Modelling Effects of Vegetation Classes on Hydrological Conditions in Water Conservation Area-2A with Regional Simulation Model

South Florida Water Management District(SFWMD)
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Danielle Morancy

Outline

1. Objective

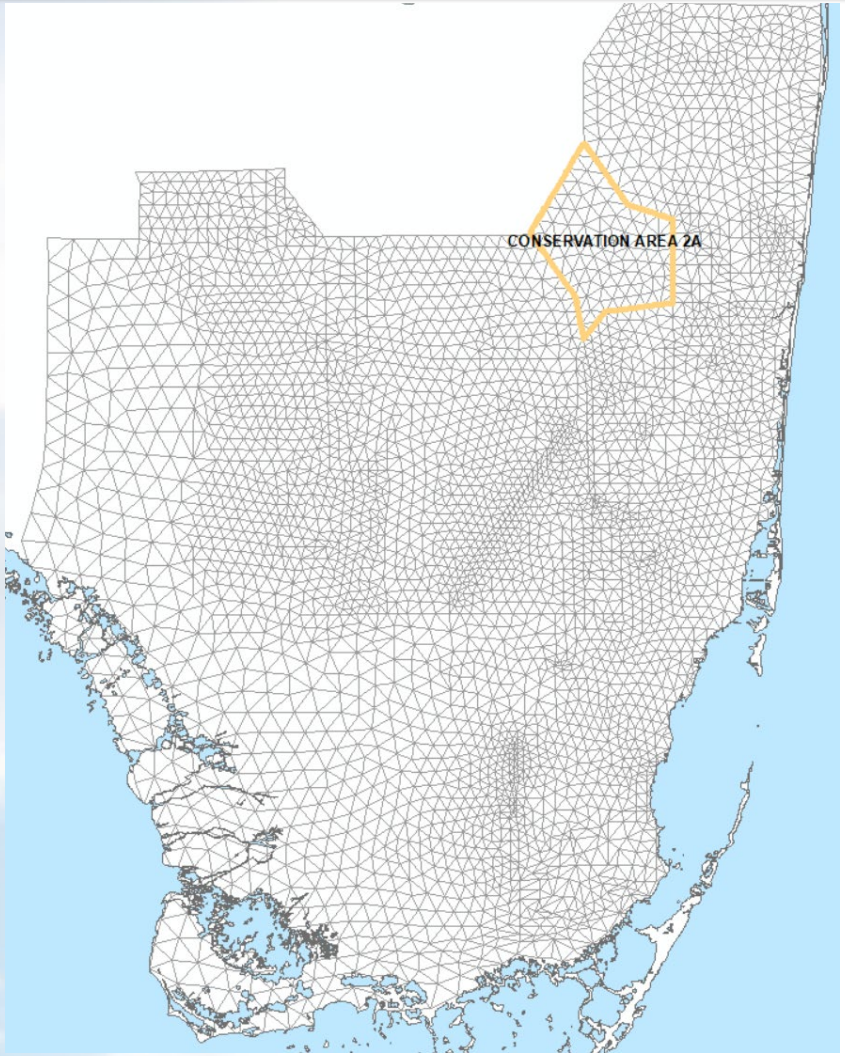
Vegetation (like topography) plays a significant role in hydrological modeling because of vegetation roughness (e.g., water flow resistance), evapotranspiration and other properties. The relationship are studied with lab experiments, field measurements. We assess and quantify the effects numerically.

2. Approaches

- Regional Simulation Model, a numerical model developed by SFWMD
- Apply two different vegetation classifications into the model, specifically in our study area.
- Assess the effects of vegetation on model results using several key performance measures

3. Conclusions and future works

Approach: Regional Simulation Model



Regional Simulation Model was implemented in model domain (left). The domain consists of 7073 varying size triangular cells with average cell size of approximately one square mile. Model Period: 1/1/1965 to 12/31/2016 with daily time step

The model implementation has been well calibrated and validated, is a robust application of RSM.

All model settings are same in our study except vegetation classes in WCA-2A in models:

- RUN1 with the land use data developed by SFWMD (2019)
- RUN1RC with the land use developed by FIU (Gann et al., 2023)

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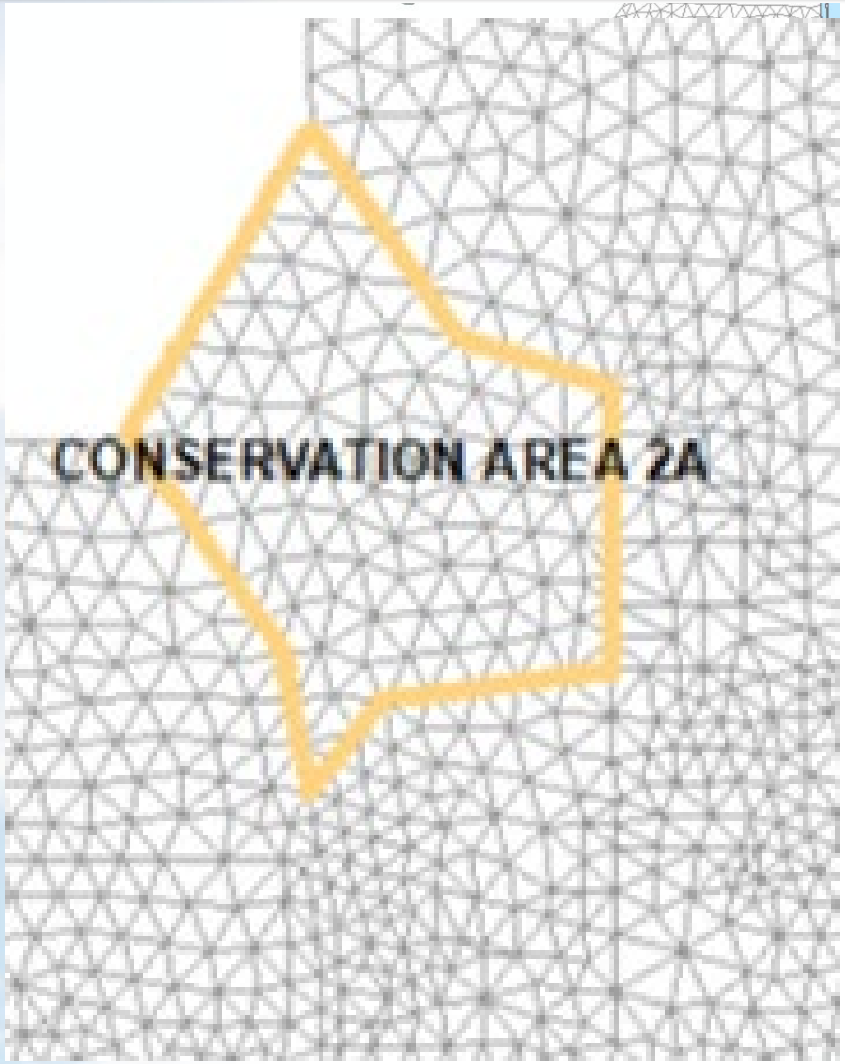

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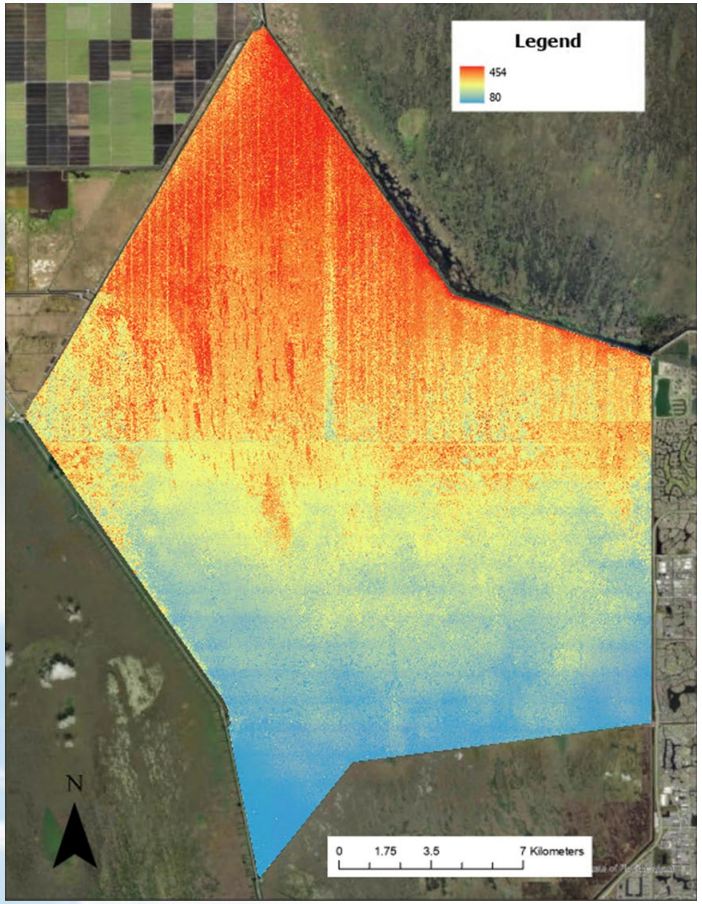
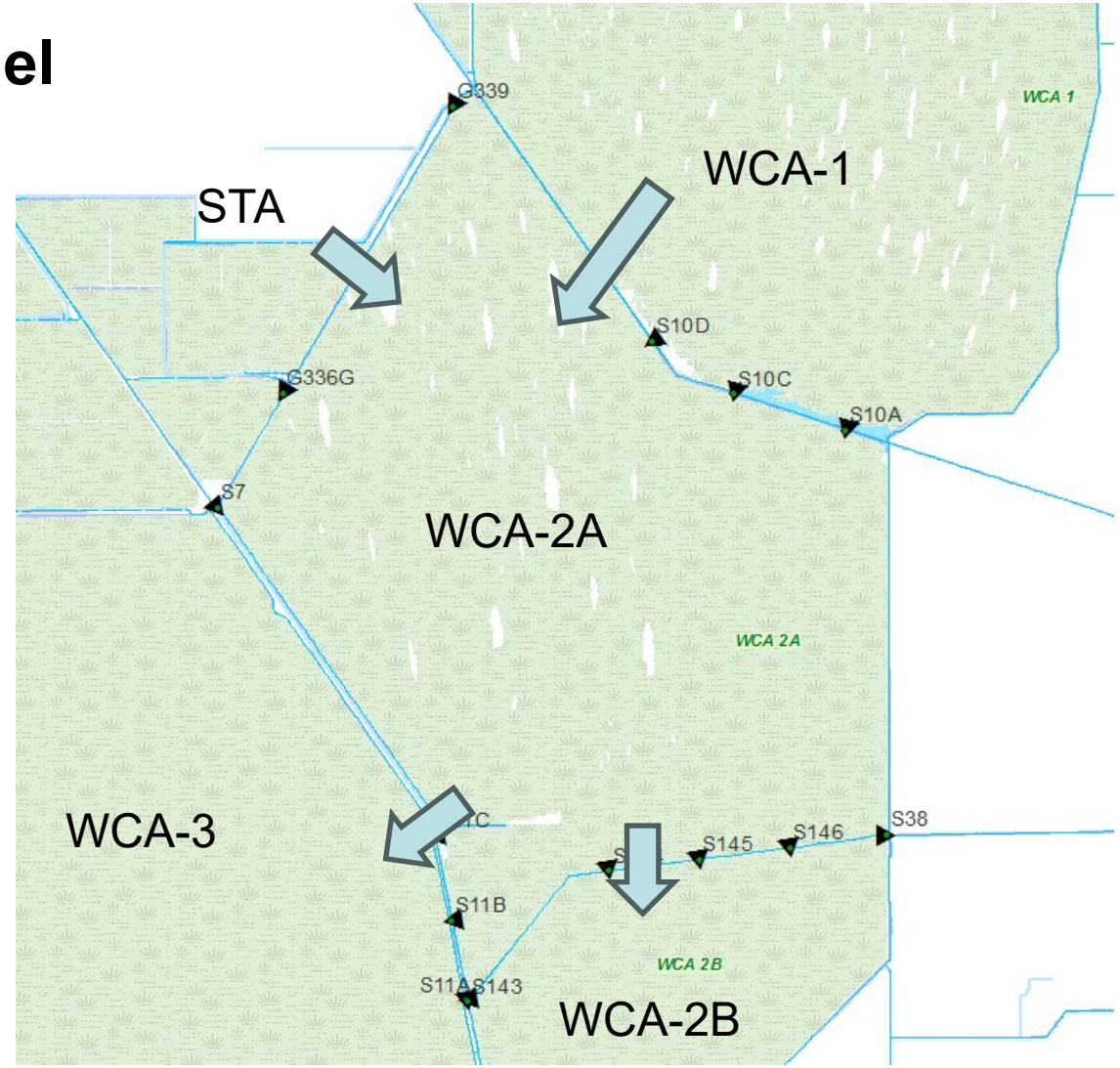
Overview of WCA-2A

