

2018 SWAT INTERNATIONAL CONFERENCE, JAN 10-12, CHENNAI

Comparative analysis of SWAT model with Coupled SWAT-MODFLOW model for Gibbs Farm Watershed in Georgia

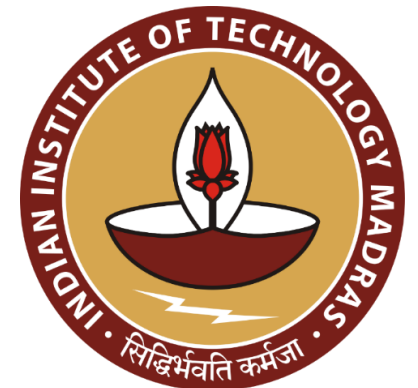
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Outline of the Study

- ❑ Motivation
- ❑ Study Area Description - Gibbs farm watershed
- ❑ Methodology
- ❑ Model setup
- ❑ Results and Discussions
- ❑ Conclusion
- ❑ Future Work

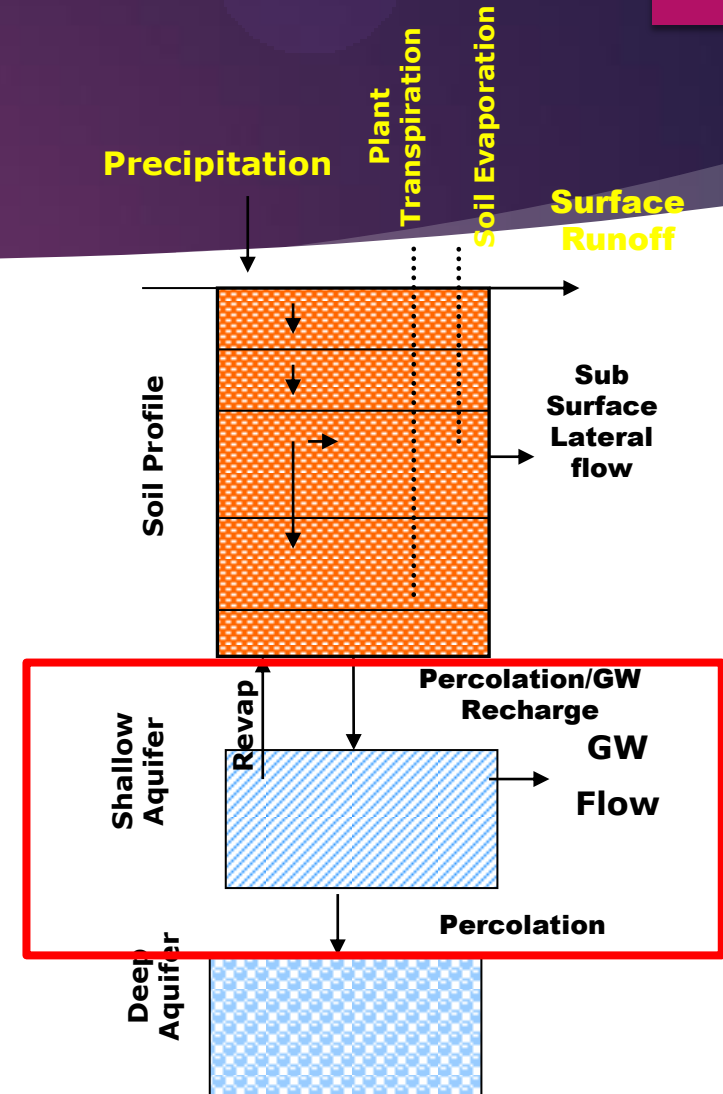


Motivation

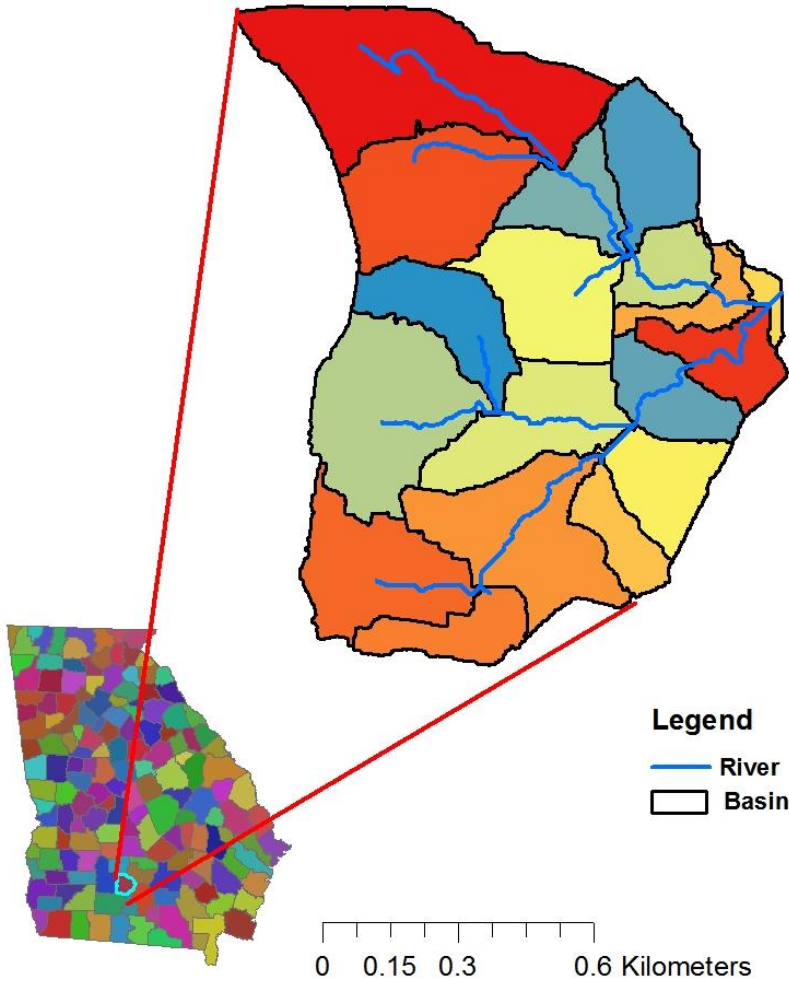
- ❑ Streams and lakes interact with adjacent aquifers and need to be treated together in water resource assessment.
- ❑ For efficient water resource management, linkage between SW & GW is essential
- ❑ Many models are integrated for understanding the SW-GW interaction - (SWAT - MODFLOW)
- ❑ This study attempts to demonstrate and analyse the application of SWAT model with recently developed GUI (SWATMOD-PREP)

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- ❑ SWAT considers each HRU and sub-basins as separate 1-D unit
- ❑ Spatial locations of each HRU - sub-basins are not considered
- ❑ Model lacks in simulating the GW distribution and recharge rates for watershed



