The New LiDAR Program at DNR: Collection, Analysis, and Dissemination

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DNR, Division of Geology and Earth Resources

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Division of Geology and Earth Resources

- The Division of Geology and Earth Resources (DGER) is the Washington State Geologic Survey, and is a part of the Department of Natural Resources (DNR). Responsible for:
  - Mining, oil and gas regulation
  - Geologic mapping
  - Geologic hazards
  - Geothermal exploration
  - Library and publications

LiDAR is a foundation dataset to support all of this work
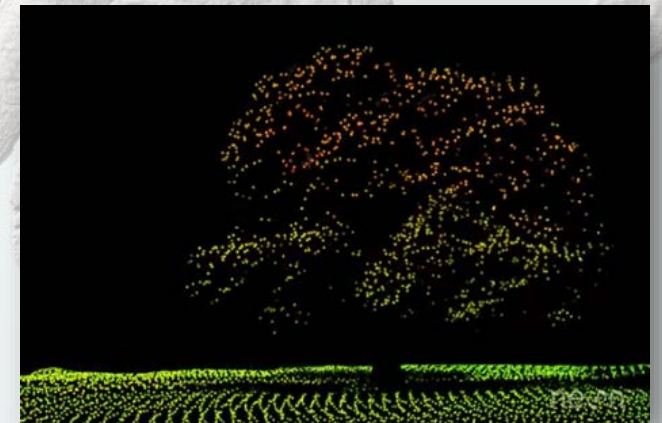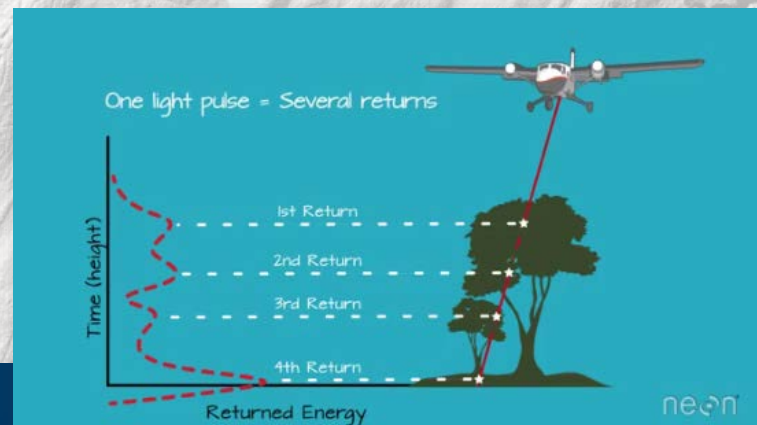
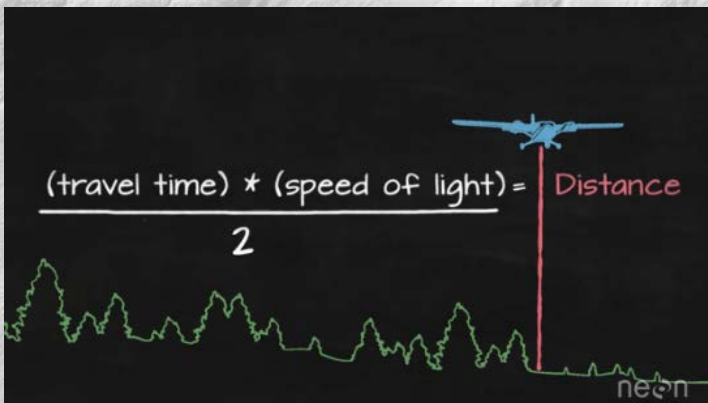WASHINGTON STATE DEPARTMENT OF
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DGER LiDAR Program Background

- RCW 43.92.025, 2015: The geological survey must conduct and maintain an assessment of hazards in Washington. The geological survey must acquire and process new LiDAR data or update deficient data and create and maintain an efficient, publically available database of LiDAR data
  - Funding for LiDAR data collection, storage, and dissemination
  - Two dedicated LiDAR positions
  - 4 new, dedicated landslide hazard positions
  - All since January 2016!

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What is LiDAR?

- Light Detection and Ranging (LiDAR) utilizes a pulsed laser to measure distance, typically from a sensor on a plane to the ground

- Measurements are accurate within 10-15cm and create a dense "point cloud" from the laser returns

- The returns can be filtered for ground or vegetation information, used to derive highly detailed digital elevation models

- Key points: high accuracy, high resolution, classified and can "see" through foliage

$$\frac{(travel\ time) * (speed\ of\ light)}{2} = Distance$$

neon

One light pulse = Several returns

1st Return
2nd Return
3rd Return
4th Return

Time (height)

Returned Energy

neon

LiDAR Applications

Geologic hazard mapping including landslides, faults and susceptibility

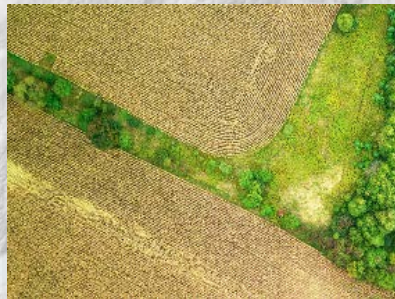Urban planning, infrastructure mapping, transportation
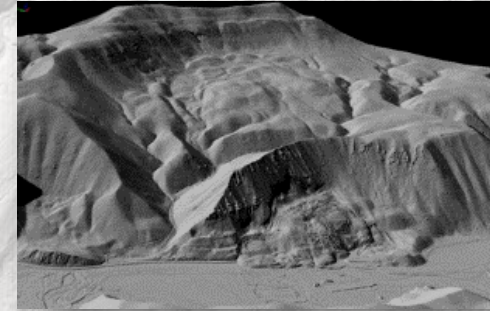
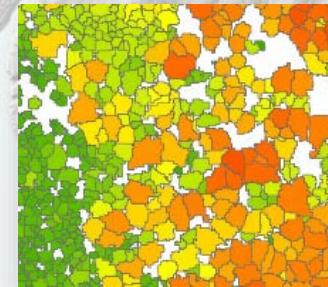Flood modeling, delineation of inundation zones
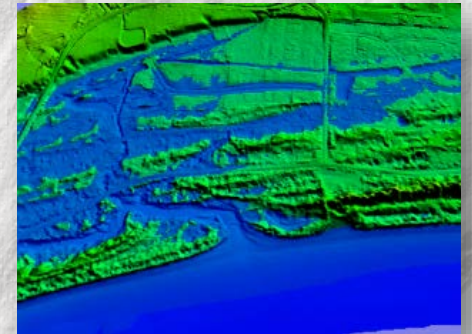
Wildfire mitigation

