



# Climate Vulnerability Assessment

FINAL REPORT | JULY 2024

IMPACTS of  
WEATHER &  
CLIMATE



# WEATHER VS CLIMATE





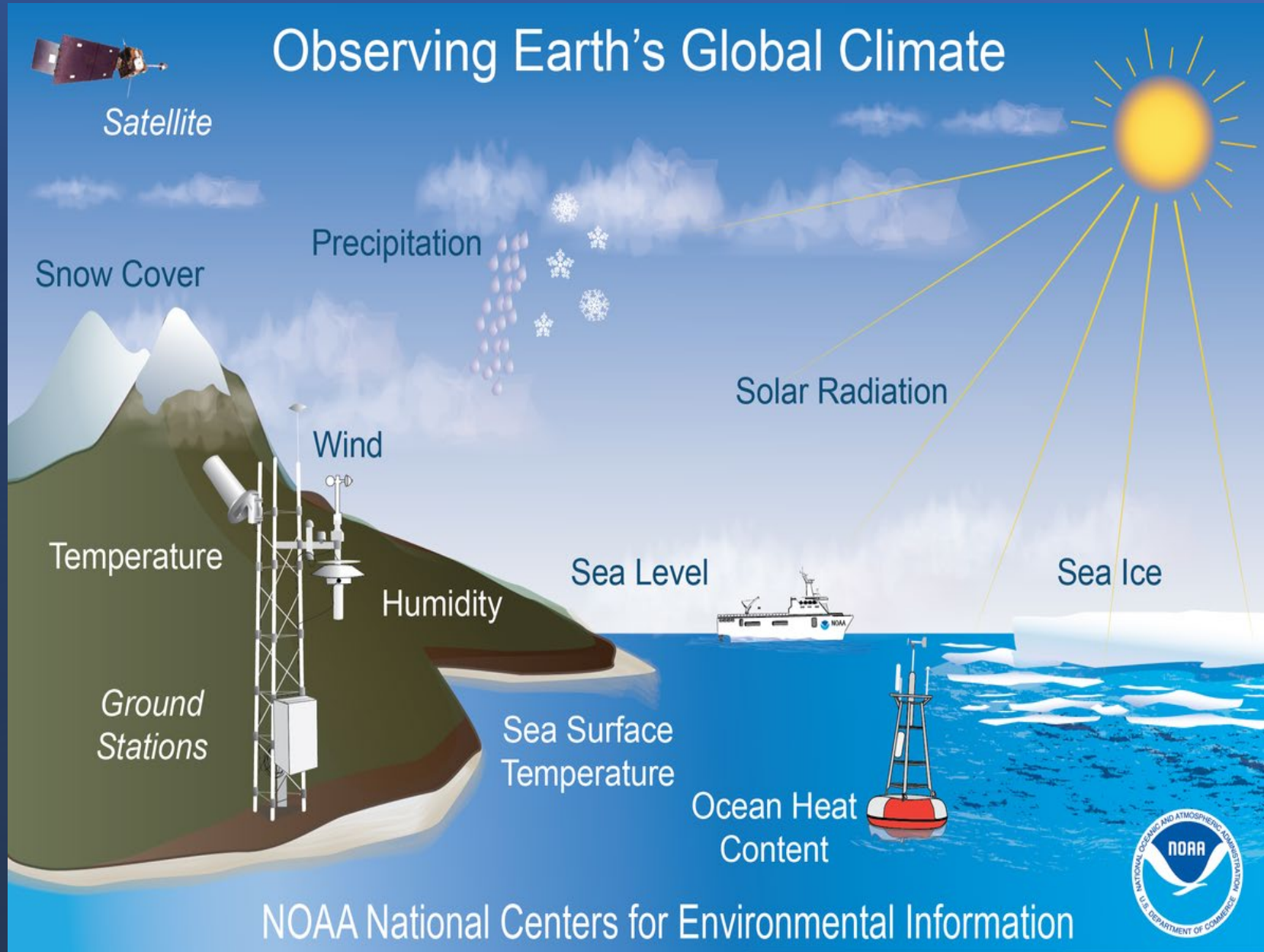
# WEATHER

- The Current State of the Atmosphere

Temp, Wind, Air Pressure, Clouds & Precipitation



# Observing Earth's Global Climate



NOAA National Centers for Environmental Information

## CLIMATE

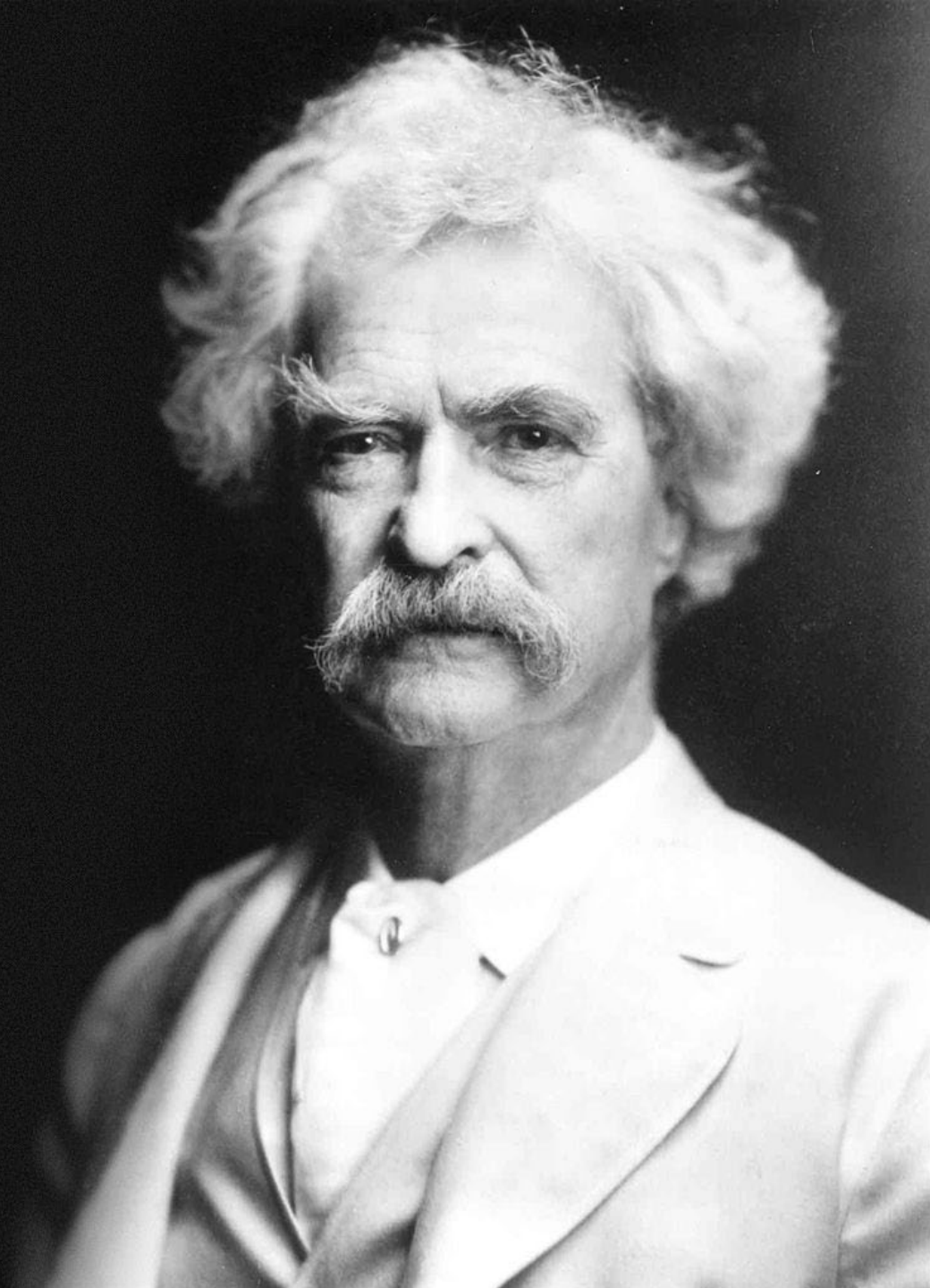
- The Expected Frequency of the Specific State of the Atmosphere Over a Period of Time



Mark Twain

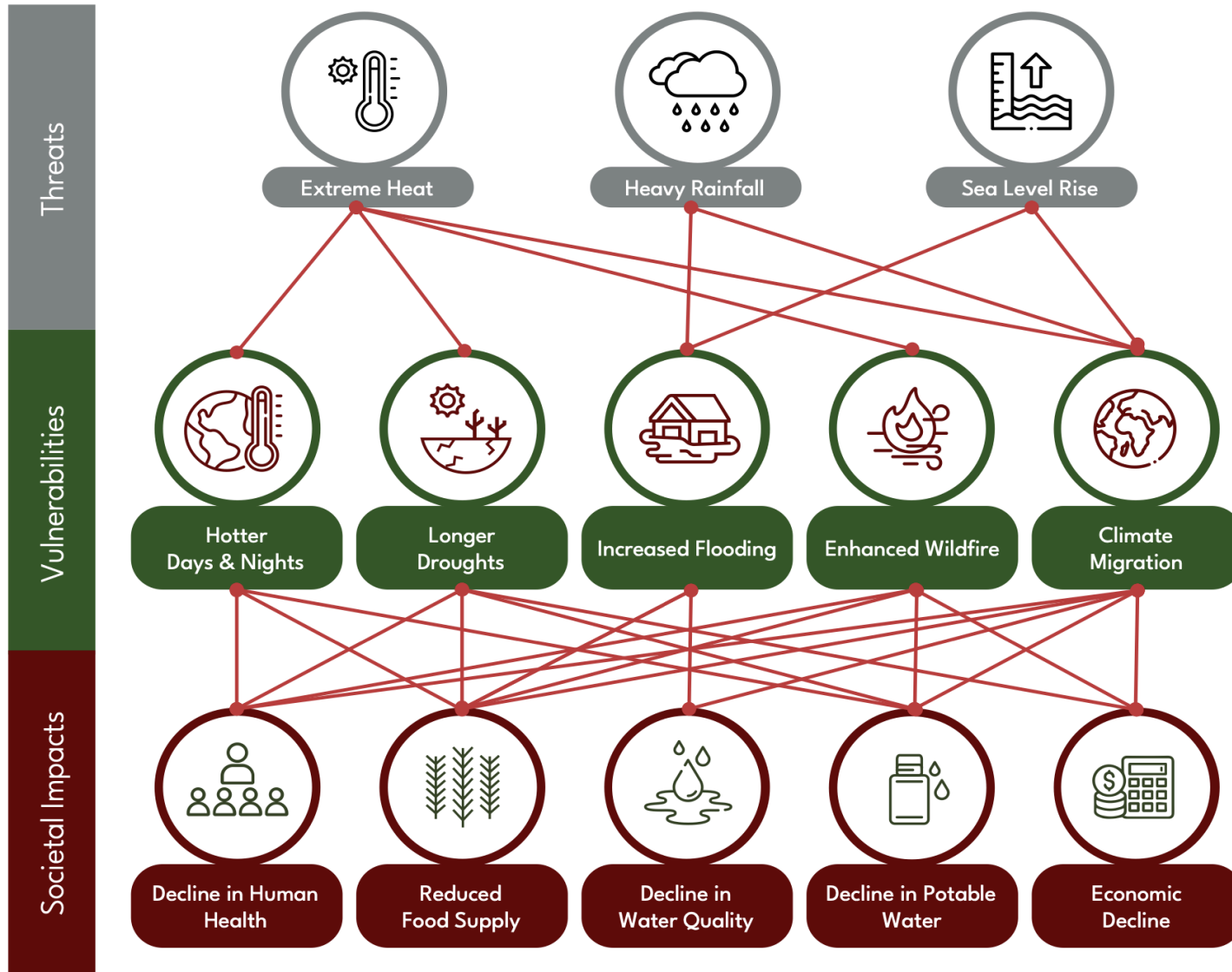
Climate is What you  
Want...

Weather is What You  
Get...



# CLIMATE CHANGE THREATS

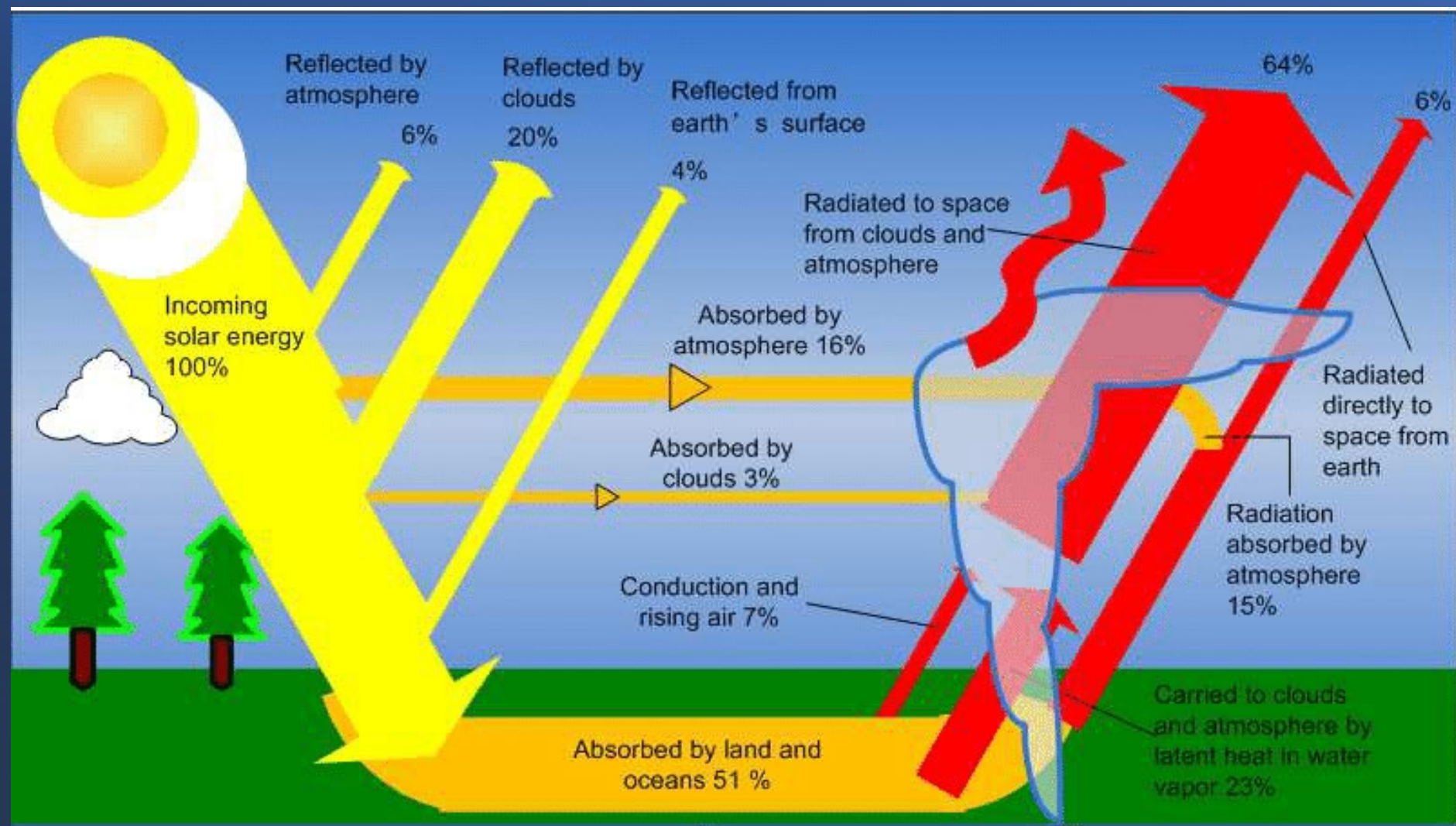
## Global Temperature Increase



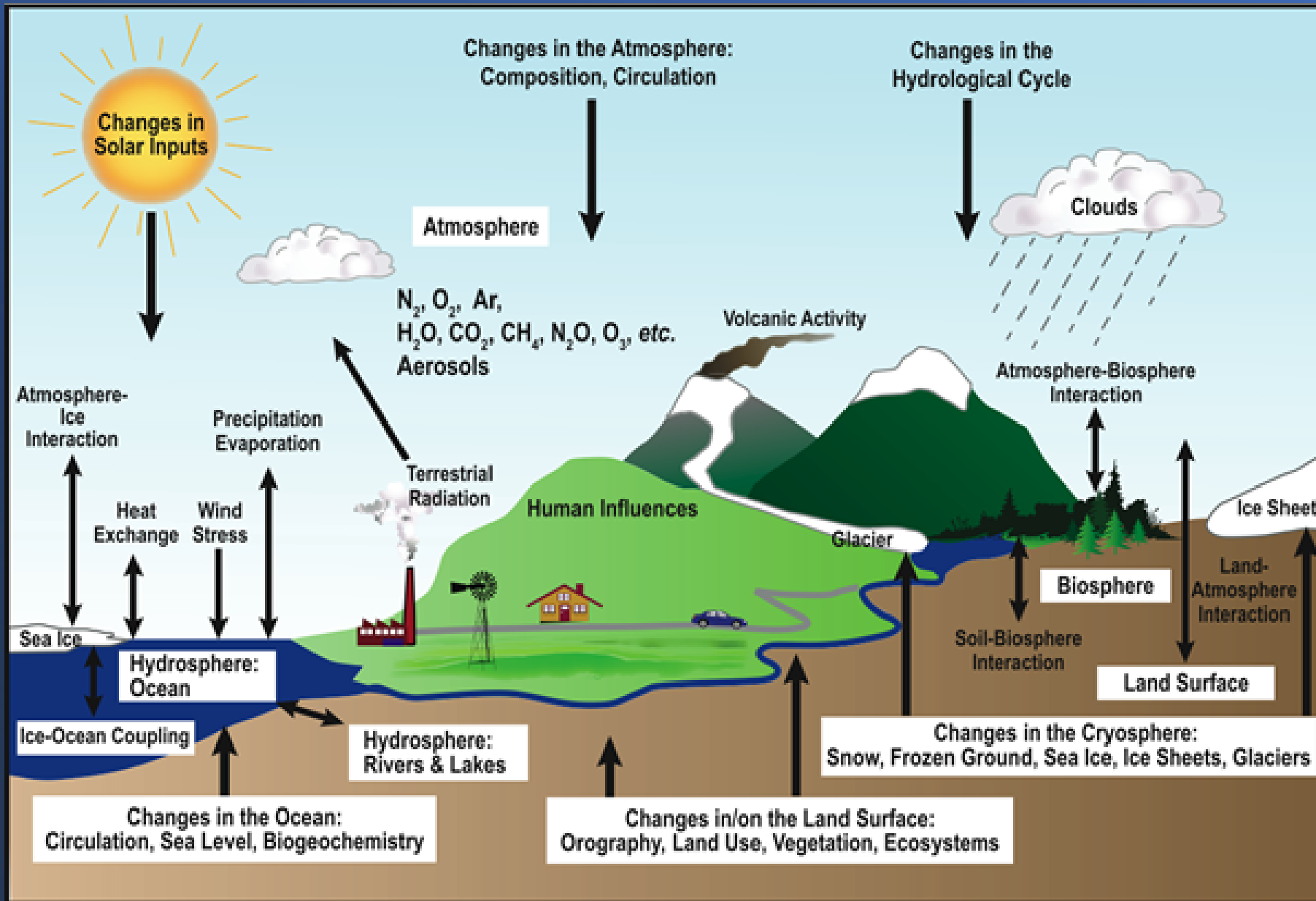
- Extreme Heat
- Rainfall Events
- Sea Level Rise?



