How Close to Catastrophe?

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James Lovelock is among the planet's most interesting and productive scientists. His invention of an electron capture device that was able to detect tiny amounts of chemicals enabled other scientists both to understand the dangers of DDT to the eggshells of birds and to figure out the ways in which chlorofluorocarbons (CFCs) were eroding the ozone layer. He's best known, though, not for a gadget but for a metaphor: the idea that the earth might usefully be considered as a single organism (for which he used the name of the Greek earth goddess Gaia) struggling to keep itself stable.

In fact, his so-called Gaia hypothesis was at first less clear than that - "hardly anyone, and that included me for the first ten years after the concept was born, seems to know what Gaia is," he has written. But the hypothesis has turned into a theory, still not fully accepted by other scientists but not scorned either. It holds that the earth is "a self-regulating system made up from the totality of organisms, the surface rocks, the ocean and the atmosphere tightly coupled as an evolving system" and striving to "regulate surface conditions so as always to be as favourable as possible for contemporary life."

Putting aside questions of planetary consciousness and will (beloved as they were by an early wave of New Age Gaia acolytes), the theory may help us understand how the earth has managed to remain hospitable for life over billions of years even as the sun, because of its own stellar evolution, has become significantly hotter. Through a series of processes involving, among others, ice ages, ocean algae, and weathering rock, the earth has managed to keep the amount of heat-trapping carbon dioxide in the atmosphere, and hence the temperature, at a relatively stable level.

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This homeostasis is now being disrupted by our brief binge of fossil fuel consumption, which has released a huge amount of carbon dioxide into the atmosphere. Indeed, at one point Lovelock predicts - more gloomily than any other competent observer I am aware of - that we have already pushed the planet over the brink, and that we will soon see remarkably rapid rises in temperature, well beyond those envisioned in most of the computer models now in use - themselves quite dire. He argues that because the earth is already struggling to keep itself cool, our extra increment of heat is particularly dangerous, and he predicts that we will soon see the confluence of several phenomena: the death of ocean algae in ever-warmer ocean waters, reducing the rate at which these small plants can remove carbon from the atmosphere; the death of tropical forests as a result of higher temperatures and the higher rates of evaporation they cause; sharp changes in the earth's "albedo," or reflectivity, as white ice that reflects sunlight back out into space is replaced with the absorptive blue of seawater or the dark green of high-latitude boreal forests; and the release of large amounts of methane, itself a greenhouse gas, held in ice crystals in the frozen north or beneath the sea.

Some or all of these processes will be enough, Lovelock estimates, to tip the earth into a catastrophically hotter state, perhaps eight degrees centigrade warmer in temperate regions like ours, over the course of a very few decades, and that heat will in turn make life as we know it nearly impossible in many places. Indeed, in the photo section of the book there is one picture of a red desert captioned simply "Mars now - and what the earth will look like eventually." Human beings, a hardy species, will not perish entirely, he says; in interviews during his book tour, Lovelock has predicted that about 200 million people, or about one thirtieth of the current world population, will survive if competent leaders make a new home for us near the present-day Arctic. There may also be other survivable spots, like the British Isles, though he notes that rising sea levels will render them more an archipelago. In any event, he predicts that "teeming billions" will perish.

Lovelock, who is in his eighties, concedes that this is a gloomier forecast than those of scientists more actively engaged in peer-reviewed climatology; it is, in a sense, a visceral feeling. It should be approached somewhat skeptically, for Lovelock has been (as he has always forthrightly admitted) wrong before in his immediate reactions. Though he invented the machine that helped us understand the dangers of CFCs, he also blithely dismissed those dangers, arguing that they couldn't do enough damage to matter. The American chemists Sherry Rowland and Mario Molina ignored his assurances and performed the groundbreaking work on the depletion of the ozone layer that won them the Nobel Prize. (And won for the planet an international agreement on the reduction of CFCs that allowed the earth a chance to repair the ozone hole before it opened so wide as to annihilate much of life through excess ultraviolet radiation.) Lovelock has also failed to identify any clear causal mechanism for his sudden heating hypothesis, explaining that he differs with more conventional forecasts mostly because he thinks they have underestimated both the extent of the self-reinforcing cycles that are causing temperatures to rise and the vulnerability of the planet, which he sees as severely stressed and close to losing equilibrium. It also must be said that parts of his short book read a little oddly - there are digressions into, say, the safety of nitrates in food that don't serve much purpose and raise questions about the rigor of the entire enterprise.

