



EARTH COMMISSION EXPLAINER BRIEF

NUTRIENTS

TACKLING THE CHALLENGES OF EXCESS – OR LACK OF – NUTRIENTS TO ENSURE A SAFE AND JUST FUTURE FOR ALL

Fertilisers are used in agriculture to provide extra nutrients, particularly nitrogen and phosphorus, for good crop yields. However, excess nutrients can degrade neighbouring ecosystems. This process is known as eutrophication, and it can push aquatic and land ecosystems past tipping points, beyond which biodiversity collapses. Conversely, in some parts of the world, there is not enough fertiliser to ensure a secure food supply. We must act now to ensure a safe and just future for humanity.

WHAT ARE EARTH SYSTEM BOUNDARIES?

The groundbreaking Earth System Boundaries (ESBs), identified by the Earth Commission, are scientifically quantified safe and just limits for climate, freshwater, biodiversity, nutrient cycles and aerosol pollutants.

They delineate a long-term *corridor* for humanity on a global scale – *a safe and just zone for people and planet*. By operating within these limits, we can maintain a stable and resilient planet and ensure access for everyone to the resources necessary for a dignified life.

Even temporary overshooting of some of the Earth System Boundaries can permanently damage the planet's critical systems, causing irreparable harm to life.

Earth System Boundaries can guide action towards a safe and just future for every human and the planetary web of life we rely on.

- *Safe* boundaries ensure stable and resilient conditions on Earth, within the Holocene range of variability, that we know can support human development.

- *Just* boundaries minimize human and nature's exposure to significant harm. In addition, the Earth Commission quantified minimum levels for access to resources for a dignified life and freedom from poverty for everyone.

WHAT DOES THE EARTH COMMISSION SAY ABOUT NUTRIENTS?

Nutrient Earth System Boundaries focus on the global nitrogen and phosphorus cycles, and the Earth Commission has calculated the maximum allowed agricultural surplus. The surplus is the input beyond what is used and removed by the crops. It is this surplus that drives environmental degradation. The surplus can be reduced to as close to zero as possible through increased fertiliser use efficiency.

Boundaries are set across different scales from local to global. This is because nutrient pollution is highly localised and context dependent, but the global aggregate is important too. Rich countries are overusing fertilisers, while low-income countries need more.

WHAT ARE THE KEY INSIGHTS WE CAN DRAW FROM THE EARTH SYSTEM BOUNDARIES FOR NUTRIENTS?

- Excess nutrients from fertiliser overuse drive pollution in soils, freshwater and the ocean, leading to biodiversity loss, toxic algal blooms, and water quality degradation. Excess fertiliser use also leads to significant emission of greenhouse gases and air-polluting aerosols.
- Damage to ecosystems affects the millions of people who depend on them for clean water. Eutrophication threatens the survival of fish and other aquatic life. There is a serious impact on human health.
- Huge amounts of nutrients are lost and wasted between field and plate, and most sewage ends up polluting land and water rather than being recycled as fertiliser.
- While rich countries mostly overuse fertilisers, many of the world's poorest don't have access to enough fertiliser, leaving them in food insecurity.
- Reserves of rock phosphate are limited, and requires often damaging mining.
- Synthetic nitrogen fertilisers also require climate-polluting natural gas and lots of energy to make, but could be replaced by "green ammonia".
- For the global Safe boundaries for nutrients, we've quantified maximum agricultural surpluses of 61 (35-84) teragrams of Nitrogen a year (TgN/yr - 1 teragram = 1 million tonnes) for Nitrogen and 4.5-9 TgP/yr for Phosphorus. Beyond these boundaries environmental degradation due to eutrophication becomes widespread.
- The global Just boundary for Phosphorus aligns with its Safe boundary because human harm here occurs due to eutrophication.
- For Nitrogen, the global Just boundary is set at 57 (34-74) TgN/yr. This is slightly more stringent than Safe because in a few places Nitrogen over-use pollutes drinking groundwater before environmental degradation occurs.

WHAT ARE THE SAFE AND JUST NUTRIENT BOUNDARIES BASED ON?

The Earth Commission has focused on agriculture when setting the boundaries, as this is the source of around 90% of human-driven

nutrient inputs to the Earth system. Human sewage is also accounted for, as is the potential for global redistribution of inputs.

- The *safe nutrient boundaries* are based on recent scientific papers identifying concentrations of nitrogen and phosphorus beyond which eutrophication and ecosystem degradation occurs.
- This was used to estimate the maximum nutrient surplus or input in each local area for nitrogen, and globally for phosphorus. For nitrogen, local surpluses were added together to estimate a global total surplus, and make a global safe nitrogen boundary.
- The *just nutrient boundaries* are based on the point at which widespread harm occurs to people. The safe boundary is also the just boundary for phosphorus, as harm begins with eutrophication.
- The safe and just ESB for nitrogen is more stringent because nitrogen pollutes drinking water first in some areas.

WHAT CAN YOU DO?

It is essential to tackle the challenges of excess nutrients or lack of nutrients in our soil. Innovation and redistribution are needed to provide a safe and just future for all. We need to examine the irreversible damage caused to ecosystems by excess nutrients, and the impacts of eutrophication. *We must stay within the safe and just boundaries for nitrogen and phosphorus. We can and must take action now.*

The Earth Commission is part of a bigger system of changemakers: the Global Commons Alliance, which created the Science Based Targets Network (SBTN) to translate scientific boundaries into science-based-targets (SBTs). Businesses and decision makers can work with SBTs for Nature as part of their commitment to stay within the safe and just boundaries, across all sectors of the economy.

The ambition of the first phase of science-based targets for nature, just released by SBTN, is aligned with the Earth Commissions scientific findings. Building on existing environmental knowledge and aligned with local ambitions, these targets, including science-based targets for climate, will put businesses, cities and policy-makers on the right path so that we move towards a safe and just space for people and the planet.

Read more at earthcommission.org