The following was presented at DMT'12
(May 20-23, 2012).

The contents are provisional and will be
superseded by a paper in the
DMT'12 Proceedings.

See also earlier Proceedings (1997-2011)
http://ngmdb.usgs.gov/info/dmt/

3-D Elevation Program

May 22, 2012

Larry Sugarbaker
Senior Advisor, National Geospatial Program

USGS

The National Map

National Elevation Dataset

A Rich History

Lithographic Section preparing stone blocks used in the printing of topographic maps. USGS, 1917

Cartographer Yutaka Hamamoto working on a Wild A-7 stereoplanigraph. USGS, 1968

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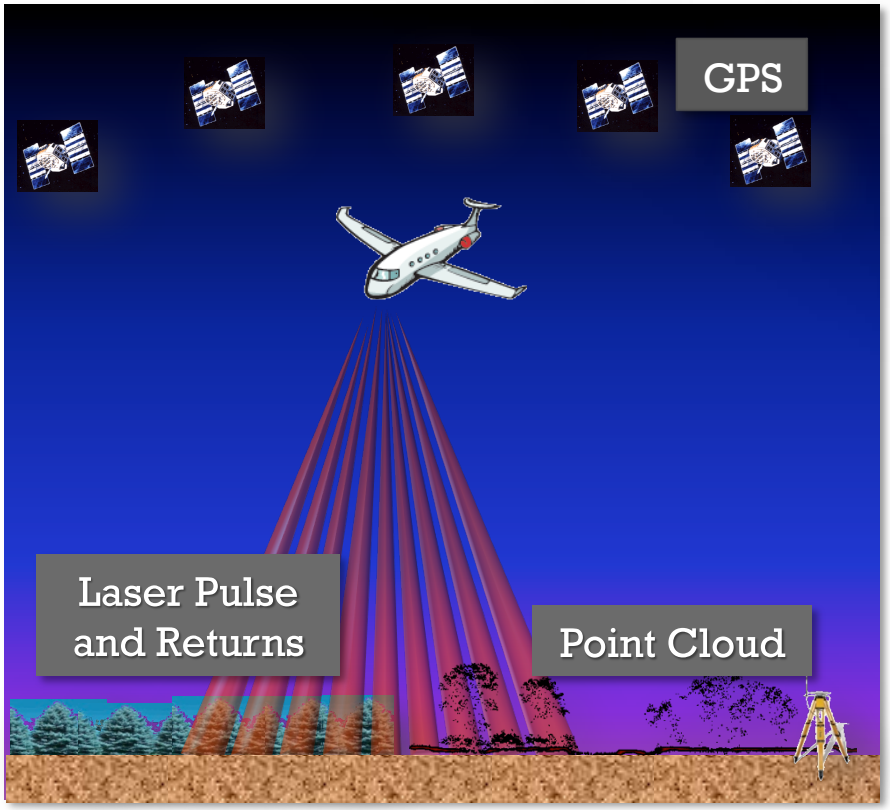
+ Two Modern Technologies of Choice

Light detection and ranging (LiDAR)

- System with a laser and detector (range), scanning mirror (laser direction), GPS (location), and IMU (orientation).
- 300,000+ laser pulses per second
- Billions of recorded points create 3-dimensional representation of bare earth, vegetation and structures at centimeter-level accuracy.

Interferometric synthetic aperture radar (IfSAR)

