

Gaia Theory: Model and Metaphor for the Twenty-first Century

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James Lovelock's "Gaia theory" is the most recent and complete rendition of the scientific view of Earth as a living system. Lovelock (2000: 11) has described Gaia as "the Earth seen as a single physiological system, an entity that is alive at least to the extent that, like other living organisms, its chemistry and temperature are self-regulated at a state favourable for its inhabitants." In *Scientists Debate Gaia* (2004: 3) he also characterizes Gaia as "a new way of organizing the facts about life on Earth, not just a hypothesis to be tested." Gaia Theory is both of these descriptors and more.

Earlier scientists presaged the idea of Earth as a living system. For example, Russian scientist Vladimir Vernadsky (1998, translated from 1926) discussed how processes at the level of the organism were reflective of processes in the biosphere, writing that "there is a close link between breathing and the gaseous exchange of the planet." In *Elements of Mathematical Biology* (1956: 16, originally published in 1924), ecologist Alfred Lotka wrote that "it is not so much the organism or the species that evolves, but the entire system, species and environment. The two are inseparable." Aldo Leopold, in a pioneering 1923 article (published in 1979: 140) entitled "Some Fundamentals of Conservation in the Southwest," wrote of "the indivisibility of the earth—its soil, mountains, rivers, forests, climate, plants, and animals," urging us to "respect it collectively not only as a useful servant but as a living being."

The Impact of Lovelock's Gaia

Forerunners notwithstanding, it was Lovelock who created a compelling and enduring research program into how our planet operates in ways *analogous* to a self-regulating organism. Heeding the advice of novelist

William Golding, Lovelock named his idea “Gaia” to reflect the fact that contemporary science is rediscovering early cultural views of the Earth as living being. The living planet metaphor has engendered both interest and controversy, raising challenging questions for science: in what sense is the Earth alive, how does the Earth work, and how do humans fit into this reality? Metaphor should not intrude unnecessarily into the exactitude of given scientific tests and processes nor should scientists subject metaphor to a rigorous peer-review process: both science and metaphor of the Earth as a living system *can* enrich and expand each other. This chapter submits that “pure science” (often referred to as Earth system science) and the “pure metaphor” (that of the Greek goddess of the Earth, but extending to the widely held indigenous view of the Earth as a living entity) are of great benefit to our contemporary world. Moreover the synergy between the science and the metaphor can add to our overall understanding of the planet without compromising the integrity of either.

In accepting the Philadelphia Liberty Medal at Independence Hall in 1994, Vaclav Havel alluded to this expansion of the scientific mind. He pointed to the Gaia hypothesis as a reason for his optimism about the future, referring to it as “postmodern—a science that in a certain sense allows it to transcend its own limits.” The image of a mythical living Earth, of which humans are a part, has already prompted valuable questions that scientists might not have dreamed about asking just a few decades ago; such a challenging enterprise will likely continue. Lovelock’s preface to his book, *Gaia: The Practical Science of Planetary Medicine* (2000), also contains an excellent overview of this and similar sentiments on science and metaphor.

Today, we possess unparalleled knowledge and technology for solving discrete problems and challenges. Whether it provides cures for diseases, the use of satellites for communication, or developments in space travel and biotechnology, modern science is unsurpassed in its ability to make things work. In the midst of this awesome power, however, humanity suffers some of the most entrenched and large-scale problems ever known; consequently, we are perched precariously on the edge of massive disruptions in energy availability, climate change, and food production. There are many reasons for this paradoxical juxtaposition of dire problems in the presence of unsurpassed knowledge: solutions to narrowly defined problems often cause new sets of problems; a perceived entrenchment of a cultural divide between “pure science” and “faith and values” has clouded effective understanding; and underlying

assumptions in technological developments often remain unquestioned, skewing progress down harmful paths instead of ecologically and socially healthy ones.

Many of our intractable problems stem from an imbalance between human activity (especially resource use) and the integrity of living systems. We stand in great need of an interdisciplinary understanding of how Earth systems work and how human systems can fit harmoniously; we also need a holistic context that will allow us to perceive and solve large-scale problems. Gaia theory offers both the knowledge and perspective required. In this chapter, I discuss both the science and metaphor of Gaia, including examples of their synergy, and then sketch the implications of Gaia theory for energy policy, global warming, and agriculture.

