NOAA's Digital Coast LiDAR Data Overview: Sources, Tools, Online Applications, and Trainings/Technical Assistance

Office for Coastal Management

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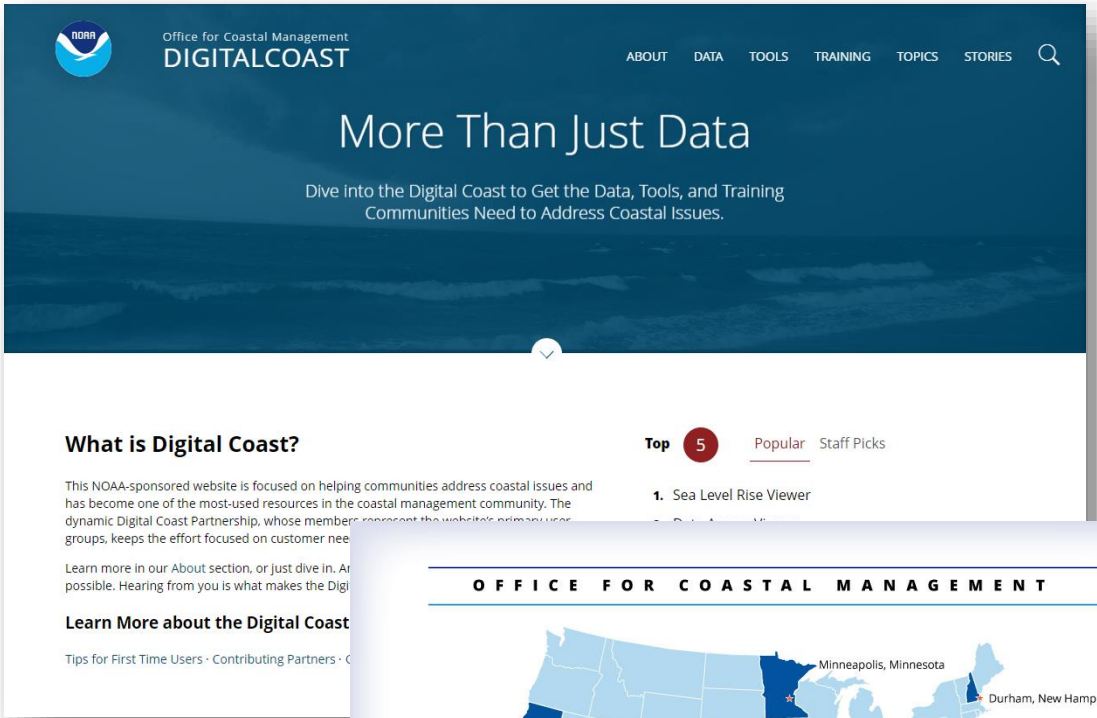
Digital Coast Overview

Approach: Bring the geospatial and coastal management communities together

Outcome: A constituent-driven, integrated enabling platform supporting coastal resource management

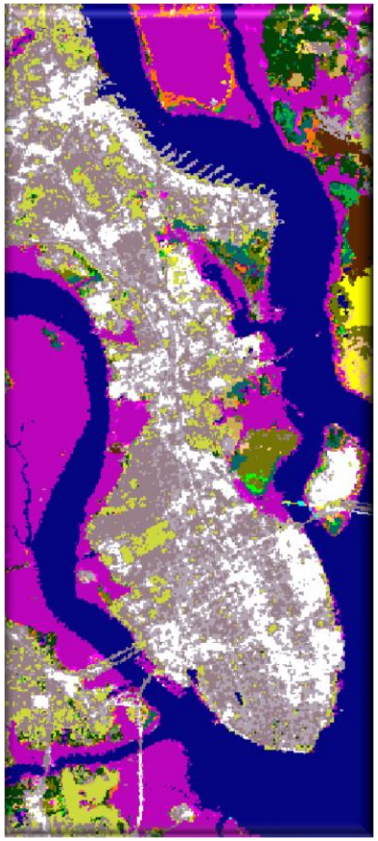


Approximately 250 people around the country

A Broad Spectrum Approach: Facilitating Use and Application

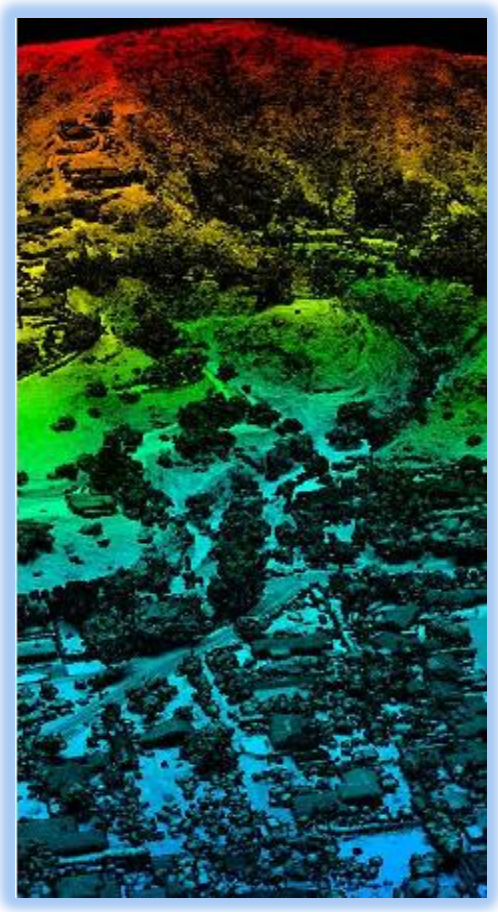
Digital Coast: Data

- Over 80 terabytes of high-resolution elevation data, land cover data, and orthoimagery
- 350+ web mapping services
- Linkages to over 40 national-level coastal data sets

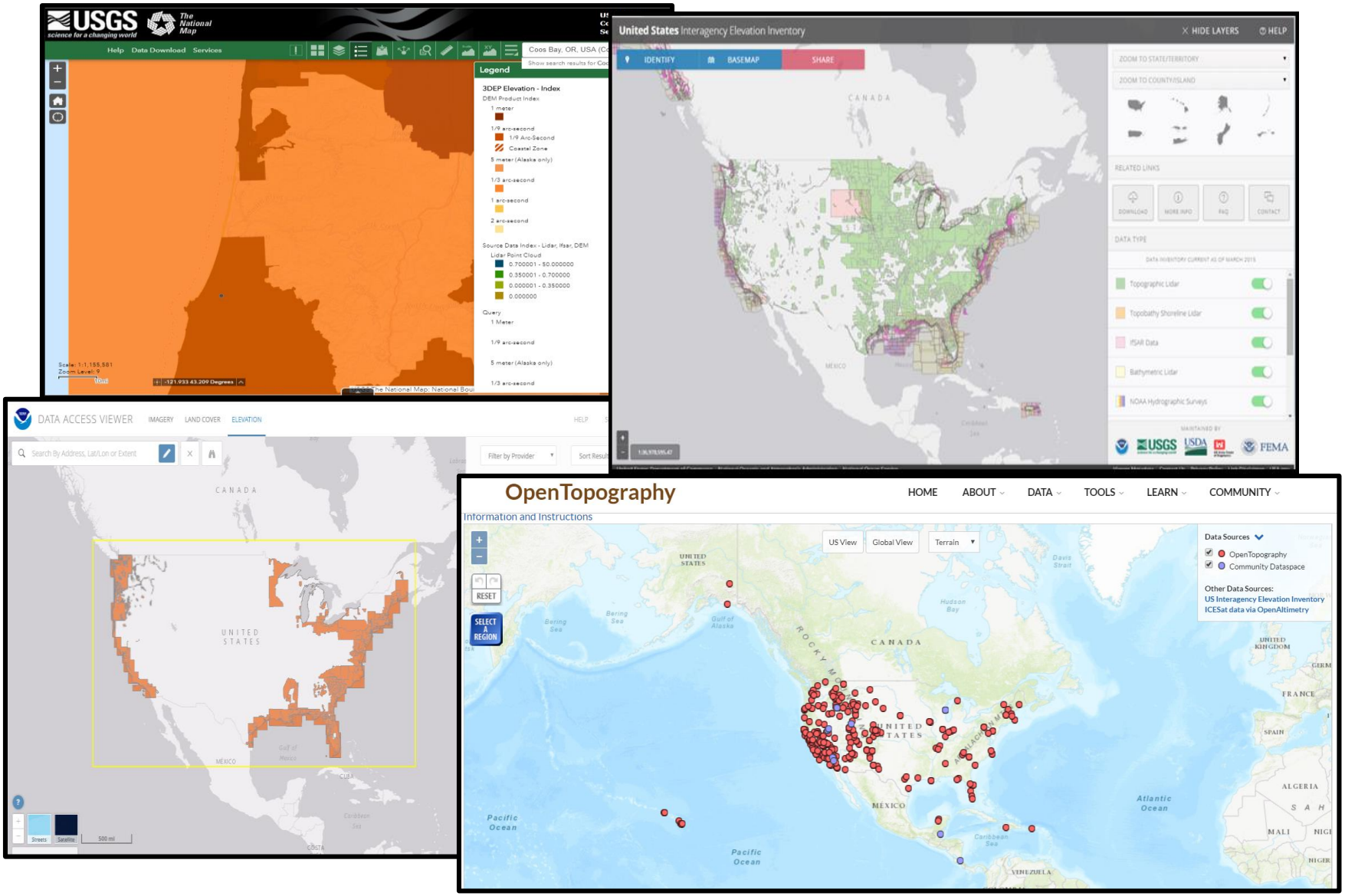


Back to LiDAR…lets get to the details!

