THE GREAT DISCONNECT

BILL BARRON

INSTITUTE FOR THE ENVIRONMENT
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

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CIVIC EXCHANGE

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FOR

Leung Siu Tak, Kaseem Wesley, Ng Cheuk Kiu, Lucas Suter, Max Simpson, Leah Norma Ehrlich, and *Cheung Ming Ching*, each born in the early years of the twenty-first century and for *their* children, who will know first-hand what we can only surmise.

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ABOUT THE AUTHOR

A Life Well-Lived

William F. Barron – Bill – lost his battle with kidney cancer on 4 January 2018 in Portland, Oregon – a battle he fought valiantly for a decade. He was 73 years old. Bill grew up in Gloucester City, New Jersey, US, and received his elementary education from St. Mary's Grammar School. He graduated from Gloucester Catholic High School in 1963. Bill received a B.S. in Business and Economics from La Salle University, Philadelphia; obtained two Master degrees, one in Economics from the Southern Illinois University, and another in Education from South Carolina State University, and received his Ph.D. in Economics for Public Decision-Making from the Department of Geography and Environmental Engineering at Johns Hopkins University in 1980. From 1980 to 1986, Bill worked at Oak Ridge National Laboratory on energy technology assessment and integrated energy planning. He then served as resident energy advisor to the government of Liberia and then Pakistan. Bill moved to Hong Kong in 1989.

Bill began his university teaching career in Hong Kong at the University of Hong Kong, Centre of Urban Planning and Environmental Management (CUPEM), where he taught environmental economics. He served as coordinator for the inter-departmental graduate program in environmental management from 1990 to 1994. In 2005, he joined the

Atmospheric, Marine and Coastal Environment Program at the Hong Kong University of Science and Technology (HKUST) as Visiting Professor and in 2010, he moved to the Division of the Environment at HKUST as one of the founding members. Bill served as the Environmental Protection Department's special advisor for six months in 2013 before retiring and returning to the US later that year.

Bill was a committed and passionate teacher throughout his life. He was first a teaching assistant before becoming a kindergarten teacher in Sumter, South Carolina in the 1960s. He moved to Washington DC in 1971 and taught pre-school there till 1974 before starting graduate studies at John Hopkins University. In the 1960s and 1970s, he was a member of the National Teacher Corps, an organisation engaged in programs to improve teaching in low-income areas. Bill is well-remembered by his many students in Hong Kong as an energetic teacher who held their attention by his sheer enthusiasm for the subject. He is best-remembered by his Ph.D. students to whom he gave his time generously and to whom they could rely upon for the best advice and supervision.

Bill gave advice to the Legislative Office of Christine Loh from around 1994. He had a long association with the non-profit think tank, Civic Exchange when it was set up by Loh in 2000. There, he engaged actively in energy, transport and environmental policy research, and was author of many important research work that helped to shift decisions in Hong Kong.

Bill had many life-long interests. He loved to travel, and he was a fine photographer and writer. He wrote *If you get far enough*

away … Stories mostly true as well as *The Great Disconnect.* He was an acute observer of the world around him and he loved to share his thoughts with friends. He lived the 'good life', which to Bill was an active, engaged life to help solve the world's problems and assist others in need but at the same time to enjoy what life has to offer.

FOREWORD 2018

Bill Barron was a very good friend to many people. He made life-long friendships during each period of his life. We are fortunate in Hong Kong to have him with us from 1989. He was a teacher to many students, who remembered his enthusiasm in class and they said it was hard not to be touched by the energy he exuded for the subject. His Ph.D. students became his friends. He cared for them deeply and he spoke about them to his other friends – a mark of how involved he was in supervising them to do well.

Bill had a great impact in Hong Kong on public policy. I first met Bill when he was at CUPEM and when I was a member of the Hong Kong Legislative Council. I sought his advice on energy and transport issues. Over time, we became close allies in environmental protection and we also became good personal friends. He was involved in the formation of the non-profit think tank, Civic Exchange, which I co-founded in 2000. He played many roles for the organisation, including being a board director, donor, project manager, researcher and mentor to young researchers. He authored and co-authored many research publications, the quality of which have stood the test of time.

Bill was instrumental in the success of several public policy battles – including stopping the excessive reclamation of Victoria Harbour, as well as stopping the construction of Route 7 by providing evidence-based economic analysis for rail extension in favour of the highway.

He suffered a stroke in 1999 from which he recovered well and was able to continue to work on the many issues he cared for. It was the kidney cancer which finally took his life but not before he did everything he could to fight it over a decade. During that time, we had many deep conversations about 'living' and 'dying'. Bill wanted to live as long as he could maintain a reasonable quality of life, which to him was to be able to enjoy a good conversation with friends, to share a good meal with them, and to enjoy the world that he could still take in. Bill was willing to try new treatments in the US in immuno-therapy, which no doubt extended his life by several years. He returned to Hong Kong in mid-2017 for a few weeks to see his many friends. He wanted to talk about the world and his thoughts and feelings. However, he knew in late 2017 that he was losing the battle and he begun to plan for his final journey in earnest with his typical modesty and no-fuss attitude. He thought he would depart in April or May but he left us very quickly in early January 2018.

The Great Disconnect is the culmination of his thoughts on a key global problem – how our modern, materialistic lifestyle seriously degrades the natural environment. It is a warning of where the human species is heading. Bill Barron remained hopeful, however. Things could be reversed but we would need to understand how we got into such a mess in the first place and how we could get out of it. *The Great Disconnect* carries the

voice of a consummate teacher. Bill said a lot in not too many pages. While there are more famous books that talk about environmental challenges, this book can be digested in one-sitting and the reader would 'get it'. I recommend it to any student and indeed, any general reader who wants to grasp an important subject – perhaps the most defining subject as it relates to all life on earth. We have republished this book precisely because we know how important it is.

Christine Loh

Chief Development Strategist
Institute for the Environment
The Hong Kong University of Science and Technology

PREFACE

The world economy has expanded to the point where a number of planetary boundaries, of which climate change is the most talked about, are being severely stretched. There are simply too many unsustainable trajectories for the system to continue as it has for the past several decades for several more decades to come. Moving to a more sustainable development path will require making truly basic changes in what, how, and how much is produced and consumed. That, in turn, will require nothing less than restructuring the economy, a makeover of consumer lifestyles, and re-examining values.

No matter how overwhelming the task seems, today's best science makes a very strong case for initiating this shift not in another 20 or 30 years, but within about a decade, and the sooner the better. Yet in mid-2009 the goal of governments around the world is further economic growth, as if at least several decades still remain before we must change. Implicit in this is an assumption that in the meantime the market will be able to overcome any resource limit it might encounter, and the planet will accommodate whatever demands are placed on it. This disconnect is the subject of the first half of this short book.

In recent years, the lifestyles of middle class urban dwellers around the world have taken on increasingly similar forms. This fast-growing population is this book's prime intended audience. Their shared experiences, ones that in certain crucial respects transcend national and even cultural boundaries, along with their direct and indirect influence on political, economic, and social value setting, puts them at the forefront of how the world will respond to the coming challenges. Considering the different types of responses to the challenges, and how the numerous possibilities might be sorted, and a particular set of responses fitted together, is the subject of this book's second half.

The urban focus noted above is not to say that the sustainability challenges and responses to them will be largely urban-centred. Nor is it to suggest that rural populations are not an important audience. Indeed, it is the rural poor (the majority of the world's population) who will suffer most from a failure to make the needed connections. Nonetheless, the modern world is an increasingly urban one, and collective decision-making tends to rest in the hands of urban, rather than rural, populations.

Reviews of projected environmental disasters and the costs of adapting to a changed atmosphere, as well as to a seriously diminished biosphere, have been provided by others. These points are touched upon here only by way

of brief example to make the concerns more concrete.

The aim here is to tell the story in a way that is simple but not simplistic, communicating its key features to the non-specialist in the hope that a graspable whole emerges from the parts. For this reason, a number of points are touched on but not explored in depth. For example, the need for some mechanism to impose a high monetary price on carbon dioxide emissions is stressed, but only the broad outlines of a tax or permit system (or some hybrid) are noted here.

While some of the particular risks faced and the differentiated responsibilities for the needed changes will vary from one place to another, *The Great Disconnect* is a story whose essential elements are applicable to people living in Hong Kong, Shanghai, Mumbai, Frankfurt, Cape Town, Philadelphia, or São Paulo. It is also a story whose cautions about future conditions, if we fail to act, apply most strongly to the rural hinterlands on which the residents of these, and every other city, depend.

The focus here is on descriptions of the underlying challenges, along with a review of options, noting possible *responses*, rather than suggesting 'solutions'. This is deliberate. The challenges appear to be so great, and the time within which we must to act so short, it is unlikely that most of whatever actual responses emerge

will be part of a carefully planned strategy leading to a comfortable overall solution. Rather, there will probably be something of a scramble, an ad hoc mix of this and that until a reasonably effective and workable set of responses emerges over time. Crucially, the major thrusts will probably come between about 2020 and 2040 and so it will be for the coming generation, more than this one, to sort out the set of responses that best suit the evolving circumstances and reflect *their* values. Nonetheless, decisions made in the interim, that is by the present generation, will set the broad parameters within which the coming generations will be able to manoeuvre. We also bear substantial responsibility for how things will 'play out'.

Bill Barron, Hong Kong, July 2009

ACKNOWLEDGEMENTS

Christine Loh, Alexis Lau and Mike Kilburn provided comments on the broad thrust and many of the specific points in this work. J. Robert Gibson suggested ideas and approaches. He did this through specific comments on earlier work now incorporated into this book, and, over the past several years, through conversations, long and short, we had on these and related topics. Andrew Lawson provided feedback in discussions about some of the broader issues. Andrew was also responsible for shepherding the work though the final stages of preparation, ensuring that everything needed doing was done in a timely manner.

John Boland, Mishko Hansen, Supidto Dasgupta, and David Bevan provided comments on Chapter II when it was very much still a work in progress.

Jonas Chau and Michelle Wong patiently worked to create the illustrations. Thanh Nguyen provided options for the formatting. With all three, the exchanges were an iterative process in which we explored potentials for communication on different levels. Veronica Booth served as a meticulous and resourceful copy editor and Megan Pillsbury proved a most efficient proof-reader for final version.

Thanks to ADM Capital Foundation for supporting Civic Exchange's involvement in publishing this book and to the Hong Kong University of Science and Technology which also contributed financially.

In addition, a number of friends and colleagues patiently listened to sometimes less than cogent discourse on aspects of the points considered here. They provided critical feedback as the original ideas emerged and evolved. We should all be so fortunate as to have around us those who really listen and then offer thoughtful advice and healthy scepticism (preferably both).

OVERVIEW

1) LIVING ON DIFFERENT PLANETS?

> *'All we have to do to destroy the planet's climate and biota and leave a ruined world to our children and grandchildren is to keep doing exactly what we are doing today, with no growth in human population or the world economy.'*
>
> *J. G. Speth, The Bridge at the Edge of the World, p. x.*

A growing chorus of voices is warning that continuing our current way of life, even for another few decades, will leave a seriously impaired planet for coming generations.

The warnings concern a world with widespread shortages of accessible water, regional food shortages, flooding in heavily populated coastal regions, and humankind living with a vastly reduced natural ecology. And if any of a number of possible tipping points is passed, the changes will come much sooner and be far worse. With or without passing tipping points, a seriously impaired planet would quite possibly be one with frequent conflict where highly interdependent modern civilization itself would be at risk. While there are considerable uncertainties, the dominant scientific view is that these are more ones of timing and specifics, rather than of basics.

Calls for fundamental change now in what, how much and how we produce and consume come from two basic concerns:

1. Mounting evidence that rising concentrations of greenhouse gases (GHGs) in the atmosphere are leading to serious climatic changes much sooner than what had been predicted; and
2. The worldwide average human ecological footprint is greater than what the planet renewably produces. We are 'mining', not only the Earth's minerals, but the planetary biosphere as well.

The best current science makes clear that to head off catastrophic damage to the Earth's life support systems, economic activity must be fundamentally restructured. This shift needs to begin within years, not decades.

The restructuring would be felt most directly in the use of energy, of which the vast majority today is from fossil fuels. The burning of fossil fuels is the source of most of the carbon dioxide put into the atmosphere by humankind. By 2050 worldwide average emissions of carbon dioxide per person must fall by about 80% from what they are today.

For higher income economies the per person cut backs would need to exceed 90%. That is, higher income economies could only burn a mere 10% (or less) of the fossil fuels on which they now heavily rely for electric power, heat, transport and virtually every aspect of everyday modern life (including the production, processing, packaging, and shipping of most of our food).

Mid-century may seem like a long time, but considering the vast scale of change being called for, it is actually rather short. For example many of the coal burning power plants being built today would, under business as usual conditions, still be operating in 2050. Yet coal-fired electric power generation is the greatest single source of fossil fuel-derived carbon dioxide emissions. Unless practical carbon capture and sequestration is developed, coal-fired electric power will need to be virtually banned in the near future.

The level of carbon dioxide emissions reductions being called for will require a fundamental transformation of the economy, along with a drastic lifestyle 'makeover' for the world's consumers.

Yet, little connection is evident between:

a. On the one hand, the weight of scientific opinion about how much longer the Earth can support the growing demands being placed on it; and

b. On the other hand, the way markets continue to function, governments continue to plan, and the lifestyles many of us lead and to which so many more aspire.

It is as if the two sides live on different planets.

How is this possible? Part of the answer probably lies in the fact that so far at least, evidence of unsustainable damage to vital planetary systems is mostly too subtle, occurs too far away, or is still sufficiently in its early stages to be evident to most people. Images on television aside, when we look at the world around us, most of us probably find it difficult to believe the situation could possibly be as dire, and the need for action as urgent, as the warnings make it out to be. Further, when faced with an immediate concern, such as a major economic downturn, people naturally tend to prefer to deal with problems near at hand while postponing consideration of broader issues.

Yet, *the Earth does not negotiate*.

Continuing as we are creates considerable risk of physical calamities compared to which any financial problem would pale to insignificance. The best current science indicates this is not hyperbole.

2) BUT HAVEN'T WE HEARD ALL THIS BEFORE?

There have, of course, been warnings of impending resource limits from at least the time of Malthus in the eighteenth century to the Club of Rome in the twentieth. Yet, today the Earth is feeding close to 7 billion people, and average resource consumption is higher than ever! In the past two decades in China alone, hundreds of millions of people have begun taking on consumer lifestyles similar in scope (if not yet quite in scale) to those long enjoyed in higher income economies.

One might ask, *'What problem?'* As for threats on the horizon 'surely', we might think, 'technology will overcome these, if and when they arrive'.

While such faith in human ingenuity is not entirely unwarranted, what few people realize is the scale of hidden subsidies involved in supporting today's level of human activity. We have been consuming at ever-faster rates the Earth's *stock* of resources, biological as well as mineral, and ignoring vast environmental damage.

Humankind's demands on the planet have increased approximately 20 fold in little more than half a century! This is far beyond what technology and the market alone have made possible. But now we are running out of untapped natural resources that might simply be exploited, rather than carefully managed.

3) THE ANTHROPOCENE: IT'S NOT JUST ABOUT CLIMATE CHANGE

By 2003, humankind was imposing an overall ecological footprint that exceeded by an estimated one quarter what the planet renewably provides. In addition to directly harvesting biological resources faster than they can be replenished, diverse natural ecologies around the world are being replaced by planted monocultures. We know of five times in the history of life on Earth when there has been a mass dieback of existing species followed by a dramatic rebalancing of the different types of life forms. In the process of transforming the planet to suit near-term human needs we have launched the planet's sixth great species extinction. We are doing so without understanding the ecological role of most of these lost species and with no idea of what other species will emerge to fill the vacated niches.

To note only a few examples of the scale of impact on the biosphere: humans channel more than half of the planet's accessible rainfall runoff and are now responsible for about 60% of the total nitrogen cycle; marine fisheries are being wiped out and most of the species we currently harvest could be commercially exhausted in a few decades; and the body of virtually every person on Earth contains dozens of different persistent toxic compounds, a consequence of pervasive global pollution. As human

water demands continue to grow, groundwater is being depleted and rainfall patterns are shifting.

The United Nations estimates that by 2025, two of every three people on Earth could face some degree of water shortage and many more than today will face severe water shortages.

Destruction and transformation of the biosphere and climate change feed off each other. Biosphere destruction releases enormous quantities of carbon dioxide, while planted monocultures are less able than genetically diverse natural ecosystems to adapt to a changed climate. Meanwhile, the world economy continues to inefficiently use up finite reserves of petroleum and natural gas, along with dwindling deposits of other key non-renewable resources, literally as if there is no tomorrow.

Such exploitation has always occurred, of course. Yet the process is now occurring far faster, the number of key resources involved is far more, and the degree of economic interconnectedness is far higher. Hence, vulnerability to supply disruptions is far greater than ever before. As evidenced in the on-going financial crisis, interconnectedness may not so much spread the risk as intensify it.

4) LAGS AND TIPPING POINTS

The full effects of the GHGs being emitted and the destruction of the biosphere occurring today will not be felt for decades. To reduce the risk of severe damage in say 2050 or 2060, we cannot wait until 2030 or 2040 to begin. It often takes decades for major technological and economic structural changes to be widely implemented (e.g. in electric power and other major energy systems). As evidence of on-going climate change mounts, widespread deforestation and habitat destruction continue, and resource demands continue to grow, even waiting until 2020 to act may well prove to be too late to avoid an unpleasant latter part of this century and far worse by early in the next century (i.e. within the expected lifetimes of some of today's young children and most of their children).

Acting in advance becomes truly compelling when considering the risk of passing tipping points, where runaway climate change or ecosystem collapse could set in. Among the feared tipping points are:

- Ocean warming leading to widespread changes in rainfall patterns;
- Ocean acidification leading to loss of parts of the marine ecology, and the oceans being able to absorb much less carbon dioxide;

- A sudden *partial* melting of the Greenland or Antarctic ice sheets and with it rapid sea level rise; and
- As the arctic warms, the release of vast amounts of carbon dioxide and methane now locked in the permafrost, along with methane now frozen on the ocean floor.

Passing any of these (or other) tipping points would leave humankind in a defensive retreat.

Of course, what is being noted here are risks, not certainties. Nonetheless, these risks are ones much of the scientific community takes very seriously.

Pandemics present another type of risk, and might be thought of as a sustainability wildcard. Much of our animal protein is raised in extremely dense concentrations, fed highly unnatural diets, and reared in populations with very little genetic diversity.

Because pathogens flourish under such conditions, the animals (e.g. chickens, pigs, cattle) are fed high doses of antibiotics. As pathogens are swapped back forth between species (including humans), mutating along the way, there is an increased risk of pandemics accompanied by resistance to antibiotics. We need to ask ourselves if the way so much of our animal protein is raised is safe enough to be considered sustainable.

5) THE DRIVER

In high-income economies, and increasingly in parts of urban China, India, Brasil and other newly industrializing economies, people live lives not so much of consumption but of throughput. Consumers buy, use for a time, discard, and replace, as if the supply of natural resources is unlimited.

The ultimate driving force behind the unsustainable destruction of the biosphere and emission of billions of tonnes of GHG is an economic system geared to the treadmill of throughput. High employment and the market prices of things like stocks and real estate depend on it. When the treadmill slows down, governments see it as a crisis and frantically intervene to get it back up to speed.

Yet considering that the risks the current economic system poses to the future of humankind, doing everything possible to get 'back on track' is the ultimate folly.

6) THE DEVELOPMENT IMPERATIVE

In Asia, it is sometimes said 'development is not so much a goal, as it is an imperative'.

In newly industrializing economies, where so many people have recently joined the consuming classes, and so many

more look forward to doing so, the notion that the planet cannot indefinitely support resource-intensive lifestyles for ever more people may seem a cynical ploy to take away what was so hard (and so recently) won.

How can the development imperative be reconciled with the need for the world as whole to consume a lot less 'stuff'?

Most basically, it is essential to distinguish 'development' from 'growth'. Growth is quantitative expansion. Development is qualitative progress.

Much of this progress could be in quality of life improvements with relatively low resource intensity (e.g. education, clean water and air), along with a social contract providing basic material needs for all and with a greater sense of security. It would also involve progressively more efficient systems of production and consumption along with greater attention to the quality and durability of material goods.

7) CHANGING TRACK

How might we begin to change track? Investing in environmentally friendly infrastructure will be important. Yet the hardest part will be in getting off the addiction to economic growth. For this to happen, employment and asset values will need to become far less dependent on the 'material throughput economy' and based more on labour-intensive goods and services, along with the far more frugal use of non-renewable resources and the carefully managed use of renewables. There seems to be no escaping the conclusion that this *will* be the future, whether it comes as a choice or is imposed by resource constraints.

The place to begin is put a price on carbon dioxide (and later on emission of other GHGs as well as on activities that damage the productivity of the natural environment). Making people pay a price for the environmental damage resulting from their market decisions will slow the pace of damage. Hopefully, it will provide enough breathing space for incentives to be put in place that move the economy in the directions noted above.

8) SUSTAINABILITY AND SUSTAINABLE DEVELOPMENT

Sustainability is about maintaining internal conditions in the face of external changes. It is what societies that are doing reasonably well strive for when faced with external threats. In contrast, sustainable development is about both internal and external change. Through it, societies seek to progress, even as they respond to external challenges.

For both sustainability and sustainable development substitutions are key: in technology, resources, the composition of consumption, and values.

9) RESPONDING

In responding to the challenges of climate change and an overexploited planetary resource base, the options are so many and so varied in approach and focus it can be difficult to sort them out. Here, responses are grouped into those that are market-led, government-led, and values-driven.

Market-led responses include niche technical fixes, price changes, along with 'green' business practices and consumerism.

Government-led responses include green infrastructure

investments, efficiency standard setting, and broad-based technical fixes, along with addressing market failures by internalizing externalities and changing the way economic success is measured and pursued.

Values-driven responses might include re-assessing the appropriate balance between material and non-material aspects of how we view quality of life, emphasizing efficiency and thrift, and re-evaluating how robust the 'social contract' should be. Civil society can play an important role in this process.

9. a) Technical Fixes

Our initial inclination will almost certainly be to place considerable faith in technology, especially in attempting to limit climate change and in adapting to it. Climatic-related technical fixes can be 'passive' or 'active'.

Passive climate fixes attempt to reduce GHG emissions. Examples include:

- Carbon capture and sequestration;
- Satellites to beam solar energy to Earth as microwave energy;
- The far greater use of traditional renewable energy such as wind, solar, biomass, and hydro, along with more nuclear energy;

- Electrification of land transport (so that electricity from renewable resources can be used in place of petroleum fuelled vehicles); and
- Designing for much greater energy efficiency.

Active technical fixes for climate change include those referred to as 'geo-engineering'. These approaches would attempt to actively cool the planet. Among the wide variety of proposals are ones to:

- Inject sulphate particles into the upper atmosphere; and
- Position mirrors in space to deflect a portion of the incoming sunlight.

Other less radical proposals involve schemes to draw more carbon dioxide out of the atmosphere than is being put into it. One way is to make then bury vast amounts of elemental carbon (char), presuming of course that this could be done in an energy- and carbon-efficient manner.

The 'geo-engineering' approaches might be characterized as, '*Maybe the Earth can be made to negotiate*'.

For the geo-engineering fixes, beyond the question of whether they would actually work, there are the sometimes staggering costs (e.g. mirrors in space) as well as the risks of tampering with poorly understood natural systems.

Still, embedded climate change has probably reached the point where the only option is to employ both active and passive 'technical fixes'. If successful, they can buy valuable time.

Yet if we do not get off the treadmill of throughput, we would soon be back in trouble, and like an addict, periodically need to frantically set out in search of the next 'fix'.

9. b) Addressing Market Failure

The reason we emit so much GHG, even while we are beginning to recognize the long-term harm it does, is that for the most part, we do not pay a direct money price for doing so. Putting a price on carbon (and later on other GHGs and on activities that undermine the long-term productivity of the biosphere) will be essential. In a global economy this is something that eventually must be a matter of governments working together.

For reference, a US$100 per tonne tax on carbon dioxide would add about US$43 to a barrel of oil. Such a price would probably not be high enough to bring about reductions in carbon dioxide emissions on the scale needed (i.e. by 2050 down 80% worldwide compared to current levels and down by more than 90% in high income economies). A price on carbon dioxide that is closer to US$200 per

tonne is being put forward as what is required.

Beyond putting a price on GHG and activities that damage the biosphere, government-led responses will need to include changing the way national income accounting is done. Today when we gauge economic success we rely on measures like Gross Domestic Product (GDP), in which the value of anything not bought and sold is ignored.

At a minimum, when governments appraise the performance of their economy they need to employ double-entry bookkeeping. In this, environmental damage and resource depletion (biological as well as mineral) would be entered as debits, even if they were not always able to be fully valued in monetary terms.

9. c) The Future Isn't What It Used To Be

In the second half of the twentieth century something close to 1 billion people led relatively resource-intensive lifestyles. By the early part of the 21st century another several hundred million in the newly industrializing economies had begun to take on similar lifestyles. On the sidelines, billions more aspire to do the same.

Yet, rather than a picture of what the future reasonably holds for ever more people, resource-intensive lifestyles for entire populations seem destined to be a temporary

phenomenon, soon to be part of history.

Humankind need not live in poverty. But it will have to come to:

- Value development over growth;
- Focus on quality and not primarily on quantity; and
- Examine the worth of different aspects of life, and not measure success by the quantity of material things passing through our lives, as is generally done today.

9. d) Re-examining Values: The Future Is What We Make Of It

Even with green consumerism and more efficient infrastructure, even with technical fixes and concerted international cooperation on carbon dioxide pricing, there seems no avoiding the prospect that, for a considerable time at least, people will have no choice but to adapt to living in a more material resource-constrained world. This will first and foremost be a world in which energy use is heavily constrained by higher prices and other restrictions. Higher energy costs in turn will significantly affect the price of things such as food, transport, and indoor temperature control. To some degree, it will affect the price of most manufactured things. Faced with higher prices, consumers will do what they can to live with less.

How well we adapt will not only be a matter of technology or how much of the planet's resources some of us can secure for ourselves, but of the values we hold.

How we come to view quality of life in a less materially abundant world will depend firstly on whether our basic material needs are being met. For many people, the concern will be survival. For their governments, it will be a scramble to minimize material hardship and maintain social order.

Even those of us able to avoid serious material deprivation, will have to leave behind a world where the material throughput of our lives is nowhere near as high as it is today. There is also likely to be a move away from a collective value system where high status is bestowed on those who accumulate material wealth, almost regardless of how it is amassed or used.

If we find ourselves with a lot less stuff, we can compensate in various ways, including through what economists refer to as 'psychic income'. This might include enhancing social relationships, and a greater focus on personal interests and personally satisfying accomplishments.

While potentially the most far-reaching of the ways we might respond to the looming challenges, the shifting of values also stands as the most unwieldy. As propagandists

on the left and the right, religious leaders and those offering utopian visions of one sort or another have learned, people can be swayed for a time, but ultimately values come from within.

But then, there is *zeitgeist*—the spirit of the times—a pronounced shift in widely shared values that sometimes arises, seemingly out of nowhere, to lead a whole population or a generation to enthusiastically embrace a quite different worldview.

The idea of a new *zeitgeist* is not noted here as a prediction but as a reminder that values do change, and not always incrementally. It is of course comforting to consider the possibility of a new spirit of the times bringing in its wake the belief that the good life does not require high material throughput. Indeed, in the absence of something like that, the likely outcome would be prolonged conflict over the shrinking resource base.

10. IN CLOSING

The elephant *is* in the room, this massive but so far largely hidden problem of coming up against planetary limits with which most of us would rather not deal with, just yet. Denial is tempting because, so long as the elephant remains quiet, the risks his presence creates do not seem

Suggested Principles for Moving Toward a More Sustainable Development Path

1. Sustainable development cannot primarily focus on technical fixes.
2. Green chemistry is key, for example, manufactured materials engineered for minimal toxicity and to decompose into useful raw materials with minimal energy.
3. Emphasize good design. Design should be efficient, allow materials and parts to be readily reused or recycled, and be functional and aesthetically pleasing.
4. Distinguish 'development' from 'growth'.
5. Promote economic efficiency by internalizing externalities.
6. Acknowledge the need for a much larger role for governments in ensuring that markets respect planetary boundaries.
    - Yet also stress the importance of freedom of expression, and participatory decision-making, even while market freedoms are constrained.
    - Stress the importance of increasing competence and transparency in government decision- making, i.e. demand a value shift on the part of civil servants and political leadership.
7. In place of GDP use income measures based on double-entry bookkeeping (i.e. ones that have debits as well as credits and account for un-priced benefits and costs).
8. Invest now in environmental protection to reduce future risks (i.e. take out more insurance).
9. As average material consumption declines, limit market-driven income inequalities.

truly real. Meanwhile, we continue to prod and poke him and ask ourselves if he is even alive.

