FORESTS AS CARBON SINKS

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Terrestrial carbon sequestration is the process through which carbon dioxide (CO2) from the atmosphere is absorbed by trees, plants and crops through photosynthesis and stored as carbon in biomass (tree trunks, branches, foliage and roots) and soils. Forests contain nearly 75 percent of the earth's biomass, so it is crucial to understand the role forests have with carbon and climate change.

Carbon Sink refers to forests, crop lands, and grazing lands, and their ability to sequester carbon. Agriculture and forestry activities also release CO2 to the atmosphere. Therefore, a carbon sink occurs when carbon sequestration is greater than carbon releases over some time period. About one-half the weight of dry wood is carbon, and that carbon is stored as long as the wood is in existence. When trees die, decay or burn, they release carbon stored in the soils and biomass (organic matter such as stems, stumps and slash) as CO2 into the atmosphere. Carbon is also released as CO2 when trees are harvested, although considerable carbon is stored in wood put into long-term use such as in houses, furniture, and books.

Carbon Sequestration Potential of the United States

Current Carbon Capture: The U.S. landscape currently sequesters more carbon than it emits.

- Net sequestration (i.e., the difference between carbon gains and losses) in U.S. forests, urban trees and agricultural soils totaled almost 840 teragrams (Tg) of CO2 equivalent (or about 230 Tg or million metric tons of carbon equivalent) in 2001 (Inventory of U.S. Greenhouse Gas Emissions and Sinks).
- This offsets approximately 15% of total U.S. CO2 emissions from the energy, transportation and other sectors.
- However, the overall sequestration level in the U.S. has been declining and is projected to continue to decline due to increasing harvests, land-use changes and maturing forests. Carbon sequestration by forests and other lands decreased by approximately 20 percent from 1990 to 2001, a decline stemming primarily from unsustainable timber management (especially on privately owned forests) and the clearing of forests for development.

Potential Carbon Capture: The technical potential for forest carbon sinks is great. According to the Intergovernmental Panel on Climate Change, on the global level, 1-1.5 billion tons of carbon (equal to about 12-15% of total global carbon emissions) per year on average over the next half century could be managed through forestry activities. Much of this potential is related to addressing land degradation in developing nations. When trees are cut and are then burned or allowed to decay, much of the carbon they store is released back into the atmosphere.

Carbon Sequestration Capacity: Carbon sequestration rates vary by tree species, soil type, regional climate, topography and management practice. In the U.S., widely accepted values for carbon sequestration rates are available for most tree species.

- A newly planted tree in the tropics can remove 50 kilograms of CO2 from the atmosphere each year during its growth period of 20–50 years.
- A tree in the temperate regions can take in 13 kilograms.
- New trees planted on 171 million hectares of degraded land that can be profitably reclaimed at a carbon price of $210 per ton could, in 2020, take up over 950 million tons of carbon.

Tree Carbon Management

Preserving and expanding the world's carbon sinks must be a critical element of any strategy to abate emissions and raise carbon productivity. Managing forests to reduce carbon dioxide emissions and to

increase carbon sequestration is possible through the following approaches:

- Forest preservation: keeping forests as forests
- Afforestation: converting non-forest lands to forests such as when trees are planted on lands previously used for marginal crops or along streams.
- Reforestation: planting trees on lands previously used in forestry such as replanting quickly after a fire.
- Forest Management: implementing strategies such as thinning or increasing the length of rotations (the period of time between harvests) to minimize risk of catastrophic fire.

Forest Preservation

End Deforestation: The foremost human-caused contributor to atmospheric carbon dioxide globally is the use of fossil fuels. Tropical deforestation (primarily for land conversion to agriculture) accounts for 20% of global CO2 emissions. This is more than the annual CO2 emissions generated in the United States by burning fossil fuels.

Deforestation has already been banned in some areas to moderate flooding, stabilize soils, and prevent erosion. Because the Earth's remaining forests store massive amounts of carbon, the impetus for forest protection now goes beyond local environmental protection to global climate protection. Stopping forest destruction will involve reducing wood and paper consumption, boosting recycling, and curbing the pressures to deforest that come from population growth and the expansion of agriculture and rangelands. By ending net deforestation, we can cut 2020 CO2 emissions by 1.5 billion tons of carbon.

