



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

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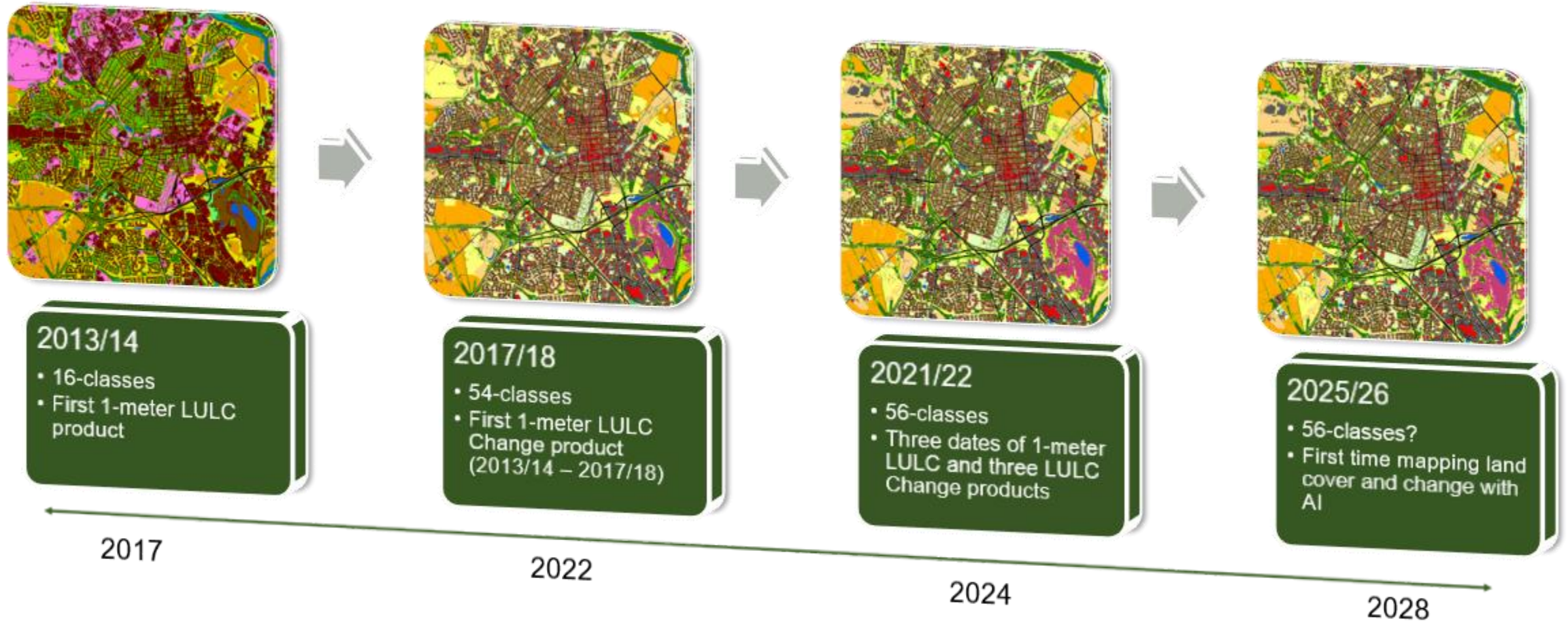
² Chesapeake Conservancy's Conservation Innovation Center

³ University of Vermont's Spatial Analysis Laboratory

Chesapeake Bay Program Webinar
June 25, 2025

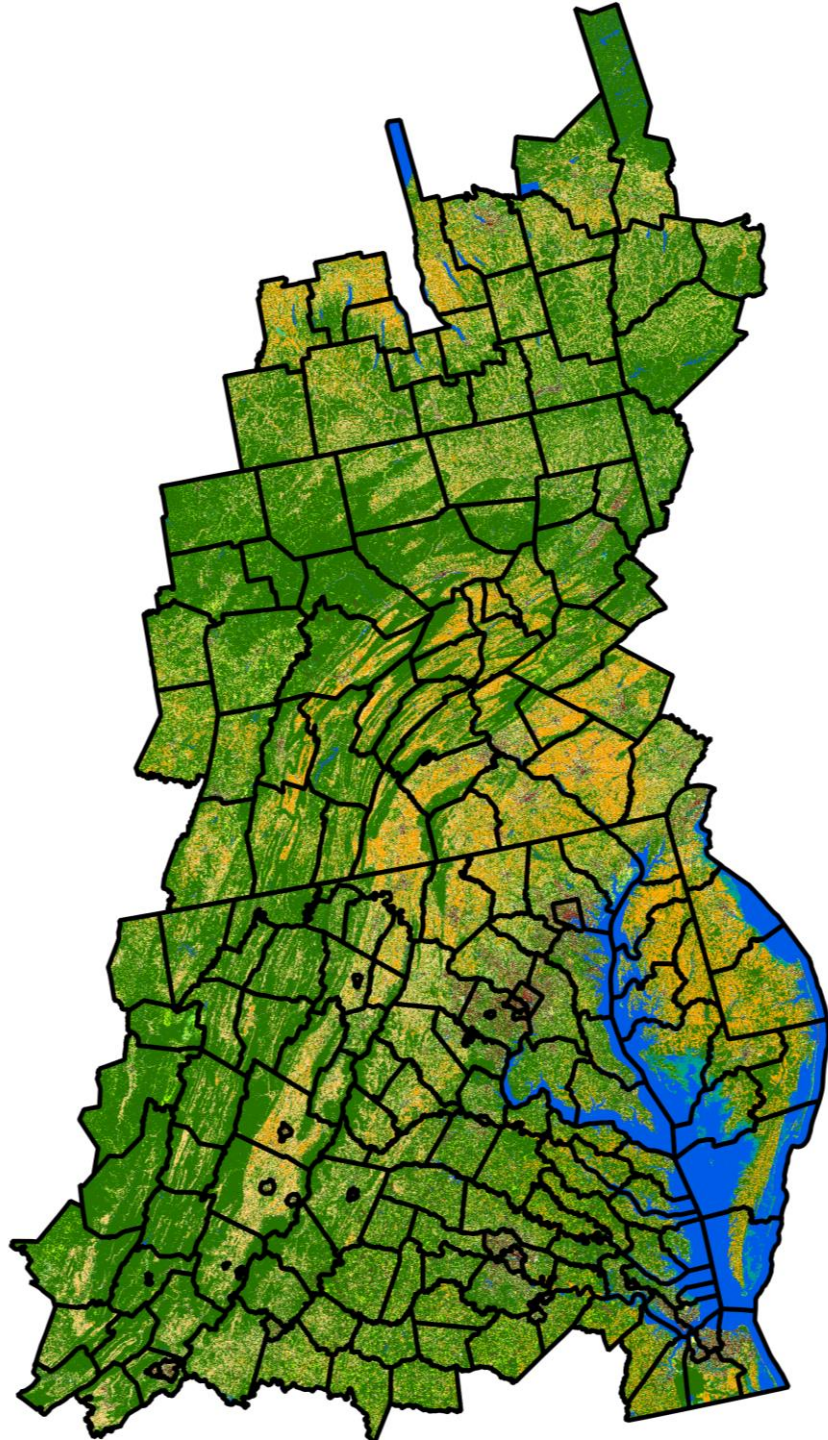


Chesapeake Bay Program Land Use/Land Cover (LULC) Project: A Brief History



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-meter² cells
- Temporal Resolution
 - 2013/14, 2017/18, 2021/22
- Categorical Resolution
 - 56 Land Use/Land Cover classes

Why Monitor Land Use/Land Cover?