Hopefully, the dangers will soon be appreciated and we will begin to sooth the beast instead of continuing to provoke him as we begin the long, slow process of easing

him out of the room. Or perhaps, we will only act when the elephant stirs and we have no choice but to accommodate ourselves to his ever more unruly presence.

When we do act, the response strategy will likely be a combination of cleared-headed planning along with a good dose of reflexive reactions to an evolving context. The particular combination of responses will change from place to place and evolve over time.

Nonetheless, we must:

- Truly make the connection between the picture science is painting of what is likely to happen to the global atmosphere and biosphere in the coming decades, and what most of us expect the near future to look like;
- Appreciate that basic change is coming—too many of today's activities are simply unsustainable and something must give;
- Understand that technology will help but cannot save us; and
- Try to make the most of the new situation, in large part by re-examining our values individually and collectively.

But first let us begin by really talking about the elephant with whom we share this increasingly crowded room.

THE GREAT DISCONNECT

BILL BARRON

I. THE GREAT DISCONNECT

The warnings from the scientific and policy communities grow increasingly dire. And as the perceived window of opportunity narrows, the calls for action grow more strident.

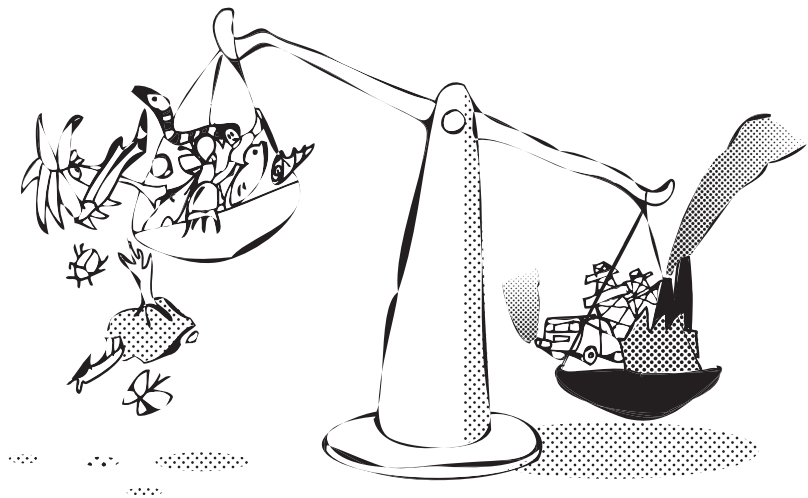
As a consequence of resource-intensive lifestyles, we are perilously close, we are told, to inflicting irreversible damage on the natural world on which, even with advanced technology, we ultimately depend.

Climate change is the most pressing worry, but the problems go beyond that. For several decades now humankind has consumed, transformed or destroyed more of the biological resources on which it depends than the planet renewably generates. Human civilization is no longer living off the Earth's annual biological 'interest'. For about two decades now human activities have resulted in a net reduction in the planet's total 'stock' of biological 'capital'.

To save what remains of the natural world (the 'biosphere') and constrain climate change we must soon make fundamental changes in what, how much, and how, we produce, consume, and discard. Yet even as the calls for action grow more urgent, in 2009 governments around the world are struggling to get their economies *back on track*, not to *change track*.

Meanwhile, the world's consuming classes are expanding as hundreds of millions of people in places like China, India, Brasil, and Mexico have moved out of poverty and begun taking on the type of resource-intensive lifestyles long taken for granted in higher income economies. Waiting in the wings are many more people in the developing world looking forward to the same prospect.

To those in the developing world being told that the planet cannot continue to support such a way of life may seem little more than a cynical attempt to take away what they have long struggled for and so recently have begun to win. It might also be interpreted by some as an indication that those in higher income economies want to permanently lock-in the remaining differences in the level of resource



use between themselves and the rest of the world though regimes that limit emissions of greenhouse gases (GHGs) or curtail on-going transformation of the biosphere.

And for many of us, whether we live in higher income economies, newly industrialized ones, or developing economies, the warnings may simply be too much at odds with what we see for ourselves: a natural world that, while diminished (often severely so), seems far from truly exhausted and appears to quickly rebound when given a chance. As for that part of the natural world that has been lost, we might wonder how important that is to an industrialized and increasingly urbanized society.

While many of us might accept that climate change is on the horizon, truly serious impacts seem to be something for future generations to deal with. And when that day finally comes (generations from now) we might nonetheless still believe advancing technology will see *them* through.

Yet, consider some of what is being said about how fundamental the challenges are to the sustainability of our way of life. As cited in the Overview, Speth notes that even without further economic growth, current demands on the Earth are already so great that it would be catastrophic to simply keep going as we are. Speth is not alone in how anxious he is about the future of humankind. Here is what some others are saying:

'The world's current ecological, demographic, and economic trajectory is unsustainable, meaning that if we continue with "business as usual" we will hit social and ecological crises with calamitous results.'

Jeffrey Sachs, Common Wealth: Economics for a Crowded Planet, p. 5.

'Environmental degradation is therefore undermining development and threatens future development progress.'

United Nations Environment Programme, Global Environmental Outlook (GEO-4), p. 4.

'Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level.'

Intergovernmental Panel on Climate Change, Climate Change 2007: Synthesis Report, p. 3.

'Humanity must make a decision, and make it right now: conserve Earth's natural heritage or let future generations adjust to a biologically impoverished world.'

E.O. Wilson, The Creation: An Appeal to Save Life on Earth, p. 91.

Yet, little connection is evident between:

- On the one hand, the weight of scientific opinion about the severity of the pressures the world economy is putting on planetary support systems and how near truly dire consequences are if we do not act now; and
- On the other, how markets continue to function, governments continue to plan, and the resource-intensive lives so many of us continue to live and to which so many more aspire.[1]

At its heart, this disconnect stems from the highly visible success of the global economy in providing unprecedented levels of material abundance, while evidence that humankind's demands on the planet have grown beyond what can be sustained without causing radical damage to both the atmosphere and biosphere remains, so far at least, much less visible.

And perhaps at some level many of us are simply taken aback by the notion that humankind must accommodate itself to living within natural limits that can only temporarily be exceeded ('planetary boundaries'), rather than using technology to push back the limits, as we seemingly always have been able to do.[2]

Awareness is also important. Even if few of us understand in much depth the process of climate change or how it is expected to play out in coming years, we have at least heard of it. Yet, in addition to

changing the radiative chemistry of the atmosphere through emission of greenhouse gases, human activity is transforming and damaging the planet's biosphere on a scale almost beyond comprehension. About this most people know very little.

THE ANTHROPOCENE: IT'S NOT JUST CLIMATE CHANGE

Few of us realise that over the past several decades, human activity relative to the size of planetary systems has grown to the point where the entire biosphere is being profoundly altered to satisfy the wants of the *current* generation. Nobel Prize holder Paul Crutzen has dubbed the present era 'The Anthropocene' to emphasize the truly fundamental role humankind now plays in the planet's overall ecology.[3] The scale of the changes is suggested by the following examples:

- Humans channel more than half the planet's potentially accessible rainfall runoff for crops and other uses.[4]
    - The absence of extensive, underutilized, accessible water resources will make it difficult to meet future growth in water demands, even if climate change does not reduce accessible rainfall runoff.[5]
        - As the United Nations notes, 'If present trends continue, 1.8 billion people will be living…with

absolute water scarcity by 2025 and two thirds of the world population could be subject to some degree of water stress'.[6]

- Cropland, planted forests, and sites otherwise transformed for human activities (like housing, roads, and industry) take for near-term human use much of the Earth's land-based photosynthesis potential.[7]
  - Land degradation (from soil erosion, nutrient depletion, water scarcity, rising salinity) is widespread, persistent, and getting worse.[8]
  - Most of the world's natural forests and wetlands are gone, and much of what remains is under pressure. Rapid deforestation continues in the tropics.[9]
    - Only about one third of remaining forests worldwide are diverse, ecologically robust, natural ecosystems.[10]
- Nitrogen fixed by chemical fertilizers and human crops now accounts for about 60% of total nitrogen fixation planet-wide, with excess nitrogen fertilizers contaminating drinking water and harming the ecological balance of lakes, estuaries and coastal waters worldwide.[11]
- The world's commercial marine fisheries are being wiped out. About 30% have crashed[12] while another 40% are severely overexploited (i.e. on their way to crashing).[13]
  - No significant untapped marine fishery resources remain. Current trends would lead to the collapse of virtually all existing commercial marine fisheries within another several decades.[14]

- Of those ecosystem services that have been assessed, about 60% are degraded or used unsustainably. These include not only fisheries, but also a wide range of natural biological systems that treat and detoxify wastes, purify water, offer flood and soil erosion control, and help regulate air quality, temperature, and climate.[15,16]
- The body of virtually every person on Earth today contains dozens of different persistent toxic compounds, a consequence of pervasive global pollution.[17]

In each case cited above the pace of change continues unabated and in many cases is accelerating.[18]

Five times in the history of life on Earth there have been mass extinctions of many life forms. The sixth such 'great dieback' is now underway. Humankind's transformation and destruction of the natural world is the cause. Cropland and planted forests support relatively few species in place of the many that the lost natural ecologies had supported. When such transformations occur worldwide, as they are today, many species are unable to simply move and so become extinct.

The rate of species extinction appears to be at least 100 times what would naturally occur, and as the United Nations notes, if current trends continue, 'it is feasible that extinction rates will increase to the order of 1,000-10,000 times background rates'.[19]

Very little is known about what ecological roles most of the lost species play and the effect their loss will have on provision of environmental services important to humankind.[20]

In the words of E.O. Wilson,

> *'the natural world…is everywhere disappearing before our eyes—cut to pieces, mowed down, plowed under, gobbled up, replaced by human artifacts.'*
>
> *E. O. Wilson, The Future of Life, p. xxii.*

In the process, we are undermining ecosystem services that we barely understand, but on which we know we depend on in some manner.

> *'The degradation of the world's ecosystems is a "quiet crisis", largely hidden from view, but the consequences of this degradation are potentially catastrophic for human beings.'*
>
> *J. Milillo and O. Sala, 'Ecosystem Services', in Sustaining Life: How Human Health Depends on Biodiversity, p. 76.*

CLIMATE CHANGE IN AN ALREADY STRESSED BIOSPHERE

James Lovelock notes that this mining and transforming of the biosphere has direct consequences for the stability of the climate.

> *'The natural ecosystems of the Earth are not just there for us to take as farmland, they are there to sustain the climate and the chemistry of the planet.'*
>
> *J. Lovelock, The Revenge of Gaia, p. 16.*

The Tällberg foundation also stresses the crucial linkage between climate and the health of the biosphere.

> *'…climate change must be addressed within the wider challenge of preserving the capacity of global ecosystems to continue to function as sinks for greenhouse gases, and avoid ecosystem feedbacks that accelerate global warming.'*
>
> *B. Ekman, J. Rockström and A. Wijkman, Grasping the Climate Crisis, p. 6.*

Climate change is underway.[21] Broadly, spring activities, such as the greening of vegetation, seed ripening, egg laying and migrations are occurring earlier in the year, while ecosystems preferring temperate climates are migrating toward the poles and to higher elevations.[22] In the process, the closely timed activities of some interconnected species are being thrown out of synchronization (e.g. emergence of flowers at times when the pollinating insects are active).[23] The changes are occurring widely, on land, fresh water and in the oceans.

Rainfall patterns around the world are shifting, while mountain-snow and glacier-fed rivers face long-term

declines as the planet warms.[24] The United Nations estimates as many as a billion people could be adversely affected by reduced long-term flows from glacier and snowpack-fed rivers as more winter moisture falls as rain that immediately runs off, rather than being stored as snow which is gradually released in spring and summer.[25]

The effects of climate change on water availability will be felt in a world where in a number of important food-producing regions (e.g. the North China Plain, the High Plains of the United States, the Indo-Gangetic Plain in South Asia) human water use already exceeds annual average replenishment.[26] The bottom line as noted by the United Nations Environment Programme (UNEP) is that in only another 15 years or so, two of every three people on Earth could face some degree of shortfall in water supply.[27]

Confronted with environmental stress, people, like animals and plants, attempt to move. Yet human numbers are now far larger than ever before and there are few hospitable under-populated lands to which they might freely migrate. 'Climate refugee' is likely to become a commonly applied term.[28]

TIPPING POINTS: REAL RISK, BUT DIFFICULT TO PREDICT

An important consideration in the potential for mass migrations by humans and other species is that a changing climate will not necessarily always come gradually. In addition to the slow-building effects, there are a number of feared tipping points where even moderately higher temperatures could trigger runaway effects in which changes occur suddenly in large jumps, rather than gradually in small increments.[29] To list some tipping points of concern:

- Uncontrollable massive methane releases from thawing of methane hydrates on the floor of the arctic as well as methane and carbon dioxide released from thawing tundra and peat bogs in the arctic landmasses;[30]
- Acidification of the oceans reaching the point at which they stop being carbon sinks and become far less supportive of marine life;[31]
- Substantial melting of the West Antarctic and/or Greenland ice sheets with a rapid sea level rise in the order of metres; and in the case of Greenland, the inrush of fresh water possibly disrupting the Gulf Stream which makes the North-Eastern United States and Western Europe far milder in climate than they

otherwise would be, given their latitude;[32] and

- Warmer seas leading to near permanent El Niño events and, as a consequence of the resulting shifts in rainfall patterns, part of the world's landmass switching from being carbon sinks to carbon sources, as forests die back.[33]

PANDEMICS: THE WILD CARD

In the highly integrated modern world a new pathogen can spread around the world (as did SARS in 2003) even before it is detected. And once detected, for some time it may defy our understanding to the point where we do not know how to defend ourselves against it or effectively slow its spread.[34] The human swine flu of 2009, while at the time of this writing still relatively mild in its impact on most people who catch it, serves as a reminder of just how difficult it can be to contain a new communicable disease. It also demonstrates how much of a moving target pathogens can be as they pass back and forth between host species (including humans), mutating along the way.

Mutating pathogens are not new. But a number of things are different today. Among them: the density of human populations, commonplace high speed, long distance travel, and how we mass produce much of our animal protein. We raise pigs, cattle, and chicken in extreme

concentrations, feed them highly unnatural diets, and systematically breed-out genetic diversity. Since animals raised in such circumstances have increased susceptibility to disease, they are routinely administered heavy doses of antibiotics. The entire process facilitates on-going mutations of viruses, along with the potential for resistance to antibiotics.

While pandemics (even horrific medieval ones) tend to eventually burn themselves out, they can be highly disruptive for months or years. They can also be nothing short of terrifying to entire populations while they are underway.

With regard to sustainability, we may need to consider if the way we raise so much of our animal protein is 'sustainable'.

CLIMATE CHANGE: WHERE WE STAND AND WHERE WE NEED TO GO

Atmospheric CO_2 was about 280 parts per million (ppm) before the industrial revolution. In September 2008 it stood at 384 ppm, 37% higher and the highest in at least 650,000 years.[35]

Ramanathan and Feng (23 September 2008) estimate we

have already committed the Earth to 2.4 ˚C of warming, but have so far been spared much of the effect due to global dimming from air pollution. Indeed, this effect is so important that they caution against too aggressively curtailing sulphur and nitrate air emissions. They argue for the need to keep these artificial atmospheric brown clouds (ABCs) in place for some time so that they will continue to provide a net cooling effect.[36]

Nicholas Stern (2005) notes that current trends would lead the planet to about a 5 ˚C rise in global average temperature by the end of this century. By comparison the Earth today is about 5 ˚C warmer than during the last ice age. At a minimum, this would mean an Earth far less benign from a human standpoint. As Lovelock (2006 & 2009) cautions, it could very well be a world in which humankind's very existence becomes precarious, with those who survive being pushed into isolated ecological pockets. And this is not some imagined worst possible case. It is Stern's business as usual scenario, if we simply keep going as we are!

Stern (2005) estimates that to stabilize CO_2 at about 500-550 ppm, which would hopefully limit the global average temperature increase to about 3 ˚C, would take about 2% of world Gross Domestic Product (GDP) each year up to 2050.

Stern (2008) argues that world carbon emissions must peak before 2025 and then steeply decline to a point where by 2050 they are half of 1990 levels. To attain this will mean, among other things, that most of the world's electric power generation must be de-carbonized, and soon (i.e. it can no longer be generated from the burning of fossil fuels, unless accompanied by almost universal carbon capture and sequestration).

Yet today coal, the most carbon-intensive of fossil fuels, accounts for close to half of all power generation and the world continues to build coal-fired electric power plants at a fast rate. Under normal circumstances, many of these would still be operating in 2050. Meanwhile carbon capture and sequestration (CCS) on a large scale is not yet a proven technology and despite considerable research, the goal of widely applicable CCS remains an elusive one.[37]

James Hansen (23 June 2008) believes that aiming for a limit of 500-550 ppm risks accepting a far too dangerous degree of climate change. He proposes a target atmospheric CO_2 concentration of no more than 350 ppm, that is, one somewhat lower than what it is today.

In other words, in James Hansen's view, even Stern's ambitious proposals may not be anywhere near enough. As one means of getting to his proposed target, Hansen (25 February 2009) proposes a tax on fossil fuel in the

United States with the funds raised being returned to the public with each person receiving the same amount of dividend. In his paper Hansen does give not a specific level for the tax, but he illustrates his point using US$ 115 per ton of carbon (or about US$103 per metric tonne).

There are of course other greenhouse gases, with methane (CH4) being a major concern. Methane concentrations are now about 150% above pre-industrial levels and still rising.[38] Methane is much shorter-lived in the upper atmosphere than carbon dioxide (decades rather than a century or more). Yet despite its relatively short atmospheric life and the fact methane contributes less than 20% to global warming, vast quantities of methane can be released suddenly from natural sources, as Flannery (2005) notes. Over geologic time scales, such phenomena sometimes played important roles in negative feedbacks that lead to rapid global warming.

Another consideration with methane is its association with agricultural practices (e.g. ruminant livestock such as cattle and sheep, as well as rice grown in paddies).[39] Hence, its control has implications for what types of food production would be considered ‘sustainable’.[40]

BUT HAVEN'T WE HEARD THIS BEFORE?

The preceding has been a sketch of arguments from one side of the great disconnect. From the other side sceptics have long argued that warnings of impending global resource scarcity (and other doomsday forecasts) have been put forward in one form or another since at least the time of Thomas Malthus in the eighteenth century on through cases like The Club of Rome in the second half of the twentieth.

And aren't there numerous cases of humankind bringing things back from the brink? Consider for example, that once the use of the pesticide DDT was ubiquitous, but it is now used far more sparingly. At least some tuna is now caught with dolphin friendly nets. And most significant of all, the Montreal Protocol initiated the phasing out of ozone-depleting substances, and isn't the ozone layer beginning to recover?

If we reversed the destruction of the ozone layer, so the logic goes, then surely we can do the same with carbon dioxide once we feel it is truly necessary to do so. In short, when we need to, we do act. And if 'factory farming' presents risks, so too does trying to feed unprecedented numbers of people using traditional

farming techniques!

Despite all the doomsday warnings about resources limits, the world economy has continued to grow. We are now feeding nearly 7 billion people. As for other material resources, per person consumption is higher than ever before. And this despite the fact that there are many more people than ever before!

One might reasonably ask: 'What problem?'

> **Clearly, or so it would seem, advancing technology and clever economic organization have been more than enough to fend off resource limits when they are threatened. And if we have successfully fended them off so far, why not indefinitely?**
>
> **And even if we are now facing less elastic planetary limits, when one considers that the rate of technological progress is faster than ever, it would seem that all we need do is to channel technology research and development (R&D) in the proper direction.**

Such optimism about human ingenuity is not entirely unfounded, of course. Information technology, for example, has transformed to at least some degree the

lives of most people on the planet with relatively little in the way of the consumption of scarce resources.[41]

For all the talk of peak oil, we have, decade after decade, pushed back that day, even as consumption has grown enormously.[42] On the horizon, genetic engineering is proposed as the source of a more plentiful and lower cost food supply. One day perhaps, even the holy grail of clean, virtually unlimited, energy from nuclear fusion will be ours. And with bountiful, pollution-free energy, other problems such as water or metals scarcity, as well as climate change could be overcome.[43]

Yet, when the matter is considered carefully, it is evident that modern resource-intensive lifestyles have not entirely been made possible by advances in technology and the organizational advantages of the modern market economy alone.

Hidden Subsidies

The modern consumer has received large, hidden subsidies as the economy has used up in a few years what life on Earth built up over millennia, and geology over eons. We have cut down most of the old forests, taken much of the ocean's fish, depleted long-stored groundwater reservoirs, let soils badly erode, and heavily contaminated most of the planet's rivers and lakes.[44]

Yes, there are substitutes for some of these resources. Canals, for example, can be dug to bring water long distances from water-surplus regions to make up for depleted groundwater in drier regions. Chemical treatments can be applied to contaminated water supplies. Planted fast-growth forests can supply wood once supplied by old growth forests, and chemical fertilizers can increase productivity on lands with degraded soils.

Yet these substitutes are generally far more costly than the resources they are intended to replace. In some cases, the damages are ones for which artificial replacements are impossible or impractical, such as the many species driven to extinction in the process of widespread land clearing or the contamination of soils and river sediments with long-lived hazardous pollutants.

And while electronic gadgets of all sorts have steadily fallen in price, buyers have not yet had to pay for most of the resulting environmental damages of material extraction, transport and processing, let alone face charges to cover the cost of safe disposal/recycling of the toxic wastes (or for the health damages to waste handlers—typically in low income countries—when it is not).

In the process of expanding the modern economy we have (almost without even being aware of it) launched the *Sixth*

Great Species Extinction in the history of life on Earth. This on-going mass extinction has little-understood (though probably quite important) implications for the long-term provision of ecosystem services including new drugs, disease and drought resistant strains of vital crops, natural limits on the spread of pathogens, soil and water nutrient recycling, soil formation, insect pollinators, and more.[45]

In short, we have been living not only off what we produce, and harvesting what the Earth renewably generates, we have also been consuming the planet's *stock* of natural capital and failing to pay for the pervasive damage to the Earth that sustains us.

We have been living beyond our means.

Counting on the Next Breakthrough and the ones After

When presuming that we can count on continual technological advances, it is important to consider several factors. First, technological advances are highly uneven, with breakthroughs occurring in quick succession in some fields (e.g. electronics, genetics) and far more slowly in others (e.g. energy storage, electric power generation, mining technology). Second, new capital intensive technologies, such as carbon capture and sequestration, tend to require long lead times (often decades) to become well entrenched.

Of even greater importance is that so long as the economy is geared to relentless quantitative expansion (i.e. growth), even when a technological advancement is fully implemented, this merely facilitates the taking of yet another step on the treadmill of what economists commonly refer to as unlimited wants. As noted in Chapter II, the global economic system is insatiable, compelled to grow simply to keep from declining. It acknowledges no natural limits.

Jeffrey Sachs (2008) points out that world population increased more than two-and-a-half times since the 1950s, while the world's Gross Domestic Products (GDPs) have increased eight-fold over the same period.

> **By this accounting, we have increased our demands on the planet twentyfold in little more half a century!**

This represents an annual compound growth rate for the past 50 years of more than 6%, a pace that simply cannot be accounted for by technological advances and economic organization alone. To be sure, technological advancement and market dynamics accounted for a large part of the growth, but the expansion in consumption was also a matter of widespread mining of the stock of natural resources, biological as well as mineral, and simply ignoring most of damage done to the environment.

Exponential growth cannot be maintained indefinitely if the system is reliant in some important way on finite resources.[46] With current technology (and even considerable advances on it) humankind remains dependent on the natural world for: raw materials, sinks for waste disposal, and on a diverse ecology to provide essential environmental services. Yet resources are being consumed, sinks are clogging up, and ecosystems being extinguished like never before.[47]

Admittedly, with on-going technological advances and an agile economy that almost indiscernibly substitutes away from a resource when it starts to become scarce to another resource still temporarily plentiful, 'limits to growth' can be far more elastic than some past commentators have appreciated. Yet it would imprudent to mistake a relatively elastic resource supply for one that is endlessly malleable (and hence effectively infinite).

For all our science and organizational abilities:

- at least some resources we inefficiently use up today will be costly or impractical to replace tomorrow;[48]
- the un-priced ecosystem services we undermine today will have to be replaced by costly and less efficient priced manufactured goods and services tomorrow;[49] and
- we are quite literally using up and damaging the planet as if there is no tomorrow.[50]

We would also do well to reflect on the fact that so much of this frenetic consumption/destruction of what are ultimately finite resources (even taking technology into account) is to support lifestyles characterized not so much by rising consumption as by increasing *throughput*.[51]

It may be asking for a leap of imagination, but in a crowded, finite world, we would do well to take heed of the admonition that, a wealthy man is not necessarily one who has a lot, but one who needs little.[52]

RE-CONSIDERING THE WAY FORWARD

Chapter II considers the economic driving forces behind the difficulty in addressing the underlying causes of climate change and biosphere destruction. It also describes the challenges of sustainable development in the context of a major economic downturn.

Chapter III provides further context for considering possible responses to the challenges we face. It outlines a number of distinctions such as that between 'sustainability' and 'sustainable development' and 'hard' and 'soft' sustainability, while also highlighting the key role of substitutions.

Chapters IV through VIII consider possible responses to the sustainability challenges.

To wrap up Chapter I, Figure 1 provides a summary illustration of the major pressures on the planet and the resulting challenges to the sustainability of the current development path.

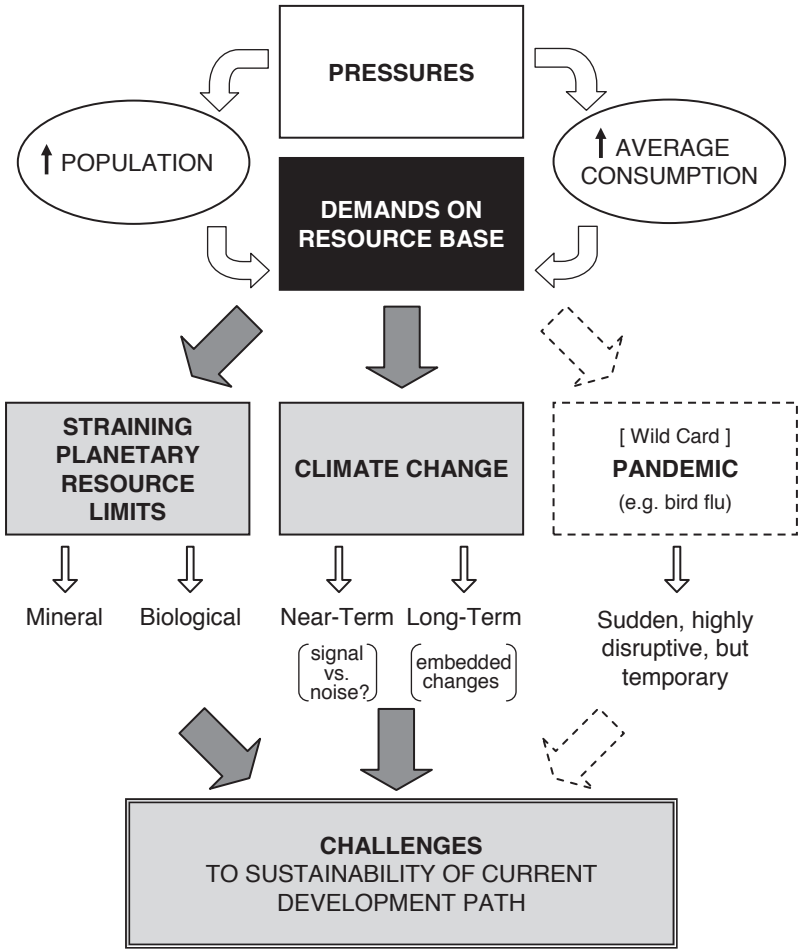


FIGURE 1: PRESSURES AND CHALLENGES

CHAPTER 1 NOTES

1 Indeed, some recently published forward-looking books (e.g. R. Shapiro's *Futurecast 2020: A Global Vision of Tomorrow* (2008) and G. Friedman's *The Next 100 Years: a Forecast of the 21st Century* (2008)) see climate change mostly as a backdrop to other, more important dynamics (human demographics in Shapiro's case and technological advance in Friedman's). Biosphere degradation is hardly on either author's radar screen.

Perusal of comments in media (e.g. Bloomberg Television) or from government officials about the need to restart economic growth further reinforces the notion of how deep-seated the disconnect remains. This continues to hold true even as the warnings from the scientific and policy communities grow more ominous: the climate is changing faster than expected while carbon dioxide emissions are increasing more rapidly than projected even under recent worst case scenarios.

2 We may live on 'Spaceship Earth', but many of us might prefer to think of it as being more like the *Starship Enterprise*, where technology allows us to make whatever we might need from whatever is available.