Gaia Theory Offers Interdisciplinary Context

Ecology, the science often referenced vis-à-vis environmental issues, is defined as the study of interrelationships among organisms and their environment. Gaia theory can then be viewed as the fullest expression of ecology available to us today. It provides a context in which the largest possible scope of interrelationships (including those involving human beings) can be examined because it views the surface of the planet as one living system. This was definitively *not* the science taught to most of us in high school and college—where we received an image of the Earth conveniently orbiting the sun at just the right distance so as to neither burn nor freeze.

One of the key examples of how Gaia theory transcends traditional biology and geology is the postulate that the Earth has reacted as a single, living system in response to the sun’s becoming hotter during the past 3.8 billion years. Pre-Gaian views of life on Earth reflected in biology and geology textbooks published over the past few decades explained the Earth’s atmosphere, for instance, by way of what Joseph (1990) called the “greenhouse metaphor.” This rather mechanical view examined the effects of human-made greenhouse gasses on the temperature of the Earth, but did not describe a dynamic system of feedback mechanisms. According to Joseph, a “membrane metaphor” suggested by Gaia theory is a more apt description; it views the Earth’s atmosphere as more analogous to the semi-permeable cell membrane than to the glass panes of a standard greenhouse. Physician and essayist Lewis Thomas (1974: 171) celebrated this idea in his book, *The Lives of a Cell*, in which he

wrote: "Viewed from the distance of the moon, the astonishing thing about the earth, catching the breath, is that it is alive.... Aloft, floating free beneath the moist, gleaming membrane of bright blue sky is the earth, the only exuberant thing in this part of the cosmos." The "membrane metaphor" represents a paradigm shift of scientific inquiry.

Pre-Gaian textbook science often did not address the fact that the sun's luminosity has increased at least 25 percent during life's tenure on Earth. Armed with a "greenhouse metaphor," it would have had to conclude that the Earth's temperature would have been expected to rise to levels impossible for life as we know it (Lovelock 1991, 2000). On the contrary, our planet has experienced a temperature regime much cooler than would be expected by its distance from the sun—around 40°C cooler, depending on the calculation (Lovelock 1979; Volk 1998; Schwartzman and Volk 2004). And, although there have been variations in temperature over time, the overall trend has been remarkably stable—a stability largely, if not mostly, attributable to living processes (Harding 2006). According to Gaia theory, it is the living system, consisting of tightly coupled organic and inorganic components, that has exerted this moderating influence on climate and other features of the Earth.

The maintenance of somewhat stable surface temperatures by the Gaian system, even in the face of increasing solar luminosity, may be regarded as *roughly* analogous to our own bodies that maintain a core temperature even as external temperatures change. The Earth's living system maintains conditions that are quite different than what would be expected through chemistry and physics alone. Among other factors, the living system heavily influences cloud formation, levels of carbon dioxide and other gasses in the atmosphere, and the color (and thus albedo) of the Earth's surface (Lovelock 2000, 2004). While Lovelock and some of his colleagues (e.g., Lenton 2004; Harding 2006) have characterized these moderating influences of life as "self-regulation," others, like Tyler Volk and David Schwartzman, have asserted that the idea of "self-regulation" is misleading since there are no system set points in terms of atmospheric gas composition, temperature regimes, or other factors (Volk 2003; Schwartzman and Volk 2004). At least part of the disagreement over self-regulation stems from the term's connotations of purpose. Some Gaian thinkers have tried to steer away from teleological implications by eliminating the concept of self-regulation altogether. Regardless of whether self-regulation is regarded as acceptable terminology, Gaian theorists certainly converge on the premise that life powerfully shapes surface conditions.

There is virtually no evidence of self-regulation around *unvarying* set points, nor evidence that self-regulation is equally strong for all factors. However, Lovelock (2000: 141) has used the term "homeorrhesis" to describe the dynamic stability of, for example, temperature, oxygen, and ocean salinity around *shifting* balance points over vast periods of time. "Gaia's history," he noted, is "characterized by homeorrhesis with periods of constancy punctuated by shifts to new, different states of constancy. With some variables, such as temperature, the changes are small... with others, such as gaseous abundance, the levels of homeostasis have progressively changed in steps." Oxygen, for instance, which was present in only trace amounts at the beginning of life, rose rapidly with the advent of photosynthesis and was stable over vast periods of time before increasing to new plateaus and staying relatively constant again for long geological periods (Lovelock 2000; Lenton 2004; Volk 1998).

