3D Elevation Program – Status for Hawaii
Contact Your National Map Liaison

https://liaisons.usgs.gov/geospatial
What is Lidar?

Light Detection and Ranging (lidar) provides digital elevation (bare earth) and 3D models.
3D Elevation Program (3DEP)

- Complete acquisition of nationwide lidar (IfSAR in AK) in 8 years to provide the first-ever national baseline of consistent high-resolution elevation data – both bare earth and 3D point clouds – collected in a timeframe of less than a decade

- 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
### 3D Elevation Program

**Mission Critical Applications**

Documented in the 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>
<td></td>
<td>Conservative</td>
</tr>
<tr>
<td>1</td>
<td>Flood Risk Management</td>
<td>$295M</td>
</tr>
<tr>
<td>2</td>
<td>Infrastructure and Construction Management</td>
<td>$206M</td>
</tr>
<tr>
<td>3</td>
<td>Natural Resources Conservation</td>
<td>$159M</td>
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<tr>
<td>4</td>
<td>Agriculture and Precision Farming</td>
<td>$122M</td>
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<tr>
<td>5</td>
<td>Water Supply and Quality</td>
<td>$85M</td>
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<tr>
<td>6</td>
<td>Wildfire Management, Planning and Response</td>
<td>$76M</td>
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<tr>
<td>7</td>
<td>Geologic Resource Assessment and Hazard Mitigation</td>
<td>$52M</td>
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<tr>
<td>8</td>
<td>Forest Resources Management</td>
<td>$44M</td>
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<tr>
<td>9</td>
<td>River and Stream Resource Management</td>
<td>$38M</td>
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<tr>
<td>10</td>
<td>Aviation Navigation and Safety</td>
<td>$35M</td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Land Navigation and Safety</td>
<td>$0.2M</td>
</tr>
<tr>
<td></td>
<td><strong>Total for all Business Uses (1 – 27)</strong></td>
<td><strong>$1.2B</strong></td>
</tr>
</tbody>
</table>
## 3DEP Quality

### Quality Level 2 or better

<table>
<thead>
<tr>
<th>Quality Level</th>
<th>Data Source</th>
<th>Vertical Accuracy RMSEz (cm)</th>
<th>Nominal Pulse Spacing (NPS) (meters)</th>
<th>Nominal Pulse Density (NPD) (points per square meter)</th>
<th>Digital elevation mode (DEM) cell size (meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QL0</td>
<td>Lidar</td>
<td>5 cm</td>
<td>$\leq 0.35$ m</td>
<td>$\geq 8$ pts/meter$^2$</td>
<td>0.5 m</td>
</tr>
<tr>
<td>QL1</td>
<td>Lidar</td>
<td>10 cm</td>
<td>$\leq 0.35$ m</td>
<td>$\geq 8$ pts/meter$^2$</td>
<td>0.5 m</td>
</tr>
<tr>
<td>QL2</td>
<td>Lidar</td>
<td>10 cm</td>
<td>$\leq 0.7$ m</td>
<td>$\geq 2$ pts/meter$^2$</td>
<td>1 m</td>
</tr>
<tr>
<td>QL3</td>
<td>Lidar</td>
<td>20 cm</td>
<td>$\leq 1.4$ m</td>
<td>$\geq 0.5$ pts/meter$^2$</td>
<td>2 m</td>
</tr>
<tr>
<td>QL4</td>
<td>Imagery</td>
<td>139 cm</td>
<td>N/A</td>
<td>N/A</td>
<td>5 m</td>
</tr>
<tr>
<td>QL5</td>
<td>Ifsar</td>
<td>185 cm</td>
<td>N/A</td>
<td>N/A</td>
<td>5 m</td>
</tr>
</tbody>
</table>
National Enhanced Elevation Assessment

Recommended Elevation Data Program

Quality Level 2 (QL2) LiDAR* - 8 year acquisition

- Total Possible Benefits Satisfied: 58%
- 3-D Elevation Program (3DEP)

* Note: All scenarios include QL5 (IfSAR) for Alaska
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
3D Nation Elevation Study

- Refresh NEEA: all feds, all states and territories
- Integrate bathymetry requirements
- Update benefits
- Refocus program, integrating inland, nearshore, and offshore bathymetry
- New materials, factsheet
- Provide data for strategic planning
3DEP for Flood Risk Management

