



KENTUCKY DISASTERS

Multi-Hazard Approach to Mapping Flood
Susceptibility and Vulnerability in Kentucky

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Jason Reynolds

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North Carolina – NCEI | Spring 2024



MEET THE TEAM



Team Lead
Daniel Feinberg



Claire
Beezley



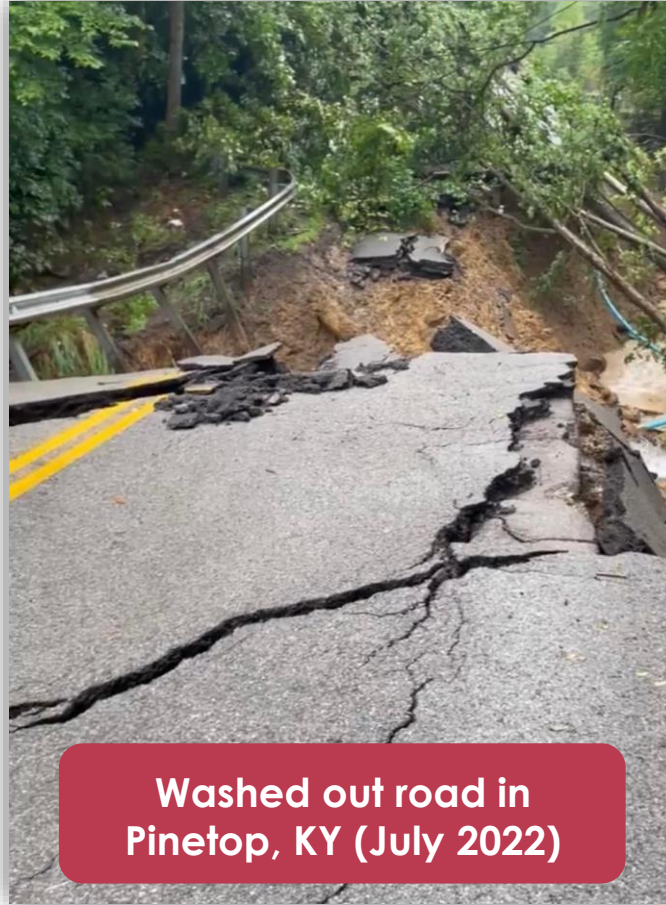
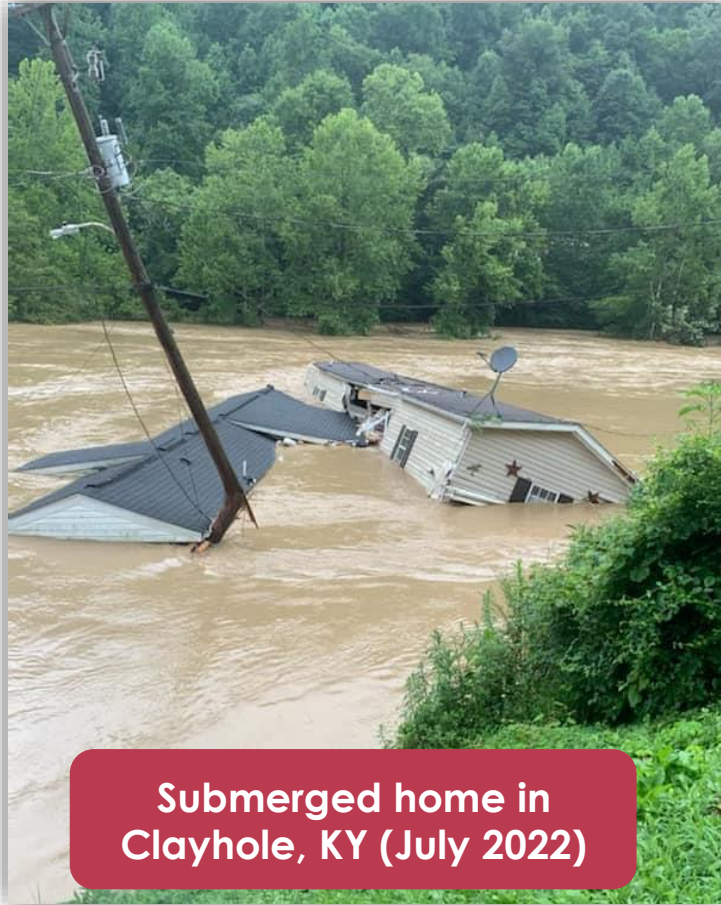
Jaydi
Swanson



Jason
Reynolds

BACKGROUND

Flooding in Kentucky is *prevalent, dangerous, and predicted to increase*



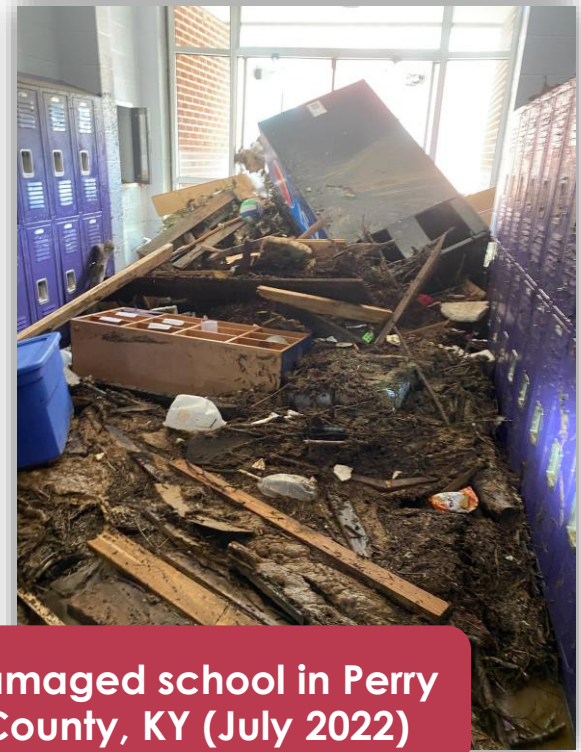
COMMUNITY CONCERNS

The human cost of flooding

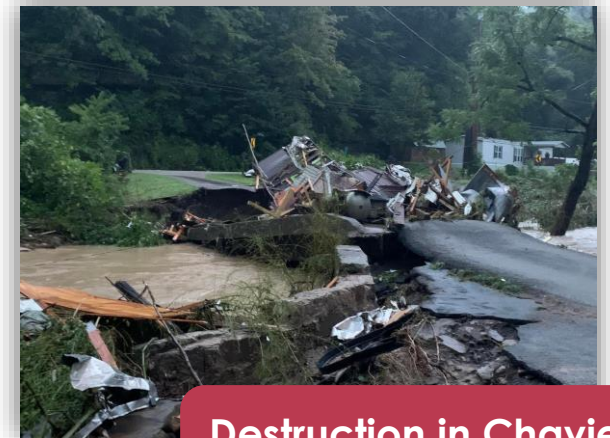
Understanding flood risk

Allocating resources

Building long-term resilience



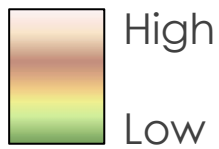
Damaged school in Perry County, KY (July 2022)



