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Generating Surface Flow Features from 1-meter Lidar-Derived Digital Elevation Models

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U.S. Geological Survey

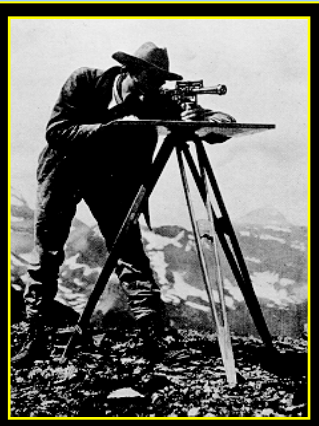
Overview

- Topographic Timeline and the National Elevation Dataset (NED)
- Incorporating remotely sensed data into NED
- Light Detection and Ranging (lidar)
- Generating surface flow from lidar-derived digital elevation models
- Challenges and future applications

USGS

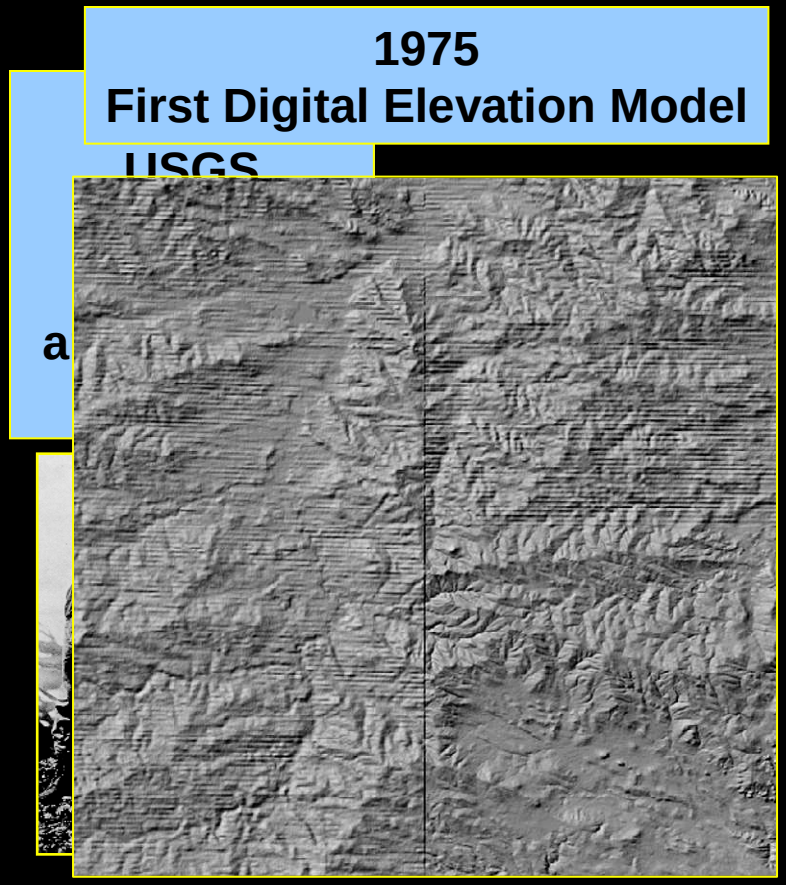
The Topographic Timeline

1879
USGS initiates surveying and mapping of the U.S.



USGS

The Topographic Timeline



USGS

The Topographic Timeline

1990
1:24,000 topo maps complete

Firs

US

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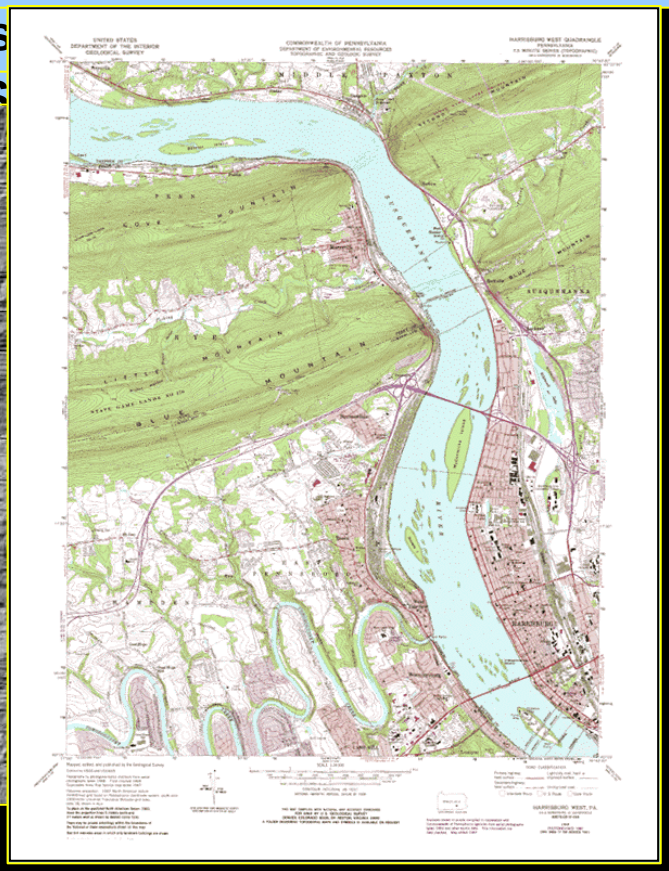


USGS

The Topographic Timeline

1990

1:24,000 t

Firs

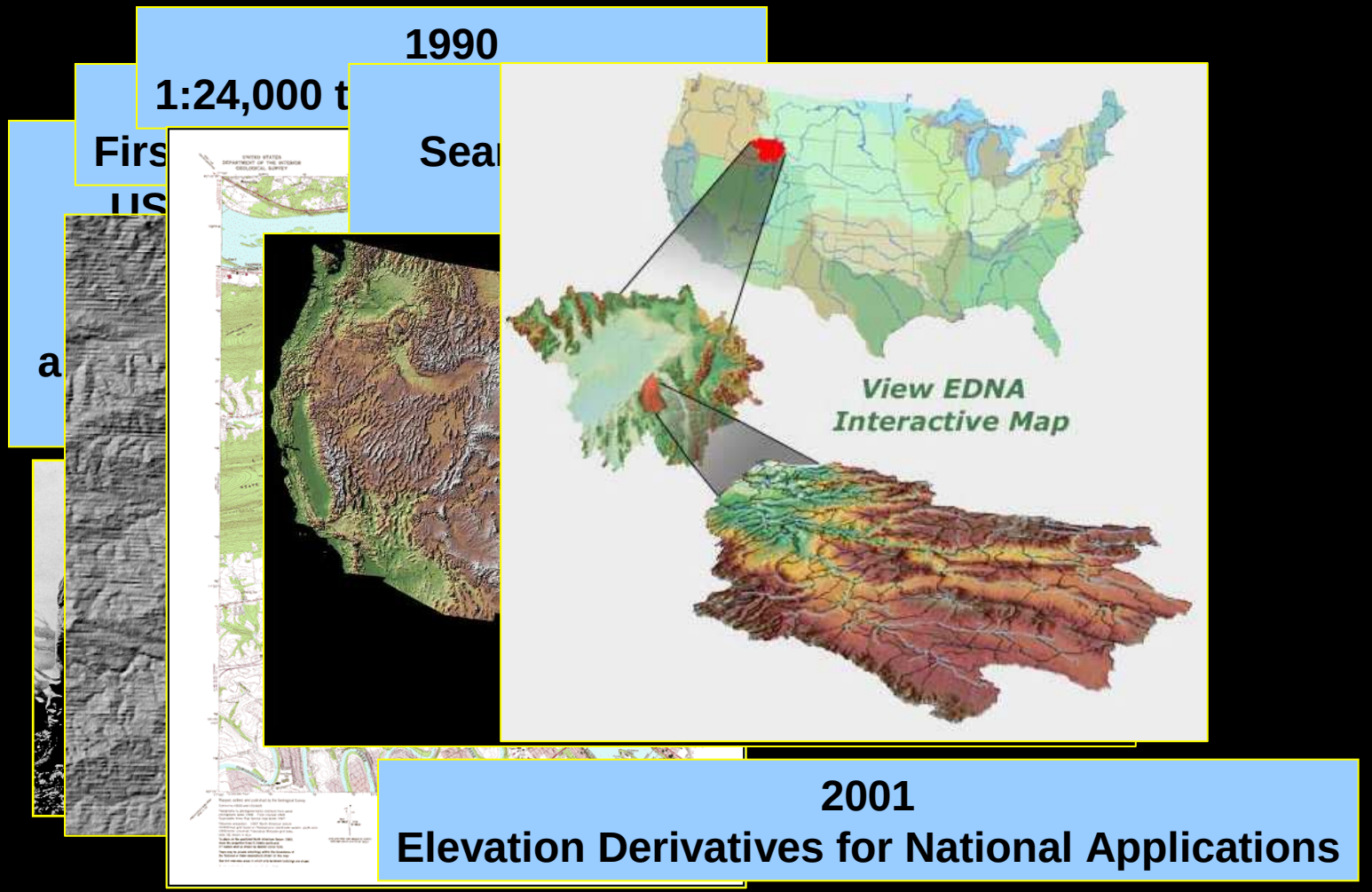
US

a

1999
Seamless National Elevation
Dataset complete

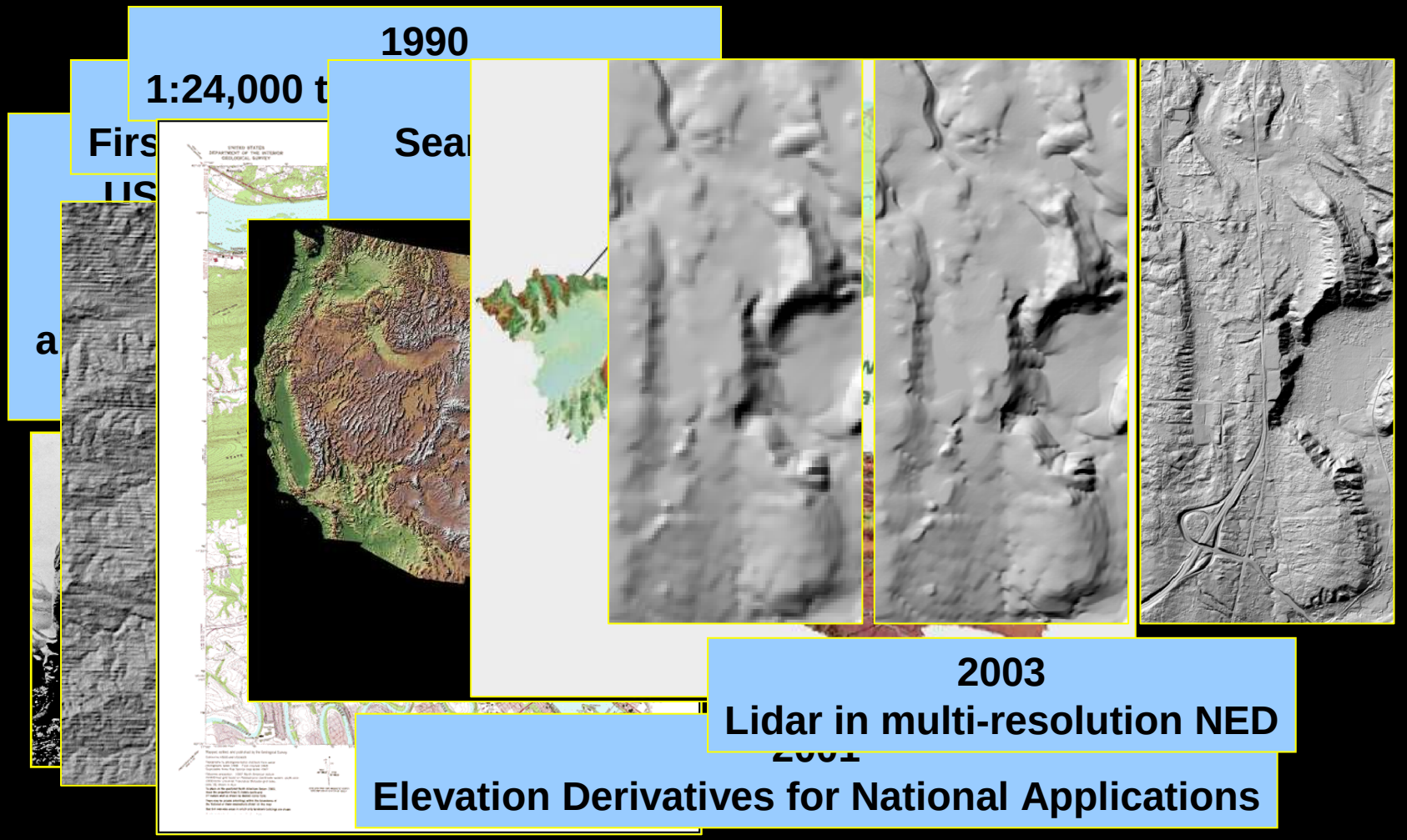
USGS

The Topographic Timeline



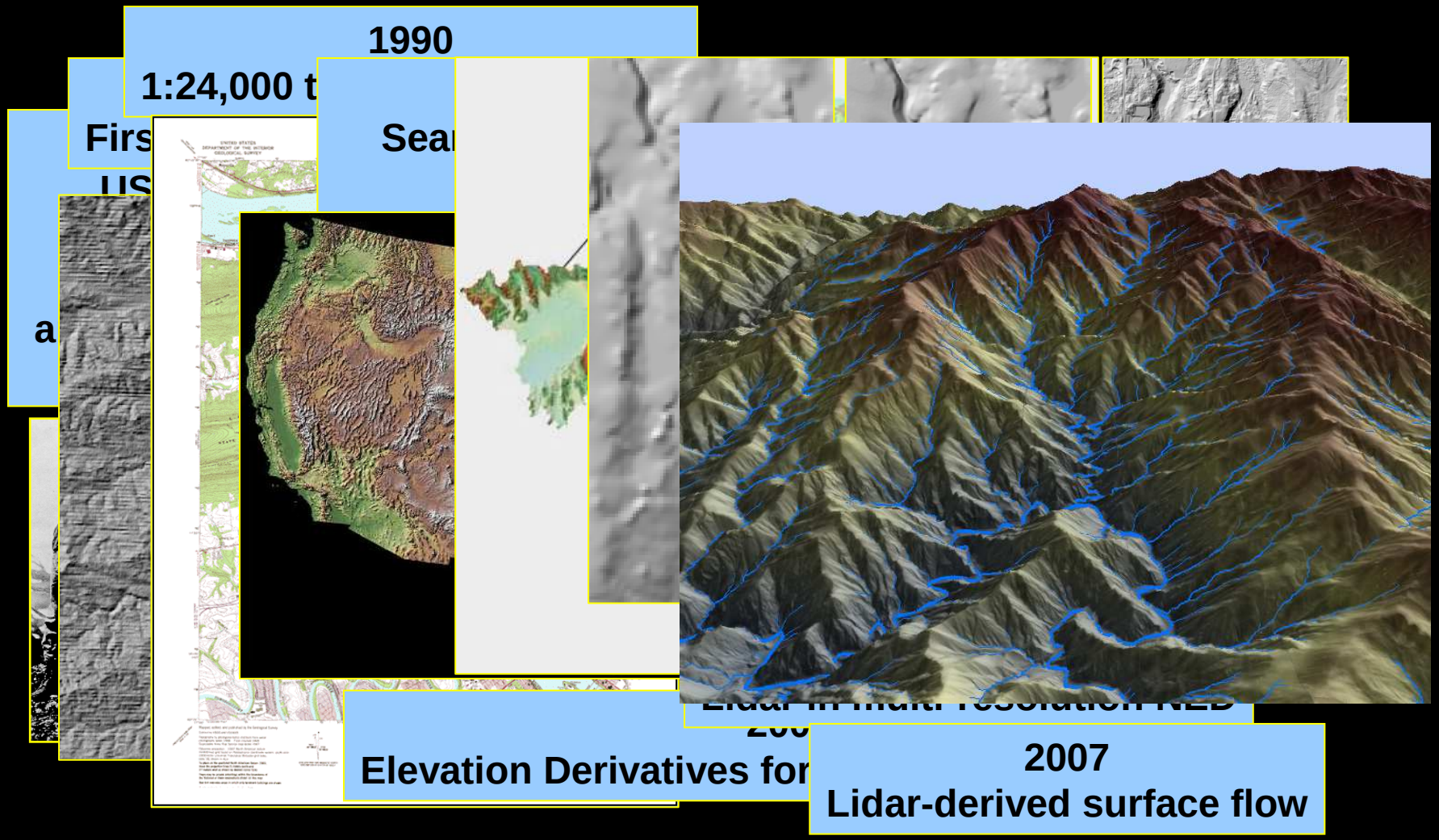
USGS

The Topographic Timeline



USGS

The Topographic Timeline



USGS

National Elevation Dataset (NED)
Developed in 1999 - 30-meter resolution

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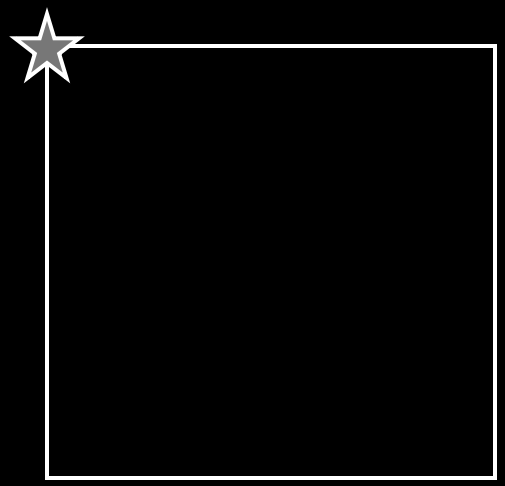
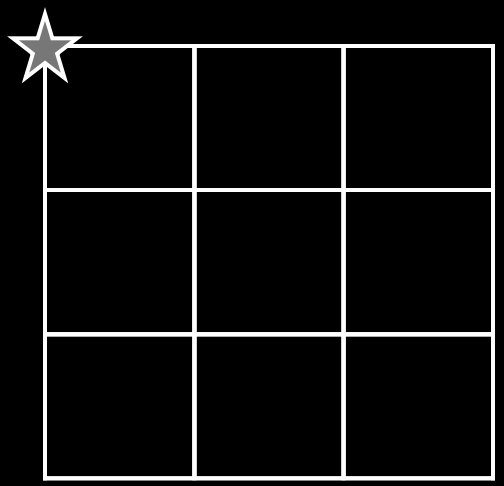
National Elevation Dataset (NED)



