The Prophet of Climate Change: James Lovelock

One of the most eminent scientists of our time says that global warming is irreversible — and that more than 6 billion people will perish by the end of the century

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At the age of eighty-eight, after four children and a long and respected career as one of the twentieth century's most influential scientists, James Lovelock has come to an unsettling conclusion: The human race is doomed. "I wish I could be more hopeful," he tells me one sunny morning as we walk through a park in Oslo, where he is giving a talk at a university. Lovelock is a small man, unfailingly polite, with white hair and round, owlish glasses. His step is jaunty, his mind lively, his manner anything but gloomy. In fact, the coming of the Four Horsemen -- war, famine, pestilence and death -- seems to perk him up. "It will be a dark time," Lovelock admits. "But for those who survive, I suspect it will be rather exciting."

In Lovelock's view, the scale of the catastrophe that awaits us will soon become obvious. By 2020, droughts and other extreme weather will be commonplace. By 2040, the Sahara will be moving into Europe, and Berlin will be as hot as Baghdad. Atlanta will end up a kudzu jungle. Phoenix will become uninhabitable, as will parts of Beijing (desert), Miami (rising seas) and London (floods). Food shortages will drive millions of people north, raising political tensions. "The Chinese have nowhere to go but up into Siberia," Lovelock says. "How will the Russians feel about that? I fear that war between Russia and China is probably inevitable." With hardship and mass migrations will come epidemics, which are likely to kill millions. By 2100, Lovelock believes, the Earth's population will be culled from today's 6.6 billion to as few as 500 million, with most of the survivors living in the far latitudes -- Canada, Iceland, Scandinavia, the Arctic Basin.

By the end of the century, according to Lovelock, global warming will cause temperate zones like North America and Europe to heat up by fourteen degrees Fahrenheit, nearly double the likeliest predictions of the latest report from the Intergovernmental Panel on Climate Change, the United Nations-sanctioned body that includes the world's top scientists. "Our future," Lovelock writes, "is like that of the passengers on a small pleasure boat sailing quietly above

the Niagara Falls, not knowing that the engines are about to fail." And switching to energy-efficient light bulbs won't save us. To Lovelock, cutting greenhouse-gas pollution won't make much difference at this point, and much of what passes for sustainable development is little more than a scam to profit off disaster. "Green," he tells me, only half-joking, "is the color of mold and corruption."

If such predictions were coming from anyone else, you would laugh them off as the ravings of an old man projecting his own impending death onto the world around him. But Lovelock is not so easily dismissed. As an inventor, he created a device that helped detect the growing hole in the ozone layer and jump-start the environmental movement in the 1970s. And as a scientist, he introduced the revolutionary theory known as Gaia -- the idea that our entire planet is a kind of superorganism that is, in a sense, "alive." Once dismissed as New Age quackery, Lovelock's vision of a self-regulating Earth now underlies virtually all climate science. Lynn Margulis, a pioneering biologist at the University of Massachusetts, calls him "one of the most innovative and mischievous scientific minds of our time." Richard Branson, the British entrepreneur, credits Lovelock with inspiring him to pledge billions of dollars to fight global warming. "Jim is a brilliant scientist who has been right about many things in the past," Branson says. "If he's feeling gloomy about the future, it's important for mankind to pay attention."

Lovelock knows that predicting the end of civilization is not an exact science. "I could be wrong about all this," he admits as we stroll around the park in Norway. "The trouble is, all those well-intentioned scientists who are arguing that we're not in any imminent danger are basing their arguments on computer models. I'm basing mine on what?s actually happening."

When you approach Lovelock's house in Devon, a rural area in southwestern England, the sign on the metal gate reads:

COOMBE MILL EXPERIMENTAL STATION

SITE OF NEW NATURAL HABITAT

PLEASE DO NOT TRESPASS OR DISTURB

A few hundred yards down a narrow lane, beside the site of an old mill, is a white, slate-roofed cottage where Lovelock lives with his second wife, Sandy, an American, and his youngest son, John, who is fifty-one and mildly disabled. It's a fairy-tale setting, surrounded by thirty-five wooded acres -- no vegetable garden, no manicured rosebushes. "I detest all that," Lovelock tells me. Partly hidden in the woods is a life-size statue of Gaia, the Greek goddess of the Earth, whom Lovelock named his groundbreaking theory after.

