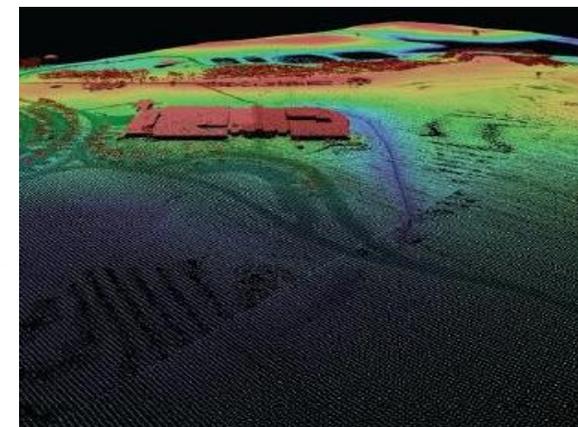
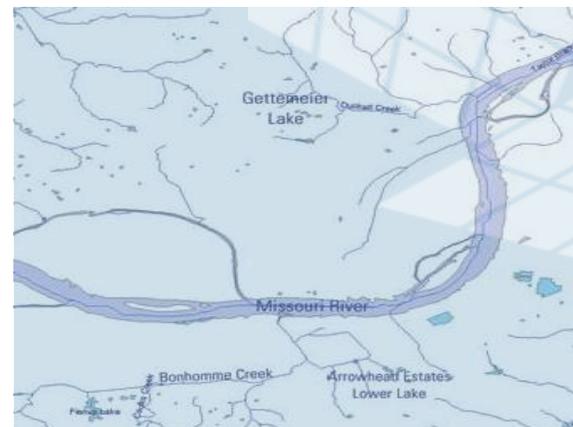
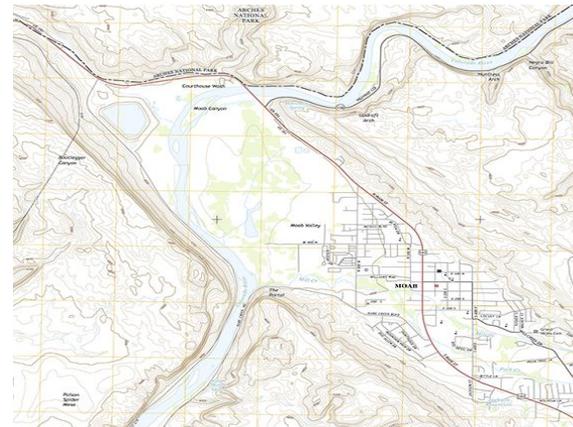




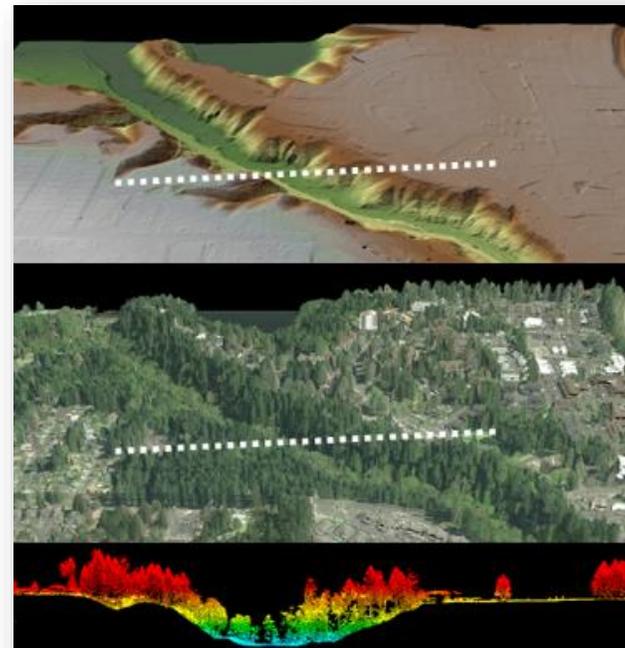
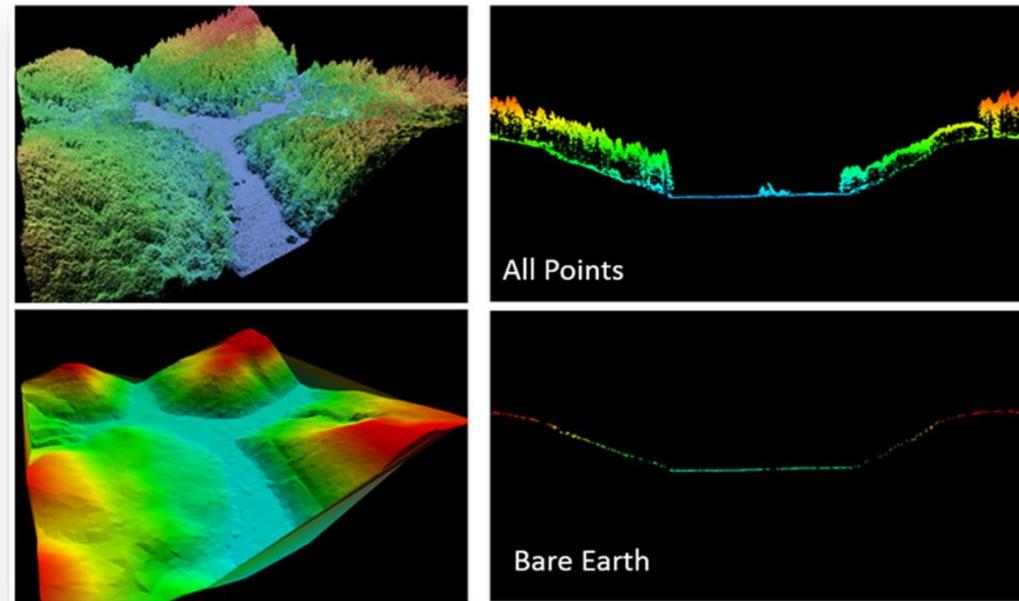
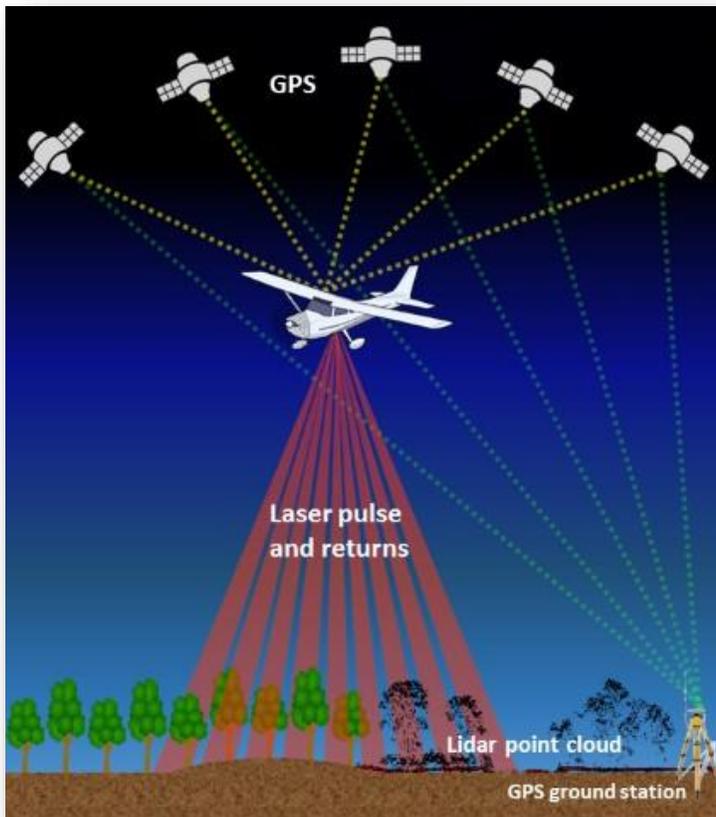
# 3D Elevation Program for the Task Force for Reviewing the Connectivity and Technology Needs of Precision Agriculture



