# What Lies Ahead – A Comprehensive Inland Climate Vulnerability Assessment

JonesEdmunds


FSA Annual Conference

June 2023

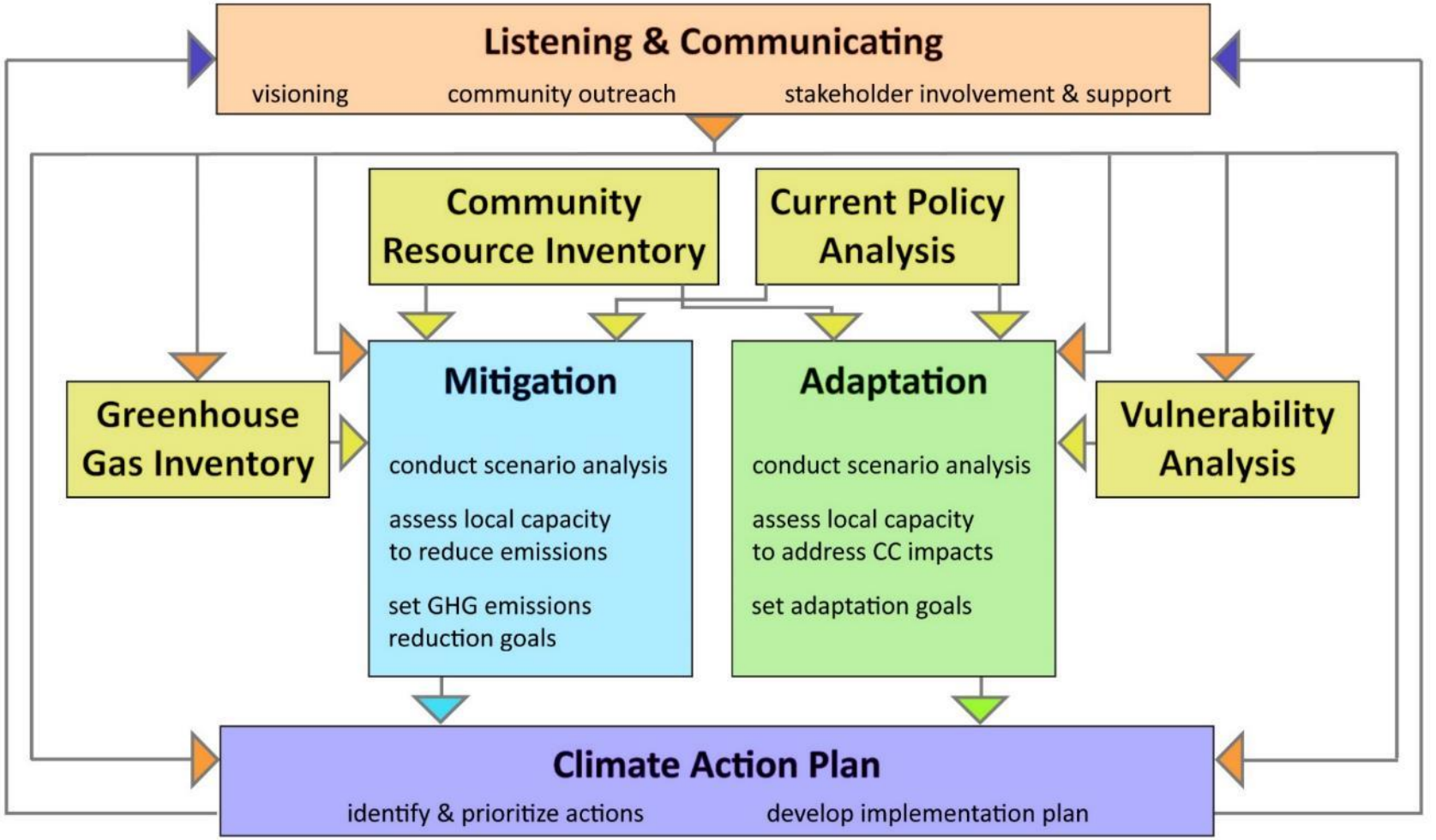
# Alachua County Climate Initiatives

- In 2020 the County Commission directed staff to begin development of a Climate Action Plan.
- We envisioned a vulnerability analysis similar to what had been done in coastal counties but tailored for an inland county's risk.
- The analysis was planned to be Countywide. Much critical infrastructure and County assets are in Cities in the County.

# Part of a Broader Set of Climate Actions

- Created a Citizens Climate Advisory Board
- Created Joint Water & Climate Policy Committee
- Created the county sustainability manager position
- Created a climate planning group
- Awarded Resilient Florida grants
- Completed Greenhouse Gas (GHGI) Reports
- Developed outline for Climate Action Plan
- Reviewed existing climate related policies
- Surveyed current climate related programs
- Presented to the Regional Planning Council
- Awarded DOE Local Energy Action Program (LEAP) community assistance
- City adopted zero waste ordinance
- City hired a new Chief Climate Officer
- Completed countywide vulnerability analysis

# Climate Action Planning Process: Components




*adapted from "Guiding Principles for City Climate Action Planning", UN Habitat for a Better Urban Future

# Vulnerability Analysis Drivers & Goals

- Flooding becoming more frequent.
  - Hurricane Irma in 2017 caused significant flooding.
  - TS Elsa in 2021 also caused significant flooding.

Photos by Alachua County Public Works

# Vulnerability Analysis Drivers & Goals

- The final scope expanded flood risk to include parcel level analysis to identify structures at risk.
- Impacts of climate migration were added to the project scope.
- The final scope included effects of climate change on:
  - Population vulnerable to high temperature
  - Groundwater and water supply impacts
  - Surface water impacts
  - Agriculture production and drought
  - Wildfire risk

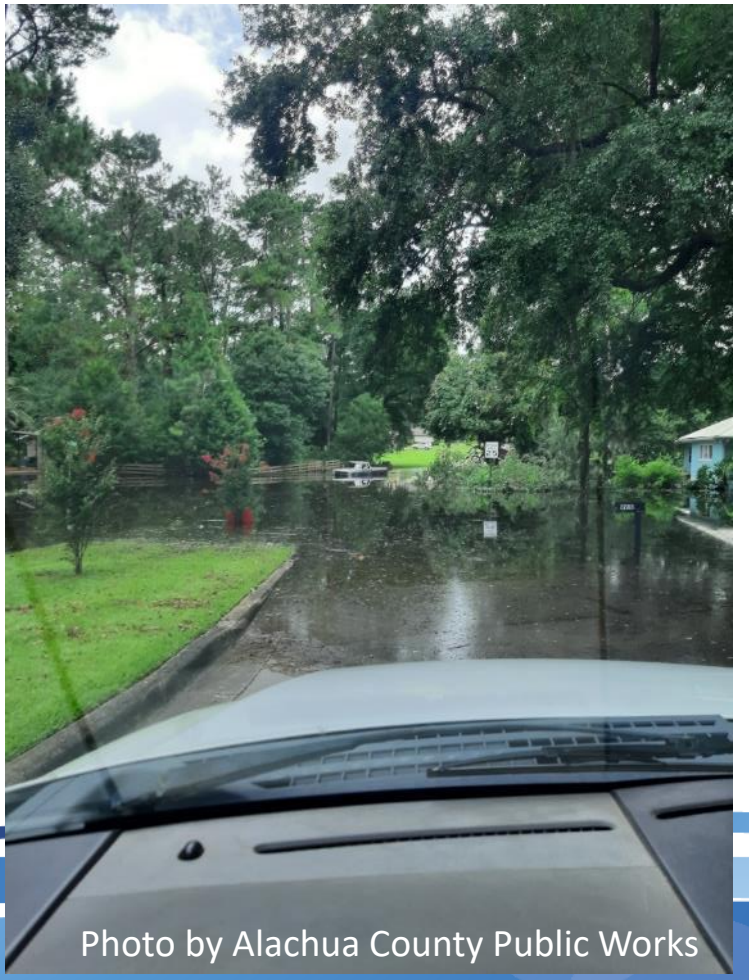


Photo by Alachua County Public Works

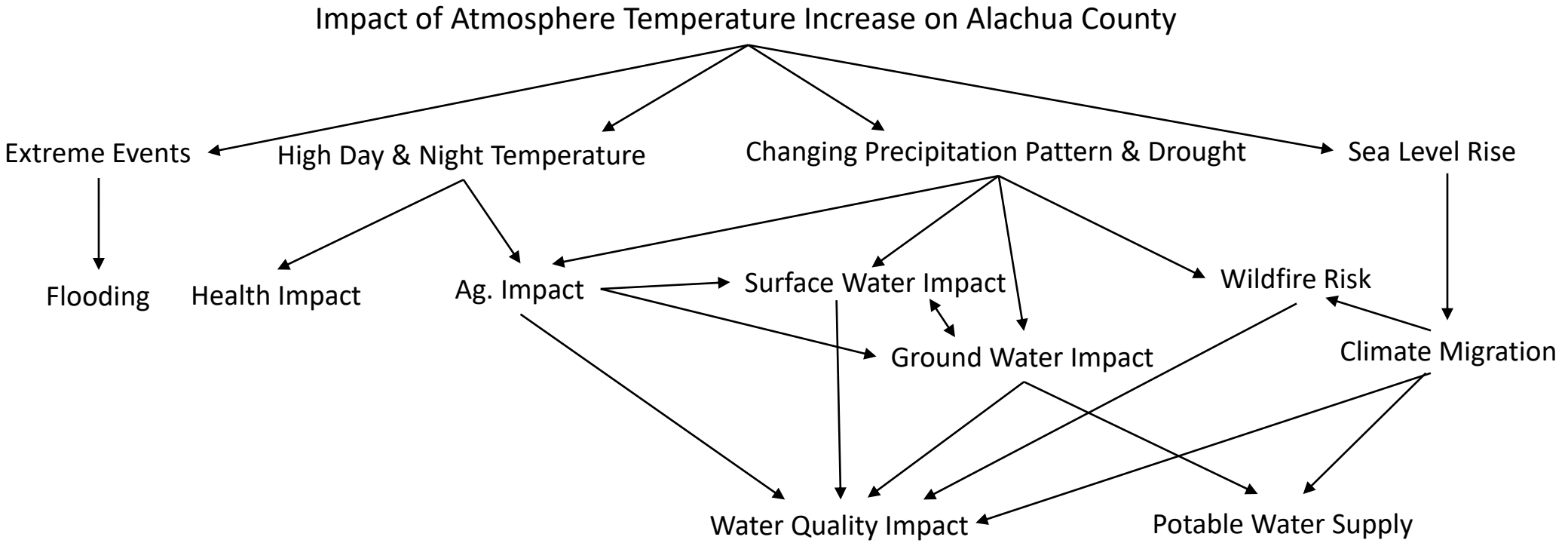
# Climate Impacts Beyond Flooding

- Impacts on County residents.
  - Reduced crop yield affects producers financially.
  - Increased heat stress affects health.
  - Groundwater impacts on water availability.
  - Increased wildfire risk affecting property.

- Impacts natural and water resources.
  - Reduced crop yield may increase fertilizer use and irrigation.
  - Lower lake levels are associated with worse water quality.
  - Climate migration leads to more developed areas.
  - Wildfire risk affects how we manage our preserves and impacts waterbodies.


Photo by FDEP


Photo by John Moran


Impact of Atmosphere Temperature Increase on Alachua County
Extreme Events
High Day & Night Temperature
Changing Precipitation Pattern & Drought
Sea Level Rise
Flooding
Health Impact
Ag. Impact
Surface Water Impact
Wildfire Risk
Ground Water Impact
Climate Migration
Water Quality Impact
Potable Water Supply

# Task Breakdown

- Task 1: Future Climate Change Impacts Analysis – Review of applicable climate science and qualitative impacts to Alachua County.
- Task 2: Location of Critical Infrastructure Vulnerable to Flooding – Critical infrastructure as defined by SB 1954 that is vulnerable in current and future flooding conditions.
- Task 3: Assessment of Increased Climate Change Related Vulnerability to Neighborhoods and Cultural Resources – Deeper look at vulnerabilities by census block.

# Stakeholder Engagement

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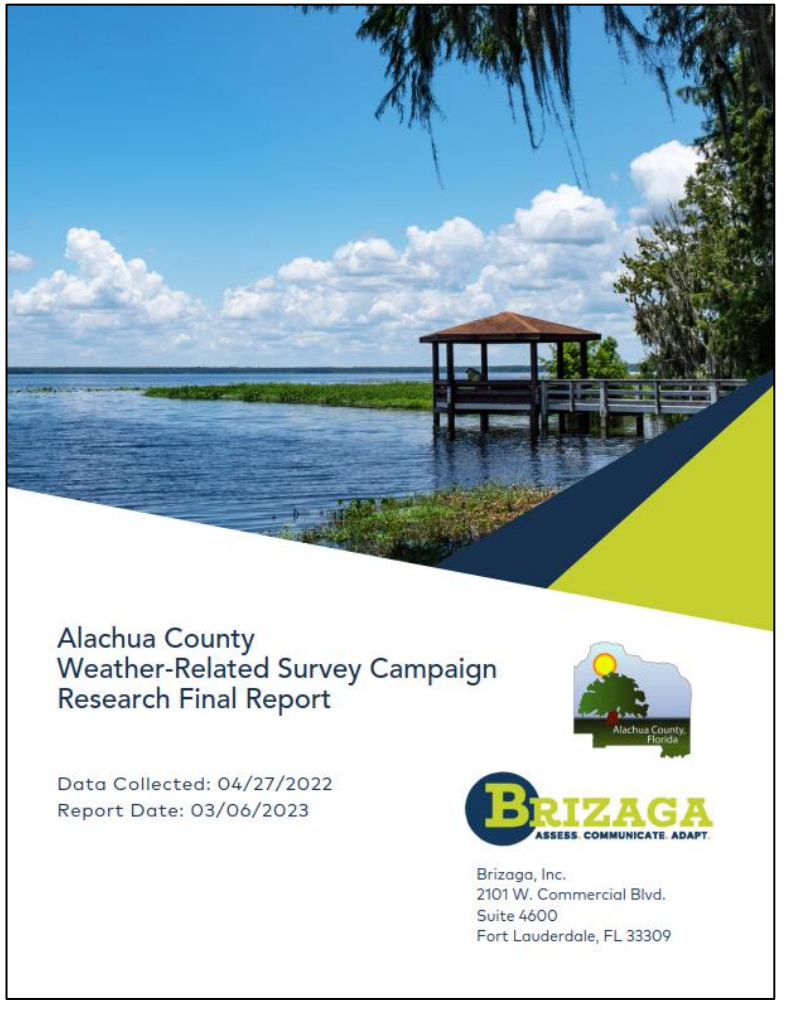
- **Survey Results**
  - **601 total responses**
  - **Target was 400 responses**
  - **Summary report and results provided to staff**



# Selected Climate Change Scenario

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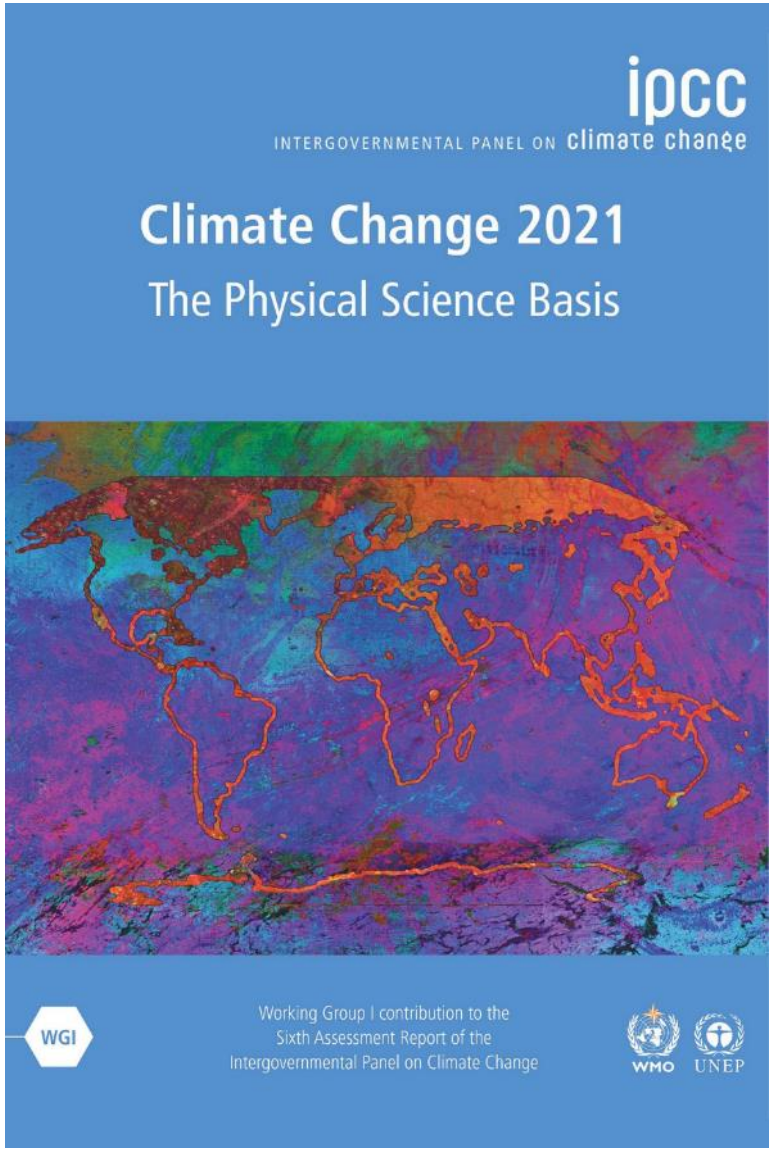
- Coupled Model Intercomparison Project (CMIP)
  - CMIP 5 (published 2014)
  - CMIP 6 (published 2021)
- Five Shared Socio-Economic Pathways
  - SSP1 - high level of mitigation & adaption ~ 1.5°C rise by 2100
  - SSP5 – low mitigation & adaptation ~ 5°C rise by 2100
    - More likely to show trends
    - Highlights planning needs