Study Area - Location Map

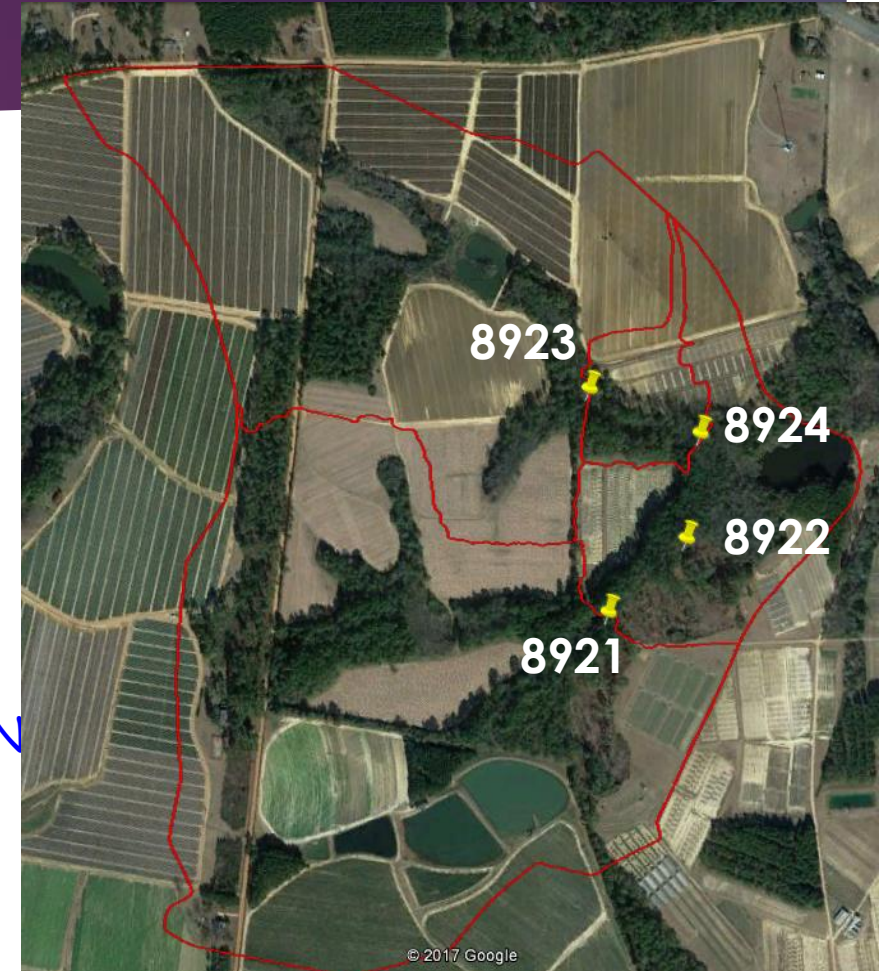


Study area - Gibbs Farm Watershed



Description of Study Area

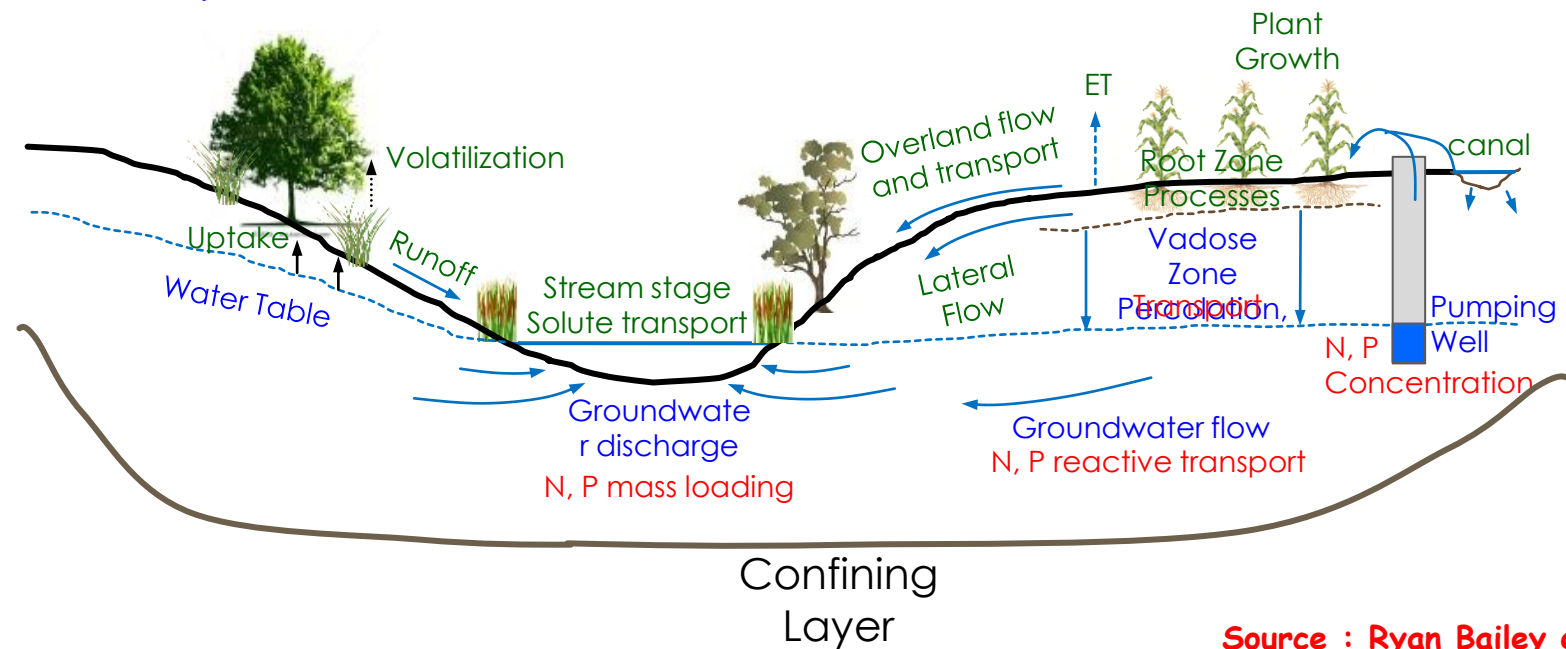
- ❑ Gibbs Farm Watershed, TIFTON, Georgia
- ❑ Intensive agriculture and dense riparian forest buffers along stream channels
- ❑ Geology : Hawthorne formation by quaternary sands and surface soils (4m @ top of landscape and 2.5 m @ below land surface)
- ❑ Area of watershed : 115 hectares ; Soil : Loamy sand with TIFTON loamy sand
- ❑ Annual Mean Precipitation : 1200 mm; Monitoring Wells : 29 wells (Fox Den Field)



Overview Of Coupled SWAT-MODFLOW

Linking 3 Models: Graphical User Interface - SWATMODPREP

SWAT
MODFLOW
RT3D

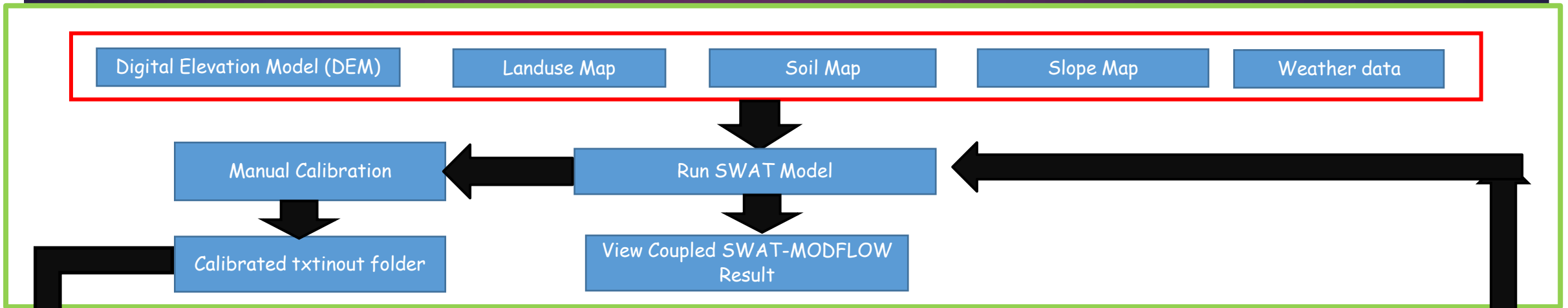


Source : Ryan Bailey et al ,
SWATMODFLOW Tutorial,
February-2017

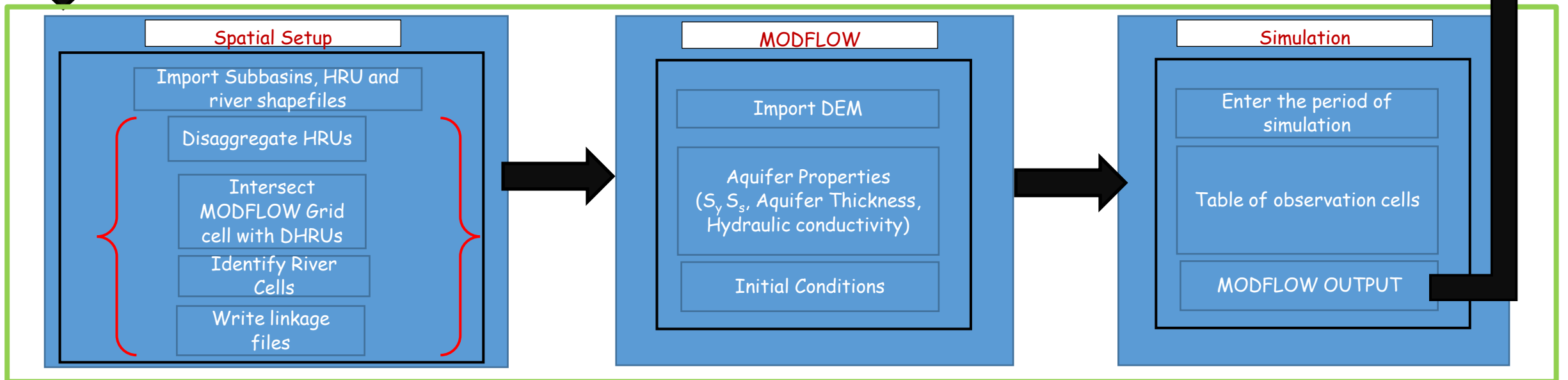
Methodology

SWAT MODEL

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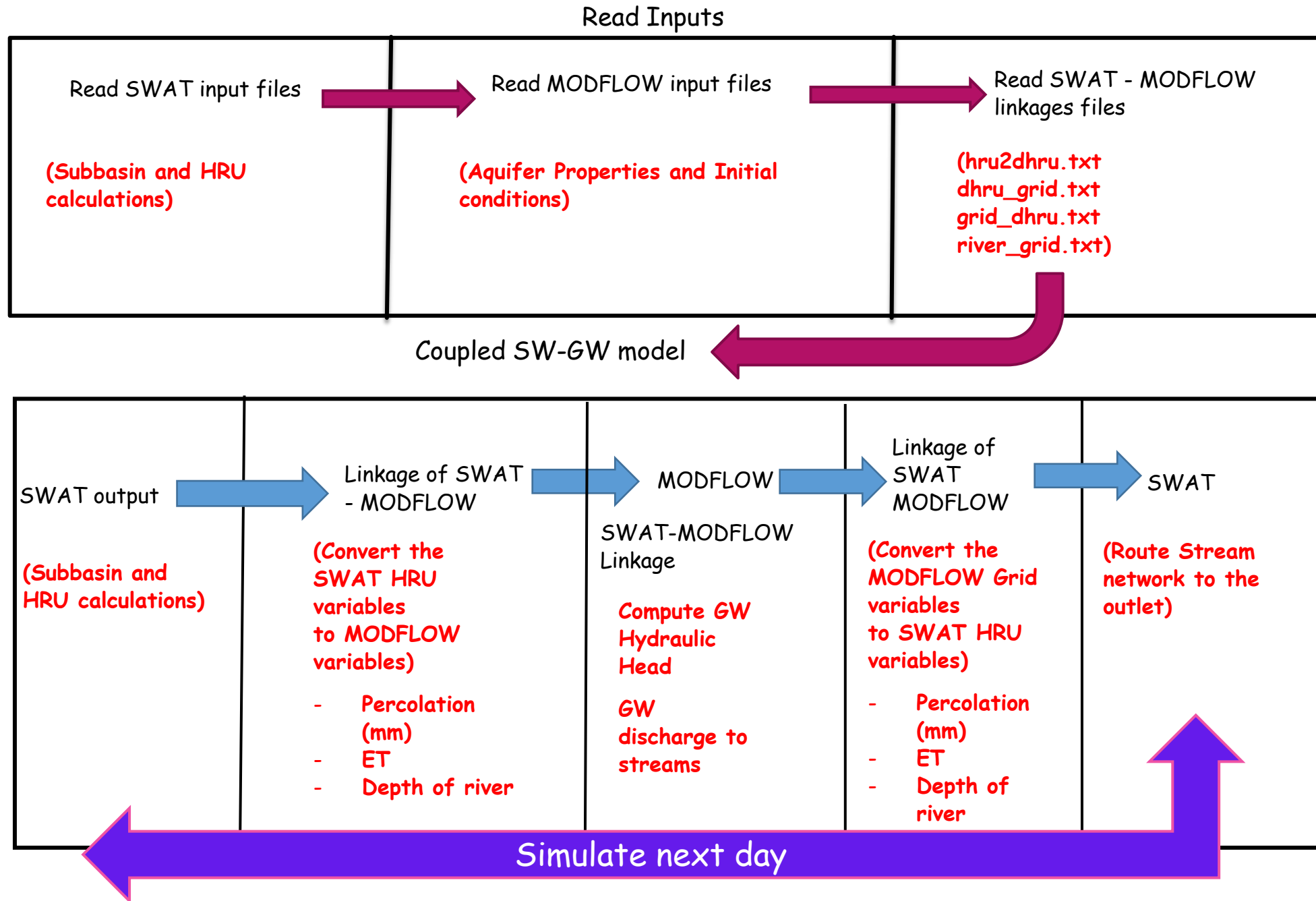
SWATMOD-PREP



