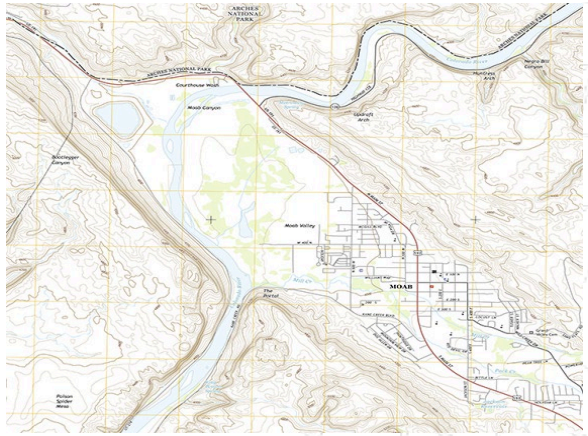
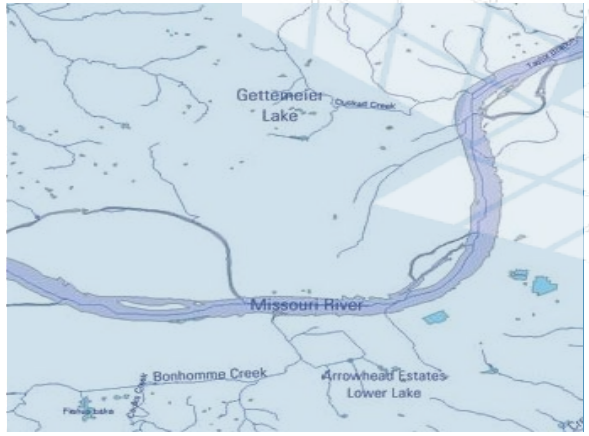
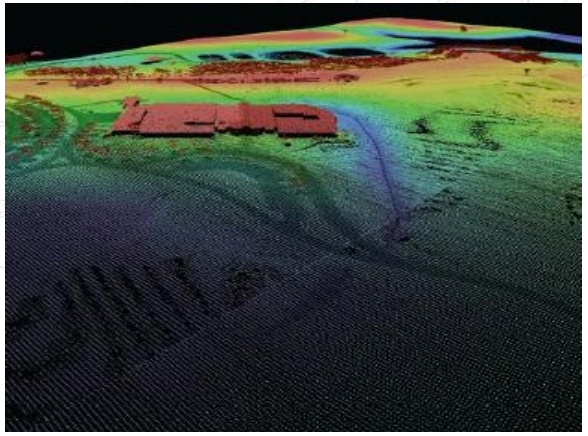
3DEP Data Distribution: USGS Activities and Objectives







USGS science for a changing world

The National Map
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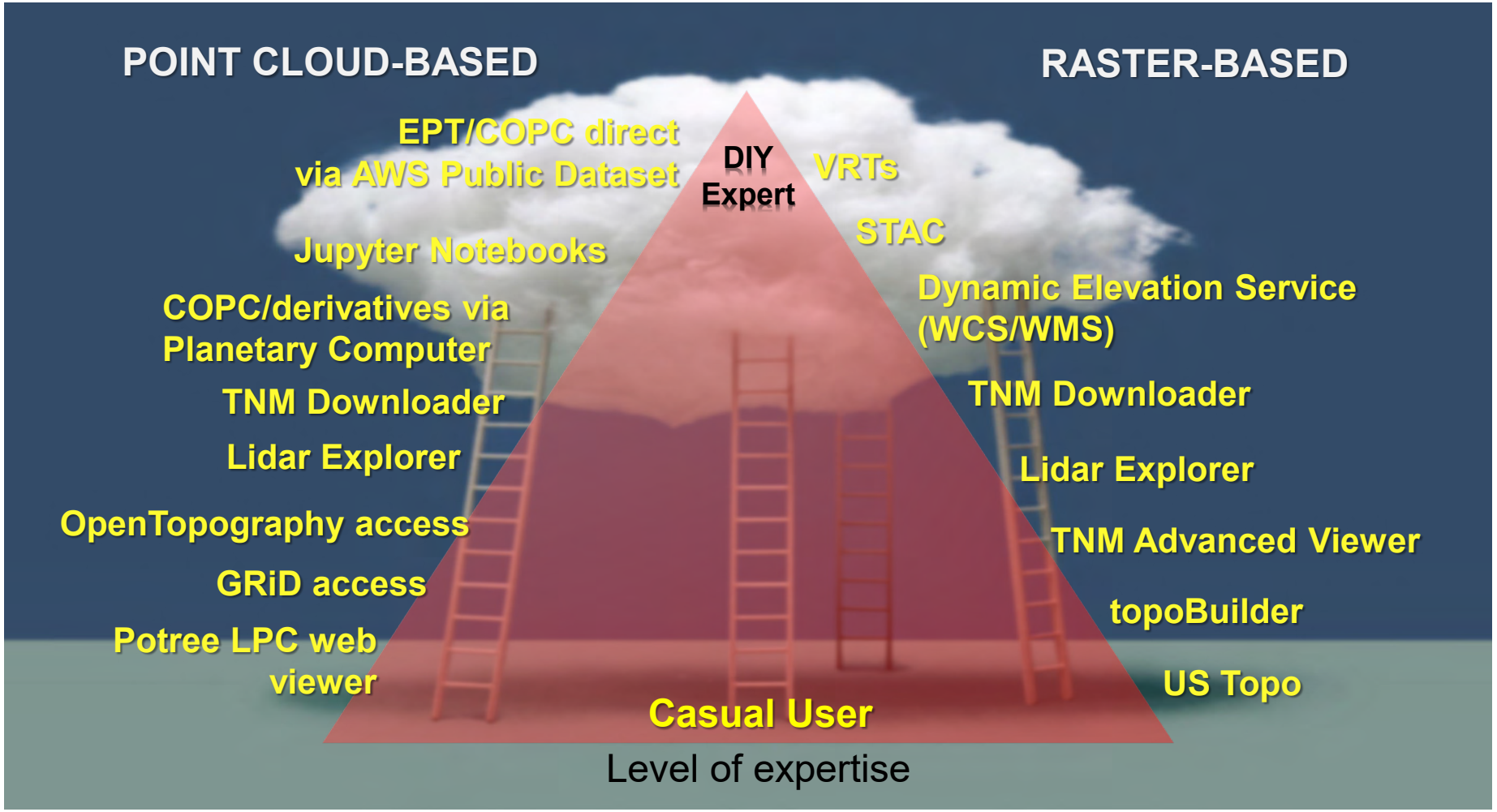
NSGIC 3DEP User Meeting
6/30/22
Rob Dollison, Jason Stoker, and Rick Brown

3DEP caters to a wide range of user needs

Supporting everything from casual to expert requirements

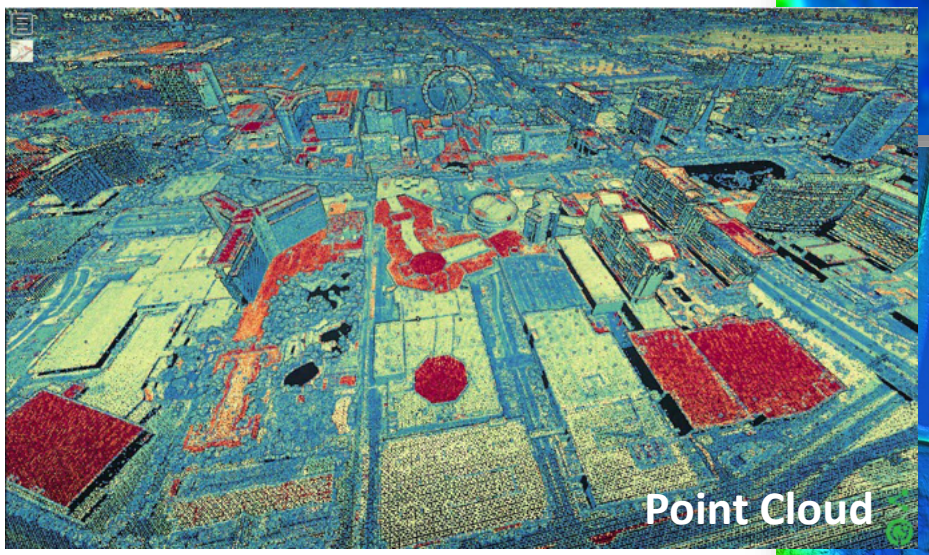


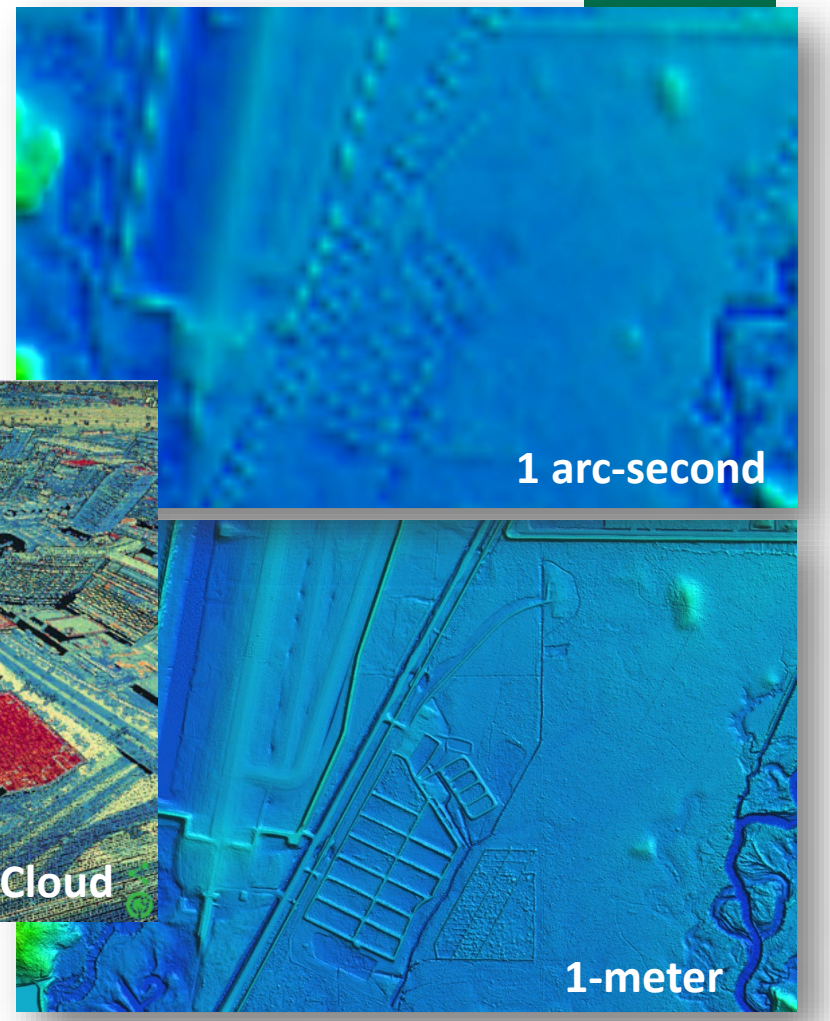
3DEP Products

- Standard DEMs
  - Nationally Seamless
    - 2 Arc Second
    - 1 Arc Second
    - 1/3 Arc Second

  Previously referred to as the National Elevation Dataset (NED)

  - 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)





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https://apps.nationalmap.gov/downloader/#/

Operationalize processing and delivery

Product Updates

- Seamless DEMs
  - "Current" folder – only current DEMs without timestamp
  - "Historical" folder – all DEMs (current & historical) with timestamp
  - VRT available for use with GDAL and other tools
- FTP replaced with HTTPS
  - More difficult to download entire folders.
  - Some solutions
    - Every LPC and OPR WorkUnit directory has a list of products included.
    - Utilities: uGet, wGet, Rclone.

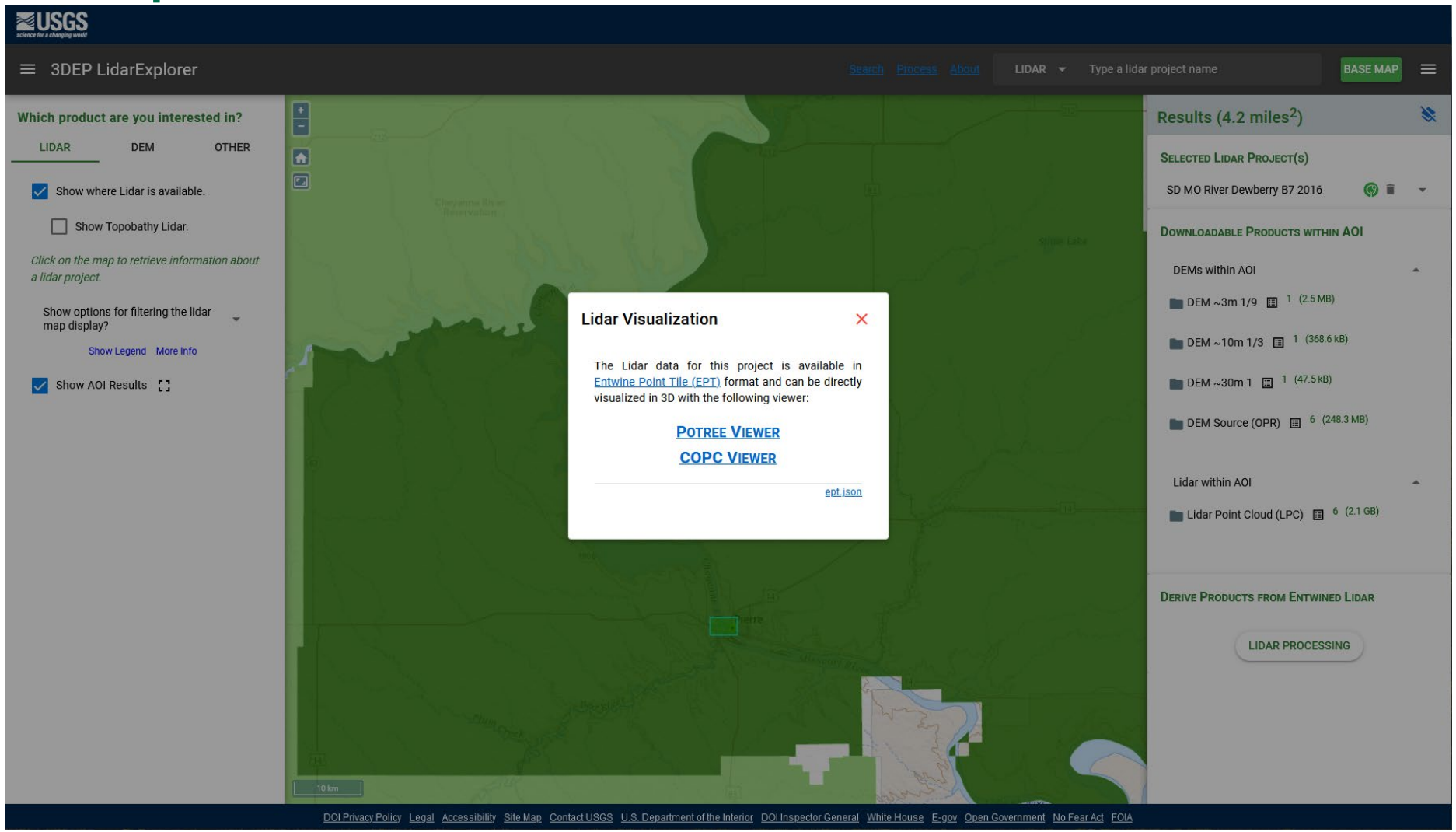
Staged Products Directory

Last Modified	Size	Key
		../
2022-03-19T01:30:05.000Z	743.6 kB	USGS_Seamless_DEM_13.vrt
	0	current/
	0	historical/