Research by Lovelock and colleagues has shown that the Gaian system may moderate not only oxygen but other atmospheric gases, including methane, carbon dioxide, hydrogen sulfide, among many more. Some gas levels do indeed stay within narrow limits over significant periods of time. Oxygen has hovered around 21 percent in the atmosphere for at least the millions of years that large vertebrates (that require such levels) have been on Earth (Lovelock 2000, 2004; Volk 1998; Lenton 2004). Oxygen is consumed in great gulps in fires and in the oxidation of elements from the Earth's interior; it is exchanged in photosynthesis and respiration and is otherwise being pulled out of and added to the atmosphere. Given oxygen's great reactivity in both organic and inorganic processes, just the fact that oxygen levels have consistently remained very close to 21 percent over even a few million years can be regarded as a remarkable testament to the self-regulative tendency of the Gaian system.

Harding (2006) wrote extensively about how life heavily influences ocean alkalinity and salinity, temperature, and other environmental factors, all of which show remarkable stability. For instance, global cycles of calcium, phosphates, and sulfur are moderated by the activity of microscopic algae called coccolithophores. Through their metabolism and adaptations for maintaining salt balance in their own bodies, these tiny organisms release gases that influence cloud formation, form skeletons that are part of limestone deposition, and otherwise exert significant influence on the global system. Organic and inorganic processes form a seamless continuum in the new understanding of the living Earth articulated in Gaia theory.

Gaian-oriented research also provides a context within which we can account for all aspects of human biology as part of this seamless continuum. In a traditional ecological study of a pond, we would not arbitrarily decide to leave out the biggest fish or its behavior, for to do so would obviously constitute an incomplete study. Until recently, however, ecological studies have made scant reference to human activity and, even today, often leave out our behavior. In relegating determinants of our behavior (belief systems, metaphors, symbol formation, etc.) to completely separate fields such as philosophy and religion, we severely limit our understanding of not only our *relationship* to the Earth's living system but, indeed, of the living system itself.

The Metaphor of a Living Planet

When we conceive of human emotion as part of our biology, and thus as a part of the Gaian system, we can discern the value of metaphor and myth more clearly. Metaphor and myth may actually be biological adaptations unique to us as creatures with high levels of self-awareness and awareness of time. They are important parts of our behavior to understand and tap into as we move into an uncertain future. Our emotional connection with Gaia is profoundly affected by symbolism, stories, and myths, as it is by reasoning and scientific observation. Just as we need to be guided by compelling and accurate science, we also need to be moved emotionally by compelling and accurate metaphors.

Physicist Freeman Dyson placed great importance on human emotions, seeing them as integral to our relationship to the Earth. In *From Eros to Gaia* (1988: 343), he maintained that "the central complexity of human nature lies in our emotions, not in our intelligence. Intellectual skills are means to an end. Emotions determine what our ends shall be." Dyson recognized how the human brain's hardwiring is integrally linked to the prospects for a healthy relationship with the living system of which we are a part. He regarded "one hopeful sign of sanity in modern society" to be "the popularity of the idea of Gaia, invented by James Lovelock to personify our living planet. As humanity moves into the future and takes control of its evolution," he added, "our first priority must be to preserve our emotional bond to Gaia" (Dyson 1988: 345).

Joseph Campbell (1972), one of the world's foremost authorities on mythology, described mythology as "coeval with mankind," noting that myths are present in every culture, past and present, and exist because

of the evolution of an intense awareness of self and of one's own imminent death. In an interview with journalist Bill Moyers shortly before his death in 1987, Campbell shed light on the importance of incorporating the mythology of a living Earth into our society. In response to a question of whether new myths would come from "the Gaia principle," Campbell responded that "myths come from the realizations of some kind that have then to find expression in symbolic form. And the only myth that is going to be worth thinking about in the immediate future is one that is talking about the planet, not the city, not these people, but the planet and everybody on it. That's my main thought for what the future myth is going to be. And until that gets going, you don't have anything" (see Flowers 1988: 32).

