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The 3D Elevation Program—Summary for Vermont

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 Vermont, elevation data are critical for hazard mitigation, geologic resource assessment, natural resources conservation, agriculture and precision farming, flood risk management, infrastructure and construction management, 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 Vermont by the Numbers

Expected annual benefits	$1.63 million
Estimated total cost	$3.21 million
Payback	2.0 years
Quality level 1 buy-up estimate	$2.04 million

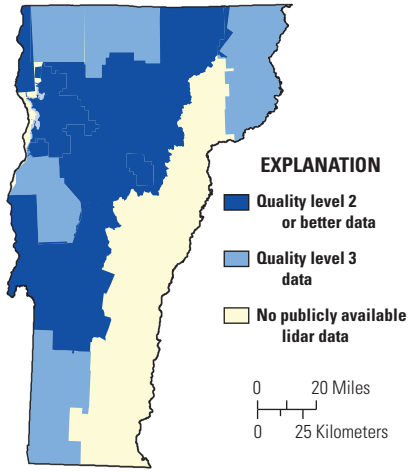


Figure 1. Map of Vermont showing the extent of existing and planned publicly available lidar data. Information source is the United States Interagency Elevation Inventory, October 2014 (*http://coast.noaa.gov/inventory/?redirect=301ocm#*), which is updated annually. Quality level 2 or better data meet 3DEP requirements. See table 1 for quality level information.

3D Elevation Program Benefits for Vermont

The top 10 Vermont 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 Vermont estimated that the national 3DEP initiative would result in at least $1.63 million in new benefits annually to the State. The cost for such a program in Vermont is approximately $3.2 million, resulting in a payback period of 2.0 years and a benefit/cost ratio of 4.1 to 1 over an 8-year period. Because monetary estimates were not provided for all reported benefits, the total benefits of the 3DEP to Vermont are likely much higher. On the basis of the NEEA survey results, all levels of government and many organizations in Vermont could benefit from access to statewide high-resolution elevation data.

For Vermont, approximately 83 percent of the identified business use requirements will be met in geologic resource assessment and hazard mitigation, 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 Vermont is shown in figure 1.

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.

By enhancing coordination between 3DEP and various government and private organizations in Vermont, 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 Vermont: (1) Lidar provides detailed data that enhances surficial geologic mapping used for the identification of landslides and assists with geologic resource assessments such as the identification of sand and gravel aquifers. As a headwater State, Vermont experiences landslides (fig. 2) throughout all its physiographic provinces. Currently (2015), statewide landslide data are mostly derived from topographic maps that have several limitations, including low resolution for elevation (based on contour interval) and age (some data are derived from maps that are decades old). Lidar provides a more current and detailed elevation dataset, thus allowing identification of potential landslide areas previously missed because of the lack of elevation detail. (2) Enhanced elevation data can enable public and private organizations to more effectively implement natural resources conservation practices while providing additional cost savings. If higher quality lidar data were available statewide, the public and private sectors could expand their use of lidar for planning and site-level engineering, which would reduce field work for conservation ponds, grassed waterways, pipelines, terracing, calculating runoff, identifying historic wetlands (drained), and wetland restoration. (3) For post-tropical storm Irene planning, lidar elevation data are critical to setting new baseline elevations in order to manage potential inundation and stream erosion areas. The data can support infrastructure planning and development, hazard mitigation, and in some cases, emergency response.



Figure 2. Landslide in glaciolacustrine sediments overlying glacial till on Great Brook in Plainfield, Vermont. A house and garage at the top of the landslide are at risk from further slope failure. Photograph taken July 19, 2013, courtesy of George Springston, Norwich University Department of Geology and Environmental Science.

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

Rank	Business use	Annual benefits (thousands)
1	Geologic resource assessment and hazard mitigation	$417
2	Natural resources conservation	378
3	Agriculture and precision farming	326
4	Flood risk management	236
5	Infrastructure and construction management	84
6	Forest resources management	83
7	Water supply and quality	69
8	Aviation navigation and safety	29
9	River and stream resource management	4
10	Renewable energy resources	3
	Other	6
	Total	1,635

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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