HYDROLOGIC AND WATER QUALITY MODELING FOR EVALUATING BEST MANAGEMENT PRACTICES IMPLEMENTATION IN A WESTERN EVERGLADES WATERSHED

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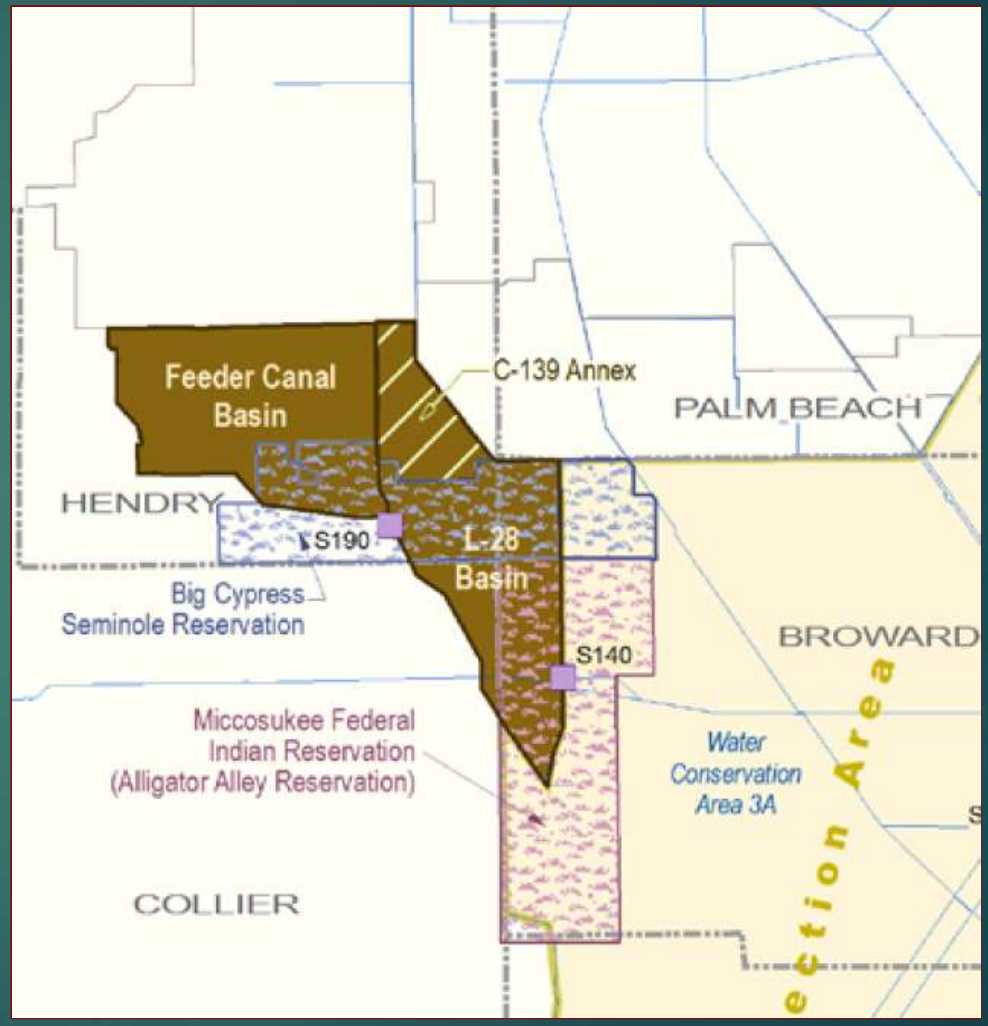
Background

