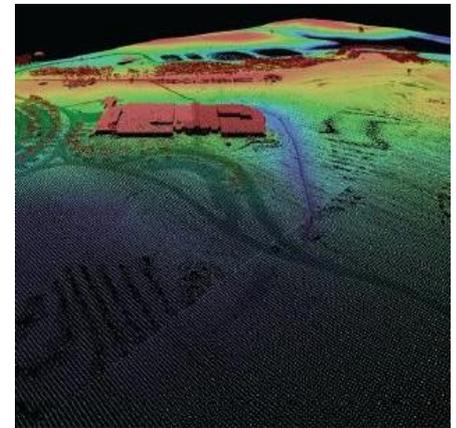
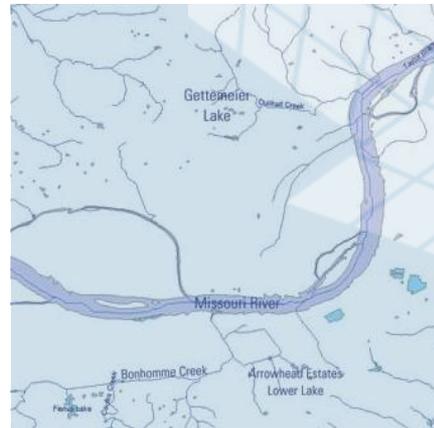
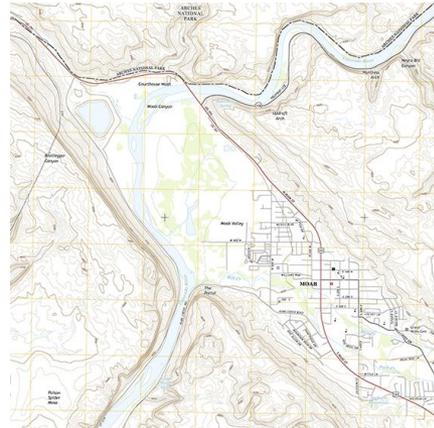




Elevation-derived Hydrography and the National Terrain Model Concept



Stephen S. Aichele, PhD
National Geospatial Program

+ 135 Years of topographic mapping



Testimony to Congress on
December 5, 1884

“A Government cannot do any scientific work of more value to the people at large, than by causing the construction of proper topographic maps of the country”

+ Technologies change

Mission remains the same

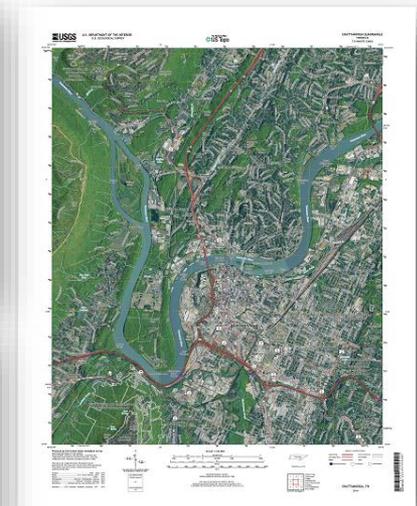
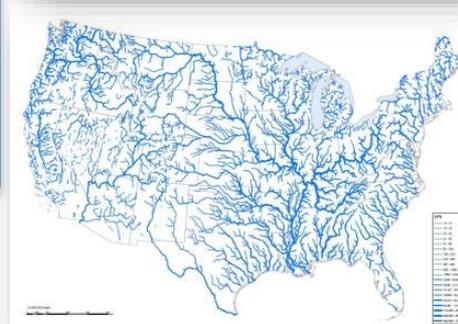
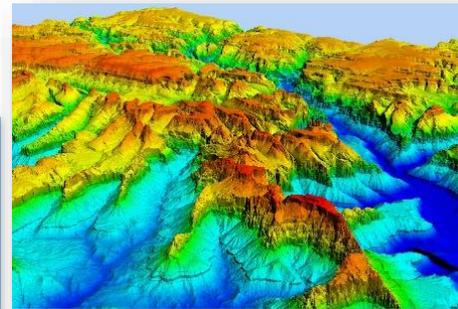




The National Geospatial Program

The mission of the NGP is to provide National topographic information to advance science, support government, enlighten citizens, and enable decision making.

Area of National Leadership	Program Emphasis
OMB A-16 Co-Lead for Elevation	3D Elevation Program (3DEP)
OMB A-16 Co-Lead for Inland Waters	National Hydrography and Watershed Boundaries Datasets (NHD and WBD), and NHDPlus High Resolution
Nationwide Topographic Maps	U.S. Topo and Alaska Mapping



 **The National Map**
Your Source for Topographic Information

6 STRATEGIES

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1

COMPLETE NATIONWIDE BASELINE DATA

- Unifies observations and measurements onto one multiscale hydrography framework
- Realizes the benefits and ROI of nationwide lidar

3DEP & NHDPlus HR



2

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3

3DEP & 3D NHD

4

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5

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National Terrain Model

4D National Terrain Model

REPEAT COVERAGE

6

- Enable monitoring and change detection
- Analytical capabilities increase exponentially with the availability of multiple data vintages

Enables 3D topographic maps and links with 3D geologic models to visualize data in new and unimagined ways



Supports the National Water Model, National Water Census, drought, water availability and use



Supports the 3D Nation vision of elevation data from the depths of the oceans to the peaks of the mountains

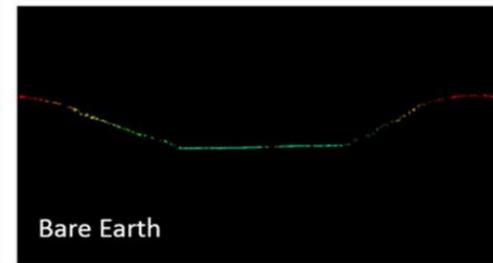
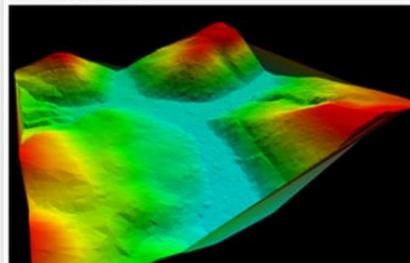
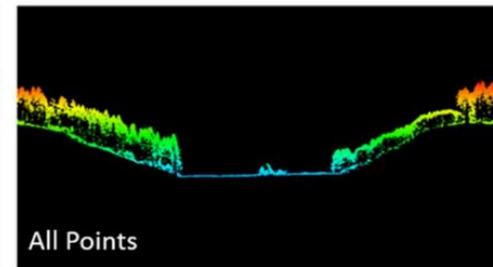
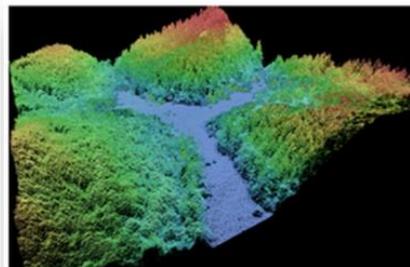
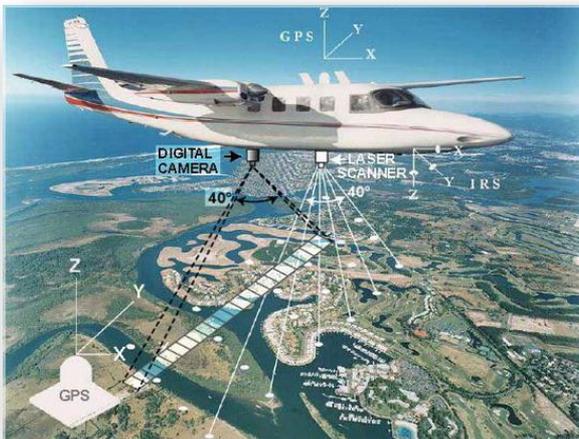


Realizes the benefits and ROI of the 3D Nation Study



+ 3D Elevation Program (3DEP)

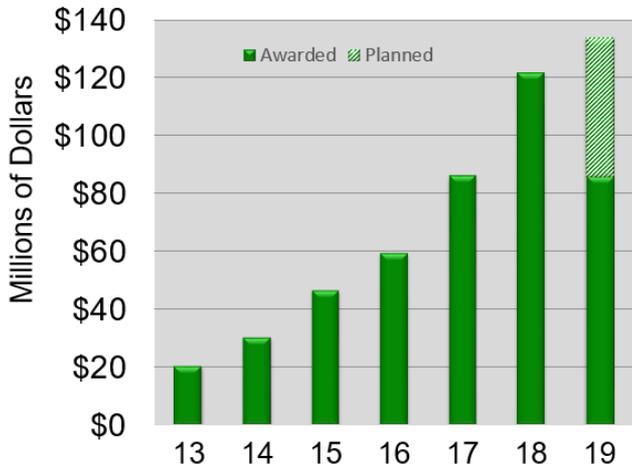
- Complete acquisition of nationwide lidar (IfSAR in AK) in 8 years to provide the **first-ever national baseline of consistent high-resolution elevation data – both bare earth and 3D point clouds – collected in a timeframe of less than a decade**
- Address Federal, state and other mission-critical requirements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



