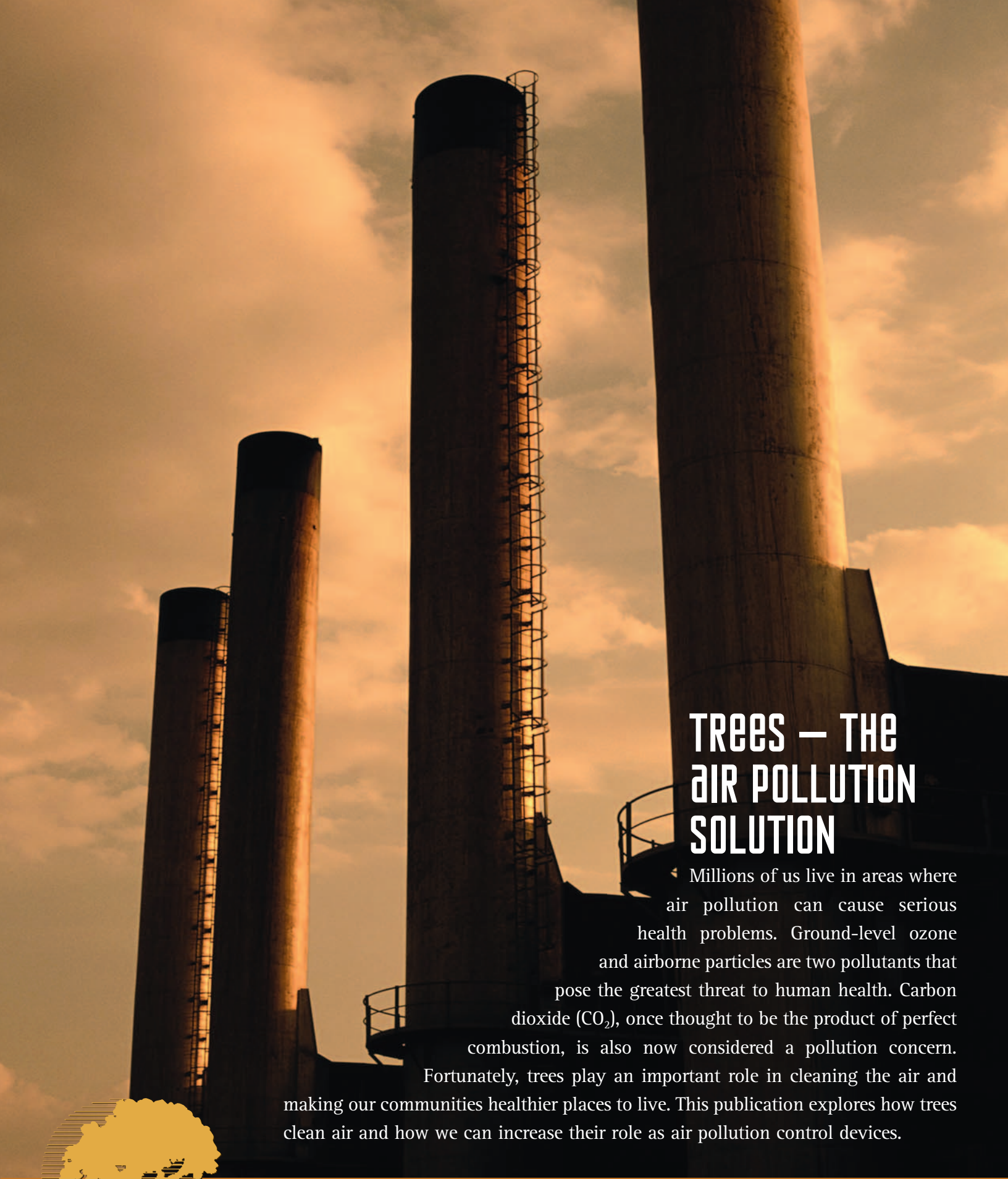

Trees – The Air Pollution Solution

Millions of us live in areas where air pollution can cause serious health problems. Ground-level ozone and airborne particles are two pollutants that pose the greatest threat to human health. Carbon dioxide (CO_2), once thought to be the product of perfect combustion, is also now considered a pollution concern. Fortunately, trees play an important role in cleaning the air and making our communities healthier places to live. This publication explores how trees clean air and how we can increase their role as air pollution control devices.

