

# “Are Humans Unsustainable by Nature?”

**William E. Rees**  
**2007 Trudeau Fellow**  
**University of British Columbia**  
**School of Community and Regional Planning**  
[9674 words]

## **Trudeau Lecture**

*Memorial University of Newfoundland, January 28, 2009*

### ***Introduction: The State of the World ‘in Light of Human Evolution’***

This paper is an exploration of an extended and admittedly somewhat discomfiting hypothesis, namely that the human species, *H. sapiens*, is unsustainable *by nature*. In short, I am proposing the deteriorating state of the biophysical world and the threat that it poses to the human prospect is a natural outcome of what humans themselves have evolved to be. Initially, some of you may take this proposition to be radically nonsensical. By the end, however, I hope you will see that the main threads of my argument, many of which have been recognized for centuries, have merely wanted knitting into whole cloth.

Most of you will be well aware of the context for this discussion. People are destroying their ecosystems; we are undermining the life-support functions of the ecosphere. Our best science warns that the human enterprise has already overshoot the long-term carrying capacity of Earth. According to the latest (fairly conservative) estimates by the World Wide Fund for Nature, the human ecological footprint exceeds global biocapacity by almost 30% (WWF 2008).

This should come as no surprise. Back in 1992 (the year of the first United Nations Conference on Environment and Development) the Union of Concern Scientists issued its famous *World Scientists’ Warning to Humanity*:

“We the undersigned, senior members of the world’s scientific community, hereby warn all humanity of what lies ahead. A great change in our stewardship of the earth and the life on it is required if vast human misery is to be avoided and our global home on this planet is not to be irretrievably mutilated” (UCS 1992).

No waffly ambiguity there! Nevertheless, in the course of the subsequent decade—a decade characterized by increasingly rousing rhetoric on the needed shift to ‘sustainable development’—ecological trends generally worsened. Thus in 2005, the authors of Millennium Ecosystem Assessment (the most comprehensive examination of the state of the ecosphere ever undertaken) were moved to echo the UCS’s statement in their own summary document:

“At the heart of this assessment is a stark warning. Human activity is putting such a strain on the natural functions of the Earth that the ability of the planet’s ecosystems to sustain future generations can no longer be taken for granted” (MEA 2005, p.5).

And still the dismal data accumulate. One recent peer-reviewed climate change analysis concludes that “an optimistic interpretation of the current framing of climate change implies that stabilization much below 650 ppmv CO<sub>2</sub>e is improbable.”<sup>1</sup> To stabilize at 650 ppmv CO<sub>2</sub>e, the majority of OECD nations would have to begin “draconian” emission reductions within a decade. Thus, unless we can reconcile economic growth with unprecedented rates of decarbonisation—in excess of 6% per year—this would require *a planned economic recession* (Anderson and Bows, 2008). If this seems outrageous, consider that 650 ppmv CO<sub>2</sub>e implies a catastrophic 4 C° mean global temperature increase—the impact of a major recession, planned or not, would be mild by comparison.<sup>2</sup>

In effect, the world’s top scientists are warning that staying our growth-based path to global development virtually guarantees catastrophe for billions of people and threatens the possibility of maintaining a complex global civilization. Such warnings should galvanize any self-proclaimed science-based culture to corrective action. Nevertheless—and this is really the starting point for our analysis—there is scant evidence that national governments, the United Nations or other official international organizations have begun openly to contemplate the implications for humanity if the scientists are right, let alone articulate in public the kind of policy responses the science evokes. Despite decades of accumulating evidence and growing anxiety about the risks of global change, the modern world remains mired in a swamp of cognitive dissonance and collective denial. Just what is going on here? How can we make sense of such conflicting realities?

There is, of course, no shortage of explanations for the ecological crisis. No doubt it can be traced, in part, to technological hubris and humans’ inflated sense of invulnerability; some blame it on ignorance, greed, and even the desperation of impoverished people; others point to the flawed structure of industrial capitalism or the sheer momentum of growth-bound techno-industrial society. No doubt all of these reasons are valid, some more than others and at different times and places, but each such explanation has the superficial sheen of *proximal* cause. What we really want to know is the root source of human greed, why some people are propelled by desperation and just how industrial capitalism came to be the way it is. This paper therefore advances a more *distal* cause of our common dilemma, one that lies beneath all the others.

The explanation we explore below was actually inspired by a phrase first penned by famed Russian-born geneticist, Theodosius Dobzhansky in 1964:

**“Nothing in Biology Makes Sense Except in the Light of Evolution”**  
(Dobzhansky 1964, p.449)

To get straight to the point, my thesis is that we will only fully understand the modern sustainability conundrum and society's apparent paralysis in the face of it, if we examine its root causes in human evolutionary biology.

***Premise 1: H. sapiens is an evolved species***

My argument begins from two related and, I hope, non-controversial premises. The first should already be obvious: *H. sapiens* is an evolved species like all the others and human evolution, like that of all the others, has been shaped by the forces of natural selection. Since individual and emergent social behaviour are as much exposed to selective pressure as any other genetically-influenced human quality, it is therefore not much of a leap to extend Dobzhansky's principle to assert that *nothing in human affairs—including much of economic and socio-political behaviour— makes sense except in the light of evolution*. This is not to say that other factors are not involved. Rather, I am arguing that the picture is unintelligibly incomplete unless we factor in the bio-evolutionary contribution.

It is true, of course, that human evolution differs significantly from that of other species. Most significantly, human evolution is now determined as much or more by socio-cultural factors (memes) as by biological factors (genes).

Now everyone knows that a 'gene' represents a unit of genetic information encoded in DNA that is passed from parent to offspring and that interacts with 'the environment' to help determine the physical and behavioural phenotype (the 'appearance') of the individual. But fewer people are familiar with the concept of the 'meme' first introduced by evolutionary biologist, Richard Dawkins in 1976 (Dawkins 1976). A 'meme' is a unit of cultural information that, like a gene, can be passed between generations and that influences the 'phenotype' of the culture. A meme can be a persistent belief, an entrenched assumption, a particular value, a scientific concept or a working technology. Memes are thus the basis of cultural inheritance. Significantly, memes differ from genes in that they can be shared and spread rapidly among living individuals in the *same* generation or population.

Indeed, people acquire much of their memetic endowments passively, just by being exposed to a particular cultural environment and various social contexts, including schools, religious institutions and the family home. Once acquired, such 'cultural programming' asserts considerable, often subconscious, influence over both individual and group behaviour. (More on this to follow.) While an individual's meme-based cultural programming *can* be modified, we shall see that humans are often extremely resistant to change.

Genetic science tells us that genes generally don't perform solo. Many complex characteristics under genetic control are 'polygenetic,' i.e., they are influenced by several genes acting in consort as what might be called a 'gene complex.' Thus, we can extend the analogy and refer to any coherent, integrated set of memes that characterize a particular ideology, paradigm, discipline or worldview as a 'meme complex.'

