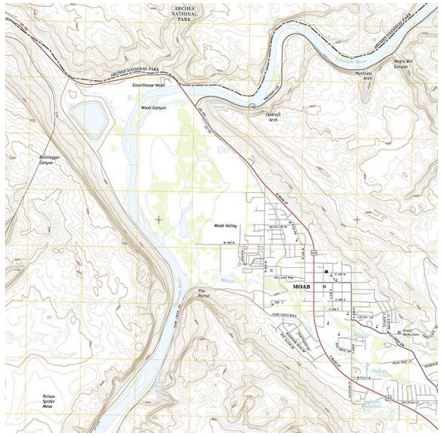
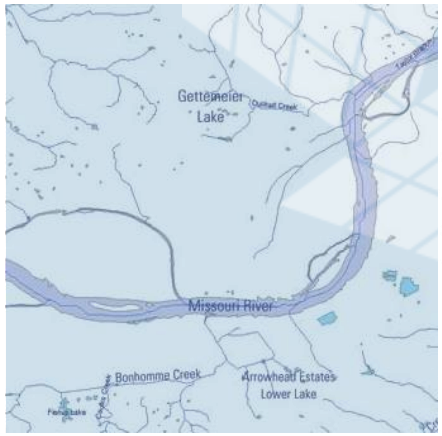
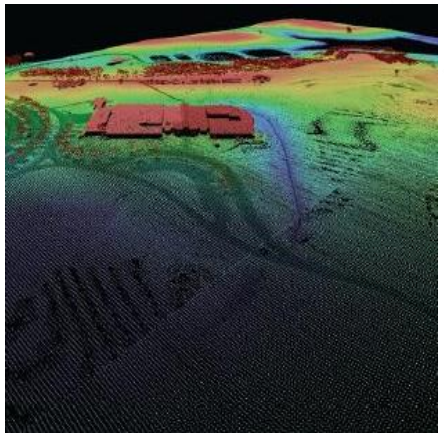
Elevation-derived Hydrography and the National Terrain Model Concept







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Stephen S. Aichele, PhD
National Geospatial Program

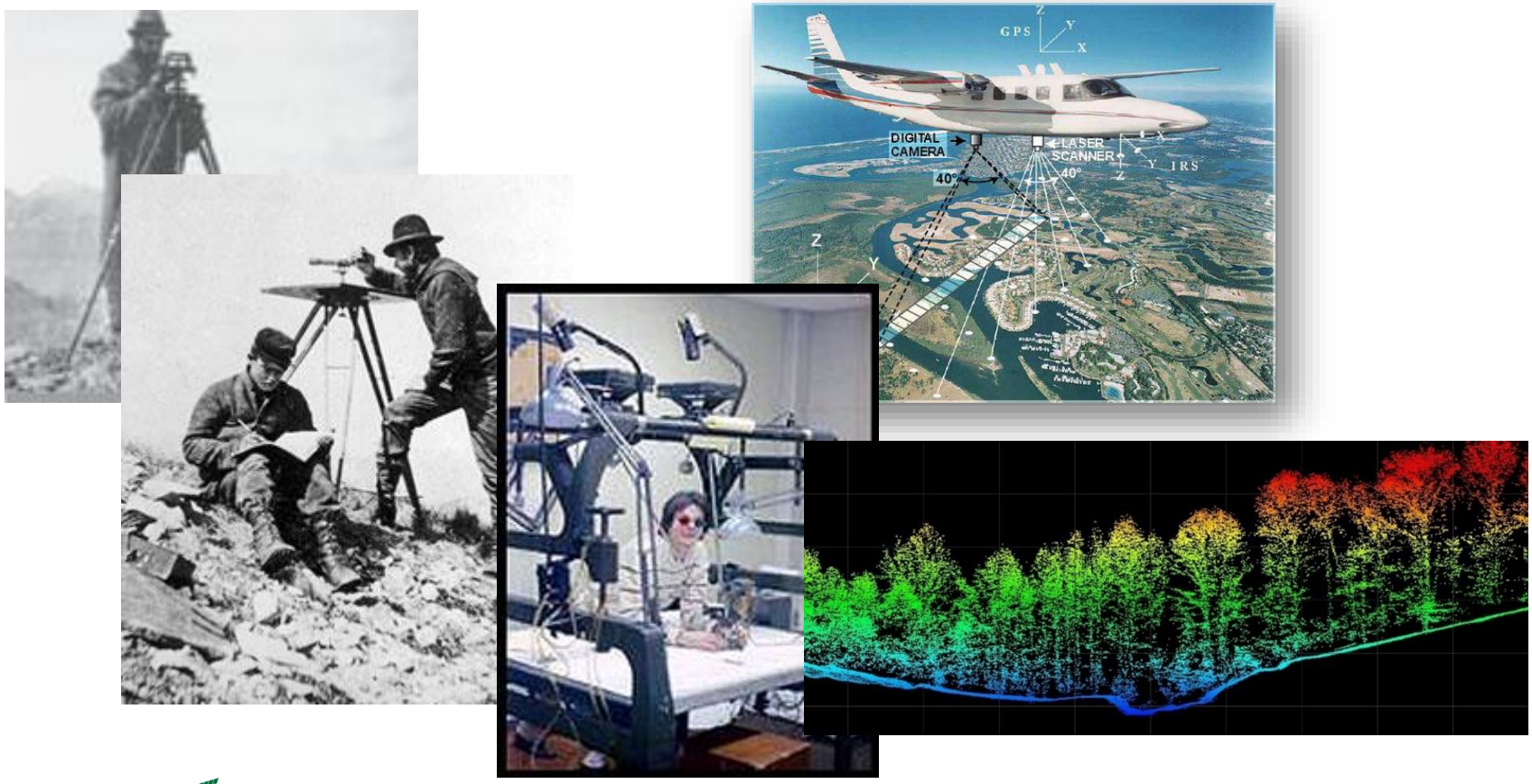
135 Years of topographic mapping

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

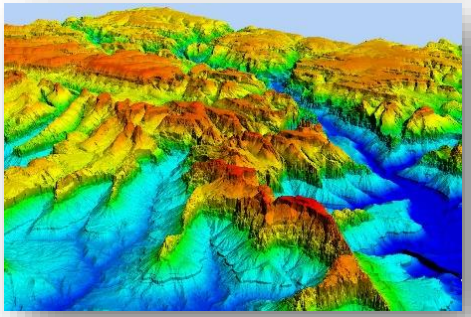
Mission remains the same

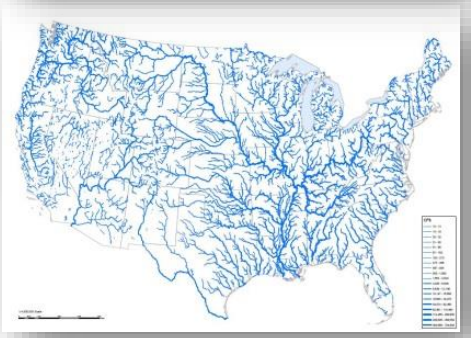


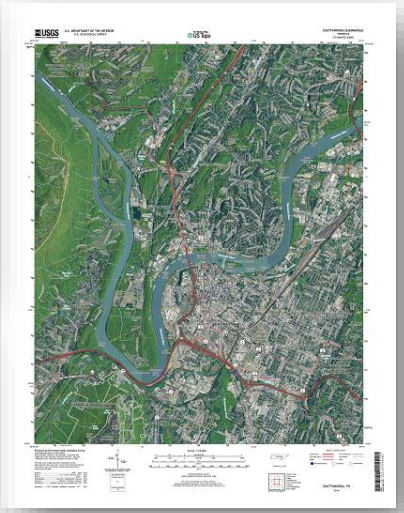
The National Geospatial Program

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







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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

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National Terrain Model

- Extend elevation surface under water bodies
- Replace estimated flow volume with volume calculated from the mapped surface

6 REPEAT COVERAGE

4D National Terrain Model

- 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 ★★★★★

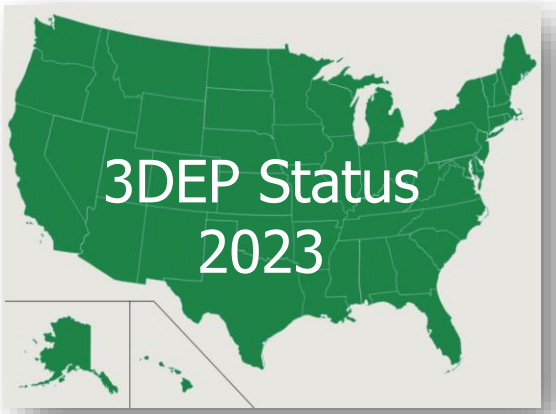
Supports the National Water Model, National Water Census, drought, water availability and use ★★★★★

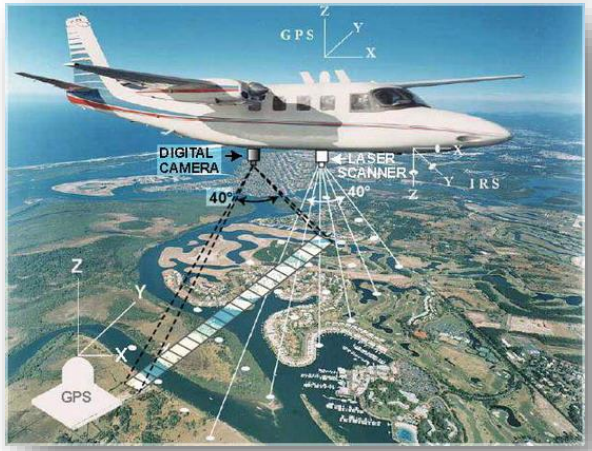
Supports the 3D Nation vision of elevation data from the depths of the oceans to the peaks of the mountains ★★★★★

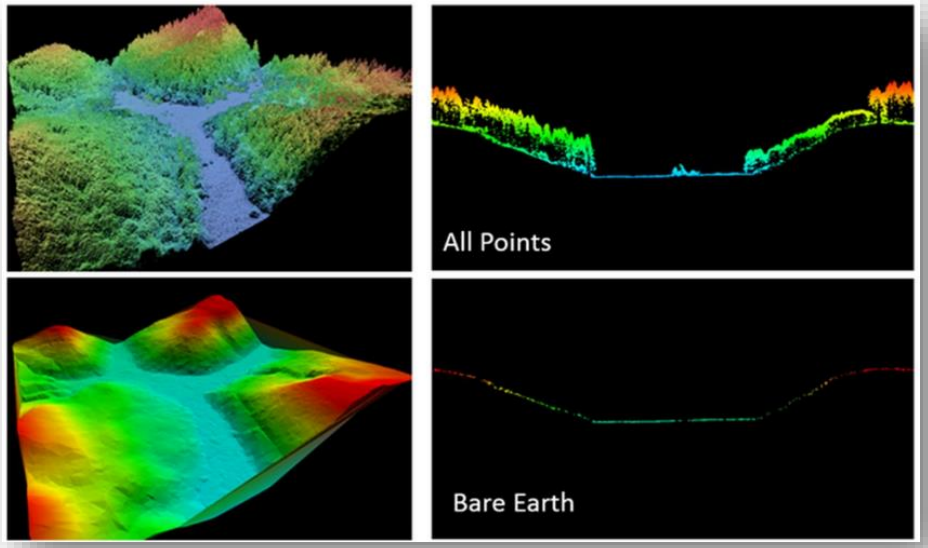
Realizes the benefits and ROI of the 3D Nation Study ★★★★★