Center for
Urban Forest Research

THE TREE SOLUTION

THE POLLUTANTS

OZONE *is not emitted directly, but is created by chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOCs) in sunlight. The rate of ozone formation is increased by higher air temperatures. Emissions from industrial facilities and electric utilities, motor vehicle exhaust, gas vapors, and chemical solvents are some major sources of NOx and VOCs.*

PARTICULATES *Particle pollution consists of microscopic solids or liquid droplets so small that they can be inhaled deep into our lungs, causing serious health problems. Most of them start as smoke and diesel soot and form in the air from NOx and sulfur oxides (SOx), even obscuring our visibility.*

CO_2 *is a greenhouse gas that traps the earth's heat and contributes to global warming. Human activities add greenhouse gases to the atmosphere at a rate of about 3 percent of annual natural emissions – enough to tip the balance and overwhelm the environment.*

CO_2 REDUCTION

Community trees reduce atmospheric CO_2 by storing it or by reducing demand for heating and cooling. On the other hand, vehicles, chain saws, chippers, and other equipment release CO_2 during the process of planting and maintaining trees. And eventually, all trees die and most of the CO_2 that has accumulated in their woody biomass is released into the atmosphere through decomposition. A comprehensive study of these "opposing" effects was conducted in Sacramento County, California. Its 6 million trees contribute to an annual net reduction of CO_2 by about 335,000 tons. Of that total, 262,300 tons of CO_2 remain sequestered in the trees. But, the encouraging piece of this annual reduction is that an additional 83,300 tons – nearly 25% of the reduction – is attributable to tree shade on homes, buildings, and other structures. The CO_2 released due to tree planting, maintenance, and other program-related activities is only about 2 – 8 percent of annual CO_2 reductions and the release of CO_2 through decomposition accounts for only another 1 percent. So, the total CO_2 released in Sacramento County is less than 10,600 tons per year.

OZONE & PARTICULATE REDUCTION

Three factors principally affect the uptake of ozone and particulates: concentrations of pollutants, canopy cover, and "surface roughness." Sacramento County's 6 million trees remove approximately 1,607 tons of air pollutants annually. As expected, they were most effective at removing ozone and particulate matter (PM_{10}). These trees removed 665 tons of ozone and 748 tons of PM_{10}.

WHAT IS THIS SERVICE WORTH?

Our findings indicate that the reduction of atmospheric CO_2 by the 6 million trees in Sacramento County has a current annual value of $3.3 million. That means that each tree's contribution is worth $0.55/yr on average. The total value of the annual reduction of ozone and particle pollution is $28.7 million, or nearly $5 per tree on average. However, it is important to understand that even though trees are highly efficient at reducing air pollution, their contribution to the overall reduction of air pollutants is fairly small, amounting to only about 2 percent of the total emitted. Nearly 98% of air pollution is currently not being "treated" by trees.

THE STRATEGY: The Planting Solution

Get trees into your State Implementation Plan:

1. Conduct a resource assessment. Assess the current canopy cover in your Air Quality Management District (AQMD). Determine how many potential sites could be successfully planted or regenerated.
2. Develop a range of planting scenarios representing business as usual, and selected future plantings to determine the impact of different species mixes and tree densities on air quality 10 to 40 years in the future.
3. Model the effects of planting scenarios on air quality. Using data in the canopy cover assessment, conduct a modeling analysis to account for the following:
   - Impacts of air temperature changes on atmospheric chemistry including formation of ozone, other oxidants and particulate matter.
   - Impacts of deposition (removal of pollutants from the atmosphere) changes on air pollutant concentrations.
   - Impacts of increased tree cover on biogenic volatile organic compounds (BVOCs) emissions. Emissions of BVOCs are of concern because they are precursors to ozone and particulate matter formation.
   - Impacts of avoided emissions changes. Avoided emissions may occur because of reduced urban temperatures resulting from increased tree cover. Examples include reduced mobile source emissions and reduced emissions related to power generation for air contitioning.
4. Develop a plan to increase tree canopy cover based on the modeling. Be sure to consider the number to plant, where to plant, species (particularly the high emitters of BVOCs), growth, ultimate size, maintenance requirements, and mortality. For information on tree selection go to: *http://selectree.calpoly.edu*
5. Consider developing a database to account for new plantings and a change in tree canopy cover. This program evaluation will be required to verify that the estimated increase in canopy is attained. One idea being used in Houston is a web-based system for tracking new plantings.
6. Submit measure within your State Implementation Plan (SIP). Since trees are new to the SIP process, work with your EPA regional office and local AQMD to develop your tree canopy enhancement program.

