



FOREST CANOPY ECOLOGY

Effects of a Severe Summer Storm at SERC

Characteristics and Ecological Consequences of a Disturbance in the SERC Forest

by Brianna Smith, Forest Canopy Lab

On the evening of June 5th, 2002, warm summer breezes passed through the SERC forest as the setting sun met a leafy horizon. This peaceful mixed-deciduous forest, however, was about to experience a destructive summer storm. Just before 9 p.m. high winds and heavy rains crashed into the area and quickly passed through. Numerous limbs were torn from trunks and healthy live trees were snapped off or ripped from the ground, leaving large openings in the canopy.

Often the damage happened in localized groups, affecting several trees and sometimes a falling tree affected neighboring trees. Fallen trees brought down power lines and electricity was not restored until the next afternoon. Oddly, though the damage was severe, the overall area affected was small. SERC had probably been hit by a **microburst**, a powerful short-term, localized type of wind gust.

An event such as this summer storm is called a **disturbance** by ecologists because it can have a dramatic impact on the structure and productivity of an ecosystem. A disturbance is defined as a relatively discrete event that



Figure 1. A fallen tree, the result of the storm on June 5.

storm. This area, called the "Big Tree Plot," includes the central part of the old Java Farm and adjoining lands belonging to our neighbor to the north, Y. Kirkpatrick-

disrupts the structure of an ecosystem, community, or population, and changes the physical environment or the availability of resources. The causes, patterns, and consequences of disturbances are major research topics in ecology. There are many types of natural disturbances, from the violent winds of hurricanes, tornadoes, and thunderstorms to loading of ice storms and out-of-season snowfalls to biological events such as insect outbreaks, diseases, and invasive species. Humans can also cause disturbances through, for example, damming waterways, land clearing, and landscape fragmentation.

Comparing before and after

How do you determine the effects of a disturbance on the forest? One way is to determine how the individual trees have fared. To do this you really need an idea of their condition **before** the event. Luckily, over the last decade, the SERC Forest Canopy Lab has been studying trees in an area that was affected by the

Howatt. It's a large study area, about 47.5 hectares (117 acres) in size—about the size of 106.5 football fields or 2840 volleyball courts. Historical accounts tell us that the land used to be managed as pasture and farmland. Over the past ten years SERC's Forest Canopy Lab has, with the help of many volunteers, regularly recorded information on every tree in the plot over 20 centimeters in diameter, measured at breast

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height—a standard method used by forest ecologists—noting the species, whether it is live or dead, the diameter, and the location and elevation of the tree. We had also recorded information on each tree's dominance class—either dominant, codominant, intermediate, or suppressed—a characteristic that is determined by the position of the tree's crown relative to the neighboring trees (see Figure 3).

With this information, we were in a unique situation to assess, in a quantitative way, the damage to the forest by the storm. Moreover, because we had information on the location of all the trees, we could also examine how the effects of the storm were spread over the landscape and create maps showing the trees and their conditions.

Based on a preliminary survey we took to understand the nature of this particular storm, we devised a scheme for classifying tree damage, and then, with the help of many volunteers and interns, set out into the field to assess the damage to all the trees within the Big Tree Plot. We took compass readings to determine the direction trees had fallen and wrote down the cause of the damage to each tree. The damage was either *direct*, directly caused by the storm, or *indirect*, caused by another tree—the result of a kind of “domino effect.” Tree damage was further classified into categories of either major (snapped, topped, and uprooted trees) or minor (loss of branches) damage. After the fieldwork, which took about a month to finish, we used Geographic Information System (GIS) software to organize the spatial information of the damage and to make maps. We also estimated the elevation of the trees using a high-resolution map of the ground surface provided by Steve Prince at the University of Maryland, College Park.



Figure 2. Brianna Smith in the Big Tree Plot where she is assessing the effects of the storm to the forest. Behind her are the remains of a sycamore and a white oak that snapped in the storm.

We had several ideas about how the storm affected the forest. With the data we collected in the field, we could determine whether the damage to the trees was random or that the storm had affected different trees in different ways. We were also interested in knowing whether the direction in which the trees fell was random and, finally, what the impact of the storm was on the forest's production of biomass, a measurement of the amount of plant materials in the forest.

Was the damage to the trees random?

Overall, we found that 4.28 percent of all 9,528 trees in the plot were damaged by the storm; 21 different tree species were affected in 22 different categories of damage. Our research showed that the

storm damage to the forest was not random among the trees. Although tulip poplars were the most commonly affected species (35 percent of the total number of trees damaged), only 5 percent of all tulip poplars in the plot were damaged, while a higher proportion (7.8 percent) of the Southern red oaks in the plot were damaged by the storm. Also, trees with their leaves above or at the outer edge of the canopy—the dominant and codominant trees—experienced more minor damage than you would expect if the damage to the trees had been random, while the intermediate and suppressed trees experienced less damage. Similarly, larger trees, especially those with a diameter between 80 and 100 centimeter, experienced more damage than would be expected if the damage were random, while smaller trees did not have as much damage as expected. And, finally, trees in low elevation, floodplain areas were also damaged more than expected. In short, the effects were not random, and especially Southern red oaks, dominant and codominant trees, trees with a larger diameter, and trees rooted in the lower areas of the plot were damaged in the storm.

Did the trees fall in a random direction?