Coupled SWAT- MODFLOW MODEL (SWATMOD-PREP)

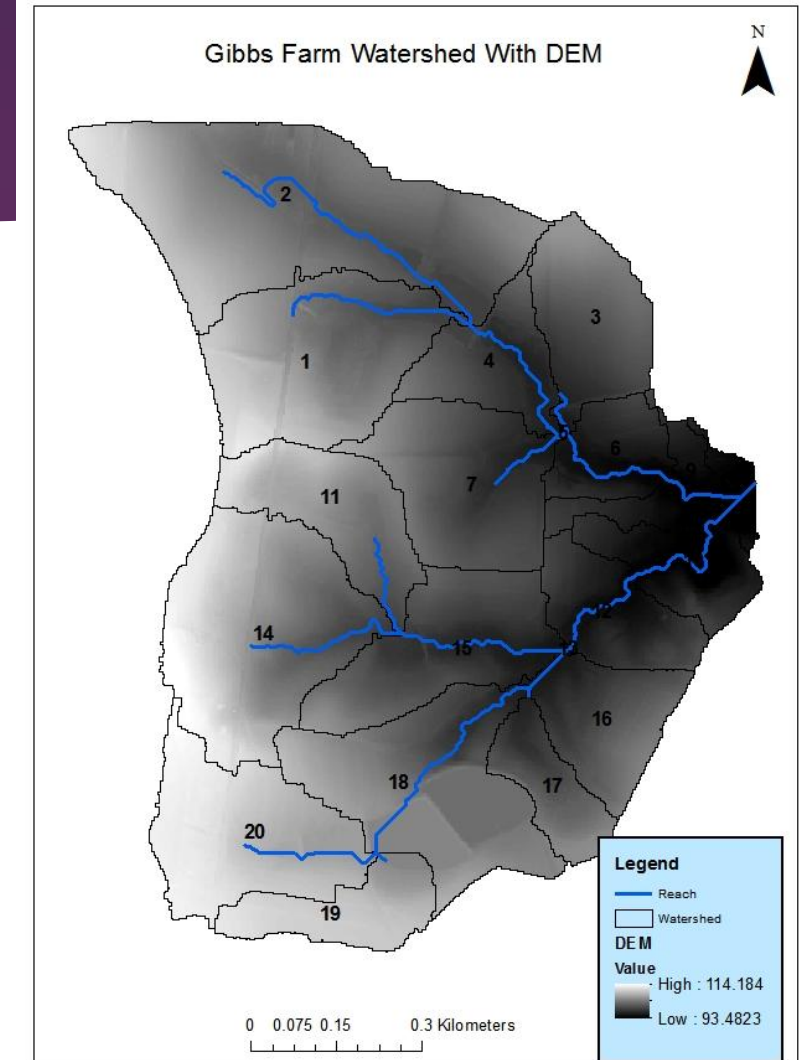
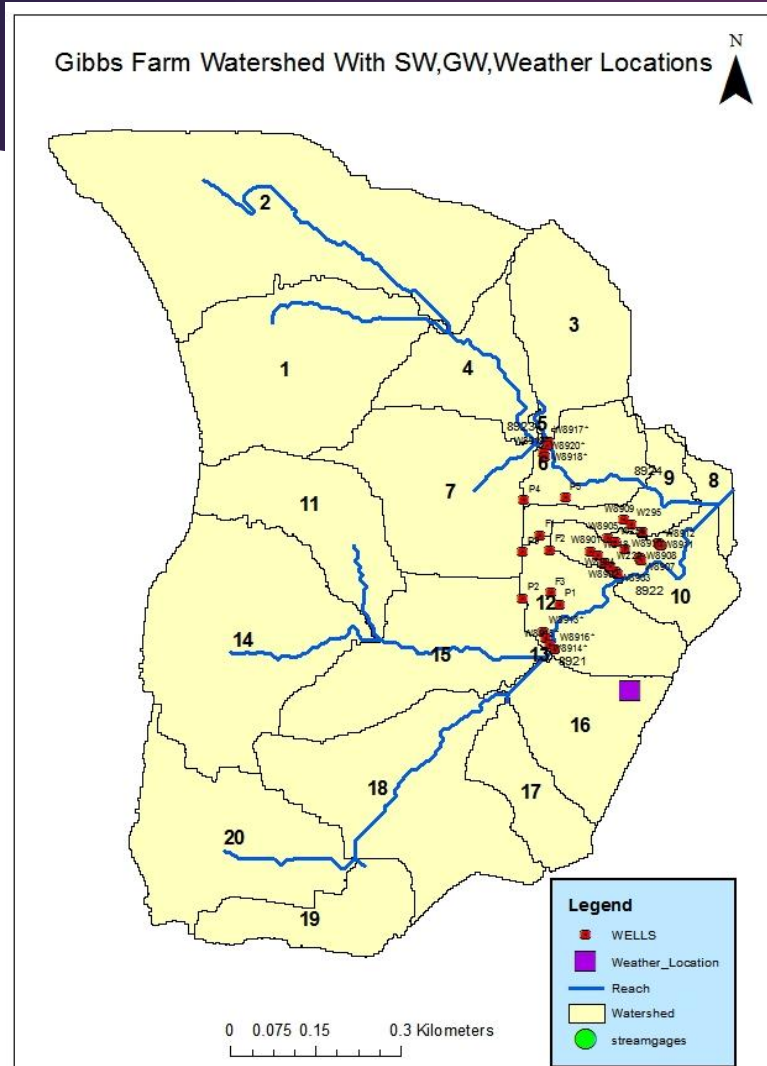
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- ❑ Developed for exchanging the characteristics between HRU's of SWAT model and grid cells in MODFLOW model
- ❑ GW module in SWAT is replaced by MODFLOW
- ❑ Coupled model simulates the spatial- temporal GW recharge and Stream aquifer interactions by RIVER Package in MODFLOW



SWAT Model Input Data

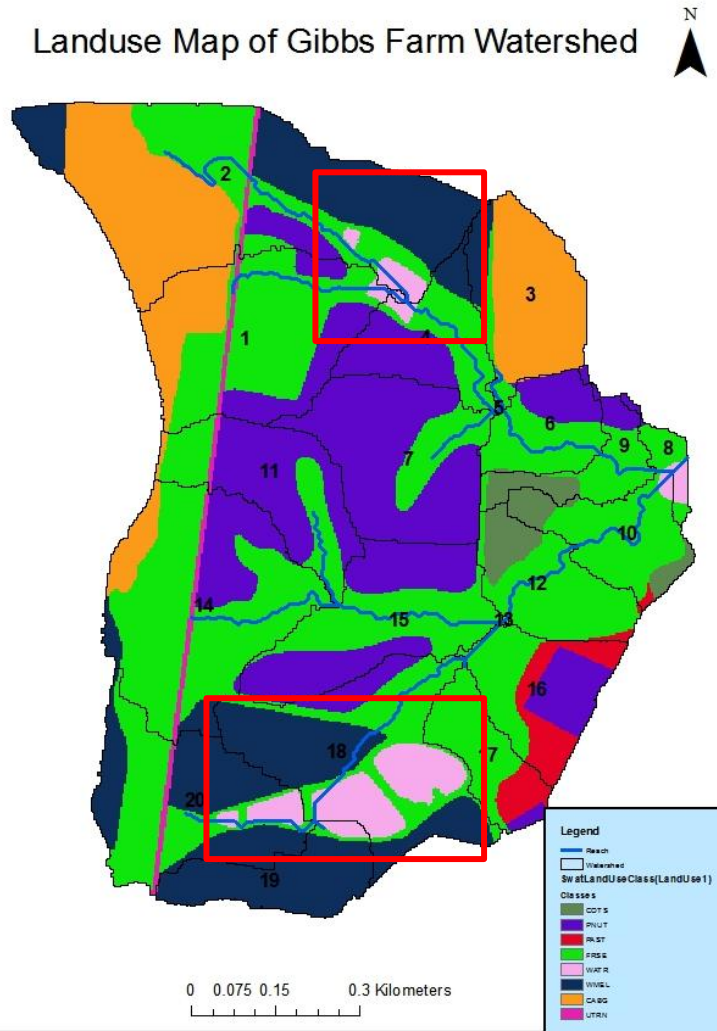
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SWAT Model Input Data