Kevin T. Gallagher  
Associate Director, Core Science Systems  
Dec 17, 2020

# + What is Lidar?

Light Detection and Ranging (lidar) provides digital elevation (bare earth) and 3D models



- Bare earth DEM, colorized point cloud, and lidar profile in Olympia, WA.
- No current technology other than lidar supports the efficient production of highly accurate, 3D surface feature and bare earth models for nationwide coverage
- Stripping away vegetation on the DEM allows for detection of features that are not detectable using traditional imagery-based methods

# + 3D Elevation Program (3DEP) Goal

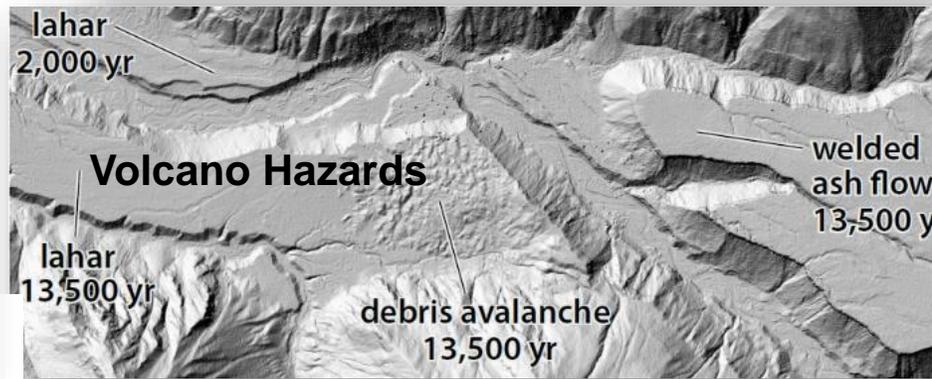
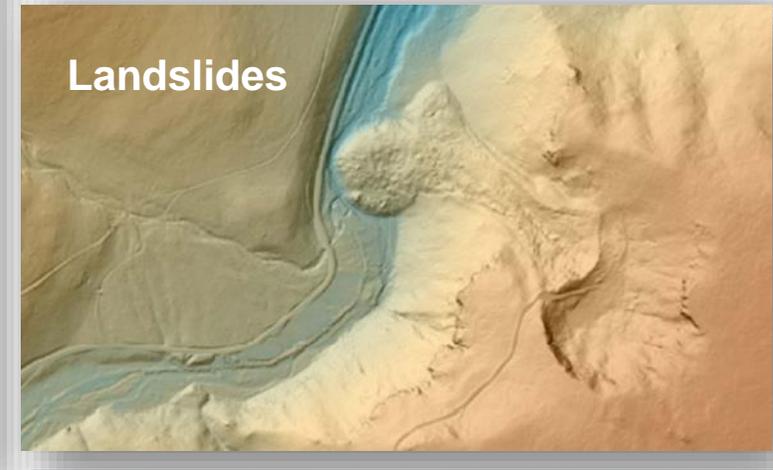
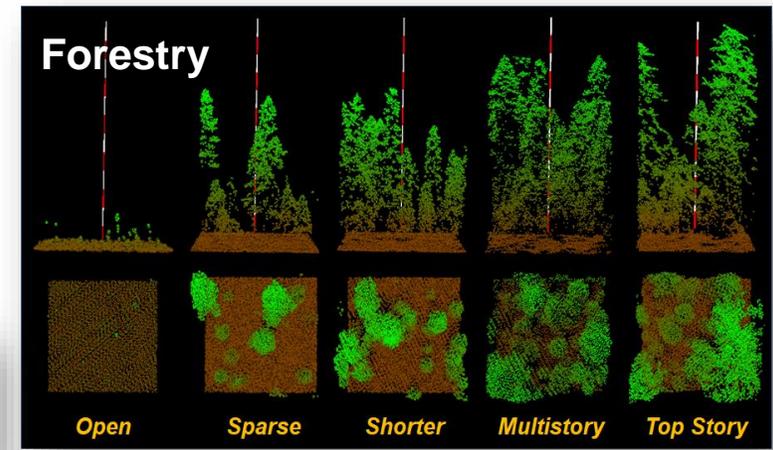
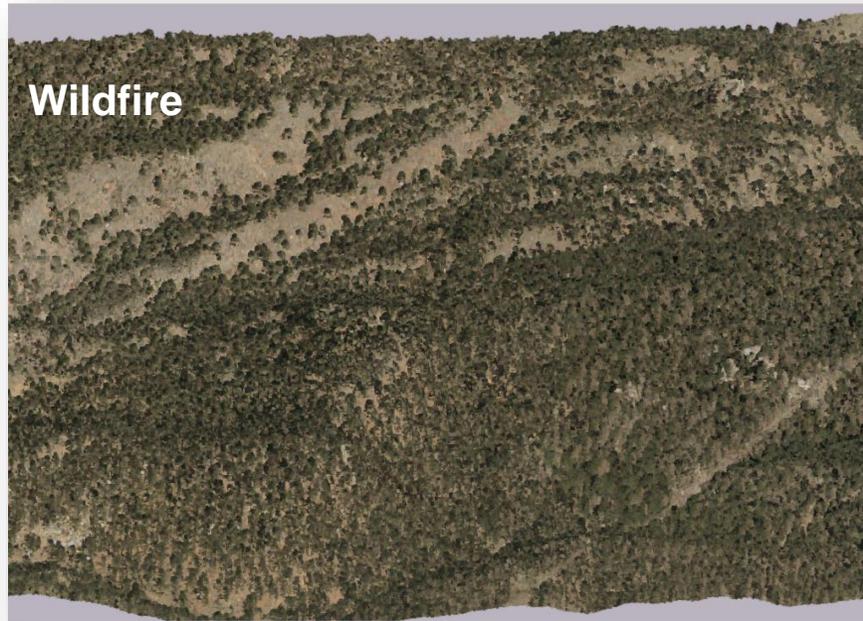
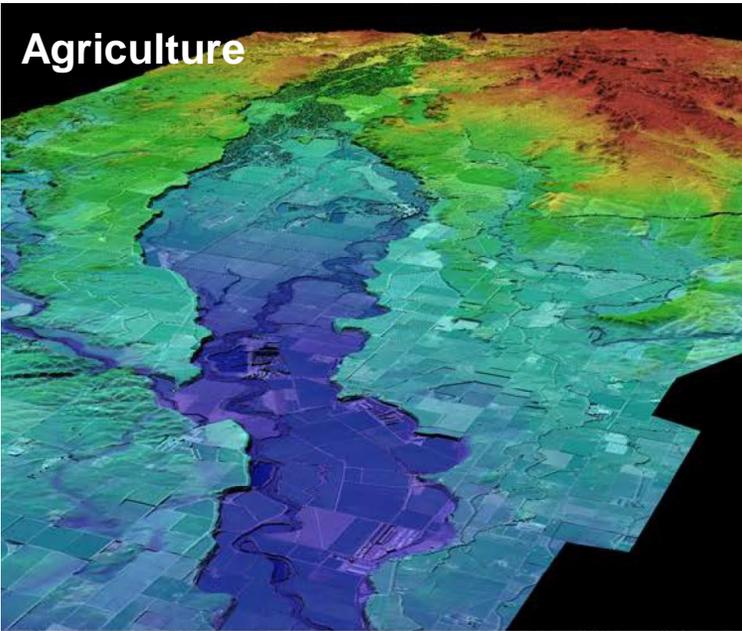
- Complete acquisition of nationwide lidar (IfSAR in AK) by 2023 to provide the **first-ever national baseline of consistent high-resolution elevation data – both bare earth and 3D point clouds – collected in a timeframe of less than a decade**
- Address Federal, state and other mission-critical requirements
- Realize ROI 5:1 and potential to generate \$13 billion/year
- Leverage the expertise and capacity of private mapping firms
- Achieve a 25% cost efficiency gain
- Completely refresh national data holdings

