32 Thinking like a planet: Gaian politics and the transformation of the world food system

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Science influences culture not only through its contributions to technological development, but also through the concepts and metaphors it offers for enlivening social, political, economic, and ethical life. From the eighteenth century onward, the Newtonian world of atomistic bodies in motion was grafted onto a socio-political philosophy of possessive individualism.[1] Beginning in the late nineteenth century, metaphors from Darwinian biology infiltrated social, political, and economic discourse. With the emergence of environmental awareness in the late twentieth century, the language of ecology quickly found its way into political discourse, and its metaphors of biologically rich networks and interdependence found a happy home in the budding field of environmental ethics. As early as 1949, Aldo Leopold, a prescient wildlife ecologist, established the discursive context for this new field when he made the radical shift from an anthropocentric to a biocentric ethics. According to his "land ethic," "a thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise."[2] Leopold further advised his readers to "think like a mountain." In other words, before acting, consider the web of relationships among organisms and their environing rock, soil, water, air, and sun that will be affected.

Yet, however ancient and massive it might be, a mountain remains a local phenomenon, while many of our most pressing problems are global. "Think globally, act locally," the saying goes, but just how do we think globally? Gaia theory, an interdisciplinary scientific perspective that understands Earth holistically as an integrated, self-regulating biogeochemical system, offers a rich portfolio of concepts and imagery for "thinking globally." The theory, first proposed in 1970 by British chemist James Lovelock, has developed from a controversial hypothesis to a broadly accepted set of ideas about the deep interpenetration among Earth's physical, chemical, and biological features. By virtue of its whole-systems understanding of our planet's functioning, Gaia theory offers both practical and philosophical guidance for addressing what is likely to become the preeminent question of the twenty-first century: how to harmonize human systems with the larger Earth system.

From the beginning, Gaia theory was as much a cultural phenomenon as it was a scientific hypothesis. In response to his first book, Lovelock was astonished to receive twice as many letters from people intrigued by its religious and spiritual aspects as from those with a more scientific bent.[3] Gaia theory awakens us to the crucial fact that human systems are embedded in and utterly dependent upon a greater whole, a fact that for many evokes a sense of wonder and awe. In a wider cultural context, Gaia theory serves not only as a model depicting the co-evolution of life and Earth's geophysical systems, but also as an archetypal metaphor for wholeness, interconnectedness, and belonging.

[1] Macpherson 1962.
[2] Leopold 1949, 204.
[3] Lovelock 1979, xi.

Gaia theory has come on the scene just as the twin phenomena of globalization and environmental destruction compel a planetary perspective on human systems. If the task, then, is to harmonize human systems with the Earth system, how might Gaia theory inform our efforts? The following section offers a socio-political reading of Gaia theory, tracing some implications of three qualities of living systems – holism, autopoiesis, and symbiotic networks – for human systems. Unlike Gaia's great biogeochemical cycles, the global economy functions on a linear model that moves from resource extraction to production to consumption to waste. Yet the generativity of living systems can only be sustained for so long under a linear model. Ultimately, sustainability requires thinking in circles.

Given that human systems are ultimately a subset of Gaia and that our global economy is now producing Gaian-scale perturbations, we might wish to identify (and perhaps rectify) the weakest link in our systems. The second half of this chapter suggests that the world food system is already showing signs of being that most vulnerable link. The convergence of industrialized agriculture and political institutions rooted in a free-market ideology has spawned an exceedingly complex global food economy that enables billions of people to eat food they could never have eaten in the past. Yet, as the 2008 world food crisis signaled, this system is becoming increasingly susceptible to catastrophic disruption. Agriculture, probably more than any other human endeavor, is responsible for destabilizing our planet's carbon, nitrogen, phosphorus, and water cycles. Gaia, however, is not at risk, as I argue in the next section. With or without us, "she" will find a new equilibrium; meanwhile, it is we who must find a way to feed ourselves within her limits. Nonetheless, there is reason for optimism. A Gaian analysis also reveals that the world food system may be the best point of intervention for harmonizing human systems with the Earth system.

