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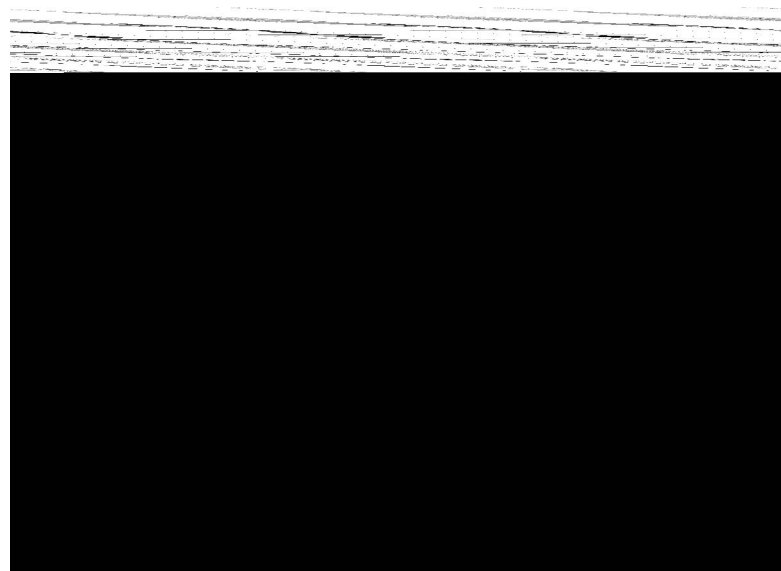
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ESSAY

Environmental Alarmism, Then and Now

The Club of Rome's Problem -- and Ours

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Forty years ago, humanity was warned: by chasing ever-greater economic growth, it was sentencing itself to catastrophe. The Club of Rome, a blue-ribbon multinational collection of business leaders, scholars, and government officials brought together by the Italian tycoon Aurelio Peccei, made the case in a slim 1972 volume called *The Limits to Growth*. Based on forecasts from an intricate series of computer models developed by professors at MIT, the book caused a sensation and captured the zeitgeist of the era: the belief that mankind's escalating wants were on a collision course with the world's finite resources and that the crash would be coming soon.

The Limits to Growth was neither the first nor the last publication to claim that the end was nigh due to the disease of modern development, but in many ways, it was the most successful. Although mostly forgotten these days, in its own time, it was a mass phenomenon, selling 12 million copies in more than 30 languages and being dubbed "one of the most important documents of our age" by *The New York Times*. And even though it proved to be phenomenally wrong-headed, it helped set the terms of debate on crucial issues of economic, social, and particularly environmental

policy, with malign effects that remain embedded in public consciousness four decades later. It is not too great an exaggeration to say that this one book helped send the world down a path of worrying obsessively about misguided remedies for minor problems while ignoring much greater concerns and sensible ways of dealing with them.

THAT '70S SHOW

If the 1950s and early 1960s had been a period of technological optimism, by the early 1970s, the mood in the advanced industrial countries had begun to turn grim. The Vietnam War was a disaster, societies were in turmoil, economies were starting to stagnate. Rachel Carson's 1962 book *Silent Spring* had raised concerns about pollution and sparked the modern environmental movement; Paul Ehrlich's 1968 book *The Population Bomb* had argued that humanity was breeding itself into oblivion. The first Earth Day, in 1970, was marked by pessimism about the future, and later that year U.S. President Richard Nixon created the Environmental Protection Agency to address the problem. This was the context in which *The Limits to Growth* resonated; its genius was to bring together in one argument the concerns over pollution, population, and resources, showing how so-called progress would soon run into the natural world's hard constraints.

Founded in 1968 and grandly declaring itself to be "a project on the predicament of mankind," the Club of Rome had set as its mission the gathering of the world's best analytic minds to find a way "to stop the suicidal roller coaster man now rides." This led it to Jay Forrester, an MIT professor who had developed a computer model of global systems, called World2, that allowed one to calculate the impact of changes in several variables on the planet's future. The club appointed a team led by two other MIT researchers, Donella Meadows and Dennis Meadows, to create an updated version, World3, and it was the output of this model that was presented in book form in *The Limits to Growth*. In an age more innocent of and reverential toward computers, the reams of cool printouts gave the book's argument an air of scientific authority and inevitability; hundreds of millions of logical microcircuits seemed to banish any possibility of disagreement.

