

# Debris Flow Hazard Mapping in Colorado: *The Need and Plan for a Statewide Assessment*

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# Presentation Topics

What are debris flows

Debris flow damage from the 20

What are debris flow hazard maps  
them?

Priority areas

How are they made

Importance to watersheds

Moving forward

Additional resources



# Debris Flows

A **DEBRIS FLOW** is a moving mass of loose mud, sand, soil, rock, water and organic matter that travels down a slope under the influence of gravity

Occur with little warning

Triggered by heavy rainfalls on steep slopes

Exacerbated in burned areas

Tear into the hillsides and deposit accumulated material when they reach flatter ground, creating an alluvial fan

Speeds can reach 100 MPH; typically 2-20 MPH



# Debris Flow Damage from the 2013 Floods

Affected Larimer, Jefferson and Boulder Counties

Triggered >1,100 debris flows

Occurred on steep (>25°), predominantly south- and east-facing slopes with contributing basins <3300 m<sup>2</sup>\*

Two rain periods-12.5 hours and 8 hours (67 and 39mm/hr)\*

Debris flows/flooding resulted in 8 fatalities; 3 from debris flows\*

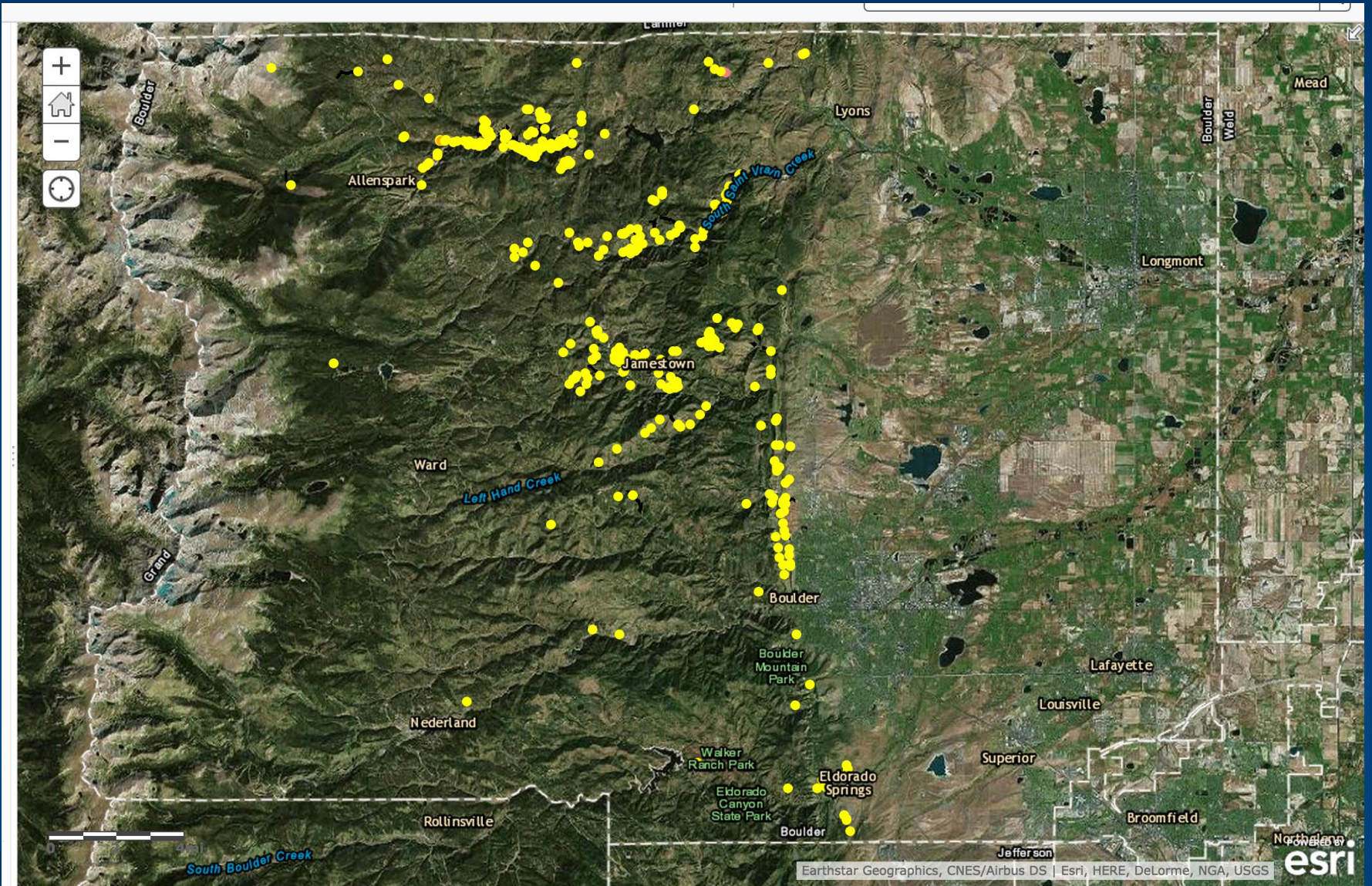
125 residences destroyed; 3,773 damaged\*

