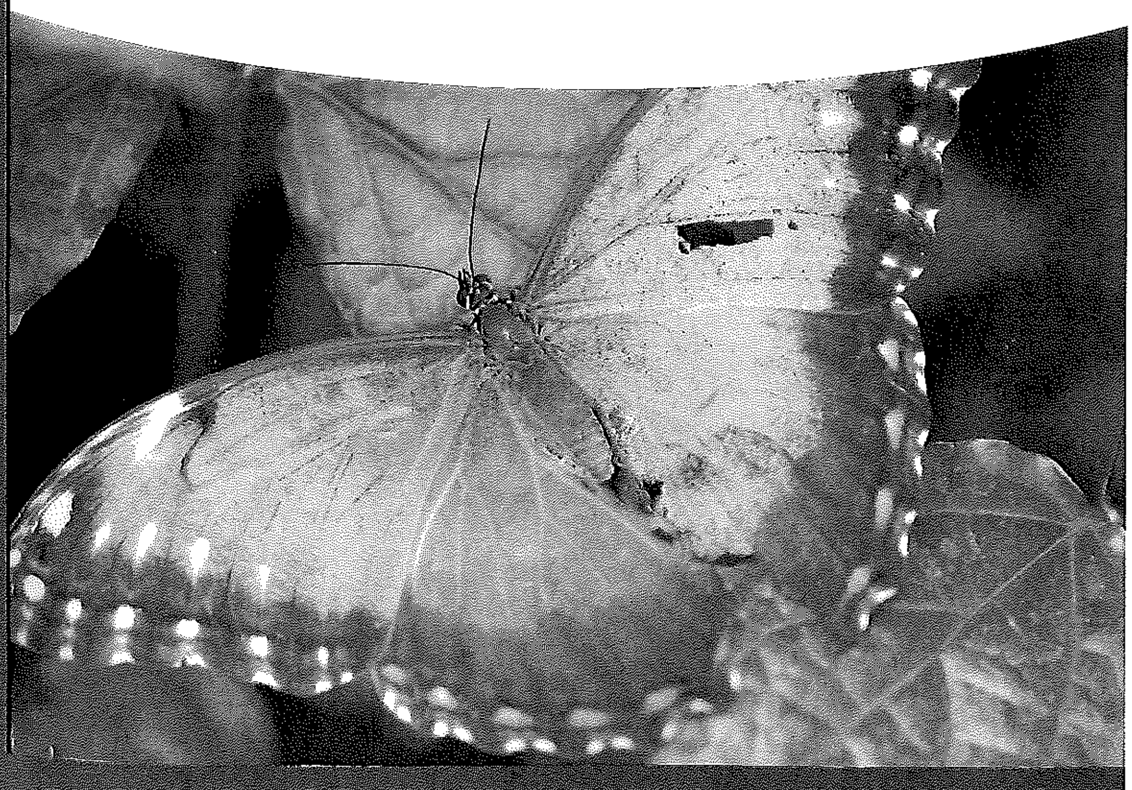
Gaia in Turmoil

Climate Change, Biodepletion, and Earth Ethics in an Age of Crisis

edited by Eileen Crist and H. Bruce Rinker
foreword by Bill McKibben



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We dedicate this collection
to Rob Patzig
and to the next generation of Earth stewards,
especially
Jordan Chase Littrell and
Hunter Marshall Littrell

rld, by David Abram; *Rethinking Nature: Essays in* y, edited by Bruce Foltz and Robert Frodeman; *The* ical History, by Edward Casey. *Inhabiting the Earth: Heidegger, Environmental Ethics, and the Metaphysics of Nature,* by Bruce Foltz; *Maurice Merleau-Ponty: Basic Writings,* edited by Thomas Baldwin.