3 Crutzen, P. J. and Stoermer, E. F. (2000), 'The "Anthropocene"', *Global Change Newsletter*, 41: 17-18.

4 Speth, J. G. (2008), *The Bridge at the End of the World: the Environment and Crossing from Crisis to Sustainability*; and Wilson, E. O. (2006), *The Creation: an Appeal to Save Life on Earth*.

5 Even if total rainfall increases in a warmer world this will not necessarily mean an increase in accessible rainfall storage. For example when winter moisture falls as rain instead of snow, it is not available to feed rivers in the dry summer. Rainstorms are also predicted to become more intense, making it more difficult to capture and store the water that falls.

6 United Nations Environment Programme (UNEP) (2007), *Global Environment Outlook [GEO-4]: Environment for Development*, p. 116.

7 Sachs, J. (2008), *Common Wealth: Economics for a Crowded Planet*.
8 UNEP (2007) *GEO-4*.
9 Wilson, E. O. (2002), *The Future of Life*.
10 UNEP (2007) *GEO-4*, Chapter 3.
11 J. Sachs (2008).
12 'Crashed' in the sense that the remaining fish in the particular fishery are too few to be worth the increased cost and effort to catch.
13 UNEP (2007) *GEO-4*.
14 Fish farming can partly make up the shortfall. In the future oceans will remain an important source of food, but probably with severely degraded production potential, higher costs and involving exploitation of species that are now considered unappetizing.
15 UNEP (2007) *GEO-4*, p. 161.
16 The un-priced environmental service benefits we carelessly destroy today will need to be made up tomorrow (as best we can) by priced monetary investments.
17 Speth (2008).
18 UNEP (2007) *GEO-4* provides a comprehensive overview of how human activities are affecting the environmental resource base and its ability to continue to provide essential services.
19 UNEP (2007) *GEO-4*, p. 164.
20 In addition to UNEP (2007) *GEO-4* also see: Speth (2008); Wilson (2006); and Lovelock, J. (2009), *The Vanishing Face of Gaia: a Final Warning*.
21 See for example Intergovernmental Panel on Climate Change (IPCC) *Climate Change 2007: Synthesis Report*; and Flannery, T. (2005), *The Weather Makers: Our Changing Climate and What it Means for Life on Earth*.
22 See IPCC (2007) *Synthesis Report*, and Flannery (2005). Adding to the problem that climate change is occurring faster than many plant species can naturally migrate, the vast areas transformed to suit human purposes (e.g. urban sprawl, mono-cultured croplands or planted forests) interfere with the routes by which animal and plant species would attempt to migrate. This makes localized species extinction far more likely.

23 Eventually (e.g. over millennia or longer) new synchronizations will be established, of course, but meanwhile humans will live surrounded by an ever more diminishing natural ecology.

24 In the interim, of course, river flows may increase due to accelerated melting of long ago accumulated snow and ice.

25 UNEP (2007) *GEO-4*.

26 UNEP (2007) *GEO-4*. The difference is made up by mining 'fossil' groundwater or with energy-intensive water imports.

27 UNEP (2007) *GEO-4*.

28 Lovelock (2009) argues that dealing with climate change refugees will be among the major challenges facing those places that are spared the worst effects of climate change. J. Sachs (2008) and Flannery (2005) also note the likelihood of such developments.

29 See for example Flannery (2005); Hansen, J. *et al.* (11 Mar. 2009) *Air Pollution Climactic Forcing with the Big Climate Picture*; and Ekman, B., Rockstöm, J., and Wijkman, A. (2008), *Grasping the Climate Crisis*.

30 See for example Flannery (2005); Speth (2006); and Lynas, M. (2008), *Six Degrees: Our Future on a Hotter Planet*.

31 With higher acidity, carbon is less available to marine organisms that use it to build their shells, with the vital coral reefs being particularly hard hit.

32 See for example, Flannery (2005); Hansen, J. (2007), 'Huge sea level rises are coming—unless we act now'; Hansen, J. (2008), 'Twenty years later: tipping points near on global warming'; and Lynas (2008).

33 See for example, Flannery (2005); UNEP (2007) *GEO-4*; Tickell, O. (2008), *Kyoto 2: How to Manage the Global Greenhouse*; and Lovelock (2009).

34 What was so frightening about SARS was the extreme uncertainty with regard to what was safe behaviour and what was risky. The Spring 2009 human-swine flu epidemic, while not particularly virulent, seemed able to re-emerge suddenly in ways that suggested relatively easy (if sporadic) human-to-human transmission.

The 1918-20 influenza pandemic killed tens of millions of people out of a world population about a quarter of what it is today. And,

in an age before widespread air travel, it spread (over two years) to almost every part of the globe.

35 Blasing, T. J. (2009), 'Recent greenhouse gas concentrations', *Carbon Dioxide Analysis Information Center*, <http://cdiac.ornl.gov/pns/current_ghg.html>.

36 It should be noted the picture is quite complex. While the *net* cooling effect of atmospheric pollution is established, different parts of the pollution mix have different effects. For example, while sulphates and some other pollutants do have a substantial cooling effect in the atmosphere, 'black carbon' (soot) which also tends to be part of ABCs is a warming, not cooling, agent.

37 In order for carbon capture and sequestration for coal power plants to be widely applied, it probably cannot depend on injection of CO_2 as a gas or liquid underground or into deep ocean currents. Suitable locations are too limited for that. Locking the carbon in a solid that could be buried would make CCS far more widely applicable. Such systems are technically feasible but are energy intensive (as are those for gaseous and liquid state storage) and have not yet been demonstrated on a large scale.

Research and development on a range of approaches to CCS is being vigorously pursued. If and when practical systems are developed, to be able to contribute substantially to meeting carbon reduction targets, CCS would then need to be adapted with unprecedented speed for a capital-intensive technology.

38 Speth (2008).

39 See for example, GreenHouse Gas Online, 'Methane Sources—Rice Paddies' *Methane: Sources, Sinks and Science*.

40 Reducing the number of ruminant animals, especially those raised in high density factory farming systems, would probably be the initial target in reducing food-based methane emissions, in part because meat is an highly inefficient use of resources to produce edible food (unless it is free range grass fed). For both ruminant livestock and paddy rice, the methane intensity of production depends on the particular techniques employed. Research on these matters has been on-going since the early years of concern about GHG emissions.

41 Though at considerable cost in planned obsolescence and with the creation of excessive toxic waste.

42 Nonetheless, this cannot continue forever, and probably not past mid-century, if that long. Demand for petroleum products has been rising too fast, while for the past several decades, new discoveries have been too few and small to keep pace. Through technological advances which allow extraction of more of the oil in a reservoir and by drawing down existing reservoirs, we are not yet 'running out of oil'. Yet unless the use of petroleum products is drastically reduced, that day will surely come within the lifetimes of children alive today. A useful book on this topic is Deffeyes, K. (2005), *Beyond Oil: The View from Hubbert's Peak*.

43 With plentiful, cheap energy, desalination of seawater and the ability to pump it far inland becomes feasible, as does more extensive and repeated recycling of metals. And if the energy source we rely on does not emit greenhouse gases, then climate change becomes potentially much more manageable (though not necessarily resolved).

44 Wilson (2002).

45 See for example, UNEP (2007) *GEO-4*; Wilson (2002); and Chivian, E. and Bernstein, A. (2008), *Sustaining Life: How Human Health Depends on Biodiversity*.

46 In other words, resources for which we cannot find a substitute. This is a point stressed in Hawken, P., Lovins, A., and Lovins, L. H. (1999), *Natural Capitalism: Creating the Next Industrial Revolution* with regard to the inadequacy of artificial substitutes for a number of key services provided by the natural environment.

47 Chronic air pollution in many cities and the build-up of toxic residues contaminating rivers may be thought of as sinks becoming clogged when we dump more waste into them than the natural cleansing mechanisms (e.g. winds and the flow of water) can adequately dilute. Likewise while the oceans and forests provide sinks for absorption of significant amounts of carbon dioxide, when carbon dioxide emissions are high enough, these sinks become overwhelmed and the excess carbon dioxide builds up in the atmosphere.

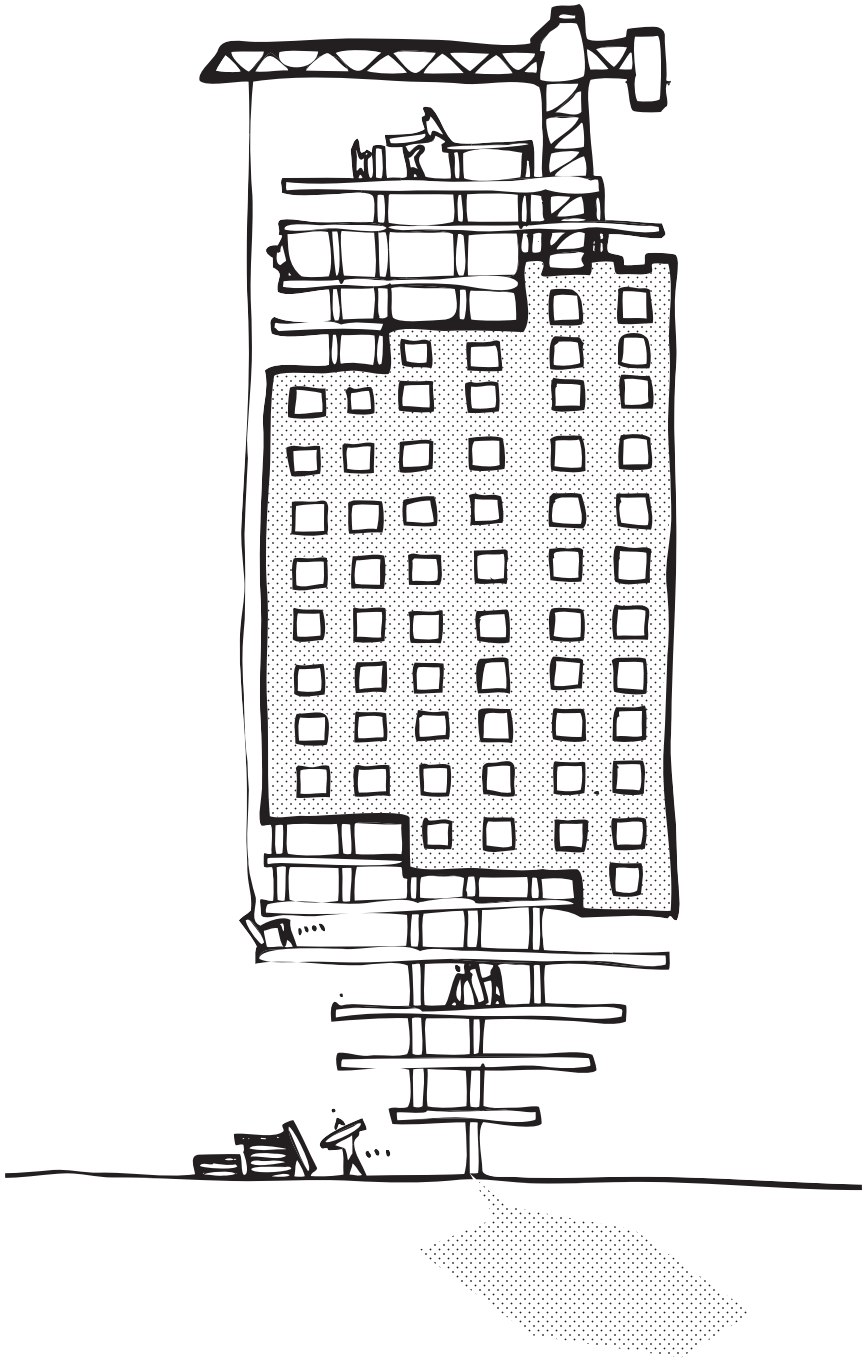
48 For example, depletion of 'fossil' groundwater to provide drinking water to so many of the world's cities and to irrigate crops in arid climates.

49 For example, the destruction of estuaries, and with it reduction in future fish stocks, may lead to costly and environmentally-damaging *fish farming* to partially make up supplies. Likewise when we drain and develop natural wetlands, (e.g. along the Yangtze River; see Wu, D. (2004), *Evaluation on Flood Control System of Yangtze Basin*), we lose the associated flood control potential and must try to make up for the lost natural flood services as best we can with constructed dykes and levees.

50 Under standard discounting calculations, long-term environmental damages have little in the way of a 'present value'. To illustrate, at a modest 4% discount rate an environmental damage to be faced in 50 years (i.e. in the middle adulthood of young children alive today) has a present value only 14% of the value we would place on that damage if *we* had to bear the consequences today. This point is considered further in Annex A.

51 In other words, instead of a paying more for something with a long useable life, we buy the cheaper alternative, use it for a short time, discard and replace it. When enough buyers show such a preference, over time the market tends to withdraw the more durable option. Planned obsolescence (e.g. for personal computers or other forms of telecommunications) presents another obstacle to getting off the treadmill of excessive throughput.

52 Points along this line are sometimes considered under the heading of *'sufficiency'*. See for example, Porritt, J. (2005), *Capitalism as if the World Matters*; and Sachs, W. and Santarius, T. (2007), *Fair Future: Limited Resources and Global Justice*.



II. THE DRIVER

NO RETURN

In 2008, the world economy suddenly lurched from relatively prolonged expansion to steep contraction. In an effort to offset the dramatic fall in private consumption, governments around the world formulated stimulus packages pledging to inject *trillions* of dollars to get their economies 'back on track'. While much is made of directing part of such stimulus to 'green investments', the ultimate purpose of the spending is to increase consumption.[1]

At the time of this writing (mid-2009), few if any governments have openly paused to ask, 'should we return to the way things were?' Yet, this question begs to be asked when we consider:

1. Already by 2003 the average person on Earth imposed an ecological footprint that exceeded by about one quarter what the planet renewably produces of these resources;[2]
2. Climate change is occurring faster than expected, particularly with respect to melting of ice in the arctic.[3] Meanwhile carbon dioxide emissions have been rising faster than expected until the recession of 2008 slowed the rise;[4] and

3. As stressed by a variety of climatologists, economists, biologists and environmental policy analysts,[5] returning to the pre-mid 2008 economic growth trends for as little as another decade or so would result in a permanently impoverished natural world, while also creating a very substantial risk of locking the planet into climate change of catastrophic proportions.[6]

The driving force behind the unsustainable exploitation of the biosphere and looming climate change is an excess (no other word for it) of material consumption; too many people consuming too much 'stuff' while generating far too much waste. As Jeffrey Sachs (2008) puts it, 'the planet has filled up with people and economic activity much faster than we have realized'.[7]

In reducing such excess, widespread use of 'green' technologies will help, but the world must go much further. This is especially true if the 'development imperative' in lower income economies is to be reconciled with the need to drastically reduce *overall* planetary resource use.

The first step is to explicitly acknowledge that the task at hand today is *not* to get 'back on track', but to 'change tracks'.

As far as possible, the economic stimulus funds would be better directed toward:

1. an increase in the provision of services (e.g. education, health care, information technology);
2. an increase of qualitative improvements (e.g. a more efficient and cleaner built environment via better infrastructure for energy, water, and transport), and intangibles (e.g. fostering creativity and stronger sense of community); and
3. an emphasis on quality, durability, and safe disposability or reuse for what we do consume materially.

Each of the points above will require a retooling of production, and in their own way would generate considerable economic value.

Failing to get off and stay off the throughput economy risks physical calamities compared to which any financial meltdown would pale to insignificance. As outlined in Chapter I, while uncertainties remain, the best current science tells us that the above statement is not hyperbole.

While recessions slow the pace of environmental damage, we cannot be lulled into believing we have enough time to deal first with the economy and then face up to sustainability challenges. Indeed, lower prices, especially for energy, risk luring consumers back to profligate ways and turn the market away from capital-intensive environmentally-friendly investments.

As noted, a broad consensus among those concerned with climate change and the state of the biosphere is that the world has years—not decades—to fundamentally redirect the economy and with it modern lifestyles.

> **This is not something that can be put off until it is convenient to deal with. The fact is: *the planet does not negotiate.***

To put the matter bluntly, from a sustainability standpoint, perhaps the best scenario is one in which the current effects of climate change or biosphere degradation become sufficiently visible, that they grab (and hold) the world's attention.[8]

FEEDBACKS AND ENTANGLEMENTS

Consider how the world economy got into its current predicament. In the first half of 2008, the prices for petroleum and other commodities rose to unprecedented levels as the global economy surged. Riding the crest of the wave were the newly industrializing economies, led by China, India and Brasil.

But by mid-2008 commodity prices had plummeted as the global financial system imploded, in turn sending the world economy on the steepest decline since the great depression of the 1930s.

So what drove the wild swings? While the world economy is a highly complex system, it is possible to sketch the broad outlines of how the 're-setting' occurred.

Simply stated, the recent steep rise in commodity prices stemmed from demand rising faster than supply could expand. Demand for petroleum and many other commodities climbed as the large, fast-growing economies of China, India, and Brasil along with a few others such as Mexico sought raw materials to supply strong demand for their exports. These exports were sent largely to higher income economies, where, buoyed by rising asset prices (homes, the stock market), consumers felt increasingly wealthy and spent accordingly.

In addition, several hundred million people in the emerging middle classes of the newly industrializing economies began taking on aspects of the resource-intensive lifestyles long enjoyed in higher income economies.[9] This directly added to existing consumer demand in the higher income economies, with its knock-on effects for demand for petroleum products, food, metals and other commodities.

Because the supply infrastructure for many such commodities is capital-intensive, it takes time to expand output potentials. Prices go up in order to ration supply shortfalls. Crucially, into early 2008 speculation generally

weighed in the side of a continuing strong world economic growth, meaning that the supply situation for many commodities could be expected to remain tight. Some major customers (e.g. airlines) used futures markets to lock in historically high fuel prices, fearing even worse to come.

But then, beginning with defaults in the United States housing market, credit risks began to loom large. And for a staggeringly diverse set of credit instruments, the risks soon proved to be far more interconnected (and murky) than almost anyone had appreciated. Lenders around the world found they had taken on risks they had only dimly been aware of, if at all. 'Toxic assets', it turned out, were embedded throughout the world's financial system.

A pervasive sense of uncertainty spread through the financial sector, breeding wariness on the part of lenders. Credit (often called the 'lubricant' for the engine of the modern economy) began to dry up. Those dependent on revolving loans to finance on-going operations were hit hard. With financing tight, economic activity slowed.

Within months, one economy after another slipped into recession. As the downturn began to deepen into the largest one since the 1930s, it became apparent that not only prices for commodities and housing, but asset prices generally (e.g. stocks), had been buoyed by the expectation of continuing economic expansion.

In the modern market economy most demand is not about satisfying basic 'needs', but rather about fulfilling discretionary 'wants'.[10] The ability to satisfy wants can change dramatically with the availability of credit. The willingness to satisfy wants shifts with changes in income, the perceived security of future income, and consumers' overall notional wealth.

When asset values are high and rising, consumers tend to spend a higher fraction of current income and borrow against accumulated notional wealth (as measured by prevailing market prices for things they own). When asset prices fell, those who had thought themselves financially secure (and spent accordingly), were left to ask, 'what are my assets really worth?' When the answer is unclear, no one has to remind us of the discretionary nature of so much of our expenditure. Consumers switched from being relatively free spending to frugal and made the switch in what seemed not much more than an economic heartbeat.

Many of us may like to believe there is a 'true' underlying value for physical assets like property, raw materials, and finished products, and even for things less tangible such as knowledge, experience, and talent. In other words, we want to believe they have an intrinsic value because of their usefulness or desirability.

A growing economy, where demand keeps pressing up against supply, reinforces such beliefs. For example, when banks aggressively encourage people of quite modest means to buy a home, and a broad spectrum of prospective buyers come to see property as a long-term hedge against inflation, home prices are bid up. If this phenomenon lasts long enough, many homeowners come, not surprisingly, to believe that a home as a durable asset, will always be in sufficient demand that it represents a low risk investment.

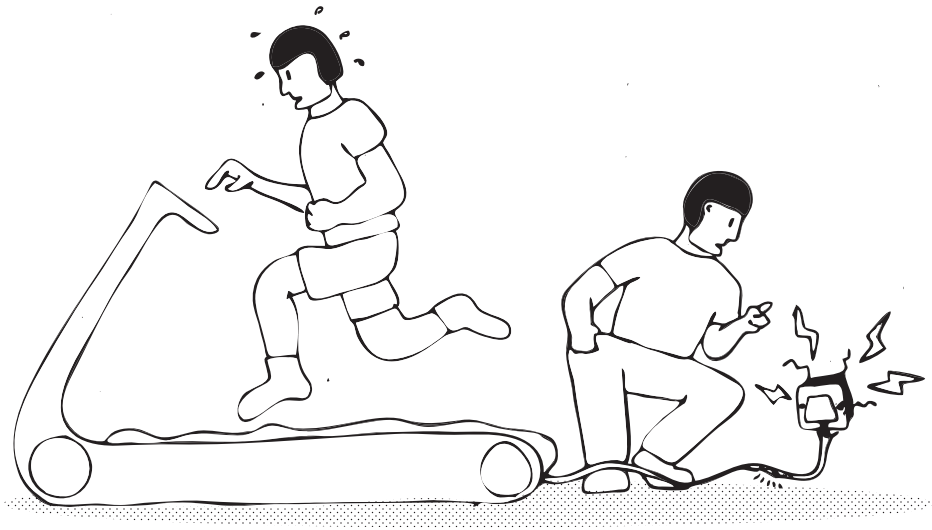
Yet, no matter how useful or desirable a home might be, at any time what it sells for depends on what bidders offer. And what bidders offer depends on the availability of credit and how many choices they have. When access to credit tightens, the currently available supply of a wide range of things is soon in excess of current demand.

When this becomes evident, prices tend to fall as those who need to sell willingly forego part of the extraordinary profits they had hoped to enjoy. Crucially, if speculation now weighs in on the side of further contraction, buyers begin holding-off in the expectation of lower prices to come.

RUNNING ON RELENTLESS CONSUMPTION

The dominant view in economics has long been that wants are unlimited. As the popular introductory economics textbook by Samuelson and Nordhaus (1989) succinctly put it, 'higher incomes bring in their train higher consumption standards and ever [emphasis added] higher "needs"'.[11]

By implication, economies are naturally geared to grow (expand) without end. Recent economic swings reveal how fundamental relentless throughput[12] has been to commodity and asset valuations. When no longer propped up by a rising, or at least firm, demand, market values fall.



In the most widely used measure of economic performance, Gross Domestic Product (GDP), success is gauged by increases in the value of what is bought and sold in markets, regardless of whether it is something desired or instead represents a defensive expenditure to limit harm. For example, money spent for medicine adds to GDP, but doing exercise to promote good health does not, unless it involves spending money (e.g. for gym membership or running shoes).

Nor does GDP reflect un-priced damages that economic activity often inflicts on the regenerative capacity and stability of the environment. For example, the value of something like a standing forest is not reflected in GDP figures until it is cut down and sold. The environmental service value of a standing forest for protection against soil erosion and the consequent accelerated silting-up of a downstream reservoir is ignored in GDP figures *until* defensive expenditures are incurred to deal with the damages resulting from removal of the forest (e.g. due to the newly created need to dredge the reservoir more frequently). The value of the standing forest in providing a viable habitat for a large number of species is likewise ignored in calculations of GDP.

Nicholas Stern (2005) in his review of the economics of climate change notes that the fact that market prices do not account for the impact on climate of GHG emissions presents 'a unique challenge for economics: it is the greatest and widest ranging market failure ever seen'. [13]

Markets rely on price signals. When such signals are absent, as in the case of GHG emissions, markets fail in their primary role in bringing about an efficient allocation of resources.

Yet, as important as it is to recognize this massive market failure, correcting prices to reflect environmental impacts would only take us part way.

We also need to question the presumption of supposedly unlimited wants and 'needs'.

Perhaps more to the point, we need to challenge the importance attached by politicians to unending increases in the volume of things marketed, while attaching much less significance (or simply ignoring) things that are un-priced.

To question the need for relentless growth and an almost exclusive focus on values expressed in monetary terms is not as new as we might think. In the eighteenth century none other than Adam Smith argued that human welfare was not maximized through having ever-more material goods (most of which would be bought in the market). Instead, he stressed that once basic needs are met, the well-being of the population is primarily a matter of the un-priced quality of people's social relationships.

For Smith, an important purpose of an economy's output of material goods beyond what is needed for meeting basic needs is to allow a country to defend itself and so maintain the independence and freedoms of its people. The inability of the eighteenth century Native Americans' economy to do that provided Smith with a cautionary tale.[14]

Speth (2008) points out that both John Maynard Keynes in the 1930s and John Kenneth Galbraith in the 1950s questioned not only the practicality of endless economic expansion, but its very appropriateness as a goal.[15]

In his book *Happiness: Lessons from the New Science*, Richard Layard (2005) notes that once basic needs are met, happiness does not grow proportionally with increases in income. Further, the initial increase in one's sense of well-being that accompanies increases in wealth quickly dissipates. In short, societies that provide the most material goods do not necessarily deliver the greatest happiness.

As we come up against planetary boundaries, we should recognize that maintaining high material throughput in our lives is not only counterproductive from a resource standpoint, it is arguably misdirected with respect to quality of life.[16]

THE DEVELOPMENT IMPERATIVE

The development imperative comes first and foremost from the fact that almost half the world's population still lives on less than US$2 per day.[17] In other words for nearly one of every two people alive today, meeting basic material needs is a relentless daily struggle. If moral considerations count for anything, the call for further development in the lower income economies is not something that can simply be postponed indefinitely while higher income economies struggle to pull themselves back within planetary boundaries.

When the world economy drastically reduces GHG emissions (initially though much higher prices for fossil fuel-derived energy), the burden cannot be shared equally. This point is embodied in the principle of 'common but differentiated responsibilities'.[18]

Yet, as evident in the disagreements over the treatment of developing countries under the Kyoto protocols and the on-going debates about the post-Kyoto regime from 2012 onward, the world has yet to find a consensus on what 'differentiated responsibilities' means in practice. The 'in practice' part will need to be decided not only with respect to income differentiated responsibilities for carbon dioxide reductions, but also with respect to the allocation of the large sums that would be generated by either a globally

applied carbon tax or the auctioning of carbon emission permits, along with other equity-based steps such as transferring low-carbon production technologies under preferential terms to newly industrializing economies.

In Asia it is often noted that further development is not so much a 'goal', as it is an 'imperative'.

For example, China sees the need to maintain high levels of growth until at least 2050. Hu (22 May 2009) notes that even with substantial improvements in energy efficiency, in order to satisfy the vast unmet material needs of its population, China will continue to increase its carbon dioxide emissions until at least 2050. Hence, she notes, it will likely remain the world's largest emitter for decades to come. Such increases in total emissions must, Hu stresses, be viewed in the context of China's still low per capita carbon emissions compared to those of other major economies.[19]

The particular impetus of the development imperative in Asia stems in part from the fact that as many as half a billion of its people have recently moved out of poverty to join, to some degree at least, the world's 'consuming' classes. This large and increasingly influential emerging middle class naturally wants to retain what was so recently and so hard won.

Indeed, the rise in income in China, and to a lesser extent India, has been so great that it represents a narrowing of the wealth gap with older industrialized economies.[20]

From the 1990s onward, each successive year of high economic growth reinforced expectations in the newly industrializing economies that this was only the beginning of a long-term (and perhaps permanent) process.

Indeed, throughout much of the region, expectations are palpable that a materially better future is on the way.

For the vast majority of Asians, prosperity has been, of course, far more modest. Yet many of the poor also benefited from labour-intensive work that, despite the poor working conditions, offered wages high enough for a worker or a young couple to provide for the basic needs (and some luxuries) for an extended family (often left back on the farm).

What was also evident, including to many of those left out of the new economy, was a highly visible and very rapid expansion in infrastructure (e.g. roads, water and electricity supply systems, and telecommunications). Alongside these has been the equally visible growth of supply chains to feed not only the rapidly expanding local manufacturing and services economies, but the fast

growing local consumer economy as well. Such evidence further reinforces the sense in much of developing Asia, that the world would, from now on, gradually become a materially better place for ever more people.[21]

Such expectations are backed-up by increasing economic clout. In the current economic slowdown China is looked to as an engine of growth for the world economy. Its government will command a major place at the table when the world's economies decide how to deal with the coming environmental challenges.[22]

The notion that the planet cannot continue to support resource intensive lifestyles for large numbers of people may seem to many in the newly industrializing economies (and perhaps to some in their governments) as little more than a cynical attempt to change the rules just as they were beginning to win.

One approach to addressing *intra*-generational equity issues that also takes account of *inter*-generational concerns is to allocate rights to further GHG emissions on a per capita basis while also taking into account who historically used up the CO2 absorptive capacity of the atmosphere.[23] In effect, this would mean that higher income economies would be carbon emission debtors, while lower income economies would be their creditors.