# Extreme Temperatures

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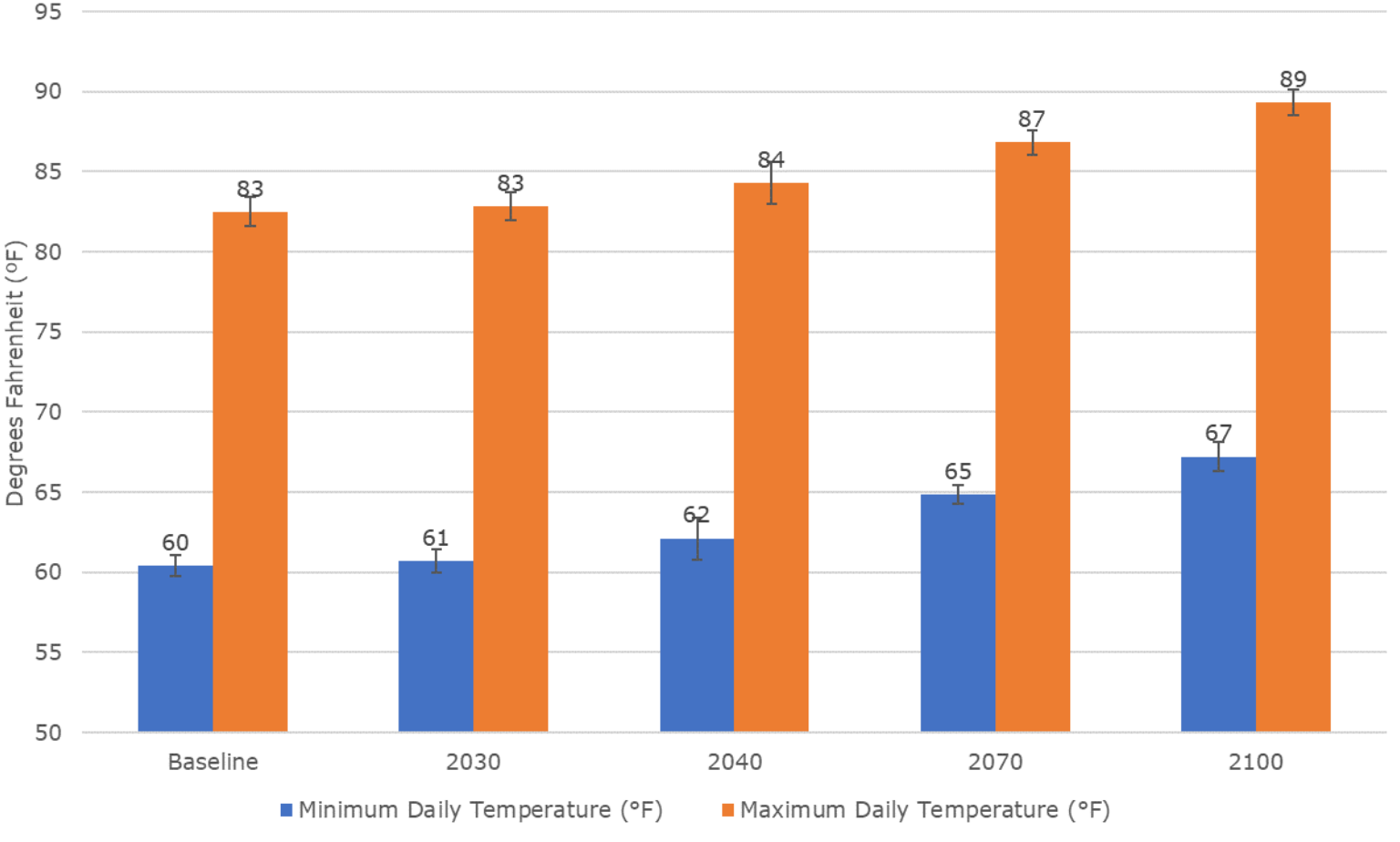
## Average Annual Daily Minimum and Maximum Temperatures



# Heat Index

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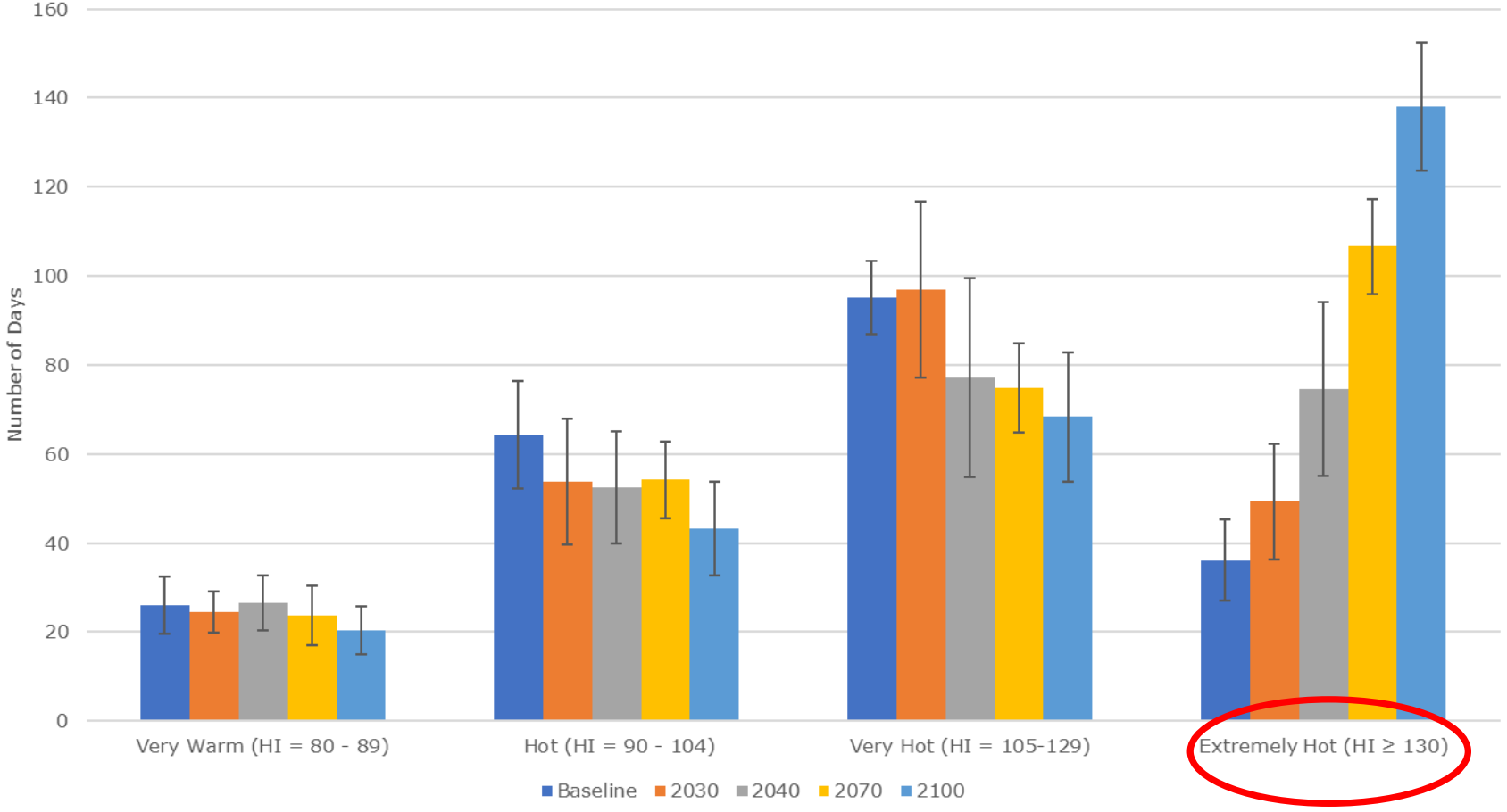
## Average Number of Days Maximum Heat Index Exceeds NWS Thresholds



# Extreme Heat Vulnerability

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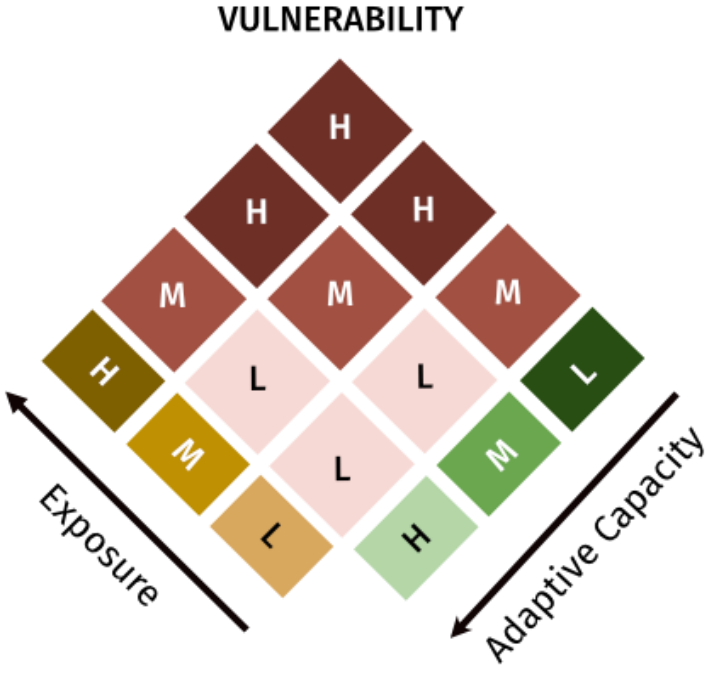
## Assessment Ruleset

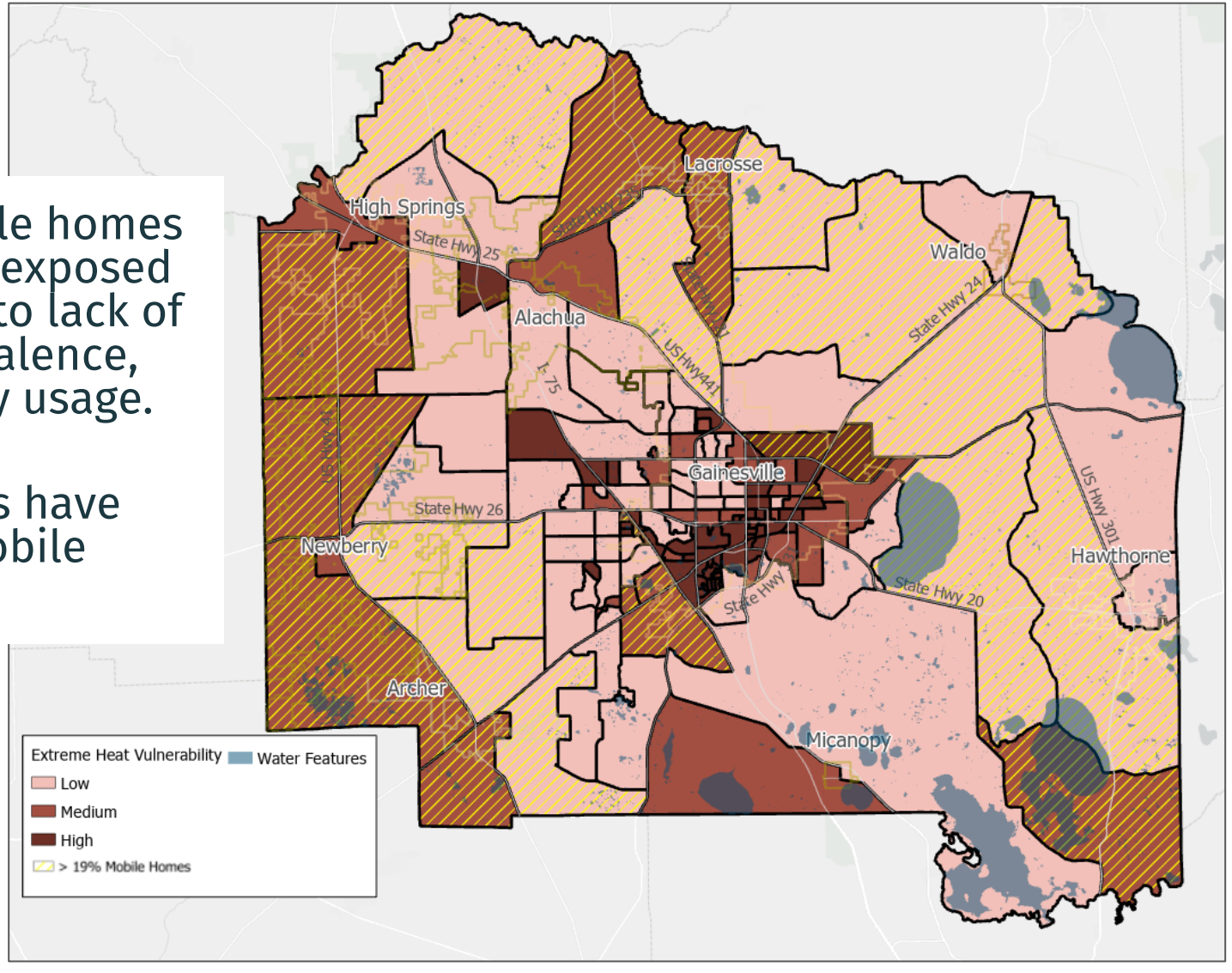
| Exposure | | Adaptive Capacity | |
|---|---|---|---|
| H | >75th percentile developed land cover | L | <25th percentile tree canopy coverage AND/OR <25th percentile median income |
| M | 25th-75th percentile developed land cover | M | 25th-75th percentile tree canopy coverage AND/OR 25th-75th percentile Median Income |
| L | <25th percentile Developed Land Cover | H | >75th percentile tree canopy coverage AND/OR >75th percentile Median Income |



# Extreme Heat Vulnerability

People living in mobile homes are likely to be more exposed to extreme heat due to lack of air conditioning prevalence, insulation and energy usage.

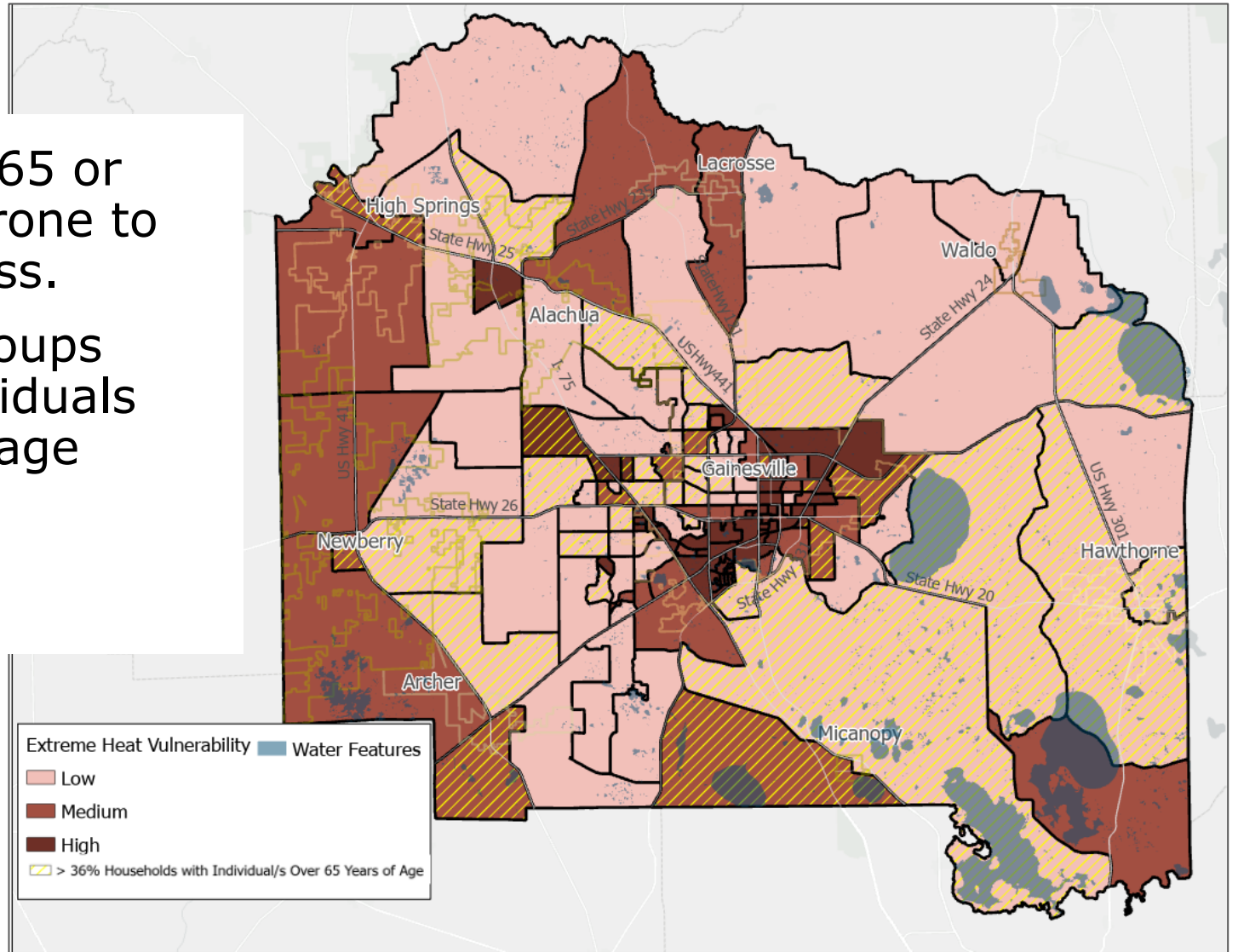
Hatched block groups have greater than >19% mobile home residences



# Extreme Heat Vulnerability

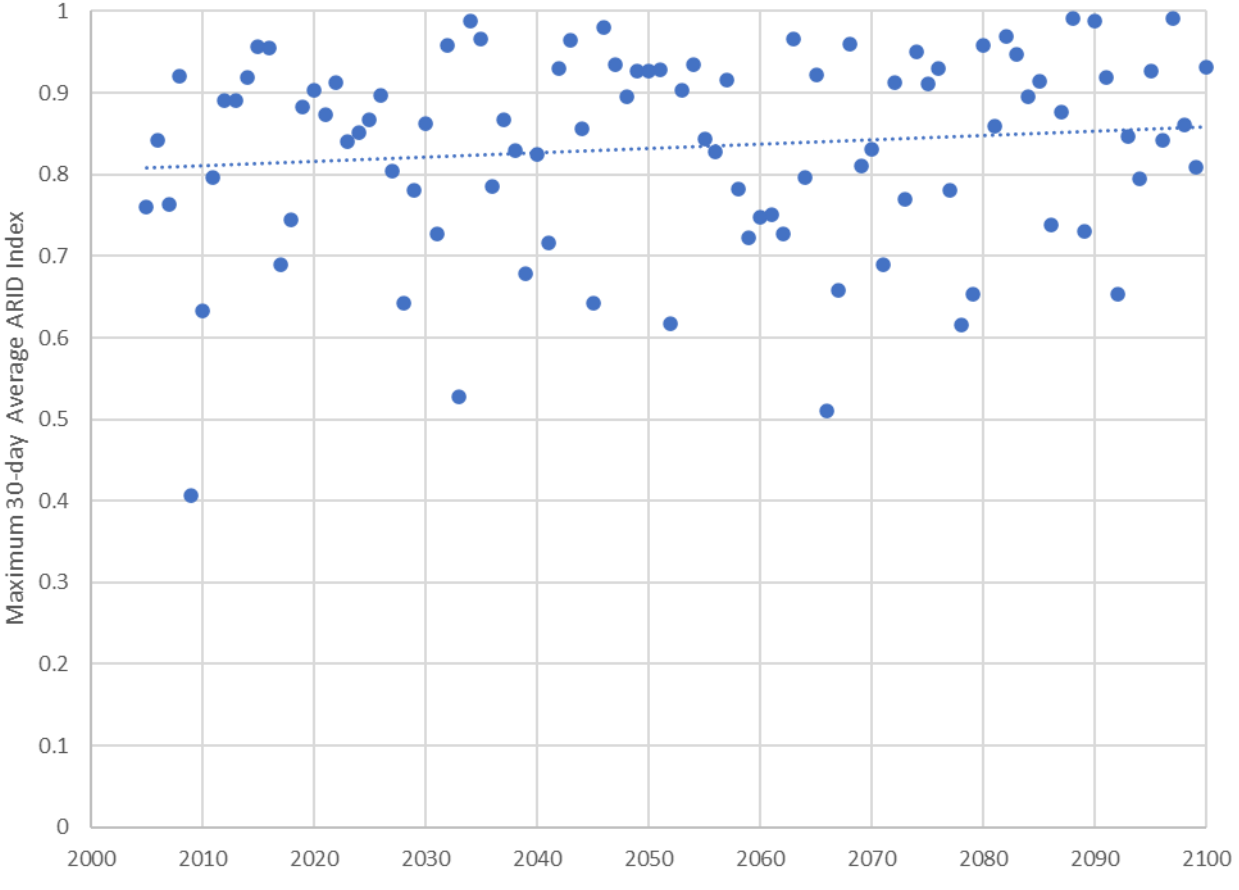
Individuals aged 65 or older are more prone to heat-related illness.