Elevation-Digital Terrain Model

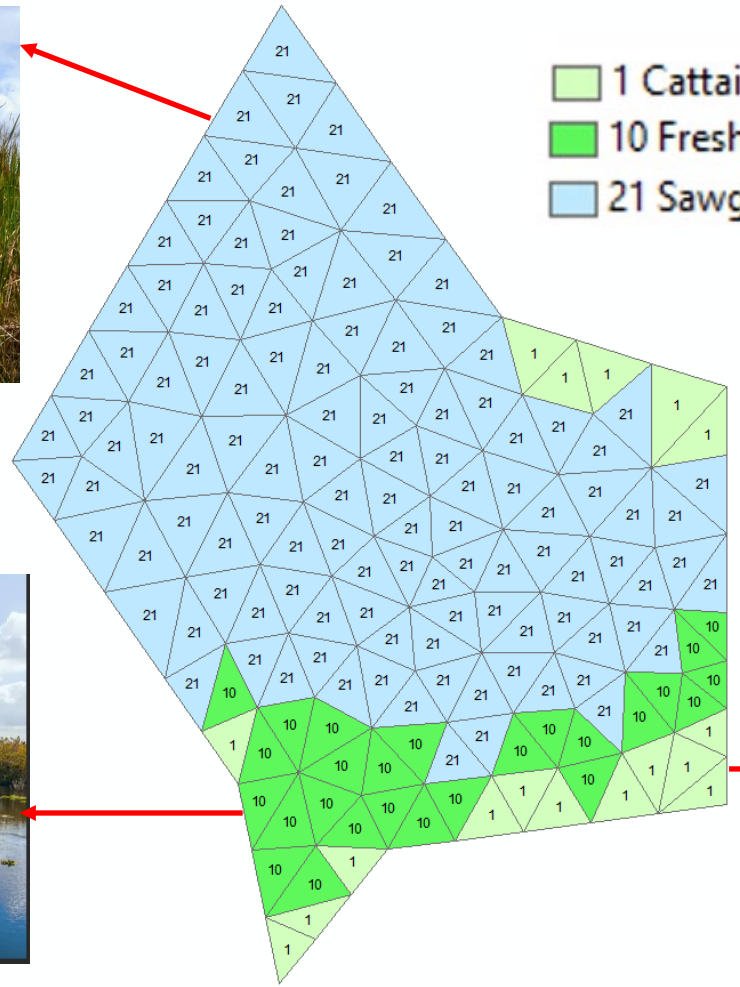
LiDAR/Worldview based





Vegetation classes (SFWMD) in WCA-2A: Run1

21 Sawgrass

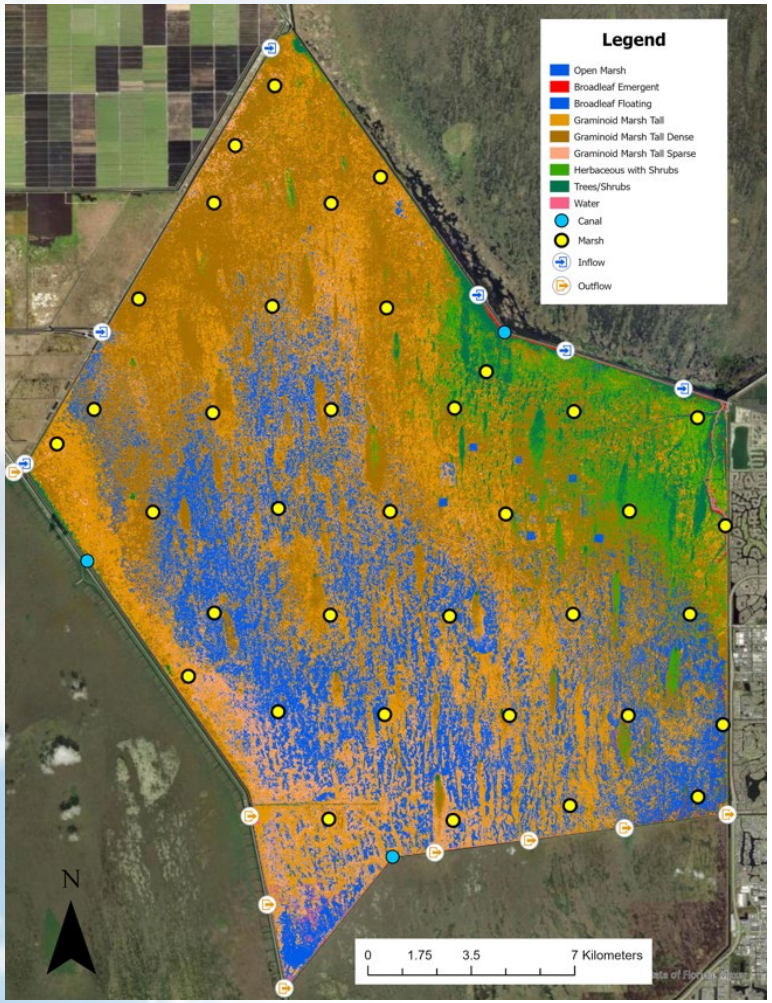


SFWMD land cover (2019) mapped to WCA-2A and used in Run1

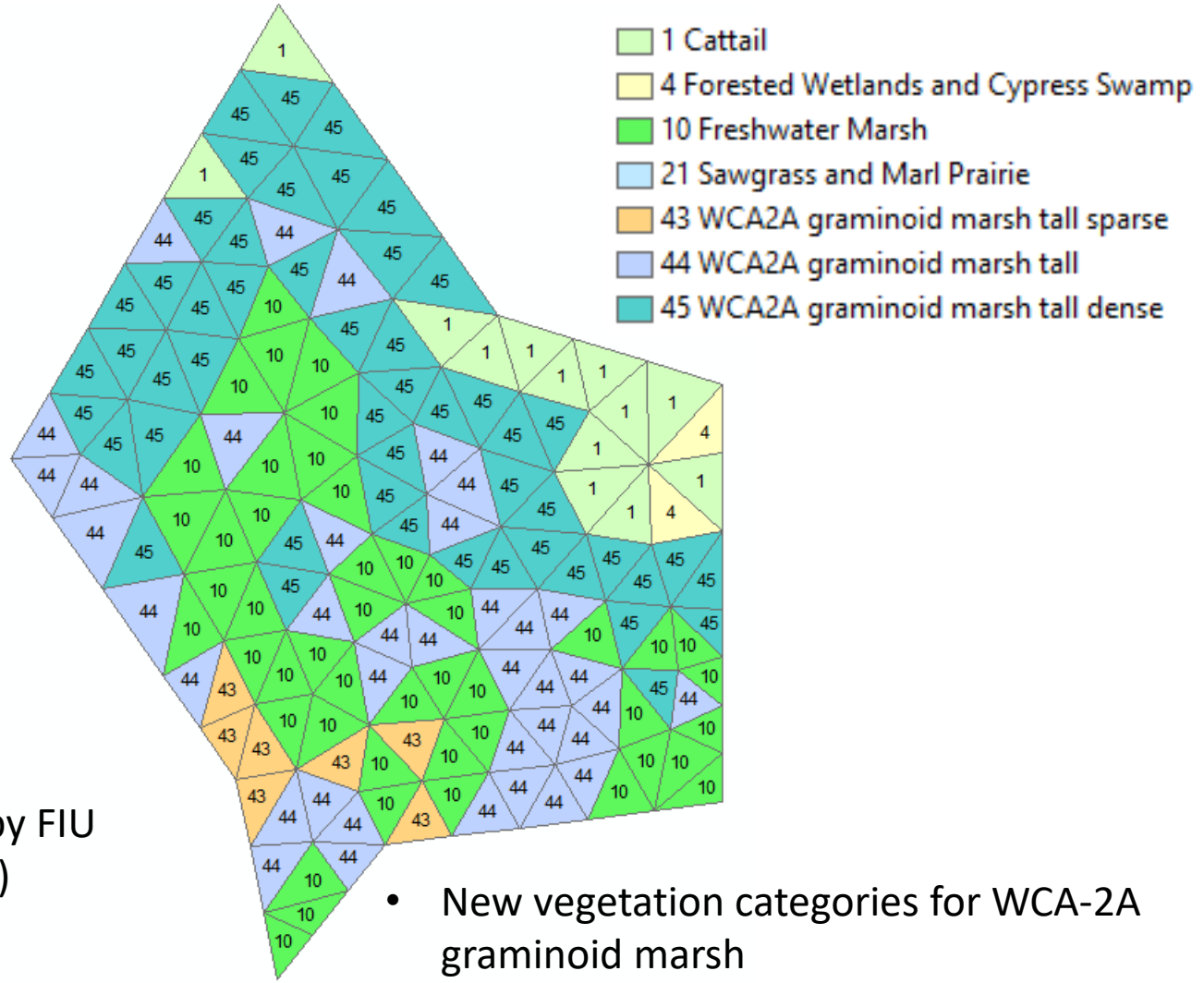
10 Freshwater Marsh

1 Cattail

Vegetation classes (FIU) in WCA-2A: Run1RC

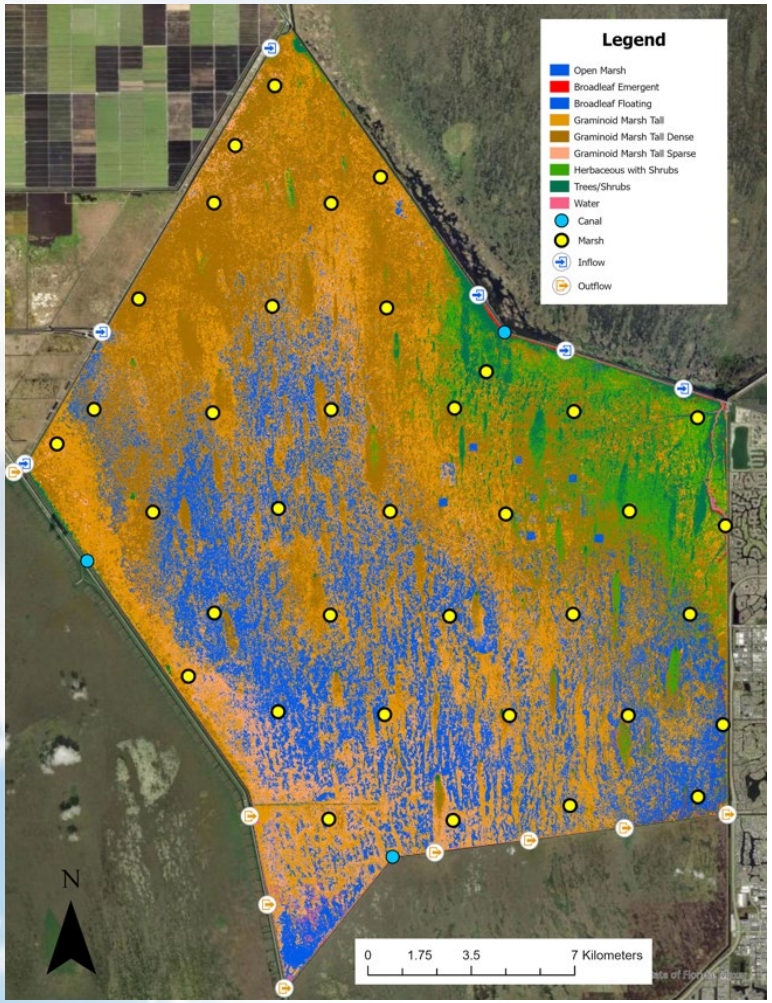


Vegetation map by FIU (Gann et al. 2023)



- New vegetation categories for WCA-2A graminoid marsh

Vegetation classes (FIU) in WCA-2A: Run1RC



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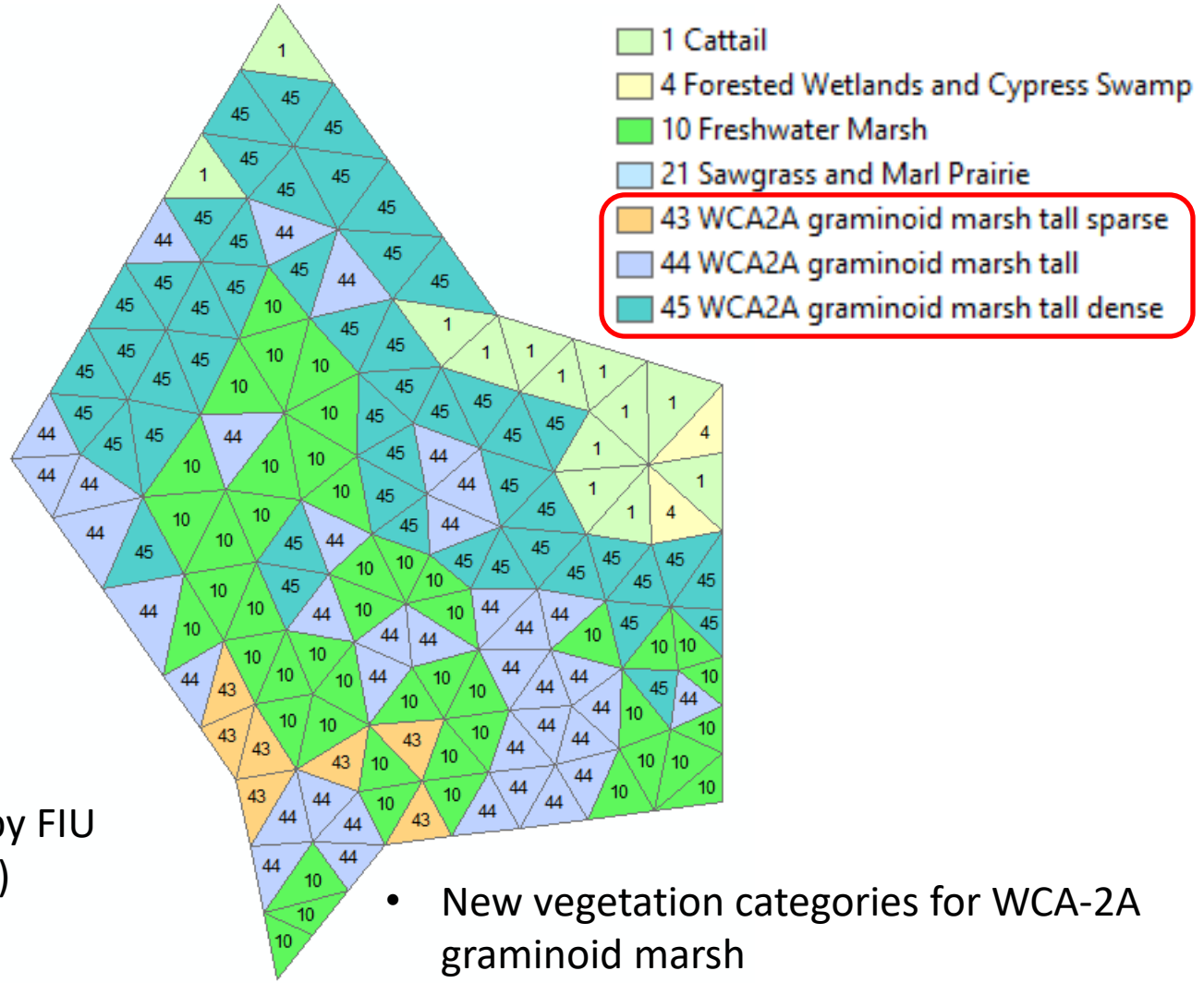

