DETECTING PATTERNS OF LAND COVER CHANGE

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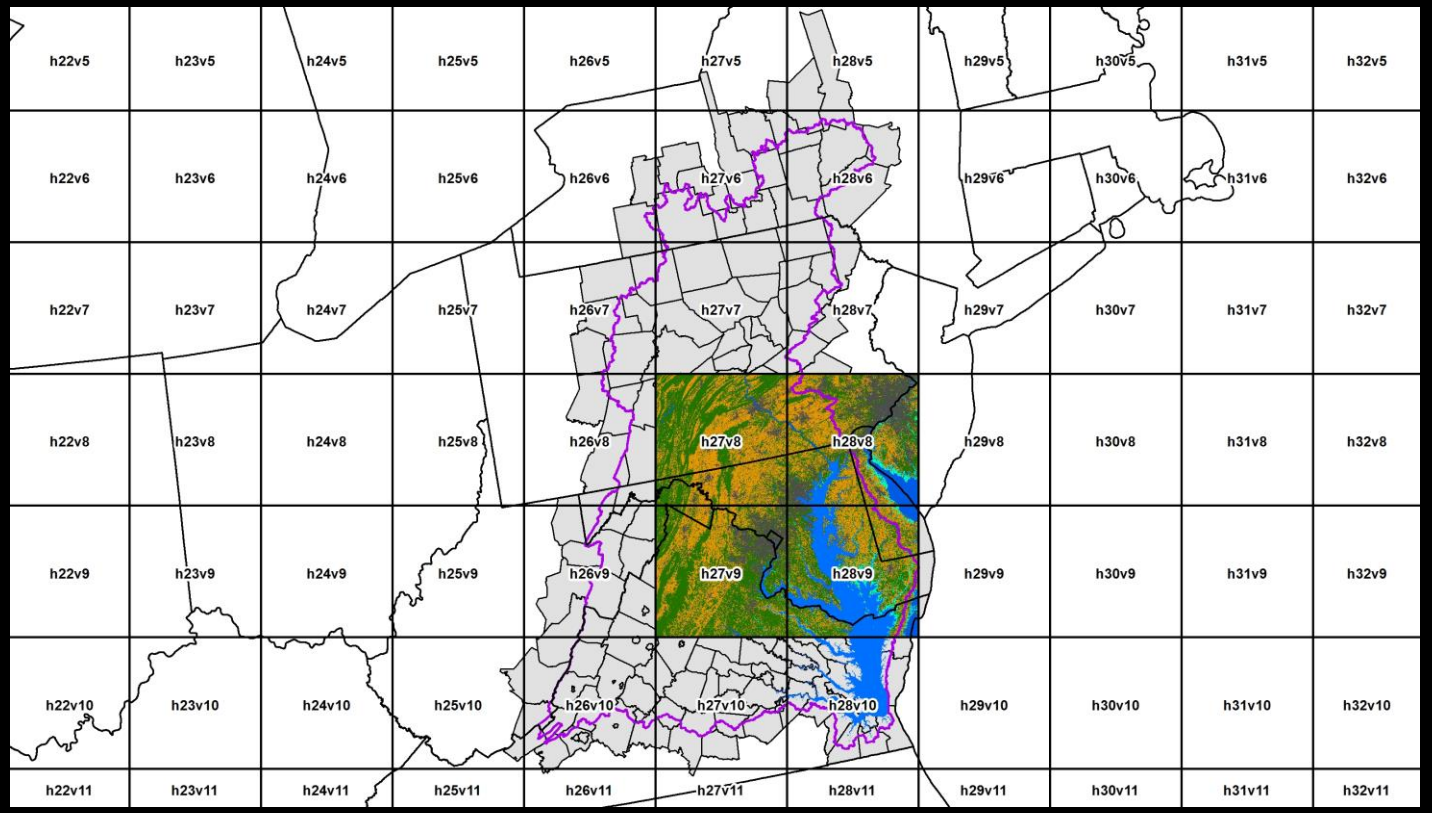
USGS LAND CHANGE MONITORING, ASSESSMENT, AND PROJECTION (LCMAP)

