USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

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Forest Carbon Status and Trends

Forests are the largest terrestrial carbon sink in the world, absorbing carbon dioxide (CO_2) and storing it as carbon (C) in soils and woody plants. In the United States, forests, wood products, and urban trees collectively offset annual CO_2 emissions by roughly 10–15 percent. Forest health and conditions, management practices, disturbances such as fire, and wood harvesting and use all influence how much carbon is stored and released from forests over time (referred to as "carbon flux"). Tracking these dynamic processes over vast landscapes is crucially important for understanding and harnessing the power of forests to curb our greenhouse gas footprint.

The USDA Forest Service Forest Inventory and Analysis (FIA) program is legislated by Congress to conduct the Nation's forest census. FIA is the basis of national greenhouse gas estimates from forest land use and land use change. FIA estimates on the carbon content among forest types are used by policy makers at local, State, and national levels to estimate the carbon benefits from land management activities and inform climate change mitigation measures. The FIA program's work directly supports voluntary and compliance carbon markets, including providing common practice baseline carbon values for forest projects seeking to sell offsets under California's cap-and-trade system. A summary of how FIA conducts forest carbon and flux accounting is provided in the "Forest Carbon Estimation & Monitoring" factsheet.

Carbon Storage

Forests ecosystems in the United States contained just under 60 gigatonnes of carbon in 2019, more than 6 percent of the global terrestrial biomass. Most of this stored carbon is in forest ecosystem pools (95 percent), with the remainder as harvested wood products. Forest soils store the largest amount of carbon (54 percent), followed by aboveground biomass (26 percent). However, in terms of active carbon removal, live vegetation has the largest impact, accounting for more than 84 percent (0.5 metric tons of carbon per hectare per year) of the uptake.

Carbon Flux in U.S. Forests and Grasslands

In 2019, forest land, harvested wood products, woodlands, and urban trees in settlements removed a net 775.7 million metric tons of carbon dioxide equivalent (MMT CO2 Eq.) from the atmosphere, offsetting more than 11 percent of total U.S. greenhouse gas emissions (about 15 percent of only the CO2 emissions). This estimate represents total greenhouse gas flux, including emissions from forests (e.g., deforestation, fire), removals from forests, woodlands, and urban trees, as well as carbon stored in harvested wood products (figure 1).

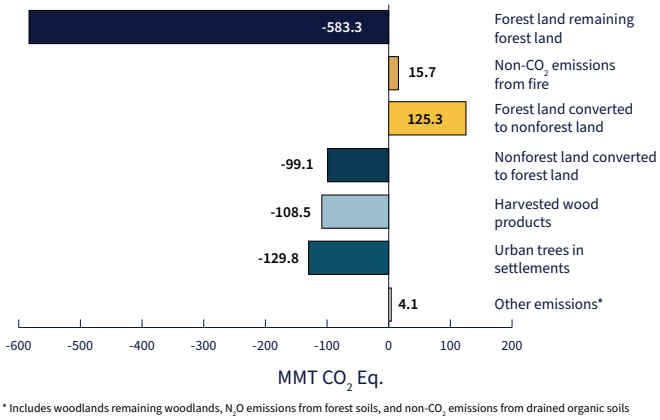

Figure 1. Emissions and removals by category, 2019

Most States in the conterminous United States are carbon sinks, yet in recent years, several intermountain western States including Colorado, Montana, New Mexico, Wyoming, and Utah have become sources of carbon (figure 2). This is due to increases in the frequency and severity of natural disturbances including wildfire, weather, insects, and disease in recent decades.

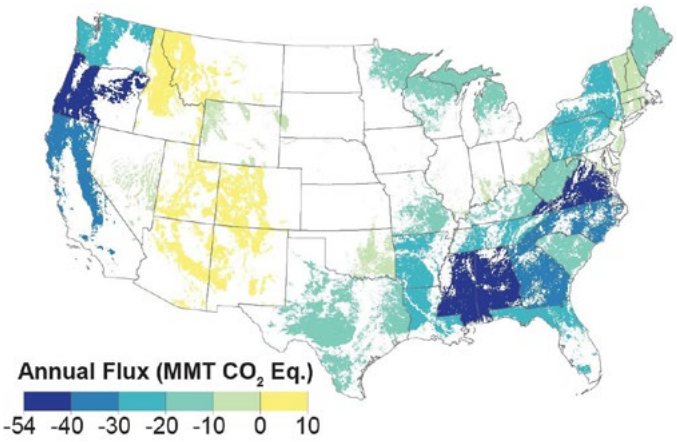

Figure 2. Estimated greenhouse gas emissions and removals on forest land by U.S. State in 2018. Negative estimates indicate net C uptake (i.e., a net removal of C from the atmosphere). Does not include stored carbon in harvested wood products. Adapted from Domke et al. 2020b

Forest Carbon Projections and Planning

The congressionally mandated Resources Planning Act (RPA) Assessment is published every 10 years, with consideration of updates at the 5-year midpoint. It offers long-term (50 year) projections of the status of key natural resources across the United States, in a nationally consistent framework, with regional-level outputs. Much of the input information for the RPA and model development relies on FIA data. This includes the carbon estimates and projections developed for the RPA Assessment, which are used for a range of purposes such as policy making, biennial reporting to the United Nations Framework Convention on Climate Change (UNFCCC), climate action reporting, and to inform management activities, including the Forest Service Strategic Plan, State forest action plans, national forest management plans, and regional assessments.

Revised forest carbon projections are underway for the 2020 RPA Assessment, and include:

- Better insight into the implications of climate change on forest conditions and overall productivity.
- Enhancing modeling to improve the precision of carbon sequestration estimates of forest carbon pools, from soils to tree biomass.
- Refined tracking of carbon stock transfers from land use change.
- Improved incorporation of age dynamics associated with forest disturbance, as well as the impacts of harvesting and distrubance on forest carbon sequestration.

The anticipated publication data of the 2020 RPA Assessment is summer 2022. The subsequent RPA update will apply life cycle assessment techniques to provide estimates of avoided emissions resulting from the substitution of wood for energy (bioenergy) and nonwood materials in construction (mass timber).

About Forest Service Research and Development: The Research and Development (R&D) arm of the Forest Service works at the forefront of science to improve the health and use of our Nation's forests and grasslands. Research has been part of the Forest Service mission since the agency's inception in 1905. The organization consists of 7 research stations and 81 experimental forests and ranges. Forest Service R&D partners with other Federal agencies, States, Tribes, nongovernmental organizations, universities, and the private sector. Today, more than 400 Forest Service scientists work in a range of biological, physical, and social science fields to promote sustainable management of the Nation's diverse forests and rangelands.