AAAS ScienceNetLinks

Nitrogen Pollution

Red tide in La Jolla, California

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Human sources of nitrogen may be just as environmentally costly as carbon emissions.

TRANSCRIPT

The perils of excess nitrogen. I'm Bob Hirshon and this is Science Update.

It's no secret that human carbon emissions are a big problem. But two recent reviews in the journal *Science* warn that we also need to curb our production of reactive nitrogen. University of Virginia bio-geochemist James Galloway notes that in 2005, humans produced roughly twice as much reactive nitrogen as nature did—mainly by farming with nitrogen-packed fertilizers and burning fossil fuels.

Galloway:
And so as this reactive nitrogen is lost, it cycles throughout the earth's reservoirs—soils, waters, and the atmosphere, As it moves through these reservoirs, it causes these cascades of environmental impacts.

Impacts that include air pollution, acidic soil and water, ozone depletion, and global warming—and the resulting threats to animals and people. I'm Bob Hirshon for AAAS, the Science Society.

MAKING SENSE OF THE RESEARCH

Carbon emissions have been dominating the headlines lately, and there's a lot of interest in trying to control them. Within the past few years, the term “carbon footprint” (how much carbon a person, organization, or activity pumps into the environment) has gone from environmental jargon to mainstream language. But recent scientific reports suggest that we're ignoring an equally large problem: our “nitrogen footprint.”

You probably know from basic science class that nitrogen is everywhere. In fact, it makes up 78 percent of the air you breathe, and about 3 percent of your body. However, the nitrogen in the air is actually **molecular** nitrogen, or (N2), which is **inert**. In other words, it doesn't react chemically with anything else.

Galloway and his colleagues are concerned about **reactive** nitrogen, which comes from two main sources: burning fossil fuels (which is also a source of carbon emissions) and agricultural fertilizers. All plants need reactive nitrogen to grow, and it takes lots of nitrogen-rich fertilizer to grow a farm full of crops. However, only about 50 percent of the nitrogen in fertilizers gets absorbed by crops, and only 10 to 15 percent ultimately gets consumed by people. The rest ends up washing out of the soils and into streams and rivers that ultimately carry it out to the ocean. Even the nitrogen that humans do eat gets back into the environment through the human waste in our sewage.

What's more, a single reactive nitrogen atom can pass from the air to the soil to the water, wreaking havoc every step of the way. For example, a nitrogen atom that's released from factory smoke may start by forming smog in the air. If rain flushes that same atom out of the air, it can end up in lakes and forest soils as nitric acid, which can kill fish and insects.

From there, the nitrogen atom could be carried out to the coast and contribute to environmental problems like **red tides** and **dead zones**. A “red tide” is an intense bloom of (sometimes red) algae that results from nitrogen-rich runoff seeping into the ocean. When the algae die, they sink to the sea floor and are eaten by bacteria, which consume excess oxygen that fish and other marine life need to survive. If the oxygen drops too low, it can create a “dead zone” in which no life can survive; there's a famous one in the Gulf of Mexico that's the size of New Jersey. After contributing to that damage, that same nitrogen atom can evaporate back into the atmosphere as part of the greenhouse gas nitrous oxide, which destroys the atmospheric **ozone layer** that protects us from harmful ultraviolet radiation.

Unfortunately, reducing our so-called “nitrogen footprint” may be even tougher than reducing our carbon footprint. Cutting back industrial emissions is challenging enough, but cutting back food production is virtually impossible: as the world population grows, so will food demand. “Society must maximize the benefits of nitrogen towards the goal of feeding the people of the earth, yet still, at the same time, minimize the problems associated with the loss of reactive nitrogen to the environment,” Galloway says. “And of course that's a very easy thing to say; it's much tougher to do.” He says our best hope is to figure out how to make the nitrogen in fertilizers more efficient. Doing so will take a lot more study and a concerted effort by farmers around the globe.

Now try and answer these questions:

1. What is the difference between reactive nitrogen and inert nitrogen?
2. What are some of the dangers posed by reactive nitrogen?
3. What are the main sources of reactive nitrogen from human activities?
4. In what other days has the increasing standard of living of the human species come into conflict with long-term sustainability?

You may want to check out the June 6, 2008, **Science Update Podcast (http://audio.scienceupdate.com/podcast/080606_sciup_pod.mp3)** to hear further information about this Science Update and the other programs for that week. **This podcast's topics include:** CO2's dangerous overlooked cousin, the origins of the southern hemisphere, why magnetic credit cards don't stick to the fridge, and why so many white cats are deaf.

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