Building the Biocarbon Economy: How the Northwest Can Lead

Re-Greening Cities: The Carbon Landscape

Greenspaces and green infrastructure to build biocarbon and climate resiliency while saving energy and tax dollars

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URBAN AND URBANIZING – THE BIOCARBON DIMENSION

Urban and suburban areas represent under three percent of the U.S. land base, around 60 million acres. That is relatively small compared to the 442 million acres of cropland, 587 million of grazing land, and 651 million of forest.[1] Nonetheless, **developed and developing areas represent biocarbon opportunities that deserve a focus for several reasons.**

FIRST, urbanization is absorbing more land. **Urbanized American land has more than doubled since 1960** when U.S. Census measurements showed urban areas occupying 25.5 million acres.[2] It is critical to control urban growth and guide toward development patterns that preserve forest cover and other carbon stocks within and around urban/suburban areas. Constraining sprawl and preserving greenspaces in urban and suburban areas are the needs.

"If recent trends continue, the expansion of urban areas will markedly outpace the growth in urban populations . . . making urban carbon dynamics very important within the global carbon cycle," write a team of urban ecologists in a study of Seattle area carbon accumulations.[3]

SECOND, enlightened city governments are already taking a lead on climate action. As of June 2010, over 1,000 U.S. cities signed on to the U.S. Mayors Climate Protection Agreement committing to efforts to meet Kyoto climate treaty goals within city boundaries. Initiated by then Seattle Mayor Greg Nickels, the agreement has grown to span the largest cities in the U.S. including New York City, Chicago and Los Angeles.

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[1] Ruben M. Lubowski et al, *Major Uses of Land in the United States 2002*, USDA Economic Research Service.
[2] Land Use, Value, and Management: Urbanization and Agricultural Land, USDA Economic Research Service, http://www.ers.usda.gov/Briefing/LandUse/urbanchapter.htm viewed June 3 2010
[3] Hutyra, L. Yoon, B. and M. Alberti. 2010, "Terrestrial carbon stocks across a gradient of urbanization: A study of the Seattle, WA region," *Global Change Biology*, forthcoming

Dozens of Northwest cities have signed on, including Portland, Spokane, Tacoma and Boise. [4]

Actions to build and leverage biocarbon resources synch well with city efforts to control sprawl, create and preserve urban greenspaces, and replace fossil fuels with biomass waste streams. And the opportunity to directly engage citizens in climate preserving activities, discussed later in this briefing, has implications beyond the amount of carbon that can be stored. (The opportunity to transform municipal waste streams into valuable products is covered in the *Recycling Carbon* briefing.)

Greener cities will also be better prepared to buffer the heat and extremes of drought and storms that will come with global warming. Local governments are already taking this into account. For example, ***Portland and Multnomah County, Oregon*** have included greenspace-oriented climate adaptation in their climate action plans. ***Seattle Public Utilities*** is one of a group of eight large city water systems that is building climate adaptation into its strategies. This includes green features as well as other strategies to harvest rainwater. ***King County,*** working with University of Washington Climate Impacts Group at the University of Washington, and ICLEI-Local Governments for Sustainability, has developed a publication to guide adaptation work around the U.S. *Preparing for Climate Change: A Guidebook for Local, Regional and State Governments*.[5]

THIRD, carbon storage potentials within developed areas are not small, as innovative research emerging from Northwest cities is demonstrating. The Seattle study noted above looked at carbon at 154 sites ranging from the city center to lots 58 kilometers distant. The study found that:

- Central Puget Sound lands store an average of 89 metric tons of live biomass carbon above ground per hectare (MTC/ha) and another 12 MTC/ha in woody debris.
- Forested areas within the region average 140 MTC/ha and hold 89 percent of live biomass carbon, while urbanized lands average 18 MTC/ha.
- Forest canopy covers 57 percent of the Central Puget Sound region.