Rank	Business Use	Annual Benefits	
		Conservative	Potential
1	Flood Risk Management	\$295M	\$502M
2	Infrastructure and Construction Management	\$206M	\$942M
3	Natural Resources Conservation	\$159M	\$335M
4	Agriculture and Precision Farming	\$122M	\$2,011M
5	Water Supply and Quality	\$85M	\$156M
6	Wildfire Management, Planning and Response	\$76M	\$159M
7	Geologic Resource Assessment and Hazard Mitigation	\$52M	\$1,067M
8	Forest Resources Management	\$44M	\$62M
9	River and Stream Resource Management	\$38M	\$87M
10	Aviation Navigation and Safety	\$35M	\$56M
:			
20	Land Navigation and Safety	\$0.2M	\$7,125M
<b>Total for all Business Uses (1 – 27)</b>		<b>\$1.2B</b>	<b>\$13B</b>



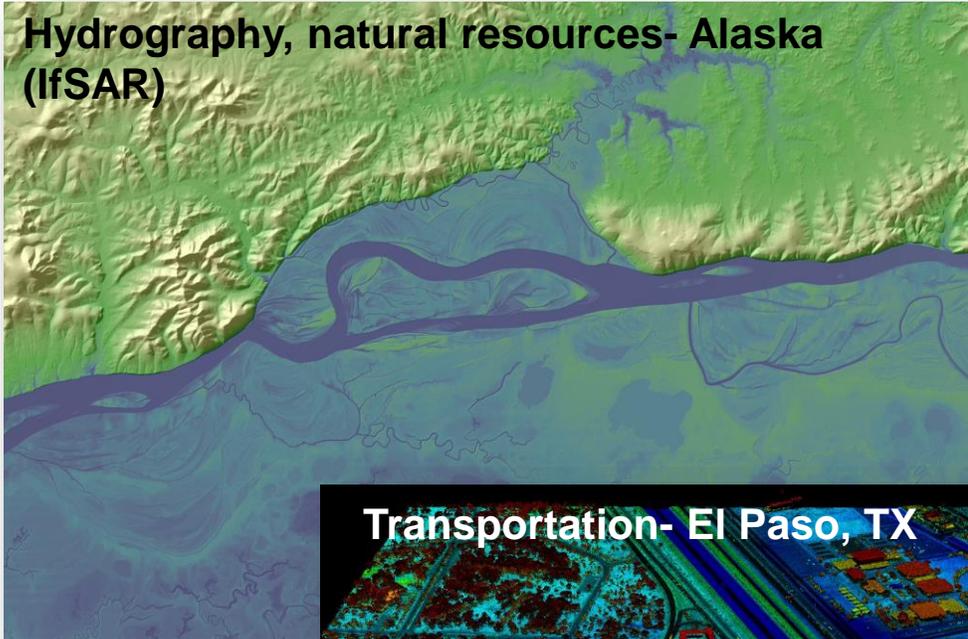
# + 3D Elevation Program (3DEP)

Lidar supports a broad range of applications

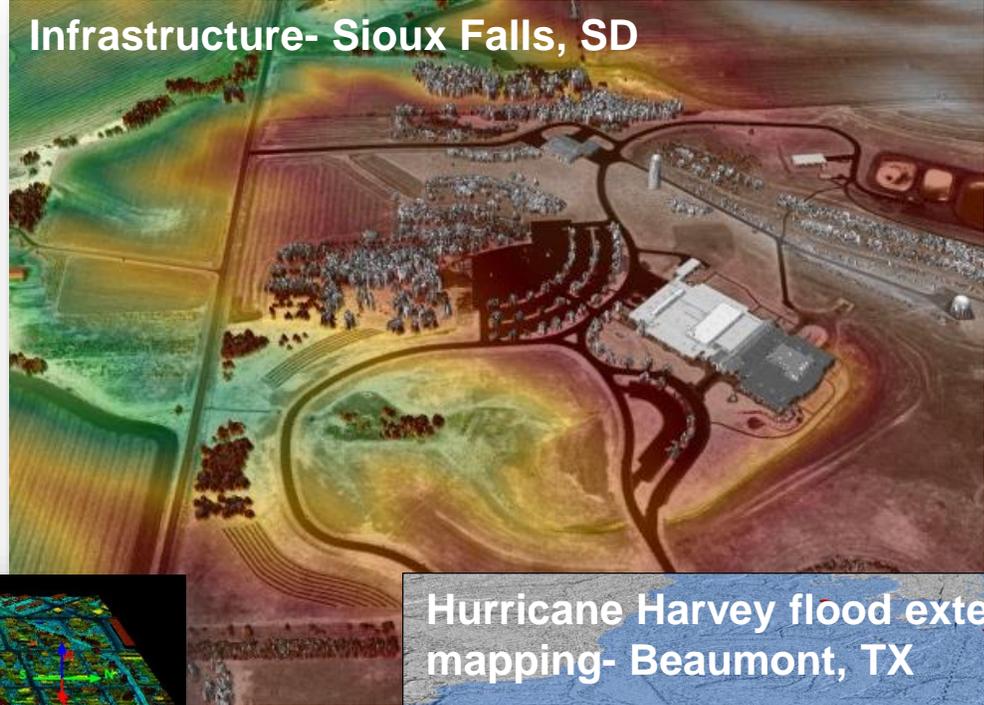


# + 3DEP Lidar Applications

Hydrography, natural resources- Alaska (IfSAR)