Most scientists toil at the margins of human knowledge, adding incrementally to our understanding of the world. Lovelock is one of the few living scientists whose ideas have touched off not only a scientific revolution but a spiritual one as well. "Future historians of science will see Lovelock as a man who inspired a Copernican shift in how we see ourselves in the world," says Tim Lenton, a climate researcher at the University of East Anglia, in England. Before Lovelock came along, the Earth was seen as little more than a cozy rock drifting around the sun. According to the accepted wisdom, life evolved here because the conditions were right -- not too hot, not too cold, plenty of water. Somehow bacteria grew into multicelled organisms, fish crawled out of the sea, and before long, Britney Spears arrived.

In the 1970s, Lovelock upended all this with a simple question: Why is the Earth different from Mars and Venus, where the atmosphere is toxic to life? In a flash of insight, Lovelock understood that our atmosphere was created not by random geological events but by the cumulative effusion of everything that has ever breathed, grown and decayed. Our air "is not merely a biological product," Lovelock wrote, "but more probably a biological construction: not living, but like a cat's fur, a bird's feathers or the paper of a wasp's nest, an extension of a living system designed to maintain a chosen environment." According to Gaia theory, life is not just a passenger on Earth but an active participant, helping to create the very conditions that sustain it. It's a beautiful idea --life begets life. It was also right in tune with the post-flower-child mood of the Seventies. Lovelock was quickly adopted as a spiritual guru, the man who killed God and put the planet at the center of New Age religious experience.

Lovelock is not an alarmist by nature. In his view, the dangers of nuclear power are grossly overstated. Ditto mercury emissions in the atmosphere, genetic engineering of food and the loss of biodiversity on the planet. The greatest mistake in his career, in fact, was not claiming that the sky was falling but failing to recognize that it was. In 1973, after being the first to discover that industrial chemicals called chlorofluorocarbons had polluted the atmosphere, Lovelock declared that the buildup of CFCs posed "no conceivable hazard." As it turned out, CFCs weren't toxic to breathe, but they were eating a hole in the ozone. Lovelock quickly revised his view, calling it "one of my greatest blunders," but the mistake may have cost him a share in a Nobel Prize.

At first, Lovelock didn't view global warming as an urgent threat to the planet. "Gaia is a tough bitch," he often said, borrowing a phrase coined by a colleague. But a few years ago, alarmed by rapidly melting ice in the Arctic and other climate-related changes, Lovelock became convinced that Gaia's autopilot system -- the giant, inexpressibly subtle network of positive and negative feedbacks that keeps the Earth?s climate in balance -- is seriously out of whack, derailed by pollution and deforestation. Lovelock believes the planet itself will eventually recover its equilibrium, even if it takes millions of years. What's at stake, he says, is civilization.

"You could quite seriously look at climate change as a response of the system intended to get rid of an irritating species: us humans," Lovelock tells me in the small office he has created in his cottage. "Or at least cut them back to size."

Lovelock's cottage in the woods is a world away from South London, where he grew up with coal soot in his lungs, coughing and pale and working-class. His mother was an early feminist; his father grew up so desperately hungry that he spent six months in prison when he was fourteen for poaching a rabbit from a local squire?s estate. Shortly after Lovelock was born, his parents passed him off to his grandmother to raise. "They were too poor and too busy to raise a child," he explains. In school, he was a lousy student, mildly dyslexic, more interested in pranks than homework. But he loved books, especially the science fiction of Jules Verne and H.G. Wells.

To escape the grime of urban life, Lovelock's father often took him on long walks in the countryside, where he caught trout by hand from the streams and gorged on blueberries. The freedom and romance Lovelock felt on these jaunts had a transformative effect on him. "It's where I first saw the face of Gaia," he says now.

By the time Lovelock hit puberty, he knew he wanted to be a scientist. His first love was physics. But his dyslexia made complex math difficult, so he opted instead for chemistry, enrolling at the University of London. A year later, when the Nazis invaded Poland, Lovelock converted to Quakerism and soon became a conscientious objector. In his written statement, he explained why he refused to fight: "War is evil."

