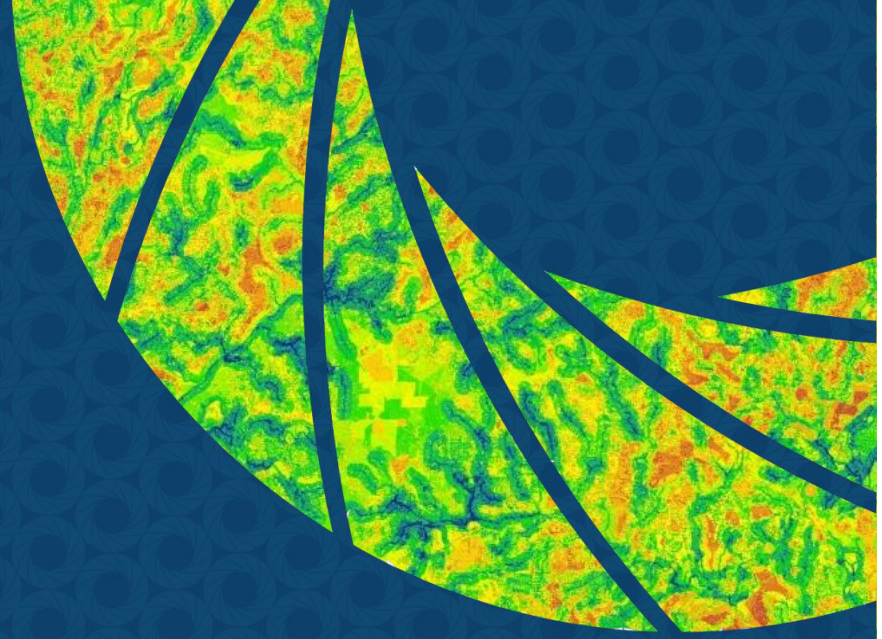


Atlanta Water Resources

Identifying Key Urban Areas to Reduce Stormwater Runoff and Maximize Conservation Efforts in Metropolitan Atlanta

National Aeronautics and Space Administration

Project Lead:
Christopher Cameron

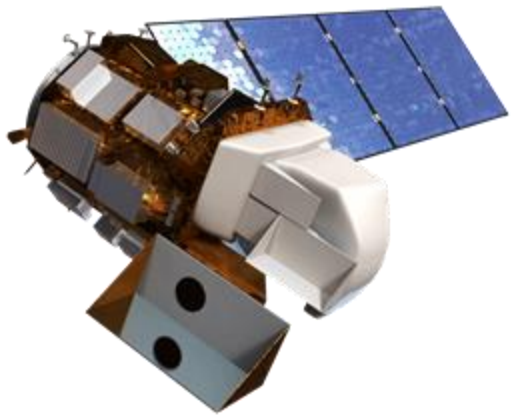
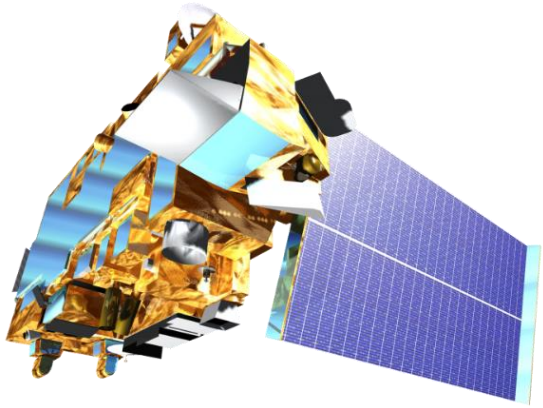
Project Team Members:
Amanda Aragon
Ike Sari Astuti
Natalia Bhattacharjee
Alys Hannum
Doori Oh
Kamalakanta Sahoo

Science Advisors:
Rosanna Rivero
Marguerite Madden
Adam Milewski

TNC Project Partners:
Sara Gottlieb
Myriam Dormer

Project Overview

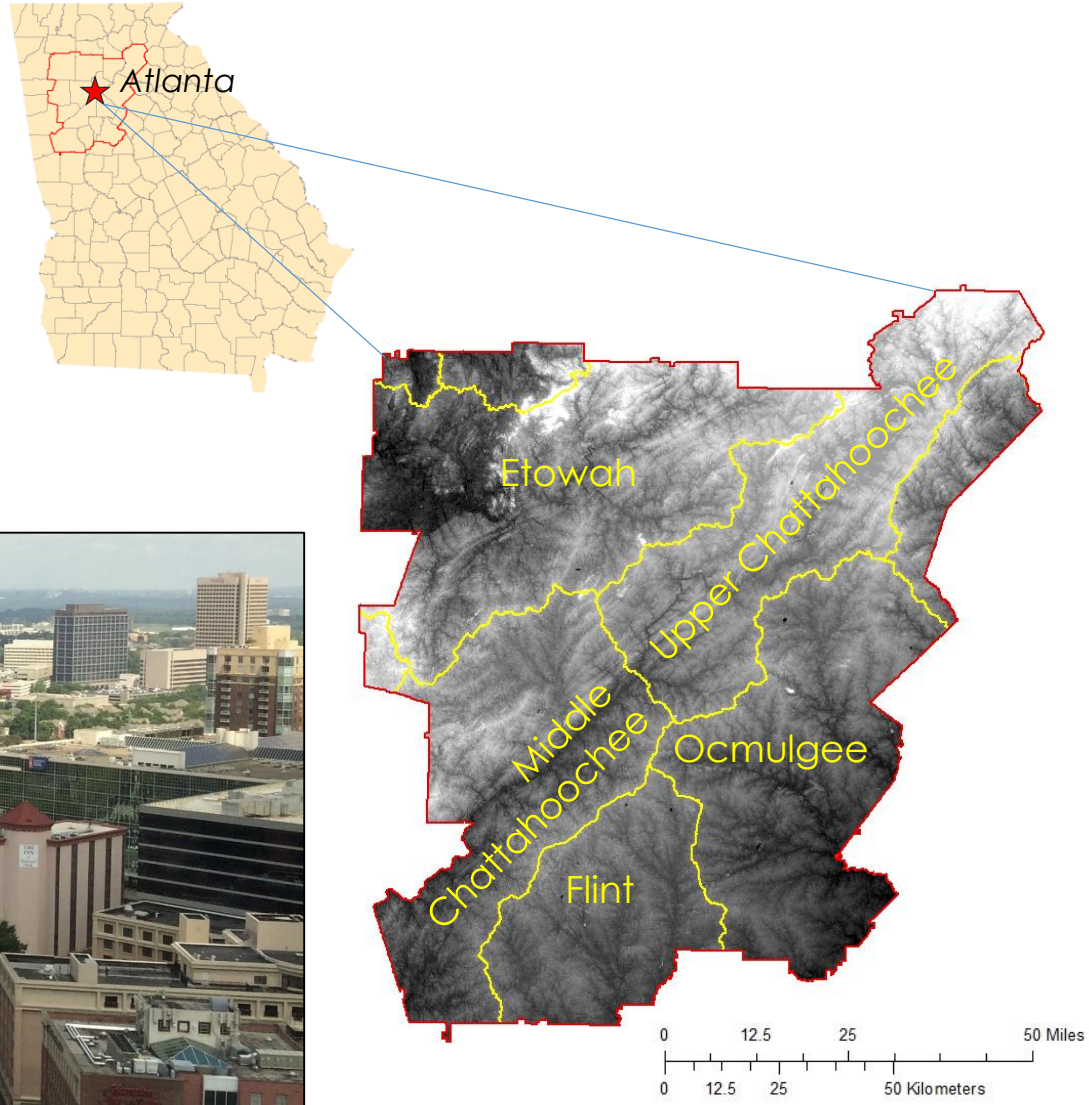
- **Identify** reforestation targets to help reduce harmful stormwater runoff
- **Integrate** NASA Earth Observation data into a multi-input spatial analysis
- **Analyze** watershed processes using the **Soil Water Assessment Tool (SWAT)**
- **Model** multiple land allocation scenarios for reforestation purposes using the **Land Use Conflict Identification Strategy (LUCIS)**


Study Area & Period

- Metropolitan North Georgia Water Planning District (**MNGWPD**)
  - **15 counties** (~ 12,000 km^2)
  - **9 major watersheds**

- Contains the greater Atlanta area
  - Population of approximately **5.2 million** (U.S. Census, 2010)



Community Concerns

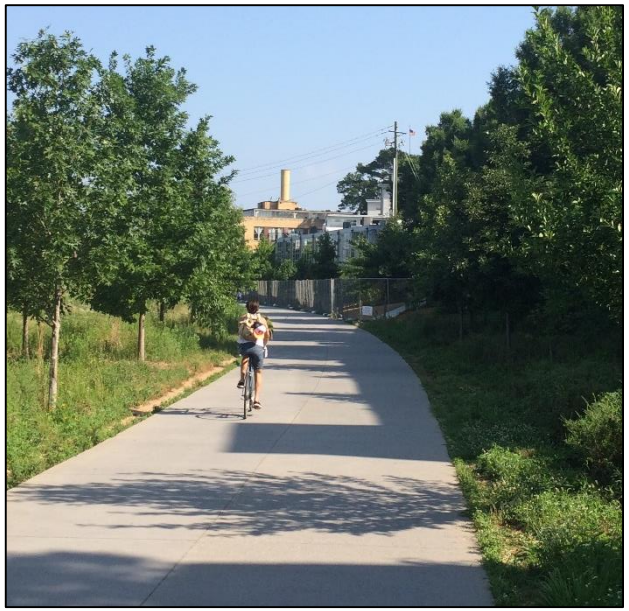
Image credit: David Cotten

- **Rising** cost of municipal water management in metro Atlanta
- **Growth** of Atlanta exacerbates stormwater management problems
- **Increased** impervious surface cover could mean more pollution entering waterways

