How and Where is Land Use Changing?

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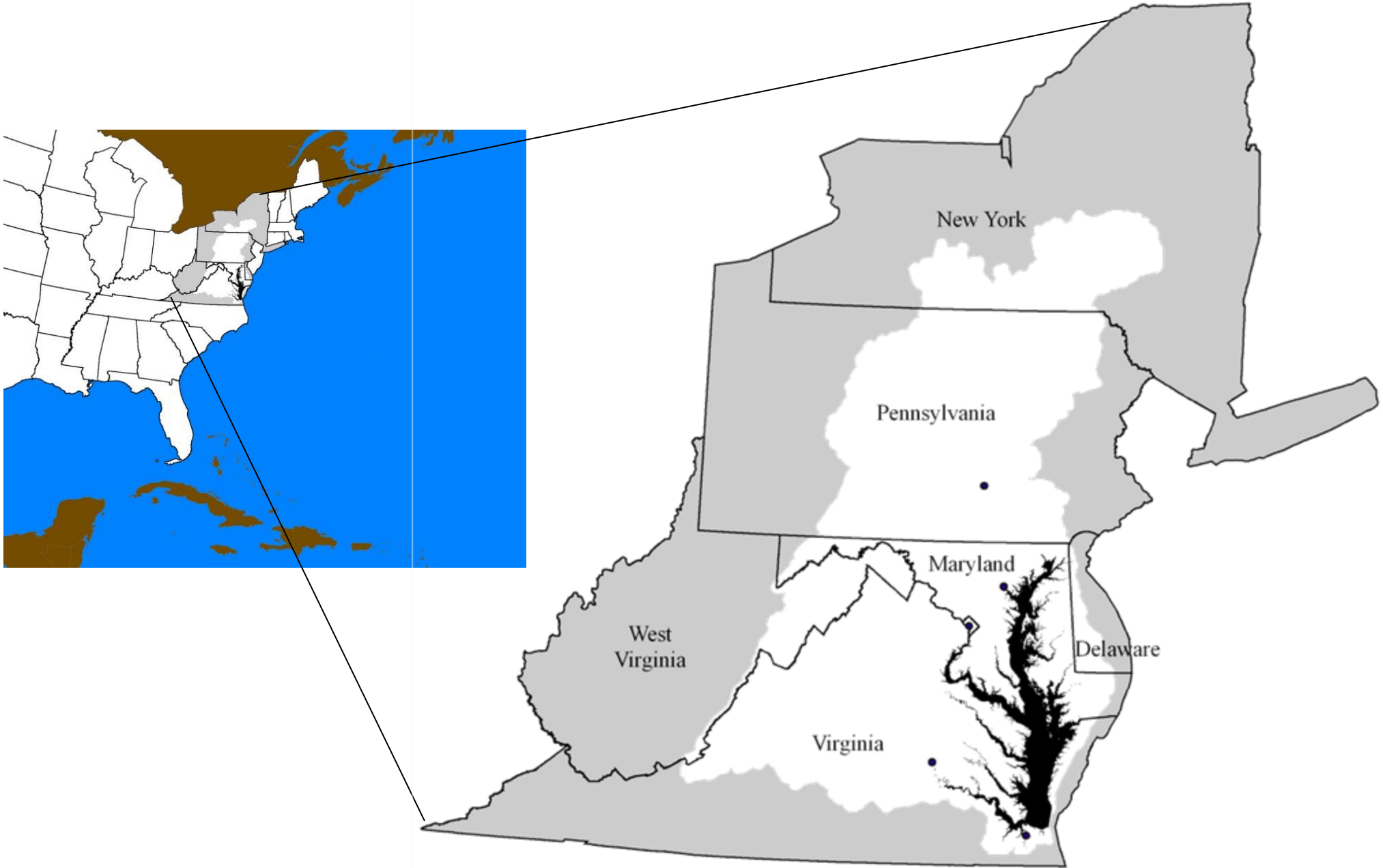
Local Government Advisory Committee
June 5, 2025

Chesapeake Bay Watershed, U.S.A.



Chesapeake Bay LULC

Land Use/Land Cover Data

- spatial extent: 99,000 mi2
- resolution: 1m^2 cells
- temporal resolution: 2013/14, 2017/18, 2021/22
- categorical resolution: 56 classes
- LULC accuracy: 95%
- LULC change accuracy: 86%

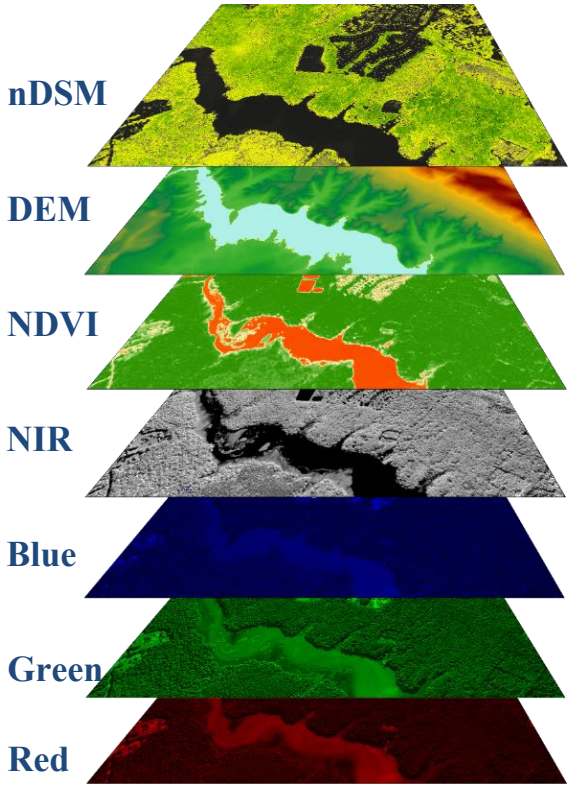
Claggett, P. R., McDonald, S. M., O'Neil-Dunne, J., MacFaden, S., Walker, K., Guinn, S., Ahmed, L., Buford, E., Kurtz, E., McCabe, P., Pickford, J. A., Royar, A., Schulze, K., 2025, Chesapeake Bay Land Use/Land Cover (LULC) Database 2024 edition: U.S. Geological Survey data release, https://doi.org/10.5066/P14BEBRC.

