



Environmental Assessment of the Okeechobee Basin Using the Watershed Assessment Model (WAM)



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Outline

- **Background and History of WAM in the Okeechobee watershed**
- **2008 WAM Runs and 2012 Updates**
- **Use of the 2012 WAM simulation results in the Okeechobee BMAP**
- **Current WAM Updates (Completion July 2015)**
- **WAM Activities (Starting July, 2015)**



Why Model?

Educate stakeholders on watershed behavior for better decision making!

- ***Help set TMDLs and develop reasonable BMAPs***
 - Quantify change from native conditions
 - Quantify relative contributions by land use
 - Evaluate alternative abatement scenarios
 - Environmental benefits of BMPs and other Projects
 - Economic impact
 - Evaluate compliance of implemented programs



WAM Development History

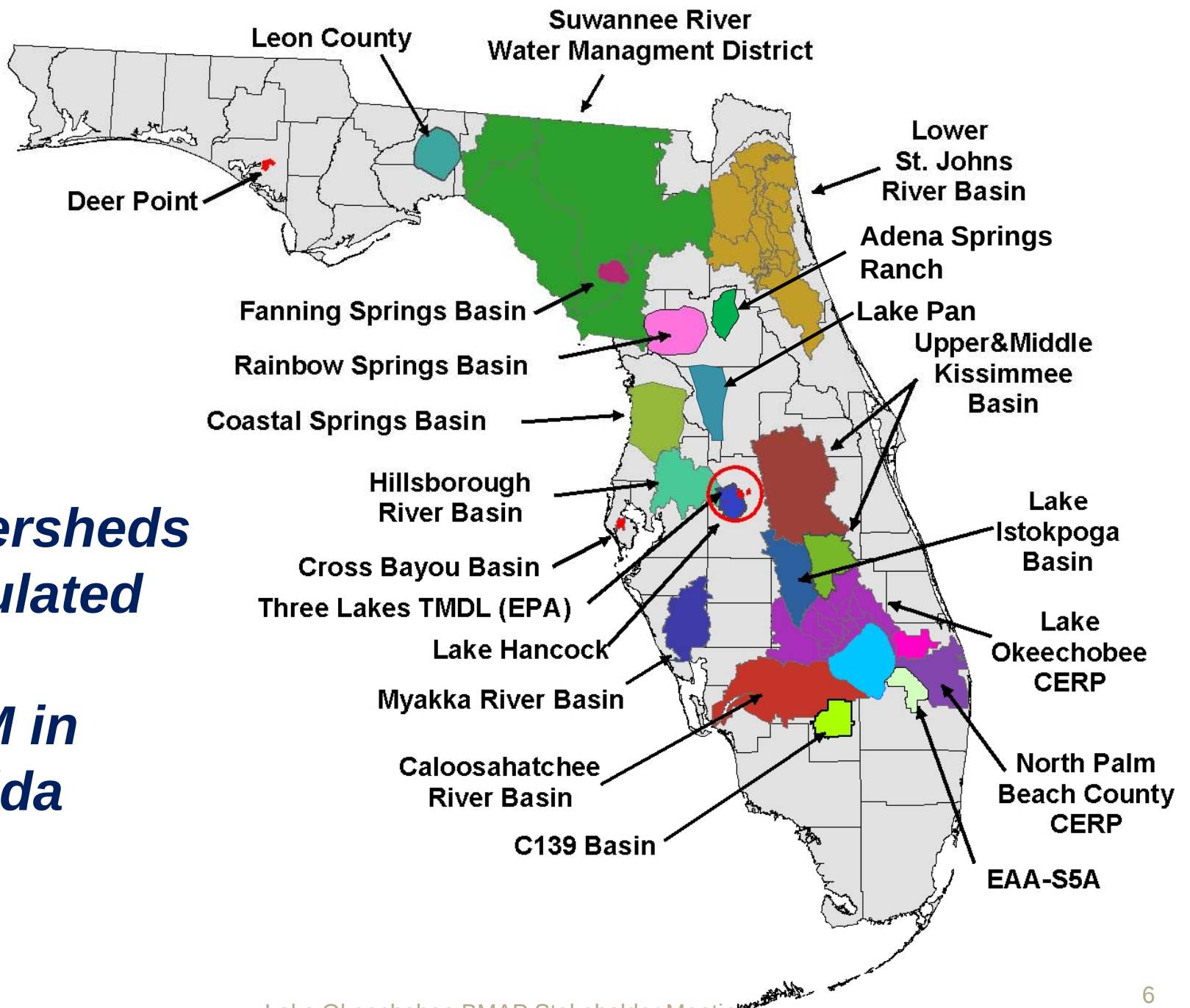
- **1984 - 1st GIS Okeechobee watershed model “Basin” (UF / COE)**
- **1988 - Basin New Zealand (BNZ) (UF/SWET/NIWA)**
- **1988-96 - Multiple upgrades of BNZ (UF/SWET)**
- **1993-1996 - Development of EAAMOD**
- **1997 – 1st Release of WAM (Suwannee River WMD)**
- **1998 - Daily routing option of WAM (SWET/SJRWMD)**
- **2000 - WAMView Release (ArcView version of WAM Model)**
- **2000 - WAM-O(Okura Catchment) release in New Zealand**
- **2001-06 – Multiple upgrades of ArcView Version of WAM**
- **2006-pres. – Development of ArcMap Version of WAM**
- **2008-09 – WASP/DMSTA/Lake model added to WAM**
- **2009 – Peer Review of WAM**
- **2009 –2011 – Release of ArcGIS Interface and Documentation**



Watershed Assessment Model (WAM)

- Developed specifically for Florida conditions
- Simulates surface and groundwater flow, TSS, and nutrient loadings. DO and Chl-a when combined with WASP
- GIS based to maximize use of spatial datasets
- Detailed field scale land source simulation
- Handles complex flow networks
- User friendly interface

