FACETS: Floridan Aquifer Collaborative Modeling for Sustainable Management

Presentation by Kristin Rowles to ACF Waters Conference, April 28, 2022

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FACETS

Floridan Aquifer Collaborative Engagement for Sustainability

Brings together scientists and stakeholders to:

´ develop new knowledge needed to explore tradeoffs and synergies between the regional agricultural economy and environmental quality;

´ understand changes needed to achieve agricultural water security and environmental protection; and

´ develop tools, incentives and educational programs for improved decision making

The Floridan Aquifer

- **~10 million people** depend on Upper Floridan Aquifer (UFA) for water
- **~$9B in agriculture**-related economic activity; corn, cotton, peanuts, timber
- Among largest & most productive aquifers; **vital *regional* resource**
- **Many uses** – sometimes competing: urban, agriculture, forestry, & environmental water uses
- **Unique aquatic ecosystems**

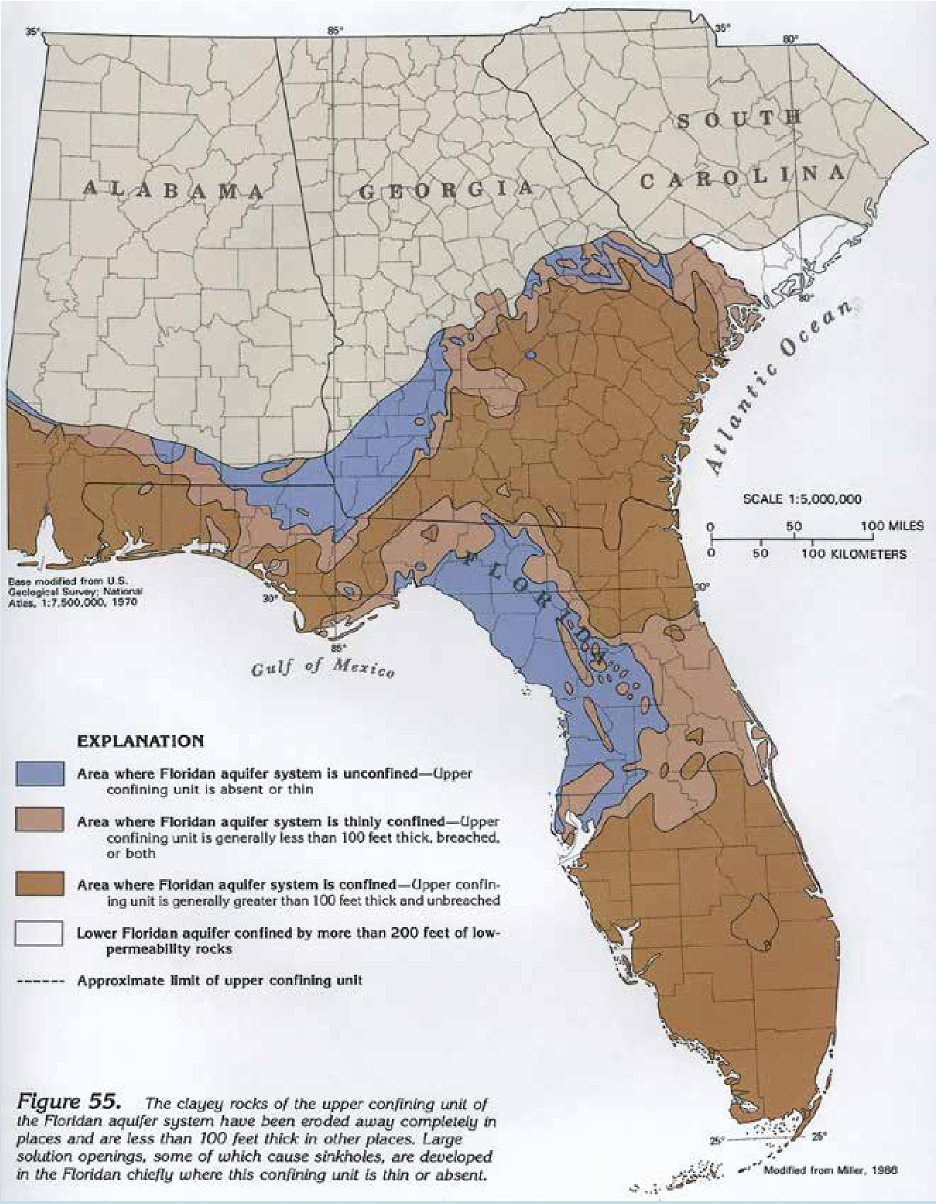
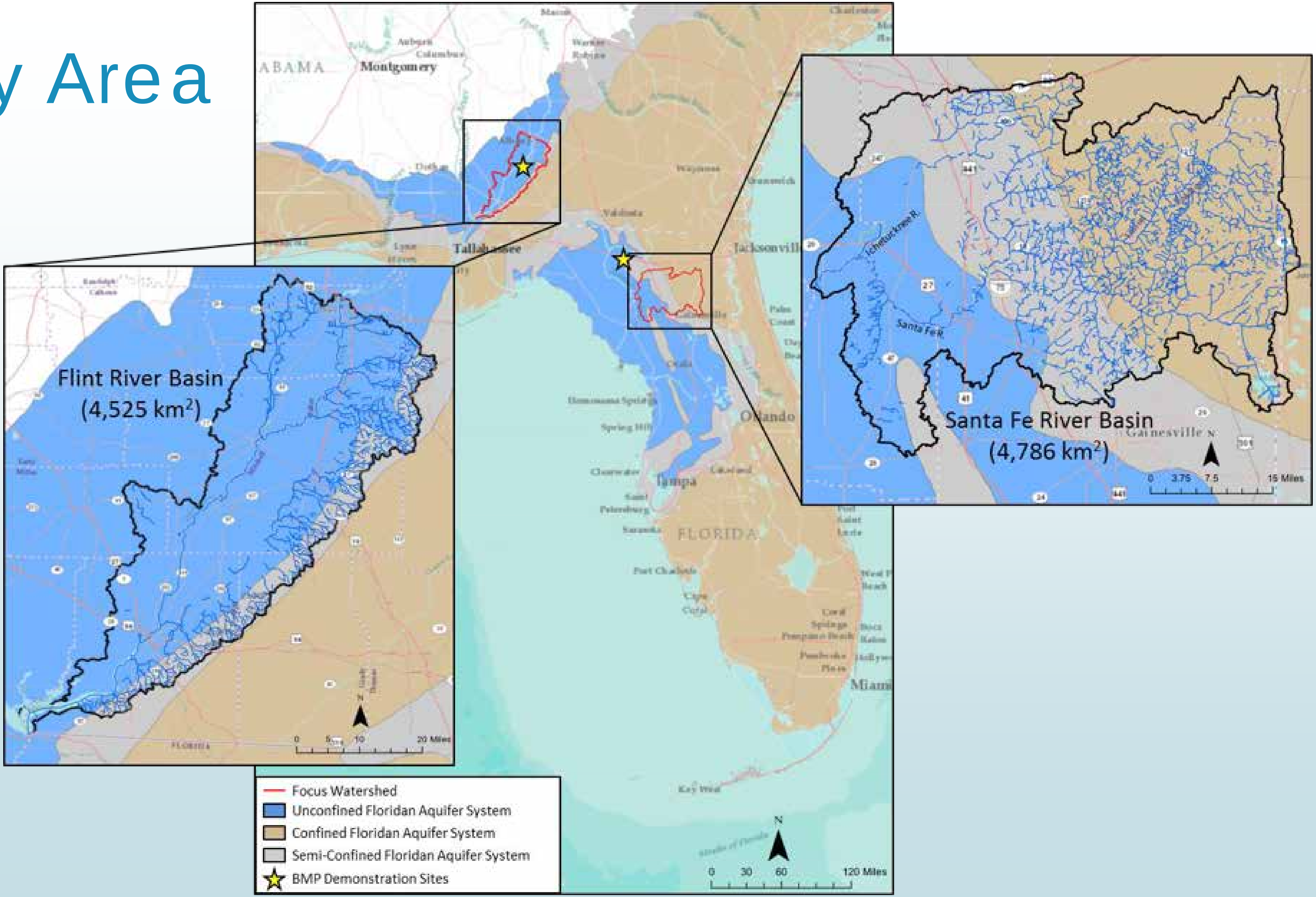


Figure 55. The clayey rocks of the upper confining unit of the Floridan aquifer system have been eroded away completely in places and are less than 100 feet thick in other places. Large solution openings, some of which cause sinkholes, are developed in the Floridan chiefly where this confining unit is thin or absent.