High Pollution:
Impervious Surfaces

Assess sources of pollution to the Bay

Highest Pollution:
Cropland

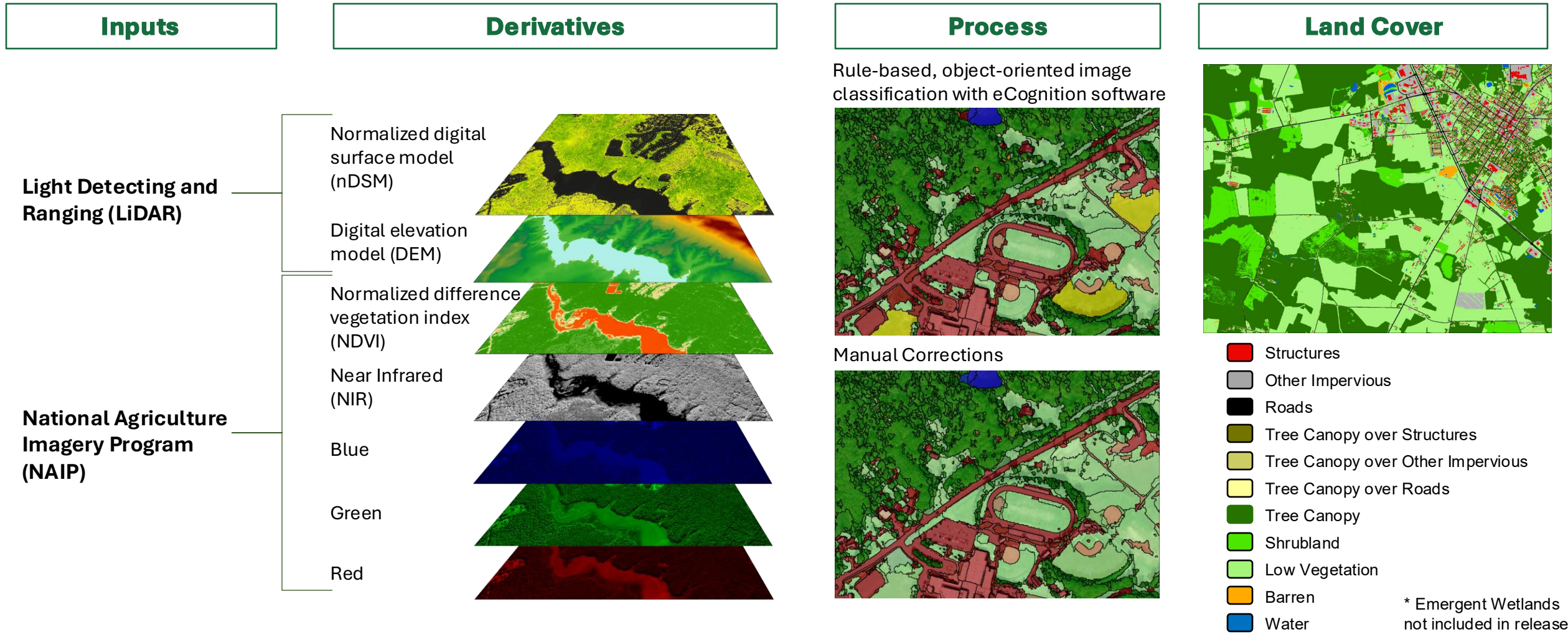
Lowest Pollution:
Forest & Wetlands

Although designed to monitor impacts of land use on water quality, the Chesapeake Bay Program also uses the data to report:

1. Impervious cover
2. Farmland conversion
3. Forest land conversion
4. Wetland conversion
5. Riparian dynamics

What is Land Cover?

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

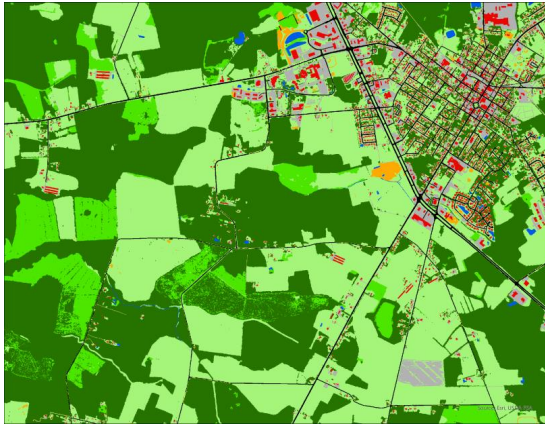


What is Land Use?

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

Inputs*

Land Cover



Timber Harvest



Parcels



Cropland Data Layer (CDL)

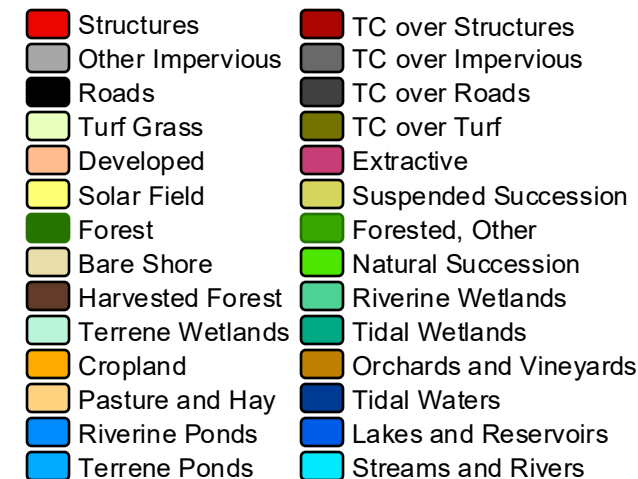
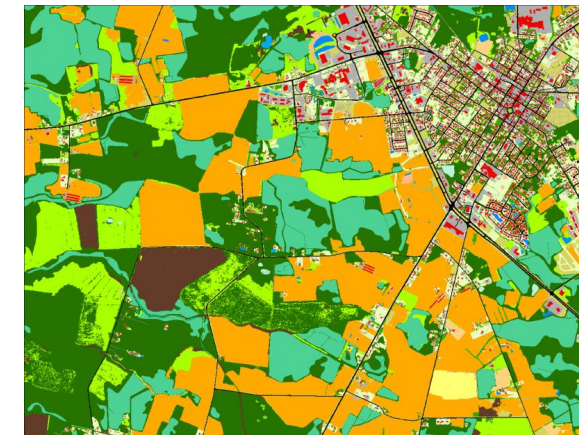


Process

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



Land Use

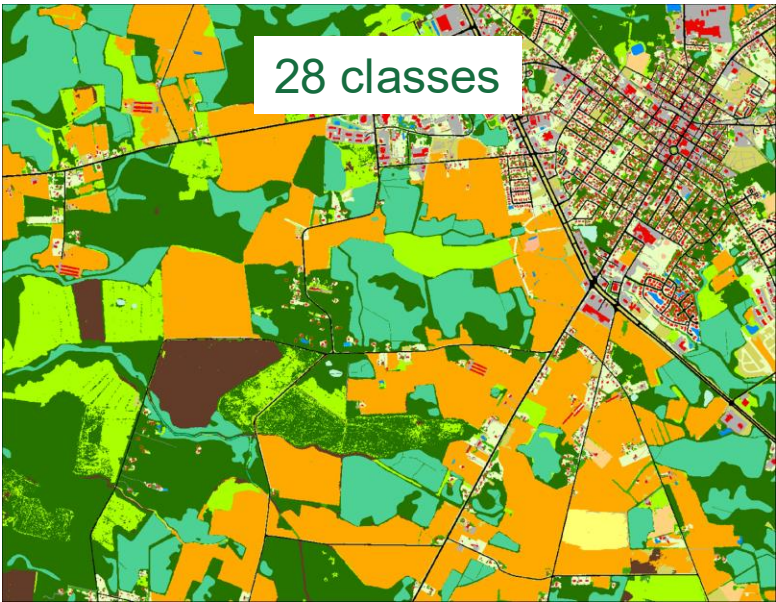


* Subset of inputs shown (over 25 ancillary datasets used)

