What can biology tell us about our future, and why do we seem to be having such difficulty acknowledging and addressing the implications of our unsustainable living?

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Abstract

As of last October, there are now seven billion people on Earth. The environmental destruction caused by our species has reached levels that threaten the future of our civilisation. Population size and the resource intensities of our individual lifestyles are the two most fundamental issues affecting our sustainability. Many of the technologies we have developed contribute more to the problem, than to the solution. In addition, our behaviour is influenced by our genetically endowed traits for reproduction, competition/growth, distraction and even denial. Here, I argue that we must recognise and subsume our most basic biological drives if we are going to put ourselves on a more promising, and less painful, track toward sustainable living. We must recognise the realities of our cultural and genetic heritages, as well as the patterns of populations dynamics observed in all other species. Realism is our best hope.

Introduction – The island analogy

This truly extraordinary point in the Earth's history has recently been categorised as a distinct geological time period – the Anthropocene – the period of significant human impact on the planet (Steffen et al., 2011). Our species is unique relative to all other life forms in that we have a developed sense of consciousness. Not only do our activities dominate the Earth's ecosystems, but we are aware of it. As individuals, we are conscious of a past, of a future, and even of our own inevitable mortality. However, we are just like any other species in the sense that when presented with a stock of resources, we utilise those resources to the best of our ability to grow and multiply. As a simple analogy, imagine a small island in a lake on which maize and other seed-bearing plants are the dominant vegetation. Imagine that there were no animals on this island until one day an old barrel containing several mice drifts from the mainland on to the shore line. The mice disembark and soon find themselves in a 'land of plenty'. They feed, they grow, they reproduce. The mouse

population rapidly increases over the years albeit with occasional diebacks due to harsh winters, disease outbreaks etc. At some point, it is almost certain that the mouse population will grow to a size where it begins to exceed the rate of food production. At this stage, those individuals that are stronger, more competitive, and more fecund will tend to dominate the gene pool - the weaker will tend to die off first. Nevertheless, if almost all the seeds are being consumed, there will be little left to provide the basis for plant growth the following year and so even the more competitive or best adapted mice will begin to die off. The mouse population crash is essential for the long term viability of the system.... whatever seeds that remain during the crash have a much better chance of surviving to germinate, grow and reproduce in subsequent years, eventually renewing the food resource for the surviving mice. My point with this simple analogy is that cycles of population rises and crashes are typical of any species. –It is a basic biological pattern, and therefore, as Rev. Malthus pointed out over 200 years ago, the same fundamental drivers also apply to our own species (Malthus, 1798). In the past decade, a small but growing number of eminent thinkers such as Sir Martin Rees (Britain's recent Astronomer Royal), James Lovelock, Thomas Homer-Dixon, Clive Ponting, Jared Diamond, David Attenborough, David Suzuki have expressed deep concerns about the projected state of our civilisation by the end of this century. Knowing the biological realities, and hearing these calls, why then do we seem to be having such difficulty acknowledging and addressing the implications of our unsustainable living? Here, I argue that we must recognise and subsume our most basic biological drives (- not just for reproduction, but also for competition, individualism, denial and escapism) if we are going to put ourselves on a more promising and less painful track toward sustainability, and delay and soften the seemingly inevitable population crash that we are currently heading toward.

<u>What do we know about historical population cycles?</u>

The history of ‘progress’ within civilisations has been carefully documented for the Sumerians who lived in modern day Iraq, the Easter Island communities, the Romans, the Mayans, and now ourselves – the civilisation spawned by the Industrial Revolution that began in the 1870s (Wright, 2004, Ponting, 2007). Most previous civilisations grew in size and complexity over time, and then peaked. Their declines are attributed to several interacting factors, one of which is the depletion of resources necessary to support the growing populations and their increasingly varied activities. The Romans for example expanded out from central Italy and waged great wars across the Mediterranean to enlarge land resources to supply their food and fuel demands. In addition, they needed extra land to support their increasing desire for the ‘finer things in life’ – such as wine and olives that had been introduced to them by the Greeks. Rising sophistication and hierarchical structure within developing civilisations is typical as the ‘social pyramid’ grows in size and in the number of specialist components (Wright, 2004). Ultimately, the whole civilization becomes increasingly fragile as a growing proportion of the populus becomes disconnected from the natural environment that is supporting it, and as its leaders become ever more vested in promoting the status quo (Wright, 2004, Ponting, 2007).