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







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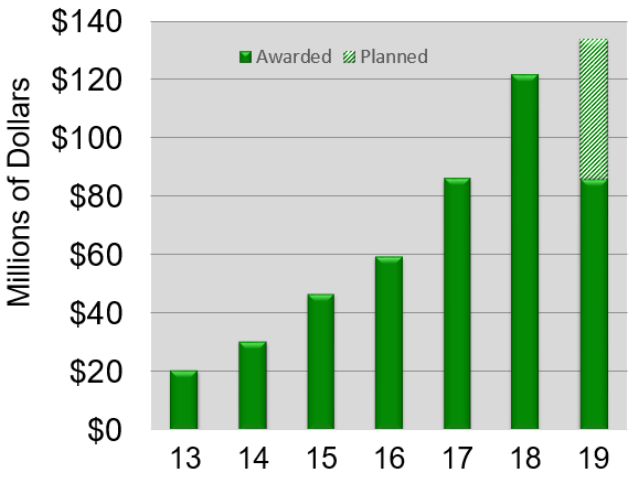
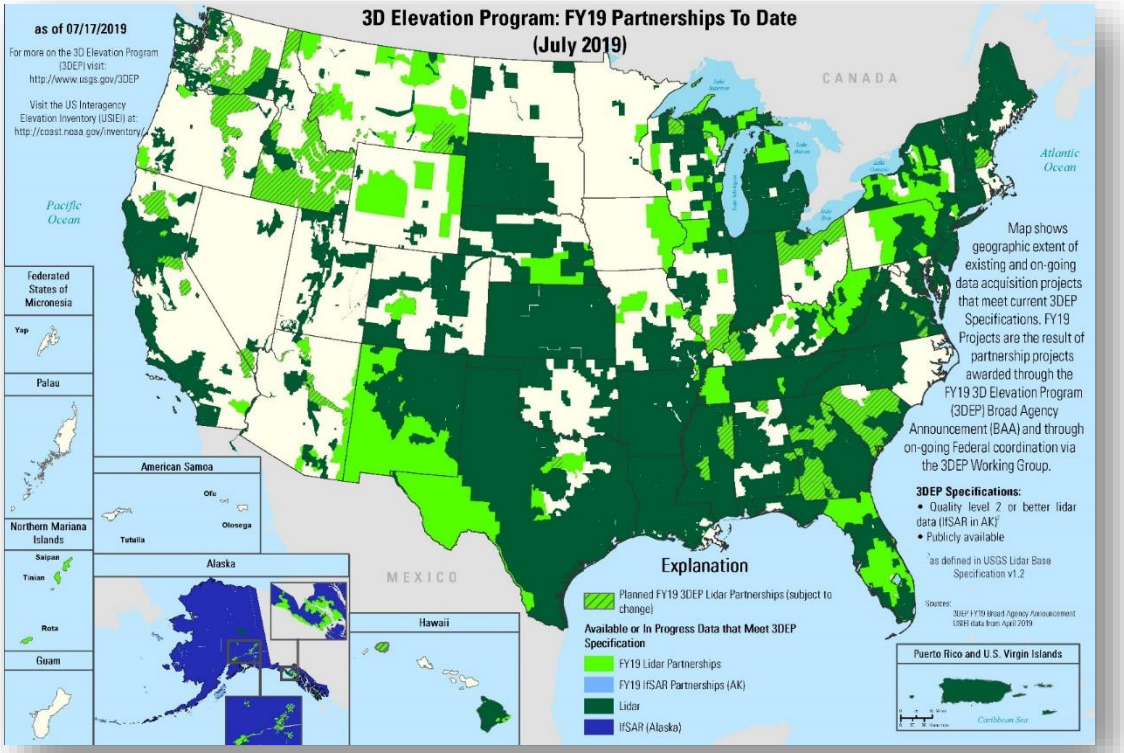
3DEP Status Including FY18 Partnerships

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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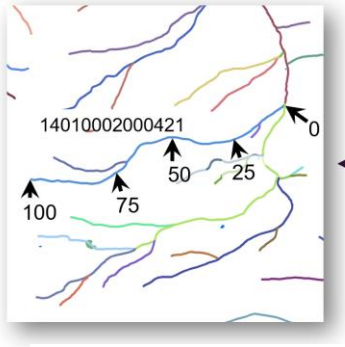
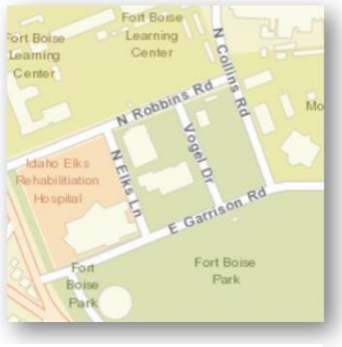
National Hydrography Datasets

Foundational datasets for indexing water-related information…

NHD reach code and measure



Street address



Hydrologic Unit Codes

Zip Codes

…to the network and drainage area: NHD and WBD

…and to the landscape: NHDPlus HR

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

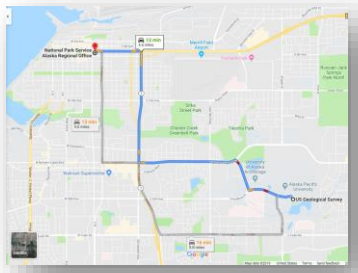
Value-Added Attributes (VAAs) pre-calculate network characteristics to support routing like Google Maps driving directions

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



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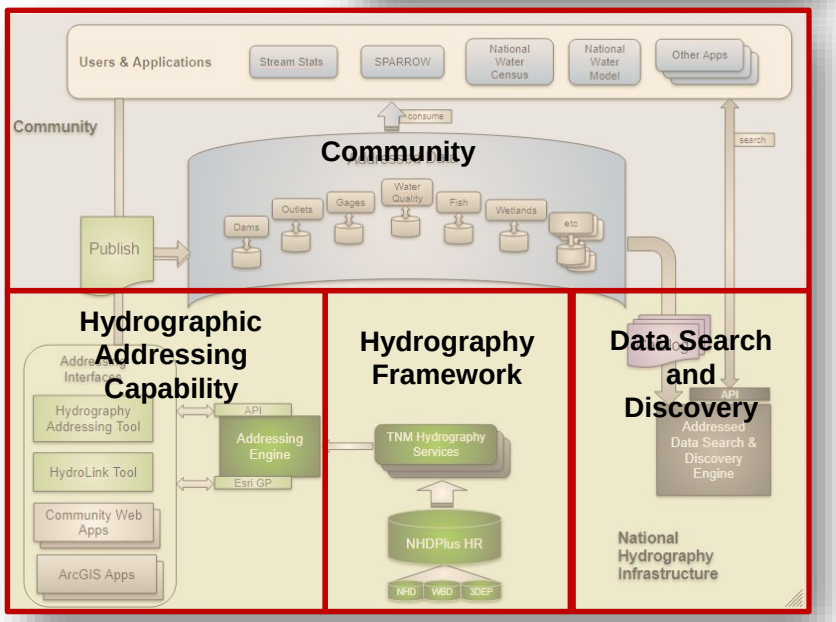
National Hydrography Infrastructure

