

An Integrated Hydrologic-Hydrodynamic Model for Simulating Floods in the St. Johns River Basin

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University of Central Florida

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3/27/2015

Outline

- Integrated hydrologic-hydrodynamic modeling
- Hydrologic modeling on Tropical Storm Fay (2008)
- Assessment
 - ✓ Impact of climate change
 - ✓ Impact of land use change
- Summary

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Hydrologic Model & Hydrodynamic Model

- Soil and Water Assessment Tool (SWAT)
- Watershed/basin
- Runoff from upper river
- Runoff from tributaries
- Interaction with ocean unknown

- ADvanced CIRCulation Model (ADCIRC)
- Coastal ocean/estuaries
- Storm surge
- Tides
- Need the tributary/upper river inflow

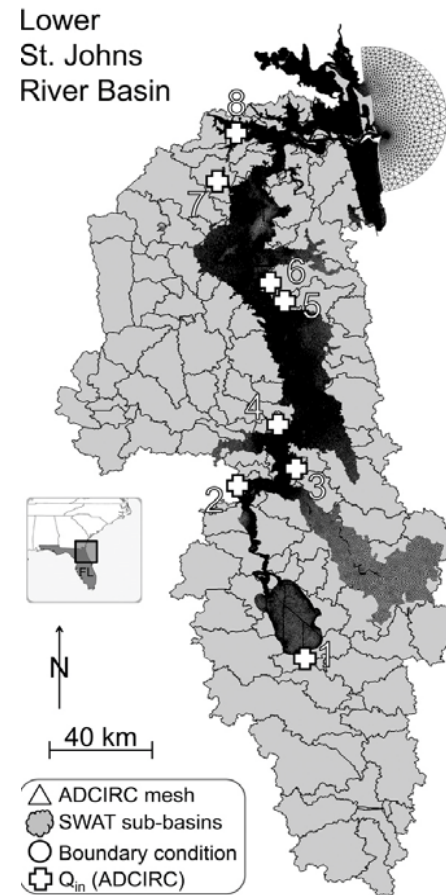
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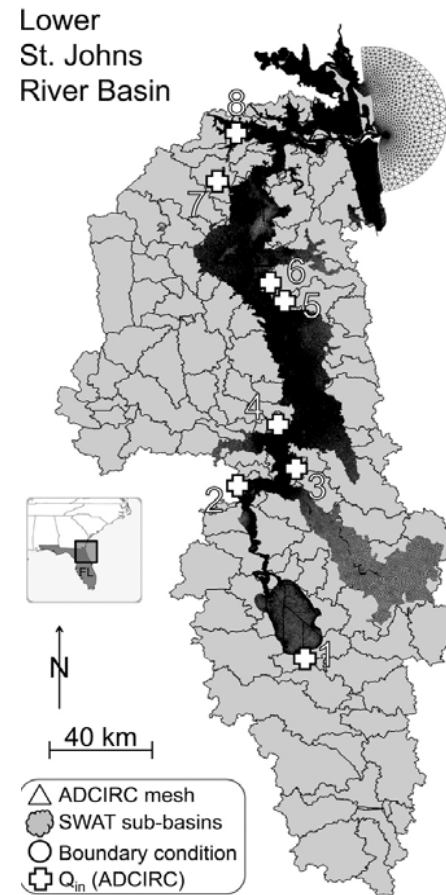
Integration of SWAT and ADCIRC Model

- Simulated runoff from tributaries/upper river by SWAT
- Consolidated to some inflow inlets for ADCIRC (8 inlets)
- SWAT model can provide river inflow boundaries under different scenarios (climate/land use change)



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- Detailed hydrologic processes
- Processes expressed by physical/empirical equations
- GUI – friendly, easily for the users

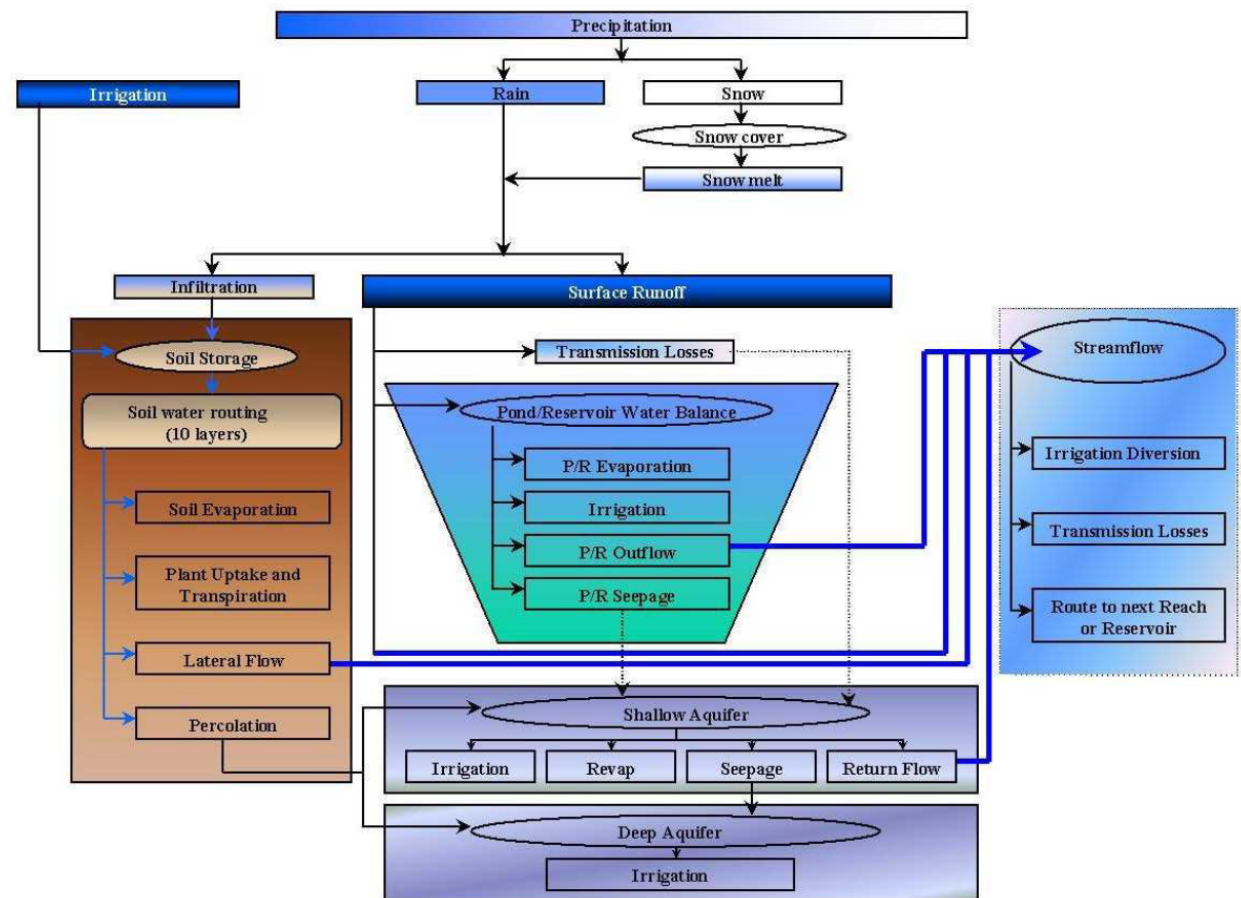


Figure 1.5: Schematic of pathways available for water movement in SWAT (Neitsch et al., 2009)

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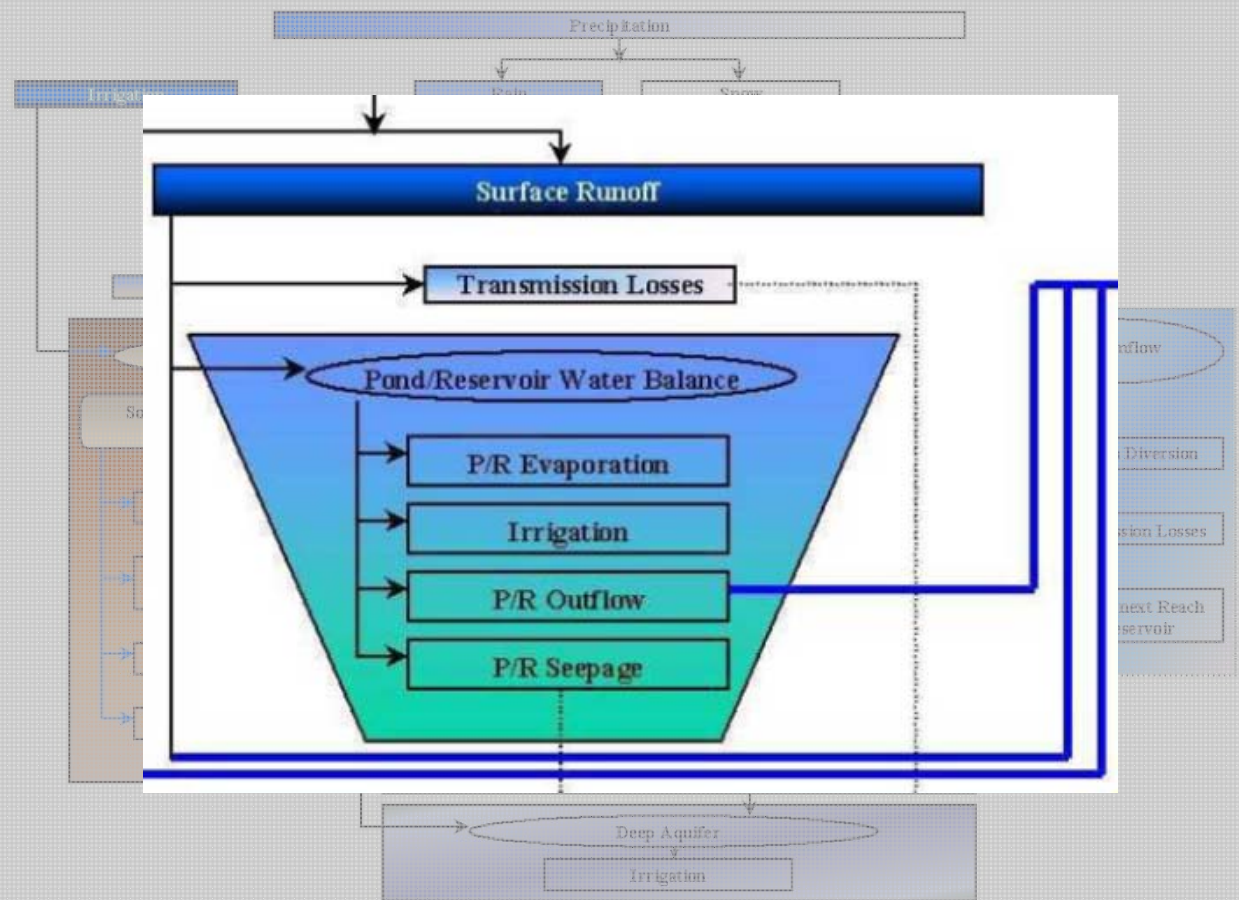


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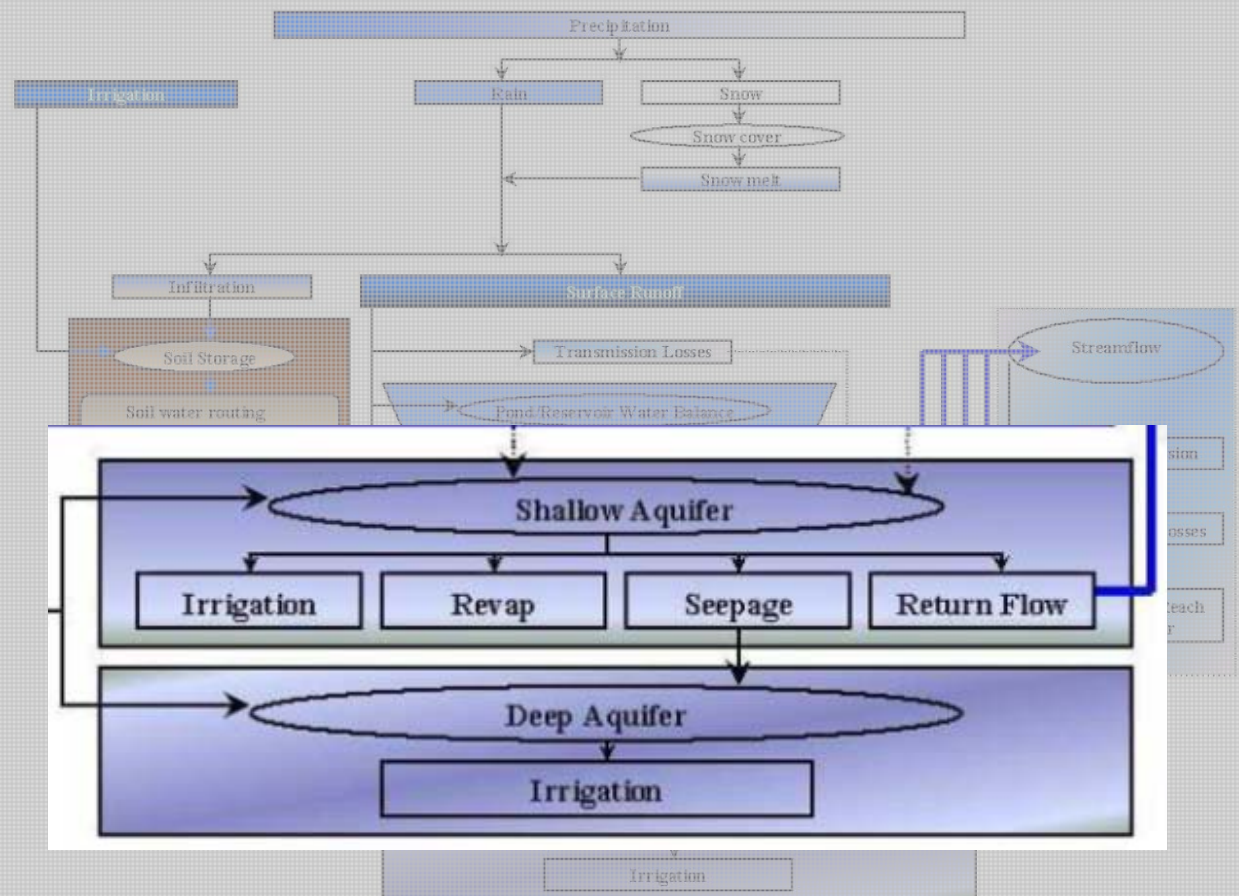