Staged Products Directory

Last Modified	Size	Key
		../
2022-04-06T12:24:19.000Z	187.9 kB	0_file_download_links.txt
	0	TIFF/
	0	browse/
	0	metadata/

Lidar Explorer



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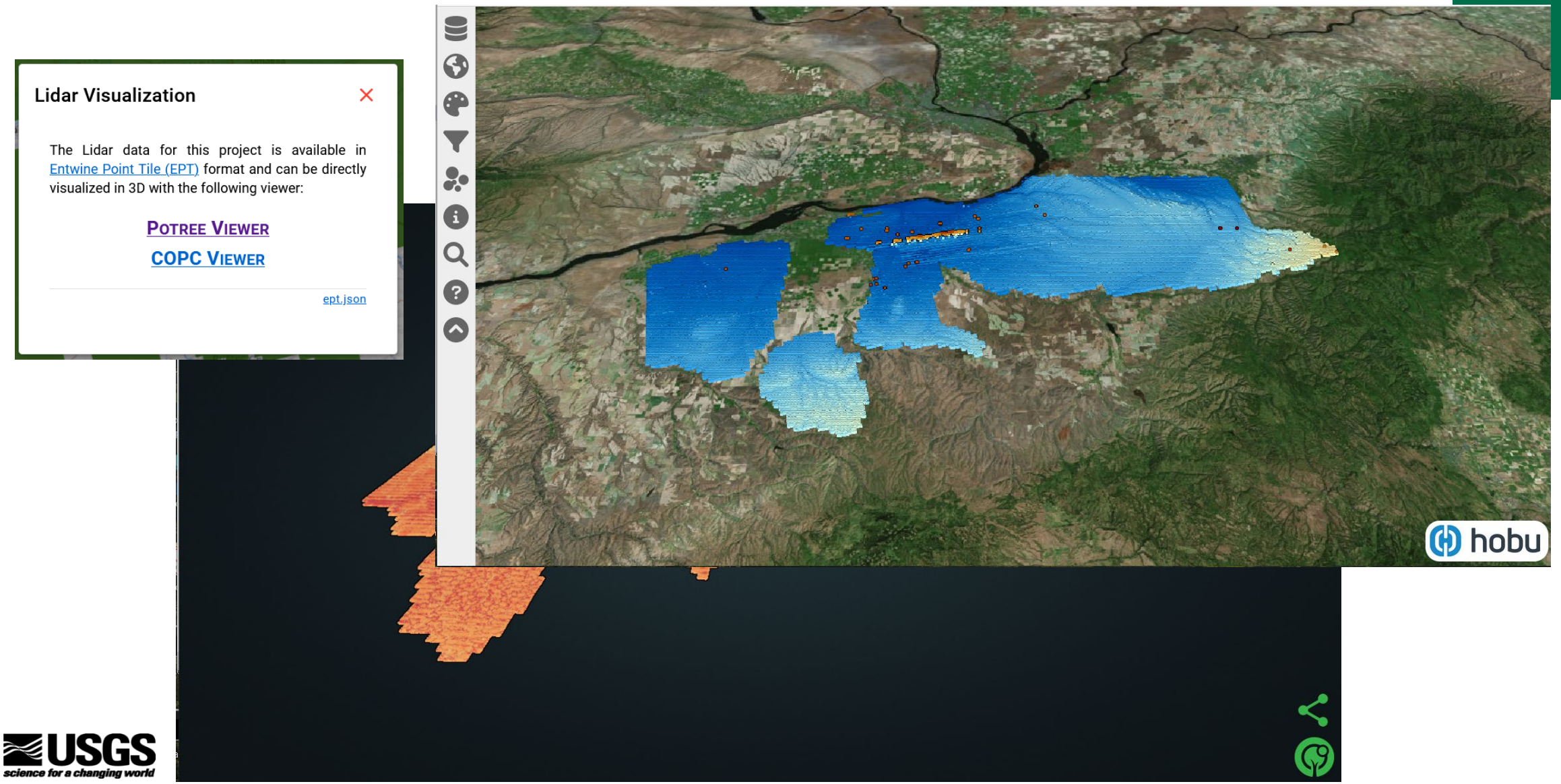
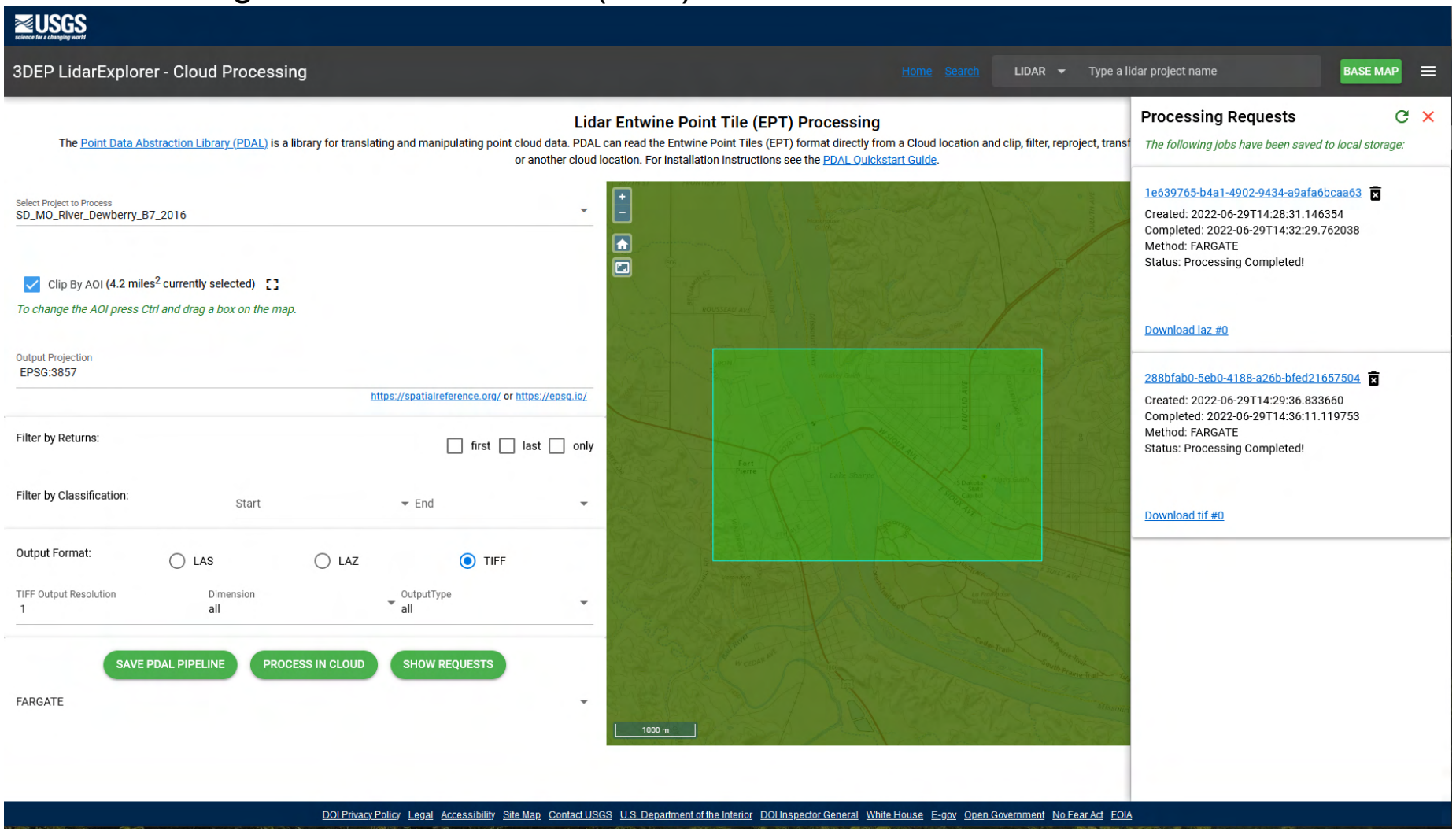
https://www.usgs.gov/NationalMap/LidarExplorer

Lidar Explorer – 3D Visualization



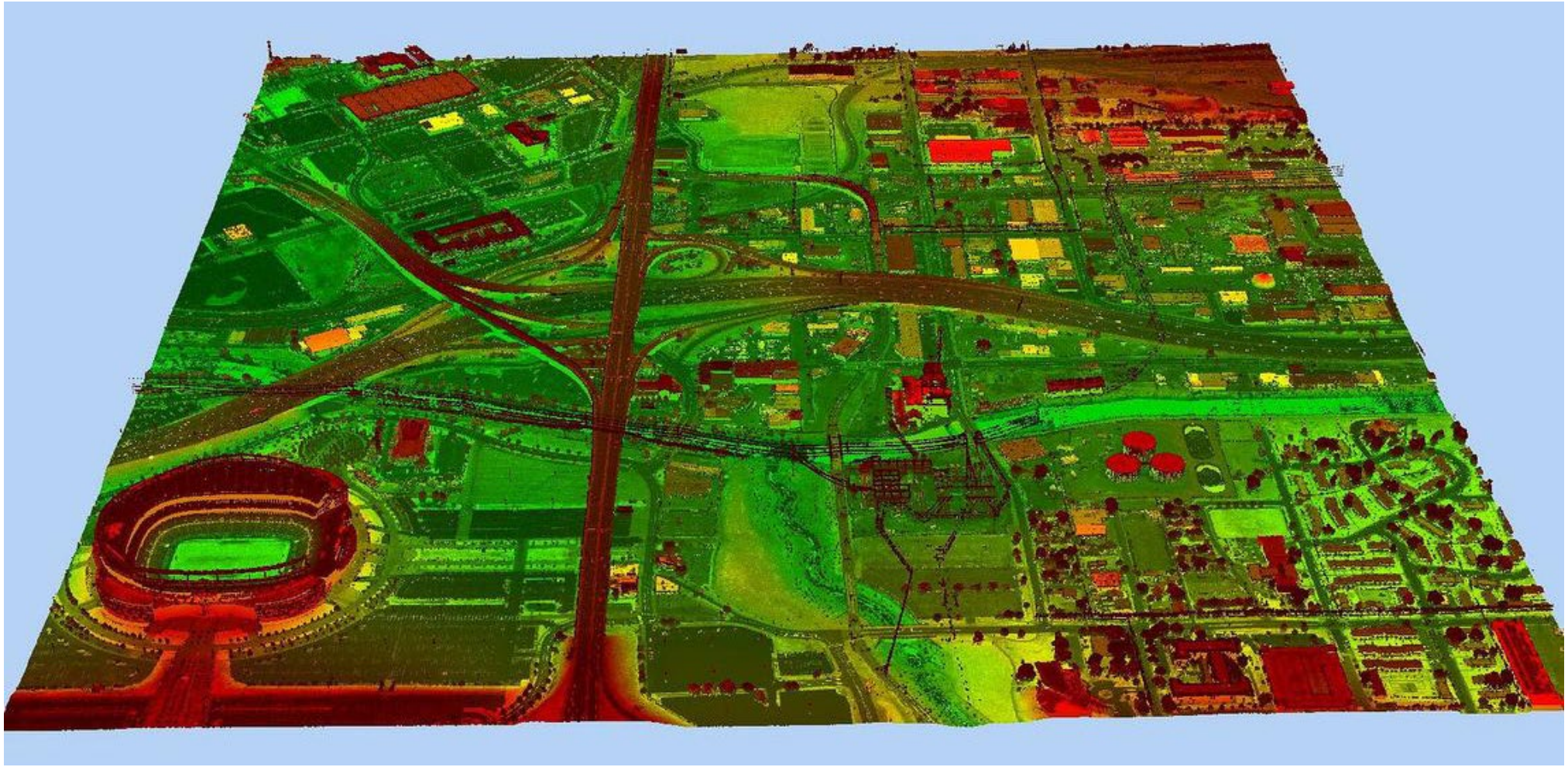
3DEP Lidar Explorer

Deriving Products using Entwine Point Tiles (EPT) & PDAL



Provide the raw materials a user can “mine”

Moving away from a download-first paradigm, with focus on provisioning, data management, standardization

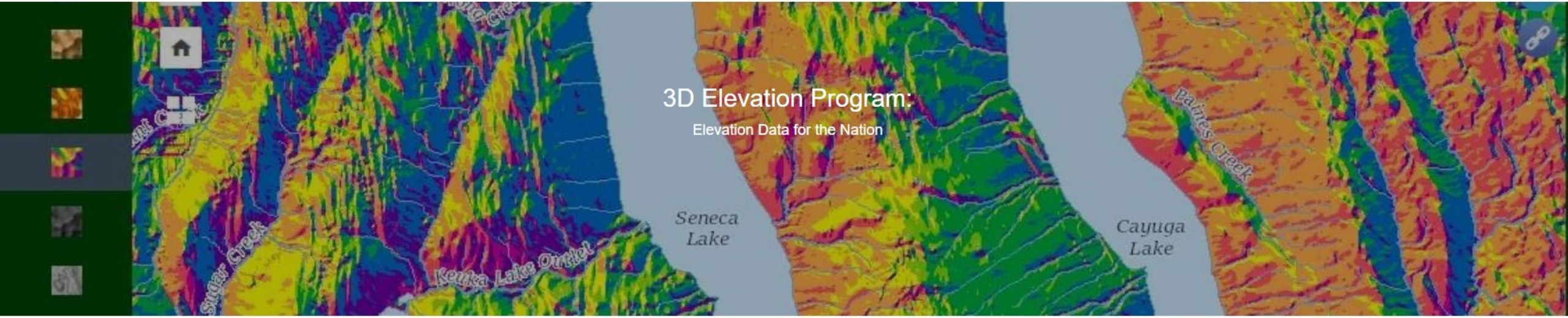


3DEP Dynamic Elevation Service

Allowing users to ‘tap in’ to DEMs without Downloading

- Built as a Web Coverage Service
- Multi-resolution (highest resolution on top)
- Can bring into ArcMap, ArcGIS Pro, Global Mapper, QGIS
- Process directly (use geoprocessing tools)- 8k x 8k areas
- NOT Seamless- seams found especially b/w 10m & 1m

New Elevation Map Service Available From the USGS 3D Elevation Program



Release Date: AUGUST 8, 2018

The USGS 3D Elevation Program (3DEP) announces the availability of a new dynamic map service.

The recently released map service allows users to explore multiple resolutions of 3DEP data available in The National Map. Service Directory: https://elevation.nationalmap.gov/arcgis/rest/services/3DEPElevation/ImageServer

The new elevation map service creates multi-resolution visualizations on-the-fly, allowing users to explore a variety of representations including: hillshade; aspect; slope; and tinted hillshade maps, as well as automated contours and more. In addition, Open Geospatial Consortium (OGC) Web Map Service (WMS) and Web Coverage Service (WCS) interfaces are enabled to support interoperability across systems.