- Cloud penetration
- Lower acquisition cost than lidar



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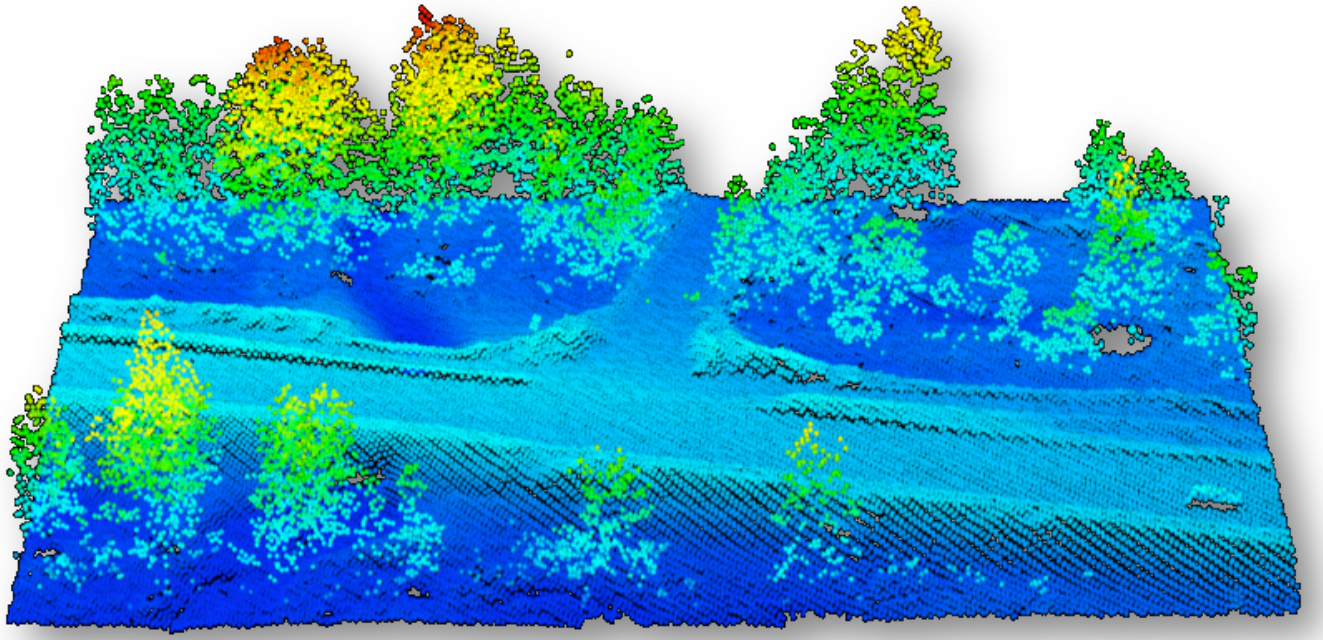
What Does LiDAR Measure?

- Ground
- Roads and other surface features
- Vegetation
- Structures



LiDAR return data colored by height

Courtesy USFS

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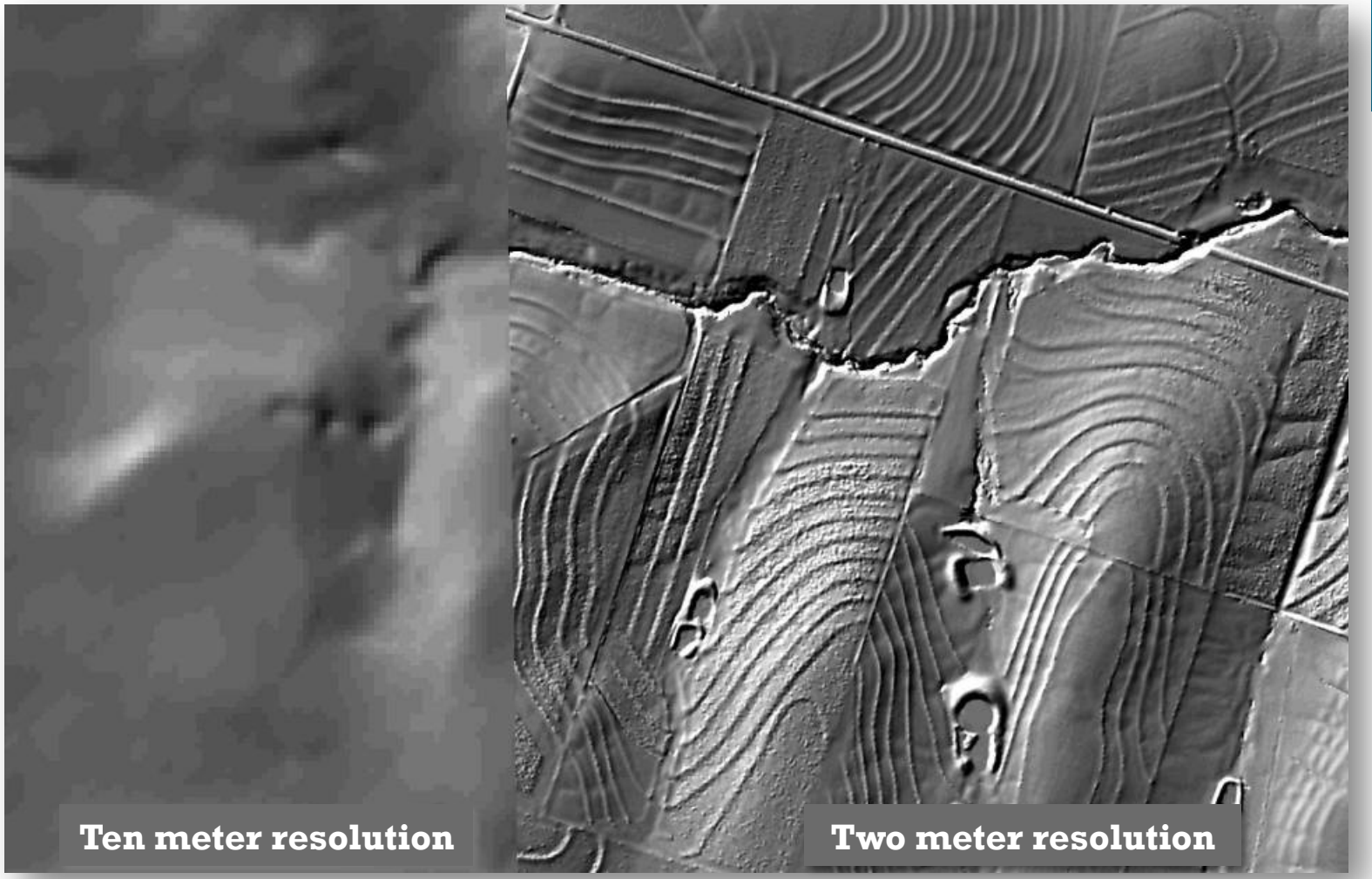
+ LiDAR Improves Data Quality