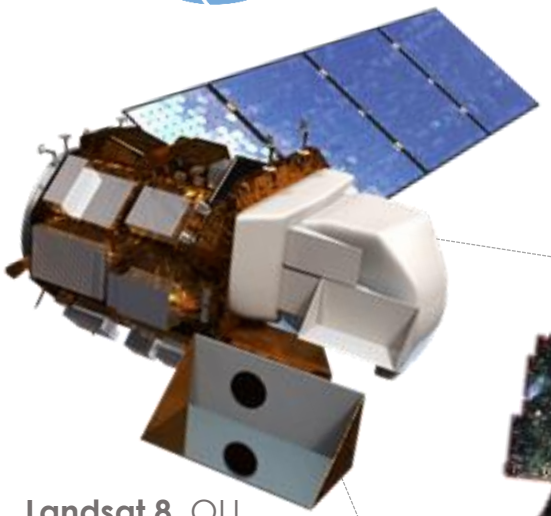
Green Infrastructure & Reforestation

- **Green infrastructure** refers to a network of forests, wildlife habitats, parks, and natural areas within urban landscapes (McMahon, 2000)
- Acts as a natural remediator and is a cost-effective tool for managing water quality in cities (Livesly et. al., 2011)
- Provides recreational services, improves air quality, and enhances biodiversity

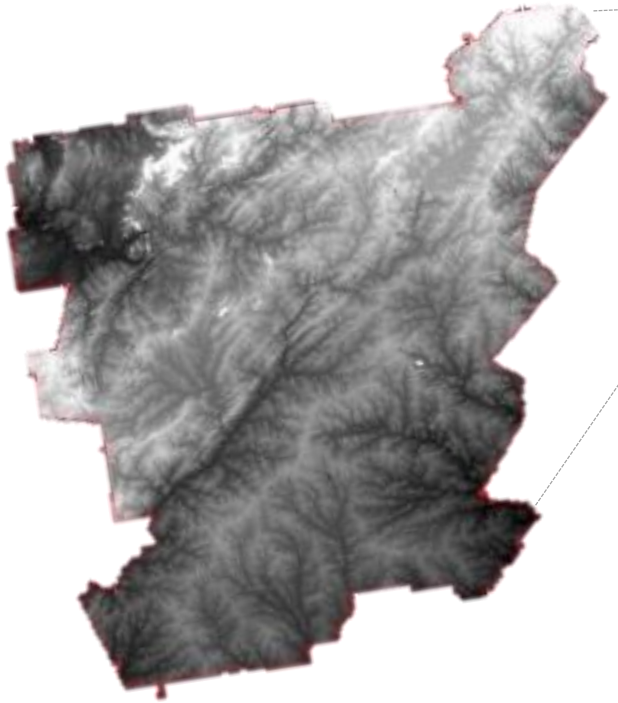
Image credit: David Cotten

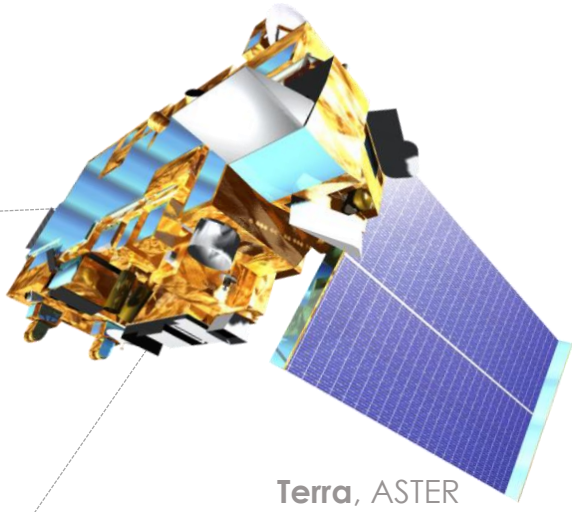


NASA Earth Observing Systems



Landsat 8, OLI





Terra, ASTER

Landsat 8 and **Terra** satellites were utilized in this project to produce land cover and topographic datasets

2015 Land Cover Classification

Processing

- Mosaic
- Atmospheric Correction

Classification

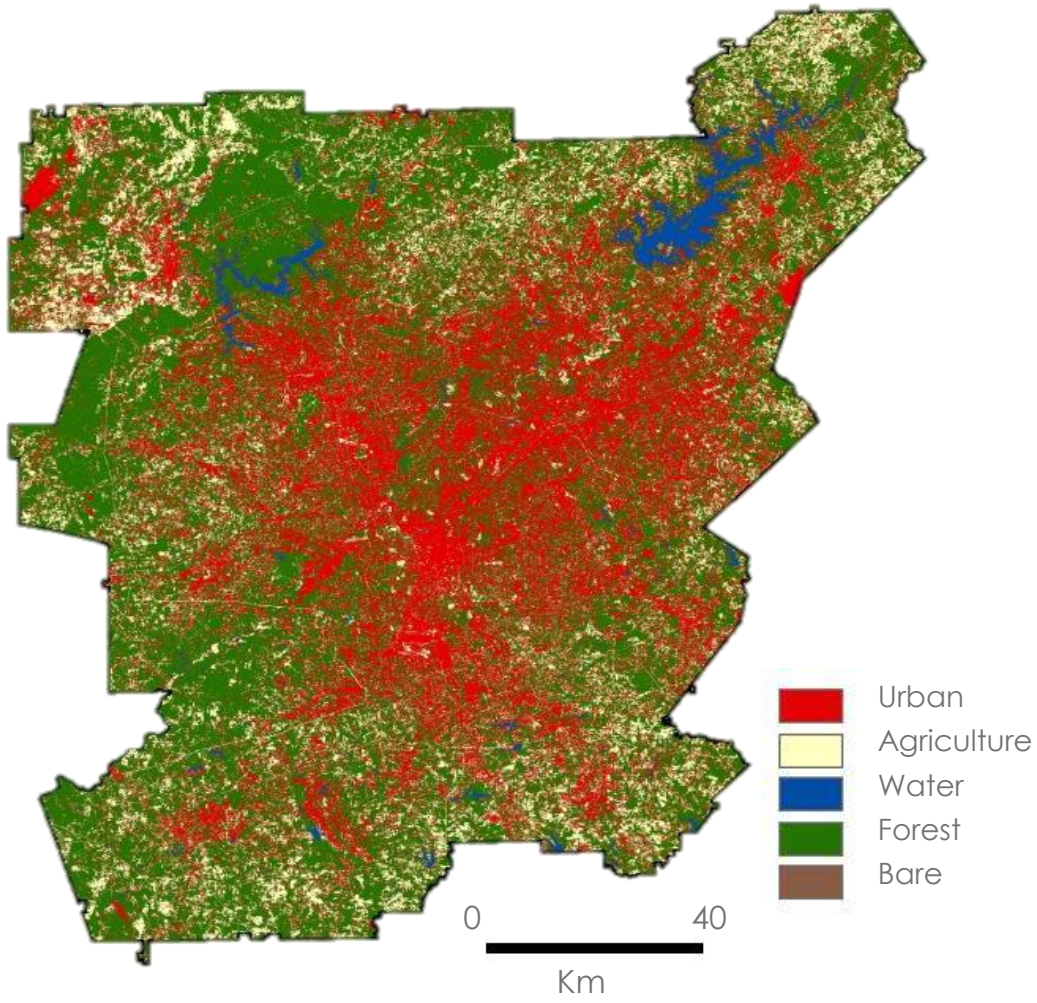
- Training Sets
- Maximum Likelihood Classification

Validation

- Accuracy Assessment
- Confusion Matrix

End-Product

- Supervised 2015 Land Cover Classification



2015 Land Cover Classification

	Urban	Agriculture	Water	Vegetation	Bare Land	User Accuracy
Urban	**25**	2	0	6	0	76%
Agriculture	6	**31**	0	4	7	65%
Water	0	0	**6**	0	0	100%
Vegetation	2	1	0	**57**	1	93%
Bare Land	0	1	0	0	**2**	67%
Producer Accuracy	78%	89%	100%	85%	20%	**81%**
					Kappa	**0.75**

- From 2001 to 2015, approximately one-third of this area (4,000 km^2) experienced a change in land cover
- Almost half of all land cover change was deforestation

