The Vermont Lidar Initiative:
Acquiring, Sharing and Applying Lidar Data

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OVERVIEW:
• Acquisition: 3DEP/USGS Broad Agency Announcement/GPSC
• Dissemination: Vermont's Open GeoData Portal
• Application: Access from variety of platforms via OGC, WCS & WMS protocols
Light Detection and Ranging (LiDAR) Acquisition

- Airborne approach is the most cost effective over large areas.
- Terrestrial approach affords for more targeted application extents.
LiDAR “Point Cloud”
Waterbury State Complex: Post TS Irene 2011
DEM, DSM and Derivatives
extracted from the “Point Cloud”

Middlebury, VT: 1m Digital Surface Model (DSM) and “Bare Earth” DEM (last returns”)

Images and Descriptions courtesy of the UVM Spatial Analysis Lab.
LiDAR: No Longer a case of Why, but How$: Leveraging Federal Grant Funding

What is the 3D Elevation Program?

3DEP is a call for community action to...

- Address the mission-critical requirements of 34 Federal agencies, 50 states, and a sampling of local governments, tribes, private and not-for profit organizations documented in the National Enhanced Elevation Assessment
- Return more than $690 million annually in new benefits, ROI = 5:1
- Leverage collaboration among Federal, states, local and tribal partners to systematically complete national 3D data coverage in 8 years
- Leverage the capability of private industry mapping firms, create jobs
- Achieve a 25% cost efficiency gain by collecting data in larger projects
- Completely refresh national elevation data holdings with new lidar and ifsar elevation data products and services

Natural Resource Conservation  Infrastructure Management  Flood Risk Mitigation  Precision Farming  Land Navigation and Safety  Geologic Resources and Hazards Mitigation

USGS  The National Map  Your Source for Topographic Information
USGS BAA FFY17/FY18 Proposal: 3DEP LiDAR Acquisition for Statewide QL2

Deliverables Overview:
- Classified LAS Point Cloud Files
- Hydro Flattened & Hydro Enforced Bare Earth DEMs
- Digital Surface Model (DSM)
- 1' Contours
- Hydro Flattened & Enforcement Breaklines
- Intensity Images

<table>
<thead>
<tr>
<th>Quality Level</th>
<th>Data Source</th>
<th>Horizontal Resolution</th>
<th>Vertical Accuracy RMSEz</th>
<th>Equivalent Contour Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>QL1</td>
<td>Lidar</td>
<td>8 points/m²</td>
<td>10 cm</td>
<td>1 foot</td>
</tr>
<tr>
<td>QL2</td>
<td>Lidar</td>
<td>2 points/m²</td>
<td>10 cm</td>
<td>1 foot</td>
</tr>
<tr>
<td>QL3</td>
<td>Lidar</td>
<td>0.5 points/m²</td>
<td>20 cm</td>
<td>2 foot</td>
</tr>
<tr>
<td>QL4</td>
<td>Imagery</td>
<td>N/A</td>
<td>139 cm</td>
<td>8-15 feet</td>
</tr>
<tr>
<td>QL5</td>
<td>Ifsar</td>
<td>N/A</td>
<td>185 cm</td>
<td>N/A</td>
</tr>
</tbody>
</table>
LiDAR as Infrastructure

Few sources of geospatial data offer the richness of “LiDAR as infrastructure” to inform today’s more technical society.

Myriad Use Cases:

Cost Effective:
3DEP 2012 National Enhanced Elevation Assessment (NEEA) estimates a 5:1 ROI nationally. Likely differs by state, region and application.

Avoids/Reduces Duplication of Effort:
Precludes the need for more costly, less automated methods of data capture for many applications, e.g., 1’ contours and elevation model vertically accurate to 9.25 cm (< 4 inches!).