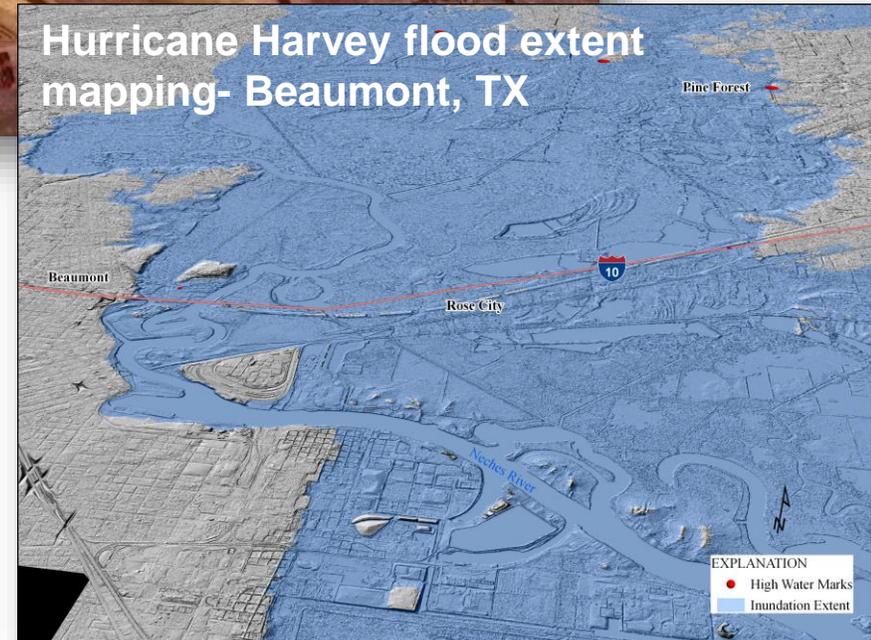
Infrastructure- Sioux Falls, SD



Transportation- El Paso, TX



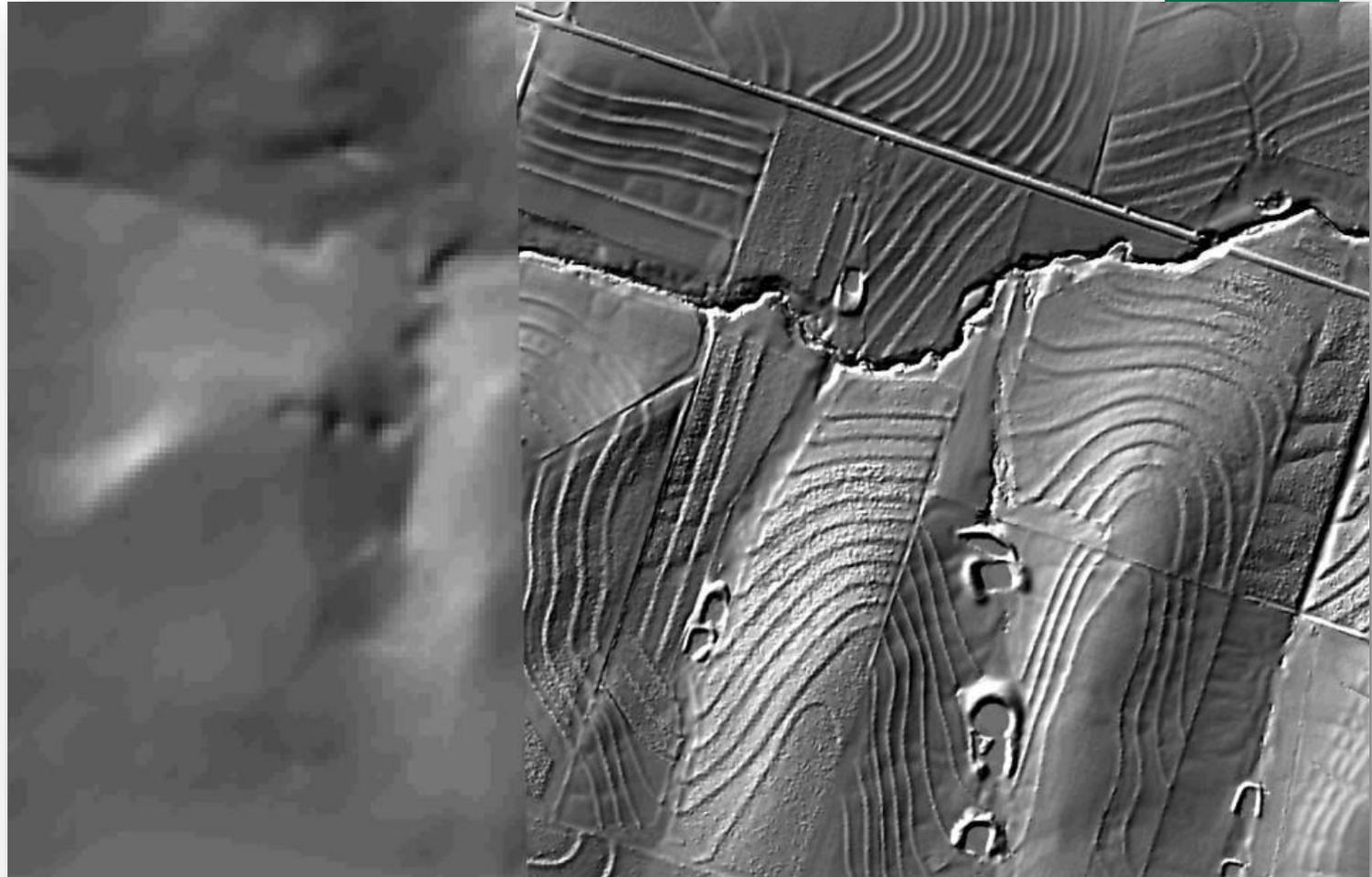
Hurricane Harvey flood extent mapping- Beaumont, TX



# + Uses of 3DEP data in Agriculture

## Improved Data Quality with 3DEP

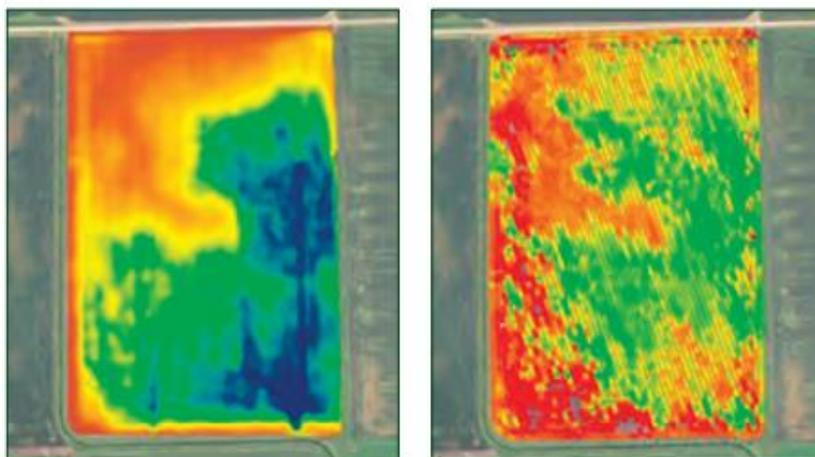
- Prescription application of seed, fertilizer, water, pesticides, and herbicides
- Farm pond design
- Farm contour design
- Tribal, State, and local government farmland program management
- Farmland suitability analysis
- Drainage analysis
- Conservation planning
- Mapping of floodplains, cultural resources, wetlands, grasslands, forests, and wildlife habitat



# + Benefits to the Agriculture Industry

Improved cropland management and farming practices with 3DEP

- Increased crop yield
- Decreased crop losses due to flooding or poor site design
- Improved compliance for the application of regulated chemicals
- Reduced design costs for farm ponds and other farm infrastructure
- Conservation of critical natural resources and habitats



Business use	Conservative annual benefit (million dollars)
Agriculture and precision farming	122
Natural resources conservation	159
Forest resources management	44
River and stream resource management	38
Wildlife and habitat management	2
<b>Total</b>	<b>365</b>

The image on the lower left shows lidar elevations, and the image on the lower right shows farm yield. The top photograph shows a tractor equipped with a Global Positioning System (GPS) and precision agriculture equipment, allowing for the precise application of seeds and chemicals. Images courtesy of J.R. Simplot Company.

# + 3DEP for Broadband

Lidar for permitting, design and siting broadband infrastructure

- Line-of-sight analyses for signal propagation studies
- Identification of the optimum locations and heights for cell tower networks
- Modeling the potential clutter impacts to wireless signals of future development and vegetation growth
- Mapping existing towers and designing and permitting new infrastructure

