Trees of Life

CAN FORESTS SAVE THE EARTH FROM GREENHOUSE GASES?

BY SUSAN SELIGSON

ADRIEN FINZI'S STATELY research subjects are uncomplaining as he and his team thread their way through the group, measuring girth, tracking fluids, and extracting samples for unsparing scrutiny. Call it Finzi's Forest. As they inch skyward, these 65-to-80-foot-tall stands of loblolly pine are serving a greater good: nurturing the air with oxygen. And as the scientists who study them know well, trees do talk. According to Finzi, a College of Arts & Sciences associate professor of biology, over the last 14 years in circular plots called rings, deep in North Carolina's Duke Forest, these pines have spoken volumes about the future of a planet under siege from carbon emissions and the extent to which forests can help rescue it.

The longest-running study of its kind, FACTS-1 (Forest Atmosphere Carbon Transfer and Storage) employs a sprawling labyrinth of pipes, steel grids, and towers to blast trees with carbon dioxide to determine how the elevated levels of the compound affect the forest over the long term. As in any rigorous study, some of the trees are part of a control group that is monitored, prodded, and blasted with nothing but placebo—the ambient air.

Crucial to the global carbon cycle, forests absorb carbon dioxide during photosynthesis, and that process is the most potent of all the natural ways carbon is removed from the atmosphere and stored on land, Finzi says. While this process absorbs nearly 30 percent of the 10 billion metric tons of carbon dioxide emissions released each year through fossil fuel combustion, he says, the carbon that remains in the atmosphere intensifies the greenhouse effect, the major culprit in global warming.

WEB EXTRA Watch a video about Adrien Finzi and his research in a North Carolina forest at bu.edu/bostonia.

As the world's climate is growing increasingly deranged by greenhouse gases—especially carbon dioxide—the refrain from many nonscientific corners is "plant more forests." But Finzi has found that conventional wisdom needs rethinking.

PHOTOGRAPHS BY MELODY KOMYEROV

"SOIL IS WHAT we study; the rest is dirt," says Adrien Finzi (facing page), kneeling at a soil boring hole that yields a sample for carbon testing. Towering loblolly pines and test trees (above right) are part of Duke Forest, a sprawling research tract originally planted for lumber.

At first glance, the FACTS site looks like a cinematic version of mischief by colonizers from outer space. Unfolding among a network of gravel roads in the U.S. Department of Energy's Brookhaven National Laboratory woodland outpost at Duke University, the field study demands gritty legwork in all seasons. Finzi loves the place. A tall, buoyant prodigy who earned an assistant professorship at 29, he has presided for eight years over the $50 million study, two-thirds of which is funded by the DOE, with the rest underwritten by the National Science Foundation and the U.S. Department of Agriculture.

LIKE AN ERECTOR SET

On a sweltering July morning, doused in bug repellent and with pants tucked into socks to discourage chiggers, Finzi and his research assistants tend to the experimental plots, which will soon be torn down as the study ends. Over the course of the study, the team has monitored the trees in ways macro and micro, from their roots to the forest canopy, from photosynthesis at the cellular level to the shedding of leaves and limbs—all of it in hopes of answering the question, can we rely on forests to reverse the effects of pollution?

Spread over 7,086 acres across a former pine plantation in Alamance, Durham, and Orange counties, Duke Forest has served science and education for 30 years. At the Brookhaven site, a gleaming tank of liquid carbon dioxide sits beside a gravel road. Finzi explains that the liquid warms as it moves along a house-sized pipe grid beside the tank, then vaporizes as it shoots through a network of pipes fanning out along the forest floor to each of the nine test sites, 90 feet in diameter. There the gas pours out of holes the size of a quarter in a series of pipes that soar up to the crown of the clustered pines they encircle.

Completing this eerie—and noisy—setup is a faintly wobbly tower that looks like an Erector set at each plot's center, which researchers can scale to have a look at the experimental plots and beyond the treetops to the hills of Durham and Chapel Hill.

"In the beginning the carbon dioxide was pumped around the clock," Finzi says. "That got too expensive, so now it's pumped into the forest from just before dawn to after dusk, which costs a million dollars a year."

Over the years, as the young forest grew, so did the amount of carbon dioxide required. Planted in 1984, the forest now has a hardwood "understory," Finzi says as he leads the way deeper into the oak-studded piney woods along a narrow path that hugs the

ALTHOUGH DATA MINING can be intrusive, the trees in Finzi's control quadrant (top left) aren't pelted with carbon dioxide. All samples, such as forest debris (top right) and soil diluted for nitrogen testing (bottom right), are carted back to the lab for analysis.

carbon dioxide pipe. Along the way are junctures with signs pointing toward the numbered rings, and the steel of the experiment's infrastructure reflects sunlight through the trees. Wildlife—mostly deer—are unperturbed, and their browsing, which doesn't discriminate between carbon dioxide–fed rings or control rings, is one of many wild cards in this unwieldy project.