Data-Driven Suitability Analysis

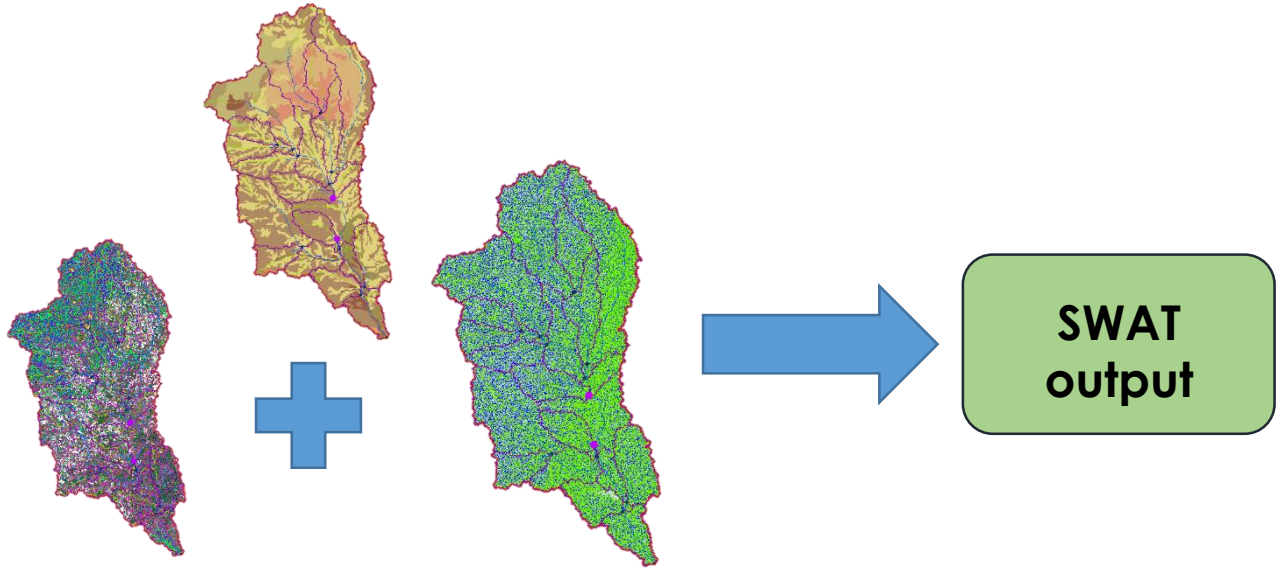
- **SWAT** combines weather, surface runoff, evapotranspiration, and water storage data to characterize hydrologic processes

- **LUCIS** integrates a broad range of input datasets to create suitability data layers based on defined goals and objectives for primary land use allocations

- Both of these models can be adapted to incorporate a range of spatial data inputs

The SWAT Model

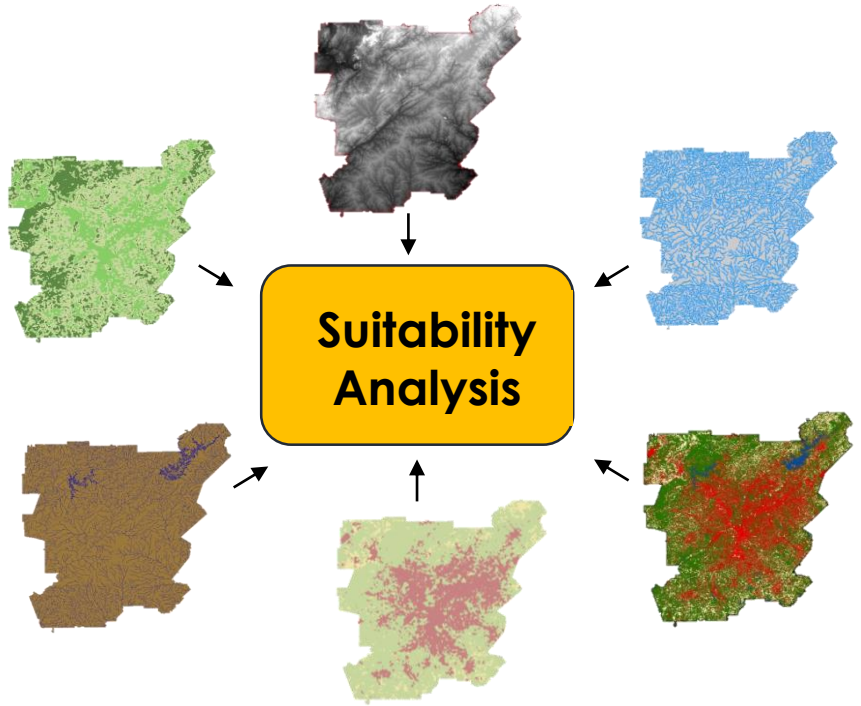
Soil Water Assessment Tool (SWAT)



- **Delineates** watersheds and their sub-basin from chosen location utilizing a DEM
- **Incorporates** soil data to best model the interaction between soil properties and precipitation.
- **Produces** hydrological model of water-related processes in watersheds
- **Quantifies** the effect of land use and management on ecosystems to inform best management practices

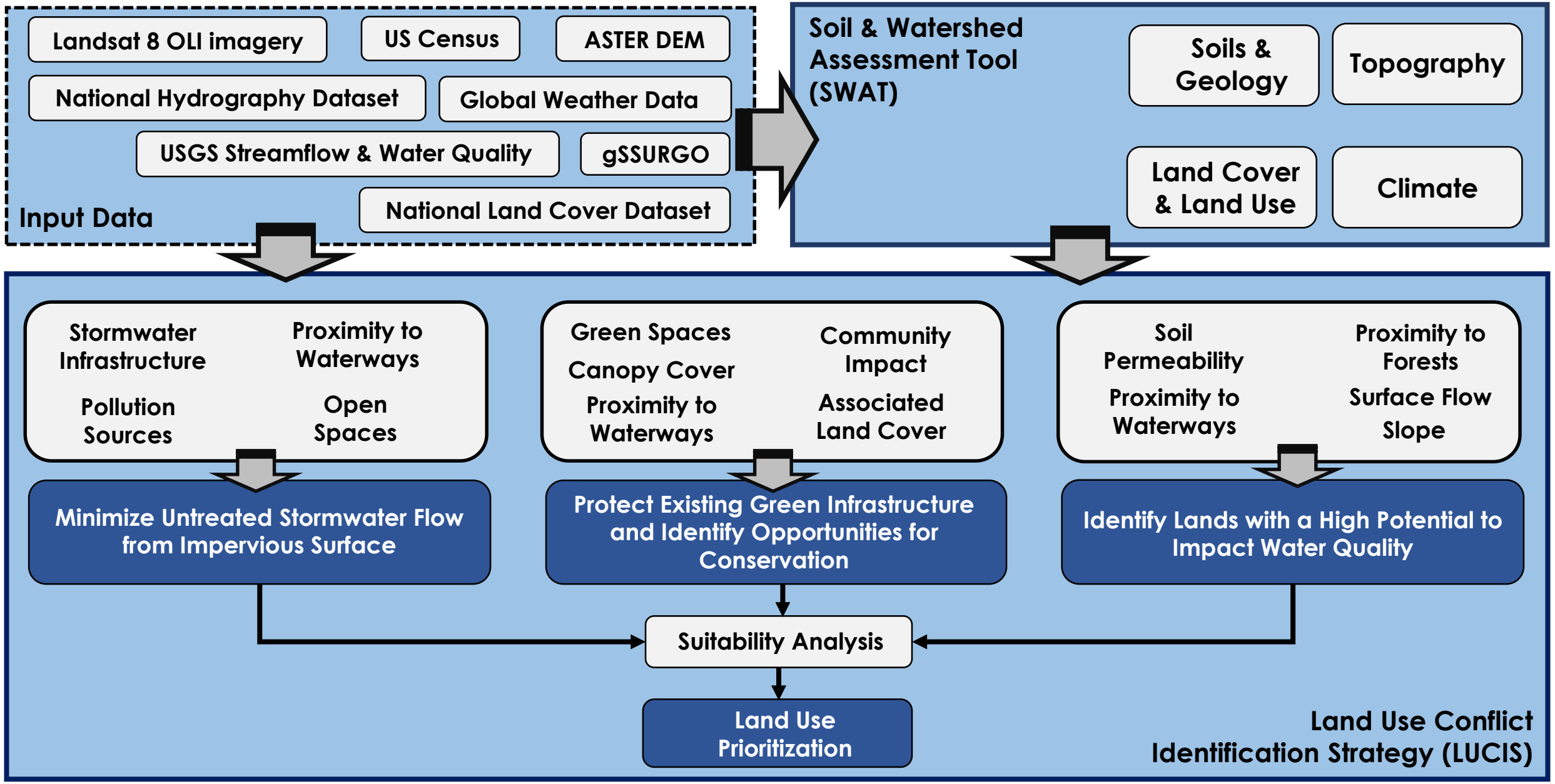
The LUCIS Model

Land Use Conflict Identification Strategy (LUCIS)