Remote Sensing

2013 NAIP

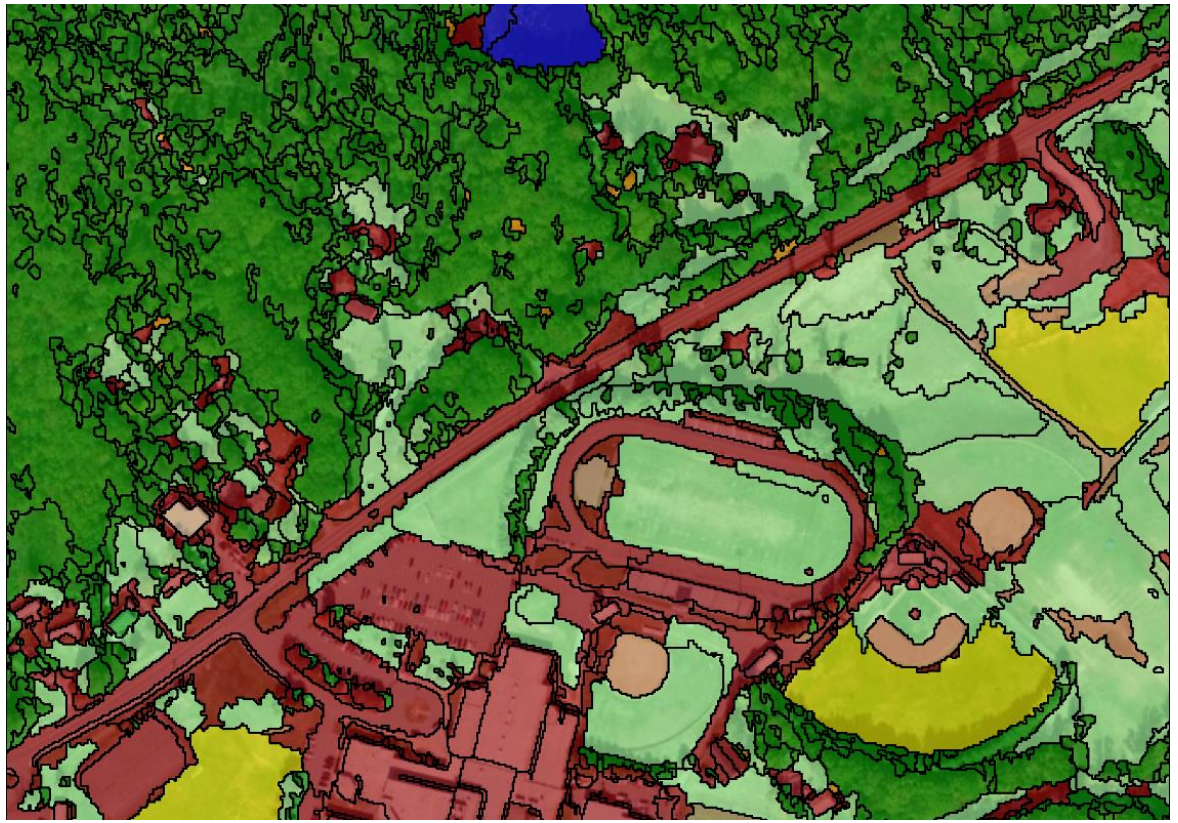
Ortho-imagery

LiDAR



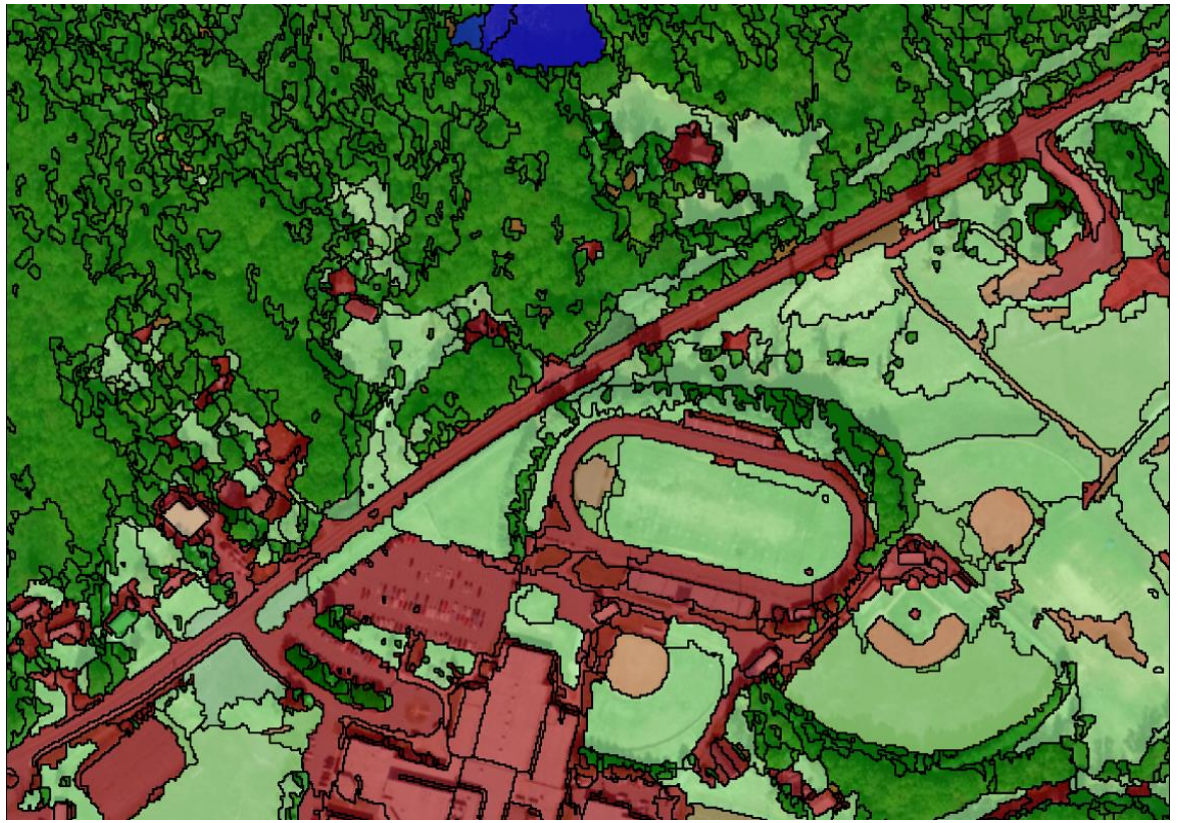
Remote Sensing

- **Initial semi-automated feature extraction with 900x the resolution of NLCD**
  - **Rule-based, object oriented image classification**



Remote Sensing

- **Initial semi-automated feature extraction with 900x the resolution of NLCD**
  - **Rule-based, object oriented image classification**
- **Manual corrections**



LULC Process

Local, state, and national ancillary datasets (25+)

- Parcels
- Institutions
- Surface mines
- Railways
- Airports

High-resolution land cover data (12 classes)

- Impervious surfaces
- Tree canopy
- Low vegetation
- Water

Deep-Learning Model
- Animal operations
- Solar fields

Chesapeake LULC

- Roads
- Forests
- Turf Grass
- Cropland

Open-source Python

USGS

Blue = LULC 56-class schema
White = General 18-class schema

General 18-class Schema for Visualization

1. Impervious Roads (1)
Roads

2. Impervious Structures (1)
Structures

3. Impervious, Other (2)
Other Impervious (Parking lots, driveways)
Solar Field Panel Arrays

4. Tree Canopy Over Impervious (3)
TC over Roads
TC over Structures
TC over Other Impervious

5. Turf Grass (1)
Turf Grass

6. Tree Canopy over Turf Grass (1)
Tree Canopy over Turf Grass

7. Pervious, Developed (7)
Bare Developed
Solar Field Barren
Solar Field Herbaceous
Solar Field Shrubland
Suspended Succession Barren
Suspended Succession Herbaceous
Suspended Succession Shrubland

8. Extractive (2)
Extractive Barren
Extractive Impervious

9. Forest (4)
Forest
Riverine Wetlands Forest
Terrene Wetlands Forest
Tidal Wetlands Forest

10. Forested, Other (4)
Forested, Other
Riverine Wetlands Tree Canopy
Terrene Wetlands Tree Canopy
Tidal Wetlands Tree Canopy

11. Natural Succession (4)
Natural Succession Barren
Natural Succession Herbaceous
Natural Succession Shrubland
Bare Shore

12. Harvested Forest (5)
Harvested Forest Barren
Harvested Forest Herbaceous
Riverine Wetlands Harvested Forest
Terrene Wetlands Harvested Forest
Tidal Wetlands Harvested Forest

13. Cropland (5)
Cropland Barren
Cropland Herbaceous
Orchards and Vineyards Barren
Orchards and Vineyards Herbaceous
Orchards and Vineyards Shrubland

14. Pasture and Hay (2)
Pasture and Hay Barren
Pasture and Hay Herbaceous

15. Wetlands, Riverine Non-forested (3)
Riverine Wetlands Barren
Riverine Wetlands Herbaceous
Riverine Wetlands Shrubland

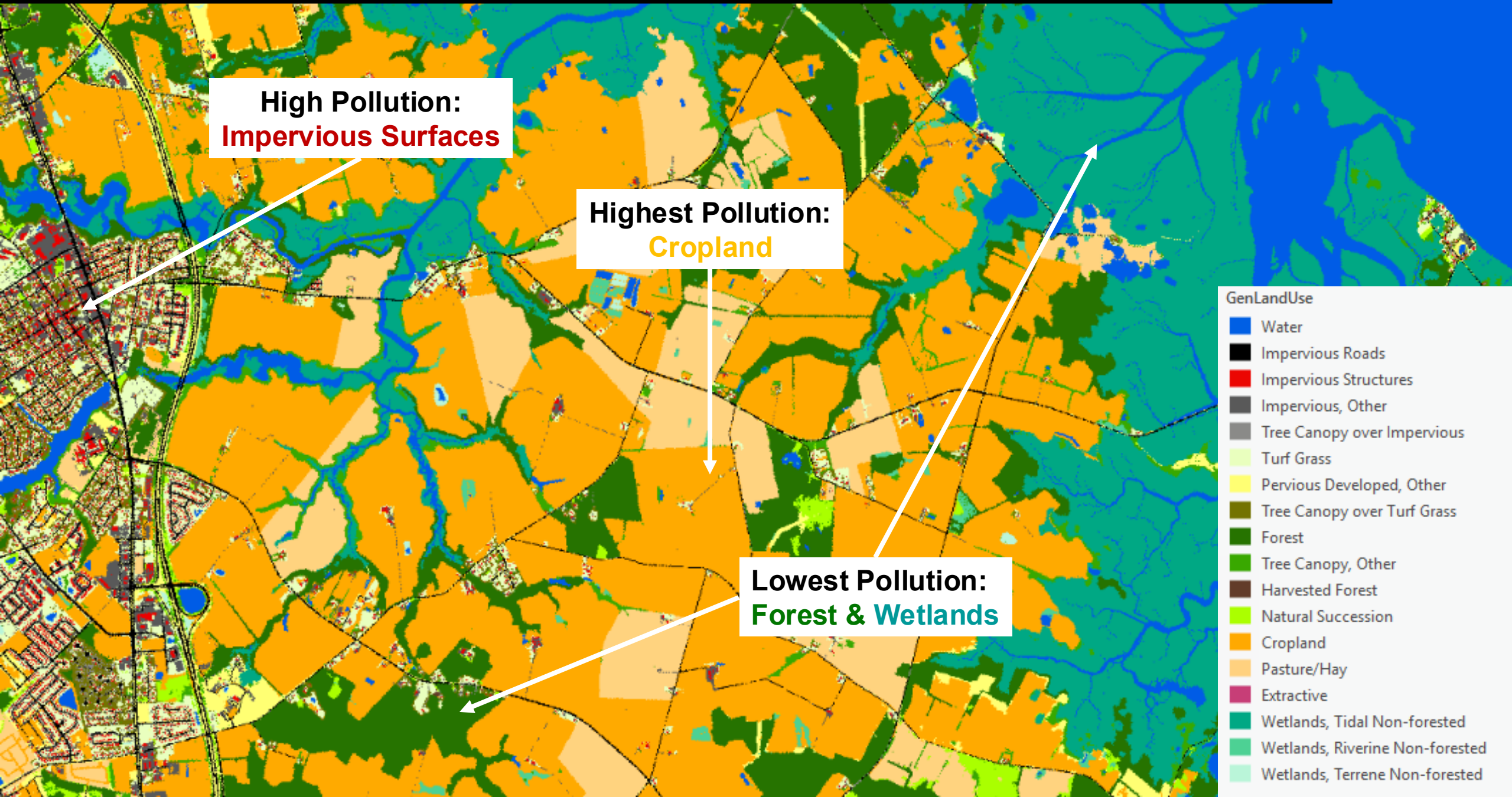
16. Wetlands, Terrene Non-forested (3)
Terrene Wetlands Barren
Terrene Wetlands Herbaceous
Terrene Wetlands Shrubland