A Socio-political Reading of Gaia Theory

Gaia is more than a testable scientific hypothesis. It conveys a philosophical view of Earth as a living, self-generative system, a view with both ancient roots and potentially far-reaching implications as planetary perturbations escalate in the coming decades. Throughout history, the perception of Earth as a living, intelligent being was widespread and perhaps even the norm. After the scientific revolution, however, the "living Earth" persisted only as minority perspective. As Bruce Scofield and others have argued:

> The seventeenth century was witness to a momentous shift in natural philosophy. The Earth was no longer perceived as living; it was dead and quantifiable, and this was very much in tune with the agenda of the rising forces of capitalism. The idea of matter as living and the cosmos as interconnected was not a view that supported this new capitalistic agenda. Dead nature, on the other hand, was more convenient; it presented no moral conflicts in regard to exploitation for profit.[4]

After Descartes, Western science and philosophy generally understood the world as a machine, a view that has been increasingly globalized in recent decades. Yet, in the larger context of human thought, including the West, the mechanistic view of nature is an aberration.

Ironically, the Gaia hypothesis was born from the search for extraterrestrial life. Lovelock's analysis of the atmospheres of Mars and Venus for NASA (National Aeronautics and Space Administration) in the 1960s, yielded a fresh look at Earth's highly anomalous atmosphere. The

[4] Scofield 2004, 157. For further discussion of the modern shift from an organic to a mechanistic worldview, see Merchant 1980.

"amazing improbability of the Earth's atmosphere" includes the persistence of highly reactive oxygen and methane in constant quantities and carbon dioxide in minute quantities. Approximately one billion tons of methane and two billion tons of oxygen must be introduced into the atmosphere each year, and the only explanation he could find was "the invisible hand of life." Most of Earth's atmosphere, it turns out, recently existed as parts of living cells. Likewise, life has kept Earth's temperature in a relatively narrow range for 3.5 billion years, even as the Sun increased its output by at least 30 percent. Gaia theory postulates that life does not merely adapt to its environment; it co-creates its environment. "Life, therefore, is a property of planets rather than of individual organisms."[5] Our blue planet functions much like a supraorganism with internal metabolic systems of temperature and chemical modulation, enveloped by an atmospheric membrane that separates it from an otherwise lifeless Solar System.

Gaia theory articulates "a new iteration of an old intuition" – the ancient Earth goddess, reborn late modernity. Yet while Gaian holism corroborates a planetary perspective, it also tempers that perspective with a strong cautionary note. The fossil-fuel-driven extravaganza of globalization has opened a Pandora's Box of global changes, compelling us to situate our lives at every level, from the household to global governance, within the systemic logic of Gaia.

Systems theory is a conceptual tool for separating one part of the universe from the rest in order to understand how it operates under various conditions. There are three broad types of systems.[6] Hard systems include electrical grids, machines, and transport systems. Because of their linear logic, they do well in terms of short-term efficiency, predictability, and performance. Living systems, of which Gaia is the largest known instance, are nested systems of biota and their environments. The emergent properties of these complex systems transcend the linear logic of purely physical systems, requiring a more dynamic and holistic approach. Soft systems encompass the full panoply of human institutions: marriage, warfare, schools, corporations, governments, clubs, and so on. The human faculties of perception, intention, interpretation, and imagination, however, make soft systems far more complex and dynamic than other living systems. Interestingly, the global repercussions of hard-systems thinking are becoming evident just as living-systems thinking, including Gaia theory, counsels an alternative.

Living systems theory offers several core concepts that can help to steer human systems toward sustainability; Gaia endows these with a planetary scope. Holism helps us to see that systems are more than the sum of their parts. Autopoesis, or the self-generative quality of living systems, ensures systemic continuity through constant change. Symbiotic networks entail a reciprocal entanglement of Earth's organic and inorganic parameters, propelling Gaia's great nutrient-waste cycles.