That said, there are very few people on earth - maybe none - with the same

kind of intuitive feel for how it behaves as a whole. Lovelock's flashes of insight about Gaia illuminate many of the interconnections between systems that more pedestrian scientists have slowly been trying to identify. Moreover, for the past twenty years, the period during which greenhouse science emerged, most of the effects of heating on the physical world have in fact been more dire than originally predicted. The regular reader of Science and Nature is treated to an almost weekly load of apocalyptic data, virtually all of it showing results at the very upper end of the ranges predicted by climate models, or beyond them altogether. Compared with the original models of a few years ago, ice is melting faster; forest soils are giving up more carbon as they warm; storms are increasing much more quickly in number and size. As I'm writing these words, news comes across the bottom of my computer screen that a new study shows methane leaking from Siberian permafrost at five times the predicted rate, which is seriously bad news since methane is an even more potent greenhouse gas than CO2.

In this fast-changing scientific puzzle, the Intergovernmental Panel on Climate Change (IPCC), which has given the world valuable guidance for a decade, stands the risk of being outrun by new data. The panel is supposed to issue a new report in the coming year summarizing the findings made by climate scientists since its last report. But it's unlikely that its somewhat unwieldy procedures will allow it to incorporate fears such as Lovelock's adequately, or even to address fully the far more mainstream predictions issued during the last twelve months by James Hansen of NASA, the planet's top climatologist.

Hansen is not quite as gloomy as Lovelock. Although he recently stated that the Earth is very close to the hottest it has been in a million years, he said that we still have until 2015 to reverse the flow of carbon into the atmosphere before we cross a threshold and create a "different planet." When Hansen gave this warning last December we had ten years to change course, but soon we'll have only nine years, and since nothing has happened in the intervening time to suggest that we're gearing up for an all-out effort to reduce greenhouse gas emissions, the divergence between Hansen and Lovelock may be academic. (Somehow it's small comfort to be rooting for the guy who says you've got a decade.)

What's amazing is that even Al Gore's fine and frightening film An Inconvenient Truth now lags behind the scientific cutting edge on this issue - the science is moving fast. It's true that the world is beginning slowly to awaken to the idea that global warming may be a real problem, and legislatures (though not ours) are starting to nibble at it. But very few understand with any real depth that a wave large enough to break civilization is forming, and that the only real question is whether we can do anything at all to weaken its force.

It's to the question of solutions to mitigate the effects of global warming that Lovelock eventually turns, which is odd since in other places he insists that it's too late to do much. His prescriptions are strongly worded and provocative - he thinks that renewable energy and energy conservation will come too slowly to ward off damage, and that an enormous program of building nuclear reactors is our best, indeed our only, real option. "We cannot turn off our energy-intensive, fossil-fuel-powered civilization without crashing," he writes. "We need the soft landing of a powered descent." That power can't come from wind or solar energy soon enough:

"Even now, when the bell has started tolling to mark our ending, we still talk of sustainable development and renewable energy as if these feeble offerings would be accepted by Gaia as an appropriate and affordable sacrifice." Instead, "new nuclear building should be started immediately."