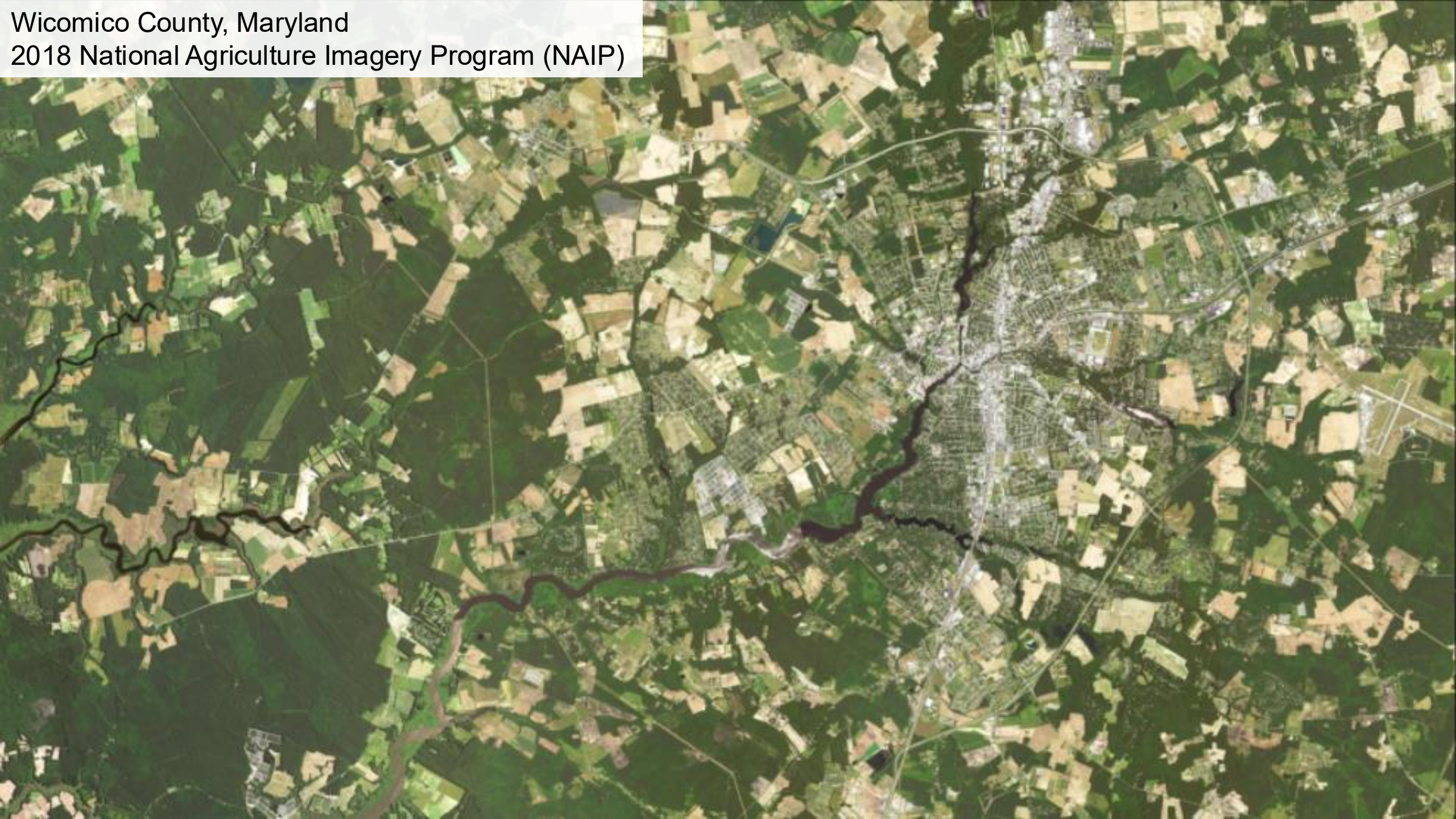
17. Wetlands, Tidal Non-forested (3)
Tidal Wetlands Barren
Tidal Wetlands Herbaceous
Tidal Wetlands Shrubland

18. Water (5)
Tidal Waters
Lakes & Reservoirs
Riverine Ponds
Terrene Ponds
Streams and Rivers (visible water)

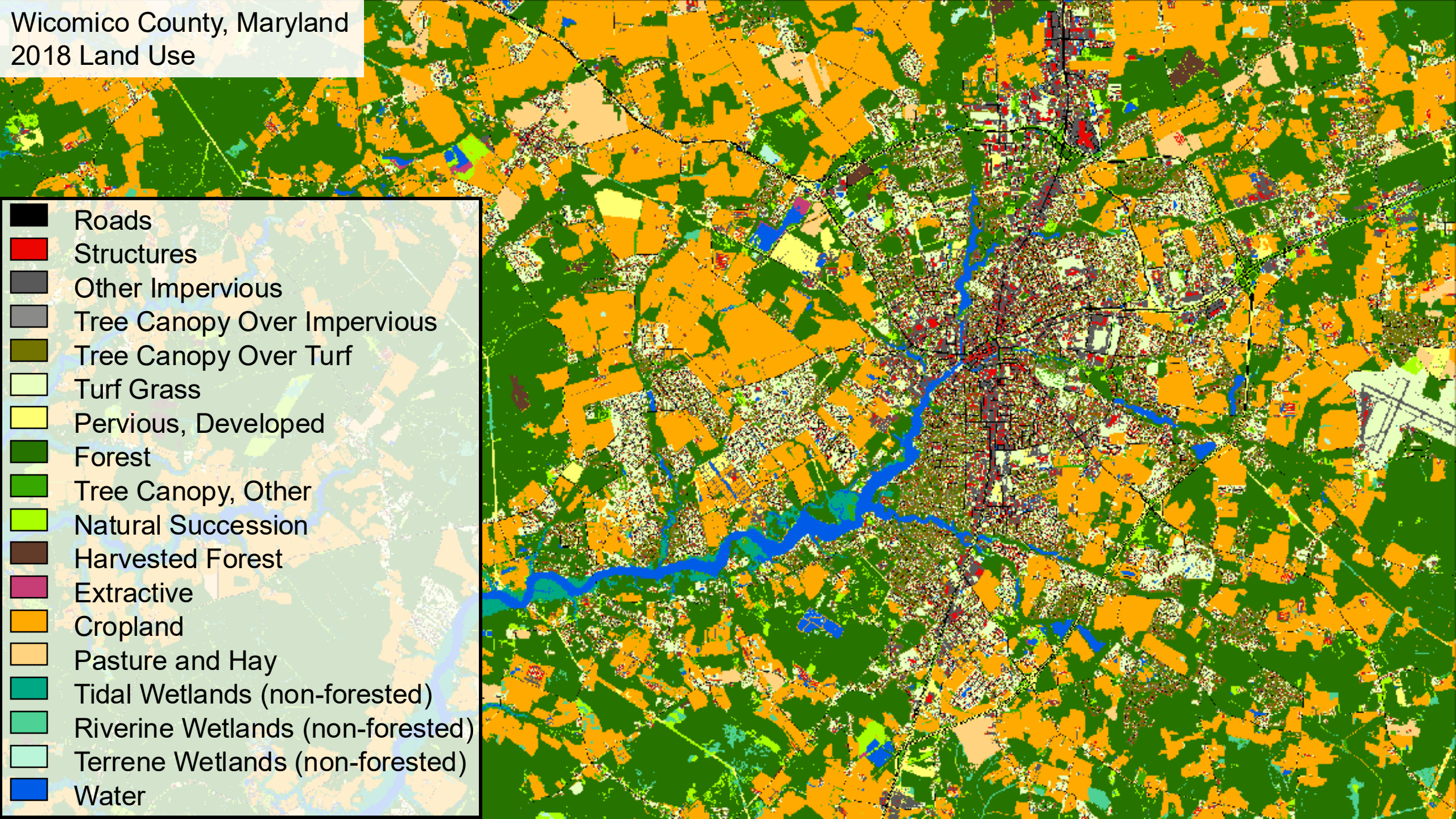
Land Use Impacts to Water Quality: Nitrogen, Phosphorus, and Sediment

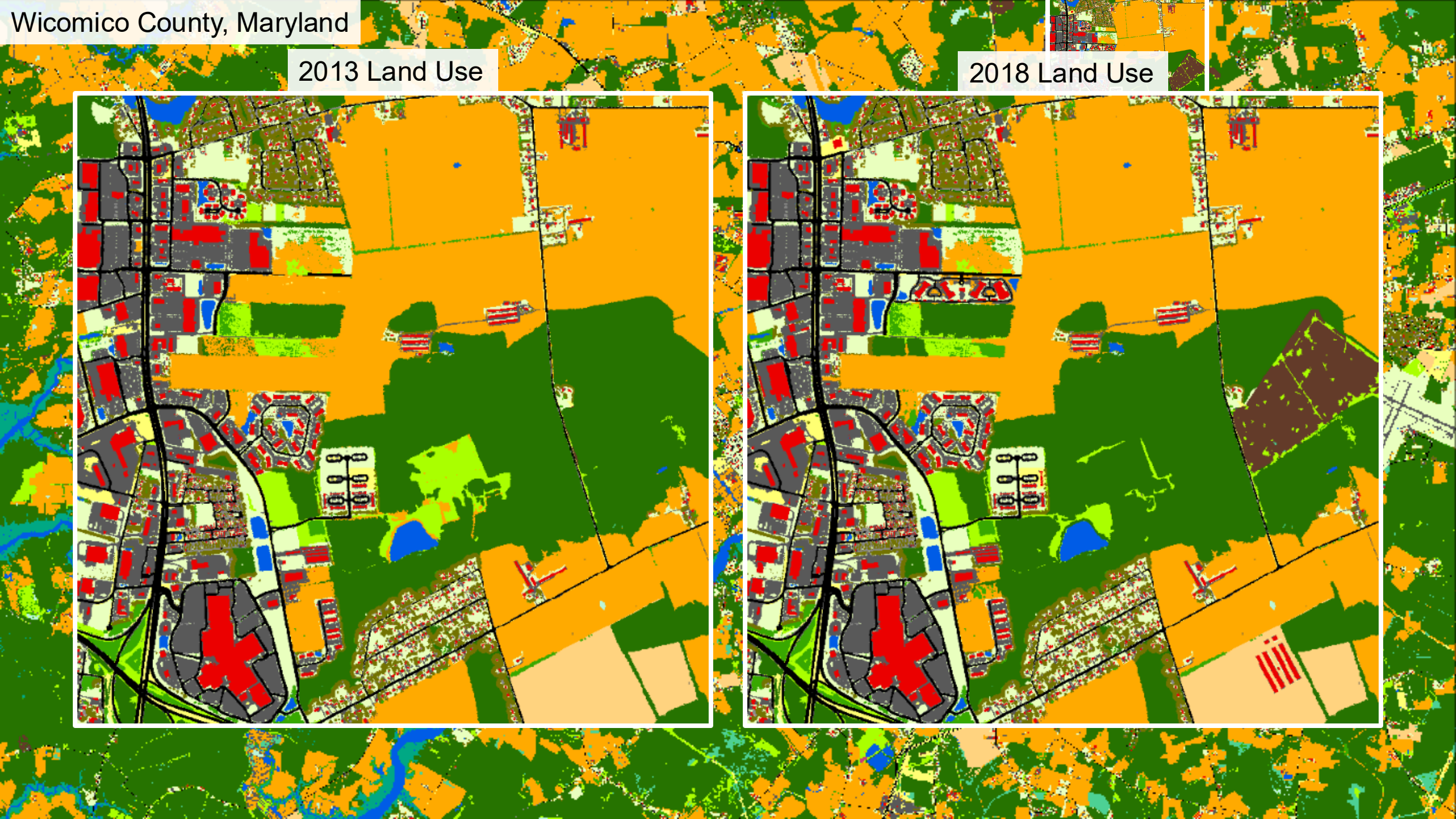
USGS science for a changing world




Wicomico County, Maryland
2018 National Agriculture Imagery Program (NAIP)