Conservative annual benefits estimated at $502M

- Produce higher quality flood maps, including Flood Insurance Rate Maps
- Manage dam and levee safety programs to reduce flood risks
- Improve hydrologic modeling and flood forecasting
- Improve State and local flood risk management and response
- Improve storm water facilities and dam design
- Extract building footprints and identify the finished floor elevation to quantify potential damages based on flooding depths

Lidar aids hydraulic modeling to determine flood-inundation on the Saluda River, near Greenville, SC
3DEP for Landslides Recognition, Hazard Assessment, and Mitigation Support

- Input to slope-stability models used to identify where shallow landslides may mobilize into fast-moving, potentially damaging and deadly debris flows
- Determine boundary and conditions for landslide initiation
- Plan for evacuations and staging areas
- Create accurate landslide inventory and deposits maps
- Estimate the shape and activity of landslides
- Provide baseline information for change-detection comparisons

Lidar reveals landslides not visible in aerial imagery, Oregon
3DEP for Volcano Hazards

- Model volcanic processes and the path of lahars that can travel downstream to populated areas
- Plan for escape routes
- Unravel the volcano’s history by mapping volcanic deposits hidden by heavy forest cover and inaccessible on steep terrain
- Design a new real-time monitoring network
USGS Lidar Base Specification v2.0

- Version 2.0 posted in July
- Notable changes:
  - Changed review and approval process
  - Changed the delivery method – LBS online at Specifications Explorer and 3DEP Standards website
  - Changes to bridge treatment
    - Bridges removed from bare earth
    - Hydro-flattening continues under bridges
    - Terrain interpolated below bridge
  - Draft version for download

https://cms.usgs.gov/atom/80278
3DEP Governance

- **3DEP Executive Forum**
  - Facilitates executive collaboration on strategies to fund and implement 3DEP for the benefit of all its stakeholders
  - Provides direction to 3DEP Working Group

- **3DEP Working Group**
  - Coordinates implementation of 3DEP

**Member Agencies**

<table>
<thead>
<tr>
<th>Bureau of Land Management</th>
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<tbody>
<tr>
<td>Department of Homeland Security</td>
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<tr>
<td>Department of Transportation</td>
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<tr>
<td>Environmental Protection Agency</td>
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<tr>
<td>Federal Aviation Administration</td>
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<tr>
<td>Federal Communications Commission</td>
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<tr>
<td>Federal Emergency Management Agency</td>
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<tr>
<td>US Forest Service</td>
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<tr>
<td>US Fish and Wildlife Service</td>
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<tr>
<td>National Oceanic and Atmospheric Administration</td>
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<tr>
<td>National Park Service</td>
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<tr>
<td>Natural Resources Conservation Service</td>
</tr>
<tr>
<td>Office of Surface Mining Reclamation and Enforcement</td>
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<tr>
<td>US Department of Agriculture</td>
</tr>
<tr>
<td>US Army Corps of Engineers</td>
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<tr>
<td>US Geological Survey</td>
</tr>
<tr>
<td>American Association of State Geologists</td>
</tr>
<tr>
<td>National States Geographic Information Council</td>
</tr>
</tbody>
</table>
3DEP Data Acquisition
3DEP is built on partnerships

**Federal Partners = 3DEP Working Group**

**Federal Interagency Agreements (IA)**

**Broad Agency Announcement (BAA)**
- Fair and equitable process for non-Feds to partner with Federal Agencies
- Publicly announced
- Competitive, clear criteria
- Can include Federal Agencies
- Partners can propose to use USGS contract (GPSC) or their own contract

**Together determine acquisition plan for the year**
3DEP Broad Agency Announcement

Partnerships to acquire high-quality 3D elevation data

- Provides visibility and opportunity to the broadest stakeholder community possible through FedBizOpps.gov and grants.gov
- Federal, state and local governments, tribes, academic institutions, and private sector are eligible
- Partners may propose to use the USGS Geospatial Product and Services Contracts (GPSC) or their own contracting vehicles
- National Map Liaisons can assist partners with the process and coordinating partnerships
- 2020 BAA will open first week of September, webinar held August 7

https://nationalmap.gov/3DEP
3DEP BAA Selection Criteria

- **Project Location**
  - Areas with no lidar coverage
  - Or areas where existing data is more than 8 years old; QL 3, 4, 5; significant changes to the landscape have occurred

