# Rachel's Environment & Health News
## #557 - A New Global Problem
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A new global environmental problem has emerged from an unexpected source: nitrogen. Nitrogen makes up 78% of Earth's atmosphere; however, in its atmospheric form nitrogen is an unreactive gas, unavailable to most living things. Now a new peer-reviewed report from the Ecological Society of America (ESA) portrays nitrogen as a triple threat: warming the planet via the greenhouse effect, damaging the Earth's protective ozone layer, and reducing biodiversity (the diversity of species upon which ecological stability ultimately rests).[1] ESA is the nation's professional organization for ecologists. Ecology is the branch of biological science that deals with the relationships between organisms and their environment.

Nitrogen problems arise when human activities --mainly industrial agriculture and combustion of fossil fuels --"fix" nitrogen out of the atmosphere by combining it with hydrogen or oxygen. In its "fixed" forms, nitrogen becomes biologically active. Other human activities (burning grasslands and forests, draining wetlands, clearing land for crops) move nitrogen out of long-term storage, making it available to living things.

Two big natural forces fix nitrogen from the atmosphere: lightning and microorganisms, many of which work together with legumes (for example, peas, beans, and alfalfa) and algae. As every farmer knows, planting legumes adds nitrogen to the soil because microorganisms on the plants' roots fix nitrogen from the atmosphere.

Nitrogen fixation in the oceans is poorly understood; however, on the land, natural forces fix somewhere between 90 and 140 million metric tonnes (MMT) of nitrogen per year. (A metric tonne = 1.1 tons, or 2200 pounds.) Of this, lightning accounts for perhaps 10 million metric tonnes (MMT) and microorganisms account for the rest.

Human activities now fix something just over 140 million metric tonnes (MMT) per year, thus doubling (or more) the amount of biologically active nitrogen on the land, according to ESA. Doubling a natural flow of a chemical like nitrogen is "an enormous effect on a global cycle," says Dr. William H. Schlesinger of Duke University, one of the authors of the new ESA report.[2]

Until 1940, human industrial activities fixed almost zero nitrogen. Therefore biologically available nitrogen has increased very rapidly. The ESA report says, "The immediacy and rapidity of the recent increase in N[itrogen] fixation is difficult to overstate." Indeed, a study in 1990 found that half of all the nitrogen ever fixed by industrial processes has been produced after 1980.

Many of the Earth's plant species are adapted to --and function best in --soils and waters containing low levels of available nitrogen. By doubling the amount of available nitrogen, and by increasing the movement of nitrogen from place to place, humans are disrupting ecosystems on a grand scale. "No place on earth is unaffected," says the ESA report. Here is a listing of some of the problems identified by the ESA report:

** Nitrous oxide (N2O) added to the atmosphere is a potent greenhouse gas, allowing sunlight in but refusing to allow heat to escape, thus tending to warm the planet (just the way the glass roof over a greenhouse captures the sun's energy and warms the greenhouse). Nitrous oxide presently accounts for "a few percent" of the global greenhouse gas problem, says the ESA report.

** When it reaches the stratosphere (6 to 30 miles up in the sky) nitrous oxide contributes to the destruction of the Earth's ozone shield. Reducing the ozone shield in turn increases the ultraviolet radiation striking the surface of the Earth which, in turn, damages some of the creatures that form the bottom of the oceans' food chains, [3] and may harm other creatures (including humans) as well.[4]

Nitrous oxide is increasing in the atmosphere at the rate of 0.2% to 0.3% per year. It comes from many sources: fertilizers, nitrogen-enriched groundwater, nitrogen-saturated forests, burning of biomass (grasses and forests), land clearing for crops, and manufacture of nylon.

** Nitric oxide (NO) plays a key role in creating toxic ozone near the ground. Ozone is the most harmful common air pollutant to humans and vegetation. Ozone and other nitrogen compounds are key components of the smog that now envelopes large areas of the planet, especially urban areas.[5]

** The final product of oxidizing NO is nitric acid, a key component of acid rain, which is damaging forests in Canada, the U.S. and Europe. Combustion of fossil fuels is the main source of nitric oxide (20 MMT per year), followed by biomass burning (8 MMT per year). Human sources now account for 80% of all atmospheric NO.