Agricultural applications including field drainage, sun-angle analysis

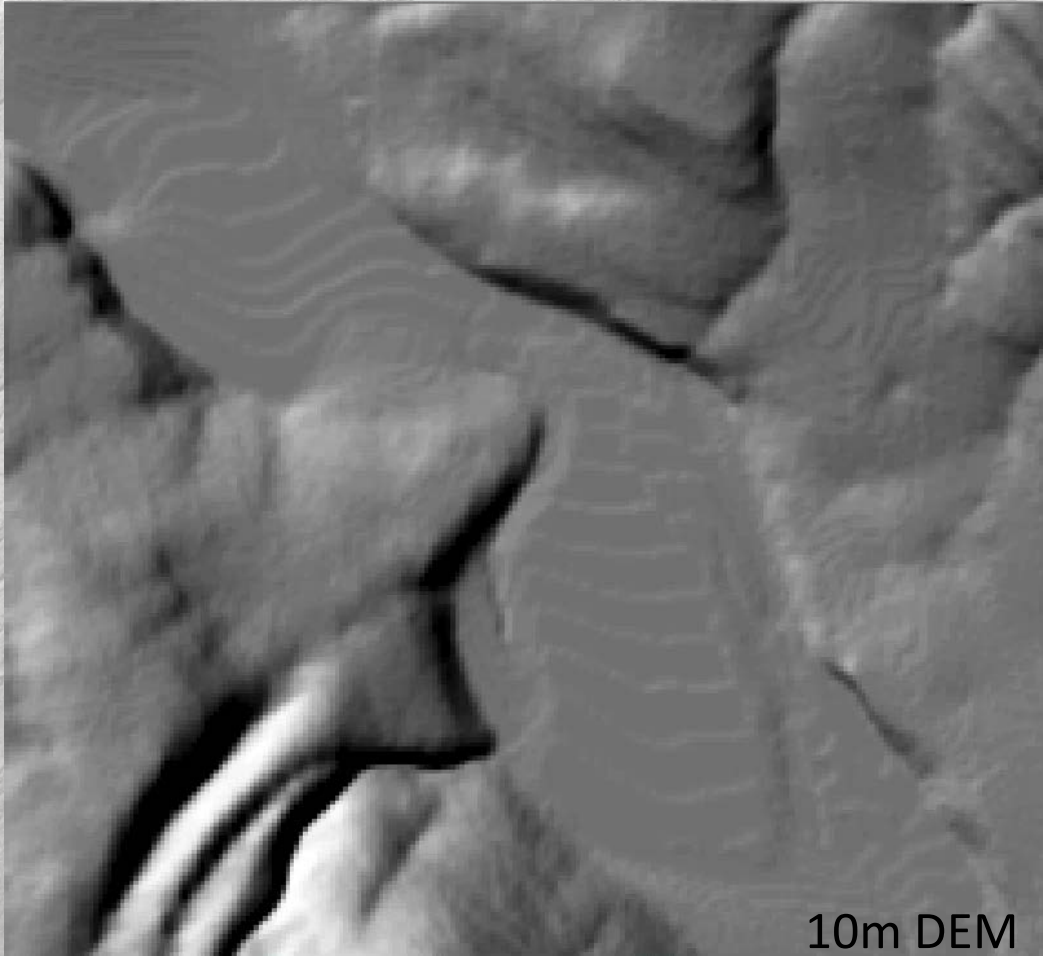Forestry and Environmental Monitoring

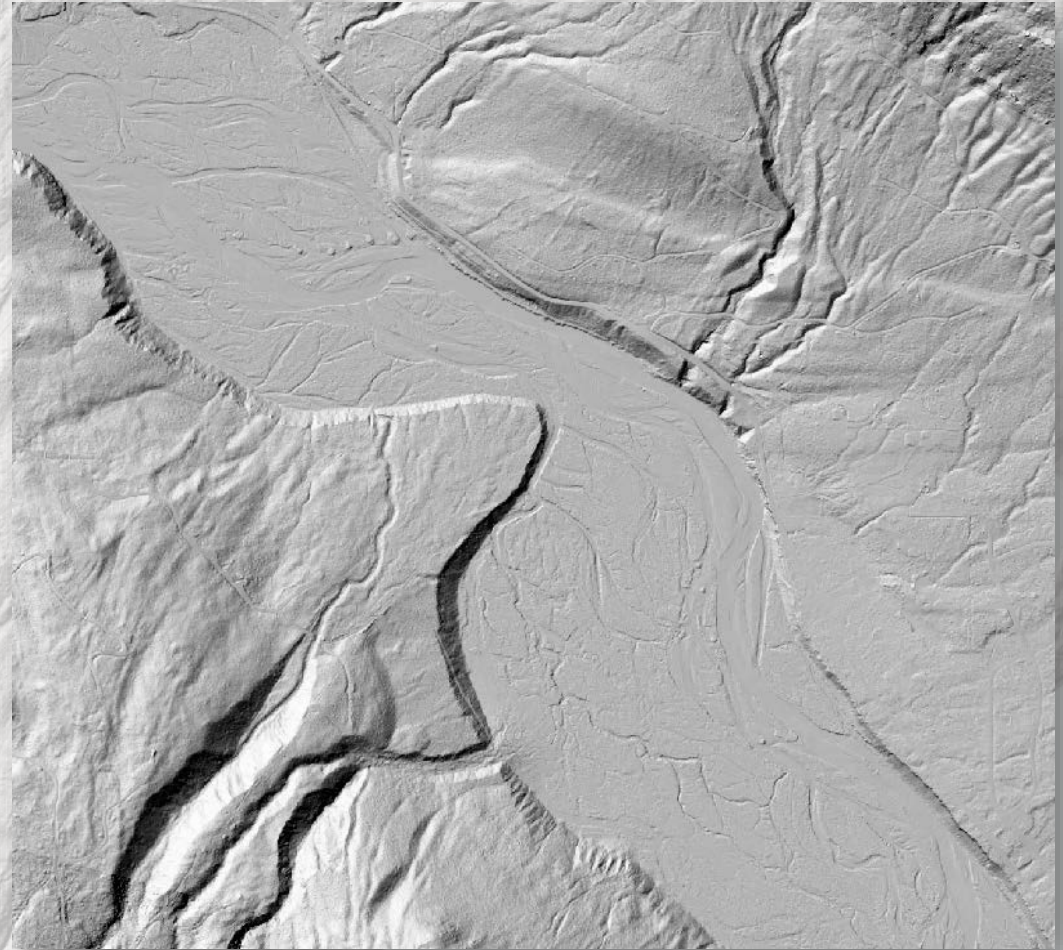# For the Love of 1064 nm

Sauk River

Van Zandt Landslide

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Paying Attention to Resolution and Quality

10m DEM

3ft 2006 North Puget LiDAR

3ft 2013 Nooksack LiDAR

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Current LiDAR Data….


...Depends on Quality

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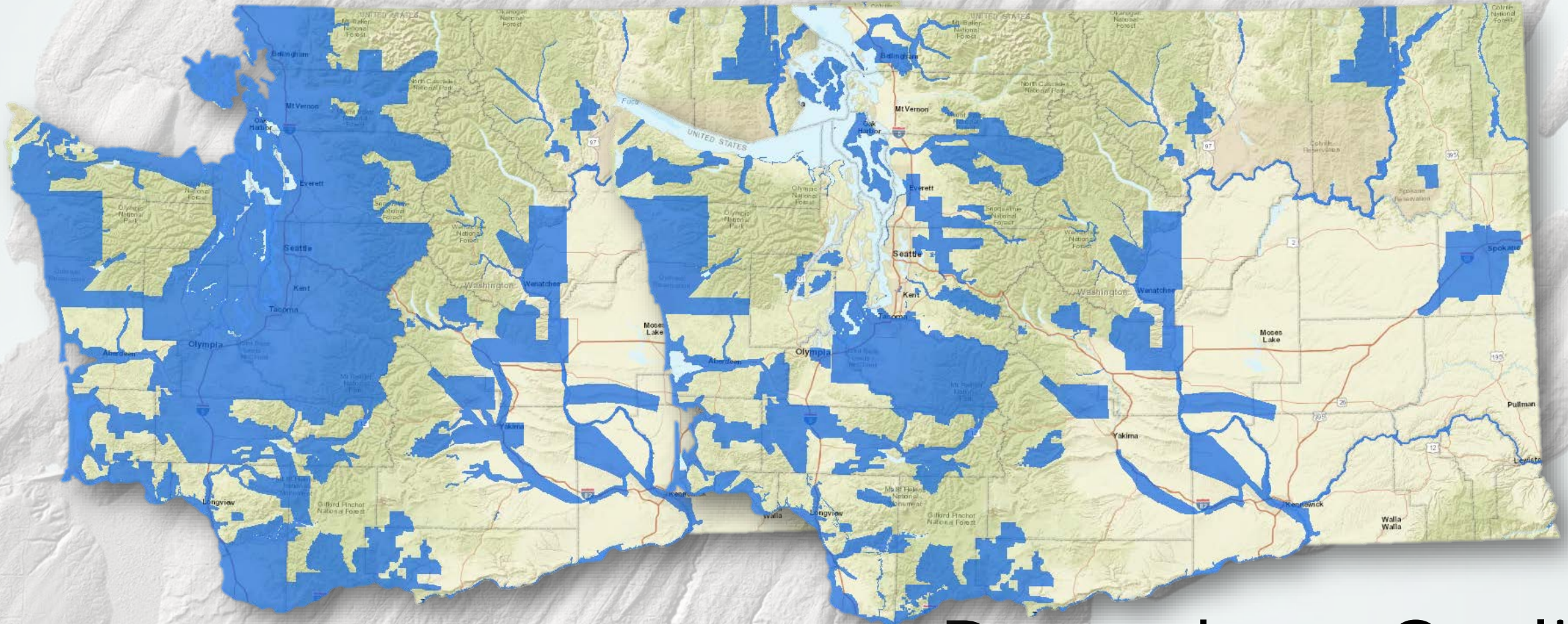
Goals for LiDAR Collection