Hatched block groups have >36% individuals over 65 years of age

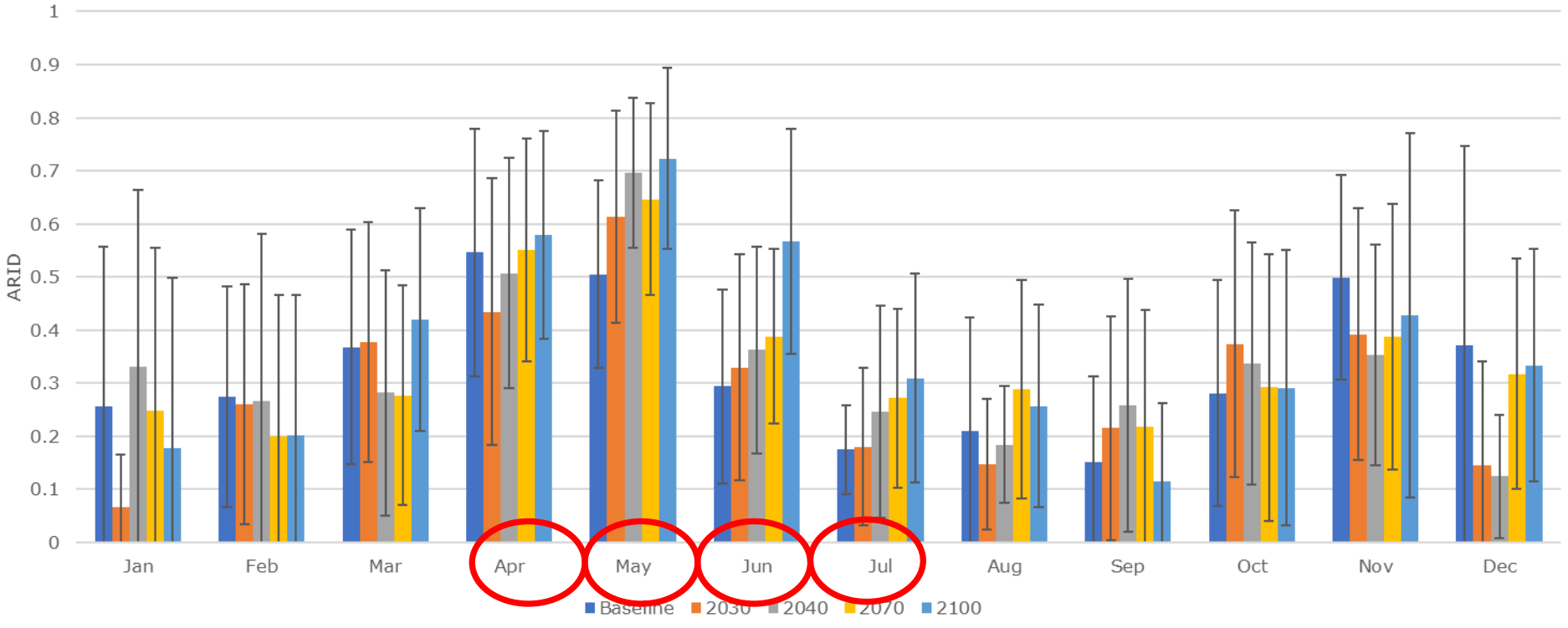


# Food Systems and Agricultural Production - Drought

- Agricultural Reference Index for Drought (ARID)
  - Used to quantify drought in the SE
  - Focused on agricultural drought
  - Developed at UF



# Food Systems and Agricultural Production - Drought




- **High variability in monthly ARID**
- **Significant increases in May, June, July**

# Food Systems and Agricultural Production – Crop Modeling

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- Three Crop Models
  - Field Crop (corn)
  - Forage Crop (Bahia)
  - Vegetable Crop (snap bean)

# Food Systems and Agricultural Production – Crop Modeling

- Three Crop Models
  - Field Crop (corn)
  - Forage Crop (Bahia)
  - Vegetable Crop (snap bean)
- Irrigated & non-irrigated
- Fertilized & non-fertilized

# Food Systems and Agricultural Production – Crop Modeling

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- Yield
- Biomass
- Fertilizer demand
- Irrigation demand
- Evaluation Periods
  - 2030
  - 2040
  - 2070
  - 2100

# Food Systems and Agricultural Production – Crop Modeling

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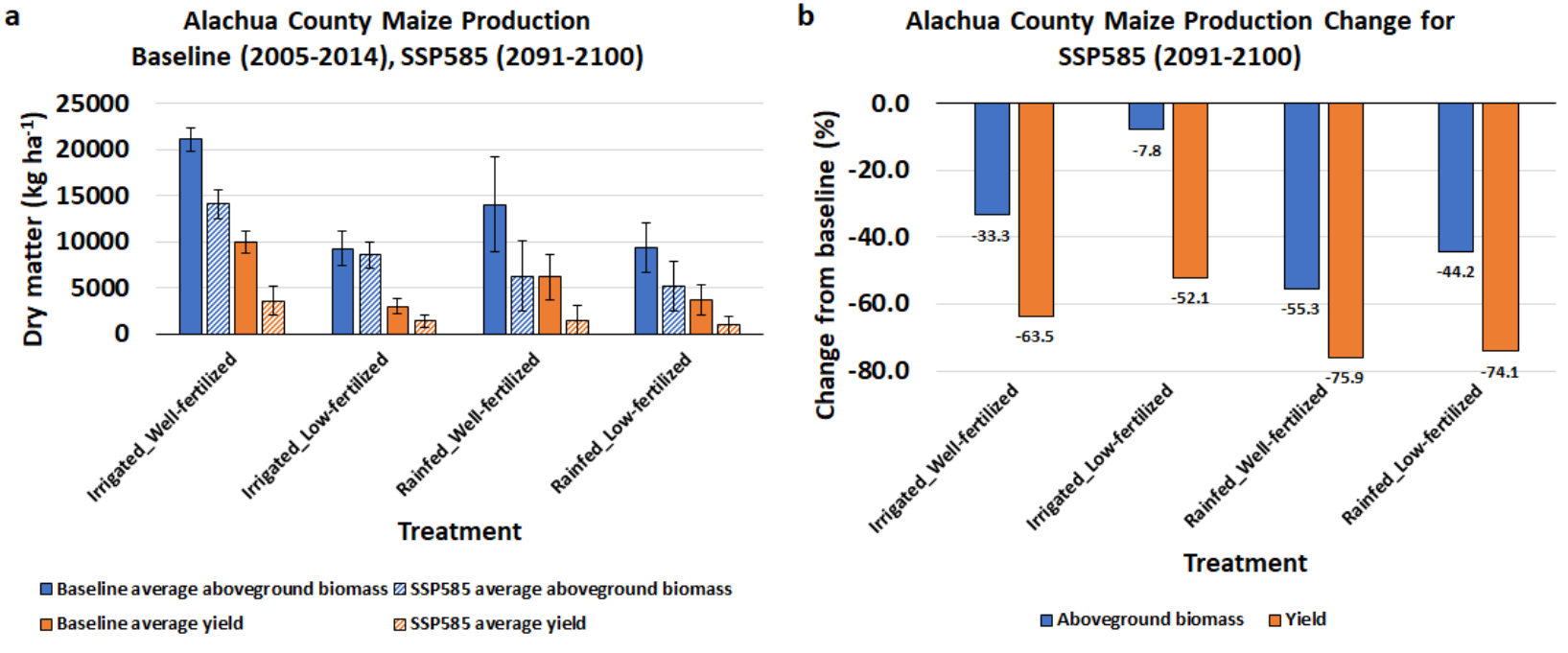
- Corn
  - Significant reduction in yield
  - Heat and water deficit stress
  - Increased irrigation and fertilizer need



# Food Systems and Agricultural Production - Crop Modeling

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- **Snap Beans**
  - **Initial increase in yield (increased $CO_2$)**
  - **Eventual reduction (heat and water deficit stress)**
  - **Increased irrigation and fertilizer need**

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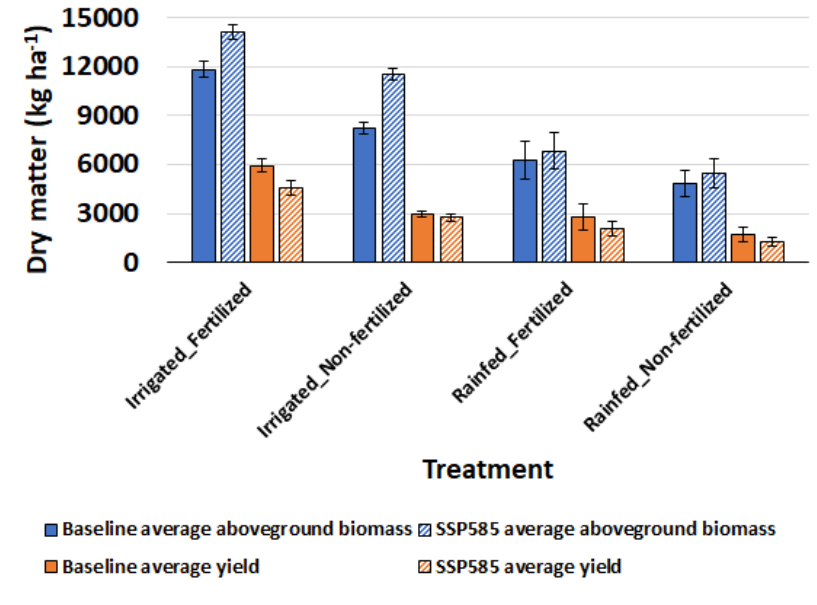


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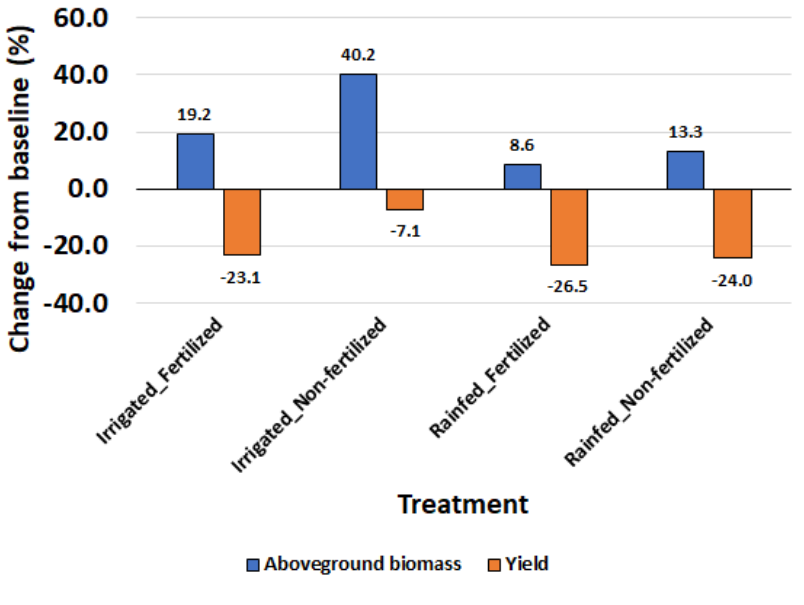

# Food Systems and Agricultural Production - Crop Modeling

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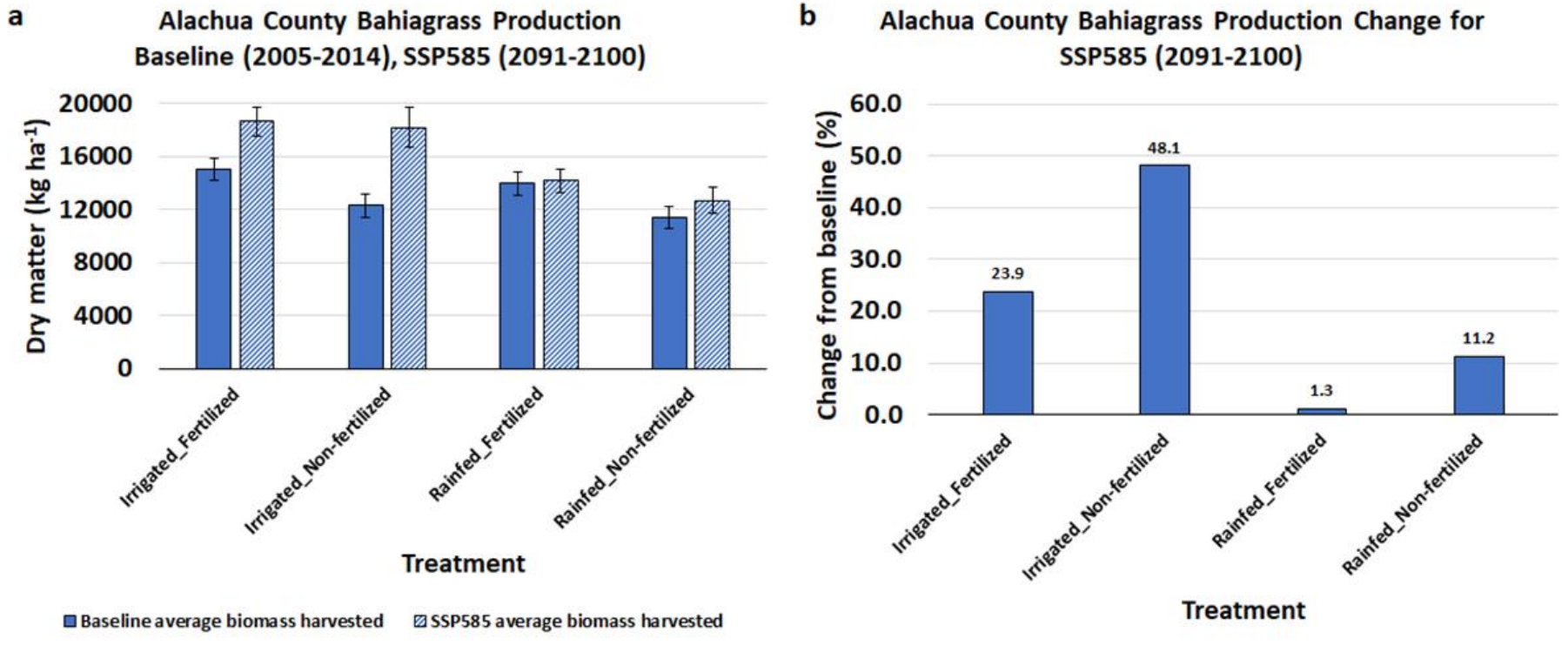
- **Bahia Grass**
  - **Increase in yield (increased $CO_2$)**



# Food Systems and Agricultural Production – Heat Stress

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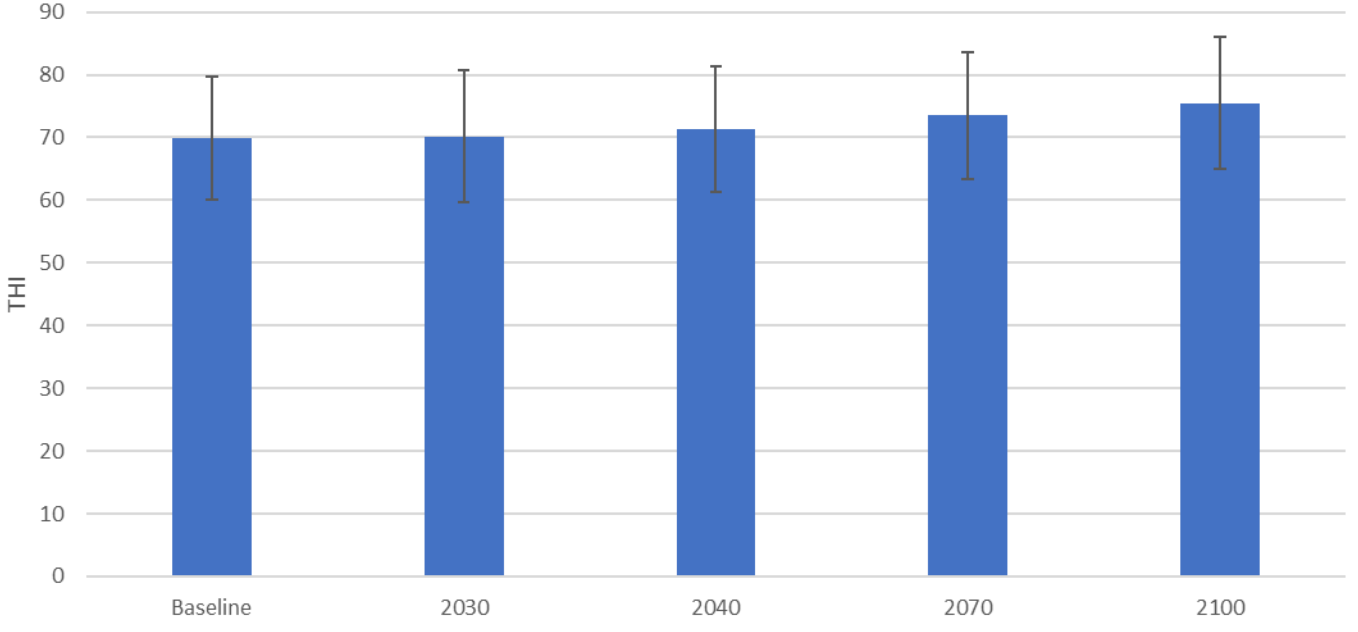
**Livestock Heat Stress**

