

The 3D Elevation Program—Summary for Massachusetts

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 Massachusetts, elevation data are critical for flood risk management, natural resources conservation, agriculture and precision farming, infrastructure and construction management, coastal zone 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 Massachusetts by the Numbers

Expected annual benefits	\$1.23 million
Estimated total cost	\$2.71 million
Payback	2.2 years
Quality level 1 buy-up estimate	\$1.72 million

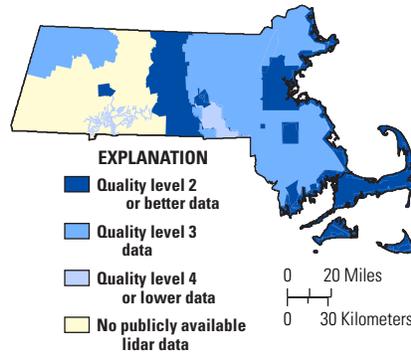


Figure 1. Map of Massachusetts showing the extent of existing and planned publicly available lidar data. Information source: United States Interagency Elevation Inventory, June 2014, updated annually. Quality level 2 or better data meet 3DEP requirements. See table 1 for quality level information.

3D Elevation Program Benefits for Massachusetts

The top 10 Massachusetts 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 Massachusetts estimated that the national 3DEP initiative would result in at least \$1.23 million in new benefits annually to the Commonwealth. The cost for such a program in Massachusetts is approximately \$2.7 million, resulting in a payback period of 2.2 years and a benefit/cost ratio of 3.6 to 1 over an 8-year period. Because monetary estimates were not provided for all reported benefits, the total benefits of the 3DEP to Massachusetts are likely much higher. On the basis of the NEEA survey results, all levels of government and many organizations in Massachusetts could benefit from access to statewide high-resolution elevation data.

For Massachusetts, approximately 75 percent of the identified business use requirements will be met in flood risk management, natural resources conservation, agriculture and precision farming, and infrastructure and construction management uses, as shown in table 2. The status of publicly available lidar data in Massachusetts is shown in figure 1. By enhancing coordination between 3DEP and various government and private organizations in Massachusetts, it may be possible to

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 January 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.

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 Massachusetts: (1) Lidar data provide high-quality terrain information as input for more accurate and less expensive hydrologic and hydraulic modeling for flood studies, retention dam design, dam breach studies, and stormwater management and engineering. Lidar data support the identification of river corridors vulnerable to inundation and fluvial erosion, facilitating better river corridor and floodplain-management decisions and education of the public on true flood risks. Dynamic 3D models that include lidar data provide more detailed information on the potential effects of flooding. (2) Climate change can have profound effects on the economy, public health, water resources, infrastructure, coastal resources, energy demand, natural features, and recreation. Lidar-derived digital elevation models and more accurate maps and surveys will help update current conditions, identify vulnerable natural features (fig. 2) and manmade facilities and structures, and improve the predictive capability of climate change models. A better understanding of the



potential effects of climate change will help in developing strategies that minimize the anticipated effects. For example, infrastructure can be adapted to address climate change projections by adhering to maintenance schedules; building system redundancies; updating land use, siting, design, and building standards; using natural systems for enhanced protection; and increasing the resilience of infrastructure and the built environment.

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. The marshes of Plum Island Estuary near Rowley, Massachusetts, are among those predicted by scientists to become inundated during the next century based on conservative projections of sea-level rise. U.S. Geological Survey, Matthew Kirwin photographer.

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

Rank	Business use	Annual benefits (millions)
1	Flood risk management	\$0.37
2	Natural resources conservation	0.34
3	Agriculture and precision farming	0.12
4	Infrastructure and construction management	0.09
5	Coastal zone management	0.08
6	Sea level rise and subsidence	0.08
7	Forest resources management	0.06
8	Aviation navigation and safety	0.04
9	Urban and regional planning	0.02
10	Geologic resource assessment and hazard mitigation	0.02
	Other	0.01
	Total	1.23

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. 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.

For Further Information:

Director,

USGS National Geospatial Program
12201 Sunrise Valley Drive, MS 511
Reston, VA 20192
Email: 3DEP@usgs.gov

Daniel H. Walters,

USGS Geospatial Liaison
196 Whitten Road
Augusta, ME 04330
Email: danwalters@usgs.gov

<http://nationalmap.gov/3DEP/>

By William J. Carswell, Jr.