- Consistent, high quality data that will support multiple applications
- Acquire in wide-area blocks, temporally consistent if possible
- Prioritize based on LiDAR "holes" and outdated information, hazards and population
- Economical use of funding and pooling resources
- Statewide collection – broad plan, subject to change and opportunities
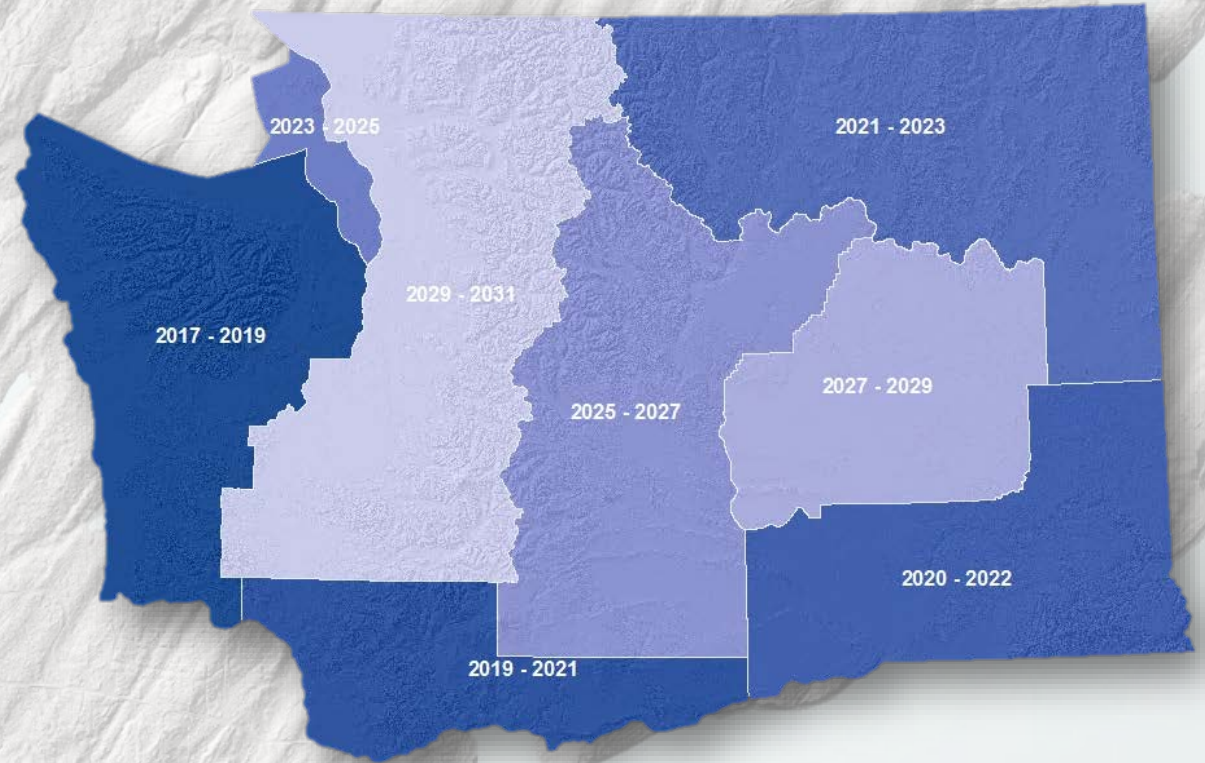
Challenges of LiDAR Quality and Collection

- Weather!
- Diverse environments
- Vegetation, "leaf-off"
- Different collection parameters
- **Cost**
- **Time**

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How LiDAR Data is Collected

It all starts with a plane, right?

For DNR, it starts with a contract
- Puget Sound LiDAR Consortium
- Geospatial Product and Services Contract (USGS)
- DNR Forest Resources Contract
- New options: DGER RFP

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Technical Specifications

- ≥ 4 pulses per square meter each swath, ≥ 8 ppsm aggregate
- ≥ 3 returns per pulse
- On ground laser beam diameter: 10-40cm
- Laser scan angle: ±15°
- 50% swath overlap
- Washington State Plane South projection
- Leaf off conditions in lower elevations, no snow or standing water
- Bathymetric LiDAR and orthophoto options
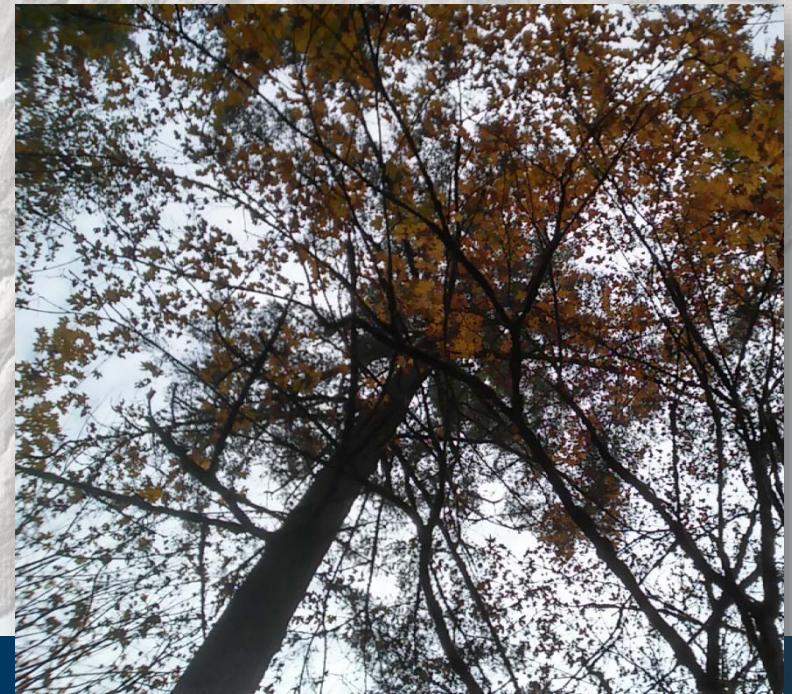
Current DGER LiDAR Projects