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Sustainability and an Earth Operating System for Gaia

Tim Foresman

A convergence is being witnessed that combines a growing social awareness of the fragile condition of our Earth's life support systems with the evolution of spatially enabled technologies (e.g., GIS, RS), which operate at no cost to the general public from the World Wide Web. This convergence marks a clear signpost for humanity. A new era is being launched where an Earth Operating System (henceforth EOS) can be designed and implemented for the benefit of humanity and the natural world. That this represents a critical juncture for the planet and its living systems is well documented by the current mass extinction spasm and other catastrophic events for nonhuman and human life, like rapid climate change. An EOS is proposed as requisite for the continued survival of the Earth's species and for the betterment of the human condition.

An Earth Operating System Approach

An EOS is predicated upon the application of a Gaian global system model for the monitoring and restoration of the planet and its ecosystems. Technologies have evolved from the fields of geographic information system (GIS) and remote sensing (RS) into tangible Digital Earth implementation systems, as demonstrated by Google, Microsoft, ESRI, NASA, and other purveyors of 3D geobrowsers. These technologies, in combination with the activism of communities focused on sustainable practices, can spearhead the kind of EOS needed to bridge ecological, economic, and social arenas. Cross-domain management is needed for our species' future, while orienting to a new, harmonious relationship between humanity and the Earth's natural systems. This chapter presents the comprehensive evolutionary paths that create the conditions for an EOS—a concept defined by Buckminster Fuller half a century ago.

Our universe has been in existence for nearly 14 billion years since the Big Bang, according to the calculations of cosmologists (Hawking and Ellis 1968; Hawking and Penrose 1970). Scholars have been working diligently for millennia to unravel the mysteries of the star's and planet's mathematical choreography and to discover the operating principles for the universe. This cosmic choreography is sufficiently well understood today to allow humans to launch spaceships in our solar system with engineered precision. Regarding the question of "the operating system for the universe," we are intellectually comforted by the advanced discoveries of the laws of physics. The laws of physics govern the universe and can be applied to explain the motions of the planets and the speed of light, as well as gravity and how televisions work. Whether these laws were created by deistic design, or simply are, is fodder for a never-ending dialogue between the faithful and the secular; even so, the physical laws of the universe as formulated and refined in the twentieth century are egalitarian and work for everyone—sinner and saved. Still, much remains to be discovered in this universe and physicists are increasingly allowing for metaphysical phenomena to coexist within their mathematical maize as they seek ultimate unification laws for explaining the cosmos (Radin 1997).

As has been well articulated in the Gaian literature, the Earth began 4.5 billion years old from a molten and sterile state that finally cooled enough to allow (in less than a billion years) for the incubation of complex molecular compounds of exotic chemistry, fostering basic life forms in shallow seas (Lovelock 1965, 1969, 1988; Margulis and Lovelock 1974). The laws of evolution, put forth by Charles Darwin in his *On the Origin of Species*, have acted for millennia to keep the life forms of our planet unfolding toward ever-increased complexity and diversity, bound by constraints of the physical world, creating wondrous ensembles of life (Darwin 1859; Dennett 1995).

If we are to ask "what is the operating system for the planet Earth," it might be reasonable to regard the laws of evolution as representing the Earth's operating system, albeit in full compliance with the universe's own operating system. Another view regarding an EOS, however, is raised for the reader to consider: that which can be studied with the aid of computing and technology. The mechanistic and ecological system components along with their feedback loops can be understood, measured, and perhaps modeled. These Gaian components include atmospheric constituents and dynamics, the climate system, water distribution (as well as its abundance and quality), the oceans and their life forms, global biodiversity, and other parameters that can be assessed both quantitatively and qualitatively. If we wish to advance a Gaian, whole-Earth perspective into the mainstream of human operations for international collaboration and cooperation, then the introduction and application of an EOS, as a *lingua franca*, might prove to be beneficial.

A conceptual path for the foundation of these ideas can be traced to the visionary writings of R. Buckminster Fuller. His seminal 1968 book, *Operating Manual for Spaceship Earth*, explores the metaphor of Earth as a self-contained life-support system that travels through the universe bounded by requirements similar to those for a human-occupied spacecraft. These requirements incorporate a raft of basic life-support components, such as an energy source, basic chemical elements and molecules, and the requirement to recycle and regenerate within a closed system containing all of these constituent parts. His contribution was timely, concurrent with the birth of the space age, in creating a metaphor that would resonate with an exploding human population clearly beginning to overtax the Earth's carrying capacity. Fuller's contribution was all the more poignant as the Earth's denizens became mesmerized by the landmark Apollo photo of our unique and lonely blue planet set against the immensity of the universe.

