30 Gaia theory: intimations for global environmental politics

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Gaia theory, first proposed in 1970 by British chemist James Lovelock and later elaborated by microbiologist Lynn Margulis, has developed from a controversial hypothesis to a broadly accepted set of ideas about the relationships among Earth's physical, chemical and biological features. Gaia theory represents a creative synthesis that has emerged through and built upon reductionist science, viewing the Earth holistically as a living entity in two senses. First, living organisms regulate the planet's geochemistry to the benefit of the whole. Second, and more radically, Earth itself may be understood as a complex, bounded, self-organizing, adaptive organism. The Gaian perspective has helped to spawn a paradigmatic shift in the natural sciences, most clearly seen in the new integrative field of Earth system science. Because the concept of Gaia appeals to the popular imagination, its societal influence is already surprisingly deep and broad. Lovelock (2000: xi) was astonished to receive twice as many letters in response to his first book on Gaia from people interested in its religious aspects as from those with a more scientific bent. The evocative image of Gaia as Earth goddess and mother of all creation has animated discussion in religious, literary and philosophical circles. The political implications of Gaia theory, however, have not been so widely explored. This chapter seeks to open that discussion.

The image of a living Earth may be as old as the human species. Throughout history, the perception of the Earth as a sacred and self-generative organism was common in religion and mythology. Among modern scientists, this perspective was rare but never fully absent. Johannes Kepler viewed the Earth as a single round organism. The Scottish scientist James Hutton, recognized as the father of geology, suggested in 1785 that the Earth is a superorganism that can only be understood in terms of physiology (Lovelock, 1990: 10). More recently, French palaeontologist Teilhard de Chardin (1959) proposed that evolution is a spiritual unfolding from cell to organism to planet to solar system and ultimately the entire universe. Because none of these earlier ideas made testable predictions, they were not considered scientific hypotheses. Gaia theory brings the ancient idea of a living Earth into the realm of verifiable science. Whereas past science, divided into the separate disciplines of biology, chemistry and physics, provided an inventory of the Earth's parts,

Gaia theory offers us a view of the Earth as a living entity. The theory comes just at a time when the twin phenomena of globalization and environmental destruction call us to adopt a planetary perspective.

Gaia theory, which views the Earth as a complex and bounded system, draws upon the more general systems theory. The basic ideas of systems theory open up fresh possibilities and a new language for understanding political processes. Gaia theory helps us to awaken to the fact that we are embedded in and dependent upon a greater whole. Because the Earth system is the wider context in which our political systems operate and because our actions now have planetary consequences, we are increasingly faced with the need to develop forms of governance that are compatible with the larger system which sustains us. This monumental task may well occupy generations to come. Therefore this brief chapter can only be suggestive at best.

This chapter examines the central concepts of systems theory in light of Gaia theory, and attempts to draw out in a rudimentary way some of their applications to global politics. These interrelated concepts include holism, autopoiesis (or self-making), networks, feedback, homeostasis and punctuated equilibrium. While human systems are subsystems of Gaia, they are also distinctive, especially with regard to temporal scale and questions of purpose. Gaia theory may have something to offer with respect to our political ideas and practices. As an alternative to the reductionistic worldview of modern science, Gaia provides important concepts and metaphors that can help move us towards a sustainable future.

Principles of systems theory

One of the pioneers of systems thinking, the 19th-century American scientist Josiah Willard Gibbs, defined a system as

> any portion of the material universe (including ourselves and everything we have invented including social systems) which we choose to separate in thought from the rest of the universe for the purpose of considering and discussing the various changes which may occur within it under various conditions. (Rukeyser, 1942: 445; cited in Madron and Jopling, 2003: 43)

In other words, the universe is the largest system, containing all other systems, and whenever we delineate the boundaries of a particular system, there is always a subjective quality to our decision. This is true whether we are investigating an ecosystem, a planet, an organism, a country or the global economy.

