Climate Change and Water Issues for the Eastern US

USDA Forest Service

Eastern Forest Environmental Threat Assessment Center

Southern Global Change Program

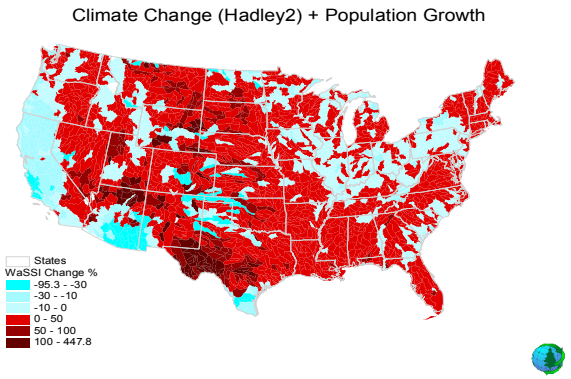
SGCP

Lots Of Water, But Not Always In The Right Places

The eastern United States is generally considered "water rich" in that annual precipitation rates are moderate to high and region-wide water shortages are very rare. However, three factors — 1) population growth, 2) climate change, and 3) groundwater shortages — are significantly reducing the ability of National Forest lands to provide sufficient water to the people living in the eastern US.

Forest Service scientist Dr. Ge Sun (gesun@fs.fed.us) and colleagues have developed a Water Supply Stress Index (WaSSI) model that examines climate and landuse changes, and population growth on human water supplies for the lower 48 US. Sun concluded that urban areas will become increasingly water stressed, even if water is regionally very abundant. Municipal water supplies can be increased more by reducing irrigation than by removing trees.

Finally, Sun found that the depletion of groundwater supplies would have a much greater impact on the total water supply than would forecasted changes in climate associated with global warming across much of the lower 48 US.

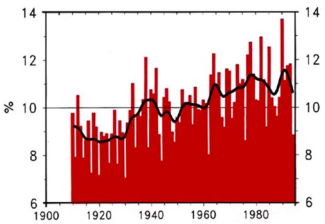


WaSSI model prediction of climate change and water stress impacts on water shortages in 2050

> *"population growth, climate change, and groundwater shortages are significantly reducing the ability of National Forests to provide sufficient water to the eastern US"*

Changes in Water Quality

In addition to changes in air temperate and the annual amount of precipitation, climate change has begun to alter the intensity of individual rainfall events. As the atmosphere warms, energy increases and extreme rainfall events are becoming more common.



Percent of rain that occurs as an "extreme event" of more than two inches in a 24 hour period

Since 1910, the chance of an extreme rain event has increased by over 30% (from about 8% to 12%), and as the climate continues to warm, this percentage will likely continue to increase. Increased rainfall intensity can cause soil erosion, stream sedimentation, and flooding.

Forest managers need to consider increased rainfall intensity when placing trails, calculating culvert size, and determining flood zone locations. Many of the tools developed by the Forest Service under historic climate such as broad based dips, bridge mats, and down slope slash piles, will also be effective under a changing climate.

However, these traditional forest management tools may need to be used more often or in combination with other yet to be developed soil erosion and control practices.

Increased air temperature will also result in increased stream water temperature. Eastern trout populations are very temperature sensitive, so as the water warms, habitat for brown and brook trout fisheries is likely to decrease in coming years, with the greatest reductions coming from the southern end of the a Appalachian mountain range, according to FS ecologist Joan Louis (jlouis@fs.fed.us).

