Orlando's Investment in Stormwater Data Pays Dividends in Mapping Flood Risk across the City

FSA 2025 Annual Conference

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Max Wallace, PE, CFM (Drummond Carpenter)

Brett Cunningham, PE, ENV SP (Jones Edmunds)

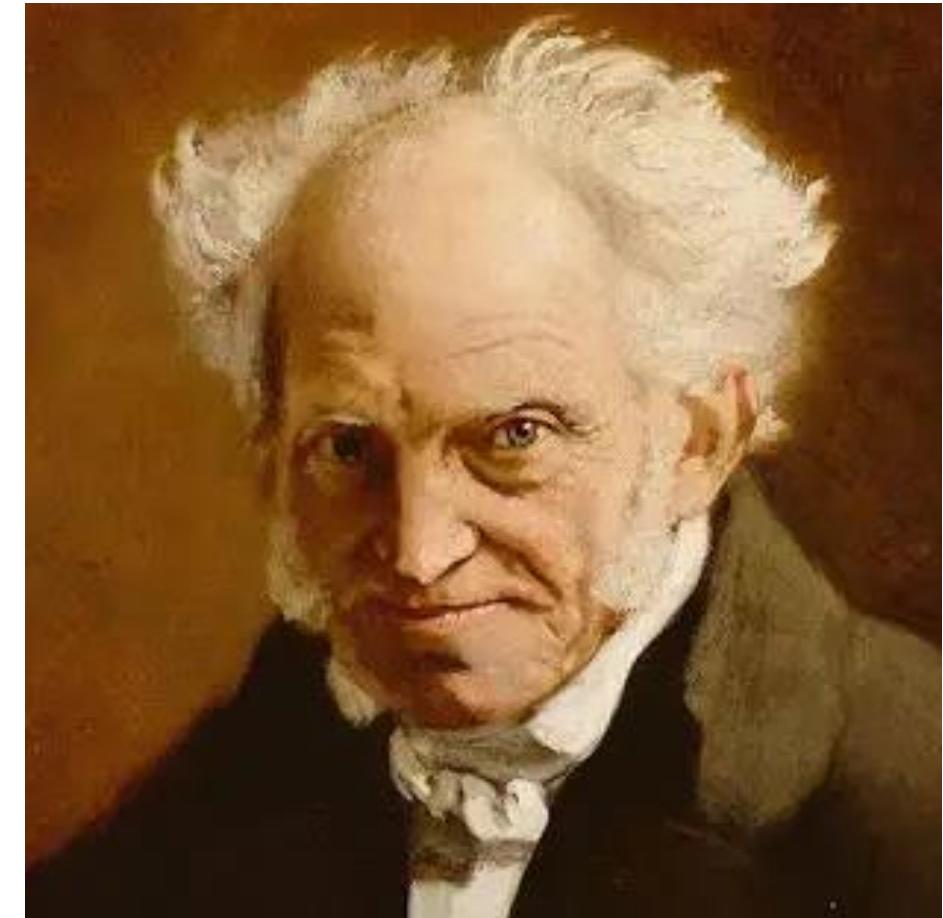www.DrummondCarpenter.com

1

Introduction

- **Takeaways**
  - Advocating for change
  - Demonstrating that the change is worthy

- **Three stages of change**
  - Ridicule
  - Recognition
  - Acceptance

Source: Medium.com

Evolution of Watershed Planning

- ## Key Feasibility Factors
  - Availability and quality of data
  - Computing power

Source: USGS

Source: FDEM

Evolution of Watershed Planning

- **Key Feasibility Factors**
  - Availability and quality of data
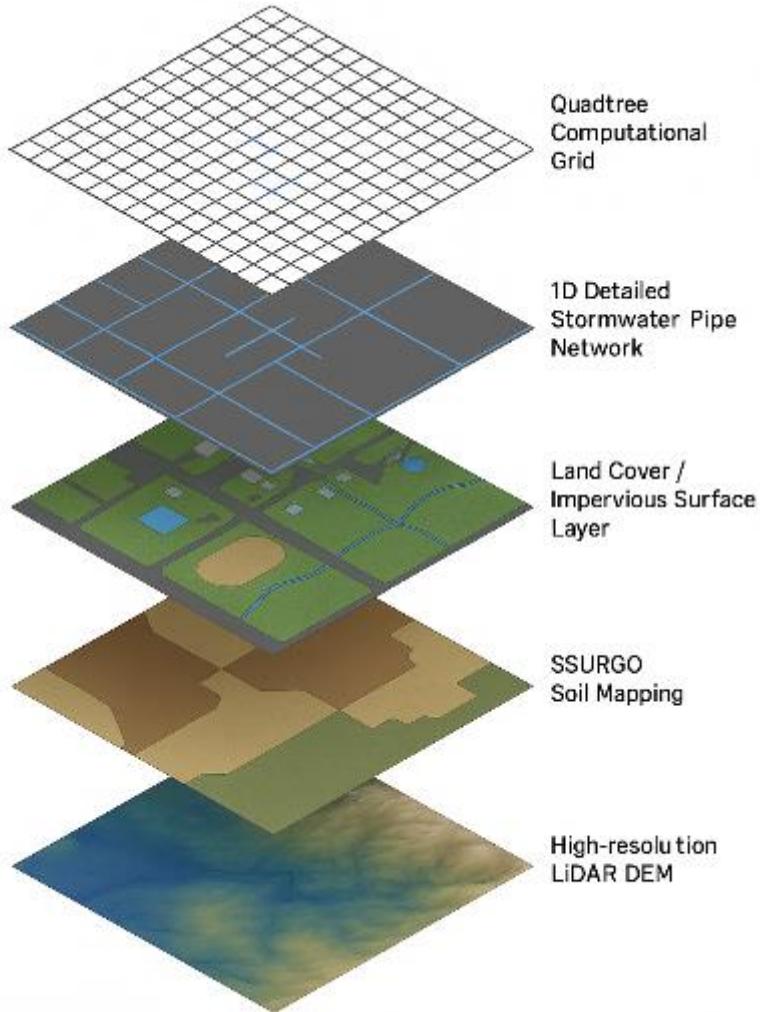 - Computing power

Source: Medium.com

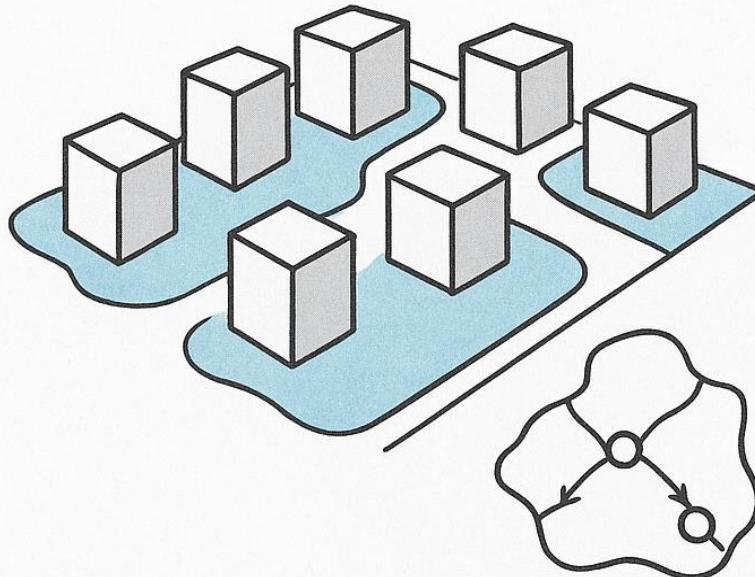*Source: AIBrilliance.com*

Source: Medium.com

Model Data for Self-Build

✓ **DEM**
  - o 2018 LiDAR (2.5-feet)

✓ **Soils**
  - o SSURGO Soils (Green-Ampt)

✓ **Land Cover**
  - o WMD
  - o NOAA C-Cap Imperviousness
  - o MS & Google Building Footprints
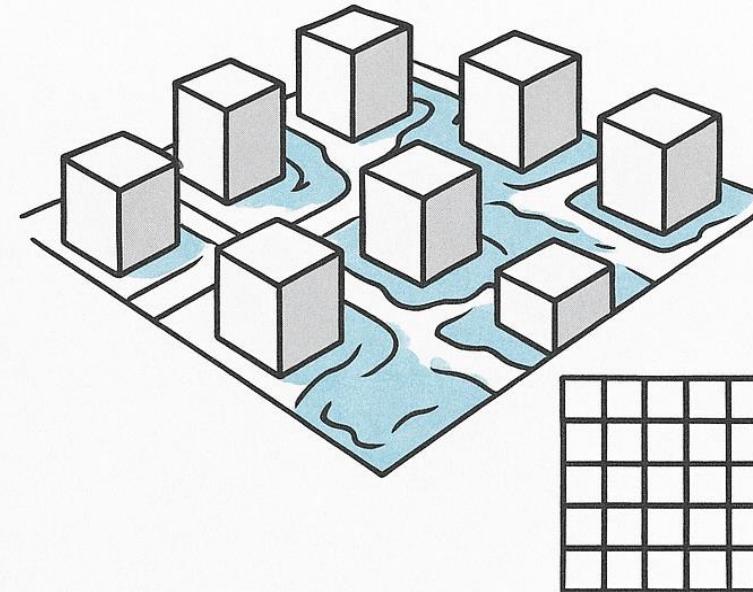
✓ **Pipe network**
  - o City & County Stormwater GIS

Quadtree
Computational
Grid

1D Detailed
Stormwater Pipe
Network

Land Cover /
Impervious Surface
Layer

SSURGO
Soil Mapping

High-resolution
LiDAR DEM

TUFLOW as an Example

SIMPLIFIED INUNDATION MAPPING

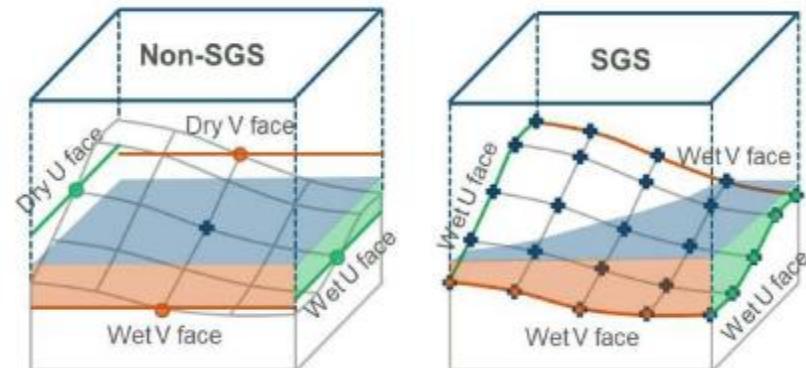DETAILED LOCAL INUNDATION MAPPING

TRADITIONAL 1D LUMPED MODEL

MODERN HIGH-RESOLUTION 2D MODEL

Source: vvw.com.hk

TUFLOW Attributes

✓Full SWE (momentum & turbulence)