Full results are contained in the chart below.[6]

[4] United States Conference of Mayors Climate Protection Center, http://www.usmayors.org/climateprotection/revised/ , Map of cities at http://www.usmayors.org/climateprotection/ClimateChange.asp viewed June 3, 2010
[5] Available at www.cses.washington.edu/cig/fpt/planning/guidebook.shtml
[6] Hutrya

	Impervious Surface	Live Biomass	Woody Debris
Heavy Urban	+80%	2	0.6
Medium Urban	50-80%	13	0.2
Low Urban	20-50%	38	2.6
Mixed Forest	-	98	12.7
Conifer Forest	-	182	27.1
Weighted mean		89	11.8

"Within most carbon studies, urban and urbanizing areas have only been considered as a source for emissions . . .," the researchers write. "The vegetation within urban areas has been largely ignored or assumed to be negligible within the carbon cycle . . . In this study, we have found that **the Seattle urbanizing region . . . has very significant carbon stores within its terrestrial vegetation, which do play an important role in the terrestrial carbon cycle** through a combination of carbon storage, carbon uptake, and urban land development activities."

The researchers add, **"Both the total carbon stocks and mean vegetated canopy were surprisingly high, even within the heavily urbanized areas**, well exceeding observations within other urbanizing areas and the average U.S. forested carbon stocks." Earlier studies found urban forests averaging 25 MTC/ha and U.S. forests in general at 53.5 MTC/ha.

"We were pretty astonished at how much carbon stock is out there," comments Marina Alberti, a member of the research team and director of the University of Washington Urban Ecology Research Laboratory.

"The remarkable magnitude of observed carbon stocks in the rapidly urbanizing Seattle region is particularly clear when compared to the biomass stored in Amazonian rainforests," researchers note. Central Puget Sound conifer forests at 182 MTC/ha compare favorably with the 197 MTC/ha found in a heavily studied Amazonian rainforest tract.

The Seattle region lost 40 percent of its forest cover in the last 100 years, and is projected to lose another 20 percent as metropolitan population grows 32 percent to 4.3 million by 2030. These "patterns of urbanization and sprawl . . . are not atypical for Western U.S. cities."

The Seattle region results send a broader message summed by the Seattle study team: **Pay attention to vegetation "as urban land covers and populations continue to rapidly increase around the globe."**[7]

[7] Ibid

THE NORTHWEST'S GROWTH MANAGEMENT HERITAGE

Northwest states are among the nation's leaders in growth management strategies to constrain sprawl and preserve natural greenspaces, with substantial biocarbon benefits. Oregon, the nation's original leader in state land use planning and growth management, began implementing its system in the 1970s. Washington followed in 1990 with its Growth Management Act. Today, both states require growth boundaries around cities and metropolitan areas, and have enacted policies to concentrate development in city and town centers. Growth management has preserved carbon-rich greenspaces in and around cities, even though carbon storage has not been a prime goal.

"**In the Portland metropolitan region 2040 Growth Management Plan, one of our most important efforts is ensuring there is nature in the city,"** notes Mike Houck, director of the Urban Greenspaces Institute and a veteran Portland areas greenspaces advocate. "Carbon sequestration has not been an explicit reason for doing so, at least not until recently. Regardless of the lack of explicit connection, we are doing it. **Now it's time to formalize the link between sound land use planning, carbon sequestration and climate change adaptation."**

The value of bringing climate into the picture "is huge," Houck says**. "**Many public officials are more dialed in on climate than other aspects of green infrastructure. **Climate brings in new people and strengthens our existing alliances**."

Growth management already generates unusual alliances. The original 1970s Oregon land use legislation was a product of coalitions between farmers and civic groups. That pattern is repeated in current efforts to set aside large rural reserves beyond the Portland Urban Growth Boundary for at least 40 years, "close as possible to a permanent UGB," Houck says. "We believe that within the existing UGB land can be used more efficiently." The Agriculture and Natural Resources Coalition backing expanded rural reserves includes groups ranging from ***1000 Friends of Oregon*** to the ***Washington County Farm Bureau*** and ***Oregon Association of Nurseries***.