Holism

In popular parlance, holism means that the whole is more than the sum of its parts. In other words, systems have emergent properties such that their behavior is not reducible to their component parts. An organism, for instance, is qualitatively different from the sum total of its cells or organs. In brain science, cognition is an emergent property of neural networks. Likewise, Gaia's emergent properties arise out of the interaction of Earth's atmosphere, lithosphere (soils and rocks), hydrosphere, and biosphere.

[5] Morowitz 1992, 6. This does not mean that Earth is literally alive; rather, like an ecosystem, it functions as a living system.

[6] This threefold typology is adapted from Checkland 1981; and Madron and Jopling 2003, 30–31.

Humanity is now operating on a Gaian scale. The rate of species extinction is between 1,000 and 10,000 faster than in the pre-industrial era, rivaling the last great wave of extinctions 65 million years ago.[7] Climate scientists predict that global temperatures will rise between 1.5 and 6 degrees Celsius in the coming century, a warming on the order of the shift from the depths of the last ice age to the present interglacial period.[8] All of the key Gaian biogeochemical cycles are being altered by human action. As Robert Clark argues, a globalized humanity is gradually outcompeting other life forms. Since 1860, the proportion of terrestrial biomass represented by humans and their domesticated animals has quadrupled from 5 to 20 percent, and may rise to 60 percent in the next 50 years. Globalization has been "a tragedy for terrestrial life forms" and its long-term success, even for humanity, is far from assured.[9]

Some environmentalists criticize Gaian holism because they believe it encourages complacency. Lovelock's early claims that Gaia would patch up the ozone hole reinforced this uneasy relationship between greens and Gaia.[10] Yet complacency would be a tragically shortsighted misreading of Gaia theory. While some may find solace in the fact that Gaia always establishes a new homeostasis after each "catastrophe," any future equilibrium state will almost certainly be far less favorable for humans than the present one. Human civilizations emerged in a rare inter-glacial period in which species diversity was probably at its all-time high. A healthy dose of prudence is therefore in order. "Gaia is stern and tough," Lovelock cautions, "always keeping the world warm and comfortable for those who obey the rules, but ruthless in her destruction of those who transgress."[11] Gaia theory is helping to uncover those rules.

Gaia theory's holism contributes to political thinking in two ways. First, prioritizing the functioning of the Gaian system as a whole calls into question both anthropocentrism and individualism. Second, Gaia theory is at once resonant with *and* challenging of globalization, calling for a planetary perspective while casting doubt upon the long-term viability of globalization's current trajectory.

Autopoiesis

Living systems, including human systems, are autopoietic ("self-making," from the Greek). They continually regenerate themselves, undergoing constant change while preserving their web-like pattern of structural integrity.[12] Through a constant influx of energy (in Gaia's case, from the sun), a living system can counter the tendency towards entropy. Gaia's fundamental autopoietic processes were devised when bacteria colonized the planet during Earth's first two billion years: reproduction, photosynthesis, fermentation, nitrogen fixation, respiration, and locomotion. Gaia theory predicts long periods of stability until some drastic change, like an asteroid impact, precipitates a crisis and a subsequent systemic shift to a new geochemical equilibrium.

Human systems, the largest being the global economy, are also autopoietic.[13] Unlike Gaia's great biogeochemical cycles, the global economy operates principally on a linear model that

7 United Nations Environment Programme 2002.
8 Intergovernmental Panel on Climate Change 2006.
9 Clark 1990.
10 Shannon 1991.
11 Lovelock 1990, 212.
12 Maturana and Varela 1998.
13 Luhmann 1990.

moves from resource extraction to production to consumption to waste. Yet self-generativity can only be sustained for so long under a linear model. Ultimately, sustainability requires thinking in circles.