"The carbon dioxide gets blown around, so the effect is very realistic," Finzi says. Today's destination is Ring 9, the oldest, where his team is gathering data and injecting soil at the test sites with "heavy" nitrogen isotope—with an atomic weight of 15 rather than the usual, ubiquitous 14—that can be traced later in the lab. "This is an island of carbon dioxide," he says, adding that the environmental impact of the experiment itself is negligible, "less than chump change. It gets diluted so quickly. The knowledge we gain is far more than the environmental cost. It's really important, what we're measuring here."

After nearly a decade and a half of activity, the rings look both festive and clinical, part pagan carnival, part intensive care unit. The trees themselves are belted and swathed in strips of silvery space blanket material, secured with bungee cords and dripping computer cables that crawl down the bark like kudzu. Here and there, immense Coleman coolers keep data recorders dry in all weather. Nothing is as whimsical as it appears; every flourish is in the service of science.

FINZI'S CREW SPENDS a lot of site time getting down and dirty, gathering samples ranging from soil to sticks to leaves from deciduous undergrowth.

» Forests absorb carbon dioxide, eliminating 30 percent of the 10 billion metric tons released each year by fossil fuel combustion.

"Some of this is standard for tree and soil studies, and some was designed by Adrien and built in the basement," says John Drake, a BU postdoctoral fellow and research associate. Drake and Joy Cookingham, Finzi's longtime assistant, know these rings like they know their reflections in the mirror.

As he uncaps a pipe poking from the forest floor, Finzi explains that the pipe is a window to the trees' roots.

"Root growth is really hard to measure, so we do it visually, by inserting micro cameras," he says. Both corrals and laundry baskets cradle debris, from seeds and leaves to "coarse wooden debris," more commonly known as sticks, that will be carted back to the lab, weighed, and analyzed. The steel bands, called dendrometers, encircling every one of the thousands of trees studied here are calibrated to measure growth; like the waistband of stretch pants, a small length of spring allows them to expand with the tree trunk. And the space blankets stabilize the temperature of sap flow meters, also called water sensors, which measure photosynthesis, information stored in the data loggers and transferred to laptops by Finzi's crew of assistants, graduate students, and postdoctoral fellows.

"The water sensors measure the rate of water movement in the tree's stomata, which open during photosynthesis," says Finzi. "The higher the rate of water movement—measured with heat readings, hence the added insulation—the more photosynthesis."

FERTILIZER EFFECT

Initially, pumping more carbon dioxide into their environment made the trees convert carbon to sugars and woody cellulose more efficiently, supporting the view—one Finzi finds overly simplistic—that forests naturally compensate for increased carbon levels in the atmosphere.

"Initially the carbon dioxide works as a fertilizer, stimulating growth 20 to 30 percent," says Finzi. But longer-term experiments have shown that the effect levels off.

At FACTS-2, at Oak Ridge National Laboratory in Tennessee, another DOE facility, the fertilizer effect dropped way back after six years. And at Duke the fertilizer effect has made the trees grow quicker, so the overall benefit decreases; it isn't continuous, Finzi says.

"Watch out for wolf spiders," he calls to a straggler as he trots up the seemingly perilous wobbly stairs to the forest canopy. From his perch 125 feet above the forest floor, Finzi puts the study into perspective. The site served him and his team far better than expected. Animals moved in and out of it freely, and the infrastructure didn't succumb to weather; a Category 3 storm plowed right through it and all the grids and towers held.

One of the most productive of a global network of carbon dioxide evaluation sites, research here spawned 250 scientific publications. And as scientists around the world look to projects like these to assess and head off global warming, results so far point to just one conclusion: carbon dioxide can stimulate productivity of some forests, but not all.

"The conclusion of the study is bittersweet," says Finzi.

"Our research shows that we can't expect forests to soak up all the carbon dioxide, and different forests soak up different amounts," he says. "The research here is very useful for climate models of global warming. And it shows that early predictions of climate models were very overly generous. Planting more forests can't absorb all the impact of fossil fuels and rampant deforestation."

Although the FACTS project leaves a trove of data that will be analyzed for years to come, Finzi is certain of one thing even before the first ring is harvested: "Simply planting more trees is not the solution."