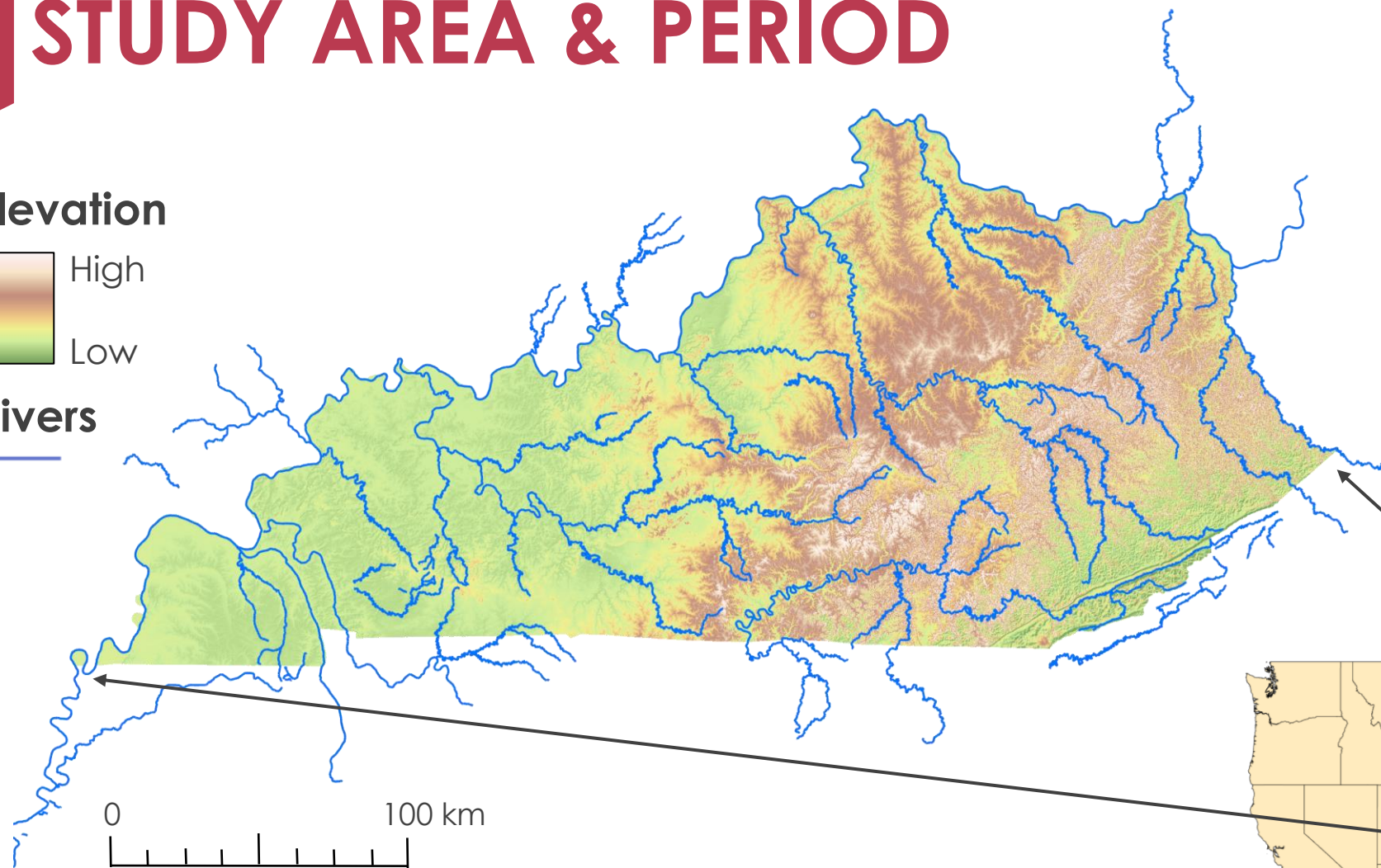
Destruction in Chavies, KY (July 2022)

STUDY AREA & PERIOD

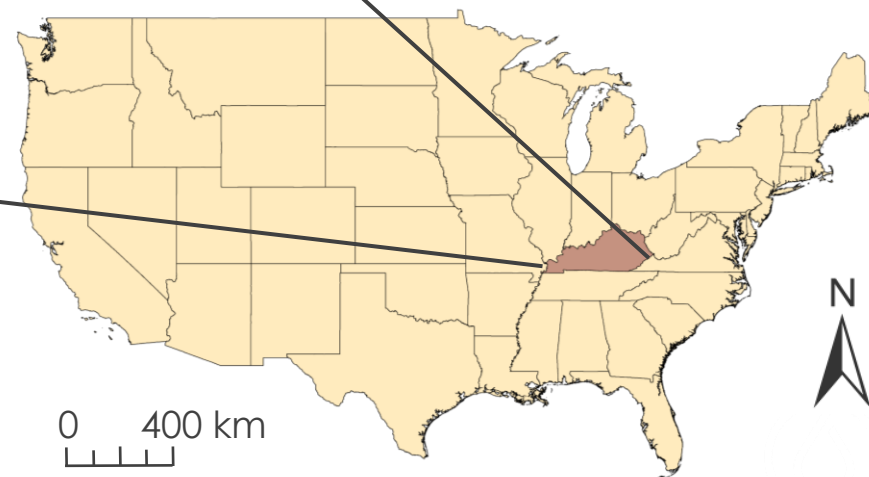
Elevation



Rivers



- **Study area:**
Kentucky
- **Study period:**
January 2022 to
August 2023



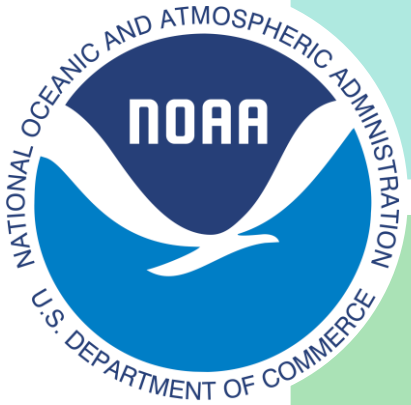
0 400 km



Basemap Credits: Kentucky From Above, US Census States

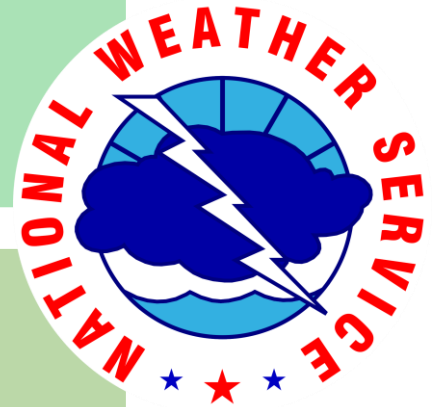
PARTNERS

KENTUCKY CLIMATE CENTER (KCC)