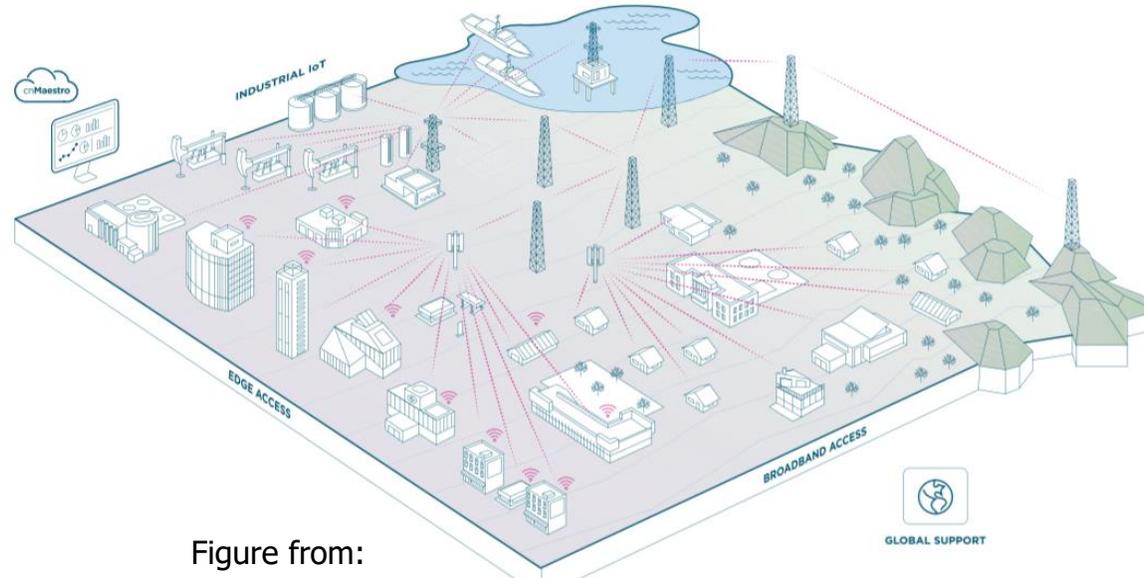
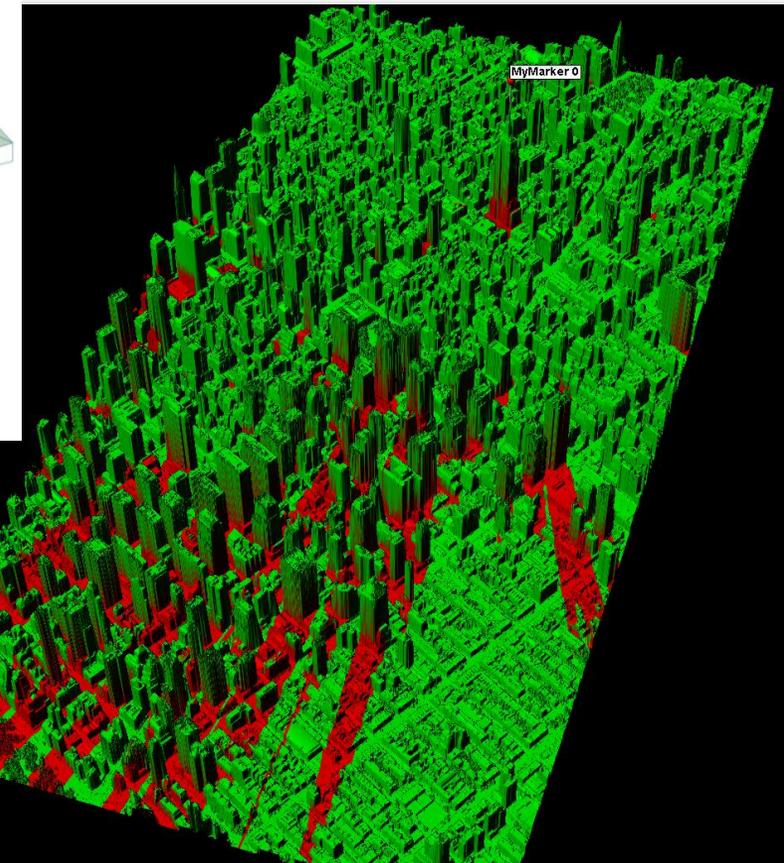


Figure from:





# Viewshed Analyses Based on 3DEP Lidar

Viewshed Layers Places

Settings

Cell Size  meters

Analysis Distance  meters

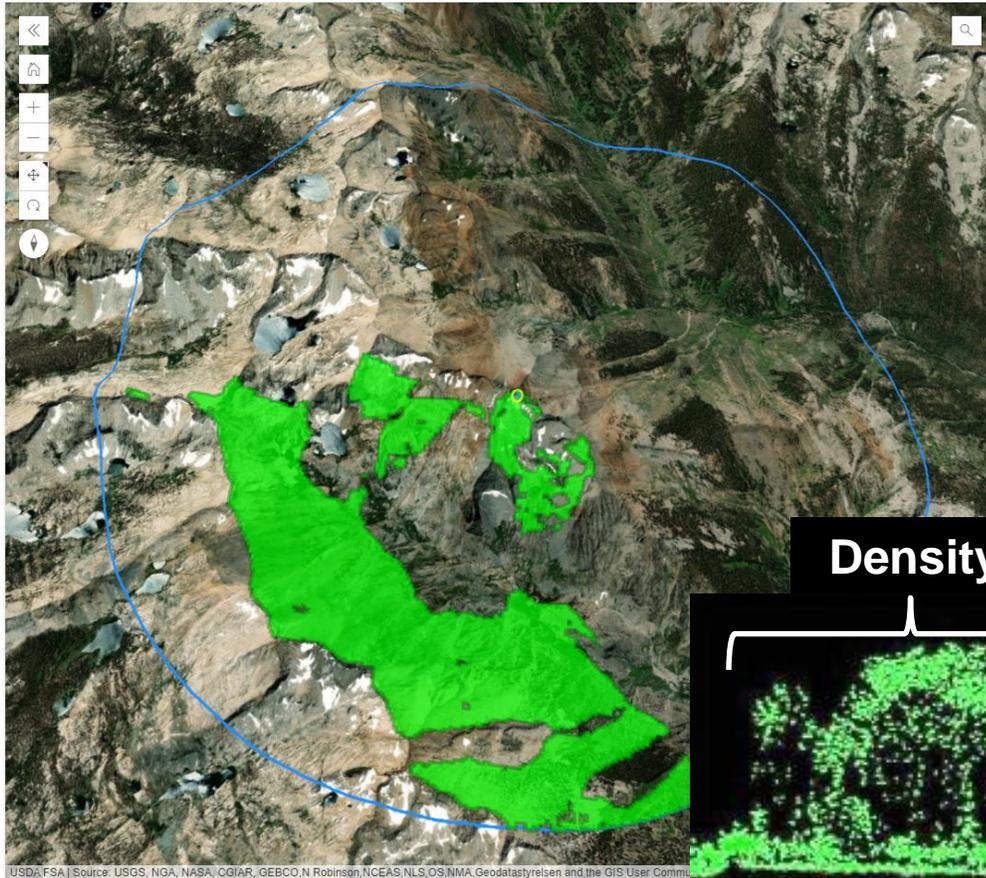
Observer Offset  meters

Viewshed Analysis

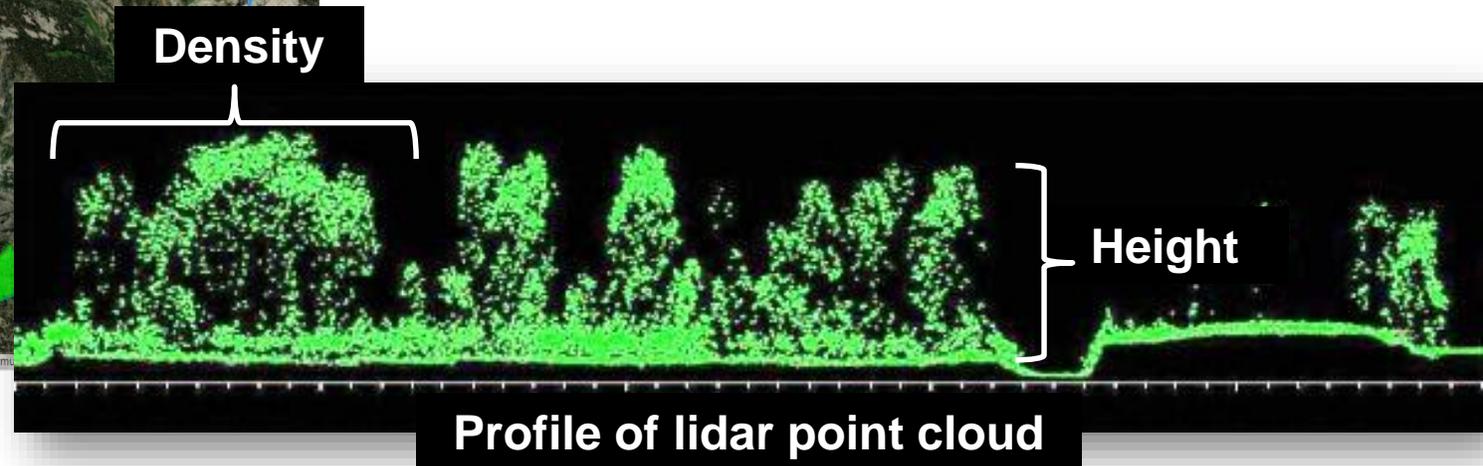
[location](#) [path](#) [route](#) [clear](#)