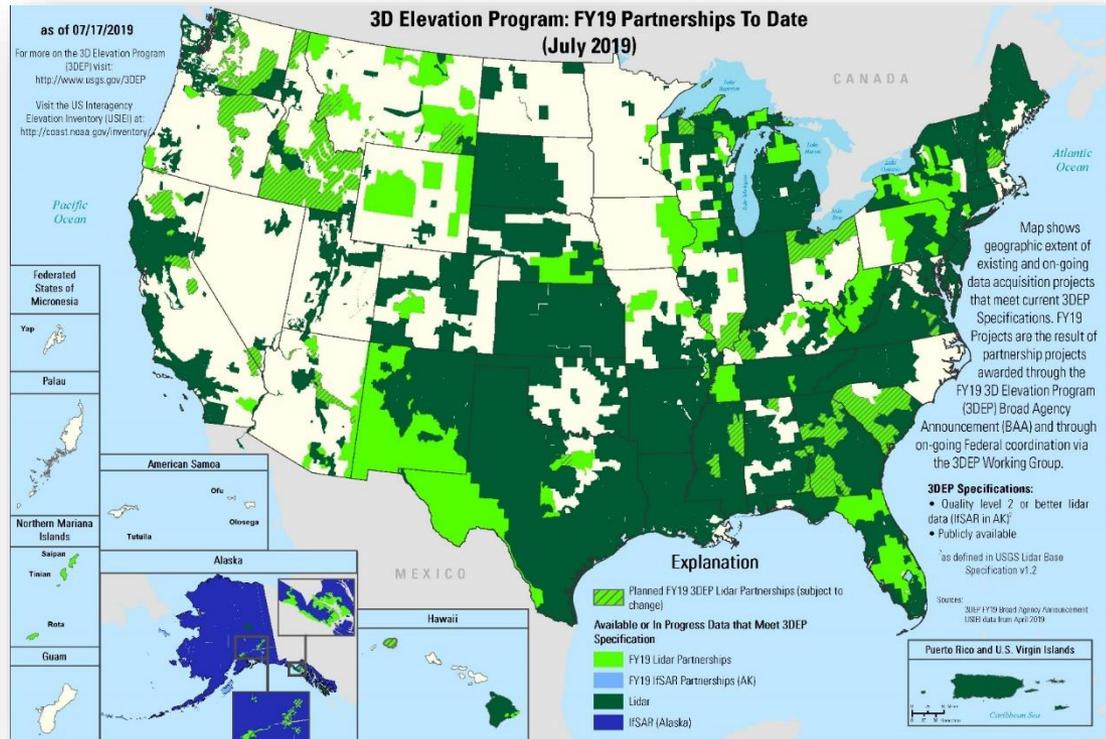
+ 3DEP Status Including FY18 Partnerships

Data are available or in progress for 61% of the Nation

*includes lidar and AK IfSAR



Data acquisition investments by all partners, by fiscal year



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† National Hydrography Datasets

Foundational datasets for indexing water-related information...

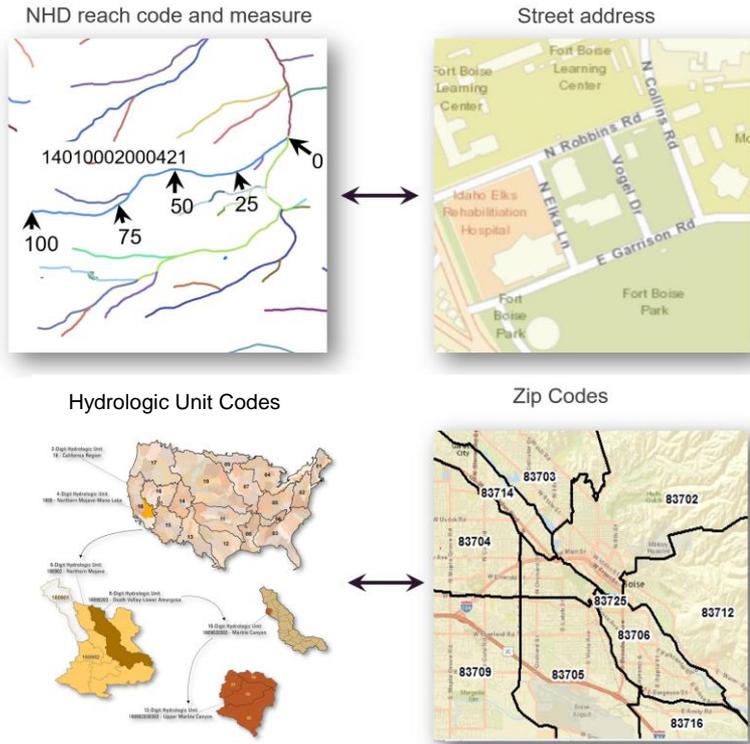
...and to the landscape: NHDPlus HR

Elevation-based catchments for each flowline in the stream network provide more detail like ZIP Code +4

Value-Added Attributes (VAAs) pre-calculate network characteristics to support routing like Google Maps driving directions

Together enable analysis between the stream network and terrestrial characteristics on the landscape, making network analysis easier and richer

Limitless data can be linked to NHDPlus HR, supporting development of consistent and repeatable modeling results



NHDPlus HR catchments and VAAs

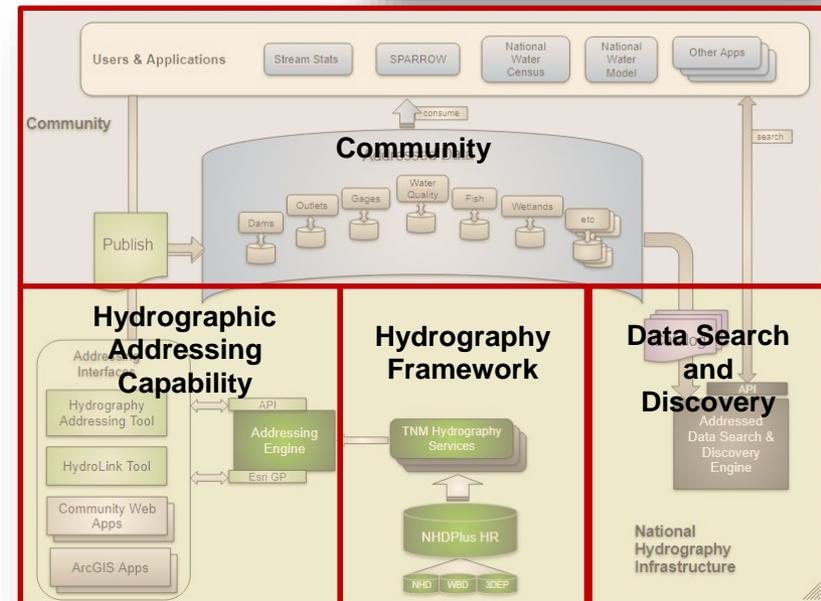
Zip Code +4 and Google Maps routing



...to the network and drainage area: NHD and WBD

+ National Hydrography Infrastructure

- Combine foundational hydrography datasets with hydrographic addressing, catalog, and search engine functionality
- Provides the universal infrastructure for sharing and discovering limitless sources and types of water information
- Underpins interagency hydrologic observing systems and enable models that account for all the water in the water cycle – from the atmosphere to the oceans



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4D National Terrain Model

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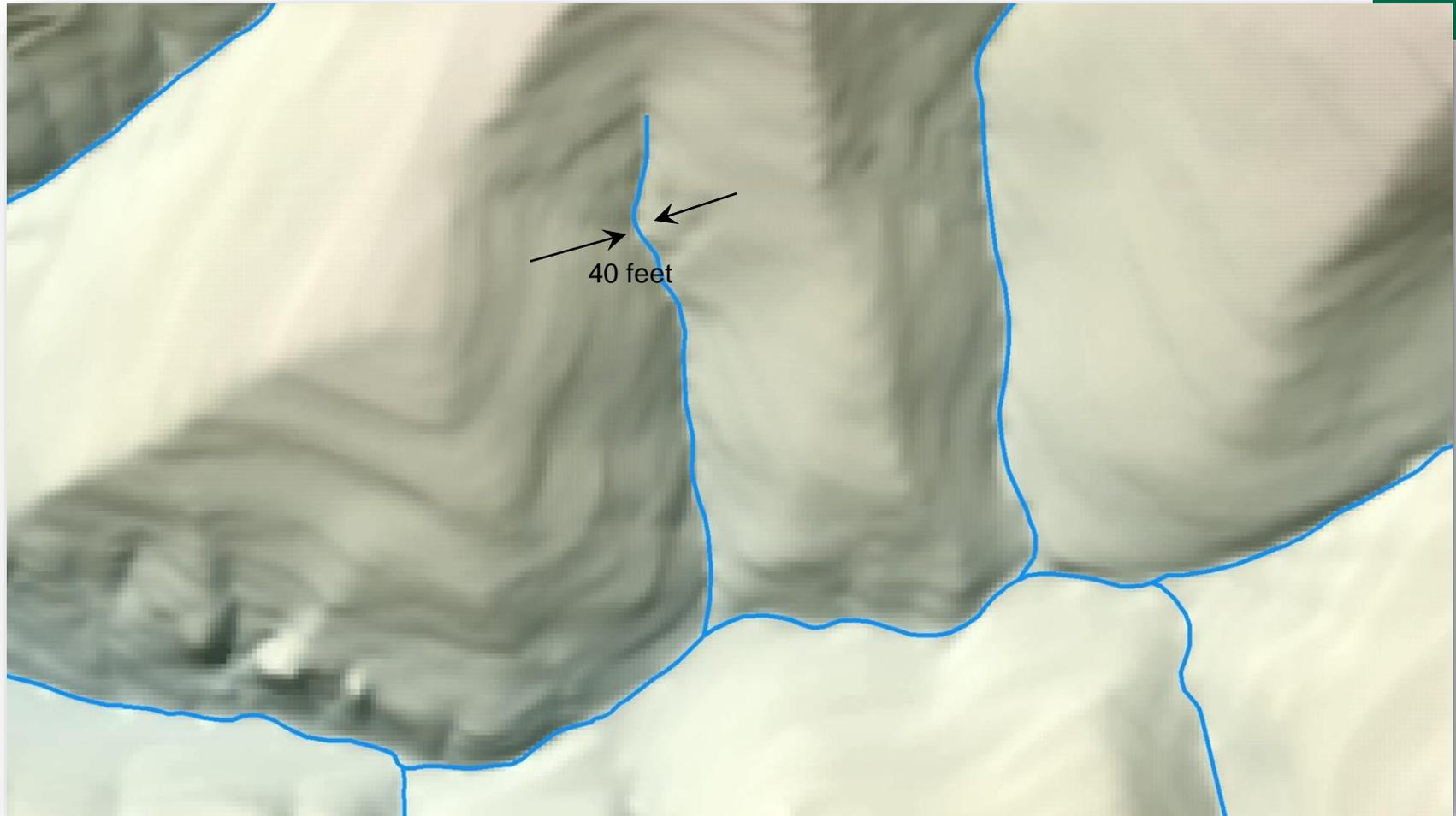


