ECOLOGICAL & ECONOMIC IMPACTS OF LAND USE AND CLIMATE CHANGE ON COASTAL FOOD WEBS & FISHERIES

NATIONAL ACADEMIES Sciences Engineering Medicine

Quantifying Impacts of Climate and Land Use Change on the Waters of the Suwannee River Basin

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UF | Water Institute UNIVERSITY of FLORIDA

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Image: Google Earth

Suwannee River and Estuary

- 11,000 mi^2 watershed dominated by agriculture/silvicultural land uses
- Largest undammed river in SE USA
- Coastal ecosystems support fisheries, aquaculture, and tourism
- Agricultural/development pressure
- Uncertainty in future climate
- **How will future changes in land use and climate affect the watershed and estuary?**

Image: Google Earth

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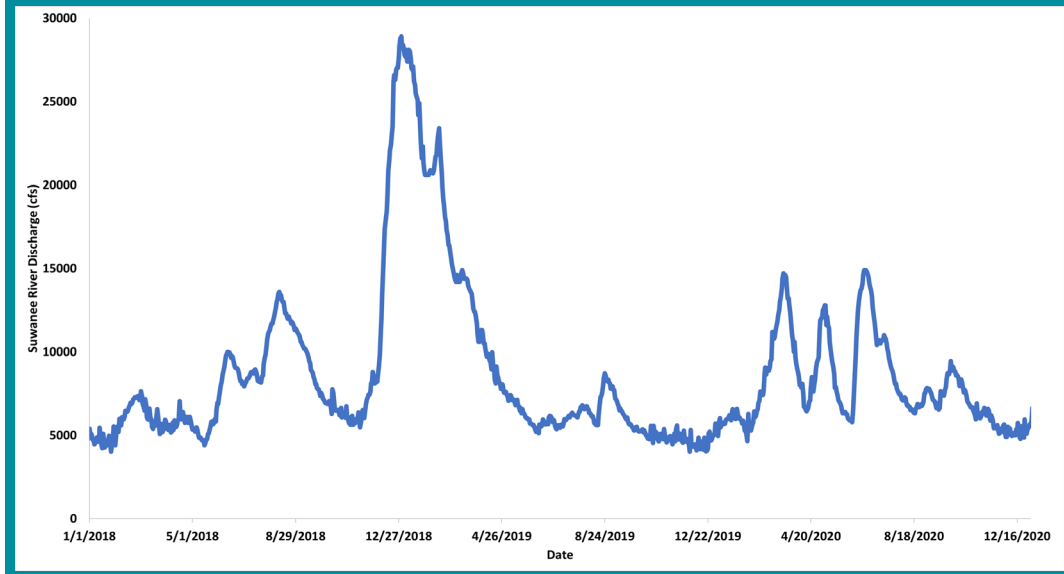
NASA Earth Observatory image by Dr. Alice Alonso

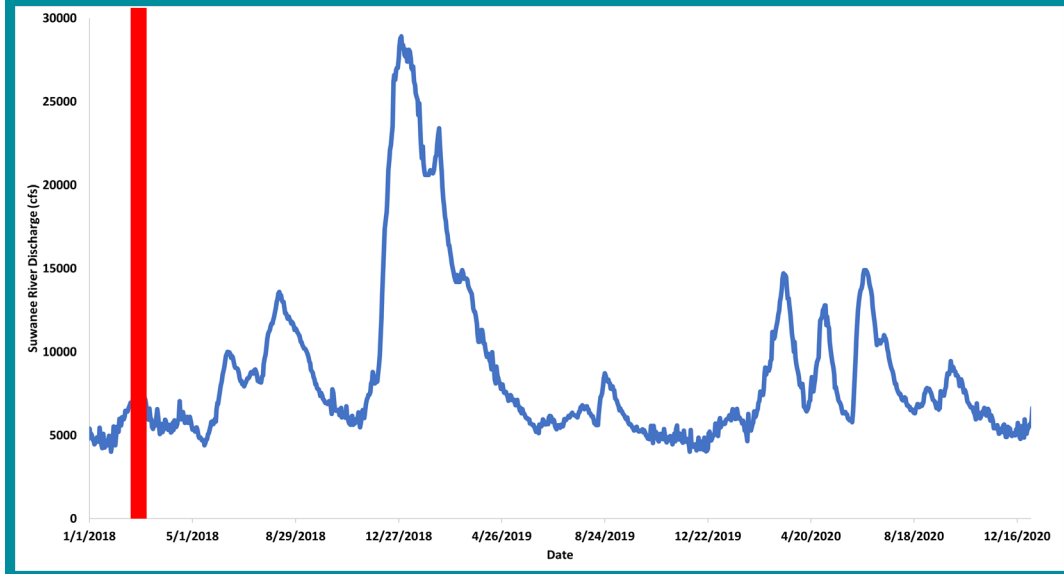
Suwannee River and Estuary

- Blackwater river with significant groundwater input from the Floridan Aquifer

Suwannee River and Estuary



Suwannee River and Estuary



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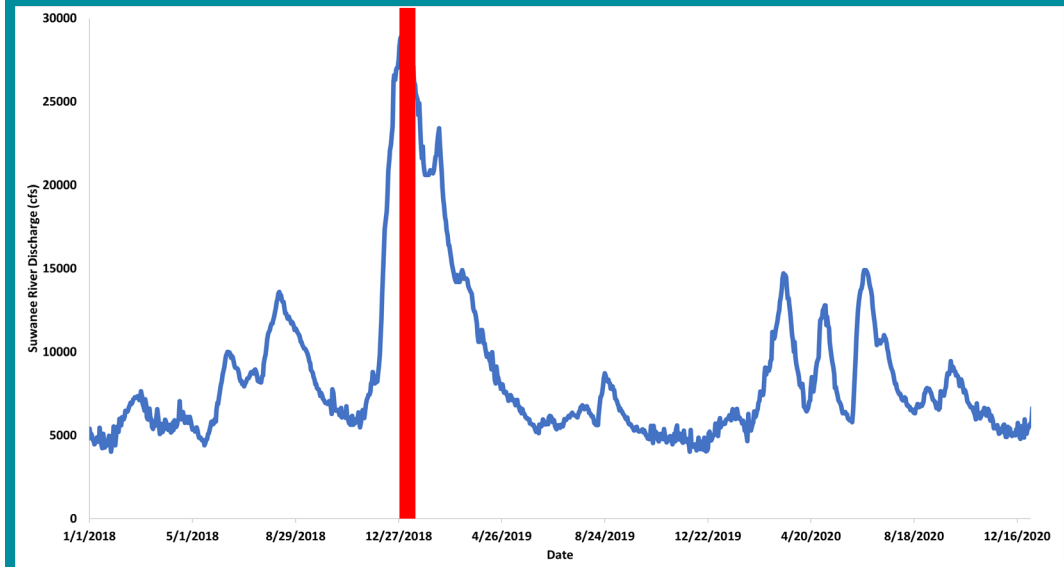
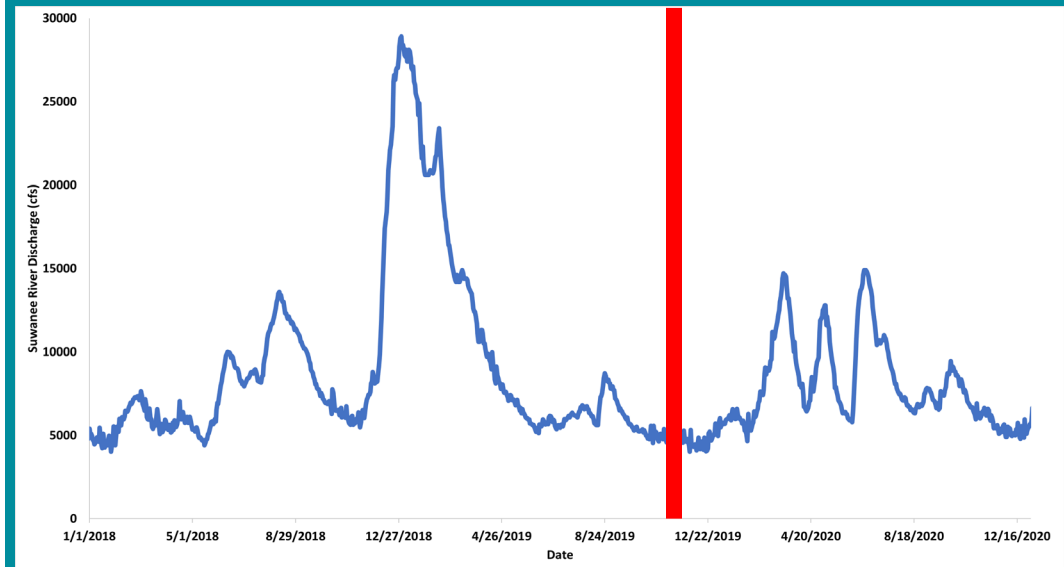


Suwannee River and Estuary



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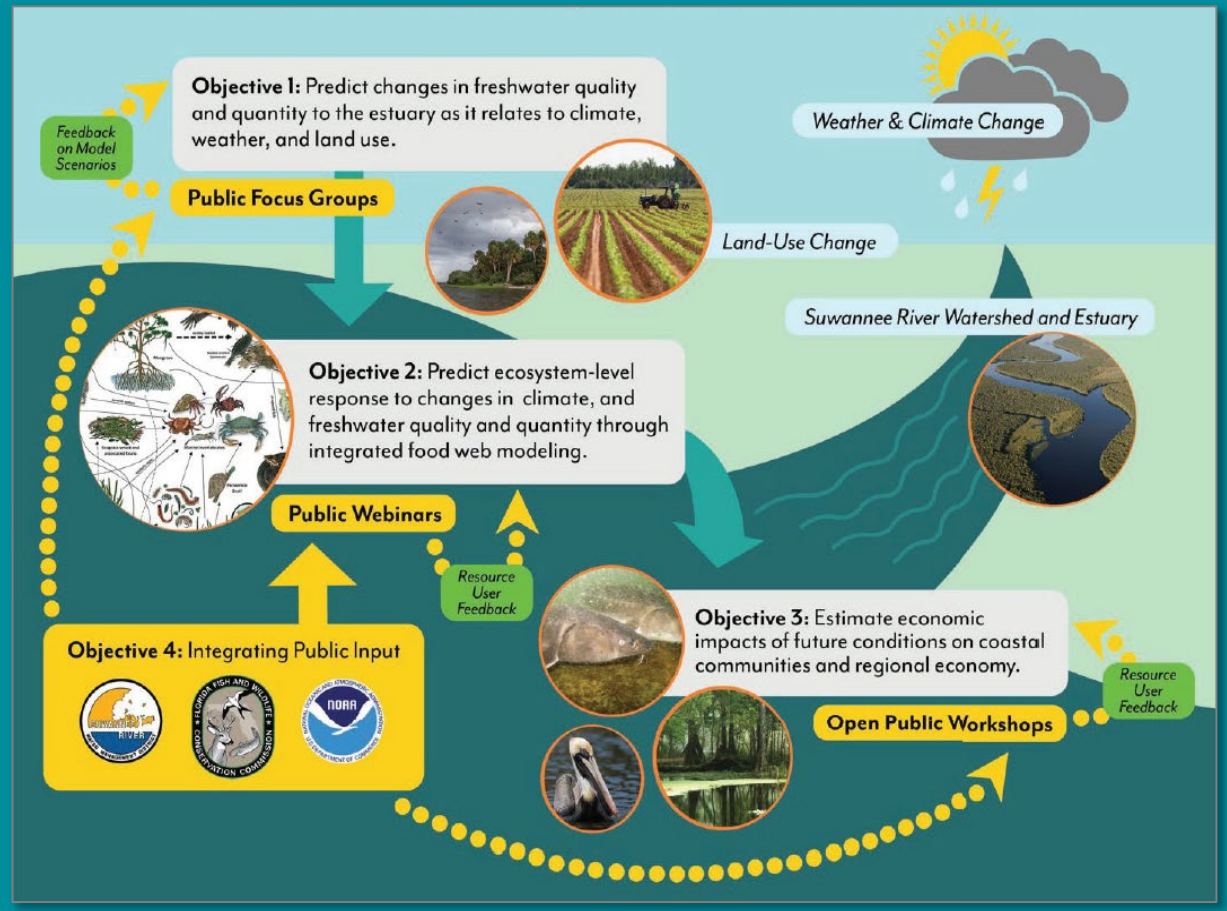
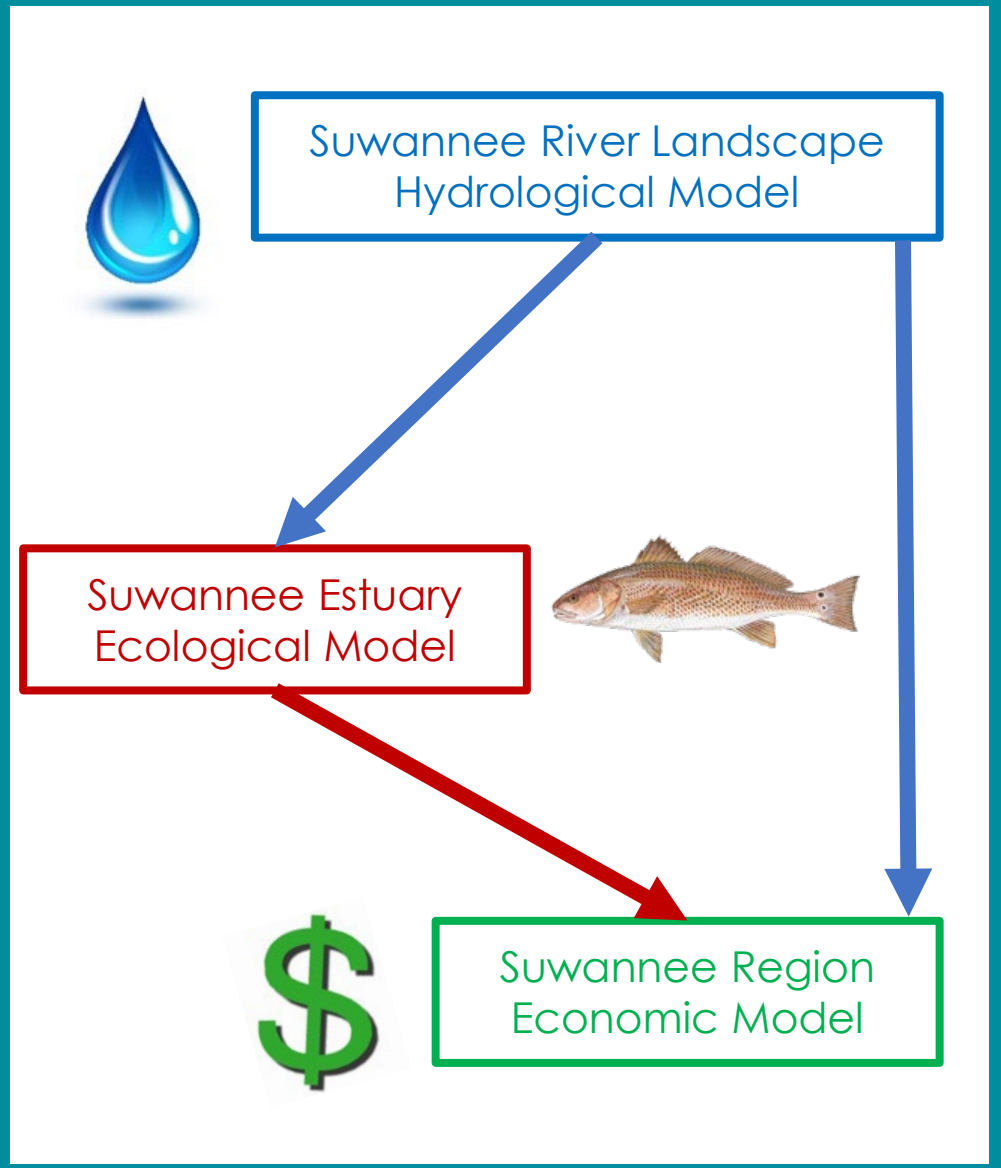
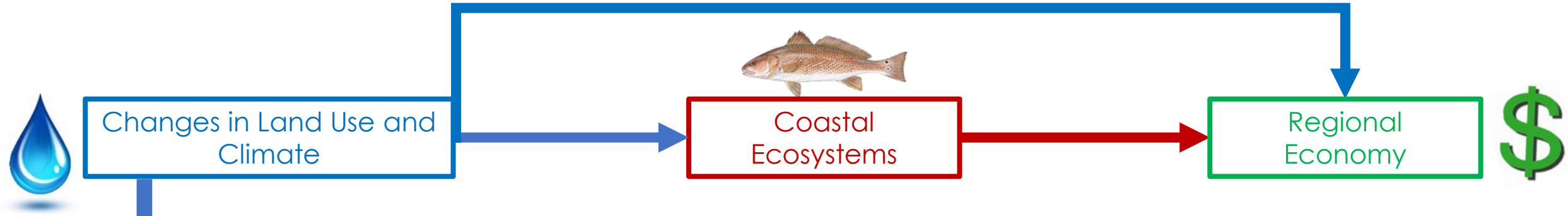
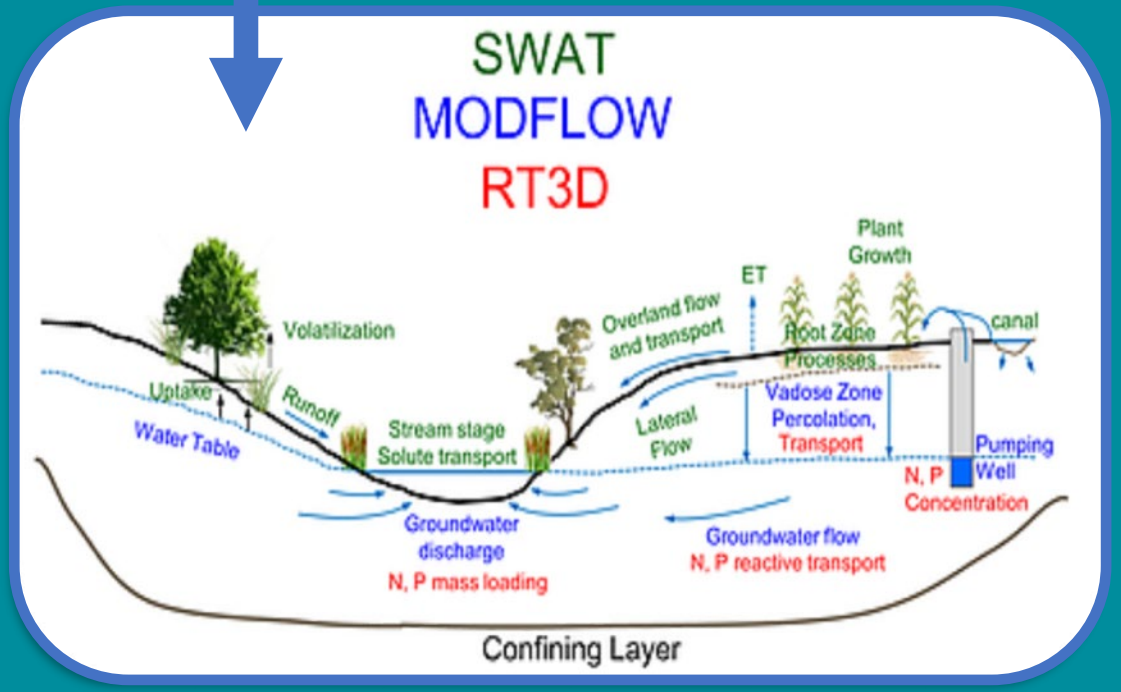




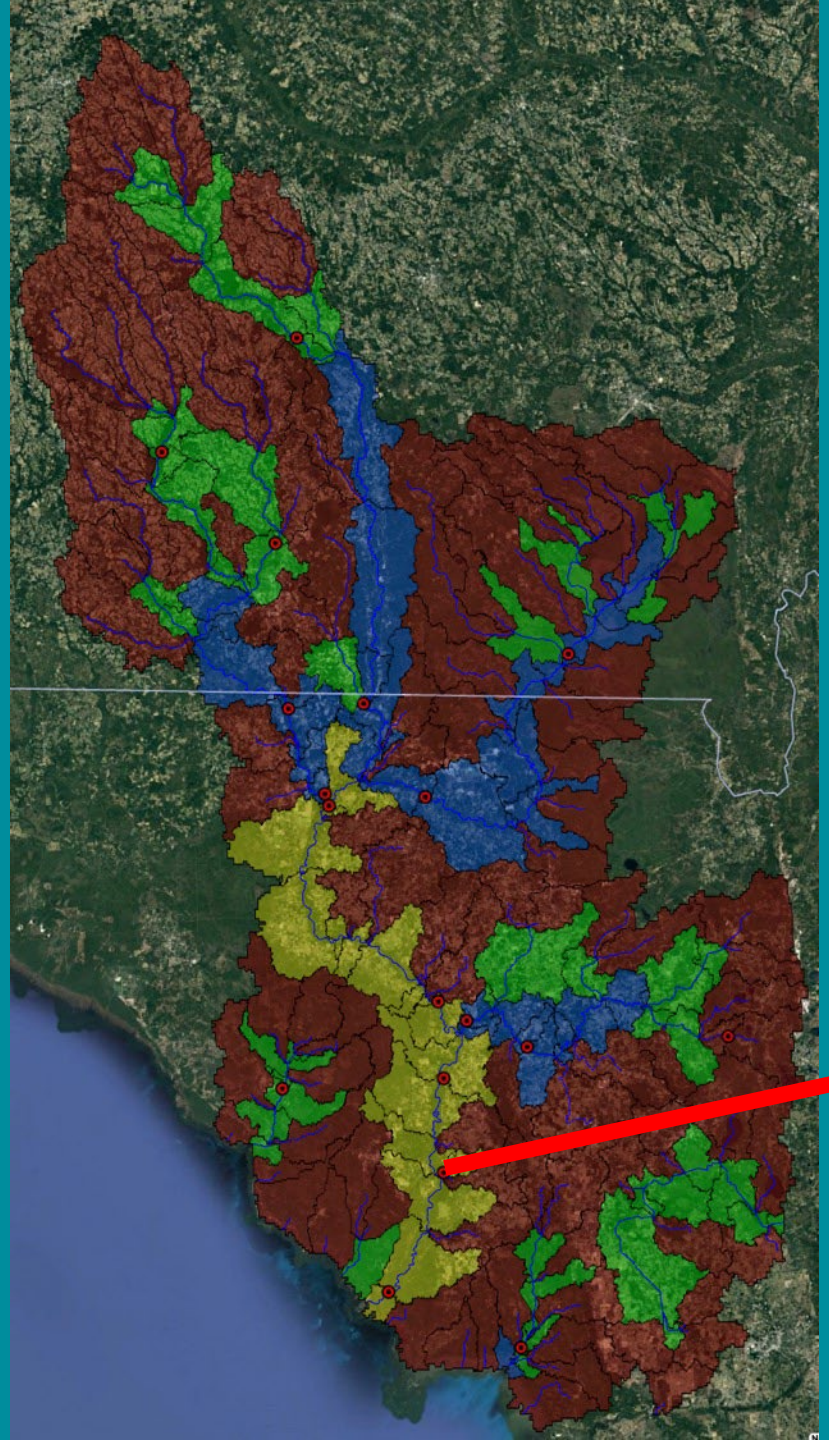
Modeling Framework

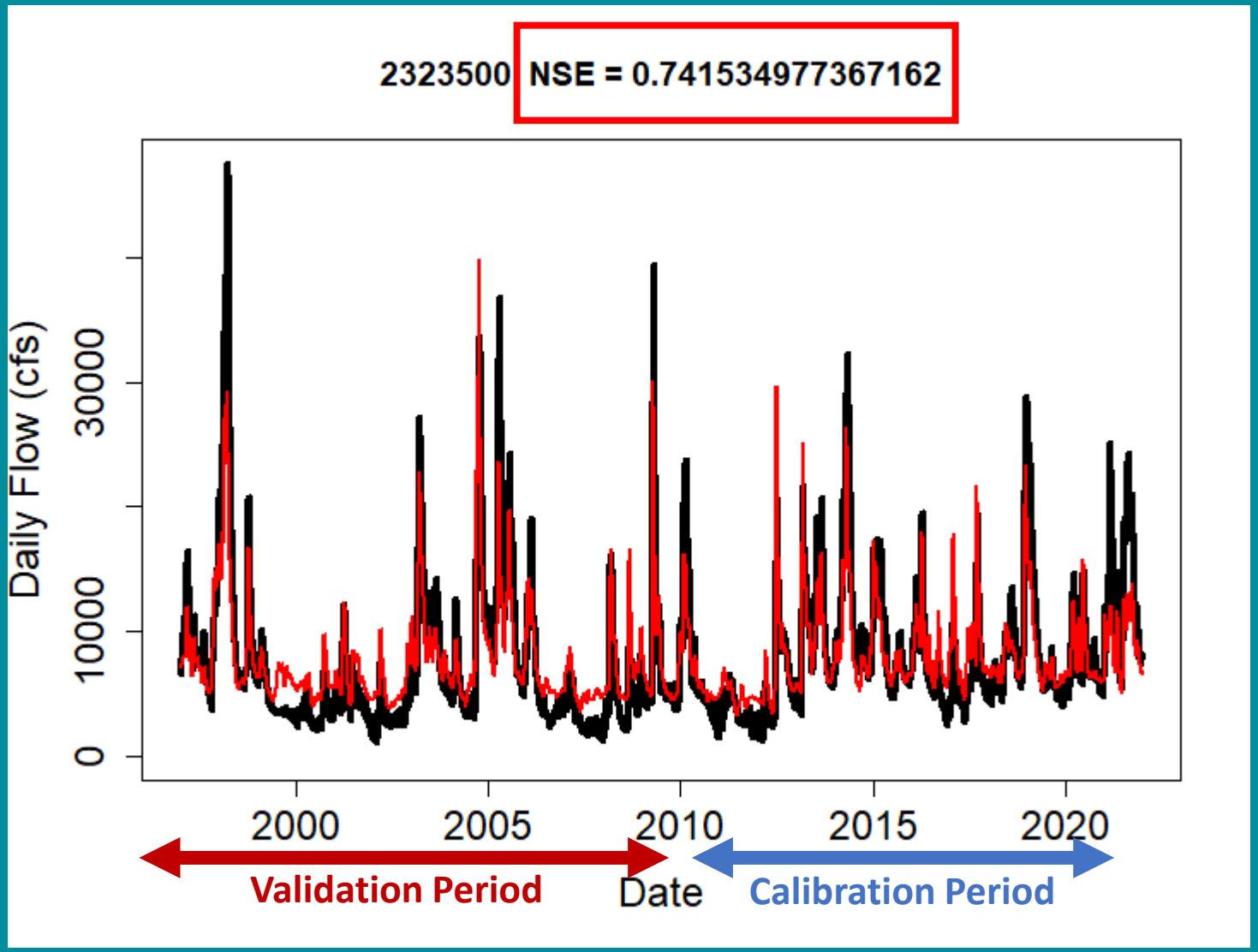




- Landscape Hydrological Model
- SWAT-MODFLOW
- Simulate spatially explicit land use, management, and climate scenarios
- Outputs: river flow, nitrogen concentration, crop yields, water temperature, etc.