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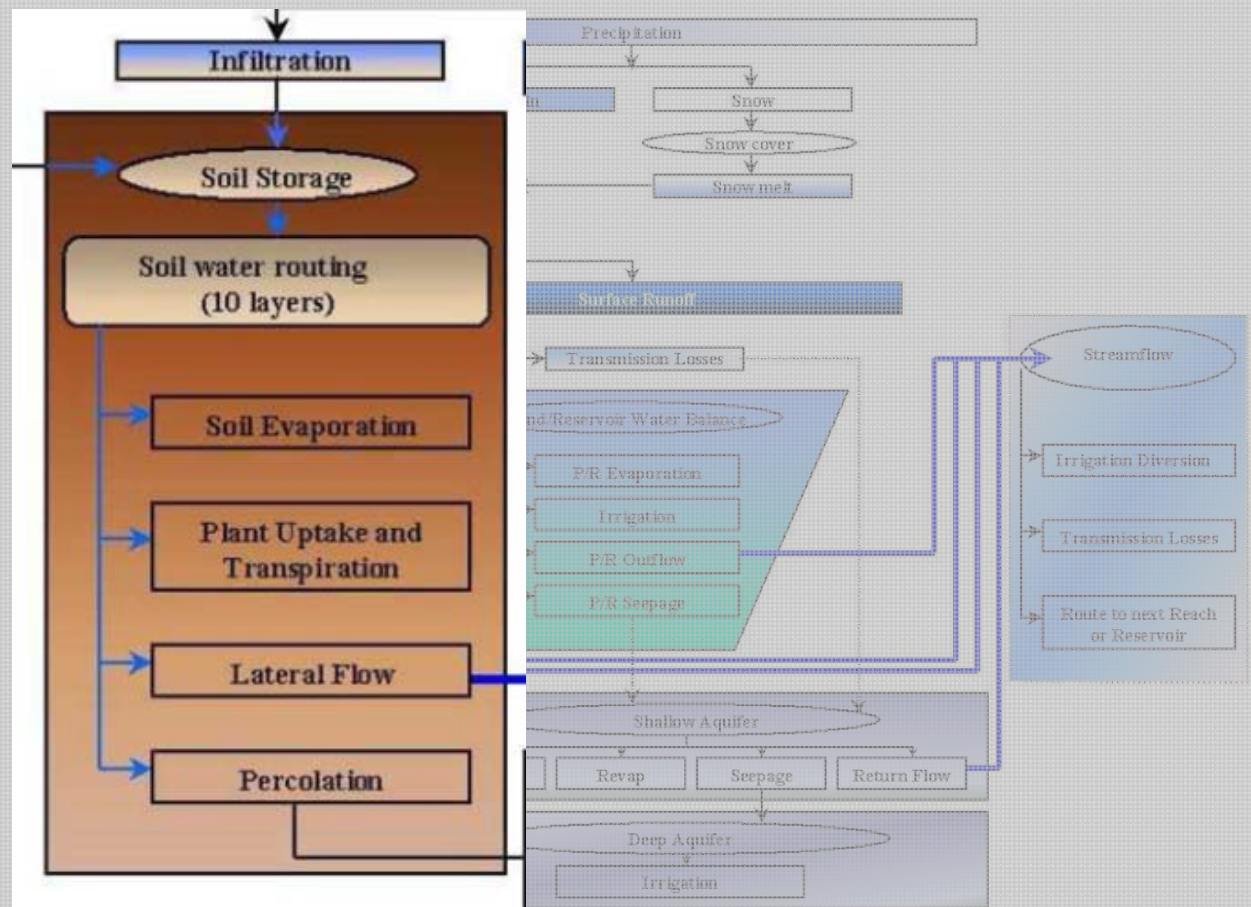


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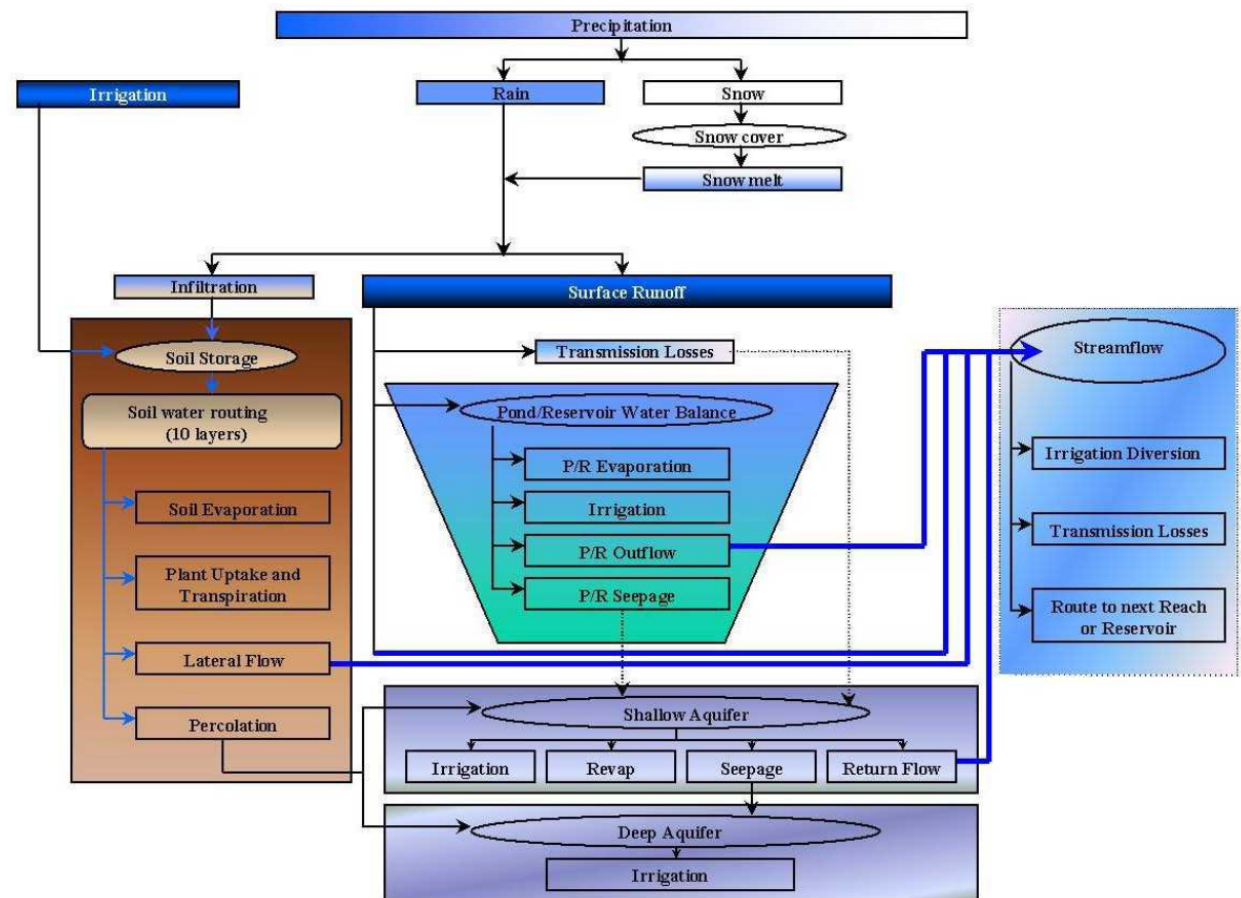
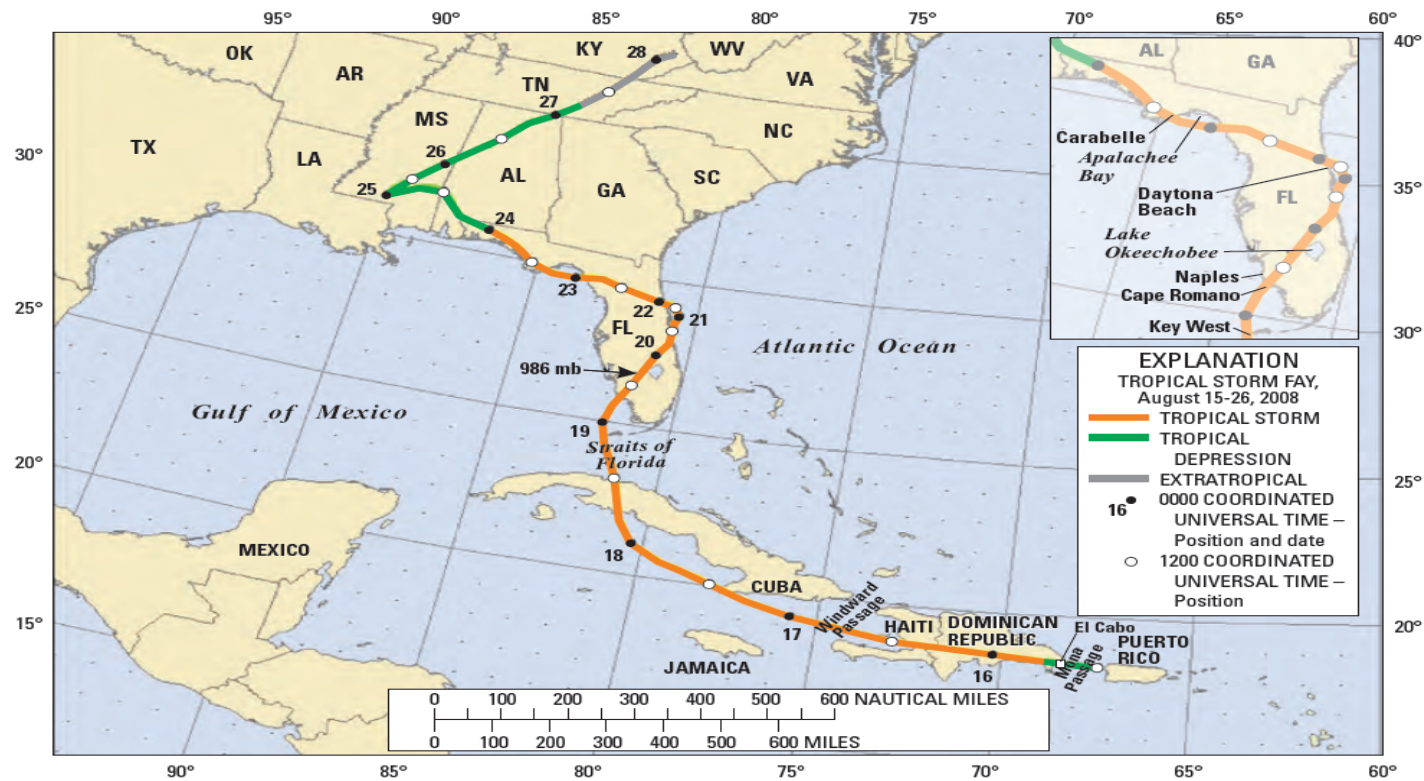
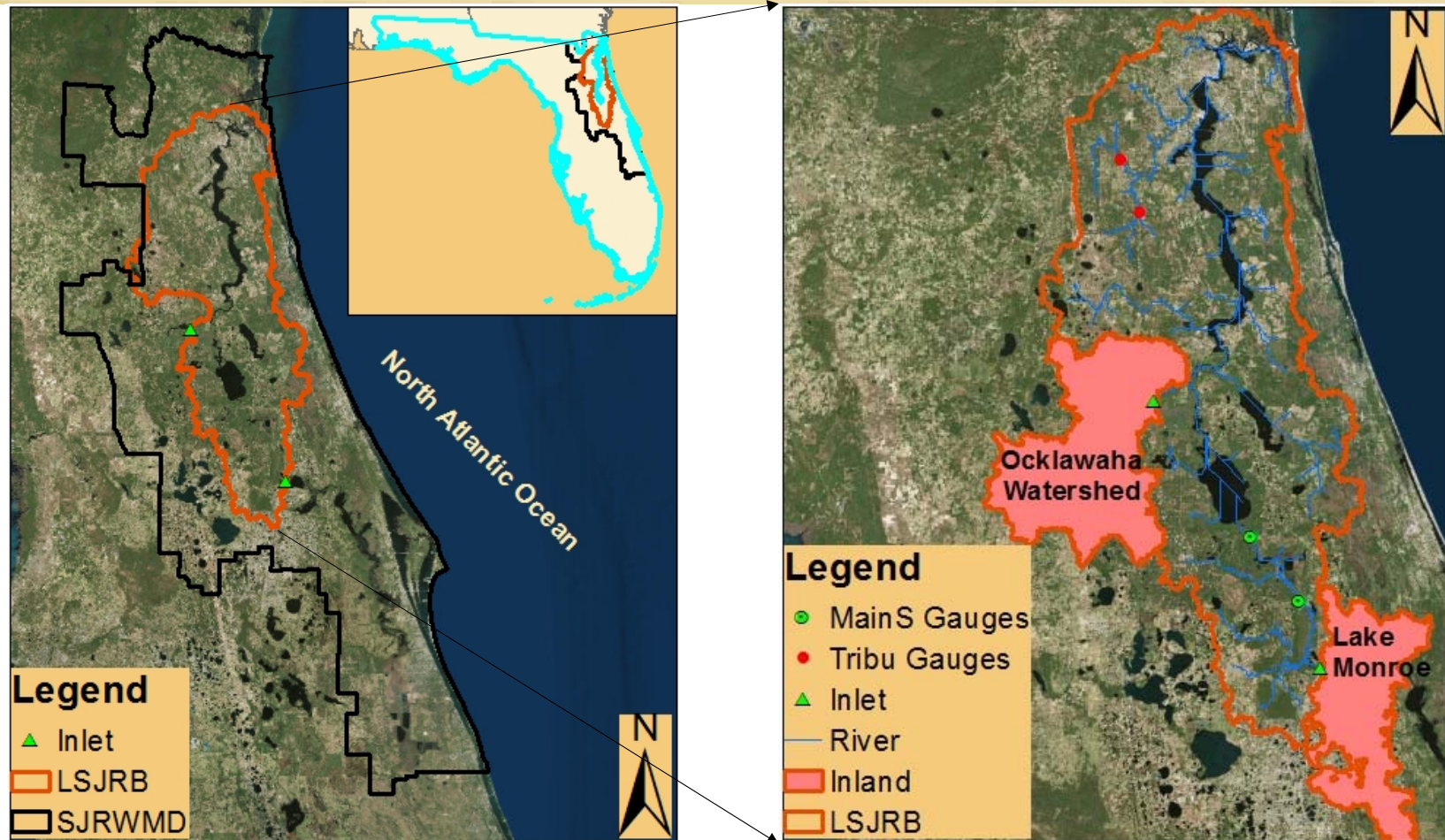


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Tropic Storm Fay (08/15/2008 ~ 08/27/2008)