The dynamic platform supports the exploration of Digital Elevation Models (DEMs) for the US and territories at a mixture of scales, including 1 meter DEMs. That data will continue to become increasingly available as 3DEP progresses towards its goal to complete nationwide lidar data coverage

Contacts

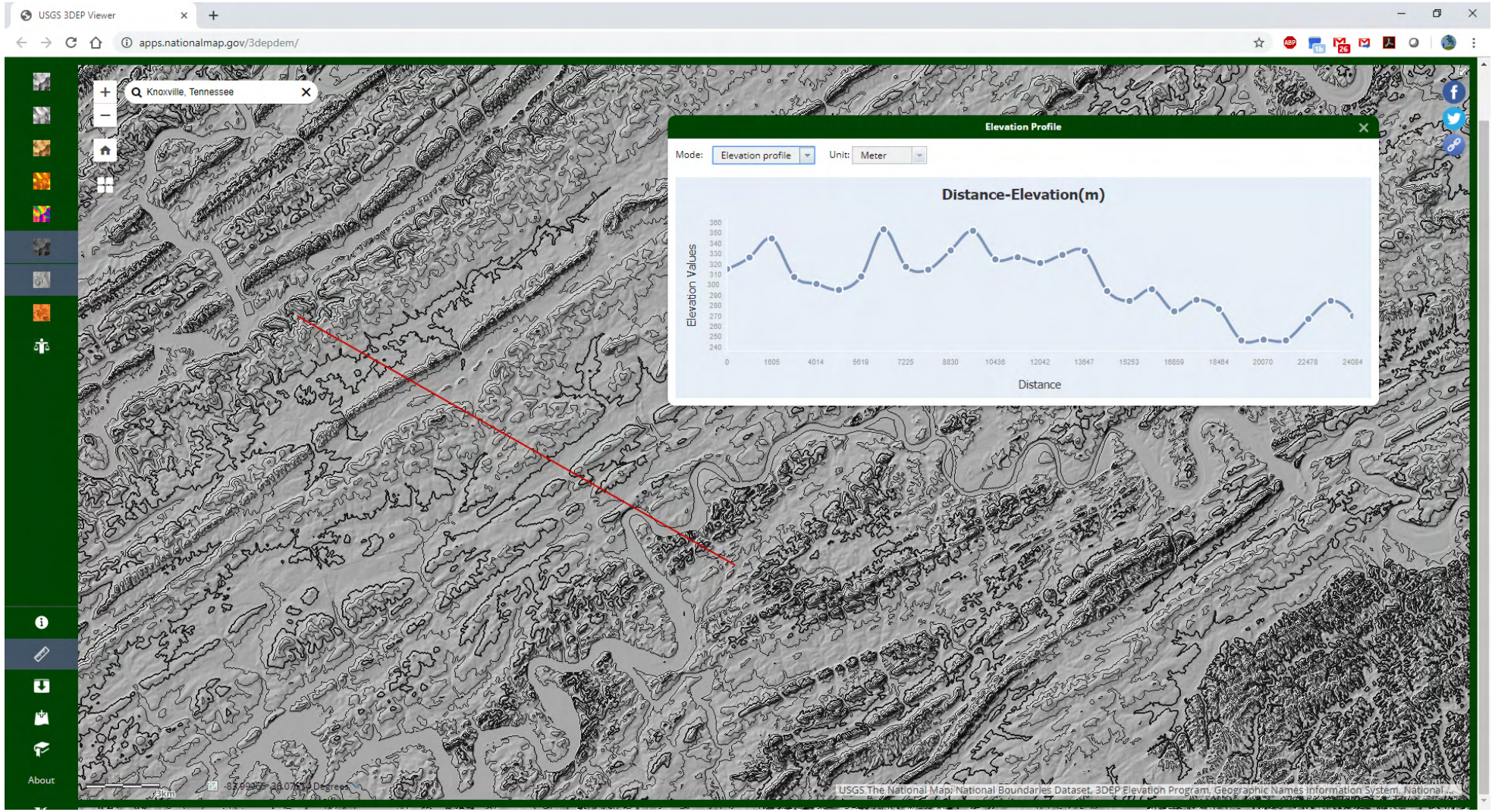
Department of the Interior,
U.S. Geological Survey

Office of Communications and Publishing
12201 Sunrise Valley Drive
Reston, VA 20192
United States
Phone: 703-648-4460

Robert Dollison

Program Manager
National Geospatial Program (NGP)

Elevation Demonstration Viewer



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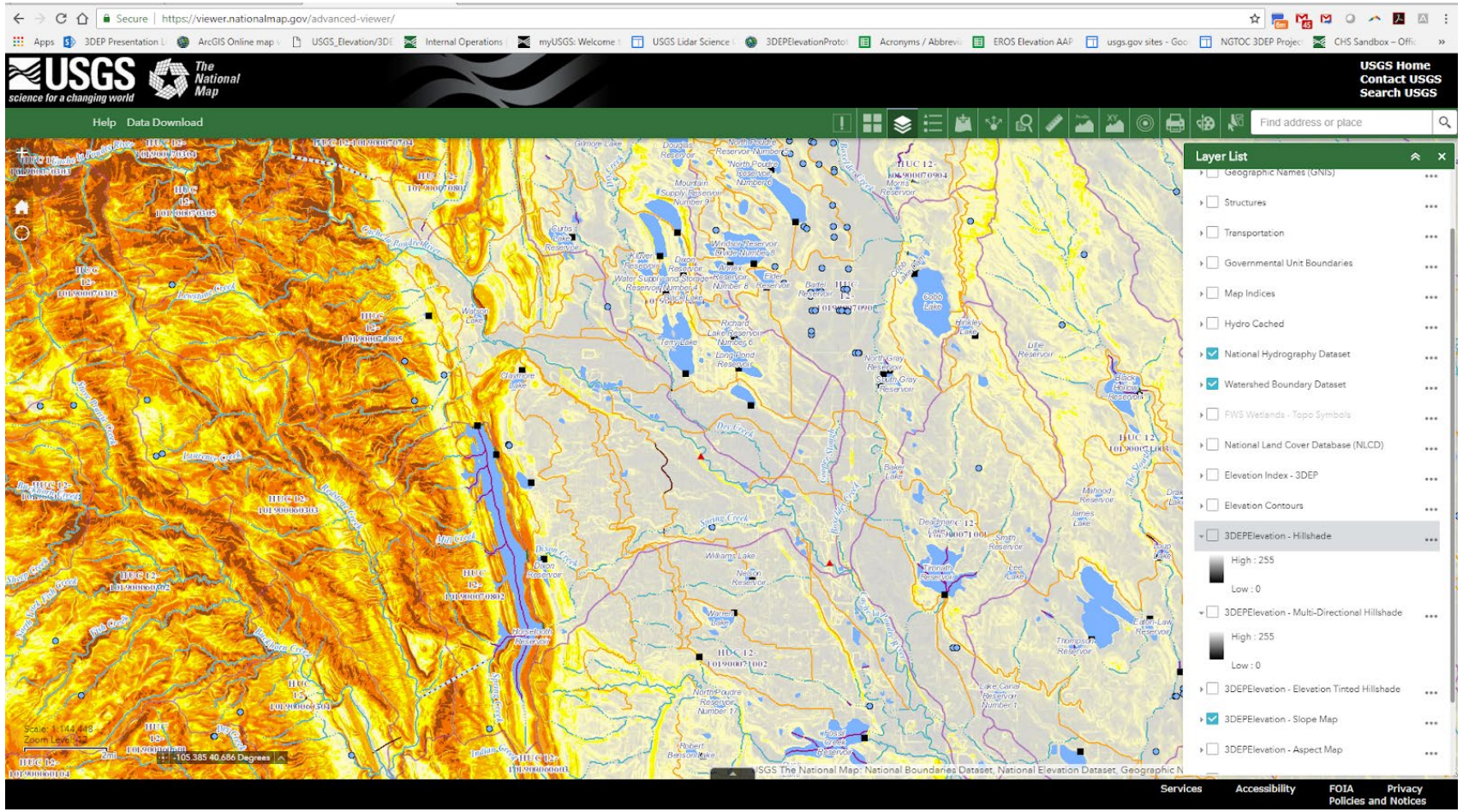
Demonstration Elevation Viewer - https://apps.nationalmap.gov/3depdem/

