

# High-resolution Landscape Characterization to inform the Next Generation of Hydrologic Models

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**Modeling Workgroup Quarterly Review**  
**January 6, 2020**

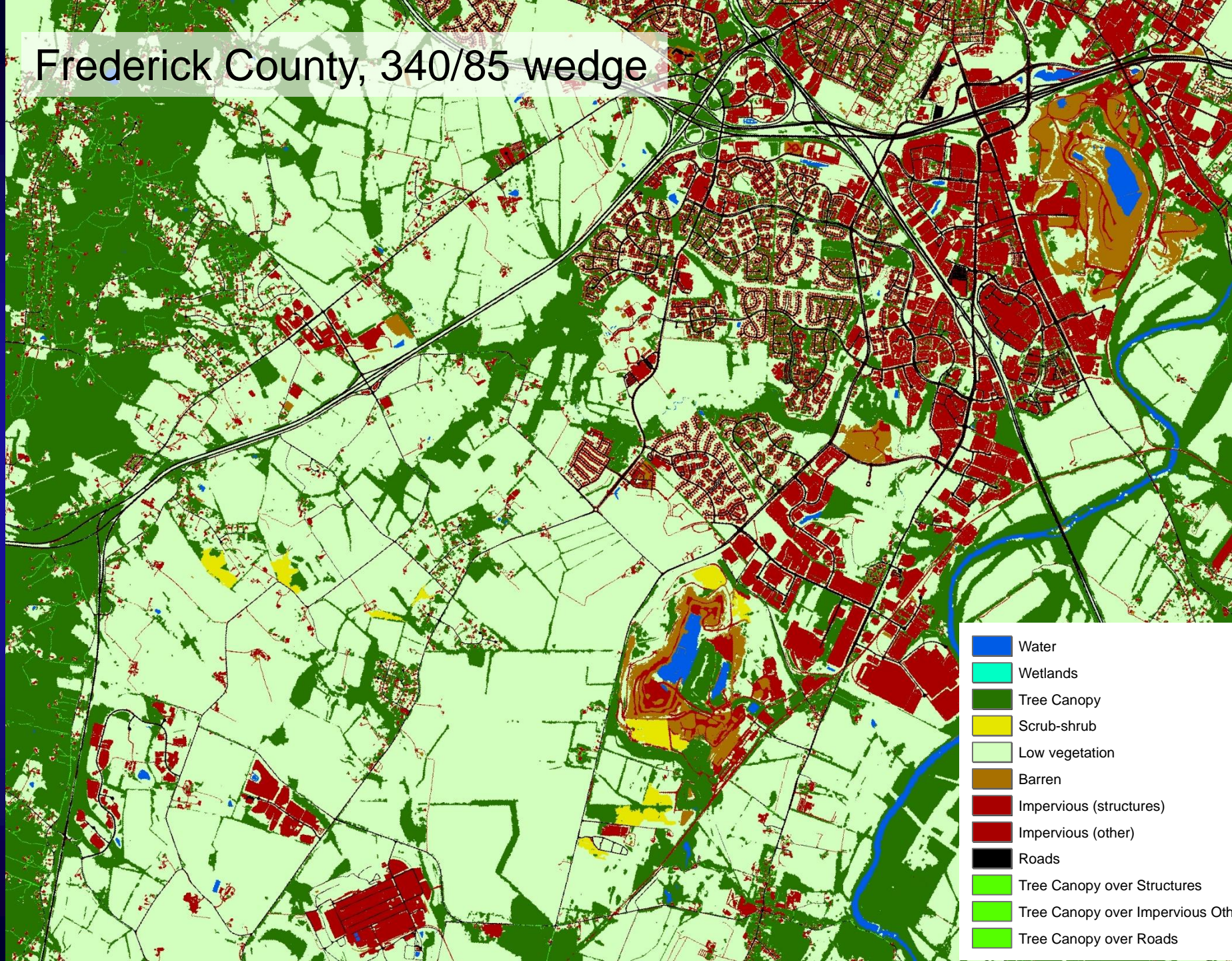


# Frederick County, 340/85 wedge





# Frederick County, 340/85 wedge





## Local land use and parcel data

- Low-density Residential
- Recreation
- Agriculture
- Roads

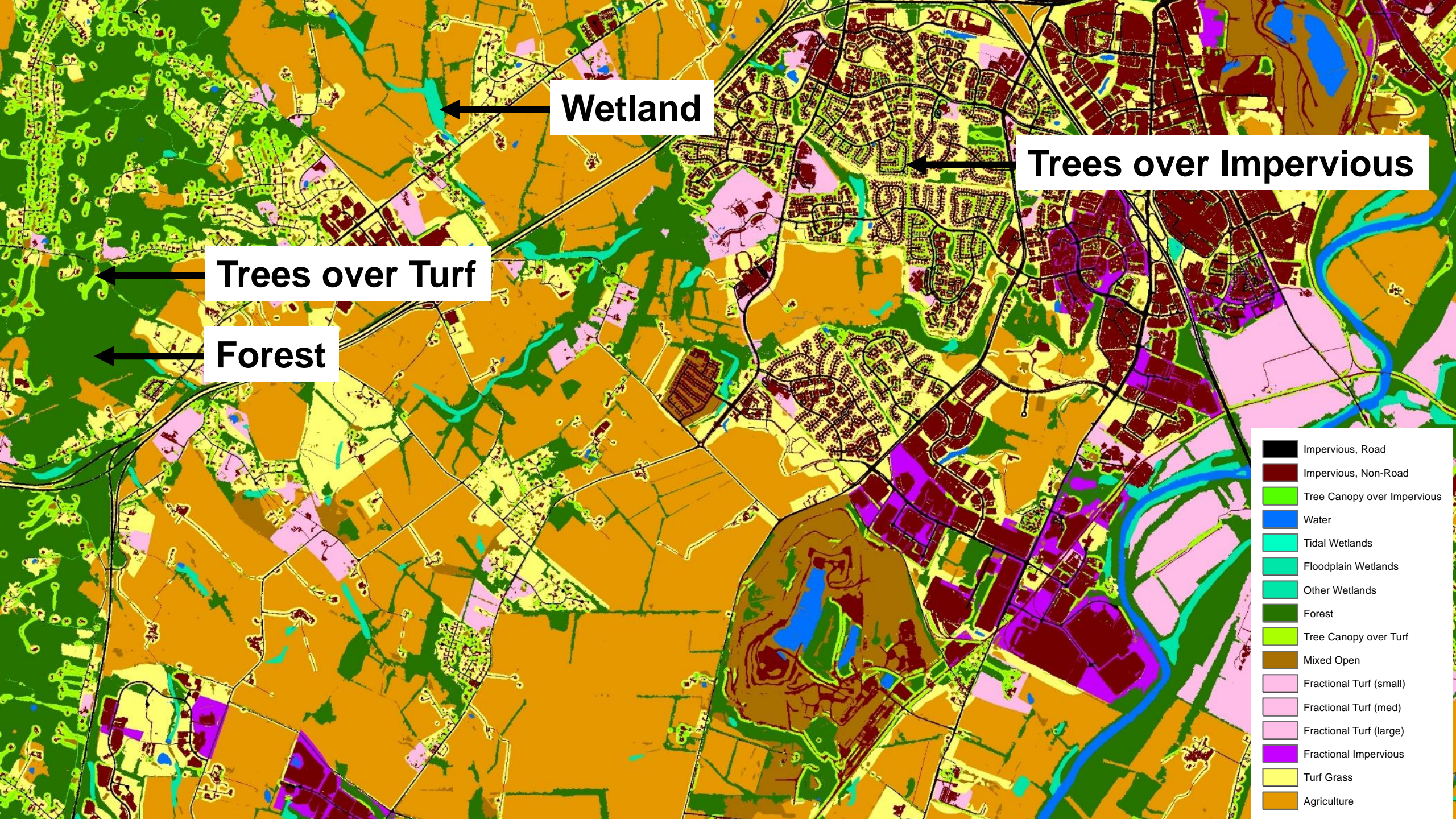
## High-resolution land cover data

- Impervious surfaces
- Tree canopy
- Low vegetation
- Water

### CBP Land Uses

- Impervious-Roads
- Forests
- Turf Grass
- Open Space







# Chesapeake Bay Program Land Use Classification (54 classes)

## 1. Water (8)

### 1.1 Lentic

- 1.1.1 Estuary
- 1.1.2 Lakes & Ponds

### 1.2 Lotic

- 1.2.1 Streams
  - 1.2.1.1 Sunlit
  - 1.2.1.2 Shaded
  - 1.2.1.3 Culverted/ Buried
- 1.2.2 Ditches
  - 1.2.2.1 Sunlit
  - 1.2.2.2 Shaded
  - 1.2.2.3 Culverted/ Buried

## 2. Developed (12)

### 2.1 Impervious

- 2.1.1 Roads
- 2.1.2 Structures
- 2.1.3 Other Impervious (Parking lots, driveways)

### 2.2 Pervious

- 2.2.1 Turf Grass
- 2.2.2 Bare Construction
- 2.2.3 Suspended Succession (rights-of-way)
  - 2.2.3.1 Barren
  - 2.2.3.2 Herbaceous
  - 2.2.3.3 Scrub-shrub

### 2.3 Tree Canopy (TC)

- 2.3.1 TC over Roads
- 2.3.2 TC over Structures
- 2.3.3 TC over Other Impervious
- 2.3.4 TC over Turf Grass

## 3. Forest (7)

### 3.1 Forest ( $\geq 1$ acre)

### 3.2 Fragmented Forest ( $< 1$ acre)

### 3.3 Harvested Forest

- 3.3.1 Barren
- 3.3.2 Herbaceous

### 3.4 Natural Succession ( $> 3$ years)

- 3.4.1 Barren
- 3.4.2 Herbaceous
- 3.4.3 Scrub-shrub

## 4. Production (13)

### 4.1 Agriculture

- 4.1.1 Cropland
  - 4.1.1.1 Barren
  - 4.1.1.2 Herbaceous
- 4.1.2 Pasture
  - 4.1.2.1 Barren
  - 4.1.2.2 Herbaceous
- 4.1.3 Orchard/vineyard
  - 4.1.3.1 Barren
  - 4.1.3.2 Herbaceous
  - 4.1.3.3 Scrub-shrub

### 4.2 Solar fields

- 4.2.1 Barren
- 4.2.2 Herbaceous
- 4.2.3 Scrub-shrub
- 4.2.4 Impervious

## 4.3 Extractive

- 4.3.1 Barren
- 4.3.2 Impervious

## 5. Wetlands and Water Margins (14)

### 5.1 Tidal

- 5.1.1 Barren
- 5.1.2 Herbaceous
- 5.1.3 Scrub-shrub

### 5.2 Non-tidal

- 5.2.1 Riverine - Floodplain
  - 5.2.1.1 Barren
  - 5.2.1.2 Herbaceous
  - 5.2.1.3 Scrub-shrub
  - 5.2.1.4 Forest
  - 5.2.1.5 Fragmented Forest
- 5.2.2 Riverine - Headwater
  - 5.2.2.1 Barren
  - 5.2.2.2 Herbaceous
  - 5.2.2.3 Scrub-shrub
  - 5.2.2.4 Forest
  - 5.2.2.5 Fragmented Forest