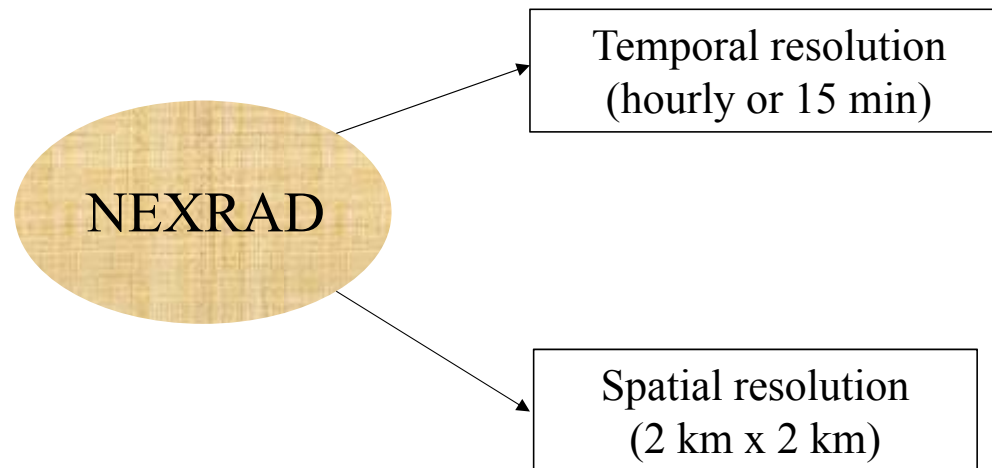
Lower St. Johns River Basin



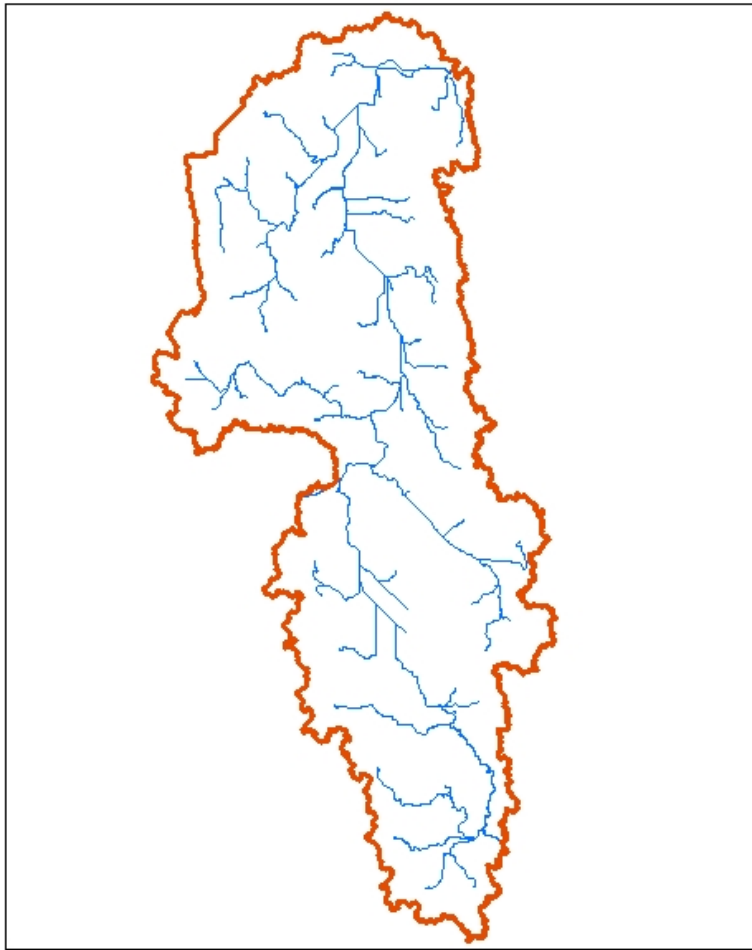
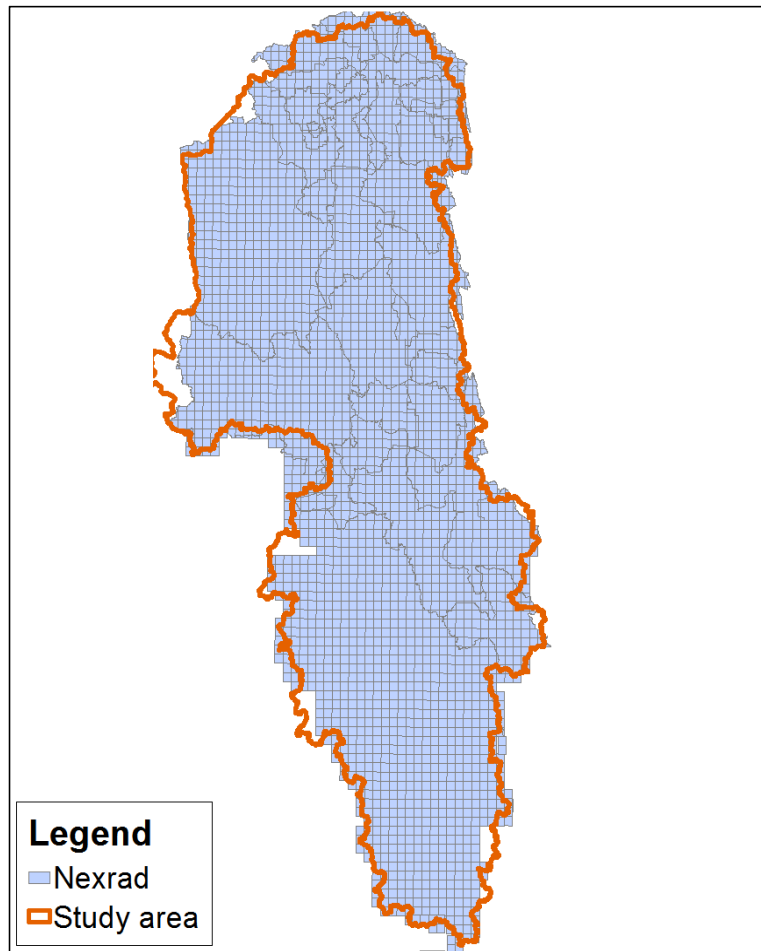
Data Sources

URL	Organization	Data
http://ned.usgs.gov	USGS	DEM
http://www.sjrwmd.com	SJRWMD	NEXRAD
		LULC
http://www.soilinfo.psu.edu	Informatics at PSU	Soil
http://waterdata.usgs.gov/nwis	USGS	Streamflow