Most importantly in the present context, meme-theory holds that memes, like genes, vary within and between populations, are exposed to competition, can mutate, and will be exposed to varying biophysical and socio-cultural environments. In other words, memes are subject to a form of natural selection and evolve over time. It follows that if a meme or meme complex becomes maladaptive under particular environmental circumstances it may be eliminated or ‘selected out.’ Thus, while memetic evolution is theoretically much faster than the genetic variety, there may be circumstances in which it is not fast enough. In extreme circumstances, whole societies stuck with maladaptive meme-complexes have foundered and collapsed.

***Premise 2: H. sapiens as work-in-progress***

My second premise is that human evolution is incomplete. We may think of ourselves as the pinnacle of earthly evolution but *H. sapiens* remains very much a work in progress. We can get a good sense of humanity-in-transition by considering just the brain. Neurologist Paul MacLean, argued that the human brain has evolved in at least three overlapping phases, each with a corresponding anatomical sub-component having distinct functions, memory and ‘intelligence.’ MacLean referred to the three quasi-independent structures of the human brain as the reptilian or R-complex (the brainstem and cerebellum), the limbic or paleo-mammalian system and the neocortex or neo-mammalian brain (MacLean, 1990):

- The reptilian complex is concerned with autonomic functions associated with the body’s physical survival (e.g., circulation and breathing). It also influences instinctive social behaviour (e.g., pertaining to territoriality, social stature, mating and dominance), executes the fight or flight response and controls other mainly hard-wired ritualistic or instinctive behaviours.
- The limbic system is the primary seat of emotions (e.g., happiness, sorrow, pleasure, pain), personal identity and related behavioural responses (e.g., sexual behaviour, play, emotional bonding, separation calls, fighting, fleeing). It also houses our affective (emotion-charged) memories and seems to be the seat of our value judgements and informed intuition.
- The neo-cortex or ‘rational brain’ is the most recent elaboration but occupies over two thirds of the human brain by volume. More importantly, it is responsible for the higher cognitive functions that distinguish humans from other mammals; it is the seat of consciousness and the locus of abstract thought, reason and logic. It makes us uniquely capable of moral judgement and forward planning. The neo-cortex facilitates language, speech and writing and, with these, the very possibility of civilization.

Although some critics consider MacLean’s conceptual separation of major brain components to be somewhat simplistic, animal and human research has generally supported the fundamental elements of the theory (Panksepp 1998). In any event, however localized its various functions, the healthy brain generally acts as an integrated whole—the three sub-brain systems are intricately interconnected, each continuously influencing the others (e.g., emotions stimulate thought and thought may trigger emotion). The emergent behaviour and overall personality of the individual is thus a melding of thoughts, emotions and instincts. However, under particular

circumstances, one of the sub-brains, with its distinct capacities and limitations, may assume the dominant role. Significantly, *the individual may not be fully aware of what part of the brain is in control.*

This last point is particularly important in the context of (un)sustainability. Humans think of themselves as uniquely self-aware and rational. However, because of the seeming success of the enlightenment project and subsequent scientific revolution in giving humans mastery over the physical world, western society has come to overestimate the power of mindful intelligence and reason. We seemingly ‘live’ in consciousness conferred by the human neo-cortex but remain paradoxically unaware of critical influences over our individual and group behaviour that spring from the lower brain centres (see Buchanan 2007). The circumstances in which logic and reason dominate may still actually be limited and their effect relatively trivial in the grand evolutionary context.

What this implies is that much of expressed human behaviour, from routine one-on-one social interaction to international political posturing, is shaped, in part, by innate subconscious mental processes and their associated chemical/hormonal agents. Most importantly, in situations of conflict or resource scarcity, social/political/behavioural predispositions that operate beneath consciousness (i.e., in the limbic system and reptilian brain stem) may well override higher logic and rational thought in delivering a response. You will all be aware—perhaps even from personal experience?—that passion frequently trumps reason.

The main point to take from this is that *humanity is a conflicted species*, torn on the one hand between what reason and moral judgement says we should do and what pure emotion or baser instincts command us to do. With no knowledge of its neurological basis, 15<sup>th</sup> Century Italian Renaissance philosopher Giovanni Pico della Mirandola nevertheless recognized the tension. He saw humanity’s unique capacity for reason as a bridge to godliness and feared the consequences of ‘loosing it’ to more primitive drives:

“Man was created by nature in such a way that reason might dominate the senses and that by its law all rage and desire of passion and lust might be restrained, but when the image of God has been forgotten... we begin to serve the beasts within us...” (Mirandola, paraphrased from his *Oration on the Dignity of Man* [1486]).

Famed modern-day neuroscientist Antonio Damasio, who studies the actual neuro-chemical mechanisms of such internal conflict, expressed the same idea as follows: “There are indeed potions in our own bodies and brains capable of forcing on us behaviours that we may or may not be able to suppress by strong resolution” (Damasio, 1994, p.121).

### ***Working Hypothesis: Humanity is Unsustainable by Nature***

With this as background, let me advance the following double-barrelled elaboration of my opening hypothesis:

*Unsustainability is an inevitable emergent property of the systemic interaction between techno-industrial society, as presently conceived, and the ecosphere. Both purely innate (genetic) and quasi-cultural behavioural factors are involved.*

Some explanation is in order. For present purposes we will define ‘emergent property’ as a characteristic, quality or phenomenon that arises from the particular interaction of two complex systems. In this case, the interacting systems are techno-industrial society and the ecosphere. Thus, I am arguing that the various symptoms of unsustainability, from fisheries collapses to human-induced elements of climate change, emerge from fundamental incompatibilities between the structure and behaviour of natural ecosystems and the structure and behaviour of the human enterprise. Ecosystem behaviour is wholly determined by the laws of physics, chemistry and biology and ultimately governed by the laws of thermodynamics. The human enterprise is subject to those same laws, but its actual behaviour is now as much influenced by various socially-constructed technological and conceptual memes. Problems emerge when, for example, effects of techno-cultural innovations overwhelm the natural processes that ultimately sustain the integrated whole. (E.g., fish-catching technology and fishers’ strategies now vastly outstrip the escape mechanisms and reproductive capacities of fish stocks.)

### ***The biological drivers***

Just what are the genetic presets that are pressing us toward the brink? The suspect biological drivers are basic reproductive and survival instincts that humans share with all other species. Many experiments with organisms ranging from bacteria cultured in Petri dishes to reindeer introduced to previously uninhabited islands reveal the following universal properties of life: *unless or until constrained by negative feedback, all species populations expand to occupy all accessible habitats and to use all available resources.* Moreover, in the competition for habitat and resources, evolution favours individuals who are most adept at satisfying their short-term selfish needs whether by strictly competitive or by cooperative means, despite potential negative consequences down the road—i.e., a tendency to discount the future has evolved by natural selection. As my friend and colleague Dr Ronald Brooks argues, the potential for ecological destruction “is not merely a cultural trait, or even a [human] species trait, but a characteristic of any species that has evolved by Darwinian selection” (Brooks 2001, p. 72).