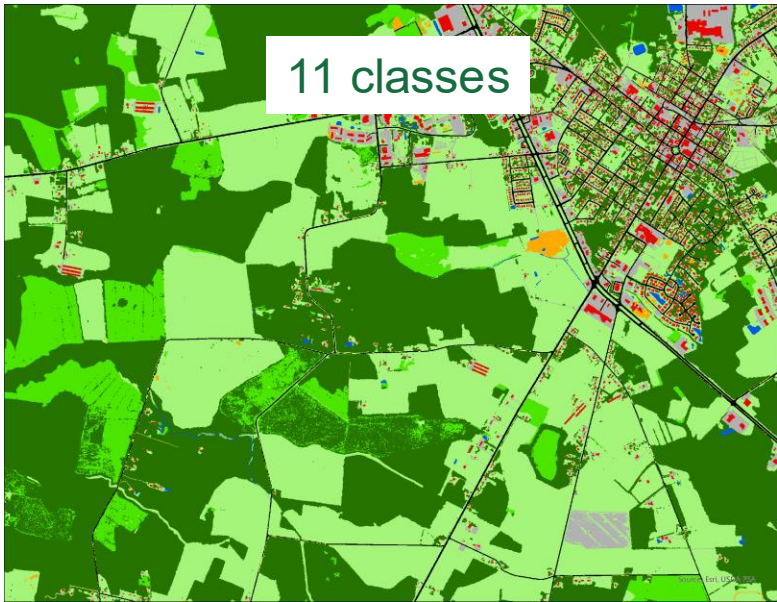
What is Land Use/Land Cover (LULC)?

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

Land Use



Land Cover



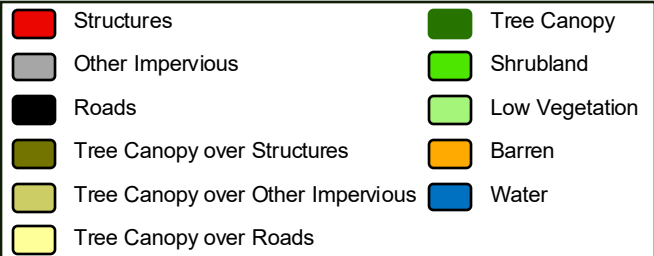
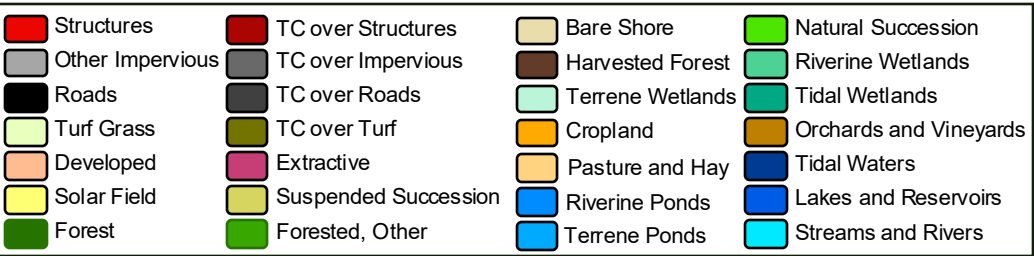
Land Use / Land Cover

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

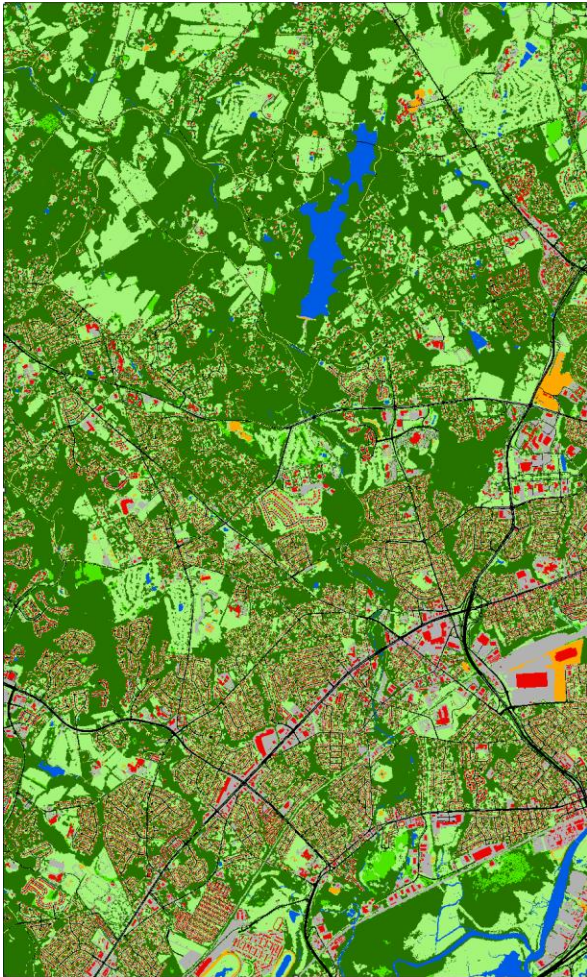
Tidal Waters
Lakes and Reservoirs
Riverine Ponds
Terrene Ponds
Streams and Rivers

Natural

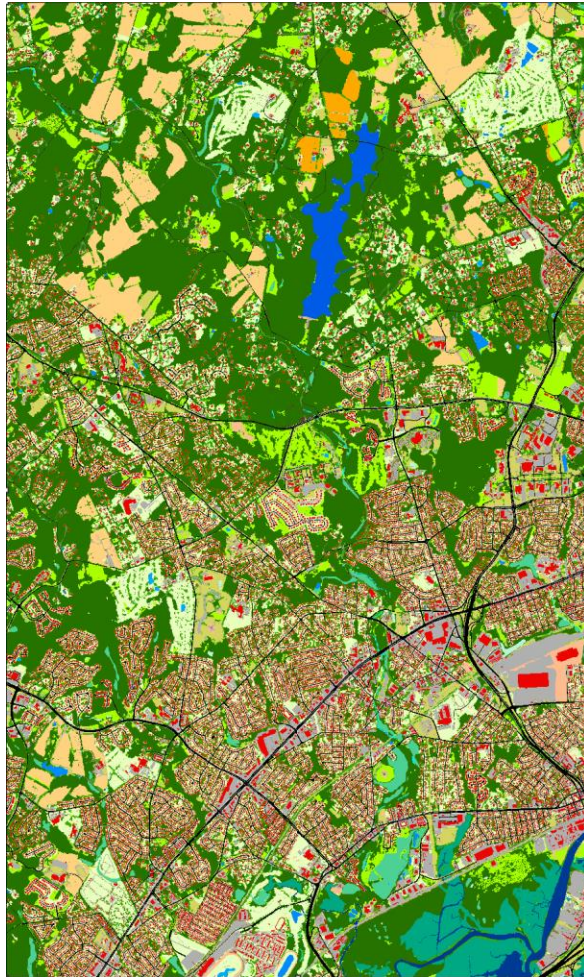
Forest
Riverine Wetlands Forest
Terrene Wetlands Forest
Tidal Wetlands Forest
Forested, Other
Riverine Wetlands Tree Canopy
Terrene Wetlands Tree Canopy
Tidal Wetlands Tree Canopy
Natural Succession Barren
Natural Succession Herbaceous
Natural Succession Shrubland
Bare Shore
Harvested Forest Barren
Harvested 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

