130 Degrees

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Review of: **Our Final Warning: Six Degrees of Climate Emergency**

by Mark Lynas **(**London: 4th Estate, 372 pp., $27.99)

Illustration by Anders Nilsen

So now we have some sense of what it's like: a full-on global-scale crisis, one that disrupts everything. Normal life—shopping for food, holding a wedding, going to work, seeing your parents—shifts dramatically. The world *feels* different, with every assumption about safety and predictability upended. Will you have a job? Will you die? Will you ever ride a subway again, or take a plane? It's unlike anything we've ever seen.

The upheaval that has been caused by Covid-19 is also very much a harbinger of global warming. Because humans have fundamentally altered the physical workings of planet Earth, this is going to be a century of crises, many of them more dangerous than what we're living through now. The main question is whether we'll be able to hold the rise in temperature to a point where we can, at great expense and suffering, deal with those crises coherently, or whether they will overwhelm the coping abilities of our civilization. The latter is a distinct possibility, as Mark Lynas's new book, *Our Final Warning*, makes painfully clear.

Lynas is a British journalist and activist, and in 2007, in the run-up to the Copenhagen climate conference, he published a book titled *Six Degrees: Our Future on a Hotter Planet*. His new volume echoes that earlier work, which was by no means cheerful. But because scientists have spent the last decade dramatically increasing understanding of the Earth's systems, and because our societies wasted that decade by pouring ever more carbon into the atmosphere, this book—impeccably sourced and careful to hew to the wide body of published research—is far, far darker. As Lynas says in his opening sentences, he had long assumed that we "could probably survive climate change. Now I am not so sure."

The nations that use fossil fuel in large quantities have raised the temperature of the planet one degree Celsius (that's about 1.8 degrees Fahrenheit) above its level before the Industrial Revolution. We passed the mark around 2015, which was coincidentally also the year we reached the first real global accords on climate action, in Paris. A rise of one degree doesn't sound like an extraordinary change, but it is: each second, the carbon and methane we've emitted trap heat equivalent to the explosion of three Hiroshima-sized bombs. The carbon dioxide sensors erected in 1959 on the shoulder of the Mauna Loa volcano in Hawaii recorded a new record high in late May of this year, showing an atmosphere of about 417 parts per million CO2, more than a hundred above the levels our great-great-grandparents would have known, and indeed higher than anything in at least the last three million years.

As we drive and heat and light and build, we put about 35 billion tons of CO2 into the atmosphere annually. At the moment oceans and forests soak up slightly more than half of that, but as we shall see, that grace is not to be depended on into the future, and in any event it means we still add about 18 billion tons annually to the air. That is by far the most important bottom line for the planet's future.

A survey of the damage done at one degree is impressive and unsettling, especially since in almost every case it exceeds what scientists would have predicted thirty years ago. (Scientists, it turns out, are by nature cautious.) Lynas offers a planetary tour of the current carnage, ranging from Greenland (where melt rates are already at the level once predicted for 2070); to the world's forests (across the planet, fire season has increased in duration by a fifth); to urban areas in Asia and the Middle East, which in the last few summers have seen the highest reliably recorded temperatures on Earth, approaching 54 degrees Celsius, or 130 degrees Fahrenheit. It is a one-degree world that has seen a girdle of bleached coral across the tropics—a 90 percent collapse in reproductive success along the Great Barrier Reef, the planet's largest living structure—and the appalling scenes from Australia in December, as thousands of people waded into the ocean at resort towns to escape the firestorms barreling down from the hills.

Consider what we've seen so far as a baseline: we're definitely not going to get any cooler. But now consider the real problem, the news that scientists have been trying to get across for many years but that has not really sunk in with the public or with political leaders. As Lynas puts it:

If we stay on the current business-as-usual trajectory, we could see two degrees as soon as the early 2030s, three degrees around mid-century, and four degrees by 2075 or so. If we're unlucky with positive feedbacks…from thawing permafrost in the Arctic or collapsing tropical rainforests, then we could be in for five or even six degrees by century's end.

That's a paragraph worth reading again. It's an aggressive reading of the available science (research published in early July estimates we could cross the 1.5-degree threshold by 2025), but it's not outlandish. And it implies an unimaginable future. Two degrees will not be twice as bad as one, or three degrees three times as bad. The damage is certain to increase exponentially, not linearly, because the Earth will move past grave tipping points as we slide up this thermometer.

You may be thinking: Didn't the world leaders who signed the Paris climate accords commit to holding temperature increases to "well below" two degrees Celsius, and as close as possible to 1.5 degrees? They did—in the preamble to the agreement. But then they appended their actual pledges, country by country. When scientists added up all those promises—to cut emissions, to build renewable energy, to save forests—and fed them into a computer, it spit out the news that we are headed for about a 3.5-degree rise this century. And not enough countries are keeping the promises they made in Paris—indeed, our country, which has produced far more carbon than any other over the last two centuries, has withdrawn from the accords entirely, led by a president who has pronounced climate change a hoax. The En-ROADS online simulator, developed by Climate Interactive, a nonprofit think tank, predicts that at this point we can expect a 4.1-degree rise in temperature this century—7.4 degrees Fahrenheit. All of which is to say that, unless we get to work on a scale few nations are currently planning, Lynas's careful degree-by-degree delineation is a straight-on forecast for our future. It's also a tour of hell.