Of course, *H. sapiens* has always had to compete with other consumer species for food and other resources and there is little doubt that humans have prevailed in the competition. In particular, written language and cumulative technology—unique assemblages of meme complexes—give us a powerful ‘leg up’ in the Darwinian struggle. As a result *H. sapiens* has the greatest geographic range of any ecologically comparable species. There is no sizable patch of habitable landscape on Earth that has not been claimed and occupied by people. And does anyone imagine that if, somehow, another resource-rich continent were discovered today we would collectively say, “Well, we’ve certainly messed up everywhere else. Let’s just leave this one in its pristine state”? Consider the universal official response to the disappearing sea-ice in the Arctic. Do

governments react in alarm and redouble efforts to negotiate a climate change mitigation treaty or otherwise protect the Arctic ecosystem? Certainly not! Canada and other circumpolar nations are tripping over each other in their frenzy to stake or reinforce their claims to the newly-exposed resource endowment of the ocean floor, including more of the petroleum and natural gas that are the cause of the problem in the first place (Gamble 2009).

In fact, this is the typical human response to anything we take to be resources. One recent study shows that in terms of energy use (and therefore carbon dioxide emissions), biomass consumption and various other ecologically significant indicators, human demands dwarf those of similar species by orders of magnitude. Human consumption of biomass, for example, exceeds the upper 95% confidence limits for biomass ingestion by 95 other non-human mammal species by two orders of magnitude (Fowler and Hobbs 2003). By virtue of cumulative knowledge and technology, *H. sapiens* has become, directly or indirectly, the dominant macro-consumer in all major terrestrial and accessible marine ecosystems on the planet.<sup>3</sup> All of which means that, our species may well be the most voraciously successful predatory and herbivorous vertebrate ever to walk the earth. In this light we can interpret unsustainability as the most recent and possibly terminal manifestation of humanity's competitive superiority.

Humanity's extraordinary material success actually makes us the archetype for an idea first articulated by ecologist Alfred Lotka in 1922 and now known as the 'maximum power principle': systems that prevail in the struggle for life (i.e., successful individuals, species and ecosystems) are those that evolve in ways that *maximize* their use of available energy and material resources (see Lotka 1922). *H. sapiens*' adoption of agriculture ten millennia ago was the first great leap forward in our species' capacity to harvest energy from nature and the one that made permanent settlements and large-scale civilization possible. However, more than any other factor, our ability to exploit fossil fuels explains the explosive expansion of the human enterprise that began in the 19<sup>th</sup> Century. In effect, the modern world is made from petroleum.

There is, however, a compound problem.<sup>4</sup> First, despite today's material abundance, people's competitive drive and tendency to accumulate remains unsatisfied. Modern humans don't have a built-in 'off' switch that is tripped by sufficiency (which, by the way, is the basis for the economists' caricature of humans as *Homo oeconomicus*, as 'a self-interested utility maximizer with fixed preferences and insatiable material demands'). Second, humanity's technological capacity to exploit nature now exceeds nature's reproductive capacity. The combined result of these forces haunts the sorry history of so-called resource management, particularly common pool assets: "While there is considerable variation in detail, there is remarkable consistency in the history of resource exploitation: resources are inevitably overexploited, often to the point of collapse or extinction" (Ludwig, Walters and Hilborn 1993, p.17). The implosion of North Atlantic cod in 1992, until then the world's greatest fishery, is a striking Canadian example.

### ***The cultural Re-enforcer: The myth of perpetual growth***

These basic facts of human ecology alone are sufficient to explain how even primitive hunter-gatherers often caused permanent changes in ecosystems, including the extinctions of many large mammals and (particularly flightless) birds. Certainly, too, humanity's expansionist tendencies, combined with such preindustrial technologies as sail-power, were sufficient to drive the European "rape of the world" that was well under way by the end of the 16<sup>th</sup> Century (Ponting 1991). But the contemporary sustainability crisis, the global-scale degradation that threatens the future of humanity itself, is a product of the industrial era. This is the period when cultural forces, endowed with unprecedented technological leverage, emerged to *reinforce* humanity's innate expansionism. In particular, industrial culture acquired a universal unifying goal—promoting economic growth has become the principal *raison d'être* of national governments the world over.

There is actually a second layer of nature-nurture interaction at work here. Humans are natural story-tellers and myth-makers. No society is without its myths and legends, its grand cultural narrative. In fact, the 'social construction of reality' (or better, the 'social construction of perceptions') in the form of stories, myths, ideologies and paradigms is a universal property of human societies that plays a vital role in every culture including our own (Grant 1998). The key point is that while the tendency to mythologize is yet another vessel cast from our genes, what we put into it (in this case, the idea of perpetual growth) is determined by social and cultural context. If the modern mind has difficulty in accepting this notion, it is only because we prefer to believe that we are essentially a science-based culture. Most 'educated' people have learned to equate myth with falsehood, superstition, and the mystical beliefs of 'primitive' peoples.<sup>5</sup> But this is a particularly sterile and dismissive view of myth. Consider instead Colin Grant's description of myths "not as mistaken views but as comprehensive visions that give shape and direction to life" (Grant 1998, p.1).

With this perspective in mind, I submit that the entire world today is united in a grand mythic vision of global development and poverty alleviation centred on unlimited economic expansion fuelled by open markets and more liberalized trade (Rees 2002). This myth springs from the assumption that human well-being derives from perpetual income growth. No other cultural narrative in all of history has given greater "shape and direction to [the lives]" of so many people.

The perpetual growth ethic, still spreading into the developing world, has actually taken hold in a remarkably short period of time. Only eight or ten generations of people have experienced sufficient economic growth or related technological change to notice it in their lifetimes—99.5% of human history has been no-growth history. As an *influential* memetic construct, perpetual economic growth has actually been around for only *two* generations. Indeed, there was virtually no interest in economic growth as a policy objective anywhere before 1950. Yet, by the end of the '50s, economic growth had bubbled to the top as the "supreme overriding objective of



policy” in many countries. By then, “...more rapid economic growth came to be regarded as a prophylactic or remedy for all the major current ailments of western economies” (Arndt 1978, cited in Victor 2008, p.13). Here the point to remember is that like maladaptive genes, ill-considered memes—no matter how successful in the short term—may ultimately be selected out by a changing ‘environment.’

