# Too much of a good thing? Nutrients & Water Quality

Featuring Dr. Helen Jarvie

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**DJ May:**

Welcome to the Decode 6 Podcast, where we take your questions about carbon and ecosystem services and match them to the experts with the answers. I'm your host, DJ May, and today we're talking about the relationship between nutrients like phosphorus and nitrogen and water quality. How is it that too much of a good thing can be a problem and what can we do about it? Our expert with the answers today is Helen Jarvie, a professor at the University of Waterloo, Canada. Helen's research explores the drivers of eutrophication and water quality impairment from local watersheds all the way up to global scales. She's super interested in the way that nutrients like phosphorous and nitrogen cycle in rivers and fresh water, and how climate variability and land use change can impact water quality. Helen, thank you so much for being here.

**Helen Jarvie:**

Hi, DJ. Thank you for inviting me.

**DJ May:**

Excellent. Well, we will dig right in. So before we start, can you give me an overview of the relationship between nutrients and water quality?

**Helen Jarvie:**

Thank you. Yes. The nutrients that are most important for water quality are phosphorus and nitrogen, and these two nutrients are also essential for our food production. So phosphorus and nitrogen are applied as fertilizers or manure to agricultural land to ensure healthy crops and high yields, and all plants and animals need nutrients to grow and thrive. But like many things in life, too much of a good thing can be a problem because when excess phosphorus and nitrogen enter our rivers, lakes, and coastal waters, they can impair the water quality in ecology. A process known as eutrophication. Runoff of nutrients for agricultural land to streams, rivers and lakes and nutrients in wastewater, effluent discharged into waterways, stimulates excessive growth of nuisance and sometimes harmful algae. Now, individually, algae are tiny, but when they proliferate, when nutrients are available, they can have huge impacts on the health of water bodies shading out and suffocating aquatic life.

When the algae die off, their decomposition uses up vital dissolved oxygen supplies in the water, and this is dead zones of low oxygen water. Now, example of this is the Gulf Coast, so water carrying phosphorus and nitrogen from agricultural and wastewater flows all the way down the Mississippi River to the Gulf where those nutrients stimulate algal blooms and habitats that should be teaming with life become suffocated when these algal blooms die off. Algae can also limit our use of water bodies for recreational activities such as swimming, sailing, and fishing. But eutrophication doesn't only impact the ecological health and recreational value of our water bodies. It can harm human health too because some algae are toxic to humans. Now, during the 2014 water crisis in Toledo, Ohio, a harmful algal bloom in Western Lake Erie resulted in the release of a dangerous toxin into the drinking water and a do not drink advisory was issued for over 400,000 people. So nutrients are vital. We simply can't grow our food without them, but we need to strike the right balance between using them in agriculture and losing them in runoff, which impairs our water quality.

**DJ May:**

Absolutely. Yeah. So it's essentially like what we need for crops. If we have too much, you end up feeding other things that obviously enjoy those nutrients as well.

**Helen Jarvie:**

That's right.

**DJ May:**

So I mean, we can't do without them, but what can we do to maybe manage this relationship or prevent some of those negative things you talked about, like toxins in the water or algal blooms?

**Helen Jarvie:**

Well, yes, fortunately, there are ways that we can use nutrients to ensure a healthy food supply whilst also protecting the environment through what's called sustainable nutrient stewardship. So farmers need to determine the right amount of nutrients and place them on their fields at the right time, in the right place, and in the right form for their soil to minimize nutrient losses in runoff. And these are known as the four R's of nutrient management. The four R's take account of the requirements of the crop for growth, but also the protection of water quality and also the conservation of nutrients is an important resource.

Watershed conservation programs are another way that we can help keep nutrients on the land and in the soil so that they're available to crops, but they don't wash off into our waterways. The other thing to say is that cities are also areas of excess nutrient accumulation, so owing to the concentration of people and food consumption and our production of waste, human waste is very nutrient rich from the food we eat and the products we use in our homes. These waste nutrients get into the sewers and wastewater and wastewater treatment plants can successfully remove some of these waste nutrients. However, their effectiveness of treatment can be variable and sewage effluent can be an important source of nutrients entering water bodies in many highly populated areas.

**DJ May:**

So it sounds like there are lots of ways that we can better manage the nutrients that we're already using, but are there any other factors that we should consider when it comes to striking that balance between using and losing nutrients?

**Helen Jarvie:**

Yeah, that's a good point. Another important factor that we need to consider in our use of nutrients is that one of these nutrients, phosphorus in itself is a non-renewable resource. So most of the phosphorus that we use today for fertilizers is mined from the earth, and there are in fact only a few countries in the world that have the concentrated phosphate rock reserves that are currently economically viable to use and to mine. And these reserves, of course, are being depleted. So there are concerns about the long-term availability and security of phosphorus to grow our food. And we face what's known as a phosphorus paradox. Too little phosphorus threatens our food security. Too much phosphorus causes water quality impairment. So our future food and water security will be increasingly dependent on our ability to better manage phosphorus and finding solutions to this phosphorous paradox are really a huge significance for humankind.