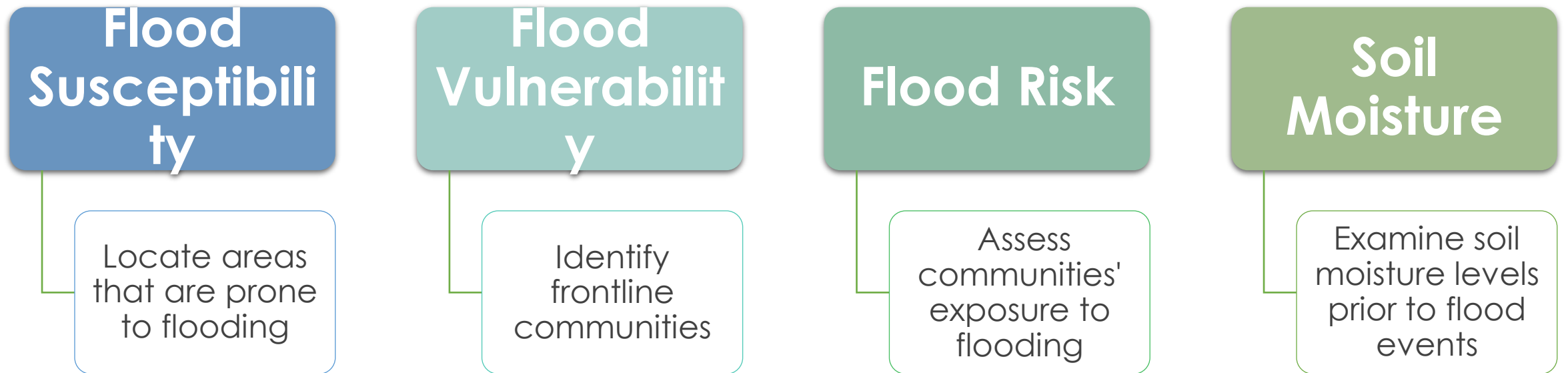
NWS FORECAST OFFICE – JACKSON, KY

NWS FORECAST OFFICE – PADUCAH, KY



OBJECTIVES

Facilitate flood preparation and awareness in Kentucky by mapping...



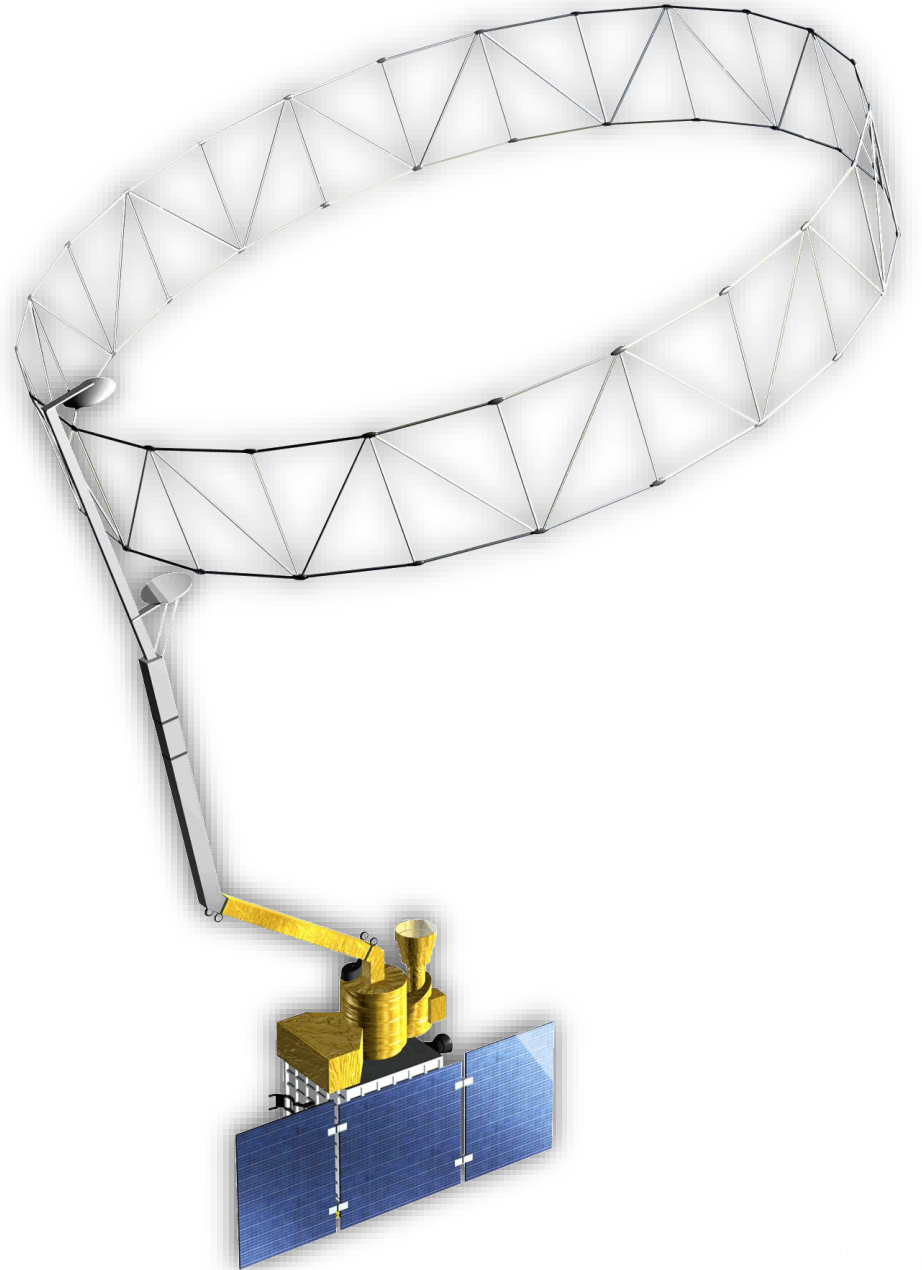
...which can aid weather offices in forecasting and outreach efforts.

EARTH OBSERVATIONS

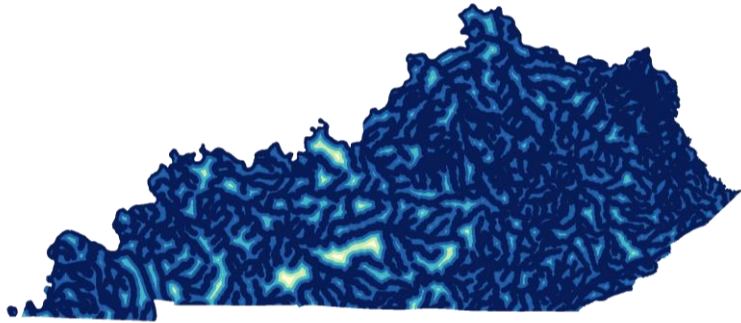
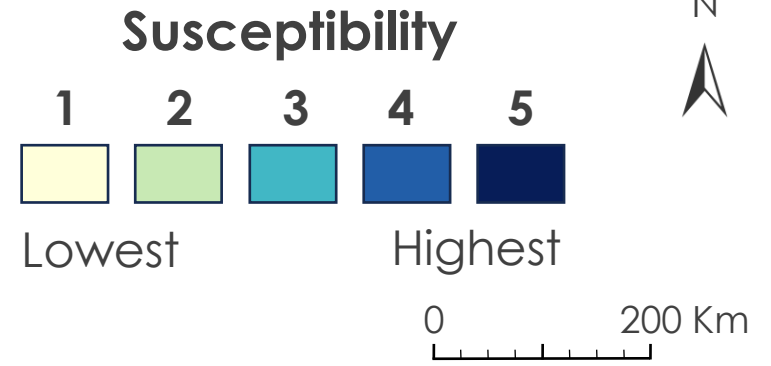
SMAP

(Soil Moisture Active/Passive)