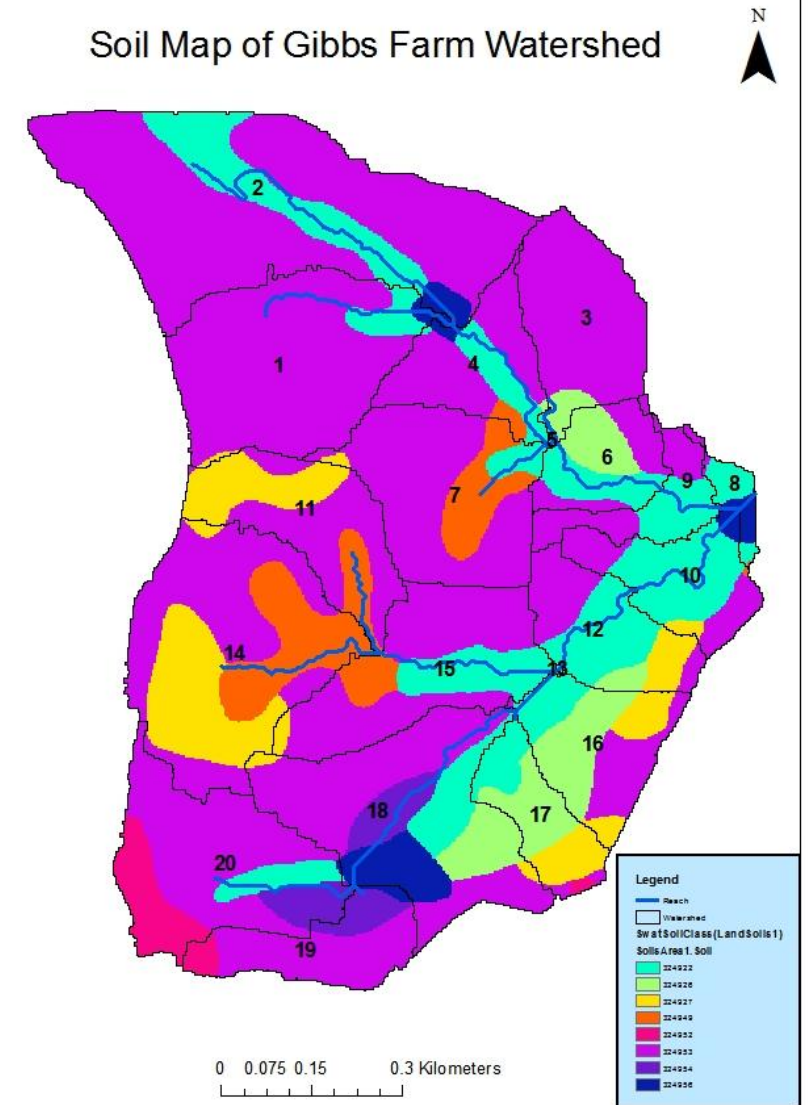
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Landuse Map of Gibbs Farm Watershed



Landuse : North basin (more crops in plastic covered beds) and south basin (more ponds and less land for crops)

Soil Map of Gibbs Farm Watershed



Effect of Ponds in the Watershed

- ❑ Farm ponds - agricultural source for the watershed in the south basin and also for irrigating the north basin fields.
- ❑ Ponds constructed on Miocene Hawthorne formation which act as Aquiclude
- ❑ Ponds store stream flow and utilized for irrigation
- ❑ Water is pumped from Floridan aquifers at a depth of 60-200 m below land surface - mostly surface and shallow GW

Pond Simulation in the watershed

Name of Basins	Pond Fraction (%)	Surface area (Hectares)	Volume (*10 ⁴ m ³)	Subbasin number
North Basin	0.879	0.74	1.48	4
South Basin	0.98	0.607	1.214	20
South Basin	0.1272	2.994	5.988	18

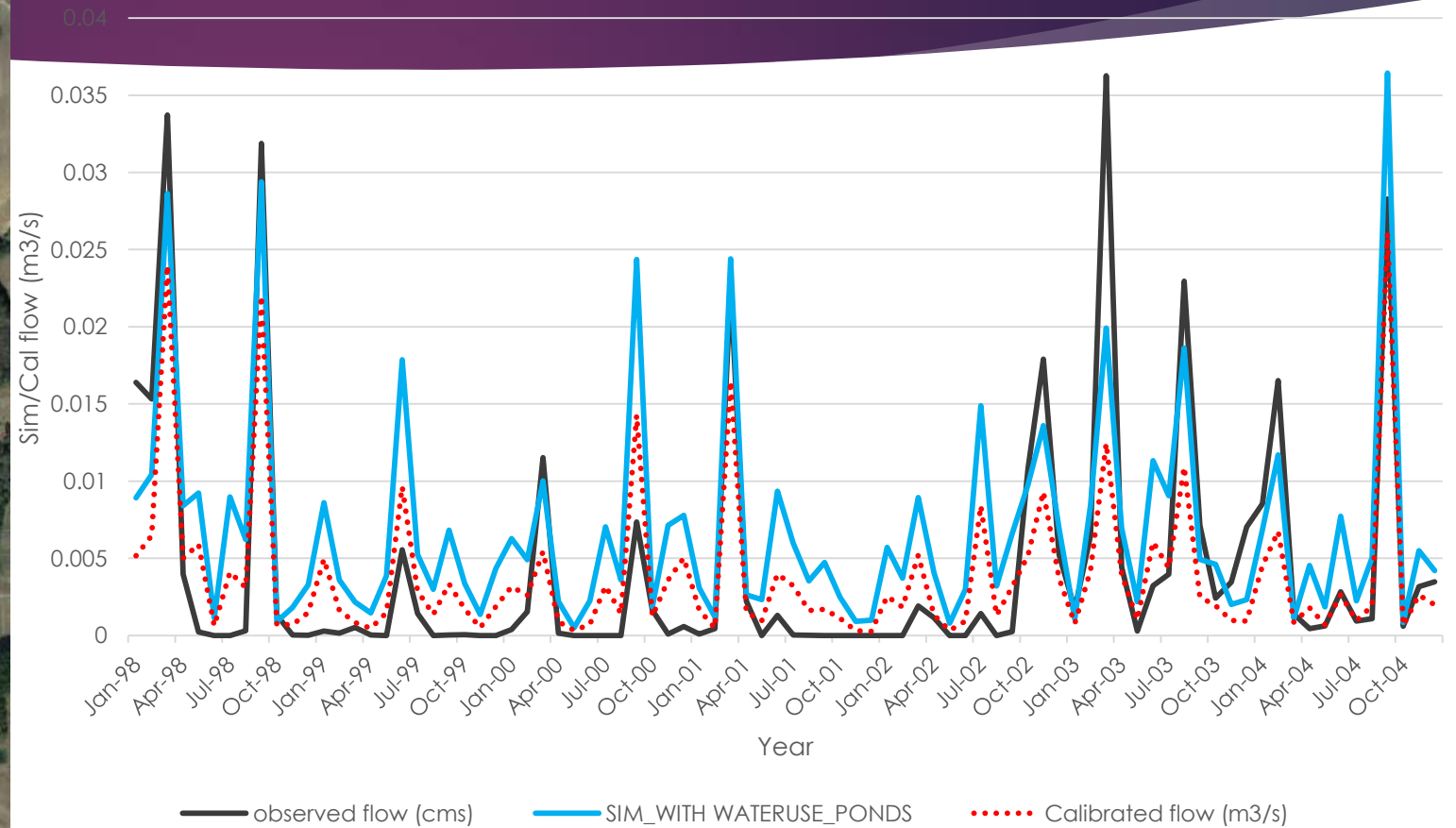
SWAT Model Setup

- ❖ Simulation periods : January 1995 through December 2004
- ❖ Warm up period : January 1995 through December 1997
- ❖ Calibration sites : U/S Stream gauge :8924 ; D/s Stream gauge : 8922
- ❖ Validation sites : U/S stream gauge : 8923 ; D/s Stream gauge : 8921
- ❖ Observed data : Stream flow (January 1998-December 2004)
- ❖ Model performance indices : NSE and R^2
- ❖ Pond simulation in both north and south basin

