3D Elevation Program (3DEP)
Status and Plans
Outline

I. 3D Nation NEEA revisit

II. Focus Areas:
   I. 3DEP for Infrastructure
   II. 3DEP for Landslides

III. 3DEP in legislation

IV. Current Status

V. Future improvements
   I. Multi-year planning
   II. National Tiling Scheme
   III. Emerging Tech

VI. Budget

VII. FY18 BAA

VIII. LBS 1.3
3D Elevation Program (3DEP)

- Apply lidar technology to map bare earth and 3D data of natural and constructed features to enable more accurate understanding, modeling, and prediction
- Goal to complete acquisition of national lidar coverage with IfSAR in Alaska in 8 years
- Address the mission-critical requirements of 34 Federal agencies, 50 states, and other organizations documented in the National Enhanced Elevation Assessment
- ROI 5:1, conservative benefits of $690 million/year with potential to generate $13 billion/year
- Leverage the capability and capacity of private industry mapping firms
- Achieve a 25% cost efficiency gain by collecting data in larger projects
- Completely refresh national elevation data holdings with new products and services
# National Enhanced Elevation Assessment (NEEA) of 2012

<table>
<thead>
<tr>
<th>Rank</th>
<th>Business Use</th>
<th>Annual Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>Conservative</td>
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<tr>
<td>1</td>
<td>Flood Risk Management</td>
<td>$295M</td>
</tr>
<tr>
<td>2</td>
<td>Infrastructure and Construction Management</td>
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<tr>
<td>3</td>
<td>Natural Resources Conservation</td>
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<td>4</td>
<td>Agriculture and Precision Farming</td>
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<td>5</td>
<td>Water Supply and Quality</td>
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<td>6</td>
<td>Wildfire Management, Planning and Response</td>
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<tr>
<td>7</td>
<td>Geologic Resource Assessment and Hazard Mitigation</td>
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<tr>
<td>8</td>
<td>Forest Resources Management</td>
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<tr>
<td>9</td>
<td>River and Stream Resource Management</td>
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<td>$0.2M</td>
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<tr>
<td>Total for all Business Uses (1 – 27)</td>
<td>$1.2B</td>
<td>$13B</td>
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3D Nation Elevation

Requirements and Benefits Study - Goals

- Understand inland, nearshore and offshore bathymetric data requirements and benefits
- Understand how requirements and benefits dovetail in the nearshore coastal zone
- Plan for the next round of 3DEP after completion of nationwide coverage
- Gather technology-agnostic user information to be able to assess new technologies against requirements and identify the tradeoffs between different approaches
- Improve our understanding of needs to guide development of the next generation of 3DEP products and services
3DEP for Flood Risk Management

Conservative annual benefits estimated at $502M

- Producing much higher quality flood maps, including Flood Insurance Rate Maps
- Managing dam and levee safety programs reducing flood risks
- Improving hydrologic modeling and flood forecasting
- Improving State and local government flood risk management and response
- Improving storm water facilities and dam design
- Extracting building footprints and identifying the finished floor elevation in order to quantify potential damages based on flooding depths

Lidar aids hydraulic modeling to determine flood-inundation on the Saluda River, near Greenville, SC

Building footprints extracted from lidar in red

Courtesy of J. Dorman, NC Department of Public Safety, Floodplain Mapping Program
3DEP For America’s Infrastructure

The significant challenge of improving the Nation’s infrastructure depends on high-quality elevation data.

Conservative annual benefits estimated at $170M

- Route, grade, line-of-sight, and utility surveys and corridor mapping
- Terrain and other obstruction identification for aviation
- Dam, levee, and coastal-structure failure modeling and mitigation
- Hydraulic and hydrologic modeling
- Evaluations of geologic, coastal, and other natural hazards, and geotechnical evaluations
- Permit application and construction plan development and evaluation
- Drainage issues and cut-and-fill estimate requirements
- Vegetation, topographic, and geomorphologic feature analysis
- As-built model development
- Preliminary engineering, estimate development, and quantity estimation activities
- Bridge site selection
- Base-map and elevation model creation

Lidar point cloud (top) and a derived bare-earth digital elevation model (bottom) for Denver, CO
3DEP for Landslides Recognition, Hazard Assessment, and Mitigation Support

Conservative annual benefits estimated at $20.2 M

- Input to slope-stability models used to identify where shallow landslides may mobilize into fast-moving, potentially damaging and deadly debris flows
- Determine fundamental and highly detailed descriptions of boundary and conditions for landslide initiation
- Plan for evacuations and staging areas
- Create accurate landslide inventory and deposits maps and estimate the shape and activity of landslides
- Provide baseline information for change-detection comparisons, such as estimating sediment transport rates
- Develop novel approaches for estimating landslide thickness and ages of landslide deposits

