Friend and foe: Nitrogen pollution's little-known environmental and human health threats

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(PhysOrg.com) -- Billions of people owe their lives to nitrogen fertilizers -- a pillar of the fabled Green Revolution in agriculture that averted global famine in the 20th century -- but few are aware that nitrogen pollution from fertilizers and other sources has become a major

environmental problem that threatens human health and welfare in multiple ways, a scientist said here today.

"It's been said that nitrogen pollution is the biggest environmental disaster that nobody has heard of," Alan Townsend, Ph.D., observed at the 242nd National Meeting & Exposition of the American Chemical Society (ACS), being held here this week. Townsend, an authority on how human activity has changed the natural cycling of nitrogen to create a friend-turned-foe dilemma, called for greater public awareness of nitrogen pollution and concerted global action to control it. He spoke at a symposium on the topic, which included almost a dozen reports (abstracts of each presentation appear below) by other experts.

"Awareness has grown, but nitrogen pollution remains such a little-recognized environmental problem because it lacks the visibility of other kinds of pollution," Townsend explained. "People can see an oil slick on the ocean, but hundreds of tons of nitrogen spill invisibly into the soil, water and air every day from farms, smokestacks and automobile tailpipes. But the impact is there — unhealthy air, unsafe drinking water, dead zones in the ocean, degraded ecosystems and implications for climate change. But people don't see the nitrogen spilling out, so it is difficult to connect the problems to their source."

Townsend described the scope and the intensification of the nitrogen pollution problem as "startling." He noted that nitrogen inputs to the terrestrial environment have doubled worldwide during the past century. This increase is due largely to the invention and widespread use of synthetic fertilizer, which has revolutionized agriculture and boosted the food supply.

The concern focuses on so-called "reactive" nitrogen. Air contains about 78 percent nitrogen. But this nitrogen is unreactive or "inert," and plants can't use the gas as a nutrient. In 1909, chemist Fritz Haber developed a

way to transform this unreactive gas into ammonia, the active ingredient of synthetic fertilizer. By 2005, human activity was producing about 400 billion pounds of reactive nitrogen each year.

"A single atom of reactive nitrogen can contribute to air pollution, climate change, ecosystem degradation and several human health concerns," Townsend said. He is an ecology and evolutionary biology professor at the University of Colorado at Boulder. Damage to the ecosystem — a biological community interacting with its nonliving environment — includes water pollution and reduced biological diversity, including the loss of certain plant species.

Though the full extent is currently unknown, nitrogen pollution can impact human health. Reactive nitrogen is a key contributor to air pollution, including the formation of ground-level ozone, which is a well-known health risk. Recent estimates suggest that nitrogen-related air pollution costs the U.S. well over $10 billion per year in both health costs and reduced crop growth. And though less well studied, high nitrogen levels in water can cause a variety of health concerns, ranging from the effects of drinking water nitrate to the potential to alter the risks of several human diseases.

Increased nitrogen levels also have implications for climate change, Townsend noted. Excess nitrogen can affect the rate of climate change in multiple and opposing ways. One the one hand, it leads to more warming via the greenhouse gas nitrous oxide, but on the other hand, it can reduce warming by fueling extra plant growth and by forming substances called reflective aerosols in the atmosphere, the scientists noted.

"The net effect of these processes remains uncertain, but appears to result in minor cooling presently," Townsend said. However, he noted that excess nitrogen also has large and clear consequences for some

worrisome impacts of a changing climate, notably air and water pollution.

"Climate change is expected to worsen each of these problems worldwide, but reduction of nitrogen pollution could go a long way toward lessening such climate-driven risks," he added.

"We're just now starting to recognize the scope of the problem," said Townsend. "But the good news is that there are many opportunities for us to lessen the problems. These include ways in which chemists can help, ranging from the development of new technologies to reduce nitrogen's impact to new measurement technologies and techniques that can better diagnose the problems we face with nitrogen."

He outlined several possible solutions to the problem. They include continued and greater support for technologies that remove or reduce reactive nitrogen formation during fossil fuel burning and incentives that can encourage farmers to be more efficient with their fertilizer use. The latter could include subsidies that reward the application of environmental practices that reduce nitrogen levels, he said.

Several other solutions exist for improving the efficiency of agricultural nitrogen use, Townsend added. "In many ways, we already know how to do it —the problems are largely about finding the political and cultural means to implement these new practices," he said.

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