Consider both urban forestry options – new tree plantings and preservation of canopy.

1. New tree plantings include all trees added to your area, both public and private. Be sure to count any natural regeneration.
2. Preservation of canopy is a totally different approach. The goal here is to maintain existing canopy cover and you must demonstrate that canopy was preserved by incorporating various urban development strategies. In other words, a predetermined loss of canopy was avoided because of your intervention.

Increase the traditional tree planting programs in your state.

Don't stop what you are already doing. Make a good thing better.

Think extremely long term (40-50 years).

Once you have reached attainment, planting millions of trees to mitigate air pollution will be part of a long-term plan. Bad air quality is a regional problem that requires a regional solution, especially one requiring millions of trees. Communities must work together in public-private partnerships to achieve better air quality.

Develop a Greenprint project for your region or state.

Greenprint in the Sacramento, California region is a great example of how to establish a regional coalition. Greenprint invites a region's cities and counties to develop livable and sustainable communities by building the best urban forests. Adequate tree canopy contributes to a healthy community. For more on Greenprint go to: *http://www.sactree.com/aboutUs/programsServices/greenprint/STF_GP_broch_v12.pdf*

Continue caring for and nurturing your existing trees.

They already provide the benefits you are seeking. The air pollution solution is to add more of them.

Follow the progress we are making as a nation.

Periodically visit our partnership website at: http://*www.treescleanair.org*

Resources

Geiger, J.R. 2002. *Green plants or power plants?* Davis, CA: Center for Urban Forest Research, Pacific Southwest Research Station, USDA Forest Service; 4p. Research summary. *http://www.fs.fed.us/psw/programs/cufr/products/3/cufr_148.pdf*

Geiger, J.R. 2002. *Where are all the cool parking lots?* Davis, CA: Center for Urban Forest Research, Pacific Southwest Research Station, USDA Forest Service; 4p. Research summary. *http://www.fs.fed.us/psw/programs/cufr/products/3/cufr_151.pdf*

McPherson, E.G., D.J. Nowak, and R.A. Rowntree. 1994. *Chicago's urban forest ecosystem: results of the Chicago urban forest climate project.* Part 2. NE GTR-186. Radnor, PA: USDA Forest Service, Northeastern Forest Experiment Station, 201. *http://www.fs.fed.us/psw/programs/cufr/products/cufr_188_gtr186a.pdf*

McPherson, E.G. 1998. *Atmospheric carbon dioxide reduction by Sacramento's urban forest.* Journal of Arboriculture. 24(4): 215-223. *http://www.fs.fed.us/psw/programs/cufr/products/cufr_26_EM98_9.pdf*

McPherson, E.G. and J.R. Simpson. 2003. *Potential energy savings in buildings by an urban tree planting programme in California.* Urban & Fischer Verlag. Urban Green. 2 (2003)L 073-086. *http://www.fs.fed.us/psw/programs/cufr/products/cufr_415_energy-savings.pdf*

Nowak, D.J. 2005. *Strategic tree planting as an EPA encouraged pollutant reduction strategy: How urban trees can obtain credit in State Implementation Plans.* Syracuse, NY: Northeastern Research Station, USDA Forest Service. P.7. *http://www.wflccenter.org/ts_dynamic/research/22_pdf_file.pdf*