✓Automated grid generation

✓Sub grid sampling

✓Seamless 1D integration

✓GPU accelerated

✓Automated high-resolution mapping

✓Non- Proprietary Inputs & Outputs

Processes Eliminated

x Subbasin delineation

x Time of concentration (or similar)

x Imperviousness/curve number calculation

x Full model schematic

x Stage-area extraction

x GIS-model exchange

x Floodplain delineation

Bonus: No errors introduced in eliminated processes and QC not required for them

2D Pros and Cons

- Modeling Approach of the future?
  - Pros
    - Fast setup
    - High resolution
    - Accurate
    - Quick updates
  - Cons
    - Not widely used
    - Growing regulatory acceptance

- Still a place for traditional lumped models
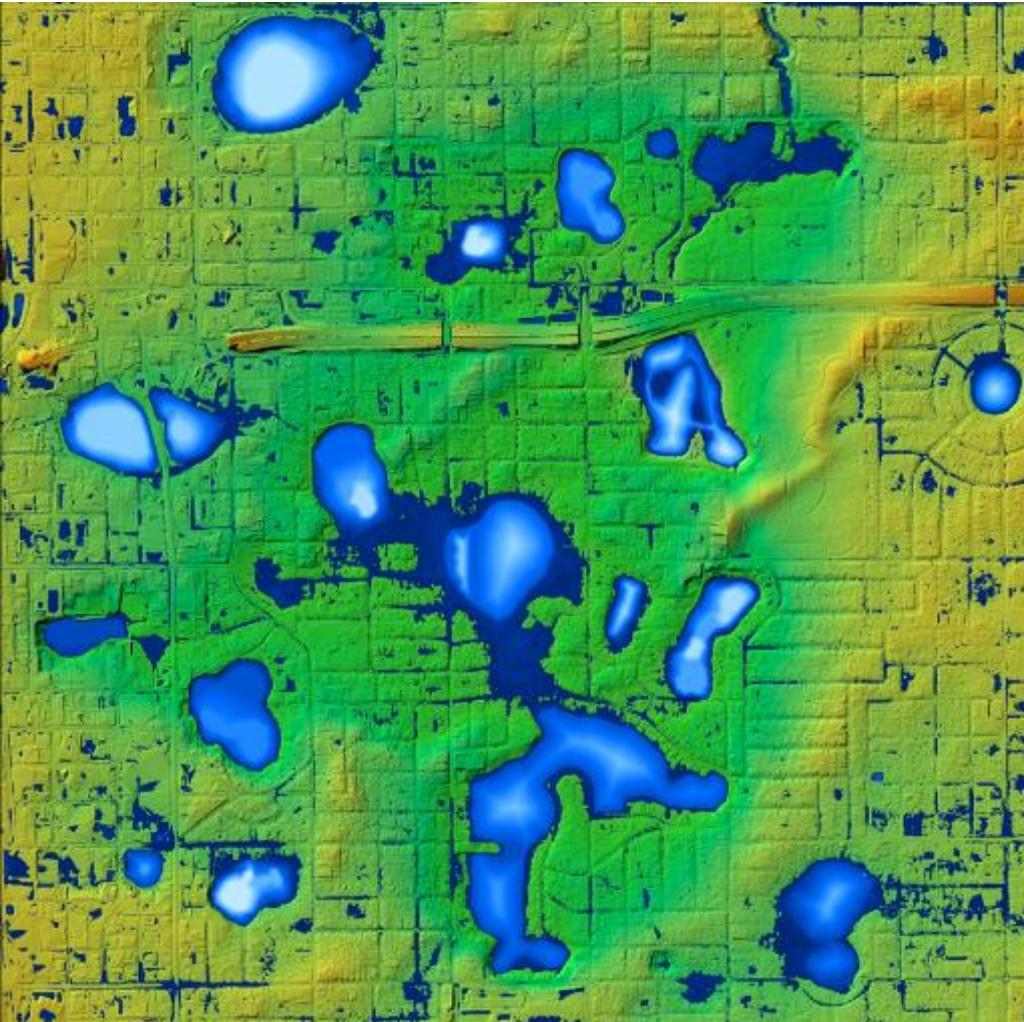
A Need for Rapid City-wide Model

- Resilient Florida Planning Grant (23PLN24)

- **$275k** approx. total project cost

- **1.5 year** estimated project duration
  - ~13 month of technical work

- City-wide flood depth estimates required

- Accurate representation of flood risk desired

Source: Patch.com
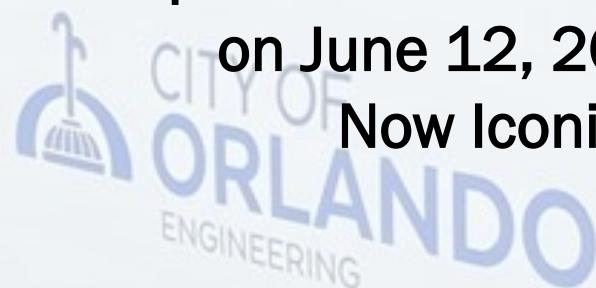
City Stormwater Infrastructure Survey

- Originally led by Jim Hunt and Rick Howard
- Initiated in 2009
- $11.5M investment

Top movies at the box office on June 12, 2009...
Now Iconic

City Stormwater Infrastructure Survey

- Collected in GIS framework
- View on [Public Utilities Data Portal](#)
- "This has paid for itself many times" – Orlando Staff

Component	Count / Length
Structures	61,499
Culverts	57,241 / 1,081 mi
Open channels	3,516 / 297 mi
Ponds	1,853
Pump Stations	22

Model Data

DRUMMOND CARPENTER
JonesEdmunds
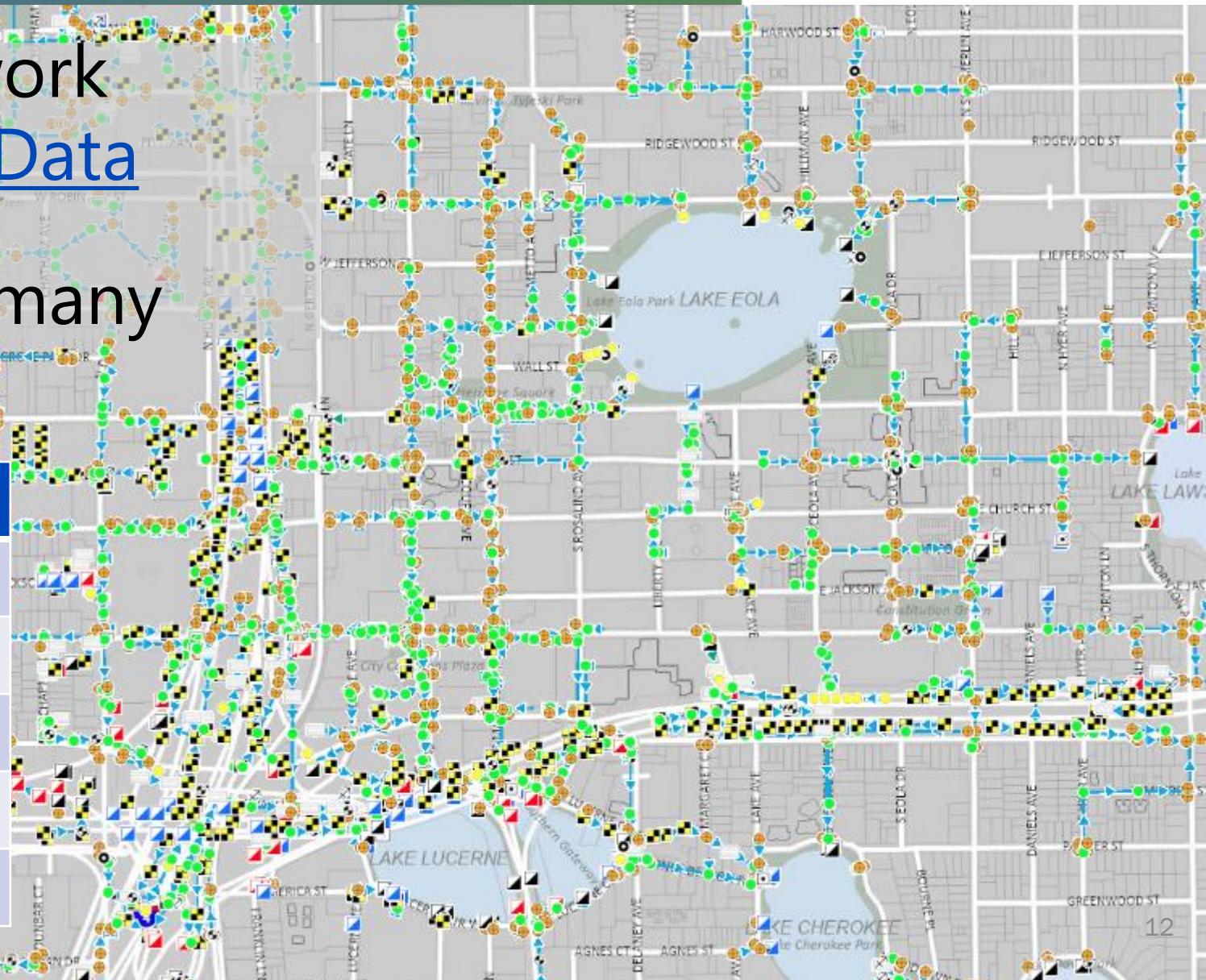
NOAA C-CAP Imperviousness