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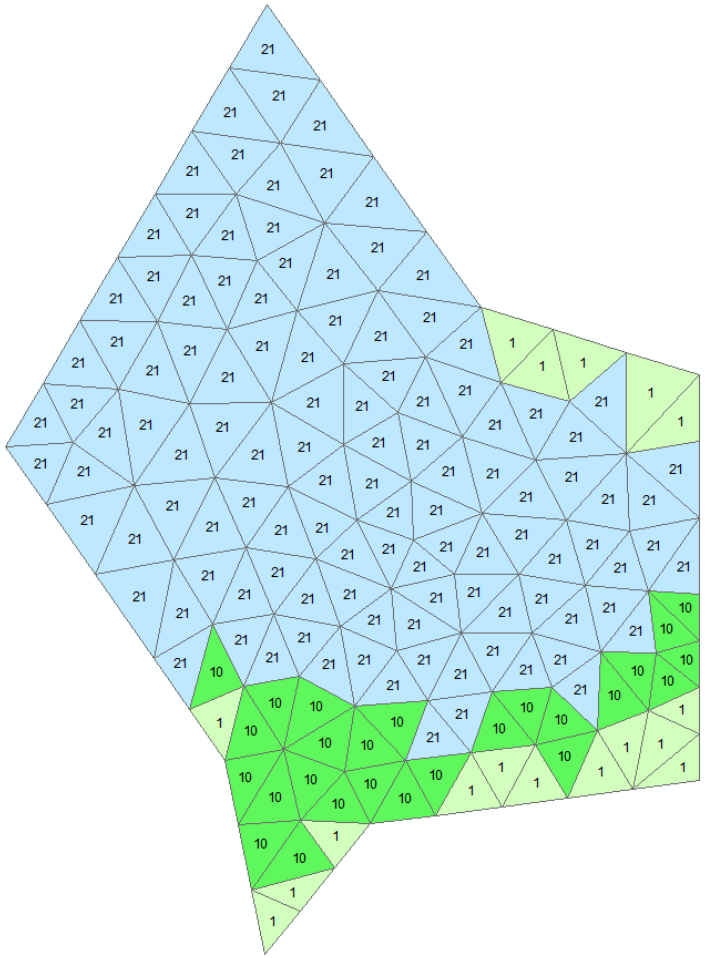
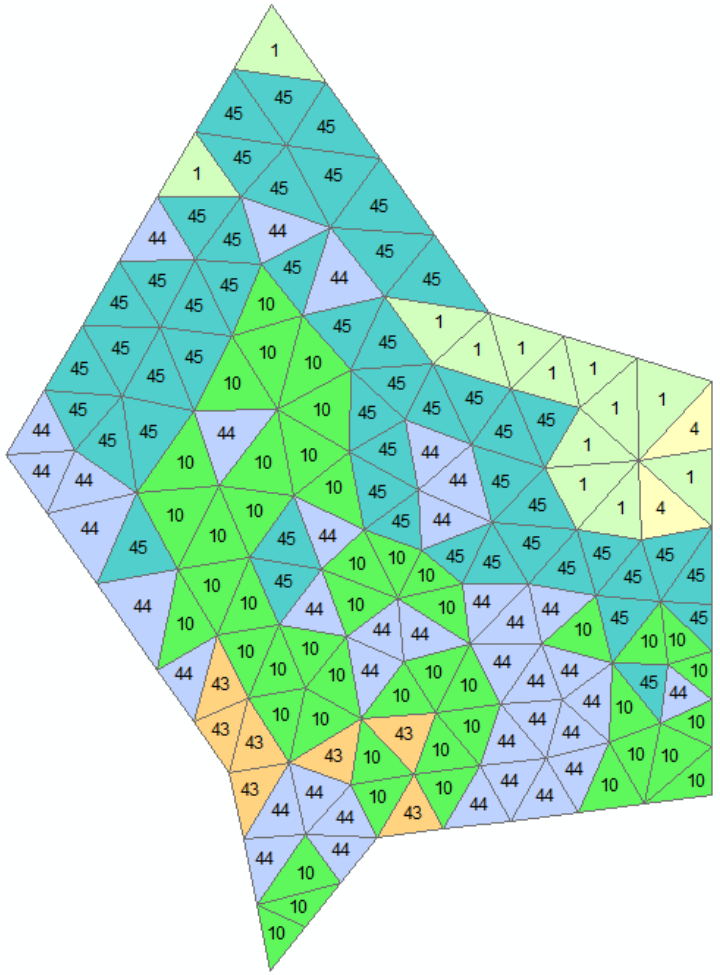
Vegetation classes in WCA-2A: Roughness

Run1



- 1 Cattail
- 4 Forested Wetlands and Cypress Swamp
- 10 Freshwater Marsh
- 21 Sawgrass and Marl Prairie
- 43 WCA2A graminoid marsh tall sparse
- 44 WCA2A graminoid marsh tall
- 45 WCA2A graminoid marsh tall dense

Run1RC



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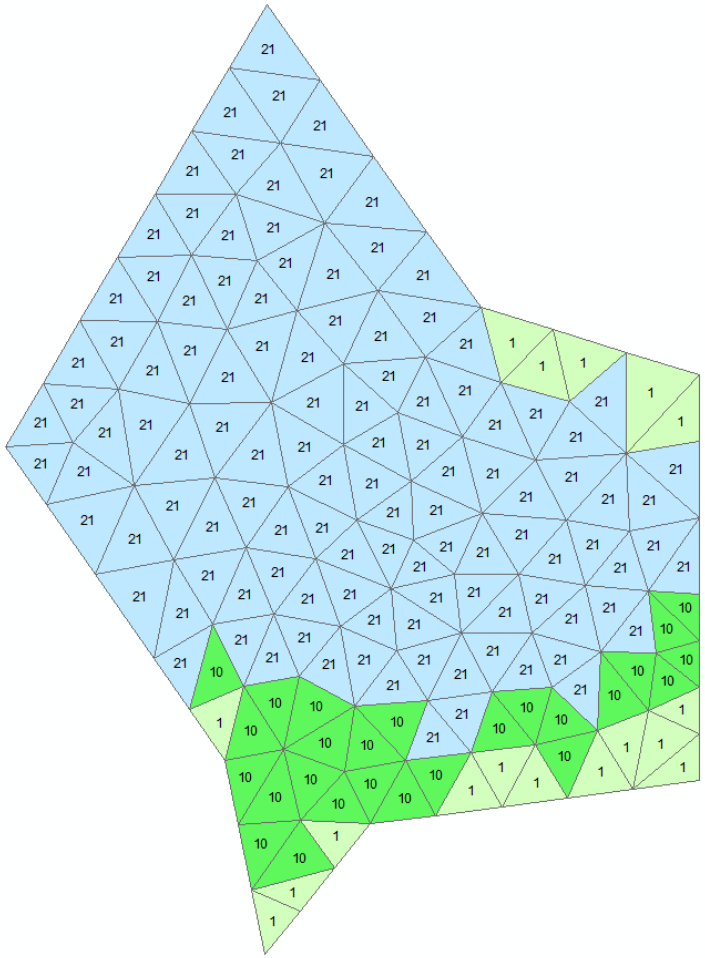

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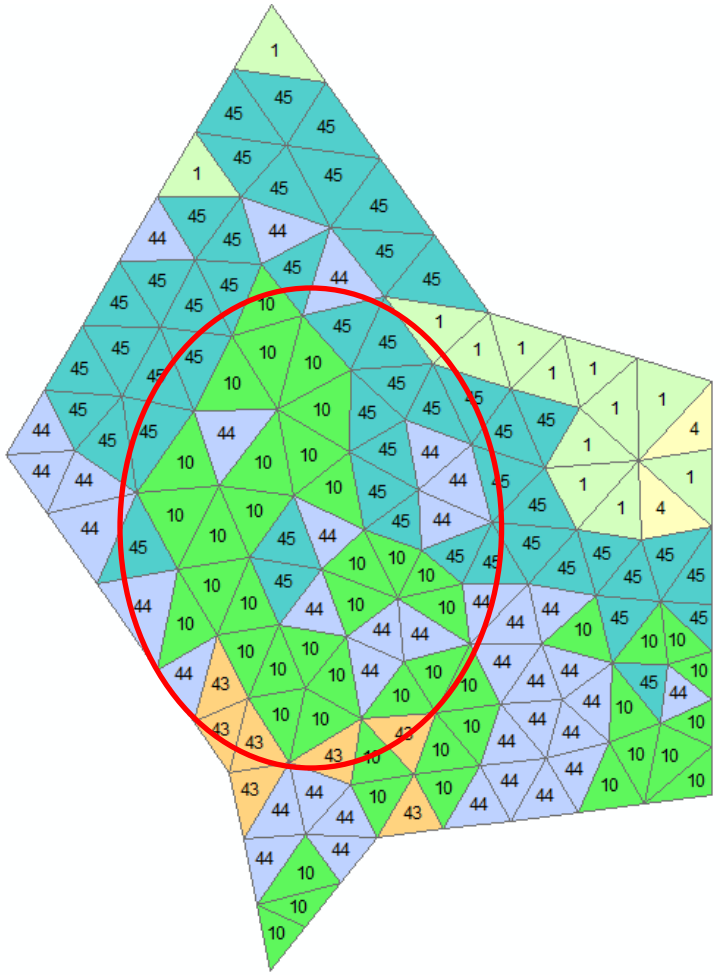
Run1RC



Vegetation classes in WCA-2A: Roughness

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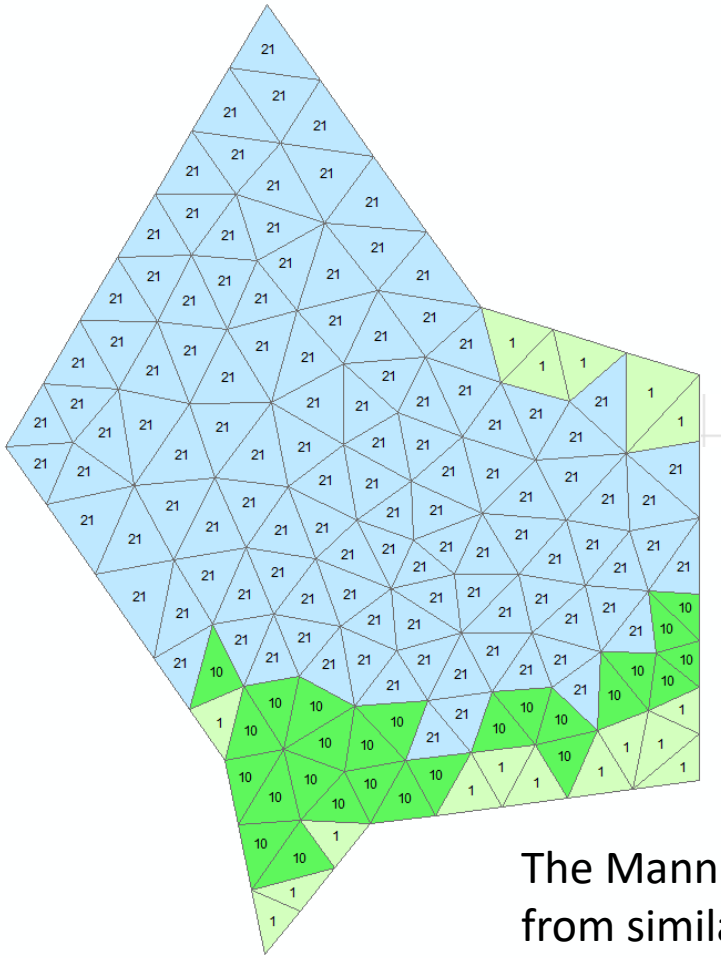

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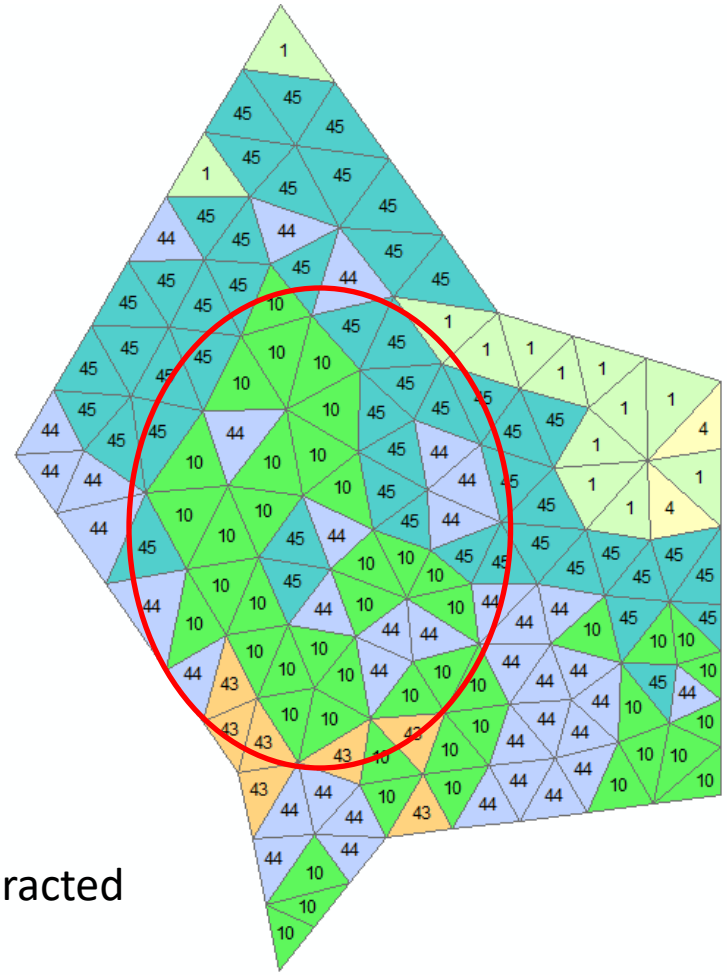
Manning's Coeffient (n) when depth is unit length

1	Cattail	1.08
4	Forested Wetlands and Cypress Swamp	0.21
10	Freshwater Marsh	0.66
21	Sawgrass	0.75
43	WCA2A graminoid marsh tall sparse	0.65
44	WCA2A graminoid marsh tall	0.70
45	WCA2A graminoid marsh tall dense	0.75