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Lidar maps clutter in 3D (buildings, bridges vegetation, etc.) and terrain that can attenuate broadband signals



# + FCC Preliminary Requirements and Benefits

## 3D Nation Requirements and Benefits Study Results

### ■ Requirements

- Quality Level 1 level data will be crucial in performing propagation modeling and analysis of radiofrequency spectrum usage because the behavior of radio waves depends on the topology (clutter) as well as the underlying terrain
- Having more accurate lidar information will result in higher confidence in the modeling results

### ■ Benefits

- The ability to provide simplified, consistent, and reliable processes for radiofrequency spectrum usage and interference analyses
- Better spectrum management, frequency coordination, and licensing of non-federal radio communications facilities will be possible when using accurate and consistent higher resolution elevation data nationwide
- More accurate and reliable propagation studies by can be performed by applicants for radio licenses
- Simpler and quicker approvals will be possible when the FCC and applicants all use the same nationwide coverage. As consequence, better use will be made of the spectrum, benefitting all who use broadband services for improved productivity and competitiveness



# Broadband Deployment Accuracy and Technological Availability (DATA) Act

## Public Law No: 116-130 (03/23/2020)

- This bill requires the FCC to change the way broadband data is collected, verified, and reported
- Specifically, the FCC must collect and disseminate granular broadband service availability data (broadband maps) from wired, fixed-wireless, satellite, and mobile broadband providers. To do this, the FCC is required to establish the Broadband Serviceable Location Fabric (a dataset of geocoded information for all broadband service locations, atop which broadband maps are overlaid) as the vehicle for reporting broadband service availability data
- Requires consultation with the Federal Geographic Data Committee established under section 753(a) of the Geospatial Data Act of 2018 to **coordinate mapping**

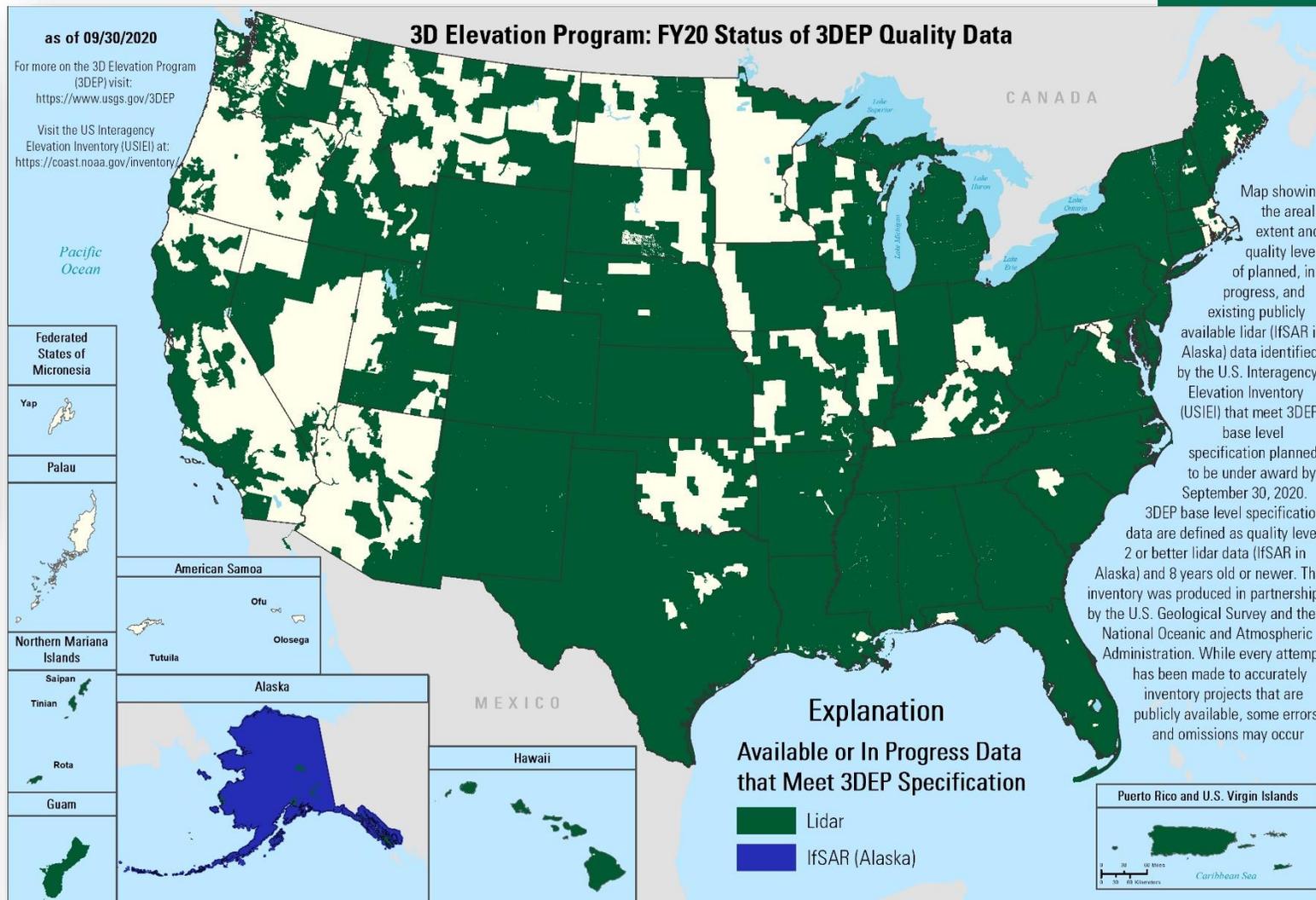
# + 3DEP Status

Data are available or in progress for 77% of the Nation

\*includes lidar and AK IfSAR



Data acquisition investments by all partners, by fiscal year





# 3DEP Operational Infrastructure

## Supporting Partner Needs

- **Broad Agency Announcement** - Fair and equitable process for non-Feds to partner with Federal Agencies, announced on FedBizOpps.gov and grants.gov
- **Geospatial Products and Services Contracts (GPSC)**
  - Preferred method for acquiring 3DEP data because it ensures quality and consistency of data
  - Value added service – GPSC staff coordinate partnership funding; handle contracting; provide project planning, tracking, and management; and provide quality review and delivery
- **US Interagency Elevation Inventory** – Co-managed with NOAA to ensure all publicly available lidar is discoverable and to avoid duplication
- **USGS Lidar Base Specification** – Ensures consistent data across multiple sources
- **The National Map** - Data delivered free to the public via The National Map website