Realizes the benefits and ROI of the 3D Nation Study



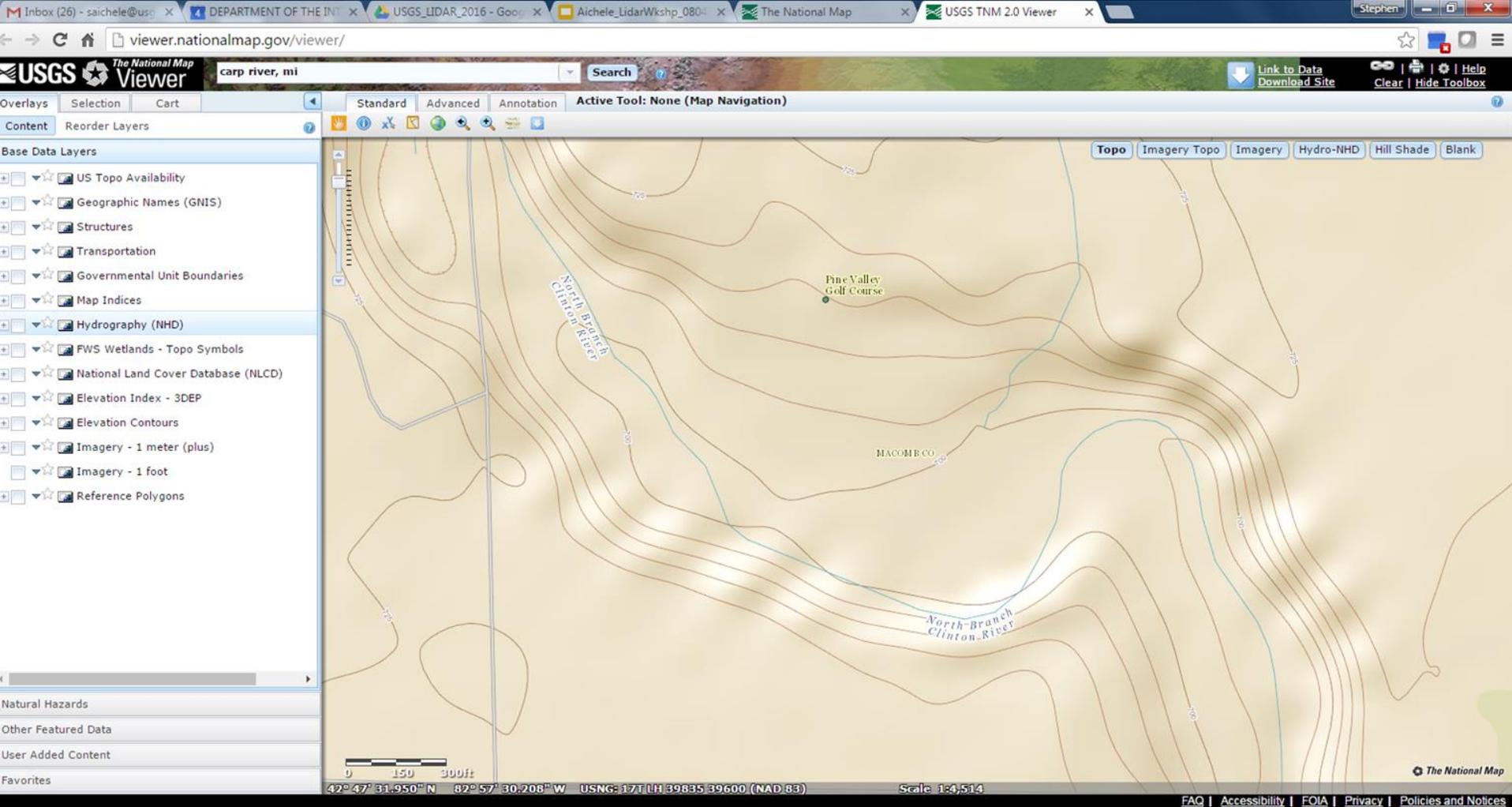
+ Data with 24K Mapping Origins

Integration error is in the 40 foot range



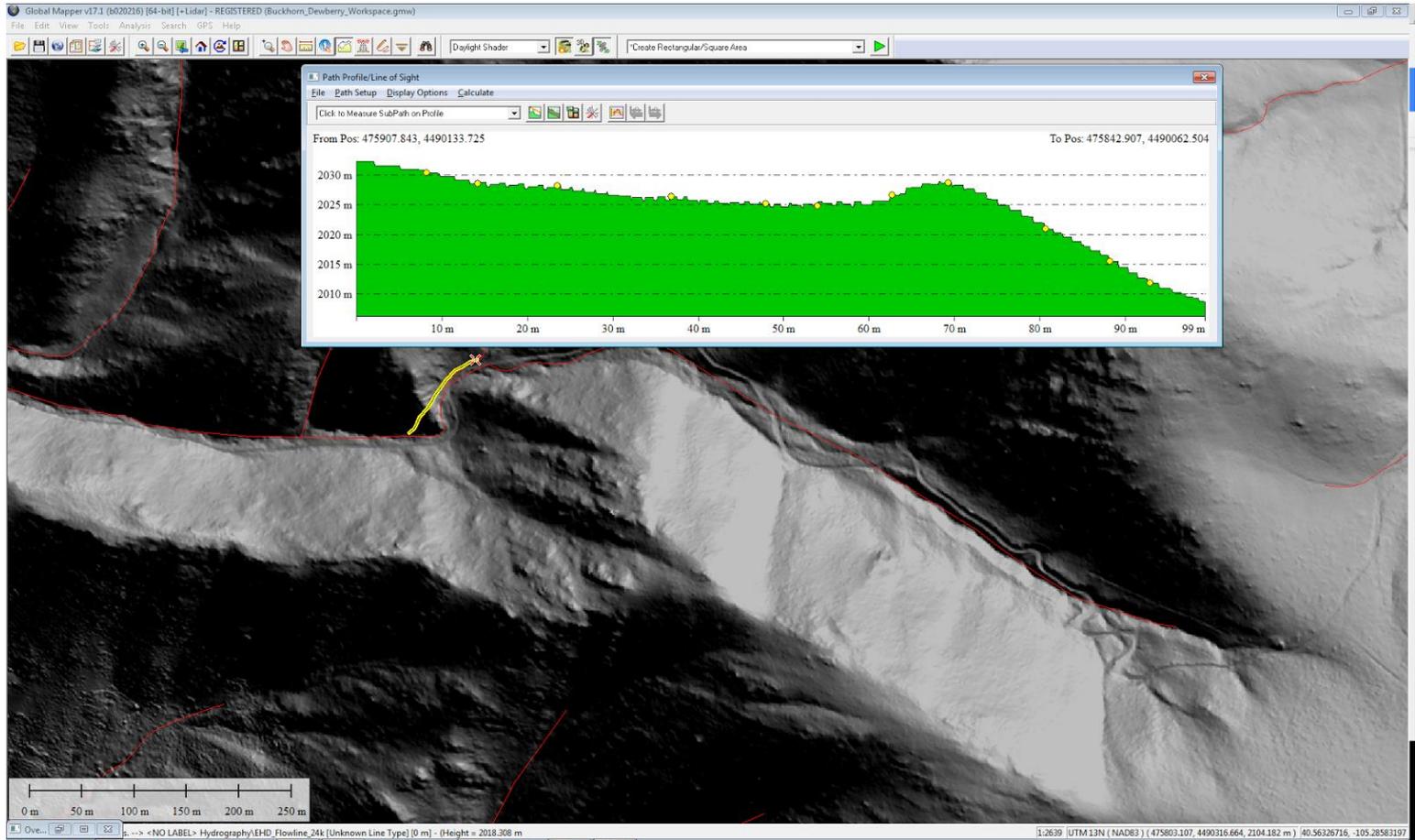
+ Water flows uphill...