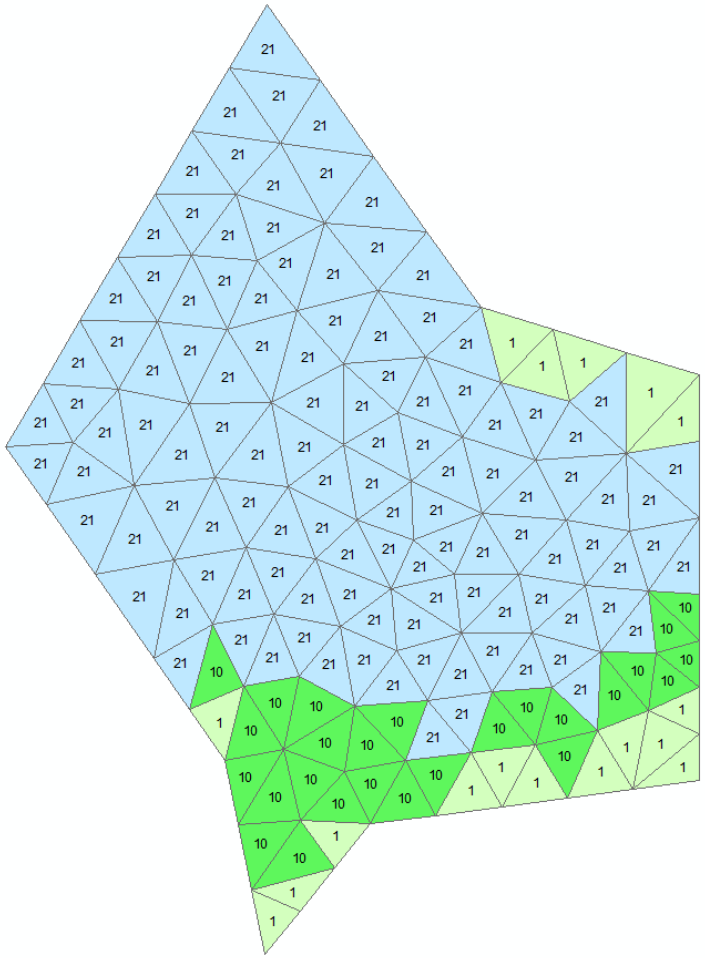
Run1RC



The Manning's n values in the land use map were extracted from similar modeling studies in Florida.

Vegetation classes in WCA-2A: ET

Run1



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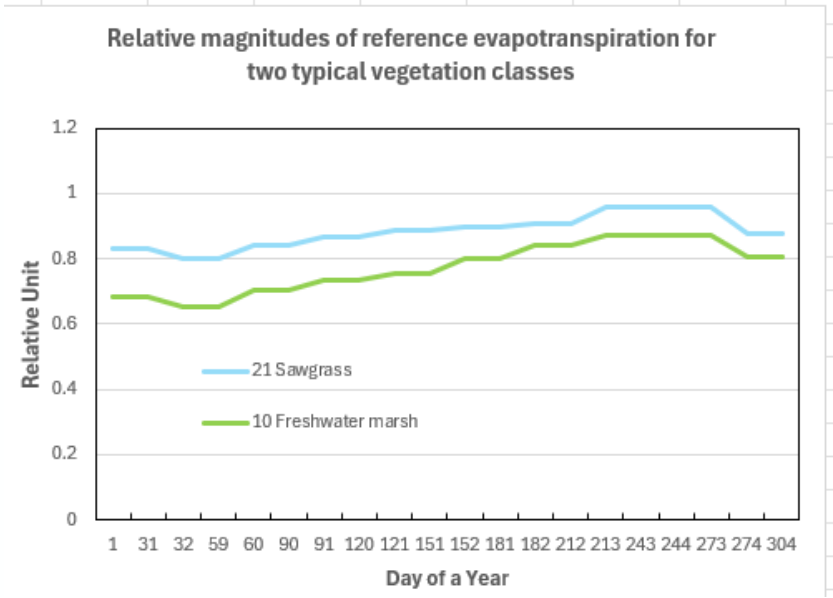
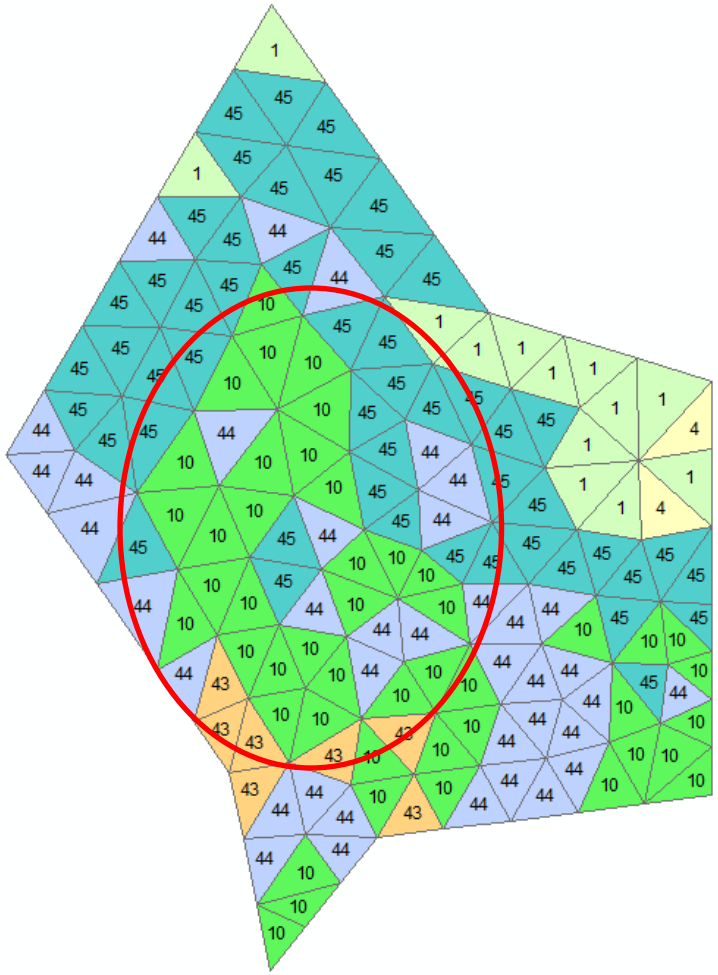
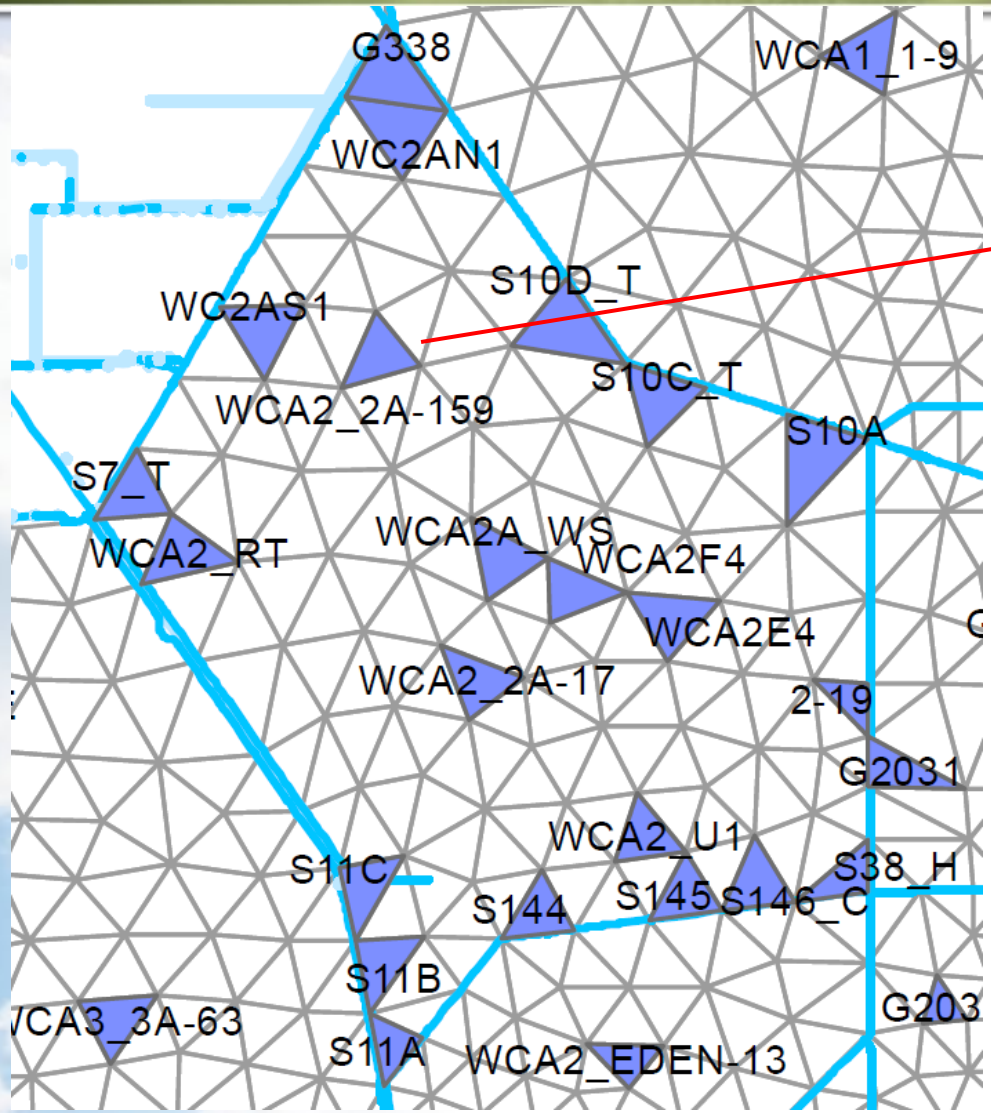
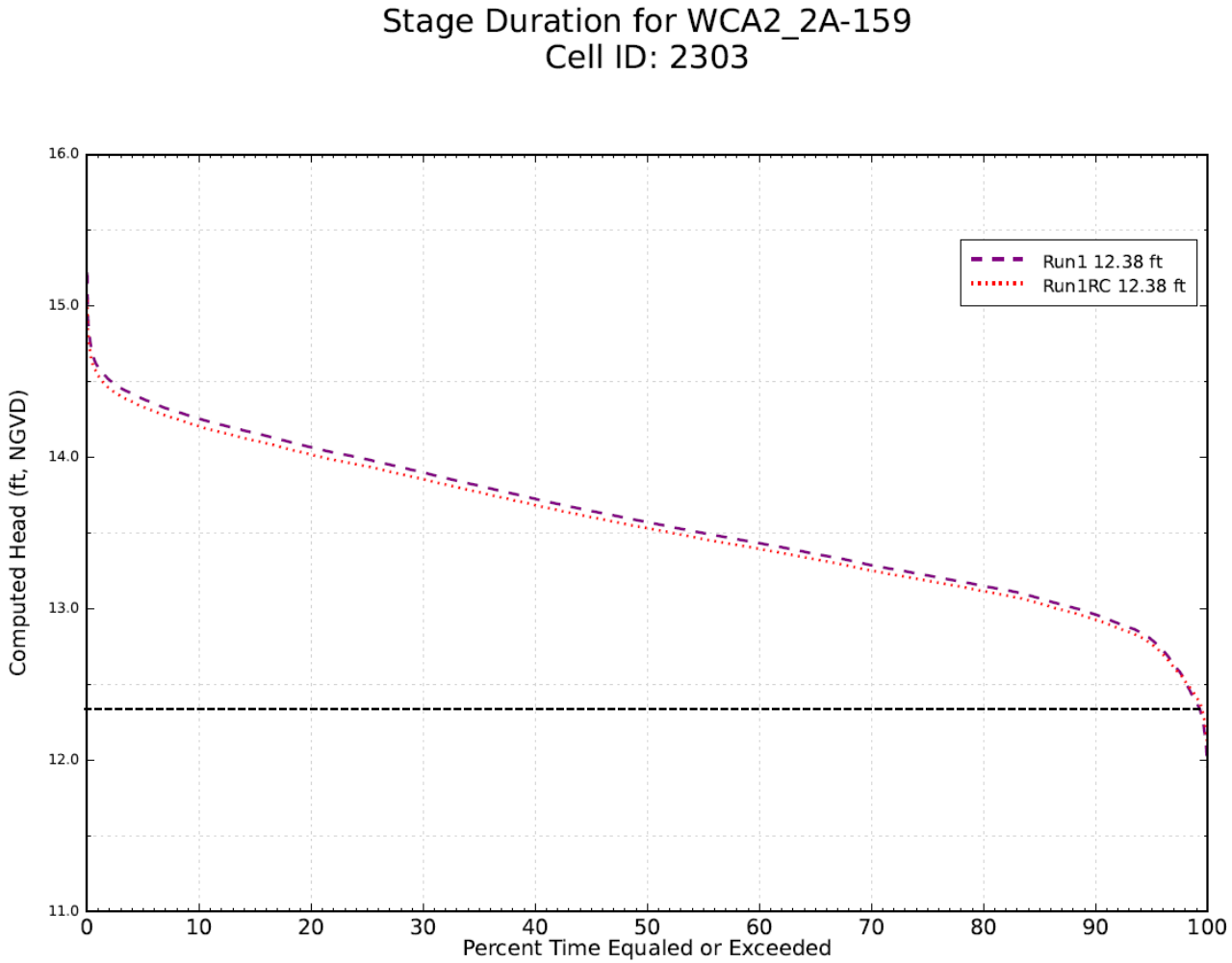