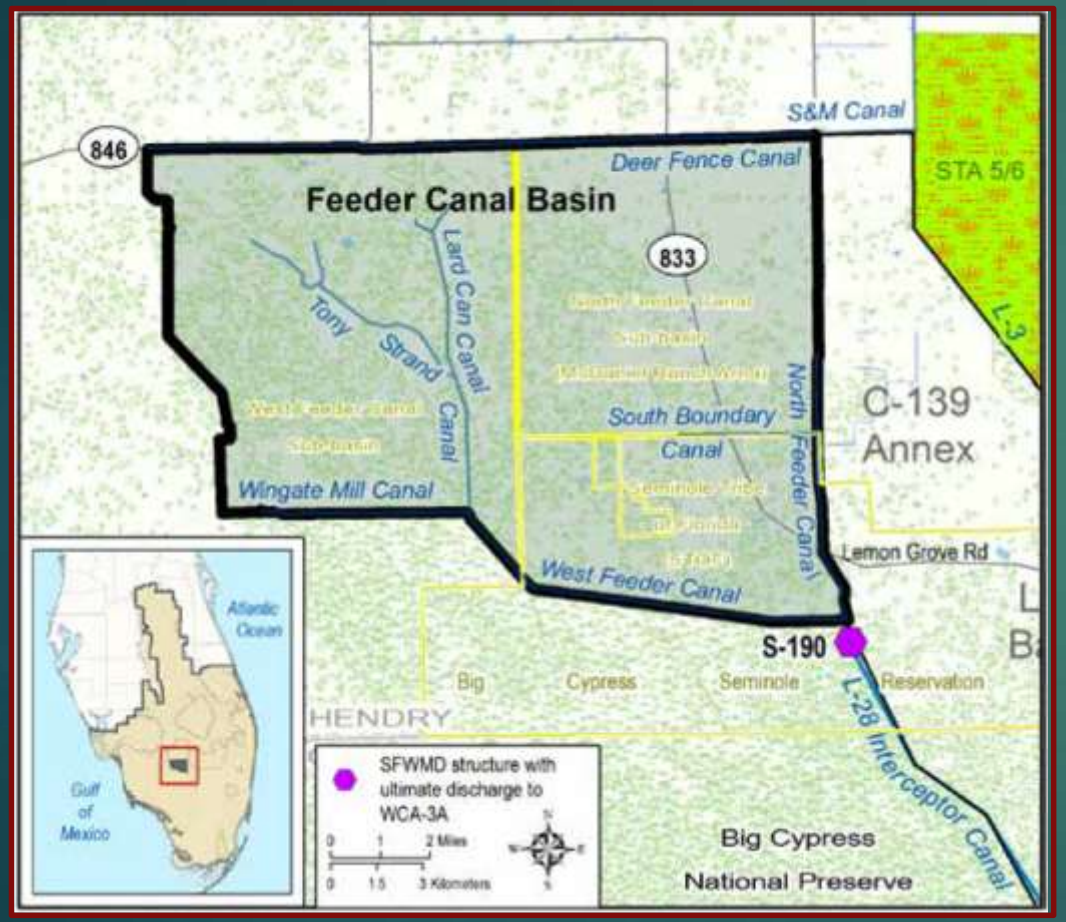
Feeder Canal (FC) Basin

- Non-ECP Basin
- SE Hendry County
- Predominantly agricultural
- Area: 108 sq. miles
- Drains to WCA3A through L28 Interceptor Canal
- S190 – Gated Spillway



Adopted from - SFER (2017) Volume 1, Chapter 4

Background



Adopted from - SFER (2017) Volume 1, Chapter 4

- Top TP Contributor to WCA3A (WY2012-2016)
  - TP FWMC: ~87 ppb
  - TP Load: ~ 6 tons/yr
- FC Basin is part of 'zone 2' of Western Everglades Restoration Project (WERP).
- ~20% of FC is within Big Cypress Seminole Reservation

Objectives

Objective 1:

To model hydrology and water quality for the existing conditions (2000-2014) in FC Basin.

Objective 2:

To assess potential of TP load reduction from FC Basin through implementation of Agricultural and Urban Best Management Practices (BMPs).

- Tool: Watershed Assessment Model (WAM)

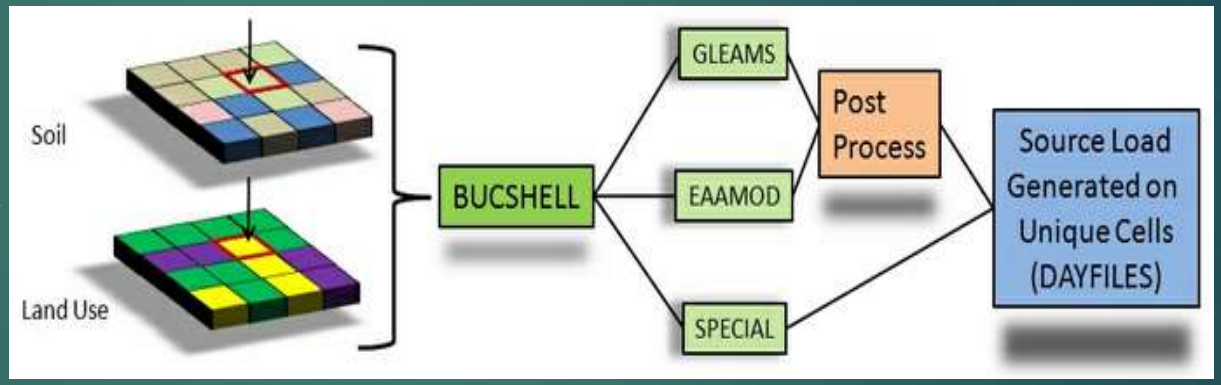
WAM Details

WAM Inputs
Soil, land use, topography, weather, utility zones etc.

Unique Cells

Area Discretization

BUCSHELL



Adopted from WAM Manual (SWET, 2014)

WAM Details

WAM Inputs
Soil, land use, topography, weather, utility zones etc.