Baum and others (2014) showed that compared to other technologies, using 3DEP data identified 3 to 200 times the number of landslides in densely forested areas
National Landslide Preparedness Act

115TH CONGRESS S. 698

- Bipartisan legislation - To establish a national program to identify and reduce losses from landslide hazards, to establish a national 3D Elevation Program
- Establish an interagency coordinating committee composed of the following members
  - The Secretary of Interior, who shall serve as Chairperson of the Committee
  - The Secretary of Agriculture
  - The Secretary of Commerce
  - The Secretary of Homeland Security
  - The Director of the National Science Foundation
  - The Director of the Office of Science and Technology Policy
  - The Director of the Office of Management and Budget
  - The head of any other Federal department or agency, at the request of the Secretary
- The Secretary shall establish, within the National Geospatial Advisory Committee, a subcommittee
  - Representatives from research and academic institutions; industry standards development organizations; units of State and local government; and the private sector
  - Conduct an assessment of trends and developments in the collection, dissemination, and use of 3D elevation data; and science and technology relating to 3D elevation data; the effectiveness of the program, the need to revise or reorganize the 3DEP; and the management, coordination, implementation, and activities of the 3DEP
  - Not later than 1 year after enactment, and every 2 years thereafter, submit to the Committee a report that includes the findings of the assessment and recommendations
3DEP FY17 Partnerships To Date

10.7%* of the Nation has been contracted
* Excludes Alaska, and does not include all projects under development

- Including FY17 planned data, 3DEP data have been contracted for nearly 37% of the entire US
- Alaska IfSAR – 84% available or in work to date in FY17

Map shows lidar from FY13 – FY16
10.7%* of the Nation has been contracted

* Excludes Alaska, and does not include all projects under development
Data Contracted in FY17
Alaska IfSAR – 84% Available or In Work
3DEP National Multiyear Plan

Background

- 3DEP Executive Forum tasked the 3DEP Working Group to develop plan to:
  - Move from an annual, opportunistic process to a unified multi-year plan
  - Move from patchwork irregular acquisition footprints to a defined planning and delivery unit (tiling scheme)
  - Implement a phased approach beginning in FY18

- Benefits
  - Facilitate greater investments and leveraging through longer planning lead times
  - Defined units facilitate planning and understanding costs, allow for improved reporting and justification of investments
  - Presents a plan for nationwide coverage
3DEP Multi-Year Planning (FY18 – FY20)
PRELIMINARY Federal Plan

- Based on input from Federal agencies
- Assumes a level budget
- Identifies projects with a minimum/ partial planned funding
- Will be adjusted annually and based on funding
The 3DEP Working Group has agreed that all future 3DEP collections within the lower 48 should be coordinated by using a 1km x 1km tiling scheme for the conterminous United States. We are developing a plan for implementing this policy.

- Albers Equal Area projection (EPSG:6350), XYZ units in meters
- Each tile is 1 square km in area
- A standard national tiling naming convention that represents the XY location for each tile, for ease of searching
- Tiles can be grouped or block nested by various attributes (counties/states/HUCs), but each tile should be part of one and only one group (1:1 relationship)
3DEP improvements

National Tiling Scheme (cont.) • Naming Convention

- Name for each tile uses easting and northing location of the tile in the lower left corner
- Example
  - ‘w0002n0612

- Other attributes can be attached to the tile name later on

A nested block tiling scheme/naming convention to be built around the “TileID” so that tiles are grouped together for larger-area acquisition purposes.
3DEP improvements

National Tiling Scheme (cont.)

Example

- Original Project AOI
  2,361 sq miles

- Expand out using the 1 km grid

- New Project AOI
  2,457 sq miles
3DEP improvements

National Tiling Scheme (cont.)

Benefits

- 1 square km is small enough to approximate watersheds, county and state boundaries, etc., without adding a lot of area to projects
- Tile sizes are equal in area no matter their location in latitude or longitude
- Avoids slivers and unnecessary overlap between projects
- More orderly approach to nationwide coverage
- The MASTER 1k x 1k tile scheme will be provided online for public use and download
- Conversion services to be developed in the future
3DEP improvements

National Tiling Scheme (cont.)

What is the timeline for adopting the tiling scheme?