Indeed, the problem for sustainability is that the perpetual growth myth knows no ecological bounds. Mainstream academic models of the economy make no functional reference whatever to the ecosystems that contain it. Co-lateral damage to ‘the environment’ is considered to be a mere ‘negative externality’ that can be corrected by appropriate pricing through, for example, pollution charges or taxes. Resource shortages? No matter—we can relieve local shortages through trade, and should the problem be more widespread, we play the technology card—the expansionist myth asserts that human ingenuity will find a substitute for any depleting resource. The late business professor Julian Simon put the techno-mantra this way:

“Technology exists now to produce in virtually inexhaustible quantities just about all the products made by nature... We have in our hands now – actually in our libraries – the technology to feed, clothe and supply energy to an ever-growing population for the next seven billion years... (Simon 1995).

This is such an arithmetically-challenged statement, that only the terminally gullible would take it seriously,<sup>6</sup> but it makes the point to which Simon dedicated his business and academic life—there is no basis whatsoever for concern about resource scarcity or ecological degradation. Indeed, growth advocates regard environmentalists and other critics as imposing a dangerous drag on the world’s growth-based pursuit of progress.

It goes almost without saying that industrial capitalism both feeds and feeds on perpetual growth—material accumulation is both the objective of and a necessary fuel for the capitalist production and consumption. But because of its insatiable thirst for cheap resources and labour, capital has become tightly tied to the political and military power needed to sustain its global expansion (just as US President Eisenhower warned it would). The history of conflict since WW-II (particularly the recently-ended Bush administration’s record) shows how this particular alignment of powers responds to any effort to resist it.

Finally, we must note the average citizen’s generally unconscious role in all this. Capitalism needs people to buy its prodigious output. In the 1950s, private capital therefore began to re-think what has become today’s multi-hundred billion dollar advertising industry to flog the products of its factories. At that point, the social construction of reality had become a commercial enterprise with the goal of converting potentially self-aware citizens into autonomic consumers. (By the way, this is achieved by playing on people’s innate insecurities, competitive instincts, envy, concerns about social status, etc., i.e., a bevy of emotions and instincts resident in the mid-brain and R-complex.) Our throw-away consumer society was literally invented by private capital mainly to serve the interests of private capital. Listen to how 1950s marketing expert Victor Lebow described the mission:

Our enormously productive economy demands that we make consumption our way of life, that we convert the buying and use of goods into rituals, that we seek our spiritual satisfaction and our ego satisfaction in consumption. We need things consumed, burned up, worn out, replaced and discarded at an ever-increasing rate (Lebow 1955).

Little wonder that theologian Colin Grant describes the consumer sub-myth as going beyond materialism: "...it is about spiritual reality. It represents the most sustained attempt in the history of humanity to accord total spiritual significance to material consumption" (Grant 1998). All of which underscores an essential factor impeding progress toward sustainability: The current generation of people has been thoroughly, if unconsciously, socially-engineered as reflexive mega-consumers with no consideration of the long-term effects on personal health or the earth.

### ***Parsing the Growth-Based Development Myth***

I have argued that that the modern world is in the thrall of a global development myth based on continuous economic growth. This myth essentially equates human well-being with ever-rising income (i.e., capacity to consume). It posits that we need ever greater money-wealth to provide the means better to protect 'the environment.' The myth promotes global economic integration as a means to increase gross economic output by taking advantage of the efficiencies associated with specialization and trade. Most importantly, in the present context, growth advocates argue that economic expansion is essential to relieve the debilitating poverty that is still the dominant reality for at least a third of the human family.

It seems appropriate to assess how we are doing in light of these assumptions and in pursuit of these goals: What does the empirical record of the past half century tell us not only about the merits of the myth itself but also about the human nature of (un)sustainability?

- First, we know that growth-driven 'development' is degrading the biophysical basis of our own existence—and the problem is not just climate change. Humans are acidifying the oceans; deserts are spreading; tropical forests are disappearing; biodiversity is declining; fisheries are collapsing; soils are eroding; aquifers are falling; surface waters are polluted beyond life and use, etc. The climate system and major ecosystems are approaching tipping points beyond which they may well "flip" into new equilibrium states that might not be compatible with human economic or ecological needs. Such changes may be irreversible in practical terms on time scales that matter to people. Again, the collapse of Canada's Northern Cod stocks serves as an archetype of systems collapse. Obviously, such trends can only detract from long-term human well-being.
- We know that the world's most serious ecological problems (e.g., climate change) can be traced mainly to high-income consumers. The wealthy have the per capita ecological footprints twenty or more times larger than the very poor. The richest 20% of the population consume most of the world's economic and ecological output (see below). Clearly, greater income is no assurance of greater environmental protection.

- We know that while economic growth has raised millions out of poverty the absolute number of poor has never been greater. Particularly in the impoverished parts of Africa, Asia and Latin America, about 1.2 billion people still lack access to potable water and 2.6 billion have no sanitary or sewage facilities. Almost a billion people live on less than a dollar per day and most are calorically deprived. About 2.6 billion people or 40% of the human population live in poverty at less than two dollars a day and most are otherwise malnourished. Over 26,000 children die every day from poverty (meaning hunger, water-borne and other preventable illnesses) (Shah 2008, World Bank 2008). These billions of people, ostensibly the intended beneficiaries of global growth, would benefit greatly from even modest income increases but are gaining little ground.

By contrast:

- We know that the greatest share of national and global income growth flows to upper income groups who need it least. In 1966 the world's wealthiest countries with one billion people—15% of the world population—accounted for 76% of gross world product (\$36.6 trillion out of \$48.2 trillion). The richest 20% of the world's population take home 76.6% of the world's income; the poorest 20% subsist on 1.5% (Shah 2008, UNDP 2007).
- We know that further income growth for the rich is borderline futile and certainly an egregious waste of the world's resources. Beyond a certain point, a point long past in the development of high-income countries, there is no significant positive relationship between various objective indicators of population health (longevity, infant mortality, post-operative survival, etc.) and rising incomes (Siegel 2006, Victor 2008). The same is true for subjective indicators, measures of 'felt' well being (e.g., for the United States, Robert Lane describes "...the strange, seemingly contradictory pattern ... of rising real income and a falling index of subjective well-being" (Lane 2000).
- Nevertheless, we know that the income gap both between and within countries is widening. In 1960, the 20% of the world's people living in the richest countries took home 30 times the income of the poorest 20%; by 1997, this had increased to 74 times as much. The average American who was 38 times richer than the average Tanzanian in 1990 was 61 times richer in 2005. (By 2005, the average African household was consuming 20 percent less than it did 25 years ago [UNDP 2005]). As noted, the already wealthy increasingly appropriate the greatest share of national income growth. As a result, by 2000, the richest five percent of the United States' population owned 60% of that nation's wealth. That is, the top five percent had more wealth than the remaining 95% of the population combined. (The US now has the widest income gap of any high-income nation.)

