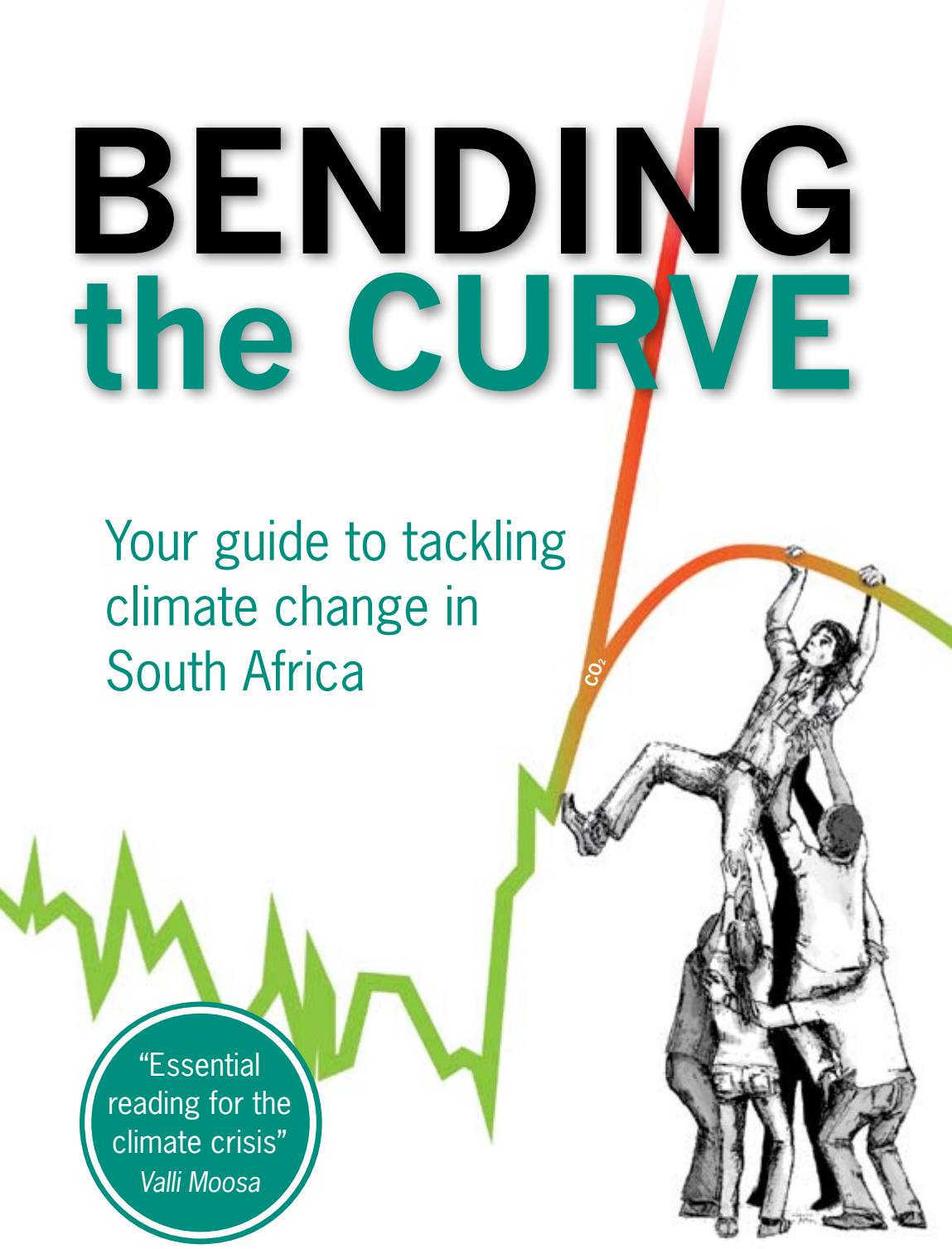
BENDING the CURVE