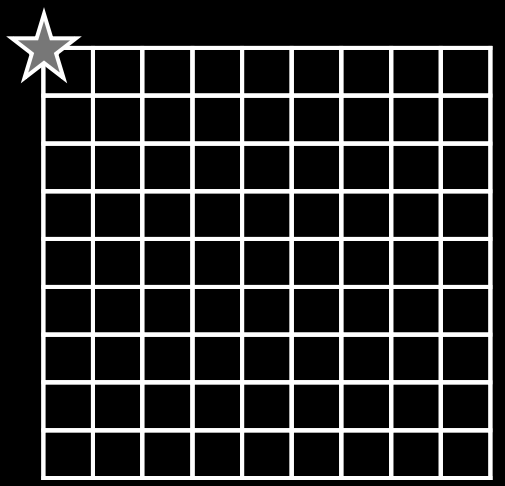
1-arc-second

(30-meter) resolution



1/3-arc-second

(10-meter) resolution



1/9-arc-second

(3-meter or better) resolution

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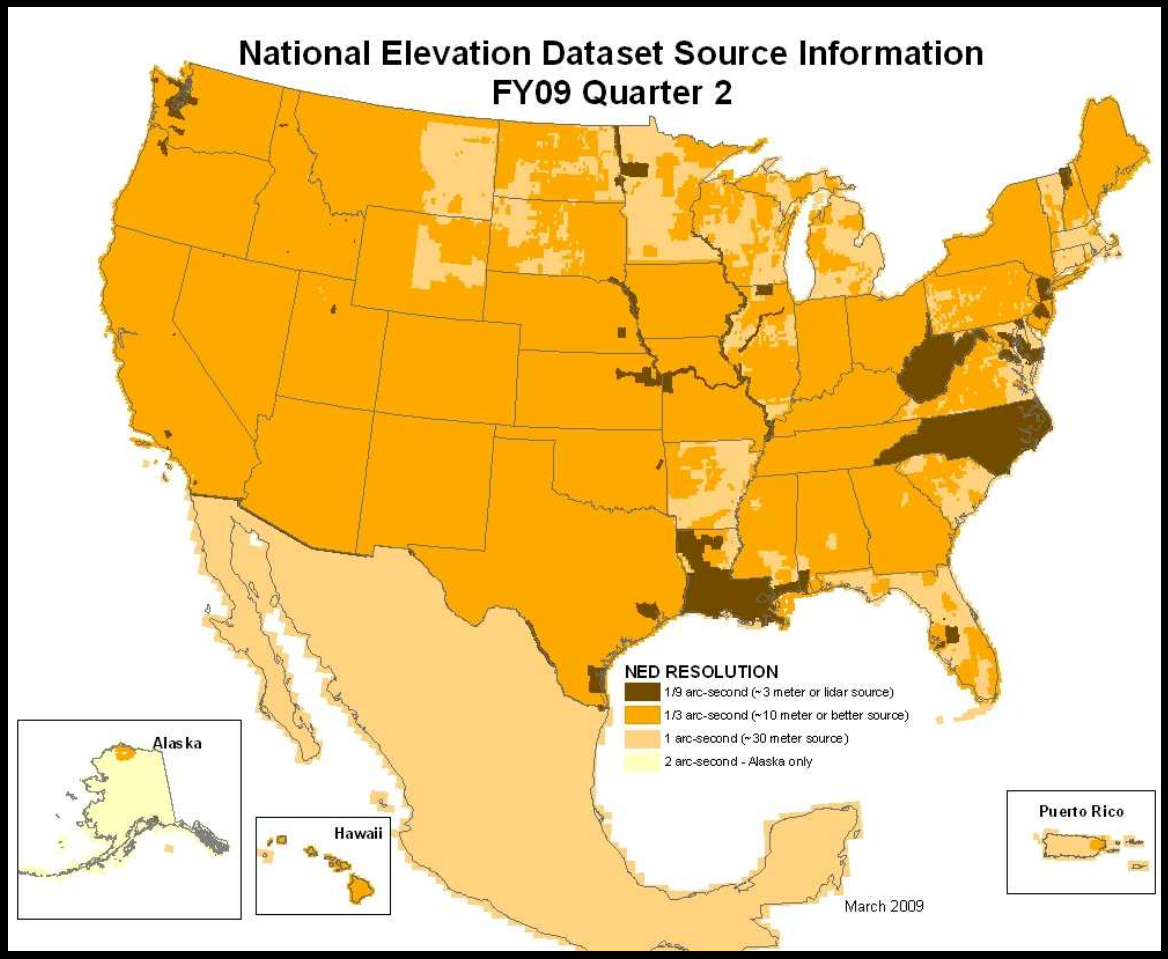
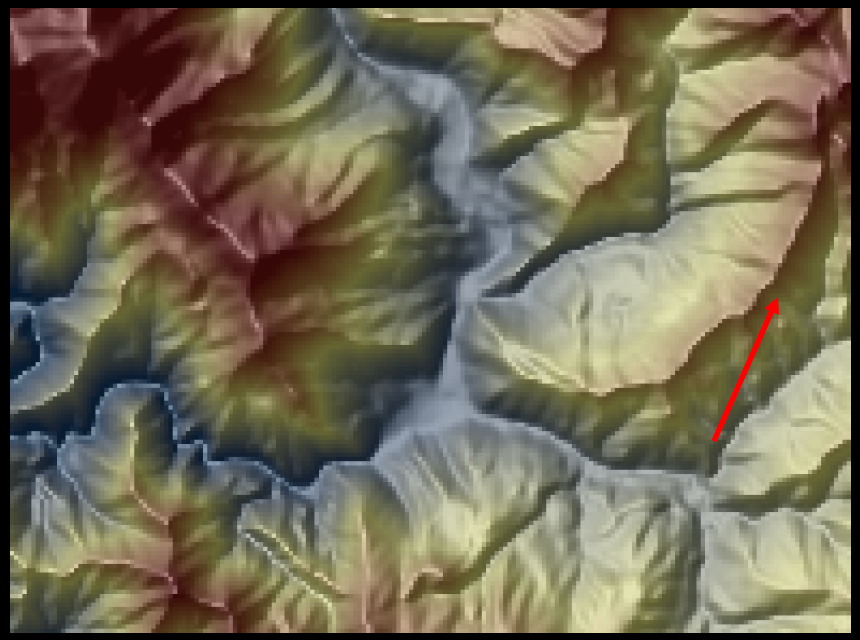
Multi-resolution NED Status, March 2009

- The NED has evolved from a 30-meter resolution dataset to a multi-resolution dataset
- Remotely sensed data, such as 3-meter or better data are integrated into the NED

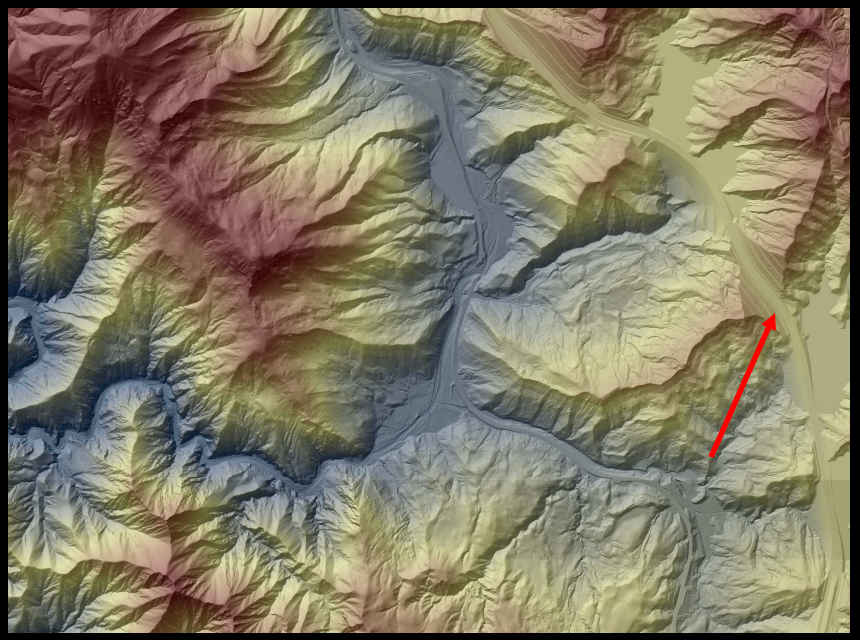


USGS

Importance of improved elevation
30-meter vs 1-meter lidar



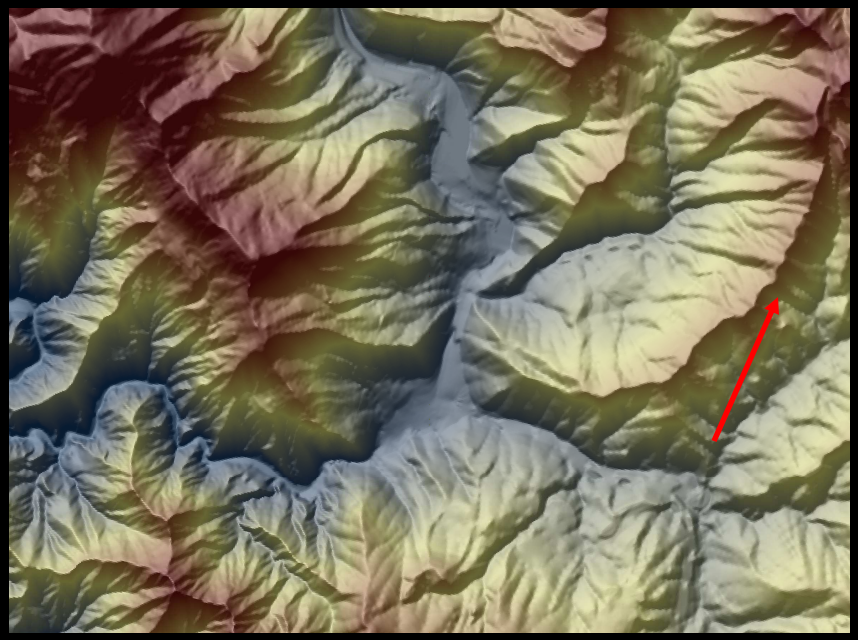
30 meter elevation data



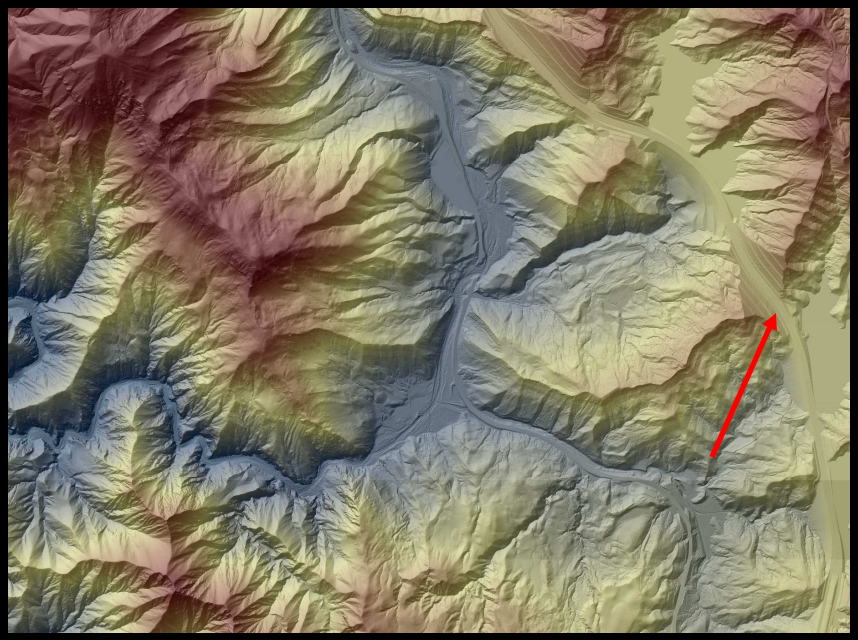
1 meter elevation data
derived from lidar

USGS

Importance of improved elevation
10-meter vs 1-meter lidar



10 meter elevation data



1 meter elevation data
derived from lidar

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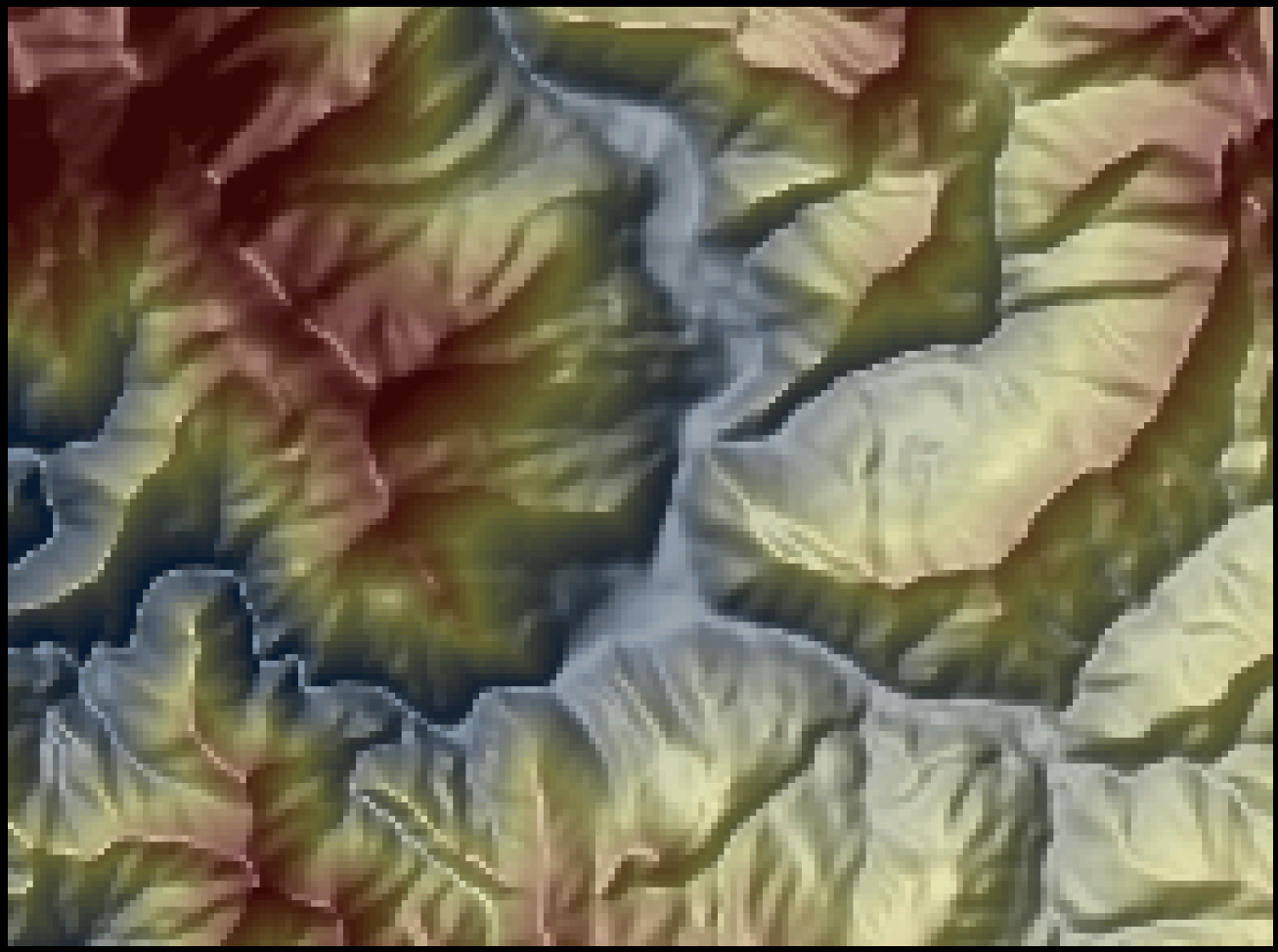
Elevation – 30m, 10m, & 1m)