- We also know—ironically—that one of the most significant contributors to declining population health and increasing civil unrest in poor and rich countries alike is income disparity. Countries with increasing inequality and deepening social divisions “...tend to show markedly higher rates of alcohol related deaths, accidents, homicide, crime, violence and probably drug use” (Wilkinson 1996). Yet we actively promote national and global political economies that systematically and dramatically increase inequity. More than 80% for the human population lives in countries where income differentials are increasing, including Canada and the US (UNDP 2007).

It seems that over the past few decades virtually the entire world has bought into an economic growth paradigm that, contrary to its implicit assumptions and stated goals, is wrecking the ecosphere, undermining essential life-support systems, failing the chronically poor, making the already rich richer without improving well-being, and increasing inequality virtually everywhere with negative implications for population health and social stability. This is not exactly a stellar record. As ecological economist Herman Daly has frequently argued, we may be well into a period of uneconomic growth in which the (mostly unaccounted) costs *outweigh* the benefits. Yet the universal response to these failings—and, most recently, to the collapse of the global financial system—is to add fuel to the (now somewhat dampened) fire. Rather than seize the opportunity to create a potentially sustainable new economy, governments everywhere are attempting to resurrect the old—bailing out corrupt financiers and failed banks, salvaging a grossly mismanaged auto industry, lowering interest rates, assembling ‘stimulus packages’ and doing everything else they can to reignite the flames of national and global growth.

And we have certainly not forgotten that programmed automaton, the lowly consumer. Governments are lowering income taxes to renew people’s enthusiasm for performing their assigned role in the capitalist economy (and the blind-sided ‘beneficiaries’ mostly cheer, apparently oblivious to the fact that this means reducing government services that they may actually need). The media are certainly firmly with the program. A recent *Globe and Mail* editorial chided Canadians for their thrift and parsimony, even in these uncertain times. Saving apparently stifles growth. For our own good, the *Globe* urged, “spend wisely, but spend nonetheless” (G&M 2009).

Now, an alien observer might be puzzled by all this. Can we really claim to be a science-based society? Certainly repetitive futile actions are not the mark of high intelligence and reason. Wasn’t it Einstein who quipped, “insanity is doing the same thing over and over again, and expecting different results?”

But this precisely is the point—intelligence and reason are not the primary determinants of human social behaviour. It is raw instinct and emotion, combined with familiar constructed beliefs, not logical analysis and reason, that “give shape and direction to life.” We prefer our myths and ignore the data; shared illusion provides a psychological shield against the harsh barbs

of reality. Popular social critic and environmentalist Derrick Jensen nailed the point nicely when he wrote that:

“For us to maintain our way of living, we must... tell lies to each other, and especially to ourselves... [the lies] are necessary because without them many deplorable acts would become impossibilities” (D. Jensen 2000).

### ***Intelligence, Self-delusion and Sustainability***

Modern humans may not be insane but we can make the case that they are genuinely confused. I argued earlier *H. sapiens* is a conflicted species “torn on the one hand between what reason or moral judgement says we should do and what pure emotion or baser instincts command us to do.” I want now to return to that argument.

In 1955, at the time economic growth was pushing its way to prominence on the policy agenda, German philosopher Martin Heidegger lamented that “...man today is *in flight from thinking*” (Heidegger, 2003, p.88). Heidegger was not referring to the short-term, goal-driven *calculative* thinking of the kind that, for example, drives the economy, advances technology and proliferates electronic gadgetry. He meant that people have abandoned *meditative* thinking, that uniquely human form of intellectual activity that contemplates “...the meaning which reigns in everything that is” (Heidegger, 2003, p.89). Meditative thinking requires concentrated effort, wilful determination, and active consciousness in deep exploration of present reality. This is the kind of thinking that is missing from the roiling boil of modern life. Heidegger is arguing that we moderns have allowed to “lie fallow” one of our greatest and uniquely human abilities. Instead we are being swept along in the techno-material tide, guided, if at all by careless whims and sheep-like adherence to prevailing mythology.

Our Renaissance philosopher friend, Mirandola, actually anticipated Heidegger’s concern by 500 years (unconscious human behaviour is fairly constant). Indeed, we may well be living Mirandola’s worst nightmare. You will recall that Mirandola intuitively sensed the evolutionary role of the cerebral cortex—to him the capacity for contemplative thinking was a gift of God that raised ‘man’ above the beasts. But Mirandola feared that even his contemporaries disparaged philosophy, seeing the pursuit of answers about “the causes of things, the ways of nature and the plan of the universe” as “occasion for contempt... , rather than honour and glory.” He was pained to recognize that society had “reached the point... where the only persons accounted wise are those who can reduce the pursuit of wisdom to a profitable traffic.” In Mirandola’s view, “...if you see a man [thus] bedazzled by the empty forms of the imagination... and through their alluring solicitations made a slave to his own senses [read: ‘emotions and instincts’], you see a brute and not a man” (Mirandola 1486).

Exactly so. By allowing our capacity for self-conscious intelligence to “lie fallow” we also allow relatively brutish behavioural predispositions that originate *beneath* consciousness in the limbic system and brainstem to dominate our actions. Short-term self-interest, material greed,

possessive accumulation, competitive exclusion—these have been the primary and proudly public drivers of industrial capitalism’s expansion around the world in recent decades.

By contrast, acting with high intelligence, consistent with the scientific evidence on global change, and exercising our capacity for moral judgment, would require that rich countries recognize that it is now in their own long-term interest not only give up the idea of continuous material growth but begin a planned *shrinkage* of their national economies. This is necessary on a finite planet already in overshoot to make room for needed growth in the developing world (Rees 2008, Victor 2008). Climate science says that to avoid potentially catastrophic climate change, global society must reduce its CO<sub>2</sub> emissions by 80-90% by mid-century, beginning almost immediately (and even this may prove too little too late). Similarly, our eco-footprint work shows that for sustainability with equity, North Americans would have to reduce their ecological footprints by about 80%, from around nine global average hectares per capita to our ‘fair Earth-share’ of about two gha (Rees 2006, WWF 2008).

These may seem to be impossible goals, but analysis shows that we actually have the technology today to enable a 75% reduction in energy and (some) material consumption (e.g., Weizsäcker *et al.* 1997) while improving quality of life in the first world and increasing general well-being in the developing countries. Remember, too, that, on average, people in wealthy countries were actually happier with half and less of today’s average per capita income.

