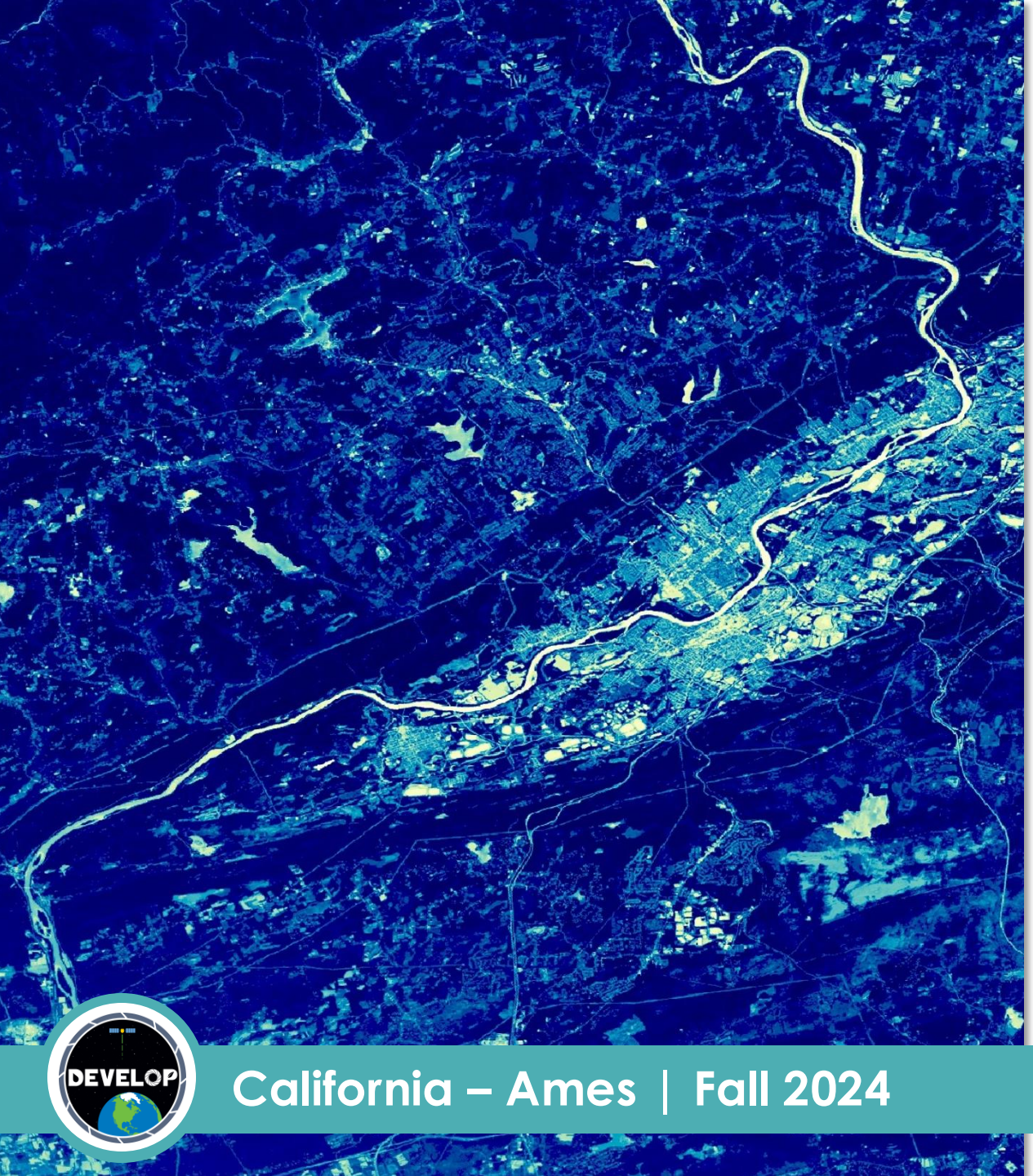


National Aeronautics and Space Administration

PENNSYLVANIA WATER RESOURCES

Assessing the Impacts of Acid Mine Drainage Reclamation in Pennsylvania

Melissa Widas

Vavi Nemec

Mia Day

Julie Pichonnat

DEVELOP

California – Ames | Fall 2024

Luzerne County, PA

Luzerne County in Pennsylvania was a hotspot for anthracite coal mining in the 20th century.

Abandoned mine lands are historic sites of coal extraction, processing, and waste deposition which can lead to acid mine drainage.

Decline in the coal mining industry left areas with abandoned mine lands.

Image Credits (Left to Right): Glen Alden Corporation, Earth Conservancy, Nicholas A. Tonelli

Legacy Mining Impacts

Acid mine drainage has:

Low pH & High Concentrations of Metals

The legacy of abandoned mine lands and resulting acid mine drainage has resulted in environmental and economic damages to the area such as:

Public Health Risks

Ecosystem Degradation

Economic Burden

Image Credits (Left to Right, Top to Bottom): Umeicon, Freepik, CPWF, Eric Engbretson, Assiniboine and Gros Ventre Tribes

Partners

Earth Conservancy

USGS Geology, Energy, and Minerals Science Center

Image Credits (Left to Right): Earth Conservancy, U.S.G.S.

Reclamation Efforts by Earth Conservancy

Mission: the **reclamation** and **return** of 16,000 acres of former coal company-owned land to the region

Mine Land Reclamation

Watershed Restoration

Recreation & Conservation

Education & Outreach

In the last 30 years, **over 2,000 acres** of mine-scarred lands **have been reclaimed** and now are available for – or are already in – constructive use.

