

RAYS OF THINGS TO COME: A POSTSCRIPT

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“Men’s courses will foreshadow certain ends, to which, if persevered in, they must lead ... But if the courses be departed from, the ends will change. Say it is thus with what you show me!”

Charles Dickens

It is possible to argue that public perceptions about environmental conditions are linked to watershed events that trigger political action for change. Such events include Rachel Carson’s (1962) *Silent Spring*, which led to the recognition of the impacts of pesticide use; the sight of phosphate generated foams and algal bloom in lakes that led to the clean water act and banning of phosphates in detergents sold in almost all the jurisdictions surrounding the Laurentian Great Lakes (Ashworth 1986); the chemical spill at Bophal, which led to the acknowledgement of risks of large-scale production facilities to humans (Jasanoff 1994); or the waterborne *Cryptosporidium* and *E. coli* tragedies at North Battleford Saskatchewan and Walkerton Ontario (Hrudey and Hrudey 2004), which drove drinking water quality to the forefront of environmental concerns in Canada – a country with one of the largest freshwater resources. In many ways these events are analogous to the revolutions in science – paradigms shifts – defined by Kuhn (1970) for changes in the fundamental manner in which the world is perceived. What is not evident, however, is whether there is a cumulative memory or progressive nature to these events that would tend to ladder these actions and therefore better serve our understanding and protection of the natural world.

Unfortunately, this does not appear to be the case given the lectures in this year’s *Kenneth Hammond Lecture Series on the Environment, Energy, and Resources* (Ackerman and Chesworth 2005). The current set of Hammond Lecturers focus on tangible and measurable factors in sustainable development (Caccia 2005), agricultural practices and geology (Chesworth 2005), soil-chemistry (McBride 2005), forest ecology and forestry practices (MacLean 2005), and water and vector-borne

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diseases and climate change (Charron 2005). They present a clear message that the health of plants and animals (*Homo sapiens* is included in the animal kingdom) are affected, usually deleteriously, by human activities. These authors do not generally note a progression – on the contrary they note examples, some dating to 10,000 years ago, of where the correct approach was or is not taken or the possible (and perhaps probable) are ignored by well-entrenched concepts. Two sets of commentators envision some opportunities for change in more effective natural resource policy (Deaton and Harrington 2005) and in a broader engagement of interdisciplinary approaches in defining environmental problems and their solutions (Wayne 2005). The Hammond Lecturers and Commentators hold out some hope for humanity and sometimes provide prescriptions for improvement – in other words, its not all doom and gloom. Collectively they present a reasonable set of concerns and solutions to existing and emerging environmental problems facing humanity. Whether, this represents a progression in thinking about the environment is not guaranteed, because in the Western World these watershed events have been tied to post-war demography. Now that the baby boomers are facing their senior years it seems fitting that environmental conditions become linked to their own, their children, and their grandchildren's health.

This year's *Kenneth Hammond Lectures* is devoted to the issue of health and terrestrial environments. It represents an attempt to capture a new movement emerging which links environments with health – health of the humans being the operative term. The concept is not new by any means and there are cultural traditions and motivations that can be interpreted as designed to protect humans from each other and from their wastes, and to maintain barriers among humans and their animals (Levin 1999). The contemporary manifestation may be centered on the recent overarching concern for health inputs and outcomes that have emerged in various avenues and most notably in the political area where it is close to or dominates debate – especially during election campaigns. Indeed, mainstream scientists have ventured into this area by promoting the concept that there are hitherto neglected or ignored “ecosystem services” – for example, oxygen production by plants, a hydrological cycle that moves and leads to the renewal of freshwater as well as thermal regulation – that occur on earth and which create and maintain the conditions for life. Ecosystem services represent the unaccounted quantities that resource and environmental economists – the intellectual foundation for political activities – have and continue to ignore in their valuation and assessment of policies. These scientists have argued that the ecosystem services cannot be ignored and that they should be expressed in economic terms where they amount to somewhere on the order of twice the gross global production by 6 billion humans (Costanza et al. 1997). Note that this is purely an economic model that does not account for the aesthetic or spiritual value, let alone our ignorance of how the

ecosystem services operate or whether there are some that we have neglected to include. Regardless it is a beginning.

In addition to raising the profile of ecosystem services in terms of economic arguments related to their value, the scientists are also providing an opportunity to model or predict the future. In the case of ecosystem services, this may also be regarded as an alarm about the growth of the human population and its encroachment on more and more of the earth's surface. Following the projection through, this will lead to progressively less service that can be provided because there will be more demand by the increased population as well as less capacity by smaller and more heavily impacted ecosystems. Chesworth (2005) presents the well-worn, historical example of the Polynesian colonization of Easter Island where the demands and degradation of the island by human population led to disaster in environmental and human terms. Both he and I feel that it is a specious argument to believe that the services are boundless – the cornucopian dream – because, as others have also noted, we have yet to invent an ecological perpetual motion device that works counter to the laws of thermodynamics. Moreover, even though I am a fan of science fiction (some may say, obsessed) I worry about the faith in technology as a cure for our ills. This amounts to a belief that a future alchemist will solve our problems using her bag of technology. The problem with alchemy and this argument is that technology is based on science and the realization that there are thermodynamic limits on ecosystem services. Contrary to a common perception that technology involves a linear series of events – perhaps as a result of recent myth building (Campbell and Moyers 1988) – historians of science have noted the non-linear manner in which new technologies have emerged (Burke 1978). This is somewhat encouraging as a ray of hope that this dream may come true, but I would not base my future on it.