Elevation Services in TNM Viewer

These services are available in the National Map



The National Map Viewer
https://viewer.nationalmap.gov/advanced-viewer/

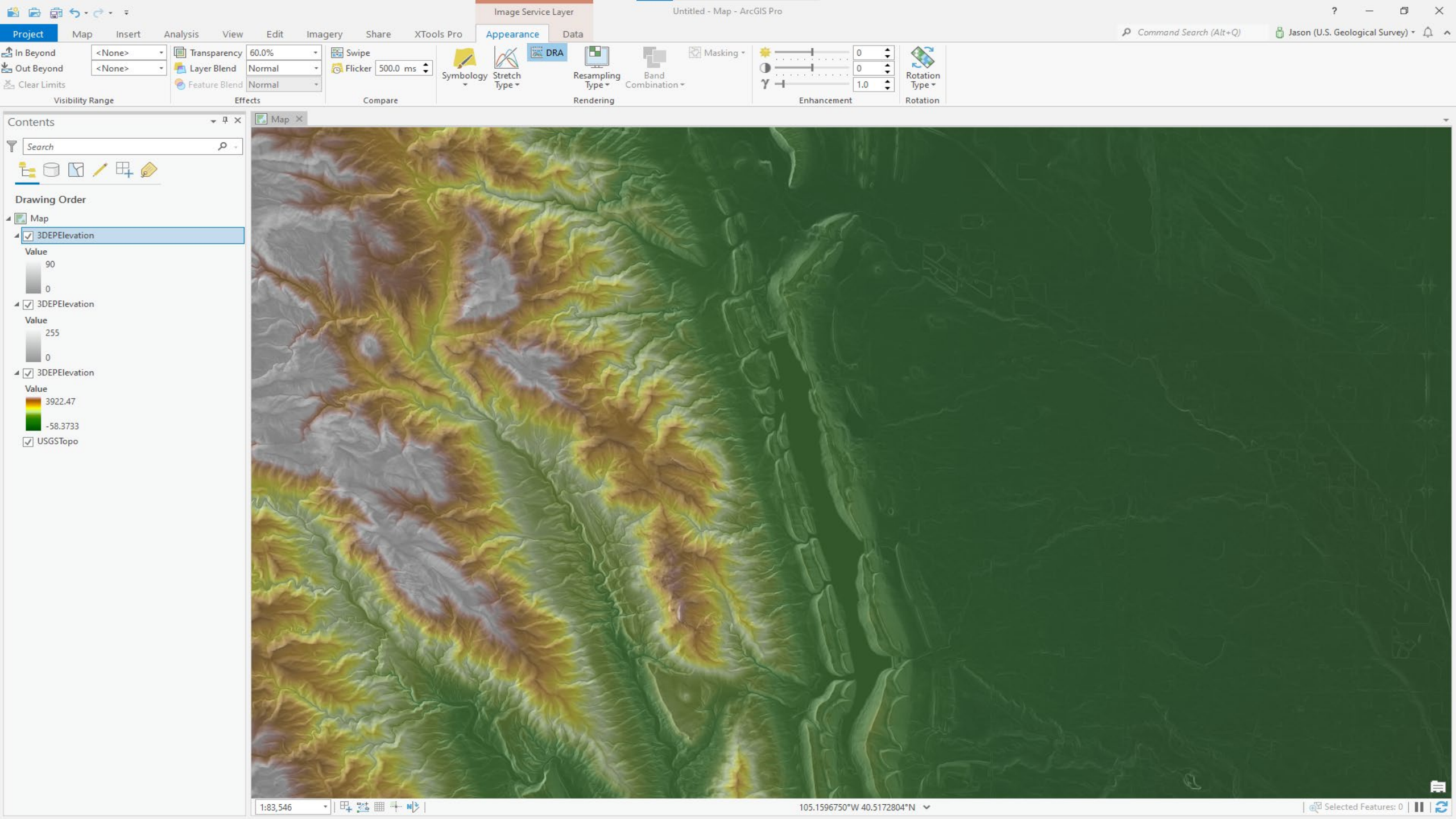


Image Service Layer
Untitled - Map - ArcGIS Pro
Project
Map
Insert
Analysis
View
Edit
Imagery
Share
XTools Pro
Appearance
Data
Command Search (Alt+Q)
Jason (U.S. Geological Survey)
In Beyond
Out Beyond
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Visibility Range
Transparency
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Layer Blend
Normal
Feature Blend
Normal
Effects
Swipe
Flicker
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Symbology
Stretch Type
DRA
Resampling Type
Band Combination
Masking
Rendering
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Enhancement
Rotation Type
Rotation
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Search
Drawing Order
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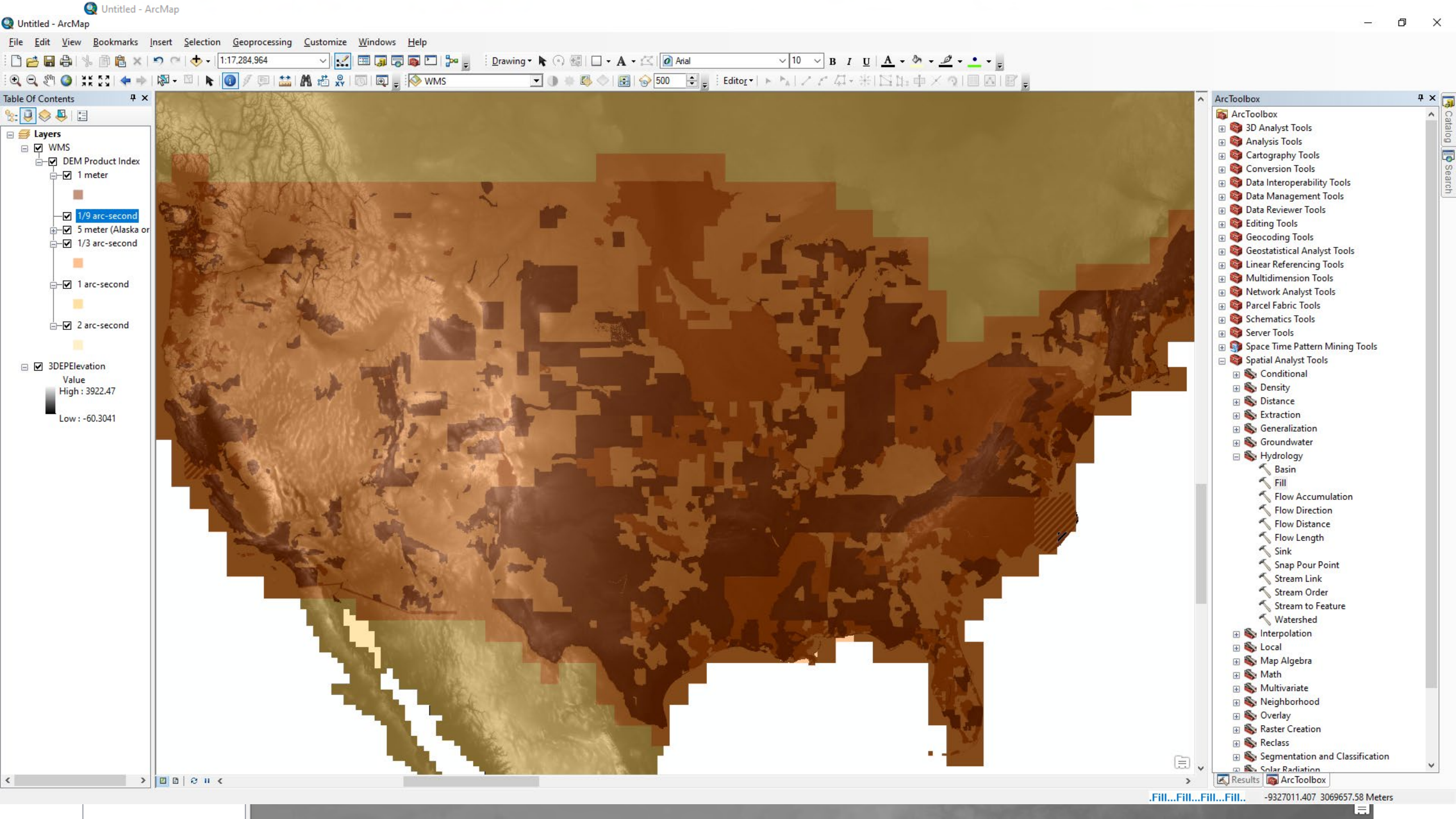
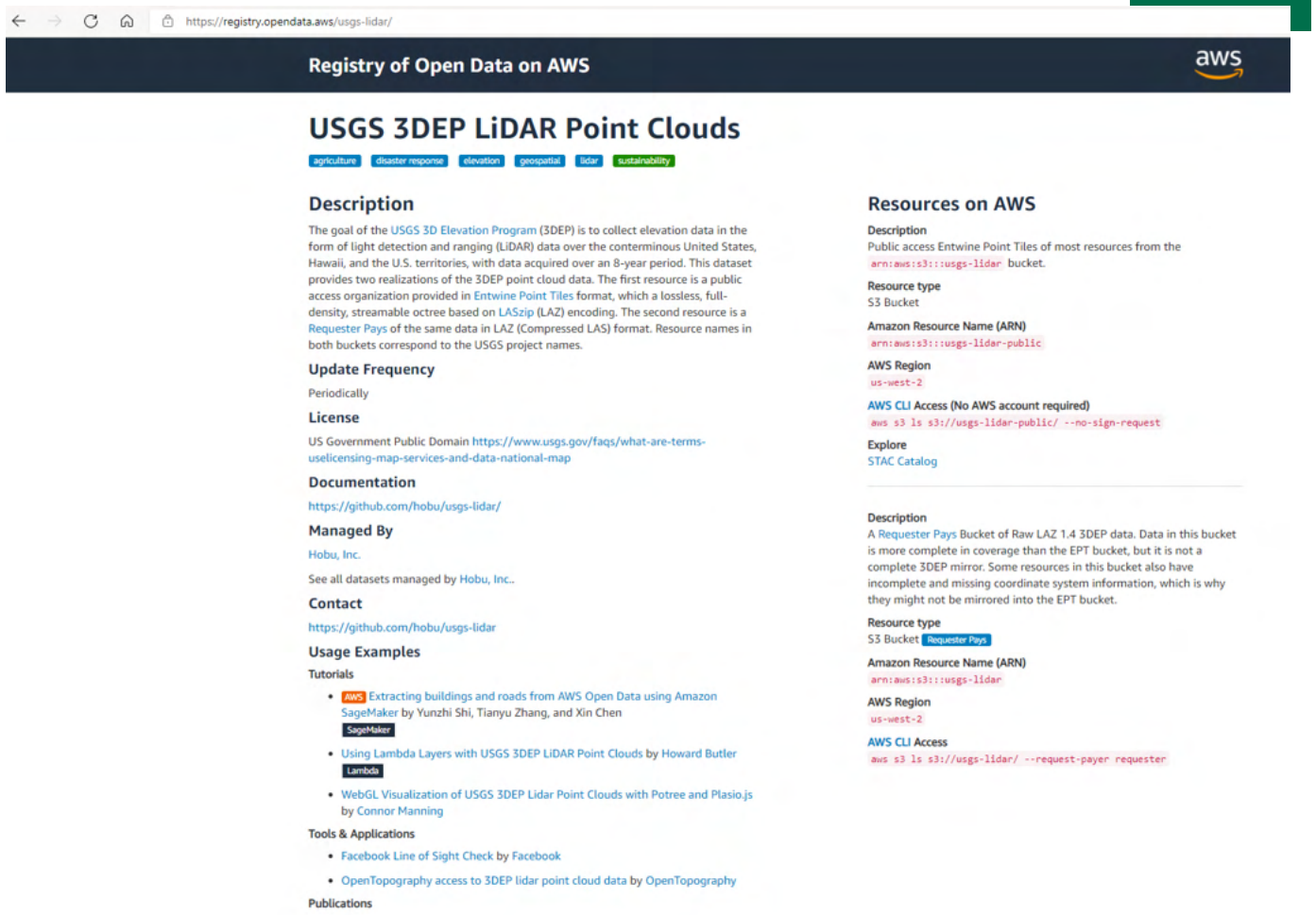

Untitled - ArcMap
File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help
1:17,284,964
Drawing
Arial
10
WMS
500
Editor
Table Of Contents
Layers
WMS
DEM Product Index
1 meter
1/9 arc-second
5 meter (Alaska or
1/3 arc-second
1 arc-second
2 arc-second
3DEPElevation
Value
High : 3922.47
Low : -60.3041
ArcToolbox
ArcToolbox
3D Analyst Tools
Analysis Tools
Cartography Tools
Conversion Tools
Data Interoperability Tools
Data Management Tools
Data Reviewer Tools
Editing Tools
Geocoding Tools
Geostatistical Analyst Tools
Linear Referencing Tools
Multidimension Tools
Network Analyst Tools
Parcel Fabric Tools
Schematics Tools
Server Tools
Space Time Pattern Mining Tools
Spatial Analyst Tools
Conditional
Density
Distance
Extraction
Generalization
Groundwater
Hydrology
Basin
Fill
Flow Accumulation
Flow Direction
Flow Distance
Flow Length
Sink
Snap Pour Point
Stream Link
Stream Order
Stream to Feature
Watershed
Interpolation
Local
Map Algebra
Math
Multivariate
Neighborhood
Overlay
Raster Creation
Reclass
Segmentation and Classification
Results
ArcToolbox
-9327011.407 3069657.58 Meters

3DEP LPC data as Amazon Public Dataset

Enabled much of the advancements we are seeing

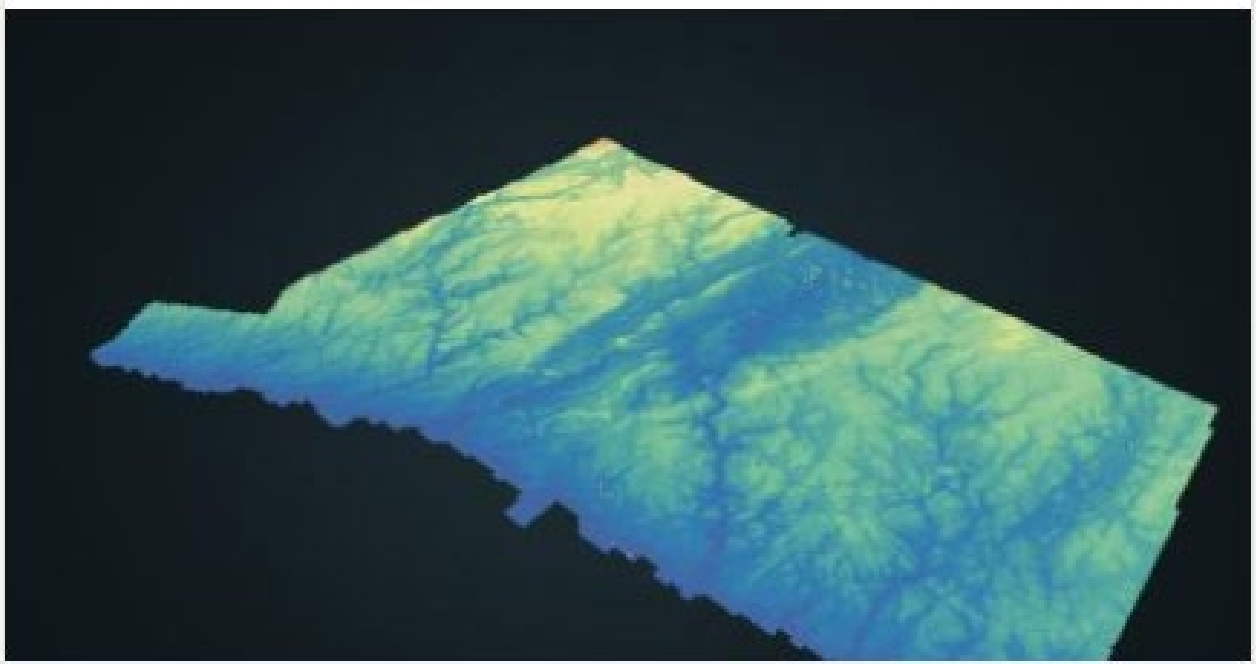
- https://registry.opendata.aws/usgs-lidar/
- Currently 238 Amazon Public Datasets
- Began in January of 2019
- The AWS Open Data Sponsorship Program covers the cost of storage for publicly available high-value cloud-optimized datasets. We work with data providers who seek to:
  - Democratize access to data by making it available for analysis on AWS
  - Develop new cloud-native techniques, formats, and tools that lower the cost of working with data
  - Encourage the development of communities that benefit from access to shared datasets



For more information

Kirk Waters with NOAA wrote a great blog post about Entwine Point Tiles

https://geozoneblog.wordpress.com/2021/09/29/new-ways-to-access-lidar/

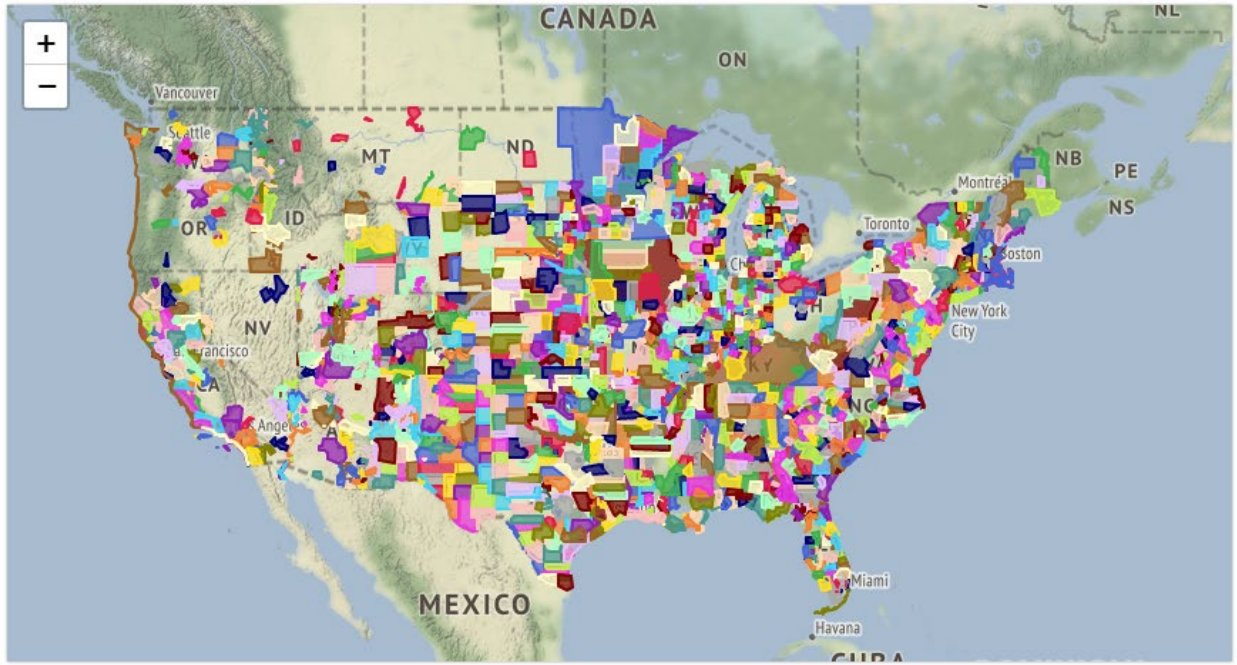


entwine

About

USGS / Entwine

42,755,083,428,969 points in **1,814** resources



Filter

Name ↓	Points	Potree	Cesium	EPT
AK_BrooksCamp_2012	529,285,317	●	●	●
AK_Coastal_2009	55,711,772	●	●	●
AK_DeltaJunction_1_2021	19,036,249,620	●	●	●