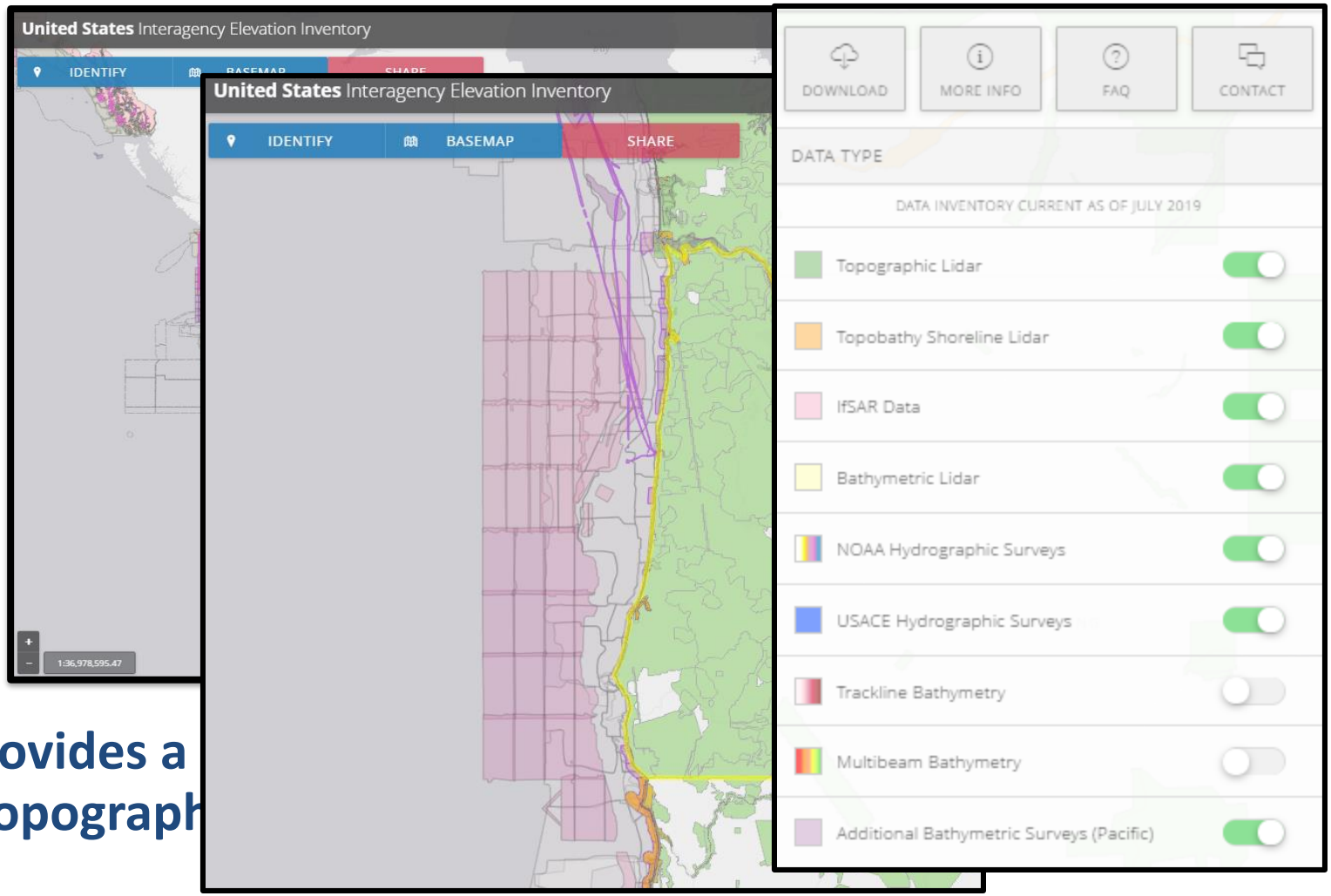
- **Got LiDAR? – Who's got it and where can I get it?**
- **What's the latest and greatest?**
  - Sources and Keeping Current
- **Accuracy Measures, Coordinates, and Formats**
- **Considerations for Deriving Products Using Lidar in a GIS**
  - Points, Contours, and DEMs



Finding LiDAR data using the “Heavy Hitters”



U.S. Interagency Elevation Inventory



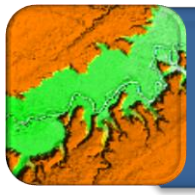
Provides a
topograph

U.S. Interagency Elevation Inventory

Collaborative effort - NOAA, USGS, FEMA, NRCS, USACE, USFS, NPS

Updated bi-annually

Includes planned, in progress, and completed projects



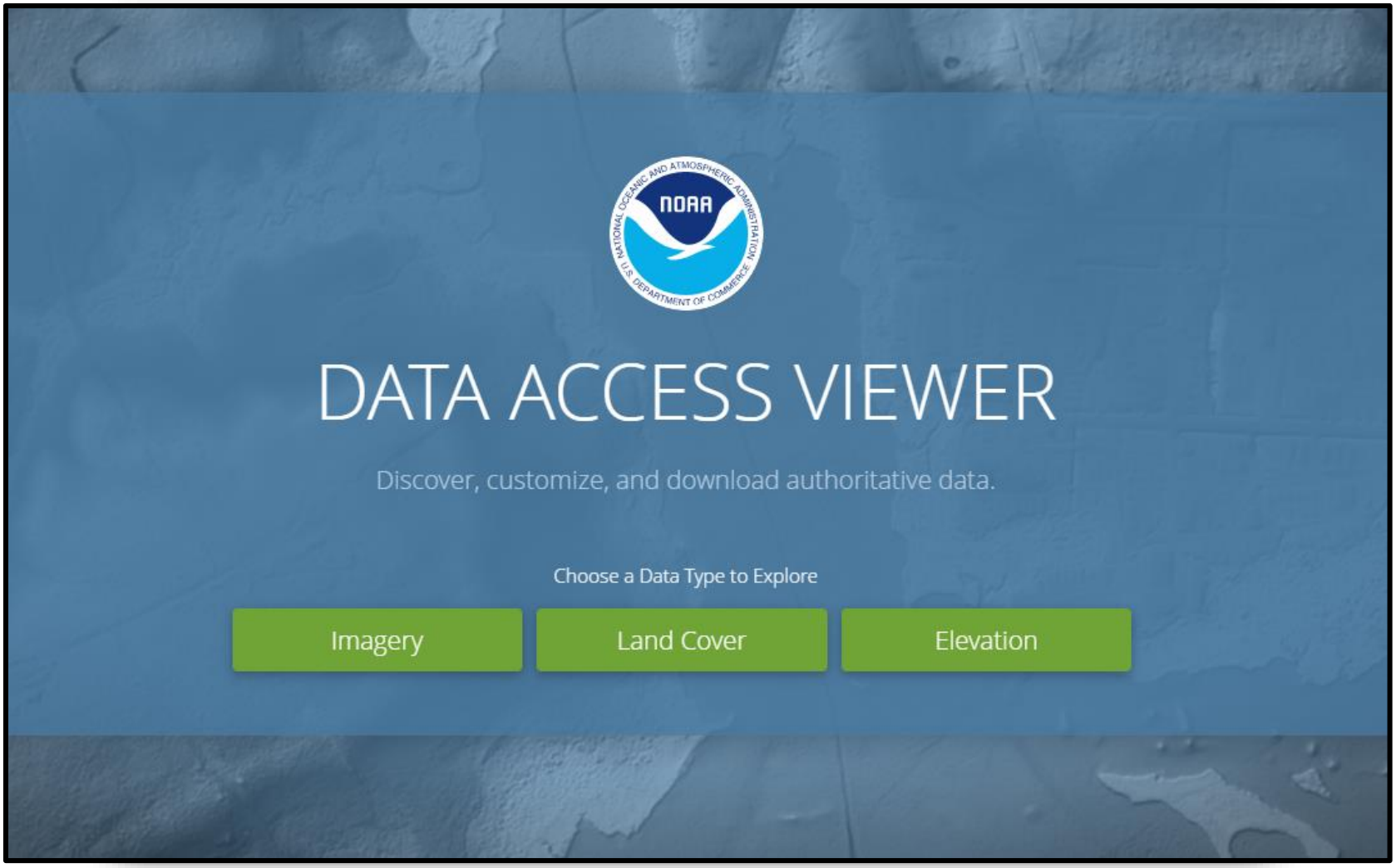
2481 lidar and IfSAR data sets

Elevation Inventory Goals

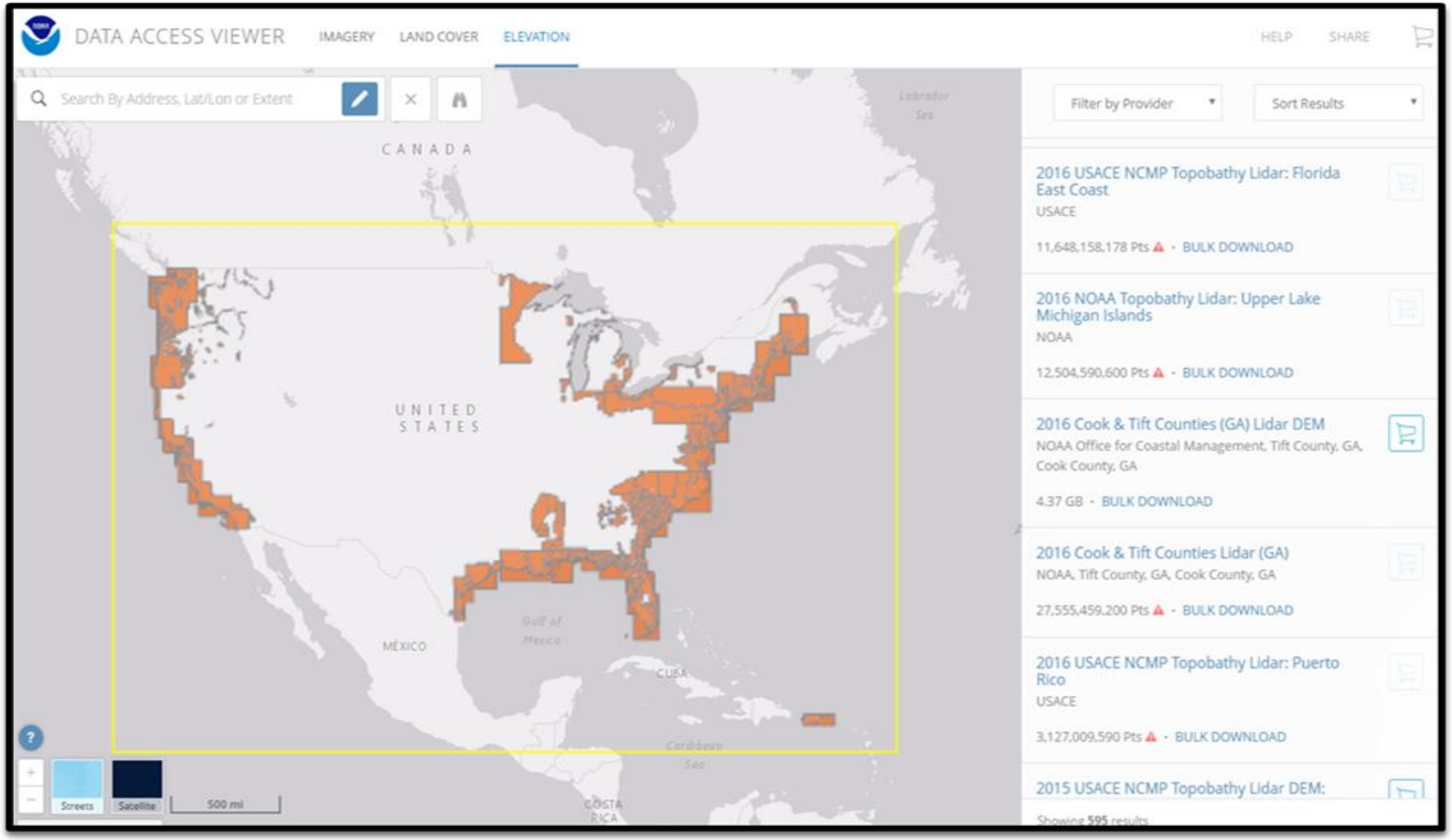
Provide a single resource for a nationwide inventory of high-resolution topographic and bathymetric data

