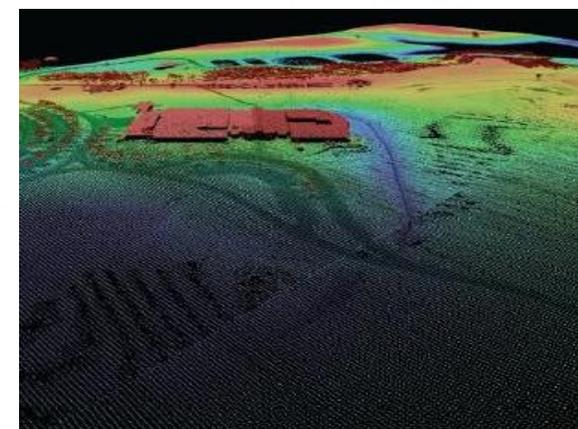
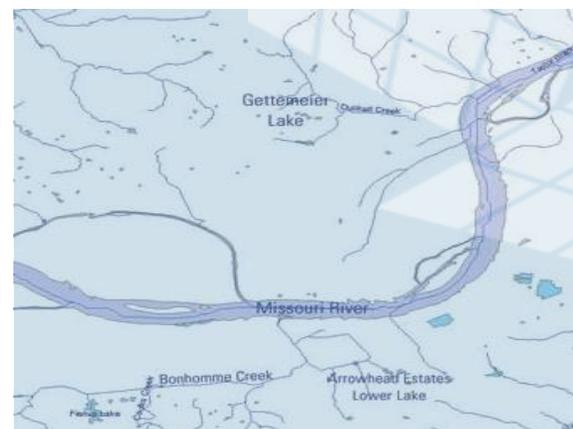
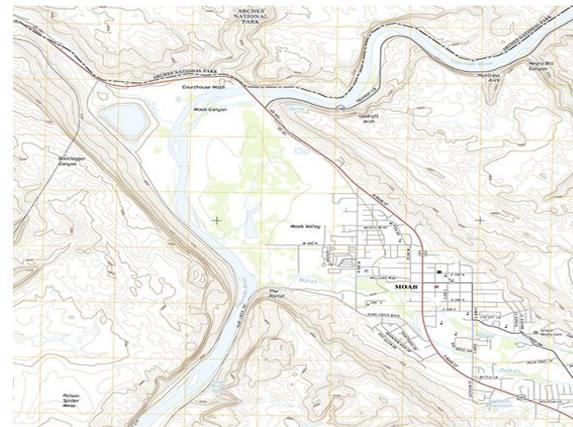




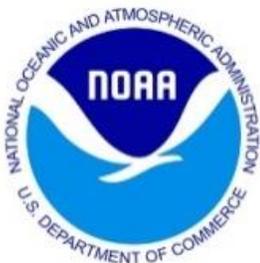
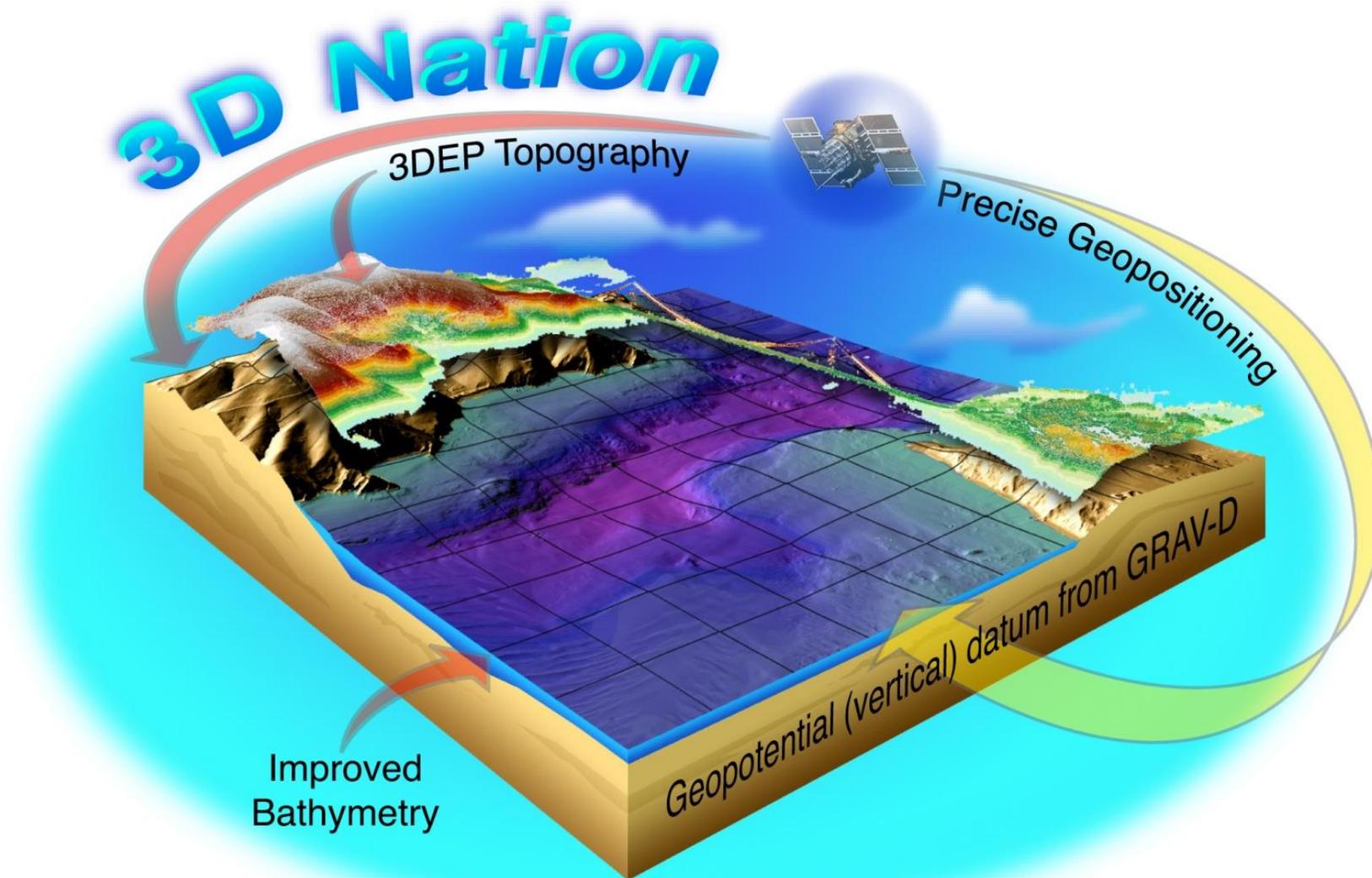
3D National Topography Model (3DNTM)



Vicki Lukas
Chief, Topographic Data Services
National Geospatial Program
April 15, 2021

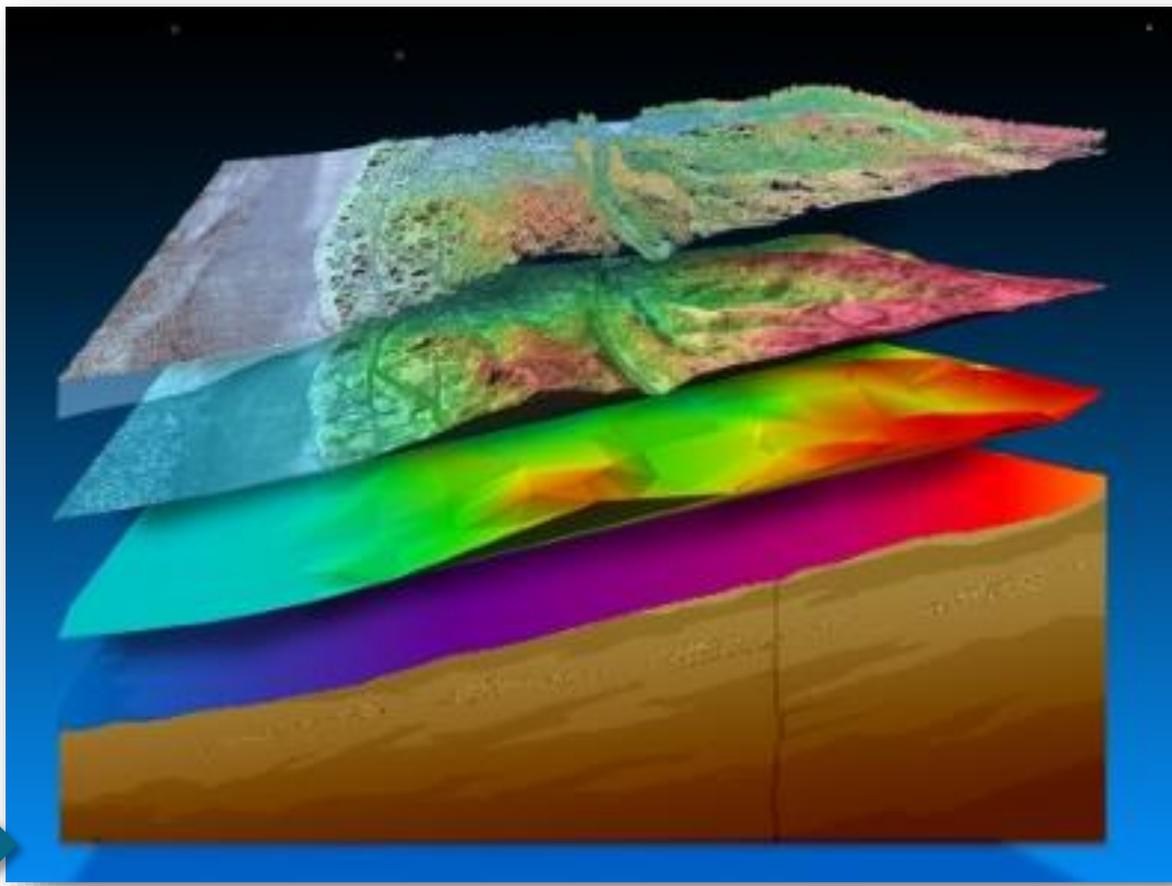
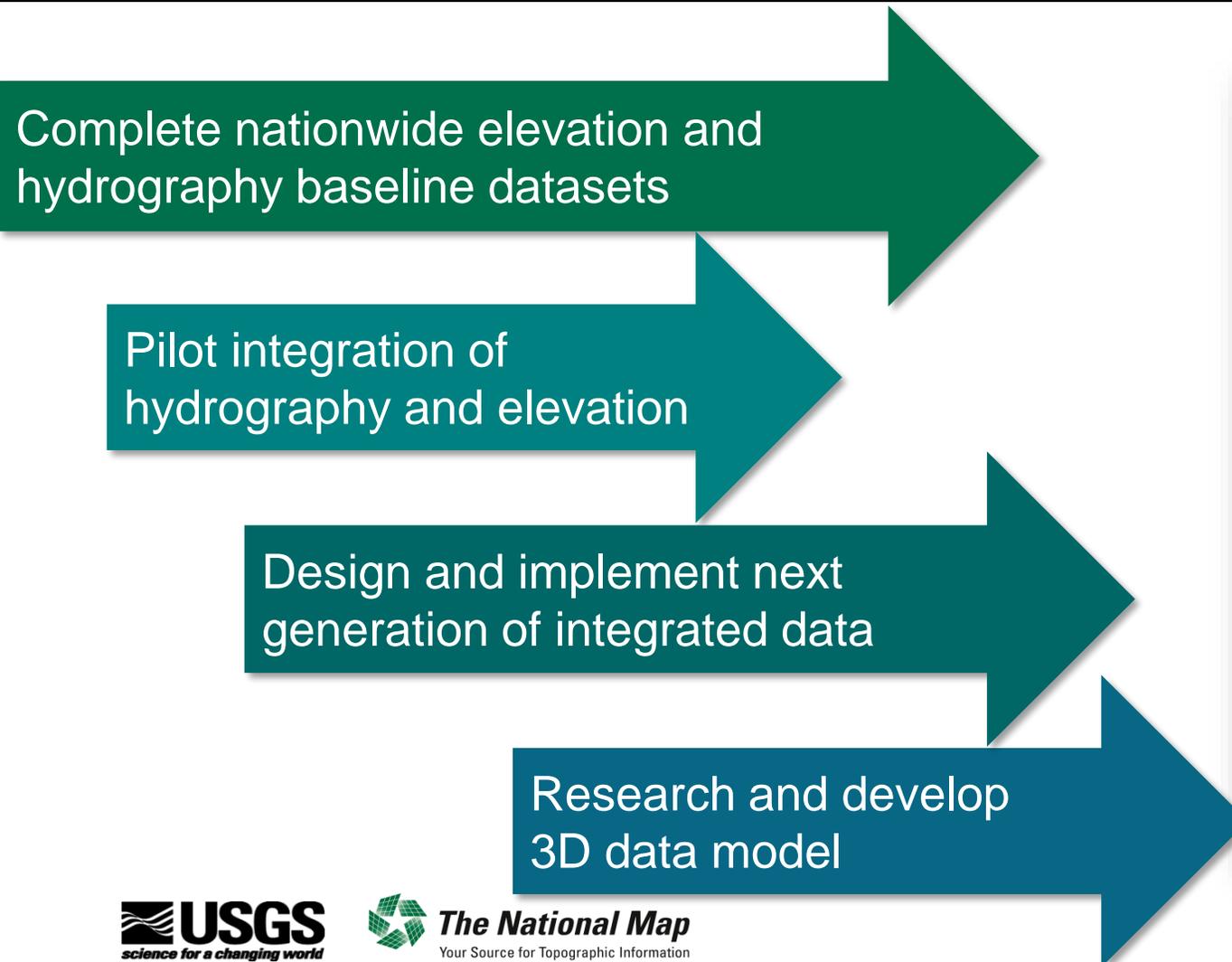
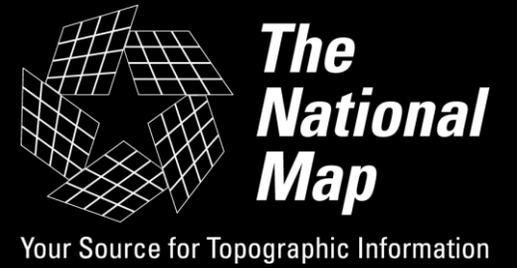
+ 3D Nation