Advancing beyond current policies, new strategies for development hold promise for biocarbon.

"The way we develop may actually influence the amount of carbon that can be stored," Alberti says.

For example, research indicates that **larger patches of greenspace could provide more effective carbon storage than dispersed vegetation, the urban forest versus street trees.**

"We can do something about protecting carbon stocks in urban areas, perhaps by cluster development that maintains a larger portion of the forest," Alberti says. "We haven't lost the battle in urban areas."

"At the urban fringe we find a lot of viability, depending on whether we develop very compact buildings or sprawl," the urban ecologist adds. "In a place with more density in terms of people and height of buildings, you have the ability to maintain more carbon stocks."

Cascade Land Conservancy is advancing the concept of "conservation villages", which cluster new rural development in a manner resembling older towns rather than spreading it out in conventional suburban fashion. That would allow greenspace blocks surrounding the village to be preserved.

"Even in the core area you still find quite a bit of carbon, primarily in small parks**,"** Alberti adds. **"There is an issue of how many trees you can keep together in developed areas. It is important to think about development practice.** The question is what rules and building codes and practices are in place for one type of urban development or another."

Refining development policies will require more site-specific research, Alberti says. "Right now we have a general understanding. But **we will not be able to provide rules until we have better understanding of urban carbon storage**."

She adds that another area in need of research is how growth boundaries cause spillover patterns such as low development in rural areas.

"Urbanization extends very much beyond what we call urban," Alberti says. "It's a big mistake if we don't pay attention to this. Depending on how we develop we will impose different resource patterns. We need to find out how much."

MOVING FROM GREY TO GREEN INFRASTRUCTURE

Moving to incorporate more green features in developed and developing areas has benefits beyond climate. **Increasingly, municipal jurisdictions are finding that economic benefits make a powerful case for greening cities and suburban areas**. Impervious street and building surfaces intensify stormwater runoff and urban heat that were absorbed by vegetation and soils before development.

Rich options to "move from grey to green" are coming to the fore in cities around the U.S. They are finding ways to create green features such as pocket wetlands, green roofs and walls, rain gardens, swales and vegetated buffers that hold water and cool the air. A U.S. Environmental Protection Agency study contrasted development strategies employing green features and conventional "hard" infrastructure. In most cases **savings of "greenfrastructure" are substantial, ranging from 15-80 percent, with reduced costs on the one-quarter to one-third range common**.[8]

[8] Dominique Lueckenhoff, U.S. Environmental Protection Agency, Green Infrastructure: *Saving Money & Water, Creating Jobs and a Sustainable Future*, Mayors Innovation Project Annual Meeting, Washington, D.C., Jan. 23, 2010. All statistics in this section drawn from presentation.

Northwest municipalities are leaders in moving "from grey to green." Portland already requires that new and redeveloped buildings manage stormwater. By disconnecting 45,000 drain spouts, one billion gallons of water that would have gone down municipal pipes now stays on site. **In Southeast Portland's Brooklyn Creek Basin green infrastructure has cut city costs for stormwater control by $63 million.** Portland's Bureau of Environmental Services has convened an expert panel to quantify a broad range of ecosystem services derived from the city's greening efforts.

Seattle is also adding green to its streets and has installed a green roof on its new city hall. King County gathers water for toilets and irrigation at its King Street Center. The new Bill and Melinda Gates Foundation headquarters includes rainwater harvesting tanks. **A 30-year goal set by Seattle to increase urban forest cover** to 30 percent from the current 18 percent is **projected to increase annual economic benefits** including stormwater management, cleaner air and carbon storage **by $15 million** to $44.6 million.

Greening cities generates many other benefits. **Chicago's extensive green roof program, buffering the urban heat island effect, is saving residents $100 million annually in energy bills.** The city hall roof alone, reducing temperatures 10-15° Fbelow a nearby tar roof, saves city taxpayers up to $3,600 on annual energy bills. If Los Angeles greened 15 percent of its roofs, a study shows, it would reduce urban temperatures by 5-9° F and save from 500-1,000 megawatts in peak power annually.