Raise awareness of, and increase access to, existing elevation data	Help identify data gaps	Help prevent duplication in collection	Inform and encourage collaboration in future collections

Digital Coast: Data Access

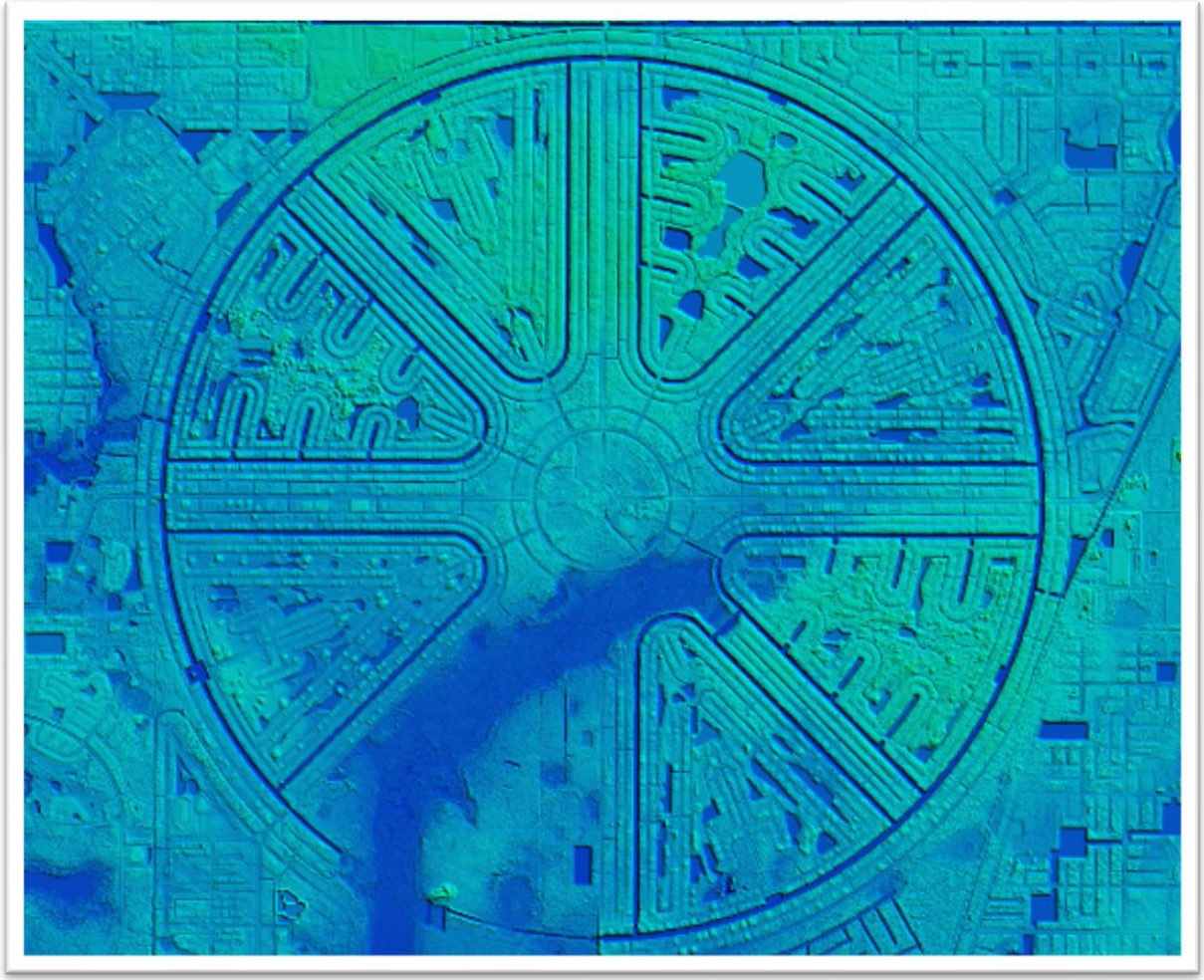


Data Access Viewer



Allows users to discover and make custom requests or bulk download imagery, land cover, and elevation data in the coastal regions of the United States and territories.

Data Access Viewer



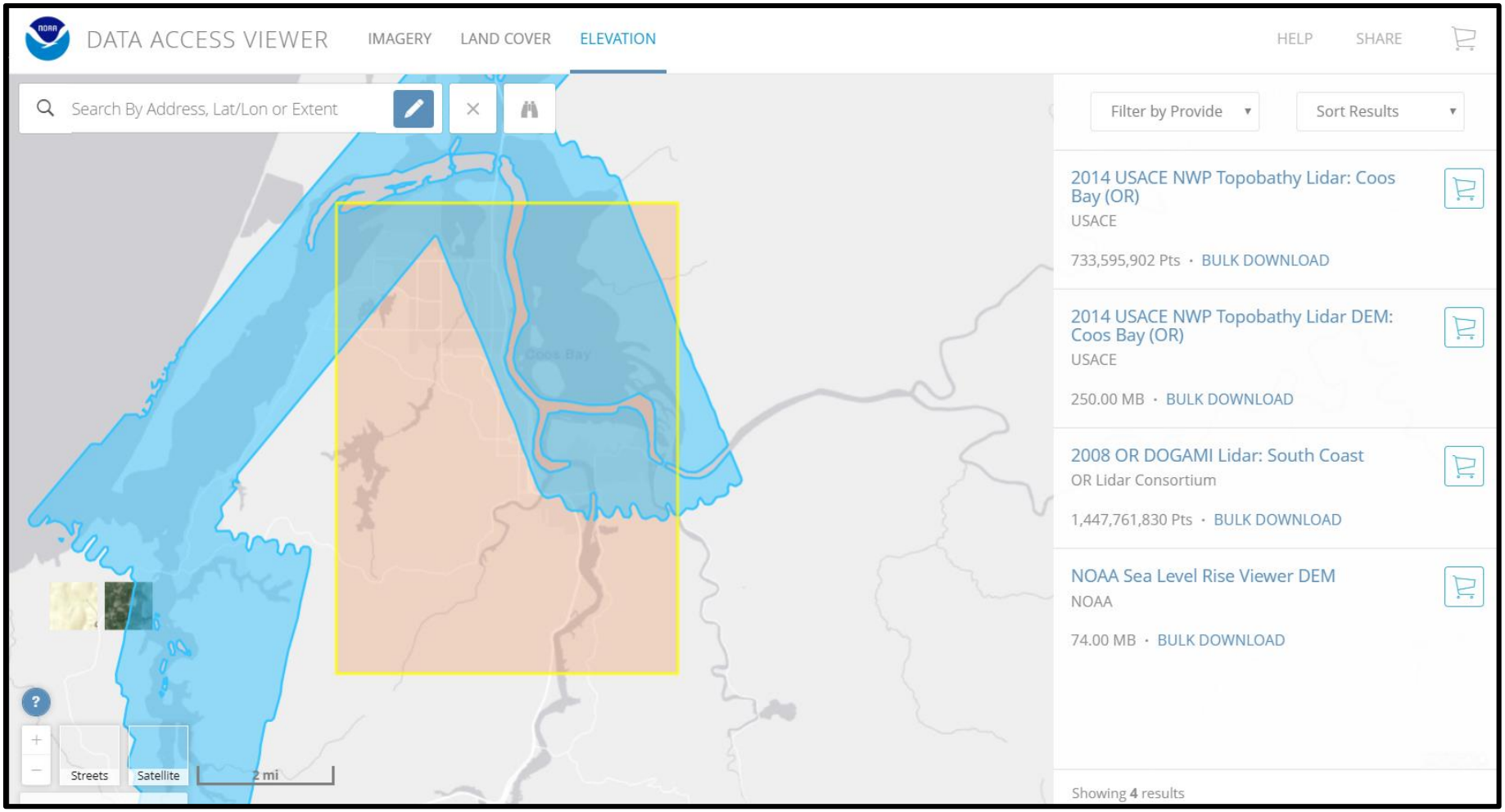
644 coastal data sets

4.1 trillion points

Custom points, rasters, contours

Custom datums, projections, formats

“Checking Out” the Data Access Viewer



Metadata!

