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The 3D Elevation Program—Summary for Pennsylvania

Introduction

Elevation data are essential to a broad range of applications, including forest resources management, wildlife and habitat management, national security, recreation, and many others. For the Commonwealth of Pennsylvania, elevation data are critical for natural resources conservation (including the effects of drilling for oil and natural gas), agriculture and precision farming, flood risk management, infrastructure and construction management, water supply and quality, geologic resource assessment and hazard mitigation, and other business uses. Today, high-density light detection and ranging (lidar) data are the primary sources for deriving elevation models and other datasets. Federal, State, and local agencies work in partnership to replace data that are older and of lower quality. A joint goal of Commonwealth and Federal partners is to provide a temporal and density refresh of the current statewide coverage in order to support existing and emerging applications enabled by improved lidar data.

The National Enhanced Elevation Assessment (NEEA; Dewberry, 2011) evaluated multiple elevation data acquisition options to determine the optimal data quality and data replacement cycle relative to cost to meet the identified requirements of the user community. The evaluation demonstrated that lidar acquisition at quality level 2 (table 1) for the conterminous United States and quality level 5 interferometric synthetic aperture radar (ifsar) data (table 1) for Alaska with a 6- to 10-year acquisition cycle provided the highest benefit/cost ratios. The 3D Elevation Program (3DEP) initiative (Snyder, 2012a,b) selected an 8-year acquisition cycle for the respective quality levels. 3DEP, managed by the U.S. Geological Survey (USGS), the Office of Management and Budget Circular A–16 lead agency for terrestrial elevation data, responds to the growing need for high-quality topographic data and a wide range of other 3D representations of the Nation's natural and constructed features.

3DEP in Pennsylvania by the Numbers

Expected annual benefits	$7.50 million
Estimated total cost	$15.13 million
Payback	2.0 years
Quality level 1 buy-up estimate	$9.63 million

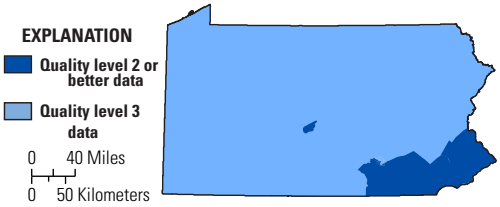

Figure 1. Map of Pennsylvania showing publicly available lidar data. Information source is the United States Interagency Elevation Inventory, March 2015 (http://coast.noaa.gov/inventory/?redirect=301ocm#), which is updated annually. Quality level 2 or better data meet 3DEP requirements. See table 1 for quality level information.

3D Elevation Program Benefits for Pennsylvania

The top 10 Pennsylvania business uses for 3D elevation data, which are based on the estimated annual conservative benefits of the 3DEP initiative, are shown in table 2. The NEEA survey respondents in the Commonwealth of Pennsylvania estimated that the national 3DEP initiative would result in at least $7.5 million in new benefits annually to the Commonwealth. The cost for such a program in Pennsylvania is approximately $15 million, resulting in a payback period of 2.0 years and a benefit/cost ratio of 4.0 to 1 over an 8-year period. Because monetary estimates were not provided for all reported benefits, the total benefits of the 3DEP to Pennsylvania are likely much higher. On the basis of the NEEA survey results, all levels of government and many organizations in Pennsylvania could benefit from access to statewide high-resolution elevation data.

For Pennsylvania, approximately 82 percent of the identified business use requirements will be met in natural resources conservation, agriculture and precision farming, and flood risk management uses, as shown in table 2. The status of publicly available lidar data in Pennsylvania is shown in figure 1. By enhancing coordination in Pennsylvania, it may be possible to realize more than the cited conservative benefits and attain the higher potential benefits for many business uses.

The following examples highlight how 3DEP data can support business uses in Pennsylvania: (1) Dense vegetation and woodland can obscure hazardous areas. Lidar digital terrain (bare earth) models can be used to locate

3D Elevation Program

3DEP is a national program managed by the USGS to acquire high-resolution elevation data. The initiative is backed by a comprehensive assessment of requirements (Dewberry, 2011) and is in the early stages of implementation. 3DEP will improve data accuracy and provide more current data than is available in the National Elevation Dataset (NED). The goal of this high-priority cooperative program is to have complete coverage of the United States by the end of 2022, depending on funding and partnerships. 3DEP can conservatively provide new benefits of $1.2 billion/year and has the potential to generate $13 billion/year in new benefits through improved government services, reductions in crop and homeowner losses resulting from floods, more efficient routing of vehicles, and a host of other government, corporate, and citizen activities (Dewberry, 2011). A shared, common elevation dataset would foster cooperation and improve decision-making among all levels of government and other stakeholders.