We might as well take that tour systematically, as Lynas does.

At two degrees' elevated temperature, "scientists are now confident" that we will see an Arctic Ocean free of ice in the summer—when already the loss of ice in the North has dramatically altered weather systems, apparently weakening the jet stream and stalling weather patterns in North America and elsewhere. A two-degree rise in temperature could see 40 percent of the permafrost region melt away, which in turn would release massive amounts of methane and carbon, which would whisk us nearer to three degrees. But we're getting ahead of the story. Two degrees likely also initiates the "irreversible loss of the West Antarctic ice sheet." Even modest estimates of the resulting sea-level rise project that 79 million people will be displaced, and protecting vulnerable cities and towns just along the Eastern Seaboard of the US behind dikes and walls will cost as much as $1 million per person. "I suspect no one will want to pay for sea walls at such vast expense, and the most vulnerable (and the poorest) communities will simply be abandoned," Lynas writes.

Researchers once hoped that modest warming of two degrees might actually slightly increase food production, but "now these rosy expectations look dangerously naïve." He cites recent studies predicting that two degrees will reduce "global food availability" by about 99 calories a day—again, obviously, the pain will not be equally or fairly shared. Cities will grow steadily hotter: current warming means everyone in the Northern Hemisphere is effectively moving southward at about 12.5 miles a year. That's half a millimeter a second, which is actually easy to see with the naked eye: "a slow-moving giant conveyor belt" transporting us "deeper and deeper towards the sub-tropics at the same speed as the second hand on a small wristwatch."

But that statistical average masks extremes: we can expect ever-fiercer heatwaves, so, for instance, in China hundreds of millions of people will deal with temperatures they've never encountered before. The natural world will suffer dramatically—99 percent of coral reefs are likely to die, reducing one of the most fascinating (and productive) corners of creation to "flattened, algae-covered rubble."

As we head past two degrees and into the realm of three, "we will stress our civilization towards the point of collapse." A three-degree rise in temperature takes us to a level of global heat no human has ever experienced—you have to wind time back at least to the Pleistocene, three million years ago, before the Ice Ages. In his last volume, Lynas said scientists thought the onset of the collapse of the West Antarctic ice sheet would take place at four degrees; now, as we've seen above, it seems a deadly concern at two, and a certainty at three. Higher sea levels mean that storm surges like those that marked Superstorm Sandy in 2012 could be expected, on average, three times a year. The record-setting heatwaves of 2019 "will be considered an unusually cool summer in the three-degree world"; over a billion people would live in zones of the planet "where it becomes impossible to safely work outside artificially cooled environments, even in the shade." The Amazon dies back, permafrost collapses. Change feeds on itself: at three degrees the albedo, or reflectivity, of the planet is grossly altered, with white ice that bounces sunshine back out to space replaced by blue ocean or brown land that absorbs those rays, amplifying the process.

And then comes four degrees:

Humans as a species are not facing extinction—not yet anyway. But advanced industrial civilisation, with its constantly increasing levels of material consumption, energy use and living standards—the system that we call modernity…is tottering.

In places like Texas, Oklahoma, Missouri, and Arkansas, peak temperatures each year will be hotter than the 120s one now finds in Death Valley, and three quarters of the globe's population will be "exposed to deadly heat more than 20 days per year." In New York, the number will be fifty days; in Jakarta, 365. A "belt of uninhabitability" will run through the Middle East, most of India, Pakistan, Bangladesh, and eastern China; expanding deserts will consume whole countries "from Iraq to Botswana."

Depending on the study, the risk of "very large fires" in the western US rises between 100 and 600 percent; the risk of flooding in India rises twenty-fold. Right now the risk that the biggest grain-growing regions will have simultaneous crop failures due to drought is "virtually zero," but

at four degrees "this probability rises to 86%." Vast "marine heatwaves" will scour the oceans: "One study projects that in a four-degree world sea temperatures will be above the thermal tolerance threshold of 100% of species in many tropical marine ecoregions." The extinctions on land and sea will certainly be the worst since the end of the Cretaceous, 65 million years ago, when an asteroid helped bring the age of the dinosaurs to an end. "The difference," Lynas notes, "is that this time the 'meteor' was visible decades in advance, but we simply turned away as it loomed ever larger in the sky."

I'm not going to bother much with Lynas's descriptions of what happens at five degrees or six. It's not that they're not plausible—they are, especially if humanity never gets its act together and shifts course. It's that they're pornographic. If we get anywhere near these levels, the living will truly envy the dead: this is a world where people are trying to crowd into Patagonia or perhaps the South Island of New Zealand, a world where massive monsoons wash away soil down to the rock, where the oceans turn anoxic, or completely deprived of oxygen. Forget the Cretaceous and the asteroids—at six degrees we're approaching the kind of damage associated with the end of the Permian, the greatest biological cataclysm in the planet's history, when 90 percent of species disappeared. Does that seem hyperbolic? At the moment our cars and factories are increasing the planet's CO2 concentration roughly ten times faster than the giant Siberian volcanoes that drove that long-ago disaster.