### 5.3 Bare shore



# Phase 6 Land Use Classification (21/54 classes)

## 1. Impervious, Roads – IR (1)

### 2.1 Impervious

#### 2.1.1 Roads

## 2. Impervious, Non-Roads – INR (4)

### 2.1 Impervious

#### 2.1.2 Structures

#### 2.1.3 Other Impervious (Parking lots, driveways)

### 4.2 Solar fields

#### 4.2.4 Impervious

### 4.3 Extractive

#### 4.3.2 Impervious

## 3. Tree Canopy Over Impervious – TCI (3)

### 2.3 Tree Canopy (TC)

#### 2.3.1 TC over Roads

#### 2.3.2 TC over Structures

#### 2.3.3 TC over Other Impervious

## 4. Tree Canopy over Turf Grass – TCT (1)

### 2.3 Tree Canopy (TC)

#### 2.3.4 TC over Turf Grass

## 5. Turf Grass – TG (1)

### 2.2 Pervious

#### 2.2.1 Turf Grass

## 6. Mixed Open – MO (13)

### 2.2 Pervious

#### 2.2.2 Bare Construction

#### 2.2.3 Suspended Succession (rights-of-way)

##### 2.2.3.1 Barren

##### 2.2.3.2 Herbaceous

##### 2.2.3.3 Scrub-shrub

### 3.4 Natural Succession (> 3 years)

#### 3.4.1 Barren

#### 3.4.2 Herbaceous

#### 3.4.3 Scrub-shrub

### 4.2 Solar fields

#### 4.2.1 Barren

#### 4.2.2 Herbaceous

#### 4.2.3 Scrub-shrub

### 4.3 Extractive

#### 4.3.1 Barren



## Phase 6 Land Use Classification (33/54 classes)

### 7. Forest – FORE (4)

- 3.1 Forest ( $\geq 1$  acre)
- 3.2 Fragmented Forest ( $< 1$  acre)
- 3.3 Harvested Forest
  - 3.3.1 Barren
  - 3.3.2 Herbaceous

### 8. Cropland - CRP (5)

- 4.1 Agriculture
  - 4.1.1 Cropland
    - 4.1.1.1 Barren
    - 4.1.1.2 Herbaceous
  - 4.1.3 Orchard/vineyard
    - 4.1.3.1 Barren
    - 4.1.3.2 Herbaceous
    - 4.1.3.3 Scrub-shrub

### 9. Pasture – PAS (2)

- 4.1 Agriculture
  - 4.1.2 Pasture
    - 4.1.2.1 Barren
    - 4.1.2.2 Herbaceous

### 10. Water – WAT (9)

- 1.1 Lentic
  - 1.1.1 Estuary
  - 1.1.2 Lakes & Ponds
- 1.2 Lotic
  - 1.2.1 Streams
    - 1.2.1.1 Sunlit
    - 1.2.1.2 Shaded
    - 1.2.1.3 Culverted/ Buried
  - 1.2.2 Ditches
    - 1.2.2.1 Sunlit
    - 1.2.2.2 Shaded
    - 1.2.2.3 Culverted/ Buried
- 5.3 Bare Shore

### 11. Wetlands, Floodplain – WLF (5)

- 5.2 Non-tidal
  - 5.2.1 Riverine - Floodplain
    - 5.2.1.1 Barren
    - 5.2.1.2 Herbaceous
    - 5.2.1.3 Scrub-shrub
    - 5.2.1.4 Forest
    - 5.2.1.5 Fragmented Forest

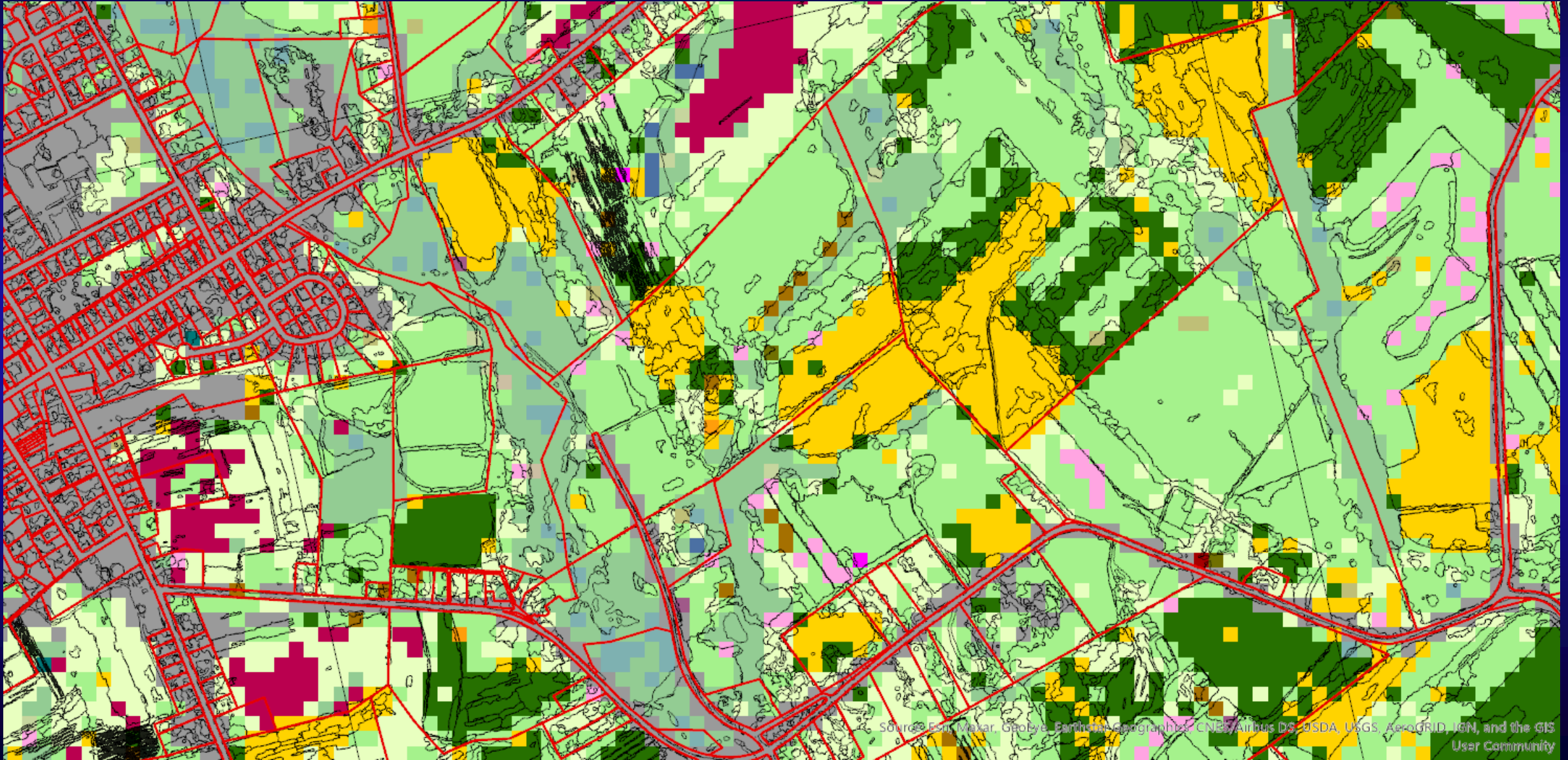
### 12. Wetlands, Other – WLO (5)

- 5.2 Non-tidal
  - 5.2.2 Riverine - Headwater
    - 5.2.2.1 Barren
    - 5.2.2.2 Herbaceous
    - 5.2.2.3 Scrub-shrub
    - 5.2.2.4 Forest
    - 5.2.2.5 Fragmented Forest

### 13. Wetlands, Tidal – WLT (3)

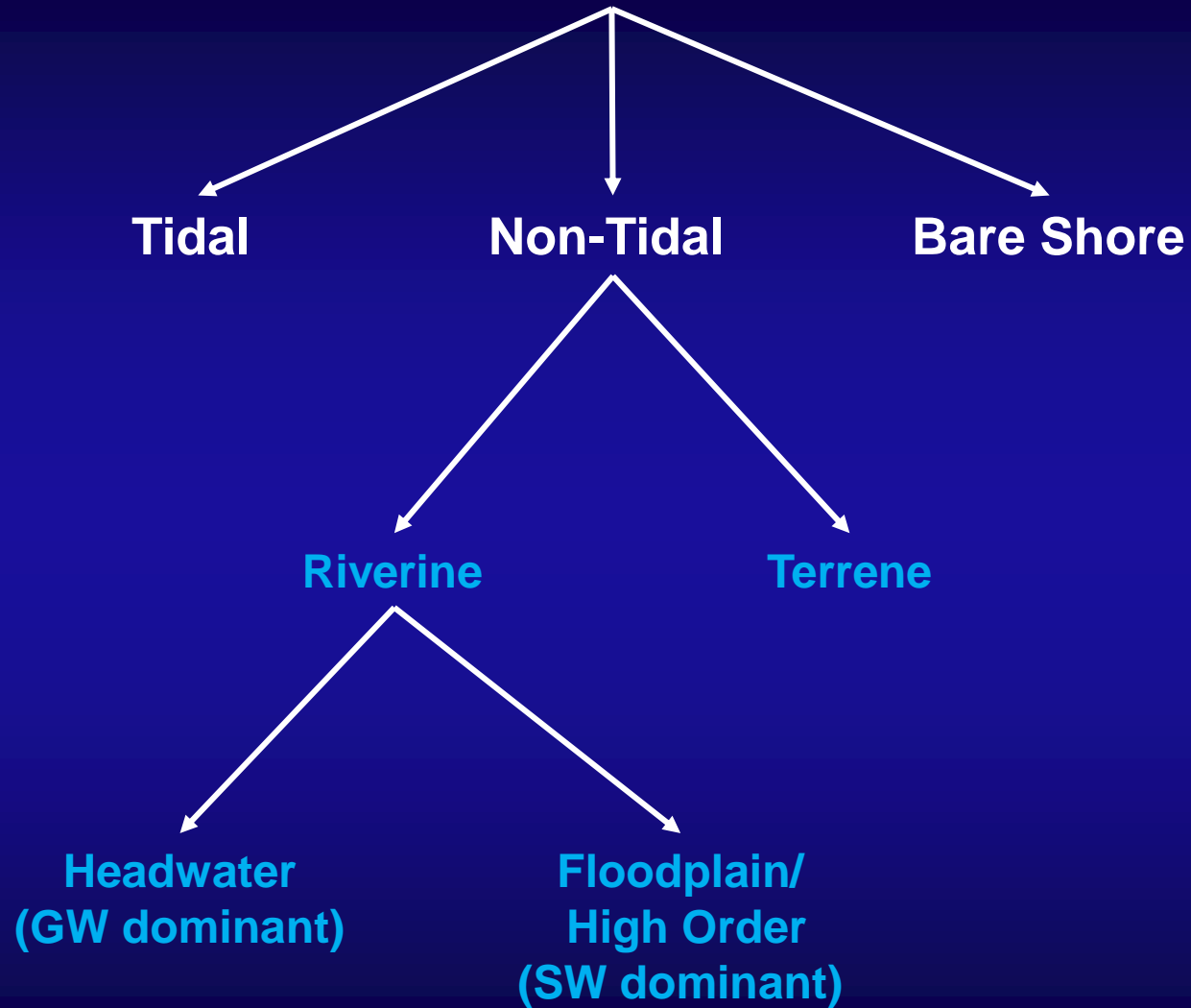
- 5.1 Tidal
  - 5.1.1 Barren
  - 5.1.2 Herbaceous
  - 5.1.3 Scrub-shrub