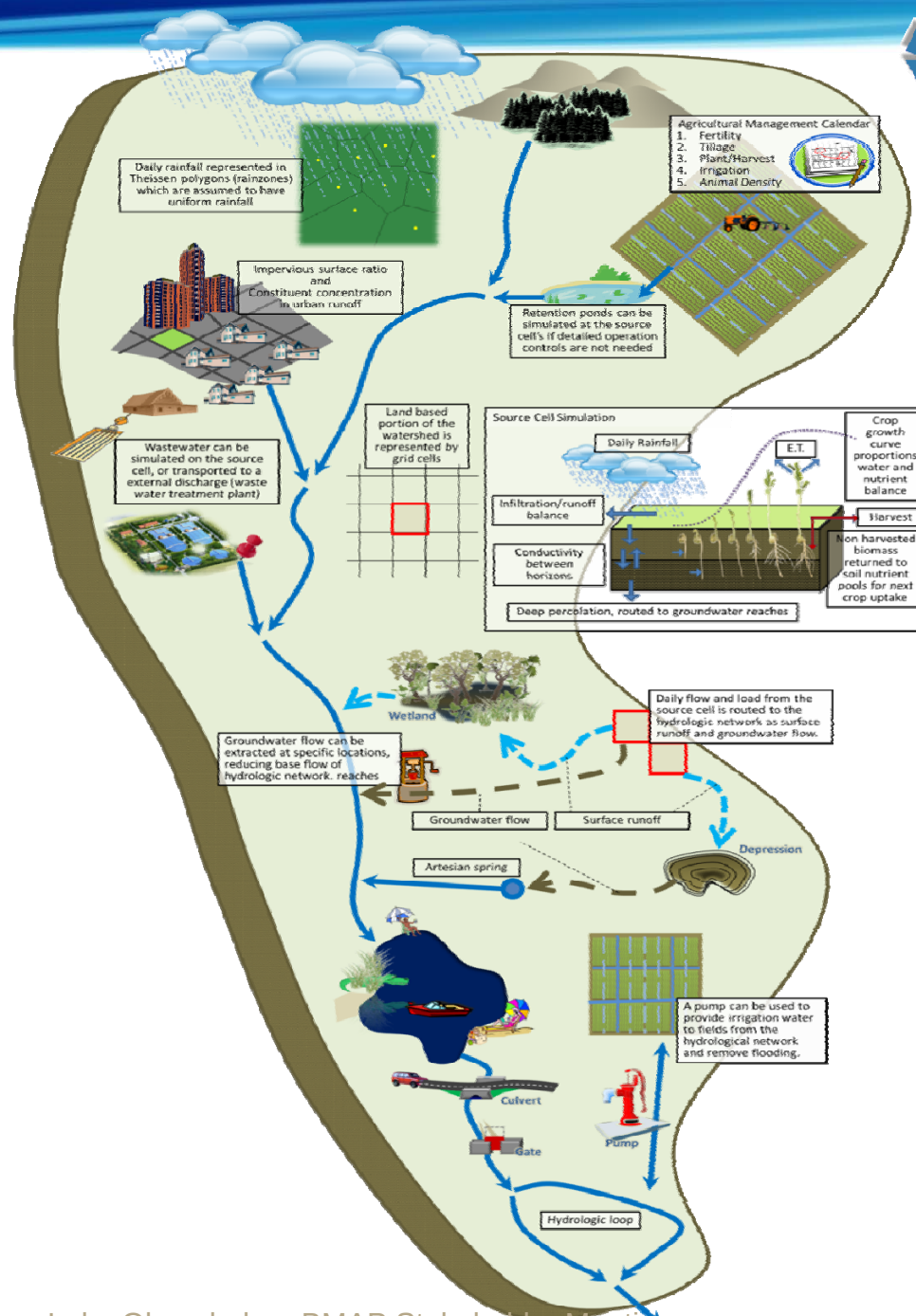
Watersheds Simulated by WAM in Florida





Conceptual Layout of WAM

Processes Handled

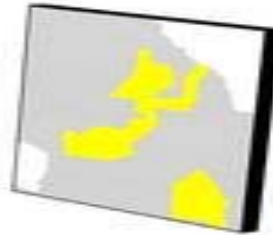




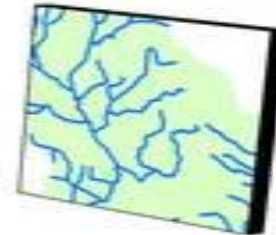
GIS Coverages Used by WAM



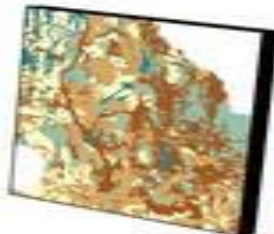
Land Use



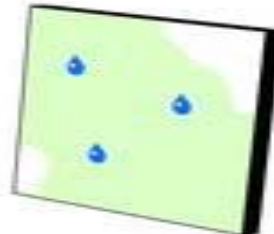
Utility Zone



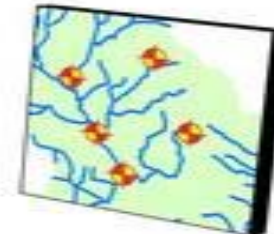
Reaches



Soil



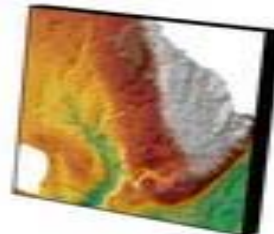
Rain Zone



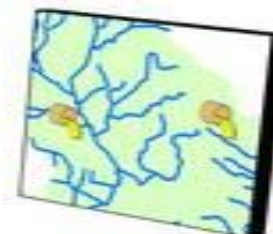
Structure



Subbasin



Topography



Point Source



Background of Modeling Activities in Okeechobee Watershed

- 2008 - WAM simulation using 2004/6 land use for rainfall from 1998-2007
- 2012 - WAM simulation using 2004/6 land use for rainfall period 1975 -2010
- 2012 - Fisheating Creek modeled for hotspot identification and pre-development conditions
- 2013 - Draft pre-developed land use and hydrography for Okeechobee watershed
- 2014 – FDEP using WAM output for Load Estimation Tool
- 2015 – Updating Okeechobee Basins through 2013

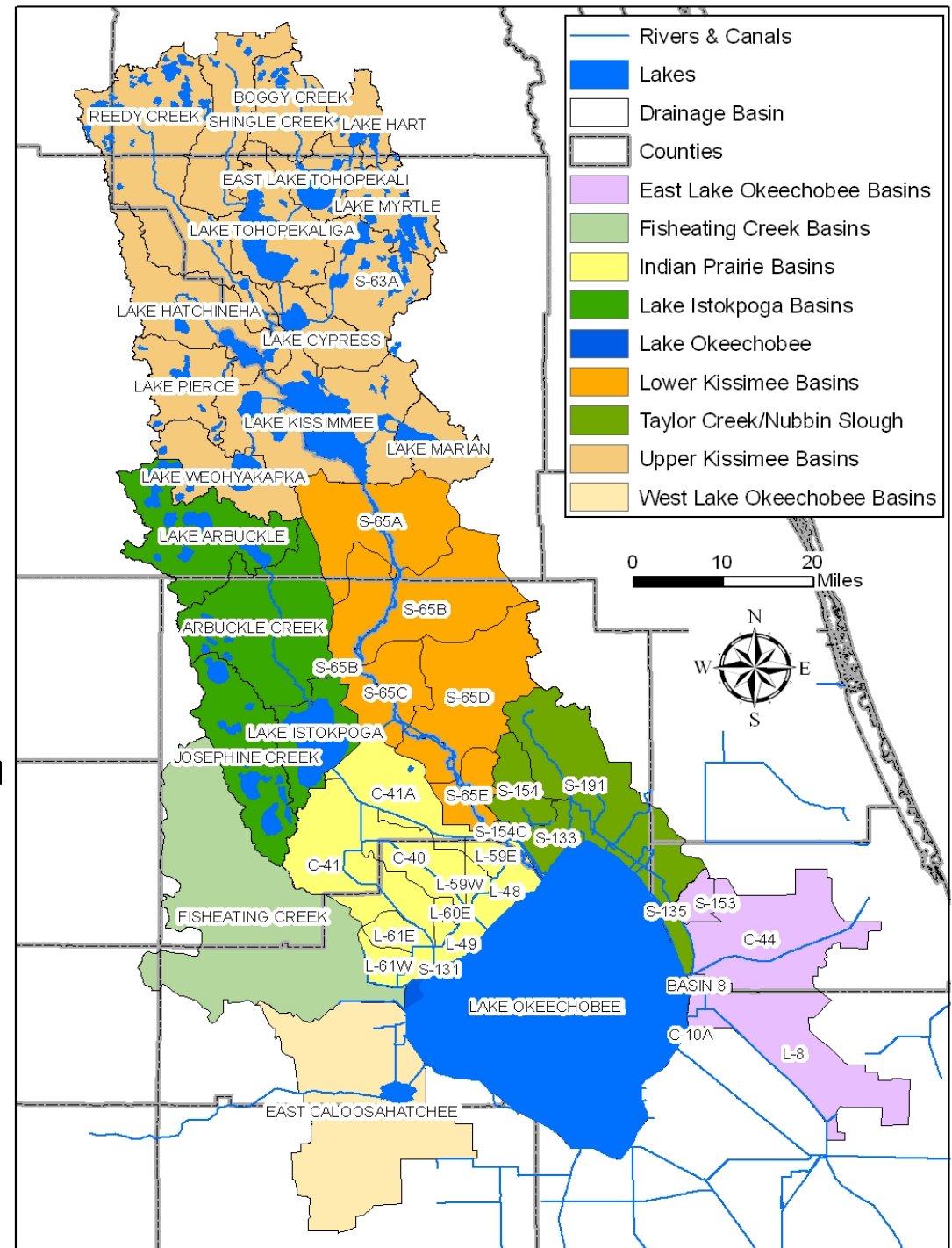
NOTE: P is primary focus because it has been identified as the nutrient causing impairment of Lake Okeechobee

Simulated Watersheds in the Okeechobee Basin for 2008 & 2012 Update

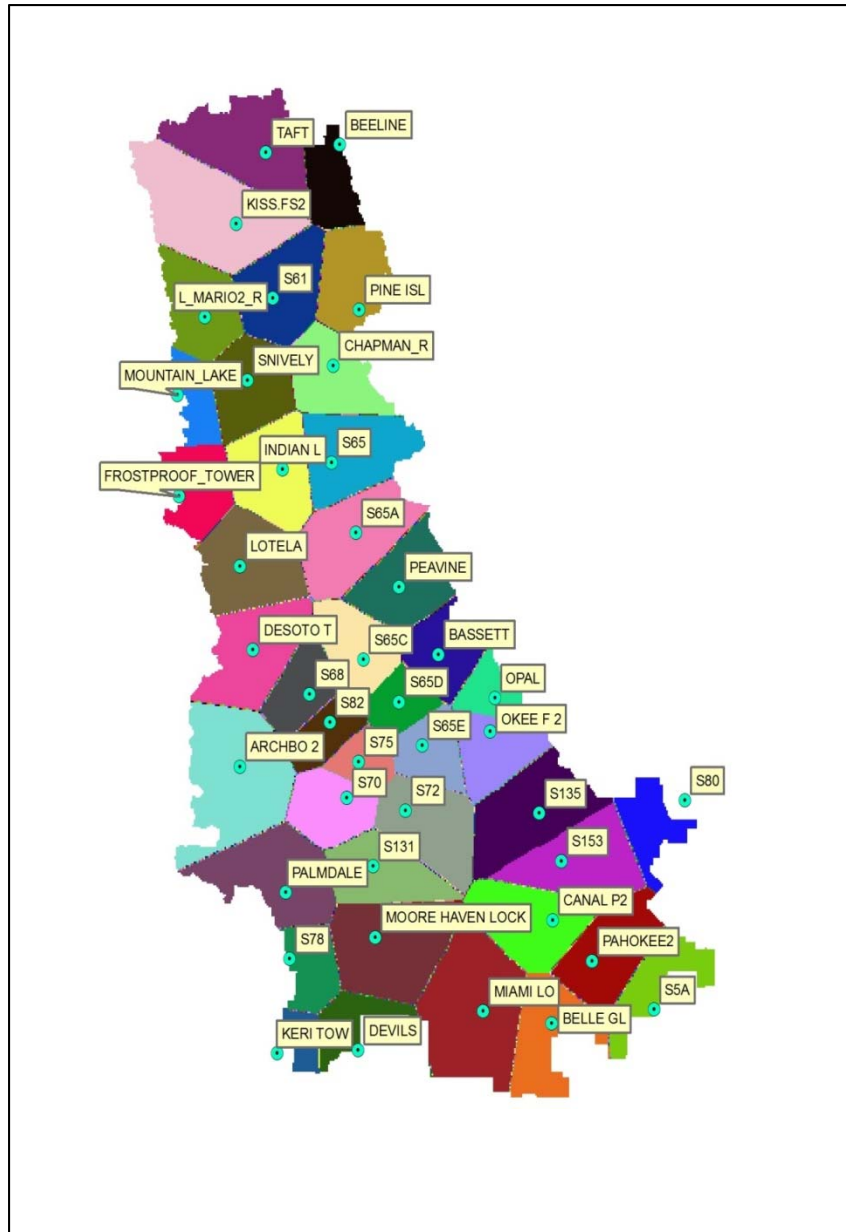
Supported by SFWMD

Includes 14 Model Domains:

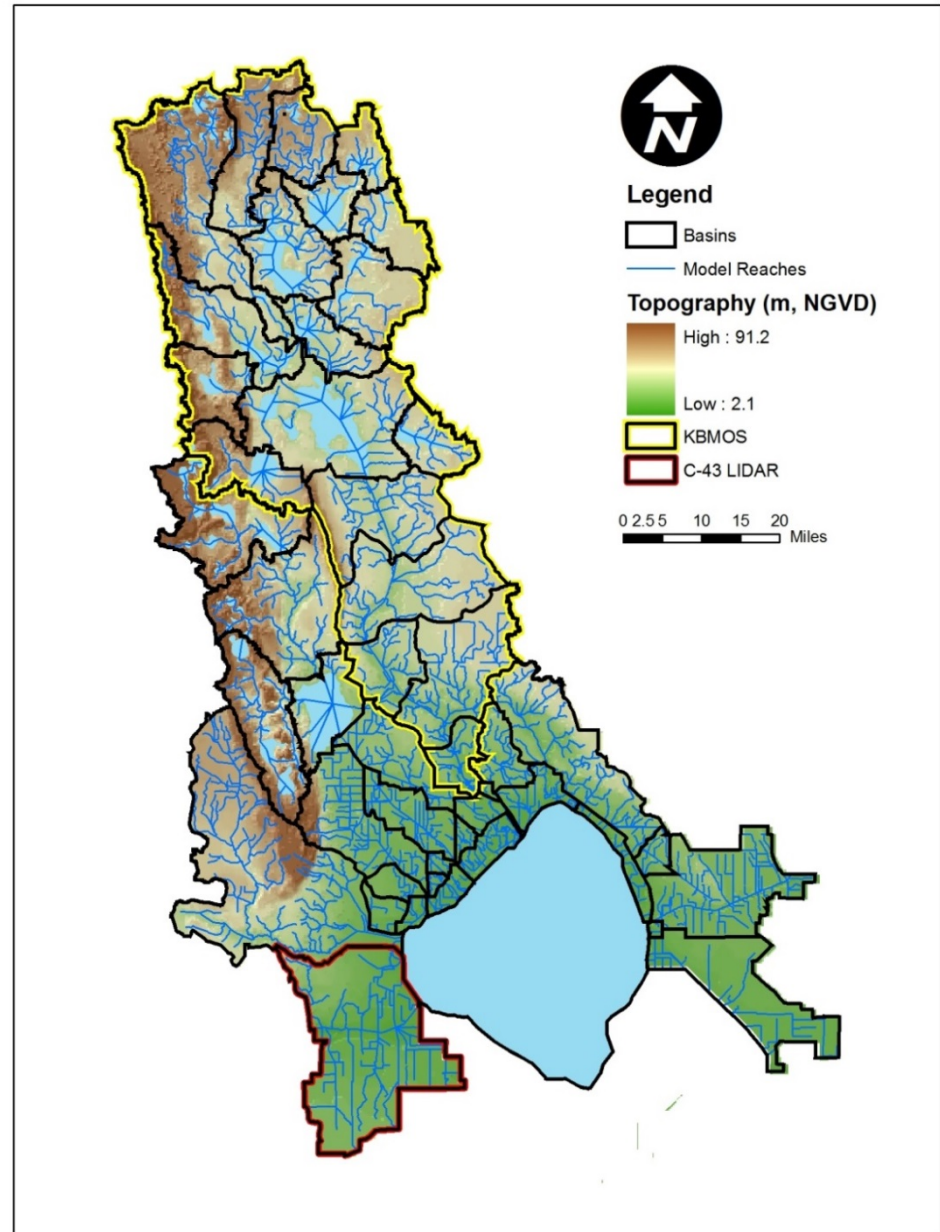
- ❖ Upper Kissimmee
- ❖ Lower Kissimmee (C-38)
- ❖ Lake Istokpoga
- ❖ Indian Prairie
- ❖ Fisheating Creek
- ❖ Taylor Creek/Nubbin Slough
- ❖ Six Near Lake Basins
- ❖ West C-44 and East C-43
- ❖ L-8 Basin



