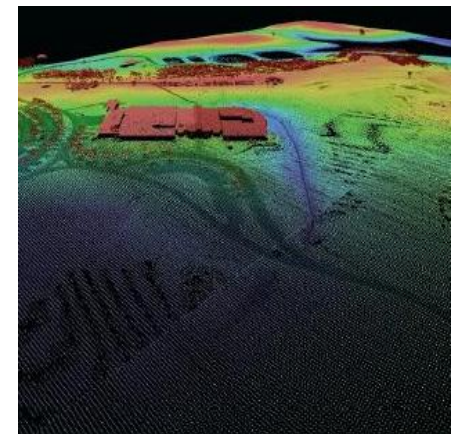
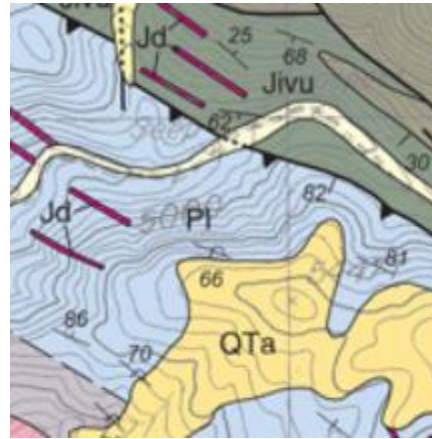




# Saving Lives and Protecting Infrastructure Through Foundational Mapping



Kevin T. Gallagher  
Associate Director, Core Science Systems

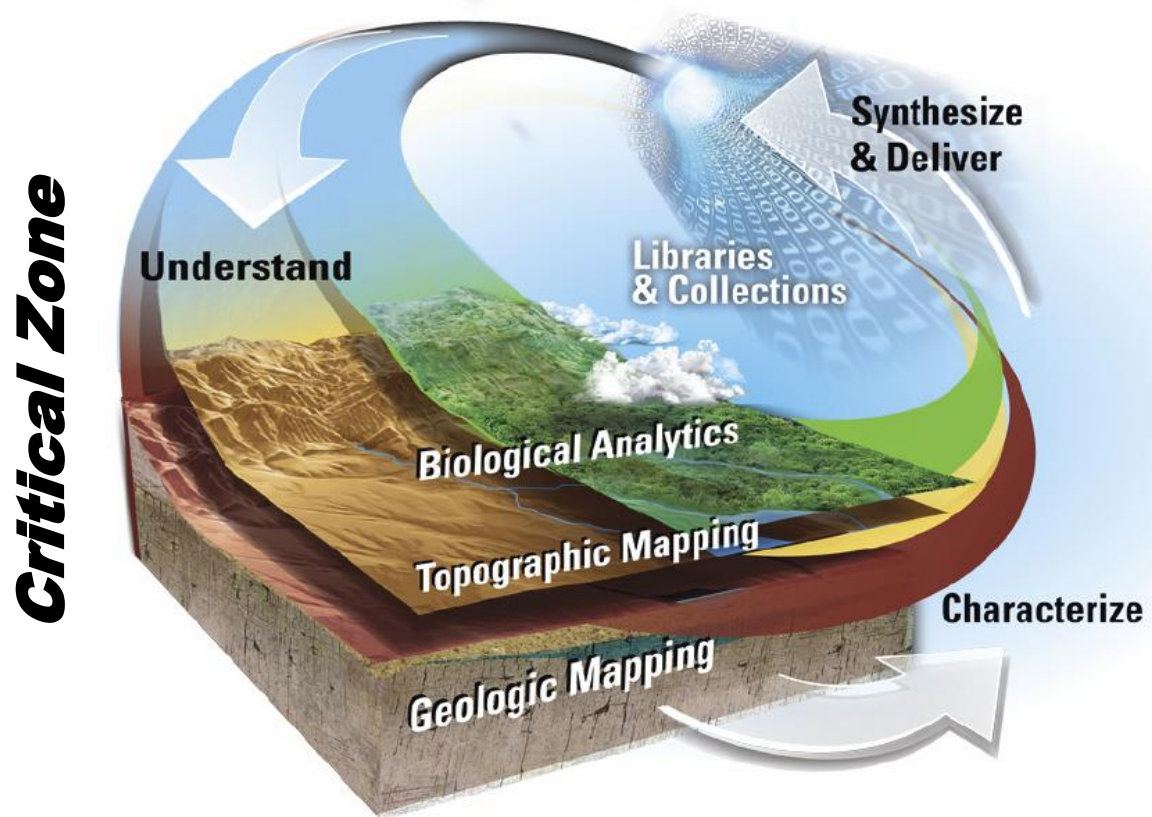
April 6, 2017



# Mapping Saves Lives and Protects Infrastructure

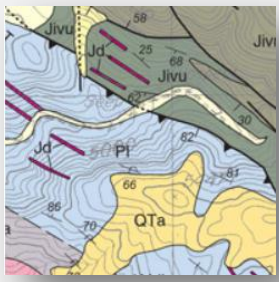
## By Underpinning Hazards Research and Response

- Every year and across all regions in the United States, natural hazard events threaten lives and livelihoods, resulting in deaths and billions of dollars in damage
- Hazards research and response by USGS and other Federal, State, local and Tribal agencies rely on foundational data
  - **Geologic mapping**
  - **Topographic mapping**
    - Elevation
    - Hydrography
- Examples
  - Earthquake
  - Volcano
  - Landslide
  - Tsunami
  - Flooding



# + Consistent, National Foundational Data

## Geologic mapping



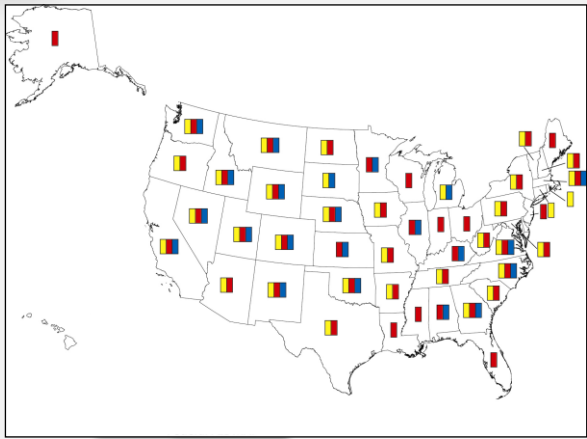
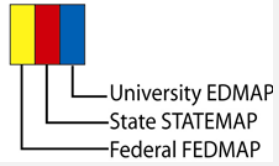
### National Cooperative Geologic Mapping Program (NCGMP)