Building a modern elevation foundation – from the peaks of our mountains to the depths of our waters – for stronger, more resilient communities and U.S. economy



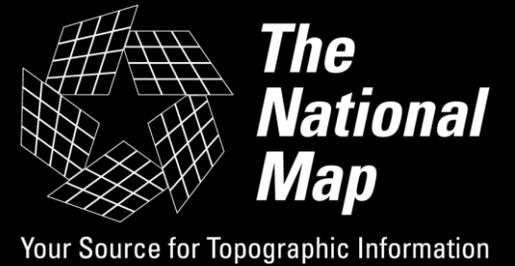
3DNTM Development Tracks

Topography is defined by elevation and hydrography; elevation shapes hydrography, and hydrography shapes elevation. To support a broad range of applications, the **3D National Topography Model** integrates USGS elevation and hydrography datasets to model the Nation's topography in 3D.



3DNTM Development Tracks

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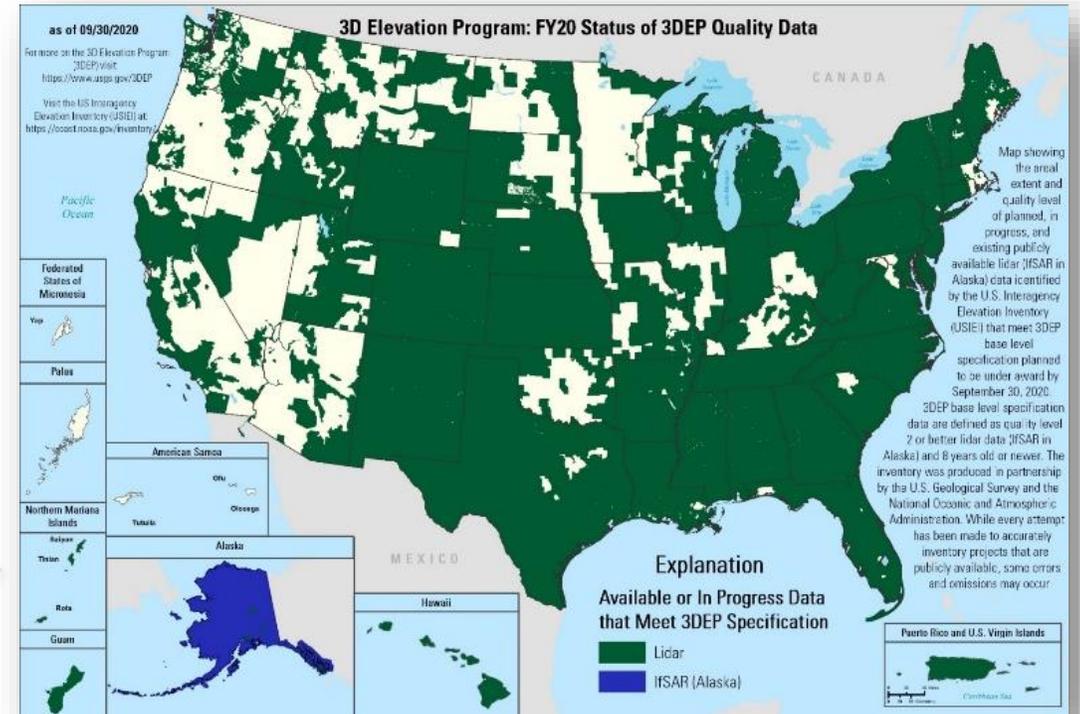
Complete nationwide elevation and hydrography baseline datasets

Pilot integration of hydrography and elevation

Design and implement next generation of integrated data

Research and develop 3D data model

- **3D Elevation Program (3DEP)** - 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
 - Goal to complete by 2023
 - At the end of FY20 78% of the Nation had 3DEP-quality data available or in progress



3DNTM Development Tracks

Topography is defined by elevation and hydrography; elevation shapes hydrography, and hydrography shapes elevation. To support a broad range of applications, the **3D National Topography Model** integrates USGS elevation and hydrography datasets to model the Nation's topography in 3D.



Complete nationwide elevation and hydrography baseline datasets

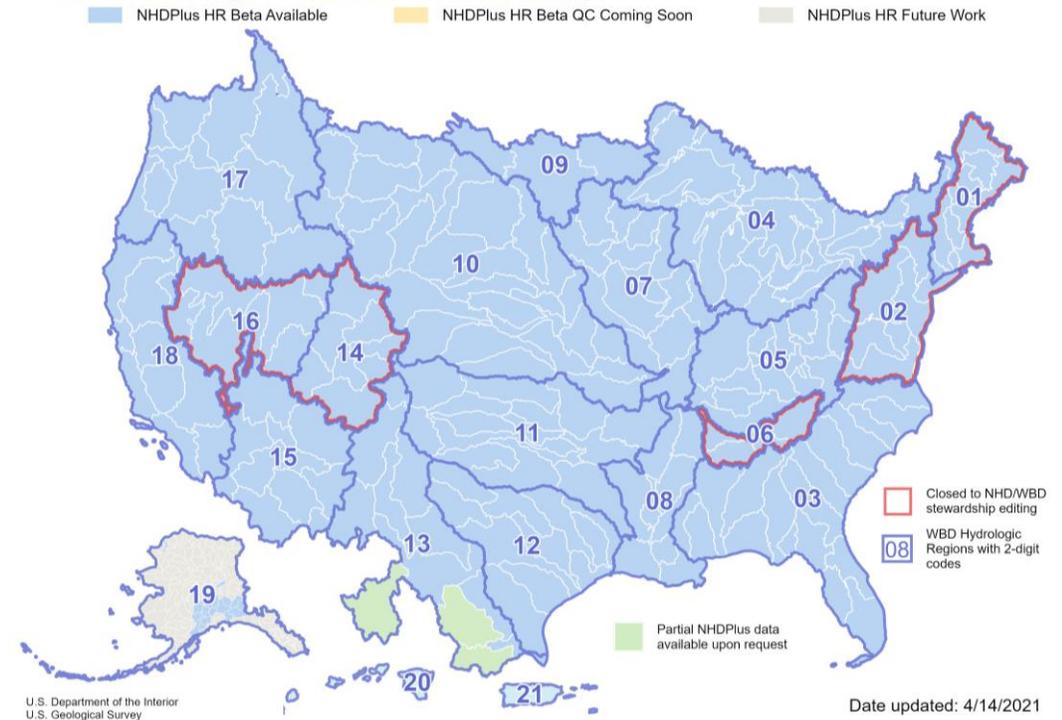
Pilot integration of hydrography and elevation

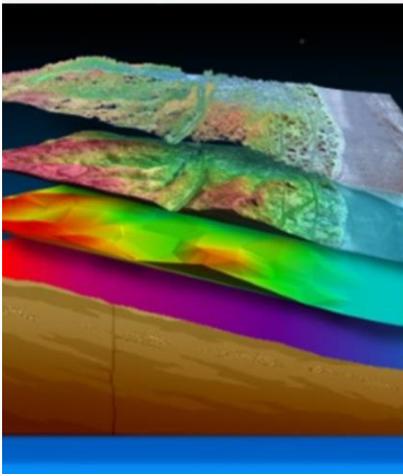
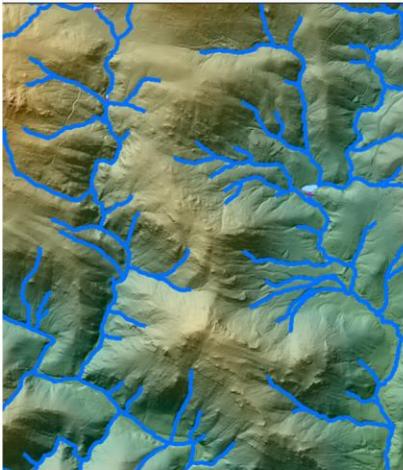
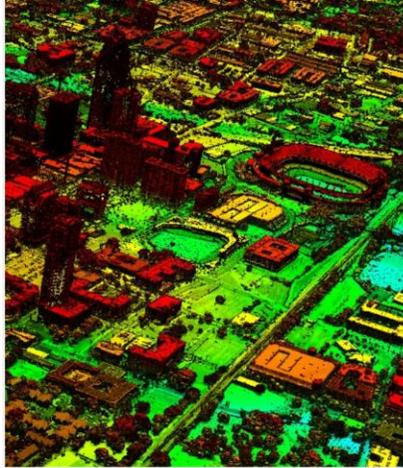
Design and implement next generation of integrated data

