URBAN FORESTRY AND CARBON
What the Reporting Protocol Means to You

By E. Gregory McPherson

Urban forests have a role to play in reducing levels of carbon dioxide and other greenhouse gases (GHG) in the atmosphere (Abdollahi et al. 2000; Pataki et al. 2006). However, very few tree planting projects have been undertaken because of the uncertainty regarding their performance and permanence. The Urban Forest Project Reporting Protocol was developed to reduce this uncertainty by providing a standard set of guidelines for use throughout the United States. This article is meant to distill the protocol into information that is meaningful to professional arborists and urban foresters.

How Does the Urban Forest Reduce Carbon?

Urban trees reduce atmospheric carbon dioxide (CO_2) through sequestration and reducing GHG emissions by conserving energy used for space heating and cooling. Carbon sequestration is the process by which CO_2 is transformed into above- and belowground biomass and stored as carbon. During photosynthesis, atmospheric CO_2 enters the leaf through stomata, combines with water, and is converted into cellulose, sugars, and other materials in a chemical reaction catalyzed by sunlight. Most of these materials become fixed as wood, although some are respired back as CO_2 or used to make leaves that are eventually shed by the tree.

Tree shade reduces summer air conditioning demand, but can increase heating energy use by intercepting winter sunshine (Heisler 1986; Simpson and McPherson 1998). Lowered air temperatures and wind speeds from increased tree cover can decrease both cooling and heating demand. Reduced consumption of electricity and other fuels for heating and cooling results in reduced GHG emissions from power plants. Reduced emissions can be substantial, especially in regions with large numbers of air-conditioned buildings, long cooling seasons, and where coal is the primary fuel for electric power generation.

Once trees die or are cut down, they begin to decompose and return stored carbon to the atmosphere. The rate of decomposition differs greatly based on the fate of the wood. Wood that is chipped and applied as mulch decomposes relatively quickly, while wood salvaged for use in wood products can survive 50 years or more, before gradually decomposing. The combustion of gasoline and diesel fuels by vehicle fleets, and by equipment such as chainsaws, chippers, stump removers, and leaf blowers is a GHG emission source (Nowak et al. 2002). Typically, CO_2 released due to tree planting, maintenance, and other program-related activities is about 2 to 5 percent of annual CO_2 reductions obtained through sequestration and reduced power plant emissions (McPherson and Simpson 1999).

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Figure 1. Brazilian soil scientist Helvecio De-Polli collects a gas sample for measurement of greenhouse gas emissions from a long-term soil-management plot at the Beltsville Agricultural Research Center (Beltsville, Maryland).

Can the Urban Forest Make a Difference?

The California Global Warming Solutions Act of 2006 (AB32) requires a reduction in GHG emissions to 1990 levels by 2020 (CARB 2007). This amounts to a reduction of 173 Mt (million metric tons) from the predicted level in 2020. Our initial research suggests that planting lots of trees in California communities can make a difference when it comes to fighting climate change. Using aerial photography, we found 242 million empty tree planting sites in California cities (McPherson and Simpson 2003). If 50 million trees were planted, they would sequester about 4.5 Mt CO_2 (million tons) annually.

If these trees were planted strategically to shade east and west walls of residential buildings, they would reduce air conditioning energy use by 6,408 GWh, equivalent to an average annual CO_2 equivalent emission reduction of 1.8 Mt. The estimated total CO_2 reduction of 6.3 Mt annually is 3.6 percent of the 173 Mt statewide goal, about the same as would be obtained from retrofitting homes with energy-efficient electric appliances.

What is an Urban Forest Carbon Offset?

An urban forest offset sequesters carbon dioxide through implementation of a tree planting and stewardship project intended to compensate for emissions occurring at another source. One offset is equivalent to an emission reduction of one metric ton (t) (2,205 lb), sometimes called a Carbon Reduction Ton (CRT pronounced carrot).

Carbon offsets are purchased through registries such as the Chicago Climate Exchange and the Climate Action Registry to:

- offset an individual's GHG emissions and, in some cases, to demonstrate carbon neutrality
- fulfill corporate GHG reduction targets, especially when internal reductions are not feasible or cost-effective
- gain carbon market experience to increase authority and influence in policy discussions about climate change
- prepare for a potential cap and trade market, and to benefit from possible accommodation for "early-adopters"
- enhance branding by offering products that are carbon neutral at a price premium.