# EARTH'S SOLAR BUDGET



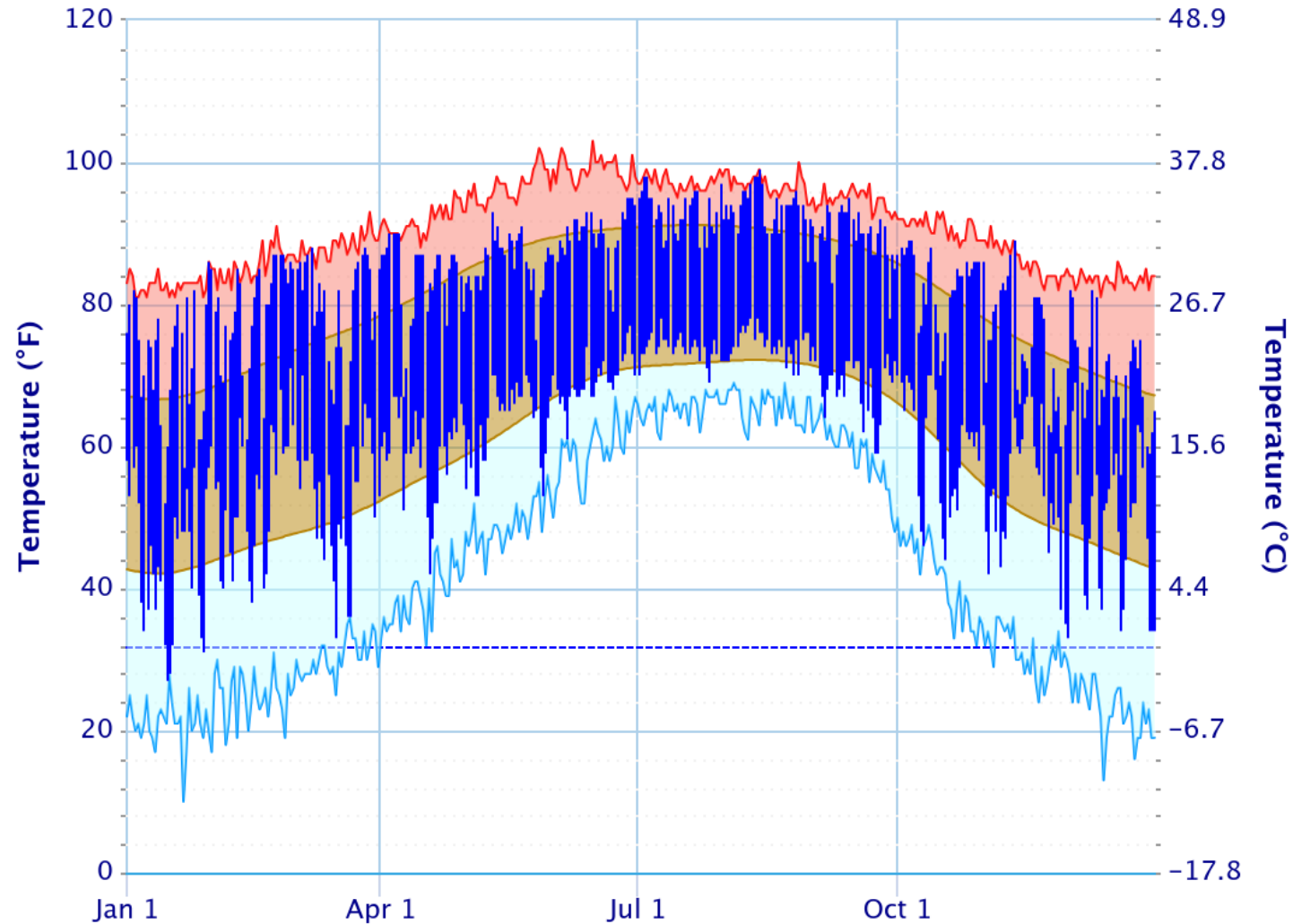
# COMPONENTS of CLIMATE





# Daily Temperature Data – GAINESVILLE REGIONAL AP, FL

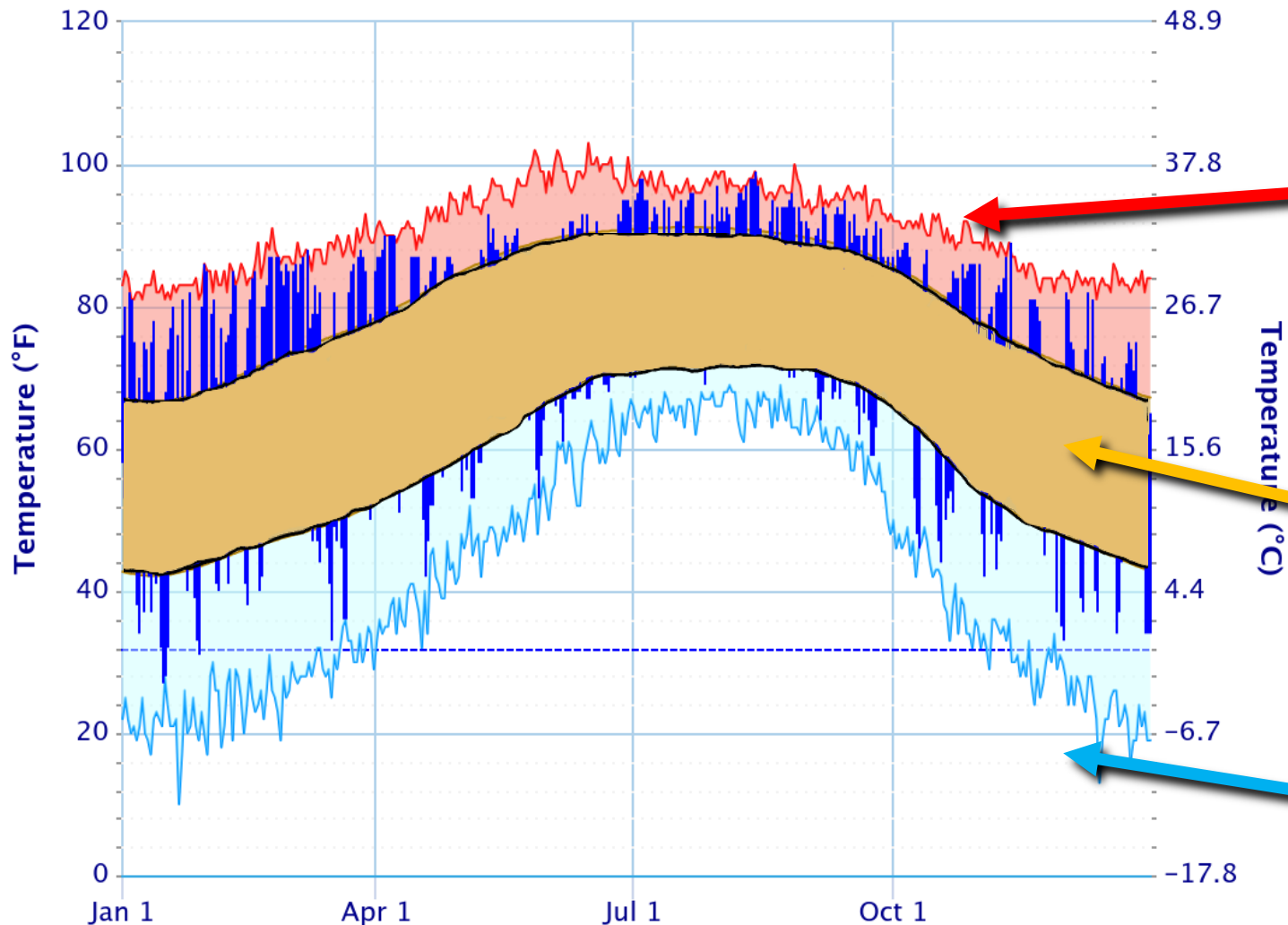
Period of Record – 1960-05-17 to 2024-08-12. Normals period: 1991-2020. Click and drag to zoom chart.



● Observed temperature range (2023) ● Normal temperature range — Record Max  
— Record Min

# Daily Temperature Data – GAINESVILLE REGIONAL AP, FL

Period of Record – 1960-05-17 to 2024-08-12. Normals period: 1991-2020. Click and drag to zoom chart.



Record Highs

Average Temp Range

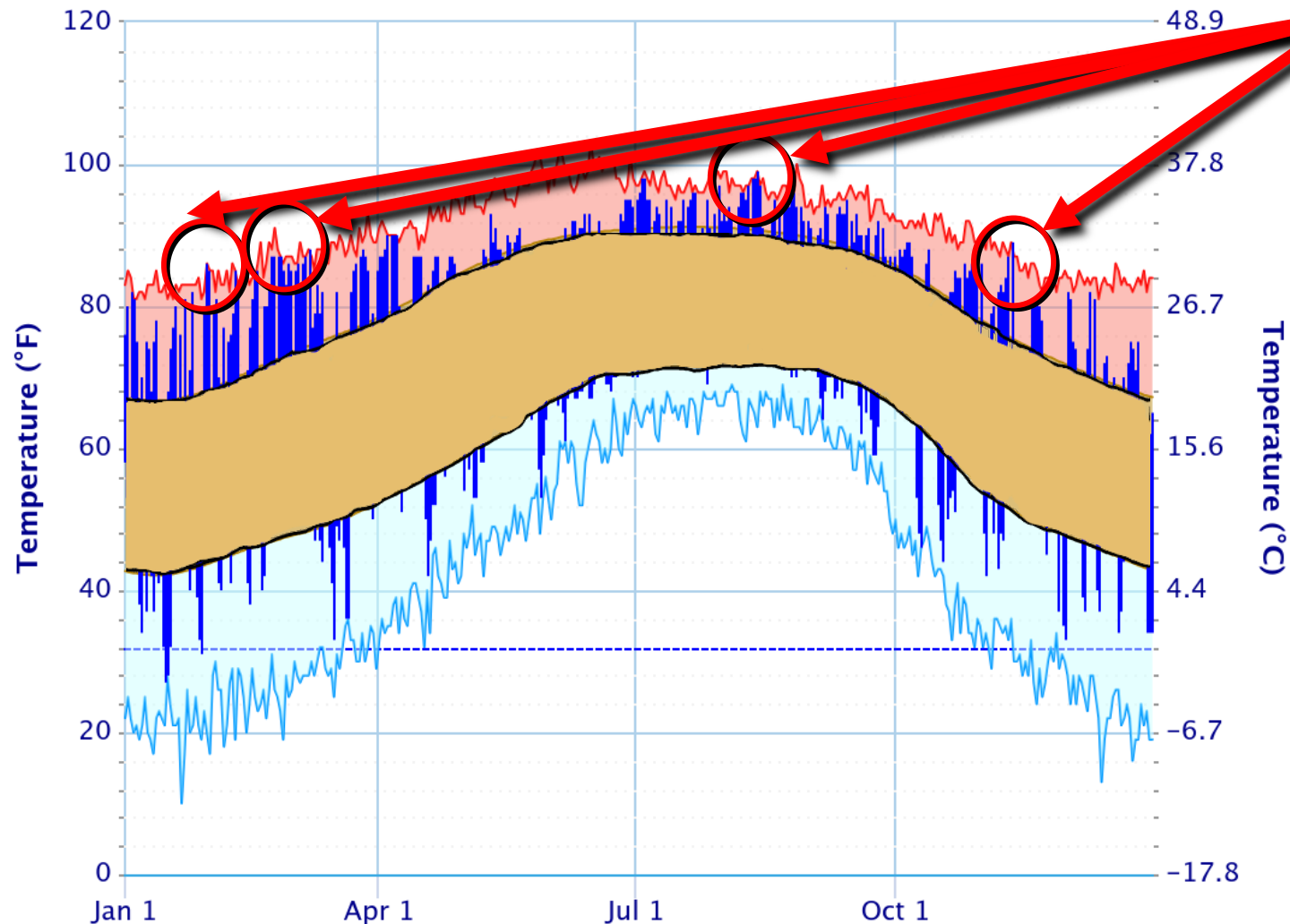
Record Lows

● Observed temperature range (2023) ● Normal temperature range — Record Max  
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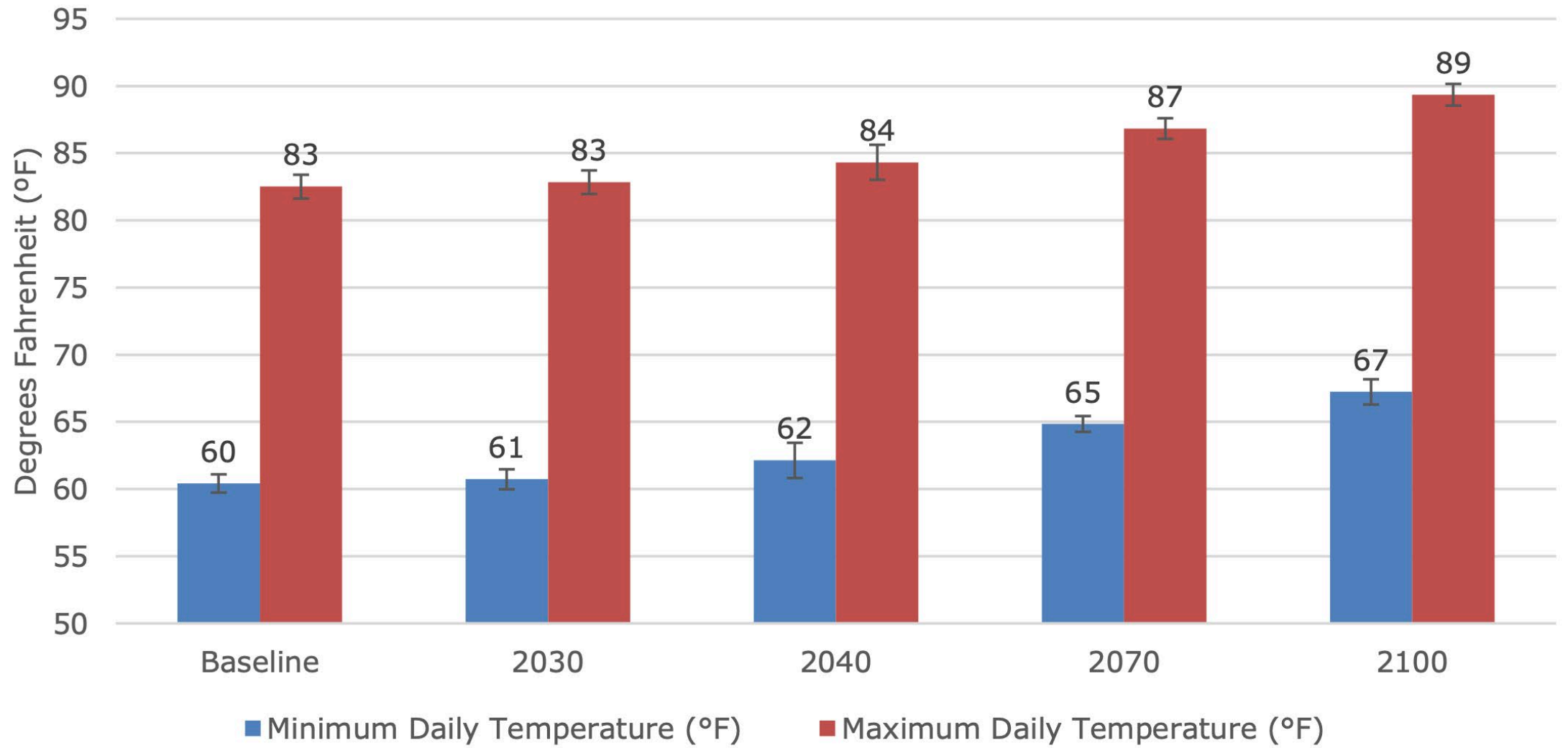
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11 New Record Highs in 2023

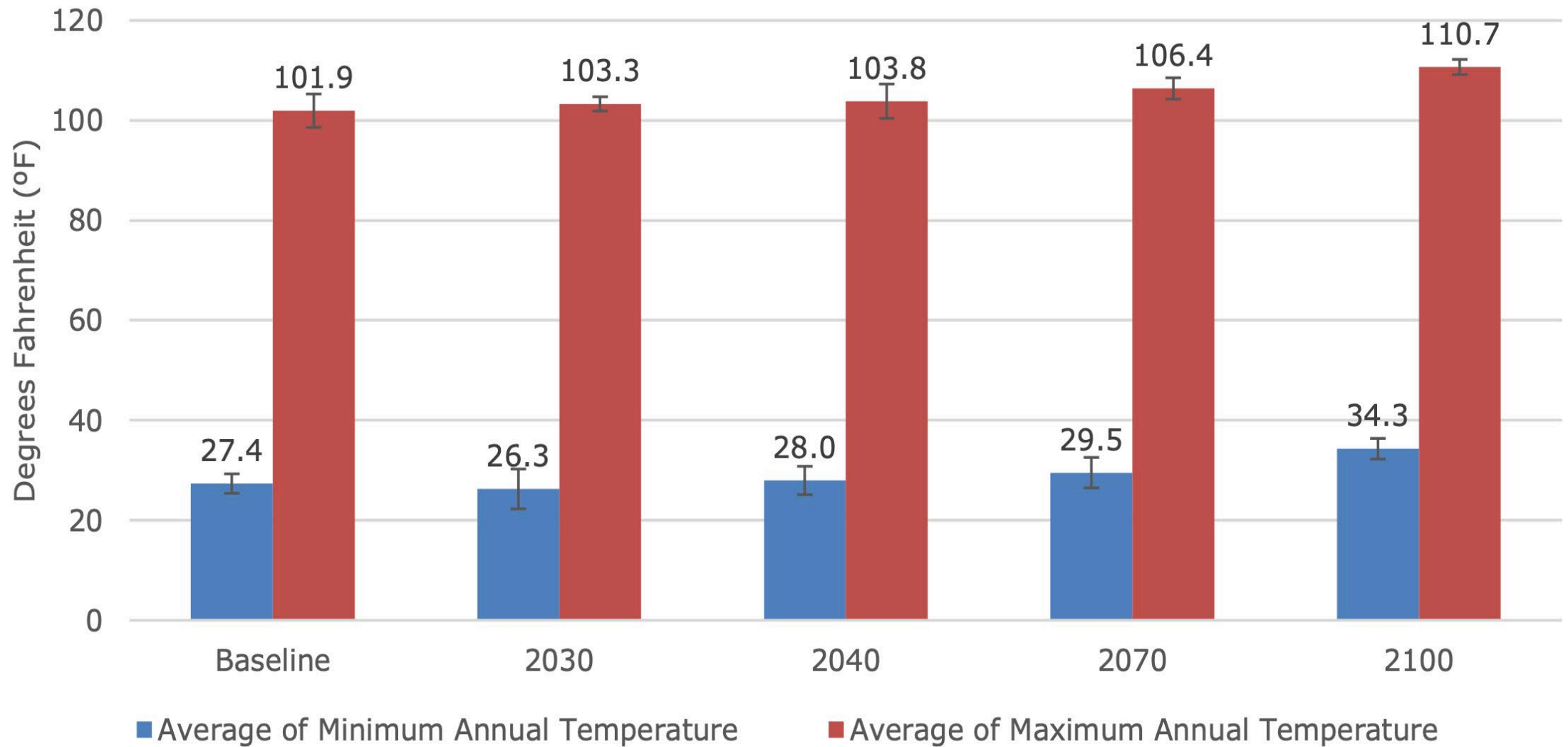
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## Average Annual Minimum and Maximum Daily Temperatures

