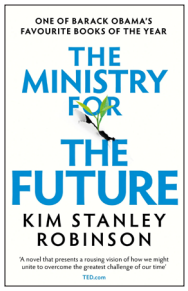
resolutions:
the climate emergency

Thanks to *The BMJ*'s climate steering committee for their advice with this series of articles: Howard Frumkin, Andy Haines, Mala Rao, and Renee Salas



In 2020, the book The Ministry for the Future by Kim Stanley Robinson was published. Set in 2025, the novel presents possible solutions to the climate emergency. The following series of articles is inspired by Robinson's ideas and discusses the changes that we need to consider to protect people, the planet, and ensure a liveable future for younger generations

What can't wait: climate triage and The Ministry for the Future

As a hospital consultant, I regularly make triage decisions—who to admit from the emergency room, when to call the intensive care unit, which procedures can wait, and which patient can't. Kim Stanley Robinson's *The Ministry for the Future* is a book about exactly such decisions, decisions that determine not just who lives and dies now, but who will live and die in a future we must begin to imagine.

Is there a more harrowing introduction than the devastating Indian heat wave that opens *Ministry*? We meet Frank May, a US aid worker in an "ordinary town" in Uttar Pradesh, India, as he makes grim choices on a Wednesday. The temperature is 103 degrees Fahrenheit at 6 am—a temperature that would have been record breaking just years before. Decisions must be made: who to move indoors, when to run the generator, how to conserve drinking water. At first, only older people and children die; their bodies are swaddled in funereal white and moved to the roofs. Then more follow: "Every rooftop was now a morgue."

The living stumble on below. One reads through an opalescent heat haze. Misleading, too, is the steaming lake that the town's residents stagger into seeking relief from the heat. Frank muses, "hot water in one's stomach meant there was no refuge anywhere, the world both inside and outside well higher than human body temperature ought to be. They were being poached." One of the few rescued, Frank is found "burned, or boiled." He becomes a traumatised climate migrant lurching from place to place while experiencing profound survivor's guilt.

Robinson shows us how the climate calamity impacts everyone while deftly handling its differential liability

Transnational moonshot

The Indian catastrophe (20 million dead) administers a shock treatment to the world and spurs the United Nations' 2025 launch of the titular "Ministry for the Future," based in Zurich. This transnational moonshot is charged with advocating for "future generations of citizens, whose rights, as defined in the Universal Declaration of Human Rights, are as valid as our own."

Enter Mary Murphy, an Irish bureaucrat who leads the agency over the next 500 pages and several decades. That both of its main protagonists are from the global north is a tension the novel never resolves. The premise, however, shouldn't be so unusual: we owe future generations our greatest efforts at preventing catastrophe. And yet *The Ministry for the Future* illustrates how—even after such commitment—collective healing is anything but inevitable.

Robinson shows us how the climate calamity impacts everyone while deftly handling its differential liability, especially the unjust burden placed on the global majority after centuries of colonial resource extraction. This is not theoretical entanglement but an exigent natural, physical, mental, and spiritual crisis. The salvo must occur on many fronts: the novel's interventions include geoengineering; new currency to incentivise decarbonisation; renewable transitions; widespread electrification; ecosystem repair; and systems to support climate refugees. *Ministry* bundles many of the preoccupations of climate fiction (cli-fi) past and present into an encyclopaedia, a syllabus of collective response.

Beloved of statesmen and innovators—former US President Barack Obama named it one of his favourite books of 2020—*Ministry* quickly became popular among climate scientists and health professionals. At its publication, Robinson was already a prize winning trailblazer in both sci-fi and cli-fi. His bona fides in "hard science fiction" gave *Ministry* credibility with a wide range of readers—it isn't common for both entrepreneurs such as Bill Gates and political columnists such as Ezra Klein to rate a sci-fi novel.

In the *BMJ*, Howard Frumkin used it as an example of how fiction can help us understand and manage the climate crisis. Grounding his writing in rigorous research (he consulted climate scientists and activists, read policy briefs, and studied economics), Robinson, like other hard sci-fi practitioners, emphasises scientific accuracy, technical precision, and workaday detail as part of his world building.

But he is also a literary innovator. He has given interviews positioning his writing in a longer, realist tradition casting back to Cervantes,

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Sterne, and Defoe—calling his brand of sci-fi a "proleptic realism" trying to "cast realism into the future." *The Ministry for the Future* is a polyphonic novel assembled as a collage—a nod to the novelist John Dos Passos, among others. Like Bram Stoker's *Dracula*, which strains to understand industrialisation and its threats through communication technologies (telegrams, typewriters, phonographs, and cameras).

Aspires to the allegorical

The Ministry for the Future assembles its world through an assortment of voices and perspectives: impersonal booming entities speaking in free verse (the sun, heat, the market, photons), meeting minutes, policy reports, speeches, confessionals. This gives it a documentary and a dialogic quality—we are awash with information and must re-anchor ourselves in each chapter. For all its hard boiled and technical detail and its articulation of a kind of global "Green New Deal," this is a book that aspires to the allegorical. It tries for a politics of hope, a future where decency, collectivism, and good decisions pull us out of moral infirmity and certain death. Despite its excruciating opening and inflamed depictions of life and bodies on our burning planet, *Ministry* asks us to believe in transformation and that our constraints are manufactured.

Climate crisis becomes a portal, as the author Arundhati Roy once hopefully (and unexpectedly) said about the covid-19 pandemic, to imagine a different world and different conditions. It is a "hard science" humanist novel—testament to our ingenuity and an expression of faith in there being enough to go around.

But I want to acknowledge now that we are not living in a time of great hope. The politics of 2020 feels remote, as we face down science denialism, climate scepticism, and a sense of collective fracture. Literary scholar Nathan Hensley's recent, stunning book *Action Without Hope* asks: "What does it feel like to live helplessly in a world that is coming undone?" Hensley turns to 19th century literature to unearth a prehistory of this familiar sense of powerlessness, showing how Victorian writers, faced with vast and seemingly irreparable damage, rescaled climate action away from the grandly heroic towards smaller, collaborative interventions. Away from wholesale argumentation towards gestures and details.

I want to acknowledge now that we are not living in a time of great hope

Three great enemies to humanity

This matters for how we read *The Ministry for the Future*—and for how we practise it as we contemplate 2026. More than 100 years ago William Osler declared that humanity has three great enemies: fever, famine, and war. Robinson reminds us that climate catastrophe contains all three, and multitudes more. So many of the ideas in the book reflect in macrocosm what we know about good medicine: understanding thresholds and tipping points; prevention instead of reaction; building systems that can withstand stress; recognising how crisis worsens existing disadvantages in access to care, clean air and water, secure housing, social safety nets, and attending to collective stress, mental health, and moral injury.

Robinson asks us to imagine an entirely new entity operating at planetary scale. *Ministry* marries realism and radicalism precisely because of its combination of bureaucratic and shocking solutions—a pluralistic text dealing with everything from ecoterrorism to working within current monetary systems. But we might also work at the smaller scale: the local, the particular, taking care with the language we use, and the decisions we make every day about who and what can wait. We are making those decisions now, in areas the articles in this issue emphasise: artificial intelligence, biotechnology, alternatives to viral capitalism, biomedical ethics, green energy, biodiversity, legal and regulatory frameworks, and multilateralism.

What can't wait? There is scale, room, need, action for the sweeping vision and the humble choice.

Lakshmi Krishnan, founding director of medical humanities initiative and assistant professor of medicine, Georgetown University, Washington, DC

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The author of The Ministry for the Future on climate fiction, political imagination, and health

In an interview with Kamran Abbasi, Kim Stanley Robinson, whose book is the inspiration behind The BMJ's special issue, talks about his admiration for the medical profession and why he still has hope in troubling times

? We have just left 2025, the year in which The Ministry for the Future begins. How does the book feel to you now, five years after publication?

It's holding up very well in terms of still looking like a book that you could read now. Science fiction is about the future, so it's always going to be wrong eventually—especially once it gets past the date where it postulates its setting. *Ministry* was written in 2019. You can see that it's not aware of the covid-19 pandemic or the Russian invasion of Ukraine. But it describes a kind of disorderly and chaotic future, so it still seems pretty fitting. People were quite shocked by the political violence in it in 2020 [when the book was published] but now nobody's shocked because worse things have happened in the five years since.

? You've cited medical research as a key inspiration for the novel

It was a bit of medical news that shocked me and made me decide I've got to write this book. That was "wet bulb 35" [a wet bulb temperature of 35°C has been theorised to be the limit to human adaptability to extreme heat, where the body can no longer cool itself by sweating]. It comes from medical research putting together disparate parts of the problem, because of course we've never really had a wet bulb 35 heatwave lasting for a month to see what it does to people.

That was a medical report from 2010. I ran into it in about 2015 and at that point I realised that my anger at the adaptationists had a point to it, there was a reason for it, because the adaptationists were saying, "Don't worry about climate change, we'll charge ahead, humans are so adaptable, we can adapt to anything, we've done so in the past, we'll do it in the future, why are you so worried about climate change?" Why? Because it's fatal. It's fatal when you hit the combination of heat and humidity that they call wet bulb 35.

I chose the word "ministry" for its many meanings—the medical community is more than just taking care of illnesses

When I read that article, it was as if I had been spiked with a needle in the eyeball. We can't just adapt to climate change. We have to mitigate. We have to cope. We have to make sure that we do not have the hottest futures that are likely to happen given what we're doing now. And so that was the inspiration for *Ministry*.