Legend:
- Willapa Doty Fault Project
- King County Project
- Western Washingtion 3DEP Project
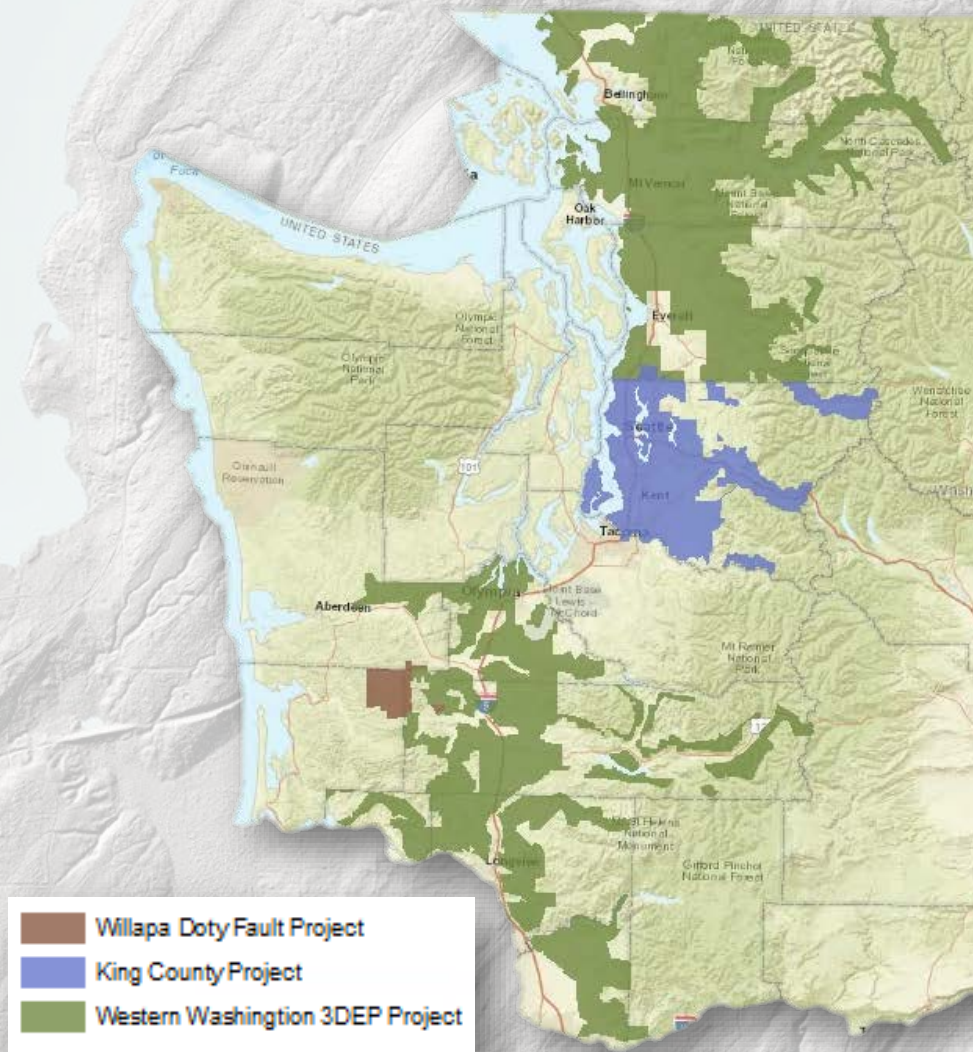
- King County
  - Partnership with the county and many of the cities, through the Puget Sound LiDAR Consortium
  - Will help continue hazards mapping into urban areas

- 3D Elevation Program (USGS grant)
  - Partners: Skagit, Snohomish, Whatcom, Lewis Counties, Sierra Pacific Industries, the Swinomish Tribe, Seattle City Light
  - Updates and acquires new data with higher quality and broader utility

- Willapa Doty Fault
  - Fault and geologic mapping

Near Future DGER LiDAR Projects

- USGS 3DEP grants submitted in October, to be flown in fall 2017
  - Western Washington – Olympic, Kitsap and Southwest
  - USFS and DNR also collecting in this region
  - Columbia and Garfield Counties applied to 3DEP
- Partnership is the best way to cover large areas, a high level of quality, and achieve collection goals

LiDAR Around the State

- If you know of any LiDAR work being done around the state, please let us know!

- If your agency or local government is thinking about LiDAR

  - Not too early to plan, even if collection may be a few years away

  - Welcome to contact DNR, we can help with specifications and other considerations

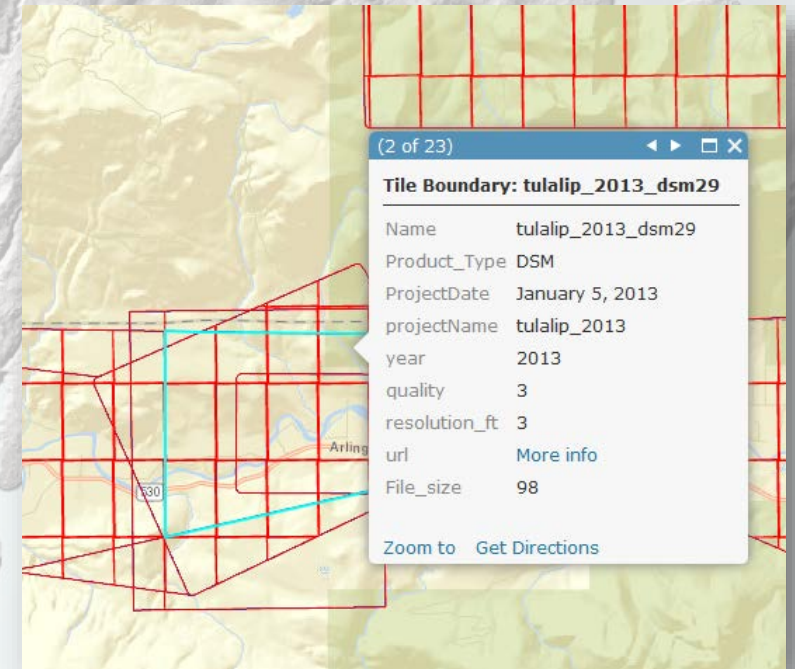 - Other interested groups may be present, DNR will try to track interest
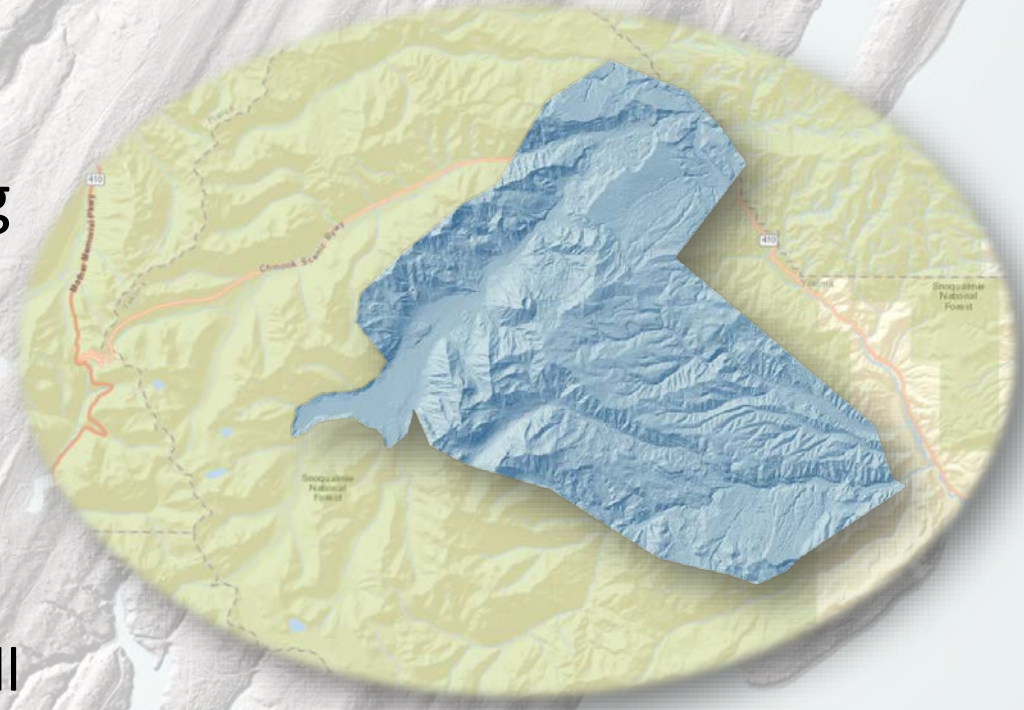
LiDAR Portal