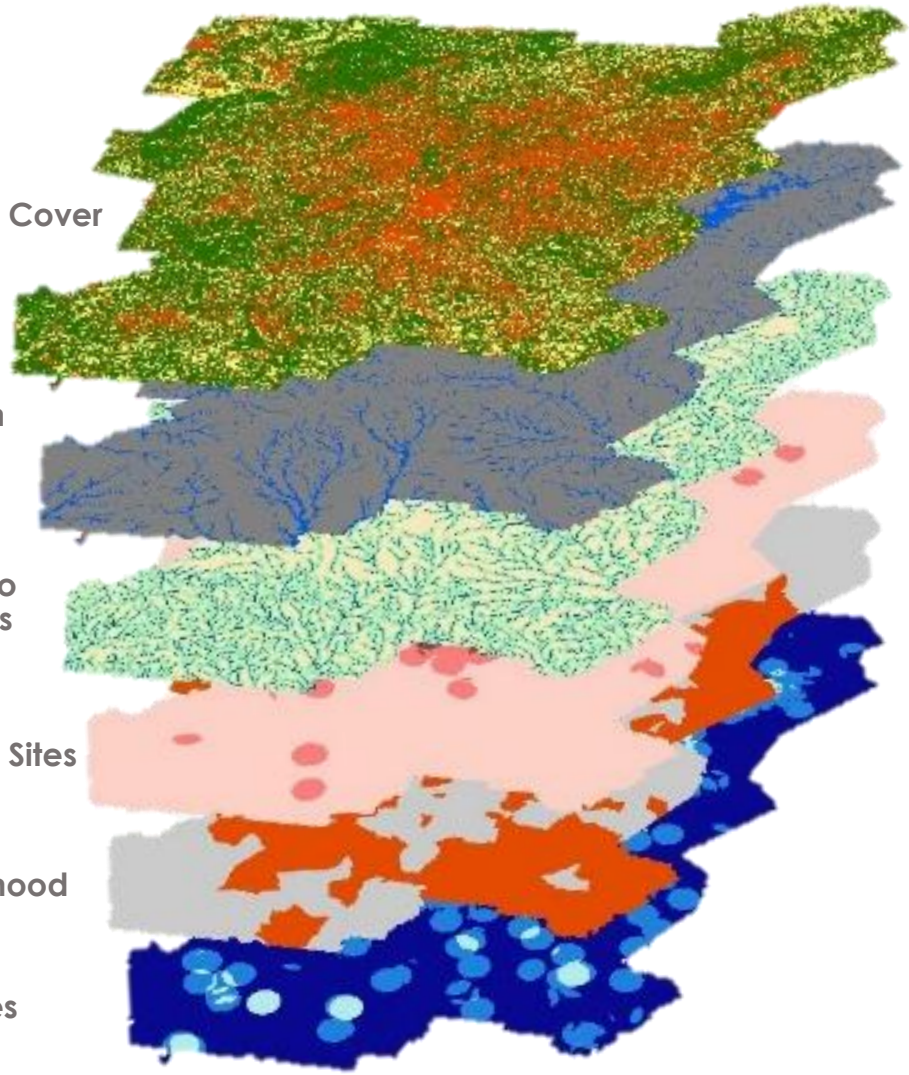


- **Integrates** input datasets to create suitability data layers based on defined goals and objectives
- **Locates** areas of potential land use conflict based on suitability prioritization and ranking
- **Produces** flexible land use allocation scenarios based on goals and objectives that can be easily adapted

A Data-Driven Approach To Suitability Analysis



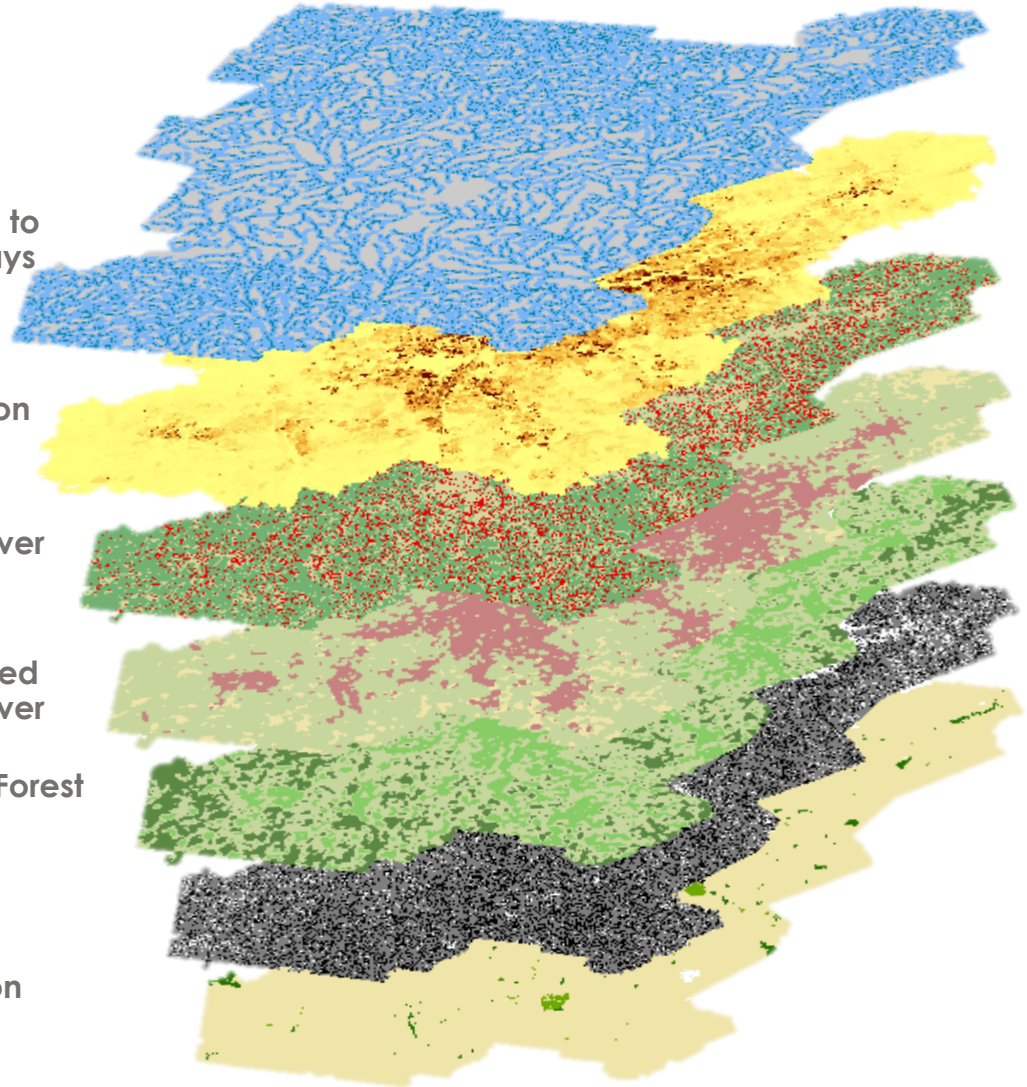
Minimize Untreated Flow from Impervious Surfaces



Objectives:

1. Identify locations that contribute pollutants by point source
2. Identify superfund sites, abandoned, and open bare land
3. Identify areas of high impervious surface not currently served by green infrastructure
4. Identify regions in close proximity to waterways
5. Identify areas of greater preference or suitability for development

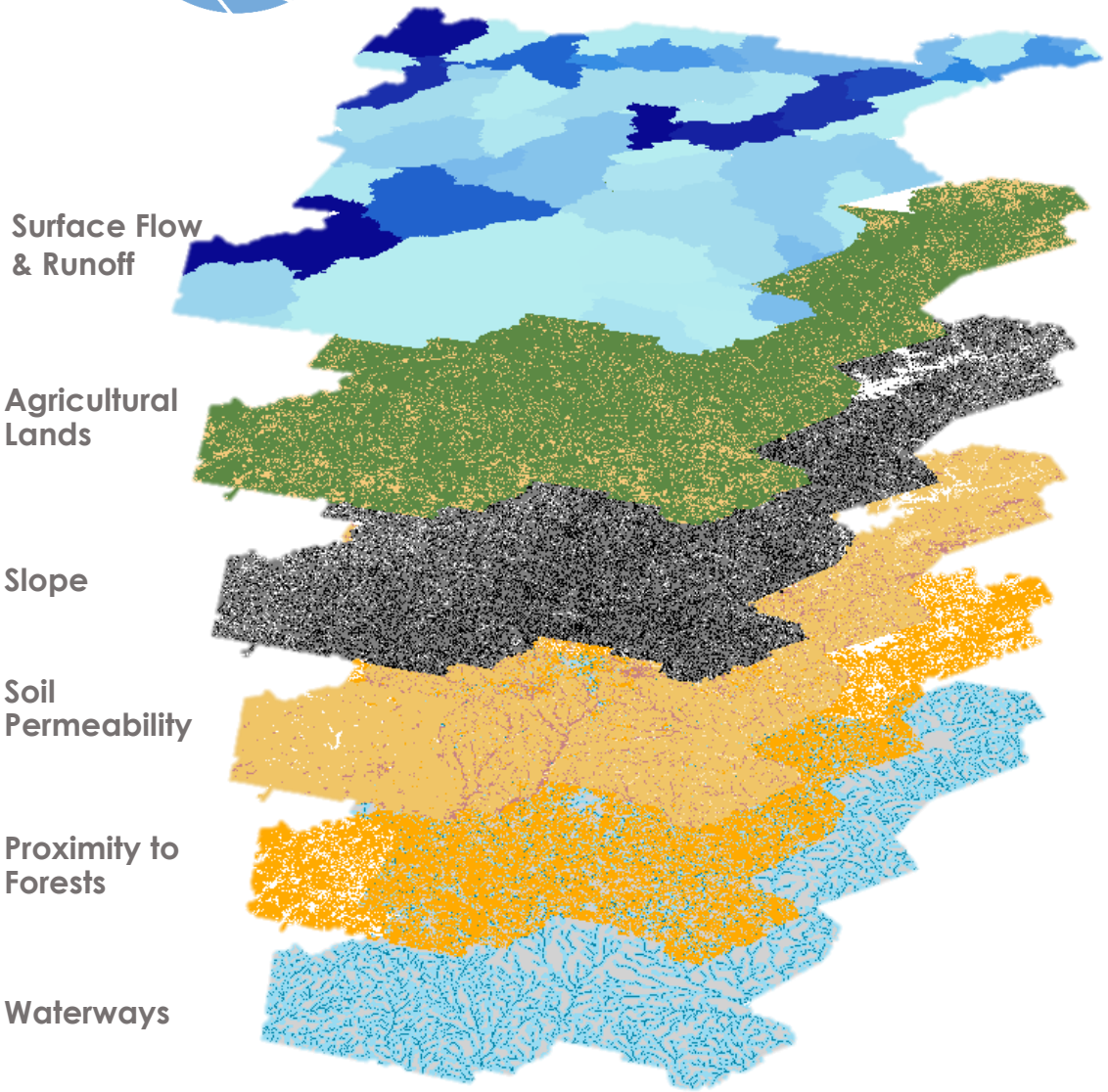
Protect Green Spaces & Identify Conservation Areas