13³



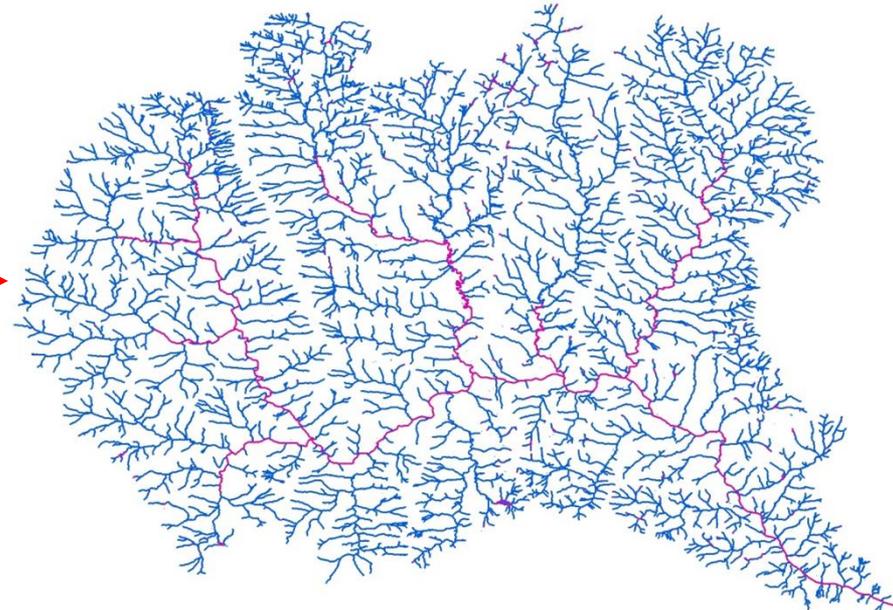
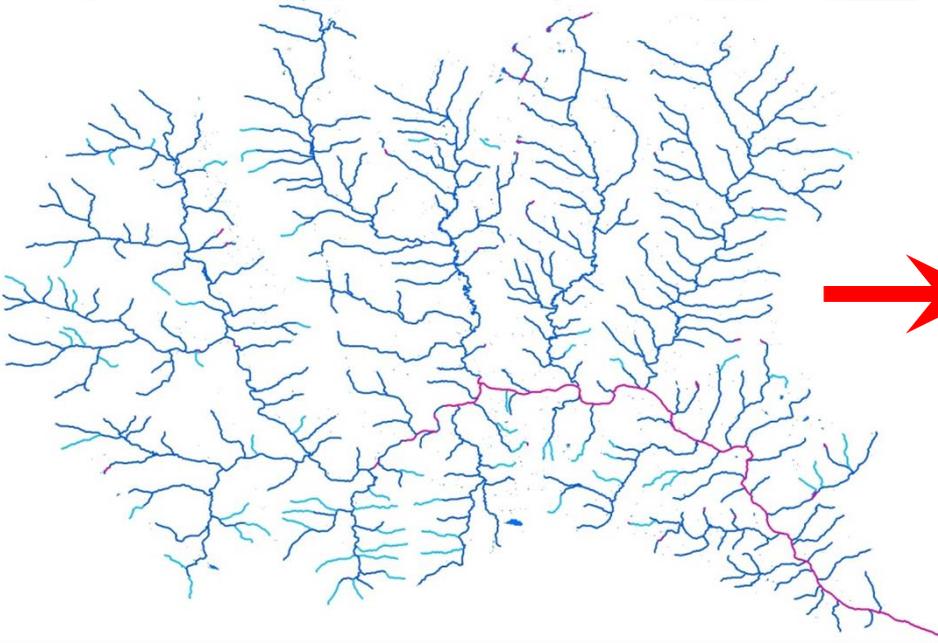
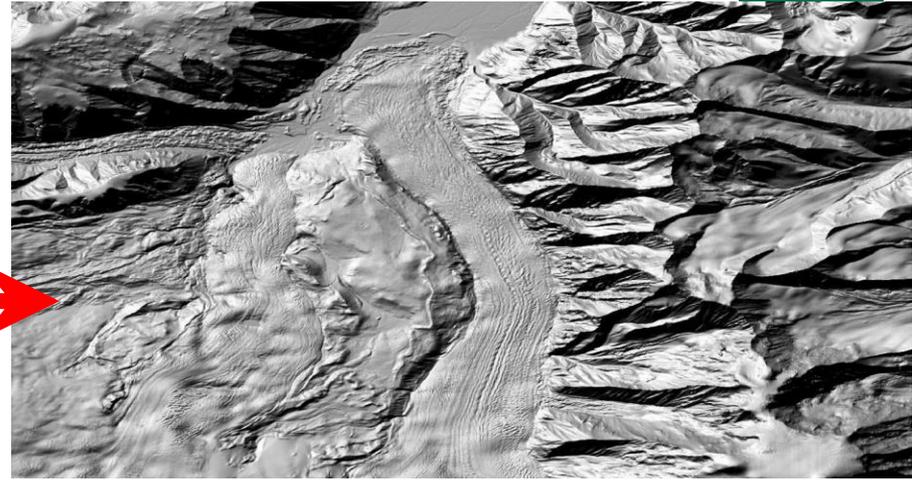
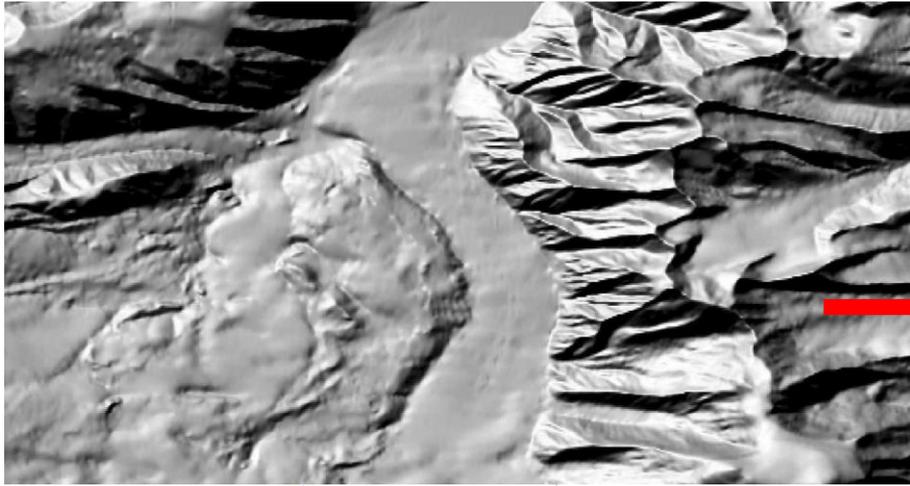
+ Dis-integration causes trouble

Water flowing uphill...

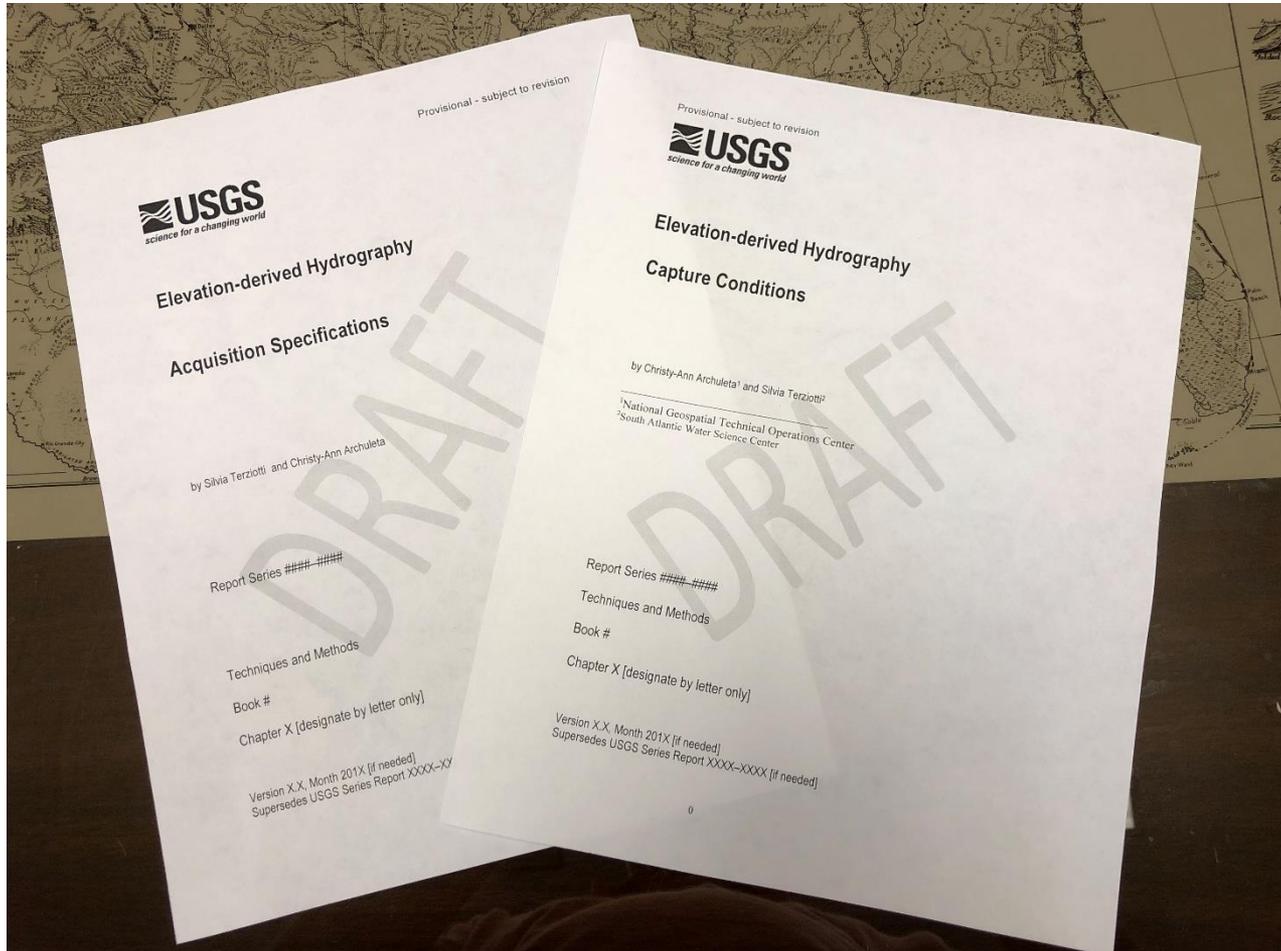


+ 3D Elevation Program

Improving resolution and accuracy for hydrography



+ Capture conditions and acquisition specifications



+ Three key concepts

- Z values for flowlines should decrease monotonically downstream
- Vector representations of hydrography should be located inside of raster representations
- Z values should be below, but “close to”, the z value of the elevation source data