Systems theory has developed over the last 50 years and has been beneficially applied in engineering, education, finance, health, psychology and natural science. There are three broad types of systems.[1] *Hard systems* include many of the technologies associated with industrial life, such as electrical

grids, transport systems and telecommunications. Because of their mechanical character and their linear logic, hard systems are very effective in terms of their efficiency, predictability and performance. *Living systems*, of which Gaia is the largest known instance, are nested systems of biota and their environments. These complex systems cannot be understood in terms of the linear, reductionist logic of purely physical or chemical systems. They require a more dynamic, interactive and holistic approach. *Soft systems*, or purposeful human systems, encompass all social institutions and organizations: marriage, warfare, schools, corporations, governments, clubs and so on. Like living systems, they are nested and complex; they can evolve, reproduce themselves and die. In contrast to living systems, however, the human faculties of perception, intention, interpretation and imagination make soft systems far more complex and dynamic. Purpose, which is not an obvious property of hard or living systems, is essential to soft systems. The purposes of human systems are often tacit, and rarely acknowledged and debated publicly. Soft systems problems, which have no obvious solutions and involve many actors with differing perspectives, are generally exacerbated when they are addressed in terms of hard systems logic and methods. Therefore neither the Earth system nor the world political system, to say nothing of problems arising as a consequence of their interaction, can be understood in the linear logic of hard systems thinking.

The following section explores three central features of living and human systems: holism, autopoiesis and networks. These concepts are essential to Gaia theory and may also shed some light on political and economic practices in a global era. Holism helps us to see each system as more than the sum of its parts. Living and human systems, including Gaia and the world political system, are self-generative entities composed of dynamic and interactive networks.

Holism

Any system (except perhaps the universe itself) is also a subsystem or a part, yet can also be understood as a bounded whole. Holism means that, if a system is broken down into its component parts, it will not behave in the same way as when it was undivided: the whole is more than the sum of its parts. In systems language, the emergent properties of a system are those novel phenomena that are qualitatively different from the phenomena out of which they emerged. For example, when sodium and chlorine atoms bond in a specific way to make salt, the resulting saltiness is an emergent property that results not from the atoms but from their combination. In systems language, life is an emergent property of the interaction of cells. Cognition is an emergent property of networks of neurons. And the self-generative Earth system is an emergent property of the interaction of the planet's atmosphere,

lithosphere (soils and rocks), hydrosphere and biosphere. Among human systems, the United States, for instance, is an emergent property of governmental agencies, cultural practices and shared meanings.

Living and human systems are also bounded, that is, they are distinguishable in some sense from their environments. A cell, the simplest living system, is a 'membrane-bounded, self-generating, organizationally closed metabolic network' (Capra, 2002: 31). That network includes complex macromolecules, such as proteins, enzymes, RNA and DNA. The permeability of the cell's membrane gives it access to the nutrients and waste depositories it needs to survive, while also making it vulnerable to incursions from outside. Thus cells and all living systems, including human systems, are autonomous in the sense that they maintain some degree of structural integrity, yet they can never be truly independent. From a Gaian perspective, it is not possible fully to isolate one environment or system from all others.

This radical concept of systemic interdependence stands in contrast to modern political and psychological notions of human independence. In the words of Vernadsky, the Russian systems biologist, 'human independence is a political, not a biological concept' (quoted in Primavesi, 2000: 6). At the level of the individual, a healthy human body is host to billions of bacteria, upon which its survival depends. Human well-being is utterly dependent upon local ecosystems and the larger Gaian system, which includes that ceaseless generative and decompositional work of plants, phytoplankton, bacteria, fungus, earthworms, and so on. Current economic and political institutions reflect a state of consciousness that is essentially oblivious to our embeddedness within and dependence upon the entire Gaian system.

The holism of Gaia is also relevant to current social and political questions in that it invites a planetary perspective. Oddly enough, the Gaia hypothesis had its origins in the search for life on Mars, when Lovelock was hired by NASA in the 1960s to design sensitive instruments to analyse the atmospheres of other planets. The surprising consequence of that research was a fresh look at the Earth's highly anomalous and chemically unstable atmosphere. In Lovelock's (1990: 8) words,

> The unceasing song of life is audible to anyone with a receiver, even from outside the Solar System. …[Unless] life takes charge of its planet, and occupies it extensively, the conditions of its tenancy are not met. Planetary life must be able to regulate its climate and chemical state. Part-time or incomplete occupancy or mere occasional visits will not be enough to overcome the ineluctable forces that drive the chemical and physical evolution of a planet.

