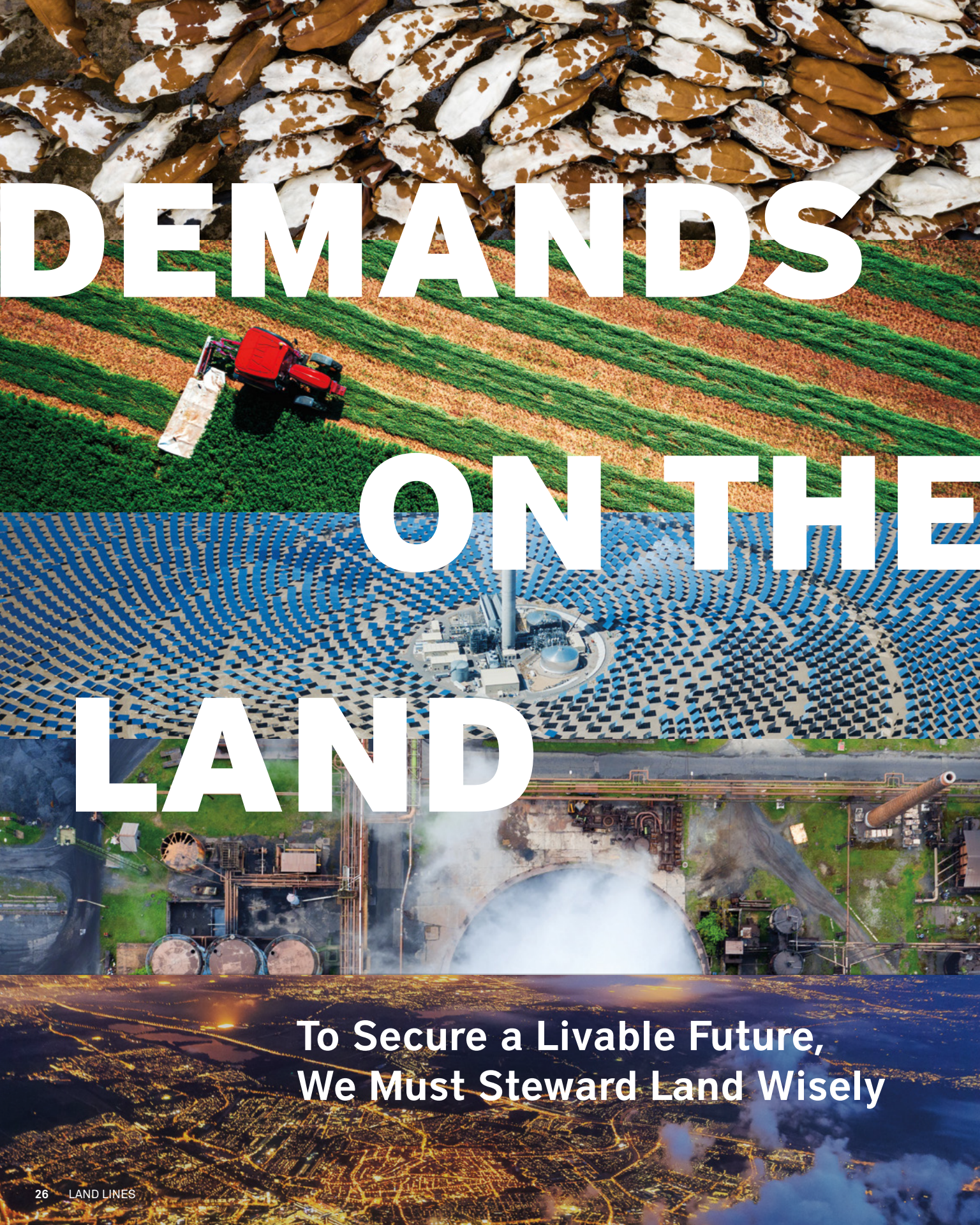

DEMANDS ON THE LAND

To Secure a Livable Future, We Must Steward Land Wisely

By Sivan Kartha

SINCE THE WORLD FIRST NEGOTIATED A CLIMATE TREATY in 1992, three precious decades have ticked by while we've allowed a climate challenge to evolve into a climate crisis. The latest assessment from the Intergovernmental Panel on Climate Change, released this spring, eschewed the moderate language of the staid scientific body, making it clear that society faces an urgent crisis and must take action. That report represents "a litany of broken climate promises," said UN Secretary General António Guterres. "It is a file of shame, cataloguing the empty pledges that put us firmly on track toward an unlivable world."

