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Nitrogen emerges as the latest climate-change threat

By Robert S. Boyd

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WASHINGTON -- Scientists are raising alarms about yet another threat to Earth's climate and human well-being. This time it's nitrogen, a common element essential to all life.

For years, people have been bombarded with warnings about the harmful effects of carbon - especially in the form of carbon dioxide (CO₂), a greenhouse gas widely blamed for global warming.

Now, it's becoming clear that human activities, such as driving cars and raising crops, also are boosting nitrogen to dangerous levels - polluting air and water and damaging human health.

An expanding flock of international scientists is concentrating on the nitrogen threat. There's a reactive nitrogen conference somewhere in the world almost every month.

"The public has learned a lot about carbon and its contribution to global change," said James Galloway, an authority on nitrogen at the University of Virginia. "However, they know less about nitrogen and its numerous impacts on environmental issues, including global change."

"It's crucial for people to become aware of the nitrogen problem," said Cheryl Palm, an expert on tropical agriculture at Columbia University.

Pure nitrogen is a colorless, odorless gas and the largest single component of Earth's atmosphere. Every breath you take is almost 80 percent nitrogen.

However, about 1 percent of the stuff is so-called "reactive nitrogen." It combines with other elements, such as oxygen and hydrogen, to form hundreds of thousands of chemical compounds - some beneficial, some harmful.

Many of these compounds are valuable in industry and agriculture. They preserve foods and wine, enhance oil production, make plastics and explosives, and fill automobile airbags. They form the building blocks of life: DNA, genes and proteins. Their biggest use is in synthetic fertilizers.

"We estimate that nitrogen fertilizers are currently responsible for feeding 48 percent of the world's population," Galloway said.

On the other hand, reactive nitrogen has many negative effects. Its compounds create smog, cause cancer and respiratory disease, and befoul rivers, lakes and coastal waters.

They create "dead zones" in the ocean, corrode roads and bridges, weaken the ozone shield and add another greenhouse gas to the already overburdened atmosphere.

"The challenge is to maximize the beneficial uses of reactive nitrogen while minimizing adverse environmental impacts," said a scientific advisory committee to the Environmental Protection Agency in draft report on the problem.

"While there is tremendous benefit from food production, there is also tremendous damage to the health of both ecosystems and people due to the introduction of reactive nitrogen," the report said.

Scientists call the need to balance the good and the bad aspects of reactive nitrogen the "nitrogen paradox."

"The paradox is nitrogen is vital to human survival, yet its use negatively impacts both people and ecosystems," Galloway said.

Some areas of the world, such as Africa, suffer from too little nitrogen, leading to poor crops and spreading deserts. But developed countries such as the U.S. have excess.

"It is a daunting task to improve nitrogen management because of the need to address two opposite extremes: too little nitrogen in some places and too much in others," said a December 2007 report from a United Nations environmental unit.

Experts say the most pressing need is to increase the availability of nitrogen fertilizer in poor countries and reduce its inefficient and wasteful use in U.S. factories and farms.

"Too much nitrogen is carried off of farmers' fields by rain and irrigation, spewed out of automobiles and factories into the air, and leached from septic tanks and sewage treatment facilities into rivers and groundwater," said Eric Davidson, a nitrogen expert at the Woods Hole Research Center in Massachusetts.

Meanwhile, the output of reactive nitrogen is accelerating at an alarming rate.

"Human activity has doubled the rate of formation of reactive nitrogen over natural rates on the land surfaces of the Earth," said Alan Townsend, director of the North American Nitrogen Center at the University of Colorado in Boulder. "The change is recent and rapid, making accelerated nitrogen cycling one of the most immediate and consequential facets of global change."

Some environmental scientists worry that raising alarms about the danger of nitrogen - at the same time as carbon dioxide - may overwhelm government agencies and private citizens.

"It has taken some of the public and the government quite some time to be aware of the CO2 problem," Palm said. "Adding another 'element' to their concerns could cause confusion."

"Maybe this is complicated and overwhelming," Davidson said, "but it's also a reality that must be met head-on."

On the Web:

North American Nitrogen Center: <http://ibl.colorado.edu/NANC.html>

Woods Hole Research Center: <http://www.whrc.org/index.htm>