Run1RC



Stage Changes in WCA-2A





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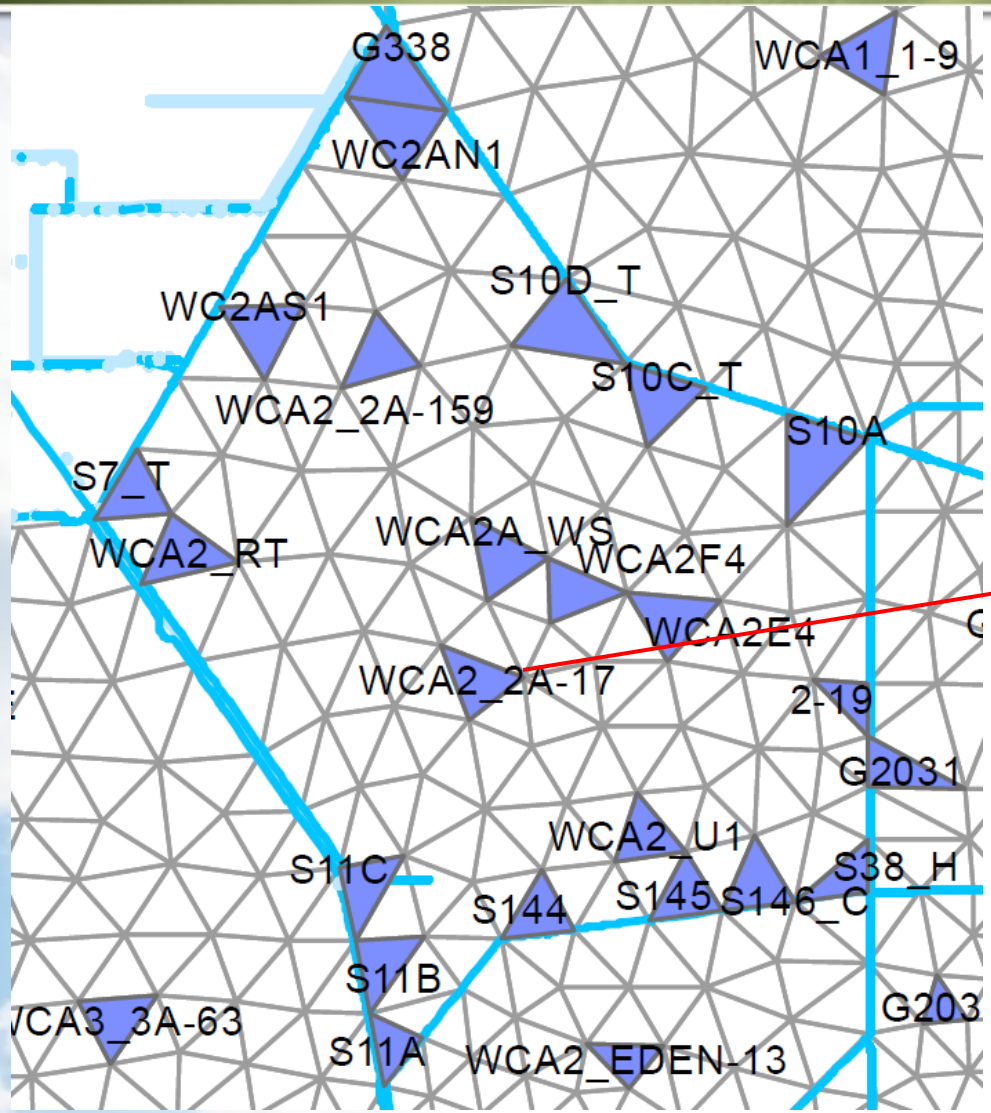

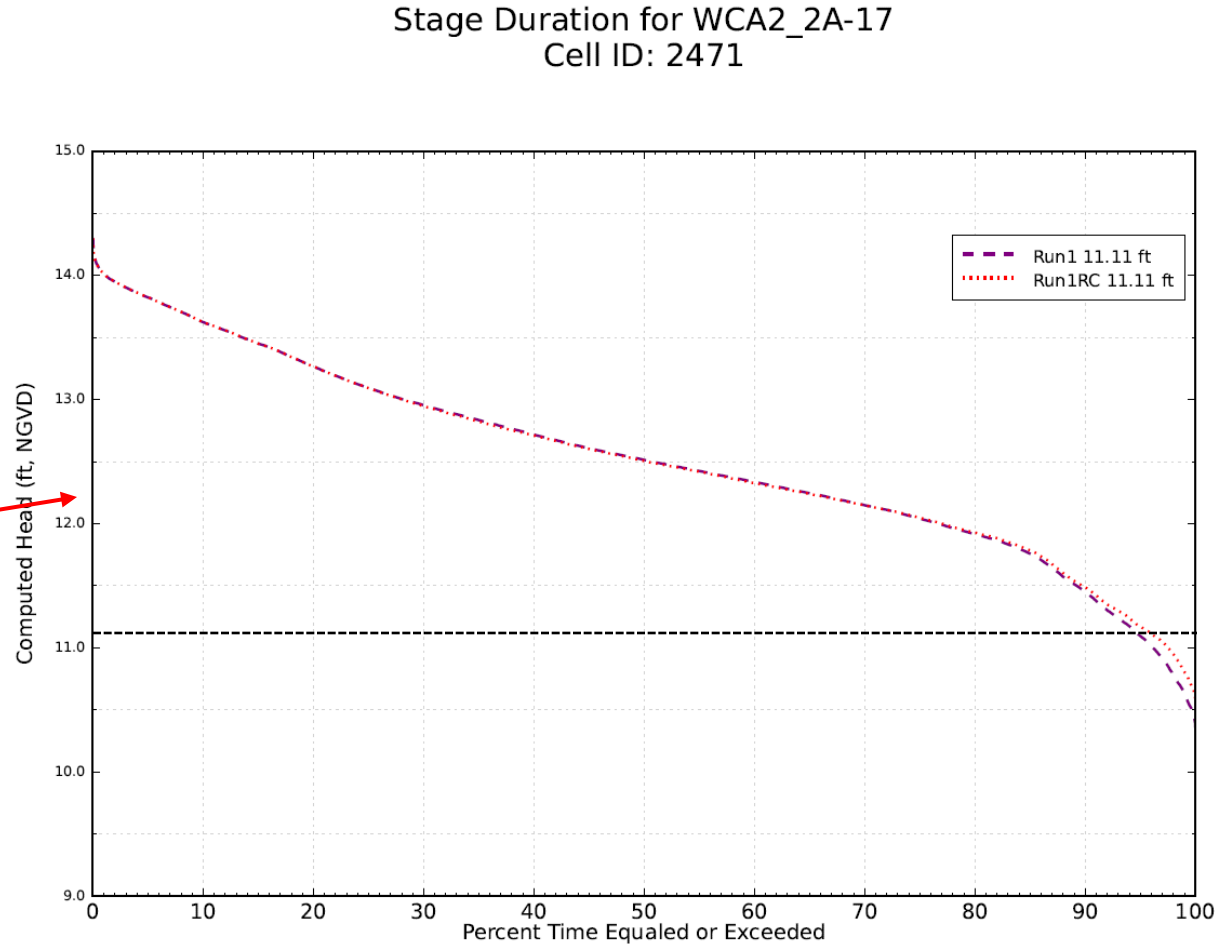

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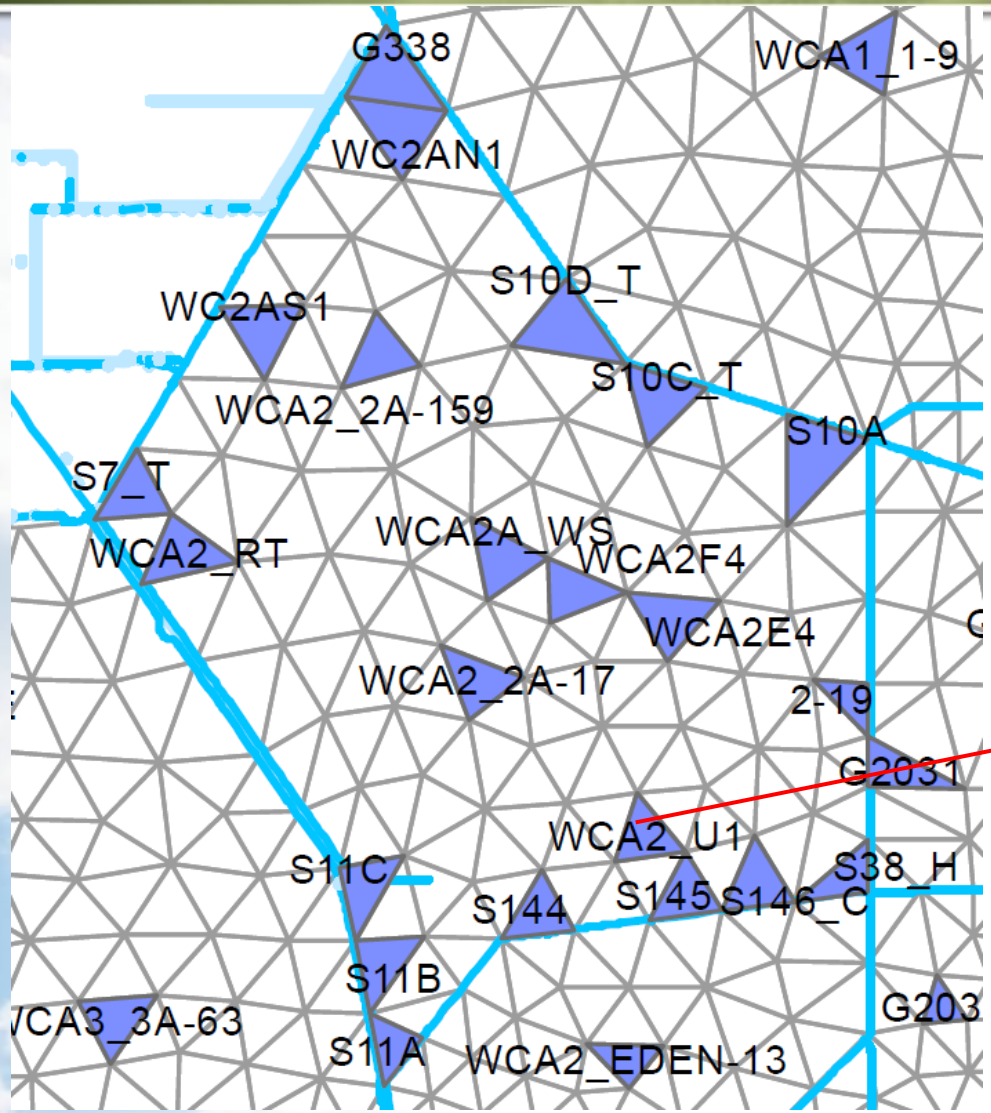
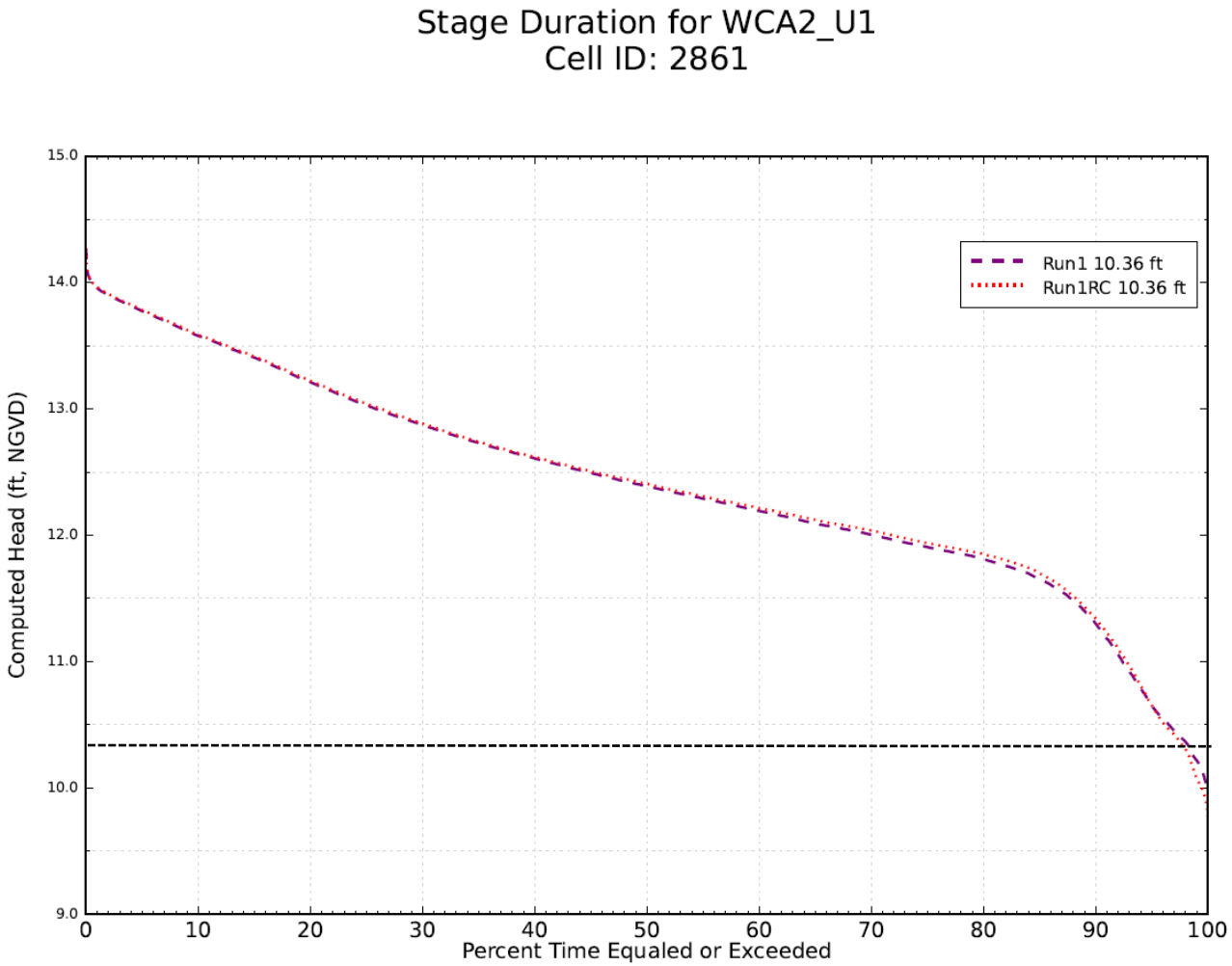
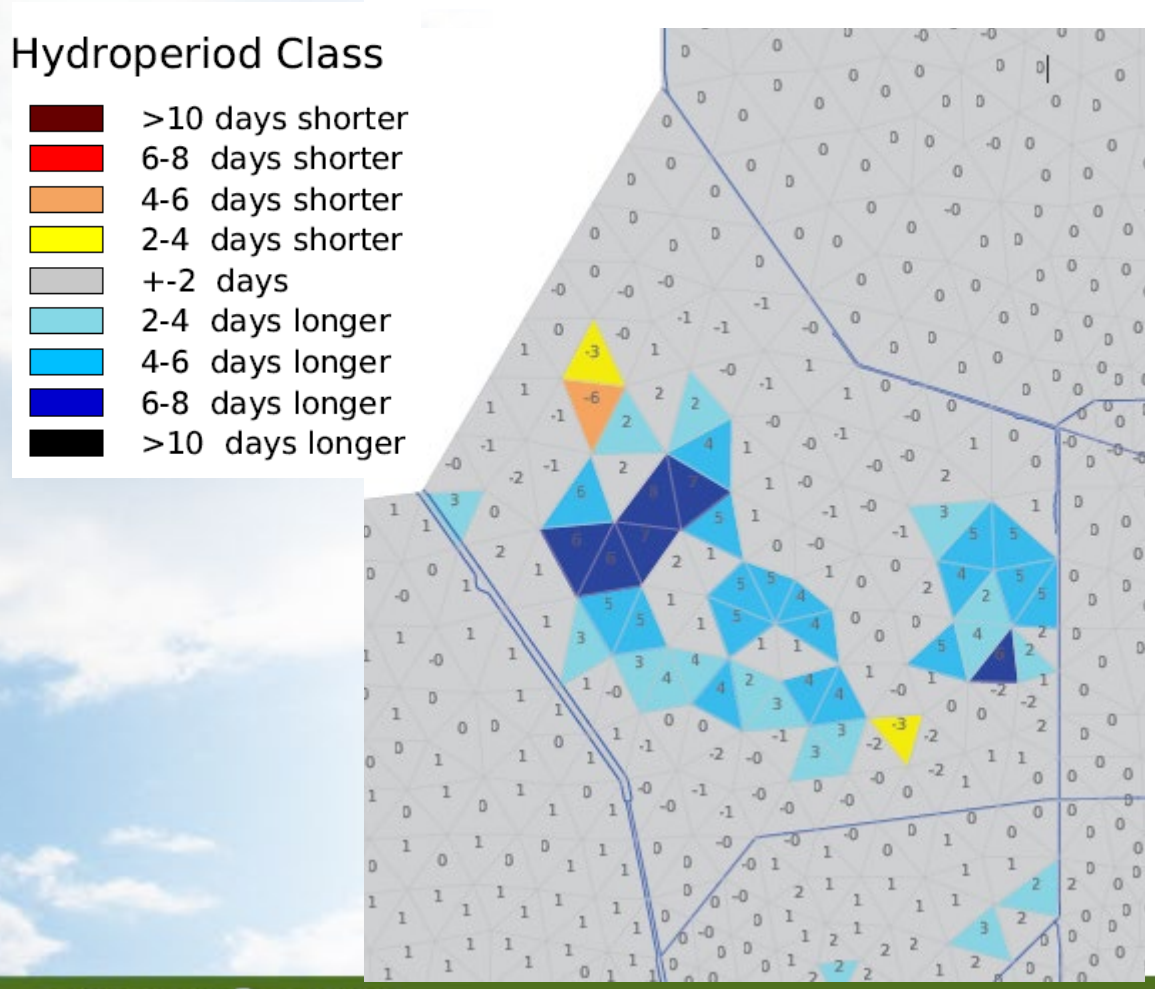