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Importance of improved elevation data

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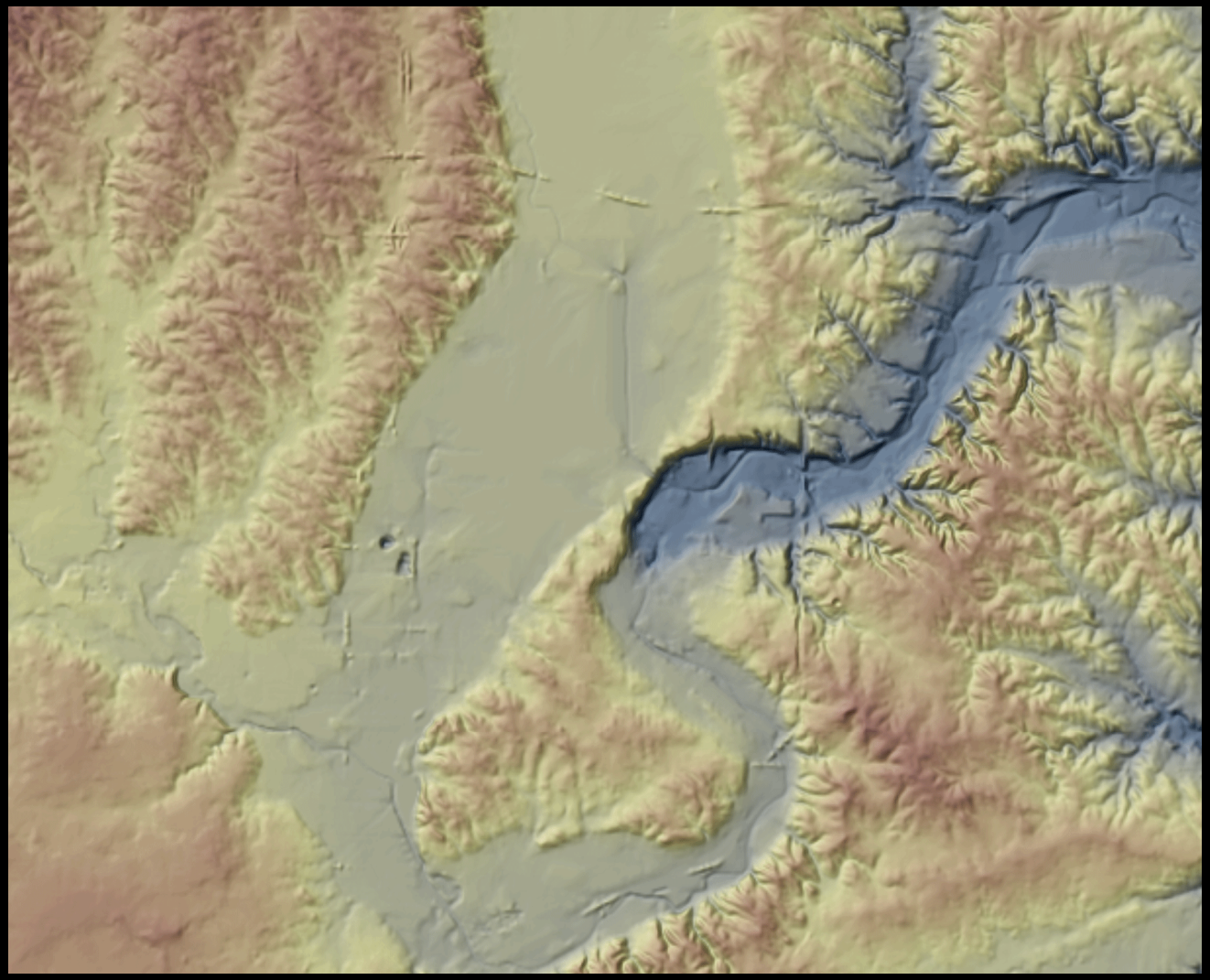
Improved elevation data in Sioux Falls

Surface Flow

Transportation network

Structures

Vegetation



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Light Detection and Ranging (lidar)

- **Acronym:**
- **Li**ght **D**etection **a**nd **R**anging
- Remote sensing technology
- Airborne platform
- Laser pulses determine the position and other characteristics of imaged features

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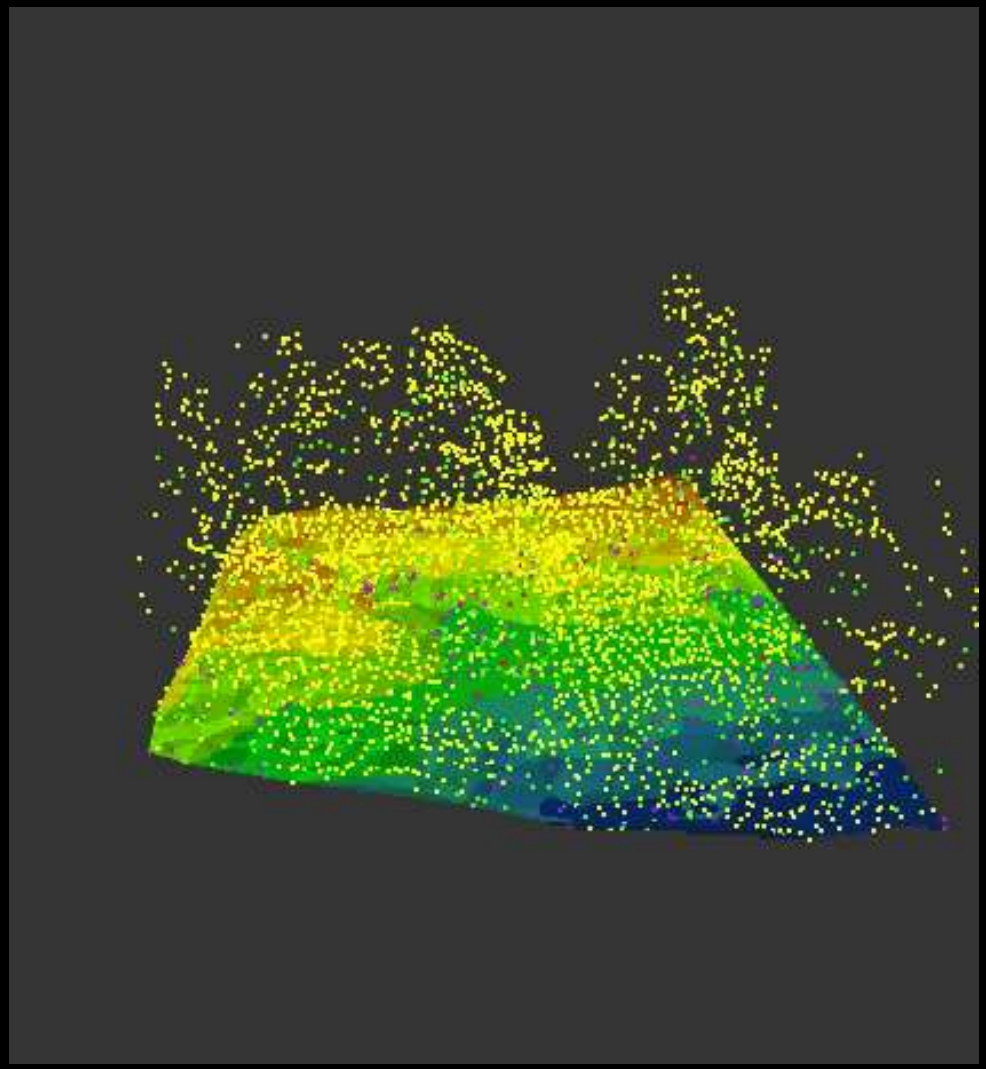
Lidar point cloud



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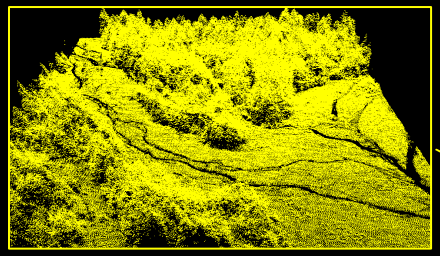
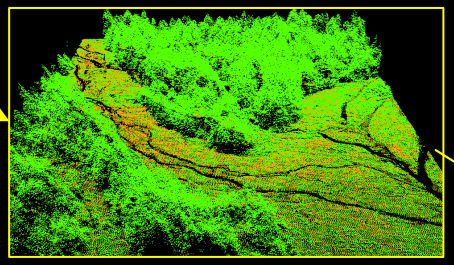
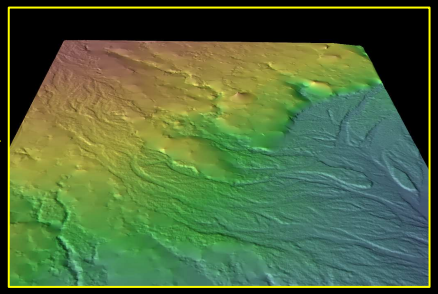
Lidar Flow



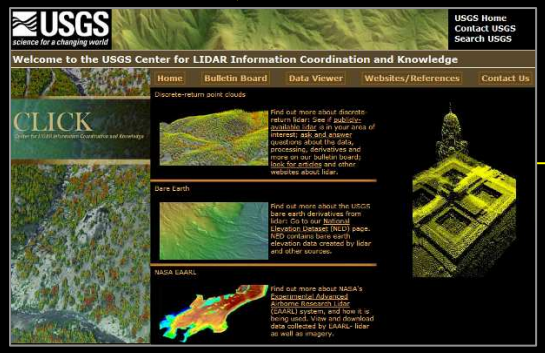
Raw Points



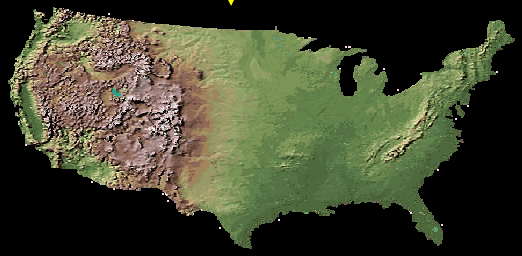
Processing



Bare Earth



Research and Derivatives



NED

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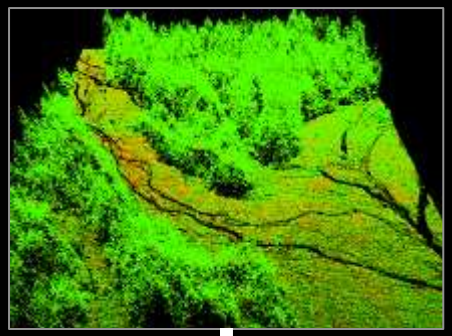
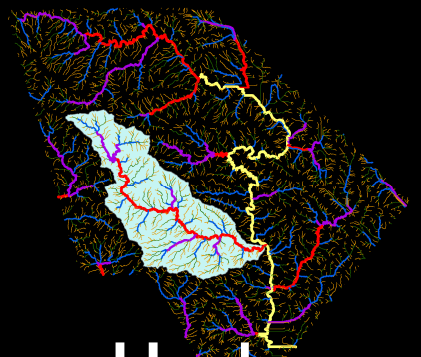
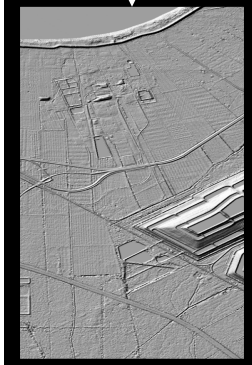
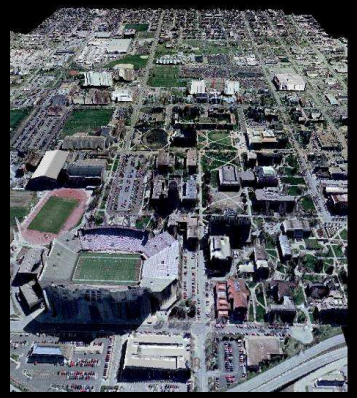
Data integration