Detailed geologic maps and 3D framework models

### Partnerships

Over 20 years of successful cooperation

Ongoing Geologic Mapping Projects

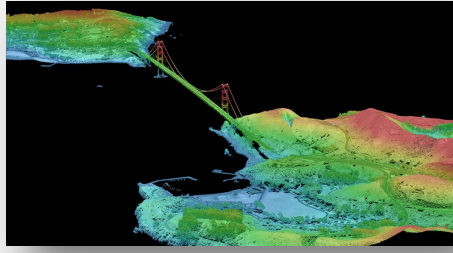


### National Geologic Map Database

a resource for maps and information about geology, natural hazards, earth resources, geophysics, paleontology, marine geology, and more



## Topographic mapping

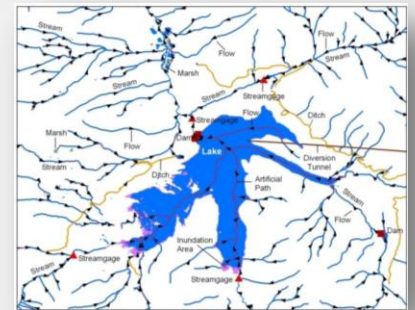


### 3D Elevation Program (3DEP)

High accuracy 3D elevation from lidar (lower 49) or IfSAR (Alaska) – Estimated \$13B annual benefits for nationwide data

### National Hydrography and Watershed Datasets (NHD and WBD)

Intelligent network map of surface water – current annual benefits \$538M



### Partnerships

The National Map is a collaborative effort among the USGS and other Federal, State, local and Tribal partners to improve and deliver topographic information for the Nation



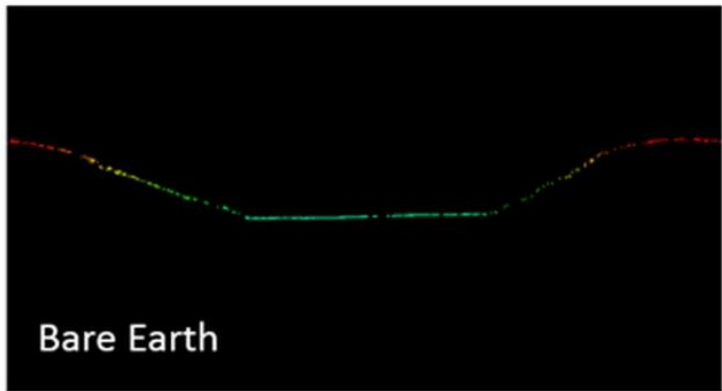
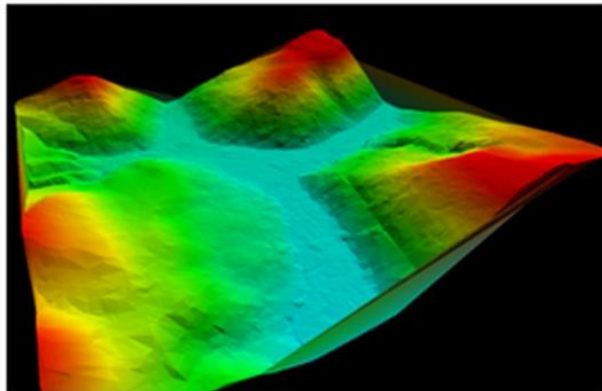
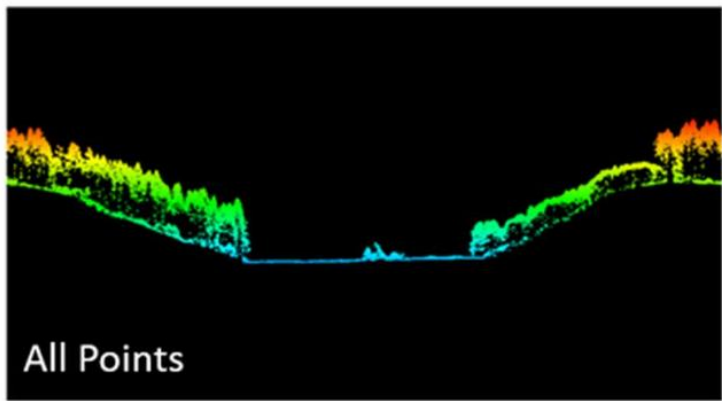
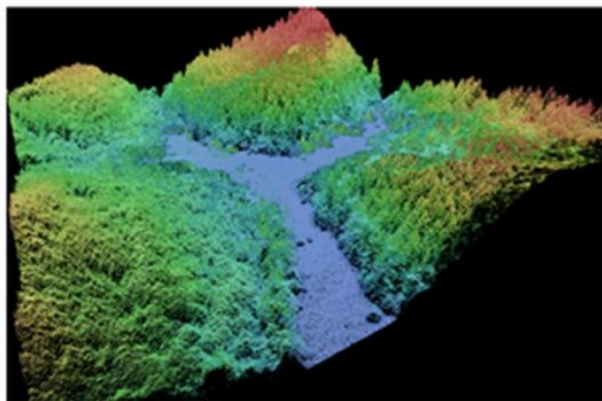
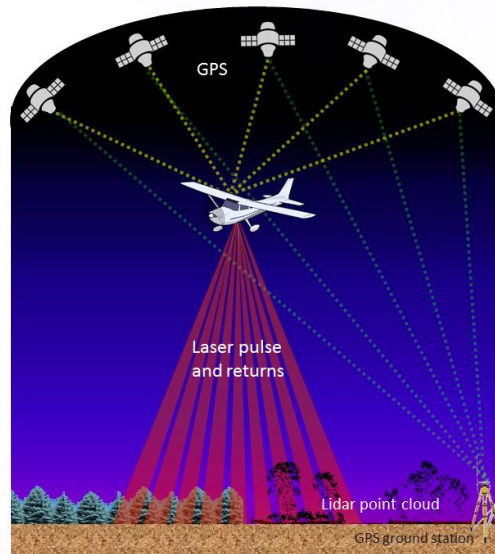
Your Source for Topographic Information