Lovelock took a job at the National Institute for Medical Research in London, where one of his first assignments was to develop new ways to stop the spread of infectious diseases. He spent months in underground bomb shelters studying how viruses are transmitted -- and shagging nurses in first-aid stations while Nazi bombs fell overhead. "It was a hard, desperate time," he says. "But it was exciting! It's terribly ironic, but war does make one feel alive."

As a result of his research in the bomb shelters, Lovelock ended up inventing the first aerosol disinfectant. A few years later, as a pioneer in the field of cryogenics, he became the first to understand how cellular structures respond to extreme cold, developing a means to freeze and thaw animal sperm -- a method still in use today. "Thanks to Lovelock," says biologist Lynn Margulis, "they don't have to send the entire bull to Australia."

But Lovelock's most important invention was the Electron Capture Detector, or ECD. In 1957, working at his kitchen table, Lovelock hacked together a device to measure minute concentrations of pesticides and other gases in the air. The instrument fit into the palm of his hand and was so exquisitely sensitive that if you dumped a bottle of some rare chemical on a blanket in Japan and let it evaporate, the ECD would be able to detect it a week later in England. The device was eventually redesigned by Hewlett-Packard: If Lovelock had retained the patent, he would have been a rich

man. "Jim has never cared much for money," says Armand Neukermans, a Silicon Valley entrepreneur and old friend of Lovelock, "except to buy himself freedom as an independent scientist."

As it turned out, Lovelock's invention roughly coincided with the publication in 1962 of Rachel Carson's *Silent Spring*, which alerted the world to the dangers of pesticides like DDT. By the time her book appeared, scientists were already using the ECD to measure pesticide residue in the fat of Antarctic penguins and in the milk of nursing mothers in Finland, giving hard evidence to Carson's claims that chemicals were impacting the environment on a global scale. "If it hadn't been for my ECD," Lovelock says, "I think critics in the industry would have dismissed the whole thing as wet chemistry -- 'Oh, you can't measure this stuff accurately, can't extrapolate.' And they would have been right."

A decade later, Lovelock made an even more important discovery. In the late 1960s, while staying at an isolated vacation house in Ireland, he took a random sample of the haze that drifted into the area and found it laced with chlorofluorocarbons. CFCs are man-made compounds used as a refrigerant and as a propellant in aerosol cans -- a sure sign of man-made pollution. If CFCs are in remote Ireland, Lovelock wondered, where else might they be? Hitching a ride on a research vessel for a six-month voyage to Antarctica, he used a jury-rigged ECD to detect the buildup of CFCs in the atmosphere. But Lovelock failed to grasp the danger that they posed; two other scientists won the Nobel Prize for correctly hypothesizing that CFCs would burn a hole in the stratosphere, allowing dangerous levels of ultraviolet light to reach the Earth. As a result, CFCs were banned. "If Lovelock hadn't detected those CFCs," says Stanford University biologist Paul Ehrlich, "we'd all be living under the ocean in snorkels and fins to escape that poisonous sun."

If you type "gaia" and "religion" into Google, you'll get 2,360,000 hits -- Wiccans, spiritual travelers, massage therapists and sexual healers, all inspired by Lovelock's vision of the planet. Ask him about pagan cults, though, and Lovelock grimaces -- he has no interest in soft-headed spirituality or organized religion, especially when it puts human existence above all else. At Oxford, he once stood up and admonished Mother Teresa for urging an audience to take care of the poor and "leave God to take care of the Earth." As Lovelock explained to her, "If we as people do not respect and take care of the Earth, we can be sure that the Earth, in the role of Gaia, will take care of us and, if necessary, eliminate us."

Lovelock came up with the Gaia theory during a rough time in his life. In 1961, he was forty-one and working at a research center in London. It was a good job, decent pay, plenty of freedom, but he was bored. He had four kids at home, including John, who was born with a birth defect that left him brain-damaged. In addition, Lovelock?s mother -- cranky, demanding, aged -- was driving him nuts. He smoked, he drank. Today, we'd call it a midlife crisis.