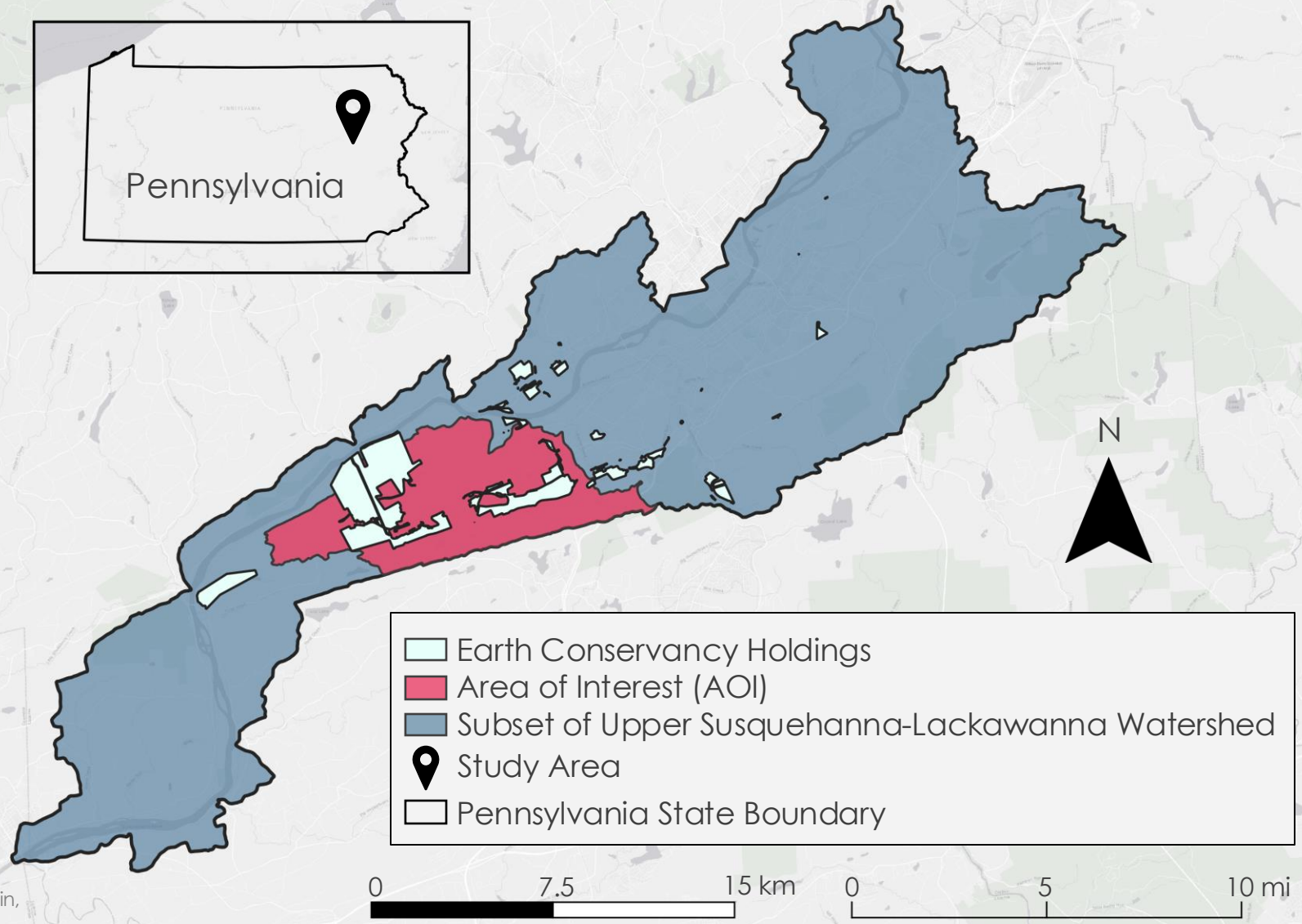
Image Credits: Earth Conservancy

Study Area and Period

Study Area:
Subset of the Upper Susquehanna-Lackawanna Watershed

Area of Interest:
Nanticoke and Newport Creek sub-watersheds

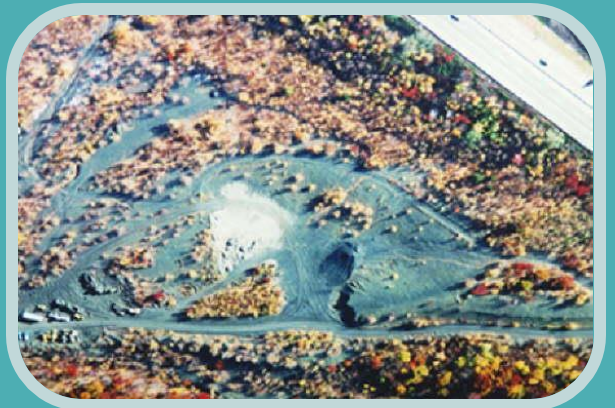
Study Period: 1986–2024



Project Objectives

Map **land use land cover** changes over five decades

Assess impacts of reclamation efforts on surrounding **vegetation and water runoff**



Investigate changes to the community's **environmental justice area** designation

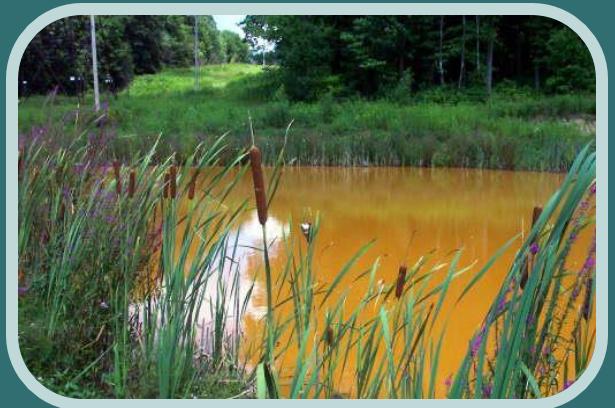


Image Credits: Earth Conservancy

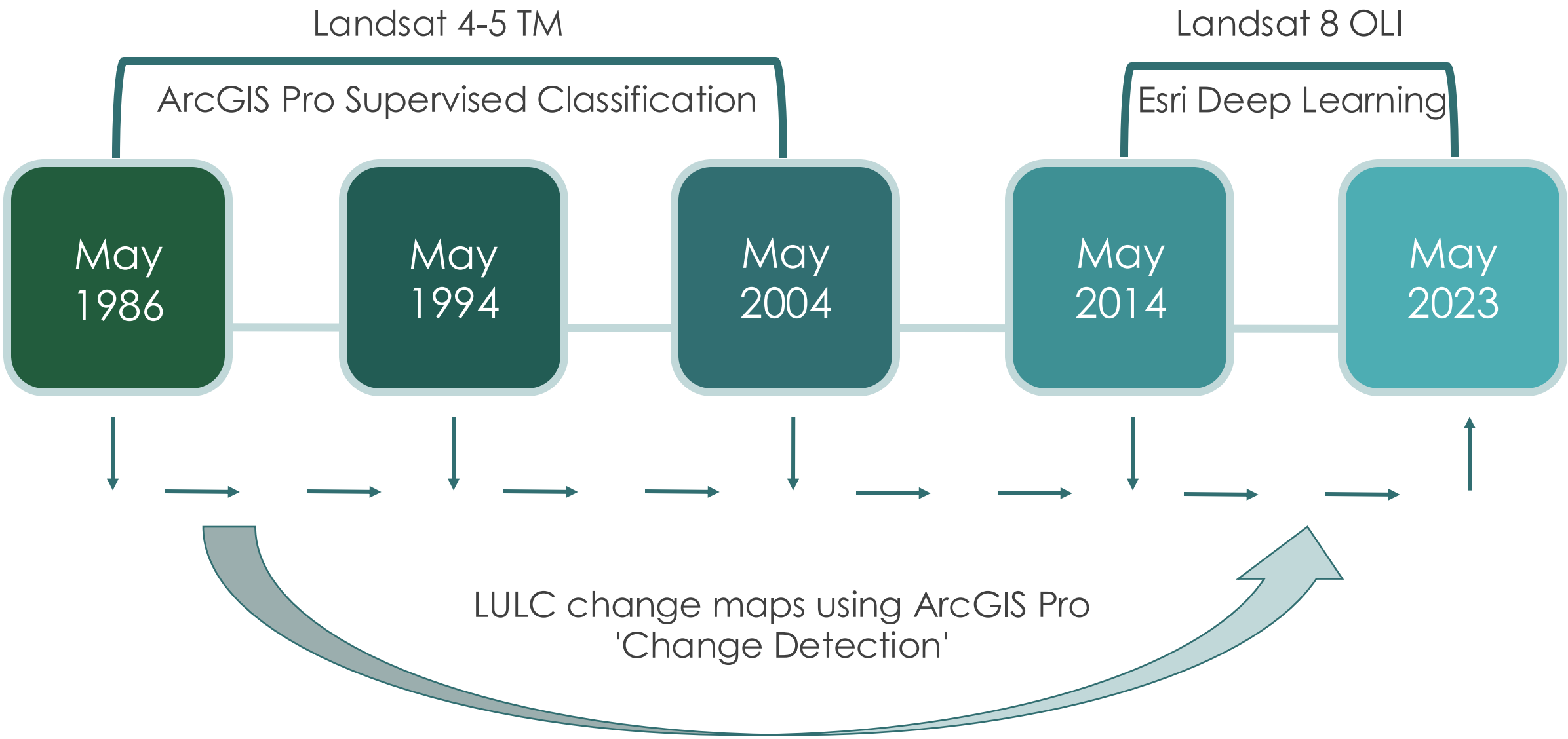
Earth Observations

Landsat 4-5
Thematic Mapper (TM)

Landsat 8
Operational Land Imager (OLI)

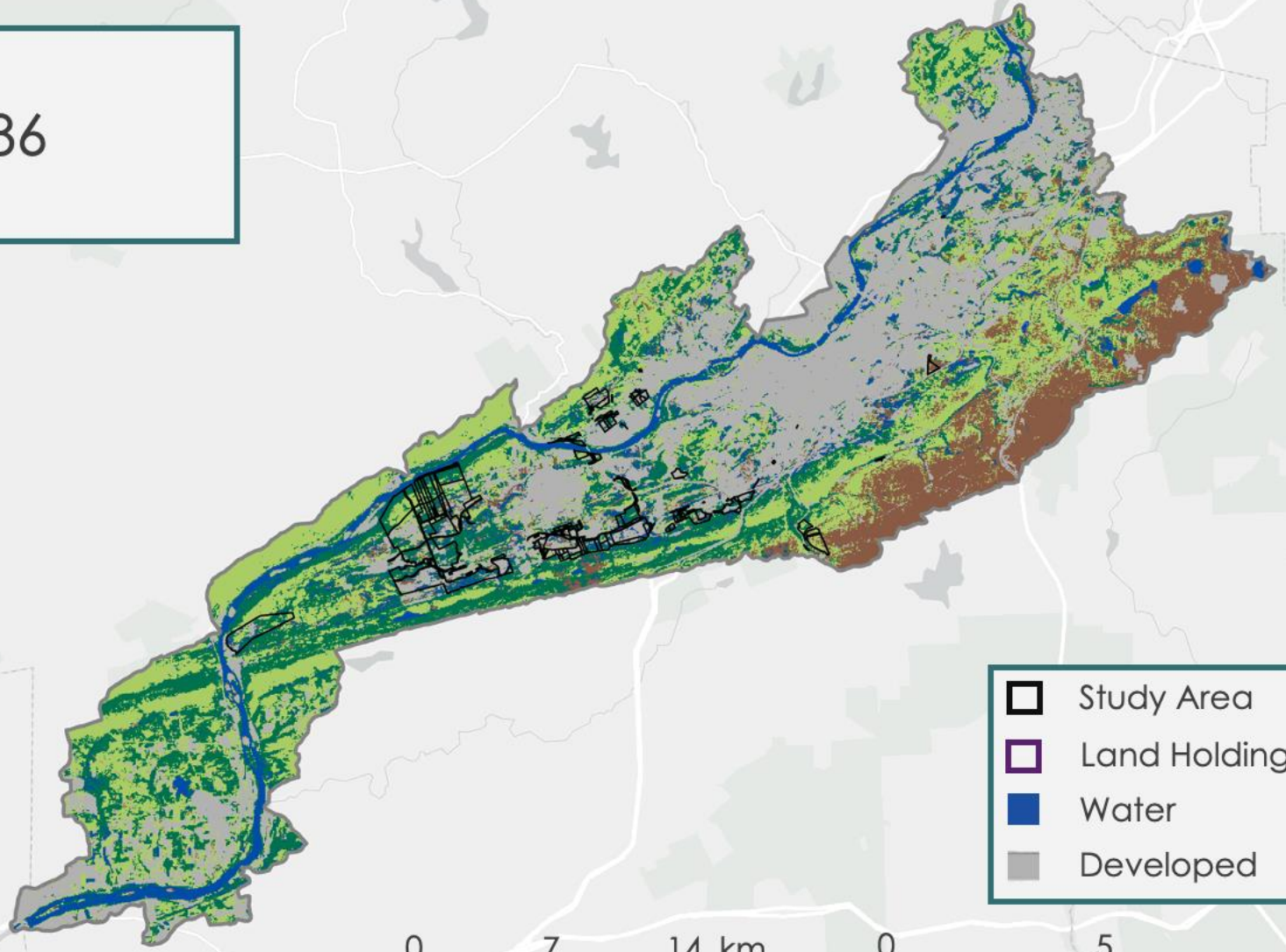
Image Credits (Left to Right, Background): NASA, NASA, ESA/Hubble