With his extravagant rhetoric, Lovelock does us a favor - it is true that we should be at least as scared of a new coal plant as of a new nuclear station. The latter carries certain obvious risks (which Lovelock argues convincingly loom larger than perhaps they should in our imaginations), while the coal plants come with the absolute guarantee that their emissions will unhinge the planet's physical systems. Every potential source of non-carbon energy should be examined fairly to see what role it might have in avoiding a disastrous future. But Lovelock also undermines his own argument with what amounts to special pleading. He is a foe of wind power because, as he says, he doesn't want his Devon countryside overrun with windmills, placing him in the same camp as Cape Cod vacationers resistant to wind farms offshore in Nantucket Sound or Vermonters reluctant to see some of their high ridgelines dotted with towering turbines. "Perhaps we are NIMBYs," he writes, referring to the abbreviation for the phrase "Not In My Back Yard,"

"but we see those urban politicians [pushing wind power] as like some unthinking physicians who have forgotten their Hippocratic Oath and are trying to keep alive a dying civilization by useless and inappropriate chemotherapy when there is no hope of cure and the treatment renders the last stages of life unbearable."

This is an understandable aversion, but it would need to rest, as Lovelock admits, on something more than aesthetics, and in this case the foundation is all but nonexistent. He quotes a couple of disillusioned Danes to the effect that wind power hasn't been a panacea in Denmark, and says that Britain would need 54,000 big wind turbines to meet its needs, as if that huge number simply ends the argument. (The lack of adequate notes in this book makes checking sources laborious.) But in fact the Germans are adding 2,000 windmills annually, and nearing 20,000 total. Some object to the sight of them scattered across the countryside, and others are enchanted. In any event, whatever one's opinion of wind power, it's not at all clear that a crash program of building atomic reactors makes sense. Most of the economic modeling I've seen indicates that if you took the money intended for building a reactor and invested it instead in an aggressive energy conservation project (one that provided subsidies to companies to modify their factories to reduce power use, for instance), the payoff in cutting back on carbon would be much larger. This doesn't end the argument, either - we will obviously need new energy sources, and the example of the French success with nuclear power (it generates three quarters of their electricity) means it has to be included in the mix of possibilities, as Jim Hansen recently argued in these pages. But Lovelock's argument against wind power is remarkably unpersuasive.

Much more deeply researched, and much more hopeful, data come from the investment banker Travis Bradford. MIT Press has just issued his first book, Solar Revolution, which argues at great length and in great detail that we will soon be turning to solar panels for our power, in part for environmental reasons but more because

they will soon be producing power that's as cheap - and much easier to deploy - than any other source. This is a fairly astounding claim - the conventional wisdom among environmentalists is that solar energy lags behind wind power by a decade or more as a cost-effective source of electricity - but he makes the case in convincing fashion.

During the last decade (as Janet Sawin of the Worldwatch Institute has previously described), Japan has heavily subsidized the purchase of rooftop solar panels by home owners. The Japanese authorities began to do this, in part, because they wanted to meet the promises they made on their own soil at the Kyoto conference on global warming, but also, Bradford suggests, because they sensed that the industry could grow if it were encouraged by an initial investment. Within a few years, the subsidy had the desired effect - the volume of demand made both manufacturing and installation much more efficient, driving down the price. Today, the government subsidy has almost entirely disappeared, but demand continues to rise, for the panels now allow homeowners to produce their own power for the same price charged by the country's big utilities.

Japan in some ways is a special case - blessed with few domestic energy sources, it has some of the world's most expensive electricity, making solar panels more competitive. On the other hand, it's not particularly sunny in Japan. In any event, Bradford says the Japanese demand for solar power (and now an equally large program in Germany) will be enough to drive the cost of producing solar panels steadily down. Even without huge technological breakthroughs, which he says are tantalizingly near, the current hardware can be made steadily cheaper. He predicts the industry will grow 20 to 30 percent annually for the next forty years, which is akin to what happened with the last silicon-based revolution, the computer chip. No surprise, too, about who will own that industry - almost all the solar panel plants are now in Japan and Germany.