One day, a letter from NASA arrived in Lovelock's mailbox, inviting him to join a group of scientists who were about to explore the moon. He had never heard of the space agency -- but within a few months he had dumped his job, packed up the family and moved to America to join the space race. Before long, though, he concluded that, scientifically speaking, the moon wasn't a very interesting place. The real excitement was Mars. "With the moon, the question was, is it safe for astronauts to walk on the surface?" Lovelock recalls. "With Mars, the question was, is there life there?"

Lovelock's colleagues at the Jet Propulsion Laboratory in Pasadena, California, struggled to design instruments to test for life on the Martian surface. Lovelock, as usual, took a different approach. Instead of using a probe to dig up soil and look for bacteria, he thought, why not analyze the chemical composition of the Martian atmosphere? If life were present, he reasoned, the organisms would be obliged to use up raw materials in the atmosphere (such as oxygen) and dump waste products (like methane), just as life on Earth does. Even if the materials consumed and discharged were different, the chemical imbalance would be relatively simple to detect. Sure enough, when Lovelock and his colleagues finally got an analysis of Mars, they discovered that the atmosphere was close to chemical equilibrium -- suggesting that there had been no life on the planet.

But if life creates the atmosphere, Lovelock reasoned, it must also, in some sense, be regulating it. He knew, for example, that the sun is now about twenty-five percent hotter than when life began. What was modulating the surface temperature of the Earth, keeping it hospitable? Life itself, Lovelock concluded. When the Earth heats up, plants draw down levels of carbon dioxide and other heat-trapping gases; as it cools, the levels of those gases rise, warming the planet. Thus, the idea of the Earth as superorganism was born.

The idea was not entirely new: Leonardo da Vinci believed pretty much the same thing in the sixteenth century. But Lovelock was the first to assemble all the existing thinking into a new vision of the planet. He soon quit NASA and moved back to England, where his neighbor William Golding, author of *Lord of the Flies*, suggested that he name his theory after Gaia, to capture the popular imagination. When established scientific journals refused to touch his ideas,

Lovelock put out a book called *Gaia: A New Look at Life on Earth*. "The Gaia hypothesis," he wrote, "is for those who like to walk or simply stand and stare, to wonder about the Earth and the life it bears and to speculate about the consequences of our own presence here." Gaia, he added, offers an alternative to the "depressing picture of our planet as a demented spaceship, forever traveling driverless and purposeless around an inner circle of the sun."

Hippies loved it. Darwinists didn't. Richard Dawkins, author of *The Selfish Gene*, dismissed Lovelock's book as "pop-ecology literature." British biologist John Maynard Smith went further, calling Gaia "an evil religion." In their view, Lovelock's concept flew in the face of evolutionary logic: If the Earth is an organism, and organisms evolve by natural selection, then that implies that somehow the Earth out-competed other planets. How is that possible? They were also troubled by Lovelock's suggestion that life creates the condition for life, which seems to suggest a predetermined purpose. In the minds of many of his peers, Lovelock was dancing very close to God.

But that was not what Lovelock had in mind. Large systems, in his view, don't need a purpose. To prove it, Lovelock and a colleague devised a simple, elegant computer model called Daisyworld, which used competing fields of daisies to show how organisms evolving under rules of natural selection are part of a self-regulating system. As the model planet heats up, white daisies thrive, reflecting more sunlight; that, in turn, lowers the temperature, which favors black daisies. Working together, the flowers regulate the temperature of the planet. The daisies are not altruistic or conscious -- they simply exist and, by existing, alter their environment.

Daisyworld quieted some of the critics, but the scientific debate over Gaia raged throughout the 1980s. Lovelock continued refining his thoughts despite troubles in his personal life. His first wife, Helen, was in the midst of a slow and painful decline from multiple sclerosis. Lovelock himself had several major surgeries, including the removal of a kidney he damaged in a tractor accident. He supported himself in part as a consultant for MI5, England's top counterintelligence agency, where he developed a method to monitor the movements of KGB spies in London by using an ECD to track their vehicles. To Lovelock, working for the spy agency was the equivalent of writing potboiler novels for a quick paycheck. "It was enjoyable work, and it kept food on the table," he says now.

