

## Planetary Boundaries

**Planetary boundaries** define the “safe operating space” for all of humanity, including all governments, organisations and communities as a precondition for sustainable development. If the impact of human activities exceeds these thresholds there is a risk of abrupt and irreversible environmental change. The boundaries are usually represented as a circular graph, coloured green, amber and red.

**Land system change.** This describes land converted for human use, e.g. for agriculture. Globally, this is approaching red.

**Ozone depletion** The ozone protects the earth from UV radiation from the sun. CFCs from refrigerants and aerosols caused a hole in the stratospheric ozone layer. Actions taken as a result of the Montreal Protocol mean that this boundary has not been exceeded.

**Ocean acidification.** This is owing to increased CO<sub>2</sub> dissolving into oceans forming carbonic acid. Organisms with calcium carbonate shells, like corals and molluscs, can't make shells in acid water. This has a knock-on effect to food chains and webs, and could drastically reduce fish stocks. This boundary could be avoidable but is approaching amber.

**Biosphere integrity** describes biodiversity loss and extinctions. The cause is increased demand for food, water and natural resources. These are increasing in intensity and the boundary has been crossed. Habitats are being lost rapidly, e.g. coral reef bleaching caused by ocean acidification and rising temperatures.

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**Climate change.** The level of CO<sub>2</sub> has risen dramatically and continues to do so. The boundary has been crossed and scientists believe that the loss of polar sea-ice could be irreversible. This could push global temperatures and sea levels up. Destruction of rainforest and weakened carbon sinks in tundra and ocean could accelerate the Earth's warming and climate change.

**Chemical pollution and novel entities.** These are emission of toxic and long-lived substances, such as heavy metals, radioactive materials and synthetic organic pollutants. These can cause reduced fertility and genetic damage, e.g. DDT dramatically reduced bird populations. These have yet to have a quantified boundary.

**Aerosols** are atmospheric pollutants. Their effects in the atmosphere are complex and they have yet to be quantified.

**Freshwater consumption and the water cycle** - not yet quantified. Nevertheless, globally, fresh water is becoming scarce because of modification of water bodies and land use change. Desalination of sea water may ease the situation.

**Nitrogen and phosphorous cycles.** Fertiliser production and application are a concern; both elements are fixed into fertilisers but up-take by plants is limited leading to eutrophication.