- 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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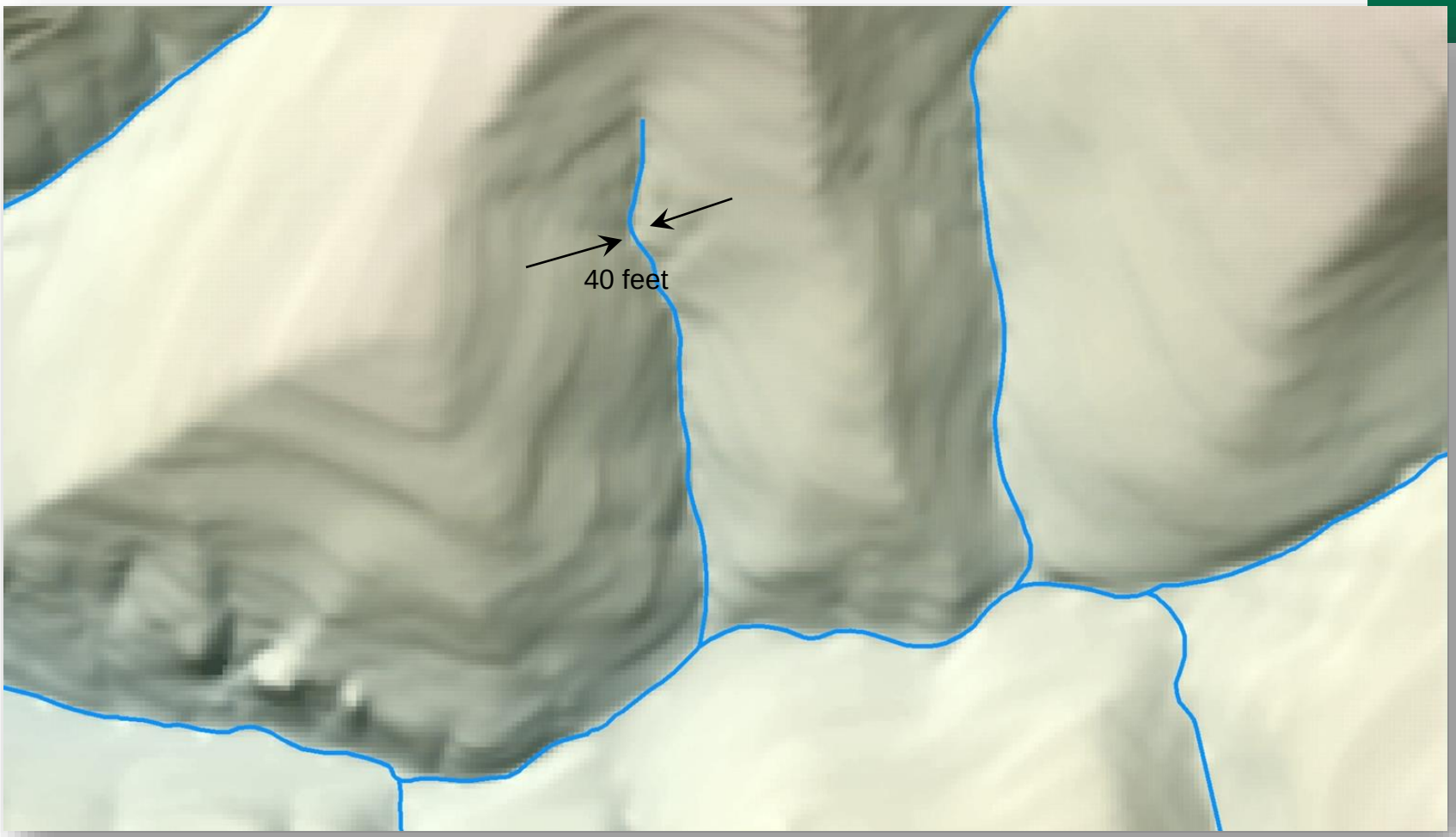
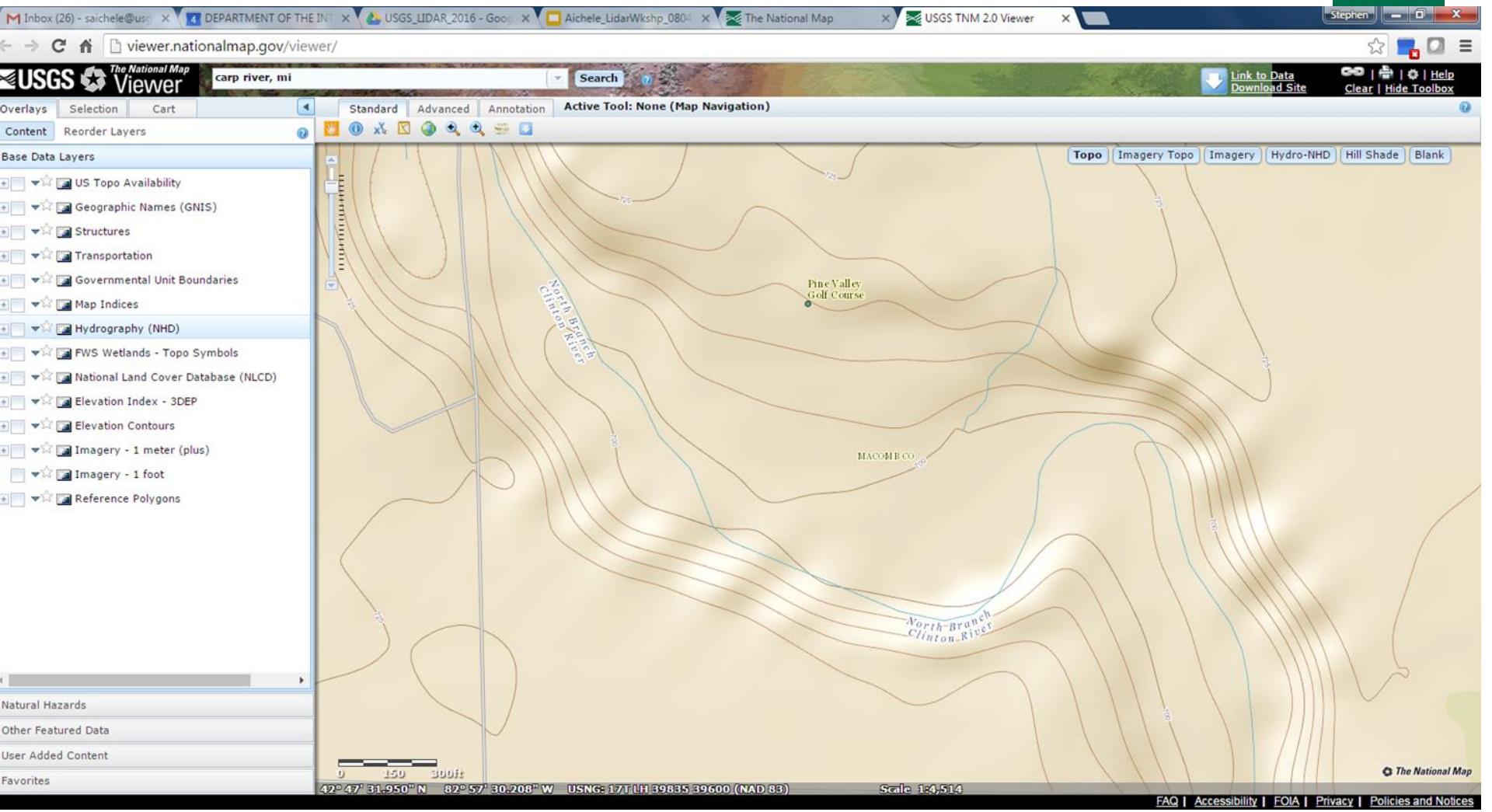
Data with 24K Mapping Origins

Integration error is in the 40 foot range

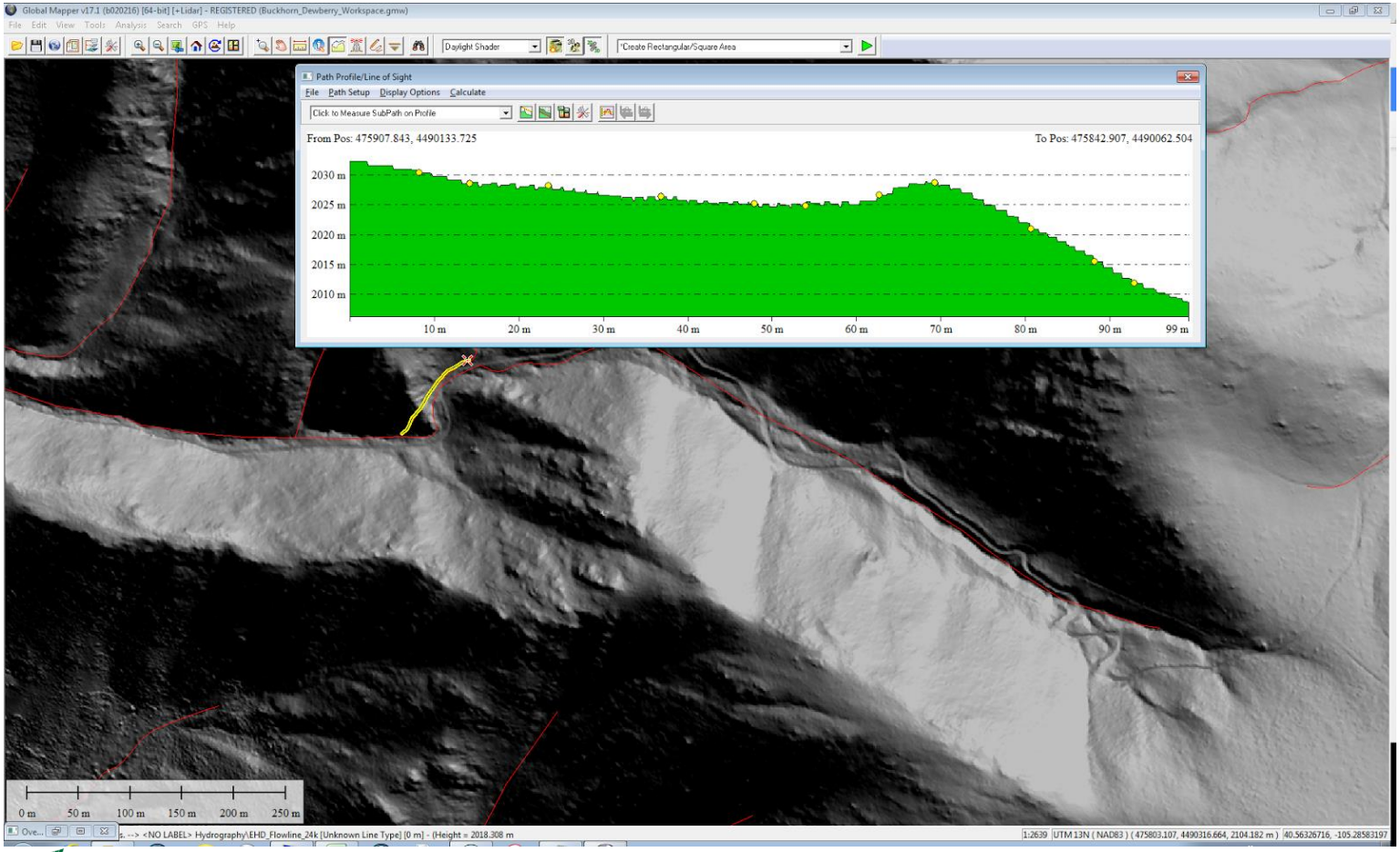


Water flows uphill...



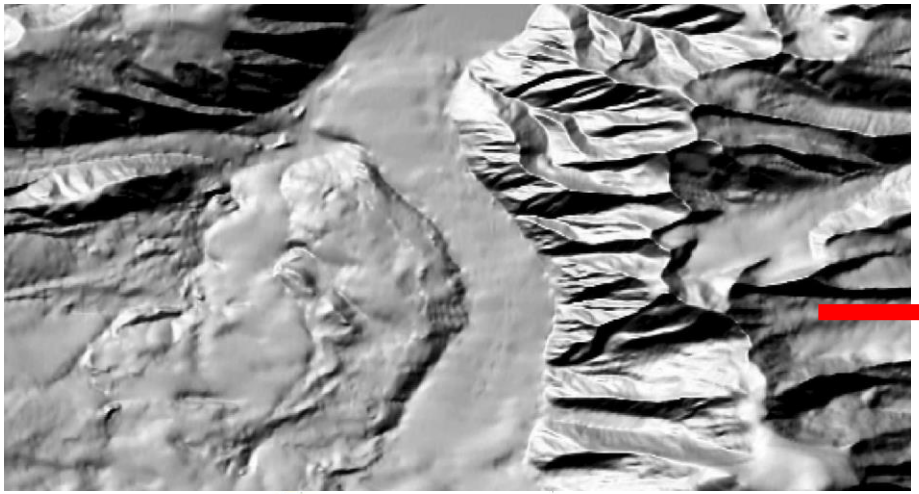
Dis-integration causes trouble

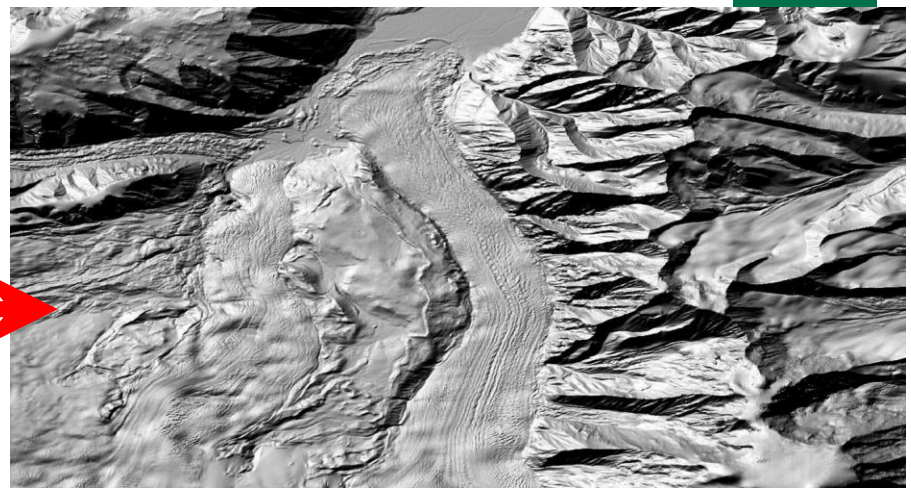
Water flowing uphill...