Gaia theory predicts that when a species' actions favor both its environment and itself, it will tend to spread. We may therefore be tempted to optimistically infer from humanity's rapid globalization that our activities are favorable to (or at least compatible with) Gaia. This logic ignores the fact that Gaian time scales are vastly longer than human concepts of time. A period of 100,000 years dwarfs human history, yet represents only 0.003 percent of Gaia's lifespan. Human-induced climate change will persist for millennia, scientists predict, but only in 1996 did they reach a consensus that it has begun. The sobering fact is that we are running a planetary experiment, the results of which are unpredictable.

The concept of autopoiesis raises an important philosophical question. If a living system somehow "makes itself," does it do so purposefully? Because it hinted at such a possibility, Lovelock's original Gaia hypothesis met with intense criticism. He countered with a purely biophysical model showing how a planet could regulate its temperature cybernetically, without any intentionality.[14]

Purpose, however, is essential to human systems. While a human system's purpose might be misunderstood, ignored, debated, and even obscured, reconfiguring the system from its base requires identifying its purpose(s) and implicit values. The global economy is self-generating, but does it have an orienting purpose? Growth, development, prosperity – these are different words for what many would agree is the system's underlying purpose. Some might say that economic growth is only a means to a greater purpose of increasing human happiness, but the link between wealth and happiness is a murky one at best. Growth as the system's purpose is evident in its almost universal acceptance – across the political spectrum from left to right, and around the world from to North to South. Even amid radical disagreement on how to pursue economic growth, we find a striking consensus on its desirability. Yet because infinite growth on a finite planet is impossible, this purpose will inevitably get us into trouble.

If human systems are to persist as a global subsystem of Gaia, then we shall need to align our purposes with the functioning of Gaia. The longer we wait, the greater the risk. Reconfiguring the current system entails rethinking our purposes beyond the growth imperative. To borrow from Leopold, preserving the integrity and stability of the Gaian system must become a core human purpose. This need not preclude other purposes, such as justice or the growth of knowledge; these, indeed, are essential to viable human systems.

Symbiotic Networks

Gaia theory depicts the Earth system as a vast autopoietic network of interlinked communities. In this sense, Gaia, like other living systems, is inherently social in the sense that it comprises nested collectives. Every organism within Gaia, including the human body, contains the heritage of billions of years of interaction among sunlight, soil, air, water, and the biosphere. Living systems, including human systems, are autonomous only in the sense that they maintain some degree of structural integrity. This radical concept of systemic interdependence stands in contrast to modern political and psychological notions of human independence. Just as modern psychology is oriented towards the autonomous ego, modern political thought is premised on individual rights and state sovereignty. Yet, as Gaian scientists observe, "independence is a

[14] Lovelock 1990, Chapter 3.

political, not a biological term."[15] Even the "individual" person is host to and utterly dependent upon billions of bacteria. Likewise, human well-being depends upon the ceaseless generative and decompositional work of plants, phytoplankton, bacteria, fungus, and earthworms.

Living systems are constituted through symbiosis, whereby dissimilar entities coexist in a mutually beneficial arrangement. Contrary to the neo-Darwinist view of life as a harsh competition for survival, Gaia theory understands cooperation as much more the rule. Bacteria, the most long-lived class of organisms and the basis of all subsequent life, "live by collaboration, accommodation, exchange, and barter."[16] At the macro-scale, Gaia is the result of eons of symbiogenesis.[17] In the words of microbiologists Margulis and Sagan, "Life did not take over the globe by combat, but by networking."[18]

On a global scale, the human system comprises innumerable networks of communication in the arenas of production and consumption, diplomacy and warfare, advertising and entertainment, education and ritual, none of which could function without cooperation. Yet the driving force of the global economy is competition: firms compete with one another for resources and markets; workers compete for jobs; countries compete for investment. Indeed, the individualistic race to extract resources and transform them into consumer products, waste, and profits is often legitimated in the Darwinian language of "survival of the fittest."

