High-resolution Land Use/Land Cover for the Chesapeake Bay Watershed

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[3] University of Vermont's Spatial Analysis Laboratory
[4] EarthDefine LLC

Local Government Leadership Work Group Meeting
Communicating Forest and Tree Canopy Trends Using High-Resolution Data
August 25, 2026

Chesapeake Bay Program Land Use/Land Cover (LULC) Project: A Brief History

2013/14
- 16-classes
- First 1-meter LULC product

2017

2017/18
- 54-classes
- First 1-meter LULC Change product (2013/14 – 2017/18)

2022

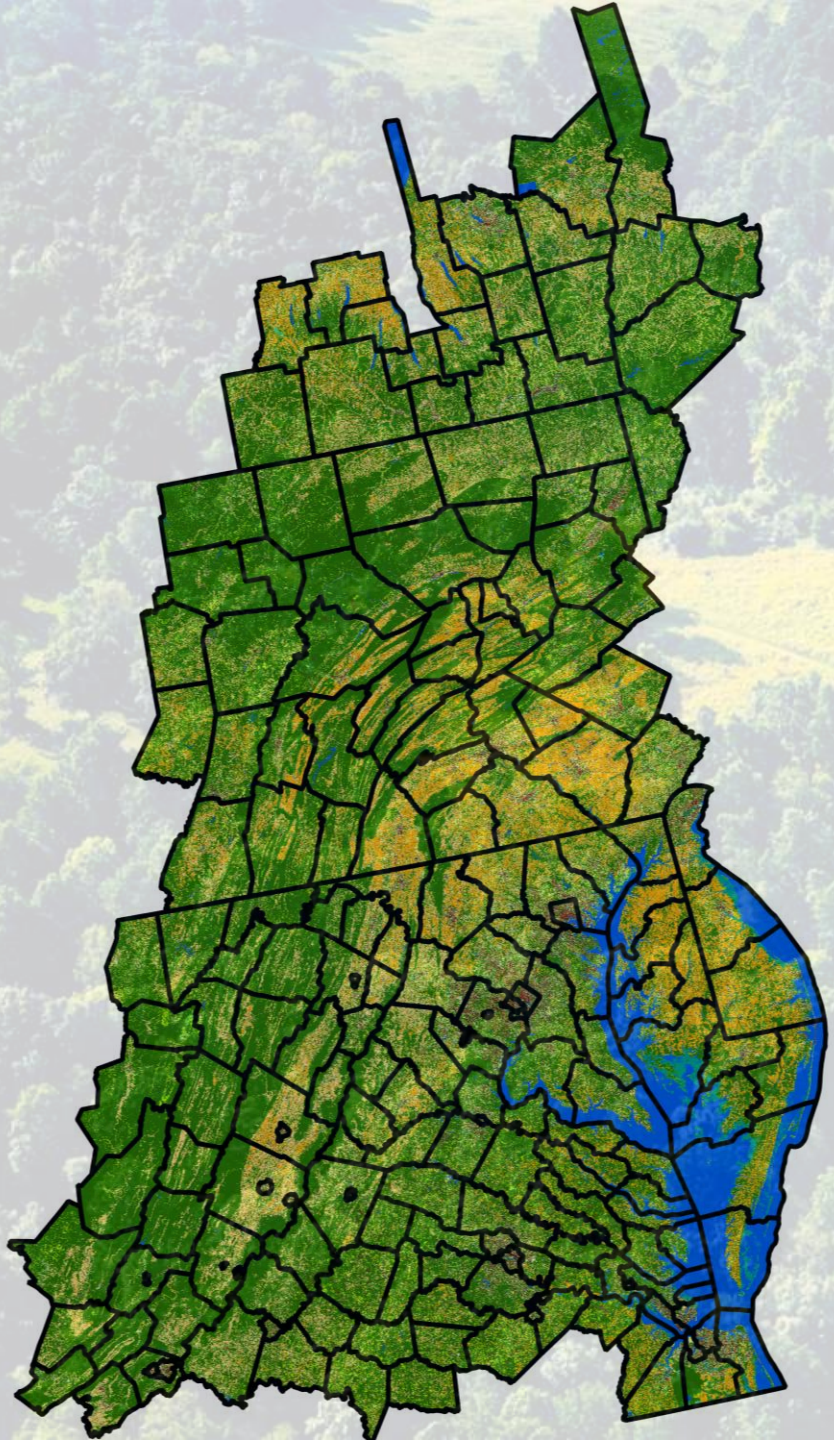
2021/22
- 56-classes
- Three dates of 1-meter LULC and three LULC Change products

2024

2025/26
- 56-classes?
- First time mapping land cover and change with AI

2028

Land Use/Land Cover Monitoring
With each newly mapped year, the previous year(s) are remapped using the same methods for consistent change detection



Spatial Extent and Resolution

- Mapped extent
  - 205 counties intersecting or adjacent to the Chesapeake Bay watershed
  - 99,000 square miles
- Spatial Resolution
  - 1-meter^2 cells
- Temporal Resolution
  - 2013/14, 2017/18, 2021/22
- Categorical Resolution
  - 56 Land Use/Land Cover classes

What is Land Cover?

University of Vermont Spatial Analysis Lab

The physical characteristics of the land surface (e.g., impervious, tree canopy, herbaceous)

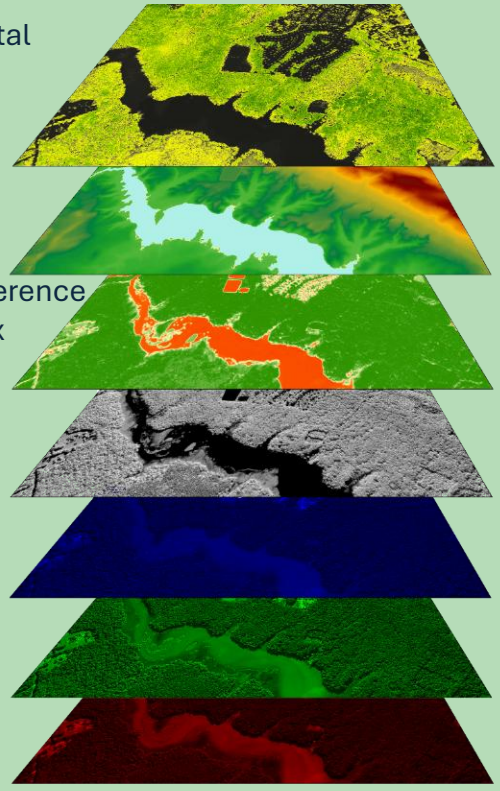
Inputs	Derivatives	Process	Land Cover

Light Detecting and Ranging (LiDAR)

- Normalized digital surface model (nDSM)
- Digital elevation model (DEM)

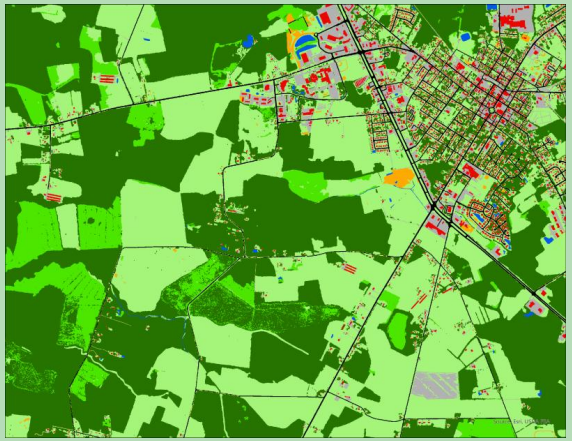
National Agriculture Imagery Program (NAIP)

- Normalized difference vegetation index (NDVI)
- Near Infrared (NIR)
- Blue
- Green
- Red



Rule-based, object-oriented image classification with eCognition software

Manual Corrections



- Structures
- Other Impervious
- Roads
- Tree Canopy over Structures
- Tree Canopy over Other Impervious
- Tree Canopy over Roads
- Tree Canopy
- Shrubland
- Low Vegetation
- Barren
- Water

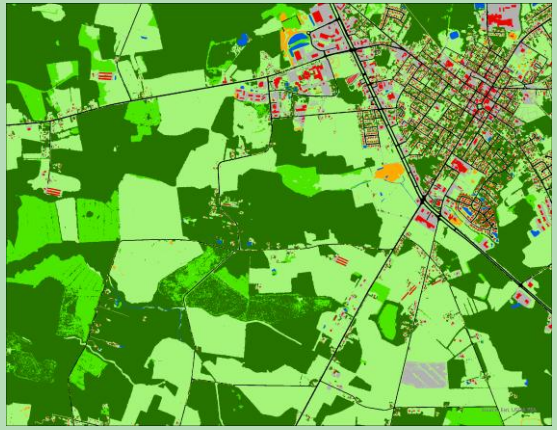
* Emergent Wetlands not included in release

What is Land Use?

