cm)	Aggregate nominal pulse spacing (m)	Aggregate nominal pulse density (pls/m ²)
QL0	≤5	≤0.35	≥8.0
QL1	≤10	≤0.35	≥8.0
QL2	≤10	≤0.71	≥2.0



0 100 MILES
0 100 KILOMETERS

EXPLANATION

3DEP baseline lidar data

 Available and in-progress*

* Some areas may be restricted

Figure 1. Map of Kansas showing status of 3D Elevation Program (3DEP) baseline lidar data as of July 2024. Visit <https://usgs.gov/NationalMap/LidarExplorer> to find and download currently available data.

3D elevation data, which are based on the estimated annual conservative benefits of 3DEP, are shown in [table 2](#).

Status of 3DEP in Kansas

The State of Kansas has statewide lidar coverage consisting mostly of quality level 2 (QL2) lidar collected between 2010 and 2018. Quality level 1 (QL1) projects that are existing or underway in 2024 will provide QL1 coverage for approximately one-third of the State. Future acquisitions will be needed as older QL2 data age beyond the eight-year 3DEP guideline, and as the need for QL1 data becomes more widespread for change detection and in areas of low relief that are predominant in much of the State. Kansas participated in the 3D Nation study (Dewberry Engineers, Inc., 2022) to help define needs for the next generation of lidar data for the State and the Nation.

Water Supply and Quality

The Kansas Water Vision (Kansas Water Office, 2015) and the Kansas Water Plan (Kansas Water Office, 2022) are in place to evaluate water supplies and future water-use demands. Lidar data play a key part in the work to support these plans, including conducting sedimentation analyses upstream of water-supply reservoirs, evaluating geomorphic changes, identifying actively eroding streambanks, calculating lost sediment volumes and impacts to downstream public water-supply reservoirs, analyzing erosion from agriculture

sites, and identifying sources of nutrients and upstream erosion that cause harmful algal blooms.

Flood Risk Management

High-resolution elevation data are the basis for flood mapping by the Kansas Department of Agriculture and the Kansas Biological Survey & Center for Ecological Research. Accurate mapping of flood plains provides citizens information on the dangers of development in these high-risk areas, and to subsequently reduce financial costs and loss of human life due to flooding. Higher quality elevation data such as quality level 1 can provide significant benefits for flood inundation modeling.

Geologic Resource Assessment and Hazard Mitigation

Geologic mapping, including the assessment of mineral deposits and geologic hazards, can be performed more efficiently and accurately using lidar data. Geologic maps depict bedrock—the solid rock at the Earth's surface or directly beneath vegetation, soil, and thin deposits of unconsolidated material—and thick layers of sediment. These maps are essential for basic geologic research, evaluating natural resources, and land-use planning. Lidar data also are essential for geoarchaeology investigations of sediments, soils, and landforms to help identify areas of potential cultural deposits and assess prehistoric environments.

Natural Resources Conservation

Conservation of natural resources is assisted by lidar data for a variety of applications including soil conservation techniques, stream bank stabilization, point-source and non-point-source pollution modeling, and identification of wetlands for wildlife habitat and recreational purposes. A Topographic Wetland Identification Process (Kastens and others, 2016) was developed by the Kansas Biological Survey & Center for Ecological Research in collaboration with the Kansas Water Office to develop a standardized methodology and tool for wetland assessment and prioritization (Kansas Water Office, 2019) that can be used for wetland protection and restoration efforts by all agencies, watershed planners, and stakeholder groups in the State ([fig. 2](#)).

3DEP by the Numbers: Kansas

Expected annual benefits	\$14.41 million
Quality level 2 completion	100 percent
Quality levels 0 and 1 collection is at additional cost.	

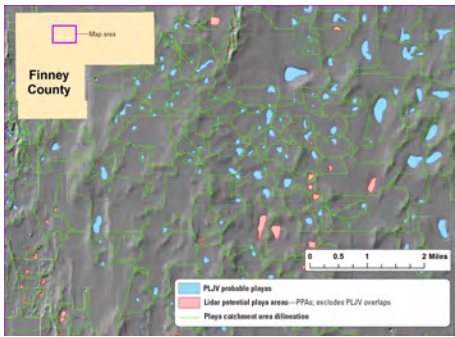


Figure 2. Map of an area in Finney County in western Kansas, where playa lakes were originally mapped (blue) using photointerpretation in the Playa Lakes Joint Venture (PLJV) database. Once lidar became available, additional playas were identified (in red) and playa catchment delineations were made (in green). Graphic courtesy of Kansas Biological Survey & Center for Ecological Research.

Infrastructure and Construction Management

State and regional agencies in Kansas use high-resolution elevation data for infrastructure and construction planning and management. Primary lidar uses include highway safety improvement, airspace protection near airports and air ambulance sites, emergency response planning, and bridge and road design, construction, and maintenance.

Table 2. Conservative benefits estimates for the top nine Kansas business uses of the proposed 3DEP data identified in the National Enhanced Elevation Assessment (Dewberry, 2012).

Rank	Business use	Annual benefits (millions)
1	Agriculture and precision farming	\$7.75
2	Natural resources conservation	3.19
3	Flood risk management	1.96
4	Infrastructure and construction management	1.05
5	Geologic resource assessment and hazard mitigation	0.16
6	Renewable energy resources	0.10
7	Aviation navigation and safety	0.10
8	Water supply and quality	0.07
9	Forest resources management	0.03
Total		14.41

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ISSN 2327-6916 (print)
ISSN 2327-6932 (online)
<https://doi.org/10.3133/fs20243053>

3D Elevation Program (3DEP)

The 3D Elevation Program is managed by the U.S. Geological Survey (USGS) on behalf of the community of Federal, State, Tribal, local, and other partners and users of elevation data. In response to growing needs for high-quality elevation data, the goal of 3DEP is to complete acquisition of nationwide light detection and ranging (lidar) data (interferometric synthetic aperture radar [IfSAR] data in Alaska) to provide the first-ever national baseline of consistent, high-resolution topographic elevation data—both bare-earth digital elevation models and 3D point clouds.

Benefits

- Economies of scale by acquiring data for larger areas.
- Predictable and flexible Federal investments that can reduce costs and allow better planning.
- Consistent national coverage that provides data for applications that span project, jurisdictional, and watershed boundaries.
- Simplified data acquisition that provides contracts, project management, quality assurance, and published data specifications.
- National benefits of \$690 million per year conservatively, with the potential to generate \$13 billion per year in additional benefits through applications that span the economy (Dewberry, 2012).

High-Quality Data and Products

3DEP lidar data provide coverage with a minimum of two points per square meter and a vertical error not to exceed 10 centimeters, measured as root mean square error in the elevation (z) dimension (RMSE_z) (table 1). 3DEP baseline lidar data products include all data points collected (point clouds) and bare-earth digital elevation models with a 1-meter or better resolution. The USGS integrates the elevation data into The National Map. Data are available free of charge and without use restrictions. To download 3DEP products visit <https://apps.nationalmap.gov/downloader/>.

Ways to Participate

Participation in 3DEP is open to Federal, State, Tribal, U.S. territorial, and local government partners, as well as private sector partners, and offers the option to acquire even higher quality data. Partners may contribute funds toward projects managed by the USGS, or they may receive cooperative funds to manage their own projects. An annual Data Collaboration Announcement is the mechanism used to establish partner agreements. Organizations and the private sector may contribute existing data that meet 3DEP requirements. For more information refer to the 3DEP website at <https://www.usgs.gov/3DEP/collaborate/>.