Breach of Planetary Boundaries

Why in news?

The study, '*Earth beyond six of nine planetary boundaries*', by a group of scientists has found that out of the 9 planetary boundaries, humans have breached 6.

What are the planetary boundaries?

- **Planetary boundaries**- They are the thresholds within which humanity can survive, develop and thrive for generations to come.
- It sets limits on how much humans can be allowed to impact not only the climate but also other global processes that are essential for maintaining conditions on the planet to support modern civilisations.
- **Planetary boundaries framework** – It was developed in 2009, and includes nine planet boundaries that scientists believe capture all of the processes critical for maintaining the Earth's system state.
- For each boundary, control variables are chosen to capture the most important anthropogenic influence at the planetary level of the boundary in focus.

Planetary boundaries	Control variables
Biosphere integrity	• The health of ecosystems • Rate of extinction of species
Climate change	• Atmospheric CO2 concentration • Change in radiative forcing — a measure of the balance of energy from sunlight that hits Earth, in comparison with thermal energy the planet loses.
Novel entities	Levels of plastic, concrete, synthetic chemicals, gene-modified organisms, etc. that would not be found on Earth if we humans were not here.
Stratospheric ozone depletion	The anthropogenic release of manufactured chemicals that destroy ozone molecules
Freshwater change	Human-induced impact on • Blue water (found in lakes, rivers, and reservoirs) • Green water (available in the soil for plants and soil microorganisms)
Atmospheric aerosol loading	Tracking various particles from anthropogenic emissions that affect • Cloud formation • Global and regional atmospheric circulation
Ocean acidification	Reduction in the pH of the ocean over an extended period of time
Land system change	Changes in land use, especially the conversion of tropical forests to farmland

Biogeochemical flow	Alteration in the natural flows and the forms of nitrogen and phosphorus cycles, which are essential elements for plant growth

What does the study reveal?

- **Planetary boundaries-** 6 out of 9 planetary boundaries, have been transgressed because of human-induced pollution and destruction of the natural world.



- **Other planetary boundaries**- Atmospheric aerosol loading and ozone depletion remain within the constraints while ocean acidification is close to being breached.
- **Biogeochemical flow boundary**- It refers to the *phosphorus and nitrogen cycles.*
- The widespread use of nitrogen and phosphorus as crop fertilisers is wreaking havoc by,
    - Triggering algal blooms- It can cause entire fish populations to leave an area or even die
    - Ocean dead zones- A reduced level of oxygen in the water.
- **Biosphere integrity boundary**- It was violated in the last 19th century when
    - Land use-acceleration in land use caused a strong impact on numerous species.
- **Freshwater-** The boundary was breached last century, between 1905 and 1929.
- **Novel entities**- There is rising levels of novel entities in the environment.
    - Humans have been releasing unprecedented amounts of synthetic chemicals like pesticides and plastic, without adequate safety testing for decades.
- **Land system change**- Land-use conversion, fires and deforestation of the Amazon tropical forest, etc. has increased such that it has now transgressed the planetary boundary.
- **Climate change-** The analysis notes that both the atmospheric CO2 concentration and radiative forcing are steadily increasing.
    - *CO2 concentration currently stands at 417 parts per million (ppm), whereas it was just 280 ppm before the Industrial Revolution. Its safe boundary limit is 350 ppm, which was breached in the 1980s.*
- **Exhausted life support systems-** The broken boundaries show Earth's life-support systems have been driven far away from the safe operating space for humanity that existed during the Holocene period.

Holocene period started with the end of the last ice age and the start of the Industrial Revolution. It is characterised by relatively stable and warm planetary conditions.



What lies ahead?

- Earth can heal if the planetary boundaries aren't like tipping points.
- If humans do away with fossil fuel burning and end destructive farming, the transgressed boundaries can be brought back into "space operating space.

Stratospheric ozone depletion boundary is one of the improving and recovering boundary, owing to the combined international efforts initiated by the Montreal Protocol in 1987.

References

1. Indian Express-Human breaches most of the planetary boundaries
2. Science- Earth beyond 6 of 9 planetary boundaries report

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