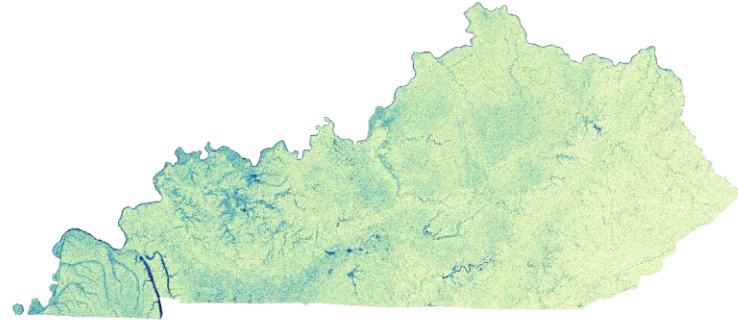
- L-Band Radiometer



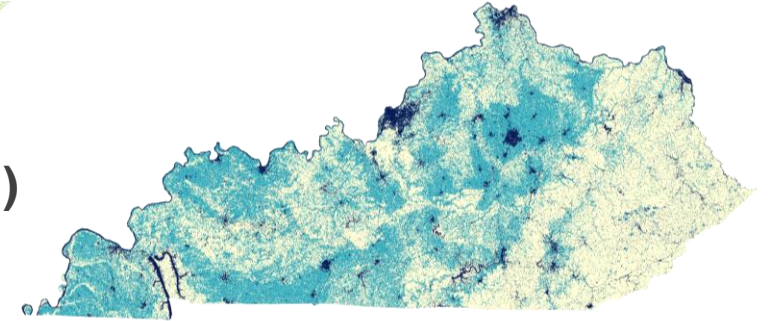
FLOOD SUSCEPTIBILITY VARIABLES



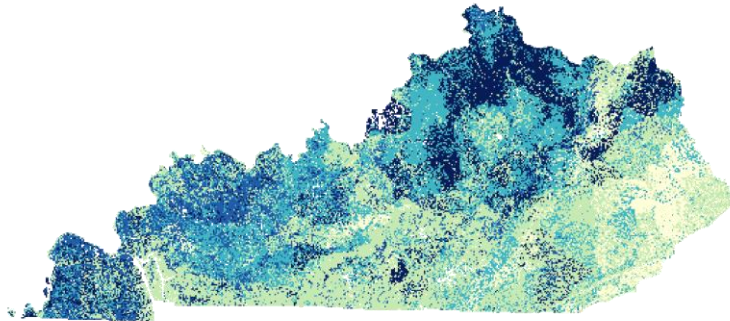
Distance to Rivers



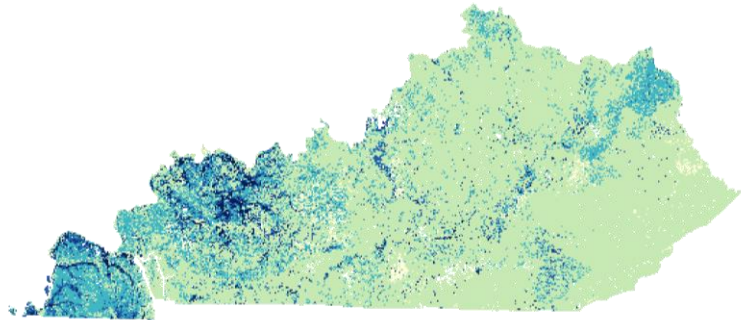
Topographic Wetness Index (TWI)



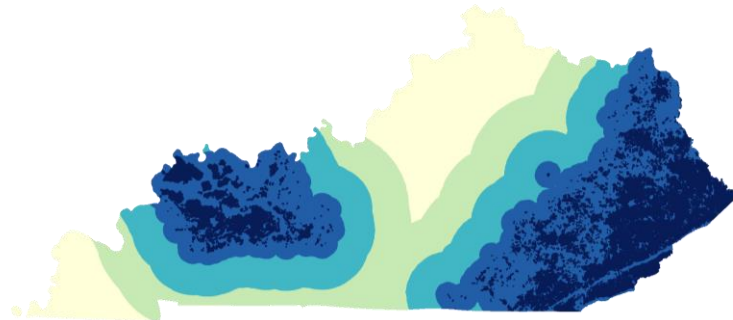
Land Cover



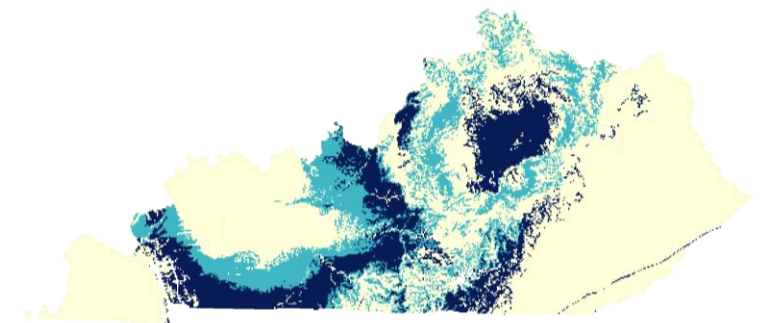
Soil Hydrologic Group



Soil Drainage Class



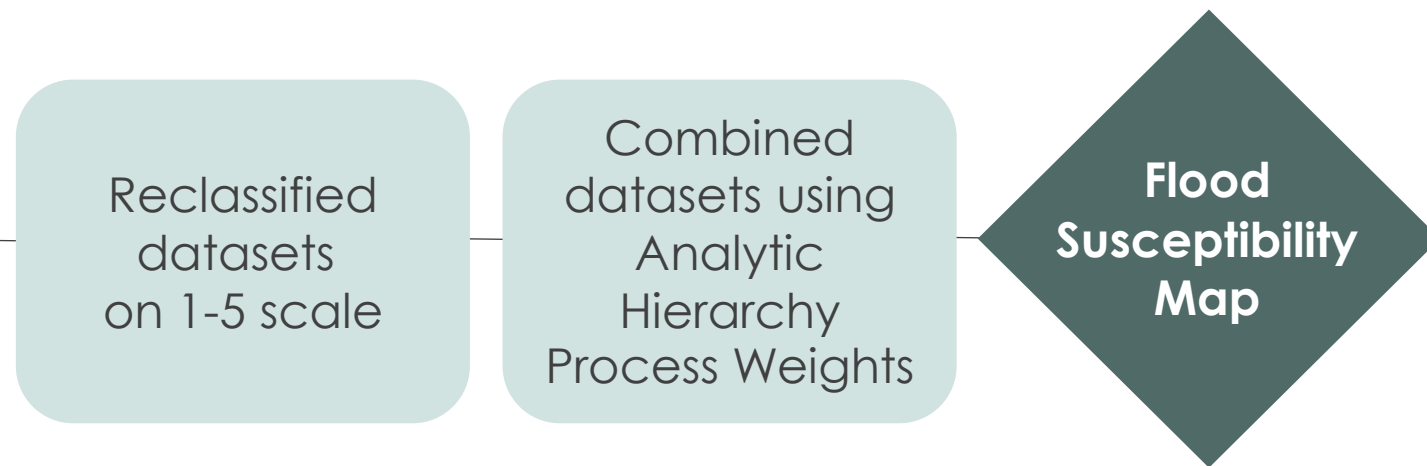
Distance to Mines



Karst Area Classification

FLOOD SUSCEPTIBILITY DATA PROCESSING

Distance to Rivers	30%
Topographic Wetness Index	25%
Land Cover	14%
Hydrologic Groups	12%
Drainage Class	11%
Karst Areas	5%
Distance to Mines	3%



RECLASSIFICATION SCALE

1

Furthest from rivers, low TWI, forested land, well-drained soil with little run-off, non-karst area, far from mines