The National Map provides 3DEP, NHD, WBD and other topographic information via web visualization, services, and downloadable data

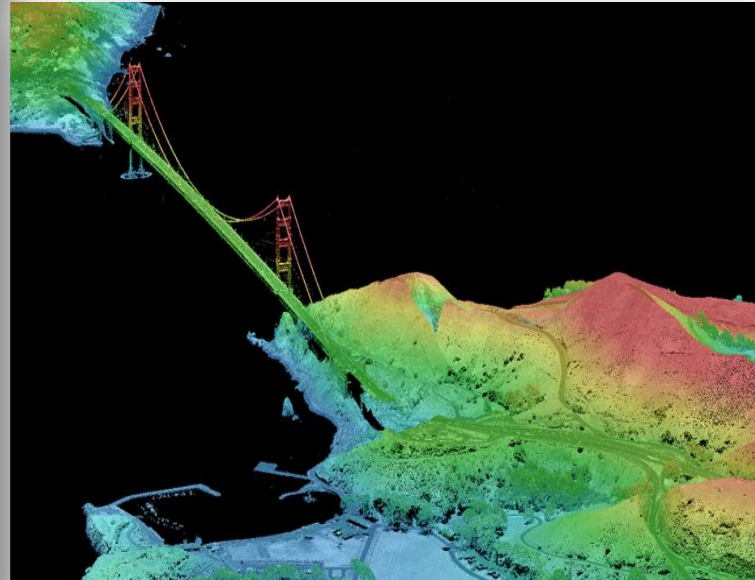
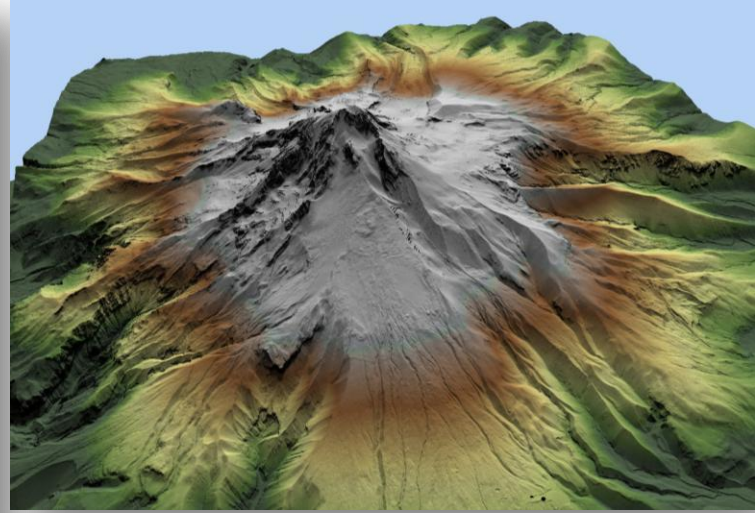


# + What is Lidar?

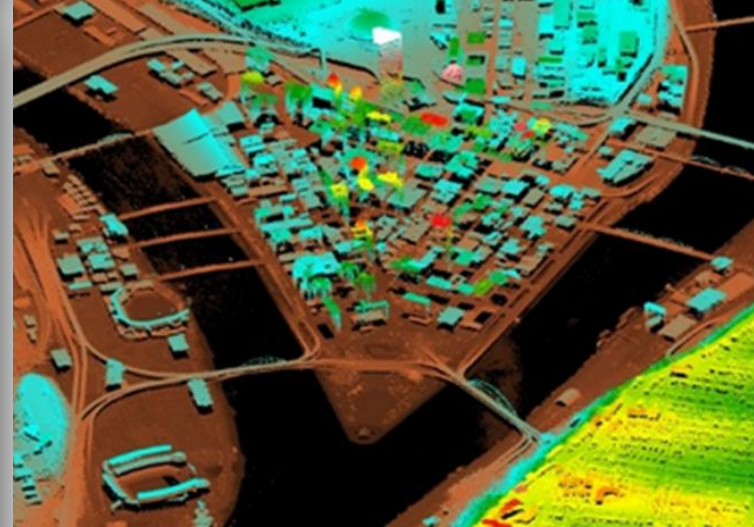
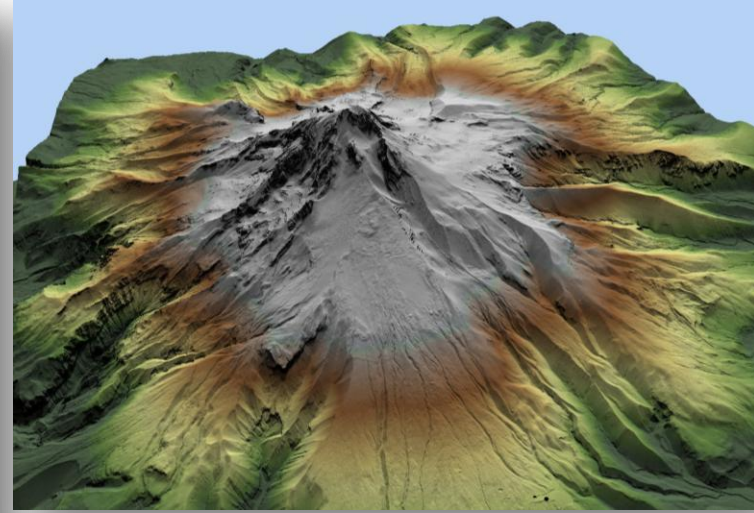
Light Detection and Ranging (lidar) provides digital elevation (bare earth) and 3D models



