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

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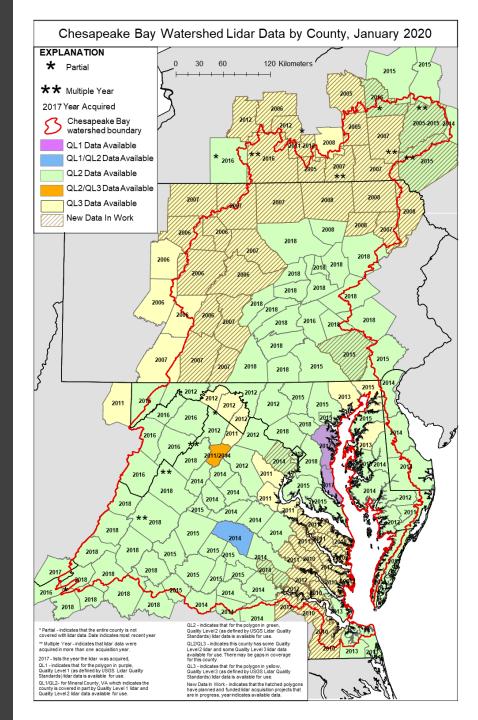U.S. Department of the Interior
U.S. Geological Survey

Chesapeake Bay 1-Meter Resolution Data

1. Land cover (12 classes): 2013/14, 2017/18, 2021/22

2. Land use (58 classes): 2013/14, 2017/18, 2021/22

3. Streams/ditches: best available LiDAR data

4. Stream channel and floodplain attributes: best available LiDAR data
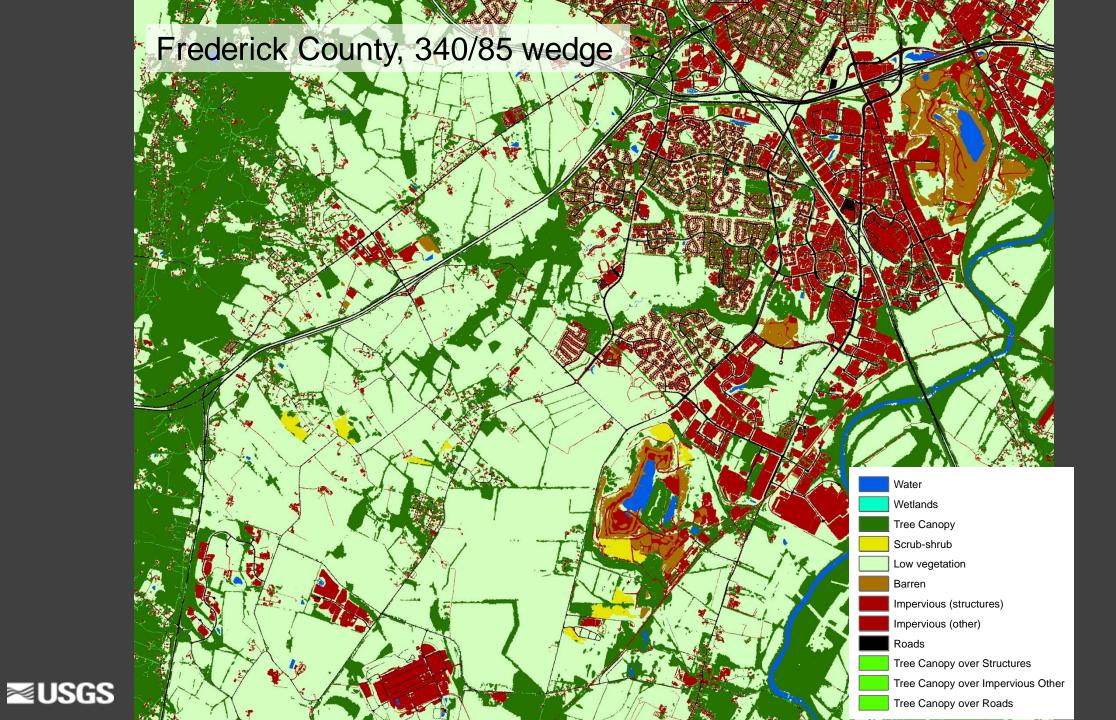
Additional LiDAR Derivatives

- Height (normalized Digital Surface Model (nDSM), 1m LiDAR)

- Compound Topographic Index (3-meter, LiDAR)

- Topographic Wetness Index (1-meter, LiDAR)

- Multiscale Landforms (1-meter, LiDAR)

Chesapeake Bay Watershed Lidar Data by County, January 2020

USGS

Frederick County, 340/85 wedge

Frederick County, 340/85 wedge

Legend:
- Water
- Wetlands
- Tree Canopy
- Scrub-shrub
- Low vegetation
- Barren
- Impervious (structures)
- Impervious (other)
- Roads
- Tree Canopy over Structures
- Tree Canopy over Impervious Other
- Tree Canopy over Roads