2

Grass land

3

Agricultural land, some karst areas

4

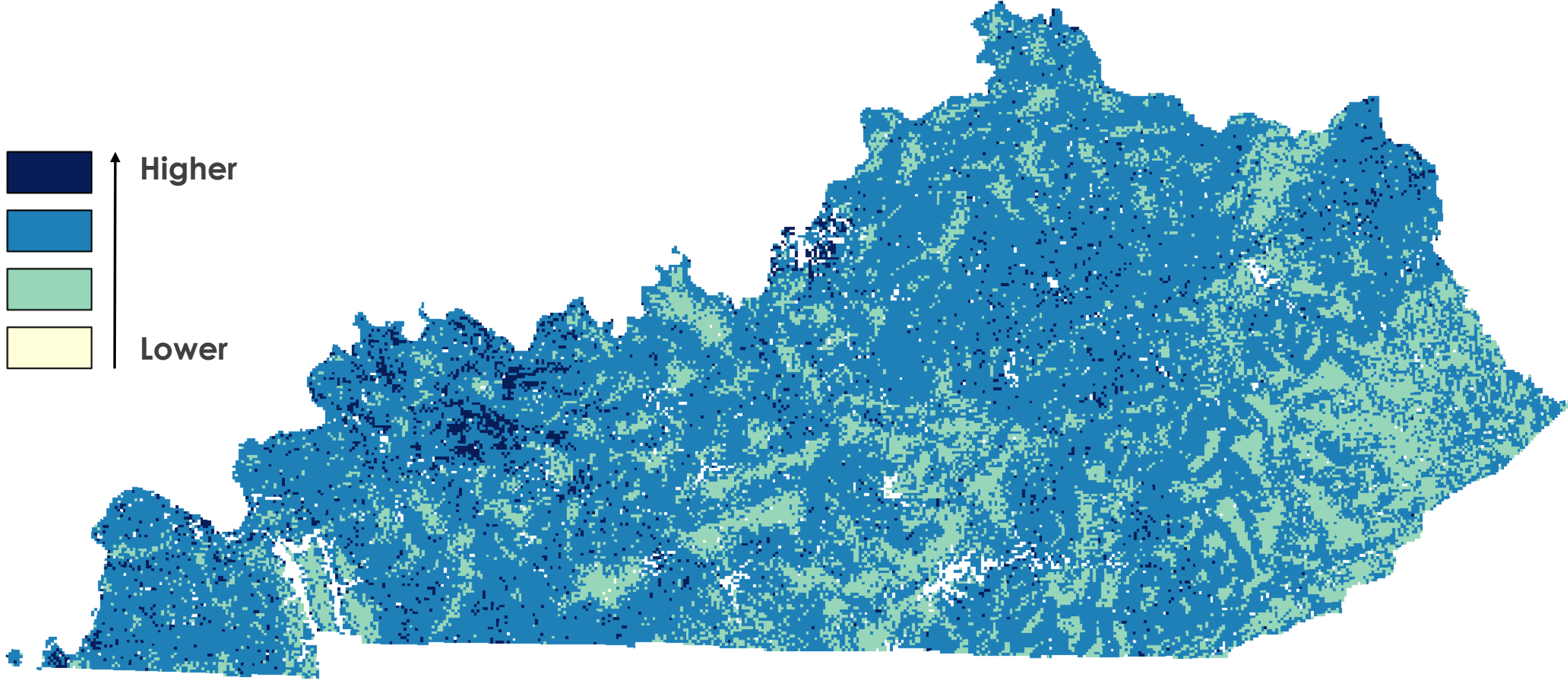
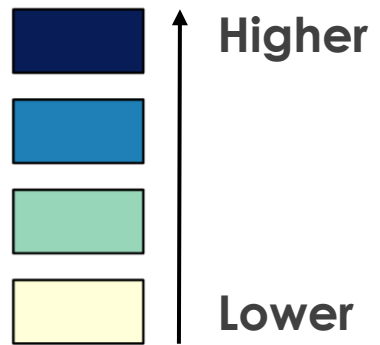
Barren land

5

Closest to rivers, high TWI, developed land, poorly drained soil with high run-off, intense karst areas, close to mines

These five classifications mean the pixel has some combination of these parameters—not necessarily all.

FLOOD SUSCEPTIBILITY



FLOOD VULNERABILITY DATA PROCESSING

Socioeconomic Data

2022 Census Planning Database

Poverty
Limited English Speaking
Population 65 and Over
Population Under 5
Disability
Mobile Homes
No Internet Access
No Phone Service
No Computer Access
Population Density