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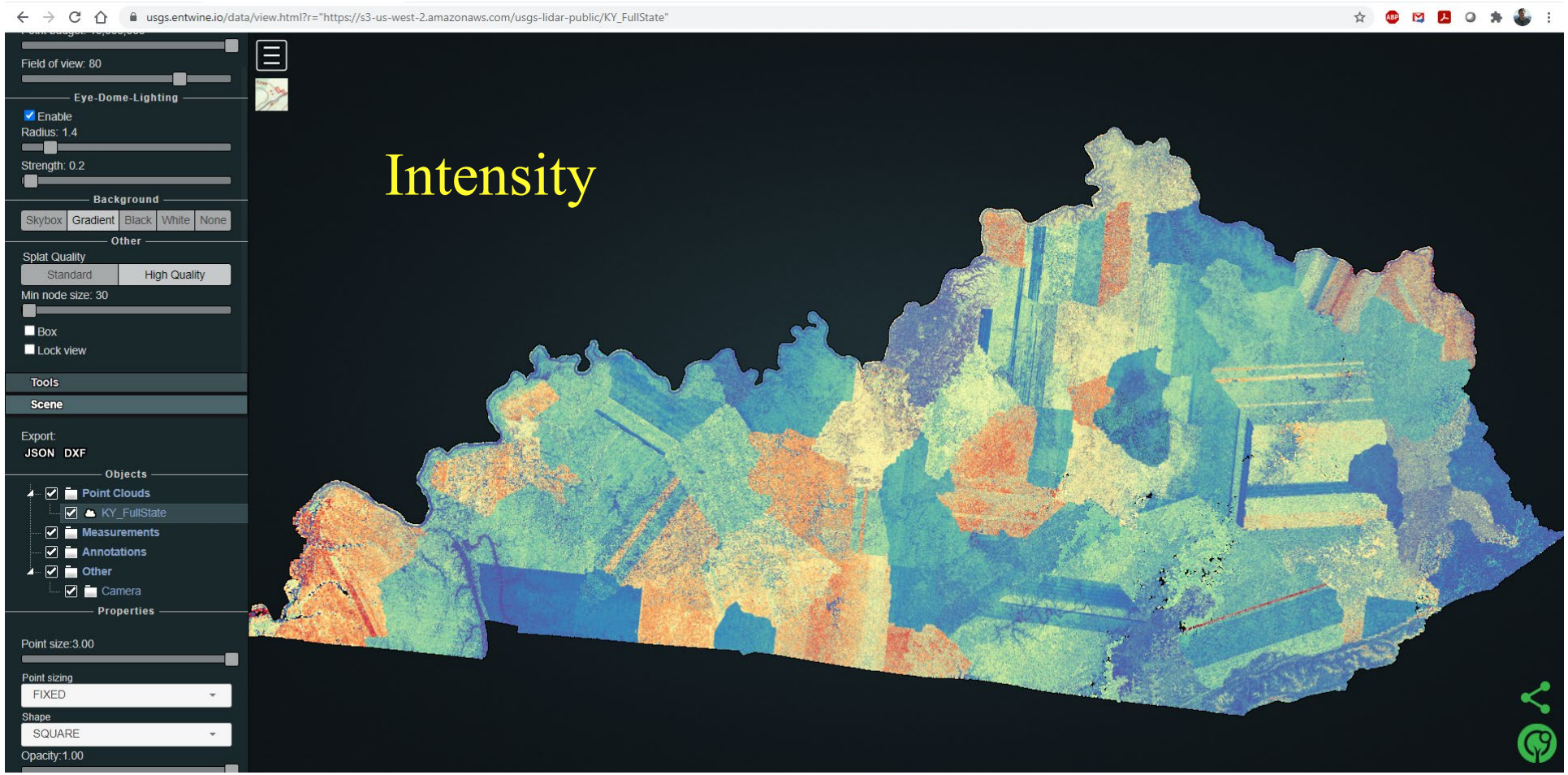
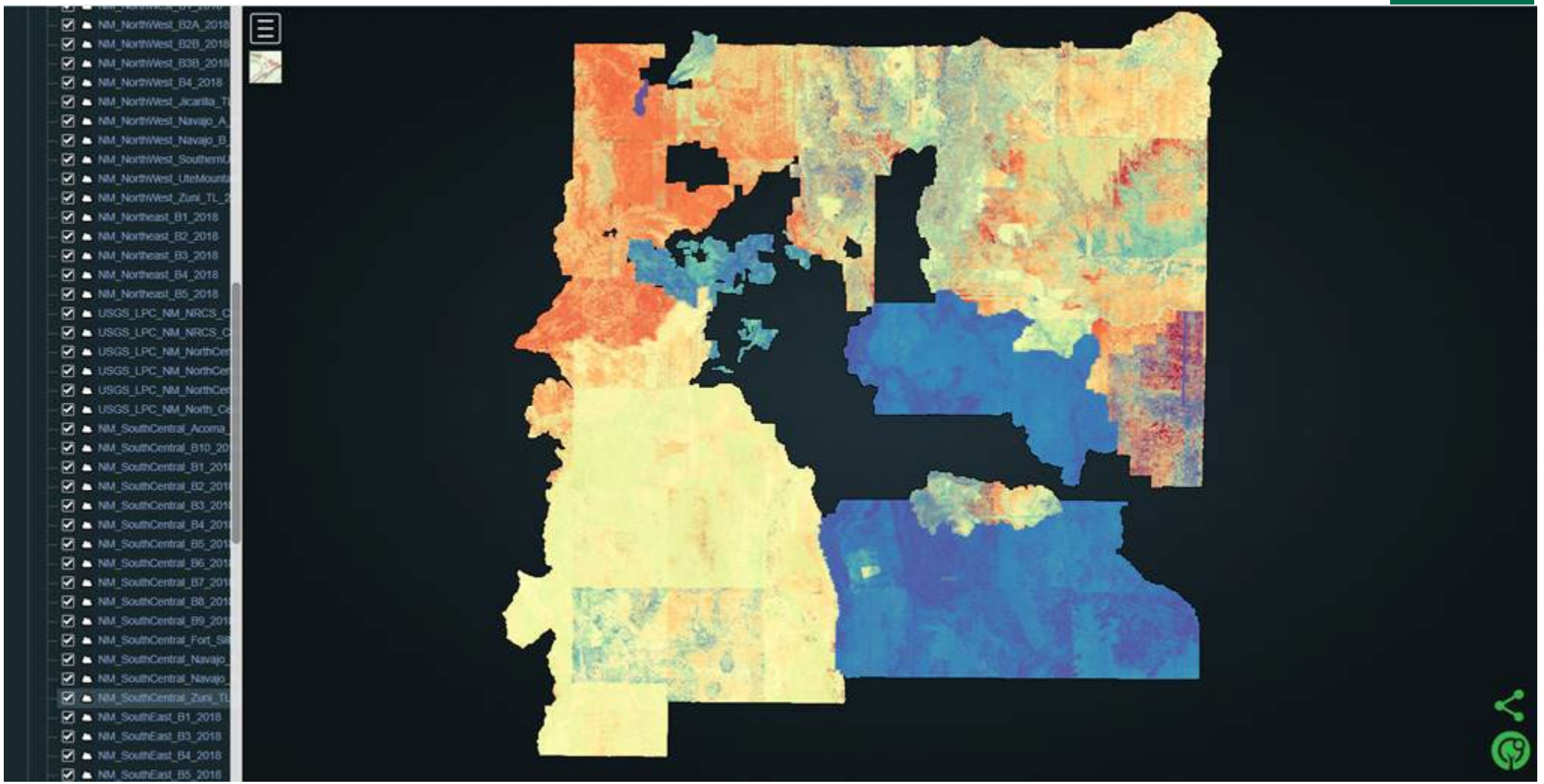
http://usgs.entwine.io

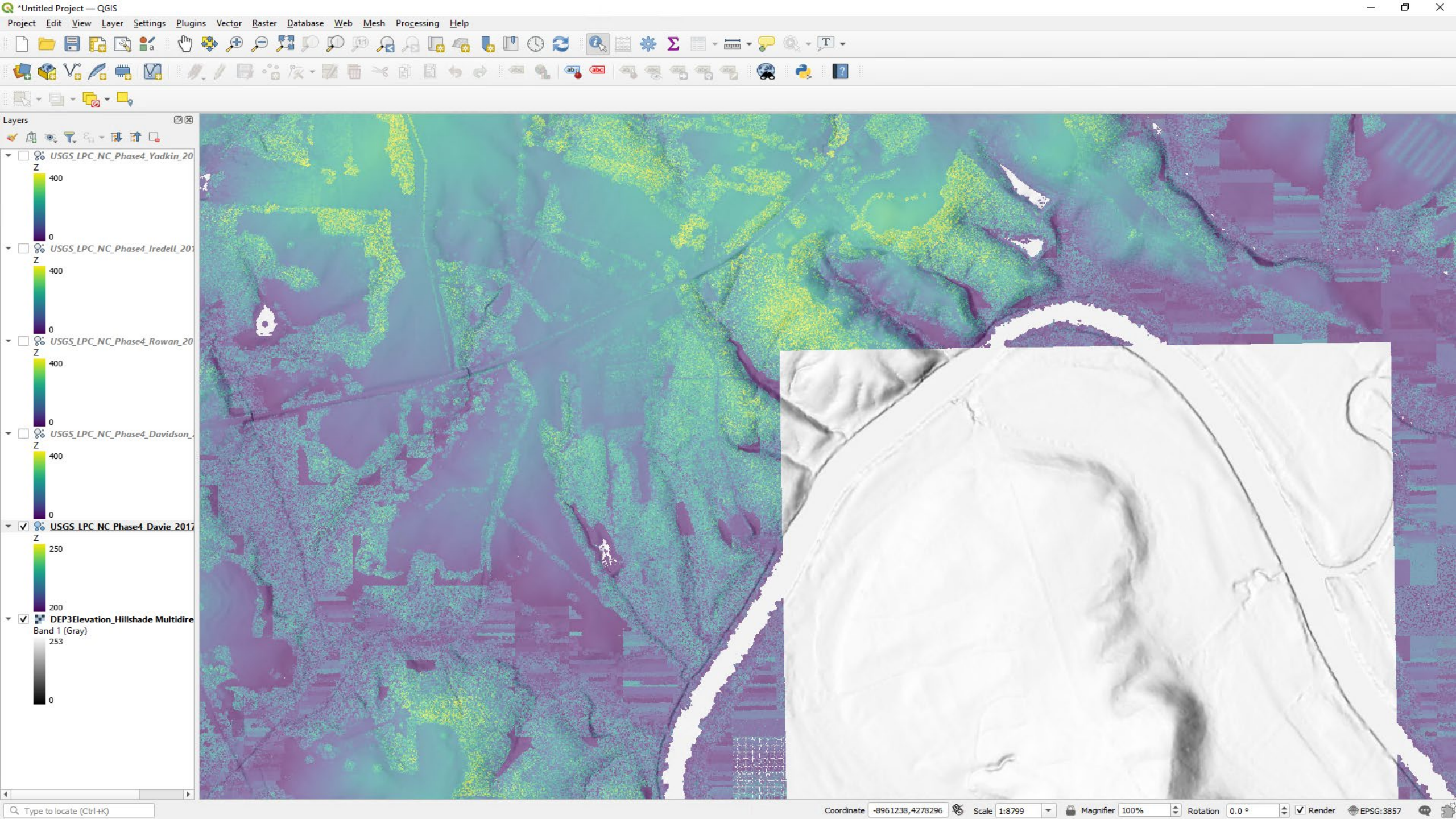
3DEP Lidar Visualization

Enabled visualization of all 3DEP lidar data



EPT enables looking at ‘big data’ at once

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250
200
DEP3Elevation_Hillshade Multidire
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Render
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Processing using AWS public dataset