USGS

Local land use and parcel data

- Low-density Residential
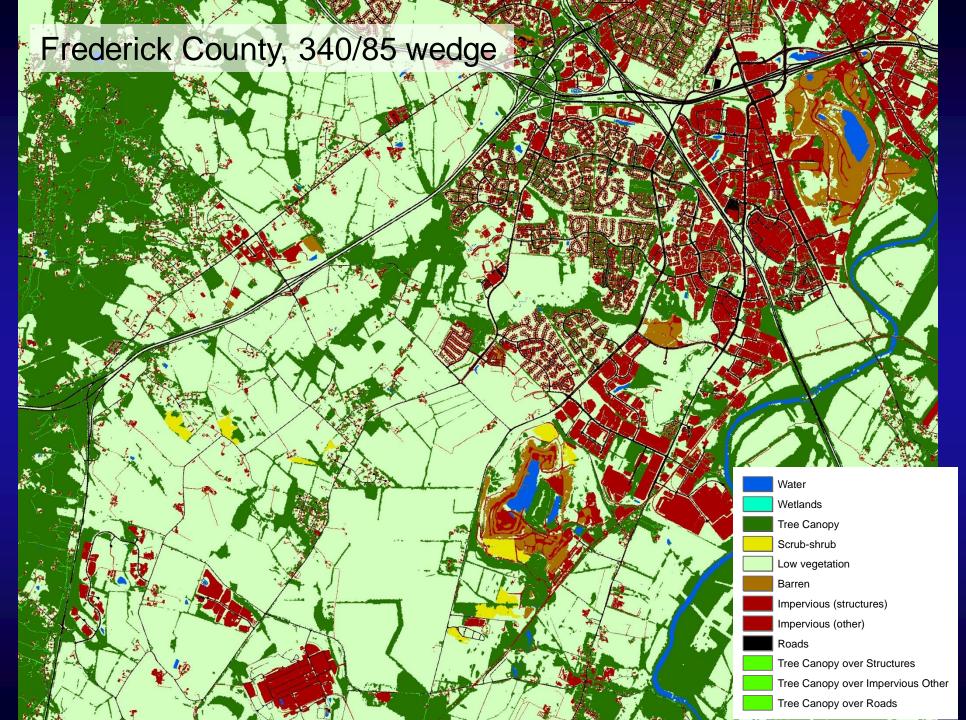- Recreation
- Agriculture
- Roads

High-resolution land cover data

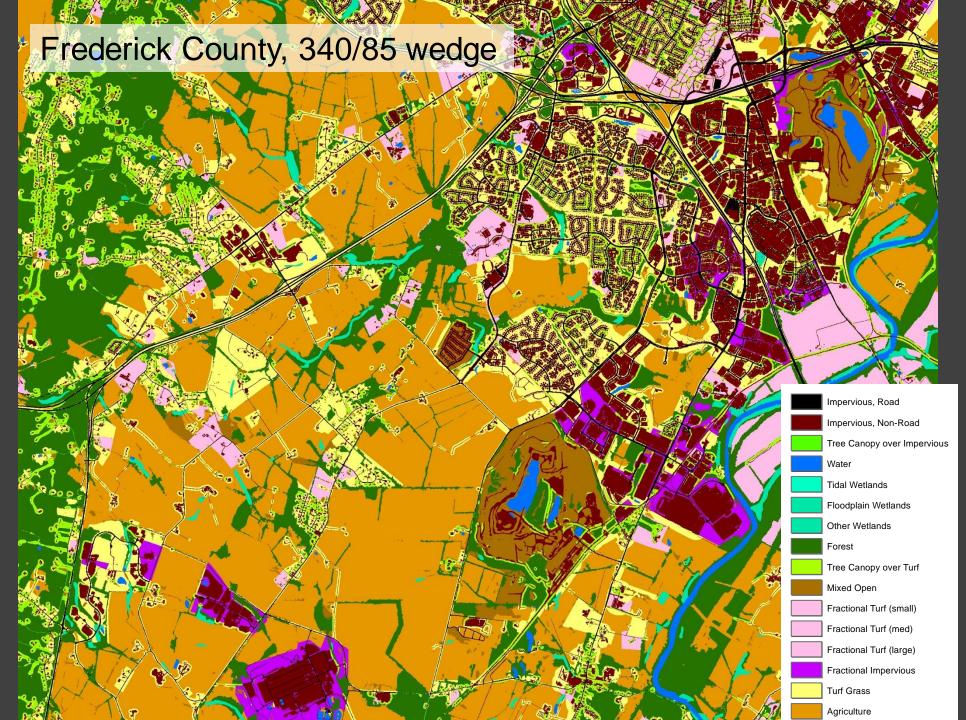- Impervious surfaces
- Tree canopy
- Low vegetation
- Water

