

Global Catastrophic Risks 2026



**Global
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Foundation**

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Editor and Researcher: Lewis Day

Layout and graphics: J Lokrantz/Azote

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Contributors

Earth system stability

Fatima Denton, Director of the United Nations University Institute for Natural Resources in Africa (UNU-INRA) and co-chair of the Earth Commission

Johan Rockström, Director of the Potsdam Institute for Climate Impact Research (PIK) and co-chair of the Earth Commission

Risk 1 – Governing the unthinkable: Imagination and responsibility in the age of Earth system tipping points

Manjana Milkoreit, Researcher at the University of Oslo

Risk 2 – Nature in global governance

David Obura, Chair of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) and founding Director of CORDIO East Africa

Risk 3 – Weapons of Mass Destruction and Multi-domain escalation risk

Wilfred Wan, Director of the Stockholm International Peace Research Institute (SIPRI) Weapons of Mass Destruction Programme

Risk 4 – AI in military decision-making and AI in military decision-making: The global governance challenge

Denise Garcia, Professor of Political Science and International Affairs, Northeastern University and Commissioner at the Global Commission on Responsible AI in the Military

Risk 5 – Protecting Earth from the asteroid impact hazard

Romana Kofler, Programme Management Officer The United Nations Office for Outer Space Affairs (UNOOSA)

Conclusion – A system under stress: Adapting global governance to a world of accelerating risk

Eva Mineur, Head of Climate and Sustainability, Global Challenges Foundation (GCF)

Anna Möller-Loswick, Head of Common Security, GCF

Anja Olin-Pape, Head of Programmes, GCF

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Global catastrophic risks 2026

It may sound a bit boring, but I am a big fan of rules. From dividing a cake, to how we regulate the use of advanced technology. Rules offered protection for me as I was the smallest in the classroom and the youngest of my siblings. When handling conflicts, a rules-based order is a good thing for us who reject the idea that “might is right”. It offers a kind of protection when choosing a stance in a power game and might even give us a say in creating those rules.

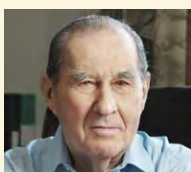


Our planetary commons — the shared systems that sustain life — have a weak voice in our decision-making systems. Space, the deep sea, freshwater, forests, and ice are not the infinite resources we once imagined but are part of a delicate balance, providing us with a life-sustaining environment. Never did I think that the Greenland Ice Sheet had anything to do with my future. Yet, human activities have affected ice sheets and other commons to such a degree that they will, inevitably, affect us all.

Welcome to the Global Challenges Foundation's (GCF) Global Catastrophic Risks report 2026. In the following pages, we present today's most threatening global catastrophic risks against human life on Earth. This is an exercise we have been doing since GCF was founded by László Szombatfalvy in 2012. As Johan Rockström and Fatima Denton describe in the chapter on Earth system stability, each of the risks described are deeply interconnected. Man-made risks such as climate changes, biodiversity collapse, weapons of mass destruction and the military use of artificial intelligence (AI) cannot be addressed in isolated silos. As climate and environment become increasingly intertwined with peace and security, we need a paradigm shift in international cooperation — one that bridges silos and reflects today's interconnected risks.

Each section of this report highlights a different risk. Each risk section begins with a two-page overview of the background, current development and existing governance — or the lack of it. This is followed by an article exploring a specific theme concerning the risk and potential pathways forward. The articles are written by some of the world's most recognised scientists and experts in their fields. That does not mean that we are turning away from other voices, perspectives and solutions. On the contrary, the purpose of this report is to stimulate open debate on how to understand, address and mitigate these risks. Civil society must be part of policy-making to protect ecosystems, and non-nuclear states must have a voice in nuclear risk-reduction discussions — especially those already affected by cross-border threats.

Measures to adapt the current system of multilateral co-operation to handle these risks are seldom straightforward. Our patterns of production and con-



ABOUT OUR FOUNDER

Global Challenges Foundation was founded in 2012 by the Swedish Financial analyst and author László Szombatfalvy (1927-2022).

sumption, as well as our ability to prevent and handle conflicts, remain misaligned with a sustainable and safe world. It can be tempting to seek purely technical solutions or attempt to out-arm one's neighbour.

We can see this today in the ongoing arms race around autonomous weapon systems. Establishing a meaningful, legally binding instrument to govern autonomous weapons development and use feels as urgent as it is complex and difficult. Additionally, our planetary commons cannot be negotiated with. The Greenland Ice Sheet, for example, does not respond to threats but to temperature.

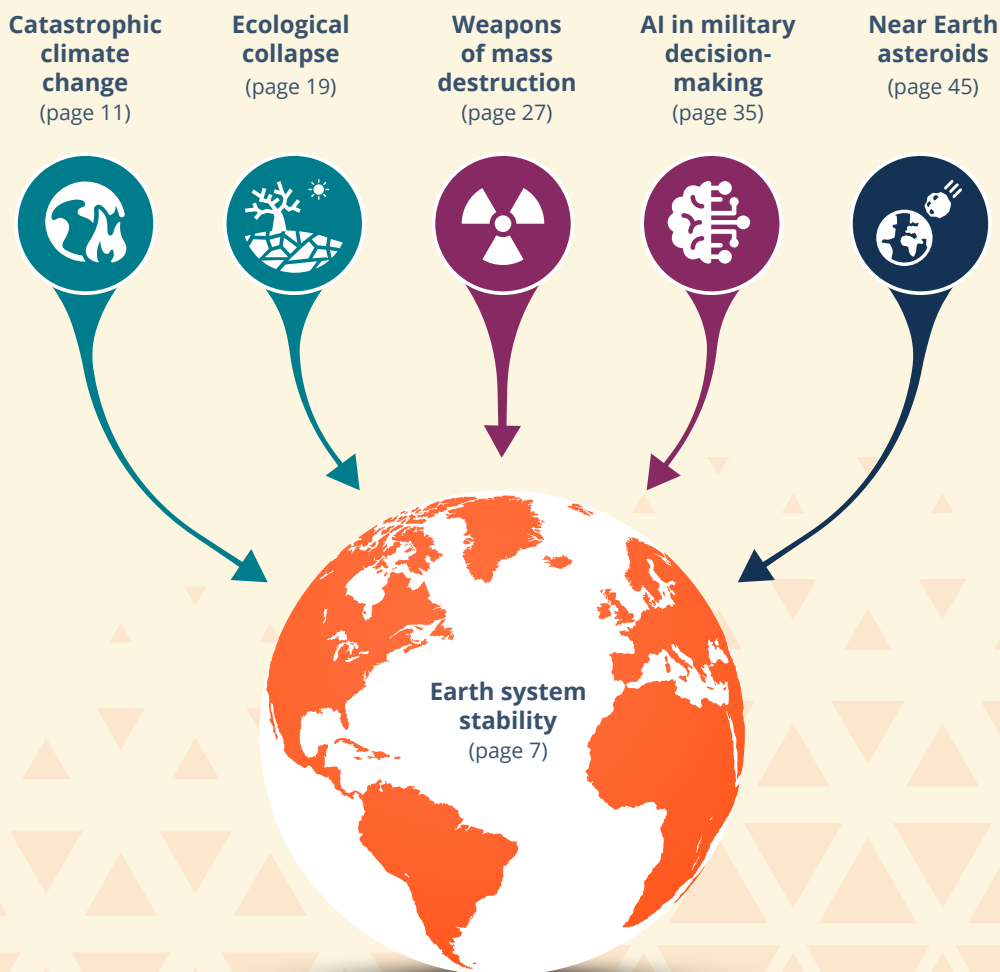
Meaningful steps have been taken before and can be taken again. At the end of this report some of my colleagues draw conclusions and give recommendations on the multilateral management of these risks. Humans are a remarkably adaptable species, and the Earth, with its built-in resilience, still offers us a window of opportunity — let's embrace it together.

Jens Orback

Strategic Advisor,
Global Challenges Foundation



Content in the 2026 risk report





Earth system stability

BY FATIMA DENTON & JOHAN ROCKSTRÖM

Humanity stands within the governance of its own destiny. The systems we build now will decide whether Earth remains habitable. We are pushing the planet beyond the limits of a safe operating space with more than three-quarters of the Earth's support systems outside the safe zone. The latest scientific assessment shows that seven of the nine planetary boundaries have now been breached, with the ocean acidification boundary most recently breached.



A stable Earth system is vital for a safe and just future

From the Arctic sea ice to the Amazon rainforest, from ocean circulation patterns to freshwater systems, these interconnected processes form the foundation of life, economies and societies. The Earth system is a single, dynamic web of physical, chemical and biological processes that regulate carbon, water and nutrient cycles across land, oceans, atmosphere and ice. All life on Earth, including human societies, depends on this delicate balance and feedback loops between these inseparable subsystems.

However, human actions have pushed these global commons out of balance and the Earth is on the brink of irreversible tipping points. The health of planet Earth and its people is at risk. The deterioration of the natural systems is already amplifying risks to energy, food and water security, while increasing the likelihood of disease, displacement and conflict.

The past 12,000 years — the epoch known as the Holocene — is the only state of the Earth system we have evidence of being able to support human development. Today, this system is out of balance. We are well into the Anthropocene, the proposed new geological epoch where human pressures have put the Earth on a trajectory moving rapidly away from the stable Holocene. For the first time in human history, we are forced to consider the real risk of destabilising our only home, planet Earth.

How can scientists and policy-makers collaborate to re-establish nature's own ability to uphold a stable Earth system, and better navigate and govern towards a safe and just future in the Anthropocene?

Defining the boundaries for a stable Earth system

Tipping points are thresholds beyond which parts of the Earth system, such as ice sheets, rainforests or coral reefs, abruptly shift into new and often irreversible states. Because these processes reinforce one another, one tipping point can trigger others, setting off cascading effects across the climate, oceans and biosphere.

To prevent such self-reinforcing changes, scientists have developed complementary tools to determine what is required to maintain a stable and resilient Earth system. For example, the Planetary Boundaries framework identifies nine critical Earth system processes within which humanity can safely operate: climate, biodiversity, land use, freshwater, ozone, aerosols, biogeochemical flows, ocean acidification and novel entities.

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For the first time in human history, we are forced to consider the real risk of destabilising our only home, planet Earth.

Expanding this scientific foundation, the Earth Commission's Earth System Boundaries integrate justice within and across generations. They define both safe boundaries that avoid undermining the resilience of the Earth system and thereby secure life-support and stay away from crossing tipping points, and just boundaries that prevent harm to people and ecosystems. Together, these upper ceiling limits and the social foundation of minimum access to resources define a safe and just space for humanity, where environmental stability and human well-being can coexist. This framing provides a science-based compass for policy and governance, guiding equitable resource distribution and systemic transformation toward a stable Earth system.

A projection to 2050 shows that the safe and just space will shrink, unless we urgently transform. For example, providing even basic living standards for everyone, without decarbonising technologies and adjusting for high energy consumption by some, would take global warming far outside the safe boundary and into a high-risk scenario of crossing dangerous tipping points.

On a more hopeful note, scientific evidence shows that despite the multiple pressures of the Anthropocene, from biodiversity loss and land degradation to disrupted nutrient cycles and ocean change, the Earth system continues to demonstrate significant resilience. It still buffers many of the impacts of unsustainable human activity, maintaining a degree of stability that can be strengthened through deliberate action. The most credible pathway to recovery involves navigating a temporary period of overshoot, not only in global temperature but across several Earth system boundaries, before returning to a safe and just operating space by mid-century and beyond. Achieving this will require coordinated governance that restores balance across the whole Earth

“To strengthen Earth system governance in the Anthropocene, scientists and legal experts are calling for a new approach to the global commons.”

system: halving global emissions each decade to 2050, regenerating degraded ecosystems, reducing pollution and nutrient overload, and rebuilding the resilience of terrestrial and ocean systems. The coming decades must therefore be governed as a period of managed planetary recovery aligning policy, finance and innovation to secure the biophysical foundations of a liveable planet.

Transformation & Earth System Governance

Just and systemic transformations are now urgently required. Decarbonising the global energy system, while essential, is only one part of the solution. Pushing beyond boundaries related to land, biodiversity, nutrients, water and pollution can independently destabilise the planet, even if climate targets, through reducing emissions from fossil-fuel burning and other greenhouse gases are met. Respecting the deep interconnections of the Earth system is therefore key to lasting stability and requires a new way of organising global co-operation. It means governing for the planet as a whole, rather than managing environmental issues in isolation.

To strengthen Earth system governance in the Anthropocene, scientists and legal experts are calling for a new approach to the global commons. Existing legal frameworks mainly cover areas beyond national jurisdiction, such as the high seas. The emerging planetary commons concept expands this to include the critical biophysical systems — atmosphere, cryosphere, land and biosphere, that regulate the planet's state and liveability. Building on this, proposals for a new global framework grounded in Earth system boundaries and justice aim to align international law, institutions, and finance with the realities of a finite planet.

The Earth Commission outlines a portfolio of transformations capable of reducing pressure on the Earth system while ensuring fair access to essential resources. These transformations must operate across scales, from local innovation to global coordination, and address the root causes of degradation: unsustainable consumption, inequitable resource use and short-term economic incentives. Transforming governance also means transforming norms — embedding stewardship, justice and long-term responsibility into the way decisions are made. We cannot realign into a safe and just operating space without the governance levers

that create alignment and synchrony across systems and scales. Justice and governance are not passive backdrops to transformation; they are active levers of stabilisation or destabilisation depending on how they are exercised and resourced.

At every level, governing for a safe and just future requires shared accountability.

Globally, through frameworks like the Paris Agreement, the Kunming–Montreal Global Biodiversity Framework, and emerging initiatives such as the European Union’s (EU) Fit for 55 and the High Seas Treaty. Strengthening the implementation of these and integrating science-based Earth system boundaries into international law can help define new planetary commons that safeguard the biophysical systems underpinning life on Earth.