Although no urban forest offsets have been purchased at the time of this article, two California forests managed by non-profits, the Garcia River (Conservation Fund/Nature Conservancy) and Van Eck (Pacific Forest Trust), have contracted to sell more than

800,000 tons of offsets (DeBare 2008). Pacific Gas & Electric has purchased 200,000 tons at about $10 per CRT through its Climate-Smart program, and individuals such as Governor Schwarzenegger purchased small amounts to offset emissions from air travel. Individuals or businesses can purchase these forest carbon offsets through private companies such as Green Mountain Energy and 3 Degrees. Similar transactions are anticipated for urban forest carbon offsets once CRTs have been registered by reputable registries.

Why is a Reporting Protocol Needed?

Although urban forest offsets are an easy-to-understand concept, you are buying tree rings, eventually all trees die and the emissions claimed to be offset are released into the atmosphere. Investors cautiously assess risk to determine if permanent and equivalent offsets will result from a project. A rigorous reporting protocol and independent verification of each CRT reduce the risk and increase the value of offsets.

The Urban Forest Project Reporting Protocol provides detailed guidance to ensure that tree projects meet eligibility requirements, produce GHG reductions that are additional to a baseline, are sustained for at least 100 years, and do not detract from management of existing trees. Also, it describes how to calculate and report carbon storage by project trees, as well as emissions associated with their maintenance. A separate verification protocol is used by independent verifiers to confirm that results are accurately reported.

The protocol was adopted by the California Air Resources Board and the California Climate Action Registry (CCAR). Urban forest projects anywhere in the U.S. can follow the new protocol and be reported to CCAR's Climate Action Reserve, which will register and serialize GHG reductions after independent verification. If these offsets are sold or retired, the Climate Action Reserve will track their transaction, adding confidence and credibility to the voluntary carbon market. The accuracy, transparency and integrity of all of the CCAR project protocols have earned it the reputation as a respected and internationally recognized leader in climate change issues.

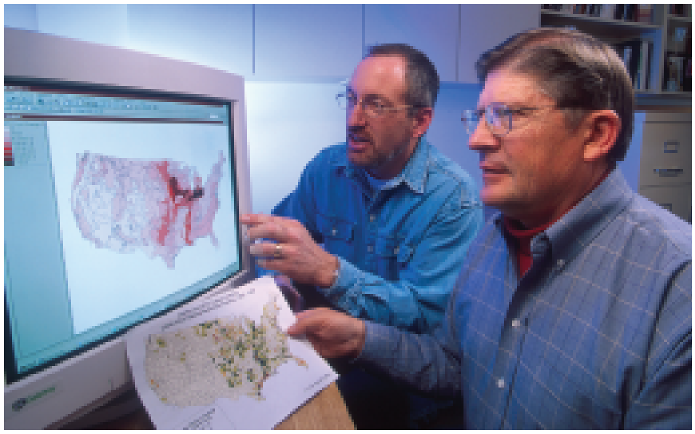
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Figure 2. USDA Agriculture Research Service soil scientists Marlen Eve (left) and Ron Follett are searching for ways to collect, or sequester, CO_2.

Considering a Tree Project?

Thinking about starting a GHG tree planting and stewardship project in your community? Here are some questions and answers.

- *Am I an eligible project developer?* At this time only cities/counties/special districts, utilities, and educational campuses are eligible project developers. Non-profits, corporations, and others can participate as project partners.
- *Will I meet the baseline by maintaining a stable population of existing trees?* On average, cities and campuses must plant a new tree for every tree they remove. Once this baseline is attained, net carbon stored by project trees can be reported as additional to the baseline.
- *Where will my tree sites be located?* Tree sites must be spaced at least 5 m (16 ft) apart. Locating sites where risk of loss due to disturbance is relatively low will increase profitability. Clustered sites will be easier to monitor than dispersed sites. Larger projects (> 1,000 tree sites) will realize economies of scale. Projects are not restricted to California, but can be implemented anywhere in the U.S.
- *How will I quantify carbon storage and emissions related to planting and care?* Measurements and growth models are used to calculate carbon storage. The CUFR Carbon Tree Calculator (CTCC) is a spreadsheet tool that can be used to estimate tree carbon. Several methods are described in the protocol for estimating GHG emissions from motor vehicles and equipment such as chain saws, chippers, and bucket trucks.
- *What level of tree monitoring is required?* A full inventory of project tree sites is required every 10 years, using either field surveys or remote sensing. Tree species and location should be recorded in a database at planting. The full inventory can be accomplished by sampling a different 10 percent of the tree sites each year. More intensive monitoring allows you to address health threats and replace dead trees sooner, but is more expensive.
- *How often will I report project activity?* Before registering reductions from a project you prepare a Project Submittal Form to list your project. Then, you submit annual reports through the Registry's online registration software.