- Increasing **water use**
- Reduced **spring and river flows**
- Increases in **nitrate concentration** in surface and groundwater
- **In the context of** climate variability, environmental standards, history of interstate conflict

Study Area

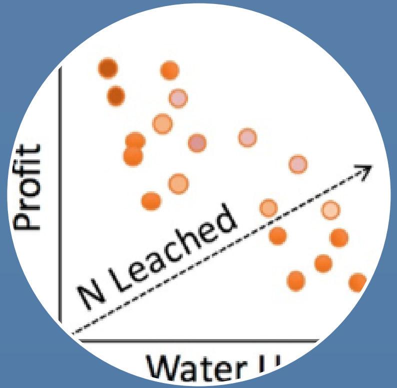


Flint River Basin
(4,525 km²)
Santa Fe River Basin
(4,786 km²)
Santa Fe R.
Focus Watershed
Unconfined Floridan Aquifer System
Confined Floridan Aquifer System
Semi-Confined Floridan Aquifer System
BMP Demonstration Sites
Montgomery
Tallahassee
Jacksonville
Orlando
Tampa
FLORIDA
Miami
0 30 60 120 Miles
0 5 10 20 Miles
0 3.75 7.5 15 Miles

PROJECT ACTIVITIES AND OUTPUTS

BMP Research

- Water use, quality, yield impacts of alternative irrigation & nutrient practices
- Digital decision toolkit



Modeling Platform

- Land use/mgmt. impacts on water quantity/quality, crop/forest production and regional economy
- BMP supply and demand curves

Stakeholder Engagement

- Baseline & future scenarios
- Tradeoffs & synergies
- Social Learning
- Communication tools

Extension

- On-farm BMP demos
- In-Service Training programs
- Water Schools (Georgia: June 2022)

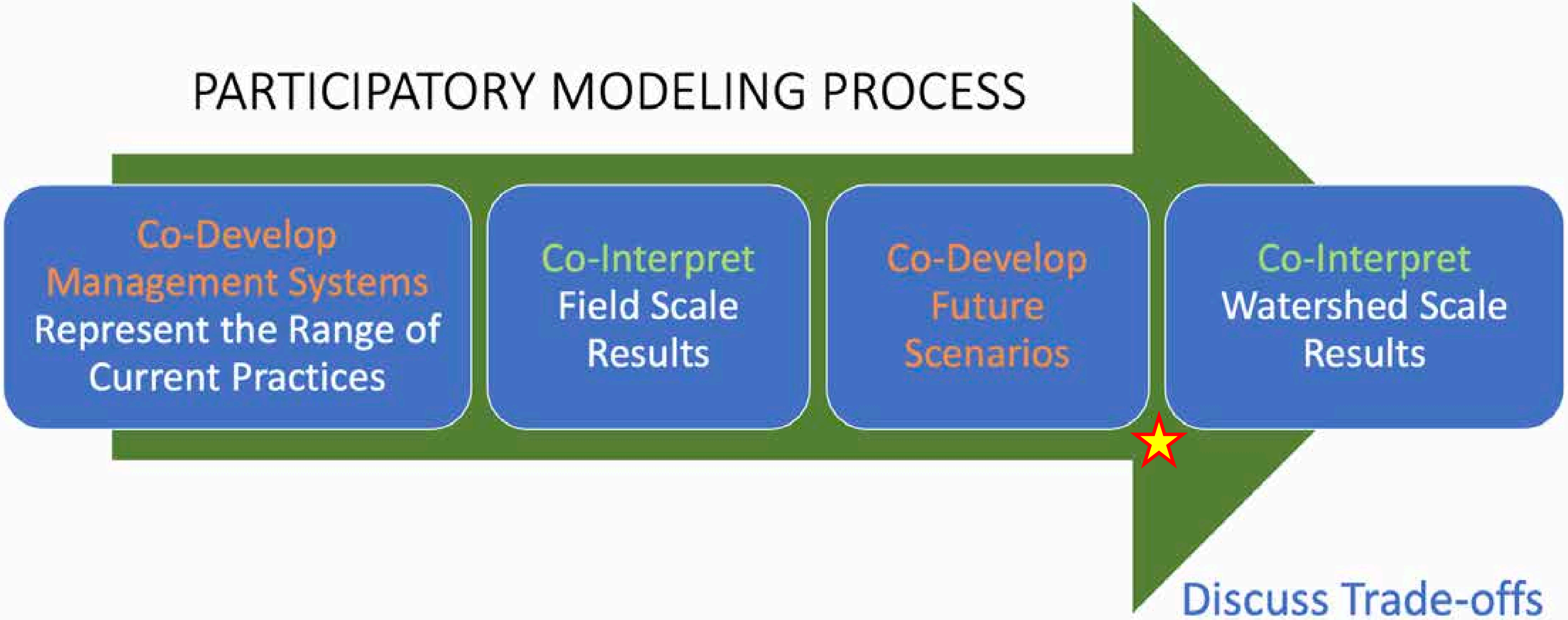
collaborative research and Extension

Participatory Modeling Process (PMP)

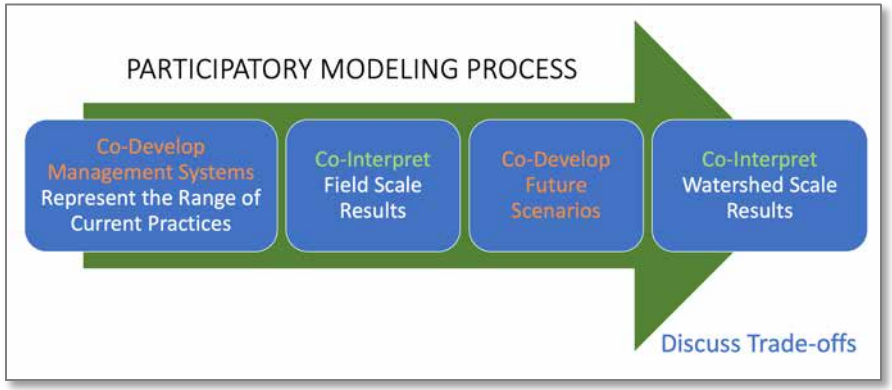
PARTICIPATORY MODELING PROCESS (PMP) STAKEHOLDER MEMBERS

Lesley Bertolotti, The Nature Conservancy	**Perri Campis**, Flint River Soil & Water Conservation District
Kirk Brock, Brock Farms	**Chase Cook**, UGA Sustainable Forestry Initiative
Jason Chandler, Grimmway Farms	**Michael Dooner**, Southern Forestry Consultants
Kevin Coyne , Florida Department of Environmental Protection	**Bert Earley**, Georgia Forestry Commission
Stacie Greco, Santa Fe Springs Protection Forum	**Steve Golladay**, Jones Ecological Center
Eric Handley, Usher Land and Timber, Inc.	**Sara Gottlieb**, The Nature Conservancy
Kathryn Holland, Florida Department of Agriculture and Consumer Services	**Connie Hobbs**, Baker County
Lucinda Merritt, Ichetucknee Alliance	**Elliott Jones**, Flint Riverkeeper
Dan Roach, Rayonier Inc	**Greg Murray**, Dollar Farm Products
Charles Shinn, Florida Farm Bureau Federation	**Mike Newberry**, Hillside Farms
Jacqui Sulek, Audubon	**Steve Sykes**, City of Thomasville, GA
Hugh Thomas, Suwannee River Water Management District	**Anna Truszczynski**, Georgia Environmental Protection Division

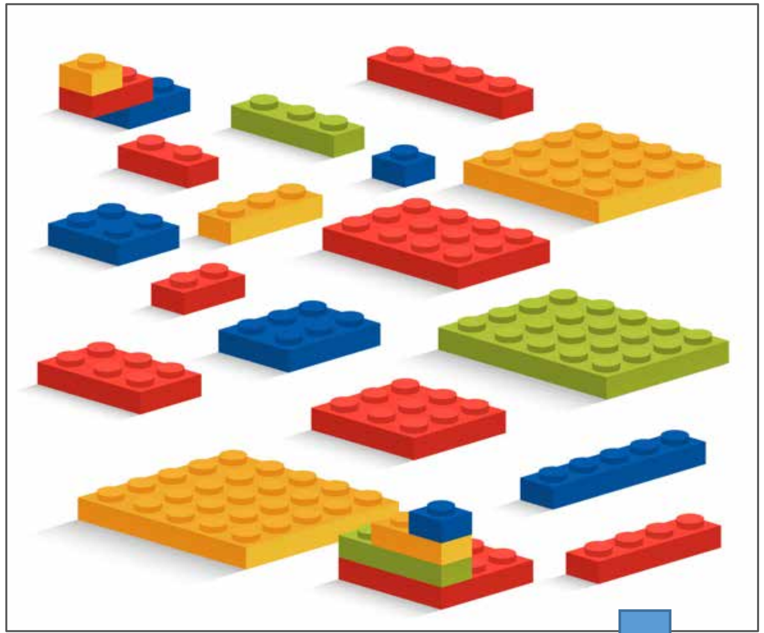
PARTICIPATORY MODELING PROCESS



Modeling at Two Scales



Field-Scale Models



Regional/Watershed-Scale Models

Model Input and Outputs

Inputs à "Levers or Scenarios"

- Cropping/forest systems (e.g., corn-fallow-peanut; slash pine plantation)
- Management systems (e.g., practices used for nutrient management, water management)
- Soil types
- Weather/climate data and scenarios

Field Scale Model Outputs

- Net returns ($)