- **Temperature-Humidity Index**
- **Correlated with Stress in Livestock (cattle, goats, chickens, etc)**



# Food Systems and Agricultural Production – Heat Stress

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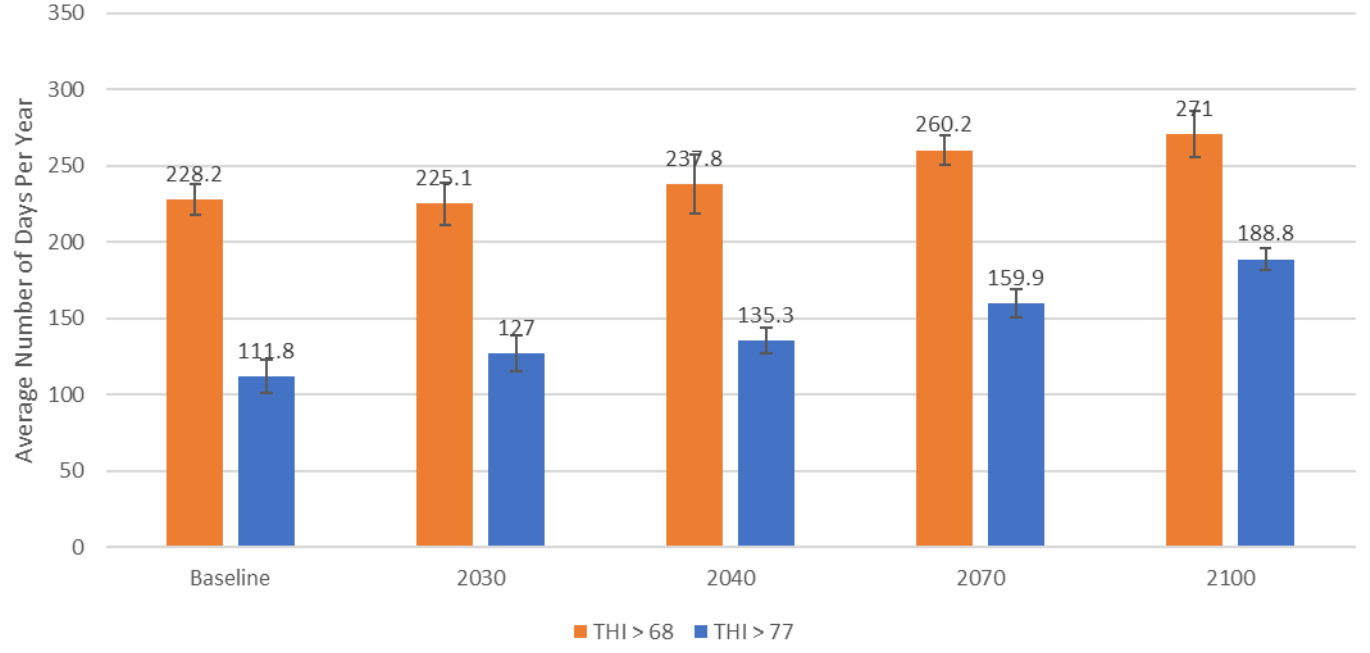
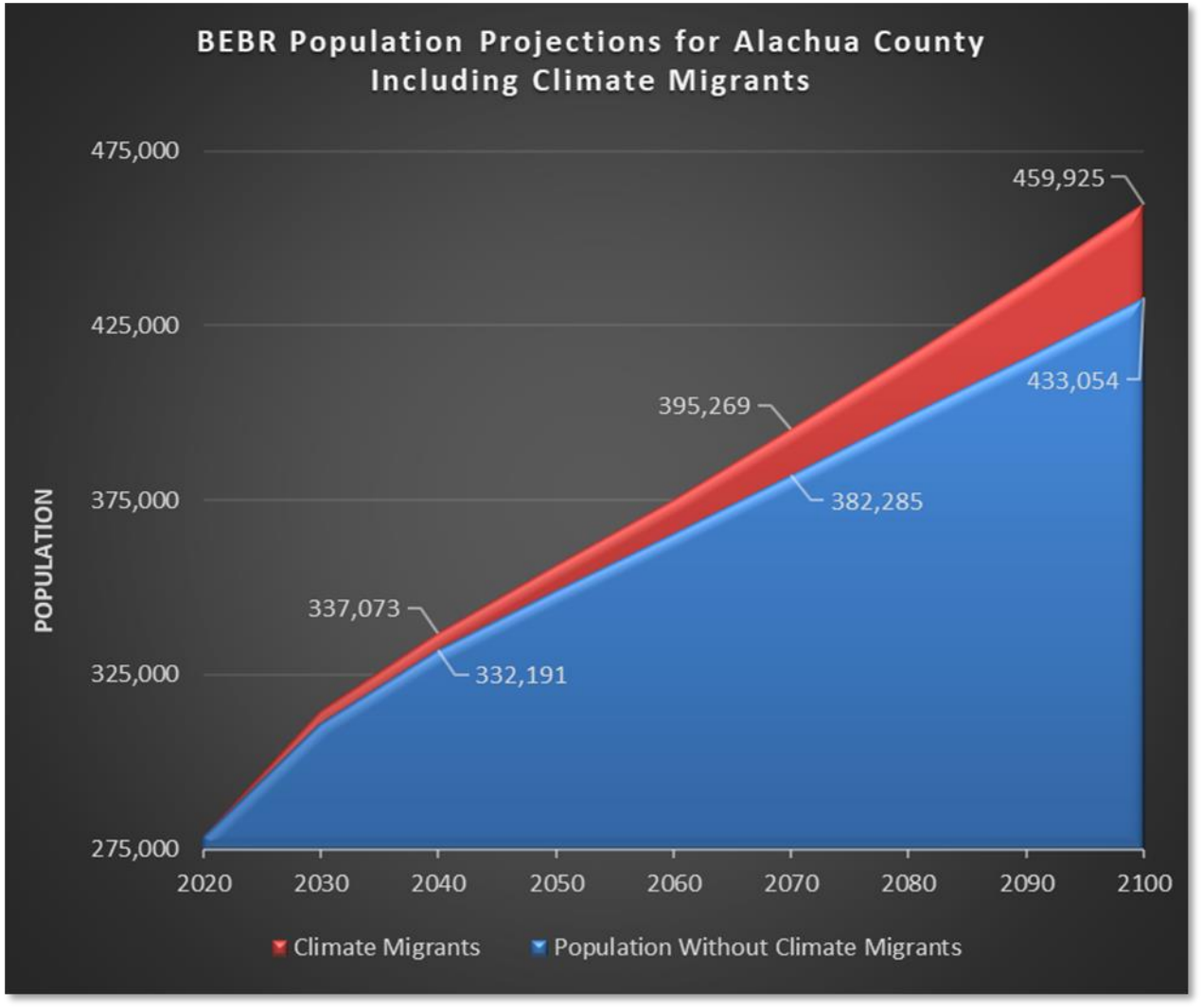
## Dairy Farming Example

- Dairy cow production impacted - THI > 68
- Dry cow stress - THI > 77

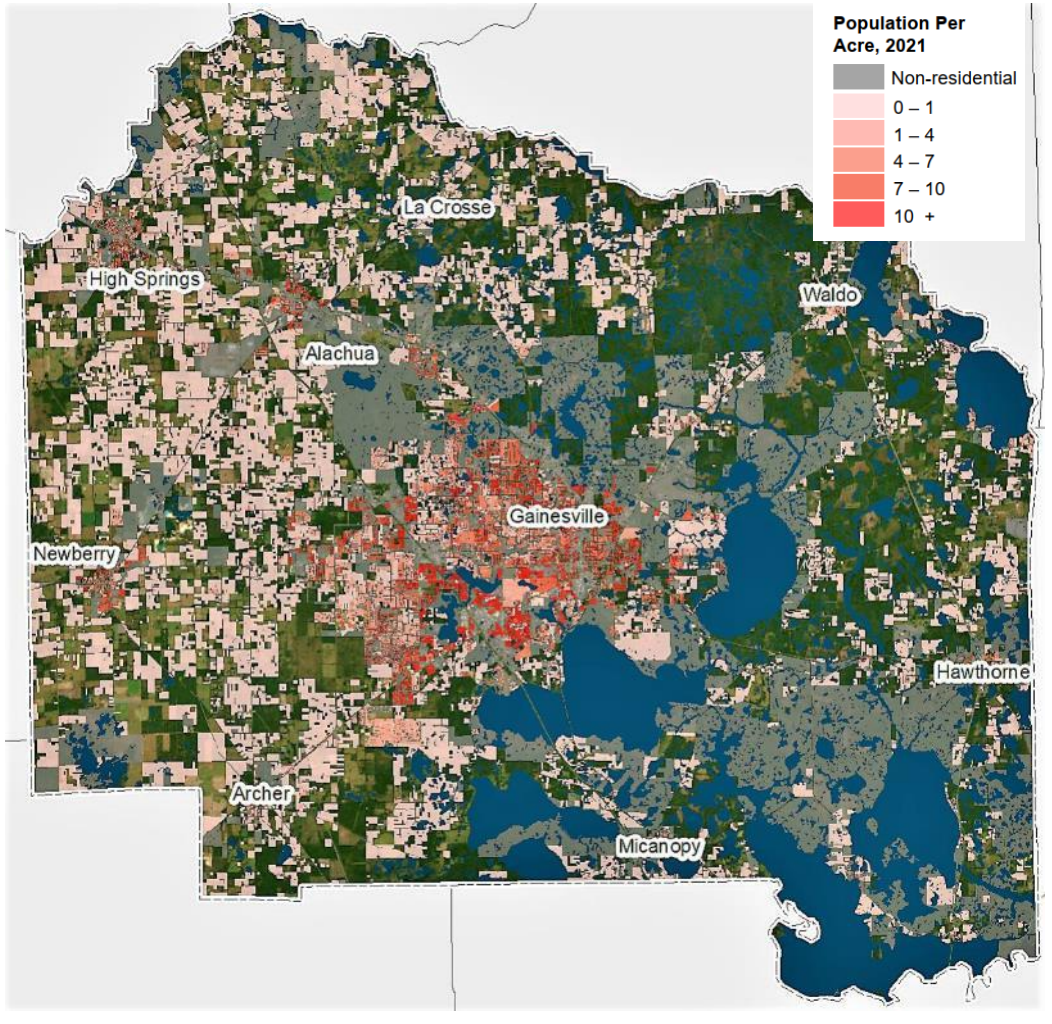


# Effects Of Climate Migration On Population Projections




- Extended State Population Projections
- Adjusted Projections Based on Climate Migrants (sea-level rise)
- Used Mathew Hauer (2017) Study

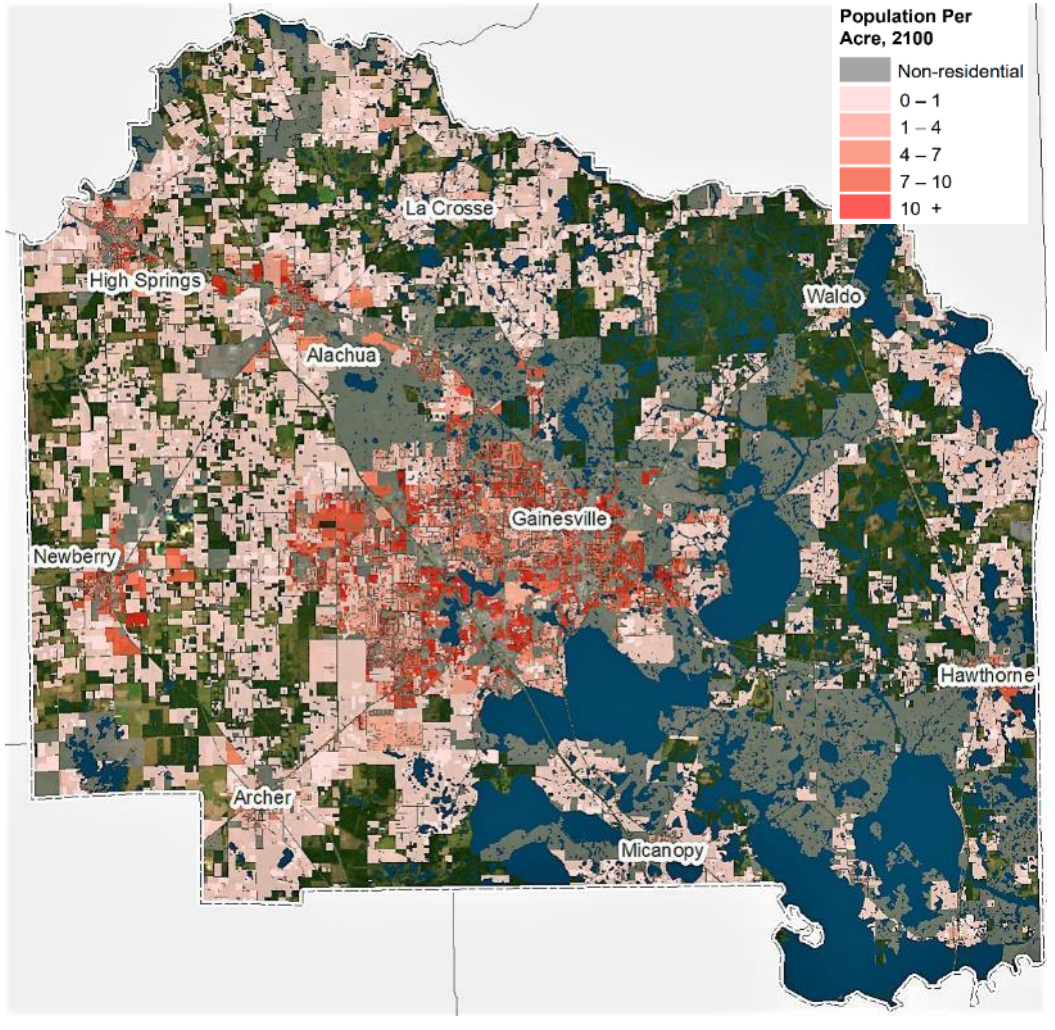
# Effects Of Climate Migration On Population Projections