How humans use the land (e.g., residential, agriculture, recreation)

Inputs*

Land Cover



Timber Harvest

Parcels

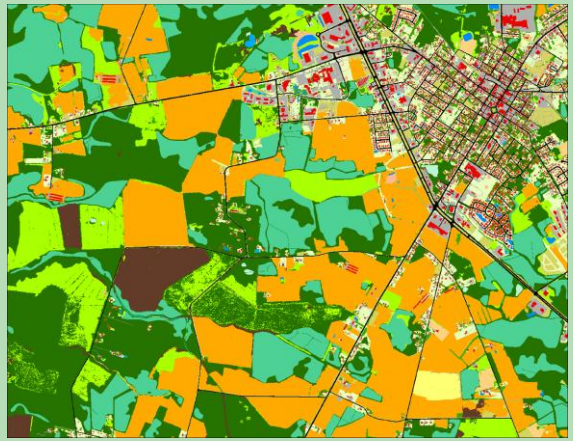
Cropland Data Layer (CDL)

* Subset of inputs shown (over 25 ancillary datasets used)

Process

Rule-based, geospatial model in open-source Python to produce vector overlays and reconcile them into a land use raster

Land Use

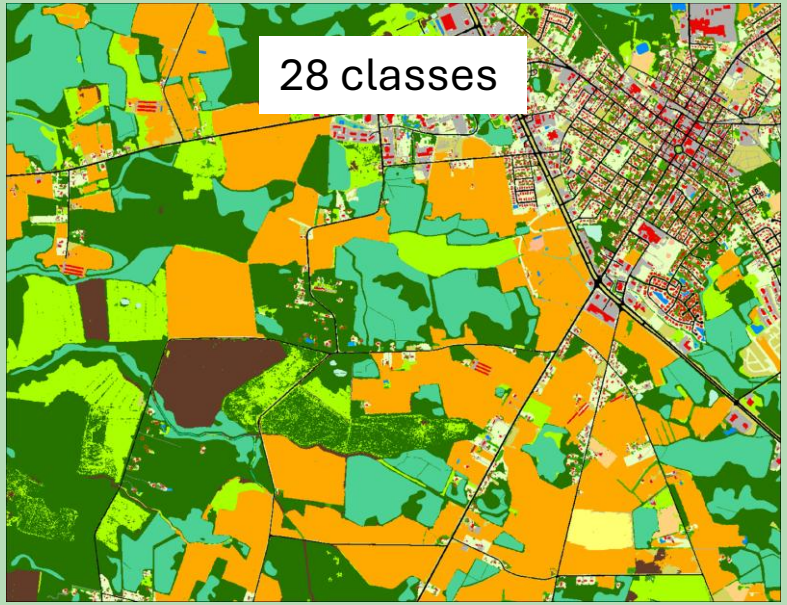


- Structures
- Other Impervious
- Roads
- Turf Grass
- Developed
- Solar Field
- Forest
- Bare Shore
- Harvested Forest
- Terrene Wetlands
- Cropland
- Pasture and Hay
- Riverine Ponds
- Terrene Ponds
- TC over Structures
- TC over Impervious
- TC over Roads
- TC over Turf
- Extractive
- Suspended Succession
- Forested, Other
- Natural Succession
- Riverine Wetlands
- Tidal Wetlands
- Orchards and Vineyards
- Tidal Waters
- Lakes and Reservoirs
- Streams and Rivers

What is Land Use/Land Cover (LULC)?

The combination of land use and land cover, reflecting both the physical surface and how humans make use of the land.

Land Use



Structures
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Tidal Wetlands
Orchards and Vineyards
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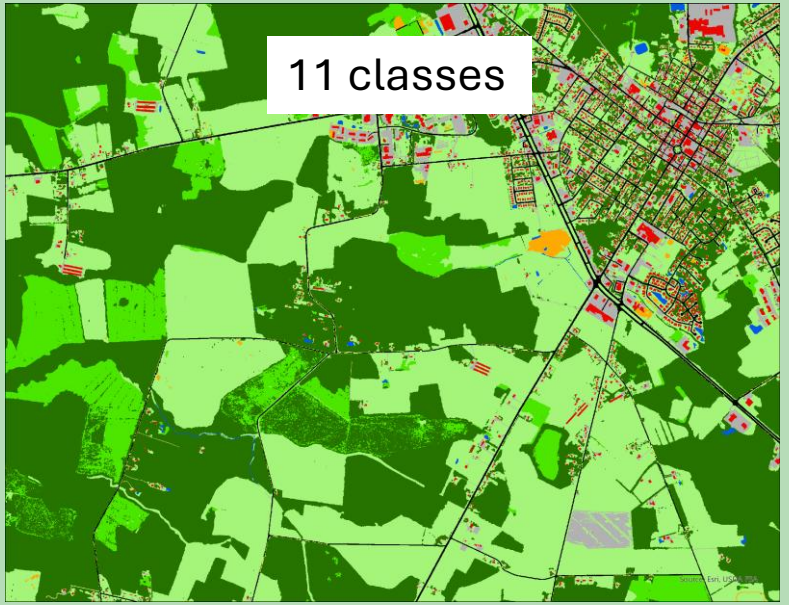
Lakes and Reservoirs
Streams and Rivers

Land Cover



Structures
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Tree Canopy over Structures
Tree Canopy over Other Impervious
Tree Canopy over Roads
Tree Canopy
Shrubland
Low Vegetation
Barren
Water