# + What is Lidar?

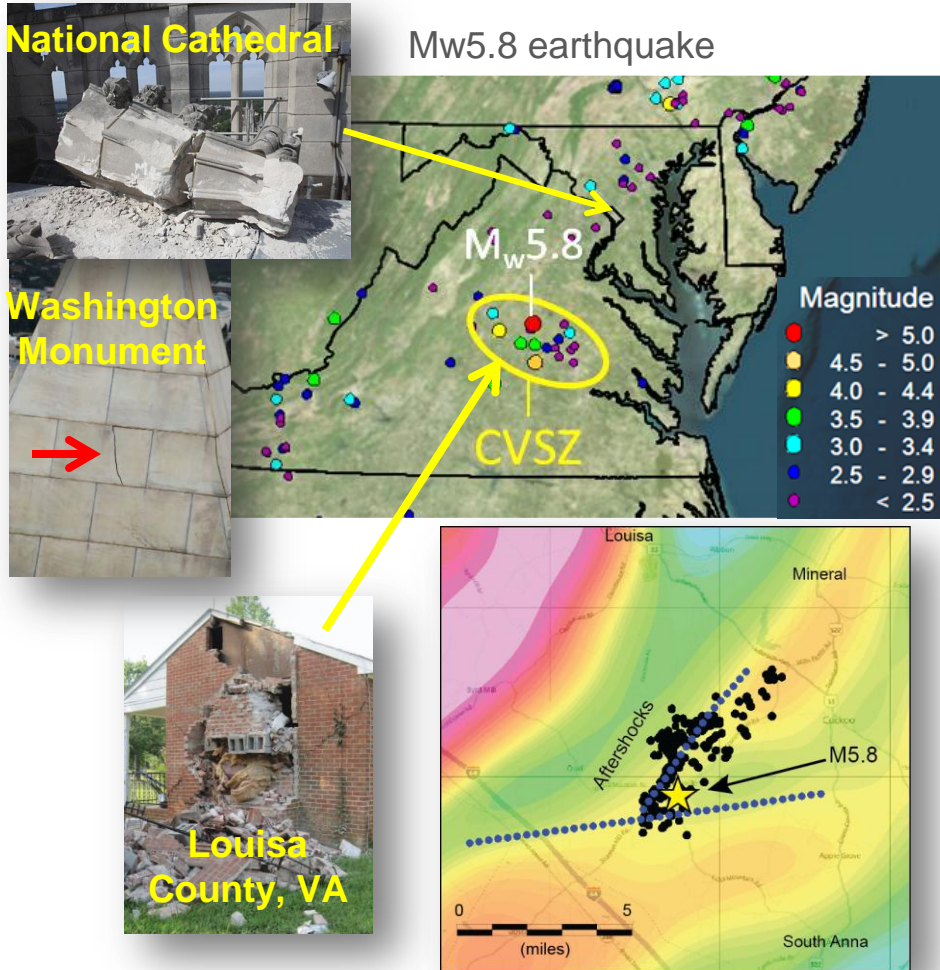


# + What is Lidar?

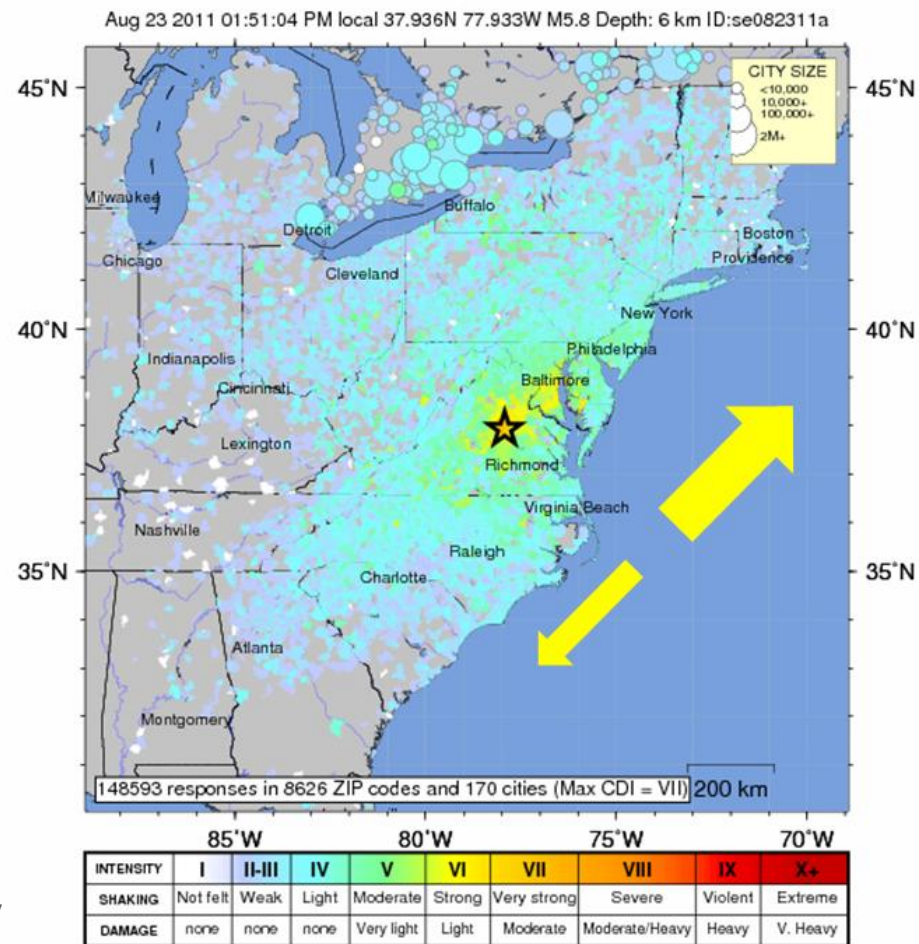


# + NCGMP Collaboration

To Understand the Central Virginia Seismic Zone with Virginia Division of Geology and Mineral Resources