Our civilisation is using an unprecedented range of resources at an unparalleled rate, and on a global scale. New civilisations arose in earlier times in part because there were relatively untouched areas to expand into. For example, our Western civilisation has its origins in Europe but really only got going when the development of shipping allowed it to import the resources of its American, African and Asian colonies. There were ~1 billion people on the planet in 1800. That number rose to 3 billion by 1960, and reached 7 billion last October. Now, there is almost no new area to expand into. Our whole civilisation has been founded on extraordinary technological developments and in particular the ability to harness cheap energy from coal, oil, and natural gas. But all of these energy sources are finite and non-renewable on our time scale. Furthermore, we

94 also need fertile land, clean water, clean air and a whole range of other 'ecosystem services'. Over
95 thirty years ago, the seminal book 'The Population Bomb' (Ehrlich, 1968) heralded our population
96 size and growth trends as a fundamental problem for our future existence. But we have since come
97 to realize that our requirements are not just determined by the size of our population – the range of
98 activities and the rates at which we do them are at least as important. For example, over the last
99 century, the global population grew by a factor of 4, but the economy (which is directly linked to per
100 capita resource use) grew by a factor of 40 (Steffen et al., 2011, Wright, 2004). Every adult across
101 the planet does not just want access to clean water, they also want an electric clothes washing
102 machine. That appliance requires a whole suite of resources for its manufacture and use, and
103 produces a variety of wastes. At one level – the global level – it's all unnervingly simple. The more
104 people on the planet *and* the more intensive their lifestyles are, the more resources are required, and
105 the more waste is produced (Fig. 1).
106 Carbon dioxide is a waste product from fossil fuel combustion that alters climate. But the
107 use of carbon is only the tip of the iceberg – there's nitrogen, phosphorus, soil, water, the rare earth
108 metals in electronics devices and in the latest wind generators etcetera .... the wastes from the use of
109 each and all of these resources have impacts. In fact, climate change itself is only the 'tip of the
110 iceberg' in terms of the impacts of our activities on the planet (Steffen et al., 2011). We have fished
111 the oceans to the extent that major species such as cod are at risk of extinction. Estimates suggest
112 that we are currently in the midst of the 6^{th} major extinction event in the history of life on earth – on
113 average, 10% of all species on Earth are currently threatened (Chapin et al., 2000). Of equal
114 concern, our prolific movements around the planet are transporting a vast range of invasive species
115 into new habitats where they are causing all kinds of problems. Across the globe, land clearance
116 including tropical deforestation, and energy intensive agriculture, are degrading soil health, literally
117 eroding our ability to feed ourselves, and hence global food security has become a major issue

(Kendall and Pimentel, 1994). We in the 'developed world' have been able to feed most of our growing population up until now by developing the technology to use fossil fuels to manufacture cheap nitrogen-based synthetic fertilisers and pesticides. Biotechnology has helped by producing new hybrid rice varieties and genetically modified crops in particular, but the availability and use of fertiliser has been the principal driver of the so called 'green revolution' (Tilman et al., 2002). In summary, most technologies including many in medicine (-but not contraception obviously) have resulted in extraordinary population growth and particularly resource-intense lifestyles – most therefore are part of the problem, rather than part of the solution (Wright, 2004, Boyden and Dovers, 1992).