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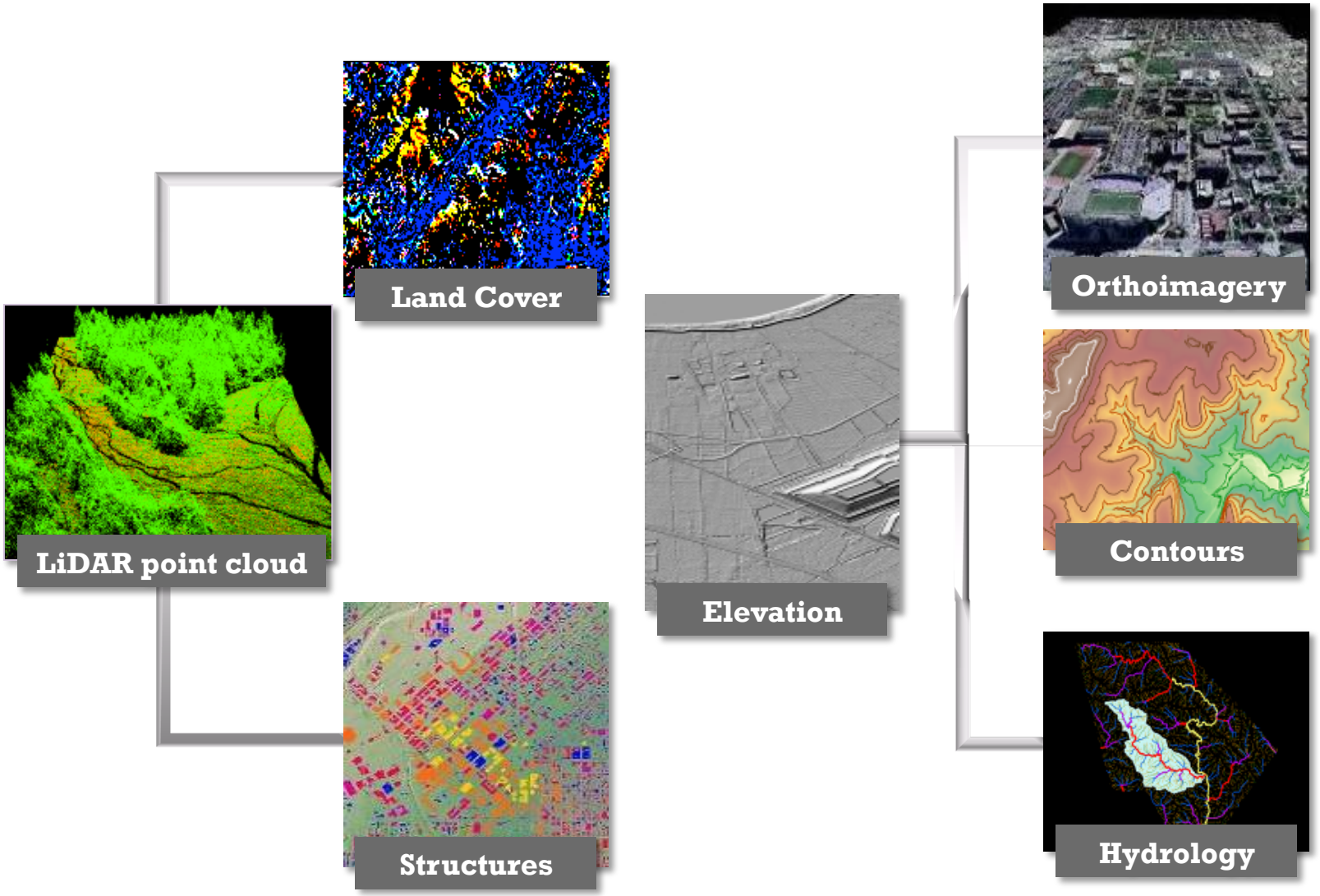
Courtesy of NRCS