Research and develop 3D data model

- **NHDPlus High Resolution (NHDPlus HR)** - Unify observations and measurements onto one multiscale hydrography framework
 - Goal to complete by 2029
 - At the end of FY20 84% of the Nation had NHDPlus HR beta version data available

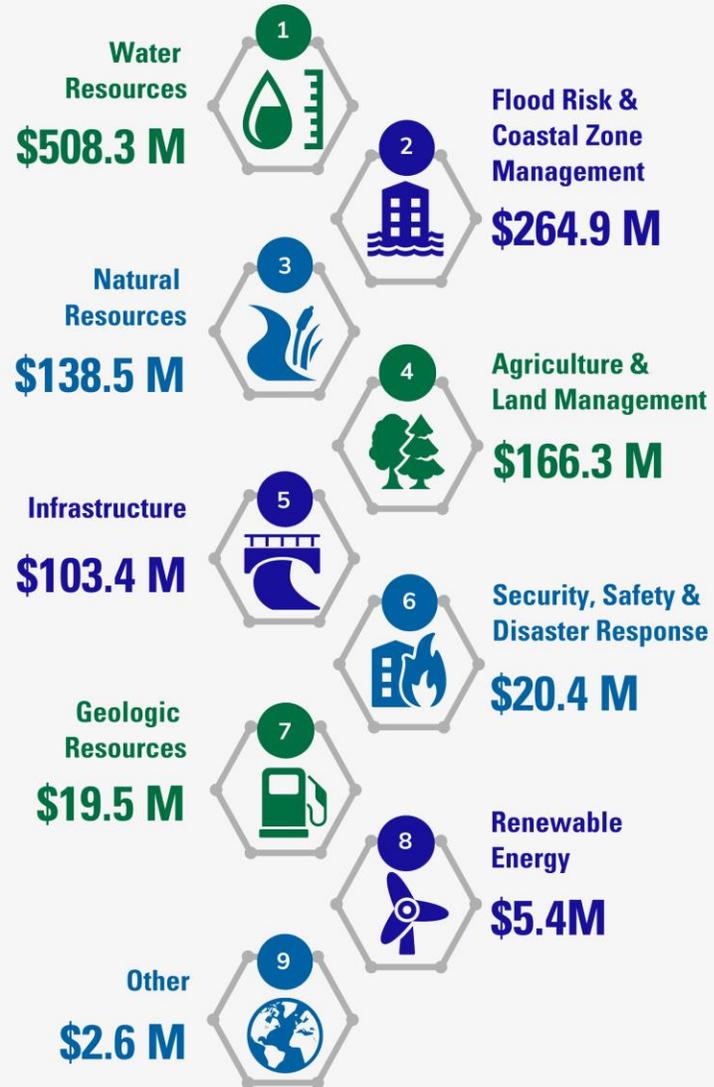
NHDPlus High Resolution Availability





3D Elevation Program and National Hydrography Datasets Combined Annual Benefits

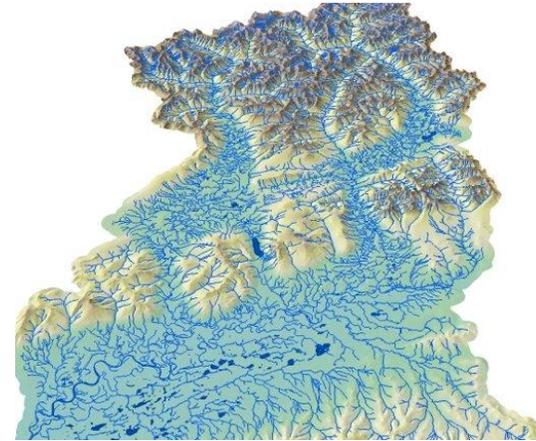
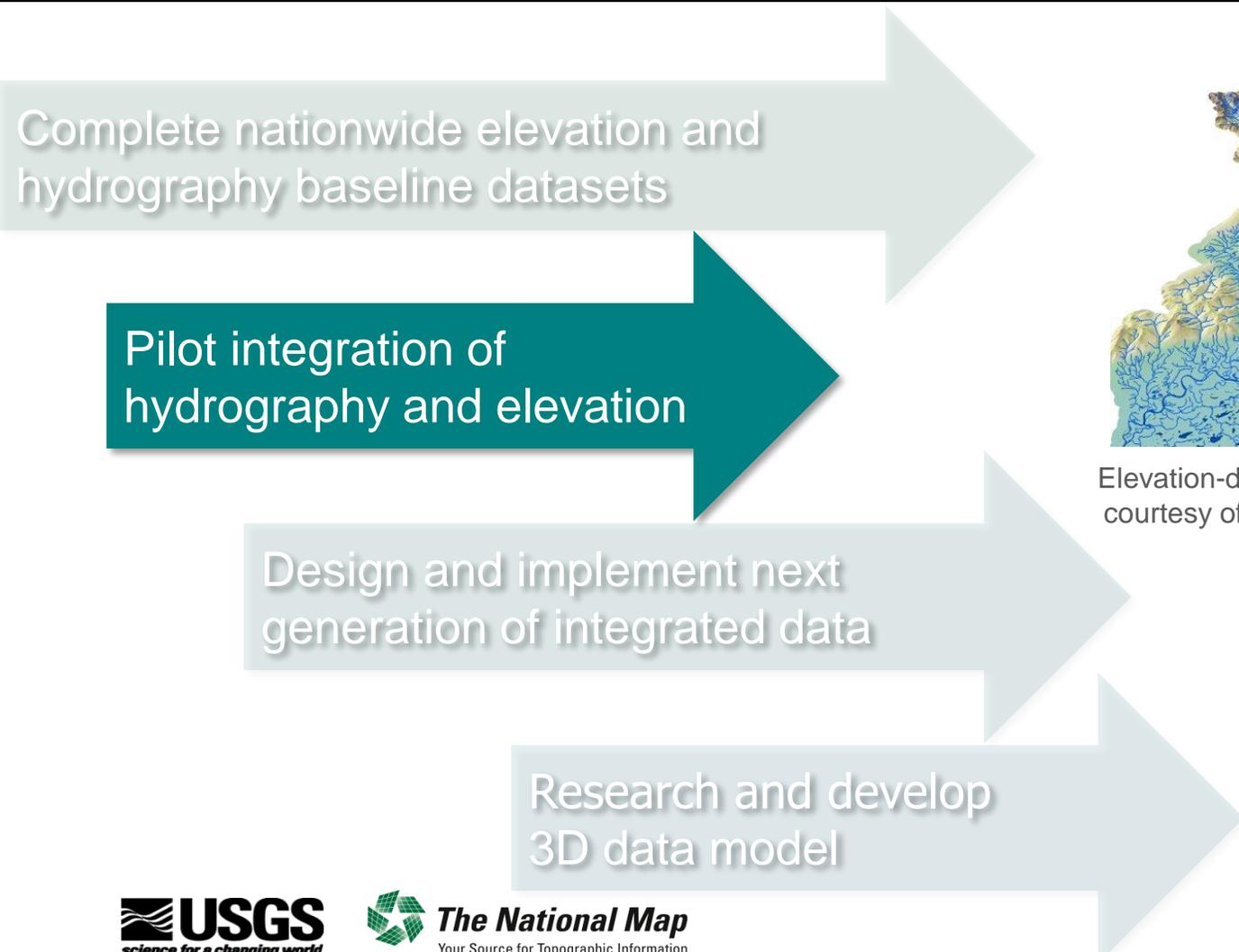
\$1.23 Billion



Combined benefits of current programs

3DNTM Development Tracks

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Elevation-derived hydrography, Alaska, courtesy of Image by Quantum Spatial

- Derive hydrography with Z-values from lidar to move from the neighborhood to the street-level in accuracy of features
- Extend the 3DEP elevation surface under waterbodies with inland bathymetry to replace estimated flow volume with volume calculated from the mapped surface



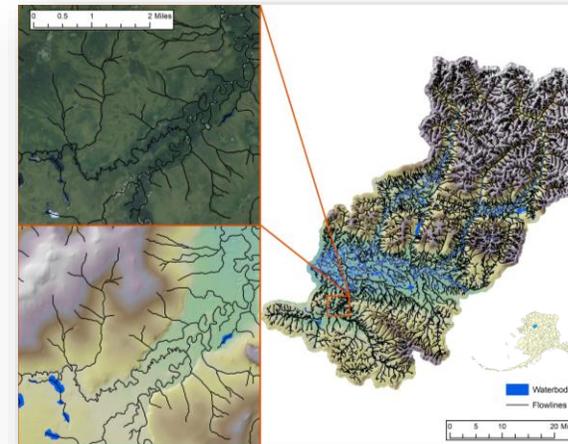
Derive Hydrography from Elevation

Pilot Projects

- Goals of Pilots
 - Build inspection procedures and assess specifications
 - Understand costs and any issues with contracting
- Alaska Pilots - Kobuk River Basin
 - 3DEP 5m IfSAR as elevation base to update NHD and WBD
 - 3 contractors worked across four areas
 - Majority of data has been completed
- Southeast Texas Pilot
 - Updating the NHD and WBD using 3DEP QL2 lidar 1m DEMs
 - Part of a larger interagency project to create a seamless topography model above and below water
 - Important for improving hydrologic and hydraulic networks and inform decision making on flood prediction and response



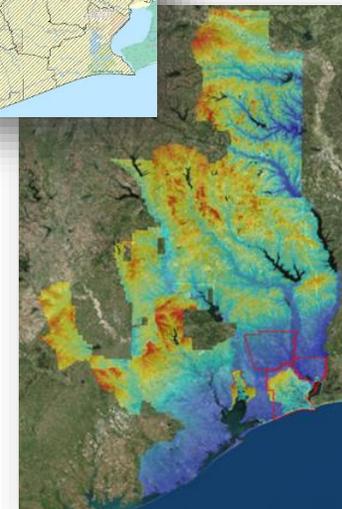
2017 Pilots: 5 areas across the US



2020 Pilots: Kobuk River Basin, AK



2021 Pilot:
SE TX



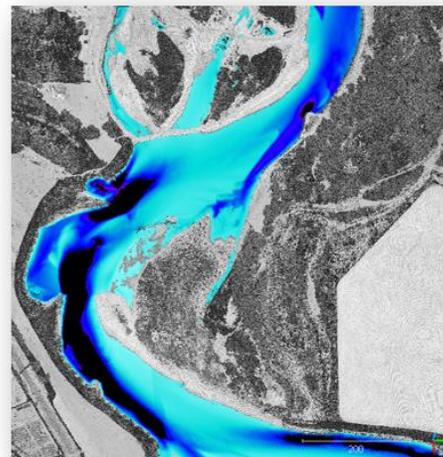
+ Inland Bathymetry

Pilot Projects

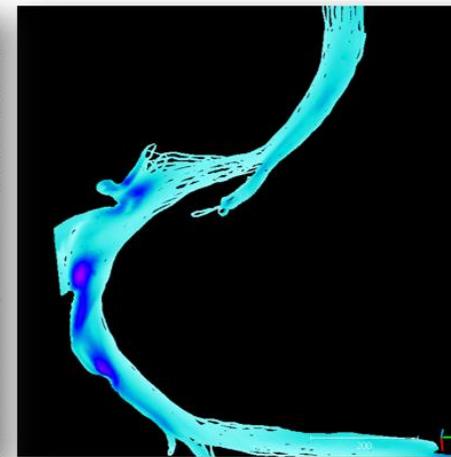
Use pilot projects to inform

- Topo-bathy lidar collection criteria
- Development of specifications
 - Collaborating on an effort led by USACE JALBTCX and NOAA to develop bathymetric lidar specifications
- Process to operationalize inland bathy
 - Data validation and publishing methods
 - Research on accuracy, influence of water clarity on bottom detection, and lidar processing techniques
 - Integration of data sources into topobathy models