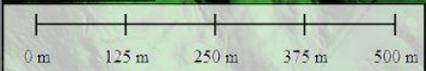
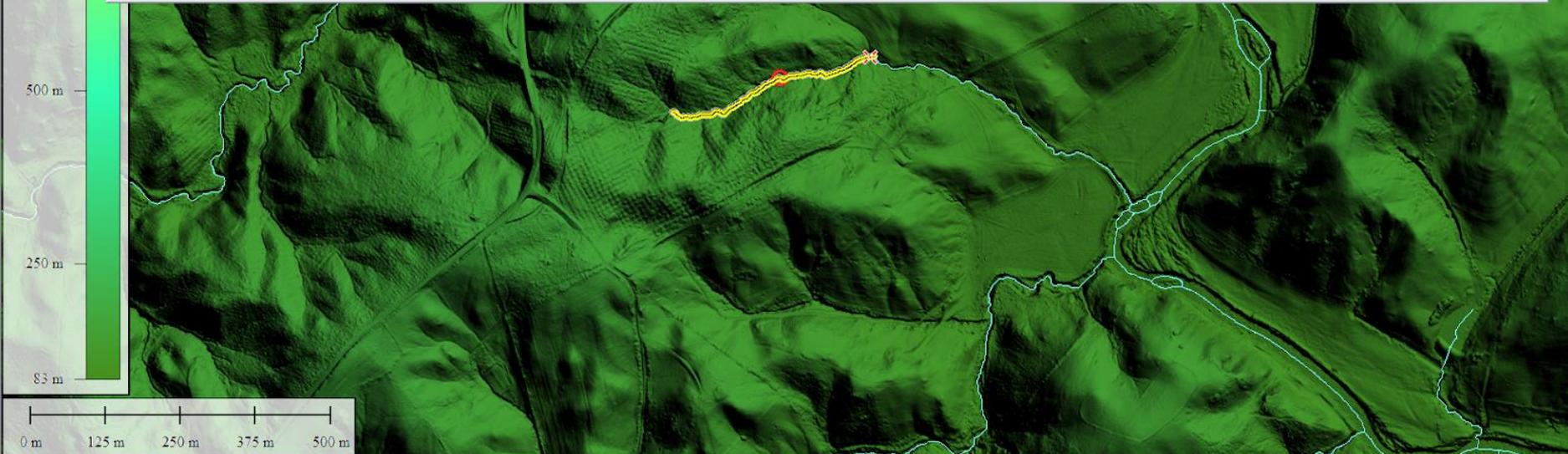
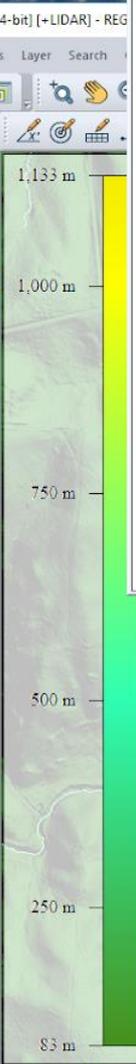
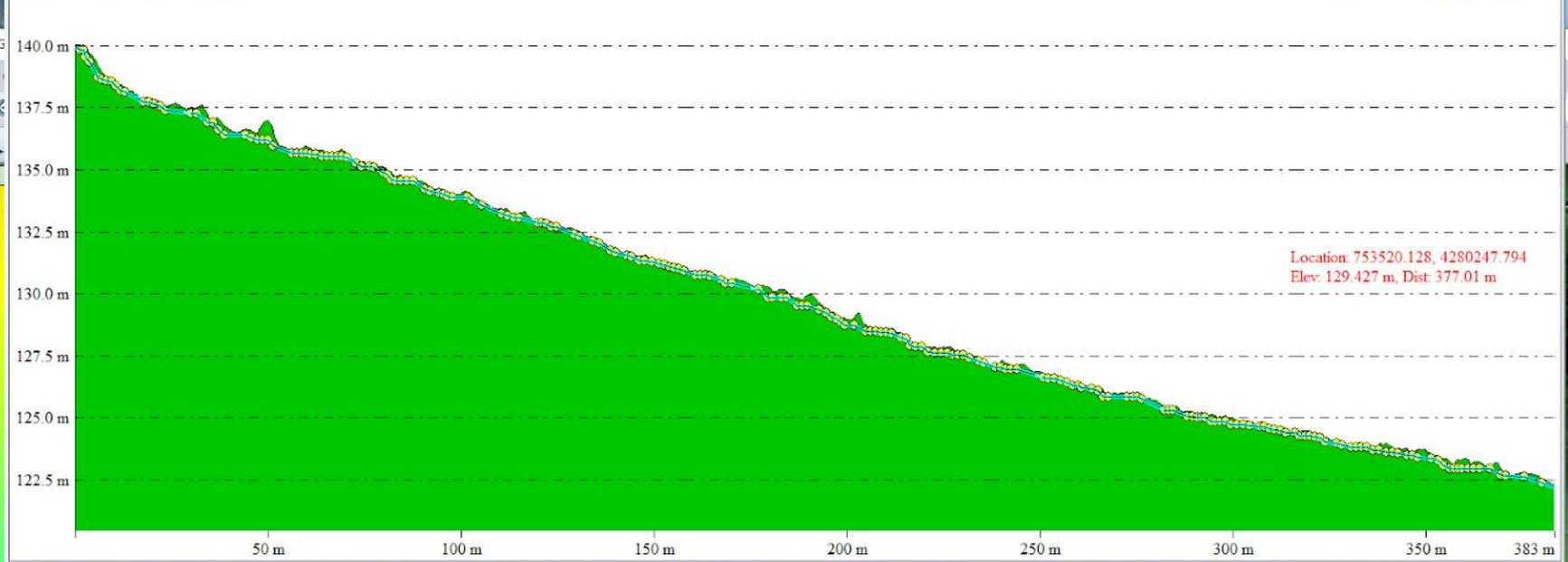
Path Profile/Line of Sight (781)

File Path Setup Display Options Calculate



From Pos: 753191.501, 4280155.508

To Pos: 753526.501, 4280248.507



+Integrating elevation and hydrography

19

The screenshot displays the USGS National Map web interface. At the top left, the USGS logo and 'The National Map' branding are visible. A navigation bar includes 'Help', 'Data Download', and 'Services'. A search bar on the right contains the text 'Find address or place'. The main map area shows a topographic map with brown contour lines and blue hydrographic features. A purple line highlights a specific stream path. Labels on the map include 'Missisquoi River', 'Le Clair Brook', and 'STEPHENSON RD'. A scale bar at the bottom left indicates 'Scale: 1:9,028' and 'Zoom Level: 16'. The bottom of the interface features a footer with 'U.S. Department of the Interior | U.S. Geological Survey', a URL, a 'Page Last Modified' date of '22-Oct-18', and links for 'Services', 'Accessibility', 'FOIA Policies and Notices', and 'Privacy'. The 'esri' logo is also present in the bottom right corner.

+ Integrating elevation and hydrography

20

The screenshot displays the USGS National Map Advanced Viewer interface. The main map shows a topographic view of a region with contour lines, roads (STEPHENSON RD, CARTER RD, BLODGETT RD), and a stream (Le Clair Brook). A blue line indicates the path for an elevation profile across the stream. A red 'X' marks a specific point on the profile. The elevation profile chart on the right shows a cross-section of the terrain with a vertical line at 0.15 miles and a peak elevation of 1,014 feet. The chart's y-axis is labeled 'Elevation in Feet' (1,010 to 1,190) and the x-axis is 'Distance in Miles' (0.0 to 0.4). A red 'X' is also present on the chart at the 0.15-mile mark. The interface includes a search bar, navigation tools, and a footer with contact information and logos for the U.S. Department of the Interior and USGS.

USGS Home
Contact USGS
Search USGS

Help Data Download Services

Find address or place

Elevation Profile

Measure Profile Result

Hover over or touch the Elevations Profile chart to display elevations and show location on map.