- Yield

- Leached N
- Water use
- Net recharge

Watershed Scale Model Outputs

- Regional Economy

- Regional crop and forest production

- Aquifer/stream N concentrations
- Spring & stream flows
- Aquifer water levels

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Management Systems

Current Production Systems

CROPS
- Cotton-cotton-peanut
- Corn-cotton-peanut

FORESTS
- Longleaf
- Loblolly
- Slash pine

GEORGIA

Management System Summaries

Management Increases (Crops)

Management Increases (Forest)

Inputs Increase (All land uses)

	Crop	Forests
MS1	• SMS based irrigation • Lowest fertilization • Cover crops • Strip tillage	• No thinning • No fertilization • Longer rotation age • Lower initial planting density
MS2	• Checkbook irrigation • Medium N rate • No cover crops • Conventional tillage	• Thinning • Medium N rate • Medium rotation age
MS3	• Least efficient irrigation • Highest fertilization • No cover crops • Conventional tillage	• Thinning • Highest N rate • Shortest rotation age

Regional Model: Simple scenarios

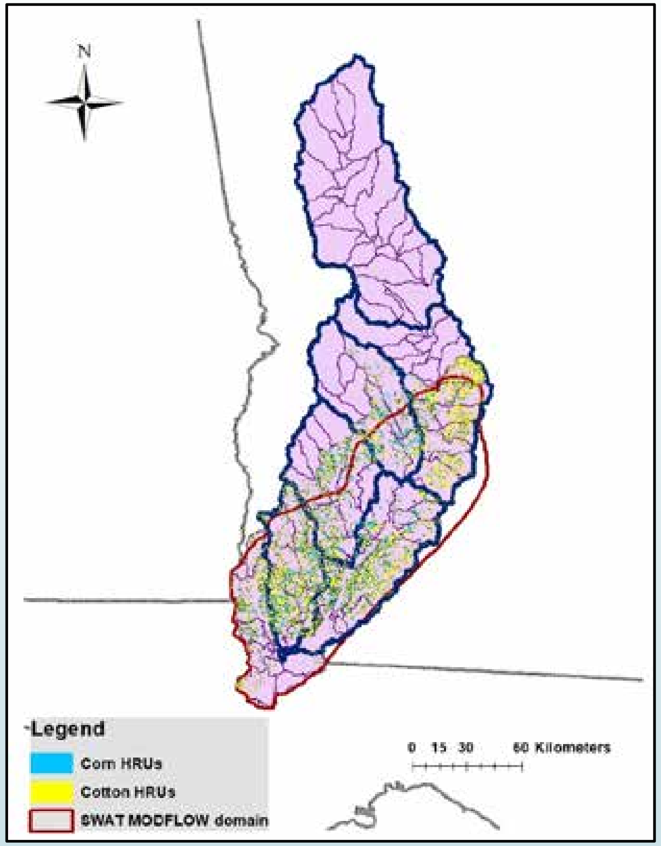
Scenario	Management Systems
All Ag MS1 **Row crops:** corn-cotton-peanut cotton-cotton-peanut **Forest:** Loblolly	All row crops use MS1, Forests MS1
All Ag MS2 **Row crops:** corn-cotton-peanut cotton-cotton-peanut **Forest:** Loblolly	All row crops use MS2, Forests MS1
All Ag MS3 **Row crops:** corn-cotton-peanut cotton-cotton-peanut **Forest:** Loblolly	All row crops use MS3, Forests MS1

GEORGIA

Findings: Aquifer pumping

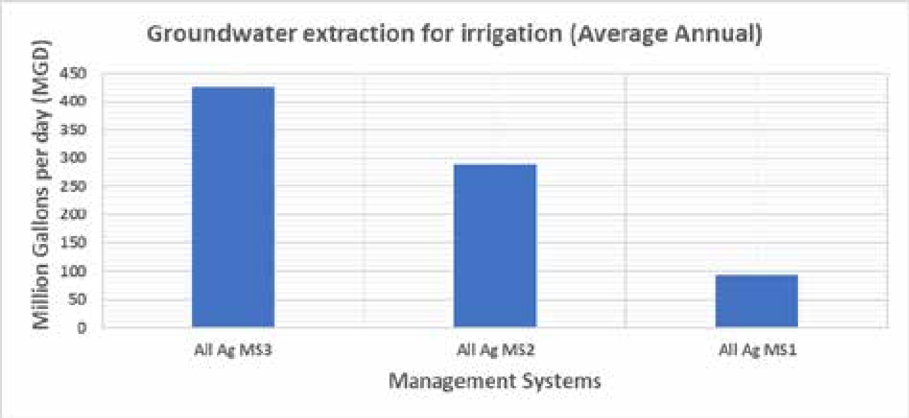
These FACETS results represent work in progress and are not suitable for public distribution.