# + Ensuring 3DEP Accuracy

- Professional Land Surveyors from the mapping firms independently record high-precision GPS field coordinates in vegetated and non-vegetated areas
- The mapping firms provide survey reports comparing ground to lidar values and USGS validates those calculations using ASPRS accuracy standards
- The pass/fail metrics for multiple quality levels are documented in our lidar base specification
- Note that we currently only test vertical accuracy for bare earth; we are researching how to assess horizontal accuracy and accuracy of the lidar point cloud

Courtesy TerraSurv/Fugro Geospatial  
 SW South Dakota LiDAR GCP 17079



**Table 4. Absolute vertical accuracy for light detection and ranging data and digital elevation models.**

[QL, quality level; RMSE<sub>z</sub>, root mean square error in the z direction; NVA, nonvegetated vertical accuracy; VVA, vegetated vertical accuracy; m, meter; ≤, less than or equal to]

Quality level	RMSE <sub>z</sub> (nonvegetated) (m)	NVA at the 95-percent confidence level (m)	VVA at the 95th percentile (m)
QL0	≤0.050	≤0.098	≤0.15
QL1	≤0.100	≤0.196	≤0.30
QL2	≤0.100	≤0.196	≤0.30
QL3	≤0.200	≤0.392	≤0.60

+

3DEP PARTNERS

Since FY15, 3DEP has partnered with  
more than 300 Federal, State, Tribal, and  
**THANK YOU TO ALL OUR**  
private entities  
**PARTNERS!**

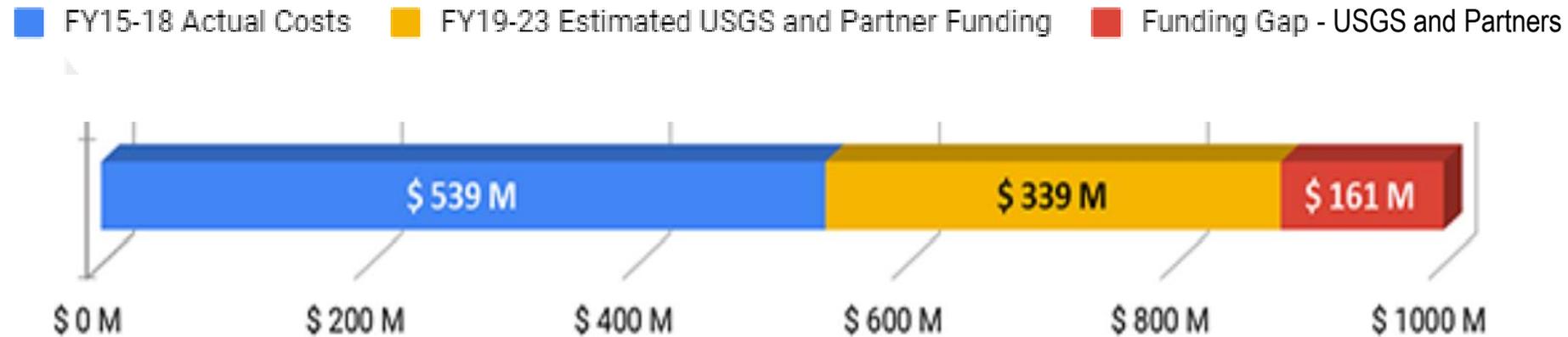
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**3DEP COALITION** includes more than 50 organizations

3DEP COALITION

# 3DEP Goal to Complete Acquisition by 2023

## Estimated Funding Gap

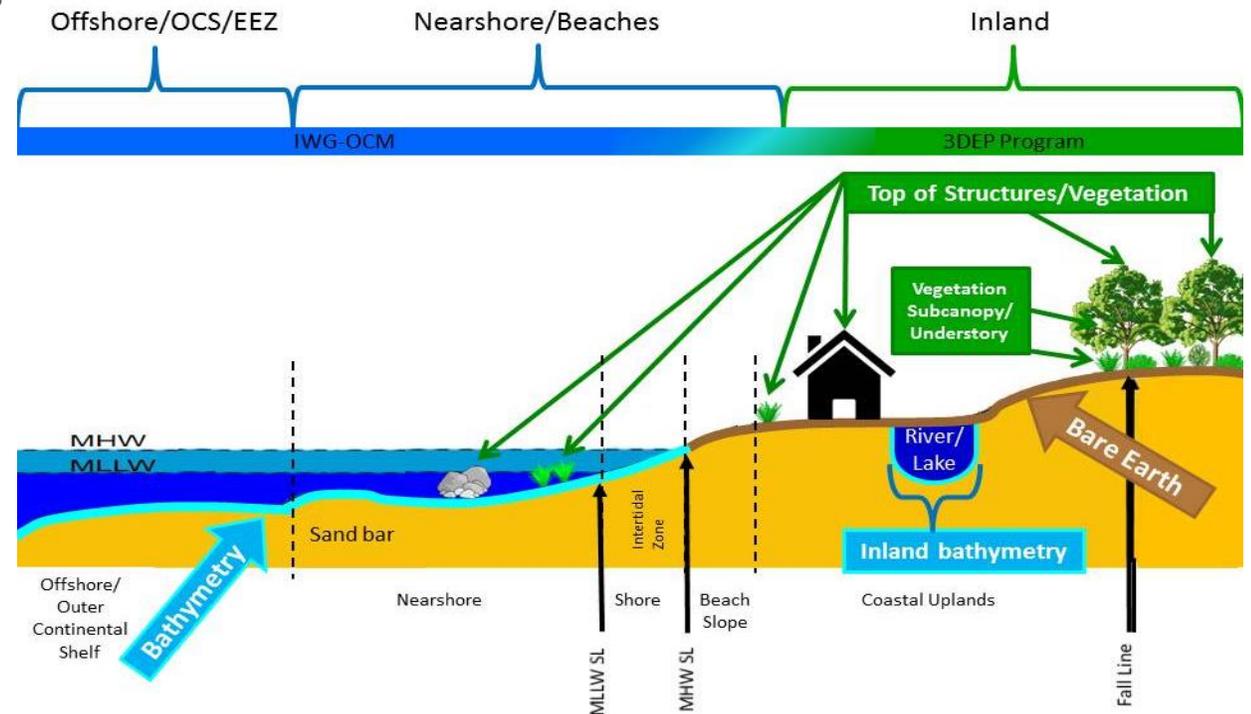
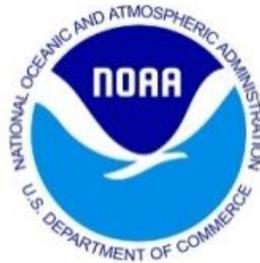


Total estimated program cost and funding gap to complete nationwide 3D Elevation Program data acquisition by 2023