This linear model is profoundly at odds with ecology. In living systems, one species' waste is always another species' food. Likewise, Earth's major nutrients – carbon, hydrogen, oxygen, and nitrogen – are continually recycled. For Gaia, there no "out there" into which "waste" can be dumped. Yet industrial societies are based upon "the toilet assumption," the implicit belief that waste can be simply "flushed away."[19]

Ecological principles based upon cyclical processes and symbiotic networks, however, are being (re)introduced into human systems. The recent growth of consumer-based recycling is one such trend, although it has not served to decrease overall consumption or waste production.[20] *Virtuous cycles*, as opposed to vicious cycles, move toward the elimination of waste.[21] Some promising examples include zero-emissions production processes, community-supported agriculture, and "cradle-to-cradle" design. In contrast to the linear industrial model, the emerging field of ecological design "introduces us to an era based not on what we can extract from nature, but on what we can learn from her."[22] Likewise, symbiotic social networks are generating a host of virtuous cycles.[23]

Applying Gaia principles to human systems will require an epic shift, reorienting our thinking and actions toward a participatory embeddedness in the greater whole. Principles of ecological design and symbiogenesis would become foundational rather than peripheral, sparking revolutionary changes in architecture, transportation, farming, financing, and industrial practices.

15 Margulis and Sagan 1995, 26.
16 Thomas 1974, 6–7.
17 Margulis and Sagan 1995, 156.
18 Margulis and Sagan 2001, 11.
19 Slater 1970.
20 Recycling "works within the same system that caused the problem in the first place, merely slowing it down with moral proscriptions and punitive measures." McDonough and Braungart 2002, 62.
21 Madron and Jopling 2003, 35.
22 Beynus 1997, 2.
23 See Botsman and Rogers 2010; and 350.org.

A Note on Global Justice

Because Gaia's "big picture" perspective displaces anthropocentrism, we might be tempted to sidestep the thorny questions of justice and equity and get on with the business of "saving the planet." Again, however, it turns out that Gaia underscores the human questions. When we could naively assume that infinite growth on a finite planet was possible, we could also imagine that development would eventually be universalized. Today, we are faced with the dawning awareness that the overconsumption of the North cannot be globalized without destabilizing Gaia. Developing countries, representing 80 percent of the human population, are the wave of the future. They will not voluntarily change their development trajectories in the absence of a compelling moral and practical exemplar, nor without financial and technological assistance, from the wealthy countries. Justice, therefore, becomes a matter of "geoecological realism."[24] While Gaia's planetary perspective may undercut humanism in the big picture, the pragmatic requirements of moving toward sustainability have the surprising effect of highlighting questions of justice and equity. Gaia's planetary perspective reminds us that we are all in this together. Importing Gaian insights into the social arena requires, therefore, that we pay attention to the needs and aspirations of those who are less well off than ourselves.

The World Food System through a Gaian Lens

If human systems are out of sync with the Gaian system, as most environmental trends indicate is the case, then it makes sense to consider three questions: which of these systems have the greatest impact on the Gaian system, which are most vulnerable from a human security standpoint, and which are most amenable to constructive change. In this section, I argue that, with respect to each of these questions, the world food system warrants attention. According to the UN Millennium Ecosystem Assessment, agriculture is a greater threat to biodiversity and ecosystem function than any single human activity.[25] To my knowledge, no other global human system is as deeply implicated in destabilizing all of the great Gaian cycles, nor is any so utterly essential to the daily sustenance of every person. Most promising, however, are the myriad benefits for both human and ecological communities, from the local to the global, of a living-systems approach to food.

Over two hundred years ago, Thomas Malthus famously predicted that population growth would eventually outpace the ability of industrial societies to feed themselves. What Malthus did not foresee was that agriculture itself would become industrialized, reliant upon heavy machinery, petrochemical inputs, the hybridization of high-yield seeds, a vast transportation infrastructure, and a highly specialized division of labor. Today's tightly networked world food system manages to feed 7 billion people. That system, however, is showing signs of stress, as is the larger Earth system of which it is a subset – and those stresses are, in many cases, mutually reinforcing. The world food system is destabilizing the great Gaian cycles even as it is utterly reliant upon them.

