

The 3D Elevation Program—Supporting Arkansas’s Economy

Introduction

In recent years, Arkansas has coordinated with Federal and local partners to improve the quality and availability of high-resolution elevation data for the State. With high-quality elevation data, Arkansas can improve services offered to the public and within government, resulting in better quality of life, improved public safety, and higher return on investments. Elevation data are beneficial in numerous business activities, including agriculture and precision farming, flood risk management, geologic resource assessment and hazard mitigation, infrastructure and construction management, urban and regional planning, and natural resources conservation. 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; see 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 Arkansas. The status of available and in-progress 3DEP baseline lidar data in Arkansas 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

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 (2014, p. 3 and table 1); for quality levels 1 and 2 the 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

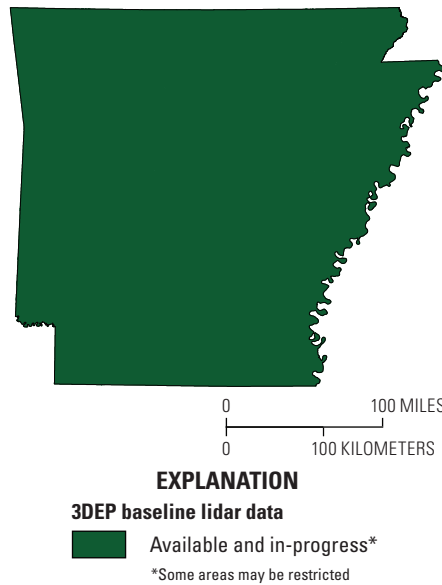


Figure 1. Map of Arkansas showing status of 3D Elevation Program (3DEP) baseline lidar data as of May 2023. Visit <https://usgs.gov/NationalMap/LidarExplorer> to see and download currently available data.

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 \$7.32 million in new benefits annually to the State. The top seven Arkansas business uses for 3D elevation data, which are based on the estimated annual conservative benefits of 3DEP, are shown in table 2.

Flood Risk Management

In the spring of 2019, historic flooding occurred in Arkansas, setting new records for river crests and inundating homes, businesses, farms, and entire communities, some of which had no recorded history of floods (Yount and Boulden, 2019). Economic effects included loss of crops and shutdown of river traffic, halting the movement of commerce. Lidar data can be used to improve inundation and forecast models (fig. 2), conduct analyses of flood impacts and timing within urban and natural landscapes, and plan evacuation routes, to help mitigate damage, improve public safety, and protect life and property. In 2017, the Federal Emergency Management Agency and the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS) led an effort to collect quality

level 2 lidar data for large areas of the State, including those affected by flooding. These data are used to help mitigate damage from the impacts of natural disasters.

Natural Resources Conservation

Lidar data enable State, regional, and local governments to effectively implement natural resources conservation practices such as grade stabilization, dam safety oversight, provision of habitat easements, siting of pipelines, terracing, wetland restoration, and protection of sensitive areas, while providing cost savings to the public. Arkansas is using quality level 2 lidar to conduct detailed geologic mapping of a watershed in the northwestern part of the State, with the results being used by the NRCS in Arkansas.

Urban and Regional Planning

Regional planning commissions and local governments use elevation data to develop policies for sustainable development, evaluating factors such as transportation, land use planning, cultural assets, public safety, water supply, and infrastructure management. Having regional lidar data reduces the time required for gathering base data and conducting analyses. Visual planning and mapping tools can be created to display existing and future conditions for land suitability, proposed development, and growth patterns, which help inform the general public and elected officials.

Geologic Resource Assessment and Hazard Mitigation

The Arkansas Geological Survey (AGS) uses elevation data to conduct detailed mapping, analysis of geologic structures and stratigraphy, and assessment of critical mineral resources with grant funding assistance from the USGS (U.S. Geological Survey, 2020a,b). The availability of statewide high-resolution elevation data allows for improved accuracy and detail in geologic maps and data that inform public policy and support Arkansas’s mineral and fossil-fuel production, valued at more than \$1 billion per year (Cannon, 2017).

The AGS also uses elevation data to improve understanding of the geologic hazards

3DEP by the Numbers: Arkansas

Expected annual benefits	\$7.32 million
Quality level 2 completion	100 percent
Quality levels 0 and 1 collection is at additional cost.	



Figure 2. Lidar-derived 5-foot contours (white lines) were a critical asset for emergency managers during historic Arkansas River flooding in spring 2019.

that not only impact vulnerable areas with property damage and loss, utility disruption, and loss of access, but also require costly mitigation. The AGS is currently conducting a statewide landslide inventory using 1-meter-resolution lidar.

References Cited

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Table 2. Conservative benefits estimates for the top seven Arkansas 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	\$2.39
2	Natural resources conservation	2.12
3	Flood risk management	1.47
4	Infrastructure and construction management	0.59
5	Forest resources management	0.30
6	River and stream resource management	0.15
7	Geologic resource assessment and hazard mitigation	0.11
	Other	0.19
	Total	7.32

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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 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 provides 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) (see 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

3DEP participation 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 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 Broad Agency 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 see the 3DEP website at <https://usgs.gov/3DEP/collaborate/>.