Objectives:

1. Identify existing protected areas/green spaces
2. Analyze existing proportions of local vegetation and forests
3. Identify associated land cover types for potential reforestation areas
4. Identify regions in close proximity to waterways
5. Prioritize reforestation targets

Identify Lands with Potential to Impact Water Quality



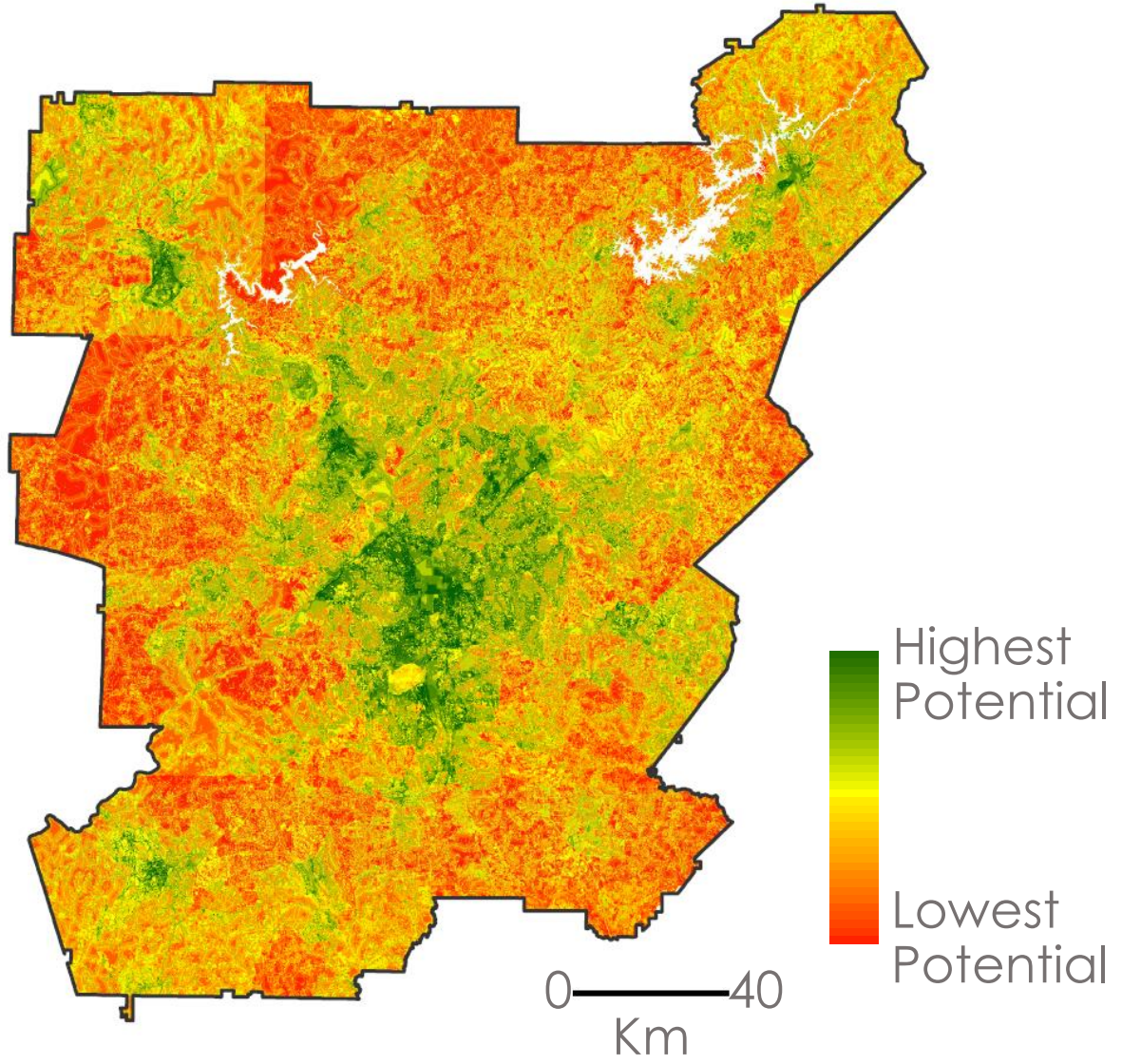
Objectives:

1. Identify regions in close proximity to waterways
2. Identify regions with high topographic gradients
3. Identify regions with highly permeable soils
4. Identify agricultural land in close proximity to forest cover

Results: LUCIS Goals

Minimizing Untreated Stormwater Flow From Impervious Surfaces

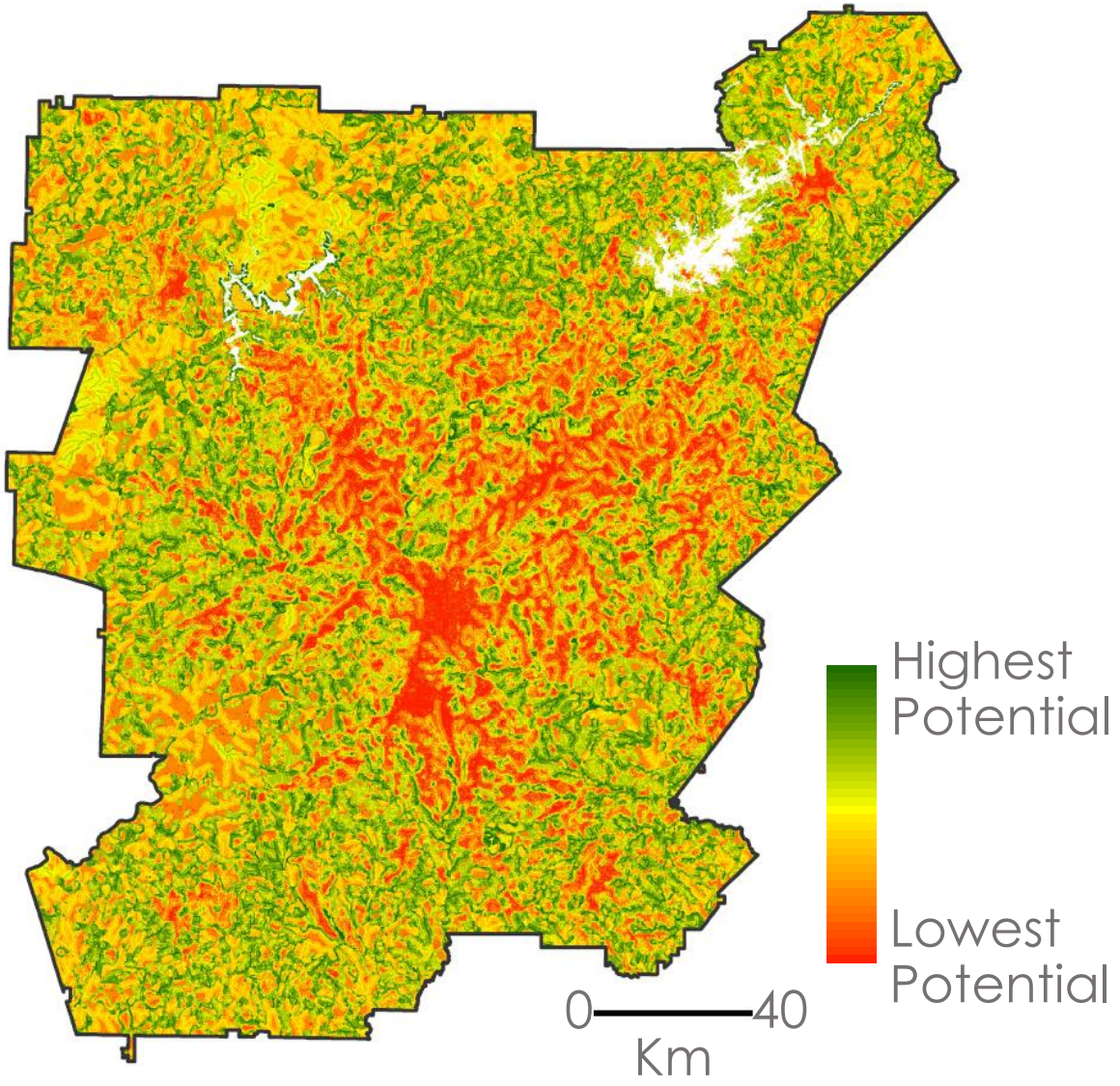
- Atlanta and its suburbs are major sources of impervious surface and stormwater runoff
- These regions also represent areas with the highest potential to minimize stormwater flow through development of green infrastructure



Results: LUCIS Goals

Protecting Existing Green Infrastructure and Identify Reforestation Opportunities