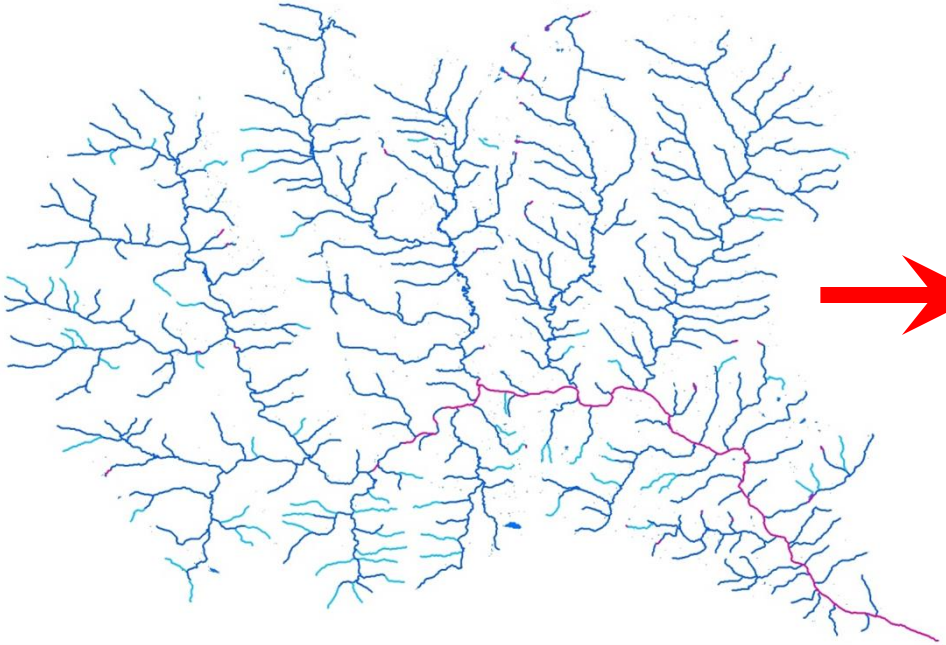


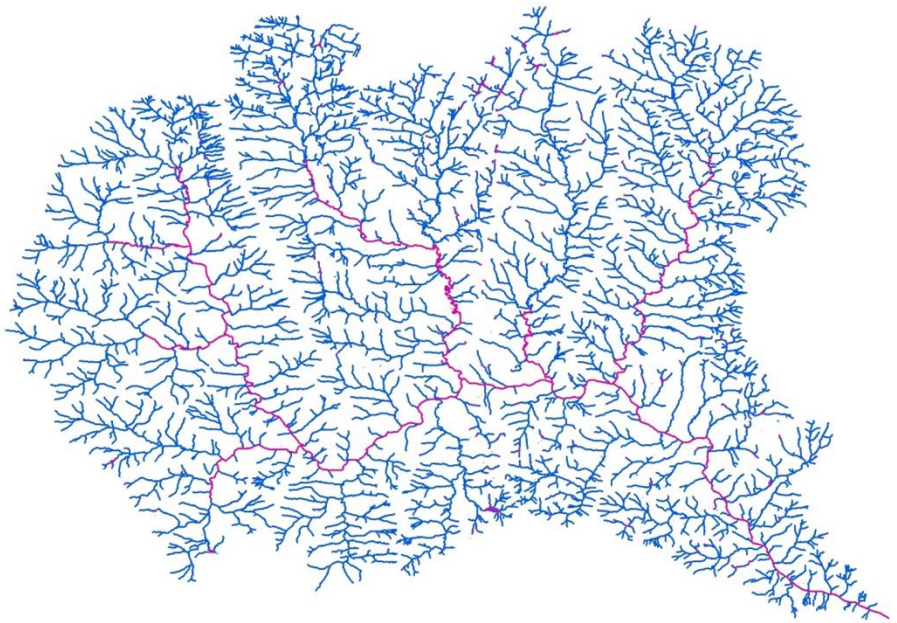
3D Elevation Program

Improving resolution and accuracy for hydrography

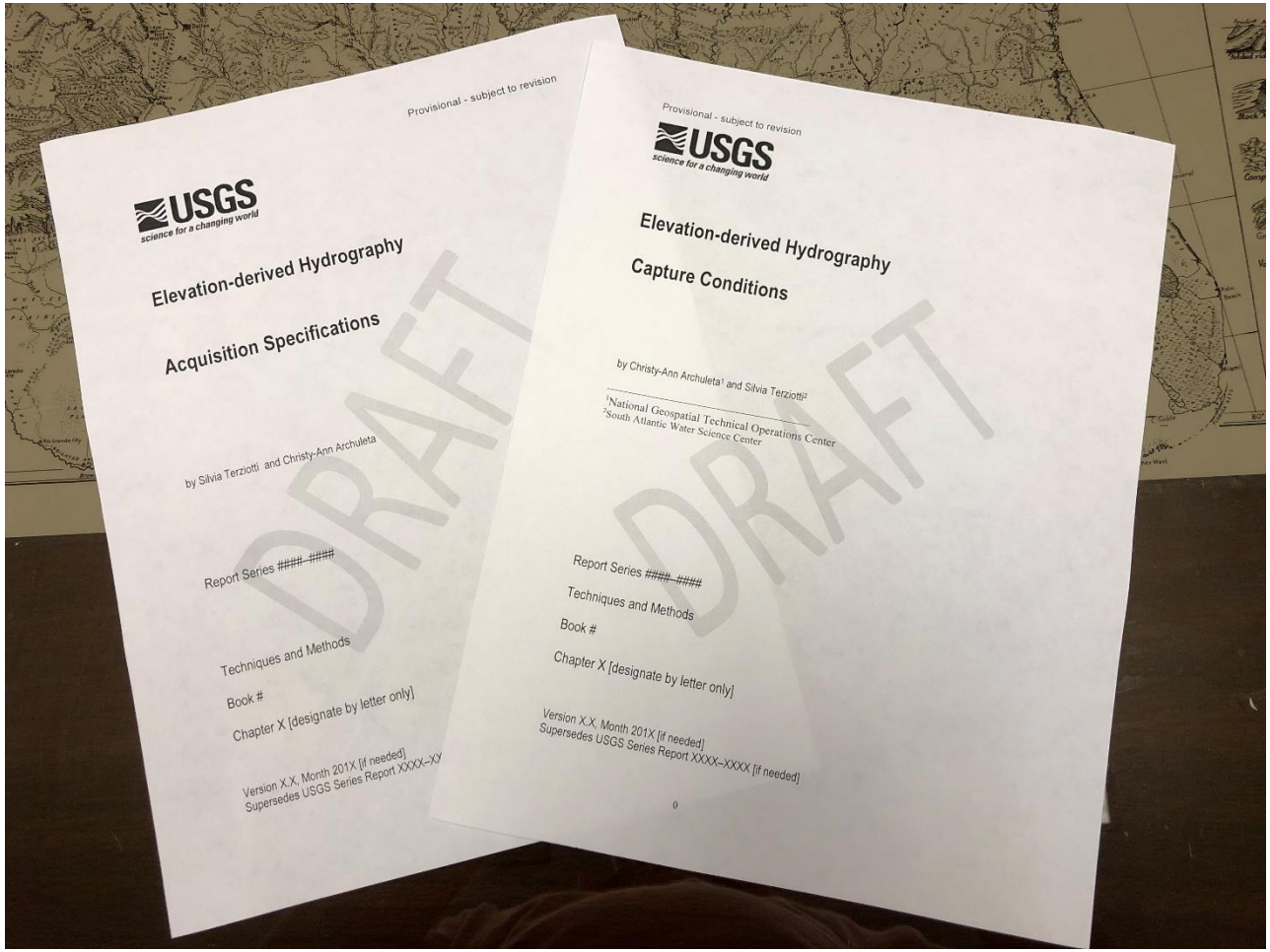






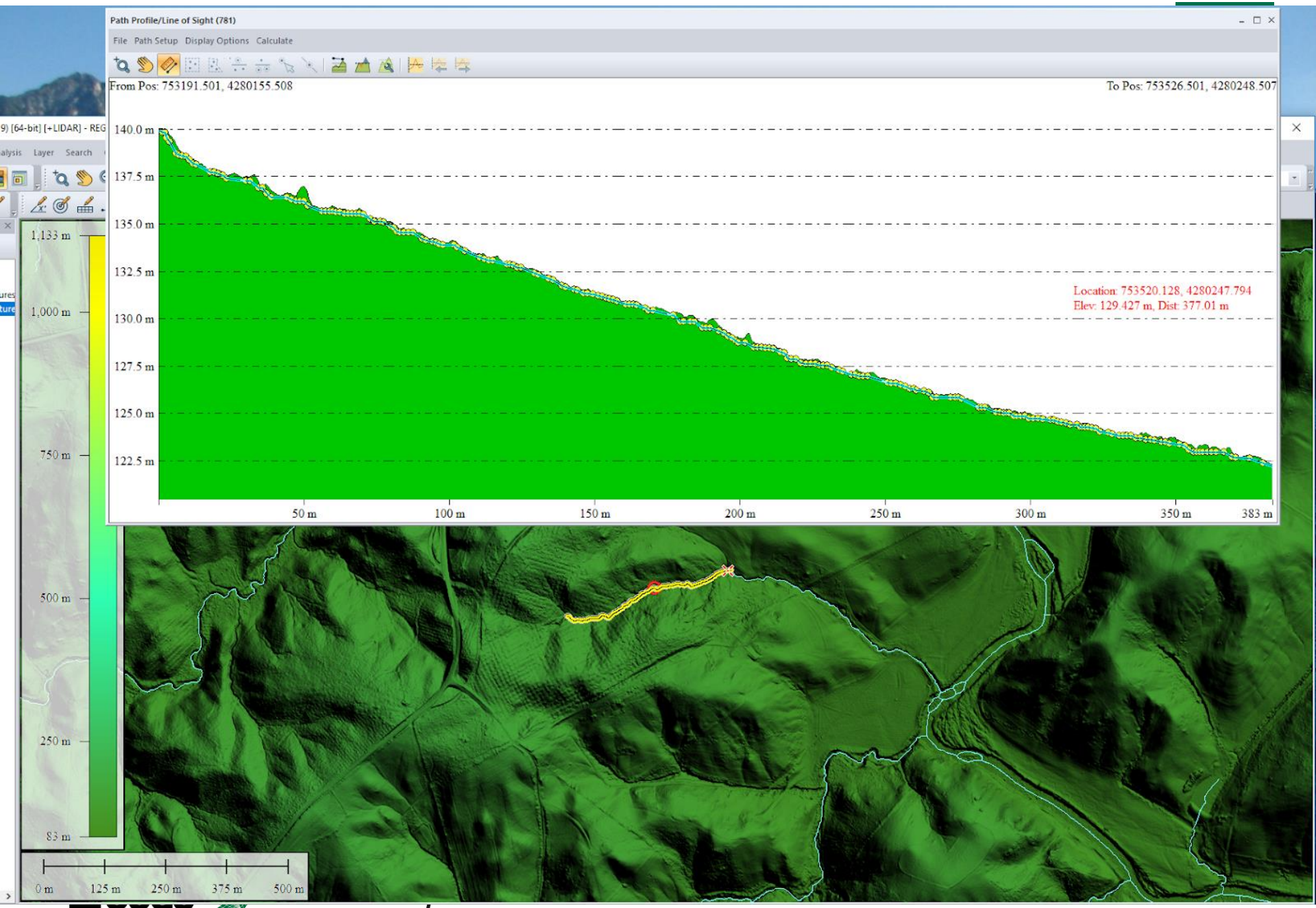


Capture conditions and acquisition specifications



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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File Path Setup Display Options Calculate
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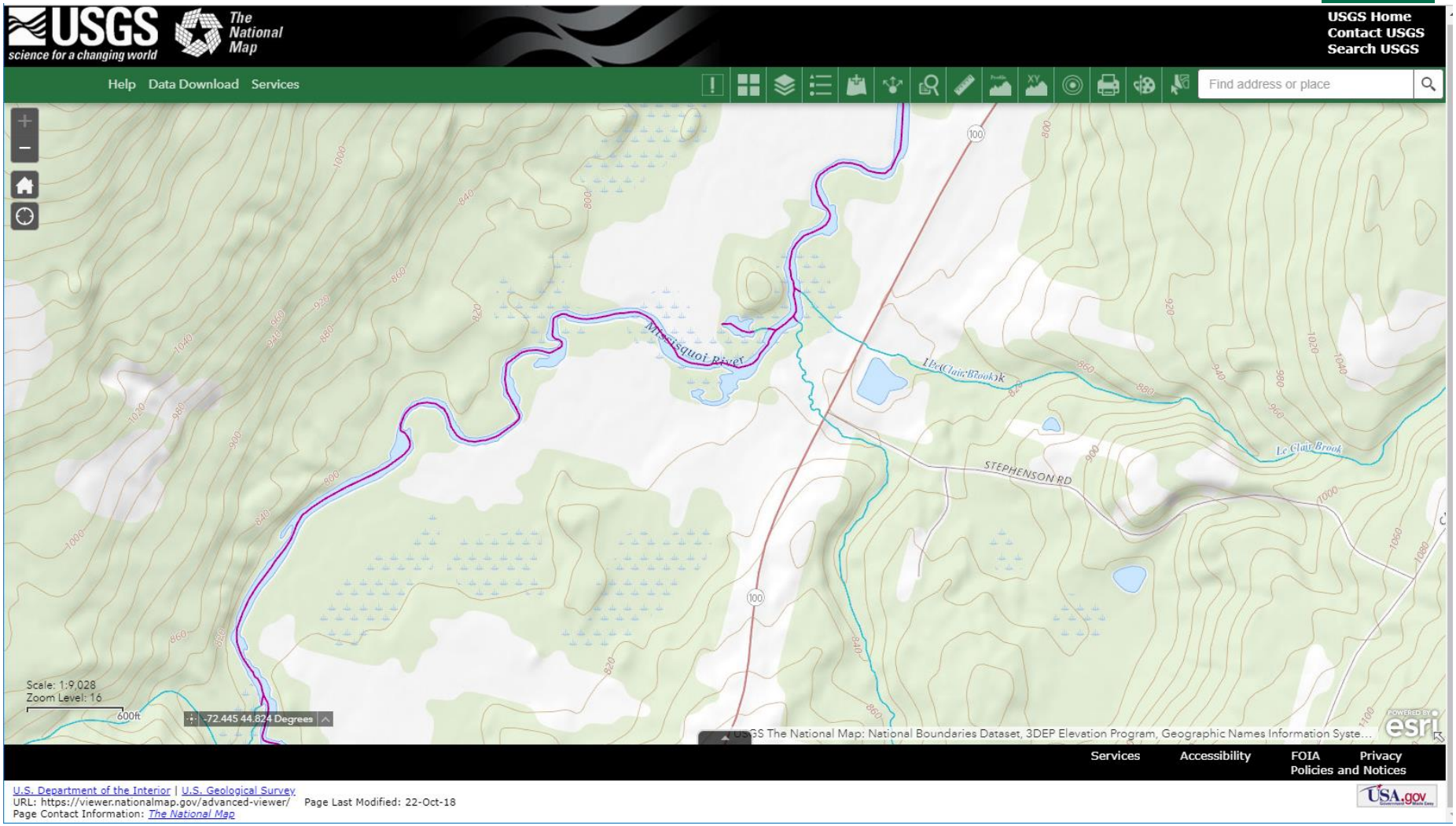
