Clothing, furniture also to blame for ocean and freshwater pollution

August 2 2018

Credit: CC0 Public Domain

Think summer holidays and you'll likely call up images of a beautiful beach or a glittering blue lake. But more and more lakes, rivers and coastal areas are plagued by an oversupply of nutrients that causes algae to grow at an explosive rate, which can eventually lead to water bodies that can't support aquatic life.

Scientists call this type of water pollution eutrophication, and it is an enormous problem worldwide: There are more than 400 marine 'dead zones' caused by over-fertilization, covering an estimated 245,000 km^2, which is an area six times the size of Switzerland.

In some water bodies, eutrophication causes huge fish kills and toxic blue green algae blooms, which affects food supply, biodiversity and your favorite swimming spot.

Governments around the globe have battled eutrophication by working with farmers to control nutrient-laden runoff from fields and feedlots. But there's more to the picture, a new study published in *Nature Sustainability* shows.

Using a detailed modeling tool called MRIO, a team of researchers identified important, but often overlooked sources of water pollution, namely clothing, and other manufactured products and services.

When they did their analysis, the team found that the overall demand for non-food products in 2011 accounted for more than one-third of the nutrients causing eutrophication in both marine and freshwater systems worldwide. This was a 28 percent increase compared to 2000.

"Normally, we think of food production as being the culprit behind eutrophication. However, if we're trying to fully understand and control eutrophication, ignoring the contributions from other consumer products such as clothing and furniture means that we're only addressing part of cause of the pollution," said Helen Hamilton, a postdoc in the Norwegian University of Science and Technology's Industrial Ecology Programme, and first author of the paper. "We need to look at the whole picture to address the whole problem."

Wealthier world, more pollution

Agriculture will most likely always be the most important cause of eutrophication, the researchers said. But as countries develop and people become richer, the amount of money that is spent on food relative to the total GDP decreases.

With increased wealth, people have the opportunity to spend their extra cash on products that can also depend on agriculture in their supply chains, such as textiles, clothing and furniture.

A second challenge with goods and services is that they can often have long, complex supply chains across a number of countries before reaching the consumer, the researchers said.

"For example, when we buy a shirt that was made in China, it is China and not the consumer that has to deal with the pollution related to producing it. All traded goods have this problem: the place of production and, thus, pollution is often far removed from the consumers," Hamilton said. "This makes it difficult to tackle pollution because the relevant players, such as farmers, policy makers and consumers, are spread across several countries."

All those reasons, the researchers say, make it even more important to know how much goods and services contribute to eutrophication worldwide.

"From our work, we know that non-food consumption is growing over time and as people get richer. It is, therefore, increasingly important to consider the consumption of clothing, textiles and furniture in our strategies for solving this major ecological problem," she said.

Nitrogen and phosphorus most important

Fertilizer typically contains a mix of nitrogen, phosphorus and potassium, all of which are vital to plant growth. But when excess fertilizer reaches water bodies, it's mainly the nitrogen and phosphorus that matter in feeding algal blooms.

The production of non-food goods, such as clothing, can involve the release of nutrients directly, as when a farmer grows cotton or linen for the fabric to make the clothing. There are also more indirect sources, such as when electricity or another energy source is used to power the factories where the clothing is made. That can release NOx, oxides of nitrogen, as air pollution which then can be absorbed by the oceans and add to the nutrient load.

Knowing the importance of these nutrients and how they can be released in any number of different steps during production gives researchers the ability to nail down when and in which stage of production the pollution occurs.

Eutrophication footprints

By looking at how much nitrogen and phosphorous are released along the entire global supply chain for the product, they can then figure out how much the production of different goods and services contributes to eutrophication.

Using their MRIO (which stands for multi-region input output) method, the researchers calculate country-specific "eutrophication footprints", which are simply the sum of all the pollution that occurs worldwide due to a country's consumption.

This includes both the pollution that occurs within the country's own borders and the pollution that is generated in other parts of the world due to the production of imported goods.