** NH3, or ammonia, injected into the atmosphere is a major source of nitrogen movement between ecosystems. Each year, fertilizer contributes 10 MMT of ammonia to the atmosphere; domestic animal wastes contribute 32 MMT, and biomass burning adds 5 MMT. Humans contribute 70% of all the ammonia reaching the atmosphere.

** As a result of all these contributions of fixed nitrogen to the atmosphere, fixed nitrogen is deposited back on land and oceans at an increased rate. In the midwestern and eastern U.S., nitrogen deposition from the atmosphere onto the land is more than 10 times as great as the natural rate. In parts of northern Europe nitrogen deposition is now more than 100 times as great as the natural rate.

** Nitrogen deposited on the land tends to move into nearby waters, carrying with it calcium and magnesium from the soil. As a result, both the soils and the receiving waters tend to become more acidic. After calcium in the soil has been depleted, then aluminum begins to move into nerby waters with the nitrogen. Aluminum is toxic to many aquatic species.

As sulfur dioxide emissions have been curbed in recent years, nitrogen has become better-recognized as a source of acidification in lakes. As areas of land become nitrogen-saturated (meaning, they can't absorb any more of it), nitrogen run-off and consequent acidification are increasing.

Another effect of all these changes is to create nutrient imbalances in trees. Such imbalances can lead to reduced photosynthesis, reduced forest growth and even to increased tree deaths, according to the ESA report.

** Ecologists in Minnesota treated 162 plots of land with varying amounts of nitrogen and examined the results.[6] After 12 years they found three important changes:

1. Some plant species disappeared completely, driven out by others that thrived better in a high-nitrogen environment. The result was a loss of biodiversity as "weedy" species took over and the land became biologically impoverished.

2. When these weedy species died, their higher nitrogen content put more nitrate nitrogen into the soil. Nitrate is highly soluble in water and moves readily into local streams. In high concentrations, nitrate is toxic to humans; at lower concentrations it can cause blooms of algae, depleting oxygen and upsetting the balance of aquatic ecosystems.

3. Because the weedy plants were rich in nitrogen, bacteria and fungi that feed on nitrogen decomposed them rapidly. Because of the rapid decomposition, these plants did not capture and retain any more carbon than the plants they had displaced. This was a disappointing discovery. Ecologists had hoped that, by encouraging

plant growth, high nitrogen levels would capture increased carbon, thus reducing the threat of global warming from carbon dioxide, the main greenhouse gas. It turns out not to work that way. Evidently, planting trees won't get us out of the global warming jam.[7]

** The nitrogen content of the Mississippi River has more than doubled since 1965, and nitrate concentrations in the major rivers of the northeastern U.S. have increased 3-to 10-fold since 1900, according to the ESA report. The same is true of European rivers. Nitrogen from rivers is now reaching the Atlantic Ocean at rates 2 to 20 times as great as during pre-industrial times. Around the North Sea, the increase has been 6-to 20-fold.

** Nitrogen entering the oceans is causing fertilization and eutrophication of estuaries and coastal seas: "...it represents perhaps the greatest threat to the integrity of coastal ecosystems," says the ESA report. Eutrophication is the excessive growth of plants, leading to oxygen deficiency which has killed significant numbers of fin fish and shellfish in the Chesapeake Bay, Long Island Sound, the Black Sea, the Baltic Sea, and elsewhere.

Nitrogen-fed algae blooms have been identified as the source of a major outbreak of cholera in South America in 1991. The algae harbor the cholera-causing bacterium. In 1991, 500,000 people fell ill and 5000 died when cholera erupted along the coastline of Peru and quickly spread to 18 other countries.[8]

These nitrogen problems are not going to be easy to solve. The ESA report says, "The momentum of human population growth and increasing urbanization ensure that industrial N[itrogen] fixation will continue at high rates for decades."