Wicomico County, Maryland
2018 Land Use

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2013 Land Use
2018 Land Use

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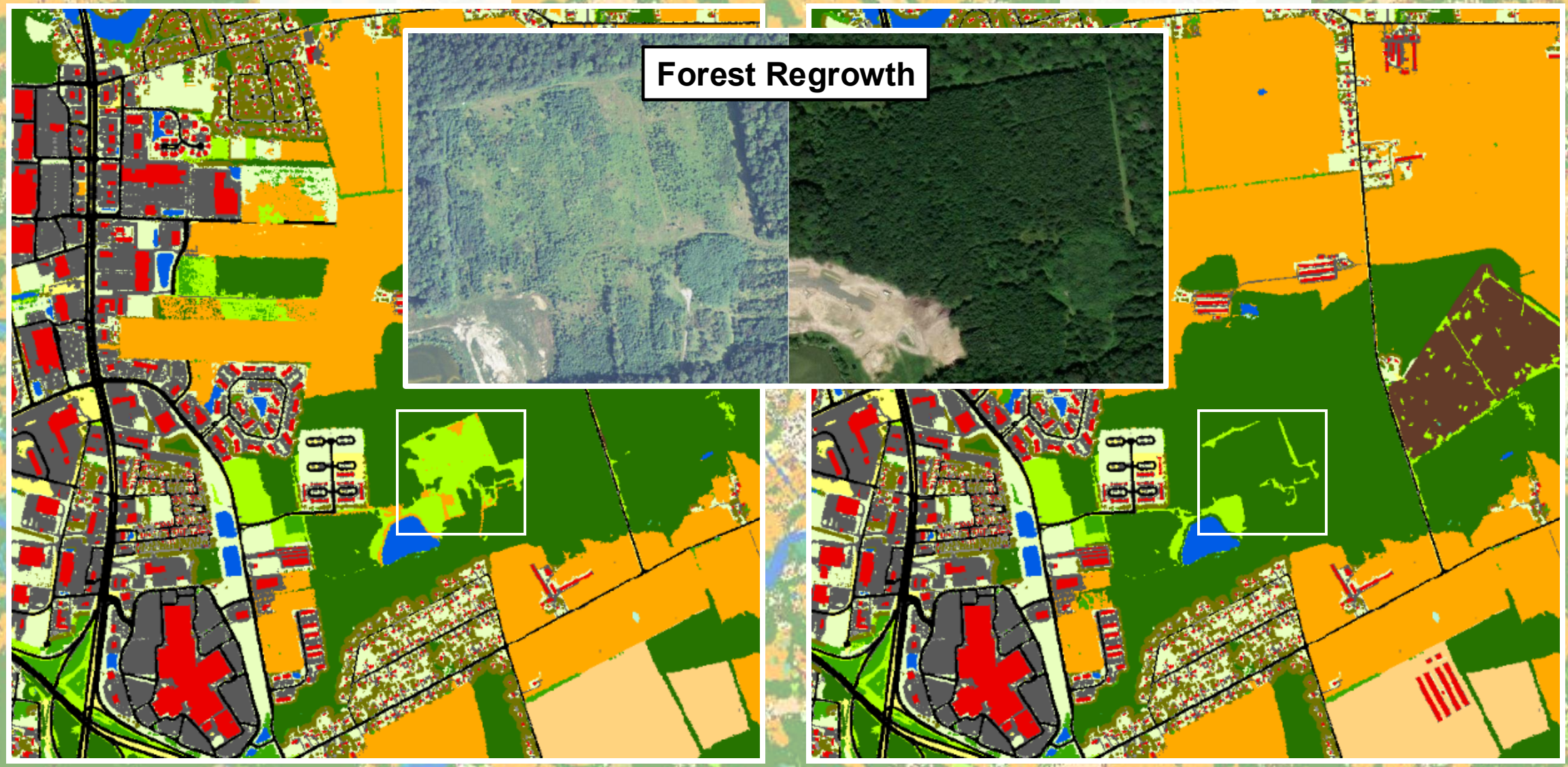
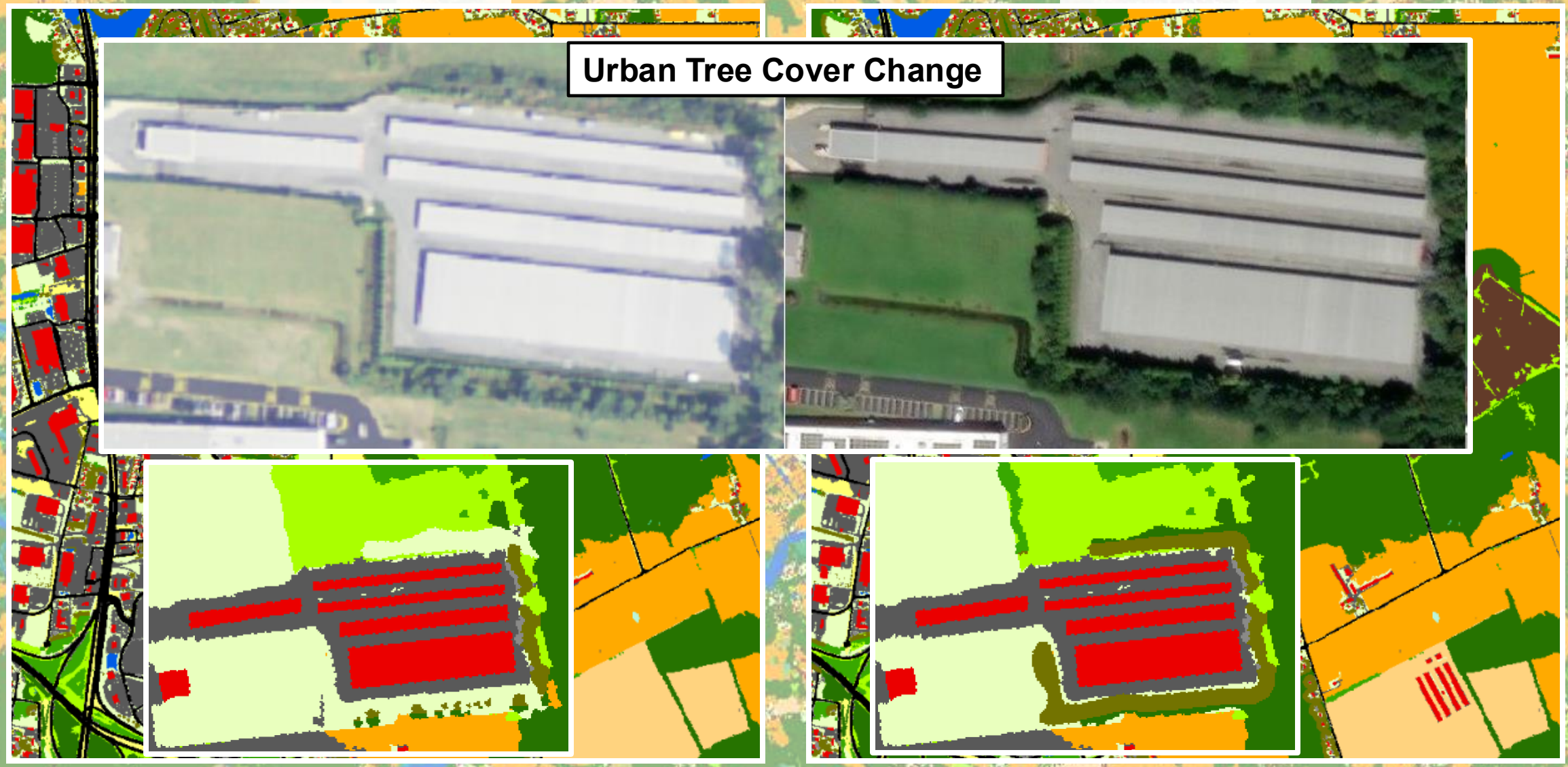
2018 Land Use



Wicomico County, Maryland

2013 Land Use

2018 Land Use



Wicomico County, Maryland

2013 Land Use

2018 Land Use

Wicomico County, Maryland

2013 Land Use

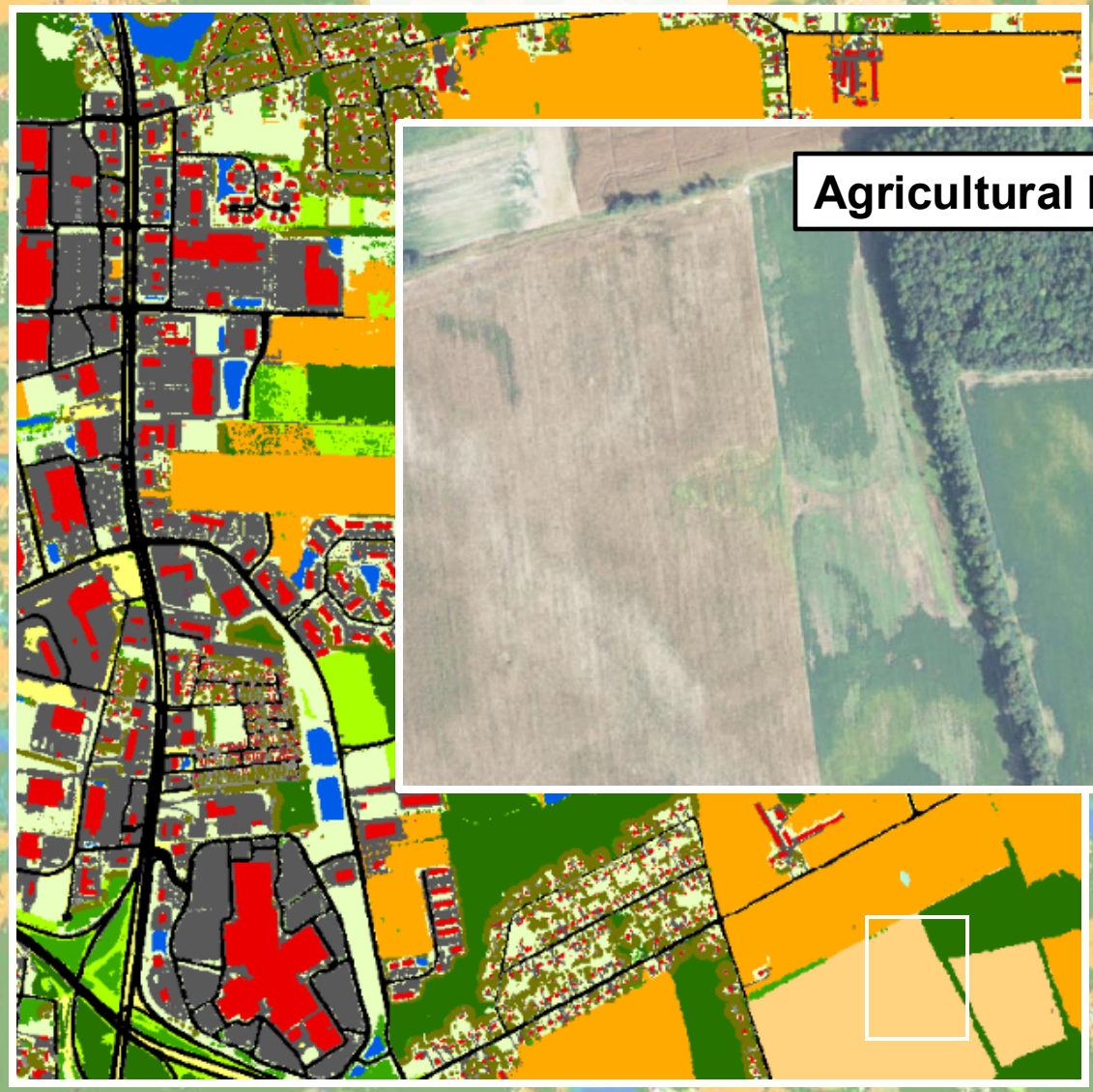
2018 Land Use

Agriculture Conversion to Development

Wicomico County, Maryland

2013 Land Use

2018 Land Use



Improvements in LULC, 2024 edition (compared to 2022 ed.)