Among scientists, Lovelock redeemed himself with a second book, *The Ages of Gaia*, which offered a more rigorous exploration of the biological and geophysical feedback mechanisms that keep the Earth's atmosphere suitable for life. Plankton in the oceans, for example, help cool the planet by giving off dimethyl sulfide, a chemical that seeds the formation of clouds, which in turn reflect the sun's heat back into space. "In the 1970s, plenty of us thought Gaia was nonsense," says Wally Broecker, a paleoclimatologist at Columbia University. "But Lovelock got everyone thinking more seriously about the dynamic nature of the planet." Of course, scientists like Broecker rarely used the word "Gaia." They prefer the phrase "Earth system science," which views the world, according to one treatise, as "a single, self-regulating system comprised of physical, chemical, biological and human components." In other words, Gaia in a lab coat.

Gaia offers a hopeful vision of how the world works. After all, if the Earth is more than just a rock drifting around the sun, if it's a superorganism that can evolve, that means -- to put it in a way that will piss off biology majors and neo-Darwinists everywhere -- there is a certain amount of forgiveness built into our world.

For Lovelock, this is a comforting idea. Consider his little spread in Devon. When he bought the place thirty years ago, it was surrounded by fields shorn by a thousand years of sheep-grazing. But to Lovelock, open land reeks of human interference with Gaia. So he set out to restore his thirty-five acres to its more natural character. After consulting with a forester, he planted 20,000 trees -- alders, oaks, pines. Unfortunately, he planted many of them too close together, and in rows. The trees are about forty feet tall now, but rather than feeling "natural," parts of his land have the look of a badly managed forestry project. "I botched it," Lovelock says with a grin as we hike through the woods. "But in the long run, Gaia will take care of it."

Until recently, Lovelock thought that global warming would be just like his half-assed forest -- something the planet would correct for. Then, in 2004, Lovelock's friend Richard Betts, a researcher at the Hadley Centre for Climate Change -- England's top climate institute -- invited him to stop by and talk with the scientists there. Lovelock went from meeting to meeting, hearing the latest data about melting ice at the poles, shrinking rain forests, the carbon cycle in the oceans. "It was terrifying," he recalls. "We were shown

five separate scenes of positive feedback in regional climates -- polar, glacial, boreal forest, tropical forest and oceans -- but no one seemed to be working on whole-planet consequences." Equally chilling, he says, was the tone in which the scientists talked about the changes they were witnessing, "as if they were discussing some distant planet or a model universe, instead of the place where we all live."

As Lovelock was driving home that evening, it hit him. The resiliency of the system was gone. The forgiveness had been used up. "The whole system," he decided, "is in failure mode." A few weeks later, he began work on his latest and gloomiest book, *The Revenge of Gaia*, which was published in the U.S. in 2006.

In Lovelock's view, the flaws in computer climate models are painfully apparent. Take the uncertainty around projected sea levels: The IPCC, the U.N. panel on climate change, estimates that global warming will cause Earth's average temperature to rise as much as 11.5 degrees by 2100. This will cause inland glaciers to melt and seas to expand, triggering a maximum sea level rise of only twenty-three inches. Greenland, according to the IPCC's models, will take 1,000 years to melt.

But evidence from the real world suggests that the IPCC is far too conservative. For one thing, scientists know from the geological record that 3 million years ago, when temperatures increased to five degrees above today's level, the seas rose not by twenty-three inches but by more than eighty feet. What's more, recent satellite measurements indicate that Arctic ice is melting so rapidly that the region could be ice-free by 2030. "Modelers don't have the foggiest idea about the dynamics of melting ice sheets," scoffs Lovelock.

It's not just ice that throws off the climate models. Cloud physics are notoriously difficult to get right, and feedbacks from the biosphere, such as deforestation and melting tundra, are rarely factored in. "Computer models are not crystal balls," argues Ken Caldeira, a climate modeler at Stanford University whose career has been deeply influenced by Lovelock's ideas. "By observing the past, you make informed judgments about the future. Computer models are just a way to codify that accumulated knowledge into automated educated bets."