The 'amazing improbability of the Earth's atmosphere' includes the persistence of oxygen and methane in constant quantities, despite the fact that they easily react to form carbon dioxide and water vapour. Approximately one

billion tons of methane and two billion tons of oxygen must be introduced into the atmosphere to maintain constant concentrations of these gases. The only explanation is 'the invisible hand of life'. Indeed, apart from miniscule amounts of certain rare gases, virtually all of the Earth's atmosphere recently existed as parts of living cells (ibid.: 29, 72). Thus the US space programme not only brought us the physical image of the Earth as seen from outer space, but it also contributed to a paradigmatic shift in evolutionary science. Life, it turns out, is 'a property of planets rather than of individual organisms' (Morowitz, 1992: 6). From a Gaian perspective, our blue planet is a living entity with internal metabolic systems of temperature and chemical modulation, enveloped by an atmospheric membrane that separates it from an otherwise lifeless Solar System.

The planetary perspective of Gaia science appears just as the effects of human systems have become global in scope. For the first time in history, humanity has become a geophysical force with planetary effects. The rate of species extinction is between 1000 and 10 000 times faster than in the preindustrial era, rivalling the last great wave of extinctions that wiped out the dinosaurs 65 million years ago (UNEP, 2002). Climate scientists predict that global temperatures will rise between 1.5 and 5 degrees Celsius in the coming century, a warming on the order of a shift from an ice age to an interglacial period (Houghton *et al.*, 2001). Most key resources, including forests, minerals, petroleum, freshwater, topsoil and fisheries, are being depleted at unsustainable rates. Like life itself, human beings have evolved the capacity to inhabit virtually every corner of the Earth. Globalization of some form therefore seems to be part of our destiny (Madron and Jopling, 2003: 10). The question now before us is what new forms globalization might take as the incompatibility of current practices with the larger Gaian system becomes increasingly acute. As part of a greater whole, we are called upon to harmonize our social, economic and political systems with Gaia. International environmental politics over the past 30 years represents a piecemeal movement in this direction, yet, because it sidesteps the crucial questions of purpose and process that give rise to the destruction, green diplomacy and its variants do not offer a systemic solution.

From a Gaian perspective, it is the health of the planet that matters, not that of any particular species – including humans. We are just another species, far more expendable to Gaia's functioning than bacteria. While some may find solace in the fact that Gaia has survived for aeons by always establishing a new homeostasis after each 'catastrophe', any future equilibrium state will almost certainly be far less favourable for humans than the present one. For most of Gaia's 3.8 billion years, glacial periods have been the norm and species diversity has been far lower than at present. So a healthy dose of prudence would make sense. In Lovelock's words (1990: 212), Gaia is 'stern

and tough, always keeping the world warm and comfortable for those who obey the rules, but ruthless in her destruction of those who transgress'.

Autopoiesis

Living systems and human systems are self-organizing, meaning that they generate high degrees of order through complex relationships among their parts and with the environment rather than as a consequence of any clear external agency. The system is maintained through dynamic interaction of its subsystems. In the Gaian system, the main chemical subsystems involve the cycling of key elements: carbon, nitrogen, oxygen and sulphur (Lovelock, 1990). The largest human system, the global political economy, involves the dynamic interaction of corporations, governments, international organizations, banks and nongovernmental organizations. In both cases, the systems may be said to be 'self-making'.

Biologists Humberto Maturana and Francisco Varela (1998) coined the term 'autopoiesis' (from the Greek words for 'self 'and 'making') to describe 'the systemic organization of the living'. This term highlights the self-generative network of metabolic processes within an organism. The network continually 'makes itself', maintaining its structural integrity and organic functioning through exchange with its environment: intake of solar energy and nutrients, breathing and excretion. The minimal autopoietic entity is a bacterial cell, and the largest is likely to be Gaia (Primavesi, 2000: 2). An essential feature of an autopoietic system is that it undergoes unceasing change, all the while preserving its weblike pattern of organization. In the words of microbiologist Lynn Margulis (quoted in Primavesi, 2000: 4), 'It changes in order to remain the same.' During the first two billion years, bacteria ruled the planet and devised all of life's essential processes: reproduction, photosynthesis, fermentation, nitrogen fixation, respiration and locomotion (Capra, 2002: 29). For nearly four billion years, Gaia has repeated and elaborated upon these processes.