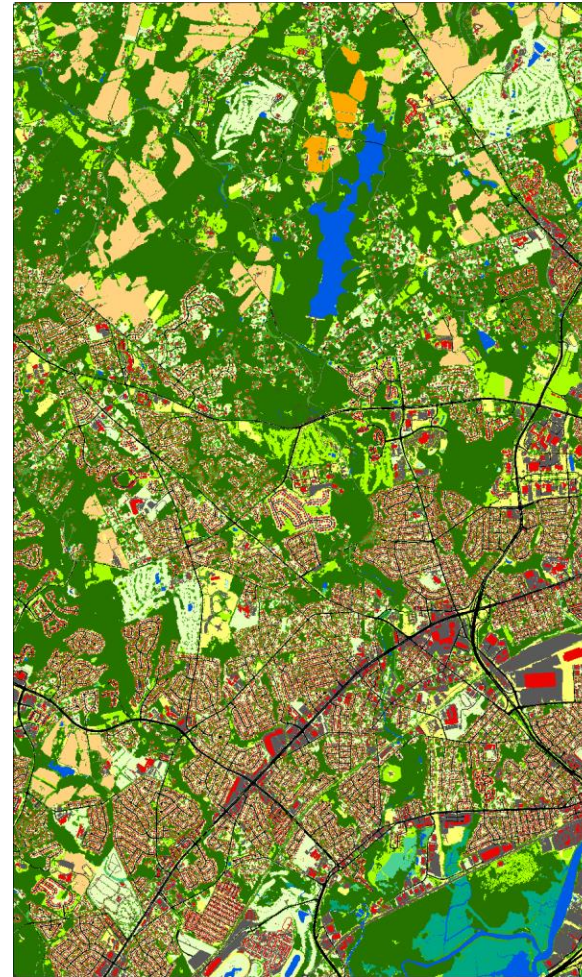
Land Cover (11)



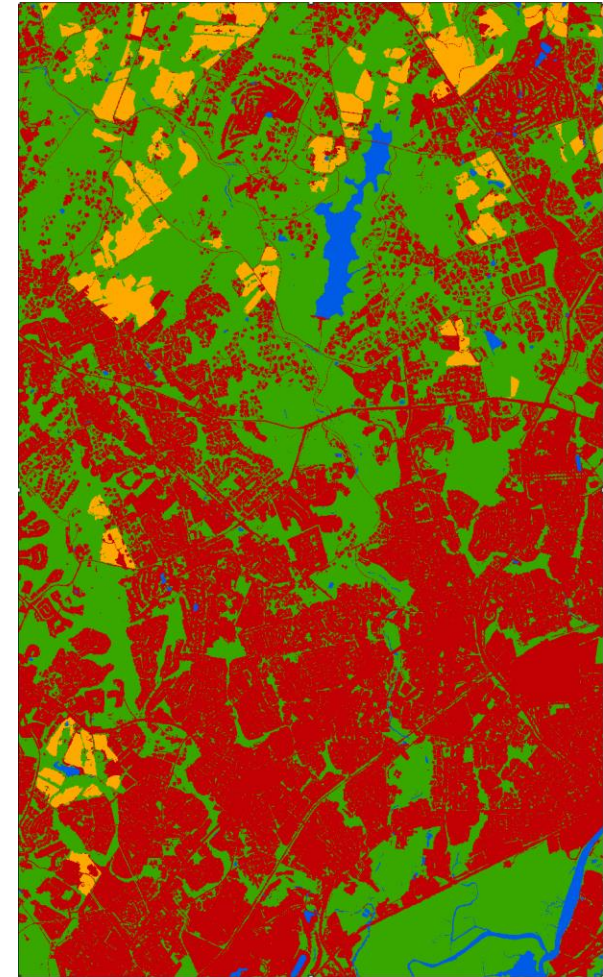
Land Use (28)



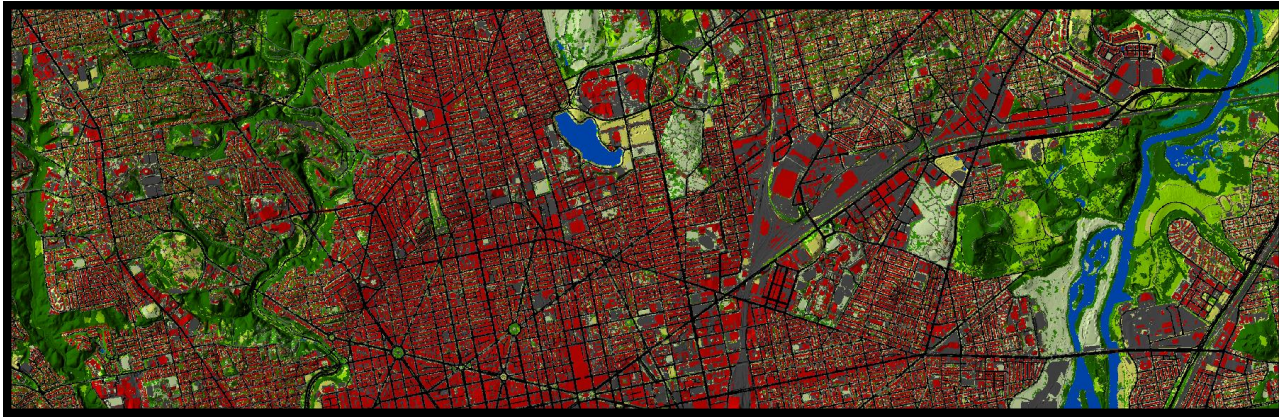
General Land Use (18)



Macro Land Use (4)



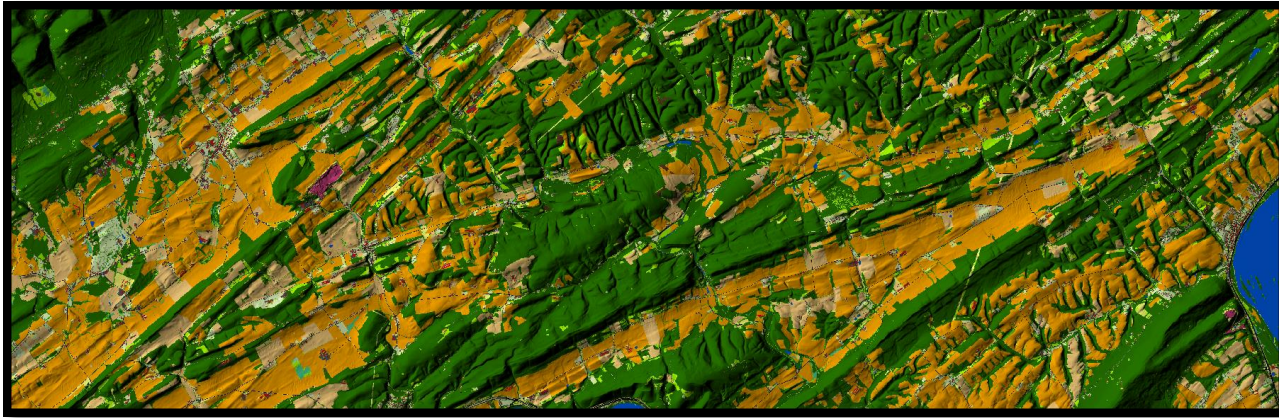
Land Use/Land Cover in the Chesapeake Bay Watershed 2021/22



Development

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

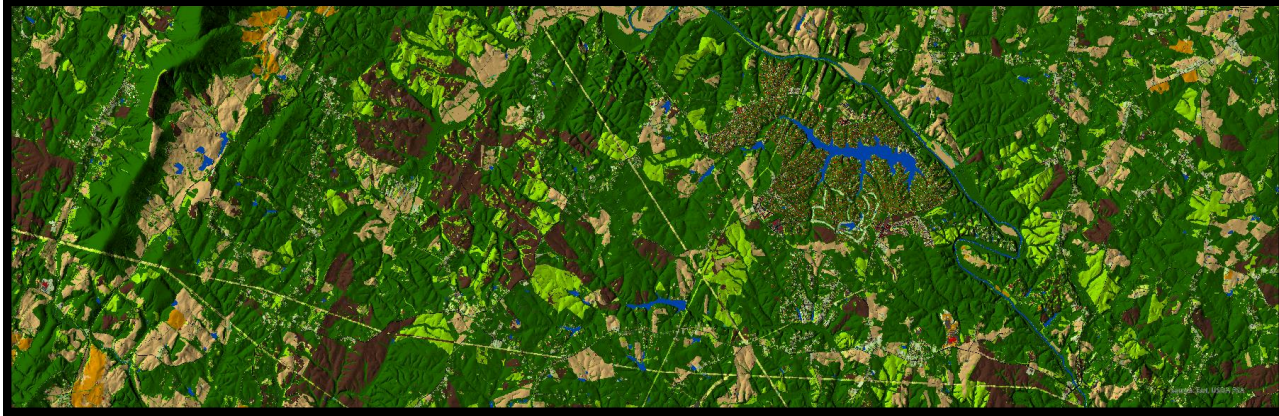
- 40% of the developed area is impervious (e.g., roads, structures, parking lots, solar panels, surface mines)
- 60% of the developed area is pervious (e.g., turf grass, trees over turf grass, transmission line and road rights of way, landfills)