CBP Land Uses
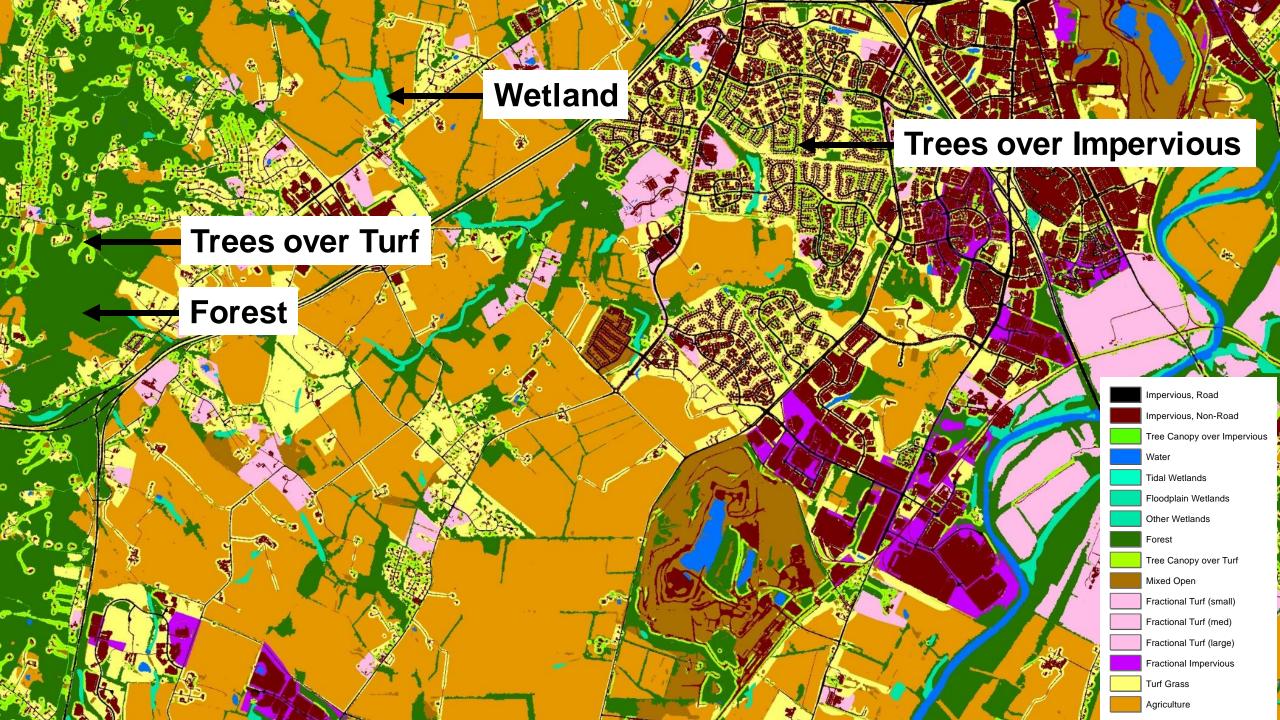
- Impervious-Roads
- Forests
- Turf Grass
- Open Space

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Frederick County, 340/85 wedge

Legend:
- Water
- Wetlands
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- Barren
- Impervious (structures)
- Impervious (other)
- Roads
- Tree Canopy over Structures
- Tree Canopy over Impervious Other
- Tree Canopy over Roads

USGS

Frederick County, 340/85 wedge

■ (black)	Impervious, Road
■ (dark red)	Impervious, Non-Road
■ (green)	Tree Canopy over Impervious
■ (blue)	Water
■ (cyan)	Tidal Wetlands
■ (teal)	Floodplain Wetlands
■ (teal)	Other Wetlands
■ (dark green)	Forest
■ (light green)	Tree Canopy over Turf
■ (brown)	Mixed Open
■ (light pink)	Fractional Turf (small)
■ (pink)	Fractional Turf (med)
■ (pale pink)	Fractional Turf (large)
■ (magenta)	Fractional Impervious
■ (yellow)	Turf Grass
■ (orange)	Agriculture

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Wetland

Trees over Impervious

Trees over Turf

Forest

■	Impervious, Road
■	Impervious, Non-Road
■	Tree Canopy over Impervious
■	Water
■	Tidal Wetlands
■	Floodplain Wetlands
■	Other Wetlands
■	Forest
■	Tree Canopy over Turf
■	Mixed Open
■	Fractional Turf (small)
■	Fractional Turf (med)
■	Fractional Turf (large)
■	Fractional Impervious
■	Turf Grass
■	Agriculture

2013/14 Chesapeake Bay Watershed Land Cover/Use Data

1m Land Cover

- Water
- Wetlands
- Tree Canopy
- Scrub-shrub
- Low vegetation
- Barren
- Impervious (structures)
- Impervious (other)
- Roads
- Tree Canopy over Structures
- Tree Canopy over Impervious Other
- Tree Canopy over Roads

1m Land Use

- Impervious, Road
- Impervious, Non-Road
- Tree Canopy over Impervious
- Water
- Tidal Wetlands
- Floodplain Wetlands
- Other Wetlands
- Forest
- Tree Canopy over Turf
- Mixed Open
- Fractional Turf (small)
- Fractional Turf (med)
- Fractional Turf (large)
- Fractional Impervious
- Turf Grass
- Agriculture