Like Stern (2008), Pan and collaborators (2008) propose a carbon emissions goal that would reduce emissions to about 50% of 1990 levels by 2050. Pan et al. propose to allocate this budget on the basis of national per capita cumulative emissions.[24] Baer et al. (2008) propose something similar, but would base allocations on the proportion of a nation's population living on less than about US$16 per day (purchasing power parity adjusted).[25]

Under either Pan et al. or Baer et al., most higher income economies will have already used up their entire carbon budget, while most developing economies would still be in surplus. This fact, both sets of authors argue, establishes the basis by which those who have used up their budget would need to bid for part of the surplus budgets held by lower income economies. In effect, there would be massive capital transfers from higher to lower income countries as former are forced to buy carbon emission rights from the latter.

Most fundamentally, such calls represent an attempt to firmly link efforts to begin living within planetary boundaries with equity considerations.[26] As outlined by Wang (2004), this call for putting equity in the forefront has a number of legal dimensions, including: (i) allocation of responsibility (or more bluntly, 'blame'); (ii) how entitlements are to be distributed; and (iii) 'comparative equity' (how what one party is asked to do compares to what others are asked to do).

In contrast to Pan et al. and Baer et al., Oliver Tickell (2008) believes that the matter of historical emissions should be put aside, arguing that it is the current generation that is mostly responsible, and even more important, is the only generation fully aware of the consequences of its GHG emissions. Hence, he reasons, the current generation alone should be held accountable. Tickell proposes selling all permits on the basis of uniform price sealed bid auction subject to a reserve (floor) price and ceiling price. He does, however, recommend that funds from the auction be disproportionately allocated to lower income economies to help them adapt to climate change, and to fund investments to move these countries toward less carbon intensive economies.

> **At this stage it seems likely that a pre-condition for countries like China, India, and Brasil to agree to serious cut backs in their own GHG emissions would be for higher income economies to make greater sacrifices commensurate with their greater wealth and longer history of GHG emissions.**[27]

In addition, on the financial side there is a strong case to be made for assistance (in the form of technology or capital transfers) from higher income to lower income economies to help ease the pain of the transition to the low carbon economy, as well as to help fund adaptation

measures. Without some form of significant equity-driven 'differentiated responsibilities', climate change mitigation efforts will surely be further delayed and could well flounder as the window of opportunity for acting continues to narrow.

> **While it is difficult to argue against a prominent place for equity considerations in climate change debates, what cannot be allowed to happen is for *intra*-generational equity issues to derail the transition to a low carbon economy to the point where future generations pay a very high price (i.e. where *inter*-generational equity is sacrificed in the name of better *intra*-generational equity).**

Although a number of governments of higher income countries in the run-up to the December 2009 Copenhagen climate meetings are speaking of making commitments to GHG emission reductions, these are often framed as something for a decade or more in the future (e.g. 2020 or 2025), with only far smaller steps promised for the interim. Meanwhile, as noted, higher income economies have yet to agree in principle to undertake major income transfers to the newly industrializing economies or the developing world more generally as part of a future GHG control regime.

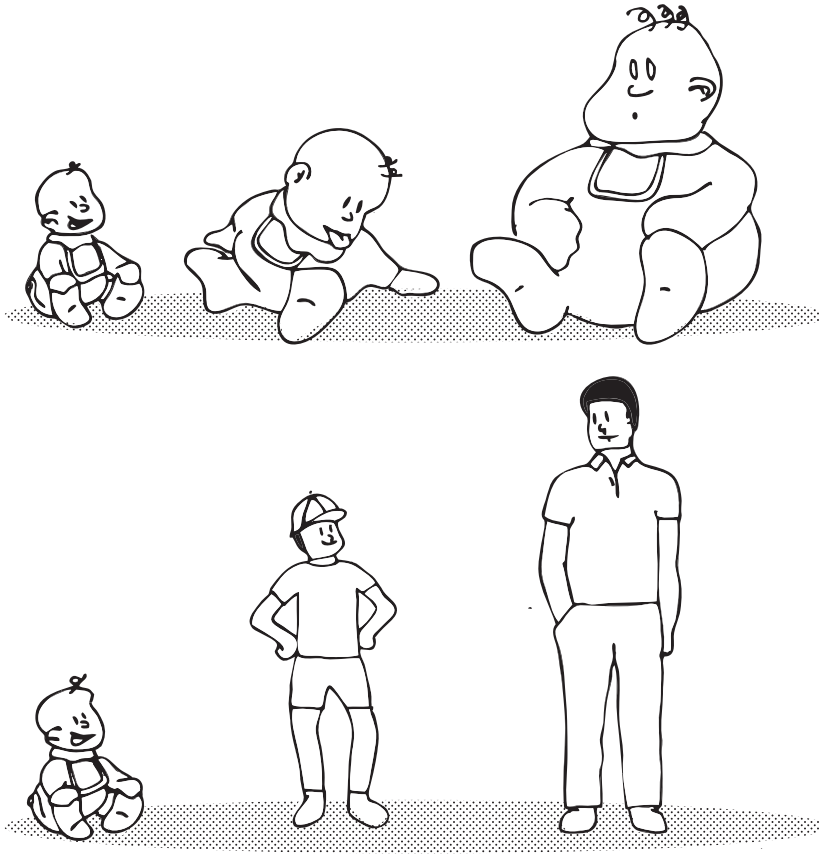
Meanwhile, GHG emissions continue to rise, and world population growth, while slowing, continues to add nearly 80 million people (four and a half times the size of the mega-city of Shanghai) *each year*.[28]

Strains on the planetary resource base are such that even with advancing technology, it is becoming increasingly difficult to imagine how these ever-rising demands can continue to be met for much longer.

The potential for climate or biosphere-related disruptions severe enough to shake the foundations of civilization, possibly starting before the end of this century, are being put forward as entirely plausible (and even likely) scenarios.[29] While the poor are most vulnerable to disruptions, natural or artificial, the entire population of the Earth would be seriously affected. The conclusion seems inescapable:

Clearly, if further 'development' is to be possible, it must be re-defined in way that distinguishes it from 'growth'.

DEVELOPMENT VERSUS GROWTH



One inevitable part of the response to the challenges of sustainable development must be to emphasize the importance of 'development' as qualitative progress, and move away from the pursuit of growth as quantitative expansion.

By analogy, we might think of the development of a child as distinct from its growth.

A child who merely grew in size, but did not develop his or her intellect, talents and personality would be seen as an abomination.

What might such qualitative progress, as distinct from mere quantitative expansion, look like? At its broadest, it would seek to provide a higher quality of life with far less material throughput.[30] Hawken, Lovins and Lovins (1999) stress it should involve not only greater efficiency in materials and energy but a greater recognition of the importance of the ecological services provided by natural capital. We inherited a substantial legacy in this respect, but have been squandering that legacy as if it cannot be exhausted. In 'a more developed' rather than simply larger economy, ecosystem services would be protected (and as feasible, enhanced) and the value of ecosystem services would be explicitly accounted for when measuring the well-being of the population.

There will, of course, also be sacrifices. Efficiency comes at a price. The very fact that so much material need still goes unmet in the world (e.g. for safe drinking water, health care, adequate diet, and access to electricity) means that sacrifices cannot be shared proportionally. When the world community decides to use much less fossil fuel, cut down fewer forests, till soil in ways that release less carbon dioxide, pump less groundwater, raise

fewer ruminant livestock, harvest fish more sustainably, and so on, the onus must fall most heavily on those who can most afford to sacrifice.

As the world cuts back in various ways, the proportion of on-going activities devoted to meeting basic human needs should go up. This will need to be true not only for dealings between higher and lower income economies, but also within economies. In other words, equity is not only a matter of income differences between countries but also for the populations within a country. Some of the poorest countries have the least equitable sharing of income.[31]

Obviously, statements like those above carry not only the potential for considerable wishful thinking, but the spectre of social engineering. A number of the authors cited in this book[32] have attempted to lay out ways in which such aspirations might be pursued while not unduly infringing on freedoms.

The task all societies will face is to somehow promote as good a quality of life as possible, even while vastly lowering total fossil energy use and the unsustainable exploitation of biological resources. The ways this might be attempted (and what will prove to be most workable) will vary from one society to the next and indeed from one individual to the next.

Resource-intensive lifestyles with high throughput are something many of us took for granted our entire lives, that hundreds of millions in newly industrializing economies have begun to acquire, and billions more aspire to.

Yet based on what we know today, such lifestyles are not so much the probable future for an ever-larger proportion of humankind, but rather are to be a transitory phenomenon nearing its end.[33]

Severe pressures on the resource base, the clogged sinks for wastes (including GHGs), and the ability of the stressed biosphere to provide essential environmental services would have soon come up against planetary boundaries even without the rise in consumerism among the expanding middle classes of the newly industrializing economies. Their rise simply makes the limits of the current growth-led model more evident and brings nearer the time when the global economy encounters limits not readily circumvented.

This is not to say the world must live in poverty.[34]

Rather, it is to say that if we are to avoid passing on a materially impoverished world

to the next generation and beyond, we must be far more frugal, efficient, focused on quality rather than mostly on quantity, and re-evaluate what constitutes the good life.

Yet in a world of diminishing resources (e.g. water, energy, food), as well one with a very large number of climate refugees, we also need to face squarely the prospect of major conflicts. To minimize such prospects will ultimately require redefining ownership and access rights to the planet's stock of common property resources. Investigation of such issues in any depth would be a major undertaking in itself and is not explored here. Yet, the essential point is quite simple. If, in a more materially constrained world, we continue to strive for quantitative economic expansion rather than on quality-focused development, prospects for minimizing conflict are bleak indeed.

FLUID ECONOMIES AND PROACTIVE GOVERNMENTS

In times of crisis, governments much like individuals tend to focus on immediate problems and attempt to address them using familiar approaches.[35] In other words, the initial crisis impulse tends to be a conservative one: seeking to regain what was lost, not create something new. For both the higher income economies and the

newly industrializing ones it may take repeated (or much deeper) crises than ones experienced so far to elicit true interest in new goals and new means for attaining them.

Although abrupt economic re-settings are painful, the very speed and depth of the shifts of 2008 and 2009 serve as reminders that even large economic systems can be quite fluid.

In light of what is outlined above, this could prove crucial to our future.

Considering the challenges to sustaining the current types and levels of economic activity, we might take comfort in noting that we are less locked-in than we thought. When governments believe a major crisis is truly at hand, they are capable of bold and decisive (if not necessarily always appropriate) action, and consumers sometimes voluntarily decide that having less material throughput in their lives simply makes sense.

So if there are prospects for eventually re-thinking the goals of the economy, what type of considerations would that involve? Some basic ones are noted in Chapter III.

CHAPTER 2 NOTES

1 In China, for example, the government talks about investments to promote energy efficiency while at the same time helping rural households to purchase flat screen televisions, other consumer items, and motor vehicles. The Chinese stimulus funds were also pumped into resource-intensive sectors such as steel, automobile manufacturing and petrochemicals (Wang, J. (2009), '7b yuan subsidy for appliance, car purchases'). In the United States the stimulus packages put forward included 'green investments (e.g. to upgrade the power grid so wind and solar from thinly populated areas can be transmitted to more heavily populated areas), along with efforts to prop up automobile manufacturers and to encourage banks to lend to encourage consumer spending.

2 In other words, it is not only a matter of some groups (e.g. 'the wealthy') taking more than their fair share. The *sum of shares* being taken is greater than what the planet renewably provides. Humankind makes up the deficit by consuming natural capital. Extraction of the biological resources on which we depend has been greater than regeneration since the late 1980s. See Speth, (2008) and Wilson (2002) for the broader implications and for details see Global Footprint Network, <http://www.footprintnetwork.org/en/index.php/GFN/>.

3 Peterson, G. (15 Feb. 2009), 'Chris Field says rate of climate change faster than estimated'.

4 See for example, Harris, R. (29 Jan. 2007), 'Conference focuses on speed of climate change'; Associated Press (26 Sep. 2008), 'World's carbon dioxide emissions rising at "scary" rate'; and Netherlands Environmental Assessment Agency (25 Jun. 2009), *Global CO_2 Emissions: Annual Increase Halves in 2008*.

5 For example Stern, N. (2008), *Key Elements of a Global Deal on Climate Change*; IPPC (2007); Speth (2008); J. Sachs (2008); Wilson (2002 and 2006); and Lovelock 2009.

6 Stern (2008) for example argues that GHG emissions should peak as soon as possible and certainly must peak soon after 2020. From that point GHGs must fall dramatically until 2050.

7 J. Sachs (2008), p. 18.

8 By analogy consider two cancer patients. One feels no effects and the cancer continues to grow until it is difficult or impossible to treat. The other suffers noticeable ill effects in the cancer's relatively early stages, seeks a diagnosis and then receives timely treatment.

9 What is being considered here is not so much particular income strata, but rather first approximations of the number of households who have newly acquired considerable discretionary income (i.e. able to make purchases going well beyond the meeting of basic needs). Often the term 'middle class' is used, though quite loosely. Xin, Z. (2004) 'Dissecting China's middle class', reports that China in the early part of the decade had 50 million *households* (representing perhaps 150 million people) with annual income of at least US$9,000 and assets of at least US$37,000. This figure was expected to double by 2010 and in 2009 seems on track to do so. Presumably using a somewhat looser definition, Adler (2008) estimates that China *added* about 185 million people to the middle class between 2001 and 2007.

For India, Farrell, D. and Beinhocker, E. (2007) 'Next big spenders: India's middle class', put the size of the middle class at about 50 million people, while T. N. Ninan (2005) ['Middle class in India has arrived'], using what he calls a 'fairly loose definition' puts the Indian middle class at 300 million.

In Brasil, Eghbal, M. (2007) ['Brazil's new middle class has a growing appetite for consumption'] puts the middle class at 14 million households (representing perhaps somewhat more than 30 million persons), while Reuters (2008) [*FACTBOX: Brazil's new middle class*] notes that between 2005 and 2007, Brasil *added* perhaps 23 million persons to its middle class.

So, even allowing for differences in definitions, it is clear that in these three newly industrializing economies alone, several hundred million people were, in recent years, brought into some level of participation in a consumer society.

10 Even in the purchase of necessities, for all but the lowest-income buyers there is usually the potential for discretion with respect to quantity and quality.

11 Samuelson, P. and Nordhaus, W (1989), *Economics*, pp. 25-26. Samuelson and Nordhaus put quotes around the word *needs* presumably to imply that these may sometimes be more perceived than real.

12 The modern consumer lives a life not so much of high *consumption* as of high *throughput*. Even for something like computers and telecommunications that potentially reduce resource intensity, the prevailing business model is one of accelerated obsolescence and requiring replacement of entire units, rather allowing ready replacement of parts that wear out or become outdated. This not only leads to higher costs to users, but to the heedless generation of hazardous wastes.

13 Stern (2005), p. iv.

14 Hansen, M. (2008), *Note on Adam Smith as Theorist of Sustainability.*

15 Speth (2008) devotes an entire chapter to 'Consumption: Living with Enough, not Always More'. Jackson, T. (2009), *Prosperity without Growth?*, puts forward similar and somewhat farther ranging points in this regard.

16 Here again a caveat is needed. These statements refer only to consumption levels above what is needed to meet the essential material needs of *all* members of society so each can enjoy at least a minimally acceptable *material* quality of life.

17 United Nations Development Programme, United Nations Environment Programme, World Bank, and World Resources Institute (2005), *World Resources 2005*. See also, Sala-I-Martin, X. (2006), 'The World Distribution of Income: Falling Poverty and… Convergence, Period'.

18 For an introduction to this and other emerging principles of international law, see Cordonier Segger, M. C. and Khalfan, A. (2004) *Sustainable Development Law: Principles, Practices & Prospects.*

19 Among the governments of the world, the Chinese leadership is arguably among the most informed and accepting of the need for planet-wide reductions in GHG emissions. In light of this, one might interpret this position, as staking an equity claim for a larger *share* of any agreed-upon global GHG emission limits.

20 See, World Bank (2008), *2008 World Development Indicators*. However, as the World Bank stresses, exceptionally high growth in China and India distorts the overall picture for low income economies. In general 'low income countries did *not* systematically catch up with richer ones' (p. 5).

21 One indication of this confidence in the future is that in the first months of 2009 more automobiles were sold in China than in the United States.

22 Beyond the matter of China's new-found clout, Asian economies broadly are demanding to be a proactive and in some respects leading part of climate change negotiations and policy assessments. See for example, Loh, C., Stevenson, A. and Tay, S. (Eds.), *Climate Change Negotiations: Can Asia Change The Game?*.

23 Anthropogenic carbon dioxide emissions started rising in the mid 19th century, and then far more steeply from the mid 20th. Until the 1990s such emissions (at least from fossil fuels) were largely from today's higher income economies. Hence, the argument goes, higher income economies should be held accountable for past and as well as present carbon emissions.

Further, the planet provides natural 'sinks' (e.g. the oceans, growing vegetation, soils) for absorption of substantial (though finite) amounts of carbon dioxide. Because of these sinks, atmospheric carbon dioxide levels have not risen as fast as they otherwise would have. However, the sinks have become smaller due to acidification of the oceans (more acidic waters do not so readily absorb carbon) and the widespread loss of forests. In other words, when Europe, North America, and Japan industrialized in the late 19th and early 20th centuries the sinks were still working. But by the time the newly industrializing economies came into picture, the sinks had been considerably diminished.

24 Pan, J., Chen, Y., Wang, W. and Li, C. (2008), *Carbon Budget Proposal*. The authors would make allowances for the fact that carbon dioxide has a long but finite lifetime in the atmosphere. Emissions from decades long past would, in effect, be discounted.

25 Baer, P., Athanisou, T., Kartha, S., and Kemp-Benedict, E. (2008), *The Greenhouse Development Rights Framework*, (Berlin: Heinrich

Böll Foundation, Christian Aid, Ecoequity and Stockholm Environment Institute).

26 Such a linkage also underpins the work of other writers cited here, such as: Jackson (2009); and von Uexkull, J. (2009), 'From bubbles to living economies'.

27 While such a stance would likely be part of the negotiating position of newly industrializing economies, higher income economies so far have given no indication they would accept such terms.

28 For population, see, Levine, D., *World Population* <http://www.ibiblio.org/lunarbin>. For emissions, see Netherlands Environmental Assessment Agency (2009).

29 See for example, Speth (2008), Flannery (2005), Wilson, (2002), and Lovelock (2006 and 2009). And while his wording is less direct, quite dire warnings are implicit in Stern (2008) and (2005), *The Economics of Climate Change: the Stern Review*.

30 As considered in Chapter IV, we might think of this as involving a re-balancing of the material and non-material in our lives. For example, having more friends versus having more things, buying something well made that can be repaired and upgraded versus buying something poorly made and soon discarded, or having a more robust social contract that reduces the need for policing versus putting more police on the streets.

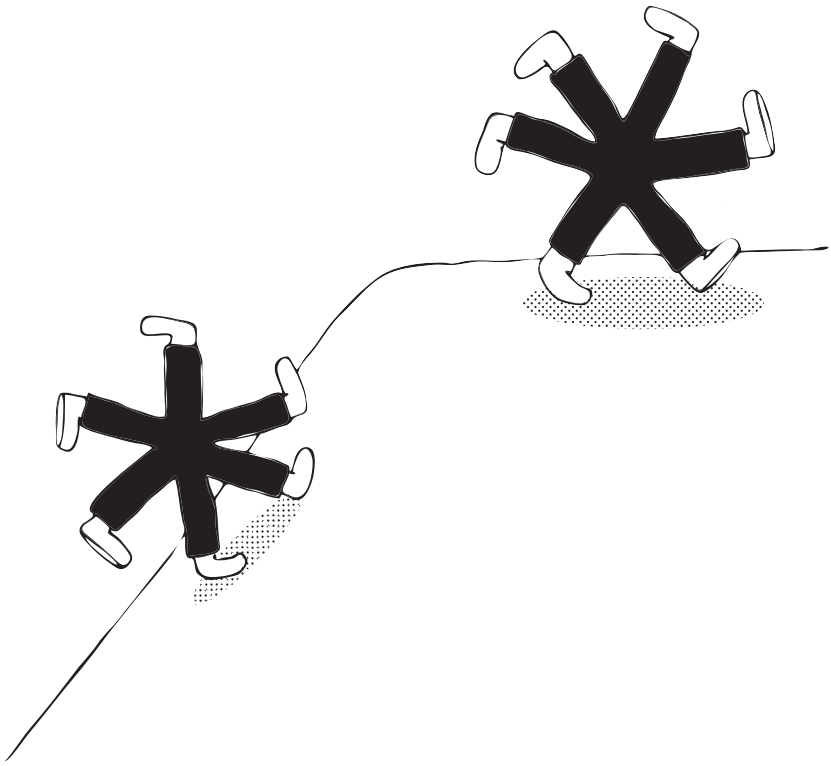
31 Baer, et al. (Nov. 2008) note that the allocation of GHG emissions rights should not be based strictly on national averages, but in a way that reflects the fact that many people in economies with low average income live lives closer to those in higher income economies, rather than what is typical in their own.

32 See, Speth (2008), J. Sachs (2008), Porritt (2005), and Flannery (2005). Others, such as Jackson (Mar. 2009) and von Uexkull (29 Mar. 2009), seem to have fewer reservations about a greatly expanded role for the state in people's lives.

33 Among the many voices warning of how we were risking the very future of humankind in our relentless pursuit of 'growth' defined as ever more *material* consumption are Wilson (2002 and 2006), Speth (2008), Lovelock (2006 and 2009), Hawken, Lovins and Lovins (1999), and Jackson (Mar. 2009).

34 While the authors have their own take on it this is a point stressed by Speth (2008), J. Sachs (2008), Stern (2005 and 2008), UNEP (2007) *GEO-4*, Jackson (2009), and Hawken, Lovins and Lovins (1999).

35 In one striking example, in early 2009 in the midst of the growing global economic slowdown, the Chinese government stopped calculating the cost of the damage done by pollution as it focused its efforts on stimulating consumption (Shi, J. (4 Mar. 2009), '"Green GDP" drive grinds to a halt').



III. SUSTAINABILITY & SUSTAINABLE DEVELOPMENT

WHAT CONSTITUTES A TRUE SUSTAINABILITY CONCERN?

It is difficult to argue with sustainability and sustainable development in principle. The adjective 'sustainable' (e.g. 'sustainable transport', 'sustainable cities', 'sustainable living') is sometimes added, it seems, to underscore long-term concerns, even if the details of what is meant by 'sustainable' in that particular case are not well defined.

For its part 'sustainable development' is widely acknowledged as an aspiration, even if we do not really understand how it might be attained. In other words, while the terms themselves are quite familiar, most people, including governments, probably know little about what they would mean in practice.

Considering carefully if a particular problem relates to sustainability and if so *how*, is essential to avoid being sidetracked by concerns that, while important, do not affect the viability of our way of life. Only then can decision makers and the public effectively engage in reasonably focused dialogue on how to move to a more sustainable path for development.

Here, sustainability or sustainable development[1] refer strictly to problems that—if left unresolved—threaten to either:

1. undermine the very functioning of society (*functional* sustainability); or
2. substantially diminish the quality of life (*qualitative* sustainability).[2]

With certain exceptions,[3] 'sustainability' and 'sustainable development' are applied here *only* to problems and challenges that are chronic (i.e. enduring) and pervasive, and not to ones that are acute (i.e. intense but intermittent) or localized.[4]

DISTINGUISHING SUSTAINABILITY AND SUSTAINABLE DEVELOPMENT

Sustainability is about being able to more or less continue what one has been doing (either in a broad sense or in specific ways). It is something we might wish for (or perhaps retreat to) when we feel we are doing reasonably well but see serious threats on the horizon. Sustainability in this sense might be conceived of as a form of steady state in which we seek to maintain an internal equilibrium in the face of anticipated changes in external conditions, much as warm-blooded animals that seek to maintain a

steady internal temperature in the face of changing outside temperatures, and do so by modifying their behaviour in response to changes in the ambient temperature.

In contrast, sustainable development is about continuing to *progress* internally in the face of changing external conditions. In seeking to develop sustainably we attempt to mould our strategies for improvement to reflect external conditions, not just as they exist today, but also by anticipating what we believe the external context will be out to the limit of our planning horizon.

Substitutions Are Key

To be sustainable or to develop sustainably in a world of tightening resource constraints requires on-going substitutions[5] in:

- technology;
- resources;
- the structure of economic activity;
- the composition of consumption; and
- values held (individually and collectively).

The potential for specific technological substitutions, obviously, is vast. What is stressed here is that in a world facing climate change and the unsustainable exploitation of the biosphere, there must broadly be substitutions of

efficient technologies for less efficient ones (i.e. so as to get more out of the inputs such as energy or materials). Another general class of substitutions is to move away from virgin resources to sustainably farmed biological resources, from newly extracted minerals to ones that have been recycled (as far as is feasible given energy requirements), and to use renewable energy.

Pricing what are now un-priced external costs will encourage useful substitutions. Once producers and their customers see something closer to true resource costs, they will tend to substitute away from products and processes which today appear inexpensive but are actually quite costly to society and to future generations (e.g. carbon intensive coal-fired electric power generation). Instead, they will select products and processes that are truly less costly when *total costs* are considered.

Yet even with less in the way of pervasive externalities, the coming resource constraints appear to be so great that consumers will need to rebalance the composition of consumption.

This will mean reducing the current focus on the quantity of material goods passing through our lives and substitute it with a greater emphasis on services, quality, and the non-material (e.g. social relationships).

Clearly, in order for this to be acceptable there will need to be a shift in values.

These points are explored in Chapter VII.

SUSTAINABILITY: HARD AND SOFT

Considering the role of substitutions in sustainability leads to the question of how particular types of substitutions affect our overall well-being. For example, if humankind comes to live more and more in enclosed climate-controlled environments because the outside environment is polluted and very hot, how does the value of what is lost compare to what might arguably have been gained (e.g. regulation of the local indoor climate)?

If one broadly feels that there is considerable potential to substitute something synthetic (by way of technology) in place of something natural, and that as a consequence the scope for substitutions is very large, that person takes a 'soft' approach toward sustainability. If, instead, one believes that synthetic substitutions tend to be inherently inferior, that person takes a 'hard' approach to sustainability.

At one end of the spectrum under extreme soft sustainability, some people might conceivably find it 'sustainable' for humankind to one day find itself confined to air conditioned cities under plastic domes

sitting as isolated habitable 'islands' in an unbearably hot or otherwise devastated natural environment, but having all the energy (nuclear fusion perhaps), food and other things they need, while travelling far and wide in a virtual sense, but being quite confined physically.

At the other end of the spectrum, under extreme hard sustainability one might take the view that cities are inherently unsustainable and, in so far as we need them, they should be small, built to minimize the need for heating and cooling, and be designed such that most inhabitants have no option but to walk or bicycle. In this world, urban dwellers would rely heavily on renewable energy, consume most of their food from nearby sources, and live as closely connected as possible with the surrounding countryside.

To take less extreme examples, consider the fact that only in quite isolated and specific places anywhere on Earth would a typical person from even a moderately wealthy society believe it was safe to drink from a stream he chanced upon. But if we can afford bottled water, have we, at the level of our own short-term well-being, really lost anything vital?

Likewise, again from a short-term individual perspective, which is better: being limited to foods locally in season, but fresh, flavourful, and free of artificial preservatives, or the ability to go to the supermarket any time of the

year and choose from a wide variety of fruits, vegetables or animal food products from around the world, albeit picked before they could naturally ripen and containing artificial preservatives? Many of us have gone from the former to the latter in our own lifetimes. This and similar examples make clear that we are quite used to a relatively soft approach to sustainability.

Still, it is important to ask, just how soft is it acceptable to go? Will human society grasp at whatever solutions technology might put forward (e.g. pervasive genetic modification of food, massive geo-engineering schemes to cool the Earth) so as to avoid, for a while longer, the need to change the lifestyles of the current generation? Many such options for an ever-softer approach to sustainability will be put forward in coming years, along with the admonition by their proponents that if such options are not taken up the alternative will be serious deprivation.

Yet it is possible that we instead collectively conclude that we have retreated far enough into artificial worlds of our own creation and accept that the ultimate solution lies less in technology and more in ourselves.

Chapter IV presents a framework considering the different ways in which we might respond, whether this be through a relatively hard or relatively soft notion of sustainability.