LiDAR Point Cloud and Derived Elevation Products

Supports Data Development and Geospatial Data Integration



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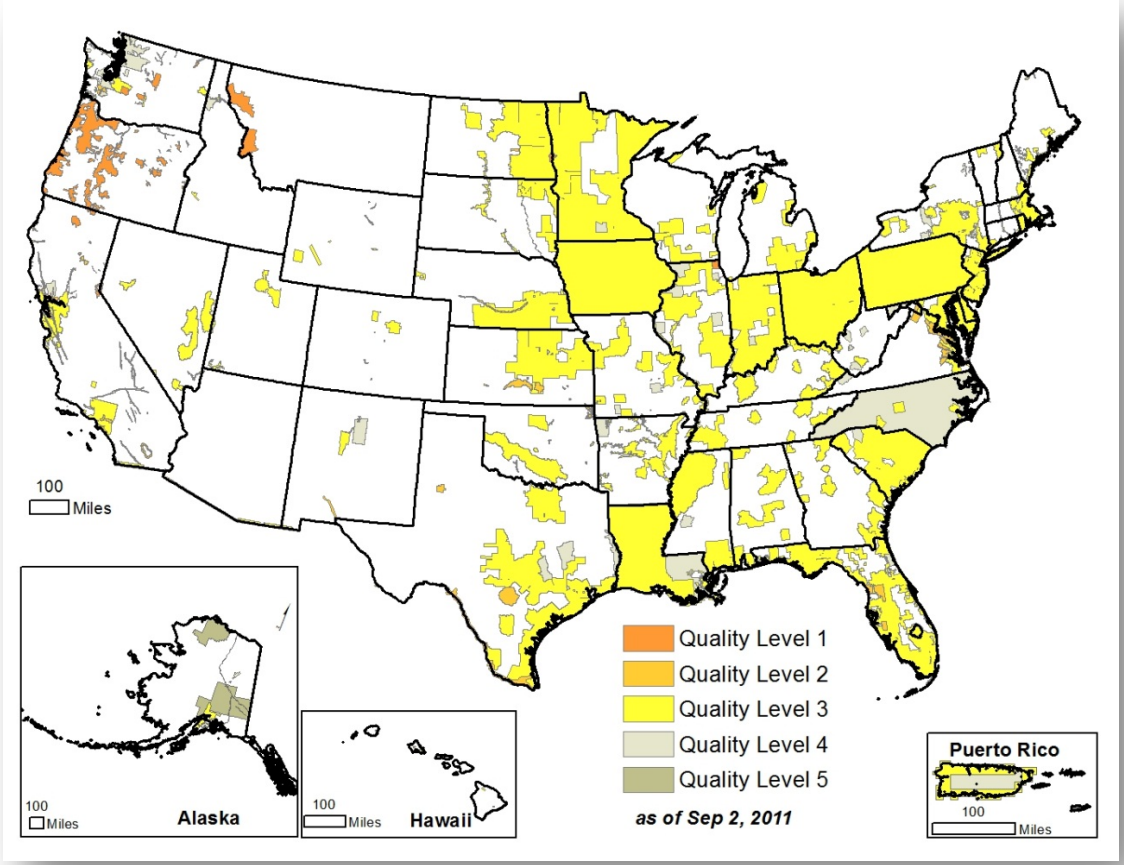
Current Status of the Nation's Elevation Data

NEEA Inventory Results

Map depicts public sources of LiDAR in all states plus IfSAR data in Alaska



1996 - 2011

- 28% coverage - 49 states
- 15% coverage – Alaska
- 30+ year replacement cycle
- Program is well coordinated – less than 10% overlap of coverage
- Data quality variable

Why is this a problem?

- Remaining 72% coverage is 30 or more years old.
- Alaska – very poor quality
- Meets 10% of reported needs
- Current and emerging needs require higher quality data

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National Enhanced Elevation Assessment

At a Glance

- Sponsored by the National Digital Elevation Program (NDEP) and funded by USGS, NGA,FEMA, NRCS and NOAA to:
  - Document national requirements for improved elevation data from technologies such as LiDAR and IfSAR
  - Estimate the benefits and costs of meeting these requirements
  - Evaluate multiple national enhanced program scenarios
- 602 mission-critical activities that require enhanced elevation data were identified by:
  - 34 Federal agencies
  - 50 states
  - A sampling of local governments, tribes, private and not-for profit organizations
- **A national program has the potential to generate $1.2 billion to $13 billion in new benefits each year when fully operational**