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

Land Use/Land Cover Change Trends in the Chesapeake Bay Watershed 2013/14 – 2021/22

Timber Harvesting

Largest acreage change in the watershed

- 585,004 acres of forest transitioned to a successional state (i.e. harvested forest and natural succession)
- 150,812 acres of successional lands came back to forest

Buckingham, Virginia has the highest net forest “loss” of the counties in the watershed – **BUT** the net change lacks the context of the *nature of the change*

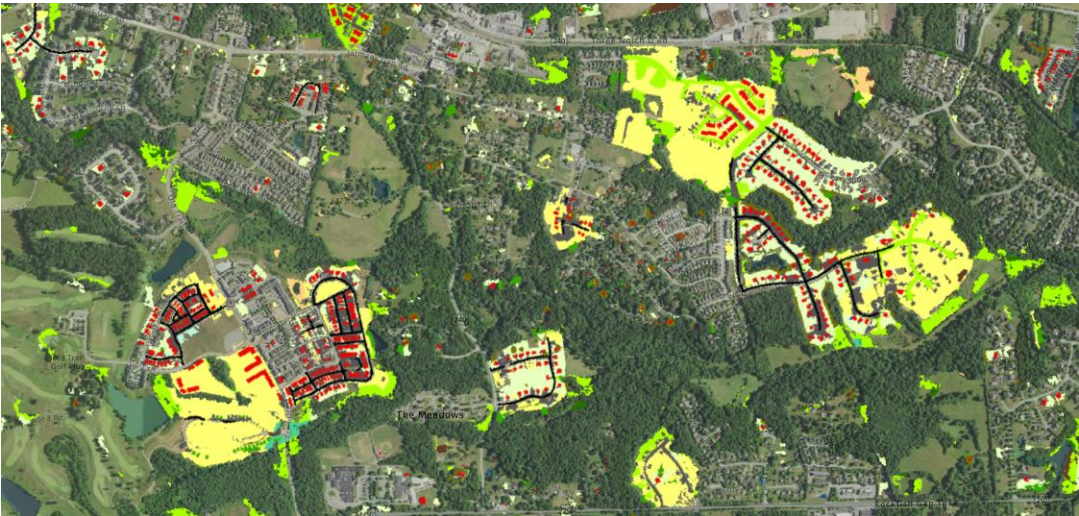
Development

Second largest acreage change in the watershed

- 105,192 acres of land converted to impervious
- 39,110 acres of land converted to turf grass

Crozet, Virginia is the town with the greatest decrease in tree canopy per acre– **BUT** the mapped change only explains the what, where and how much. Local context is necessary to answer questions such as, *why did this change occur? What are the impacts of this change?*

	Developed	Forest	Succession	Agriculture	Wetland	Water
Development	-	85	968	34	1	10
Forest	730	-	39,815	176	72	27
Succession	332	14,494	-	95	15	28
Agriculture	127	26	629	-	-	10
Wetland	0	28	0	-	-	1
Water	12	11	16	1	1	-
Increase	1,202	14,643	41,429	306	89	76
Decrease	1,098	40,820	14,965	792	29	41
Net Change	104	(26,177)	26,464	(487)	60	35



Static Accuracy

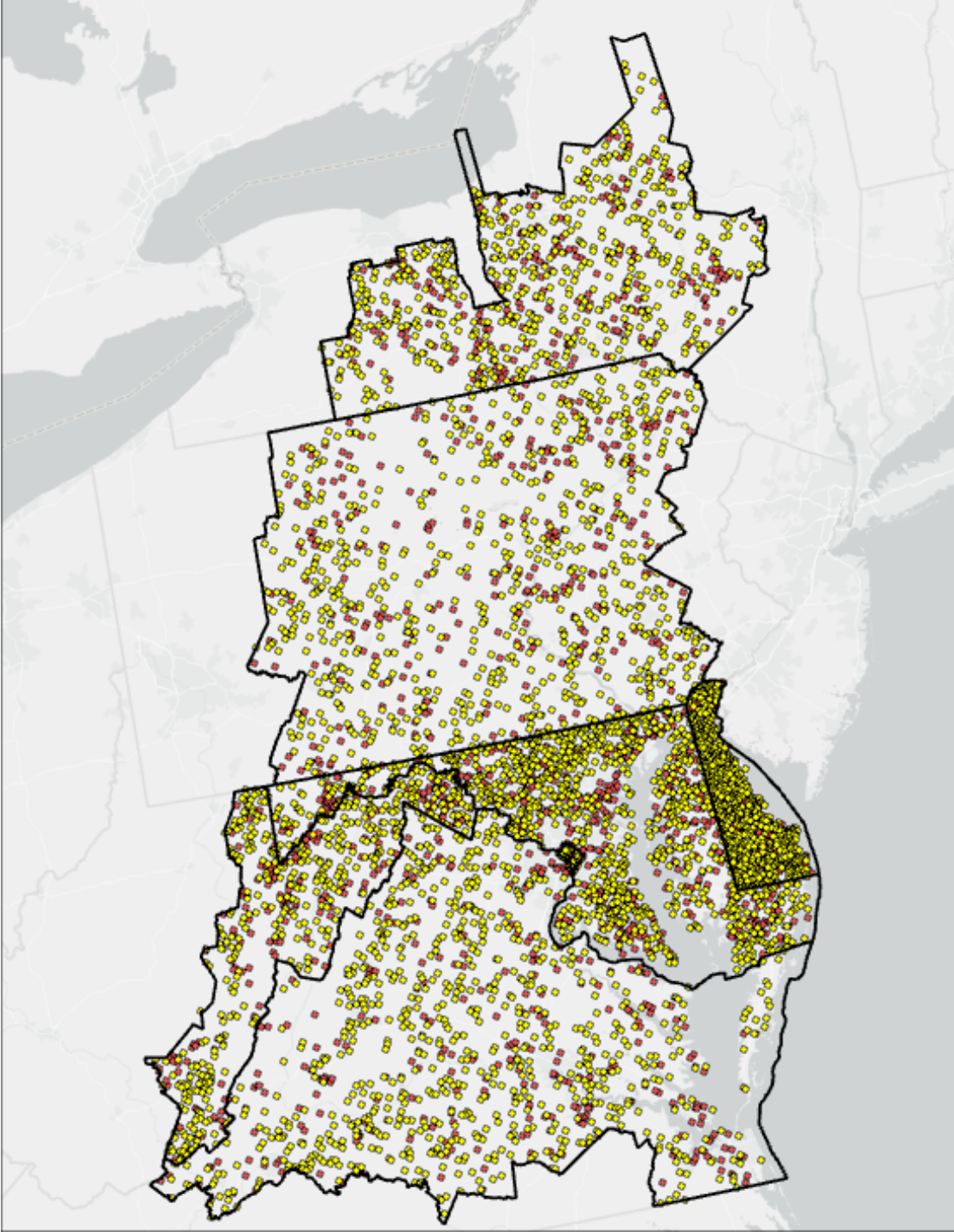
- Sampled 7,000 points across the mapped region to assess the accuracy of the land cover.
- About 96% of the region is static (i.e. was not mapped as land cover change between 2013/14 and 2021/22)

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

Water	Herbaceous	Tree Canopy	Impervious	Barren
Water	Low Vegetation	Tree Canopy	Structures	Barren
	Shrubland	TC over Structures	Other Impervious	
	Emergent Wetlands	TC over Other Impervious	Roads	
		TC over Roads		