Even the most practical of human endeavors make use of symbols and metaphor to create modern mythologies. NASA purposefully selected names like Mercury, Gemini, and Apollo for its missions. In 1960 Abe Silverstein, director of Space Flight Development, proposed that NASA's manned trip to the moon be named Apollo. After consulting a book of mythology one evening, he concluded that the image of "Apollo riding his chariot across the Sun was appropriate to the grand scale of the proposed program" (NASA).

Do the metaphor and symbolism of Gaia matter? Consider the words of Tim Flannery, author of *The Weather Makers* (2006: 17), a superb work on global warming. "Does it really matter whether Gaia exists or not?" he asked. "I think it does," he continued, "for it influences the very way we see our place in nature. Someone who believes in Gaia sees everything on Earth as being intimately connected to everything else, just as organs in a body. . . . As a result a Gaian worldview predisposes its adherent to sustainable ways of living." This is not to imply that believing in the metaphor or the science of Gaia necessarily predisposes *all* adherents or predisposes them *perfectly*. In fact many find Lovelock's own prescription of nuclear power to be contrary to sustainability. To be fair, however, Lovelock has long pointed to the "Three C's" (cars, chainsaws, and cattle) as the biggest impacts on the planet, a sentiment with which many concur who also take issue with his stance on nuclear energy. The point is that the science and metaphor of the Earth as a living system compel new views on how humans fit with that whole and, at least on balance, drive the search for self-preservation (read "sustainable") activities.

The metaphor of Gaia helps us to see beyond the blinders often set up by reductionist science. It allows us to intuit a living planet of stunning

beauty, vibrancy, and mystery where before we had seen a rock on which organisms lived at the mercy of physical and chemical circumstances—including a precise distance from the sun. Just as other metaphors help us grasp large or complicated ideas, Gaia allows us to empathize with a complex living system in ways that we are just beginning to understand. The metaphor of Gaia enables a cohesive inquiry into the nature of the living system while still debating whether regulation, self-regulation, homeostasis, homeorrhesis, or other terms are the most accurate and descriptive. And, in a very real sense, the metaphor of Gaia is a window through which we can connect with those before us who sensed the existence of a living Earth. No matter how far we may have come with our science, we are beginning to rediscover knowledge that our ancestors might have accessed in different ways.

The celebrated image of the Earth from outer space immediately calls forth a sense of limits. The world, which may appear to be infinite from the vantage point of being *on* the planet, is suddenly perceived as finite. After astronauts saw, photographed, and described the image of the Earth from space, terms like “thin film of life” and “tiny blue ball” have become more common in our communications, reinforcing the sense of limits. Gaian science also sheds light on limits and offers powerful lessons and insights for human endeavors.

Lessons from Gaia for Human Systems

We now understand key aspects of evolutionary change that have allowed life to persist in the face of various challenges ranging from ever-increasing solar luminosity to a simple exhaustion of food resources. Early in Earth’s history living things consumed the “primordial soup”—high-energy molecules thought to have been spontaneously formed due to the interaction of light/UV radiation with molecules in water. Some microorganisms consumed these molecules; some consumed other microorganisms. As these organisms multiplied, however, they could have come to a grinding halt when all available high-energy molecules in the form of the primordial soup and other organisms were digested—broken down into simpler, low-energy molecules.

Lynn Margulis and Dorion Sagan (1997), as well as Elisabet Sahtouris (1989), described developments at this point in the story of evolution that allowed life to transcend this dilemma. First, bacteria evolved the ability to photosynthesize—to use sunlight to re-energize the low-energy

molecules around them and turn them into food and useful energy. Purple photosynthesizing bacteria were the first to do this, using carbon dioxide and hydrogen or hydrogen sulfide as the raw materials for their bodies and energy for their activities. Subsequently, blue-green bacteria developed a more productive form of photosynthesis that used water in place of less common hydrogen molecules.

