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The 3D Elevation Program—Summary for Hawaii

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 Hawaii, elevation data are critical for infrastructure and construction management, flood risk management, geologic resource assessment and hazard mitigation, natural resources conservation, 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, U.S. territorial, 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, Hawaii, and selected U.S. territories, and quality level 5 interferometric synthetic aperture radar (IfSAR) data (table 1) for Alaska, all 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 three-dimensional (3D) representations of the Nation's natural and constructed features.

3DEP in Hawaii by the Numbers

Expected annual benefits	$2.95 million
Estimated total cost	$4.3 million
Payback	1.5 years
Quality level 1 buy-up estimate	$2.7 million

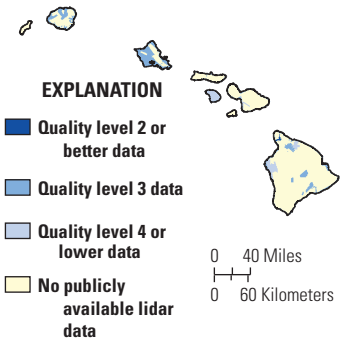

Figure 1. Map of Hawaii showing existing and planned-with-funding publicly available lidar data. Information source is the United States Interagency Elevation Inventory, fall 2015 (http://coast.noaa.gov/inventory/), which is updated annually. Quality level 2 or better data meet 3DEP requirements. See table 1 for quality level information.

3D Elevation Program Benefits for Hawaii

The top 10 Hawaii 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 Hawaii estimated that the national 3DEP initiative would result in at least $2.95 million in new benefits annually to the State. The cost for such a program in Hawaii is approximately $4.3 million, resulting in a payback period of 1.5 years and a benefit/cost ratio of 5.5 to 1 over an 8-year period. Because monetary estimates were not provided for all reported benefits, the total benefits of the 3DEP to Hawaii are likely much higher. On the basis of the NEEA survey results, all levels of government and many organizations in Hawaii could benefit from access to statewide high-resolution elevation data.

For Hawaii, approximately 87 percent of the identified business use requirements will be met in infrastructure and construction management, flood risk management, geologic resource assessment and hazard mitigation, and natural resources conservation uses, as shown in table 2. The status of publicly available lidar data in Hawaii is shown in figure 1. By enhancing coordination between 3DEP and various government and private organizations in Hawaii, it may be

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 2023, 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, Tribal, U.S. territorial, and local governments.
- Higher quality data and national coverage—Ensure consistency for applications that span State, Tribal, U.S. territorial, and watershed boundaries and meet more needs, which results in increased benefits to citizens.
- Increase in Federal agency contributions—Reduces State, Tribal, U.S. territorial, and local partner contributions.
- Acquisition assistance—Provided through readily available contracts and published acquisition specifications.

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 Hawaii: (1) When lidar data are readily available, the need for traditional topographic land surveys (including infrastructure and construction site planning and estimating) is minimized. Reducing the time required for project planning provides a cost savings to the public. Communication and energy infrastructure by both private utilities and governmental agencies have major ongoing needs, including broadband and renewable energy production (fig. 2). Enhanced elevation data help to improve compliance with building and environmental regulations and provide a sufficient level of detail to aid decisionmaking when evaluating numerous potential sites. (2) Sand resource management is of great concern within specific littoral cells around the Hawaiian Islands. Planners, engineers, and local decisionmakers could benefit from having enhanced elevation data that would help provide a more complete assessment of beach morphology and sand volume change—both to identify existing resources and active sand budgets and to help site new construction. New tools could be developed for identifying sand budgets in decline, which pose threats in the form of increased erosion and endangerment of infrastructure, property, and lives. Infrastructure and development plans could be drafted to change setbacks along the coastline, adapting to an eroding shoreline.

Figure 2. The islands of Hawaii have abundant natural resources that can be used to supply energy from wind, solar, geothermal, biofuel, and hydropower technologies. The natural resources could potentially meet a substantial portion of Hawaii's energy needs. Lidar data can help provide digital elevation models and point cloud information for the early evaluation of sites for renewable energy structures. Courtesy of Hawaii Department of Business, Economic Development and Tourism, Hawaii State Energy Office.

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

Rank	Business use	Annual benefits (millions)
1	Infrastructure and construction management	$1.77
2	Flood risk management	0.28
3	Geologic resource assessment and hazard mitigation	0.27
4	Natural resources conservation	0.24
5	Coastal zone management	0.15
6	Sea level rise and subsidence	0.14
7	Education K-12 and beyond	0.06
8	Forest resources management	0.03
9	Aviation navigation and safety	0.01
10	Homeland security, law enforcement, and disaster response	0.00
	Other	0.00
	Total	2.95

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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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, U.S. territorial, 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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