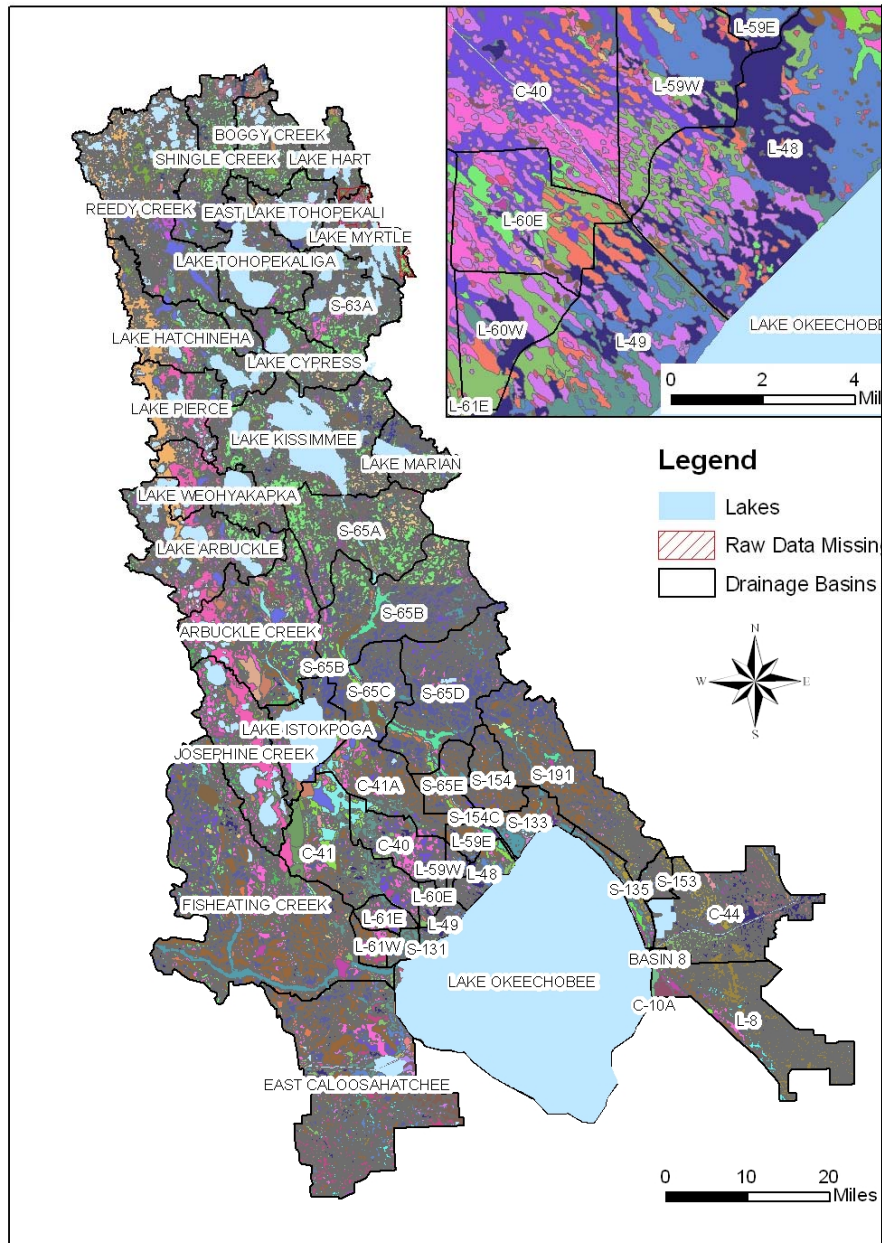
Rainfall Stations



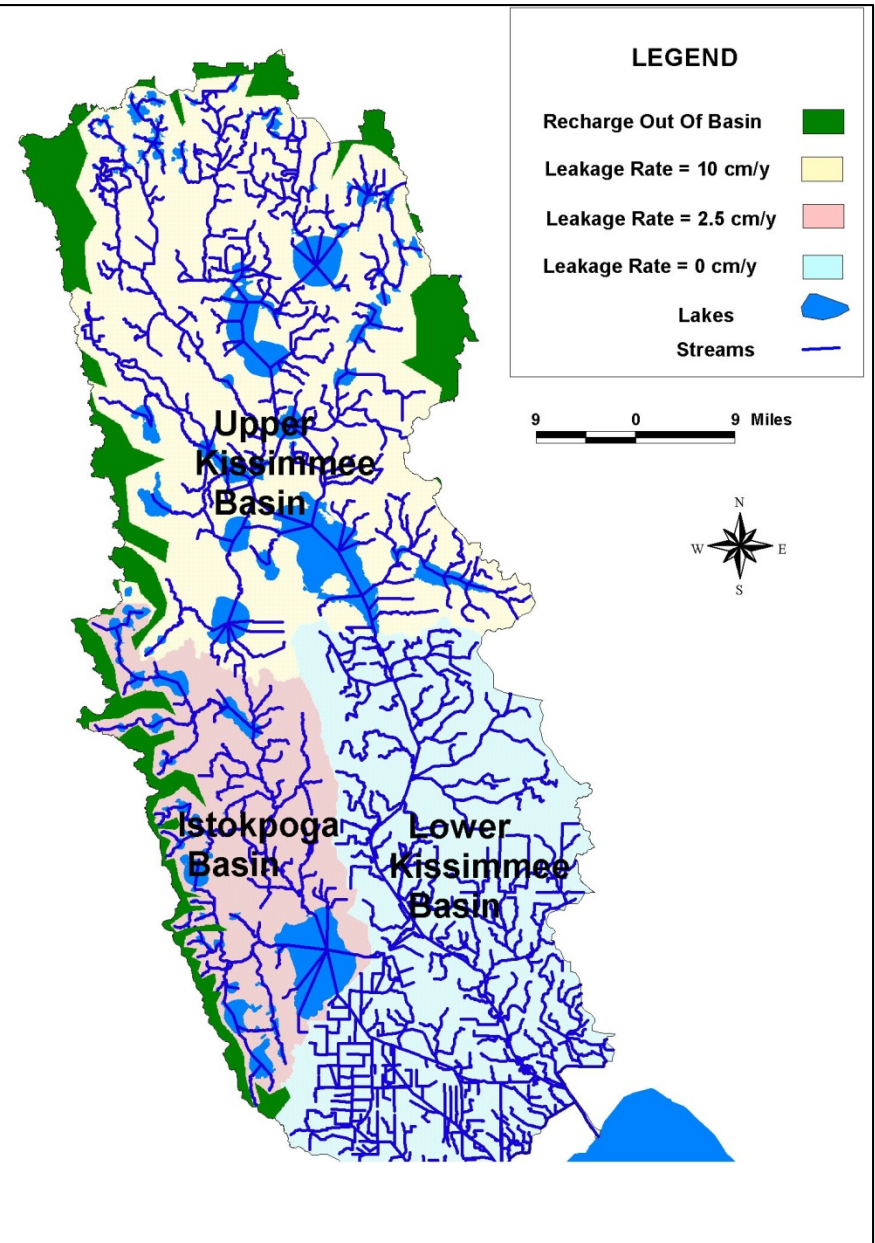
Stream & Topography



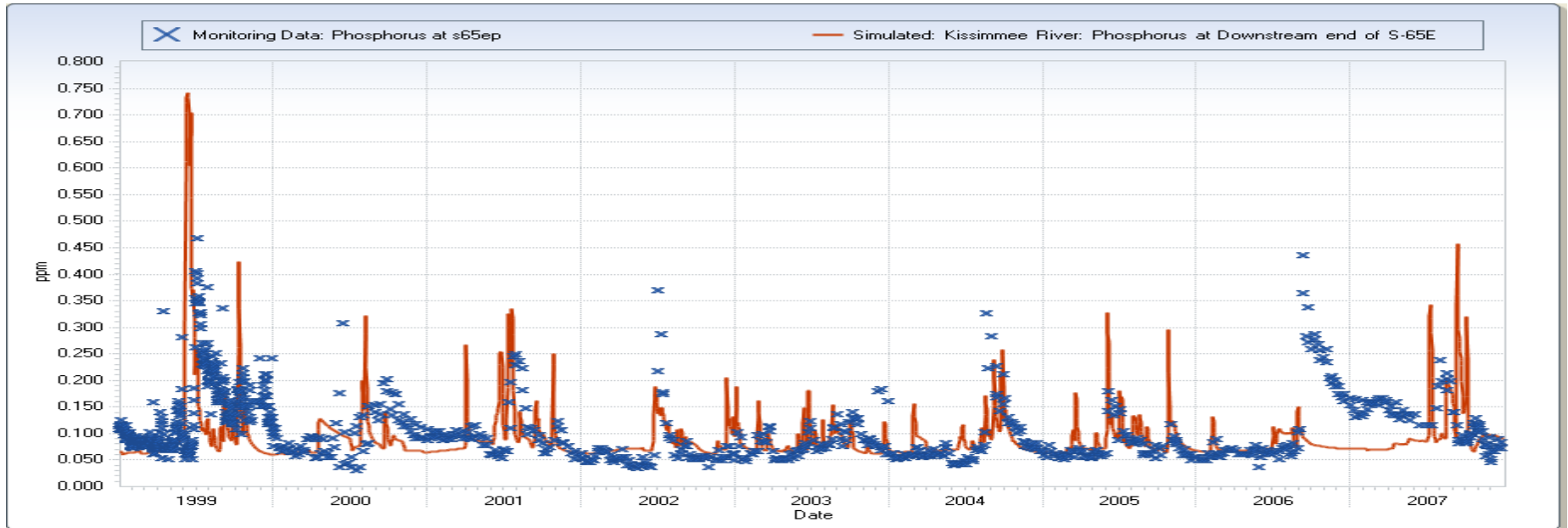
Soils (2004)