Unique Cells

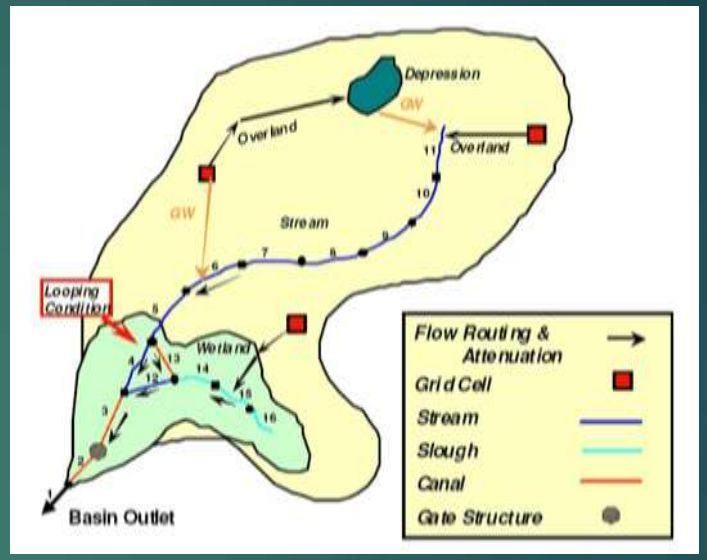
Area Discretization

BUCSHELL
Generation of flow and constituents at field scale

GLEAMS, EAAMOD and Special Case

Distance Grids

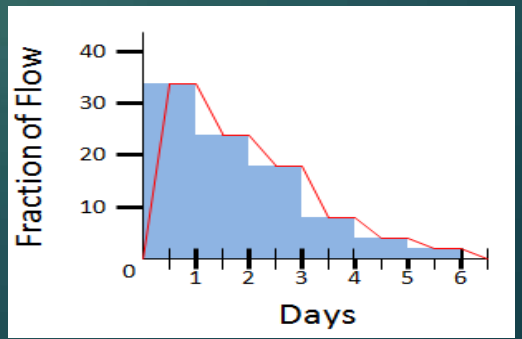
Topography



BLASROUTE

$$T = (\frac{d}{v}) + k + U\_HYDRO$$

Flow Routing



Overland WQ attn.

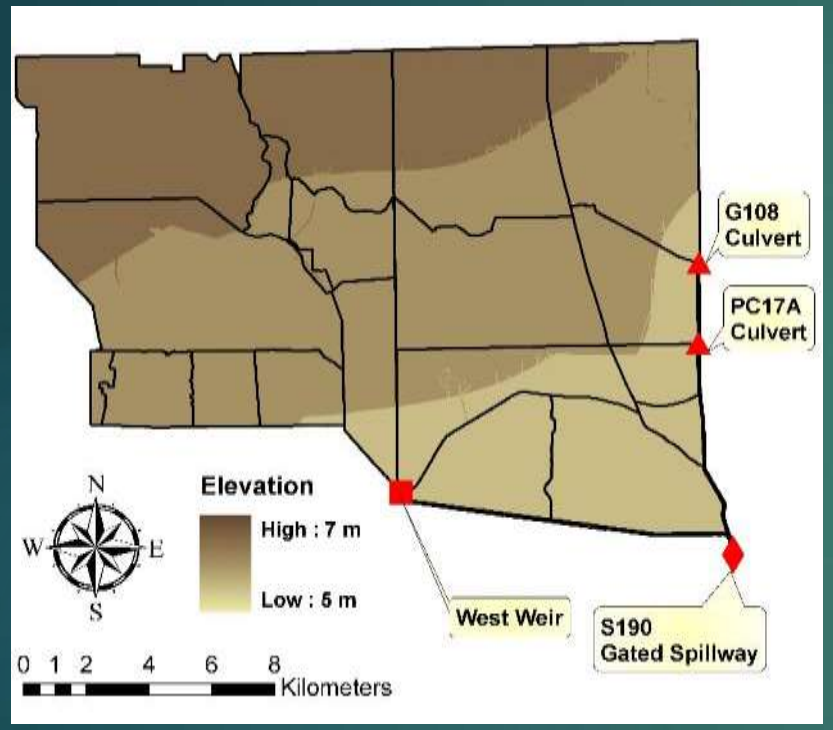
$$C = (C_o - C_b)e^{-(aq^{-b})d} + C_b$$

In-stream WQ attn.