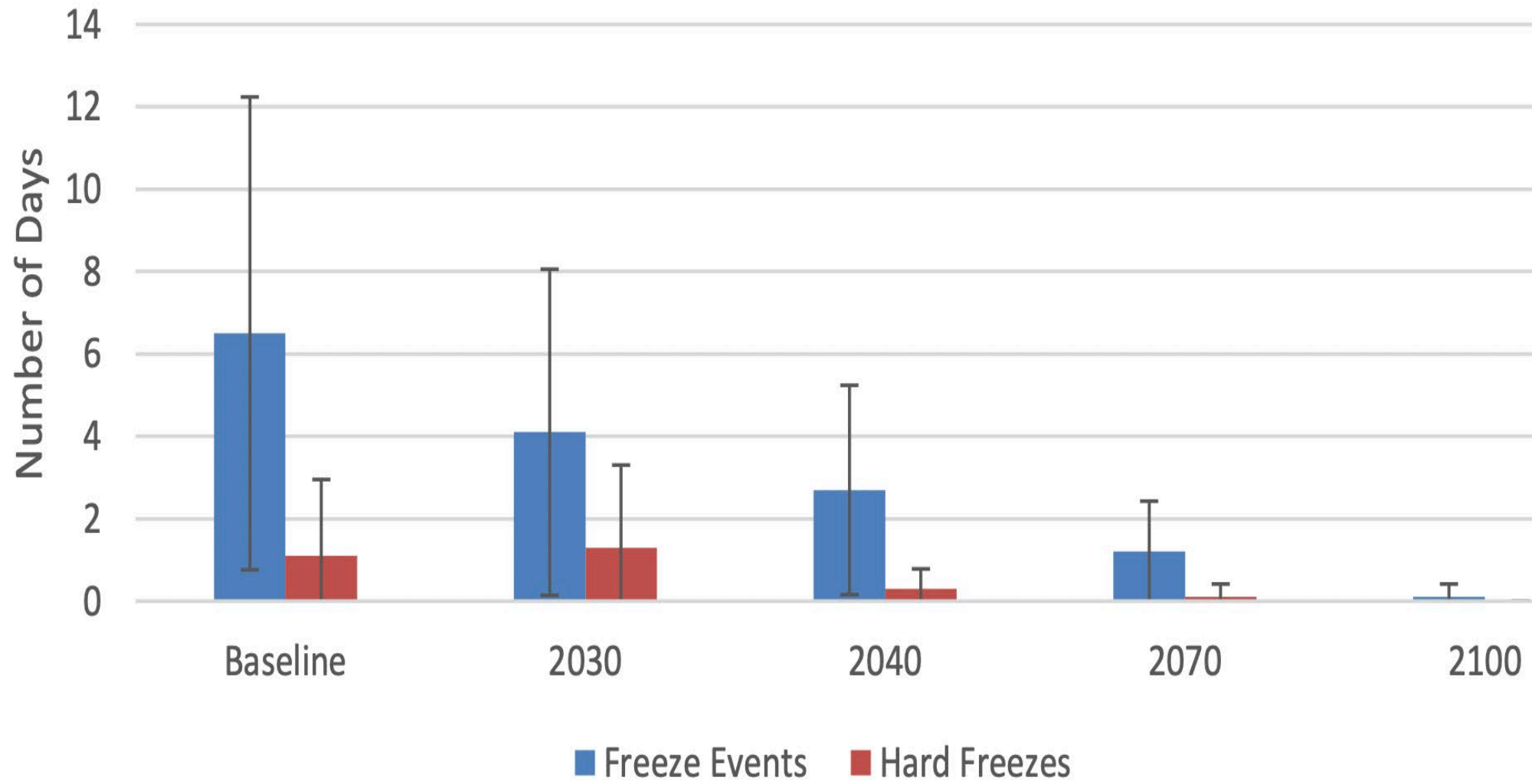




## Annual Minimum and Maximum Temperatures



## Average Annual Number of Freeze Events







## LACK OF FREEZE EVENT IMPACTS

- Potential Increase in Tropical Disease

1) Eastern Equine Encephalitis

2) West Nile Virus

3) Malaria

4) Dengue Fever

## Average Annual Number of Extreme Heat and Freeze Events over Assessment Periods.

	Number of Very Warm Nights (min. temp. >80° F) (Days)	Longest Period of Consecutive Very Warm Nights (Days)	Number of Freeze Events (min. temp. <32° F) (Days)	Longest Period of Consecutive Freeze Events (Days)
Baseline	0	0	7	3
2030	1	1	6	2
2040	1	1	4	2
2070	17	7	2	2
2100	73	28	0	0

# HEAT INDEX DANGERS

## HEAT INDEX CALCULATION

$$\begin{aligned} HI = & -42.379 + 2.04901523T + 10.14333127R - 0.22475541TR - \\ & 6.83783 \times 10^{-3}T^2 - 5.481717 \times 10^{-2}R^2 + 1.22874 \times 10^{-3}T^2R \\ & + 8.5282 \times 10^{-4}TR^2 - 1.99 \times 10^{-6}T^2R^2 \end{aligned}$$

Classification	Heat Index	Effect on the body
Caution	80°F - 90°F	Fatigue possible with prolonged exposure and/or physical activity
Extreme Caution	90°F - 103°F	Heat stroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity
Danger	103°F - 124°F	Heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity
Extreme Danger	125°F or higher	Heat stroke highly likely



# NWS Heat Index

Temperature (°F)

Relative Humidity (%)

	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										



Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

- Caution
- Extreme Caution
- Danger
- Extreme Danger

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Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution

Extreme Caution

Danger

Extreme Danger

# HEAT INDEX DANGERS

- Average Summer Heat Index



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95 100 105  
98 103 108



Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

- Caution
- Extreme Caution
- Danger
- Extreme Danger

## HEAT INDEX DANGERS

- Average Summer Heat Index
- Potential Summer Heat Index by 2100



# INCREASE IN HEAT INDEX DAYS

## Average Annual Number of Days that the Maximum HI Falls Within NOAA Categories (Steadman Method)

	Very Warm (80 to 89°F)	Hot (90 to 104°F)	Very Hot (105 to 129°F)	Extremely Hot (At or Higher Than 130°F)	Total
Baseline	55	90	71	2	218
2030	51	85	89	1	226
2040	55	71	100	6	232
2070	54	69	110	23	256
2100	42	61	105	61	268

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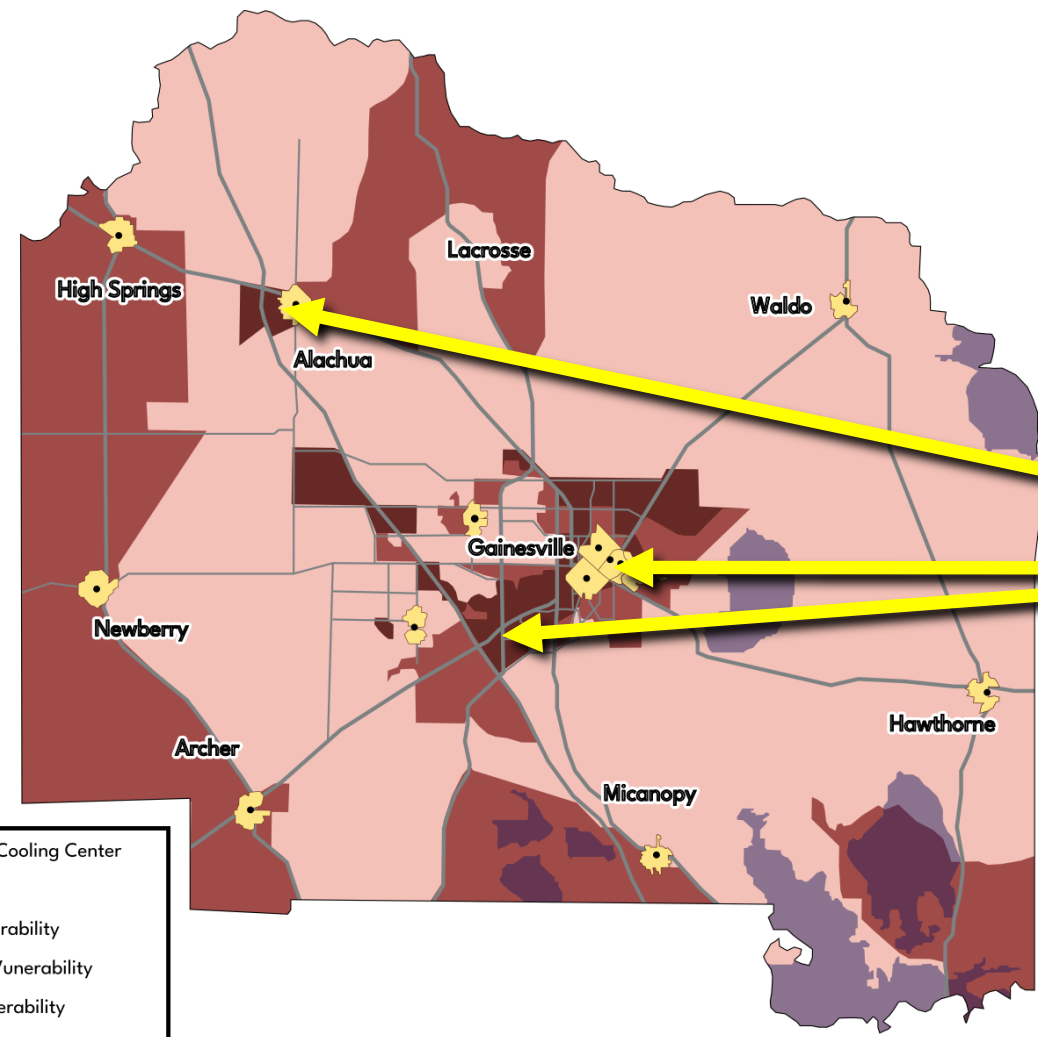
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# EXCESSIVE HEAT VULNERABILITY



- 15 Minute Walk Time to Cooling Center
- Cooling Center Location
- Low Extreme Heat Vulnerability
- Medium Extreme Heat Vulnerability
- High Extreme Heat Vulnerability
- Water

URBAN AREAS

Identified of Extreme Heat Vulnerability coincident with locations of Public Cooling Stations.





## AGRICULTURAL IMPACTS

- Increases in Temperatures ( Highs & Lows )
- Reduce Food Availability







AVERAGE MILK PRODUCTION: 53 lbs/day

MILK LOSS: ↓2.5 lbs/day

MILK LOSS: ↓6.0 lbs/day

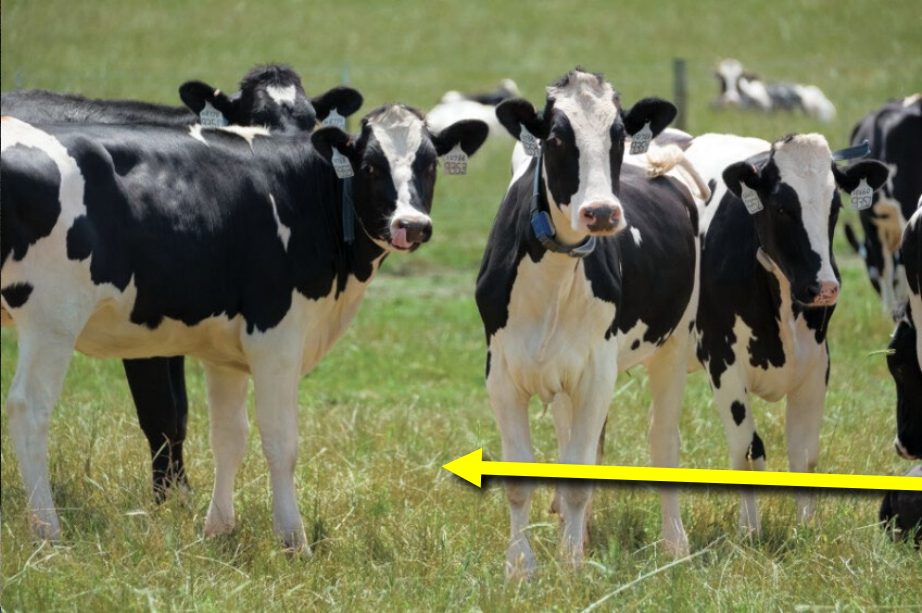
MILK LOSS: ↓8.7 lbs/day

MILK LOSS: No Milk

DAIRY COW TEMPERATURE HUMIDITY INDEX (THI)																			
Temp °F	Humidity %																		
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
72	64	65	65	65	66	66	67	67	67	68	68	69	69	69	70	70	70	71	71
74	65	66	66	67	67	67	68	68	69	69	70	70	70	71	71	72	72	73	73
76	66	67	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75
78	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75	76	76
80	68	69	69	70	70	71	72	72	73	74	74	75	75	76	77	78	78	79	79
82	69	69	70	70	71	72	73	73	74	75	75	76	77	77	78	79	79	80	80
84	70	70	71	72	73	73	74	75	75	76	77	78	78	79	80	80	81	82	82
86	71	71	72	73	74	74	75	76	77	78	78	79	80	81	81	82	83	84	84
88	72	72	73	74	75	76	76	77	78	79	80	81	81	82	83	84	85	86	86
90	72	73	74	75	76	77	78	79	79	80	81	82	83	84	85	86	86	87	88
92	73	74	75	76	77	78	79	80	81	82	83	84	85	85	86	87	88	89	90
94	74	75	76	77	78	79	80	81	82	83	84	86	86	87	88	89	90	91	92
96	75	76	77	78	79	80	81	82	83	85	86	87	88	89	90	91	92	93	94
98	76	77	78	80	80	82	83	83	85	86	87	88	89	90	91	92	93	94	95
100	77	78	79	81	82	83	84	85	86	87	88	90	91	92	93	94	95	96	98
102	78	79	80	82	83	84	85	86	87	89	90	91	92	94	95	96	97	98	100
104	79	80	81	83	84	85	86	88	89	90	91	93	94	95	96	98	99	100	101
106	80	81	82	84	85	87	88	89	90	91	93	94	95	97	98	99	101	102	103
108	81	82	83	85	86	88	89	90	92	93	94	96	97	98	100	101	103	104	105
110	81	83	84	86	87	89	90	91	93	95	96	97	99	100	101	103	104	106	107



# HEAT STRESS AGRICULTURAL IMPACTS



PEANUTS

CORN

- Reduce Food Availability

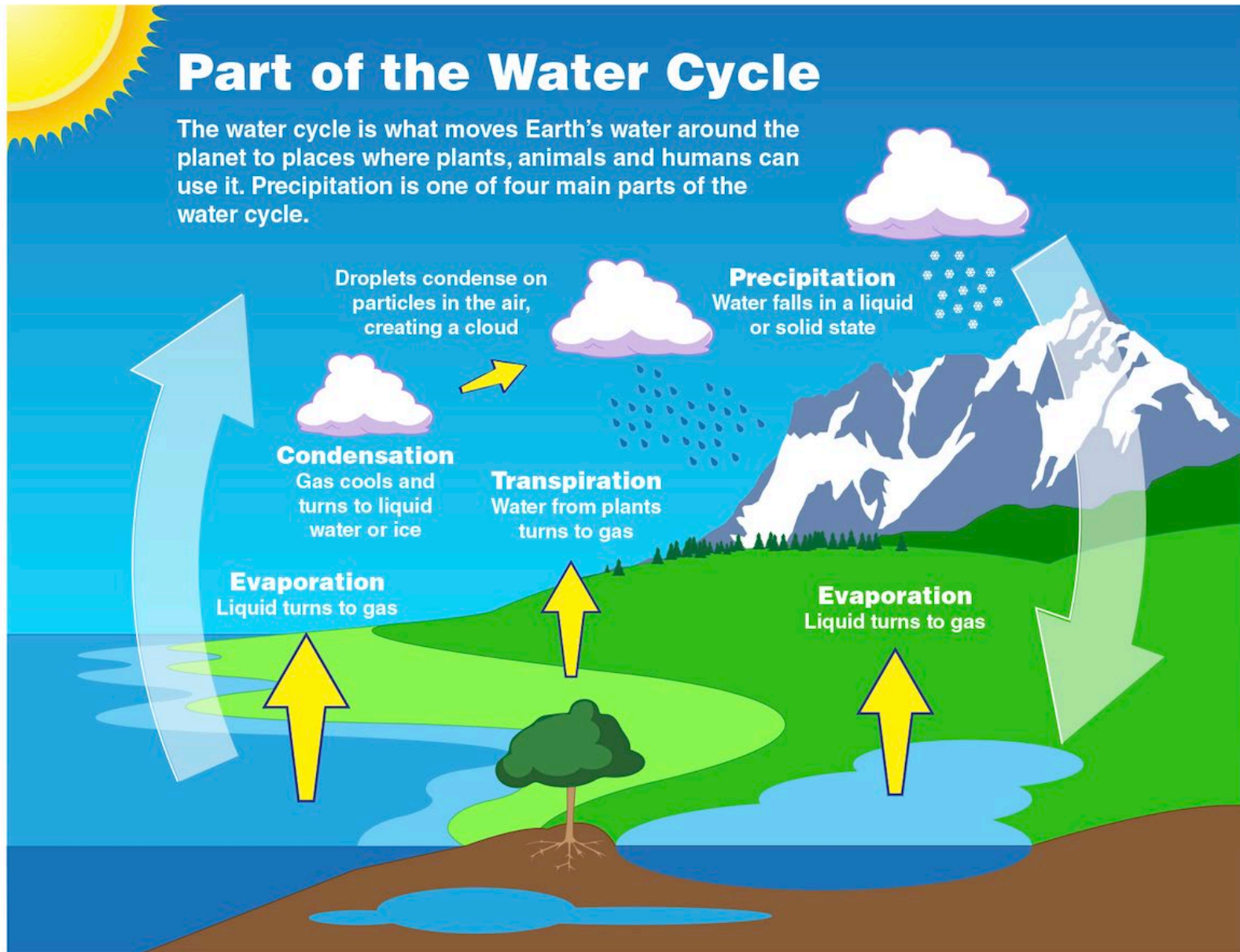
SOYBEANS

DAIRY



## Part of the Water Cycle

The water cycle is what moves Earth's water around the planet to places where plants, animals and humans can use it. Precipitation is one of four main parts of the water cycle.



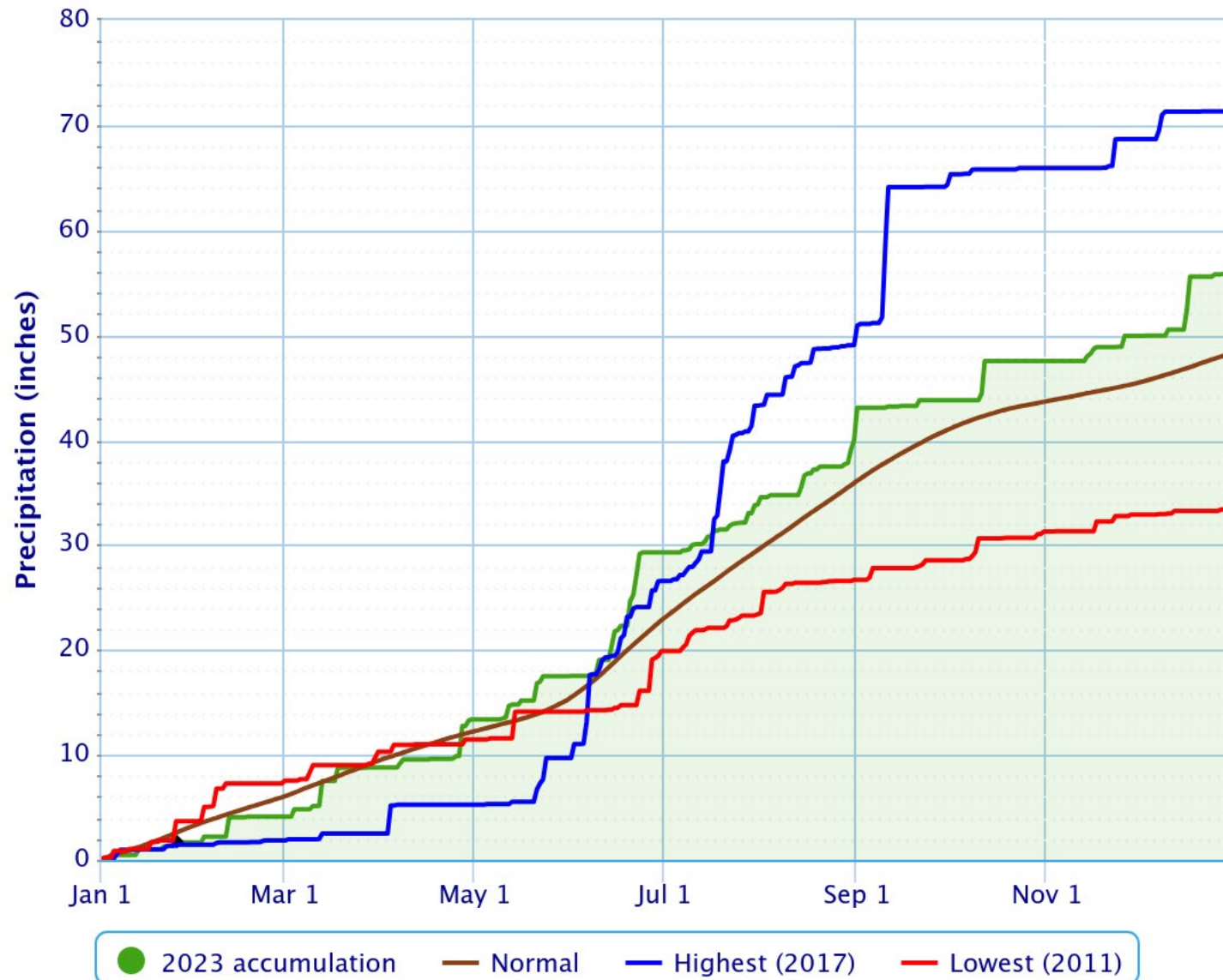
## RAINFALL

- Warmer Temperature Increases Atmospheric Moisture =
- Excessive Rainfall Events