Change Accuracy

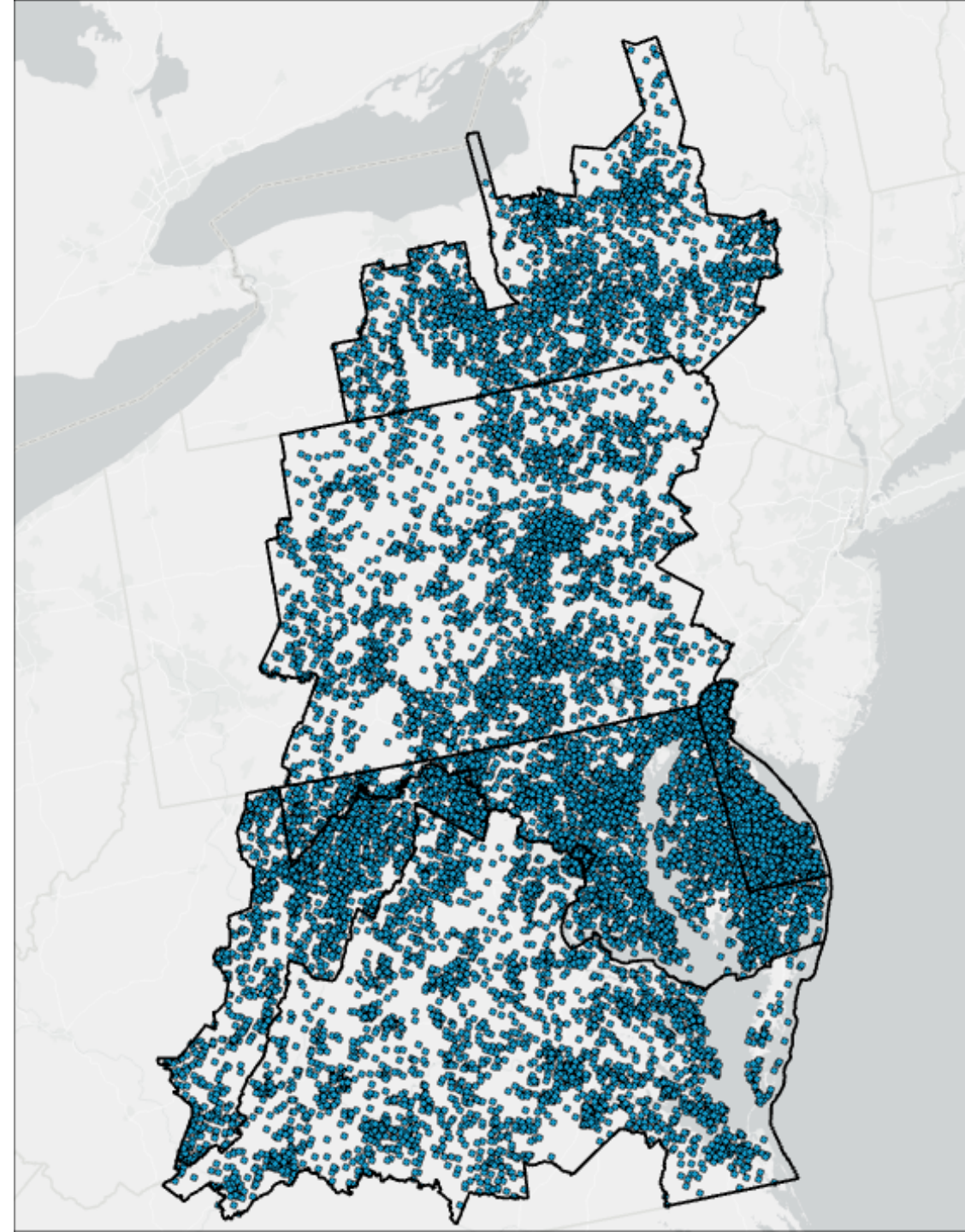
- Sampled over 23,000 points of mapped land cover change
- About 4% of the mapped region was mapped as land cover change between 2013/14 and 2021/22

Overall Accuracy**: 86%

Producer's: 96%

User's: 77%

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





Technical Study on Changes in Forest Cover and Tree Canopy in Maryland

November 2022



Harry R. Hughes
CENTER FOR AGRO-ECOLOGY



COLLEGE OF
AGRICULTURE &
NATURAL RESOURCES



Chesapeake
Conservancy



University of Vermont
Spatial Analysis Lab

SENATE BILL 526

M1

3lr1713
CF HB 723

By: **Senators Elfreth, Guzzone, Gile, Hester, Kramer, Lam, Hettleman, M. Washington, West, and Zucker**

Introduced and read first time: February 3, 2023

Assigned to: Education, Energy, and the Environment

Committee Report: Favorable with amendments

Senate action: Adopted

Read second time: March 19, 2023

The most significant changes in the legislation include:

- Setting a statewide goal to increase the acreage of forested land and tree canopy.
- Increasing replanting requirements for developers who clear forest by requiring them to replant each acre of forest cleared in most cases. Previously, developers were only required to replace a fraction, if any, of the forested land cleared for new construction.
- Providing local governments flexible options to stop net forest loss. These alternatives are coupled with regular reviews by the state's Department of Natural Resources to ensure the local plans align with state forest protection goals.

<https://www.cbf.org/news-media/newsroom/2023/maryland/historic-forest-preservation-legislation-approved-by-maryland-general-assembly.html>

Supported the reauthorization of the forest conservation act in Maryland

Tree Cover Status & Change

FOR CUMBERLAND COUNTY, PA

41.6%

Total Percent of
County with Tree Cover

\$14+ Million

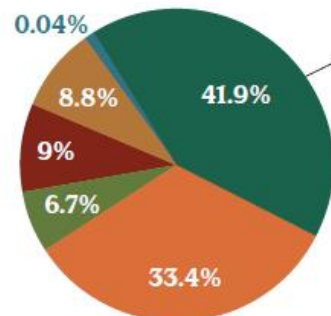
Annual Benefits provided by Tree Cover
(in reduced air pollution, stormwater, & carbon dioxide)

433 Acres

Net Loss of Tree Cover on
Developed Lands, 2013 to 2017

What is the land use/land cover breakdown in your county?

341,668 ACRES OF LAND AREA
IN CUMBERLAND COUNTY



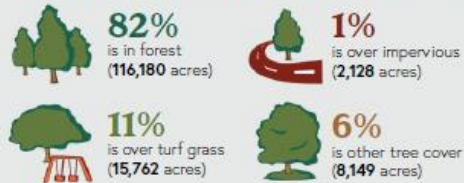
41.9% Tree Cover ¹ 142,219 acres	9% Impervious (Buildings/Pavement) 30,882 acres
33.4% Agriculture 113,222 acres	8.8% Other ² 29,890 acres
6.7% Turf Grass (Lawns) 22,569 acres	0.04% Non-Forested Wetlands 163 acres

1. Tree cover includes all trees occurring on all land uses, such as individual trees found over turf, impervious, agricultural, wetlands, or other lands. It also includes areas of "forest," defined in this dataset as patches of tree cover 1 acre or greater, with a minimum patch width of 240 feet.

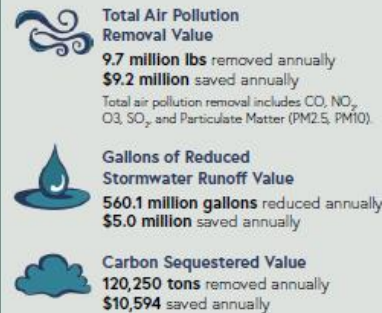
2. Other includes a mixture of non-treed land uses not captured in the main pie chart categories. See the Data Guide for detailed definitions of "other" and all the land use categories.

Land use/land cover statistics were generated using the 2022 edition of the [Chesapeake Bay Land Use and Land Cover Database](#).

Where does tree cover occur in your county?