Second, when some larger organisms ingested blue-green bacteria, instead of breaking them down for food, which would result in more low-energy molecules, they evolved permanent interactive, physical partnerships with them. The chloroplasts (the solar energy-using packets) of plants all around us are the evolutionary remnants of free-living, photosynthetic bacteria that formed seamless symbiotic ventures with other organisms (Margulis 1998; Margulis and Sagan 2002). The endosymbiosis theory of cell evolution was elaborated by Margulis, inspiring her to endorse Lovelock’s Gaia, because the Gaian system pointed toward a larger symbiotic unity—symbiosis writ large, or perceived from the perspective of outer space.

Such realizations of how evolution works highlight at least two lessons applicable to human systems: the importance of emulating photosynthesis through the use of daily incoming solar radiation as the basis for our energy consumption, and the need to envision symbiotic systems for energy production and use. The first lesson is a study in limits. Energy use is perhaps the most important place to start for it drives and limits the growth of human systems. Fossil fuels and nuclear energy have been harnessed in huge amounts historically, resulting in unsustainable impacts on the planet, including and extending well beyond the impacts of their extraction and pollution. It is now evident that supplies of some of these fuels are becoming limiting factors for growth, resulting in a feverish search for alternative energy sources such as renewables and a revived (and expanded) nuclear industry. Further there is debate on just how much energy could be supplied practically by renewable resources. Citing “limits to growth,” McCluney asserted in a report for the Florida Solar Energy Center (2003: 12) that “it is clear that attempts to solarize the world economy are fated to run into serious obstacles unless population and per capita consumption are drastically reduced.” Contrary to this assessment, reports in 2007 for the American Council on Renewable Energy (ACORE), the American Solar Energy Society, and the Institute for Energy and Environment offered much more optimistic views that renewable energy can partially-to-mostly offset fossil fuels and nuclear

energy within two or three decades. Limits and challenges are noted, however, within these reports. For instance, the ACORE report qualified its predictions based on “right policies and conditions.” Other practical limits to renewable energy, such as storage and transmission capability, have also been widely discussed.

Regardless of the feasibility, capability, or pollution levels of future energy sources, however, a Gaian view of Earth as a living system reminds us that there are other limits as well, even if we successfully harness renewable energy supplies. In his Pulitzer prize-winning book, *Collapse: How Societies Choose to Fail or Succeed* (2005), Jared Diamond listed 12 major environmental problems that confront modern society including loss of natural habitat, loss of topsoil, water shortages, and others. He noted (p. 498) that “our world society is presently on a non-sustainable course, and any of our 12 problems of non-sustainability . . . would suffice to limit our lifestyle within the next several decades. They are like time bombs with fuses of less than 50 years.” Limiting our energy use, no matter from what source, strikes some as being a recipe for miserable human existence—the proverbial “freezing in the dark.” But this need not be the case.

Within the limitations imposed by the use of renewable energy, efficiency, and conservation will allow for comfortable and fulfilling human life. Efficiency and conservation are not the same, as can be illustrated in the construction and operation of a house. Orienting a house to the south, building a sunroom, installing insulation and heat-storing materials, and buying appliances and light bulbs that need less energy make a house efficient. Conservation, however, is largely about human *behavior*—making value-based decisions such as paying more for local materials or those with low-embodied energy, taking the time to operate windows and house fans in the proper manner, or heating and cooling to moderate levels only when necessary. Both conservation and efficiency become more feasible when we adopt the attitude that we are in a symbiotic relationship with the rest of the living system. This applies at the level of personal behavior and decisions; but to take hold and make a difference, conservation must become a shared ethic at the levels of culture and society. For human culture to be sustainable, we must find ways to conduct our affairs using just a fraction of the energy we use now—what Lovelock (2006) has called a “sustainable retreat.”

In the final analysis our ability to reduce energy consumption purposefully will be determined by our stories, myths, and symbols and

by whether they imbue in us a sense of limits. As Dyson (1988) and Flannery (2006) suggested, the metaphor of Gaia may be the best metaphor to inspire this change.

