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Biogeochemical Cycling Studies

Fort Benning, GA

1999 - 2009

Bill Goran and Hal Balbach

US Army Engineer Research and Development Center
Champaign, IL

Shuguang (Leo) Liu

USGS Earth Resources Observation and Science (EROS) Center

Sioux Falls, SD

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Strategic Environmental Research and Development Program (SERDP)

- Based on 1993 Act of Congress
  - Environmental research for DoD, EPA, and DOE
- Major DoD environmental research program
  - Services identify needs
  - SERDP prepares Statements of Needs (SONs)
  - Government, academia and industry may propose
- Scientific Advisory Board (a FACA) approves projects
- In late 1990s, SAB advised SERDP to consider long term projects
- Two projects initiated
  - Army at Ft Benning – 1999 to 2009 – managed by USACE
  - USMC at Camp Lejeune – 2005 to present – managed by NCEL

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SERDP Ecosystem Management Project (SEMP) SI - 1114

- Conceptualized 1996; first funded 1999
- Focus on Ft. Benning, GA
  - PM by Bill Goran and Hal Balbach
- Multiple research projects
  - 3 focused on indicators
  - 2 focused on thresholds
- Aspects of several projects focused on
  - soil nutrient cycling
  - carbon cycles
  - prescribed fire frequency
- Result was heightened interest in related areas

SERDP's SEMP Ecosystem Management Project

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Example: ORNL Benning Studies Focused on Soil C-N and Fire Regime

SERDP project CS-1114D concluded in 2003
Results published in several ORNL TRs in early 2004

SERDP's SEMP Ecosystem Management Project

ORNL/TM-2004/14
Land Cover Differences in Soil Carbon and Nitrogen at Fort Benning, Georgia
January 2004
C.T. Garten, Jr., and T.L. Ashwood
Environmental Sciences Division

ORNL/TM-2004/41
Modeling Soil Quality Thresholds to Ecosystem Recovery at Fort Benning, Georgia
February 2004
C.T. Garten, Jr., and T.L. Ashwood

ORNL/TM-2004/77
Predicted Effects of Prescribed Burning and Timber Management on Forest Recovery and Sustainability at Fort Benning, Georgia
April 2004
C.T. Garten, Jr.

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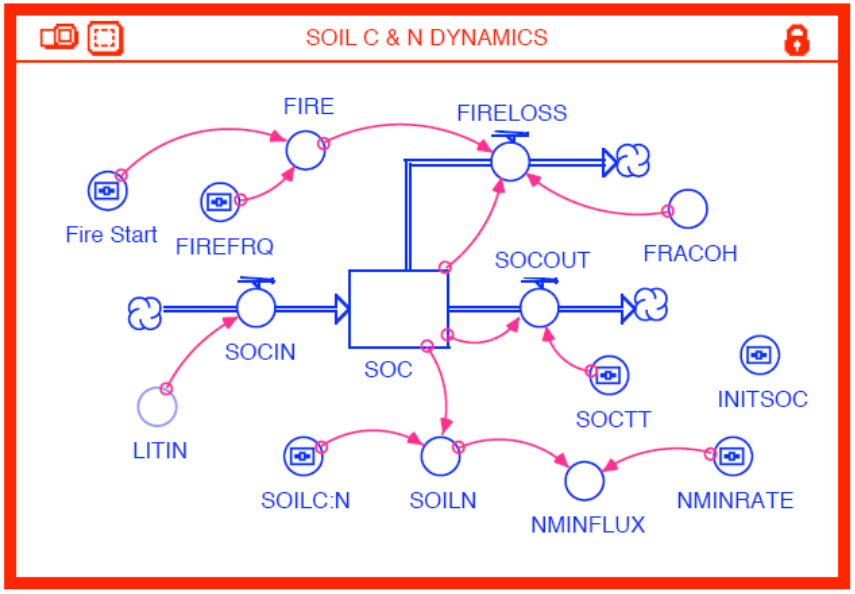
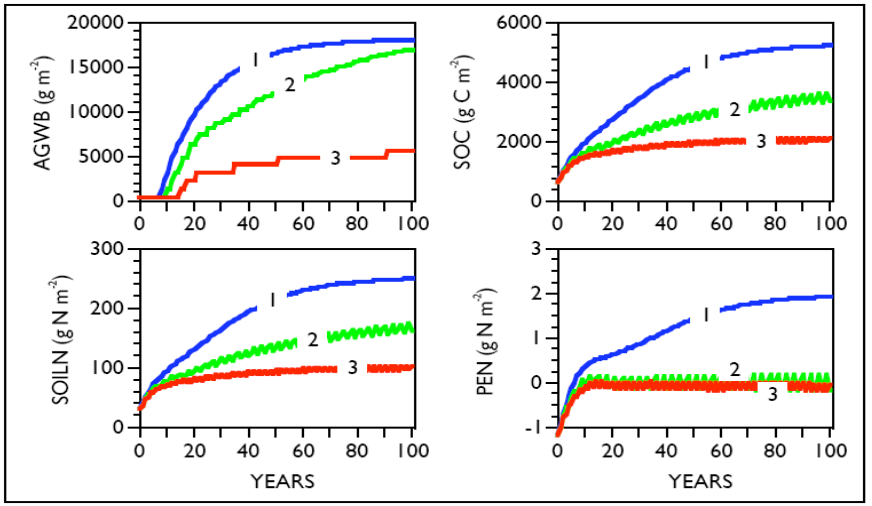
Some ORNL Results