- The 3DEP Working Group designated FY18 as a transition year.
- Use the tiling scheme for all FY18 BAA GPSC lidar projects.
- Use the tiling scheme for all FY19 Co-op projects.
Emerging Technology

- Geiger mode and single photon lidar
  - Potential to increase quality and/or bring down costs
  - Pilots in 3 states (IL, NC, SD)

- Inland bathymetry
  - Technology proven in coastal areas
  - Commercial sensors have become available
  - Pilot assessment of commercial capabilities (ID)

- Ongoing/additional review and testing to better understand:
  - The characteristics of the data
  - How the data will be processed through project lifecycle from acquisition to delivery
  - Costs associated with storage and hosting of higher density collections
FY16 Test Projects
Foster maturation of new technologies for 3DEP

- Results will not meet the specification as currently written, and will be designated as provisional datasets
- Attributes that do not affect our core requirements have been waived
- Communicating with stakeholders the higher level of uncertainty/risk with these projects

<table>
<thead>
<tr>
<th>Location</th>
<th>Area Square Miles</th>
<th>Flown</th>
<th>Sensor</th>
<th>3DEP Investment (USGS, FEMA, NRCS)</th>
<th>State/Local Investments</th>
<th>Total Project Cost</th>
<th>Status</th>
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<td>Illinois</td>
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<td>4/17</td>
<td>GML</td>
<td>$336K</td>
<td>$739K</td>
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<td>South Dakota</td>
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<td>GML: 5/16-6/16, SPL: 3/17</td>
<td>GML and SPL</td>
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<td>North Carolina</td>
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<td>3/16-4/16</td>
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<td>$362K</td>
<td>$805K</td>
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<tr>
<td>Idaho</td>
<td>28</td>
<td>TBD - Fall 2017</td>
<td>Green laser (bathymetry)</td>
<td>$75K</td>
<td>$0</td>
<td>$75K</td>
<td>Project planning</td>
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Inland Topo-Bathy Lidar

- Commercial sensors are now in use for mapping both coastal and inland bathymetry
- Collections will help inform future specifications and topo-bathy lidar collection criteria
- 3DEP pilot project to assess commercial capabilities in FY17: study area is the Kootenai River in Idaho
- USGS scientists to collect validation data for assessing quality of lidar
- Recent bathymetry data also collected through the GPSC on Elwha River in WA and in FL Everglades
3D Elevation Program (3DEP)

Budget

- FY17 Omnibus increases - $4.5M total
  - $1.5M for National Enhancement (3DEP data acquisition)
  - $2.5M for Alaska Mapping and Map Modernization
  - $0.5M for Landscape Level Assessments - Chesapeake Bay (3DEP data acquisition)
### 3DEP Funding

**USGS Budget Estimates - Includes Alaska IfSAR**

<table>
<thead>
<tr>
<th></th>
<th>FY15 enacted</th>
<th>FY16 enacted</th>
<th>FY17 enacted</th>
<th>FY18 request</th>
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</thead>
<tbody>
<tr>
<td>USGS Base budget (includes acquisition and operations)</td>
<td>$15.2M</td>
<td>$20.4 M</td>
<td>$24.7M</td>
<td>$29.2M</td>
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<tr>
<td>Increase/decrease</td>
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<td>Total USGS 3DEP budget</td>
<td>$20.4M</td>
<td>$24.7M</td>
<td>$29.2 M</td>
<td>$20.0M</td>
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*Core Science Systems.*—The Committee recommends $114,737,000 for core science systems, of which $24,397,000 is for the National Cooperative Geologic Mapping program. The recommendation includes $67,354,000 for the National Geospatial program, of which $22,500,000 is for 3DEP National Enhancement. Landscape level assessments—Chesapeake Bay, Geospatial Research and 3DEP Technical Support, 3DEP Program Functions, and the Federal Geographic Data Committee Functions are funded at fiscal year 2017 enacted levels.
FY17 BAA (for FY18 Projects) – Timeline

- Target Release Date: August 15th
- Initial Proposal Due Date: October 20th
- Decisions November – January (based on the availability of funding)
- Public Webinar Dates:
  - August 10, 2017 at 1pm ET - Registration Required
  - August 17, 2017 at 3pm ET - Registration Required
3. Exceptions for Non Linear Mode Technologies

The 3DEP program is undergoing an assessment of Geiger Mode and Single Photon lidar systems; these systems do not currently meet the USGS Lidar Base Specification, as that specification was written to specifically address linear mode lidar. The technologies are showing enough potential to warrant additional testing and the development of next steps. In FY16 the USGS supported a limited number of incubation phase acquisitions making use of these technologies. The program expects to award a similar number of incubation phase projects in FY17. By allowing for a limited set of incubator collections across the country, 3DEP can continue to learn about, adapt to, and help these systems come in to full compliance with our specifications; Exceptions to the Lidar Base Specifications applicable to these technologies are noted in the award documentation.

