

What is sustainable phosphorus management and why do we need it?

Phosphorus (P) and nitrogen (N) are indispensable macronutrients that help plants grow and are important ingredients for making synthetic fertilizers. However, due to the unsustainable management of these nutrients, there are devastating effects when they seep into lakes, rivers and the ocean.



Reducing nutrient pollution, including from phosphorus, is [key to preserving and restoring biodiversity, achieving ambitious climate targets and protecting human health](#). The challenge is to ensure the long-term availability, accessibility, and affordability of phosphorus to attain food security whilst minimizing pollution.

Solutions will come from action across multiple policy areas. It is possible to better [manage the finite reserves of phosphate rock](#) and reduce the demand and dependence on this supply. This can be done by [improving mining and processing of phosphorus](#), optimizing how phosphorus is used – i.e. maximizing efficiency while minimizing losses to the environment. There is also a need for innovation and investment to develop i.e. circular approaches for phosphorus through recovery and reuse from waste streams.

What is phosphorus?

Phosphorus compounds are derived from phosphate containing rock. As phosphorus is found in all living things, compounds can also be recovered from various domestic and industrial waste streams. The natural [cycle of phosphorus](#) is slow, playing out over millions of years. Unlike nitrogen, phosphorus does not occur as a gas.

Phosphorus is an essential macronutrient alongside [nitrogen](#) and potassium. It is an indispensable nutrient required by all living organisms, including humans. There is no substitute.

Plants require phosphorus for photosynthesis and growth. Phosphorus therefore [underpins global food systems](#) and food security. In some parts of the world, food production is undermined by the lack of available and accessible phosphorus.



What is the impact of phosphorus imbalance?

When phosphorus is not adequately managed, it leads to an [imbalance in nutrient ratios](#). Not only can too much phosphorus cause problems, but too little phosphorus can also be detrimental.

The global cost of phosphorus pollution is estimated to be [US\\$265 billion per year](#). Changes to the phosphorus cycle and the rate that phosphorus is moving through parts of this cycle has now reached a point where there is a [high risk of fundamental changes](#) to the earth's systems.

Why is too little phosphorus a bad thing?

A deficiency of phosphorus can cause health problems for humans, animals and plants. Plants need phosphorus to photosynthesize. Crops that do not have enough phosphorus will not grow as well, take longer to mature and have lower yields. Equitable access to phosphorus and its appropriate use is an important part of achieving long term food security.

Why is too much phosphorus a bad thing?

Pollution from excess phosphorus is one of the main [direct drivers of biodiversity loss](#), undermining ecosystem function and ecosystem services in soils, lakes, rivers streams and coasts, this disrupts the balance of nutrient availability, resulting in eutrophication. In freshwater and coastal ecosystems this causes a rapid acceleration of algal growth which can block light and deplete oxygen. In extreme cases it can result in areas known as dead zones. In the Caribbean, eutrophication has been linked to vast quantities of [sargassum](#) washing up on the beaches, causing social, environmental and economic problems.

The response of ecosystems to pollution can be compounded by the impacts of climate change and the other way around. Warmer water carries less oxygen, it can augment algal blooms and/or amplify the toxic cocktail of pollutants.

How did we get here – and what can we do about it?

Humanity's interference in the phosphorus cycle

Human demand for phosphorus, in particular our need for fertilizer to produce food, has led to a disruption of the phosphorus cycle. The extraction of phosphorus from mineral deposits to feed this demand has [tripled the natural rate of flow](#) of phosphorus from phosphate rock deposits to water bodies. Human-induced habitat disturbance and habitat loss impact the rates of erosion and soil quality.

[Climate change impacts](#) are another factor affecting the rate of phosphorus flows through the cycle. Changes in temperatures, rainfall, wind patterns and carbon dioxide concentrations change the availability of phosphorus to organisms as well as how it is used, with implications for agricultural production.

What are the sources of anthropogenic phosphorus losses?

[Agriculture is a major source of phosphorus loss](#) – both in production of crops and livestock, and through food waste, our sewage, municipal waste and other waste streams.



What is being done to address the phosphorus challenge?

The management of phosphorus is vital for achieving several of the **Sustainable Development Goals** (SDGs), in particular [2 Zero hunger](#), [6 Clean water and sanitation](#) and [14 Life underwater](#).

Nutrient management has been the subject of previous commitments for environmental action by the **United Nations Environment Assembly** (UNEA) ([UNEA Resolution 3/10](#) §7) with two specific resolutions adopted to address sustainable nitrogen management (UNEA Resolutions [4/14](#) and [5/2](#)).

[The Kunming-Montreal Global Biodiversity Framework](#) (GBF) tackles phosphorus within its [target 7](#), which addresses reducing excess nutrients lost to the environment as well as reducing the risk from pesticides. Phosphorus compounds are also used for several types of pesticides. Addressing target 7 is a pre-requisite to achieving other targets, including those on ecosystem restoration (target 2) and protection (target 3).

Other actions are being taken to increase cooperative action at national and regional levels, including the adoption of measures for addressing nutrient pollution and wastewater recovery and reuse through Regional Seas Conventions and Action Plans.

What are the solutions for sustainable phosphorus management?

Improving phosphorus use efficiency and reducing losses. Integrated approaches such as “source to sea” will be needed to make sure actions are coherent across sectors and are meaningful from an ecological perspective.

Changes to agricultural and livestock management practices are needed to optimize phosphorus use.

Progressing towards SDG 6 to increase access to sanitation and reduce the proportion of wastewater being released untreated, will contribute significantly to reducing phosphorus pollution from wastewater and increase opportunities for recovery and reuse.

The demand for phosphorus has increased 38 per cent per capita in the last 50 years due to dietary changes towards increasing consumption of meat and animal products and increased food waste. Around [17 per cent of food is wasted each year](#) at the household and retail level. Our behaviours and dietary choices as consumers play an important role in determining phosphorus demand and losses.