Here, in its oversimplified essence, is Lovelock's doomsday scenario: Rising heat means more ice melting at the poles, which means more open water and land. That, in turn, increases the heat (ice reflects sunlight; open land and water absorb it), causing more ice to melt. The seas rise. More heat leads to more intense rainfall in some places, droughts in others. The Amazon rain forests and the great northern boreal forests --the belt of pine and spruce that covers Alaska, Canada and Siberia --undergo a growth spurt, then wither away. The permafrost in northern latitudes thaws, releasing methane, a greenhouse gas that is twenty times more potent than CO2 -- and on and on it goes.

In a functioning Gaian world, these positive feedbacks would be modulated by negative feedbacks, the largest of which is the Earth's ability to radiate heat into space. But at a certain point, the regulatory system breaks down and the planet's climate makes the jump -- as it has many times in the past -- to a new, hotter state. Not the end of the world, but certainly the end of the world as we know it.

Lovelock's doomsday scenario is dismissed by leading climate researchers, most of whom dispute the idea that there is a single tipping point for the entire planet. "Individual ecosystems may fail or the ice sheets may collapse," says Caldeira, "but the larger system appears to be surprisingly resilient." But let's assume for the moment that Lovelock is right and we are indeed poised above Niagara Falls. Do we just wave as we go over the edge? In Lovelock's view, modest cuts in greenhouse-gas emissions won't help us -- it's too late to stop global warming by swapping our SUVs for hybrids. What about capturing carbon-dioxide pollution from coal plants and pumping it underground? "We can't possibly bury enough to make any difference." Biofuels? "A monumentally stupid idea." Renewables? "Nice, but won't make a dent." To Lovelock, the whole idea of sustainable development is wrongheaded: "We should be thinking about sustainable retreat."

Retreat, in his view, means it's time to start talking about changing where we live and how we get our food; about making plans for the migration of millions of people from low-lying regions like Bangladesh into Europe; about admitting that New Orleans is a goner and moving the people to cities better positioned for the future. Most of all, he says, it's about everybody "absolutely doing their utmost to sustain civilization, so that it doesn't degenerate into Dark Ages, with warlords running things, which is a real danger. We could lose everything that way."

Even Lovelock's friends cringe when he talks like this. "I fear he's overdrawing our despair budget," says Chris Rapley,

head of the Science Museum in London, who has worked hard to raise international awareness of global warming. Others are justifiably concerned that Lovelock's views will distract from the rising political momentum for tough restrictions on greenhouse-gas pollution. Broecker, the Columbia paleoclimatologist, calls Lovelock's belief that cutting pollution is futile "dangerous nonsense."

"I wish I could say that wind turbines and solar panels will save us," Lovelock responds. "But I can't. There isn't any kind of solution possible. There are nearly 7 billion people on the planet now, not to mention livestock and pets. If you just take the CO2 of everything breathing, it's twenty-five percent of the total --four times as much CO2 as all the airlines in the world. So if you want to improve your carbon footprint, just hold your breath. It's terrifying. We have just exceeded all reasonable bounds in numbers. And from a purely biological view, any species that does that has a crash."

This is not to suggest, however, that Lovelock believes we should just party while the world burns. Quite the opposite. "We need bold action," Lovelock insists. "We have a tremendous amount to do." In his view, we have two choices: We can return to a more primitive lifestyle and live in equilibrium with the planet as hunter-gatherers, or we can sequester ourselves in a very sophisticated, high-tech civilization. "There's no question which path I'd prefer," he says one morning in his cottage, grinning broadly and tapping the keyboard of his computer. "It's really a question of how we organize society -- where we will get our food, water. How we will generate energy."

For water, the answer is pretty straightforward: desalination plants, which can turn ocean water into drinking water. Food supply is tougher: Heat and drought will devastate many of today's food-growing regions. It will also push people north, where they will cluster in cities. In these areas, there will be no room for backyard gardens. As a result, Lovelock believes, we will have to synthesize food -- to grow it in vats from tissue cultures of meats and vegetables. It sounds far out and deeply unappetizing, but from a technological standpoint, it wouldn't be hard to do.