10m Land Cover/Use

Impervious Roads
Impervious Non-Roads
Tree Canopy Over Impervious
Tree Canopy Over Turf Grass
Turf Grass
Forest
Wetlands (Floodplain)
Wetlands (Other)
Wetlands (Tidal)
Water
Mixed Open
Cropland
Pasture

https://chesapeake.usgs.gov/phase6/map/#map=7/-8582732.74/4851421.17/0.0/0,4

USGS

Chesapeake Bay Program Land Use Classification

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 Daylighted
      1.2.1.2 Shaded
      1.2.1.3 Culverted/ Buried
    1.2.2.Ditches
      1.2.2.1 Daylighted
      1.2.2.2 Shaded
      1.2.2.3 Culverted/ Buried

2. Developed (13)
  2.1 Infrastructure
    2.1.1 Roads
    2.1.2 Tree Canopy (TC) over Roads
    2.1.3 Structures
    2.1.4 TC over Structures
    2.1.5 Other Impervious
      2.1.5.1 Railroads
      2.1.5.2 Parking Lots, Driveways, etc.
    2.1.6 TC over Other Impervious
      2.1.6.1 TC over Railroads
      2.1.6.2 TC over Parking Lots, etc.
    2.1.7 Suspended Succession
      2.1.7.1 Barren
      2.1.7.2 Herbaceous
      2.1.7.3 Scrub-shrub

  2.2 Bare Construction
  2.3 Turf Grass
  2.4 Tree Canopy over Turf Grass

3. Forest (5)
  3.1 Contiguous (> 1 acre)
  3.2 Fragmented (< 1 acre)
  3.3 Natural Succession (e.g., Fallow)
    3.3.1 Barren
    3.3.2 Herbaceous
    3.3.3 Scrub-shrub

4. Production (14)
  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 Timber Harvest
    4.2.1 Barren
    4.2.2 Herbaceous
    4.2.3 Scrub-shrub

  4.3 Extractive
    4.3.1 Barren
    4.3.2 Herbaceous
    4.3.3 Scrub-shrub
  4.4 Solar fields

5. Wetland (19)
  5.1 Tidal
    5.1.1 Open water
    5.1.2 Barren
    5.1.3 Herbaceous
    5.1.4 Scrub-shrub
    5.1.5 Contiguous Forest
    5.1.6 Fragmented Forest
  5.2 Non-tidal
    5.2.1 Floodplain/ Headwater
      5.2.1.1 Open water
      5.2.1.2 Barren
      5.2.1.3 Herbaceous
      5.2.1.4 Scrub-shrub
      5.2.1.5 Contiguous Forest
      5.2.1.6 Fragmented Forest
    5.2.2 Other
      5.2.2.1 Open water
      5.2.2.2 Barren
      5.2.2.3 Herbaceous
      5.2.2.4 Scrub-shrub
      5.2.2.5 Contiguous Forest
      5.2.2.6 Fragmented Forest
  5.3 Bare shore

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2014 Land Use

2014 - 2018 Tree Canopy Change

Loss

Gain

October 2012

October 2014

April 2018

Loss

Gain

Tree Canopy Change in Two Suburban Counties

Prince George's County: 2014 - 2018

TC Loss (7,673 acres):
- 59% of loss change occurred within forest or wetlands
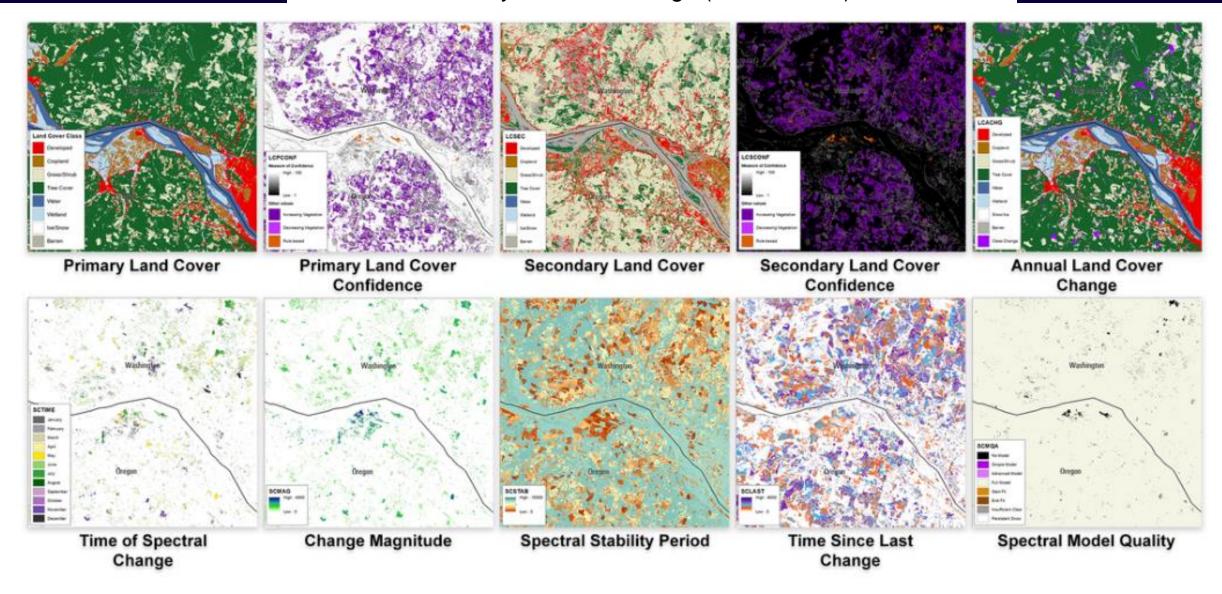- 41% of loss occurred in developed areas