Results and Discussions - SWAT model

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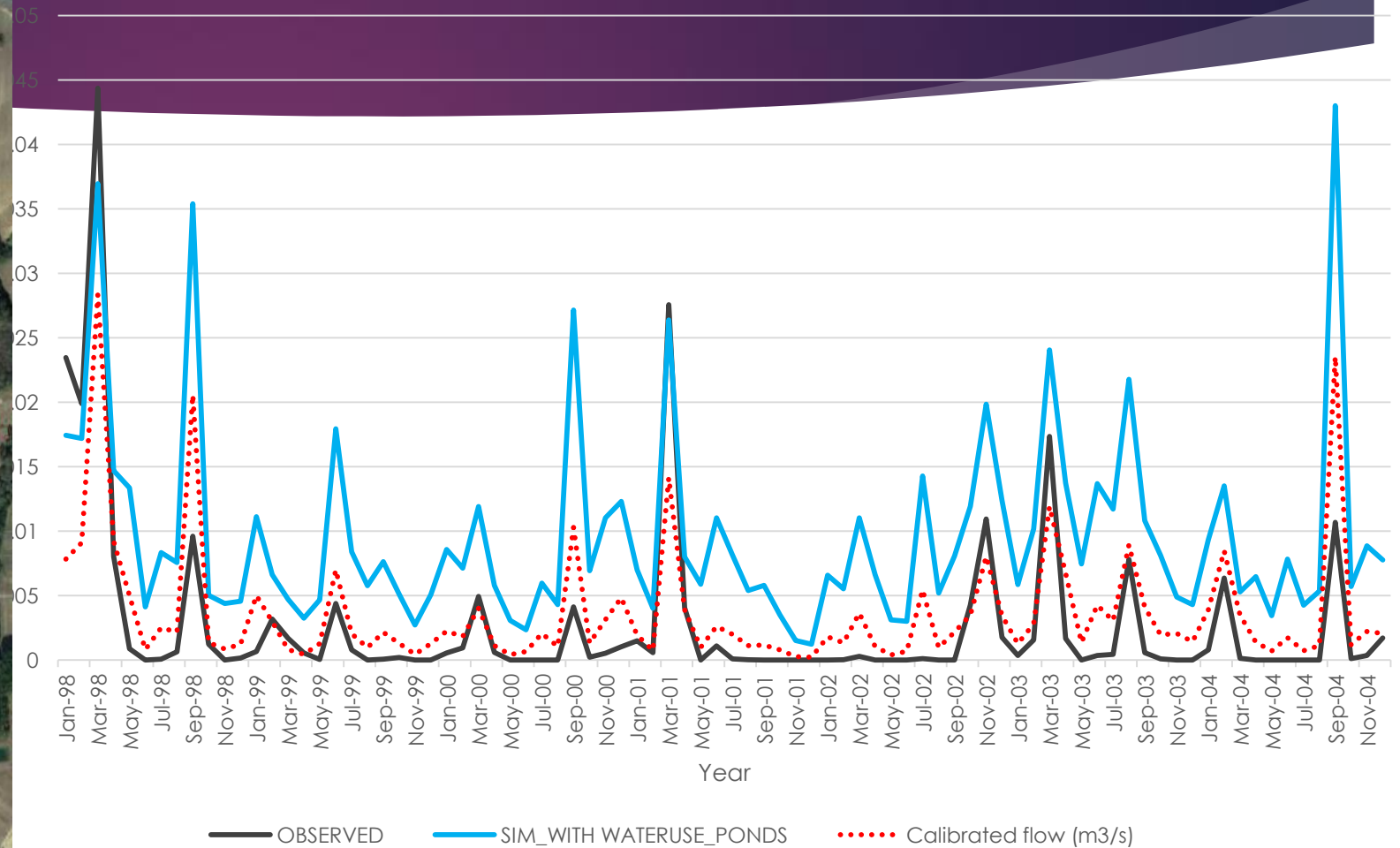
8924 - Flow Hydrograph



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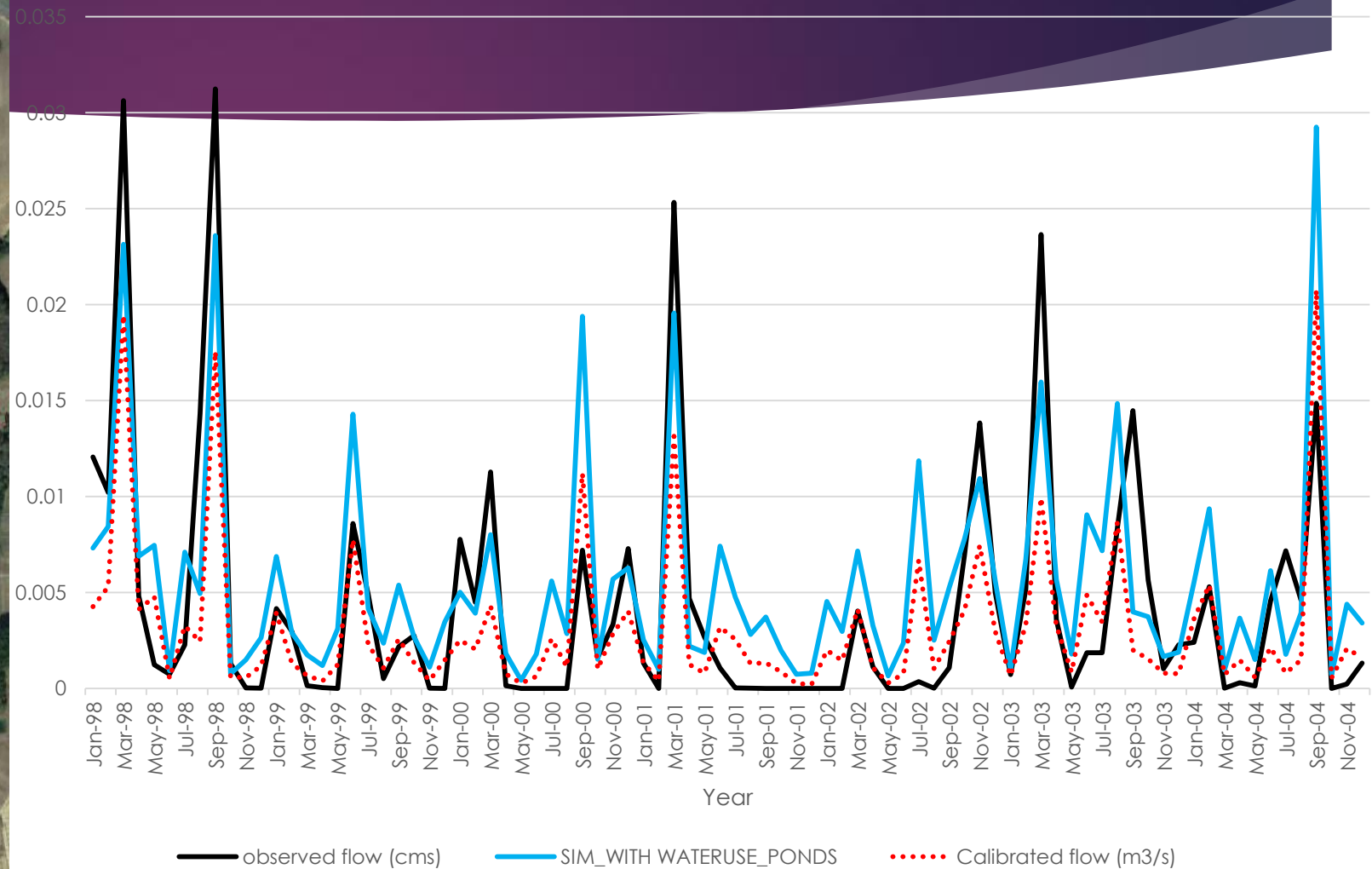
8922 - Flow Hydrograph