CHAPTER 3 NOTES

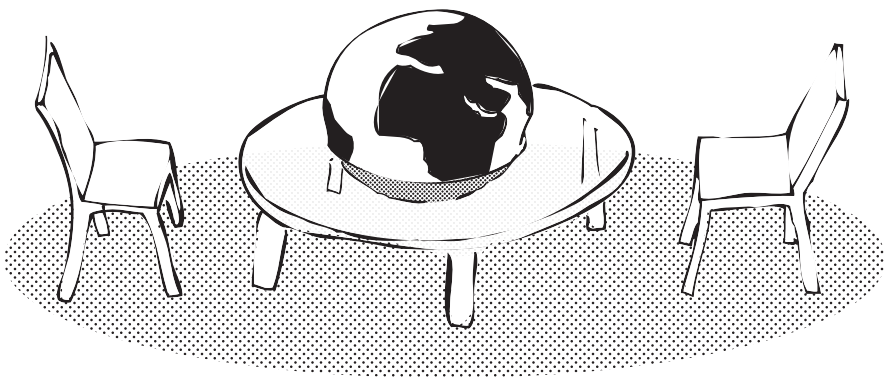
1 Later in this chapter distinctions are drawn between sustainability and sustainable development. The above points, however, apply to both concepts.

2 Functional sustainability is similar to Abraham Maslow's 'physiological' and 'safety' needs', the foundation levels of his five tier *needs hierarchy*. His three higher tiers, 'love/belonging', 'esteem', and the 'self actualization' (e.g. morality, creativity, problem solving), would come under qualitative sustainability (see Maslow, A., *Publications*, <http://www.maslow.com>.

3 One obvious exception would be a one-off truly devastating catastrophe.

4 For example, *periodic* episodes of poor air quality would only be a sustainability concern if they were severe enough to threaten the long-term economic or social viability of a society or substantially lower the quality of life for its members. By this standard, chronic very high air pollution levels in most major cities in mainland China would qualify as a sustainability concern.

5 By analogy, in walking we continually substitute one foot for another. While we are never more than one footfall away from falling flat on our face, walking is sustainable so long as we make the right substitutions at the right time. And not only can we walk but we can dance, skip, and run, all the while making the needed substitutions of being supported first by one foot, then by the other.



IV. RESPONDING TO THE CHALLENGES: An Assortment of Options

A NECESSARY CONDITION

As noted in Chapter I, before deciding how to meet the coming global environmental challenges, as a society we must accept that the challenges are serious and truly urgent. In a sense the first response must be to acknowledge:

- the nature of particular challenges themselves;
- how serious each is;
- how long it will likely be before humankind is forcefully confronted with the consequences of failing to act; and
- how soon action must be taken in order to head-off the most unacceptable consequences.

On this score, the record is mixed with respect to climate change. While fewer people today still publicly argue against the ultimate reality of climate change, some still argue it is largely a natural process, not primarily caused by humans.[1]

Among the governments of the world (who almost universally say they believe that the climate is changing and that human activities are the major cause) a lot of words have been spoken about doing this or that in response, and some preliminary actions have been taken.[2]

Yet as reactions to the financial crisis that began in mid-2008 demonstrate, the idea that we need to fundamentally change our ways, and do it very soon, is certainly not yet widely accepted at the time of this writing.

The record is even worse with respect to acknowledging the extent and consequences of the destruction and transformation of the planetary biosphere, along with the extermination of so many species whose ecological roles we do not understand.

Indeed, it is almost certainly true that most people are sufficiently unaware of the downside of Anthropocene that they believe that if we can de-carbonize the economy, we could continue indefinitely with the current economic model.

Yet, as noted in Chapter I, the current economic model is unsustainable from a resource standpoint even aside from its impacts on climate change.

It is perhaps not too much of a stretch to say that fear of climate change may help save us from ourselves with respect to biosphere degradation.

Because what we are doing to the biosphere also has major consequences for GHG

emissions, when we decide they must be substantially lowered, crucial actions that help protect what remains of the biosphere will necessarily be part of that response (e.g. stopping deforestation).

SORTING THE OPTIONS

As noted in Chapter III, sustainable development requires on-going substitutions. To the extent people acknowledge that major global environmental problems loom on the horizon, it is probably fair to say that many people believe that through a combination of technological and resource substitutions (brought about by market price signals), along with much more in the way of 'green business practices' and 'consumer environmentalism', we can meet the challenges and get on with life more or less as we know it.

What the above approaches share is a focus on using the market to change 'the what', 'the how' and if need be 'the how much' of production and consumption. In Chapter V this diverse set of actions is grouped under the heading *Market-led Responses.*

It is important to note that that even for responses labelled here as market-*led,* government would sometimes play a role by nudging (and sometimes pushing) the market in

particular directions (e.g. tax and subsidy policies). The key is that for responses in this category choices are freely made in markets, even if some of the incentives arise outside the mechanism of the market itself.

While each of the different types of actions and developments listed above will likely be a part of our responses, even in combination they will not be anywhere near enough. The world will also need truly transformative changes that go beyond what the market might reasonably be expected to accomplish in its own way and at its own speed. As noted, Stern (2005) refers to climate change as the greatest-ever *failure of the market*.

A number of authors cited in Chapter I argue that despite the clear risk of giving too much control over the economy and personal choice to governments, there is no escaping the need for strong government leadership.[3] Such leadership will need to be demonstrated in a number of ways. The first is likely to be upgrading infrastructure to make it more efficient, as well as funding certain types of R&D.

Most fundamentally, however, the expanded public sector involvement will need to include the internalization of what are now external costs associated with GHG emissions and the damage to the biosphere. Much of this is likely to be done through taxation or permitting requirements.

Yet even with a wide range of market-led responses and the types of government responses noted above, unless the underlying dynamics of the modern economy—the need for continual growth—is changed, any success in lowering the GHG-intensity of production or slowing damage to the biosphere will soon be eroded in the drive to meet supposedly unlimited wants and 'needs'.

Governments have actively promoted growth and typically failed to distinguish growth from development, while gauging success through measures like GDP, which only accounts for things if they are valued in money terms. It will be vital to replace GDP as the measure of economic success with one that accounts for damages to the planet and resource depletion, and enters these as debits in some form of double-entry bookkeeping. This new accounting must be done even if some of the impacts are not fully monetized or even fully quantified (in some cases the debit might even be in the form of estimated added risk).

The types of responses noted above are grouped here under the heading *Government-led Reponses*. They are considered in Chapter VI.

Governments presumably focus on the quantitative expansion of the economy and rely on distorting performance indicators like GDP because they believe their populations are primarily interested in the quantity

of material consumption rather than in other aspects of the quality of life.

Hence, it is essential that among the assortment of responses we consider how we, as societies and as individuals, judge the quality of life. It is important to ask, for example, what is the appropriate balance of the material and non-material in determining what constitutes 'the good life'?

Likewise, what is the appropriate balance in our own lives between our freedoms and opportunities for gain as individuals and our relationships with others in society? To reflect the significance of such questions and the impact of the choices on the potential for sustainable development, Chapter VII considers a third category, *Values-driven Responses*.

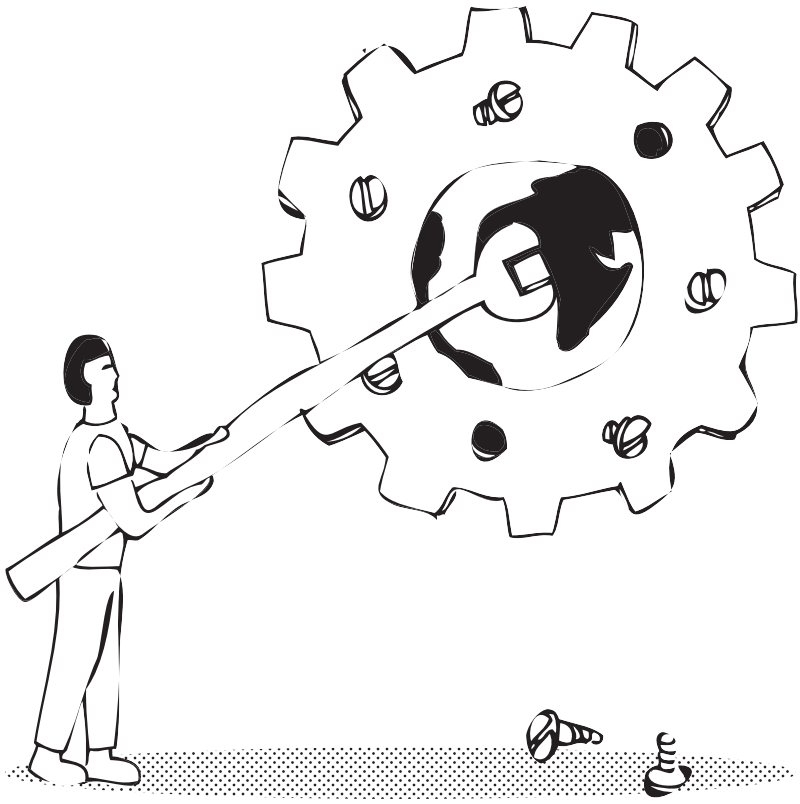
Inevitably, there will be overlap among the categories. For example, 'green consumerism' is considered under market-led responses but obviously is also part of values-driven responses. Likewise, government is likely to make use of the market for its own ends (e.g. though tax incentives). To reflect such overlaps, rather than being put forward as fully distinct sets of responses, the suggested categories reflect the mechanism (markets, government action, value shifts) that would logically be in the *forefront* of the ways in which we might respond.

CHAPTER 4 NOTES

1 Climate change may in fact be a combination of human and natural influences. Nonetheless, the weight of current scientific opinion is that human activities are a significant contributor and such contributions must be reduced. (See, IPCC (2007) *Synthesis Report*).

2 One might count among the responses the Kyoto Protocol along with the periodic meetings in preparation for its successor in Copenhagen (December 2009), as well as the limited attempts at setting up markets for the trading of carbon dioxide emission permits.

3 See for example, J. Sachs (2008), Speth (2008), Stern (2005 and 2008), and Flannery (2005).



V. MARKET-LED RESPONSES

THE PLACE TO BEGIN

In looking for ways to respond to the challenges of moving to a more sustainable development path, market-led approaches are a good place to begin. Markets process vast amounts of information and are widely participatory, if not necessarily democratic.[1] Markets will play important roles in meeting the coming challenges in a number of different ways.

TECHNOLOGIES & TECHNIQUES: 'PASSIVE' TECHNICAL FIXES

While it may have become a cliché to point out that environmental protection provides opportunities as well as challenges, it is true. Since we will have no choice but to do things differently in the future, so the logic goes, whoever correctly anticipates which options will work best (especially in the near-term) stands to profit handsomely if they are ready to help provide it.

If, for example, existing technology is not up to the task of substantially lowering the carbon intensity of some activity, then investments would be expected

to flow to R&D on improvements in, or alternatives to, current technology. As Jeffrey Sachs (2008) and Hawken, Lovins and Lovins (1999), among others, point out,[2] there are a wide variety of 'green technologies' that seem to offer the prospect of allowing us to live comfortable material lives while doing far less damage to the planet. And at a minimum, as the far less sanguine James Lovelock (2006 and 2009) puts it, advancing technology can help provide us with a 'sustainable retreat'.

Technical fixes would presumably start with the considerable expansion and enhancements of proven renewable power generation technologies (e.g. wind, photovoltaics, solar thermal, and hydroelectric), and likely a much expanded use of nuclear fission. Because electricity can be generated from many different sources, we would want to make more extensive use of electric power in general (e.g. for land transport).

We would also want to make across-the-board energy efficiency improvements, both in terms of energy 'service' delivery and through designs that minimize the amount of artificial energy inputs required in the first place (e.g. through designs to make better use of passive cooling or heating potentials for individual buildings and whole areas of the built environment).

Fuel switching would of course also be part of the market-led responses. Moving away from coal and toward natural gas for power generation would be particularly important. One possible major new source of natural gas is gas locked in ice in arctic permafrost and on the seabed of the Arctic Ocean, if ways to economically extract it can be devised.[3] Interestingly, this is same source of gas that was noted in Chapter I as playing a role in a possible tipping point, if it were to be released spontaneously due to the warming of the arctic landmass and seas.

On the biological resource side, we would need to shift technology away from the clear-cutting of old growth forests to highly selective harvesting of high value individual trees, and more broadly to harvesting wood almost entirely from plantation forests on regular rotation cycles.

In agriculture we will need to more widely apply tilling practices that reduce the loss of carbon in the soil. And as noted in Chapter I, animal husbandry we would need to substantially reduce the role of cattle and other ruminant[4] livestock in the food supply,[5] while also figuring out how to profitably raise poultry, swine and cattle in less risky ways. Eventually the world may also need to modify the techniques for growing paddy rice so as to lower the methane-intensity of production.

On the energy supply side we will, of course, need to reduce reliance on fossil fuels. Among the less well-proven or still speculative[6] energy and related technologies being put forward are: ocean energy (e.g. to capture wave, current, or tidal energies), widely applicable carbon capture and sequestration (especially for coal-fired power plants), space-based solar power where energy is captured above the atmosphere and beamed to Earth as microwave energy, second-generation biofuels,[7] and of course the holy grail of long-term energy supply, controlled nuclear fusion.

The above options might be considered 'passive' in the sense that they take as a given that in order to keep the planet from warming beyond acceptable limits, we must reduce our emission of GHGs.

ACTIVE TECHNICAL FIXES (INCLUDING 'GEO-ENGINEERING')

There are also suggestions to actively induce a cooling of the planet. An implied theme of such geo-engineering proposals might be characterized as,

'Maybe the Earth can be *made* to negotiate'.

One approach to active technical fixes is to attempt to limit the amount of solar energy reaching the Earth. This might be done by placing mirrors in space to deflect a portion of

incoming sunlight or injecting sulphate particles into the stratosphere to cut down on sunlight reaching the Earth (as happens for a time following major volcanic eruptions).

A different set of approaches involve various ideas for biologically drawing CO_2 from the atmosphere by, for example, fertilizing the oceans with iron, or by using wave-powered pumps to bring nutrient-rich deep water to the surface. Both technologies are designed to encourage the growth of phytoplankton which would take up CO_2 to build their shells, and then when the organism dies its shell sinks to the ocean floor taking the carbon with it for long-term (though not permanent) storage.[8]

Another idea is to take part of the carbon stored in living terrestrial organisms and prevent it from decomposing by burning it to make inert char and burying the char to lock-up the carbon for centuries.[9] Such techniques could be applied not only to offset greenhouse gas emissions, but if undertaken on a sufficiently large scale, to gradually lower atmospheric CO_2 concentrations by sequestering more carbon than is being emitted.[10]

The above listing of passive and active technical fixes could be expanded. The point here is to provide an illustrative overview of the types of technical fixes being put forward. It is also possible that something not yet envisioned will come to play a major role. Even so, it would be imprudent in the extreme to simply presume that technology can be counted on to come to our rescue just in time.

Some proposals for active offsets to global warming (e.g. fertilizing the oceans, adding sulphates to the atmosphere or mirrors in space) are highly controversial, not least because the planetary systems that would be tinkered with are not well understood. We could end up making things worse. And for things such as mirrors in space the costs could be staggering, while the technology itself might not even be effective.

Nonetheless, it appears likely that we have let embedded climate change get so far advanced that there is no

choice but to employ a combination of active and passive technical fixes.

Yet even when they work and are affordable, the fundamental problem with technical fixes (active or passive) is that they do not diminish the underlying pressure on the planetary resource base that comes from the world economy's relentless drive to expand.

Technical fixes treat symptoms, not causes.

While alleviation of symptoms can provide welcome relief, it is important to appreciate such 'medicine' for what it is.

PRICE ADJUSTMENTS

Another way markets are highly responsive is, of course, through price adjustments. It is price changes that drive most of the substitutions that are at the heart of the way markets continually reallocate resources to reflect changing circumstances.

If market prices rise, then some portion of 'wants' and sometimes needs (real or perceived) will shift to substitutes or simply go unmet. Meanwhile higher selling prices lure in new producers and encourage existing ones to increase

output, if they can. For example, as marine fish stocks decline, fish prices rise, and some consumers who prefer fish will switch to other sources of protein or reduce their overall protein intake. Meanwhile, even with ever higher costs involved in trying to catch the fewer and fewer fish that remain, higher fish prices encourage continued fishing, quite possibly until the fishery is wiped out.[11]

Likewise, if energy becomes more expensive, suppliers will look for cheaper sources of supply, while consumers will look for ways to reduce energy consumption. Building owners might, for example, look for designs that take advantage of the potential for passive cooling, while occupants would have an incentive to purchase more efficient air conditioners, refrigerators, etc.

> **The limiting factor with free market prices is that important consequences of market activity (in production, use, and disposal of goods) often are un-priced. Hence, such impacts remain *external* to the monetized benefits and costs on which buyers and sellers largely base their decisions.[12]**

> **In the case of GHG emissions, the external costs are so high and the difficulty in reducing emissions so great without the proper price signals that an administratively imposed**

price on carbon dioxide emissions (either imposed directly in the form of a tax or indirectly in the form of a cap and permitting system) seems virtually inescapable. (This point is considered further in Chapter VI.)

GREEN BUSINESS AND CONSUMERISM

In addition to substitutions induced by technological advances and market price changes, there are important, though less tangible, aspects of market-oriented (if perhaps not truly market-*led*) responses. For example, voluntary corporate behaviour might involve such things as a company striving to be seen as actively 'green' in its business practices. In sourcing raw materials, it might seek out raw materials from relatively more sustainable (and less environmentally damaging) sources.

Such moves may or may not have a near-term financial payoff under existing prices. Nonetheless, beyond the possible impact on its corporate image, such steps might help to competitively position the firm with respect to anticipated future environmental conditions, prices, and regulations.[13]

There is however an underlying constraint that tends to limit the effectiveness of the green business model:

shareholder pressure to maintain short-term profitability. As Al Gore noted in his film, *An Inconvenient Truth*, you cannot run the planet on the basis of quarterly reports.

Yet with a highly liquid stock market in which shareholders come and go with ease, and where a significant proportion of investors may be in it for short-term gain, managers may have little choice but to pay close attention to short-term profitability, even as they try to plan for the longer term.[14] When the world economy was on a smaller scale relative to planetary boundaries and there were more untapped or underexploited parts of the planetary resource base, this presented fewer difficulties.

Today there is no escaping the dilemma of how to reconcile:

1. the market's tendency to focus to a on short-term profitability

with

2. the need for much better long-term *planetary* resource management.

How such a response might play out in practice is something beyond the scope of this short book. Yet it is clear that when the economy has as much impact on the planet as it does today, the market simply cannot be given a free rein to focus on the near-term at the expense

of the longer term. The task is to devise a set of extra-market constraints that ensure the global economy operates within planetary boundaries, while not stifling the creativity and drive of the market economy.[15]

Another part of market-led responses is, of course, 'green consumerism' in which buyers go beyond price signals in their purchasing decisions. Environmentally conscious consumers might first ask themselves whether they should purchase particular types of things at all, and if so how much is acceptable. For the items they do purchase come the questions, 'Which of the options is the least environmentally damaging, and what is the nature of the trade-off, if any, between relative environmental friendliness and price?' And as the flipside of a company promoting a green image, consumers might also consider how other people will react to evidence of their purchase decisions.

Green business practices and consumerism will certainly play a vital and early role in moves toward greater sustainability. In a sense they will help set the stage for the much harder choices (and imposed limits on choice) to come. And of course, one should not underestimate the value of 'going green' in simply making people feel better. If we all felt and acted far more green, the situation would not be as dire, nor the time as short, as it is.

Nonetheless, green business practices and environmental consumerism, while potentially very helpful at the margin, cannot by themselves overcome the weight of free market price signals.

Broadly, we should begin to address sustainability concerns with market-led responses. The market will be a major driver for innovative responses to sustainability challenges, and it should be a primary mechanism through which actions take place. Yet, as Nicholas Stern (2005) stresses, what we are dealing with is the greatest market failure ever. Hawken, Lovins and Lovins (1999) cite Einstein's dictum that 'problems can't be solved within the mindset that created them'.[16] On their own, market-led responses will not be able to get us out of the situation in which we find ourselves.

CHAPTER 5 NOTES

1 Markets are often less than competitive; only people with enough money get to participate, and the more money one has the greater the 'vote'. Yet even so, markets are arguably one of the most widely participatory forms of collective decision-making ever invented.

2 Also, see for example: Flannery (2005); T. Friedman, (2008); Goodall, C. (2008), Ten Technologies to Save the Planet; and Lovelock (2009) and (2006), *The Revenge of Gaia: Why the Earth is Fighting Back—and How We Can Still Save Humanity*.

3 See for example, Pearce, F. (27 Jun. 2009), 'Ice on fire'.

4 Ruminant animals (e.g. cattle, sheep, goats) 'chew the cud', i.e. chew again what has been swallowed. This increases emissions of methane when 'gas' is released from both ends of the animal's digestive system.

5 Lovelock (2006) summarizes this by saying we use as little as possible of the three 'Cs': 'combustion, cattle, and chainsaws'.

6 *Speculative* in that while the logic of the system (i.e. the nature of the energy source and a mechanism to capture it) may have been worked out in principle, it remains to be demonstrated that reliable devices can be built at acceptable costs and then be applied on a sufficient scale.

7 Basically ones that do not compete with food crops (e.g. alcohol fuel from cellulosic material).

8 See for example, Kunzig, R. (Oct. 2008), 'Geoengineering: How to Cool Earth—at a Price'; Broad, W. J. (26 Jun. 2006), 'How to cool a planet (maybe)'; Homer-Dixon, T. and Keith, D. (7 Oct. 2008), 'The ultimate sun-block'; and Lovelock (2006) and (2009).

9 See for example Lovelock (2009), and Goodall (2008). A key point would, of course, be how energy-intensive the process of turning wood (or other cellulosic biomass) to char proves to be and the source of that energy.

The process would make sense from a carbon perspective only if the energy requirements were modest, much of the energy input came from renewable resources, and for any fossil fuel energy inputs

to be far lower in carbon emissions than the amount of carbon stored in the char. Also if the process were to be undertaken on a scale sufficient to attain a net atmospheric carbon reduction, the requirements for land, water, etc. to grow the material on short rotations would also need to be carefully evaluated.

10 This would not mean that the climate would return to pre-19th century conditions within human time scales. If tipping points are passed (e.g. the melting of massive ice sheets), complex ripple effects would be unleashed. Further, things like the rebuilding of ice in glaciers and snow cover at the poles could take centuries or millennia. Biodiversity could take eons to recover and would probably find a new balance quite different from what modern humans have ever known.

11 This *is* the story, for example, of the northern Atlantic cod fishery that collapsed in the early 1990s and has yet to recover.

12 Nonetheless, price signals are so effective in changing supply and demand that they should be employed extensively as part of *government-led responses*. In this case however, the price signals are ones that have been adjusted to reflect at least a portion of the external impacts.

13 For example, by not being tied to the purchase of resources likely to be become relatively scarce and hence more costly, or locked into production processes likely to be subject to far stricter regulation in the future, the firm might move into a potentially stronger competitive position. Most broadly, in anticipation of a coming carbon tax or permit system, firms would do well to lower the carbon intensity of their operations beforehand.

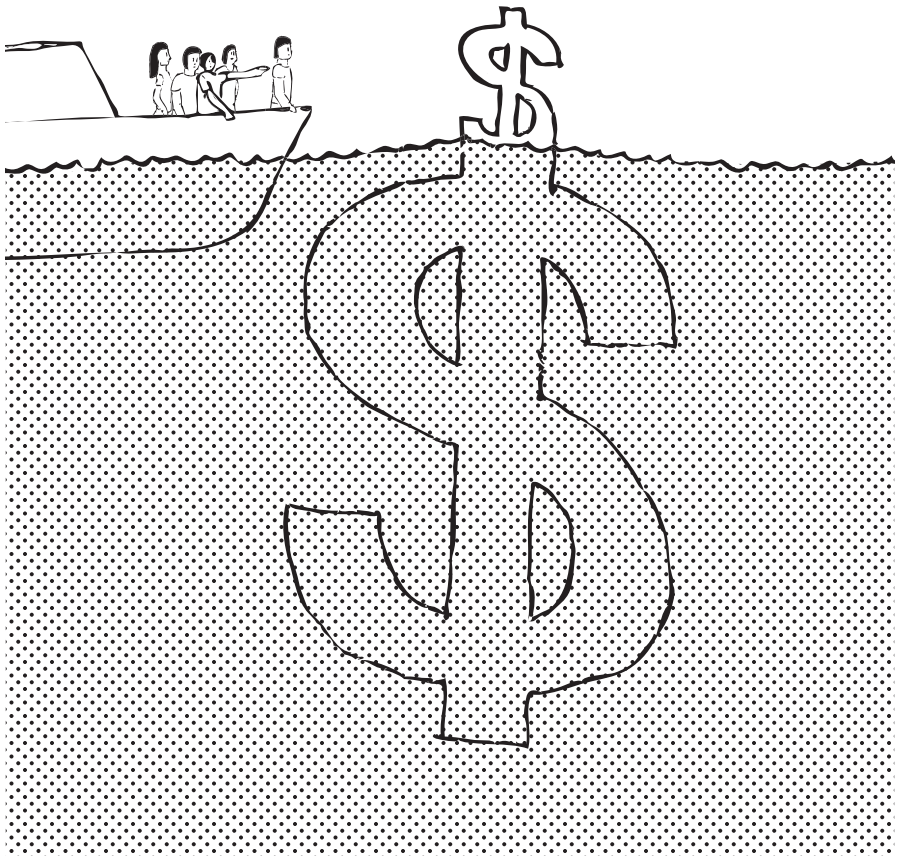
14 This is not to argue, of course, that short-term profitability considerations are always dominant. Firms can and do plan for the longer term with an eye to their own long-term profits. Most shareholders of large corporations, however, do not see such long-term profitability for their own firm as being dependent on the firm's actions with respect to helping keep the global economy within planetary boundaries.

15 The point is that while markets are often far from competitive, and the manipulation of consumer desires arguably has reached

dangerous (and perhaps occasionally even sinister) proportions, the problem lies not so much the mechanism of the market itself, but rather with what powerful interests may do when given free rein.

To say that the global economy must be constrained in its use of resources is not to say that a *market* economy is, by its nature, incompatible with a world that comes to live within planetary boundaries (though some might argue that it is incompatible). Nonetheless, just as few would say that an individual should have *total* freedom, so too markets should be free only within bounds set by the interests of the larger society (in this case including future generations and arguably other species).

16 Hawken, Lovins and Lovins (1999), p. 6.



VI. GOVERNMENT-LED RESPONSES

Whereas market-led responses focus on the actions of individuals and organizations acting on their own initiative (and typically in their own self-interest), in principle at least, government-led responses involve governments intervening on behalf of society as a whole. In other words, government actions should represent the collective response of society.

In practice, of course, governments do not necessarily work to protect the interests of all citizens equally. Further, the workings of the government bureaucracy itself may sometimes be best understood as that of yet one more interest group pursuing its own agenda. And then, of course, there is the question of competence, particularly when civil servants attempt to do such things as attempting to direct the economy and influence personal choice.

Nonetheless, despite the dangers of entrusting too much to the public sector, there seems no escaping the need for strong government action to help societies pull back to living within planetary limits. Such interventions will need to occur in a variety of ways. These include:

- investment in more efficient public infrastructure;
- standard-setting (especially for higher efficiency in the use of energy);
- imposing a cost for damages producers and consumers inflict on the planet's long-term habitability; and
- redefining the way economic success is measured and pursued.

In a sense, this expanded role for government comes from what might be viewed as the need for an expanded power of eminent domain. That is, in the interest of furthering the common good, private interests will increasingly need to be overridden when it comes to actions that damage workings of the atmosphere and biosphere. If prospects for climate change and a severely degraded biosphere prove anywhere near as great as they now appear to be, the common good will need to take precedence in many areas where private interests have dominated in recent years.

This would happen for example through much tighter regulation of the most basic of common property resources: the atmosphere (i.e. what is allowed to be dumped into it) and the biosphere (i.e. what parts of it are allowed to be removed, transformed, or contaminated).

The task will be to devise ways to preserve as much individual freedom of thought and action as possible as this shift occurs.

Equally challenging will be to somehow instil in civil servants a new set of values so that they make effective and proper use of the expanded responsibilities likely to be granted to them.

INFRASTRUCTURE, R&D, AND STANDARD-SETTING

An expanded role for government would begin with upgrading infrastructure in areas such as electric power transmission (including better network integration to allow a greater role for renewable energy),[1] reducing leakages from and contamination to fresh water systems,[2] facilitating information technology,[3] and protecting public health.[4] While some of this infrastructure is privately owned or managed, government regulation of these sectors is already quite extensive. At a minimum, this means government must be a facilitator of change. In some cases it will mean government being a full partner with private interests, or government taking the lead in setting out new directions and bringing private interests along in ways the private sector it finds financially viable.

Another obvious area of government-led responses is public sector funding for technology in areas where for-profit (or private philanthropic) funding is inadequate.

This would tend to include basic R&D and implementation of technologies that have benefits to society at large but for which it would be difficult to collect payment for benefits received, that is, technologies that provide what economists refer to as 'public goods'.