The model was neither simple nor easy to understand. Even the graphic summary was mind-numbingly convoluted, and the full specifications of the model were published a year later, in a separate book of 637 pages. Still, the general concept was straightforward. The team "examined the five basic factors that determine, and therefore, ultimately limit, growth on this planet -- population, agricultural production, natural resources, industrial production, and pollution." Crucially, they assumed that all these factors grow exponentially -- a step so important that the whole first chapter of the book is dedicated to explaining it. They asked readers to consider the growth of lilies in a pond:

Suppose you own a pond on which a water lily is growing. The lily plant doubles in size each day. If the lily were allowed to grow unchecked, it would completely cover the pond in 30 days, choking off the other forms of life in the water. For a long time the lily plant seems small, and so you decide not to worry about cutting it back until it covers half the pond. On what day will that be? On the twenty-ninth day, of course. You have one day to save your pond.

In the standard scenario, shown in Figure 1, the authors projected the most likely future that would play out for humanity. With the years 1900 to 2100 on the horizontal axis, the graph shows levels of population, pollution, nonrenewable resources, food, and industrial output on the vertical axis. As death rates drop significantly (because of improvements in medical knowledge) and birthrates drop slightly, population increases. As each person consumes more food and products, meeting the total demand "requires an enormous input of resources." This depletes the

resource reserves available, making it ever harder to fulfill next year's resource demands, and eventually leads to the collapse of the economic system. Because of lags in the effects, population keeps growing until a staggering increase in the death rate driven by a lack of food and health services kills off a large part of civilization. The culprit is clear: "The collapse occurs because of nonrenewable resource depletion."



What if the world gets better at conserving resources or finding new ones? It doesn't matter. Run the model again with double or infinite resources, and a collapse still occurs -- only now it is caused by pollution. As population and production explode, pollution does, too, crippling food production and killing off three-quarters of the population.

What if pollution is kept in check through technology and policy? It still doesn't matter. Run the model again with unlimited resources and curbs on pollution, and the prediction remains bleak. As production soars, the world's population does, too, and with it demands for food. Eventually, the limit of arable land is reached, and industry is starved as capital is diverted into ever-feeblers attempts to increase agricultural yields. With food production back at the subsistence level, death rates shoot up, and civilization is again doomed.

The authors concluded that the "basic behavior mode of the world system is exponential growth of population and capital followed by collapse." And "when we introduce technological developments that successfully lift some restraint to growth or avoid some collapse, the system simply grows to another limit, temporarily surpasses it, and falls back."

Unlike previous gloomy forecasts, this one offered no easy way out. Carson wanted to stop the use of pesticides; Ehrlich wanted to slow population growth. But *The Limits to Growth* seemed to show that even if pollution and population growth were controlled, the world's resources would eventually be exhausted and food production would decline back to the subsistence level. The only hope was to stop economic growth itself. The world needed to cut back on its consumption of material goods and emphasize recycling and durability. The only hope to avoid a civilizational collapse, the authors argued, was through draconian policies that forced people to have fewer children and cut back on their consumption, stabilizing society at a level that would be significantly poorer than the present one.

Since most people saw such a solution as wildly unrealistic, the real takeaway was simple: the world was screwed.

And so *Time* magazine's 1972 story on *The Limits to Growth* was headlined "The Worst Is Yet to Be?" It read:

The furnaces of Pittsburgh are cold; the assembly lines of Detroit are still. In Los Angeles, a few gaunt survivors of a plague desperately till freeway center strips, backyards and outlying fields, hoping to raise a subsistence crop. London's offices are dark, its docks deserted. In the farm lands of the Ukraine, abandoned tractors litter the fields: there is no fuel for them. The waters of the Rhine, Nile and Yellow rivers reek with pollutants.

Fantastic? No, only grim inevitability if society continues its present dedication to growth and "progress."

The Limits to Growth got an incredible amount of press attention. *Science* gave it five pages, *Playboy* featured it prominently, and *Life* asked whether anyone wanted to hear "the awful truth." Publications such as *The Economist* and *Newsweek* chimed in with criticisms, but in 1973, the oil embargo made the book look prescient. With the oil shock and soaring commodity prices, it seemed that the world was fast-forwarding to the Club of Rome future.