Why Is Adoption of this Protocol Important?

Adoption of the Urban Forest Protocol sets the stage for investment in large-scale tree planting and stewardship projects because projects that adhere to the protocol's guidance will generate real, reliable, additional, and permanent GHG reductions. Registered carbon reductions are "quality offsets" that pose less risk to investors than unregistered offsets. The market for quality offsets is growing as corporations, utilities, and individuals purchase them to offset their emissions or become carbon neutral.

Although complying with the protocol reduces risk to investors, it can increase project costs because of additional expenses for reporting, verification, and long term monitoring. Project developers can defray these costs by selling quality offsets. Currently, offsets sell for $5-15 per metric ton (t), but the price is expected to increase steadily to $50-60 per ton by 2020. To achieve substantial carbon reductions, as targeted in California, some reductions may be bought for $100 per ton or more.

It is estimated that for every 1,000 tree sites planted under this protocol, on average about 40-80 t of net CO_2 storage could be registered annually, assuming trees are maintained and kept healthy. This amount could be increased substantially if it included reduced GHG emissions at power plants from cooling savings by tree shade. Because of difficulties with verification and double-counting, however, this energy conservation reduction can be reported but not registered.

To estimate the cost per ton of carbon stored for a hypothetical urban forestry project, assume that 1,000 tree sites are planted at $75 each. On average, trees are removed and replaced once at each site over the 100 year period at $175 unit cost. The average annual cost per tree site for maintenance (inspection/pruning/watering), monitoring, and verification is $10. The total project cost for 100 years is $1,250 per site or $1,250,000. If we conservatively estimate that the average amount of net CO2 sequestered annually and registered for the 1,000 sites is 50 t, the total reduction is 5,000 t over the 100 year lifetime. Given these assumptions, the project cost is $250 per CRT ($1,250,000/5,000 t).

This example and other findings (McHale et al. 2007) suggest that urban forestry projects will not be the most cost-effective option for climate protection based solely on net carbon storage. However, city trees provide other services, or co-benefits, that make them attractive investments. Utilities may reimburse projects for the GHG emission reductions that trees produce through energy conservation. Stormwater management agencies and air quality districts may purchase runoff reduction and pollutant uptake services. Urban trees produce a host of other local benefits that people easily understand and experience first-hand. These "charismatic" qualities of urban forestry offsets will make tree projects attractive for some investors, even though their cost per ton may be relatively high.

What Adoption of the Protocol Means for You

Adoption of the protocol means that the services of professional arborists and urban foresters will be needed for planning and implementing tree projects. Management practices that cost effectively increase tree growth and performance over the long term will be highly valued. Also, employment opportunities will grow for independent verifiers of urban forest projects.

The Urban Forest Protocol is especially valuable to local governments interested in sustainable activities for their communities. Using guidance in the protocol, cities can reap multiple benefits from tree projects, and collect on financial rewards through selling offsets. For the first time, municipal foresters will be able to sell some of the services their trees provide to defray the costs of management. Alternatively, CRTs may be used to offset emissions associated with local government operations.

Utilities will be under considerable pressure to reduce their emissions and are likely to ramp up their investment in carbon offsets. Some will institute their own tree projects, providing new leadership opportunities for utility arborists. Other utilities will purchase carbon offsets from local tree projects led by different project developers.

Colleges and universities that are integrating sustainability as a core value in campus operations will start tree planting and stewardship projects. Grounds managers, students, and faculty can share learning opportunities as they select and locate appropriate species, properly plant trees, and implement exemplary maintenance and monitoring programs.

Nonprofit tree groups can partner with cities and utilities to create more cost effective projects that foster community goals, such as increasing tree canopy in areas with the fewest trees.

The Urban Forest Project Reporting Protocol sets a new standard for urban tree planting and stewardship projects. Moreover, adoption by the Registry and California Air Resources Board elevate urban forestry to prominence as a credible player in climate change mitigation. Now is the time to think creatively and begin implementing pilot projects in your community.

You can download a copy of the protocol online at: www.climateregistry.org/resources/docs/protocols/progress/urban-forest/urban-forest-protocol-final-082008.pdf

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