3. Exceptions for Non-Practitioner Technologies

Geiger Mode and Single Photon lidar systems do not currently meet the USGS Lidar Base Specification, as that specification was written to specifically address conventional lidar systems. Submissions for the use of these technologies will be accepted and reviewed against the stated criteria as noted in section VI. All exceptions to the lidar base specifications resulting from the use of non-conventional lidar systems will be documented, discussed and agreed upon prior to final award. Agreed upon exceptions to the Lidar Base Specifications will be noted in the award documentation.
FY17 BAA (for FY18 Projects) – Changes to Solicitation

3. Geographic overlap with areas represented on Attachment B: 3DEP FY17 Federal Areas of Interest or geographic overlap with the agency specific FY17 High Priority Areas for Data Acquisition represented in attachment C
   a) General preference is given to projects that overlap identified Federal areas of interest (Attachment B)
   b) 3DEP Federal funding partners (agencies represented in Attachment C) may give additional preference to projects that overlap their individual agency requirements

3. Geographic overlap with federal areas of interest as represented on Attachment C.D. or E1
   a) General preference is given to projects that overlap identified Federal areas of interest as noted in Attachment C: 3DEP FY18 Consolidated Federal Areas of Interest
   b) Additional preference is given to projects that overlap or are adjacent to planned/funded projects identified in Attachment D: 3DEP FY18 – FY20 Multi-Year Plan for Lidar Data Acquisition or Attachment E: 3DEP Funding Partners FY18 High Priority Areas for Lidar Data Acquisition
   c) 3DEP Federal funding partners (agencies represented in Attachment E) may give additional preference to projects that overlap or are adjacent to their individual agency requirements

a) 3DEP prefers projects between 1,500 and 5,000 square miles.

Areal extent
a) 3DEP prefers projects greater than 1,500 square miles.
FY17 BAA (for FY18 Projects) – Changes to Solicitation

OLD

NEW

N/A

4. 3D Elevation Program National Indexing Scheme

3DEP has been operating under an annual opportunistic approach to data acquisition, acquiring lidar projects of varying sizes, scattered across the US. As a result, the national 3DEP elevation layer is subject to data gaps or unnecessary overlap between adjacent collections. To mitigate this problem, future collections within the lower 48 will be coordinated by using an Albers Equal Area 1km x 1km tiling schema. FY18 is a transition year; in FY19 the tiling scheme will be fully implemented. In FY18, the project boundaries of all BAA projects that propose to use the Geospatial Products and Services suite of Contracts (GPSC) will be converted to conform to the Albers Equal Area projection and extended to complete all 1km x 1km tiles that intersect the project boundary. The data will be delivered in both the Albers Equal Area and the local projection as requested by the funding partners. All FY18 project costs associated with the implementation of the tiling scheme will be funded by 3DEP. No additional costs will be incurred by BAA applicants.
Lidar Base Specification

Version 1.3 – important changes (still in review, subject to change)

- The requirement for delivery of raw, unclassified swath data has been removed.

- A requirement for an attributed polygon feature class representing individual swath boundaries has been added.

- A requirement to use Geoid 12b to convert from ellipsoid heights to orthometric heights has superseded Geoid12a.

- A requirement for horizontal accuracy reporting have been added.

- A clarification on intensity normalization have been added.

- A clarification on handling of multiple CRS records in LAS files has been added.
Lidar Base Specification

Version 1.3 – important changes (still in review, subject to change)

- The Classification Code for “Ignored Ground” (typically used for breakline proximity) has been changed from 10 to 20, to correct the conflict with the ASPRS defined code for “Rail”.

- A Classification Code for “Snow” (21) has been added.

- A Classification Code for “Temporal Exclusion” (22) has been added.

- The recommended process for assessing intraswath relative accuracy (repeatability, precision) has been refined to normalize for naturally occurring slope.

- The recommended process for assessing interswath relative accuracy has been limited to areas with <10° slope.

- The maximum limits for interswath differences have been removed.
Lidar Base Specification

Version 1.3 – important changes (still in review, subject to change)

- A prohibition on duplication of points within a project has been added.

- A restriction on errant variations of point density within a project has been added.

- Guidelines for breakline collection, compliant with a newly-added EleHydro Data Dictionary have been added. The EleHydro Data Dictionary is included as an appendix.

- All references to the National Elevation Dataset (NED) have been changed to “the standard national DEMs available through The National Map.” The names “National Elevation Dataset” and “NED” are no longer used for data collected and processed for The National Map or 3DEP.
Thank you!