Despite the proliferation of life forms over the millennia, some essential characteristics of Gaia have remained relatively stable. For instance, even with a 25 per cent increase in the sun's heat since the emergence of life, the Earth's surface temperature has been fairly constant. Ocean salinity has also been stabilized at a level tolerable for marine life by cyclical life processes. The term for this tendency towards constancy is 'homeostasis', another property of living systems. The American physiologist who popularized the term also called it 'the wisdom of the body', since a healthy body is in a stable state. Gaia theory predicts that the climate and chemical composition of the Earth will remain in homeostasis for long periods of time until some internal contradiction or external force causes a jump to a new stable state (Lovelock, 1990: 13, 18). Most external forces have been meteor impacts. Earth's first

'environmental crisis' from internal causes probably occurred with the invention of photosynthesis, when the consumption of carbon dioxide by bacteria threatened to consume the greenhouse blanket that made the planet habitable for life. Oxygen, one of their waste products, opened up a tremendous niche for oxidizing consumers, and the subsequent growth of more complex organisms (Margulis and Sagan, 2001).

Human systems are also autopoietic, tending to reproduce and modify themselves in response to changing conditions over time. The autopoietic nature of both living and human systems means that they can adapt to internal or external changes. In his theory of social autopoiesis, sociologist Niklas Luhmann (1990) describes social systems as self-generating networks of communications. These networks have both material and cultural effects, generating both external social structures like the corporation and internal structures of meaning like rights. For example, the global economy is continually reproduced through networks of communication involving advertising, production, entertainment, financial transfers, education and so on.

According to Gaian scientists, when the activity of an organism favours both the Gaian system and itself, it will tend to spread. Eventually both the organism and the environmental change associated with it may become global in scope (Lovelock, 1990: 236). We may therefore be tempted to infer optimistically from humanity's relatively rapid globalization that this trend is favourable to (or at least compatible with) Gaia. What this logic ignores is that the time scales associated with Gaian processes are vastly longer than human concepts of time. A period of 100 000 years, for instance, is many times longer than all of human history, yet represents less than 0.003 per cent of Gaia's lifetime. Only in the last part of the 20th century did the human species become a geophysical force operating on a planetary scale. We do not know exactly when or how the Gaian system will respond to these relatively recent changes. According to the geological record, the pattern is long periods of homeostasis followed by sporadic catastrophes. These crises spark an intense period of innovation leading to a new stable state. This pattern of punctuated equilibrium seems to characterize the evolutionary trajectory of all living systems (Gould, 2002). Gaian theorists believe that, once a Gaian system-shift gets under way, it moves into a new and very different stable state very quickly – perhaps 50–100 years (Madron and Jopling, 2003: 64). Therefore it is prudent to bear in mind that the converse of the above optimistic inference also holds: any species that impairs Gaia's functioning will face extinction, even as the web of life continues towards a new homeostasis.

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 (1979) original formulation of the Gaia hypothesis met with intense scientific criticism, especially from

neoDarwinists. Critics interpreted him as proposing a sentient Gaia able to consciously control the Earth with foresight and planning. In his later formulation, Lovelock (1990) illustrated the principle of homeostasis through a simple model that involved dynamic interaction but not intentionality. For instance, the automatic self-regulation of the carbon cycle, which has stabilized atmospheric concentrations of oxygen at 21 per cent and carbon dioxide at a mere 0.03 per cent, requires no foresight and planning. Yet these numbers are very different from the virtual absence of oxygen and the 95–8 per cent concentrations of carbon dioxide on Venus, Mars and prelife Earth (ibid.: 9). The Earth's improbable atmosphere is a consequence of the mutual interaction of her biota with its nonliving systems.