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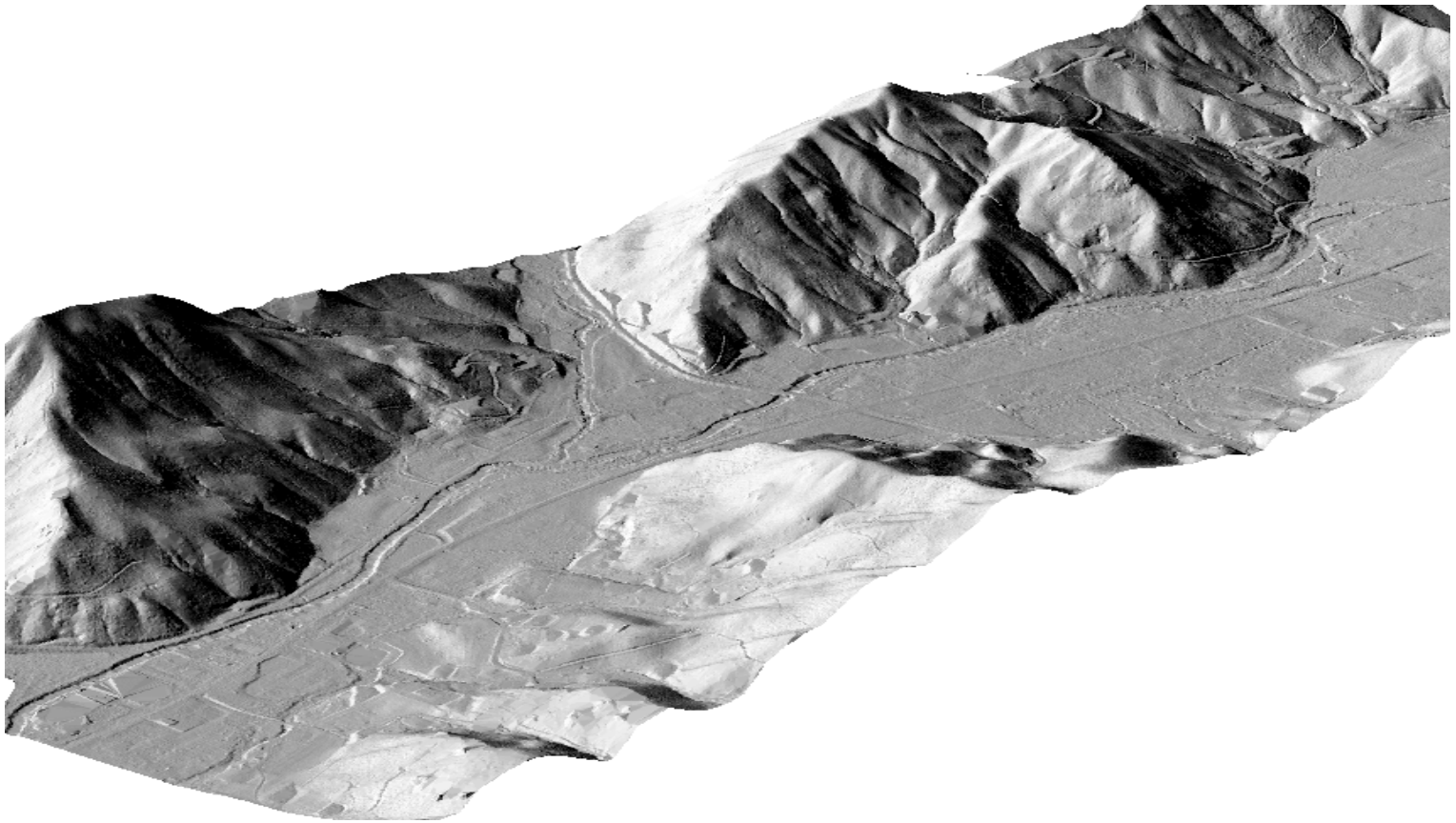
+ Oil and Gas Resources

LiDAR slope data is essential for pipeline routing across mountain ranges and beneath rivers (as shown here) **construction planning, encroachment control, and asset inventories.**