? What lessons does the book offer for the health sector?

When you say the health sector, you're gesturing at something very deep—the birth of science to attempt to take care of each other better, to work on reducing suffering. There is a kind of Buddhist underpinning, not by pretending it doesn't exist, but by inventing medicine. I think of medicine as the root of our invention of science and the scientific method, beginning with a kind of trial and error, going way back into the Palaeolithic times. It wasn't just Galileo, that moment of the Renaissance, or the early modern period: the birth of science is Palaeolithic in its origins, and always concerned with reducing human suffering in any way possible.

If that's extended to the biosphere, then you have a view that we are one living body and humans are like bees in a hive. The hive has to be healthy. The individual bee is quite a competent and intelligent creature but needs the hive and all the rest of the bees to live at all. So that larger view of health as biosphere health is individual human health. That's the way that you could look at it to solve this problem.

An organisation that I admire very much is Médecins Sans Frontières or Doctors Without Borders [which is the subject of *The BMJ*'s annual appeal]. Its name is so suggestive of higher value systems than the nation state system. The nation state system is a zero sum game; it's competitive and tribalistic in ways that aren't true to the fact that we're all one species on one planet, that the borders are arbitrary, historical, and unhelpful, that it's one people on one planet, but also all the other species.

It's important to take care of each other and doctors are the professionals of that. We need to be more interested in international collaborations of all kinds of inspirational things that come out of theoretical work or sociological work, the kind of pastoral work.

I chose the word "ministry" for its many meanings—that the medical community is more than just taking care of illnesses. It's a name for a way of life or a philosophy of being.

? Many young people feel abandoned by current climate politics. How should their concerns be tackled?

We need to listen to them because they're the ones that are going to be alive in a damaged world and they're going to be struggling with this their entire lives.

When I talk to 20 year olds, many of them, because of medical science, are going to be alive in the year 2100. And we have some deadlines in terms of action to decarbonise this civilisation that need to play out by the 2050s.

Young people can pick any possible field and it will still be relevant to coping with climate change

Young people naturally have anger and climate dread, have the feeling that they can see the trajectories as well as anyone else. They can see the political battles and the frozen nature of the discussion—the way it tends to repress the climate for more supposedly immediate concerns. And they can read all that every day on their phones while doomscrolling. And so this sense of dread, it's all very Freudian. If you repress things long enough, they are still there and they burst back out in the return of the repressed. So it will be volatile.

There's a reason that climate dread translates into political activism and into voting and into changing the system in every possible legal way so that citizens regard part of their life as a citizen to act on this stuff rather than just retreat into a private repression and despair.

? Where do you place yourself on the spectrum between hope and despair?

Hope is biological. Life is hope because life wants to live and therefore works at it. And so the cells hunt down and grab their ATP [adenosine triphosphate]. The living creature hunts down and grabs its food. Hunger is a hope, hope is a kind of a hunger for a better future, more security, or just to live on. And in more human philosophical terms, it's an existentialist point that humans need a project.

Having a project is a necessary part of human health and happiness. You have to have a project, which is simply a meaning. It gives your life meaning to have a project. Now, for young people, the project has been dropped on their heads like a ton of bricks. They have to cope with climate change, that's their project. It's both frightening and it's also energising. It doesn't matter what field they're interested in. Young people can pick any possible field and it will still be relevant to coping with climate change.

WILL IRELAND/SFX MAGAZINE/FUTURE/GETTY IMAGES

One of the many reasons to love the medical community is that there are better ways in this world to make money, but there are few better ways to do good.

Mun Keat Looi, international news and features editor, *The BMJ* mlooi@bmj.com

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The full interview with Kim Stanley Robinson can be found on bmj.com.

BIOGRAPHY

Kim Stanley Robinson (above) is an American science fiction writer known for politically and scientifically grounded climate fiction, including *The Ministry for the Future*, a novel which explores pathways to ecological survival and social transformation.

Prosperity as health: Why we need an economy of care for a liveable future

Climate breakdown can be understood as a profound abdication of care: a collective failure to maintain and protect the conditions of life. Addressing that failure will take more than clever technology and incremental policy reform. It must start by reimagining the purpose of the economy and the direction of societal progress.

For the past eight decades, progress has been measured by one dominant metric: growth in the gross domestic product (GDP)—a statistical account of the size of the economy. More is always better in this view. But relentless expansion is having profound ecological repercussions—not least on the climate. So if we're to protect the interests of future generations, we're going to have to rethink that formula. In other words, we must confront the distorted logic of economic growth.

The myth of growth

Let's accept, for the sake of argument, that growth has delivered undeniable benefits to humanity in the past. Let's agree that rising incomes are still desperately needed to lift millions out of poverty in the future. But let's acknowledge too that the relationship between income and human wellbeing—whether that's measured as life expectancy, education, or even happiness—is highly non-linear.

As the average GDP per person rises from next-to-nothing to around $15 000 to $20 000 (in today's money), average life expectancy across nations almost doubles. That represents a massive increase in real human wellbeing. But beyond that point the positive link between income and wellbeing becomes progressively weaker and sometimes goes into reverse.

Quite where the threshold lies depends on what exactly you're looking at. In a high income country like the US, self reported happiness shows positive returns even at $120 000 per person. That's largely because of relative income effects: we tend to feel better if we're richer than those around us—and worse if we're poorer. But data at the national level show diminishing and sometimes negative returns to income even beyond $25 000.

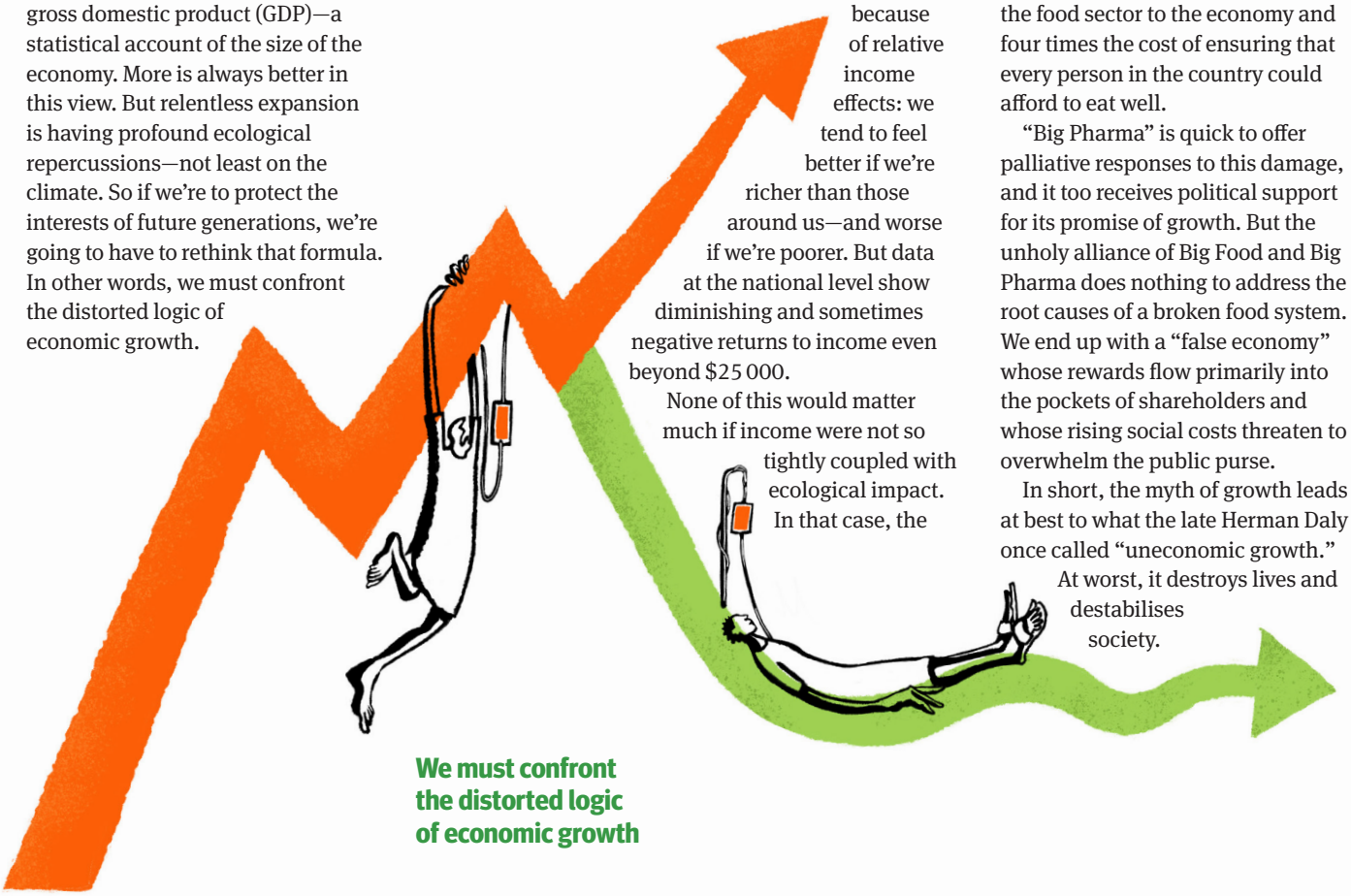
None of this would matter much if income were not so tightly coupled with ecological impact. In that case, the myth of growth becomes a recipe for collapse. Climate breakdown is the clearest expression of that collapse. Every fraction of a degree of warming increases respiratory disease, precipitates heat stress, undermines food security, and accelerates forced migration. And the impacts fall disproportionately on the poorest, compounding financial misfortune with deepening health inequalities.