While Fuller may be remembered for creating the arresting metaphor of Earth as "spaceship," what he offered was a better understanding of how the living components were to remain functional for enduring periods for human survival within a healthy biosphere. It was here that Fuller called for cybernetics to enable humans to gather, store, and manipulate vast quantities of data about the planet and societal commerce; modern cybernetic assistants—computers—would also reveal the consequences were we to remain unable to focus our collective attention on issues of survival and sustainability (Fuller 1981). Indeed Fuller foresaw and discussed the creation of a "geoscope" decades before operational Digital Earths became computer realities. He understood the need for technology and computers to assist humans in gaining knowledge about the planet, as well as command over our unsustainable economic and consumer patterns.

Gaia's ecological systems and services are the life support for all known species, and they are therefore critical parameters that require our most accurate understanding and monitoring. An EOS should therefore be designed to facilitate the capacity to assemble, integrate, and report information about Gaia life-support parameters. Subsequent to Fuller's books, the Club of Rome (in the landmark work *Limits to*

Growth) produced a series of startling projections for some of these critical Gaia parameters regarding our increasingly overpopulated and globalized planet. In retrospect, most of their so-called alarmist projections proved to be accurate, with population levels, for example, increasing precisely as had been calculated using the best growth models of the era (Meadows et al. 1972).

To our best knowledge all systems on Earth continue to exhibit a disheartening decline while human population and resource consumption grow. Data for this trend have been painstakingly assembled through the premier global assessment series produced by the United Nations Environment Programme (UNEP). An international community of scientists has focused on the comprehensive and objective measuring the planet's environmental conditions and trends, derived through a consensus process and reported in the *Global Environmental Outlook* (GEO) series (UNEP 2002, 2007). No place on Earth is unaffected by human activities including remnant wilderness and protected areas. Atmospheric chemicals are polluting even these semi-isolated natural pockets, which are also showing signs of being adversely affected by climate change. There are indeed no safe havens from the system-wide perturbations of Gaia.

Concomitant with dangerous climatic dynamics is the disturbing news of the human-driven mass extinction underway (Wilson 2002). Catastrophic species losses include extinctions of mammals, birds, reptiles, amphibians, and fish, as well invertebrates, plants, and microorganisms. Large-scale fisheries collapse is predicted by midcentury, with disastrous consequences both for marine ecosystems and for the one billion people who depend on fish protein (Murawski et al. 2007). Soil degradation moreover is compounding the agricultural communities' ability to feed a world population of 6.7 billion (and growing). Water for consumption is seriously lacking for approximately one billion people whose lives can best be described as barely tenable under severe hardships; and the water crisis is expected to deepen. Air pollution continues to create adverse ecological and societal impacts, chronically affecting the health of our young and most vulnerable citizens. It is a sober conclusion of broad consensus that our only hope lies in people joining in "urgent and cooperative action" to address the extraordinary challenges we face (Millennium Ecosystem Assessment 2005; Gore 1992, 2006; Laszlo 2001; Strong 2000; SEC 2007). In the immediate future, humans will witness an unprecedented transition for the biosphere and our life within it.

From the perspective of humanity and many current life forms and ecosystems, prognosis for Gaia, though dire, need not be hopeless. We have an array of powerful technologies that will allow for the comprehensive monitoring of the planet's living and nonliving systems in real time. While technology alone cannot furnish the full solution—but must be grounded and contextualized within a new biospheric ethic—the prowess and promise of technological innovations do give hope of a foothold. NASA, for example, launched the "Mission to Planet Earth" initiative toward the end of the last century in which it raised the clarion call for an international EOS. This concept, which has since morphed into the Global Earth Observation System of Systems (GEOSS 2005), was conceived as a connected constellation of orbiting satellites with millions of *in situ* ground sampling stations to map, measure, and model the Earth's systems for atmosphere, oceans, and land.