Hydroperiod Changes in WCA-2A

Run Name: Run1RC - Run1

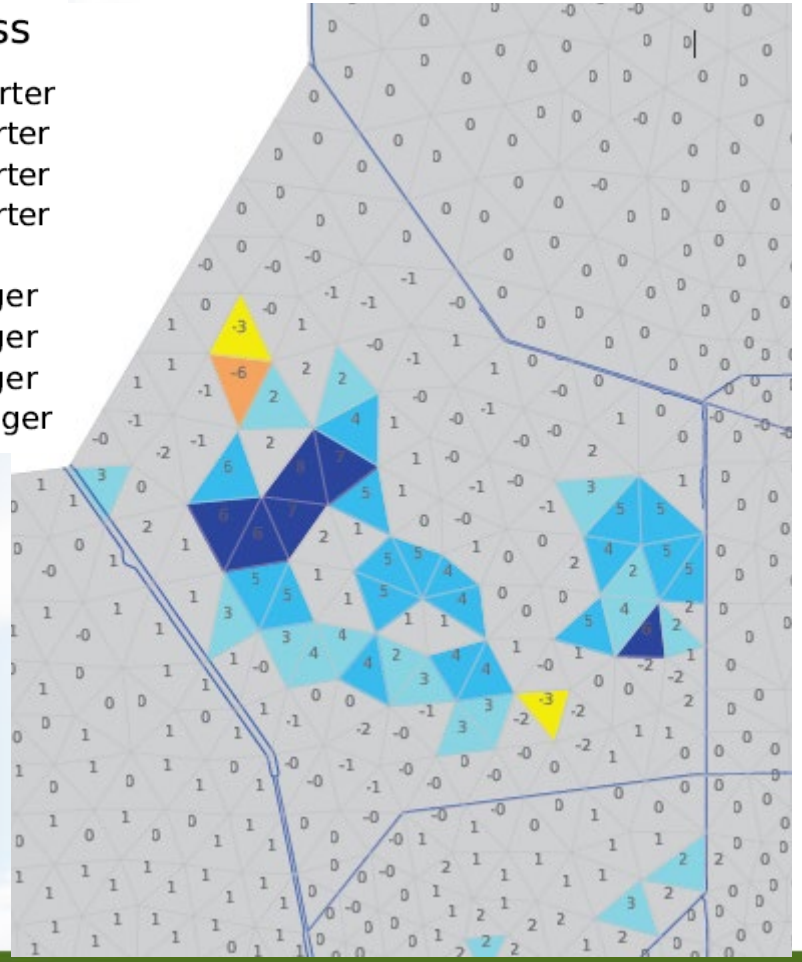


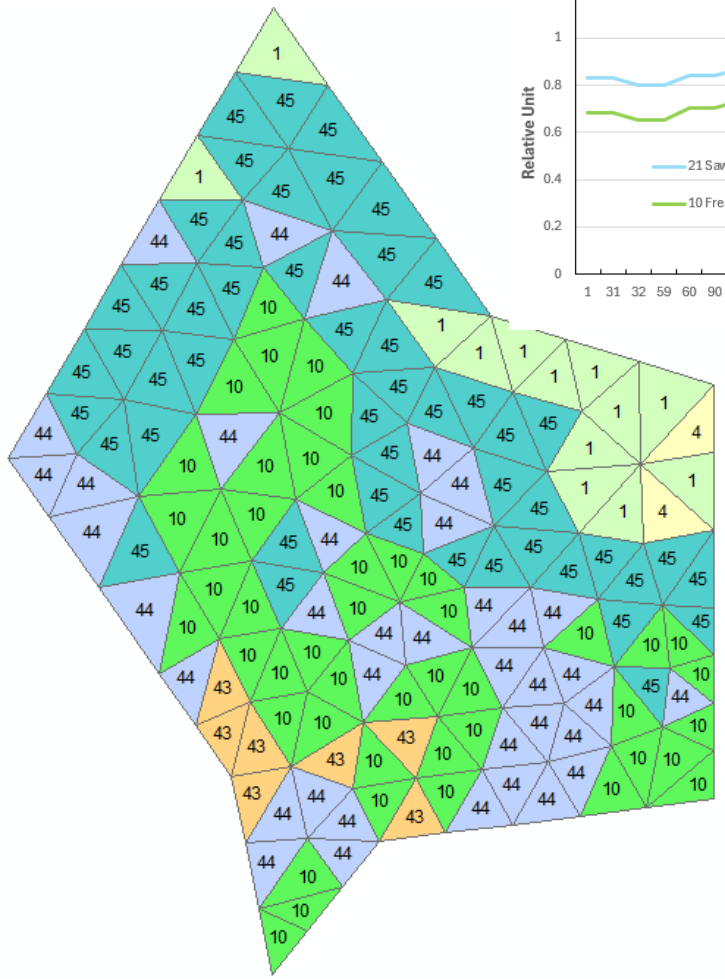
Hydroperiod Changes in WCA-2A

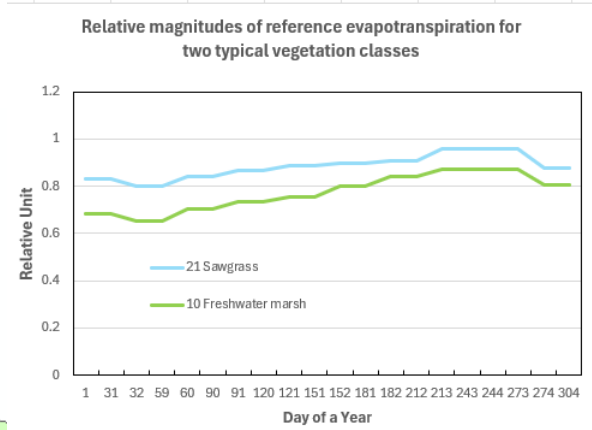
Run Name: Run1RC - Run1

Hydroperiod Class

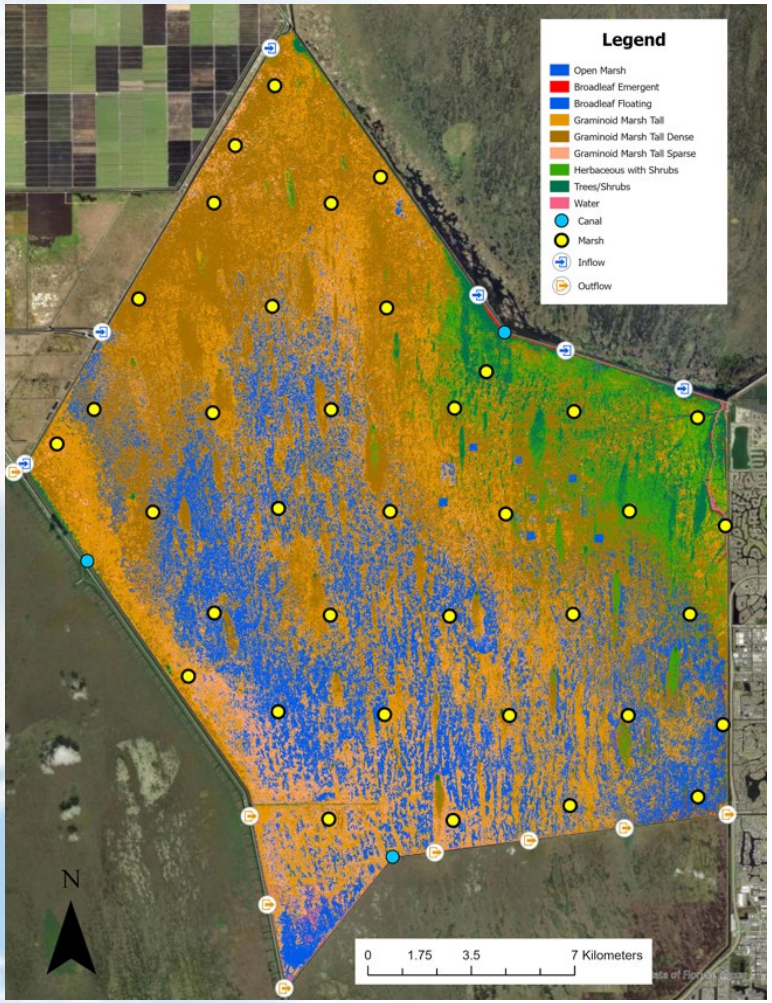
- >10 days shorter
- 6-8 days shorter
- 4-6 days shorter
- 2-4 days shorter
- +-2 days
- 2-4 days longer
- 4-6 days longer
- 6-8 days longer
- >10 days longer