Nor are these the only perverse outcomes from a growth-obsessed politic. In the rush for wealth, governments systematically overlook the places where the products (and byproducts) of growth undermine population health. What seem like economic goods turn out to be economic bads.

To take a topical example, political support for "Big Food"—including ultra-processed food (UPF)—is significantly aided by the claims of the industry to offer an engine of growth. But that same formula contributes to an epidemic of chronic disease. A recent study for the UK estimated the social costs of food related chronic disease at £268bn each year—almost twice the value of the food sector to the economy and four times the cost of ensuring that every person in the country could afford to eat well.

"Big Pharma" is quick to offer palliative responses to this damage, and it too receives political support for its promise of growth. But the unholy alliance of Big Food and Big Pharma does nothing to address the root causes of a broken food system. We end up with a "false economy" whose rewards flow primarily into the pockets of shareholders and whose rising social costs threaten to overwhelm the public purse.

In short, the myth of growth leads at best to what the late Herman Daly once called "uneconomic growth." At worst, it destroys lives and destabilises society.



We must confront the distorted logic of economic growth

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Prosperity as health

If the prevailing myth is broken, what should replace it? I've been asking that same question for more than 20 years. What can genuine prosperity possibly look like on a finite planet?

The answer that comes back time and again, from the wisdom of the ages to the wisdom of the crowd, is that prosperity is first and foremost about health: our own health; the health of our family, our friends, and our community; and ultimately the health of the planet. As Ralph Waldo Emerson argued a century and a half ago, the first and greatest wealth is health; without health there is no wealth.

That simple inversion has profound implications. It changes the dynamic of progress. When wealth is our compass the driving dynamic is accumulation: always more, always faster. The pursuit of growth is an expression of that dynamic. But the principal dynamic of health is one of balance. A living organism never grows without constraint. Its ability to survive and to thrive depends on continually maintaining and restoring internal equilibrium in the face of changing external conditions—a process Walter Cannon called homeostasis.

That process is not infallible. The restoration of balance is possible only within certain limits. Relentless changes in external conditions eventually shift the "set point" in a progression known as allostasis. An abundance of sugar in the diet (to take a pertinent example) can alter the homeostatic set point for blood glucose. Such changes tend not to turn out well, imposing what physiologists call an allostatic load on the organism—and indeed on society. In the case of sugar, that load comes in the form of diabetes, inflammation, and chronic disease.

In 1974, James Lovelock and Lynn Margulis put forward the fascinating hypothesis that we can think of planetary health in the same way: "that early after life began it acquired control of the planetary environment and that this homeostasis by and for the biosphere has persisted ever since." They called this mechanism Gaia. As Lovelock put it, in a lecture to the Royal Society in 2007, "Gaia theory is a top down, a physiologist's view. [It] sees the Earth as a dynamic responsive planet." Climate breakdown is itself a form of allostatic load imposed on the earth—and on its living creatures—as Gaia attempts to return to balance.

Framing prosperity as health creates a neat metaphorical bridge between disease and climate change. But more importantly it has profound implications for the organisation of society—for the economy.

Economy as care

Strangely those implications were also foreseen by Cannon. In an epilogue to *The Wisdom of the Body* he asks a simple question: "Might it not be useful to examine other forms of organisation—industrial, domestic or social—in the light of the organisation of the body?"

The best part of a century later, that question is still worth asking and Cannon's suggestions still bear scrutiny. They too highlight the change in dynamic which occurs when health gives way to wealth as the compass of prosperity. The myth of growth turns out to be at best just half a model—a dangerously incomplete picture of societal progress.

Where there is not enough, then "more" is a legitimate recipe for improvement. But to frame prosperity in terms of perpetual growth creates two major dangers. Firstly, the relentless rush towards more obscures the point of enough. Secondly, even if we clock that elusive equilibrium, we have no means of attaining it as we rush headlong by. The entire system is locked inexorably into growth.

Two essential course corrections follow from this. Firstly, we must pay a constant attention to the set points of human (and planetary) health. We cannot afford to let revenue, profit, GDP or any of the buzzwords of growth distract us from that task. To do so is like turning off the autonomic nervous system (ANS) that oversees our own homeostatic regulation. Secondly, the economy must incorporate viable control mechanisms. It must be able to slow down (as well as speed up) a wide range of different activities and processes that govern health.

Care is not simply a subsector of the economy or a luxury we can afford only off the back of growth

Dietary sugar, screen time, pharmaceutical interventions cannot simply run rampant if wellbeing is to be achieved. The same is true for carbon emissions, environmental toxins, and chemical additives. The economy must mirror and reinforce rather than neglect and undermine those innate restorative forces that return the organism to health.

Government's role in this process—like the ANS in our metabolism—is part oversight and part allocation. It must routinely measure what matters, regulate imbalance, curb excess, and motivate a judicial investment of the resources needed to achieve population health. In other words, it must replace the myth of growth with an ethos of care—where care has a quite precise meaning.

Care is not simply a subsector of the economy or a luxury we can afford only off the back of growth. Neither should it be seen as a site of special pleading in the contest for the moral high ground. Rather, it must be a fundamental organising principle for economic life—just as it is for organic life. A restorative force whose role is to bring us continually back into balance.

Granted, this framing of economy as care seems a million miles from where we are today. Care resists automation and defies productivity gains. As a result, it is persistently overlooked and systematically undervalued in market capitalism. It sits uneasily within an economic system predicated on growth. But that is precisely the point. Climate breakdown is fundamentally a crisis of care.

Reframing prosperity as health allows us to redress the balance. Care becomes the most fundamental investment we can make in society's most precious and irreplaceable asset: human (and planetary) health.

Tim Jackson, professor emeritus and co-director, University of Surrey, Guildford

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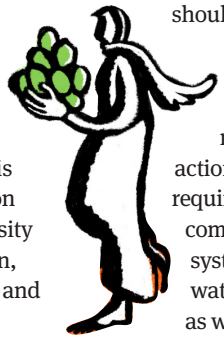
From crisis to action: A new shared vision for the future food system

We need to reimagine and reshape global food systems

The United Nations' Sustainable Development Goal 2 aims to achieve global food security by eliminating world hunger, improving nutrition, and adopting sustainable agricultural practices. This goal is necessary because the global food system is currently in crisis, with over 673 million people globally experiencing hunger, predominantly in Africa and Asia, as of 2024. These high levels of hunger have led to a global focus on producing food to fill people's stomachs with calorie dense foods that are not necessarily the most nutritious, while contributing to health (physical and mental) concerns. The situation is worsened by climate change, conflict, economic shocks, and increasing food prices. Climate induced weather extremes, such as droughts, floods, and heatwaves, are increasing and have been devastating crop yields. Meanwhile, conflicts, including the war in Ukraine, are affecting agricultural output and exports. Vulnerable populations in the global South, including smallholders, are experiencing reduced food availability and accessibility, declining nutritional quality of food, a rise in food and waterborne diseases, and increasing poverty and inequality. Without action, an additional 183 million people are projected to be at risk of hunger by 2050 owing to the climate crisis, which is worsening the multiple stressors on food systems.

A bidirectional link exists between food systems and climate change: climate change negatively impacts food systems, while food systems are among the most prominent contributors to greenhouse gas emissions. The global food system accounts for more than a quarter of global greenhouse gas emissions. This is largely owing to deforestation and land use change, biodiversity loss, rapid livestock production, and extensive use of fertilisers and other agrochemicals, which also contribute to freshwater pollution. Despite growing concern for the unsustainability of the global food system, existing governance, policy, and institutional blind spots continue to systematically shape our unsustainable food systems. These blind spots include institutional silos and a lack of coordination between departments governing the food system, as well as insufficient budgets and policy fragmentation. These tend to amplify ecosystem degradation and biodiversity decline, as well as the food system crisis, reinforcing food, nutrition, and livelihood insecurity—as well as social inequalities. Seven of nine planetary boundaries, which define the safe operating space for people and planet by establishing thresholds for human impact on environmental processes such as climate change, freshwater, and biosphere integrity, have now been transgressed. Breaching these thresholds increases the likelihood of irreversible environmental change. There is an urgency to act, but this also presents an opportunity to reimagine and reshape food systems in line with a shared vision for the future.



Climate induced weather extremes, such as droughts, floods, and heatwaves, are increasing and have been devastating crop yields

A new shared vision for the future food system

There is consensus that the current food system is unsustainable and has not delivered on nutrition, health and environmental outcomes for everyone, everywhere. We must envisage a new shared vision for a future food system that embeds equity, integrity and environmental, nutrition and health (including mental health) outcomes. This includes leveraging accountability and taking continuous, inclusive, stakeholder driven, and progressive action towards equitable, inclusive, sustainable, resilient, and healthy outcomes—"making food systems work for people and planet." In doing so, it is also important to amplify the role of women (who produce about 60% to 80% of food in developing countries), indigenous communities, and other historically marginalised groups. A future food system should reflect and celebrate the diversity of people, cultures, food traditions, and nature, serving as a foundation for regenerative practices, sustainable natural resource use, positive climate action, and planetary health outcomes. This requires systems leadership to recognise the complex interconnections within the food system and interlinked systems such as water, energy, environment, and health, as well as manage trade-offs and build synergies.