A steady supply of electricity will also be vital. Five days after his visit to the Hadley Centre, Lovelock penned a fiery op-ed titled "Nuclear Power Is the Only Green Solution." Lovelock argued that we should "use the small input from renewables sensibly" but that "we have no time to experiment with visionary energy sources; civilization is in imminent danger and has to use nuclear -- the one safe, available energy source -- now or suffer the pain soon to be inflicted by our outraged planet."

Environmentalists howled in protest, but for anyone who knew Lovelock's past, his embrace of nukes is not surprising. At the age of fourteen, reading about how the sun is powered by a nuclear reaction, he came to believe that nuclear energy is one of the fundamental forces in the universe. Why not harness it? As for the dangers -- radioactive waste, vulnerability to terrorism, the possibility of a Chernobyl-like meltdown -- Lovelock says it's the lesser of two evils: "Even if they're right about the dangers, and they are not, it is still nothing compared to climate change."

As a last resort, to keep the planet even marginally habitable, Lovelock believes that humans may be forced to manipulate the Earth's climate by erecting solar shades in space or building devices to strip huge quantities of CO2 out of the atmosphere. Although he views large-scale geoengineering as an act of profound hubris -- "I would sooner expect a goat to succeed as a gardener than expect humans to become stewards of the Earth" -- he thinks it may be necessary as an emergency measure, much like kidney dialysis is necessary to a person whose health is failing. In fact, it was Lovelock who inspired his friend Richard Branson to put up a $25 million prize for the Virgin Earth Challenge, which will be awarded to the first person who can figure out a commercially viable way of removing greenhouse gases from the atmosphere. As a judge in the contest, Lovelock is not eligible to win, but he's intrigued by the challenge. His latest thought: suspend hundreds of thousands of 600-foot-long vertical pipes in the tropical oceans, put a valve at the bottom of each pipe and allow deep, nutrient-rich water to be pumped to the surface by wave action. Nutrients from the deep water would increase algae bloom, which would suck up carbon dioxide and help cool the planet.

"It's a way of leveraging the Earth's natural energy system against itself," Lovelock speculates. "I think Gaia would approve."

Oslo is Lovelock's kind of town. It's in the northern latitudes, which will grow more temperate as the climate warms; it has plenty of water; thanks to its oil and gas reserves, it's rich; and there's already lots of creative thinking going on about energy, including, much to Lovelock's satisfaction, renewed discussion about nuclear power. "The main issue they'll face here," Lovelock tells me as we walk along Karl Johans Gate, the city?s main boulevard, "is how to manage the hordes of people that will descend upon the city. In the next few decades, half the population of southern Europe will try to move here."

We head down to the waterfront, where we pass Akershus Castle, an imposing thirteenth-century fortress that served as Nazi headquarters during their occupation of the city during World War II. To Lovelock, the parallels between what the world faced then and what the world faces now are clear. "In some ways, it?s 1939 all over again," he says. "The threat is obvious, but we've failed to grasp what's at stake. We're still talking about appeasement."

Then, as now, the lack of political leadership is what's most striking to Lovelock. Although he respects Al Gore's efforts to raise people's consciousness, he believes no politician has come close to preparing us for what's coming. "We'll be living in a desperate world in no time," Lovelock says. He believes the time is right for a global-warming version of Winston Churchill's famous "I have nothing to offer but blood, toil, tears and sweat" speech he gave to prepare Great Britain for World War II. "People are ready for this," Lovelock says as we pass under the shadow of the castle. "They understand what's happening far better than most politicians."

However the future turns out, Lovelock is unlikely to be around to see it. "My goal is to live a rectangular life: long, strong and steady, then a quick drop at the end," he says. Lovelock shows no signs of hitting his own personal tipping point. Although he's had forty operations, including a heart bypass, he still zooms around the English countryside in his white Honda like a Formula One driver. He and Sandy recently took a monthlong trip through Australia, where they visited the Great Barrier Reef. He's about to start another book about Gaia. Richard Branson has invited him on the first flight on the Virgin Galactic space shuttle late next year --"I want to give him a view of Gaia from space," says Branson. Lovelock is eager to go, and plans to take a test in a centrifuge later this year to see if his body can withstand the G-forces of spaceflight. He shuns talk of his legacy, although he jokes with his kids that he wants his headstone to read, HE NEVER MEANT TO BE PROSCRIPTIVE.