Global Climate Change

Over the eons living processes have incorporated carbon dioxide—the gaseous form that carbon takes in the atmosphere—into solid rock such as limestone (CaCO_3) and coal (largely carbon) and into other fossil fuels. With large amounts of carbon thus buried and sequestered away from reacting with oxygen, carbon dioxide levels began to decrease rapidly, from perhaps 95 percent of atmospheric gas when life began to the 0.03 percent it is today. Carbon dioxide is an effective greenhouse gas that traps heat in the atmosphere and slows its escape to space. Although the sun is about one-third brighter now than it was when life began, the thinning blanket of carbon dioxide (along with many other mechanisms) has resulted in surface temperatures that are much cooler than they would otherwise be. Life as we know it is dependent on this temperature regime. Viewing Earth as a living system allows us to see that this phenomenon of carbon-sinks is analogous to the healthy state of an individual organism. For instance, in healthy human beings, calcium resides largely in the bones and stays below certain levels in the bloodstream. The disruption of this balance causes the disease osteoporosis. Analogously, when huge amounts of carbon are released from solid carbon-sinks, an imbalance in the entire system occurs. Although the Gaian system will adjust to a new equilibrium, many organisms (including human beings) that are dependent on current conditions may not fare well (Tickell 2004). Keeping carbon in its buried or otherwise sequestered form is healthy for human beings.

Lovelock favors nuclear energy as a short-term energy solution because he considers it the only way to prevent catastrophic global warming. In his more recent book, *The Revenge of Gaia* (2006), he argues that levels of energy (and other resource) consumption *will* have to be radically lowered in the near future, no matter what energy path we follow. He describes a future in which travel occurs in sailboats and food is synthesized so that farmlands can be returned to their natural and semi-wild conditions. Many might take issue with this view of the future. Indeed the dominant economic model of modern Western society (one that shows constant growth) compels visions of a much more resource-intensive world; with just a 3 percent economic growth (considered a

modestly healthy rate), however, the economy would double in 23 years! Even allowing for economic growth not tied entirely to resource use, such growth will stress the Earth's living systems tremendously in ways not conducive to the well-being of humanity and countless nonhuman species.

There is no doubt that carbon dioxide emissions need to be curbed drastically, but if we rely solely on a transition from fossil fuel to nuclear energy to affect this change, will we be able to wean ourselves from the need for constant growth? With the massive power of nuclear energy at our fingertips, what is to prevent us from immediately bumping up against *other* critical limits, especially given that we are already at tipping points on many of them? What will prevent us from converting more forest and marsh to farmland, more living material into just so many consumer goods, or otherwise impoverishing living systems? The answer is *nothing*—unless retreat from this runaway growth becomes our stated and serious goal. We must develop a conservation ethic that flows from our scientific understanding of the Earth as a living system.

The view of the Earth as a living system speaks directly and powerfully to conservation because of the central realization of limits that it spawns. Conservation—an actual reduction of energy and resource consumption—should be at the forefront in any serious solution for global warming and in our attempts to live sustainably *as part of* the Earth. I believe Gaia theory points us in the direction of renewable energy for most of our energy needs. Whether we make this transition quickly or whether we stay reliant on today's predominant energy sources indefinitely, our main goal must be to use *far less* energy overall. If we do not effect this change now with relatively little pain, we may be forced to do so soon enough but in an uncomfortable manner.

Agriculture

Agriculture is perhaps the most important relationship between human beings and the Earth as a whole wherein the transition to food production based on inherent limits of the living system may be our biggest challenge. Lovelock (2000) has argued that “by far the greatest damage we do to the Earth, and thus by far the greatest threat to our own survival, comes from agriculture.” In fact one reason that Lovelock is a proponent of nuclear energy is that he sees the alternative of biofuels as untenable—a view with which more and more scientists and experts seem to agree. There may not be enough farmland to feed a growing human population, let alone to provide large amounts of energy.

But what about the energy needed *for*, not provided *from*, modern agriculture? This looms as a limiting factor potentially as serious as global warming or energy policy. Modern food systems require huge inputs of energy for field preparation, fertilization, harvest, transport, and storage. All these are extremely tenuous because small disruptions or shortages (especially during critical stages of the farming process) could result in enormous food shortages. Even if energy considerations were somehow neutralized, the transformation of forest, marsh, bog, and other ecosystems into farmland is a significant and unsustainable impact in itself. In the context of the Earth's living system, these ecosystems play roles analogous to organs in a body: providing crucial functions such as filtering, nutrient transfer, and gas exchange. By comparison, farmland is relatively sterile and non-diverse with less capacity to “control its own climate and chemistry” (Lovelock 2000). Either experiencing longer term fuel shortages or reaching tipping points in the loss of functioning of the Earth's ecosystems could be catastrophic without significant prior planning because the skills necessary for local food production are not possessed by the population at large.