OOPS

Forty years on, how do the predictions stack up? Defenders like to point out that *The Limits to Growth* carefully hedged its bets, with its authors claiming that they were not presenting "exact predictions" and that they were "deliberately . . . somewhat vague" on time frames because they wanted to focus on the general behavior of the system. But this is sophistry. It was obvious from the way the book was both presented and understood that it made a number of clear predictions, including that the world would soon run out many nonrenewable resources.

Assuming exponentially increasing demand, *The Limits to Growth* calculated how soon after 1970 various resources would be exhausted. Their conclusion was that before 2012, the world would run out of aluminum, copper, gold, lead, mercury, molybdenum, natural gas, oil, silver, tin, tungsten, and zinc -- 12 of the 19 substances they looked at. They were simply and spectacularly wrong.

They singled out mercury, claiming that its known global reserves in 1970 would last for only 13 years of exponential growth in demand, or 41 years if the reserves magically quintupled. They noted that "the prices of those resources with the shortest static reserve indices have already begun to increase. The price of mercury, for example, has gone up 500 percent in the last 20 years." Since then, however, technological innovations have led to the replacement of mercury in batteries, dental fillings, and thermometers. Mercury consumption has collapsed by 98 percent, and by 2000, the price had dropped by 90 percent.

They predicted that gold might run out as early as 1979 and would certainly do so by 1999, based on estimations of 10,980 tons of known reserves in 1970. In the subsequent 40 years, however, 81,410 tons of gold have been mined, and gold reserves are now estimated to be 51,000 tons.

Known reserves of copper in 1970 came to 280 million tons. Since then, about 400 million tons have been produced globally, and world copper reserves are now estimated at almost 700 million tons. Since 1946, new copper reserves have been discovered faster than existing copper reserves have been depleted. And the same goes for the other three most economically important metals: aluminum, iron, and zinc. Despite a 16-fold increase in aluminum consumption since 1950, and despite the fact that the world has consumed four times the 1950 known reserves in the years since, aluminum reserves now could support 177 years of the present level of consumption. *The Limits to Growth* also

worried about running out of oil (in 1990) and natural gas (in 1992). Not only have those not run out, but their reserves, measured in terms of years of current consumption, are larger today than they have ever been since 1970, even though consumption has increased dramatically.

WHAT THEY MISSED

The basic point of *The Limits to Growth* seemed intuitive, even obvious: if ever-more people use ever-more stuff, eventually they will bump into the planet's physical limits. So why did the authors get it wrong? Because they overlooked human ingenuity.

The authors of *The Limits to Growth* named five drivers of the world system, but they left out the most important one of all: people, and their ability to discover and innovate. If you think there are only 280 million tons of copper in the ground, you'll think you'll be out of luck once you have dug it out. But talking about "known reserves" ignores the many ways available resources can be increased.

Prospecting has improved, for example. As recently as 2007, Brazil found the Sugar Loaf oil field off the coast of São Paulo, which could hold 40 billion barrels of oil. Extraction techniques have also been improving. The oil industry now drills deeper into the ground, farther out into the oceans, and higher up in the Arctic. It drills horizontally and uses water and steam to squeeze out more from existing fields.

And shale gas can now be liberated with new fracking technology, which has helped double U.S. potential gas resources within the past six years. This is similar to the technological breakthrough of chemical flotation for copper, which made it possible to mine ores that had previously been thought worthless, and similar to the Haber-Bosch process, which made nitrogen fixation possible, yielding fertilizers that now help feed a third of humanity.