Using Conda, Entwine, PDAL

- Took 160 million points from AWS PD
- Ran PDAL pipeline to process LPC to reprojected HAG
- Took 2 hours to download and process to derivative
- Next step- mimicking in AWS EC2


```
{"pipeline":[{"type":"readers.ept","filename":"https://s3-us-west-
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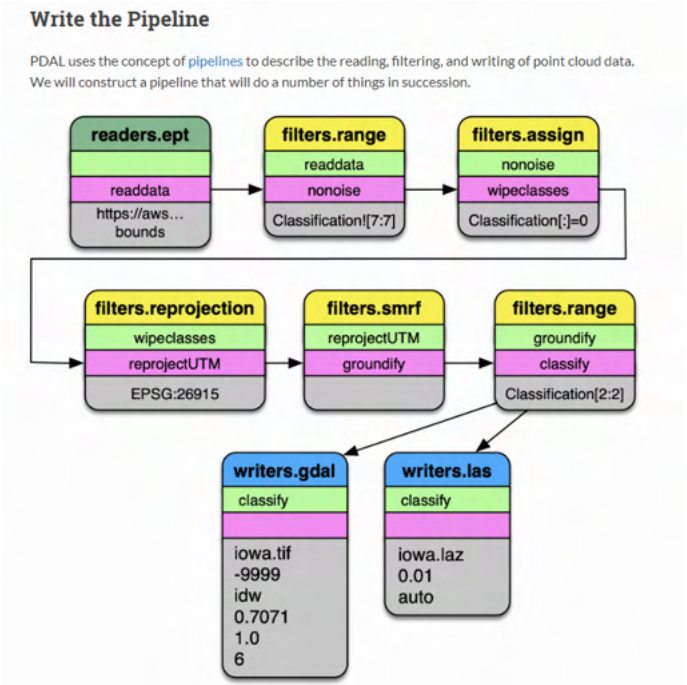
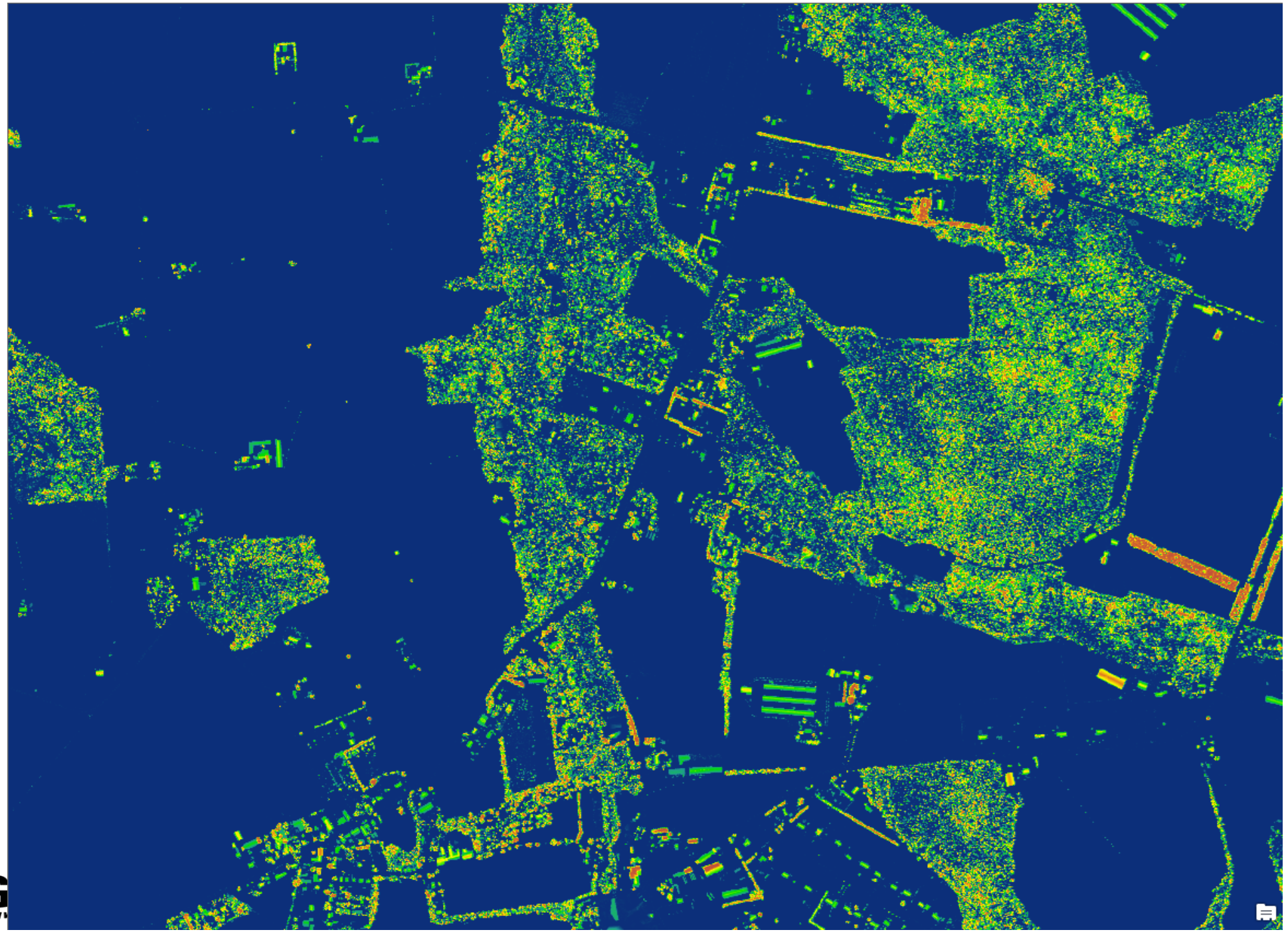




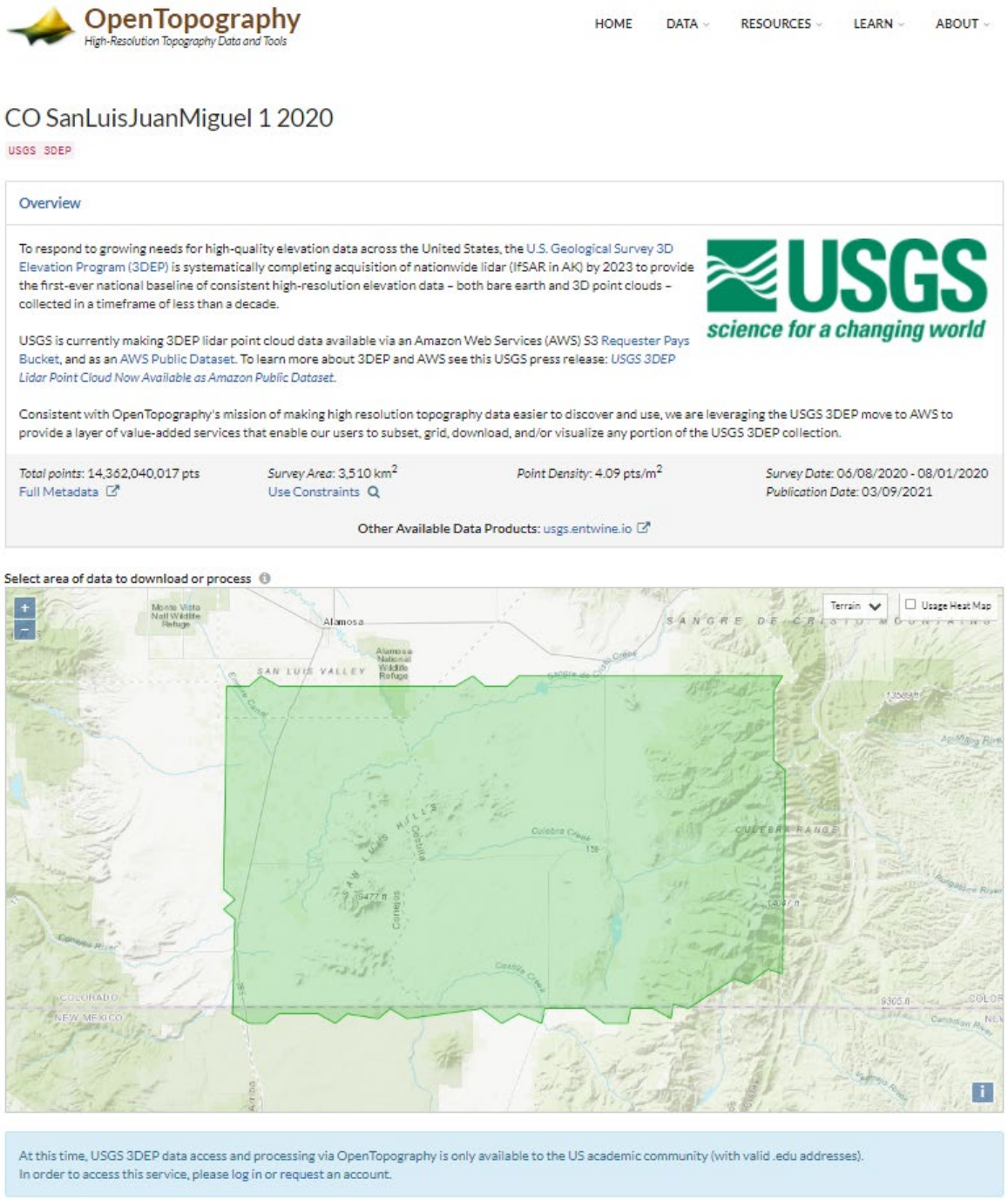
3DEP Lidar Visualization

Enabled visualization of all 3DEP lidar data

Application Highlights

3DEP Data in OpenTopography

- In 2020 registered OpenTopography users with an account associated with a valid .edu email address can seamlessly discover, download, and process USGS 3DEP data via the standard OpenTopography interface.
- Anyone can access and use the 1/3rd and 1 Arc Second Seamless layers
- Offers functionality unavailable via TNM processes
  - Reprojection
  - Custom DEM generation
  - Derivative product generation (hillshades/slope)
  - Hydrologic Terrain Analysis Products (tauDEM)



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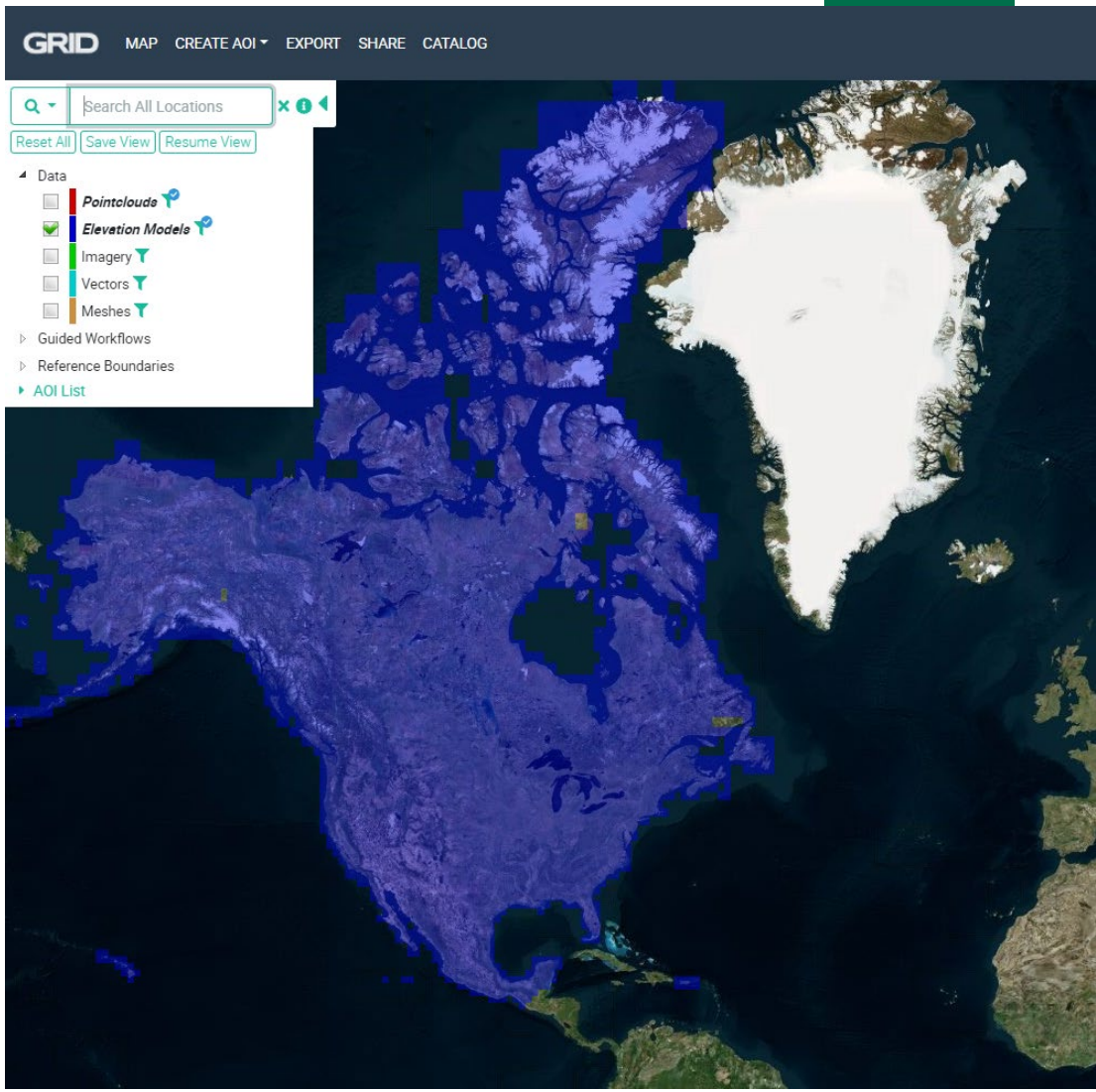
Application Highlights

3DEP Data in GRiD

(https://grid.nga.mil/grid)

- Like OT, offers another access point to our data
- Offers additional functionality as well
  - Reprojection
  - Derived products
  - File types
  - Filters



PROGRAMS // ACCESS TAGS

- ALIRT
- Artemis
- BuckEye
- DTED0
- DTED1
- DTED2
- FEMA
- FG3D
- GMTED075
- GMTED150
- GMTED300
- GeoData Cooperative DGED
- GeoData Cooperative DTED
- HALOE
- Intl Co-production
- MACHETE
- NAVFAC
- NGA Geomatics Terrestrial
- NOAA Digital Coast
- Public Datasets
- SRT1F
- SRT2F
- TERRAFORM
- TanDEM-X Final
- TanDEM-X Raw
- TanDEM-X Temporary
- TanDEM-X Temporary DTED1
- TanDEM-X Temporary DTED2
- US Cities
- USACE
- USAF Geobase
- USGS
- USGS-3DEP
- USMC GEOFidelis
- Vricon

USGS Program

Download All Footprints

(U) LiDAR collections have been acquired by the United States Geological Survey (USGS) through contracts, through partnerships with other Federal, state, tribal, or regional agencies, from direct purchases from private industry vendors, and through volunteer contributions from the science community. Product specifications such as nominal pulse spacing, area of coverage (footprint), file size, and projection will vary by project since the data come from a variety of sources.

Layer	Data Type	Access Tag *	Classification/Dissemination	Area	Size (GB)	Footprints
Elevation Models	DTM - Hydro Flattened	Public	UNCLASSIFIED	12,734.2 km^2 (4,916.7 mi^2)	107.65	
Elevation Models	DTM - Hydro Flattened	USGS (Non-Public)	UNCLASSIFIED//FOUO	5,350.3 km^2 (2,065.8 mi^2)	62.03	
Elevation Models	DTM	Public	UNCLASSIFIED	11,024.9 km^2 (4,256.7 mi^2)	31.17	
Elevation Models	DTM	USGS (Non-Public)	UNCLASSIFIED//FOUO	20,232.4 km^2 (7,811.8 mi^2)	61.21	
Imagery	EO - Georeferenced	Public	UNCLASSIFIED	285.8 km^2 (110.3 mi^2)	2.12	
Imagery	EO - Georeferenced (4 Band)	USGS (Non-Public)	UNCLASSIFIED//FOUO	15,185.8 km^2 (5,863.3 mi^2)	1307.49	
Imagery	Intensity	Public	UNCLASSIFIED	12,617.1 km^2 (4,871.5 mi^2)	23.95	
Imagery	Intensity	USGS (Non-Public)	UNCLASSIFIED//FOUO	5,893.4 km^2 (2,275.4 mi^2)	22.94	
Pointclouds	PC	Public	UNCLASSIFIED	55,479.8 km^2 (21,420.9 mi^2)	4058.66	
Pointclouds	PC	USGS (Non-Public)	UNCLASSIFIED//FOUO	15,390.2 km^2 (5,942.2 mi^2)	3317.8	

USGS-3DEP Program

Download All Footprints

Layer	Data Type	Access Tag *	Classification/Dissemination	Area	Size (GB)	Footprints
Elevation Models	DTM - Hydro Flattened	Public	UNCLASSIFIED	26,374,812.7 km^2 (10,183,372.1 mi^2)	12823.57	
Pointclouds	EPT	Public	UNCLASSIFIED	4,278,237.0 km^2 (1,651,836.5 mi^2)	775109.71	

USMC GEOFidelis Program

Download All Footprints

(U) 3D content over USMC installations.

Dynamic content highest classification up to UNCLASSIFIED//LIMDIS. Warning: This content may not be used as a source of derivative classification, refer instead to the pertinent classification guide.

Application Highlights

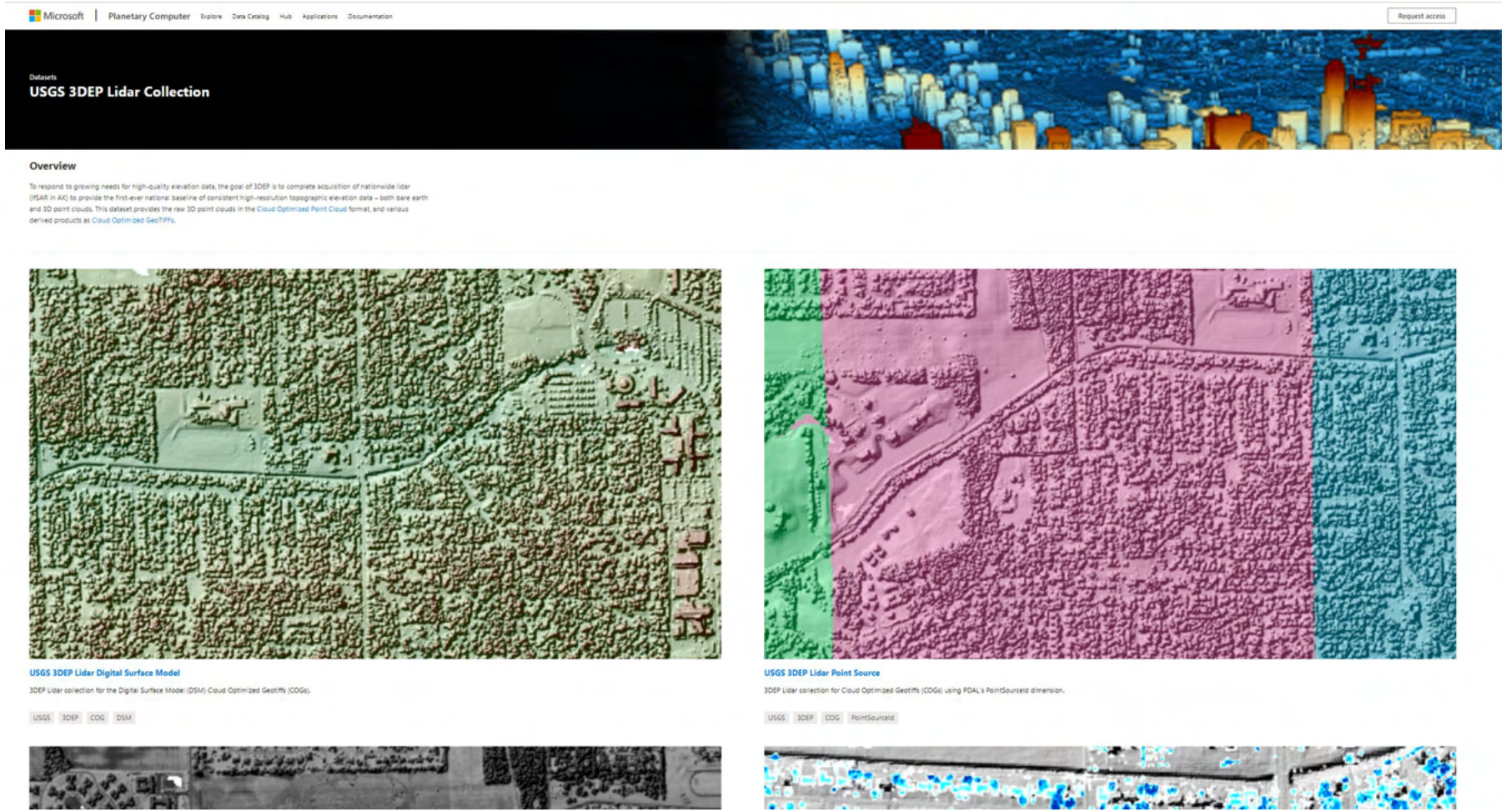
ArcGIS adding 1m data to Living Atlas

https://www.esri.com/arcgis-blog/products/arcgis-living-atlas/imagery/high-resolution-data-updates-to-living-atlas-world-elevation-layers-and-tools-june-2021/