Benefits of a Funded National Program

- Economy of scale—Acquisition of data covering larger areas reduces costs by 25 percent.
- A systematic plan—Acquisition of data at a higher quality level reduces the cost of "buying up" to the highest levels needed by State and local governments.
- Higher quality data and national coverage—Ensure consistency for applications that span State and watershed boundaries and meet more needs, which results in increased benefits to citizens.
- Increase in Federal agency contributions—Reduces State and local partner contributions.
- Acquisition assistance—Provided through readily available contracts and published acquisition specifications.

and assess abandoned mine lands, landscape changes related to oil and natural gas drilling, active landslides and preexisting landslides that are susceptible to reactivation (fig. 2), and to detect sinkhole features in karst areas that have not been identified in previous elevation programs. These lidar-derived data support public and environmental safety programs and the site-selection process for industry and commerce. (2) Millions of dollars are saved throughout Pennsylvania because many governmental units, academia, and private organizations use the PAMAP (http://www.dcnr.state.pa.us/topogeo/pamap/index.aspx) imagery, lidar, and other data and information for various applications across the State related to natural resource extraction. This readily available statewide data and information help to make informed decisions for project planning, permitting, and design, and for environmental assessment, code enforcement, and emergency response. (3) Lidar data provide high-quality terrain information as input for more accurate and cost-effective flood studies, hydrologic and hydraulic modeling, design of structures (bridges, culverts, dams) to better accommodate runoff from large rain events, and storm and wastewater management and engineering. Lidar data also aid in improved flood inundation models that facilitate better floodplain-management decisions, such as early warnings from the Susquehanna Flood Forecast and Warning System (http://www.susquehannafloodforecasting.org/mapping-data.html) and help to educate the public on flood risks.

References Cited

Dewberry, 2011, Final report of the National Enhanced Elevation Assessment (revised 2012): Fairfax, Va., Dewberry, 84 p. plus appendixes, http://www.dewberry.com/Consultants/GeospatialMapping/FinalReport-NationalEnhancedElevationAssessment.

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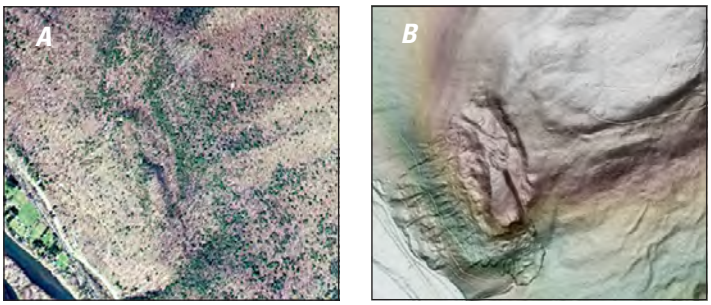

Figure 2. Comparison of an orthophoto image (*A*) and a lidar-derived image (*B*) showing the slope of a geologically old but still active landslide in Clinton County, Pennsylvania. The lidar image shows both bedrock and colluvial soil movement. Colors used are from the standard elevation ramp. Courtesy of Pennsylvania Department of Conservation and Natural Resources, Pennsylvania Geological Survey.

Table 2. Conservative benefits estimates for the top 10 business uses of the proposed 3DEP data identified in the National Enhanced Elevation Assessment for Pennsylvania (Dewberry, 2011).

Rank	Business use	Annual benefits (millions)
1	Natural resources conservation	$2.28
2	Agriculture and precision farming	2.02
3	Flood risk management	1.85
4	Infrastructure and construction management	0.35
5	Water supply and quality	0.31
6	Forest resources management	0.31
7	Aviation navigation and safety	0.16
8	Geologic resource assessment and hazard mitigation	0.14
9	Coastal zone management	0.03
10	Renewable energy resources	0.02
	Other	0.03
	Total	7.50

3D Elevation Program—Continued

The USGS and its partners will acquire quality level 2 or better (table 1) 3D lidar data over the conterminous United States, Hawaii, and the U.S. territories. Interferometric synthetic aperture radar (ifsar) data are being collected at quality level 5 (table 1) in Alaska. The data will be acquired over an 8-year period and will be made available to the public. By using this acquisition scenario a number of high-quality elevation-data products can be created to serve a wide range of business uses in government and the private sector.

Table 1. Data quality levels and related accuracies for the 3D Elevation Program (3DEP) initiative as provided on page 6 in USGS Circular 1399 (http://dx.doi.org/10.3133/cir1399). These data quality parameters for the 3DEP initiative approximate those used in the National Enhanced Elevation Assessment (Dewberry, 2011).

[$RMSE_{(z)}$, root mean square error in the *z* (elevation) dimension; n/a, not applicable]

Quality level	Nominal pulse spacing (meters)	Vertical error as $RMSE_{(z)}$ (centimeters)
1	0.35	10
2	0.7	10
3	1.4	20
4	n/a	139
5	n/a	185

Next Steps for Implementing 3DEP

Accomplishing the 3DEP initiative's goal of national coverage in 8 years depends on the following factors:

- Increased partnerships among Federal, State, Tribal, and local governments.
- Partnerships that acquire elevation data to the program's specifications across larger project areas.
- Increased communication about and awareness of the program's benefits and goals.
- Support for the program from government and other stakeholders.

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