<u>What do we know about our genetic heritage that influences our current behavior toward sustainability issues?</u>

The human concept of progression - of growth - has been a primary factor driving declines in past civilisations (Wright, 2004, Rees, 2002). We need to abandon the concept of 'growth' - this core concept within the human psyche. Abandonment of 'growth' won't be easy since it relates to 'competition' – a force driving the selection of traits that have been fundamental to our evolution, and therefore that are deeply encoded within our genes (just as they would have been in the mouse population analogy). For the first 95% of its existence, our species (*Homo sapiens*) was evolving primarily as a hunter-gatherer adapted to a very different physical and social environment than the one we live in today. Accordingly, we carry a genetic heritage favouring traits promoting competitive abilities, expansionism, material acquisition and individualism. Of course, we also carry traits for caring (especially amongst kin) and for cooperation, but given the fundamental evolutionary dictate that natural selection operates on traits of individual organisms, genes promoting individualistic or selfish behavior will always persist (Axelrod and Hamilton, 1981).

The average Indian, African, South American, as well as the poor in the developed world aspire to the lifestyles that a lot of us enjoy – physical comfort, good food, good health and education. We have them, and we have the trimmings of life that should provide more free-time. But instead of relishing that for exactly what it is - 'free time, time with no demands on it, time to sit passively, time to reflect, time to think in depth without interruptions – Instead, we frantically fill that time with other activities....movies, 'tweets', skiing trips to the other side of the country, quick holidays in the Tropics – *almost as if to avoid having to think.* A recent study indicates that the average american child aged between 8 and 18 years spends >7 1/2 hours per day watching TV/DVDs or playing computer games (Rideout et al., 2010). Karl Marx postulated that religion was 'the opium of the masses' in late 19th century Europe. Today, electronic screens seem to have become the opium of the masses. Could it be that in addition to carrying genes favouring competition and individualism, we also carry strong genes for escapism, distraction, and even denial (Trivers, 2000)? Evolutionary selection pressures have provided us with consciousness that allows us to learn from the past and to plan ahead – both very useful traits to our development and survival. However, the consciousness trait has many byproducts. We inherently crave for a meaning to our existence – even those who have concluded that there likely is no meaning. When we reflect, we are very aware of the depravity of the human condition as so well described by Samuel Beckett's verse: "Live and clean forget from day to day, mop up life as fast as it spills away". Such perspectives may make us prone to depression, even to 'ending it all'. Evolutionary selection to enhance the survival of our species may therefore have promoted traits for escapism, distraction and denial – for not facing up to the realities of our situation. We humans have extraordinary capacities to think, to understand our environment, and the impacts of our activities on it, and to plan accordingly. However, most individuals within our civilisation do not display these characteristics, and instead are shepherded along by a small minority of leaders.

Given these biological features, what hope can we have in our future?

First, we need realism. Real hope requires an acceptance of the facts. We need to recognise and acknowledge the 'big picture' (Fig. 1). The amounts, types, and rates of activities of our species are collectively having major impacts on our home – planet Earth. Although the past 200 years have been remarkably successful for our species in terms of increasing wealth (per capita gross domestic product) and better health (increasing life expectancy) (Rosling, 2010, Lomborg, 2001), past trends do not necessarily predict the future. Our population has now grown beyond the planet's carrying capacity (Wackernagel et al., 2002). In other words, we together are using more resources and producing more wastes than our planet can provide or cope with. In banking terms, we're living off the 'capital' – the Earth's accumulated resources - rather than the 'interest'. This is fundamentally unsustainable. And yet our population continues to grow, and to demand even more resources at even greater intensities. To address the latter issue, we regularly quote 'The Tragedy of the Commons'(Hardin, 1968), but we ignore its (and Ehrlich's) most fundamental core message – the need to restrain population size. The individual's choice to reproduce is even enshrined in the Universal Declaration of Human Rights. 34 years later most countries still have not even started to introduce 'carrots and sticks' to curtail our basic biological drive to reproduce, and in fact some with below replacement population growth rates (e.g. Germany, Russia) have introduced financial incentives to raise birth rates (Moore, 2010).

