CLIMATE CHANGE RESOURCE CENTER

Forest Management for Carbon Benefits

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This topic page was developed using information from the report *Considering Forest and Grassland Carbon in Land Management* (WO-GTR-95).

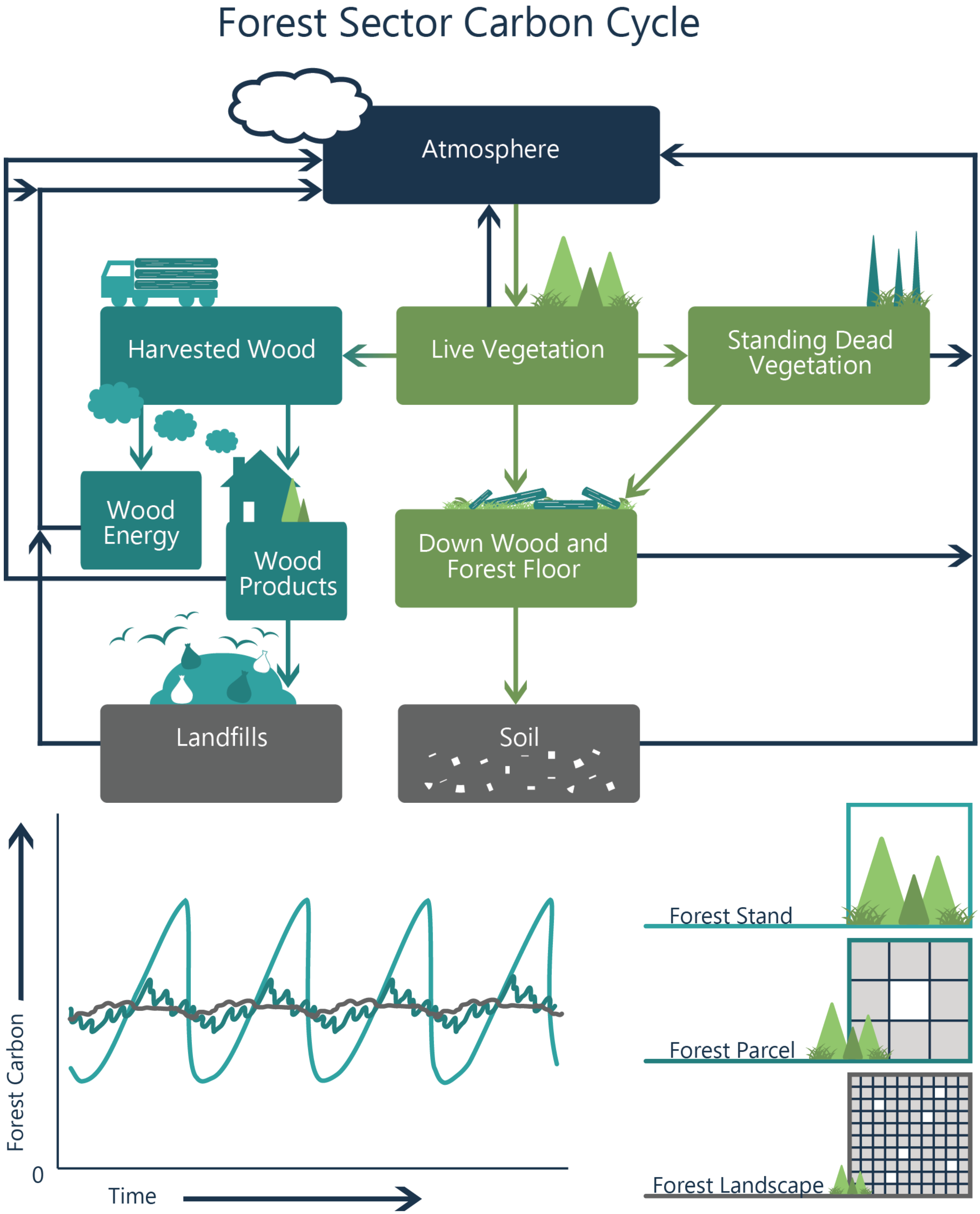
When considering carbon in the context of land management activities, it is necessary to consider the overall management objectives associated with a piece of land, the carbon stocks in different pools, and the flows of carbon between these pools. Carbon accrues in plants and soil. In forests, carbon is stored in live trees, standing dead trees, downed wood, the forest understory, and soils and can be transferred among these different pools and to the atmosphere. The industrial side of the forest carbon cycle should also be considered, as carbon can also accrue in wood products and substitute for fossil fuel-based products (1)

Figure: The forest sector carbon cycle includes forest carbon pools and carbon transfer between pools. Modified from Heath et al. (2) and United States Department of Agriculture (3).

Within ecosystems, carbon management frequently focuses on determining the amount of carbon stored in biomass and soil, as well as the rate new carbon is being sequestered into biomass from vegetation growth. The determination of management impacts on carbon cycling depend heavily on the scope of the analysis being undertaken (4-6), which can focus on fine spatial scales, such as an individual stand, to broad scales covering an entire landscape, region, or continent. The spatial scale of analysis when evaluating carbon outcomes often directly impacts the conclusions made about forest carbon stocks, as does the temporal scale (4). When looking at fine spatial scales and short timeframes, harvest may remove a large portion of the carbon within the system. However, across larger spatial scales and time periods, harvest impacts to carbon stocks may be minimal relative to total carbon within the system.

Figure: The influence of spatial and temporal scales on forest carbon storage. Modified from Bowyer et al. (7) and McKinley et al. (5).

Harvested wood can be used to create products ranging from short-lived paper products to durable wood products that can last more than 100 years, as well as wood for energy (8-10). Ultimately, the carbon stored in wood products is returned to the atmosphere through decomposition or



combustion, although the time needed for this return can vary widely based on the use and longevity of materials made from harvested wood. Additionally, there are different timeframes associated with different carbon pools that also need to be considered when evaluating how an action may affect carbon stocks and fluxes. For example, the combustion of wood for energy releases carbon to the atmosphere immediately, whereas carbon released from the decomposition of wood in the forest floor may take years to decades. Because of the dynamics of forest growth, management actions potentially have lasting effects years, decades, or even centuries into the future (11, 12).

Because the system boundaries used in carbon analyses vary widely across studies, it can be difficult to compare strategies for mitigation (6). The complexity of the forest carbon cycle—including spatial and temporal dynamics, interactions among forest carbon pools, and natural and human influences—underscores the importance of using methods that consider the net effects of management activities on carbon stocks and greenhouse gas emissions to the atmosphere (13). The long-term nature of forest growth may mean that management actions that emit carbon to the atmosphere in the short term may be able to enhance forest growth and provide greenhouse gas mitigation benefits over a longer period (11). Tools like the Forest Vegetation Simulator can simulate forest vegetation response to management and estimate the change in carbon stocks over time (via the Fire and Fuels Extension), but does not include carbon emissions associated with management operations, such as fuel for equipment use or transportation. Data-intensive approaches, such as life-cycle assessment, attempt to quantify the environmental impacts, including carbon emissions, of a product or process by factoring in all inputs and outputs of a system (14, 9).

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