Did You Feel It?  
USGS Community Internet Intensity Map  
VIRGINIA

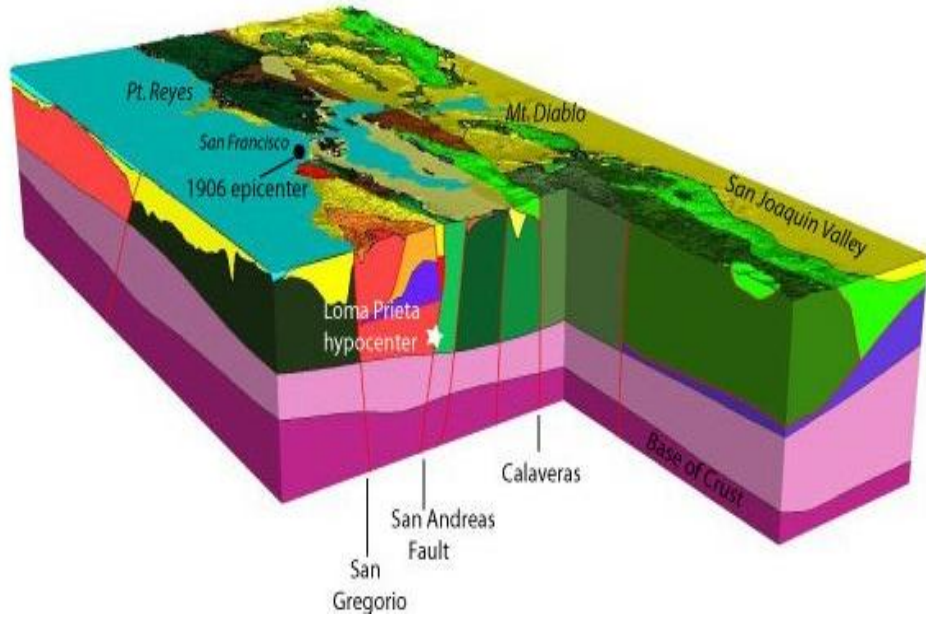


Aeromagnetic data help to identify buried faults and rock structures



# + State-of-the-art 3D Geologic Maps

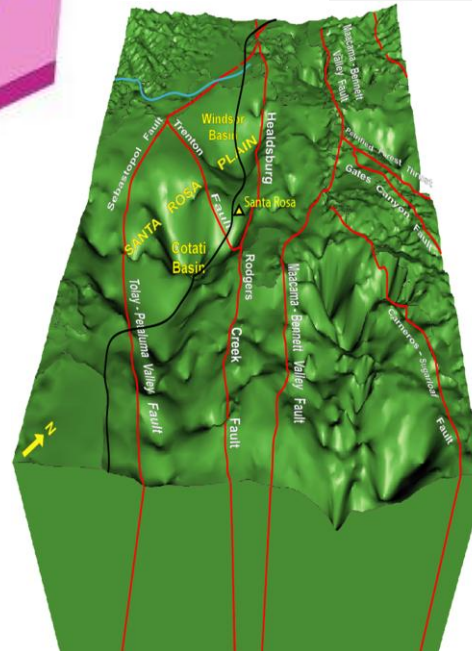
## Characterize seismic hazards – San Francisco Bay Area



1906 San Francisco Earthquake (M 7.9)

(photos from Steinbrugge collection at the EERC, UC Berkeley)

Santa Rosa City Hall

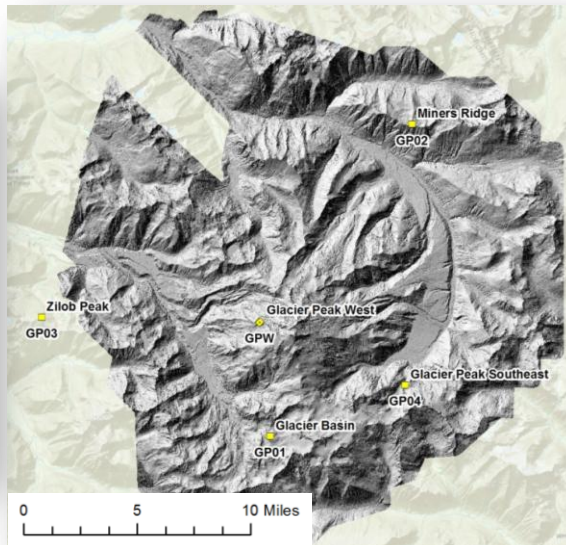


3D Map of Bedrock of the northern San Francisco Bay Area

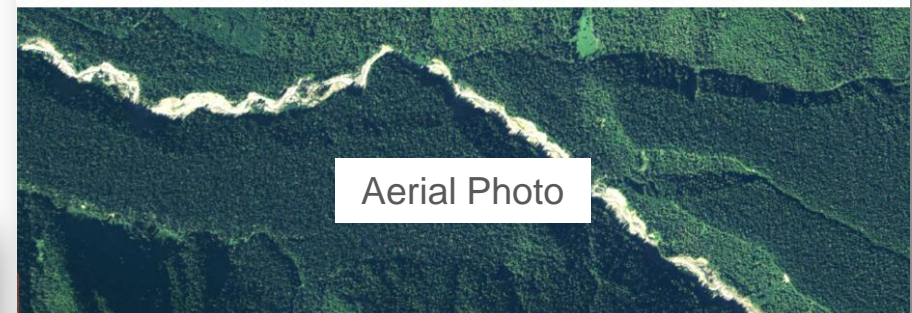
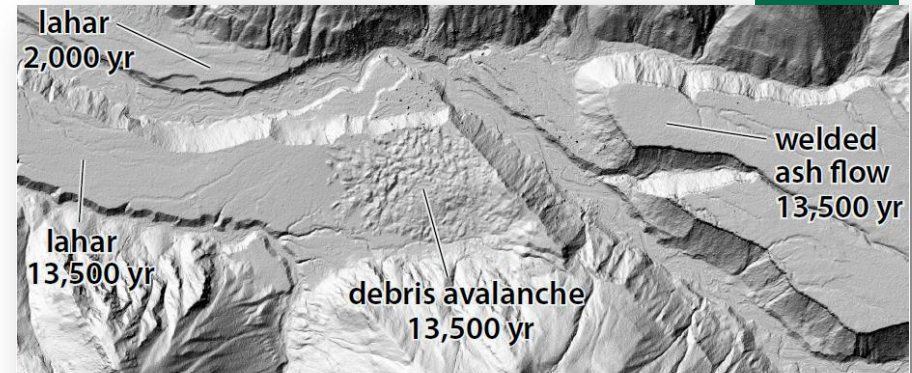
# + 3D Elevation Program (3DEP) Lidar