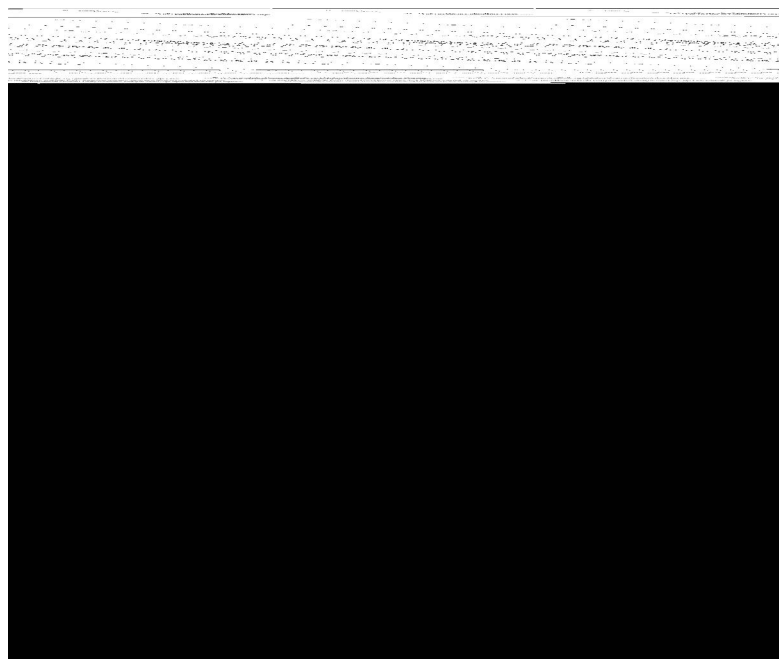
Aluminum is one of the most common metallic elements on earth. But extracting it was so difficult and expensive that not so long ago, it was more costly than gold or platinum. Napoleon III had bars of aluminum exhibited alongside the French crown jewels, and he gave his honored guests aluminum forks and spoons while lesser visitors had to make do with gold utensils. Only with the invention of the Hall-Héroult process in 1886 did aluminum suddenly drop in price and massively increase in availability. Most often, however, ingenuity manifests itself in much less spectacular ways, generating incremental improvements in existing methods that cut costs and increase productivity.

None of this means that the earth and its resources are not finite. But it does suggest that the amount of resources that can ultimately be generated with the help of human ingenuity is far beyond what human consumption requires. This is true even of energy, which many think of as having peaked. Costs aside, for example, by itself, the Green River Formation in the western United States is estimated to hold about 800 billion barrels of recoverable shale oil, three times the proven oil reserves of Saudi Arabia. And even with current technology, the amount of energy the entire world consumes today could be generated by solar panels covering just 2.6 percent of the area of the Sahara.

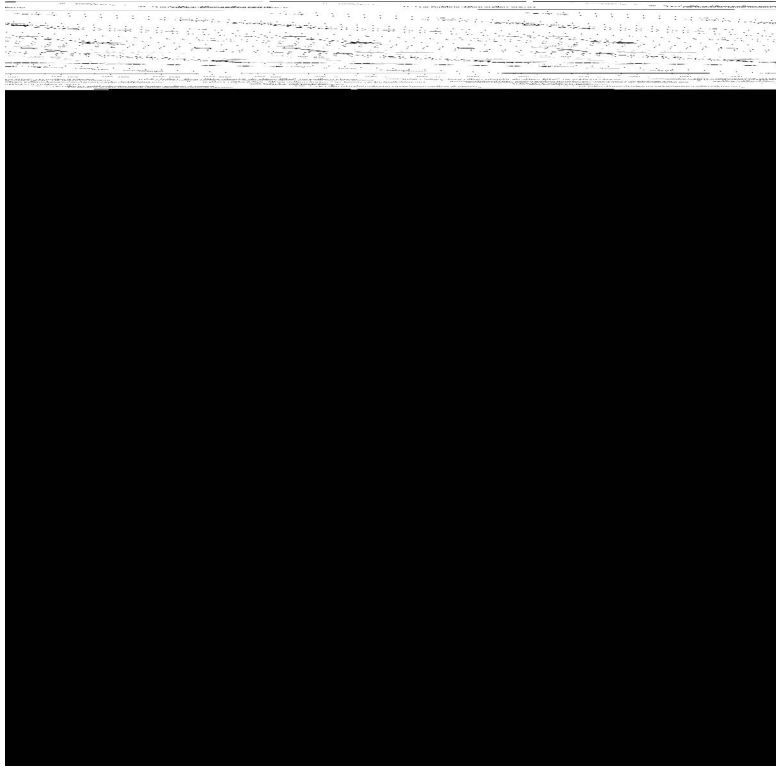
Worries about resources are not new. In 1865, the economist William Stanley Jevons wrote a damning book on the United Kingdom's coal use. He saw the Industrial Revolution relentlessly increasing the country's demand for coal, inevitably exhausting its reserves and ending in collapse: "It will appear that there is no reasonable prospect of any release from future want of the main agent of industry." And in 1908, it was Andrew Carnegie who fretted: "I have

for many years been impressed with the steady depletion of our iron ore supply. It is staggering to learn that our once-supposed ample supply of rich ores can hardly outlast the generation now appearing, leaving only the leaner ores for the later years of the century." Of course, his generation left behind better technology, so today, exploiting harder-to-get-at, lower-grade ore is easier and cheaper.