$$C = (C_o - C_b)e^{-a\frac{\tau}{R}} + C_b$$

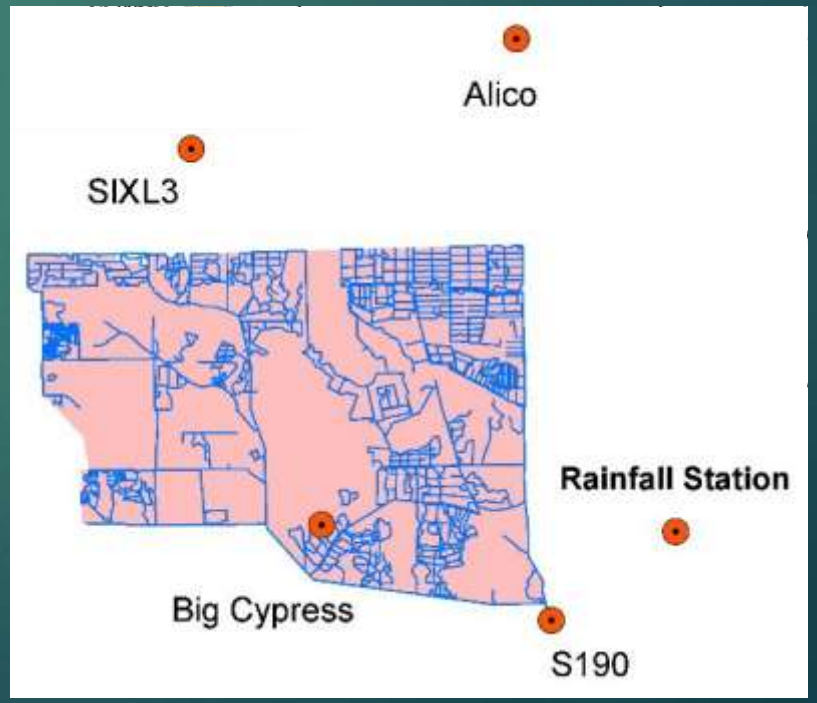
FEEDER CANAL BASIN
Existing Conditions

Feeder Canal: Input Maps for WAM



Elevation Data: FGDL Statewide DEM (2013)

- Flat terrain sloping from NW to SE
- 20 sub-basins: literature, topography and imagery



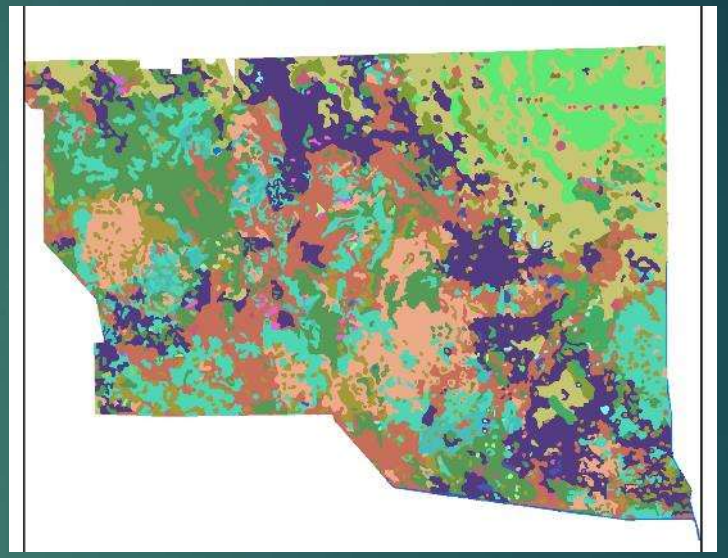
- 4 Rainfall Stations
- Thiessen Polygon

Feeder Canal: Input Maps for WAM

LU Data: FDEP Statewide Landuse (2011-12)

LU	%
Urban, developed	1
Pasture	42
Other Agriculture	19
Natural Areas	9
Wetlands	29
Total	100

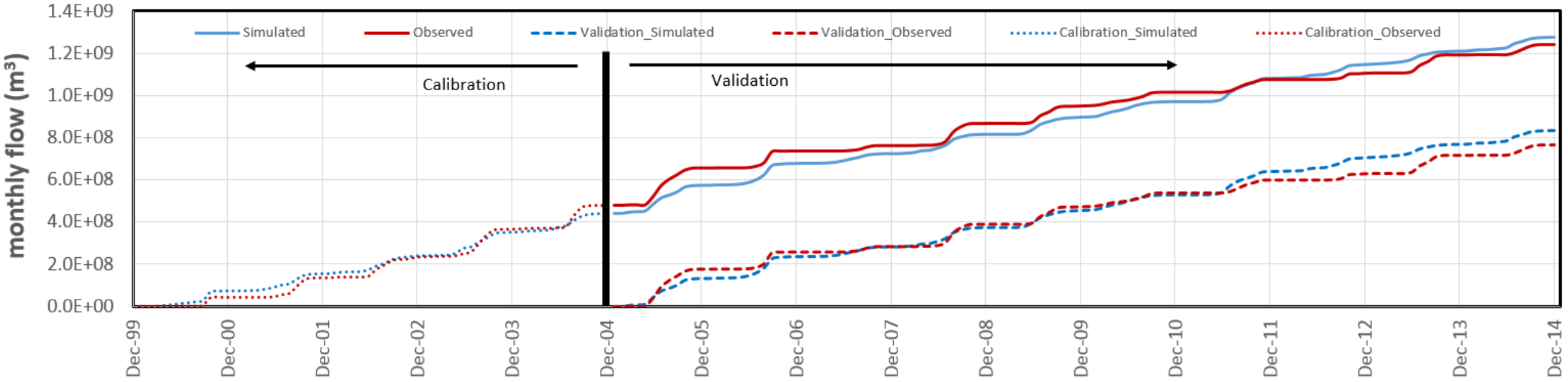
Soil	Type
Basinger	EAAMOD
Boca	GLEAMS
Chobee	GLEAMS
Hallandale	GLEAMS
Holopaw	EAAMOD
Immokalee	EAAMOD
Jupiter	GLEAMS
Riviera	EAAMOD