- 1-m resolution impervious mapping

- Available Statewide

- 2021 NAIP Imagery

- ~97% accuracy

MS/Google 2023 Building Footprints
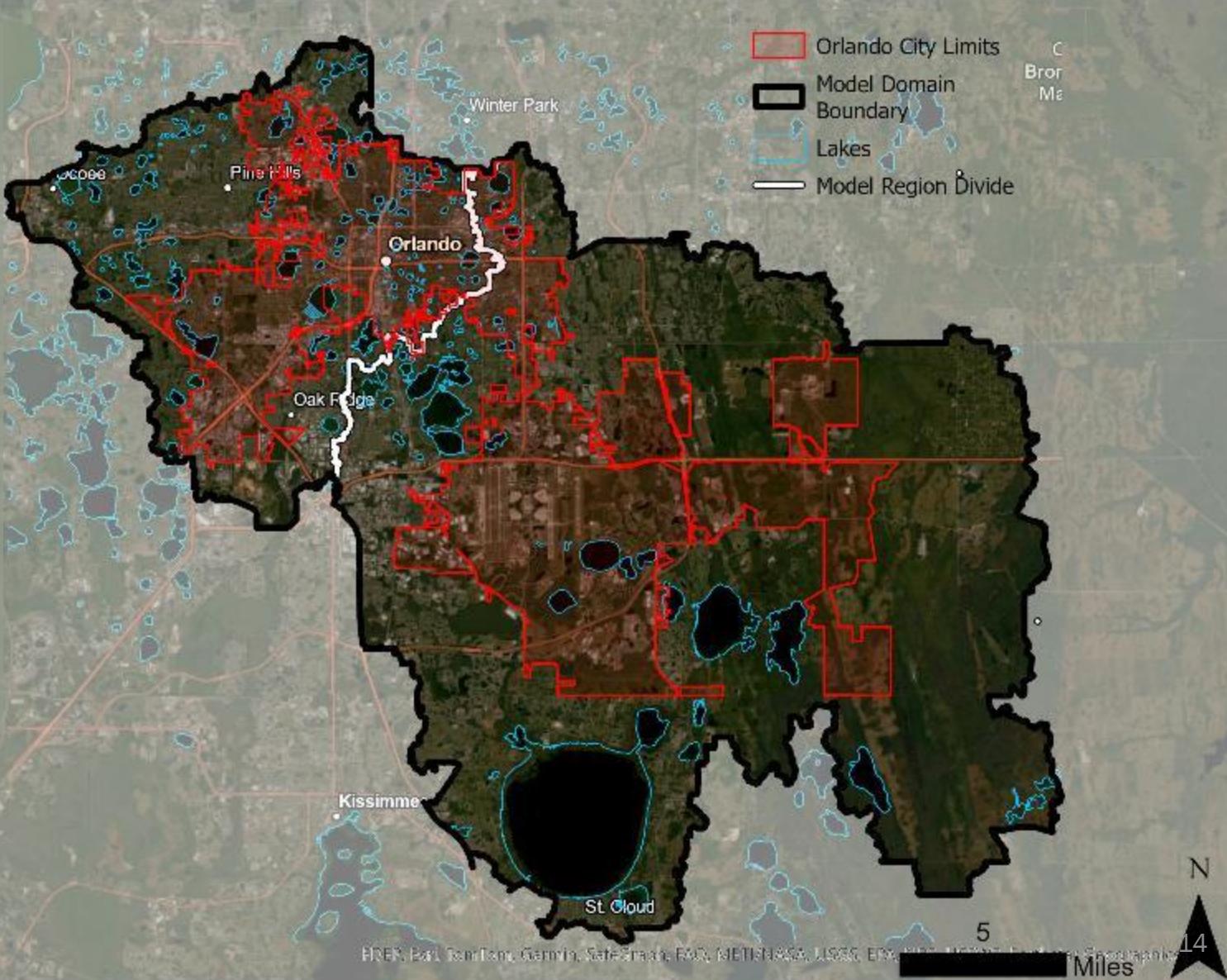
NOAA 2022 Waterbodies

NOAA 2021 Impervious

NOAA

300 Feet

N

13

Model Domain

- ~450 sq. mi.
- ~7.1M computational cells
- City - 30ft / County - 60ft
- Over 100,000 1-D Features
- 20-40 hour runtime per sim per region
- Cost: $2.1-6.8M → $169k
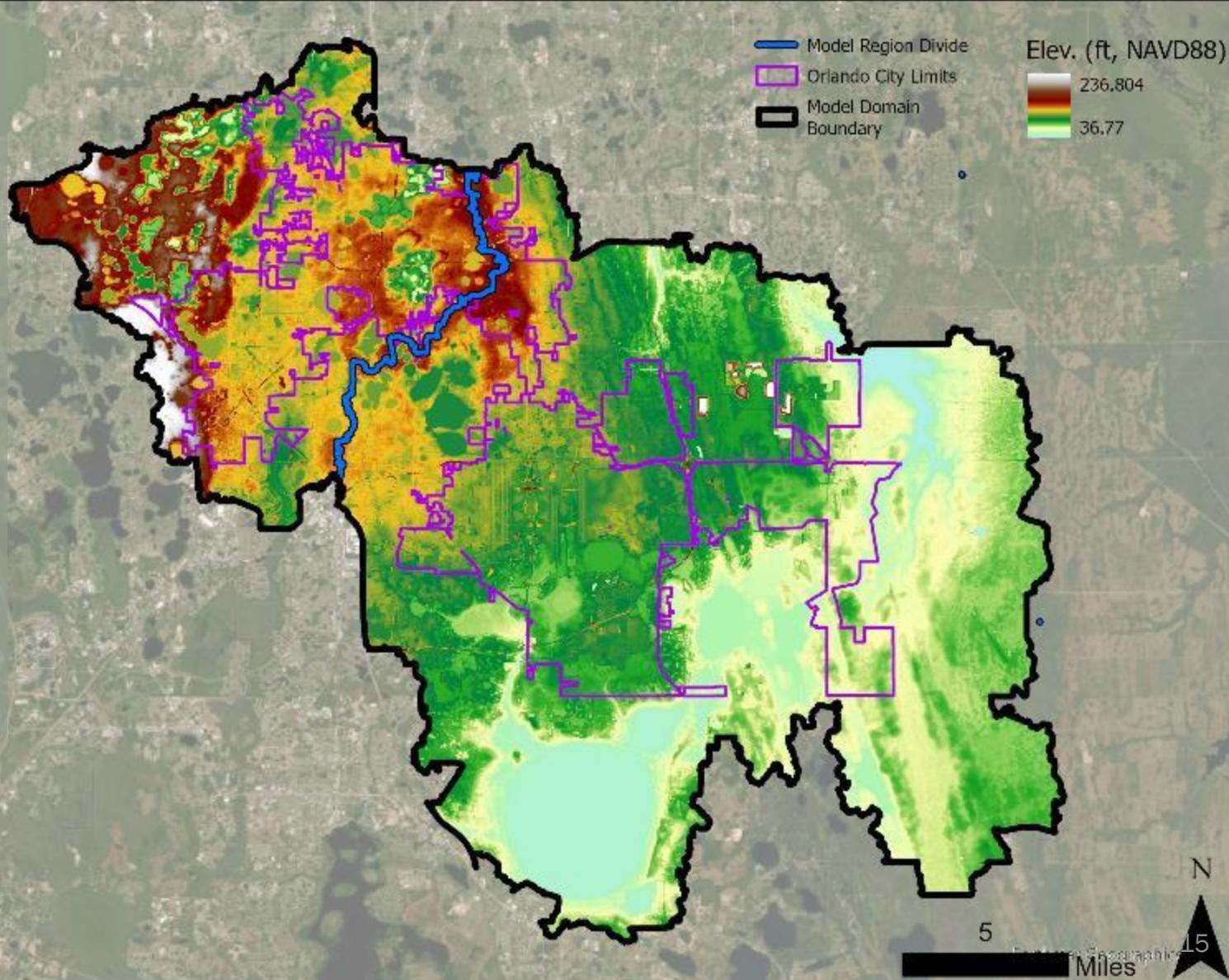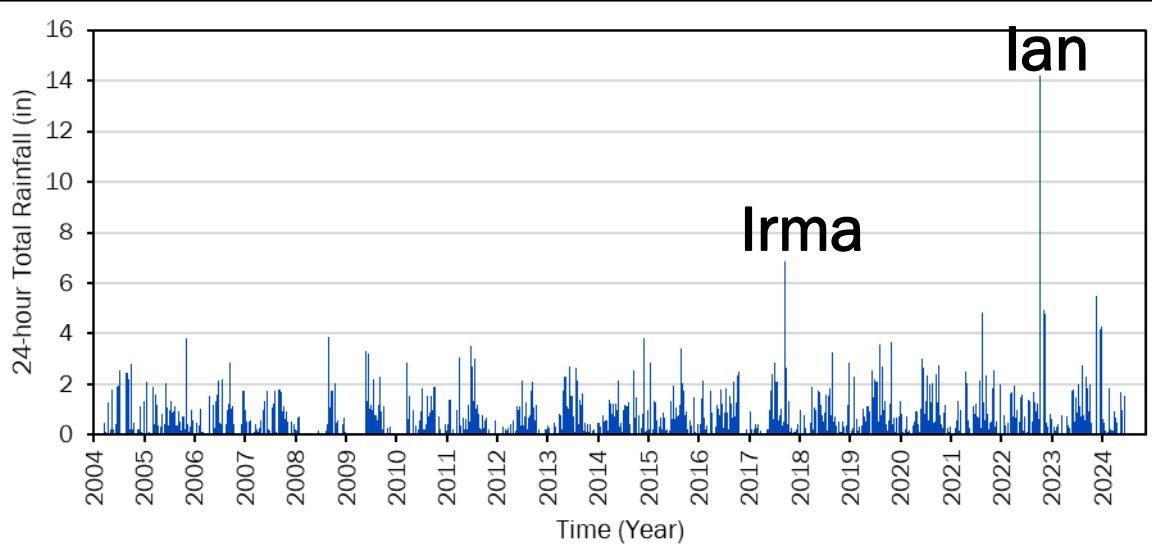
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Legend (map):
- Model Region Divide
- Orlando City Limits
- Model Domain Boundary
- Elev. (ft, NAVD88) 236.804 / 36.77