>\$670 billion in funds for recovery\*

\* source: Coe and others, 2014, New insights into debris-flow hazards from an extraordinary event in the Colorado Front Range, GSA Today, Volume 24, Issue 10.









































# Debris flow hazard maps: What are they and who uses them?

Delineate areas where debris flows have occurred in the past

Model where they *may* occur in the future; not probability

Used by local planners and emergency managers

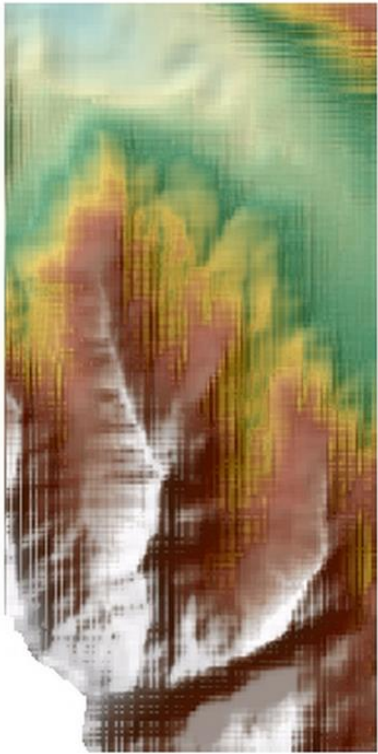
Areas to avoid/protect in the event of significant rainfall