The feedback mechanisms that lead to homeostasis in Gaia do not require intention or altruism, but rather only a reciprocal flow of influence.[2] Whenever the rate of change in a system is getting faster, positive feedback is at work. This kind of reinforcing feedback is important when a new homeostasis is getting established, but it can also lead to a pernicious spiralling effect. Examples include avalanches, stock market booms and cattle stampedes. On a Gaian scale, an example with respect to global climate change is the increase of evaporation that occurs on a warmer planet; the added water vapour, itself a greenhouse gas, increases the temperature further. When positive feedback gets out of control, the resulting runaway system can only be stopped when either the external environment or an internal instability halts the positive feedback loop. Balancing, or negative feedback, prevents the system from running away with itself. For instance, the absence of predators in an ecosystem will lead to an overpopulation of their former prey, who will in turn not be able to subsist on the given food supply, so that their numbers will fall to a sustainable level. With respect to climate change, an example of negative feedback would be the increased growth of plants in a warmer climate. Since plants take up carbon dioxide and store carbon, their enhanced growth would tend to decrease the greenhouse effect. In each of the cases above, the feedback is an automatic function. The system is responsive, yet no purposeful agent is responsible; Gaia theory does not entail teleology.[3] Questions of larger purpose and intention in living systems are simply beyond the bounds of scientific methodology.

Purpose, however, is essential to human systems. It consists of the most cherished values that inform and orient the system. Humanity is just beginning to awaken to the necessity of aligning our purposes with the functioning of Gaia. In the examples of climate change feedback mechanisms cited above, Gaia is responsive but human systems are responsible for setting them in motion. As a consequence of our global economic, political and social networks, people have become a geophysical force operating on a planetary scale.

While a system's purpose might be unexamined, misunderstood, ignored, debated and even disguised, reconfiguring it requires identifying its purpose(s) and implicit values. The global economy is a self-reproducing network of networks, but can we point to a basic purpose or set of purposes that drive it? Growth, development, prosperity, wealth – these are different words for what many would agree is the underlying purpose of the system. 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 (see Durning, 1993). The systemic nature of this purpose is evident in the fact that it is almost universally embraced: across the political spectrum from left to right, and around the world from to North to South. There is plenty of disagreement on how to pursue this goal, but a striking consensus on the fundamental purpose itself. Yet, because infinite growth on a finite planet is impossible, this purpose will inevitably be thwarted at some point.

Understanding the core purpose of a human system is necessary but not sufficient for empowering us to reorient it. With respect to the global economy, we must also discern how the pursuit of growth is institutionalized in actual practices and embodied in social networks. Though such a task is beyond the scope of this chapter, we can make some simple observations. Systems theorists Madron and Jopling (2003: 69-73) suggest that the true purpose of the 'Global Monetocracy' is that of 'money growth in order to maintain the current debt-based money system'. Virtually all of the money we use (all except notes and coins, which constitute only about 3 per cent of the total) comes into existence as a result of interest-based loans or 'debt-money'. As a consequence, the economy must grow to avoid collapsing. In systems terms, the growth imperative imposed by the debt-money system is a positive feedback mechanism, and therefore runs the risk of creating a runaway system that can only be stopped when either the external environment or an internal instability halts it. Systems theory does not predict exactly when or how that might happen, but it does say something about the consequences of positive feedback loops in general.

If human systems are to persist as a global subsystem of Gaia, we will need to align our purposes with the functioning of Gaia. The longer we wait, the greater the risk. If money growth is the purpose of the global economic system, reconfiguring the current system means first and foremost rethinking our purposes. For human systems to be harmonious with the wider Gaian system, sustainability must become a core human purpose. Other purposes could include justice, a less materialistic vision of human well-being, the growth of knowledge, and so on. Individuals and groups around the world are taking up the challenge of revising the purposes of human systems in light of Gaia (see Berry, 1999; Redefining Progress, 2004; Jackson and Svensson, 2002). They are articulating different purposes and setting up new networks

of communication. In short, they are seeking to establish the rough outlines of an alternative to current practices.

Networks

All parts of any living or human system are interconnected in an intricate network of relationships. Life, human and otherwise, is social in the sense that it exists in nested collectives. For instance, our bodies consist of a collection of organs and tissues. These are in turn made up of billions of living cells, each one of which can also live independently. The cells themselves are communities of microorganisms (Lovelock, 1990: 18). On a larger scale, ecosystems are sustained by complex food webs. Gaia theory holds that the Earth system consists of networks of organization analogous to the physiological processes of an organism. Every organism in Gaia, including the human body, is a product of billions of years of interaction between sunlight, soil, air, water and the biosphere.