TC Gain (518 acres):
- 16% of gain occurred within forest or wetlands
  - shrub/scrub; edge of forest
- 54% of gain occurred in developed areas
- 29% of gain occurred on agricultural lands

Anne Arundel County: 2014 - 2018

TC Loss (2,544 acres):
- 57% of loss change occurred within forest or wetlands
- 42% of loss occurred in developed areas

TC Gain (188 acres):
- 9% of gain occurred within forest or wetlands
  - shrub/scrub; edge of forest
- 55% of gain occurred in developed areas
- 35% of gain occurred on agricultural lands
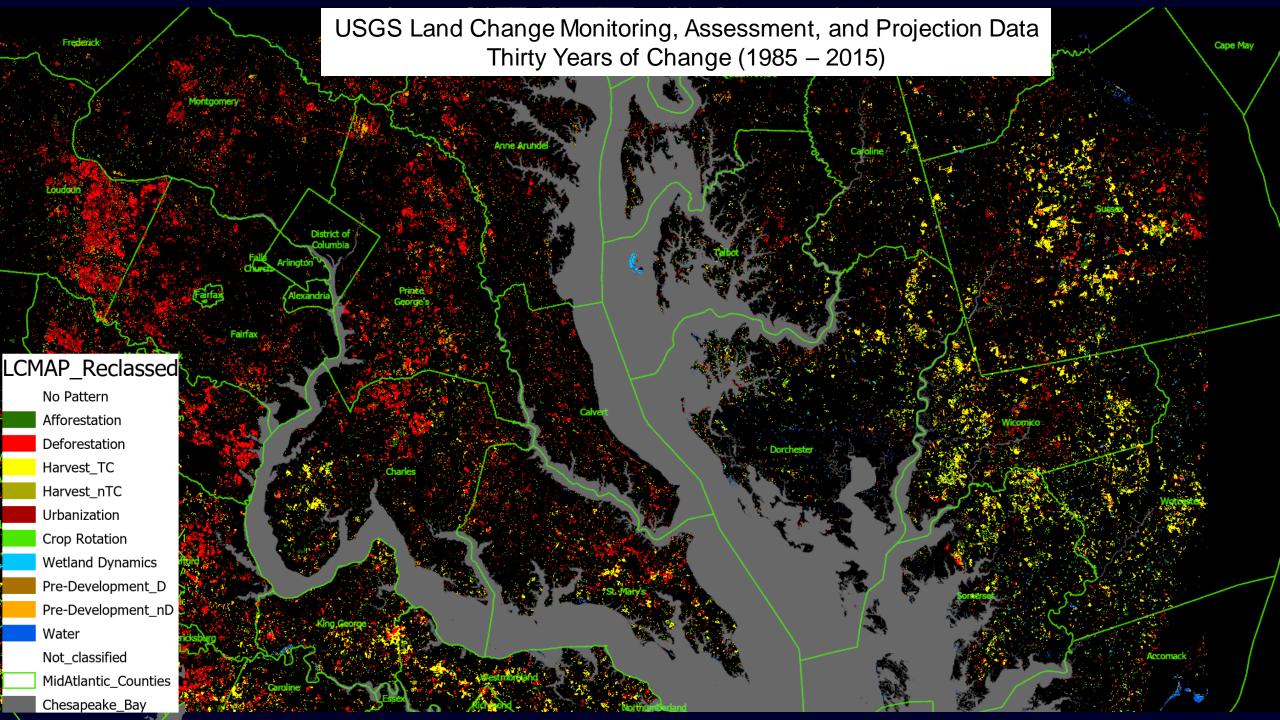
2017 Land Cover Production Status

https://cicgis.org/portal/apps/webappviewer/index.html?id=262ce838a60048e9a0f136d904639f66

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

LCMAP CCDC Ten Individual Products
(Public domain)