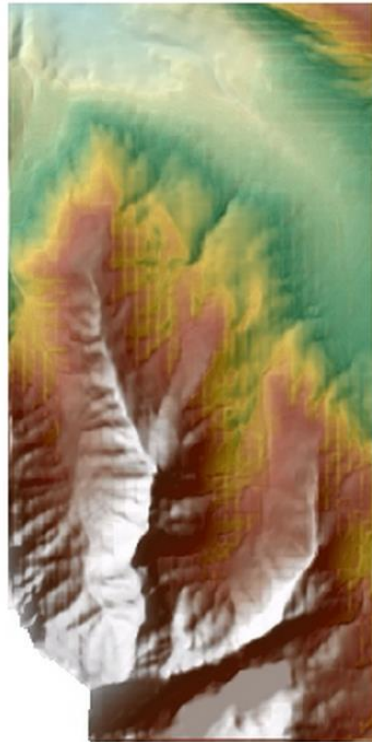


# How are debris flow hazard maps created?

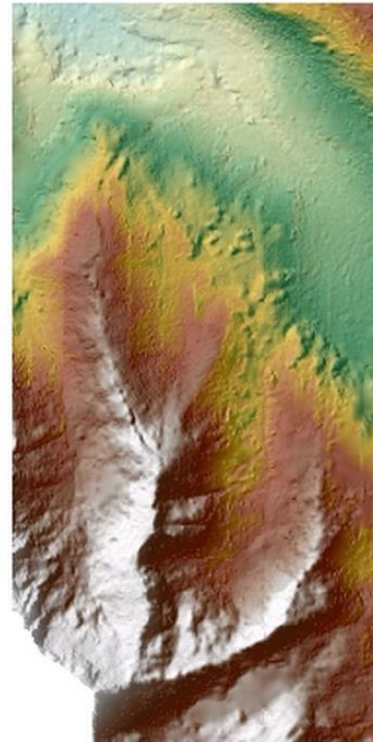
30 Meter DEM



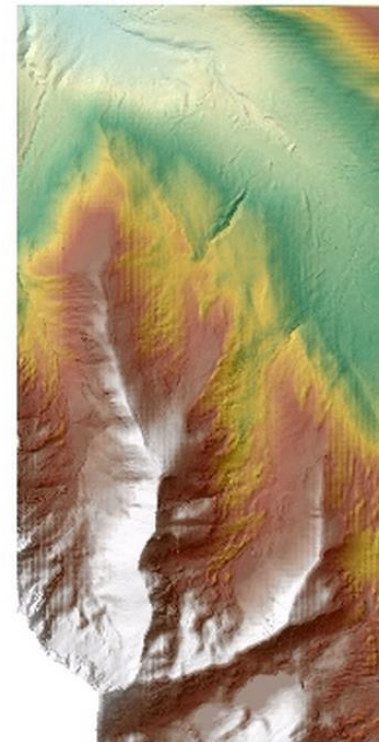
10 Meter DEM



5 Meter DEM



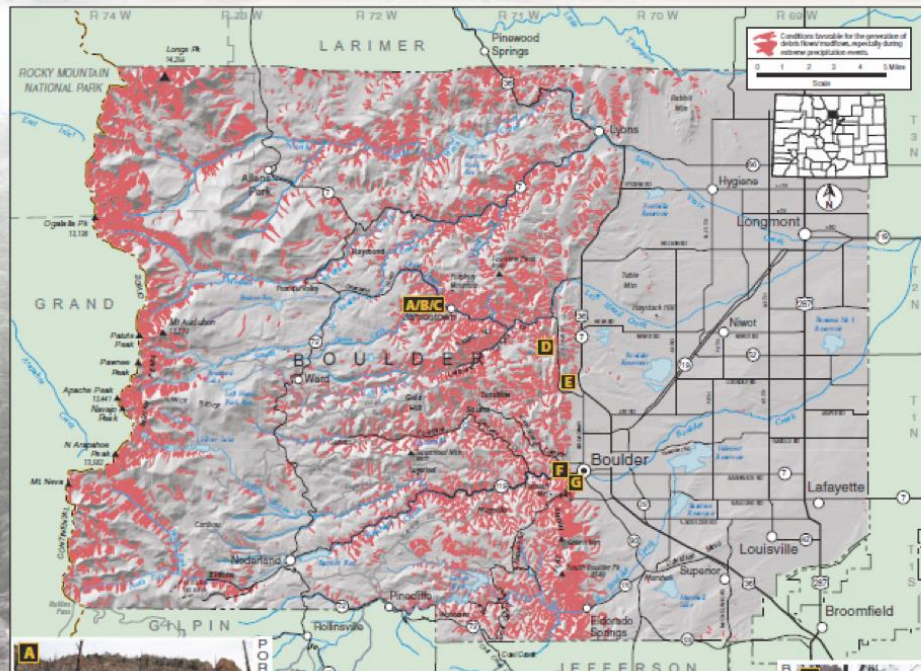
2 Meter DEM





# FOOTHILL AND MOUNTAINOUS REGIONS IN BOULDER COUNTY, COLORADO THAT MAY BE SUSCEPTIBLE TO DEBRIS/MUD FLOWS DURING EXTREME PRECIPITATION EVENTS

Matthew L. Morgan, Jonathan L. White, F. Scot Fitzgerald, Karen A. Berry and Stephen S. Hart  
Colorado Geological Survey, 2014  
Open-file Report 14-02



## ABOUT THIS MAP

The red polygons on this map represent areas where conditions (e.g. slope angle, channel curvature) are favorable for the generation of debris flows/mudflows, especially during extreme precipitation events. New and existing structures, roadways, bridges and other infrastructure located within these areas may be at risk of sediment inundation. It is recommended that future construction within these zones be evaluated by a professional geologist with consideration given to proper debris flow/mudflow mitigation techniques.

Initial source areas and run-out zones were calculated using Flow-R (Flow path assessment of gravitational hazards at a Regional scale; <http://www.flow-r.org/>), a MATLAB-based flow-path modeling program. The resulting areas were then subject to verification by professional geologists, and geoprocessing functions using GIS, to produce the final hazard polygons.