2016 USACE NCMP Topobathy Lidar: Puerto Rico Point Cloud files with Orthometric Vertical Datum NAVD88 using GEOID12B

Below are links to the files that make up the 2016 USACE NCMP Topobathy Lidar: Puerto Rico dataset in an orthometric vertical datum NAVD88 using GEOID12B. This HTML file is here to emulate the access you would have gotten through an ftp site. The files containing geospatial indices, metadata, etc., are listed first, followed by the files. To download in bulk, it is suggested you use a program such as wget (example below). The geospatial index file in shapefile format also has a URL attribute that some GIS programs can use to download files. You can also subset the data, make derived products, and change projection, datum, etc., using the Digital Coast Data Access Viewer (add to cart, the link to bulk download or LAZ fmt will take you here).

The files are in LAZ format, a lossless compressed version of the ASPRS LAS format. The compression and decompression is done with the free and open source 'laszip' program available at http://laszip.org. This is not the same as the more general zip format. Many geospatial programs will read LAZ files natively and decompression is often not necessary. There is a list of software with native support on the laszip site.

Example to download entire data set using wget (windows version at http://gnuwin32.sourceforge.net/packages/wget.htm):

```
wget -np -r -nH -L --cut-dirs=2 https://coast.noaa.gov/htdata/lidar1_z/geoid12b/data/5037/
```

This will give you the directory structure starting with geoid12b. Modify the --cut-dirs=2 argument to modify the start directory (e.g. --cut-dirs=4 will start at 5037). Wget is a command-line program and the output will be to the directory you run it in. More options and information can be found at http://www.gnu.org/software/wget/manual/wget.html. The other options in the example mean:

- -np = don't grab the parent directory
- -r = recursive (descend into directories)
- -nH = don't generate host-prefixed directories
- -L = follow relative links only (so you don't download wget just because it's linked here)

If you have problems with wget that look like an authorization or certificate issue, you may need to add the option "--no-check-certificate".

The total size to download all the files is 33G.

Georeferencing Note

You may find the georeferencing on the files refers to generic NAD83 (EPSG code 4269). All files, with the exception of the few in WGS84, are in a more recent realization of NAD83 such as NAD83(CORS96), NAD83(HARN), NAD83(NSRS2007), or NAD83(2011).

Meta Info

Tile Index: tileindex.zip
XYZ range table: pr2016_usace_ncmp_pr_m5037_minmax.csv

Supplemental Info

supplemental/pr2016_usace_ncmp_pr_m5037.kmz

Point Cloud Data Files

MY CART

Provision Your Data

Help

2014 USACE NWP Topobathy Lidar: Coos Bay (OR) - 1

Lidar

Projection & Datum Options:

Projection: State Plane 1983

Zone: Zone 3602 Oregon South

Horizontal Datum: NAD83

Horizontal Units: International Feet

Vertical Datum: What's this? NAVD88

Vertical Units: Feet

Output Options:

Output Product: Raster

Output Format: Grid - GeoTiff 32-bit

Grid Method: What's this? Average

Grid Units: Feet

☑ Fill Small Gaps What's this?

Grid Size: 1.5

Data Options:

☐ Use Advanced Options What's this?

Data Classes: What's this?

Ground
All

☐ Add Intensity Images

Reset

Review and Submit

Lidar ×

MY CART

Success

Your request has been successfully submitted for processing.

Your order number is **325891**. You will receive an email at **matt.pendleton@noaa.gov** when your order has been processed, with a link to retrieve the data.

If you have questions about your request, contact us at ocm.dds@noaa.gov

I want to receive informat

Data Classes Ground

Return Types Any

al Management website.

Contact Info

Email matt.pendleton@noaa.gov

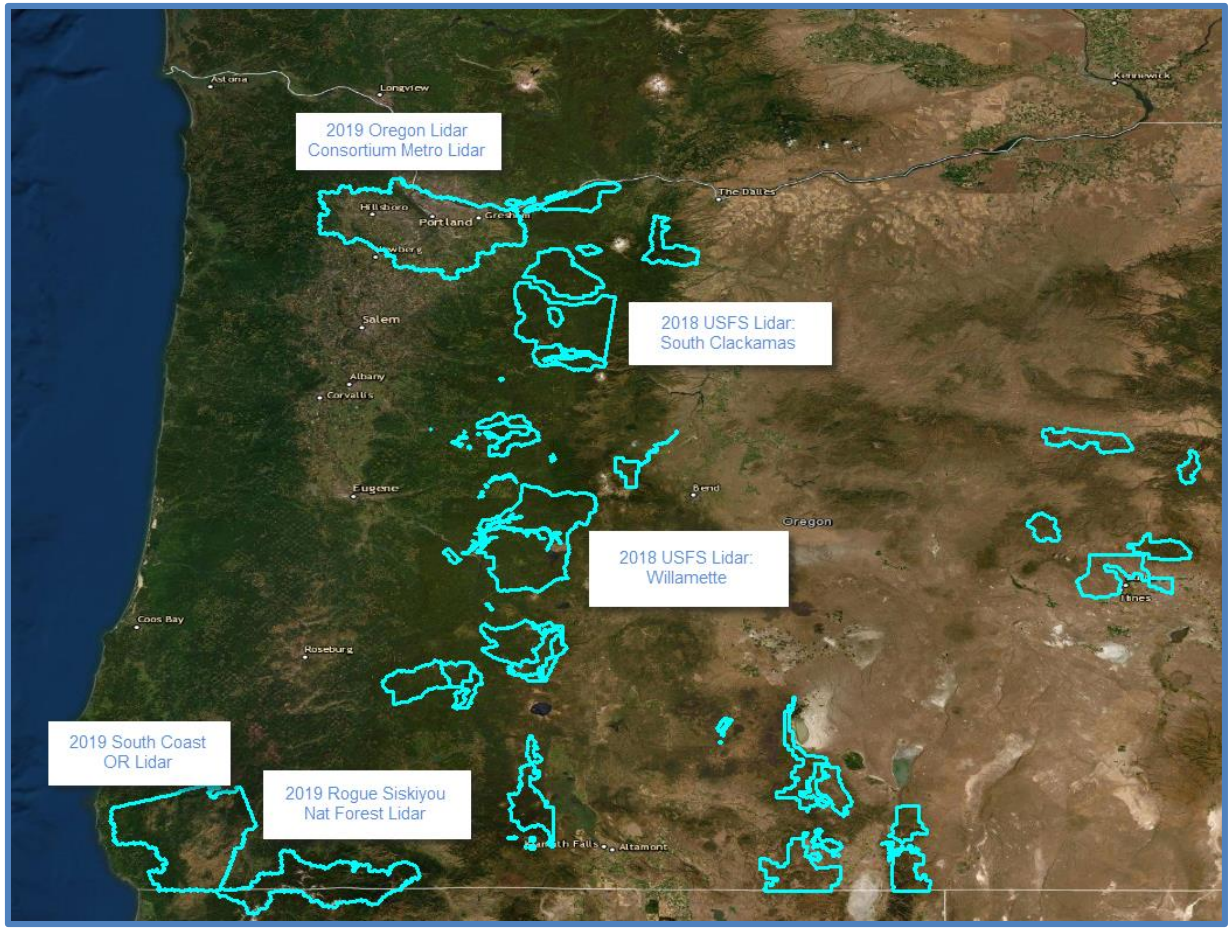
You will receive an email at this address when your order has been processed,

Digital Coast

Bonus! Current and On-going LiDAR Collects for Oregon

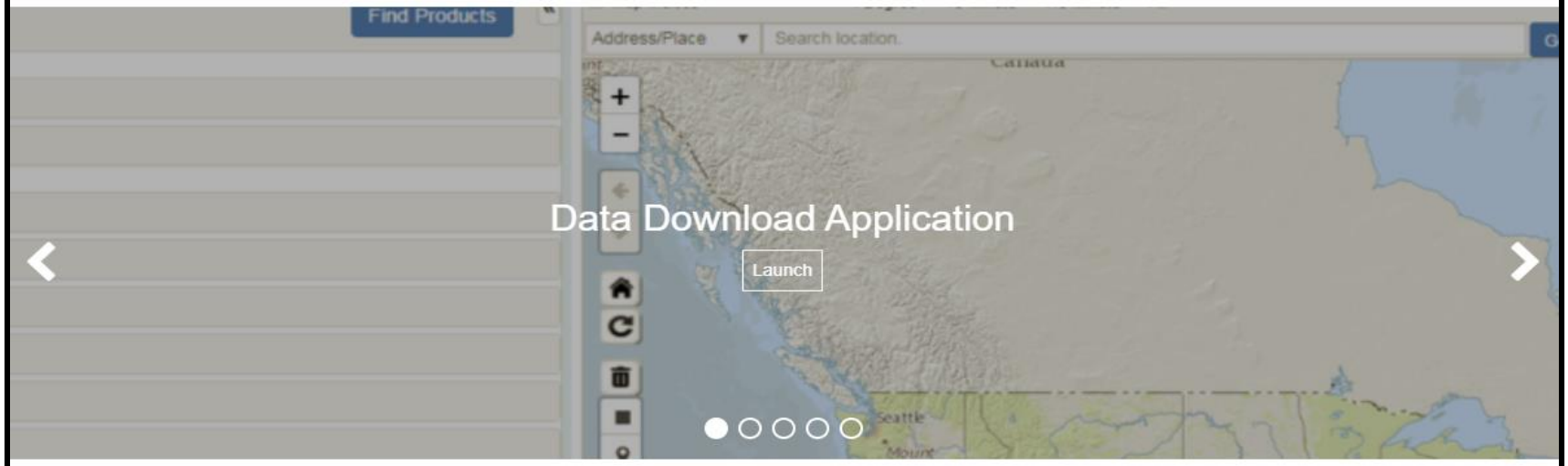
There are many US Forest Service data sets in the works. There are **5 larger data sets** that are also either Planned/Funded or In Progress.