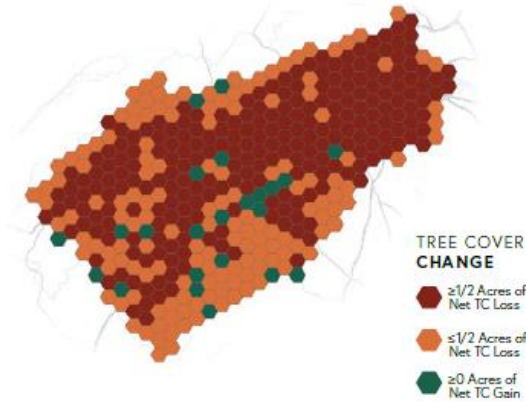


What are some benefits of tree cover in your county?



Calculated based on 2017 tree cover data using:
[landscape itreetools.org](#)

How is tree cover changing on developed and developing lands?



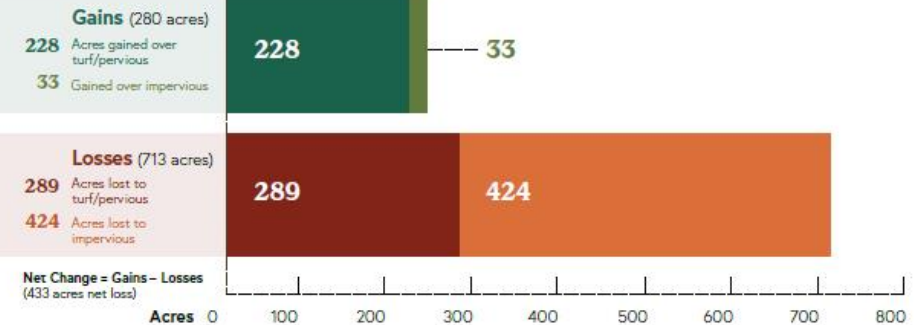
Understanding how your tree cover changes over time can inform the sustainable management of forests and community trees. The map to the left shows where your county has lost and gained tree cover from 2013 to 2017, focusing on land that is already or newly developed.

Tree cover can be lost quickly due to human activities (e.g., construction) or natural events (e.g., severe weather).

Tree cover can be gradually increased through tree planting and natural regrowth, but maintaining this new growth requires long-term investments.

Since mature, healthy trees provide significantly greater community benefits than newly planted trees, it is important to both preserve existing tree cover and seek opportunities to grow new trees and forests. Local land use planning, ordinances, and tree programs play a critical role!

Tree Cover Change on developed/developing lands (2013–2017)



Learn More: [Chesapeake Tree Canopy Network](#)
Links to county fact sheets, user guides, map viewers, datasets, and more

Tree Equity Score
Explore maps of how tree benefits are distributed across communities

Capitalizing on the Benefits of Trees
A slideshow for local leaders featuring tree benefits, case studies and resources

State Urban and Community Forestry Assistance
(State contact and website)



Fact sheets produced through a grant from the [USDA Forest Service](#). USDA is an equal opportunity provider, employer and lender.

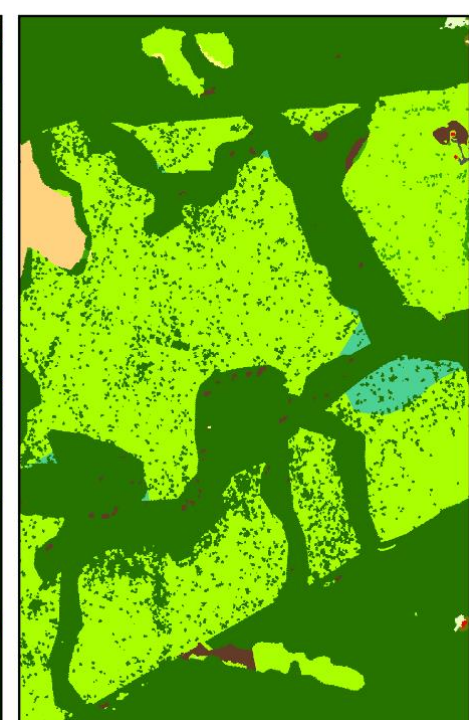
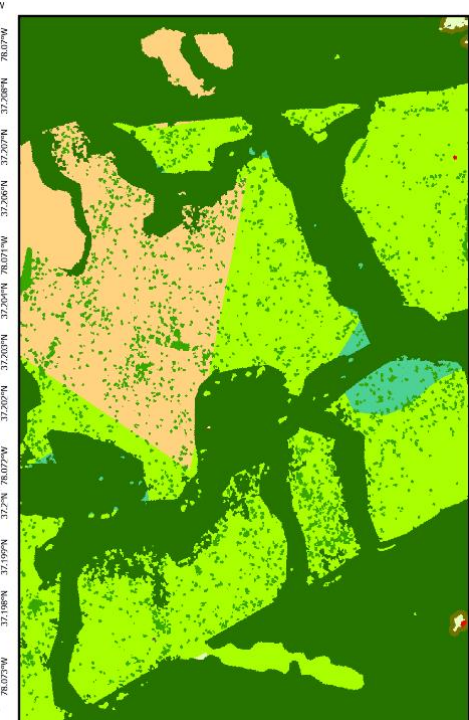
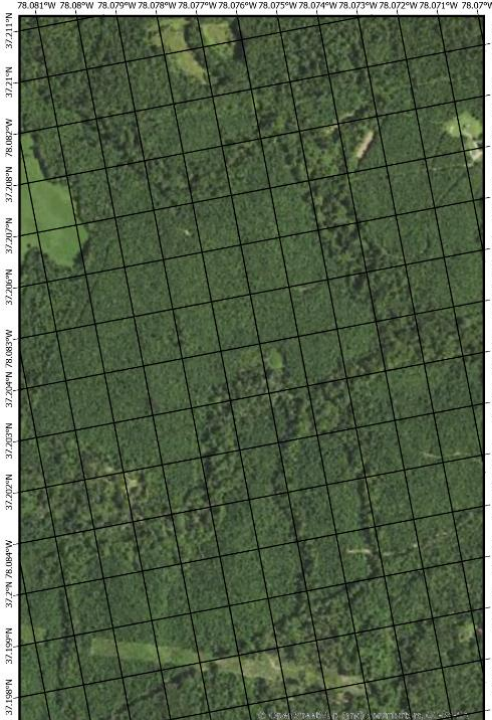
What is different in the new data?