Land Use Land Cover (LULC) – Study Period & Methods



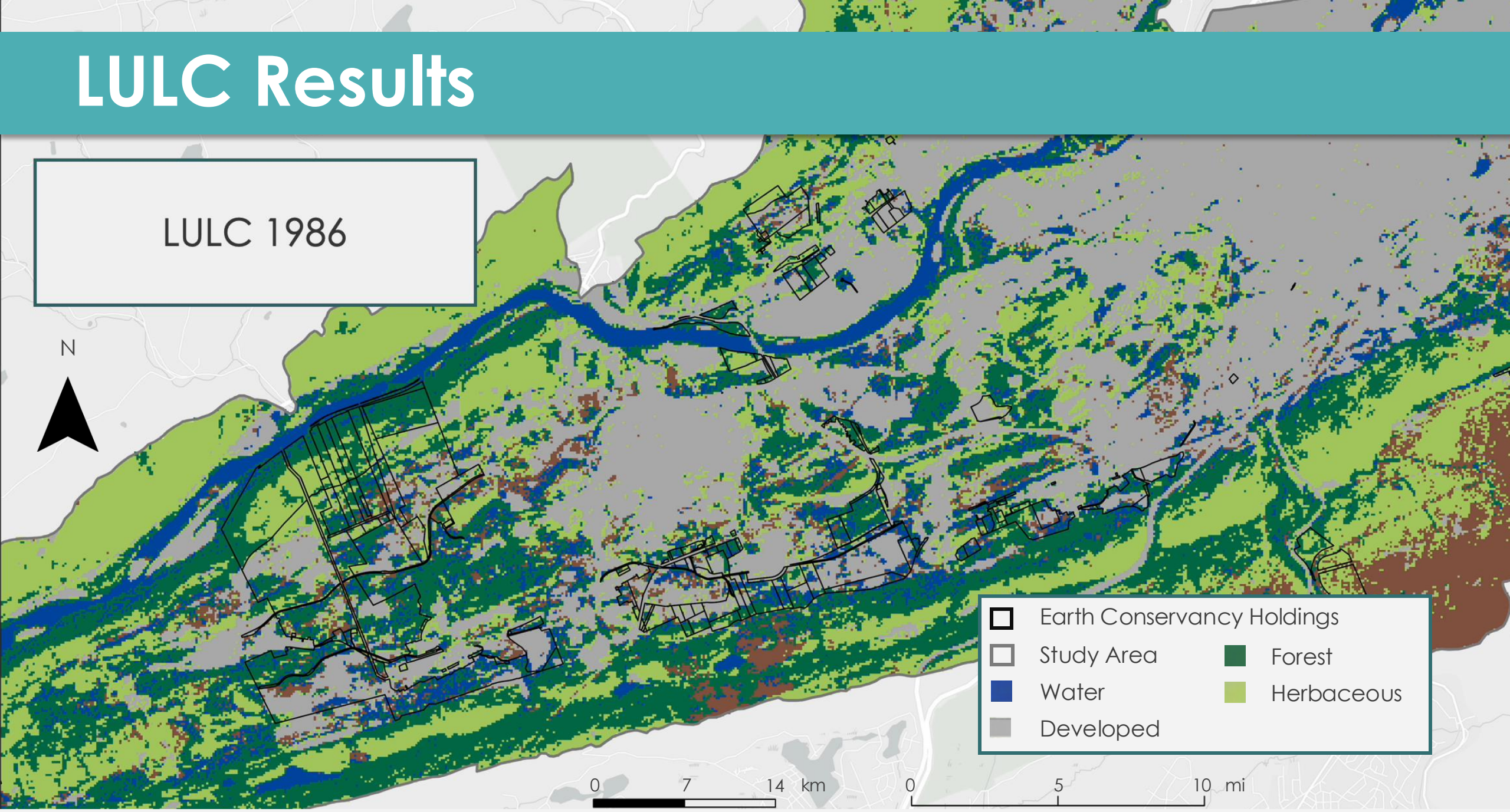
LULC Results

LULC 1986



Basemap Credit: PSU Office of Physical Plant, data.pa.gov, Esri, TomTom, Garmin, SafeGraph, MET/NASA, EPA, NPS, USDA, USFWS; Image: Famo