Land Use / Land Cover

56 Land Use/Land Cover Classes

Example

Natural Succession
+
Shrubland
=
Natural Succession
Shrubland

Land Use / Land Cover (LULC) 56-Class Schema

Development

Roads

Structures

Other Impervious

Solar Field Panel Arrays

TC over Roads

TC over Structures

TC over Other Impervious

Turf Grass

Tree Canopy over Turf Grass

Bare Developed

Solar Field Barren

Solar Field Herbaceous

Solar Field Shrubland

Suspended Succession Barren

Suspended Succession Herbaceous

Suspended Succession Shrubland

Extractive Barren

Extractive Impervious

Agricultural

Cropland Barren

Cropland Herbaceous

Orchards and Vineyards Barren

Orchards and Vineyards Herbaceous

Orchards and Vineyards Shrubland

Pasture and Hay Barren

Pasture and Hay Herbaceous

Water

Tidal Waters

Lakes and Reservoirs

Riverine Ponds

Terrene Ponds

Streams and Rivers

Natural

Forest

Riverine Wetlands Forest

Terrene Wetlands Forest

Tidal Wetlands Forest

Forested, Other

Riverine Wetlands Tree Canopy

Terrene Wetlands Tree Canopy

Tidal Wetlands Tree Canopy

Natural Succession Barren

Natural Succession Herbaceous

Natural Succession Shrubland

Bare Shore

Harvested Forest Barren

Harvested Forest Herbaceous

Riverine Wetlands Harvested Forest

Terrene Wetlands Harvested Forest

Tidal Wetlands Harvested Forest

Riverine Wetlands Barren

Riverine Wetlands Herbaceous

Riverine Wetlands Shrubland

Terrene Wetlands Barren

Terrene Wetlands Herbaceous

Terrene Wetlands Shrubland

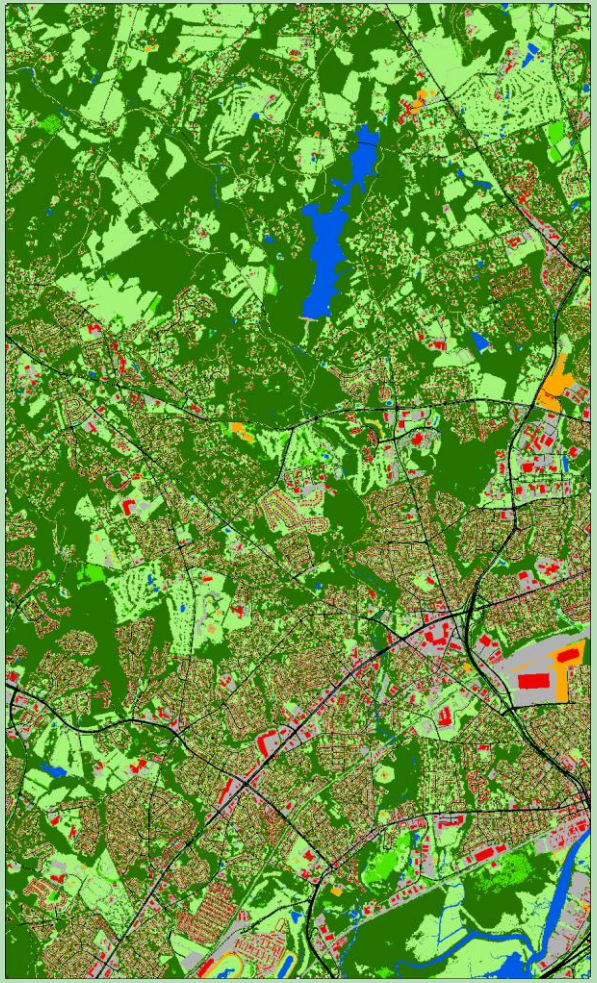
Tidal Wetlands Barren

Tidal Wetlands Herbaceous

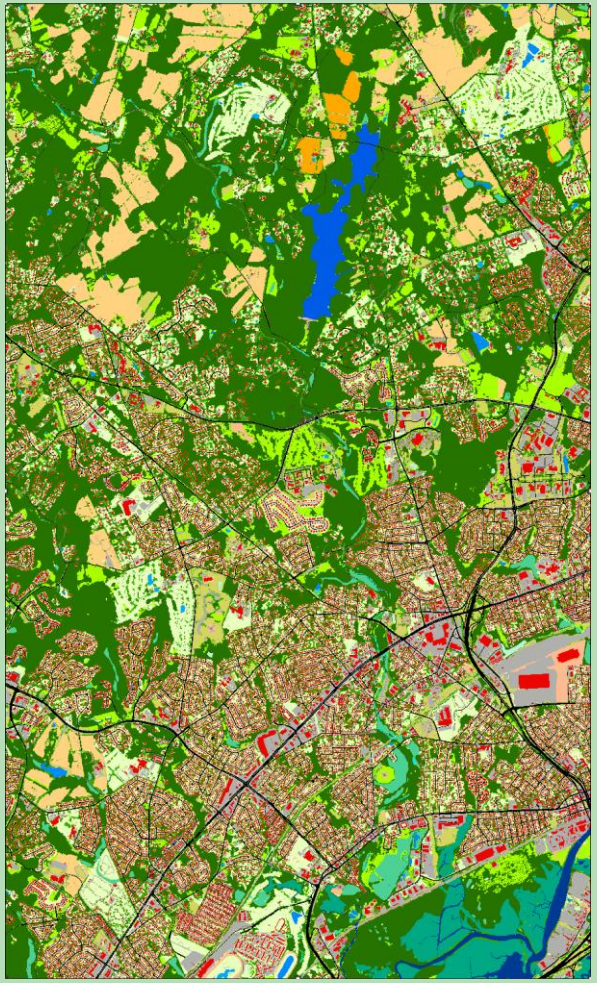
Tidal Wetlands Shrubland

Aggregating Land Use/Land Cover Classes

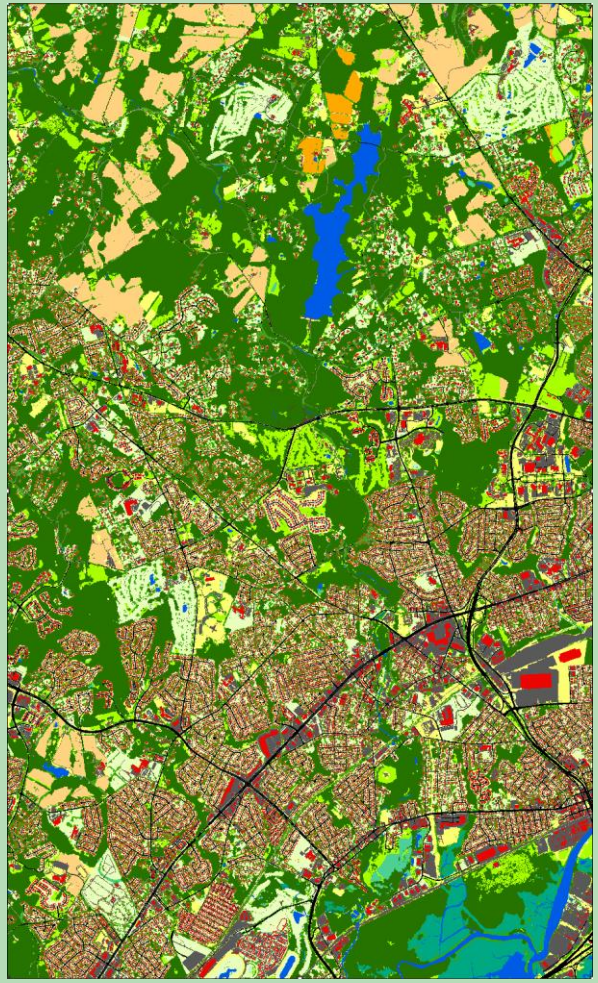
Land Cover (11)



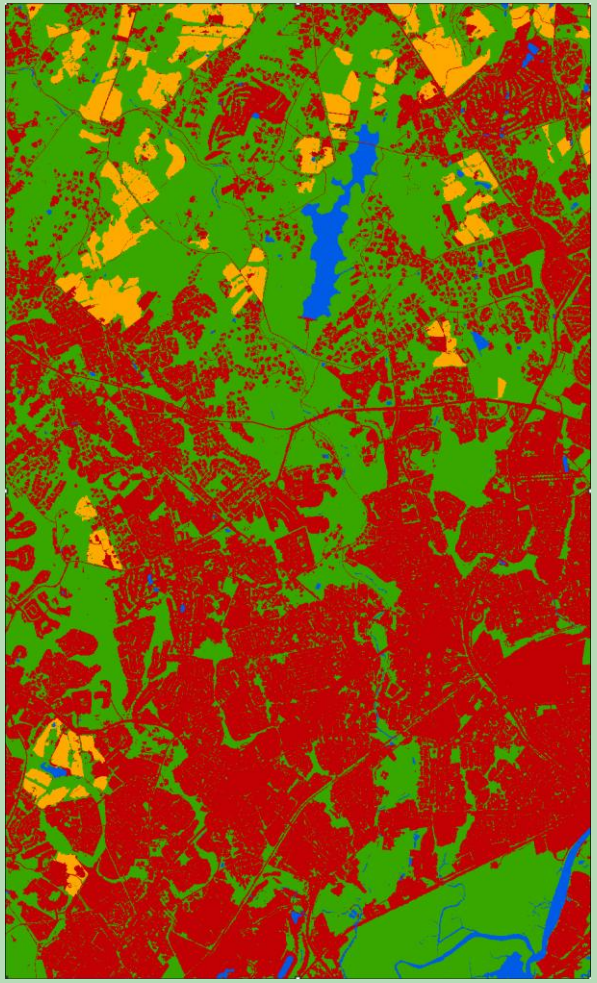
Land Use (28)



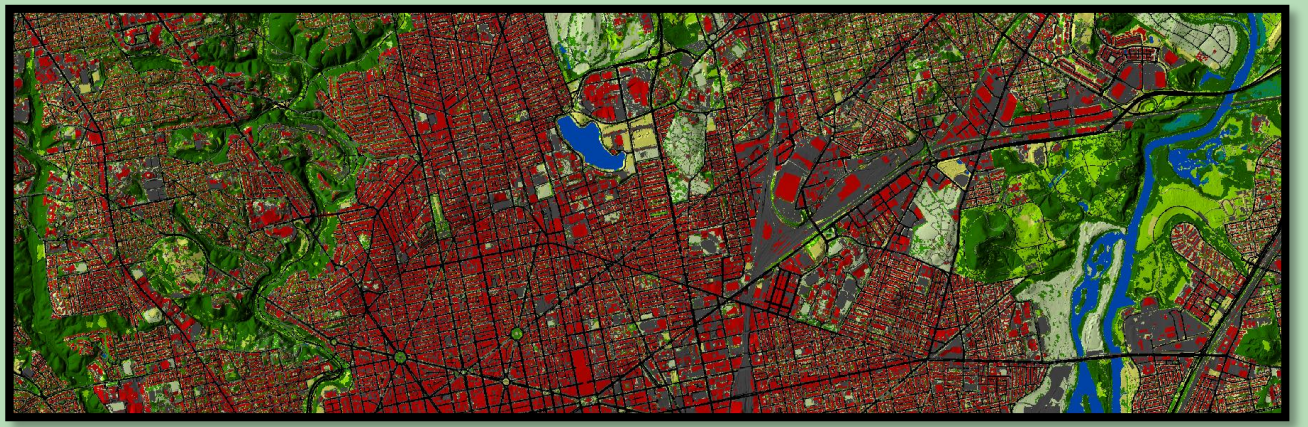
General Land Use (18)