Many of the geo-engineering planetary cooling ideas being put forward (see Chapter VI) would fall into this category,[5] as would such things as facilitating the migration of endangered species in the face of a changing climate. It would also include research into areas that would have only very long-term net payoffs, if they succeeded at all (e.g. controlled nuclear fusion or mirrors in space).

Further, considering the importance of lowering carbon emissions, the setting and enforcement by governments of tighter energy efficiency standards (e.g. for motor vehicles, industrial processes, home appliances) will be key. Eventually regulation will probably be needed to affect how things are made with respect to the option to repair rather than replace damaged units, as well as for upgrading via replacement of parts rather than replacement of entire units.[6]

ADDRESSING THE GREATEST MARKET FAILURE

While it seems likely that most, if not all, of the above areas will feature prominently in governments' expanding functions, there is a far more fundamental way in which they will need to play a bigger role (and play it well). This role is in limiting the pervasive external costs associated with the way today's economies function and how we live our lives. As noted in Chapter II, Stern (2005) identifies climate change as greatest and widest ranging market failure of all time.[7] His assessment would apply equally well to how the world economy is devastating the planet's biosphere for the short-term profit of a few, without regard to loss of long-term productive potential for all (including future generations).

Stern (2008) and J. Sachs (2008) argue strongly not only for more involvement in the economy by national governments, but for greater and more effective *international* cooperation than the world has ever seen. A number of the other authors cited here reach similar conclusions, although sometimes with considerable reluctance.[8]

A body of international law relating to sustainable development is emerging, albeit often still largely in the form of 'soft instruments' (declarations and international statements),[9] rather than hard ones along the lines of explicit and enforceable rules under the World Trade Organization (WTO).

A major test case for effective global cooperation on sustainable development will be the ability of the international community to work out a mechanism (and do so in years, not decades) to put a worldwide price on carbon dioxide emissions.

PRICING CARBON AND BEYOND

The scale of needed cutbacks in GHG emissions is made clear by Stern (2008) who argues for a peak no later than the early 2020s[10] and then a steep drop so that by 2050 they are only half of what they were in 1990.[11] This would require a reduction in emission levels (from both the burning of fossil fuels and biological sources) down to about 1 tonne per person per year. By comparison emissions in 2006 from the burning of fossil fuels alone were about 4.5 tonnes per person.[12]

When carbon releases from deforestation are taken into account, emissions would go up by about one fifth,[13] bringing the total to nearly 5.4 tonnes per person.

In other words, the current estimate is that in order to avoid catastrophic climate change, world-wide carbon dioxide emissions per person in mid century can be no more than about 20% of what they are today.

For higher income economies, cut backs would need to be down to well under 10% of what they are today because the lower income economies could not undertake proportional reductions without creating severe deprivation for their populations.

Administrative measures to enforce cutbacks of such a scale would, if applied strictly on their own, be too inefficient, cumbersome and involve an endless struggle to plug loopholes. As Stern (2008) notes, what is needed is a 'liquid international carbon market' (i.e. one in which emissions trading takes place). This would need to be implemented against a regulatory context of strict energy efficiency standards, financial incentives for the use of low carbon technologies, cost-effective reforestation, etc.

One way to put a price on carbon (and eventually on other GHGs) would be to do so directly through a global tax. For fossil fuels, the closer the tax is imposed to the point of extraction of the coal, petroleum and natural gas, the simpler it would be from an administrative standpoint.[14] The effects would then work their way down the supply chain. Eventually end-users would face financial incentives to switch away from the more carbon-intensive fuels, invest in energy efficiency improvements, and cut back on energy-intensive activities.

Such taxes could be revenue neutral. For example James Hansen (25/02/09) proposed a carbon dioxide tax in the US in which the all the revenue collected would be distributed equally to each US citizen. He illustrates the proposals with a price of US$115 per short ton (or about US$103 per metric tonne).

If we use US$100 per metric tonne of carbon dioxide[15] as the base line, the price of a barrel of crude petroleum would go up by about US$43 per barrel.[16] This would add about US$0.24 per litre to the price of petrol or jet fuel, about US$0.20 per cubic meter of natural gas, and somewhere between about US$125 and US$260 per tonne of coal, depending on the type of coal.[17]

In other words the cost implications of a price of US$100 per tonne of carbon dioxide would be significant and result in a strong shift away from coal. But it would not necessarily be so high as make most current types of carbon-intensive activity unaffordable.[18]

If that proved to be true, US$100 per tonne of carbon dioxide may well not be high enough to bring about the level of carbon dioxide emissions reduction being proposed.

Nobuo Tanaka, Executive Director of the International Energy Agency (IEA), believes that to keep atmospheric carbon dioxide concentrations at not more than 450 ppm, a carbon dioxide emission price of US$180 per tonne must be in place no later than 2030.[19]

The price at which a tax on carbon dioxide is set would need to be adjusted periodically to ensure that emissions are sufficiently curtailed to meet long-term climate management goals (which have been, and will likely continue to be, a moving target), as well as to avoid having its impact eroded by general price inflation.

The substantial funds generated by the tax could then be used to in any number of ways including to offset other taxes, funding further GHG mitigation or for adaptation to a changing climate, and to address global equity concerns.

An alternative to a carbon dioxide tax as a way to put a price on it would be the creation of a system of permits for the emission of carbon dioxide (or other greenhouse gases). This would be set up under a cap and trade regime. The number of permits issued would need to be capped at levels significantly less than current emissions. Over time the number of permits would be steadily reduced.

If we assume, for the moment, that emitters would have to bid for available permits, this would set a

market price for carbon dioxide emissions. Prospective emitters who could abate their emissions in-house at a cost lower than the going price of a permit (e.g. via in-house energy efficiency improvements or investing in more efficient equipment or processes) would have an incentive to do so.

Emitters in economies where strict energy efficiency has long been mandated (or taxes have induced it) will need to most aggressively bid for available permits (since further in-house reductions will tend to be difficult). Hence, if all permits were put up for auction, firms in higher income economies would tend to be the ones with the strongest incentive to bid. If the revenues collected were disproportionally distributed to lower income economies, it would represent a substantial capital transfer from higher income to lower income economies.

As noted in Chapter II instead of auctioning permits, a substantial proportion could be allocated to reflect equity considerations as proposed by Pan et al. (2008) and Baer et al. (2008). If those who received an allotment[20] could sell (trade) them to others, an incentive would still exist for them cut back on their own emissions so as to be able to sell more of their allotment. Such an arrangement would, of course, send substantial funds to developing economies (where opportunities for in-house reductions tend to be substantial).

An emission tax or permit system is economically efficient in that instead of a proportional reduction by all emitters, most of the cutbacks would occur in those economies where the reductions come at the lowest cost per tonne of avoided carbon dioxide emission.

As with the level of a carbon dioxide (or other GHG) tax, the number of permits would need to be adjusted periodically in-line with climate management goals. To allow for this, permits would need to be valid for only a specified time, perhaps (e.g. 3-5 years), with fewer permits being offered in each successive round.

While measures to price carbon dioxide will likely come first, later other GHGs (starting with methane) will need to come under some form of pricing, whether by way of a tax or through a permitting system. Eventually, imposing some form of cost to reflect the damage human activity does to the productivity of the biosphere (especially through deforestation) would also need to be put in place.

In choosing between a tax or permit system, or some hybrid combination of them, each has its advantages and limitations. *Annex A* sets these out and notes the tradeoffs when one approach is chosen over another.

While economic incentives like carbon taxes or permits offer significant efficiency advantages, they cannot be relied upon completely.

For something as important and urgent as vast reductions in carbon dioxide emissions, economic incentives should be applied within an administrative context of direct controls for some of the most readily identifiable areas of inefficiency.

For example, rather than wait for a tax or permit system to gradually lead to the shutting down inefficient power plants using low grade coal, it probably will be necessary to legislate that no new plants of that type be built and that existing ones be shut down within a specified timeframe.[21] Likewise, rather than using higher prices to discourage the use of low grade bunker fuel for shipping, it may be best to simply ban it, or if allowed, to forbid its use in areas like the newly opening Arctic where the soot in the exhaust would accelerate snow and ice melt, further warming the plant through reduced polar albedo.

Beyond Fossil Fuels

A complicating but crucial factor in a GHG emission tax or permit system is how to treat emissions from biological sources. Land use changes, especially deforestation, can rival in scale the burning of fossil fuels when it comes to GHG emissions.[22] Such activities also tend to carry the additional penalty of a threat to biodiversity and the undermining of long-term biological productive potential due to soil degradation.

The advantage of the biological side is that, unlike fossil fuel energy use, well-designed programmes can remove carbon dioxide from the atmosphere while enhancing prospects for biodiversity and long-term soil productivity. Despite the administrative complexities, afforestation and actions to protect standing forests deserve credit in carbon accounting and other international agreements (e.g. for biodiversity) for providing such benefits.

Under an 'offset', growing trees in a newly planted forest in one part of the world, might for example, be put forward as offsetting (over the lifetime of the surviving trees) some of the emissions from a fossil fuel power plant in another part of the world. While offsets are appealing conceptually, there is the matter of ensuring credit is not taken for avoiding emissions that would in fact not otherwise actually occurred (what is termed 'additionality').

Further, even if emissions are reduced in one location, can we be sure the activity does not simply shift somewhere else? Such issues have arisen with regard to Clean Development Mechanism (CDM) under the Kyoto Protocol[23] where some emissions in a developed economy are offset via projects funded from the emitter to reduce emissions in a developing economy.

While the world will need to start with pricing fossil fuel-based carbon dioxide, this would only be the beginning of efforts to internalize what are now pervasive external costs that are undermining the sustainability of our way of life. Eventually, we would also need to price carbon dioxide emissions from deforestation as well as methane emissions from ruminant livestock, and possibly paddy rice. Alternatively, some of these activities (as well as others such as GHG emissions coming from soil disturbances from ploughing) might be limited through administrative controls implemented on a localized basis under national and international oversight.

In addition, other substances (e.g. CFCs, carbon tetrachloride, and HCFC) have both greenhouse forcing and ozone depleting properties and will eventually need to be brought into a comprehensive management regime with due account taken of their multiple impacts.

In the end, humankind will need to come to live within a series of planetary boundaries rather than assume, as we have until now, that these can simply be pushed back indefinitely.[24]

It is difficult to imagine how this could be accomplished without strong and effective leadership from governments working together.

It is also clear that that government-led responses must include a combination of market-based and administrative measures. The market-based measures would, in effect, put a price on emissions of GHG. This would need to be supported by administrative measures such as funding or other backing for the development and use of low carbon technologies, along with strict energy efficiency standards, and prohibitions (e.g. perhaps banning new coal-fired electric power generation without carbon capture and sequestration).

Clearly, management regimes would need to evolve over time, gradually encompassing more of the problem areas while being fine-tuned with respect to what types of controls and incentives are found to work best in particular cases.

It will be a long, difficult process likely to play out *at least* through the rest of the 21st

century, but one in which, as the cliché puts it, failure is not an option.

ACCOUNTING FOR WHAT REALLY MATTERS

As noted in Chapter II, if we are to *keep* GHG emissions low after they have been lowered, the economy must be taken off the treadmill of high throughput. We must also move beyond the assumption of supposedly ever-rising wants and perceived 'needs'.[25] As good a place as any to start is by changing the way we measure economic success.

Existing national income accounts[26] (e.g. GDP, Gross National Product (GNP), GDP per person or GNP per person) give highly distorted pictures of the workings of the economy and send misleading guidance to decision-makers. Speth (2008) describes GDP as 'frequently used as a proxy for throughput' (p. 111). It tells us little about what is happening to the material resource base (beyond those aspects that markets deal with) and ignores unpriced aspects of current or future well-being of the population.[27]

Among the most basic problems with accounts such as GDP is that they are not in the form of double-entry bookkeeping. For example, a standing forest is not assigned a value as natural capital until it is cut down and the wood sold. The

fact that the forest (as natural capital) no longer exists is not entered as a debit (except when costs are incurred if it is replanted). Likewise, the values of un-priced ecological services provided by a standing forest (e.g. reducing soil erosion and with that the fostering of biological productivity on-site and reducing siltation in downstream reservoirs) tend to be ignored because such benefits are typically not traded in the market and so are un-priced.

Ironically, dealing with the negative consequences of losing such services *is* reflected as an addition to GDP. If, for example, money must be spent to dredge a downstream reservoir to remove the greater inflow of silt, it adds to GDP. Indeed, tracking such 'defensive' expenditures is one way to put a money equivalent value on environmental services.[28]

Similarly, if out of fear for their personal safety the wealthy choose to live in 'gated' communities, this 'defensive' expenditure shows up as consumption, and hence adds to GDP. Meanwhile, the foregone value of being able to live safely without spending money for private security is not valued, because being un-priced, it simply lies outside the accounting framework. GDP is simply blind to it. Absurdities abound, and this very short list of examples could easily be extended.

While criticisms of national income accounts have been made for decades and alternatives put forward for as

long, the income accounts commonly used have largely remained unchanged beyond adjustments for things like purchasing power parity.

> **We would do well to consider the fact that GDP reflects what most political leaders (and arguably a large part of their populations) still believe is most important with respect to the economic performance, that is, the consumption of marketed goods and services.**
>
> **Presumably, this stems in part from the fact that when demand for such things is high, asset values and employment also tend to be high (see Chapter II).[29] For the emerging middle classes of the newly industrializing economies it is even more straightforward. Things that are priced tend to be the types of things they were denied when they were poor.**

Yet regardless of its appeal, if the world is to successfully rise to the challenge of sustainable development, an essential step along the way will be to pay far less heed to measures like *GDP* and instead focus on very different measures of economic performance to guide decision-making. At a minimum, any new national income accounting measures should be in the form of double-entry bookkeeping so that un-priced environmental

damages or resource consumption can be entered (in one form or another) as debits.

In some cases we will be able to put a shadow price on un-priced impacts (for example on the need to replace depleted groundwater aquifers with water imports). In other cases, we will find it difficult to even fully quantify the impacts, or if quantifiable, may believe that no meaningful shadow price could be assigned to it.[30] In such cases we should at least note them as debits in qualitative terms in our income accounts.

We can then go further. Non-monetized, and not even fully quantified impacts, may still be incorporated into planning decisions through a 'trade-off assessment' with respect to how much monetized value we are willing to give up to prevent such impacts (or to lower the risk of their occurrence). This point is explored further in *Annex B*.

Suggesting the specifics of alternative 'income accounts' that remove the more severe distortions of GDP, and which governments and international bodies would actually be willing to employ, is beyond the scope of this short book. A number of candidate measures in this regard have been put forward. When governments show real interest, many more offerings for 'a better GDP' will certainly be put forward.

As if the preceding set of government-led interventions was not ambitious (and risky) enough, there is at least one more fundamental issue that warrants careful consideration: that of how to put a 'present value' on costs or benefits that are passed on to coming generations. *Annex B* also considers this point and suggests ways to deal with some the most serious drawbacks of current discounting practices.

TRULY ONE WORLD

In the globalized economy, measures such as emission taxes, permits and credits for offsets ultimately must be applied worldwide. And while the parties agreeing to it would be national governments, an international body would be required to deal with its enforcement and to adjudicate disputes. Hence, such a body should have at least as much clout as the World Trade Organization does today (and preferably more).

Clearly, if we are to manage long-term GHG emissions and limit further damage to the biosphere, there will need to be effective international cooperation such as the world has never witnessed. Such a system will take time to mature as the world learns what works and what does not.

Speth (2008) is scathing in regard to the track record for international agreements designed to protect one aspect of the world environment or another, with the notable exception of ozone layer protection. The world will, he notes, have to do far better this time around and undertake international cooperation with an unflinching commitment to ensuring that what needs to be done is done.

As noted throughout this book, sustainability challenges are not limited to climate change. The world arguably should begin with climate change in terms of international agreements and action, but it cannot leave it at that. Even with a stable climate, the world economy cannot continue for much longer to 'mine' the biosphere, if we are to leave a productive, diverse ecology for coming generations.[31]

We must act effectively and quickly to protect and preserve as much as possible of what remains of the natural world. This will involve strictly enforced internationally agreed limits and controls, along with market-based measures such as taxes and tradable permits on activities that are now either not regulated or inadequately regulated (e.g. tropical deforestation, overfishing, water diversions, soil erosion).

Considering the apparently short time we have to radically change the way the world economy functions, it is unlikely that

government intervention can be limited to only changing the financial incentives faced by buyers and sellers in the market.

There will almost certainly also need to be strong doses of command and control (e.g. bans and administrative restrictions, along with detailed reporting requirements). The challenge will be how to do this in ways that are sufficiently effective while not being unduly onerous.

For example, are world fish stocks today in good enough shape to allow a tax or permit system to gradually work its way into market decisions? Such an approach would be risky at best. It is likely that to bring about sufficient change and to do so in time, much stricter catch limits or total bans will need to be imposed on the taking of certain species, or the taking of any fish in high risk regions of the open sea.

And sticking with the fishery example, should national governments be allowed full authority to regulate the taking of fish from within their exclusive economic zones or should international agreements take precedence when national controls are not deemed effective? And who should control fishing outside the exclusive economic zones of the world's coastal nations?

The 2008-09 financial crisis provides a valuable opportunity for a new beginning. When global economic activity rebounds, be that relatively quickly or slowly over years, it would be most unfortunate if it represented the re-emergence of things as they were with respect to a lack of concern about planetary boundaries.

The need for unprecedented levels of national government intervention, along with effective supranational regulation, will undoubtedly present us with a very different political and economic world from the one we have known. To work, it would have to.

The world probably has no choice but to go down the road of greater government control (national and international) over economic activity. Speth (2008) and Jeffrey Sachs (2008) are relatively optimistic that we can work out ways to reconcile the need for greater government control with individual freedom and a more participatory society, while Flannery (2005) is somewhat less so.

Chapter 6 notes

1 The best wind, sun, and hydro sources are often located in sparsely populated areas far from major energy demand centres. The power grids need to be well interconnected and capable of efficient and reliable long distance transmission from places where power can be renewably generated to where it is most needed. Likewise, if nuclear power is to be more acceptable, locating plants far from (and preferably downwind of) urban areas could reduce resistance to it, though cooling water requirements would remain an issue.
2 As noted in Chapter I, water looks to be a much scarcer resource relative to demand in coming decades.
3 In a world where we must lower carbon emissions, physical travel will be more costly, putting a premium on enhanced communications.
4 A warmer world is likely to be one where diseases and pests once confined to tropical and subtropical areas move into what are now more temperate regions, where adequate defensive measures would need to be put in place.
5 Some of the active technical fixes such as mirrors in space would likely be so expensive that only a consortium of governments could even consider financing them.
6 Substantial charges and restrictions on the creation and disposal of toxic waste, for example, would begin to move the market in this direction.
7 The *market failure* to which Stern refers results from the fact that according to the best evidence available today, the emission of greenhouse gases affects the stability of the climate, but the prices as seen by buyers or sellers in the market fails to reflect this key long-term consequence of their market decisions.
8 For example, Speth (2008), Flannery (2005), and Porritt (2005).
9 See for example, Coronier, Segger and Khalfan (2004).
10 The proposed outer limit for the time when carbon emissions must peak before falling sharply, has been pulled back in progressive assessments of the situation as (i) emissions have risen even faster than under what had been previously been considered the worst

case scenario, and (ii) as evidence of *on-going* climate change becomes clearer.

Whereas in the 1990s talk was of carbon emissions peaking sometime around 2050, not many years later this was revised back to 2040 or 2030, and Stern (2008) calls for something closer to 2020. Writing in July 2009 ['Low carbon route'], former British Prime Minister Tony Blair noted, 'what is being asked' is that global emissions peak 'before 2020', while D. Sethuraman, (2009) ['Carbon price must rise, IEA director says'] notes, 'United Nations Scientists say greenhouse gas output should peak by 2015'.

It is likely that mid-2009 calls for carbon dioxide emissions to peak by 2015 are in part a negotiating stance to create a greater sense of urgency ahead of the December 2009 Copenhagen climate negotiations. In practical terms, beginning to bring down carbon dioxide emissions in absolute (and not just relative) terms within another 5 years would require a level of commitment so far beyond what has been evidenced to date as to seem extremely unlikely. Nonetheless, the time by which the world must do so is probably not all that much longer.

Yet considering that carbon dioxide emissions are still rising and the less than promising prospects for international agreements to soon slow the GHG emission increases, the situation only reinforces the idea of just how wide the *great disconnect* is. Indeed, as the time to act gets closer to the present, the disconnect in perception grows wider.

11 Pan *et al.* (Dec. 2008) use target cutbacks of similar scales when presenting their arguments for assessing how the world should allocate future carbon emission rights.

12 Energy Information Administration, *Voluntary Reporting of Greenhouse Gases Program (Fuel and Energy Source Codes and Emission Coefficients).*

13 J. Sachs (2008).

14 In other words, it would require worldwide monitoring and collecting taxes from some tens of thousands of coal mines, and petroleum and natural gas wells, rather than hundreds of thousands of refiners/processors, electric power generators and wholesalers.

15 It is important to distinguish between a tax on a tonne of carbon and a tax on a tonne of carbon dioxide. Here all comments and figures refer to *tonne of carbon dioxide*.

16 US Environmental Protection Agency, *Clean Energy: Calculations and Resources*, <http://www/epa/gov/cleanrgy/energy-resources/refs.html>.

17 See Energy Information Administration (EIA), US Department of Energy, *Voluntary Reporting of Greenhouse Gases Program, Fuel and Energy Source Codes and Emission Coefficients*. For comparison of the price increases from a carbon dioxide tax using the EIA figures with 2009 USA energy prices, see 'Carbon Tax', *Wikipedia*. This shows for example a US$100 tonne carbon dioxide tax raising US petrol, diesel and jet fuel prices by about 20 to 40%, natural gas price increases of 60 to 150% and for coal, a 500 to 1,000% increase.

18 As noted in the preceding note, for coal-fired electric power generation without carbon capture and sequestration, a price of $100 per tonne of carbon dioxide would raise fuel costs by a factor of 5 to 10 times current levels. This would make coal-fired electric power prohibitively expensive compared to other sources of energy.

19 See Sethuraman (8 Jun. 2009).

20 This might be done through governments, who in turn would decide on their own allocation methods to individual emitters, rather than directly to emitters themselves.

21 Exceptions might be offered, though sparingly, in cases where the local incomes are very low and no feasible alternative source of electricity exists. This might be the case in certain rural areas of developing countries where local low grade coal is the only readily available energy resource.

22 In the late 1980s for example, aggressive land clearing in a number of low income Asian economies resulted in more carbon dioxide being emitted than came from their use of fossil fuel at the time (Barron, W. and Hills, P. (1991), 'Concerns over biomass sources of greenhouse gases: potential issues for selected Asian nations').

23 See Clean Development Mechanism, *United Nations Framework Convention on Climate Change*, <http://cdm.unfccc.int/index.html>.

24 See for example, Ekman, Rockström, and Wijkman (2008).

25 Points along these lines are outlined in a collection of short essays by several authors in a Special Issue of *New Scientist*, 'The Folly of Growth' (18 Oct. 2008).

26 In addition to national governments such measures are published by the International Bank for Reconstruction and Development ('The World Bank'). See World Bank (2009), *World Development Indicators 2009.*

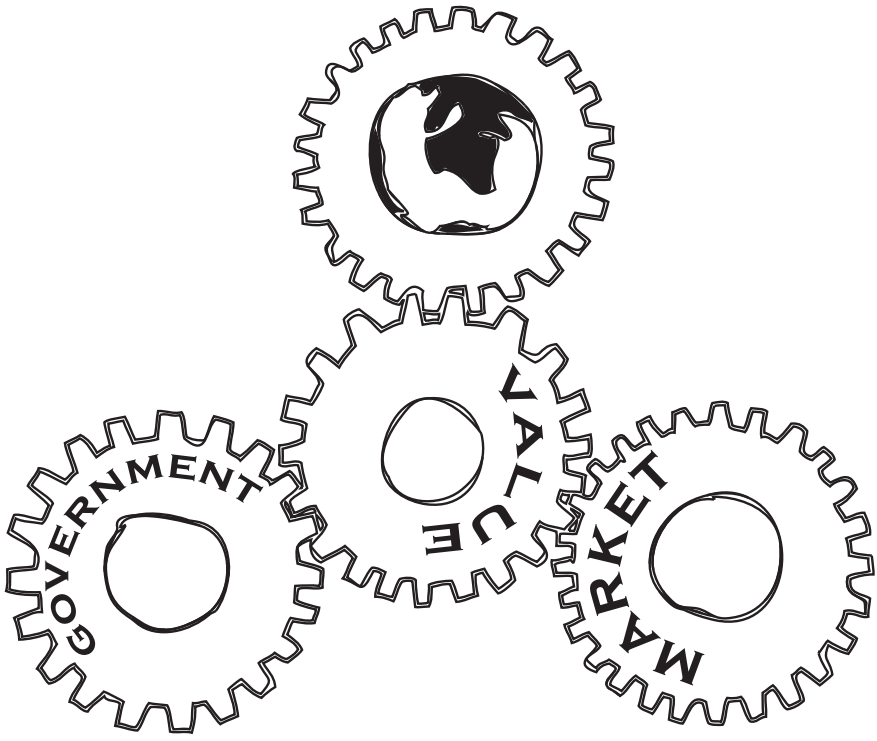
27 National income accounts have long been criticized and various forms of 'green accounting' have long been proposed in their place. For some recent examples see, Davis, G. A. and Moore, D. J. (2000), 'Valuing mineral stocks and depletion in green national income accounts'; Vellinga, N. and Withagen, C. (2009), 'On the concept of Green National Income'; and *Taiwan Area Green National Income Accounts* <http://win.dgbas.gov.tw/dgbas03/ca/eng_green/org-1.html>.

28 Being able to avoid such 'direct cost' expenditures would, however, always be only a partial reflection of the actual value of environmental services.

29 Porritt (2005) for example, notes how difficult it has been for governments to move away from GDP.

30 Hawken, Lovins and Lovins (1999) note this is the case when there is no substitute for a natural environmental service.

31 Wilson (2006) and (2002) is perhaps the most authoritative, articulate and passionate voice calling attention to the unintended slaughter of so much of the richness of life on Earth.


GOVERNMENT
VALUE
MARKET

VII. VALUES-BASED RESPONSES

THE FUTURE IS WHAT WE MAKE OF IT

A world in which the planet-wide average carbon dioxide emissions per person are only a fifth or so of what they are today is a world in which higher income consumers will be required to make much greater proportional reductions.[1] Even with the types of market- and government-led measures outlined in the previous chapters, even with a range of technical fixes and concerted international cooperation on pricing carbon, there seems no avoiding the prospect that, for at least a considerable time, humankind will have no choice but to *adapt* to living in a more resource-constrained world.[2]

How well we adapt will not only be a matter of technology or how much of the planet's resources some of us are able to secure for ourselves, but of the values we hold. As the Intergovernmental Panel on Climate Change's (IPCC) *Climate Change 2007: Synthesis Report* notes, decisions about how to respond to anthropogenic climate change are, in essence, 'value judgments.'[3] Hence, a third category is needed for ways the world might respond to sustainability challenges: values-driven responses.

As with the other two response categories, this one encompasses a variety of approaches. It will include value shifts to help in the mitigation of further damage to planetary environmental systems, along with value shifts that help us adapt psychologically to changed circumstances.[4]

Of course, the scale of changed circumstances being considered here has only just begun. The current changes in climate, along with the impacts of species loss and other damage to the biosphere, are occurring in ways that are generally too subtle or too far away (in space or time) for most people to really grasp. Hence, it is not surprising that currently prevailing values tend to be ones based on a presumption that we live in a world in which advancing technology will not only allow us overcome virtually any resource constraint, but also bring about ever greater material abundance.

Nonetheless, it is taken as a given here that the current world economic system simply cannot be maintained for more than another few decades, at most. Its operations are destabilizing the climate and undermining the ability of the biosphere to provide essential ecological services. The damages are occurring in too many different ways to be readily reversed. Once the consequences are more evident, we will have no choice but to adapt. When considering the degree and types of value changes, it is important to keep in mind the context in which they are likely to occur.

When forced to deal with serious disruptions from climate change and the provision of key ecological services, adapting to the new situation will probably take up a substantial part of available resources.

This, in turn, will tend to lead to concerted collective actions. When concerted collective action is called for, values will change, at least for a time, as happens in times of war or natural disaster.

In part the change will occur voluntarily because of what people individually believe is appropriate to the new situation, and in part from what collectively comes to be considered socially acceptable behaviour.

