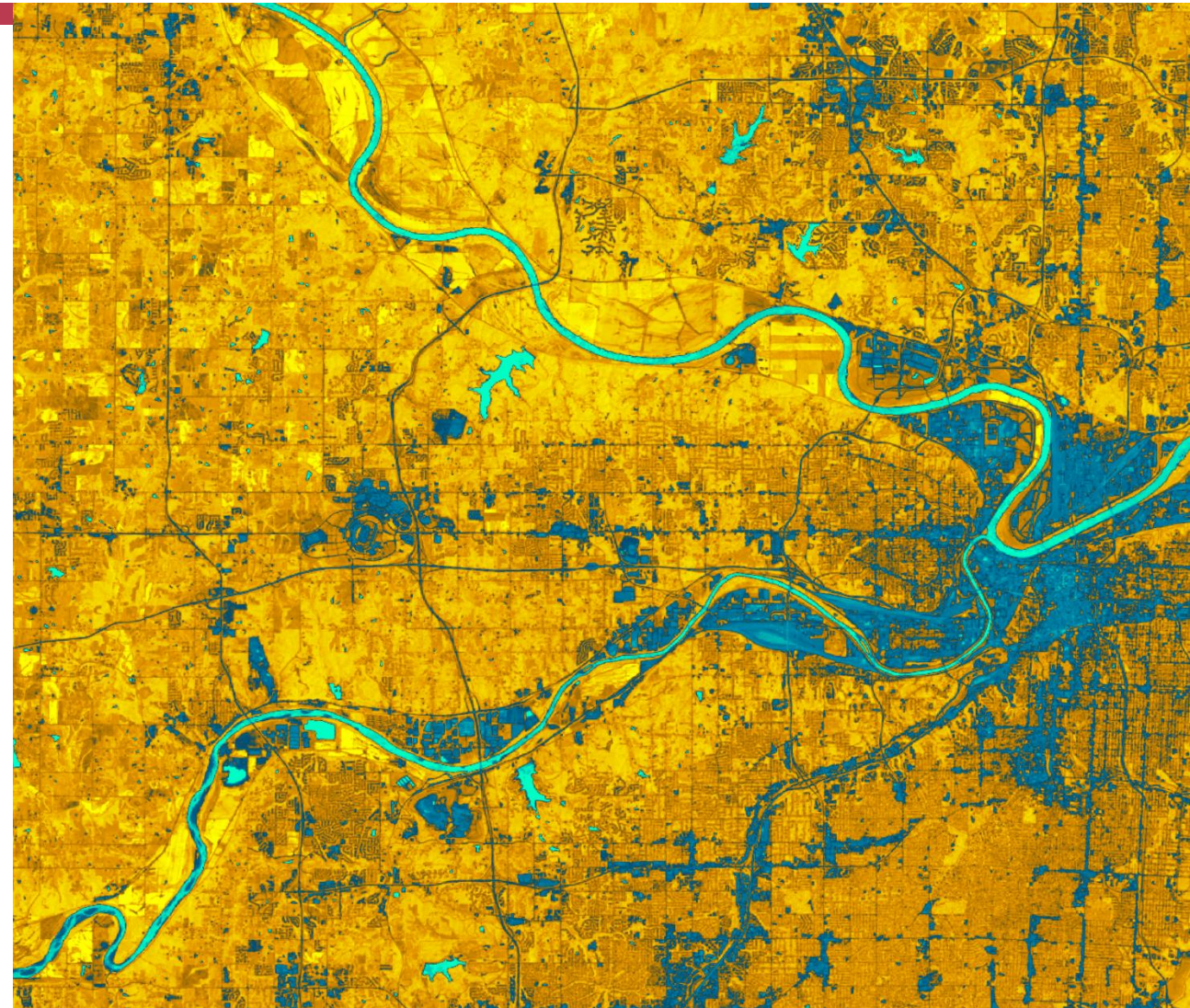# Kansas City
Disasters

Assessing Environmental and Socioeconomic Factors of Urban Flood Vulnerability in Kansas City, Kansas

M. René Castillo
Hadwynne Gross
Eric Sjöstedt
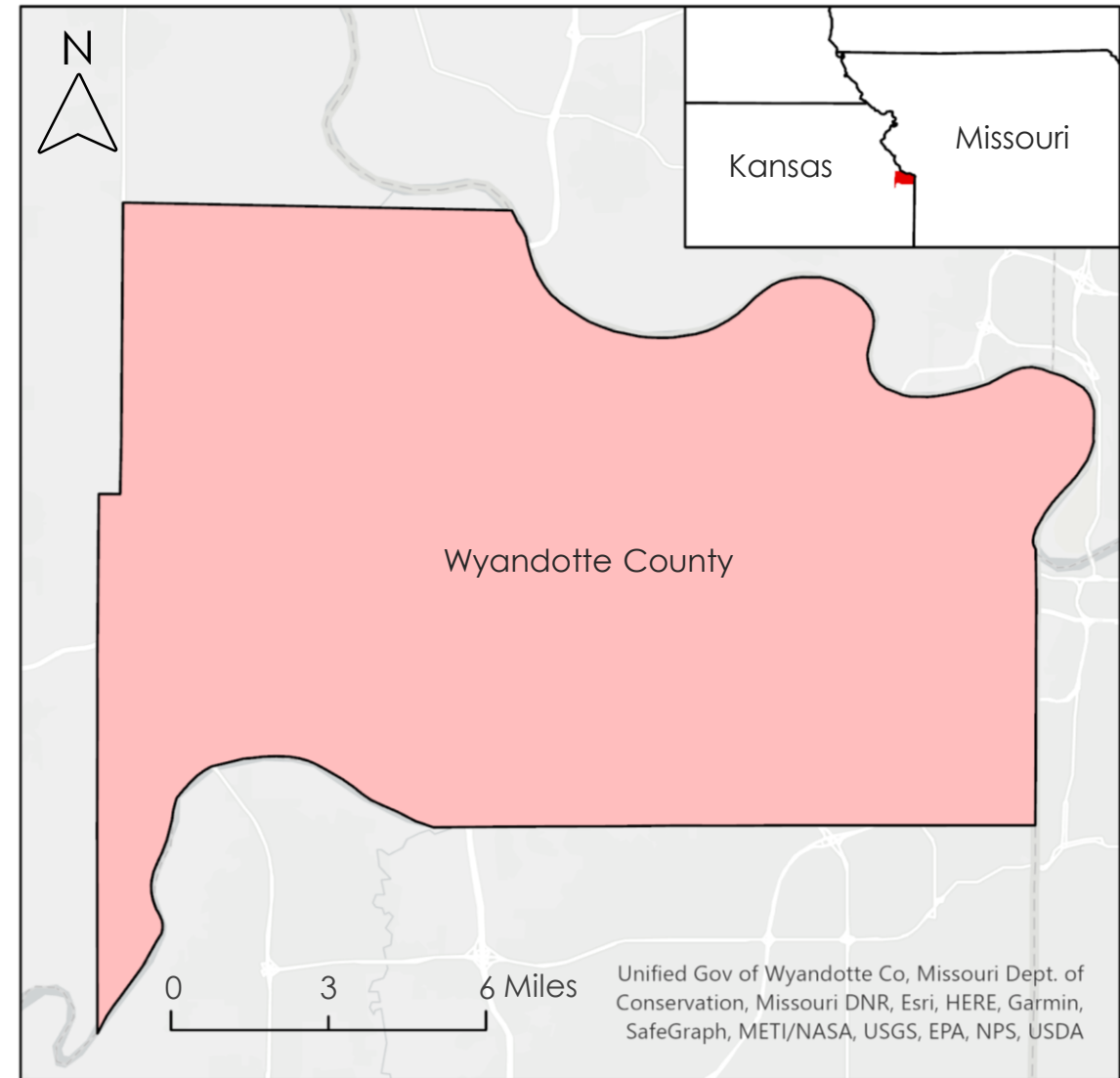Raychell Velez

DEVELOP

Project Overview

▶ Study Area
  ▶ Wyandotte County
  ▶ Kansas City, Kansas

▶ Study Period
  ▶ June 2010 to June 2021
  ▶ Flooding commonly occurs in Spring and Summer
  ▶ Pluvial flooding is characterized by high runoff volumes over impervious land cover, known to overwhelm sewage systems

Image Credit: Groundwork Northeast Revitalization Group

N

Kansas   Missouri

Wyandotte County

0   3   6 Miles

Unified Gov of Wyandotte Co, Missouri Dept. of Conservation, Missouri DNR, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA
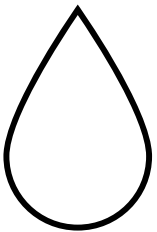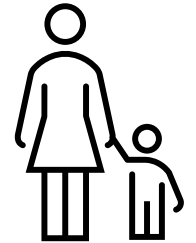
Community Concerns

Kansas City experiences runoff, exposure of raw sewage, and excessive flooding due to **overwhelmed combined sewer systems**.

Neighborhoods affected by disinvestment and historical redlining face higher levels of **social vulnerability**.

Local communities lack access to resources needed to provide financial and temporal insight for **pluvial flood mitigation**.

Project Partners

Groundwork USA

A network of local nonprofit organizations that focuses on **regeneration**, **improvement**, and **management** of urban spaces to help **mitigate environmental**, **economic**, and **social inequalities** within **marginalized communities**.

Lawrence Hoffman
Jalisa Gilmore

Groundwork Northeast Revitalization Group

A branch of Groundwork USA focused on **inclusive** action rooted in the principles of **equity**, **community cohesion**, **institutional transparency**, and **environmental justice**.

Ben Carpenter
Rev. Adrianne Showalter-Matlock

Project Objectives

1

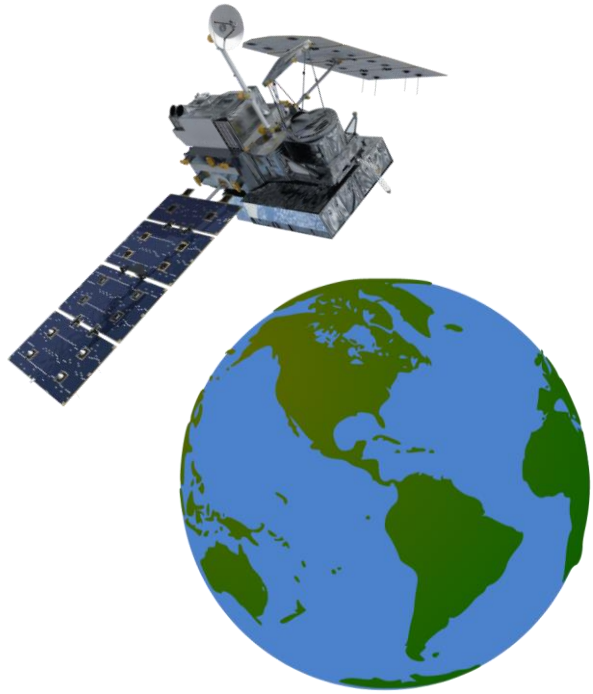Generate precipitation runoff, runoff retention, and potential damage cost maps