Macro Land Use (4)



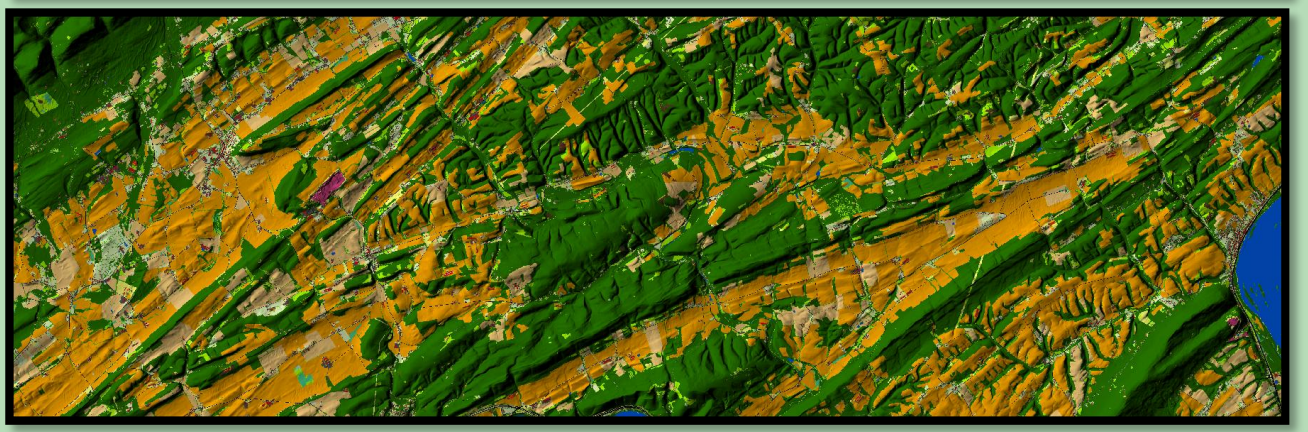
Land Use/Land Cover in the Chesapeake Bay Watershed 2021/22



Development

5,277,662 acres (13% of watershed land area)

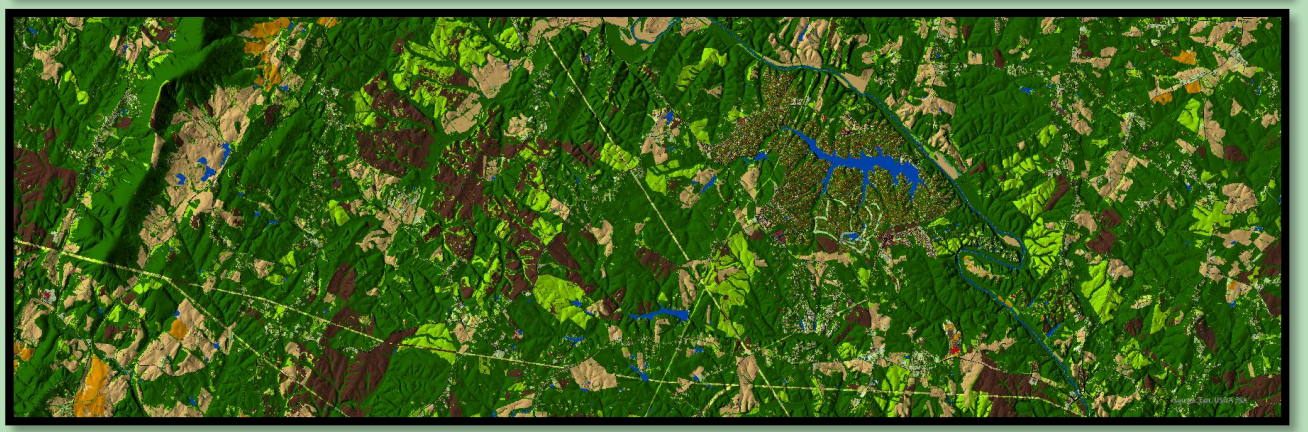
- 40% of the developed area is impervious (e.g., roads, structures, parking lots, solar panels, surface mines)
- 60% of the developed area is pervious (e.g., turf grass, trees over turf grass, transmission line and road rights of way, landfills)



Agriculture

7,868,667 acres (19% of watershed land area)

- 50% of the agricultural area is cropland (e.g. corn, soybeans, orchards, vineyards)
- 50% of the agricultural area is pasture and hay (e.g., lands used for grazing livestock or producing fodder)



Natural

27,456,881 acres (68% of watershed land area)

- 85% of the natural area is forests outside of wetlands
- 9% of the natural area is successional lands (e.g. timber harvest regrowth)
- 4% of the natural area is forested wetlands
- 2% of the natural area is non-forested wetlands

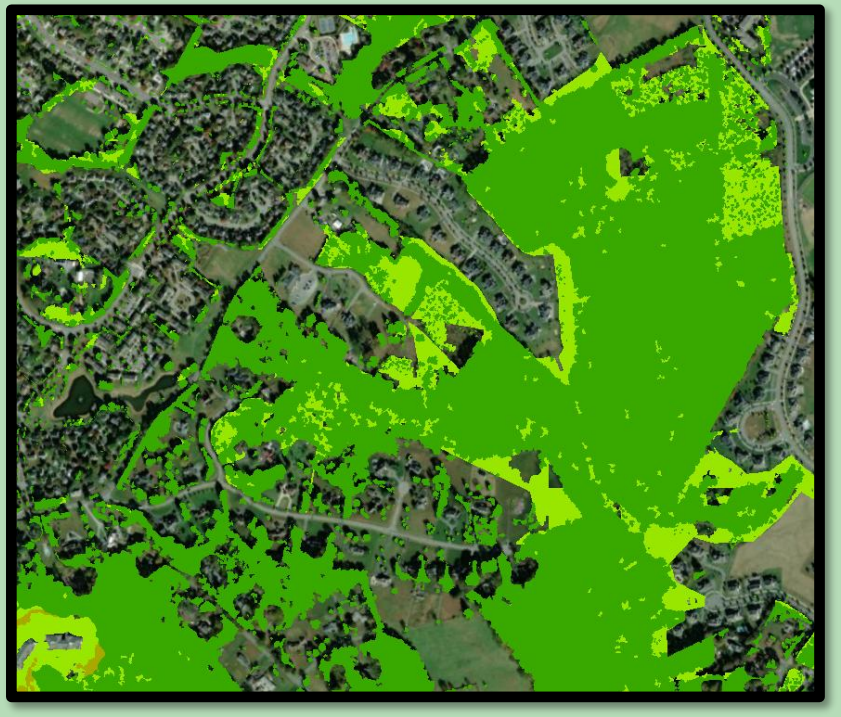
Defining Tree Canopy and Forested Extent

Tree Cover

Tree canopy is deciduous and evergreen woody vegetation of either natural succession or human planting that is over approximately 3 meters in height.

All tree canopy regardless of understory conditions. Includes land uses: tree canopy over turf, tree canopy over impervious, forest, and forested other.