Another way to look at the resource question is by examining the prices of various raw materials. The *Limits to Growth* camp argues that as resource constraints get tighter, prices will rise. Mainstream economists, in contrast, are generally confident that human ingenuity will win out and prices will drop. A famous bet between the two groups took place in 1980. The economist Julian Simon, frustrated by incessant claims that the planet would run out of oil, food, and raw materials, offered to bet \$10,000 that any given raw material picked by his opponents would drop in price over time. Simon's gauntlet was taken up by the biologist Ehrlich and the physicists John Harte and John Holdren (the latter is now U.S. President Barack Obama's science adviser), saying "the lure of easy money can be irresistible." The three staked their bets on chromium, copper, nickel, tin, and tungsten, and they picked a time frame of ten years. When the decade was up, all five commodities had dropped in price, and they had to concede defeat (although they continued to stand by their original argument). And this was hardly a fluke: commodity prices have generally declined over the last century and a half (see Figure 2).



In short, the authors of *The Limits to Growth* got their most famous factor, resources, spectacularly wrong. Their graphs show resource levels starting high and dropping, but the situation is precisely the opposite: they start low and rise. Reserves of zinc, copper, bauxite (the principal ore of aluminum), oil, and iron have all been going spectacularly up (see Figure 3).



MORE, MORE, MORE

What of the other factors in the analysis? Their devastating collapse was predicted to occur just after 2010, so it may be too soon for that to be definitively falsified. But the trends to date offer little support for the gloom-and-doom thesis.

The growth in industrial production per capita to date was slightly overestimated by *The Limits to Growth*, possibly because resources have gotten cheaper rather than more expensive and more and more production has moved into the service industry. But mainstream forecasts of long-term GDP growth, a plausible proxy, are positive as far as the eye can see, in sharp contrast to what *The Limits to Growth* expected. The Intergovernmental Panel on Climate Change, for example, the only major group to have set out informed GDP scenarios through 2100, estimates that global GDP per capita will increase 14-fold over the century and increase 24-fold in the developing world.

The amount of population growth was somewhat underestimated, mainly because medical advances have reduced death rates even faster than expected (despite the unforeseen HIV/AIDS crisis). But the population growth rate has slowed since the late 1960s, unlike the World3 predictions, because birthrates have fallen along with development.

And predictions about the last two factors, agricultural production and pollution, were way off -- which is important because these were the two backup drivers of collapse if a scarcity of resources didn't do the job. Global per capita food consumption was expected to increase by more than 50 percent in the four decades after 1970, peak in 2010, and then drop by 70 percent. Calorie availability has indeed increased, if not quite so dramatically (by somewhat more than 25 percent), but the collapse of the food supply is nowhere in sight, and there is every reason to believe that the gains will continue and be sustainable. Malnutrition has not been vanquished, and the absolute number of people going hungry has in fact increased slightly recently (in part because some crops have been diverted from food to biofuel production due to concerns about global warming). But over the past 40 years, the fraction of the global population that is malnourished has dropped from 35 percent to less than 16 percent, and well over two billion more people have been fed adequately. The world is nowhere close to hitting a ceiling on the usage of arable land;

currently, 3.7 billion acres are being used, and 6.7 billion acres are in reserve. Nor have productivity gains maxed out. The latest long-range UN report on food availability, from 2006, estimated that the world would be able to feed ever-more people, each with ever-more calories, out to midcentury.

As for its pollution predictions, *The Limits to Growth* was simultaneously scary and vague. Pollution's increase was supposed to trigger a global collapse if the decrease of food or resources didn't do so first, but how exactly pollution was defined was left unclear. Individual pollutants, such as DDT, lead, mercury, and pesticides, were mentioned, but how those could kill any significant number of people was unspecified, making it a bit tricky to test the prediction. Air pollution might be considered a good proxy for overall pollution, since it was the biggest environmental killer in the twentieth century and since the Environmental Protection Agency estimates that its regulation produces 86-96 percent of all the social benefits from environmental regulation more generally. In the developing world, outdoor air pollution is indeed rising and killing more people, currently perhaps over 650,000 per year. Indoor air pollution (from using dirty fuels for cooking and heating) kills even more, almost two million per year (although that number has been decreasing slightly).