RE-BALANCING THE MATERIAL AND NON-MATERIAL

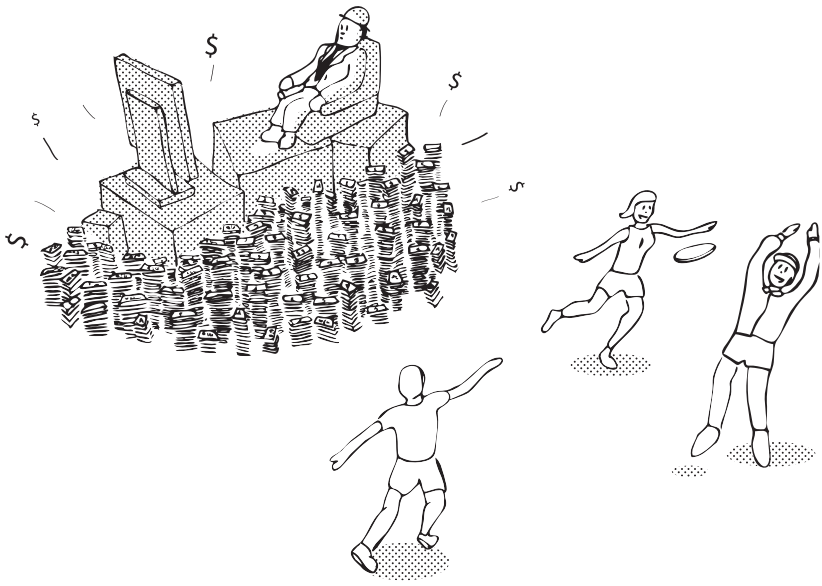
How we come to view quality of life in a less materially abundant world[5] will, of course, depend firstly on whether our basic material needs are being met. Under quite plausible scenarios, perhaps billions more people will experience significant material deprivation. The impact will probably be felt most directly in reduced water supply relative to demand. In turn this will lead to higher food prices.

For many people the principal concern will be survival. And for many governments it will be a scramble to minimize the hardship and maintain social order.[6] However, those fortunate enough not to face truly serious material deprivation will almost certainly leave behind a world where:

1. The material throughput of people's lives is anywhere near as high as it is now; and
2. One's status is closely tied to the ability to accumulate material wealth, almost regardless of how it was obtained or to what uses it is put.

While there will always be relatively rich individuals who will not feel the need to be frugal or to be seen acting so, it is difficult to see how most of society can avoid such 'soul searching' when it comes to social expectations, acceptable norms of behaviour, and how status is conferred. Even in higher income economies, the need to cut back will probably lead many, if not most, people to re-examine for themselves the appropriate balance of the material and non-material in what they see as constituting the good life. [7]

If, as expected, we find ourselves with a lot less 'stuff', we can, if we choose, compensate in several ways including enhanced social relationships and a greater focus on finding time to engage in personally-satisfying activities. The former would broadly involve a move to living less



'atomized' lives and in its place working to build more meaningful connections with friends, family, neighbours, and colleagues.[8] As noted in Chapter II, such relationships are what Adam Smith considered most important in determining the quality of life. Abraham Maslow calls this the 'love and belonging' tier in his hierarchy of needs.

A related aspect of what economists refer to as 'psychic income' could be a greater focus on one's sense of personal self-worth and accomplishment. These are Maslow's two highest tiers of need: 'esteem' and 'self actualization' (i.e. morality, creativity, problem solving). By placing greater importance on personal development, an individual's life can be made much more rewarding, with relatively little in the way of additional material resource requirements.

It would also serve us well to consider some of the downside of the lifestyles that will need to be left behind. One does not need to have a strong attachment to religion to sense that, in the end, materialism is unfulfilling. Lives spent in frenetic pursuit of ever more material abundance can be quite shallow. When we look for contentment in the things we have, satisfaction seems always to lie just beyond our grasp. The throughput economy is based on the continually reformulated promise that we can close the gap.

This would be sad enough if it were limited to individual choice. Unfortunately, it also tends to be reflected in social relationships. If having the latest things means we must work longer hours, there is less time (and energy) left over for friends and family, or even solitary relaxation. If the workplace undergoes periodic downsizing, our co-workers may be viewed less as colleagues and more as competitors. Taking on as much work as possible becomes normal work practice, while taking time to do quality work increasingly becomes viewed (by employee and employer alike) as an expensive and increasingly unaffordable luxury, removing yet another potential source of life satisfaction.

If there are jobs on offer, no matter how mind-numbing and offering such low pay that many people holding them are forced to work more than one job, the rest of society may feel little sympathy for providing services

such as welfare and child support. In short, a materially focused society arguably tends to be one in which the importance of relationships, whether personal or societal, is diminished.

In the modern world the social isolation of lives focused on material goods also tends to be reflected in physical isolation from the natural world. In higher income societies and among the fast growing urban middle classes of the newly industrializing economies, many of us spend nearly all our time in climate-controlled indoor environments, at home, on transport, at work, or in entertainment venues. The world 'out of doors' might be experienced in mostly brief episodes, largely through television, or occasionally in visits to parks, with their artificial reconstruction of nature.

The point here is not to argue for some type of back to nature movement. Most of us would not like that and the natural world has been so diminished and human numbers have grown so large, that doing so to any significant degree would only serve to further stress an already highly stressed biosphere. Instead, the point is to suggest how it was possible for humankind to have launched the sixth great species extinction in the history of life on Earth, not only unintentionally, but with most of us not even being aware that it is happening.

The types of changes that seem inevitable in the coming several decades will mean living in a world less focused on maximizing material throughput and less able to afford such pervasive indoor climate control. This in turn will mean becoming reconnected with the natural world.

Still, the transition is unlikely to be easy or even 'natural'. Around the world, most (though certainly not all) people when faced with the choice, seem to choose lives of greater material abundance over ones of greater 'belonging', 'self actualization', and connection to the natural world. It probably will take something extraordinary to move it in another direction. If social changes in wartime or natural calamity are an indication, the perception of imminent crisis can be a sufficient condition for such shifts (at least for a time).

As noted in Chapter III, we will also need to ask ourselves just how hard or soft our approach to sustainability should be. To what extent do we protect and cherish what remains of the natural world versus trying to compensate for its loss with ever more manufactured goods and services and imitations of natural environments?

THRIFT, EFFICIENCY, AND THE BUSINESS AND GOVERNMENT SIDES OF A NEW SOCIAL CONTRACT

Making a virtue of necessity is, of course, an old human habit. In times of widespread enforced belt tightening, even the materially well off may strive to be seen be as thrifty. Even if the form does not match the substance, such moves would be a useful change from today's often conspicuous consumption and fashionable accelerated throughput (e.g. for electronic consumer goods and clothing styles).

While 'thrift' focuses on needing less, 'efficiency' stresses the avoidance of waste. In a world of diminishing material resource abundance one can imagine efficiency, like thrift, eventually coming to be seen as a moral (and not just a financial) virtue.

On the business side, there is likely to be pressure for managers and company shareholders to acknowledge a broader set of environmental and social responsibilities. Or to put it another way, managers and owners of 'capital' would need their own values shift, for example by accepting responsibility for a 'cradle to cradle' system of resource management.[9] Indeed, in an environment in which the societal risks are as great as they appear to be, it would not be too much of a stretch to imagine far less acceptance by most people of 'amoral capitalism' and

instead an insistence on a stronger moral dimension to business decision-making.

As noted in Chapter VI, if the inevitably expanded role for government action is to be effective, the types of value shifts noted above for individuals and businesses will need to have a counterpart in a shift in the values held by governments. This will need to be true for those with the ultimate power (whether elected, self appointed, or 'pulling the strings behind the scenes'), as well as in their civil services.

In a sense, everything turns on values, or perhaps values turn everything, as suggested in the illustration at the beginning of this chapter.

ENVIRONMENTAL AND SOCIAL HEALTH

Another aspect of a shift in values might be toward more of a focus on environmental and social 'health'. For the environment this would means placing a higher value on clean air, water, and soil, as well as on protecting what remains of our diverse natural environment. The point here is that as a society we would need to appreciate more fully the importance of such things and come to view their enhancement as key to maximizing the quality of our own lives.

Put most simply, pollution is poison. As noted in Chapter I, each of us carries dozens of different persistent toxic compounds inside our bodies. The first question to ask is, why do we continue to tolerate this pervasive poisoning of the world and our own bodies? As part of a value shift to a world focused on development rather than growth, it would seem logical to expect that we would become less tolerant of pollution and of those in power who stress the costs of reducing it far more than they do the benefits.[10]

Protection of biodiversity will require being far more proactive in avoiding inadvertent species extinction. It will also require prevention of further human encroachment into areas harbouring pockets of species at high risk of extinction.[11]

Social 'health' as used here refers to such things as social cohesion and personal security (including 'a safety net' with respect to having a reasonable expectation that one's basic material needs will always be met). It would also involve providing opportunities for all people for learning and creativity, and for those with the talent and drive the potential for upward mobility, regardless of the class into which they were born.

The times ahead are likely to be tumultuous. In such times a stronger religious or spiritual focus would likely be one value response in which many people would take comfort. It will be important to allow people the freedom

to find and then follow their own spiritual paths. It will be equally important to ensure that the fervent are not able to impose their values on society as a whole.

The particular values that strengthen social health would vary from one culture to another. Indeed, within limits, the selection of and relative significance attached to particular features of social health would be culturally determined.[12]

THE MEDIA AND CIVIL SOCIETY[13]

In modern society, the media often play an important role in reflecting, and at times shaping (via the information they decide to convey), public opinion on particular topics.[14] For responses to the sustainability challenges humankind faces, this firstly will need to be a matter of conveying a sense of urgency about the need for change. So far, little is evident in this regard.

Nonetheless, the media have at least sensitized the public to the likelihood of major climate change (though not yet to the consequences of biosphere degradation) that will be felt decades and centuries from now. It is probably also fair to say that through the media much of the public is aware of the potential for unpleasant (though presumably in most people's minds, localized and intermittent)

climatic impacts closer at hand.

Arguably, with an already somewhat sensitized public, societal opinion about the urgency of the situation could develop quickly. The most likely trigger for such a change would be the occurrence of a major climatic event, such as prolonged drought, widespread pest infestation of crops, or particularly violent weather. What would then be crucial is how the media interpreted the weight of scientific opinion about the degree to which that event was a harbinger of what is to come.

The media also play a role in shaping notions of what actions are environmentally responsible and what are not. If there is a major shift in the public's perception about the urgency of responding to the situation, parts of the media are likely to enthusiastically take on the role of 'watchdog'. While this might be useful, so far at least, the media have not been particularly good at distinguishing those actions that have important but subtle impacts from those that are less important but highly visible. For example, the media tend not to report particularly well on the importance of energy efficiency codes for buildings and in urban design that minimize the need for artificial cooling or lighting, but do play up the benefits of things like the type of light bulbs consumers choose.[15]

Civil society (in the form of non-governmental organizations—NGOs)[16] also plays important roles in promoting public engagement and dialogue on sustainability issues. They also may provide information that the regular media may ignore or downplay. Indeed, often it is NGOs that bring issues sufficiently to the public's attention that the commercial (or even official government) media eventually feel they have no choice but to 'jump on the bandwagon'.[17]

NGOs can also openly play advocacy roles with regard to pushing government for action in situations where the media may be reluctant to be seen doing so, restricted from doing so, or simply do not want to get involved. Finally, with their stress on community involvement, activism, and advocacy, NGOs can play an important role in helping to shape an evolving set of social values.

In Hong Kong it has been local civil society (including elements of the business community) that have been proactive in raising public awareness about climate change and pressing the Hong Kong Government to prepare for coming changes in the way the built environment is constructed (as noted in the endnote above), and in lowering the territory's GHG emissions. This is not to say that in the absence of an active civil society the Hong Kong Government would have done nothing. Rather, it is to argue that the Government has gone as far as it has at

least partly in response to public pressure generated by an active civil society.

The media and civil society are noted here because they are likely to play an important role in the way societal and individual values evolve as sustainability challenges become clearer.

Value Shifts: A Will of their Own?

While potentially the most far reaching of the ways in which we might respond to challenges, re-assessing values also stands as the most unwieldy. As propagandists on the left and right, religious leaders, and those with utopian visions have learned, people can be swayed for a time, but ultimately values come from within. And just where particular types of values come from, and how embedded certain tendencies are in the human psyche rather than being the product of environment, remains, of course, a matter of on-going debate.[18]

And then there is z*eitgeist*—the spirit of the times—a pronounced shift in collective values that sometimes seemingly arises out of nowhere to lead whole populations or a particular generation to enthusiastically embrace quite a different worldview.[19] By their nature, the timing of such shifts is difficult to predict, as is the direction they may

take. The phenomenon is noted here not as a prediction but as a reminder that values can and do change, and not always incrementally. Hence, the collective human spirit of the coming decades need not necessarily be the same as it today.

It is, of course, comforting to think of such a possibility and to hope it would bring in its wake less materialistic lifestyles and other value shifts that allow humankind to have a good (and in some respects perhaps even better) quality of life even with fewer material goods, less ability to live in climate controlled environments, etc. The alternative might well be a long transition period in which conflict is common as people (and nations) scramble to get as much as they can for themselves of a shrinking material resource 'pie'.[20]

CHAPTER 7 NOTES

1 The half of the world's population living on less than US$2 per day already emit very little carbon dioxide and could not scale back proportionally. This means that the higher income half must make deeper cutbacks. For all those in higher income economies carbon dioxide emission cutbacks in the next 4 decades probably would need to be at least 90% if the world were to follow Nicholas Stern's proposed path for pulling back from the brink of climate catastrophe.

2 With a world price on carbon dioxide emissions high enough to induce sufficient reductions, the effects will for the most part be felt directly through much higher costs for fossil fuels. In addition to the obvious ripple effects on higher electricity and transport costs, real prices (i.e. even after adjusting for the effects of general price inflation) of manufactured goods will go up, as will those for chemical fertilizers and most crop irrigation, etc. Since much of the world's food production is dependent in varying degrees on pumped irrigation water, chemical fertilizers and on mechanized planting, weeding and harvesting, food costs will rise as well even without considering the effects of a changing climate on crop yields.

   There will be considerable inflationary pressure as a result. However, in order for the carbon dioxide reduction effects to remain in force, such higher costs cannot be allowed to be eroded through general price inflation. The affordability of carbon intensive goods and services will have to fall dramatically. While the greater use of renewable energy will help to cushion the blow, this will not be the case across the board. The world's energy system is almost entirely based on fossil fuels for the very good reasons that alternatives tend to be less efficient, convenient and versatile.

   Some things now commonplace for middle class consumers around the world probably will become luxuries affordable to only the few or to the middle class only on occasion. Consider two aspects of a

single example, jet transport. Food flown in fresh or frozen from half way around the world, along with discretionary air travel, went within the lifetimes of many of us from being luxuries to relatively commonplace. When priced to reflect the impact of the associated carbon dioxide emissions, at a minimum they are likely to again become far less a part of everyday life. While such examples are perhaps trivial in the larger scheme of things, they do serve as reminders that the impacts of the seemingly unavoidable coming of a high price for carbon dioxide will be pervasive.

3 One area where such values ultimately need to be reflected is in law. Coronier Segger and Khalfan (2004) identify 7 *emerging principles of sustainable development in international law* that, they believe, reflect a changing set of internationally recognized legal values.

To list some of them: (i) *the duty of states to ensure sustainable use of natural resources* (applied not only to resources within national boundaries and benefiting national populations, but to protection of common property resources that are the heritage of all of humankind); (ii) *the principle of common but differentiated responsibilities* (both with respect to the relative share of responsibility for creating the problem in the first place, and with respect to the ability of different states to materially address the problem); and (iii) *precaution regarding human health, natural resources and ecosystems* (the responsibility of states, even if there is a lack of full scientific understanding, to avoid undue risk to human health, the unsustainable use of natural resources, and ecosystem destruction).

4 Values useful for mitigation and for adaptation will, of course, often be closely related. For example, by coming to terms with the idea that a good life is not necessarily one with high material throughput, we not only promote the potential for our own personal happiness in a world with fewer material 'goods', we lay the groundwork for behavioural changes that reduce on-going damage to the planet.

5 While advancing technology will over time allow us to be less damaging in our use of the planet in meeting our needs (and many

of our wants), until such time as there are far fewer people for the Earth to support, there will be no escaping the need for reductions in average material and energy resource use. A planet-wide per person ecological footprint greater than one (which has prevailed for about two decades now) cannot be maintained indefinitely.

J. Sachs (2008) is relatively optimistic about the ability of technology and economic reorganization to provide a high *material* quality of life even as the world addresses the coming sustainability challenges. Lovelock (2009) and (2006) on the other hand is much more pessimistic.

6 In such circumstances, it is quite likely that there could be an initial, and perhaps prolonged, period of conflict as the allocation of the diminished resource base is worked out.

7 It is useful to remember that collective values can and do change quite noticeably in relatively short periods of time. Indeed, many of us alive today have witnessed major cultural value shifts in our lifetime. One broad refrain that is probably only partly a matter of selective memory is that in decades past people had far less materially but often had much stronger social relationships (family and community). It seems that as societies grew materially richer, they tend to grow less cohesive and supportive. Hopefully, the reverse will also prove true.

8 In the modern world, some this connection would, of course, be virtual rather than in-person.

9 See for example, Braungart, M. and McDonough, W. (2009), *Cradle to Cradle: Re-making the Way We Make Things*.

10 This is not to say that pollution can, or even should, be reduced to zero. The 'optimal' level of pollution involves reducing it to the point where the costs of *further* reduction would be greater than the *added* benefits of that additional increment of pollution control. Where this point would be is not a simple matter to determine. However, we can say with confidence that when the polluter does not pay for its pollution, it is almost certainly producing far too much of it. In other words, the polluter could probably lower its pollution output *at a cost to itself* that is less than the damage the polluter imposes on everyone else by emitting that level of

pollution. Issues of fairness aside, a zero cost on the polluter for creating pollution is wasteful from the standpoint of economic efficiency. Further descriptions of these points may be found in Barron, W., Perlack, R. and Boland, J. (1998), *Fundamentals of Economics for Environmental Managers*.

Over the last several decades environmental regulations have in effect begun to put a price on certain types of excess pollution. Yet we clearly have a long way to go.

11 Under conditions of embedded climate change or the passing of a tipping point (thus unleashing runaway effects, see Chapter II), there may be little we can effectively do to avoid further massive species extinction. However, we can stop (or at least considerably slow) the species loss resulting from the on-going transformation of the planet's lands for near-term human purposes. Sometimes such transformation is strikingly inefficient, as in the case of tropical deforestation to create grazing land for cattle to supply the fast food hamburger market, but where the local soil soon becomes exhausted. The grazing then is forced to move on, leaving behind an unproductive landscape where before rich ecologies had flourished.

12 For example, the relative balance between family and local community provision of help to those in need versus having it come primarily from the community-at-large (via legislated national or provincial social security systems) tends to be culturally determined. Similarly, there will be culturally determined differences in what is seen as the appropriate balance between personal choice and the responsibility to respect the values held by others.

13 As used here, 'the media' refers to organized providers of information such as television, radio, and newspapers along with commercial and NGO web-based sources of information. It does not refer to informal, highly personal ad hoc communications such as most blogs. Of course, as demonstrated following the Iranian election of June 2009, ad hoc communications can sometimes be a major primary information source for 'the media'.

14 This is certainly not to argue that the media necessarily always play the leading role. For example, in the building opposition in the United States to the Vietnam War in the 1960s, a major part of the

public had turned against the war even while the media still largely supported it. Nonetheless, when the media turned sceptical, they encouraged a much wider outpouring of public sentiment against the war. There is also the matter of how much trust the public puts in its media. Where there is suspicion of bias or that parts of the media are promoting particular agendas, the formal media may become less important than informal web-based communications or even word of mouth.

15 This is not to say that reducing the use of inefficient light bulbs is unimportant. Rather, the point is that designing to minimize the need to artificially (rather than naturally) heat and cool or light buildings tends to be of far greater significance in determining how much energy is used. Such tendencies on the part of the mainstream media may also reflect their perception that it is less risky to highlight individual responsibility than stressing the failure of the government and the business sectors to do what they can to bring about the bigger changes.

16 'NGO' is of course, a potentially very broad category encompassing professionally staffed organizations that have been in existence for decades (perhaps with a broad overriding theme but an evolving agenda), more narrowly focused advocacy groups, ad hoc volunteer groups and ones representing stages in between.

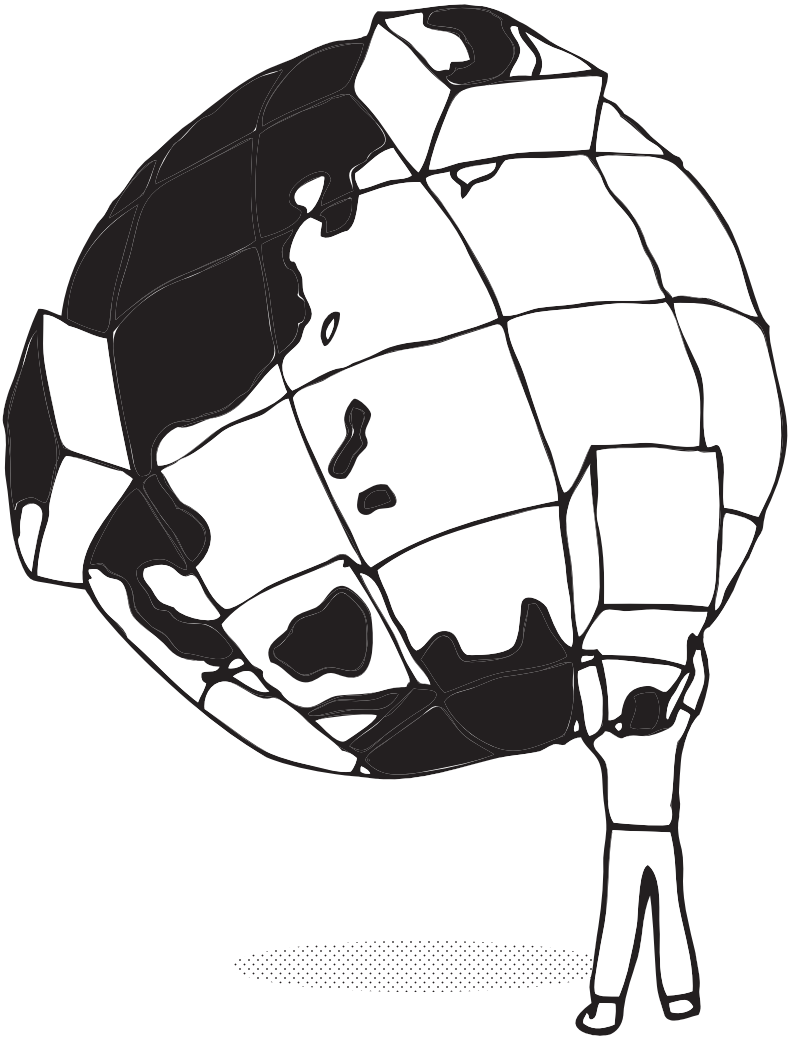
17 One example of this in Hong Kong is centred around the so-called 'wall effect' of buildings lining the harbour. NGOs stressed how such designs were encouraged by the Hong Kong Government's land sales policies, and that such policies significantly added to the city's worsening urban heat island effect. The NGOs pointed out how this ran counter to the Government's professed interest in lowering carbon emissions.

Publically the Government initially challenged the wall effect argument on scientific grounds claiming it was not significant. But slowly the Government began to modify lease terms on new land sales and eventually came to publically embrace the need to avoid the wall effect. How effective the steps taken so far by the Hong Kong Government to reduce future wall effects remain a matter of debate.

18 See for example, Garvey, J. (2008), *The Ethics of Climate Change: Right and Wrong in a Warming World*.

19 1848 and 1968 arguably are cases in point.

20 See for example, Lovelock (2006) and (2009); Flannery (2005); and Foster, J. (2008), *The Sustainability Mirage: Illusion and Reality in the Coming War on Climate Change*.



VIII. FITTING THE PIECES TOGETHER

If the world is to respond with any real effectiveness to the coming sustainability challenges, we will need to draw on each of the three broad categories of responses outlined above. In other words, the task is to weave together a strategy incorporating quite different approaches. Indeed, 'many of the above', if not necessarily 'all of the above', probably will eventually be called for.

The questions will be:

- Which responses should be employed at a particular time;
- What should be their relative weightings in the overall scheme of response; and
- To what extent will the process be one of crafting an integrated strategy, versus responding in an ad hoc manner as we muddle through?

The initial inclination will almost certainly be to stress technical fixes, with carbon capture and sequestration high on the list. While in principle technical fixes can be used to buy time to decide how to address underlying causes, in practice they may lessen the sense of urgency and thus weaken the impetus for on-going reform.

Putting a price on carbon dioxide (and later on all GHGs and on activities that undermine the long-term productivity of the biosphere) will be fundamental. This is something that only governments working together can do. Pricing carbon dioxide and broadly internalizing crucial environmental externalities takes advantage of the efficiency of markets. But at their core such moves are government-led interventions that use the market as a tool for attaining extra-market aims.

Still, in the end things like technical fixes and even internalizing externalities are largely matters of treating symptoms. They do not directly address the underlying cause of planetary stress. At the heart of the non-sustainably of the current economic model sits a structure in which asset values and employment depend heavily on the overall level of economic activity, hence the stress on throughput.[1]

It is a world in which wants and even 'needs' are seen as unlimited and the purpose of the economy is the Sisyphean one of working to satisfy the insatiable.

This would be sad enough in its own right. But to risk, in the process, undermining the stability of the climate and biosphere is nothing less than the ultimate folly.[2]

An economy condemned to forever grow must sooner or later find itself with too many people consuming too much stuff and generating too much waste to stay within key planetary boundaries. Advancing technology does not mean we are off the treadmill, merely that it can run faster.

In the last quarter of the twentieth century roughly a billion people (mostly in higher income nations) lived resource intensive lifestyles.[3] In the past two decades or so perhaps another half billion people in the rapidly expanding middles classes of newly industrializing economies have begun to take on similar lifestyles (albeit not yet at the same average level of throughput). On the sidelines, billions more aspire to stop being among the 'have nots' of this world and joining the 'haves'.

Yet, rather than being a picture of what the future likely holds for an ever larger portion of humanity, resource intensive lifestyles for whole societies seem destined to be a temporary phenomenon, soon to be part of history.

Population growth adds further pressure, of course. But since most of that growth is in lower income economies, the nature of the pressures is somewhat different. It tends to be largely a matter of the over-exploitation of

the biosphere and biosphere-based GHG emissions (e.g. from the removal without full replanting of fuel wood resources) rather than the use of fossil fuels.

Humankind need not live in poverty. But it will have to come:

- to value qualitative development and not so heavily stress expansion (growth);
- to focus on the quality and not merely the quantity of what is consumed; and
- not judge the quality of life largely by the level of material throughput, but on the basis of other criteria.[4]

Along the way, of course, there will be considerable pressures (e.g. food or water shortages) and probably strife. There will also be difficulties in getting the world's current population to agree to sacrifice now for the sake of future generations and to do so, not for merely for the length of a major war (i.e. years), but for decades. The issue of intra-generational versus inter-generational equity will be a consistent part of the dialogue.

The task is daunting. But humankind is resilient. We will adapt, but almost certainly need a different mindset. Crucially, this will need to involve:

- a willingness to take on and keep to a longer term perspective (i.e. with respect to the rights of future generations);
- acknowledging more fully humankind's dependence on the natural world along with a greater appreciation of the importance of non-human life forms; and
- the ability to make more out of less.

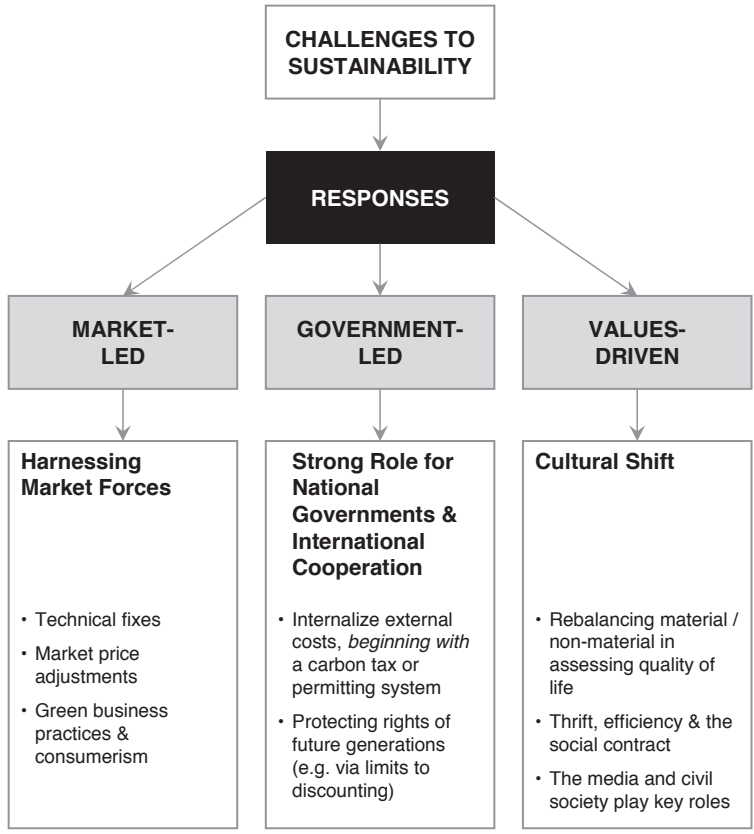


FIGURE 2: A FRAMEWORK FOR CONSIDERING RESPONSES
This figure brings together this book's major points regarding the ways we might respond to the sustainability challenges to our current way of life.

