Guidelines for Evaluating Atmospheric Carbon Dioxide Reductions by Urban Forestry Programs

Jim Simpson and E. Gregory McPherson
USDA Forest Service, Pacific Southwest Research Station
Davis, California

Urban forestry can be a cost effective option to achieve substantial greenhouse gas reduction in addition to other social, economic, and ecological benefits. This paper describes an analysis tool that utilities and other organizations can use to evaluate and report net carbon dioxide emissions avoided and sequestered by urban forestry programs throughout the U.S. Uses include 1) projecting future CO2 reductions from proposed programs, 2) reporting CO2 reductions from existing programs, and 3) design of cost effective urban forestry programs. Results can be used to calculate cost per ton of CO2 saved (net value). Application of the tool is demonstrated using a proposed program (Boulder City, NV) and an existing program at a military base in Tucson AZ. In addition to providing information for quantifying CO2 reductions, the U.S. Forest Service General Technical Report contains information on program design and delivery (i.e., tree selection and siting guidelines, tree planting instructions, tips for increasing cost effectiveness). Quantifying net CO2 reduction from an urban forestry program is a three step process. The user first enters input data using regional defaults (the Short Form) or locally specified values of utility, building, site, tree and program delivery information (the Long Form). Second, regional data on CO2 impacts (e.g. lbs CO2 per tree or per building) from Look-up Tables are combined with the input data to estimate annual impacts for mature trees. Finally, mature results are adjusted to account for tree growth and mortality and to calculate net CO2 reduction every 5 years. A 40 year planning horizon is used. Benefits accounted for are carbon sequestration in tree biomass and CO2 emissions avoided due to reduced space conditioning demand fostered by trees. CO2 released through decomposition of dead trees, maintenance, nursery, and other program activities are included.

Avoided CO2. Space conditioning energy use is reduced in summer by tree shade (direct effect). In addition, lowered air temperatures and wind speeds from increased regional tree cover (indirect effects) produce a net decrease in cooling demand (reduced wind speeds by themselves tend to increase cooling demand). In winter, reduced wind speeds decrease heating requirements, while shading has the opposite effect. A combination of extensive energy analysis computer simulations and results taken from the literature are used to quantify these effects for 11 climatic regions of the United States, accounting for regional differences in utility, building, site, tree, and program characteristics. Carbon dioxide emissions avoided due to these energy savings are calculated using utility-specific emission factors. Energy savings attributed to shading and climatic amelioration can be accounted for separately (i.e., a park tree that
provides no building shading).

Sequestration. Carbon sequestration rates (expressed as equivalent mass of CO2/tree/year) are determined from biomass equations based on tree dimensional relationships (stem diameter, tree

height), growth rates, and species commonly planted in each region. Biomass equations were selected from a number of sources and evaluated for accuracy in predicting dry weights for several tree species for which actual weights were known. Sequestration rate is determined as difference in CO2 storage between current and previous year for each tree size.

Decomposition. It is conservatively assumed that dead trees are removed and mulched in the year that death occurs, and that 80% of the carbon is volatilized as CO2 in the same year. Total annual decomposition is based on the number of trees of each size class that die in a given year combined with calculated biomass for those trees. The user can select from a menu of mortality rates or enter custom values.

Maintenance. City arborists, private tree service providers and the literature were used to estimate work and equipment operation time as a function of tree size; e.g., more maintenance was required for larger trees. Equipment running time was converted to CO2 emissions with estimates of vehicular and maintenance equipment (chain saws, chippers, equipment trucks) fuel consumption.

Nursery and Program. CO2 emissions result from nursery operations and program administration, including office space electricity and natural gas use, vehicle use, and tree production area energy use. Energy consumption (kWh, MBtu or gallons) estimated by one of three optional methods is converted to pounds of CO2 released.

Global Climate Change: Science, Policy, and Mitigation/Adaptation Strategies

Proceedings of the Second International Specialty Conference
October 13-15, 1998
Washington, DC

Edited by:

John Kinsman
Edison Electric Institute
Washington, DC

C.V. Mathai
Arizona Public Service Company
Phoenix, Arizona

Mitchell Baer
American Petroleum Institute
Washington, DC

Elmer Holt
U.S. Department of Energy
Washington, DC

Mark Trexler
Trexler and Associates
Oak Grove, Oregon

Global Climate Change: Science, Policy, and Mitigation/Adaptation Strategies

VIP-89

Volume II

Publication Policy

This publication contains technical papers published as they were presented at a recent specialty conference sponsored by the Air & Waste Management Association (A&WMA). The papers have not been subject to the editorial review procedure of A&WMA, and opinions expressed therein are not to be interpreted as having the endorsement or support of the Association.

Published in September 1999.

ISBN: 0-923204-19-9

Printed in the United States of America.

Additional copies of this book may be purchased by contacting the Publications Order Department, Air & Waste Management Association, P.O. Box 1020, Sewickley, PA 15143-1020 USA, phone 1-800-275-5851 (U.S. and Canada) or +1-412-741-1288 (international); fax +1-412-741-0609; or e-mail awmorder@abdintl.com. Specify order code VIP-89.