Irrigated HRUs in the model



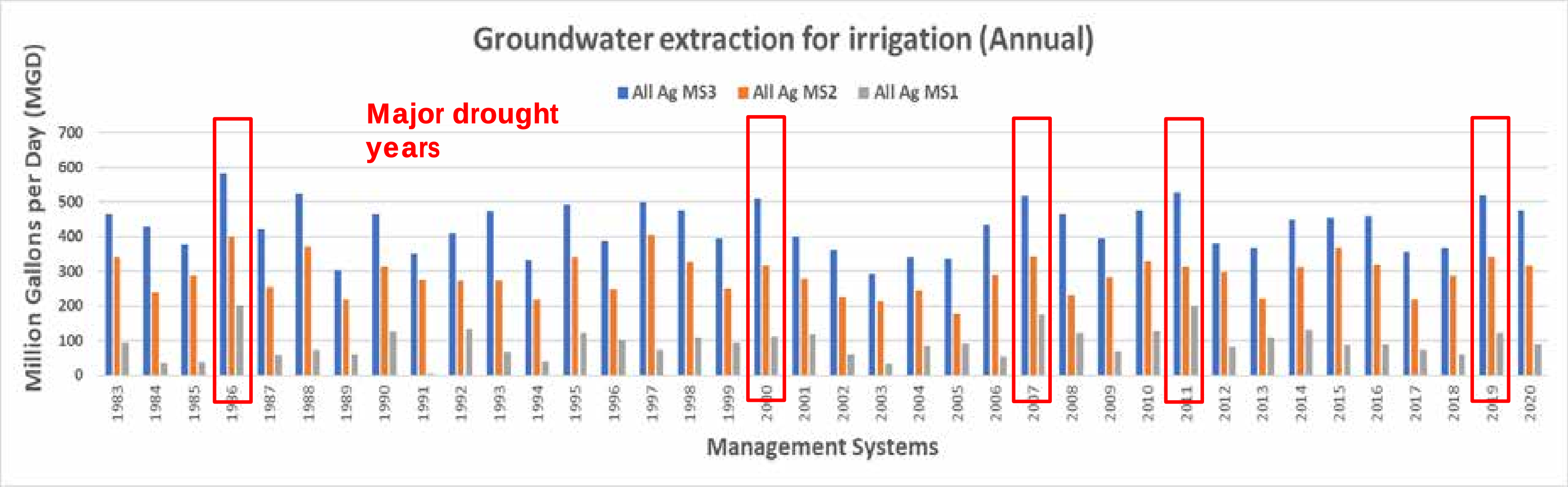
GEORGIA

Average annual pumping for irrigation from 1983 - 2020



Groundwater pumping ranged from ~100 MGD in All MS1 to > 400 MGD in All MS3

Pumping was over 500 MGD in major drought years in All MS3



Findings: Net recharge

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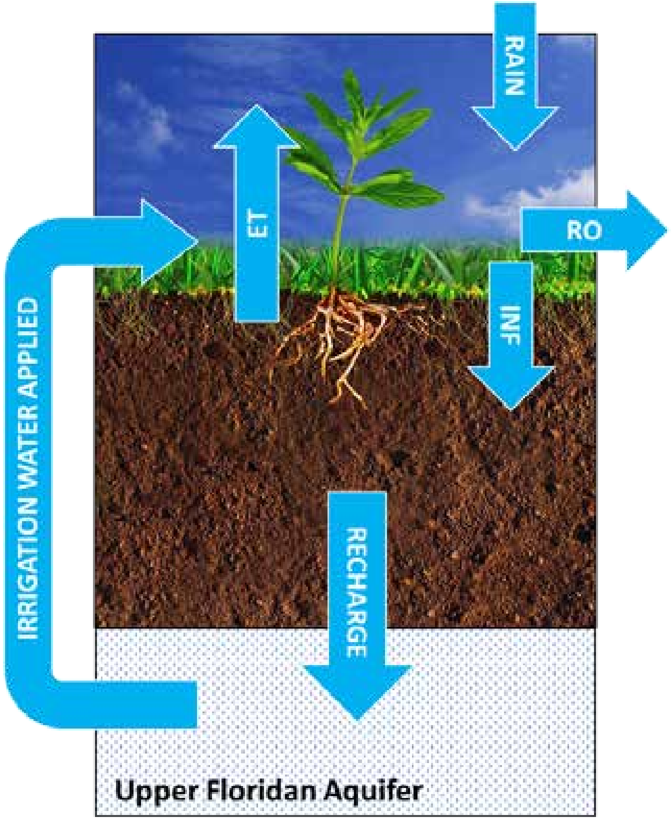
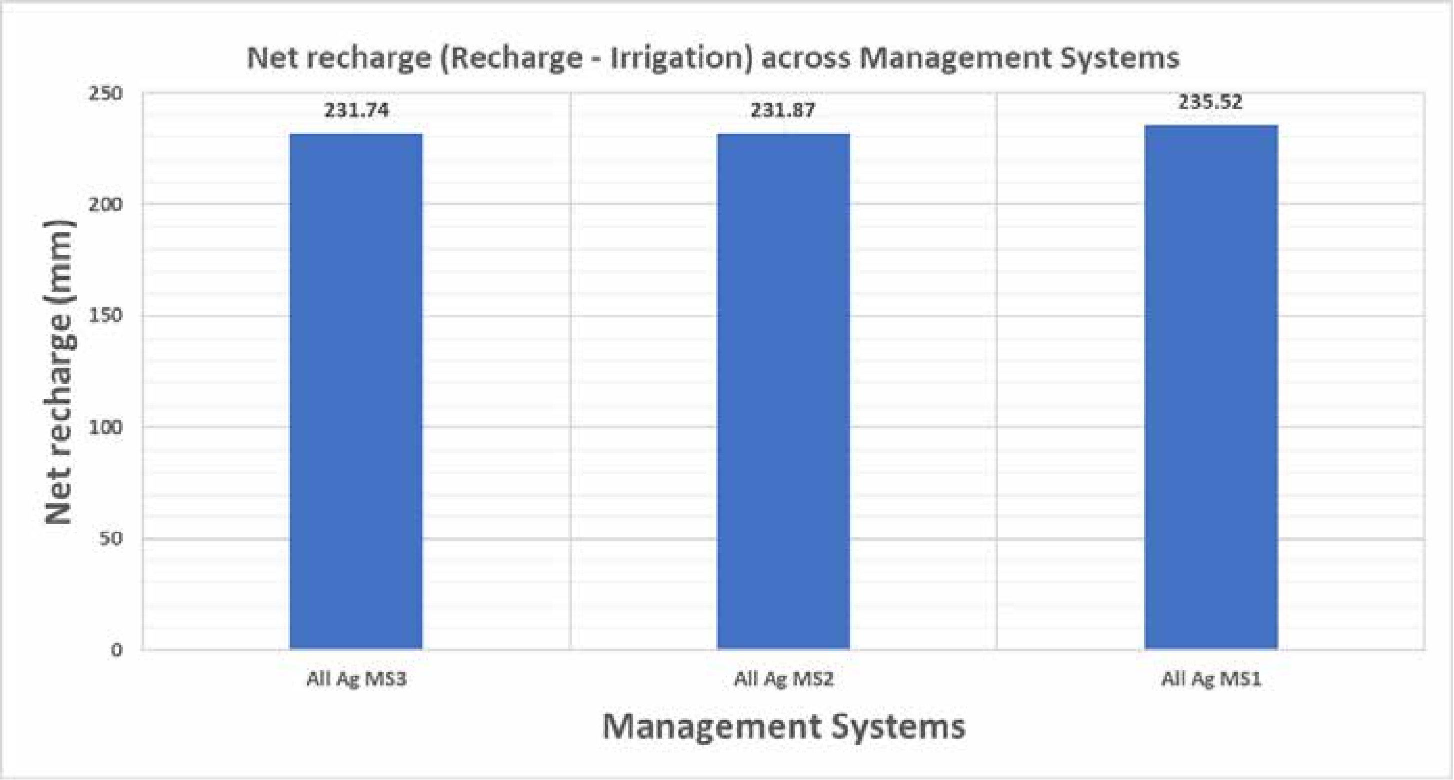
Net recharge = Recharge - Irrigation



Annual average net recharge was slightly higher for MS1

All Ag MS1 has lower irrigation but same precipitation as the other two scenarios



GEORGIA

Findings: Net recharge
(Spatial evaluation)

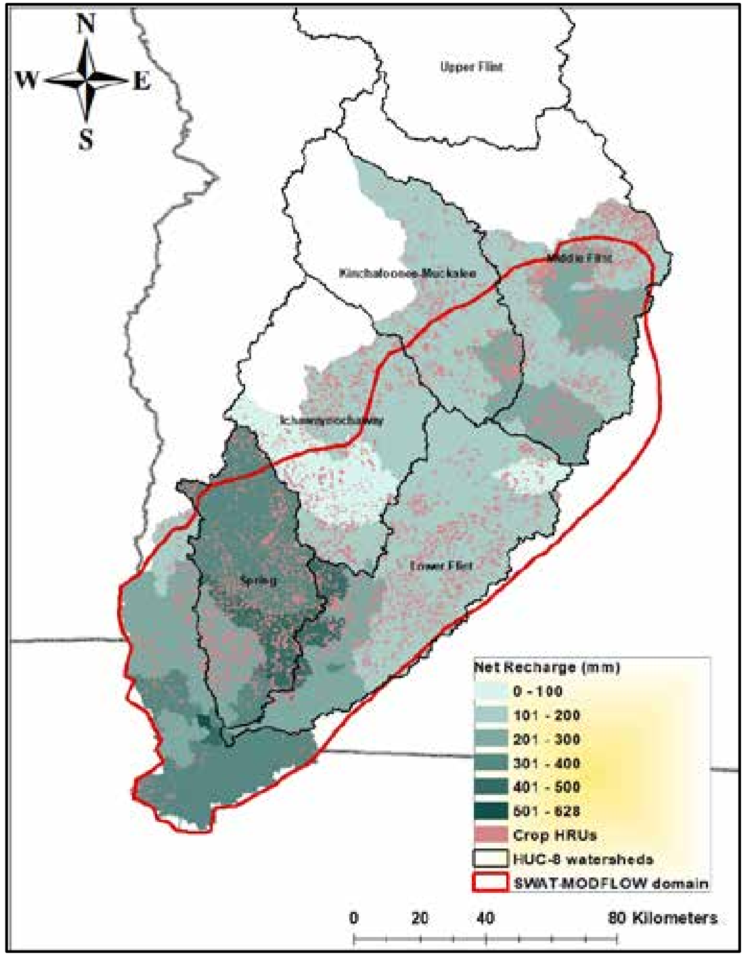
These FACETS results represent work in progress and are not suitable for public distribution.

GEORGIA

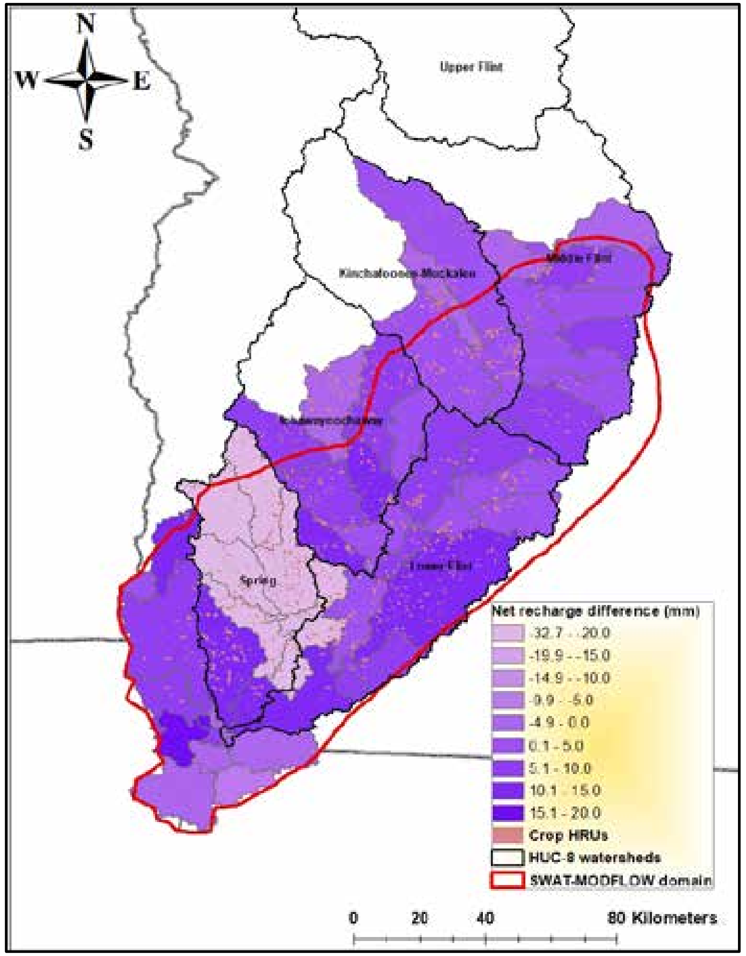
Although net recharge is similar for the whole basin, net recharge differs when evaluated spatially

Spring watershed seems to have a different trend than other watersheds in the study region