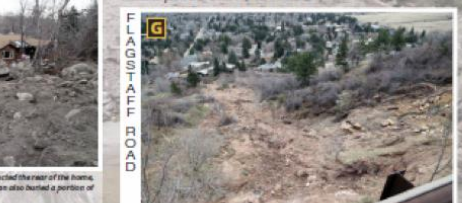
Limitations of this map relate to the scale of the mapping used to create the dataset and time limitations to conduct extensive field verifications. This map is for general planning purposes and should not be used to assign risk for a specific site or take the place of a detailed site-specific investigation.

The degree of susceptibility to a particular geologic hazard, in any given area, is related to ever changing natural and human-induced conditions. Any alteration in the balance of forces may increase or decrease susceptibility to a particular hazard. This map is based upon the current understanding of existing conditions.



OLD STAGE HIGHWAY 7

Photos D and E - The combination of heavy precipitation, shallow soils, and steep hillside often result in soil slips that may quickly mobilize into debris flows. These soil slips originated within this colored area that became saturated by heavy rainfall and began to flow down the hillside, just east of nearby homes. Location of photo D: 40°5'42.30"N, 105°18'12.21"W  
Location of photo E: 40°2'43.54"N, 105°17'54.38"W



FLAGSTAFF ROAD

A mixture of boulders, silt, and pine debris threatened the steep hillside below and caused a portion of Flagstaff Road to collapse. Like many debris flows, it occupied a drainage where debris flows have occurred in the past and will likely affect these areas in the future. Location: 40°11'21"N, 105°17'23.53"W



Layers created by a boulder-rich debris flow on the south side of Porphyry Mountain near Silverthorn. The debris flow and associated fan deposits cover within 100 feet of residence. The homeowner reported hearing rocks calling along with a low rumbling sound. Location: 40°7'12.57"N, 105°22'26.71"W



This boulder debris fan was created by a fast-moving debris flow that dropped over 1000 vertical feet in less than 15 miles. The flow covered a portion of Overland Road near Jamestown with several feet of rocks, silt, and debris, and boulder debris, some of the rock fragments measured 8 feet in diameter. Tragically, the resident of the home on the east side (left side in the image) of the channel was killed when the rock debris flow cut through the side of the structure. Location: 40°8'06.12"N, 105°13'22.78"W