- Used Stella® and spreadsheet modeling
- Projected C and N changes related to forest harvest cycle and prescribed fire regimes



Stella® modeled soil N relationships



Biomass, soil C, soil N, and excess N projected over 100 year cycle

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Next Step: New SERDP Statement Of Need

- Increased interest in biogeochemical aspects of ecosystem change led to new 2005 Statement of Need for higher-level biogeochemical study
- SON also reflected SEMP interest in carbon management
- CSSON-05-03 “Developing Terrestrial Biogeochemical Cycle models for Fort Benning Ecosystems”
- Selection made September 2005
- PI was Shuguang Liu, US Geological Survey EROS Data Center, Sioux Falls, SD
- Became SERDP Project SI-1462
- Funded 2005-2008

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USGS Fort Benning Project

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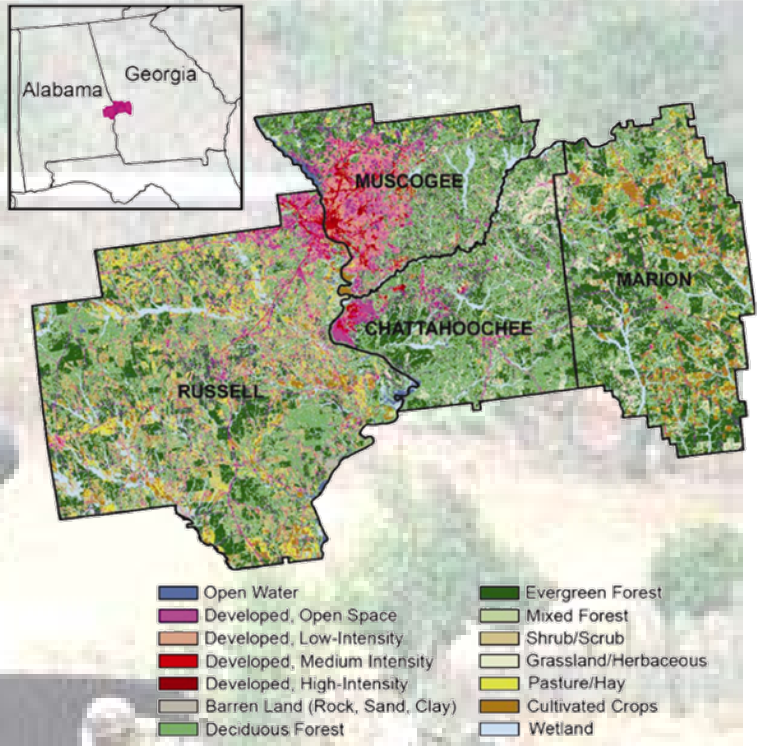
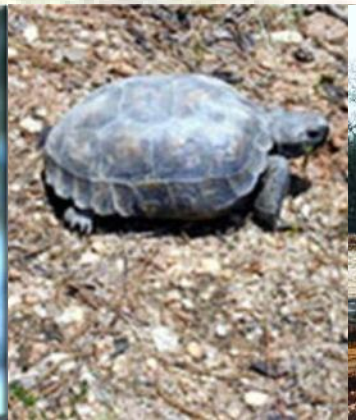
- **Problem Statement:** Models are required to provide information on the impacts of land management and uses, climate change and variability, and other processes on the biogeochemical cycles of C and N at military installations to installation managers.