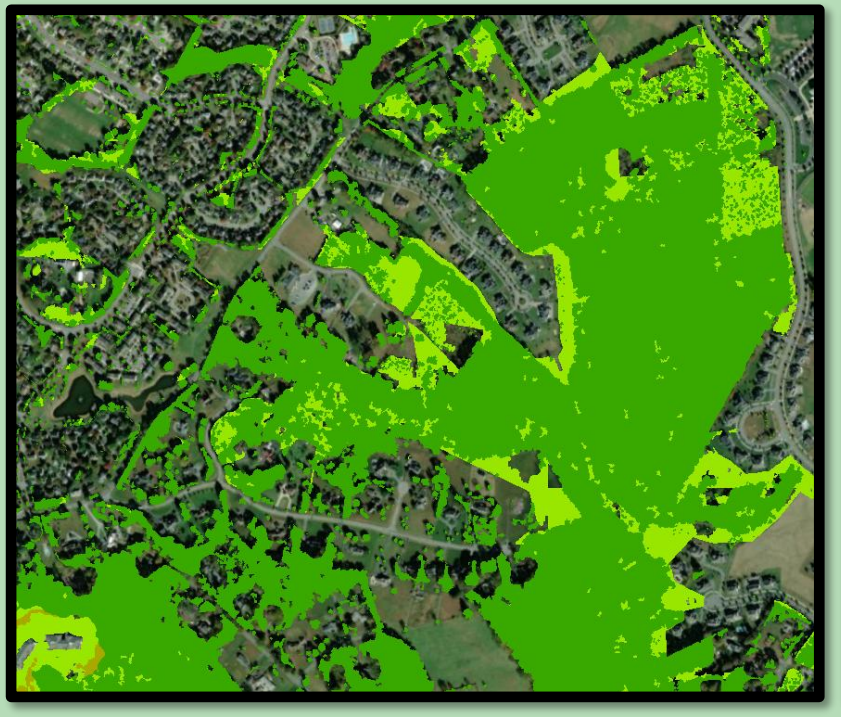
Forested Extent



Tree canopy with an unmanaged understory (i.e. forest) and early successional forests, including recently harvested areas and areas undergoing natural succession

Tree Cover and Forested Extent

Forested Extent



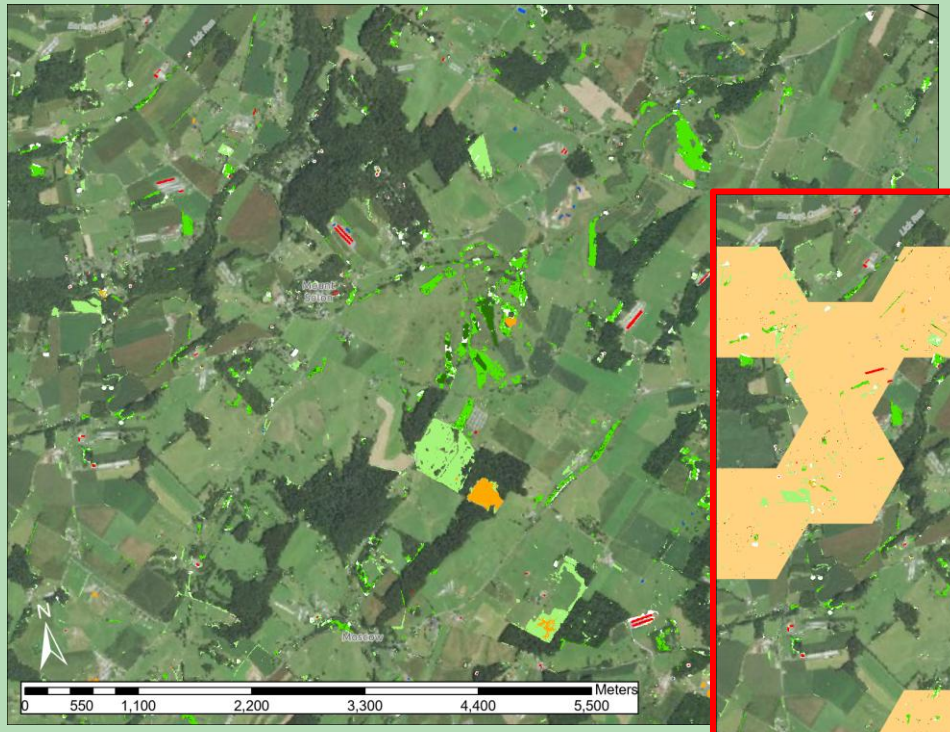
Tree canopy with an unmanaged understory (i.e. forest) and early successional forests, including recently harvested areas and areas undergoing natural succession.

Tree Cover

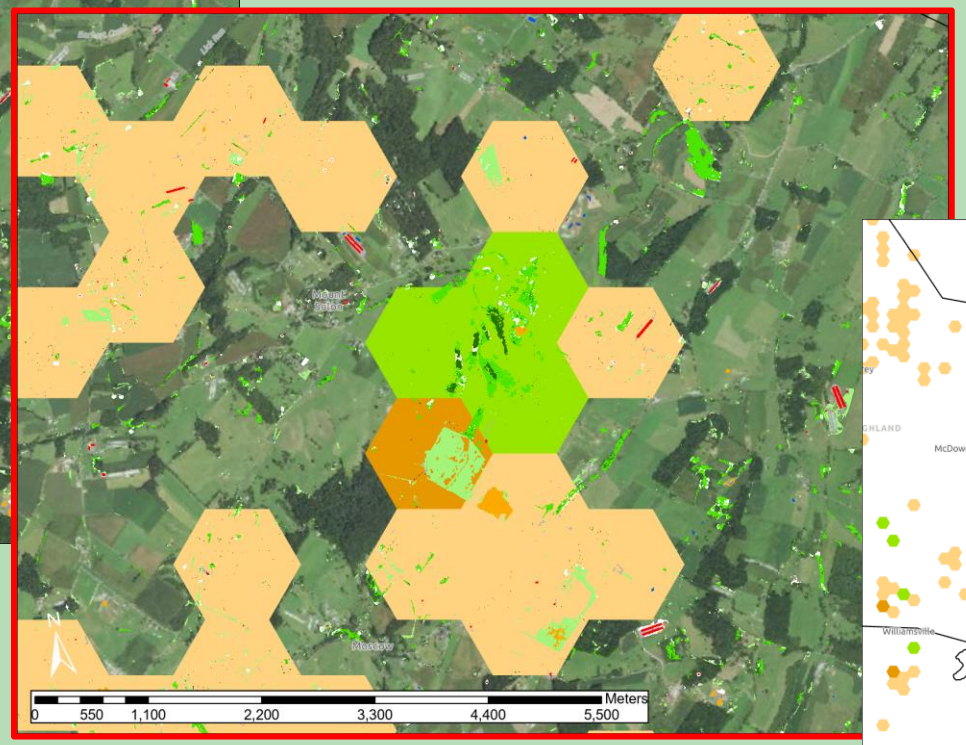
All tree canopy cover including tree canopy over turf, tree canopy over impervious, and tree canopy in forested areas.

State	% Total tree cover	% Total forested extent
DC	34.8%	23.3%
DE	43.5%	45.9%
MD	49.4%	50.1%
NY	62.9%	68.3%
PA	63.6%	68.0%
VA	64.0%	70.0%
WV	74.7%	79.0%
CBW	**62.0%**	**66.5%**

