Global Warming Potential of Urban Turfgrass Ecosystems

Susan Trumbore, Amy Townsend-Small, and Claudia Czimczik

Project Objectives

The objectives of this project are: 1) to measure net changes in C storage and CH$_4$ and N$_2$O emissions in turfgrass under low- and high-intensity management within community parks in the City of Irvine established at different times with known management history; and 2) to assess the soil properties underlying spatial and temporal patterns of soil C storage and trace gas fluxes in order to improve process-level and management-based models to scale fluxes from point measurements to the scale of net greenhouse gas emissions for a whole managed park.

Approach and Procedures

We have made significant progress on objective 1. We set up two to three study sites in four parks in the city of Irvine. The parks are Harvard Park (34 years old), Northwood Park (28 years old), Bill Barber Park (9 years old), and Las Lomas Park (4 years old). In each park, we have established at least one sampling site in a picnic or leisure area, and one or two sites in sports (baseball and soccer) fields. Our soil sampling campaign was conducted during the spring of 2008 and, to date, we have succeeded in characterizing C and N stocks and stable isotopic composition in all of our four study sites. We have also been making continuous measurements of N$_2$O emissions at all of the study areas.

Preliminary measurements of methane efflux showed very little result, so we decided early in the study to focus on N$_2$O fluxes, which are often quite high. We plan to continue our monthly measurements of trace gas fluxes at each park until May of 2009, which will give us a complete dataset for one year. We have also made preliminary progress on objective 2. We have observed very high spatial variability in N$_2$O fluxes and are currently analyzing inorganic nitrogen availability at each of our three sites. This stems from our measurements of the stable isotopic composition of N$_2$O from these turfs, which has shown that both nitrification and denitrification are active in producing N$_2$O in our study sites. Our measurements of nitrate and ammonium concentrations and $\delta^{15}$N will aid us in interpreting our N$_2$O isotope data.
Discussion

The results for carbon storage in these park soils are quite interesting, and in line with our initial expectations. Figure 1 shows how carbon storage increases linearly with park age over a ~30 year time period. The data in figure 1 represent soils found in non-sports (or leisure) areas only. For our sports fields, there is no relationship of park age and carbon storage because of regular re-sodding. We are currently analyzing radiocarbon ages of these sports turf to determine whether we can measure C storage rates with that method.

Clearly, the older parks in our study are storing a great deal of carbon underground. However, in figure 2 we show that N\textsubscript{2}O emissions are also higher in older systems. This discovery was quite unexpected.

While there does not appear to be a linear relationship between park age and total N\textsubscript{2}O emissions, we hope that with our upcoming winter and spring sampling campaigns and our ongoing analysis of nutrient content in soils, we will be able to formulate a predictive model for what drives N\textsubscript{2}O emissions from lawns. However, in general it appears that either organic carbon storage or inorganic N retention in older soils results in higher N\textsubscript{2}O emissions under the same management regime. This is illustrated particularly well in figure 3, which shows the response of two different parks to the same fertilizer treatment. Both parks were fertilized by the city between July 9 and 10 with 4.8 g N m\textsuperscript{-2} of sulfur coated urea. The response of N\textsubscript{2}O emission to this treatment was much greater in the older park.
Global Warming Potential of Urban Turfgrass Ecosystems—Trumbore

In general, we feel we have made excellent progress towards our objectives. Starting in June, we plan to start sampling N$_2$O emissions more intensively in order to assess spatial variability in our sites, which appears to be quite large. This will be the final step in scaling up our measurements to the level of the entire city of Irvine.

Figure 3.

This research was funded by the Kearney Foundation of Soil Science: Understanding and Managing Soil-Ecosystem Functions Across Spatial and Temporal Scales, 2006-2011 Mission (http://kearney.ucdavis.edu). The Kearney Foundation is an endowed research program created to encourage and support research in the fields of soil, plant nutrition, and water science within the Division of Agriculture and Natural Resources of the University of California.