# Parcel Segments: the key to classifying high-resolution land use

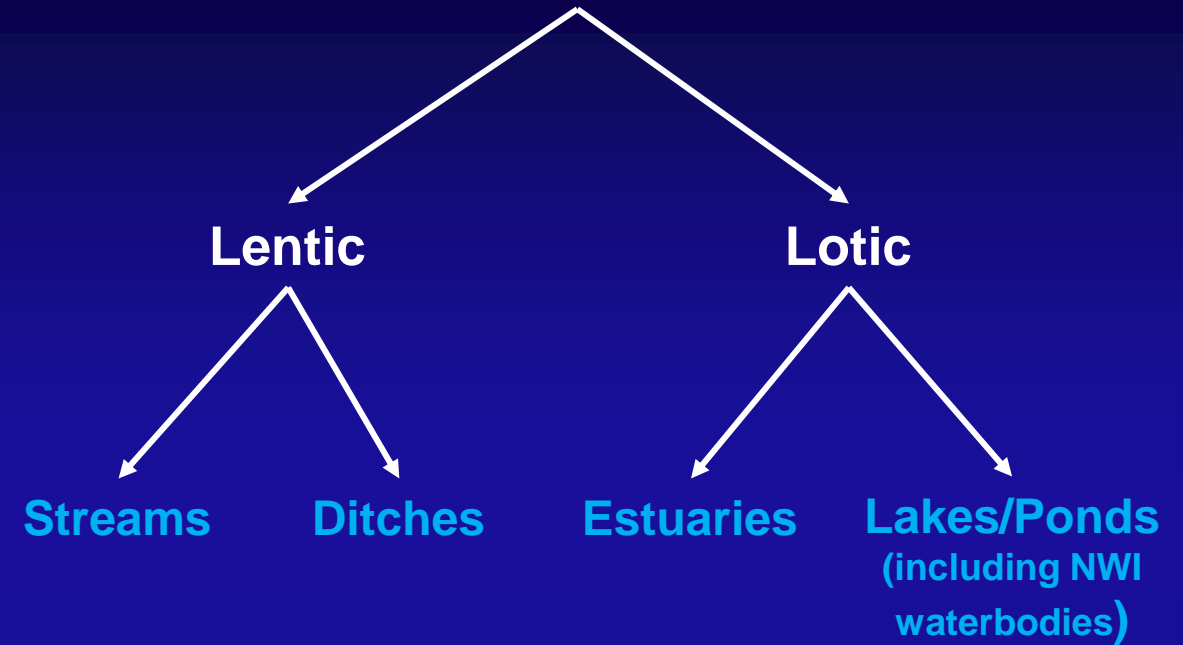




# Wetlands and Water Margins

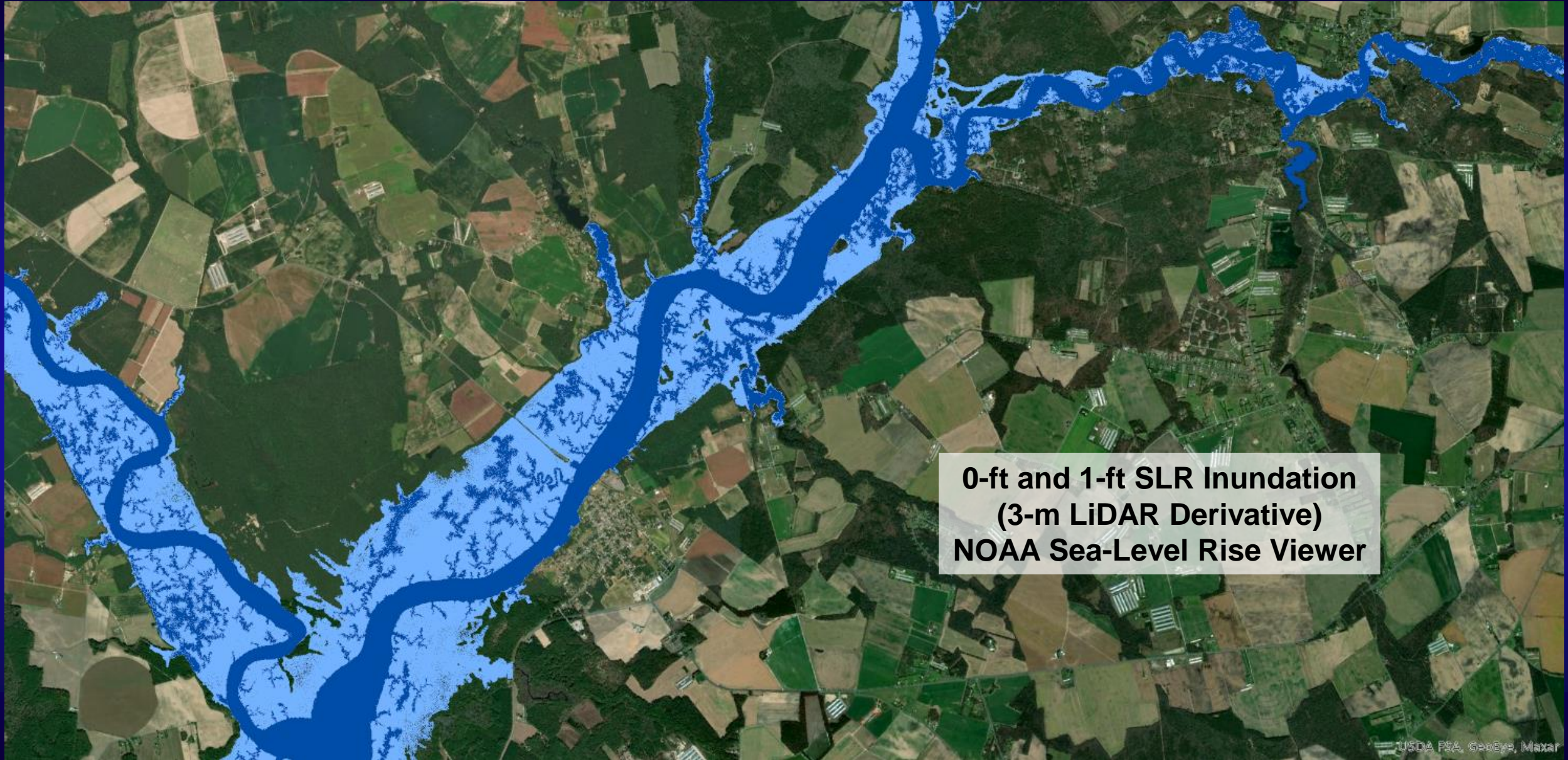


# Water





# Maryland and Delaware Wetland Datasets





# Fauquier County, VA

Agriculture



## **Lancaster County, PA:**

## Total Farmland

2012 Census of Agriculture:

377,807

2013 High-res Land Use:

272,655

Trial with 2017 Parcel and Patch Data:

303,132

## **Clearfield County, PA:**

## Total Farmland

2012 Census of Agriculture:

41,436

2013 High-res Land Use:

115,343

Trial with 2017 Parcel and Patch Data:

67,052

## **Fauquier County, VA:**

## Total Farmland

2012 Census of Agriculture:

166,587

2013 High-res Land Use:

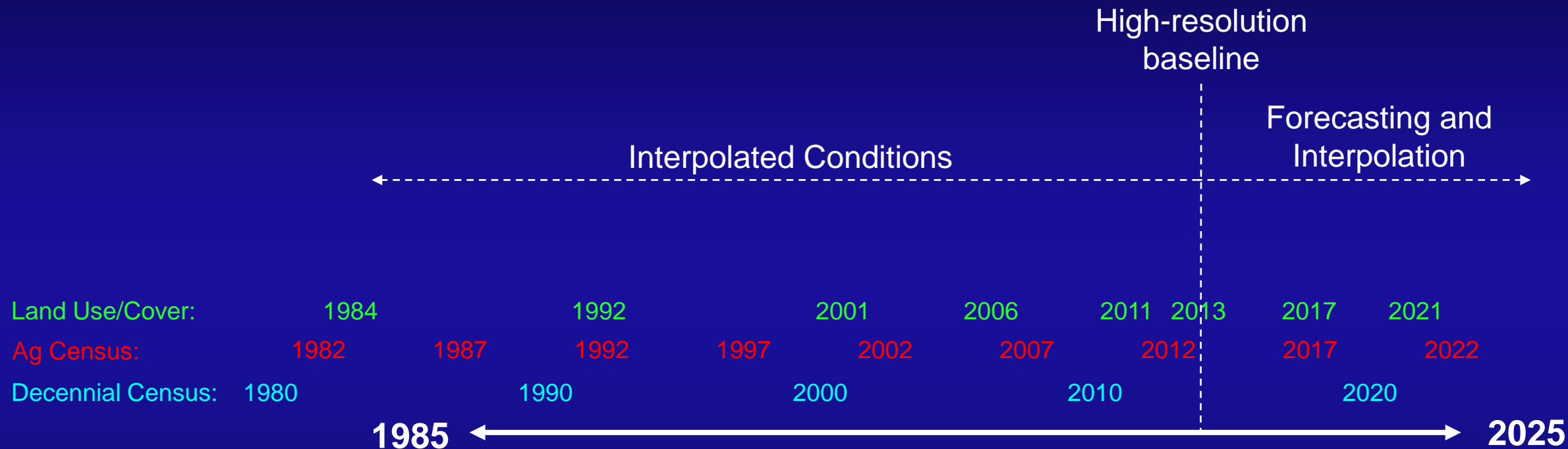
119,175

Trial with 2017 Parcel and Patch Data:

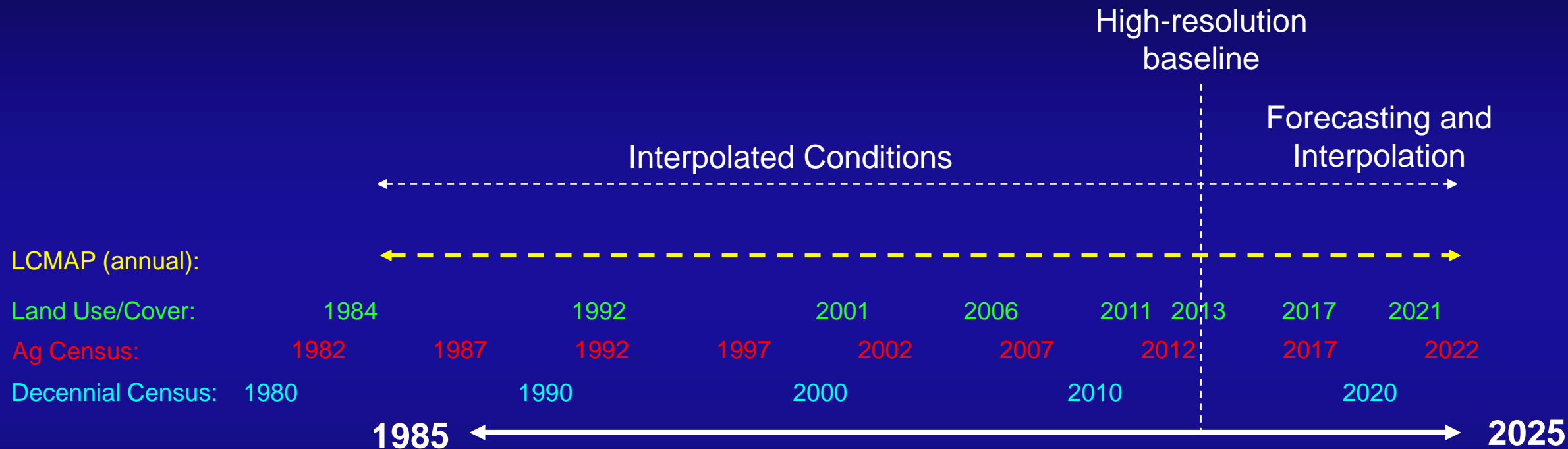
135,954



# High-res Land Use Updates and the Phase 7 Model



# High-res Land Use Updates and the Phase 7 Model

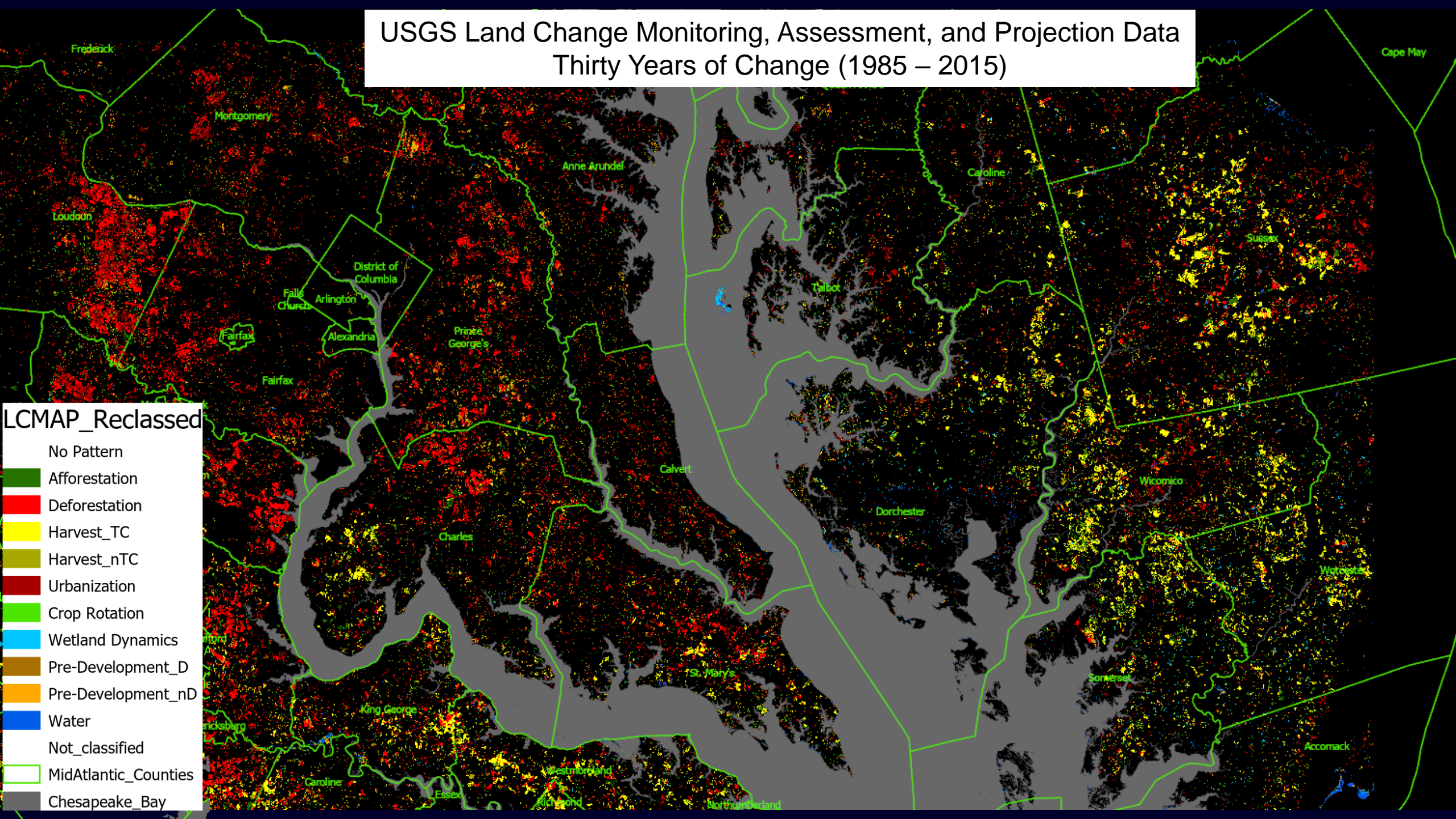




# USGS Land Change Monitoring, Assessment, and Projection Data Thirty Years of Change (1985 – 2015)

## LCMAP\_Reclassified

- No Pattern
- Afforestation
- Deforestation
- Harvest\_TC
- Harvest\_nTC
- Urbanization
- Crop Rotation
- Wetland Dynamics
- Pre-Development\_D
- Pre-Development\_nD
- Water
- Not\_classified
- MidAtlantic\_Counties
- Chesapeake\_Bay

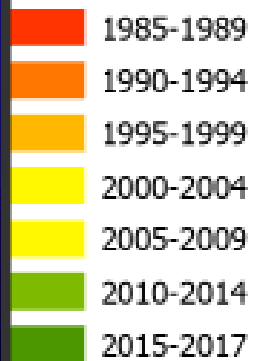




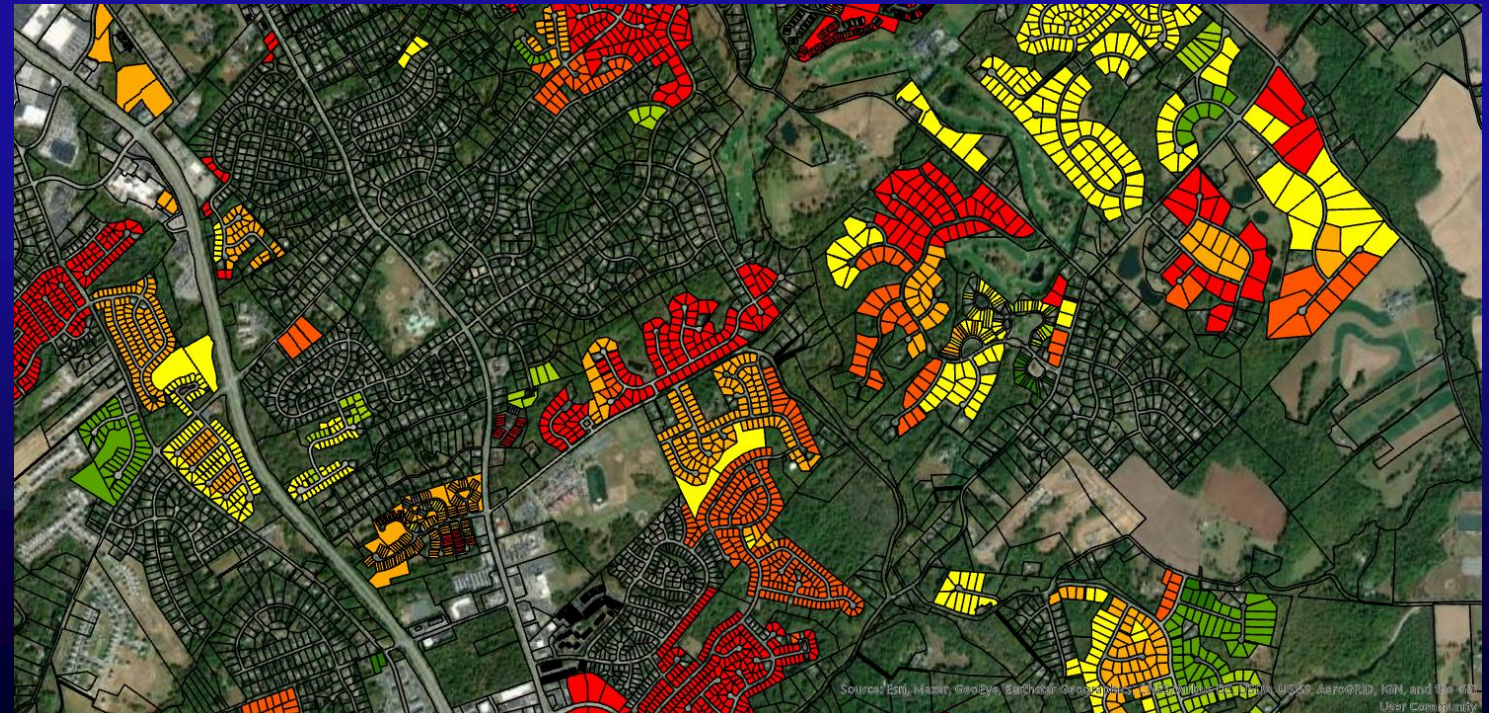
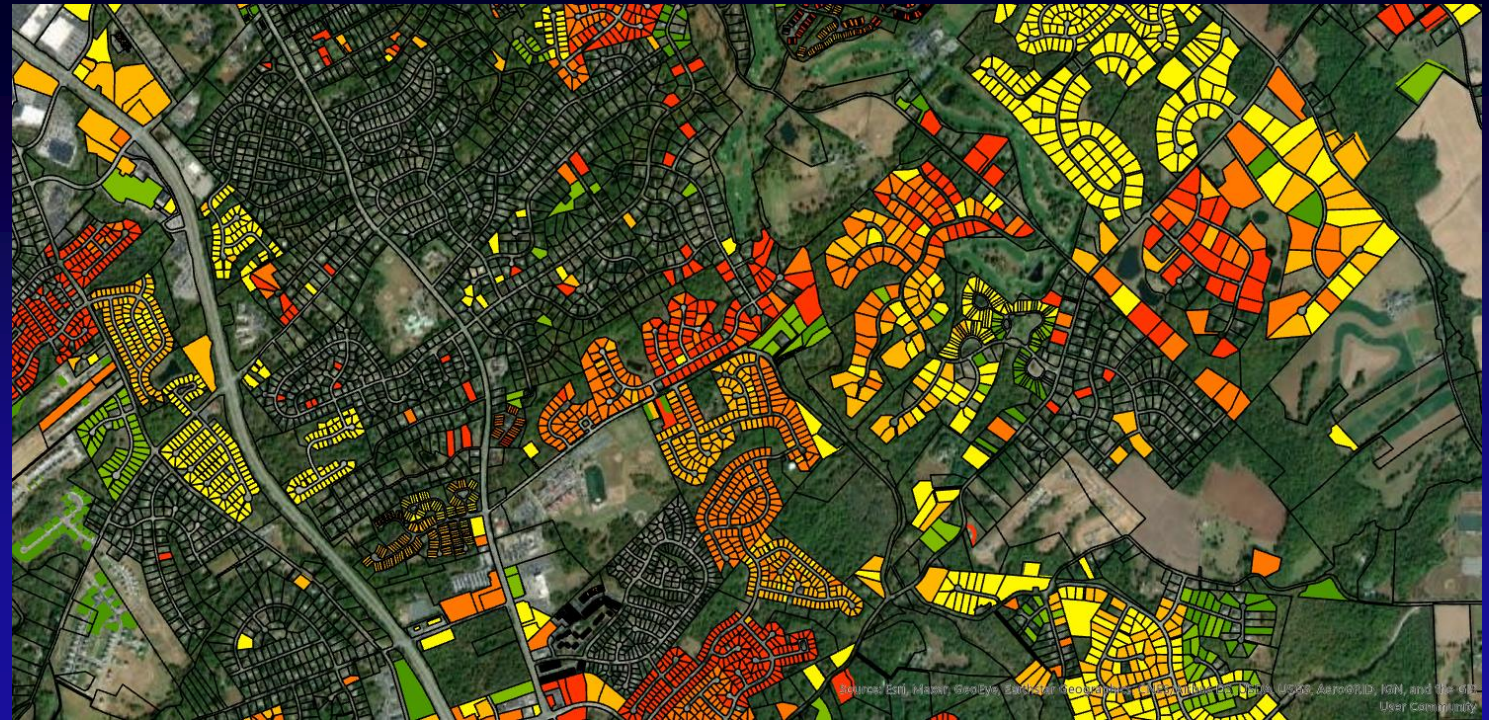
# Parcel-Level Deconstruction of Urban Development