- 2019 South Coast OR Lidar
- 2019 Rogue Siskiyou National Forest Lidar
- 2019 Oregon Lidar Consortium Metro Lidar
- 2018 USFS Lidar: South Clackamas
- 2018 USFS Lidar: Willamette



3DEP Program – The National Map

The National Map - Data Delivery



- HOME
- TRAINING
- LINKS
- DOWNLOAD
- NEWS
- CONNECT
- ABOUT
- FAQS

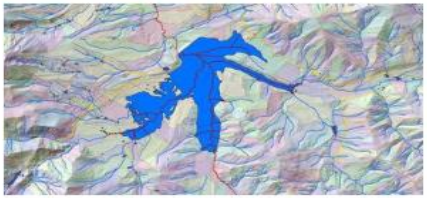
Home

The National Map Data Download and Visualization Services

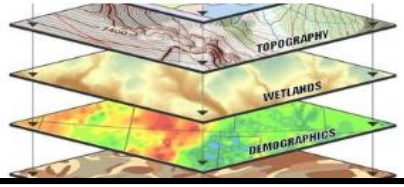
This site provides applications and web map services for "Topographic Information for the Nation". This information includes topographic maps and geographic information system (GIS) data for elevation, hydrography, watersheds, geographic names, orthoimagery, governmental units/boundaries, transportation, and land cover. Change notifications

Topo Maps

GIS Data



Applications & Visualization Services



USGS

TNM Download *(V1.0)*

How to | Start Over | Custom Views | Share Link

Datasets

Find Products

Advanced Search Options

Map

- [ ] US Topo
- [ ] Historical Topographic Maps

Data

- [ ] Boundaries - National Boundary Dataset
- [x] Elevation Products (3DEP)

Product Search Filter

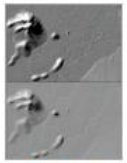
- [ ] All Subcategories
  - [ ] 1 arc-second DEM
    Show Availability
  - [ ] 1 meter DEM
    Show Availability
  - [x] 1/3 arc-second DEM
    Show Availability
  - [ ] 1/9 arc-second DEM
    Show Availability
  - [ ] 2 arc-second DEM - Alaska
    Show Availability
  - [ ] 5 meter DEM (Alaska only)
    Show Availability
  - [ ] Contours (1:24,000-scale)
    Show Preview

Data Extent
1 x 1 degree

File Format
- (•) ArcGrid
- ( ) GridFloat
- ( ) IMG

Show All Availability

Availability legend



Description

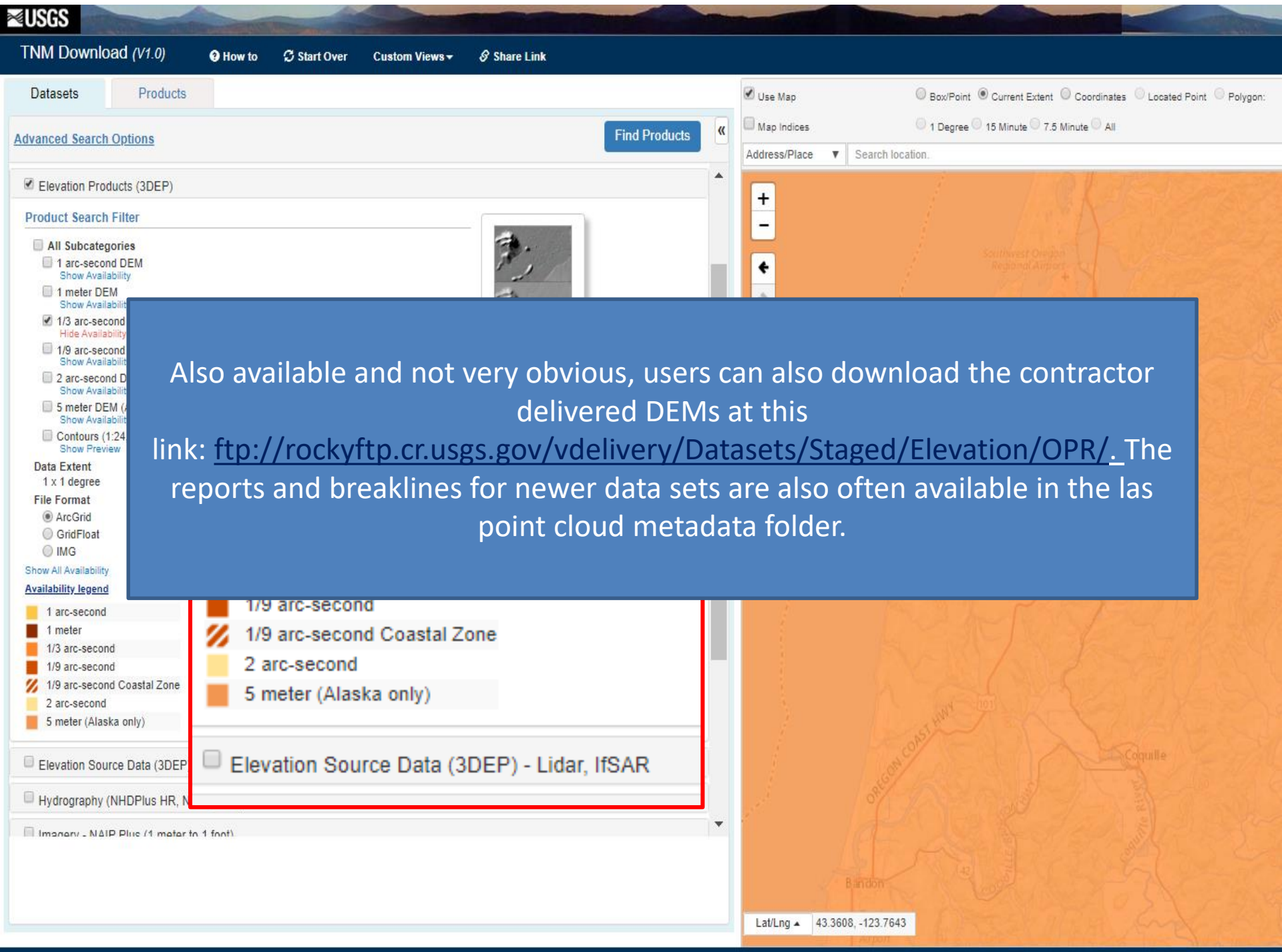
- [ ] Elevation Source Data (3DEP) - Lidar, IfSAR
- [ ] Hydrography (NHDPlus HR, NHD, WBD)
- [ ] Imagery - NAIP Plus (1 meter to 1 foot)

Use Map | Box/Point | Current Extent | Coordinates | Located Point

Map Indices | 1 Degree | 15 Minute | 7.5 Minute | All

Address/Place | Search location.

Lat/Lng 43.4296, -123.6984

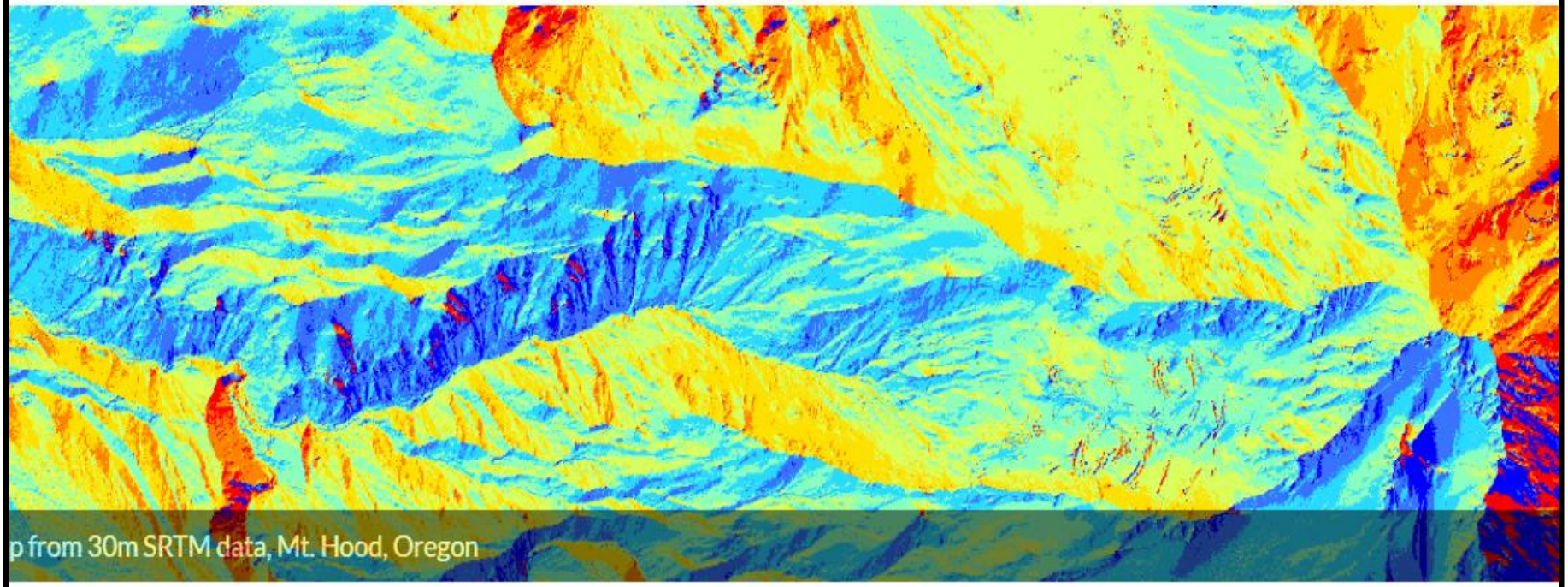


Also available and not very obvious, users can also download the contractor delivered DEMs at this link: ftp://rockyftp.cr.usgs.gov/vdelivery/Datasets/Staged/Elevation/OPR/. The reports and breaklines for newer data sets are also often available in the las point cloud metadata folder.