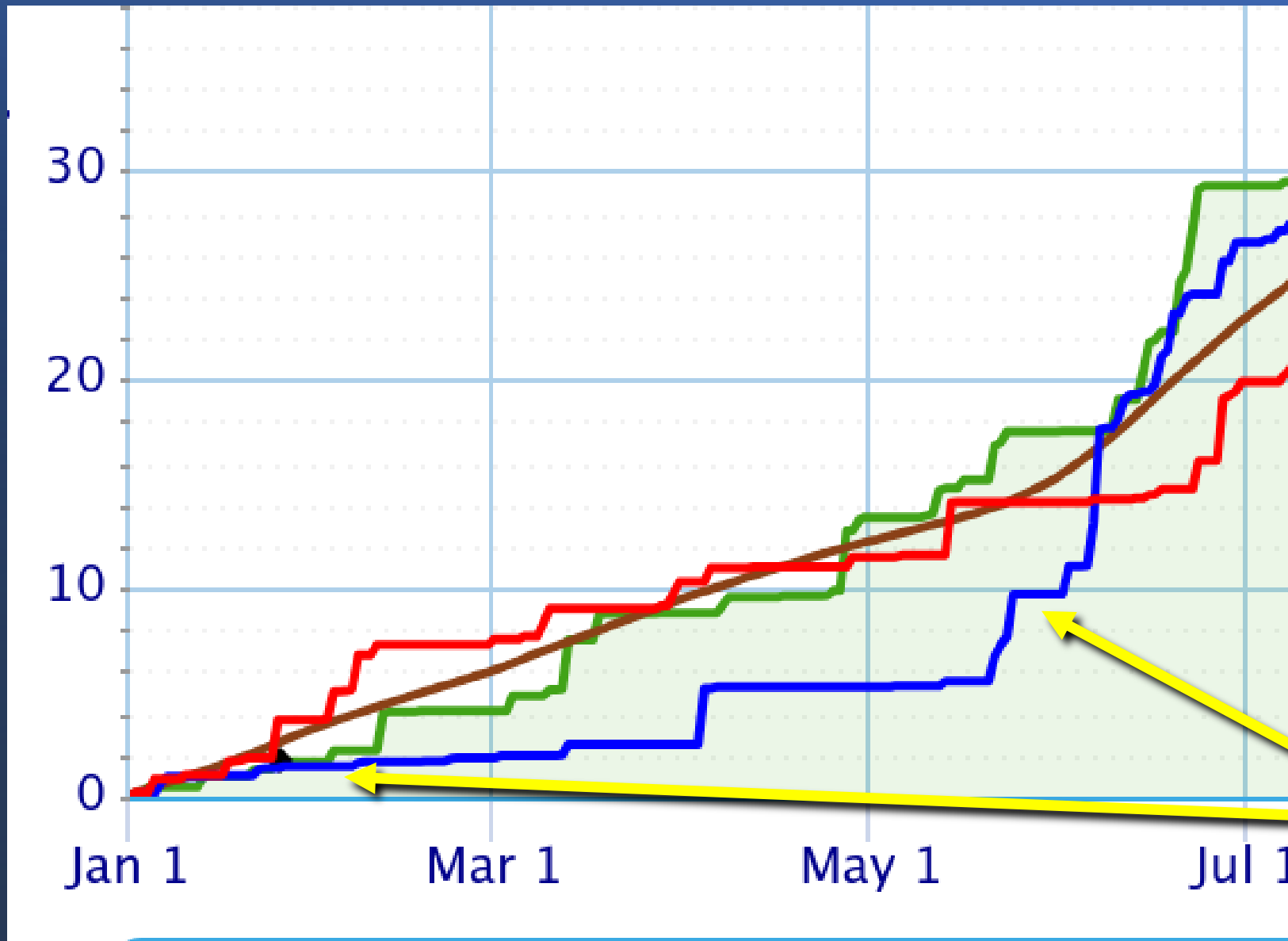
# Accumulated Precipitation – GAINESVILLE REGIONAL AP, FL

Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



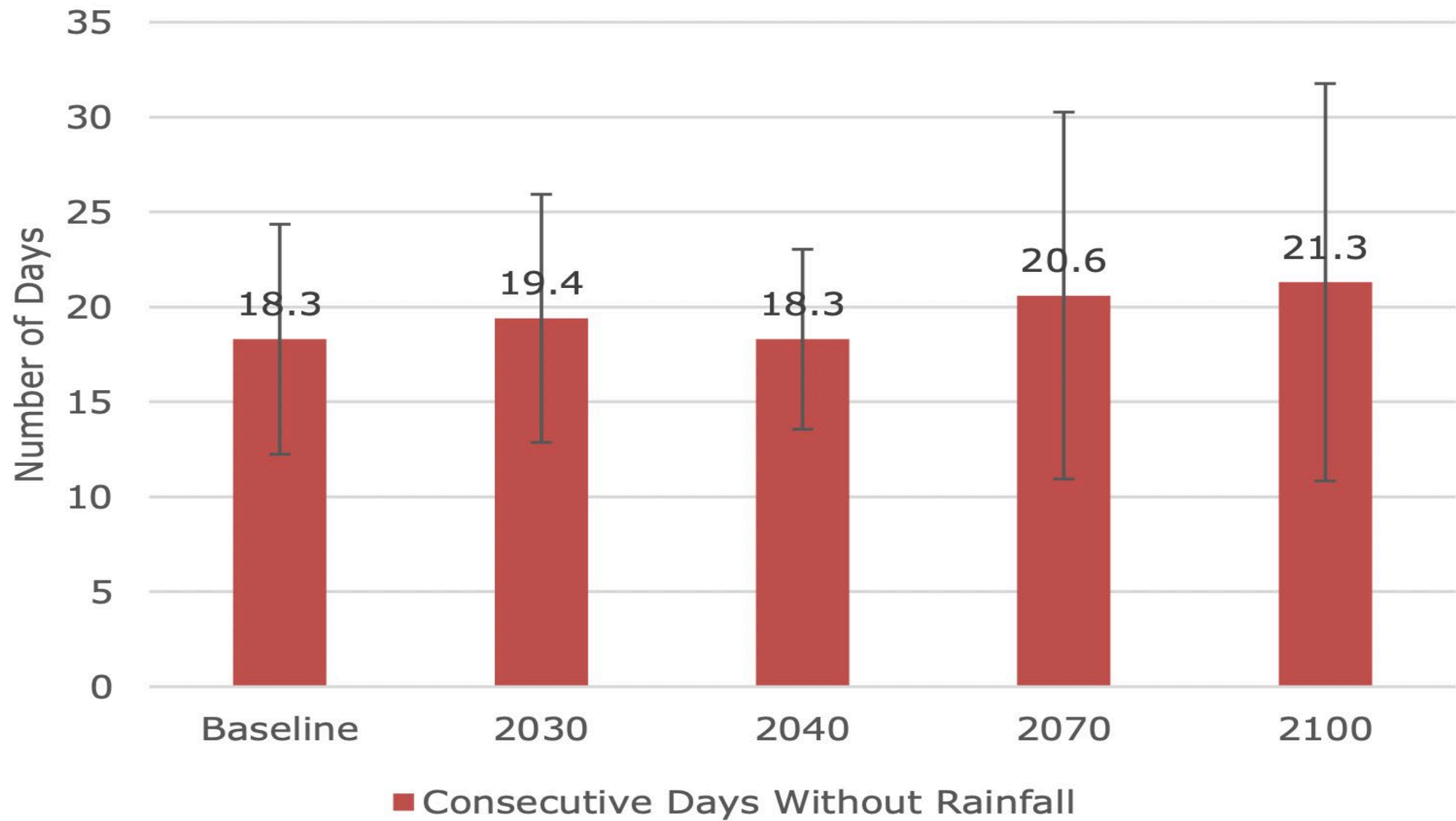
# GAINESVILLE ANNUAL RAINFALL

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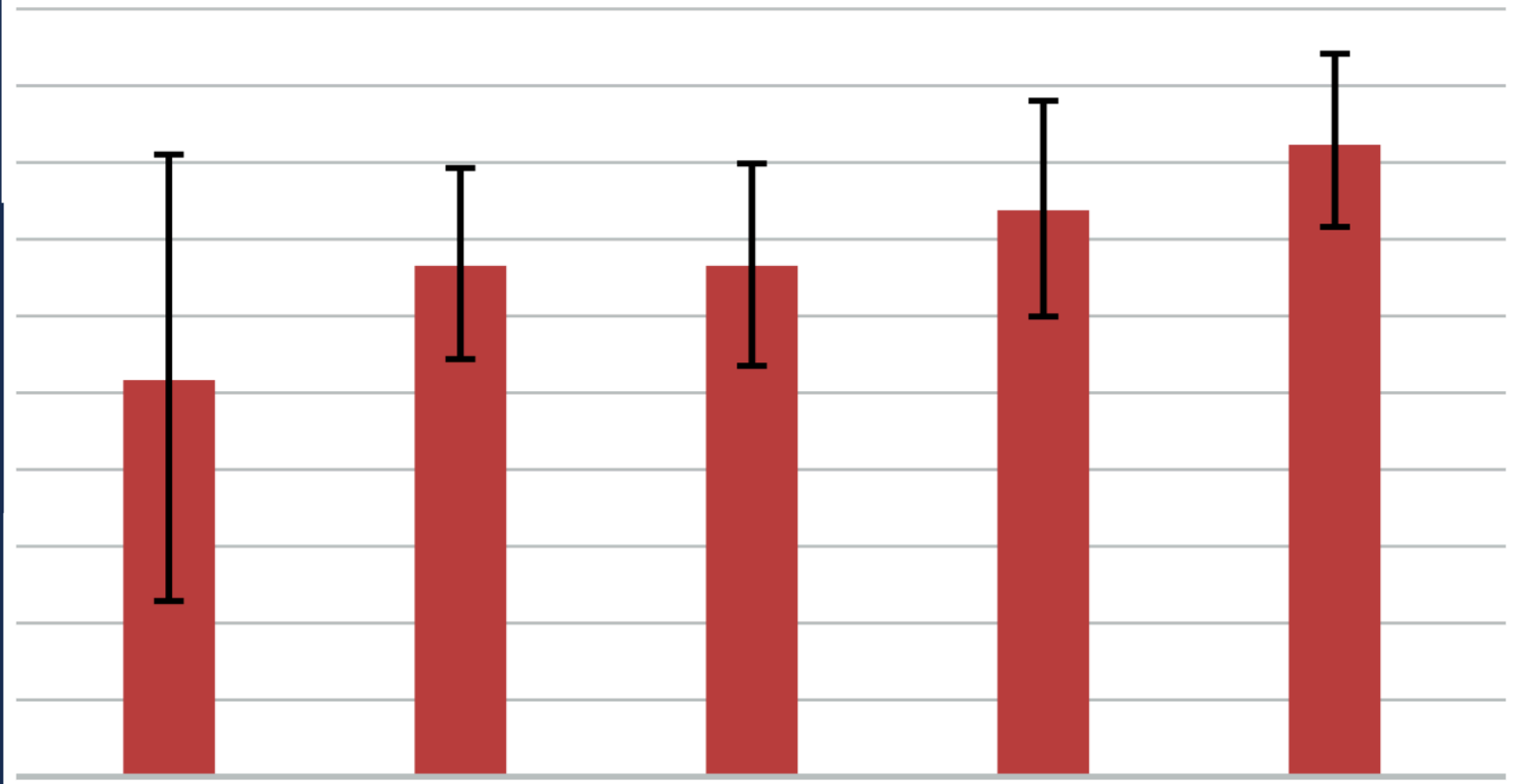
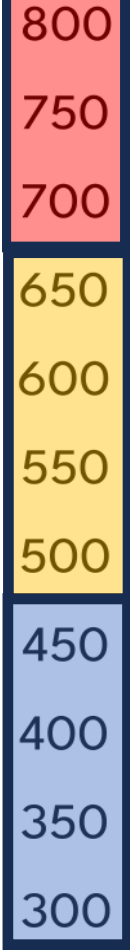
- 2017- Record Yearly Rainfall

Extreme Spring Drought



# KBDI – Potential Fire Threat

High  
Med  
Low



■ Annual Average of the Maximum 30-Day KBDI



Some potential impacts seen during a drought include:



**Reduced  
Agricultural  
Production**



**Decrease  
of Local Plants  
and Animals**



**Increase in  
Sinkholes**



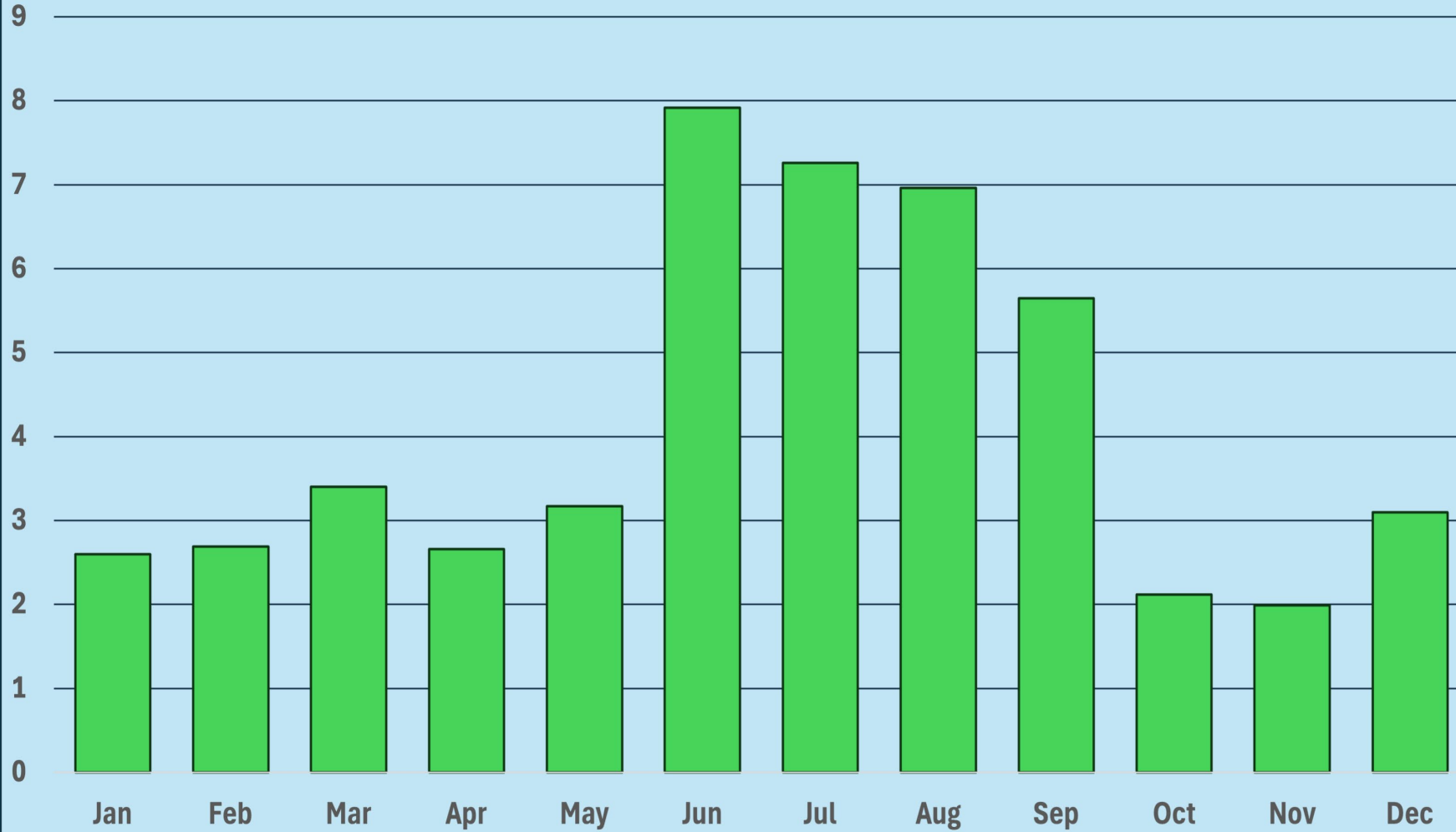
**Increase in  
Wildfires**



**Water Use  
Restrictions and  
Emergencies**

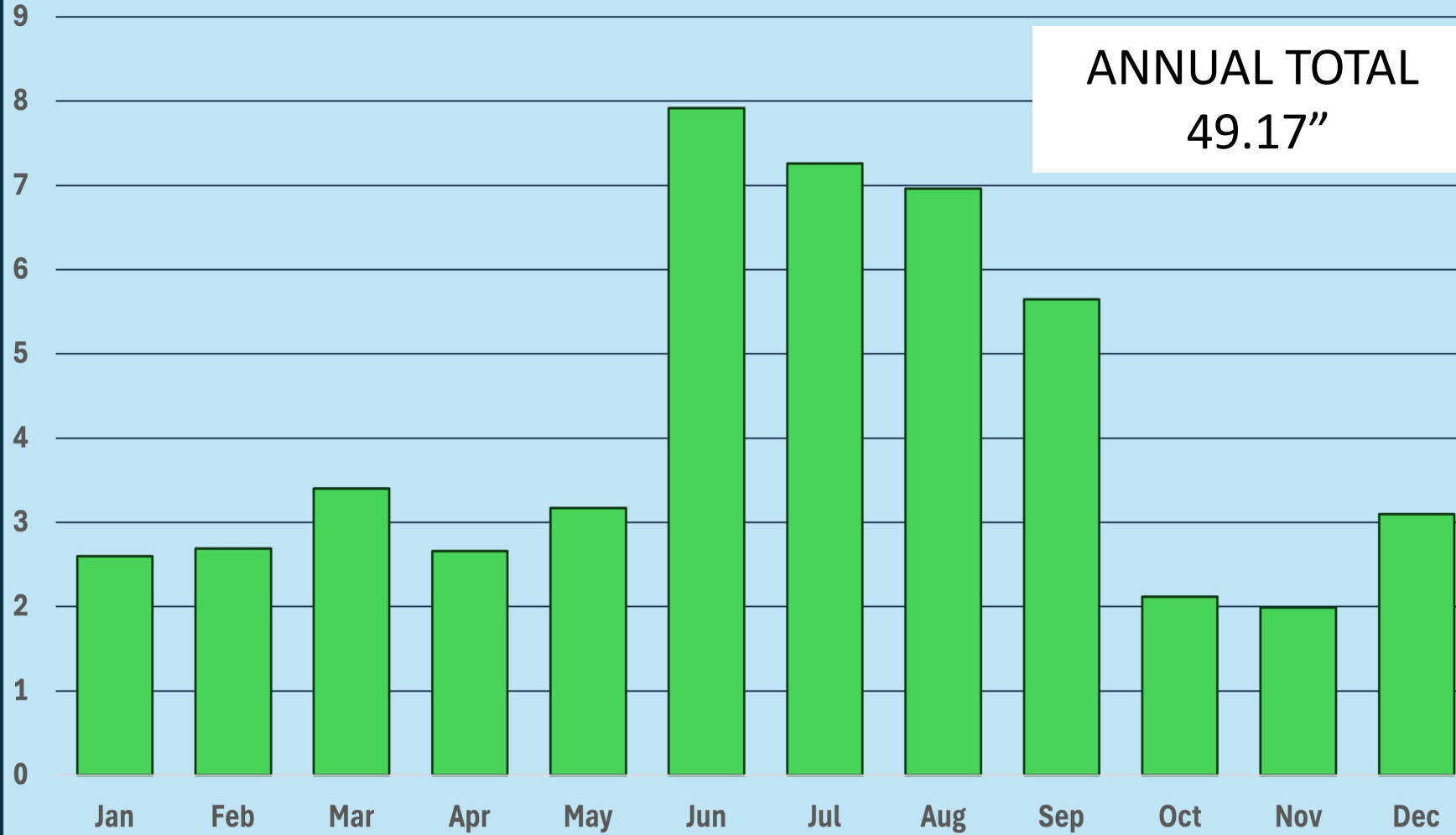
# GAINESVILLE AVG MONTHLY RAINFALL

KGNV: AVG ANNUAL PRECIPITATION 2000-2024



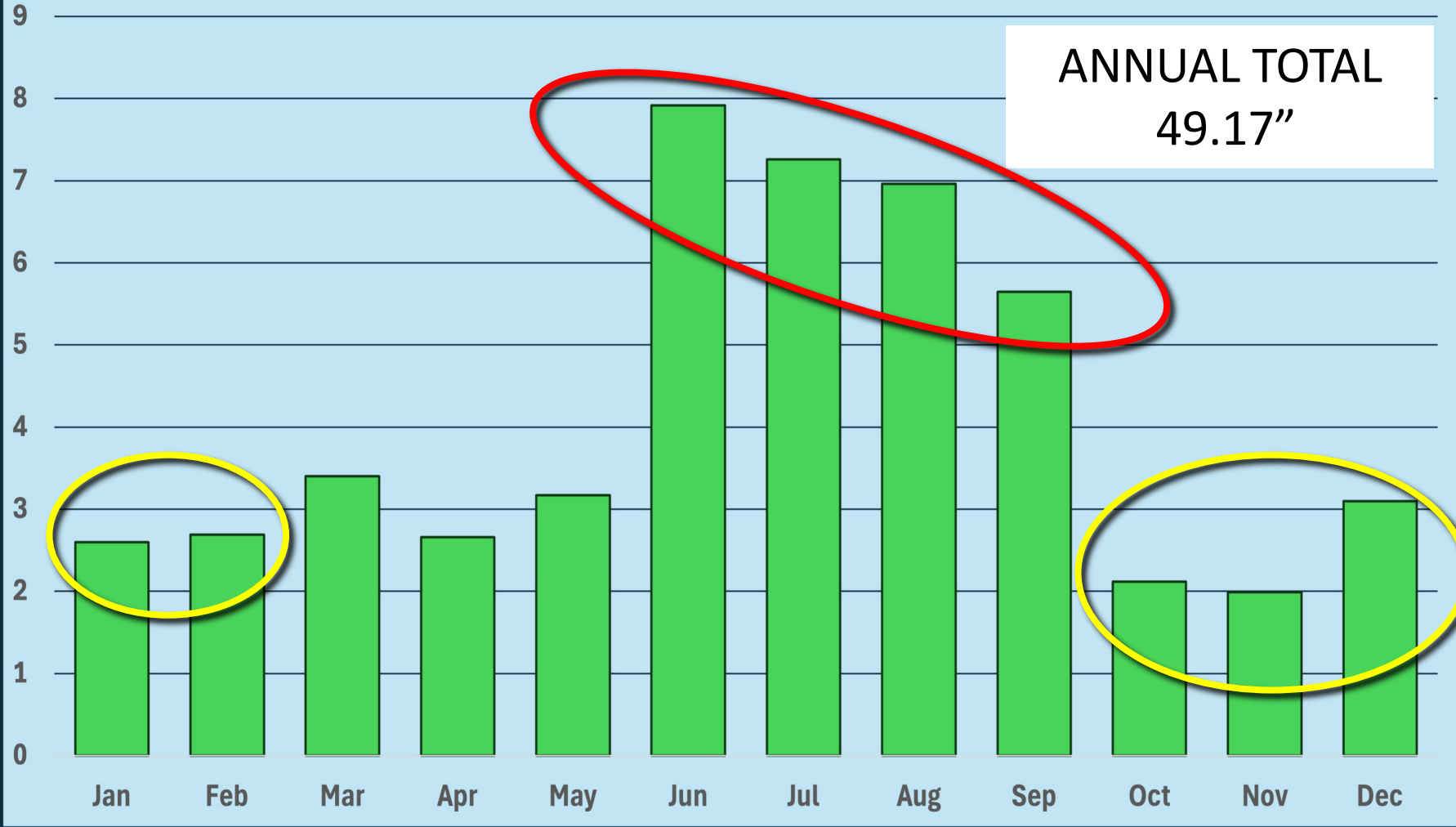
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# GAINESVILLE AVG MONTHLY RAINFALL