- Consistent mapping of solar panel arrays
- Mapping of impervious surfaces on extractive lands
- Improved mapping of turf grass, reducing confusion with suspended succession and natural succession
- Restricting area classed as tree canopy over turf grass to parcel boundaries and limiting its extent in large parcels
- Improved mapping of timber harvests and natural succession- reducing confusion with agriculture
- Inclusion of Pennsylvania' probabilistic non-tidal wetlands
- Spatial homogenization of cropland and pasture classes
- Elimination of ghost parcels (future building footprints appearing on herbaceous lands)

Updated Mapping Methods

Notable Reductions

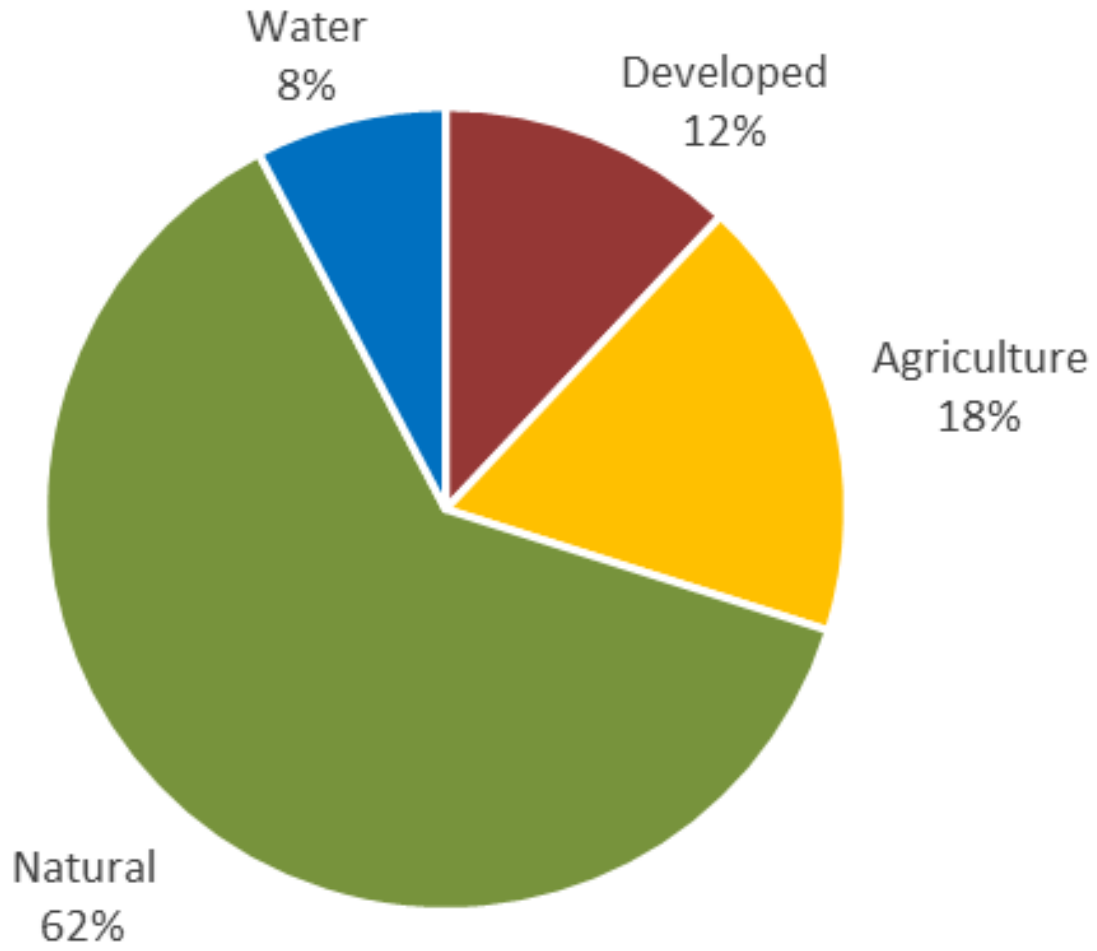
Pasture and Hay Herbaceous	(1,853,545)
Tree Canopy Over Turf Grass	(921,083)

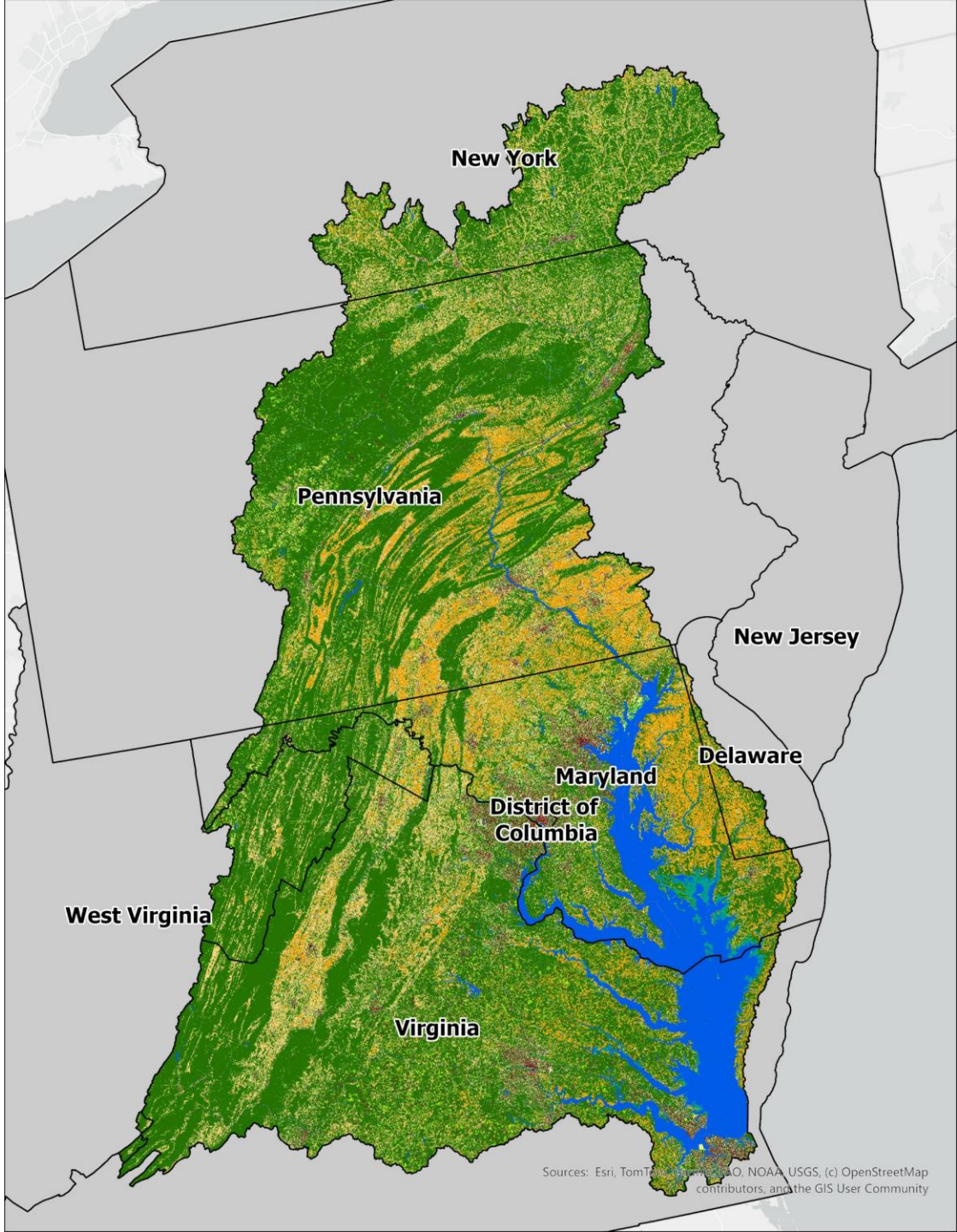
Notable Additions

Natural Succession Herbaceous	1,018,518
Suspended Succession Herbaceous	563,324
Riverine Wetlands Forest	439,920
Forested Other	334,070