OpenTopography

High-Resolution Topography Data and Tools

HOME ABOUT DATA TOOLS



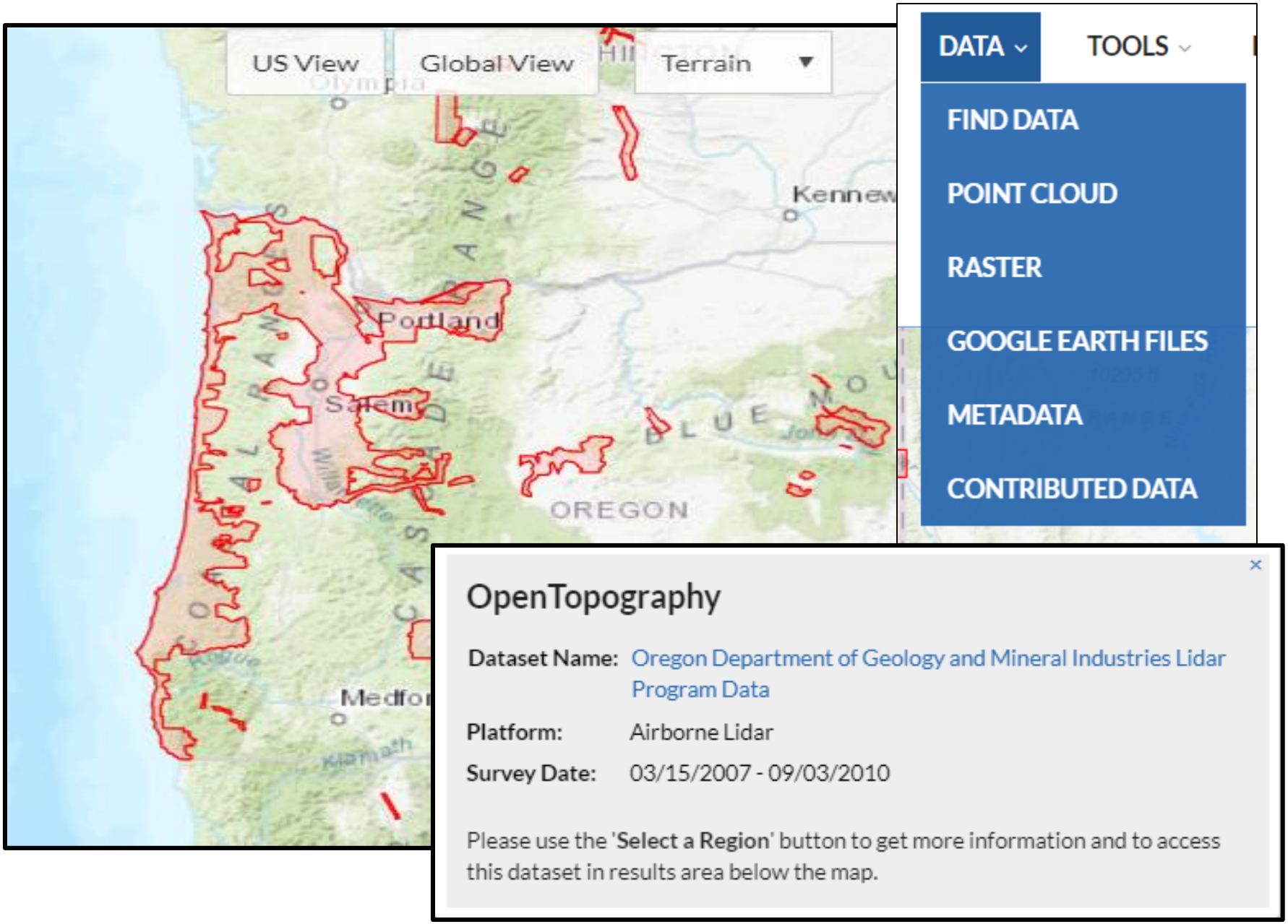
p from 30m SRTM data, Mt. Hood, Oregon

Latest News

Undergraduate Topographic Differencing Exercise

Sep 22, 2019

After a big earthquake happens people ask, 'Where did the earthquake occur? How big was it? What type of fault was activated.' We have designed an undergraduate laboratory exercise where students learn how geologists and geodesists use airborne...


US View
Global View
Terrain
DATA
TOOLS
FIND DATA
POINT CLOUD
RASTER
GOOGLE EARTH FILES
METADATA
CONTRIBUTED DATA
Portland
Salem
OREGON
OpenTopography
Dataset Name: Oregon Department of Geology and Mineral Industries Lidar Program Data
Platform: Airborne Lidar
Survey Date: 03/15/2007 - 09/03/2010
Please use the 'Select a Region' button to get more information and to access this dataset in results area below the map.

What's the Latest and Greatest?

Key Note: A lot of new and emerging technology regarding LiDAR

Many good sources for keeping up to date with current trends

LiDAR News
Home of the LiDAR Industry

LIDAR MAGAZINE

Digital Coast GeoZone
Tech talk for the Digital Coast

https://lidarnews.com/articles/single-photon-lidar-best-sensor/

LiDAR Accuracy Measures – Very Important!!

95% Confidence Level

- The NSSDA (National Standard for Spatial Data Accuracy) provides guidance for reporting geospatial accuracy in the U.S. government. It specifies reporting the 95% confidence level. This means the value of error at which we expect 95% of the errors to be at or below that value.

Root Mean Square Error (RMSE)

- If errors are normally distributed, you can compute the root mean square error and multiply by 1.96. You'll see this a lot in lidar data reports. We typically expect the non-vegetated areas will have normally distributed errors, so this works well. Note that it means that 10 cm RMSE is the same as 19.6 cm at 95% confidence, so that answers the original question.

Standard Deviation

- It is similar to, but a bit more complicated than the RMSE. One drawback to the standard deviation is that it doesn't stand alone very well. You might have a point cloud with a standard deviation of 5 cm, which sounds pretty good, but if the mean error is 1 meter you may have to reconsider. In contrast, the RMSE for such a dataset would be near 1 meter.

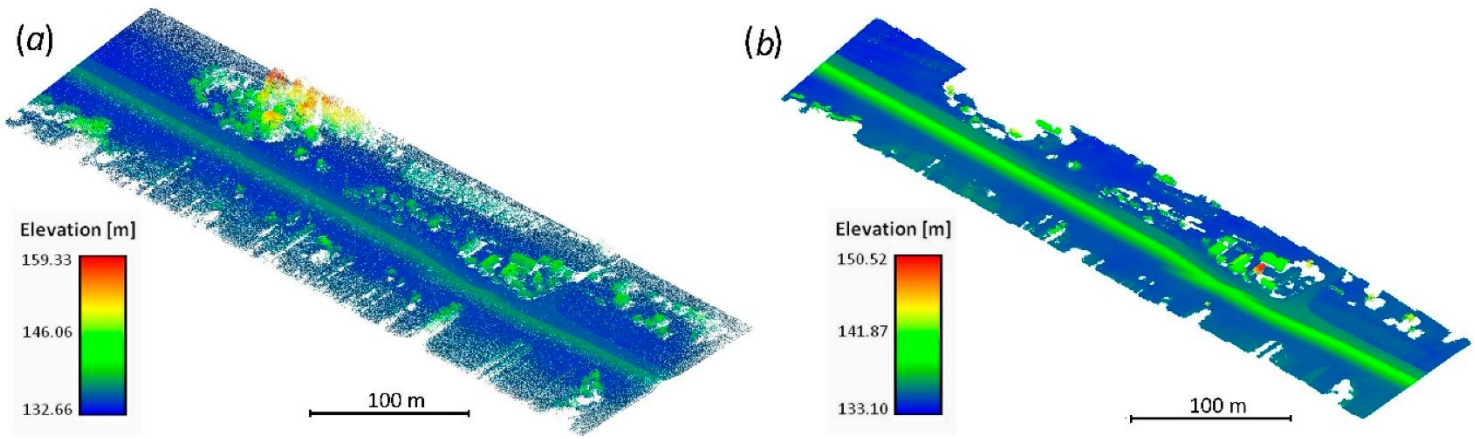
Accuracy Measures

Depth Dependent

- Finally, there are the accuracy standards used by the IHO (International Hydrographic Organization). It's a 95% confidence level for total vertical uncertainty (TVU), but incorporates a depth component such that the uncertainty increases with depth.

Conclusion

You can learn a lot more about making lidar accuracy measurements from the ASPRS Positional Accuracy Standards document (and other resources).



Source: https://www.mdpi.com/2220-9964/7/9/342

The 411 on LiDAR Coordinates and Formats

There was recently a question about the Digital Coast lidar holdings via twitter. The questions involved why our lidar had horizontal coordinates of latitude and longitude. The answers are too long for twitter, so I'll try to address them here.

We keep things in their native format and not everyone wants the same projection!

Lidar Datasets at NOAA Digital Coast

https://coast.noaa.gov/htdata/lidar1_z/

Below are links to lidar datasets available in the NOAA Digital Coast. Users that need access to the full datasets in compressed point cloud LAZ format should use the ftp or https links. Please be patient after clicking a link as there may be thousands of files. For customized lidar data products or to do a geographic search, please use the Digital Coast Data Access Viewer (DAV) or the links to DAV below, particularly if you don't need the full dataset.

All datasets linked below on ftp are point clouds in LAZ format (laszip.org for free decompression tool). A README file with each dataset provides further information.

Columns are sortable by clicking table headers. A table of imagery and elevation DEMs is also available.