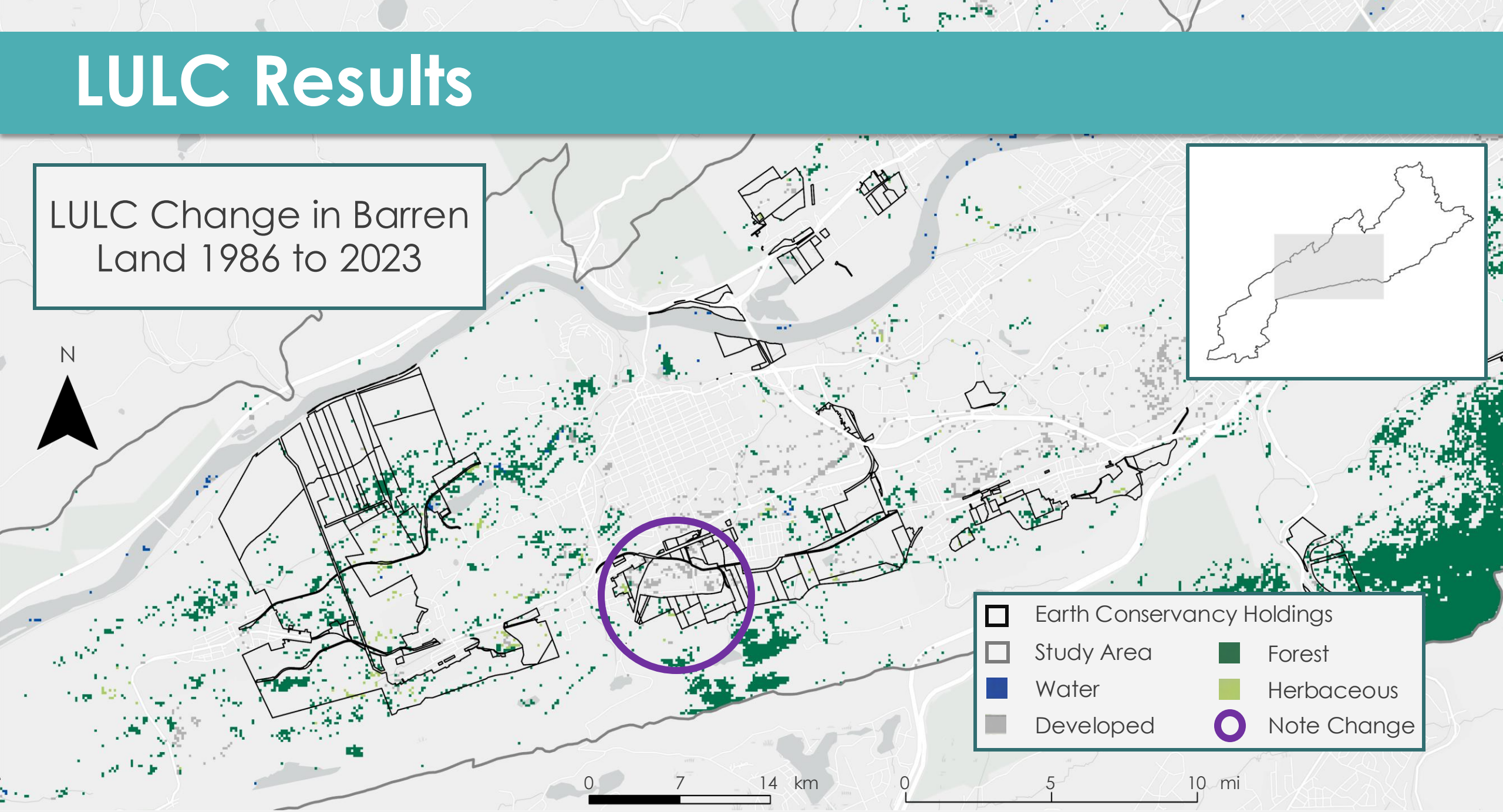
LULC Results



Basemap Credit: PSU Office of Physical Plant, data.pa.gov, Esri, TomTom, Garmin, SafeGraph, MET/NASA, EPA, NPS, USDA, USFWS;Image: Famo

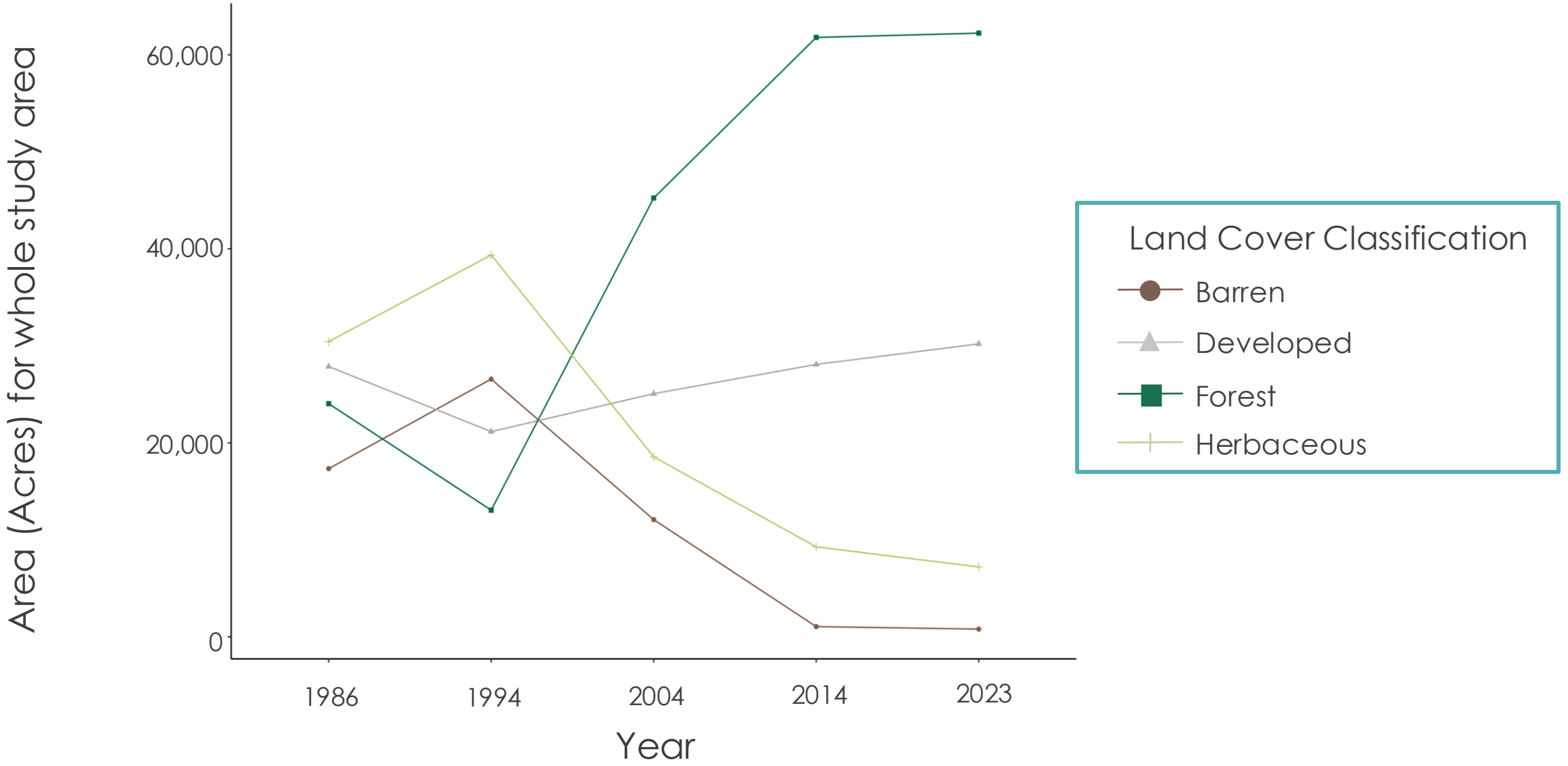
LULC Results

LULC Change in Barren Land 1986 to 2023



Basemap Credit: PSU Office of Physical Plant, data.pa.gov, Esri, TomTom, Garmin, SafeGraph, MET/NASA, EPA, NPS, USDA, USFWS; Image: Famo

LULC Results



Vegetation Greenness - Methodology

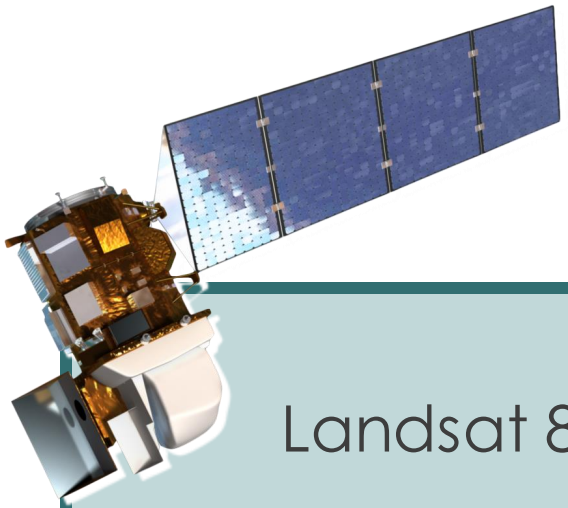
Normalized Difference Vegetation Index (NDVI)

1

healthy vegetation

development, bodies of water

-1



Landsat 8 OLI

May 2015

May 2023

Compute NDVI

$$\frac{\text{Infrared} - \text{Reflectance}}{\text{Infrared} + \text{Reflectance}}$$

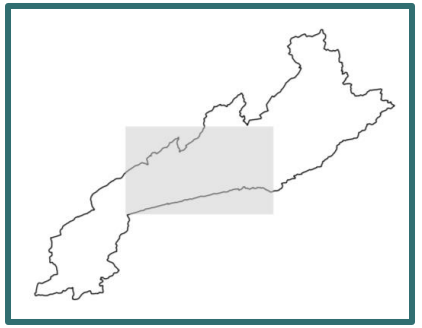
NDVI Percent of Normal

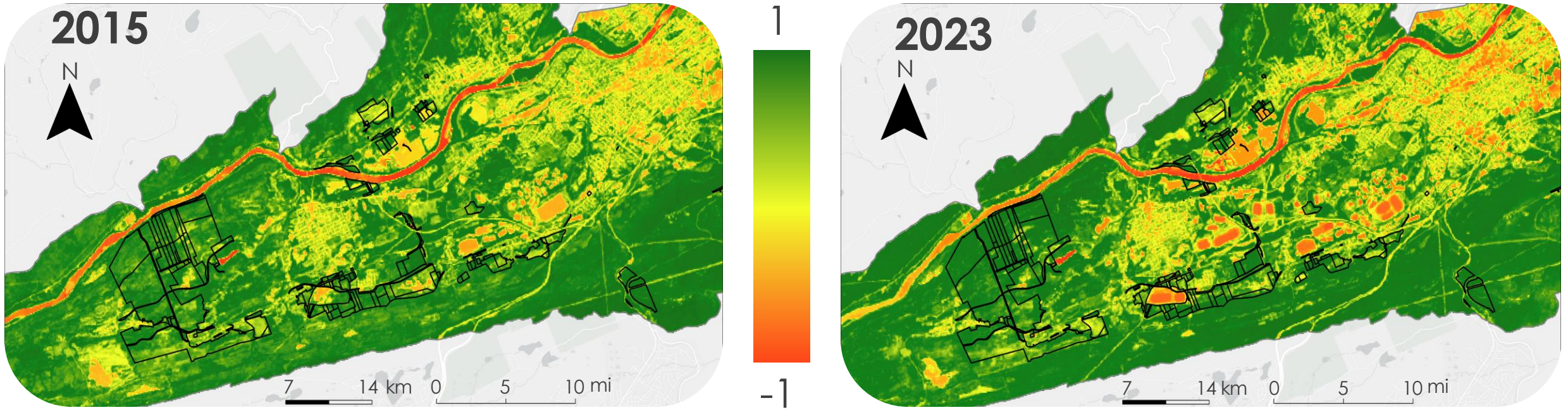
$$\left[\frac{\text{2023 NDVI}}{\text{2015 NDVI}}\right] \times 100$$