Model Calibration





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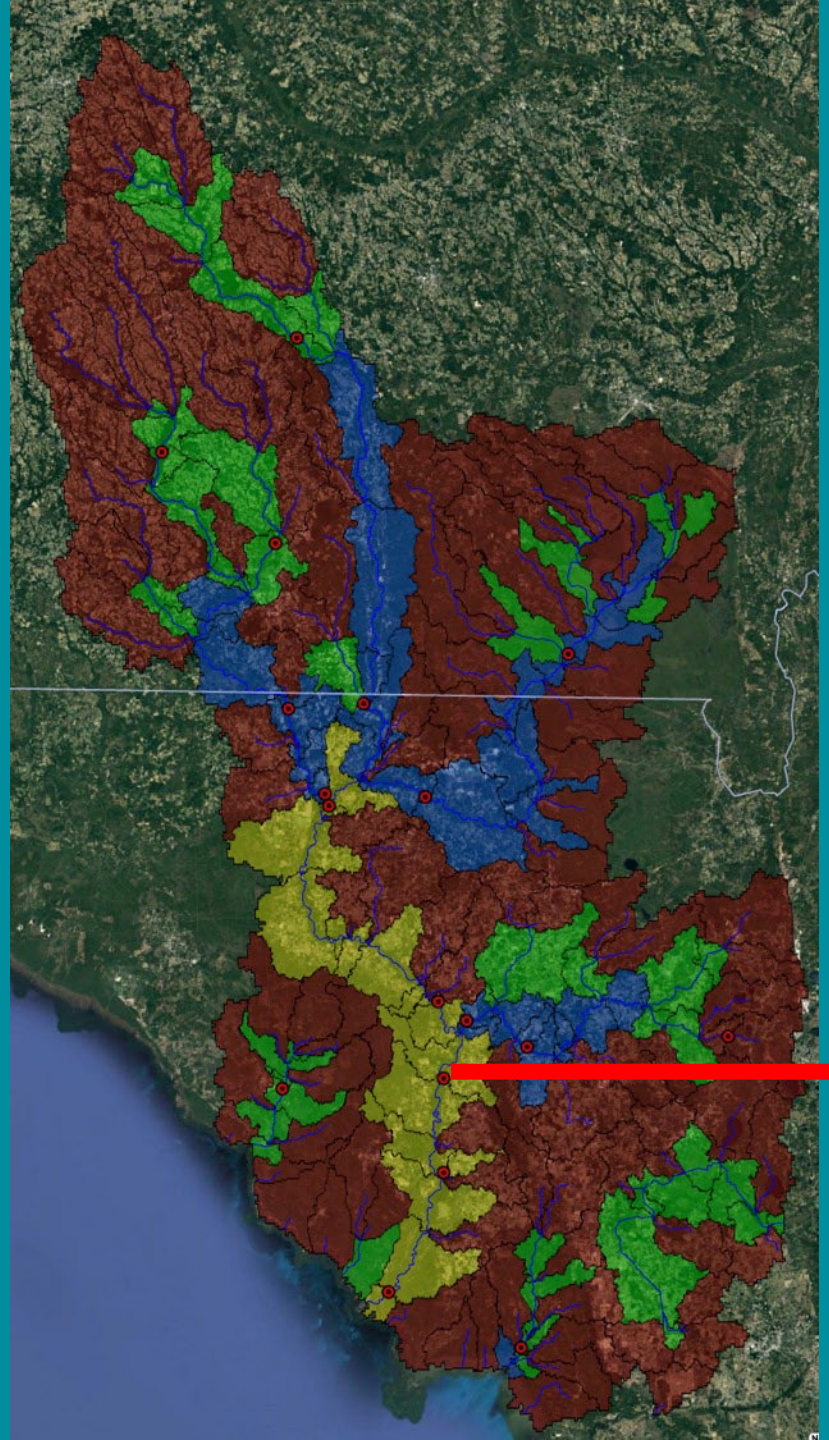

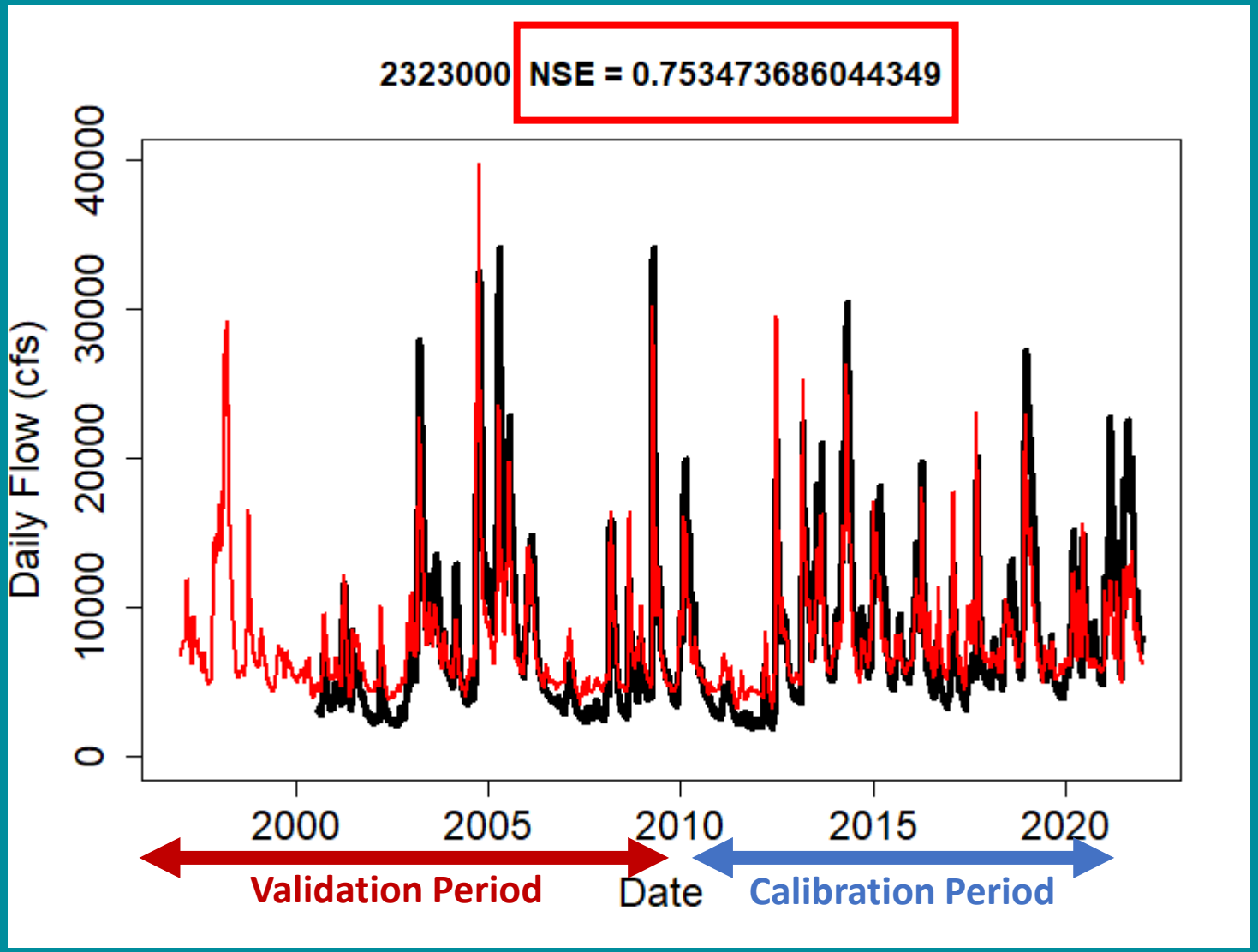

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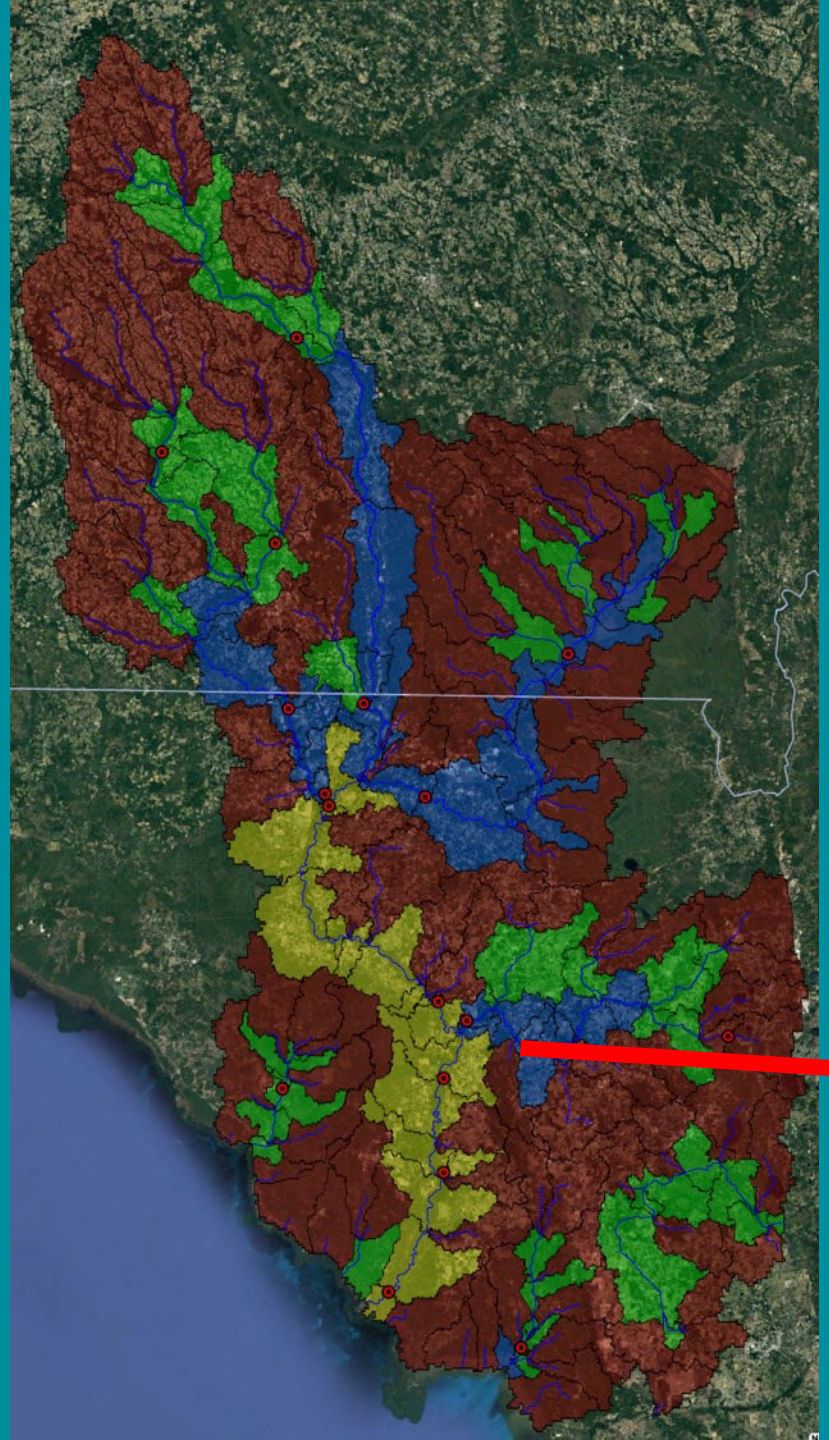

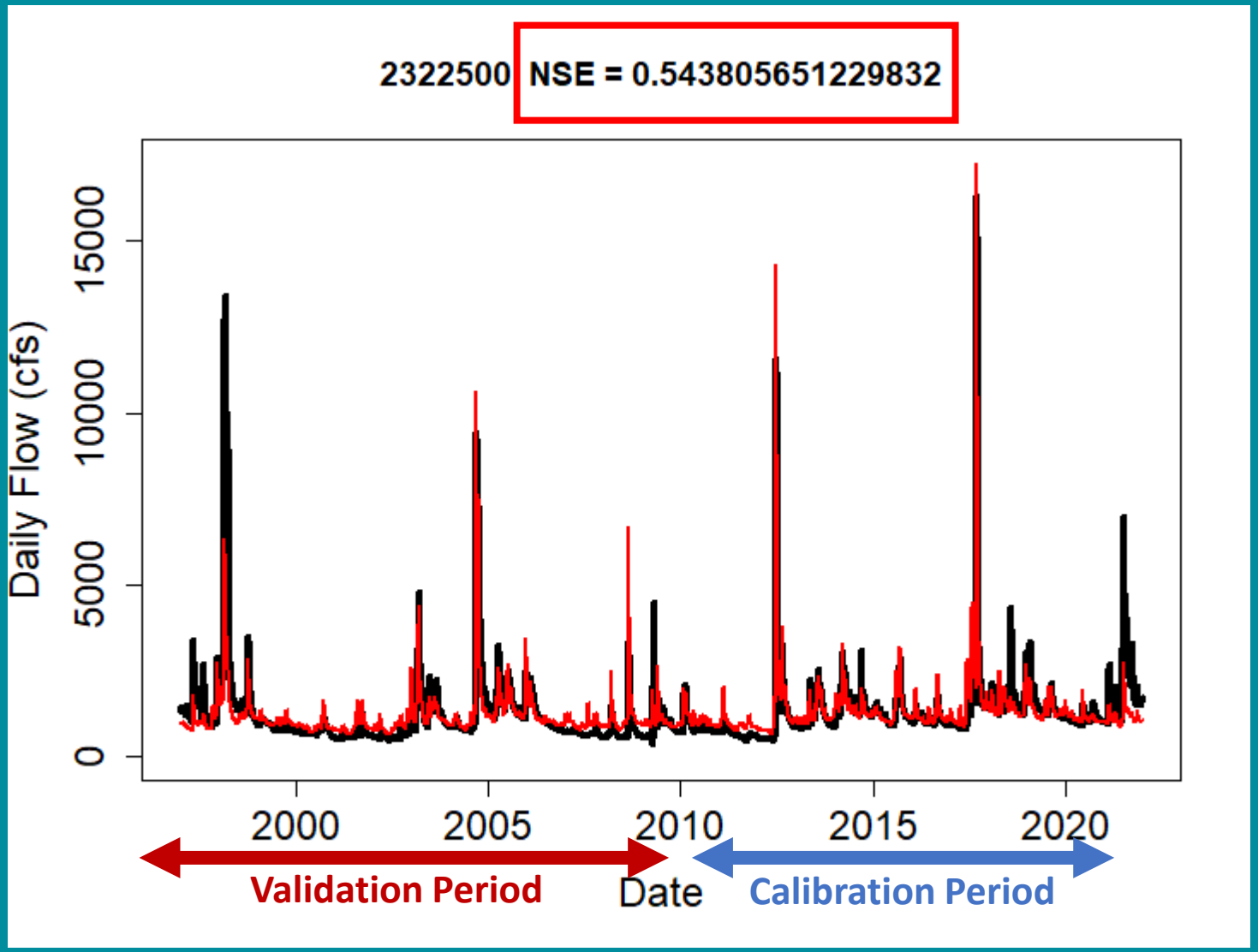

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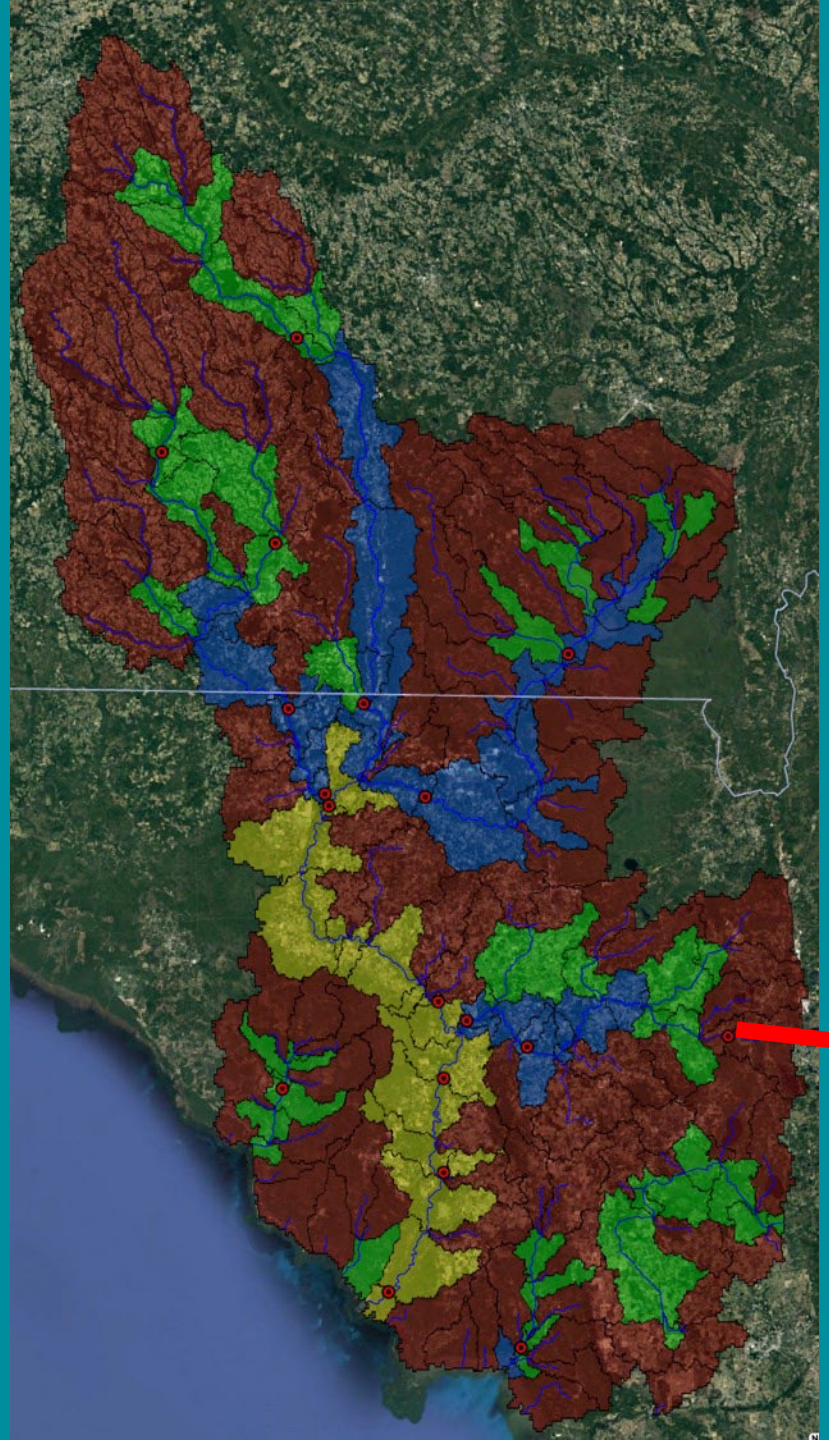

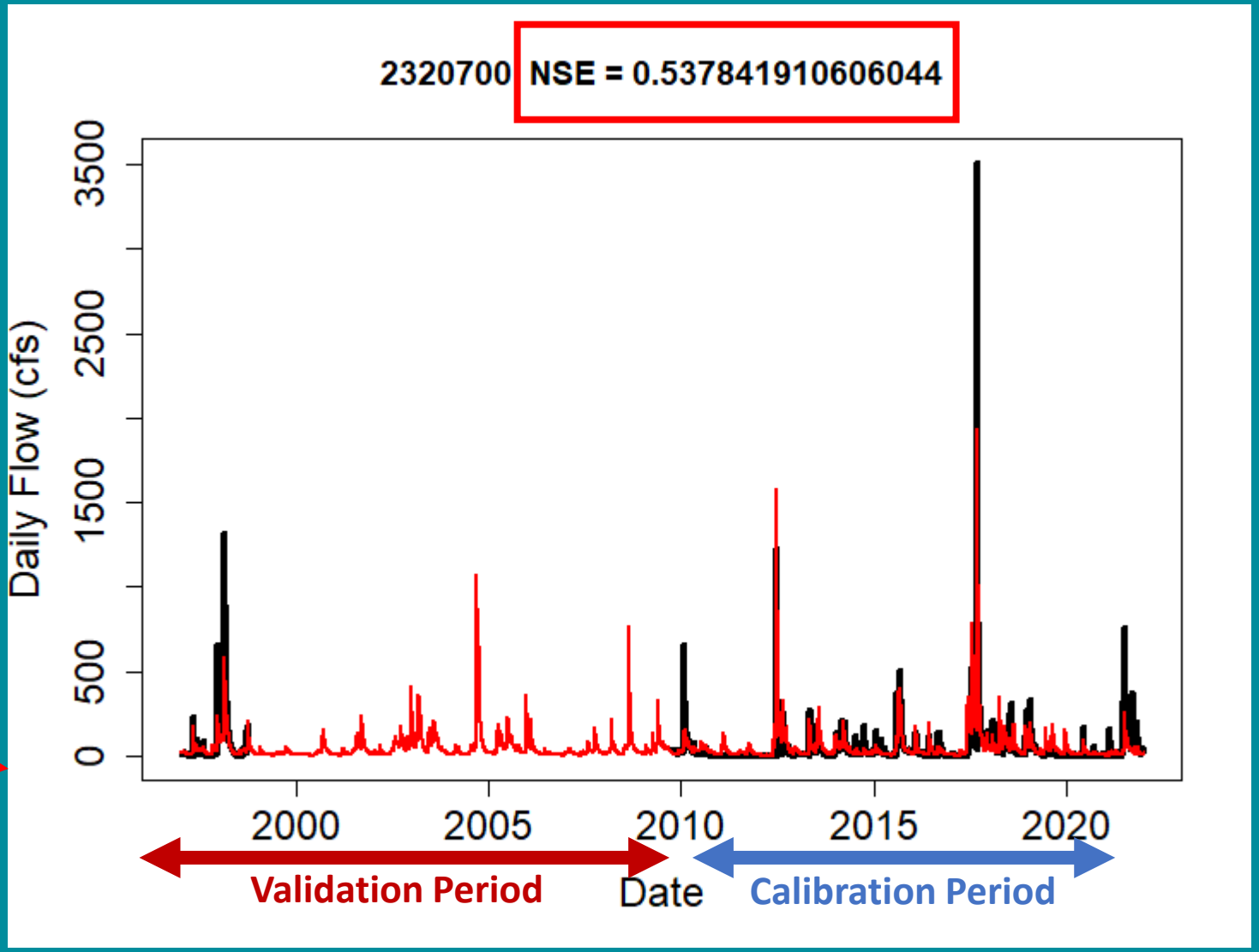

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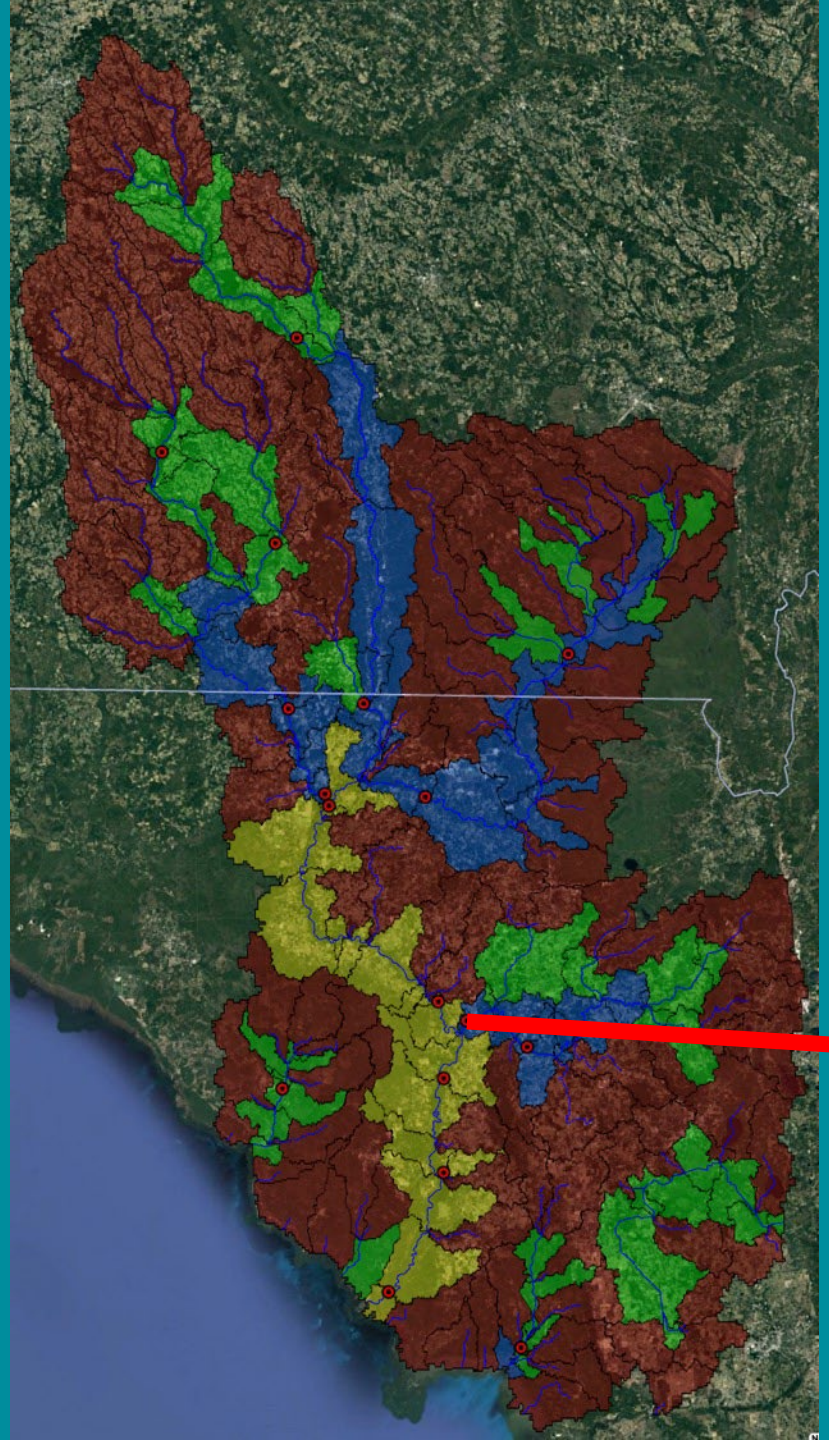