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8923 - Flow Hydrograph

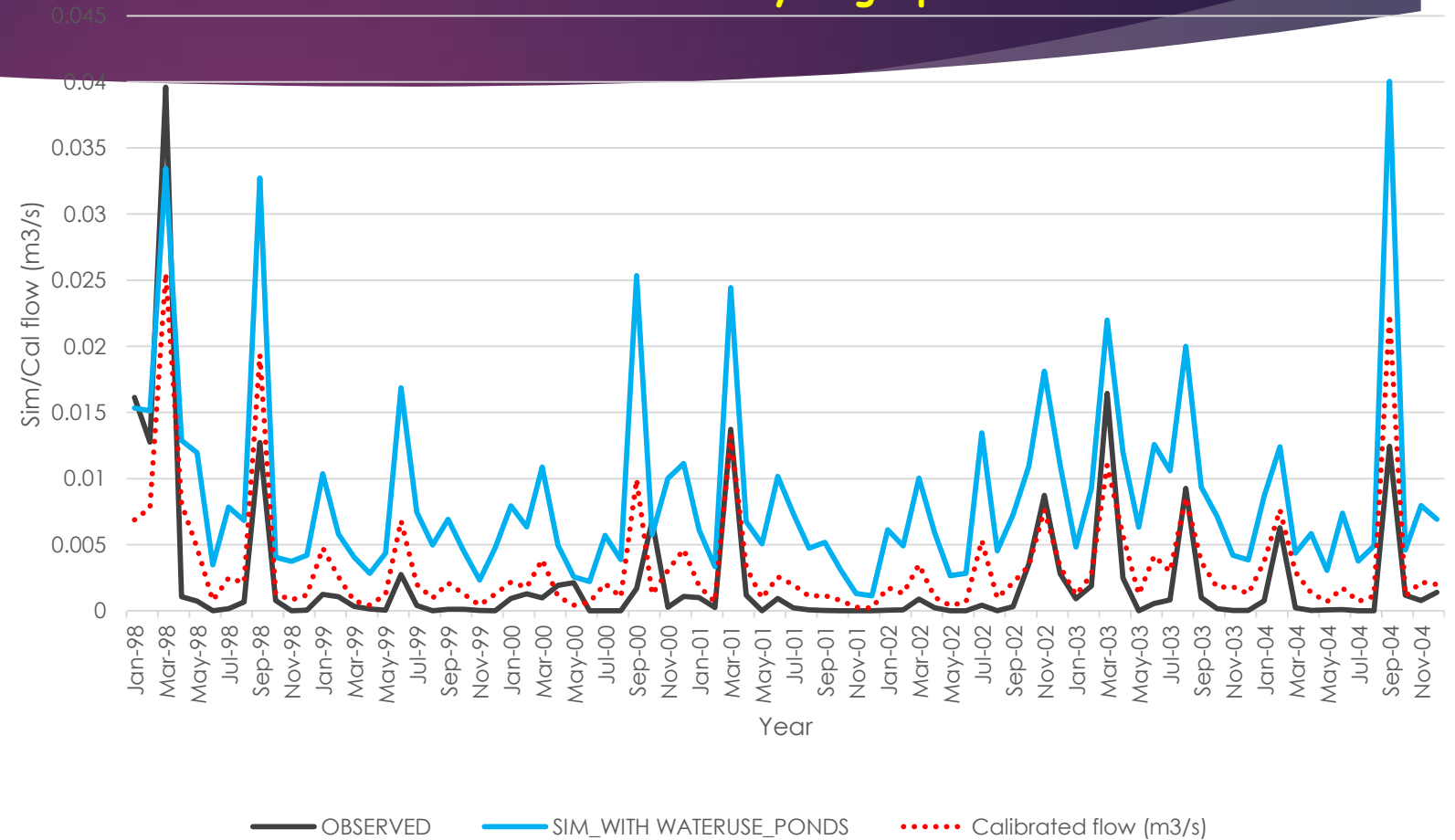


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8921 - Flow Hydrograph



Challenges in Model Calibration

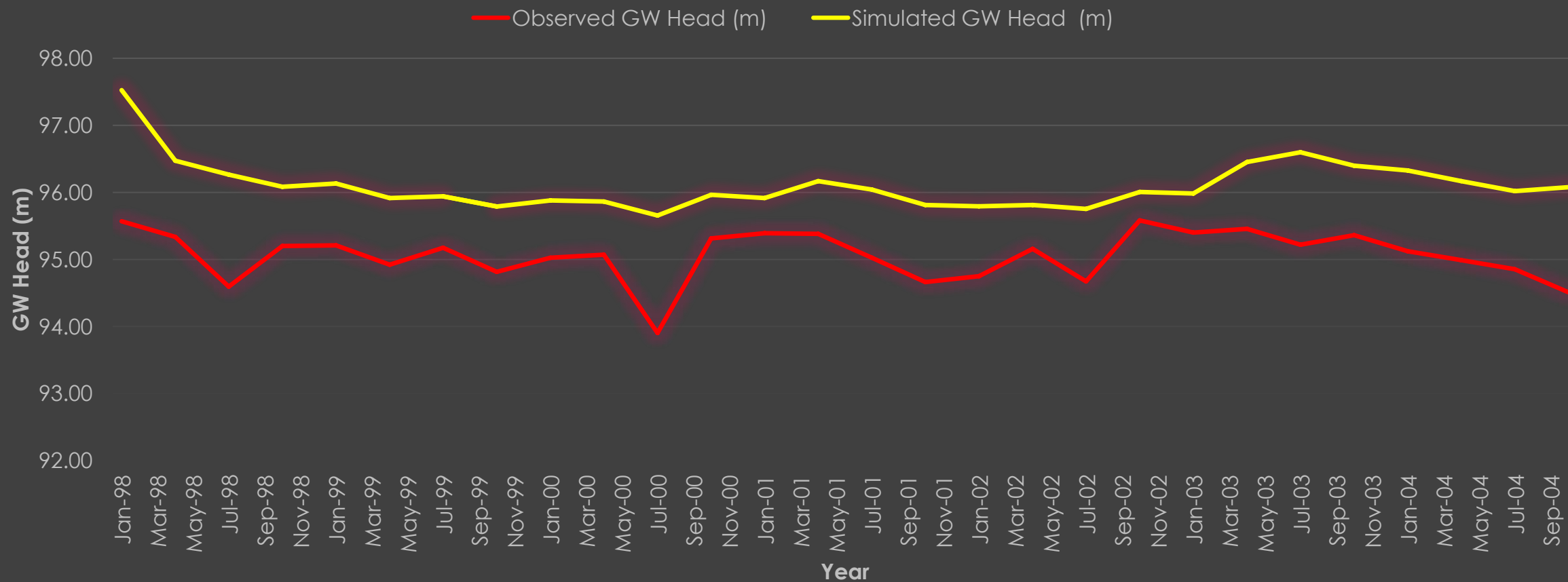
- ❑ In north basin, more cropland and in south basin, more ponds
- ❑ In south basin , Ponds decrease surface runoff and increase baseflow and north basin almost all vegetables plastic covered which increases surface runoff
- ❑ Parameters was slightly different for both because of significant difference in north and south basins

Performance Indices for both Upstream and Downstream sites

Name of Stream Gauge	Daily Values (Simulated)		Monthly Values (Simulated)		Daily Values (Calibrated)		Monthly Values (Calibrated)	
	R ²	NSE	R ²	NSE	R ²	NSE	R ²	NSE
8921	0.500	-0.067	0.566	-1.009	0.651	0.645	0.707	0.667
8922	0.510	-0.416	0.527	-0.636	0.662	0.635	0.662	0.635
8923	0.616	0.581	0.610	0.566	0.691	0.672	0.667	0.596
8924	0.650	0.566	0.677	0.580	0.740	0.735	0.728	0.628

Results and Discussions (SWATMOD-PREP)

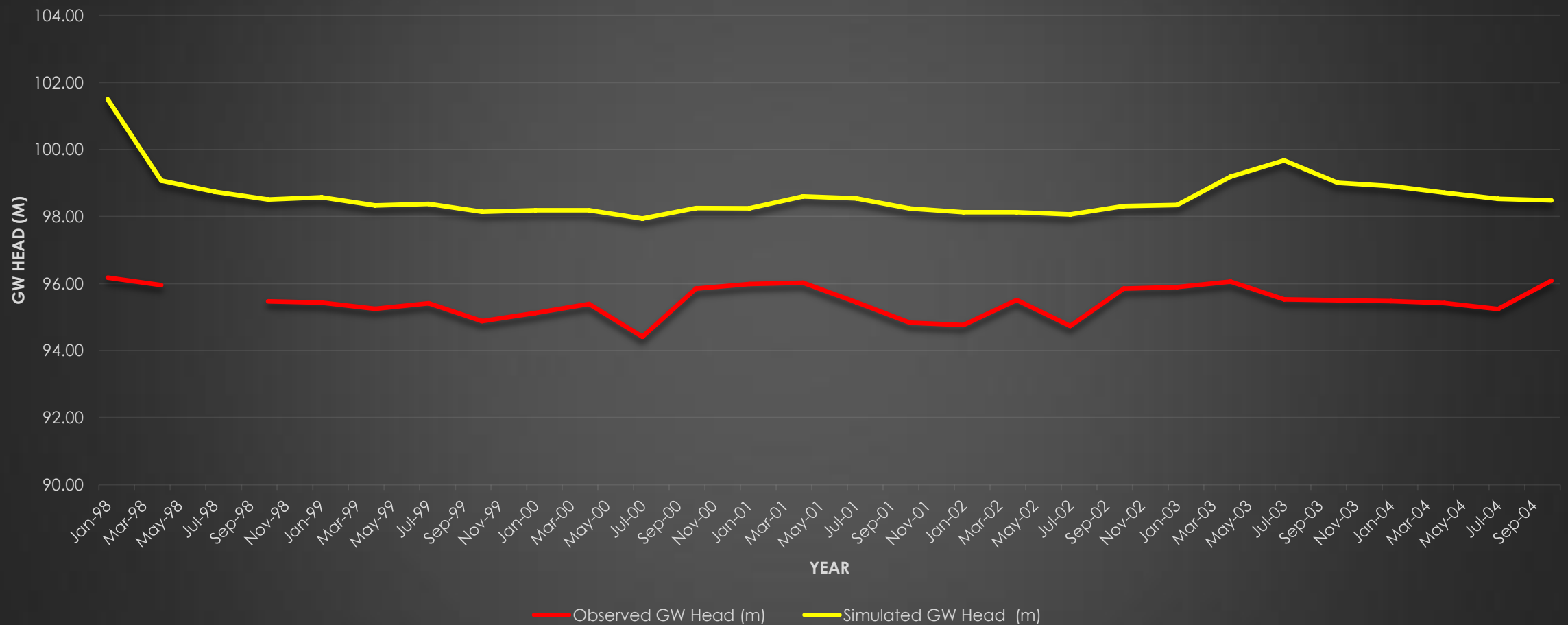
P1



(CONTD..)

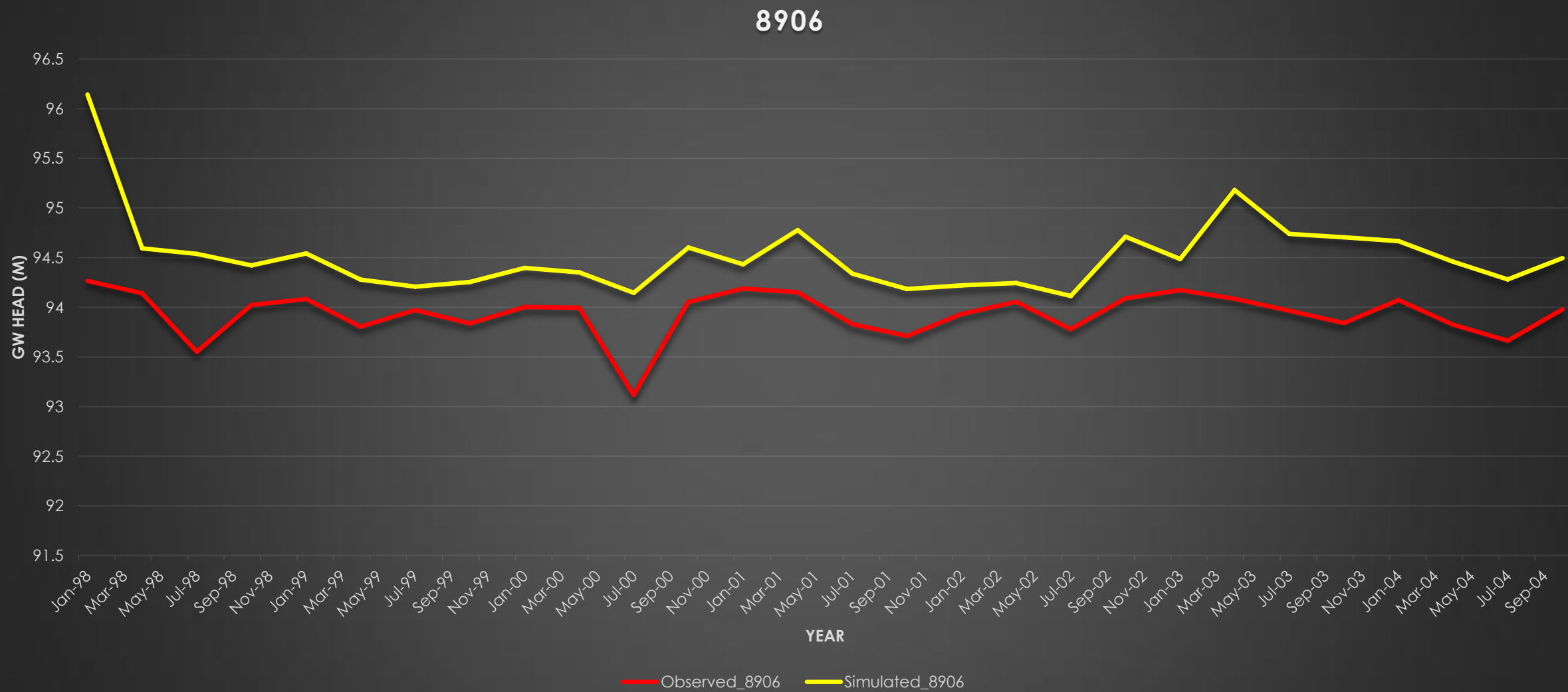
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P3