Image Credit: NASA

NDVI Results

NDVI May 2015 vs May 2023

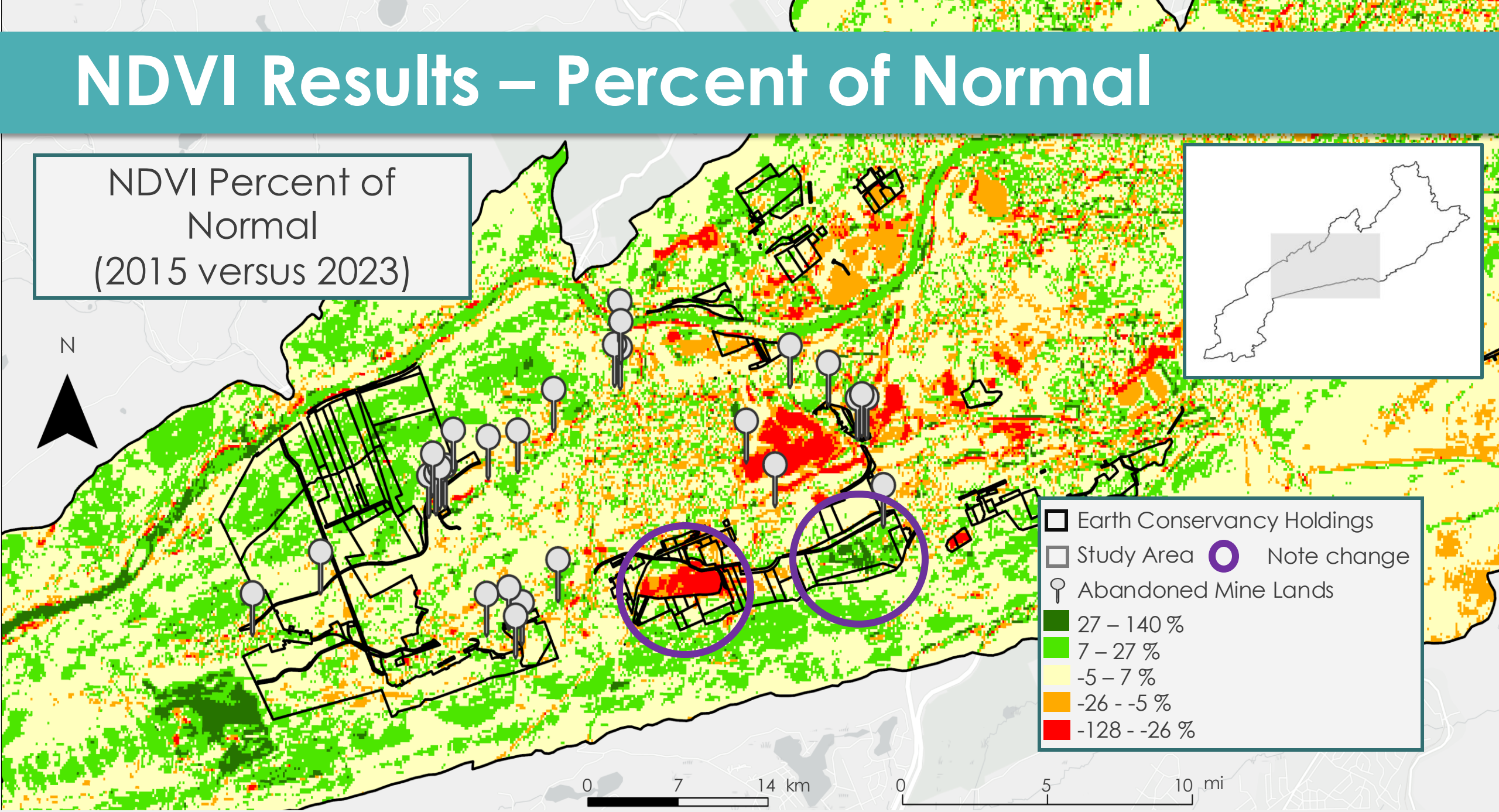




Earth Conservancy Holdings Study Area

Basemap Credit: PSU Office of Physical Plant, data.pa.gov, Esri, TomTom, Garmin, SafeGraph, MET/NASA, EPA, NPS, USDA, USFWS; Image: Famo

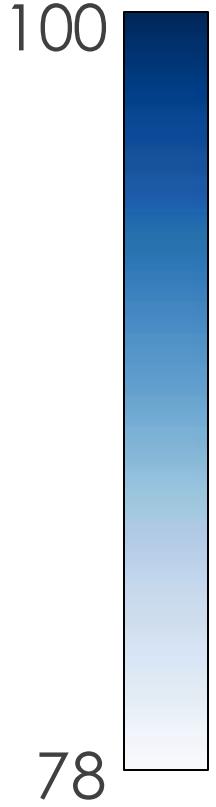
NDVI Results – Percent of Normal



Basemap Credit: PSU Office of Physical Plant, data.pa.gov, Esri, TomTom, Garmin, SafeGraph, MET/NASA, EPA, NPS, USDA, USFWS; Image: Famo

Surface Runoff Methodology

Surface Runoff measures...



Low water infiltration, high runoff potential ie. developed

High water infiltration, low runoff potential ie. forested

NDVI for 2015 & 2023

NDVI x 100 +100

NDVI 8-bit

-0.11 x NDVI +100

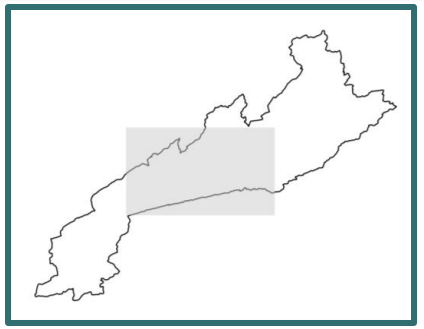
Dynamic Runoff Curve Number (CN)

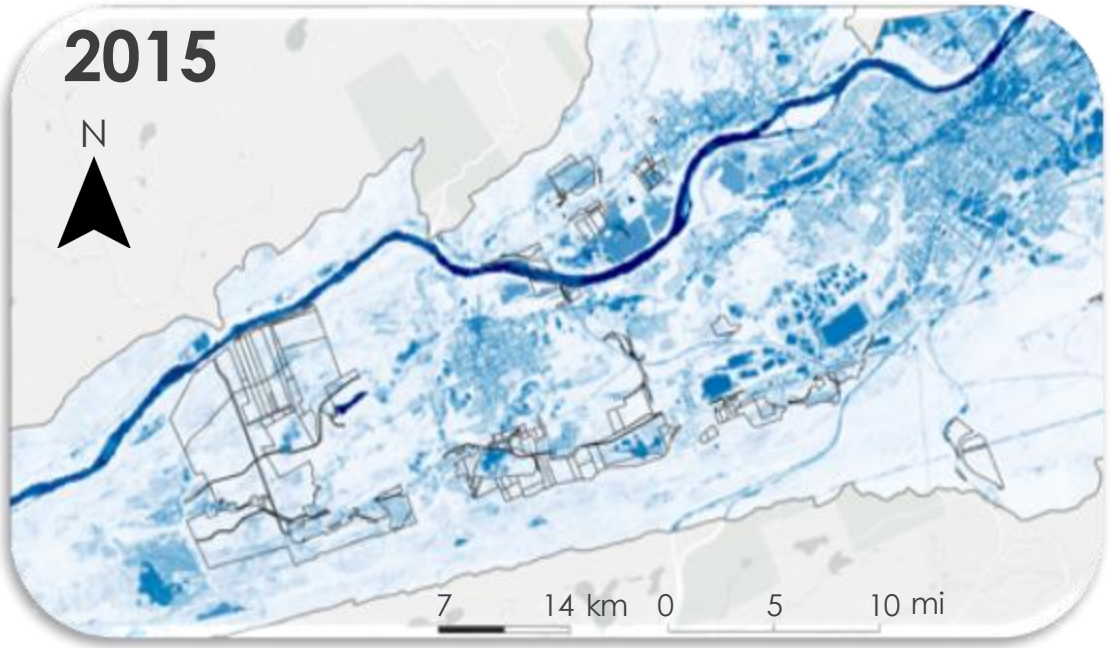
$$\left[\frac{\text{2023 CN}}{\text{2015 CN}}\right] \times 100$$