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- Drier Fall & Winter 

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- Rainy Season in Summer 

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# SEASONAL RAINFALL CHANGES

## Average Annual and Average Seasonal Changes in Rainfall

	Wet Season (inches)	Dry Season (inches)	Annual (inches)	Annual Increase from Baseline (%)
Baseline	30.3	22.5	52.8	-
2030	33.8	23.6	57.4	8.8
2040	29.6	23.6	53.2	0.8
2070	32.0	24.9	56.9	7.8
2100	31.4	25.1	56.5	7.1

- Variable Wet Season Totals
- Increase in Dry Season & Annual Totals

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# WILDFIRE THREAT

- Wetter Winter Wx = Increased Growth of Biofuels
- Longer Spring Droughts = Rise in Wildfire Threats Late Spring





# FLOODING THREAT

- RIVER FLOODING
- AREAL FLOODING
- FLASH FLOODING

(Short Term)  
(High Volume)  
(Rain Events)

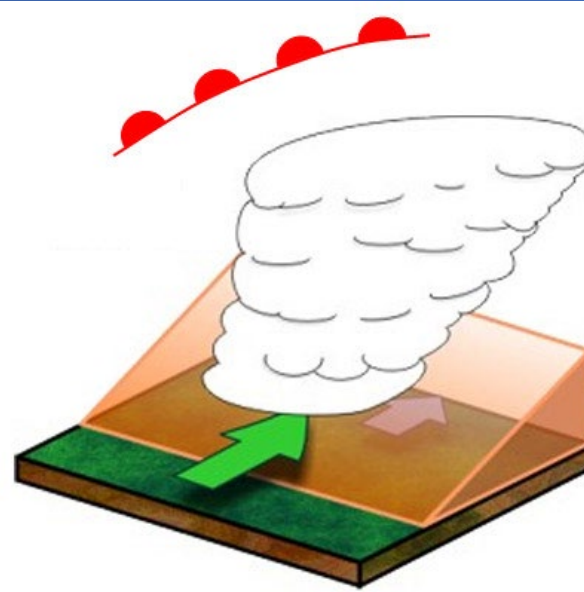


# RAINFALL ORIGINS

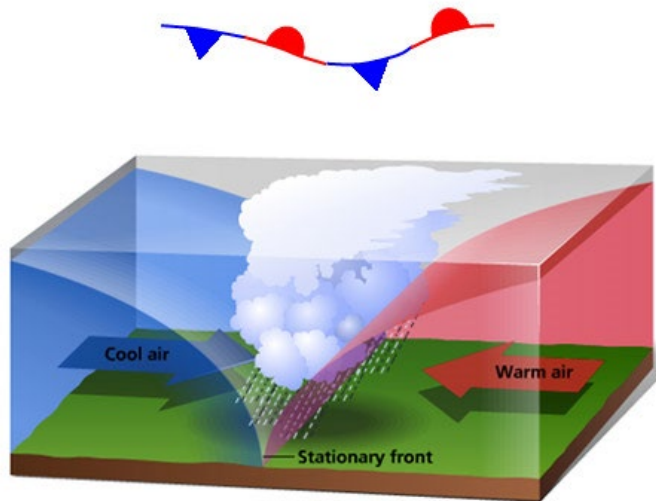
- DRY SEASON



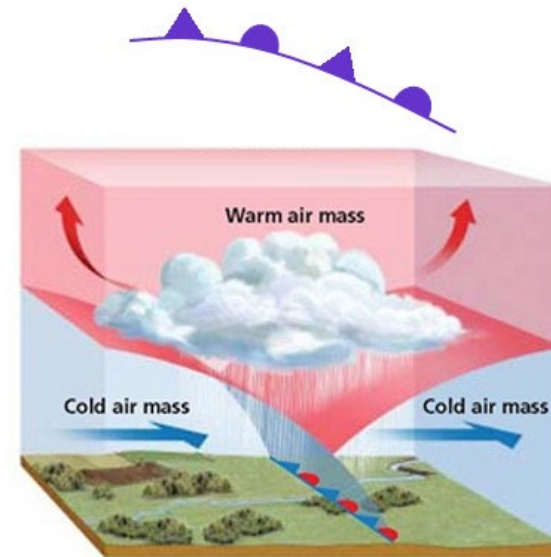
(1)



(2)



(3)



(4)

- (1) Cold Fronts
- (2) Warm Fronts
- (3) Stationary Fronts
- (4) Occluded Fronts



# RAINFALL ORIGINS

(1)

- WET SEASON

(1) Sea Breeze  
Thunderstorms  
(3"-5")

(2)

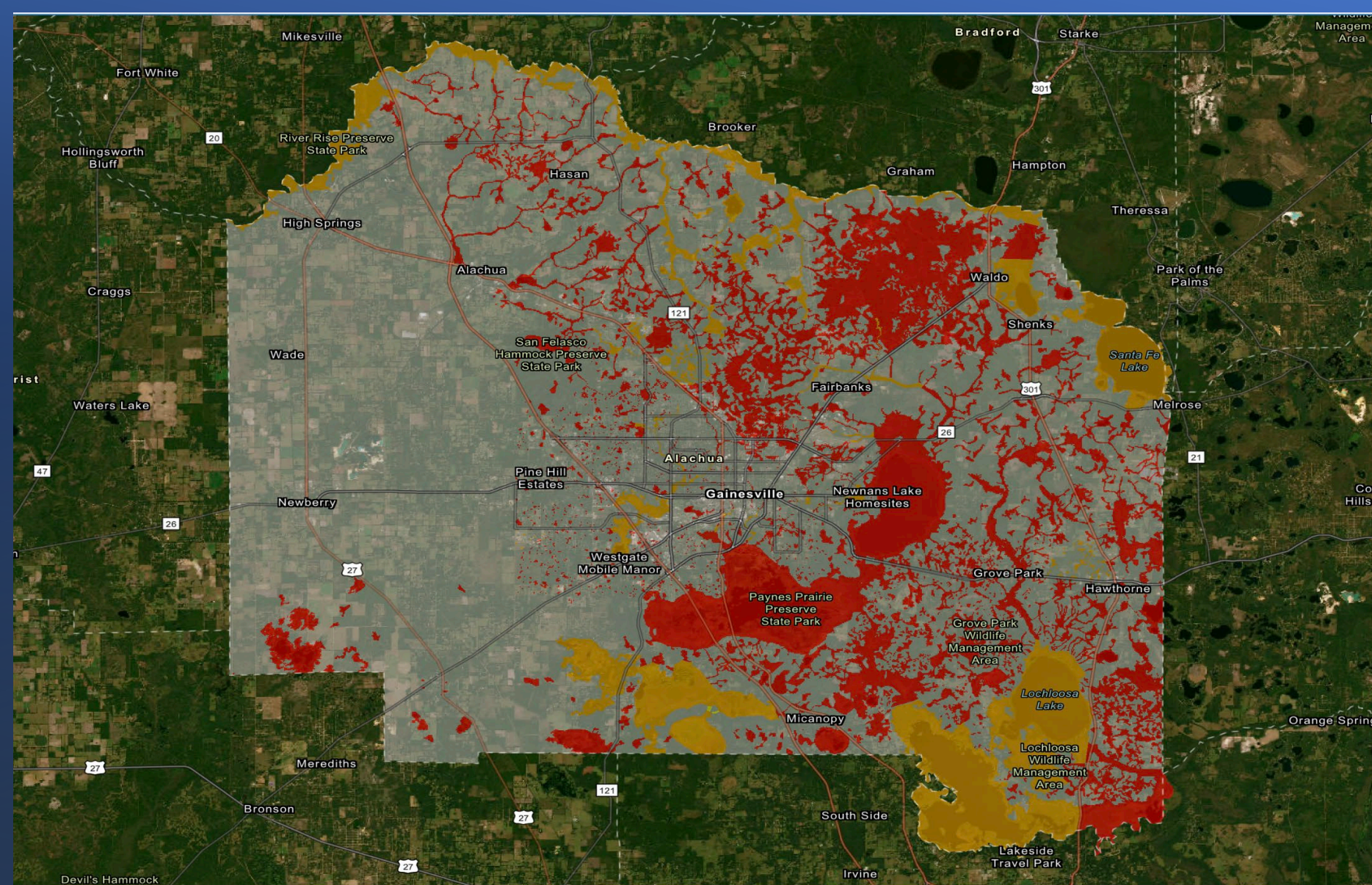
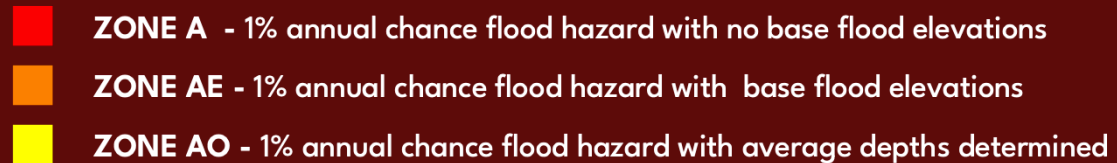
(2) Tropical Systems  
(10"-20")





# ALACHUA CO FLOOD ZONES

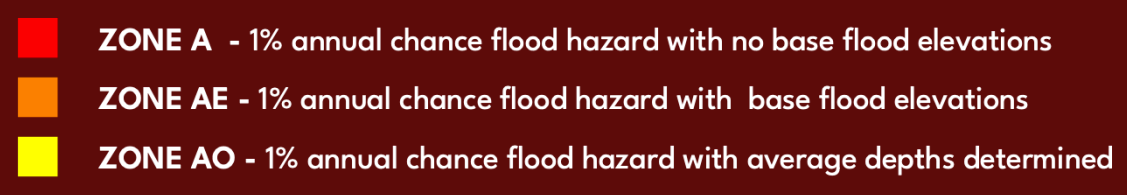
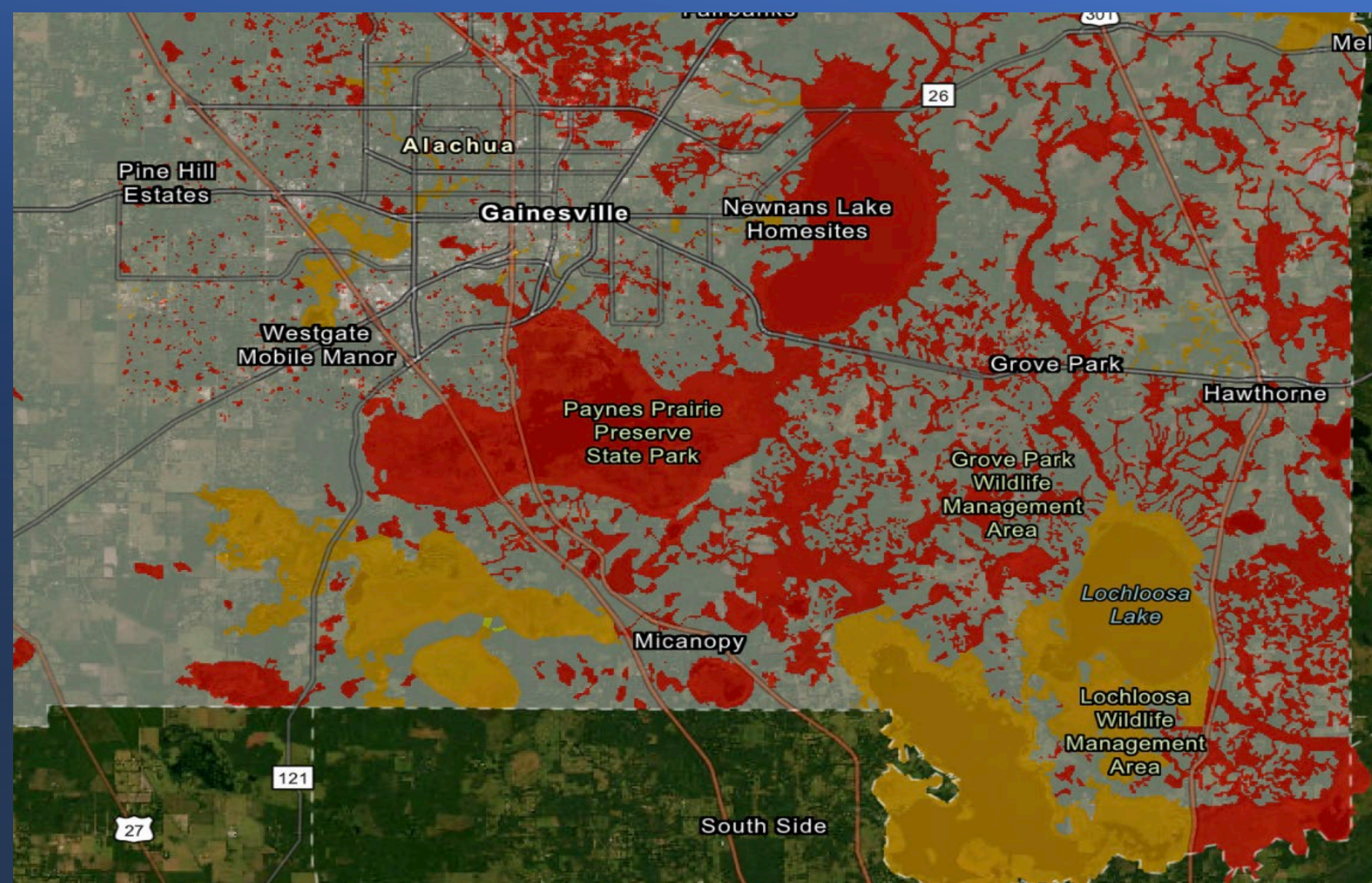
- ZONE: **A**  
Widespread Area
- ZONE: **AE**  
Moderate Area
- ZONE: **AO**  
Santa Fe River,  
Streams & Creeks





# ALACHUA CO FLOOD ZONES

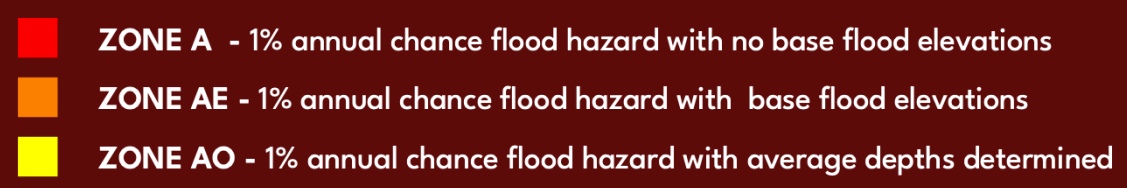
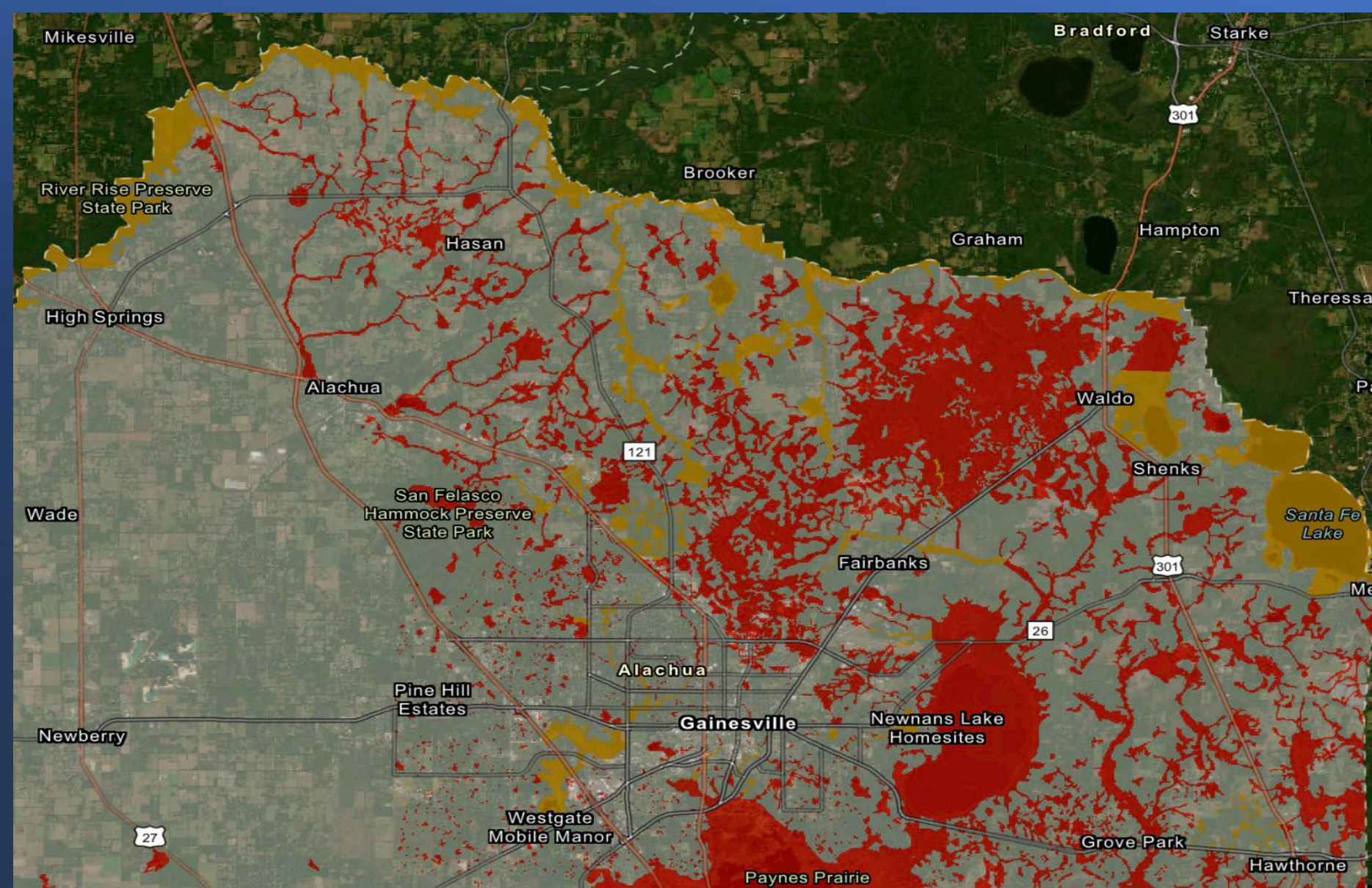
- ZONE: **A**  
Widespread Area
- ZONE: **AE**  
Moderate Area
- ZONE: **AO**  
Santa Fe River,  
Streams & Creeks