Leverage points for food systems transformation: game changers for people and planet

Climate and food systems crises are interconnected; therefore, transformative and integrated frameworks, approaches, and leverage points towards the changes are needed. Leverage points exist at the intersection of dismantling systemic barriers and connecting science and policy with local indigenous systems to enable transformation towards equitable, inclusive, and integrated approaches for resilient food systems under climate change. Most of these leverage points are well known and have been included in several global strategies. However, what has been lacking is systems leadership for food systems transformation. The proposed strategies described below should be addressed from local to global levels, with an emphasis on local solutions.

Sustainable production

A shift towards sustainable agricultural practices and nature based solutions, such as agroecology, that reduce environmental impacts such as greenhouse gas emissions, chemical inputs, and biodiversity loss, is necessary.

Responsible consumption

Consumption patterns that balance nutrition, physical health, mental health, and environmental sustainability should be promoted. This includes promoting healthy and nutritious diets while reducing food loss and waste along the supply chain. This can be achieved by mainstreaming foods and meals made from or with locally adapted and nutrient

dense neglected and underutilised crops as healthy and sustainable options for dietary diversification. Additionally, integrating food sustainability, nutrition, and climate education into school curriculums, public communications, and health professional training can help build food system literacy.

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Ambitious thinking is needed to develop new policies and strategies that align the food system with improved human and environmental health outcomes

Inclusive and equitable livelihoods

Food sovereignty and equitable livelihoods for farmers, food producers, labourers, and consumers, especially marginalised groups, can be achieved by strengthening local food systems through greater production of neglected and underutilised crops. There needs to be improved access to productive assets such as land, water, renewable energy, and credit, along with education, training, and social protection for vulnerable populations—especially women, who have historically faced challenges in accessing these resources. Lastly, social and economic policies that reduce poverty and promote decent and gender sensitive employment opportunities within the food system need to be adopted.

Governance and policy integration

Food systems governance with multistakeholder engagement that addresses power imbalances needs to be strengthened. This includes developing gender transformative policies that ensure women's empowerment, equal rights to resources, and fair pay. It should also incorporate systemic perspectives across all levels of government and across scales. Subsidies need to be repurposed, and there need to be financial incentives to support sustainable practices such as agroecology rather than environmentally harmful inputs.

Intersectionality of climate, nutrition, and health focus

Food sovereignty can serve as a framework to enhance access to resilient, affordable, safe, diverse, and healthy diets, thereby addressing food insecurity and malnutrition in all their forms. This is achieved by intensifying agroecosystems and making food systems sustainable, diverse, fair, inclusive, and regulated to achieve health outcomes within planetary boundaries.

Economic and social resilience

It is necessary to scale up social safety nets and support mechanisms to ensure access to affordable and healthy food, particularly for the poorest and most vulnerable populations, amid shocks such as pandemics or conflicts. There is also a need to foster digital infrastructure, innovation, and development targeted at improving the feasibility and effectiveness of safety nets; and advocate for better health and safety regulations for farm labourers, thereby promoting sustainable livelihoods, and resilience of food systems actors.

For example, city and local governments could encourage "buy local" initiatives, encouraging all organisations within their spheres of influence to source locally produced foods. They could also promote urban vegetable and fruit growing to help children and adults better appreciate the process of food production, thereby reducing food waste.

Capacity building and strengthening

Complex problems require multisectoral collaborations, and we need a new generation of pracademics (academics with strong practical understanding and real world knowledge, skills, and experience) trained in equitable, transdisciplinary approaches. New interdisciplinary and transdisciplinary undergraduate and postgraduate programmes that address planetary health are needed. It is also necessary to fund research, development, and innovation for sustainable and healthy food alternatives, such as neglected and underutilised crops, and to enhance the food environment to enable responsible and healthy food choices to be easy and attractive. Health professionals could champion a behavioural change movement, promoting changed lifestyles and the health (physical and mental) benefits of a more sustainable and diverse diet.

Call to action: a planetary health approach to transforming food systems

The intersectionality of climate change, food systems, nutrition, and health highlights how climate change disrupts food systems, while unsustainable food systems contribute to climate and environmental change, impacting nutrition and public health, which disproportionately affects vulnerable populations. Addressing this complex nexus requires bold and ambitious thinking, as well as transdisciplinary collaboration grounded in planetary health, which integrates environmental sustainability, public health, and social equity. Bold actions are needed to empower local food producers to produce more food sustainably, support indigenous communities in restoring lost food traditions, and mainstream underutilised crops into the food system. Ambitious thinking is needed to develop new policies and strategies that align the food system with improved human and environmental health outcomes, and promote inclusion and equity for vulnerable groups. The opportunity before us is to integrate humanity's collective wisdom and our shared history, embracing our cultural and natural diversity, to create a shared vision of a future food system that works for both people and the planet.

Tafadzwanashe Mabhaudhi, professor of climate change, food systems, and health, London School of Hygiene & Tropical Medicine, London, UK

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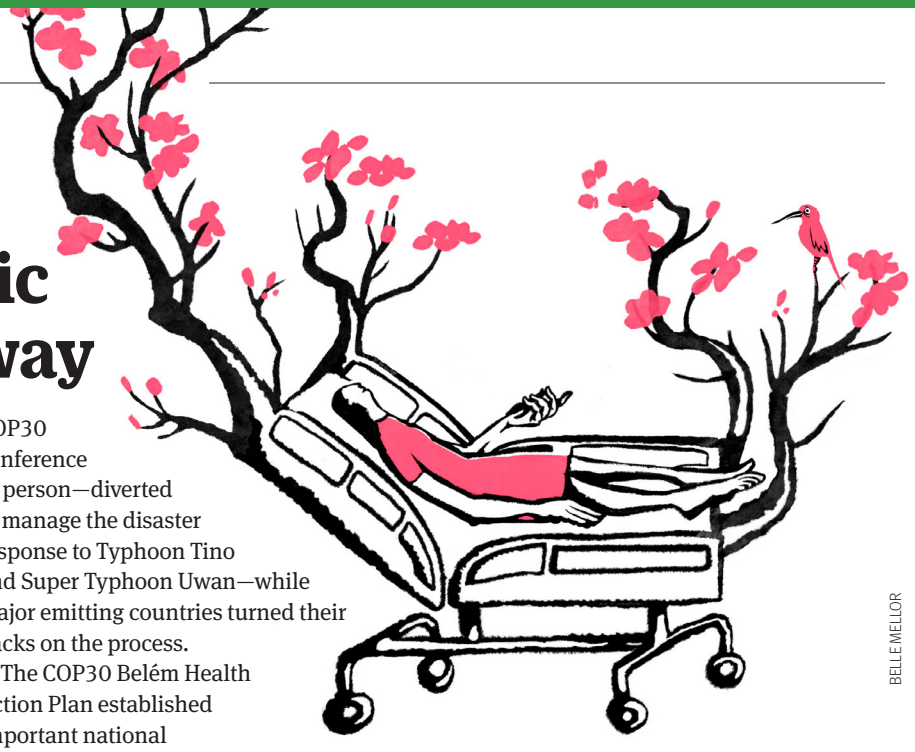
Sustainable healthcare: How Asia Pacific is leading the way



BELLE MELLOR

In 2008, the World Health Assembly formally recognised the health threats of climate change. In the years that followed, the centre of gravity of sustainable healthcare hovered over the North Atlantic, driven first by health professionals and then by governments, predominantly in Europe, North America, and Australia.

The implicit theory of change was that progress in high income health systems would drive action worldwide. Today, despite global headwinds, health systems across the Asia Pacific region are accelerating decarbonisation efforts most quickly.

Healthcare's global emissions are substantial, equivalent to the world's fifth most polluting country, and will continue to rise without preventive action. The Asia Pacific region is where the causes (55% of global healthcare emissions), healthcare needs (more than 50% of global population), and climate risks (nearly 90% of people affected by natural hazards) converge. Ageing populations and expansion of healthcare access could see the region's share of global health spend increase by 34% by 2050. Any viable global response to the climate emergency must therefore succeed here and the region is well placed to act as a test bed for systems based approaches.

More than 20 Asia Pacific countries have committed to the World Health Organization Alliance for Transformative Action on Climate and Health

Climate impacts are a growing threat multiplier: each disaster forces health systems to rebuild and replace infrastructure and supplies, treat injuries and disease, and absorb additional costs, while generating further emissions to replace lost assets. A profound irony of climate change was exposed in November 2025 when Philippines Department of Health officials were unable to attend the COP30 conference in person—diverted to manage the disaster response to Typhoon Tino and Super Typhoon Uwan—while major emitting countries turned their backs on the process.

The COP30 Belém Health Action Plan established important national commitments and new evidence on health adaptation, backed up by a hugely encouraging $300m philanthropic fund from the Climate and Health Funders Coalition, but further work is needed to match that ambition on health decarbonisation.