Year-Built Attributes  
from Tax Records

yearblt



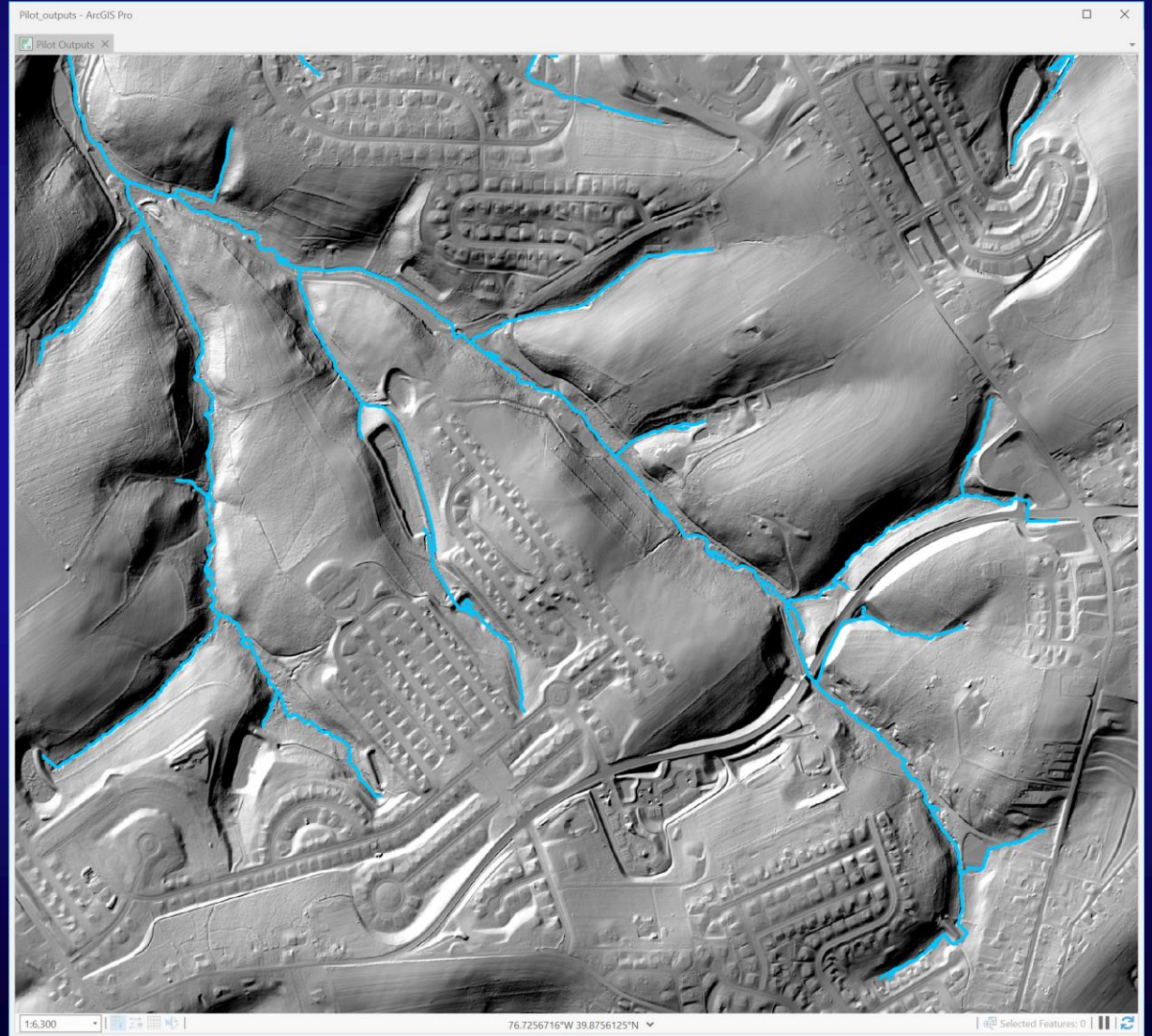
Year-Built Attributes  
from USGS' LCMAP





# Hyper-Resolution\* Hydrography

1. Lidar elevation
2. Valley-scale geomorphons
3. Channel-scale geomorphons
4. Extract valley network
5. Extract channels using valley network
6. QAQC channel skeleton
7. Connect stream network