NEXRAD Rainfall Data

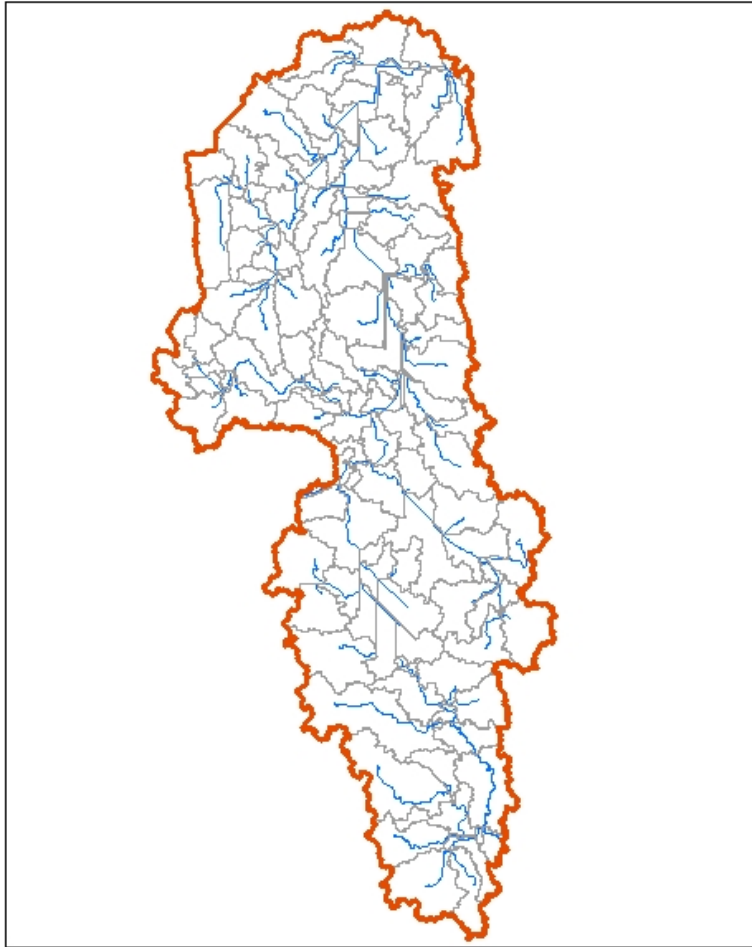


NEXRAD and SWAT



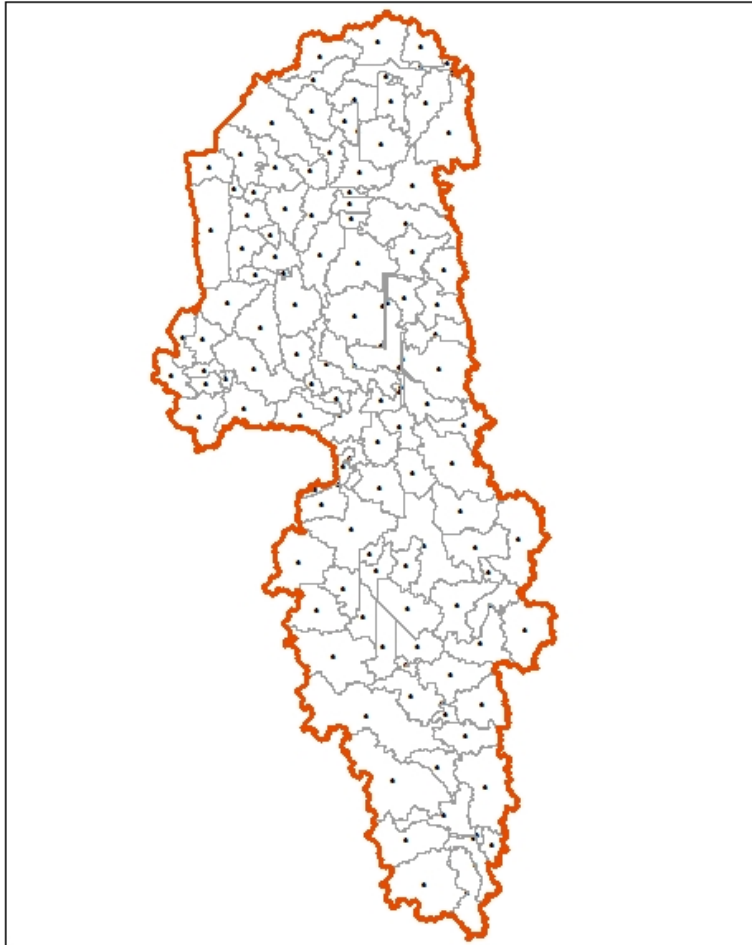
NEXRAD and SWAT

Delineate the study area into
many subwatersheds



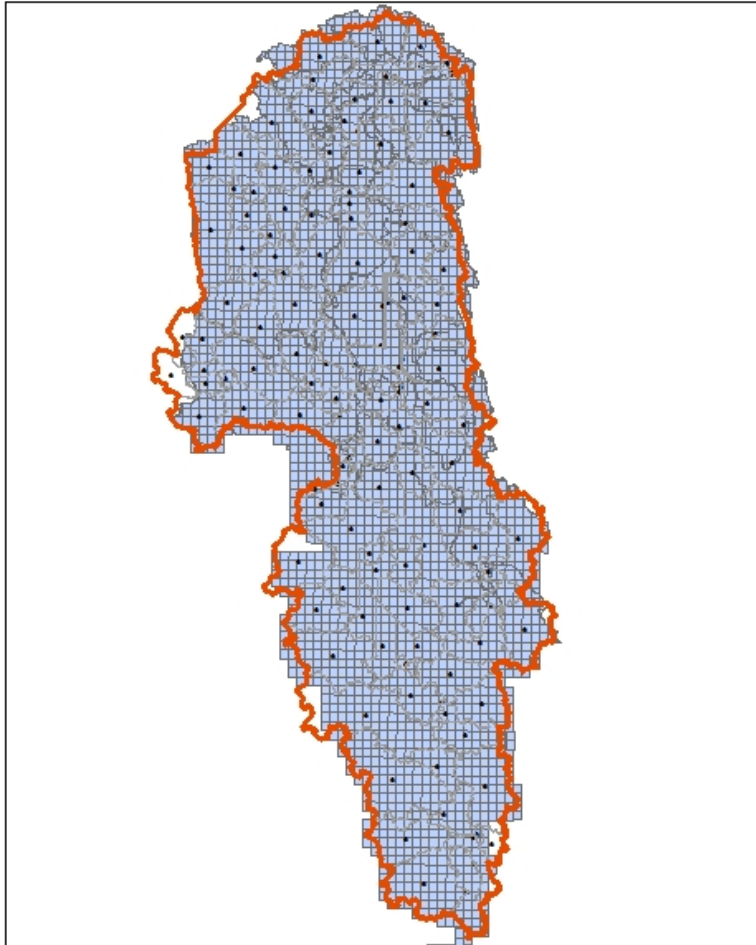
NEXRAD and SWAT

Generate the centroid of
each subwatershed

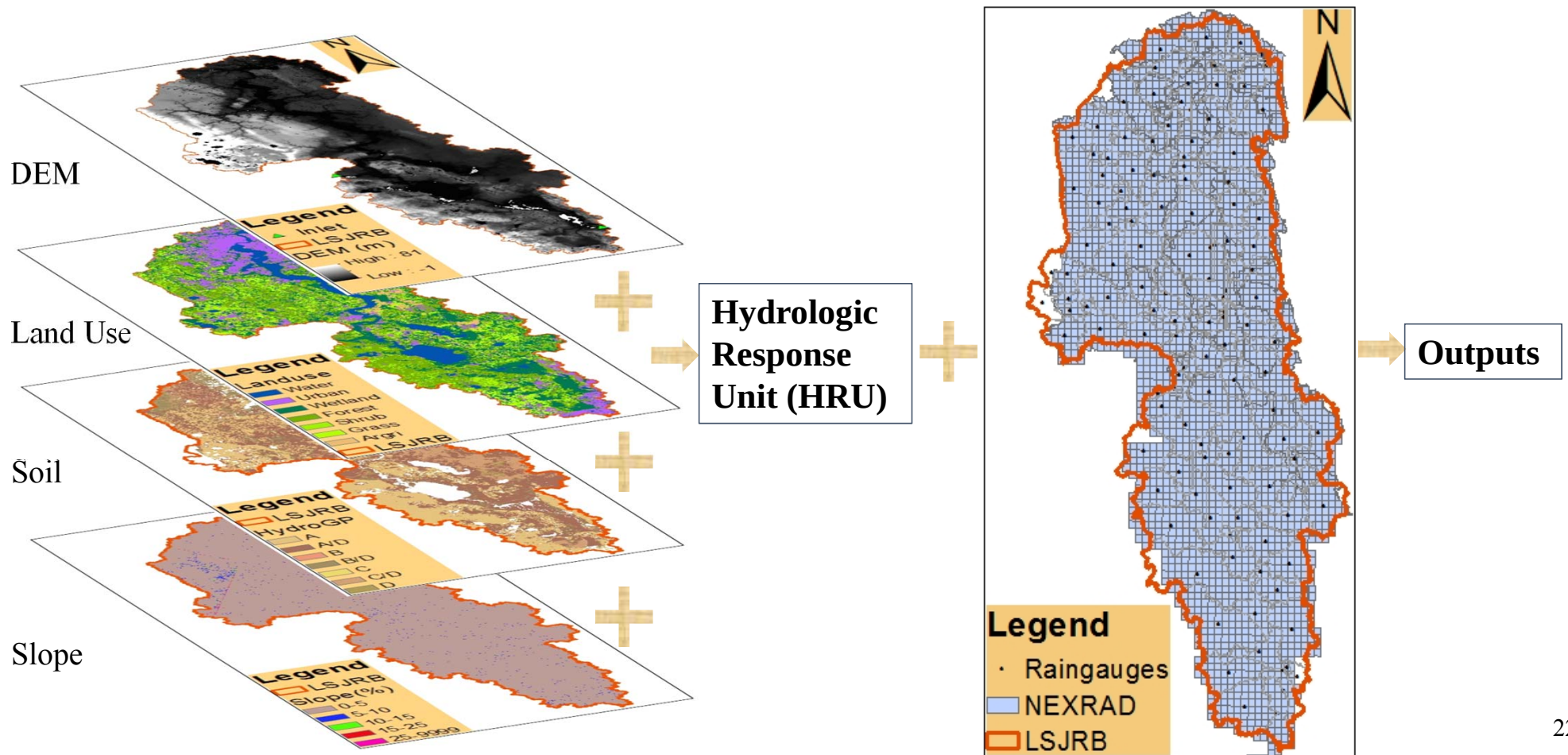


NEXRAD and SWAT

Overlap the NEXRAD
gridded rainfall with
subwatersheds



SWAT Model for Lower St. Johns River Basin



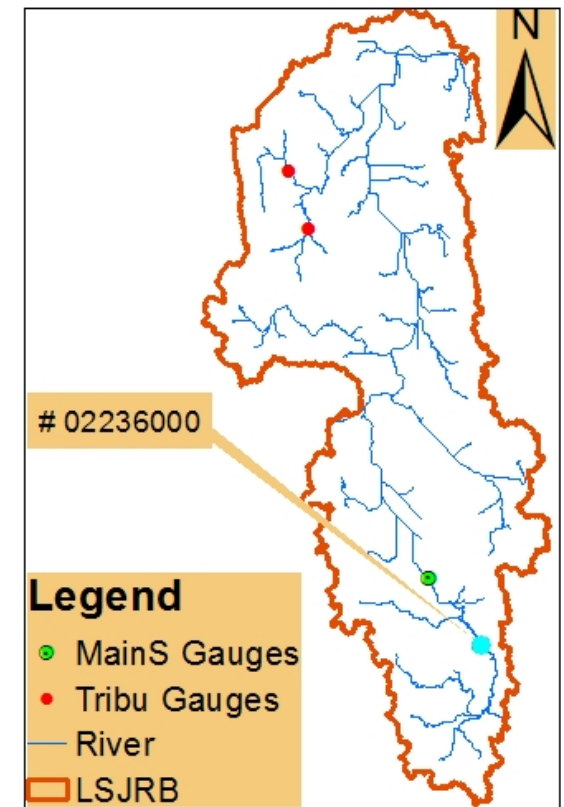
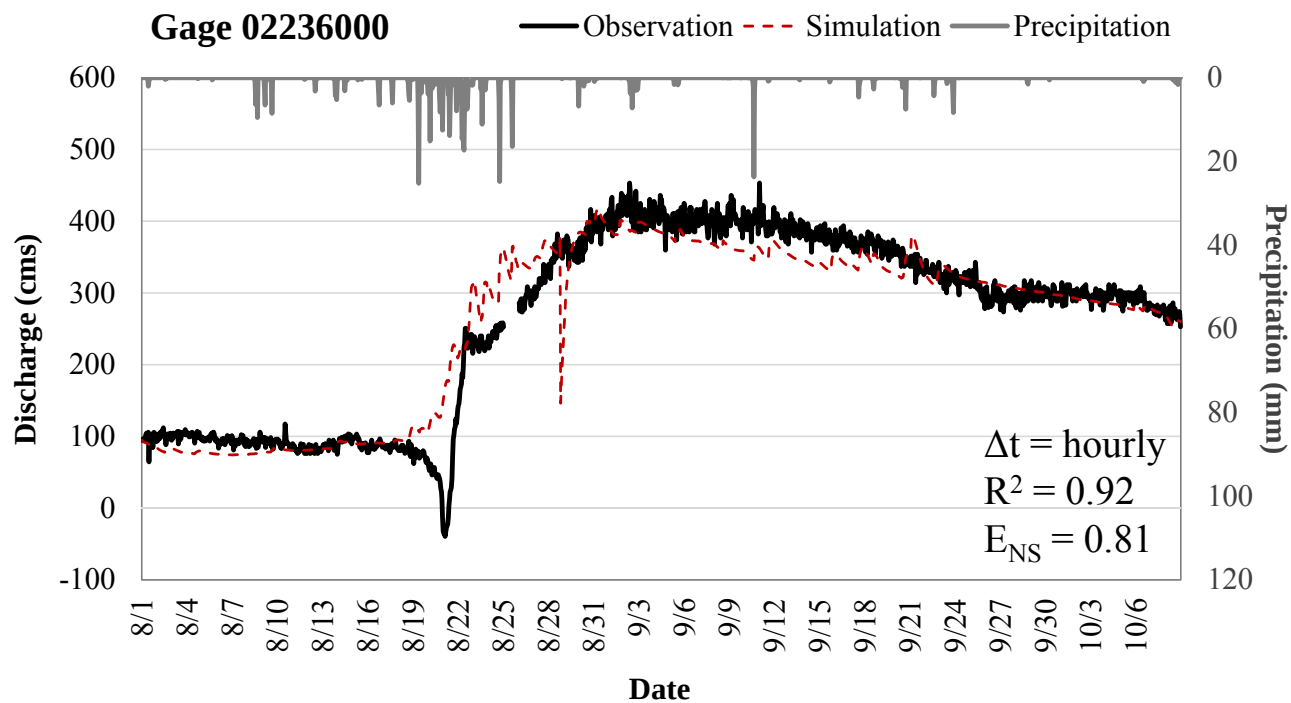
Calibrated Model Parameters

Parameters	Definition	Initial Value	Range	Calibrated Value at Gauge			
				#02236000	#02236125	#02245500	#02246000
ALPHA_BF	Base flow recession constant	0.048	0.001~1	0	0	0	0
GWQMN	Threshold water level in shallow aquifer	0	0~2000	0	0	30	0
GWDELAY	Delay time for aquifer recharge	31	0~100	0.018	0.012	0.98	0.98
CN2	SCS runoff curve number for moisture condition II	35~92	30~98	-15%	-10%	+20%	+5%
ESCO	Soil evaporation compensation factor	0.95	0~1	0.55	0.55	0.95	0.5
AWC	Available water capacity of soil layer	0~0.4	0~1	+20%	+20%	-5%	+15%
Ksat	Saturated hydraulic conductivity	331.2	0~2000	600	331.2	730.264	180.264
PND_FR	Fraction of the subbasin area draining into the pond	0	0~1	0.05	0.3	0.001	0.05
WET_FR	Fraction of the subbasin area draining into the wetland	0	0~1	0.4	0.5	0.1	0.3
CH_N1	Manning's n value for the tributary channels	0.014	0.014~30	0.014	0.014	30	30
CH_N2	Manning's n value for the main channels	0.014	-0.01~0.3	0.032	0.032	0.074	0.034
OVR_N	Manning's n value for the overland flow	0.1	0~10	0.14	0.14	30	30
MSK_CO2	Weighting factor for influence of normal flow on storage time constant	0.25	0~10	4.5	4.5	4.5	4.5
MSK_CO1	Weighting factor for influence of low flow on storage time constant	0.75	0~10	1.75	1.75	1.75	1.75

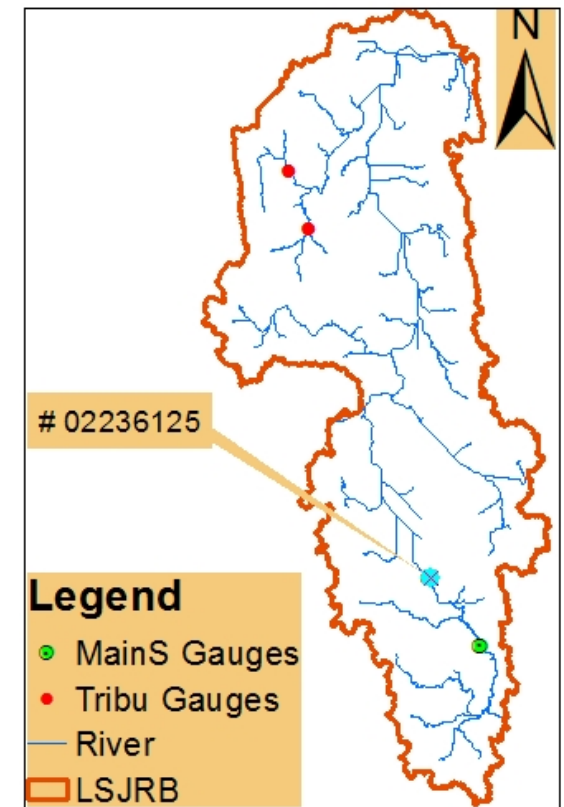
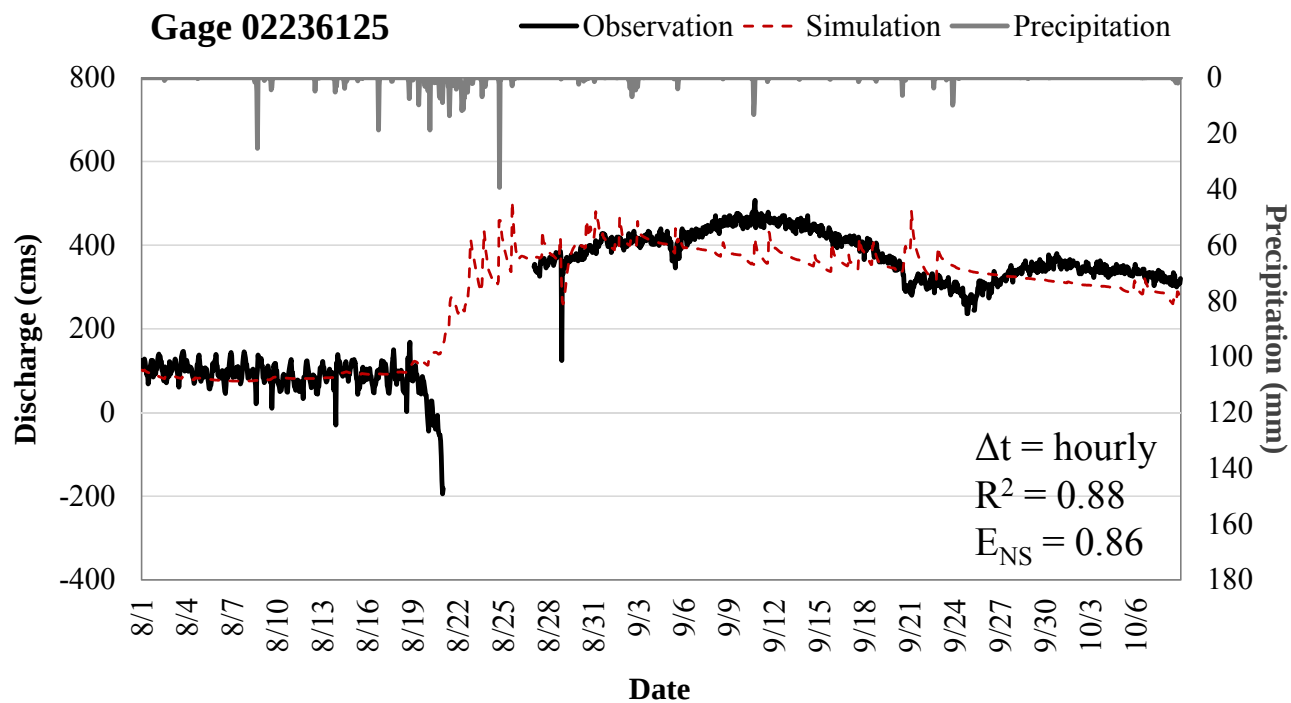
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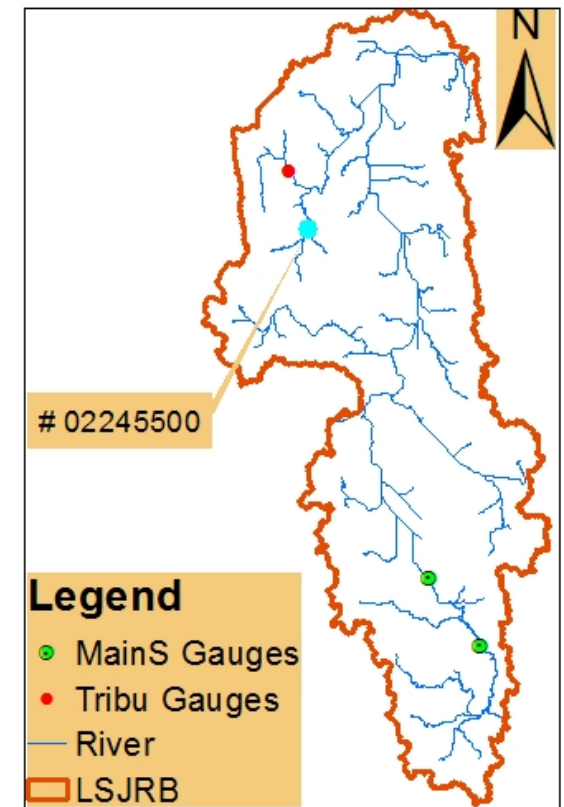
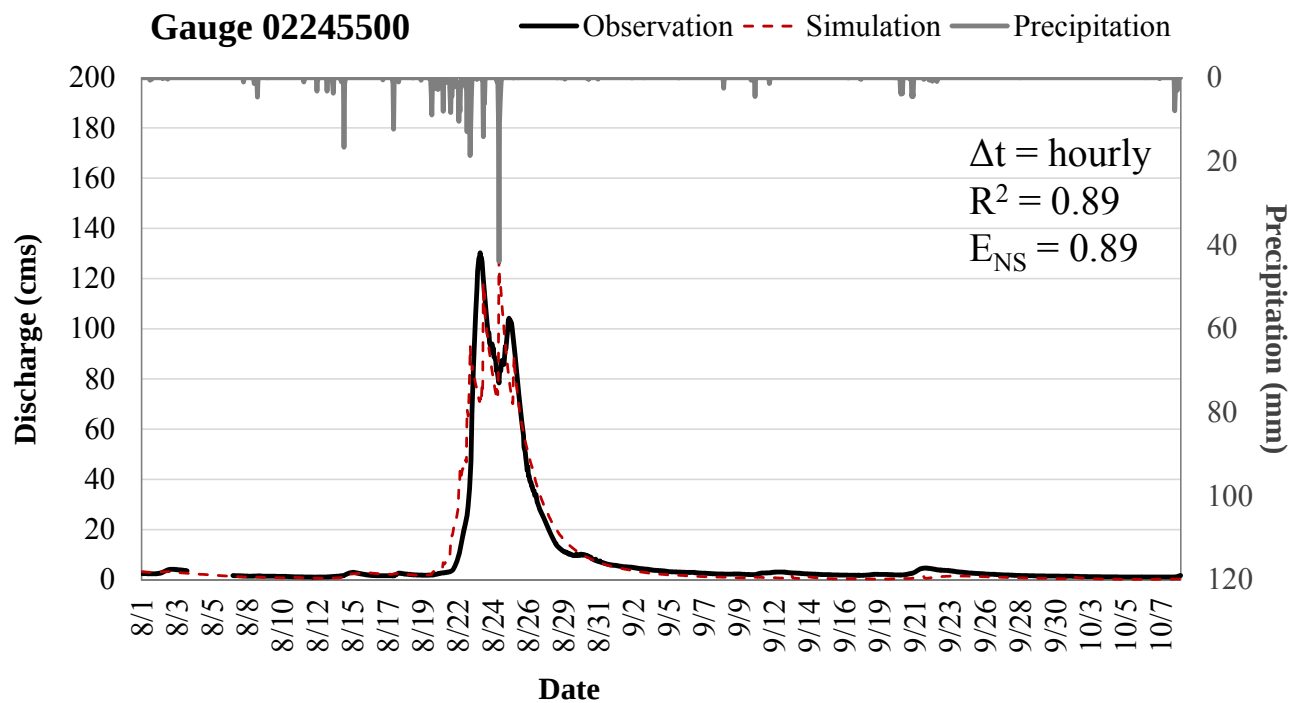
Calibration (08/01/2008 – 10/08/2008)