- RCW 43.92.025, 2015: create and maintain an efficient, publically available database of LiDAR data

- Current solution: partnering with Alaska DGGS
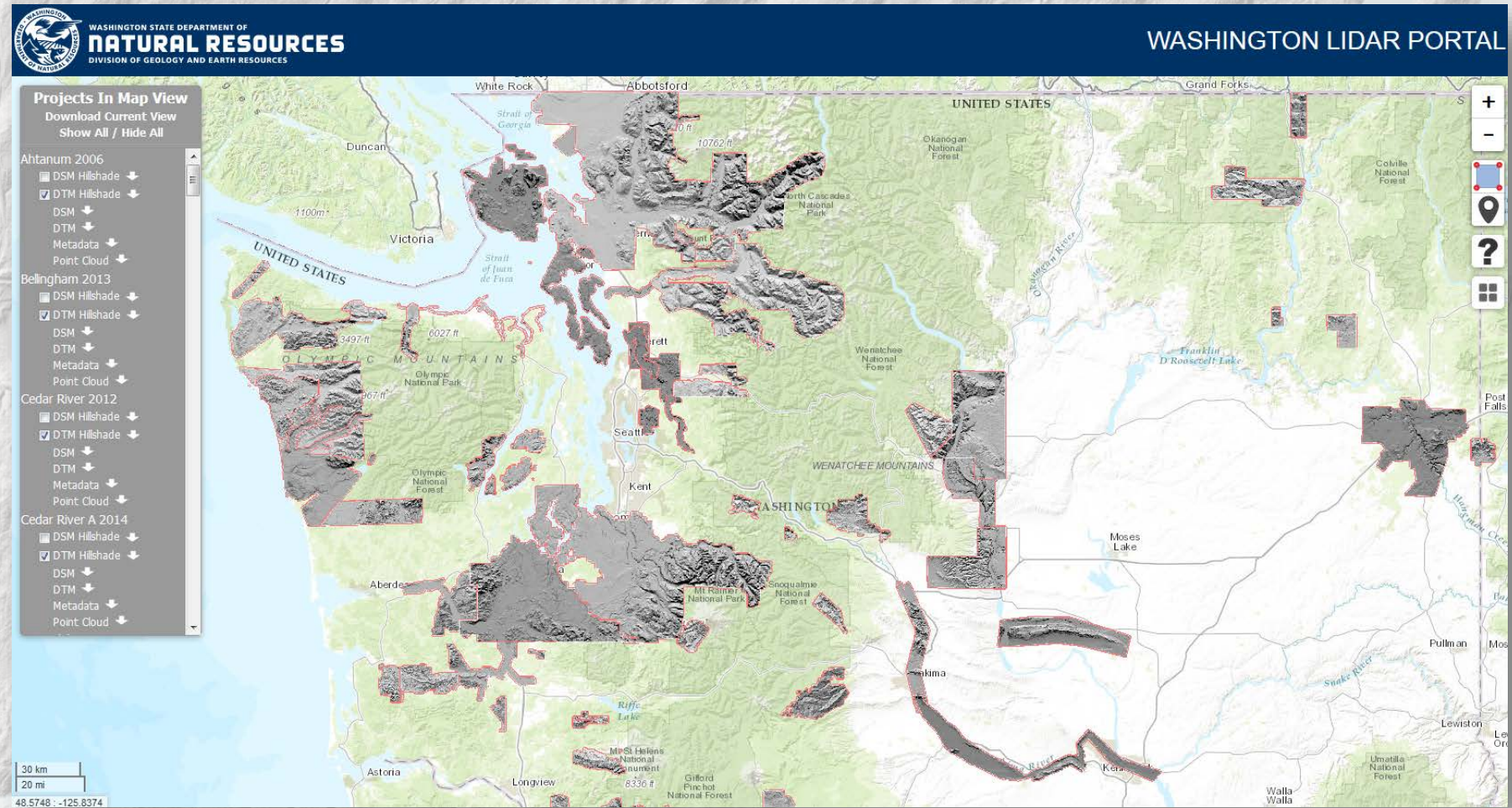
LiDAR Portal

- Current solution: partnering with Alaska DGGS
  - Offers LAZ point cloud files, bare-earth and top-surface rasters, hillshades
  - Tiled to allow for user specified download
  - Image services will be available

- Lots of other solutions:
  - Esri – we completed a pilot project this summer
    - Cloud storage with Amazon
  - WaTech
    - Local storage

(2 of 23)

Tile Boundary: tulalip_2013_dsm29

Name	tulalip_2013_dsm29
Product_Type	DSM
ProjectDate	January 5, 2013
projectName	tulalip_2013
year	2013
quality	3
resolution_ft	3
url	More info
File_size	98

Zoom to   Get Directions

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Working with LiDAR Data - GIS

- LAS point clouds
  - Quality Assurance and statistics
  - Visualization and analysis

- Digital Elevation Models, Rasters, and Derivatives
  - Managed through Mosaic Datasets
  - Disseminated to public using Mosaic Datasets and image services
  - Raster functions

Individual tiles or DEMs   Mosaic Dataset

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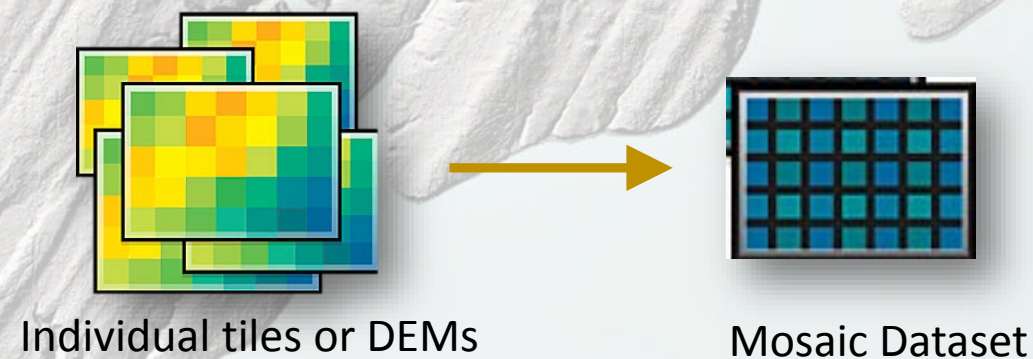
LiDAR data – LAS Point Clouds

- LAS (LASer file format) is a public, binary file format designed to support large 3-dimensional datasets

- Whereas a Raster format holds x,y,z data, LAS files contain x,y,z, GPS timestamp, intensity, return number, point classification, scan angle, RGBIR values, point source ID, number of returns, and other user defined data

- Given that a LiDAR pulse may have multiple returns at the same x,y location (ground and tree branch, for example), cell based formats do not work. Instead a point cloud format that can carry all of the information for multiple returns at the same x,y location

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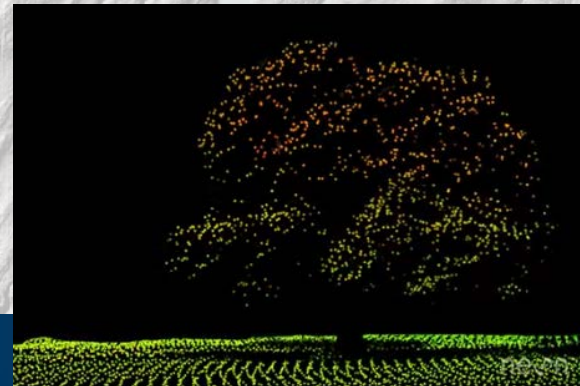
Working with LAS data in ArcGIS