## Glacier Peak Volcano, WA

- Unraveling the volcano's history through lidar-guided geologic mapping of volcanic deposits that are otherwise hidden by heavy forest cover and inaccessible on steep terrain
- Modeling the path of lahars that can travel downstream to populated areas, planning for escape routes
- Numeric modeling of volcanic processes
- Designing a new real-time monitoring network



Elevation model from 3DEP lidar used to improve monitoring

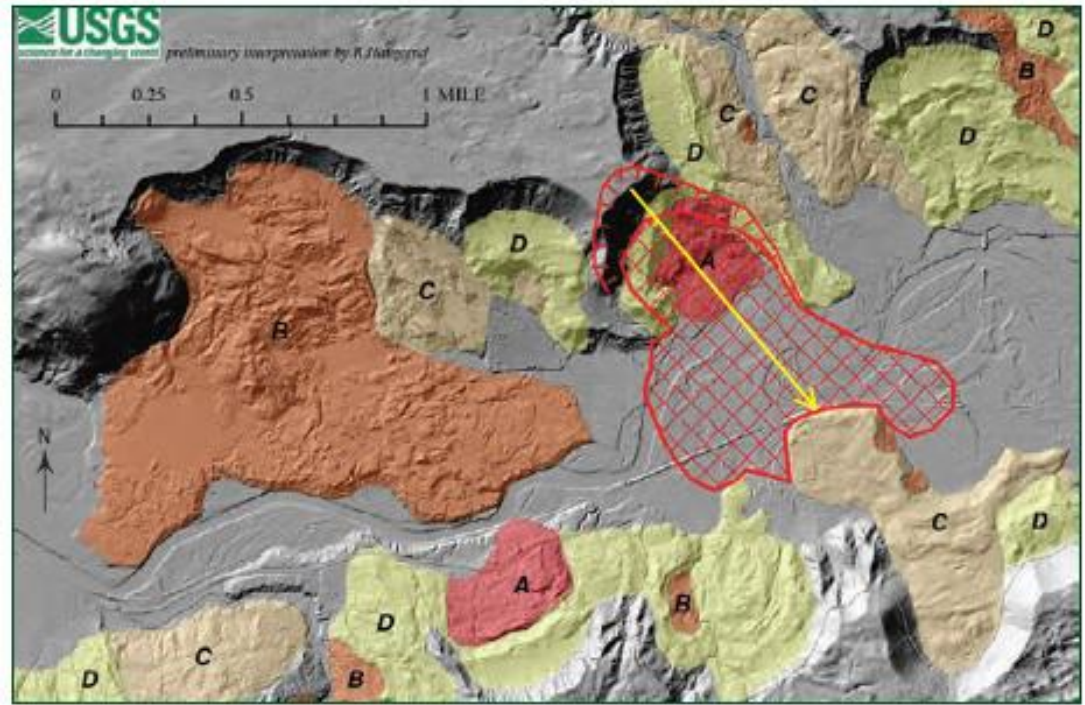


Courtesy of D. Ramsey, USGS

# + 3DEP for Landslides Recognition, Hazard Assessment, and Mitigation Support

## Oso, Washington Landslide

- Create accurate landslide inventory and estimate thickness and ages of deposits
- Estimate the shape and activity of landslides
- Provide input data for models used to identify conditions that trigger landslides, and to forecast their potential impacts on people and infrastructure
- Identify locations for safe evacuation and staging in response to landslide crises
- Conservative annual benefits of lidar for landslides is estimated at \$20.2 M

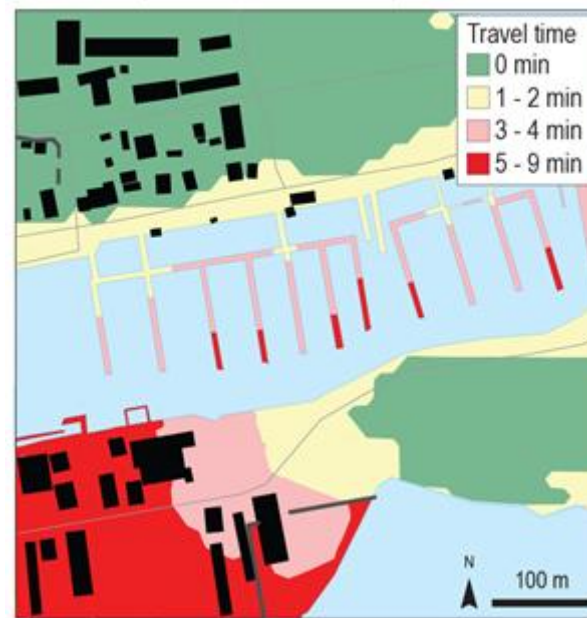


Red cross-hatched area marks the approximate extent of deposits from the 2014 Oso landslide. Colored areas show older landslide deposits by their relative age: **A**, youngest, to **D**, oldest. Modified from Haugerud (2014). Yellow arrow shows the direction of material flow

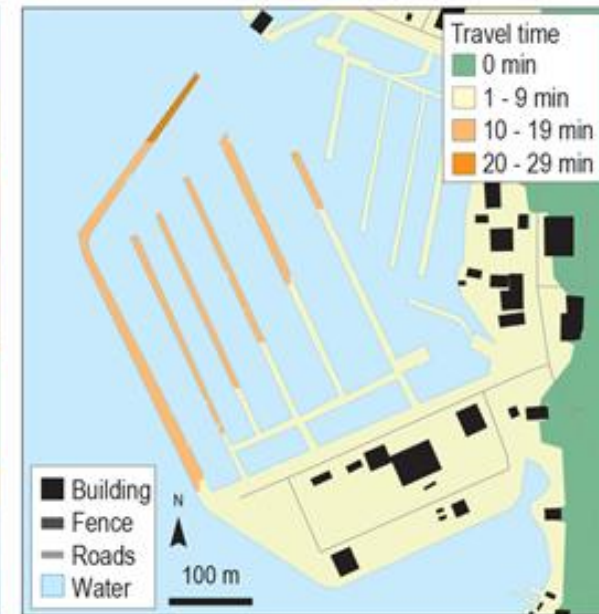
# + Topographic Mapping

## Tsunami evacuation modeling to save lives in Alaska

- Modeling identifies areas where life loss is possible from Alaska tsunamis
- Analysis based on 3DEP lidar and IfSAR, NHD, land cover, roads, structures, and populations
- Identified life-safety concerns with local tsunamis generated by submarine landslides
- Alaska State agencies are using model to continue local mapping