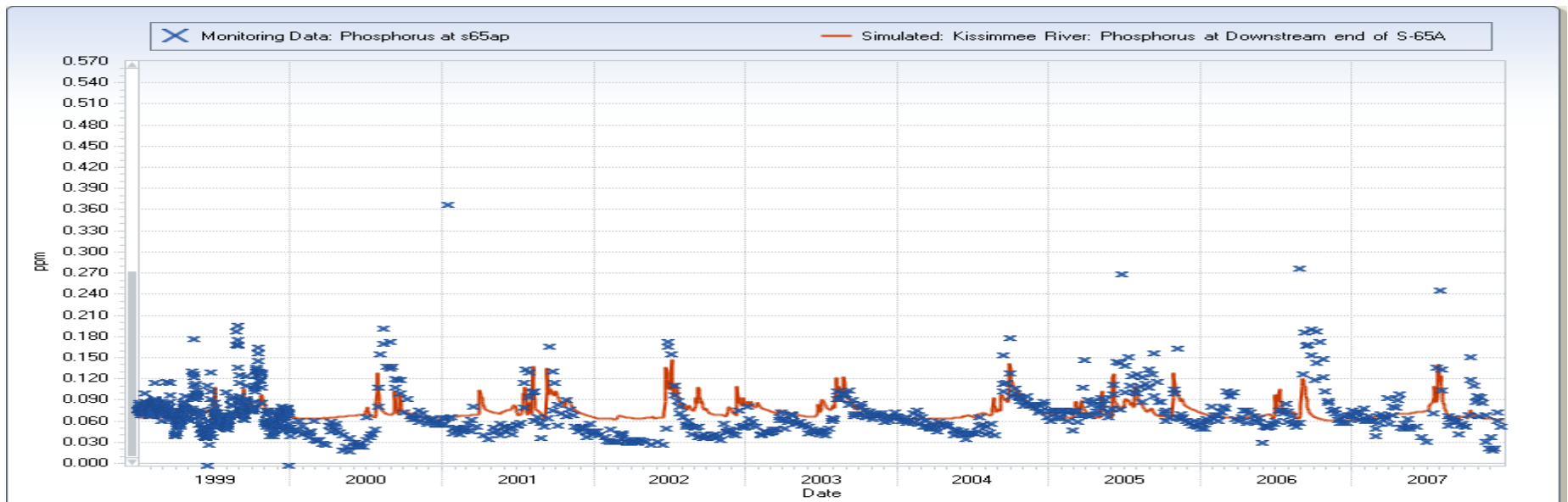
Groundwater Flows



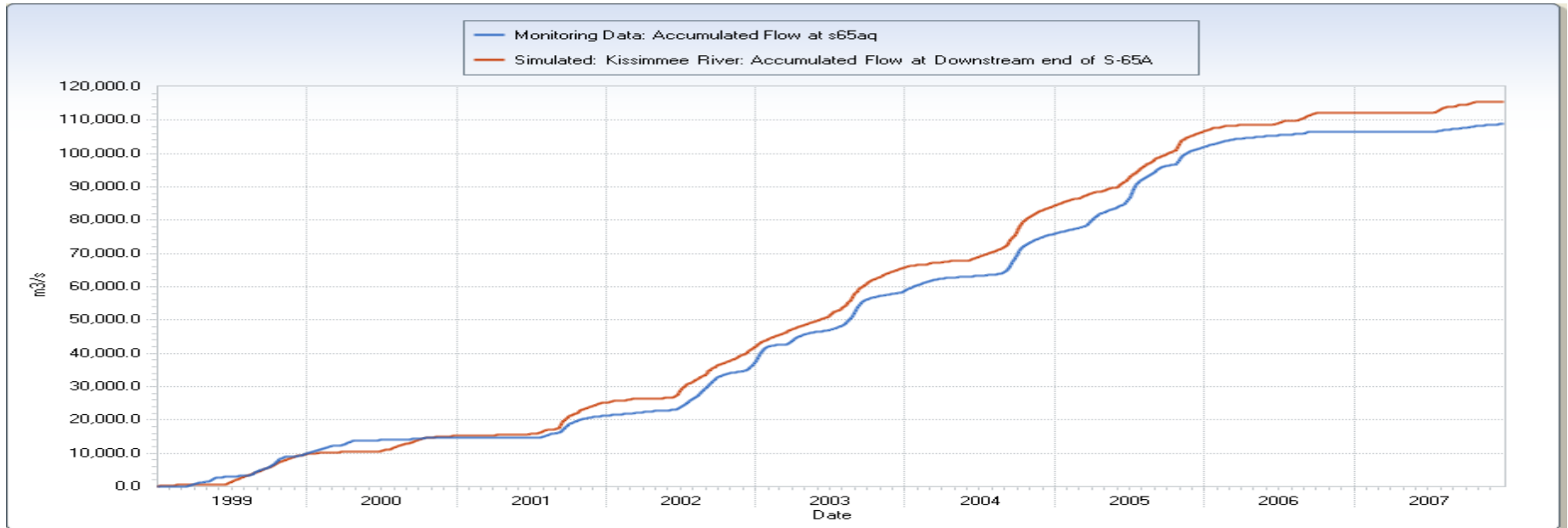
TP Conc. at S65A below Lake Kissimmee



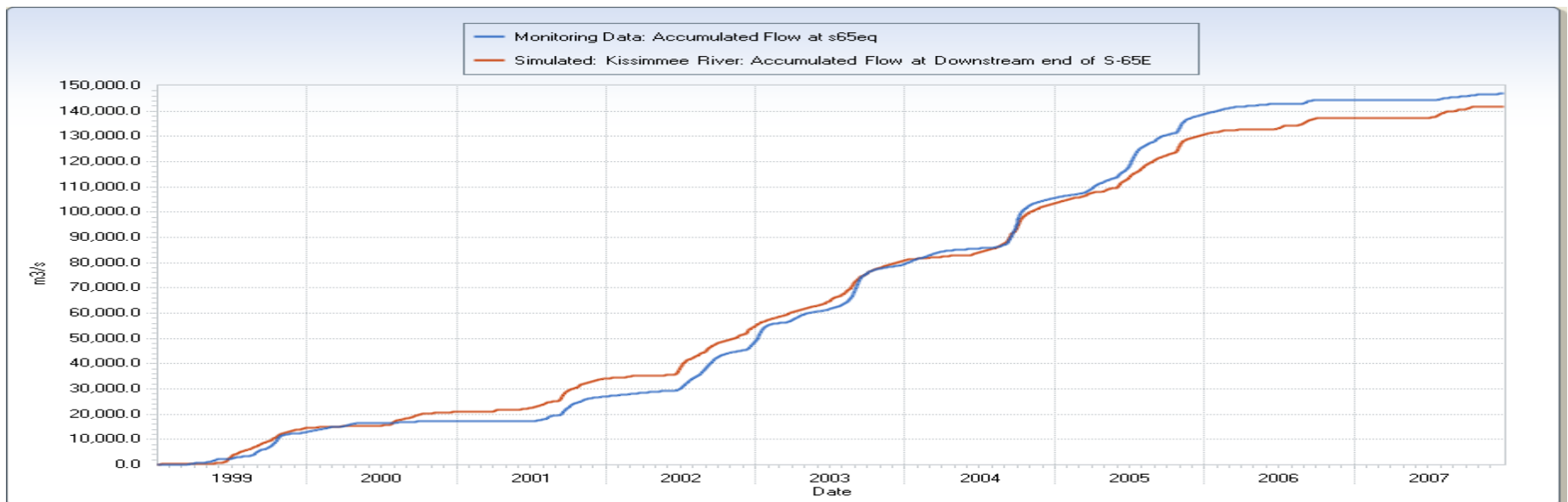
TP Conc. at S65E before entering Lake O



Accum. Flow at S65A below Lake Kissimmee



Accum. Flow at S65E before entering Lake O



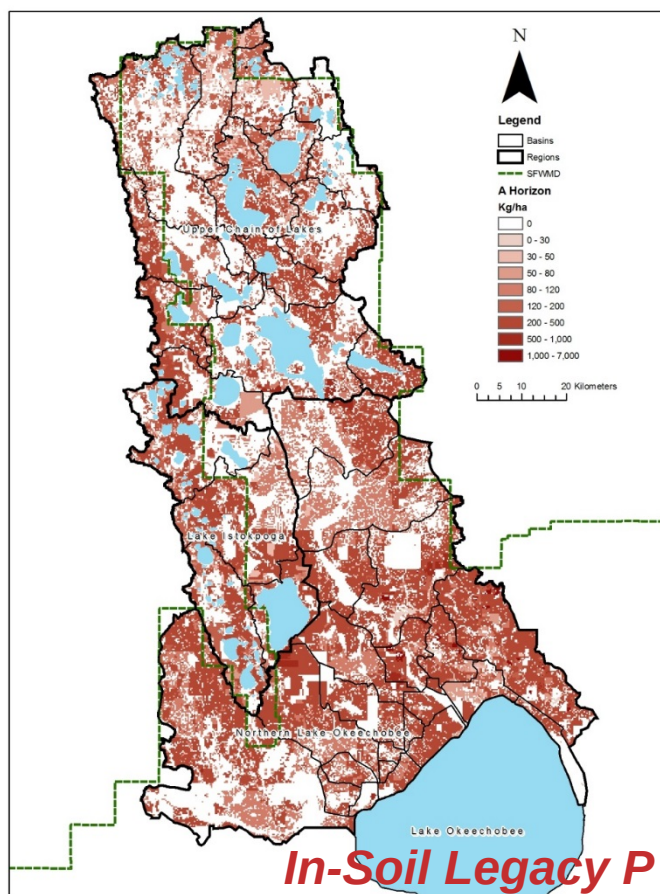
Simulated Flows and TP Loads

Basin	Struct	WAM Reach	Annual Average Flow (m3x106)			Annual Average TP Load (mt)			Years
			Measured	Simulated	% Diff	Measured	Simulated	% Diff	
C-38	S-65	836	974	1021	5%	82.1	83.5	2%	99-07
	S-65A	602	1045	1108	6%	87.4	92.0	5%	99-07
	S-65C	519	1204	1227	2%	96.5	101.7	5%	99-07
	S-65D	87	1318	1343	2%	125.3	137.6	10%	99-07
	S-65E	79	1410	1362	-3%	150.8	153.1	1%	99-07
	S-68	657	346	352	2%	25.4	26.6	5%	99-07
C-43	S-78	2	1201	1195	0%	149	160	7%	99-07
C-44	S-80	5	470	542	15%	102	115	12%	99-07
L-8	L-8 @ C-51	3	108	98	-9%				99-07
	WPB PS2	49				2.1	3	67%	98-02
L-48	S-127	2	12	13	6%	3.0	3.0	-1%	99-07
L-49	S-129	2	14	14	-7%	1.1	1.2	10%	99-07
S-131	S-131	2	11	11	-8%	1.3	1.5	10%	99-07
S-133	S-133	2	23	22	-5%	5.6	6.1	8%	99-07
S-135	S-135	2	22	22	1%	2.8	3.1	10%	99-07
S-191	S-191	2	116	116	0%	72.7	75.3	4%	99-07
FEC	US-27	60	233	239	3%				99-07
15	SR-78	4				57.8	52.3	-10%	99-07

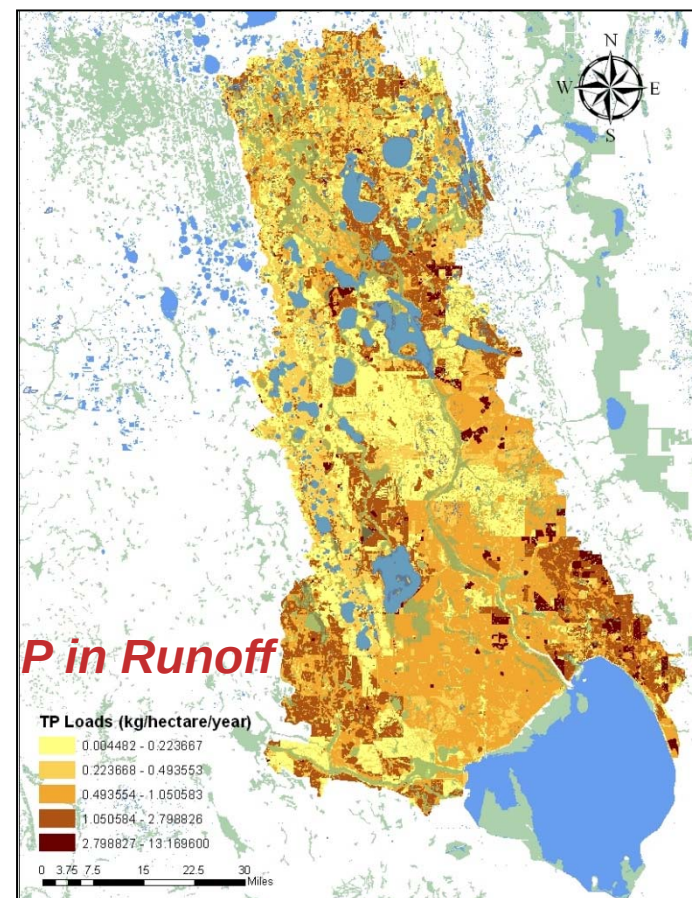


How is Legacy P Handled in WAM?

- The land use definition files contain an initial soil phosphorus content parameter to represent accumulative past inputs



7/1/2015



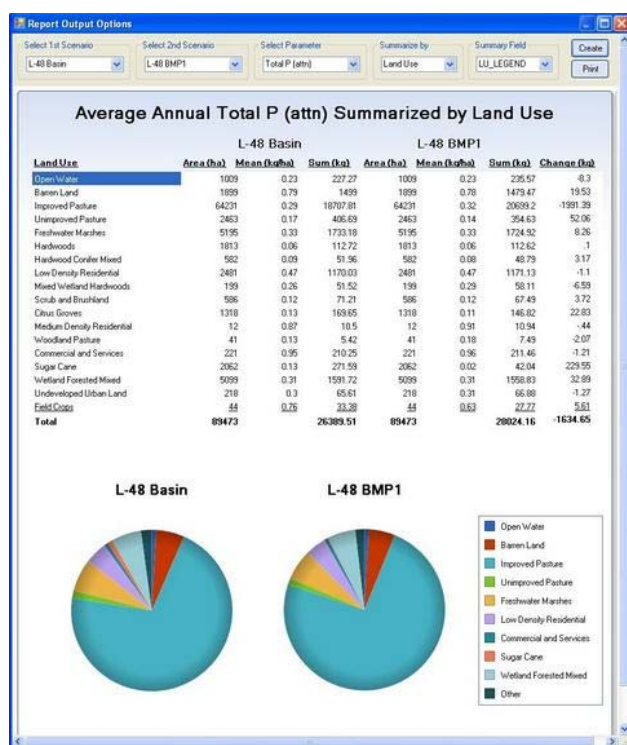


2012 Updates of WAM for Lake Okeechobee Watershed

- Simulation period extended from 1999-2007 to 1975-2010
- No other changes made
- Results showed some phosphorus buildup from 1975 to 1998, otherwise very similar results



Development of FDEP BMAP Load Estimation Tool



- Develop unit loads at source cells by land use by using WAM
- Develop attenuation factors from source cells to watershed outlet based on WAM estimates
- Apply WAM units loads and attenuation factors to updated 2009 Land Use Coverage
- Develop fraction of outlet loads attributed to specific land uses
- Use of LET for future load allocations:
 - ❖ By watershed and land use
 - ❖ Impact of existing projects in works
 - ❖ Cost effectiveness of abatement technologies by land use

