Steps to Sustainability
Part 38 of a Series:
Nitrogen Cascade Harms Vegetation,Human Health

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Plants appear to require about 18 essential elements to thrive. Some of these – zinc, iron, manganese, cobalt, nickel, etc. – are needed in small amounts called *micronutrients*. Carbon, and oxygen, however, each make up around 45% of the dry weight of a plant while hydrogen adds another 6%. [Jacke and Toensmeier 2005: 174 – 175]

Despite their relatively small 1.8% total contribution to plant biomass, nitrogen, phosphorous and sulfur are critical to plant growth. And – while plants can get most of their nutrients – micro or macro – from soil, nitrogen has proven to be a major limiting factor in ecosystem productivity worldwide.

The problem with nitrogen at first seems surprising: after all, it makes up 78% of the earth's atmosphere in the zone up to 11 miles from the surface. As an atmospheric gas, nitrogen may be performing a sort of "calming" effect, keeping in check possible side effects of too much oxygen, which makes up about 21% of the atmosphere.

According to physicist Fritjof Capra, oxygen had to stabilize in earth's atmosphere at about the 21% level to prevent two disasters. If oxygen levels go below about 15%, every life form dependent on oxygen could asphyxiate. If oxygen levels go above 25% "everything would burn." [Capra 1995:241 – 242]

The nitrogen in the atmosphere poses a problem of its own, however. Plants cannot directly absorb and utilize large amounts of nitrogen because to "fix" it to the plants requires the work of various microbes and the limit on the numbers and processing capacities of these microbes has limited nitrogen's potential to grow more biomass. For food crops this means that nitrogen limits harvests.

Getting more nitrogen into food plants was a major scientific challenge until 1909 when the German chemist Fritz Haber developed a process using high heat and pressure to turn atmospheric nitrogen into ammonia, which can be made into a liquid or a solid. By 1913, fellow German chemist and engineer Carl Bosch had figured out a practical means to apply Haber's discovery. This Haber-Bosch technique created the modern fertilizer industry, generating about 100 million tons annually of artificial nitrogen, thereby vastly increasing the world's food supply. Some experts estimate that 1/3 or more of the current world population would not be alive without the Haber-Bosch process. [https://en.wikipedia.org/wiki/Carl_Bosch#cite_note-7] As succinctly noted by *New Yorker* writer Elizabeth Kolbert [2013], Haber and Bosch "turned air into bread."[i]

The powerful benefits of fixable, reactive nitrogen brought on its rapid expansion in fertilizer factory production. In recent decades, accumulated "anthropogenic reactive nitrogen" has surpassed the total fixed fertilizer from natural processes. Over half of the synthetic nitrogen has been made since 1985. Vast commercial expansion of nitrogen-fixing legumes such as soybeans adds to Haber-Bosch. Furthermore, farmers tend to overfertilize when in doubt about optimal amounts. [UNEP 2007:13] Add to this human and animal waste – especially livestock dung – and the result is that there is now a lot of nitrogen in our planet's soil and water. This new nitrogen is not inert, like the nitrogen in the atmosphere – instead, it reacts easily with other chemicals, hence the name "reactive nitrogen."

But reactive nitrogen causes problems. Reactive nitrogen in large amounts moves around effortlessly in air, water and soils, a process called the "nitrogen cascade." [UNEP 2007:15] As it moves around, it contributes to a lot of problems. These include

- Raising ozone levels in the lower atmosphere (troposphere – the part of the atmosphere where we don't want too much ozone)
- Causing or magnifying respiratory problems
- Damaging vegetation
- Causing corrosion in buildings and bridges
- Rendering some water sources unfit for humans
- Causing the "blue baby syndrome"
- May contribute to colon cancer and some other cancers [UNEP2007:15–16]

Most dramatically, however, in recent decades excess reactive nitrogen has become associated with water body *dead zones*. These dead zones are typically areas of the ocean, coastal enclaves and even lakes and streams — where oxygen levels drop for part or all of a year from their normal level of about 10 parts per million to 5 parts, or even below 2 parts in some cases. Fish swim away from the zone or die and bottom dwelling creatures mostly die.

Dead zones have proliferated in parallel with the spread of reactive nitrogen – they are almost certainly connected to the increase in nitrogen cascades around the world. Up to 90% of the known dead zones appear to have developed since 1950. [Breitburg *et al* 2018:1] During this period, fertilizer usage – that is, reactive nitrogen – increased by ten times. Since 1970, reactive nitrogen discharges from rivers into coastal waters have gone up by 43%. [Breitburg *et al* 2018: 2]

How does a dead zone occur? As reactive nitrogen levels build up in a body of water, phytoplankton – microscopic plant life – proliferate into gigantic blooms. Some of these blooms contain cyanobacteria, many of which may be toxic and which are not yet well understood scientifically. When the plankton die, they fall to the bottom and are digested by microorganisms – a process that removes oxygen from the lowest levels of the water body and sometimes even the bottom muds. [Dybus 2005: 554; Breitburg *et al* 2018:2 and 6]

Although dead zones can develop in any water body fed by streams that carry excess reactive nitrogen runoff – even in the Finger Lakes – the biggest concerns have centered on ocean dead zones. The world's second largest lies at the mouth of the Mississippi River, in the coastal areas of the Gulf of Mexico. It is about the size of New Jersey. (The largest is in the Baltic Sea.) Recent studies indicate that 43 of the more than 500 coastal dead zones are in U.S. waters. [Dybus 2005: 554]

And – the entire process of creating dead zones is reinforced by global warming as phytoplankton and algal blooms reproduce faster in warmer temperatures. [Breitburg *et al* 2018:1 and 2]

Can anything be done about dead zones? Currently available scientific data suggest a slowing of the nitrogen cascade and a slowing of global warming are likely to be the most effective means to reduce dead zones. Unfortunately this pits the evidence directly against the enormous infrastructure of international large-scale agriculture.

1079 words

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https://msuweb.montclair.edu/~franker/FrankeTompkinsWeekly.htm

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[i] Kolbert cites Alan Weisman, author of *The World Without Us* who suggests that everyone above 2 billion persons owes their existence to the Haber-Bosch process. A United Nations Environmental Program document [UNEP 2007: 11] offers the figure of "nearly 40 percent of the current world population." At the time of publication in 2007 the world's population was estimated at 6.7 billion.