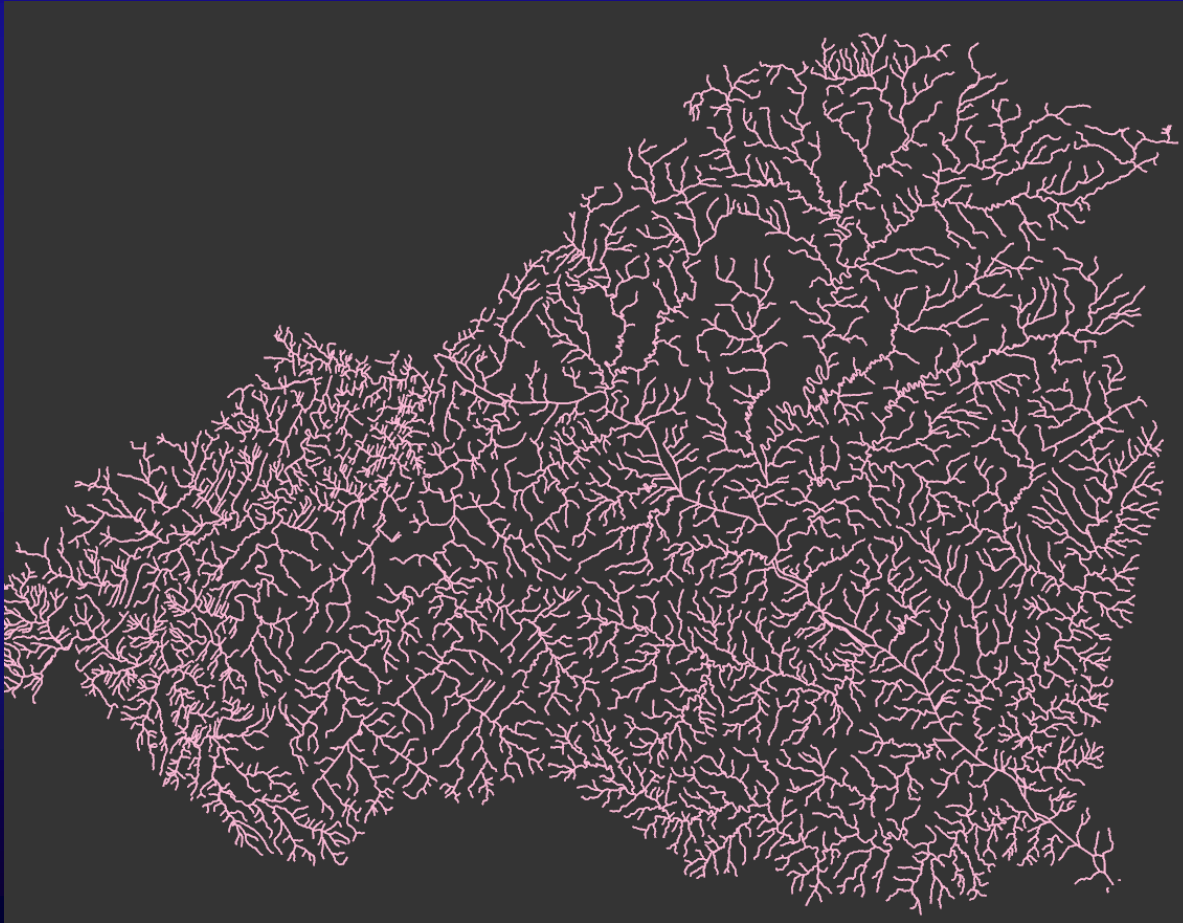




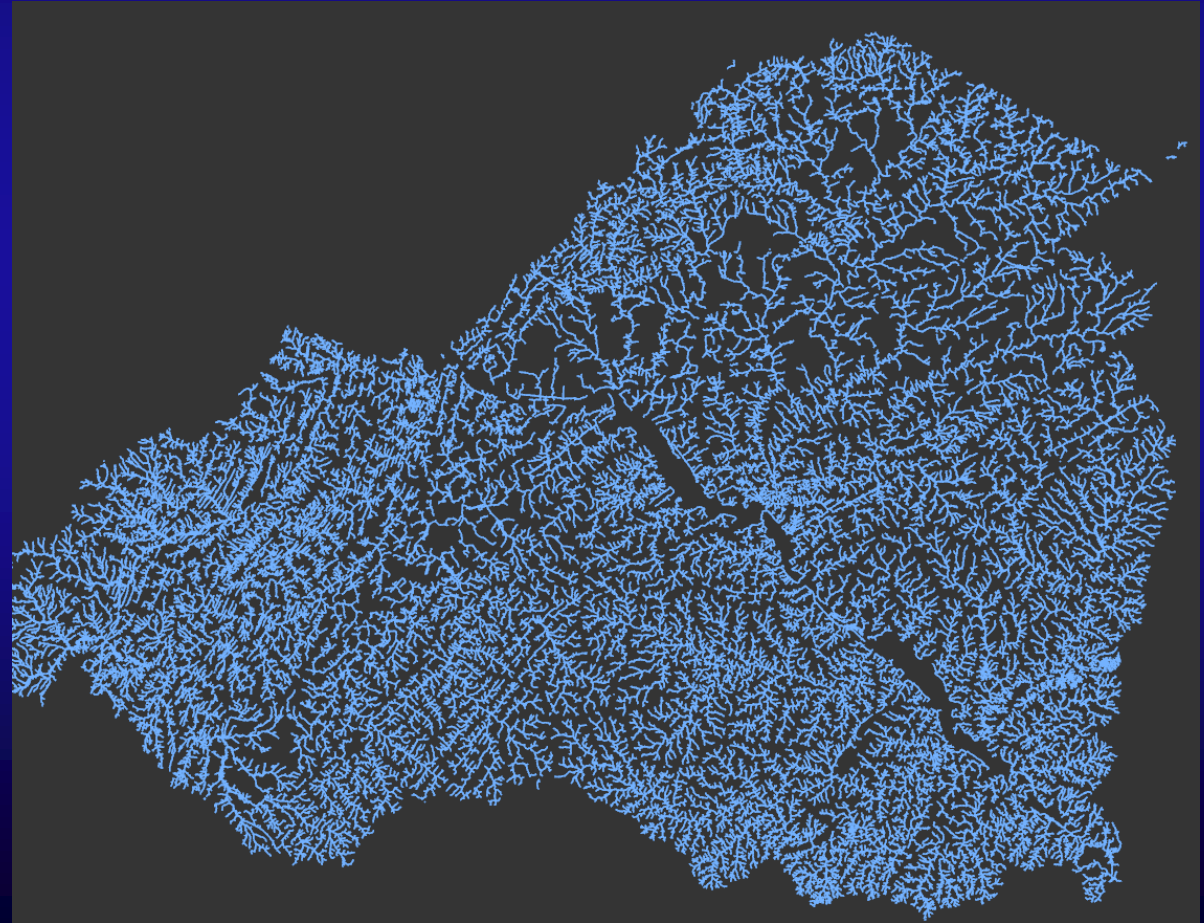
## Alternative Stream Resolutions

### Lower Susquehanna Example

National Hydrography Dataset, 1:24,000  
6,923.6 km



CBP Hyper-Resolution Streams, 1:2000  
16,784.6 km



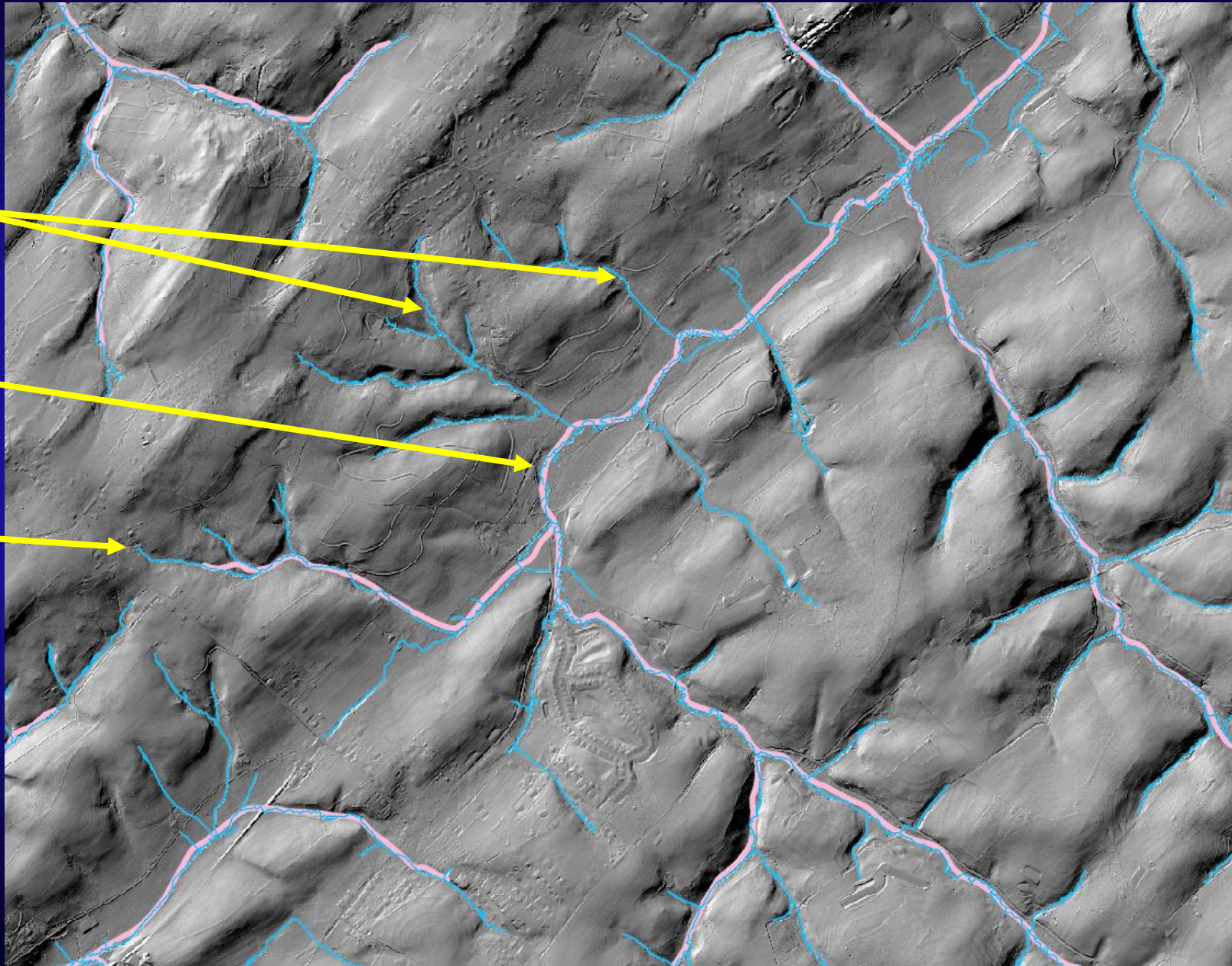


# Why the 2x difference in stream length?

Added  
Tributaries

Increased  
Complexity

Extended  
headwaters



— NHD24K

— HyperRes



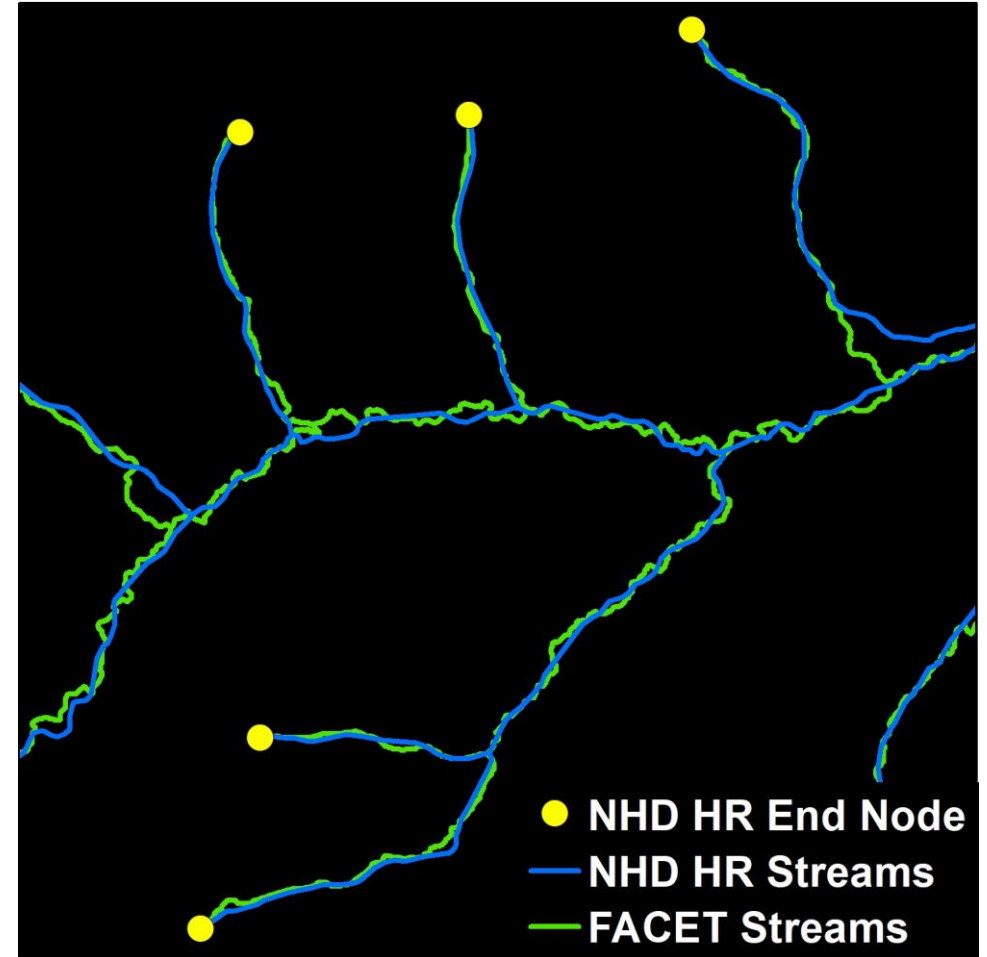




# Hydrologic conditioning of DEM and generating stream network

**Step 1:** DEM is automatically breached through Census roads and railroads and Whitebox's Breach algorithm

**Step 2:** Channel initiation points of an existing stream network are used to derive a stream network using TauDEM



NHD Plus HR (1:24,000 scale) stream end nodes used to define starting points of channel.