Earth observation systems (e.g., GEOSS) are in harmony with Fuller's visionary prescriptions that these systems could be used to reveal invisible processes and interactions among the Earth's biotic and abiotic systems. What is needed, however, is the capacity to integrate and broadcast the data and information about the Earth systems to all of Earth's citizens. GEOSS and its deliberating body of international representatives may take decades before reaching even their primary bureaucratic goals for interoperability among the varying constituent nations' monitoring systems. There are, however, alternatives that portend short cuts toward improving the interoperability and data exchange needed to understand and care for the planet's systems. NASA's Digital Earth initiative, launched in 1998, provides a refreshing model for both technological infrastructure and enhanced human collaboration, on a broad scale, that could be viewed as requisite conditions for an EOS.

Digital Earth Foundations

Vice President Al Gore, in a 1998 speech addressed to a crowded auditorium in Los Angeles, portrayed a future when a girl could sit before a virtual or three-dimensional representation of the Earth, and receive information in response to inquiries about the planet, living systems, and human ecologies. This Digital Earth vision launched a movement in the US government, with a metaphor that scientists and nonscientists alike could comprehend and use to accelerate the development of visual-information technologies (Gore 1998). This vision was able to bring together heretofore disconnected groups whose common ground resided in the study of Earth—its dynamics, resources, and ecosystems. The vision would also allow disenfranchised groups access to helping society define how to direct our actions toward a sustainable future. Gore's position as vice president of the United States added gravitas to the Digital Earth initiative, led by NASA in collaboration with other US agencies.

International enthusiasts began constructing major components of the Digital Earth vision yielding the present set of early prototypes to support an EOS. This movement has also been fueled by the tremendous quantities of satellite and remote sensing data, as well as by the efforts of collaborative data resource sharing among digital frameworks like Global Map and the Global Spatial Data Infrastructure (GSDI 2008; ISCGM 2008). Combined with city- and national-level GIS data, this Digital Earth design and framework enables a host of applications across a wide range of human and physical scales. Partnerships that include business, government, NGOs, and universities are developing to capture Digital Earth's promising technological solutions and to direct focus on the increasing calamities facing both developing and developed nations from anthropogenic pressures.

Operational, web-enabled 3D geobrowsers and their applications were comprehensively premiered at the Fifth International Symposium on Digital Earth (Foresman 2008a). These geobrowsers represent the first wave of novel and ubiquitous user-interface tools for harnessing the Digital Earth vision for an Earth Operating System. Many technological partnerships exist in this field, including NASA Worldwind, Microsoft Virtual Earth, ESRI ArcGIS Explorer, GeoFusion, and Google Earth. These achievements support the optimistic proposition that the elements from the Digital Earth community can and will provide the operational components for use in an EOS.

Google Earth as EOS Prototype

Google Earth is the most widely recognized player in the virtual Earth world, and those familiar with its platform functions can easily visualize further evolutions of an EOS for Gaia. Google Earth—originally Keyhole Technologies—focused on creating a tessellation engine (a virtual globe that data and images can be electronically pasted onto) that would be accessible via the internet. Environmental and humanitarian applications were not components of Keyhole's original mission until UNEP developed a global environmental assessment software application in 2000. Google purchased Keyhole in 2004 and launched Google Earth in 2005 spawning tremendous interest in connecting information searches with geo-locations. These geo-locations have been visually intuitive and appealing to masses of nontechnical public users on the internet (Foresman 2008b).

An avalanche of community-initiated applications has emerged to provide remarkable reporting on leading social and environmental issues. Stunning and unexpected developments include the documentation of genocide in Darfur, pernicious forest clear-cutting in Burma, and tragic mountain-top removal for coal in Appalachia (Foresman 2007). The successful strategy of Google Earth lies in the accessibility and simplicity of tools that enables users to interface with KML (keyhole markup language) to display their information and satellite images from the internet overlaid on a 3D virtual globe. This startling interface between public technology and current events demonstrates the powerful applications that virtual 3D Gaia can have both in social-justice and ecological arenas.