Even in the developed world, outdoor air pollution is still the biggest environmental killer (at least 250,000 dead each year), although environmental regulation has reduced the death toll dramatically over the past half century. Indoor air pollution in the developed world kills almost nobody. Whereas the Club of Rome imagined an idyllic past with no pollution and happy farmers and a future world choked by fumes and poisons from industrialization run amok, the reality is quite different. Over the last century, pollution has neither spiraled out of control nor gotten more deadly, and the risk of death from air pollution is predicted to continue to drop (see Figure 4).



WHO CARES?

So the *Limits to Growth* project got its three main drivers spectacularly wrong and the other two modestly wrong. The world is not running out of resources, not running out of food, and not gagging on pollution, and the world's population and industrial output are rising sustainably. So what? Why should anyone care now? Because the project's analysis sunk deep into popular and elite consciousness and helps shape the way people think about a host of important policy issues today.

Take natural resources and the environment. Ask someone today whether he cares about the environment and what he is doing about it, and you are likely to hear something like, "Of course I care; I recycle." The caring part is all to the good and a major positive change from a few decades ago. But the recycling part is often just a feel-good gesture that provides little environmental benefit at a significant cost.

Recycling is not a new idea. It made sense for companies and people to recycle precious commodities long before the *Limits to Growth* project came along, and they did so. Copper, for example, was recycled at a rate of about 45 percent throughout most of the past century, for purely practical, and not environmental, reasons. Why wasn't the rate higher? Because some used copper comes in great bundles and is easy to reprocess, making the recycling effort worthwhile, whereas other used copper is dispersed in small, hard-to-get-at pieces, making recycling inefficient.

When people think of recycling today, however, they often think of paper. This, too, is not a new idea; trash has been a resource for centuries, with the extent of its culling and reprocessing depending on the current market prices of the goods in question. Throughout the past century, about 30-50 percent of all paper was recycled, before the advent of public information campaigns or peer pressure.

But now, in the wake of jeremiads such as *The Limits to Growth*, recycling tends to be seen less as an economic question and more as a matter of personal and civic virtue. Children learn to "reduce, reuse, and recycle" as part of their official moral education. They are told that by doing so, they are "saving trees." Yet in fact, well-managed forests for paper production in countries such as Finland and Sweden are continuously replanted, yielding not fewer trees but more. Artificially encouraging the recycling of paper lowers the payoff for such forests, making them more likely to be converted into agricultural or urban land. Nor does recycling paper save the rain forests, since it is not made with tropical timber. Nor does recycling paper address a problem of municipal waste: incineration can recapture much of the energy from used paper with virtually no waste problems, and even without incineration, all U.S. municipal waste from the entire twenty-first century could be contained in a single square dump that was 18 miles on each side and 100 feet high.

The effort to recycle substances such as paper and glass, however, consumes money and manpower, which are also scarce resources and could be expended on other socially valuable efforts, such as building roads or staffing hospitals. And so as the price of paper has declined and the value of human work has risen dramatically, today we pay tribute to the pagan god of token environmentalism by spending countless hours sorting, storing, and collecting used paper, which, when combined with government subsidies, yields slightly lower-quality paper in order to secure a resource that was never threatened in the first place.

What is true about resources, moreover, is also true about two of the other supposed drivers of collapse, population and pollution. Spurred by analyses such as that presented in *The Limits to Growth*, much time and effort over the years has been diverted from useful activities to dubious or even pernicious ones. The specter of an ever-increasing population chewing up ever-dwindling resources, for example, helped scare people into draconian responses such as the one-child policy in China and forced sterilizations in India. These actions were not warranted, and other policies could have done a better job, at lower cost and with more preferable outcomes. Increasing education for women, reducing poverty, and ensuring higher economic growth, for example, would have reduced family sizes with many more ancillary benefits.

Scary scenarios of pollutants such as DDT and pesticides killing off humanity, meanwhile, have led to attempts to

ban them and to the widespread growth of the organic-food movement. But although it is true that the use of such products has costs -- in large doses, DDT is likely harmful to birds, and even well-regulated pesticides probably cause about 20 deaths each year in the United States -- it also yields substantial benefits. DDT is the cheapest and one of the most effective ways to tackle malaria. The ban on DDT in much of the developed world (which in itself might have made sense) led to pressures from nongovernmental organizations and aid agencies for bans elsewhere, and these campaigns, now abandoned by the World Health Organization, have likely contributed to several million unnecessary deaths.