A good example of this is the EU, Hamilton says.

"Our results show that the vast majority of all eutrophication related to the EU's non-food consumption occurs in other regions," she said, a phenomenon that researchers call displacement.

"In other words, the EU is generating an enormous amount of pollution in other countries by consuming imported products without having to deal with the consequences," Hamilton said.

The researchers found that the EU drives the largest global non-food eutrophication displacements, to the Asia-Pacific region for marine eutrophication and to Africa for freshwater eutrophication.

US, China play a major role in overall eutrophication

Not surprisingly, the US and China have some of the biggest eutrophication footprints, the researchers found —although most of this pollution occurs within their own borders due to the high consumption of domestic goods, both food and non-food.

China had the largest non-food eutrophication footprint for marine ecosystems. The country's total marine eutrophication footprint was 8.6 metric tons of nitrogen equivalents, with fully 3 metric tonnes of this attributable to the consumption of both imported and domestically produced non-food goods.

"This was also double China's 2000 non-food marine eutrophication footprint, which really exemplifies the recent boom in the Chinese economy," Hamilton said.

The researchers also found a similar trend with China's food marine eutrophication footprint, which increased by over 25% from 2000, peaking at 5.4 metric tonnes of nitrogen equivalents in 2011 for marine eutrophication. That's the highest country-level food footprint, Hamilton said.

"It was also interesting to look at food-related eutrophication impacts to find trends there as well. In China, population growth combined with changes in diet have certainly contributed towards making them the world leader in food-related eutrophication," says Hamilton.

However, when considering total eutrophication, or the sum of both food- and non-food related eutrophication, the U.S. takes the lead. In 2011, the U.S. was the largest overall country-level contributor for both marine and freshwater eutrophication. This is nearly triple its 2000 values, which highlights how much U.S. consumption is growing over time.

More than one-third of eutrophication due to clothing, other products

When they looked at the big picture, the researchers found that clothing, goods for shelter, services and other manufactured products accounted for 35% of global marine eutrophication and 38% of the global freshwater eutrophication footprints in 2011, up from 31 and 33%, respectively, in 2000.

"By comparison, the global food footprints only modestly increased by roughly 10% from 2000 to 2011 values," Hamilton said.

In the end, from a production standpoint, agriculture is the most important contributor to the problem, accounting for 84% of the total footprints for both marine and freshwater eutrophication. But the researchers pointed out that approximately one-quarter of these agricultural impacts in 2011 were due to non-food consumption.

Another important aspect about non-food consumption is that, compared to food, it is also significantly more sensitive to changes in wealth and is more likely to be traded across borders.

"Simply put, there are natural limits to how much people can eat. This means that as the population gets richer, diets and food consumption might change a bit, but where we see the biggest increases is with buying other products such as cars, clothing and furniture," Hamilton said. "These are also the products that are easiest to trade around the world because, unlike food, they don't have an expiration date. Therefore, we see much higher pollution displacement with non-food as compared to food."

Wealthy countries can drive improvements in developing countries

As economies develop, this points to the need for trade agreements and policies to consider the displacement of ecosystem impacts, the researchers said.

And while the EU has developed frameworks and strategies for tackling eutrophication within Europe, for example, there aren't many policies that integrate international supply chains for addressing eutrophication abroad.

"Countries that are responsible for the largest footprints could set consumption-based targets, such as a 40% reduction in the EU's global eutrophication footprint," Hamilton said. "That could help increase the transfer of technology or skills, such as improving fertilizer efficiencies or animal waste management, in producing countries."

It also provides consumers in wealthier countries a way to drive improved environmental policies in developing countries, the researchers said, since wealthy regions can more easily afford the resources needed to support the implementation of these policies in developing countries.

More information: Helen A. Hamilton et al, Trade and the role of non-food commodities for global eutrophication, *Nature Sustainability* (2018). DOI: 10.1038/s41893-018-0079-z

Provided by Norwegian University of Science and Technology