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

LCMAP_Reclassed

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

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

* 1-meter raster, 1:2000 scale

Hyper-Res Hydrography Production

USGS Floodplain and Channel Evaluation Toolkit

Output of Layers from USGS Tool

Legend
- Floodplain
- Bank Points
- Cross-sections
- Stream

0   50   100   200 Meters
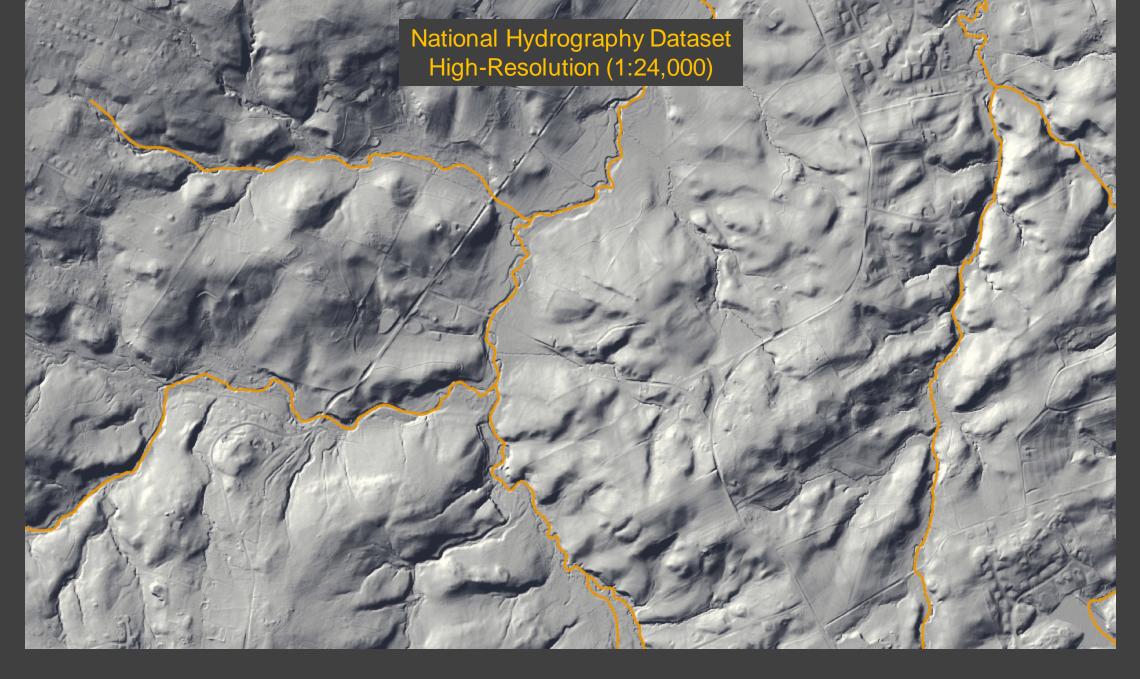
Channel Reach Measures
- Bank height (m)
- Bank angle, avg (deg)
- Bank angle, max (deg)
- Channel width (m)
- Channel length (m)
- Bankfull area (m^2)
- Sinuosisty
- Drainage area (km^2)
- Slope (%)
- Floodplain width (m)
- Floodplain elevation, range (m)
- Floodplain elevation, sd (m)

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LiDAR Digital Elevation Model

National Hydrography Dataset
High-Resolution (1:24,000)

Draft CBP Hydrography
Hyper-Resolution (1:2,000)

USGS

Hyper-Res Hydrography
Near-stream Inundation Areas (1.6m above stream water level)
Hydric and Partially-Hydric Soils

