Assessing urban influences on ecosystems and the atmospheric

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Urban areas represent a critical gap in current measurement networks and modeling frameworks that must be addressed to improve understanding of human impacts on the global environment. Nearly three-quarters of anthropogenic greenhouse gas (GHG) emissions are attributable to cities, but most efforts to study atmospheric and terrestrial carbon and nitrogen dynamics avoid urbanized areas. Using an urban-to-rural gradient approach in the greater Boston, MA area as a case study, we have been monitoring greenhouse gas mixing ratios, changes in ecosystem structure and chemistry, and land cover change to systematically evaluate how urbanization impacts on atmospheric chemistry and ecosystem productivity changes. We have found that aboveground biomass (live trees, dbh > 5 cm) for the Boston Metropolitan Statistical Area was 7.2 ± 0.4 kg C/m2, reflecting a high proportion of forest cover. Vegetation C was highest in forest (11.6 ± 0.5 kg C/m2), followed by residential (4.6 ± 0.5 kg C/m2), and then other urban developed (2.0 ± 0.4 kg C/m2) land uses. Soil C (0–10 cm depth) followed the same pattern of decreasing C concentration from forest, to residential, to other urban developed land uses (4.1 ± 0.1, 4.0 ± 0.2, and 3.3 ± 0.2 kg C/m2, respectively). Soil N concentrations were higher in urban areas than nonurban areas of the same land use type, except for residential areas, which had similarly high soil N concentrations. Unlike previous studies, we found no significant relationship between NDVI or ISA fraction and foliar %N. Variations in foliar %N appeared to be driven more strongly by changes in species composition rather than phenotypic plasticity across the urbanization gradient. Median atmospheric concentrations of CO2 within Boston's urban core were 12.7 ± 1.4 ppm greater that concurrent measurements at the rural Harvard Forest study area (~100 km away). Weekday concentrations were 2.1 ppm greater than weekend concentrations, with an 11.1 ppm and 5.1 ppm amplitude in the diurnal cycle on weekdays and weekends, respectively. Taken as a whole, it is still unclear how urban modifications to the growing environment, such as enhanced nitrogen deposition, the urban heat island lengthening the growing season, residential fertilizer applications, and enhanced urban CO2 concentrations balance again the negative impacts of urbanization such as soil compaction, enhanced ozone and SOx concentrations, fragmentation, and human removal of nutrients and organic matter.

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