At the same time, a global "geopolitical recession," marked by rising instability and declining faith in multilateral organisations, is shrinking political horizons and turning attention inwards. Retrenchment in international development financing threatens progress on equitable healthcare access, resilience, and mitigation across the region. Finally, misinformation from industry and politically motivated actors may have shifted from "climate change does not exist" to "climate action is unnecessary, impossible or unaffordable" but is no less insidious: lobbying, counter research, limited transparency, and creative carbon accounting all act to delay momentum when it is most needed.

More than 20 Asia Pacific countries have committed to the World Health Organization Alliance for Transformative Action on Climate and Health—more than from Europe or the Americas—and financial support from some multilateral organisations, notably the Asian Development Bank (ADB), is growing.

Here, we highlight four countries that demonstrate leadership towards decarbonisation, then examine the preconditions for sustainable healthcare to succeed.

The Philippines: sustainability as quality improvement

The Philippines has embedded sustainability across its Department of Health. Multiple teams, including a dedicated Health and Climate Change Office and expert capacity within health facility development programmes, are integrating mitigation into quality improvement programmes.

The strategy relies on guidance and recognition of achievement to empower hospitals to act, rather than regulation or scarce central funding. Measures that deliver multiple benefits are prioritised: solar panels reduce electricity bills and help keep critical equipment running when typhoons destroy power lines; white roofs reduce cooling demand and keep patients safer during heatwaves; regular energy audits and data collections provide structured processes for nearly 2000 hospitals to find efficiencies, verify savings, and report emissions. This depth and breadth of data on hospital energy consumption is rare, particularly in a middle income country, and allows the department to focus effort where it is most effective.

Fiji: health sustainability as climate leadership

Fiji is an international climate leader—the first country to ratify the Paris Agreement and the only Small Island Developing State (SIDS) to preside over a UN Climate Conference. The Special Initiative on Climate Change and Health in SIDS under

Fiji's COP23 presidency emphasised how mitigation and resilience must proceed in parallel to protect the most vulnerable and secure the health benefits of decarbonisation.

Fiji is building an evidence base in a context where data have historically been sparse. The Ministry of Health and Medical Services has adapted World Health Organization guidance on sustainable healthcare to Fiji's geographical context, integrated ambitious mitigation actions in its Health Adaptation Plan, and, with ADB support, is developing a world-first healthcare emissions model in a Pacific SIDS context. Effective mitigation measures here focus on access, resilience, and cost: delivering services closer to where people live reduces high carbon, expensive transport, improves patient outcomes, and enhances the ability to sustain care during climate disasters.

Singapore: health sustainability as long term security

Singapore, a high income country with an advanced healthcare system, is turning its long term decision making approach towards climate and health. A growing network of sustainability professionals across the system—board members, procurement experts, clinical leads, building managers, researchers, and policymakers—has a mandate to plan for the future.

The 2025 Ministry of Health study of Singapore's healthcare emissions provides many examples of quick wins—new hospital construction that reduces energy bills by 30%, sustainability criteria in procurement, nitrous oxide consumption cuts of more than 90% through leakage prevention, and the world's first hospital certified for Healthcare Sustainability by Joint Commission International.

For Singapore, sustainability is a tool for operational excellence and a means to run the system as efficiently as possible for current and future generations.

China: industrial strategy driving health supply chains

Net zero healthcare cannot be achieved without decarbonising upstream manufacturing supply chains, which can be influenced by demand-side actions in health systems and by supply-side transformation in producer economies.

As national grids integrate renewables at scale and manufacturers electrify heating and processes, the embodied emissions in drugs and medical devices will fall. China's healthcare footprint—larger than the whole economy emissions of all but a handful of countries—and vast manufacturing base present opportunities for demand-side and supply-side leadership. In 2023, it built more renewable capacity than the rest of the world combined, and electricity is now the largest source of industrial energy demand.

Opportunities and conditions for success

These examples are not exhaustive but demonstrate how sustainable healthcare in Asia Pacific is possible, necessary, and already under way.

Widespread, rapid implementation depends on clinical champions who demonstrate feasibility and benefits in real settings and provide confidence to peers. Contagion effects can extend beyond national borders, and the region's medical networks can help disseminate successful examples of low carbon care. Delivering this will require sustainable medicine to scale dramatically, to the point where it stands within and alongside disciplines such as cardiology, pharmacology, or paediatrics. Every clinician and health leader must understand the fundamentals and know where to turn for expertise. This, in turn, demands reform in academic medicine that teaches clinicians how to deliver care under mounting climate pressures and run health systems that are sustainable and efficient.

The expansion of healthcare towards Universal Health Coverage in Asia Pacific is a once in a generation chance to lock in low carbon, resilient infrastructure by design. Following well established blueprints to make hospitals energy efficient, powered by renewables, and resilient to extreme heat, storms, and flooding will ensure that future generations inherit systems capable of delivering care, while avoiding costly retrofits and saving costs over building lifetimes.

The purchasing power of health systems in Asia Pacific is huge. When the NHS announced its Net Zero Supplier Standard in 2023, industry responded positively with previously undisclosed emissions data. A credible, collective push from the world's second largest pharmaceutical market would give suppliers little choice but to publish emissions data and implement credible decarbonisation strategies.

Asia-Pacific's high income economies must treat sustainability as a core part of long term system investment. Governments here can also help bridge the recent 40% fall in health aid through direct government funding, or indirect support of multilateral development banks, funds, and philanthropic foundations. Financing institutions should establish clear health targets within investment portfolios, and minimise non-cost barriers to finance.

In public funded systems, governments will hold greater responsibility for operational delivery, but private health providers, professional bodies, teaching institutions, and manufacturers all hold critical levers for implementation. Governments will need to stand firm in the face of increasing pressures to provide certainty, set goals, and hold every part of the health sector to account through target setting, monitoring, evaluation, and regulation.

Researchers across Asia Pacific need to mobilise faster to generate evidence to guide decarbonisation. This requires a shift from glamorous global research questions down to hyper local clinical questions that healthcare professionals encounter daily.

Asia Pacific has become the decisive test of whether sustainable healthcare takes hold. Success will depend on sufficient investment to lock in climate-ready infrastructure, transparency in health supply chains, and medical professionals equipped with the knowledge and motivation to act.

For years, it was assumed that voluntary action in high income systems would drive changes elsewhere; increasingly, the opposite seems true. As the Asia Pacific region is now demonstrating, sustainability is not "nice to have," it is the only tolerable future of healthcare.

Thomas Andrew, head of health systems analysis
Lydia Loh, research associate
Nick Watts, director, Centre for Sustainable Medicine, Yong Loo Lin School of Medicine, National University of Singapore
Ronald Law, director, Health and Climate Change Office, Republic of the Philippines
Isimeli Tuiteci, health inspector (high grade), Ministry of Health and Medical Services, Fiji

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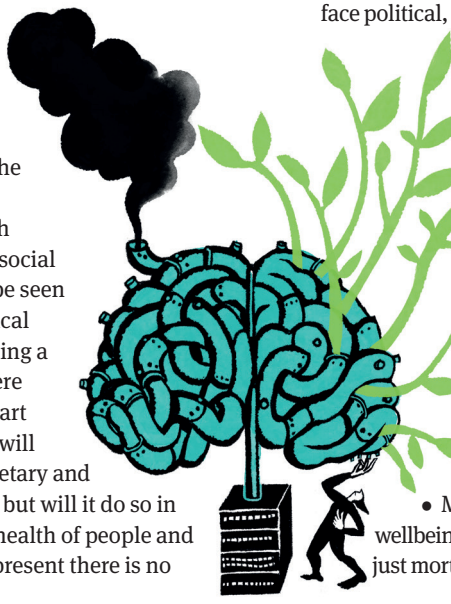
World leaders need to manage the impact of AI on human and planetary health

We need to reimagine global governance. The climate crisis, biodiversity loss, pollution, pandemics, and inequity are not isolated challenges—they are symptoms of one interlinked system under strain. The institutions that once protected global health and stability now struggle to keep pace with this complexity.

The rise of artificial intelligence (AI) and the accelerating planetary health crisis are not only simultaneously reshaping global systems, but also introducing immense systemic risk. We lack an awareness that AI is not sustainable. As Galindo and colleagues have said: "Governments are racing to develop national AI strategies, but rarely do they take the environment and sustainability into account. The lack of environmental guardrails is no less dangerous than the lack of other AI related safeguards."

Yes, these new technologies could optimise health, climate, and resource management—as tech leaders never tire of telling us. The technologies could support the development of "planetary sapience" to tackle the challenges we face. But they can also deepen inequality, expand ecological harm owing to extraction, and increase misinformation. For example, current AI models have large energy and water demands, and supply chains for semiconductors rely on intensive mining that could pose an existential threat to the planet.

AI is increasingly part (and to some extent a driver) of the living socioecological system, rather than set apart from it. The integration of technology with ecological and social processes can be seen as a philosophical shift, representing a new epoch where technology is part of life itself. AI will transform planetary and social systems, but will it do so in support of the health of people and the planet? At present there is no structure in place that ensures this rapid technological innovation is accountable.



BELLE MELLOR

Action on AI and the planetary crisis needs an ethical and systems based lens for governance, that emphasises socioecological wellbeing, long term and intergenerational impacts, and includes equity and justice as preconditions for sustainability. Both the planetary crisis and AI transcend national borders and require multilateral norms. However, our existing system of global governance is not set up for this.

Policies will need to not only look towards the planetary boundaries but also ensure AI development respects ecological and social limits. At the same time, it will be necessary to explore whether AI could become the nervous system of a resilient Earth: sensing, predicting, and regenerating rather than exploiting and extracting natural and human resources.