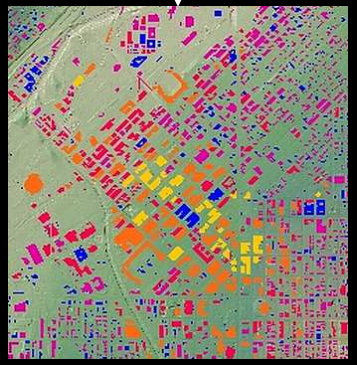


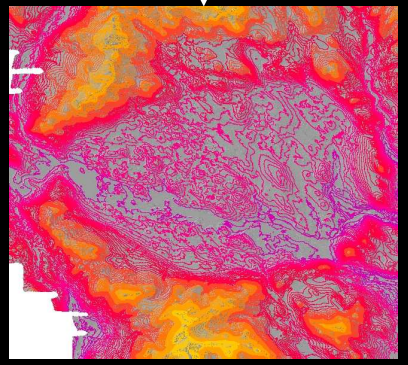


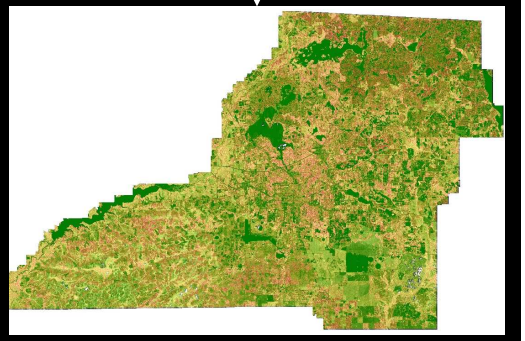
Hydro











NED Ortho Structures Contours Land Cover

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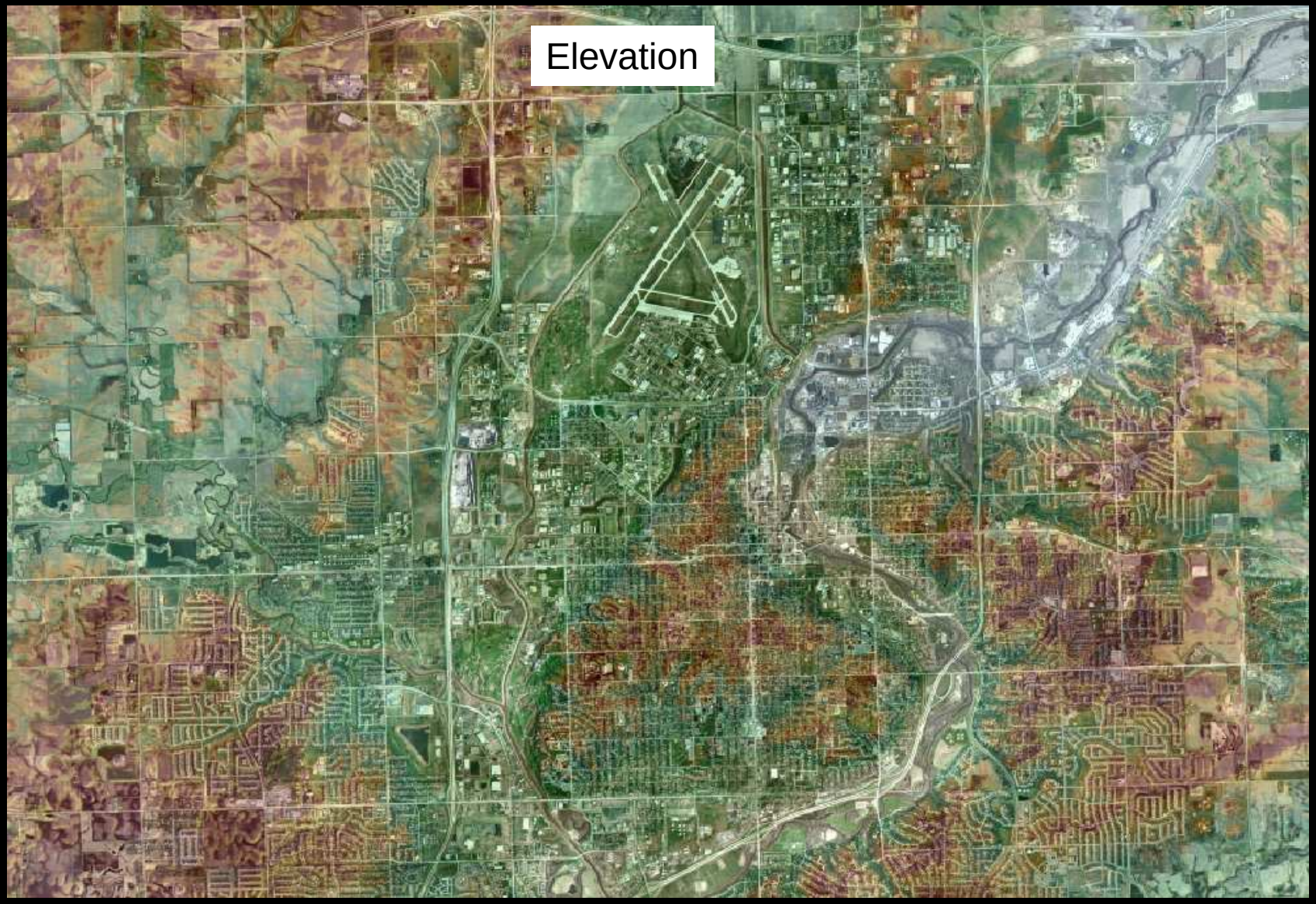
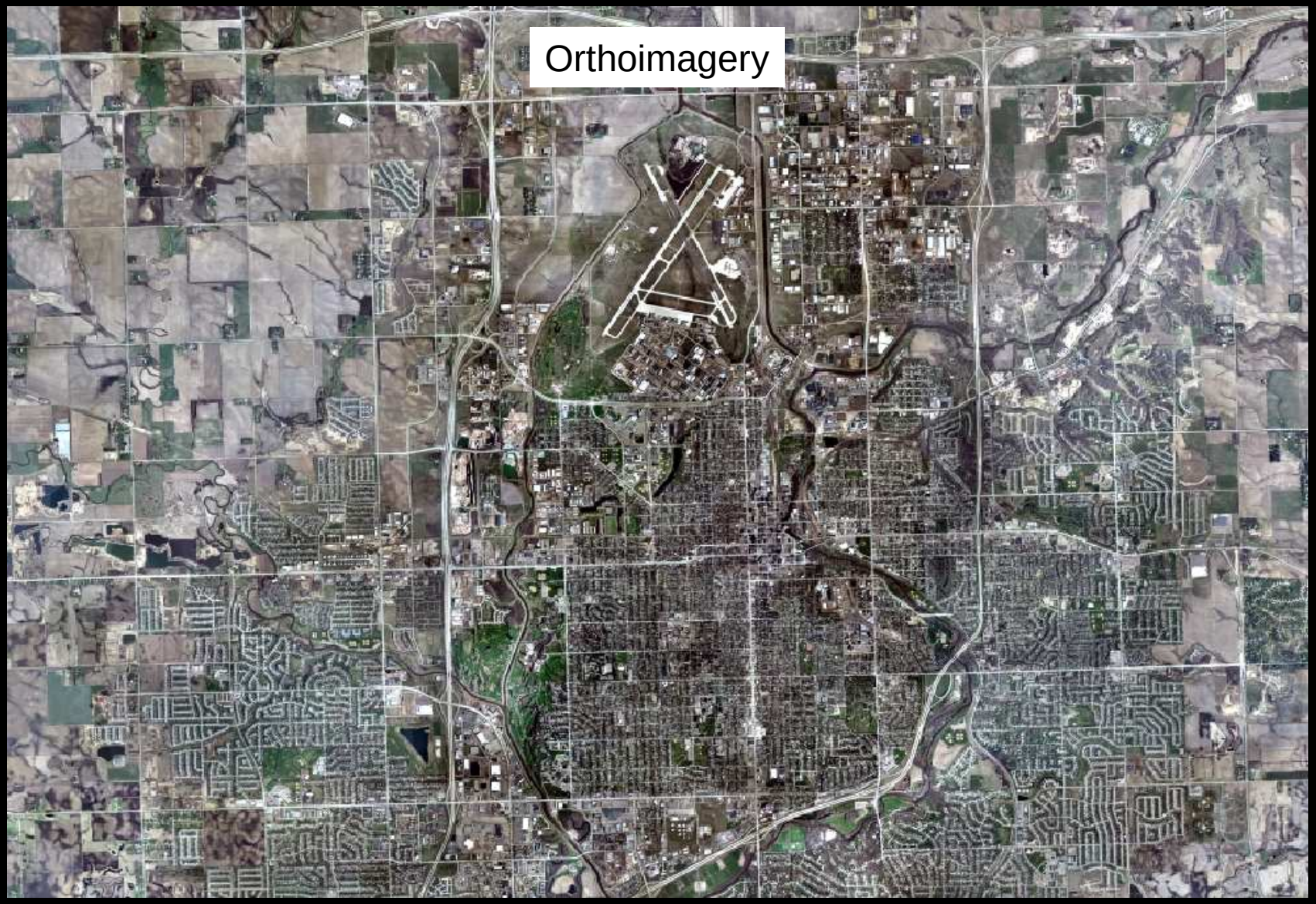
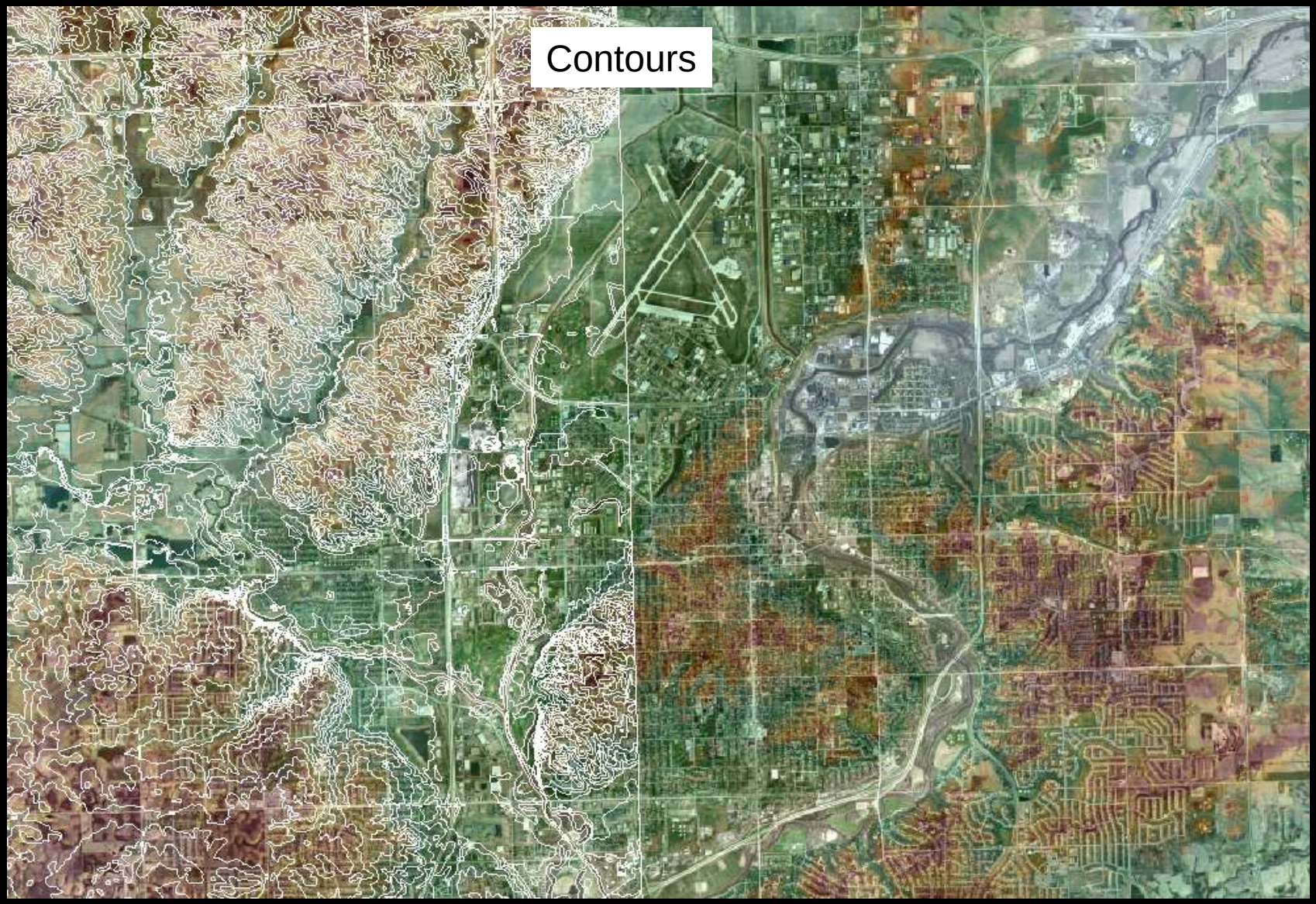