In the developed world, the push to eliminate pesticides has ignored their immense benefits. Going completely organic would increase the cost of agricultural production in the United States by more than \$100 billion annually. Since organic farming is at least 16 percent less efficient, maintaining the same output would require devoting an additional 50 million acres to farmland -- an area larger than the state of California. And since eating fruits and vegetables helps reduce cancer, and since organic farming would lead to higher prices and thus lower consumption, a shift to purely organic farming would cause tens of thousands of additional cancer deaths.

Paying more than \$100 billion, massively increasing the amount of the country's farmland, and killing tens of thousands of people seems a poor return for avoiding the dozens of American deaths due to pesticides annually. Yet this is how the *Limits to Growth* project and similar efforts have taught the world to think, making people worry imprudently about marginal issues while ignoring sensible actions for addressing major ones.

DO THE RIGHT THING

The problematic legacy of *The Limits to Growth* is not just the unnecessary recycling of paper and a fascination with organic produce. More generally, the book and its epigones have promulgated worst-case environmental-disaster scenarios that make rational policymaking difficult.

Alarmism creates a lot of attention, but it rarely leads to intelligent solutions for real problems, something that requires calm consideration of the costs and benefits of various courses of action. By implying that the problems the world faces are so great and so urgent that they can be dealt with only by massive immediate interventions and sacrifices -- which are usually politically impossible and hence never put into practice -- environmental alarmism actually squelches debate over the more realistic interventions that could make a major difference.

One of the most insightful original reviews of *The Limits to Growth*, by the economist Carl Kaysen in these pages, actually, was cleverly titled "The Computer That Printed Out W*O*L*F*." After mercilessly picking apart the flaws in the book's argument, it noted that in the fable of the boy who cried "wolf," "there were in the end, real wolves," just as "in the world today, there are real and difficult problems attendant on economic growth as we now experience it." The challenge is differentiating between false alarms and real ones and then coming up with prudent efforts at risk management.

Take pollution. Thanks to works such as *Silent Spring* and *The Limits to Growth*, worrying about pesticides captured much of the early environmental debate and virtually monopolized the policy agenda of the Environmental Protection Agency during the 1970s. Unfortunately, this did nothing to address the real wolf of indoor and outdoor air pollution. The latter may still kill some 135,000 Americans each year -- more than four times the number who die in traffic accidents. But because it is less interesting and has no celebrity backers, it remains an ignored wolf -- as is

indoor pollution, which kills about two million people annually in the developing world.

But the Club of Rome did not just distract the world's attention. It actually directed that attention in precisely the wrong direction, identifying economic growth as humanity's core problem. Such a diagnosis can be entertained only by rich, comfortable residents of highly developed countries, who already have easy access to the basic necessities of life. In contrast, when a desperately poor woman in the developing world cannot get enough food for her family, the reason is not that the world cannot produce it but that she cannot afford it. And when her children get sick from breathing in fumes from burning dung, the answer is not for her to use environmentally certified dung but to raise her living standards enough to buy cleaner and more convenient fuels. Poverty, in short, is one of the greatest of all killers, and economic growth is one of the best ways to prevent it. Easily curable diseases still kill 15 million people every year; what would save them is the creation of richer societies that could afford to treat, survey, and prevent new outbreaks.

By recommending that the world limit development in order to head off a supposed future collapse, *The Limits to Growth* led people to question the value of pursuing economic growth. Had its suggestions been followed over subsequent decades, there would have been no "rise of the rest"; no half a billion Chinese, Indians, and others lifted out of grinding poverty; no massive improvements in health, longevity, and quality of life for billions of people across the planet. Even though the Club of Rome's general school of thought has mercifully gone the way of other 1970s-era relics, such as mood rings and pet rocks, the effects linger in popular and elite consciousness. People get more excited about the fate of the Kyoto Protocol than the fate of the Doha Round -- even though an expansion of trade would do hundreds or thousands of times as much good as feeble limitations of emissions, and do so more cheaply, quickly, and efficiently for the very people who are most vulnerable. It is past time to acknowledge that economic growth, for lack of a better word, is good, and that what the world needs is more of it, not less.

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