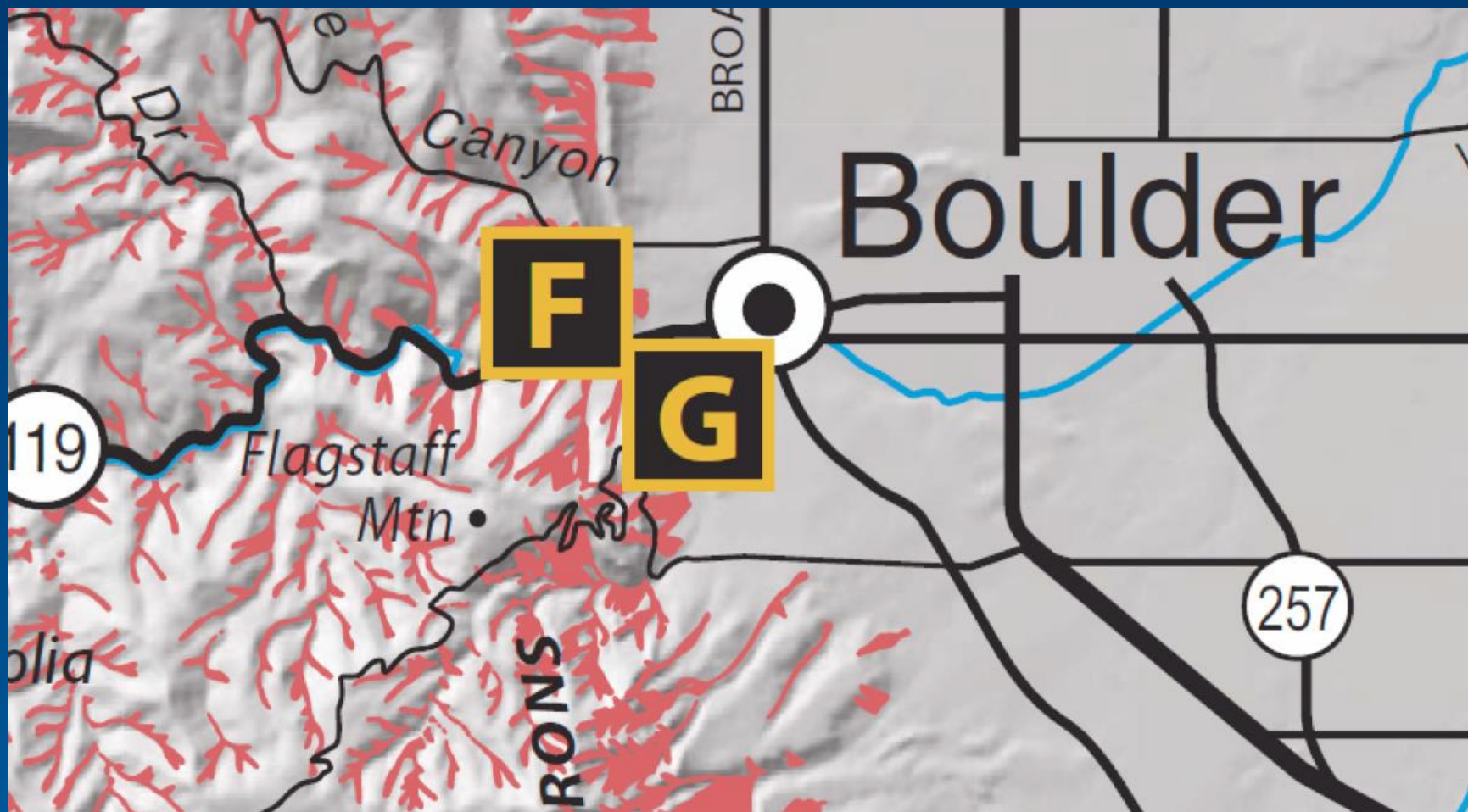


Debris flows that occur in steep areas where the colluvial soil cover is thinner often and non-cohesive may occur their channel down to bedrock. These types of debris flows are typically fast moving, carry more sediment within the flow, and depending on the degree of coarseness of the entrained sediment, can be highly erosive. Location: 40°7'16.67"N, 105°23'42.44"W