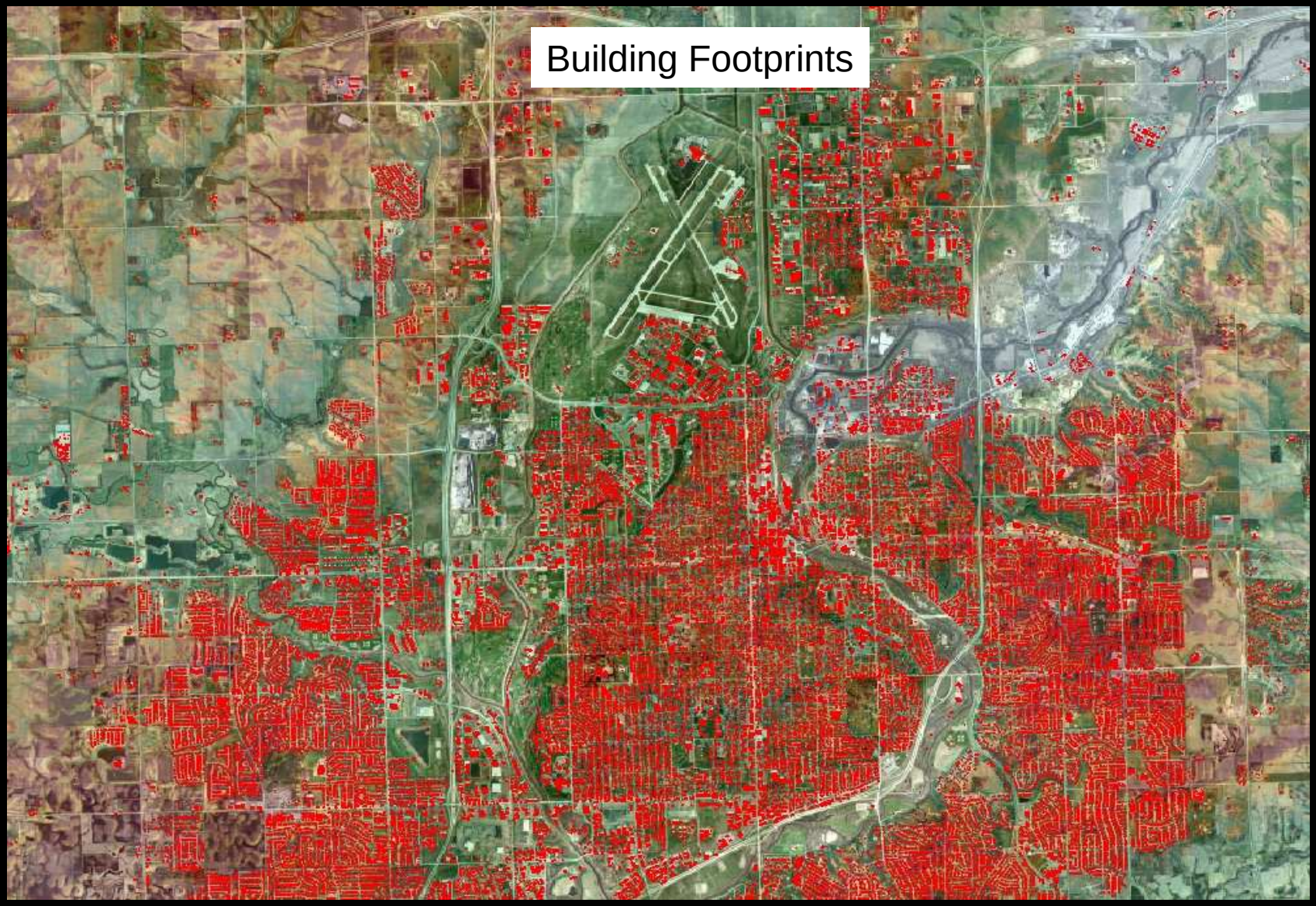
USGS



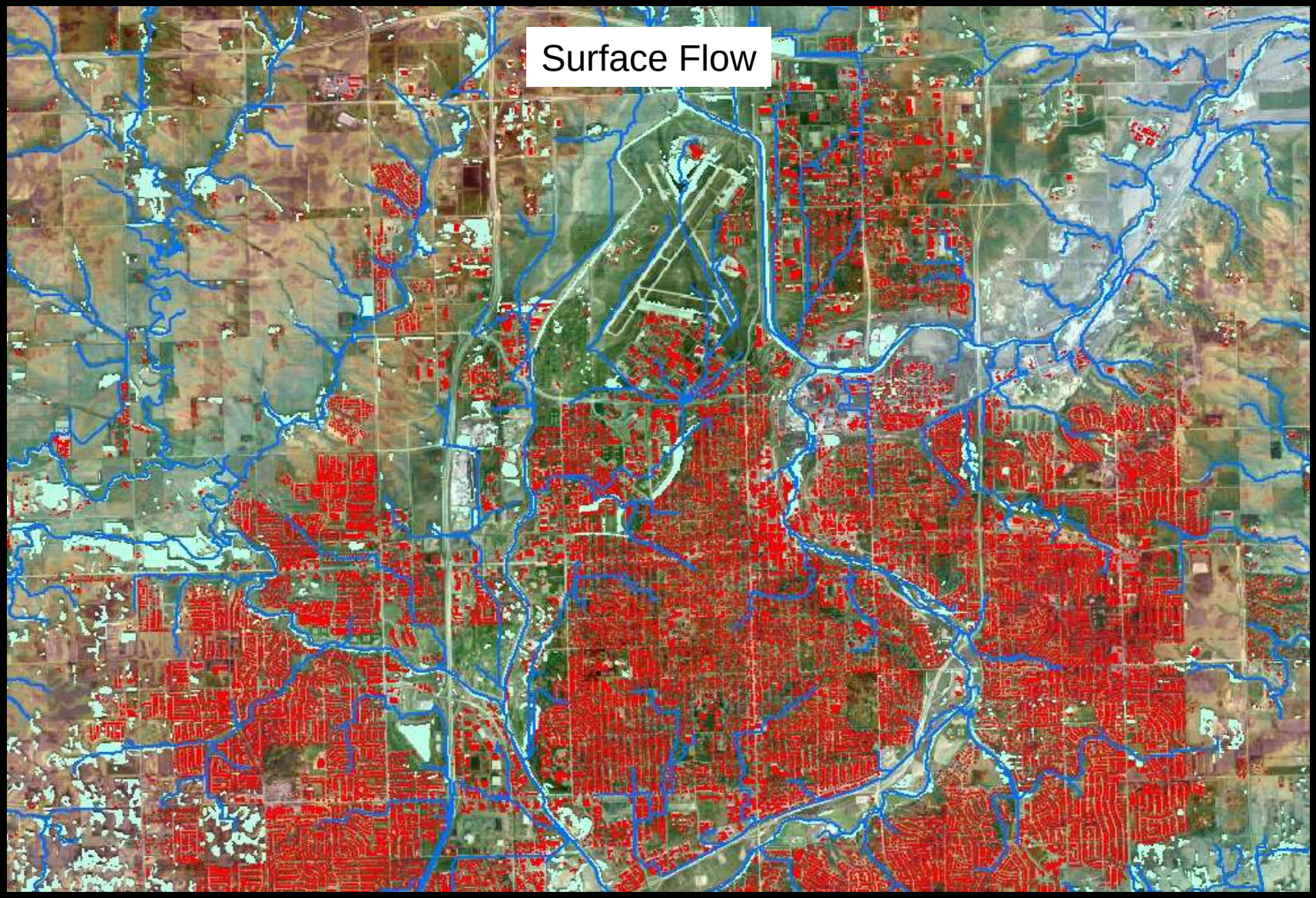
USGS



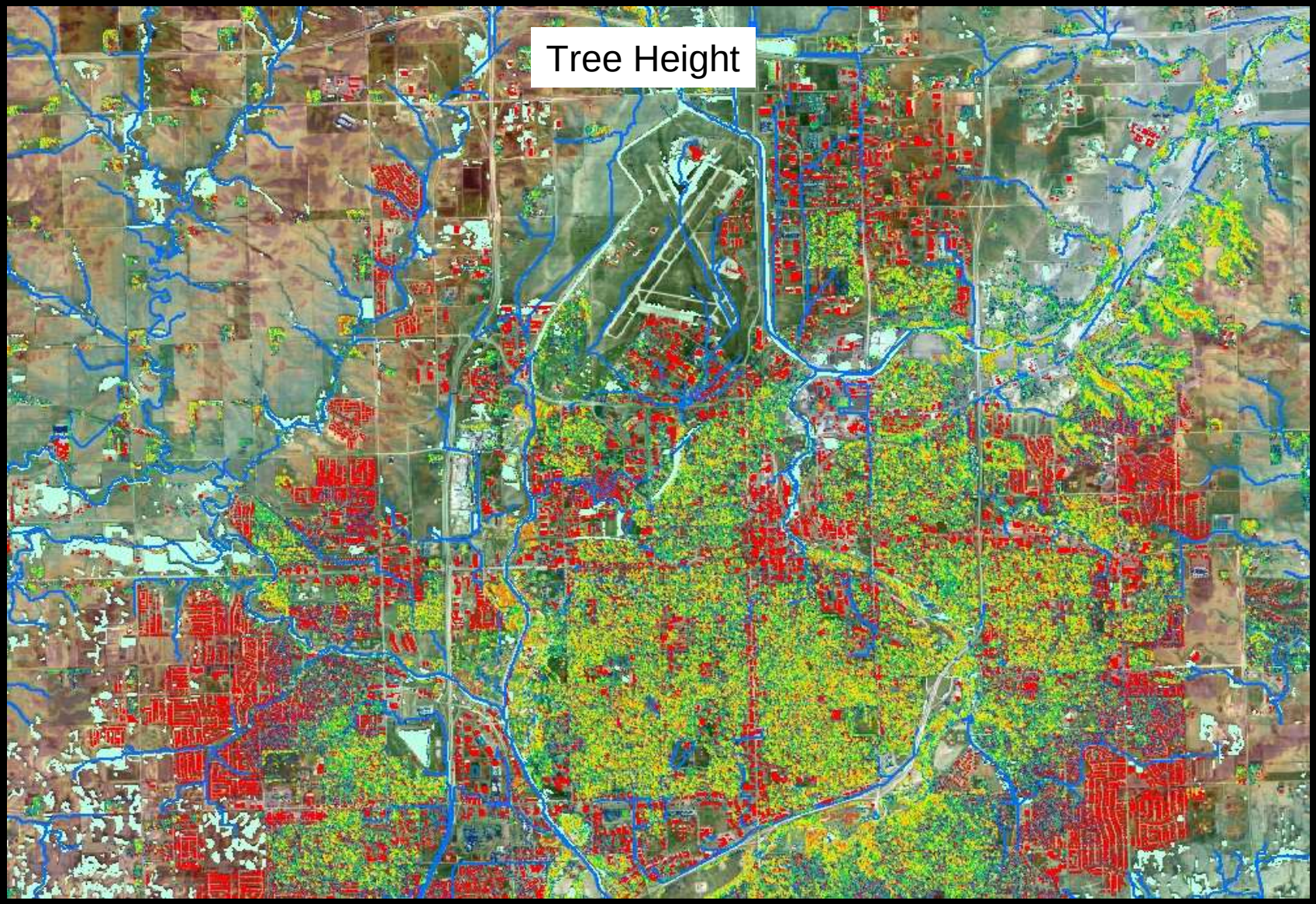
USGS



USGS



USGS



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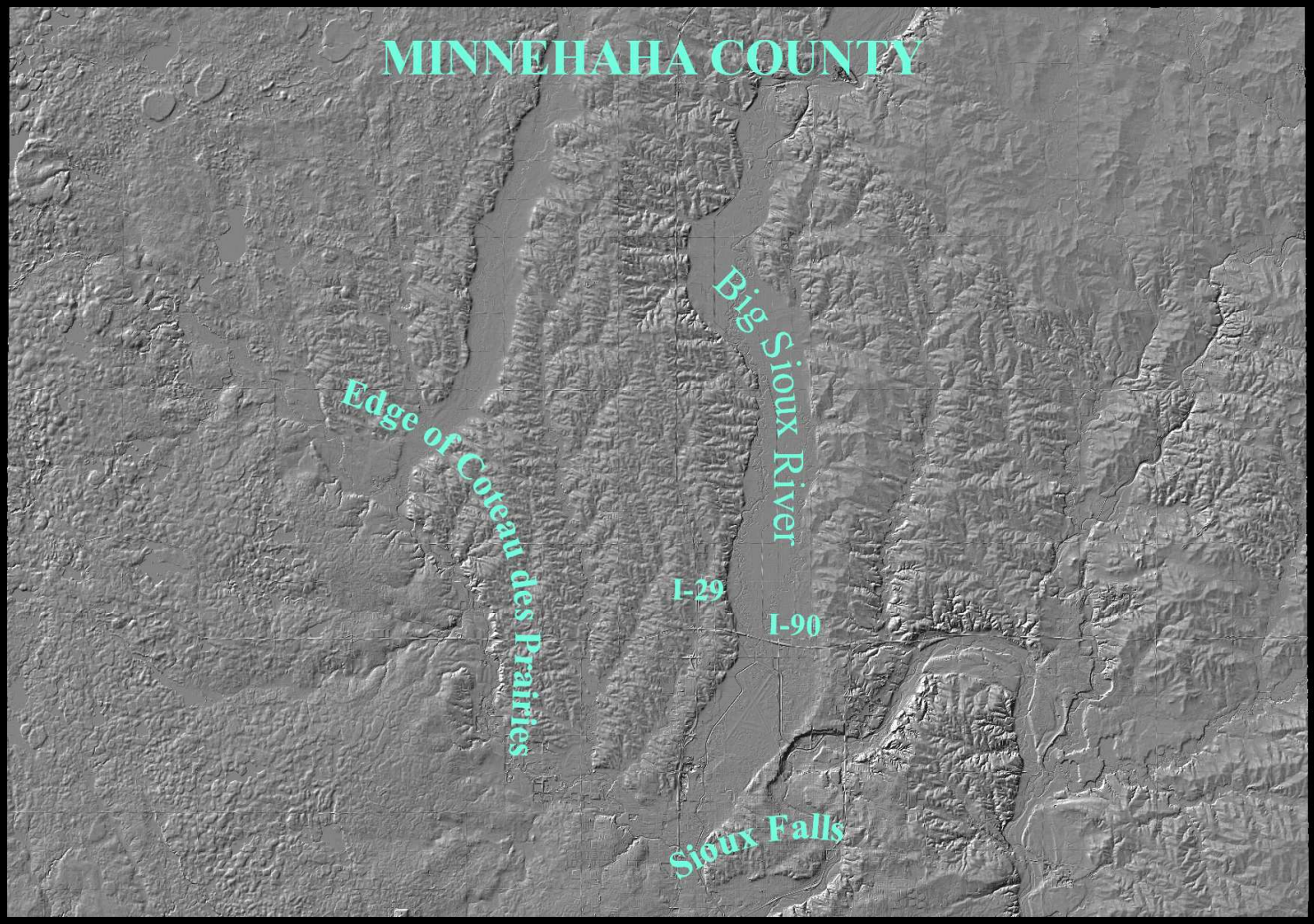
In 2008, one-meter resolution lidar data were acquired for Minnehaha County, South Dakota

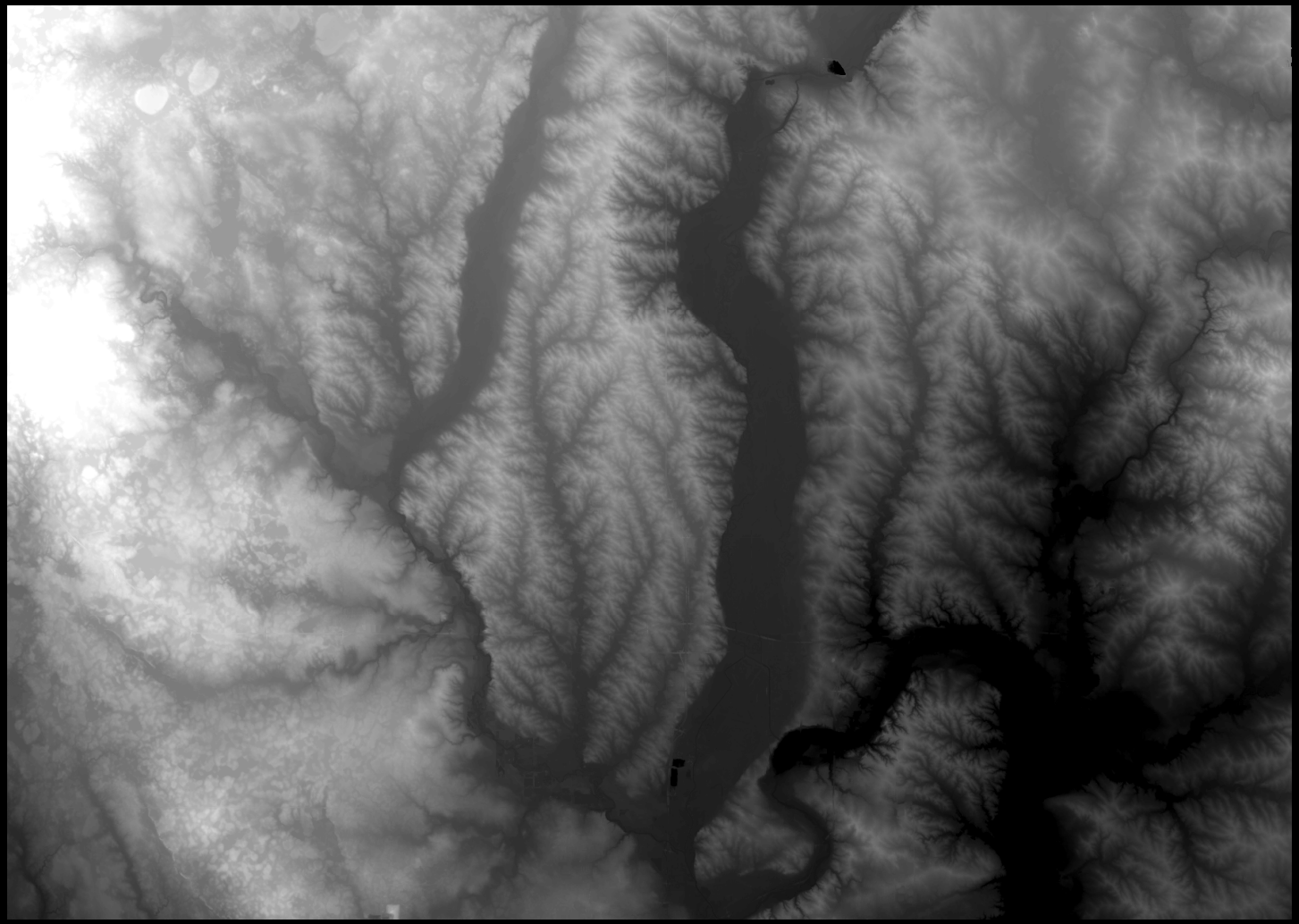
USGS

Lidar-derived elevation data



USGS

Using the lidar-derived digital elevation model (DEM), surface flow is characterized