Profile Information Prepare Download... Clear

Elevation Profile

1,190
1,180
1,170
1,160
1,150
1,140
1,130
1,120
1,110
1,100
1,090
1,080
1,070
1,060
1,050
1,040
1,030
1,020
1,010

1,014 Feet
-82

0.0 0.1 0.2 0.3 0.4

Distance in Miles

Scale: 1:9,028
Zoom Level: 16
600ft

-72.416 44.826 Degrees

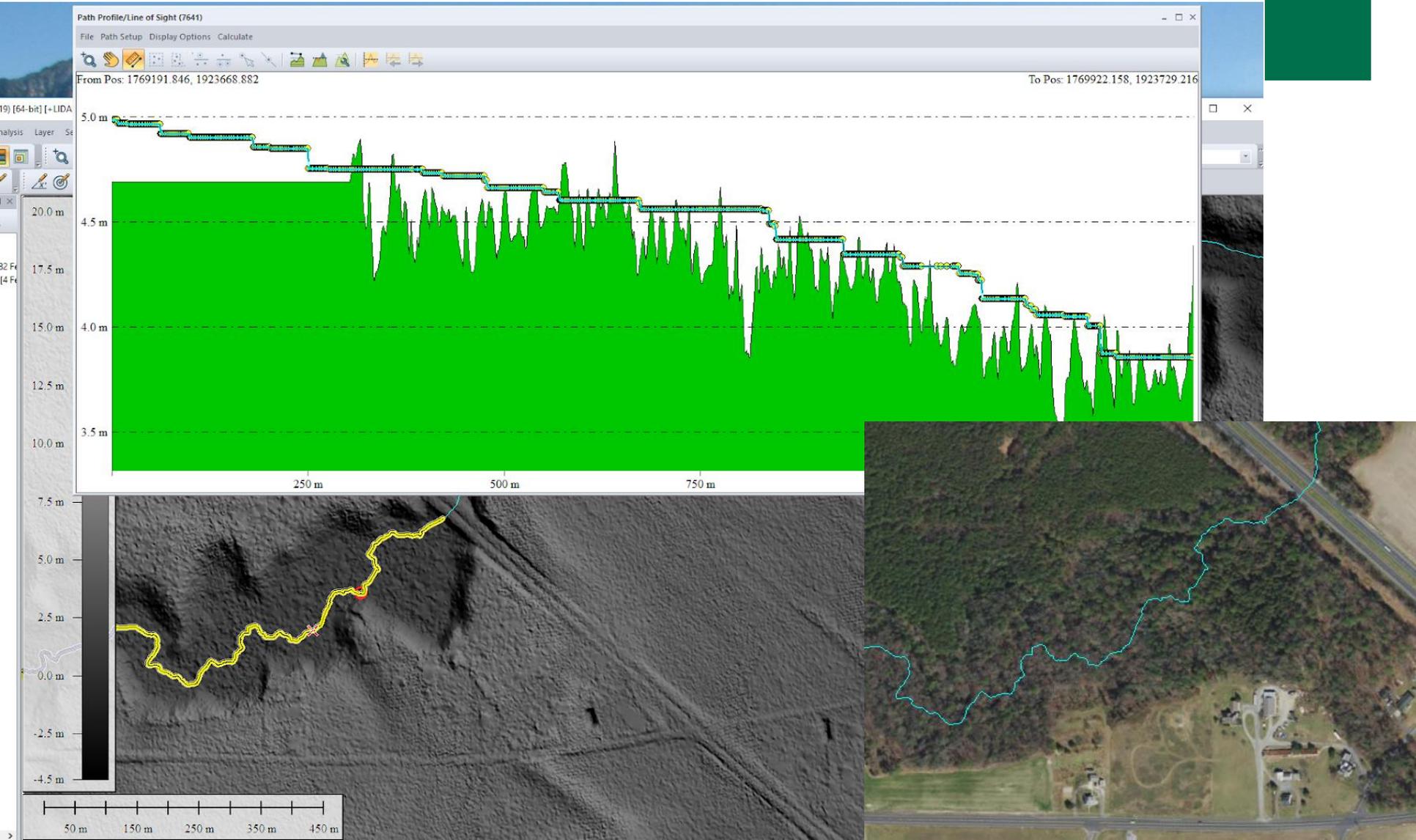
U.S. Department of the Interior | U.S. Geological Survey
URL: https://viewer.nationalmap.gov/advanced-viewer/ Page Last Modified: 22-Oct-18
Page Contact Information: The National Map

Services Accessibility FOIA Privacy Policies and Notices

USA.gov

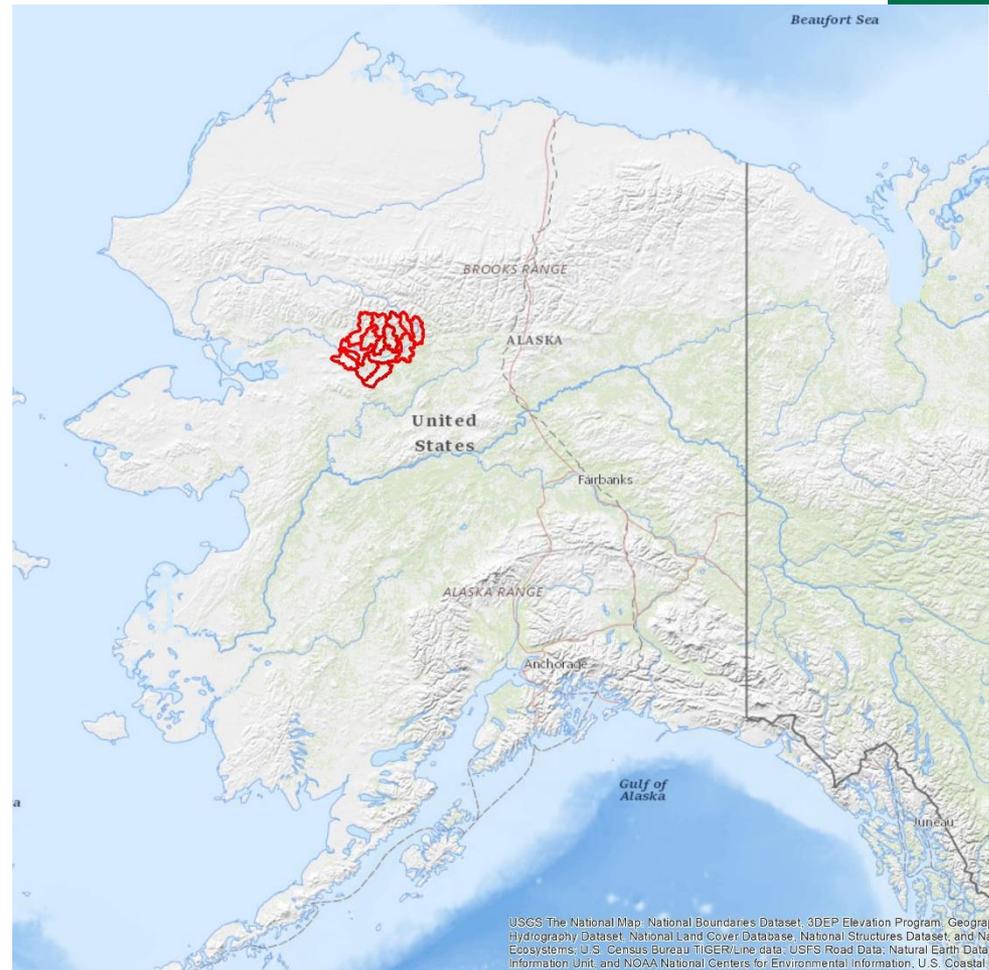
+

Keep the water below the lidar returns



+ Alaska pilot projects

- Total area of about 4700 sq. mi. (12,000 sq. km.)
- Roughly the size of Connecticut
- Mixed terrain
- High-interest because of a proposed road
- Very similar capture conditions to existing 1:24,000 scale data
- Customized elevation-derived hydrography specification and requirements
- z-enabled hydrography data that integrates with elevation data



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4D National Terrain Model

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Realizes the benefits and ROI of the 3D Nation Study



+ Washington DC – urban desert

26

USGS Home
Contact USGS
Search USGS

Find address or place

USGS The National Map: National Hydrography Dataset. Data refreshed April, 2019. **POWERED BY esri**

Services Accessibility FOIA Policies and Notices Privacy

[U.S. Department of the Interior](#) | [U.S. Geological Survey](#)
URL: <https://viewer.nationalmap.gov/advanced-viewer/> Page Last Modified: 22-Oct-18
Page Contact Information: [The National Map](#)

