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The 3D Elevation Program—Summary for West Virginia

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 State of West Virginia, elevation data are critical for natural resources conservation, flood risk management, forest resources management, infrastructure and construction management, agriculture and precision farming, 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, Tribal, and local agencies work in partnership to (1) replace data that are older and of lower quality and (2) provide coverage where publicly accessible data do not exist. A joint goal of State and Federal partners is to acquire consistent, statewide coverage to support existing and emerging applications enabled by 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 West Virginia by the Numbers

Expected annual benefits	$2.65 million
Estimated total cost	$8.10 million
Payback	3.1 years
Quality level 1 buy-up estimate	$5.15 million

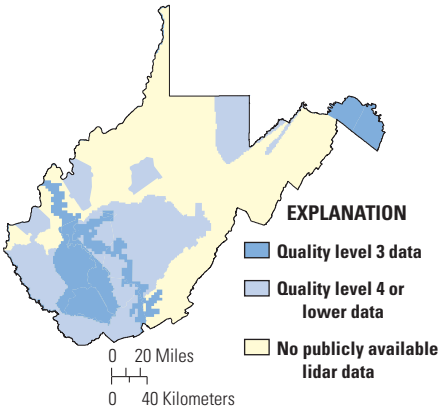

Figure 1. Map of West Virginia showing publicly available lidar data. Information source is the United States Interagency Elevation Inventory, June 2014 (*http://coast.noaa.gov/inventory/?redirect=301ocm#*), which is updated annually. No data that meet 3DEP requirements for quality level 2 or better are publicly available for West Virginia. See table 1 for quality level information.

3D Elevation Program Benefits for West Virginia

The top 10 West Virginia 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 State of West Virginia estimated that the national 3DEP initiative would result in at least $2.6 million in new benefits annually to the State. The cost for such a program in West Virginia is approximately $8.1 million, resulting in a payback period of 3.1 years and a benefit/cost ratio of 2.6 to 1 over an 8-year period. Because monetary estimates were not provided for all reported benefits, the total benefits of the 3DEP to West Virginia are likely much higher. On the basis of the NEEA survey results, all levels of government and many organizations in West Virginia could benefit from access to statewide high-resolution elevation data.

For West Virginia, approximately 72 percent of the identified business use requirements will be met in natural resources conservation and flood risk management uses, as shown in table 2. The status of publicly available lidar data in West Virginia is shown in figure 1. By enhancing coordination between 3DEP and various government and private organizations in West Virginia, it may be possible to realize

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 be operational by early 2015, and 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.

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 West Virginia: (1) Lidar data provide high-quality terrain information as input for more accurate and less expensive hydrologic and hydraulic modeling for flood studies; the design of structures such as bridges and culverts to accommodate runoff and flooding from large rain events; and retention dam design, dam breach studies, and stormwater management and engineering. Lidar data also aid the identification of vulnerable properties within a floodplain, facilitating better floodplain-management decisions and education of the public on true flood risks. (2) Geologic hazards, such as slope failures (landslides), active faults, abandoned mines, and sinkholes in karst terrain can be hidden or obscured by heavy vegetation or forest cover, making them difficult to identify and locate. With the availability of lidar bare-earth imagery, a detailed view of the earth's surface without vegetation is possible, allowing for the identification and systematic mapping of these features, which can support geologic risk assessment, hazard mitigation, land use planning, and the site selection process for industry and commerce. For example, bare-earth lidar digital elevation models and slope-shade maps can be used to identify diverse anthropogenic (human impacted) landforms generally related to mining, roads, and railroads (fig. 2). The largest anthropogenic landforms tend to be unreclaimed strip-mine benches. The near-vertical high walls above and angle-of-repose fill slopes below the mining benches are potentially unstable; thus, these landforms commonly contribute to landslides within the New River Gorge National River in southern West Virginia.

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.

Snyder, G.I., 2012a, National Enhanced Elevation Assessment at a glance: U.S. Geological Survey Fact Sheet 2012–3088, 2 p., http://pubs.usgs.gov/fs/2012/3088/.

Snyder, G.I., 2012b, The 3D Elevation Program—Summary of program direction: U.S. Geological Survey Fact Sheet 2012–3089, 2 p., http://pubs.usgs.gov/fs/2012/3089/.

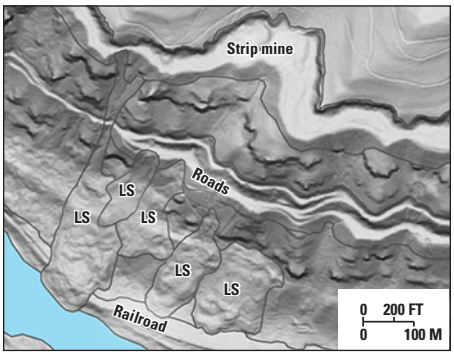

Figure 2. Bare earth imagery allows for the identification of landslides (LS) within the New River Gorge National River park, southern West Virginia. Black lines bounding a strip mine, roads, and a railroad show the extent of disturbed ground associated with these features. Image courtesy of Marla K. Yates and Stephen J. Kite, Department of Geology and Geography, West Virginia University.

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

Rank	Business use	Annual benefits (millions)
1	Natural resources conservation	$0.97
2	Flood risk management	0.95
3	Forest resources management	0.21
4	Infrastructure and construction management	0.17
5	Agriculture and precision farming	0.12
6	Geologic resource assessment and hazard mitigation	0.10
7	Water supply and quality	0.05
8	Aviation navigation and safety	0.05
9	River and stream resource management	0.01
10	Renewable energy resources	0.01
	Other	0.01
	Total	2.65

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 are 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	2.0	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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