Second, we need to lower the intensity of our lifestyles. There's a saying "Don't rest on your laurels" – but as a civilisation, that is exactly what some of us in the developed world should be doing – "resting on our laurels"....slowing down..... doing less with less, and contemplating more. We need a new philosophy of life, based on slow, reflective living and doing more for others (especially the disadvantaged) than for ourselves. 'Carpe diem' – (seize the day) is an important piece of wisdom passed down through the generations, but it urgently needs amending. It should

now be: ‘Carpe diem - but not at the expense of others – other days and other people’. The more rapidly and intensively each of us lives life, the more each of us messes up the potential for fulfilled future living for ourselves, and for others. We need to slow down. We need to step off this current track of individualism and self-absorption, and recognise that like it or not, we’re all in this together. We need to rebuild the sense of ‘community’ that we have lost over the past 50 years (Putnam, 2000). We’ve done this in the past, especially in ‘hard’ times such as the social mobilisation during the second world war. In addition, we need to move toward a sense of community at much larger scales than ever before – global problems (such as CO_2 emissions from fossil fuels) require global (international) solutions.

Third, we need to reassess the relative importance of our society’s three categories of values (Homer-Dixon, 2006). Utilitarian values involve likes and dislikes – the basis of marketing and the driver of our consumer culture. Moral values involve fairness, justice, and the distribution of power, wealth and opportunity among people across the globe and through time. As individuals and as a civilisation, we demonstrate our commitment to morality by doing ‘random acts of kindness’, by the development of the welfare system, by charitable giving, and by international aid programs... but of course we could do a lot more. Finally, existential values – those that give our lives significance and meaning – those that are driven from our conscious mind’s demand for asking how we fit into the larger scheme of the Universe, and what is the purpose of our existence. Religious or non-religious, there are many who would agree that as utilitarian values have risen in prominence over the past 50 years, the moral and existential values have faded into the background. It’s time for a major paradigm shift away from individualism and materialism toward more mature perspectives on human existence and quality of life (Rees, 2002).

Fourth, at the level of the individual – each one of us – we need to recognise the ecological as well as the moral and ethical responsibilities of each and every decision we make. In the words

of Gro Brundtland, the former Prime Minister of Norway who had a profound influence in developing the concept of sustainability as chair of a UN commission in the mid-80s, “We must consider our planet to be on loan from our children, rather than being a gift from our ancestors”. Each of us is faced with an extraordinary array of decisions, most of which have an ecological component that we need to be more conscious of. Should you pay more for produce from small local farms, or go with the cheaper mass-produced varieties that have been transported long distances? Should you become vegetarian? Should you buy a car or rely on public transport? Should you take that holiday plane trip? The biggest decision of them all? – Should you have children? These are decisions made at the individual level that hopefully can be reinforced at the community level. Yes, we need leadership at higher levels but our political system is based on democracy – in general, we get the leaders we deserve. Of considerable concern is voter apathy – turnout is typically ~60% (and is particularly low among youth). Proportional representation voting systems are substantially better than ‘first past the post’ because every vote contributes positively to the outcome, but in either case decisions are often clearly influenced by lobby groups and ‘big money’. There’s also an inherent problem with democracy in that it generally operates over a 4-5 year cycle. Leadership and decisions are inherently short-sighted while the sustainability problems we face require much longer-term visions. In any event, or perhaps because of this short-sightedness in the electoral system, long-term behavioural change at the individual level is likely to be the strongest catalyst for real change in government policy. We need a properly informed public that is capable of thinking independently and critically, that will look beyond the short-term, and that is willing to act regardless of what others are doing.

Fifth, the rises and falls of past civilisations have been almost exclusively led by males. Females have evolved distinctive features in their behaviour and social interactions. Perhaps, just perhaps, increasing leadership by females will more inherently and effectively interconnect

economic, social and environmental perspectives in future policy development, and will move us away from individualism toward more communal perspectives on living.