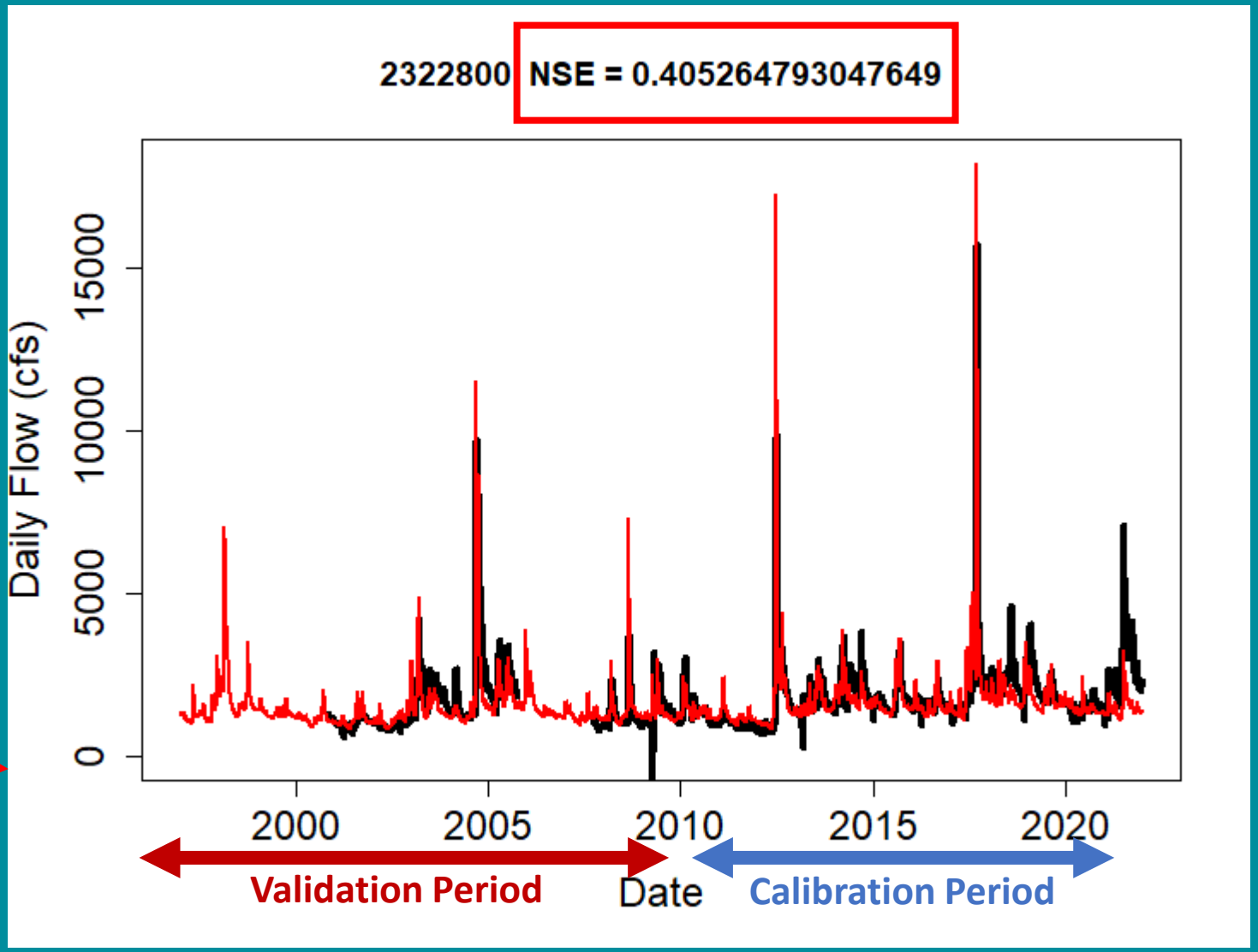

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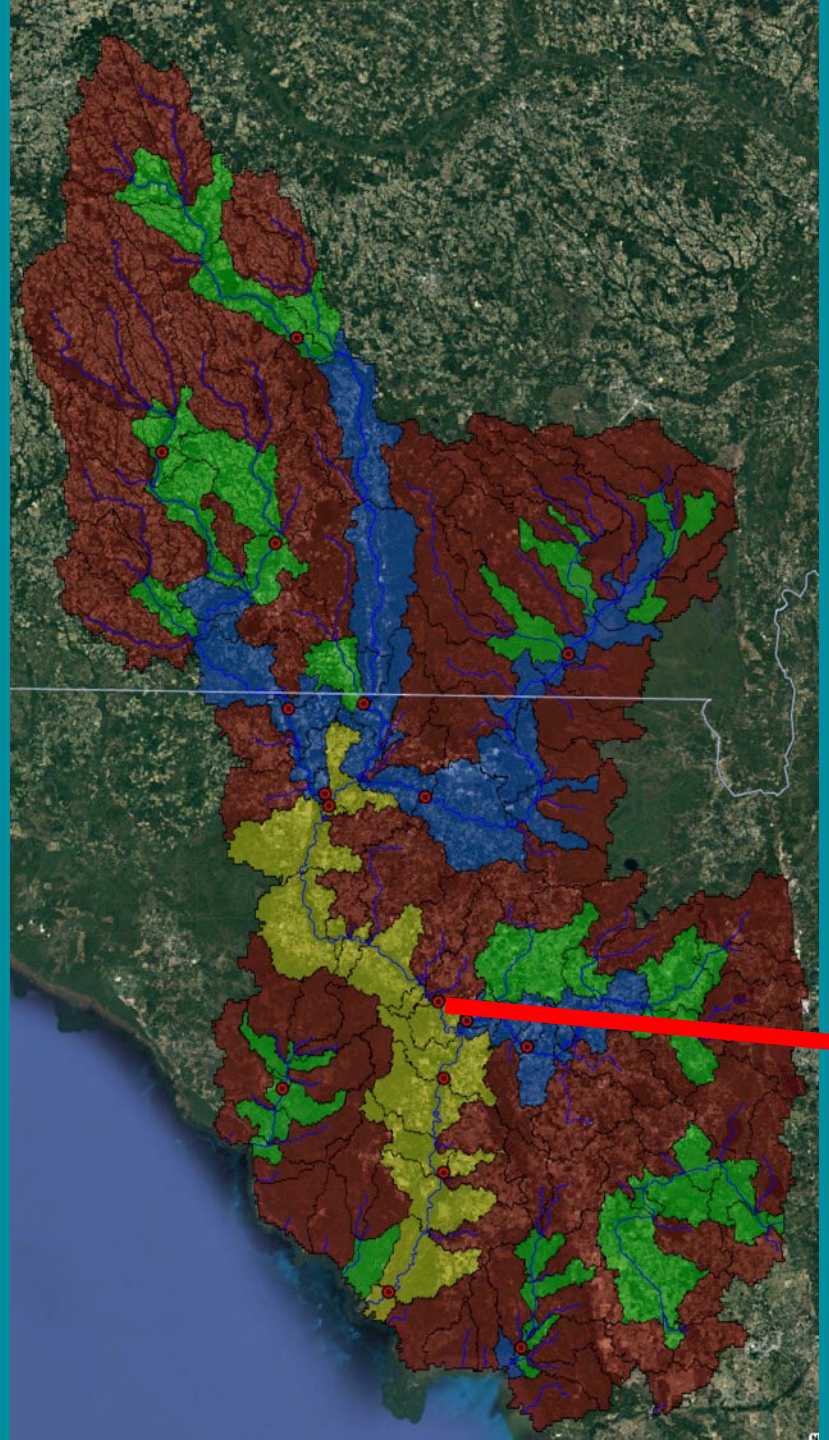

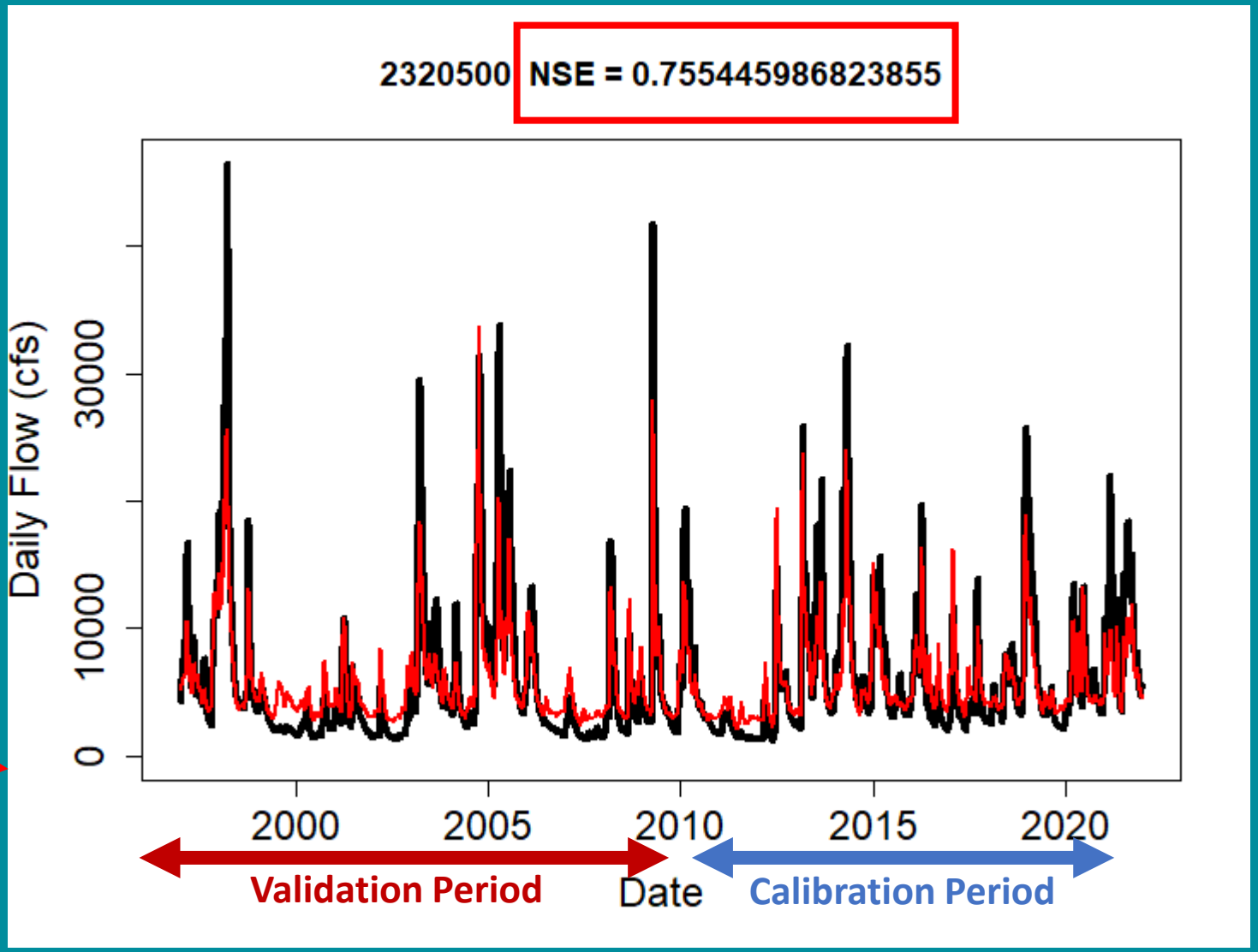

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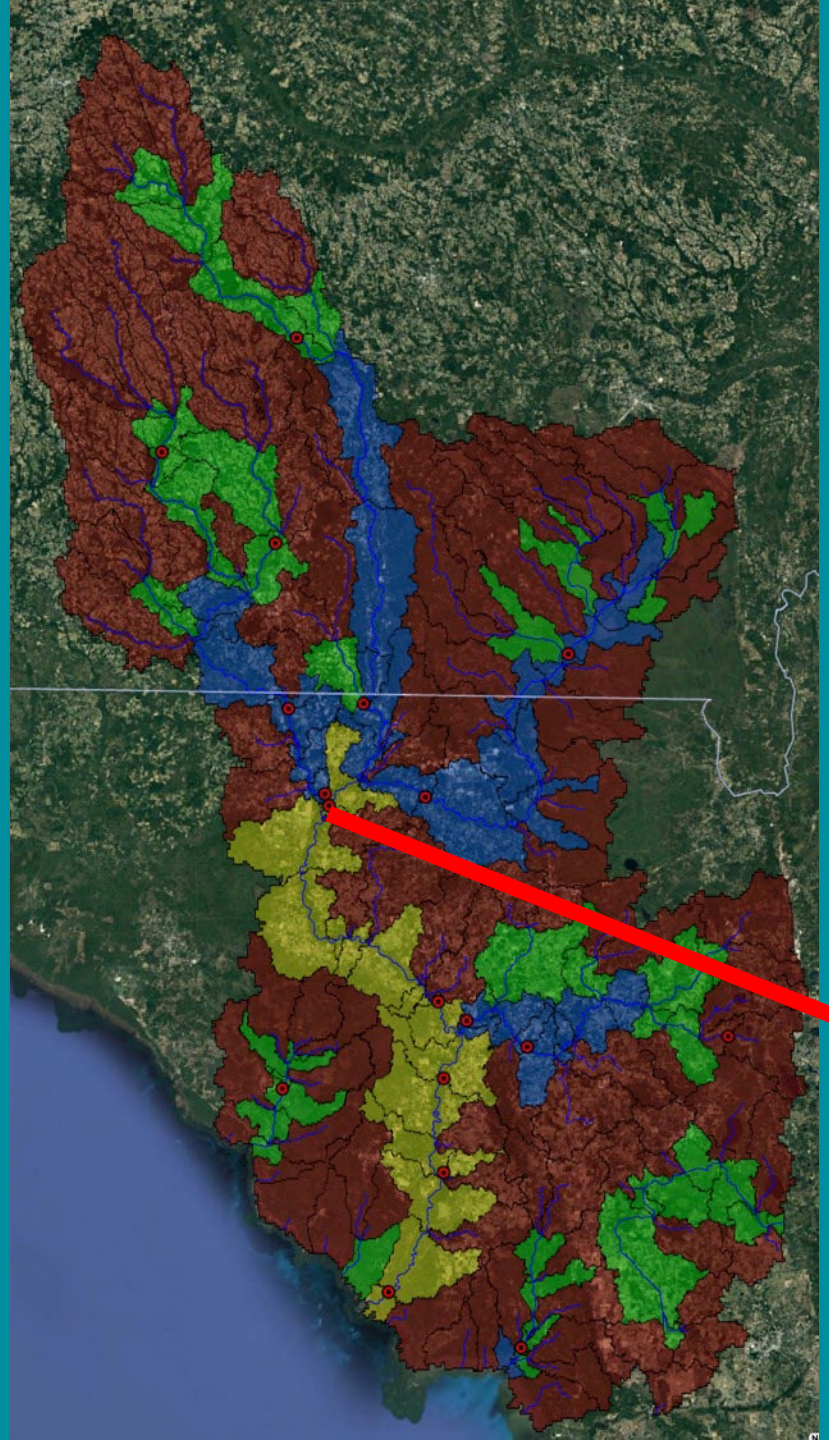

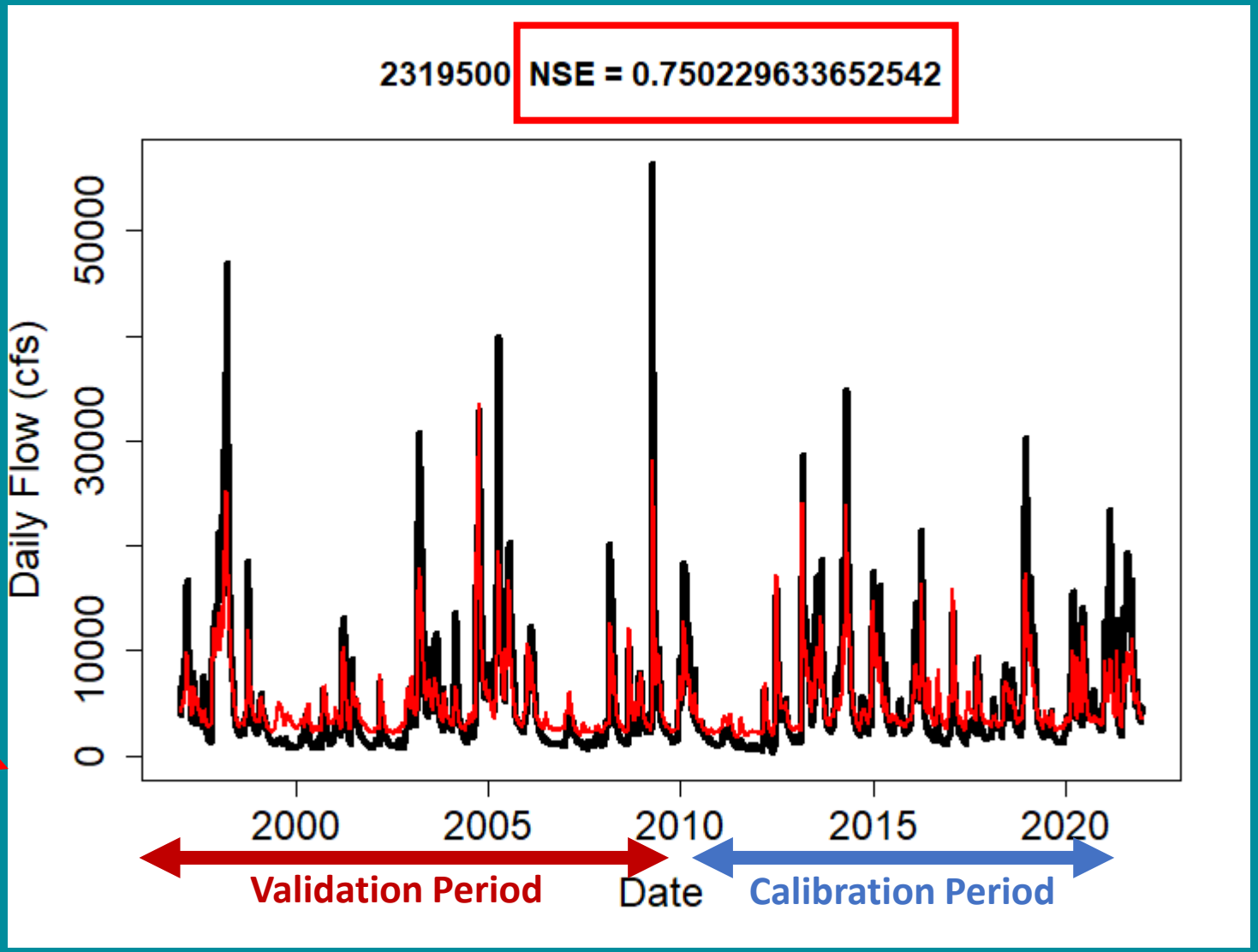

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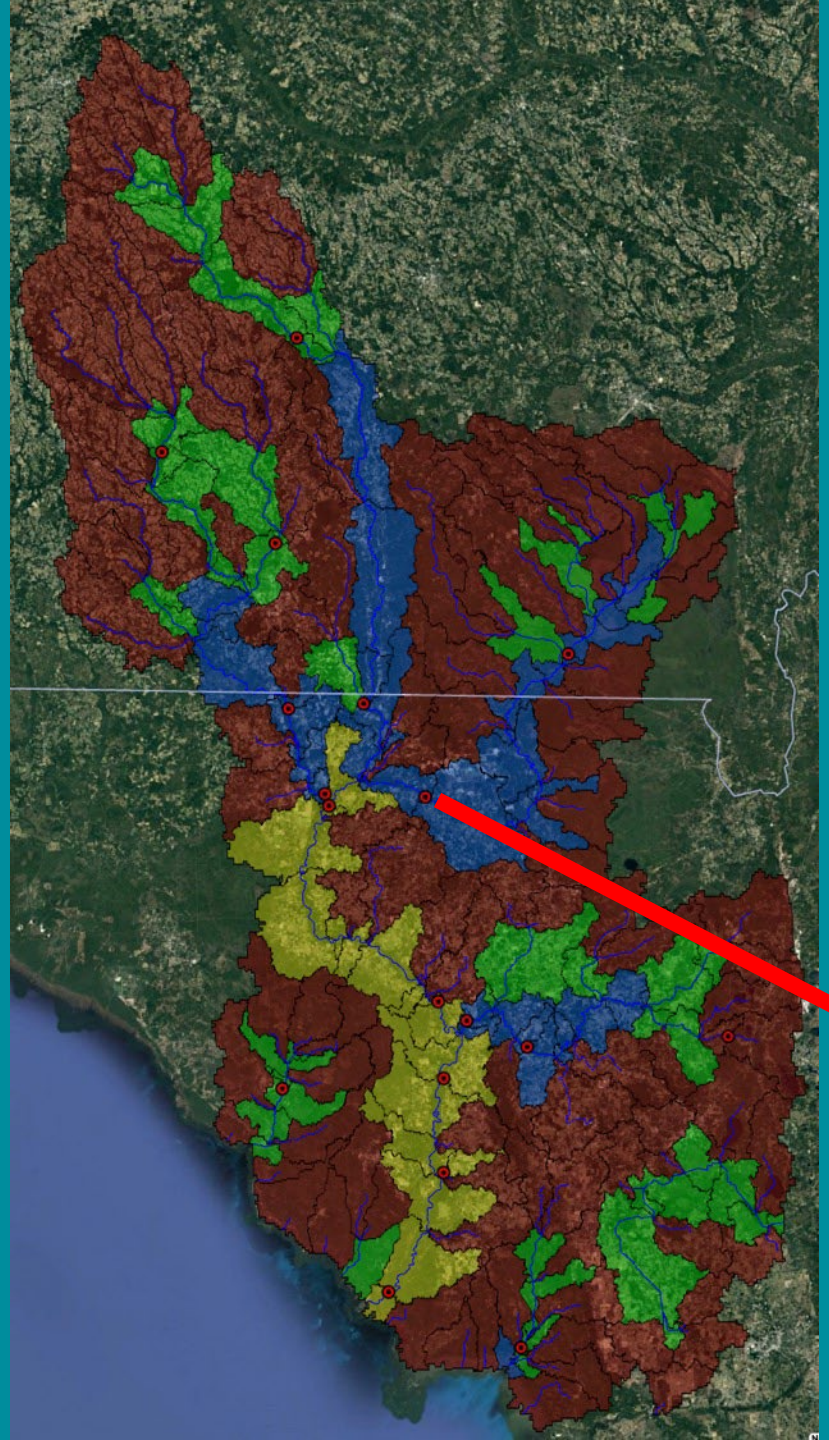