Prior to the modern era, most people were engaged in the growing and harvesting of food. Even up until the twentieth century, most Americans lived on farms. Today, fewer than 2 percent do, and the average age of the US farm operator is 55.[26] A similar demographic shift, albeit to a lesser extent, has occurred throughout the world – in developing countries, within a few

[24] Athanasiou and Baer 2002, 74.
[25] Jackson 2010, 134.
[26] Allen and Harris 2005, 1

decades. Today, cropland and pasture cover 37 percent of Earth's land area while most people live in cities.[27]

Oil is the lifeblood of the world food system. The farm machinery that tills the soil, plants the seeds, and harvests the crop runs on petroleum. Virtually all of the fertilizers, pesticides, and herbicides that have increased crop yield as much as tenfold over pre-industrial yields are petroleum derivatives. The transportation network of trucks, trains, cargo ships, and airplanes that carries commodities from farm to fork, increasingly by way of processing factories, is almost entirely powered by petroleum. Small wonder, then, that food is cited as the number one source of greenhouse gas emissions, quite likely greater than transportation, domestic energy use or manufacturing.[28] And it is easy to see how this situation emerged: just one large spoonful of the stuff is equivalent to eight hours of manual labor.[29] As a species, we are now burning black gold at a rate approaching 90 million barrels per day, with a large portion of that sum being poured into the world food system.[30]

From a living-systems perspective, our oil-dependent food system is inherently problematic on both ends. With respect to inputs, petroleum is the non-renewable resource *par excellence*, fueling the extraction of countless other non-renewables, including the gargantuan quantities of fresh water required by industrial farms. While the year when global oil production peaks before the inevitable decline will not be known for some years after the fact, "peak oil" seems to have occurred in 2006.[31] From a Gaian perspective, dredging up fossil fuels from beneath Earth's crust and burning them introduces, in effect, geological time scales into the dynamics of the atmosphere and the biosphere. Human civilizations, including the agricultural systems upon which they were based, developed during the last 10,000 years, a period nicknamed "the sweet spot" by one climate scientist.[32] Given this fact, prudence might be in order when tampering with Gaia's carbon cycle.

Even if policy responses are slow and inadequate, Gaia's carbon cycle has at least been elevated to the international political agenda. The same cannot be said of the global nitrogen cycle, although some scientists believe that it is an equally pressing problem. Human activities have more than doubled the amount of nitrogen stored in the biosphere, resulting in acidification and eutrophication of freshwater systems all over the world.[33] With approximately 80 percent of anthropogenic nitrogen emissions coming from fertilizers, meat production, and the cultivation of nitrogen-fixing legumes (primarily soy),[34] the primary point of intersection between human systems and Gaia's nitrogen cycle is agriculture. Unlike petroleum, however, nitrogen is not a scarce resource: it comprises most of the atmosphere, although its production is extremely energy intensive. The Gaian problem is that millions of tonnes of the stuff are being transferred from the atmosphere to the biosphere each year, with catastrophic consequences for freshwater, coastal, and forest ecosystems.

The world food system has also ramped up the tempo of the global phosphorus cycle. An essential nutrient for plants, this mineral constitutes only 0.1 percent of Earth's crust. Until the late twentieth century, the phosphorus cycle, moving from rock to soil to plant to waterway to

27 Matthews and Hammond 1999, 11.
28 Hertwich and Peters 2009, 6414.
29 Homer-Dixon 2006.
30 International Energy Agency 2011.
31 International Energy Agency 2010.
32 Cited in Aitken 2010, 129.
33 Matthews and Hammond 1999, 12–19.
34 Vitousek et al. 1997.

ocean to sediment, probably took millions of years to complete.[35] Since the advent of industrialized agriculture and modern mining technologies, prodigious quantities of phosphorus have been unearthed, making their way from mines in a handful of countries into farms and waterways throughout the world within a few years. As with nitrogen, one result is extensive eutrophication of freshwater systems. What the long-term consequences of this planetary experiment might be, it is too early to say, but clearly the experiment is underway.