- Modeled spatial distribution of population change

**2021 Population Density with Climate Migration**

# Effects Of Climate Migration On Population Projections

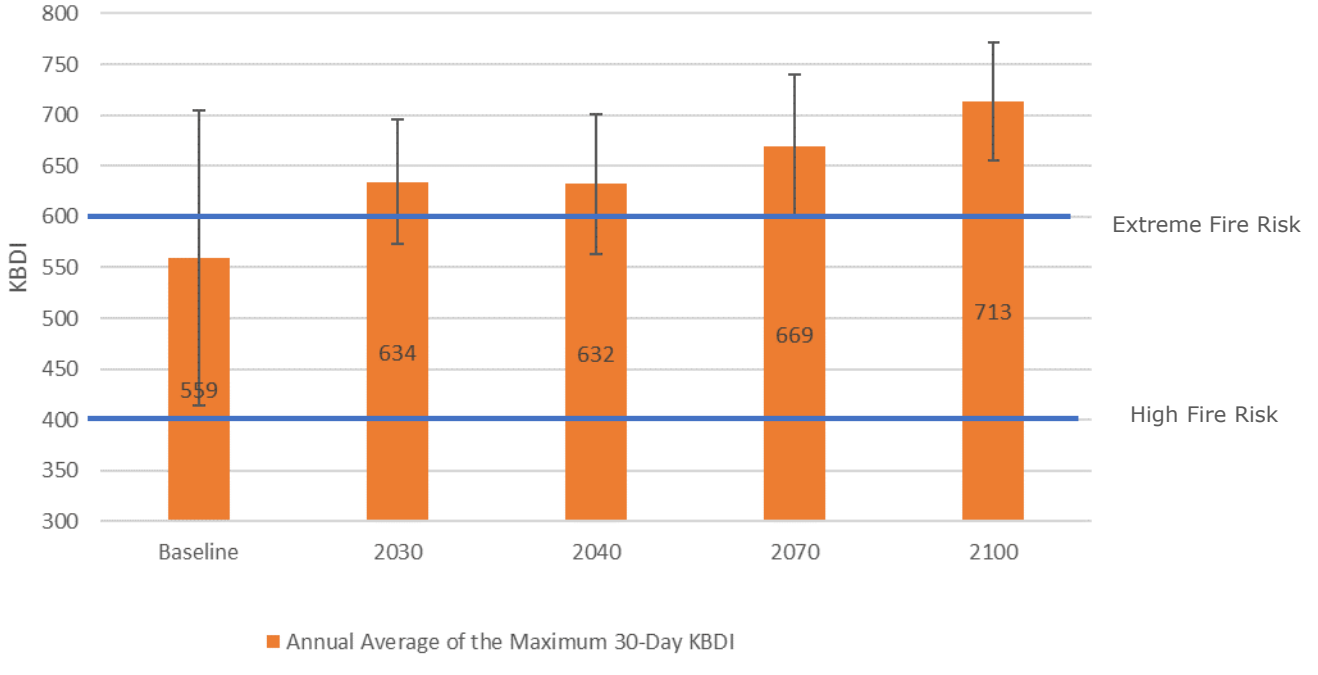



## 2100 Population Density

- Modeled spatial distribution of population change

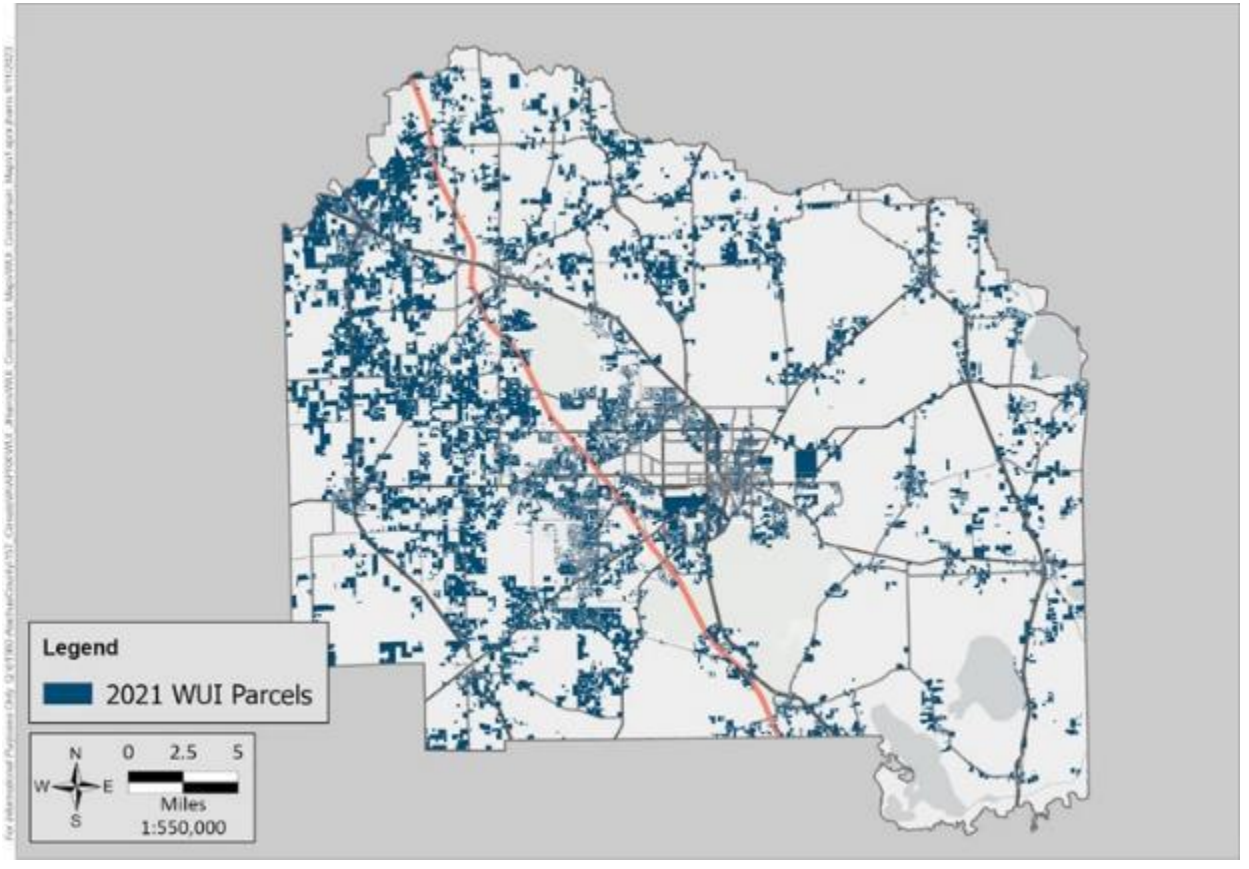
# Wildfire Risk

- **Keetch-Bryam Drought Index**
- **Annual Maximum 30-Day KBDI**



# Wildfire Risk

- Wildland Urban Interface
- Projected 2040, 2070, 2100

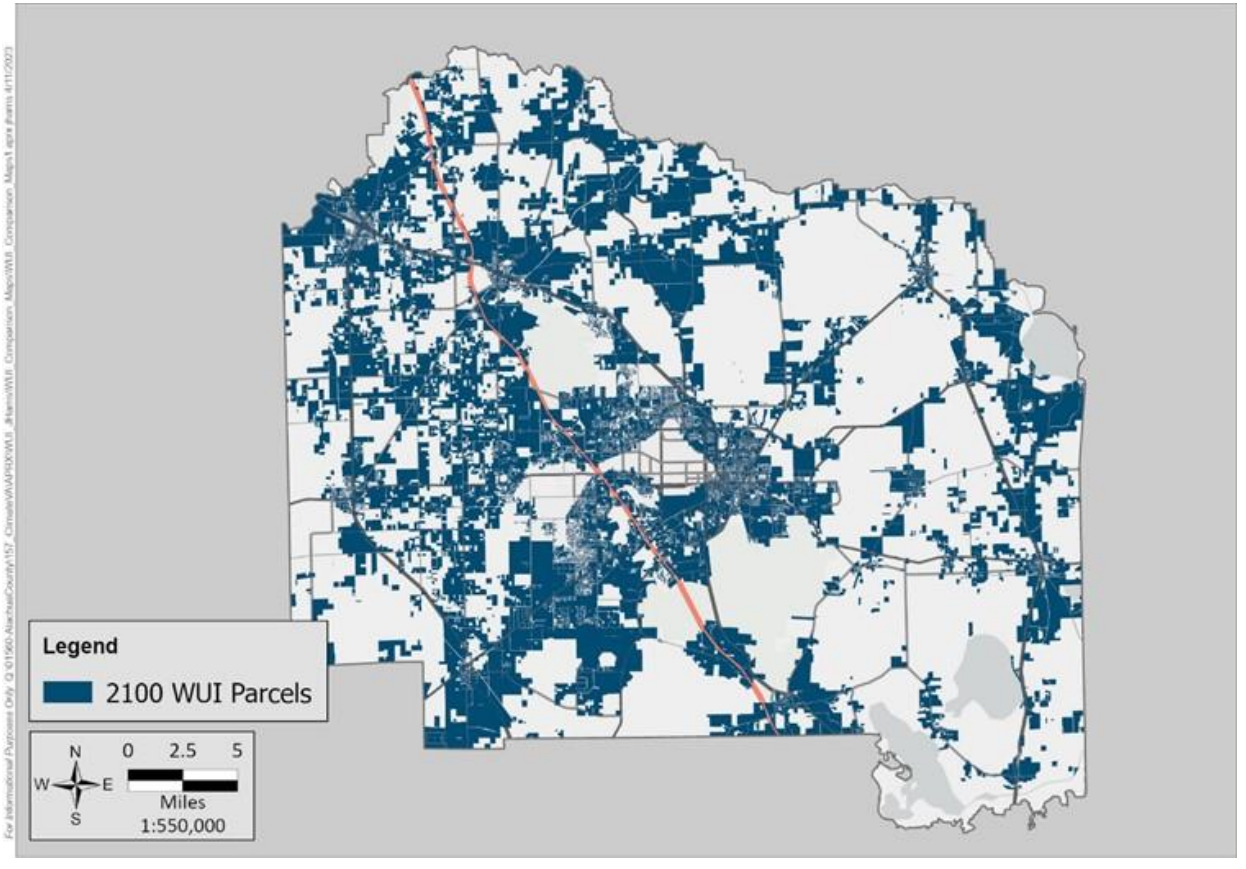



**1990-2010: 30% Increase**

**2021 ~ 316 sq miles**

# Wildfire Risk

- Wildland Urban Interface
- Projected 2040, 2070, 2100



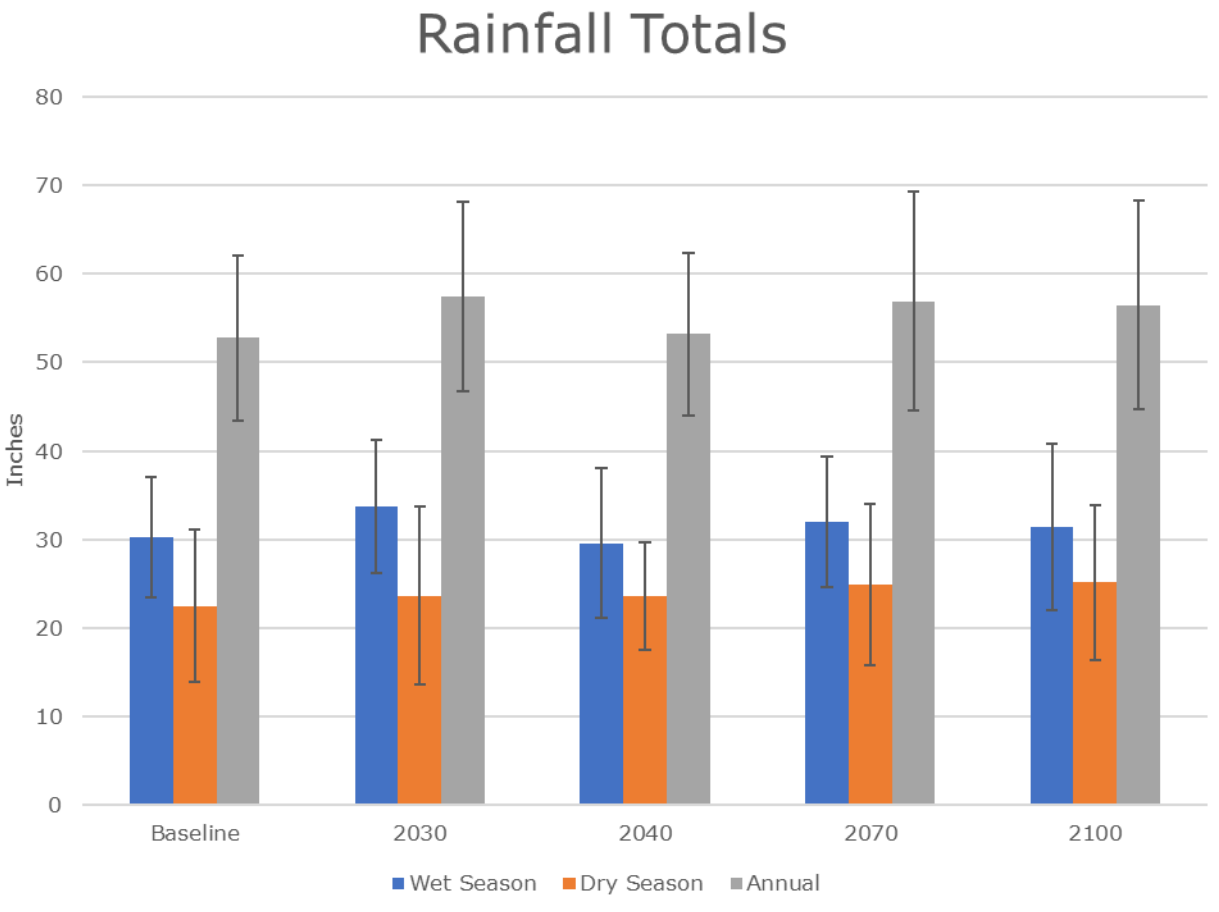

**2021-2040: 33% increase**

**2021-2070: 67% increase**

**2021-2100: 97% increase**

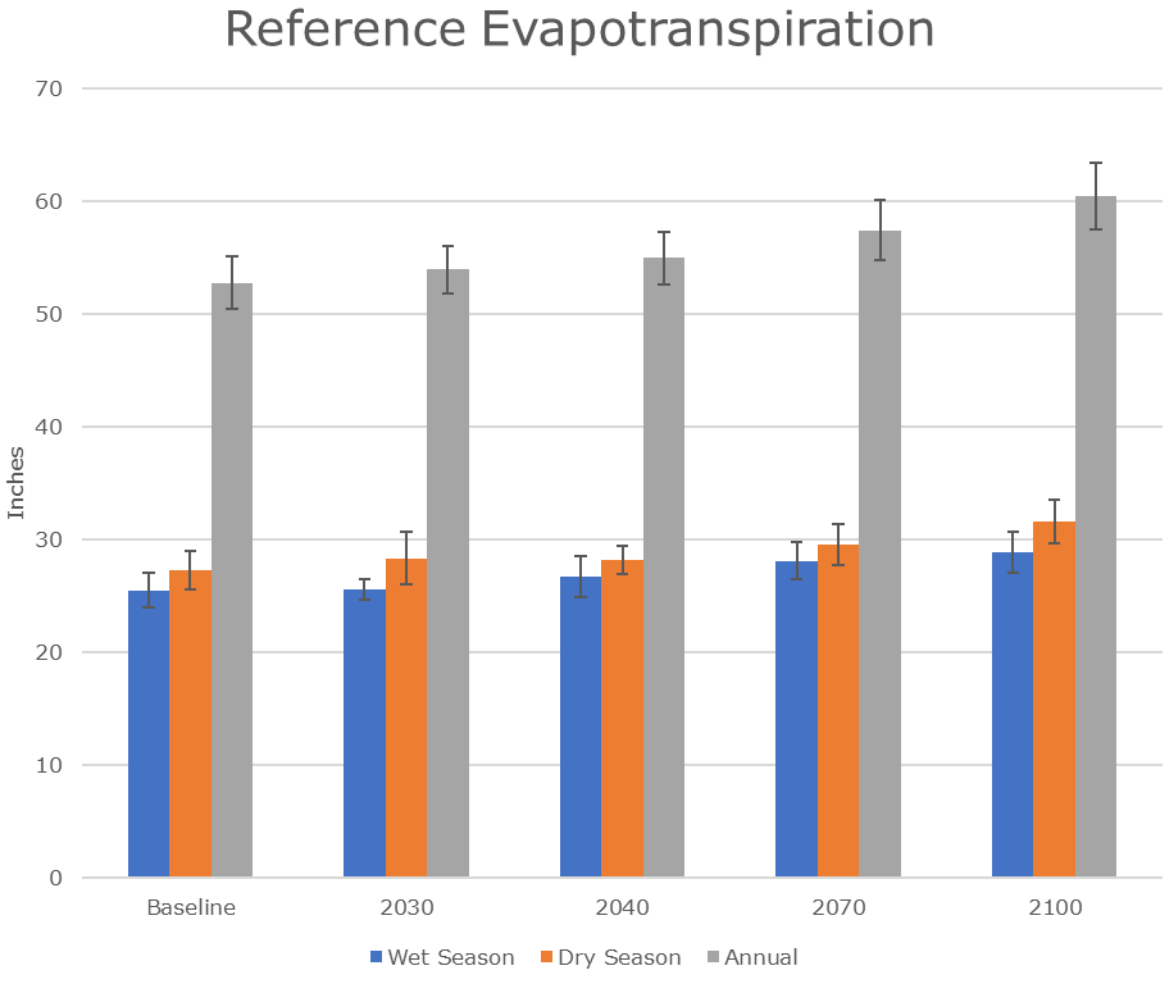
# Rainfall

- Highly variable
- Small increase in long term average
- Change in extreme storm events



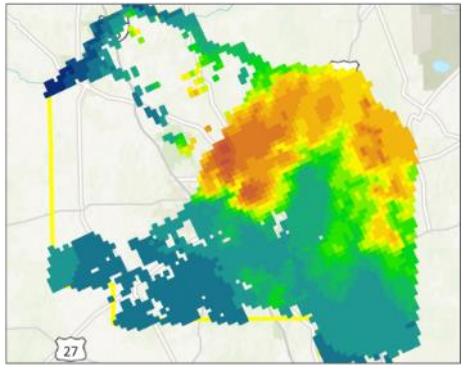
# Reference Evapotranspiration

- Increasing trend
- Aligns with observations
- Increased actual ET

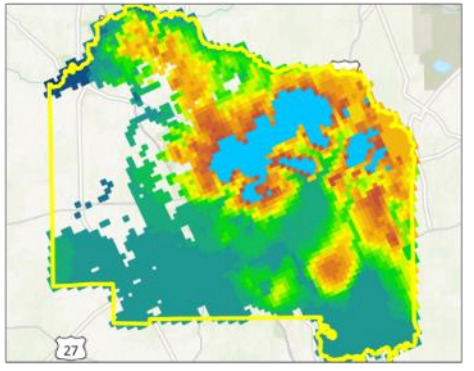


# Groundwater Impacts

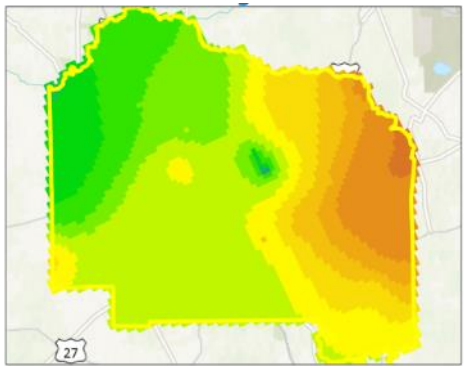
- NFSEG Groundwater Model
  - Updated to account for projected changes in recharge & ET
  - Evaluated changes in pumping
- Surficial Aquifer
- Upper Florida Aquifer



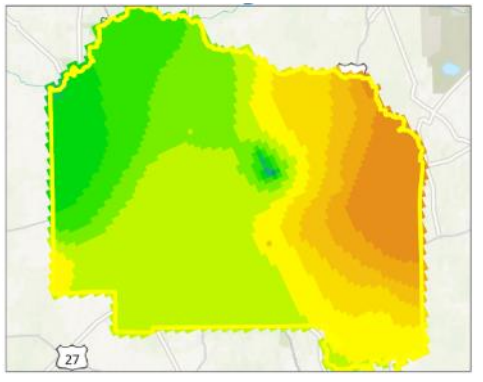

SAS – Baseline Wet Year




SAS – 2100 Wet Year




UFA – Baseline Average Year




UFA – 2100 Average Year

# Groundwater Impacts

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**Average Year:**

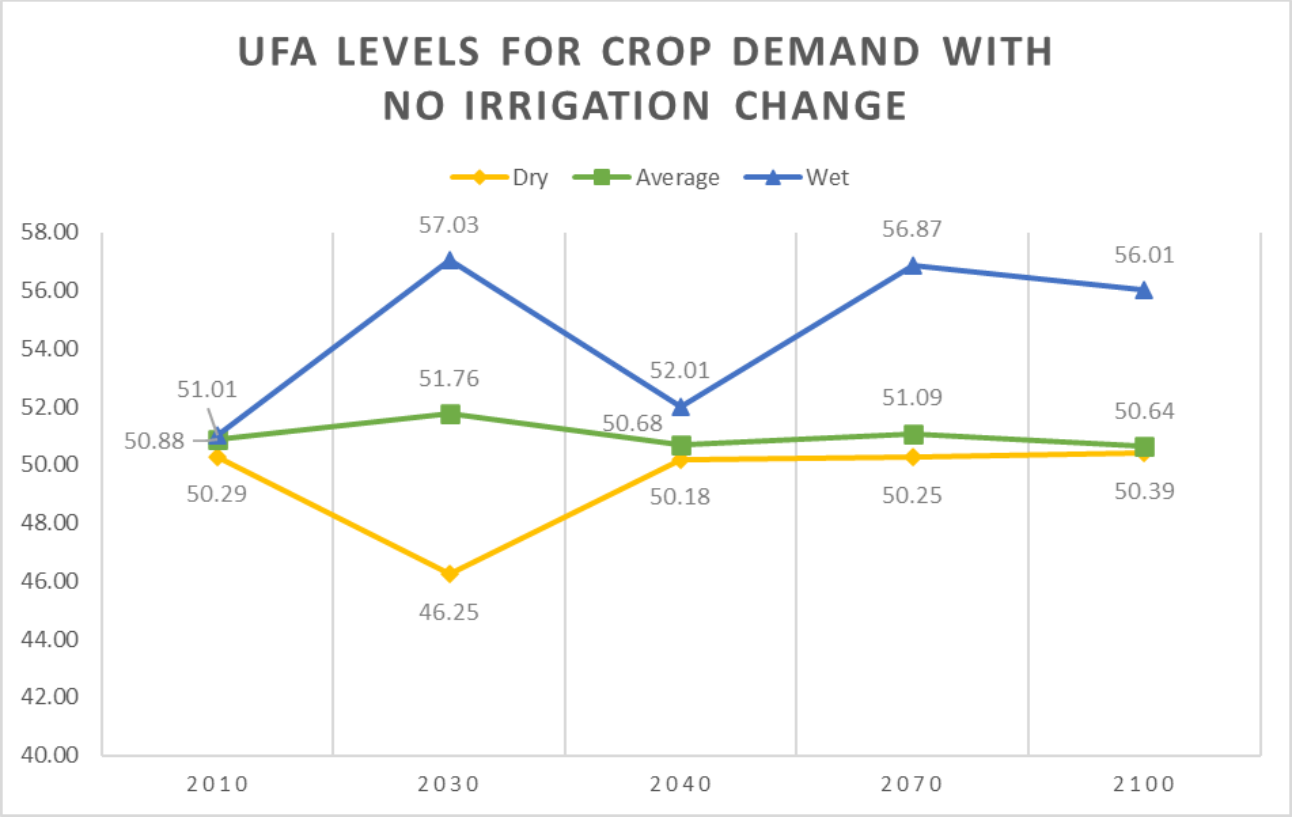
- **Projected range similar to baseline**