- LAS Dataset
  - Pointer to LAS data
  - Allows 2D and 3D views of point cloud
  - Provides detailed statistics about information stored in LAS file
  - Allows filtering based on point classifications
  - Used to make edits to the source LAS files
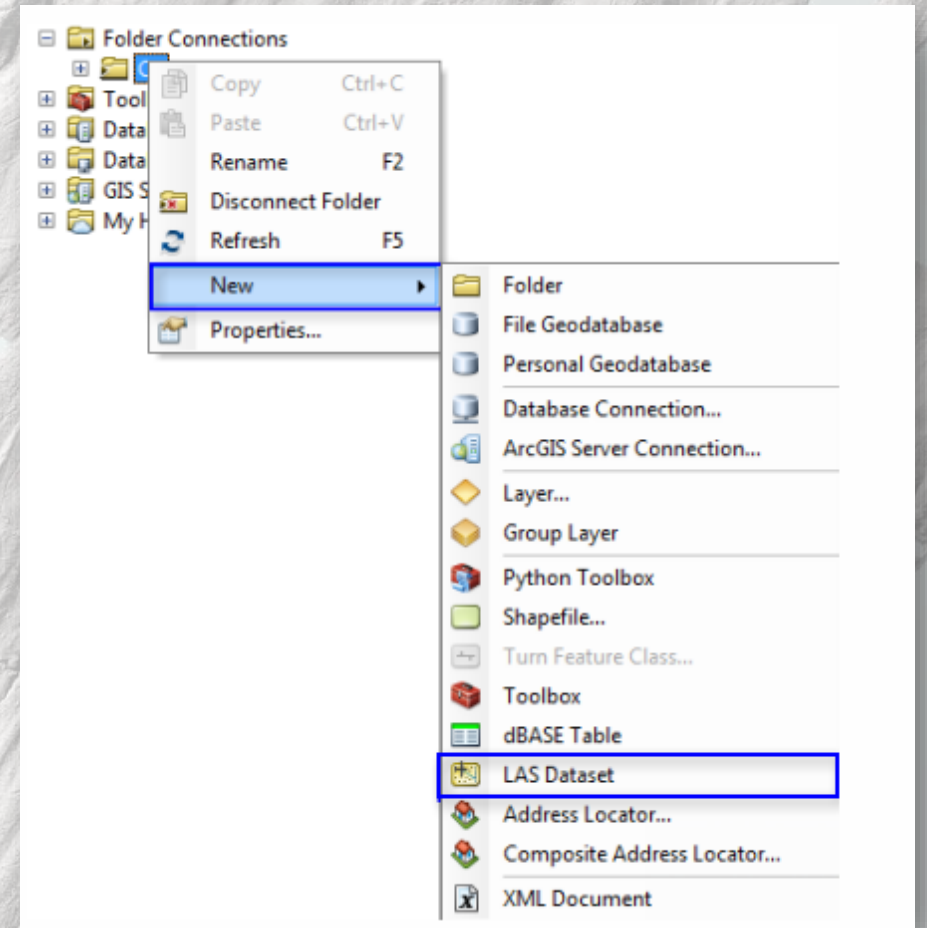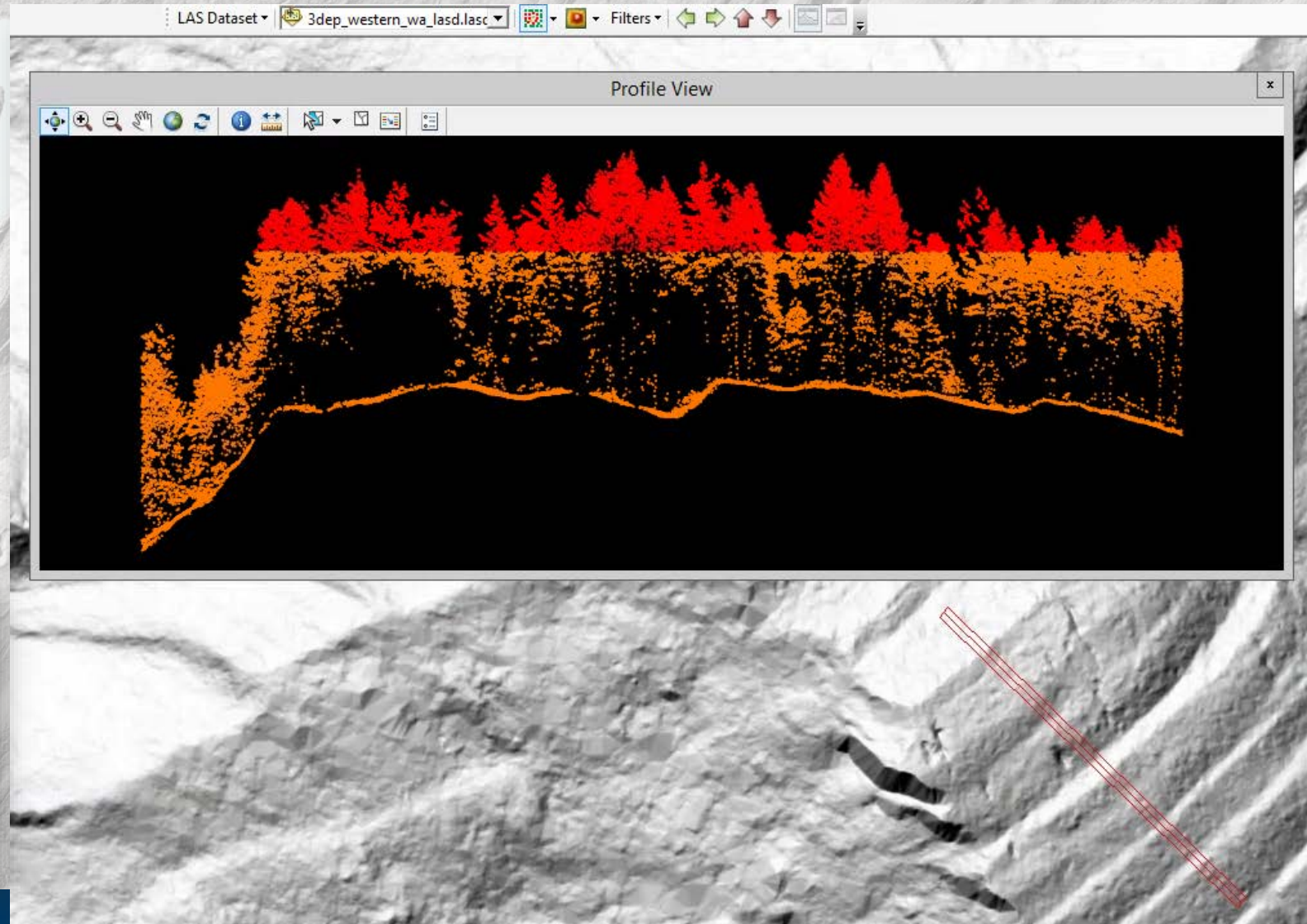
LASD Result and LAS Toolbar

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LASD – Viewing the Data

LAS point elevation
- 2289.56 – 2613.18
- 1997.284 – 2289.56
- 1705.009 – 1997.284
- 1412.733 – 1705.009
- 1120.457 – 1412.733
- 828.181 – 1120.457
- 535.906 – 828.181
- 243.63 – 535.906
- -583.07 – 243.63

LASD – Profile Views

LAS point elevation
- 2289.56 - 2613.18
- 1997.284 - 2289.56
- 1705.009 - 1997.284
- 1412.733 - 1705.009
- 1120.457 - 1412.733
- 828.181 - 1120.457
- 535.906 - 828.181
- 243.63 - 535.906
- -583.07 - 243.63