- ArcGIS Living Atlas of the World provides foundation elevation layers and tools to support analysis and visualization across the ArcGIS system. These layers get updated quarterly with high resolution elevation data from federal agencies, open sources, and the community maps program. Esri is providing these datasets as ready to use services that benefit the GIS community and extend the use of data in new and innovative ways. In this release, world elevation layers and tools are updated with a few high-resolution elevation datasets.
- ESRI able to update their services automatically with no need to do data transfers on our end

Planetary Computer

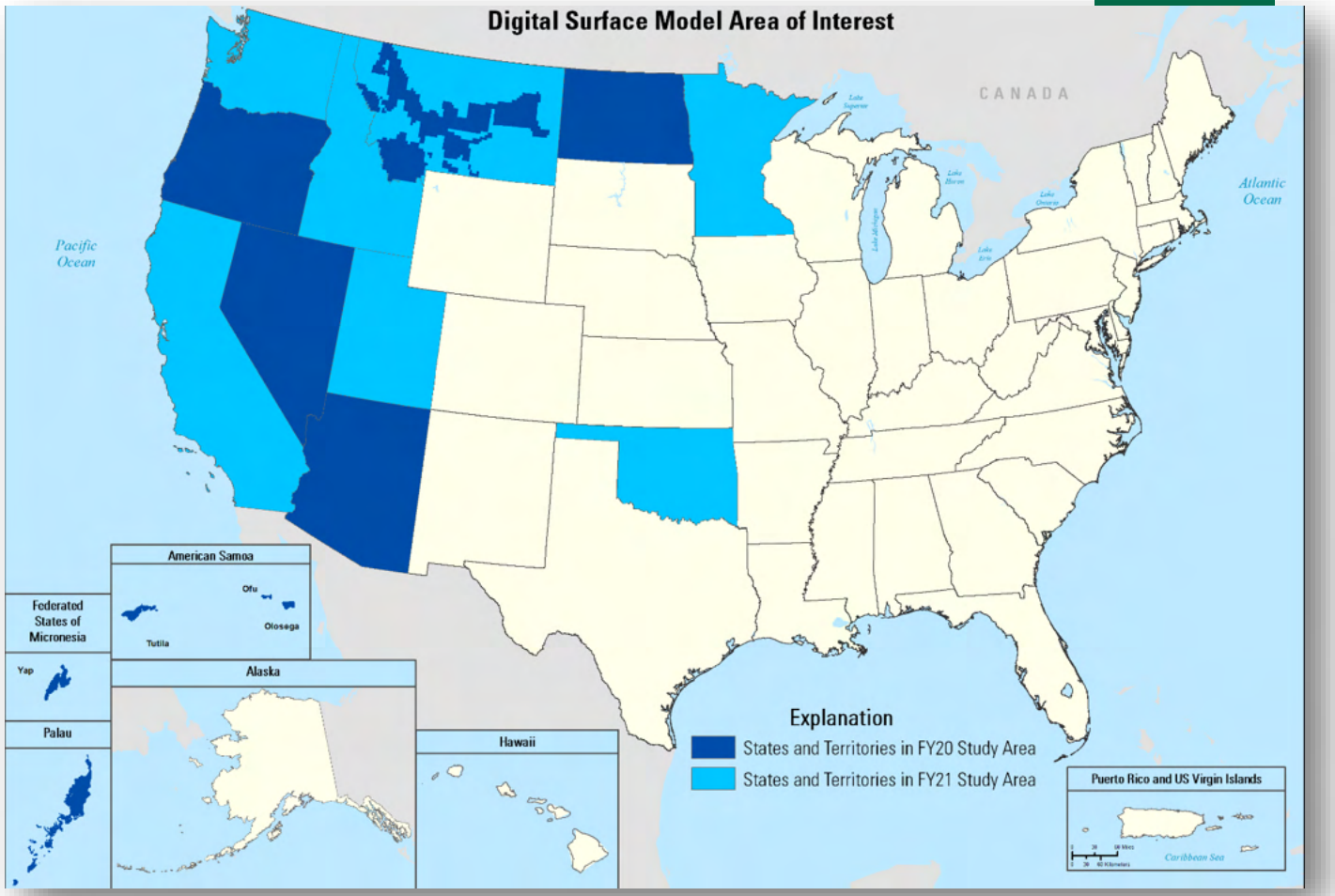
USGS 3DEP Lidar Collection | Planetary Computer (microsoft.com)



Digital Surface Models

Partnership with NGA GeoData Cooperative

- FY20 and 21 Congressional appropriations language: "*$3,000,000 to produce digital surface models using unclassified satellite optical data for the U.S. and territories not mapped with LiDAR in 2021*"
- Product is a 1-meter resolution top-of-surface elevation model
- Data will be published and available without use restrictions



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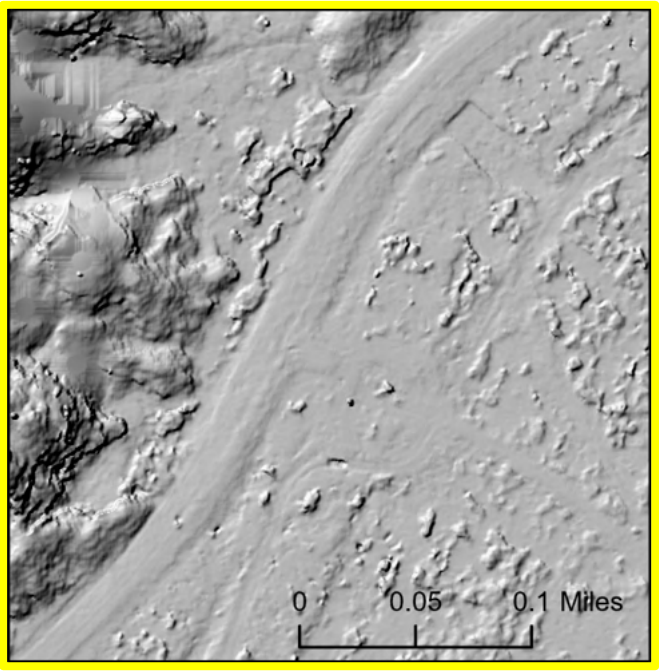
More Details about the DSMs

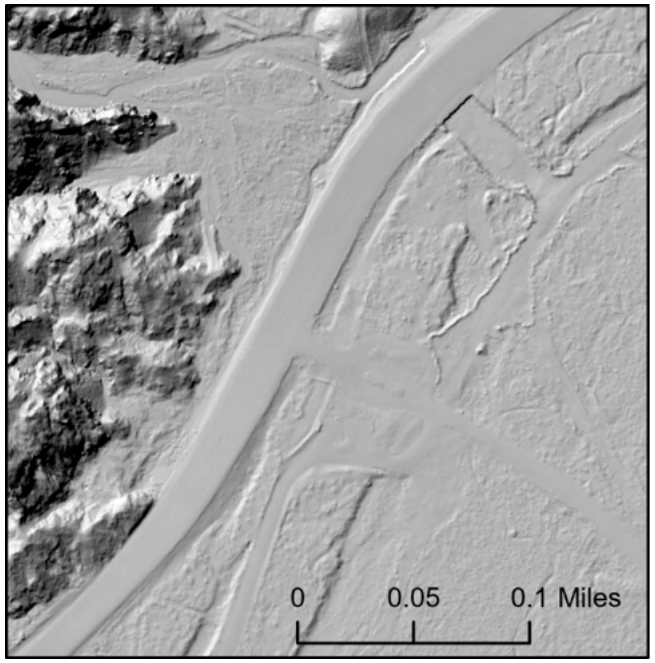
- Team led by NGA, and includes GeoNorth and Lockheed Martin
- Based on WorldView-1, WorldView-2, WorldView-3, and GeoEye-1 satellite images
- Images processed with high performance computing systems, using the OpenRosetta API for data processing
- DGED-6 10 x 10 km tiles
- Voids in the dataset caused by clouds, shadows, or poor image correlation are filled using the 1/3 Arcsecond National Elevation Dataset bare earth DEMs.
- DSMs are not hydroflattened

Digital Surface Models

Sample data located in Nevada



1m Digital Surface Model

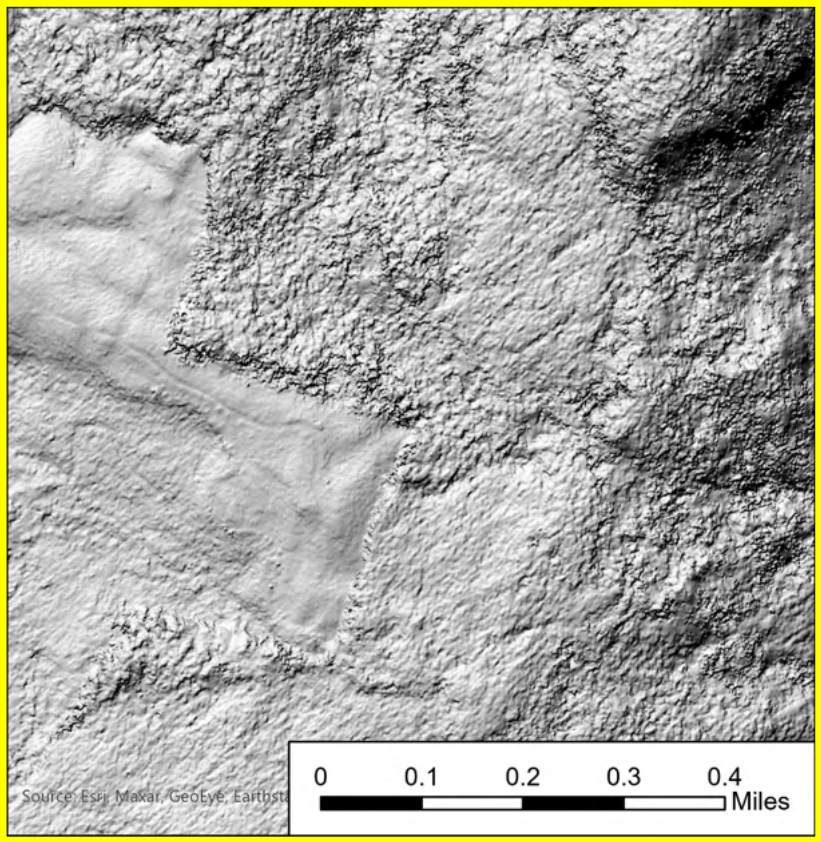


1m Digital Elevation Model

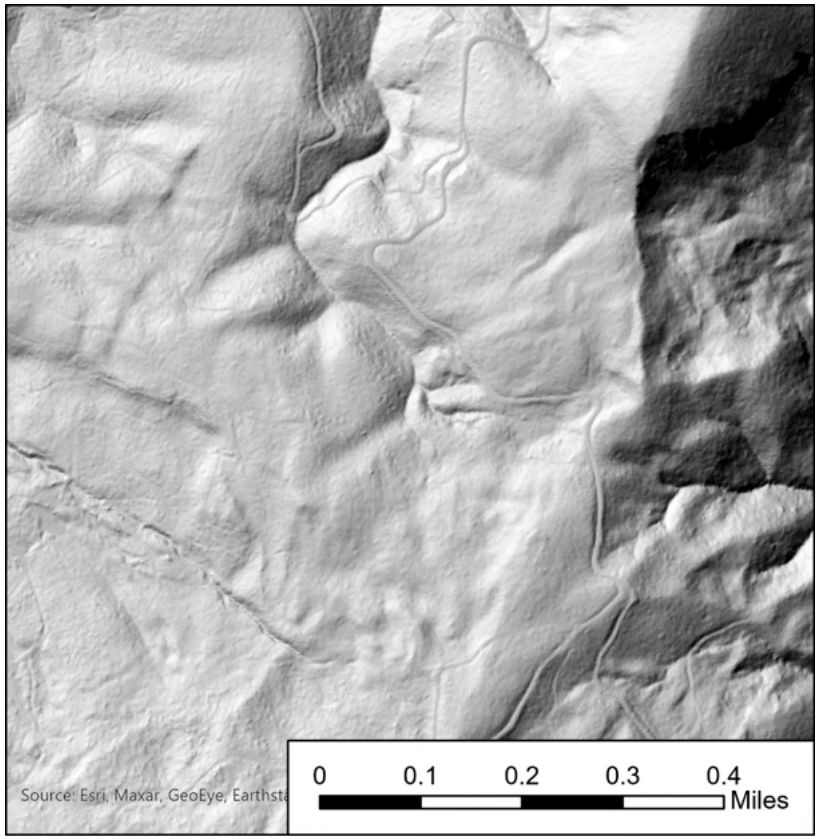
Aerial photo

Digital Surface Models

Sample data located in western Oregon



1m Digital Surface Model



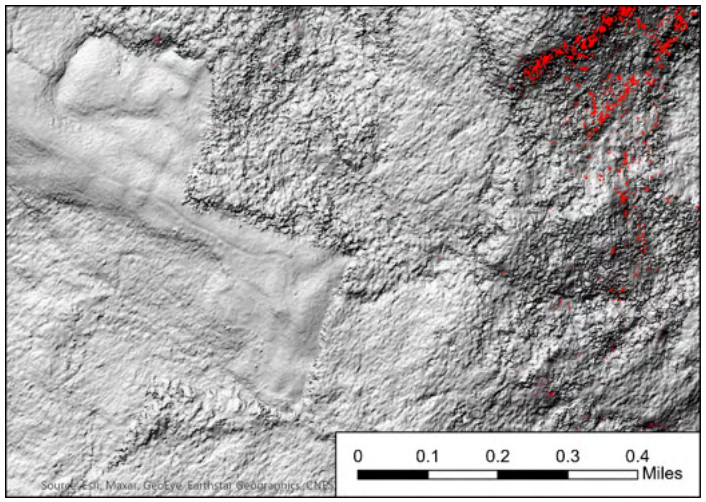
***10m** Digital Elevation Model*

Aerial photo

USGS science for a changing world

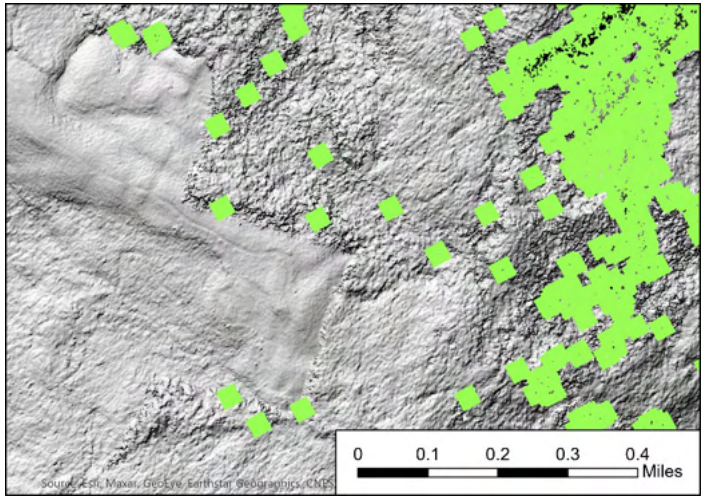
The National Map
Your Source for Topographic Information

Ancillary Datasets



Source Lineage Mask

- Input imagery contribution is identified on a per-pixel basis
- Red=1/3 arc second USGS DEM.
- Other raster values correspond to each image stereo pair used to derive the elevation value



Source Processing Mask

- Green= interpolation
- All other= “No Editing”

XML Metadata

- All USGS DGED6 products use the UTM WGS84 coordinate system, and the EGM2008 geoid height.
- Dates and catalog IDs of the stereo pairs used to produce the tile. For this Oregon sample file, images from 2017 and 2020 were used.
- Vertical accuracy by tile, calculated using NASA’s ICESAT2 sensor as ground checkpoints.
- NGA will also provide a Product Guide with more details about the data processing and raster products.

Data Delivery Schedule

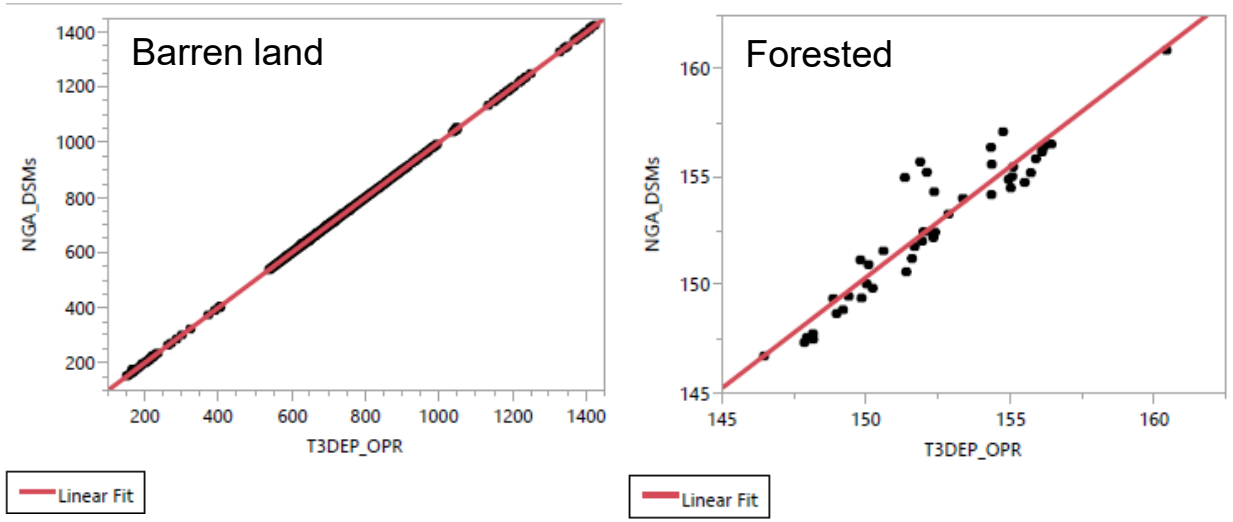
- Nevada will be delivered first in March. Additional states will be delivered approximately every 2 weeks following additional delivery.
- Data publication estimated in late summer 2022

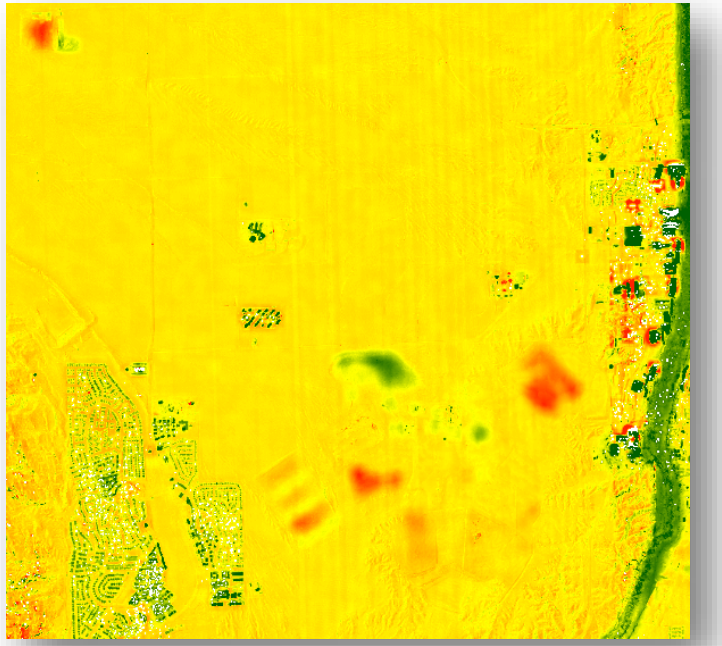
Digital Surface Models

Data Evaluation

- NGA will provide assessment compared to ICESat-2 and Compass Data checkpoints
- USGS will assess vertical accuracy using NGS benchmarks and survey-grade GPS Checkpoints
- Compare to 3DEP lidar data where available
- Provide users with a clear understanding of the differences between the two types of data
- Assess the technology for inclusion in the 3DEP set of mapping tools

Example comparison of 3DEP and DSM elevation values at sample locations in barren and forested land cover types.

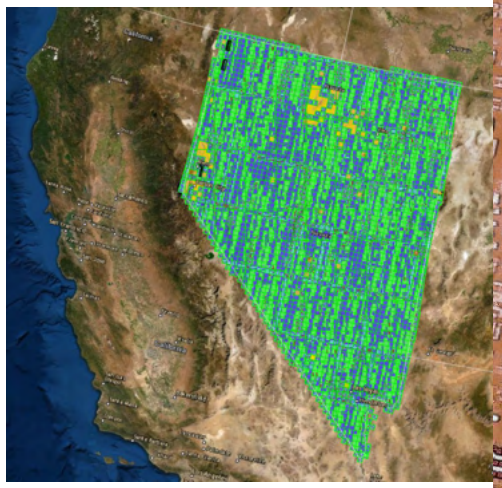


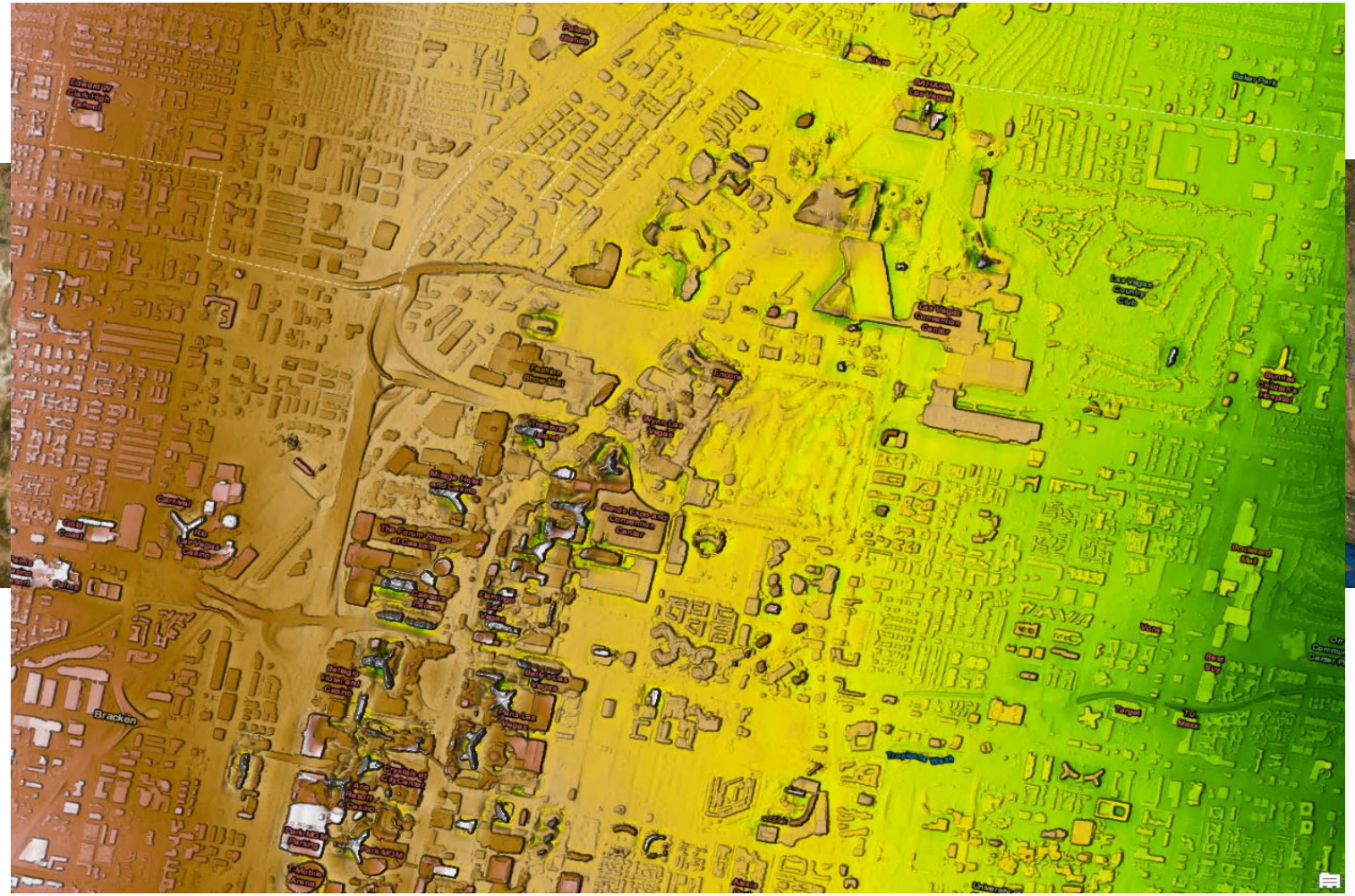


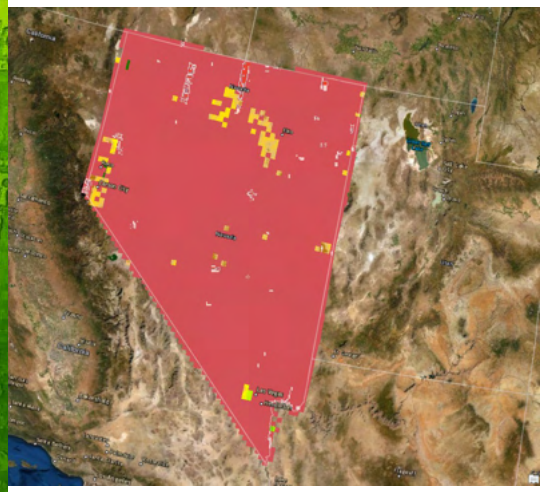
Vertical difference between DSMs and 3DEP DEMs for sample pilot data in NV. Analysis by Jason Stoker

Preliminary Look at DSMs

Data delivered for NV





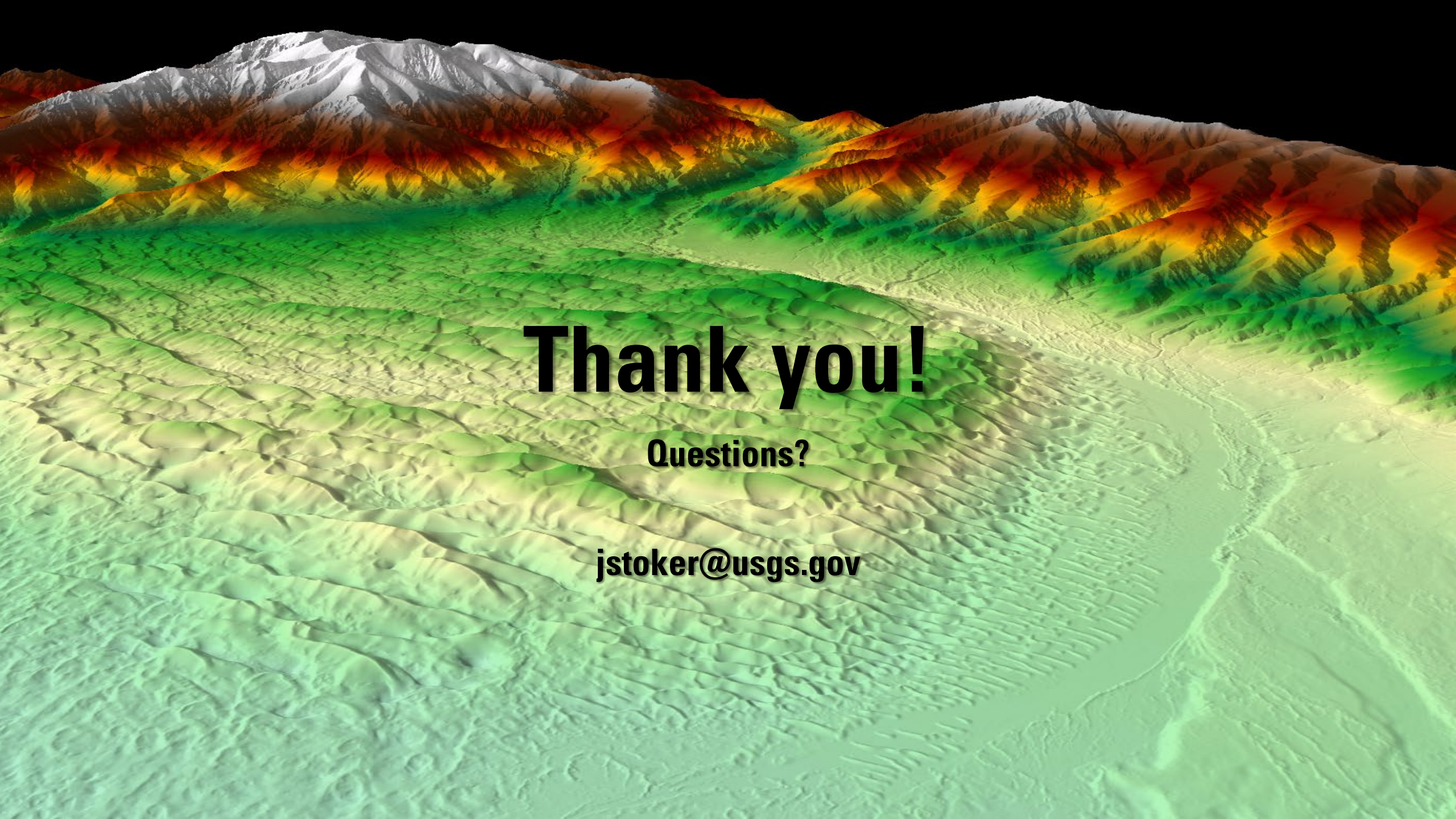


DSM Data Publication Plans

- Data for states and territories in the study area will be delivered to USGS by end of FY2022
- DSM raster data will be published on The National Map
- DSM rasters will be available as a web coverage service.
- Potential for restricted data over some Tribal lands.

Example applications:

- Aviation safety
- Forestry (wildfire, tree canopy metrics)
- 3D visualizations



Thank you!

Questions?

jstoker@usgs.gov

Links of interest

New Mexico Example- copy and paste into browser