**Dry Years**

- **Lower minimums in some locations**

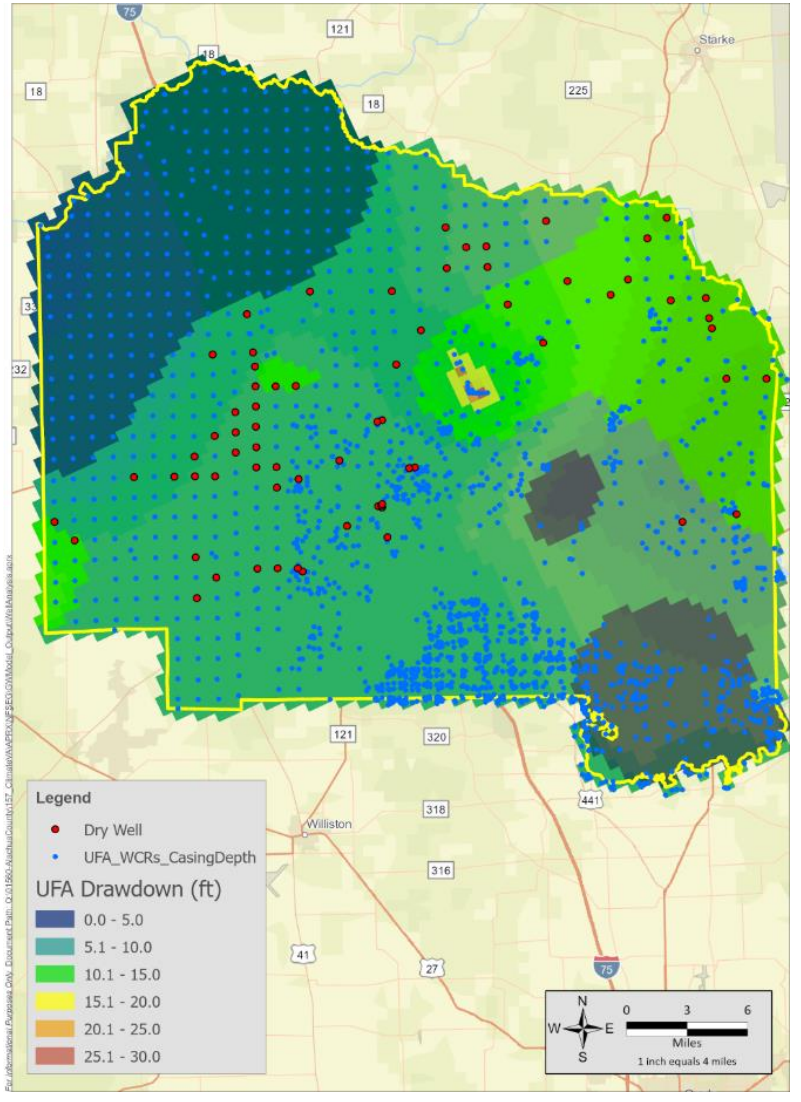
**Wet Years**

- **Consistently higher**

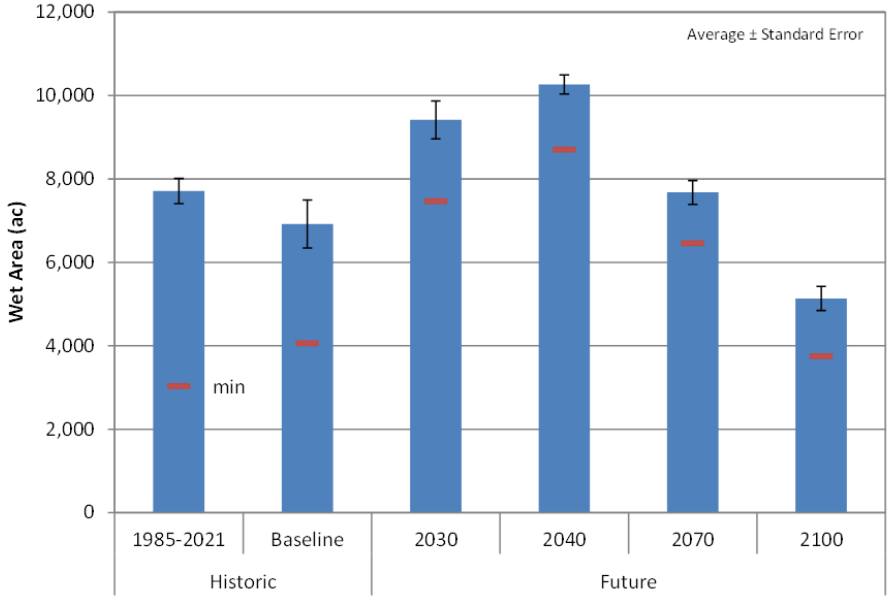


# Groundwater Impacts

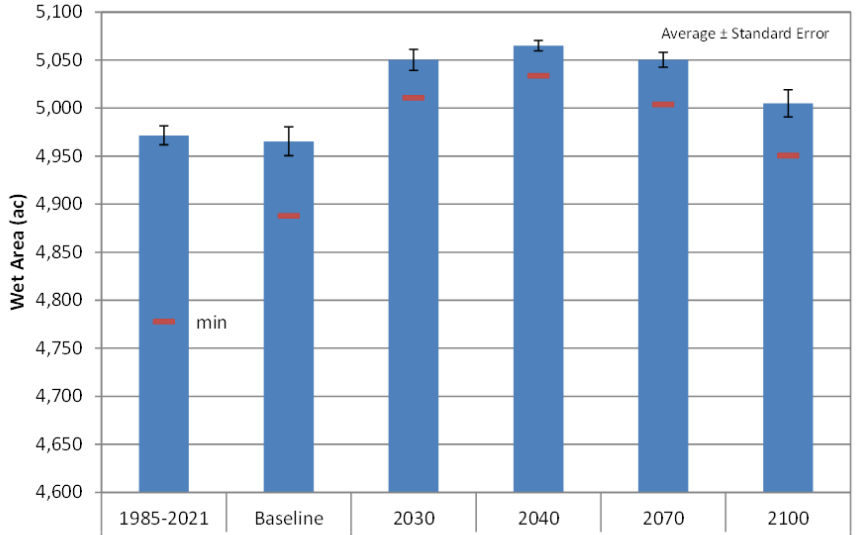
- More variation in groundwater levels
- Identified potential well impacts
- Central & NE County impacted



# Surface Water Impacts




Orange Lake




Lake Santa Fe

## Lakes

- Correlation between monthly net rainfall & change in stage
- Calculated monthly stage
- Calculated monthly lake discharges

# Surface Water Impacts

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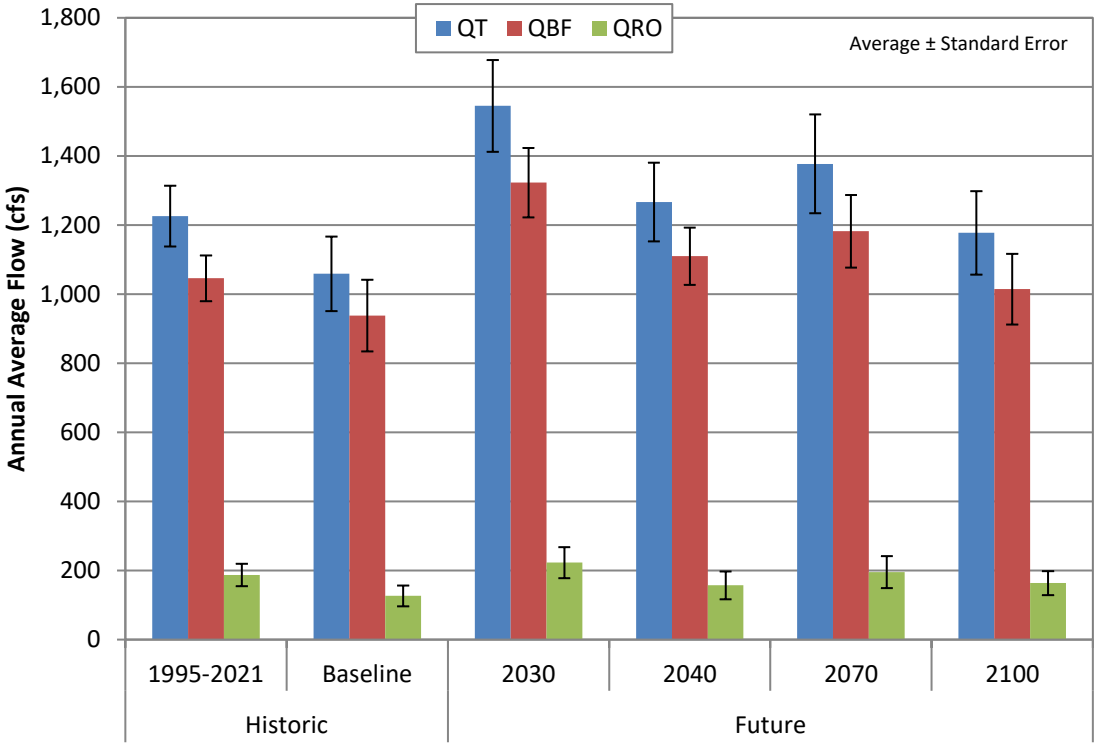
## Santa Fe River

- Correlation between:
  - 3-year net rainfall & annual baseflow
  - Monthly net rainfall & runoff
- Calculated monthly annual baseflow
- Calculated monthly runoff flows



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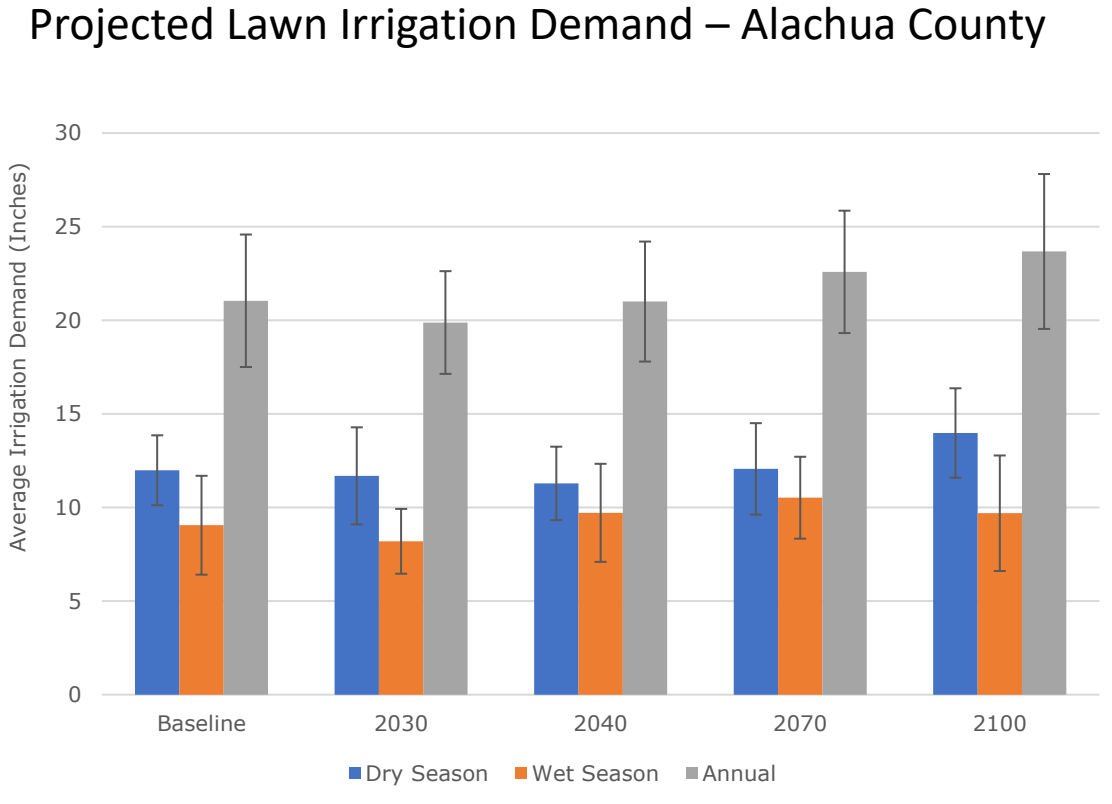
## Changing Water Use

- Rainfall
- ET
- Population
- Land use
- Agricultural practices



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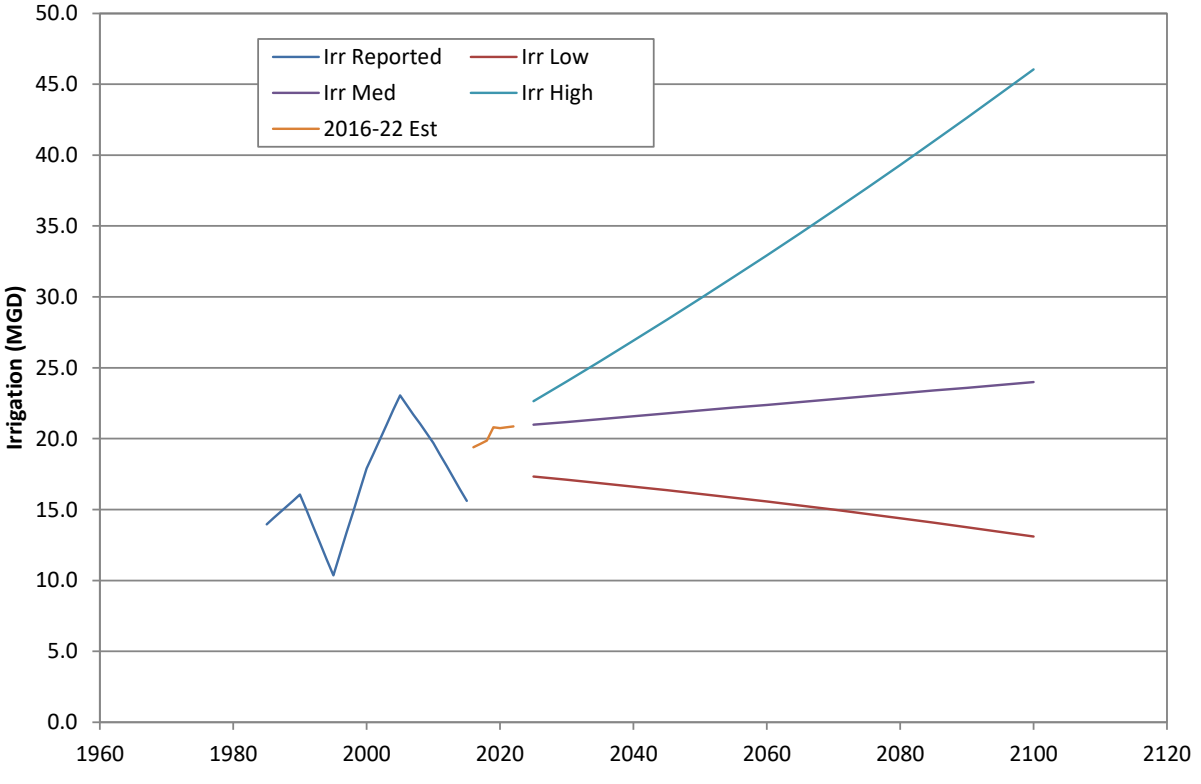
## Agricultural Water Use

- High - Constant acreage & continued increase in percent irrigated
- Medium – Irrigated area remains constant
- Low – Acreage decreased linearly & percent irrigated constant
- Irrigation rate increased



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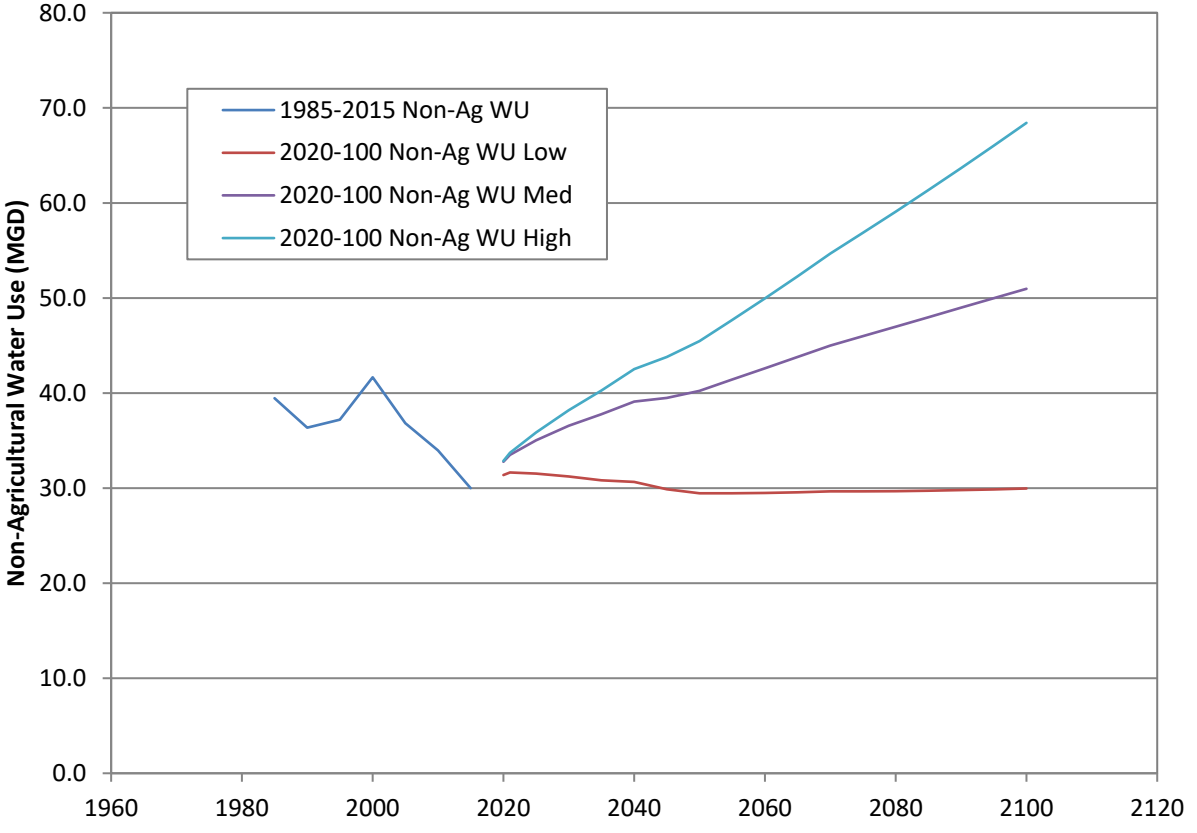
## Non-Agricultural Water Use