To Pos: 753526.501, 4280248.507
140.0 m
137.5 m
135.0 m
132.5 m
130.0 m
127.5 m
125.0 m
122.5 m
50 m
100 m
150 m
200 m
250 m
300 m
350 m
383 m
Location: 753520.128, 4280247.794
Elev: 129.427 m, Dist: 377.01 m
1,133 m
1,000 m
750 m
500 m
250 m
83 m
0 m
125 m
250 m
375 m
500 m

Integrating elevation and hydrography



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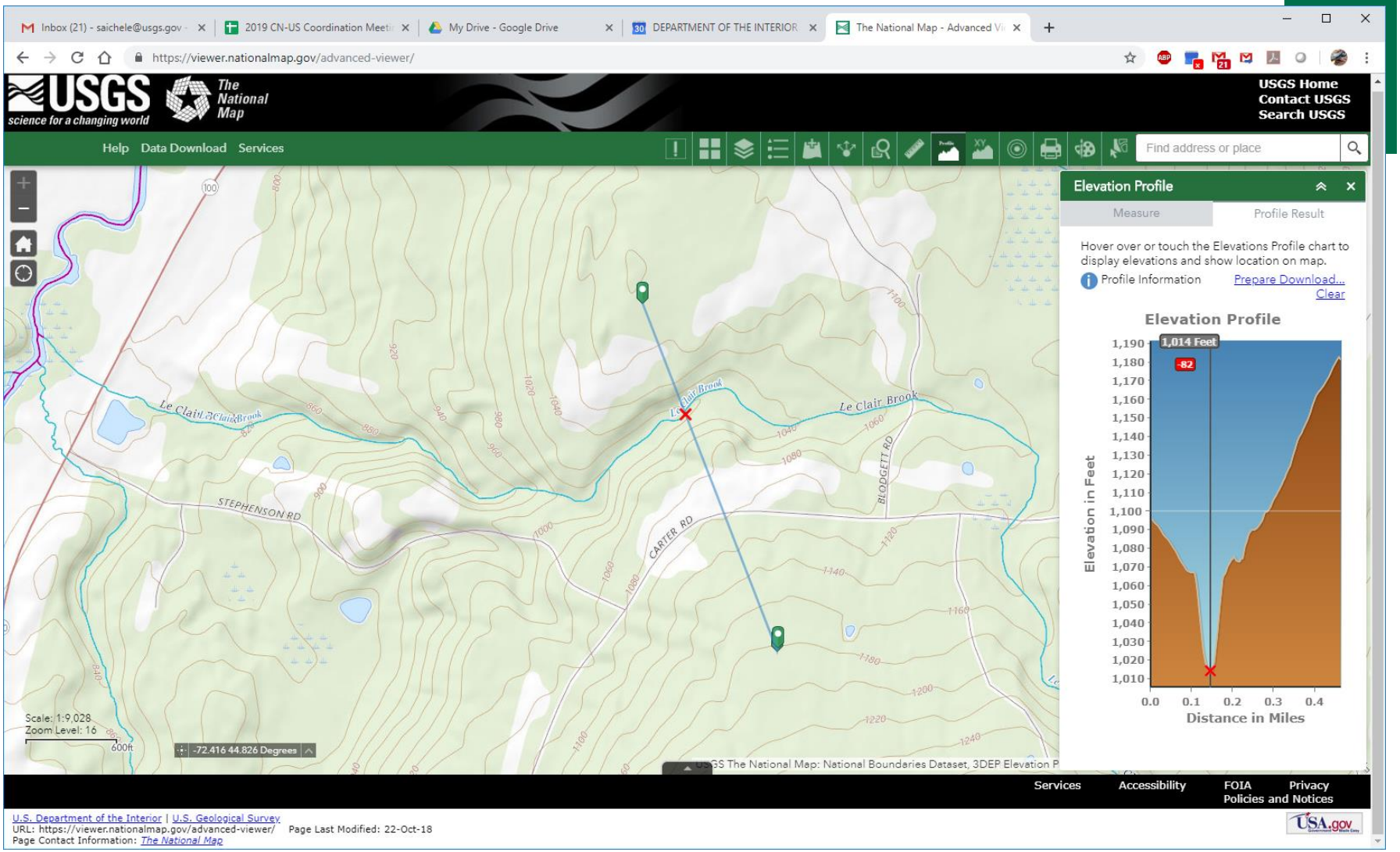
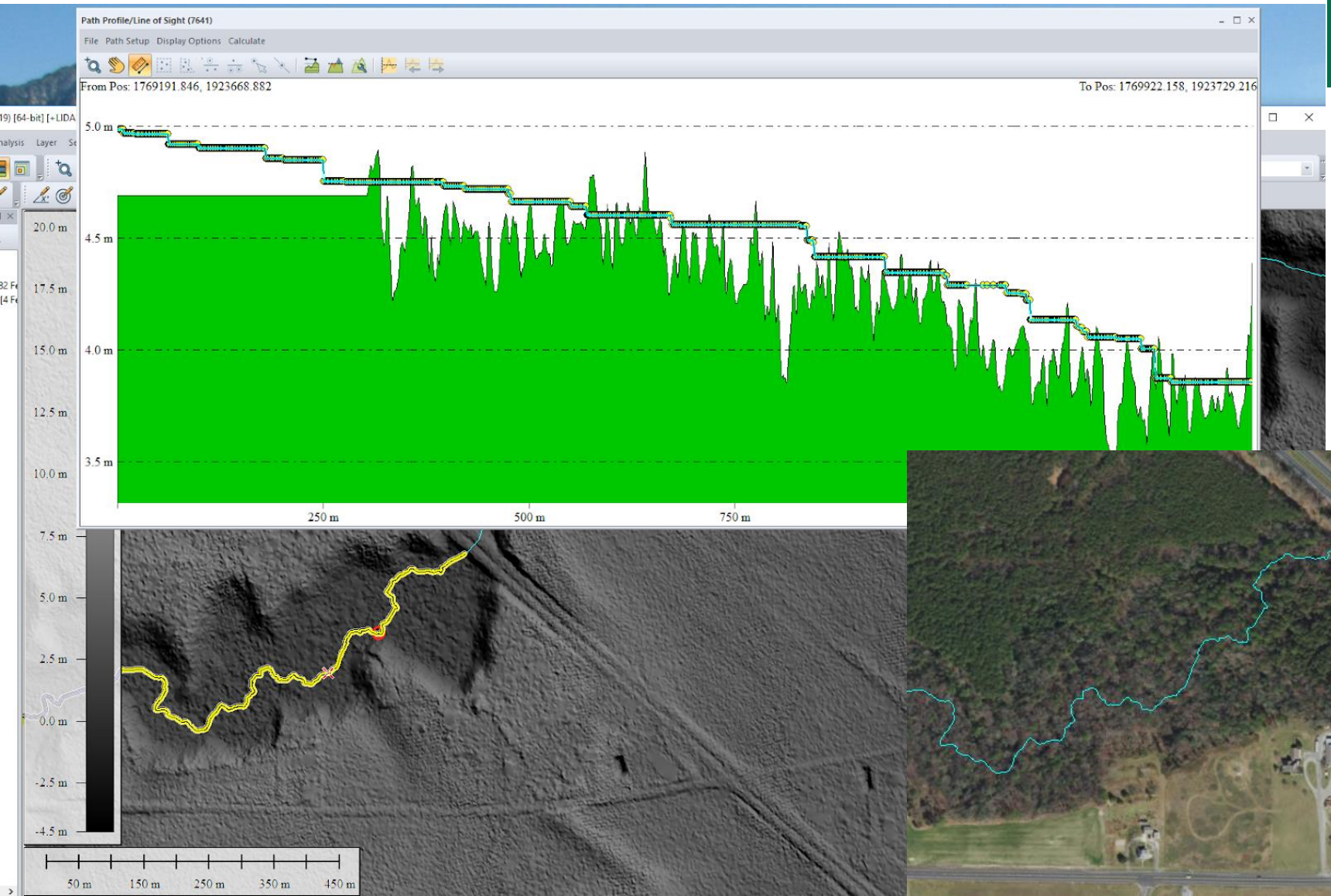
Integrating elevation and hydrography