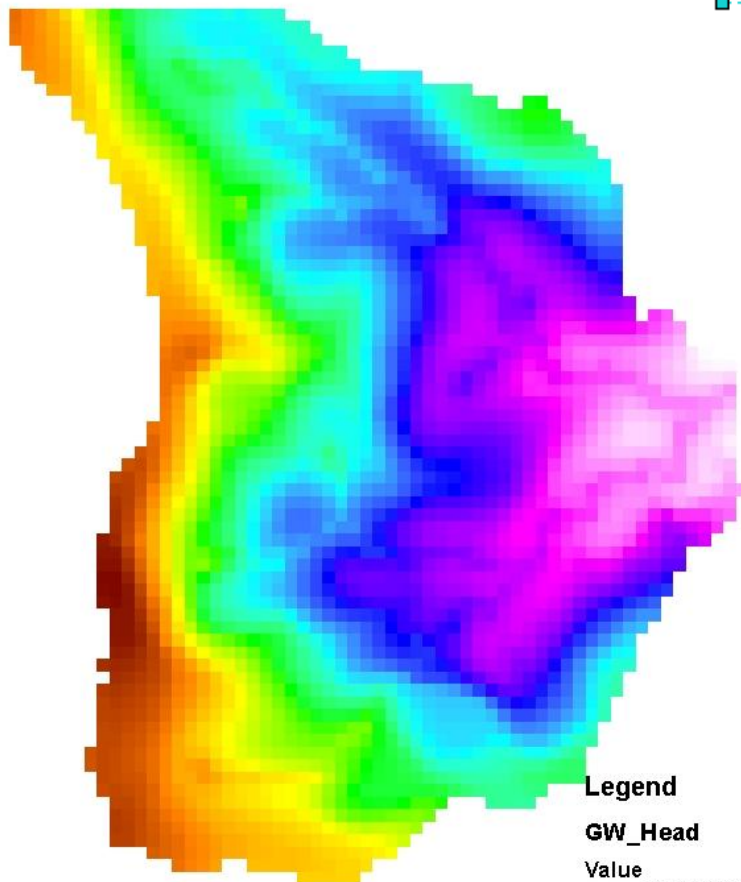
(CONTD..)

