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## Our Anthropocene Future

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# What Biology Can Tell Us

Paul Grogan

## Introduction: The Island Analogy

**T**his truly extraordinary point in Earth's history has recently been categorized as a distinct geological time period—the Anthropocene—a period of significant human impact on the planet. 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 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 utilize those resources to the best of our ability in order 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 onto the shore. The mice disembark and find themselves in a land of plenty. They feed, they grow, they reproduce. The mouse population rapidly increases over the years, albeit with

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 two hundred years ago, the same fundamental drivers apply to our own species.

In the past decade, a small but growing number of eminent thinkers—including Sir Martin Rees (Britain's recent Astronomer Royal), James Lovelock, Thomas Homer-Dixon, Ronald Wright, Clive Ponting, Jared Diamond, David Attenborough, and David Suzuki—have expressed deep concerns about the projected state of our civilization 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 practices? Here, I argue that we must recognize 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, thereby delaying and softening the seemingly inevitable population crash toward which we are currently heading.

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occasional diebacks due to harsh winters, disease outbreaks, and the like. 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, and 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 sharp decline (crash) in the size of the mouse population is essential for the long-term viability of the system. Whatever seeds that remain during the crash will have a much better chance of surviving to germinate, grow, and reproduce in subsequent years, eventually renewing the food resource for the surviving mice.

## What Do We Know about Rises and Falls in Earlier Civilizations?

The history of "progress" within civilizations 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 civilization spawned by the Industrial Revolution that began in the 1870s.

Most previous civilizations 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, which had been introduced to them by the Greeks. Ronald Wright points out that rising sophistication and hierarchical structure within developing civilizations is typical as the "social pyramid" grows in size and in the number of specialist components. Ultimately, the whole civilization becomes increasingly fragile as a growing proportion of the populace becomes disconnected from the natural environ-

ment that is supporting it, and as its leaders become ever more vested in promoting the status quo.

Our civilization is consuming an unprecedented range of resources at an unparalleled rate, and on a global scale. New civilizations arose in earlier times in part because there were relatively untouched areas to expand into. For example, our Western civilization has its origins in Europe but really got going only when the development of shipping allowed it to import the resources of its American, African, and Asian colonies. There were about one billion people on the planet in 1800. That number rose to three billion by 1960 and reached seven billion in October 2011. Now, there is almost no new area on Earth to expand into. Our whole civilization has been founded upon extraordinary technological developments, in particular upon the ability to harness cheap energy from coal, oil, and natural gas. But all of these energy sources are finite and nonrenewable on our time scale.

Furthermore, we also need fertile land, clean water, clean air, and a whole range of other "ecosystem services." Over thirty years ago, Paul Ehrlich's seminal book, *The Population Bomb*, heralded our population size and its growth trend as a fundamental problem for our future existence. But we have since come to realize that our requirements are not simply determined by the size of our population; the range of our activities and the rates at which we undertake them are at least as important. For example, over the last century, the global population grew by a factor of four, but the economy (which is directly linked to per capita resource use) grew by a factor of forty. Across the planet, each adult now wants not just access to clean water but also an electric clothes-washing machine. That appliance requires a whole suite of resources for its manufacture and use and produces a variety of wastes. At one level—the global level—it's all unnervingly simple. The more people on the planet and the more intensive their lifestyles, the more resources are required, and the more waste is produced (figure 1).

Carbon dioxide is a waste product from fossil-fuel combustion that alters climate. But the use of carbon is only the tip of the iceberg—there are also nitrogen, phosphorus, soil, water, the rare-earth metals in electronic devices and in the latest wind generators, and so on. The wastes from the use of each and every one of these resources have impacts on our environment. In fact, climate change itself is only the "tip of the iceberg" in terms of the impacts of our activities on the planet. We have fished the oceans to the extent that major species such as cod are at risk of extinction. Estimates suggest that we are currently in the midst of the sixth major extinction event in the history of life on Earth—on average, 10 percent of all species on Earth are currently threatened.