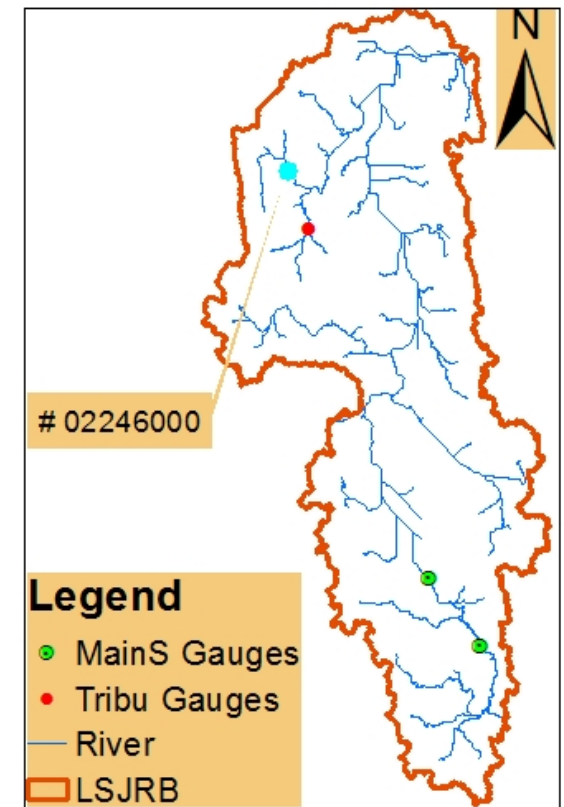
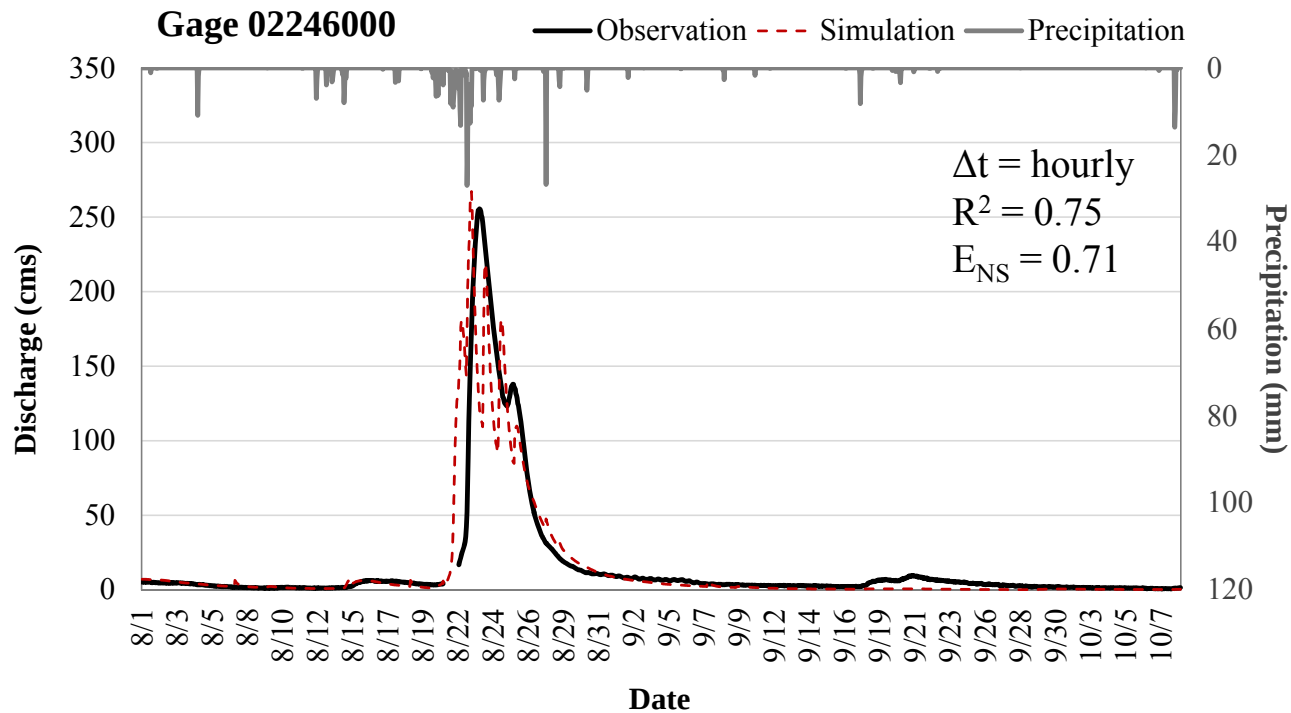
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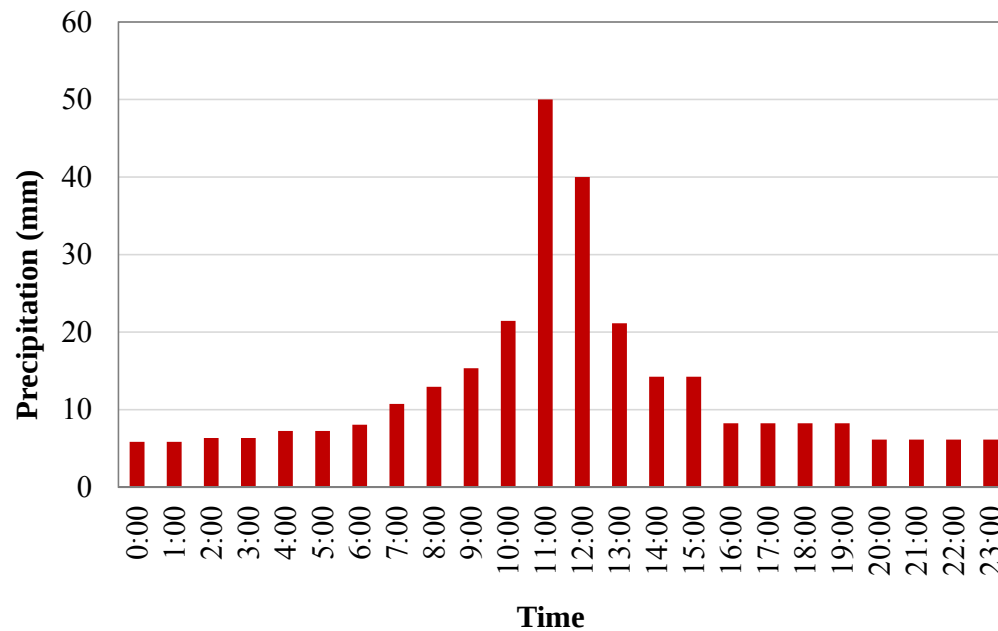
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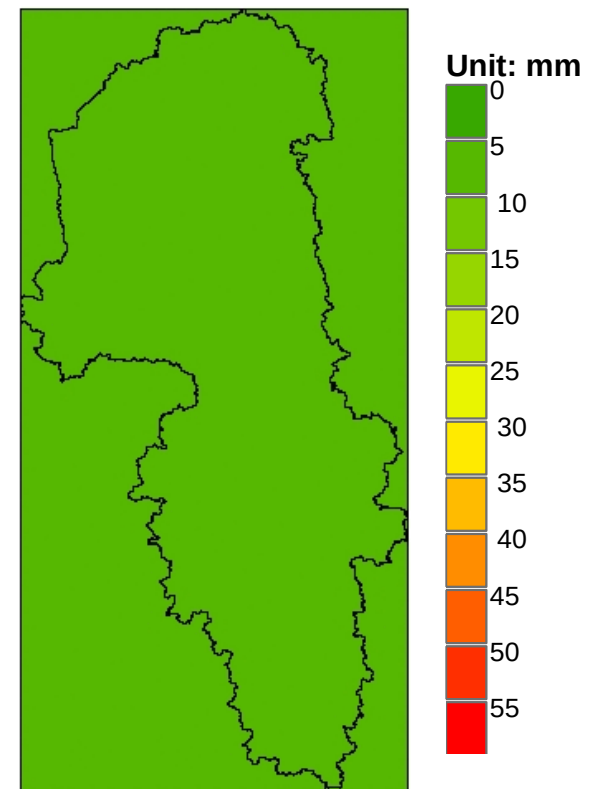
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100-Year 24-Hour Rainfall

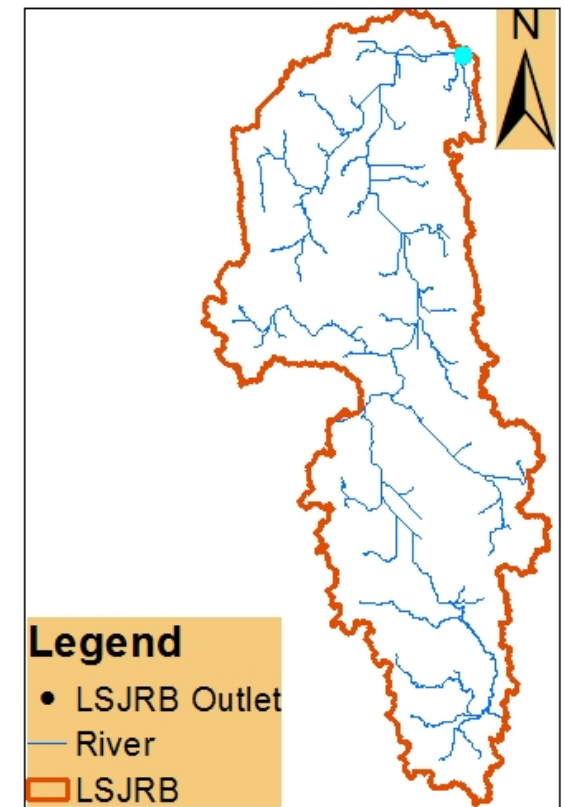
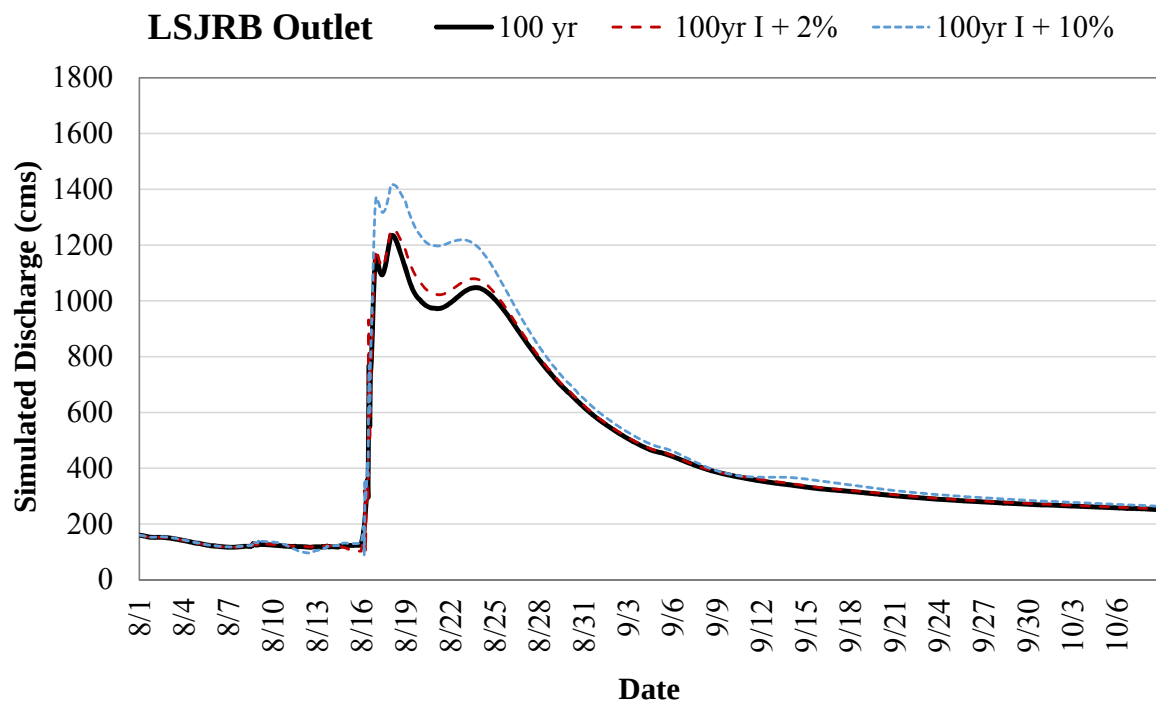


Climate change scenarios: +2% (S1); +10% (S2)

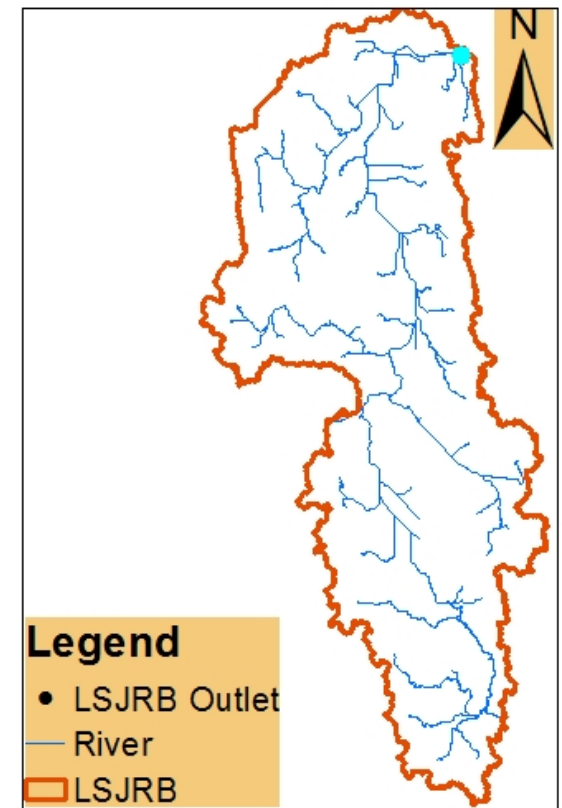
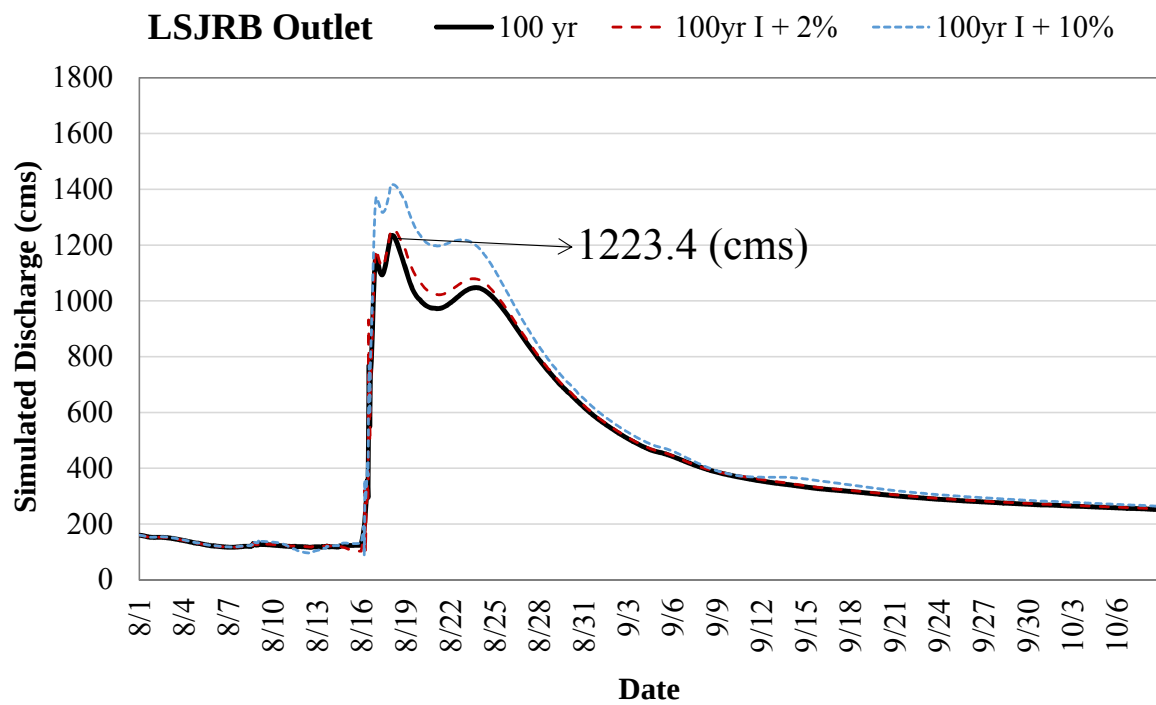
Hourly rainfall 12:00pm~23:00pm