- **Technical Purpose:** To develop an advanced, spatially distributed terrestrial biogeochemical cycle modeling system for Fort Benning ecosystems and its surrounding areas to support sustainable military training activities and management practices.





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Technical Approach

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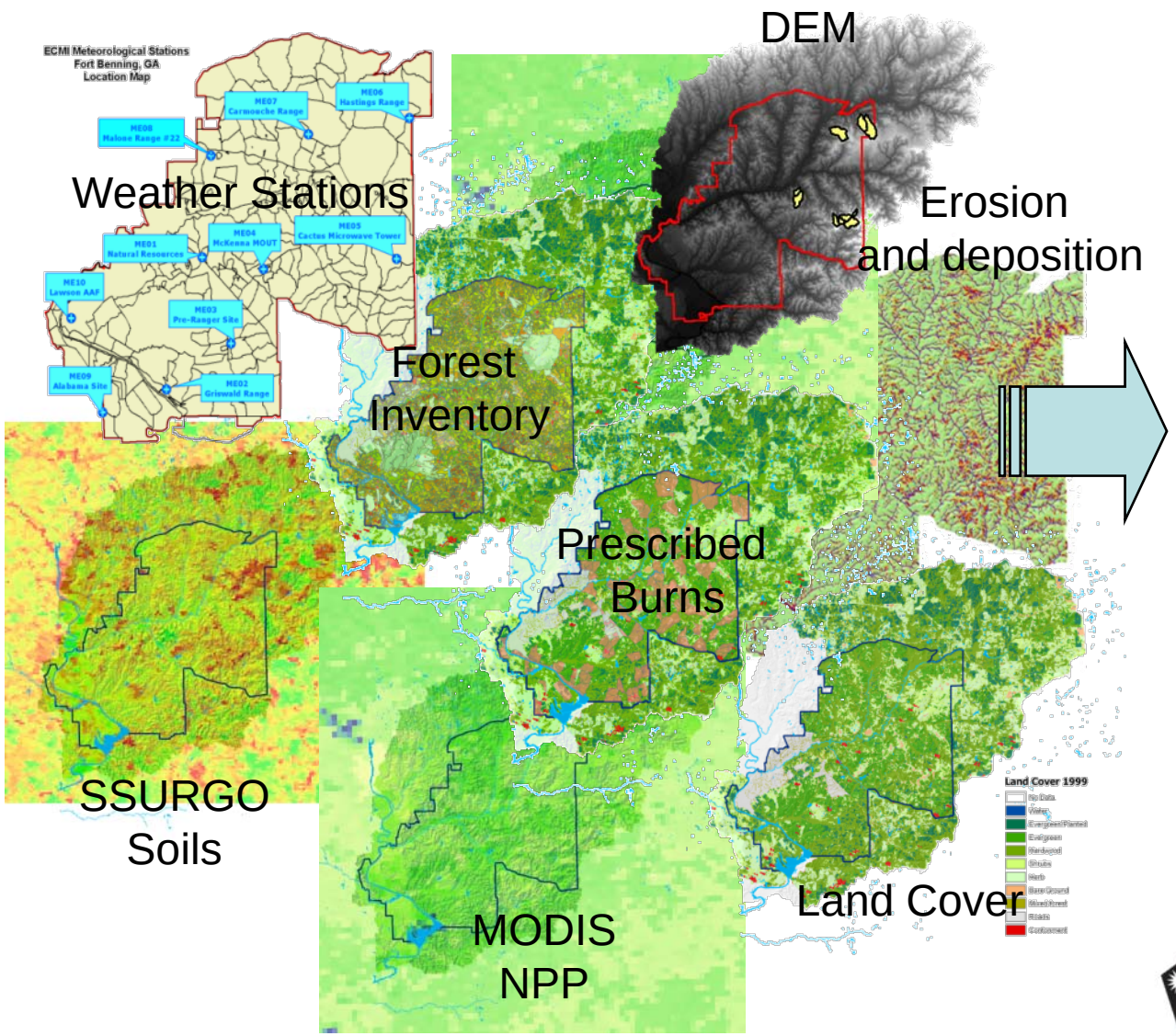