We need to manage phosphorus as efficiently as possible in agriculture, but we also need to minimize the losses of phosphorus across the entire food chain. So from mining that phosphate rock to fertilizer production, from farm to fork to wastewater treatment plants. There are some important opportunities to recover phosphorus from organic waste, such as urban wastewater, and also from intensive livestock production and recycle that phosphorus back into the food production system. Although this may sound like a bit of a no-brainer and a simple solution, it is expensive. And the other thing is that the recovered phosphorus usually has to travel a long way back to areas of crop production where it's needed. So there are transport costs as well to think about.

And so far, really the main focus in most urban wastewater treatment plants has been better treatment to remove phosphorus and clean up the effluent discharges. But this in itself doesn't capture and recover the phosphorus from the wastewater. And it's this capturing waste phosphorus and returning it to farmers as a fertilizer for food production that will ultimately be required to improve both food and nutrient sustainability, but also to reduce phosphorus in wastewater effluent that impairs our waterways.

**DJ May:**

Yeah, yeah. Well, that's funny. I mean, it's not, when you think reduce, reuse, recycle phosphorus probably isn't the first thing that comes to mind. But it sounds like that process is really similar to some of the other things we've seen as non-renewable resources we started to shift.

**Helen Jarvie:**

Yes, in indeed, it's closing that phosphorous cycle.

**DJ May:**

Yeah. Yeah. Well, tell me about timing. Say you realize maybe you're using a little too much, or there's ways that you could be more precise with your nutrient management, but how long will it take before we see these changes to the relationship with nutrients in our water supply?

**Helen Jarvie:**

So that's a great question because the time scales over which water quality recovers in downstream water bodies can be quite variable. So reducing wastewater effluent discharges of nutrients often results in quite rapid improvements in water quality. In many ways, that's like turning off a tap. You can quickly reduce the loading of nutrients entering a river or a water body from the effluent pipe. And we've been working here in southern Ontario on the effects of improved wastewater treatment on the water quality of the Grand River. This is Canada's largest river draining into Lake Erie.

And here, improvements in wastewater treatments have resulted in some rapid and really quite dramatic improvements in the river water quality and the river ecology. But for agricultural nutrient stewardship, we sometimes have to wait longer to see the effects. And this is because there can be a large legacy of nutrients from past land use practices that are stored in the soil, in sediments and in groundwater, and it can take years or even decades for these legacy nutrients to work their way through the watershed system and into our water bodies. And this means that it can take longer to see the effects in terms of improvements in water quality downstream at the watershed outlet.

**DJ May:**

Okay. So it might take a little bit longer than maybe turning off a tap, but it sounds like there's a lot of good things going on. Can you kind of give me the state of everything we're seeing right now with water quality? Are we making progress?

**Helen Jarvie:**

Well, yes. And despite these nutrient legacies and the lag times in recovery, we are seeing progress and research continues a pace on the best ways to manage nutrients in agricultural systems. Now, there are many factors at play here, and these factors include the nutrients of concern, whether it's nitrogen or phosphorus or both, whether the phosphorus is in dissolved or particulate form, because the chemistry and the transport pathways through watersheds can be quite different. And this requires different management solutions. Other important factors include the climate, the type of agriculture, different soil types, and different hydrology and drainage. And so nutrient management and conservation practices do need to be quite carefully tailored to those local factors and conditions because we don't have a single silver bullet or a one size fits all solution that works everywhere all of the time. And going back to recovering phosphorus and organic wastes, these wastes produced in intensive livestock production and from human waste in urban areas, recycling that phosphorus back to areas where it's needed for food production.

Now, this all offers some real win-win opportunities, so opportunities for water quality by reducing those losses of waste phosphorus to water bodies and in terms of phosphorus security by reducing our reliance on those non-renewable phosphate rock reserves. So really, all of this will be needed to help us achieve that vital balance in securing the benefits of nutrients for our food security whilst ensuring that too much of a good thing doesn't become a problem for our rivers and our lakes and coastal waters. And ultimately what we're aiming to do is to safeguard those green pastures and blue waters for future generations.

**DJ May:**

That is a really beautiful vision. I can't think of anyone who would hate to see green pastures and blue rivers. Thank you so much, Helen. I really appreciate your time today.

**Helen Jarvie:**

Thank you, DJ. It's a pleasure.

**DJ May:**

If you want to learn more about the relationship between nutrients and water quality, check out the show notes for some related research. And if you want to dig deeper into carbon, ecosystem services, nutrients and water quality, come visit us at decode6.org. We'll see you there.