You can see signs of this change already. When I was in Tibet this summer, I repeatedly stumbled across the yak-skin tents of nomadic herders living in some of the most remote (and lofty) valleys in the world. They depended on yak dung, which they burned to cook food and heat their tents, and also often on a small solar panel hanging off one side of the tent, powering a light bulb and perhaps a radio inside. Every small town had a shop selling solar panels for a price roughly equivalent to that of a single sheep. Solar power obviously makes sense in such places, where there's probably never going to be an electric line. But it also increasingly makes sense in suburban developments, where new technologies like solar roof tiles are reducing the cost of outfitting a house to use solar power; in any event, the cost of such tiles would be a small part of the government-subsidized mortgage.

These systems are usually tied into the existing grid - when the sun is shining, my Vermont rooftop functions as a small power plant, sending power down the line. At night, I buy electricity like everyone else; in the sunny months of the year, the power the house uses and the power it generates are about the same. All this would make more economic sense, of course, if the destructive environmental costs of burning, say, cheap coal were reflected in the price of the resulting electricity. That seems almost certain to happen once George Bush leaves office. All plausible presidential candidates for both parties are committed to imposing some limits on the use of coal. It's already the rule in the rest of the developed world. But the testimony of Lovelock, Hansen, and

the rest of organized science makes it very clear that it would be a wise investment, indeed the wisest possible investment, to spend large sums of government money to hasten this transition to solar power. Where should it come from? One obvious candidate is the Pentagon budget, now devoted to defending us against dangers considerably less threatening than climate change.

But even the widespread adoption of solar power would not put an end to the threat of global warming. The economic transition that our predicament demands is larger and more wrenching even than that. Some scientists have estimated that it would take an immediate 70% reduction in fossil fuel burning simply to stabilize climate change at its current planet-melting level. And that reduction is made much harder by the fact that it is needed at just the moment that China and India have begun to burn serious quantities of fossil fuel as their economies grow. Not, of course, American quantities - each of us uses on average eight times the energy that a Chinese citizen does - but relatively serious quantities nonetheless.

Kelly Sims Gallagher, one of the savviest early analysts of climate policy, has devoted the last few years to understanding the Chinese energy transition. Now the director of the Energy Technology Innovation Project at Harvard's Kennedy School, she has just published a fascinating account of the rise of the Chinese auto industry. Her research makes it clear that neither American industry nor the American government did much of anything to point the Chinese away from our addiction to gas-guzzling technology; indeed, Detroit (and the Europeans and Japanese to a lesser extent) was happy to use decades-old designs and processes. "Even though cleaner alternatives existed in the United States, relatively dirty automotive technologies were transferred to China," she writes. One result is the smog that is choking Chinese cities; another is the invisible but growing cloud of greenhouse gases, which come from tailpipes but even more from the coal-fired utilities springing up across China. In retrospect, historians are likely to conclude that the biggest environmental failure of the Bush administration was not that it did nothing to reduce the use of fossil fuels in America, but that it did nothing to help or pressure China to transform its own economy at a time when such intervention might have been decisive.

It is precisely this question - how we might radically transform our daily lives - that is addressed by the cheerful proprietors of the WorldChanging website in their new book of the same name. This is one of the most professional and interesting websites that you could possibly bookmark on your browser; almost every day they describe a new technology or technique for environmentalists. Their book, a compilation of their work over the last few years, is nothing less than The Whole Earth Catalog, that hippie bible, retooled for the iPod generation. There are short features on a thousand cool ideas: slow food, urban farming, hydrogen cars, messenger bags made from recycled truck tarps, pop-apart cell phones, and plyboo (i.e., plywood made from fast-growing bamboo). There are many hundreds of how-to guides (how to etch your own circuit board, how to break in your hybrid car so as to maximize mileage, how to organize a "smart mob" (a brief gathering of strangers in a public place).

WorldChanging can tell you whom to text-message from your phone in order to advocate for international debt relief, and how to build an iPod speaker from an old tin of Altoids mints. It's a compendium of everything a younger generation of environmental activists has to offer: creativity, digital dexterity, networking

ability, an Internet-era optimism about the future, and a deep concern about not only green issues but related questions of human rights, poverty, and social justice. The book's pragmatism is refreshing: "We can do this" is the constant message, and there are enough examples to leave little doubt that sheer cleverness is not what we're lacking as we approach our uncertain future. "We need, in the next twenty-five years or so, to do something never before done. We need to consciously redesign the entire material basis of our civilization," Alex Steffen writes in his editor's introduction.