- **Areal Extent**
  - 3DEP prefers project between 1,500 and 5,000 square miles
  - Preference given to larger projects

- **Geographic Overlap with Federal Areas of Interest**

- **Project Cost and Cost Share (funds contributed by applicant)**

- **Maturity of Applicant’s Proposal and Maturity of Designated Funding Sources**

- **Technical Approach**
  - Projects making use of GPSC as the acquisition mechanism receive full score for technical approach
  - Applicants proposing to manage their own contract will be evaluated on the applicant’s approach to data acquisition and required project deliverables

- **Past Performance**
3DEP BAA Selection Criteria

Overlap with Federal Areas of Interest
Getting Involved in 3DEP Acquisition

Checklist

1. Check if data already exist - Use the US Interagency Elevation Inventory (USIEI) [https://coast.noaa.gov/inventory/](https://coast.noaa.gov/inventory/)

2. Coordinate and form partnerships
   - For Federal agencies, contact your 3DEP Working Group member
   - Contact state and local agencies
   - Use the Seasketch site to identify potential partners
   - Contact your National Map Liaison

3. Submit a BAA proposal to receive 3DEP funding for the project
3D Elevation Program (3DEP)

Data are available or in progress for 53% of the Nation

*includes lidar and AK IfSAR
U.S. Interagency Elevation Inventory and Seasketch: Find data and partners

USIEI

coast.noaa.gov/inventory

NOAA sponsored Seasketch site

fedmap.seasketch.org
3D Elevation Program (3DEP) Goals

- Complete acquisition in 8 years
- Address Federal, state and other mission-critical requirements
- Realize ROI 5:1 and potential to generate $13 billion/year
- Leverage the capability and capacity of private mapping firms
- Achieve a 25% cost efficiency gain
- Completely refresh national data holdings
3DEP National Multiyear Plan

Background

- 3DEP Executive Forum tasked the 3DEP Working Group to develop a plan to:
  - Move from an annual, opportunistic process to a unified multi-year plan
  - Move from patchwork irregular acquisition footprints to acquisition following a national tiling scheme

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

Move from this…

…to something more like this
Emerging Technology

- Geiger mode and single photon lidar test
  - Potential to increase quality and/or bring down costs
  - Pilots in NC, SD, IL and HI
- Inland bathymetry
  - Technology proven in coastal areas
  - EAARL-B topobathy lidar survey of Delaware River was promising
  - Commercial sensors are available through GPSC
  - Began assessments of commercial capabilities in FY17

Frenchtown Subregion of the Delaware River, integrated EAARL-B and topographic lidar
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; survey conducted in Sept. 2017
- USGS scientists collected field data during lidar survey for assessing instrument performance and data quality
- Bathymetry lidar also recently collected through the GPSC on Elwha River in WA and in FL Everglades
While the technology shows promise, the USGS has not yet completed a determination that data acquired via Gieger Mode, Single Photon or green laser technologies are suitable for use by 3DEP. Ongoing test projects are being used to learn about, adapt to, and help these systems come in to full compliance with 3DEP specifications. Results of pilots will not meet the current specification, 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</th>
<th>Acquired</th>
<th>Sensor</th>
<th>Cost</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>3,358</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spring 2017</td>
<td>GML</td>
<td>$1.1 M</td>
<td>USGS assessment of pilot data in progress</td>
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<tr>
<td>South Dakota</td>
<td>11,805</td>
<td>Spring 2017</td>
<td>GML and SPL</td>
<td>$2.8 M</td>
<td>USGS assessment of pilot data in progress</td>
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<tr>
<td>North Carolina</td>
<td>8145</td>
<td>Spring 2016</td>
<td>GML</td>
<td>$2.3M</td>
<td>USGS QA/QC in progress (partial delivery)</td>
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<tr>
<td>Hawaii</td>
<td>4,009</td>
<td>Winter 2018</td>
<td>SPL</td>
<td>$1.7M</td>
<td>Acquisition</td>
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<tr>
<td>Big Island</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idaho</td>
<td>28</td>
<td>Fall 2017</td>
<td>Green laser (bathymetry)</td>
<td>$75K</td>
<td>USGS QA/QC in progress</td>
</tr>
</tbody>
</table>
USIEI – HI (Aug 2019)
3DEP data for Hawaii

