

A Modest Message From Forests - Nitrogen Saturation

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According to Dr. Mirai Watanabe, who has been researching Japanese forests, something similar is happening in our forests. I thought that forests are naturally filled with fresh air and that the water in their small streams is cool and clear, refreshing our bodies and clearing our heads. It would be terrible if these forests were to become sick or weak in the future.

In the area where Dr. Watanabe grew up, there was a rich forest, which was his playground, his way to school, and a part of his life. The colors of the forest were beautiful in every season: Pale-colored spring with blooming flowers, blazing green in summer, brown in fall, and gray in winter. For Dr. Watanabe, the forest was not someone else’s story. Even if, unlike him, we don’t have daily contact with a forest, we can’t remain ignorant and indifferent.

What Is Happening In Our Forests?

What exactly is happening in the forests of Japan? Dr. Watanabe has been investigating forests from various perspectives, including their soil, trees, and air, but this



Photo 1: Stream water at Mount Tsukuba

time he explained his investigations to me **in terms of stream water**. He said that stream water quality surveys have detected the nitrate, and that the stream water in **forests near cities has particularly high concentrations**.

To begin with, nitrogen on the earth is circulating. And when nitrogen in the air (N_2) is converted into

compounds such as ammonia (NH_3) and nitric acid (HNO_3), trees and organisms can use it to sustain life. After death of these organisms, bacteria and other microorganisms decompose these nitrogen compounds and turn them back into the air as nitrogen gas. But in the forests near cities, nitrogen compounds are present in excess of the amount what the forest ecosystem needs, and they flow into the stream water as nitrate.

Is This Excess Nitrogen a Problem?

Do we have a problem with more nitrate in our stream water? Dr. Watanabe honestly told me that **we don’t yet know the direct answer** to that question. But we can’t rest assured. Nitrogen circulates in the environment as mentioned earlier, but if an excess of nitrogen compounds accumulates somewhere, problems will arise.

When it occurs in the air, it is called air pollution. Various measures are being developed to deal with this, as it is already known to have a negative impact on both the environment and human health. But what if there is too much nitrate in the stream water? According to Dr. Watanabe, this means that a lot of nutrients flow into our rivers, lakes and ponds. This isn’t a good thing at all: It causes an imbalance in the ecosystem, **making it difficult for fish and various other organisms to live**. Also, if the nitrate are carried into the groundwater and are accumulated, the groundwater can become unsafe to drink. (although tap water is properly treated, so you don’t have to worry about drinking it.)

In summary, high nitrate levels in stream water **may not be an immediate problem now**, but it’s a situation that requires great caution, Dr. Watanabe explained. This is hardly a healthy state of affairs, to say the least.

Where Does the Nitrate Come From?

Where does the nitrate in our stream water come from? According to Dr. Watanabe, it comes mainly from **fossil**

fuels, agricultural fertilizers, and livestock waste. The amount of nitrogen compounds produced by humans has increased more than 10 times in the past 150 years. During this period, people have burned fossil fuels and developed chemical fertilizers for agriculture, allowing us to harvest large quantities of crops. This has helped to fill our dining tables and make our lives more comfortable. The fact that fossil fuel consumption and food production contribute to high nitrate levels may represent a **dilemma**. It is said, **“If you please one, you can’t please the other.”**

Keeping Our Forests Healthy

How can we keep our forests healthy? Of course, for our part we want to do all we can. Dr. Watanabe is also looking for solutions from the perspective of forest management. He has found that planted needle-leaf forests, which are common in Japan, have particularly high levels of nitrate that can flow out if they are not well taken care of, such as by thinning.

Dr. Watanabe has been investigating the forests around Mount Tsukuba. He has conducted a statistical analysis based on steepness and other geographical features and tree species to find factors that cause high nitrate concentrations in stream water.

As a finding, he discovered that the stream water in **broad-leaf forests has nitrate concentrations lower than those in needle-leaf forests**. The results of these



Photo 2:
Going
through
the forest

studies may make an important contribution to the future health management of forests; this may include the planting of broad-leaf trees.

Future of Research

The overabundance of nitrate in the stream water flowing through our forests may seem currently to be **a modest message from the forests**, so the message may not yet be clear. It may not even be a problem that needs to be addressed urgently. However, when we consider the various effects of nitrogen compounds, it is clear that we should not overlook them.

Forests support all living things by purifying air and water, and we hope that they will continue to do so. Dr. Watanabe is continuing his research with the aim of deepening his understanding of forests and becoming **able to interpret forest health checkups**—in other words, to be able to recognize and cure any problems that may arise, even if the results of his efforts don’t become apparent for decades or centuries from now.

Field work



Photo 3: Collecting stream water samples



Photo 4: Collecting samples of fallen leaves



Photo 5: Collecting soil and air samples

Planted Forest



- 6 Cedar plantation
- 7 Blooming Torch Azalea
- 8 small stream in a forest



Japanese forests are dominated by cedar trees. Cedar and cypress trees have historically been planted, and now about 40 percent of our forests are planted. Japanese cedar is endemic to Japan; it grows quickly and straight and is easy to process.

Planted forests can grow thick, good trees if they are thinned out and well managed, in the same way that cropland need to be cared for. However, recently, the number of people managing our forests has been decreasing, and some forests are being left unattended. If the forests are not cared for, they will become dark and crowded with thin, weak trees; this can easily lead to landslides and other disasters in the event of heavy rains.

Continuing on Despite Severe Pollen Allergies

Dr. Watanabe has pollen allergies. Pollen allergies—caused mainly by cedar pollen—cause sneezing, a runny and stuffy nose, and itchy eyes. For many people, early spring is the season when they don't want to go outside. Even if his pollen allergies are bad, Dr. Watanabe still goes into the forests to conduct his research.



Related Papers

- 1) Watanabe M, Miura S, Hasegawa S, Koshikawa KM, Takamatsu T, Kohzu A, Imai A, Hayashi S (2018) Coniferous coverage as well as catchment steepness influences local stream nitrate concentrations within a nitrogen-saturated forest in central Japan. *Sci. Total Environ.*, 636, 539–546.
- 2) Nishina K, Watanabe M, Koshikawa KM, Takamatsu T, Morino Y, Nagashima T, Soma K, Hayashi S (2017) Varying sensitivity of mountainous streamwater base-flow NO₃– concentrations to N deposition in the northern suburbs of Tokyo. *Sci. Rep.* 7: 7701.
- 3) Watanabe M (2021), Nitrogen Saturation in Forest Ecosystem and Its Impacts on Environmental Water Quality: Special Feature: Current Status and Assessment of Ecosystem Impacts from Acid Deposition. *JOURNAL of ENVIRONMENTAL CONSERVATION ENGINEERING (Japanese)*, 50, 256–261.



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