Infrastructure Data

Various Sources

Bridges
Fire Departments
Hospitals

Reclassified
datasets on
1-5 scale

Unweighted
average

**Tract-
Level Flood
Vulnerability
Map**

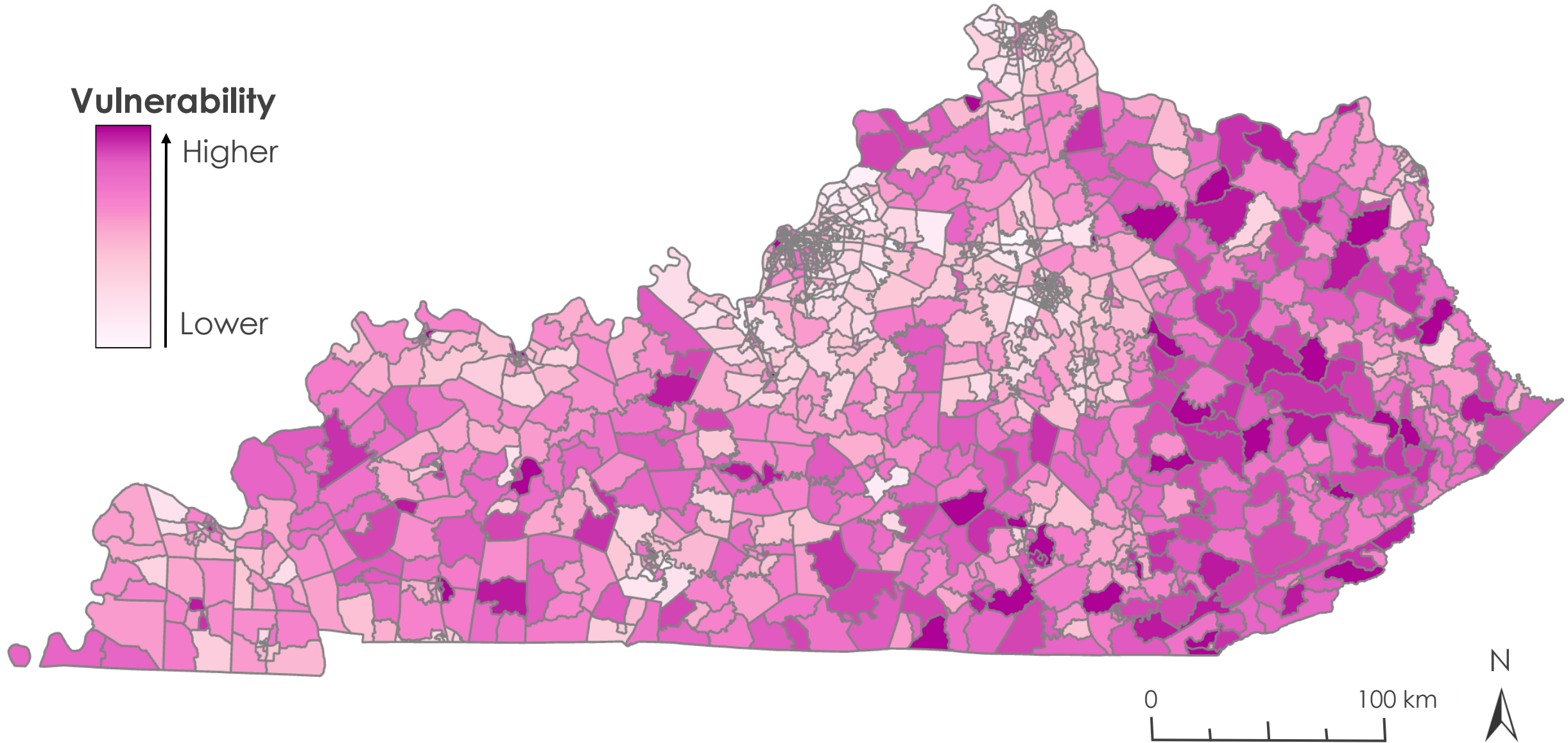
Combined
data at
county level

Reclassified
datasets on
1-5 scale

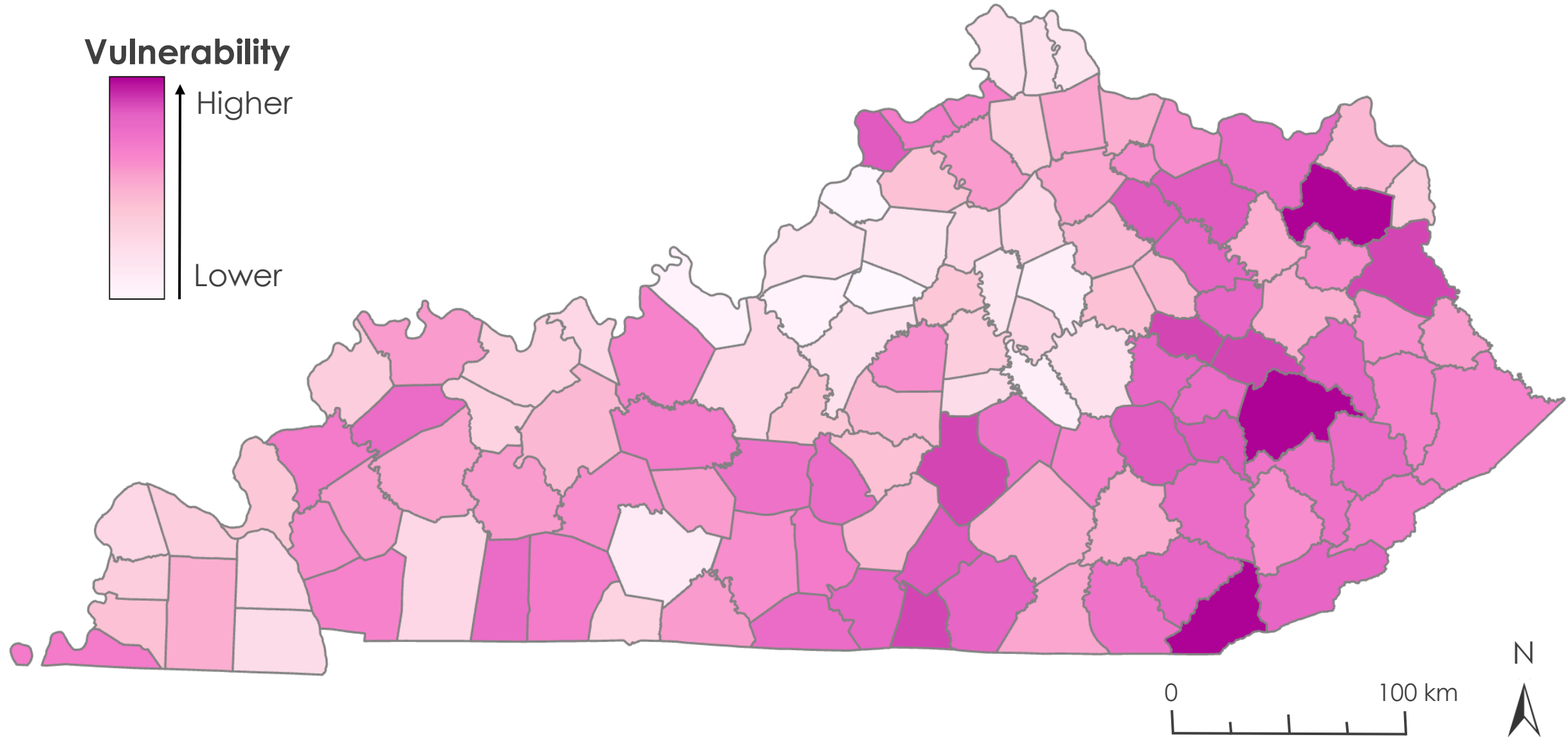
Unweighted
average

**County-
Level Flood
Vulnerability
Map**

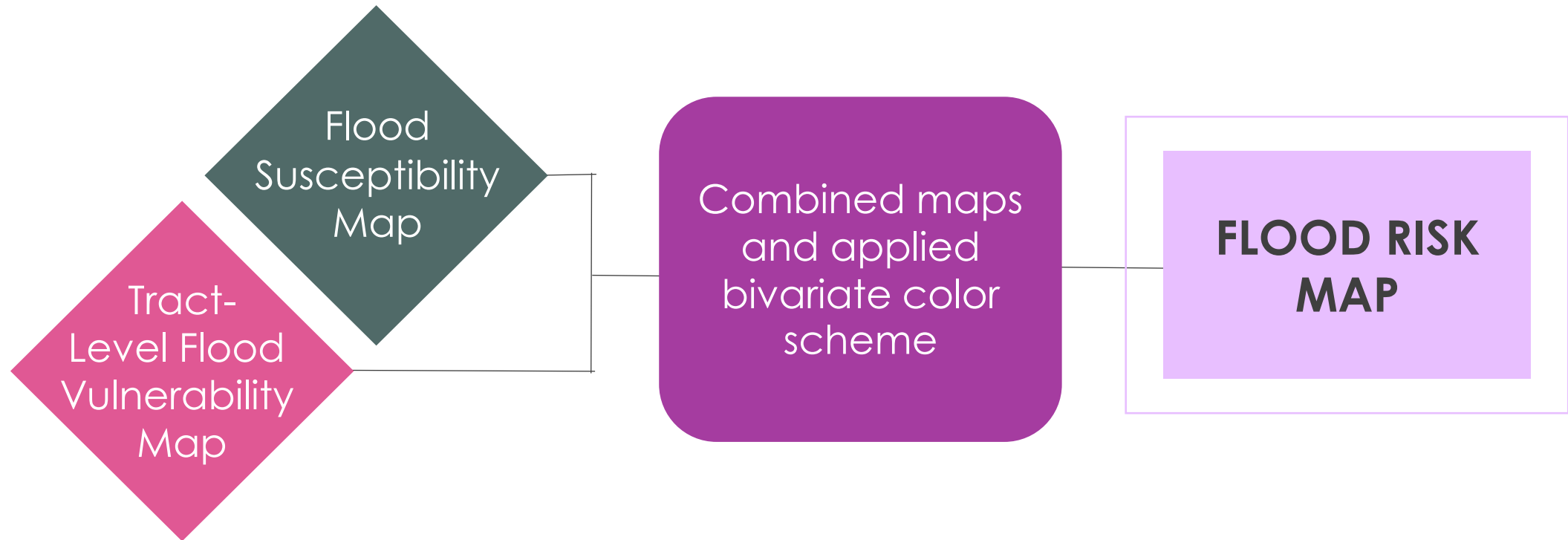
FLOOD VULNERABILITY — CENSUS TRACT LEVEL