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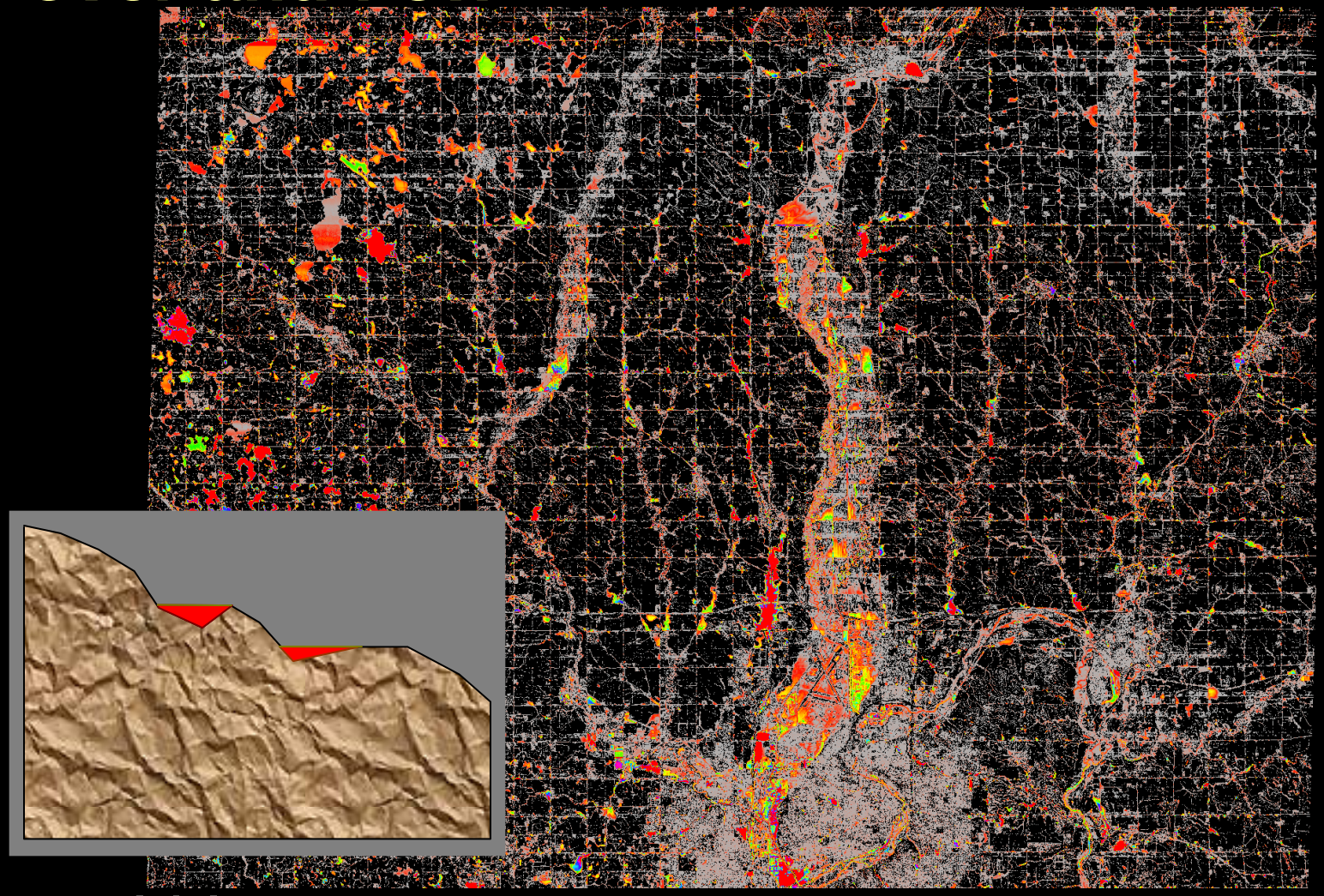
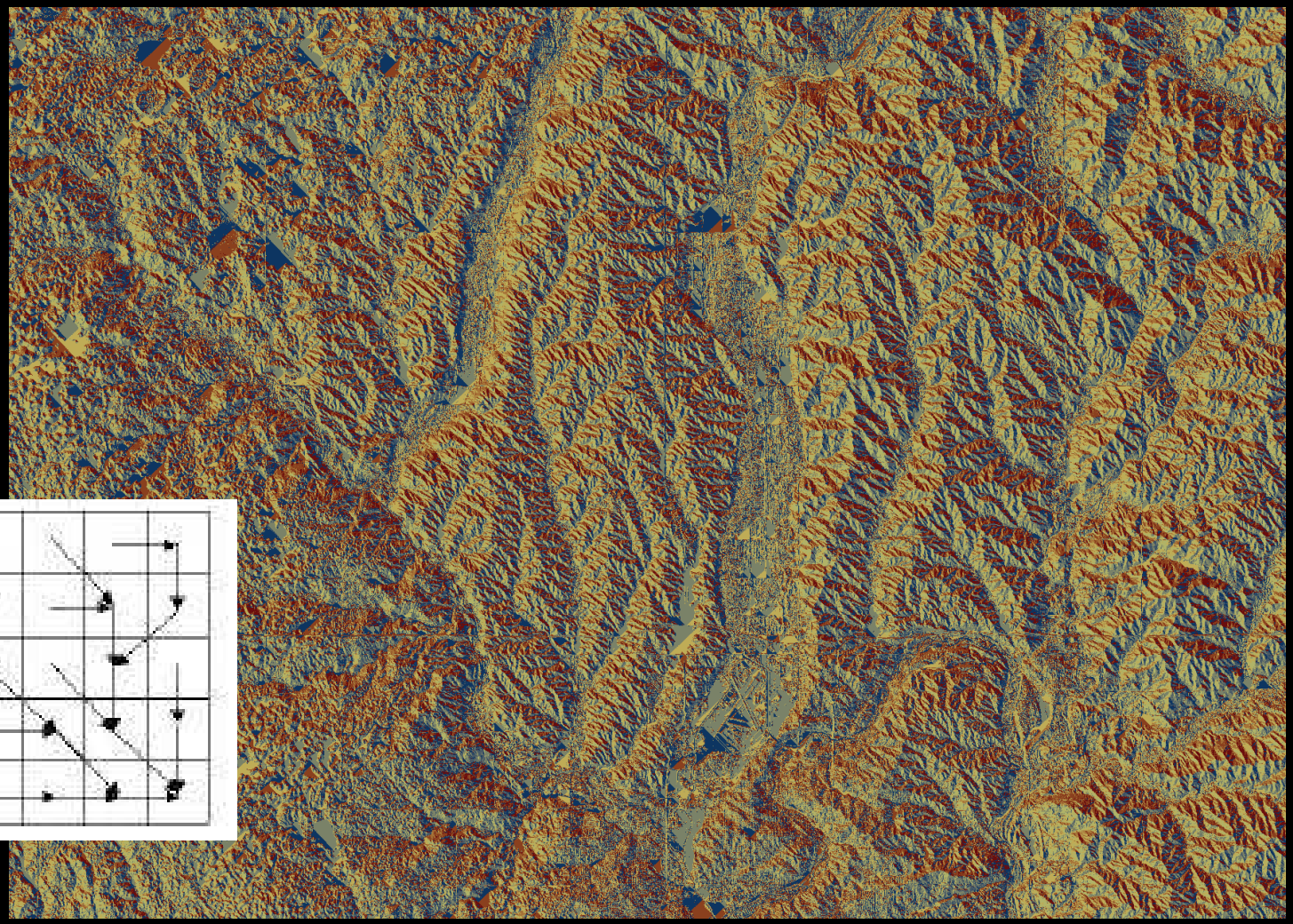
Sinks (depressions) are filled to create overland flow



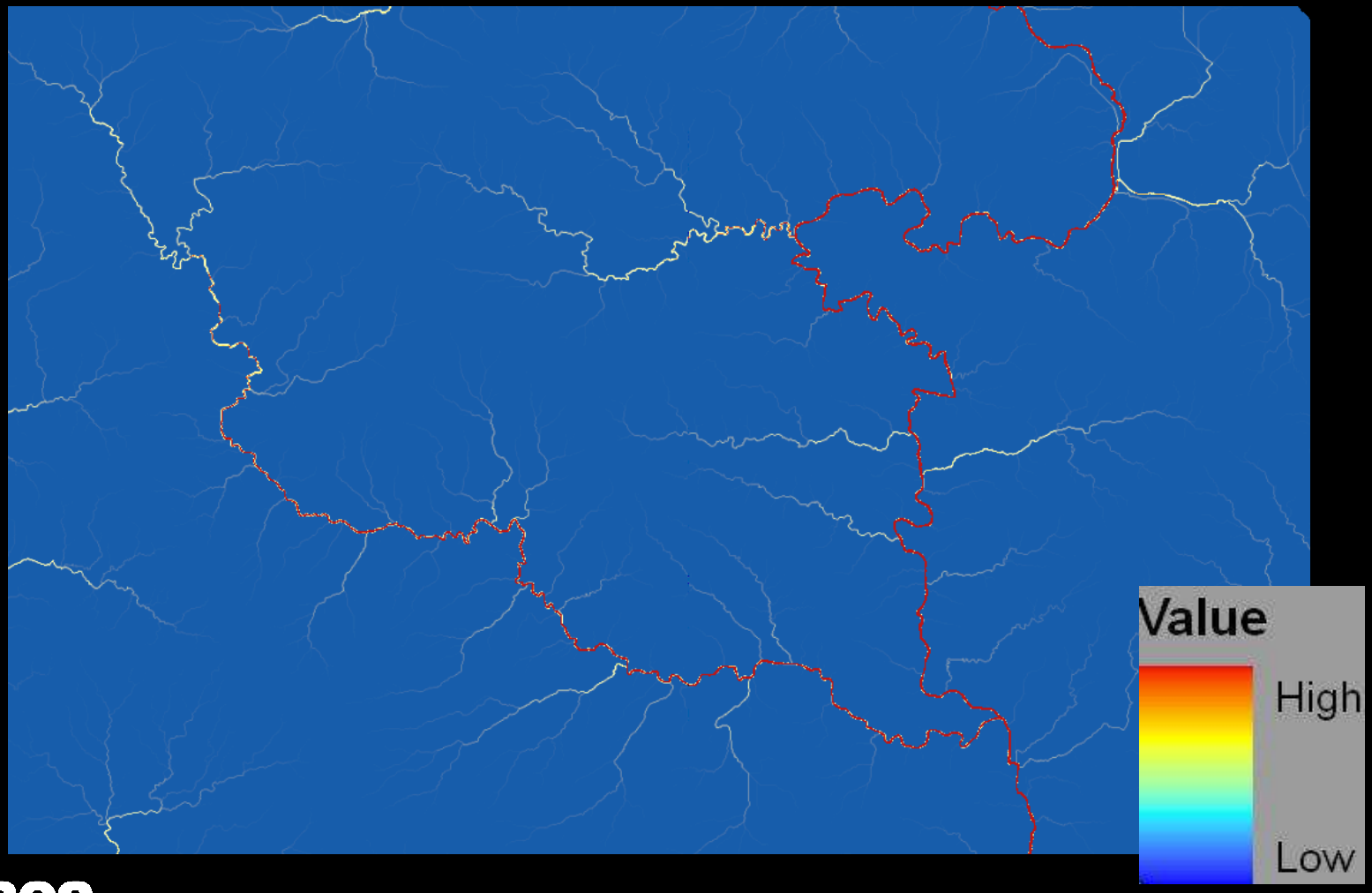
USGS

Flow direction - water would flow out of each cell to its steepest slope



USGS

Flow accumulation- number of upslope cells flowing to a location



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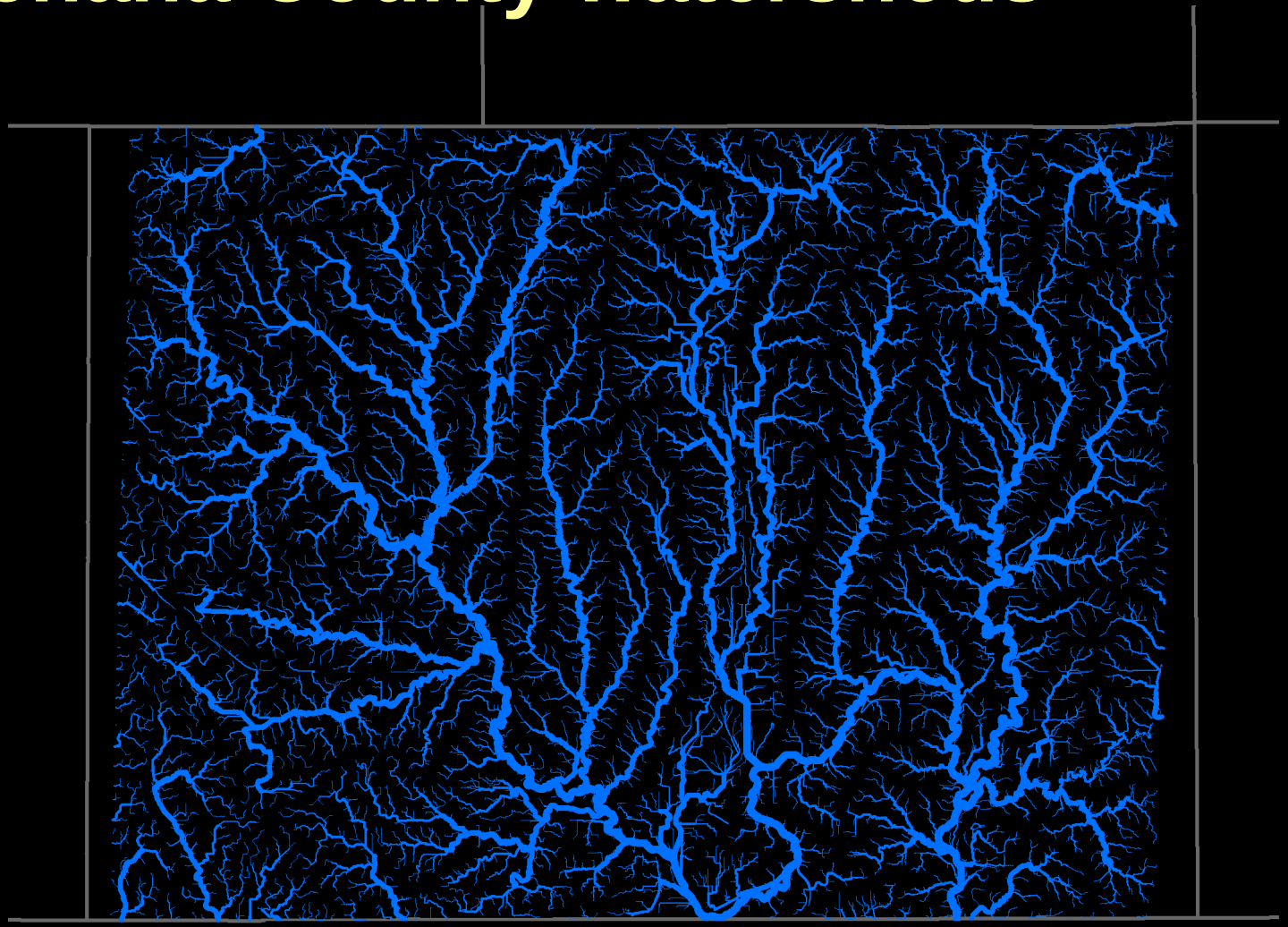
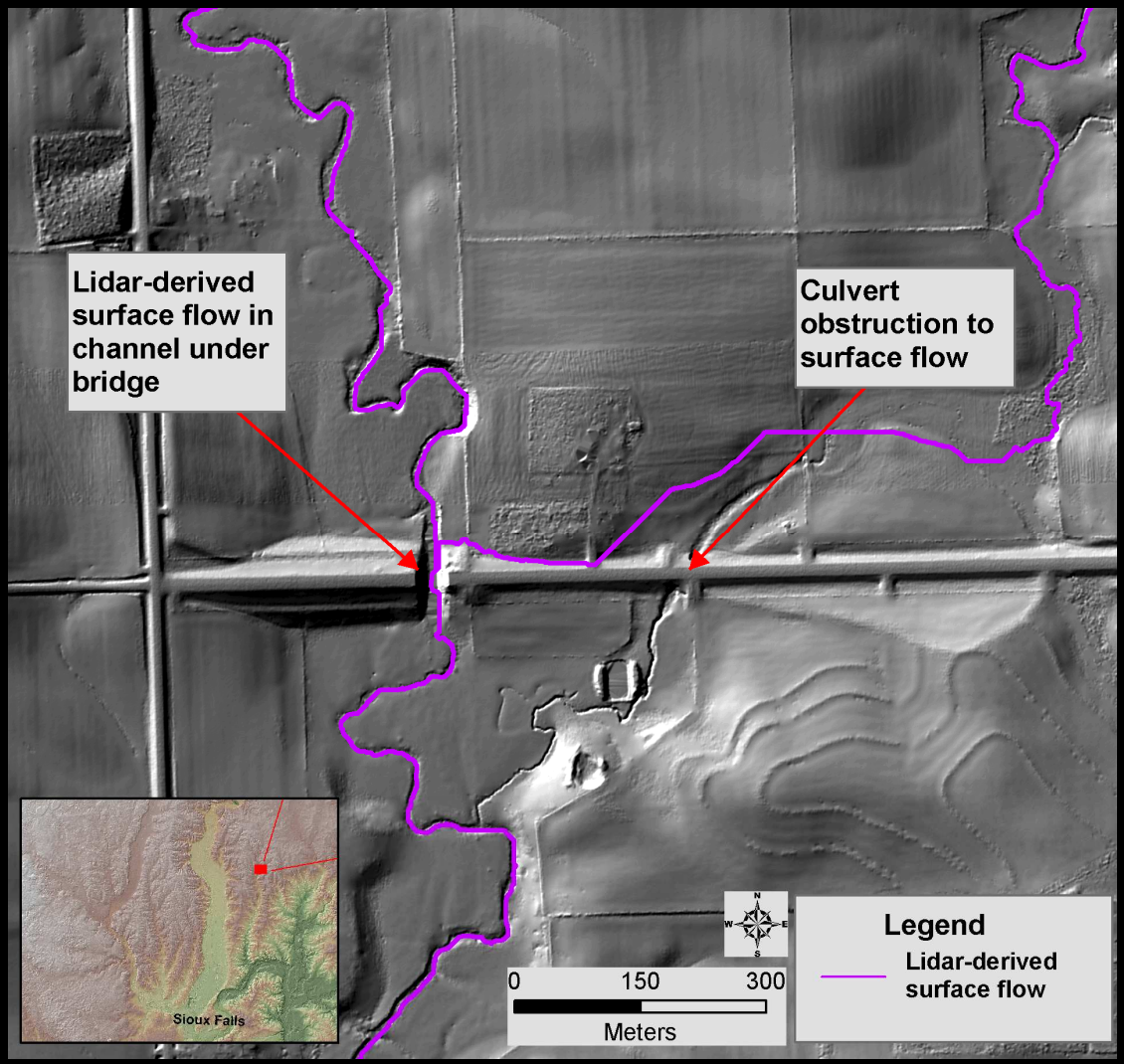
Minnehaha County watersheds