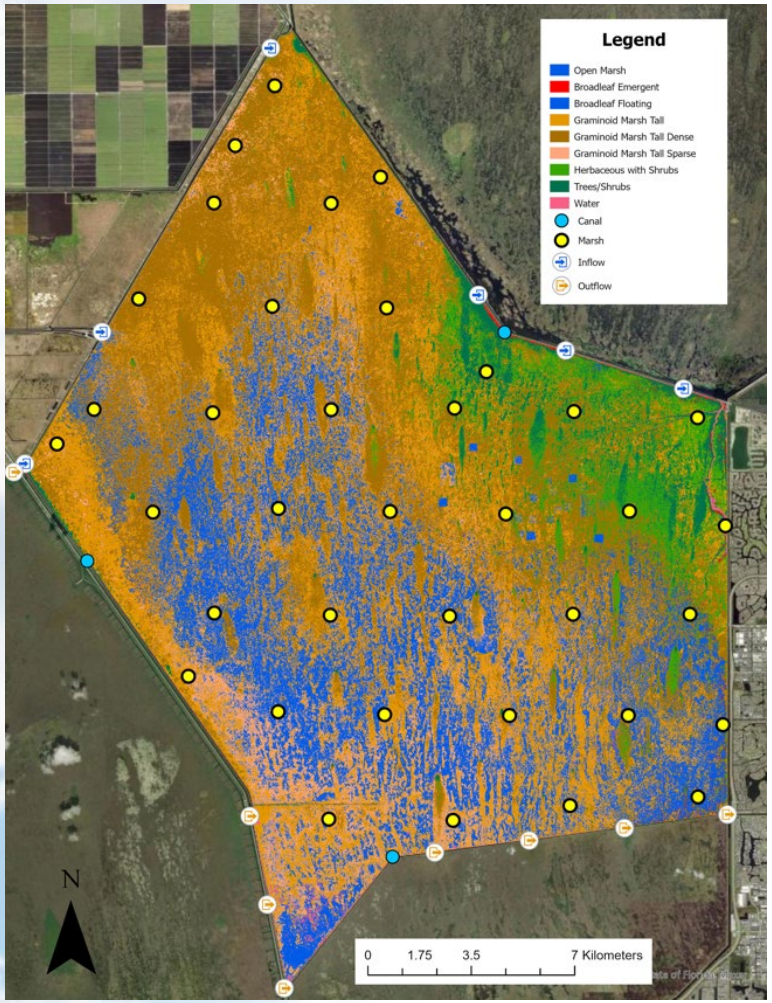


Stage and Water Depth in RUN1RC: Validation

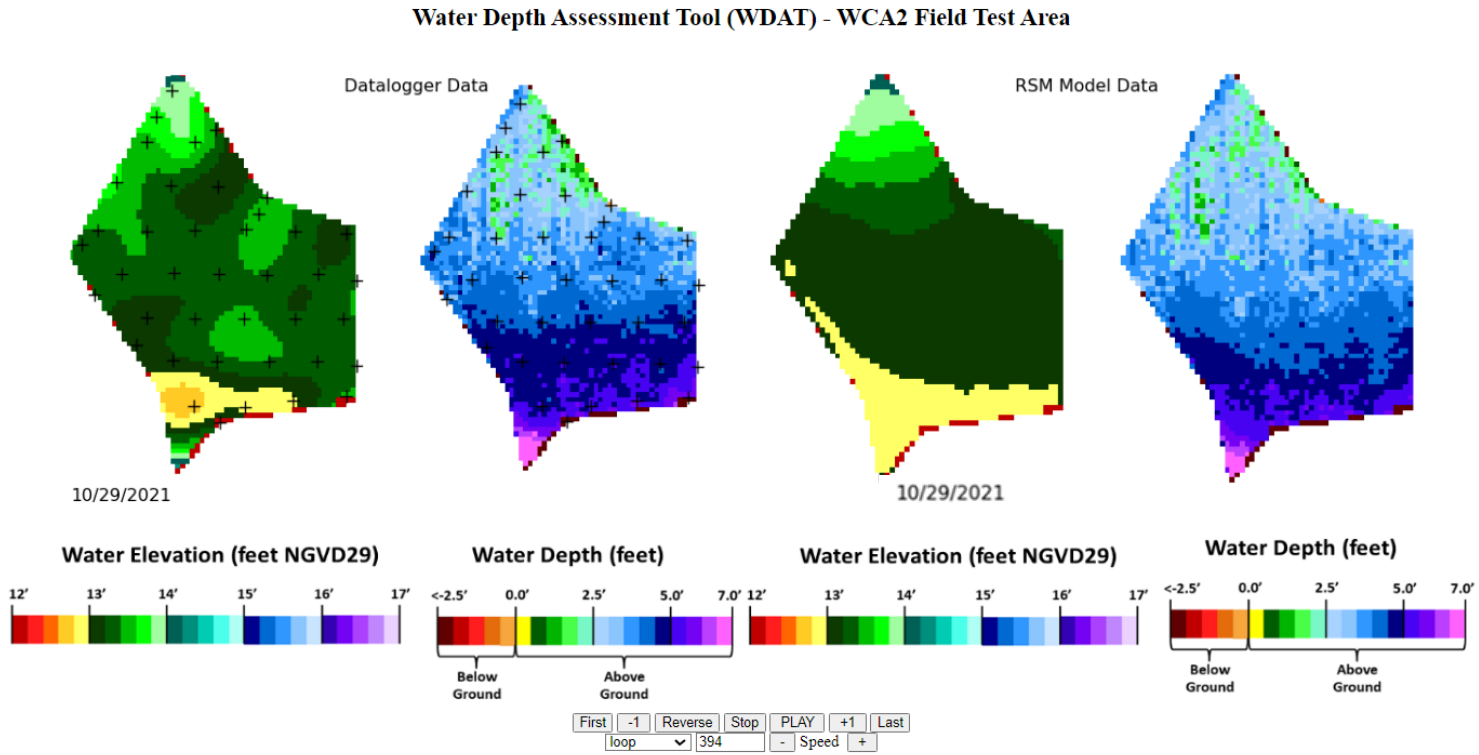


1. Field stage data collected in the POR (10/1/2020-12/26/2022)
2. While model POR range from 1965-2016, we imposed rainfall, ET and flows from above POR to model period (10/1/1998-12/26/2000) to simulate similar conditions as field data as a way to validate RUN1RC model results

Stage and Water Depth in RUN1RC: Validation



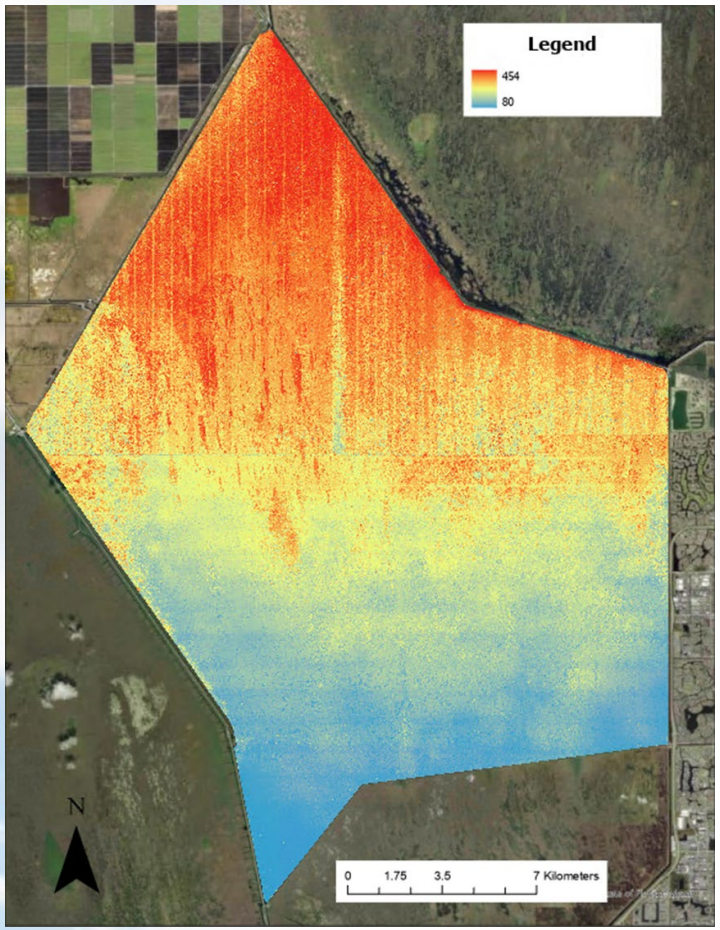
Example animation showing field data stages & depths on the left and RSM simulated stages and depths with imposed historical rainfall & flows on the right