At last year's UN Climate Summit in Glasgow, the nations of the world doubled the emissions reductions they had previously promised for this decade, but we actually need a *fivefold* enhancement of those goals. As things stand now, we can emit only about 300 billion tons of carbon dioxide ($GtCO_2$) before global temperatures are expected to exceed the 1.5 degrees Celsius identified in the Paris Agreement as the upper limit of acceptable warming. If countries fail to cut emissions far beyond what they've promised so far, the world will exceed that 300 billion tons within this decade. That will lead us toward chaos far greater than the unparalleled storms, droughts, wildfires, and displacements the globe is already experiencing.

It's well within our capabilities to dramatically cut emissions. We know which renewable energy technologies and energy-efficient practices we need to deploy widely, we know that protecting ecosystems and other species supports our own ability to thrive, and we're equally aware of the exceedingly wasteful and fossil fuel–intensive agricultural practices and land-intensive diets that we need to alter.

As it turns out, land figures prominently in many of our most promising climate solutions, and is thus central to many of the tensions and trade-offs we must now deftly navigate. Having pushed the clock to the limit, we must find a way to avoid moving forward haphazardly, running roughshod over fundamental ecological and human needs in a mad dash for "climate-friendly" solutions. Stewarding land wisely while we face an increasingly hostile climate will prove critical to securing a livable future.

EVEN WHILE LAND IS INCREASINGLY STRESSED BY A CHANGING CLIMATE, it will face rising and conflicting demands from human society in our pursuit of both climate solutions and sanctuary from a more hostile climate. Let's lay out the main aspects of this contested landscape.

Land will be required to sustain species and ecosystems that are increasingly threatened by climate change to the point of extinction or collapse. Earth is currently undergoing its sixth mass extinction since the Cambrian explosion half a billion years ago. Writing of the evolutionary tree of life, Elizabeth Kolbert, a scholar of such extinctions, explains: "During a mass extinction, vast swathes of the tree are cut short, as if attacked by crazed, axe-wielding madmen" (Kolbert 2014). Even as a metaphor, this may be an understatement, as we now also have bulldozers,

Even while land is increasingly stressed by a changing climate, it will face rising and conflicting demands from human society in our pursuit of both climate solutions and sanctuary.

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big dams, and other even less judicious means of directly appropriating land from natural ecosystems. As human-caused climate change accelerates, it will overtake our appropriation of land as the top driver of the ongoing extinction (IPCC WGII 2022). A report from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services found that more than a million species are threatened with extinction, many in the next few decades (IPBES 2019).

Sustaining the natural ecosystems on which human survival depends—from the mountainous snowpack from which rivers run year-round to the rich soils in which our food grows to the coral reefs that sustain coastal fisheries—ultimately will rest on our ability to reduce and reverse our appropriation and fragmentation of natural habitat, all while we stop fueling climate change. As a critical first step, nearly 100 countries comprising the High Ambition Coalition for Nature and People have called for a global 30x30 deal to protect 30 percent of the world's land and oceans by 2030. This ambitious effort aims to halt biodiversity loss and preserve ecosystems, with the added benefits of supporting economic security and a stable climate. Today, only about 15 percent of our land and 7 percent of our oceans is protected.

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Evacuees from Hurricane Maria in Dominica in 2017, top, and from flooding in Bangladesh in 2019, bottom. Credits: U.S. Navy Photo/Alamy Stock Photo (top); UN Women Asia and the Pacific via Flickr CC BY-ND-NC 2.0 (bottom).