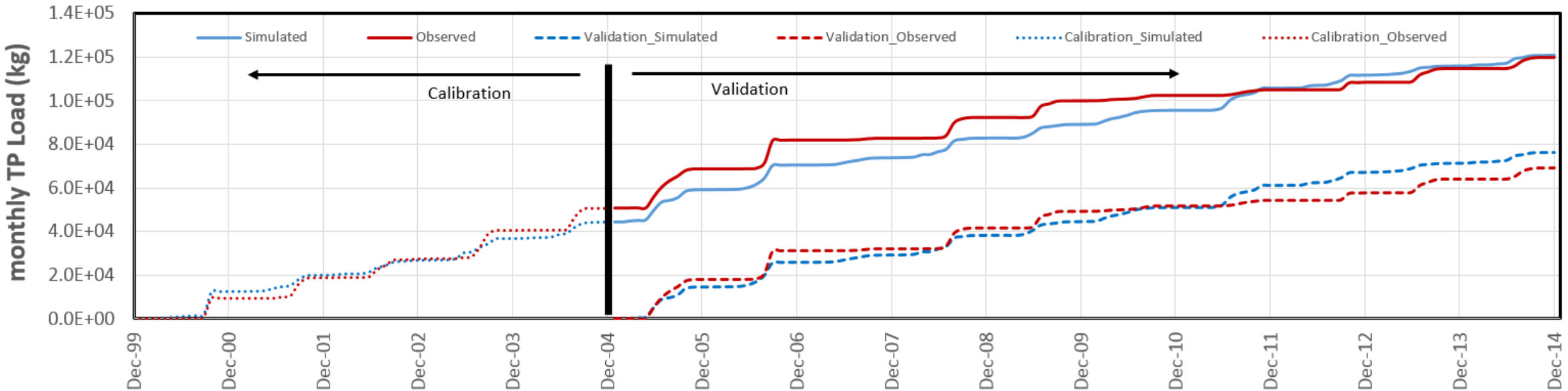
Model Calibration - Validation

- Simulation Period – 2000 to 2014
  - Calibration – 2000 to 2004 (5 years)
  - Validation – 2005 to 2014 (10 years)
- Target Variables and Goodness of Fit Measures
  - Monthly flows and monthly TP load @ S190
  - Nash-Sutcliffe Efficiency and Percentage Bias
- Sequential manual calibration – H&H then Nutrient
  - H&H – ET factors, manning's n, runoff velocity and unit hydrograph
  - Nutrient – background P concentrations and attenuation parameters

FEEDER CANAL BASIN CUMULATIVE OUTFLOW AT S190



FEEDER CANAL BASIN CUMULATIVE TP LOAD AT S190



Summary GOFs for flow and TP at S190

GOF	Monthly Flow			Monthly TP Load		
	CALIBRATION	VALIDATION	OVERALL	CALIBRATION	VALIDATION	OVERALL
NSE	0.70	0.70	0.70	0.68	0.66	0.67
PBIAS	+8.4	-9.3	-2.5	+12.1	-10.0	-0.6