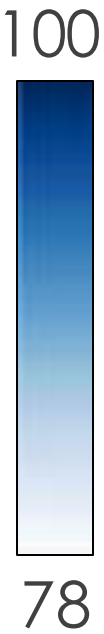
CN Percent of Normal

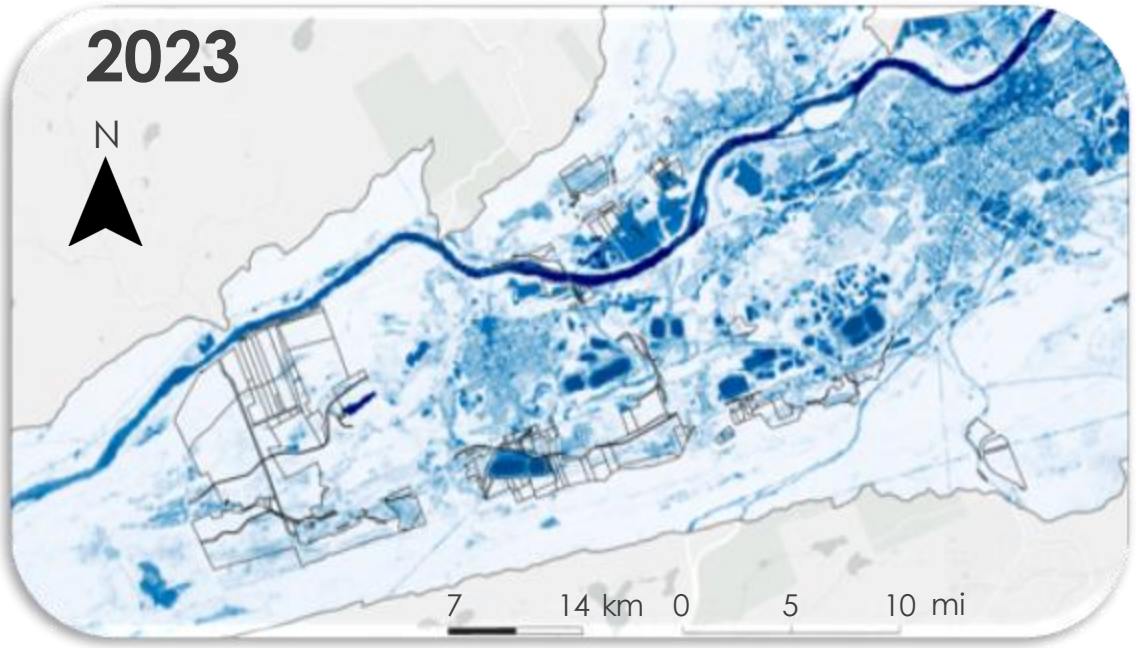
Surface Runoff

Surface Runoff Curve Number
May 2015 vs May 2023









Earth Conservancy Holdings Study Area

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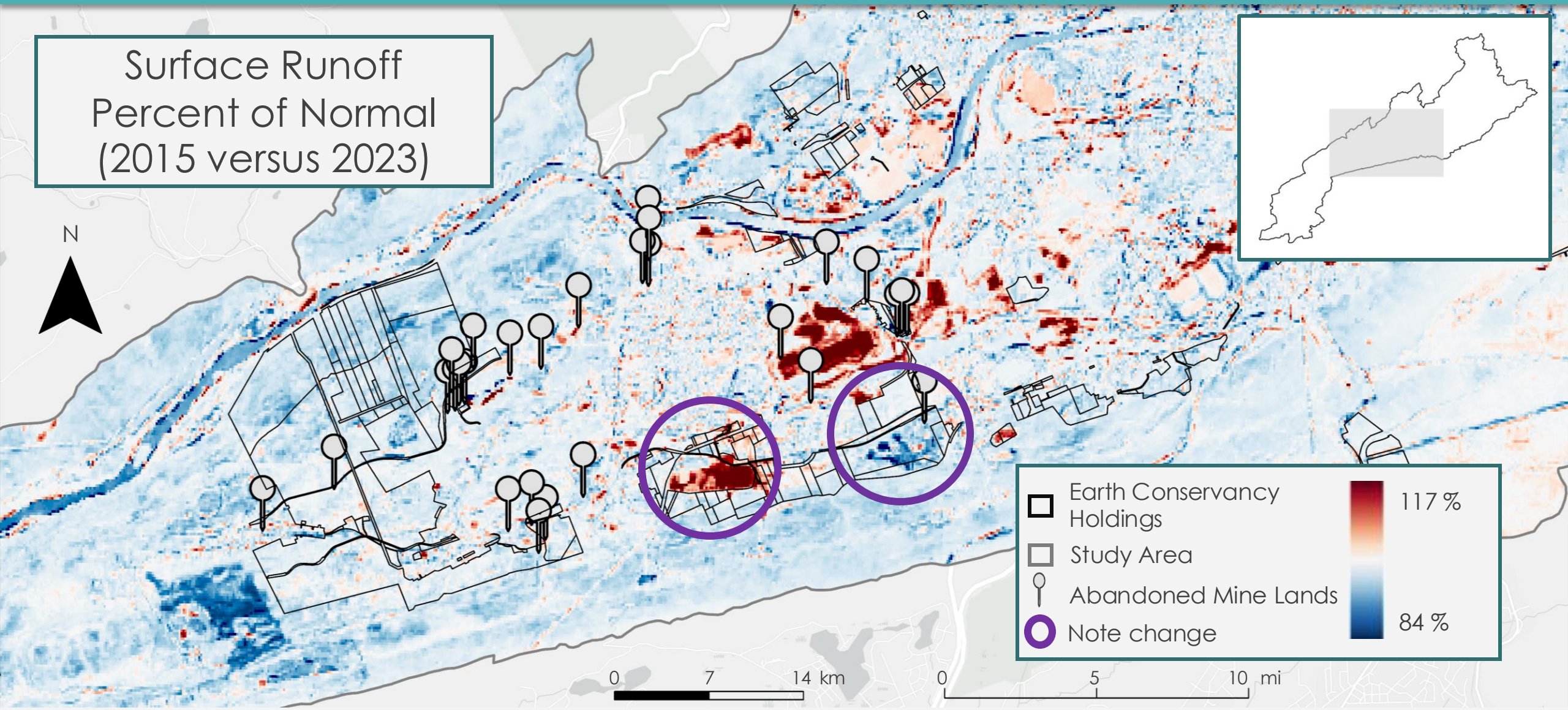
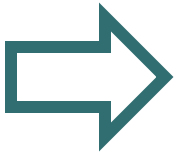
Surface Runoff



Basemap Credit: PSU Office of Physical Plant, data.pa.gov, Esri, TomTom, Garmin, SafeGraph, MET/NASA, EPA, NPS, USDA, USFWS; Image: Famo

Social Vulnerability Methodology

Data Acquisition		
EPA IRA 1.0	2023	Disadvantaged Areas
EPA IRA 2.0	2024	Disadvantaged Areas
CEJST 1.0	2022	EJ Status Standards
EJ Screen 2.2	2023	Low-Income
EJ Screen 2.3	2024	Low-Income
Earth Conservancy	2024	Abandoned Mine Lands