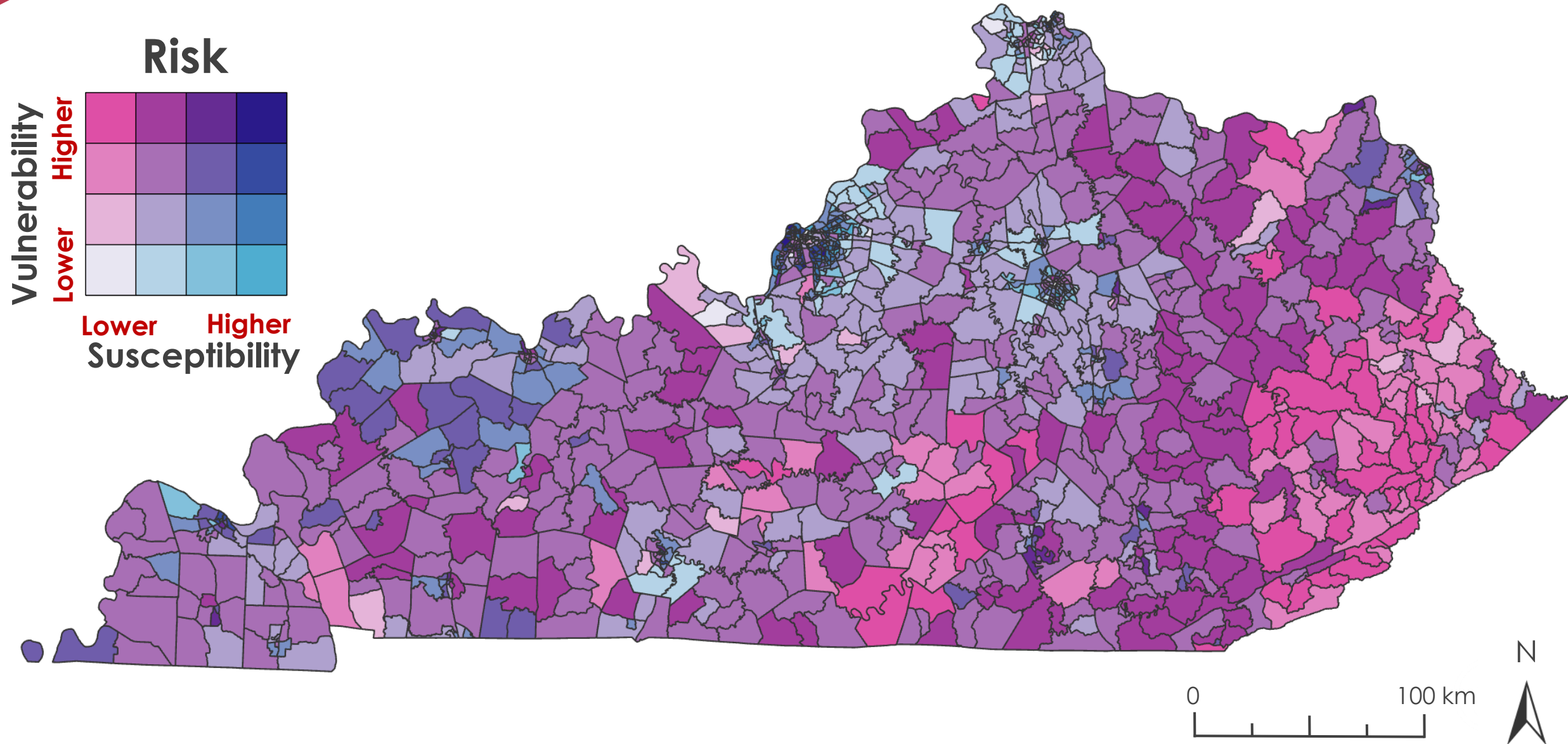
FLOOD VULNERABILITY — COUNTY LEVEL



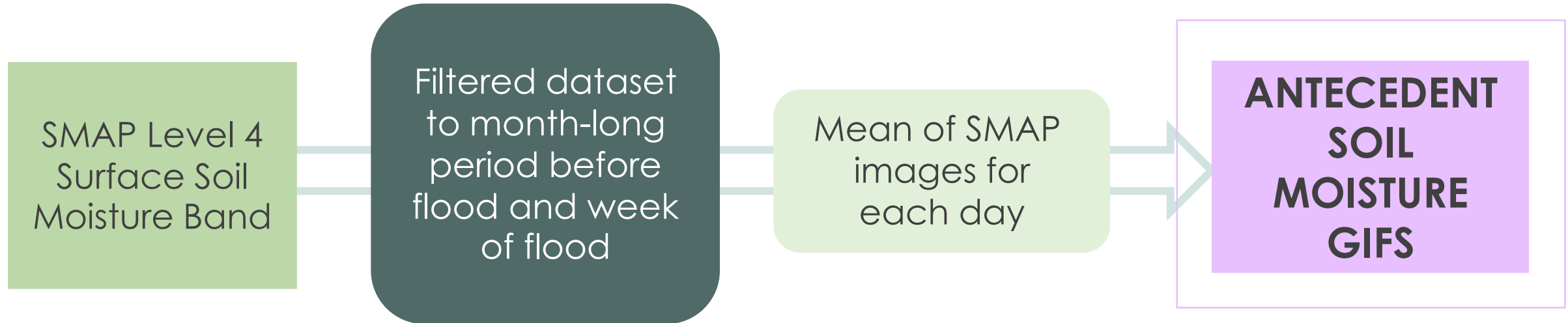
FLOOD RISK MAP CREATION



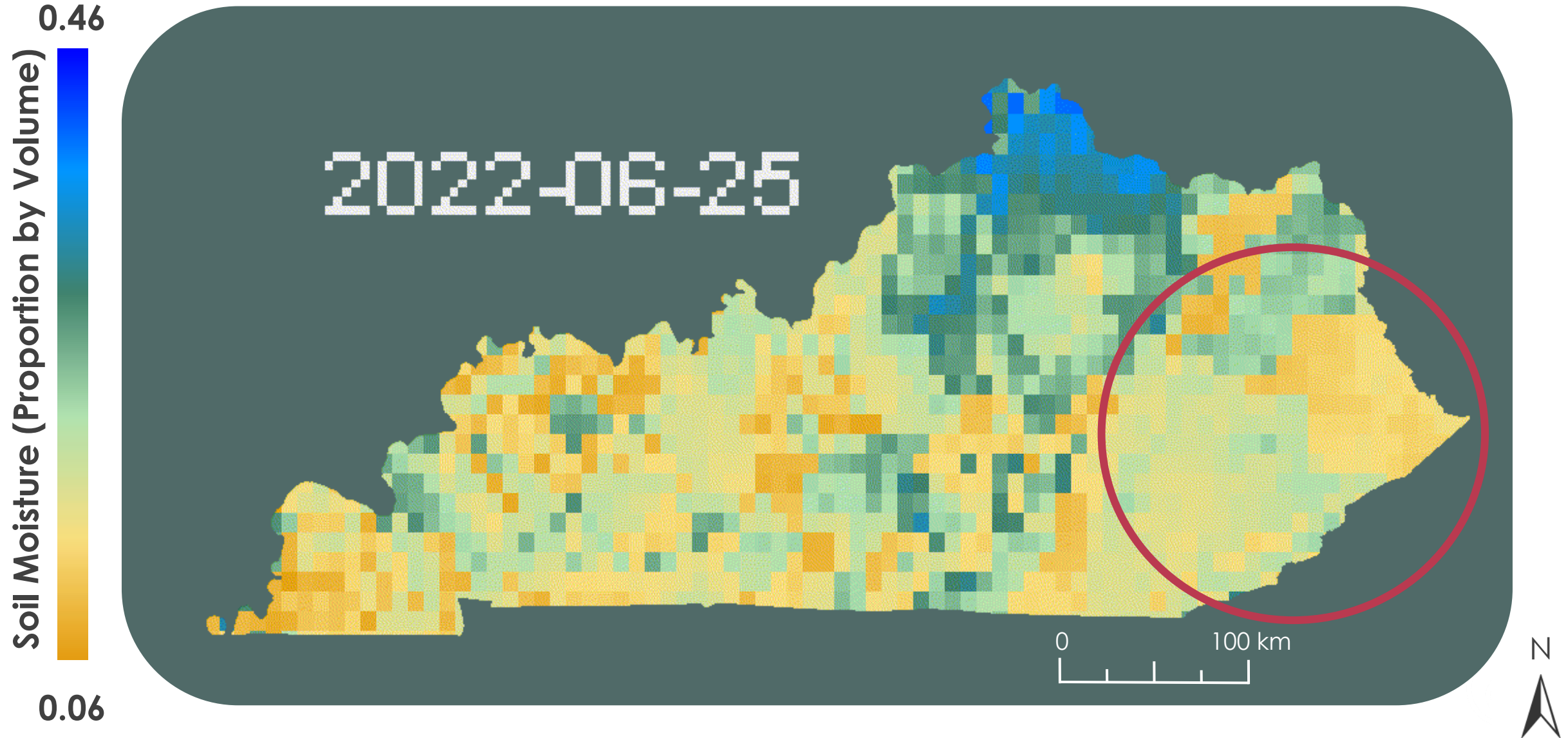
FLOOD RISK — CENSUS TRACT LEVEL



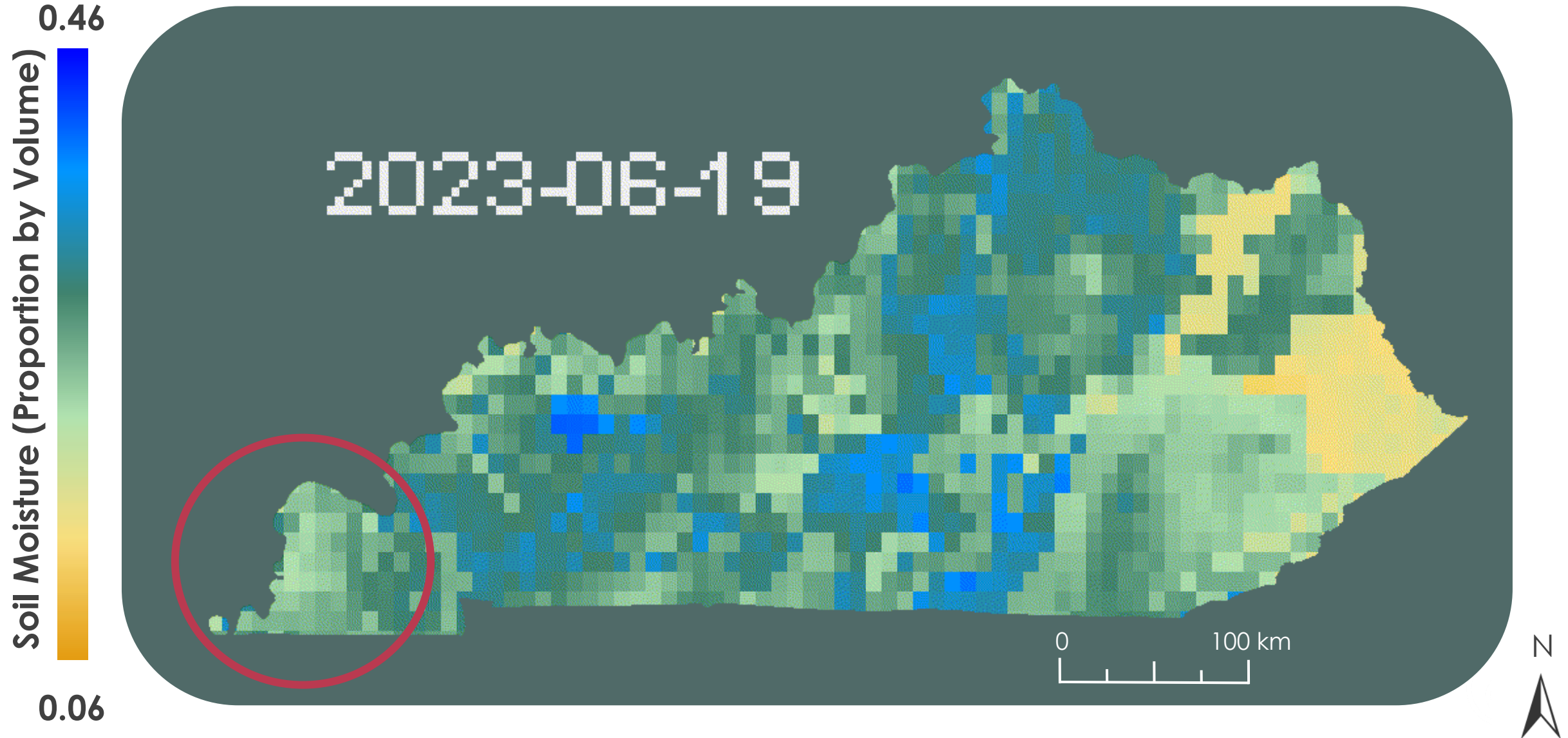
ANTECEDENT SOIL MOISTURE GIF CREATION



ANTECEDENT SOIL MOISTURE GIF – 07/28/22



ANTECEDENT SOIL MOISTURE GIF – 07/19/23



ERRORS AND UNCERTAINTIES

AHP and Weighting Schemes

Reclassification Process

Data Omission

River Size and Other Data Gaps

Lack of Robust Validation

CONCLUSIONS

Demonstrated feasibility of using aerial and ground-based measurements to map flood risk

Produced a snapshot of flood susceptibility and vulnerability in Kentucky

Created resources to assist partners in community outreach

Provided emergency managers a comprehensive view of risk



FUTURE WORK

Explore weighting schemes besides Analytic Hierarchy Process or pursue refinements

Analysis of how antecedent soil moisture conditions impacted floods in 2022 and 2023

Additional validation of flood risk maps using historical inundation data

Acknowledgments



Project Partners and Advisors:

- **Katie Caruso** (NASA DEVELOP Lead at NOAA's National Centers for Environmental Information)
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- **Dr. Venkataraman Lakshmi** (University of Virginia)
- **Jim Noel** (NOAA, National Weather Service Ohio River Forecast Center)

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