Calibration – Event Selection

Calibration - Example

Lake Lucerne (Hurricane Ian)
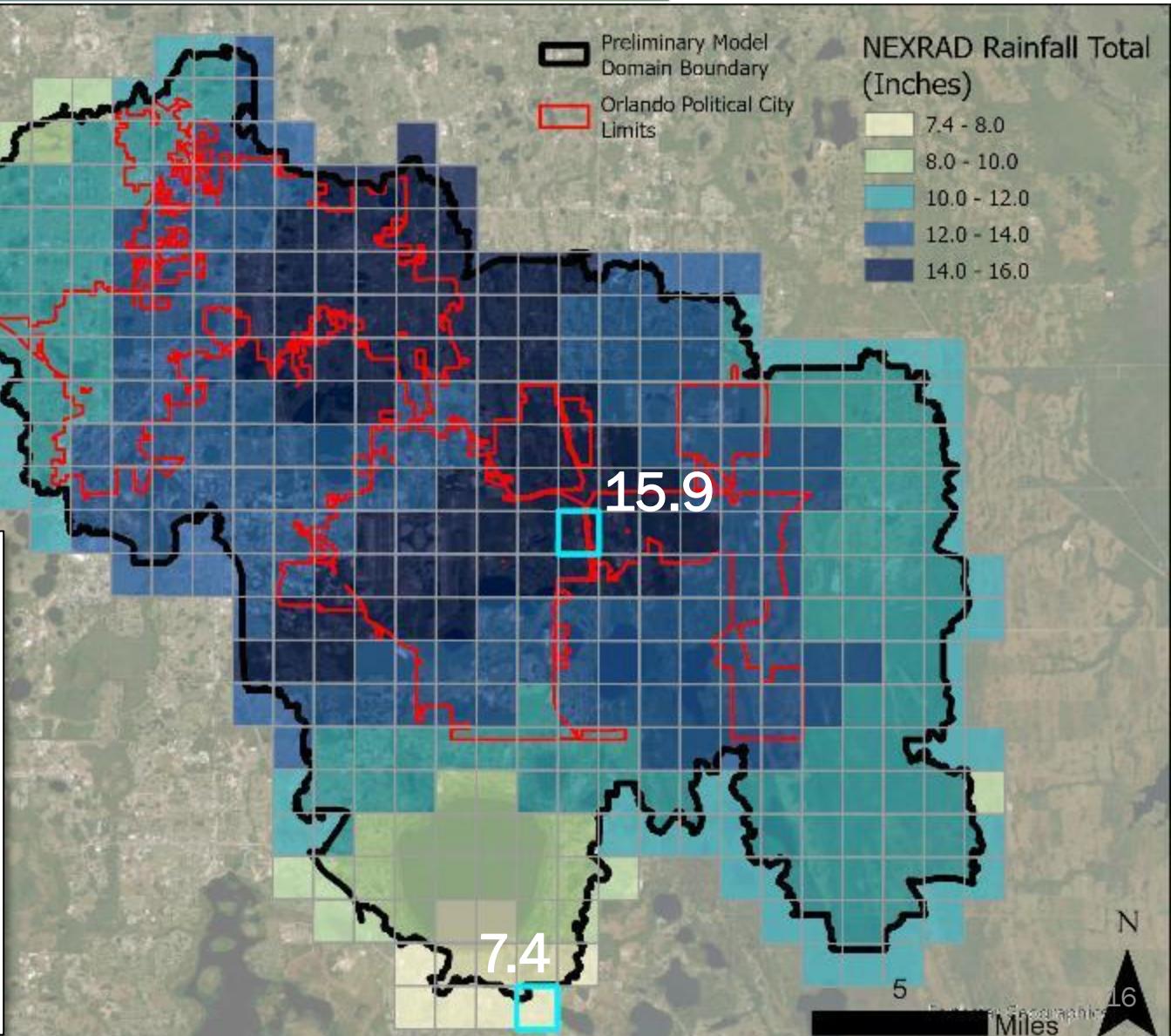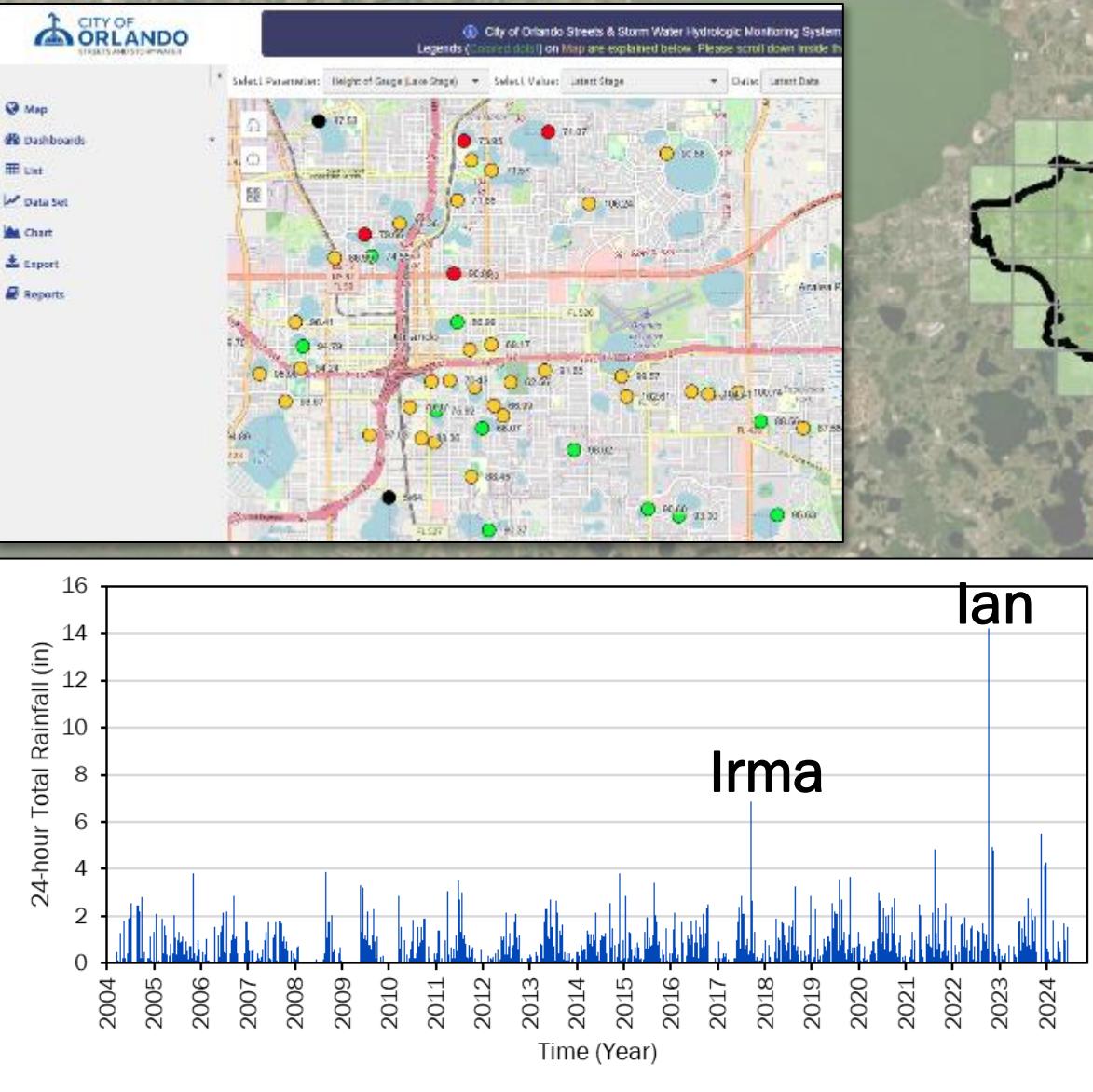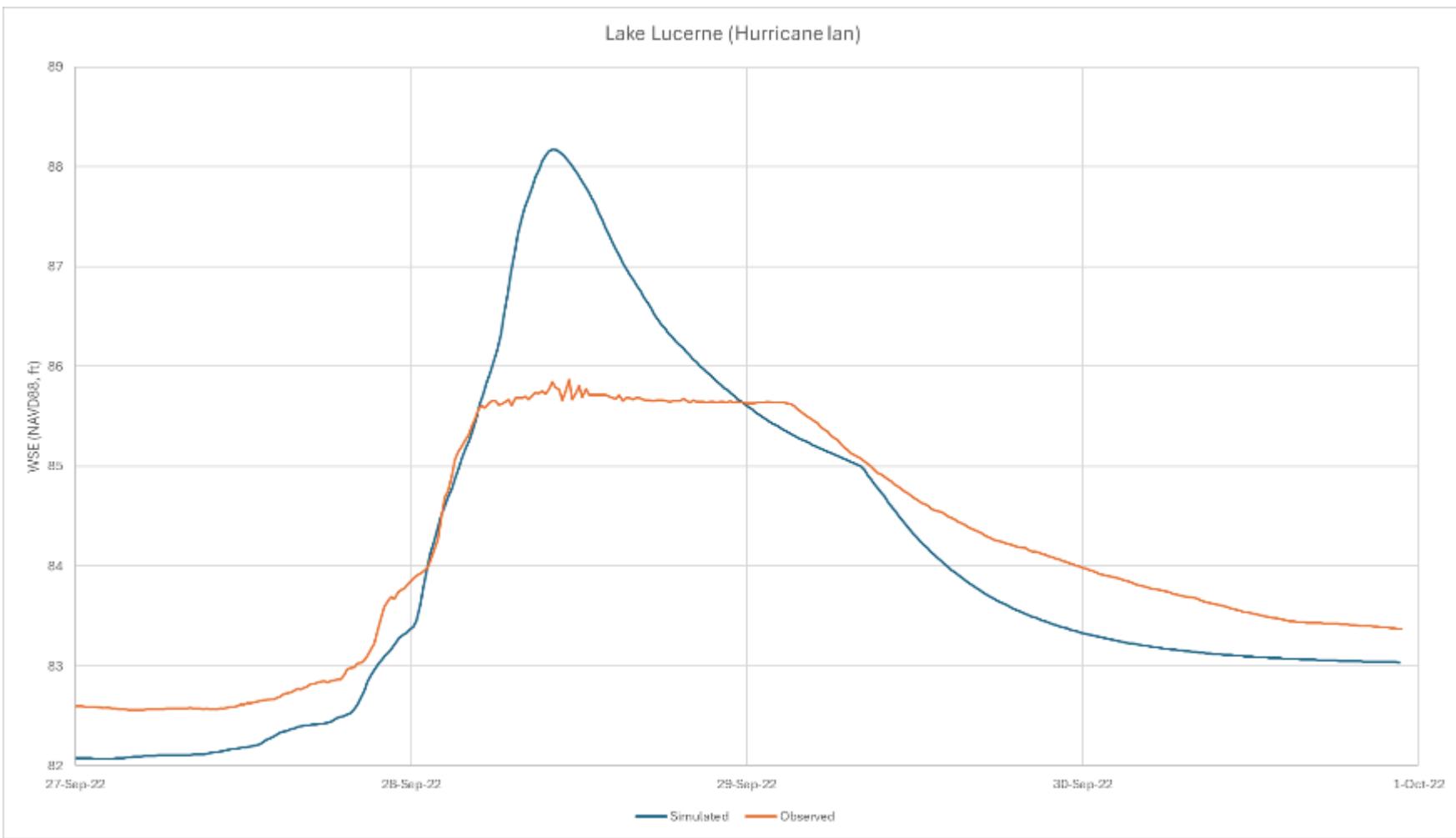
Calibration - Summary
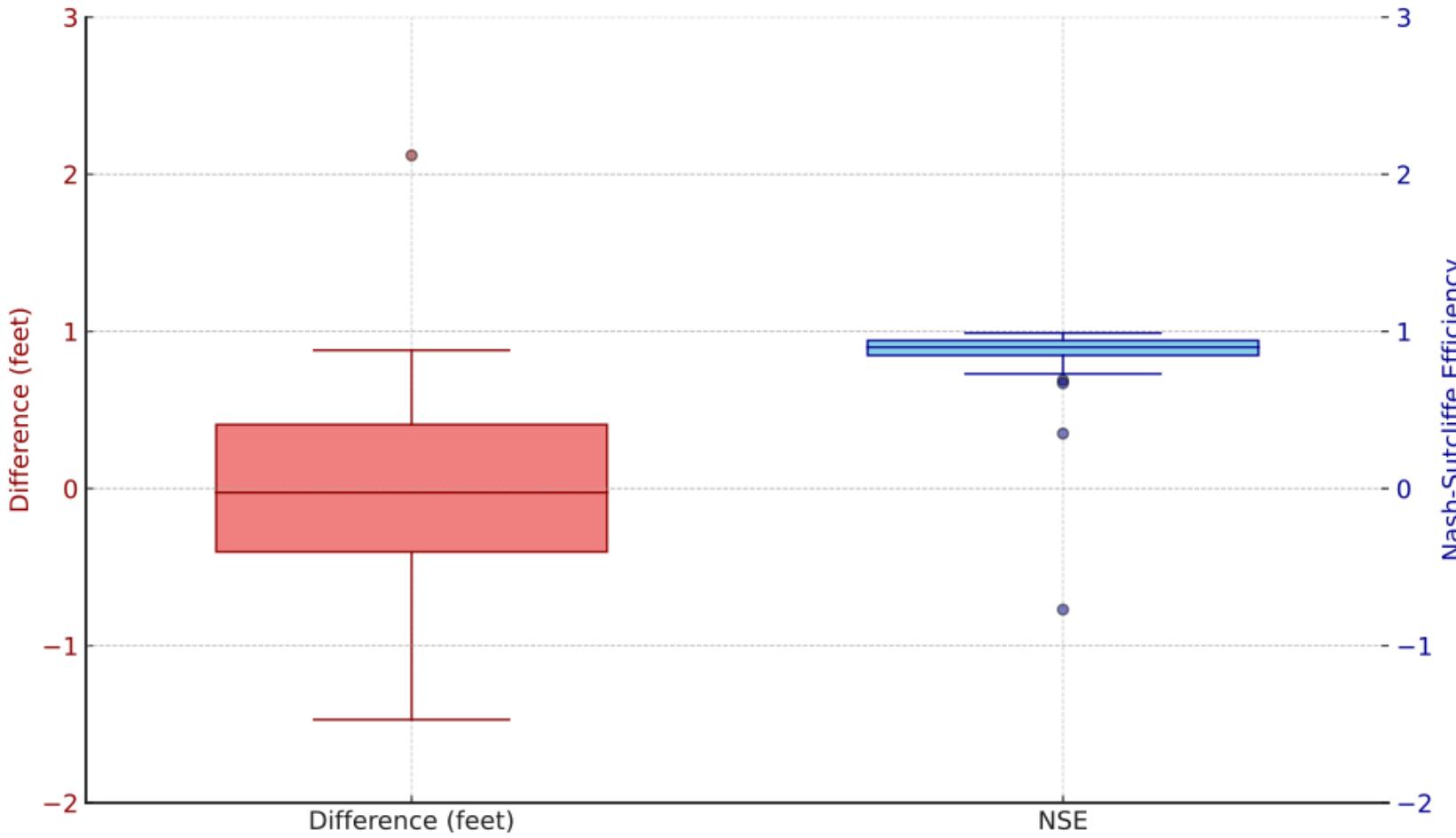
48 Gauges