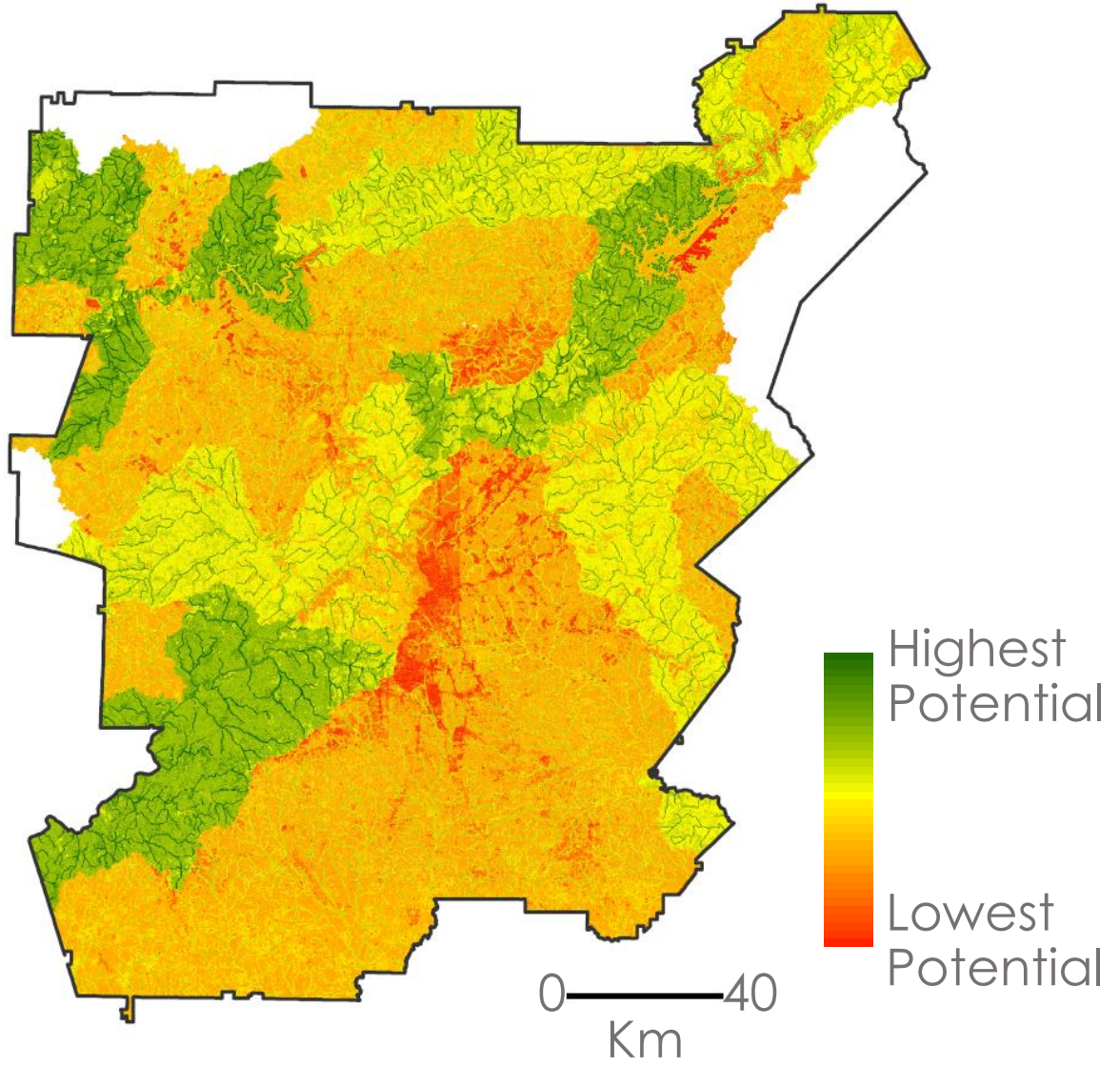
- Reforestation and green space development opportunities exist along several waterways adjacent to Atlanta
- Existing protected areas or forests can be expanded to help promote this strategy as an alternative to municipal infrastructure



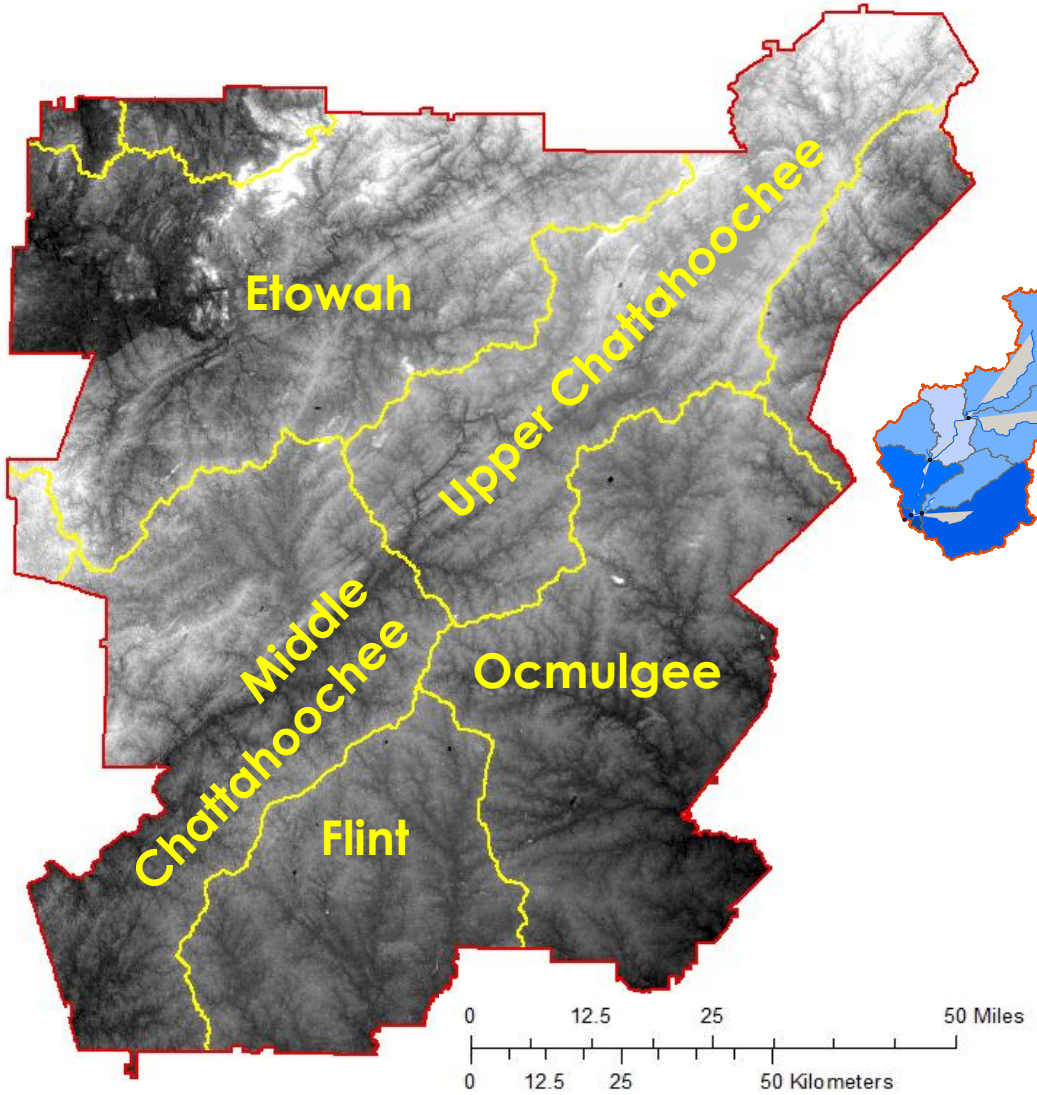
Results: LUCIS Goals

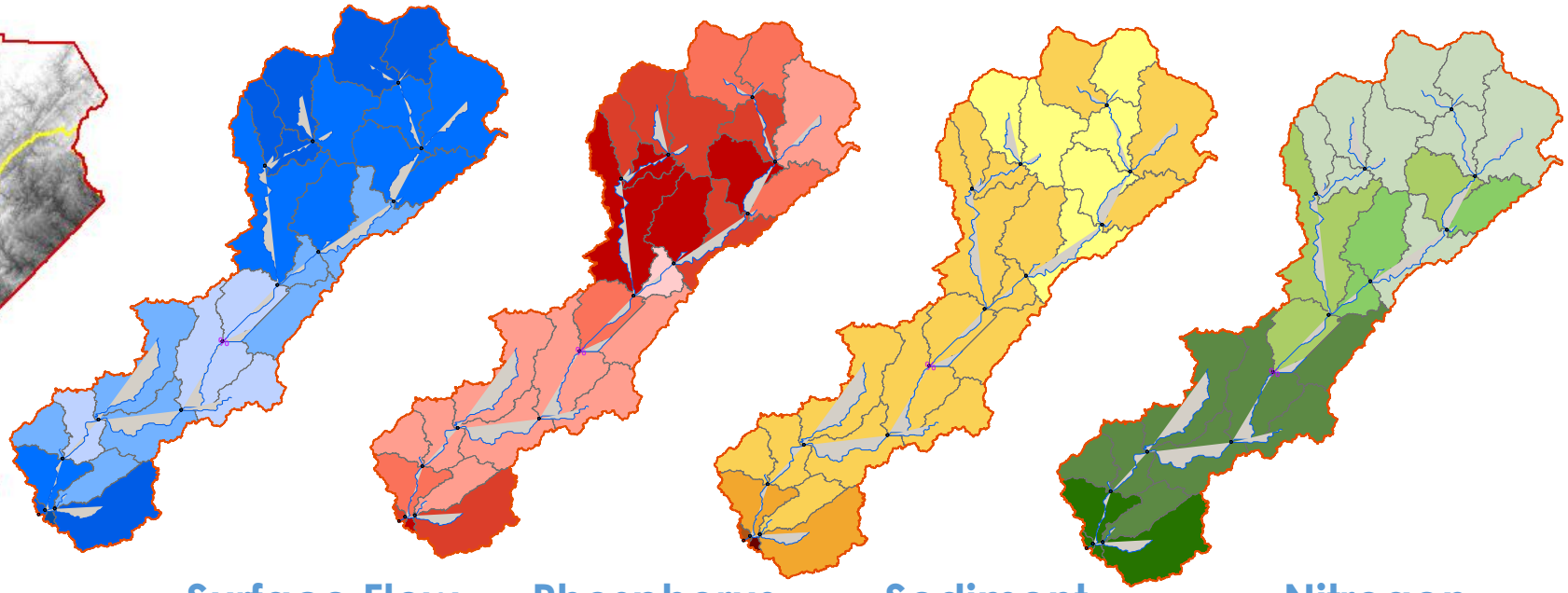
Identifying Managed Lands with a High Potential to Impact Local Water Quality