The ESA report suggests that, by 2020, industrial agriculture will be contributing 134 MMT per year, up 68% from the 80 MMT it contributes annually today. And by 2020, fossil fuel combustion will be contributing 46 MMT per year, about twice its present contribution.

Obviously these projections could prove wrong if the corporations promoting industrial agriculture and fossil fuel combustion could be brought under control. The Ecological Society of America's report does not consider this possibility. In the section, "Future Prospects and Management Options," the report only considers slightly-less-wasteful ways of using nitrogen fertilizer on industrial farms.

Disappointingly, ESA's report never acknowledges the really viable alternative to industrial farming, which is ecological farming that seeks to mirror and maintain the natural ecology in which it is practiced.[9]

As the ESA report documents to a dismaying degree, the industrial farming model is leading to widespread deterioration of global ecosystems. It is not sustainable.[10]

Instead of the Henry Ford model, which aims to alter natural ecological neighborhoods to maximize short-term yields of a few specialized crops for export to world markets, the organic farming model achieves higher yields[11] using less energy[12] and emphasizes food locally produced for local people with local control.[9] It is an ecological approach that views humans as products of, and partners in, the local ecology, not masters of it.

--Peter Montague (National Writers Union, UAW Local 1981/AFL-CIO)

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[1] Peter M. Vitousek and others, "Human Alteration of the Global Nitrogen Cycle: Sources and Consequences," ECOLOGICAL APPLICATIONS Vol. 7, No. 3 (August 1997), pgs. 737-750.

[2] William K. Stevens, "Too Much of a Good Thing Makes Benign Nitrogen a Triple Threat," NEW YORK TIMES December 10, 1996, pgs. C1, C8.

[3] Kirk D. Malloy and others, "Solar UVB-induced DNA damage and photoenzymatic DNA repair in antarctic zooplankton," PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES Vol. 94 (February 1997), pgs. 1258-1263.

[4] See Arjun Makhijani and Kevin R. Gurney, MENDING THE OZONE HOLE; SCIENCE, TECHNOLOGY AND POLICY (Cambridge, Mass.: MIT Press, 1995), Chapter 2.

[5] National Research Council, NITROGEN OXIDES (Washington, D.C.: National Academy of Sciences, 1977).

[6] David A. Wedin and David Tilman, "Influence of Nitrogen Loading and Species Composition on the Carbon Balance of Grasslands," SCIENCE Vol. 274 (December 6, 1996), pgs. 1720-1723.

[7] See Peter M. Vitousek, "Can Planted Forests Counteract Increasing Atmospheric Carbon Dioxide?" JOURNAL OF ENVIRONMENTAL QUALITY Vol. 20 (1991), pgs. 348-354.

[8] Paul R. Epstein and others, "Marine Ecosystems," THE LANCET Vol. 342 (November 3, 1993), pgs. 1216-1219.

[9] Frederick Kirschenmann, "Can Organic Agriculture Feed the World?... And is That the Right Question?" in Patrick J. Madden and Scott G. Chaplowe, editors, FOR ALL GENERATIONS: MAKING WORLD AGRICULTURE MORE SUSTAINABLE (West Hollywood, California: World Sustainable Agriculture Association, 1997), pgs. 154-172. $30.00 plus shipping and handling from the World Sustainable Agriculture Association; phone: (310) 657- 7202; fax: (310) 657-3884.

[10] P.A. Matson and others, "Agricultural Intensification and Ecosystem Properties," SCIENCE Vol. 277 (July 25, 1997), pgs. 504-509.

[11] National Research Council, ALTERNATIVE AGRICULTURE (Washington, D.C.: National Academy Press, 1989).

[12] Sharon Clancy, FARMING PRACTICES FOR A SUSTAINABLE AGRICULTURE IN NORTH DAKOTA (Carrington, N.D.: Carrington Research Extension Center, 1993). Phone: (701) 652-2951.

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