Visualizing Tree Cover Change Spatial Patterns

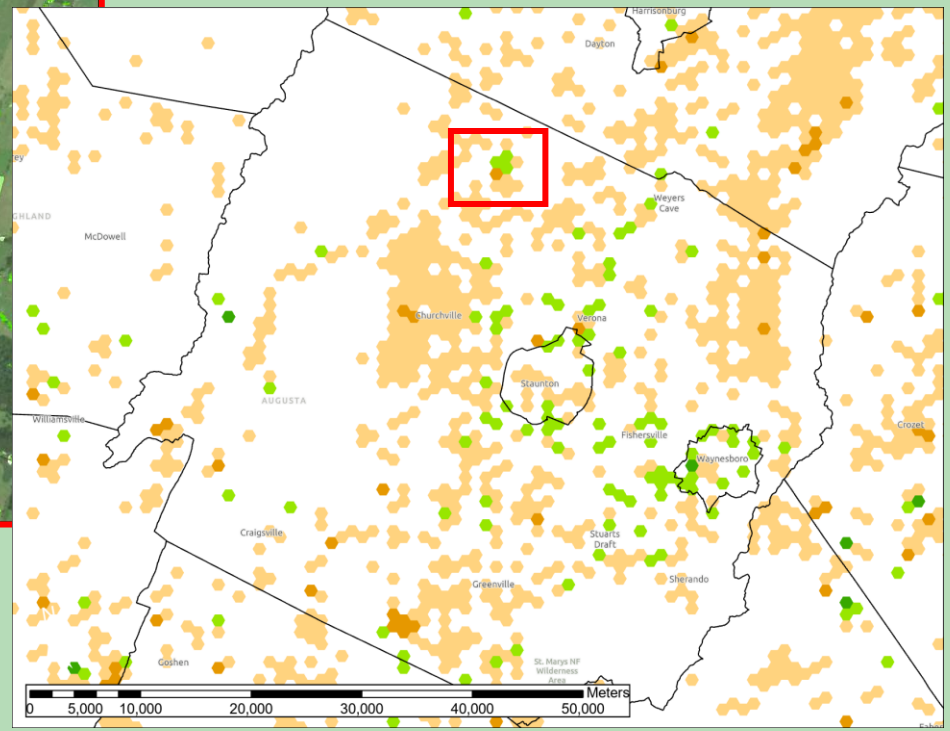


1. Map Land Use/Land Cover Change

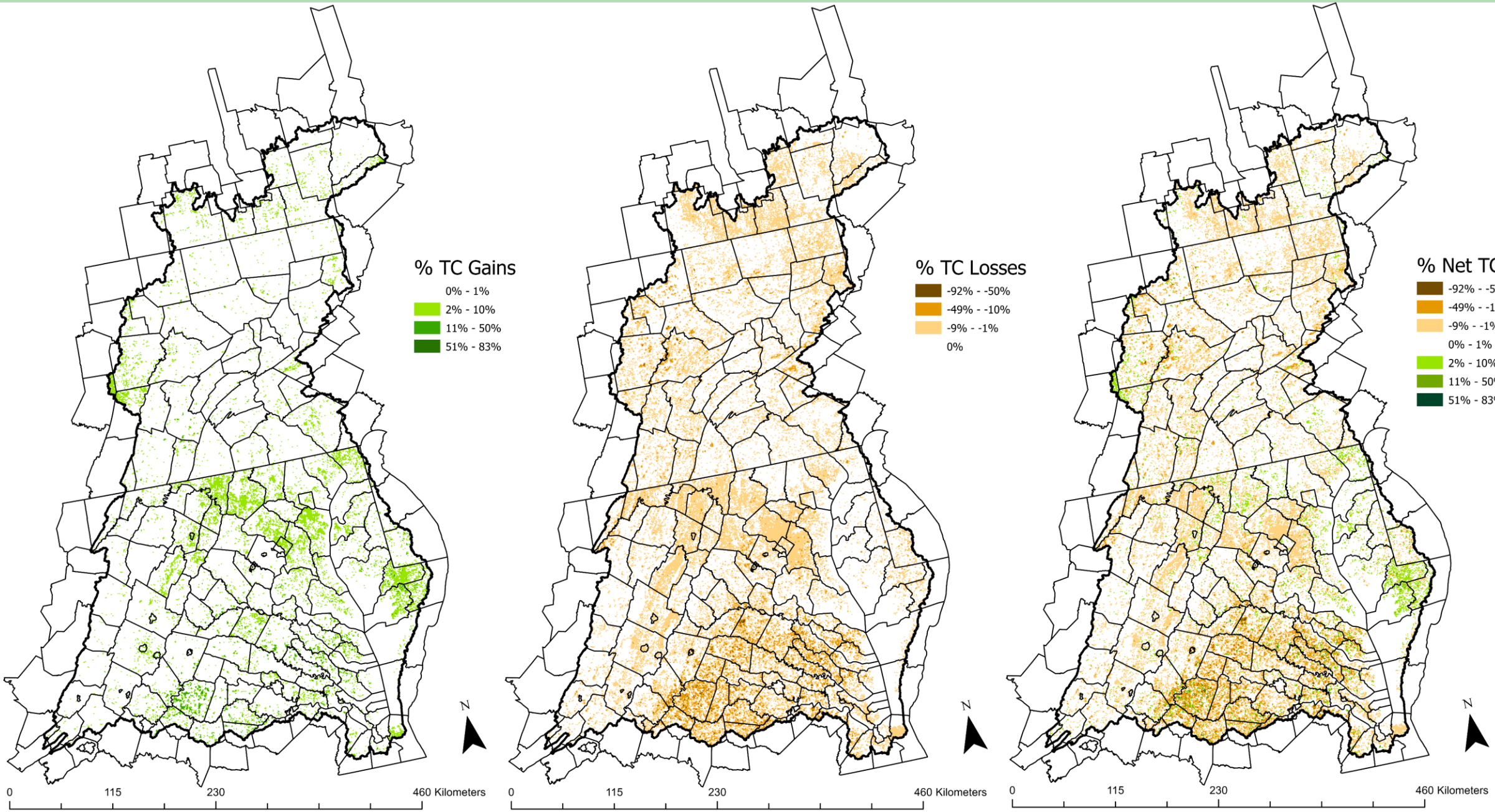


2. Summarize Land Use/Land Cover Change by 1 km^2 hexagons

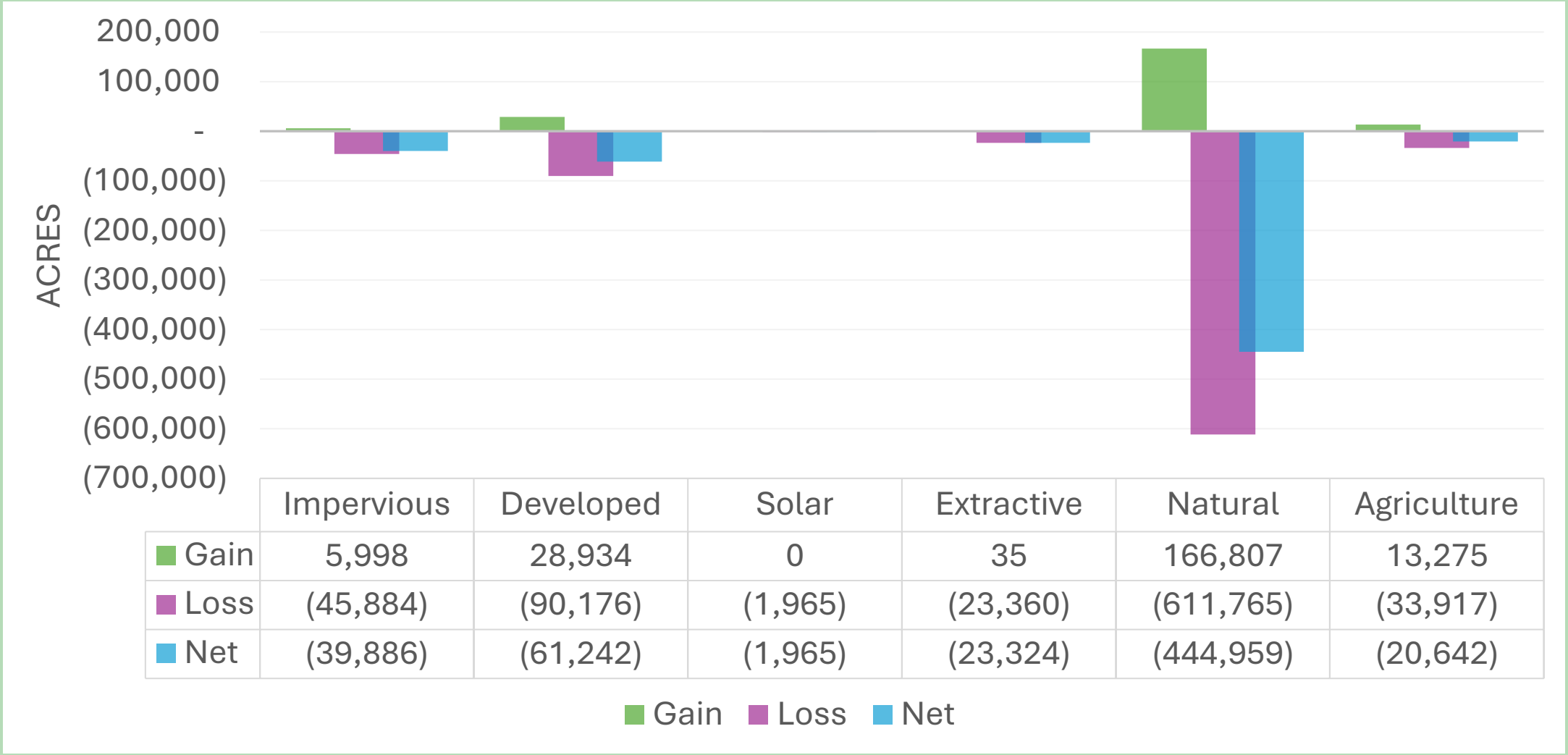
3. Visualize and explore spatial patterns using equal-area hexagons