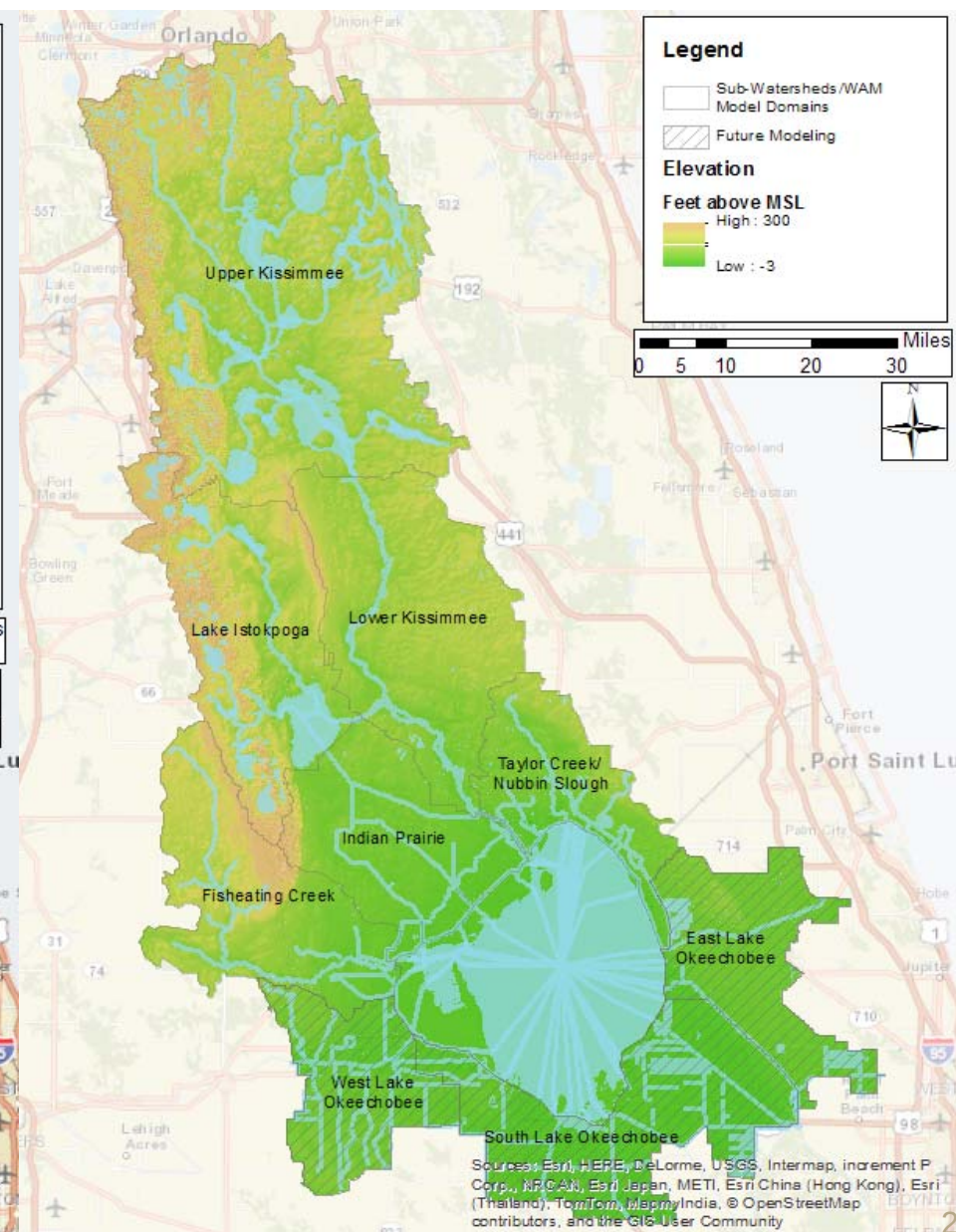
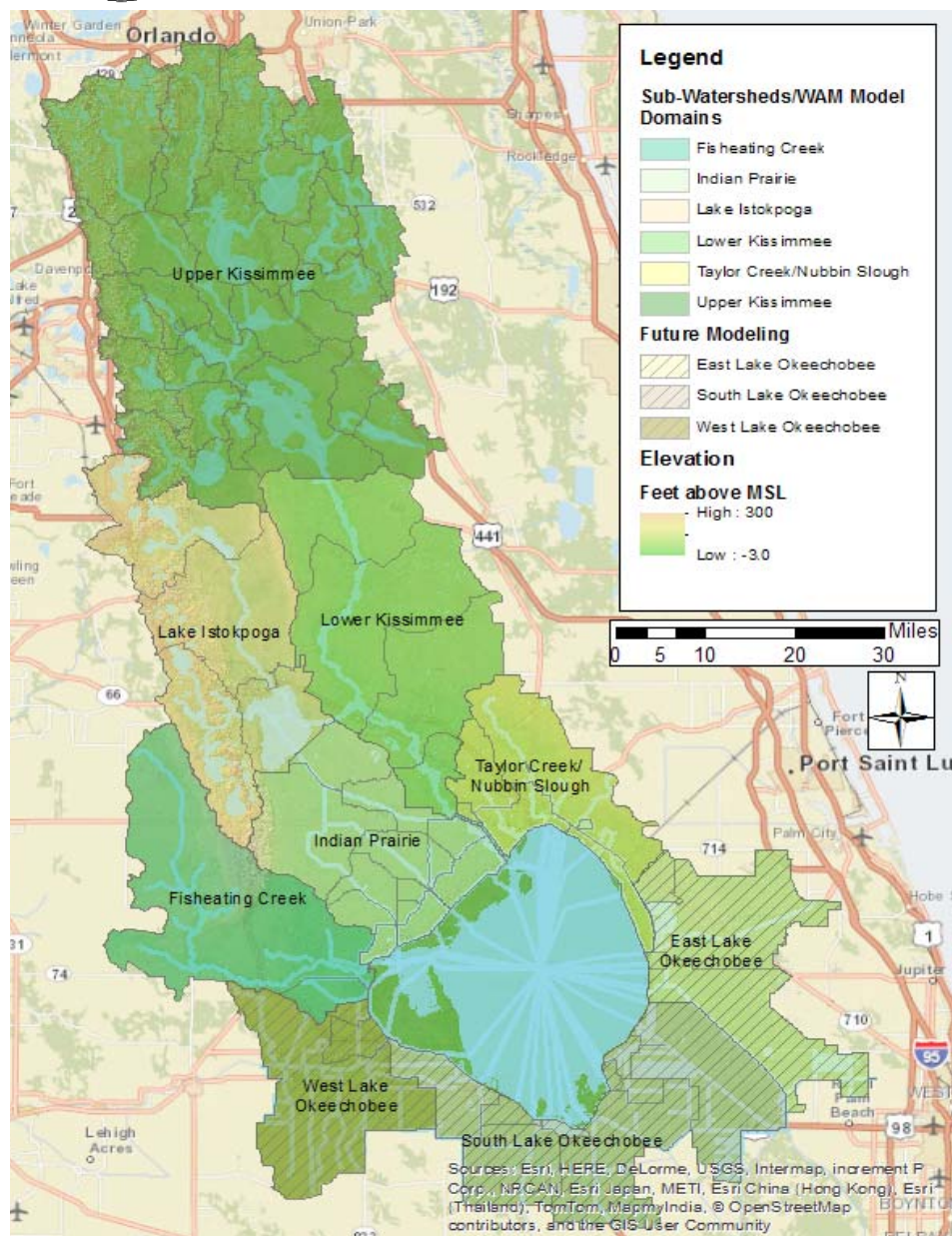


Current WAM Activities (Completion Date July, 2015)

- WAM simulation period has been expanded to 35 years through 1978 - 2013
- Updated hydrography, land use, basin/subbasin boundaries, and included major restoration projects
- Identified that additional calibration will be needed due to the many changes
- Developed the plan of work for the uncertainty and sensitivity analyses
- Developed plan of work for expanding WAM to the Southern Okeechobee sub-watersheds