# ALACHUA CO FLOOD ZONES

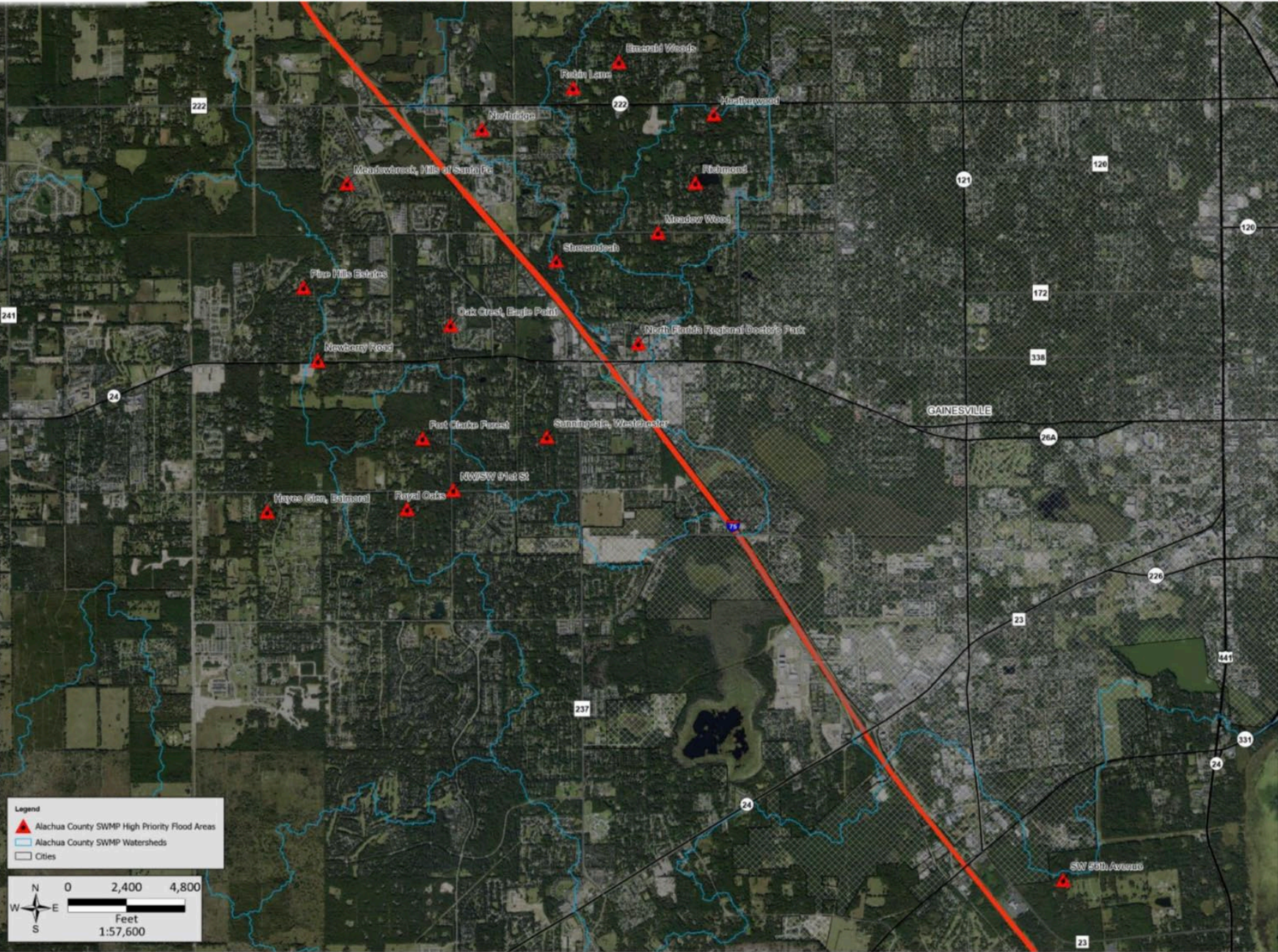
- ZONE: **A**  
Widespread Area
- ZONE: **AE**  
Moderate Area
- ZONE: **AO**  
Santa Fe River,  
Streams & Creeks





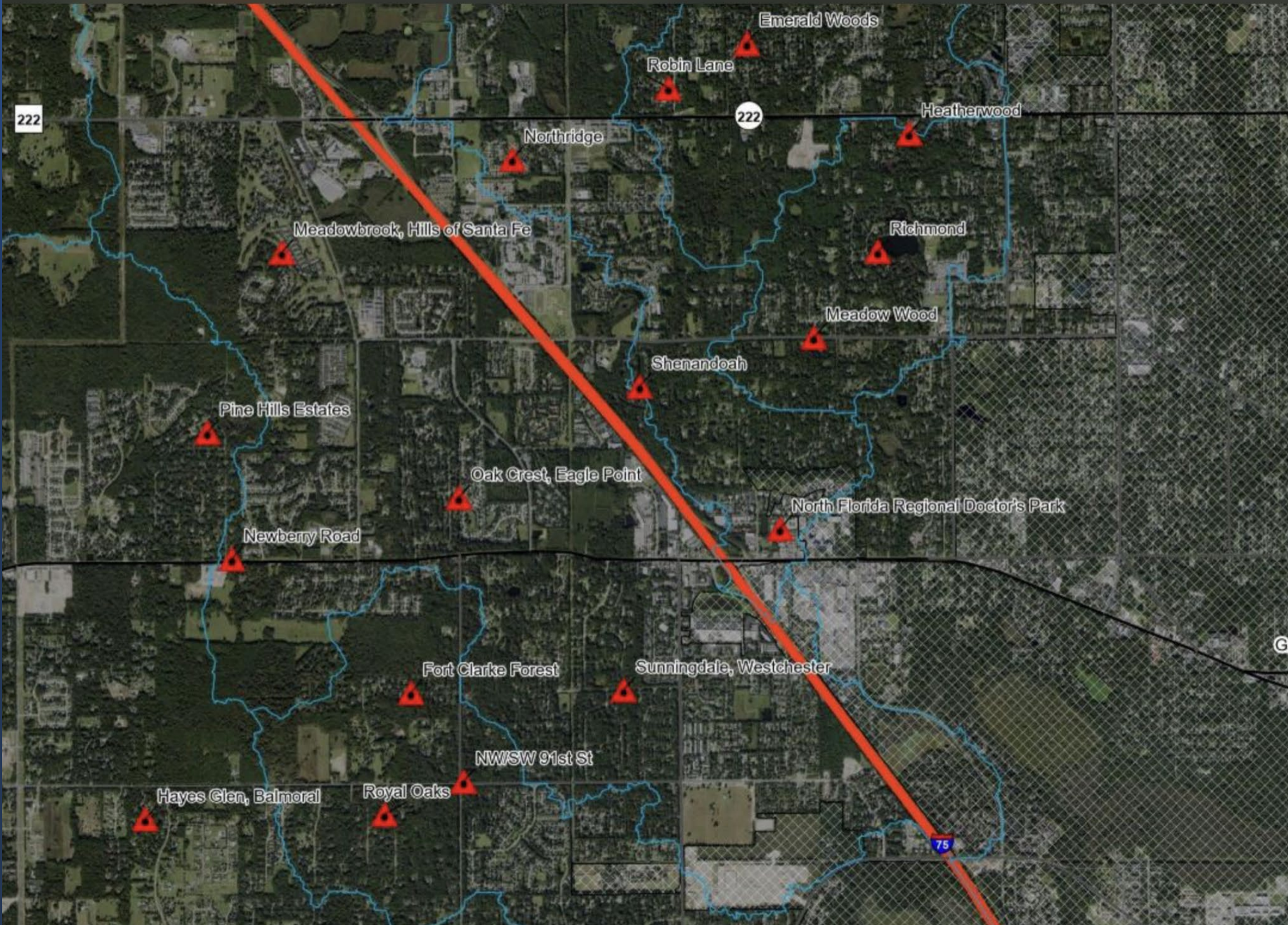
# County High-Priority Flood Problem Areas (Inwood, 2010)

For Informational Purposes Only 0:10:15610-AlachuaCounty\157\_Climat\VA\MXD\Task\_1\_Map\from\collective\Map\Package\_Pro\_Conversion\SWMP\255MM\2.aprx JBreckson