- MAE – 0.62 ft
- RMSE – 0.82 ft
- < 1 ft – 87%
- Average NSE – 0.88 (excluding outliers)

Validation

- Media Reports of Flooding
- NearMap ImpactResponse Imagery
- Web Map City Review
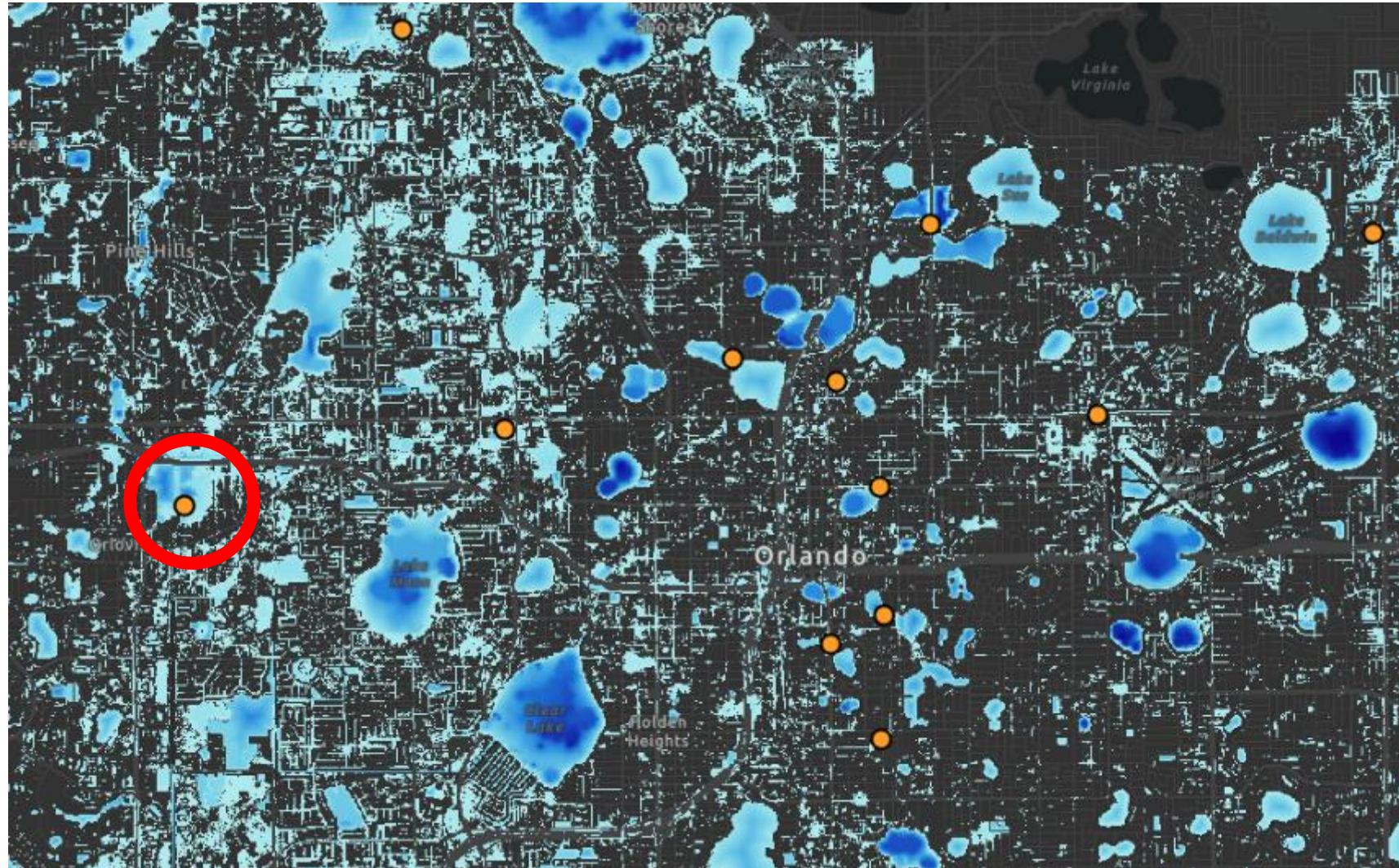
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Rainfall Change Factors (USGS & FFH)

DRUMMOND CARPENTER
JonesEdmunds
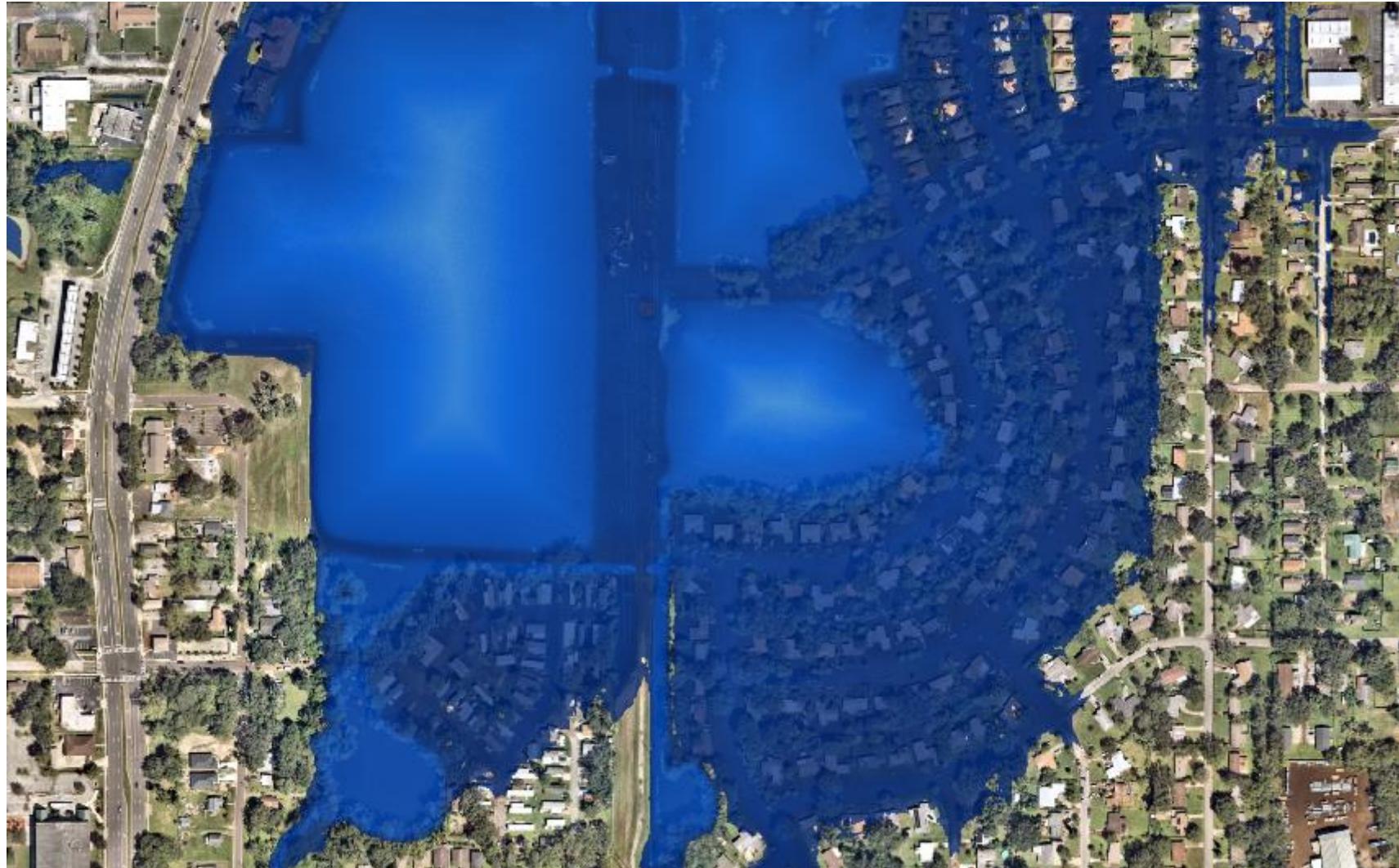
Script Inputs/options