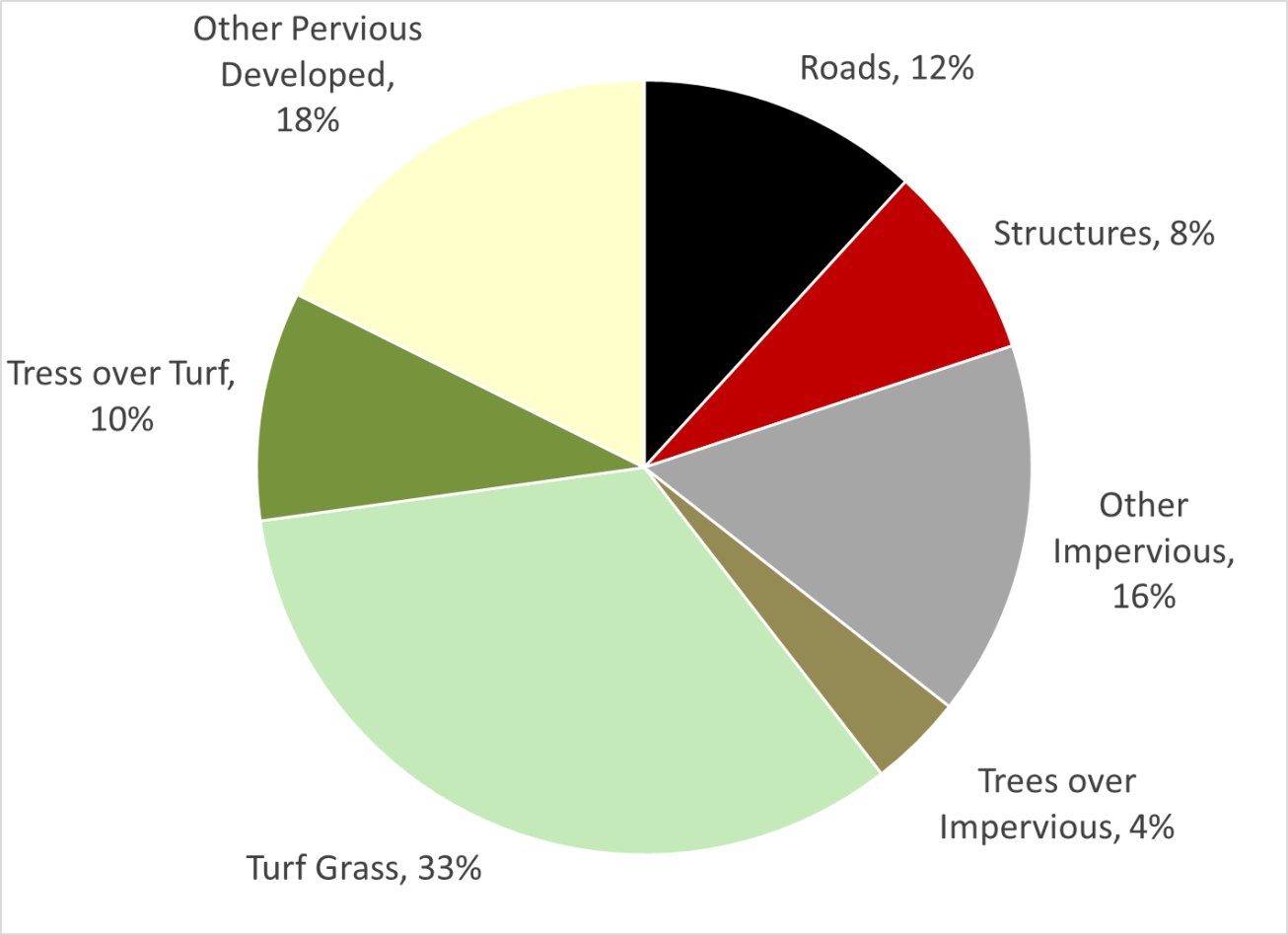
Chesapeake Bay Watershed Land Use

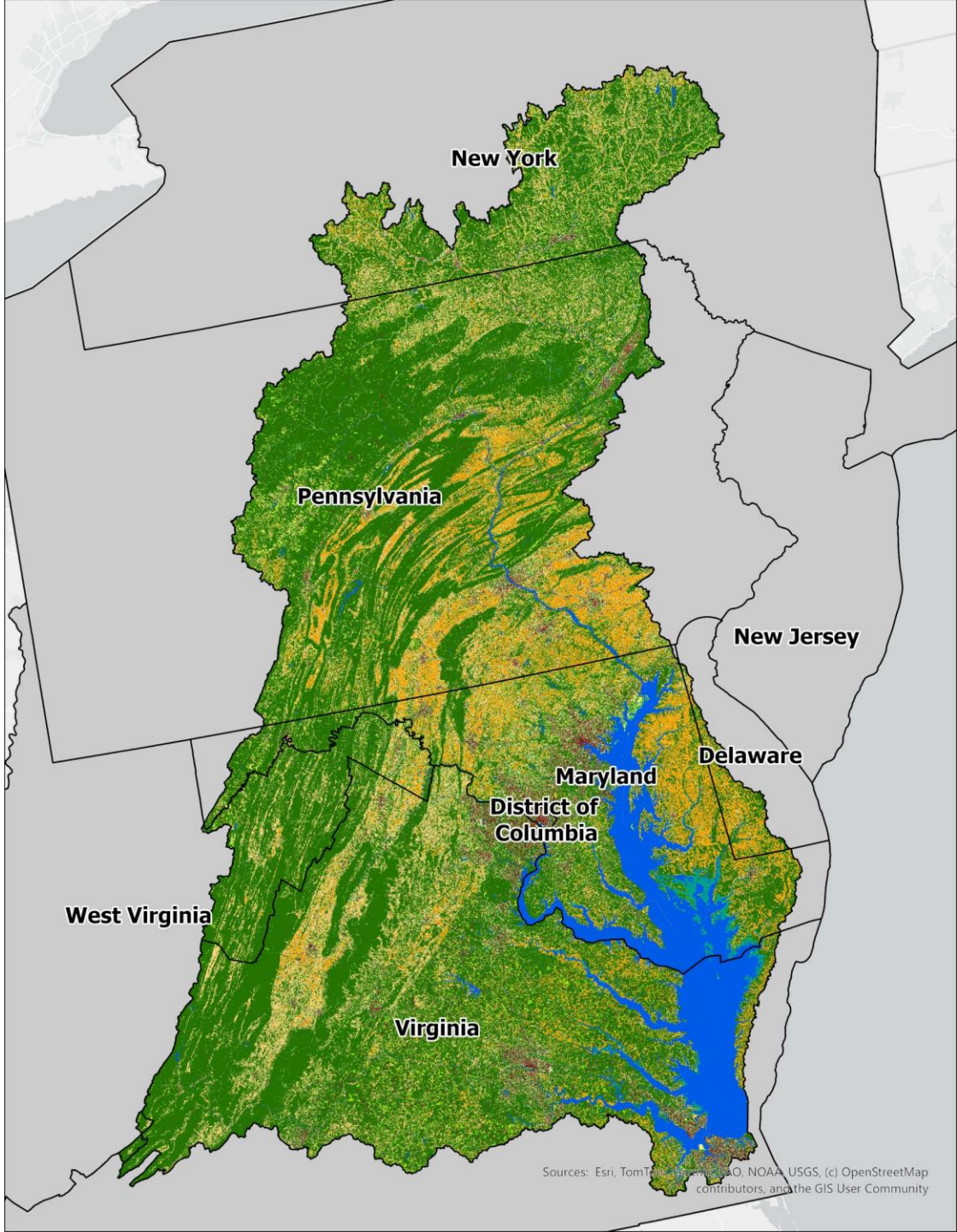
2021/22 1-meter resolution imagery





Components of Development





Land Use / Land Cover Change from 2013/14 to 2021/22
Highlights

Rotational timber harvest:

- 570,000 acres forest

+ 502,000 acres early successional forest

Impervious surfaces

+ 105,000 acres

Turf Grass

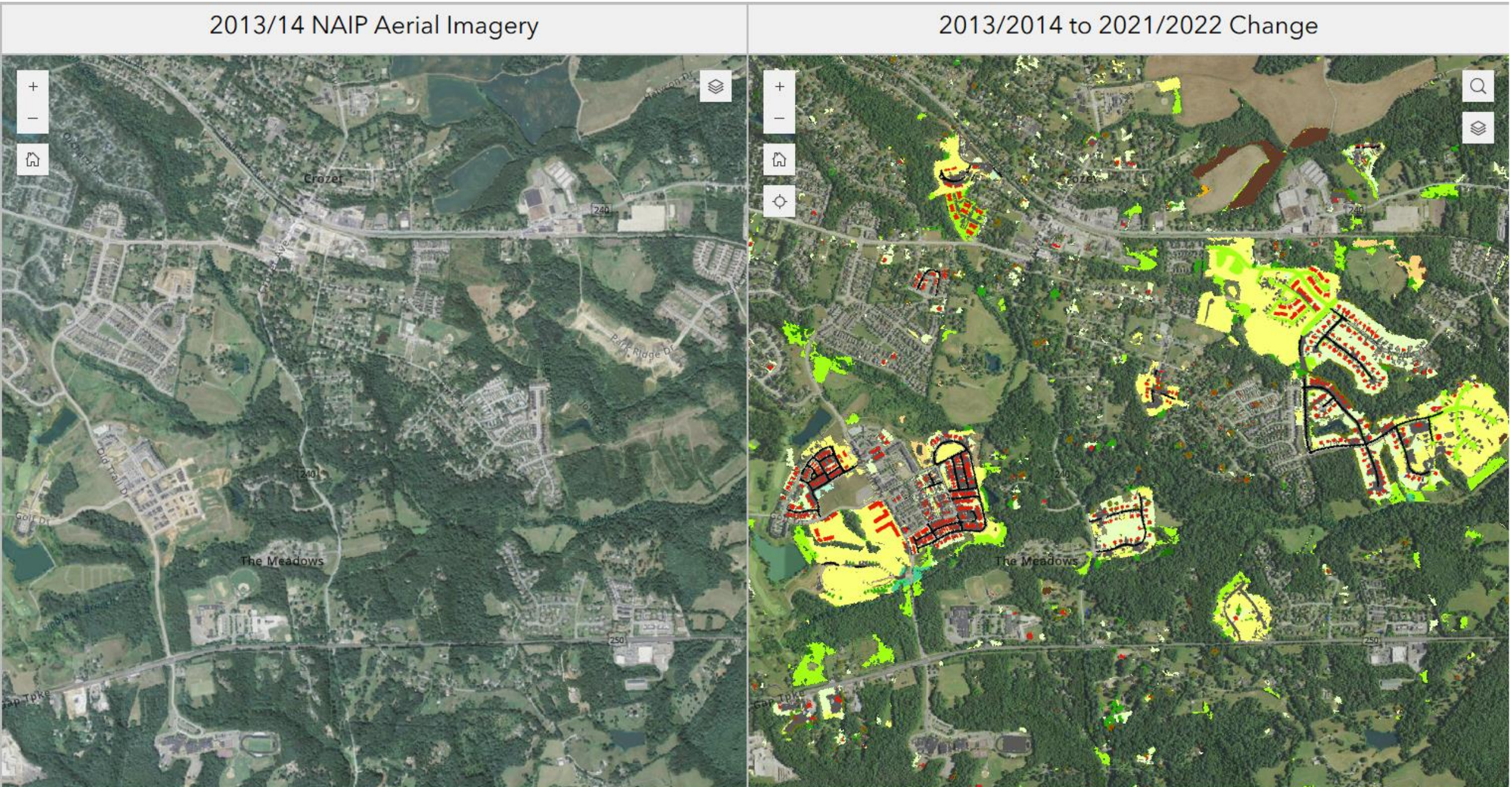
+ 51,000 acres

Forest and farmland conversion to development

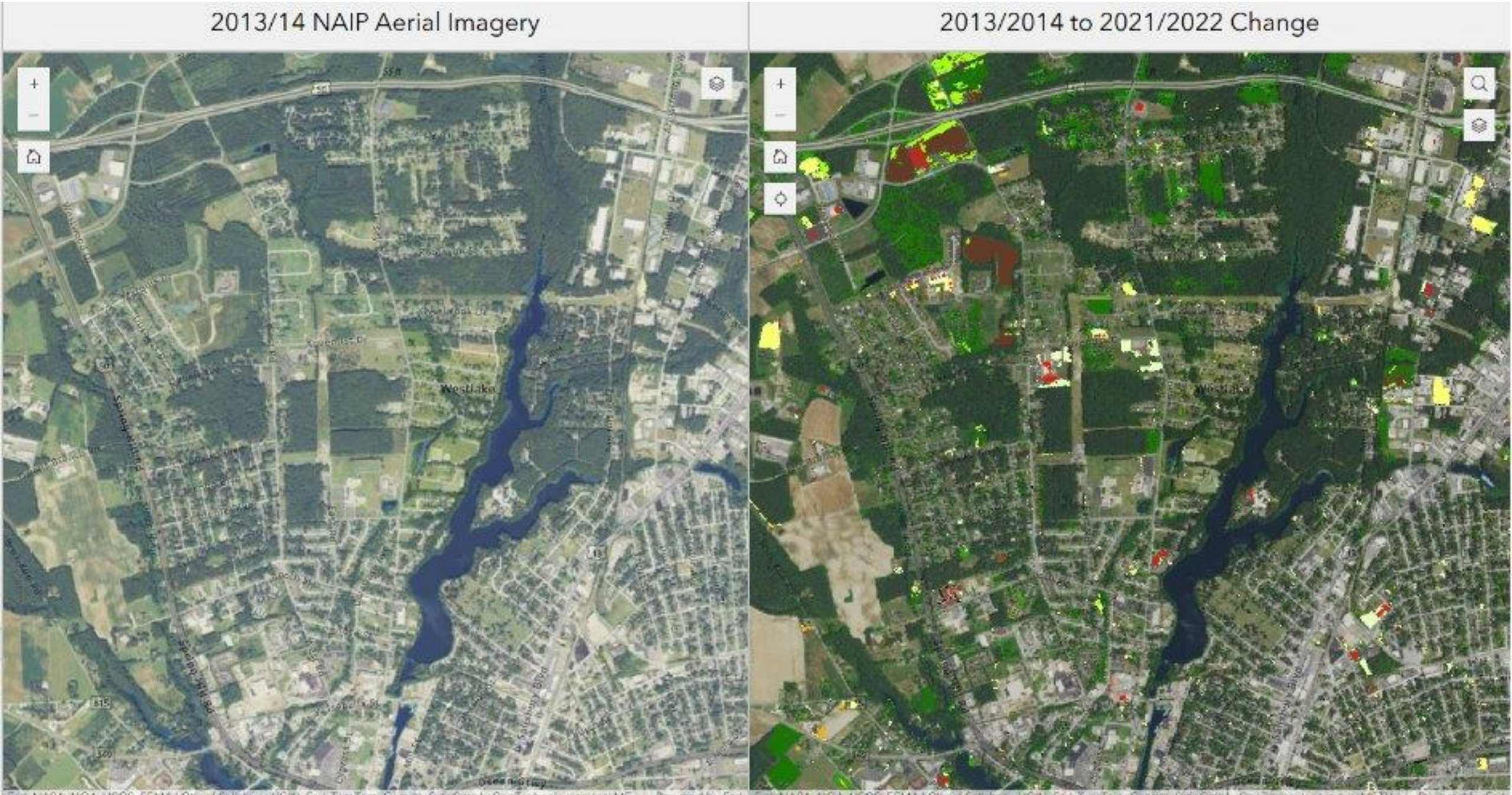
5:1 ratio of forest to farmland

- 100,000 acres of early and late-successional forest
- 21,000 acres of cropland and pasture/hay

High Impervious Surface Growth/Acre: Crozet, Virginia



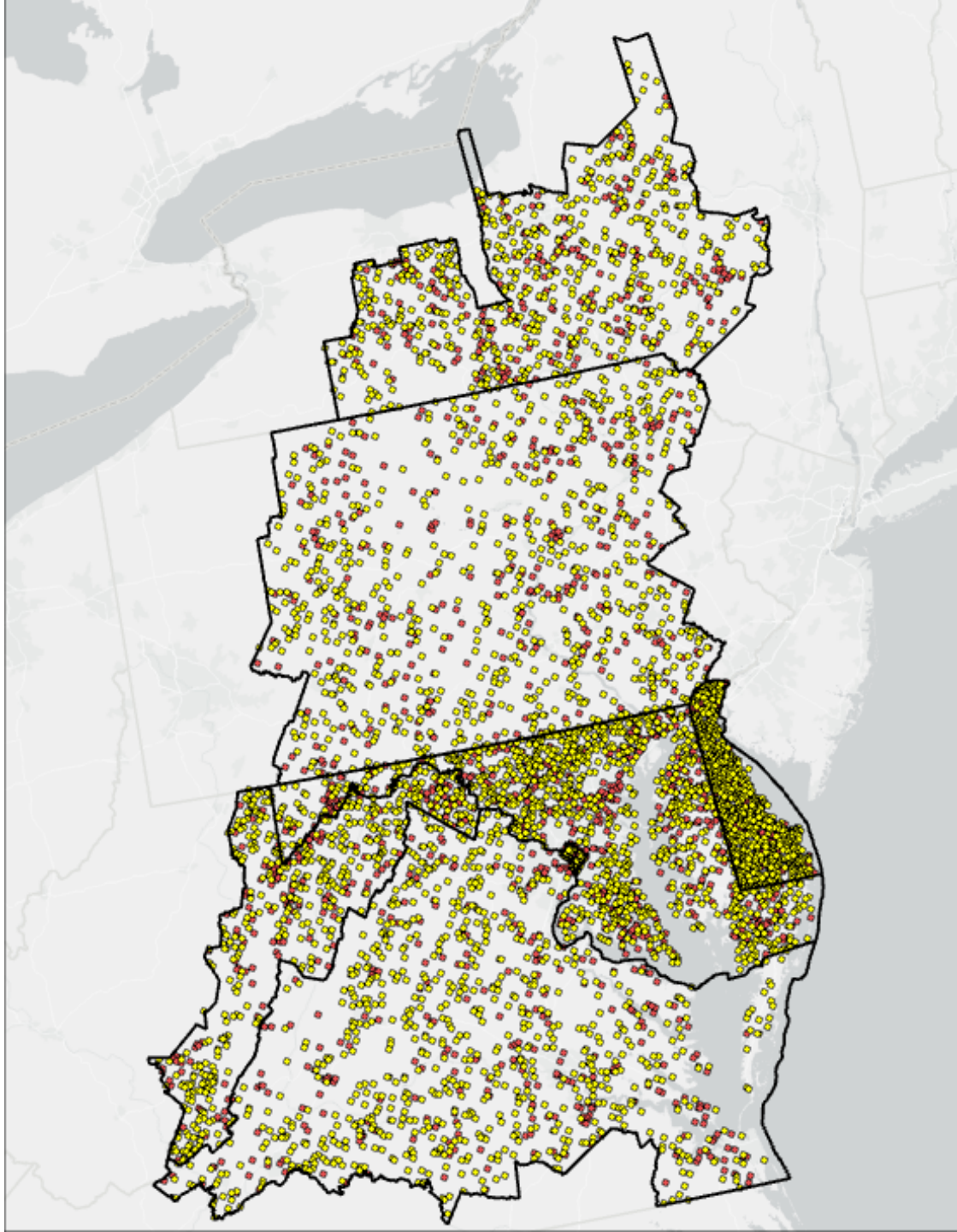
High Urban Tree Canopy Growth/Acre: Salisbury, Maryland



Static Accuracy

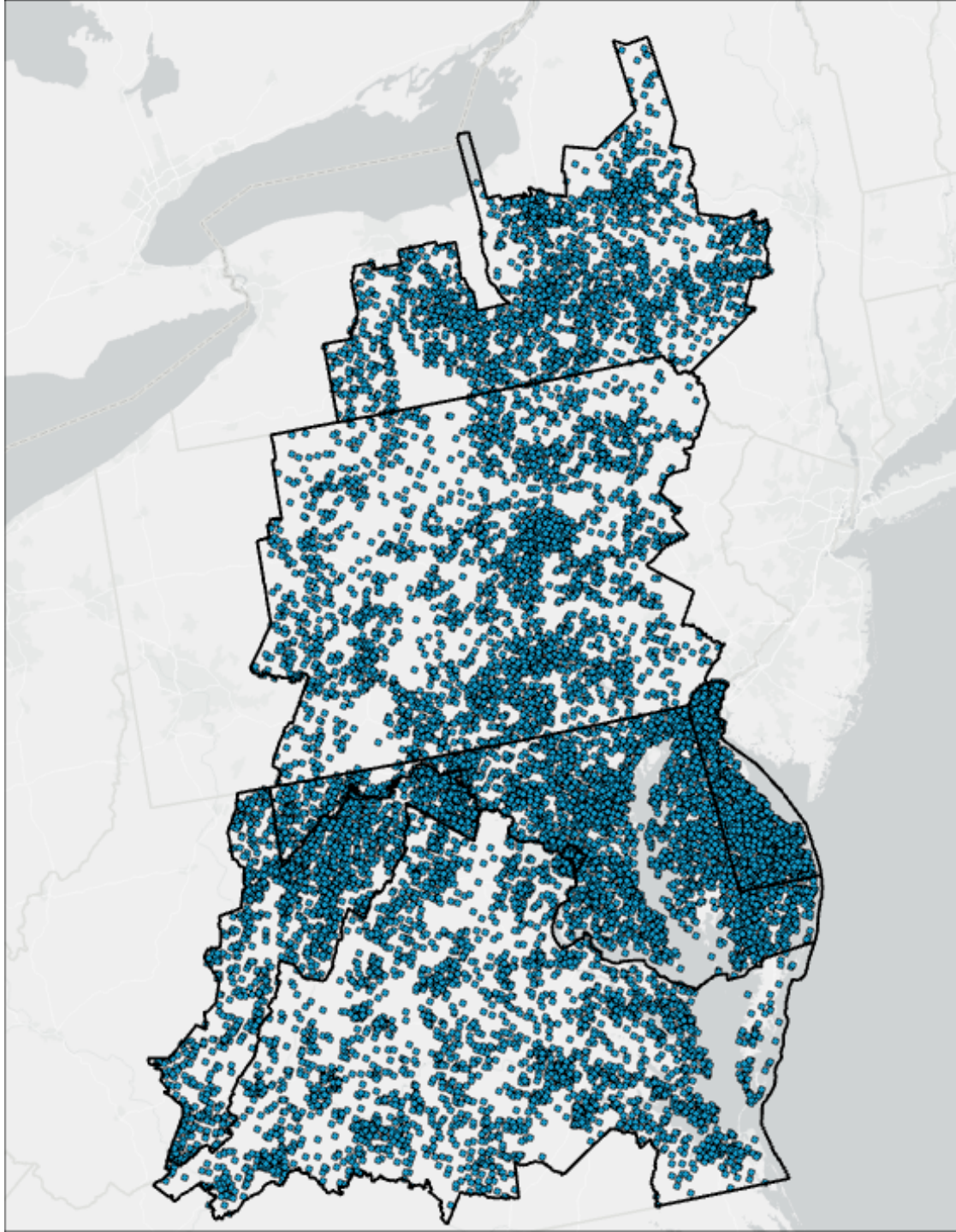
- 7000 points from the Static and Buffer types represent areas where no change is mapped in 2021/22

- Change points are excluded for static accuracy because:
  - Static accuracy is most likely to be incorrect where change occurred AND
  - Mapped change makes up only 3.8% of the total mapped area.