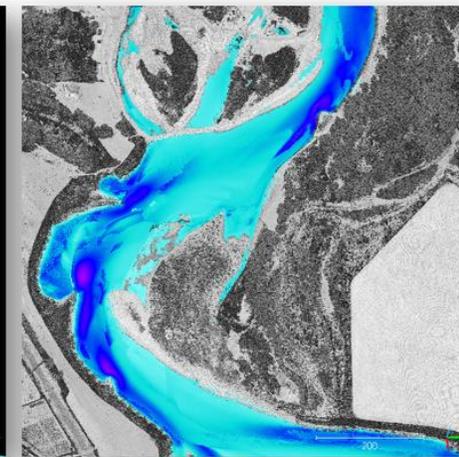
3D Nation Study PRELIMINARY Information Source of approx. 500 mission critical activities that identified the need for inland bathymetry	
State or U.S. Territorial government	43%
Federal Agencies and Commissions	31%
Regional, County, City, or other local government	11%
Academic or Not-for-Profit	10%
Private or Commercial	5%
Tribal government	1%



Bathymetric lidar point cloud (topo and bathy points)

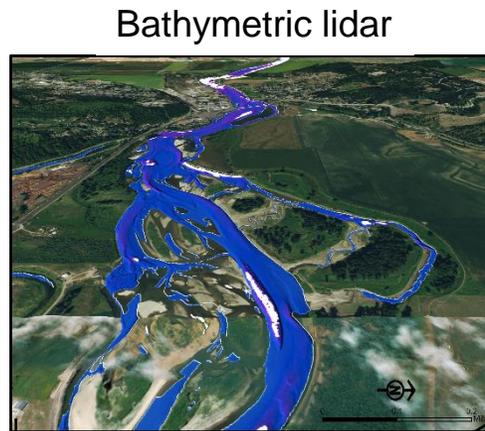
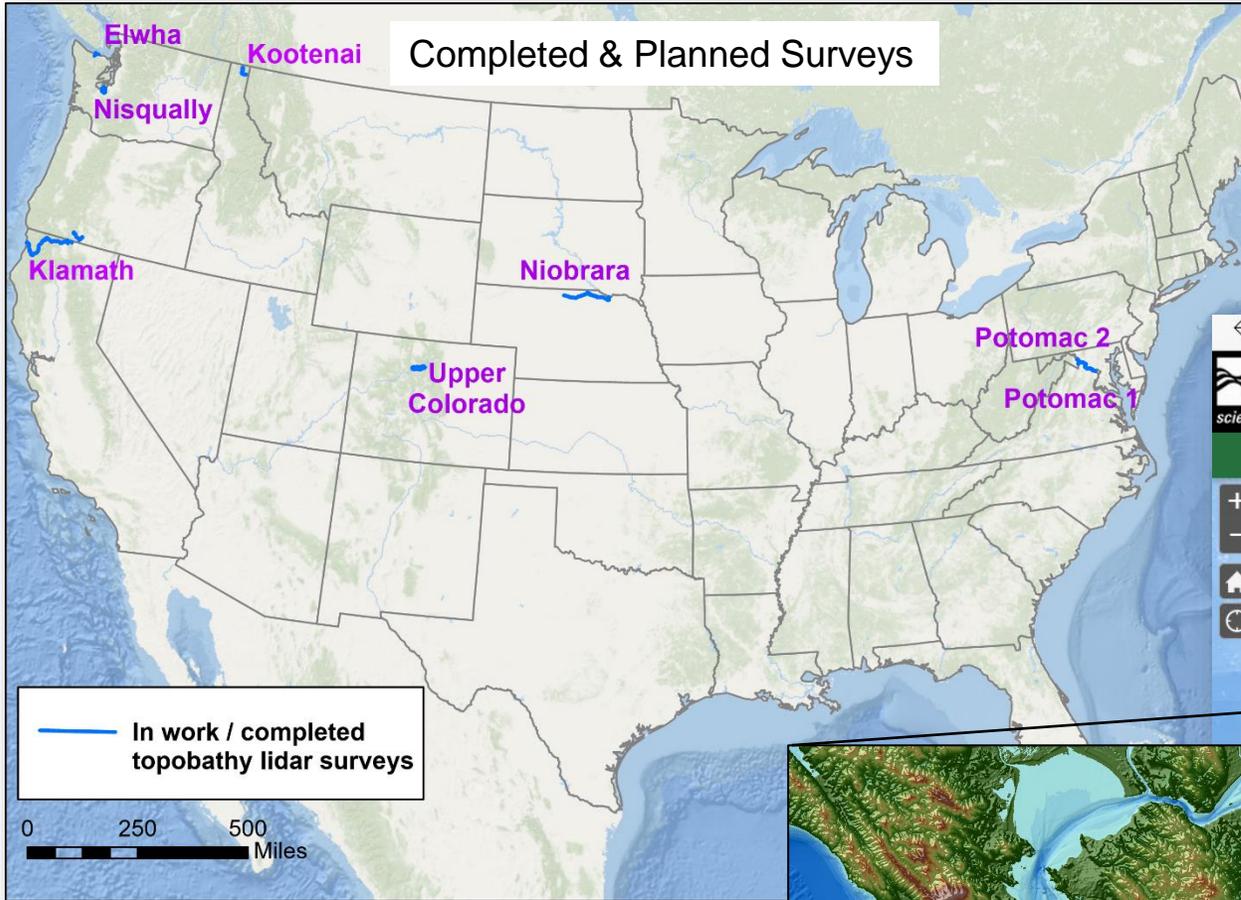


Multibeam echosounder sonar data



Sonar data fills data gaps in areas with deep pools or riffles

+ Bathymetry Data on TNM



Bathymetric lidar

USGS science for a changing world

The National Map

The National Map Advanced Viewer

USGS Home Contact USGS Search USGS

Help Data Download Services Find address or place

Layer List

- NLCD Shrublands
- Elevation Contours
- 3DEP Elevation - Index
- DEM Product Index
- Source Data Index - Lidar, Ifsar, DEM
- Topobathymetric Data Index
- Query
- 3DEP Elevation - Hillshade
- 3DEP Elevation - Multi-Directional Hillshade
- 3DEP Elevation - Elevation Tinted Hillshade
- 3DEP Elevation - Slope Map
- 3DEP Elevation - Aspect Map
- 3DEP Elevation - Hillshade Stretched
- 3DEP Elevation - Auto Contours
- Geologic Map of North America (GMNA)

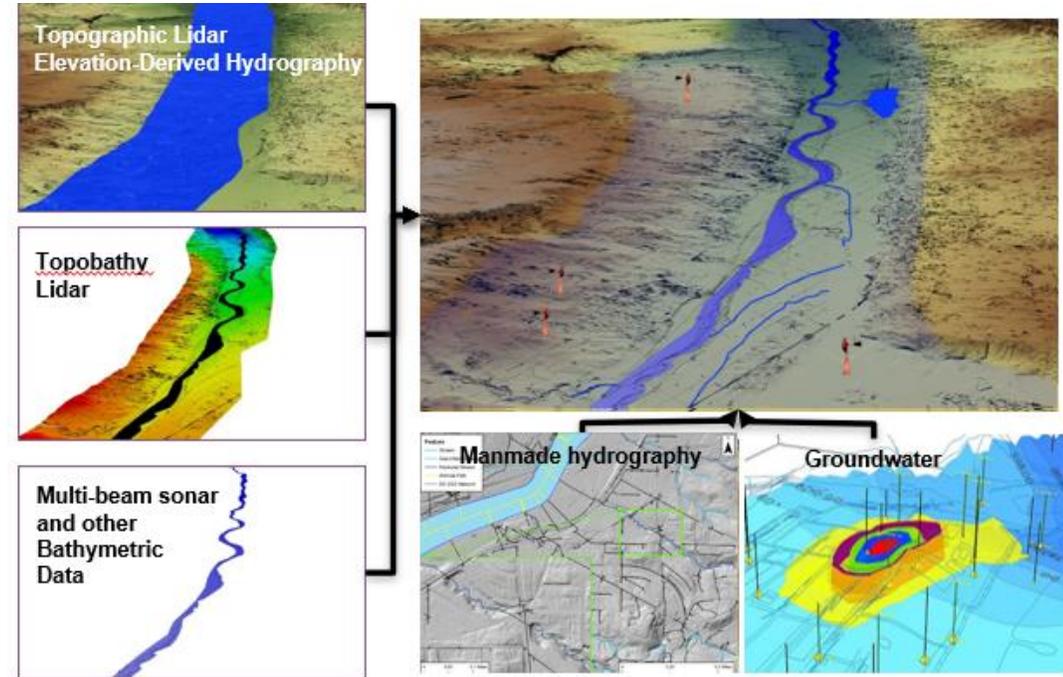
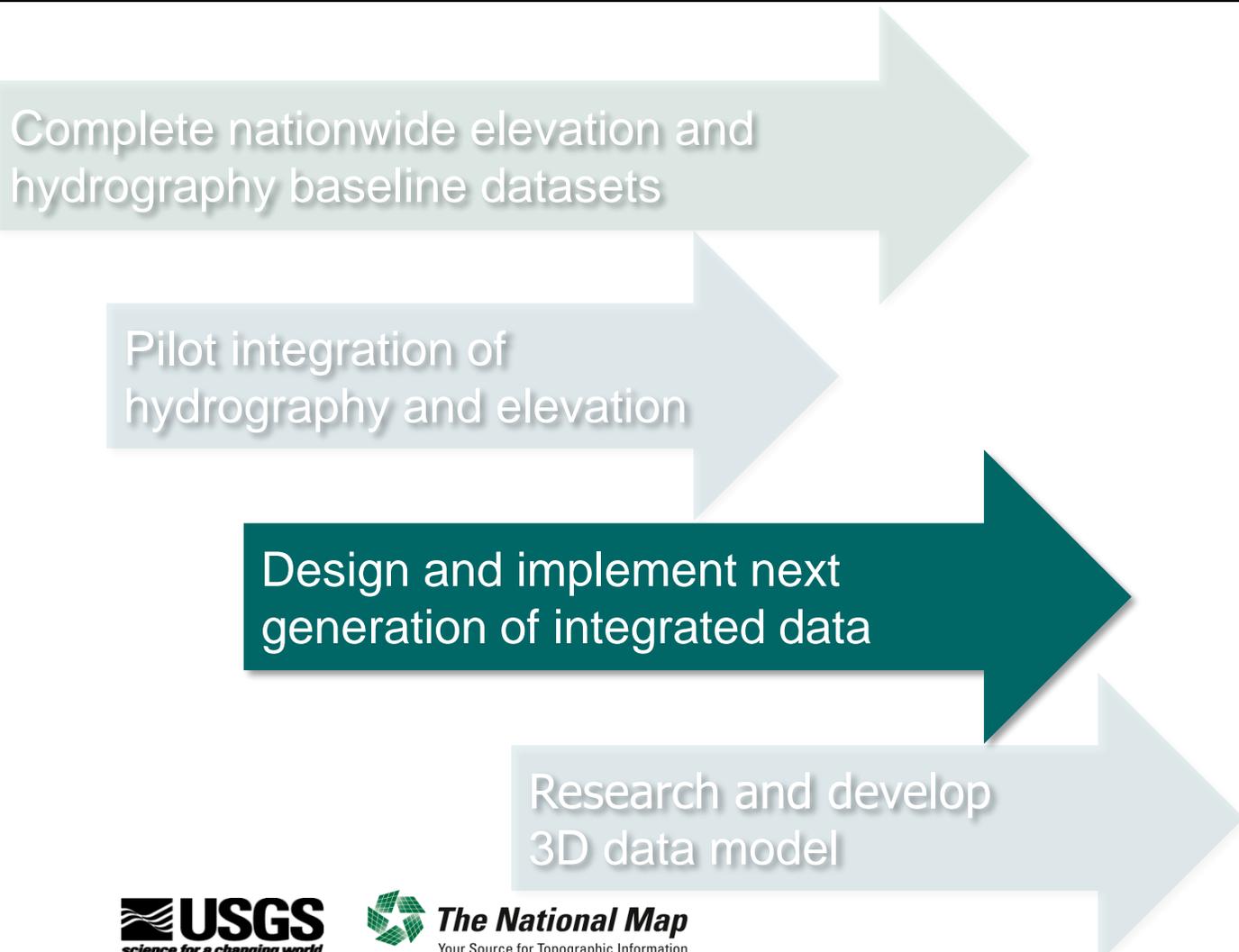
Integrated topobathy model