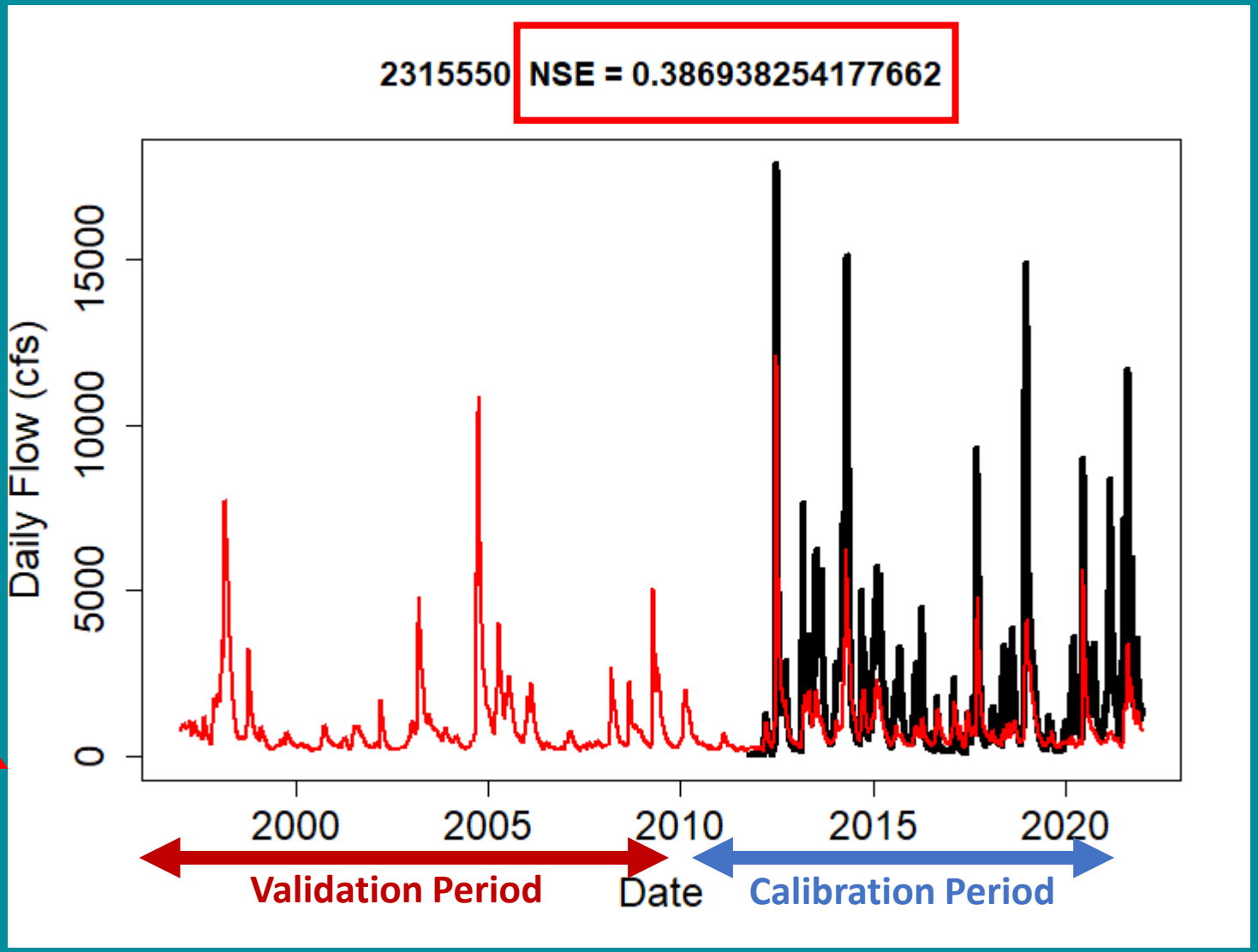

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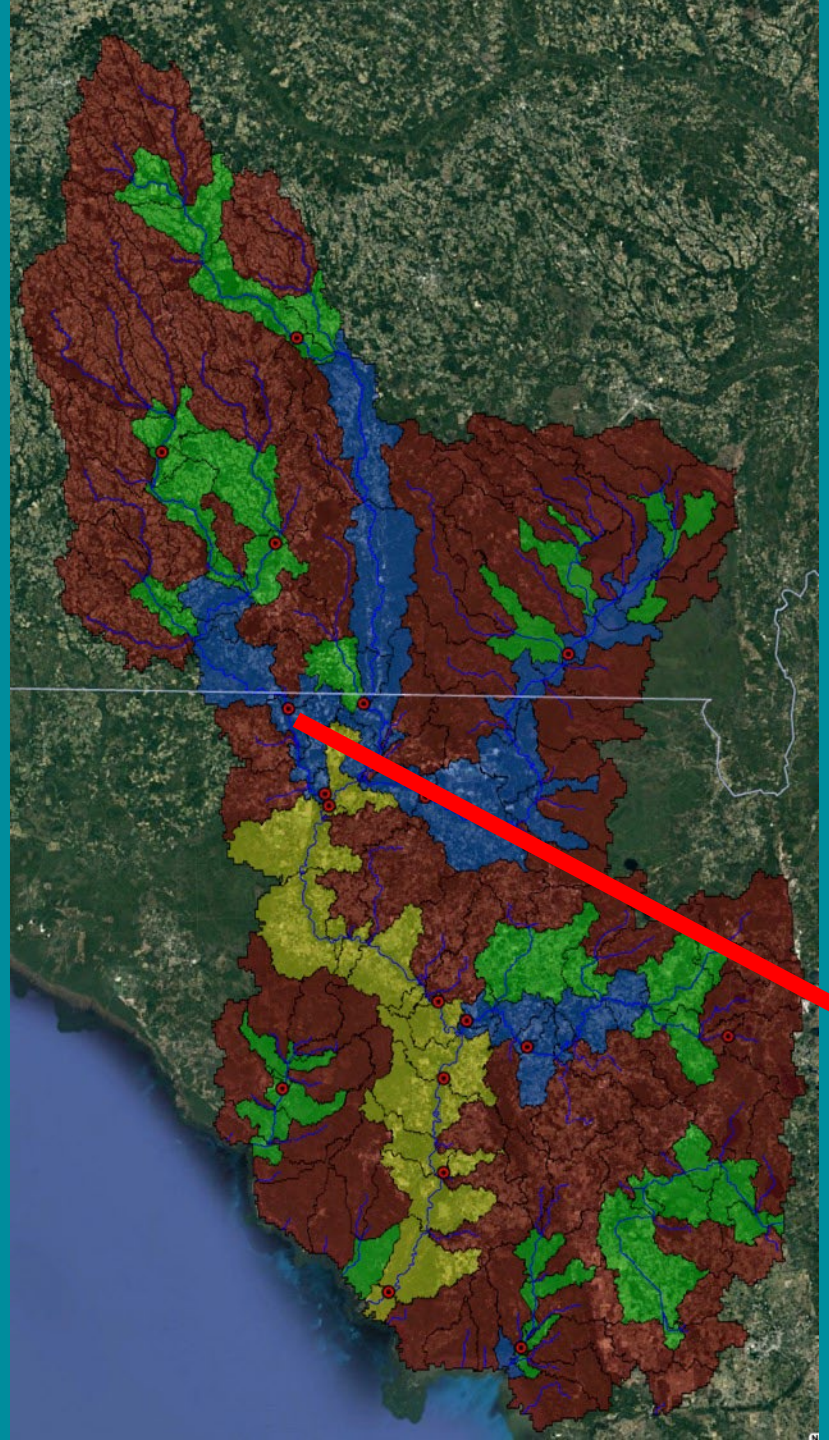

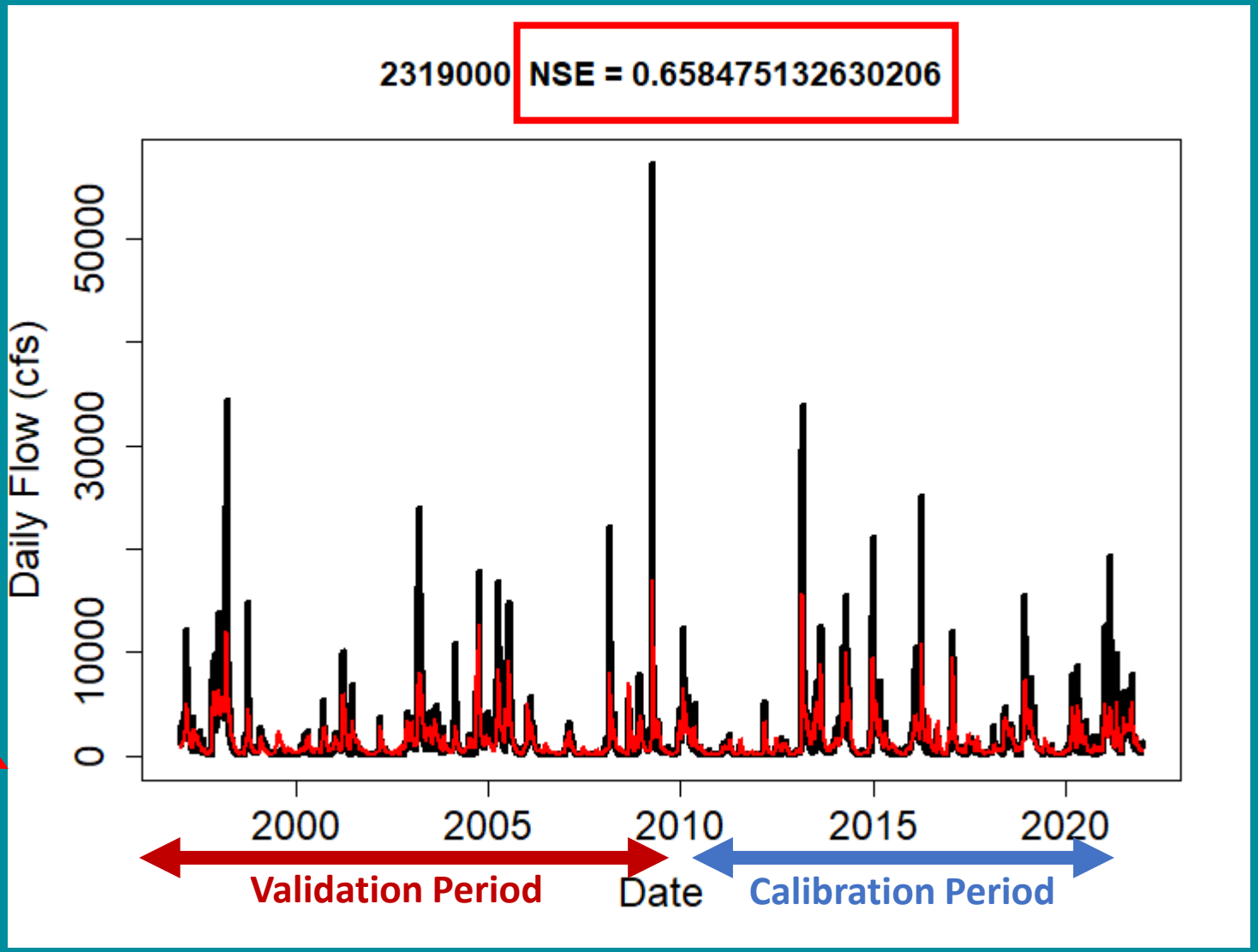

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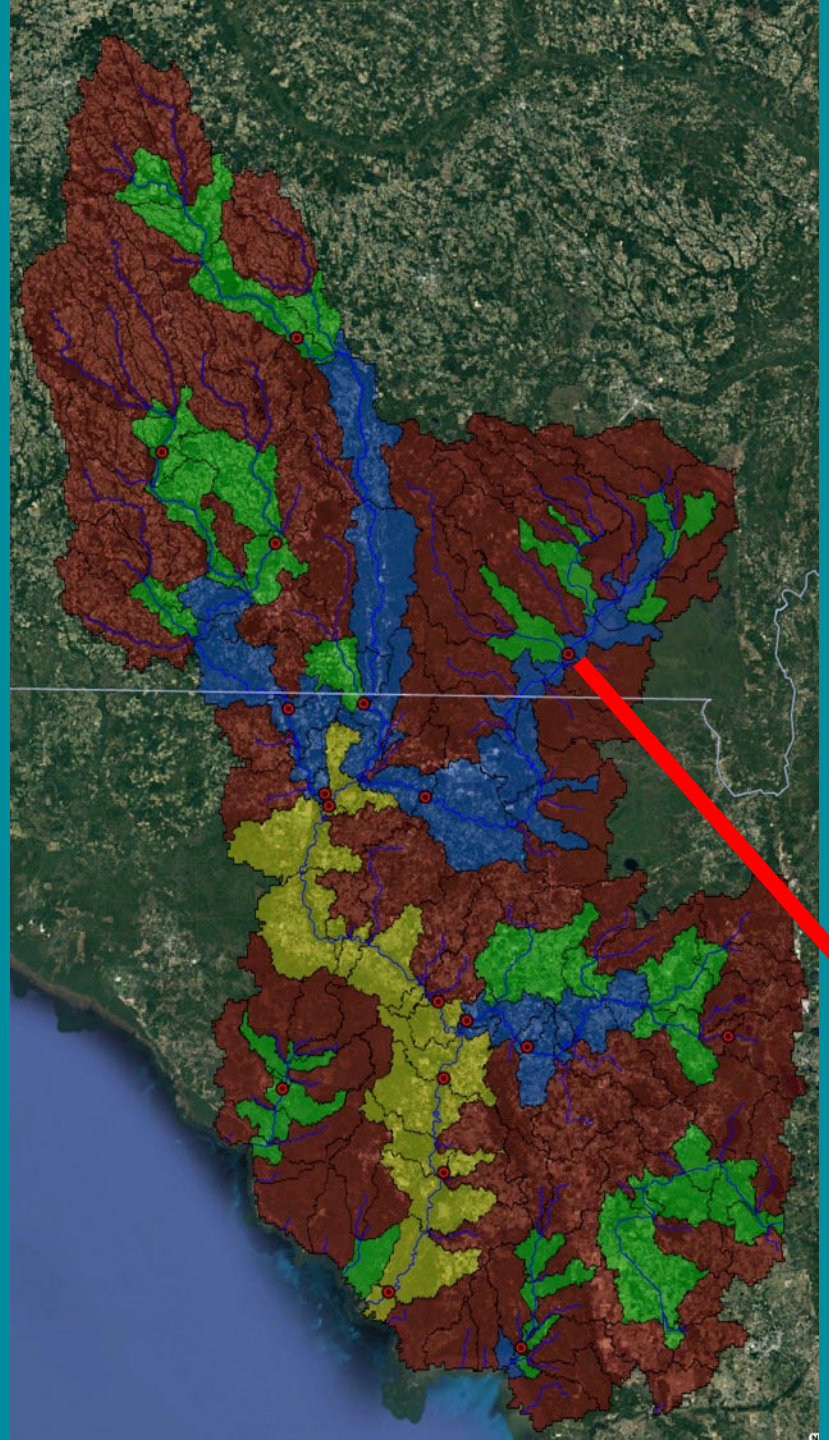

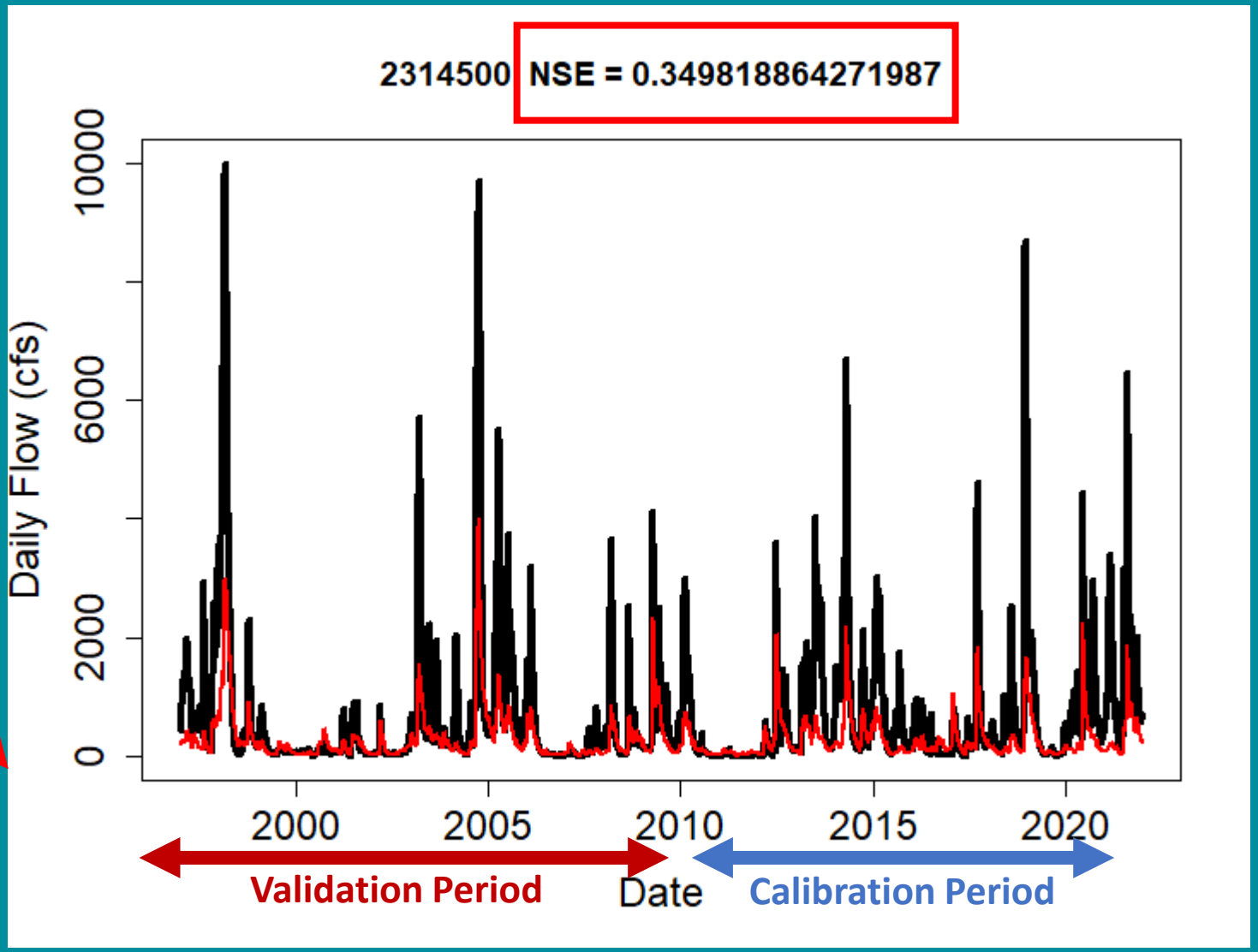

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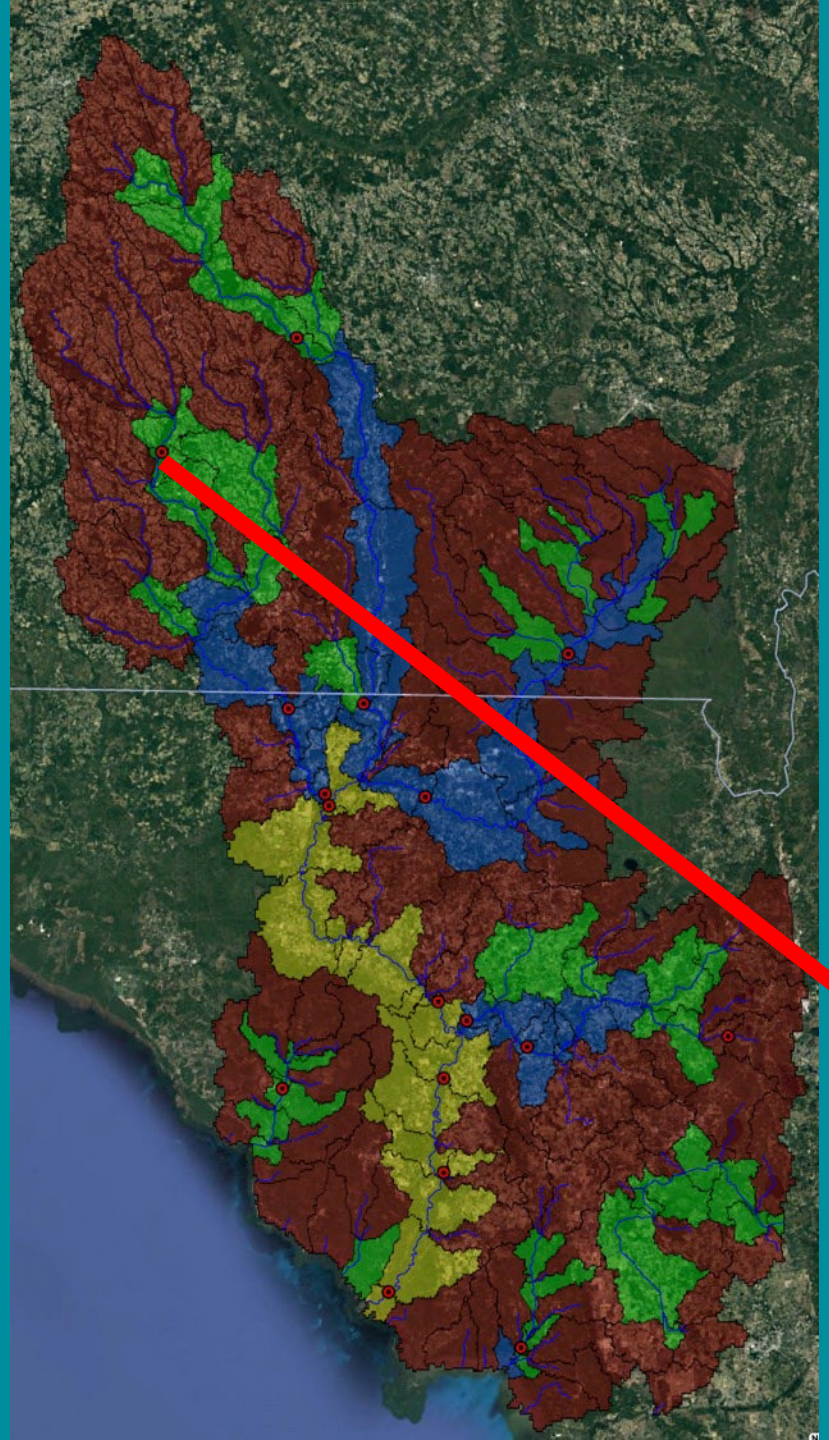