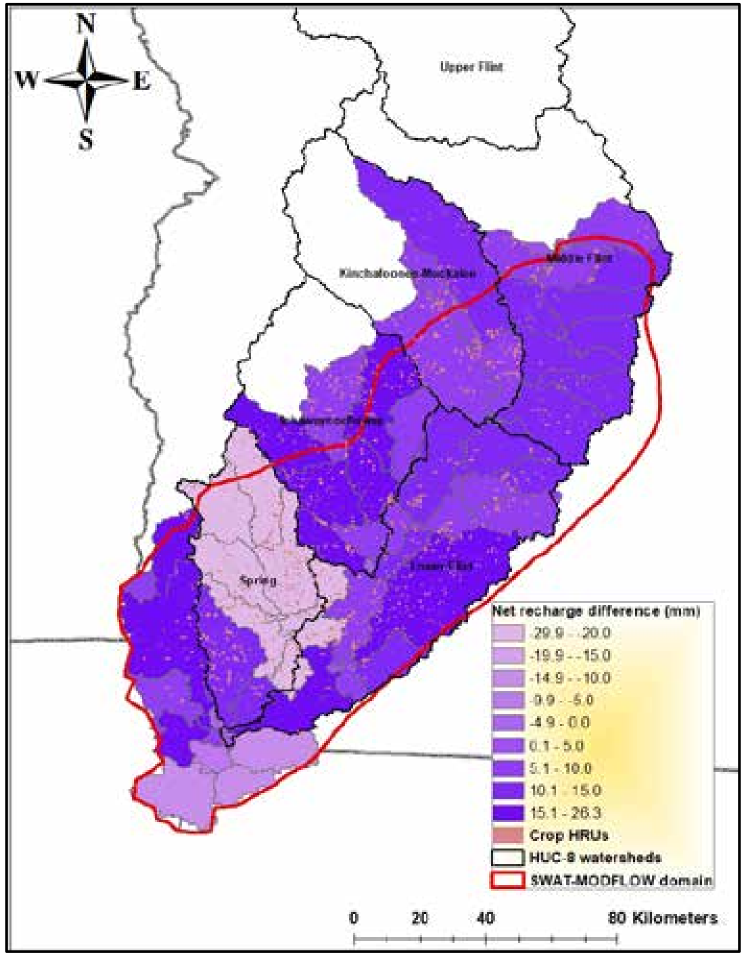
Net recharge (All Ag MS3)



Difference in net recharge (MS2 – MS3)



Difference in net recharge (MS1 – MS3)



Findings: Streamflow

Evaluating differences in drought years

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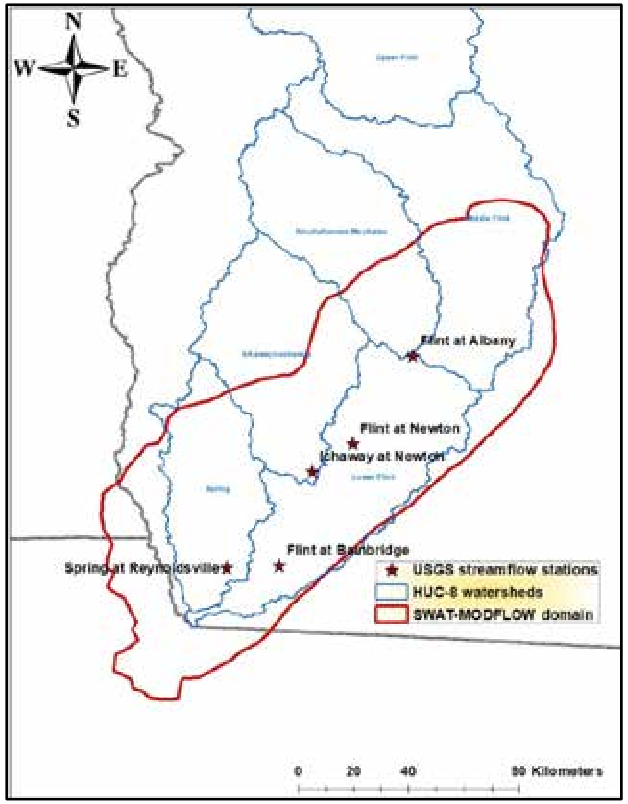
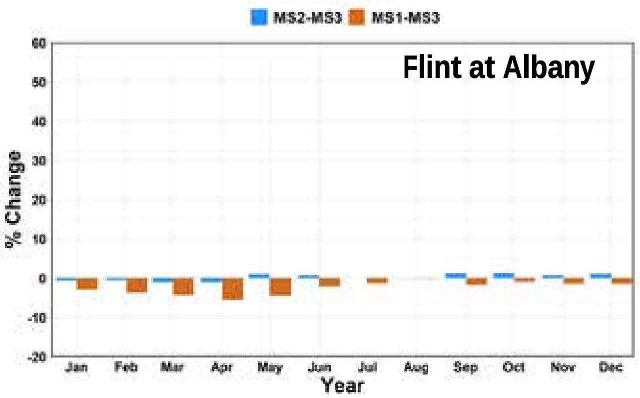
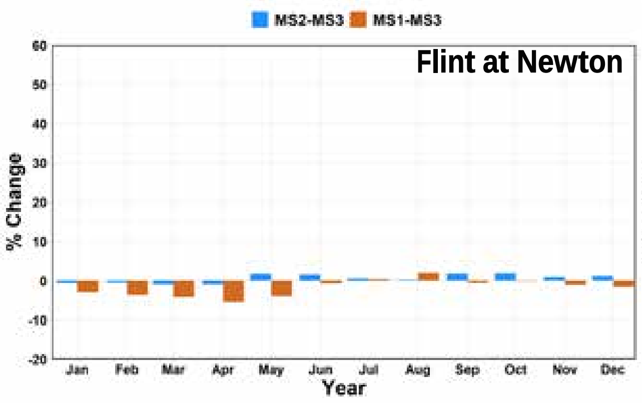
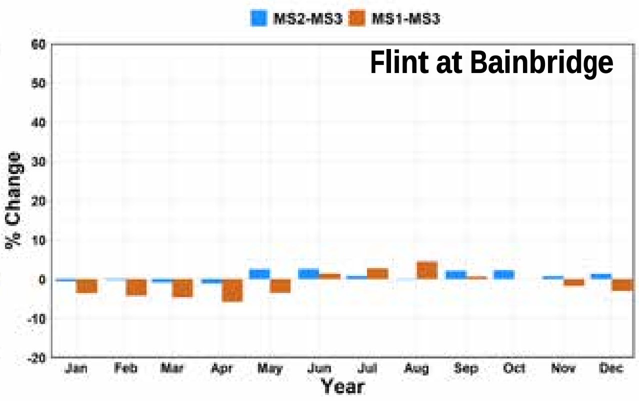
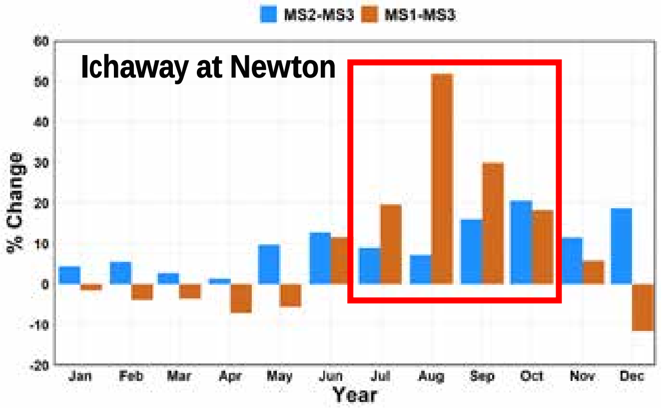
GEORGIA