2

Examine social and socioeconomic factors of flood vulnerability

3

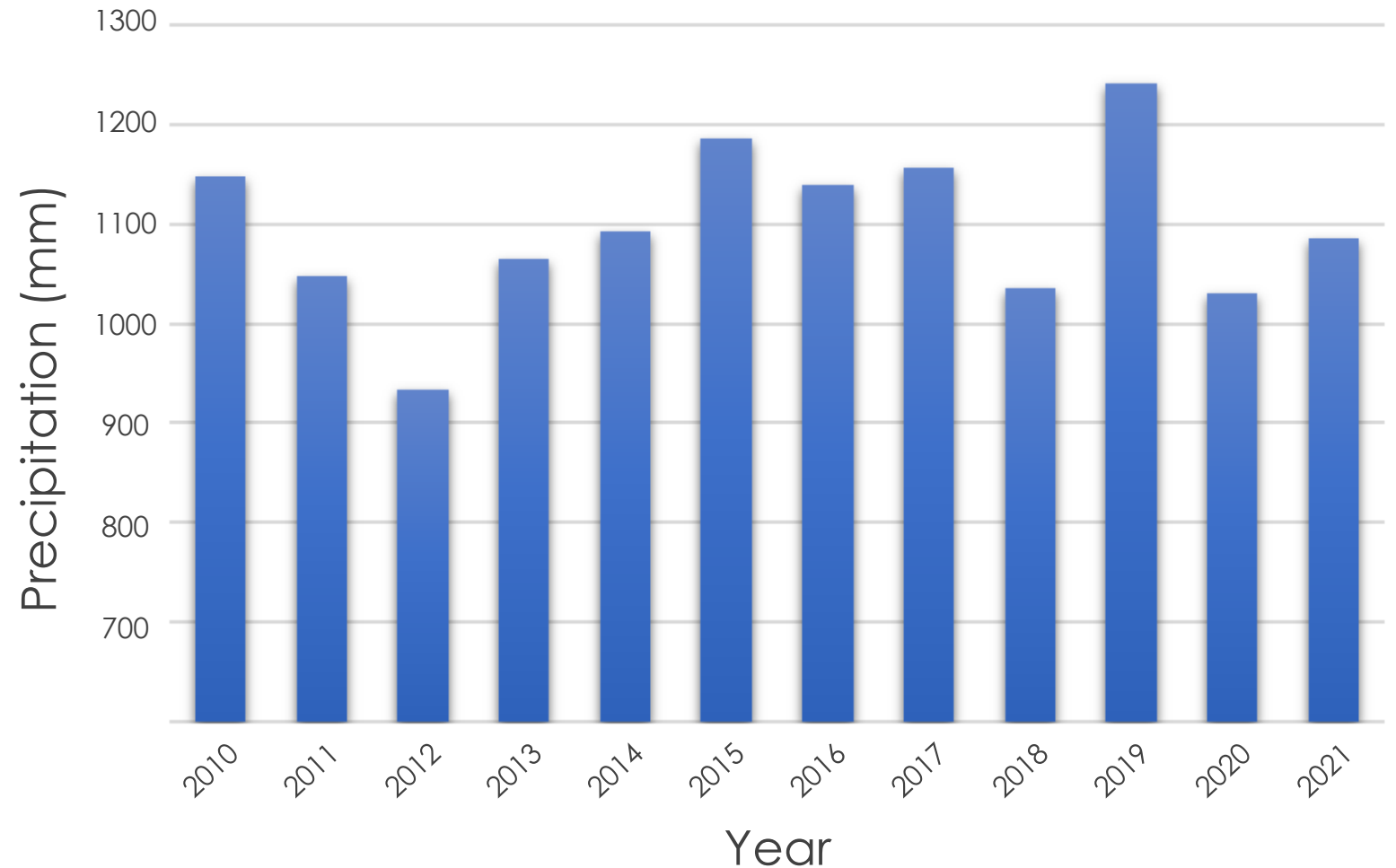Identify neighborhoods where flood mitigation efforts are needed most
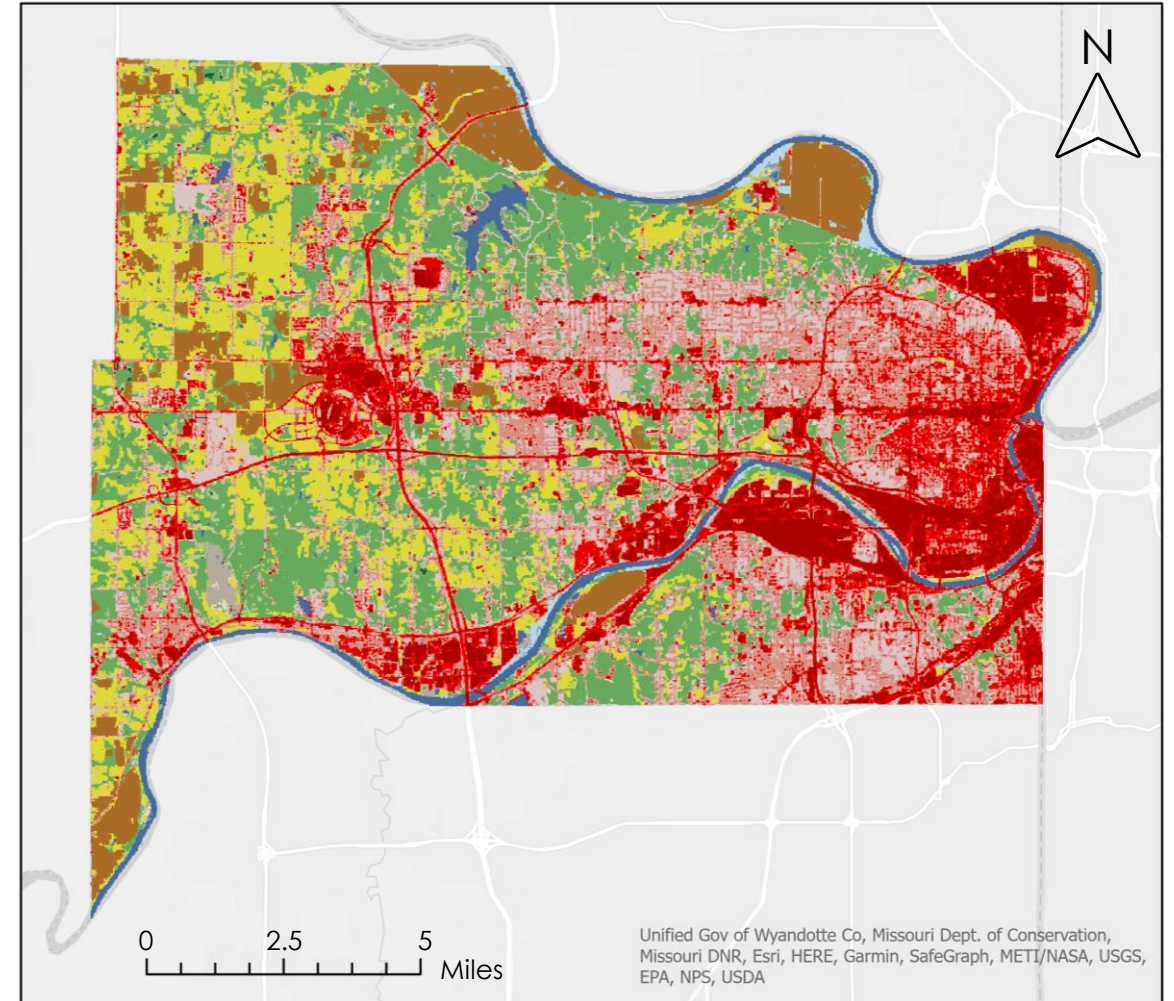
Earth Observations

Global Precipitation Measurement
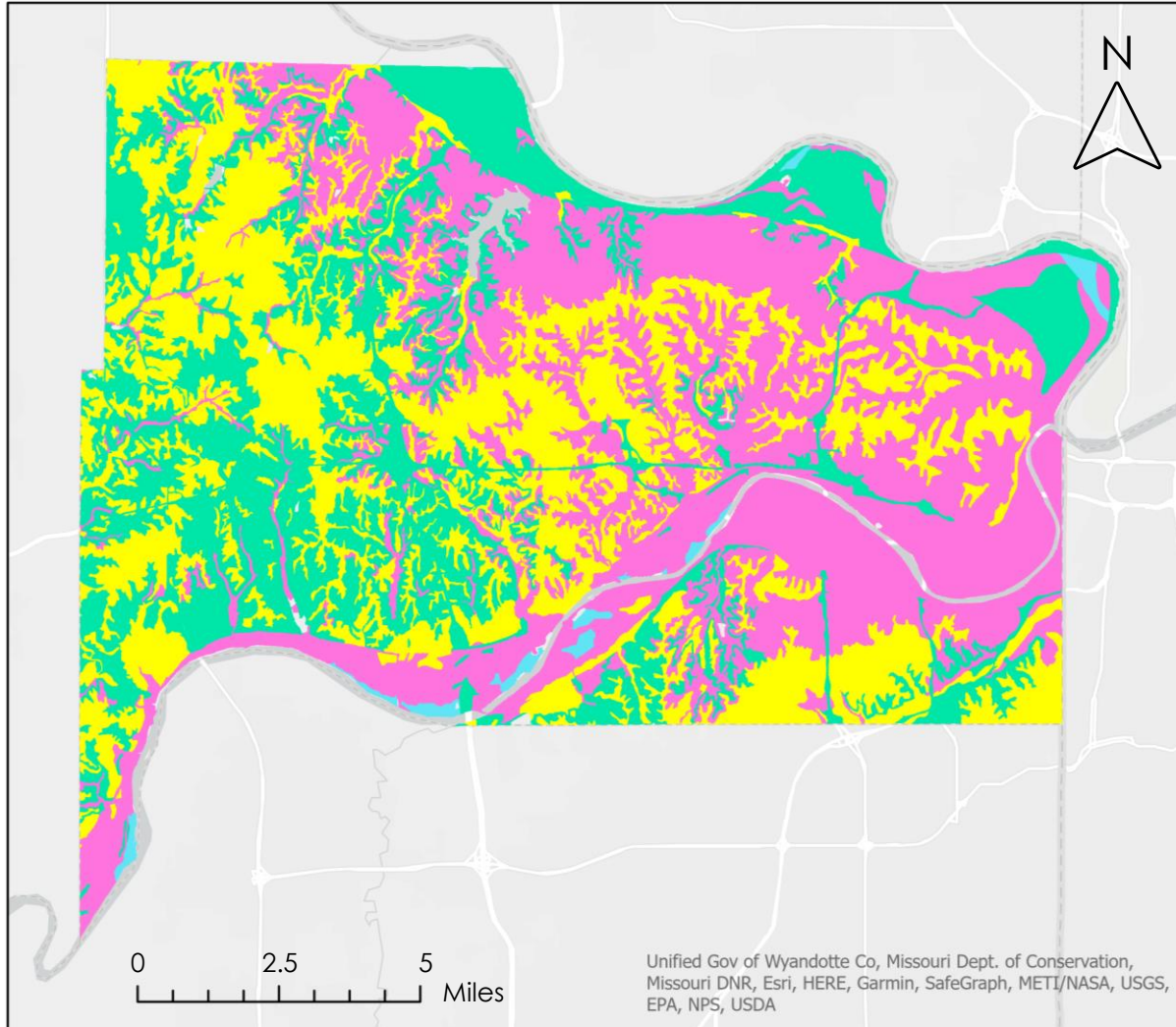Integrated Multi-satellitE Retrievals (GPM IMERG)

Annual Precipitation

Land Cover and Land Use

Legend:
- Open Space Developed
- Low Developed
- Medium Developed
- Highly Developed
- Barron Land
- Mixed Forest
- Deciduous Forest
- Evergreen Forest
- Shrub or Scrub
- Herbaceous
- Hay or Pasture
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands
- Open water

Unified Gov of Wyandotte Co, Missouri Dept. of Conservation, Missouri DNR, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA

0   2.5   5   Miles
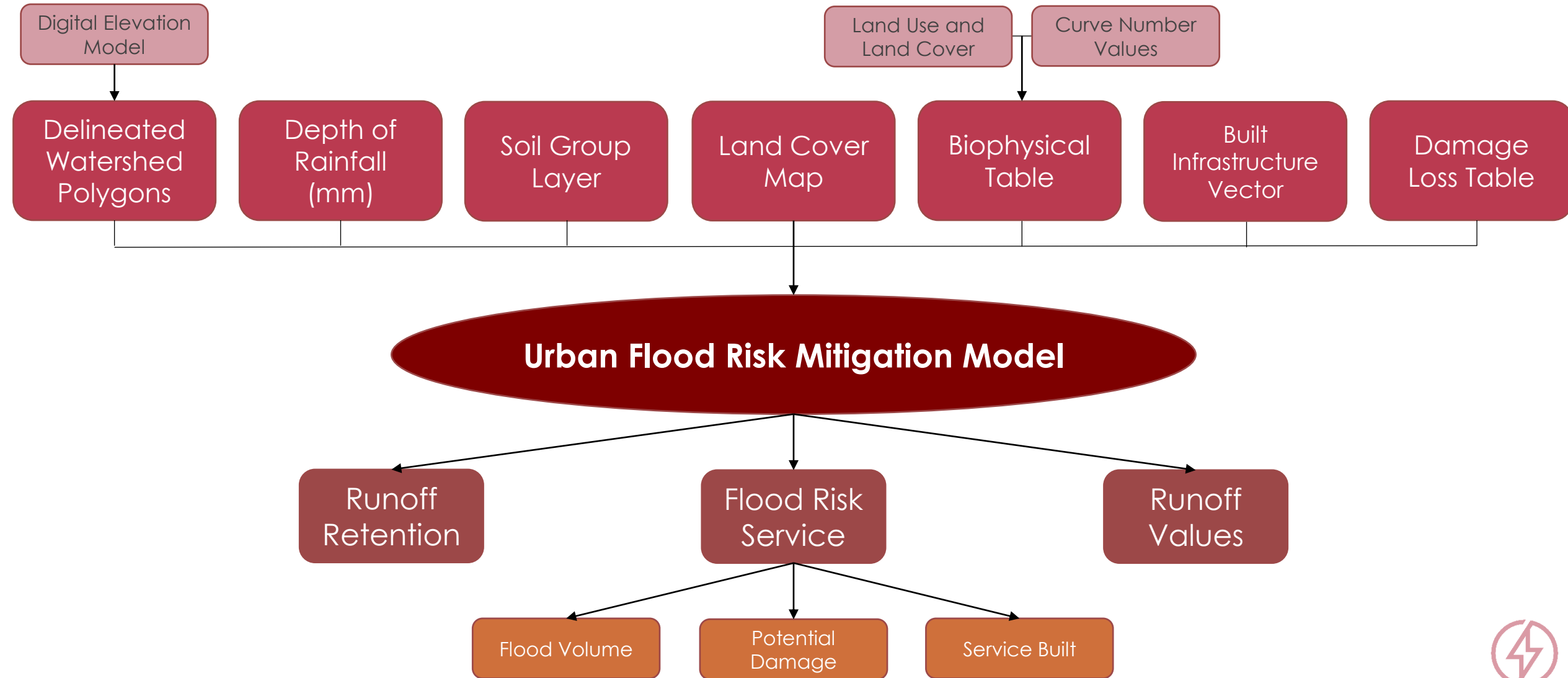
N

Soil Hydrologic Groups

Group A — High infiltration when wet

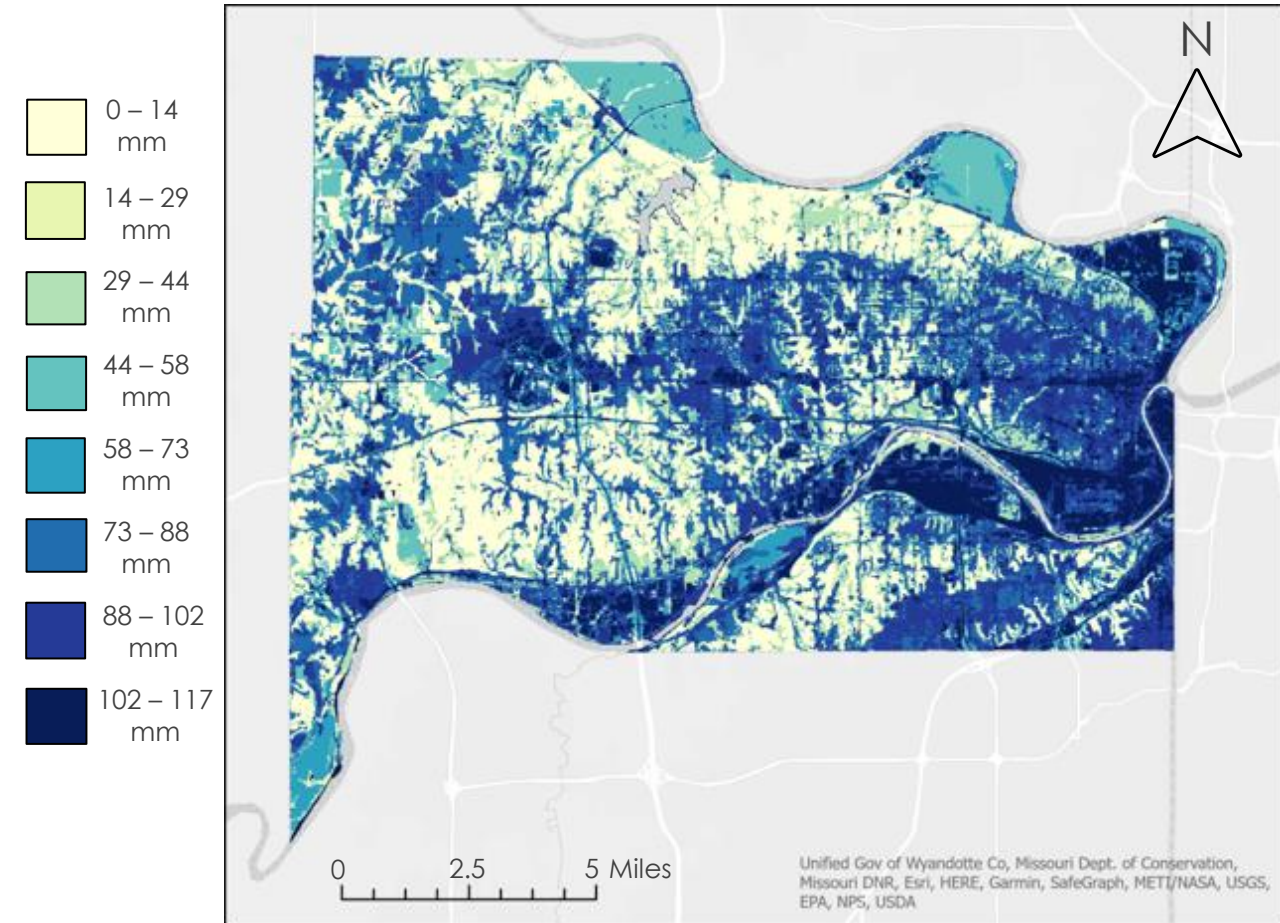Group B — Moderate infiltration when wet

Group C — Slow infiltration when wet

Group D — Very slow infiltration when wet

Unified Gov of Wyandotte Co, Missouri Dept. of Conservation, Missouri DNR, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA
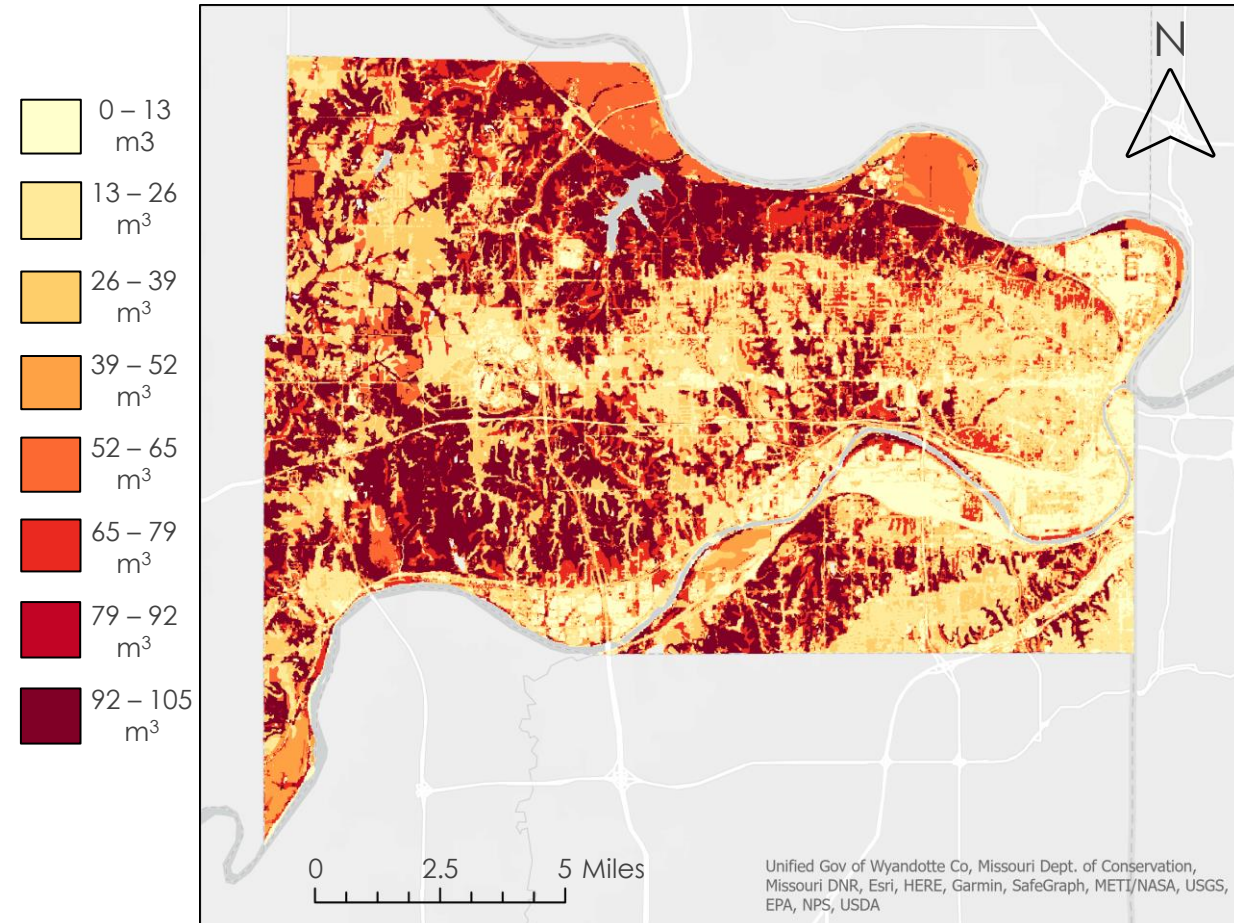
0   2.5   5   Miles