With the climate crisis, returning to "normal" is not a feasible goal—no one is going to produce a vaccine.[1] But that doesn't mean we have no possibilities. In fact, right now we have more options than at any previous point in the climate fight, but we would need to use them at dramatic scale and with dramatic speed.

For one thing, engineers have done their work and done it well. About a decade ago the price of renewable energy began to plummet, and that decline keeps accelerating. The price per kilowatt hour of solar power has fallen 82 percent since 2010—this spring in the sunny deserts of Dubai the winning bid for what will be the world's largest solar array came in at not much more than a penny. The price of wind power has fallen nearly as dramatically. Now batteries are whooshing down the same curve. In many places, within a few years, it will actually be cheaper to build new solar arrays than it will be to keep running already-built-and-paid-for gas and coal-fired power plants. (That's because, when the sun comes up in the morning, it delivers the power for free.) Because of this, and because of strong campaigns from activists targeting banks and asset managers, investors have begun to move decisively toward renewable energy. Such activist campaigns have also begun to weaken the political power of the fossil fuel industry, which has used its clout for three decades to block a transition to new forms of energy.

[1] Some have called for "geoengineering" solutions to global warming—techniques like spraying sulfur dioxide into the atmosphere in an attempt to block incoming sunshine, which would do nothing to slow the other dire crisis caused by the burst of carbon we've sent into the air, the acidification of the ocean, and might well wreak new forms of havoc with the planet's weather. Such methods are rightly described by Lynas as at best a Faustian bargain: "The planet we would bring into being would not be the Earth I love and want to protect."

But—and this is the terrible sticking point—economics itself won't move us nearly fast enough. Inertia is a powerful force—inertia, and the need to abandon trillions of dollars of "stranded assets." That is, vast reserves of oil and gas that currently underpin the value of companies (and of countries that act like companies—think Saudi Arabia) would need to be left in the ground; infrastructure like pipelines and powerplants would need to be shuttered long before their useful life is over. This process would probably create more jobs than it eliminated (fossil fuel tends to be capital-intensive, and renewable energy labor-intensive), but political systems respond more to current jobholders than to their potential replacements. The poorest nations should not be expected to pay as much as rich nations for the transition: they're already dealing with the staggering cost of rising sea levels and melting glaciers, which they did very little to cause. So even absent leaders like Donald Trump, the required effort is enormous—that's precisely why those pledges by the signatories in Paris fell so far short of the targets they'd set. And leaders like Trump not only exist, they seem to be multiplying: Brazil's Jair Bolsonaro can singlehandedly rewrite the climate math simply by continuing to encourage Amazonian deforestation. It will take a mighty and ongoing movement to speed up change.

What Lynas's book should perhaps have made slightly more explicit is how little margin we have to accomplish these tasks. In a coda, he writes valiantly, "It is not too late, and in fact it never will be too late. Just as 1.5°C is better than 2°C, so 2°C is better than 2.5°C, 3°C is better than 3.5°C and so on. We should never give up." This is inarguable, at least emotionally. It's just that, as the studies he cites makes clear, if we go to two degrees, that will cause feedbacks that take us automatically higher. At a certain point, it *will* be too late. The first of these deadlines might be 2030—the Intergovernmental Panel on Climate Change, in 2018, told us we needed a "fundamental transformation" of energy systems by that date or the targets set in Paris would slip through our grasp. (By "fundamental transformation," it meant a 50 percent fall in emissions.) That is, the period in which we retain the most leverage to really affect the outcome may be measured in years that correspond to the digits on your two hands.

The Covid pandemic has provided us with some way to gauge how important time is in a crisis. South Korea and the US reported their first casualties on the same day in January. And then the American government wasted February as the president dithered and tweeted; now Seoul has something closer to normalcy, and we have something closer to chaos. (In a single day in July, the state of Florida reported more cases than South Korea had registered since the start of the pandemic.) As the US wasted February spinning its wheels on the pandemic, so the planet has wasted thirty years. Speed matters, now more than ever. And of course the remarkable progress made by the Black Lives Matter protests this summer reminds us both that activism can be successful and that environmental efforts need to be strongly linked to other campaigns for social justice. The climate plan announced by the Biden campaign last month is a credible start toward the necessary effort.

The pandemic provides some useful sense of scale—some sense of how much we're going to have to change to meet the climate challenge. We ended business as usual for a time this spring, pretty much across the planet—changed our lifestyles far more than we'd imagined possible. We stopped flying, stopped commuting, stopped many factories. The bottom line was that emissions fell, but not by as much as you might expect: by many calculations little more than 10 or 15 percent. What that seems to indicate is that most of the momentum destroying our Earth is

hardwired into the systems that run it. Only by attacking those systems—ripping out the fossil-fueled guts and replacing them with renewable energy, even as we make them far more efficient—can we push emissions down to where we stand a chance. Not, as Lynas sadly makes clear, a chance at stopping global warming. A chance at surviving.