The situation might be serious enough to propose that the World Health Organization (WHO) change its role and its constitution. It was created to promote "the highest attainable standard of health" for all peoples. But in the 21st century, the determinants of health lie predominantly with the planetary crisis and AI development. This requires a body that integrates ecological, social, and economic dimensions of wellbeing. Its purpose: to safeguard the conditions that make health possible on a thriving planet increasingly subject to historic technological disruption as experienced with AI. Thinking of the WHO as a "ministry for planetary health" would face political, financial, and sovereignty barriers, but could also create momentum and pragmatic entry points to move forward.

A WHO "planetary health and AI taskforce" could explore the shifts that are necessary, which could include:

- Expanding the mandate from disease control to safeguarding human experience and the systems that support planetary life
- Measuring success by using wellbeing and resilience indicators, not just mortality and gross domestic product
- Embedding "do no harm to the Earth and its peoples" as a core ethical principle in all planetary health policies.

One of the most important shifts is to institutionalise intergenerational mechanisms, including planetary health investments, that generate measurable economic and social returns (eg, climate mitigation measures to reduce air pollution deaths now also reduce the probability of tipping points in the future). Priority should be given to creating planetary health impact assessments for AI which could lead to establishing a "planetary AI standard."

Global AI observatory

AI developers should be required to be transparent in relation to their energy use, water, carbon, and supply chain impact; and governance of AI accelerated extractive industries must be established. Of particular importance would be the establishment of a global observatory for AI and planetary health that would monitor not only ecological footprints, but also new challenges such as misinformation, extraction patterns, and the dependency of health systems on AI. A model for how to proceed could be the Treaty on the Non-Proliferation of Nuclear Weapons, which entered into force in 1970 and was considered a breakthrough in international negotiations.

Health is an integral part of the climate agenda, but the new technological developments that we face are not yet aligned with human values or human health and AI companies act irresponsibly in relation to planetary limits. The United Nations AI advisory body issued its final report on Governing AI for Humanity in 2024. The UN has now launched two AI governance bodies: the Global Dialogue on AI Governance and the Independent International Scientific Panel on AI. The new architecture is intended to usher in a more inclusive form of international governance for AI. Health must be a key partner in all these developments. In view of the impact on humanity, health should be a driver of AI governance. There is still time, writes Tim Berners-Lee, "to build technology to promote the dignity of our fragile species on this isolated globe. We can do it, all of us, everyone, together."

Ilona Kickbusch, director, Digital transformations for health Lab, University of Geneva

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Climate migration is inevitable; we are unprepared

Leaders must acknowledge the consequences of our changing world as people seek refuge from the lethal effects of the crisis

BELLE MELLOR

As the climate crisis develops, conditions in many parts of the world are becoming increasingly unliveable. This is forcing people to move.

Yet there has been little preparation for this at national levels, let alone globally. One modelling study found that for every 1 degree Celsius rise in temperature, around one billion people will find themselves living outside the "human niche" of climate conditions that has sustained our civilisations for thousands of years. During the second half of the century, this will describe places that are home to more than one third of the world's population.

The regions currently most affected by climate change are in the tropical belt. Climate models predict a dramatic increase in extreme conditions across this zone in the coming decades. Hundreds of millions of people may be forced to move north to cooler latitudes. The effects will increasingly impact the Americas, Africa, and southern and central Europe, as well as India and China. Europe already sees tens of thousands of excess deaths annually due to heat, and climate disasters will make even high income countries uninhabitable in places. Nevertheless, the impacts in northern latitudes will be comparatively lesser and the adaptive ability greater, and so this is where migrants will increasingly head.

Risks to health

Extreme climate events present acute health risks: heat increases risk of stroke, cardiovascular disease, kidney failure, heatstroke, and miscarriage. Droughts risk malnutrition and conflict over scarcity of resources, and fires cause respiratory conditions. Floods risk fouling of drinking water and bacterial and mosquito-borne diseases.

The climate crisis disproportionately affects women and girls because of their lower social status and vulnerabilities. Women and children are 14 times more likely to die during a climate disaster than men, and around 80% of people displaced by climate change are women and girls.

Disasters weaken populations and the institutions they rely on, including health centres and schools. People who are displaced often end up in crowded refugee camps that have poor sanitary facilities and are susceptible to outbreaks of cholera, diphtheria, parasitic infestations, and dengue. They face difficulties accessing healthcare, from navigating a foreign system and its bureaucracy, to dealing with prejudice and racism, fear of authorities, or wariness of disclosing immigration status. This means they are more likely to miss key schedules for vaccinations and screenings.

There has been little preparation for this at national levels, let alone globally

This is a systemic, planetary scale crisis that demands a global response—and which must include acknowledgment from leaders that climate migration is an inevitable and growing consequence of our changing world. Upheaval can be managed with a range of interventions, starting with international cooperation on rapid cuts in greenhouse gas emissions (at least five times faster than at present) and the vast scaling up of adaptation to dangerous conditions. But with this must be the admission that some places with large populations will be beyond adaptation. We need to prioritise global, regional, and bilateral agreements on human mobility, including mechanisms for safe passage of refugees, new routes to citizenship (particularly for the millions of stateless people and those likely to be made stateless by the crisis), and pragmatic city planning for changing populations. Globally, health and disaster response in the places most vulnerable to climate change should be met by adequately funded, competent UN bodies, not left to underfunded institutions and charities. Cuts to the United States Agency for International Development have been devastating to these efforts.

Doctors need to be ready

Doctors should recognise that they are increasingly likely to be personally involved in a climate disaster, wherever they live, and will need to be ready with commensurate skills. For healthcare professionals, the response starts with a compassionate approach to individual needs, including understanding the toll of migration on a person's physical and mental health. It can be as fundamental as ensuring access to nutritious food, especially for pregnant women and new mothers. Along with addressing their medical needs, healthcare professionals—a vocation notably staffed by first and second generation immigrants—have an important role to play in advocating for the care and rights of climate displaced people, particularly during a time of increased anti-immigrant policies and sentiment. Doctors have a trusted status in society, and with that comes a responsibility to counter misinformation around climate science and to publicly recognise that it is a serious health threat.

Gaia Vince, anthropocene researcher, strategist and author

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BELLE MELLOR

The narrowing legal operating space for climate action

Buttressed by scientific developments, law is catching up with corporate and state climate inaction; a new era of accountability may follow

A decade on from the adoption of the Paris Agreement, global temperatures are on the cusp of bursting through its principal goal, to limit warming to 1.5°C. How are legal rights, duties, and obligations responding to the world's failure to limit climate risks within acceptable bounds?

A common response, reflecting a widely held narrative of despondency about ineffective legal climate protection, is "not enough." Yet, even as Paris overshoot territory approaches, all is not lost. Scientific advancements are facilitating legal processes that constrain state and corporate actors' space to emit greenhouse gases and lead to accountability for harms that their emissions cause.

Legal intransigence on climate

Law commonly lags behind scientific developments. This reflects many legal systems' reliance on social and ethical understanding, acceptance, and interpretation of science. These processes favour clearly visible impacts, rooted in geographically and temporally proximate cause-and-effect relations. Climate change does not conform to that description: emissions anywhere affect impacts everywhere that persist for decades or centuries and are the consequence of cumulative emissions of many actors.

This matters more than it should. After all, there is no strong legal or principled reason why apparent remoteness of cause and effect should imply a different legal status, provided the evidence of causation is clear. Indeed, substantively the same scientific methods underpin our understanding of the impacts of climate change and the impacts of toxic substances and other forms of environmental pollution, although legal enforcement is much more common for the latter. Delays in the legal response to scientific insight matter. The carbon pollution that has taken the world to the brink of 1.5°C is more than a century in the making. Yet, despite decades of scientific understanding of the dangers of climate change and near-universal ratification of the Paris Agreement, global emissions are as high as ever.

Legislation driving climate action

Governments are starting to take meaningful action. Climate considerations are increasingly woven into the legislation and regulation that governs economies. The UK's 2008 Climate Change Act was the first long term legally binding framework for a state

to cut carbon emissions, updated in 2019 to commit to reaching net zero greenhouse gas emissions by 2050. A total of 107 countries covering 82% of global greenhouse gas emissions have followed suit and developed net zero targets. To implement these goals, several states have introduced policies to green public procurement and require companies to make climate disclosures and develop transition plans. Among the most ambitious proposals for such transition planning rules is the beleaguered directive that would require the European Union's largest companies to develop and put into effect a climate transition plan that includes emission cuts aligned with the goals of the Paris Agreement.

Still, emission reduction laws are limited and handicapped by uneven, patchy, and slow implementation. Climate action is not necessarily contingent on laws and compulsion, but clear and stable legal frameworks supporting decarbonisation create favourable conditions and, crucially, accountability.

Litigation enforcing legal duties

Where legislative developments are perceived to fall short, parties have taken to the courts. Legal norms and principles are often written to permit recurrent interpretation such that they remain effective in resolving present day problems like those presented by climate change. To do so, judges lean on scientific evidence that facilitates quantitative interpretations of legal duties. For instance, research showing the emissions that can be produced if global warming is to be limited to a given level (the "remaining carbon budget") provide a factual basis for articulating what states and companies need to do (or, more commonly, not do) to act consistently with the Paris Agreement temperature goal. Climate change attribution and projections show the physical and humanitarian consequences of past greenhouse gas emissions and the consequences of climate inaction. Longstanding legal obligations to protect human rights and not inflict harm on other parties, among others, can thus be brought to bear in the context of climate change.