Methodology: InVEST

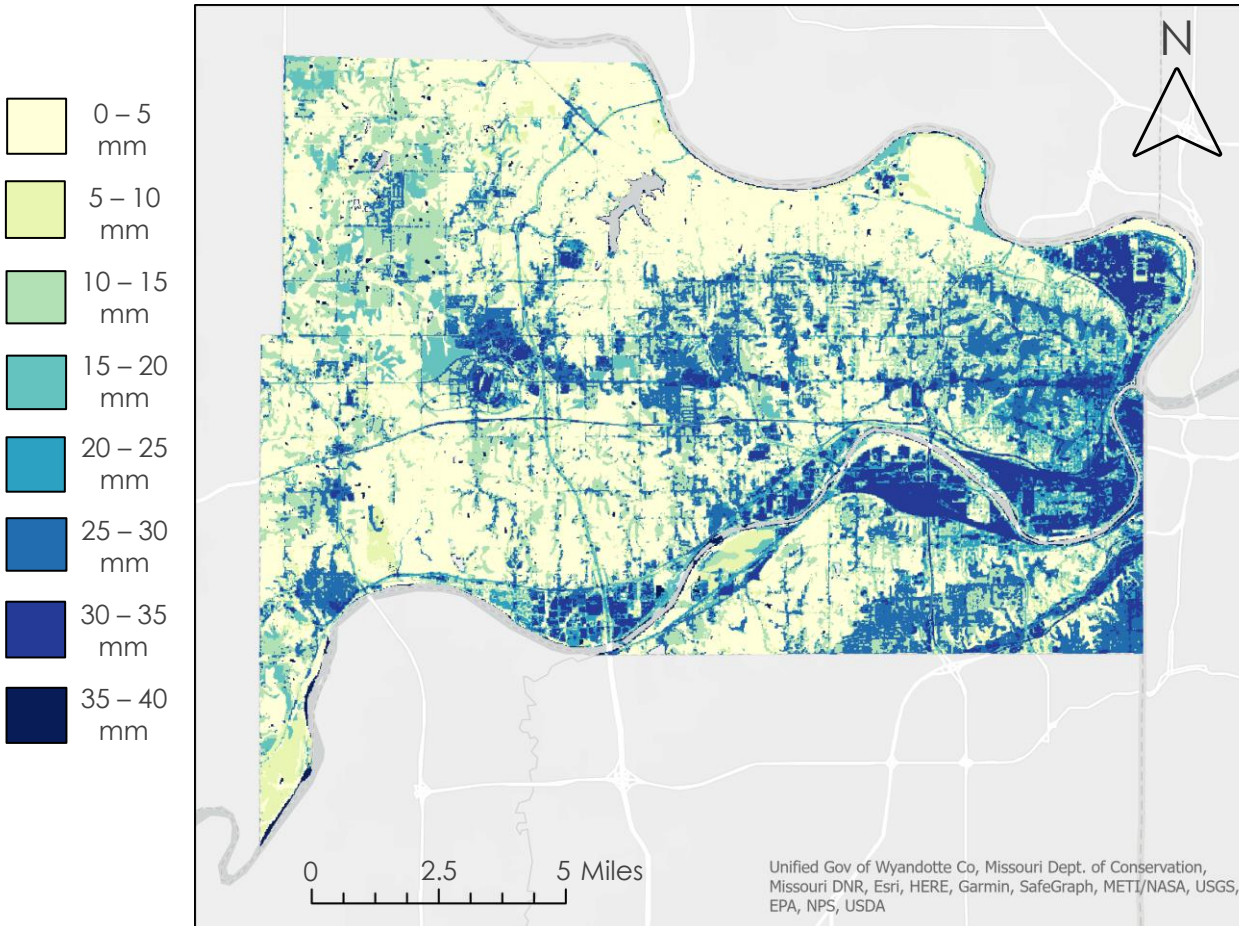# InVEST Model: 2017 Storm (August 21st – 24th)
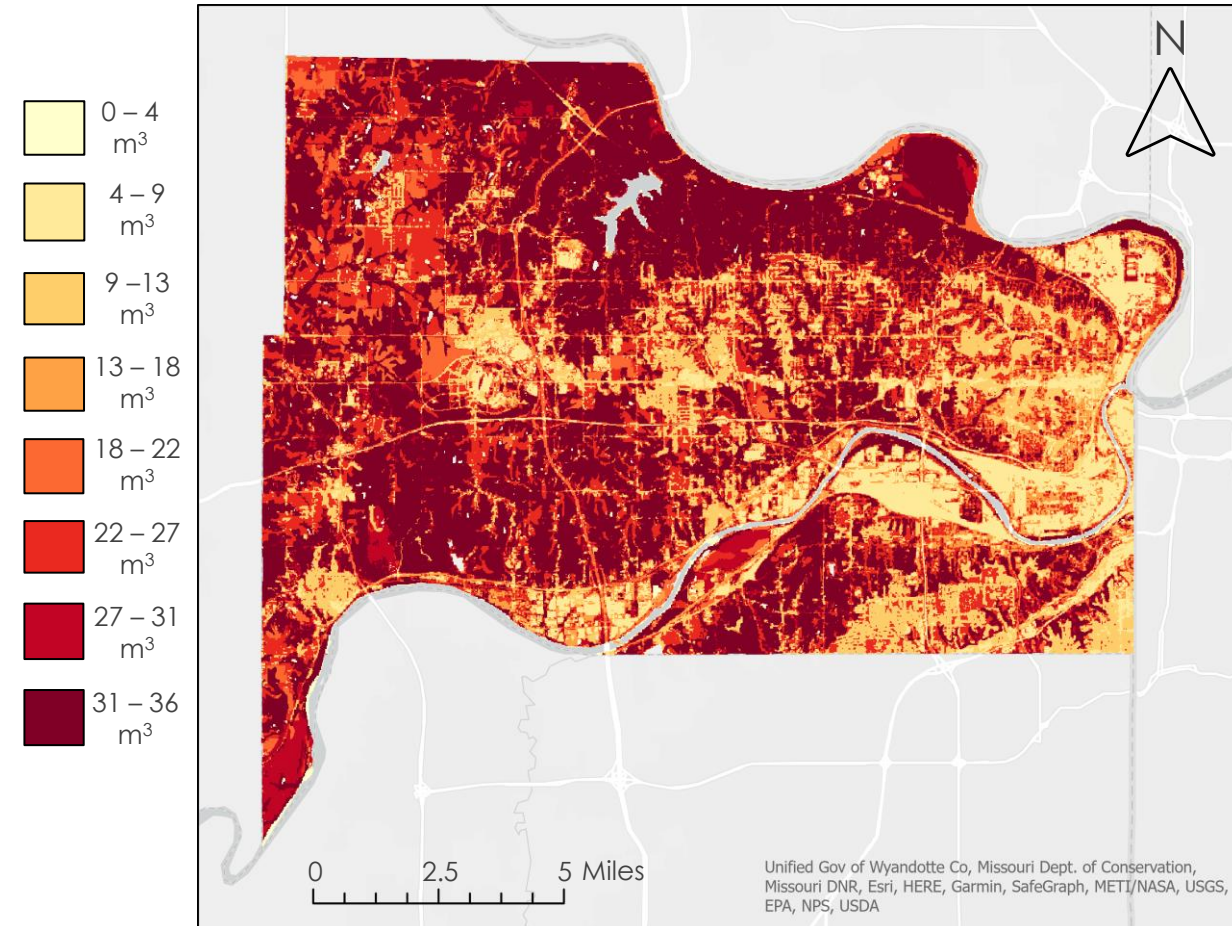

Surface Runoff (mm)

Runoff Retention (m³)

InVEST Model: 2019 Storm (May 25th – June 6th)