Of equal concern, our prolific movements around the planet are transporting a vast range of invasive species into new habitats where they are causing all kinds of problems. Across the

globe, land clearance, including tropical deforestation, and energy intensive agriculture are degrading soil health and literally eroding our ability to feed ourselves. Hence, global food security has become a major issue. 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 fertilizers and pesticides. Biotechnology has helped by producing new hybrid rice varieties and, in particular, genetically modified crops. Still, the availability and use of fertilizer has been the principal driver of the so-called Green Revolution.

In summary, most technologies, including many in medicine (with the obvious exception of contraception), have resulted in extraordinary population growth and particularly resource-intensive lifestyle. Most, therefore, are part of the problem rather than part of the solution.

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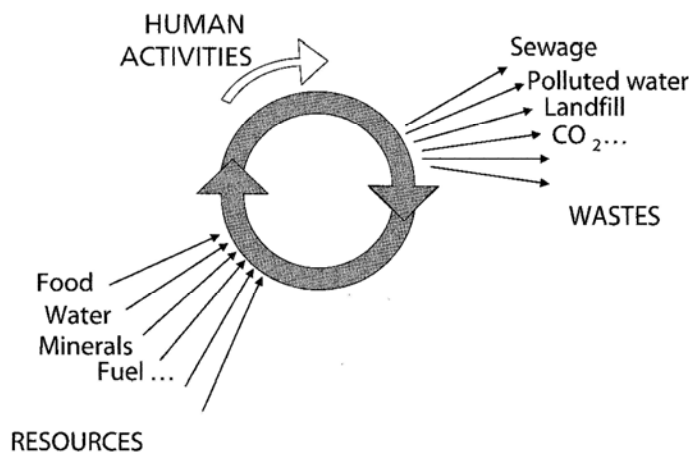


Figure 1. Human activities can be represented by a spinning wheel that requires resource inputs and produces waste outputs. Rates of resource use and waste production are determined by two factors: the size of the population (the thickness of the wheel), and the intensity of the lifestyle activities (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).

## How Our Genetic Heritage Influences Our Current Behavior toward Sustainability Issues

The human concept of progression—of growth—has been a primary factor driving the decline of past civilizations. 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 are therefore deeply encoded within our genes (just as they would have been for the mice in the island analogy described in the Introduction). For the first 95 percent of its existence, our species (*Homo sapiens*) was evolving primarily as a nomadic hunter-gatherer, adapting to a very different physical and social environment than the one we live in today. Accordingly, we carry a genetic heritage favoring 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.

Most people in Africa, Asia, and South America—as well as the poor throughout the developed world—aspire to the lifestyle that many of us enjoy, with physical comforts, good food, good health care, 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

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with no demands on it, time to sit passively, time to reflect, time to think in depth without interruptions—instead, we frantically fill our 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 eight and eighteen years spends more than seven and a half hours per day watching television programs and movies, communicating on the Internet, or playing computer games. Karl Marx postulated that religion was “the opiate of the masses” in late nineteenth-century Europe. Today, electronic screens seem to have taken its place. Could it be that in addition to carrying genes favoring competition and individualism, we also carry strong genes for escapism, distraction, and even denial? Evolutionary selection pressures have provided us with consciousness that allows us to learn from

the past and to plan ahead—both very useful traits for our development and survival. However, the consciousness trait has many by-products. We inherently crave a meaning to our existence. This is true even for those who have concluded that there likely is no meaning. When we reflect, we are very aware of the depravity of the human condition, 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—traits that actively predispose us against 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 civilization do not display these characteristics and are instead shepherded along by a small minority of leaders.