Nationally, governments can embed science-based targets (SBTs) into economic planning, energy and land-use policy, and climate legislation, ensuring that national actions contribute to global stability.

Locally, cities, regions and companies can set measurable goals aligned with planetary boundaries, from circular economies and regenerative agriculture to restoring biodiversity and reducing pollution.

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Justice and governance are not passive backdrops to transformation; they are active levers of stabilisation or destabilisation depending on how they are exercised and resourced.

Together, these actions mark a shift from managing crises to regenerating resilience, shaping a future where both people and planet can thrive within the limits that make life on Earth possible. We are in a moment of both crisis and choice. We cannot opt out of either. This generation bears both the burden and the privilege of responsibility — to realign our systems, reconnecting our world within the confines of a stable Earth system and transform peril into purpose, providing prosperity and equity for all peoples, today and tomorrow.



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About the authors

Fatima Denton is Director of the United Nations University Institute for Natural Resources in Africa (UNU-INRA) and the co-chair of the Earth Commission, along with **Johan Rockström**. Rockström is also the Director of the Potsdam Institute for Climate Impact Research (PIK). This article contains contributions from Lisa Jacobson, Earth Commission/Future Earth Global Hub Sweden.



Catastrophic Climate Change

Climate change is accelerating, pushing Earth systems toward dangerous tipping points. Even small temperature increases intensify extreme weather and strain societies. Despite global commitments, current action is insufficient. Preventing catastrophic impacts demands rapid emissions cuts, stronger governance and coordinated, equitable efforts to protect planetary stability.

What is the risk?

Climate change is the long-term alteration of the Earth's climate system, driven primarily by the accumulation of greenhouse gases. This warming affects the atmosphere, oceans, land and cryosphere — the systems that regulate stability of the planet. Every year in the past decade (2015–2024) has ranked among the warmest on record. The global mean temperature for 2024 was 1.55°C above the 1850–1900 pre-industrial average, according to the World Meteorological Organization.¹ While short-term variations occur, the long-term trend is unmistakable: the planet is warming at an accelerating pace.

A single year above the 1.5°C threshold set by the 2015 Paris Agreement does not mark permanent overshoot but shows how close we are to destabilising key Earth systems. Even at today's levels, intensifying heatwaves, droughts, wildfires and floods are straining societies with the harshest impacts on those least responsible for emissions. The risk lies not only in continued warming but in cascading disruptions that could move the climate beyond humans' ability to adapt and manage it. Each fraction of a degree narrows the space for stability.

What is at stake?

If warming exceeds 1.5°C, it will lead to increasingly frequent and dangerous extreme weather events.² Every additional 0.1°C of global warming increases the intensity and frequency of temperature extremes, both now, when the Earth systems are considered stabilised, and in the overshoot period beyond the 1.5°C warming threshold.³ In a more extreme scenario, where warming exceeds 3°C, the planet could shift to climate conditions unseen for millions of years.⁴ Sea-level rise, crop failures and extreme heat would render regions uninhabitable and trigger mass displacement. Ecosystem collapse would undermine food, water and climate regulation.

Climate change is not linear: once tipping points are crossed, self-reinforcing feedbacks — melting ice, thawing permafrost, dying forests — can accelerate more change. Some systems are already near these limits.

“The risk lies not only in continued warming but in cascading disruptions that could move the climate beyond human's ability to adapt and manage it.”

Coral reefs, for instance, have passed their tipping point and may functionally collapse within a decade.⁵ The Global Tipping Points Report (2025) warns that averting coral reef collapse will require swift, coordinated global action to limit overshoot beyond 1.5°C and bring temperatures back below 1.0°C in the long run.

What are the driving forces and causes?

Climate change is driven by a combination of physical, economic and social forces that together disrupt the Earth's energy balance and carbon cycle. These drivers can be grouped into four interrelated areas.

1. Greenhouse gas emissions from human activity

The dominant cause of global warming is the accumulation of greenhouse gases in the atmosphere. According to the Intergovernmental Panel on Climate Change (IPCC), emissions from fossil fuel combustion, industry and agriculture are responsible for nearly all observed warming since the mid-20th century. Carbon dioxide accounts for about three-quarters of global emissions, largely from energy and transport, while methane and nitrous oxide from livestock, fertilisers, and waste add substantially to the planet's warming.

2. Land use and ecosystem degradation

Deforestation, land conversion, and the loss of peatlands and coastal wetlands release stored carbon and weaken natural carbon sinks. These ecosystems also moderate local climates and store moisture; their destruction intensifies regional warming, drought and biodiversity loss. Land-use change accounts for roughly one-fifth of historical emissions and continues to erode the biosphere's capacity to regulate the climate.

3. Economic and structural dependence on fossil fuels

The global economy remains locked into high-emission infrastructure and consumption systems — from energy and transport to industry and food. Capital, trade and subsidies reinforce this dependence, creating powerful inertia that delays transition.

4. Social, political and behavioural drivers

Lifestyles, consumption patterns and inequitable resource use contribute substantially to emissions disparities both within and between nations. Wealthier populations have far higher

per capita footprints, while limited awareness and delayed policy action reinforce the trajectory. Together, these social and political dynamics sustain the structural causes of climate change.

What is being done to govern catastrophic climate change and where are there gaps?

Global climate governance is anchored in the Paris Agreement, where nations pledged to limit warming to well below 2°C and pursue efforts to stay below 1.5°C. However, current national pledges remain far below what science indicates is necessary.

Successive UN Climate Conferences (COPs) have advanced climate diplomacy through new pledges on loss and damage, methane and deforestation. However, climate policies remain fragmented — separated from related domains such as biodiversity, energy, food, and finance — despite their deep interconnections. This lack of systemic integration weakens collective capacity to anticipate and manage cascading risks.

Unequal access to finance and technology as well as lack of institutional capacity further limits the ability of countries, not least low- and middle-income countries, to both adapt and transition away from fossil fuels.

Beyond technical and economic barriers lies a deeper leadership gap. There is a huge implementation gap in relation to what is needed according to science. This underscores the urgent need for strong accountability mechanisms at local, national and global levels to ensure that climate pledges translate into concrete, sustained implementation. Avoiding catastrophic climate change requires political courage to confront vested interests and align economic priorities with the Paris Agreement and planetary boundaries. Incremental diplomacy and short-term agendas are no longer sufficient.



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The Greenland Ice Sheet is only one of more than 20 recognised tipping elements.

Humpback whales swimming among icebergs from the Jakobshavn Glacier in Ilulissat Icefjord, Greenland.

Governing the unthinkable: Imagination and responsibility in the age of Earth system tipping points

BY MANJANA MILKOREIT

At the mouth of Ilulissat Icefjord, the Jakobshavn Glacier lurches forward about forty metres a day. Each summer, its face leans toward the sea, heavy with centuries of compressed snowfall, until something inside it gives. A crack begins high up in the wall of ice. Then, it widens and deepens until a city-sized block slides forward. The sound is less an explosion than a deep, resonant exhale, a noise you feel in the chest. The newborn iceberg turns and moves out to sea.



Scientists log the event, but the real data point is invisible: another infinitesimal step toward a planet reorganising itself. The moment is both ordinary and epochal — another Tuesday in Ilulissat, a threshold in the Earth system¹.

What is breaking here is not just ice, but the continuity that governance depends on. The rules we've written for a stable world no longer fit the one that's forming in front of us.

From control to navigating complexity: What makes tipping points different

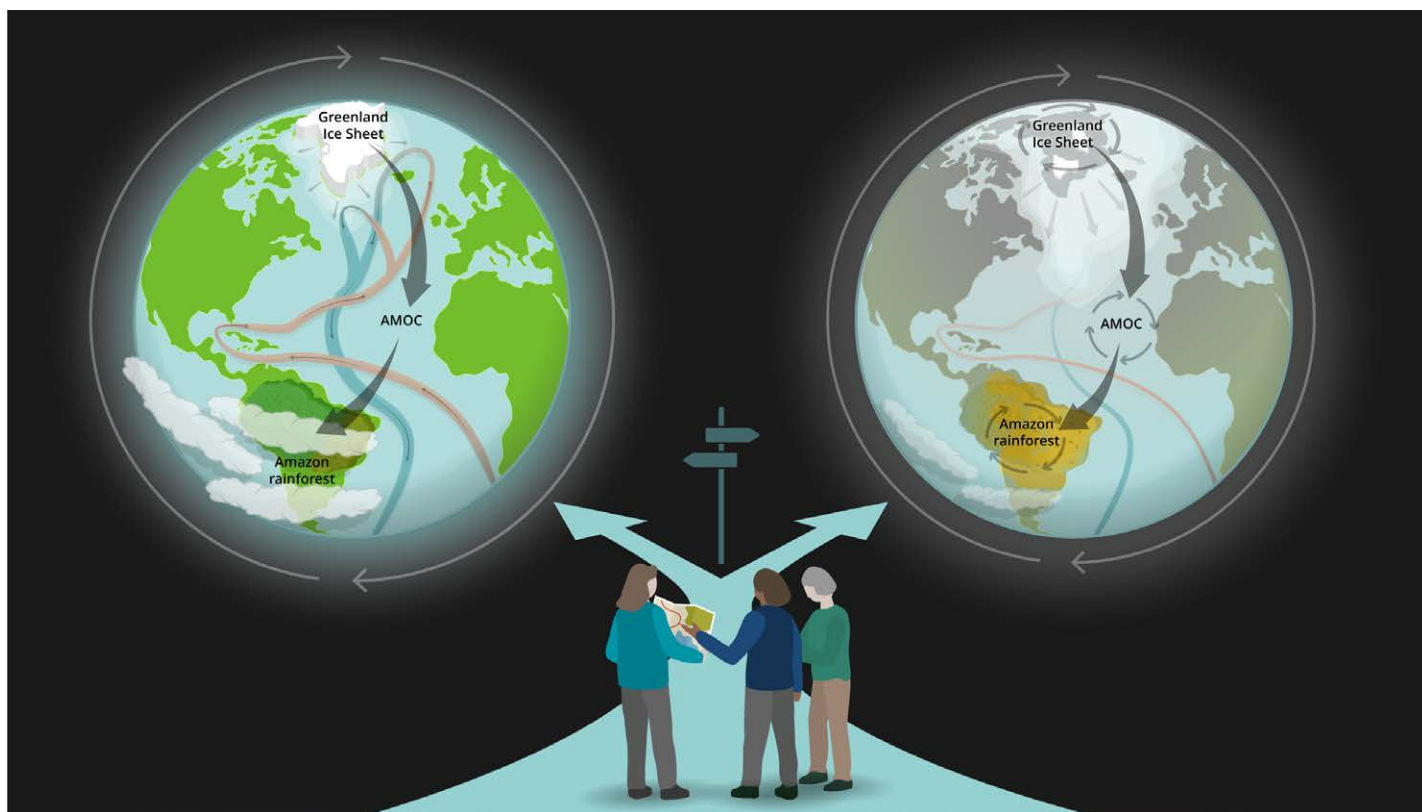
The Greenland Ice Sheet is only one of more than 20 recognised tipping elements in the Earth system, including ocean currents, forest biomes, permafrost and monsoons^{2,3,4}. Several features differentiate tipping points from the climate change we are accustomed to managing, transforming the basic grammar of governance⁵.

Thresholds and reorganisation: Conventional climate governance assumes continuity⁶. It relies on temperature targets, carbon budgets and sea-level projections — tools suited to gradual, predictable, reversible change. The Paris

“**[Tipping processes] are moments of commitment to irrevocable systemic shifts.**”

Agreement's 1.5°C goal, for instance, presumes a stable relationship between emissions and impacts; national adaptation plans proceed as if change will remain incremental along one of the IPCC's scenarios. But tipping processes violate that logic. They are moments of commitment to irrevocable systemic shifts. When thresholds are crossed, Earth systems do not simply deteriorate — they become something new. An unfamiliar territory for social organisation and human development. Governance can no longer aim only to optimise within a stable baseline; it must anticipate disruption, prioritise prevention and learn to navigate complexity. A first important case is the world's warm water coral reefs, which have now reached their tipping point and are likely to experience dieback over the coming two decades.⁴

This requires a shift toward precautionary, adaptive and integrative governance — approaches that recognise uncertainty



and work across domains. Climate, biodiversity, marine and land systems cannot be governed in isolation when the processes binding them together may reorganise as one. Today's institutional silos must give way to governance capable of navigating the dynamics of the whole.

Temporal dislocation and irreversibility: The second challenge is temporal. Tipping points collapse time in the moment of crisis yet expand it indefinitely through their consequences. The dieback of the Amazon or the loss of the Greenland Ice Sheet unfold over decades, centuries and millennia. But the decisions that determine these outcomes are being made now, within election cycles, planning periods and fiscal years.

This temporal dislocation compresses moral and political responsibility in the present: we hold unprecedented power to shape conditions far beyond our own lifetimes. Traditional democratic structures struggle to represent such extended futures. Recent court decisions have highlighted this failure, for example, the *German Federal Constitutional Court's 2021 ruling* affirming the rights of future generations.⁷

Governing tipping points therefore demands anticipatory and intergenerational capacities — institutions that can sense early warnings, act before certainty and give political voice to those who will live with the results.

Cascades and systemic ripples: What begins at Jakobshavn does not stay in Greenland. The ice released into the Labrador Sea changes the density of the ocean, nudging the great Atlantic circulation that shapes weather across half the planet^{8,9}. Far away, rainforests dry quicker than before, and the rhythms of the monsoon begin to drift¹⁰. Such connections reveal a deeper insight: tipping points are not only regional breakdowns but planetary reorganisations¹¹. Tipping impacts also unfold in cascades across coupled systems, such as coral bleaching leading to decline in fish stocks, which leads to decreased fish catches and dwindling incomes, growing hunger and migration. Effective governance must therefore become systemic — aware of linkages, able to detect cross-scale interactions and coordinate responses across policy arenas, jurisdictions and timeframes¹².