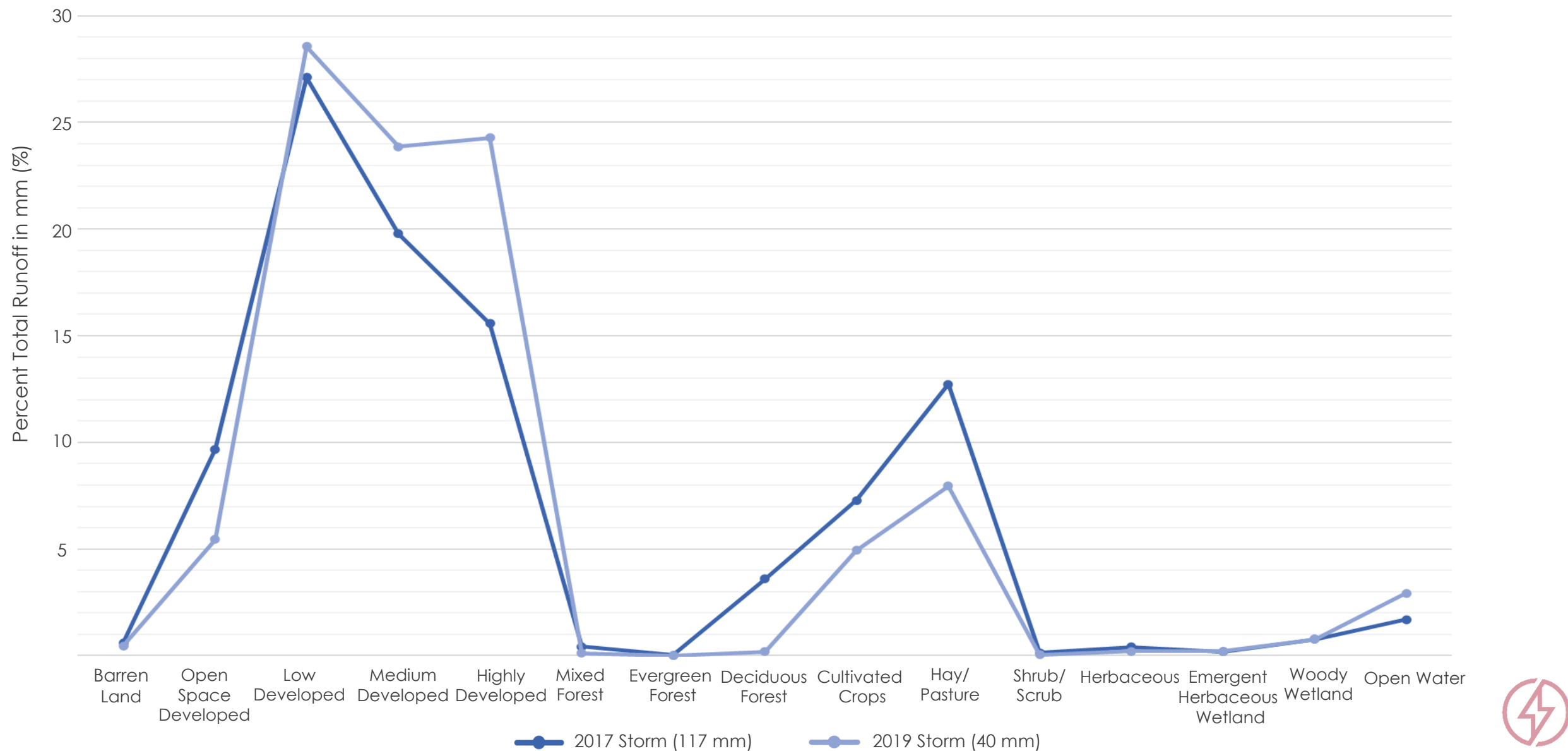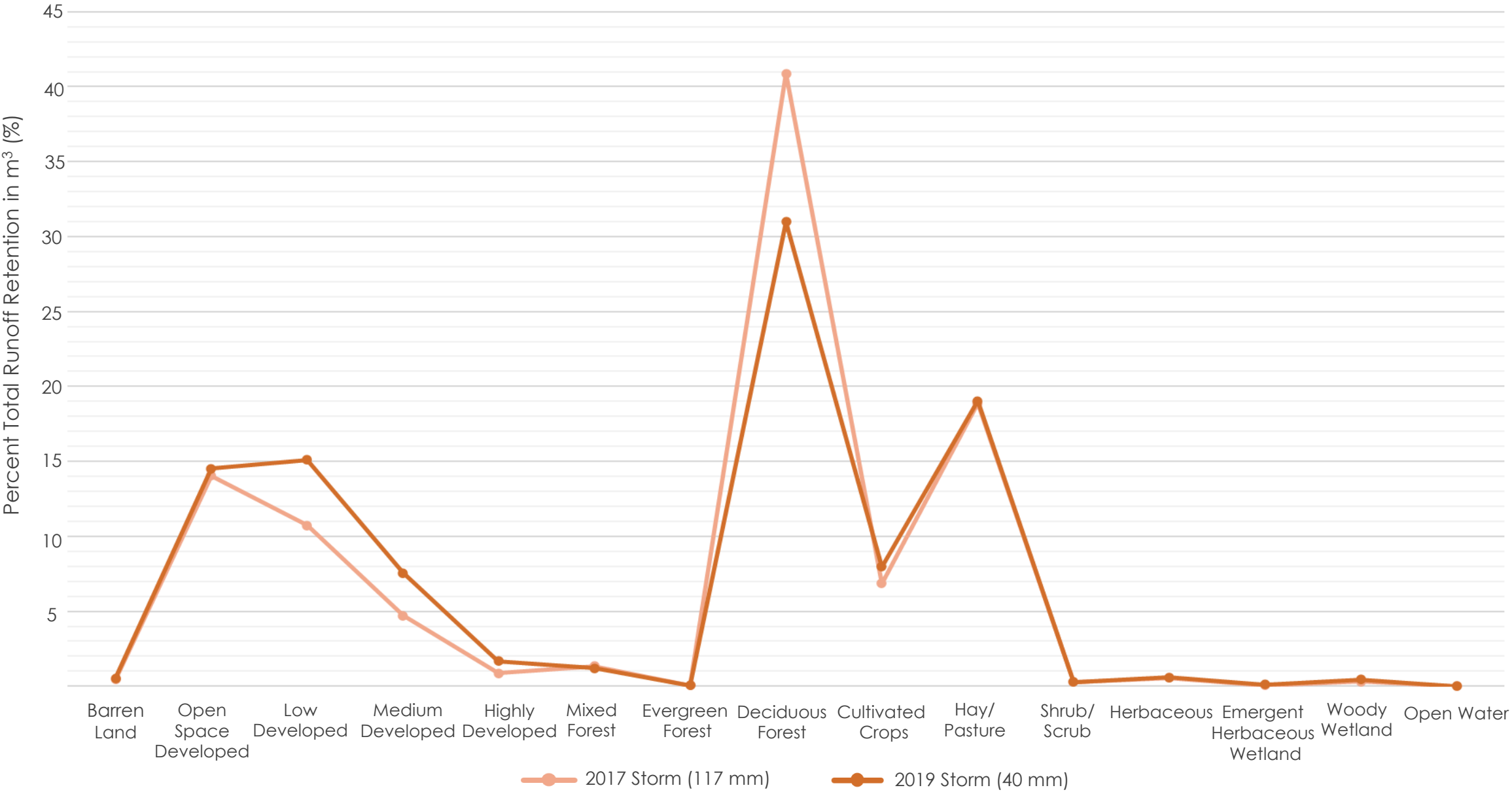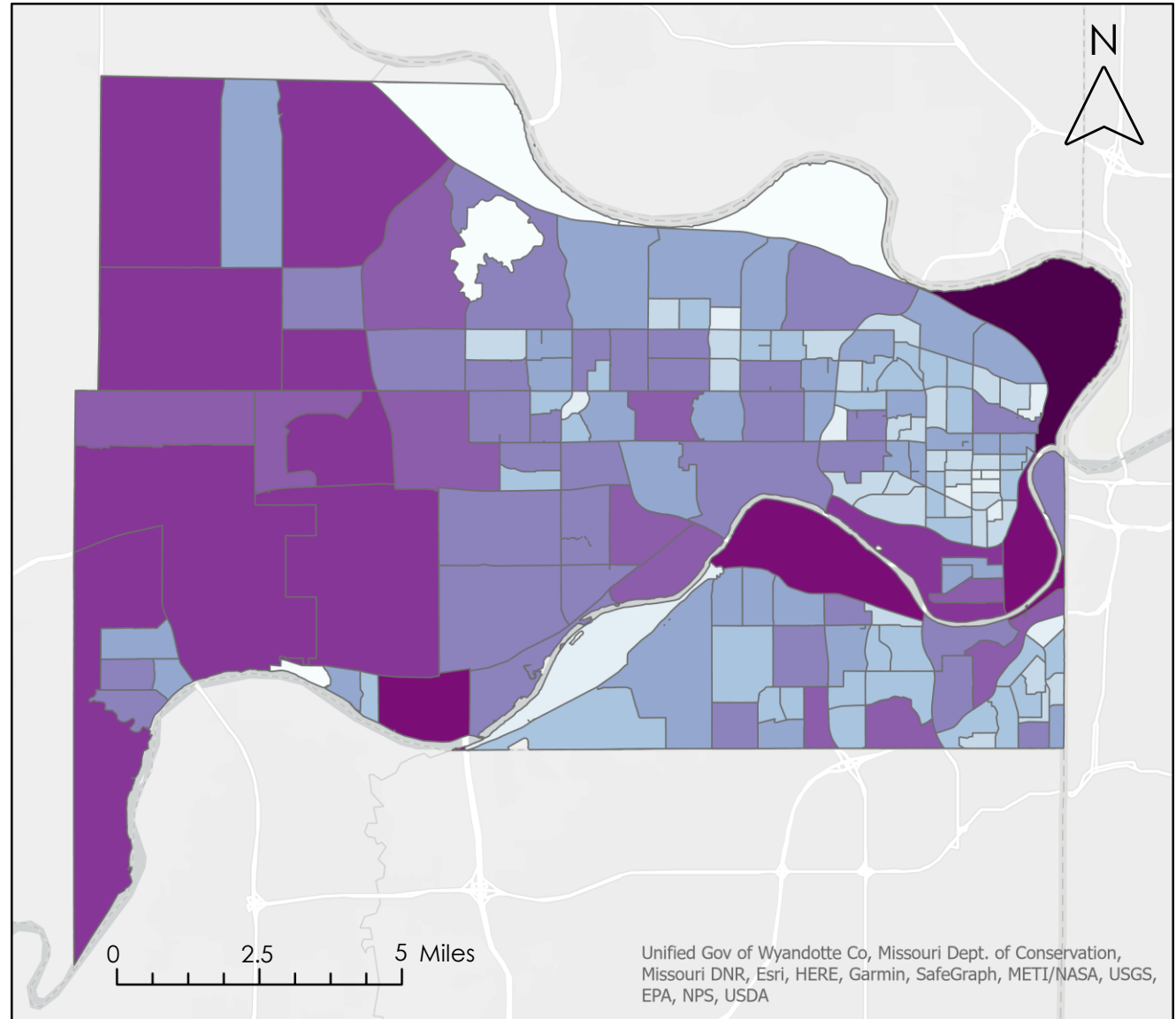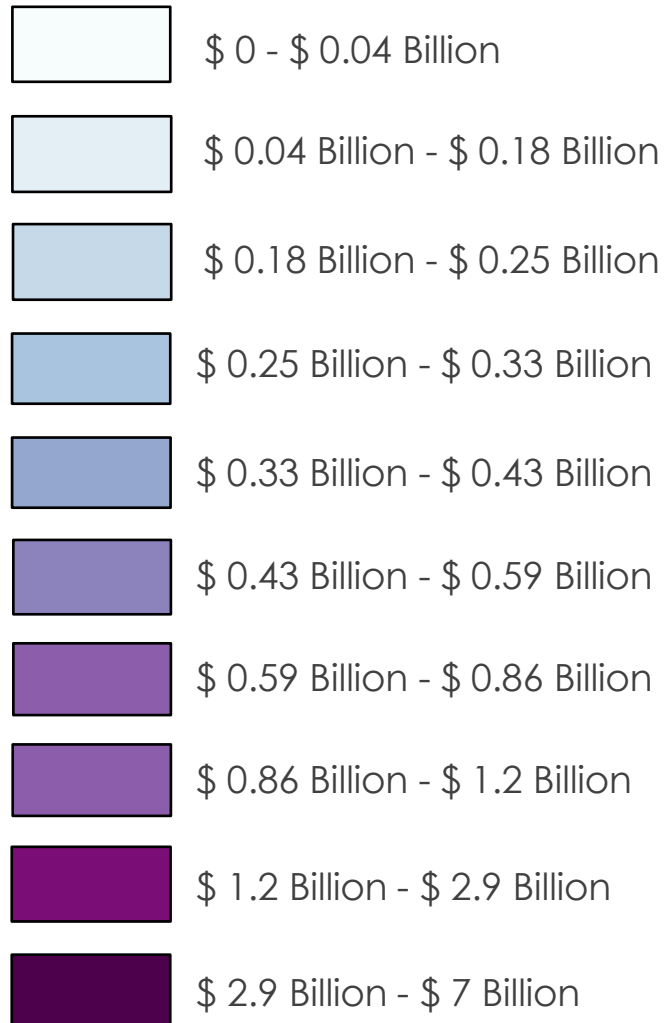
Surface Runoff (mm)

Runoff Retention (m³)

InVEST Model: Percent Runoff per Landcover Class

InVEST Model: Percent Runoff Retention per Landcover Class

Percent Total Runoff Retention in m³ (%)

Barren Land, Open Space Developed, Low Developed, Medium Developed, Highly Developed, Mixed Forest, Evergreen Forest, Deciduous Forest, Cultivated Crops, Hay/Pasture, Shrub/Scrub, Herbaceous, Emergent Herbaceous Wetland, Woody Wetland, Open Water

2017 Storm (117 mm)   2019 Storm (40 mm)

InVEST Model: 2017 Storm Potential Economic Damage

Legend:
- $ 0 - $ 0.04 Billion
- $ 0.04 Billion - $ 0.18 Billion
- $ 0.18 Billion - $ 0.25 Billion
- $ 0.25 Billion - $ 0.33 Billion
- $ 0.33 Billion - $ 0.43 Billion
- $ 0.43 Billion - $ 0.59 Billion
- $ 0.59 Billion - $ 0.86 Billion
- $ 0.86 Billion - $ 1.2 Billion
- $ 1.2 Billion - $ 2.9 Billion
- $ 2.9 Billion - $ 7 Billion

Unified Gov of Wyandotte Co, Missouri Dept. of Conservation, Missouri DNR, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA

0   2.5   5 Miles

Balstrøm et al, 2017 - Surface Elevation Based Pluvial Flooding

Unified Gov of Wyandotte Co, Missouri Dept. of Conservation, Missouri DNR, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA

0   2.5   5 Miles

0   0.25   0.5 Miles

Legend:
- Bluespots/Pooling Water
- Building Footprints
- Wyandotte County Outline
- Flow Direction
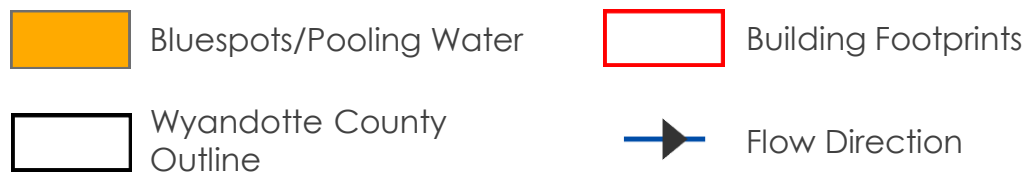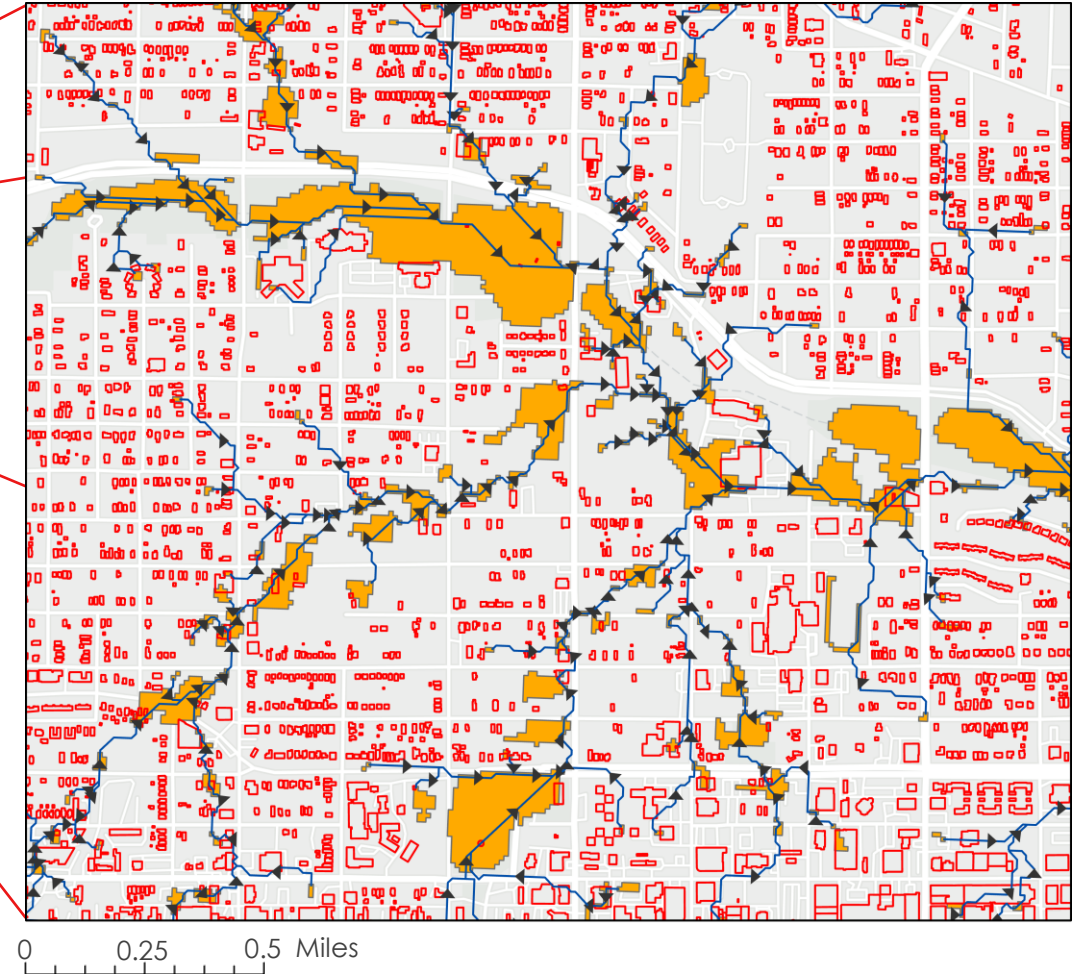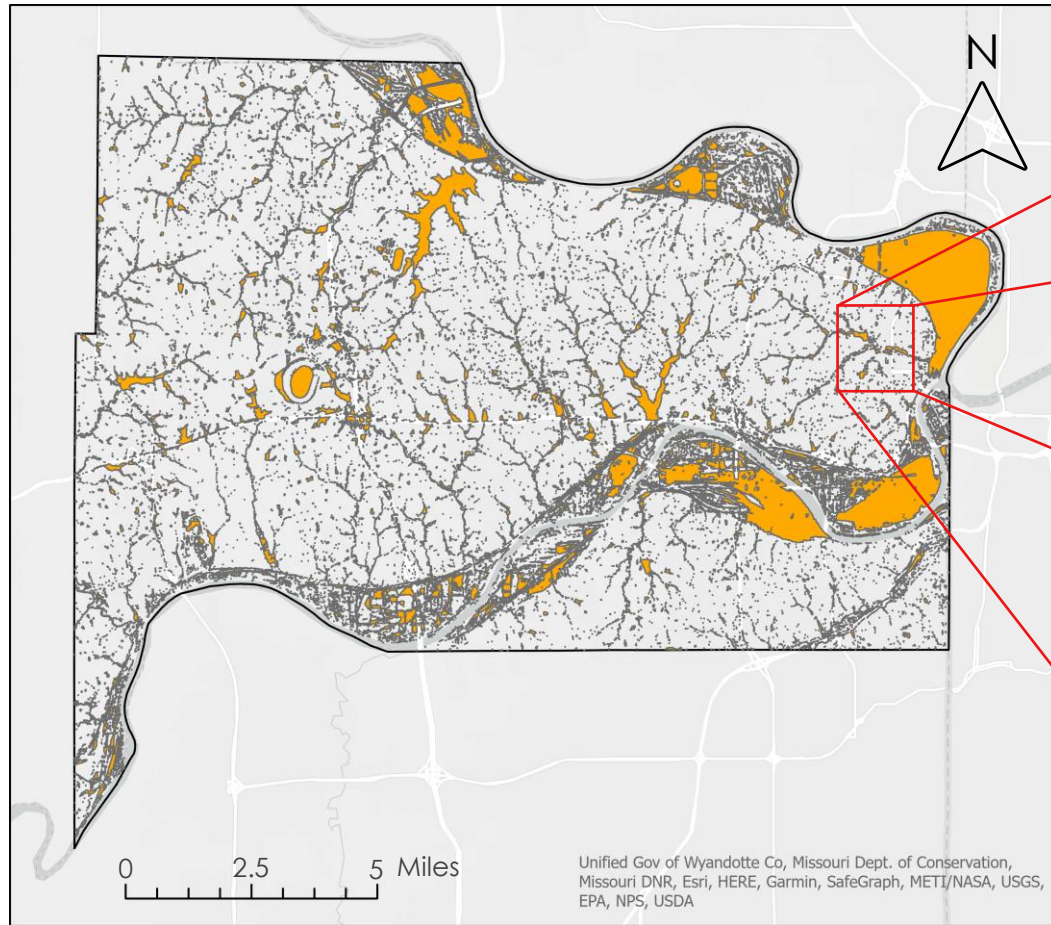
Social Vulnerability & Environmental Justice

1 Low Income

3 Age 65 and Older
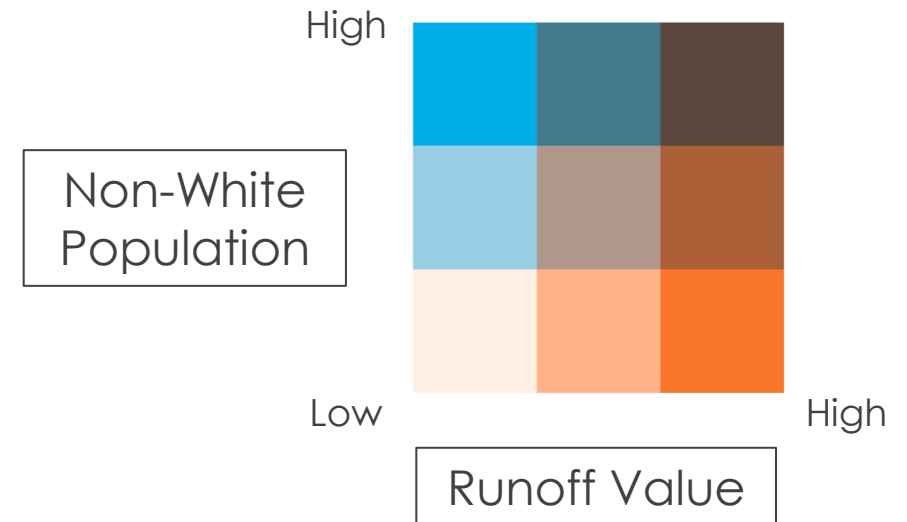
2 No High School Diploma

4 Minority

Results:
Low Income

Population with Income Below $50,000

High

Low

High

Runoff Value

Results:
Minority

Non-White Population — High / Low

Runoff Value — Low / High

Unified Gov of Wyandotte Co, Missouri Dept. of Conservation, Missouri DNR, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA

0   3   6 miles

N
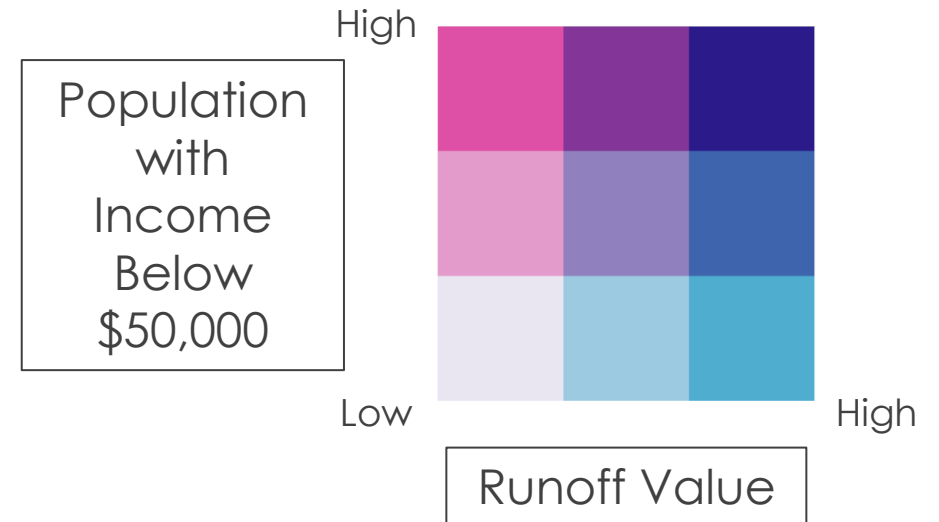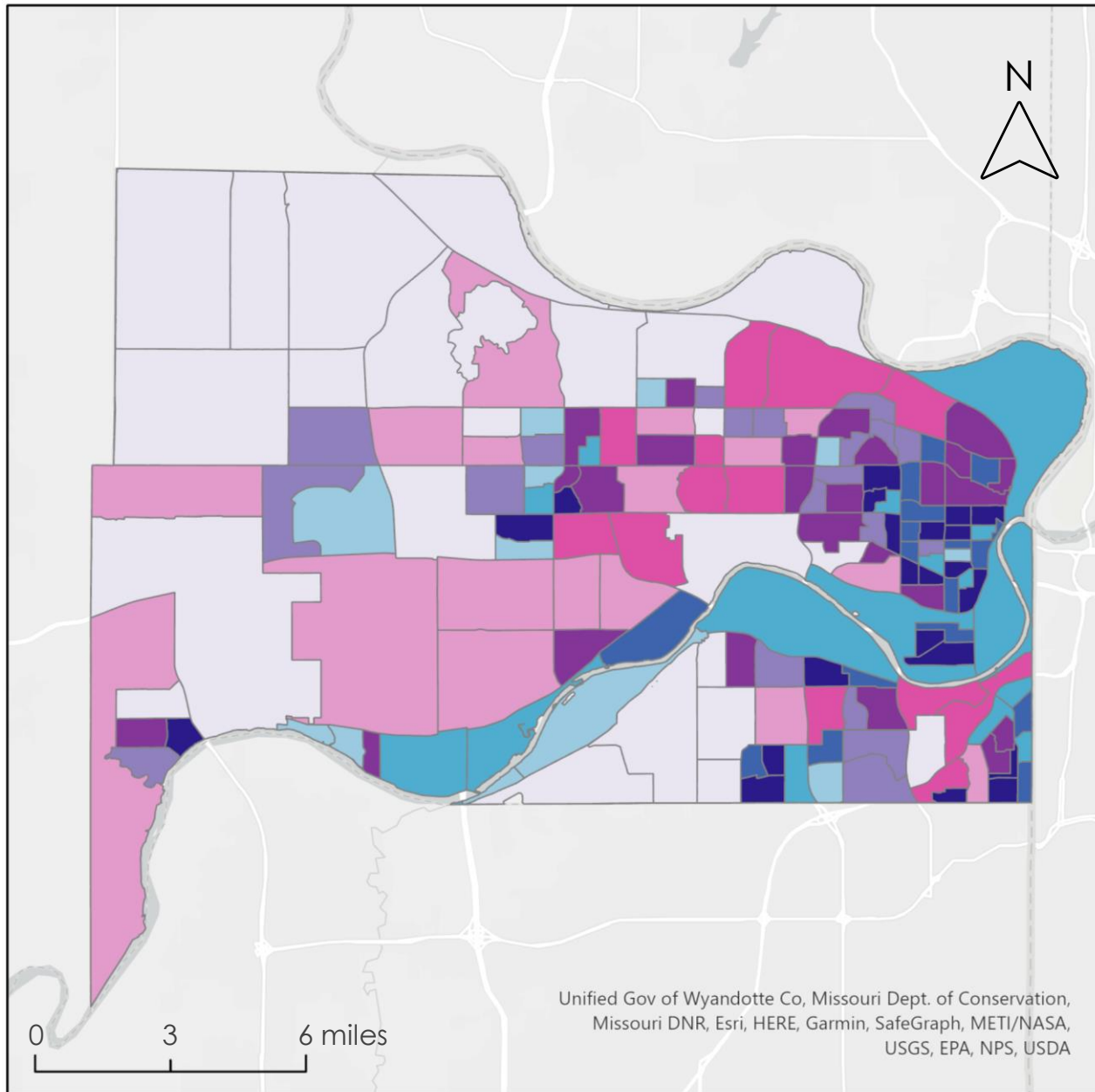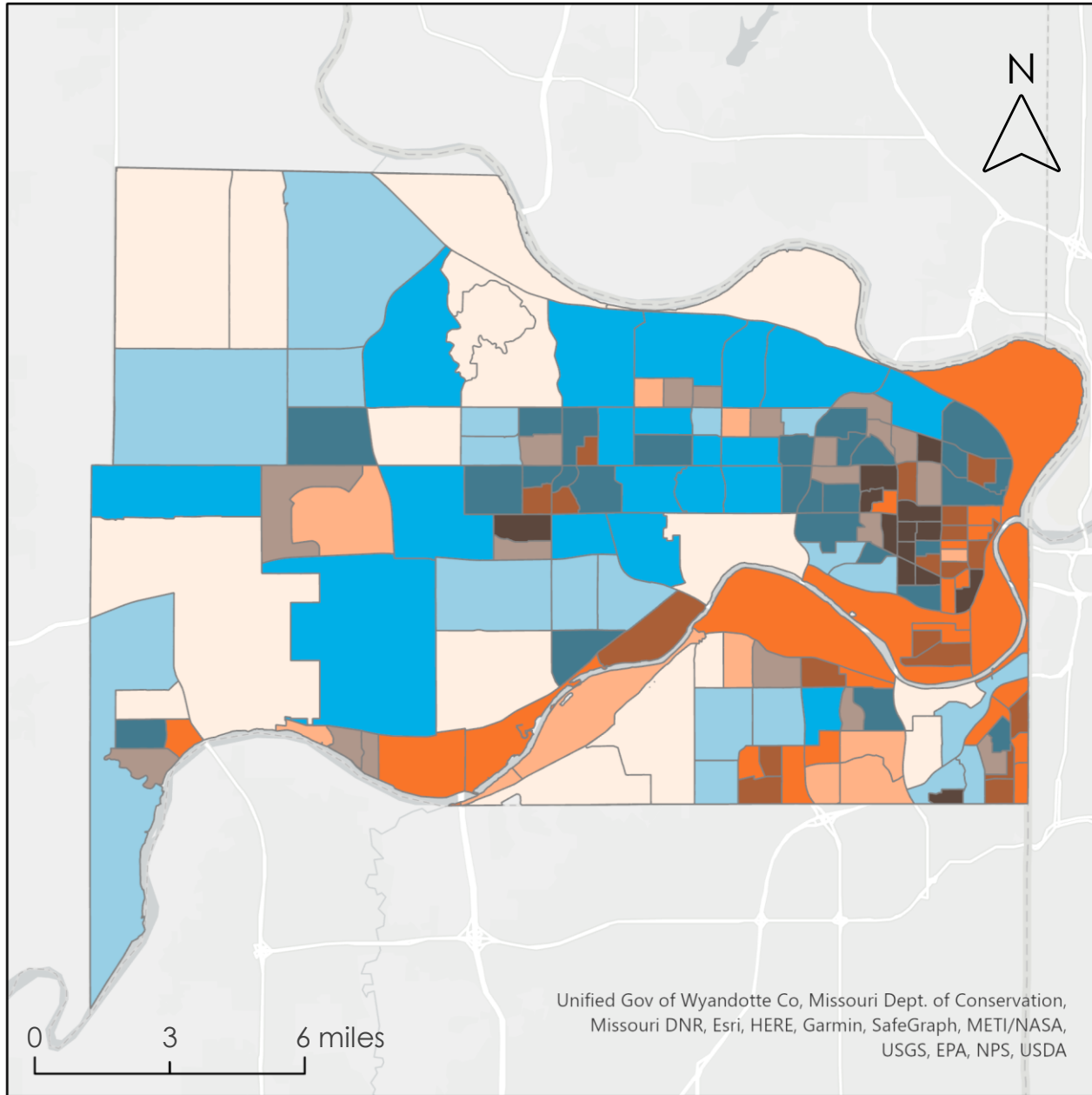
Results: No High School Diploma

Population Over 25 without a High School Diploma

High

Low   High

Runoff Value

0   3   6 miles

Unified Gov of Wyandotte Co, Missouri Dept. of Conservation, Missouri DNR, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA

Results:
65 and Older

High

Population
Over 65

Low · · · · · · · · · · · · · · · · · · High

Runoff Value
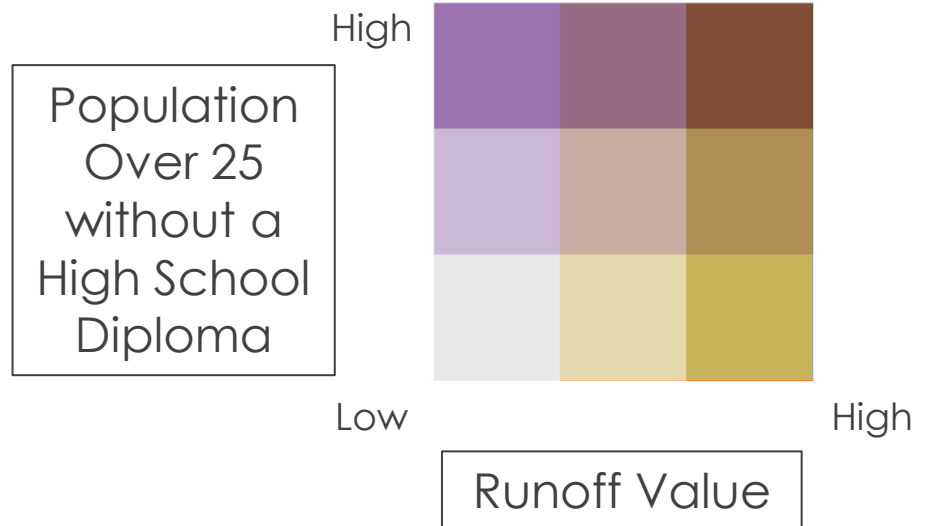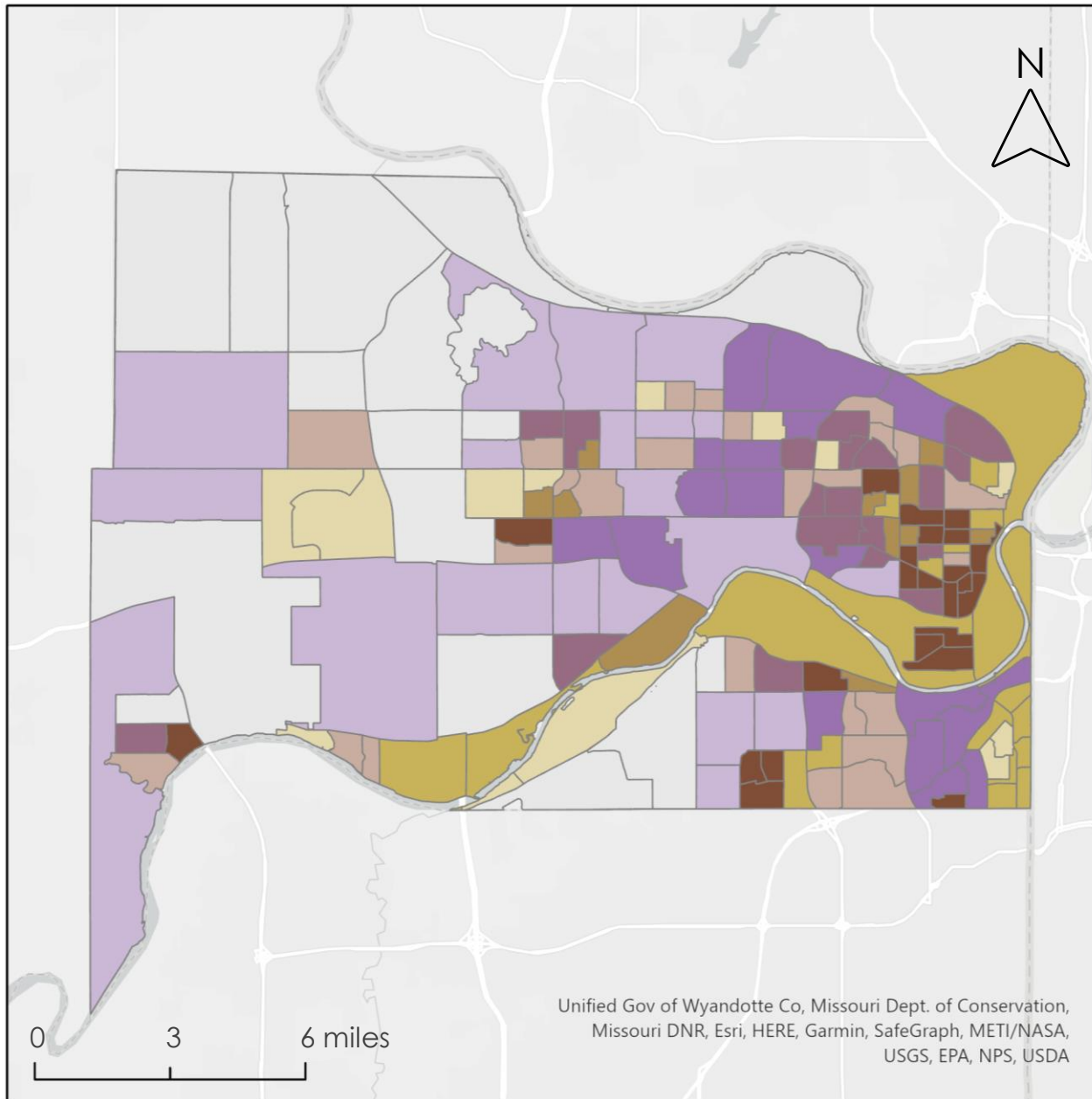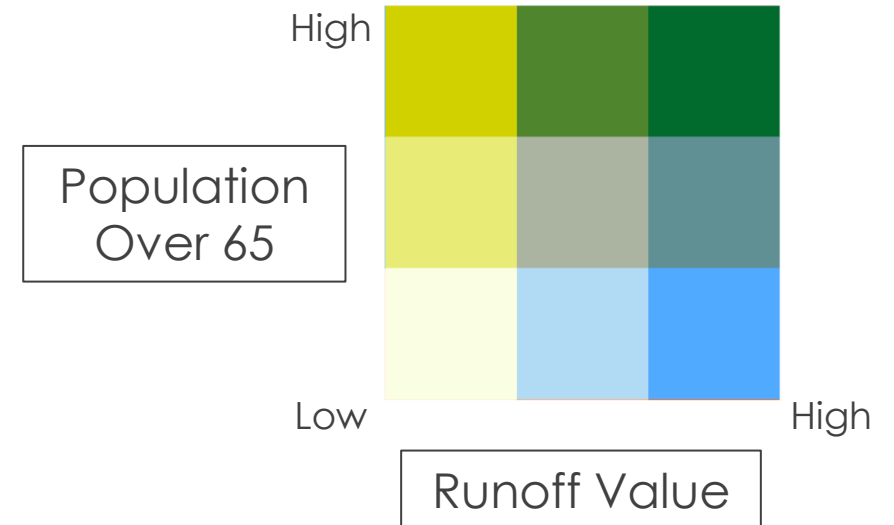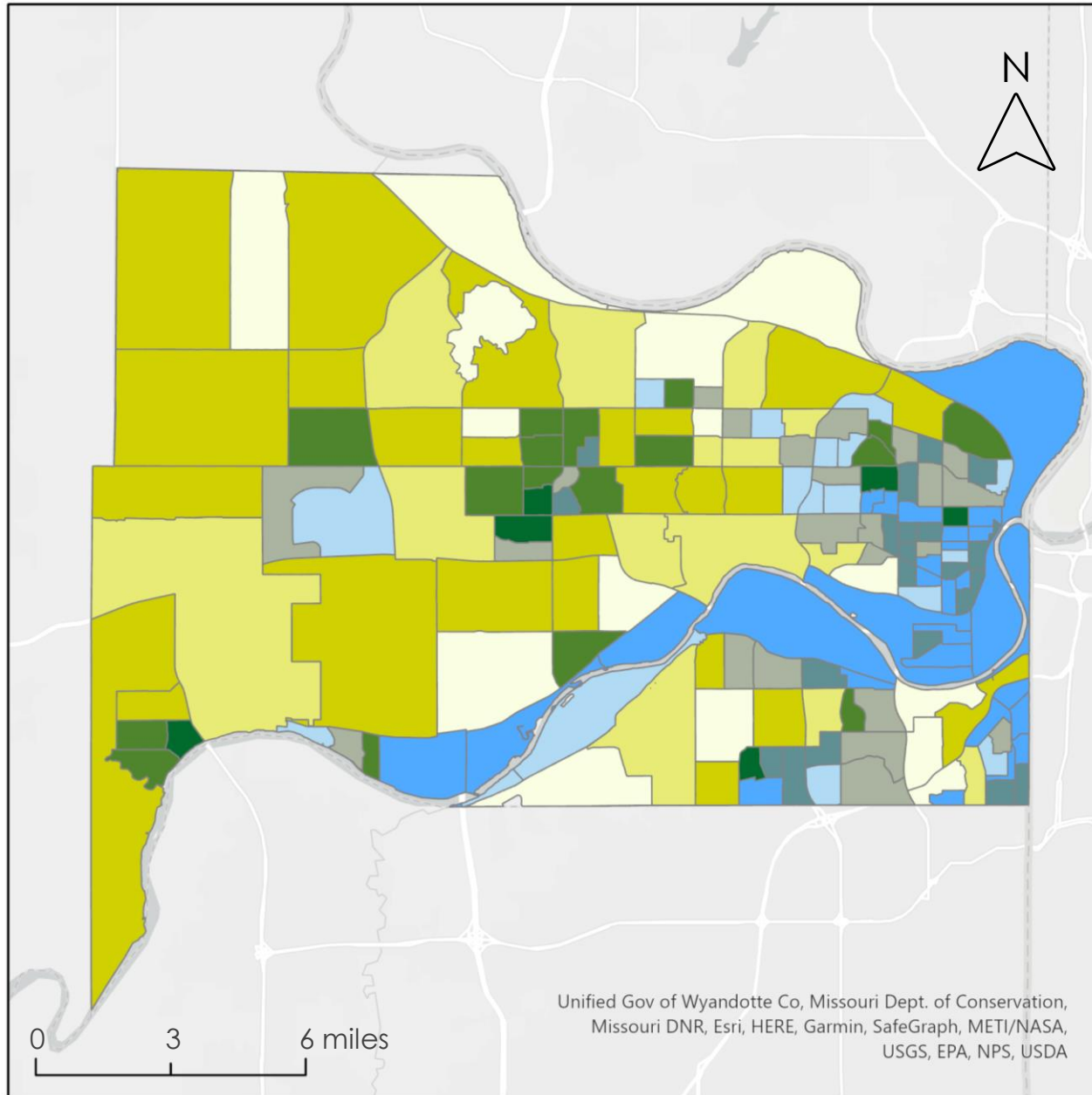
Limitations & Uncertainties
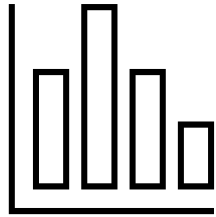
Limited validation of flooding and damages due to lack of data

Model precipitation is represented as a single value instead of a raster layer
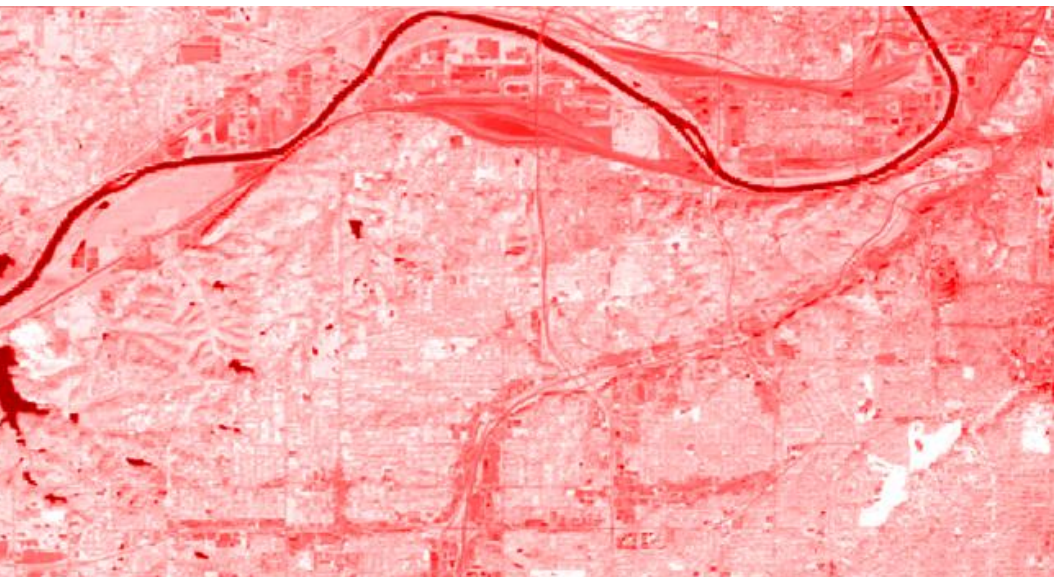
Census block group data are not fully representative of neighborhood-scale analysis

Conclusion

Collected precipitation data using satellite imagery, processing data from GPM IMERG

Developed a successful methodology to run InVEST Urban Flood Risk Mitigation Model

Produced maps that show pluvial flooding dynamics and intersections with environmental justice concerns for Kansas City, Kansas
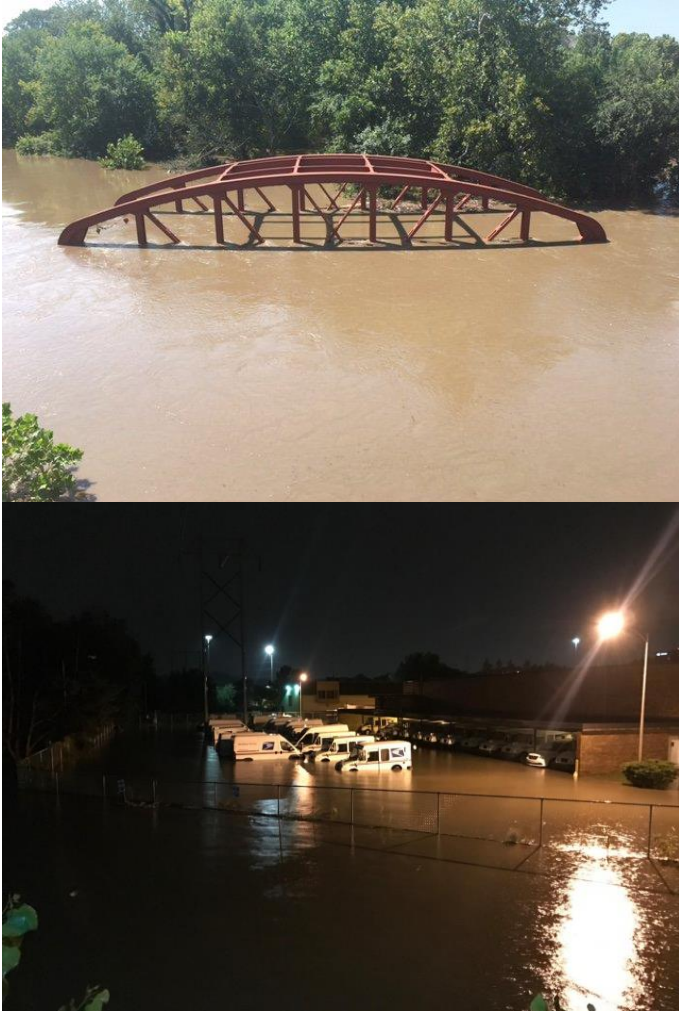
Esri, NASA, NGA, USGS, Unified Gov of Wyandotte Co, Missouri Dept. of Conservation, Missouri DNR, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA

Future Work: Kansas City Disasters II

Understanding water quality in Kansas City, KS utilizing the InVEST Urban stormwater model

Collaborate with Groundwork USA & Groundwork NRG to develop the citizen science interaction with urban flooding reporting in Kansas City, KS

Image Credit: Tim Hansen, Johnson County Emergency Management, and the National Weather Service

ACKNOWLEDGEMENTS

The team would like to thank the following people for their contributions to this project:

Fellow

Tyler Pantle,

DEVELOP MA – Boston

Senior Fellow

Celeste Gambino,

DEVELOP MA – Boston

Science Advisor

Dr. Kenton Ross,

NASA Langley Research Center

Project Partners

Groundwork NRG

Ben Carpenter

Reverend Adrianne (Adri) Showalter-Matlock

Groundwork USA

Jalisa Gilmore

Lawrence Hoffman