- High – PC water use increases to 2015 levels
- Medium – PC water use constant
- Low – PC continues decreasing trend
- Population projections



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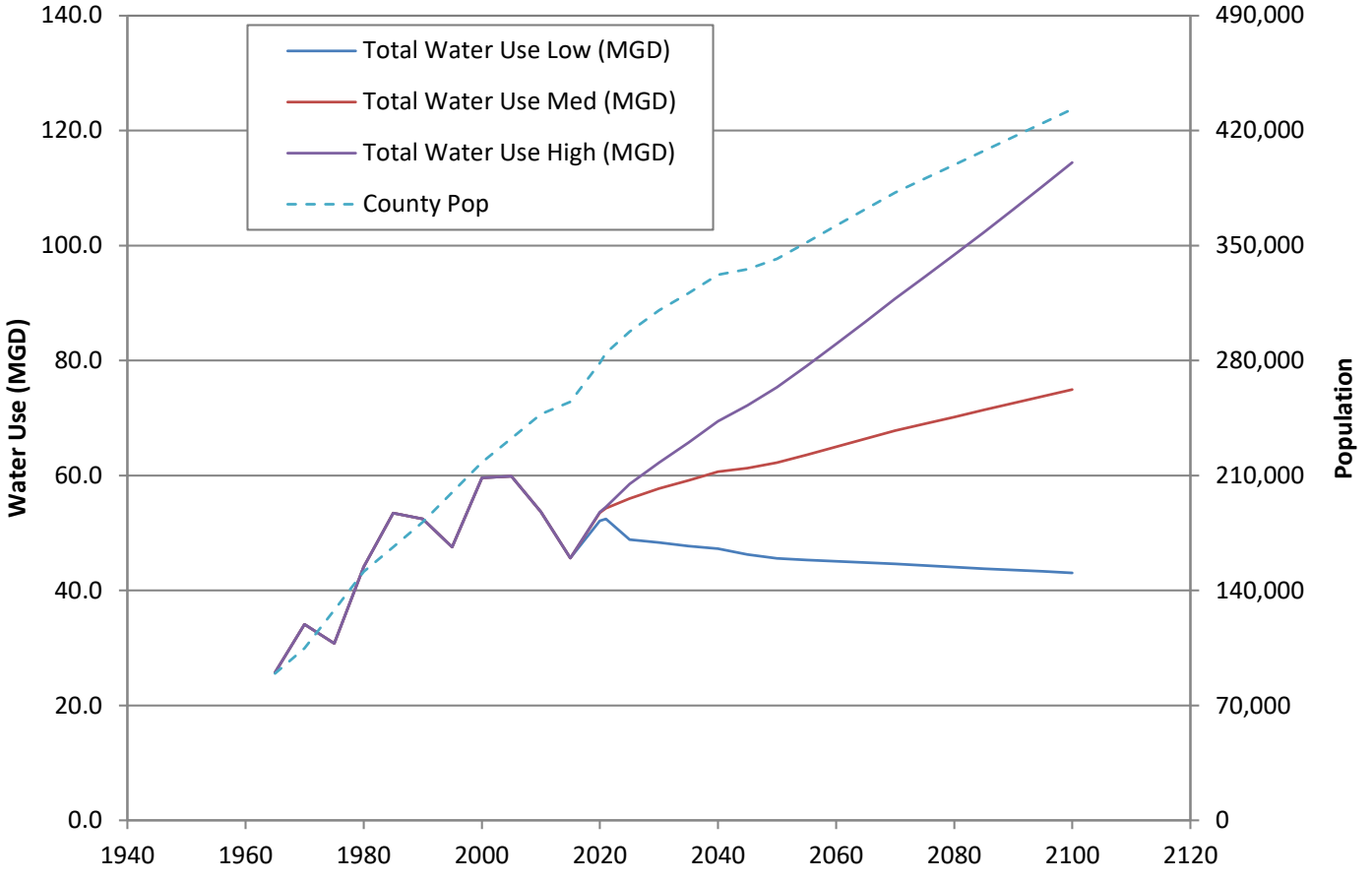
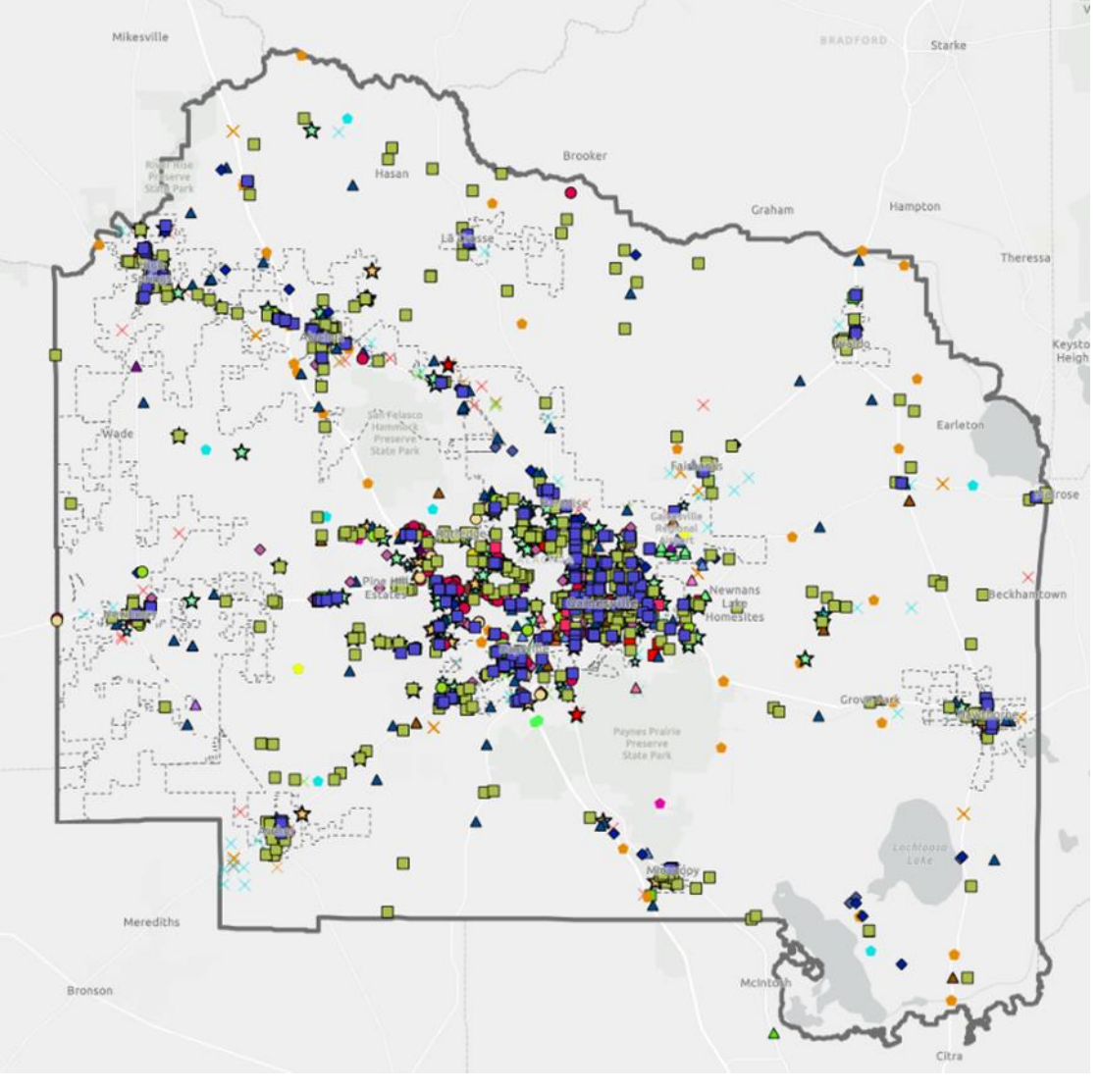
## Countywide Water Use

- Significant uncertainty
- Many drivers
- Adaptation



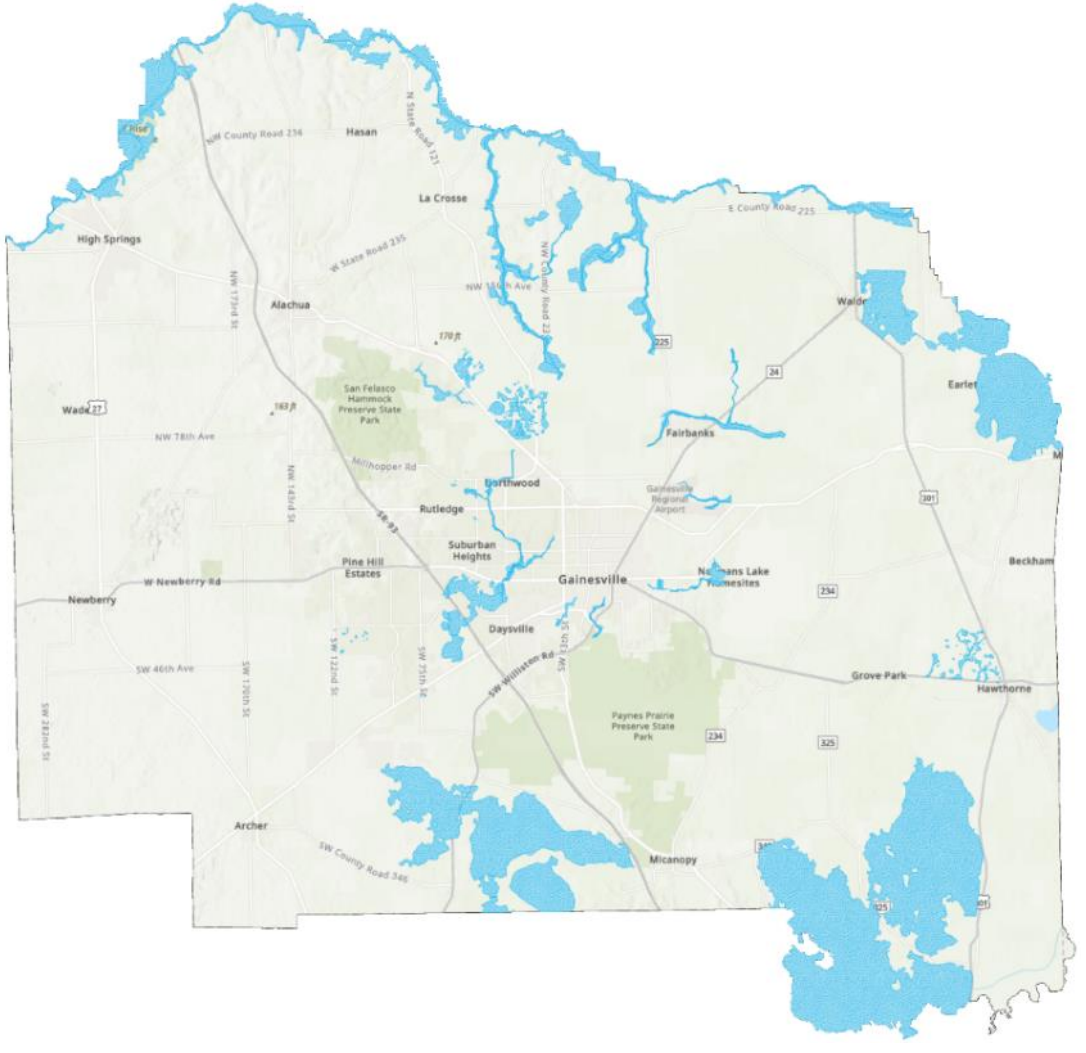
# Flood Vulnerability

- **Mapped critical assets**
  - **Critical infrastructure**
  - **Transportation assets & evacuation routes**
  - **Natural, cultural, and historical resources**



# Flood Vulnerability

- Effective FEMA studies
  - Limited extents
  - Generally outdated



# Flood Vulnerability

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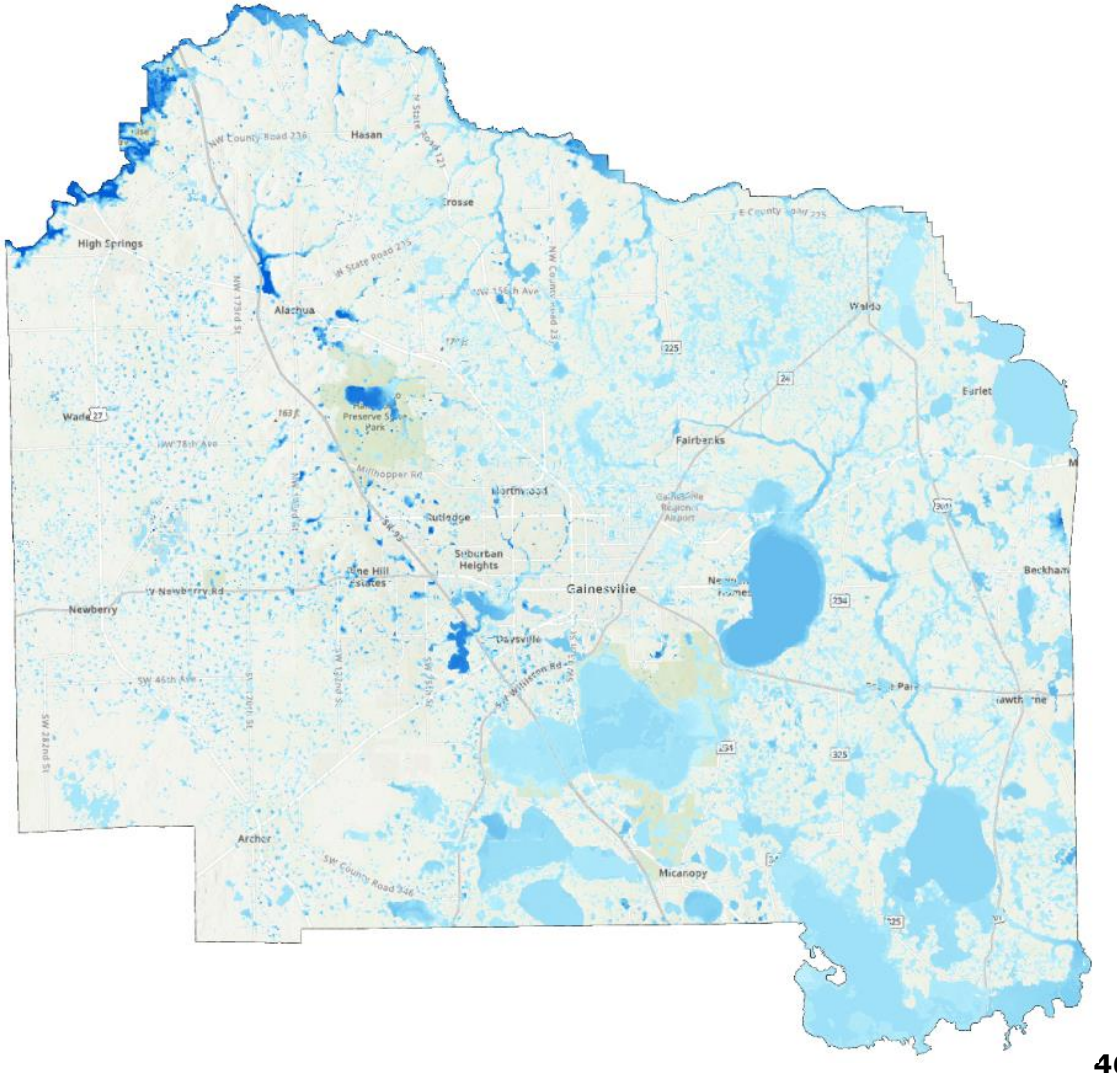
- New countywide flood model
- 2D Model with pipe network
- 2019 LiDAR (2.5 ft)
- 14,300 stormwater structures

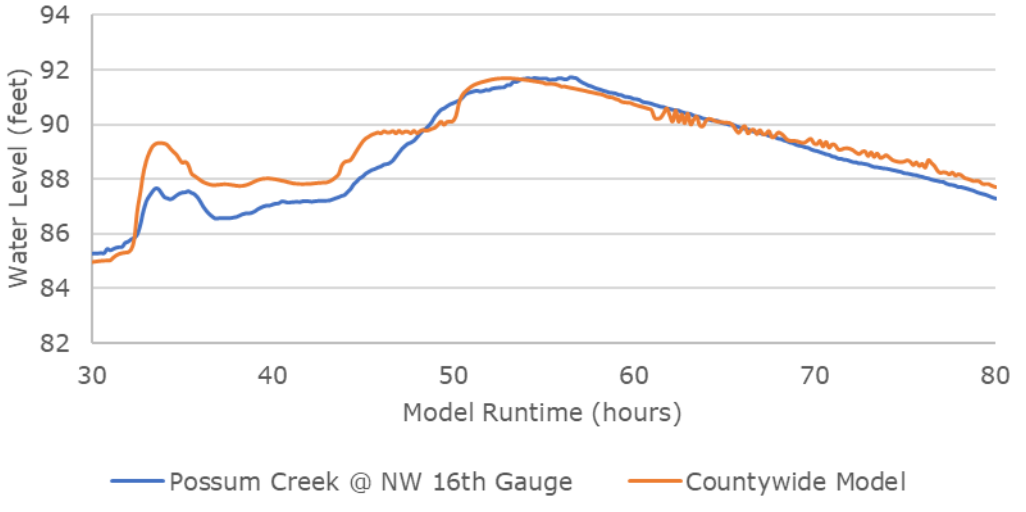


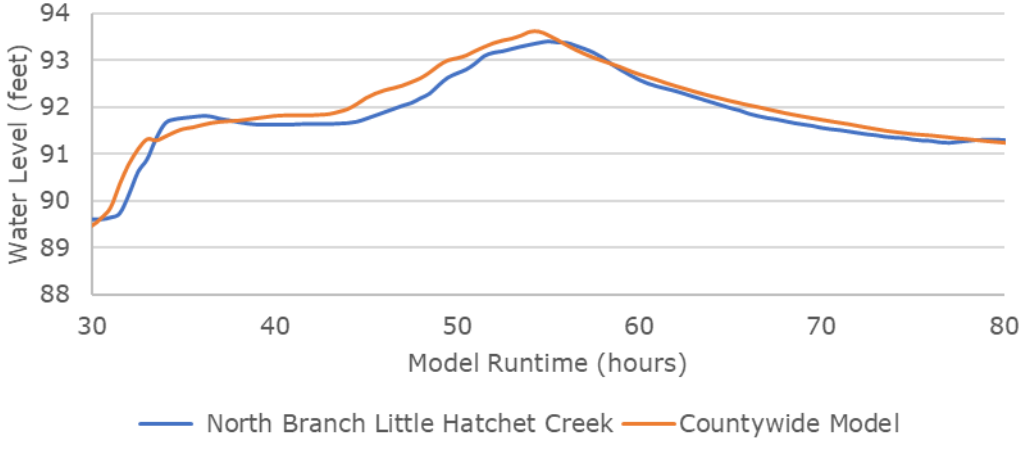
# Flood Vulnerability

- New countywide flood model
- 2D Model with pipe network
- 2019 LiDAR (2.5 ft)
- 14,300 stormwater structures
- Variable resolution (80 ft → 10 ft)