Year	Dataset Name	Geoid	https	ftp	DAV	footprint	Tile Index	ID #
2019	NOAA OCM Unmanned Aerial System Lidar: Great Bay NERR (metadata:xml)	geoid12b	http	ftp	custom via DAV	KMZ	Index SHP	8844
2018	USACE NCMP Topobathy Lidar: Gulf Coast (AL, MS) (metadata:xml)	geoid12b	http	ftp	custom via DAV	KMZ	Index SHP	8626
2018	USACE NCMP Post-Florence Topobathy Lidar: Southeast Coast (VA, NC, SC) (metadata:xml)	geoid12b	http	ftp	custom via DAV	KMZ	Index SHP	8617
2018	USACE FEMA Topobathy Lidar: Main Island, Culebra, and Vieques, Puerto Rico (metadata:xml)	geoid12b	http	ftp	custom via DAV	KMZ	Index SHP	8560

****If we hadn't turned everything into geographic coordinates, we would probably need to do the same thing others did and put it out in whatever projection in came in as (not all UTM by the way).****

The 411 on LiDAR Coordinates and Formats

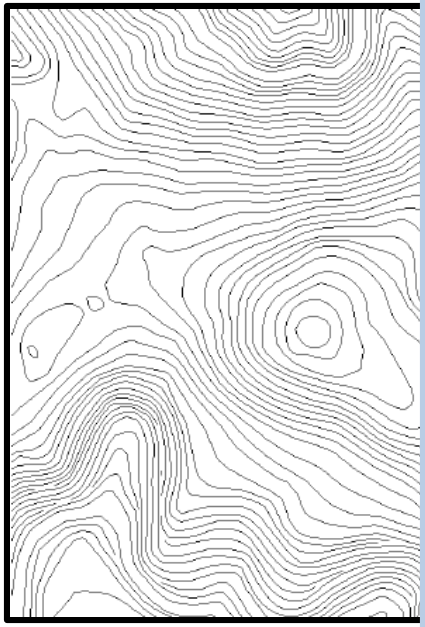
What about the future?

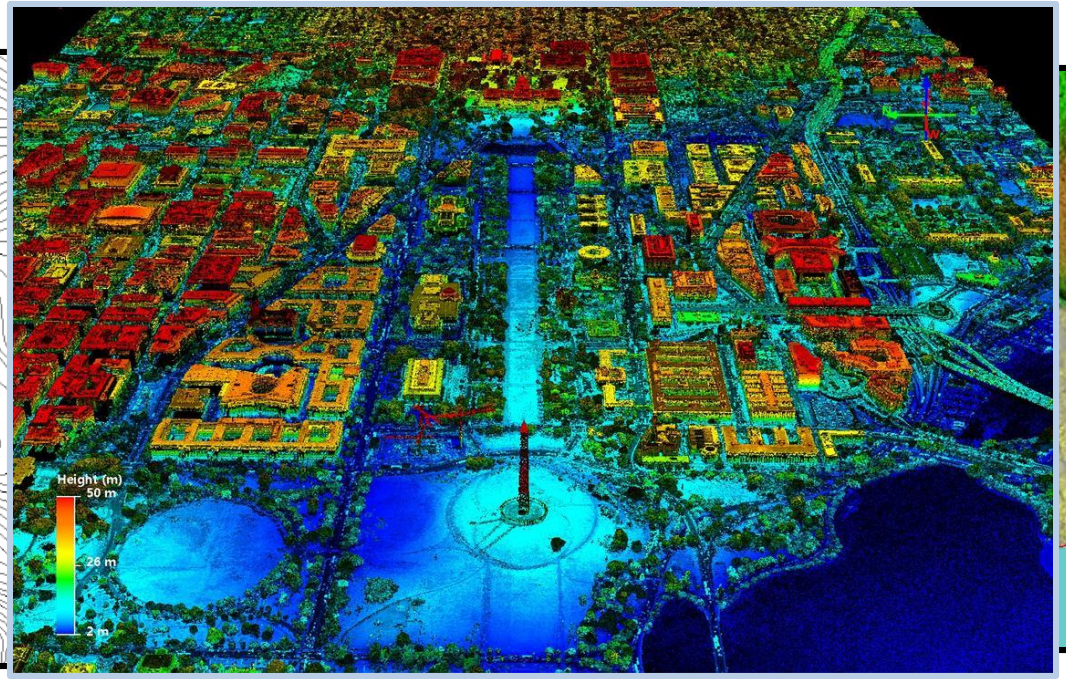
- The USGS and 3DEP plan is to use Albers Equal Area projection as their standard.
- There are lots of things to work out still and it's likely we'll see data delivered in multiple projections. Essentially making the same sort of decision we did with geographic and trying to cover the ground with one system.
- They also wanted equal area for consistent acquisition sizes. There are good reasons for having different projections and your favorite system isn't going to make everyone else happy.
- It's best to make sure you've got some tools to get from one system to another. By the way, all those reprojections go through **geographic** to get from one system to another. You'll also go through **geographic** to do datum transformations.
- Also…NGS is moving quickly towards **GRAV-D**, a new official vertical datum, which means once implemented no more **NAVD88**.

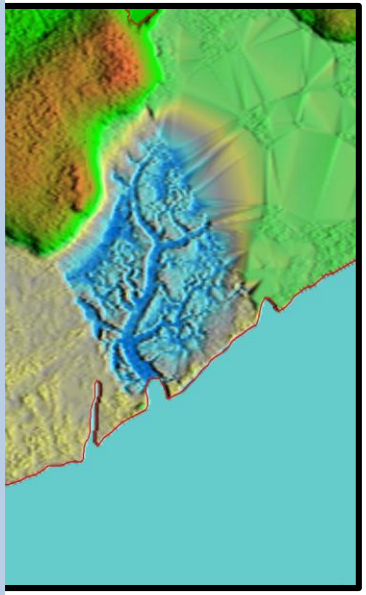
Using Lidar in a GIS

We get A LOT of questions about using lidar data in a GIS often. We don't always get many details about what data they're having trouble with or which format it's in.

A brief overview of various options we have for lidar data and derived products with a discussion of how they work in a GIS.







Using Lidar in a GIS

We've discussed where and how to get data! Here are some output options and how they relate to GIS:

- If you get data from the DAV (or other sites), it could be a point cloud, a DEM, or contours.
- If the data set name doesn't have DEM in it, we're starting from a point cloud and the DEM or contours will be derived from the point cloud upon request. It will be an automated process without breaklines.
- If the name does have DEM in it, we're starting with a DEM someone made from the point cloud and likely applied breaklines and some manual labor to clean up artifacts.

Using Lidar in a GIS

Point Clouds

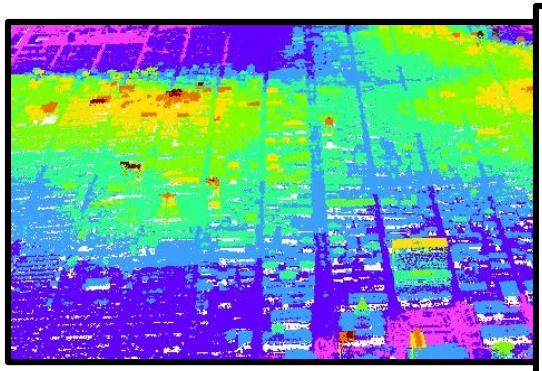
The DAV gives you the option of the formats for point clouds. The bulk download will all be in LAZ. Make sure you see the note at the end of this post if you're planning to derive surfaces from the point clouds.

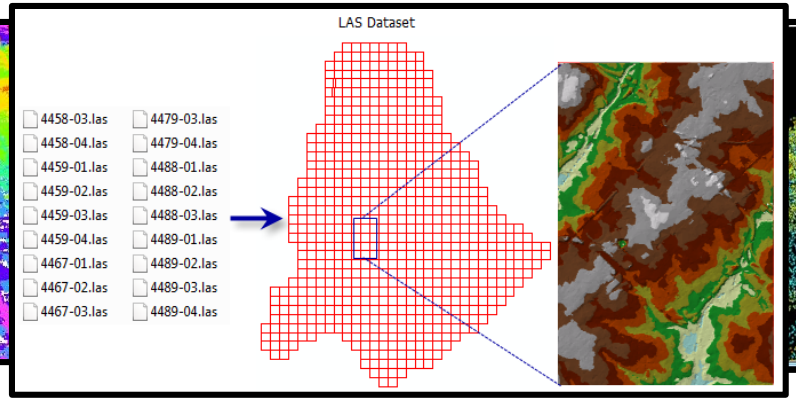
LAS

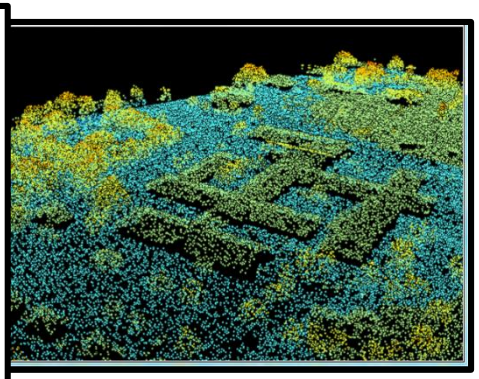
LAS format is a standard from ASPRS and is a very common format for airborne lidar. Any GIS should have no problem reading this, including the newest LAS version 1.4. You just have to make a new LASD and add the LAS files to it. ESRI has a tutorial for that.

LAZ

This is an open source format for a compressed LAS file. The compressor/decompressor is laszip (free). ArcGIS does not like this format. They use a different compression called zLAS, however, that format is proprietary. To use LAZ with ArcGIS, you simply use the laszip tool above to convert to LAS and then proceed as normal. Note that all of the bulk download point clouds are in LAZ format, geographic coordinates, and NAVD88 vertical meters (except a few rare cases where that isn't possible).







Using Lidar in a GIS

ASCII

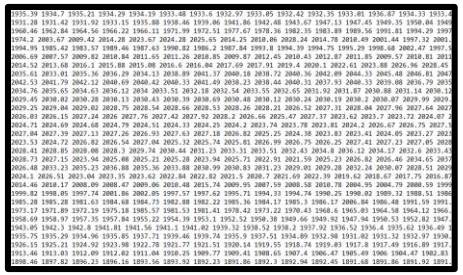
The ASCII format option is a bit restricted. It is only going to give you the x,y,z values. If you want to do any filtering (e.g. only ground points), make sure you do it in the DAV because there won't be any info later. This can be imported into ArcGIS the same way you'd import any other ASCII table of data.