$$NSE = 1 - \frac{\sum(O-P)^2}{\sum(O-Oavg)^2}$$

$$PBIAS = \frac{\sum(O-P)}{\sum(O)} * 100$$

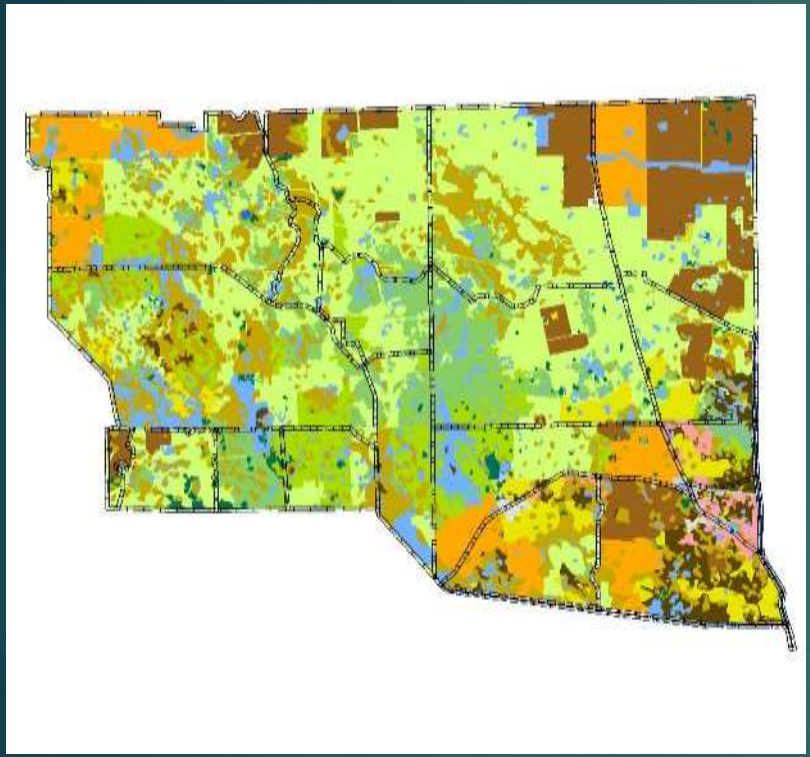
O – observation
P – prediction
Oavg – average of observations

NSE : [-inf, 1]
0 : Oavg is better then model, 1 : perfect model
NSE > 0.5 : Acceptable, NSE > 0.65 : good

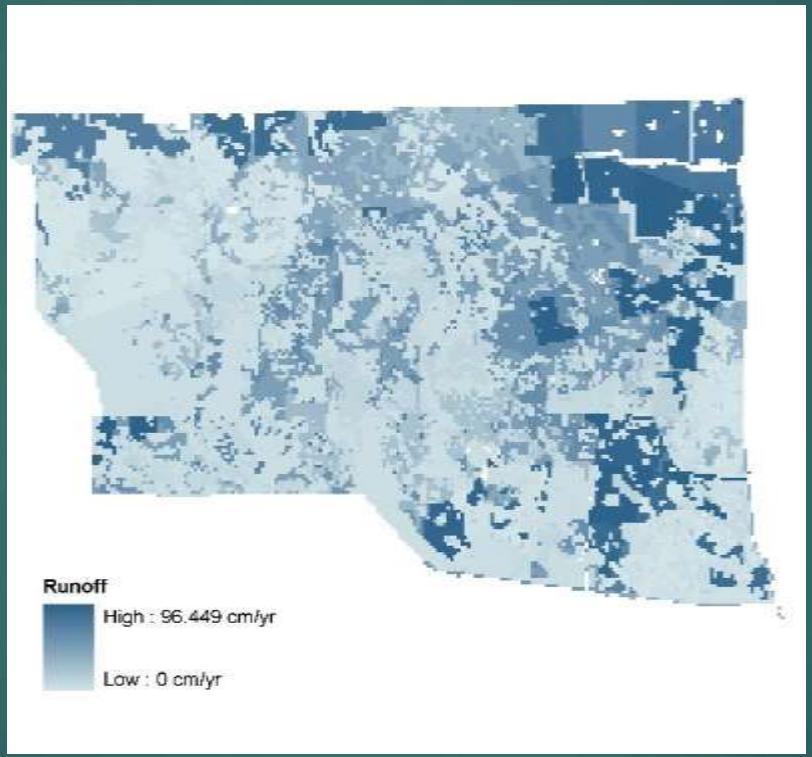
PBIAS : [-∞, +∞], +ve -> under, -ve -> over
0 : perfect model
-10% to 10% : good for flow
-25% to 25% : good for nutrient loads

Moriasi et al. (2007)
Ritter and Munoz-Carpena (2013)