Yet we do not act, even to save ourselves. ‘Contraction’ is not the narrative people are used to hearing; it is not a story we want to heed. Privileged elites with the greatest personal stake in the *status quo* control the policy levers and are steering us onto the rocks. Ordinary people hold to the expansionist myth as to a life-raft, in deep denial of present reality. It seems we are all willing to trade off uncertain but potentially major long-term gain (i.e., cultural survival) to avoid the certain but minor short-term pain of having to adjust our lifestyles. Despite the growing scale of potential catastrophe, the innate human tendency to discount the future remains intact. And, of course, the world dismisses those analysts who have actually thought things through. Nineteenth Century behavioural psychologist Gustave Le Bon described the syndrome well in his book on the workings of “the popular mind”:

“The masses have never thirsted after truth. They turn aside from evidence that is not to their taste, preferring to deify error, if error seduce[s] them. Whoever can supply them with illusions is easily their master; whoever attempts to destroy their illusions is always their victim.” (Gustave le Bon 1896).

Le Bon’s observation is no mere curiosity. Cognitive blocks and resultant behavioural inertia can determine the fates of nations. The distinguished American historian, Barbara Tuchman, details the tragic effects of self-delusion on entire societies through millennia in her 1984 classic, *The March of Folly*. According to Tuchman political folly or “wooden-headedness”:

“...plays a remarkably large role in government. It consists in assessing a situation in terms of preconceived fixed notions [i.e., ideology] while ignoring any contrary signs. It is acting according to wish while not allowing oneself to be deflected by the facts” (Tuchman 1984, p.7).

For those who still doubt the power of entrenched beliefs over thoughtful deliberation, recent cognitive research has revealed a physiological mechanism. During early development and maturation, social, cultural and sensory experiences actually *shape* the individual's brain structures and synaptic circuitry in an 'image' of those experiences. Once entrenched, these neural structures alter the individual's subsequent experience and perception. People tend to seek out experiences that reinforce their pre-set neural circuitry and to select information from their environment that matches these structures. Conversely, "when faced with information that does not agree with their internal structures, they deny, discredit, reinterpret or forget that information" (Wexler 2006, p. 180).

This problem may be particularly acute among political leaders because yet another mechanism is at play. When people perceive a threat to their status, safety or survival, innate behavioural propensities that operate beneath consciousness in the limbic system and brain-stem tend to override more rational defensive responses. Thus, in addition to being psychologically hard-wired to their political ideologies, politicians may be more than usually enslaved to brainstem-based survival instincts, particularly the deep-seated need to retain their wealth, prestige and political power. So it is that in the history of human affairs, brutish passion and instinct often overwhelm the godly gift of reason (Morrison 1999).

There is a still further complicating factor in the context of sustainability. Globalization, that hand-maiden to expansionist logic, has led to such an entanglement of interests and nations, that individual people and countries who do understand the ecological crisis cannot act to save themselves even if inclined to do so. In a thoroughly interconnected world (un)sustainability is a collective crisis that demands collective solutions. Nations that act alone to rationalize their economies would have to abrogate various international treaties and agreements (on trade, for example) and would be regarded as rogues or renegades. Unless most others followed, they would put themselves at great contemporary disadvantage with no long-term benefit—they would inevitably go down with the global ship. Machiavelli, the more cynical contemporary of Mirandola, understood this well, when he observed that:

“...the way men live is so far removed from the way they ought to live that anyone who abandons what is for what should be pursued pursues his downfall rather than his preservation” (Machiavelli 2003, p.7).

### ***Conclusions: Coming to Grips with Reality***

I want to be sure that we understand the full import of what I am proposing here. Our current unsustainable state is actually the product of *H.sapiens'* inordinate evolutionary success in the struggle for existence. However, the same genetic traits that assured the survival and competitive supremacy of primitive peoples—e.g., an emphasis on short-term individual self-interest, future discounting, loyalty to tribal myths, etc.—have become maladaptive for modern humans in the much changed circumstances created by humanity's success itself. To make matters worse, our now disadvantageous innate behavioural traits are being reinforced by cultural memes—e.g., the perpetual growth myth—that were maladaptive from the start. The problem is that both bad

genes and inappropriate memes may be selected out by an ecosphere in convulsion. Modern human society is unsustainable by nature.

This thesis is not entirely speculative. Various previous cultures great and small have initially flourished, only later to succumb to problems exacerbated by their behavioural demons. According to anthropologist Joseph Tainter “...what is perhaps most intriguing in the evolution of human societies is the regularity with which the pattern of increasing complexity is interrupted by collapse...” (Tainter 1995). The inability to cope with climate change and ecological degradation in particular are implicated in the ruin of various cultures throughout history (Diamond 2005). Once again, assuming our contemporary science is correct, the human enterprise is on a collision course with biophysical reality, only this time on a global scale.<sup>7</sup> The world may already be at a point where there are insufficient resources and sinks to support a population of eight or nine billion people at an acceptable material standard.<sup>8</sup> It is therefore by no means a stretch to contemplate the decline if not rapid collapse of global society (e.g., Greer 2008).

As this possibility becomes clearer to panicking governments everywhere, prospects for a negotiated collective solution will likely fade in inverse proportion. The tension between reason and fear would dissolve like sugar in hot rum. Base survival instincts—looking out for number one, now!—would prevail among still-powerful nations clinging to desperate dreams of maintaining the *status quo*, at least for themselves. Thus, we may well face a future of wars fought not so much over conflicting beliefs as over access to the world’s dwindling supplies of vital energy, mineral and agricultural resources. The shape of US foreign policy in recent years provides a foreshadowing template. (There is no shortage of books and reports exploring this scenario—e.g., Klare [2001], Woodbridge [2004], CSIS [2007]). Of course, if any one nation plays its nuclear card, the entire human species would be at risk.

### ***Can we fix the future?***

The sustainability conundrum obviously poses the ultimate challenge to collective intelligence, complex reasoning and the capacity for moral judgement, vital qualities we humans claim as uniquely our own. The copious historical evidence that, in times of crisis, these cerebral properties generally yield to evolutionarily older and better-tested emotional (limbic) and instinctive (R-complex) intelligence is therefore somewhat disheartening. The integrated human brain obviously does not yet trust higher order intelligence to be in charge when the pressure is on. The question is whether the world community can muster the sheer cooperative will needed to reverse the intellectual dominance order in today’s extraordinary times.

Success in this effort may be necessary for the survival of civilization for one simple reason. For the first time in the evolutionary history of *H. sapiens*, short-term individual and ‘tribal’ self-interest has all but converged with humanity’s long-term collective interest. Ecological and social selection pressures have shifted. In today’s nuclear-tipped world, “*every ‘man’ for himself!*” might well mean destruction for all; working cooperatively for all may be necessary to



save oneself. This means that the selective advantage has shifted to genes that reinforce cooperative, even (mutually) altruistic behaviour. The question is whether we can create the necessary complementary memetic mutations. Social reinforcement of newly-adaptive mutualistic behaviours is necessary for collective survival in a resource-stressed world.