Identify

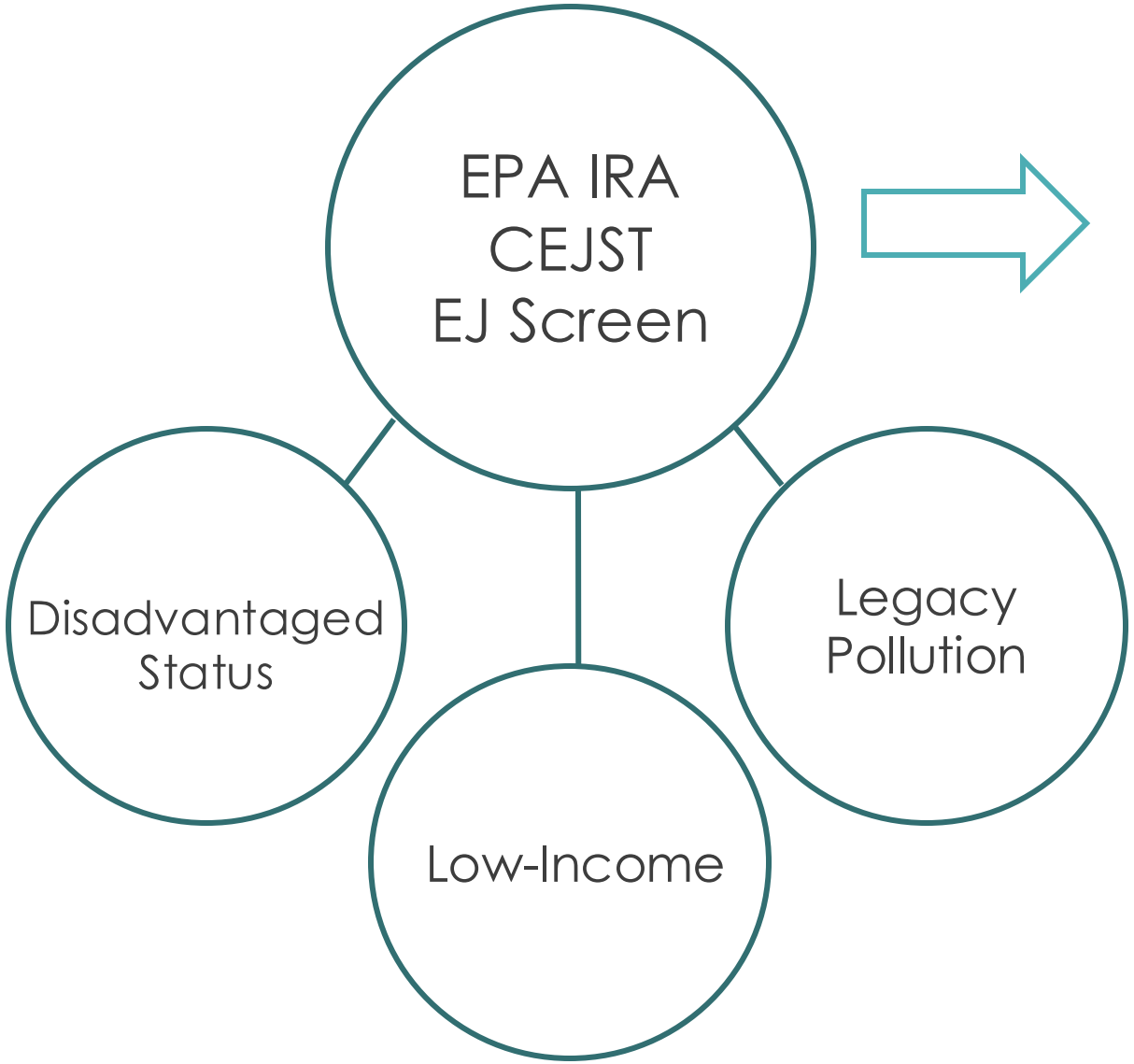
Added | Removed

Retained Status | No Change

Model

Low-Income 65th percentile & Abandoned Mine Lands

Social Vulnerability Methodology

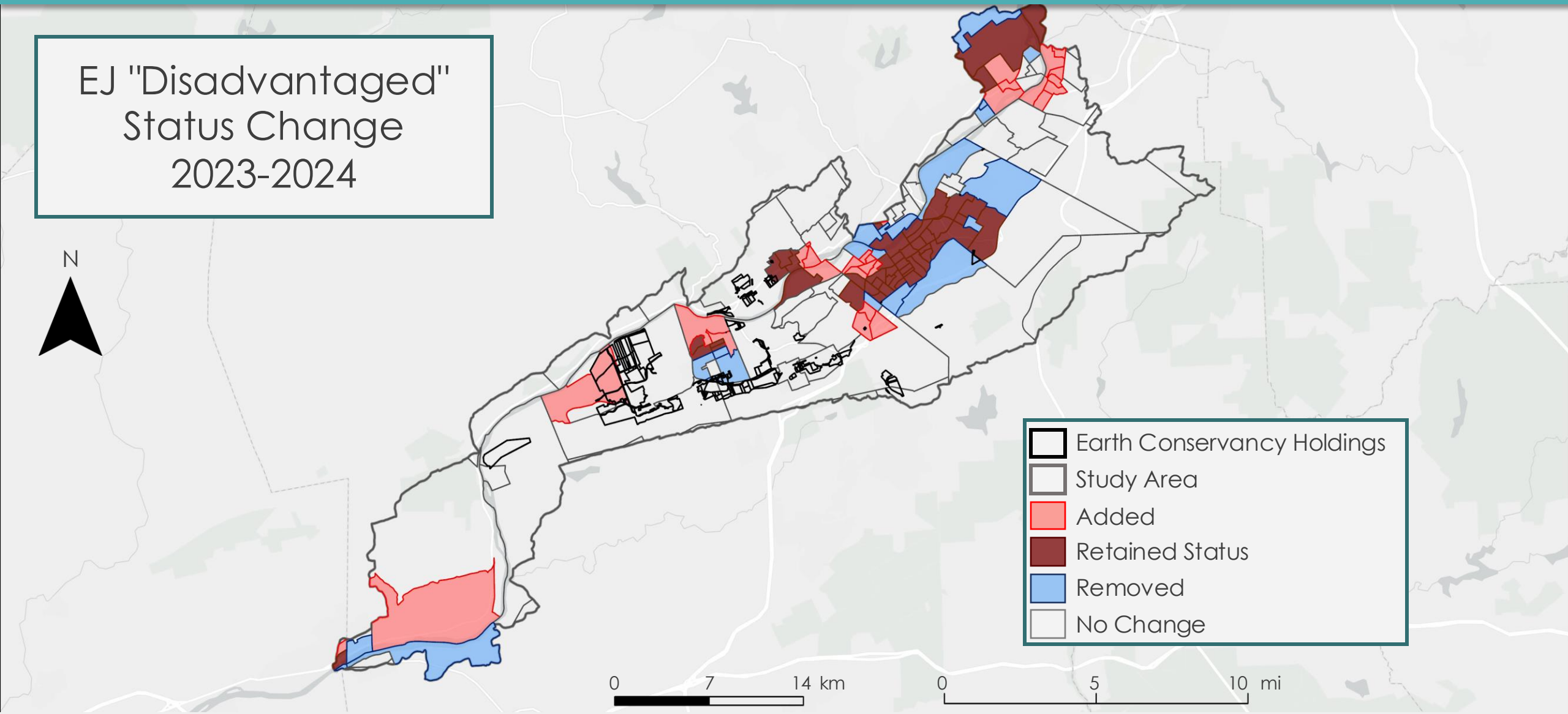


Identify
Added | Removed
Retained Status | No Change

Model
Low-Income 65th percentile & Abandoned Mine Lands

Social Vulnerability Results

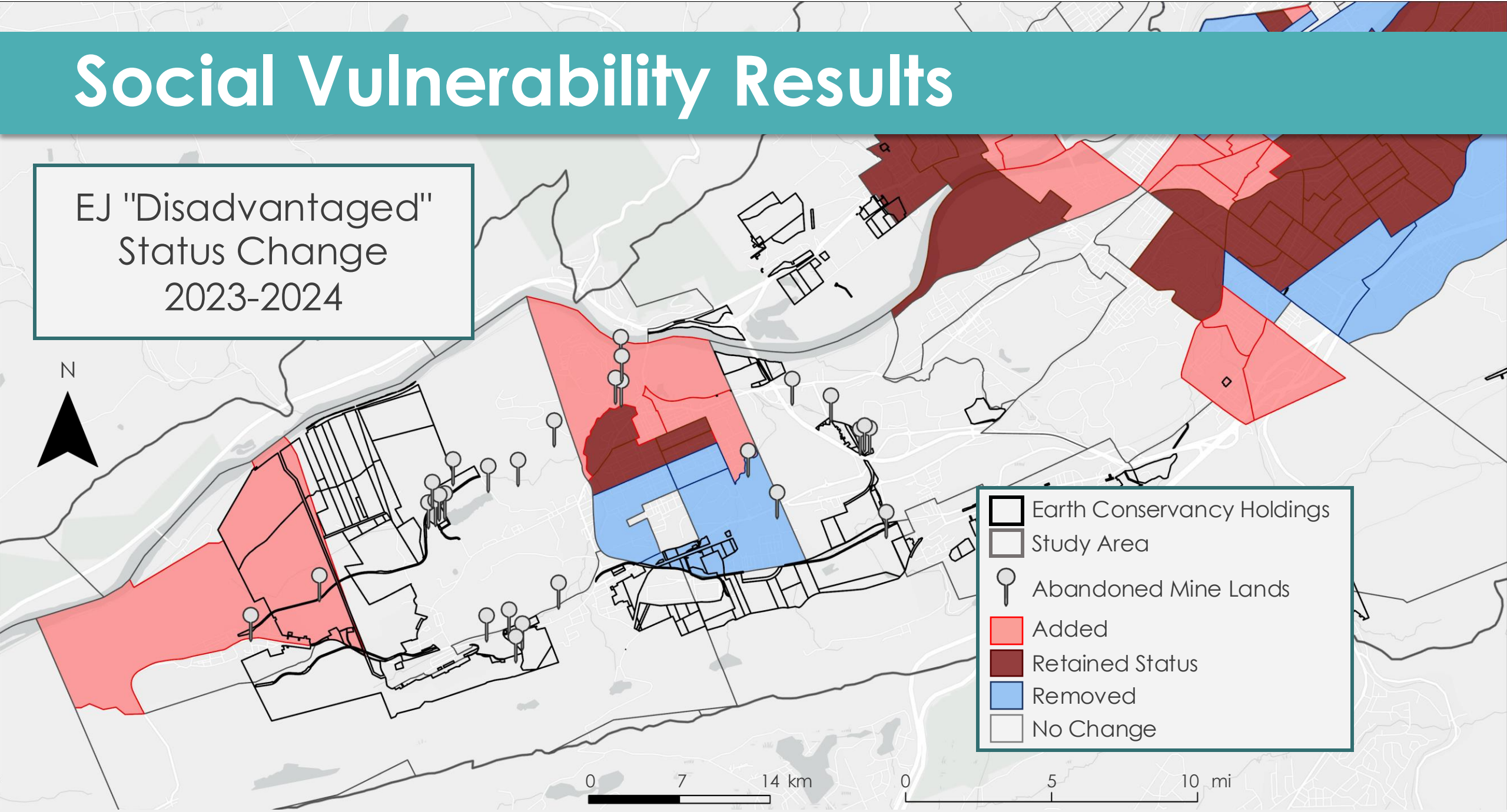
EJ "Disadvantaged" Status Change 2023-2024



Basemap Credit: PSU Office of Physical Plant, data.pa.gov, Esri, TomTom, Garmin, SafeGraph, MET/NASA, EPA, NPS, USDA, USFWS; Image: Famo

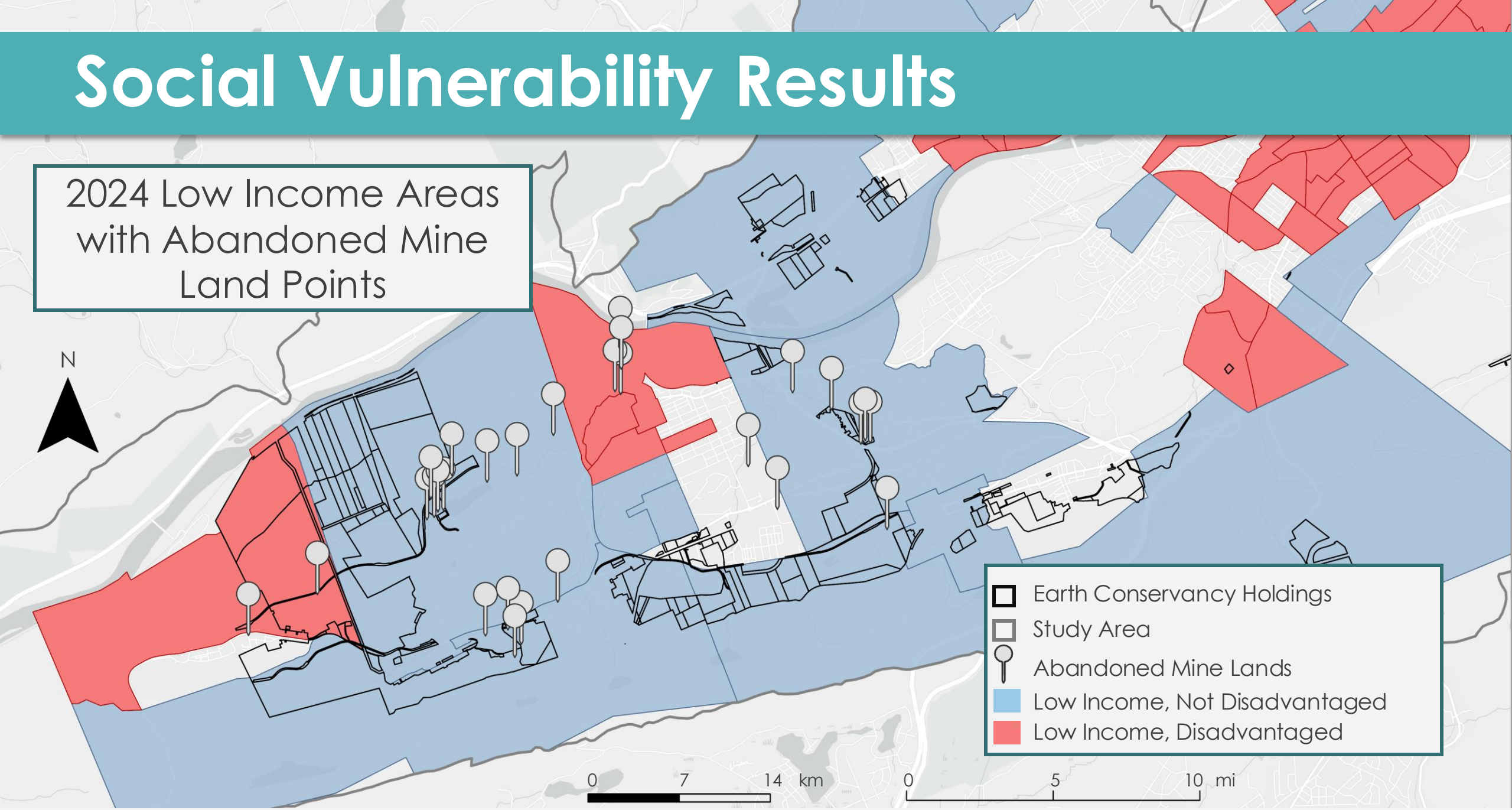
Social Vulnerability Results

EJ "Disadvantaged" Status Change 2023-2024



Basemap Credit: PSU Office of Physical Plant, data.pa.gov, Esri, TomTom, Garmin, SafeGraph, MET/NASA, EPA, NPS, USDA, USFWS; Image: Famo

Social Vulnerability Results



Basemap Credit: PSU Office of Physical Plant, data.pa.gov, Esri, TomTom, Garmin, SafeGraph, MET/NASA, EPA, NPS, USDA, USFWS; Image: Famo

Errors, Uncertainties, & Limitations

LULC Change

- Variations in green-up time
- Esri supervised classification

NDVI

- Precipitation & temperature variations
- Seasonal NDVI fluctuations
- Inability to characterize aquatic vegetation

Runoff

- Seasonal NDVI fluctuations
- Unable to account for subsurface water movement

Social Vulnerability

- Data availability limitations
- Differing census tract boundaries across indices

Feasibility & Partner Implementation