Scientifically informed interpretation of pre-existing legal norms has come to the fore because most countries lack

The UK's 2008 Climate Change Act was the first long term legally binding framework

Lawsuits could redirect the costs of greenhouse gas emissions back to those responsible for them

sufficiently strong emission reduction laws and few companies face obligations to reduce emissions. In growing numbers of cases, lawyers have asked courts to impose mitigation obligations on states and corporations. In a notable example, Dutch NGO Milieudefensie sued Shell in 2019 arguing that Shell had an obligation to reduce its emissions, on the basis of a societal duty of care which was, in turn, informed by human rights. The court of first instance agreed and instructed Shell to reduce its emissions, including those of the fossil fuels it sells, by 45% by 2030. On appeal, the court upheld that Shell had an obligation to reduce its emissions, but stopped short of imposing specific requirements on the company. Similarly, the European Court of Human Rights found Switzerland's lack of adequate climate targets was in violation of the European Convention on Human Rights. Courts have also found new high emitting projects such as coal mines to be inconsistent with legal duties under domestic law or derived from the Paris Agreement.

Accountability for climate change impacts

Lawsuits are also targeting a potentially larger source of corporate liability. Carbon majors had long predicted that the CO_2 emissions produced by their products would cause substantial climate change impacts, but the costs of this vast externality have been borne largely by others. By one recent estimate, the emissions of the 25 highest emitting companies from 1985 to 2018 resulted in around $60tn in global climate damages. Legal developments, facilitated by developments in attribution science, may destabilise this status quo.

In 2025, in a claim brought by a Peruvian claimant, a German court found that a high emitting company could, in principle, be held legally responsible for climate change impacts resulting from its emissions. The claimant also needed to demonstrate that the flood risk was the result of climate change, a question that attribution science can answer. The claim was ultimately unsuccessful because the court adjudged a catastrophic glacial lake outburst flood affecting the claimant's property, the basis for the claim, to be insufficiently imminent. Similarly, Vermont is one of several US states to have passed a Climate Superfund Act that permits the state to recover losses caused by climate change from fossil fuel companies. Lawsuits and policy could redirect the costs of greenhouse gas emissions back to those responsible for them, undermining the profitability of emitting activities. With attribution science now able to quantify the impacts of the emissions of individual entities, such as countries or companies, such claims are brought from an even stronger scientific basis.

A narrowing legal operating space for climate action

The past decades have delivered legal regimes that, despite their flaws and jurisdictional variation, effect unprecedented limits on corporate and state climate conduct. Accountability for climate harms is closer than ever, buttressed by developments in climate change attribution science that elucidate the humanitarian and economic impacts of carbon pollution. Recent judgments affirmed the principle of corporate liability for climate impacts (in Germany) and responsibilities to rapidly cut emissions (in the Netherlands) even if they have not always found explicit breaches of legal responsibilities.

A chasm has grown between legal duties and the conduct of many actors. Insufficient climate action may prove to be a misstep that has left actors teetering on the precipice of a cliff of legal risk. The misalignment of state and corporate action with their legal obligations means that in the aggregate, companies and states are breaching their legal duties. It is unpredictable as to who will be held responsible, but recent court decisions suggest that such liability may be just around the corner. The chance that such risks will materialise means legal risk is widespread for firms.

Many may find a firm legal response to the injustices of climate change overdue. The confluence of an increasingly authoritative body of climate scientific evidence and apparent judicial openness to interpreting existing law in the context of climate change raises the prospect that this may soon change.

Rupert Stuart-Smith, senior researcher
Thom Wetzer, associate professor, University of Oxford, Oxford, UK

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Carbon capture: the "scam" governments are relying on to reach net zero

Supporters, including the former prime minister, Tony Blair, say we can't decarbonise without carbon capture. Others argue that it's a deliberate smokescreen for the fossil fuel industry to continue business as usual. **Jennifer Richardson** reports

Carbon capture and storage (CCS) may sound simple and promising enough. It involves the capture of carbon dioxide (CO_2) at its source—such as an industrial plant—before it can enter the atmosphere, storing it deep underground in geological formations such as oil wells.

Supporters argue that CCS is essential for reaching net zero, alongside reducing emissions, because of globally rising energy demands and the difficulties of fully decarbonising some industries. The former UK prime minister Tony Blair is one strong advocate: an April 2025 report from the Tony Blair Institute for Global Change said that CCS should be "at the centre of the battle" to reduce carbon emissions.

Critics, however, point to problems with the technology, not least that it has yet to be proved at scale. It is also, they say, energy intensive, expensive, and inefficient, while failing to tackle pollutants other than carbon and their impact on health (box). Worse, they claim that it serves as a distraction from other, more impactful, solutions to the climate crisis—as well as a deliberate and industry sponsored smokescreen for the continued, and even expanded, extraction and burning of fossil fuels.

"The bottom line is that carbon capture just increases CO_2," says Mark Jacobson, professor of civil and environmental engineering at Stanford University, California. "It increases air pollution. It increases fossil fuel mining, fossil fuel infrastructure, pipelines, and it results in more oil being drilled. In the end, all it does is keep the fossil fuel industry in business . . . so it's basically a scam."

The disdain for this technology in favour of the purist solution of stopping fossil fuel production is totally misguided
Tony Blair

It's untested at scale. It's expensive. And it's dodging the real issue
Mike Berners-Lee

"Distraction and sabotage"

There are three major reasons why carbon capture is contentious, says Mike Berners-Lee, professor in practice at Lancaster University's Lancaster Environment Centre. "It's untested at scale," he says. "It's expensive. And it's dodging the real issue"—namely, that we need to use less energy, increase non-fossil fuel (especially renewable) energy, and reduce the extraction and use of fossil fuels.

If carbon capture is a distraction, it continues to be a big one. November 2025 saw the proposal for Australia's largest CCS facility, which would be one of the biggest in the world. The current UK government has committed tens of billions of pounds to the technology. Alex Lee, policy campaigner at Friends of the Earth Scotland, says that more than £50bn in subsidies has been earmarked by the government to support carbon capture. The total cost, says Lee, could exceed £400bn by 2050, "to be paid for by the British public."

Berners-Lee adds that CCS is part of a longtime "distraction and sabotage campaign" by people with vested interests in the continued use of fossil fuels. In 2022 a *BMJ* investigation found that oil and gas companies had poured money into the climate change research centres of elite US universities funding research on CCS.

In 2023 the Intergovernmental Panel on Climate Change, comprising the world's leading climate scientists, delivered a "final warning" on the climate crisis in a landmark report. However, an article in the *Guardian* said that the report's final section—a "summary for policymakers"—was scrutinised by governments and was allegedly changed under pressure from a large Saudi Arabian delegation to include references to CCS.

In the foreword to the April 2025 report from the Tony Blair Institute for Global Change, Blair wrote, "The disdain for this technology in favour of the purist solution of stopping fossil fuel production is totally misguided." Since leaving office as UK prime minister Blair has lobbied on behalf of fossil fuel companies, and the Institute has worked with fossil fuel companies and petrostates, including advising Azerbaijan and agreeing a multimillion pound deal with the Saudi government.

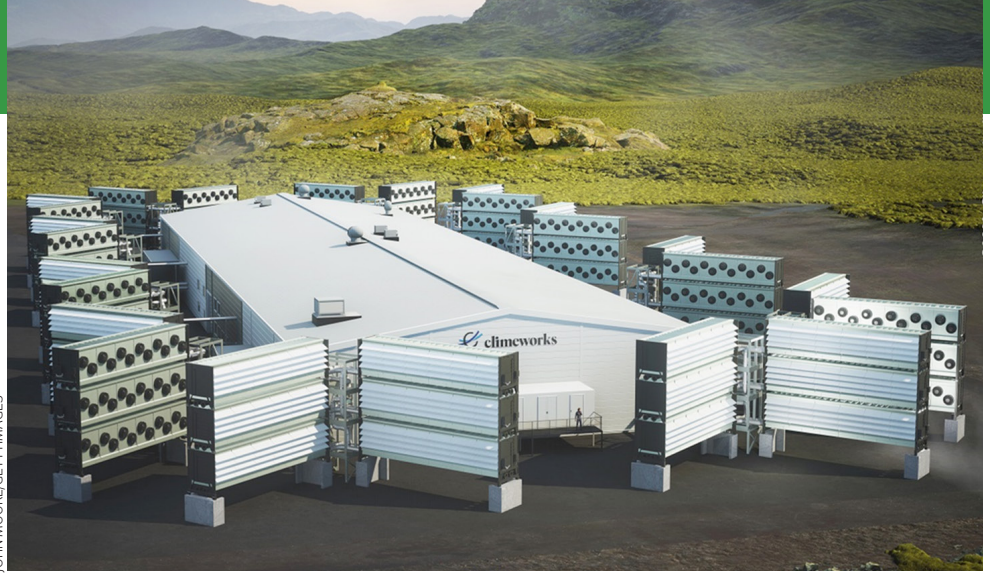
In November 2025, as COP30 took place in Brazil, Imperial College London described as "positive news" a report on the total amount of underground CO_2 storage.