Living systems are constituted through symbiosis, whereby dissimilar entities coexist in a mutually beneficial arrangement. Contrary to the popular neoDarwinist view of life as a harsh competition for survival, Gaia theory proposes that cooperation is much more the rule than competition. Bacteria, the most long-lived class of organisms and the basis of all subsequent life, are inherently social animals. They 'live by collaboration, accommodation, exchange, and barter' (Thomas, 1974: 6–7). Most bacteria cannot be isolated because they live in extremely dense communities, reconstituting their shared environment for their mutual benefit. At the macro scale, Gaia is a magnificent symbiotic network viewable from space, the result of aeons of symbiogenesis (Margulis and Sagan, 1995: 156). 'Life did not take over the globe by combat, but by networking' (Margulis and Sagan, 2001: 11).

Like other living systems, human systems consist of networks. 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. Many (if not most) social systems are more rooted in cooperation than competition: for instance, the global transportation and postal networks. Yet the overarching premise of the global economy, in contrast to living systems, is competition. Firms compete with one another for resources and markets; workers compete for jobs; countries compete for investment. Capitalism has legitimated itself in terms of the Darwinian notion of 'survival of the fittest'. Both capitalism and Darwinian biology also presume that the natural environment is a stable background to which individuals must adapt. In contrast, life from a Gaian perspective is about the ability of cooperative networks not only to adapt to but also to alter their environment on a planetary scale for their own enhancement. Both the unrelenting drive to compete, an intrinsic consequence of the growth impera-

tive, and the notion of environment as backdrop are at odds with Gaia theory. A sustainable global economy would consist of symbiotic networks acting in harmony with Gaia.

In living systems, networks continuously reorganize their elements in cyclical processes. In ecosystems and in Gaia as a whole, recycling is the rule; one species' waste is always another species' source of nourishment. Cyclical exchanges of energy and resources in a living system are sustained by pervasive cooperation. Since the first nucleated cells emerged over two billion years ago, Gaia has generated increasingly diverse arrangements of collaboration and coevolution (Madron and Jopling, 2003: 33). Neither for Gaia nor for any local ecosystem is there an 'out there' into which 'waste' can be dumped. Gaia knows no such concepts as garbage and pollution.

For the most part, existing political systems for regulating the disposal of waste (whether solid, atmospheric, toxic, biomedical or nuclear) are oriented towards developing safer technologies and practices, without ever questioning the underlying concept of waste itself. This is true for all levels of mainstream 'waste management', from municipal policies to international treaties. Yet, little by little, ecological principles based upon cyclical processes are being introduced into human systems. The recent growth of consumer-based recycling in the industrialized countries is one such trend, although it has not served to decrease overall consumption or waste production. Virtuous cycles in human systems largely eliminate waste (ibid.: 35). Some promising examples include zero-emissions production processes (see http://www.zeri.org) and community supported organic agriculture (see http://sare.org/csa).

The emerging field of eco-design organizes human systems according to the principles of ecology: networks, symbiosis, cyclical processes, dynamic balance, diversity and the primacy of solar energy in animating all living systems. Writ large, these are also the fundamental principles of Gaia theory. In contrast to industrial society, eco-design 'introduces us to an era based, not on what we can *extract* from nature, but on what we can *learn* from her' (Benyus, 1997: 2; cited in Capra, 2002: 233). The idea is to use our intelligence to sense nature's design, thereby making our own systems coherent with the larger Gaia system. Hundreds of 'eco-villages' around the world, many of them drawing upon Gaian imagery, are experimenting with principles of eco-design in order to bring this vision to life (see www.gaia.org; www.gen.org; Jackson and Svensson, 2002).

While human systems have always consisted of networks of communications, only recently have those networks been globalized. Information technologies are giving rise to a network society in economics, culture and politics (Castells, 1996). In this society, the generation of new knowledge, wealth and power is based upon global networks of communication. The so-

called 'global market' is not really a market, but an electronically based network of financial transactions informed by the fundamental purpose of money growth (Capra, 2002: 141–2). In contrast, a new kind of global network, organized around reconfiguring human systems around the core purposes of human dignity and sustainability, is gradually emerging (Keck and Sikkink, 1998). The nongovernmental organizations (NGOs) that constitute this network are using communication technologies, especially the Internet, to establish global networks of local grassroots organizations (Warkentin and Mingst, 2000). These transnational activist networks include the Climate Action Network, the Rainforest Action Network and the International Forum on Globalization. The alternative globalization movement, green politics and the global eco-village network all represent citizen-based efforts that move towards a Gaian human system.