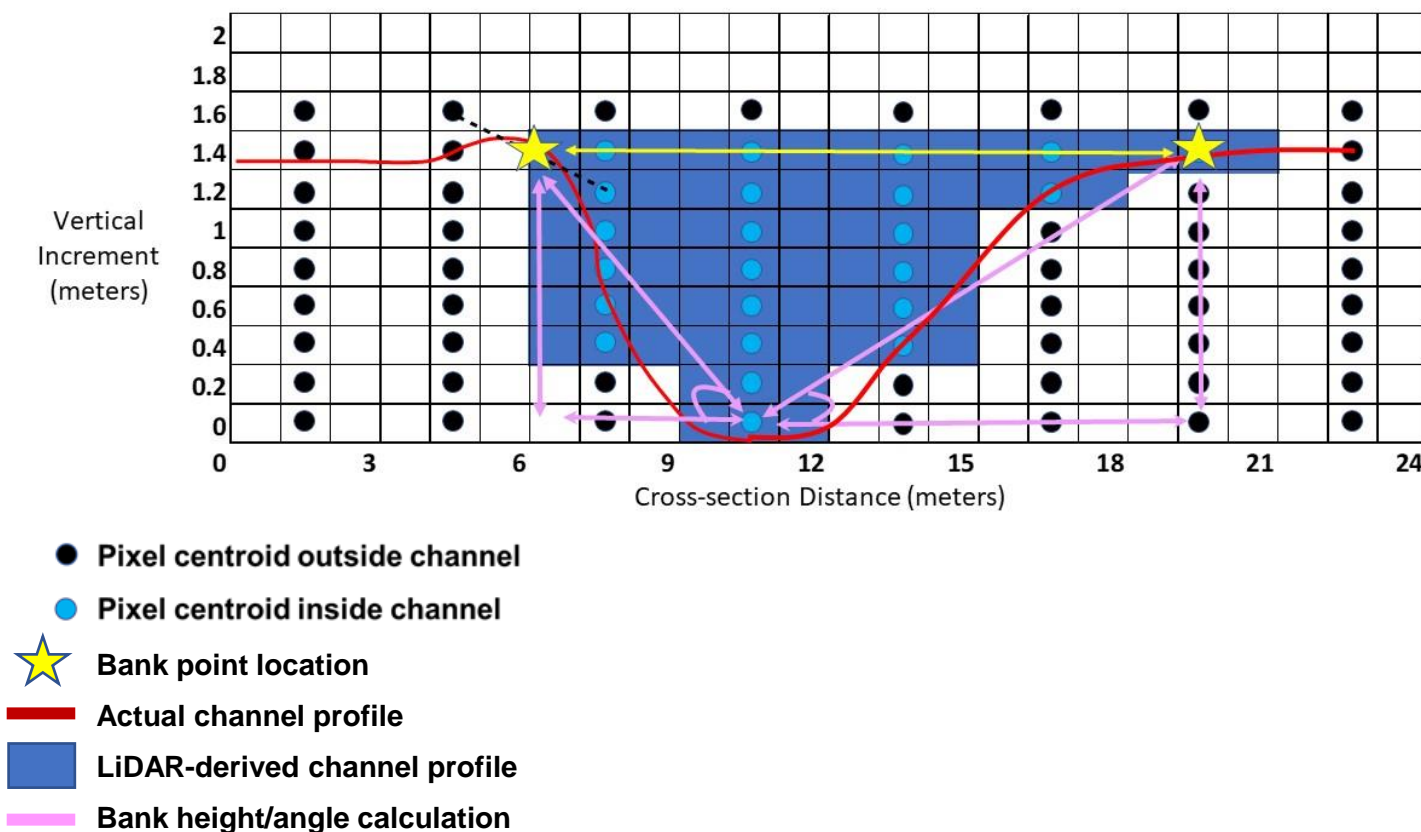
# Streambank Calculations

## 1-D Cross-Section Automation

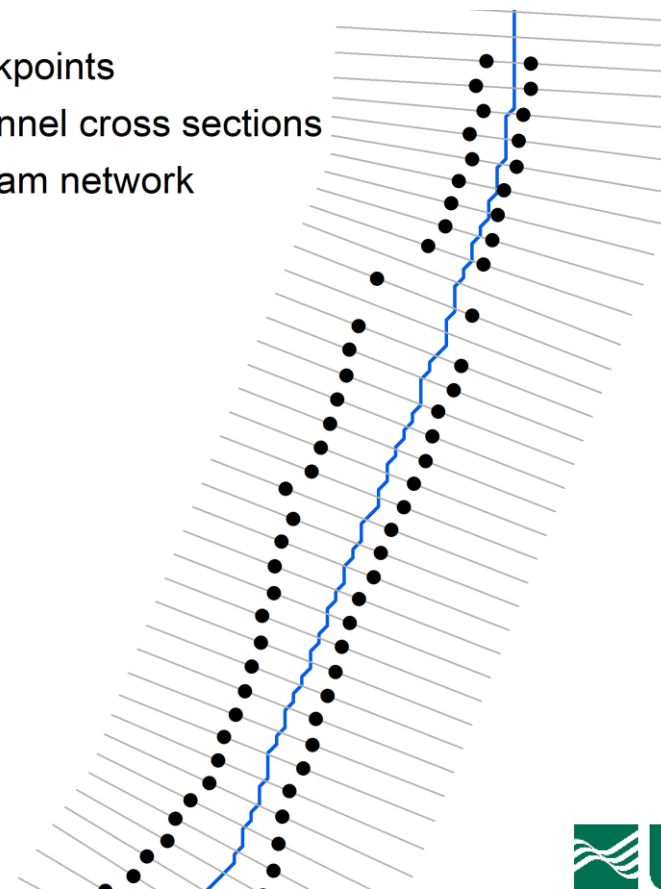
Cross-sections are automatically created parallel to reach at user specified spacing (9m).

- **Bank Height, Bank Angle, and Channel Width**

24-meter Cross Section (corresponding to a 2<sup>nd</sup> Order Stream)



- Bankpoints
- Channel cross sections
- Stream network



# Metric Calculations

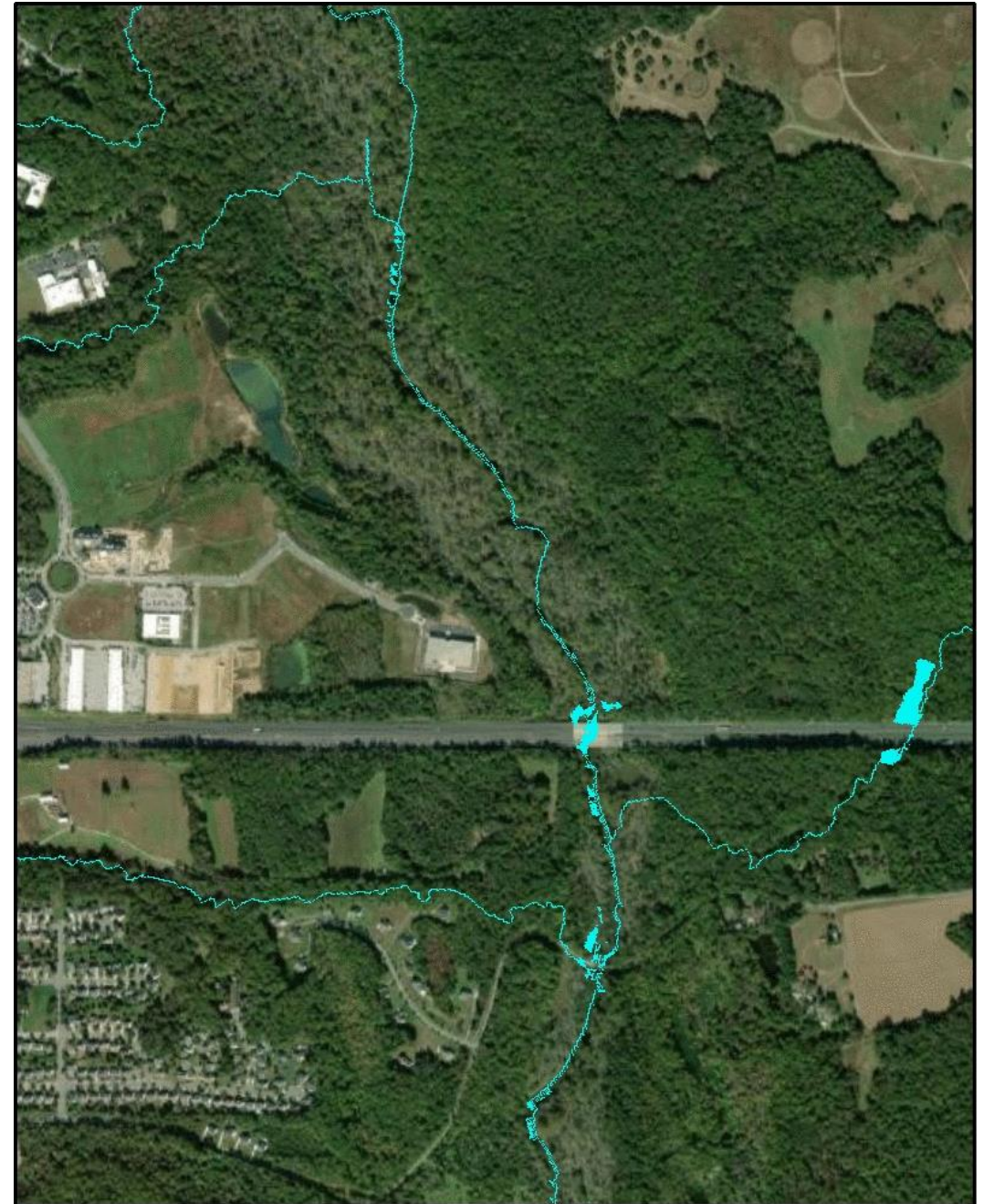
## floodplain width

Patuxent River @ HW 50

**Step 1:** Identify active floodplain extent in field based on topography, vegetation, evidence of recent flooding (e.g. fine sediment deposits, debris deposits aligned perpendicular to the channel), and flood stage magnitudes at nearby stream gages