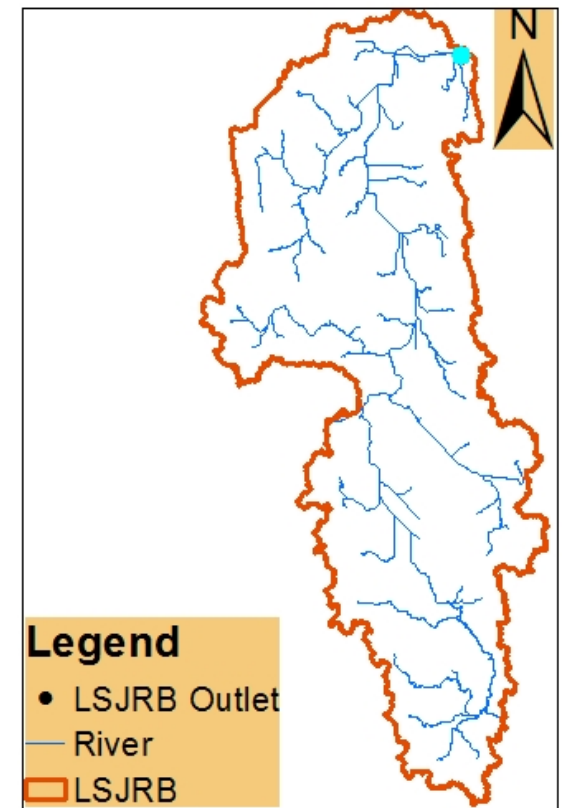
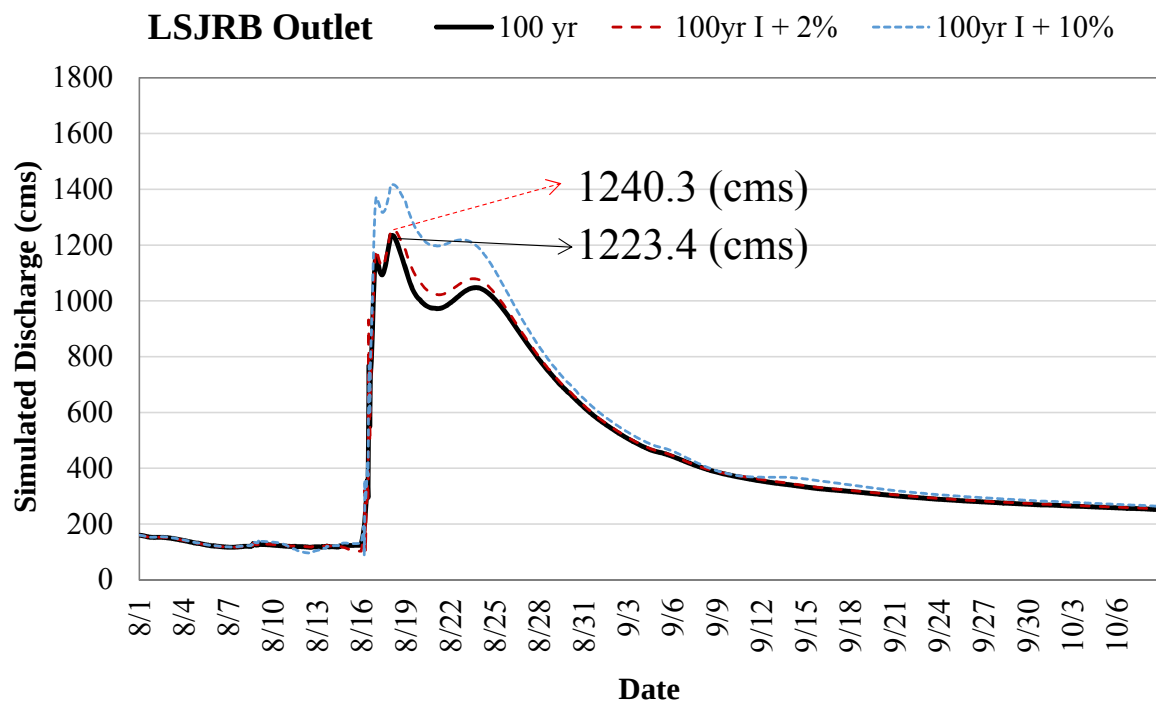
Climate Change Impact



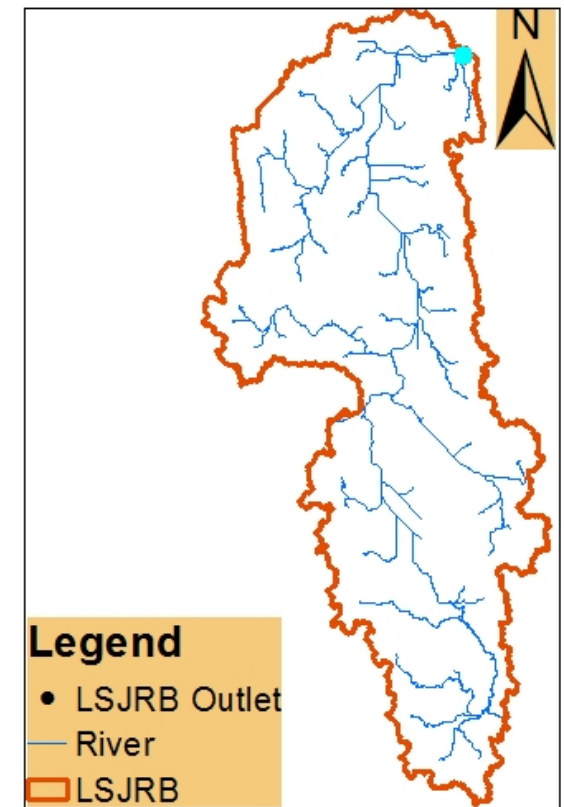
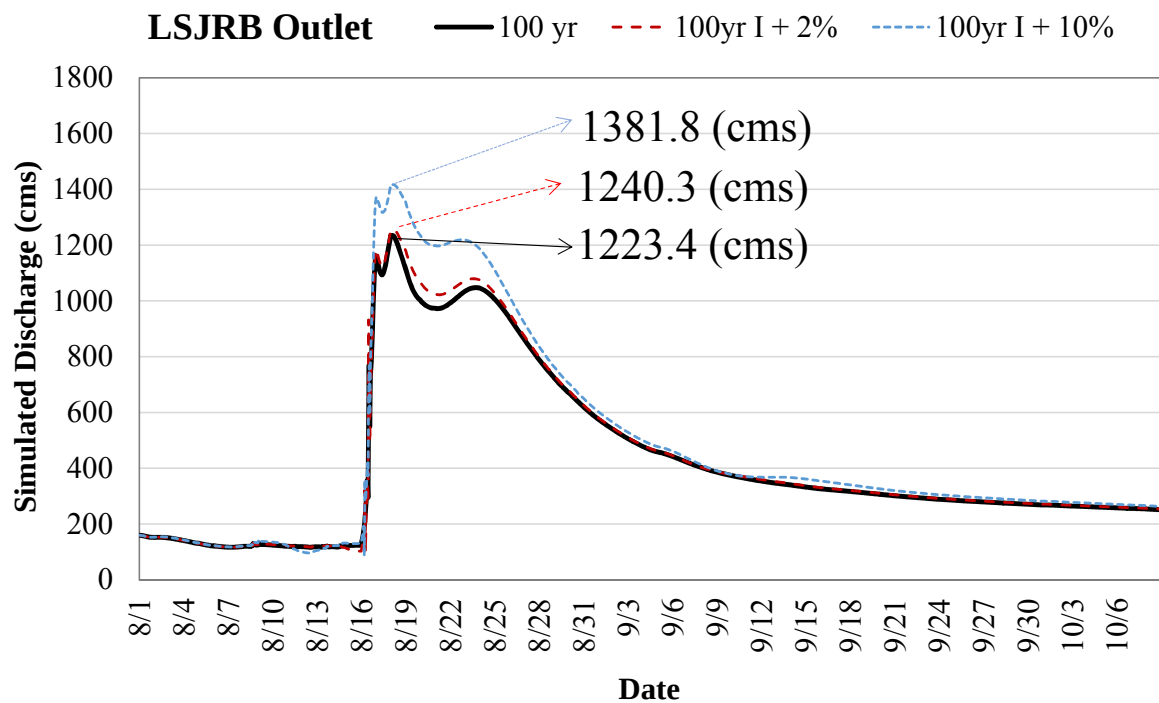
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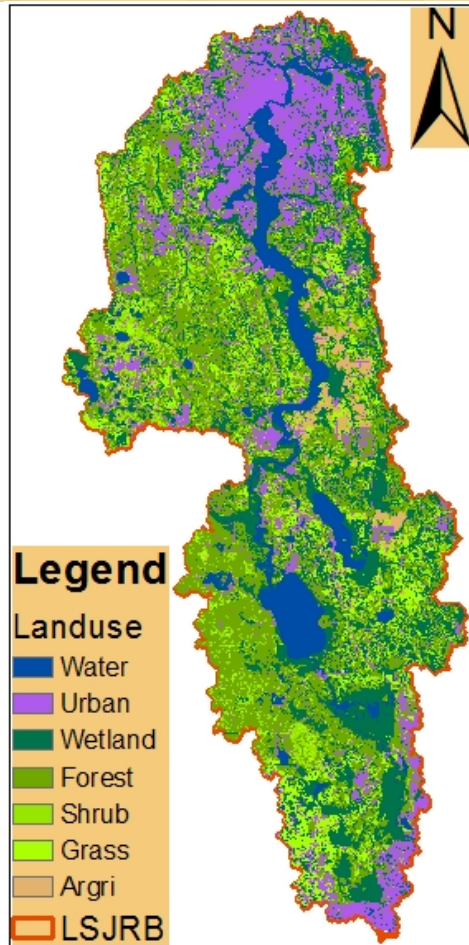
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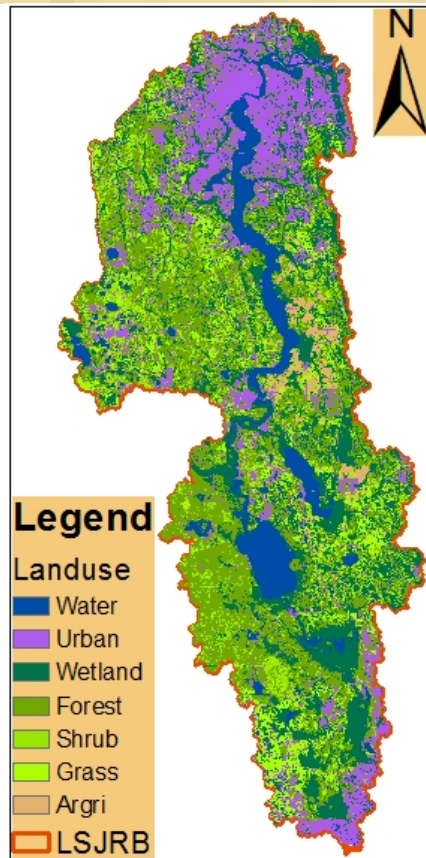
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Land Use in 2006

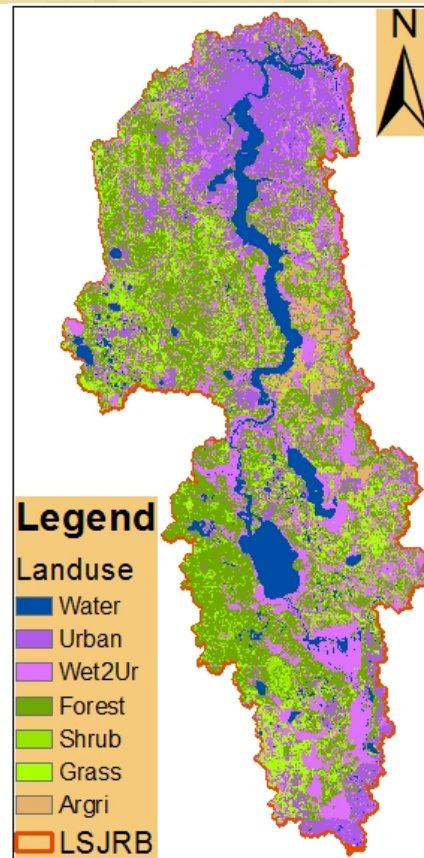


Land Use Type	Area Ratio (%)
Open water	9.07
Developed Urban	18.00
Wetland	23.10
Forest	30.52
Scrub/Shrub	9.42
Grassland/Herbaceous	8.07
Argiculture	1.83