Creating green infrastructure is a source of green jobs. **A Washington, D.C., study estimates that a major green roof effort there would create 1,769 full-time jobs for 10 years.** A 10-percent tree canopy increase is estimated to reduce energy costs 5-10 percent by providing shading and windbreaks.

Green features even seem to reduce crime. **A University of Illinois study compared similar neighborhoods and found 52 percent less crime in greener areas.**

ENGAGING CITIZENS IN BUILDING BIOCARBON KNOWLEDGE

Urban and suburban areas represent by far most of the population, offering civic engagement potential with implications for climate beyond the amount of carbon that can be stored.

Grappling with climate change is tough and often overwhelming for ordinary citizens. It is a huge issue seemingly beyond the power of any one person to affect. **Biocarbon offers a literally grassroots way for citizens to engage in climate in their own backyards.** In World War II citizens were encouraged to grow "Victory Gardens." In the climate struggle, **citizens might grow "Climate Victory Gardens" through gaining understanding of how to manage their properties.** Providing a means to make a direct contribution can translate into a sense of empowerment and broader involvement with the climate issue.

Indeed, the lawn plays a more important role in land use than most people recognize. Turf grass including lawns, parks, golf courses and sports fields covers 1.9 percent of U.S. land (this includes urban and rural locations). Consuming 75 percent of the nation's household water**, turf grass covers three times more area than irrigated corn, the largest irrigated U.S. crop, and the area is growing**.

The study which developed those numbers also concluded that **"well-watered and fertilized turf grasses act as a carbon sink." But too much water, nitrogen-based fertilizer or pesticides could eliminate positive carbon balance**.[9] Another more focused study of four parks near Irvine, California concluded that greenhouse gas emissions could actually increase. CO_2 gains in grass were equaled or exceeded by fertilizer emissions of nitrous oxide, a powerful GHG, and fossil fuel emissions to pump water and run maintenance equipment.

"Green spaces may be good to have," said lead researcher Amy Townsend-Small. "But they shouldn't automatically be counted as sequestering carbon."[10]

Replacing standard lawns with native vegetation reduces the need for water, chemicals, fertilizers and energy, all lowering greenhouse emissions. In the Northwest, with its typically dry summers, water use to maintain lawns and pumping energy to deliver water are significant. So are emissions from lawn mowers. Native vegetation adapted to the climate requires much less water, chemicals, fertilizers and yard care in general. This suggests great potential for civic engagement efforts by local governments and nonprofits to drive a major shift toward native plantings. It could include education, as well as civic science work, to measure carbon accumulations and overall emissions performance of various landscaping strategies.

Engaging neighborhood groups and residents in civic science efforts will build understanding of best practices to manage urban lands for biocarbon. Portland State University is laying the foundation for such work

PSU researchers have been undertaking studies similar to those in Seattle, The PSU team is marrying remote sensing data from satellites with ground surveys by students working with residents. PSU is undertaking an exploratory analysis of urban carbon below-ground carbon stocks while the Seattle study looked at above-ground vegetation.

Neighborhood interest is "extraordinary. Receptivity is there," says Vivek Shandas, a professor at PSU's College of Urban and Public Affairs. "We want to engage citizens around the urban environment. **Without having citizens engaged much of this is not going to go far politically or scientifically."**

Civic science engaging citizens will provide "a more nuanced characterization of soil carbon in different land uses and vegetation**,"** Shandas says**. "It could lead to a better**

[9] Cristina Milesi at al, "Mapping and Modeling the Biogeochemical Cycling of Turf Grasses in the United States," *Environmental Management*, Vol. 36, No. 3, p.426-38
[10] *Los Angeles Times*, "Urban parks: a global warming downer?" Feb. 10, 2010

and more refined model for urban soil carbon sequestration. We could make Portland into a living laboratory."