# HIGH PRIORITY FLOOD AREAS

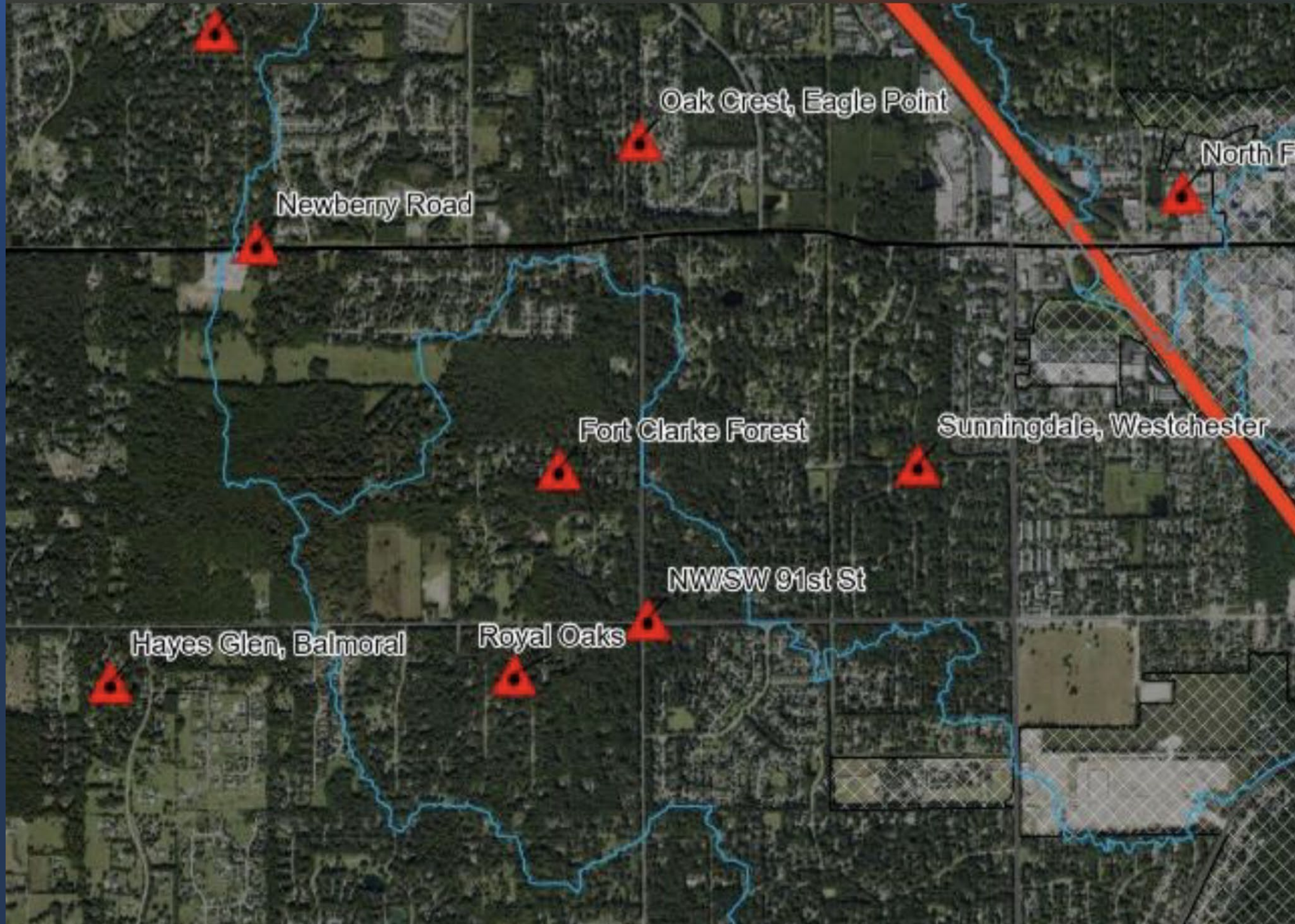




# HIGH PRIORITY FLOOD AREAS

- Flood and Flash Flood Prone Areas

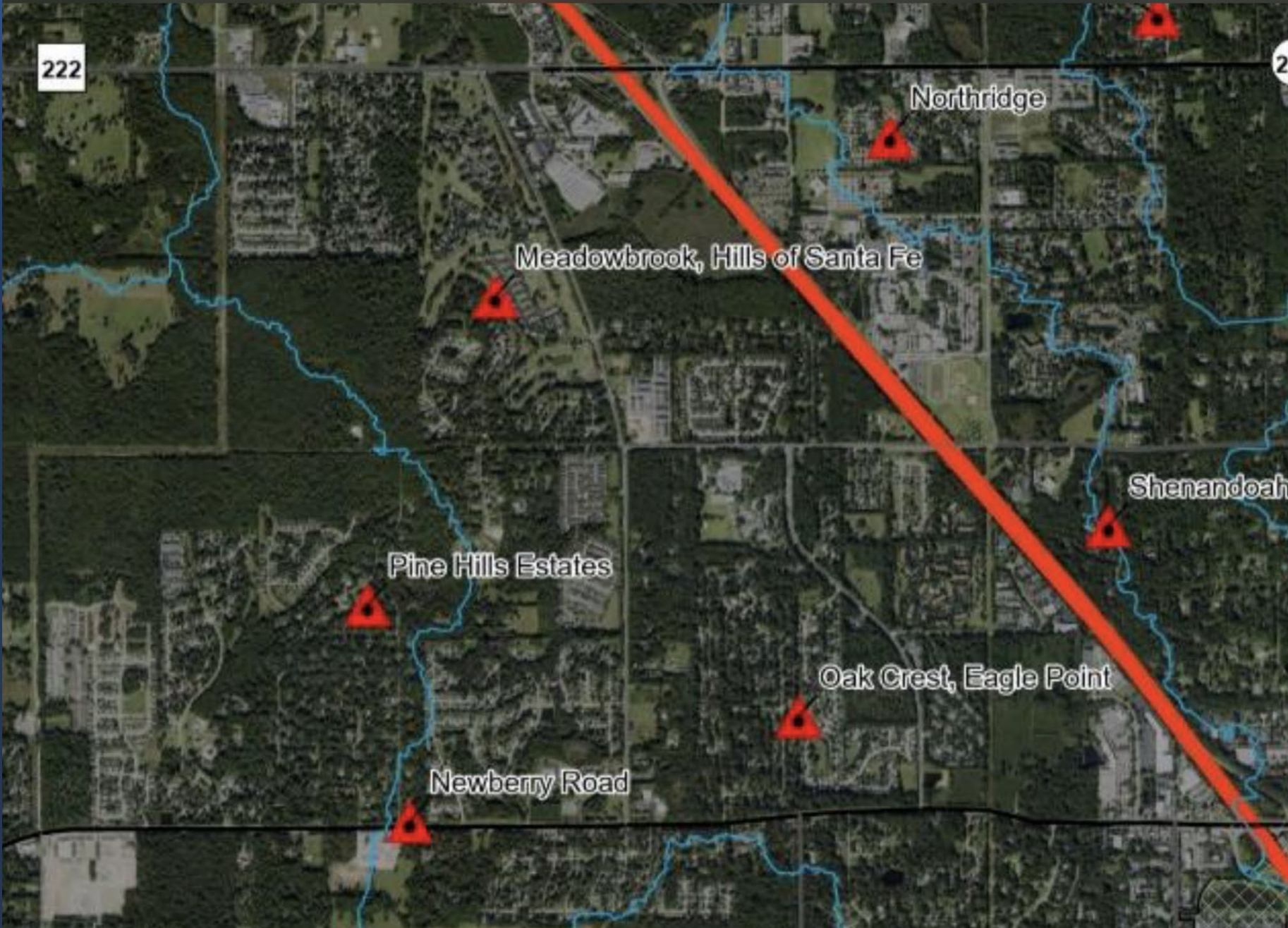




# HIGH PRIORITY FLOOD AREAS

- West of I-75, Newberry Road to the South

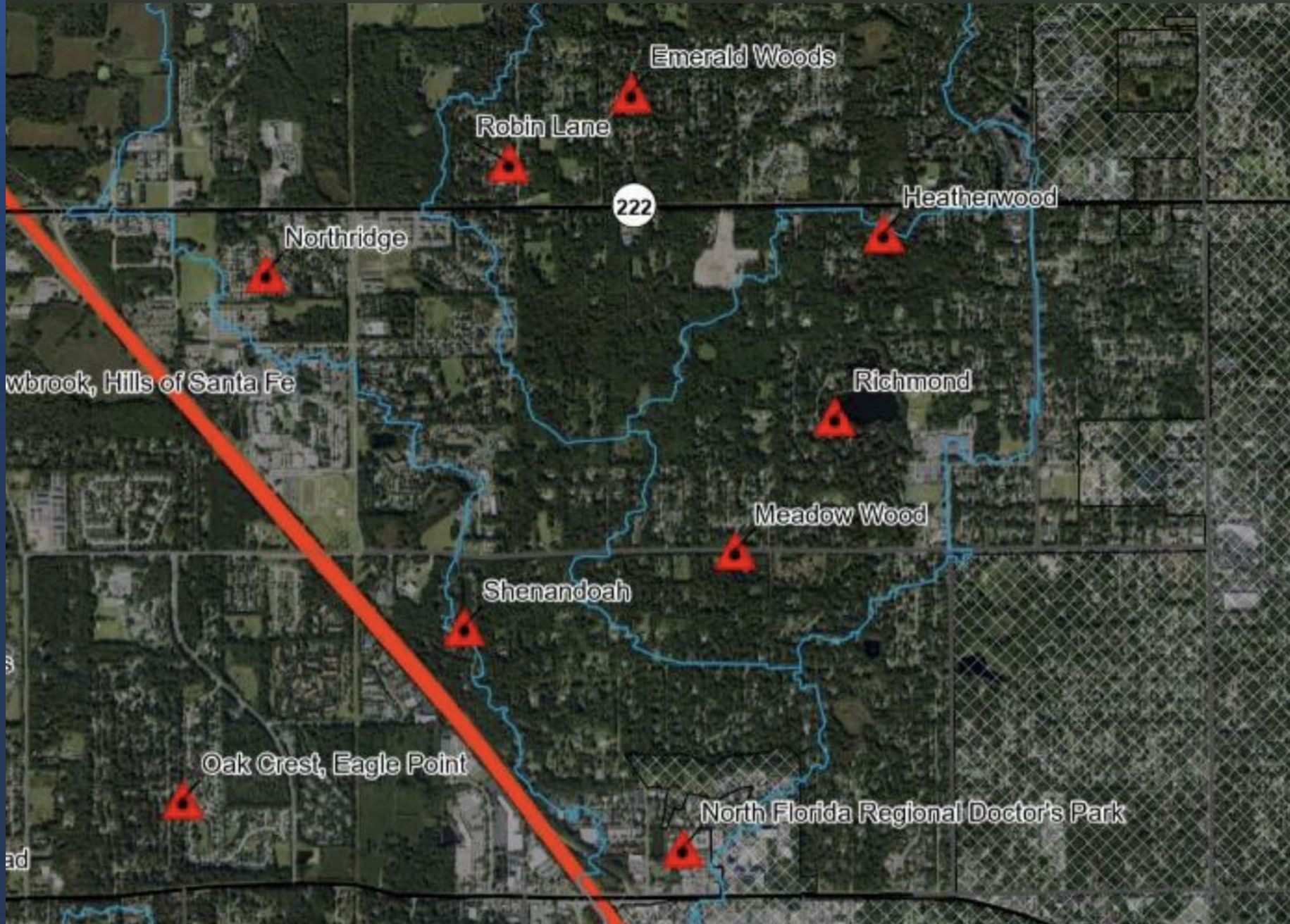




# HIGH PRIORITY FLOOD AREAS

- Newberry Road to Meadowbrook





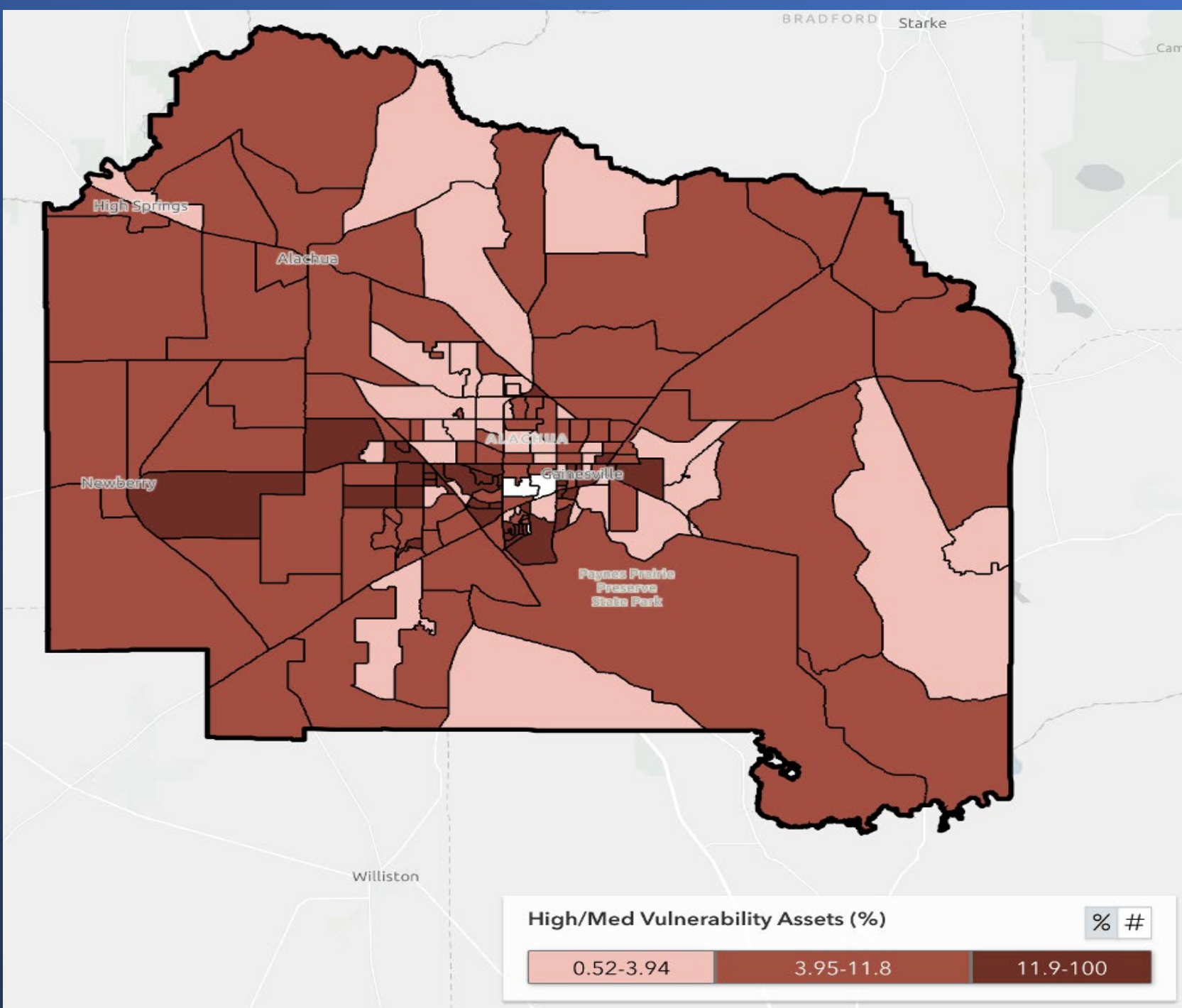
# HIGH PRIORITY FLOOD AREAS

- I-75 Northeast to SR 222 (39<sup>th</sup> Ave)



# MOST VULNERABLE ASSETS

- URBAN AREAS
  - 1) Infrastructure & Emergency Services
  - 2) Residential & Commercial Properties



## Summary of Vulnerability Assessment Results by Asset Category.

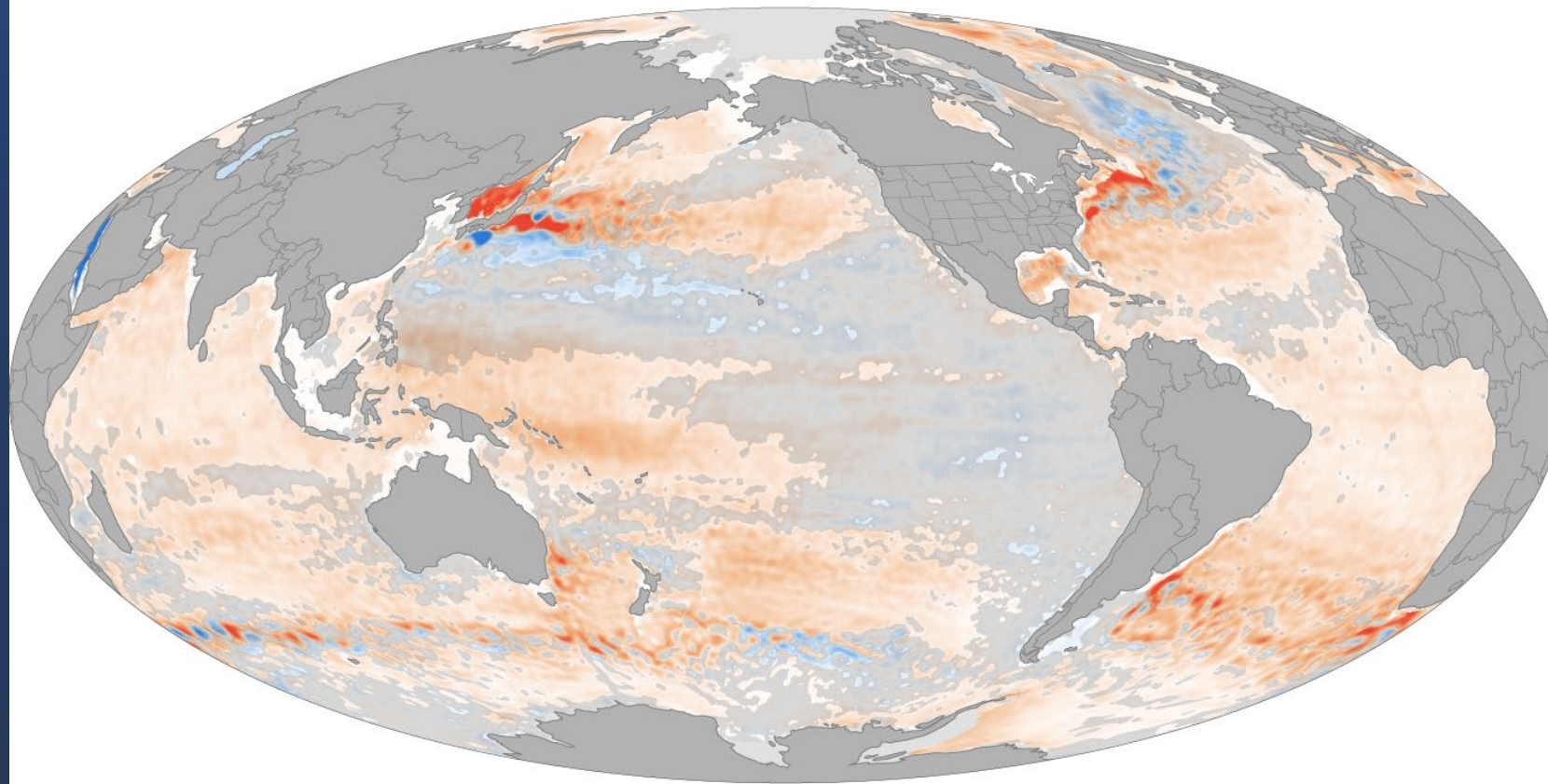
ASSETS CATEGORY	TOTAL ASSETS	100-Year Rainfall -Induced Flooding		
		2020	2040	2070
Critical Infrastructure	735	116 (16%)	134 (18%)	141 (19%)
Critical Community and Emergency Facilities	1,955	383 (20%)	467 (24%)	515 (26%)
Natural, Cultural, and Historical Resources	7,361	543 (7%)	804 (11%)	910 (12%)
Residential	73,765	5,700 (8%)	9,080 (12%)	10,921 (15%)
Commercial	5,059	658 (8%)	881 (10%)	904 (11%)
Services - Other	811	137 (16%)	179 (21%)	205 (24%)
Undeveloped Land (Exposure Only)	14,009	7,161 (51%)	8,434 (60%)	8,939 (64%)

## RAINFALL INUNDATION EVENTS

- Infrastructure, Critical & Emergency (Increase 3-6%)
- Residential and Commercial (Increase 3-7%)



# OCEAN HEAT TRENDS (1993-2022)



1993-2022

Change in ocean heat content ( $\text{W/m}^2$ )