- https://usgs.entwine.io/data/view.html?r=[%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/USGS_LPC_NM_Animas_2014_LAS_2017%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/USGS_LPC_NM_CO_SouthernSanLuis_2015_LAS_2019%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/USGS_LPC_NM_CO_Southern_San_Luis_TL_2015_LAS_2019%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/USGS_LPC_NM_NRCS_Central_A1_2017_LAS_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/USGS_LPC_NM_NRCS_Central_A2_2017_LAS_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/USGS_LPC_NM_NorthCentral_B1_2016%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/USGS_LPC_NM_NorthCentral_B3_2017_LAS_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/USGS_LPC_NM_NorthCentral_B4_2016_LAS_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/USGS_LPC_NM_North_Central_B2_2016%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/USGS_LPC_NM_RioHondo_2014_LAS_2017%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/USGS_LPC_NM_RioSanJose_2016_LAS_2019%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/USGS_LPC_NM_Roosevelt_Curry_2015_LAS_2017%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/USGS_LPC_NM_WhiteSands_2015_LAS_2017%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_Navajo-Pinabete_CoalMine_2012%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_NorthWest_B1_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_NorthWest_B2A_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_NorthWest_B2B_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_NorthWest_B3B_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_NorthWest_B4_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_NorthWest_Jicarilla_TL_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_NorthWest_Navajo_A_TL_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_NorthWest_Navajo_B_TL_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_NorthWest_SouthernUte_TL_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_NorthWest_UteMountain_TL_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_NorthWest_Zuni_TL_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_Northeast_B1_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_Northeast_B2_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_Northeast_B3_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_Northeast_B4_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_Northeast_B5_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/USGS_LPC_NM_NRCS_Central_A1_2017_LAS_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/USGS_LPC_NM_NRCS_Central_A2_2017_LAS_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/USGS_LPC_NM_NorthCentral_B1_2016%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/USGS_LPC_NM_NorthCentral_B3_2017_LAS_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/USGS_LPC_NM_NorthCentral_B4_2016_LAS_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/USGS_LPC_NM_North_Central_B2_2016%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_SouthCentral_Acoma_TL_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_SouthCentral_B10_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_SouthCentral_B1_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_SouthCentral_B2_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_SouthCentral_B3_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_SouthCentral_B4_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_SouthCentral_B5_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_SouthCentral_B6_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_SouthCentral_B7_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_SouthCentral_B8_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_SouthCentral_B9_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_SouthCentral_Fort_Sill_TL_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_SouthCentral_Navajo_A_TL_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_SouthCentral_Navajo_B_TL_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_SouthCentral_Zuni_TL_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_SouthEast_B1_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_SouthEast_B3_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_SouthEast_B4_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-public/NM_SouthEast_B5_2018%22,%22https://s3-us-west-2.amazonaws.com/usgs-lidar-pu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