Bathymetric lidar

CoNED topobathy models

3DNTM Development Tracks

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Next Generation 3D Hydrography Program (3DHP)

Next Generation 3D Elevation Program (3DEP)



Modernizing the National Hydrography Datasets

Why modernize?

Hydrography data are essential to a broad range of critical applications and the current program provides \$538M annual benefits*

What are the benefits?

A modernized 3D-enabled hydrography program could provide up to \$1.14 billion annually in benefits if all user requirements are met*

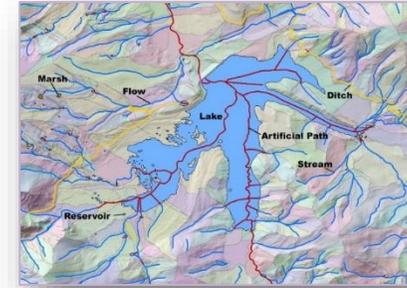


+

Current Approach

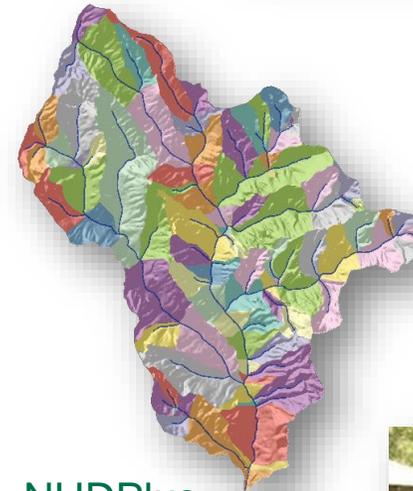
Collaborative Data Management

- The NHD portfolio of datasets is the most comprehensive and current data of the Nation's surface waters
 - 8.4 million miles stream of network, including 7.8 million waterbodies and over 130,000 nested hydrologic units
 - Provides \$538M annual benefits
- NHD and WBD leverage local knowledge and updates through a stewardship program with participants from 41 states and DC
- However, updates aren't uniform
 - Some areas updated, others untouched and based on dated information – sometimes 40+ years old
 - National consistency has **decreased** over time
 - Issues with connectivity in the NHD network and with lingering delineation blunders in the WBD
 - Don't align well with current elevation data

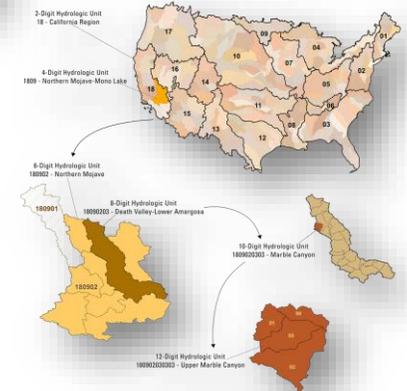


National Hydrography Dataset

13



Watershed Boundary Dataset



NHDPlus High Resolution



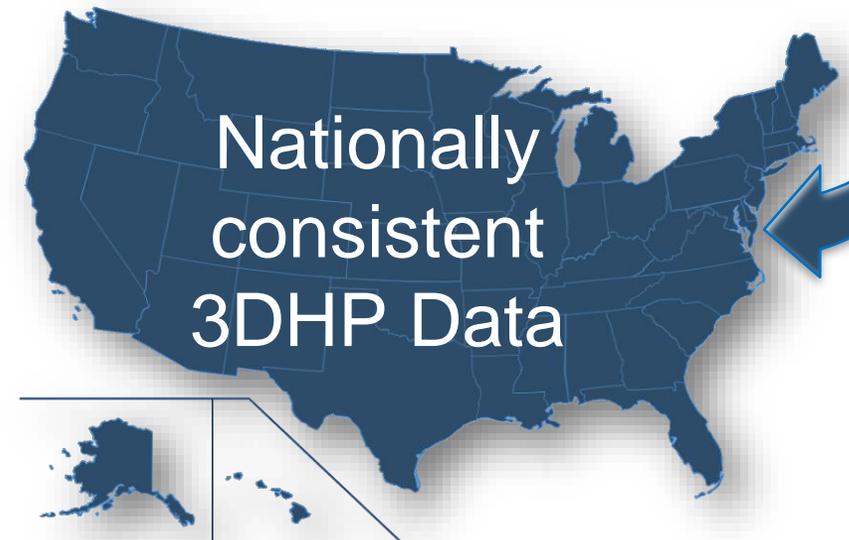
Concept courtesy of Dr. Jason Stoker



Hydrography Derived from Elevation Offers a Solution!

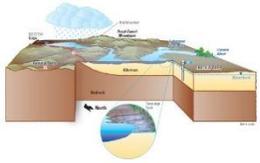
3DHP will provide national consistency while meeting local needs

- Goal to standardize the NHD to align vertically, horizontally, and temporally with 3DEP data
 - Supports national and regional-level issues like flooding, contaminant spills, water quality and quantity, drought, climate change, etc.
 - Supports more accurate, updated modeling and analysis capabilities
 - Provides the basis for updating WBD and NHDPlus HR
- Hydrography Requirements and Benefits Study documented widespread need for integration of hydrography and elevation
- Stewards continue to provide local knowledge on attributes and flagging issues on the geometry with the markup tool

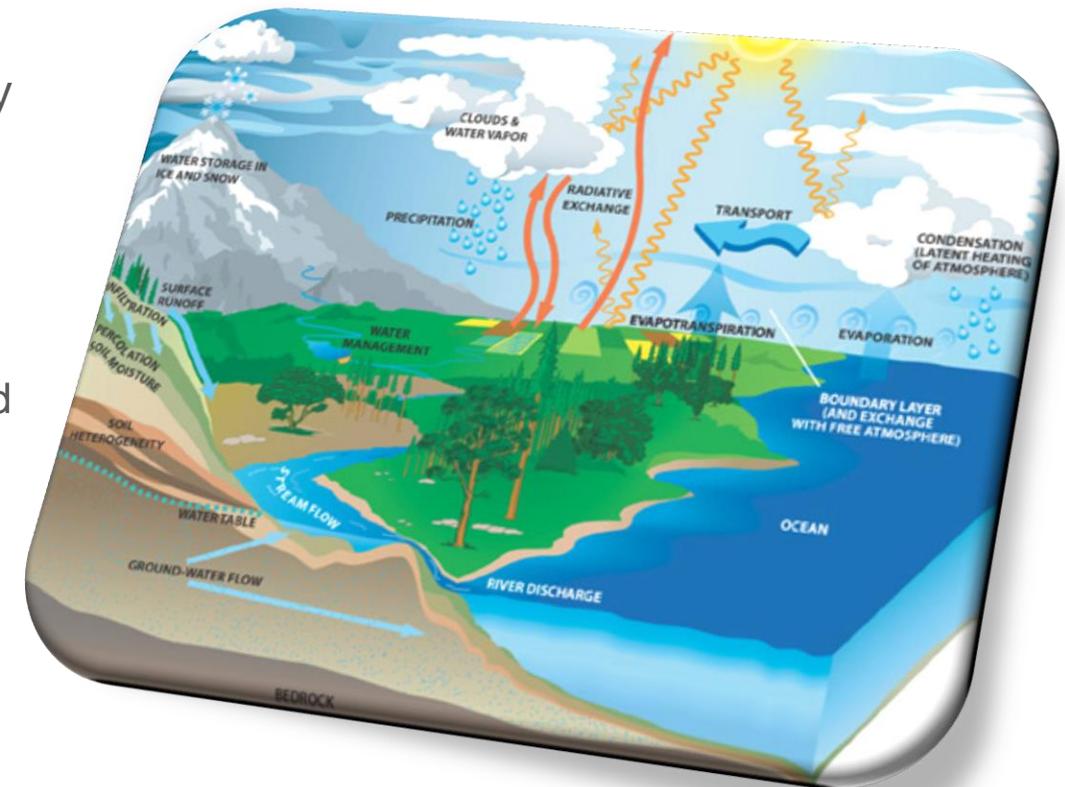


+ 3DHP Data Enhancements

To enable better accounting of the hydrologic cycle



- Adding connections to groundwater
- Align with and National Wetlands Inventory
 - Working with FWS to understand how to improve mapping across these data
- Including engineered hydrologic systems
 - In particular, storm water systems in mid-sized to larger cities
 - Need more research into the "Goldilocks" level of storm system mapping