- Station, Basin, or County

- Downscaled GCM Dataset(s)

- 2040 or 2070 planning horizon

- Return period and duration
  - 5, 10, 25, 50, <u>100</u>, 200, or <u>500–yr</u>
  - 1-,3-, or 7-day

USGS ScienceBase-Catalog

Change factors to derive projected future precipitation depth-duration-frequency (DDF) curves at 242 National Oceanic and Atmospheric Administration (NOAA) Atlas 14 stations in Florida (ver. 2.0, May 2024)

HUC-8 Basins

NOAA Atlas 14 Stations
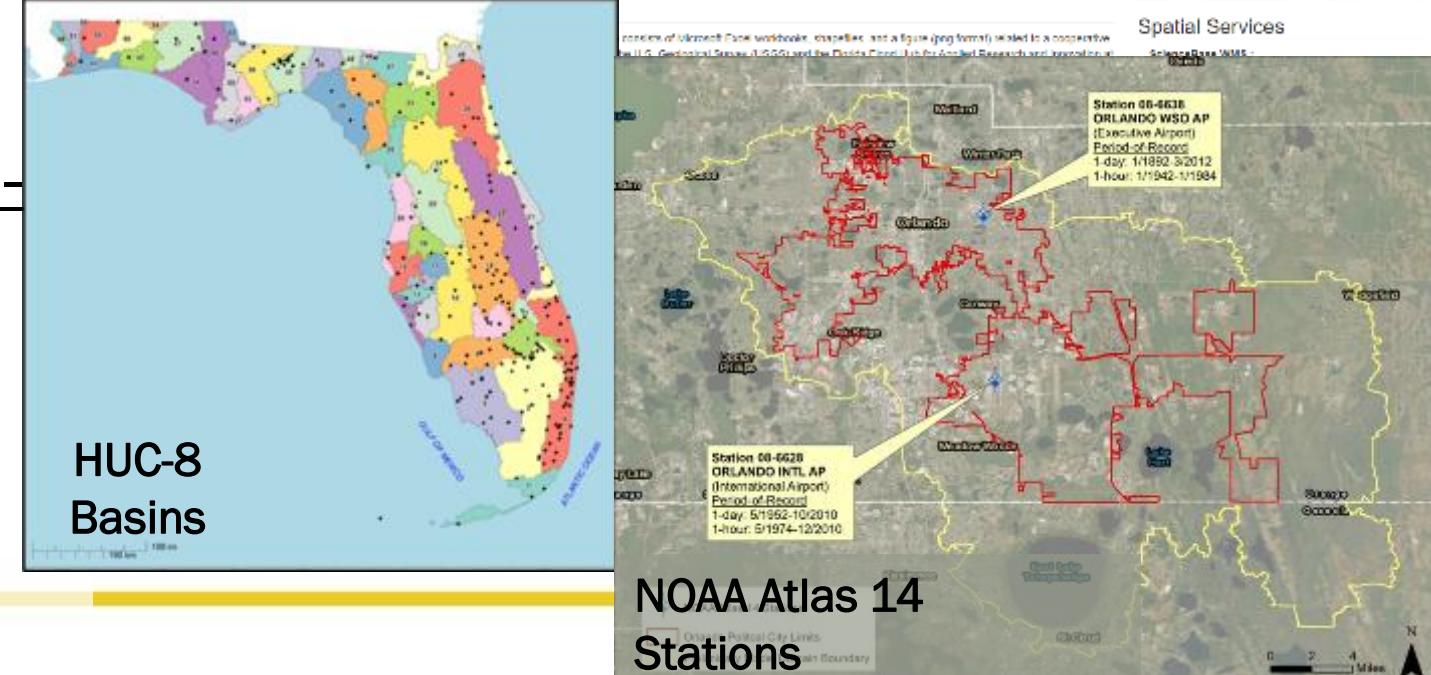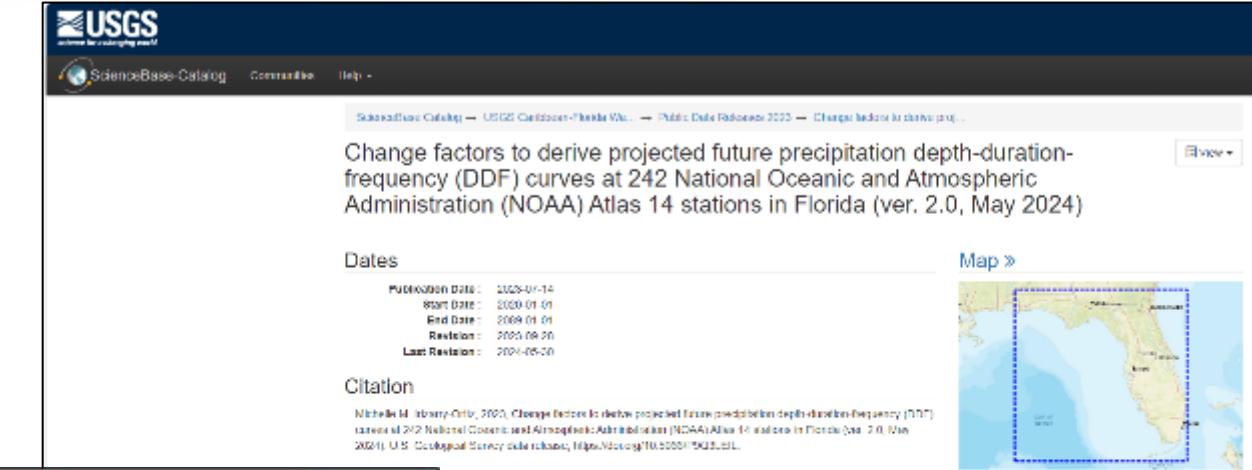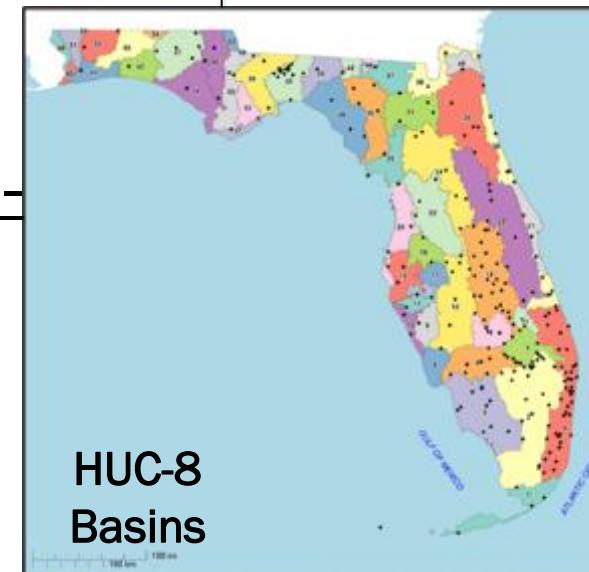
Rainfall Change Factors (USGS & FFH)

Planning Horizon	Return Period	Duration	CMIP5					CMIP6	
			CORDEX	Jupiter WRF	LOCA	MACA	All Datasets	LOCA 2	NASA
2040	100-yr	1-day	1.23	1.11	1.105	1.355	1.18	1.055	1.07
		3-day	1.2	-	1.115	1.295	1.21	1.07	1.09
		7-day	1.16	-	1.25	1.33	1.245	1.055	1.13
	500-yr	1-day	1.2	1.1	1.15	1.46	1.18	1.055	1.05
		3-day	1.23	-	1.16	1.45	1.29	1.065	1.11
		7-day	1.23	-	1.32	1.565	1.305	1.075	1.175
2070	100-yr	1-day	1.29	1.24	1.05	1.435	1.34	1.075	1.095
		3-day	1.21	-	1.12	1.405	1.34	1.105	1.075
		7-day	1.18	-	1.17	1.48	1.34	1.135	1.16
	500-yr	1-day	1.26	1.26	1.065	1.655	1.44	1.075	1.02
		3-day	1.23	-	1.17	1.575	1.46	1.09	1.035
		7-day	1.26	-	1.24	1.785	1.485	1.165	1.175

18 – 46% (CMIP5) vs 2 - 10% (CMIP6) for durations studied in this VA

Currently, FL Flood Hub seems to be favoring LOCA 2

Rainfall Change Factors – Unknowns

- Assumptions or compromises in selecting CFs
- Pending official recommendations (from FL Flood Hub)
  - Station, County, or Climate Region Scale
  - CMIP5 vs CMIP6 (number/detail of GCMs, review)
  - NOAA Atlas 15 recommendations
- Uncertainty
  - GCMs can struggle with rain/tropical cyclone path
  - Are Small CFs appropriate in VA context?
  - Will rainfall distribution/regions change?
  - Future development
  - "Acceptable" flood risk
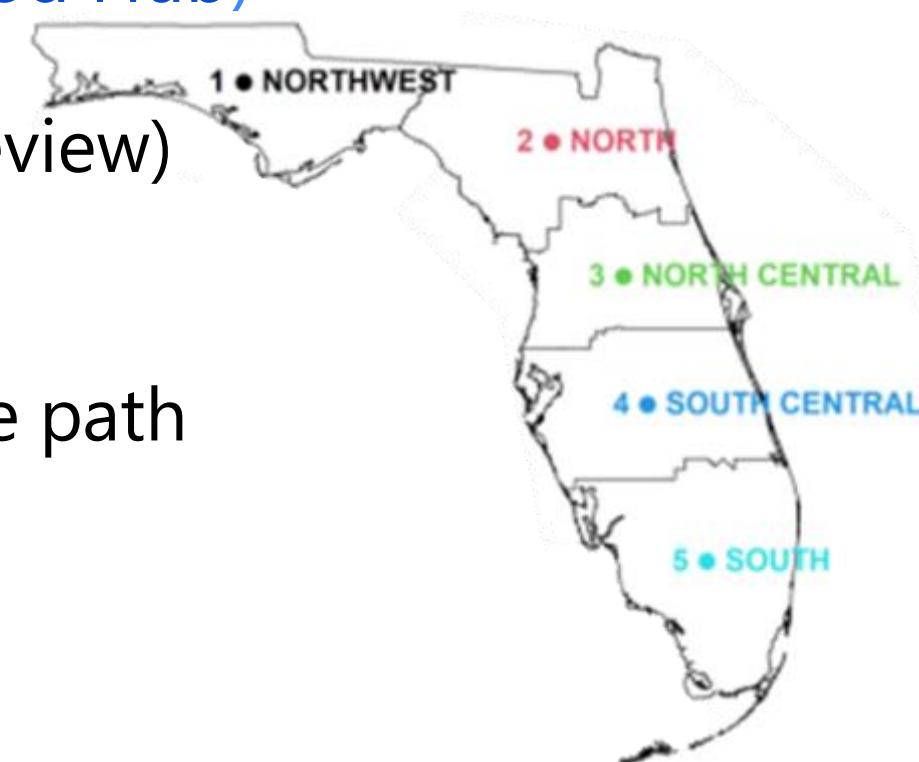
Critical Assets – Statewide Dataset