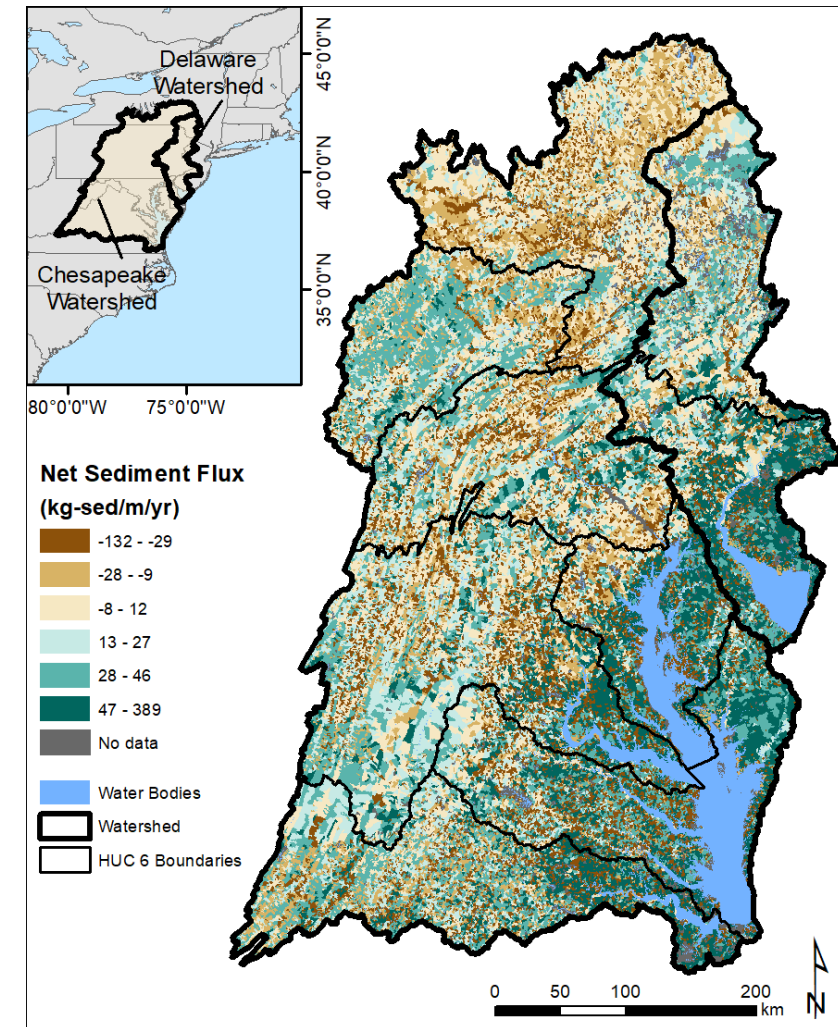
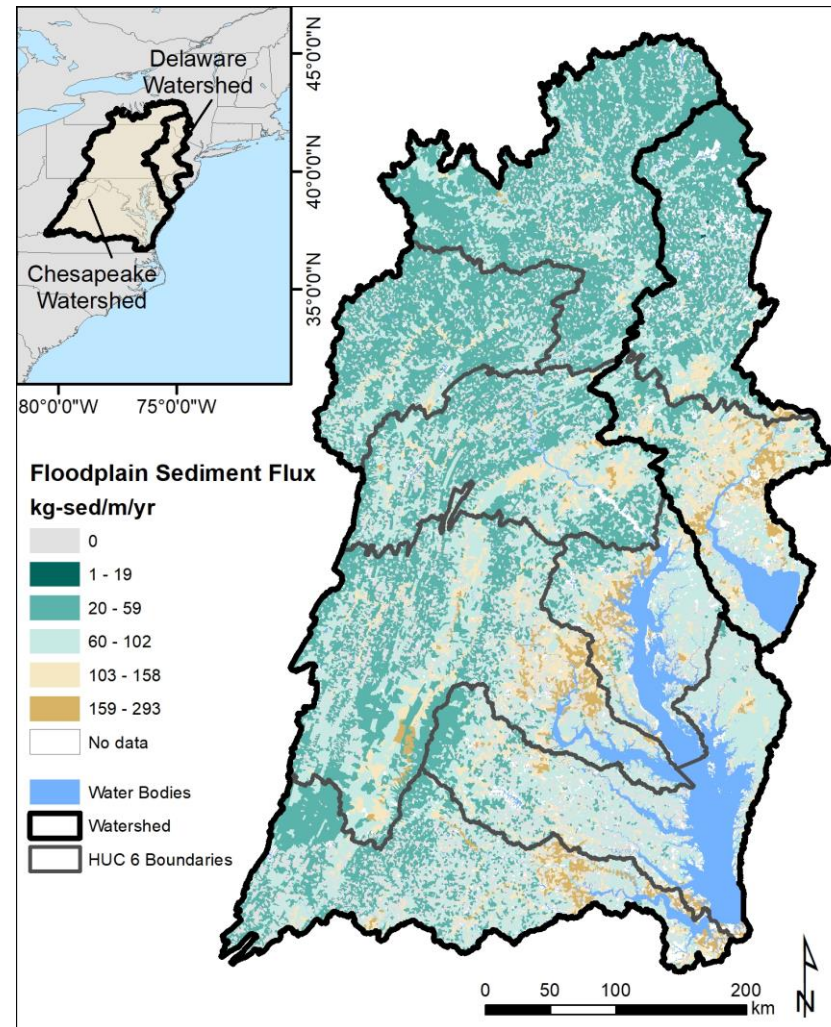
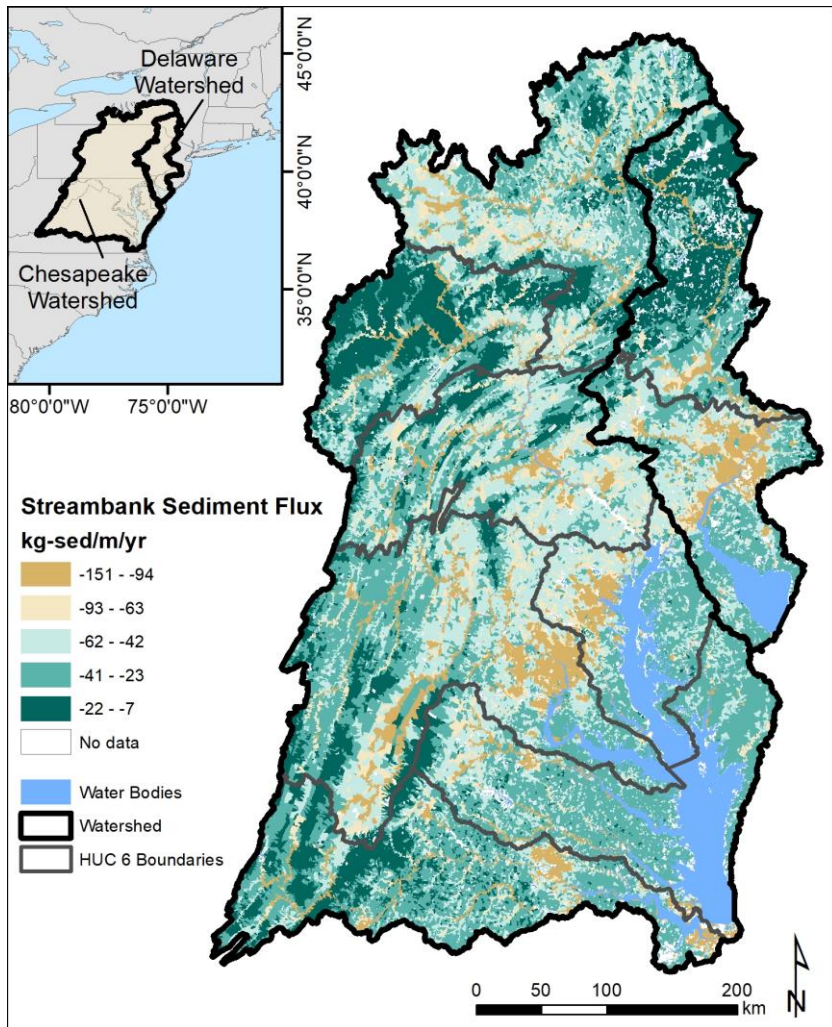
**Step 2:** Identify HAND threshold aligning with field-measured floodplain extent at each field site

**Step 3:** Predictive linear model related HAND height thresholds to drainage area and physiographic province





# Predictions for each of the nontidal streams in the mid-Atlantic



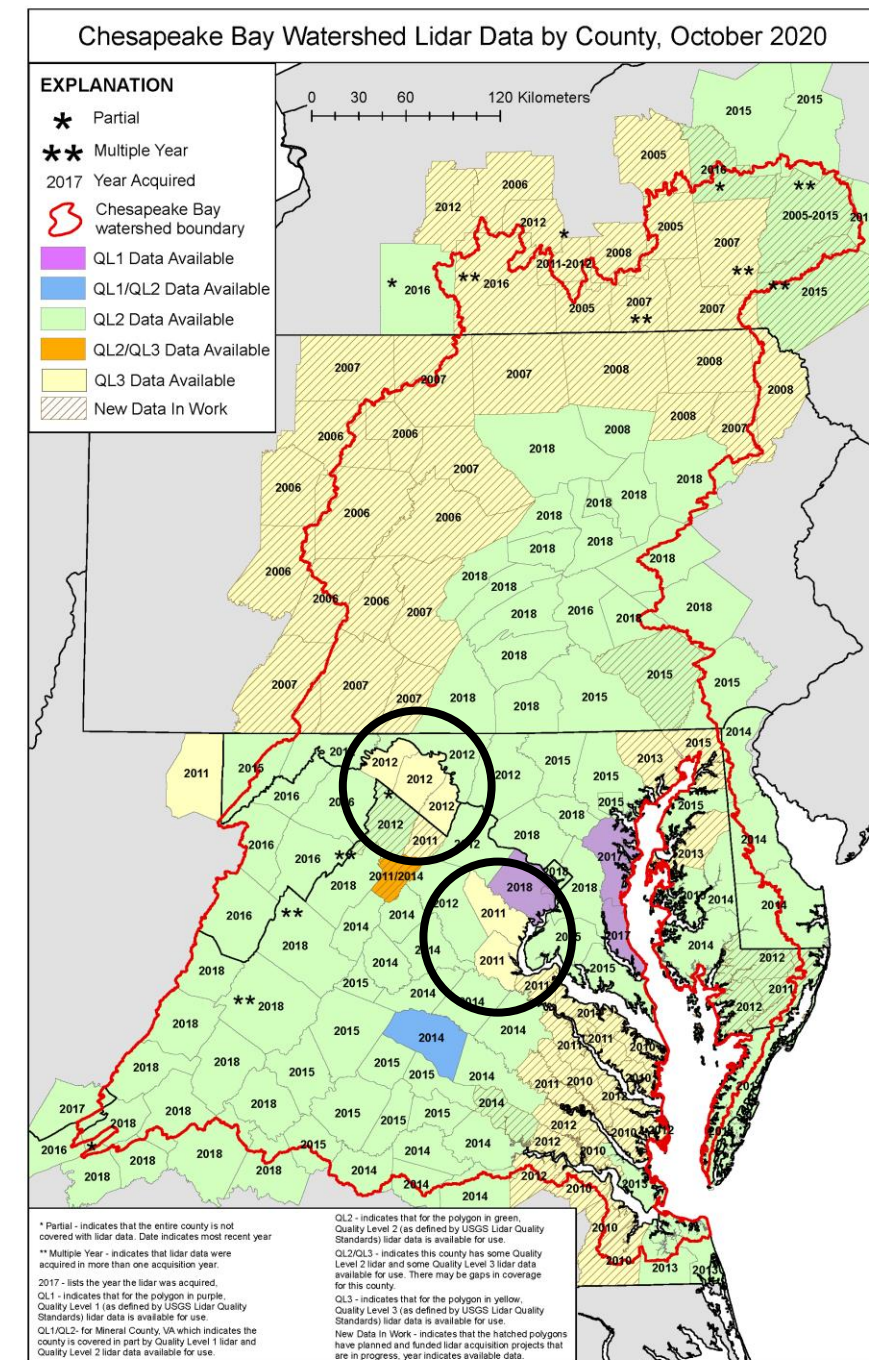
<https://doi.org/10.5066/P93OUWYZ>

Noe, G.B., Hopkins, K.G., Metes, M.J., Ahmed, L., Claggett, P.R., Doody, T.R., Schenk, E.R., and Hupp, C.R., 2020, Predictions of floodplain and streambank geomorphic change and flux, streambed characteristics, and catchment inputs and exports of sediment and nutrients for stream reaches in the Chesapeake Bay and Delaware River watersheds: U.S. Geological Survey data release, <https://doi.org/10.5066/P93OUWYZ>.



# Additional LiDAR Derivatives

- Height (normalized DSM to ground elevation, 1m LiDAR)
- Compound Topographic Index (3m, LiDAR)
- Topographic Wetness Index – Texture (3m, LiDAR)
- Multiscale Landforms (3m, LiDAR)





# Chesapeake Bay 1-Meter Resolution Release Dates

Land cover (12 classes, 1-meter):

- 2013/14 (available now- <https://chesapeakeconservancy.org/conservation-innovation-center/high-resolution-data/land-cover-data-project/>)
- 2017/18 (summer 2021)
- 2021/22 (summer 2024)

Land use (16 classes, 1-meter):

- 2013/14 (available now- <https://chesapeakeconservancy.org/conservation-innovation-center/high-resolution-data/land-use-data-project/>)

Land use (13 classes, 10-meter):

- 2013/14 (available now- <https://chesapeake.usgs.gov/phase6/map/#map=7/-8582732.74/4851421.17/0.0/0,4>)

Land use (54 classes):

- 2013/14 (June 2021, December 2021, June 2023, December 2023)
- 2017/18 (June 2021, December 2021, June 2023, December 2023)
- 2021/22 (June 2023, December 2023)

Streams/ditches

- Draft (summer 2021)
- Final (summer 2023)

Stream channel and floodplain attributes (FACET)

- Version 1 (available now- <https://www.sciencebase.gov/catalog/item/5cae39c3e4b0c3b00654cf57>)
- Version 2 (2022 - 2023)





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