- "LCMAP offers a suite of 10 annual data products that depict land cover and spectral change in the conterminous United States."
- Products include a primary land cover classification and secondary land cover classification
- Produced yearly by USGS/EROS dating from 1985 – 2017
- Products are 30 m resolution
- Learn more at https://www.usgs.gov/land-resources/eros/lcmap

USGS LAND CHANGE MONITORING, ASSESSMENT, AND PROJECTION (LCMAP)

- Covers the entire Chesapeake Bay Watershed in the form of tiles

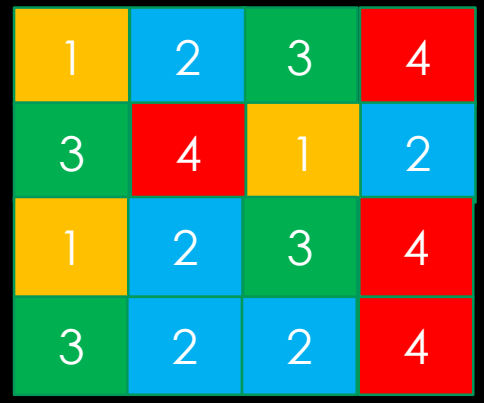


OVERVIEW

- Goal: Detect and classify patterns in land cover change using LCMAP primary/secondary land cover data
- The detection and classification algorithm is written in python using open source libraries
- Algorithm has 2 steps:
  - 1. Detect Pattern
  - 2. Classify Pattern

DETECTING PATTERNS

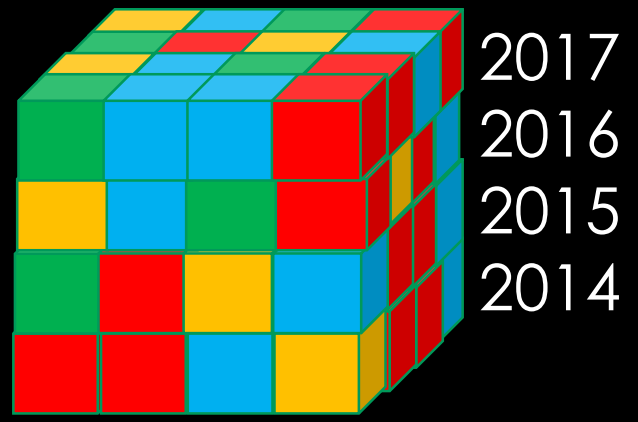
- The detecting patterns section of the algorithm reads in LCMAP data and stacks it by year. It retrieves the land cover value by year for each pixel and determines if there is a pattern that needs to be classified.
- 1. Read in LCMAP primary or secondary land cover rasters for years 1985 through 2017



- 2. Stack the rasters year by year to form a cube

4, 3, 1, 3

- 3. Drill down at each pixel and pull out pattern



DETECTING PATTERNS CONT.

- Each pixel has 33 land cover types in its full pattern. This is reduced by:
  - Only including land cover types that occur at least 3 consecutive years
  - Not including patterns with less than 2 unique land cover types
  - Treating agriculture and grass the same, unless they are the only land cover types found in the pattern

3, 3, 3, 3, 3, 3, 3, 3, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4

3, 4

- The reduced pattern is passed to a function which classifies the behavior of the reduced land cover types.
  - Ex: alternating types, transition from one type to another, etc.
  - Builds a value that is assigned to all patterns with the same land cover types and behavior
    - This is the value used in the unique patterns output

1 + 3, 4 = 341

Behavior + Set(Reduced Pattern) = Unique Pattern

CLASSIFYING PATTERNS

- Over one thousand unique patterns found for one tile of LCMAP primary cover data

- Grouped these unique patterns into 8 Categories:
  - Aforestation
  - Deforestation
  - **Timber Harvest** → Terminal Tree Cover
    Timber Harvest → Terminal Not Tree Cover
  - Urbanization
  - Crop/Crop Rotation
  - Wetland
  - **Development Site/Land Clearing** → Terminal Development
    Development Site/Land Clearing → Terminal Not Developed
  - Waterbody