Table 1. Top NEEA business uses

<table>
<thead>
<tr>
<th>#</th>
<th>Business use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Flood risk management</td>
</tr>
<tr>
<td>2</td>
<td>Infrastructure/constr. management</td>
</tr>
<tr>
<td>3</td>
<td>Natural resources conservation</td>
</tr>
<tr>
<td>4</td>
<td>Agriculture and precision farming</td>
</tr>
<tr>
<td>5</td>
<td>Water supply and quality</td>
</tr>
<tr>
<td>6</td>
<td>Wildfire manage/plan/response</td>
</tr>
<tr>
<td>7</td>
<td>Geologic resources and hazard</td>
</tr>
<tr>
<td>8</td>
<td>Forest resources management</td>
</tr>
<tr>
<td>9</td>
<td>River/stream resource management</td>
</tr>
<tr>
<td>10</td>
<td>Aviation navigation and safety</td>
</tr>
</tbody>
</table>
LiDAR’s Impact on the Analysis Landscape: What Resolution Are Your Decisions Based On?

Scale 1:20,000

30-meter DEM

10-meter DEM

0.7-meter DEM (QL2)

**Vertical Accuracy**: Combined reported accuracy for National Elevation Dataset (NED), i.e., 10m & 30m = 2.44m (8’)

**Vertical Accuracy**: 9.25cm (< 4”)
The Logarithmic Effect of Resolution:

**30m DEM:** Best available statewide data until 2009.

\[ 30m^2 = 900 \text{ sq. mtrs} \]

\[ 10m^2 / 900 = 9 \text{ cells} \]

**10m DEM:** Currently still the best available statewide data.

**LiDAR Sourced:**
- QL2 (0.7m – 70% of state)
- QL3 (1.6m+ – 30% of state)

\[ 0.7m^2 / 900 = 1,836 \text{ cells!} \]
Solar Radiation Assessment: Impact of Resolution on Data Accuracy

Data Points (cells) per Acre

Source Data Resolution (m)
## VLP Data Dissemination Overview

<table>
<thead>
<tr>
<th>VCGI LiDAR Data Delivery Services</th>
<th><strong>Datasets</strong>*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Access Options</strong></td>
<td><strong>DEM</strong></td>
</tr>
<tr>
<td>External Drive Product</td>
<td>✓</td>
</tr>
<tr>
<td>Direct Download</td>
<td>✓</td>
</tr>
<tr>
<td>Map Services</td>
<td></td>
</tr>
<tr>
<td>Image Services</td>
<td>✓</td>
</tr>
<tr>
<td>VT Interactive Map Viewer</td>
<td>✓</td>
</tr>
</tbody>
</table>

* Where available; coverage is not currently statewide

** Derivatives: Aspect, Normalized DSM (nDSM) and Slope rasters

***Hillshade combined with contours as map service
Integrating Vendor Data

**Migrate to VCGI Naming Convention** (filenames vary widely over entire collection);

- **Individual Tiles:** Elevation_DEM0p7M2013_RVT0001 (RVT0001.img)
- **File Mosaics:** ElevationDEM_DEM0p7M2013

**Various Source Formats**

**Standardized Convention**
Mosaic Datasets

- Mosaic datasets facilitate management of large data collections;
- Simultaneously used to publish web services.

Note: Web Mercator projection equivalent services pending.
Design Considerations

- Mosaics and “Parent Mosaics”, i.e., Mosaics-of-Mosaics
- Mosaics can be “referenced” to create other mosaics via functions

Mosaics:
- CONTOURS
- DEM (last returns)
- DSM (first returns)
- nDSM (DSM-DEM; height of feature)

Referenced Mosaics:
- ASPECT
- HILLSHADE
- SLOPE
Applying Web Services

• ArcGIS desktop – See online help “Adding ArcGIS for Server map services”

• ArcGIS Online (AGO)
  • Web Map:
    • http://tinyurl.com/LidarWebMap-NEARC2016
    • http://tinyurl.com/StAlbansSolarDemo

  • Web App:
    • http://arcg.is/2dPmUIS

• Application
  • ArcGIS API for JavaScript (Sandbox)
  • Web AppBuilder for ArcGIS (... create custom widgets and themes)
VLP Future Efforts:

- Land Cover Class data
- Hydrologic conditioned DEMs
- ...?
Questions ?

Resources:

Vermont LiDAR Initiative Homepage: http://vcgi.vermont.gov/lidar
• LiDAR status, program overview, maps and images and related info.


Letters from the SAL: http://letters-sal.blogspot.com/
• LiDAR, UAS mapping; eCognition software and so much more

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