Land Use Change



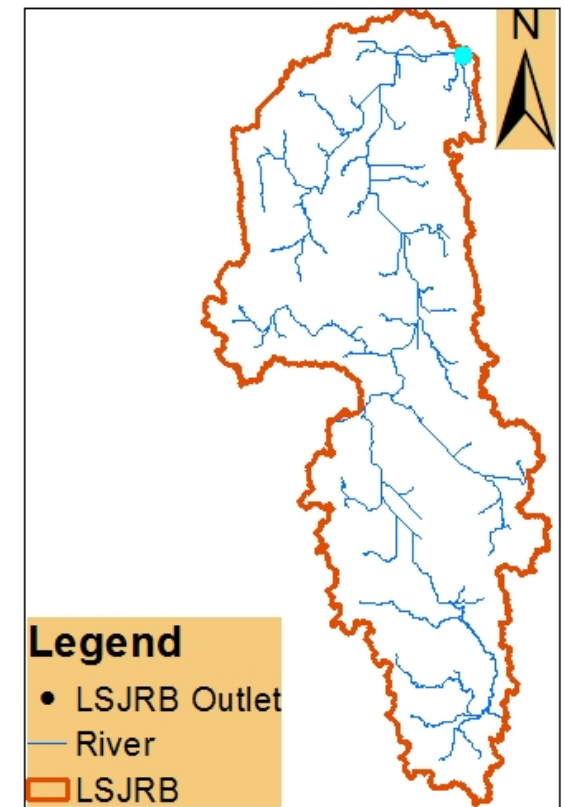
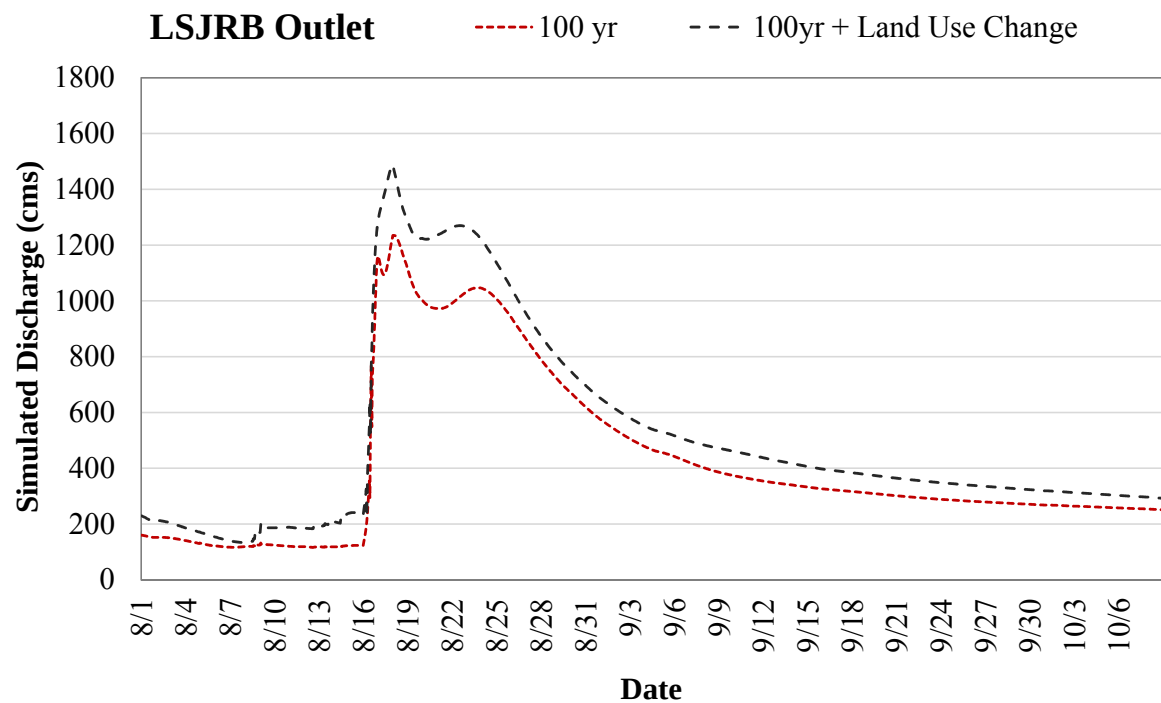
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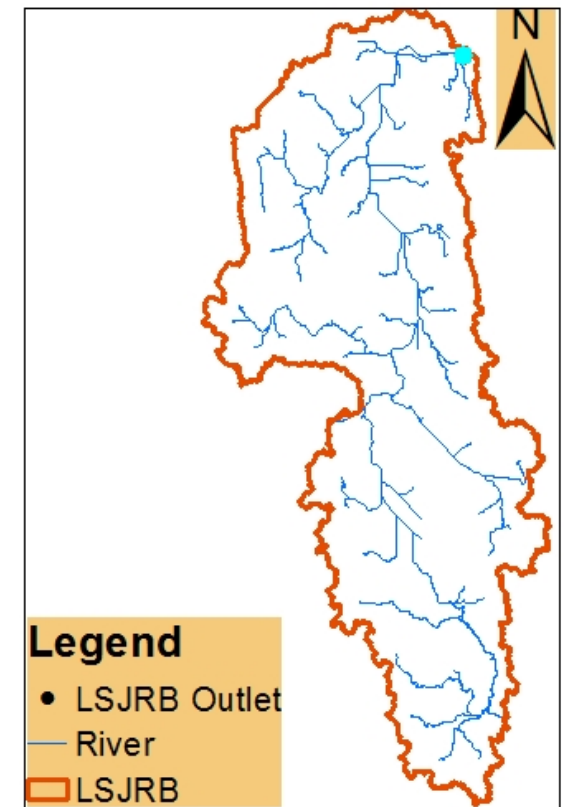
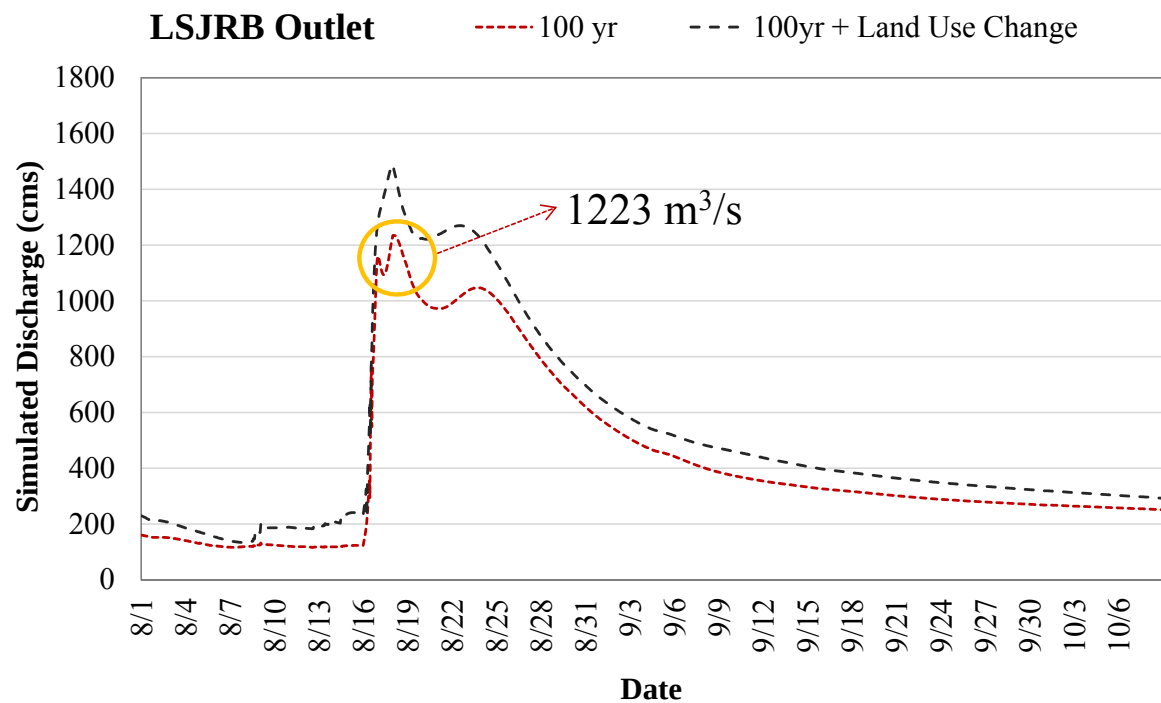
Land use change

Wetland
↓
Developed Urban

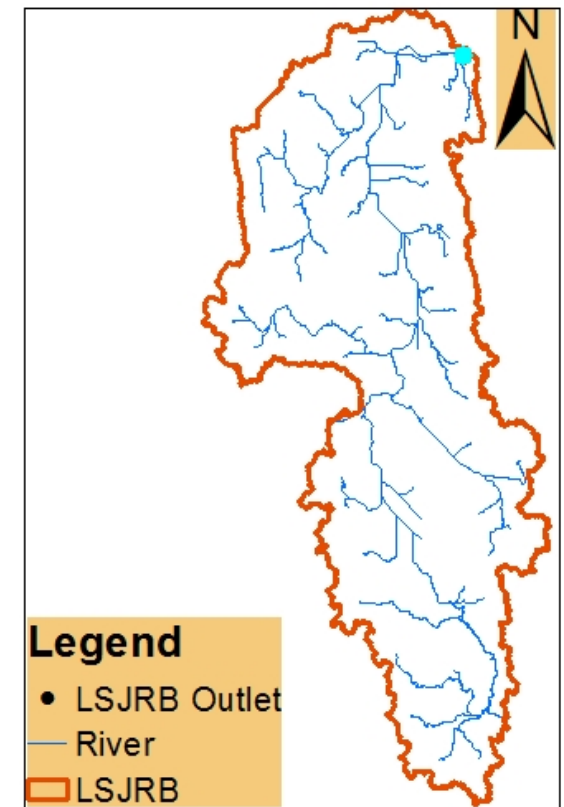
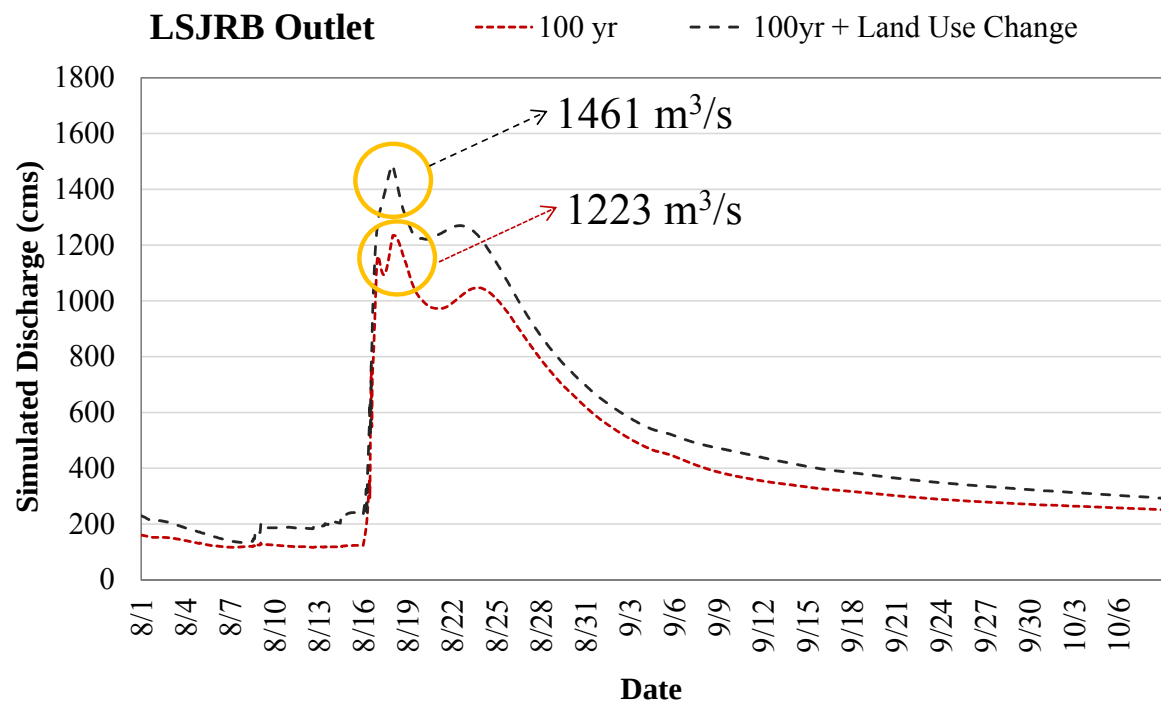
Impact of Land Use Change



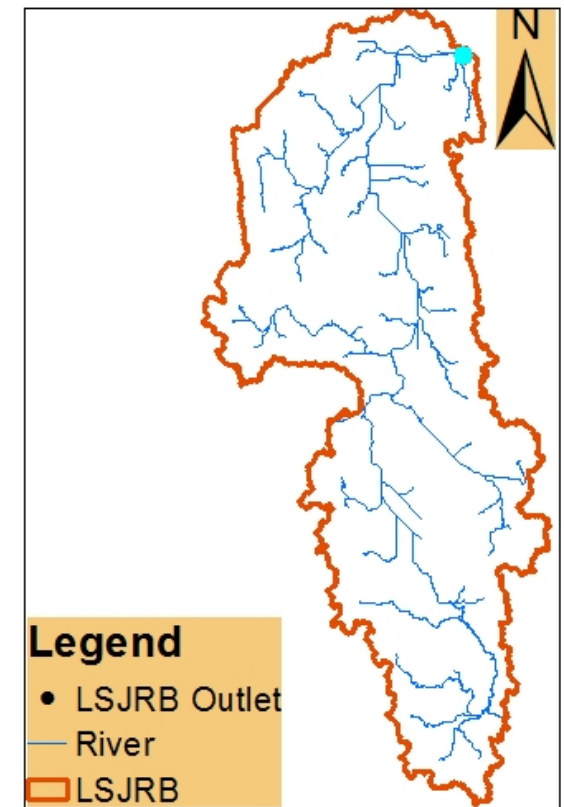
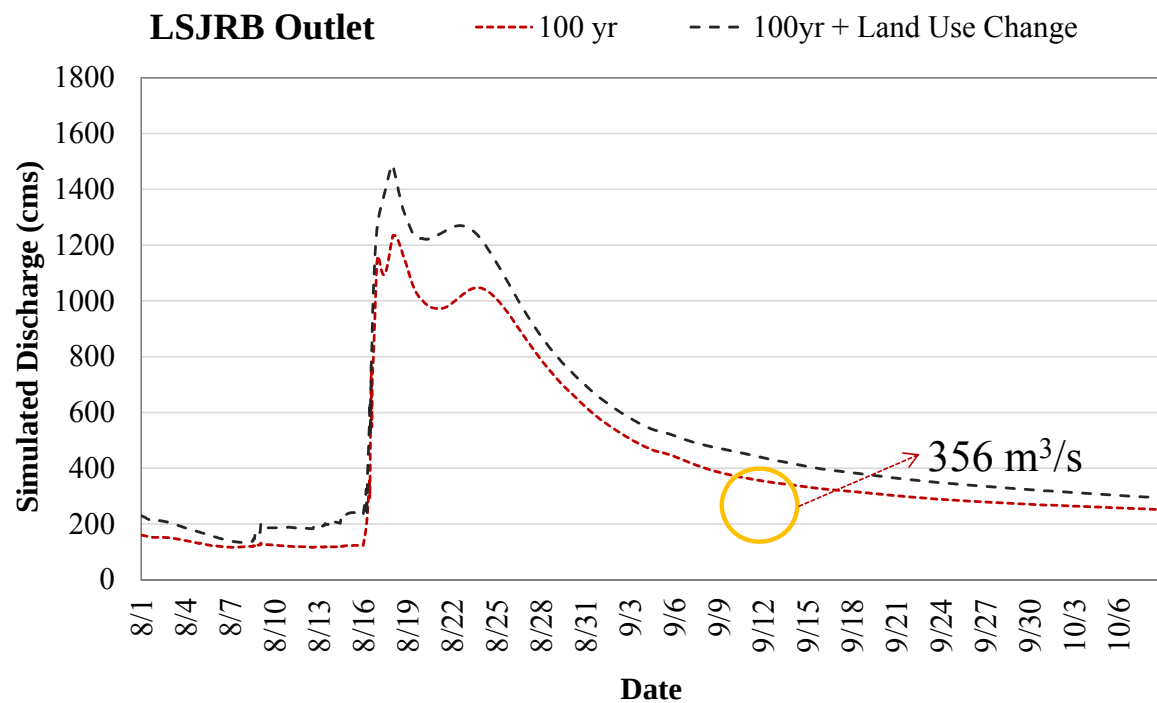
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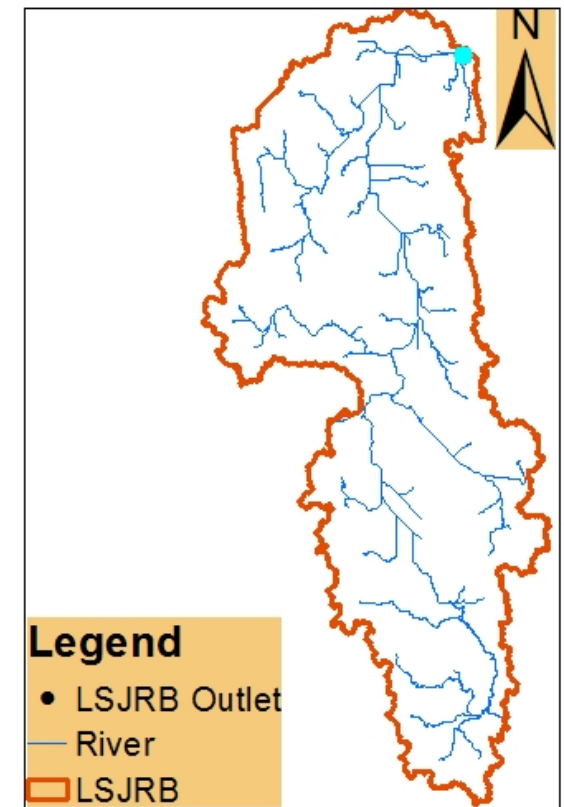
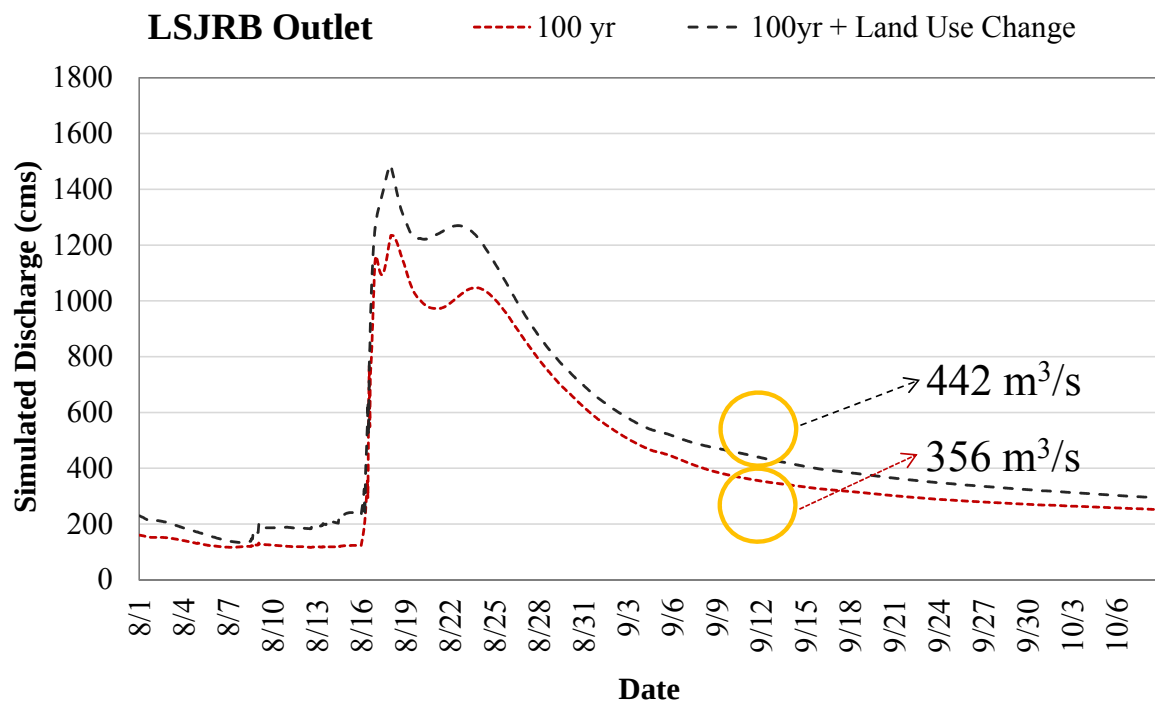
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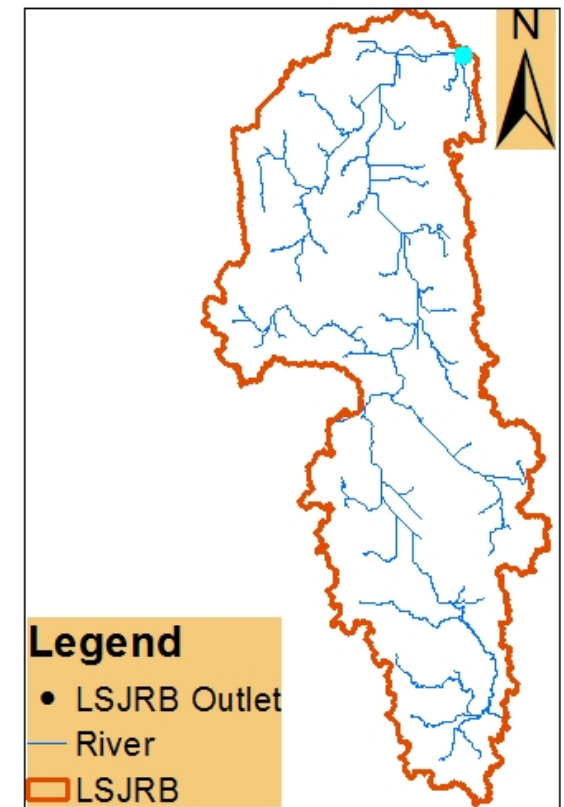
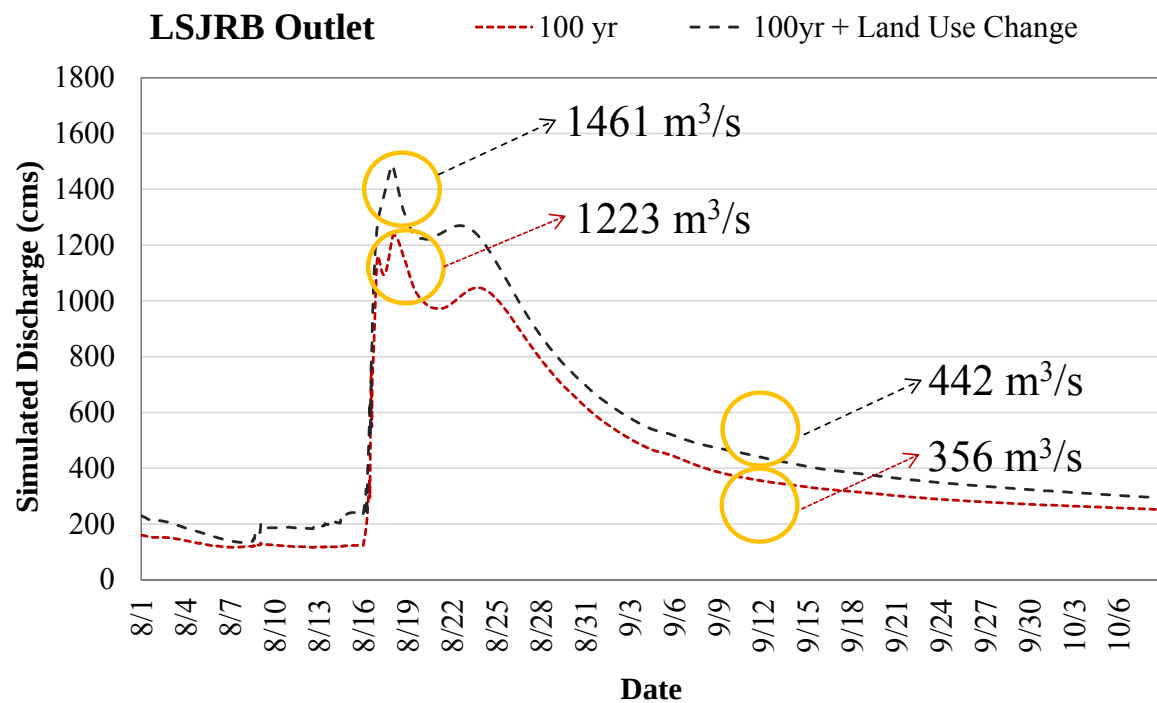
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Summary