Transportation & Evacuation Routes

- Airports
- Bridges
- Bus Terminals
- Ports
- Major Roadways
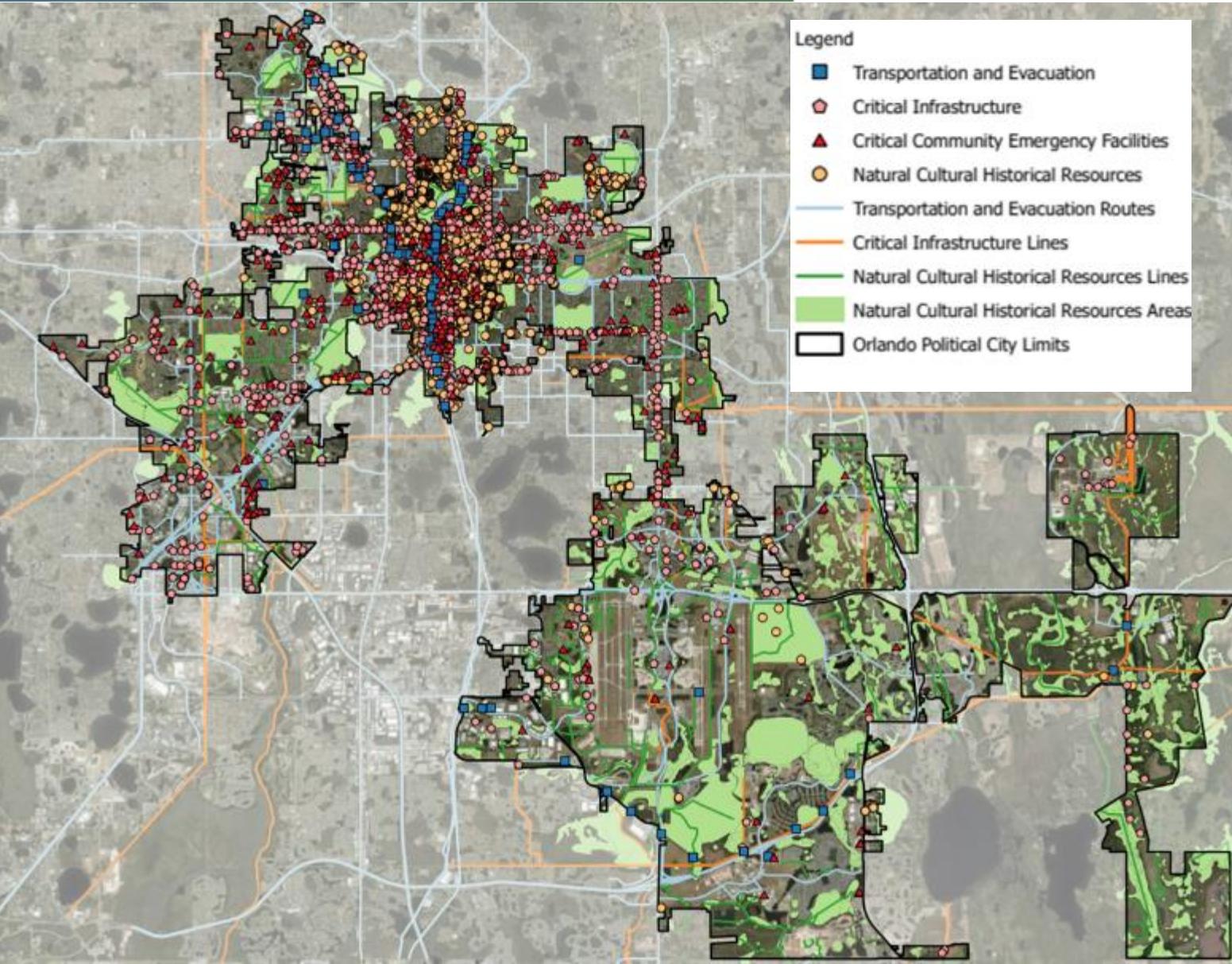- Marinas
- Rail Facilities
- Railroad Bridges

Community & Emergency Facilities

- Schools, Colleges, and Universities
- Community Centers
- Disaster Recovery Centers
- Emergency Medical Service Facilities
- Emergency Operations Centers
- Fire Stations
- Health Care/Hospitals
- Law Enforcement Facilities
- Local and State Government Facilities
- Logistical Staging Areas
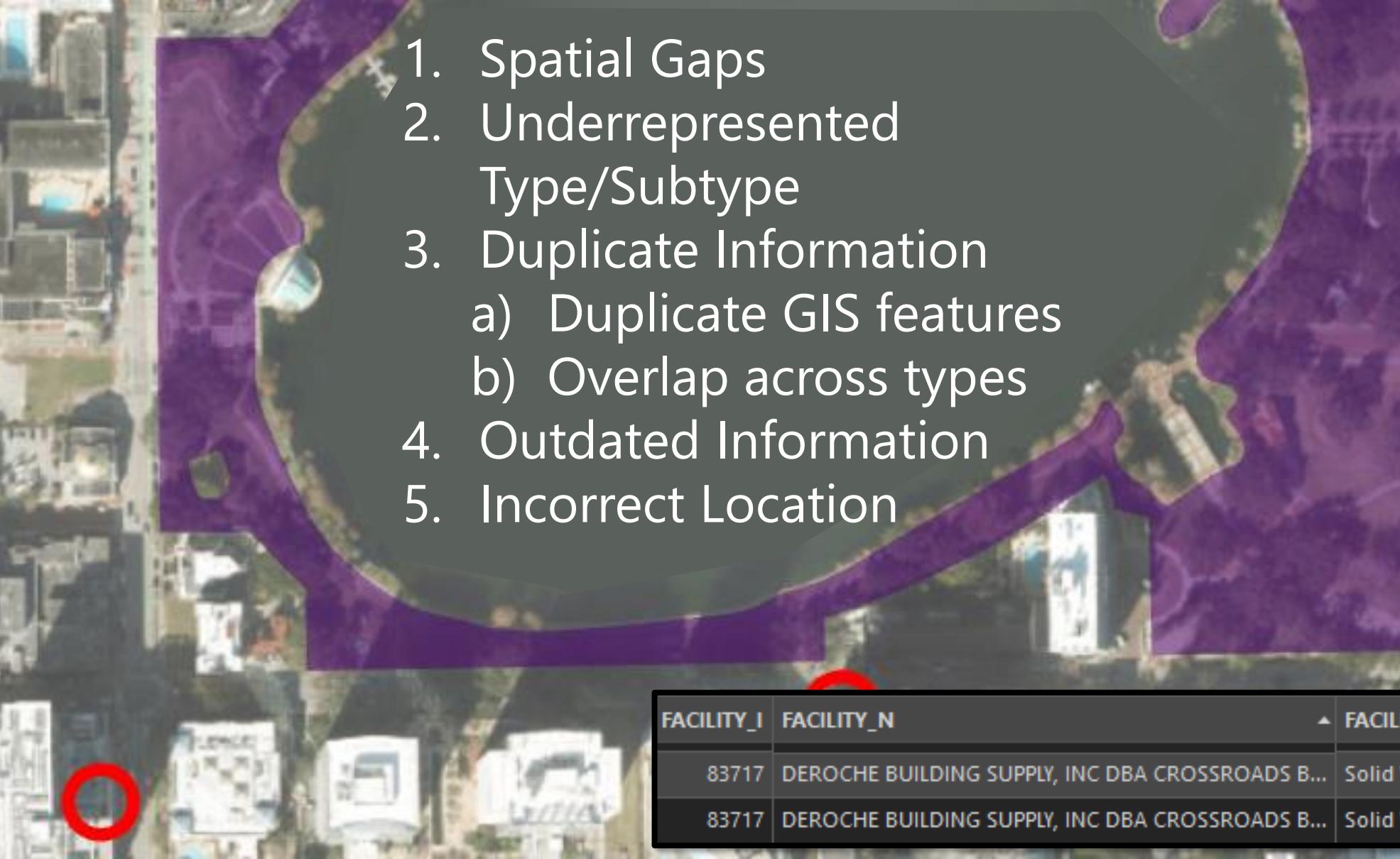- Affordable Public Housing
- Risk Shelter Inventory

Critical Infrastructure

- Wastewater Treatment Facilities
- Lift Stations
- Stormwater Treatment Facilities
- Pump Stations
- Drinking Water Facilities
- Water Utility Conveyance Systems
- Electric Production and Supply Facilities
- Solid Hazardous Waste Facilities
- Military Installations
- Communications Facilities
- Disaster Debris Management Sites

Natural, Cultural & Historical

- Conservation Lands
- Parks
- Shorelines
- Surface Waters
- Wetlands
- Historical and Cultural Assets

Legend

- Transportation and Evacuation
- Critical Infrastructure
- Critical Community Emergency Facilities
- Natural Cultural Historical Resources
- Transportation and Evacuation Routes
- Critical Infrastructure Lines
- Natural Cultural Historical Resources Lines
- Natural Cultural Historical Resources Areas
- Orlando Political City Limits

Critical Assets – Gaps

1. Spatial Gaps
2. Underrepresented Type/Subtype
3. Duplicate Information
   a) Duplicate GIS features
   b) Overlap across types
4. Outdated Information
5. Incorrect Location