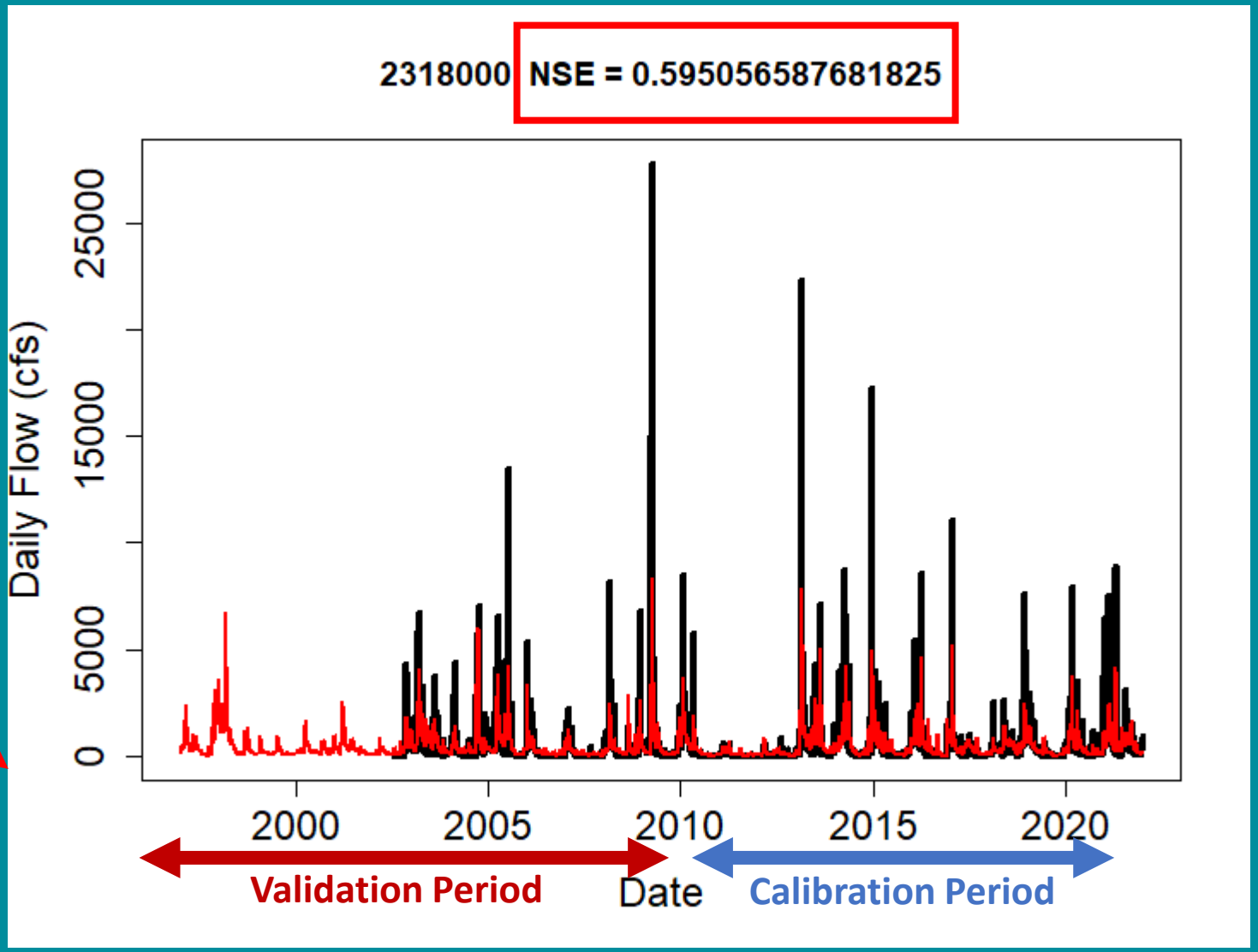

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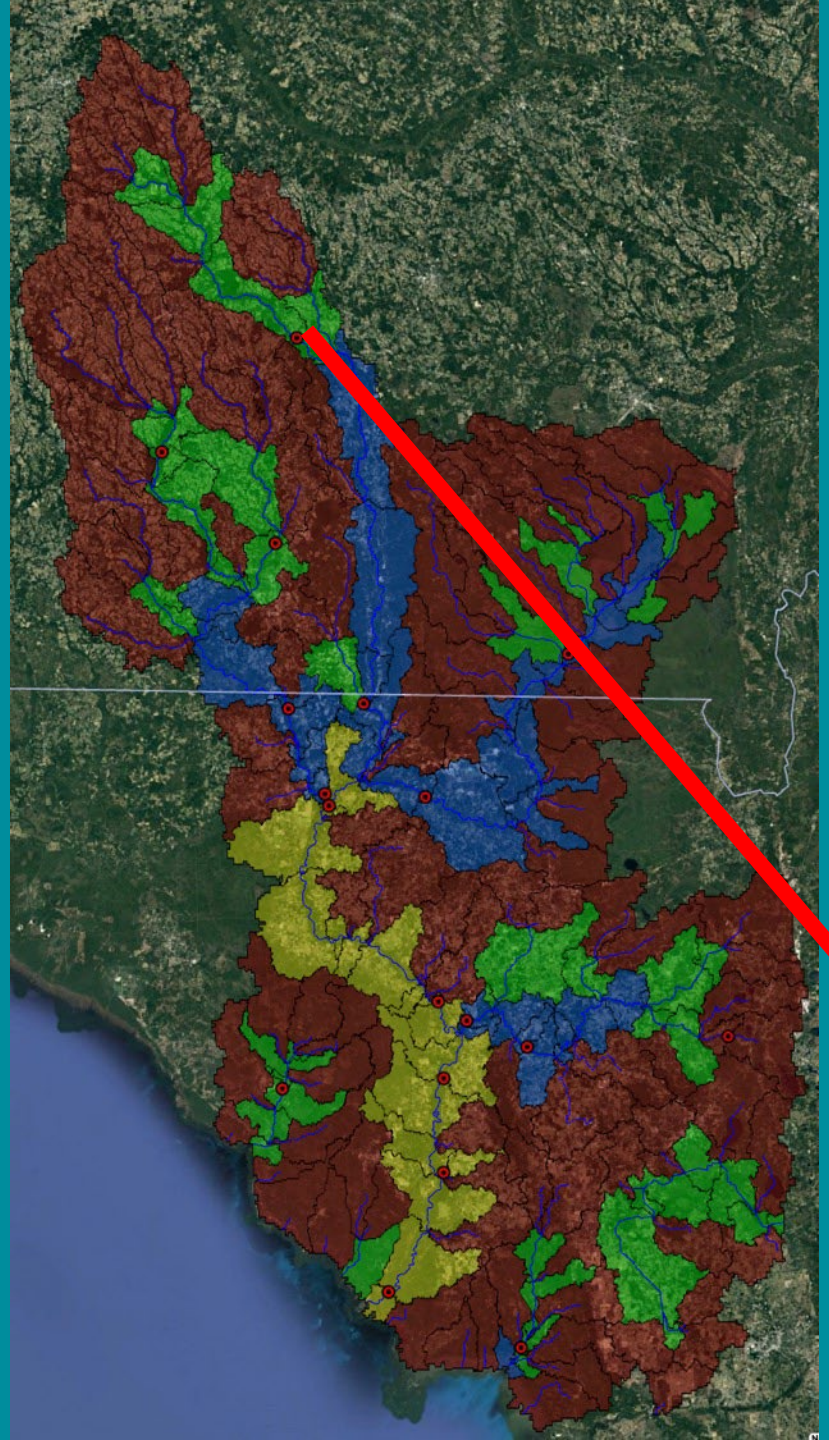

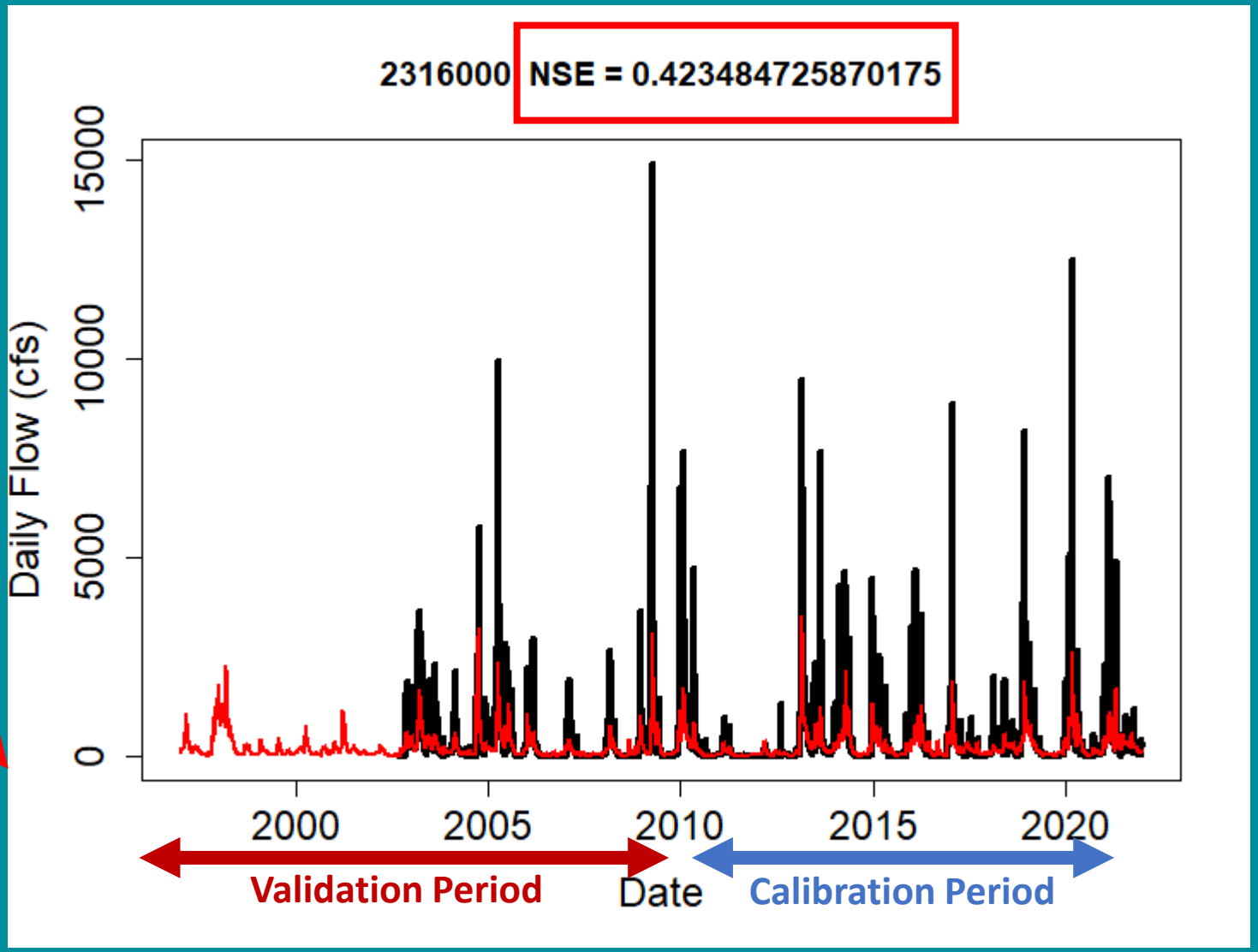

Six Land-Use Scenarios

1. “Current Conditions”
2. “Agricultural Expansion”
3. “Restoration Forestry”
4. “Southeast Conservation Blueprint”
5. “Urban Expansion 2070”
6. “Urban Expansion 2100”

Advisory Committee

Management Agencies

- Florida Department of Environmental Protection
- Suwannee River Water Management District
- FDACS Division of Aquaculture
- Lower Suwannee National Wildlife Refuge
- FL Fish & Wildlife Conservation Commission

- **Tourism and Recreation**
  - Levy County Tourism
  - Recreational fishing

Environmental NGOs

- Oceana
- The Conservation Fund
- Trust for Public Land

Science/Extension

- University of Florida/IFAS
- University of Central Florida
- Florida Sea Grant

Ag & Natural Resources

- Timber/forestry
- Clam aquaculture
- Agronomy

Center for Public Issues Education

UF/IFAS Public Issues Education (PIE) Center project page

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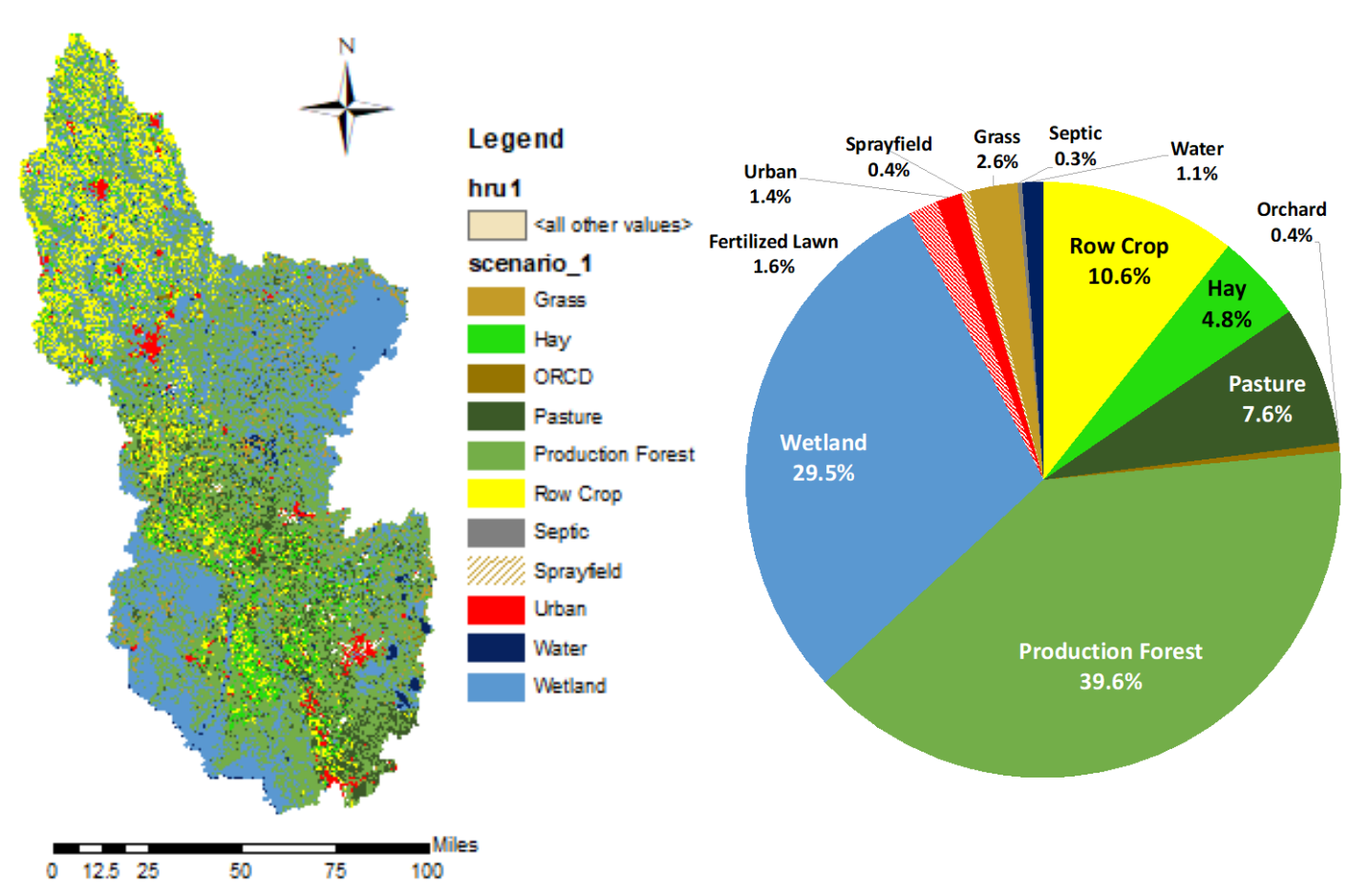

Six Land-Use Scenarios

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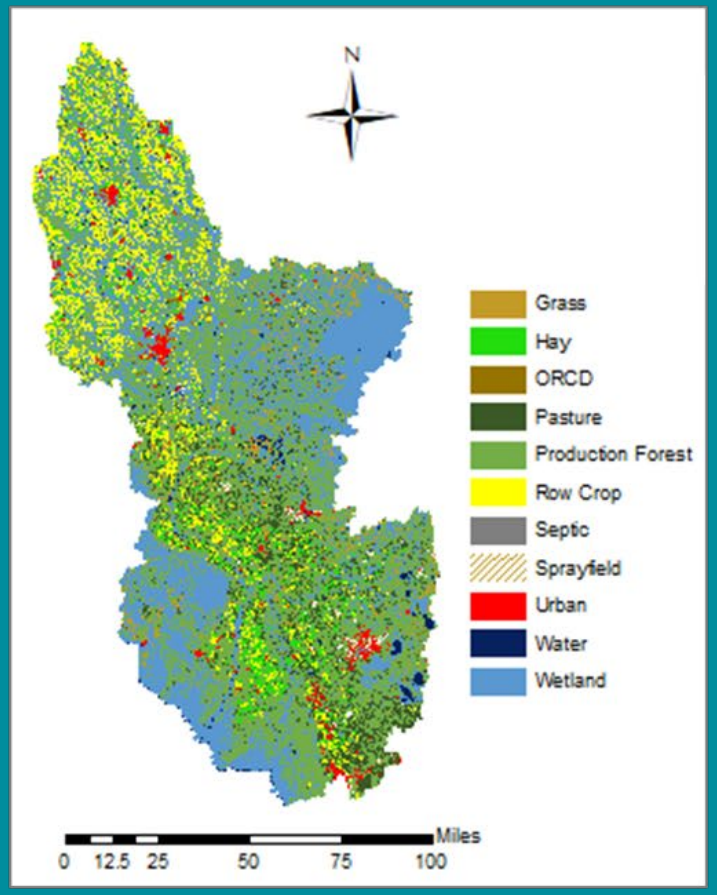
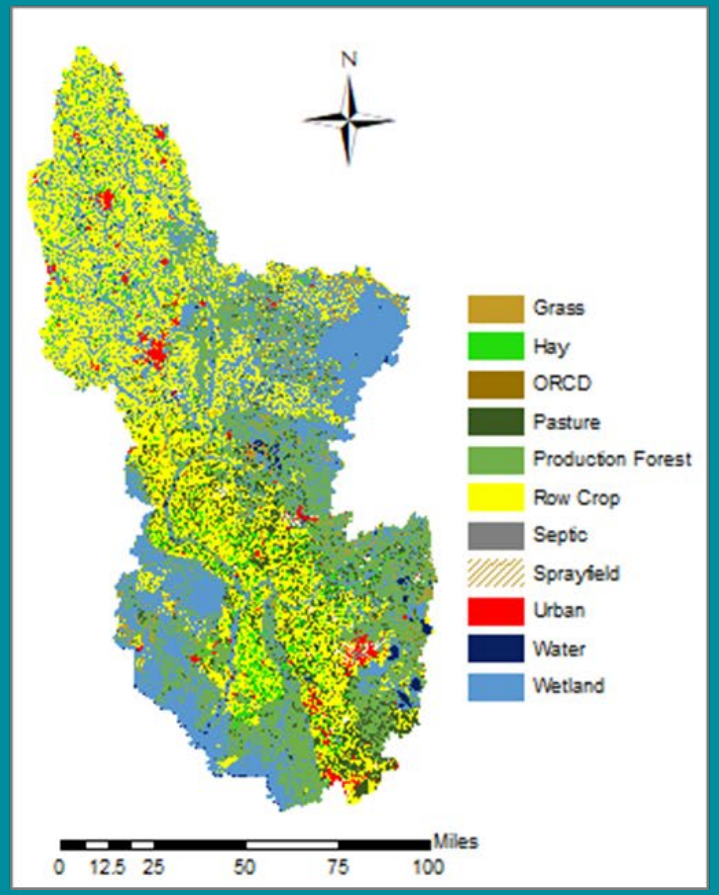


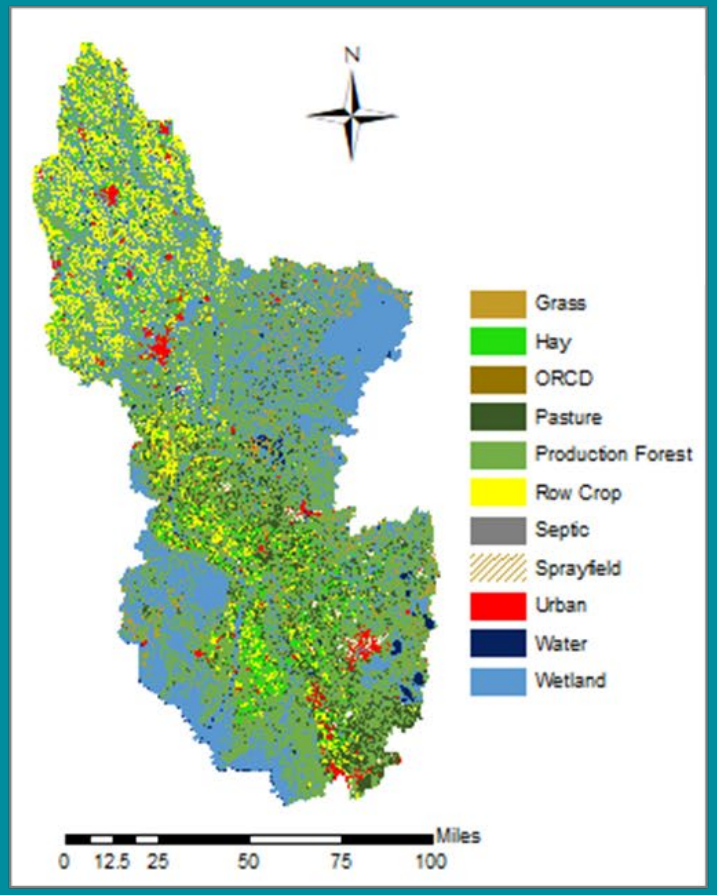
Ag Expansion



Ag Expansion – Production forestry on suitable soils is converted to row crops

Six Land-Use Scenarios

Current Conditions



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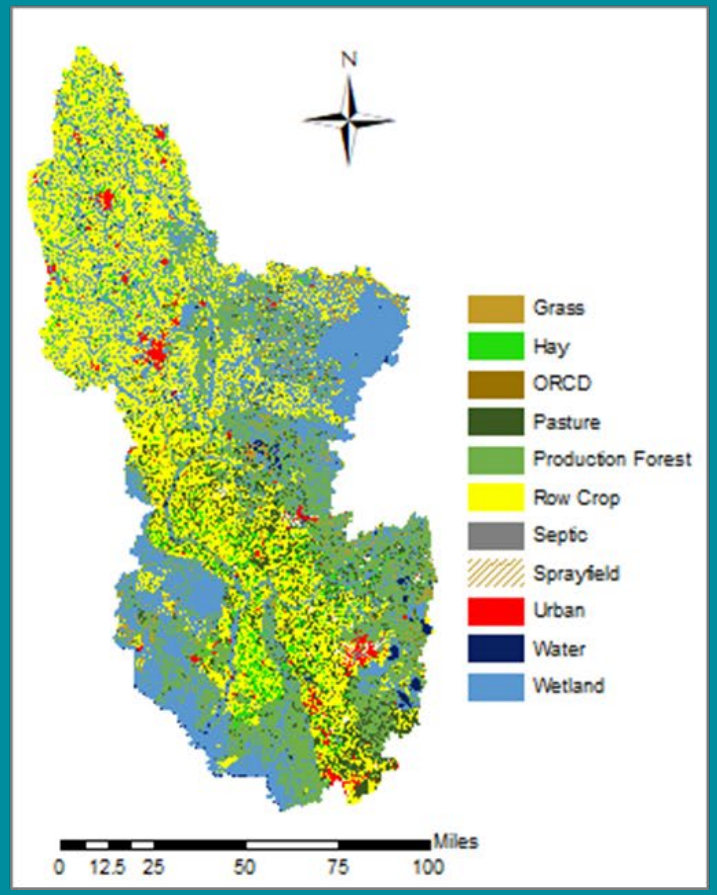
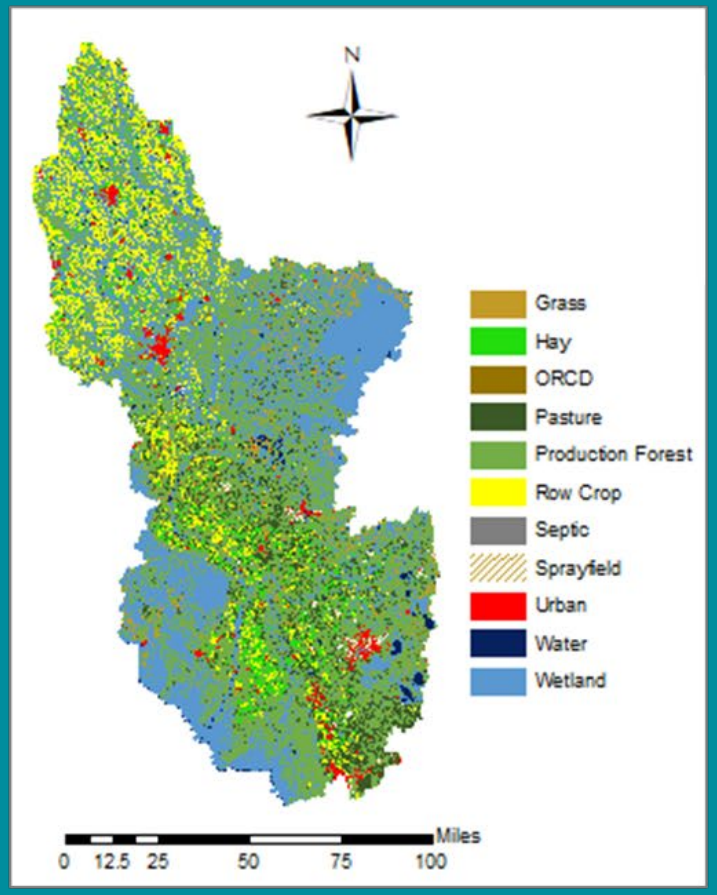


Ag Expansion – Production forestry on suitable soils is converted to row crops

Florida: Production forest on soil type A → Corn-Peanut Rotation

Six Land-Use Scenarios

Current Conditions



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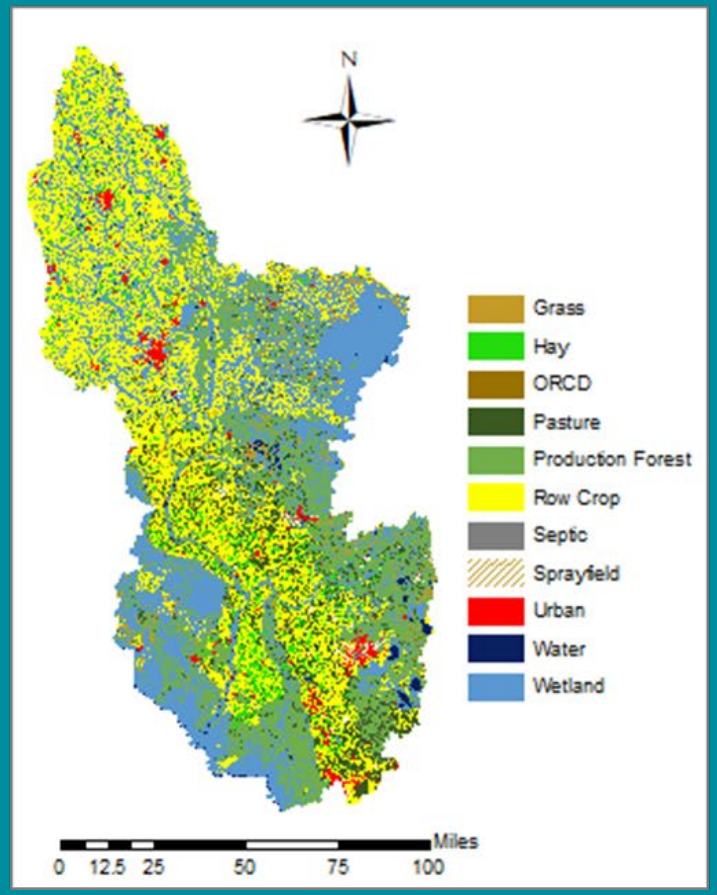