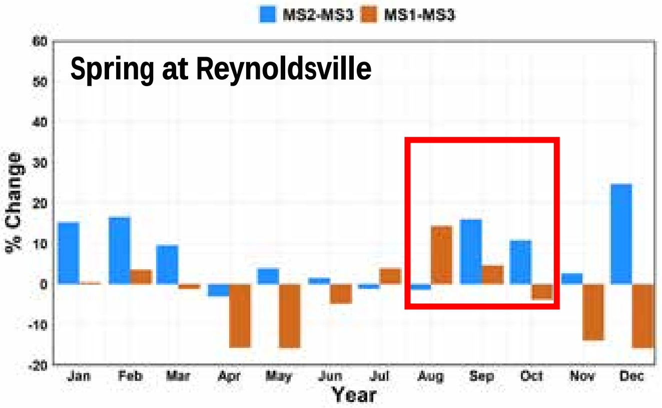








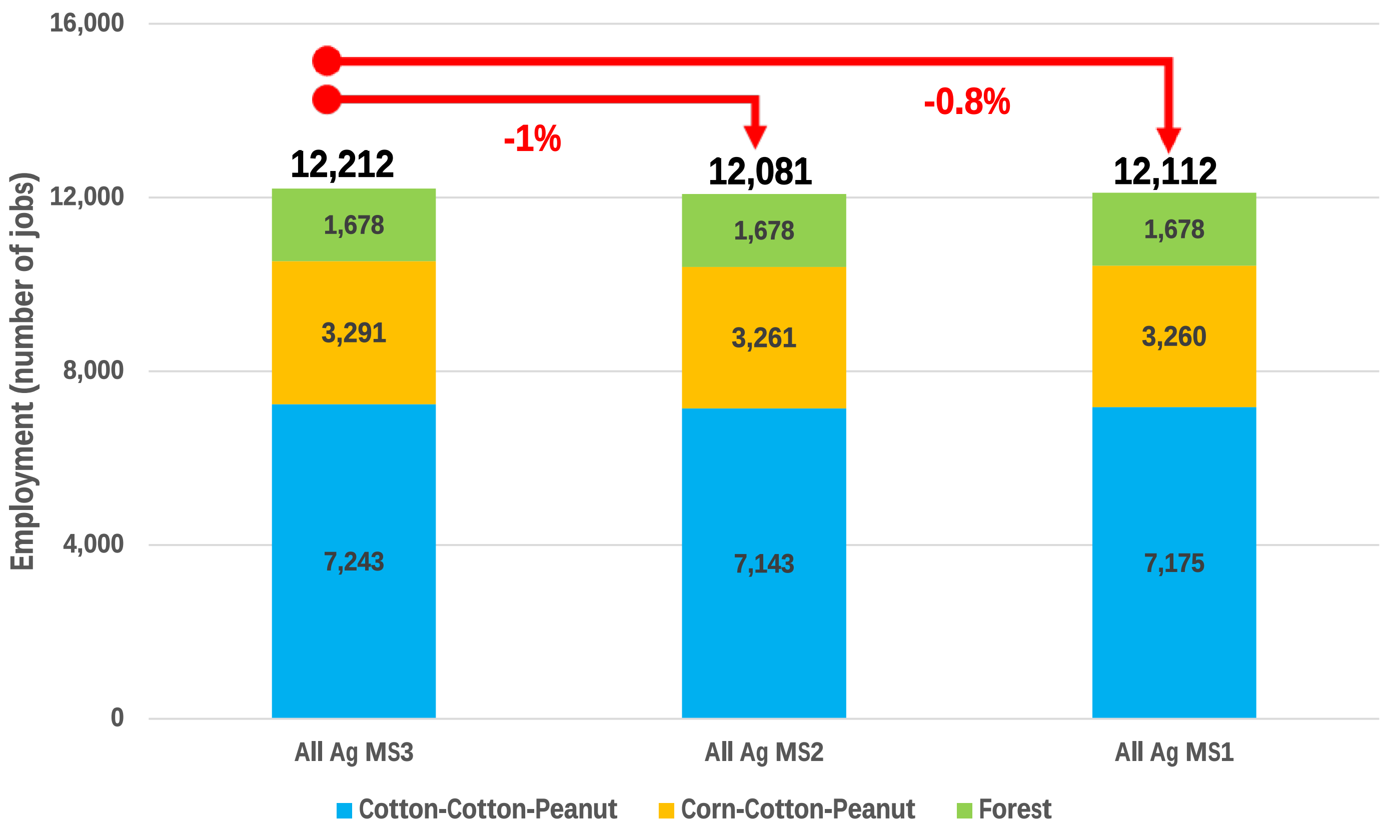




Evaluation of change in streamflow showed **minimal change along the Flint River** (less than 5%).

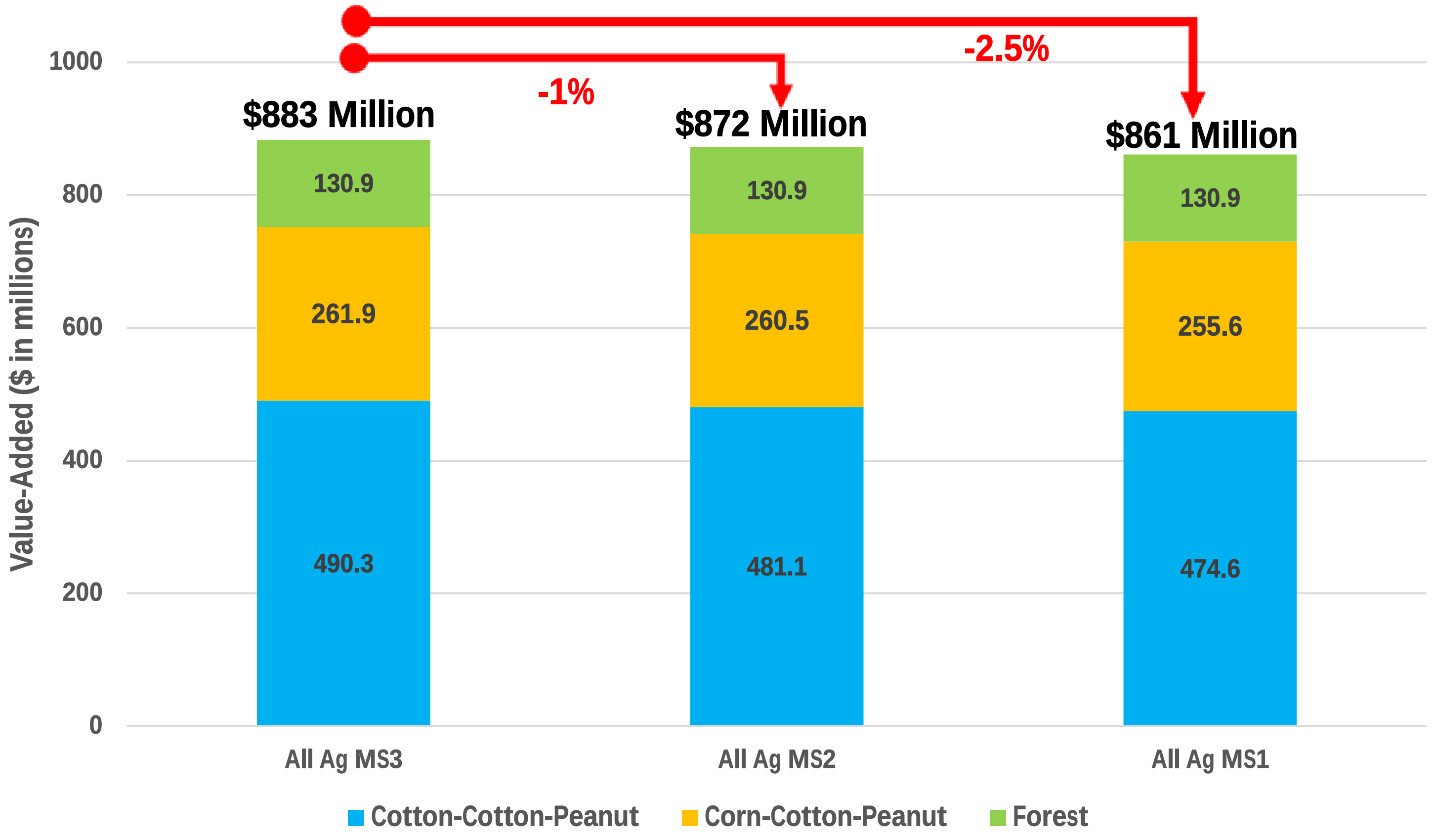
Increase in streamflow, especially at the end of the growing season, in the tributary streams was predicted when changed from MS3 to MS2 and MS1.

Georgia Simple Scenarios: Regional Economy (Employment)



- Cotton-Cotton-Peanut rotation showed higher negative impact for change from MS3 to MS2 compared to MS3 to MS1.
- Forest-based contribution estimated only for loblolly pine MS1.

Georgia Simple Scenarios: Regional Economy (Value-Added)



- Negative impact on value added as production changes from MS3 to MS2 and MS1.
- Forest-based contribution estimated only for loblolly pine MS1.
-

Regional Model: GA Scenarios – Phase I

1. Baseline: Management System 2 for row crops & forest (loblolly); historical climate

2. Multi-year drought: Management System 2 with 3-year drought; assume no land use change but possibly switch crops & inputs

3. Land use change: convert irrigated row crops in Capacity Use Areas (GAEPD red areas) to Management System 2 loblolly*

4. Temporary irrigation suspension: suspend irrigation in Capacity Use Areas for drought years*

**Note that these are not suggested as management actions but are to see what the model can tell us.*

Regional Model: GA Scenarios – Phase II

- Restoration longleaf pine
- Solar farms
- Advanced BMPs
- Alternative water sources

Participatory Modeling Process

- Models grounded in “real world”
- Guidance on baseline information and research questions
- Co-creation of scenarios to understand the system
- Collaborative interpretation of scenario results: tradeoffs & implications
- New channels and approaches for science communication
- Interstate partnership building

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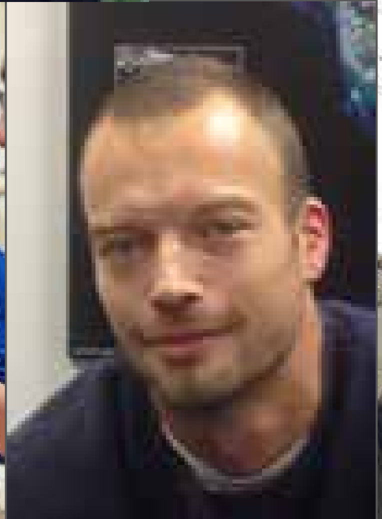