Tree Cover Change Spatial Patterns



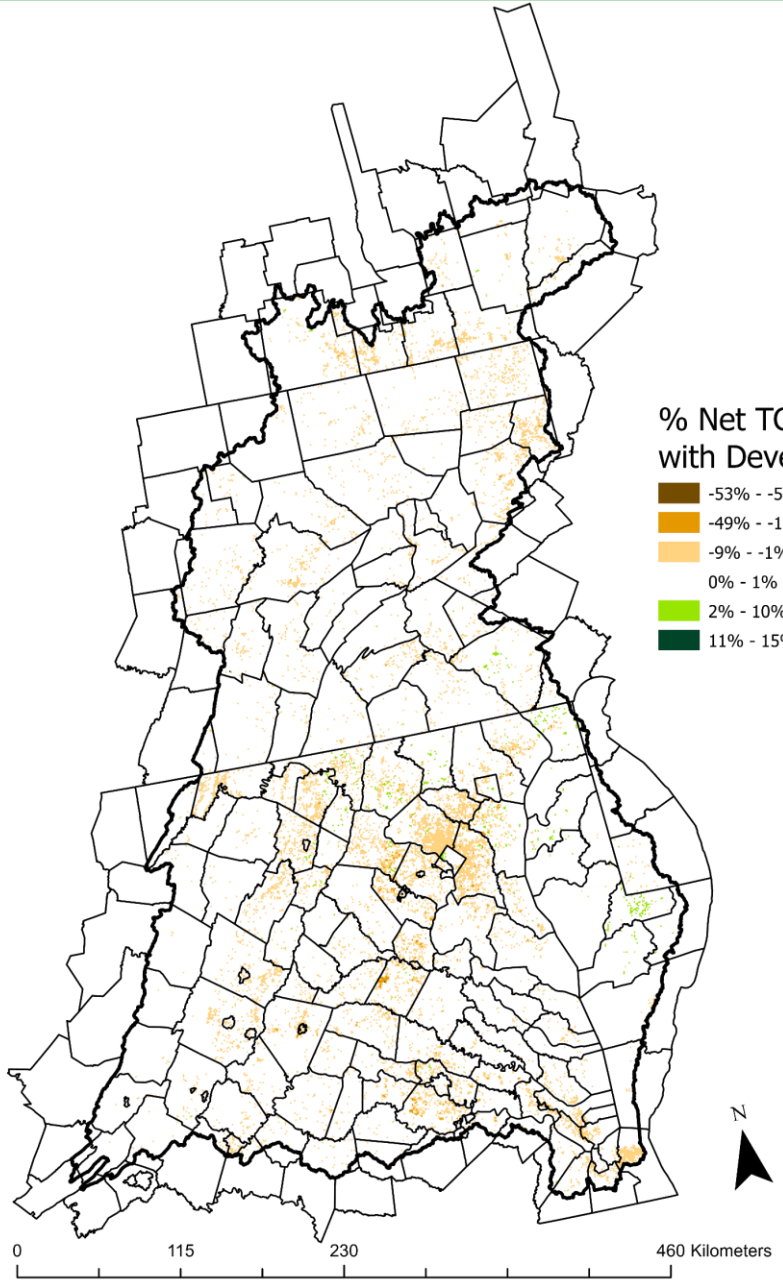
Tree Cover Change by Land Use

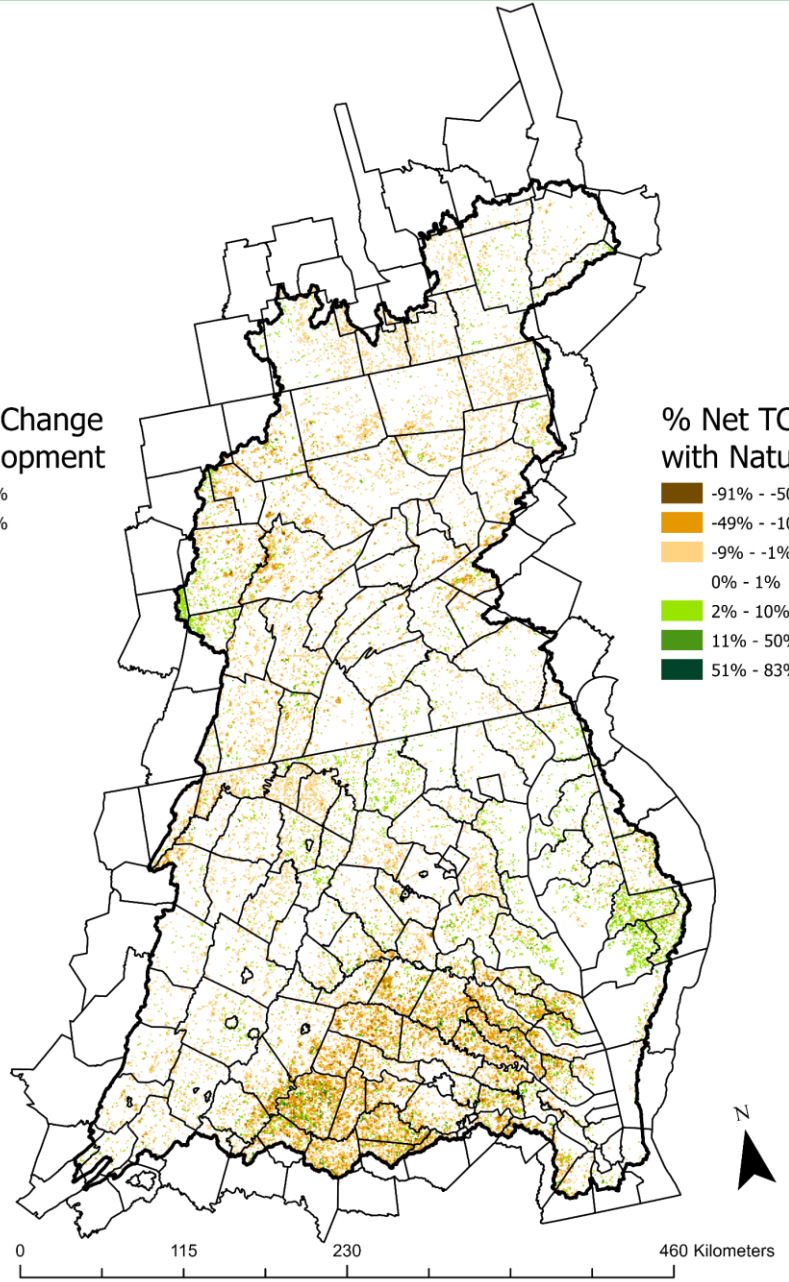


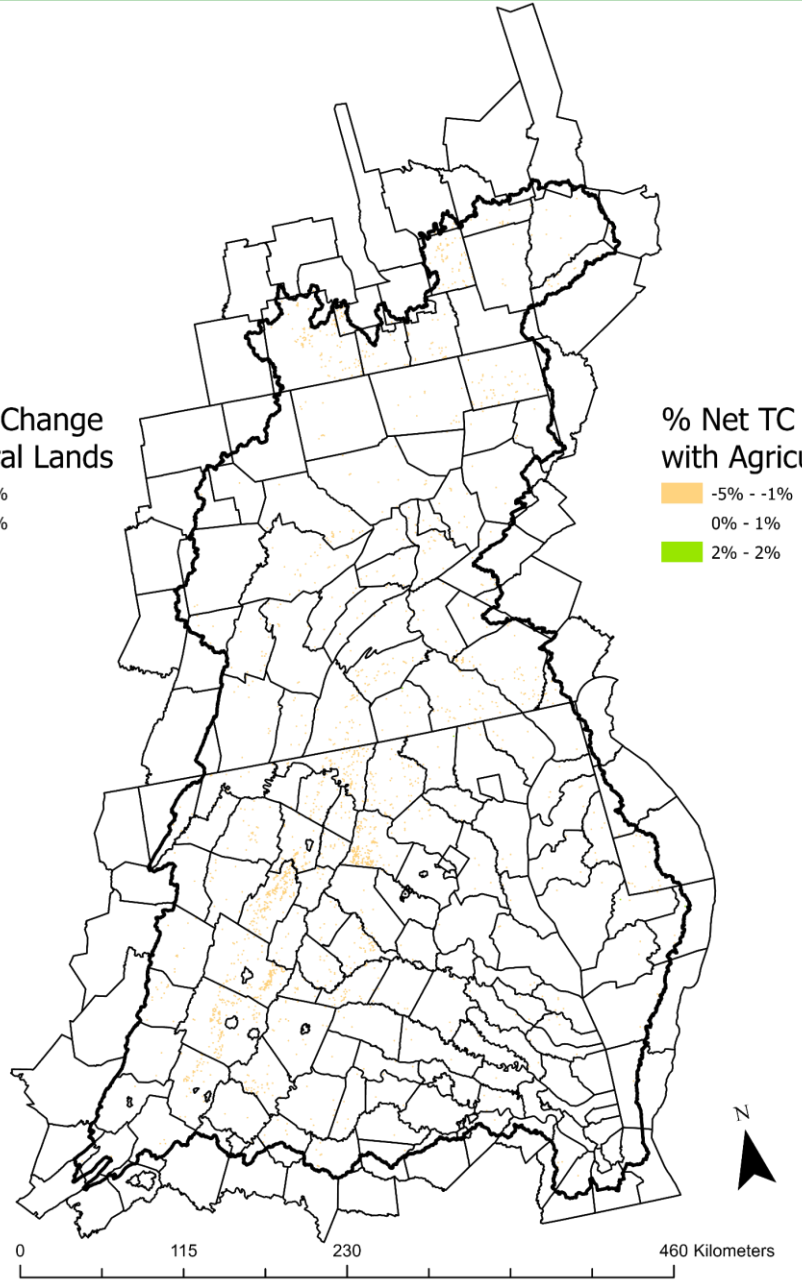
	Impervious	Developed	Solar	Extractive	Natural	Agriculture
Gain	5,998	28,934	0	35	166,807	13,275
Loss	(45,884)	(90,176)	(1,965)	(23,360)	(611,765)	(33,917)
Net	(39,886)	(61,242)	(1,965)	(23,324)	(444,959)	(20,642)