It is said that in every crisis is opportunity. To date, responses to global financial and economic meltdown have focused on reproducing the economic pyramid scheme(s) that precipitated the problem in the first place. Instead, the available data, intelligently interpreted, suggest that the world community should seize the moment to begin the creation of a global steady-state economy. The guiding principles should be sufficiency for all and a focus on true development (getting qualitatively better) rather than mere growth (getting quantitatively bigger).<sup>9</sup>

In other words, the global crisis offers us the privileged mission—should we choose to accept it—of setting out intentionally to script a new, ecologically adaptive, socially enriching global cultural narrative. This new master blueprint must better reflect ecological reality on a crowded planet than does our failing growth-based paradigm. Competition, greed, and fetishistic individualism must be balanced or replaced by cooperation, sharing and community values; short-term material wants must give way to long-term survival needs. The key is to recognize that all these terms can found in the dictionary of human behaviour, but the vocabulary we choose to give voice to our new ‘narrative for survival’ is a matter of social choice.

Of course, any attempt to engineer a social transition must confront the fact that humans are naturally behaviourally conservative. We are indeed creatures of habit. Once an individual’s synaptic pathways and associated behaviours are well-entrenched, it is difficult for that person to adapt to significant changes in either the socio-cultural or biophysical environments. To re-establish cognitive consonance between programmed perceptions and new environmental realities requires that the affected parties engage wilfully in the restructuring of their own neural pathways and psychological states. Even when people accept that such ‘reprogramming’ is necessary, the process it can be lengthy, difficult and unpredictable (Wexler 2006). The good news comes from research showing that the human brain is remarkably plastic (e.g., Schwartz and Begley 2002). Assuming the availability of adequate resources and political will, it is therefore theoretically possible to inscribe a new narrative even on the resistant psyches of the present generation. Sustainability may yet be within our grasp. Humanity, that wondrous ‘work in progress,’ may yet have an opportunity to pull itself up another rung on the evolutionary ladder.

### ***Epilogue***

In essence, the sustainability challenge for the present generation is to come fully to consciousness and to elevate humanity’s capacities for collective intelligence, inclusive reasoning and moral judgement to positions of greater prominence in global politics as it pertains to issues of ecological change. This is theoretically possible but will be extremely difficult. Many would argue that the inordinate diversity of the human family and its distressing array of

conflicting values and interests, combined with the power of maladaptive instincts and contrary narratives, render any such plan for global self-rescue little more than a utopian dream. Indeed, given the record to date, its probability of success is less than that for the survival of an overcrowded Newfie dory adrift without power in the wintery North Atlantic.

Other analysts recognize this conundrum. Sweden's 2007 Tällberg Forum focused on the question "How on Earth can we live together?" Discussions closed with two other questions together with answers: "*Do we know what to do? Probably yes. Will we do it? Probably not.*" Participants apparently saw this as a "realistic view of our common situation with regard to climate, sustainability and the necessary transition we must all achieve" (Tällberg Forum 2008).

Discouraging? Yes—but it is up to every one of us, acting together, to prove the 2007 Tällberg Forum wrong. If we do not succeed in realizing our collective dream, modern humans will, indeed, wind up visiting vast misery on themselves and irretrievably mutilating their planetary home (see UCS 1992). As I have written elsewhere, "It would be a tragic irony if, in the 21<sup>st</sup> Century, this most technologically sophisticated of human societies finally succumbs to the unconscious urgings of fatally self-interested primitive tribalism. The cycle of societal collapse will have closed once again, this time on the global scale" (Rees 2002).

## **References cited**

- Anderson, K. and A. Bows. 2008. Reframing the climate change challenge in light of post-2000 emission trends. *Phil. Trans. R. Soc. A* doi:10.1098/rsta.2008.0138 (also published online).
- Arndt, H.W. 1978. *The Rise and Fall of Economic Growth*. Longman Cheshire, Sydney.
- Bartlett, A. 1998. *The New Flat Earth Society*. Available at: <http://www.albartlett.org/articles/art1998jan.html> . Slightly revised from a version that appeared in *The Physics Teacher* 34: 6: 342-343 (September 1996).
- Brooks, R.J. 2001. Earthworms and the Formulation of Environmental Ethics and other Mythologies: A Darwinian Perspective. In: Ward Chesworth, *et al.*, eds, *Malthus and the Third Millennium*. Faculty of Environmental Sciences, University of Guelph, Guelph, Ontario.
- Buchanan, M. 2007. What made you read this? *NewScientist* 195 (2611): 36-39.
- CSIS (2007). *The Age of Consequences: The Foreign Policy and National Security Implications of Climate Change*. Center for Strategic and International Studies, Washington. Available at: [http://www.csis.org/media/csis/pubs/071105\\_ageofconsequences.pdf](http://www.csis.org/media/csis/pubs/071105_ageofconsequences.pdf)
- Daly, H.E. 1991. *Steady-State Economics* (2nd ed.). Washington, Island Press.
- Damasio, A. 1994. *Descartes' Error: Emotion, Reason and the Human Brain*. Avon Books, New York.
- Dawkins, R. 1976. *The Selfish Gene*. Oxford University Press, Oxford, UK.
- Diamond, J. 2005 *Collapse: How Societies Choose to Fail or Succeed*. Viking Press, New York.
- Dobzhansky, T. 1964. Biology, Molecular and Organismic. *American Zoologist* 4: 443-452.
- Fowler, C.W. and Hobbs L. 2003. Is humanity sustainable? *Proceedings of the Royal Society of London, Series B: Biological Sciences* 270: 2579-2583.
- G&M. 2009. Private saving, collective loss. (Editorial) *Globe and Mail*, Toronto (5 January 2009).
- Gamble, J. 2009. Arctic Landgrab. *Scientific American - Earth 3.0*, Vol. 19 (1): 58-63.
- Grant, C. 1998. *Myths We Live By*. University of Ottawa Press, Ottawa.
- Greer, J.M. 2008. *The Long Descent*. New Society Publishers, Gabriola Island, Canada.
- Heidegger, M. 2003. Discourse on Thinking – Memorial Address (orig.1955; trans. J.M. Anderson and E.H. Freund) in M. Stassen (ed.): *Martin Heidegger: Philosophical and Political Writings*. The German Library, Continuum International Publishing Group, p.87ff.