Take Home Points

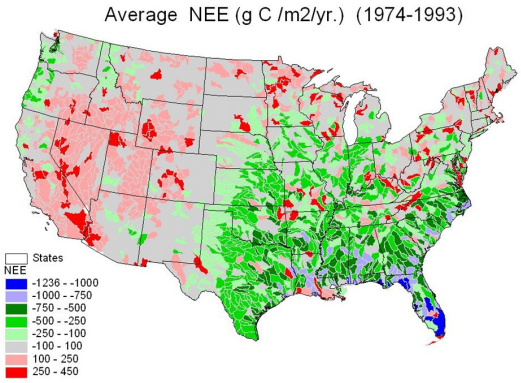
- *On average, the population of the Eastern US uses only **5%** of the annual **ecosystem water supply***
- *Unfortunately, not all water is available, or located near population centers where it is needed most, or evenly distributed across the year, therefore **water shortages do occur***
- *Increases in **population** will likely put **more pressure on the water resource** than will **climate change** in the coming decades*
- ***Loss of groundwater** would have a **greater impact** than **climate change** on local water stress*
- ***As carbon sequestration increases, forest water use increases and** water yield from National Forests decreases*

Forests and Sea Level Rise

Sea level rise is not a water issue normally associated with forests, but forests will be impacted by rising oceans and can play a role in slowing down destructive forces on coastal flooding. While there remains debate about climate change impacts on hurricane intensity and frequency, there is no debate that sea levels are rising from a combination of glacial melt (not melting icebergs) and thermal expansion of warming water. FS scientist Dr. Carl Trettin (ctrettin@fs.fed.us) has developed a wetland ecosystem model DNDC-Wetland that projects climate change impacts on wetland forest carbon loss. Sea level rise has resulted in widespread damages to forested ecosystems, and in turn, reduced the ability of these ecosystems to take up carbon from the atmosphere. Other scientists have found that the planting of mangroves along the coast will not slow sea level rise, but they will help to stabilize the shoreline from rising sea levels and hurricane caused beach erosion.

Mangrove forests like these can help to stabilize the coast line and slow down the lost of coastal forest due to sea level rise

Carbon Gain and Water Use



WaSSI-CB model estimates of annual average forest carbon sequestration potential

The United States is the world's second largest (China is the largest) emitter of carbon dioxide (CO_2), a major global warming gas. Increasing forest productivity and carbon sequestration by National Forests is seen as one option for partially offsetting CO_2 emissions. While increases in forest productivity are possible, these increases will come at the cost of increased forest water use. Forest Service scientist Dr. Steve McNulty (smcnulty@fs.fed.us) and colleagues expanded on a Water Supply Stress Index (WaSSI) model to assess the tradeoff between carbon gain and water use, WaSSI-CB.

Careful analysis of proposed management options designed to increase forest carbon sequestration must be balanced with the need for continued water supplies, especially around metropolitan areas that are heavily dependent on National Forests for municipal water.

Additionally, thorough consideration should be given to using groundwater irrigation to establish biofuel forests. WaSSI model simulations suggest that even the most optimistic projections of climate change related precipitation increases will not offset exhausted groundwater supplies in some regions of the country.

Forest Service Water Research

The Forest Service has a rich tradition in water resource research, including the **Coweeta Hydrologic Laboratory** (under the direction of project leader Dr. Jim Vose, jvose@fs.fed.us) and **Hubbard Brook Experimental Forest**. Established in 1936, Coweeta is the oldest active hydrologic laboratory in the world. Over its 75 year history, Coweeta scientists have discovered many important forest practices such as broad based dips and the appropriate use of culverts and stone to control soil erosion and stream sedimentation.

Since 1955, Hubbard Brook scientists have been pioneers in understanding watershed scale pollutant impacts on stream water quality and nutrient cycling. Both Coweeta and Hubbard Brook have studied the impacts of forest thinning and harvesting for increasing stream water flow and found that clearcut forestry resulted in a 10% to 15% increase in stream flow for about three years. Streamflow returned to precut levels after about 8 to 10 years.

These findings suggest that increasing forest water flow for increased human demand may be theoretically possible but not economically practical due to the cost associated with maintaining elevated water flow rates and possible reductions in water quality. Concerns regarding water quality may be even more pronounced given predicted increases in precipitation intensity associated with climate change.

Long-term watershed monitoring is critical to understanding climate change impacts on water quality and quantity

For additional information on areas of water research, contact FS scientist Dr. Steve McNulty:
smcnulty@fs.fed.us
919-624-9782