There remains much to be done, however, in attempting to align the major organizations that are competing for market recognition and leadership to arrive at the conditions necessary for a shared EOS. Standards exist for interoperability that include quality control metadata and open-source protocols for data exchange, but these have yet to be universally adopted thereby postponing the higher performance and achievement capabilities of web-based 3D geobrowsers. The international information and communications framework that has been building over the last two decades through collaborative efforts (e.g., the Spatial Data Infrastructure community) has not reached maturity (FGDC 2008). This framework will also need additional domain experts for facilitating the information and data flow associated with each and every location on the planet.

Collaborative science communities are also increasingly seeking wiki-based tools to enable expansion of semi peer-reviewed information catalogs. Although counterintuitive to many scientists and librarians, the wiki-tools have proved to be as reliable, or more accurate, than conventional approaches to encyclopedic knowledge repositories, and are also temporally more appropriate (Earth Portal 2008; Giles 2005; Hawken 2007). Most information and understanding necessary for sustainability, and conducive for the continued existence of all Gaia's life forms, are not restricted to the scientific community (LOHAS 2008). Indeed more connected and commonsensical knowledge, especially that which is grounded in local communities, can be supported by wiki-tools contributing interconnections and networking between people in an EOS framework. The collaborative interfacing of active citizens through a Digital Earth constitutes a key technology for local communities to move forward (and perhaps even to survive). One of our greatest challenges is how to transform society thereby enabling create grassroots implementations of what an EOS might reveal about the state of human and nonhuman ecologies and their harmonious integration. Mike Carr offers some insight into societal reorganization at bioregional levels (2001).

There are encouraging signs that more and more people around the world are asking questions regarding their individual and collective consumer behaviors. There is increasing demand to know about the origins and conditions of production of consumer goods such as wood products, food, clothing, toys, and water. An EOS could help with "truth in labeling" and could even help stimulate needed shifts in consumer behaviors. New social outlets for peace are being investigated by groups of women attempting to map episodes of violence, on a village by village case, using EOS-type technology (NWGPS 2005). The importance of such initiatives lies also in the potential of providing ecosystem information and feedback directly to women leaders who are attempting to affect social and environmental changes in their communities. As noted by Nobel Laureate Wangari Maathai, self-governance will not succeed if ecological conditions are ignored, and ecological restoration programs will fail if sustainable, democratic governance is not included in the equation (Maathai 1985).

Forward progress for an EOS is urgently required to translate the cybernetic underpinnings of Gaia theory into practical, day-to-day tools. Access to free, web-based Gaian informational systems is rapidly evolving, as evidenced by technical evolutions along the Digital Earth visionary path. Attention should next be focused on stepping up the implementation of technology-based systems for increased citizen access. A grassroots tide of deepening awareness and knowledge may effectively counter the seemingly irrepressible onslaught of biodepletion, resource exploitation, and climate change.

Conclusion

Given today's litany of global challenges, solutions that enable rapid and collaborative action by the majority of the planet's citizens are needed. An EOS for Gaia could provide the means for collective communication and action. The most promising expectation within a global setting of competing social, governance, ecological, and economic demands is the nonlinear growth of web-based social networks; such an acceleration seems plausible given society's phenomenal adoption of web-based networking and tools. If globally distributed social networks—working with NGOs, industry, universities, and governments—can be attuned directly to the realities of Gaia's systems through EOS-based knowledge and insights, then there is greater hope of directing human actions toward sustainability.

Paul Hawken's optimism is his latest work *Blessed Unrest* stems from finding that the largest social movement in history is occurring in our time: this movement is concerned with redressing both environmental and social-justice issues from local to global levels. "If you meet the people in this unnamed movement and aren't optimistic," Hawken submits, "you haven't got a heart" (2007). The fruition of this optimism will require unprecedented collaborative work, utilizing an emerging EOS, to effect the profound changes required to preserve Gaia's natural systems in harmony with human worlds.

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