USGS

Detailed lidar-derived elevation data



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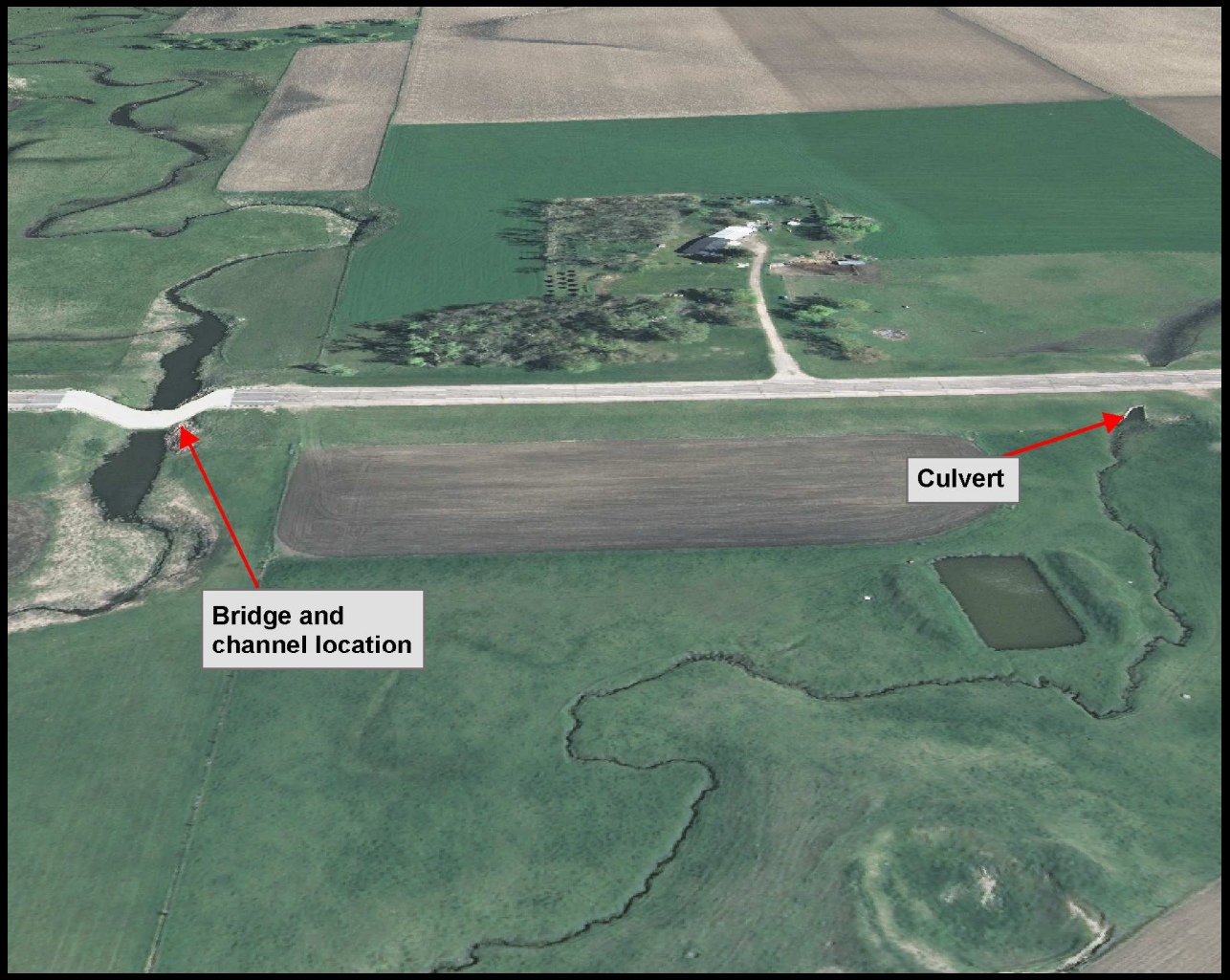
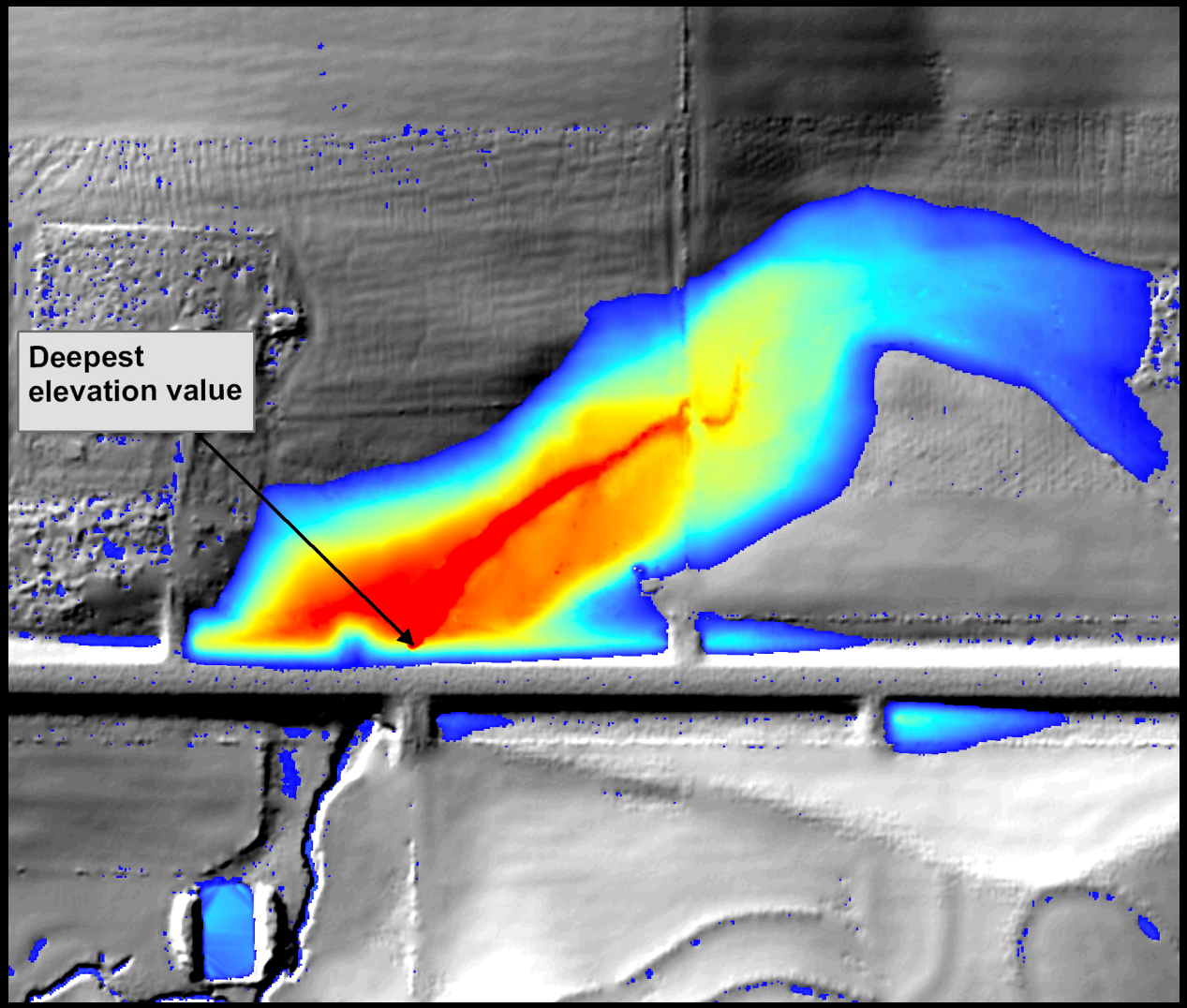
Obstructions to lidar-derived surface flow



USGS

Selective draining of sinks with obstructions



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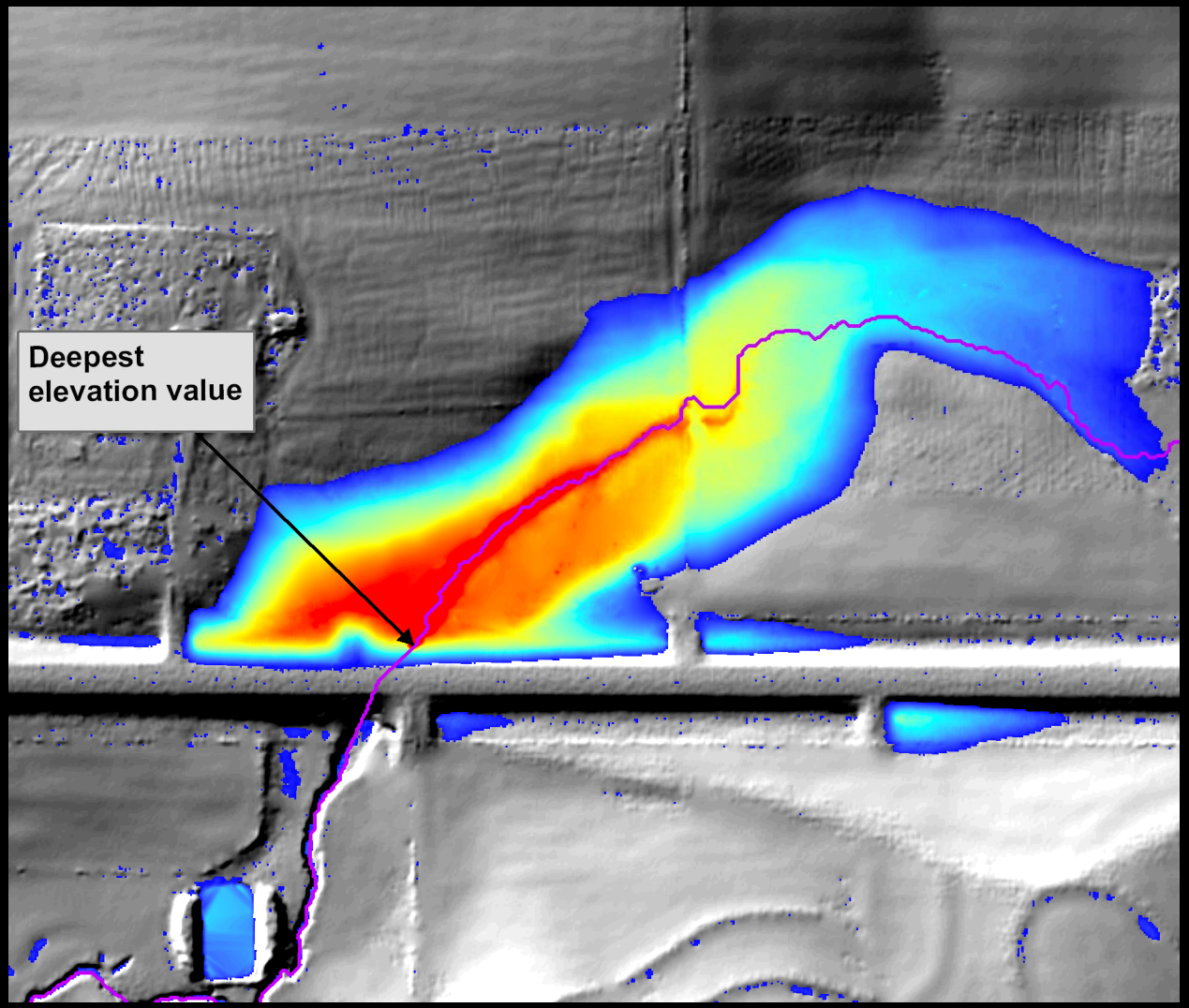
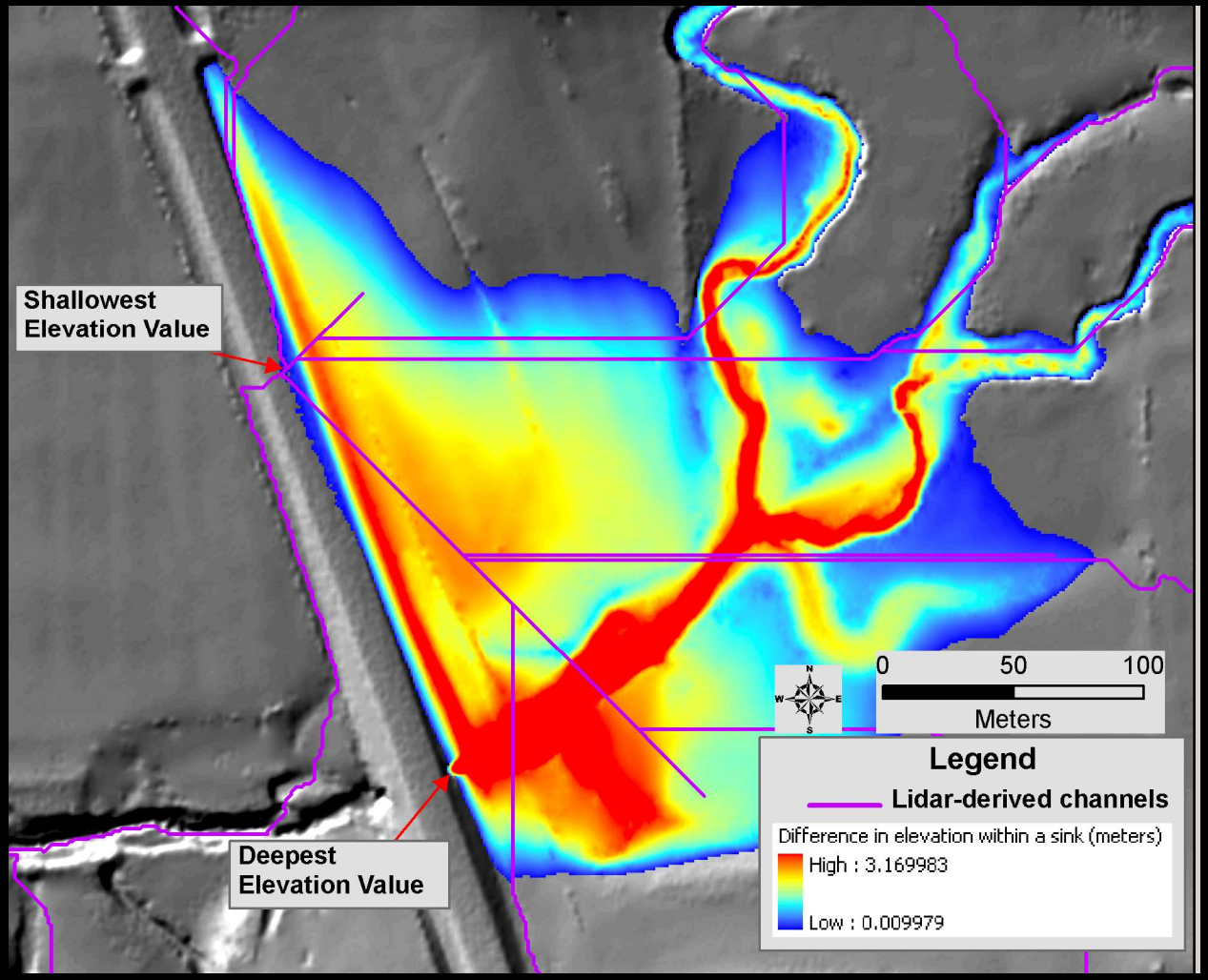
Surface flow is corrected



USGS

What about the shallowest elevation value?



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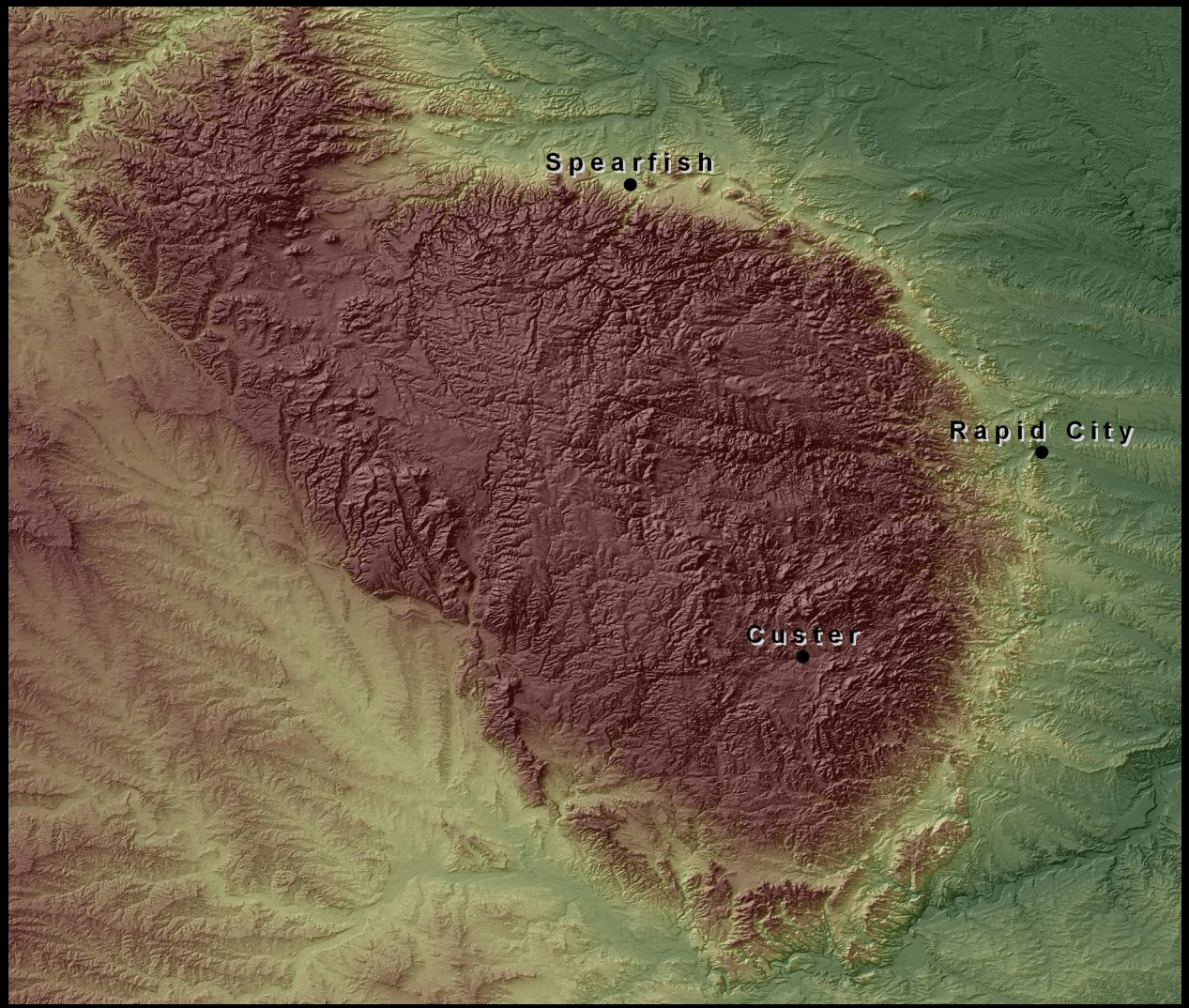
What about the Black Hills?