*terminal: the most recent land cover type in the pattern

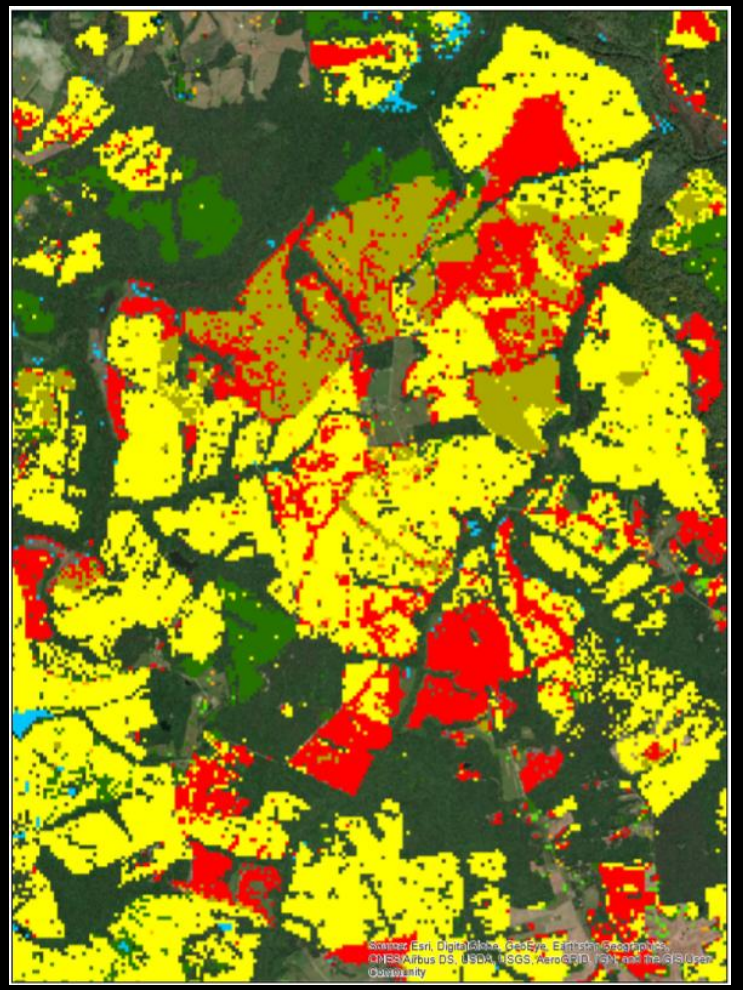
OUTPUTS

- Produces 3 tif files
  - Identify all unique patterns
  - Reclassify based on the primary pattern detected
    - **Primary Classification** – Highlights main pattern
  - Reclassify based on the secondary pattern detected
    - **Secondary Classification** – Highlights additional pattern if detected
    - Ex: Trees were cut and a pond was built
      - Primary Classification: Deforestation
      - Secondary Classification: Waterbody