LASD – Profile and 3D Views
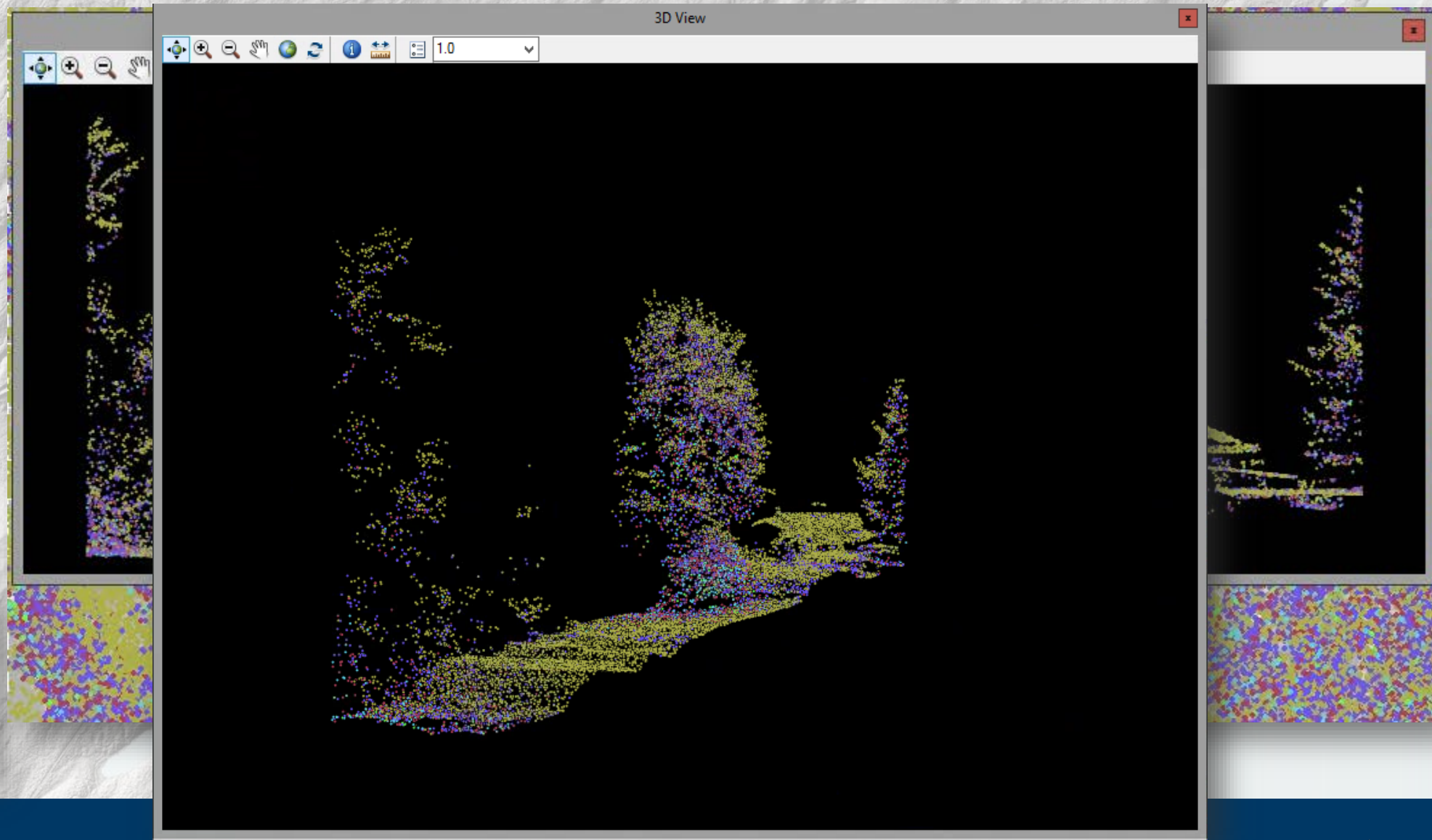
LAS Dataset Toolsets

- Create LAS Dataset
- Add Files to LAS Dataset
- Remove Files from LAS Dataset
- LAS Dataset Statistics
- Locate Outliers
- LAS Point Statistics by Area
- Point File Information
- LAS Point Statistics as Raster
- Make LAS Dataset Layer
- LAS Dataset to Raster
- LAS Dataset to TIN
- LAS to Multipoint

- Classify LAS by Height
- **Classify LAS Building***
- **Classify LAS Ground***
- Set LAS Class Codes
- Locate LAS Points by Proximity
- **Extract LAS***
- **Tile LAS***
- Surface Contour
- Surface Aspect

*new in ArcGIS 10.4 or ArcPro

Make LAS Dataset Layer

LAS Point Statistics as Raster

Number of ground returns per cell

Value
High : 25

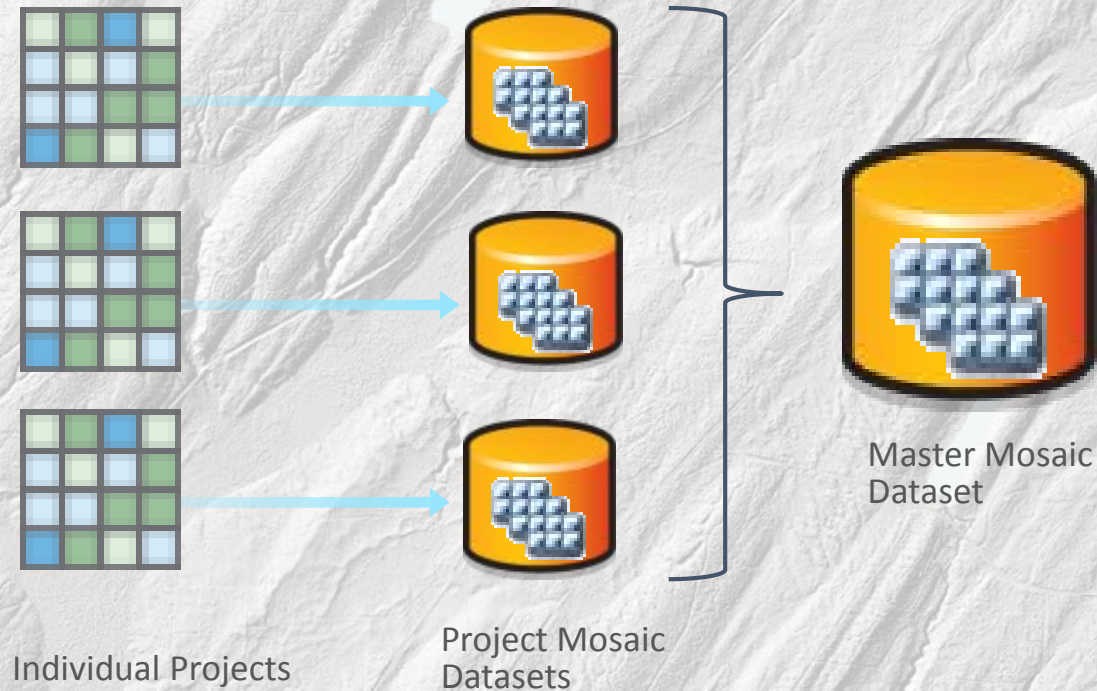Low : 1
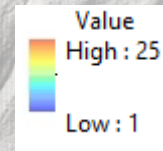
Managing Raster Products

- Mosaic Datasets within ArcGIS
  - Tiled data can be seamlessly merged together
  - The desired projection applied 'on the fly', meaning original data does not have to be reprocessed
  - Derivatives can be easily generated or viewed by applying raster functions
  - Mosaic Datasets can be applied to all rasters in the project and stored in the same geodatabase