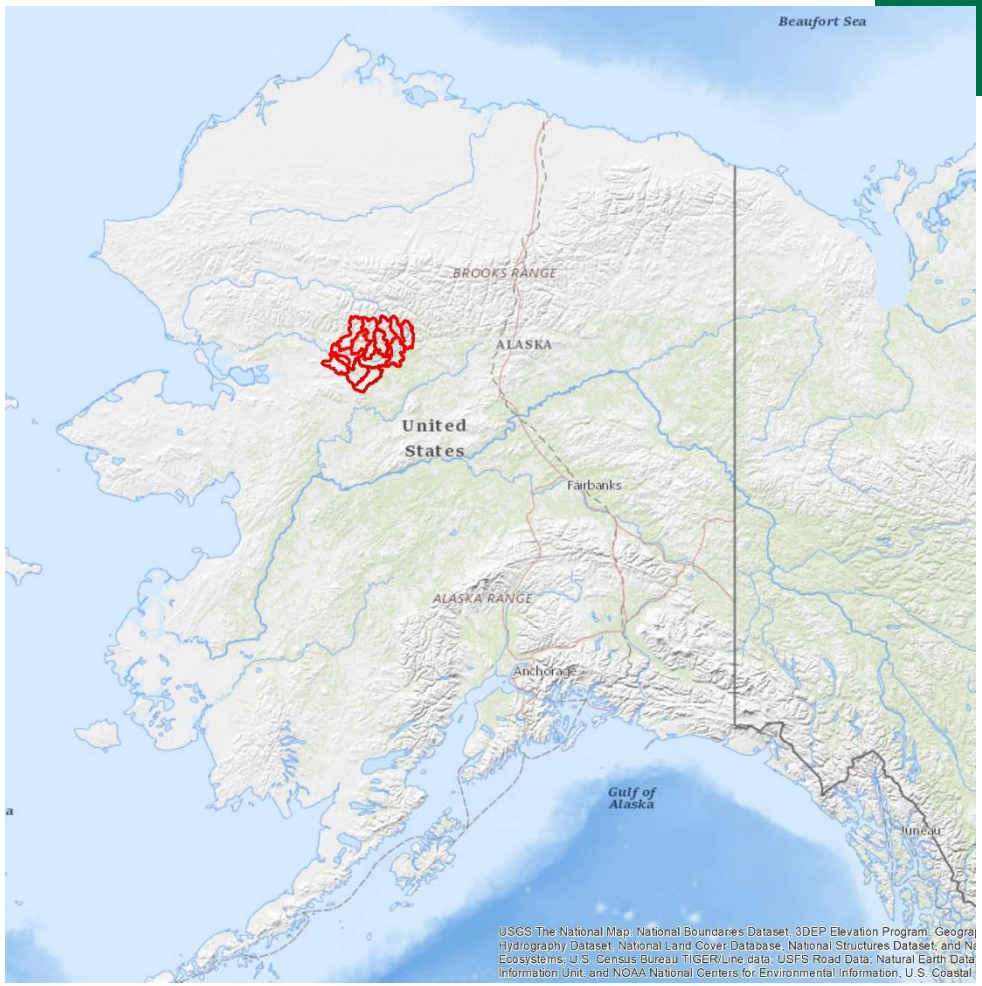


Keep the water below the lidar returns



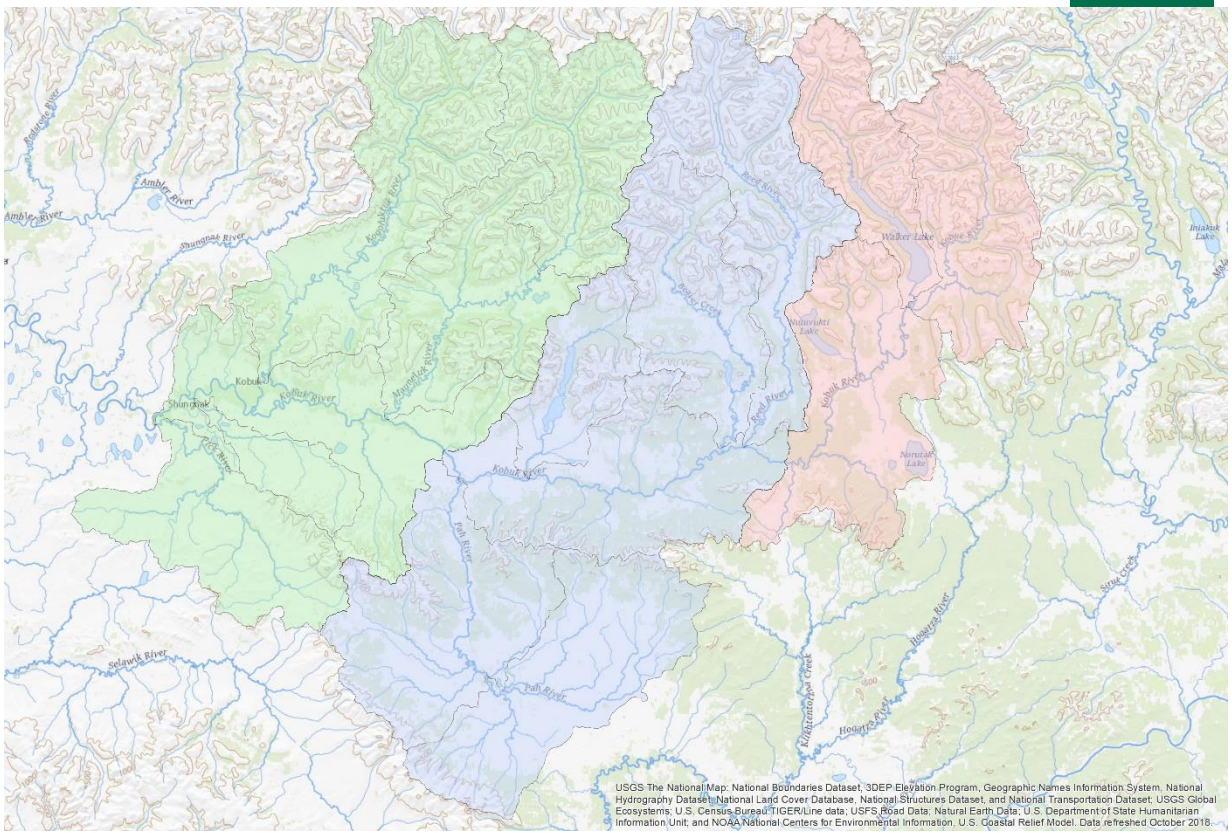
Alaska pilot projects

- 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



Alaska pilot detail

- Three AOIs
- Three contractors
- Monthly meetings between contractors and USGS staff to address issues and challenges
- Base task is to collect linework and apply a simple feature coding
- Deliveries spring 2020
- Operational 2021



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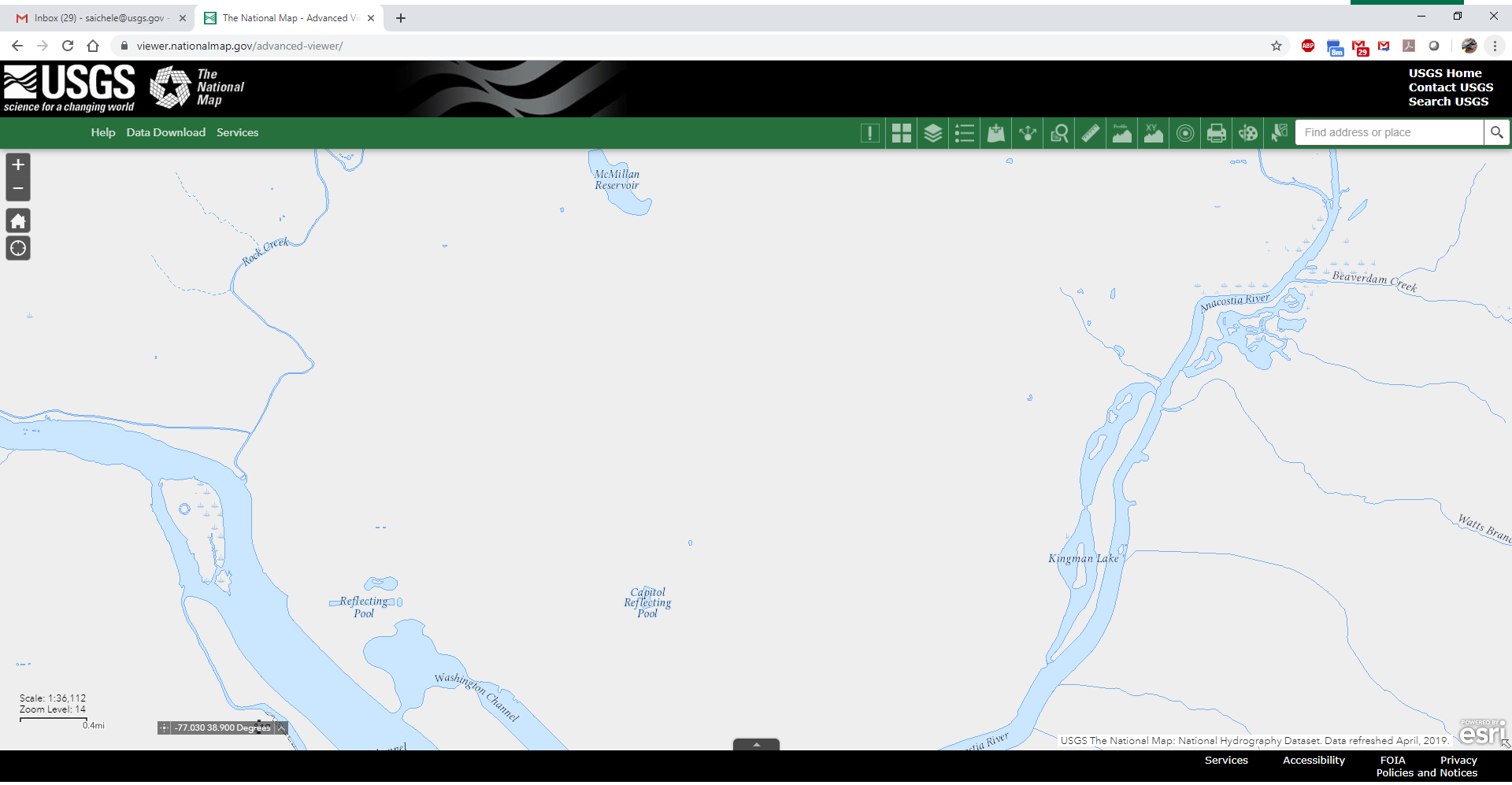
Washington DC – urban desert