From NEEA Study, 2011

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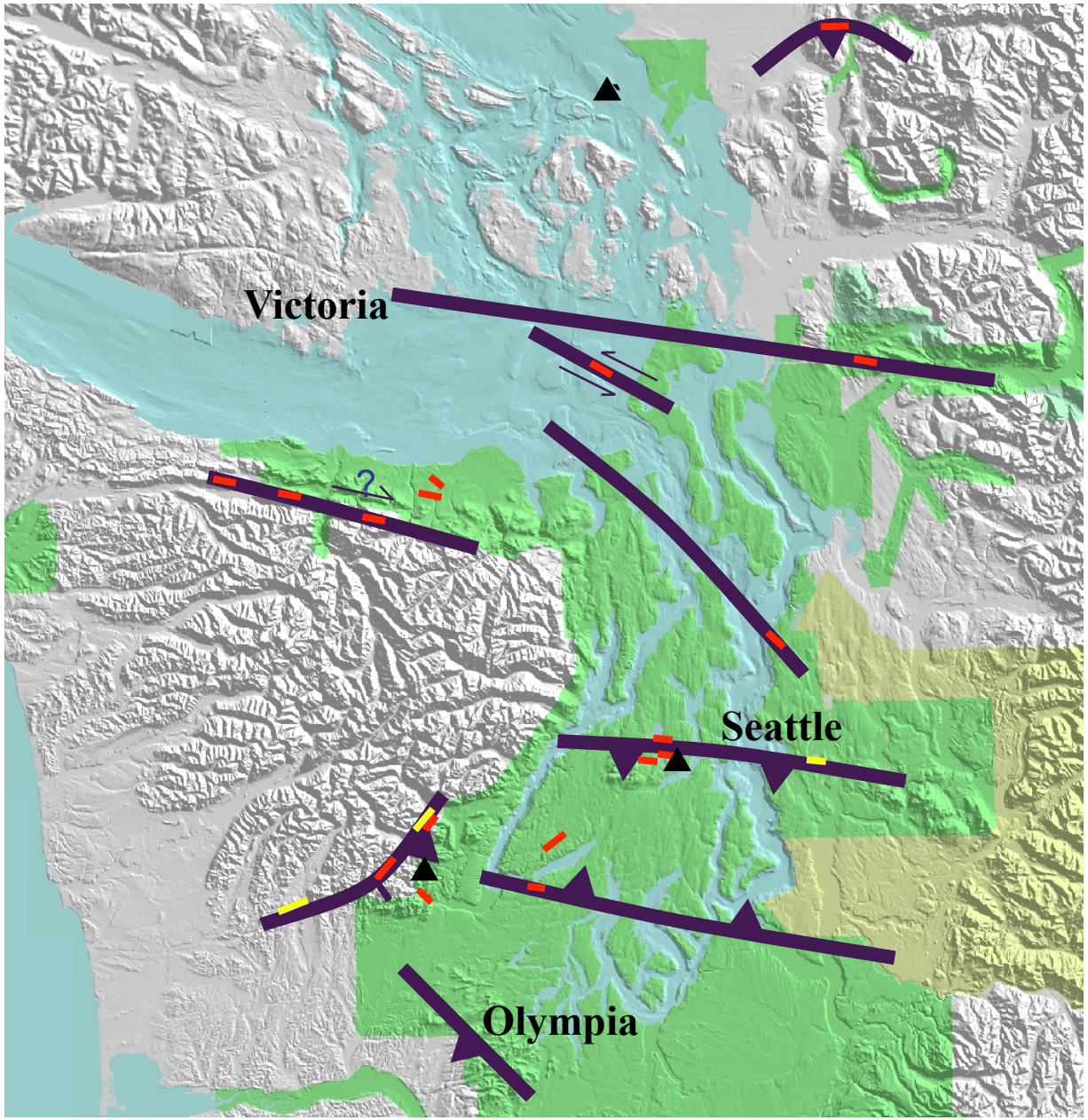
Detecting Faults



Scarp found with LiDAR

Scarp found other means

Geomorphic evidence of shoreline uplift

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Holocene Tectonism PI: Ralph Haugerud, USGS