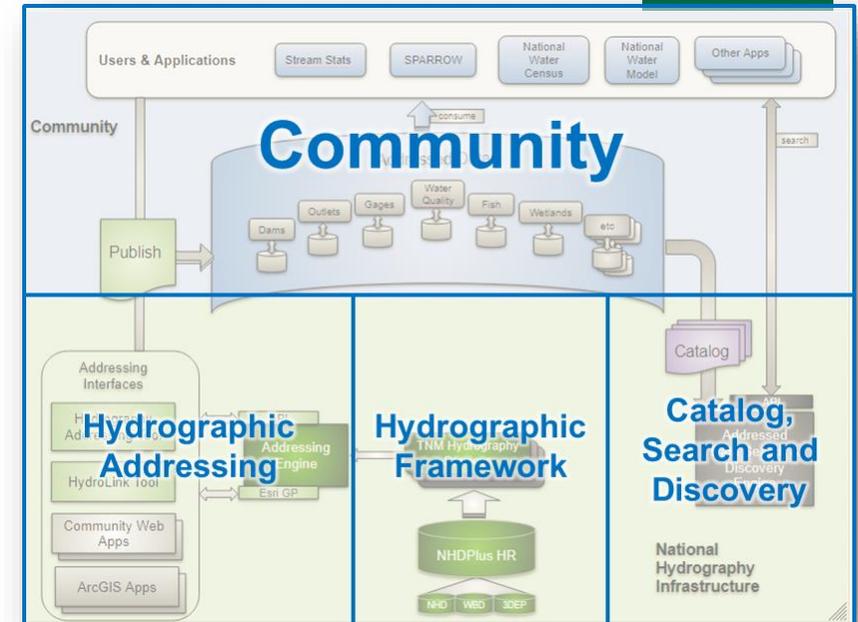




National Hydrography Infrastructure

Implement as a key component of 3DHP

- While there is an abundance of water-related data collected, the Nation lacks a systematic way to organize, search, and discover it
- USGS and NHI Working Group are developing the NHI to provide a geospatial infrastructure for *federated* sharing and discovering of water information in the context of the stream network
- Will include tools to reference data to the stream network, and to search and discover the data of others
- Search and discover tools are available as Web APIs that can be implemented as portals to find information on specific topics of interest
- NHI provides the geospatial underpinning for the Internet of Water



Internet
of Water™

+

3DNTM Development Status

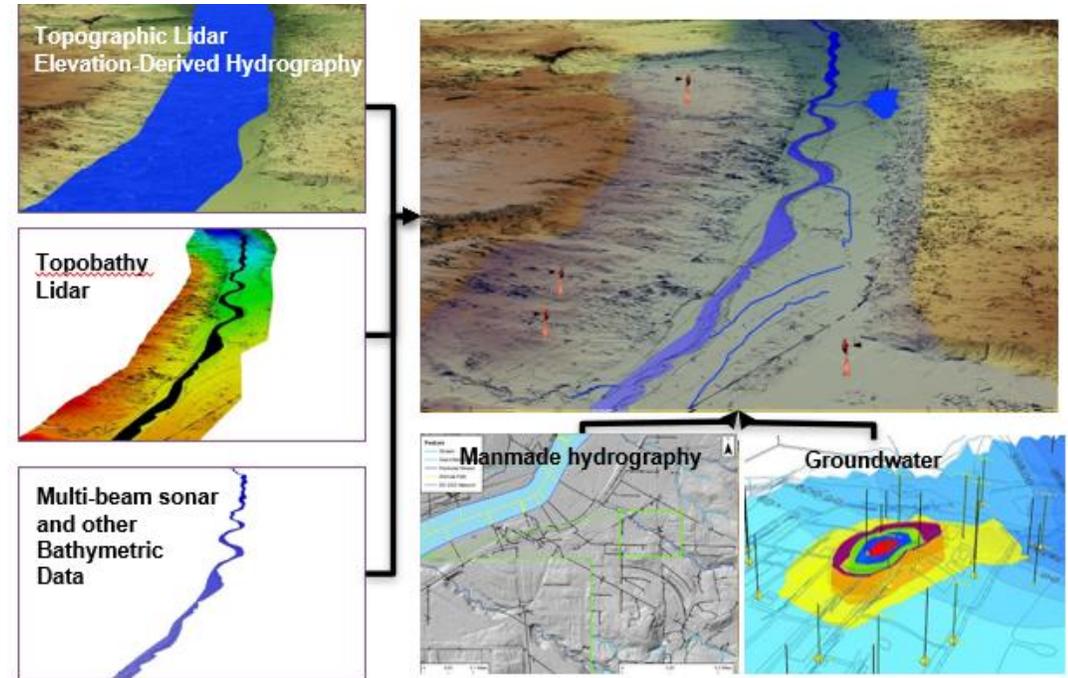
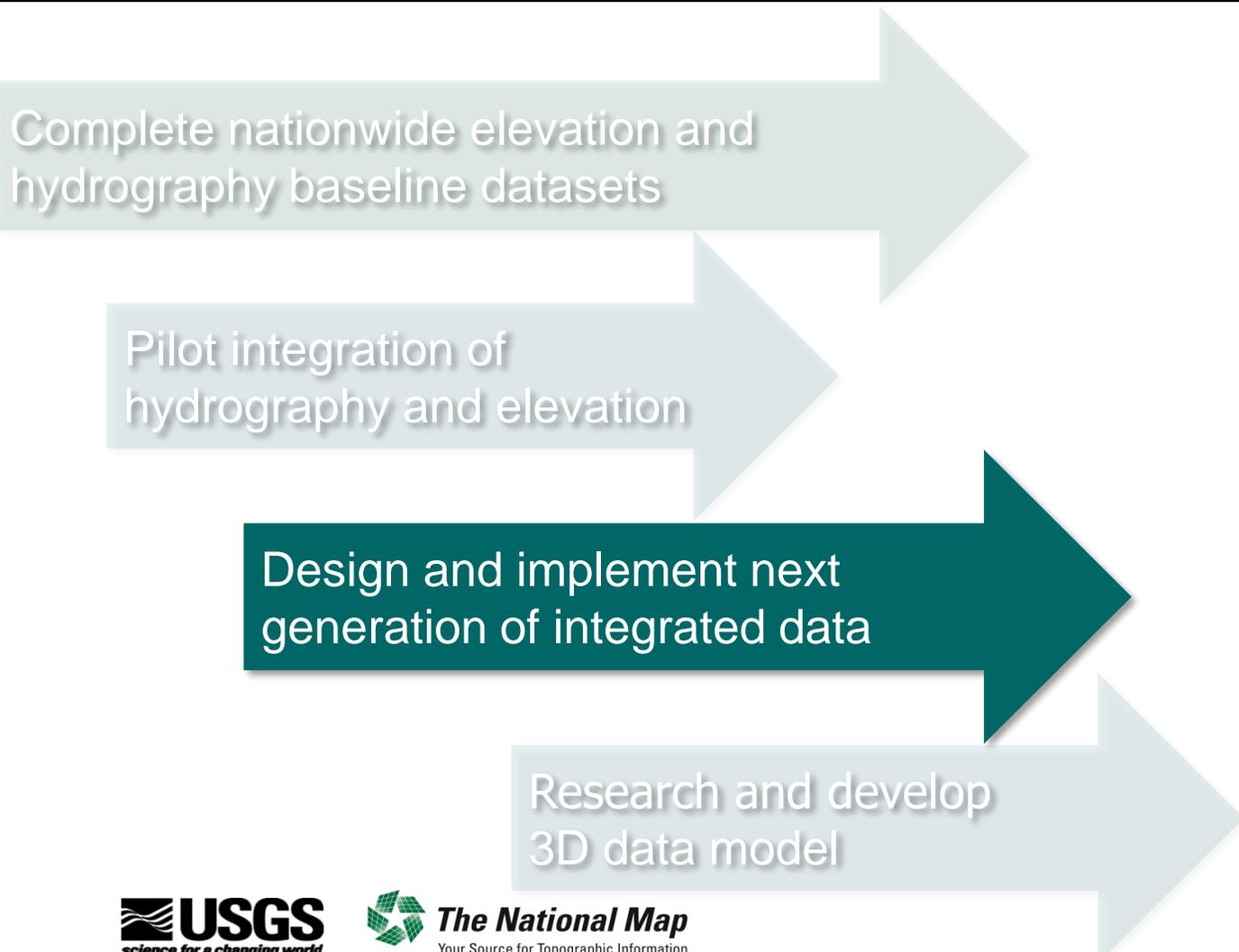
3D Hydrography Program

 = COMPLETE  = IN PROGRESS



3DNTM Development Tracks

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Next Generation NHD: 3D Hydrography Program (3DHP)

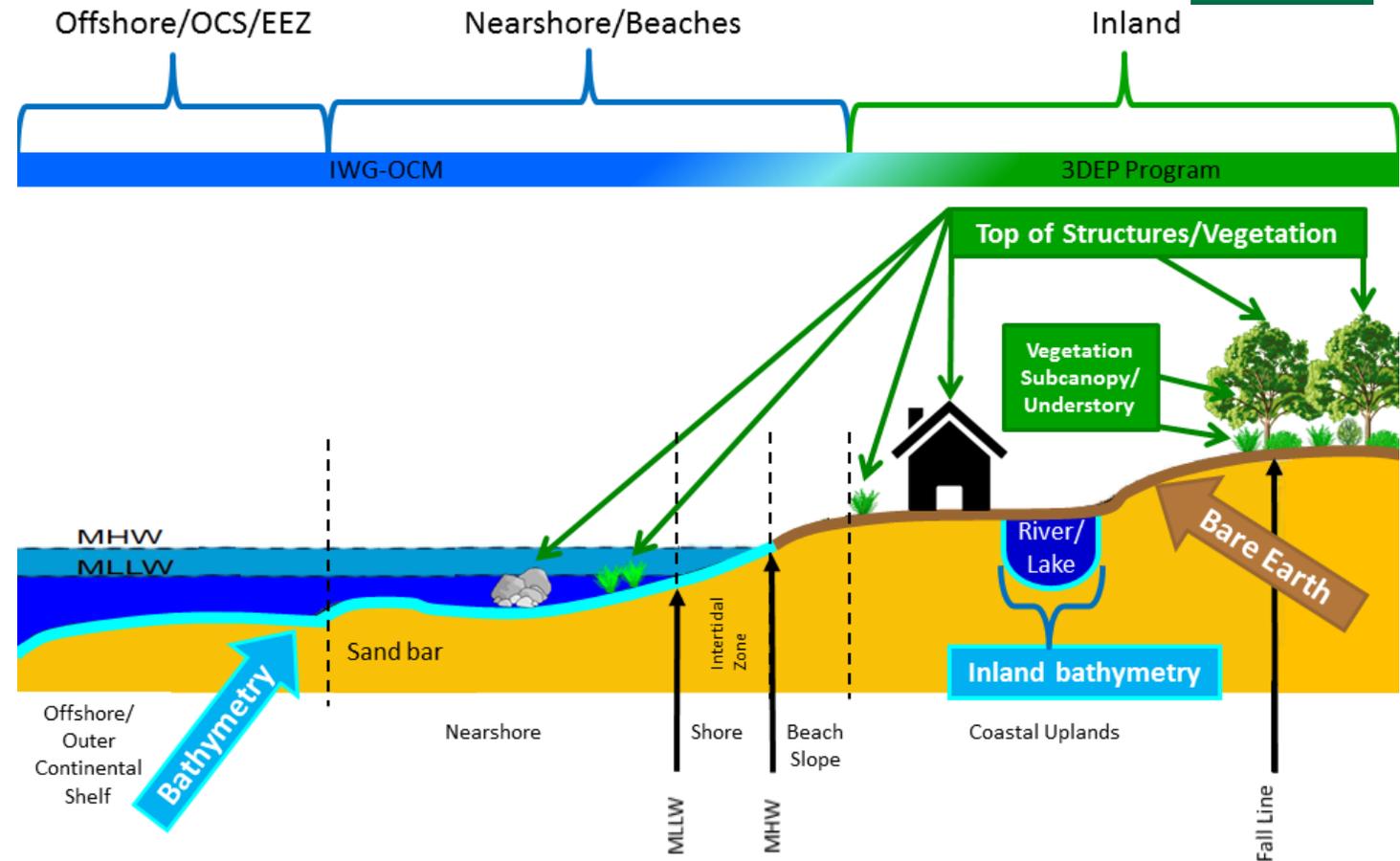
Next Generation 3D Elevation Program (3DEP)