600-ft
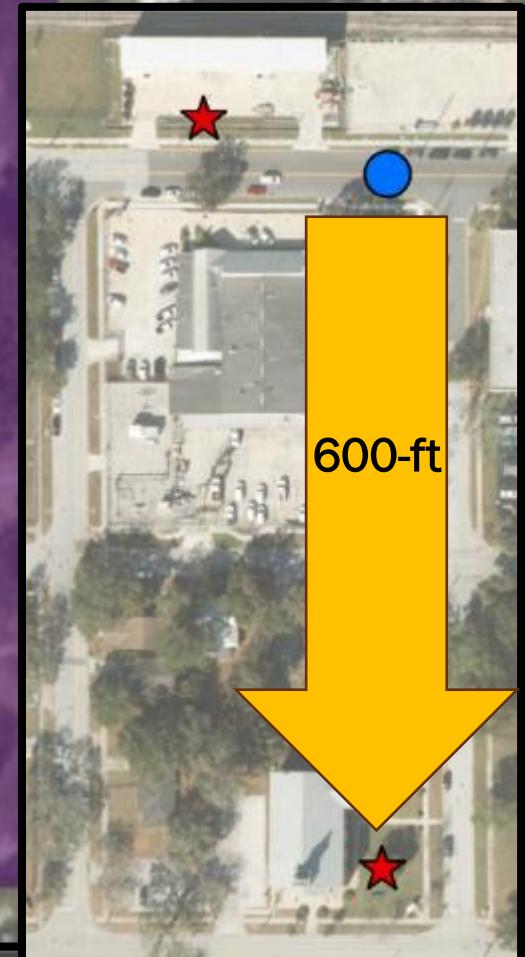
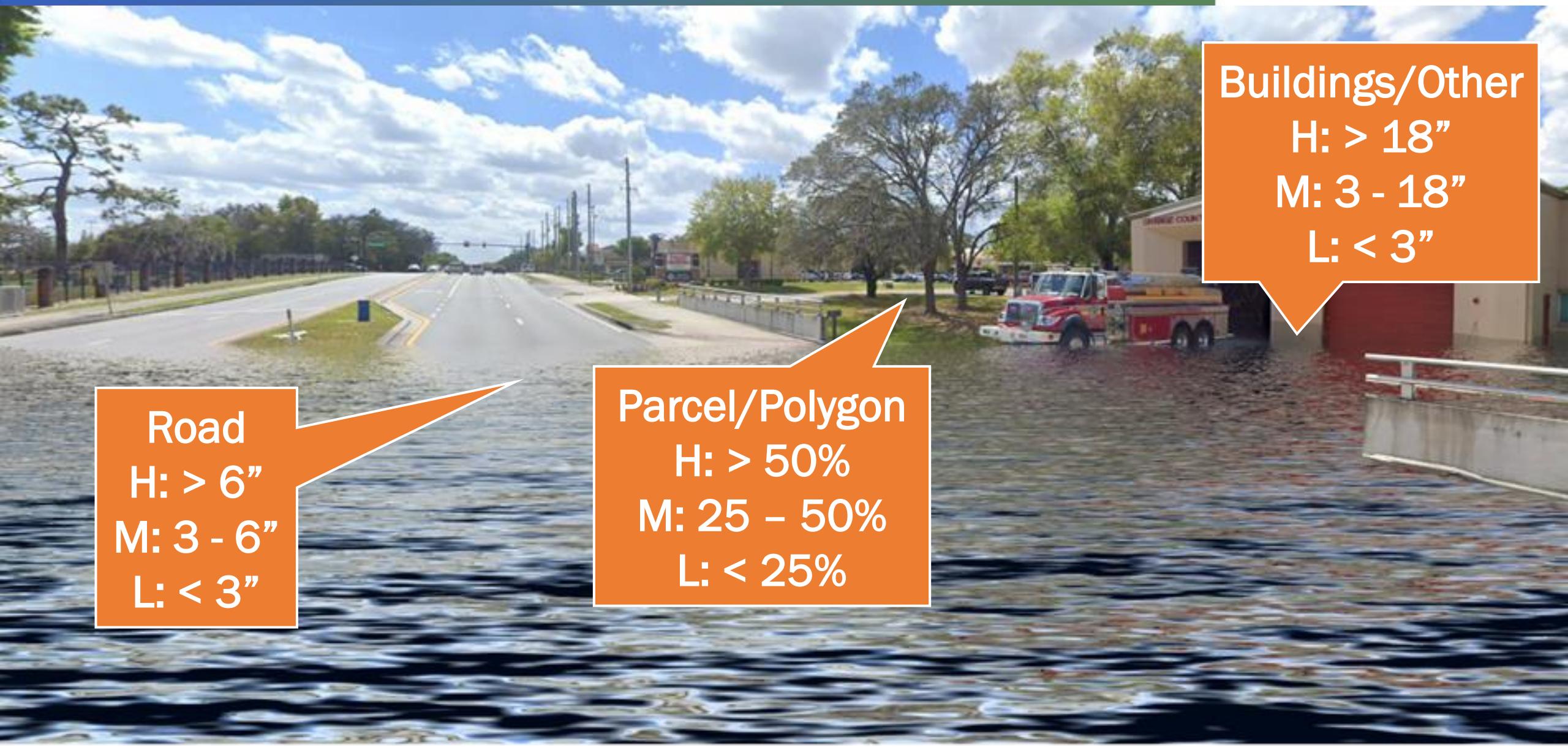| FACILITY_I	FACILITY_N	FACILITY_T	OBJECT_OF_
83717	DEROCHE BUILDING SUPPLY, INC DBA CROSSROADS B...	Solid Waste	Facility
83717	DEROCHE BUILDING SUPPLY, INC DBA CROSSROADS B...	Solid Waste	Waste Processing Area

Critical Assets – Gap Rectification

11,379 → 76,350 assets
+64,971 (+571%)
15% in statewide dataset

| Large Net Increase	• Stormwater • Hydrants • Wetlands
Large Relative Increase	• Parks • Emergency Operation Center • Military Installations
New Asset Types	• Food Security (SNAP retailers and farms) • Fueling stations (gas and EV)
Net Losses	• Reclassification • Duplicate points • Tracked under another type

Sensitivity Criteria

DRUMMOND CARPENTER
JonesEdmunds

Buildings/Other
H: > 18"
M: 3 - 18"
L: < 3"

Road
H: > 6"
M: 3 - 6"
L: < 3"

Parcel/Polygon
H: > 50%
M: 25 – 50%
L: < 25%

Summary of Impacts (PRELIMINARY)

Sensitivity to Future Rainfall (100-yr Current to 2070)	Critical Assets
Number Increase	• Stormwater structures • Hydrants • Historical Structures
Relative Increase	• Historical Structures • Gas stations • Colleges and Universities • Solid Waste Facilities • EV Charging Hubs • Water Tanks • Community Centers

What's next?

1. Complete Final VA

2. Floodplain Management Plan for CRS credits

3. Rapidly assess alternatives and identify future projects/grants

4. New frontier with high-performance models & AI
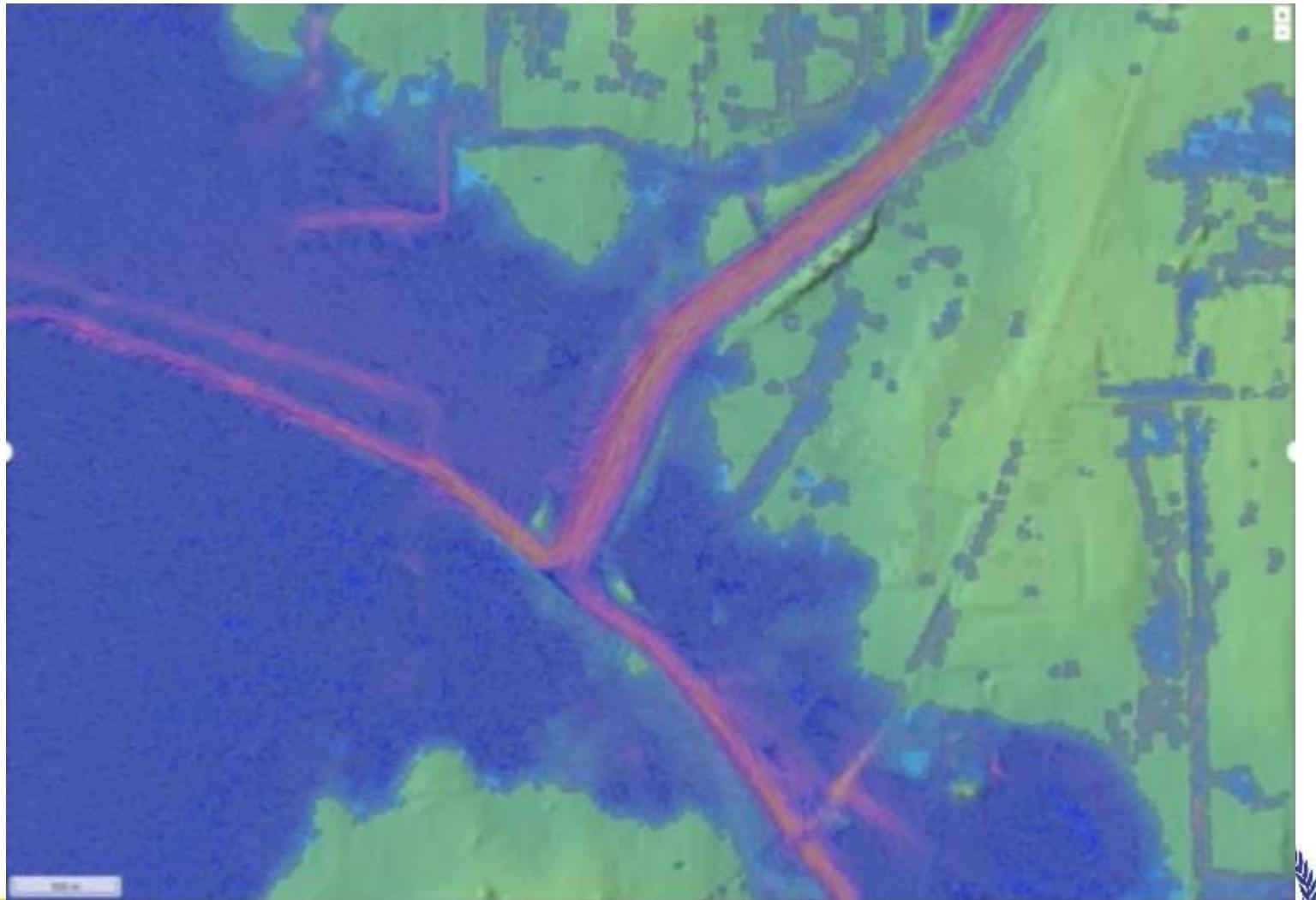
Conclusions

1. Investments in stormwater data (GIS, monitoring) WILL pay off in unforeseen ways

2. High performance computational models can now be incorporated into a single desktop to dramatically increase detail and accuracy of flood models at a fraction of the cost

3. Florida's understanding of flood risk is rapidly improving, and will help address the problems of recent storm intensification and recurrence

In Memory of Jim Hunt

- Deputy Public Works Director – City Engineer
- FSA President (2013-14)
- FSA's Volunteer Service Award named in his honor