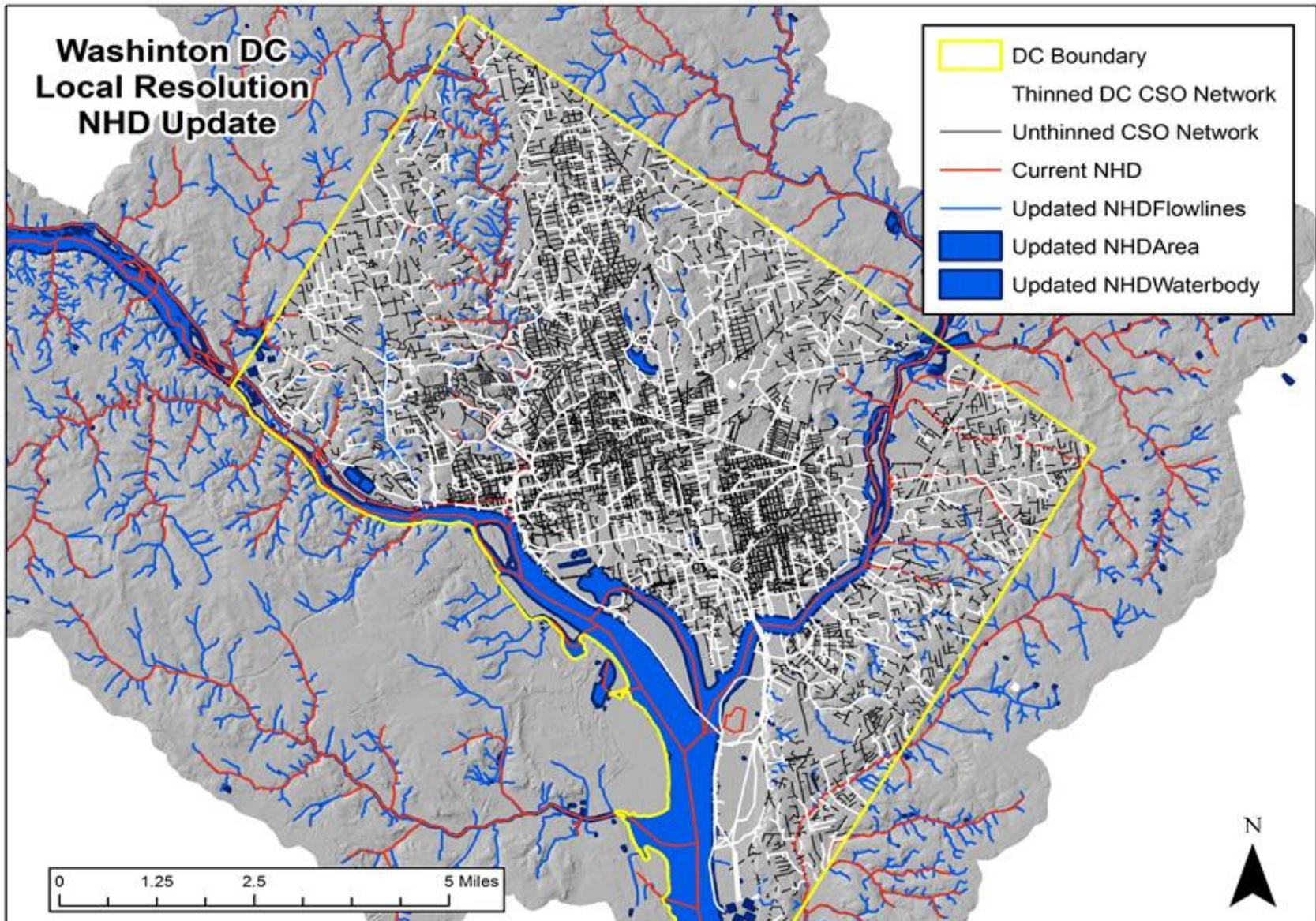


+

Urban hydrography



+ Little relation to land surface



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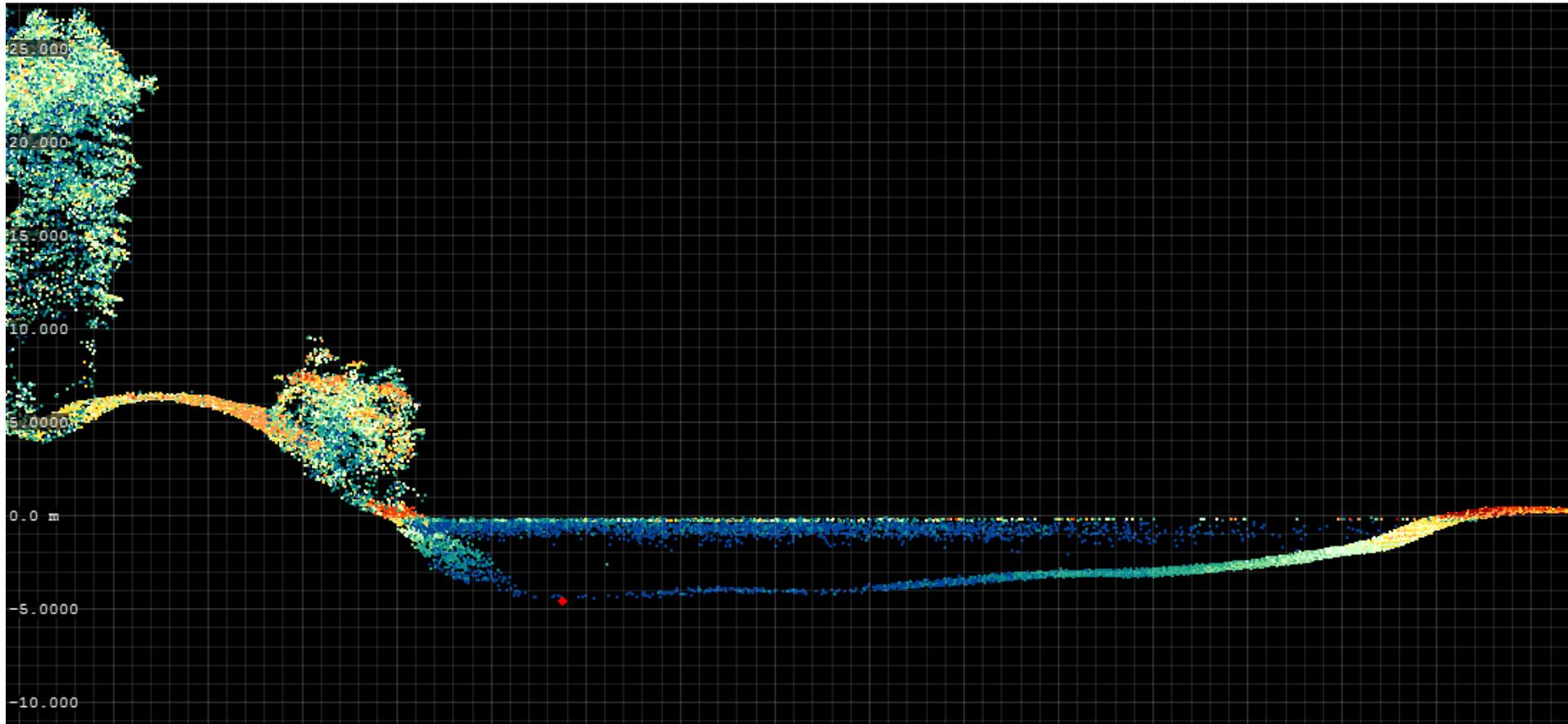


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+

Bathymetric data

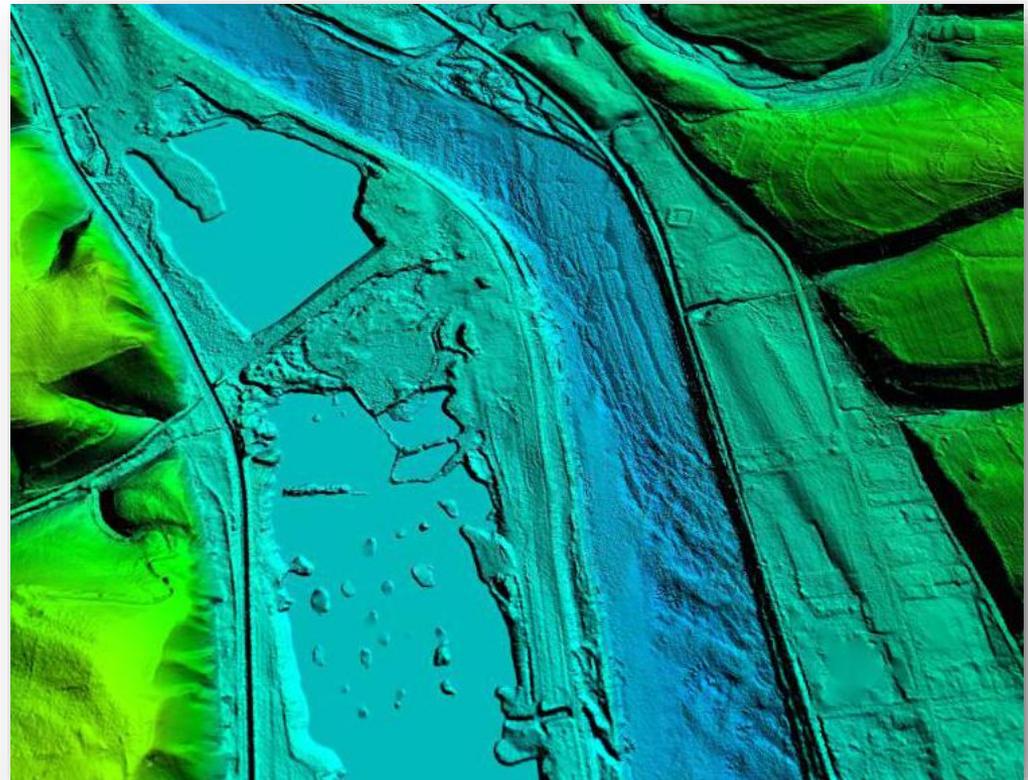


+ Emerging Technology



31

- 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
 - Topo/bathy workshop in Tuscaloosa Sept. 2019



Frenchtown Subregion of the Delaware River, integrated EAARL-B and topographic lidar