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MODFLOW HEAD

GIBBS FARM WATERSHED - GW HEAD



Legend

GW_Head

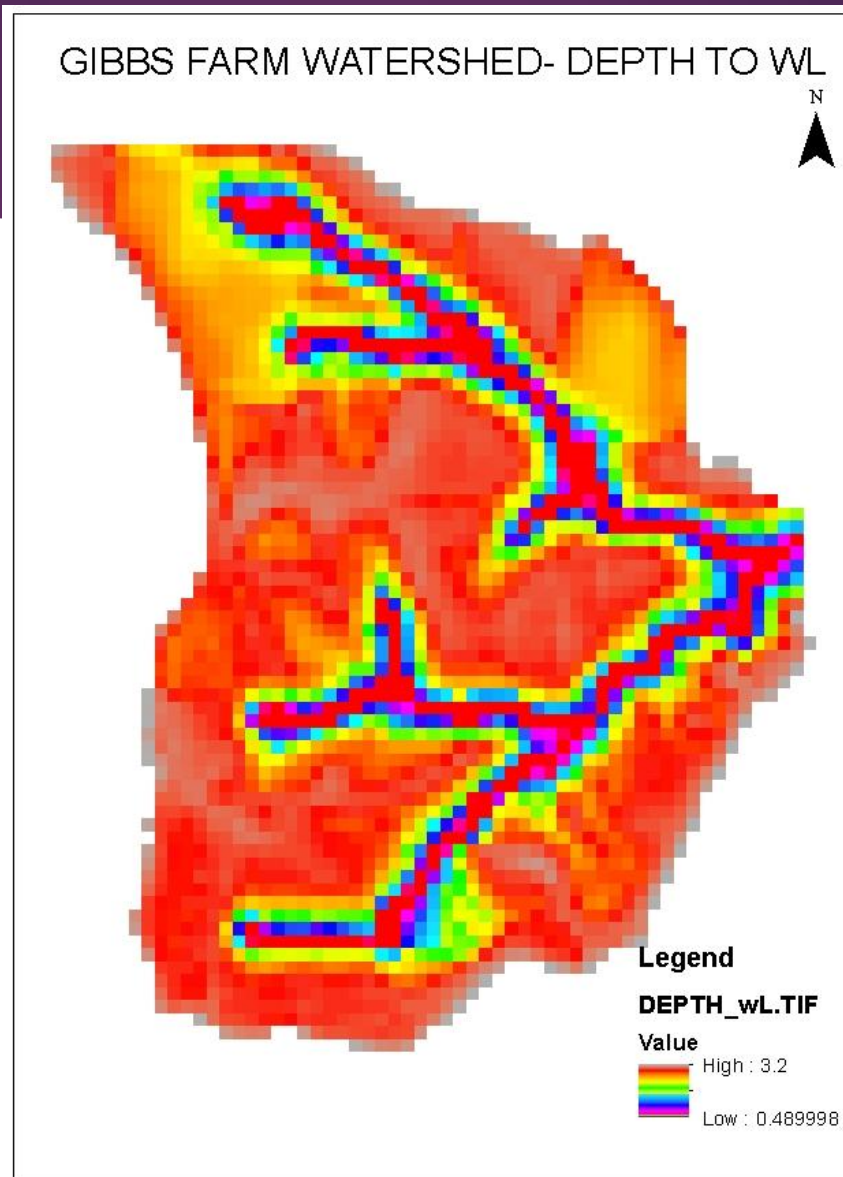
Value

High : 111.07

Low : 91.49

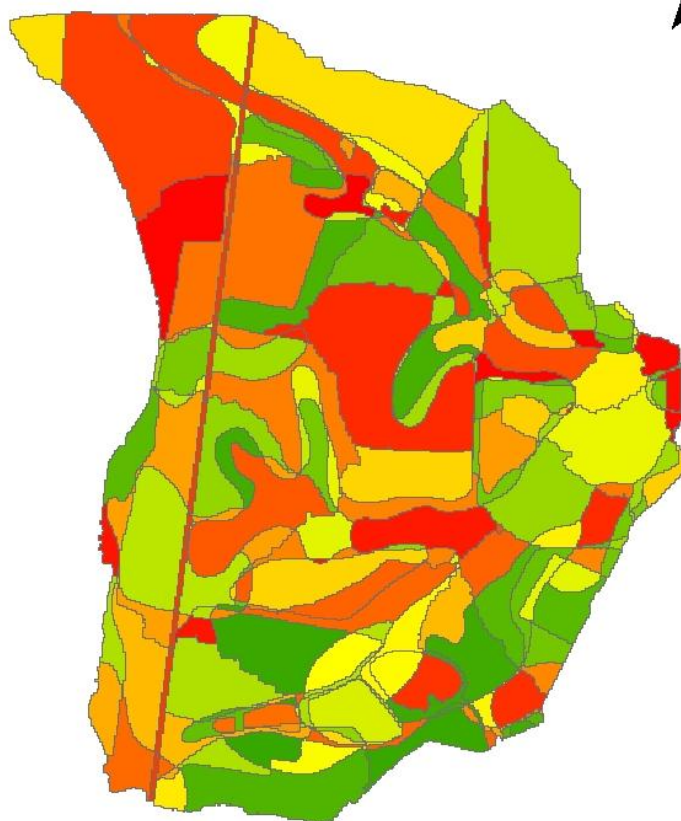
DEPTH TO WATER LEVEL PLOTS

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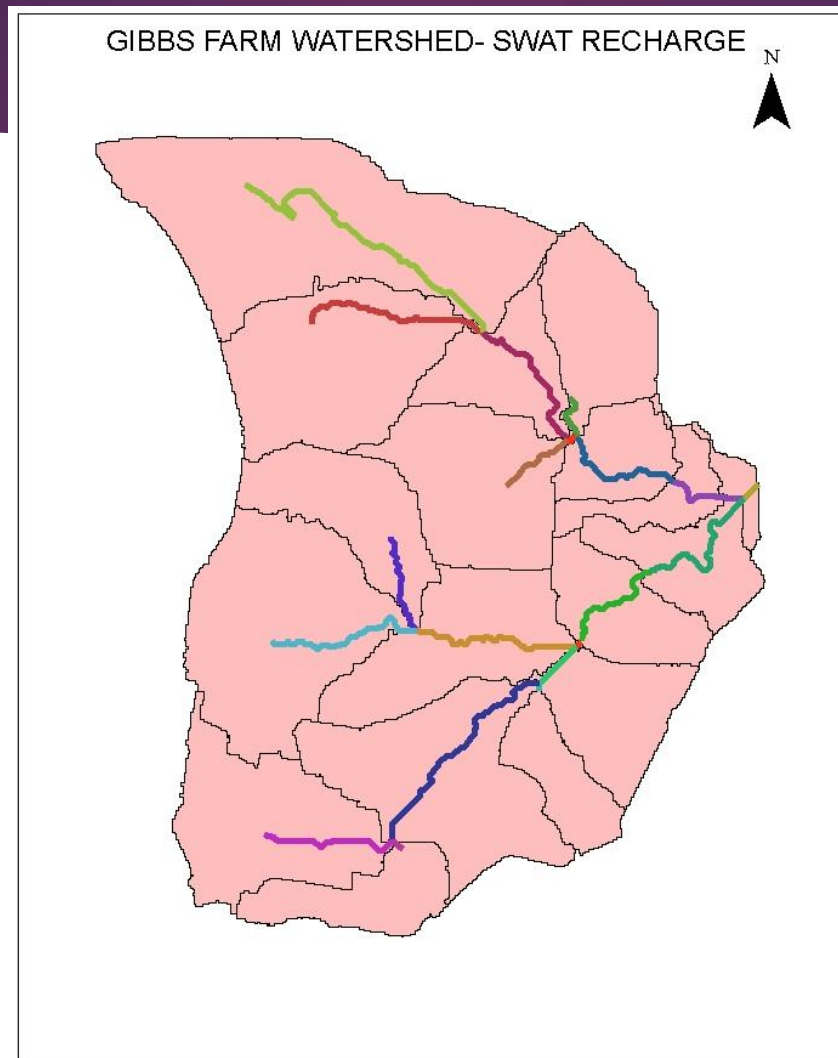
SWAT RECHARGE

GIBBS FARM WATERSHED- SWAT RECHARGE



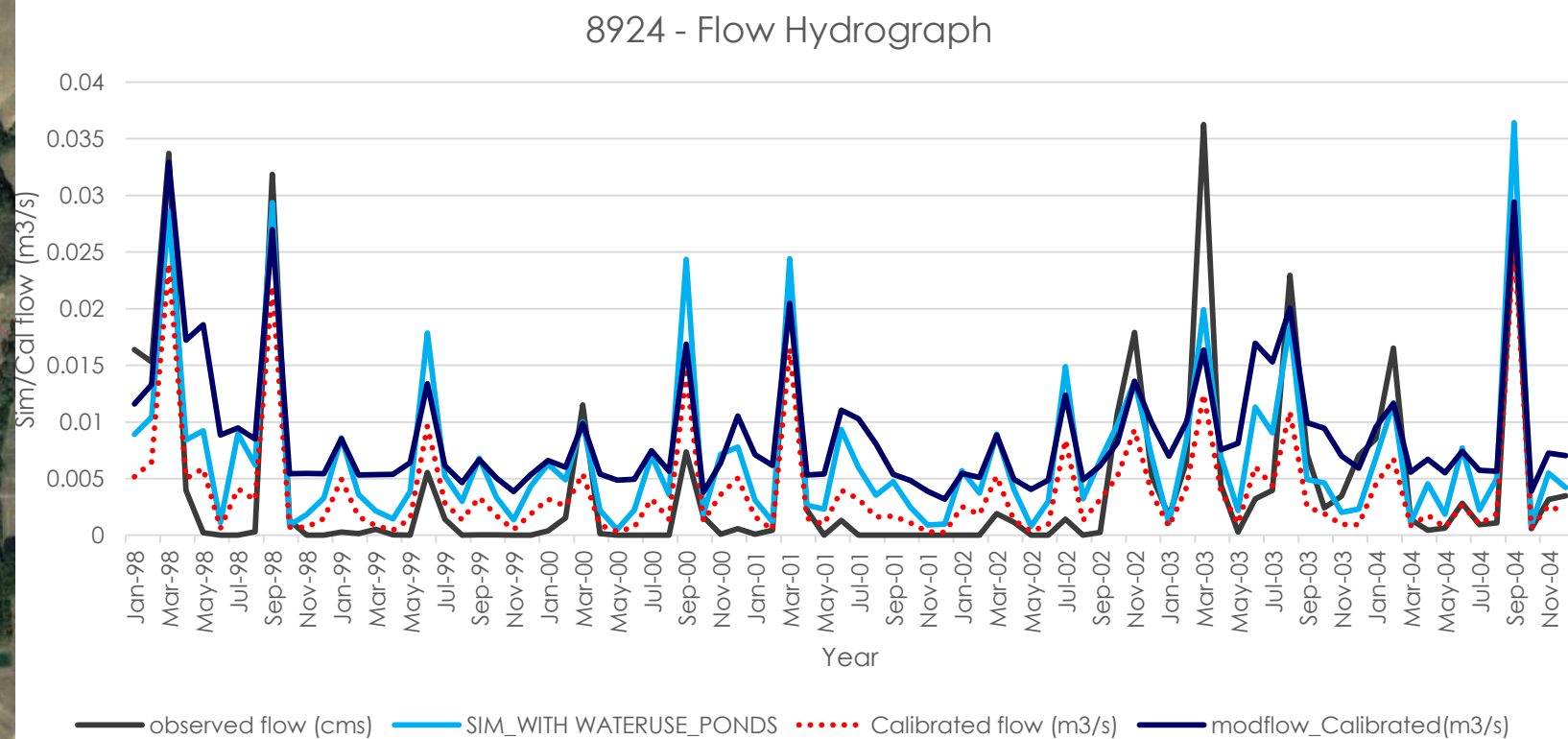
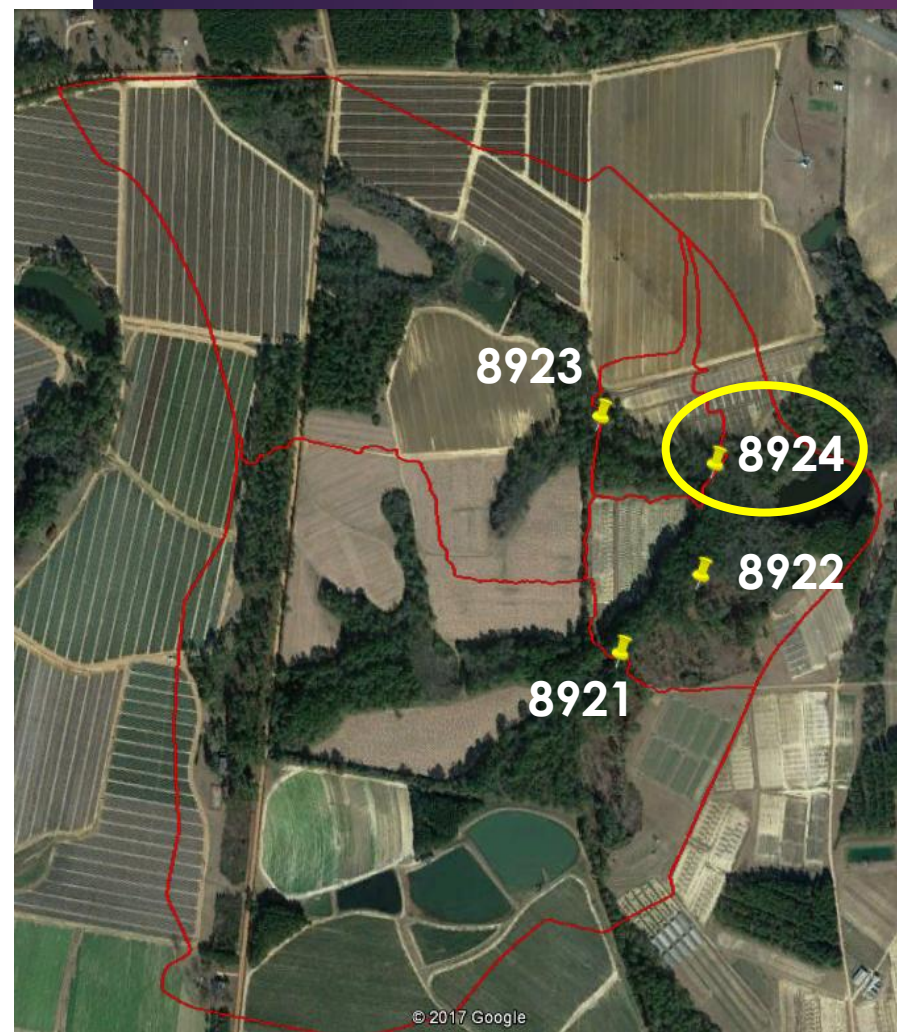
Recharge values range from 0 -3.19 m

GW SW INTERACTION SWAT



Seepage to aquifer range
from -1.48 to -167.91 m³/d

SWAT FLOW HYDROGRAPH



Findings and Future work

- ❑ SWAT model need to calibrated for SW processes
- ❑ MODFLOW model need to be calibrated for GW processes
- ❑ Comparative study of SWAT model with numerical techniques (Finite Element Method and Finite Difference Method) and Analytic Techniques (Analytic Element Method)

Thank You For Your Attention