On the topic of metaphors, it is probably appropriate to address the health-environment metaphor that may be incorrectly gleaned from the title of this Hammond Lectures (*Health and the Planet*). This is the concept that the environment is some type of super-organism – an analogy that is shared with the so-called Gaia Hypothesis (Lovelock 1979) – which can be healthy or sick. This metaphor raises a number of problems of philosophy and definition, and is counter to the inclusive model for ecosystem health, which involves the intersection of community, economic, and environmental determinants for health, as exposed by Charron (2005). The health metaphor is best examined through one of its components – namely the term, sickness. Of course, each of us has the sense of what is to be sick from a cold, and our physicians have instruments and techniques such as thermometers and blood tests that can be used to measure our symptoms and attribute the cause. This is a relatively simple attribution of sickness in a single vertebrate species (humans) to a single

disease-causing agent (the cold virus). The situation becomes much more difficult (or beggars belief in some medical circles) when the causative agent is or remains elusive (c.f., McBride 2005). More importantly, how would we apply this concept to an ecosystem, which is a localized subset of the environment that includes the communities of species that live in a particular human-recognized physical region such as a lake or a forest?

Even if we cannot see the trees for the forest, there are numerous tree species in a given forest, not to mention the other species of microbes, plants, and animals (MacLean 2005). Indeed, what might appear as a “sick forest” with many dead and dying trees may really be one that is on the road to renewal – the lack of renewal or monoculture plantings by human intervention is what appears to have caused certain catastrophic insect outbreaks in the first place (MacLean 2005). Unfortunately for the metaphor but fortunately for the forest’s organisms, there is no agent that causes sickness in all of those species, nor do we have instruments and techniques that can be used to identify their collective sickness. In fact, I can only conceive of a few examples such as volcanic activity, human development, devastating fires, or prolonged radiation exposure where all forest species are similarly affected in that they are killed. We must, therefore, examine the health of species separately rather than consider the health of the environment as a whole.

The health-environment metaphor becomes more ill defined when we recognize, philosophically, that there are no ecosystems or environment that are or behave as super-organisms or that have super-organism status in the co-operative interaction of myriad species moving toward a single goal. On the contrary, individual organisms work independently of their own con-specifics or other species (with notable exceptions of social organism and mutualistic interactions) to maximize their inclusive fitness – their own survival and that of their or their relative’s offspring (Hamilton 1964; Williams 1966). All examples of co-operative actions in nature where the individuals appear to be subsumed to the common good or the super-organism or the hive, even those of eusocial insects such as bees, are better understood through inclusive fitness. In this context, the worker bee forgoes raising her own offspring for that of her super-sisters – sisters with whom she shares three quarters of her DNA as a consequence of hymenoptera genetics – born from her mother queen because those sisters are more related to her than would be her own daughters. The worker bee has higher inclusive fitness through raising one sister (75% relations) than through raising one daughter (37.5 % relations). The situation in non-eusocial organisms – most organisms other than microbes – is 50 % relations with sisters and daughters, a situation that sometimes leads to aunt behaviour in birds and mammals (Hamilton 1964). The super-organism of the bee-hive remains the domain

of the individual bees. A more plausible explanation for the apparent self-organization of ecosystems and environments is that they are an example of “complex adaptive systems” that respond to simple sets of rules (e.g., natural selection) that govern how they responds to historical and contemporary conditions as opposed to some external or internal objective (Levin 1999). In other words, there are no super-organisms and it is thus impossible to extend the environment-health metaphor to an ecosystem or the environment because each individual of each organism behaves selfishly and are affected differently by different conditions. Unfortunately, though the environment-health metaphor remains attractive for some it is generally elusive for all.