- The majority of open land (agriculture) with the highest potential to affect water quality occurs north of Atlanta
- Downstream effects of land management practices at these locations could be significant



SWAT Results: Water Quality & Runoff





Surface Flow

m^3/s

Low

High

Phosphorus

kg/ha

Low

High

Sediment

tons/ha

Low

High

Nitrogen

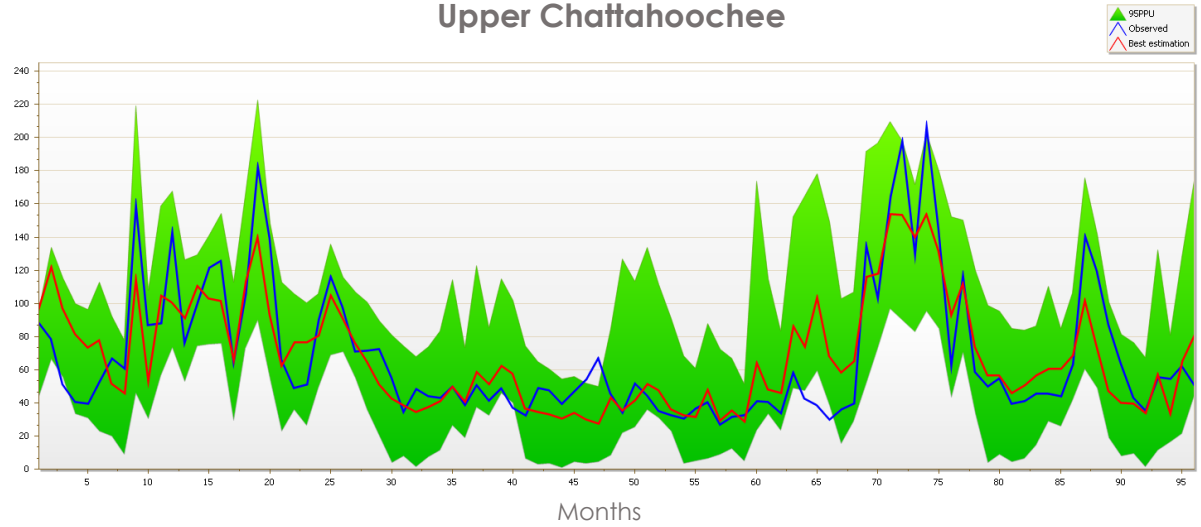
kg/ha

Low

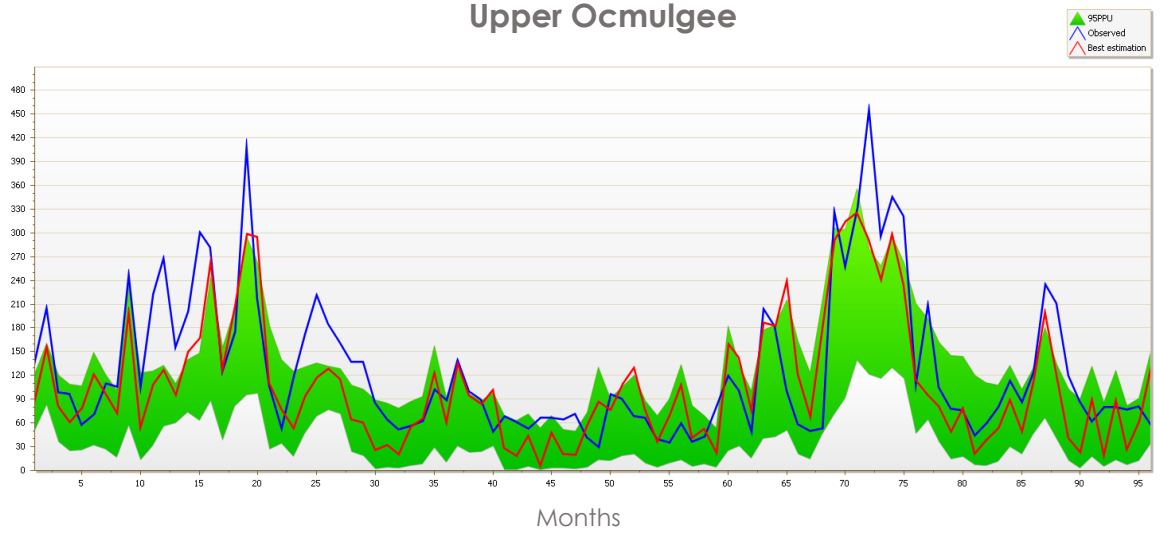
High

SWAT Results: Flow Calibration

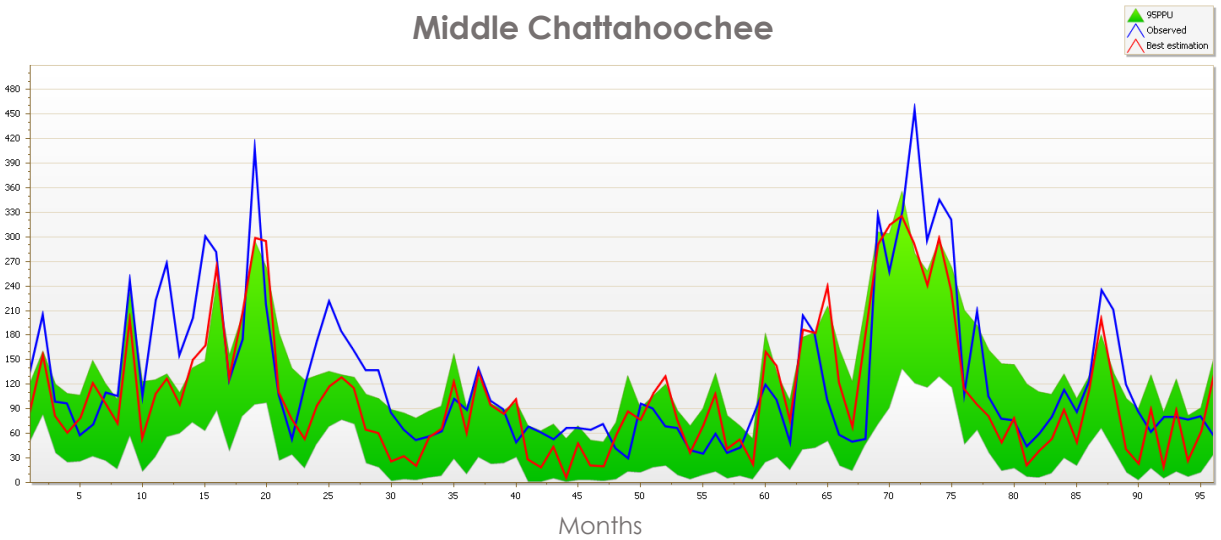
Upper Chattahoochee



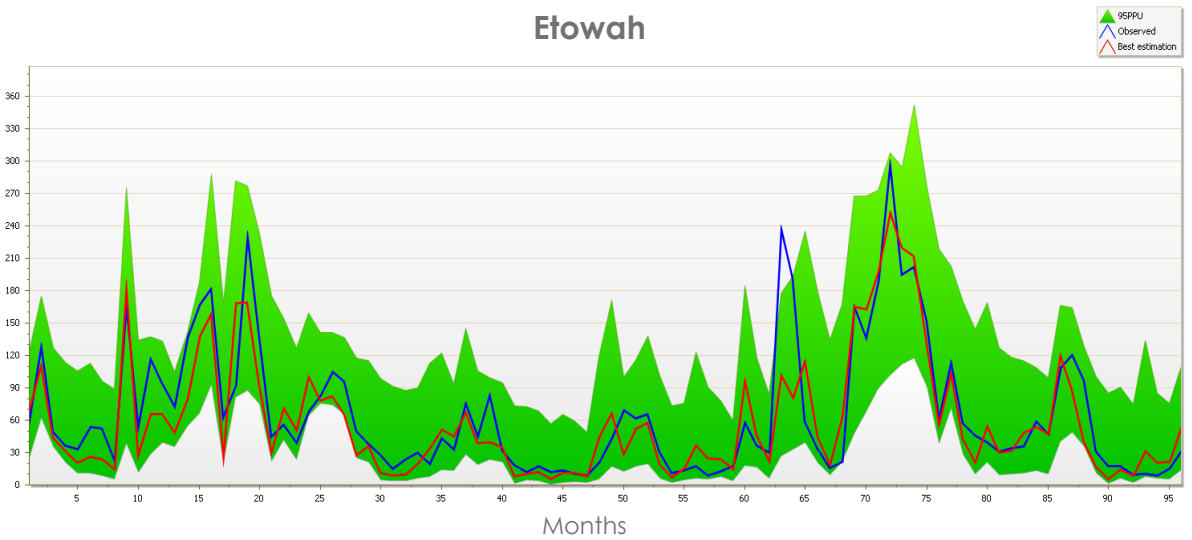
Upper Ocmulgee



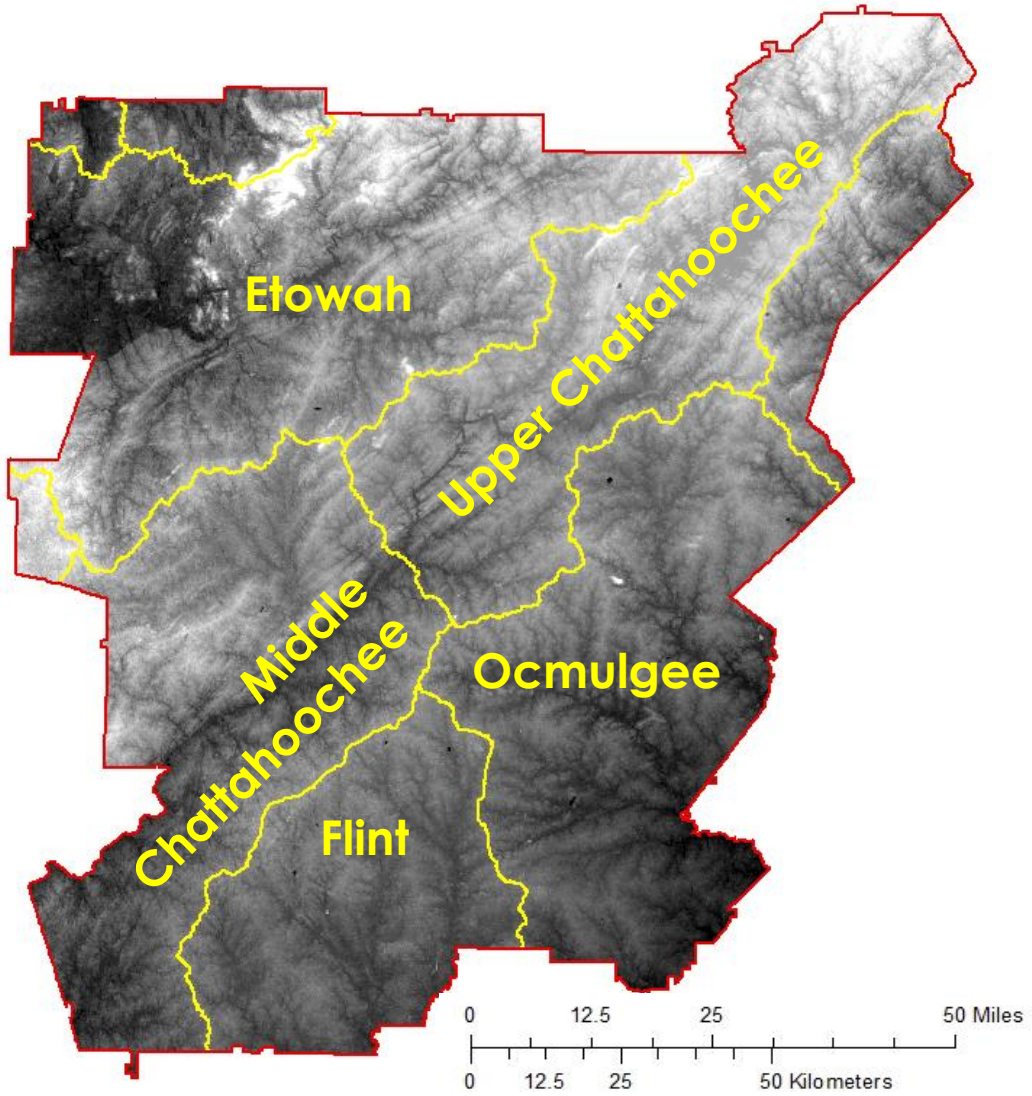
Middle Chattahoochee



Etowah



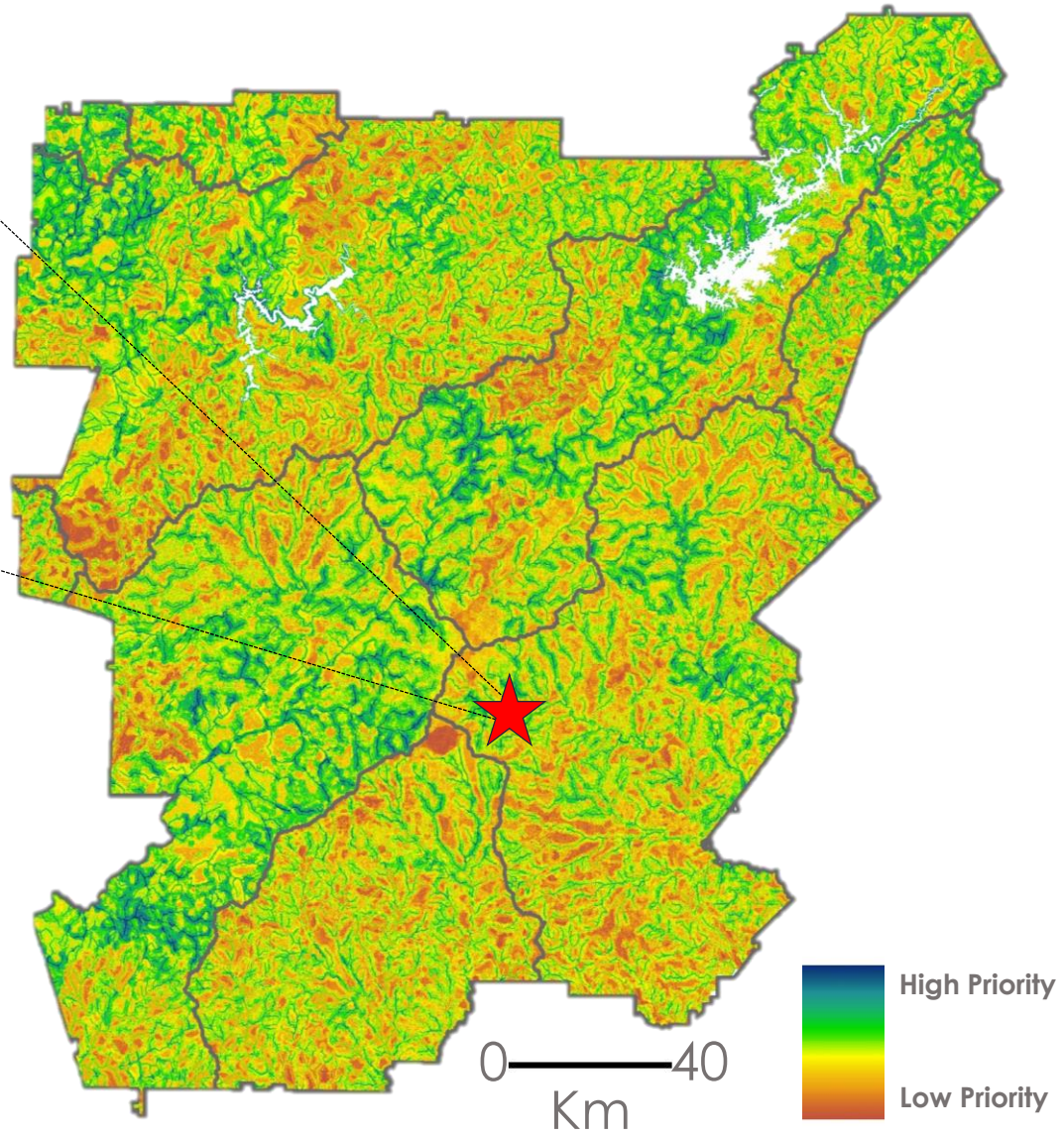
SWAT Results: Accuracy & Statistics



	R^2	NSE
Upper Chattahoochee	0.65	0.65
Middle Chattahoochee	0.63	0.55
Upper Ocmulgee	0.77	0.77
Etowah	0.68	0.67
Upper Flint	0.71	0.71

Land Use Prioritization

- **Spatially analyzes** the metropolitan region of Atlanta to designate prioritization values based on a locations suitability for conservation efforts
- **Can be used to** inform stakeholders on land acquisition and management strategies



Errors & Uncertainties

- Some datasets are incomplete
- Land cover misclassification
- SWAT model accuracy and calibration
- *Do LUCIS criteria weights accurately reflect community preferences?*

Image credit: David Cotten

Conclusions

- **NASA datasets** were successfully utilized to address three water resource management goals
- **Expansion** of green spaces will be able to assist stormwater management around Atlanta
- **Existing** urban infrastructure and associated land cover will have an important effect on water resource management

Acknowledgements

Advisors

Dr. Marguerite Madden, UGA Center for Geospatial Research

Dr. Rosanna Rivero, UGA College of Environment and Design

Dr. Adam Milewski, UGA Geology Department

Partners

Sara Gottlieb, The Nature Conservancy

Whitney Palanci, The Nature Conservancy

Myriam Dormer, The Nature Conservancy

Others

Caren Remillard, NASA DEVELOP UGA Center Lead

Past Contributors

Beatriz Avila ***Mark Beatty*** ***Veronica Fay*** ***Manasi Parkhi***

Jason Reynolds ***Alex Smith*** ***Jacob Spaulding*** ***Wenjing Xu***

This material is based upon work supported by NASA through contract NNL11AA00B and cooperative agreement NNX14AB60A.