Most trees that fell during the storm fell toward the northeast (at an

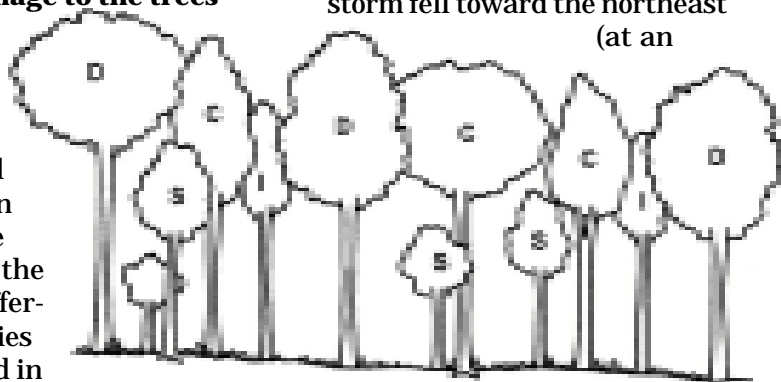


Figure 3. Classification scheme for tree dominance. Dominant trees (D) hold their crowns above their neighbors, codominant (C) and intermediate (I) crowns are at or below the outer canopy, and suppressed trees (S) are well underneath. Figure drawn by Rehanna Chaudhri.

angle of 65°, with a mean angular deviation of 49°). (See Figure 4.) While live trees very often fell in this direction, standing dead trees fell in a variety of directions, which could be due to existing structural weaknesses in those dead trees. In addition, landscape features such as hills and gullies may have affected tree fall direction by shaping the way the winds moved. Because the tree fall was not random but mostly toward the northeast, this may indicate the wind direction during the storm.

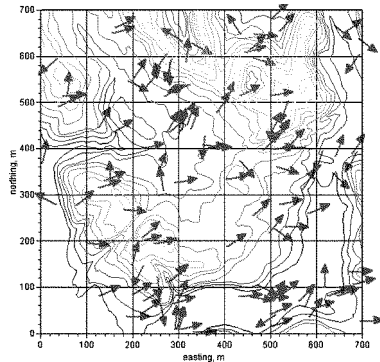


Figure 4. A map showing tree fall direction, indicated by the arrows. Most trees fell towards the northeast, indicating a potential wind pattern in that direction.

How did the summer storm affect the forest's biomass?

We estimate that in a year without a major disturbance a forest in the development stage of the Big Tree Plot would produce about 8.2 megagrams (Mg) of biomass per hectare, consisting of both wood (4.3 Mg) and leaves (3.9 Mg). (1 hectare is about 2.5 acres; 1 Mg is about 1 English ton.) This is a lot of biomass that is added to the forest each year, but when we calculated the amount of biomass lost in the storm we found that minor and major damage to the trees reduced the standing biomass—the amount of living plant material—by about 6.3 Mg per hectare, a number that is in the range of the biomass normally produced.

With a normal increase of 8.2 Mg per hectare per year and a loss of 6.3 Mg per hectare per year, almost a year's worth of growth was destroyed in the storm! Moreover, the amount of dead plant material in the forest nearly tripled (from 3.9 to 10.2 Mg/ha), due to the many fallen branches and

trees. Over time, the material will be broken down by decomposers, such as invertebrates, fungi and bacteria. This increase in decomposition creates a shift in the carbon

balance of the forest, changing it from a carbon sink to a source. Overall, as the storm proceeded in a northeasterly direction, trees in low-lying areas were especially vulnerable, as well as trees that had dominant

crowns and larger diameters than their neighbors. In an event that only affected about four per-

cent of the trees, the production of biomass by the forest was set back almost a year.

The storm, the information collected the past ten years, and the quick response of the Forest Canopy Lab staff and volunteers created a great opportunity to study the effects of this disturbance, perhaps a microburst, on the individual trees and the ecosystem of this part of the forest. Still, much more could be known about the meteorological characteristics of the storm and one of our next steps will be to see if local weather monitoring stations have meteorological data that could improve our understanding of local wind patterns during the climax of the storm. Integration of such data into our damage assessment might strengthen our hypothesis that the wind direction was northeasterly and also support our hypothesis that a microburst was the cause of much of the direct storm damage.

Although the storm is long gone, the effects of it can be seen

in the landscape for a long time to come. And the staff, interns and volunteers of the Forest Canopy Lab will be out there, collecting data to understand the complex processes that underlie the ecological processes of this mixed-deciduous forest at SERC, and others like it.

Brianna Smith was an intern in the Forest Canopy Lab. For more information you can contact Smith at smithbr@si.edu or visit the Forest Canopy Lab web pages at http://www.serc.si.edu/forest_ecology/forest_ecology_index.htm.



Figure 5. More storm damage: a branch speared into the forest floor. An example of the powerful and violent nature of the storm.

The research described in this article would not have been possible without the help of the following people: **SERC Forest Canopy Lab:** Dr. Jess Parker • Michelle Berger • Rehanna Chaudhri • George Raspberry **SERC Ecological Modeling and Spatial Analysis Lab:** Nancy Lee **UMCP – Geography Department:** Steve Prince • Marcia Snyder **Volunteers:** Dawn Miller • Joyce Schick • Melissa Parker • David Miles • Karen Yee • Kate Levendosky • Naomi Hosaka • Mandy Clancy • April Chiriboga • Jackie Allen • Chaquetta Felton.