GEMS
Fort Benning
Biogeochemical
Model

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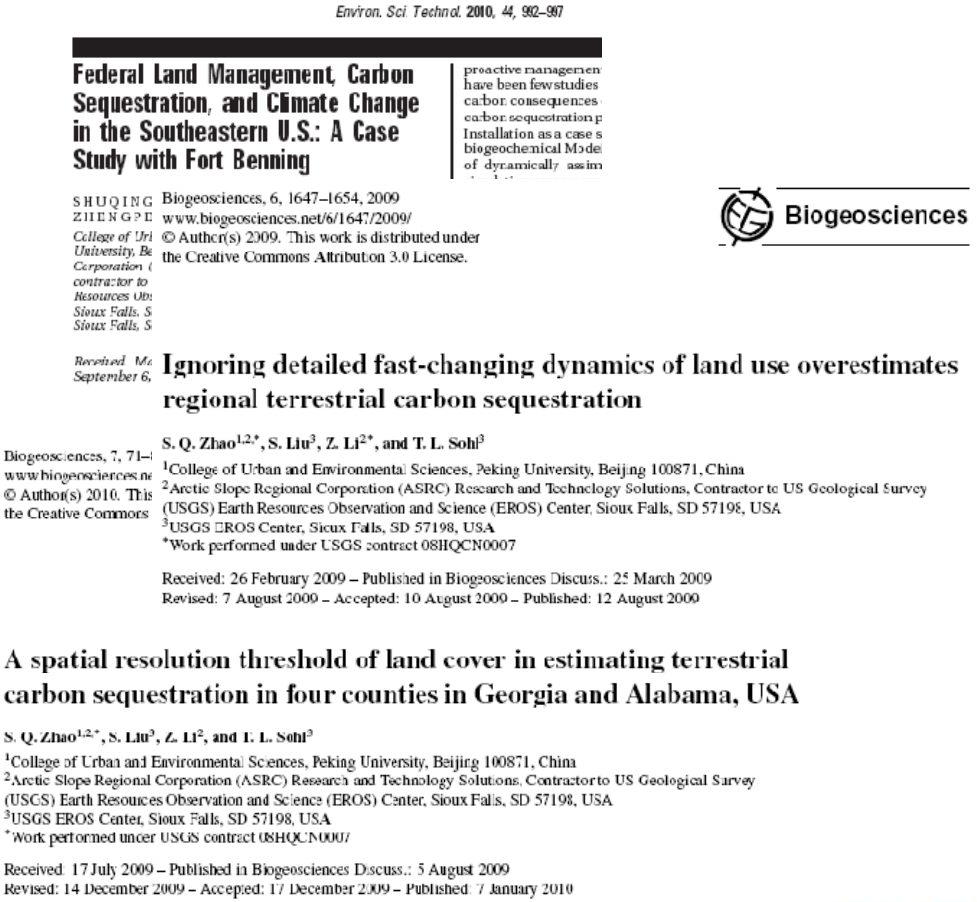
Carbon Sequestration in Four Counties

- ✓ Study areas: four counties (3,852 km^2)
- ✓ Spatial resolution: 250 m
- ✓ Model: GEMS
- ✓ Soil: USDA SURRGO
- ✓ Climate: PRISM (1992-2007) and IPCC A1B (2008-2050)
- ✓ Land cover: Landsat & FORE-SCE
- ✓ Periods: Current (1992-2007) and future (2008-2050)