As human systems become more complex, hierarchical and centralized forms of governance are becoming increasingly dysfunctional. Policy makers and leaders simply cannot process the enormous quantities of information required to make skilful decisions. Consequently information-processing and decision-making power need to be devolved as widely as possible if human systems are to become viable members of the Gaian system. Madron and Jopling (2003: 110–27) propose a Gaian model of democracy as a nested system of governance at all levels, from the neighbourhood to the global. Unlike the current system, whose purpose is money growth, Gaian democracies would be oriented towards sustainability and justice. They would be modelled upon a network model of governance, participatory change processes and forms of leadership that empower people. The command-and-control culture that still prevails in business and politics would be replaced by a culture of dialogue. Autopoiesis, or self-making, would take on new meaning with the globalization of democracy as people organized themselves according to Gaian principles.

The rise of a network society coincides with the decline of the sovereign nation-state. State autonomy, authority and control, the three components of sovereignty, are undermined by global networks of communications, finance, crime, terrorism, disease transmission, ecology and transnational activism (Litfin, 1997). From a Gaian perspective, the nation-state is neither large enough to be planetary in spirit, nor small enough to nurture the kinds of local identity and civic involvement that could form the basis for participatory governance (Thompson, 1985: 165). This does not mean that the nation-state will cease to exist, but only that it may be incorporated into broader networks of supranational, regional and local forms of governance.

If the principles of Gaia theory were applied to global political and economic systems, our world would be a very different place. The natural world would move from backdrop to centre stage, and principles of eco-design

would become foundational rather than peripheral. Farming and industrial practices, architecture and transportation would be radically different. Cyclical processes would replace wastefulness with creative methods of regeneration. Hierarchical structures of domination would give way to participatory networks, and symbiosis would displace competition as the defining modality in economic exchange.

Yet we are wise to remember that, while Gaia theory can be helpful in reorienting our thinking about human systems, it is not a panacea. Systems language and concepts offer an integrative way of understanding current problems and redirecting us down a more sustainable path, but they do not lay the stones along the path. Gaia theory can help us with the essential task of seeing the big picture, but it does not resolve the thorny problems of practical politics. In this sense, Gaia may be more important for its broader contribution to our ethical and political imagination than for its direct policy effects.

Gaian ethics and political imagination

Gaia theory raises some disconcerting ethical questions. If value in the Gaian system is related to the continuance of life in general, must our ethical concern extend beyond humans to other creatures? To the planet? In some ways, our concern for the Gaian system comes, not so much from ethical obligation, but from an enlarged sense of pragmatism: we want to save our own skins. Gaia will survive, but our interference may catapult her into a new state that is not so hospitable to ourselves. Thus Gaian pragmatism points to some ethical principles. 'Is' may not dictate 'ought', but it is suggestive. If, for instance, species diversity and a stable concentration of greenhouse gases are critical for a healthy functioning of the Gaian system, we 'should' prevent species extinctions and reduce our use of fossil fuels. Gaian thinking supports the precautionary principle: if the risk is high, action to prevent harm should be taken, even in the absence of full scientific certainty. If current practices risk destabilizing the Earth's climate and life support systems, then we should take precautionary action and change them.

If Gaia focuses our attention on the Earth, what happens to our generally accepted ethical commitments to other people? What, for instance, of questions about justice under conditions of extreme global inequality? At first, we might think that, if Gaia is the object of our concern, we must sidestep those thorny questions of North–South inequity and get onto the business of 'saving the planet'. Because Gaia's 'big picture' perspective is out of step with anthropocentrism, we might be tempted to believe that human questions can be ignored. But it turns out that Gaia brings out the human questions in stark relief.

Paradoxically a Gaian perspective compels us to consider justice. When we could naively assume that infinite growth on a finite planet was possible,

we could also believe that economic growth would eventually 'trickle down' everywhere and to everyone. The recognition is dawning upon us: the overconsumption of the North cannot be globalized without endangering the Gaian system. Yet this is exactly what is happening. With 80 per cent of the human population, developing countries represent the wave of the human future. They are not going to change their development trajectories without enormous assistance from the wealthy countries. Justice, therefore, becomes a matter of 'geoecological realism' (Athanasiou and Baer, 2002: 74). While Gaia's planetary perspective may undercut humanism in the big picture, the pragmatic requirements of moving towards sustainability have the ironic effect of highlighting questions of justice and equity. Gaia reminds us that we are all in this together.