**Landslide Tsunami Sources**  
Valdez (wave arrival = 2 min)

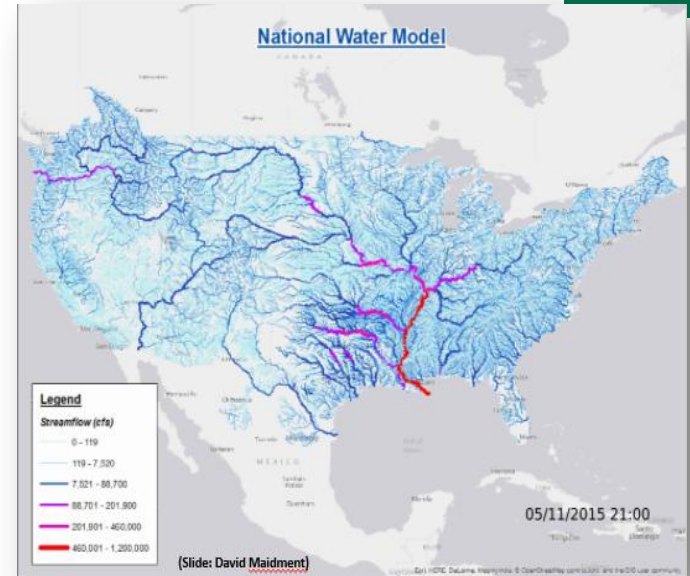


**Tectonic Tsunami Sources**  
Cordova (wave arrival = 60 min)

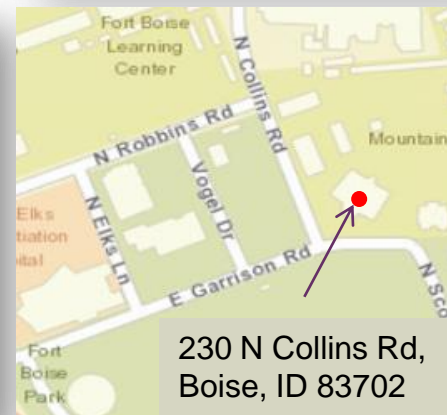
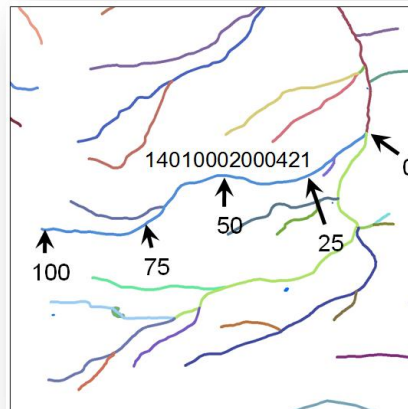
# + National Hydrography Dataset (NHD)

## Flood Forecasting with NOAA's National Water Model

- The National Water Model is a new forecasting tool that simulates conditions for 2.7 million stream reaches in the NHD, representing the biggest improvement in flood forecasting ever
- The model generates hourly forecasts for the entire network - previously, NOAA was only able to forecast streamflow for 4,000 locations every few hours
- Better meets the needs of emergency managers, reservoir operators, first responders, recreationists, farmers, barge operators, and floodplain managers with more accurate, detailed, frequent and expanded water information



The NHD provides a network and addresses for streams analogous to the addresses along the road network



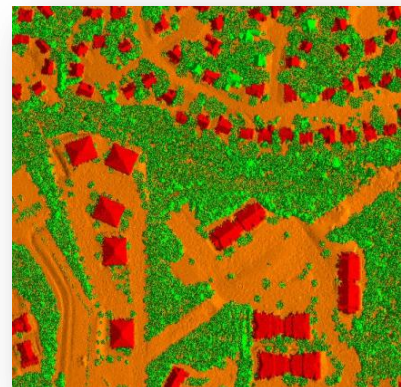
# + 3DEP and Flood Risk Management

## Southeastern US

- Enabling the production of much higher quality flood maps, including documentation studies and Flood Insurance Rate Maps (FIRMS)
- Managing dam and levee safety programs reducing flood risks
- Improving hydrologic modeling and flood forecasting for emergency management
- Improving State and local government flood risk management and response
- Improving regional and local government emergency management and floodplain and storm water management
- Improving storm water facilities and dam design
- Extracting building footprints and identifying the finished floor elevation in order to quantify potential damages based on flooding depths
- Annual benefits from 3DEP to flood risk management is \$502M



Lidar aids hydraulic modeling to determine flood-inundation on the Saluda River, near Greenville, SC