Environ. Sci. Technol. 2010, 44, 992–997

Federal Land Management, Carbon Sequestration, and Climate Change in the Southeastern U.S.: A Case Study with Fort Benning

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Biogeosciences, 6, 1647–1654, 2009
www.biogeosciences.net/6/1647/2009/
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Biogeosciences

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September 6,

Ignoring detailed fast-changing dynamics of land use overestimates regional terrestrial carbon sequestration

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[3]USGS EROS Center, Sioux Falls, SD 57198, USA
[*]Work performed under USGS contract 08HQCN0007

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A spatial resolution threshold of land cover in estimating terrestrial carbon sequestration in four counties in Georgia and Alabama, USA

S. Q. Zhao[1,2,*], S. Liu[3], Z. Li[2], and T. L. Sohl[3]
[1]College of Urban and Environmental Sciences, Peking University, Beijing 100871, China
[2]Arctic Slope Regional Corporation (ASRC) Research and Technology Solutions, Contractor to US Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center, Sioux Falls, SD 57198, USA
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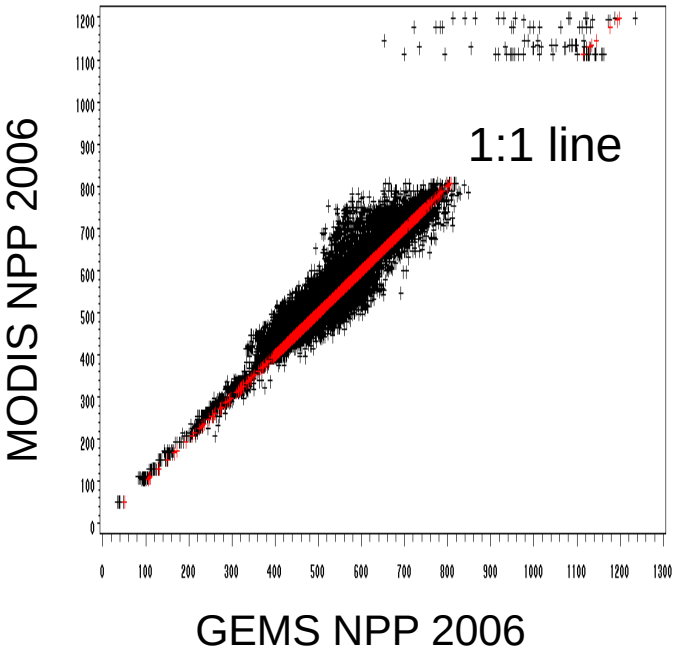
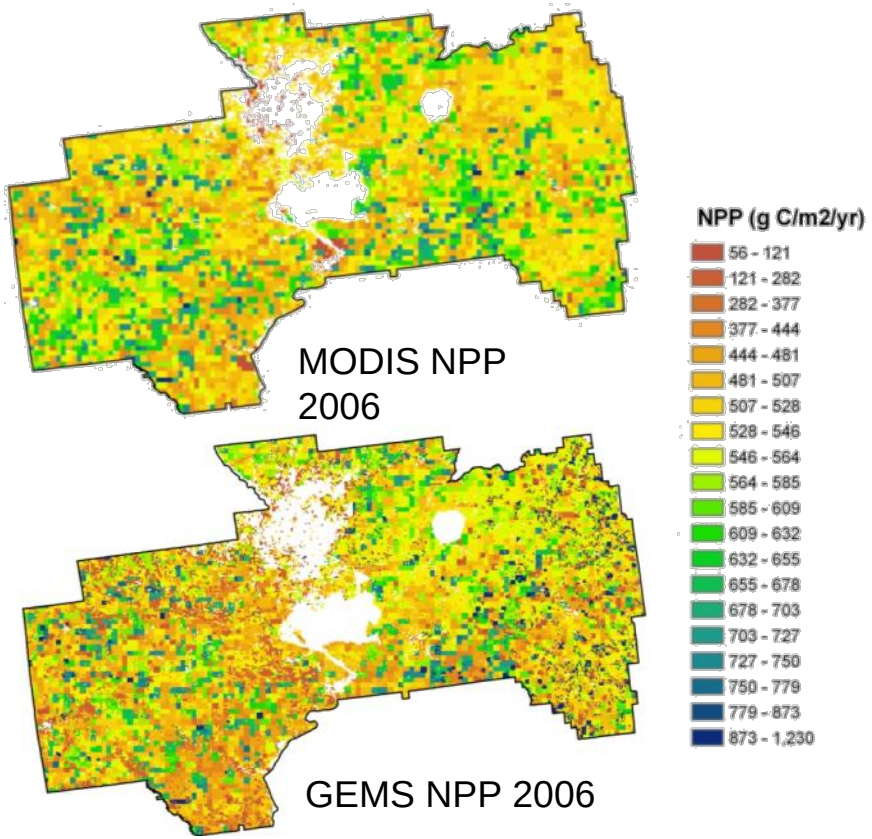
Net Primary Production