Change Accuracy

- Sampled over 23,000 points of mapped land cover change
  - Stratified by the most mapped change transitions per state
- Sampled almost 2,000 points within a 100-meter buffer of mapped change – where we are most likely to miss change



What are the Accuracies to be Reported?

Static Land Cover

96% of the mapped region

Overall Accuracy*: 95%

Land Cover	Producer's*	User's*
Water	99%	98%
Herbaceous	94%	95%
Tree Canopy	97%	95%
Impervious	89%	91%
Barren	40%	63%

* Represents fuzzy (3x3-meter window) accuracy between 5 classes

Land Cover Change

4% of the mapped region

Overall Accuracy**: 86%

Producer's: 96%

User's: 77%

** Represents fuzzy (3x3-meter window) accuracy between change and no change

Water
Water

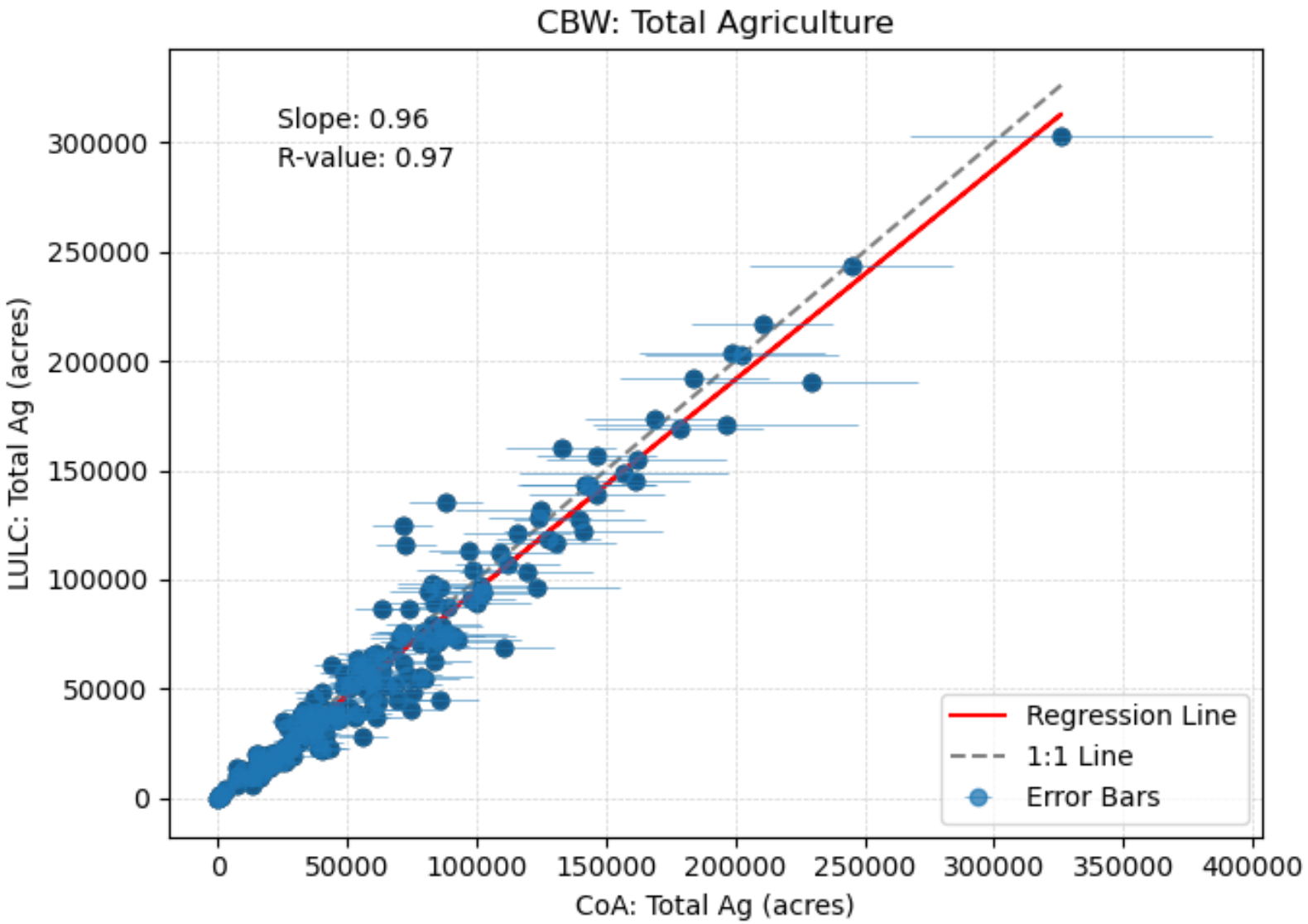
Herbaceous
Low Vegetation
Shrubland
Emergent Wetlands

Tree Canopy
Tree Canopy
Tree Canopy over Structures
Tree Canopy over Other Impervious
Tree Canopy over Roads

Impervious
Structures
Other Impervious
Roads

Barren
Barren

Comparison of Mapped Agriculture (2021/22) with the 2022 Census of Agriculture



Next-gen Land Use: Higher resolution base imagery!

Data:

- 2025/26 imagery at 30-60cm spatial resolution.

Why:

- Increased utility for Best Management Practice (BMP) verification and urban tree canopy monitoring

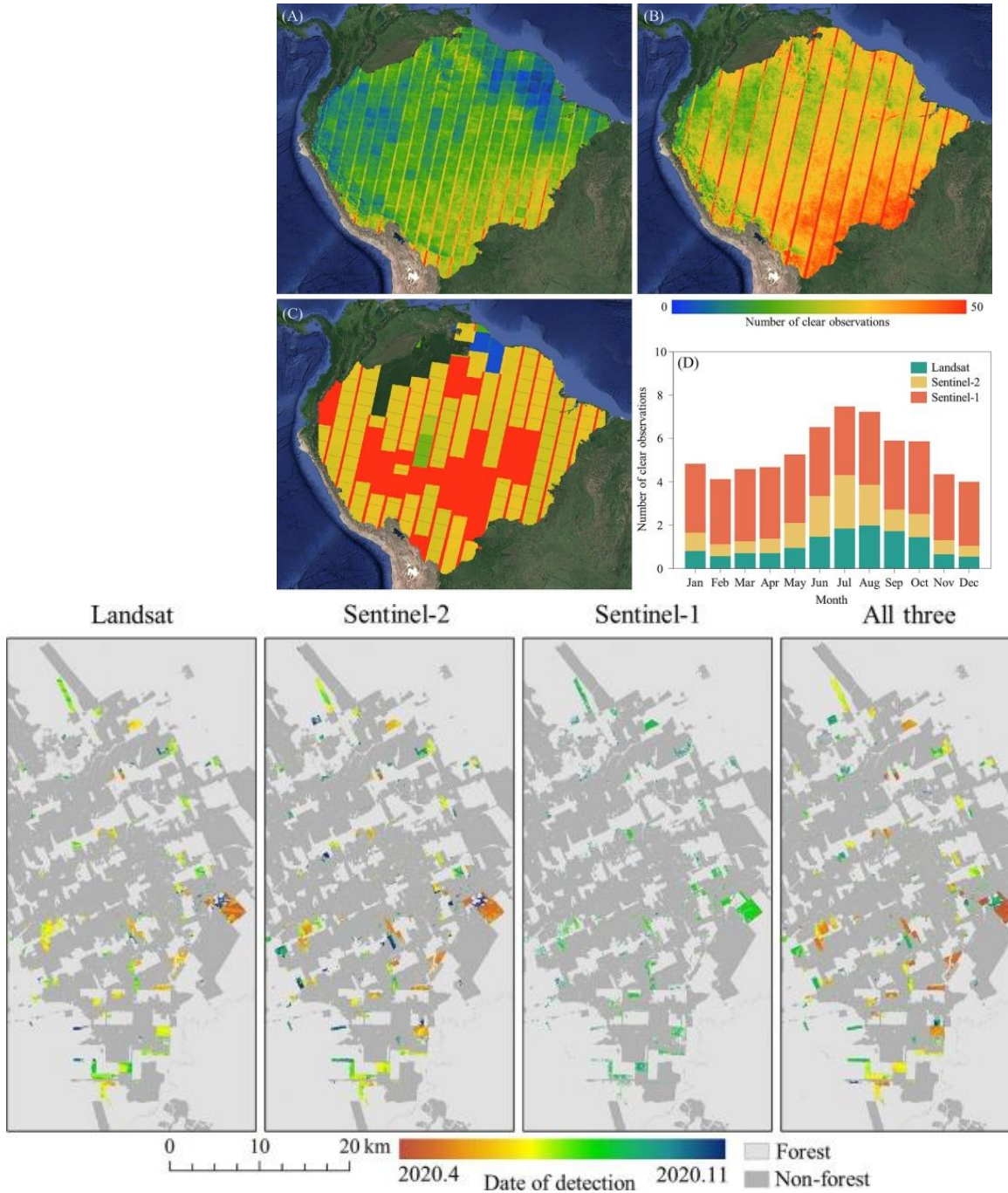
Next-gen Land Use: Hyper-temporal Monitoring!

Data:

- Monthly spectral indices (e.g., greenness, wetness) derived from Sentinel-1, Sentinel-2, and Landsat 5, 7, 8, and 9 imagery

Why:

- Improve cropland, pasture, and hay differentiation
- BMP verification: Forest buffers, Grass buffers, Cover Crops
- Assessing and tracking vegetation health
- Monitoring tidal wetland migration and inundation.



Figures from Tang et al., 2023

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