Emerging scholarship on Earth system governance and complexity points toward this evolution: reflexive, polycentric and inclusive forms of decision-making that treat governance itself as an adaptive system^{13,14}. Yet most political architectures remain designed for stability within siloes, not surprise within systems.

To govern tipping points, then, is to navigate Earth-human-system transformation — to steer societies toward wellbeing and habitability¹⁵ as the Earth reorganises.

The moral imagination of planetary governance

Earth system tipping dynamics dissolve the familiar boundaries of time, space and responsibility. Governance is no longer only about managing emissions or protecting ecosystems; it becomes about imagining the future as latent — something already unfolding through our choices¹⁶.

Meeting this challenge demands more than institutional reform. It calls for imagining a new approach to governance — one that sees the Earth as a dynamic, interdependent system with humanity as both participant and agent of change. The imagination of the past was centred on how to predict and control. The imagination needed now asks what forms of care, restraint and cooperation are possible when feedbacks transcend borders, scales and timeframes.

The Global Stocktake under the Paris Agreement gestures toward this planetary imagination. Conceived as a collective moment of reflection and course correction, it invites nations to evaluate progress toward long-term goals not in isolation but as co-authors of a shared trajectory. Yet, its potential remains constrained by short-term logics — national interests, five-year cycles and incrementalism.

Democratic governance faces both peril and promise here. Its short-term cycles make it ill-suited to deep time, yet its capacity for collective deliberation offers the best hope of navigating it. Democracy must expand — through time, to represent future generations, and across space, to embrace the interdependence of Earth's systems.

Innovations such as citizens' assemblies — deliberative forums that gather diverse publics to confront complex choices — illustrate how this imagination might be institutionalised. Operating at local to planetary scales, they offer venues where moral reasoning and scientific understanding meet.

Imagination, in this sense, is not escapism; it is a **governance capacity**. The capacity to picture what does not yet exist — to deliberate about worlds we will not personally inhabit — is what allows governance to stretch beyond the present moment.

This is, ultimately, a moral task — one today's youth climate movements are already advancing, grounded in a lifetime-spanning concern for a shrinking human niche on Earth¹⁷. To govern tipping points is to decide what forms of life and relation we wish to preserve. It requires humility about what cannot be known, and courage to act before it is. Our task is not to control the Earth's transformation, but to participate in it wisely — ensuring that as the planet's great stabilising systems approach thresholds, our values keep up with the immensity of the challenge.

Conclusion: A mandate for imagination

Every calving is an ending and a beginning. The cryosphere remakes itself, and so must we. For decades, we governed as if the planet would yield to management plans, targets and self-interests, as if linear progress pursued in national boundaries could hold a nonlinear world that ignores borders and scales. But here, among the echoes of ice collapsing into water, governance meets its limit — and perhaps its renewal.

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The dieback of the Amazon or the loss of the Greenland Ice Sheet unfold over decades, centuries and millennia.

If tipping points mark the boundaries of the Earth's resilience, they also define the frontier of human responsibility. We cannot govern these risks through management alone; we must reimagine governance itself — as a shared, anticipatory practice capable of shaping transformation before it overtakes us.

The 2030s will determine much of the planet's long-term trajectory. This decade must therefore be one of institutional imagination: building foresight and early-warning capacities into decision systems; establishing intergenerational representation in parliaments, courts and climate bodies; linking the Global Stocktake

to deliberative mechanisms that can translate planetary diagnostics into public purpose.

This is a moment to claim a new public mandate: to make imagination a civic and global responsibility. Institutions, scientists and citizens alike must learn to act across generations and borders, to guide reorganisation rather than resist it. The time for such imagination is now; the mandate is ours.



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About the author

Manjana Milkoreit is a researcher at the University of Oslo studying global climate governance with a focus on tipping points and non-linear risks, intergenerational decision-making, and future imagination. She co-led the governance work for the Global Tipping Point Reports 2023 and 2025.



Ecological Collapse

Ecosystems form the living fabric of the planet, regulating the climate, providing food and water, and maintaining the conditions that make human life possible. Since the mid-1950s, many of these systems have been pushed beyond safe limits. Concentrations of greenhouse gases, the loss of forests and biodiversity and the decline of the marine ecosystem health are accelerating, eroding the stability of the Earth system on which societies depend.

What is the risk?

These systems can tolerate some impact from human use and recover after a period of time with minimal negative effects — an attribute generally known as resilience. However, when pressure exceeds critical thresholds, or tipping points, sudden and radical disruption can occur. These tipping points may trigger cascading effects that spread through the climate, the biosphere and human systems. Beyond such thresholds, soil fertility, freshwater supplies and biodiversity can collapse and severely undermine agriculture and the habitability of large regions on Earth¹.

What is at stake?

Historical and current examples reveal the fragile balance between humans and ecosystems². The Aral sea, for example, was once the world's fourth largest lake. However, it shrank by 90 per cent due to large-scale irrigation projects, devastating regional livelihoods by causing significant environmental, economical and public health problems³.

In today's interconnected world, local crises and ecological disruptions can cascade far beyond their origin, disrupting food systems, driving migration and fueling political instability. Scientists warn that crossing multiple Earth system thresholds could lead to the rapid collapse of most ecosystems across the planet⁴ compromising the biosphere's ability to support human life.

In 2009, researchers identified nine interconnected planetary boundaries that define a safe

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In today's interconnected world, local crises and ecological disruptions can cascade far beyond their origin.

operating space for humanity. Recent assessment shows that seven of these have now been exceeded⁵. Crossing the limits of these boundaries — including land-system change and the use of certain fertilisers — signals that we are operating outside the stable conditions that allow civilisations and nature to thrive. The longer these pressures continue, the greater the likelihood of triggering large-scale, potentially irreversible shifts in the global ecological system.⁶

What are the driving forces behind risk levels?

Human activities from greenhouse gas emissions and resource exploitation are severely degrading ecosystems worldwide. While climate change intensifies impacts, such as forest fires⁷, coral loss⁸ and melting ice⁹, human activities, such as forestry, agriculture, mining, and infrastructure, continue to be critical drivers of ecosystem change. Limiting land clearance and ecosystem conversion is essential to prevent further biodiversity loss and ecosystem collapse.

The drivers behind the interconnected crises of ecosystem degradation and climate change are deeply intertwined. The continued burning of coal, oil and gas coupled with deforestation and

the depletion of peatlands and coastal wetlands continue to erode natural carbon sinks. Patterns of growth, trade and finance reinforce norms and behaviors that slow down transition, while inequality and political inaction amplify environmental stress. High-income countries and emission-heavy industries bear the largest responsibility for mitigating emissions and accelerating the transition towards sustainable pathways, while those least responsible experience the most severe impacts from both climate change and ecological collapses.

What is being done to govern the global catastrophic risk of ecological collapse and where are there gaps?

Contemporary ecological risks are increasingly global in scale, scope, and impact with strong levels of interconnection not only across national borders, but across continents. Action to address risks, however, needs to be taken at both global and national levels. The environment is a classic global common good: everyone benefits from its protection, but when some overexploit or pollute it, the consequences and costs are shared by everyone.

Since the establishment of the United Nations Environment Program (UNEP) in 1972, international environmental agreements such as the Paris Agreement on Climate Change, the Convention on Biological Diversity, as well as frameworks on ozone depletion, hazardous waste and desertification, have been the main legal instruments for collective action. However, despite this proliferation of treaties and targets, implementation has lagged far behind ambition. Of the hundreds of global environment and sustainable development targets agreed by countries, only about a tenth have been achieved¹⁰.

This shortfall highlights that the problem is not the absence of rules, but rather the inadequacy of the current system itself. Fragmented, weakly enforced and insufficiently integrated, our current system remains largely designed for a past era of smaller, slower and more localised economic activity. Climate, biodiversity and pollution policies are often treated separately, despite their deep interdependence. Many countries also lack reliable systems for data, monitoring and accountability. The distribution of economic and environmental benefits and burdens continue to reflect deep

structural inequalities. Efforts are underway to bridge these divides. More than 100 countries now incorporate biodiversity values into their national accounting systems¹¹ and there is growing recognition by banks, financial institutions and the private sector that planetary stability underpins global prosperity¹². Still, the pace of progress remains too slow compared to the speed of economic growth and environmental decline.

Bridging this governance gap will require firmer accountability mechanisms, coordinated international financing, redistribution of burdens and benefits, but also adaptive governance and systems capable of learning, responding and evolving with changing ecological realities. This in turn demands confronting the deeper, underlying drivers of ecological collapse, including entrenched inequalities and economic structures that perpetuate unsustainable exploitation. The challenge ahead is not a lack of knowledge or policy but the collective will and institutional transformation needed to act decisively within the time we have left.



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Woman working with traditional hoe in maize field in Malealea, Lesotho.



Nature in global governance

Top-down and bottom-up approaches to adaptation

BY DAVID OBURA

The world faces converging ecological and governance crises. As major biomes near collapse and inequalities grow, powerful nations prioritize short-term economic interests over climate and nature commitments. This article explores how outdated global governance structures exacerbate these pressures and why adaptive, equitable systems are essential to address the interconnected planetary emergency.



The planet faces a profound incongruity. On the one hand, a growing number of major biomes are approaching thresholds of ecological collapse under the pressure of myriad human factors. Increasingly strident voices from civil society, Indigenous and other groups are bearing witness to the lived experience of these crises. And on the other hand, the pull-back in climate, nature and social commitments, instead prioritising short-term economic growth interests by leading countries and corporate actors. This magnifies inequalities as ecosystem services, or benefits from nature, are most important to those with the least material wealth, so ecological collapse hits them hardest while they make the least contribution to global trends.

The multilateral global governance system, cobbled together in response to threats exposed by World War II, has shepherded this situation to the current state. After 80 years, the global governance system is fraying amid growing instability. This system bolstered the world order of the victors — Europe, the United States, Russia (the USSR), and an emerging China — first against a common enemy. After that enemy was defeated, they began competing for dominance amongst themselves. Over time, additional powers have emerged, wanting their seat at the table, and independent civil voices have also grown in strength.

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Powerful countries that have depleted or exceeded their own bio-capacities, seek to preserve a global order through maintaining subsidies or importing natural resources from other, less powerful nations.

This plays out in the geo- and domestic political economies of post-colonial and economic dominance. Powerful countries that have depleted or exceeded their own bio-capacities, seek to preserve a global order through maintaining subsidies or importing natural resources from other, less powerful nations. Supplier countries and demographics, locked in unequal agreements have not been able to retain enough wealth. As a result, these countries cannot develop their own resources or strengthen their economies. This leaves them increasingly restless as they try to meet their own growing needs and claim their rights. Biodiversity loss in the global south is a symptom of a world order that is breaking under its own excesses, as are the other two aspects, pollution and climate change, in the triple planetary crisis.

This article explores how the ecological crisis is also a crisis of governance, and how adaptive governance, which embraces continuous learning and responsivity, may best identify ways forward by linking coherently across scales from local to global. First, at global scales, geopolitical power relationships must adapt to new realities of today. Second, at local scales, both nature and people need to thrive, which also means adapting to climate change. Linkages across these scales are addressed in the two reports adopted by the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) in December 2024: the Transformative Change Assessment and the Nexus Assessment^{1,2}. Critically, new global governance must shift what the Transformative Change Assessment called the underlying causes of the current condition – systems of domination over people and of nature, inequalities of wealth and power, and prioritisation of short-term material gain. This is necessary to rebalance the interlinkages between key elements of human lives, most pragmatically synthesised in the sustainability paradigm built on interactions between economy, society and our natural system (Figure 1).

1) Top-down, a new global order – power

It should not be a surprise that a world order designed 80 years ago is being shaken by current challenges. Importantly, there may be positive or negative outcomes from such disruption. A positive outcome would be that the inequalities of the old system are erased, with new and emerging powers across Africa, Asia, Latin America and ocean regions gaining their just share of power in multilateral contexts. Further, the economic system did not recognise the value of nature, nor the rights of those that have stewarded it. Recognising the critical importance of natural capital and Earth system functions across all regions, and transforming the values driving decisions to be consistent with long-term sustainability and stewardship instead of exploitation, are essential foundations for lasting change. There is no doubt that equalising power relationships is a tall order, and resistance to change is demonstrably high. The increasing ferocity and damage of anthropogenically-enhanced, or human-driven, disasters and proximity of multiple ecological collapses — for example, in coral reef, moun-