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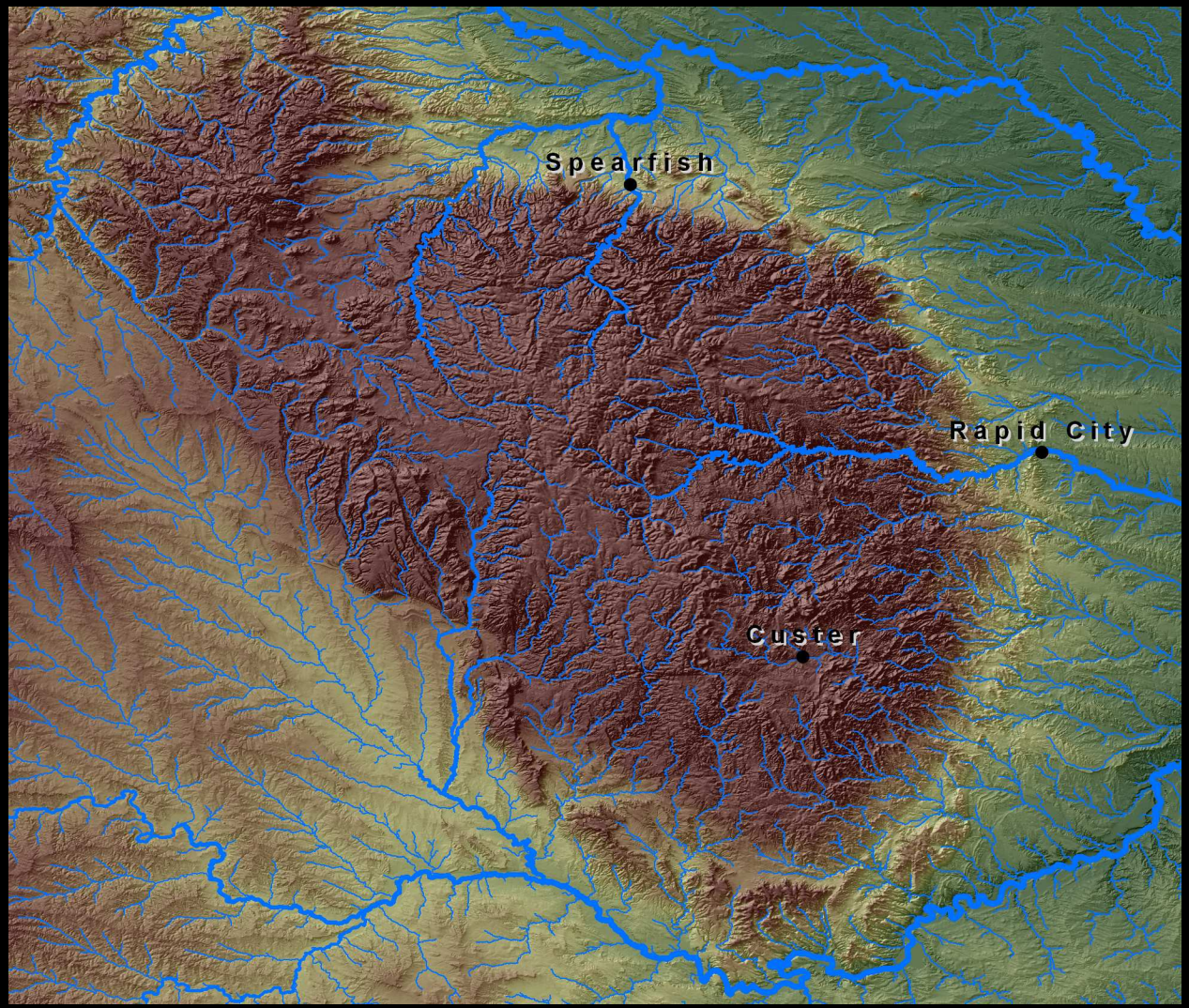
Surface flow derived from 30m elevation data



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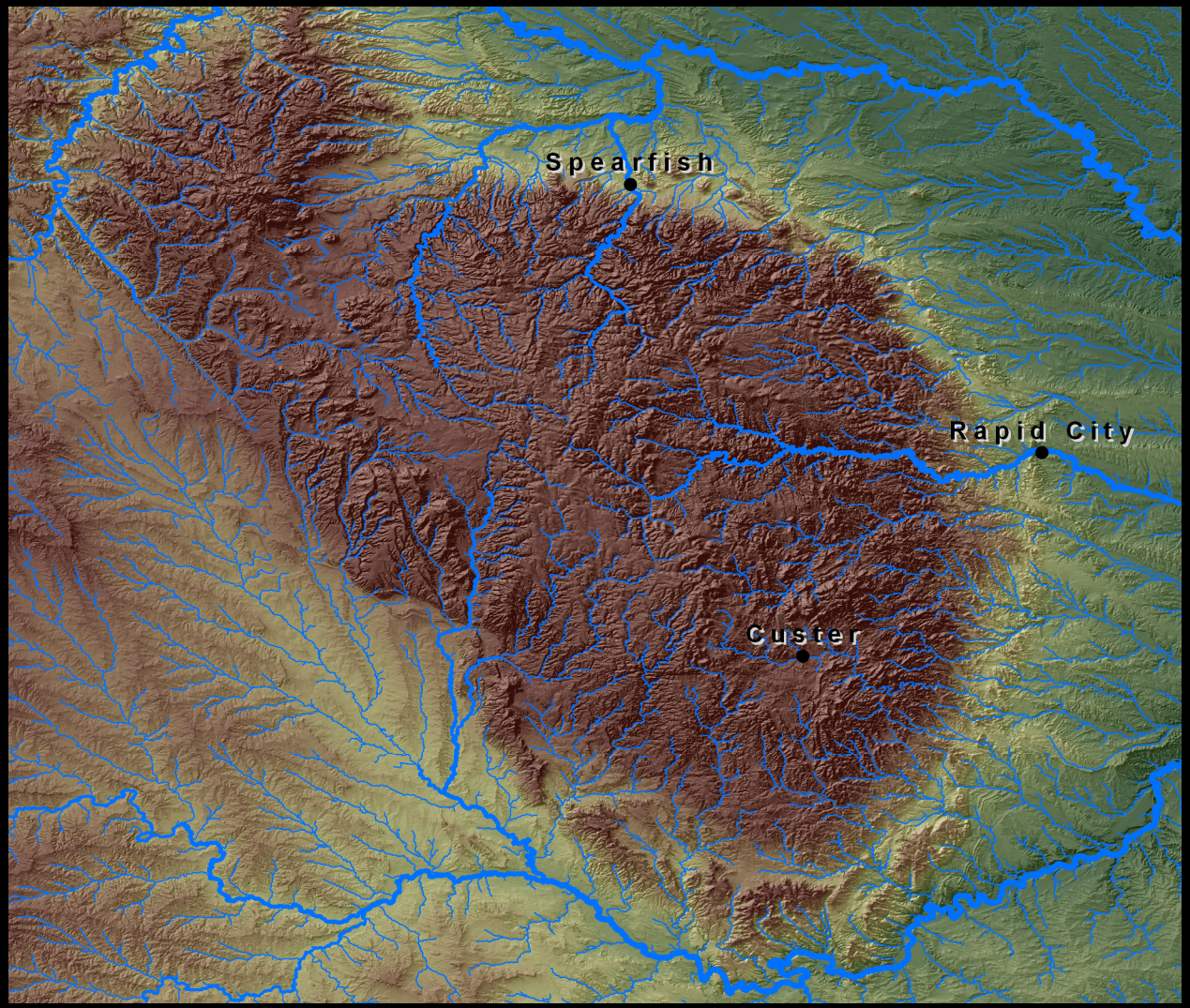
Black Hills watersheds



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Applications of Lidar

- Mapping confined urban channels vs natural stream
- In the creation of seamless topo/bathy products
- Integration of elevation data into the National Elevation Dataset
- Derivation of stream channel characteristics
- Mapping and monitoring coastal hazards
- Identification of small hydrologic features (ditches, tile drain studies)
- Mapping fish habitat
- Identification of canopy gaps
- Flood inundation modeling
- Derivative hydrologic profiling
- Disaster response
- Fire science
- High-resolution floodplain mapping
- Characterization of canopy structure
- Defining drainage basins
- Jokulhaup monitoring
- Fault-rupture mapping
- Monitoring sea level rise
- Natural Hazards
- Identifying landslide-prone areas
- Creating topographic maps
- Glacier changes
- Delineation of canopy surface
- Determination of watershed characteristics
- Delineation of building structures
- Characterization of urban settings
- Monitoring long-term shoreline change
- Mapping land cover and land use
- Measuring earthquake deformation
- Delineation of volcanic structure
- Monitoring volcano hazards
- Urban mapping
- Hydrologic Modeling
- Bare earth products
- Monitoring debris flows
- Wave height surveys
- Sedimentation into rivers
- Monitoring geomorphic processes
- Identification of ponding areas
- Mapping wetland drainage
- Creation of synthetic drainage networks
- Identifying culverts
- Transportation mapping
- 3-D visualization of buildings
- Volume visualization
- Identifying bird habitats

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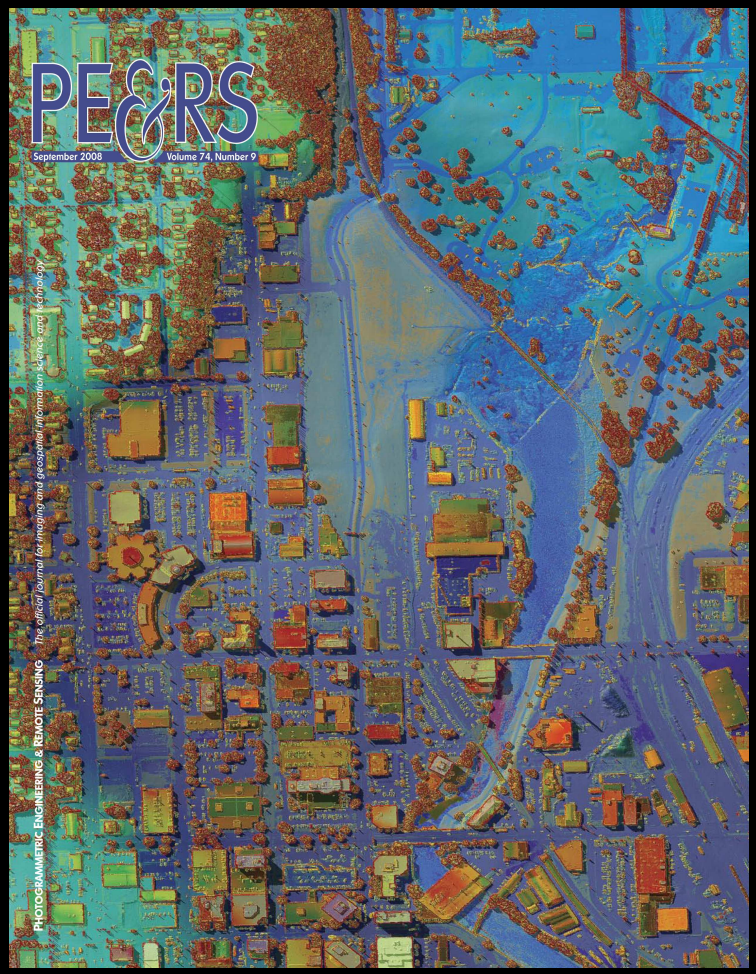
Lidar-derived surface flow

- Detailed representation of the Earth's topography and drainage network.
- High resolution, consistently generated, and hydrologically integrated
- Better surface flow representation in low relief
- Surface flow from lidar-DEMs more closely follows drainage channels except in obstructed areas
- Ongoing research to systematically remove obstructions to surface flow

USGS

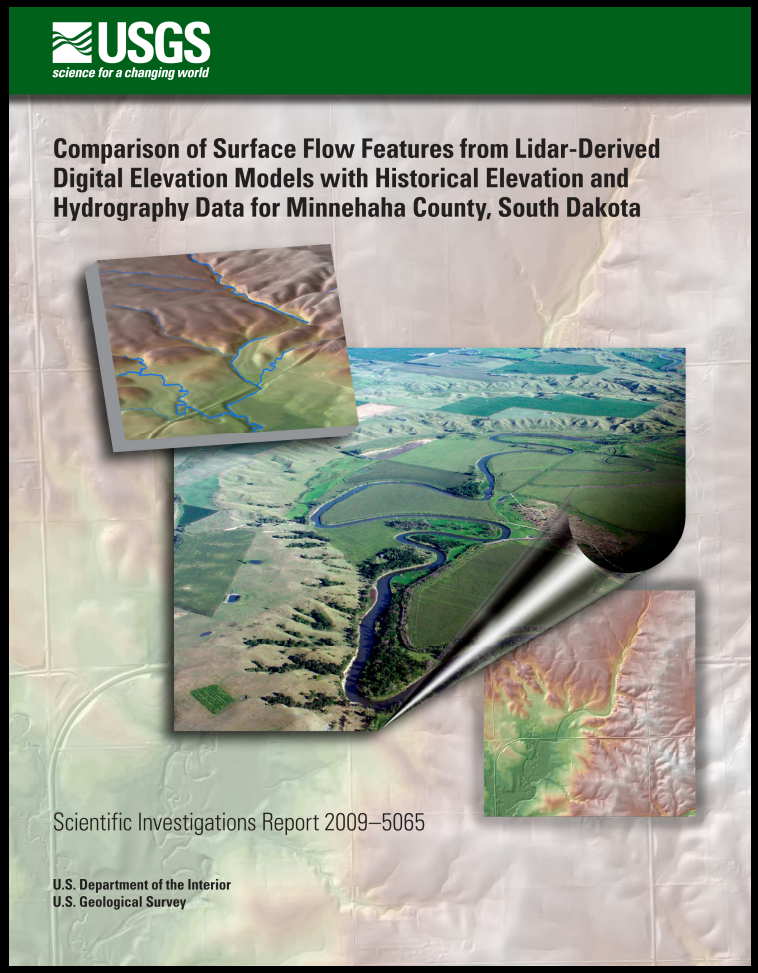
The Need For a National Lidar Dataset



http://www.asprs.org/publications/pers/2008journal/september/highlight.pdf

USGS

Comparison of Surface Flow Features from Lidar-Derived Digital Elevation Models



- **http://pubs.usgs.gov/sir/2009/5065**

USGS

Web sites

- Elevation, Topographic Science, and Lidar Branch http://topotools.cr.usgs.gov/
- National Elevation Dataset (NED) http://ned.usgs.gov/
- Elevation Derivatives for National Applications (EDNA) http://edna.usgs.gov/
- EDNA Watershed Atlas http://edna.usgs.gov/watersheds
- Light Detection and Ranging (Lidar) http://lidar.cr.usgs.gov/
- Topographic Change http://topochange.cr.usgs.gov/

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