- Simulation of Tropical Storm Fay at the LSJRB using SWAT
- Peak flow seems to be sensitive to intensified rainfall and land use change
- Base flow seems to be sensitive to land use change
- Providing river inflow boundaries for hydrodynamic model (ADCIRC)

Acknowledgment

Advisor: Dr. Dingbao Wang

Other instructors:

Dr. Scott C. Hagen,

Dr. Stephen C. Medeiros,

Dr. Peter Bacopoulos



 **CHAMPS Lab**
<http://champs.cecs.ucf.edu>



THANK YOU!

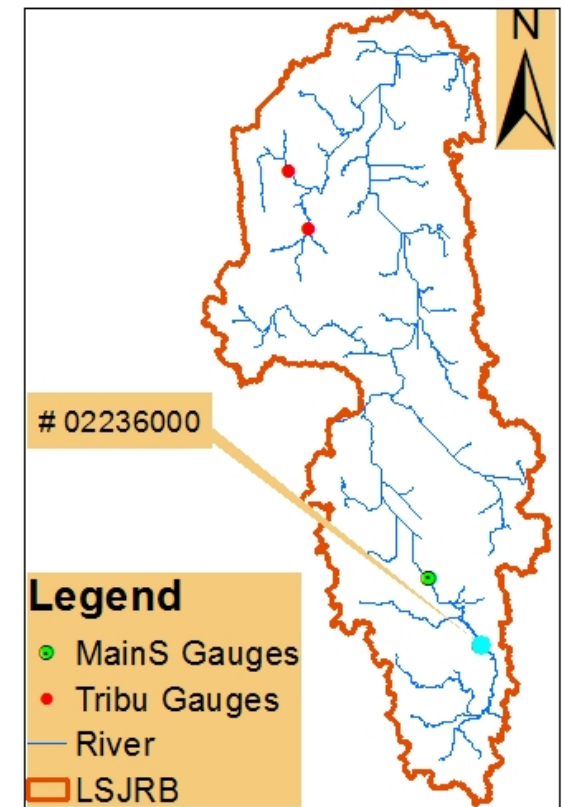
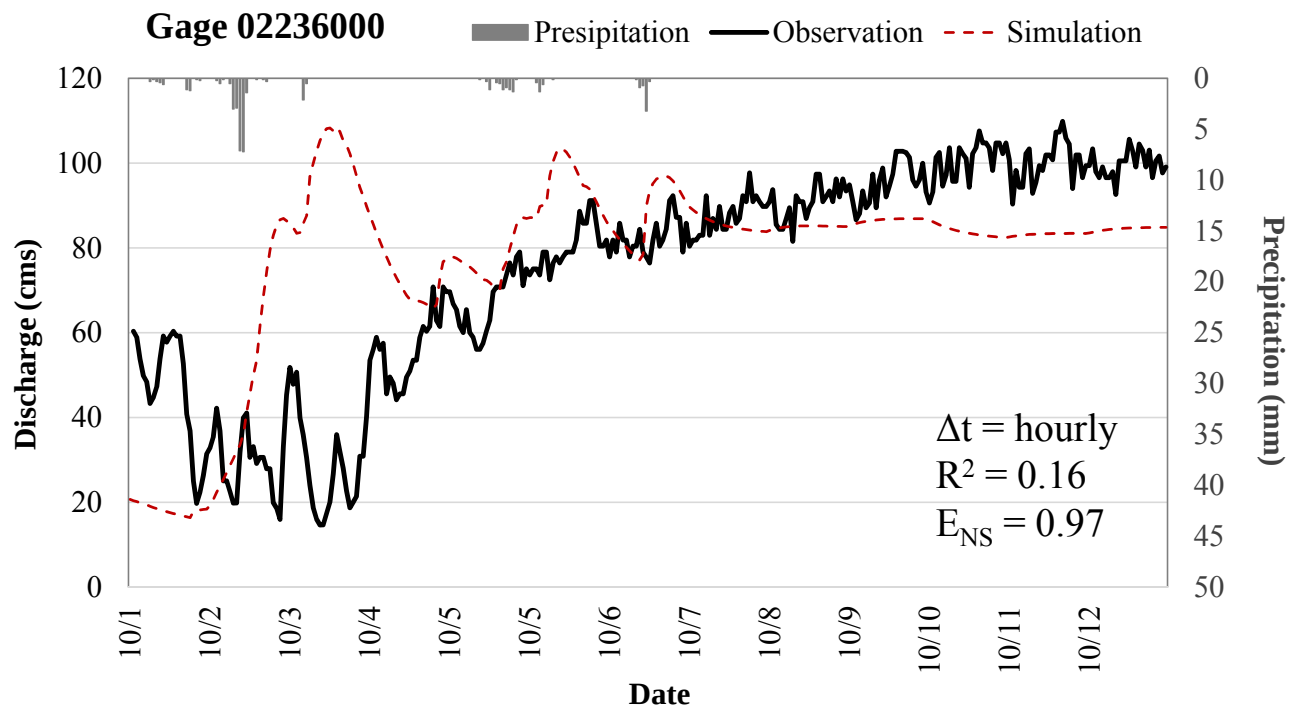
Distribution of HRUs in Sub-watershed

- Assign a single HRU to each sub-watershed
 - ✓by the dominant land use category and soil type within each watershed
- Assign multiple HRUs to each sub-watershed
 - ✓Define land use and soil threshold levels
 - ✓Threshold levels used to eliminate minor land uses and soil in each subbasin

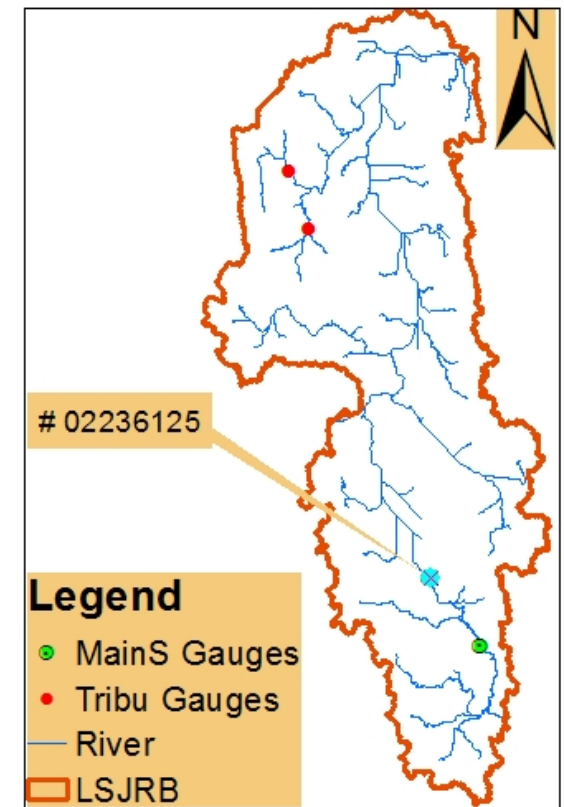
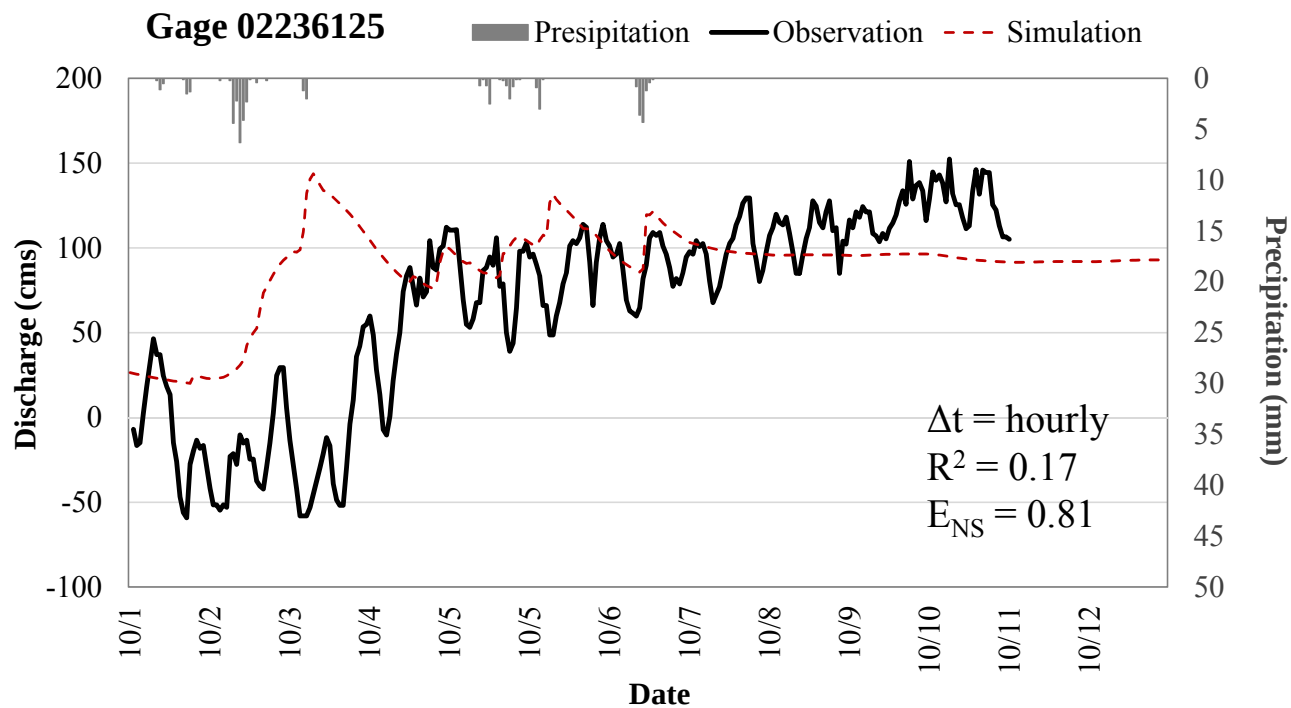
Water in HRUs to the sub-watershed

- No spatial location of each HRU in SWAT
- Considering an HRU as a very large field, bordered on its downstream edge by the stream channel
- Each large field sloping uniformly to a stream channel
- Fully mixed in the channel

Validation (10/01/02007 – 10/13/2007)



Validation (10/01/2007 – 10/13/2007)



Validation (Oct.1, 2007 – Oct.13, 2007)