USGS

Channel Reach Measures (averages)
- Bank height (m)
- Bank angle, avg (deg)
- Bank angle, max (deg)
- Channel width (m)
- Channel length (m)
- Bankfull area (m²)
- Sinuosisty
- Drainage area (km²)
- Slope (%)
- Floodplain width (m)
- Floodplain elevation, range (m)
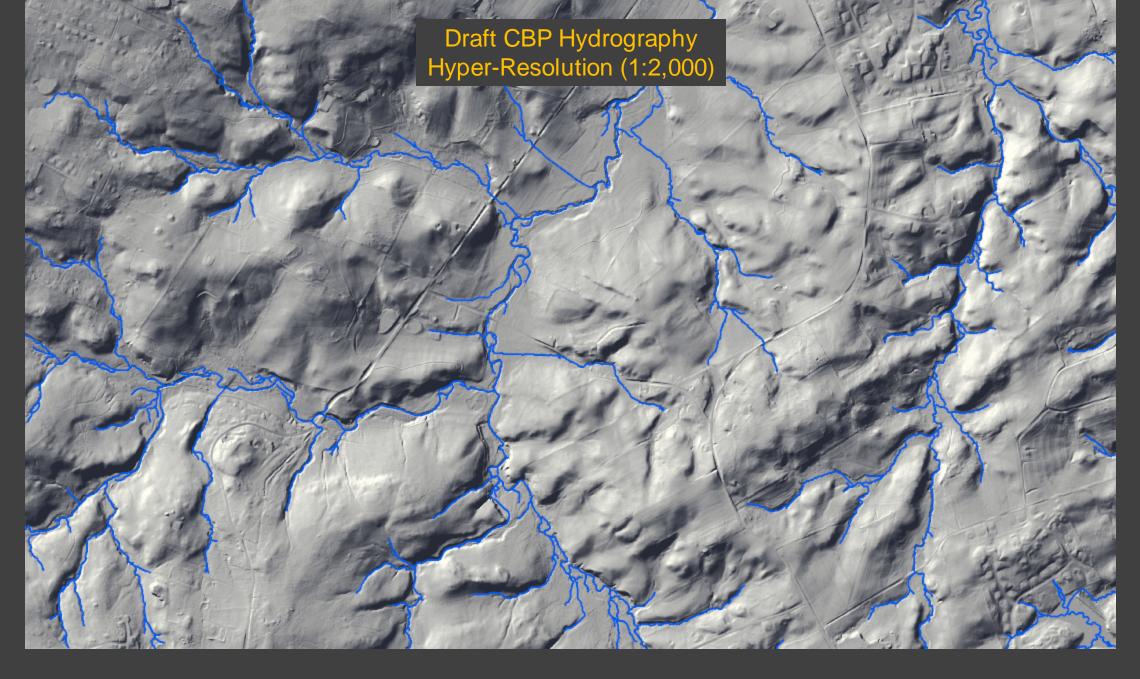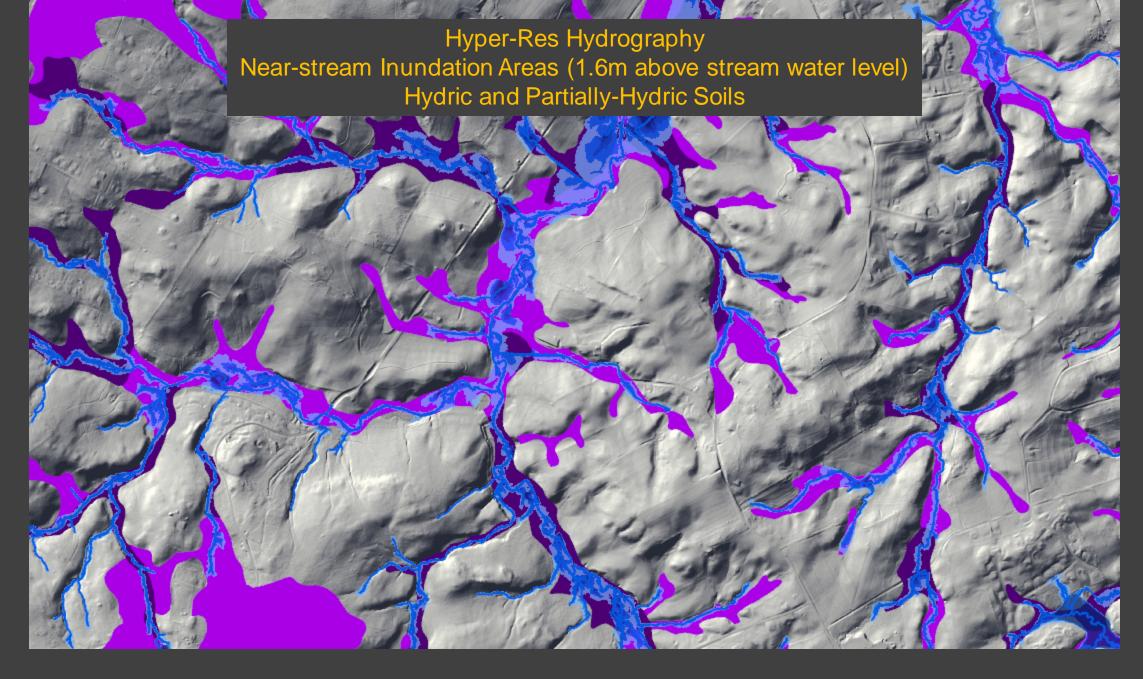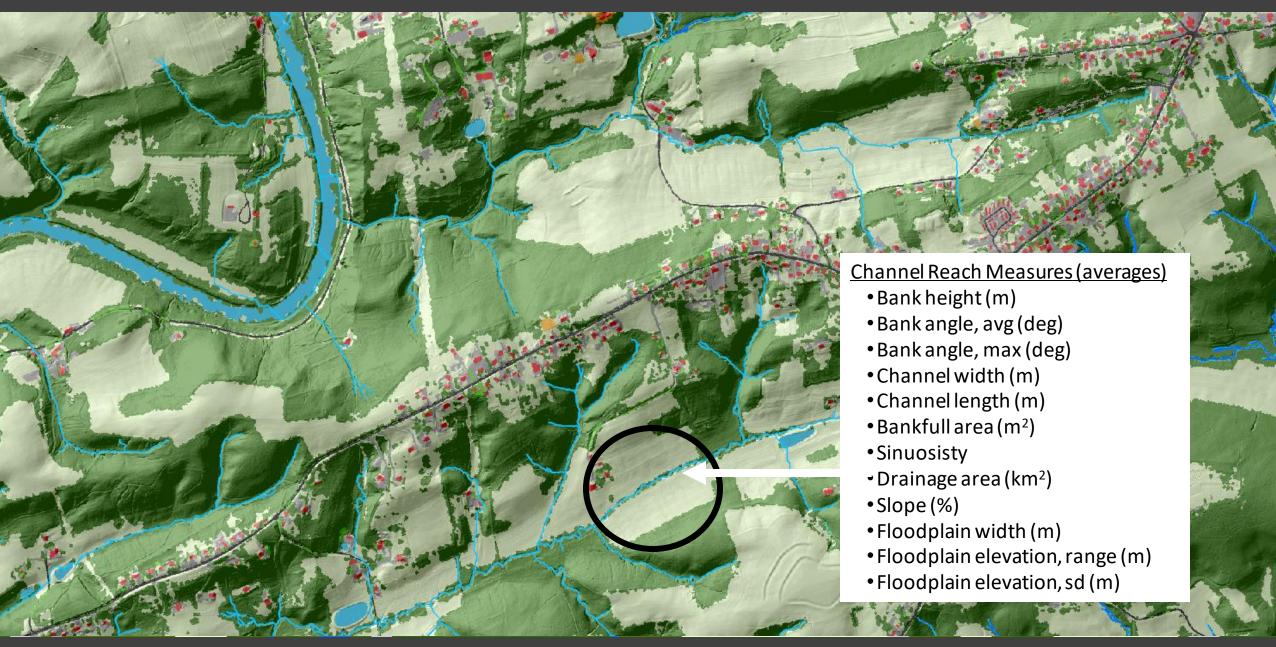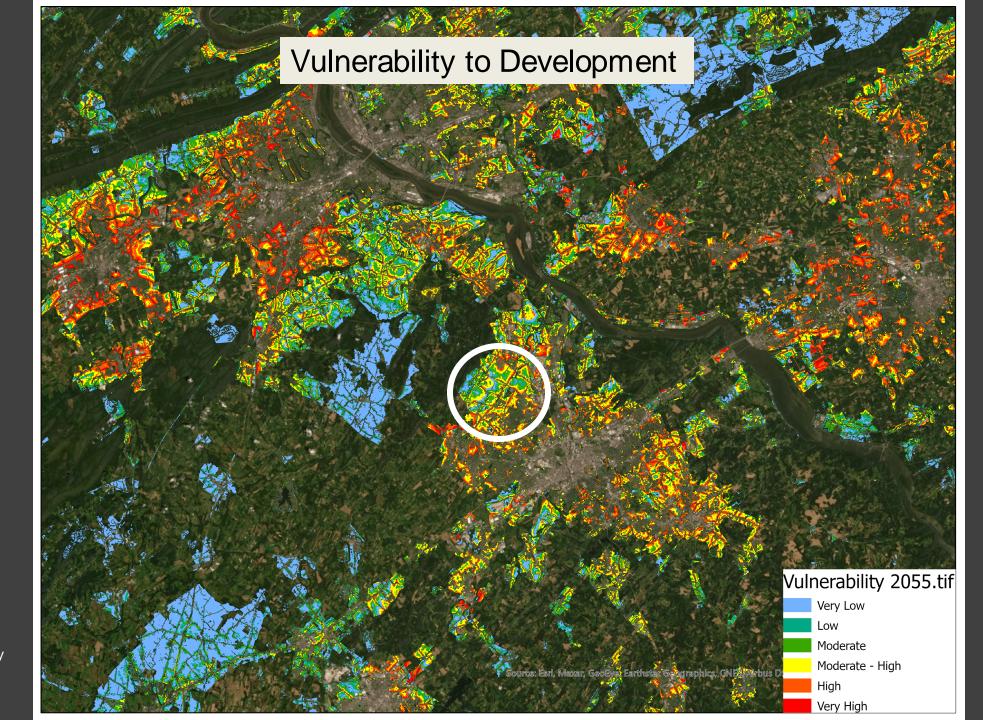- Floodplain elevation, sd (m)

USGS

Vulnerability to Development

Vulnerability 2055.tif

- Very Low
- Low
- Moderate
- Moderate - High
- High
- Very High

Chesapeake Bay
Land Change
Model v5

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS

Vulnerable farmland:
Area surrounded by recent residential and commercial growth

Summary

Under a 6-year Cooperative Agreement with the Chesapeake Bay Program, the Chesapeake Conservancy (CC) and University of Vermont (UVM) are producing 1-meter resolution land cover datasets for the years 2013/14, 2017/18, 2021/22 using the best available LiDAR and NAIP aerial imagery for the Bay watershed (including all of Maryland).

The CC and UVM are translating 12-classes of land cover into 58 of land use using ~15 ancillary datasets for each county.

The CC and UMBC are developing 1-meter resolution stream and ditch data, complementing the 1-meter resolution water bodies identified in the land cover data.

USGS has developed a GIS tool (FACET) to extract channel width, height, bank angle, and floodplain width and volumes from 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 (58 classes):
- 2013/14 (summer 2021)
- 2017/18 (summer 2021)
- 2021/22 (summer 2024)

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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