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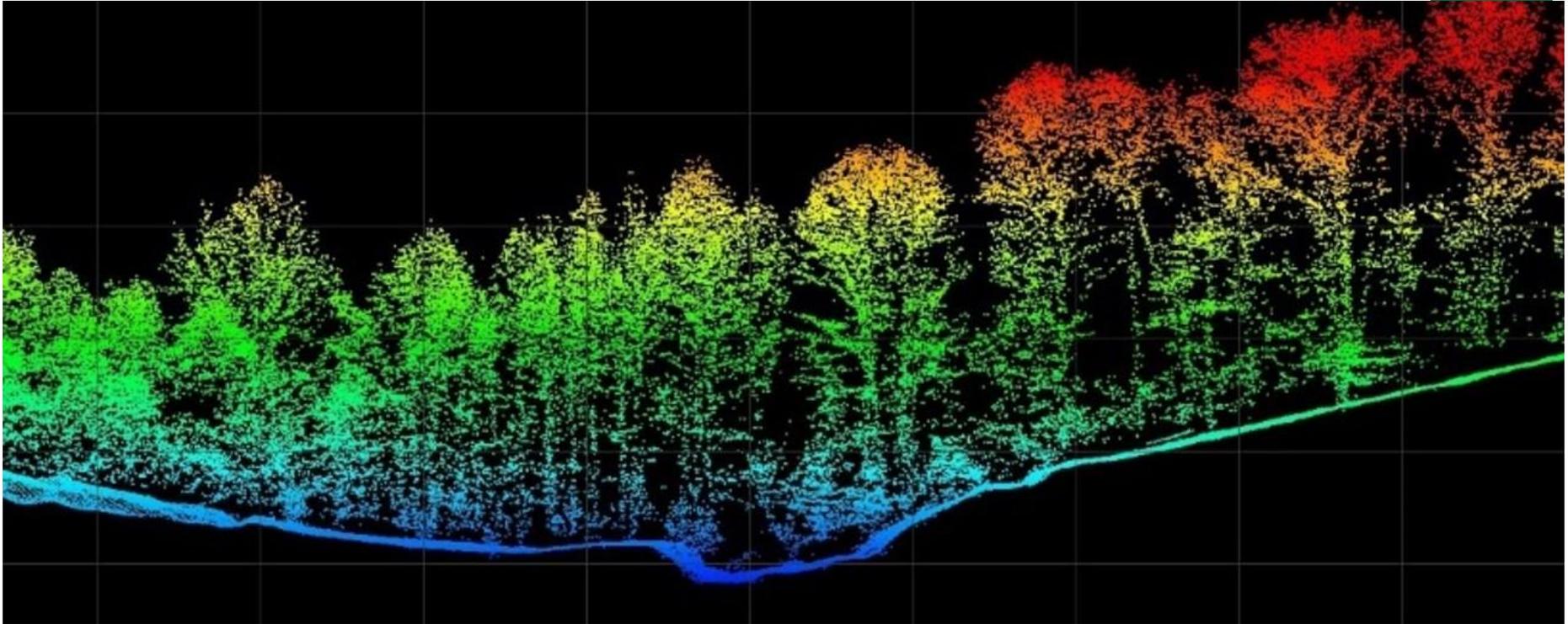
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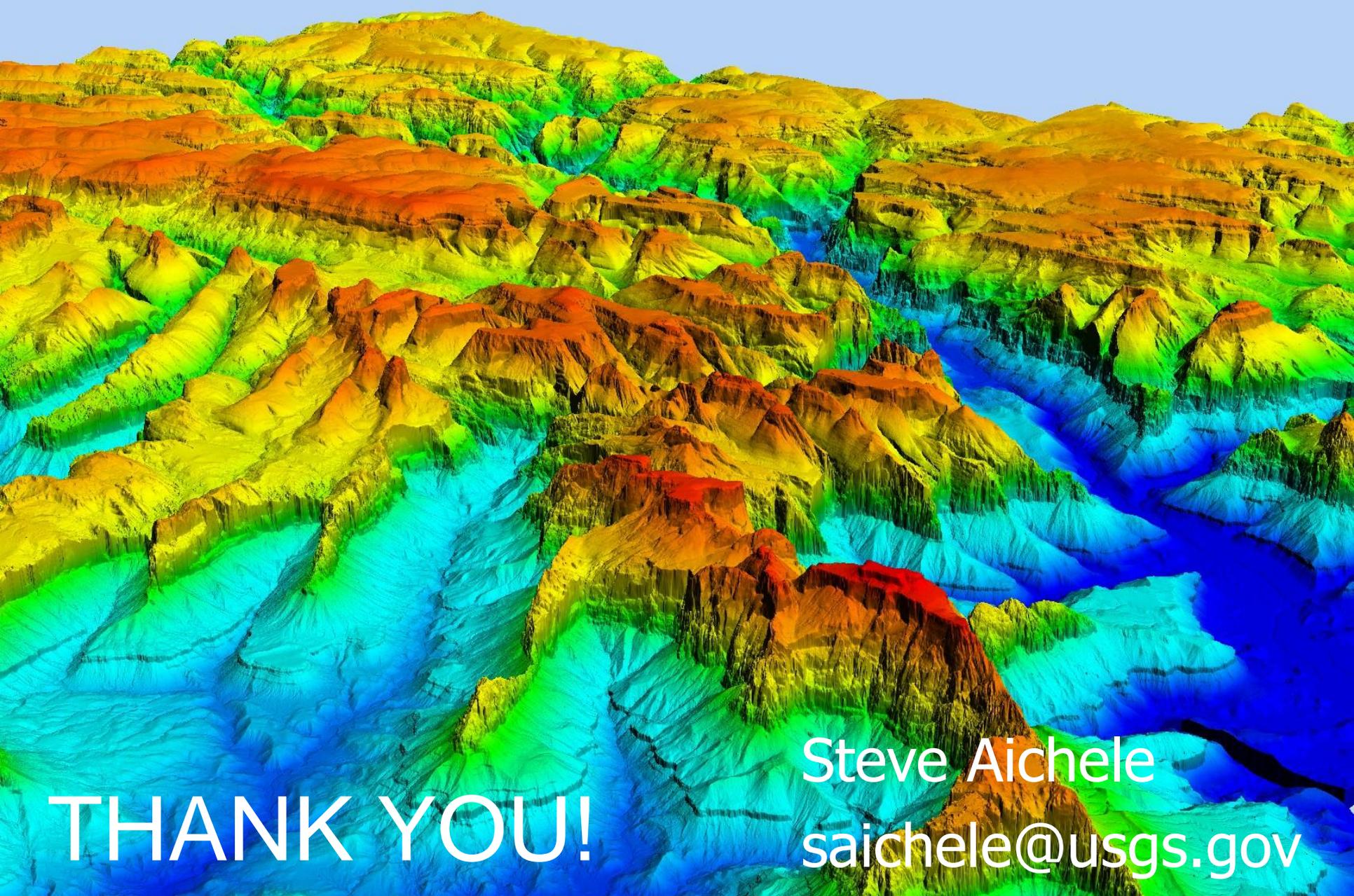
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+ Questions



Steve Aichele
saichele@usgs.gov



THANK YOU!

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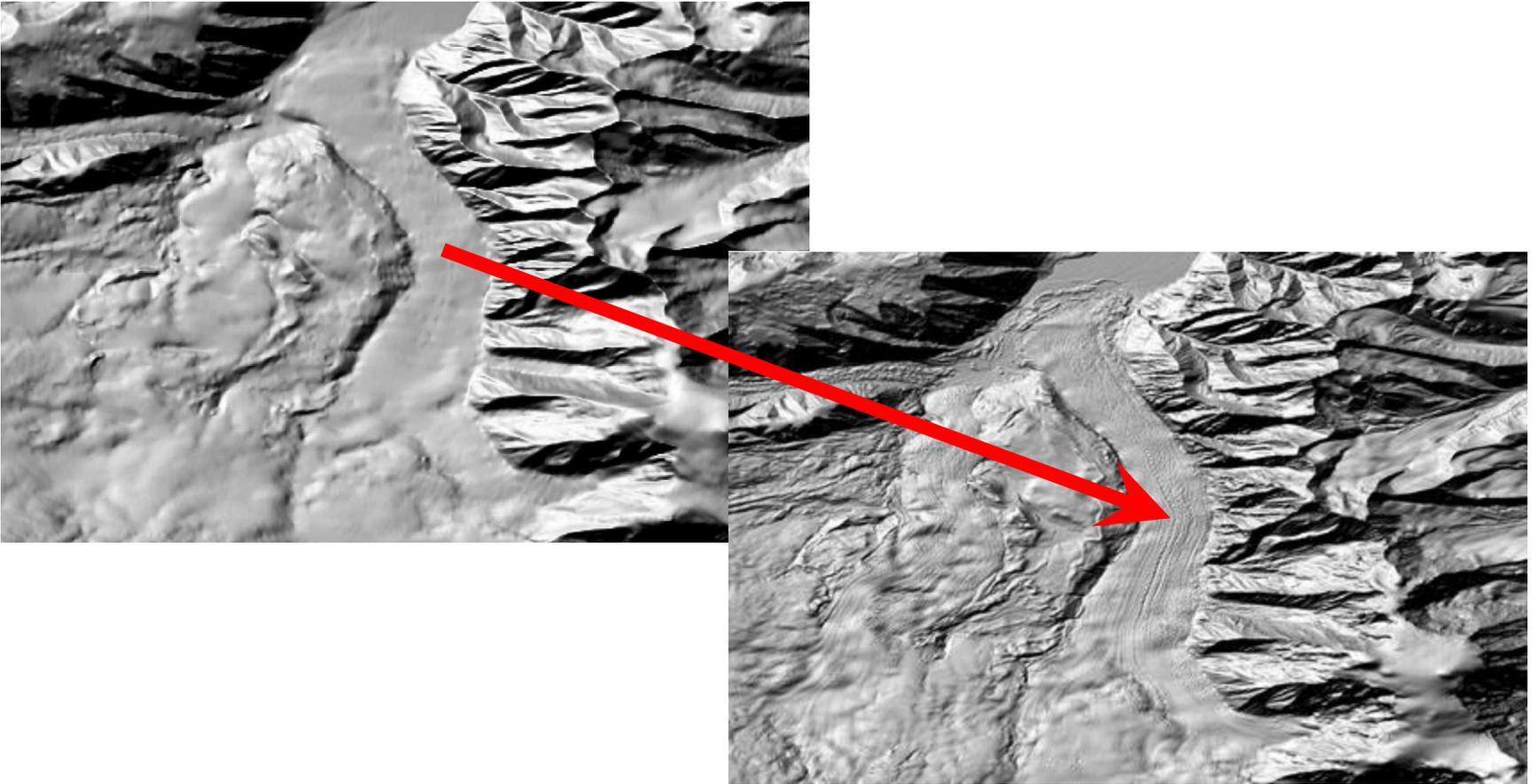


The National Map
Your Source for Topographic Information

Zion National Park, UT
3D Elevation Program (3DEP)

+ 3D Elevation Program

No longer a 40-foot paradigm!



And we still make maps

- Every map we've ever made is available online –
<https://ngmdb.usgs.gov/topoview/>
- Print-ready maps refreshed every 3 years
- Web services refreshed quarterly