# + 3DEP Future Generation Just Around the Corner

## 3D Nation Elevation Requirements and Benefits Study

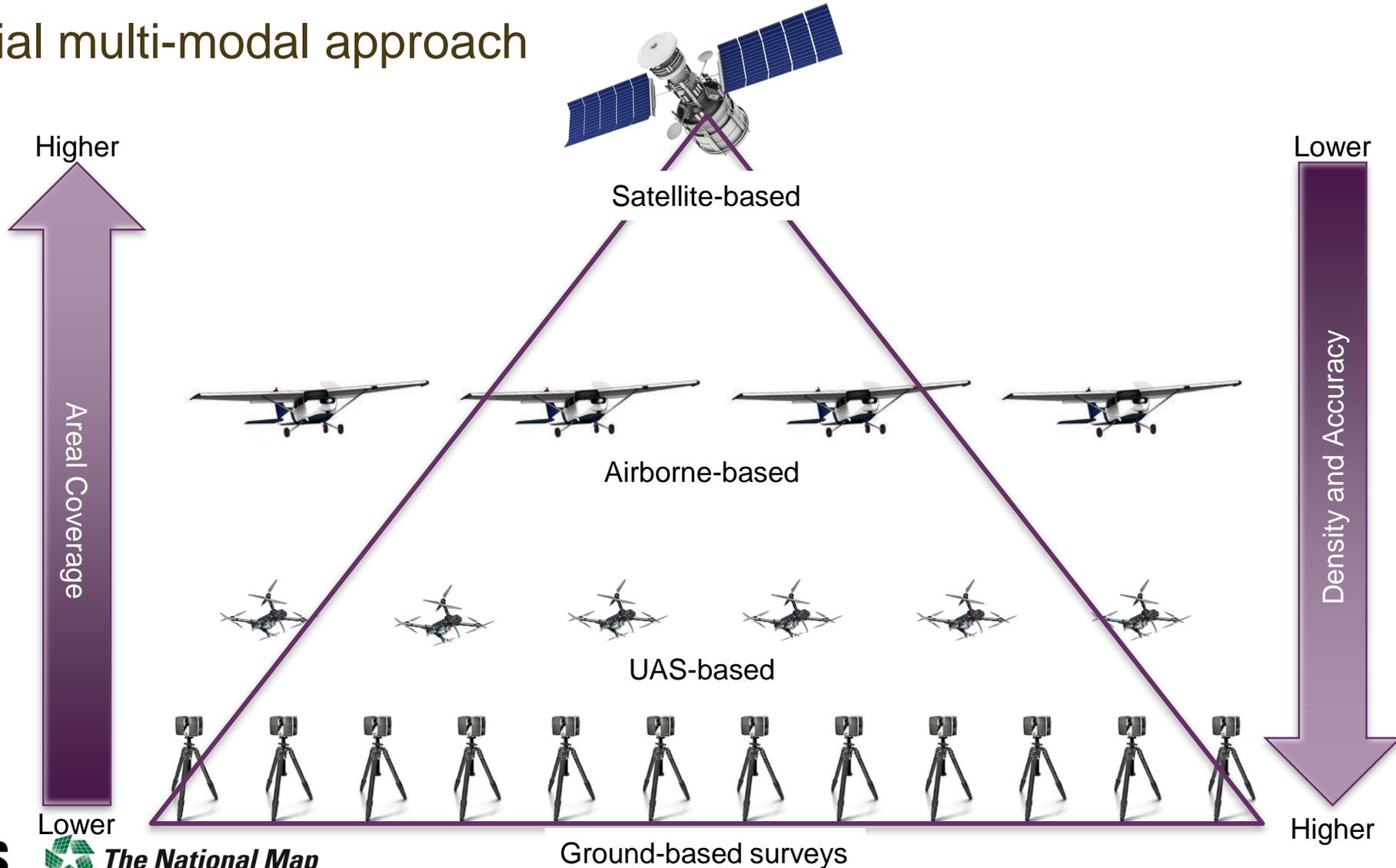
- Working with NOAA to understand inland, nearshore and offshore bathymetric data requirements and benefits
- Plan for the next round of 3DEP when the first-ever national baseline of consistent high-resolution data is in place – what is needed for monitoring, change detection and other new applications?
- Gather technology-agnostic user information to be able to assess new technologies against requirements and identify the tradeoffs between different approaches
- **Results will lead to a completely new approach regarding QLs, refresh frequency by geography, products offered, and other changes**



+

# 3DEP Future Generation Just Around the Corner

Potential multi-modal approach



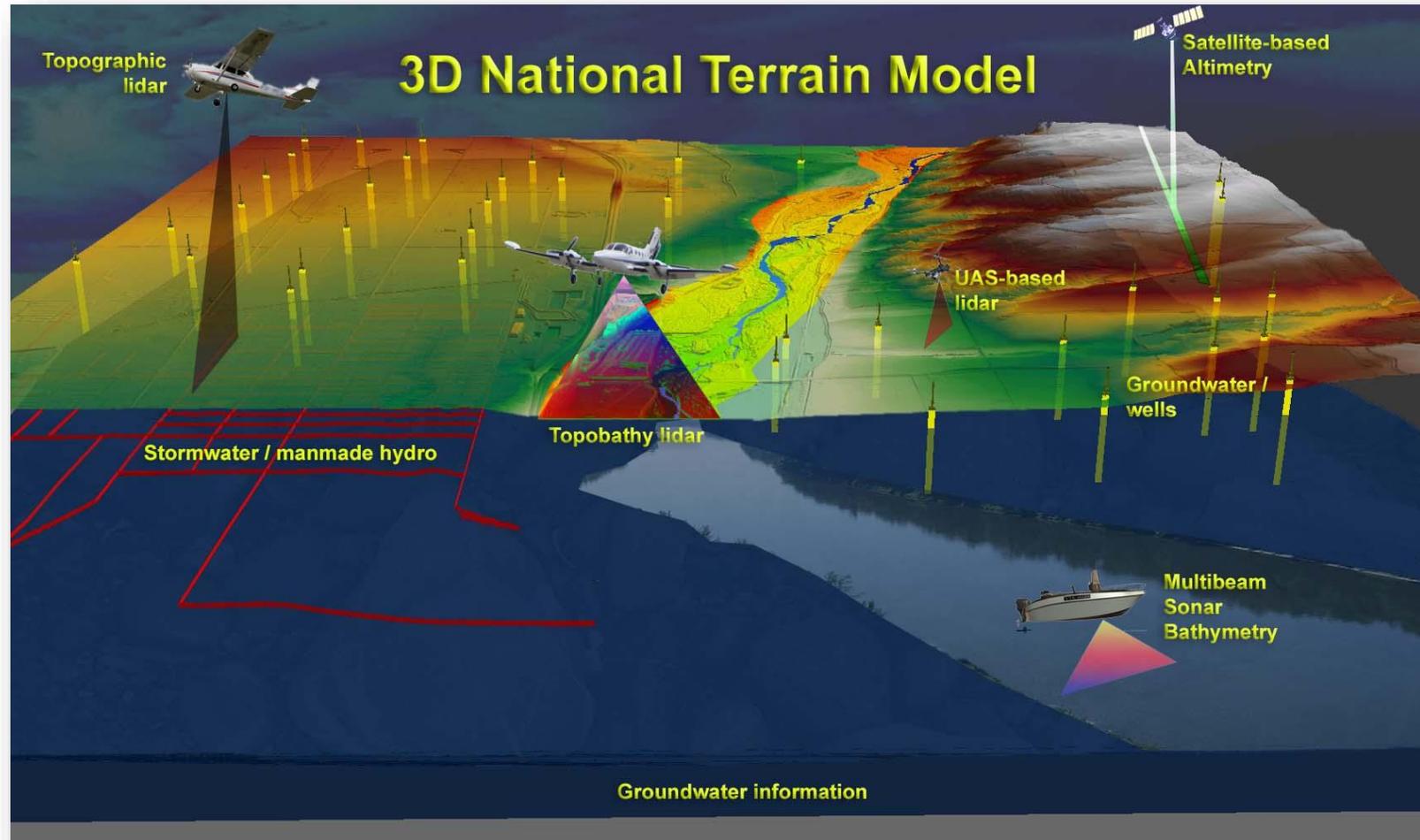
# + The 3D National Terrain Model

Implement the USGS terrestrial component of 3D Nation

A continuous, integrated 3D elevation and hydrography surface

To improve and enable critical applications

- Flood forecasting in 3D, at the street level
- Hydrologic observing systems and models that account for water from the atmosphere to the oceans
- 3D Geologic models
- New and unimagined 3D applications



A 3D elevation map of Bismarck, North Dakota, rendered in shades of blue. The map shows a river winding through the city, with various buildings and structures visible. The terrain is depicted with contour lines and shading to indicate elevation. The text "THANK YOU!" is overlaid in the top right corner.

# THANK YOU!