Availability Index
3DEP Products

- Standard DEMs
  - Nationally Seamless
    - 2 Arc Second
    - 1 Arc Second
    - 1/3 Arc Second
    - Project-based (seamless within projects)
    - 1/9 Arc Second (legacy)
    - 1-meter
    - 5-meter (IfSAR - Alaska)

- Source Data
  - Lidar Point Clouds
  - Source DEMs (original product resolution)
  - Digital Surface Model (IfSAR - Alaska)
  - Orthorectified Radar Intensity Imagery (IfSAR - Alaska)

All 3DEP seamless DEMs are provided in geographic coordinates (longitude and latitude) in units of decimal degrees, horizontally referenced on the North American Datum of 1983 (NAD83). All elevation values are in units of meters, typically referenced to the North American Vertical Datum of 1988 (NAVD88), although the National Geodetic Vertical Datum of 1929 (NGVD29) and local reference datums are used in some areas outside of the conterminous United States (CONUS). For Hawaii, Puerto Rico, U.S. Virgin Islands, and Pacific Island territories, the vertical datum is typically referenced to local mean sea level.

10M DEM characteristics

- Terraced appearance due to contour line origins
- Based on 1:24,000-scale topographic maps
- Contour line interval varies by terrain
- Other coastal or topobathy projects are more accurate
- New 3DEP data will fix the problem w/r/t USGS holdings
- Look at Kihei, Maui example; c.i. = 20 feet
NOAA Digital Coast

Access lidar data: [https://coast.noaa.gov/dataviewer/#/](https://coast.noaa.gov/dataviewer/#/)
Oahu 2013
Joint NOAA/USGS project (QL3)
3DEP FY19 - Hawaii

Big Island Lidar

- Single Photon scanner being used
- QL1 collection (minimum 8 pts per sq m)
- One foot contour deliverable
- NAD83 (PA11), ellipsoidal heights in meters
- Approximately 40% of Island collected
- Production jointly managed by NOAA and USGS
- Project halted in early 2018 due to weather
- Planned to resume last winter but delayed; continuation likely in later 2019
Funding Partners:
- FEMA (Region IX, HQ)
- NOAA
- NRCS
- Hawaii County
- USGS (3DEP)
- USGS VHP
3DEP FY19 - Hawaii

2018 Big Island Lidar – Kilauea response

- Separate data collections in June and July 2018
- QL1 collection (exceeds 8 pts per sq m)
- Helicopter platform
- Includes large amount of oblique aerial photographs
- Lidar available from OpenTopography site (http://opentopo.sdsc.edu/datasets)
- Imagery available through USACE GRiD (https://rsgis.erdc.dren.mil/griduc/)
Kilauea lidar
HI Lidar next steps

Kauai -- Fall 2019

- QL1 topography (minimum 8 points per sq m)
- QL2b bathymetry (minimum 2 points per sq m)
- Seamless coastline coverage
- Data to be collected after CNMI flight now underway

Maui County -- Summer 2020?

- Lidar/bathy quality, coverage, and timeline to be determined
- Discussion planned later this week (State of HI, NOAA, Maui County, Pulama Lanai, ESRI, USGS)
- FY19/20 BAA to be released in September 2019
Elevation viewers

https://apps.nationalmap.gov/3depdem/
3DEP Demonstration Elevation Viewer

https://prd-tnm.s3.amazonaws.com/LidarExplorer/index.html#/LidarExplorer
Access 3DEP Data: https://nationalmap.gov/3dep/
The National Map download site

- TNM layers to view and download
- Select AOI on map and choose product
- Select "Find Products" to generate list
- Download individually or place in cart
- Several elevation data options
3DEP Resources

USGS 3DEP Web Pages
https://nationalmap.gov/3DEP

3DEP Broad Agency Announcement (BAA) Information Sharing Site
https://www.usgs.gov/core-science-systems/ngp/3dep/broad-agency-announcements

NOAA sponsored Seasketch site: U.S. Federal Mapping Coordination, A Demonstration Site for Federal Mapping Data Acquisition http://fedmap.seasketch.org

NOAA sponsored US Interagency Elevation Inventory (USIEI) site http://www.coast.noaa.gov/inventory

The 3D Elevation Program Initiative – A Call for Action http://pubs.usgs.gov/circ/1399/

USGS NGP Lidar Base Specification V2.0
https://cms.usgs.gov/atom/80278

TNM Data Download
https://viewer.nationalmap.gov/basic/
Thank you!
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