RESULTS

Satellite image of VA

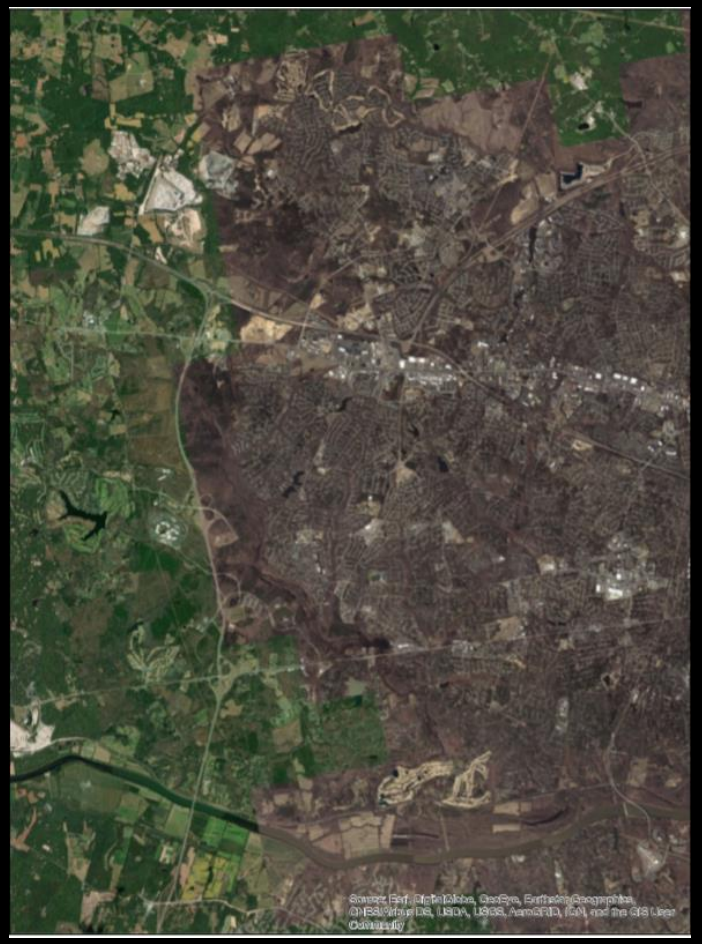
Primary Classification



- Test run on tile h27v10
- Covers part of VA

RESULTS CONT.

Satellite image of Richmond, VA



Land Cover Pattern

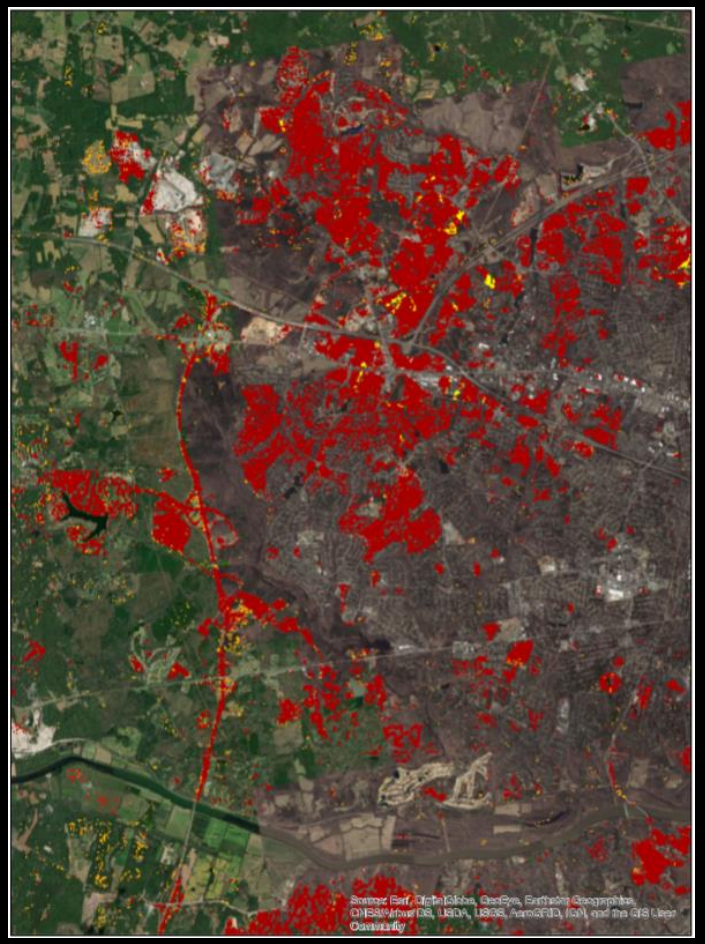
- No Pattern
- Aforestation
- Deforestation
- Timber Harvest: Tree Cover
- Timber Harvest: No Tree Cover
- Urbanization
- Crop/Crop Rotation
- Wetland
- Dev. Site/Land Clearing: Developed
- Dev. Site/Land Clearing: Not Developed
- Water
- Unclassified

Secondary Land Cover Patterns

- No Secondary Pattern
- Aforestation
- Deforestation
- Wetland Loss
- Urbanization
- Dev. Site/Land Clearing: Devleopment
- Dev. Site/Land Clearing: Not Developed
- To Water

Primary Classification

Secondary Classification



CONCLUSIONS

- Allows us to analyze changes in land cover from 1985 – 2017 (33 years) for the Chesapeake Bay Watershed

