Urban Tree Planting and Greenhouse Gas Reductions

By Greg McPherson

Several stories have appeared recently in popular news outlets suggesting that trees are not a solution in the fight against global warming. While these pop-media pieces represent the views of a few researchers, an overwhelming body of peer-reviewed research from forest scientists around the world points to the importance of forests in reducing carbon dioxide in our atmosphere and slowing the buildup of that greenhouse gas.

The pop-media pieces include a report from Reuters (Gardner 2007) in which Ken Caldeira, a Carnegie Institute climate scientist, was reported to say, "It's probably a nice thing to do, but planting trees is not a quantitative solution to the real problem." In the same article, Philip Duffy of Lawrence Livermore National Laboratory said, "If you plant a tree [CO_2 reductions are] only temporary for the life of the tree. If you don't emit in the first place, then that permanently reduces CO_2." Dr. Caldeira had made similar arguments previously in an op-ed in the *New York Times* (Caldeira 2007). A *New Scientist* article (Brahic 2006) reports results from a study by ecologist Govindasamy Bala of Lawrence Livermore National Laboratory. The model developed by Bala and colleagues indicates that, while trees planted in tropical regions have a clear net cooling effect, trees planted in mid-latitudes may absorb so much heat from the sun that they actually contribute to warming.

Because these reports fail to capture the complexity and the potential of the role that trees play in fighting global climate change, they have motivated rebuttals from the scientific community. I wrote this column to assure the public that trees do indeed reduce carbon dioxide in the air, thereby reducing the warming "greenhouse" effect of the gas, and to explain that urban trees in particular are valuable because they provide that benefit in more than one way.

First, as they grow, trees take carbon dioxide out of the air and transform it into roots, leaves, bark, flowers, and wood. Over the lifetime of a tree, several tons of carbon dioxide are taken up (McPherson and Simpson 1999). Second, by providing shade and transpiring water, trees lower air temperature and, therefore, cut energy use, which reduces the production of carbon dioxide at the power plant. Two-thirds of the electricity produced in the United States is created by burning a fuel (coal, oil, or natural gas) that produces carbon dioxide. On average, for every kilowatt hour of electricity created, about 1.39 pounds of carbon dioxide are released (eGRID 2002).

It is certainly true, as Dr. Duffy states, that not emitting carbon dioxide in the first place is a good strategy. Lowering summertime temperatures by planting trees in cities is one way to reduce energy use and thereby reduce carbon dioxide emissions. And planting trees is an immediate solution. Even if we were able to switch immediately to fuel sources that do not emit carbon dioxide, the levels in the air will remain high for decades or even centuries because of the long "lifetime" of carbon dioxide. Urban forestry doesn't require the development of new technologies or massive investment in alternative energy sources. Planting a tree to shade a building is something all of us can do now.

The following sections address the other claims previously made.

Are Carbon Dioxide and Other Greenhouse Gas Reductions from Tree Planting Temporary?

In a sense, yes. Greenhouse gas reductions are temporary if trees are removed and not replaced. To achieve long-term reductions, a population of trees must remain stable as a whole. This requires a diverse mix of species and ages so that the overall tree canopy cover remains intact, even as individual trees die and are replaced. Although sequestration rates will level off once an urban tree planting project reaches maturity, the reduced emissions due to energy savings will continue to accrue annually. Dead trees can be converted to wood products or used as bioenergy, further delaying, reducing, or avoiding greenhouse gas emissions.

Dr. Caldeira suggests in the Super Bowl article (Gardner 2007) that tree planting projects are "risky." They may appear more risky than reducing emissions by building solar or wind farms because the tree-related climate benefits are less easy to document and because the 50- to 200-year life span of a tree seems less permanent than a new power plant. This uncertainty can be offset by legally binding instruments such as contracts, ordinances, and easements that

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guarantee tree canopy in perpetuity. And, of course, trees and alternative energy sources are not mutually exclusive—both have a place in reducing carbon dioxide emissions.