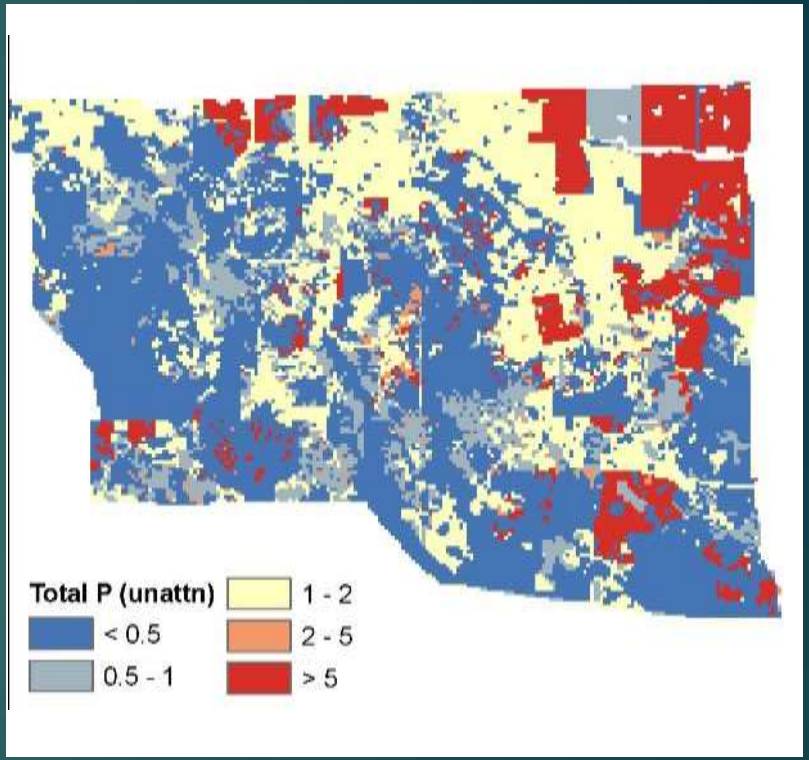
Output Maps: Source Level



Landuse



Runoff (cm/ha/yr)



Unattenuated TP (kg/ha/yr)

AVERAGE ANNUAL TP LOAD (unattenuated) BY LANDUSE

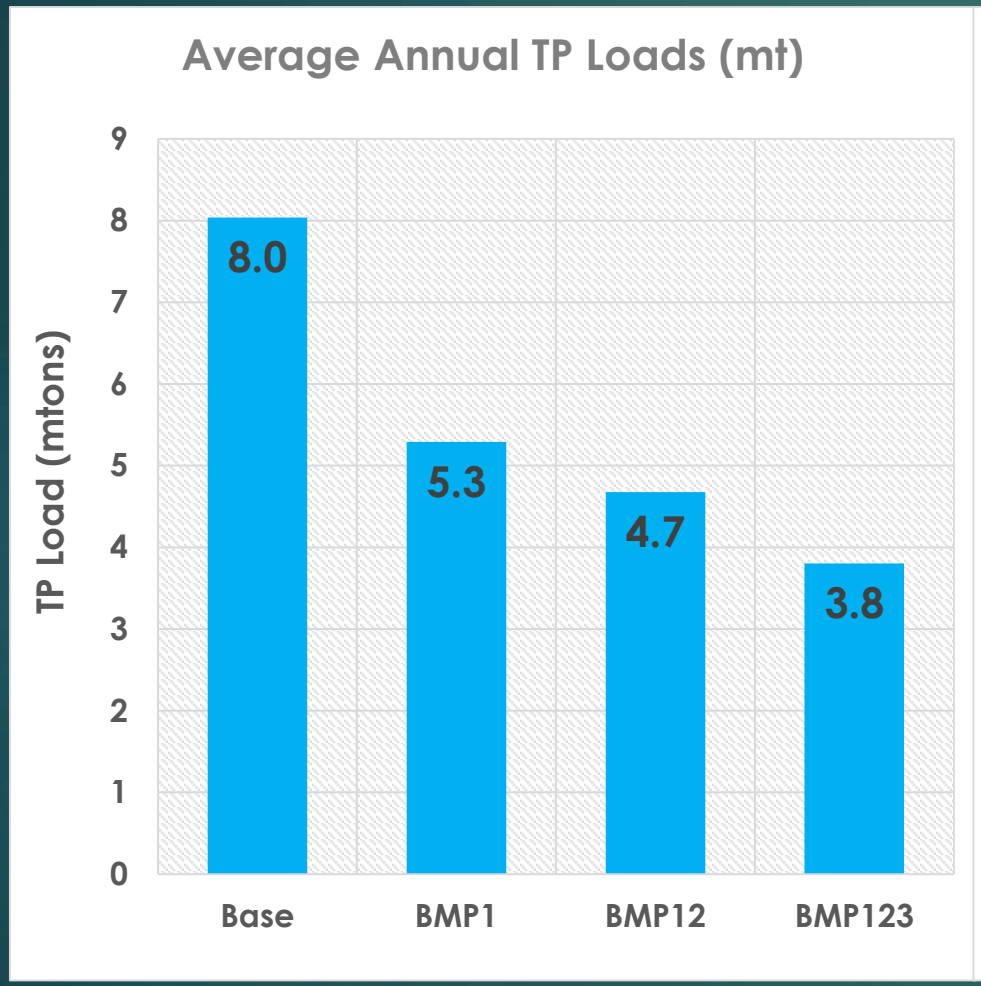
Land Use	Area (ha)	Mean (kg/ha)	Sum (kg)
Wetland Forested Mixed	1009	0.018	18.02
Cypress	4416	0.013	59.23
Wetland Hardwoods	1270	0.014	18
Citrus Groves	1812	0.309	559.79
Scrub and Brushland	1110	0.025	27.49
Barren Land	165	0.834	137.64
Hardwood Conifer Mixed	843	0.023	19.51
Row Crops	3324	1.45	4819.59
Improved Pasture	7851	0.406	3188.69
Freshwater Marshes	1156	0.013	15
Low Density Residential	304	0.158	48
Groves and Orchards	205	2.452	502.6
Commercial and Services	101	0.698	70.49
Woodland Pasture	2321	0.331	768.36
Undeveloped Urban Land	6	0.095	0.57
Unimproved Pasture	1339	0.188	251.72
Wetland Coniferous Forest	90	0.022	1.97
Emergent Aquatic Vegetation	23	0.029	0.66
Hardwoods	69	0.028	1.93
Total	**27414**		**10509.26**