Assessing Remediation Efforts

Earth observations are feasible for characterizing and identifying changes in LULC, NDVI, and surface runoff

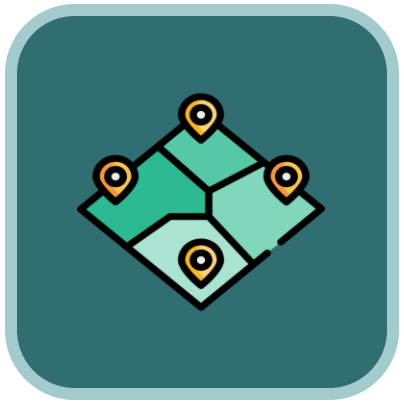
Long-term Landsat data ➡ robust datasets to track acid mining drainage & remediation parameters

Partner Use

LULC, NDVI, and surface runoff ➡ background information on land change

The social vulnerability index ➡ future grant opportunity

Conclusion



Forested land was the largest categorical increase in **land use land cover** in the study area, encompassing reclamation sites.

NDVI and surface runoff change results are consistent with changes in **land use land cover** for major reclamation sites.

Results for **vegetation** and **surface runoff** changes over time are consistent with **one another** on a small spatial resolution scale.

Federal **environmental justice indices** do not account for all low-income communities with abandoned mine lands within their boundaries.

Image Credits: Freepik, Eucalyp, Maan Icons

Acknowledgments

We acknowledge that our research takes place on the occupied territory of the Munsee Lenape and Susquehannock peoples.

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Partners

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NASA DEVELOP

Center Lead: Lauren Webster (California – Ames)

Project Coordination Editors: Brent Bowler (Virginia – Langley), Maya Hall (California – Ames)

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