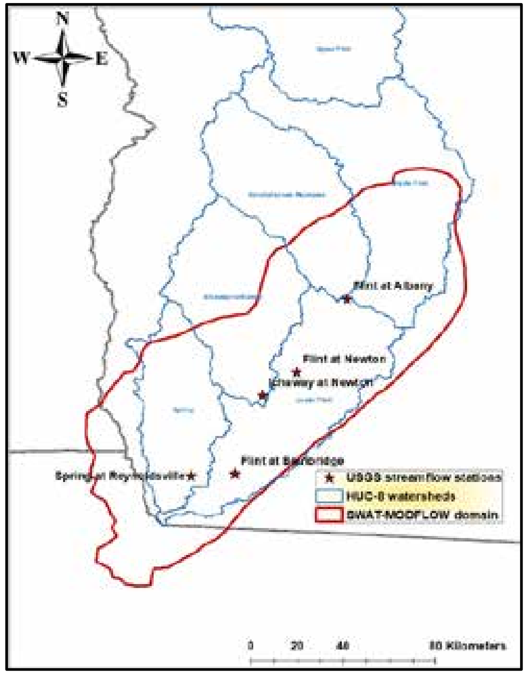


Summary

GEORGIA

These FACETS results represent work in progress and are not suitable for public distribution.

- **Aquifer Pumping**
  - All Ag MS3 had the highest groundwater pumping for irrigation use.
- **Evaluation of net recharge**
  - showed that there was minimal differences – especially when evaluated for the whole basin.
- **Evaluation of GW levels**
  - showed there was minimal difference between MS3 and MS2.
  - Comparison between MS3 and MS1 identified critical areas for groundwater level reduction.
- **Evaluation of streamflow**
  - showed minimal impact on the Flint River.
  - Impact on streamflow were significant during drought years in the two tributary streams.
- **Economics**
  - Negative impact on value-added, & state and local taxes generation as production changes from MS3 to MS2 and MS1.
  - Negative impact on employment as production changes from MS3 to MS2 but less so for MS3 to MS1.



Simple scenarios

Scenario	Land use	Management Systems
<u>All Ag MS1</u> **Row crops:** corn-cotton-peanut cotton-cotton-peanut **Forest:** Loblolly	2011 Land use	All row crops use MS1, Forests MS1
<u>All Ag MS2</u> **Row crops:** corn-cotton-peanut cotton-cotton-peanut **Forest:** Loblolly	2011 Land use	All row crops use MS2, Forests MS1
<u>All Ag MS3</u> **Row crops:** corn-cotton-peanut cotton-cotton-peanut **Forest:** Loblolly	2011 Land use	All row crops use MS3, Forests MS1

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Floridan Aquifer Collaborative Engagement for Sustainability

PROJECT VISION

Promote economic sustainability of agriculture and silviculture in N Florida and S Georgia while protecting water quantity, quality, and habitat in the Upper Floridan Aquifer and the springs and rivers it feeds.

BMP Research

- Florida
  - Corn, Carrot, Peanut
  - Corn, Cover Crop, Peanut
- Georgia
  - Corn, Cotton, Peanut
- BMPs
  - Fertilizer rates/application methods, irrigation scheduling methods, cover crops







Extension

- Water Schools

****Georgia Water Schools Coming in June****

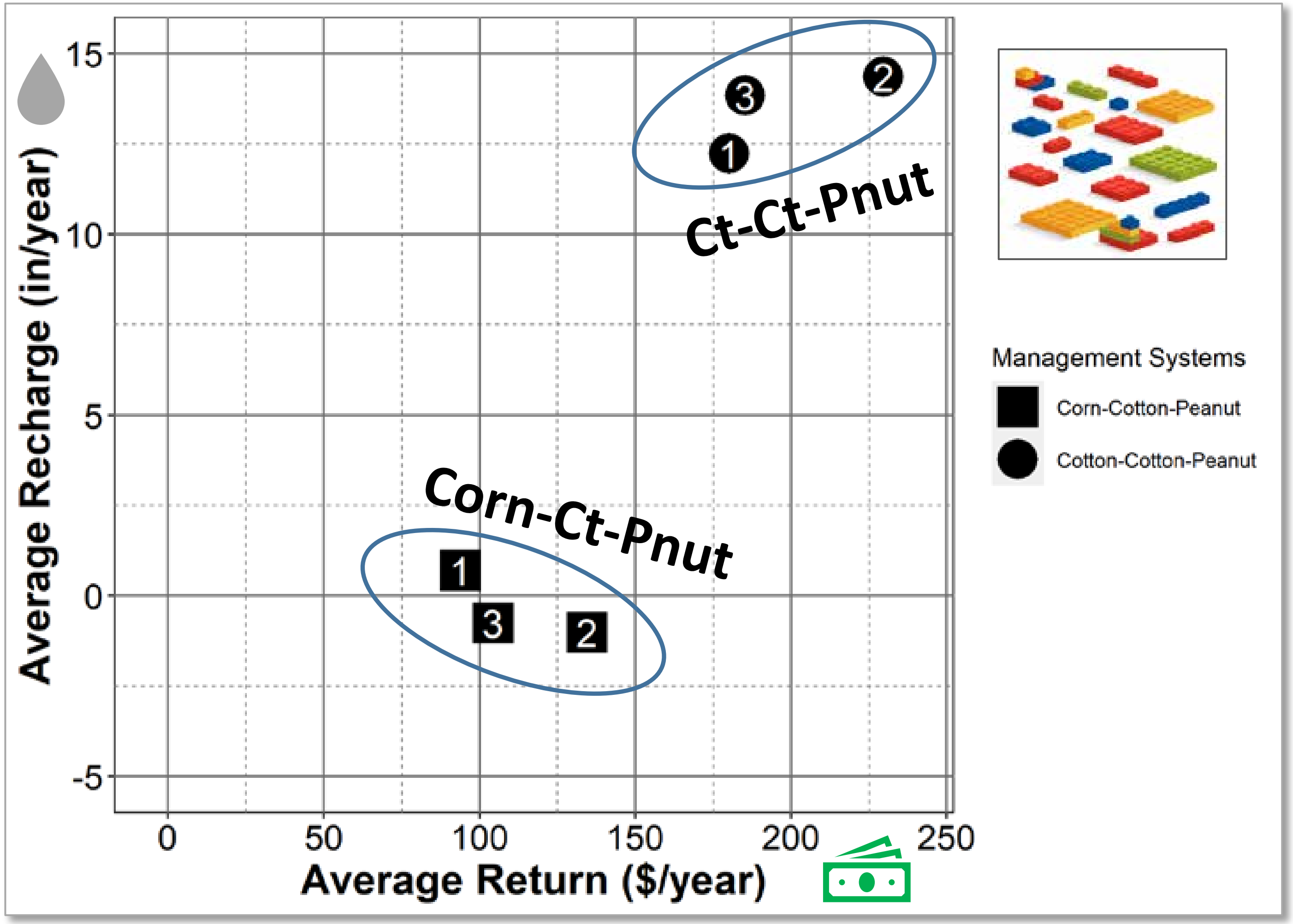
- In-Service Training
- On-Farm BMP Demos

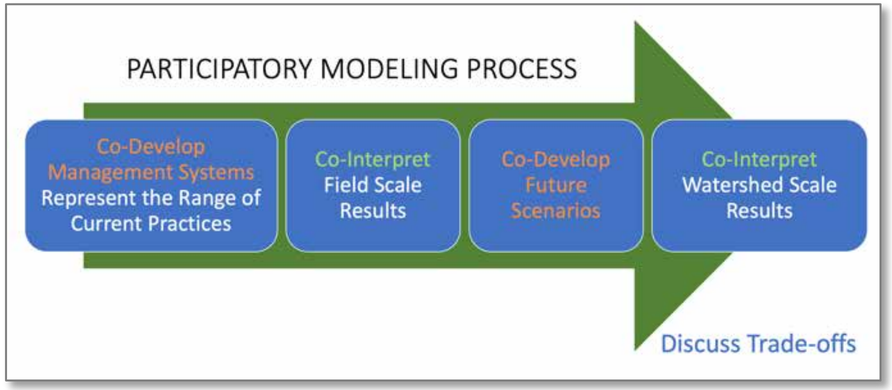






Field-Scale Results: Georgia





Georgia focused on:

Net Recharge

Net Returns

More Inputs

MS1: Most efficient irrigation, lowest N rate, cover crop, strip till

MS2: Efficient irrigation, medium N rate, no cover crop, conventional till

MS3: Least efficient irrigation, highest N rate, no cover crop, conventional till