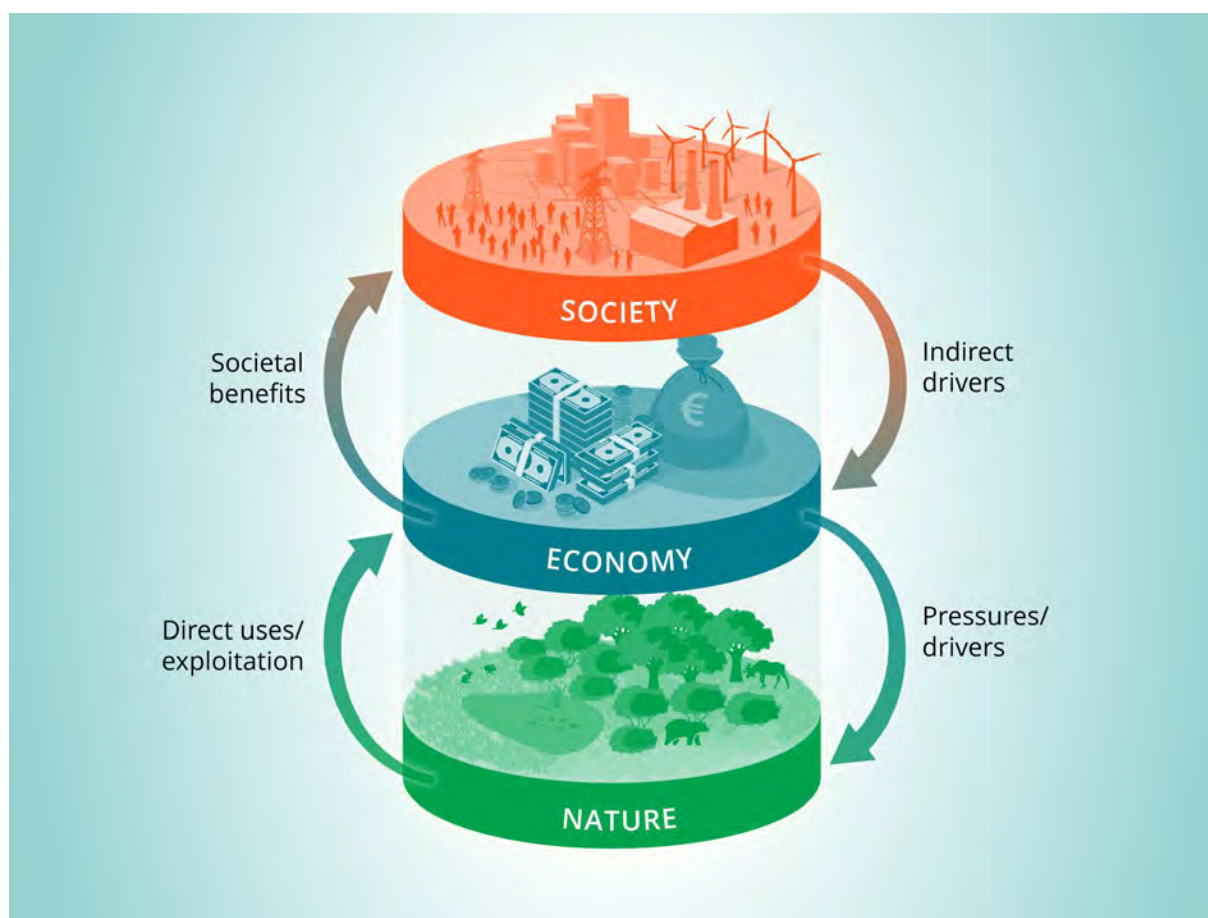


Figure 1. Synthesis figure of top-down and bottom-up elements for adaptive governance to avert ecological collapse across scales from local to global.

tain and freshwater supply systems — have catastrophically high socio-economic consequences. These could serve as key triggers to motivate shifts away from top-down exercise of power, hopefully pre-emptively. Importantly, pathways to positive transformations can start from small shifts in views, practices and/or structures that reverse the current underlying causes. Therefore, initial shifts in any of these should be encouraged and accompanied by a strong commitment to go further, not stopping at comfortable but insufficient transitions.

2) Bottom-up, nature-based governance

Recognition is rapidly growing regarding the scope and potential for localised, nature-based and adaptive solutions to emerging challenges. The Nexus Assessment addressed this and the complex and context-dependent feedbacks between five elements: two nature components, biodiversity and climate, and three economic sectors, food, water and health. The assessment synthesised over 70 solutions that demonstrate the potential to enhance co-benefits across sectors and reduce tradeoffs

(Figure 2), while recognising nuanced customisation of individual contexts, and with successes aggregating from local to larger scales. The assessment emphasised that a critical enabling factor of governance is that it is inclusive, holistic, equitable, cooperative and adaptive.

Focusing on meeting peoples' needs from nature strengthens their direct experience and connection with the natural world, and thus fosters values of reciprocity and care that are essential for positive transformations³. Further, the Nexus Assessment showed how such connectivity with nature and solutions may emerge from any of the five elements it covered (Figure 2). By contrast, consider that IPBES recognises 18 different ways that nature benefits people. Nature-based solutions may emerge from any of the 18 categories, emphasising the immense diversity of adaptive responses that can deliver economic and societal value.

Acknowledging these diverse values will certainly increase estimates of nature's true value by orders of magnitude. Hopefully this will result in more investments, both financial and non-financial, that will protect and enhance nature and its benefits. Local adaptive ap-

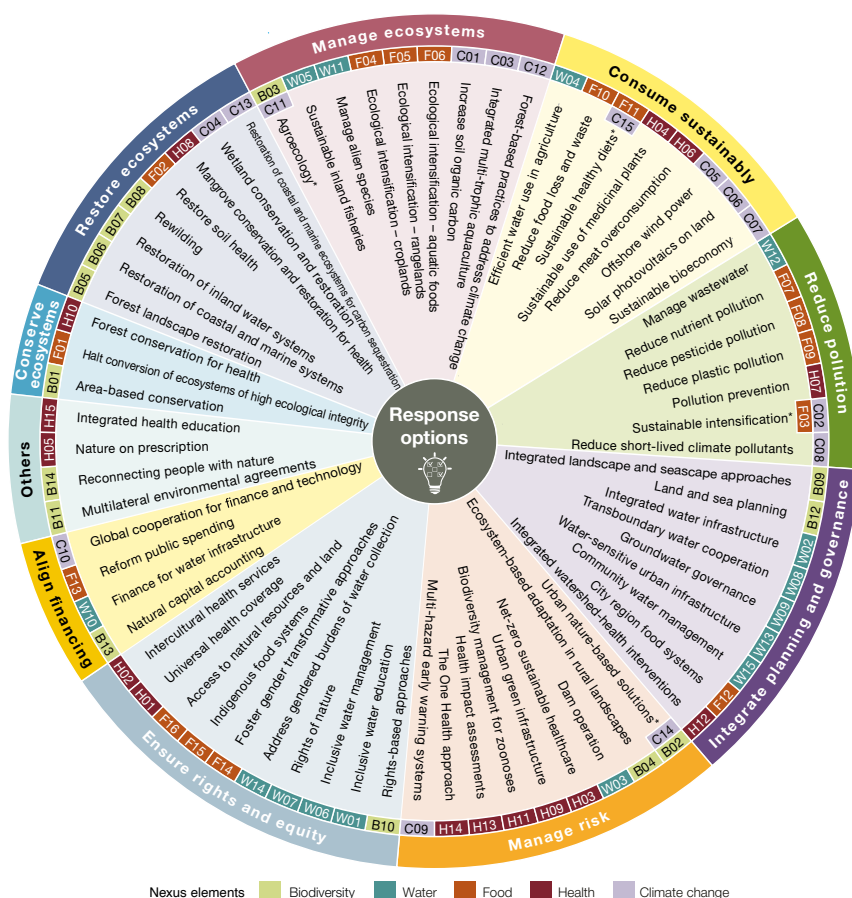


Figure 2. Response options. Illustration from IPBES's Nexus assessment.

proaches can help build collective action where actors work together in synergy, rather than in opposition.

Strategies to ensure that nature is healthy everywhere — so that it can provide what people need and sustain itself — can be applied consistently across diverse cultural, human and natural systems around the world⁴. Through a consistent framework, these adaptive approaches may scale up and work together to advance biodiversity, food, health, education, rights and other common goals as well as targets agreed multilaterally, such as the Kunming-Montreal Global Biodiversity Framework, Sustainable Development Goals.

Looking forward

The proliferating risks of ecological collapse and the breakdown of the multilateral order are interlinked consequences of a system unfit for 21st-century challenges. The current crises are direct consequences of limitations in the multilateral order. These crises strain the current system and can only offer poor responses, which creates a vicious cycle of decline. Two primary risks may compromise positive outcomes emerging from the current crises: a) holding on to the old multilateral order by continuing to patch the gaping holes enough to survive, but without shifting power relationships, and b) private-interest actors taking control, whether openly or covertly. In both cases, self-interest may help break down or bolster the old system, reinforcing existing power structures, benefit flows and inequalities.

This article has presented two complementary and necessarily linked adaptive governance approaches. Drawing from IPBES's Transformative Change and Nexus assessments. The strategy is to leverage the breakdown of the current multilateral order to grow the seeds of positive outcomes — to give the best chance of the right top-down and bottom-up solutions to take root, grow and meet in the middle (Figure 1). Importantly, the approaches engage coalitions of actors linked across scales and geographies, and are facilitated by values that promote equity (see GCF's Global Catastrophic Risks Report 2024 on ecological collapse). The mechanisms chosen to address global challenges in the coming years — across the major multilateral and other convening spaces — will provide early signs on whether a transformed new order is taking root and can be nurtured, or if business-as-usual responses will entrench existing interests.

The risk of multiple ecological collapses — both at regional and global scales — should be placed firmly at the centre of global governance discourse. This risk is of greater existential importance than short-term economic or financial concerns. Prioritising ecological risks above economic interests is necessary to motivate adaptive responses needed to prevent ecological collapse.



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About the author

David Obura chairs the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) and is Founding Director of CORDIO East Africa. His research focuses on coral reef vulnerability to climate change and addressing sustainability challenges from local to global levels.



Weapons of Mass Destruction

Mounting geopolitical tensions and rapid technological advances are eroding long-standing safeguards against weapons of mass destruction. As global regimes falter and enforcement weakens, the world faces growing risks of proliferation, misuse, and strategic instability. Understanding these shifts is essential for strengthening governance and preventing catastrophic escalation in an increasingly volatile security landscape.

What is the risk?

Hostile geopolitical relations and the deteriorated strategic context are eroding the structures that govern the world's most destructive capabilities. The decades-old regimes that are meant to curb the spread of weapons of mass destruction (WMD) — mainly, the Nuclear Non-Proliferation Treaty (NPT), the Biological Weapons Convention and the Chemical Weapons Convention — face myriad challenges. Tensions among key players are hindering compliance and enforcement efforts and undermining institutional structures. All of this is being exacerbated by rapid technological developments that can lower barriers to WMD access, delivery and use. Global governance of WMD is at a crossroads.

What is at stake?

While chemical and biological weapons are prohibited under international law, the normative barrier against their use shows signs of strain. Widespread and repeated chemical weapon use was seen in the Syrian Civil War by both government and opposition forces, despite global condemnation. Governance of chemical and biological weapons has been further undermined by years of deadlock between permanent members of the UN Security Council and the inability of the Organisation for the Prohibition of Chemical Weapons (OPCW) and the UN Security Council to investigate, attribute or hold guilty parties accountable in a timely manner. In a separate case,

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While chemical and biological weapons are prohibited under international law, the normative barrier against their use shows signs of strain.

the OPCW has found evidence of repeated use of riot control agents in the war in Ukraine¹. Dutch and German intelligence agencies also claim that Russia is increasingly using a wide spectrum of chemical weapons in that context.

A particular challenge in the chemical and biological space is the changing nature of threat. Scientific research in these fields is critical to global health and sustainable development, as seen in the response to the COVID-19 outbreak. Yet the pace of technological advances and the wider availability of dual-use tools, materials and expertise increase the risk of mistakes and deliberate misuse. Governance frameworks that rely on national implementation and slow diplomatic negotiation are poorly matched to fast, decentralised innovation cycles. Without updated risk management tools, today's treaty regimes will complicate detection and continue to fall behind the technologies they aim to govern. It remains to be seen whether common interest in tackling the shifting threat landscape can overcome geopolitical hurdles.

What is being done to govern this risk and where are there gaps?

There is unfortunately little indication that states can disentangle nuclear issues from the broader strategic context. Russia justified its suspension of the bilateral New Strategic Arms Reduction Treaty (New START) by referring to the United States' desire to inflict strategic defeat on Russia; it has consistently used nuclear coercion to shape the conflict in Ukraine.² China cited US arms sales to Taiwan in breaking off arms control dialogue.³ Experts believe that the global nuclear stockpile — an estimated 12,241 nuclear weapons with Russia and the US holding over 90 per cent of them — is on the verge of rising.⁴ Barring an extension of New START before February 2026, there will soon be no limits on the world's two largest nuclear arsenals. Extensive nuclear modernisation programmes being undertaken by nearly all of the nine nuclear-armed states underscores the potential for uninhibited arms racing.

Adherence to non-proliferation principles also appears under threat. Recent developments suggest a growing willingness among states to sidestep established norms and mechanisms of restraint, as military action, new defence alignments and shifting security doctrines take precedence over diplomatic engagement. Israeli and US attacks against Iranian nuclear facilities were condemned by UN procedures experts as a violation of international legal and normative frameworks.⁵ Saudi Arabia signed a mutual defence pact with Pakistan, also a non-NPT nuclear-armed state, that in their view “encompasses all military means”.⁶ In response to the war in Ukraine, some states are not only calling for the expansion of extended deterrence arrangements, but even revisiting the question of acquiring independent nuclear capabilities. Prospects for a constructive 2026 NPT Review Conference appear bleak as nuclear-armed and nuclear-allied states continue to shun the 2017 Treaty on the Prohibition of Nuclear Weapons.

Recognition of these trends has driven multi-lateral attention on practical action to reduce the risk of nuclear weapon use. Existing efforts have focused on bolstering the crisis prevention and management toolkit as means to reestablish minimal levels of predictability and stability. These are essential steps. But the

nuclear risk landscape itself is fundamentally changing because of the impact of emerging technologies and developments across domains and capabilities — both nuclear and conventional. Indeed it is because of these changes that some states have established a wider scope for nuclear use in their doctrines and security strategies. Only by navigating these developments can nuclear-armed states and other key actors properly reduce risk and begin to reinvigorate arms control and disarmament.



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Multi-domain escalation risk

BY WILFRED WAN

Rapid technological advances and expanding multi-domain warfare are reshaping global security, blurring lines between nuclear and conventional conflict. As cyber, space, artificial intelligence (AI) and disinformation capabilities converge, escalation risks grow increasingly unpredictable. Understanding these dynamics is essential for strengthening governance, preventing miscalculation, and reducing the mounting danger of nuclear use in a volatile strategic environment.