# Flood Vulnerability

- Model calibration – Hurricane Irma
- Model verification – Tropical Storm Elsa
- 11 gauges & 80 high water marks
- MAE = 1.3 feet



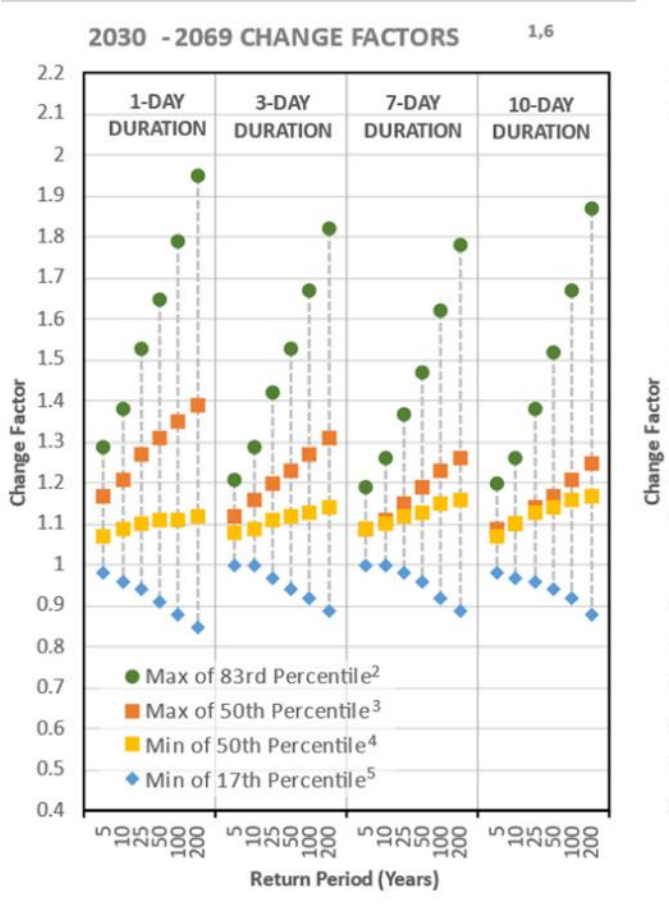



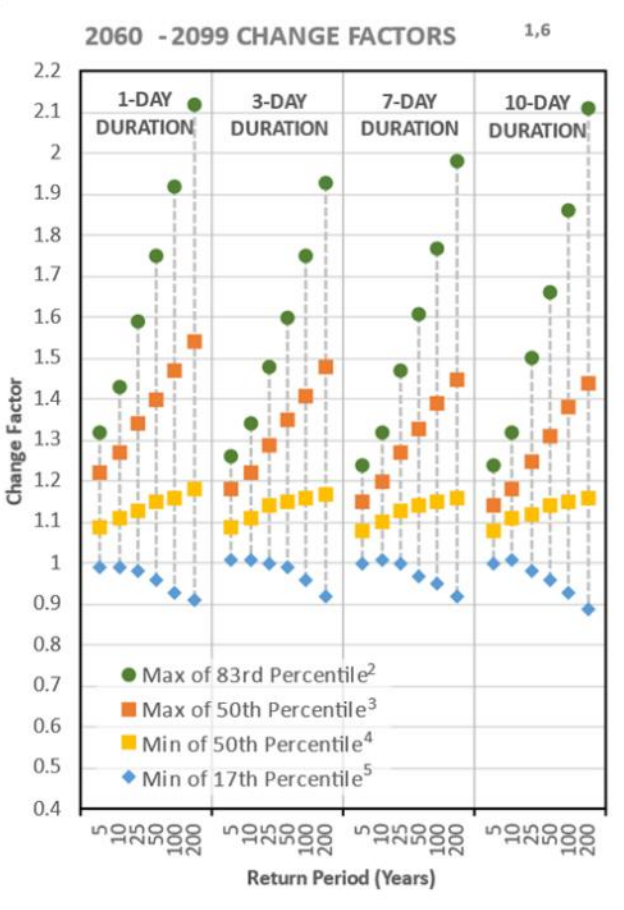
# Future Extreme Rainfall

JonesEdmunds

## Rainfall Change Factors

- Change in Extreme Rainfall <u>Depth</u>
- Change in Extreme Rainfall <u>Frequency</u>



# Future Extreme Rainfall

JonesEdmunds

**Rainfall Change Factors**

- Change in Extreme Rainfall Depth
- Change in Extreme Rainfall Frequency

| Design Storm | Rainfall (inches) | | |
|---|---|---|---|
| | Baseline | 2040 | 2070 |
| 100-year/1-day | 10.5 | 14.2 | 15.4 |
| 100-year/10-day | 16.2 | 19.6 | 22.4 |

# Future Flood Risk

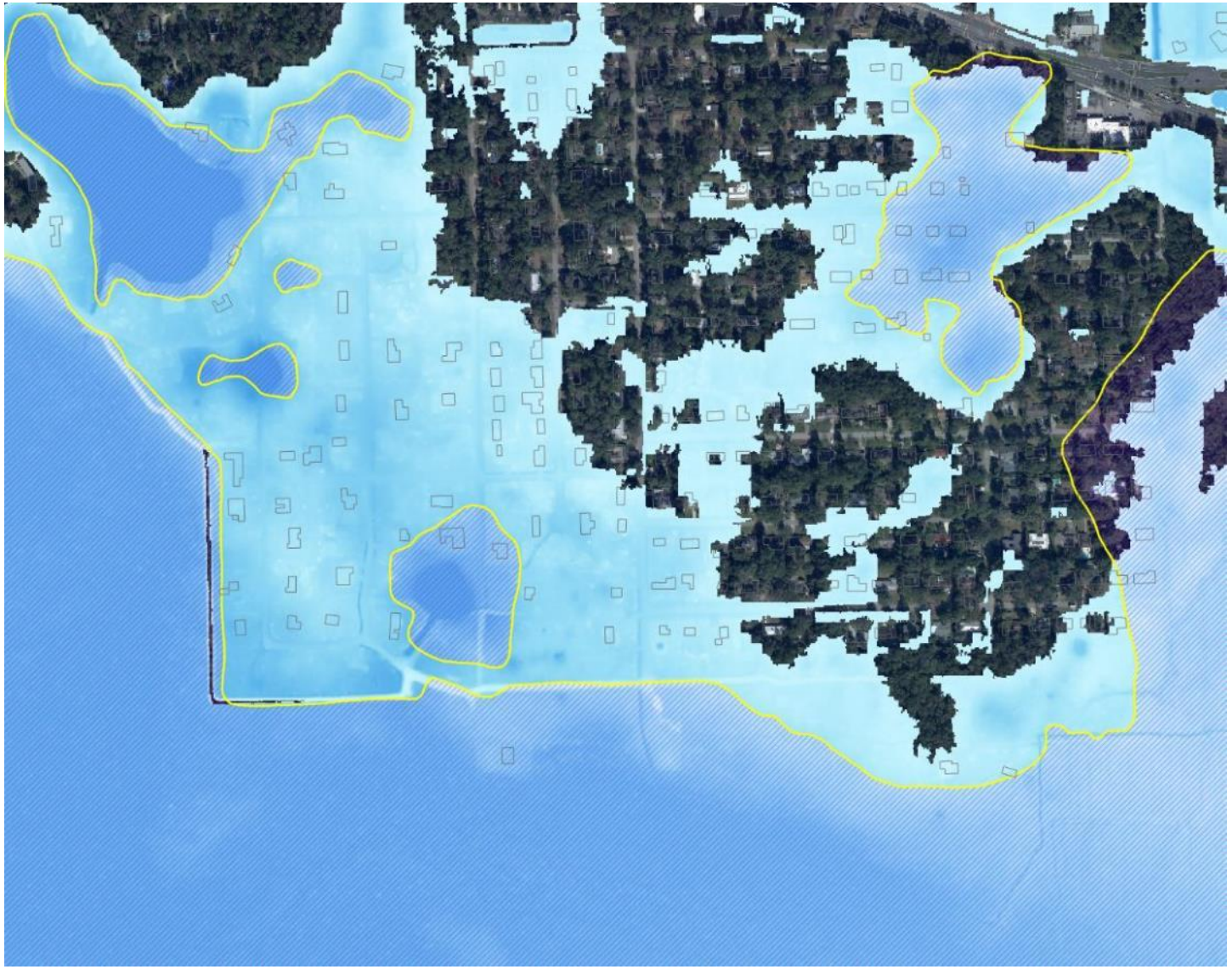
JonesEdmunds

**FEMA 100-Year Floodplain**

# Future Flood Risk

JonesEdmunds

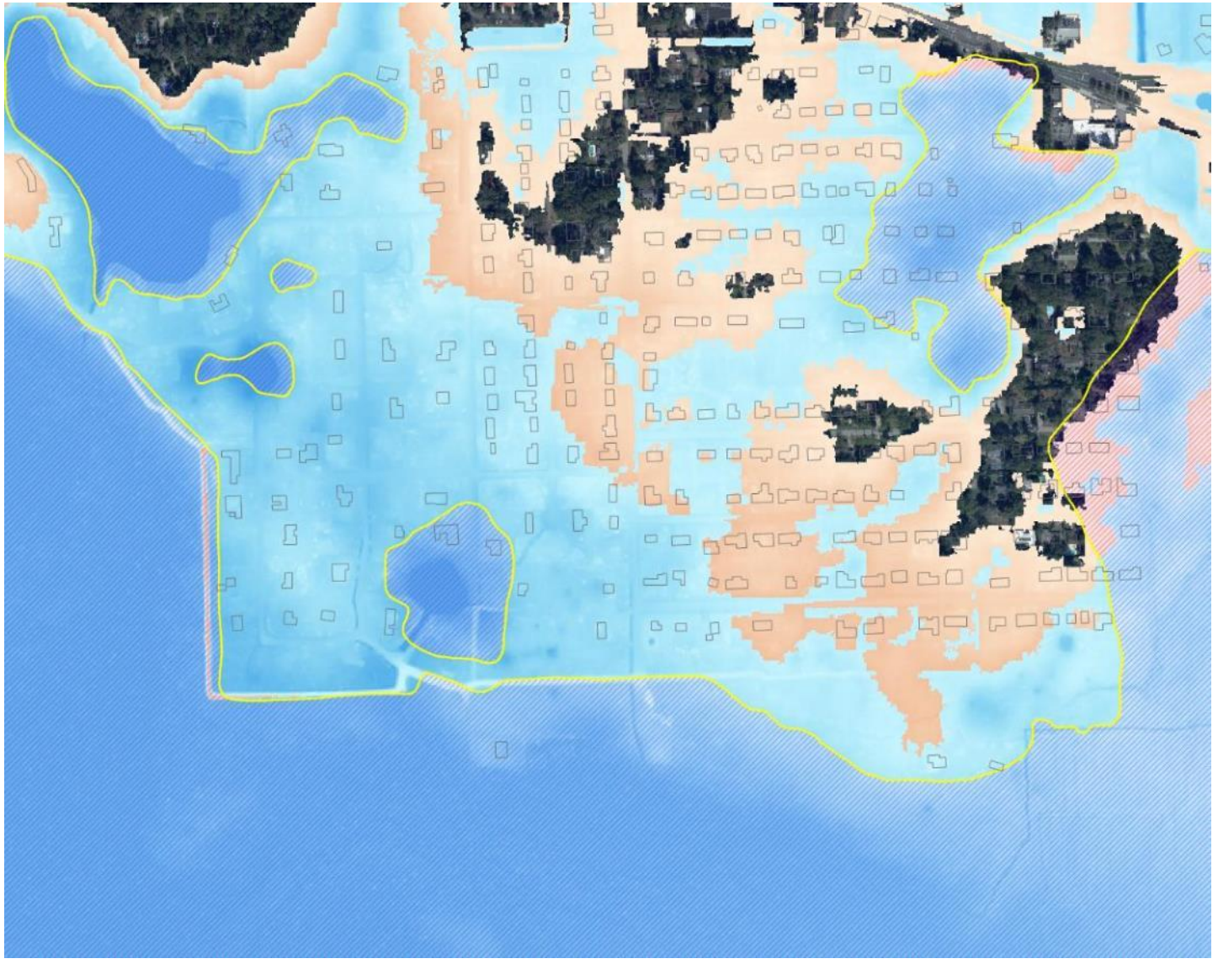
**Modeled 100-Year Flooding**



# Future Flood Risk

JonesEdmunds

**2070**
**100-Year**
**Flooding**



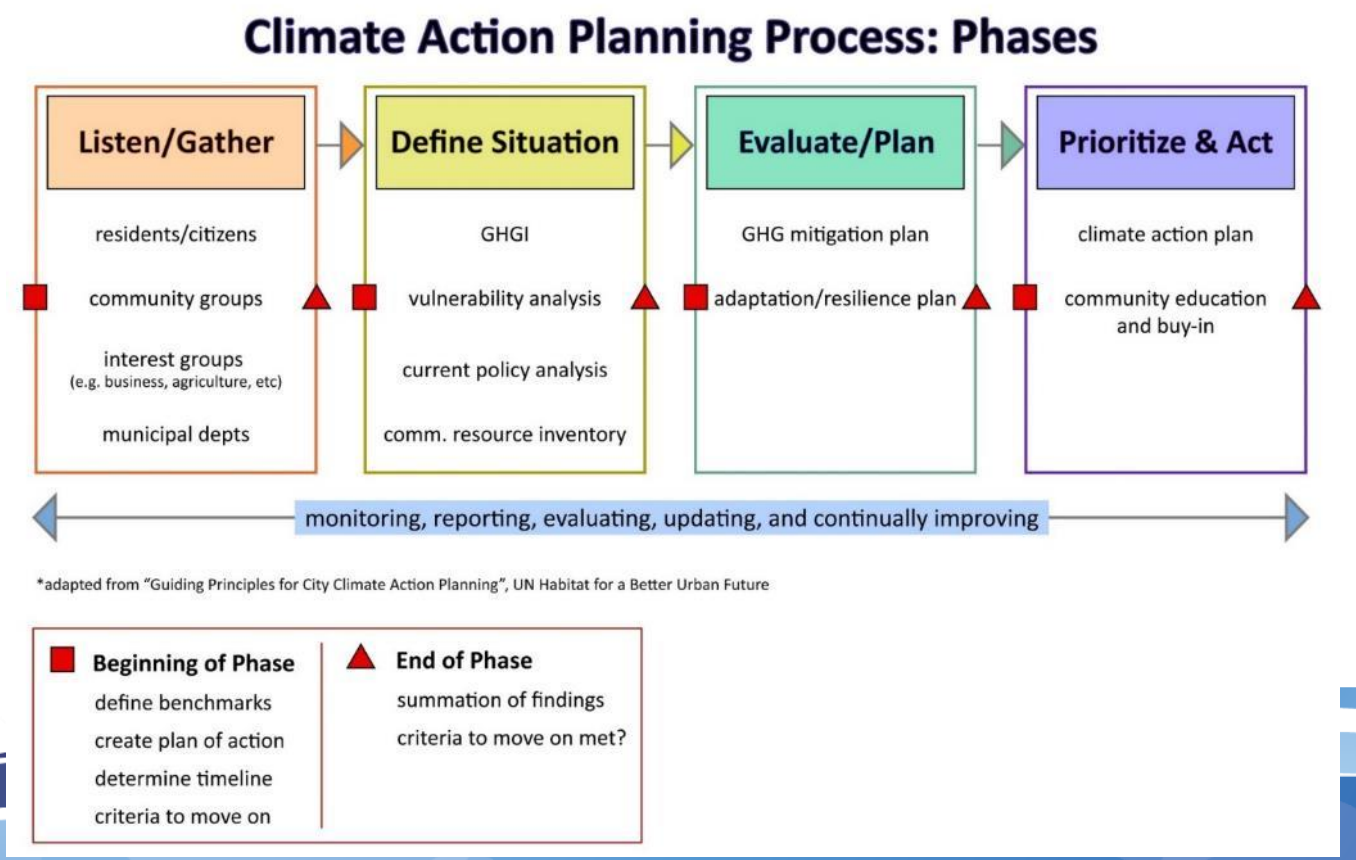
# Next Steps: Presenting the Results

- On June 2nd the County hosted a Climate Summit and Fair.
- The daytime session for elected officials and staff from the County, municipalities, UF, and other agencies. Evening session was a family event for the public.
- Goal was to begin discussion on the impacts of climate change and to begin adaptation planning.

# Next Steps: Incorporating Results into a Climate Action Plan

- Last component defining the situation.

- The results will be used to evaluate and plan where adaptation efforts need to be made.
  - Projects to address critical infrastructure vulnerability.
  - Areas of the County where the residents are more vulnerable.



# Climate Action Plan Vision Statement

To guide, develop, and cultivate environmentally, socially, and economically resilient strategies and equitable solutions to climate change for the whole community.

# A Quick Thank You To:

- Jones Edmunds and all of the project consultants for their work.
- The City of Gainesville for sharing a lot of critical infrastructure data and for review of deliverables.
- FDEP for our Resilient Florida Grant.

# QUESTIONS

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