- Jensen, D. 2000. *A Language Older than Words*. Context Books, New York
- Klare, M. 2001. *Resource Wars: The New Landscape of Global Conflict*. Henry Holt and Company, New York.
- Kollmus, A. and J. Agyeman. 2002. Mind the Gap: why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research* 8 (3): 239-260.
- Lane, R. 2000. *The Loss of Happiness in Market Democracies*. Yale University Press, New Haven.
- Le Bon, G. 1896. *The Crowd: A Study of the Popular Mind*. Batoche Press, Kitchener, Canada (2001 reprint). Available at: <http://socserv.mcmaster.ca/econ/ugcm/3ll3/lebon/Crowds.pdf>
- Lotka, A.J. 1922. Contribution to the Energetics of Evolution. *Proceedings of the National Academy of Science* 8: 147-155.
- Ludwig, D., C. Walters and R. Hilborn. 1993. Uncertainty, Resource Exploitation, and Conservation: Lessons from History. *Science* 260: 17.
- Machiavelli, N. 2003 (orig. 1513). *The Prince*. (Translated by Daniel Dono, 1966). Bantam Dell (Random House), New York. Also available at: <http://www.fordham.edu/halsall/basis/machiavelli-prince.html> (Translated by W. K. Marriott)
- MacLean, P. 1990. *The Triune Brain in Evolution: Role in Paleocerebral Functions*. Plenum Press, New York.
- MEA. 2005. Living Beyond Our Means: Natural Assets and Human Well-Being (Statement from the Board). *Millennium Ecosystem Assessment*. (Available at: <http://www.millenniumassessment.org/documents/document.429.aspx.pdf>)
- Mirandola, G.P. 1486. *Oration on the Dignity of Man*. Available at: <http://www.cscs.umich.edu/~crshalizi/Mirandola/>
- Morrison, R. 1999. *The Spirit in the Gene – Humanity’s Proud Illusion and the Laws of Nature* Cornell University Press, Ithaca, NY and London, UK.
- Myers, D. G. and E. Diener. 1995. “Who is Happy?” *Psychological Science* 6 (1): 10-19.
- Panksepp J. 1998. *Affective Neuroscience*. Oxford University Press, New York.
- Ponting, C. 1991. *A Green History of the World*. Sinclair-Stevenson, London.
- Rees, W.E. 2002. Globalization and Sustainability: Conflict or Convergence? *Bulletin of Science, Technology and Society*, 22 (4), 249-268.

- Rees, W.E. 2006. Ecological Footprints and Bio-Capacity: Essential Elements in Sustainability Assessment. Chapter 9 in Jo Dewulf and Herman Van Langenhove, eds. *Renewables-Based Technology: Sustainability Assessment*, pp. 143-158. John Wiley and Sons, Chichester, UK.
- Rees, W.E. 2008. Human Nature, Eco-Footprints and Environmental Injustice. *Local Environment - The International Journal of Justice and Sustainability* 13 (8): 685 – 701.
- Schwartz, J. and S. Begley. 2002. *The Mind and the Brain*. HarperCollins, New York.
- Shah, A. 2008. *Poverty Facts and Stats*. GlobalIssues.org (Last updated: Wednesday, September 03, 2008) Available at: <http://www.globalissues.org/article/26/poverty-facts-and-stats>
- Siegel, C. 2006. *The End of Economic Growth*. Preservation Institute, Berkeley, Ca. Available at: <http://www.preservenet.com/endgrowth/EndGrowth.html>
- Simon, J.L. 1995. *The State of Humanity: Steadily Improving*. Cato Policy Report 17, No. 5, September /October 1995. Cato Institute, Washington, D.C.
- Tainter, J.A. 1995. Sustainability of complex societies. *Futures* 27: 397-407.
- Tällberg Forum. 2008. *The Concept for the Tällberg Forum 2008 (Part 1)*. Tällberg Forum, Stockholm. Available at: <http://www.tallbergfoundation.org/T%C3%84LLBERGFORUM/T%C3%A4llbergForum2008/ConceptfortheT%C3%A4llbergForum2008part1/tabid/279/Default.aspx>
- UCS. 1992. 1992 World Scientists' Warning to Humanity. Union of Concerned Scientists, Cambridge, MA. Available at: <http://www.ucsusa.org/about/1992-world-scientists.html> .
- UNDP. 2005. *Human Development Report 2005*. United Nations Development Program, United Nations, New York.
- UNDP. 2007. *Human Development Report 2007*. United Nations Development Program, United Nations, New York.
- Victor, P.A. 2008. *Managing Without Growth: Slower by Design, Not Disaster*. Edward Elgar, Cheltenham.
- Weizsäcker, E. Von, A. B. Lovins L. H. Lovins. 1997 (orig. 1995). *Factor Four: Doubling Wealth - Having Resource Use : A Report to the Club of Rome*. Earthscan/James & James, London.
- Wexler, B.E. 2006. *Brain and Culture: Neurobiology, Ideology and Social Change*. Bradford Books (MIT Press), Cambridge, USA
- Wilkinson, R.G. 1996. *Unhealthy societies: The Afflictions of Inequality*, Routledge, London and New York.

Woodbridge, R. 2004. *The Next World War*. University of Toronto Press, Toronto.

World Bank. 2008. World Bank Development Indicators 2008. Available at:

<http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:21725423~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html>

WWF. 2008. *Living Planet Report 2008*. World Wide Fund for Nature, Gland, Switzerland.

---

<sup>1</sup> Anderson's and Bows' analysis considered several green-house gases. Thus, the term "ppmv CO<sub>2</sub>e" should be read as "parts per million by volume of carbon dioxide equivalents." The current atmospheric concentration of CO<sub>2</sub> alone is an already excessive 387 ppmv, or 38% above the estimated pre-industrial level of 280 ppmv.

<sup>2</sup> For example, a four Celsius degree increase in mean global temperature would likely convert China, India, much of Africa and the US—i.e., places where most of humanity lives—into uninhabitable deserts.

<sup>3</sup> This is ironic considering the common belief that the human enterprise is decoupling from, and no longer dependent on, nature.

<sup>4</sup> Yet another dimension of the unsustainability dilemma that I cannot dwell on here is the approach of 'peak oil,' the point at which the extraction of petroleum levels off and begins its inexorable decline.

<sup>5</sup> Balance these perceptions against the fact that much of politics and international (i.e., intertribal) tension in the modern world, from the recent pervasive influence of Christian fundamentalism in US governance to the perennial Arab-Israeli conflict in the Middle-East, is essentially myth-based.

<sup>6</sup> Simon was, in fact, challenged on this statement and promptly backed down to "seven million years," a three orders of magnitude retreat. Nevertheless, starting from 5.7 billion people in 1995, growing at just 1% per year, the human population after 'only' seven million years would be  $2.3 \times 10^{30410}$ . This is an unimaginably large number, something like "thirty-thousand orders of magnitude larger than the number of atoms estimated to be in the known universe!" (Bartlett 1998).

<sup>7</sup> And so far the science actually appears conservative—climate models, for example, have underestimated the rate of change experienced in recent years.

<sup>8</sup> Given the critical state of key biophysical systems and the accelerating pace of degradation, it may not be possible to sustain even today's 6.7 billion people at an acceptable material standard.

<sup>9</sup> "Steady-state" implies a more or less constant rate of energy and material throughput compatible with the productive and assimilative capacities of the ecosphere (Daly 1991). Humans must learn to live within the means of nature.