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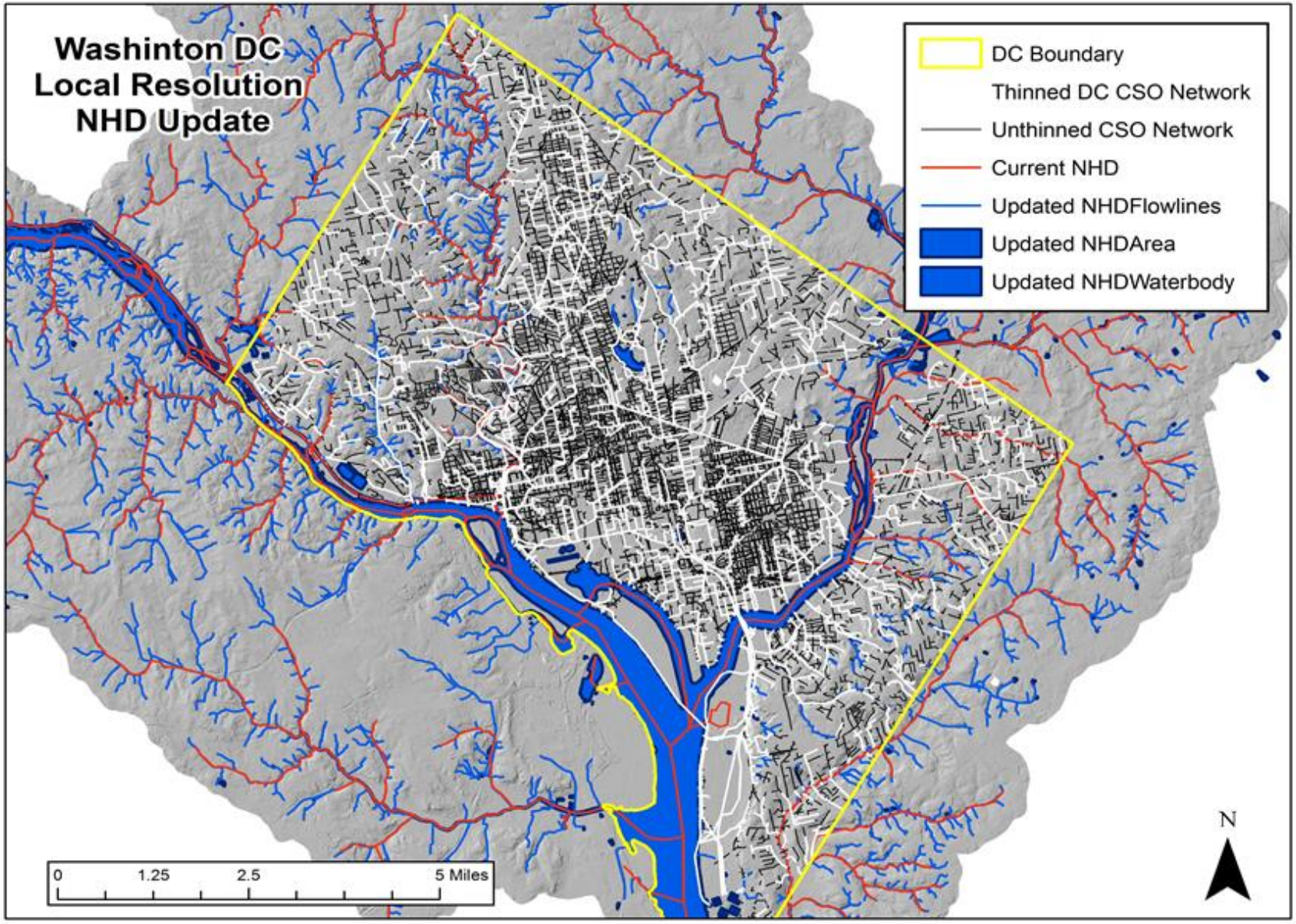
Urban hydrography

Little relation to land surface



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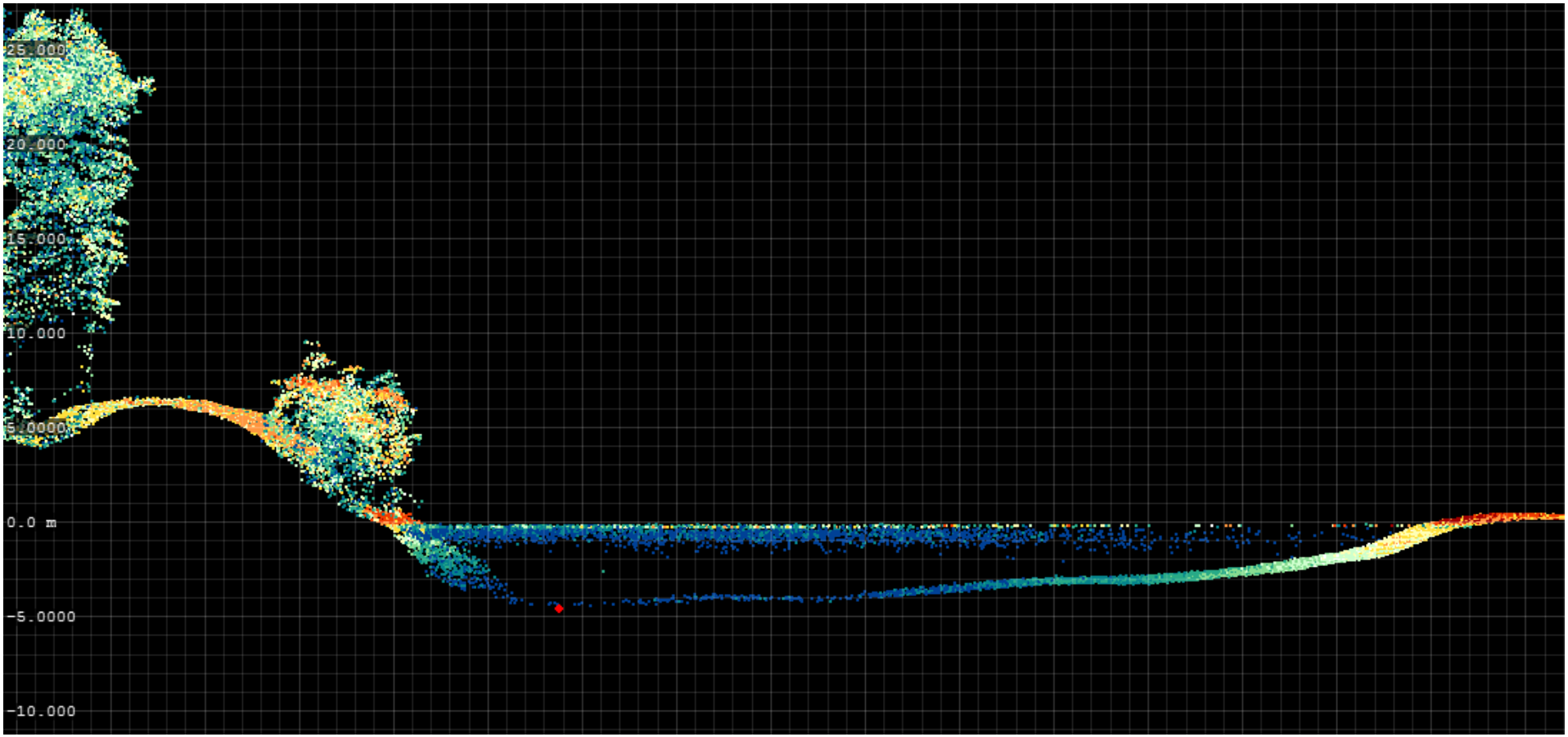
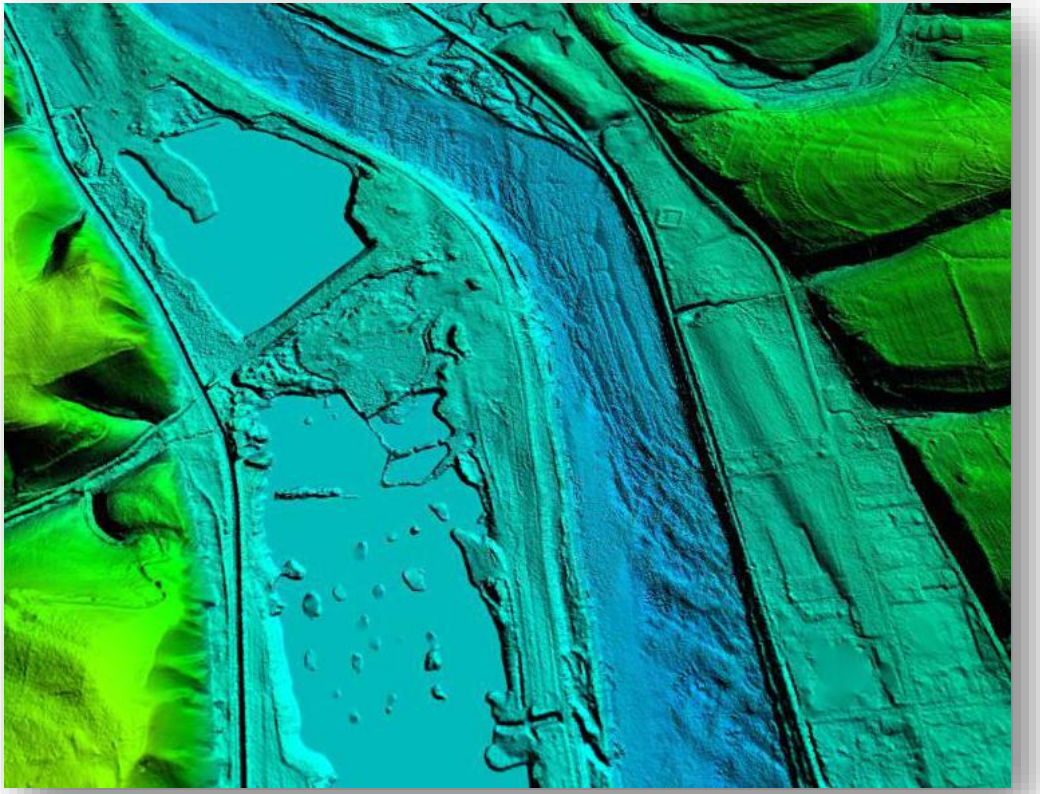
Bathymetric data



Emerging Technology

- 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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Integrate connection points to man-made hydrologic systems and groundwater to allow better accounting of the hydrologic cycle

5 INTEGRATE INLAND BATHYMETRY

National Terrain Model

- Extend elevation surface under water bodies
- Replace estimated flow volume with volume calculated from the mapped surface