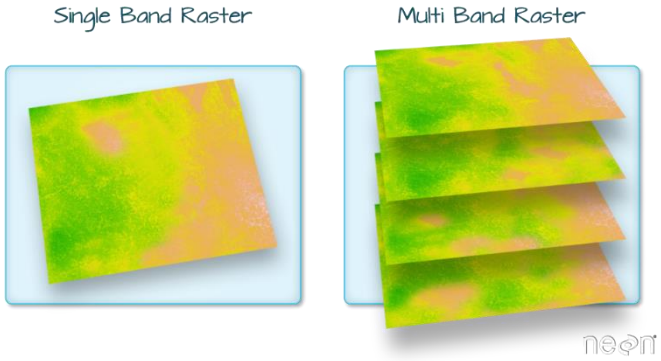
Imagine (*.img)

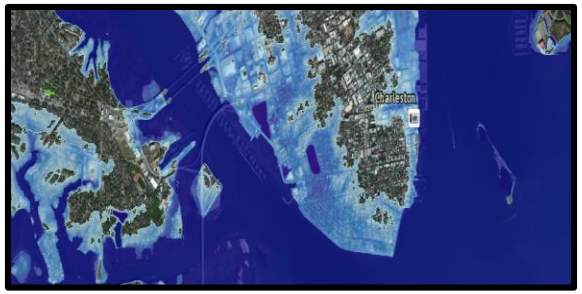
This should also load into ArcGIS without any issues.

Arc Grid

While this will have no problem being read by ArcGIS, it isn't an option for DAV and there shouldn't be any in the bulk download. There might be some that we missed though. It's a proprietary format, so we usually transform to TIFF or IMG if we receive them.







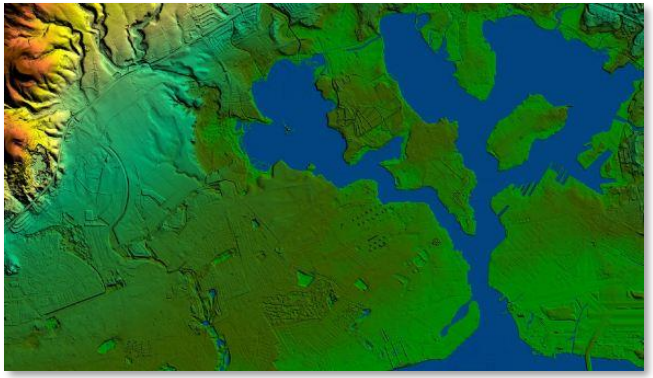
Using Lidar in a GIS

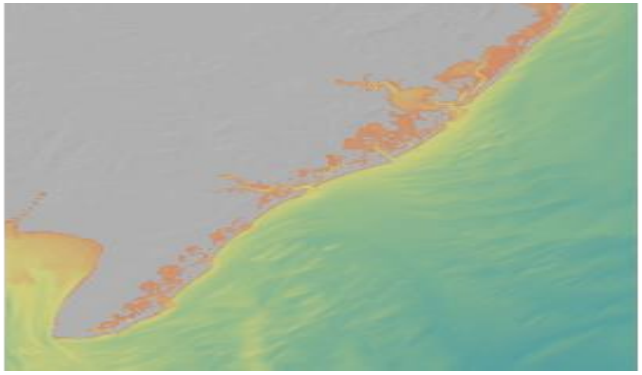
Digital Elevation Models (DEM)

Digital Elevation Models are a raster format representing a surface interpolated from the point cloud data. Usually it's only the ground points, *though it doesn't have to be.* The DAV will give you a choice of output formats while the bulk download will typically have whatever was the original format for the data. The bulk download DEMs will be the solid earth points while you can make some choices, maybe too many, about what points to use.

GeoTIFF (*.tif)

Often just called TIFF files, these should work just fine in ArcGIS. The possible problem you might have is related to the no-data value. The base specification for TIFF does not have a tag for no-data, but you'll often have DEMs that have void areas. Particularly in coastal areas. TIFF files will either use an IEEE not a number (NaN) value or will use an additional tag proposed by GDAL. Newer versions of ArcGIS should handle both of those.





Using Lidar in a GIS

Contours

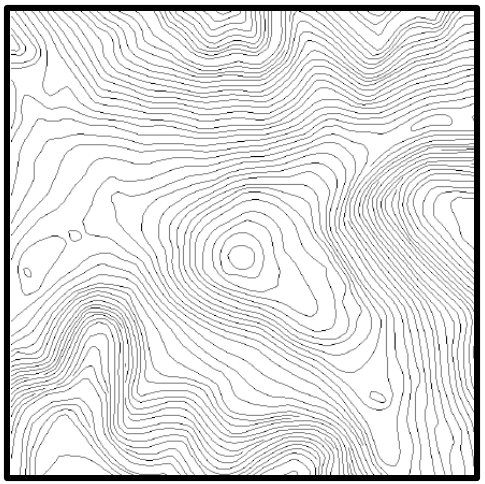
Contours are currently only available by generating them in the DAV from point cloud data sets. There are two formats available, though we hope to add LandXML as a better solution for CAD users.

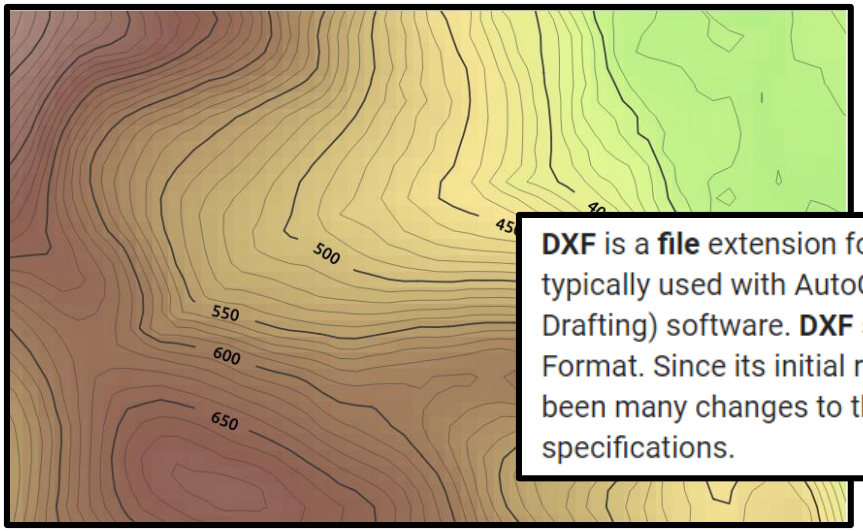
Shapefile (*.shp)

Shapefiles are an open format from ESRI and should have no problem importing into ArcGIS.

DXF (*.dxf)

The AutoCAD DXF format can be read into ArcGIS, but you'll be happier with the shapefiles. We actually make a shapefile first and then convert to DXF, so there is nothing gained for an ArcGIS user to pick DXF.





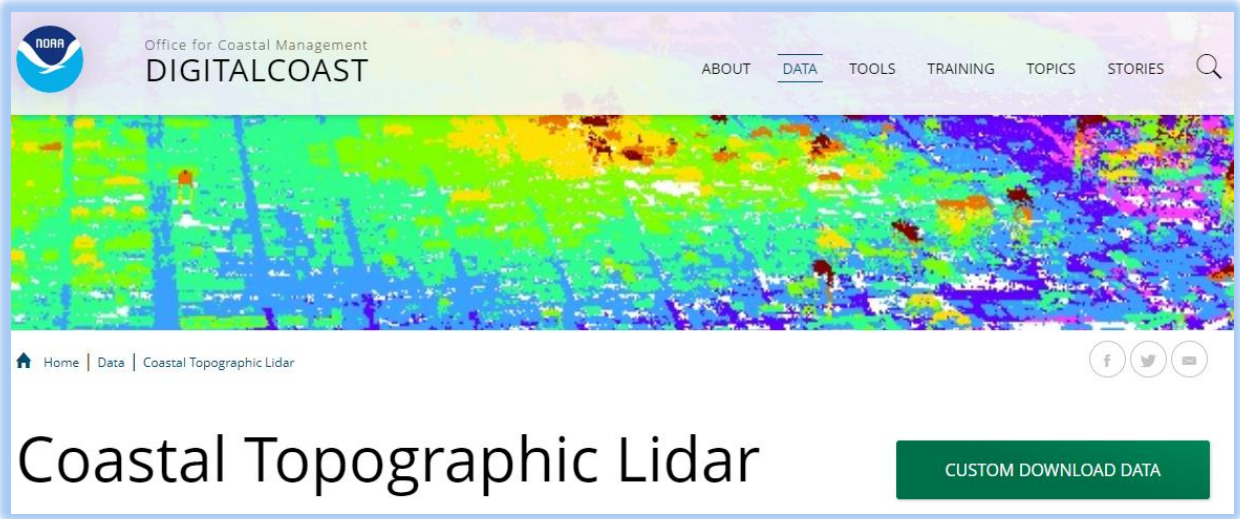
DXF is a **file** extension for a graphic image format typically used with AutoCAD (Computer Assisted Drafting) software. **DXF** stands for Drawing eXchange Format. Since its initial release in 1982, there have been many changes to the **DXF file** format specifications.

Using Lidar in a GIS

OpenSource GIS

More Good Stuff! Trainings, Blogs, and Case Studies

- **LiDAR 101** Training being revamped! Great online training for working with LidAR.
- **GeoZone OpenSource Blog Series for using LiDAR** – coming soon!
- **Coastal Inundation Mapping Course** – Two-day training that also includes building bare earth DEMs from LiDAR point clouds and breaklines.



Using Lidar in a GIS

Notes on Deriving Products From Point Clouds Useful Tips and Tricks!

Digital Coast GeoZone

Tech talk for the Digital Coast

https://geozoneblog.wordpress.com/2014/02/03/mapping-lidar/

https://geozoneblog.wordpress.com/2017/01/30/lidar-and-arcgis/

https://geozoneblog.wordpress.com/2014/07/23/first-return-lidar-in-digital-coast/

https://geozoneblog.wordpress.com/2016/02/16/lidar-contours/

https://geozoneblog.wordpress.com/2019/05/01/bulk-lidar-download-on-digital-coast/

https://geozoneblog.wordpress.com/2019/03/19/getting-lidar-data-for-a-polygon/

https://geozoneblog.wordpress.com/2014/06/11/taking-stock-of-all-that-lidar/

Questions or Follow Up

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