"If we face an unprecedented planetary crisis, we also find ourselves in a moment of innovation unlike any that has come before.... We live in an era when the number of people working to make the world better is exploding."

He's right.

If there's one flaw in the WorldChanging method, I think it might be a general distrust of the idea that government could help make things happen. There's a Silicon Valley air to the WorldChanging enterprise - over the years it's been closely connected with Wired magazine, the bible of the digerati and a publication almost as paranoid about government interference and regulation as the Wall Street Journal. Like Internet entrepreneurs, they distrust both government intentions and abilities - bureaucrats tend, after all, to come from the ranks of those neither bold nor smart enough to innovate. A libertarian streak shines through: "When we redesign our personal lives in such a way that we're doing the right thing and having a hell of a good time," Steffen writes, "we act as one-person beacons to the idea that green can be bright, that worldchanging can be lifechanging." I'm sympathetic to this strain of thinking; I believe we're going to need more local and more nimble decision-making in the future to build strong, survivable communities. But it also makes it a little harder to be as optimistic as you'd like to be when reading these pages, which are filled with good ideas that, chances are, won't come to all that much without the support of government and a system of incentives for investment.

You can see a close-up of some of that futility in the new book Design Like You Give a Damn from the nonprofit Architecture for Humanity, a book that is lovely in every sense of the word. The group started by sponsoring a competition for new shelters for refugees, and the range of replacements that people thought up for canvas tents makes clear just how much talent is currently going to waste designing McMansions. There are inflatable hemp bubbles and cardboard outhouses and dozens of other designs and prototypes for the world's poorest people and biggest disasters. As time went on, the group also collected photos and plans for attractive buildings around the world: health clinics that generate their own power, schools cheap enough for communities to construct. Still, there's something sad about the entire project - most of these designs have never been carried out, because the architects lacked the political savvy or influence to get them adopted by relief agencies or national governments. When there's a disaster, relief agencies still haul out the canvas tents.

There's another way of saying what is missing here. Almost every idea that might bring us a better future would be made much easier if the cost of fossil

fuel was higher - if there was some kind of a tax on carbon emissions that made the price of coal and oil and gas reflect its true environmental cost. (Gore, in an important speech at New York University last month, proposed scrapping all payroll taxes and replacing them with a levy on carbon.) If that day came - and it's the day at least envisioned by efforts like the Kyoto Treaty - then everything from solar panels to windmills to safe nuclear reactors (if they can be built) would spread much more easily: the invisible hand would be free to do more interesting work than it's accomplishing at the moment. Perhaps it would actually begin to operate with the speed necessary to head off Lovelock's nightmares. But that will only happen if local, national, and international officials can come together to make it happen, which in turn requires political action.

The recent election-driven decision by California governor Arnold Schwarzenegger to embrace a comprehensive set of climate change measures shows that such political action is possible; on the other side of the continent, a Labor Day march across Vermont helped to persuade even the most right-wing of the state's federal candidates to endorse an ambitious program against global warming. The march's final rally drew a thousand people, which makes it possibly the largest global warming protest in the country's history. That's a pathetic fact, but it goes to show how few people are actually needed to begin working toward real change.

The technology we need most badly is the technology of community - the knowledge about how to cooperate to get things done. Our sense of community is in disrepair at least in part because the prosperity that flowed from cheap fossil fuel has allowed us all to become extremely individualized, even hyperindividualized, in ways that, as we only now begin to understand, represent a truly Faustian bargain. We Americans haven't needed our neighbors for anything important, and hence neighborliness - local solidarity - has disappeared. Our problem now is that there is no way forward, at least if we're serious about preventing the worst ecological nightmares, that doesn't involve working together politically to make changes deep enough and rapid enough to matter. A carbon tax would be a very good place to start.

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