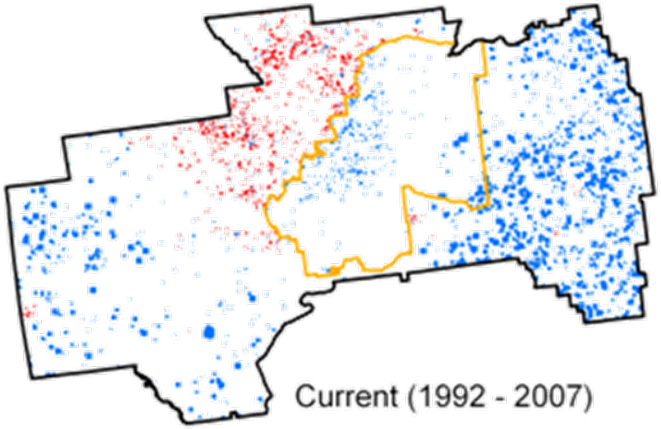
Comparison of GEMS Prediction and Satellite Obs



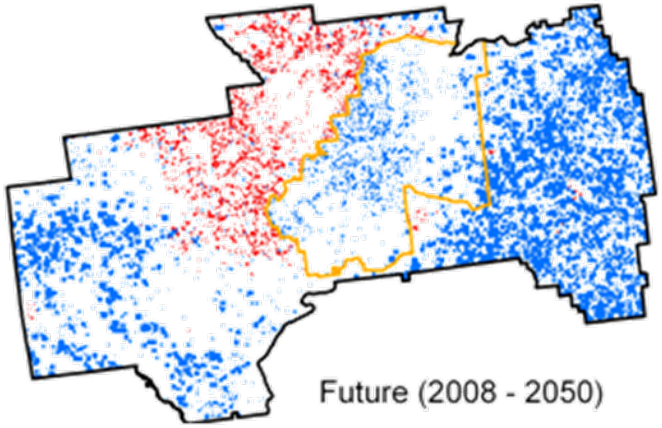


Land Cover Change

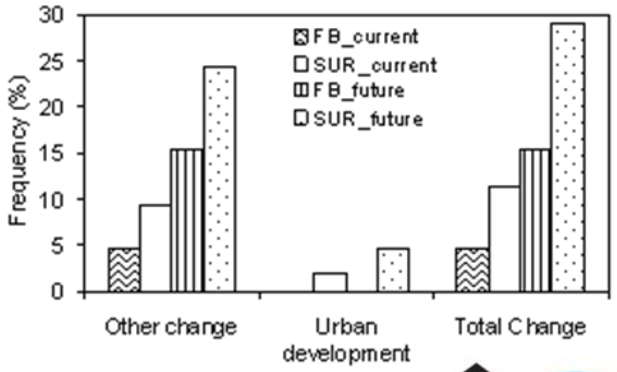
Land cover change information is derived from Landsat and USGS FORE-SCE simulations



Current (1992 - 2007)



Future (2008 - 2050)



