WaSSI: Modeling Impacts of Global Change on Ecosystem Services

Ge Sun, Steve McNulty, Erika Cohen, Jennifer Moore Myers
USDA Forest Service, Eastern Forest Environmental Threat Assessment Center
Raleigh, NC

Peter Caldwell
Coweeta Hydrologic Laboratory
USDA Forest Service, Southern Research Station
Otto, NC
Welcome to the USDA Forest Service

We are entrusted with 193 million acres of forests and grasslands. It’s a big task, but one that we take seriously. We are dedicated to restore and enhance landscapes, protect and enhance water resources, develop climate change resiliency and help create jobs that will sustain communities.

Chief Tom Tidwell
Key Issues for climate change

- Adaptation
  - Options for increasing water availability
- Mitigation
  - Opportunities to increase carbon sequestration
- Tradeoffs between managing for water or for carbon

“If mitigation is about carbon, then adaptation will be about water”
WaSSI Ecosystem Services Model

Water Availability

WaSSI

Productivity (Carbon)

Biodiversity (Under development)
Water Balance and Carbon

**Water**

\[ ET = f(PET, PPT, LAI, SM) \]

*Sun et al., Ecohydrology, 2011*

\[ Q_{out} = Q_{in} + Q_{gen} - WU \]

*Caldwell et al., HESS, 2012*

**Carbon**

\[ \text{GEP or NEE} = f(ET) \]

*Sun et al., JGR, 2011*
Water Supply Stress Index (WaSSI)

\[
\text{WaSSI} = \frac{\text{Demand}}{\text{Supply}}
\]

1981-2000 WaSSI

Sectors
1. Domestic
2. Industrial
3. Irrigation
4. Thermopower
5. Mining
6. Livestock
7. Public Supply
8. Aquaculture
Water Withdrawals

(2005 USGS Estimates)

Change in Withdrawals by 2050 (A2)
Change in stream flow by 2050-2060

Due to increased impervious cover

Due to population change

Due to climate change (GFDL CM2.0 A2)

Net change in flow

Caldwell et al., HESS, 2012
Historical WaSSI (1895-1993)
around Raleigh, NC (HUC = 3020201)

longterm average WaSSI = 0.11

2007 WaSSI=0.26
Carbon Sequestration: It is all about water!

Impacts of 30% reduction of Precip
Gross Ecosystem Productivity
Loblolly Pine
Impacts of ‘Worst’ Droughts on Streamflow in National Forests (1961-2012)
Tradeoff between water and carbon due to 20% forest conversion

Caldwell et al., 2011, USGS Scientific Investigations Report 2011–5169
Who are using WaSSI?

US
Mexico
Brazil

Rwanda
Zambia
Tanzania

China
WaSSI applications in the South

- High School Education, PINEMAP, TACCIMMO
WaSSI on the web

Create Scenario

WaSSI Ecosystem Services Model

View Inputs

View Outputs

WaSSI Ecosystem Services Model

www.forestthreats.org/research/tools/WaSSI