"This will be a key strategy—alongside vital efforts to cut emissions—for decarbonising hard-to-abate industries and cutting the total CO_2 in the atmosphere," said Samuel Krevor of Imperial College's Department of Earth Science and Engineering. Krevor's senior research fellowship is partly funded by Shell.

Berners-Lee says, "The fossil fuel industry is extremely cynical, it's extremely well funded, it knows exactly how to do its lobbying and its misinformation, and it has been astonishingly effective for a very long time and continues to be. The politicians are being levered, and the public's not being properly informed."

But does it work?

"The central message from our report is that CCS works, demonstrating a proven capability and accelerating momentum for geologic storage of



JOHN MOORE/GETTYIMAGES

One of the two carbon capture plants in Iceland built by Climeworks, a Swiss company

CAPTURE STRATEGY "FAILS TO TACKLE" POLLUTANTS BEYOND CARBON

The assertion that carbon capture and storage (CCS) doesn't tackle health harming pollutants other than climate warming CO_2 is another case against it—and here the argument gets circular. "Because carbon capture equipment requires a huge amount of energy, you actually need more fuel, and so you actually have more air pollution," says Mark Jacobson, professor of civil and environmental engineering at Stanford University. "So that causes more illness and death."

The technology in fact introduces further pollutants, in the form of amine based solvents, which much of today's CCS technology relies on to absorb CO_2 from industrial exhaust. During the carbon capture process, says Stuart Haszeldine, professor of carbon capture and storage at the University of Edinburgh, "there's a certain number of what's called nitrosamines, which are long molecules with nitrogen and ring compounds and which are potentially carcinogenic."

In a UK Environment Agency assessment researchers confirmed that, without strict monitoring and emission controls, capture plants could generate localised air quality problems linked to these chemicals. As a result, UK regulators have demanded additional controls.

"There had to be a three year conversation about how to decrease . . . emission of nitrosamines," Haszeldine explains. But he argues that "in real terms, there's very little evidence or maybe even no evidence that the tiny amounts of emissions of these compounds would actually cause a cancer." He also believes that carbon capture overall has "a very tangible positive impact on air quality."

CO_2," said Krevor in a press release. "We have found that industrial scale carbon management is already a reality and can safely sequester CO_2 deep underground."

Yet critics say that it doesn't—at least not yet, or at any scale that could make an impact. Berners-Lee points to Climeworks, a Swiss company whose two flagship carbon capture plants in Iceland have been touted as leading the field but can capture only 40 000 tonnes of CO_2 a year. "It's tiny, it's pitiful," he says—this needs to be billions of tonnes a year worldwide. The Imperial College report found that global storage to date was 383 million tonnes.

In May 2025 Climeworks announced plans to cut its workforce by more than 10%, which it said was unrelated to a story published a week earlier in which journalists in Iceland revealed that the two plants had captured far less carbon than their advertised capacity and not even enough to cover their own emissions. Climeworks has admitted that the net removal will be lower than the advertised capacity.

On top of the technology not capturing all the carbon at source—Jacobson says that the proportion is 20-80%—the vast majority of CO_2 captured worldwide is used for "enhanced oil recovery," a process using the CO_2 to make oil less dense so that more can be extracted. Between the CO_2 released during this process and the extra oil burned, says Jacobson, "You end up with anywhere from 50% to 120% of the CO_2 that was captured going right back to the air." A report by the think tank Climate Analytics published in October 2025 found that if Australia and key Asian countries fully deployed their planned and prospective CCS projects it could lead to an extra 25 billion tonnes of emissions being pumped into the air by 2050.

CCS also requires its own infrastructure. As Jacobson points out, "You need pipelines for it, so you have to build this elaborate pipeline system." On top of that, CCS itself requires energy to run. "The gains are marginal because of the energy you use," says Berners-Lee. Even using renewable energy to power the CCS technology doesn't negate this argument: Jacobson says that it would be more efficient to replace a coal plant with renewable energy than it would to use renewable energy to run the CCS equipment.

What if it could be scaled up?

A report published in *Nature* in October 2025 found that the maximum global temperature reduction that could be achieved by CCS is 0.7°C. However, supporters say that it could be part of the solution.

Stuart Haszeldine, professor of carbon capture and storage at the University of Edinburgh, tells *The BMJ*, "The UK's doing absolutely the right thing to try to move away from fossil fuels and into these renewable and cleaner energies, and CCS is part of that transition."

Blair has admitted that "at present, carbon capture is not commercially viable despite being technologically feasible"—but he believes that policy, finance, and innovation would change this.

Berners-Lee disagrees. "Even if we could scale it up, it's the same as renewable energy: it wouldn't do us any good unless we were also constraining the rate at which fossil fuel was coming out of the ground and being used directly for energy," he explains. "We can argue about whether it would be possible to scale it up properly, so it's taking billions of tonnes out of the ground—but that won't do us any good unless we're doing all the other things.

"The idea of focusing on CCS now, when we can't even stop a rising rate of fossil fuel coming out of the ground for burning in the conventional way, is a complete misdirection of attention."

Jennifer Richardson, investigations and senior features editor, *The BMJ*
jrichardson@bmj.com

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The ocean is our greatest ally

BELLE MELLOR

The ocean is central to the stability of the Earth's climate system. It is a vast, self-regulating machine that moderates global temperatures, absorbs carbon dioxide, and sustains global biodiversity. Yet, the ocean is now visibly suffering the consequences of accelerating climate change.

The deterioration of the ocean threatens to exacerbate the very crisis it has long buffered. Despite this, there is a lack of collective action as ocean governance remains fragmented and insufficient. The recently ratified Biodiversity Beyond National Jurisdiction (BBNJ) treaty has been celebrated as a historic development for the protection of the high seas. While it is a welcome initiative, it falls short of what is required.

Compounding this fragility is a growing tendency to view the ocean as a platform for highly interventionist actions labelled as climate "solutions," including large scale carbon dioxide removal and deep-sea mining. These approaches risk accelerating ecological decline.

Ocean stewardship must mirror the governance frameworks applied to terrestrial forests, with legally binding commitments to conservation, restoration, and genuinely sustainable use. Without a reorientation from extraction to protection and sustainable use, the world's most powerful climate regulator may cease to function as our ally.

More than 90% of the excess heat accumulated in the Earth's system since the 1970s has been stored in the ocean. Simultaneously, the oceanic carbon cycle continues to sequester roughly a quarter of anthropogenic CO_2 emissions annually, mitigating their impact on global temperatures. Marine ecosystems generate about half of the oxygen in the air, support

Ocean governance remains fragmented and insufficient

fisheries that feed billions of people, and underpin cultural and socioeconomic systems worldwide.

Rising temperatures, acidification, deoxygenation, and intensified marine heatwaves are driving unprecedented changes in the observational record.

These climate driven impacts are compounded by human pressures, including overfishing, coastal development, pollution, and the expansion of low-oxygen "dead zones" linked to warming and nutrient enrichment.

The consequences for human health and wellbeing are increasingly apparent: declining seafood availability, rising exposure to harmful algal blooms, intensifying storm impacts, and heightened risks to coastal populations.

If this scenario of deteriorating ocean health were presented in the context of "health of the planet," such systemic deterioration would most likely be viewed as a global health emergency—requiring urgent intervention, strong governance, and commitment from public and private agents.

Governance gaps and the risks of ocean based climate "solutions"

Currently, ocean governance is characterised by fragmented jurisdiction, inconsistent enforcement, and limited institutional coherence.

This gap in effective governance becomes more consequential as interest grows in ocean based climate interventions. In particular, the ocean is becoming the new frontier for a wide range of industrial activities framed as climate "solutions," such as marine carbon dioxide removal and deep-sea mining for supplying critical minerals for enabling renewable technologies.

Framing the ocean as a site for technological climate "solutions" risks perpetuating extractive activities that could accelerate ecological decline. Instead, effective and precautionary governance that prioritises the services already naturally provided by the ocean is essential to ensure that ocean based climate measures support rather than jeopardise climate stability.

A forest-like approach for conservation

Forests offer an example for how international consensus can evolve.

Applying an analogous approach to the ocean demands three core and interconnected pillars: Conservation, Restoration, and ecologically grounded Sustainable use (CRS).

Conservation requires expanding fully protected marine areas (MPAs) and no-take zones to safeguard biodiversity and ecosystem function. Scientific evidence indicates that MPAs enhance climate resilience, support fisheries recovery, and help maintain carbon stores within intact ecosystems.

Restoration requires scaling up both active and natural recovery of marine environments. These include coastal habitats such as mangroves, seagrass meadows, and saltmarshes, which rank among the planet's most effective carbon stores and offer co-benefits for flood protection, biodiversity, and local livelihoods. These habitats can recover rapidly with appropriate investment.

Sustainable use requires establishing clear, enforceable limits on marine exploitation. This may include stringent regulation of marine carbon dioxide removal research and deployment, a precautionary moratorium on deep-sea mining until comprehensive ecological evidence is available, and strong, evidence based governance frameworks for offshore infrastructure development, including those used by the renewable energy industry.

Collectively, these measures prioritise the reduction of stressors already negatively affecting the ocean while creating conditions under which carefully assessed innovations may contribute meaningfully and safely to climate goals.

Francisco de Melo Viríssimo, research fellow, London School of Economics and Political Science, London, UK

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