Recent and ongoing conflicts demonstrate the increasingly complex nature of contemporary warfare. Modern warfare now encompasses multiple operational domains and features the convergence of advanced technological capabilities. For instance, on the eve of the full-scale Russian invasion of Ukraine in February 2022, a massive cyber operation was attributed to Moscow by the European Union, the United Kingdom and the United States. The operation targeted Viasat's KA-SAT network — disrupting broadband satellite access, internet access and critical infrastructure across Ukraine. In the ensuing war, Ukraine has arguably achieved its greatest battlefield success through the large-scale use of drones likely trained by AI. For instance, a June 2025 attack from Ukraine resulted in damage to over 40 Russian strategic bombers in airfields across the country — undermining Russia's nuclear forces in the process.¹ Israel's military campaign in Gaza since October 2023 has reportedly included AI-enabled decision-support systems to inform targeting decisions. The May 2025 military conflict between India and Pakistan also featured a wave of AI-generated content.

Disinformation campaigns are meant “to intensify tensions, legitimise retaliatory military actions, and compel both governments to adopt increasingly belligerent stances”, as Nabiya Khan, Kaushik Raj and Zenith Khan argue in their analysis.² Indeed, the deployment of AI and other

capabilities, particularly involving nuclear-armed states, is fundamentally changing notions of escalation. Warfighting on the ground, at sea and in the air could spill over into space and cyber domains or be triggered by ongoing dynamics there. One reason for the multi-domain nature of contemporary warfare is that modern weapons are increasingly reliant on space-based assets and digital communications technology, creating new vectors of vulnerability.

Multi-domain operations that escalate introduce potential for nuclear weapon use — a scenario that is heightened in the current global context. Increasing interactions between nuclear and non-nuclear strategic capabilities, including those linked to cyber and space domains, can blur the distinction between intended military targets, amplify potential conflicts and raise questions as to the strategic rationale behind operations. This opens the door for potential miscalculations,

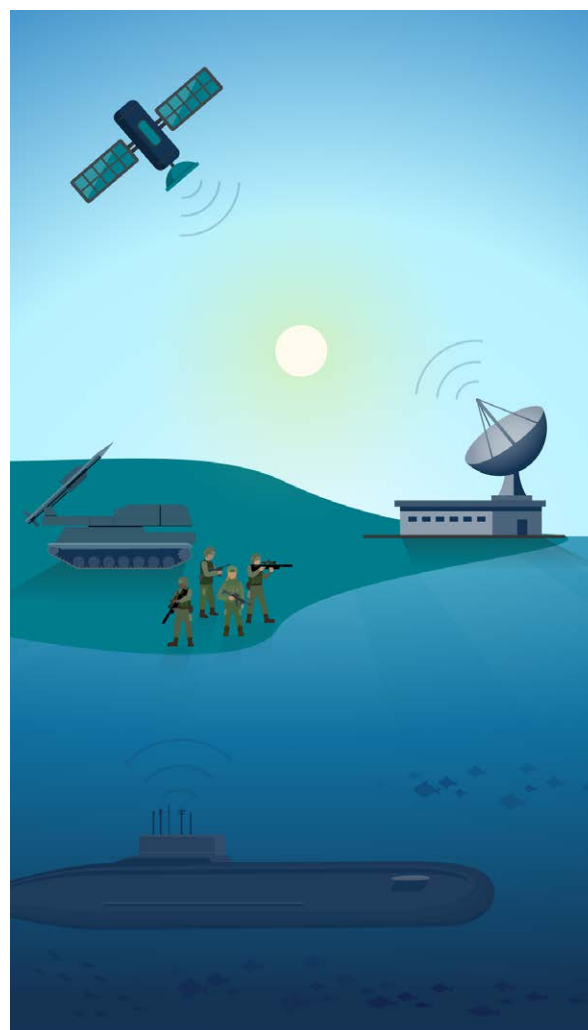
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Policymakers and military officials across the nine nuclear-armed states are increasingly using provocative nuclear language and making threats, threatening the longstanding normative taboo against nuclear use.

misperceptions and misunderstandings, with escalation in these circumstances taking place in an “accelerated and decidedly non-linear” fashion.³ This challenge is compounded by the “lack of collective experience, common understandings and established behavioural norms” that might otherwise deescalate tense situations. These gaps are particularly evident when new technologies or domains are involved.⁴ For instance, had Russia perceived a deliberate intent by the West to undermine its nuclear forces as means of inflicting “strategic defeat” — a declared objective — through Ukraine’s June 2025 drone operation, the results could have been more escalatory and catastrophic, potentially breaching the firewall between conventional and nuclear warfare.

The presence of multi-domain operations and the impact of new technologies is also paradoxically driving greater reliance on nuclear capabilities, feeding into arms race dynamics and longer-term destabilisation. Policymakers and military officials across the nine nuclear-armed states are increasingly using provocative nuclear language and making threats, threatening the longstanding normative taboo against nuclear use.⁵ Some have amended their official policies to widen the circumstances in which they would consider nuclear use, including as response to non-nuclear strategic attacks or to pre-empt aggression by non-nuclear armed states. Widespread recognition of complex escalation pathways is not inspiring risk mitigation or the diffusion of tensions. On the contrary, there is a dangerous tendency among states to believe they can control escalation with their advanced capabilities. This “false sense of supremacy” tends to lead to more aggressive behaviour.⁶ Overall, nuclear-armed states are pursuing strategic



advantages through new technologies, further worsening the dynamics that define the deteriorated strategic context.

Given these circumstances, it is especially concerning that global governance appears ill-equipped to address this more complex security environment: both in terms of preventing multi-domain escalation pathways from materialising and by reversing longer-term trends and thinking regarding strategic capabilities. Multilateral deliberations on nuclear, cyber and outer space domains remain siloed with limited engagement across communities. Exploration of the intersection between nuclear weapons and emerging and disruptive technologies has thus far been narrowly focused — notably on the integration of AI into nuclear command, control and communications systems. While this is an important topic, arguably more concerning are the broader trends that contribute to the entanglement of conventional and nuclear missions and the risk of multi-domain escalation. Moreover,

dialogue platforms for strategic — and nuclear — issues centre on traditional powers, leaving little space for civil society, private sector and even non-nuclear weapon states to engage. The strategic implications of conventional operations in Ukraine, Gaza and South Asia underscore the need for a more inclusive conversation.

Pragmatic steps to reduce the risk of multi-domain escalation alone will not resolve any underlying geopolitical tensions or arms racing dynamics. But ensuring the relevance of de-escalation mechanisms, and creating new ones, is a necessary and urgent endeavour that can help prevent worst case scenarios while rebuilding much-needed trust and confidence among nuclear-armed adversaries. This centres around developing a shared strategic value structure: for instance, in the outer space domain, where kinetic operations are unprecedented, or in the cyber domain, where operations have increased in frequency and intensity. It is imperative that states maintain common understandings on thresholds, including those pertaining to nuclear use. Exchanging views on actions seen as escalatory can establish behavioural parameters, constituting a new approach to arms control.⁷ This can also facilitate the outlining of procedures to address risky or provocative behaviours that are seen to take place. Additional tools, such as hotlines, pre-notifications and information exchange, can also be implemented.

At the same time, there is a need to reform the global governance system so that it is more adept and fit-for-purpose in addressing these new strategic realities. This includes a more forward-looking approach to tackling technological developments in nuclear structures: for instance, through systematic evaluation and exchange in a subsidiary body of the Nuclear Non-Proliferation Treaty review process. The Scientific Advisory Group of the Treaty on the Prohibition of Nuclear Weapons provides a model, as do other examples outside the nuclear space: for instance, ongoing discussions of a science and technology review mechanism in the context of the Biological Weapons Convention. This also highlights the importance of including the private sector and industry actors, who are not only responsible for driving many of these technological developments but will likely be involved in multi-domain operations on the battlefield — as seen in the role of SpaceX and the war in Ukraine. Engaging these parties in key conversations — such as

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at the national security level and in multilateral governance fora — can help mitigate inadvertent escalation scenarios linked to third-party involvement.

Further changes to global governance will require revisiting the concepts and assumptions that have long guided the current post-World War II system. This includes reckoning with increasingly potent advanced precision-strike capabilities that are bridging the conventional-nuclear divide and considering these in future nuclear arms control negotiations and frameworks. It requires reconsidering not only how new technologies can impact the vulnerability of nuclear forces and upend strategic stability and deterrence stability, but also revisiting how key states — nuclear and non-nuclear armed states alike — define those concepts in the context of multi-domain realities. It includes leveraging existing UN forums — such as those on autonomous and outer space systems — to raise issues of cross- and multi-domain issues. At the same time, it involves gauging the political viability of creating new, dedicated platforms that encompass a more comprehensive approach to addressing escalation risk and strategic instability.

Multi-domain escalation risk has become part and parcel of the nuclear landscape. To date, nuclear-armed and nuclear-allied states have responded largely by expanding the scope of deterrence and the role of nuclear weapons. But doing so can widen strategic and operational ambiguity in a manner that makes risk

unmanageable. States need to reconsider how their actions can set into motion action-reaction cycles with long-lasting destabilising effects. To begin, states need to refocus on avoiding the worst possible outcome. By identifying opportunities to reduce multi-domain escalation risks, by explicitly addressing new pathways through updated, innovative and encompassing risk reduction mechanisms, states and other stakeholders can begin to concretely account for increasing asymmetries across capabilities. Yet, this constitutes only a short-term solution. At the same time, states will need to build a foundation for comprehensive frameworks that not only rebuild confidence and enhance military transparency, but help

account for the more complex security environment. This can be achieved through more inclusive platforms, prescribing additional modalities of action and reflecting new strategic value structures. Only this more ambitious approach to global governance can facilitate longer-lasting solutions and the revitalisation of arms control and disarmament efforts.



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About the author

Wilfred Wan is the Director of the Stockholm International Peace Research Institute (SIPRI) Weapons of Mass Destruction Programme. His recent research focuses on nuclear weapon risk reduction, nuclear disarmament verification, and other issues related to arms control and disarmament.



AI in military decision-making

Artificial intelligence (AI) is rapidly reshaping military decision-making, accelerating operations and expanding the role of machine-driven analysis on the battlefield. As AI systems influence choices once reserved for humans, the risks of miscalculation, unintended escalation and legal or ethical violations grow. Understanding these dynamics is essential to strengthen governance and prevent destabilising outcomes.

How is AI integrated in military decision-making?

Several countries now incorporate AI into their military operations through decision support systems (DSS) on the battlefield. It is no longer a distant or hypothetical future. Major military powers use AI-DSS to achieve military dominance.

The risk is that accidental escalation could happen if systems fail, do not know how to respond in interactions or changing circumstances, or are hacked. As a result, AI integration raises the likelihood of miscalculation and misperception between adversaries. AI-DSS analyses intelligence data and provides commanders with recommendations.

What is at stake?

AI integration in the military increases the risk of escalation and may lead to responses that spiral out of control, as machine learning systems are inherently unreliable. Unlike traditional software that follows explicit rules, AI systems trained on data can produce unpredictable outputs when they encounter situations outside their training data. The risk of violating ethical principles and disregarding existing rules of international law, especially international humanitarian law (IHL), is high. Lowering the threshold for going to war or starting a conflict also poses a serious risk.

What are the potential risks?

AI enables military forces to process information and coordinate responses quicker

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AI enables military forces to process information and coordinate responses quicker than ever before, pushing adversaries to develop similar capabilities to avoid falling behind in the AI military race.

than ever before, pushing adversaries to develop similar capabilities to avoid falling behind in the AI military race. The reduction in decision-making time enables faster action but also shortens the window for human judgement, which is especially important when careful consideration could prevent errors in crisis situations where every second counts. Commanders might rely more on AI recommendations rather than wait for a detailed analysis. Therefore, the risks of mismanagement are significant.

The most serious long-term risk involves integrating AI into nuclear command, control and communications (NC3) systems. This integration poses significant risks, including weakening deterrence by eroding second-strike confidence, introducing vulnerabilities in command and control through cyber threats, as well as increasing the likelihood of false alarms in early warning systems. These problems could destabilise nuclear stability and lead to increased unintended confrontations.

At the deepest level, AI in military decision-making has already transformed the character of warfare and international relations. The speed of AI-enabled operations is making human judgment increasingly peripheral to conflict dynamics. Wars might be fought and decided at algorithmic speed, with humans relegated to observers of machine-driven escalation spirals they initiated but cannot control.

Cumulatively, these automation processes shift decision-making authority from humans to machines in ways that may not be intentionally chosen or fully understood. Additionally, AI systems are only as reliable as their training data, and military applications face specific data challenges. Bias in training data — such as datasets that over-represent certain regions, demographic groups or conflict types — can lead to distorted predictions. Integrating AI into military decision-making creates an accountability gap — the challenge of assigning responsibility when AI systems cause harm.

What is being done to govern this risk and the gaps?

The technology's dual-use and distributed nature across many segments of society complicates governance. AI capabilities developed for civilian use — such as facial recognition, natural language processing and predictive analytics — can easily be adapted for military applications.

IHL requires that warring parties carefully apply principles of distinction, proportionality and precaution to minimise civilian harm. These require contextual understanding, ethical judgment and flexible interpretation, which current AI systems lack. As militaries increasingly deploy AI in such contexts, the gap between legal obligations and actual practice grows while eroding legal and ethical barriers.

While new initiatives are beginning to address parts of the challenge, there are no universal norms or agreed-upon rules guiding how AI can or should be used in warfare. In particular, the absence of a shared risk framework leaves states without common standards for assessing and managing the dangers that military AI systems pose.

Current governance efforts mainly focus on broader AI applications in the civilian domain with initiatives across various multilateral forums, including the United Nations. Govern-

ance in the military domain remains fragmented, with limited coordination across different bodies: the UN Group of Governmental Experts on Lethal Autonomous Weapons Systems has met periodically since 2017 but has not produced any binding agreements. The Political Declaration on Responsible Military Use of AI and Autonomy proposal, endorsed by over 50 states, and the Responsible AI in Military Domain (REAIM) Summits outcome documents establish voluntary principles without enforcement mechanisms. While voluntary principles can help build consensus, countries face no penalties for non-compliance. The absence of a single authoritative body to oversee governance efforts allows inconsistencies and gaps to persist, with some applications covered by multiple frameworks and others left unaddressed.