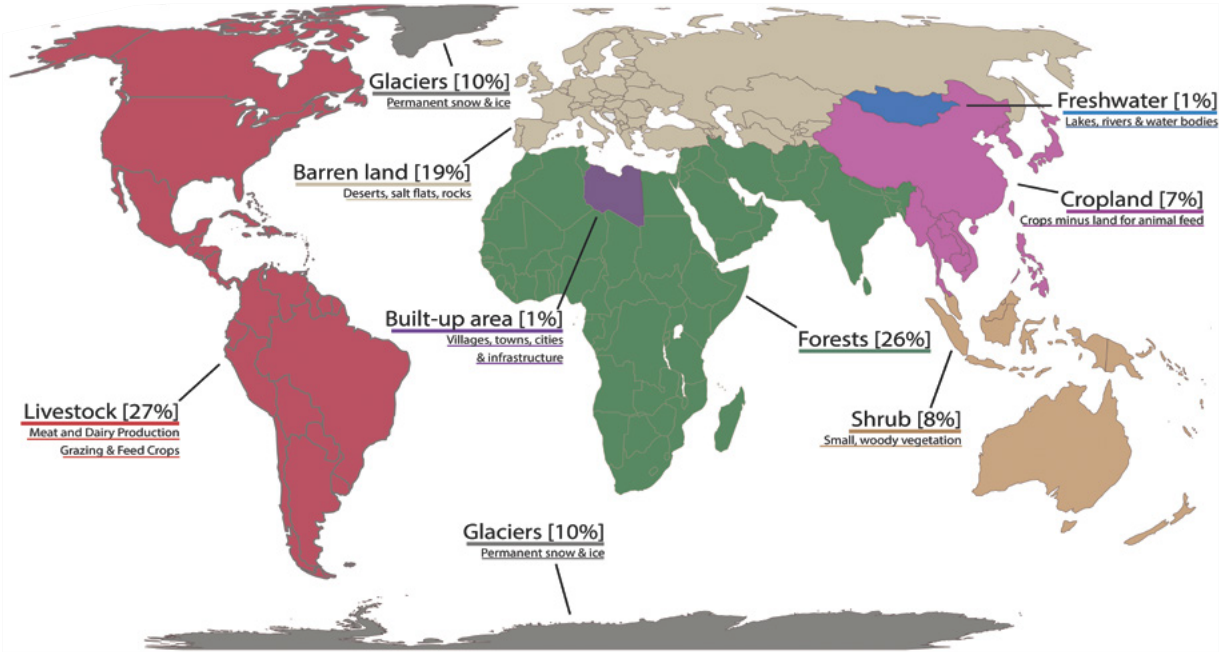
Land will be required to resettle people displaced by flooding, extreme weather, and climatic shifts that render currently inhabited areas no longer hospitable. We know the climate and weather extremes that are already driving displacement will escalate. The World Bank estimates that more than 200 million people will be forced from their homes by climate change in Asia, Africa, and Latin America in the next few decades, and millions more will be affected in other regions. This climate-induced dislocation and involuntary migration will amplify existing stressors such as conflict, food and water insecurity, poverty, and loss of livelihoods from economic or environmental pressures (IPCC WGII 2022).

In other words, marginalized and disempowered households and communities will invariably suffer the worst consequences, which will with rising frequency rise to the level of humanitarian

The strawberry poison dart frog, a species found in Central America. Credit: efenzi via iStock/Getty Images Plus.

DATA VISUALIZATION: HOW THE WORLD'S LAND IS USED

This map illustrates the aggregate surface area covered by various types of land use and terrain. Combined agricultural uses, at 34 percent, represent the largest human pressure on the landscape.



Source: Hannah Ritchie and Max Roser via OurWorldinData.org CC-BY-SA. Based on data from United Nations and World Bank.

and human rights crises. Any effort to manage these situations humanely will have implications for human settlements and the habitable land that they require. Resettlement will require far less land than other demands—one estimate suggests 0.14 percent of the planet (somewhat less than the area of the United Kingdom) could absorb 250 million climate migrants (Leckie 2013). Yet the mass climate migration already underway represents a significant shift in how and where people occupy and use land, and should be a priority for efforts to secure and preserve human rights for migrants and refugees.

Land will be required to feed our expanding global population, even as some regions face declines in water, increases in pests, and diminishing soil fertility. Climate change has slowed the growth in food productivity that was seen over the last decade, and climate-related extreme events have exposed millions of people to acute food insecurity and undermined water security.

A worsening climate will heighten these threats—which are, once again, cruelly directed at those who are marginalized and disempowered. Agriculture constitutes the primary human pressure on the global landscape; estimates suggest that it has already led to the clearing or conversion of 70 percent of global grassland, 50 percent of savanna, 45 percent of the temperate deciduous forest, and 27 percent of tropical forests. Agriculture also affects water bodies through drainage and chemical runoff, and emits greenhouse gases and pollutants into the atmosphere.

Agricultural approaches founded on principles of biodiversity and ecosystem regeneration are being increasingly proven and scaled, and have the potential to help combat climate change, even with a growing global population. Likewise, major changes to our global food

system that prioritize human rights, and that reduce meat consumption and food waste, can dramatically expand and deepen food security. A staggering share of global plant crops is eaten by livestock rather than people. More than one-third of all calories and more than one-half of all protein from agricultural crops goes to feed animals, with only a small share ultimately becoming nourishment for people. The consumption of meat is specifically charged with causing the continuing spike in deforestation of the Amazon rainforest, a biome that comprises 40 percent of the world's rainforest and serves as home to 25 percent of its remaining terrestrial species.