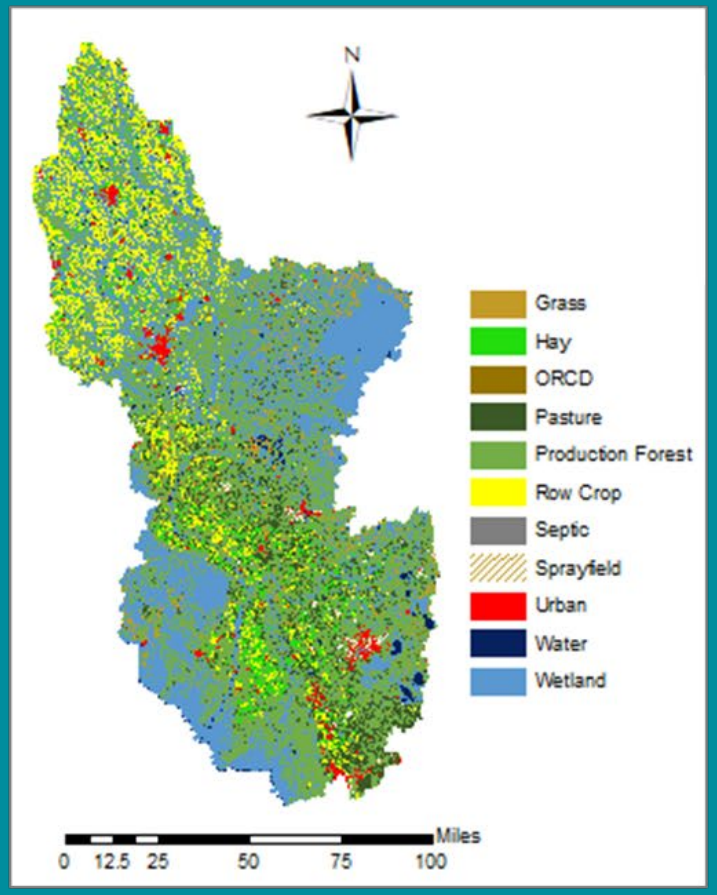
Ag Expansion – Production forestry on suitable soils is converted to row crops

Florida: Production forest on soil type A → Corn-Peanut Rotation

Georgia: Production forest on soil types A and B → Corn-Cotton-Peanut Rotation or Cotton-Cotton-Peanut Rotation

Six Land-Use Scenarios

Current Conditions



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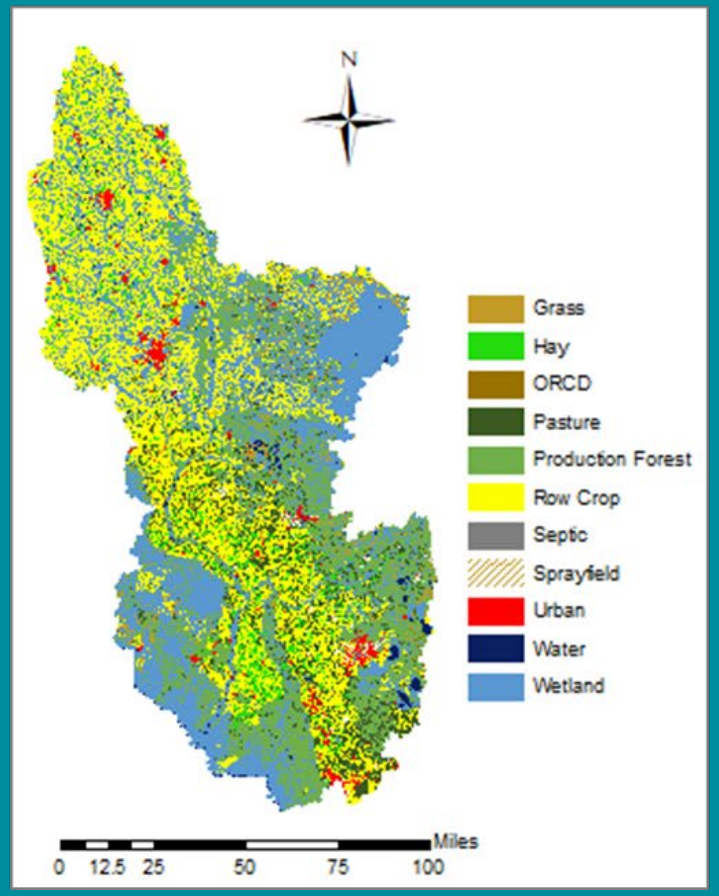
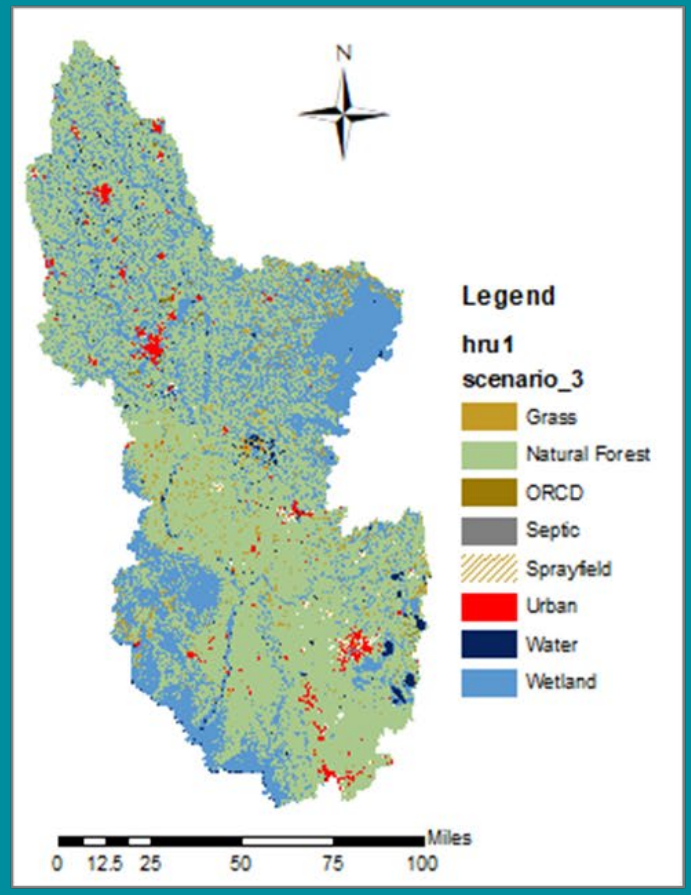


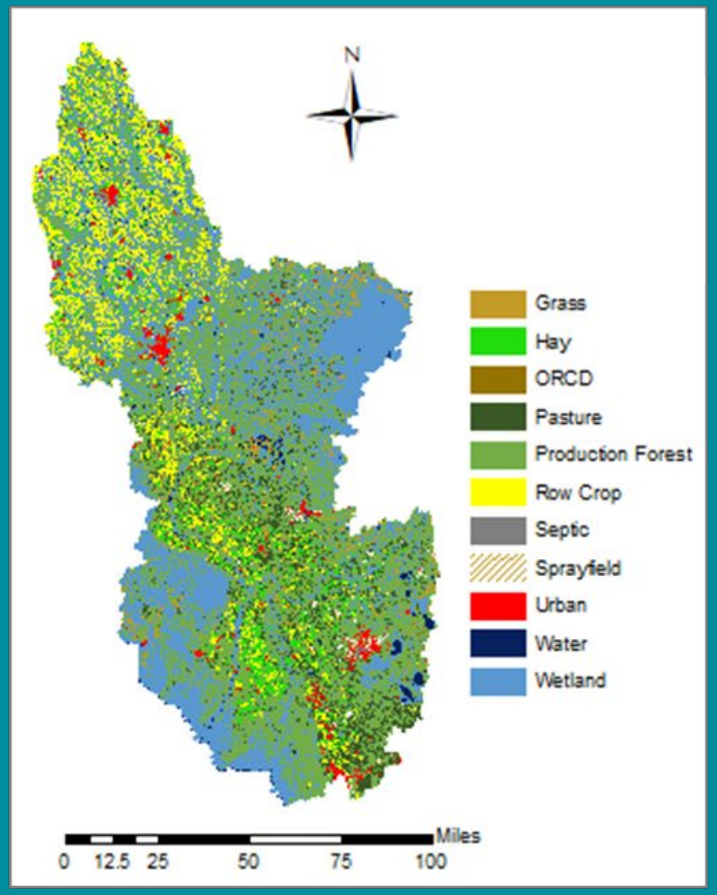
Restoration Forestry



Restoration Forestry – All production land converts to low density longleaf pine savanna

Six Land-Use Scenarios

Current Conditions



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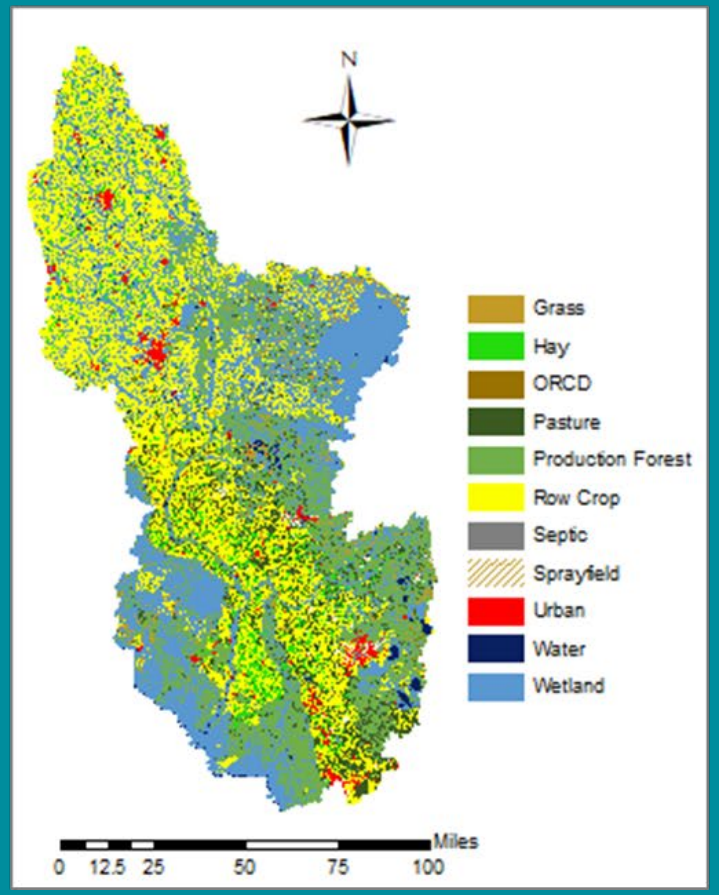

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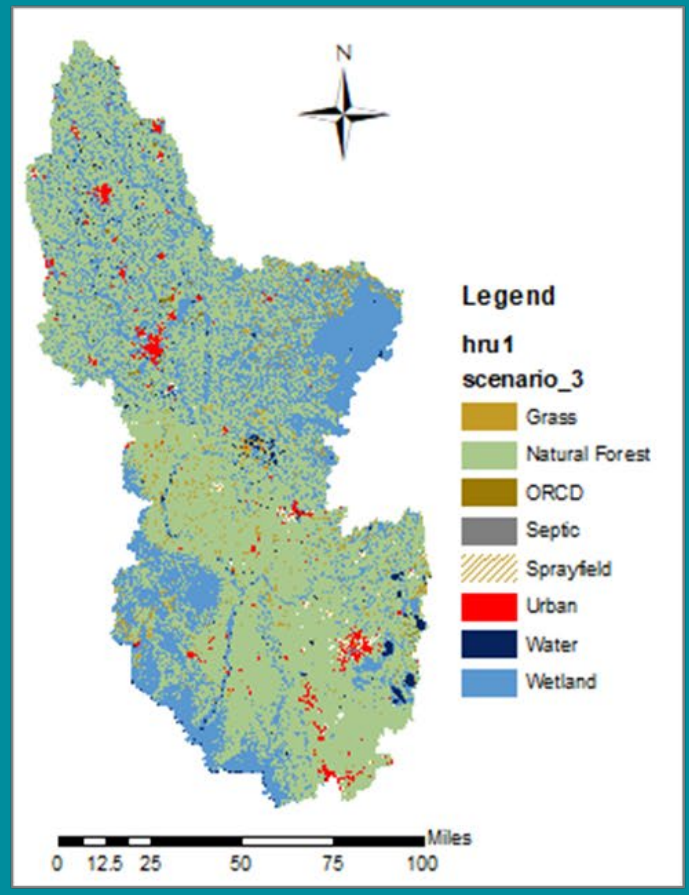

Restoration Forestry – All production land converts to low density longleaf pine savanna

Row Crops, Production Forestry, Pasture, Hay → Longleaf Pine

Six Land-Use Scenarios

1. “Current Conditions”
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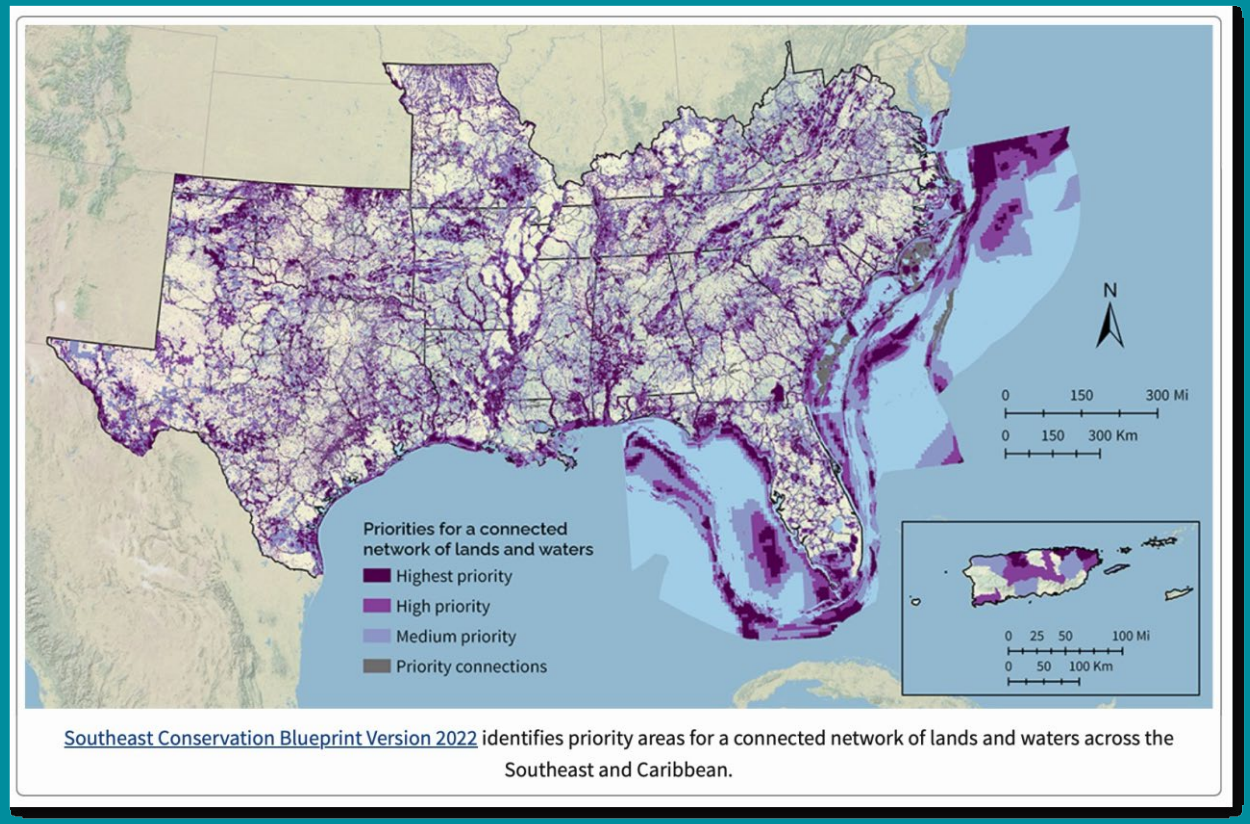
3. “Restoration Forestry”
4. **“Southeast Conservation Blueprint”**
5. “Urban Expansion 2070”
6. “Urban Expansion 2100”



- Based on Southeast Conservation Blueprint (SECAS - Southeast Conservation Adaptation Strategy)

Six Land-Use Scenarios

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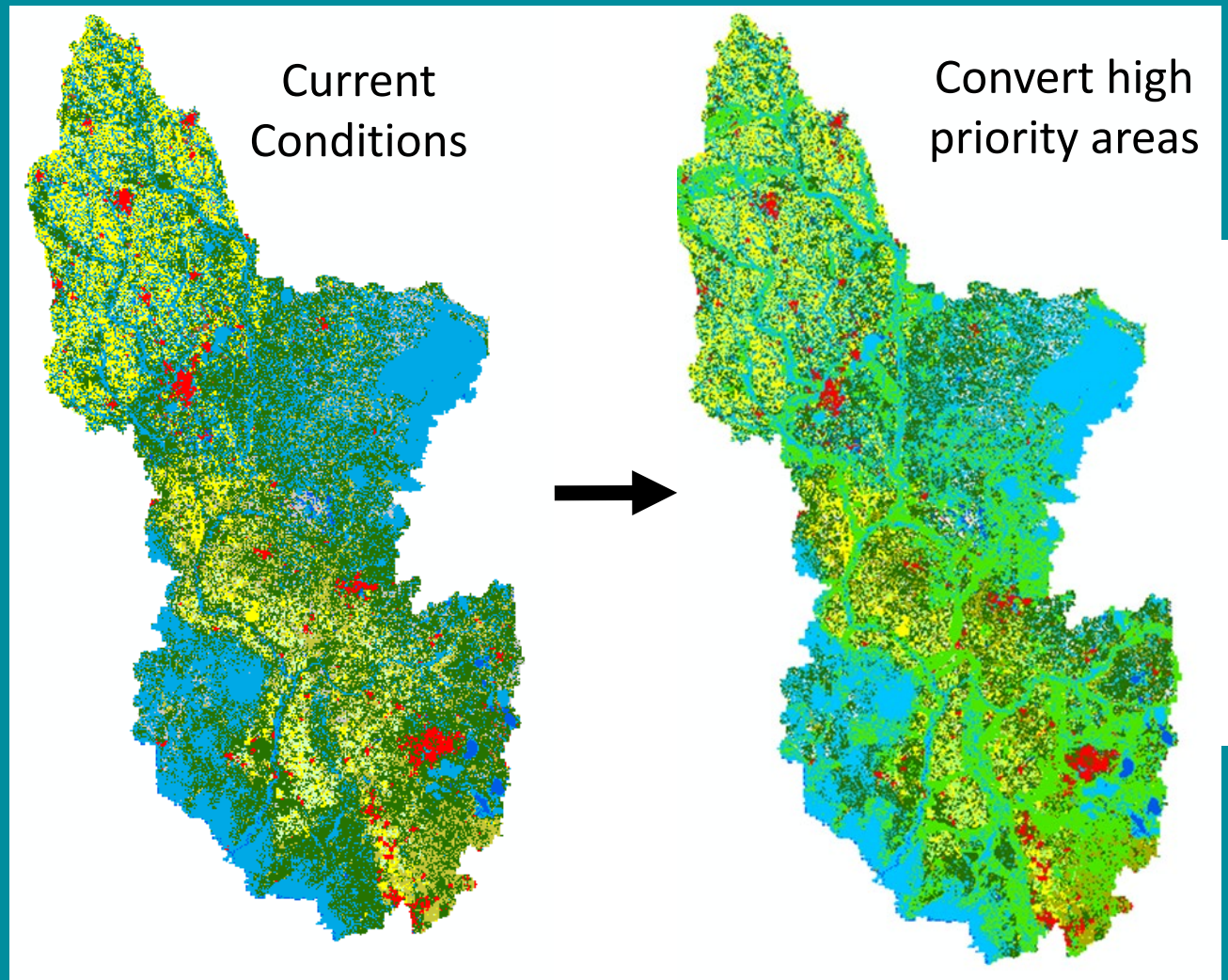
Convert **non-irrigated production land** in identified high priority areas to **low density longleaf pine**



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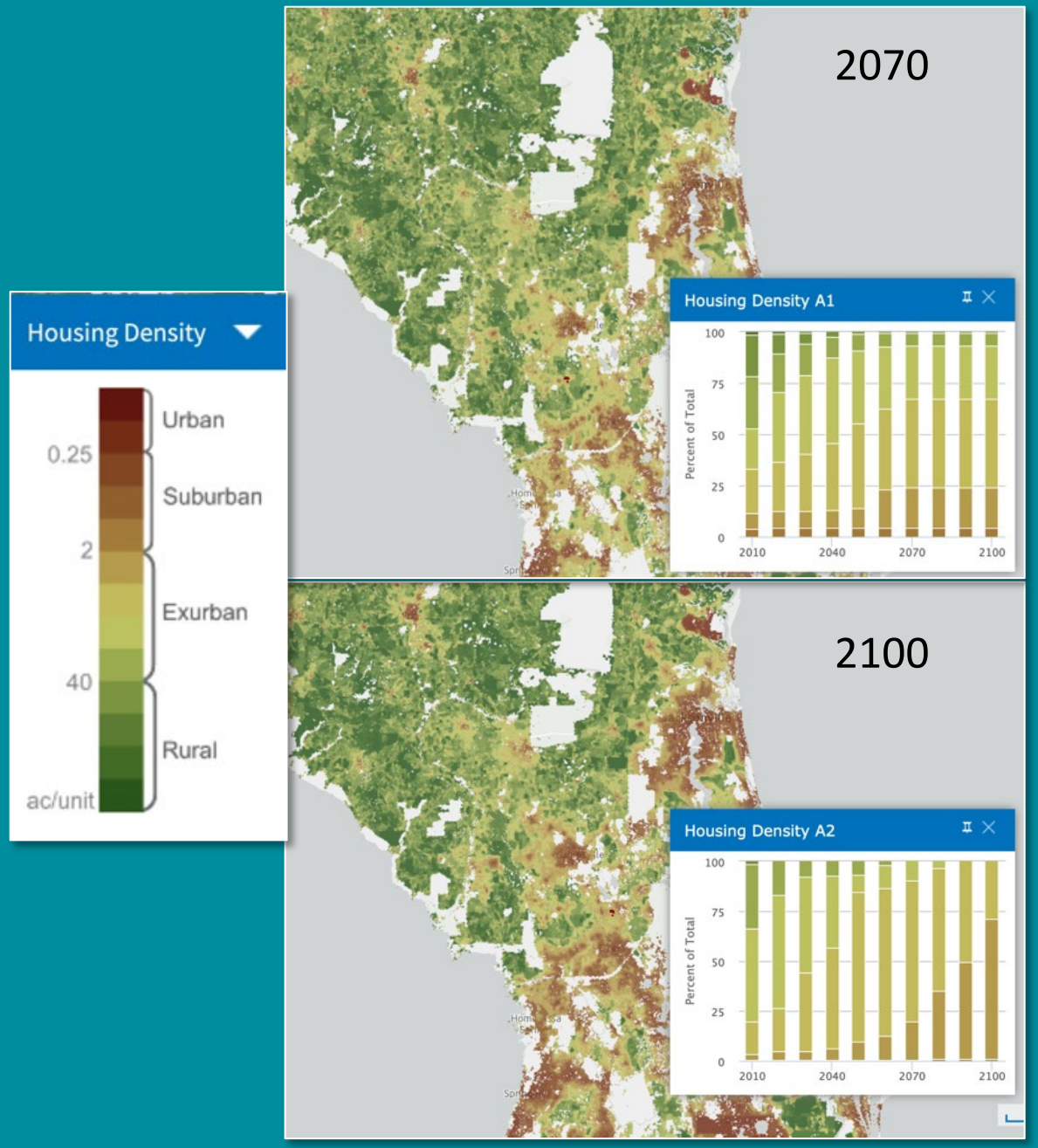
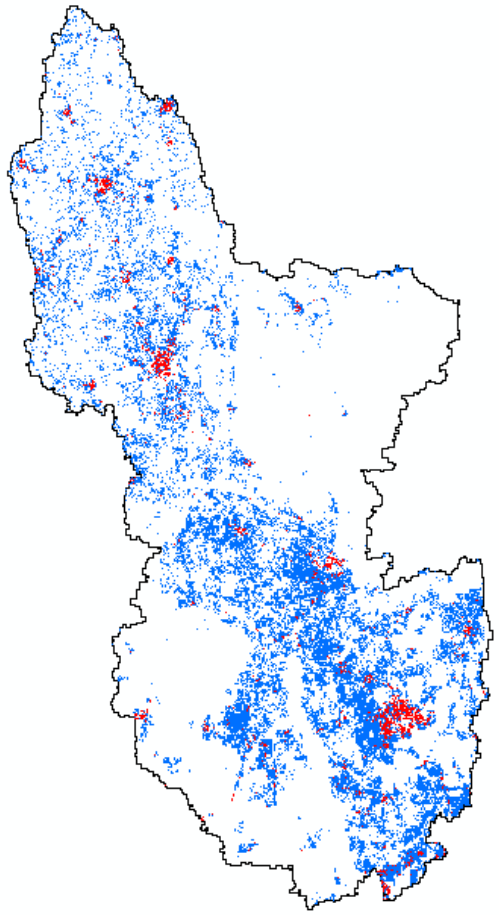
- Based on ICLUS (EPA Model)