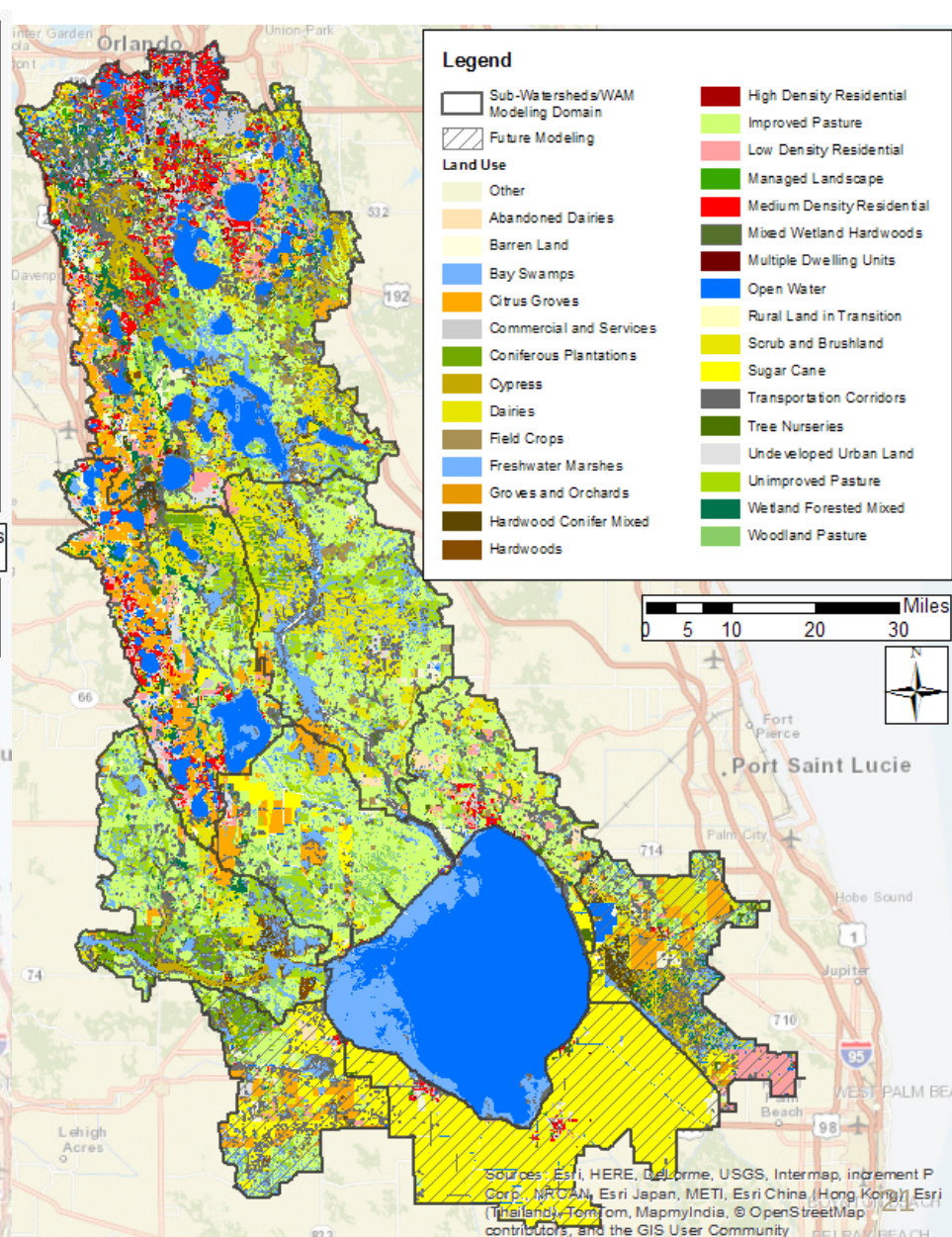
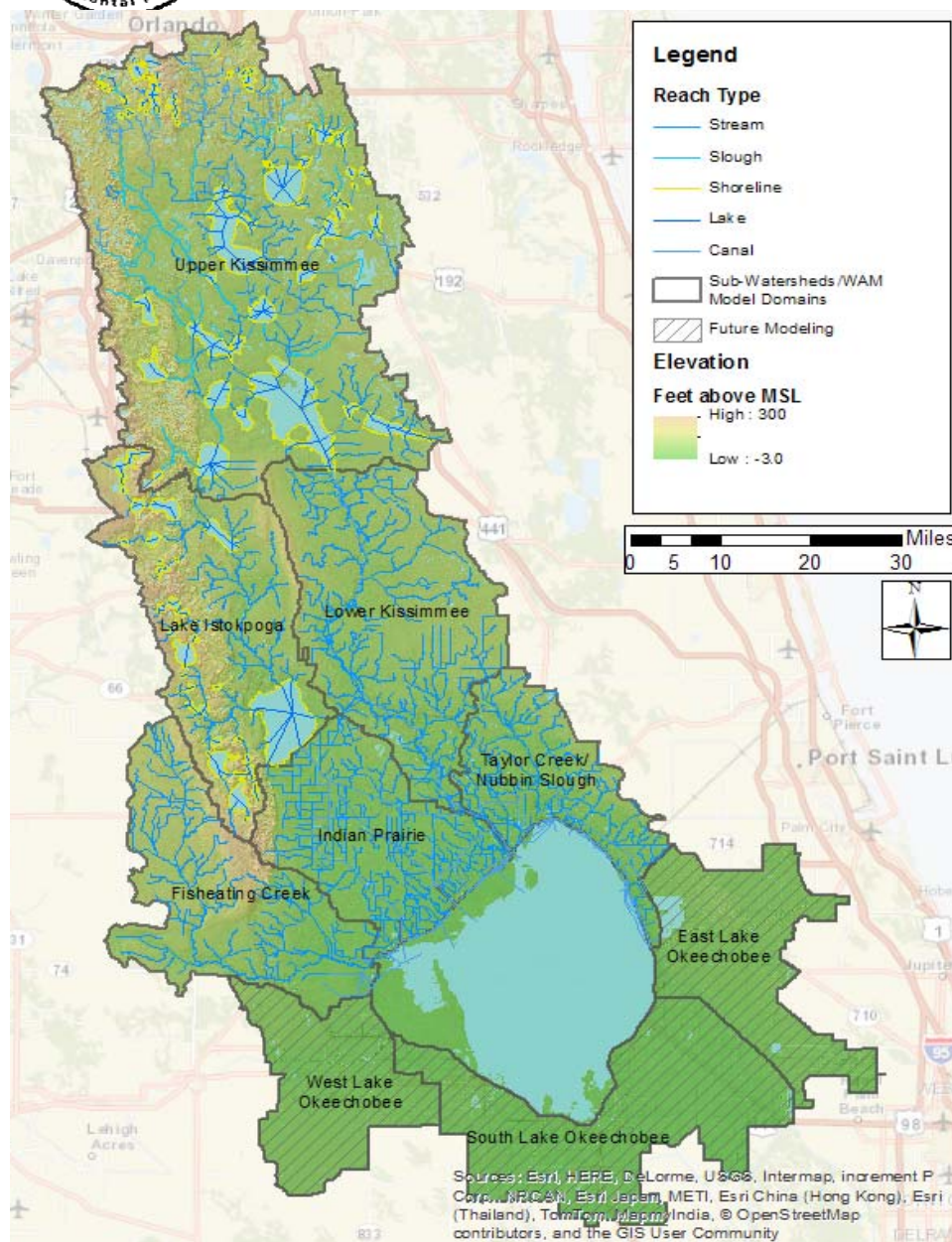


Basin Boundaries and Topography





Hydrography and Land Use



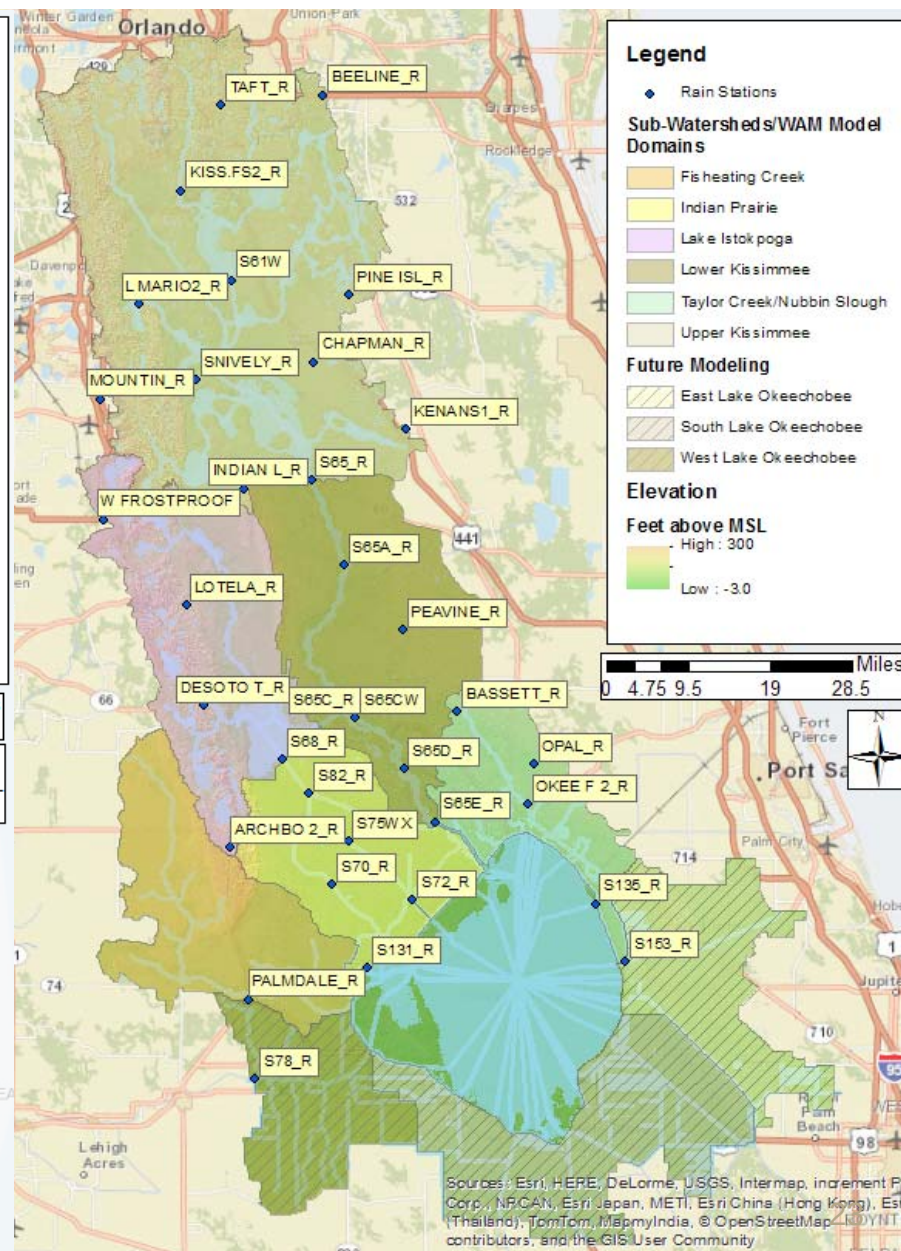
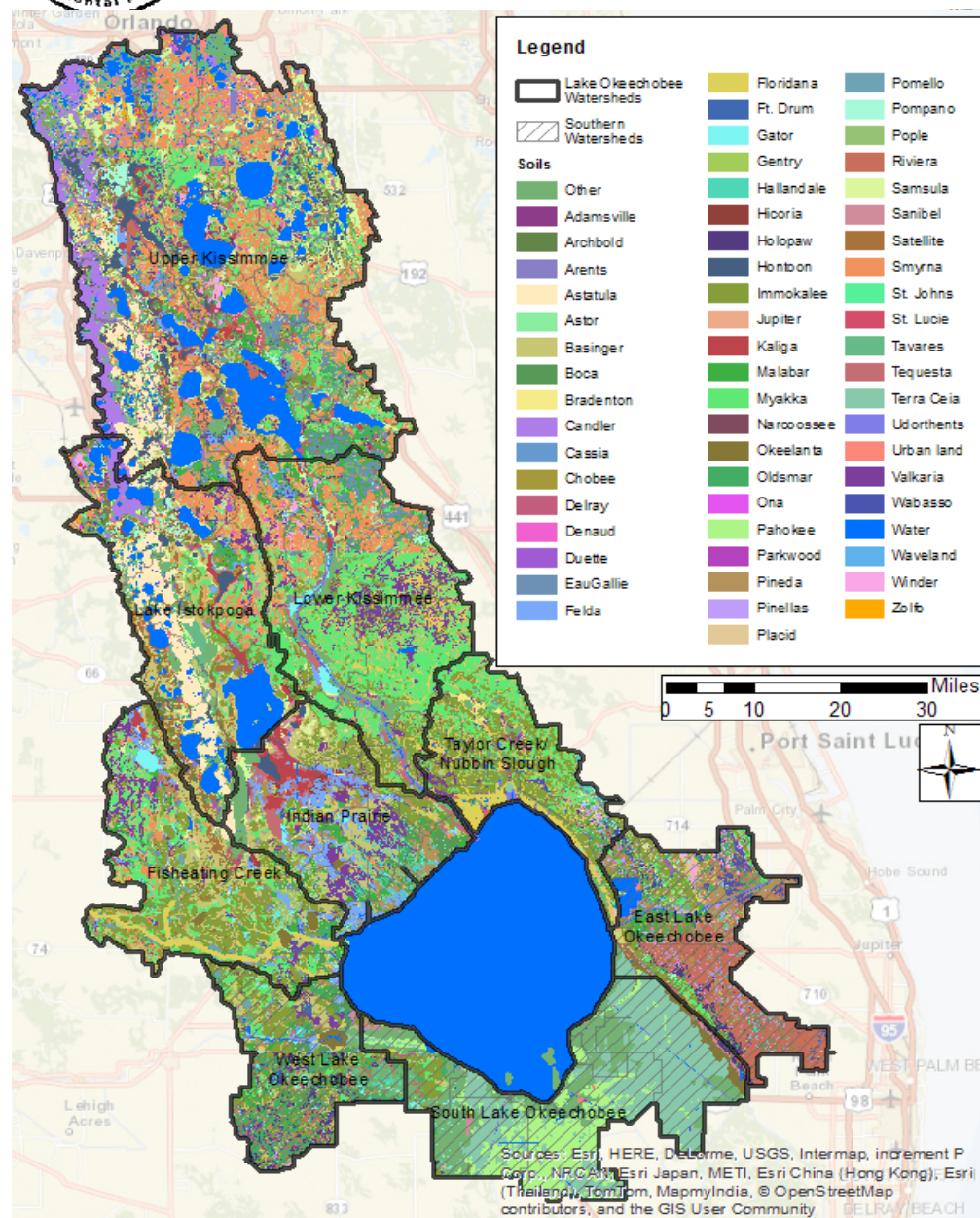