Land will be called on as a site for the energy sources—primarily solar power, wind power, and biopower—needed to replace the fossil fuels that now meet five-sixths of global energy demand. Solar and wind power, while they have undeniable impacts on the landscape, can be situated in areas suited for multiple uses; for example, wind turbines and solar panels can be sited on farmland or in urban spaces like rooftops and parking lots. Unlike solar and wind power, bioenergy—which is produced using agricultural feedstocks, in the form of either electricity (biopower) or fuels (biofuels)—must be sited on agriculturally productive land. At any significant scale, bioenergy competes with food production.

Consider the following: total cropland globally amounts to less than half an acre per person, yet it already puts considerable pressure on water, soil, and other ecological resources. Even if we posit a quite efficient process for producing and using biofuel (in contrast to the U.S. approach of burning corn-based ethanol in conventional combustion vehicles), more than 1.2 acres would be needed to keep a single passenger vehicle fueled. An efficient biopower

Major changes to our global food system that prioritize human rights, and that reduce meat consumption and food waste, can dramatically expand and deepen food security. A staggering share of global plant crops is eaten by livestock rather than people.

Farm workers in California. Credit: NNehring via E+/Getty Images.

plant would fare hardly any better, claiming roughly 0.8 acre per capita to grow the fuel needed to generate the electricity used by the average United States resident. By contrast, solar photovoltaics require less than 5 percent of one acre per person or, for the whole U.S. population, a bit less than 15 million acres. This is not a trivial footprint, but it's worth noting that in 2017 alone, federal land leases offered for oil and gas production in the United States amounted to more than 12 million acres.

To put it plainly, bioenergy would function for the typical high-energy consumer just as meat functions for the typical high-meat consumer—it would allow them to consume vastly more land than they would if they simply used that land's output directly. By extension, it would also enable the world's over-consumers to compete even more ruthlessly with the world's poor for the resources that underpin survival, like food, livelihoods, and homes.

Land will be called upon to "negate" our carbon excesses by removing accumulated carbon dioxide from the atmosphere. The world's lands serve as an enormous carbon sink, with plants and soil absorbing about a quarter of our excess carbon dioxide from the atmosphere. (Another quarter of our excess carbon emissions is absorbed by the oceans; the remaining one-half accumulates in the atmosphere and is responsible for warming the planet.) Deterioration of an ecosystem—such as by climate-induced pests, drought, fire, and deliberate human modification—diminishes its capacity to absorb carbon, and may even convert it into a source of carbon dioxide emissions. Unchecked climate change could disrupt climatic conditions enough to send a region like the Amazon rainforest across such a tipping point—converting it from a carbon sink to a carbon source—and in fact, just such a weakening of resilience is already being observed there (Boulton, Lenton, and Boers 2022).

Despite the threats that climate change poses to natural carbon absorption, it is increasingly held out as an alternative to

Sheep and solar panels share space on a farm in Germany. Credit: Karl-Friedrich Hohl via E+/Getty Images.

reducing our own emissions, or at least as a crafty expedient whereby we can buy some time, relax the mitigation burden a bit, and more gradually ramp up our emissions reduction efforts over a longer timeframe. Indeed, the hopes for these "negative emissions" strategies have grown beyond reasonable expectations. Some analysts of future mitigation options assume the removal of carbon dioxide from the atmosphere and storage of it on the land (in the form of plant or soil matter) or underground (as compressed carbon dioxide transported in pipelines) will grow to a scale comparable in land requirements to current global agriculture.

If we cooperated globally and worked strenuously to keep emissions within the 1.5-degree Celsius budget, viewing negative emissions as a possible solution for situations that were virtually impossible to address any other way (such as methane emissions from wetland rice cultivation) would be feasible and sensible. But instead, most countries have charted a slow pace of reduction efforts for the near term and inadequate reduction targets for the medium term; they have labeled these steps consistent with the Paris goals, presupposing a vast reserve of land will wondrously materialize for negative emissions duty when we need it. This is a reckless strategy. Pursuing it further means banking on land being available and hoping that negative emissions activities won't conflict with social needs such as food security.

Because the world has willfully downplayed the near-term effort needed to keep climate

change within manageable bounds, such a strategy could leave us—and future generations—stranded with an insufficiently transformed energy economy. Saddled with a fossil fuel–dependent energy infrastructure, society would face a much more abrupt and disruptive transition than the one it had sought to avoid. Having exceeded its available carbon budget, it would face a carbon debt that cannot be repaid, and ultimately see much greater warming than it had prepared for.