* Developed is pervious development (e.g. turf grass, road rights of way)

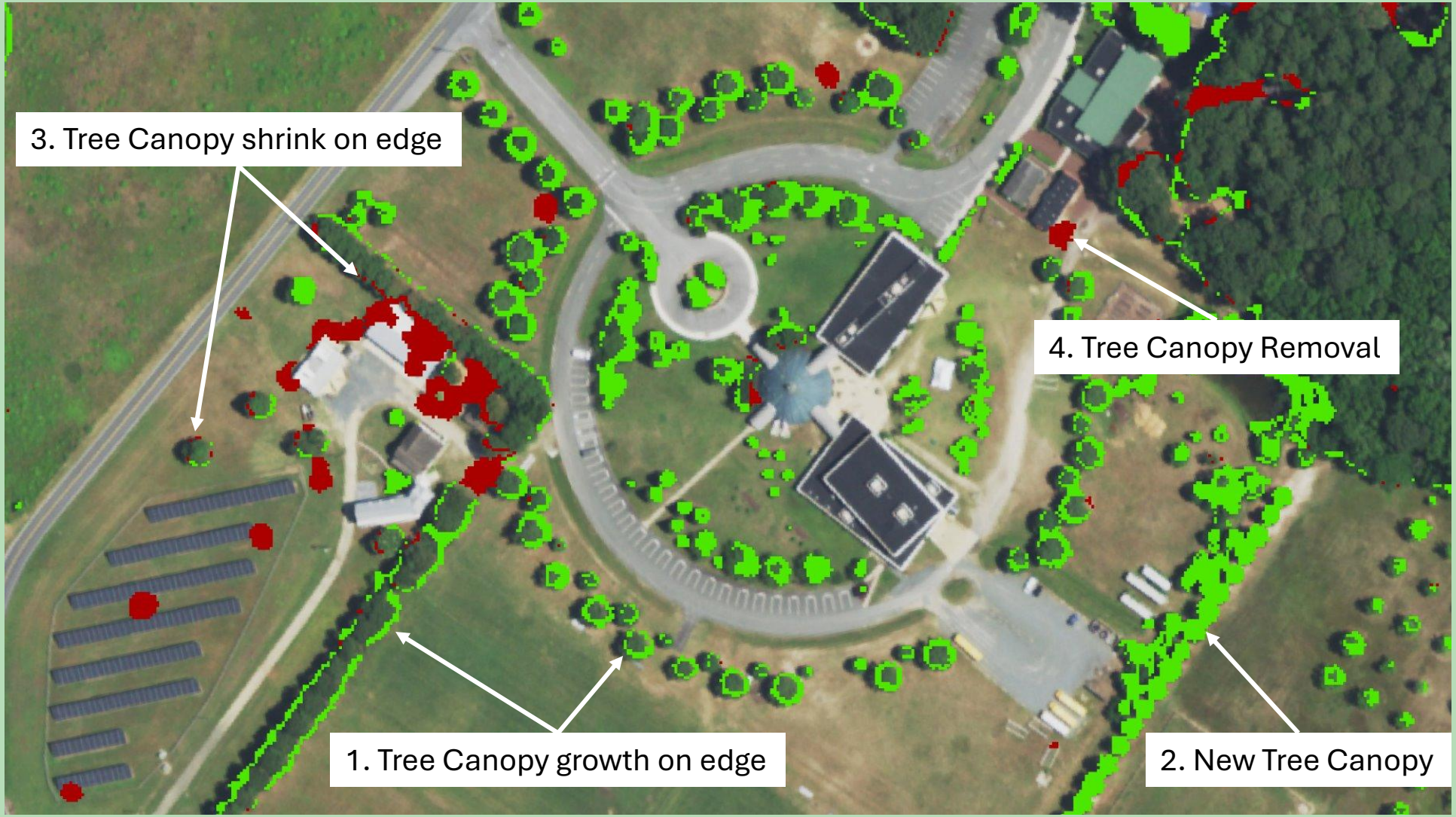
Tree Cover Change Patterns By Change Type







Planned Improvements to Tree Cover Change Reporting

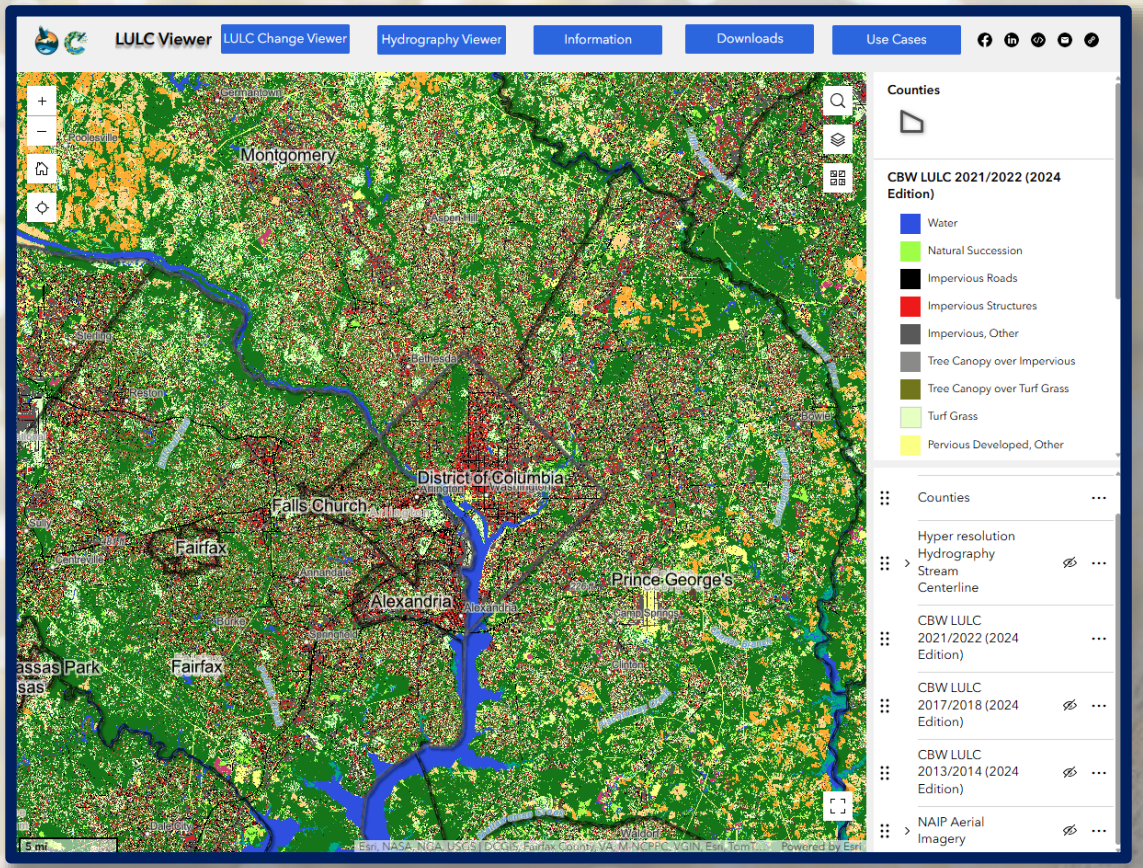


- Instead of canopy gains, losses and net change…
  1. Tree canopy growth on edge
  2. New Tree Canopy
  3. Tree Canopy shrink on edge
  4. Tree Canopy removal
- Are there other ways to make this data more actionable?

Thank you!

Check out the 2024 Edition LULC data release and the Chesapeake Conservancy's LULC Viewer:

[High Resolution Data Viewer Application]



[Data Release]