+ Landslide Inventory

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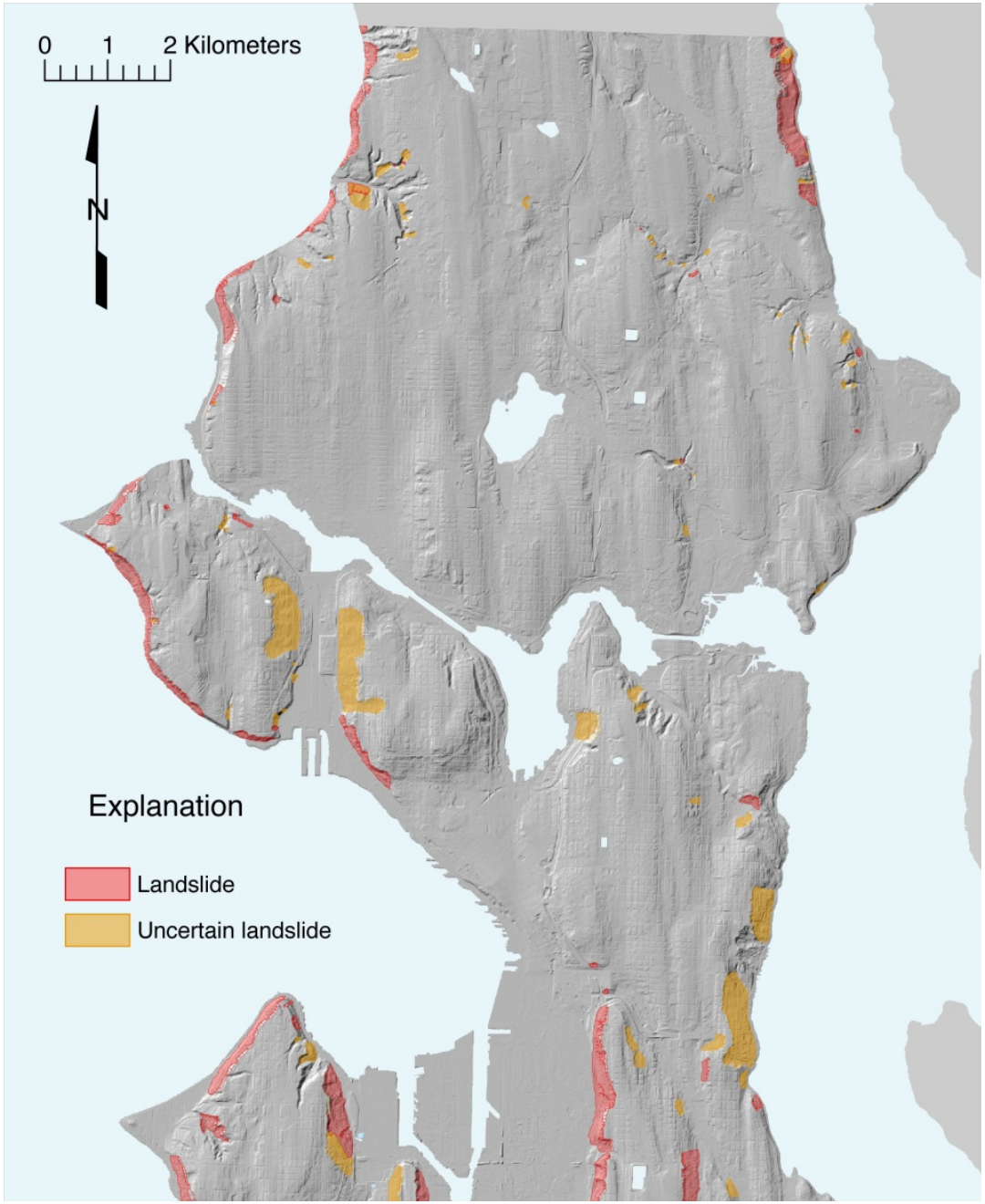
+ Landslides mapped using LiDAR imagery

Seattle, Washington



USGS, William H. Schultz, Open-File Report 2004-1396

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Data Quality Levels

Quality Levels	Data Source	Horizontal Resolution	Vertical Accuracy	
		Point Density	RMSEz in Open Terrain	Equivalent Contour Accuracy
QL 1	LiDAR	8 points/m^2	9.25 cm	1 foot
QL 2	LiDAR	2 points/m^2	9.25 cm	1 foot
QL 3	LiDAR	1 – 0.25 points/m^2	≤18.5 cm	2 feet
QL 4	Imagery/ LiDAR	1 – 0.04 points/m^2	46.3 – 139 cm	5 – 15 feet
QL 5	Imagery/ IFSAR	0.04 points/m^2	92.7 – 185 cm	10 – 20 feet

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Example: Geologic Resource Assessment and Hazards Mitigation (3 of 9 USGS activities)

Mission critical use: Identify areas, level of activity and risk associated with earth hazards to reduce losses and increase public safety

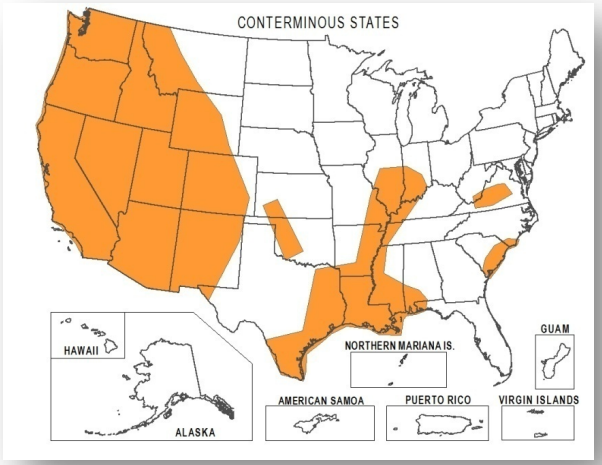
Update frequencies: 4-10 years

Expected combined benefits: $31.25M/year

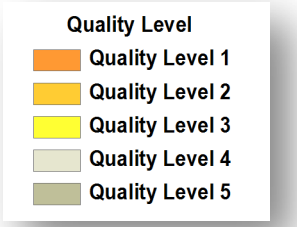
Data requirement: Predominantly quality level 1