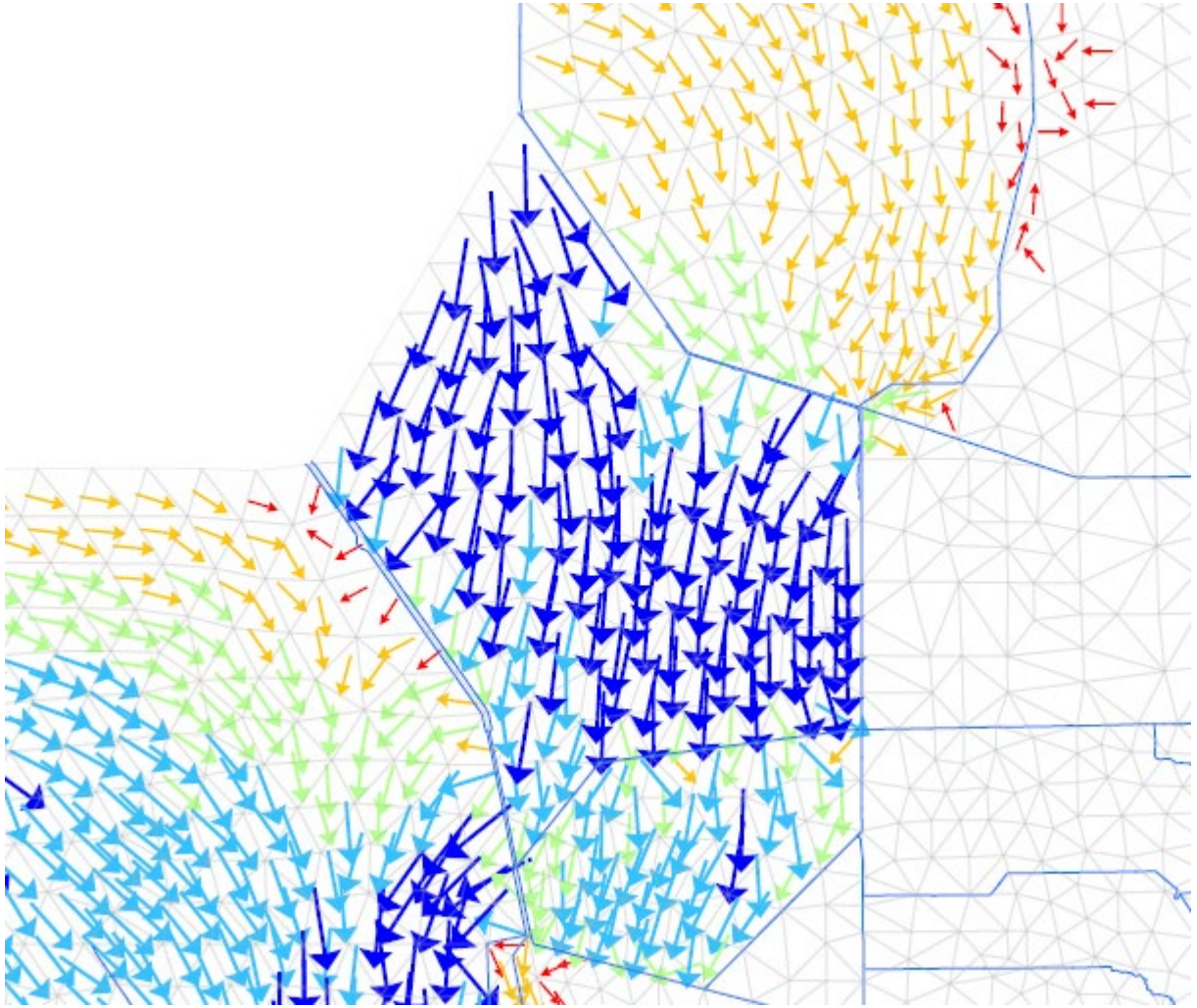


Flow Pattern in WCA-2A

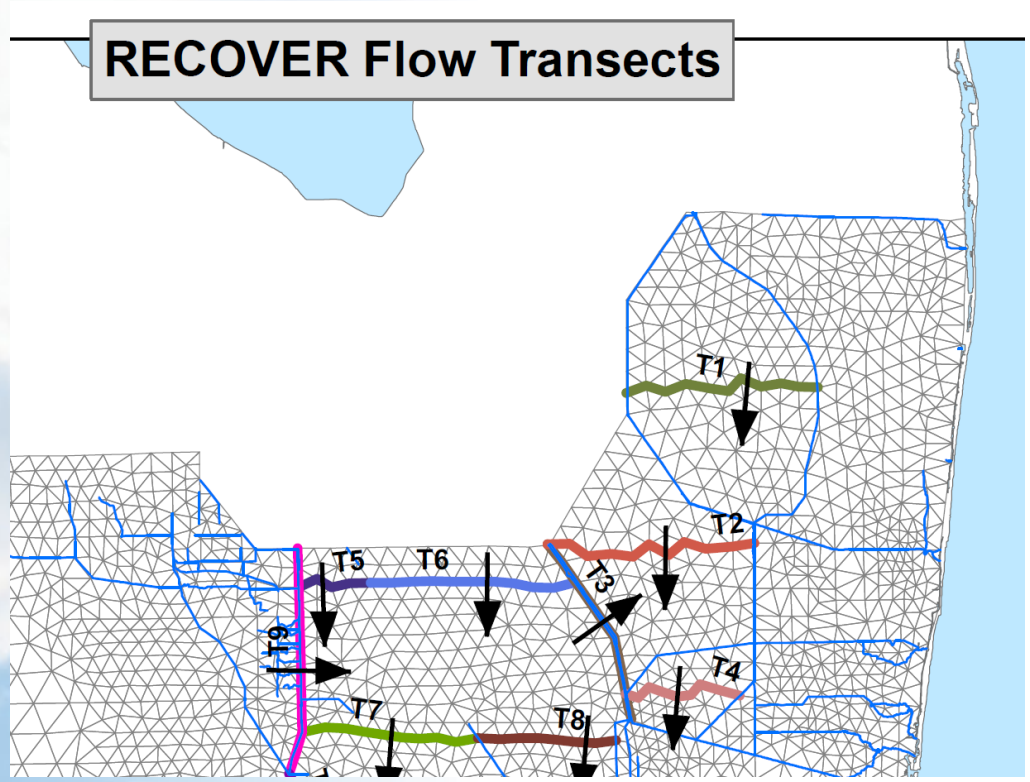
Elevation-Digital Terrain Model

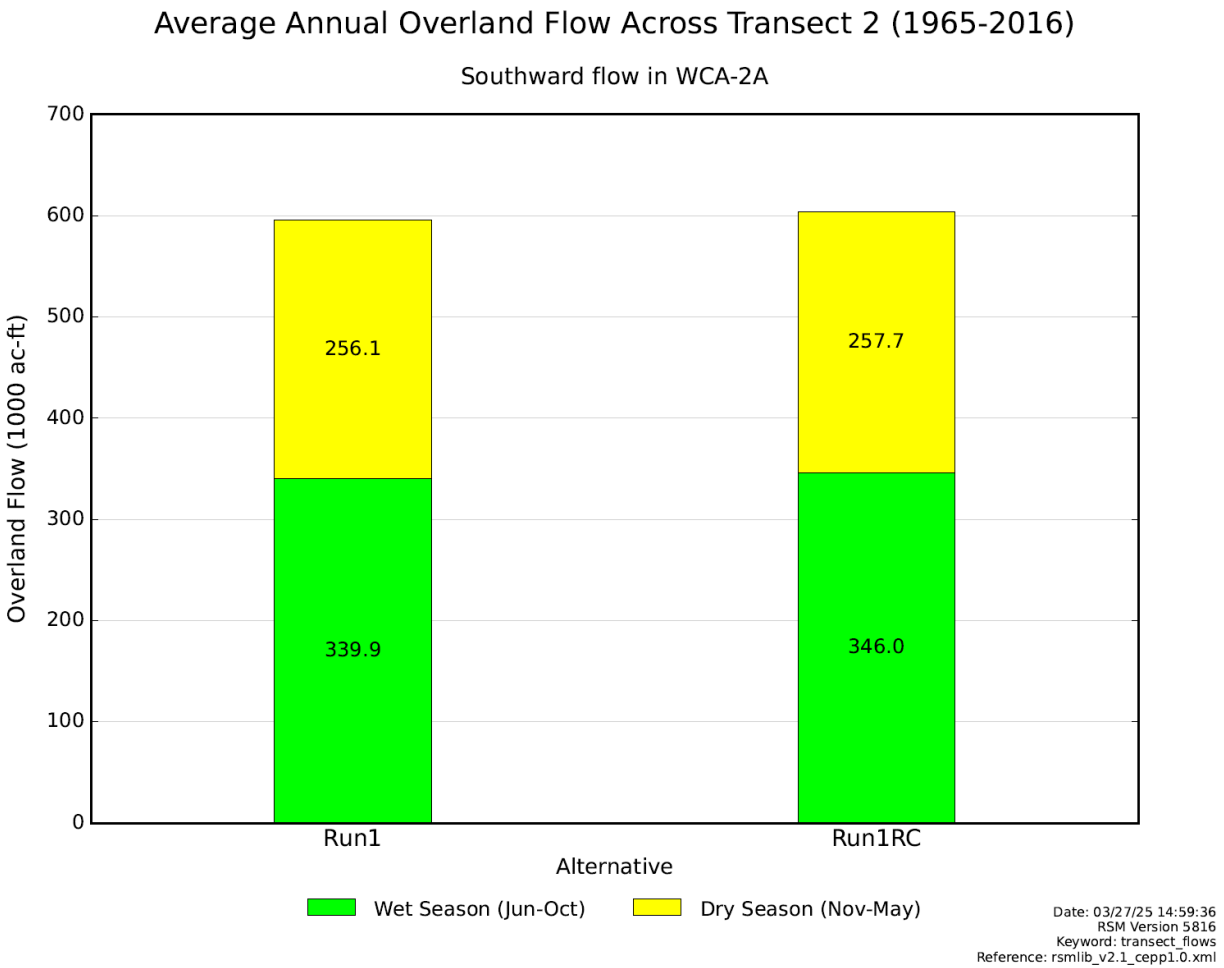
LiDAR/Worldview based



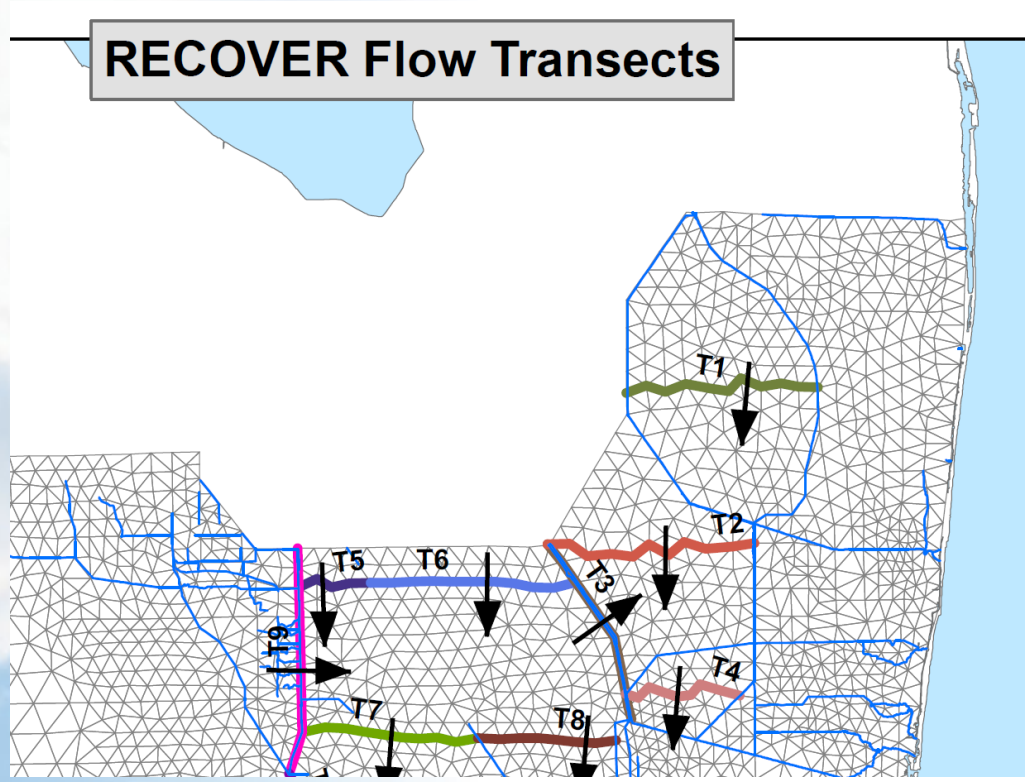


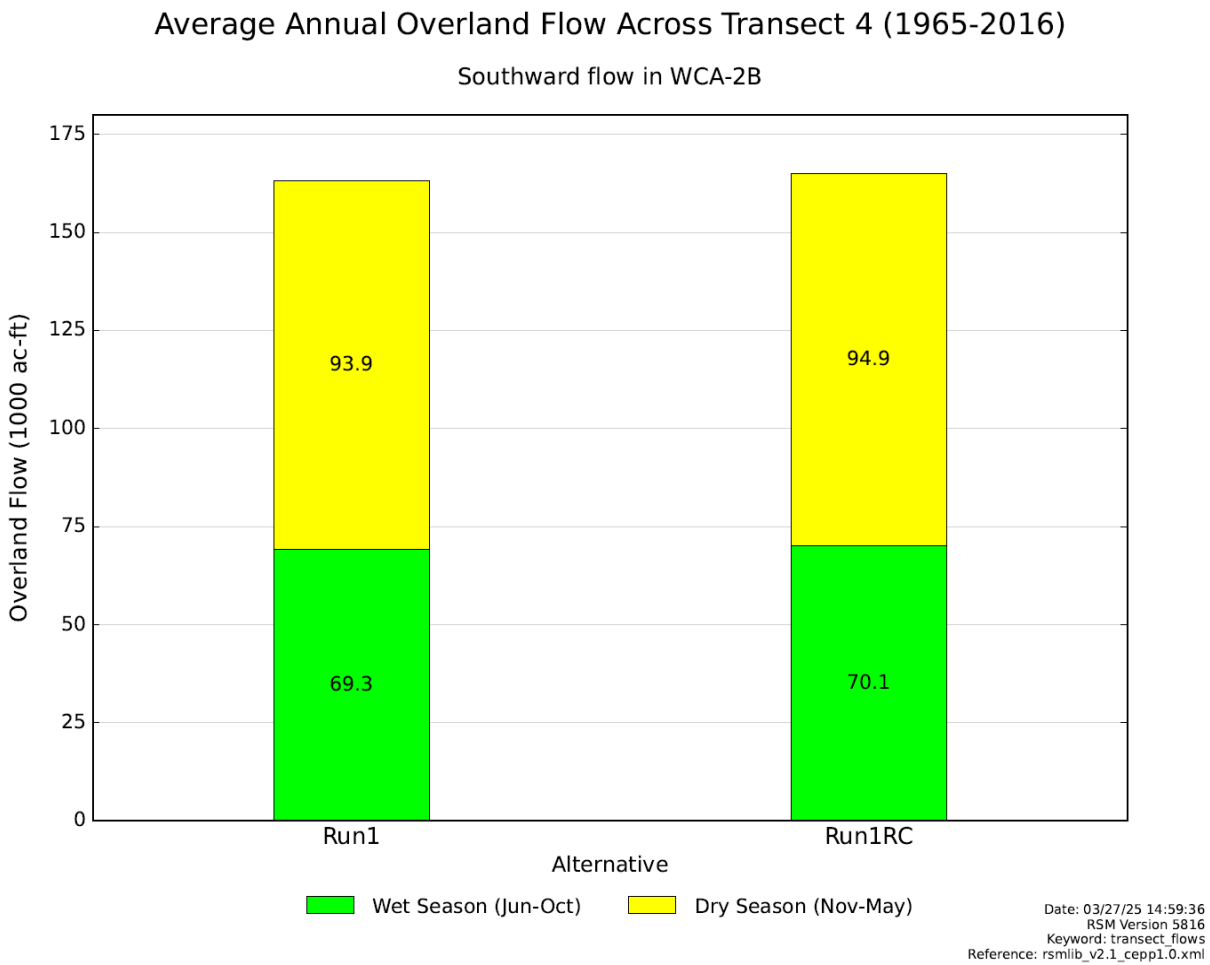
Transect Flow: Flow South in T2



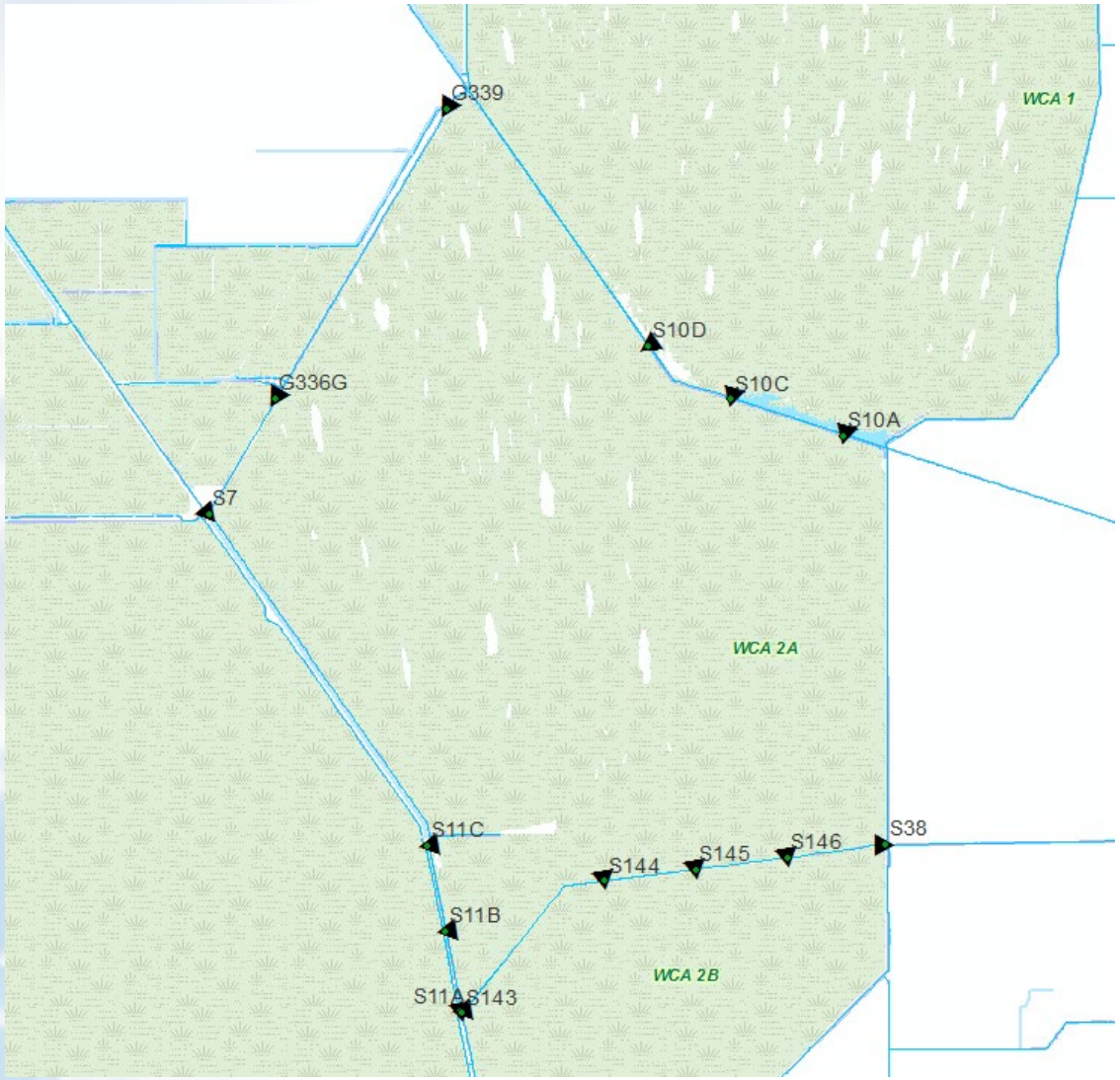


Transect Flow: Flow South in T4





Water Budgets in WCA-2A



Water Budgets in WCA2A (kacft/yr)			
	Run1	Run1RC	diff
Rainfall	435.09	435.09	0.00
ET	460.96	453.72	-7.24
HpmDelta	0.00	0.00	0.00
GW_EAA_WCA2A	5.28	5.28	0.00
S6-WL2351	0.04	0.04	0.00
S7-WL1351-WLES7	181.71	181.71	0.00
STA2O+BYP2N	465.68	465.68	0.00
STA2O+BYP2S	6.40	6.40	0.00
SW_EAA_WCA2A	0.00	0.00	0.00
marsh2seg	7.12	7.15	0.03
dry2seg	0.00	0.00	0.00
marsh2dry	30.86	31.33	0.47
S7BF_NW3A	1.60	1.61	0.01
S7BF_S150	0.82	0.84	0.02
S143	60.54	61.25	0.72
S144	39.98	40.54	0.55
S145	41.83	42.32	0.50
S146	41.15	41.67	0.52
S38	100.86	100.92	0.07
S11C	181.70	182.62	0.92
S11A	186.18	185.33	-0.85
S11B	174.31	177.98	3.66
S10E	0.00	0.00	0.00
NSID-2	0.00	0.00	0.00
NSID-3	0.00	0.00	0.00
WL1351	6.00	5.44	-0.56
S10D	79.50	79.48	-0.03
S10C	79.47	79.44	-0.03
S10A	79.65	79.64	-0.01

Summary

1. With RSM and two different vegetation classifications, the influences of vegetation on hydrological conditions in WCA-2A were evaluated, results showed that both annual hydroperiods, transect flow and structure flows changes with different vegetation classes, which likely further impact water quality and habitat suitability quality in the study area.

2. Improved vegetation classes and associated parameters in the future would be critical for better modelling of hydrological processes in the study and similar other areas.

Backup slide 1: Differences in hydroperiod