3D Nation Elevation Requirements and Benefits Study

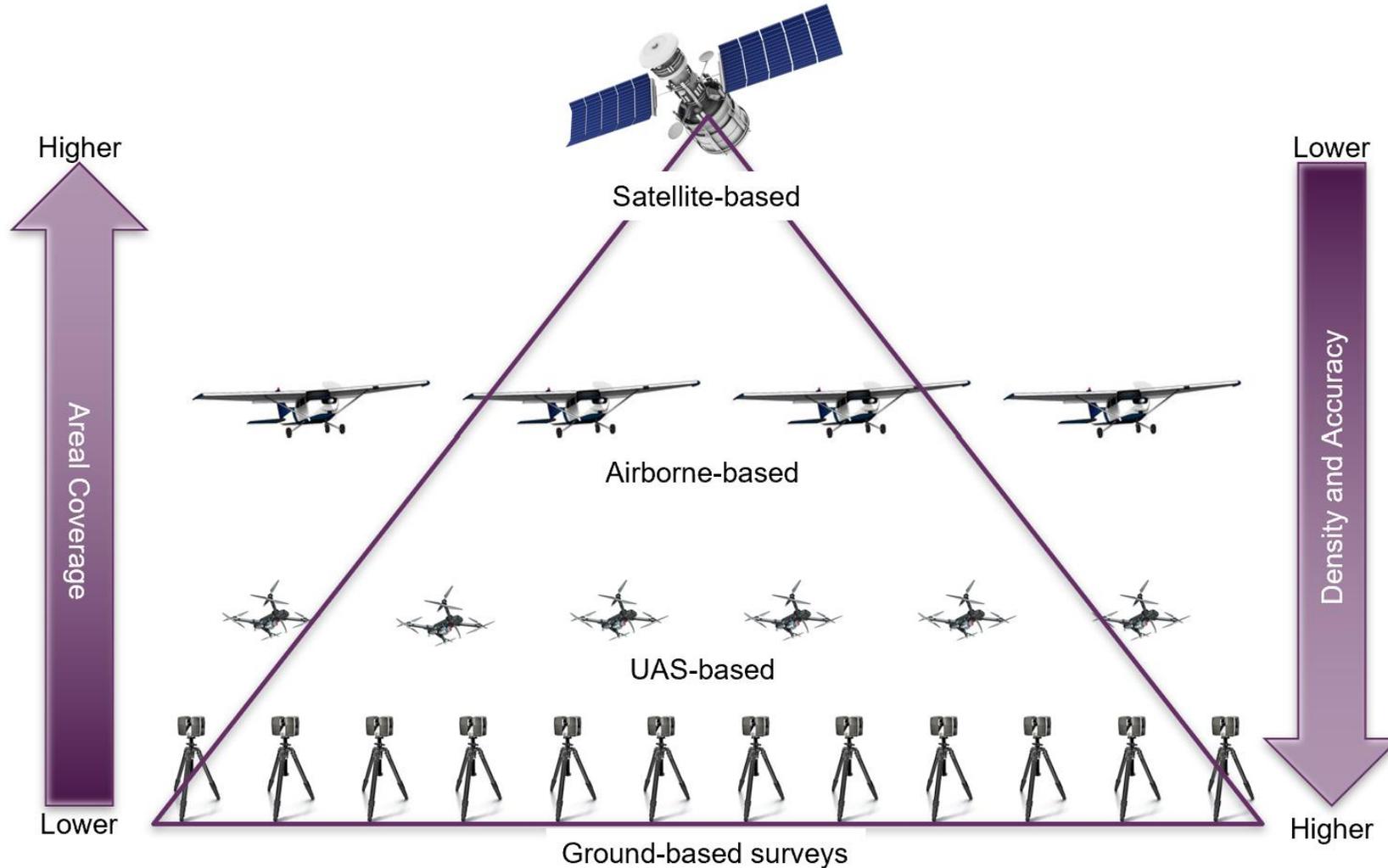
Goals

- Understand inland, nearshore, and offshore bathymetric data requirements and benefits
- Understand how requirements and benefits dovetail in the coastal zone
- Plan for the next generation of 3DEP and OCM products and services after completion of nationwide coverage
- Gather technology-agnostic user information to assess new technologies against requirements, tradeoffs between different approaches



+

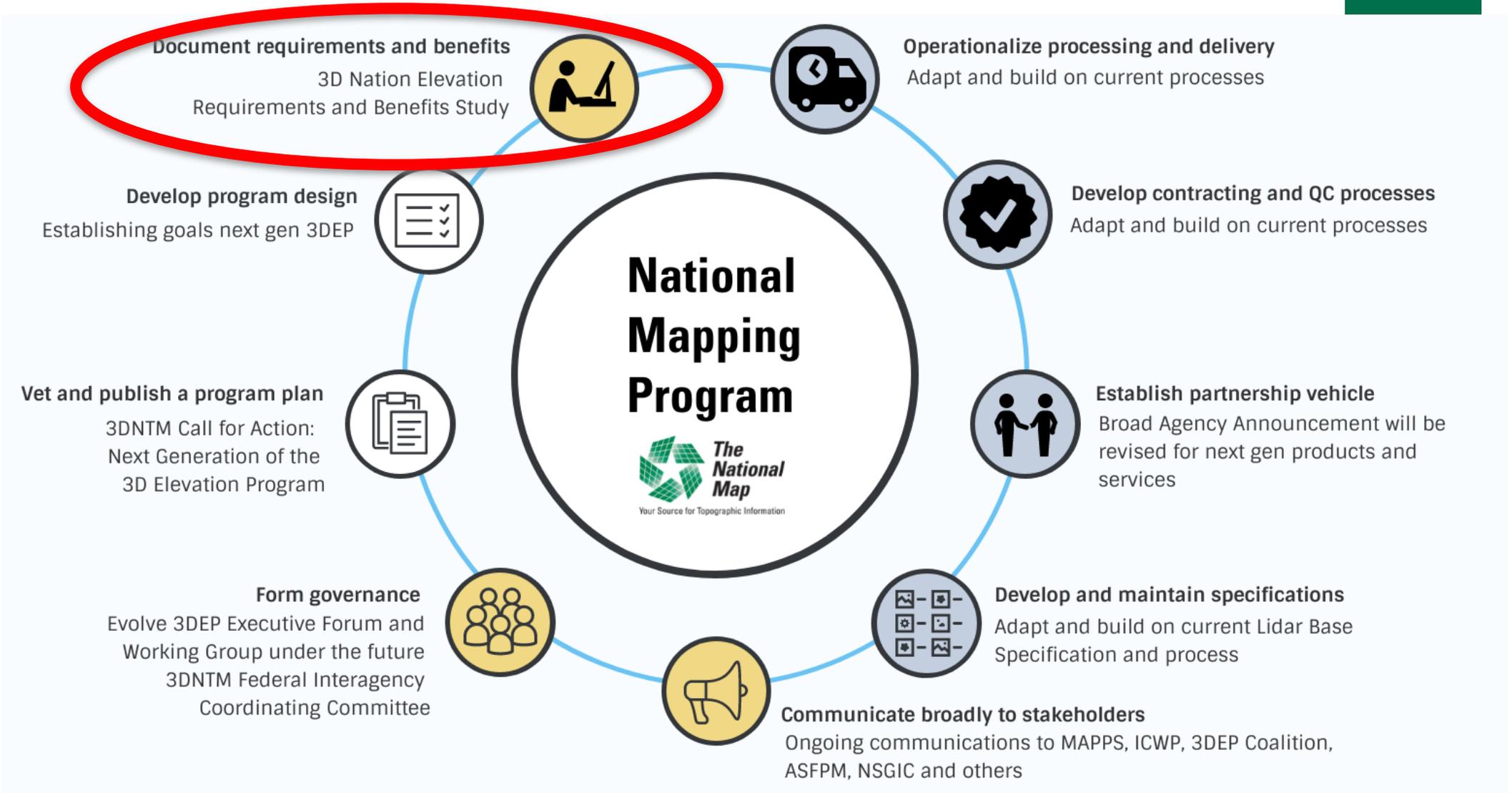
Potential Multi-modal, Multi-sensor Approach



+ 3DNTM Development Status

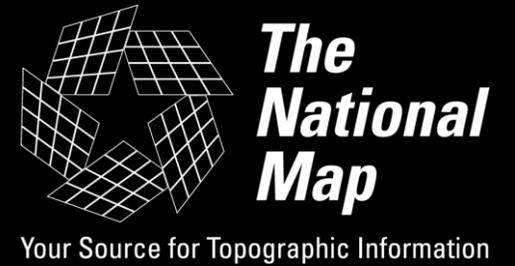
Next Generation of 3DEP

● = EXISTING SYSTEMS as a starting point ● = IN PROGRESS



3DNTM Development Tracks

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Complete nationwide elevation and hydrography baseline datasets

Pilot integration of hydrography and elevation

Design and implement next generation of integrated data

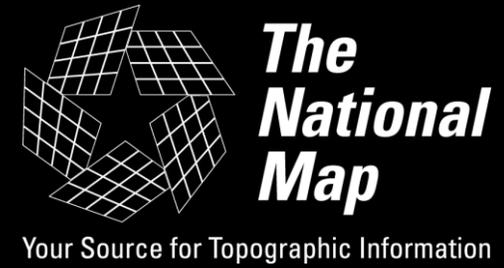
Research and develop 3D data model

Future Integration

- Research and develop a 3D data model to fully integrate 3D Hydrography Program (3DHP) and 3D Elevation Program (3DEP)
- Integrate other data from The National Map
- Research activities
 - 3D representation models and 3D volumetric mapping to include subsurface and atmospheric components
 - Data model organization techniques to support “change over time” analysis
 - 3D visualization of TNM layers - 3D Topo, street view, and 3D features like overpasses, bridges, tunnels, etc.
 - Technologies and knowledge graphs to enable integration of TNM layers in near real time
 - Generalization and multi-scale mapping techniques that preserve terrain features such as surface water, landforms, and infrastructure across scales
 - High-performance computing, artificial intelligence, and machine learning techniques to handle large data volume analysis and feature extraction

3DNTM: Supports the Nation's Critical Applications

Topography is defined by elevation and hydrography; elevation shapes hydrography, and hydrography shapes elevation. To support a broad range of applications, the **3D National Topography Model** integrates USGS elevation and hydrography datasets to model the Nation's topography in 3D.



- Delivers the terrestrial component of the 3D Nation vision of a continuous data surface from the depths of the oceans to the peaks of the mountains

- Provides universal discovery and sharing of water information as the geospatial foundation for the Internet of Water

- Provides foundational data to critical initiatives
 - FEMA Future of Flood Risk Data and Risk Rating 2.0
 - The National Water Model
 - The Clean Water Act
 - National Landslides Preparedness Act

- Enables new and emerging applications
 - Multiple vintages enable change detection
 - Water-related applications move from the neighborhood to the street-level in accuracy

- Underpins a broad range of applications including flood risk management, hazards response and mitigation, infrastructure management, climate change science, and more

THANK YOU!