All of the above are in essence behavioural changes within our civilisation (i.e. cultural evolution) that would slow down our movement toward the seemingly inevitable population crash suggested by the mouse analogy, and that would soften the crash's impacts. Unlike the mice, our species is unique in that we are aware of our fundamental biology. We know about population cycles. We know about our genetic endowment of traits for competition, individualism and escapism, and we understand at least some of the ecological effects of our activities on the Earth system. Educationalists define true learning as that which results in changed behaviour. Education of each other and of our children toward *realistic* perspectives on the future and how we can best manage and adapt to population cycles is our responsibility, and our best hope.

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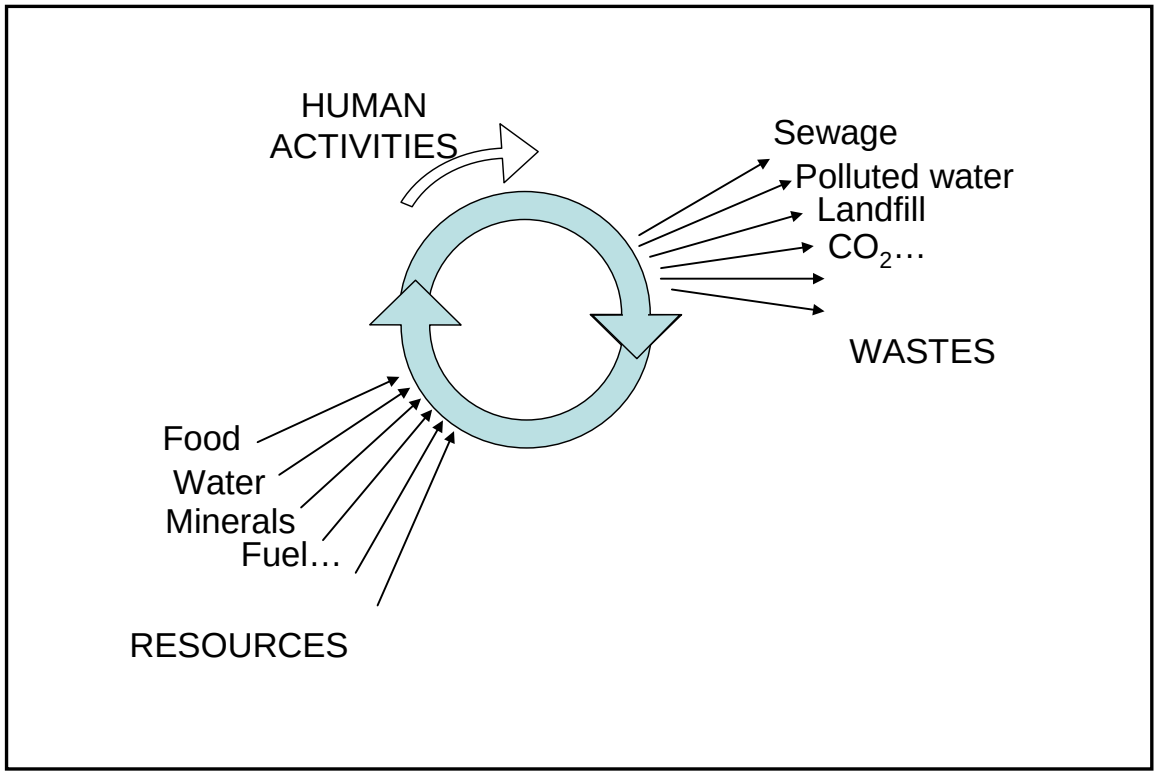

Fig. 1. Human activities can be represented by a spinning wheel that requires resource inputs and produces waste outputs. Rates of resource use and waste production are determined by two factors: the size of the population (the thickness of the wheel), and the intensity of the lifestyle activities (the spinning speed). Sustainability within this closed system (Earth) can only occur when rates of material resource consumption do not exceed rates of resource renewal (i.e. treatment and recycling of wastes).