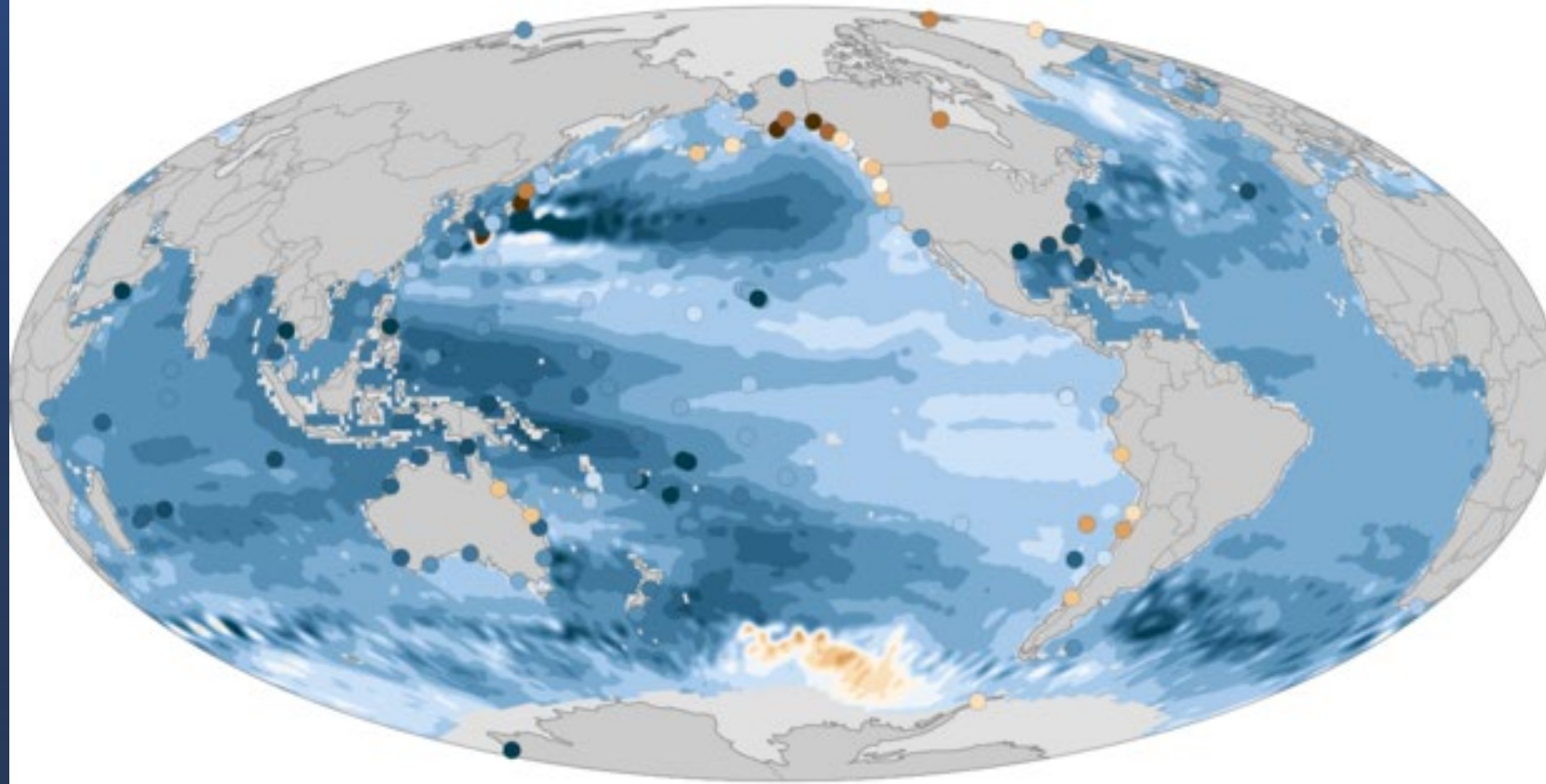


NOAA Climate.gov  
Data: PMEL

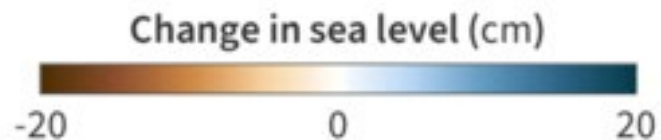
## OCEAN CLIMATE CHANGE

- Warming Water Temperatures  
=
- Expanding Ocean Volume

# SEA LEVEL CHANGE (1993-2022)



1993-2022



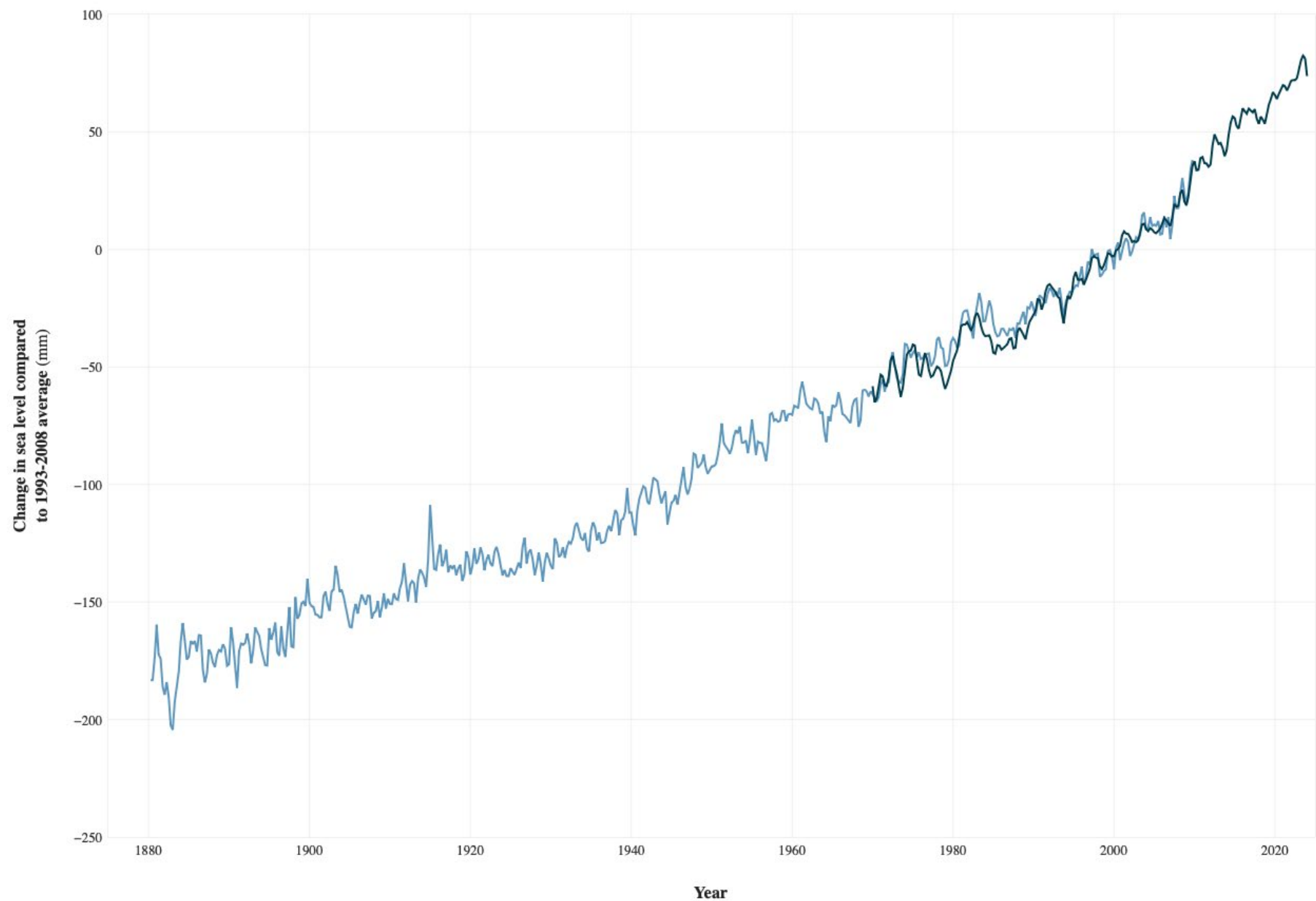
NOAA Climate.gov  
Data: UHSLC

## OCEAN CLIMATE CHANGE

- Expanding Ocean Volume
- =
- Sea Level Rise



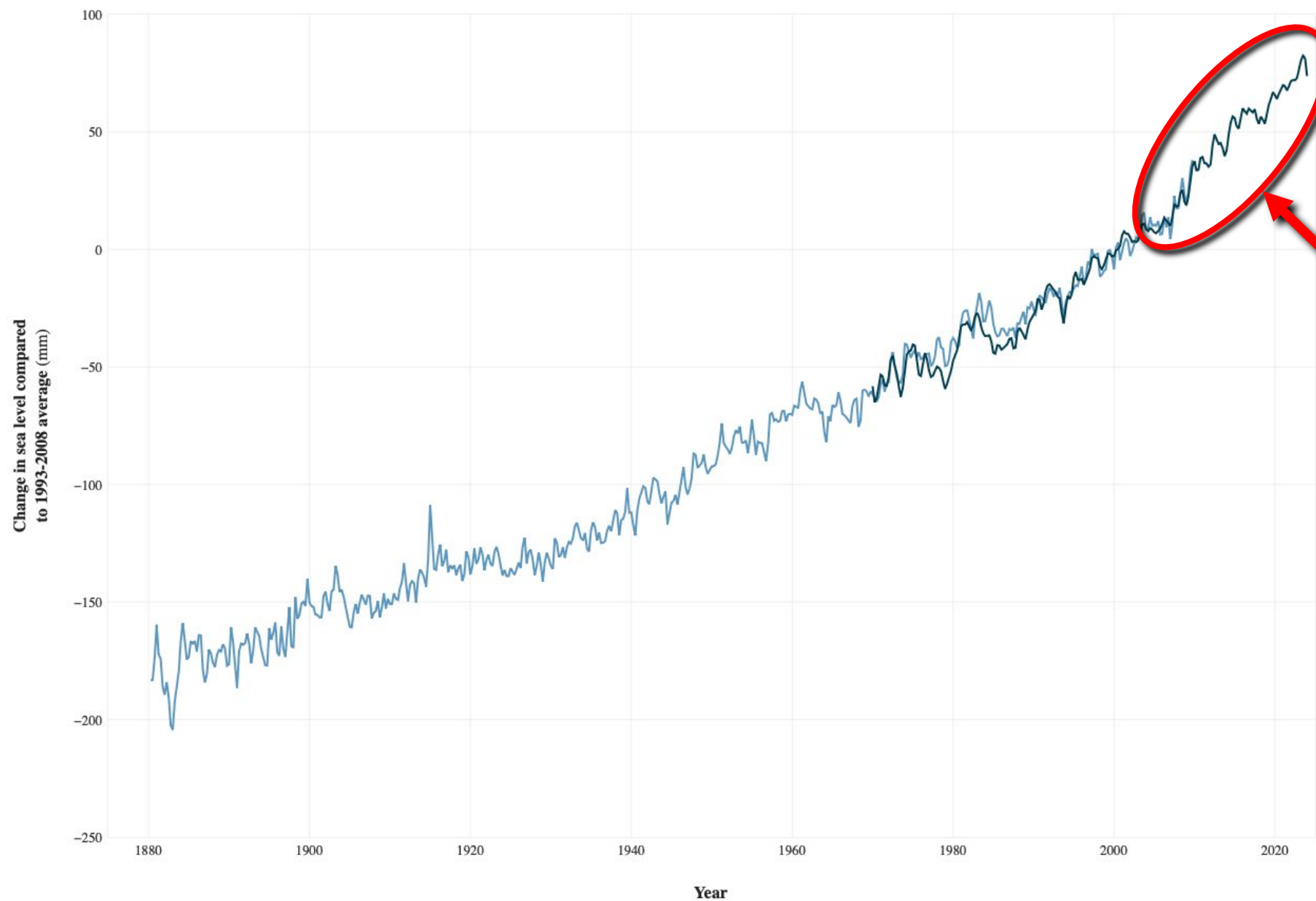
## GLOBAL SEA LEVEL



## OCEAN CLIMATE CHANGE

- Sea Level Rise Rising Quickly

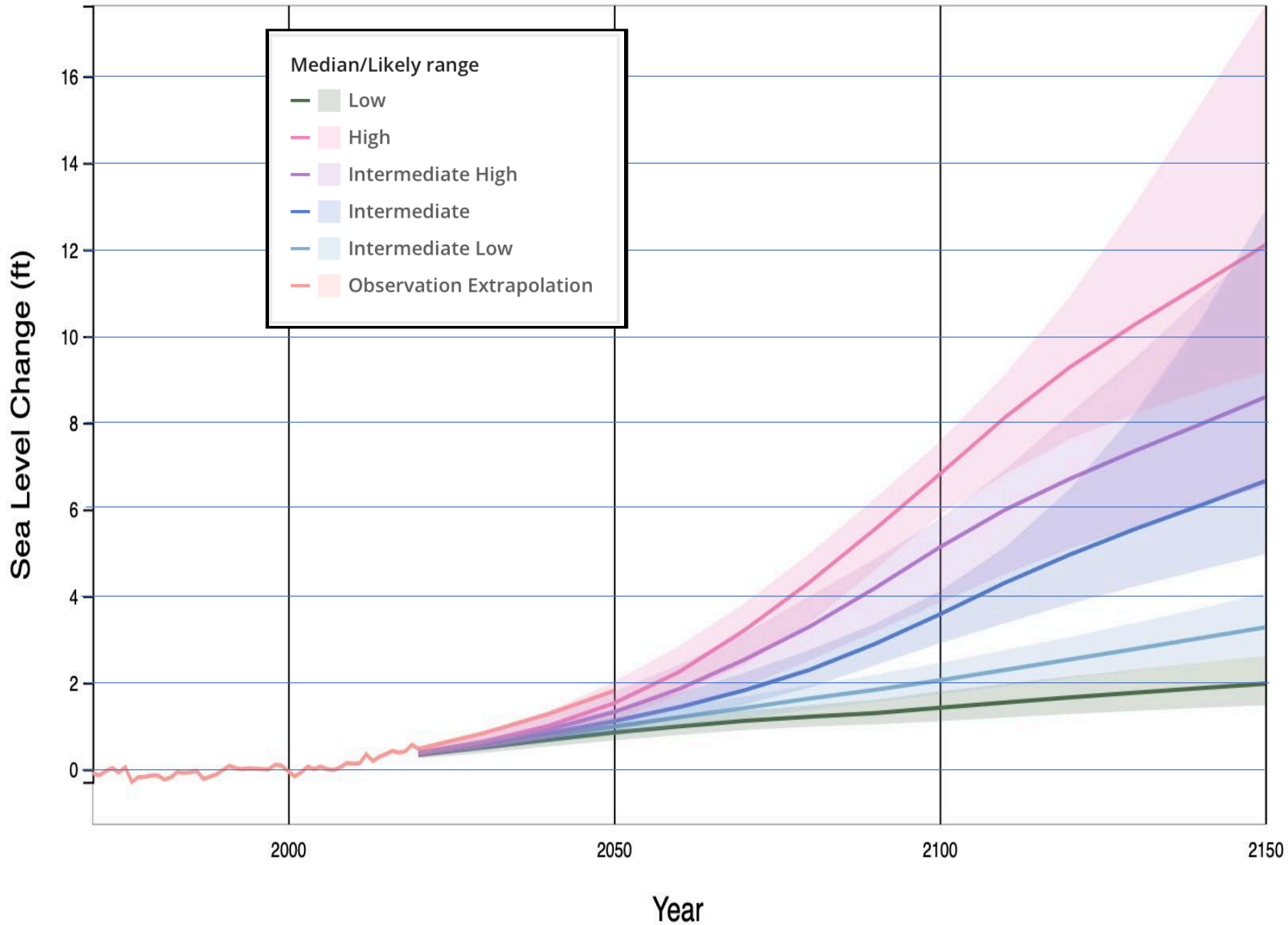
## GLOBAL SEA LEVEL



OCEAN CLIMATE  
CHANGE

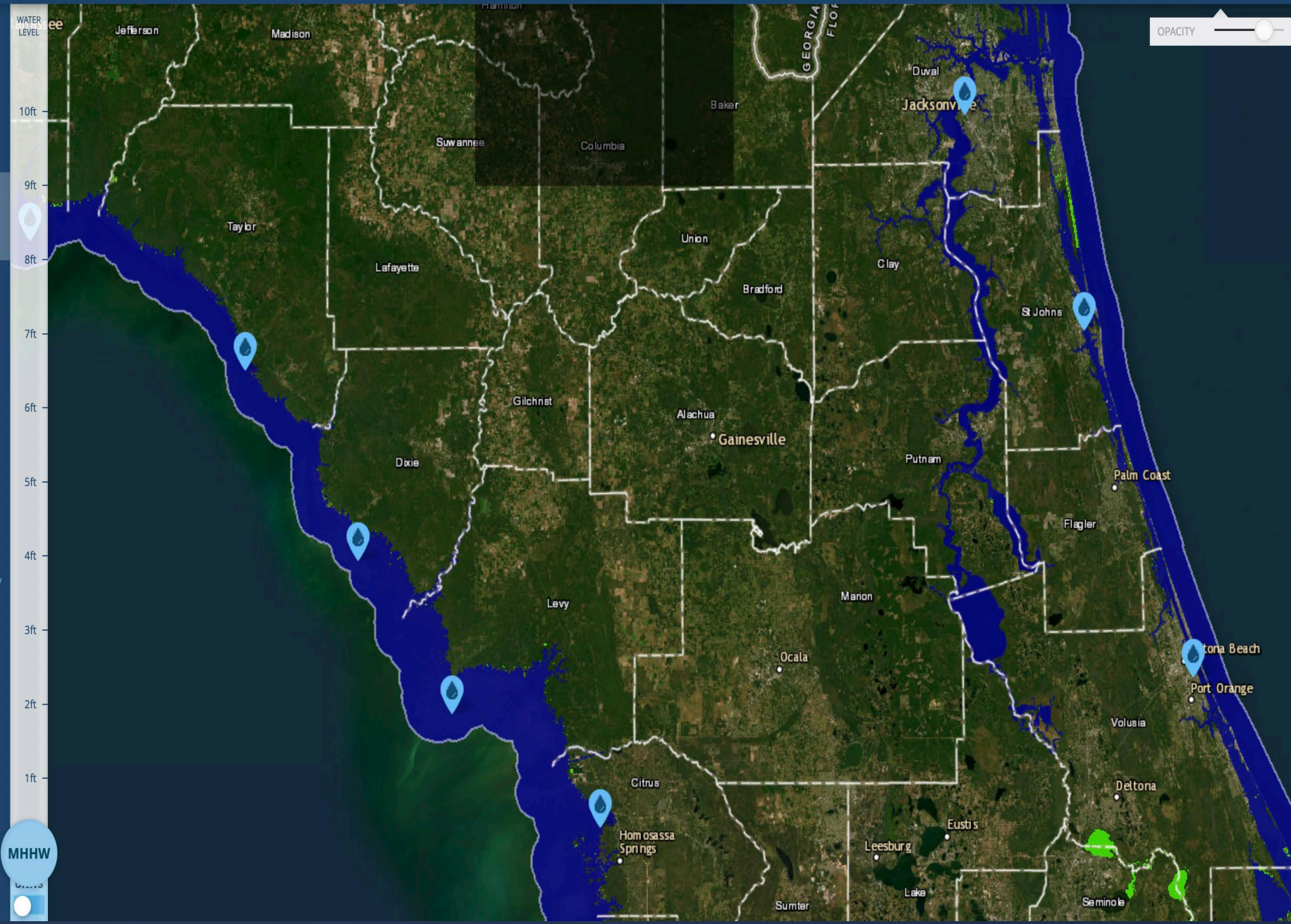
Approximately  
3" Rise in 20 Yrs





# OCEAN CLIMATE CHANGE

- Cedar Key Sea Level Rise Forecast



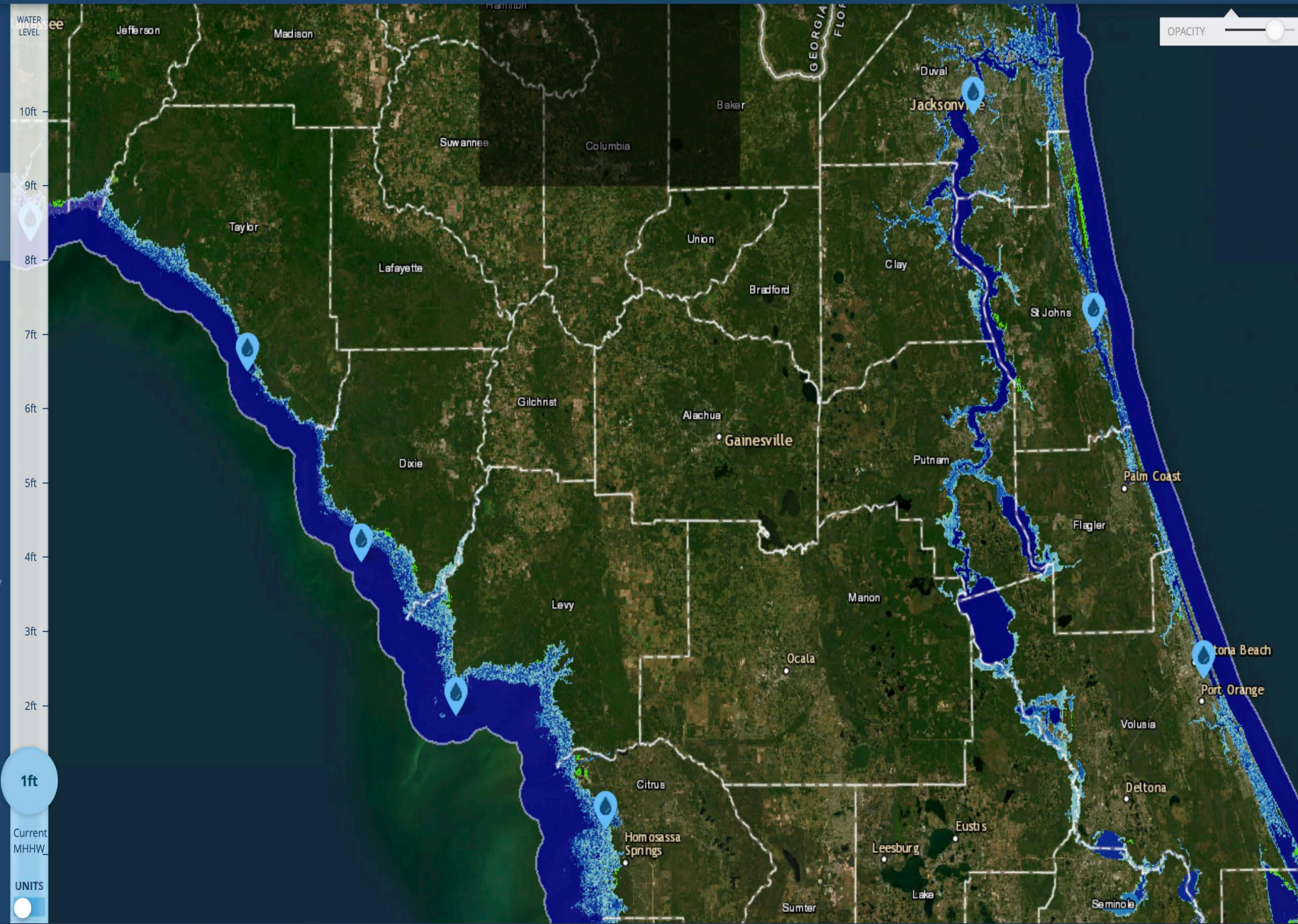
# SEA LEVEL RISE

- PRESENT – Mean Higher High Water (MHHW)





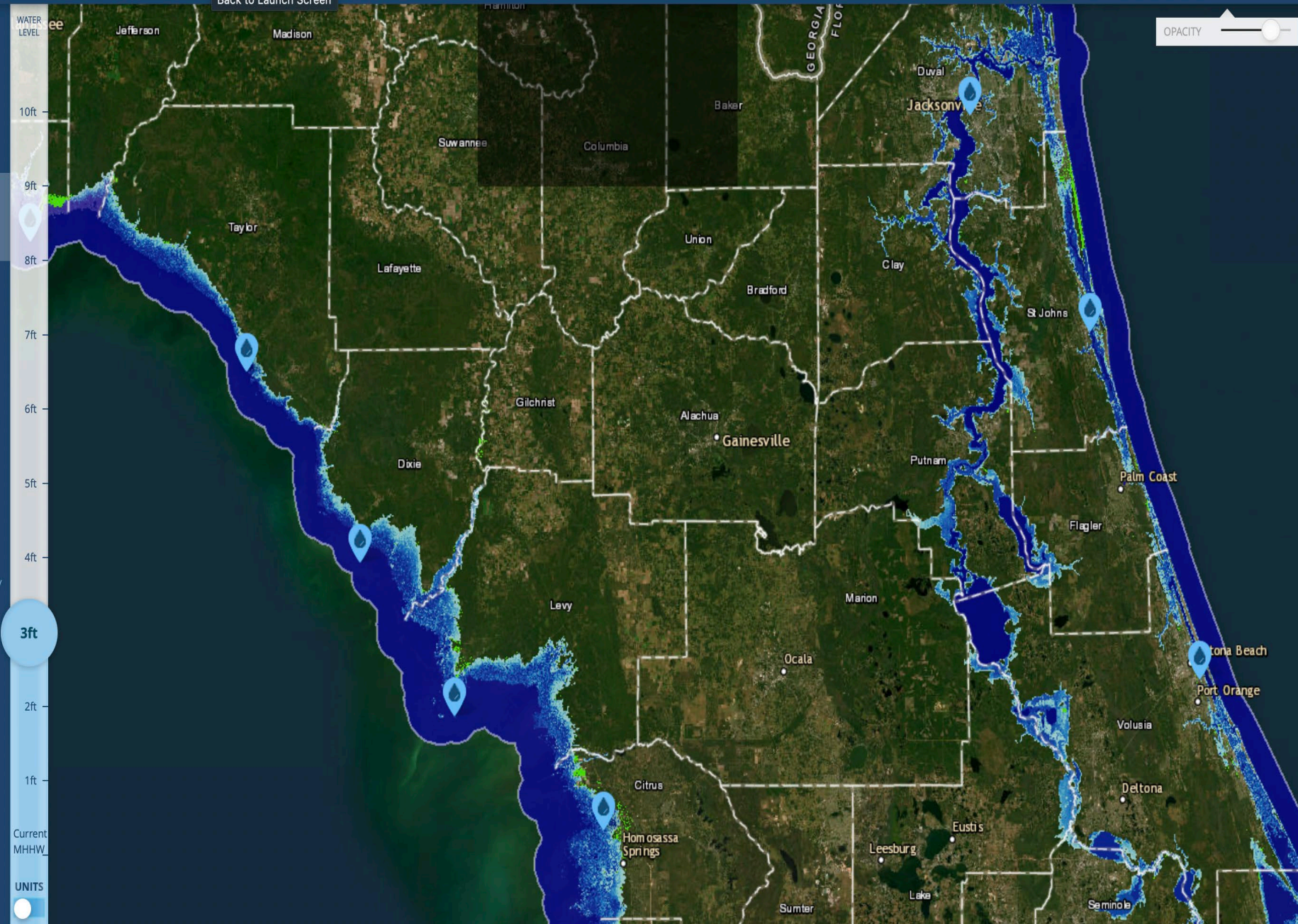
OPACITY



# SEA LEVEL RISE

- 2050: SLR = 1.3 ft





# SEA LEVEL RISE

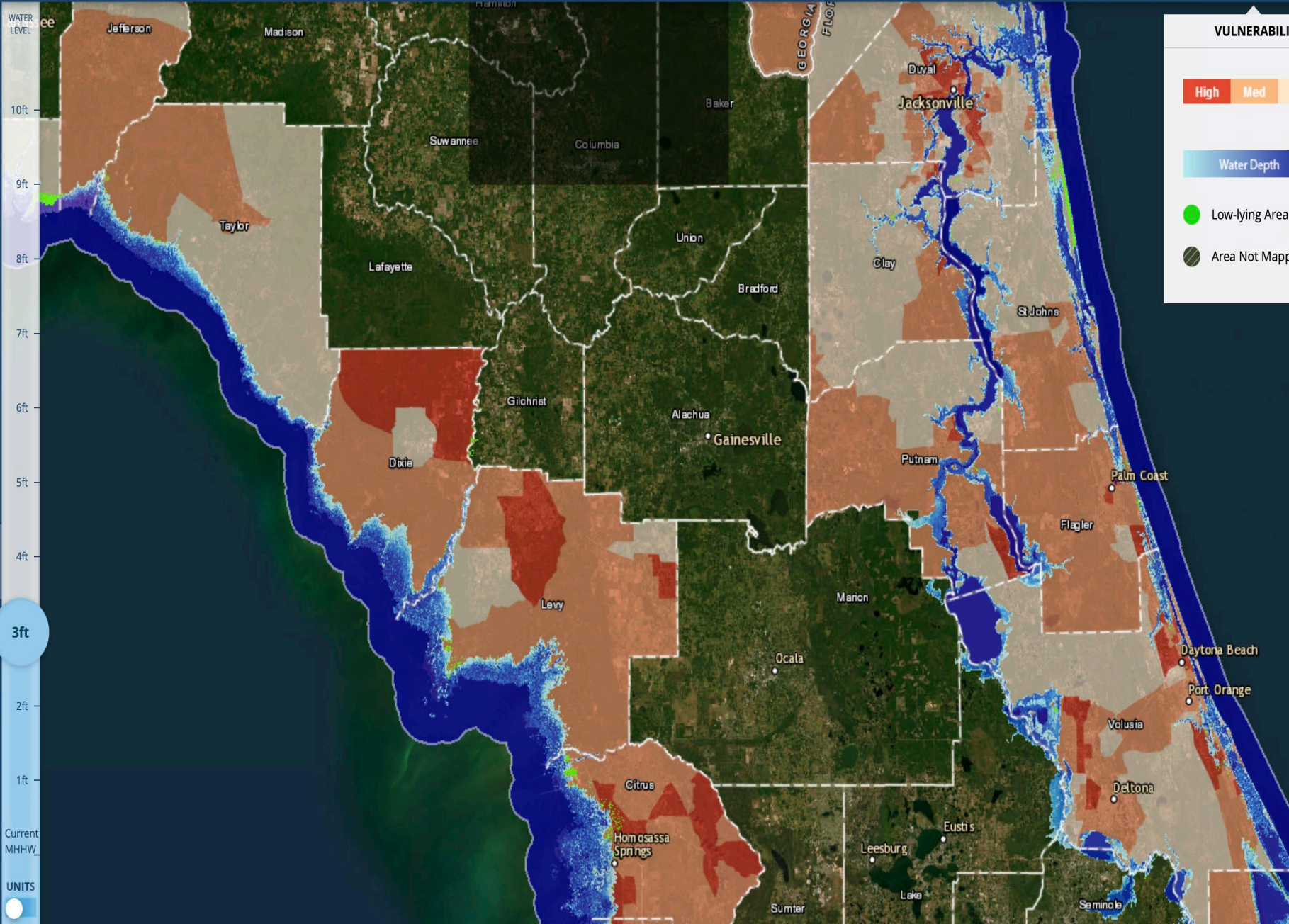
- 2080: SLR = 3.4 ft

3ft

Current MHHW

UNITS





# SEA LEVEL RISE

- 2080: Saltwater Intrusion and Inland Flooding

Low - 

Med - 

High - 





## HIGH PROBABILITY EVENTS:

**EXTREME TEMPERATURES** – Will likely impact all residents across Alachua Co. Creating uncomfortable and potentially dangerous conditions with an increased risk of disease outbreaks and a decrease of food availability

**HIGH INTENSITY RAINFALL** – Flooding and Flash Flooding potential will increase with the rising content of atmospheric moisture due to a warmer atmosphere.

**SEA LEVEL RISE** – Inundation of sea water along the coast could restrict the natural flow patterns of area rivers causing extensive flooding upstream and inland.

## LOWER PROBABILITY EVENTS:

**AVERAGE ANNUAL RAINFALL** – Local rainfall totals are subject to a wide variety of factors creating a higher uncertainty of occurrence.

**TROPICAL SYSTEM FREQUENCY** – Further uncertainty exists in an evolving tropical weather component due to Climate Change.

## SUMMARY

- CLIMATE CHANGE IS HAPPENING
- Weather Patterns Are Shifting
- NOW Is The Time for Action