Indigenous groups have protected both biodiversity and forest carbon more successfully than others, even during decades of rapacious extraction of global forest resources. Their rights must be legally recognized and actively enforced.

WISE LAND USE AND STEWARDSHIP WILL PROVE CRITICAL to navigating our future. The specific technologies, practices, and policies are enormously varied and context specific, so it would be foolish to attempt a fair treatment here. But a few broad observations are warranted.

First, several cases touched on above illustrate how society is increasingly relying on land resources to help deal with climate change, even while land is itself under rising stresses from climate change. The expected tensions and trade-offs are already testing society's capacity for wise land stewardship in a more hostile climate, with mixed results.

As biodiversity loss accelerates, there is increasing recognition that a large share of remaining biodiversity-rich areas—including more than one-third of intact forests and 80 percent of the world's terrestrial biodiversity—is in the hands of indigenous groups. These stewards have protected both biodiversity and forest carbon more successfully than others, even during decades of rapacious extraction of global forest resources (Fa et al. 2020; World Bank 2019). This understanding must now be translated into policies that legally recognize and actively enforce community-based land tenure rights consistent with the UN Declaration on the Rights of Indigenous People, which most indigenous communities do not yet enjoy. Where that is done, indigenous communities will be better able to protect common resources through locally appropriate collective action. They will also be better able to resist outside actors who are intent on either extracting and degrading forest resources or on imposing "fortress conservation" models that disregard indigenous rights and are less effective in their ostensible conservation aims.

Much the same lesson applies to a range of emerging "green grab" strategies. As pressure on land is intensified by growing demand for bioenergy and food production, negative emissions capacity, and habitable areas, those who have capital, flexibility, political savvy, and powerful networks are crafting the relevant policies and ultimately benefiting from them, including through speculation. Consequently, the cost of public efforts to meet collective needs escalates, preventing people with the least political or economic power from meeting basic needs like food, livelihood, and home.

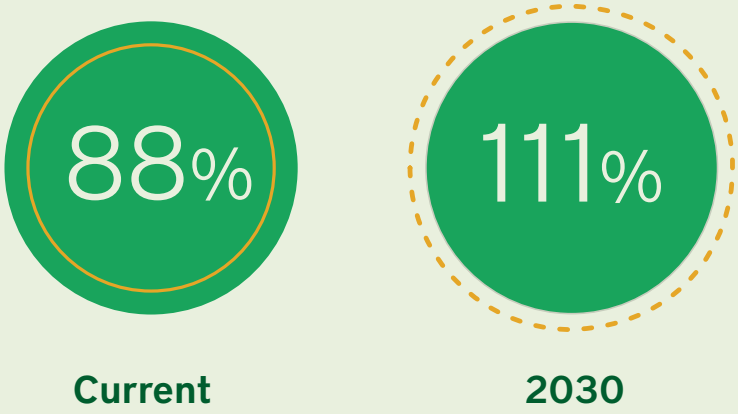
New ways of abstracting these components of land and ecosystems and integrating them into distantly removed market processes are legitimizing new forms of appropriation. Some of them are akin to financial derivatives, and indeed can be disconcertingly reminiscent of the mortgage-backed financial derivatives, the collapse of which brought on a global recession and threatened much worse. One particularly glaring example is the carbon offset program (the Clean Development Mechanism) that developed countries have used to meet their legally binding targets under the Kyoto Protocol. This mechanism is now understood to have been based overwhelmingly on fictitious greenhouse gas reductions.

We should thus be wary about market mechanisms that simply carry forward question-

Amazon rainforest, Brazil. Credit: Gustavo Frazao via iStock/ Getty Images Plus.

A Finite Resource

Land plays a central role in many currently proposed climate solutions, from increasing the absorption of greenhouse gases to growing crops for bioenergy. With global population projected to grow from 7.6 billion to 8.6 billion by 2030, the coming decade will bring difficult decisions about how best to use and protect the planet's **130 million square kilometers (km²) of ice-free land**.



Working lands (forestry and agriculture)	92.3 million km² (71%)	98.3 million km² (75%)
Conserved and natural lands	20.8 million km² (16%)	39 million km² (30%)
Developed/built areas	1.3 million km² (1%)	2.1 million km² (2%)
Additional land required for bioenergy	--	5 million km² (4%)
	114.4 million km² (88%)	**144.4 million km² (111%)**

Sources: UN Department of Economic and Social Affairs, World Resources Institute, Energy Innovation.