Preserving Existing Forests: While the impact of forestation on carbon abatement develops over years, the impact of avoiding deforestation is immediate. Stopping, or slowing, the rate at which such forests are cleared is essential to maintaining their carbon-storing capacity and the ecological "services" they provide: biodiversity, watershed protection, and recreation.

Planting Trees

Plant Native Trees: Replacing diverse ecosystems with single-species timber plantations may generate greater carbon accumulation, but could result in less biodiversity, at least at the scale of the plantation. To preserve local biodiversity, only native species and seed stocks should be used when implementing afforestation or reforestation projects.

Afforestation refers to the planting of trees on lands that have not historically supported forests. In the United States, afforestation of less-productive agricultural lands such as the lower Mississippi River alluvial valley is proving to be an effective sequestration strategy. In addition to storing up to two tons of carbon per acre each year, afforestation projects can deliver other important benefits such as improved wildlife habitat, reduced soil erosion and fertilizer runoff, and new recreational opportunities. Planting trees in cities and suburbs delivers an especially attractive climate benefit since urban trees not only sequester carbon but also provide shade, reducing emissions associated with the energy that would otherwise have been used to cool these neighborhoods in the summertime.

Reforestation restores forests that have been severely degraded. A variety of sustainable management approaches can improve carbon sequestration in existing forests. Allowing trees to grow for longer periods between harvests, planting longer-lived tree species (e.g., red oak, white pine, red spruce, hemlock), and setting aside wider buffer zones around streams and rivers have all increase carbon storage in forests.

Project Example: The Deschutes Resources Conservancy (DRC) in Oregon has a carbon sequestration offset project in partnership with The Climate Trust since 2003. The Climate Trust buys carbon offsets from the DRC program which gives landowners incentives to reforest denuded riparian areas with native trees. Carbon dioxide is absorbed by the young growing trees and sequestered in its biomass. The sequestration is quantified, and then The Climate Trust pays the DRC to "recruit and provide incentives to landowners to

participate in the program." To ensure the program is carried out, landowners are legally bound to preserve the trees for at least fifty years. Benefits of the project include:

- The project offsets an estimated 234,000 metric tons of carbon dioxide a year (equivalent to average annual emissions of 46,614 automobiles).
- By 2008, 1500 to 1800 acres of riparian habitat will have been restored and actively sequestering carbon.

Managing Forests for Carbon Sequestration

Long-term Carbon Storage: Carbon accumulation in forests and soils eventually reaches a saturation point, beyond which additional sequestration is no longer possible. This happens, for example, when trees reach maturity, or when the organic matter in soils builds back up to original levels before losses occurred. Even after saturation, the trees or agricultural practices must be sustained to maintain the accumulated carbon and prevent subsequent losses of carbon back to the atmosphere.

Permanence. The duration of carbon sequestration forest projects need to be at least l00 years. Each project must have mechanisms to ensure that the property and trees are protected in the long-term. Once the forest is established, it is expected that any removals will be managed on a sustained yield basis with removals aimed at high value products such as hardwood flooring, furniture, cabinetry, which would continue to sequester the carbon in durable products.

Leakage. We must address issues such as deforestation leakage from one region to another, high year-on-year forest-cover variation (from fires and natural catastrophes), and uncertainties about the permanence of CO2 sequestration. Many forest-rich developing countries lack an efficient bureaucracy capable of administering, monitoring, and enforcing forestry schemes and tackling illegal logging and agricultural clearing.

Monitoring and Quantification. Periodic monitoring of carbon sequestration projects must occur. Satellite and field-based methods allow increasingly precise measurements of net forestry changes. This could enable international compensation for countries that preserve and increase net forest cover.

Controversial Questions: Who is responsible for the carbon loss if a forest burns down? What if a forest is preserved in one region, but timber harvesting increases somewhere else as a result? These challenges can, and must, be overcome in order to achieve a stable climate because even the most technologically advanced solutions in the energy and industrial sectors can do nothing to stem the global loss of carbon and biodiversity associated with the loss of forests.