The window for effective AI governance in military systems is closing due to increasing integration and institutional entrenchment, which make reversal efforts difficult. Success depends on recognising that AI governance is primarily a political issue that requires international cooperation.





AI in military decision-making: The global governance challenge

BY DENISE GARCIA

The race to integrate AI into military command systems is accelerating — and changing how warfare is conducted. International law and norms governing the use of force and war are being ignored. The global community remains unprepared to address serious threats to international security. Although efforts to develop global governance continue, they are too slow and fragmented to keep up with the rapid technological advancements.

The current state of play

Across the world's major military powers, AI is rapidly moving from experimental laboratories into operational command-and-control systems. Since 2017, advances in machine learning and other computational techniques, along with many countries' decisions to incorporate AI into their military operations, have accelerated the militarisation of AI. This has led to the gradual integration of Decision Support Systems (DSS) into the battlefield, with many already active in military missions. This is guided by the goal of improving situational awareness to gain a strategic military advantage.

The promise is tempting: AI systems can quickly analyse large amounts of battlefield data, identify patterns invisible to human analysts and allow commanders to act faster than enemies. Supporters say this could lower casualties and improve targeting accuracy. Critics argue that the speed and automation pose se-

rious new risks to peace, diplomacy and international stability by undermining long-standing ethical principles and conduct norms, resulting in blatant violations of international law.

Data to decision-making — AI's expanding role in the battlefield

As AI increasingly shapes decision-making in conflict, its rapid integration into military systems raises profound challenges for safety, accountability and ethics. AI-driven tools, especially DSS, often operate with limited predictability and transparency, making it difficult for users to understand and trust their analyses and outputs. The competitive drive among states and actors to adopt these technologies risks premature deployment before they are sufficiently tested, potentially leading to grave operational and humanitarian consequences. Moreover, as machine learning systems take on roles

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AI-driven tools, especially Decision Support Systems, often operate with limited predictability and transparency, making it difficult for users to understand and trust their analyses and outputs.

traditionally held by humans, they risk eroding human judgment — the foundation of ethical and legal accountability in warfare.

Ultimately, determining responsibility for battlefield decisions must remain a human function, grounded in contextual understanding rather than technical indicators alone, to ensure compliance with international humanitarian law (IHL) and the preservation of moral agency in war.

The heightened escalation dynamics and nuclear AI dangers

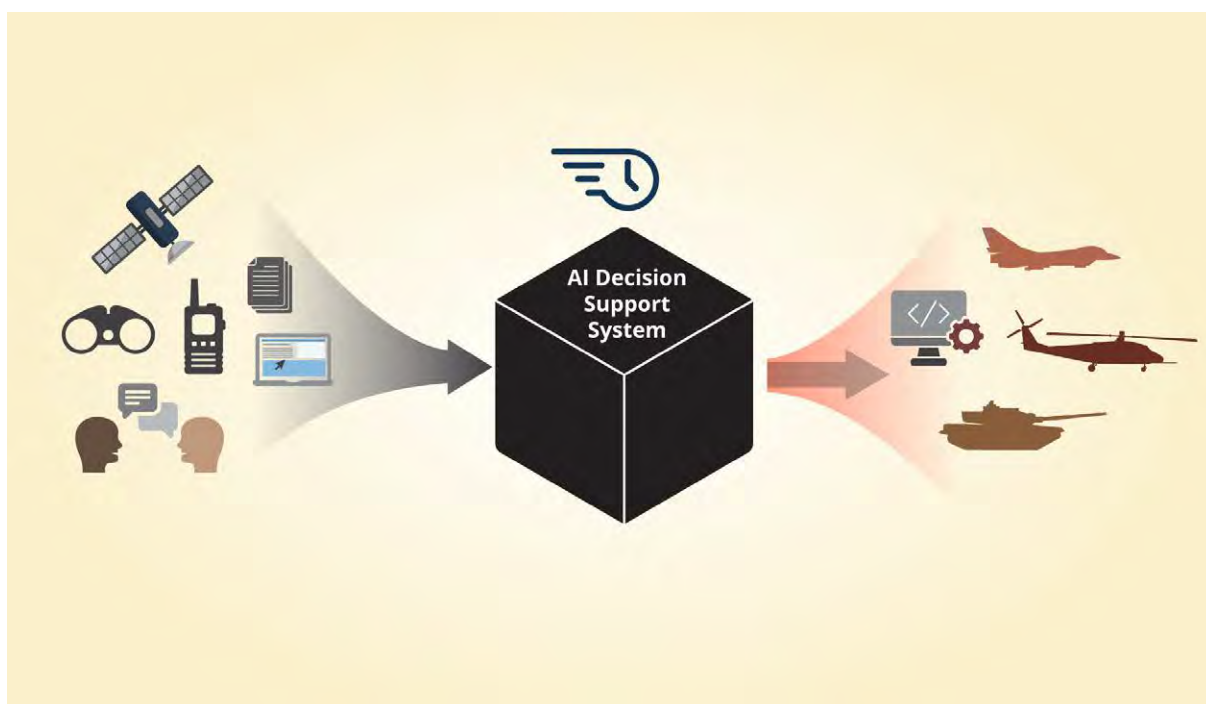
The integration of AI into military decision-making creates a dangerous paradox: while militarily advanced countries adopt these systems to reduce uncertainty on the battlefield, they simultaneously introduce new sources of unpredictability stemming from data vulnerabilities and the brittleness of algorithmic systems. This may lead to manipulation by adversaries and accidents. The gravest risk arises from the integration of AI into the command and control of nuclear arsenals and poses a governance challenge. The integration of AI in early warning systems, intelligence analysis and missile defense could threaten nuclear assets, creating multiple pathways for miscalculation and crisis instability as well as lowering their thresholds for nuclear use during a conflict.

Moreover, the speed at which AI systems operate compresses decision timelines. In a crisis scenario involving nuclear-armed states, AI-enabled systems might accelerate the tempo of operations to a pace where human leaders feel compelled to preemptively authorise responses before fully understanding the situation.

Accountability gaps and human oversight

IHL requires that human actors foresee, govern and constrain the use of weaponry. Yet, as AI systems evolve in sophistication and operate at unprecedented speeds, the scope for genuine human oversight diminishes significantly. Traditional legal frameworks presume human moral agency and deliberate decision-making; however, when an AI system is involved, assigning accountability becomes far more complex, compounding the risks of automation bias and over-reliance on AI-generated outputs.

The complexity of this issue is exacerbated by the inherent black box nature of many advanced machine learning systems. Despite their strong performance in testing environments, their underlying reasoning remains largely opaque. This lack of transparency in AI decision-making processes compromises the crucial human oversight required to uphold legal and ethical standards in military operations.



Military AI systems inherently depend on vast amounts of data for training, real-time operation and continuous learning. This dependence creates multiple vulnerabilities that adversaries can exploit. Consequently, an AI system that performs robustly in controlled testing environments may behave unpredictably in operational settings when confronted with manipulated or adversarial inputs. Data bias represents another critical concern. If AI systems are trained predominantly on data from specific operational environments or on particular adversary signatures, they may fail catastrophically when confronted with novel situations.

In sum, what is at risk is the erosion of moral and legal boundaries that limit the use of force, widening the gap between human accountability and emerging AI-driven military systems and creating destabilising effects.

The private sector: Blurring civilian-military boundaries

Military AI is primarily created by the private tech sector. Leading companies have made significant breakthroughs with both civilian and military applications. Private companies are creating sophisticated systems that the military then adapts for its needs. The dual-use and distributed nature of AI technology creates new challenges for establishing global governance.

The global nature of the AI industry further complicates governance and is leading to the militarisation of civilian AI research, potentially limiting academic freedom and international cooperation. These private companies control the development and deployment of AI, which could significantly alter global power dynamics. Power disparities between the advanced North and the developing South are likely to widen, as the vast majority of developing countries lack resources to compete for AI leadership or power to play a role in setting inclusive, just and fair rules for all.

Global governance: Significant gaps and concrete pathways forward

There are no universal rules or norms regarding the use of AI in military applications. However, efforts to regulate AI in the military began in 2017, following significant breakthroughs in machine learning and deep learning. There are three ongoing diplomatic processes.

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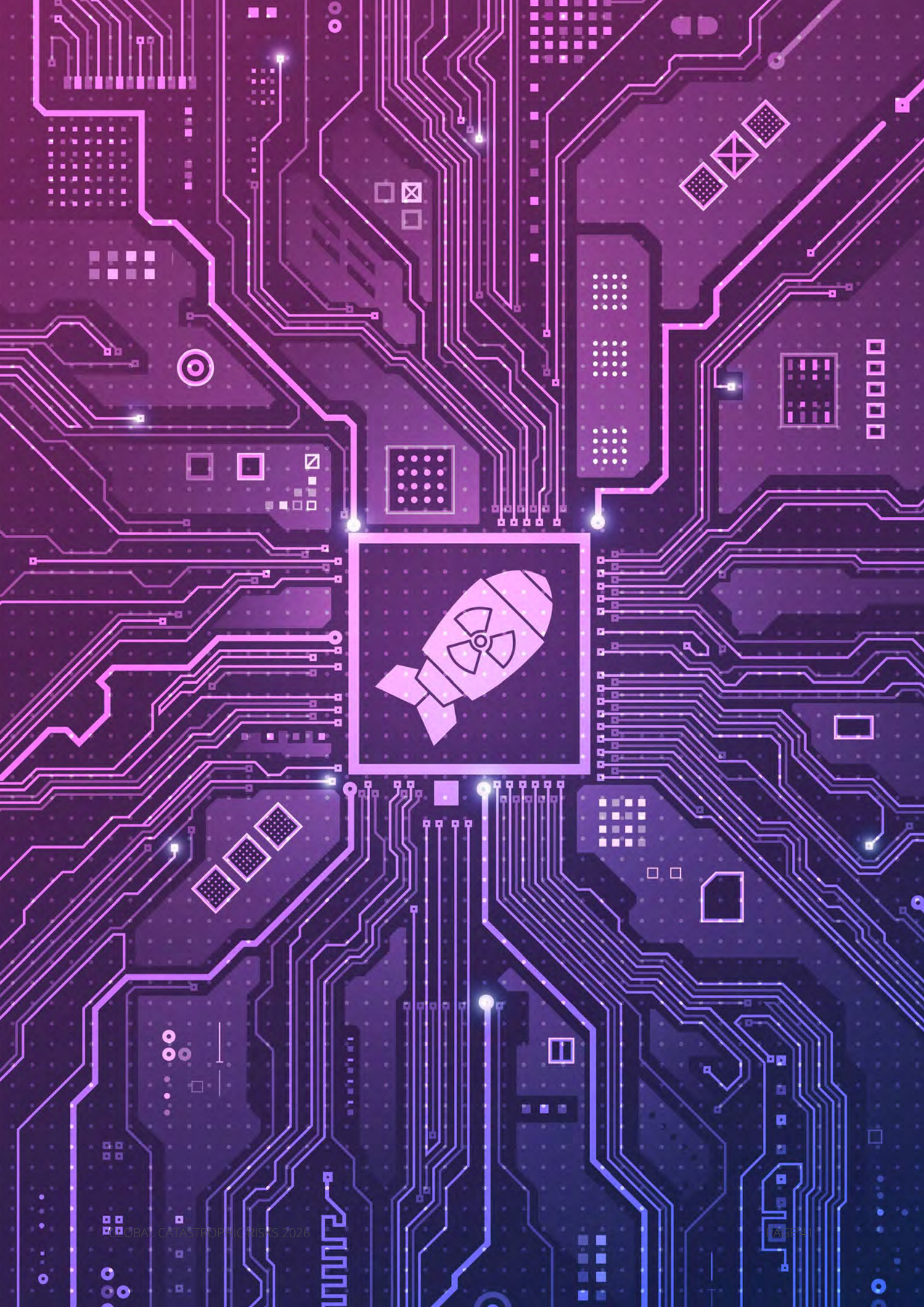
The global nature of the AI industry further complicates governance and is leading to the militarisation of civilian AI research, potentially limiting academic freedom and international cooperation.

The first is state-led and focused on creating a new treaty on autonomous weapons at the UN in Geneva that involves all the major military powers. However, talks remain mired in definitional disputes and geopolitical tensions. The process is by consensus, so breakthroughs are hard to achieve. Two key questions that remain unresolved: (1) what constitutes meaningful human control over AI-enabled weapons?; and (2) how should IHL apply to AI decision-support systems? These talks could continue at the UN General Assembly which allows for a more inclusive process and require a two-thirds majority, but this approach may fail to get the major military powers' buy-in.

The second is led by middle power, small-state coalitions calling for the responsible use of AI in the military in two summits in 2023 and 2024. This process presents an innovative opportunity to forge new global governance that counts on the voices of more actors.

The third is the first resolution on autonomous weapons, a breakthrough event at the UN in New York in December 2023. The resolution received 164 votes in favour. Subsequently, on November 6, 2024, the second resolution, *Resolution 79/239 Artificial intelligence in the military domain and its implications for international peace and security*, received overwhelming support from UN Member States: 165 in favour and only two against. Middle powers and small states are likely to continue leading international efforts to develop norms.

However, several governance gaps remain unaddressed. First, there is no universally accepted risk framework for AI in military contexts. Second, confidence-building measures remain underdeveloped. Third, transparency around military AI development is severely limited. Nations keep their AI capabilities as closely guarded secrets, making it impossible for others to assess intentions or adjust their



own responses. This opacity fuels worst-case assumptions and promotes destabilising military race dynamics.