Building footprints extracted from lidar in red

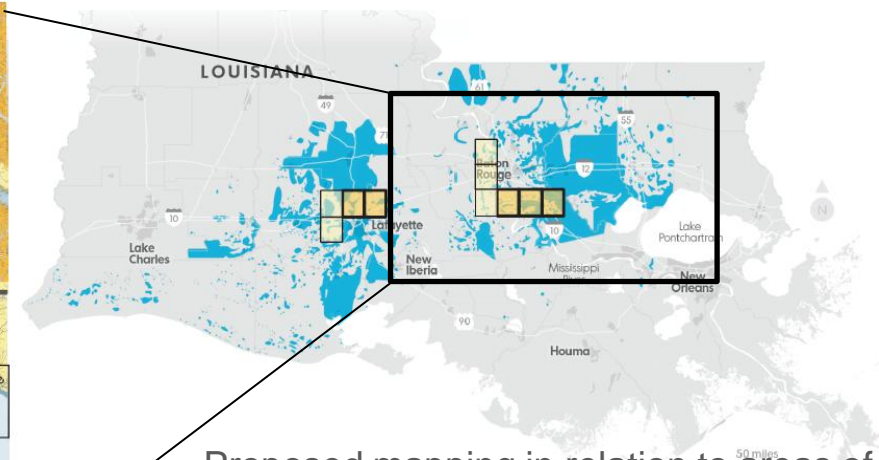
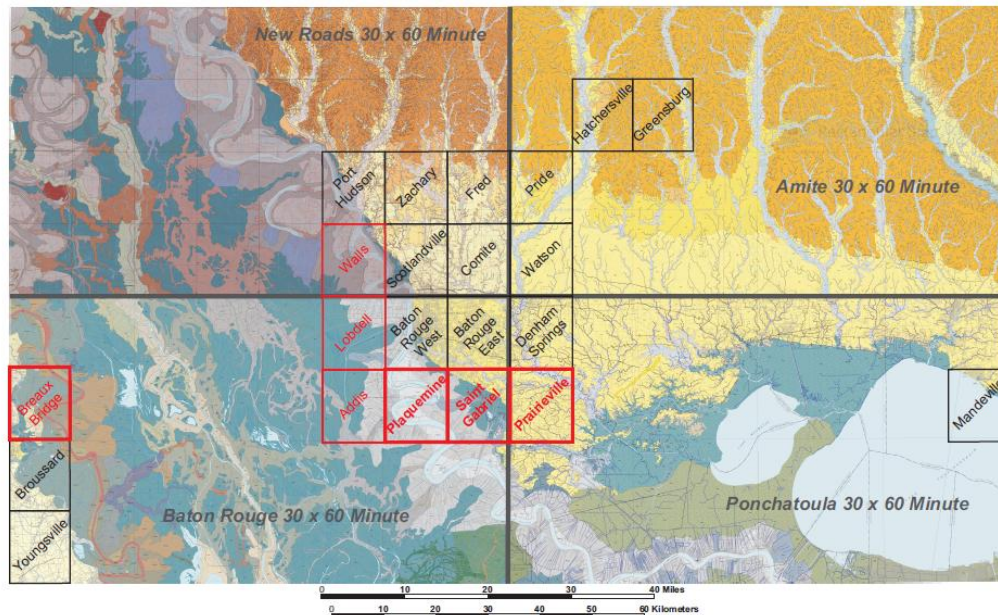
*Courtesy of J. Dorman,  
NC Department of Public  
Safety, Floodplain  
Mapping Program*

# + NGCMP Geologic Mapping

## Flood Risk Planning and Mitigation in Louisiana

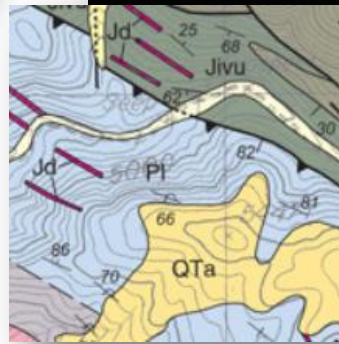
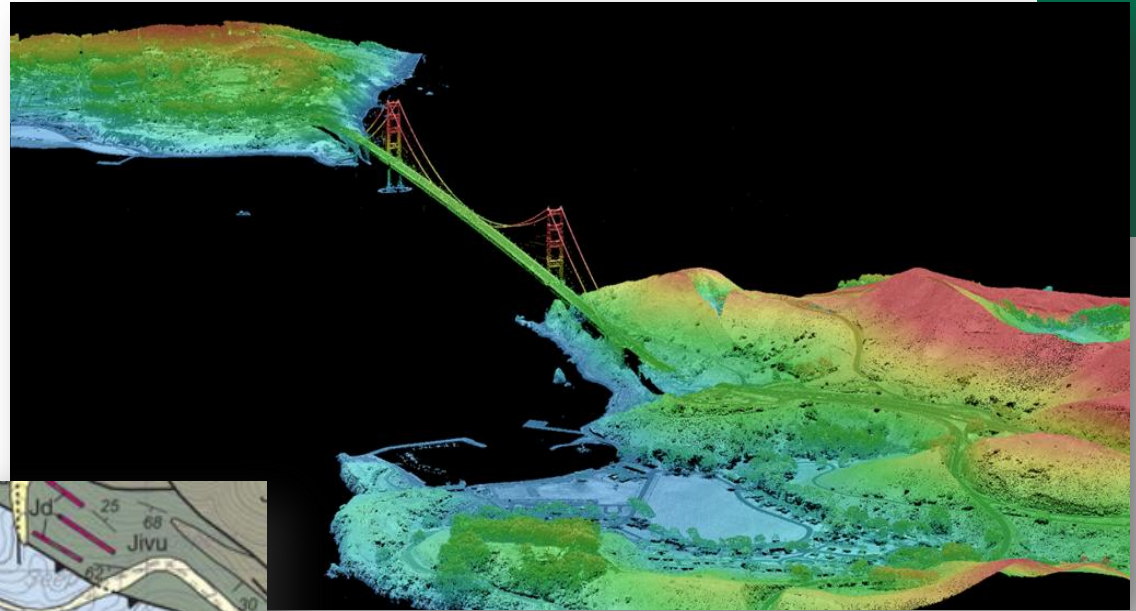
- In the aftermath of the 2016 flood event, a detailed geology layer will be compiled and analyzed to aid the reassessment of flooding risk
- Provides basic geologic data to planners in Baton Rouge and Lafayette
- Improves the planning and siting for waste-disposal and other industrial facilities and structures in relation to two large aquifer systems underlying south Louisiana, the Southern Hills (Baton Rouge) and the Chicot (Lafayette)

From LA 2017 Statemap Proposal



Proposed mapping in relation to areas of flooding (Sergent et al., 2016) Source: Stephenson Disaster Management Institute (Louisiana State University) and FEMA

+ Thank You



National Cooperative Geologic  
Mapping Program [ncgmp.usgs.gov](http://ncgmp.usgs.gov)

*The National Map* [nationalmap.gov](http://nationalmap.gov)