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Data Management and Dissemination

Mosaic Dataset Structure
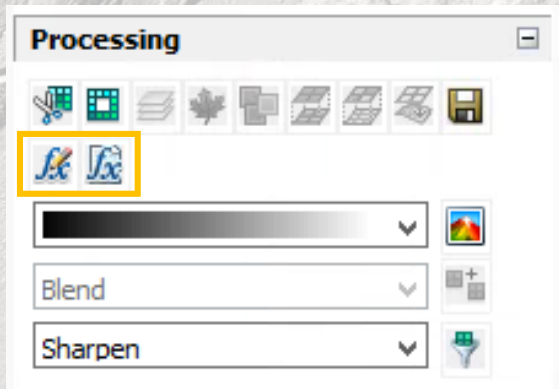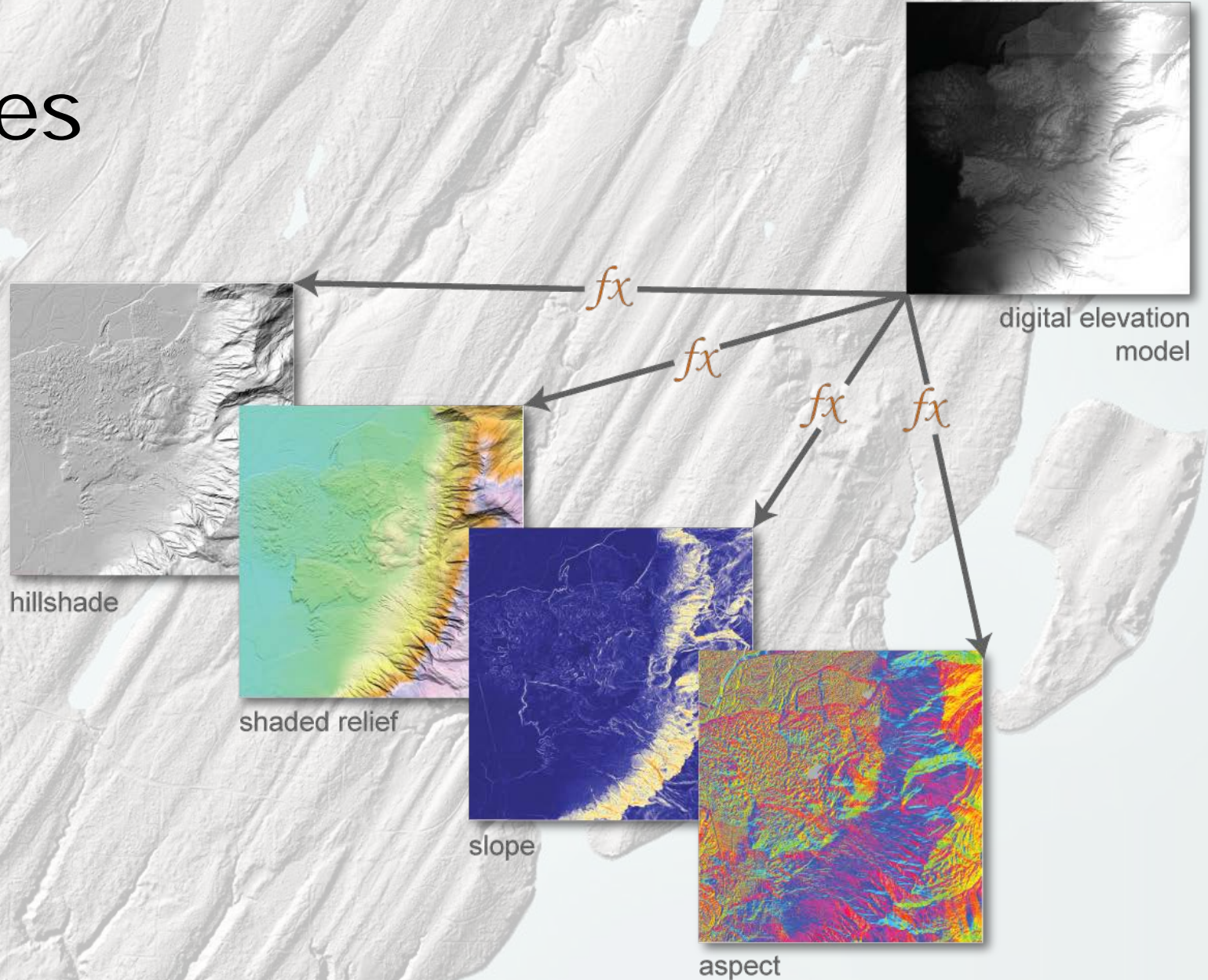

Individual Projects

Project Mosaic Datasets

Master Mosaic Dataset

- Tiled data for each project creates an individual Mosaic Dataset
- Derivatives are generated from individual Mosaic Datasets
- The individual projects are used to create a "Master Mosaic Dataset" which can also be published as an image service
- Limits number of published services, still offers capability to view each project separately

LiDAR Derivatives

- Raster functions accessed from the Image Analysis window can quickly produce derivatives

- These can be saved as layer files or image services

digital elevation model

hillshade

shaded relief

slope

aspect

fx *fx* *fx* *fx*

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DGER LiDAR Resources

http://www.dnr.wa.gov/lidar

Summary – 'Snapshot' of LiDAR at DGER

LiDAR collection

DGER will be collecting LiDAR data over the next few years for geologic hazards, but also for wide area coverage to satisfy multiple applications and partner requirements

LiDAR Portal

DGER is developing storage and public access solutions to disseminate LiDAR data and derivative products

LiDAR Resources

DGER has several LiDAR resources available and planned, including contract services, Quality Assurance, and knowledge on data management and analysis

Looking Forward

- Collection around the state

- Bathymetric LiDAR

- New sensor technologies

- Portal updates

- Updates to the website

Other resources:
- GIS/LAS software:
    - Global Mapper
    - Quick Terrain Modeler
    - LP360
- Puget Sound LiDAR Consortium
- Open Topography
- USGS
- Other counties, state agencies (DOGAMI)

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Thank You! Any Questions?
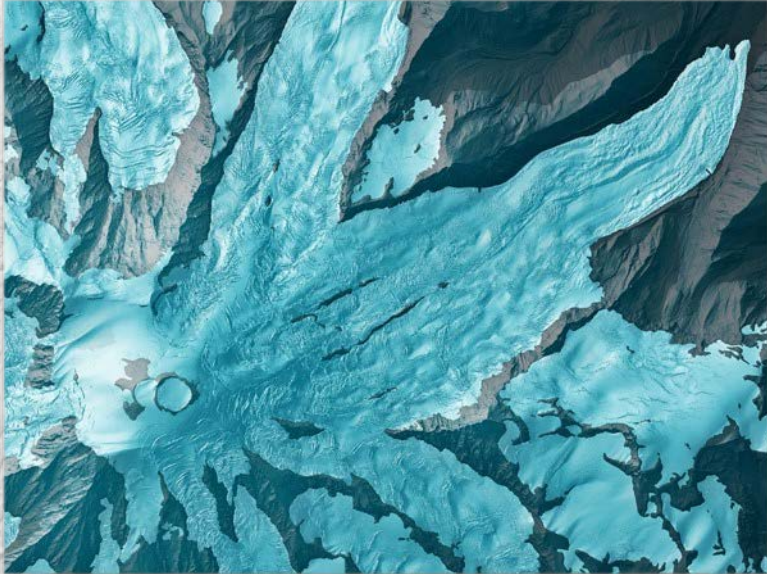
Please stay for Kara Jacobacci's presentation on Revolutionizing Landslide Mapping and Field Evaluation

And

Dan Coe's presentation on Revealing Washington's Hidden Landforms

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