Pathways forward

Effective governance of AI in military decision-making requires a comprehensive approach across multiple domains and actors. Creating permanent institutional mechanisms to support global cooperation and permanent multi-stakeholder dialogue would foster trust through confidence-building measures and allow for lessons learned from high-stakes military AI applications and risk mitigation strategies. All of this could be guided by a responsibility by design framework that integrates ethical and legal compliance from the earliest development stages through the entire system lifecycle and into the socio-technical institutions where AI is used, while protecting human dignity.

“The concrete governance framework for military AI should involve international confidence-building measures, transparency, legal accountability, technical safety safeguards and multi-stakeholder oversight.”

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The concrete governance framework for military AI should involve international confidence-building measures, transparency, legal accountability, technical safety safeguards and multi-stakeholder oversight. These steps aim to manage AI risks, prevent escalation, assign accountability and promote responsible development and deployment.

Conclusion

The integration of AI into military decision-making offers significant benefits, such as faster responses and fewer casualties, but also poses serious risks to stability and legal principles. The global community’s current governance systems are inadequate to manage these rapid technological advances, creating a troubling gap between AI development and regulatory frameworks.

Closing this gap requires sustained political will, creative institutional innovation and coordinated cooperation among nations with divergent interests and values. The stakes could not be higher. Left ungoverned, military AI could lower thresholds for conflict, compress decision timelines beyond human comprehension, blur the boundaries between peace and war, and ultimately undermine the institutions that have helped prevent great power war for eight decades.



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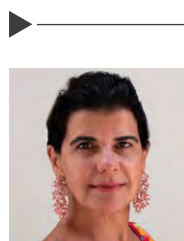
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About the author

Denise Garcia is a Professor of Political Science and International Affairs at Northeastern University and a founding faculty member of its Experiential Robotics Institute. She is also a Commissioner at the Global Commission on Responsible AI in the Military.



Near Earth Asteroids

Near-Earth objects (NEO) pose a rare but potentially catastrophic threat, ranging from local destruction to global climate disruption. Although detection and tracking capabilities have improved dramatically, vast numbers of smaller asteroids remain unknown. Understanding these risks, and the governance systems designed to prevent impacts, is essential for strengthening planetary defence and global preparedness.

What is the risk?

NEOs, asteroids and the occasional comet, are objects that travel close enough to Earth's orbit to warrant constant attention. Since the 1990s, astronomers have discovered over 39,000 of them, including more than 11,000 that are larger than 140 metres across. The largest recorded impact, the Tunguska event in 1908, is believed to have been an impactor in the lower end of this size range. It exploded in the atmosphere above the sparsely inhabited East Siberian taiga flattening trees over an area of 2,000 km², roughly the size of greater London.

An asteroid the size of a football field, approximately 100 metres, carries the energy of several thousand Hiroshima bombs. The chance of one striking Earth in any given year is extremely small, but not zero. Smaller asteroid impacts are expected to have an average frequency of roughly one per 1,000 years.

There are an estimated 300,000 small asteroids, making these the more likely, near-term threat. When it comes to larger asteroids, larger than 1 kilometre in diameter, scientists estimate that they have discovered and identified more than 96 per cent of the existing large asteroids, 878 individuals to date¹.

What is at stake?

Various sizes of asteroids would have various degrees of impacts, if they were to hit earth.

- ◀ **Asteroids >1 km** could alter global climate and threaten civilisation itself.

- ◀ **Asteroids 140 m–1 km** would devastate a region or continent, killing millions.
- ◀ **Asteroids 50–140 m** could destroy a city if it struck land.
- ◀ **Asteroids 20–50 m** usually explode in the atmosphere but can shatter windows and injure people. For example, the Chelyabinsk meteor that struck the Ural region of Russia in 2013.

What are key factors affecting risk levels?

Three things decide how dangerous an asteroid is:

1. Impact probability — how likely it is to cross Earth's path.
2. Size and makeup — rock, metal or rubble determines how it behaves in the atmosphere.
3. Where it hits — ocean, desert or city.

When an asteroid is identified, astronomers work on defining the orbit, size and composition.

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tion. This helps determine the impact corridor, the areas on Earth where the impact is most likely to occur. The impact location and potential severity of damage will determine the risk level and the required governmental response, either in terms of disaster preparedness or potential asteroid deflection attempts.

What is being done in global governance to mitigate this risk and where are there gaps?

The United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) and the United Nations Office for Outer Space Affairs (UNOOSA) — the UN entity with a dedicated mandate to advance the peaceful uses of outer space and democratise access to space and its benefits — coordinate international cooperation in space safety and sustainability. To strengthen global preparedness for NEO threats, COPUOS established two specialised agencies: International Asteroid Warning Network (IAWN) and Space Mission Planning Advisory Group (SMPAG). Together, these entities enable the detection, tracking and impact risk assessment of NEOs and support planetary defence measures, such as asteroid deflection. Collectively, these mechanisms make an asteroid impact the only natural disaster humanity has the capability to prevent — if action is taken in time.

- ◀ **IAWN** shares global observation data and issues early warnings. The IAWN links together the institutions that are already performing many vital functions, including: discovering, monitoring and physically characterising the potentially hazardous NEO population. One of its purposes is to maintain an internationally recognised clearing house for the receipt, acknowledgement and processing of all NEO observations.
- ◀ **SMPAG** is composed of member states with space agencies or intergovernmental entities that coordinate and fund space activities and are capable of contributing to or carrying out a space-based NEO mitigation campaign. SMPAG has 20 members and six observers, as of October 2025, with UNOOSA acting as its secretariat².

UNOOSA plays a pivotal role in fostering global cooperation and transparency in space activities, recognising the critical importance of timely and accurate information-sharing in the event of a potential asteroid threat. Should

IAWN detect a credible impact threat, it is mandated to provide and disseminate relevant information through UNOOSA to all UN member states.¹ This mechanism ensures that every country — including developing nations with limited technical capacity to track or assess NEO hazards — has timely access to critical data and warnings. Such coordination directly advances the UN General Assembly's annual resolution on international cooperation in the peaceful uses of outer space.²

In the event of a credible impact threat, warnings are issued by IAWN if the object is assessed to be larger than 10 metres. If the object is larger than 50 metres and the impact probability is larger than 1 per cent within the next 50 years, SMPAG would start to assess in-space mitigation options and implementation plans for consideration by the member states. With vigilance and sufficient warning, an asteroid impact is a devastating natural disaster that can be prevented.



[1] Discovery Statistics, NASA Center for Near Earth Object Studies <https://cneos.jpl.nasa.gov/stats/totals.html>

[2] List of SMPAG Members as of 09 Oct 2025. https://www.cosmos.esa.int/web/smpag/smpag_members



Protecting Earth from the asteroid impact hazard

The case of the 2024 YR4 asteroid and international collaboration

BY ROMANA KOFLER

High-impact, low-probability (HILP) events like asteroid threats test global readiness and the strength of international cooperation. The discovery of asteroid 2024 YR4 in 2025 underscored the vital role of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), United Nations Office for Outer Space Affairs (UNOOSA) and global warning networks in coordinating information, guiding planetary-defence efforts and protecting humanity through peaceful uses of outer space.



Global challenges and the space agenda

HILP events are rare but potentially catastrophic occurrences that can have lasting global consequences. The global community is still struggling to overcome the multifaceted challenges of one event, the COVID-19 pandemic, which brought about tremendous loss of life, economic downturns, social disruption and long-term health impacts. Another, perhaps less obvious, HILP scenario that could affect humanity is the impact of a near-Earth object (NEO), such as an asteroid colliding with Earth.

In early 2025, the international community was confronted with precisely such a possibility. When the asteroid 2024 YR4 was identified, initial observations indicated a small but non-negligible probability of impact with Earth in December 2032.

This development served as a real-time assessment of global preparedness. It underscored the importance of the international frameworks, established under the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) and the role of the United Nations Office for Outer Space Affairs (UNOOSA) in facilitat-

ing co-operation, information-sharing and collective action in response to potential asteroid impact hazards.

Space plays a critical role as an enabler in addressing global challenges, protecting both people and our planet Earth.

2024 YR4 asteroid: The first ever real-case for international community

At the start of 2025, UNOOSA was notified of a possible impact of the asteroid designated 2024 YR4 on Earth on Dec. 22, 2032. This was shortly after the Asteroid Terrestrial Last Alert System (ATLAS) station of the University of Hawai'i in Chile first reported a potentially hazardous asteroid 2024 YR4 on Dec. 27, 2024 during near-Earth asteroid search operations for NASA. The worldwide network of observatories of the International Asteroid Warning Network (IAWN) subsequently mobilised teams of astronomers across the globe to conduct follow-up observations, inviting them to submit observations to the Minor Planet Centre, a hub for collecting, verifying and disseminating data on the positions, motions and discoveries of asteroids, comets,

and other small solar system bodies. What followed within days were impact probability calculations, independently verified by multiple authoritative sources, including the three IAWN orbit computation centres: NASA's Jet Propulsion Laboratory Center for Near-Earth Object Studies, the European Space Agency (ESA)'s Near-Earth Objects Coordination Centre and the NEO Dynamic Site.

On Jan. 29, 2025, the day UNOOSA received notification by IAWN of 2024 YR4's potential impact, the impact probability was 1.3 per cent. While low, this exceeded the 1 per cent notification threshold that triggers international warning protocols.¹ For the first time since the adoption of the UN Resolution 70/82 *International cooperation in the peaceful uses of outer space* in 2015, that an asteroid met the minimum reporting criteria, prompting UNOOSA to issue a formal notification to all UN Member States.

At the same time, the Space Mission Planning Advisory Group (SMPAG) — for which UNOOSA serves as secretariat — was also informed. SMPAG brings together 20 space agencies with specialised expertise in planetary defence. It provides coordinated advice on possible deflection or mitigation options when an asteroid exceeding 50 metres in diameter is assessed to have an impact probability greater than 1 per cent within a 50-year timeframe. While SMPAG

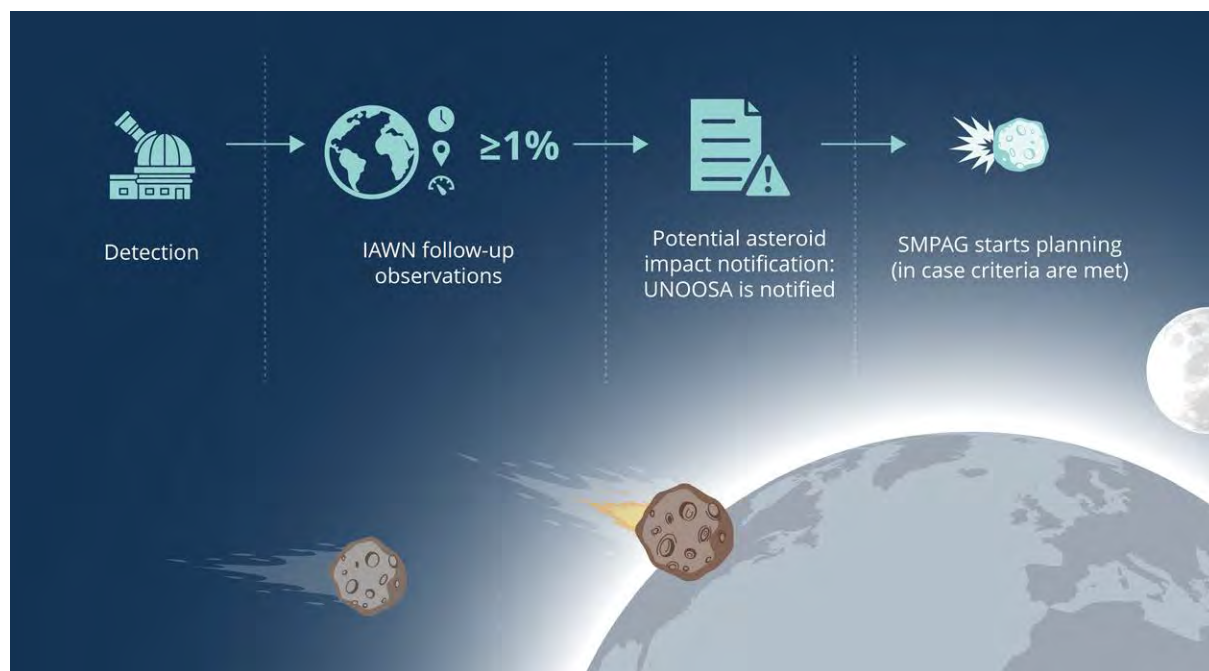
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This was a pivotal moment for the United Nations and for international cooperation in space. It was the first real-time test of our planetary defence protocols, and it showed that preparedness depends not just on technology, but on trust, transparency, and global coordination.

– Aarti Holla-Maini,
Director of UNOOSA

regularly tests its capabilities on hypothetical cases of asteroid threat scenarios, the 2024 YR4 asteroid provided a real-world test of international response coordination mechanisms for planetary defence.

The SMPAG Steering Committee reviewed the available data and the warning timeline for 2024 YR4. During meetings in late January and early February 2025, SMPAG concluded that while the probability met the group's thresholds for monitoring, it was too early for specific mission planning. Therefore, SMPAG continued



to closely monitor changes in the impact probability and size estimates.²

At the time of the initial notification, the asteroid was estimated to be between 40 and 90 metres in size, with the impact risk corridor estimated to extend across the eastern Pacific Ocean, northern South America, the Atlantic Ocean, Africa, the Arabian Sea and South Asia. Further observations by the James Webb Space Telescope in March 2025 resulted in a revised estimate for 2024 YR4's diameter to be 60 ± 7 metres. If an impact with an asteroid of this size were to occur, it could cause severe blast damage extending up to an 80-kilometre radius from the impact site. Because of its size and speed, an impact with Earth would release energy comparable to 2–30 megatons of TNT — about a thousand times the power of the Hiroshima bomb.³

While the probability remained extremely low, the situation warranted continuous attention and monitoring. The visibility period for 2024 YR4 would last through early April 2025, after which the asteroid would become too faint to be observable from Earth until 2028. UNOOSA maintained regular communication with IAWN on the asteroid's trajectory and impact probability, ensuring timely situational awareness to support any required policy or coordination efforts.