Relative Changes in Land Use from 2004 to 2009/12 Coverages

Land Use	2004/6	2009/12	% Diff. 2006:2009
Improved Pasture	591,320	612,817	3.6
Unimproved Pasture	123,811	167,744	35.5
Woodland Pasture	170,931	111,227	-34.9
Row Crop	17,336	19,225	10.9
Citrus	169,645	167,744	-1.1
Sugarcane	23,787	26,827	12.8
Dairies	20,268	20,137	-0.6
Other Ag	76,360	92,145	20.7
Native	1,072,072	1,085,407	1.2
Urban	330,237	306,324	-7.2
Other	54,789	34,640	-36.8
Total	2,650,556	2,644,238	-0.2



Soils (2015) and Rain Stations





Include Major Projects ***(Other Projects when Information comes Available)***

- STAs
 - Taylor Creek
 - Lake Side Ranch
 - Nubbin Slough
- Nicodemus Slough Water Storage Project
- Kissimmee River Restoration
- P Control Projects
- Water Storage Projects
- Others as they come available



Uncertainty and Sensitivity Analyses Work Plan

Goals:

Develop the procedure for an uncertainty analysis process that will quantify the overall uncertainty in the model outputs as influenced by input data and model algorithms uncertainties

Identify the most appropriate procedure for a sensitivity analysis process that will identify important model parameters for recalibration, ranges used in the sensitivity evaluation, and a discussion of potential interactions among the important parameters, to evaluate the robustness of the model algorithms



Uncertainty and Sensitivity Analyses Work Plan Outline

- Literature Review
- Selection of Optimal Study Basin
- Sensitivity Analysis
- Uncertainty Analysis
- Model Recalibration
- Results

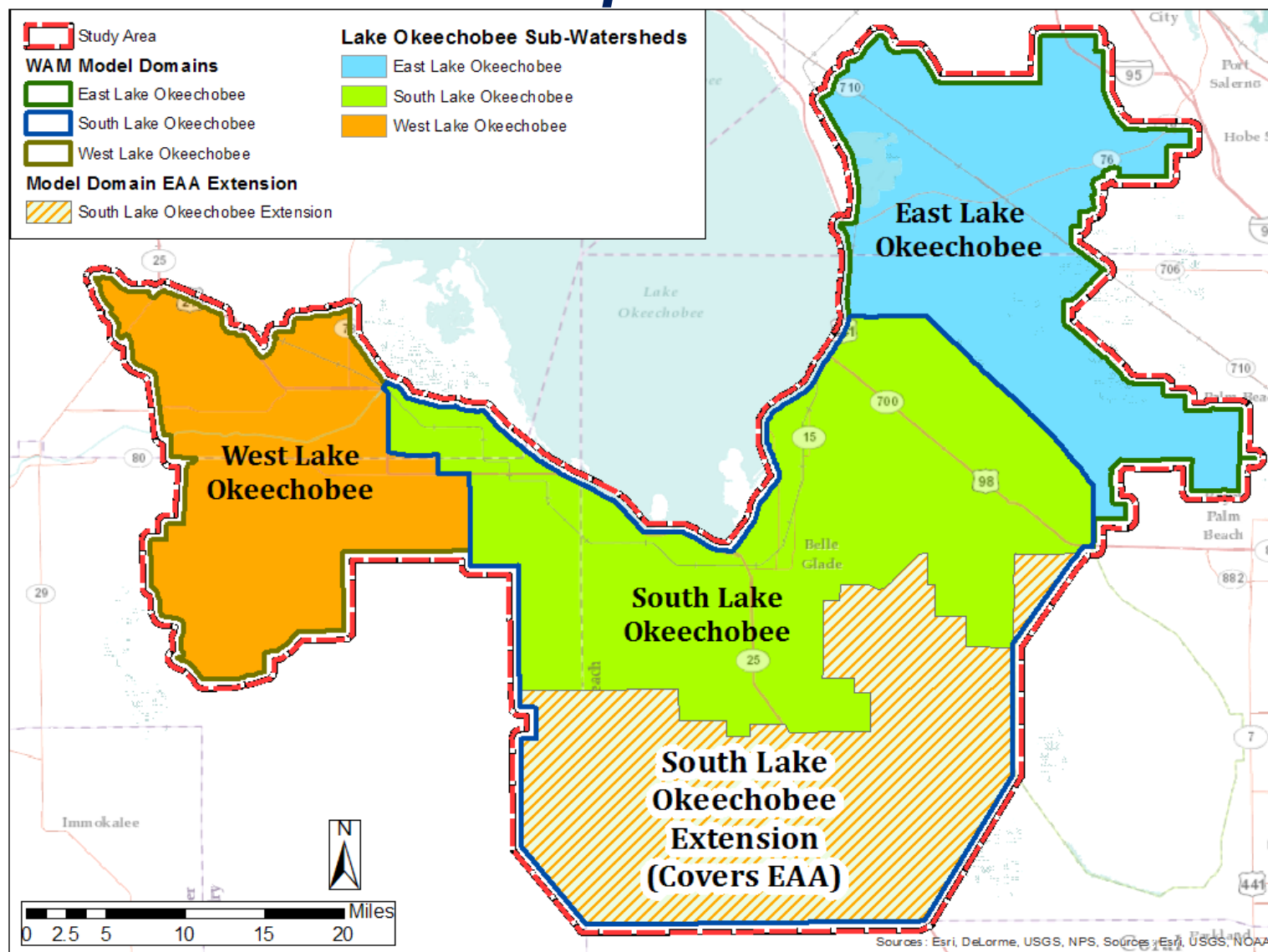


FY 2015-16 WAM Activities (Starting July, 2015)

- Select test basin
- Complete sensitivity and uncertainty analyses
- Assist FDACS on updating the land use data for northern sub-watersheds
- Update imp. pasture grazing density and fertility
- Complete the recalibration of northern Okeechobee sub-watersheds
- Provide goodness-of-fit analyses on calibrated basins
- Setup and run three southern sub-watersheds
- Update FDEP Load Estimation Tool for all sub-watersheds with additional spatial resolution



Three Southern Sub-watersheds to be Setup and Run





Update FDEP Load Estimation Tool (LET)

- Will be expanded to entire BMAP area, i.e. the three southern sub-watersheds will be added to the existing six northern sub-watersheds LET.
- Update source cell unit loads in LET to include the spatial influences of soils, rain, irrigation source, and WWT treatment areas.
- Update source cell attenuation factors based on spatial location in the watershed, i.e. uniquely accounting for the attenuation from cell to nearest stream before applying the instream attenuation factors.



Questions