



Applying Planetary Boundaries

Effective Risk Management
and Value Creation

June 2026

Executive Summary

First Sentier MUFG
Sustainable Investment Institute

About the Institute

The First Sentier MUFG Sustainable Investment Institute (the Institute) provides research on topics that can advance sustainable investing. As investors, both First Sentier Group and MUFG recognise our collective responsibility to society and that investment decisions should be made with consideration to our communities, both now and in the future.

The Institute commissions research on Environmental, Societal and Governance issues, looking in detail at a specific topic from different viewpoints. The Institute recognises that investors are now looking in far greater depth, and with far greater focus, at issues relating to sustainability and sustainable investing. These issues are often complex and require deep analysis to break down the contributing factors. If, as investors, we can better understand these factors, we will be better placed to consider our investment decisions and use our influence to drive positive change for the benefit of the environment and society.

The Institute is jointly supported by First Sentier Group (FSG) and Mitsubishi UFJ Trust and Banking Corporation, a consolidated subsidiary of MUFG. Representatives of both organisations will provide input to the activities of the Institute.

An Academic Advisory Board advises the Institute on sustainability and sustainable investment research initiatives. The Academic Advisory Board comprises prominent leaders from academia, industry and nongovernmental organisations in the fields of Responsible Investment, climate science and related ESG endeavours. The Board provides independent oversight to ensure that research output meets the highest standards of academic rigour.

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All our investment teams – whether in-house or individually branded – operate with discrete investment autonomy, according to their investment philosophies.

<https://www.firstsentierinvestors.com>

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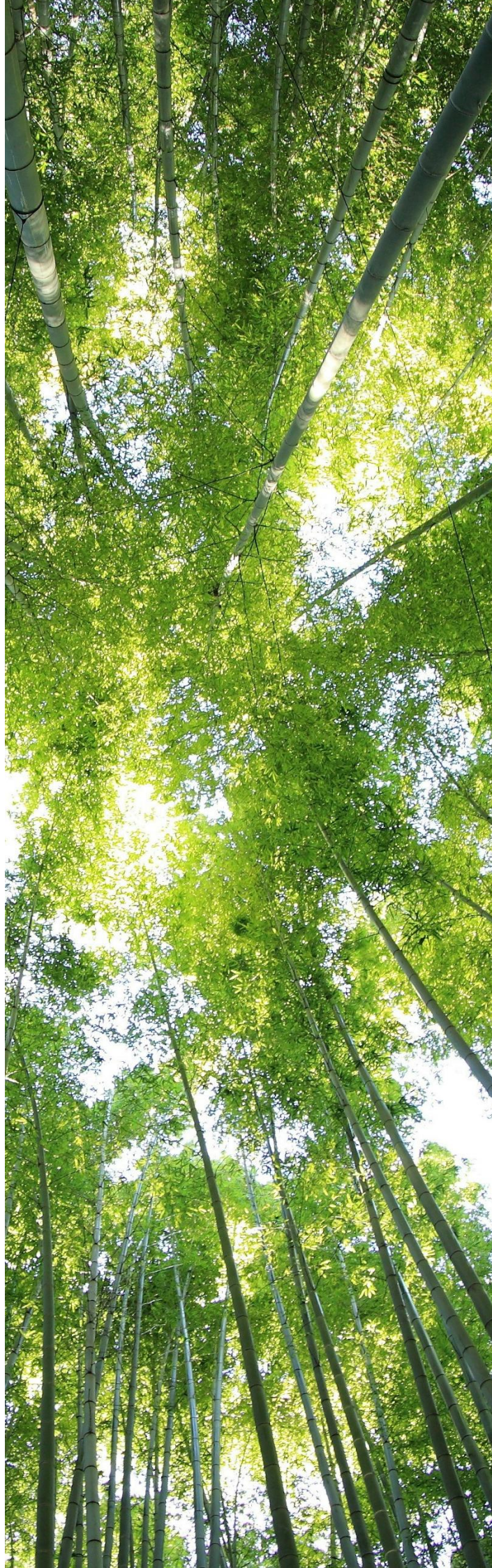
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Amongst our accolades include recognition as 'Climate Risk Advisory Firm of the Year' by Energy Risk Asia 2023, 'World's Best Management Firm' by Forbes 2024, and 'Leading Management Consultants' by the Financial Times 2026.