The asteroid reached a peak probability of impact with Earth of 3.1 per cent, before eventually dropping to 0.004 per cent (1 chance in 26,000) on Feb. 24, 2025. Through IAWN's final notification, UNOOSA informed Member States that asteroid 2024 YR4 poses no significant risk of impact with Earth over the next century. IAWN will continue tracking the asteroid to refine estimates of its close approach on Dec. 22, 2032, currently projected to pass safely beyond geosynchronous orbit and possibly even beyond the Moon.

How prepared are we? From risk to resilience: Strengthening global preparedness through the peaceful uses of outer space

The international community has shown that deflecting an asteroid is not only theoretically possible, but also technologically achievable. In 2022, in the first-ever planetary defence technology demonstration mission, NASA's Double

Asteroid Redirection Test, became the first to successfully alter the movement of a natural celestial body. The mission targeted the asteroid Dimorphos, a small moonlet orbiting the larger asteroid Didymos. Using a kinetic impact deflection technique, the mission demonstrated that Dimorphos's orbital period around Didymos was reduced by approximately 33 minutes. These measurements have drawn on global expertise, using Earth-based telescopes to assess the mission's outcomes and inform planning for future planetary defence efforts. This technique could one day be applied to help prevent a potential asteroid impact with Earth.

Confronting the hazard posed by NEOs involves a multifaceted effort: identifying asteroids that could impact our planet, assessing potential risks and developing mitigation strategies to prevent or minimise damage. Such endeavours cannot be undertaken in isolation. They demand a united response from the global community — a demonstration of solidarity and shared responsibility in safeguarding humanity.

2029: International Year of Asteroid Awareness and Planetary Defence

In 2024, the UN General Assembly proclaimed 2029 as the International Year of Asteroid Awareness and Planetary Defence⁴, marking it with an extraordinary astronomical event. On April 13, 2029, the asteroid 99942 Apophis will make an exceptionally close — yet safe — approach to Earth, passing at a distance of about 32,000 kilometres, within the orbit of many geostationary satellites. This rare event will offer

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Planetary defence is not
science fiction — it is a shared
responsibility. The risks are
real, but so is our collective
capacity to act. UNOOSA is
committed to ensuring that
every country, regardless of
its size or resources, has both.**

– Aarti Holla-Maini,
Director of UNOOSA

a spectacular sight, as Apophis becomes visible to billions of people with the naked eye under clear night skies.

While the asteroid poses no threat of impact, its close passage presents an unprecedented scientific opportunity and a powerful reminder of the importance of global preparedness. Building on this once-in-a-millennium event, the International Year will act as a catalyst for international co-operation, education and public engagement on planetary defence — aiming to inspire humanity to deepen its understanding of near-Earth objects and to safeguard our shared cosmic environment.

UNOOSA is entrusted with ensuring that this global initiative is carried out in close collaboration with UN Member States, space agencies, entities of the United Nations system, and relevant international and regional organisations, as well as other key stakeholders from the scientific and academic communities.

The close approach of Apophis provides a rare and compelling opportunity for space agencies, research institutions and private entities to send missions to a near-Earth asteroid. These missions could advance science, test new technologies or demonstrate capabilities for planetary defence. The International Year aims not only raise awareness of asteroid-related risks and opportunities but also strengthen global capacity in planetary defence, space science and sustainable space governance. It is a reminder that humanity's greatest achievements in space — such as protecting our planet — depend on collaboration, trust and the shared pursuit of knowledge that transcends borders for the benefit of all.



References

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- [2] See SMPAG Statements on “2024 YR4” at smpag.net
- [3] IAWN notification to UNOOSA (29 January 2025, see iawn.net) and JWST Observations of Potentially Hazardous Asteroid 2024 YR4,” A. S. Rivkin et al 2025 *Res. Notes AAS*
- [4] International Year of Asteroid Awareness and Planetary Defence, 2029; General Assembly Resolution 79/86, see <https://www.un.org/en/observances/asteroid-awareness-year>



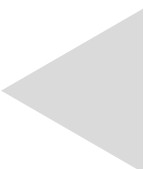
About the author

Romana Kofler is a Programme Management Officer at UNOOSA and supports UN space policy negotiations within COPUOS. As UNOOSA focal point, she works with SMPAG and IAWN in strengthening global response to hazardous asteroids.



A system under stress: Adapting global governance to a world of accelerating risk

Global risks are becoming increasingly interconnected, accelerating and reinforcing one another across environmental, technological and security domains. As this report shows, outdated governance, rising geopolitical tensions and fragmented institutions leave humanity exposed. Addressing escalating systemic threats requires renewed legitimacy, stronger cooperation and a more adaptive, anticipatory global governance architecture capable of managing shared risks.



One of the main privileges of working for an organisation that covers a broad range of global risks is the bird's eye view you get across issue areas and political processes. As this report shows, we are witnessing fundamental shifts in how global risks emerge, expand and interact, spanning climate, ecosystems, technology and security domains.

In the security sphere, states' drive for technological and strategic advantage is reshaping deterrence and altering pathways of escalation. As Wilfred Wan observes, the deepening entanglement of nuclear and non-nuclear capabilities across domains, such as cyber and outer space, blurs thresholds and increases the risk that misperception or technical failure could trigger unintended — even nuclear — escalation.

In addition, as Denise Garcia notes, diplomatic and regulatory processes remain too slow and fragmented to match the speed of technological change, such as the rapid integration of AI into military command and control. Once embedded, these technologies are extremely difficult to constrain, leaving the world to play catch-up with risks that evolve faster than the rules meant to contain them.

In the environmental sphere, a similar pattern of interconnected fragility applies. Climate change, biodiversity loss, and resource competition interact in

non-linear and cascading ways, creating pressures that destabilise both natural systems and societies. Today, we stand at what David Obura and others call a bifurcation point. A growing number of ecosystems, from coral reefs and mountain glaciers to freshwater systems, are nearing thresholds of collapse driven by climate change, land-use conversion, and over-extraction. As Johan Rockström and Fatima Denton highlight, seven of the nine safe and just Earth-system boundaries have already been transgressed, creating devastating and unjust socio-economic consequences that quickly outpace our preparedness.

We treat each of these crises as if it were separate: one agency for forests, another for oceans, a third for emissions. Yet the Earth system moves as a whole; the loss of a rainforest or coral reef sends systemic ripples through climate, food, and water systems.

“The Earth system moves as a whole; the loss of a rainforest or coral reef sends systemic ripples through climate, food, and water systems.”

At the same time, rising geopolitical tensions, resurgent nationalism and vested interests drive competition and unilateral action instead of cooperation. Our collective capacity to mitigate global catastrophic risks and protect both people and planet remains weak at best, while trust in and the legitimacy of the system is eroding. Even where institutions exist, from the UN Security Council and the International Criminal Court to the multilateral environmental regimes, their ability to act is constrained by political gridlock, weak enforcement and chronic underfunding.

Our perception of risk remains uneven, and our governance fragmented. As Romana Kofler notes in her article, for near-Earth asteroids, the world mobilises a coordinated international response when the probability of impact exceeds just one percent. Yet, for Earth-system tipping points like a potential AMOC collapse, where risk is far higher and consequences equally globally catastrophic, no comparable governance mechanisms exist. As this case illustrates, and as the GCF's founder László Szombatfalvy often noted, low-probability but high-impact events constitute potential extreme-risk scenarios that we are not yet equipped to manage at the global level.

Across most of the domains, the underlying dynamics are the same, including ineffective governance, weak accountability and a lack of multilateral coordination. This leaves humanity and the planet exposed. The rules written for a stable world no longer fit the one taking shape before us. If the international system cannot evolve to meet both existing and new kinds of global catastrophic risks, how can it maintain legitimacy?

A system fit for purpose

The GCF's long-term goal is to help build a legitimate, effective, and just global governance system. One capable of preventing and managing global catastrophic risks through stronger international law, more effective multilateral institutions and decisions grounded in science. To move this vision forward, we focus on catalytic partnerships between research, civil society and policymakers; network-building across North and South; and policy engagement in global processes and forums such as the UN, G20, BRICS+ and other minilaterals.

We see change as a process that unfolds along parallel tracks. While some institutions adapt from within, new networks, ideas and practices

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What we need now is a renewed approach to global governance. One that reinforces international law, strengthens shared norms and accelerates action, while simultaneously fostering creativity, innovation and foresight.

take shape alongside them — testing alternatives, demonstrating what works and gradually redefining what is possible. GCF helps develop these emerging solutions and connects them to decision-making arenas, increasing demand for reform, supporting coalitions of the willing and strengthening coordination across silos to reveal how risks intersect.

What we need now is a renewed approach to global governance. One that reinforces international law, strengthens shared norms and accelerates action, while simultaneously fostering creativity, innovation and foresight. It means acting on today's urgent risks while reimagining the systems that must guide us through what comes next.

We recognise that this work takes place in a deeply challenging political landscape. Change at this scale is hard, slow and rarely linear. Yet even in this environment, there continues to be space for progress, often in unexpected places. Our task is to help protect what works, support what is emerging and show that renewal of global governance is still possible.

Informed by the insights from this report, we see three major shifts that can help advance that renewal.

Shift 1: From fragmentation to connection and adaptability

As risks become increasingly interdependent, cooperation remains fragmented and siloed. Financing mechanisms, including philanthropy, often mirror this fragmentation, producing governance structures that reflect, rather than resolve, global division.

States, institutions and funders must work together to build bridges between systems so we can manage global risks as the interconnected challenges they are. Many of GCF's partners already demonstrate this: the Earth Commission maps interconnections across planetary systems, while SIPRI explores how risks across cyber, space and nuclear domains intersect and create new escalation pathways.

Governance must move from crisis response to anticipatory stewardship, embedding foresight, early warning systems and risk reduction into decision-making. As Manjana Milkoreit argues, imagination is not an escape from reality but the engine for improved governance. Without it, we drift from crisis to crises; with it, we can orient ourselves toward futures still within reach.

This requires institutional creativity and GCF's partners are already experimenting with such innovations. For example, the Igarapé Institute is exploring a Global Climate and Nature Council, the United Nations University Centre for Policy and Research is advocating for a UN Future Generations Commissioner, and Democracy Without Borders and ISWE Foundation are developing innovative mechanisms for citizen participation. Taken together, these initiatives demonstrate how creative thinking and practical experimentation can open new pathways for global governance to evolve.

Shift 2: From erosion to legitimacy

How do we defend what works while acknowledging what does not? In a divided world, we must uphold the rules we have created, even as we confront the double standards — particularly the selective respect for international law that has undermined the system's credibility and trust it depends on.

Strengthening the anchors of global governance — accountability, implementation and international legal frameworks — starts with renewing our commitment to the idea that rules matter, even when inconvenient. International

courts and accountability mechanisms need independence, resources and political backing. States must honour their commitments, defend institutions under pressure and lead by example. But states cannot do this alone. Civil society plays a crucial role, holding governments accountable, keeping attention on overlooked crises and defending international law, often with shrinking space and resources. Protecting those who defend the rule of law is as vital as safeguarding the institutions themselves.

In addition, the system must evolve, reforming what exists when needed and filling the gaps. This includes modernising international law. Among GCF's partners, Article 36 advances efforts for a new legal instrument on autonomous weapons; Stop Ecocide International campaigns to make ecocide the fifth international crime under the Rome Statute; and the European Centre for Constitutional and Human Rights pushes to close accountability gaps for the crime of aggression. Together, these efforts show that progress requires both protecting existing foundations and advancing bold reforms.

Shift 3: From imbalance to inclusion

Global governance systems still reflect deep historical imbalances. From the veto-weighted structure of the UN Security Council to climate finance arrangements where those least responsible for the crisis are often left most exposed to its consequences. The experiences and capacities of the Global South are essential for shaping systems that are more adaptive and legitimate, yet its influence remains limited in many key decision-making processes. This imbalance fuels mistrust, weakens ownership and undermines both legitimacy and effectiveness.

Strengthening global governance also means confronting the structural imbalances of power and finance that have long constrained equitable decision-making. Justice and inclusion must be structural principles; fairness, partici-

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Governance must move from crisis response to anticipatory stewardship, embedding foresight, early warning systems and risk reduction into decision-making.

pation and representation are not moral ideas alone but practical requirements for legitimacy. Through the Article 109 coalition and the Global Governance Forum we are supporting efforts to reform the UN Charter, including the Security Council. Meanwhile, the International Peace Institute, European Institute of Peace and Plataforma Cipó are strengthening trust by facilitating dialogue and cooperation between the most vulnerable states and key actors in an increasingly polarised world.

Where to go from here

As the Global Catastrophic Risks Report 2026 makes clear, the system of global governance built to manage shared risks is under immense strain. Yet it remains indispensable for navigating an increasingly complex and interconnected world.

Rather than turning inward toward nationalism and isolation, we must rebuild trust in the rules, institutions and norms that still hold while modernising them to meet new realities. Strengthening accountability, reforming international law and giving global systems the capacity to act is essential to restoring legitimacy and effectiveness.

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Rather than turning inward toward nationalism and isolation, we must rebuild trust in the rules, institutions and norms that still hold while modernising them to meet new realities.

The challenges ahead are significant. However, they also offer an opportunity to rethink how we cooperate on a shared planet and to reimagine a global governance system fit for the risks and realities of our time and those still to come.



About the authors

Eva Mineur, Head of Climate and Sustainability, GCF

Anna Möller-Loswick, Head of Common Security GCF

Anja Olin-Pape, Head of Programmes GCF



Global Challenges Foundation
Västra Trädgårdsgatan 15
111 53 Stockholm
Sweden

info@globalchallenges.org

www.globalchallenges.org