A similar experiment is underway with respect to fresh water, which constitutes only 1 percent of the potable water available for the entire biosphere. With agriculture accounting for most of humanity's water consumption, the world food system comes into focus once again. Prior to the advent of industrialized agriculture, virtually all of Gaia's fresh water was replenished through the natural cycles of rainfall, evaporation, and respiration. The petroleum revolution made it possible to drain rivers and lakes and mine groundwater on an unprecedented scale – particularly in the vital farmlands of China, India, North Africa, the Middle East, and the US. The annual depletion of the immense Ogallala aquifer beneath the midwestern US, for instance, is equivalent to the annual flow of 18 Colorado Rivers.[36] There is little doubt that water will be a political flashpoint as the human population approaches 10 billion in the coming decades.

Petroleum, the lifeblood of the world food system, plays a key role in anthropogenic perturbations of Gaia's carbon, nitrogen, phosphorus, and water cycles. It is, moreover, an eminently non-renewable resource, and therefore likely to play a key role in triggering international food crises. That likelihood became evident in 2008, in the wake of US and EU "clean energy" initiatives that shifted millions of acres of farmland into ethanol and biodiesel production, driving up grain prices and sparking food riots in some 40 countries.[37] The policies were aimed at promoting energy independence and reducing greenhouse gas emissions, with little consideration for the agricultural consequences beyond farm subsidies. But from a systemic perspective, the crisis was no surprise. A host of systemically linked factors, from World Trade Organization agricultural policies to urbanization, have rendered many developing countries highly dependent upon grain imports. What *was* surprising was how *quickly* events unfolded, an indication of how tightly networked the world food system has become. Yet in the aftermath of the 2008 crisis, virtually no institutional responses were implemented to prevent similar crises in the future.

The picture, however, is not altogether gloomy. If agriculture is the *primary point of intersection* between human systems and Gaia, then it may also be the *best point of intervention*. Because the world food system is implicated in destabilizing all of the great planetary cycles, eating itself is a Gaian action. The task at hand is to transform the world food system into a viable subset of Gaia, which means approaching it as a holistic and autopoeitic living system rooted in symbiotic networks. This is a tall order, no doubt, but evidence from food movements around the world reveals that it is already happening. School gardens, farmers markets, slow food enclaves, fair trade initiatives – all of these speak to a growing dissatisfaction with the industrialized food system. As we saw earlier, the key to sustainability is thinking in circles, and this is precisely what the new food politics is about: linking human and biotic communities

[35] Carpenter and Bennett 2002.
[36] Harwood 2010, 151–3.
[37] For an analysis of the crisis, including the complicating role of speculation and a handful of weather-related crop failures, see Clapp and Cohen 2009. Ironically, because of the central role of petroleum at every stage in the biofuels commodity chain, especially corn-based ethanol, its energy balance may negative. See Weis 2009.

together in virtuous cycles of exchange. From urban farms in Detroit to seed-saving movements in India, support is growing for regenerative food systems that nourish both people and ecosystems.

Organic farmers in particular can be considered entreprenuers of symbiogenesis, forging generative networks with bees, earthworms, and a host of beneficial insects, nematodes and microorganisms – to say nothing of their customers. Despite the rapid spread of a few genetically modified crops, organics are by far the fastest growing agricultural sector in the industrialized world. Even if large-scale organic farming remains reliant upon petroleum-based machinery and transportation, it at least takes the crucial first step of approaching soil as a living system rather than an inert receptacle for chemical inputs. Compost is, in many ways, the epitome of the virtuous cycle: transforming waste into fertility. Beyond compost, the organics movement is a hotbed of experimentation in virtuous cycles ranging from rainwater harvesting, to perennial agriculture and forest gardens, to effective micro-organisms.[38]

The overarching principle that informs these diverse practices is that agriculture must be approached as a living system.[39] In contrast to the linear economic model that propels matter from resource extraction to production to consumption to waste, the new food economy is situated in a vibrant web of generative networks. And this generativity is not simply a biological phenomenon, it is a deeply political and ethical one, for while the linear economic model excels in economic efficiency, its human repercussions can be as devastating as its ecological ones. In the new food politics, human health, social justice, and ecological sustainability are integrally connected.