Department of the Interior Priorities *(slide 1 of 4)*

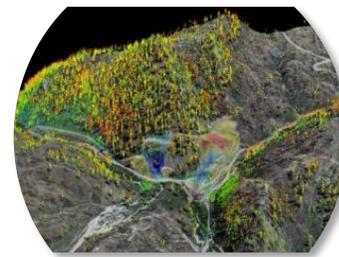
Foundational 3DEP data underpin DOI and Administration priorities

- **Conservation** - multiuse land management, wildlife and habitat management, wetlands inventory and mapping, water resource management, and coastal zone management, biological carbon stocks assessment
- **Climate Science** – flooding, wildfire prediction, water quality and quantity, drought, and sea level rise and subsidence
- **Clean Energy Deployment** – solar, wind and geothermal power; calculating range for electric vehicles

3D Elevation Program Supports Climate Science



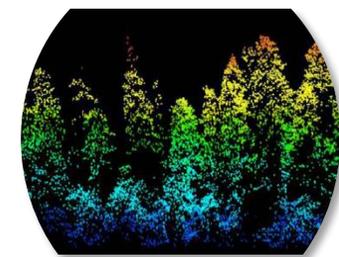
Flood forecast
and response



Wildfire
management



Sea-level rise
modeling



Habitat
management



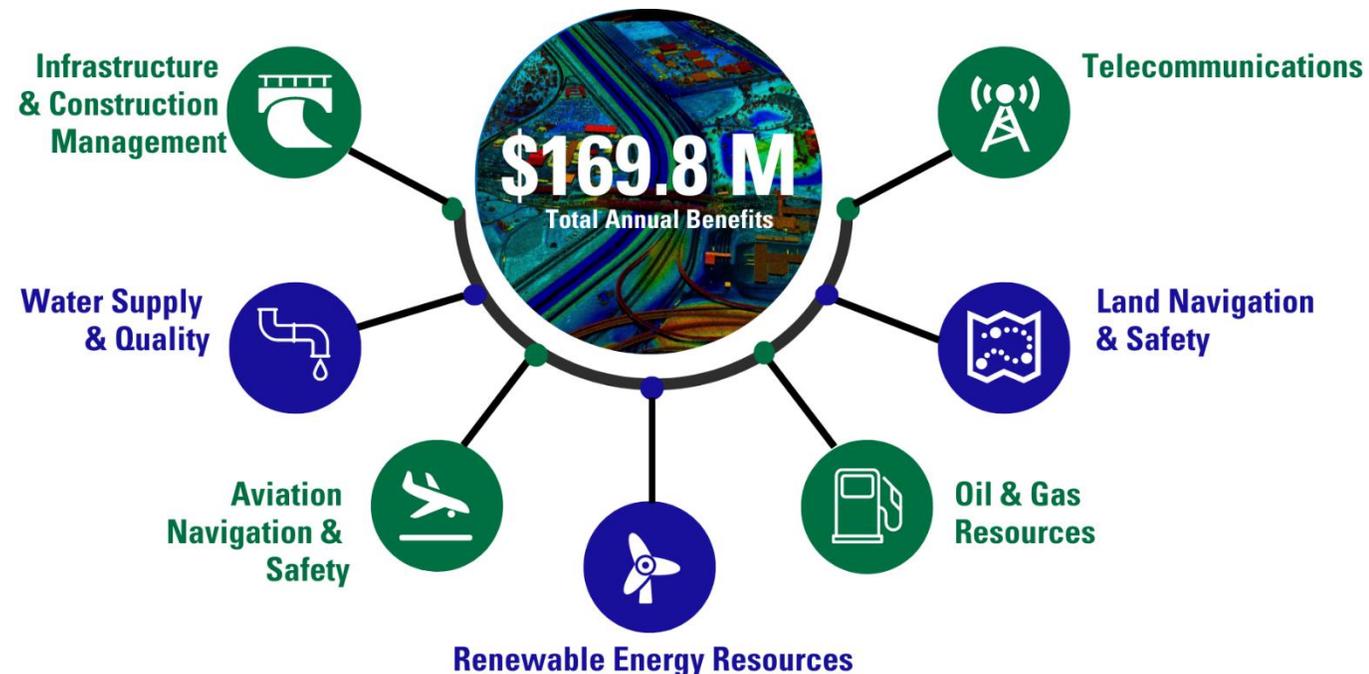
Department of the Interior Priorities *(slide 2 of 4)*

Foundational 3DEP data underpin DOI and Administration priorities

Infrastructure

- 3DEP, NHD, and geophysical data are foundational and directly applicable to a broad range of infrastructure applications
- Data acquired have a high ROI for infrastructure as well as a broad range of other applications
- Data are acquired by the private sector, creating jobs
- Data programs are “shovel ready”
- The Federal and industry capacity exist to execute and deliver
- Data acquisition is easily accounted for and auditable
- No new O&M tail is required
- We have shown success before with ARRA – a proven process

3D Elevation Program Infrastructure Benefits

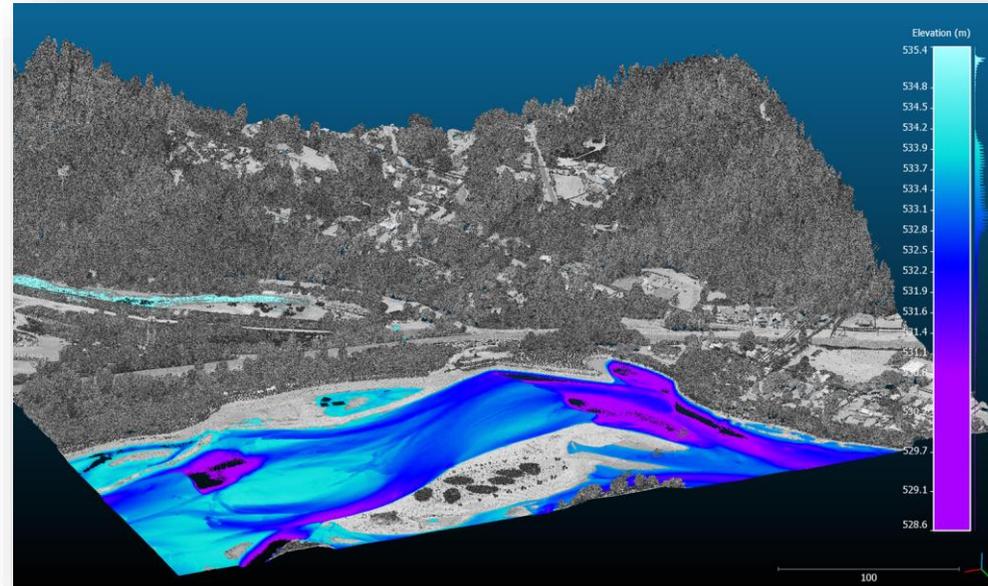




Department of the Interior Priorities *(slide 3 of 4)*

Foundational data and science underpin DOI and Administration priorities

- **Reclamation Jobs Program:** applications to map and transform orphan oil and gas well infrastructure and abandoned mine lands, and transition away from coal production
- **Economy** - data are acquired and value-added by the private sector, creating jobs and fueling user industries
- **Tribal Programs** – natural resources management, infrastructure development and maintenance, cultural resource preservation, climate science



Klamath, Kootenai, and Nisqually Tribes: using bathymetric lidar data for fish habitat restoration

Nez Perce Tribe: using lidar data to assess hazards including post-fire landslides, debris flows, and floods, and to assess ecosystem restoration in disturbed areas





Department of the Interior Priorities *(slide 4 of 4)*

Foundational data and science underpin DOI and Administration priorities

■ Racial and Economic Equity

- Applications for flooding and other hazards that disproportionately affect underserved communities
- 3DEP data can help improve maps of broadband accessibility to help address the digital divide for students in rural and underserved communities, even in urban areas

Facebook Line of Sight Tool- ISP Toolbox

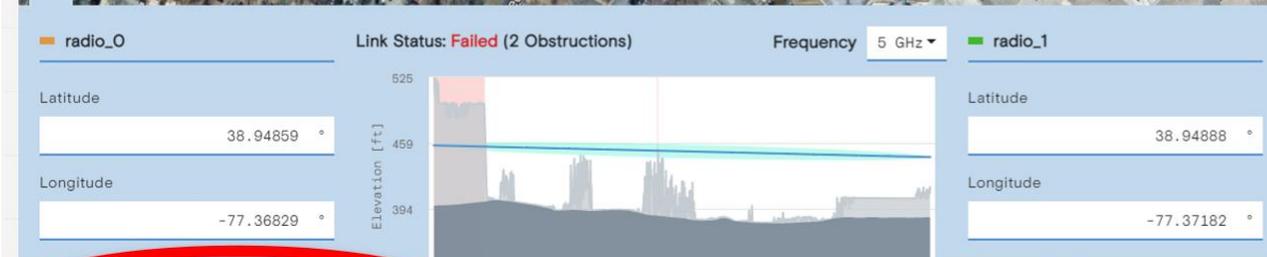
ISP TOOLBOX [beta] by FACEBOOK

Business Tools ▾

Network Tools ▾



3DEP lidar point cloud used to identify trees, buildings, or terrain that can block broadband signals



1. LiDAR Data Obtained Via USGS 3DEP. Last updated date can be found in the legend tooltip.



National Landslides Preparedness Act (P.L. 116-323)

Authorizes the 3D Elevation Program and Establishes Governance

- Establishes a 3DEP Federal Interagency Coordinating Committee, chaired by the Secretary of the Interior in coordination with the Secretary of Commerce and the Secretary of Homeland Security including:
 - Agriculture
 - Commerce
 - Homeland Security
 - National Science Foundation
 - Office of Science and Technology Policy
 - Office of Management and Budget
 - The head of any other Federal department or agency, at the request of the Secretary

- Within a year, the coordinating committee will develop a strategic plan and a management plan to implement the strategic plan

- Creates a subcommittee of the National Geospatial Advisory Committee, an entity authorized under the National Geospatial Data Act of 2018 (P.L. 115-307), to advise the 3D elevation program interagency coordinating committee
 - Not later than 1 year after the date of enactment, and every 2 years thereafter, the advisory committee will provide a report to the coordinating committee with recommendations for implementing and advancing 3DEP

National Landslides Preparedness Act (P.L. 116-323)

Goals for 3DEP FICC and NGAC Subcommittee

- Merge/evolve 3DEP Executive Forum with/to the FICC so there is only one executive committee; ensure that the 3DEP Working Group is linked to the FICC
- Evolve towards broader coordination for the future direction of the 3D National Topography Model (3DNTM), and eventually including both elevation and hydrography (Waters Inland and the National Hydrography Infrastructure Working Group)
- Encourage engagement at highest levels of DOI, DHS and DOC and listed agencies; invite new agencies to participate
- Potential topics for both groups
 - Funding
 - What creative funding options should we be looking at to complete nationwide coverage?
 - How can we complete Federal lands where the agencies do not have 3DEP funding?
 - Delivery/distribution
 - How can we improve our delivery/distribution?
 - What new products or pre-processed information should we be offering?
 - Future directions
 - Input on the 3D National Topography Model
 - Recommendations on research and future implementation of the 3D data model
 - Best practices for 3DNTM partnerships and governance