What then is the relevance of the linkage between environments and health? It may be construed as a selfish, human-centered approach that attributes value to environmental conditions when those conditions directly affect the health and welfare of the human condition. *Health and the Planet* presents a terrestrial perspective on how environmental conditions affect both human health and human welfare. Charron (2005) matches this perspective most closely in her treatment of how climate change will affect the transmission of vector and water-borne disease to humans. For example, the continued encroachment of urban and suburban sprawl (which is to say human population pressure) is placing humans within the natural environment of black-legged ticks, which are the vector for Lyme disease. Climate warming in Canada is expected to decrease the generation time for the ticks from three to two years and thus increase the incidence rates as in the northern USA. McBride (2005) also deals with human and animal health, but his approach is more fundamental in that he is searching for the cause of disease – the causative agents – in the very soils on which we live, grow our crops, and from which we draw our water. He suggests that the single-causative-disease-agent model – usually a prion or virus induction – may for many neural degenerative diseases be incorrect or only part of the explanation. His is the sort of skepticism and questioning that is most wanted in this field. The topic is also not sufficiently known or researched to be part of the public debate and time will tell whether the public will recognize that the issues of soil chemistry and plant nutrition are of personal importance.

Caccia (2005), Chesworth (2005), and MacLean (2005) all contribute to the subject of how environments affect human welfare and visa versa. Caccia (2005) approaches the subject from a political and policy perspective in which he criticizes society for using the capital rather than the interest in natural resource management – a sort of personal finance model. He also criticizes the political process in Canada for charging Government Ministers with the simultaneous protection of the public interest and the promotion of the industrial sector under their jurisdictions. Caccia (2005) attributes

the current state of the environment and human welfare to a lack of sustainable thinking. This is also a major concern of Chesworth (2005) who draws the direct link between environmental conditions and human activities, and provides a historical perspective on the concept of sustainability. He views humans as being almost incapable of sustainable activities in agriculture and reminds us that it is the geofertility cycle (the geological “dowries”) of selected environments, such as the Nile delta and North China, which receive regular external inputs from mountains and winds that have maintained resident societies for millennia, despite the actions of humans.

On a positive note, Chesworth (2005) contrasts the aforementioned disastrous outcome on Easter Island with that of the Azores, in which a forward-thinking Portuguese Governor mandated a switch from crop to animal production in order to stop soil erosion. This policy turned out to be quite successful environmentally with the return of forest cover and the reduction in soil erosion and economically with the export of meat and dairy products (unfortunately, other unintended consequences such as high levels of nitrates in surface and groundwater have emerged). I believe that this is the type of political action that Caccia (2005) would support and encourage. In fact, Caccia (2005) presents a list of 12 areas – including taxation, education and regulation – in which political and policy change is needed to achieve sustainability, a concept that is addressed further by Deaton and Harrington (2005) and, which is endorsed by other environmental economists (Brown 2003).

MacLean (2005) deals with an essential terrestrial natural resource in terms of human welfare, namely forests. Specifically he examines how outbreaks by six major insect pest species have influenced forest environments and how humans have altered these relationships. Insect outbreaks such as the Spruce budworm are part of the natural process that occur in eastern North America, but human intervention in reducing or eliminating forest fires (another natural process) and moving the forest from mixed woods (numerous tree species) to monoculture stands have exacerbated both the severity and the length of outbreaks. In terms of the health of balsam fir and the other susceptible tree species, MacLean (2005) recommends a return to ecological principles in forest management in order to achieve sustainability and also indirectly to sequester carbon in trees. A number of other important ecosystems services such as the water cycle, flood control, and oxygen production would also benefit from this approach (Brown 2003).

A common theme among the Hammond Lectures and Commentators is that integrative approaches are needed to both understand and promote changes in environmental conditions and health. This is a reasonable and sound attitude when we

consider that environmental issues involve natural, physical, and social sciences as well as the humanities. Caccia (2005) and Deaton and Harrington (2005) see this as opportunity to include different sectors in the policy process directed to resource and environmental economics. McBride (2005) sees an opportunity to include alternative hypotheses and approaches in the classification of disease, as does Charron (2005) in the characterization of ecosystem health. Both Chesworth (2005) and MacLean (2005) recognize that intrinsic and extrinsic factors affect the soils and the forests that grow on them – and importantly the factors that influence their sustainability. Solutions to the environmental and health issues described by this Hammond Lecture Series will ultimately require the multi-sectorial approaches so identified (Wayne 2005).

The question that remains is, “What will the future hold?”. Will we still be discussing the issue of health and terrestrial environments in future years, will some new analogy emerge to supplant it, or will the human enterprise be driven to the correct action. One key as Caccia (2005) promotes is to disengage from an environment versus economy model that has been so ill served in North American compared to jurisdictions in northern Europe, and work towards his 12 critical shifts. Another key goal is to stabilize population growth, reduce carbon emissions, and raise water productivity (Brown 2003). A third approach from the complex adaptive system model recommends the following eight environmental commandments (Levin 1999):

- (1) Reduce uncertainty,
- (2) Expect surprise,
- (3) Maintain heterogeneity,
- (4) Sustain modularity,
- (5) Preserve redundancy,
- (6) Tighten feedback loops,
- (7) Build trust, and
- (8) Do unto other as you would have them do unto you.

Clearly we have a reasonable understanding of current issues. Whichever approach or combinations thereof is taken will lead humanity in the future and provide rays of things to come.

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