Addressed confusion of Pasture and Hay with successional lands





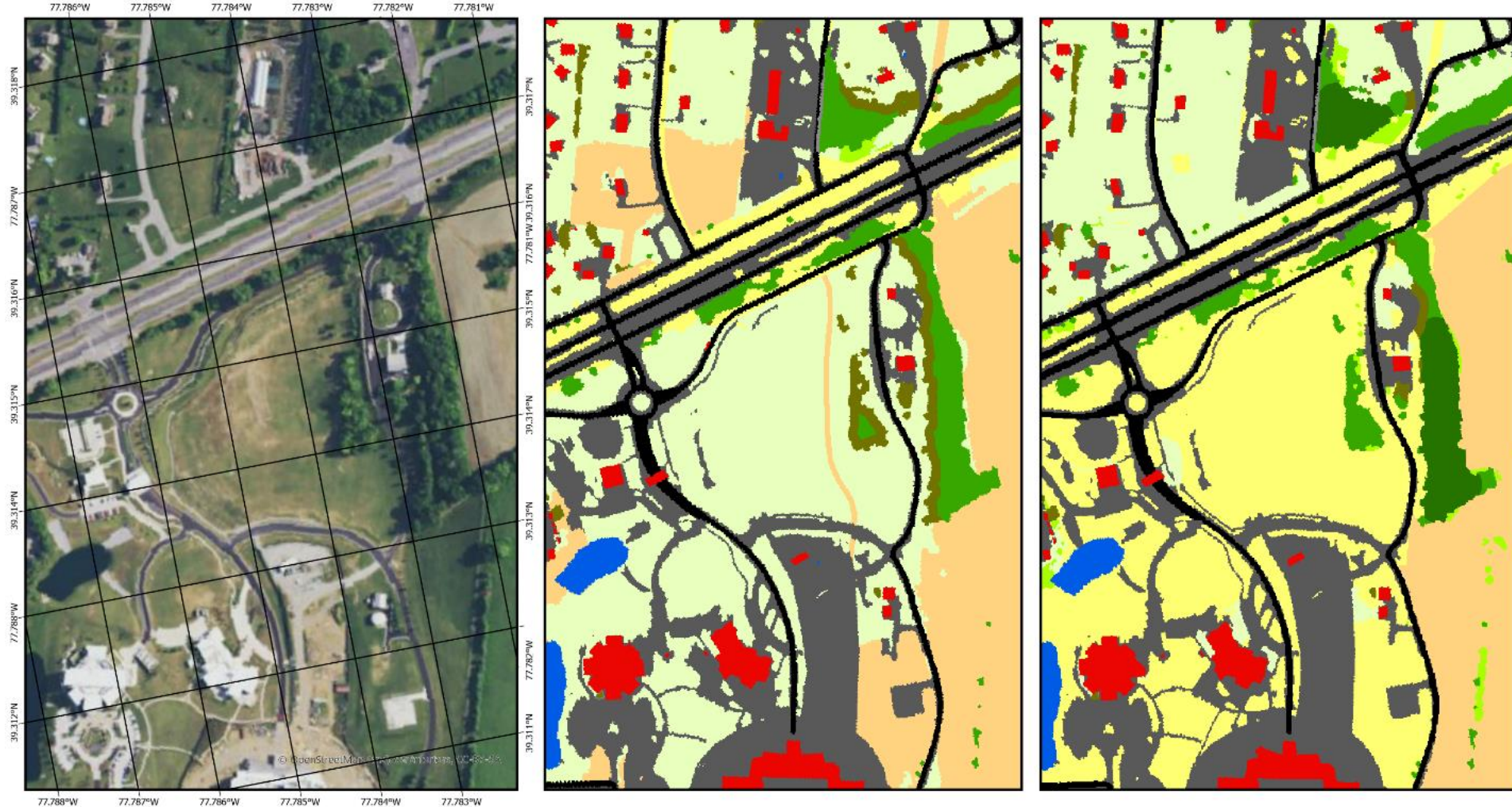
What is
different in the
new data?



Refined Tree
Canopy classification

What is different in the new data?

Refined Turf Grass mapping



What is different in the new data?

Addressed missing Solar Field Panel Arrays class





What Data Can I Download?

Land Use/Land Cover (LULC) Rasters

- County-scale Cloud-Optimized GeoTIFFs (COGs) for three dates: 2013/14, 2017/18, 2021/22
- State-scale Virtual Raster Tiles (VRTs)
- Visualization layers (ArcGIS .lyrx and QGIS .qml) for the four aggregation schemas (including land cover)
- Crosswalk table (Comma-separated values or CSV) of each unique raster value to all aggregated schemas

Land Use/Land Cover Change (LULCC) Rasters

- County-scale Cloud-Optimized GeoTIFFs (COGs) for three change periods: 2013/14 – 2017/18, 2017/18 – 2021/22, and 2013/14 – 2021/22
- State-scale Virtual Raster Tiles (VRTs)
- Visualization layers (ArcGIS .lyrx and QGIS .qml) for the four aggregation schemas (including land cover) for both the start and end of the change period
- Crosswalk table (Comma-separated values or CSV) of each unique raster value to all aggregated schemas

Land Use/Land Cover Change (LULCC) Tabular Matrices

- Tabular matrices (Excel Workbooks) by county, state, mapped region, and the Chesapeake Bay watershed portion of each for the three change periods

Region, State, and County Summary Tables

- Tabular data (Excel Workbooks) of the acres of Land Use/Land Cover for the three mapped dates by county, state, and the Chesapeake Bay watershed portion of both
- Tabular data (Excel Workbooks) of the acres of the net Land Use/Land Cover Change for the three mapped change periods by county, state, and the Chesapeake Bay watershed portion of both

Where do I Start?

LULC_User-Guide_2024-Edition.pdf

The User Guide on the main landing page is the best place to start as it includes detailed information on:

1. Structure of the data release (how to navigate the ScienceBase page)
2. Log of updates since the last release
3. Tips on how to use the provided visualization layer files
4. Definitions of each class for all of the aggregated schemas (land cover, land use, land use/land cover, general 18-classes, and macro classes)
5. Examples of how to read the change matrices
6. Citations for all ancillary data used to produce the land cover and land use datasets

Chesapeake Bay Land Use/Land Cover (LULC) Database 2024 Edition

[View](#)

Dates

Publication Date : 2025-06-23
Start Date : 2013
End Date : 2022

Citation

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>.

Summary

The Chesapeake Bay Land Use/Land Cover (LULC) Database facilitates the characterization of the landscape over time for three discrete time periods at 1-meter spatial resolution. The database was developed by Chesapeake Conservancy (CC) in cooperation with the University of Vermont's Spatial Analysis Laboratory and U.S. Geological Survey (USGS) as part of a 6-year Cooperative Agreement between Chesapeake Conservancy and the U.S. Environmental Protection Agency (EPA) and a separate Interagency Agreement between the USGS and EPA to

[... show more ...](#)

Child Items (4)

- Land Use/Land Cover (LULC) Rasters
- Land Use/Land Cover Change (LULCC) Rasters
- Land Use/Land Cover Change (LULCC) Tabular Matrices
- Region, State, and County Summary Tables

Contacts

SDC Data Owner : Lower Mississippi-Gulf Water Science Center
USGS Mission Area : Ecosystems
Point of Contact : Peter R. Claggett, Sarah M. McDonald
Originator : Kelly Schulze, Anna Royar, Jackie A. Pickford, Patrick McCabe, Elliott Kurtz, Ernie Buford, Labash Ahmad, Steven Guinn, Katie Walker, Cassi MacFaden, Jacob O'Neil

[... show more ...](#)

Attached Files

Click on title to download individual files attached to this item.

lulc_2024-Edition.xml Original FGDC Metadata	View	32.4 KB	application/fgdc+xml
visualization_lulc_2024-Edition.zip		16.4 KB	application/zip
visualization_lulcc_2024-Edition.zip "Land Use / Land Cover Change Visualization"		125.46 KB	application/zip
LULC_User-Guide_2024-Edition.pdf "User Guide"		2.8 MB	application/pdf

Map »



Spatial Services

ScienceBase WMS :

<https://www.sciencebase.gov/catalog>

Communities

USGS Chesapeake Bay

- constituent Snyder County (42109), Pennsylvania
 - constituent Blair County (42013), Pennsylvania
- [View Associated Items](#)

Tags

Theme : imageryBaseMapsEarthCover, land change, land use and land cover, land use change, maps and atlases
Place : Chesapeake, Delaware, District of Columbia, Maryland, New York, Pennsylvania, Virginia, West Virginia
Types : Map Service, OGC WFS Layer, OGC WMS Layer, OGC WMS Service

Provenance

Quick Tip: Scroll down to Attached Files to find the User Guide



Citations

Data Citation

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>.

User Guide Citation

McDonald, S. M., Pickford, J. A., Claggett, P. R., Ahmed, L., 2025, Chesapeake Bay Land Use/Land Cover (LULC) Database 2024 Edition User Guide: U.S. Geological Survey data release, <https://doi.org/10.5066/P14BEBRC>.



Final Thoughts

- High-resolution land cover, land use, and hydrography data representing every square meter of the Bay watershed are:
 - **Foundational**- informing most CBP Outcomes managed by every Goal Implementation Team.
 - **Authoritative**- providing a fully transparent, accurate, and verifiable representation of landscape conditions and change over time.
 - **Transformative**- affecting the ways that we, and our partners, understand, interpret, and manage the landscape and make local-level decisions.