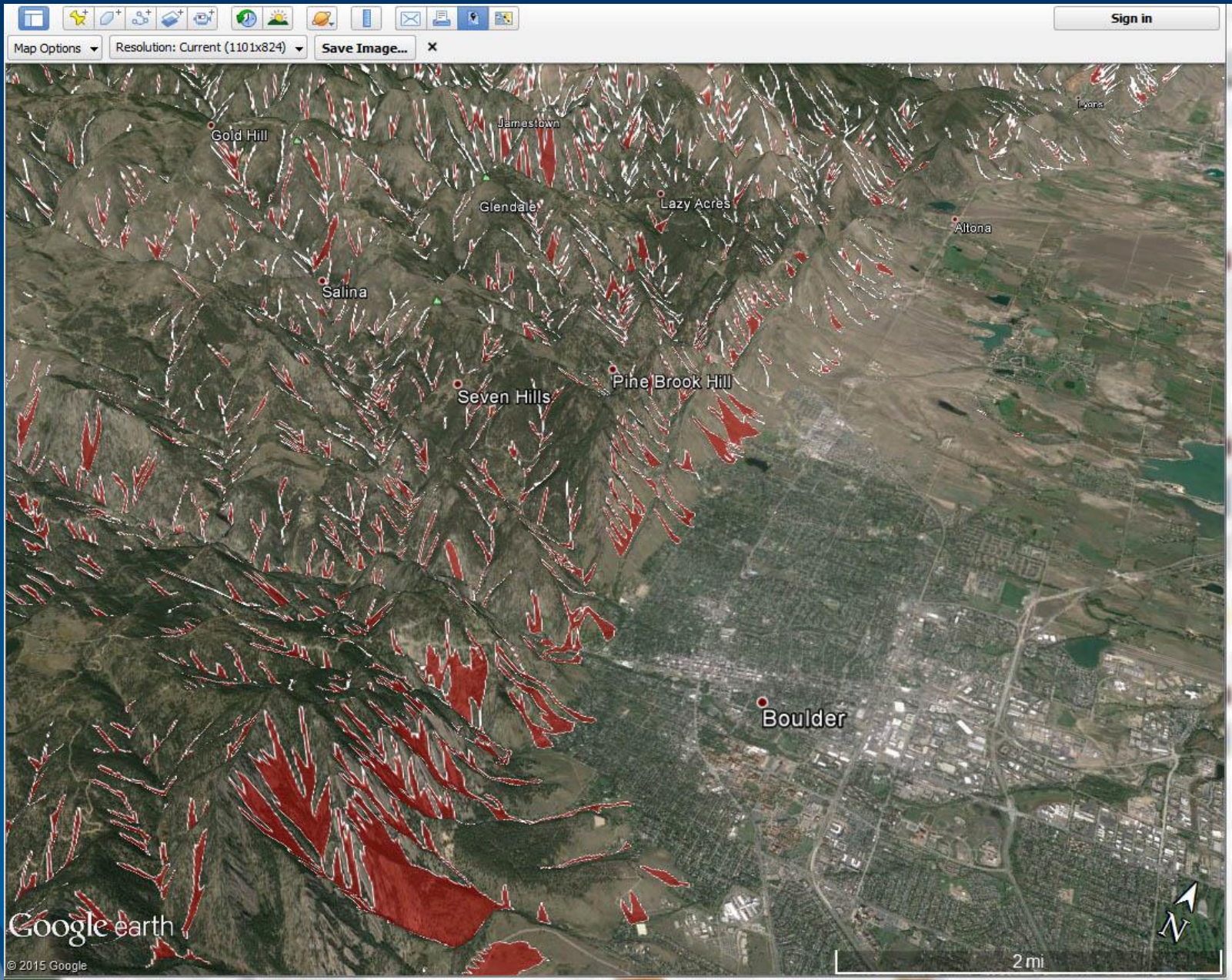


This debris fan along Boulder Canyon Road (Highway 139) impacted the rear of the home, causing half of the structure to move from its foundation. The fan also buried a portion of the parking lot. Location: 40°5'44.17"N, 105°17'50.02"W











# Legislative Action

## Senate Bill 15-245

Convene an interagency panel to develop debris flow mapping methodology

Conduct pilot projects to create debris flow hazard maps for prioritized areas based on geology, and assets at risk; El Paso, Jefferson and Douglas

Develop a 5 year implementation and funding plan to map the remainder of the at-risk areas in Colorado

Collect LiDAR data to support the project

SENATE BILL 15-245

BY SENATOR(L) Grantham, Steadman, Lambert, Cooke, Garcia, Heath, Todd, Cadman, also REPRESENTATIVE(S) Young, Hamner, Rankin, Becker K., DelGrosso, Fields, Foote, Garnett, Ginal, Kraft-Tharp, Lontine, Melton, Mitsch Bush, Pettersen, Rosenthal, Ryden, Singer, Williams, Hulinghorst.

CONCERNING THE PROVISION OF STATE FUNDING FOR NATURAL HAZARD MAPPING.









# Importance of Watersheds

Many debris flows are initiated in watersheds-  
*PROPER MANAGEMENT* is important. This includes:

Limiting intensive agricultural and grazing use,  
road construction in erosive zones

Limiting exposed soil or degraded rock

Controls on gullying and soil movement





# Moving Forward

Maps for Boulder County are available

Larimer County is in the final review stages

Jefferson and El Paso Counties are in progress

Maps for Clear Creek, Douglas, Eagle, Garfield

Mesa and Summit Counties will follow LiDAR

acquisition in spring of 2016

Create maps for the remainder of Colorado over  
the next 5-7 years





# Thank you!

- Resources
  - Colorado Geological Survey  
([www.coloradogeologicalsurvey.org](http://www.coloradogeologicalsurvey.org))
  - CGS bookstore-Free publications  
([store.coloradogeologicalsurvey.org](http://store.coloradogeologicalsurvey.org))