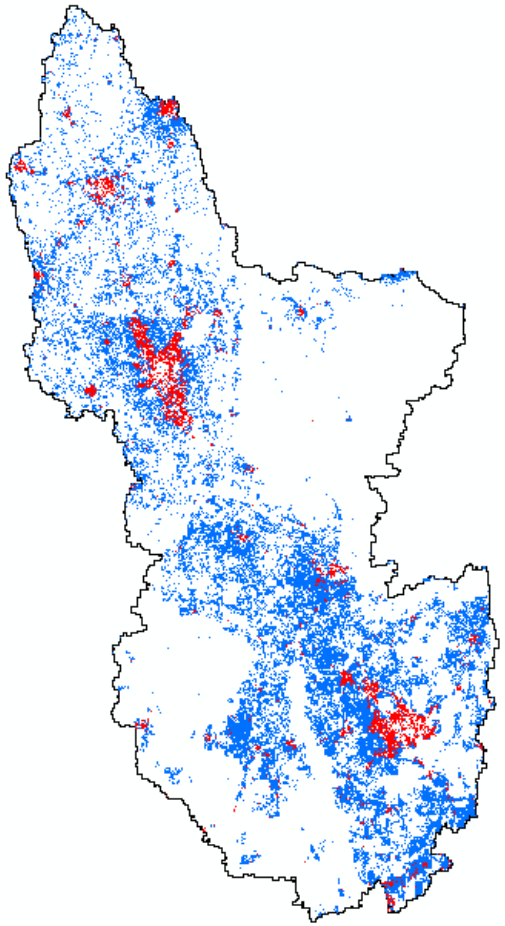
Six Land-Use Scenarios

Current Conditions



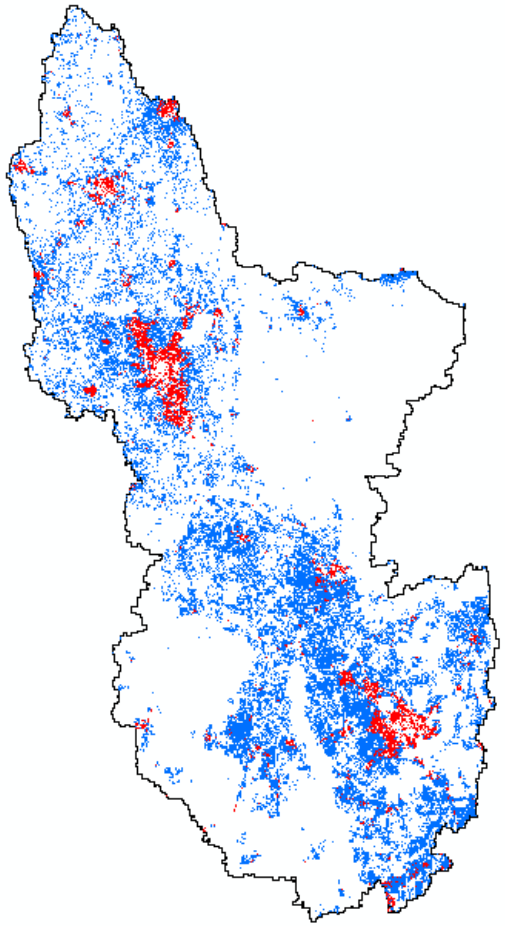
2010 pop.: 850955
Urban pop: 472050 (483 km2)
Rural pop: 378904 (5586 km2)

Urban Expansion 2070



2070 pop.: 1429972
Urban pop : 995923 (870 km2)
Rural pop : 434049 (6127 km2)

Urban Expansion 2100

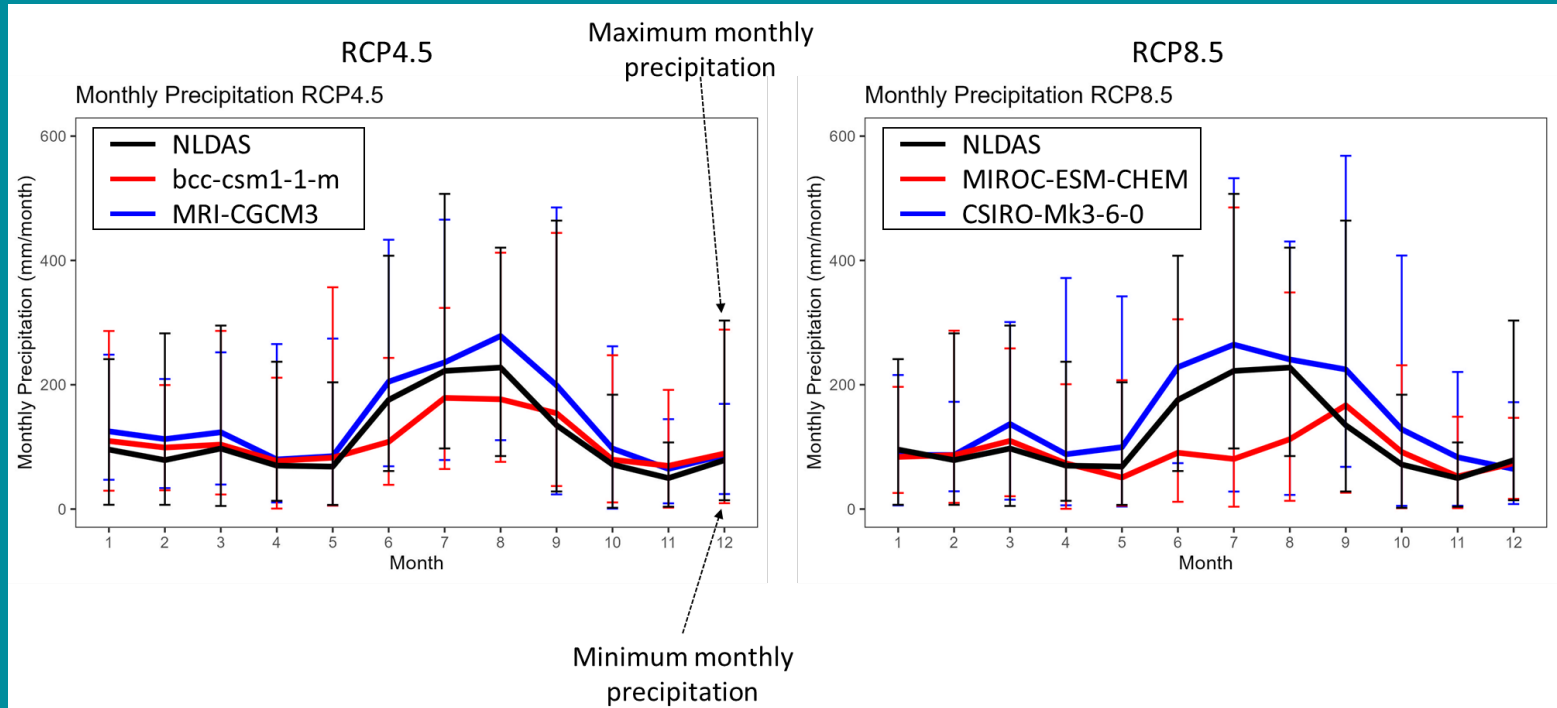


2100 pop.: 1618030
Urban pop : 1181463 (948 km2)
Rural pop: 436566 (6215 km2)

Six Land-Uses **X** **Five Climates** = 30 Scenarios

- **"Baseline"** – historical climate (1997-2020)
- Four future climates (2070-2094; RCP4.5 and RCP8.5)
  - **"Hot/Dry"** – BCC-CSM1-1-m
  - **"Hot/Wet"** – MRI-CGCM3
  - **"Hotter/Drier"** – MIROC-ESM-CHEM
  - **"Hotter/Wetter"** – CSIRO-Mk3-6-0

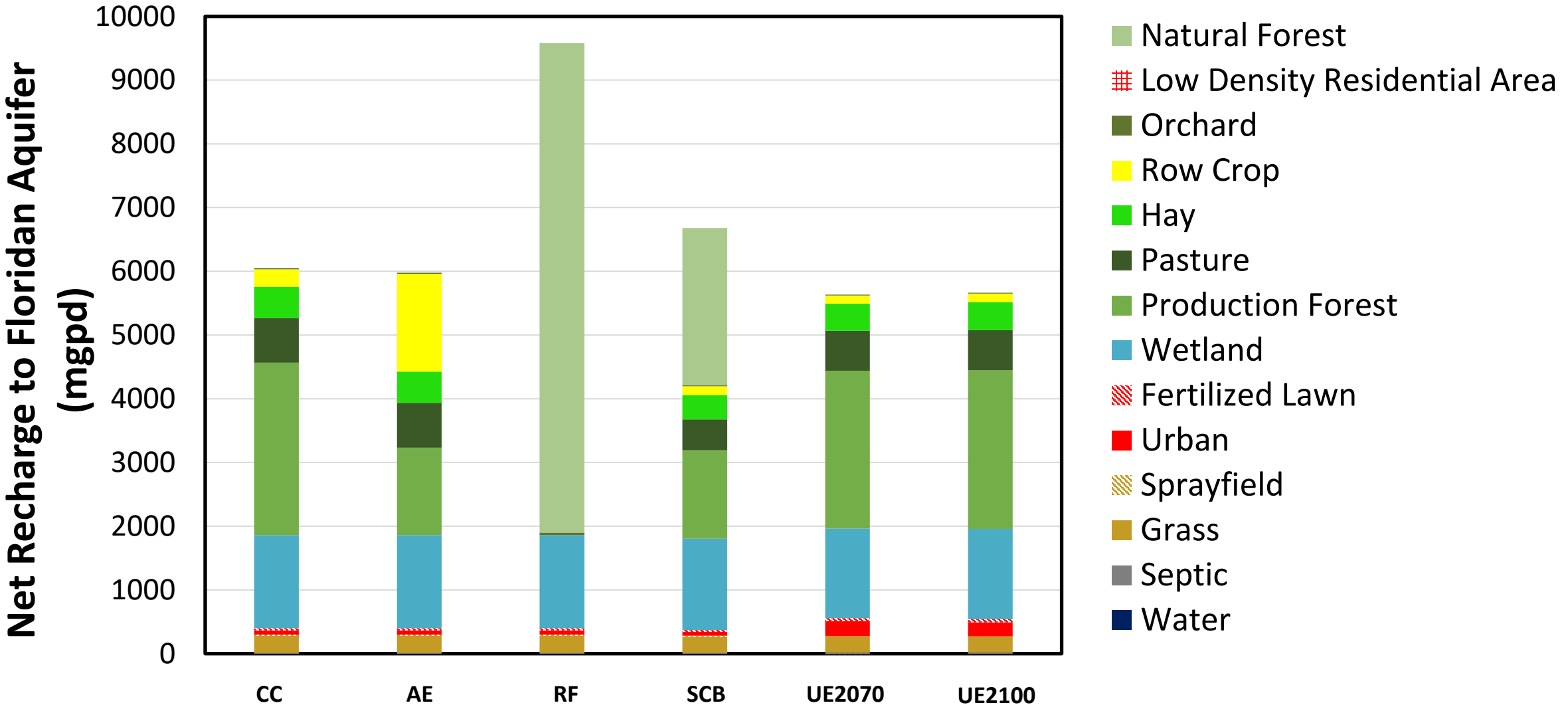
Downscaled GCMs	Annual Rainfall (in)
MIROC-ESM-CHEM (hotter/drier) – RCP8.5	41.5
bcc-csm1-1-m (hot/dry) – RCP4.5	49.8
NLDAS ("Baseline")	51.7
MRI-CGCM3 (hot/wet) – RCP4.5	61.0
CSIRO-Mk3-6-0 (hotter/wetter) – RCP8.5	61.5



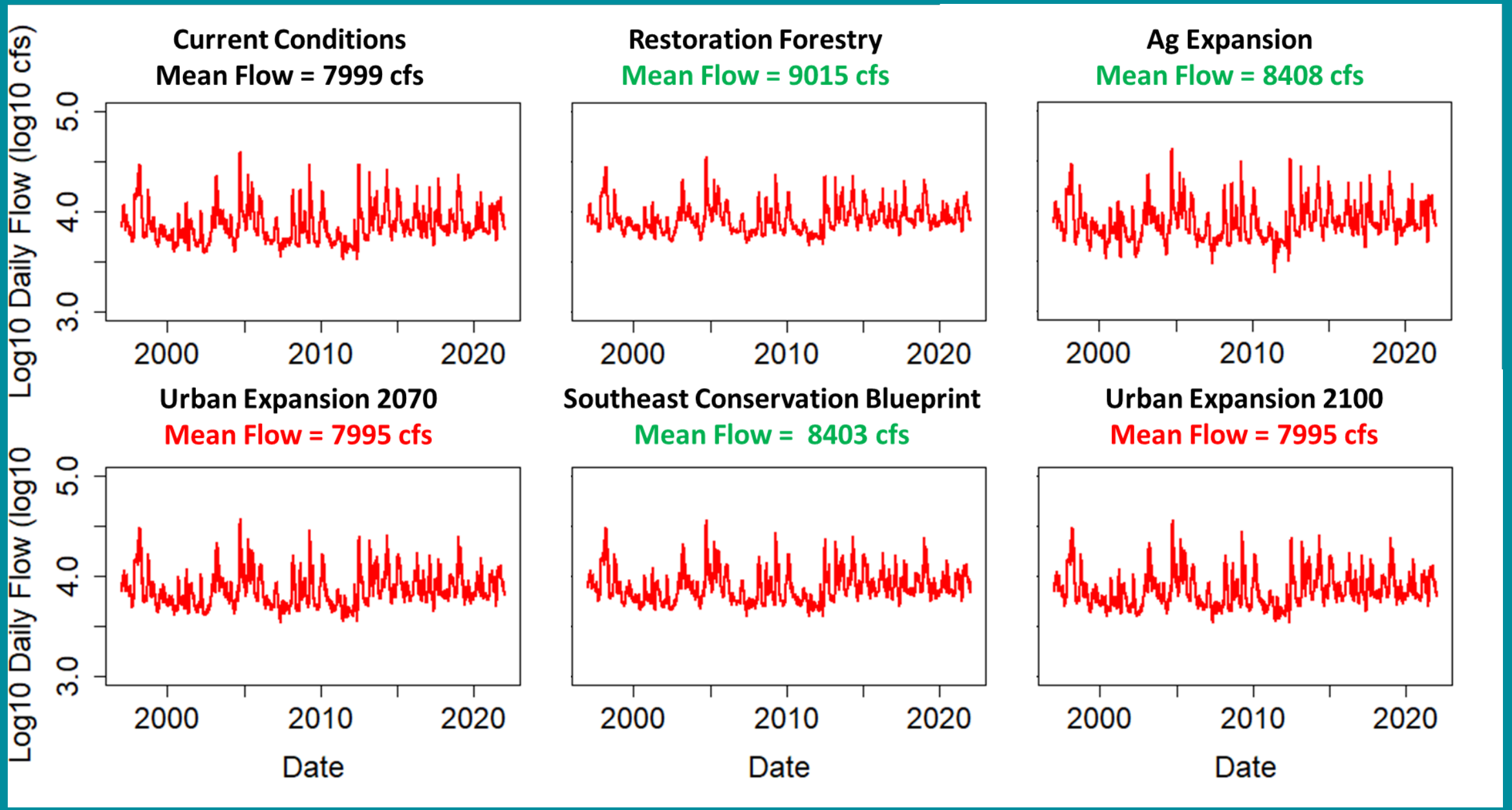
Results…


Area (m²)
Nitrate Load (ton N/year)
Net Recharge (million gallons per day)
CC_hist
CC_bcc
CC_mri
CC_miroc
CC_csiro
AE_hist
AE_bcc
AE_mri
AE_miroc
AE_csiro
RF_hist
RF_bcc
RF_mri
RF_miroc
RF_csiro
PFA_hist
PFA_bcc
PFA_mri
PFA_miroc
PFA_csiro
UE_2070_hist
UE_2070_bcc
UE_2070_mri
UE_2070_miroc
UE_2070_csiro
UE_2100_hist
UE_2100_bcc
UE_2100_mri
UE_2100_miroc
UE_2100_csiro
Natural Forest
Low Density Residential Area
Orchard
Row Crop
Hay
Pasture
Production Forest
Wetland
Fertilized Lawn
Urban
Sprayfield
Grass
Septic
Water

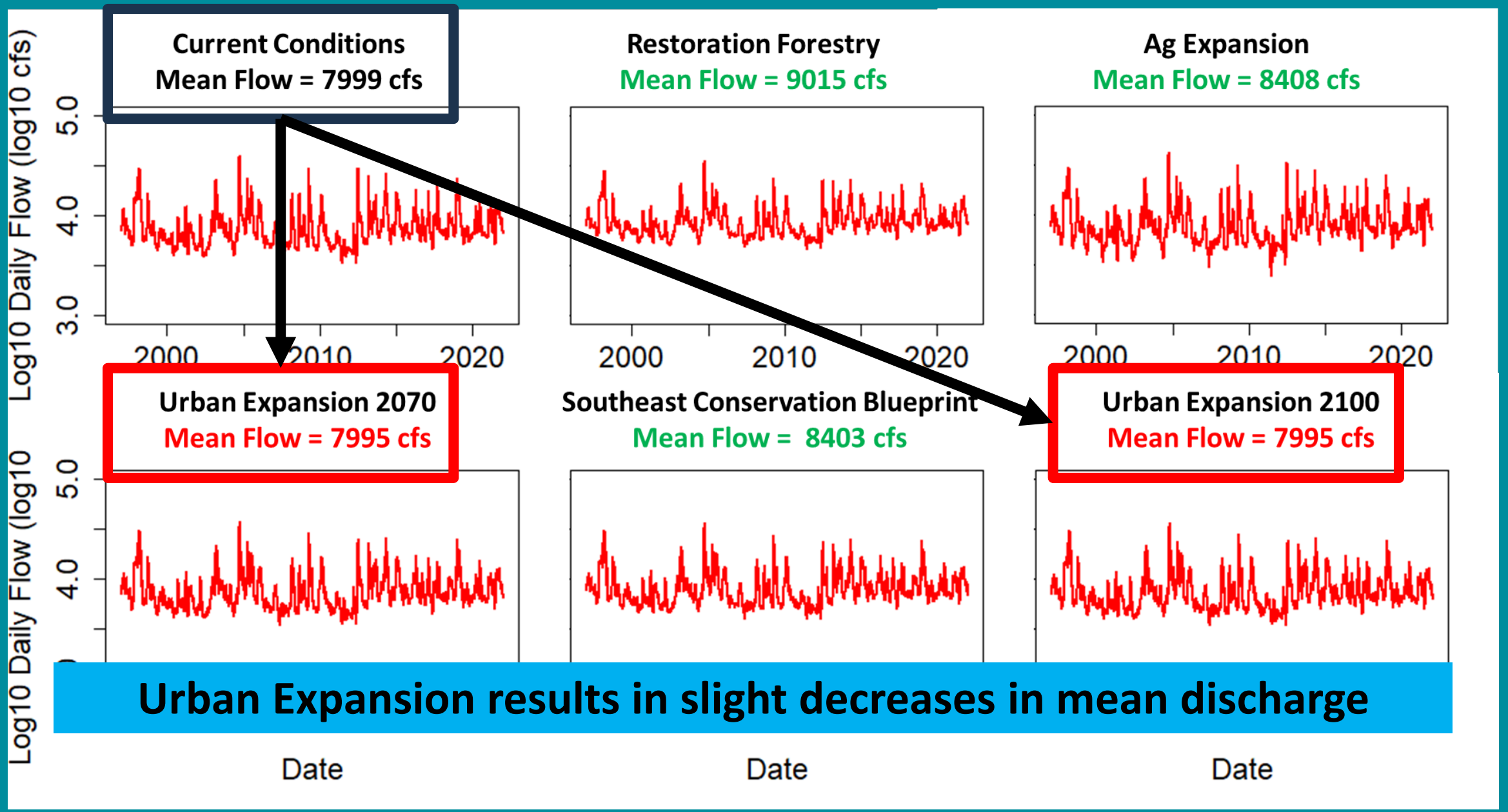
Results – Land Use Impacts – Aquifer Recharge



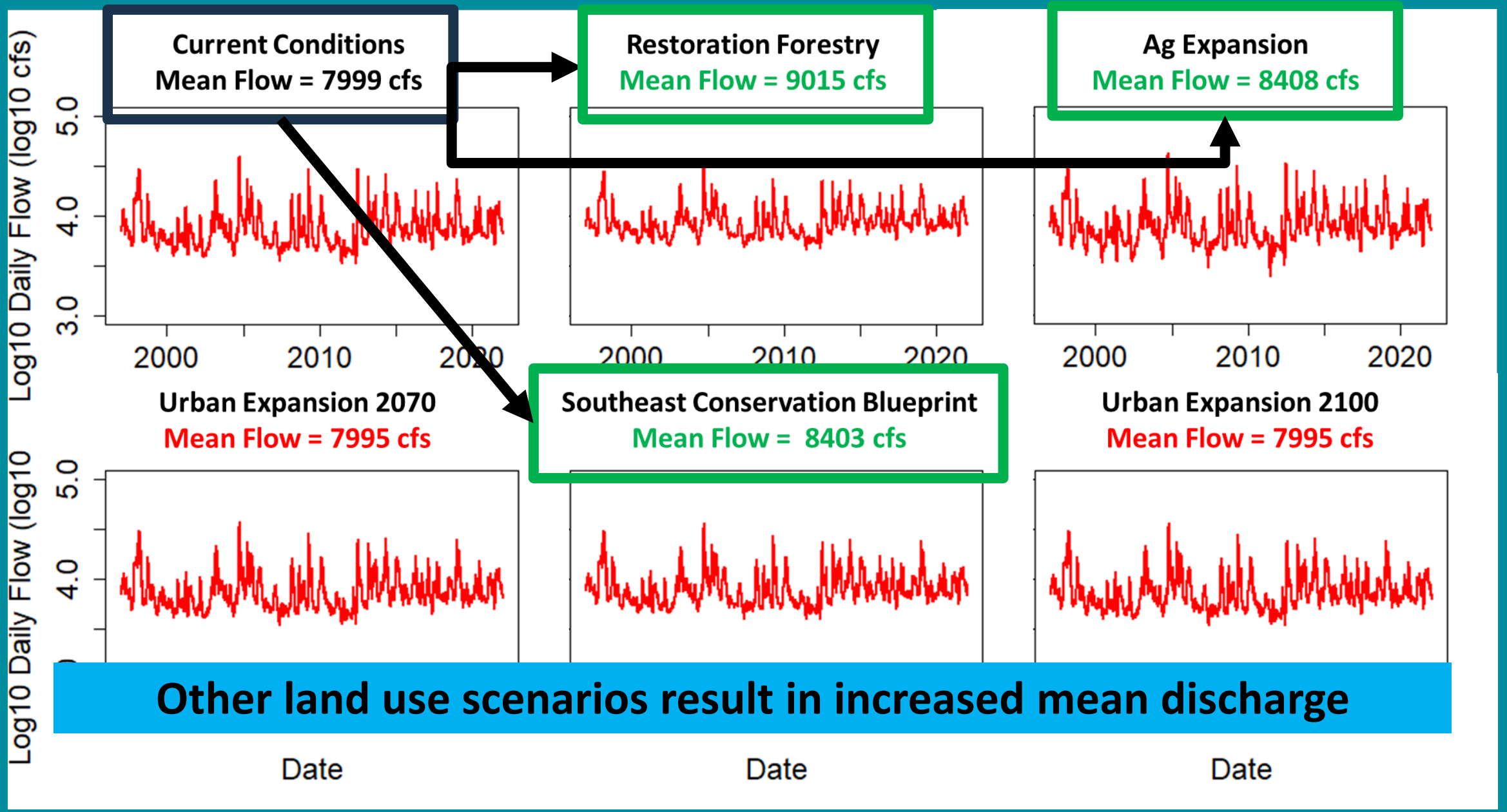
Results – Land Use Impacts – River Discharge