Whatever his epitaph, Lovelock's legacy as one of the most provocative scientists of our time is assured. And for all his gloom and doom, his notion of the planet as a single dynamic system remains a hopeful idea. It suggests that there are rules the system operates by and mechanisms that drive it. These rules and mechanisms can be studied and, possibly, tweaked. In many ways, Lovelock's holistic vision is an antidote to the chaos of twentieth-century science, which fragmented the world into quarks, quantum mechanics and untouchable mystery.

As for the doom that awaits us, Lovelock may well be wrong. Not because he's misread the science (although that?s certainly possible) but because he's misread human beings. Few serious scientists doubt that we're on the verge of a climate catastrophe. But for all Lovelock's sensitivity to the subtle dynamics and feedback loops in the climate system, he is curiously tone-deaf to the subtle dynamics and feedback loops in the human system. He believes that, despite our iPhones and space shuttles, we are still tribal animals, largely incapable of acting for the greater good or making long-term decisions for our own welfare. "Our moral progress," says Lovelock, "has not kept up with our technological progress."

But maybe that's exactly what the coming apocalypse is all about. One of the questions that fascinates Lovelock: Life has been evolving on Earth for more than 3 billion years -- and to what purpose? "Like it or not, we are the brains and nervous system of Gaia," he says. "We have now assumed responsibility for the welfare of the planet. How will we manage it?"

As we weave our way through the tourists heading up to the castle, it's easy to look at them and feel sadness. It?s harder to look at them and feel hopeful. But when I say this to Lovelock, he argues that the human race has gone through many bottlenecks before --and perhaps we're the better for it. Then he tells me the story of an airplane crash years ago at Manchester Airport. "A fuel tank caught fire during takeoff," Lovelock says. "There was plenty of time for everybody to get out, but many of the passengers wouldn't move. They just stayed there in their seats as they were told to, and the people who escaped had to climb over them to get out. It was perfectly obvious how to get out, but they wouldn't move. They died from the smoke or burned to death. And an awful lot of people, I'm sad to say, are like that. And that's what will happen this time, except on a much vaster scale."

Lovelock looks at me with unflinching blue eyes. "Some people will sit in their seats and do nothing, frozen in panic. Others will move. They'll see what's about to happen, and they'll take action, and they'll survive. They're the carriers of the civilization ahead."

James Lovelock. Originator of Gaia theory and inventor of the electron capture detector. Menu.Â â€œThe great rapidity with which we add carbon gases to the air is as damaging as is the quantity.â€ â€“ Climate Change on a Living Earth, a public lecture given at the Royal Society, 29 October 2007. â€œWe have to stop thinking of human needs and rights alone. Let us be brave and see that the real threat comes from the living earth, which we have harmed and is now at war with us.â€ Nuclear energy for the 21st Century, speech to the International Conference in Paris, 21â€“22 March 2005. â€œI think that we reject the evidence that our world is changing because we are still, as that wonderfully wise biologi James Lovelock. Photograph: Eamonn McCabe. Decca Aitkenhead.Â There's more than a hint of the controversialist in his work, and it seems an unlikely coincidence that Lovelock became convinced of the irreversibility of climate change in 2004, at the very point when the international consensus was coming round to the need for urgent action. Aren't his theories at least partly driven by a fondness for heresy? In Lovelock's view, the scale of the catastrophe that awaits us will soon become obvious. By 2020, droughts and other extreme weather will be commonplace. By 2040, the Sahara will be moving into Europe, and Berlin will be as hot as Baghdad.Â With hardship and mass migrations will come epidemics, which are likely to kill millions. By 2100, Lovelock believes, the Earth's population will be culled from today's 6.6 billion to as few as 500 million, with most of the survivors living in the far latitudes - Canada, Iceland, Scandinavia, the Arctic Basin.