## Given These Biological Features, What Hope Can We Have for Our Future?

First, we need realism. Real hope requires an acceptance of the facts. We need to recognize and acknowledge the “big picture” shown in figure 1. The amounts, types, and rates of activities of our species are collectively having major impacts on our home—planet Earth. Although the past two hundred years have been remarkably successful for our species in terms of increasing wealth (per capita gross domestic product) and better health (increasing life expectancy), past trends do not necessarily predict the future. Our population has now grown beyond the planet's carrying capacity. In other words, all of us together are using more resources than our planet can provide while producing more wastes than it can cope with. In banking terms, we're living off the “capital”—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 Garrett Hardin's “The Tragedy of the Commons,” but all too often we ignore his (and Ehrlich's) most fundamental core message—the need to *restrain population size*. Instead, the individual's choice to reproduce is positively enshrined in the *Universal Declaration of Human Rights*. Thirty-four years after its publication, most countries still have not even started to introduce “carrots and sticks” to curtail our basic biological drive to reproduce. In fact some with below-replacement population-growth rates (such as Germany and Russia) have recently introduced financial incentives to raise birthrates.



Second, we need to lower the intensity of our lifestyles. There's a saying, "Don't rest on your laurels," but as a civilization, that is exactly what some of us in the developed world should be doing—resting on our laurels, slowing down, doing less with less while contemplating more. We need a new philosophy of life—one based on slow, reflective, mindful 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 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 recognize 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 fifty years. We've done this in the past, especially in "hard" times such as during the social mobilization of the Second World War. We also need to move toward a sense of community at much larger scales than ever before. Global problems (such as CO<sub>2</sub> emissions from fossil fuels) require global (international) solutions.

Third, we need to reassess the relative importance of our society's three categories of values as described by Thomas Homer-Dixon. *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 civilization, 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. (Of course, we could do a lot more.) Finally, *existential* values—those that give our lives significance and meaning—are driven by our conscious minds' demand to figure out how we fit into the larger scheme of the universe and to figure out what is the purpose of our existence. Religious or nonreligious, there are many who would agree that as utilitarian values have risen in prominence over the past fifty years, moral and existential values have faded into the background. It's time for a major paradigm shift, a turn away from individualism and materialism toward more mature perspectives on human existence and quality of life.

Fourth, at the level of the individual—each one of us—we need to recognize the ecological as well as the moral and ethical responsibilities associated with 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 United Nations commission in the mid-1980s, "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 of which we need to be more conscious. Should you pay more for produce from small local farms or go with cheaper mass-produced varieties that have been transported long distances? Should you become a vegetarian? Should you buy a car or rely on public transport? Should you take that holiday plane trip? Then there is the biggest decision of them all: *Should you have children?* These are decisions addressed and made by individuals but that nevertheless could be more positively influenced by community-level perspectives.

Yes, we need leadership at higher levels, but our political system is based on democracy. In general, we get the leaders we deserve. Further, democracy generally operates over a four- to five-year cycle. Political decisions are inherently shortsighted, while the sustainability problems we face require much longer-term vision.

In any event, or perhaps because of this shortsightedness in the electoral system, long-term behavioral 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 rise and fall of past civilizations have been almost exclusively led by males. Females have evolved distinctive features in their behavior 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, behavioral changes within our civilization (which is to say, *cultural evolution*) that would slow our movement toward the seemingly inevitable population crash suggested by the mouse analogy and that might soften the crash's impacts. Unlike 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 Earth's systems.

Educators define true learning as that which results in changed behavior. 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. 

Paul Grogan is an associate professor in the Department of Biology at Queen's University, Kingston, Ontario. His research focuses on understanding biotic and abiotic controls on the biogeochemical cycling of carbon and nutrients in mid- and high-latitude terrestrial ecosystems. He has published more than forty scientific papers and is keen to engage more in communicating scientific perspectives to the general public. He won an Early Researcher Award from the Ontario government in 2007 and received a Canada Research Chair for his work on the ecology of arctic ecosystems and their sensitivity to climate change.