Results – Land Use Impacts – River Discharge

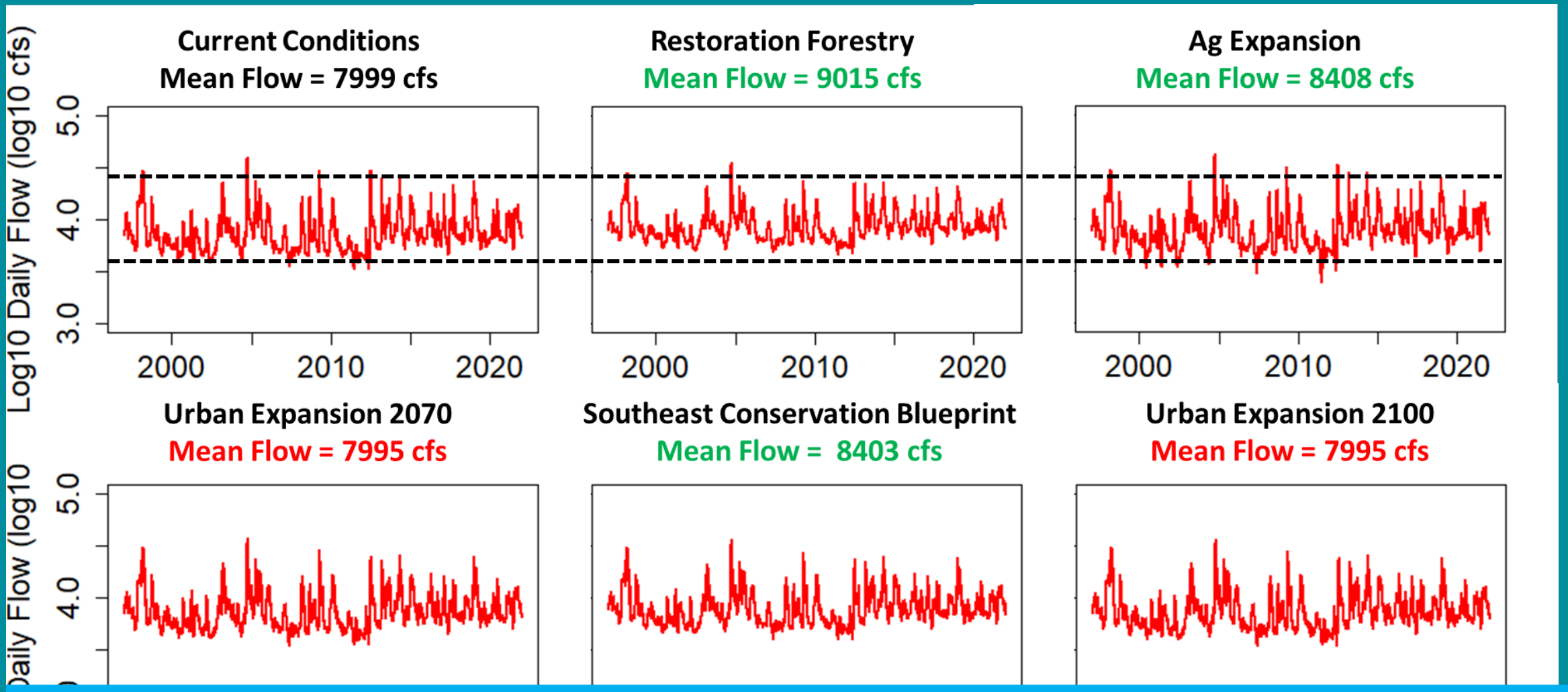


Results – Land Use Impacts – River Discharge



Other land use scenarios result in increased mean discharge

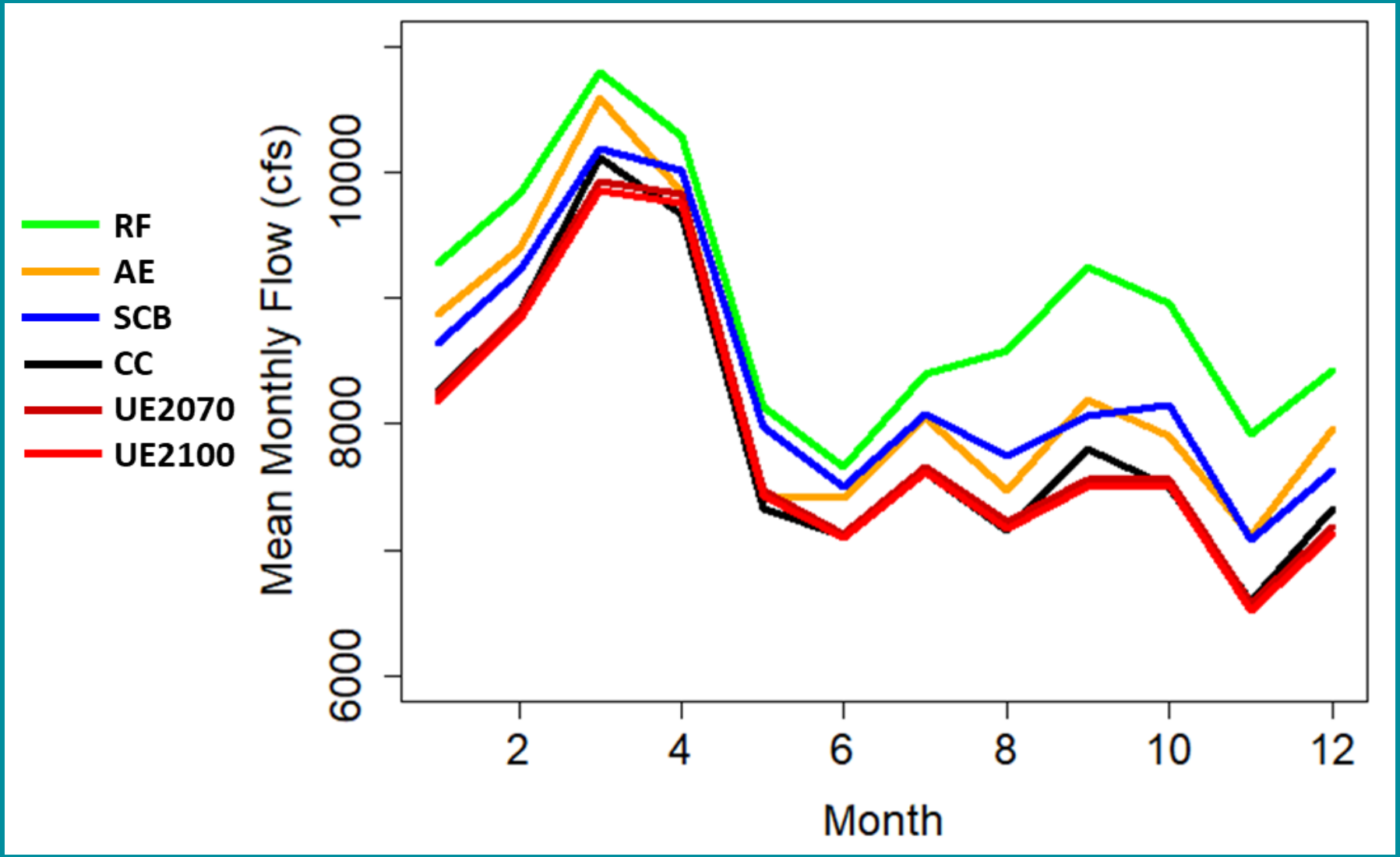
Results – Land Use Impacts – River Discharge



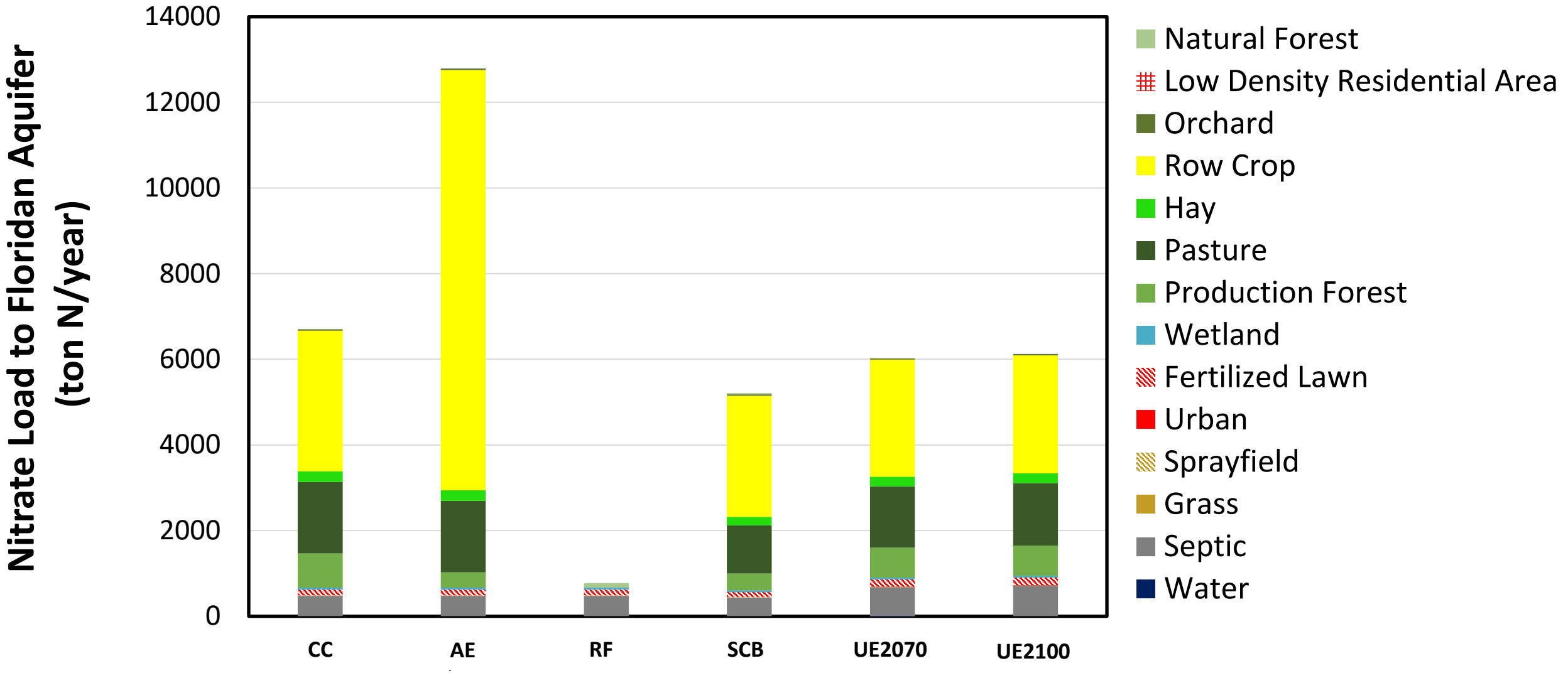
-Restoring low density longleaf increases baseflow and reduces high flows

-Agricultural expansion increases high flows and decreases low flows

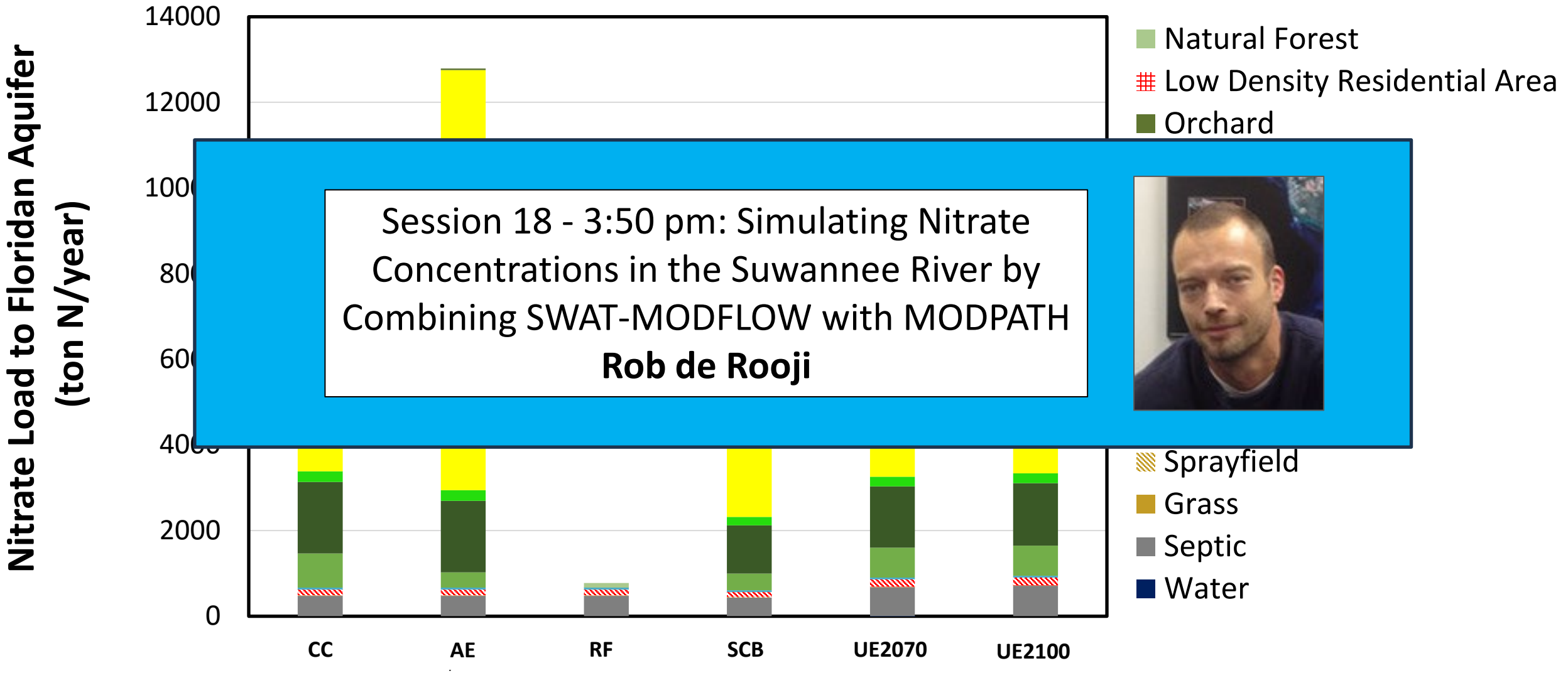
Results – Land Use Impacts – River Discharge Seasonal Patterns



Results – Land Use Impacts – Water Quality



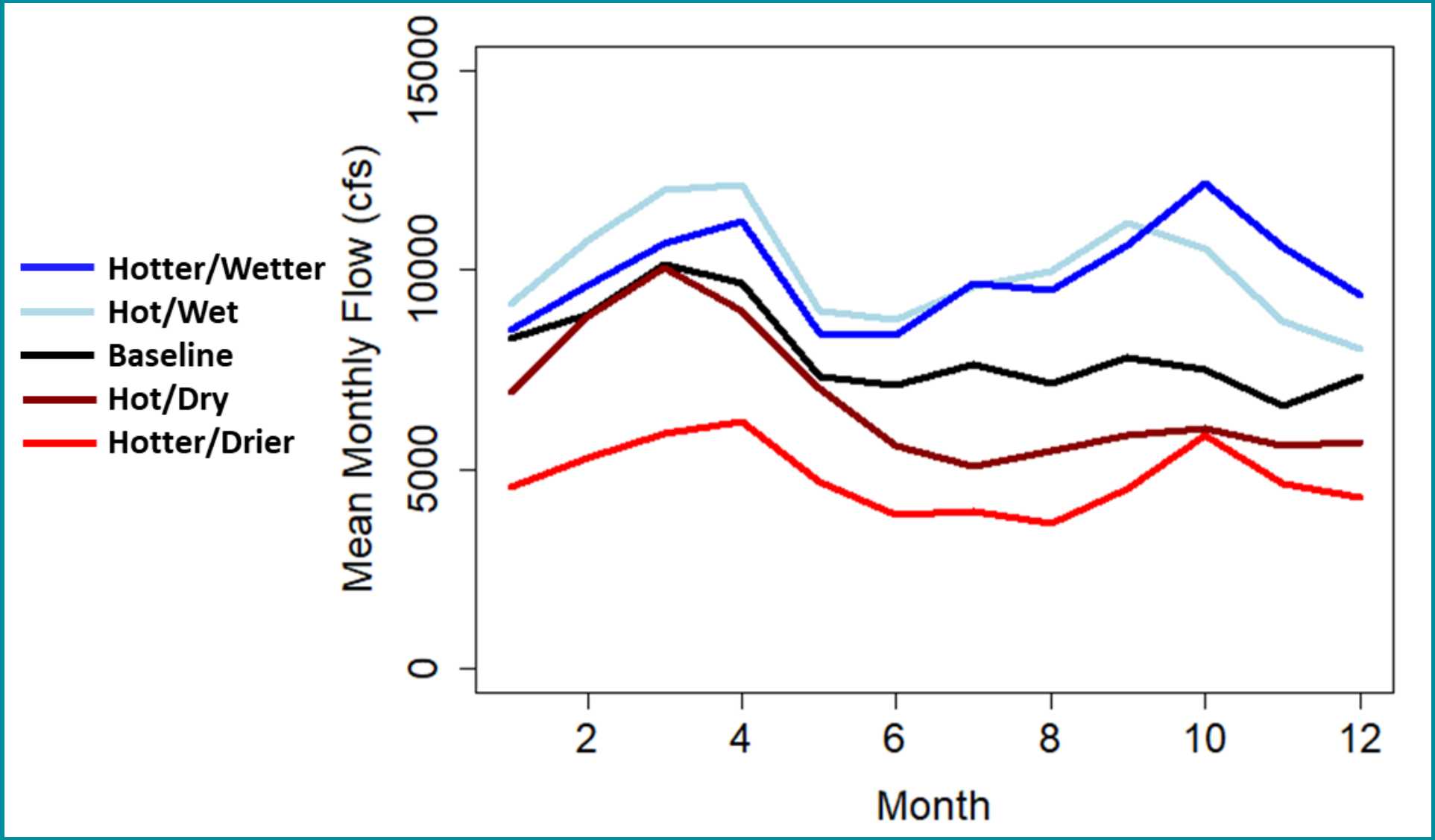
Results – Land Use Impacts – Water Quality



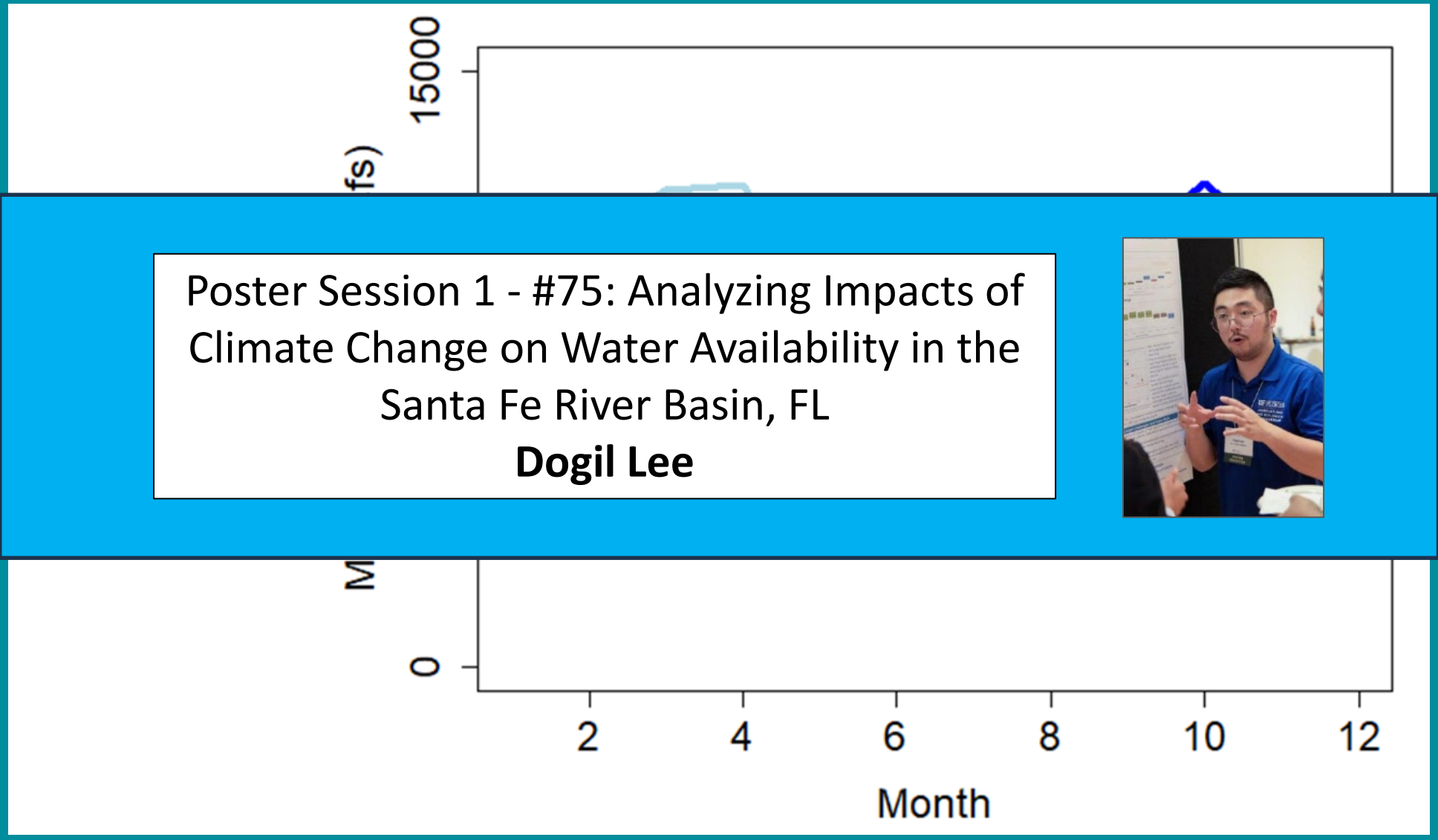
Session 18 - 3:50 pm: Simulating Nitrate Concentrations in the Suwannee River by Combining SWAT-MODFLOW with MODPATH

Rob de Rooji

Results – Climate Impacts – River Discharge Seasonal Patterns



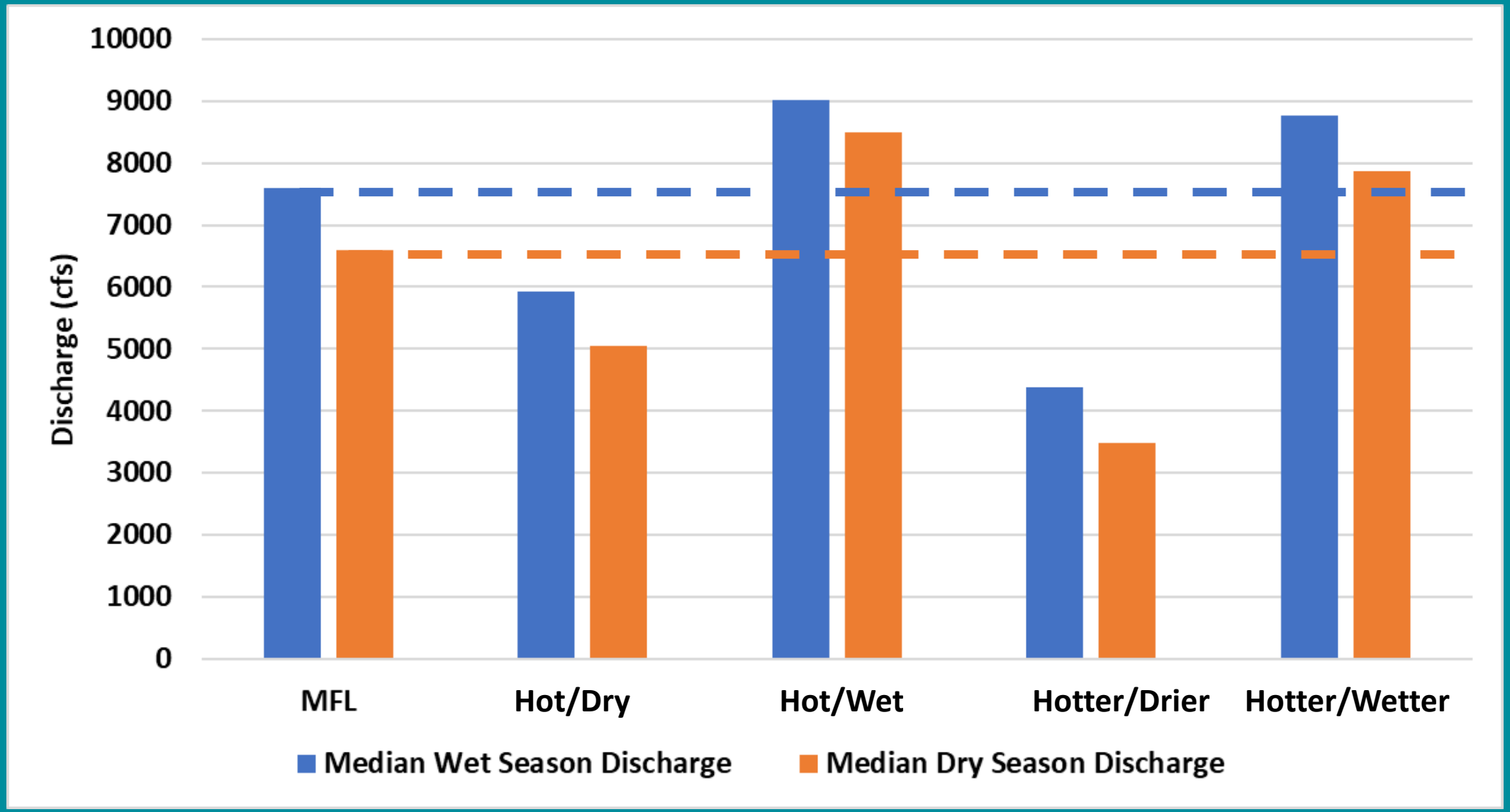
Results – Climate Impacts – River Discharge Seasonal Patterns



Poster Session 1 - #75: Analyzing Impacts of Climate Change on Water Availability in the Santa Fe River Basin, FL

Dogil Lee

Results – Climate Impacts - Lower Suwannee MFL



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Summary

- Developed landscape hydrological model for Suwannee River
- Co-developed climate and land-use scenarios with stakeholders
- Climate is dominant driver of water quantity
- Land use is dominant driver of water quality
- Land use impacts flow characteristics (e.g., magnitude of low and high flows)
- Large uncertainty in climate outcomes for the basin

Thank you for you attention!

UF/IFAS Public Issues Education (PIE) Center project page

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Image by Dr. Elliott White Jr.