Will Urban Tree Planting in Mid-Latitude Cities Result in Zero or Even Negative Climate Benefits?

Dr. Bala's study discussed in the *New Scientist* article (Brahic 2006) describes two main ways trees lower temperature: they remove carbon dioxide from the air, reducing the greenhouse effect, and they release water vapor, which increases cloudiness and helps cool the earth's surface. But because tree leaves are dark, they also absorb sunlight, which increases the temperature near the earth's surface. The difference between trees in tropical latitudes and those in mid-latitudes has to do with the difference in how much sunlight forests reflect compared to other possible surfaces, such as grass or crops. "Shiny" surfaces reflect more sunlight back into the atmosphere than forest vegetation, resulting in less heat trapped near the earth's surface. Large-scale tree planting projects that replace highly reflective surfaces with forests will result in more heat trapped near the ground during winter.

The startling conclusion that tree planting increases global warming by absorbing more heat, especially in temperate latitudes, is based on modeling of the reflectance (albedo) of forest canopies that are darker than snow, grass, or crops and, therefore, absorb more heat. The models rely on various assumptions, such as widescale afforestation (in other words, broad plantings of trees on grass and croplands). While more precise measurements may be warranted, the necessary conclusion that the earth would be cooler if the forests were cut down defies common sense and is neither realistic nor ecologically desirable.

In cities, the climate effects of incremental darkening from increased tree canopy cover are even less relevant. Asphalt, concrete, and roof surfaces account for 50 to 70 percent of urban areas, with the remaining area covered by trees, grass, and bare soil. The difference in the albedos of the different urban surfaces is small. Vegetation canopies have albedos of 0.15 to 0.30, the albedo of asphalt is 0.10, that of concrete and buildings is 0.10 to 0.35, and the overall albedo in low-density residential areas is 0.20 (Taha et al. 1988). In cities, increasing urban tree canopy cover does not appreciably alter surface reflectance or increase heat trapping.

At the same time, as previously described, a number of field and modeling experiments have found that urban trees reduce summertime air temperatures through evapotranspiration and direct shading (Akbari and Taha 1992, Rosenfeld et al. 1998, McPherson and Simpson 2003). This reduces energy consumption and the emissions related to energy generation. Recognizing the climate benefits of trees, the California Climate Action Team report (2006) recommended planting 5 million trees in cities to reduce 3.5 million metric tons of carbon dioxide. Our recent study found that by planting 1 million trees, the Million Trees LA program will reduce atmospheric carbon dioxide by about 1 million tons over the next 35 years, equivalent to taking 7,000 cars off the road each year (McPherson et al. 2007). Since 1990, Trees Forever, an Iowa-based nonprofit organization, has planted trees for energy savings and atmospheric carbon dioxide reduction with utility sponsorships (McPherson et al. 2006). More than 1 million trees have been planted in 400 communities with the help of 120,000 volunteers. These trees are estimated to offset carbon dioxide emissions by 50,000 tons annually.

Do Tree Planting Projects Give People a Feel-Good Illusion That They Are Slowing Global Warming?

The climate benefits of trees in mid-latitude cities are not an illusion, although they certainly feel good. Reductions in atmospheric carbon dioxide are achieved directly through sequestration and indirectly through emission reductions. Still, planting trees in cities should not be touted as a panacea to global warming. It is one of many complementary bridging strategies, and it is one that can be implemented immediately. Moreover, tree planting projects provide myriad other social, environmental, and economic benefits that make communities better places to live. Of course, putting the right tree in the right place remains critical to optimizing these benefits and minimizing conflicts with other aspects of the urban infrastructure.

The solutions to the problem of climate change are as complicated as the mechanisms of global warming itself. It is far too early, and we have too little information to have decided to invest only in strategies that reduce fossil fuel emissions. Certainly we must transform the way we produce and consume energy. Doing so will require the brightest minds of science, the staunchest will of politicians, and a great deal of time, effort, and money.

In the meantime, we can all plant a tree.

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