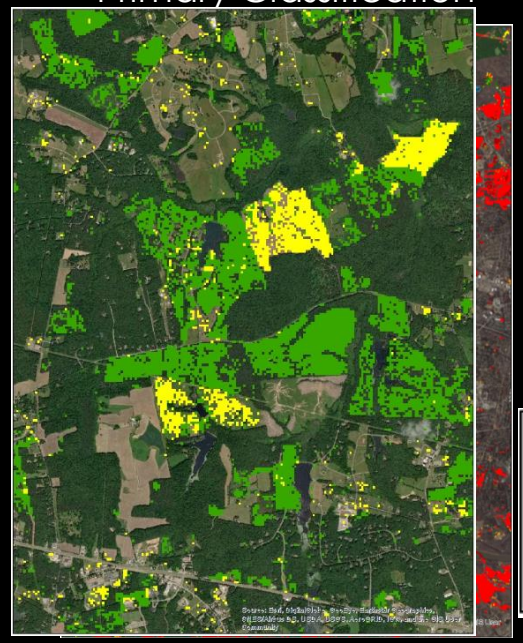
- Potential applications:
  - Determine areas of forest loss due to development
  - Locate areas used for timber harvest
  - Locate areas undergoing succession/secondary forests

NEXT STEPS

- Use con function to determine forest loss due to development
  - Con("Prim_recl_ .tif" == 2, Con("Sec_recl_ .tif" == 5, 1, 0), 0)
- Use con function to locate timber harvest
  - Con("Prim_recl_ .tif" == 3, 1, Con("Prim_recl_ .tif" == 4, 2, 0))
- Use con function to locate secondary forests (Aforestation and Timber Harvest: Tree Cover) and potential areas of succession (Development Sites/Land Clearing: Not Developed and Timber Harvest: No Tree Cover)

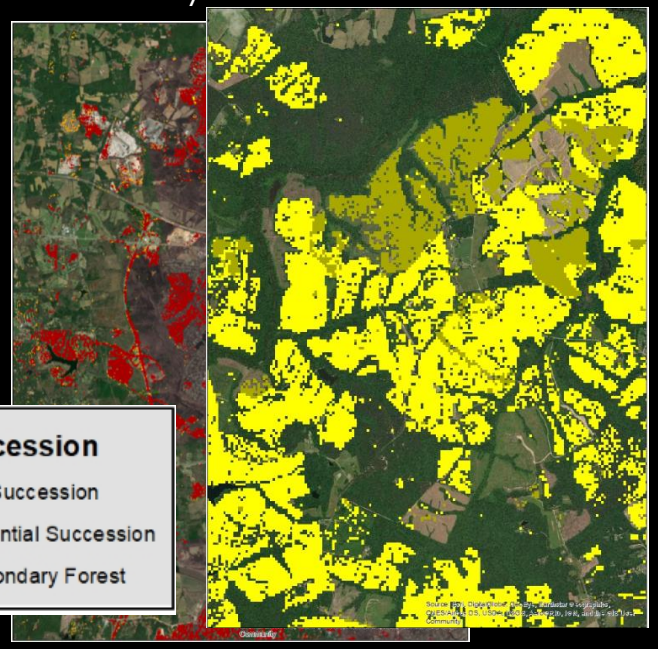
Succession

Primary Classification



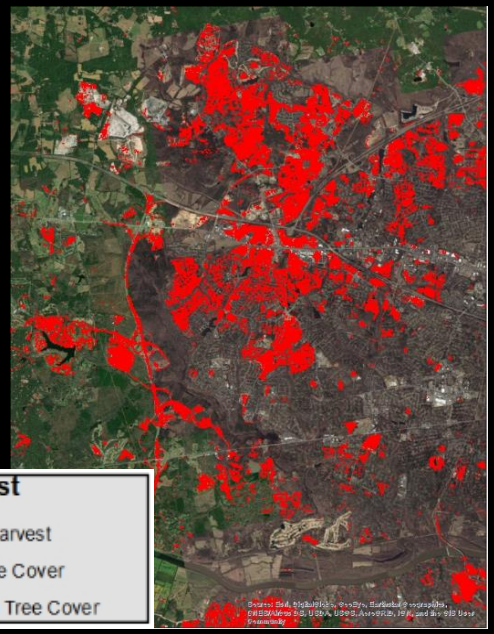
Secondary Classification

Timber Harvest



Succession
- No Succession
- Potential Succession
- Secondary Forest

Forest Loss Due to Development



Timber Harvest
- No Timber Harvest
- Terminal Tree Cover
- Terminal: No Tree Cover

Land Cover Patterns
- No Pattern
- Deforestation due to Development