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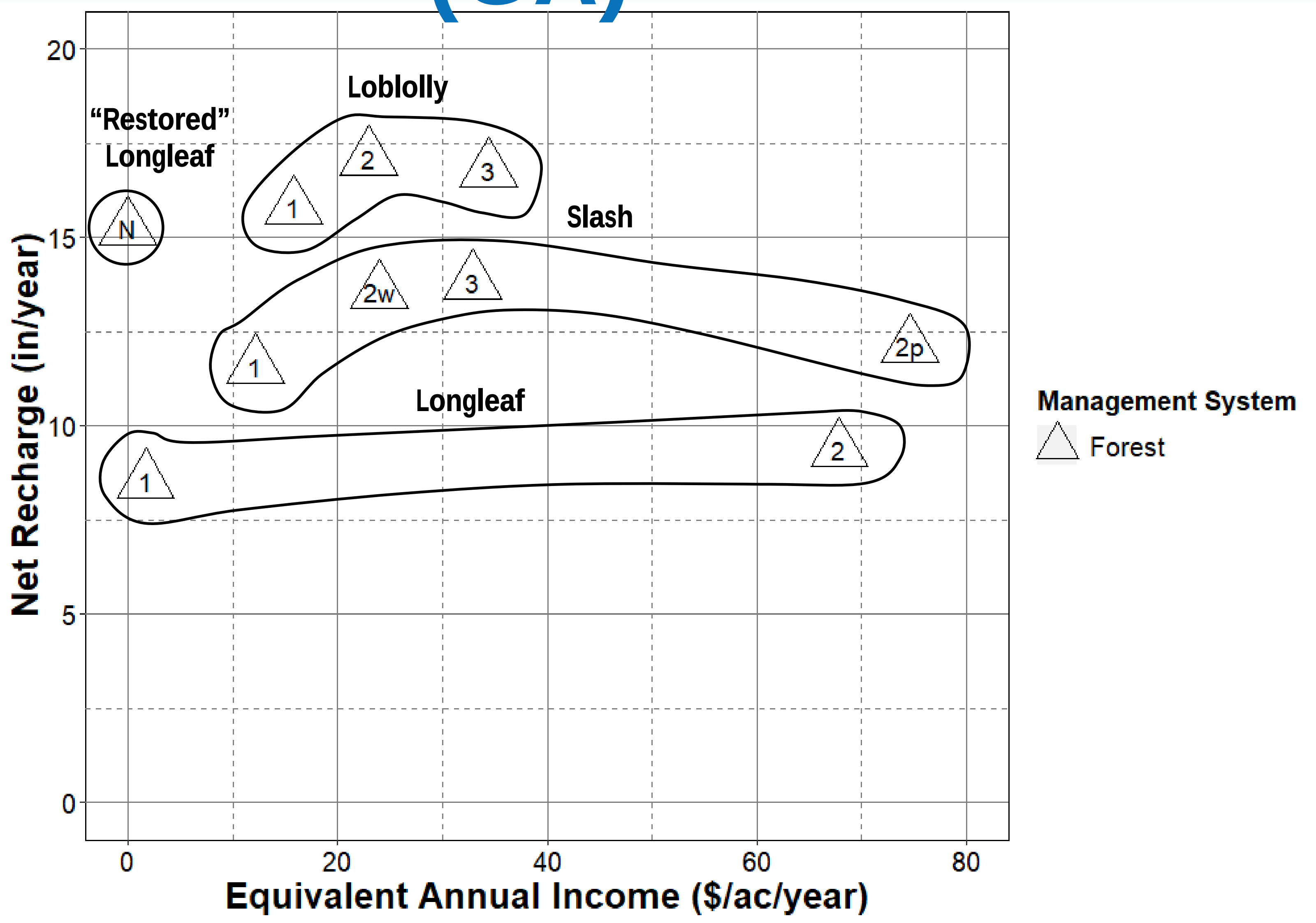
Regional Modeling Results – Tradeoffs (GA)



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PROJECT ADVISORY COMMITTEE (PAC)

Del Bottcher, President, Soil & Water Engineering Technology
Casey Cox, Longleaf Ridge Farms
Tommy Dollar, CEO, Dollar Farm Products
Michael Dooner, President, Florida Forestry Association
Bert Earley, Georgia Forestry Commission
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Beth Lewis, Director of Water Resources, The Nature Conservancy, Florida Chapter
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Steve McNulty, Director, USDA SE Regional Climate Hub
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Charles Shinn, Director, Government & Community Affairs, Florida Farm Bureau
Michael Roth, President, Our Santa Fe River, Inc.
Scott Thackston, Forester, Georgia Forestry Commission
Hugh Thomas, Executive Director, Suwannee River Water Management District

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Regional Scale Inputs and Outputs

- Regional Economy

- Regional crop and forest production

- Aquifer/stream N concentrations
- Spring & stream flows
- Aquifer water levels

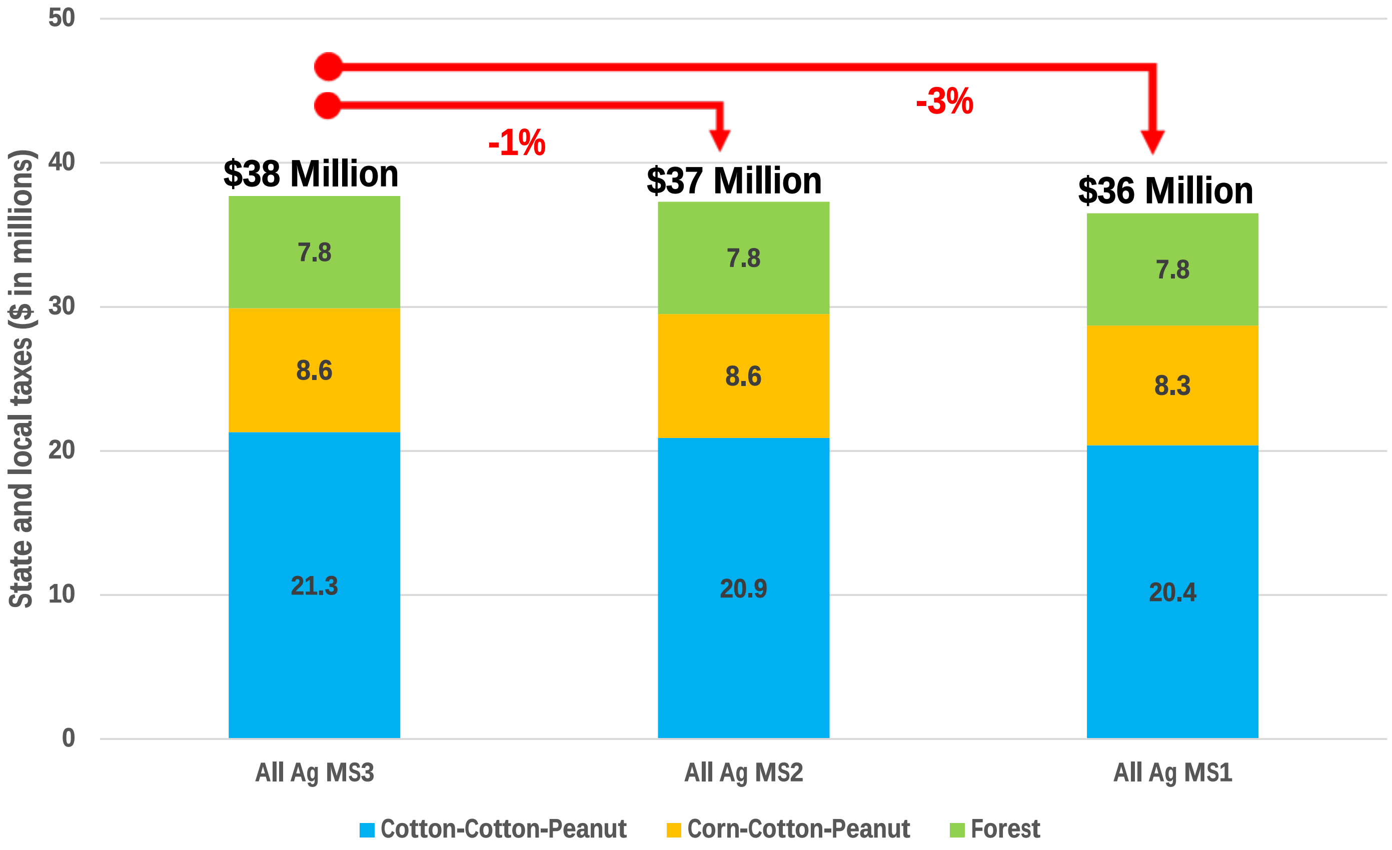
- **Employment (# of jobs)**
- **Value added ($; like GDP)**
- **Taxes ($; local, state, federal)**
- Labor Income ($; money/benefits to employees)
- Industry Output ($, sales revenue)

- **Aquifer pumping (e.g., Million Gallons Per Day)**
- **Net recharge (Recharge - Irrigation Applied; MGD)**
- **Streamflow (MGD or ft^3/s)**
- Aquifer level (ft)

NO_3^-

- **Nitrate leaching load (tons/year)**
- **Nitrate concentration in water entering spring (mg/L)**
- Nitrate concentration in river (mg/L)

Georgia Simple Scenarios: Regional Economy (State and local taxes)



- Negative impact on state and local taxes generation as production changes from MS3 to MS2 and MS1.
- Forest-based contribution estimated only for loblolly pine MS.