The importance of air quality monitoring in understanding effects of air pollution and to inform air quality management in the US.

In May, the U.S. Environmental Protection Agency announced the termination or suspension of 41 monitoring sites associated with several national air quality monitoring programs. These programs include the CASTNET (Clean Air Status and Trends Network- 11 sites), NTN (National Trends Network-8 sites), AMON (Ammonia Monitoring Network-21 sites) and the MDN (Mercury Deposition Network- 1 site). Two of these networks have a site location at the Hubbard Brook Experimental Forest, NH (CASTNET, AMON). Their suspension will significantly compromise long-term research on effects of air pollution at Hubbard Brook.

CASTNET is a national network for monitoring air quality of several pollutants, including particles and gases and provides estimates of the deposition of those pollutants to the land surface. CASTNET measurements include ozone, ammonium, sulfur dioxide, particulate sulfate, particulate nitrate and nitric acid vapor. CASTNET allows for the characterization of fine particulate matter and ozone, two of the most important air pollutants that affect human health. Together with wet deposition from precipitation inputs, CASTNET estimates allow for the quantification of total loading of nutrients and acids to ecosystems. This information enables the Nation to understand the effects of air pollutants on crops and trees and fresh and coastal waters. Across the U.S., 94 CASTNET sites measure particles and gases, and 84 measure ozone. CASTNET has provided continuous records for 34 years.

At Hubbard Brook and other research sites, CASTNET measurements are critical to our understanding of forest ecosystem function and structure. Atmospheric deposition is the major source of pollutants, nutrients and acids to natural forests. Soil condition, tree growth, and ecosystem biodiversity are affected by these inputs. In recent years at Hubbard Brook, we have seen large increases in evapotranspiration (the movement of water through trees to the atmosphere), resulting in dramatic changes to the water cycle. We are investigating a potential link between these water cycle changes and ozone concentrations.

AMON is the only network in the U.S. that estimates concentrations of ammonia in the atmosphere. Ammonia emissions are associated with agricultural activities and increasingly with transportation corridors in densely populated urban areas. Ammonia concentrations are increasing in many regions of the U.S. Ammonia reacts with water in the atmosphere to form ammonium. Ammonium is an important component of fine particulate matter and contributes to associated health effects, including respiratory conditions, asthma attacks and premature fatalities. Ammonia also contributes to ecosystem effects such as the eutrophication of soil and waters, and harmful algal blooms. While ammonia is an air pollutant and contributes to health and ecosystem effects, its emissions are not regulated through the Clean Air Act. The AMON network was launched in 2010 and includes approximately 110 sites.

Two other important atmospheric chemistry networks are NTN and MDN, one of which also operates at Hubbard Brook Experimental Forest:

NTN, the National Trends Network, is a group of stations that monitor precipitation chemistry. Measurements determine inputs of nutrients and acids in precipitation to ecosystems. There are about 260 NTN stations in the U.S. with a continuous 43-year period of record, including one at Hubbard Brook.

MDN, the Mercury Deposition Network, measures mercury levels in precipitation across participating stations. Mercury is a neurotoxin that is emitted from coal-fired power plants, industry, and mining among other sources. The MDN measures inputs of mercury in precipitation or wet deposition to ecosystems.

Why are these networks important to Hubbard Brook? Air pollution is a critical disturbance to the northern forest. It has been ongoing for decades, affecting soil, vegetation and surface water quality. Current research identifies the ways that air pollution and climate change interact to impact ecosystems. We know that climate change is altering nutrient and water availability and cycling. Quantifying nutrient inputs and ozone concentrations and their changes are essential for understanding forest responses to global change. We have relied on CASTNET measurements for decades for information on ozone and for estimates of dry deposition of air pollutants. We have relied on AMON atmospheric ammonia concentrations to understand nutrient inputs to the forest. Without these measurements, we lose capacity to understand the effects of air pollution on ecosystems and the services they provide. At Hubbard Brook, atmospheric data are integrated with many other long-term measurements made as part of National Science Foundation Long-Term Ecological Research (LTER) and Long-term Research in Environmental Biology (LTREB) programs and research programs conducted by the U.S. Forest Service, including forest ecosystem and watershed dynamics, animal populations and many more. Co-locating atmospheric monitoring sites with other ecological measurements provides valuable insights into the long-term role of air quality on ecosystem health.

Why are these networks important to the nation? These networks collectively provide a measure of the air quality status of the U.S. They are spatially distributed across the coterminous U.S. They reveal air quality conditions that affect human health associated with fine particulate matter and ozone. It is estimated that between 100,000 and 200,000 premature deaths occur in the U.S. each year due to air pollution. Air pollution also contributes to numerous other health concerns such as asthma and chronic respiratory conditions. In addition, air pollutants including ozone and atmospheric nitrogen and sulfur deposition can impair the function and biodiversity of natural lands and coastal waters and diminish crop yields in agricultural lands. These networks allow us to determine which areas of the U.S. fail to meet air quality standards and where ecosystems may be impacted by adverse air quality. These networks provide direct observations of the response of our atmosphere to air quality management, showing improvements or deteriorations. We also know that, increasingly, climate change is driving a deterioration in air quality, with vulnerable communities at highest risk. These networks allow us to understand how and where our air quality is changing under a changing climate.

These networks are well-integrated with air quality models. Air quality models are essential tools to inform decisions on air quality management programs. Models allow us to make projections of how air quality would change under different environmental management scenarios. Air quality models are parameterized and tested using data from air quality monitoring networks. Without robust networks, our ability to test and validate models decreases, along with confidence in model projections.

Finally, every five years, the EPA is required to conduct an Integrated Science Assessment (ISA) for each National Ambient Air Quality Standard (including particulate matter, nitrogen dioxide, ozone and sulfur dioxide) to evaluate changes in our understanding of air pollution and its effects. ISAs inform decision-makers on whether an air quality standard should be changed. Without a robust monitoring air quality program to characterize current air quality conditions and how these conditions have changed, it will be difficult to conduct ISAs, particularly to quantify current effects on public welfare.

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