Ranchers attend a regenerative agriculture workshop in Cimarron, New Mexico. Credit: Mario Tama via Getty Images News.

able assumptions of equivalence (among distinct bits of natural capital) or of fungibility (between natural resources and technical alternatives), and about policy regimes that privilege the idea of net economic welfare to rationalize probable casualties of distribution or outright injuries to human rights and justice.

AS SPECIFIC CHARACTERISTICS OF LAND and ecosystems—such as their promise as a carbon sink or suitability for energy production—become more highly valued and more tightly integrated into the global economy, a fundamental question becomes only more pressing: who controls land and who benefits from it?

Lincoln Institute President George McCarthy put it succinctly at the organization's Journalists Forum on climate change this spring: "Land contention redounds to power. And in disputes, power wins." If the very power structures at the root of climate change are left intact, then the resulting market mechanisms and policy interventions will fail to save the climate while worsening the global scourge of poverty and marginalization. In doing so, they can contribute to what is becoming the third injustice of climate change: the most vulnerable are not only the least responsible for and most affected by climate change, but also the frontline victims of ill-conceived climate policies.

Our global society is confronting risks of an existential magnitude. These risks—all of our own making—are equal parts ecological and social. Ecologically, we persist in placing insupportable burdens on our planet. Socially, we remain riven by obscene disparities in wealth and power that have rendered us dysfunctional in the face of a civilizational threat.

Solutions do exist. The importance of shifting to a less meat-intensive global diet for reasons of environmental sustainability—as well as personal health—is now clear. We have learned to be wary of narrowly focused mechanisms like carbon markets for protecting forests, given how complex these ecosystems are and how they provide multiple services to diverse human societies, not all of which are monetizable or even fully understood and appreciated.

Experience has shown us that indigenous communities, especially once they have legally enforced tenure rights, do a highly effective job managing forests and protecting biodiversity.

Solutions do exist. . . . We have the tools to save ourselves, but it remains up to us to actually do so.

On already significantly altered or degraded land, innovations in regenerative agriculture and ecosystem restoration are providing a means to maintain or enhance land-based carbon. And technological advances in the energy sector have made it possible for us to rehabilitate our fossil fuel–addicted global economy.

Perhaps most important, the world has finally reached a level of aggregate global welfare that—if it were shared more equitably—would make possible a dignified life for all, free from the privations of underdevelopment.

We have the tools to save ourselves, but it remains up to us to actually do so.

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Wind turbines among wheat and canola fields in Washington. Credit: Terry Eggers via The Image Bank/Getty Images.

REFERENCES

Boulton, Chris A., Timothy M. Lenton, and Niklas Boers. 2022. "Pronounced Loss of Amazon Rainforest Resilience Since the Early 2000s." *Nature Climate Change* 12 (271–278). March 7. https://www.nature.com/articles/s41558-022-01287-8.

Fa, Julia E., and James EM Watson, Ian Leiper, Peter Potapov, Tom D. Evans, Neil D. Burgess, Zsolt Molnár, Álvaro Fernández-Llamazares, Tom Duncan, Stephanie Wang, Beau J. Austin, Harry Jonas, Cathy J. Robinson, Pernilla Malmer, Kerstin K. Zander, Micha V. Jackson, Erle Ellis, Eduardo S. Brondizio, Stephen T. Garnett. 2020. "Importance of Indigenous Peoples' Lands for the Conservation of Intact Forest Landscapes." *Frontiers in Ecology and the Environment* 18(3): 135–140. https://doi.org/10.1002/fee.2148.

IPBES. 2019. "Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services." E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (eds.). Bonn, Germany: IPBES Secretariat. https://doi.org/10.5281/zenodo.3831673.

IPCC WGII. 2022. "Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change." H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.). Cambridge, UK, and New York, NY: Cambridge University Press. https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii.

Kolbert, Elizabeth. 2014. *The Sixth Extinction: An Unnatural History*. New York, NY: Macmillan.

Leckie, Scott. 2013. "Finding Land Solutions to Climate Displacement: A Challenge Like Few Others." Geneva, Switzerland: Displacement Solutions. https://unfccc.int/files/adaptation/groups_committees/loss_and_damage_executive_committee/application/pdf/ds-report-finding-land-solutions-to-climate-displacement.pdf.

World Bank. 2019. "Securing Forest Tenure Rights for Rural Development: An Analytical Framework." Program on Forests (PROFOR). Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/34183.