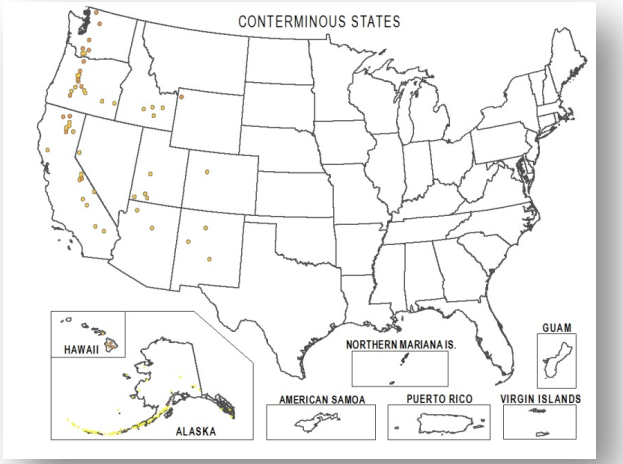
Example applications:

- Identify faults/landslides under thick vegetation
- Enhance infrastructure engineering design
- Estimate size, speed and effects of landslides
- Create loss mitigation strategies
- Provide maps and models to emergency planners

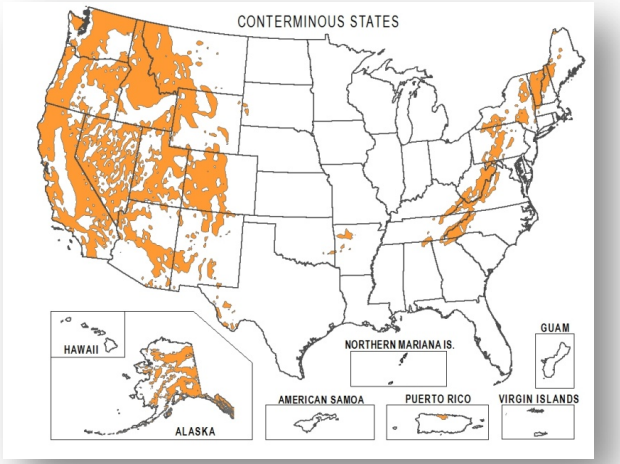


Seismic





Volcanos



Landslides

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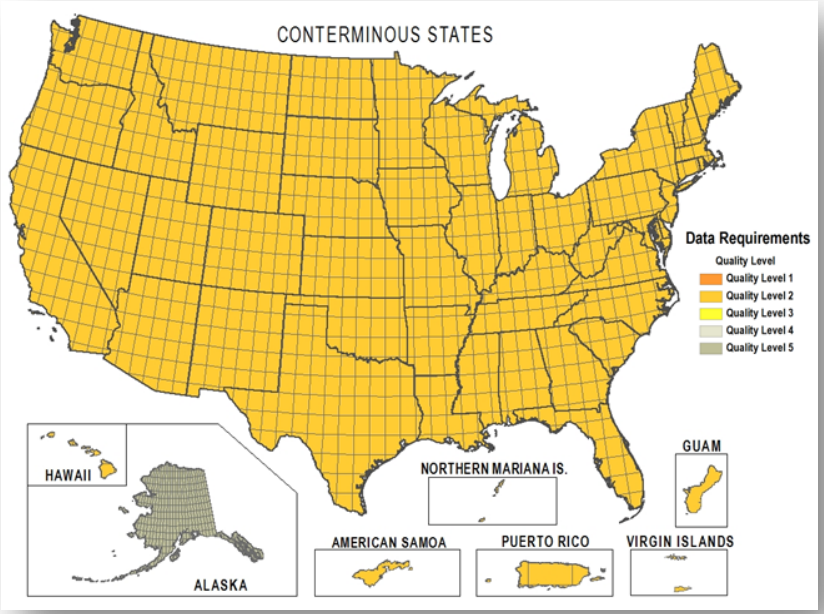
3-D Elevation Program (3DEP) Recommended Uniform Quality Level 2

Partnership Funding Model with costs shared by benefiting Federal agencies and other State and local government cooperators



Scenario 3: 8 year acquisition

Avg. Annual Costs: $146M

Avg. Annual Benefits: $690M

Avg. Annual Net Benefits: $544M

B/C Ratio: 4.7:1

Total Possible Benefits Satisfied: 58%

Proposed program includes Quality Level 5 IfSAR data for Alaska

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