Fortunately, these skills are not lost to all. The imperative of accelerating local food production, using low-energy, ecological inputs, may be as important and time-sensitive as that of reducing greenhouse gases. A Gaian viewpoint compels knowledge of place because understanding local ecosystems provides a microcosm for understanding Earth as a whole, and vice versa. Individual places on Earth hold different potentials for all aspects of human existence—from climate to the availability and types of energy, water, and soil. The homogenized and mechanized agro-industrial approach does not take into account local knowledge and relies on massive inputs of energy, fertilizer, pesticides, and water usually from places far away. In *Deep Economy* (2007), Bill McKibben examined the challenges and rewards of local economies, especially for local agriculture. He charted the trends of farm and food businesses and noted that while food has become cheap and plentiful, much of this gain has come at the expense of the environment, local communities, and the poor.

A Gaian approach is needed. We must design and run farms as intricate ecosystems that are part of larger systems up to and including the entire Earth. This will enable farmlands to mimic, to the greatest extent possible, local and wild ecosystems rather than simply displace them. Many robust, exciting, and successful examples of this kind of farming

can be found. For instance, the Land Institute (based in Salina, Kansas) is developing diverse perennial grain production systems that closely mimic the form and function of its native ecosystems. The organization has promoted the “big idea that humans can make conservation a consequence of production—in any region on the planet—if we use as our standard the ecosystems that existed in that region before it was utilized by humans.” Part of the Land Institute’s mission states that “when people, land, and community are as one, all three members prosper (Land Institute).”

Joel Salatin’s family farm (named Polyface) is unique in Virginia’s Shenandoah Valley. Attention to place and local natural processes is an intricate part of every operation on the farm, from its “pigaerator” system for producing compost to its cyclical system of running livestock and chickens on fields. The Salatins maintain that “mimicking natural patterns on a commercial domestic scale ensures moral and ethical boundaries to human cleverness.” They do not ship food because they believe that “we should all seek food closer to home, in our foodshed, our own bioregion” (Polyface, Inc.). Although initially Joel Salatin was not aware of Gaia theory, his farming methods are so intensely “systems-based” that he was invited to speak at an October 2006 conference outside Washington, DC, that centered on Gaia theory. His talk was one of the most popular presentations, and the question-and-answer session that followed extended for hours as attendees sought to draw parallels between our understanding of natural systems and agriculture. Michael Pollan featured Salatin’s work in his book *The Omnivore’s Dilemma* (2006), and juxtaposed it with farming techniques used by large-scale (industrial) corn and beef production. Experimentation and inquiry, such as those outlined above, should be ramped up in both the private and public sectors, for agriculture is essential to our own survival and has tremendous impacts on the living system as a whole.

Conclusion

The land is alive both metaphorically and in a robust scientific sense. Gaia thinking allows us to apply this worldview to all aspects of human life. No matter what our endeavor—whether food production, energy choices, or general economic activity (including our modes of recreation and leisure)—we must not push the living system to new equilibrium

points that are not conducive to human life and healthy ecosystems. Gaia theory can be the model and the metaphor that guides us through the twenty-first century’s most pressing problems, letting us emerge with a greater understanding of ourselves and the Earth of which we are a part. As Elisabet Sahtouris (1989: 23) offered, “once we truly grasp the scientific reality of the Gaian organism and its physiology, our entire worldview and practice are bound to change profoundly, revealing the way to solving what now appear to be our greatest and most insoluble problems.”

With a Gaian worldview we may be able to transcend misleading divides between disciplines, as well as transcend any false dichotomy between humans and nature. We can celebrate the incredible beauty of the Earth with a newfound sense of joy born of the realization that we belong to it. We can blend a powerful scientific understanding of our planet as a living entity with rediscovered metaphors and stories of our ancestors to best understand our relationship to our living planet and to promote decisions in a conservation state of mind.

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