Because human systems are a subset of Gaia, perhaps it should not be surprising that the key concepts of Gaia theory are also relevant to current social and political questions. Our utter dependence upon a planetary network of living systems is just dawning upon our collective awareness, and therefore is only beginning to be expressed socially and politically. Until recently the scientific metaphors that dominated the modern Western political imagination were drawn from an atomistic, mechanical and reductionistic worldview (MacPherson, 1962). Nation-states, firms and people were conceived as independent, acquisitive individuals competing for resources, power and wealth; nature was merely a backdrop to our human dramas. Gaian concepts of holism, autopoiesis and symbiotic networks offer a very different language for exploring social and political organization. Gaia theory not only provides an alternative set of ideas for describing and relating natural and human systems, it also contributes new metaphors to the political imagination. Symbols can be powerful sources of motivation, and the image of the Earth as a living, self-regenerating being is an especially powerful one. If affect precedes cognition, as many psychologists claim, then the emotional appeal of Gaia theory may be far more important than its conceptual contributions to sustainability.

An Internet search for 'Gaia theory' yields over 63 000 results, and a search for 'Gaia' yields 1 420 000 websites. Of the latter, most are about environmentalism and various forms of spirituality, but their topics also include the arts, urban planning, tourism, feminism and even sporting goods. Gaia is most often invoked by environmental activists and spiritual seekers. Had Lovelock named his hypothesis 'Earth systems theory' instead, my Internet search might not have been so fruitful. Language matters, and the ancient image of the Earth mother is far more compelling to most people than the comparatively cold language of systems theory.

Gaia theory at once revives this ancient symbol and endows it with scientific legitimacy, synthesizing empiricism with poetic inspiration. In much the same way that the image of the Earth as seen from space has been invoked by

environmentalists, Gaia is, at a minimum, a symbol of wholeness, interdependence and dynamic complexity. For many, Gaia also evokes a sense of awe and reverence, restoring a sense of connection to the cosmos that Western culture abandoned with the medieval conception of the Great Chain of Being. By evoking a sense of the sacred, Gaia challenges secularism's utilitarian orientation while leaning on its appeal to science. Yet, because we are products of a rational, technological and male-oriented culture, a simplistic revival of this ancient symbol runs the risk of shallowness. A spiritual symbol is not merely cognitive or sentimental, but rather stirs and shapes us in the deepest parts of our being.

Gaia theory encourages us to contemplate larger questions of meaning and purpose, both individually and collectively. On the one hand, the growth imperative of the dominant human system has become a planetary malady, calling into question existing arrangements. On the other hand, we are a species with the same bacterial ancestry as all other species and that is also struggling to become conscious. We are the means by which Gaia is growing into self-awareness, and current conditions may be the labour pains of that birth of consciousness. Gaia enlarges our vision of human purpose beyond the growth imperative, and reorients our action beyond the personal and local onto a planetary scale. And because Gaia acts locally as well as globally, we become more, not less, intimate with the particular landscapes we inhabit. Yet, as David Spangler (1993: 82) rightly warns, invocations of Gaia run the risk of becoming empty slogans if we do not allow them to inhabit us. If we sincerely want to reinvent our relationship with the Earth, we cannot simply deploy images of Gaia to meet emotional, religious, political or commercial needs 'without allowing them to transform us in unexpected and radical ways'. Both as a scientific theory and as a cultural image, Gaia has the potential to become an enormously transformative idea for our time.

Notes

1. This threefold typology is adapted from Madron and Jopling (2003: 30–31) and Checkland (1981).
2. The discussion in this paragraph is drawn from Madron and Jopling (2003: 38–9).
3. But neither can Gaia theory rule it out. The question of purpose informs the observation that Gaia theory is a spectrum of ideas, 'ranging from the undeniable to the radical' (Wikipedia, 2003). At one end of the spectrum is the undeniable claim that life has dramatically altered the Earth system's composition. Moderate views understand Gaia as a self-organizing system or, more radically, a single planetary being. The most radical Gaia thinkers believe that there is an underlying intelligence directing the coevolution of Gaia's physical and living systems.

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