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Executive summary

Global markets are being reshaped by a deeper ecological realignment. While the world’s attention has been on the immediate threats of climate change, broader changes to Earth’s critical global processes are creating wider systemic risks alongside new multi-trillion-dollar opportunities. Investors and corporates best positioned to succeed will be those who anticipate, adapt, and act.

- 1. Resilience and long-term growth prospects of the global economy rely intrinsically on the stability and health of our planet.** To date, understanding the ecological changes that threaten this stability has been assessed through the lens of climate change and greenhouse gas (GHG) emissions. However, there exist another eight critical global processes that are far less widely translated into corporate and investment decision-making.
- 2. Damage to these wider global processes is already causing significant risk and harm.** For example:
 - \$58tn of annual global economic value (>50% of the world's GDP) is dependent on natural ecosystems, many of which are at risk today.¹
 - \$320bn in global physical damages were caused by natural disasters in 2024 alone, while economic losses associated with air pollution accounting for nearly 7% of global GDP.²
 - Up to 1.2bn people are projected to be displaced by 2050 due to severe ecological threats, natural instability, and scarcity.³
- 3. In 2009, the Stockholm Resilience Centre developed a science-based framework outlining the nine critical global processes that regulate the stability and resilience of our planet.** Crucially, the "Planetary Boundaries Framework" also defines the quantitative **planetary boundary (PB) thresholds**. Ultimately, if these boundaries are crossed, they would **increase the likelihood of crossing Earth-system tipping points that would trigger unacceptable and non-linear environmental change**, causing irreversible damage to the Earth.

Figure 1. Current global status of the nine planetary boundaries⁴

 Climate Change	High risk	 Ocean Acidification	Increasing risk
 Biosphere Integrity	Critical	 Atmospheric Aerosol Loading	Within safe operating space
 Land-System Change	High risk	 Stratospheric Ozone Depletion	Within safe operating space
 Freshwater Change	High risk	 Novel Entities	Critical
 Biogeochemical Flows	Critical		

¹ "Living Planet Report", WWF (2024).

² "Natural Disaster Figures", Munich Re (2025); "Accelerating Access to Clean Air for a Livable Planet", World Bank (2025).

³ "Nature Risk Analysis", WWF (2025).

⁴ "Seven of nine planetary boundaries now breached – ocean acidification joins the danger zone", Potsdam Institute for Climate Impact Research (2025).

4. **The scientific consensus establishes that seven of the nine planetary boundaries have already been breached.**⁵ This is causing an increased risk of irreversible damage, amplified by the profound interconnectedness of critical global processes. Deterioration of one process has immediate negative implications for others. For instance, **Land-System Change** (driven by rapid deforestation) directly exacerbates **Climate Change** by releasing stored carbon. This influx of emissions intensifies **Freshwater Change** by disrupting global precipitation patterns, which subsequently degrades **Biosphere Integrity**, creating a dangerous feedback loop that further weakens the planet's baseline resilience.
5. **The deterioration of critical global processes and planetary boundaries brings existential risks to entire markets and segments of economic activity.** Understanding the impacts of these acute risks requires planetary boundary assessments to be:
 - **Location-specific:** Global averages mask acute regional transgressions. For example, while **Atmospheric Aerosol Loading** is globally within safe limits, severe air pollution in urban areas across Southeast Asia creates localised hotspots of significant risk.
 - **Sector- and asset-based:** Boundaries exhibit distinct 'double materiality' across industries. For instance, the Fisheries sector is existentially threatened by **Ocean Acidification**, even if it barely contributes to the reduction of oceanic pH levels. Similarly, the Transportation sector has little impact on **Freshwater Change**, yet inland shipping can be substantially affected by low river and canal levels, causing high financial materiality exposure.
 - **Time-dependent:** Not all boundaries degrade at the same speed. For example, **Freshwater Change** can create near-term operational risks where drought or water restrictions halt production, constrain hydropower, or disrupt inland shipping, while **Novel Entities** (e.g. PFAS) can build gradually over many years, before turning rapidly into material financial exposure through litigation, clean-up costs, product bans, or tighter regulation.
6. **Companies and investors face interconnected planetary boundary risks that can disrupt cash flows, operations, valuations, and access to capital.** Yet these risks are still not consistently priced by markets, partly because environmental costs remain externalised and decision-useful data is limited. Our shareholder returns analysis found no clear evidence that companies actively mitigating planetary boundary risks outperformed more exposed peers. In some cases, they underperformed the MSCI ACWI benchmark, suggesting public markets do not yet consistently reward companies that are better insulated to Earth system shocks.
7. **From a regulatory perspective, encouragingly, both global frameworks and local legislation are beginning to capture a wider range of critical global processes. However, while improved reporting is an essential tool in advancing the understanding of planetary boundary risks, the regulatory landscape remains fragmented, placing the ball in investors' and corporates' courts to examine their exposures.** This divergence undermines the transition toward transparent and comparable disclosures across jurisdictions. Essentially, until these new PB-aligned regulatory frameworks gain critical mass and establish consistent and comparable market standards, analogous to carbon budgets and well-functioning carbon markets, it remains within investors' and corporates' purview to proactively assess their own planetary boundary exposures and identify related opportunities.
8. **For those able to effectively introduce planetary boundary considerations into their strategic processes and operations, the rewards span well beyond simply improving risk management and mitigating the adverse impacts of environmental deterioration.** Increased value creation, more resilient operations, and improved financing conditions await those who are best able to anticipate, adapt, and act. For example:

⁵ "Seven of nine planetary boundaries now breached", Potsdam Institute for Climate Impact Research (2025).

- **The size of the prize:** \$10tn in annual business value is expected from transitioning the global economy to a 'nature-positive' state.⁶
- **Sectoral upside:** \$4.5tn economic opportunity in the transition to a circular economy.⁷

9. A growing range of public frameworks and open-source datasets exist to help corporates and investors navigate this transition and achieve a better understanding of planetary boundaries.

Crucially, some of these technical frameworks are free to access and help fill the precise analytical gaps that current regulation is unable to address. By leveraging mechanisms like the Earth System Impact (ESI) Score or NGFS scenarios, investors can translate abstract macro-ecological limits into highly precise, actionable investment metrics. It is in this context that we are also seeing proprietary approaches from investors and corporates emerge to integrate planetary-boundary considerations into investment processes, portfolio construction, risk management, stewardship activities, and capital-allocation decisions. This empowers asset owners and asset managers to benchmark the true biophysical intensity of different investments, structurally identifying those companies and assets driving critical boundary transgressions versus solution providers and transition leaders operating within the Earth's carrying capacity.

10. While the scale of the challenge ahead is unprecedented, governing our return to a safe operating space remains fundamentally possible.

The 1987 Montreal Protocol stands as the ultimate proof: combining unequivocal science with decisive global policy and industrial innovation, we successfully placed a critical planetary boundary, **Stratospheric Ozone Depletion**, on the path to recovery. By embracing planetary boundaries science, and integrating it into strategic and operational decision-making, corporates and investors can transition from managing existential risks to leading the multi-trillion-dollar realignment toward a more resilient, nature-positive global economy.

Recommendations for investors

The investor community has a vital role to play in this global realignment. Investors can adopt a multi-faceted approach to capitalise on opportunities by:

1. **Building capability** through tools, data, and cross-disciplinary expertise to translate planetary boundary science into investment insights and improved understanding of market demand shifts.
2. **Mapping exposure** across planetary boundaries, geographies, sectors, assets, and time horizons to identify material risks and opportunities.
3. **Assessing and pricing risks and opportunities** by embedding planetary boundary exposures into valuations, scenario analysis, funding decisions, and performance metrics.
4. **Shaping portfolio strategy** through asset allocation, portfolio construction, and risk management aligned to Earth system resilience.
5. **Engaging portfolio companies** to strengthen disclosure, governance, operational resilience, and strategic decision-making.
6. **Influencing the wider system** through policy engagement, market signalling, collaboration, and thought leadership, and by supporting the scaling of transition and adaptation technologies.

⁶ "How to unlock \$10.1 trillion from the nature-positive transition", World Economic Forum (2024).

⁷ "Circular Economy and Sustainability", Cardiff School of Management, WBCSD (2022).

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