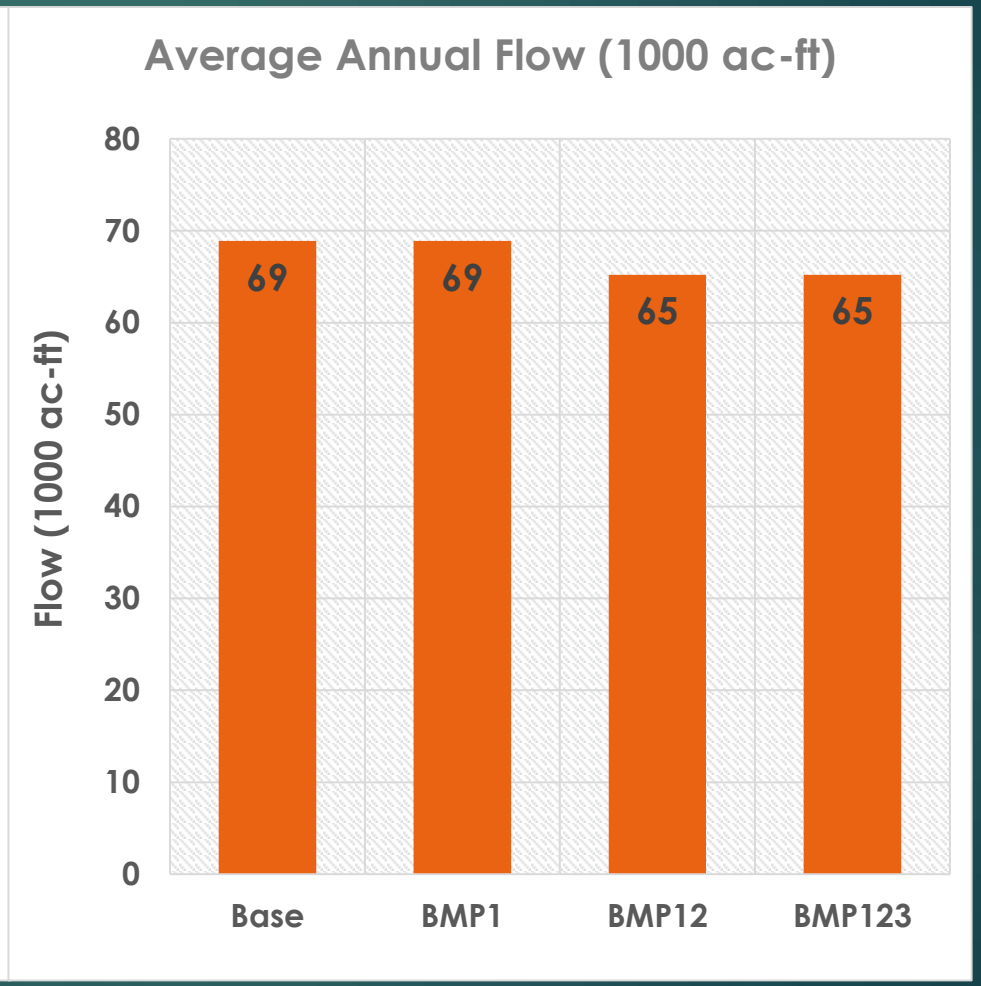
FEEDER CANAL BASIN
BMP Scenarios

Best Management Practices (BMPs)

- Restoration Strategy
- FDACS and UF IFAS BMP Manuals
- Types and Characteristics
  - Type 1 – Non-structural/Owner (fertilizer, record keeping) – Slow – Less Effective
  - Type 2 – Structural/Cost Share (irrigation, fencing, storm R/D) – Moderately Fast – Moderately Effective
  - Type 3 – Innovative (chemical treatment) – High Cost – Fast – Highly Effective
- BMP1 = Type 1, BMP12 = Type1+Type2, BMP123 = Type1+Type2+Type3
- WAM BMP Parameterization was based on earlier studies

Effectiveness of BMPs





Summary

- Successfully implemented WAM to model existing conditions in Feeder Canal Basin.
- Agricultural activities contribute the most to TP loads generated in the basin (Row crops being the highest contributor).
- Results indicate that TP loads can be potentially reduced by 34% to 53% of existing loads under BMP1 and BMP123 implementation scenarios, respectively.
- Similar study was done for L28 Canal Basin. Currently we are expanding our study area to BCNP Gap Basin adjacent to FC and L28 Basins.
- This work can provide useful insights to WERP planning process.

Acknowledgements

- Dr. Naja – chief scientist at the Everglades Foundation

Thank You!

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