Scott, K.I., E.G. McPherson and J.R. Simpson. 1998. *Air pollutant uptake by Sacramento's urban forest.* Journal of Arboriculture. 24(4): 224-234. http://www.fs.fed.us/psw/programs/cufr/products/cufr_27_KS98_43.PDF

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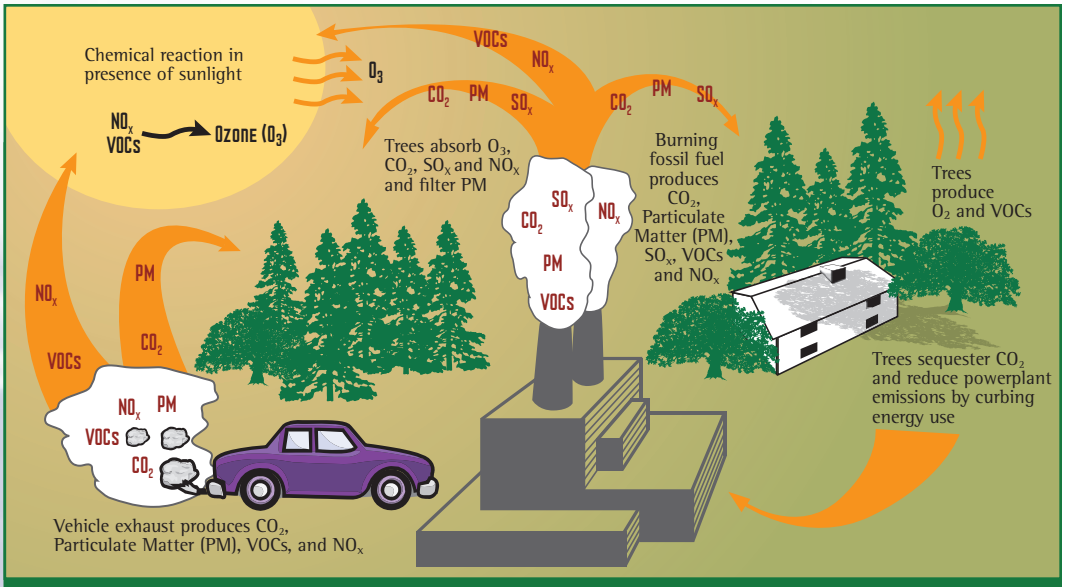

The Tree Factor – "Green Cleans"

Trees absorb, bind, intercept, and sequester pollutants. They also reduce air temperatures, provide shade, and reduce winter wind to curb energy use.

Pollutants: Particulate Matter (PM), Carbon Dioxide (CO_2), Nitrogen Oxides (NOx), Volatile Organic Compounds (VOCs), and Sulfur Oxides (SOx)

Community trees help to reduce air pollution by:

- absorbing the gaseous pollutants through leaf stomata during the normal exchange of gases.
- binding or dissolving water soluble pollutants onto moist leaf surfaces.
- intercepting and storing larger particulates on outer leaf surfaces, the epidermis, which may be waxy, resinous, hairy, or scaly.
- capturing and storing particulates on the uneven, rough branch and bark surfaces.
- sequestering CO_2 aboveground in woody tissue and belowground in the roots.
- lowering local air and building temperatures through transpiration, shading, and reducing winter wind infiltration, thus lessening the demand for cooling and heating and the formation of ozone.

Planting Pollution Control

What an opportunity!

The contribution of trees could be substantially increased if we strategically plant a large number of trees and provide long-term stewardship to maximize their health and longevity. This will maximize their benefit potential and provide us with future energy savings and improved air quality. A study we conducted in 2002, and summarized in *Green Plants or Power Plants*, found that 50 million new trees in California would eliminate the need for seven new 100-megawatt power plants—and all of the resultant air pollution.

For Additional Information On:

Controlling air pollution with trees go to:
http://www.fs.fed.us/psw/programs/cufr/products/cufr562_Newsletter_Jan05_Special_Edition.pdf

Air pollution and the law go to:
http://www.epa.gov/oar/oaqps/peg_caa/pegcaain.html

The Clean Air Act go to:
http://www.epa.gov/air/caa