Eating (and promoting) local, organic food is a big step towards weaning ourselves from the petroleum economy, but agriculture can be far more proactive on a Gaian scale. Consider, for instance, the Botanical Ark, an Australian farm that specializes in integrating endangered species into the world food system. Similarly, the potential for carbon sequestration in soils, which contain over twice as much carbon as the atmosphere, is largely untapped.[40] This would require a Gaian understanding of soil as a living web of symbiotic networks rather than an inert receptacle for chemical inputs. Or, rather than tearing into Earth's crust for scarce phosphorus, we might make the alchemical transformation of "waste-to-wealth" by mining the prodigious quantities of manure generated by poultry farms for this precious fertilizer.[41] When the governing metaphor for our earthly existence shifts from machine to organism, any number of creative possibilities are unleashed for rethinking our place in Gaia's great food webs.

Is the Earth system, however, too immense and scientific knowledge about it too abstract to command popular interest? As biologist Tyler Volk observes, we all have a personal relationship with Gaia whether we like it or not:

> With our breaths, our food intake, and our waste ejection, we participate in food webs and in the great life-supporting, global biogeochemical cycles that link us to the upper reaches of the atmosphere, to the deepest cold reaches of the ocean, to the dark, pungent places in the soil, as well as to every creature with which we cohabit all the corners of the biosphere.[42]

38 Frey 2011.
39 McNeil and Winiwarter 2004.
40 FAO 2004, 3.
41 Science News 2009.
42 Volk 2009, 35.

For some (perhaps many, as the popular response to Lovelock's work suggests), this grand integrative science-based vision can serve as a source of personal meaning and purpose. For others who require something more mundane, more immediate and visceral, food is a palpable place of contact between self and world. If the transition to a sustainable world requires linking person to planet, then food serves as the ideal medium for doing so. No wonder, then, that food has become such a powerful galvanizing force in the world today.

At the level of institutions and policy, where might a Gaian approach to the world food system lead us? On a very basic level, a living-systems approach to agriculture would generate a radical rethinking of government subsidies, research and development priorities, and agricultural education. Policies would promote farming in close proximity to human habitations: in cities, schools, prisons, and so on. Internationally, a Gaian approach to agriculture would spark a redesign of trade, aid, and development programs to promote basic food self-sufficiency everywhere, including a careful resorting of the local and the global.

Food may be the weakest link in between human systems and Gaia but, for both practical and existential reasons, it may also be the best point of intervention for harmonizing our lives with our home planet. If we are to inhabit a planetary network of food webs and biogeochemical cycles, then we need to learn to think like Gaia. This means that we must learn to ask, both physically and metaphorically, what is feeding us and what we are feeding.

In a time when fear and despair threaten our capacity for constructive action, Gaia can serve as a source of faith, humility, and inspiration, reminding us that we are an integral part – and an astonishing result – of an unfolding evolutionary process. The linear economic model may well be at the end of its tether, but Gaia theory calls us back from our isolation and despair, connecting us to the wondrous whole of creation and calling us to a greater sense of responsibility. We are a species with the same bacterial ancestry as all other species, yet we may also be the means by which Gaia is growing into self-awareness. Gaia theory at once revives an ancient symbol and endows it with scientific legitimacy, synthesizing empiricism with poetic inspiration. If affect precedes cognition, as psychologists suggest, then the emotive and symbolic resonance of Gaia theory may be as significant as its pragmatic contributions to sustainability.

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