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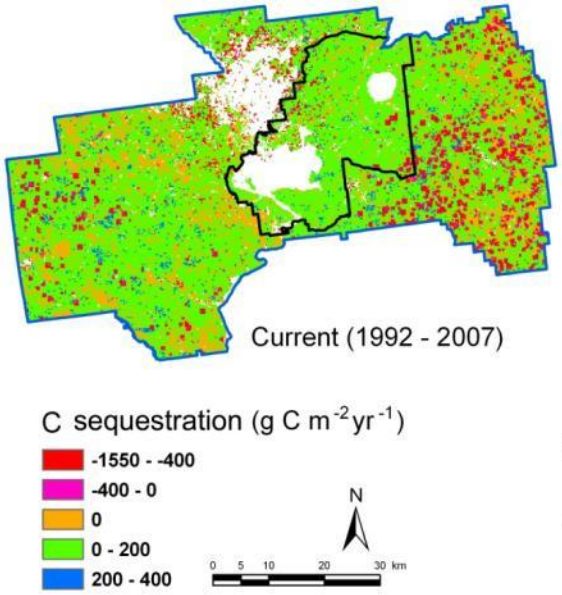
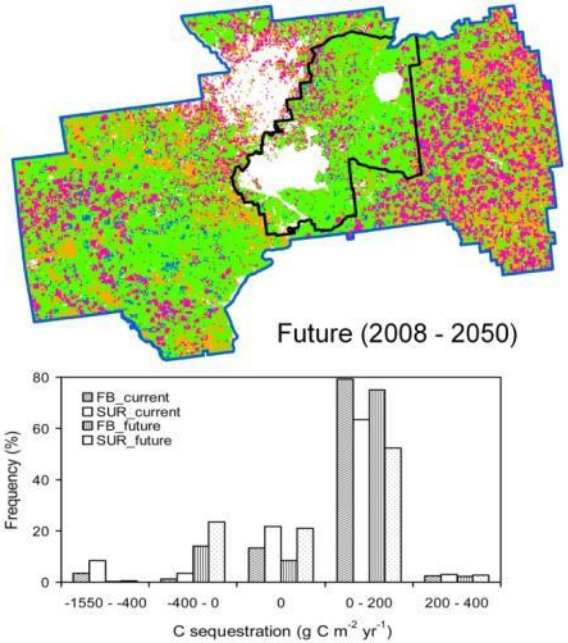
C Sequestration

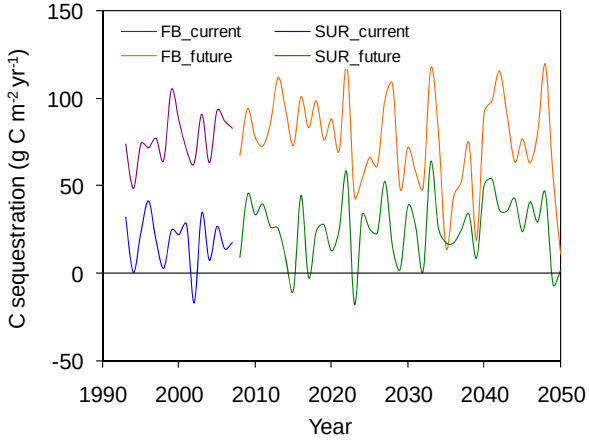
Conclusion: Fort Benning sequesters more carbon per unit area than surrounding areas

Average carbon sequestration rates (g C m^{-2} yr^{-1})

	Fort Benning	Surrounding
Current (1992-2007)	76.7	18.5
Future (2008-2050)	75.7	25.6







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How did the Ft. Benning project improve the USGS GEMS model?

- Developed a very efficient approach for assimilation of remotely sensed data which can be deployed over large areas
- Proposed and tested driving GEMS using SSURGO (finer) soil data instead of STATSGO (coarser)
- Demonstrated the importance of adequate quantification of land use and land cover change in time (temporal frequency) and space (spatial resolution) on regional carbon simulations
- Demonstrated the importance of land management practices on carbon sequestration (on vs. off installation)
- Developed new approaches for simulating both soil erosion and deposition, and linking them with carbon and nutrients cycling
- Improvements carried forward to later USGS projects

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