6 REPEAT COVERAGE

4D National Terrain Model

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

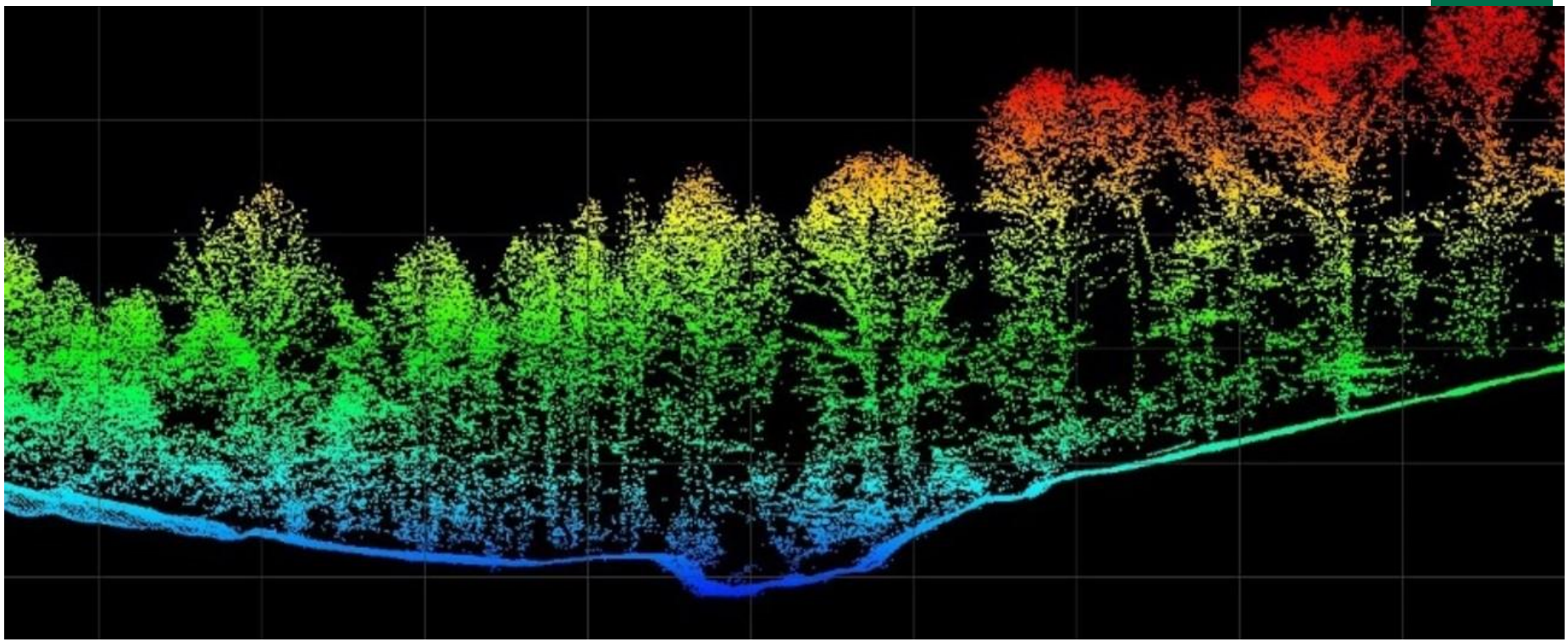
Enables 3D topographic maps and links with 3D geologic models to visualize data in new and unimagined ways ★★★★★

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 ★★★★★

Questions



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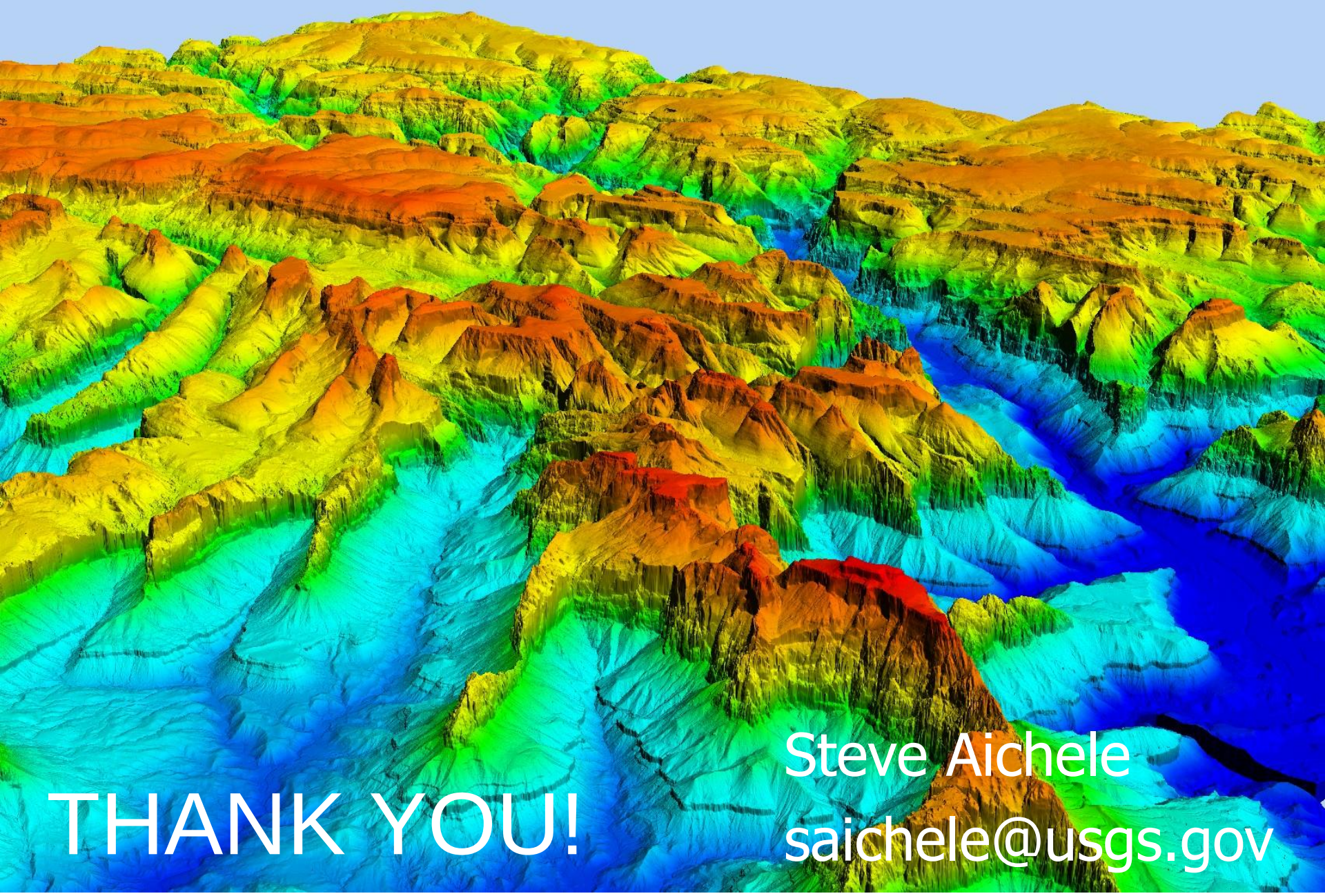
USGS science for a changing world

The National Map
Your Source for Topographic Information



THANK YOU!

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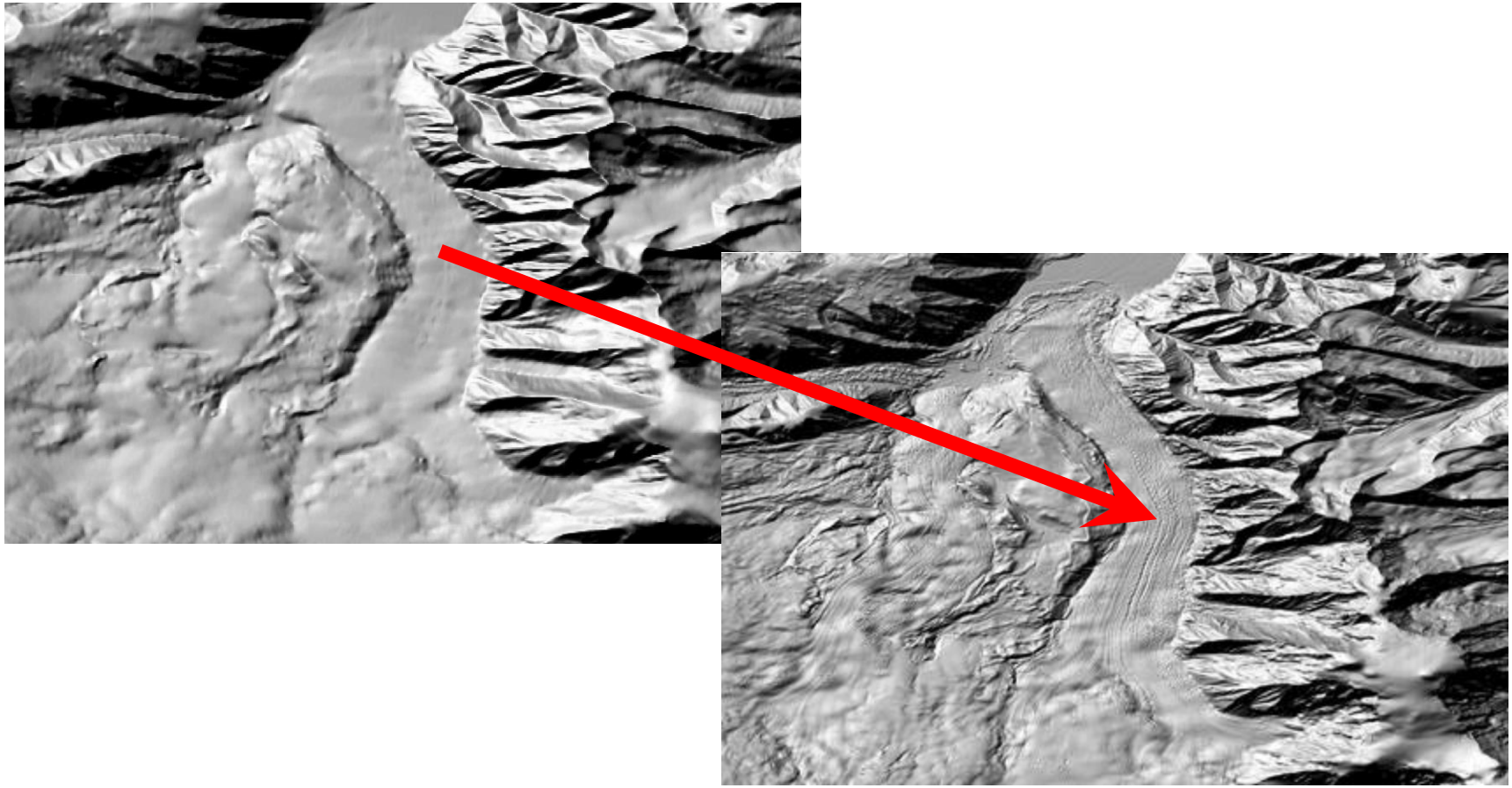
Zion National Park, UT

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

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