Costs and Benefits

Benefits: Practices that aim to reduce carbon losses and increase sequestration generally enhance the quality of soil, water, air and wildlife habitat.

- Tree planting that restores fuller forest cover may not only sequester carbon but could improve habitat suitability for wildlife and provide numerous benefits for water quality and local human populations.
- Preserving threatened tropical forests may avoid losses in both carbon and biodiversity, absent any leakage effects.
- Reducing soil erosion through tree planting or soil conservation measures can sequester carbon and improve water quality by reducing nutrient runoff.

US Solution: For the U.S., some analyses suggest that between 50 and 150 million metric tons of additional carbon sequestration per year could be achieved through changes in agricultural soil and forest management, tree planting, and biofuel substitution. These particular results consider the financial incentive to improve land-use practices at prices of, respectively, $10 and $50 per metric ton of additional carbon stored.

Global Solution: Forestation and avoided deforestation together offer the single largest abatement lever at 25% of the global total under $60 per ton. If the opportunity to preserve and expand the world's forests is not captured, the marginal cost of carbon would potentially increase 50% to $90 per ton, and other higher-cost sources abatement will need to be found.

Putting a Price Tag on Carbon: To make carbon sequestration economically viable, incentives will have to be offered to landowners who would be expected to forgo revenues from timber harvesting or other activities. Entire nations must be similarly encouraged to reduce CO2 emissions, and policy makers have responded with the Kyoto Protocol, an international framework for reducing global warming emissions that allows developing countries to offset their emissions by funding carbon sequestration projects.

Equity Concerns: Reforestation tends to result in economic displacement for some of the world's poorest people. Avoiding social problems and potentially violent backlashes requires involving key stakeholders and creating other opportunities for people using forests and the relevant areas. Approaches will need to be tailored as the economic drivers of deforestation vary significantly by country, for example, commercial timbering in Southeast Asia; cultivation of crops and cattle pastures in South America, and small-subsistence agriculture and demand fuel wood in Africa.

Plant for the Planet: 7 Billion Tree Campaign

Billions of Trees: In late 2006, the U.N. Environment Programme, inspired by Nobel Peace Prize winner Wangari Maathai, announced plans for a worldwide effort to plant one billion trees in one year. This initial target was easily exceeded, and by mid-2008, more than two billion trees had been planted in more than 150 countries. Leaders included Ethiopia with 700 million trees, Turkey with 400 million, and Mexico with 250 million. The state of Uttar Pradesh in India mobilized the planting of 10.5 million trees in a single day.

7 Billion Trees by End of 2009: The United Nations Environment Programme (UNEP) has launched a major worldwide tree planting campaign. In a call to further individual and collective action, UNEP has set a new goal of planting 7 billion trees by the end of 2009. The campaign now aims to catalyze the planting of 7 billion trees by the end of 2009—just over one tree for every person on the planet. Under the Billion Tree Campaign, people, communities, business and industry, civil society organizations and governments are encouraged to enter tree planting pledges online at its website (www.unep.org) with the objective of planting at least one billion trees worldwide each year.

Voluntary Action: The Kyoto Protocol provides formal, legally binding ways of achieving wider forest and climate-related goals. UNEP fully supports them. However, voluntary initiatives also offer an important focus for our mutual and even broader environmental, economic and social concerns, alongside a way of ensuring that the coming years achieve a decisive victory in the fight against climate change.

Resources: United Nations Environment Programme; *Cost of U.S. Forest-Based Carbon Sequestration*, Pew Center on Global Climate Change; *Time for Plan B*, Earth Policy Institute; *Carbon, Forests, and People*, World Conservation Union.

The Obed Community Association's purposes are community watershed education and volunteer involvement in ongoing appreciation and protection of the natural heritage of the Obed River watershed within Cumberland County. Louise Gorenflo, OWCA community educator, produced this fact sheet. Those wanting to join this membership organization or more information may contact OWCA at 484-9033 or at 185 Hood Drive, Crossville, TN 38555.