SUGGESTED PRINCIPLES FOR MOVING TOWARD A MORE SUSTAINABLE DEVELOPMENT PATH

1. RESPONSES TO THE CHALLENGES OF SUSTAINABILITY CANNOT FOCUS PRIMARILY ON TECHNICAL FIXES

- The relief they provide is welcome, but they treat symptoms not causes. There must be a move away from relentless growth in the demand for material resources.

2. GREEN CHEMISTRY IS KEY

- Broadly, much of what is produced needs to be reusable or made of materials that decompose into harmless substances (or preferably useful raw materials), and do so without significant inputs of non-renewable energy.
- Promote (and in crucial matters *require)* a cradle–to-cradle approach to production.
  - This will also greatly reduce the throughput behind what we usefully 'consume'.

3. EMPHASIZE GOOD DESIGN

- Good design is efficient, functional and aesthetically pleasing.
- It allows material parts to be readily reused, or recycled.

4. DISTINGUISH 'DEVELOPMENT' FROM 'GROWTH' AND PURSUE DEVELOPMENT

- Limits on planetary resources and the Earth's ability to absorb wastes mean that economies cannot continue to rely on maximizing material throughput to generate monetized 'wealth'.
- Once basic material needs are met, on-going 'development' should be largely directed toward fulfilling 'qualitative aspirations' with available material resources being directed to support that end.
- To the extent that greater material abundance is required, it should be created largely through more efficient use of the planet's renewing resource base, reuse of non-renewable resources, and greater reliance on human labour and ingenuity.
- Broadly, there needs to be far more emphasis on quality and services and far less on quantity and material goods in the mix of economic 'value added'.
  - This can be done in part through information technology.
  - It should also involve insistence on a cleaner and healthier environment (i.e. one in which poisoning of people and the natural environment becomes far less commonplace and when it happens must be explained and defended).

- In part it can be attained through a re-emphasis on the importance of social interactions, in sharing a strong sense of community, and the value of (and opportunities for) learning and creative expression for all (i.e. rediscover the potential for 'psychic income').

5. PROMOTE ECONOMIC EFFICIENCY BY INTERNALIZING EXTERNAL COSTS
- Including those associated with GHGs and biosphere degradation.

6. ACCEPT THAT THE PUBLIC SECTOR (NATIONAL & INTERNATIONAL) WILL INEVITABLY PLAY A MUCH LARGER ROLE IN SETTING LIMITS ON RESOURCE USE AND IN ORCHESTRATING ADAPTATION AND MITIGATION TO CLIMATE CHANGE AND BIOSPHERE DEGREDATION
- When governments do intervene, market-based incentives should be employed within strict bounds set by direct controls.
  - In a world facing serious near-term sustainability challenges, government, monitored by NGOs and the media, must set strict limits within which markets function and not rely entirely on incentives to encourage the necessary changes.
- Despite the risks of mismanagement and limits on personal freedom of choice, only governments can address massive market failures (both micro and macro) with respect to environmental externalities.
  - This will require considerable care to avoid overly centralized decision-making (and totalitarianism).
  - Within limits set by the need for concerted collective action, the aim should be to devise ways to ensure maximum individual freedom of expression and participation in decision making.

7. IN PLACE OF GDP, USE INCOME MEASURES IN THE FORM OF DOUBLE-ENTRY BOOKKEEPING (I.E. ONES THAT HAVE DEBITS AS WELL AS CREDITS) AND WHICH REFLECT UN-PRICED BENEFITS AND COSTS

8. INVEST NOW TO REDUCE FUTURE RISKS
- Take out more *insurance*.

9. EQUITY REQUIRES RESTRICTION OF MARKET-DRIVEN INCOME INEQUALITIES
- This need not imply communism or even socialism, but rather establishment of a robust social contract.

IN CLOSING

The 'elephant' of a changing climate and a disappearing natural biosphere *is* in the room. But, so long as he remains quiet, the risks his presence creates do not seem quite real, and so it is tempting to ignore his presence and simply get on with our lives. Meanwhile, some of us continue to prod and poke him and wonder if he is even alive. But hopefully, the dangers will soon be appreciated and we will stop provoking him and instead try to sooth the beast until the day, generations from now, when we might be begin to ease him out of the room.

Writers like Speth, J. Sachs, Stern, Flannery and Jackson hold out the prospect that this can be accomplished with the right approach and humankind may then move on to a better future. Lovelock believes it is too late for that but offers the prospect of what he calls a 'sustainable retreat', if action is taken soon. Wilson pleads for us to leave more of a diverse living planet for the generations to come.

Or perhaps we will only act when the elephant stirs enough to make the life as we have known it simply unworkable. Unfortunately, evidence to-date weighs in on this side.

When the decision is made to act, there is much that can rather easily be done, if only because existing inefficiencies

provide so much 'low hanging fruit'. The particular actions that are eventually taken will depend on many things.

The aim of this book is to help promote a clearer understanding of the situation, while offering a commentary on and preliminary critique of options for moving forward. Moving ahead will, of course, be an enormous task. Hence, the use here of the word 'responses' rather than the more confident sounding 'solutions'.

In the end, actual responses will be a combination of clear-headed planning and trial and error, along with ad hoc reflexive reactions to an evolving context. And even for the clear-headed strategies, the particular combination of responses will change from place to place and over time.

Whatever forms the responses take, if they are to stand a chance of preventing catastrophic damages to the habitability of the planet, the very act of effectively responding will involve a 'makeover' of human activities on a scale difficult to even imagine today.

But first, let's begin to talk about this elephant with which we share the room.

CHAPTER 8 NOTES

1 Perversely the point of production in such a model becomes not the output of useful or otherwise valued things, but ensuring fast replacement of whatever is produced so as to keep up the speed of the process of production itself. 'The cart before the horse' or 'the tail wagging the dog' might be appropriate metaphors here.

2 This point is noted by a number of writers in *New Scientist* (18 Oct. 2008), 'The Folly of Growth: How to Stop the Economy Killing the Planet'.

3 This figure was developed as follows: the population of the OECD countries, about 1 billion in 1999, (see OECD (2006), *Population*, Labour Force Statistics <http://www.oecd.org/dataoecd/62/38/35267227.pdf>) and assuming that the number of poor people in these economies was no larger than the number of middle and upper income people in the economies with much lower average incomes.

4 For example, by the quality of relationships with others, opportunities for creative expression and personal accomplishments, living healthier lifestyles in a cleaner environment, and living within a social contract in which everyone's basic material needs are met. It will not be a perfect world in which happiness is universal, but it can be a good world in which more people, generation after generation are able to lead satisfying lives, and do so while humankind lives within planetary boundaries. The question is how diminished will these boundaries be as a consequence of the actions and inactions of the present generation and the one that will soon take over?

ANNEX A

CARBON DIOXIDE EMISSION TAXES AND PERMITS:[1]
Definitions, Advantages, Limitations & Drawbacks

CONTEXT

Putting in place a workable global carbon dioxide emissions tax, a global carbon dioxide emissions cap and trade (permitting) system, or some hybrid system, will be a highly complex and contentious undertaking. The potential variations for the way in which either approach would be implemented are enormous and likely to be subject of protracted negotiations.

No attempt is made here to describe the likely administrative, legal, or technical complexities of putting an actual system in place on a global scale. Any system that will be able play a key role in bringing about carbon dioxide emission reductions on the vast scale required and do so in the relatively short time available would itself be the subject of volumes of commentary and analysis.

A global carbon dioxide emission tax and a permit system each have their own advocates. Also, it is possible to have

some combination of the two, such as a cap and trade system with the option (at some ceiling price) to pay a tax on excess emissions rather than bid for more. Advocates often argue for their choice by stressing what they see as practical or conceptual deficiencies in the other. Yet, in the end it would probably be fair to say that nearly all would agree that even what they see as second best is far better than leaving carbon dioxide emissions un-priced.

If we are to correct the greatest market failure *ever*, somehow, in some form, a price must be put on emissions of most GHGs, starting with carbon dioxide.

That price needs to come as soon as possible and be as high as we are willing to tolerate (and certainly high enough to substantially change market behaviour).

Starting from the above premise this Annex lays out the basics of a comparison between the two approaches for putting a 'price on carbon dioxide emissions', using generalized versions of each system (though noting along the way some possible variations).

This Annex does not make the case for one basic approach over the other, nor for specific versions of either approach. What matters is that something effective is put in place soon enough to make a real difference.

EMISSION TAXES

Definition:

This is a tax levied on each unit of output (e.g. a tonne of carbon dioxide). Ultimately, the tax would need to be internationally applied with severe penalties for non-compliance. While not every type of emission would need to be covered, a large majority of emissions would need to be subject to the tax.

In principle, the tax should be applied to all sources of carbon dioxide for which monitoring is practical and the same price applied to all carbon dioxide emitting activities anywhere in the world. In practice, it is likely that small emitters would be left out of the system. There would also surely be pleas for exemption on various grounds.

Advantages:

1. It imposes a cost on emitters for *each* unit of emissions and not those above some specified allowed level set by a standard or a technology-based control.
   - It encourages development of emissions-lowering technology and production processes so as to reduce the overall tax burden on the emitter.
2. If technological advances lower abatement costs, the tax continues to encourage emission reduction.

- In this, a tax stands in contrast to an administratively set emissions target or a requirement to employ a particular technology, under which lower abatement costs save the emitter money, but the emitter has no incentive to lower emissions beyond what is strictly required.

3. Compared to an administratively set emissions target or a requirement to employ a particular technology, an emissions tax tends to lead to the overall least-cost solution for attaining compliance.
4. Revenue from an internationally applied carbon dioxide emissions tax could be distributed in favour of lower income economies to help them adapt to climate change and fund capital investments to reduce the carbon intensity of their economies. Part of the revenue could also be used to lower other types of taxes in those economies paying the most tax.

Drawbacks & Limitations:

1. While emissions of carbon dioxide from the combustion of fossil fuels may be calculated with reasonable confidence, emissions from (or credits for) biological sources tend to be more problematic.
2. The initial tax rate might be set too low to have sufficient effect or so high that it has unacceptable impacts on economic activity. Also, general price inflation will erode the effectiveness of the tax, unless

the tax rate is periodically adjusted to maintain a particular level of 'constant dollar' impact.

Hence, in principle, the level of the tax must be readily adjustable.

- However, uncertainty about future tax levels complicates business planning and frequent changes in the level of the tax would likely be resisted by emitters.

3. Some people may feel that it is unjust for polluters to simply pay a fee for pollution, rather than being compelled to lower emissions.
4. In an expanding economy, a tax on carbon dioxide emissions will slow, but not necessarily stop, the further growth in emissions.

TRADABLE EMISSION PERMITS

Definition:

Regulated emitters of carbon dioxide must have a permit to emit a specified amount of emissions during a specific time period (e.g. thousands of tonnes per year). Permits would be valid for a specified period (e.g. 3 to 5 years). Under the types of schemes typically being considered, permits could be traded (sold) on an open market, even if the initial allocation was partly done administratively rather than by bid.

Total emissions of carbon dioxide from specific types of sources (e.g. the burning of fossil fuels), would be limited by a 'cap' on the number of permits issued. Firms emitting more carbon dioxide than they have permits for would be severely penalized.

Advantages:

1. As with a carbon dioxide tax, the permit requirement imposes costs on firms for all carbon dioxide emissions and not just amounts above an administratively set limit.
2. Thus, as with the carbon dioxide tax, there is an incentive for emitters to search for better technology and other means of carbon dioxide emission reduction.
    - Even if some permits were allocated to particular types of emitters free of charge, the efficiency incentive remains. So long as recipients can profit by undertaking further in-house emission reductions so as to be able to sell permits in excess of their needs, they will have an incentive to do so.
3. As with a carbon dioxide tax, permits lead to an overall least-cost solution for emission control.
4. Unlike the carbon dioxide tax under which emissions would tend to grow in an expanding economy, under a permit system new firms (or those wishing to expand carbon-intensive output) must purchase permits from existing firms or bid against others at the next permit

auction (i.e. total emissions remained capped, even in a growing economy).[2]

5. A permit system offers the potential for income transfers in several ways:
   - Firms in a developing country might be issued a certain number of permits at a reduced price or free of charge. As noted, recipients of administratively allocated permits still have an incentive to reduce in house emissions so they can sell part of their allocation.

     A variation on this would be for outside firms to provide assistance (e.g. by providing advanced technology) to the local firm so that it could reduce its emissions. The firm in the low income economy would then transfer permits to the firm from the high income economy which provided the assistance.[3]
   - Alternatively all permits could be sold at market prices, but a higher share of the internationally collected revenues might be distributed to the governments of lower income economies. For example, this might be done:
     - on the basis of average income alone;
     - to reflect the particular structured adjustments faced by newly industrializing economies; or
     - as added compensation for those nations facing particularly severe climatic impacts (e.g. from rising sea levels or droughts).

Limitations & Drawbacks:

1. How the initial permits are issued will be crucial and certainly contentious.
2. As with emission taxes, monitoring is relatively straightforward for fossil fuel use, but becomes more difficult if applied to biological sources and offsets.
3. As with an emissions tax, permits should be applied as far 'upstream' as possible to minimize the administrative complexity.
4. Falling costs of carbon dioxide emission abatement *will not* lead directly to lower emissions under a cap and trade permit system, but *will* lower the market price of traded permits.
    - With generally cheaper emission control, and a lower market price for permits, governments or NGOs could buy-up (and retire) some permits.
    - Lower abatement costs will also make it politically more acceptable for the permit-issuing authority to offer fewer permits for sale in coming rounds.
5. As with an emissions tax, some people may object that the permits grant a 'licence to pollute'.

TAXES VERSUS PERMITS

Taxes tend to be preferred when:

- **limiting the total cost of carbon dioxide reduction** is viewed as more crucial than attaining a particular cap on emissions;
- when it is anticipated that the cost of emissions reduction will substantially decline in the near-term; or
- if the effective implementation of a global tax is viewed as administratively more practical than that for a permit system.

Permits tend to be preferred when:

- **limiting total carbon dioxide emissions** is viewed as more important than controlling the total cost of abatement; or
- when prospects for falling abatement costs are matched by the political will to further reduce the number of permits.

WITH RESPECT TO BOTH

Carbon Dioxide Taxes and Permits

- Ultimately, a comprehensive international system will be required:
  - While a system of taxes or permits might begin as national or regional efforts, to have the needed impact they must rather quickly (in years not decades) become globally applied.
  - Considering that such an international body would collect and distribute rights to a vital economic asset and the scale of revenue involved, such an agency might, in effect, be a form of world government.[4]
    - This raises the matter of how the body will itself be managed, as well as how compliance rules will be set and enforced, revenues collected and distributed, etc.[5]
- Political will is crucial:
  - A carbon dioxide tax must be high enough to attain emissions reductions goals, and it must be adjusted as frequently as needed to attain substantial emissions in the face of either a growing economy or one experiencing general price inflation.
  - An international permit-issuing authority must be willing to limit the number of permits to a level meaningfully below what the economy would

otherwise emit. It must also be able and willing to reduce the number of permits issued each round in line with evolving emission targets.
    - The issuing agency must be willing and able to do this even in the absence of rapidly advancing emission control technology or availability of low carbon substitutes (i.e. even if reductions must come from cutbacks in economic activity).
- From the perspective of economic efficiency:
    - Both the emission tax and tradable permit systems tend broadly to lead to least costs solutions.
        - In this respect they are inherently more economically efficient than administratively set non-tradable caps or requirements to employ particular technologies.

A CARBON DIOXIDE TAX OR PERMIT SYSTEM

In a Broader Context

- With the above points noted, 'command and control' administrative approaches still have a major role to play in setting the broad limits within which market measures such as emissions taxes or permits operate.
    - For example, it may be most effective to simply ban certain types of fuels, such as the use of high

sulphur residual fuel oil for shipping or lignite (brown coal) for power generation.[6]

- Likewise, for biologically derived GHGs from deforestation and agriculture sources, market-based measures should be implemented only in the context of a far more effectively monitored and regulated land use system.

ANNEX A NOTES

1 *Annex A* draws from work that originally appeared in Barron, Perlack and Boland (1998).

2 Clearly, this capping feature is a highly salient point with regard to the comparison of permits and taxes when it comes meeting climate policy goals.

3 Most of the lowest cost opportunities to reduce emissions will lie in developing economies where inefficiencies are rife and technology often not up-to-date. In contrast, opportunities for further emission reductions tend to be harder to find and more expensive in economies in which firms that have long been subject to relatively strict environmental controls. In response, well-capitalized firms in these economies already tend to employ newer, more efficient technology. Removing more emissions from lower income economies than higher income ones therefore is efficient. So long as the higher income economies adequately compensate the lower income ones for doing this, it can also be equitable. Unlike pollution of local or regional concern, the benefits of GHG reductions are the same regardless of the particular part of the world where the reductions take place.

4 Regardless of whether one finds the prospect of some form of *de facto* world government acceptable to not, it would certainly be a 'game changer' on the world political scene.

5 It is likely that the implementing agencies would be national (and in turn provincial or local governments) working under the umbrella of (and ultimately answering to) an international body with clearly delegated enforcement and sanctioning powers. Such a body would have to have *at least* the powers of an organization like the World Trade Organization, and the legal basis would need to be in the form of 'hard' rather than 'soft' instruments (i.e. *laws* not declarations and statements of intent).

6 Except in the poorest of places where alternative sources are unaffordable.

ANNEX B

CONCEPTUAL LIMITS TO COST-BENEFIT ANALYSIS: Time-dependent Valuation and Shadow Pricing [1]

CONTEXT

'Discounting' (i.e. systematically lowering of the value we place on things that occur in the future rather than the present) and 'shadow pricing' (estimating what we think the value of something would be *if* it could be traded in the market) are both important, though sometimes controversial, aspects of benefit-cost analysis. For example what right do we have to put a low 'present value' on a cost we pass on to future generations? Likewise how do you put a price on the extinction of a species?

This Annex takes as a given that while the techniques economists typically employ for both time dependent valuation and valuing un-priced impacts are seriously flawed, there is no escaping the facts that:

a. people tend to put a lower value on things that occur in the future (and the farther in the future, the lower the value); and

b. there is often a need to compare the value of things that are un-priced with things that do have money prices.

Indeed, unless such points as *a* and *b* above are accepted it becomes quite difficult to apply economic principles to certain types of key environmental decisions. With that said, the premise of this Annex is that standard discounting and shadow pricing ('valuation') suffer from such severe limitations that their application should be carefully circumscribed. This Annex sketches the broad outlines of how this might be done for particular types of assessments.

DISCOUNTING

In benefit-cost analysis the value (positive and negative) of things that come in the future are assigned a lower 'present value' than they would be if those things occurred today. This is done by applying a discount rate. Real discount rates (i.e. those from which the effects of general price inflation have been removed) typically would range from about 2% to about 15%.

For example, consider a nuclear power plant being built today that at the end of its life (in say 50 years) would be 'decommissioned'. At decommissioning, considerable amounts of low-level radioactive waste will remain. The

safe disposal (e.g. entombment) of this waste would have significant costs. Let us assume by way of illustration that this cost would be US$500 million *if* we had to deal with it today. But since we will not need to deal with it for 50 years we can discount the cost. If we apply a 5% real discount rate, the present value is US$500 million divided by $(1.05)^{50}$ or US$500 million/11.47 = US$43.6 million.[2]

Considering that 5% is not a particularly high rate of discount, it is obvious that anything happening in 100 years means very little in present value terms (at 5% a mere 0.008% as much as we would value it, if we had to pay for it now).

The theoretical arguments in support of discounting are rooted firstly in presumptions about economic growth and rising wealth.[3] For the past one hundred and fifty years or so virtually all succeeding generations (at least in higher income economies) have been materially richer than their parents' generation. Hence, so the argument goes, coming generations can afford to pay the costs of clean up more easily than we can pay afford to avoid imposing such costs on them in the first place.

Another argument is the familiar one of advancing technology. It is often presumed that technological development will continue at least as fast as it has for the past century and a half. Thus, so the argument would go, cleanup in 50 years will presumably be easier and less expensive.

Finally, there is what economists refer to as 'pure time preference'. People simply value more highly consequences (positive or negative) that occur sooner over those that occur later.[4] Impacts on ourselves or our children therefore are valued more highly than those on felt by as our as yet unborn great-grandchildren. This tends to be true even if there is little or no uncertainty with regard to the fact that the impacts will come.

Discounting is as firmly embedded in government benefit-cost assessments as it is in private sector financial ones.[5] Yet when considering the massive, long-term impacts current economic decisions are having on the planet's habitability, it seems foolish in the extreme to fail to question the validity of standard discounting as a near-universal accounting convention for benefit cost analysis.[6]

We need to ask if the use of a discount rate is a valid way to evaluate the impacts our economic decisions today will have on future climate, or on the ability of the biosphere to continue indefinitely to provide crucial ecological services.

This point is considered below. But first we take a look at shadow pricing and consider it together with discounting with respect to how their limitations might be 'sidestepped'.

SHADOW PRICING

Another fundamental limitation of standard benefit-cost analysis is the conceptual limits to 'valuation'. Typically in benefit-cost analysis, un-priced values are assigned a shadow price. The most basic would be 'direct costs'. For example if someone is sick enough to visit a doctor, the minimal monetary equivalent value of the illness is the money spent on visiting a doctor, buying medicine, etc., plus loss wages.

There are also so called 'hedonic prices' in which markets are used to determine how much people actually pay for some environmental value. For example, if a flat with an expansive and pleasant view sells or rents for more money than a similar one with a more constricted or less appealing view, then we can begin to estimate the market value of a good view for one's home.

And then there are so called 'contingency valuations', typically estimated through willingness to pay surveys.

Direct cost evaluations, while relatively reliable, are highly limited and in all cases represent quite minimum estimates of value. Hedonic pricing is plagued with issues of comparability (i.e. how to control for factors other than the difference in view out the window). Willingness to pay (or willingness to accept) surveys, while potentially

all encompassing, are plagued by issues of validity, both with respect to the honesty of the answers (i.e. the temptation to tell the interviewer what the respondent believes he or she wants to hear), whether the respondents truly understand what they are being asked, and if the questions are framed in a meaningful way (e.g. how much are you willing to pay to save a particular species from extinction).

SIDESTEPPING

However, in selected cases, we can sidestep the discounting process and concerns about the ability to develop meaningful shadow prices by refusing to assign a monetary value to those impacts with the most serious sustainability consequences (or risks). Where economists would typically set about estimating shadow prices for un-priced impacts and then discount such values when they occur in the future, it is possible instead use to the political process to frame the decision as one of:

> ***'are we, or are we not, as a society willing to forgo $X amount of profit to ourselves today***
>
> ***so as to avoid imposing a cost of Y on a future generations?'***[17]

Notice that the Y here is not expressed as a monetized value.

This decision need not, of course, be limited to 'go or no go' decisions for an entire activity. It would more commonly be applied when comparing different versions of a proposed project.

Consider for example a project to build waterfront apartment buildings. Let us assume that project *Version A* has a Net Present Value (NPV) of US$1 billion but due to the lack of space between buildings would reduce air flow to the buildings behind. This in turn will add to summer cooling costs in those buildings and reduce dilution of pollution from traffic there. Now consider project *Version B* which, let us say, has an NPV of US$950 million and due to its lower density and wider spacing between the new buildings has minimal impacts on air circulation in the neighbourhood behind the new waterfront complex. The trade-off assessment decision then becomes one of:

> ***is preventing the reduced air flow (and associated heat and pollution build up) now and over the entire life of the existing neighbourhood worth enough to us that we agree to forgo US$50 million for their sake?*** [8,9]

While framing it this way is obviously no guarantee of a thoughtful decision, this approach at least sets out the issues clearly. The alternative would probably be to ask economists to develop shadow prices for the direct health costs of the poorer ambient air quality and the need for additional air conditioning. The economists would then sum and discount the annual stream of such costs year after year for forty years. This summary value for monetized added costs would then be compared to the foregone US$50 million. This result would then likely be subsumed within the overall benefit-cost analyses for projects *Version A* and *Version B*. The decision maker would likely focus on which version had the larger NPV. The impacts of that decision on public health and energy usage would become merely two of the many details of project design, rather than a particular focus of the decision.

In a world that seeks to aggressively lower its carbon dioxide emissions, the ability of urban areas to do that will depend in large part on how much energy is required to cool the 'built environment'. Decisions made today will have effects for decades to come. In light of this, it would seem appropriate to explicitly consider the value of passive cooling in anticipation of such effects taking on more and more importance over the useful life of the buildings.

Broadly, the point being made here is that due to the inherent conceptual limitations of benefit-cost analysis, both with respect to standard discounting and, in many cases, the ability to develop meaningful shadow prices, governments should not rely on it too heavily.

This is particularly important when evaluating major, long-term sustainability concerns.

In closing, it is important to reiterate that what is being recommended here is a *selective withdrawal* from standard benefit-cost analysis, not a wholesale rejection of it. What is being suggested is a modified form of benefit-cost analysis in which for certain types of major projects the *monetized part* of project analysis is stopped before it subsumes crucial sustainability concerns evaluated under questionable assumptions and conceptually flawed techniques.

The suggested approach allows an explicit trade-off assessment among project alternatives between differences in monetized present value compared to differences in un-priced impacts (or even the risk of them occurring).

ANNEX B NOTES

1 Annex B draws from work that originally appeared in Barron, Perlack and Boland (1998).

2 Again it is important to stress that this calculation has nothing to do with general price inflation. It is about discounting the value, *not* the price, of something occurring in the future.

3 The most basic rationale for discounting is that if instead of paying US$500 million today, we took only US$43.6 million and invested it in an economy growing annually at 5%, that US$43.6 million would have grown to US$500 million in 50 years. The crucial caveat economists add is that it is not actually necessary to put aside US$43.6 million and let that earmarked 'set aside' grow. Rather, all that matters is that the overall economy, or the wealth of whoever is responsible for meeting the cleanup costs, grows at 5% annually.

4 This has nothing to do with money. Consider this: which would you be more concerned about, a warning from your dentist that you will need unpleasant dental next week or in about 10 years? Part of your personal answer might have to do with uncertainty (i.e. if my teeth are okay for 10 years, perhaps they will be okay for longer, or maybe I will be dead in 10 years), but part of it is likely to involve the human tendency to not value something as highly if it is postponed into the future. And the farther into the future, the less we value it.

5 The major difference between public sector benefit-cost analyses and private sector financial analyses is that while benefit-cost assessments attempt to put a shadow price on some un-priced benefits and costs and adjust market prices to remove the effects of taxes or subsidies, private sector financial assessments deal *strictly* with things that are priced and use the prices seen by buyers and sellers in the market (with certain possible exceptions such as attempting to account for the value of such intangibles as consumer brand recognition or brand reputation).

6 The use of any particular single discount rate for vastly different types of benefits and costs and applied over vastly different time scales, is arguably not only overly mechanistic but highly simplistic.

7 Such a statement would be anathema to the vast majority of economists for whom the last thing they want is the substitution of political 'feel' for 'analytic rigour' of economics (even if such rigour might often be more apparent than real).

8 Remember this is a government benefit-cost assessment where the *net public good* should be the basis of making the decision not how the benefits and costs are distributed among the government, the project developers, the new flat owners or those living in the existing neighbourhood behind the new buildings.

9 Likewise by framing it this way we avoid the need to *explicitly* discount the value of the quality of life impacts on those who will live in the existing neighbourhood decades from now.

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Yes, the warnings are dire, and time is short, but...

Little connection exists between:

- The weight of scientific opinion about the real *urgency* for radically changing the way we use resources and emit wastes and
- How markets continue to function, governments plan, the lives so many of us lead ... and so many more aspire to.

It is as if the two sides live on different planets.

—

The world economy is increasingly geared to *throughput*,

- Underpinned by an assumption that given the right technology the raw materials and waste disposal potentials are effectively unlimited.
- Governments see a slowing of the throughput as a crisis. Our economic system is addicted to growth (as quantitative expansion), not focused on development (as qualitative progress).

—

This book lays out in clear language the challenges to the sustainability of the current economic system. It then considers possible market, government, and values-driven responses.

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