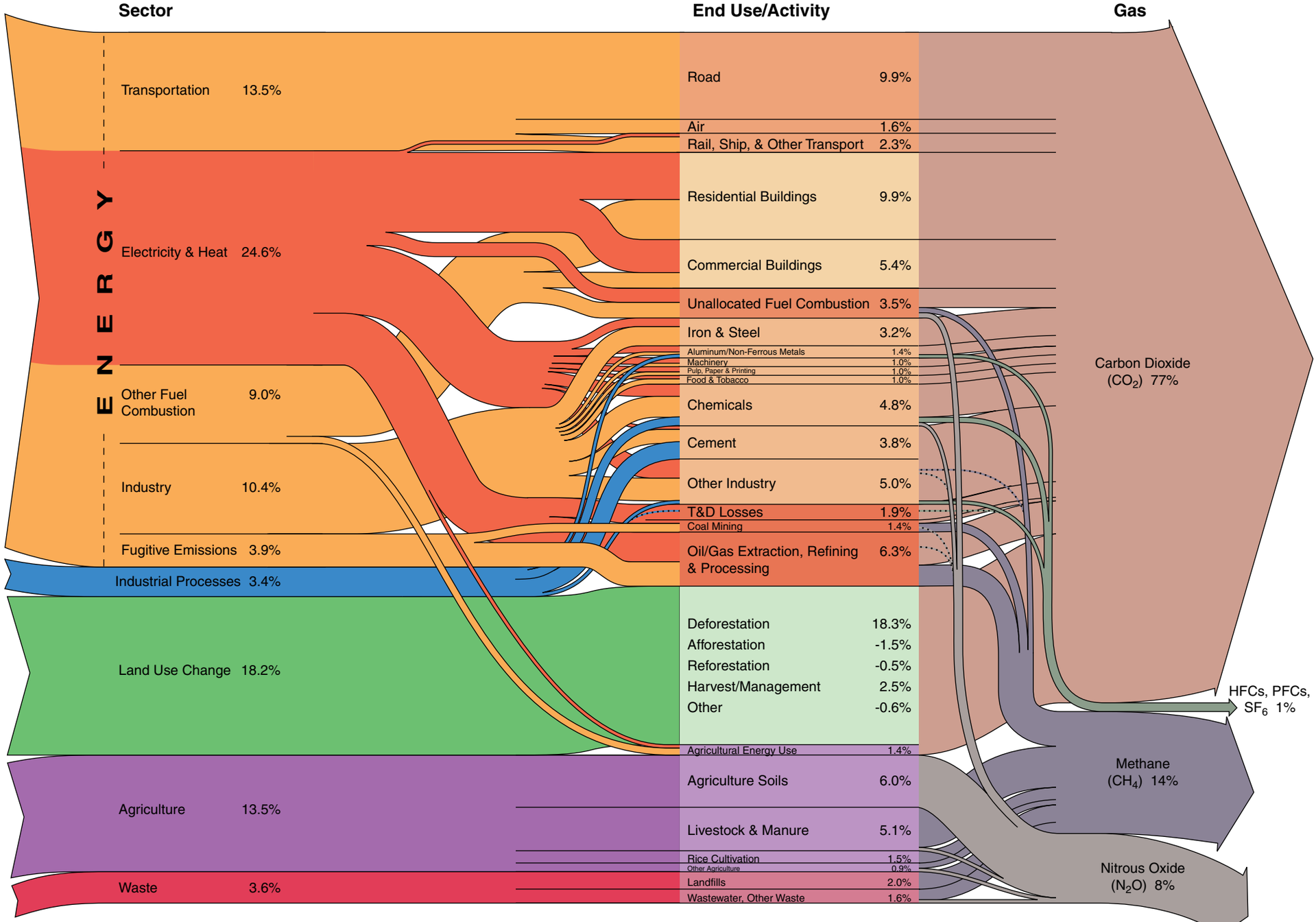
Your guide to tackling climate change in South Africa



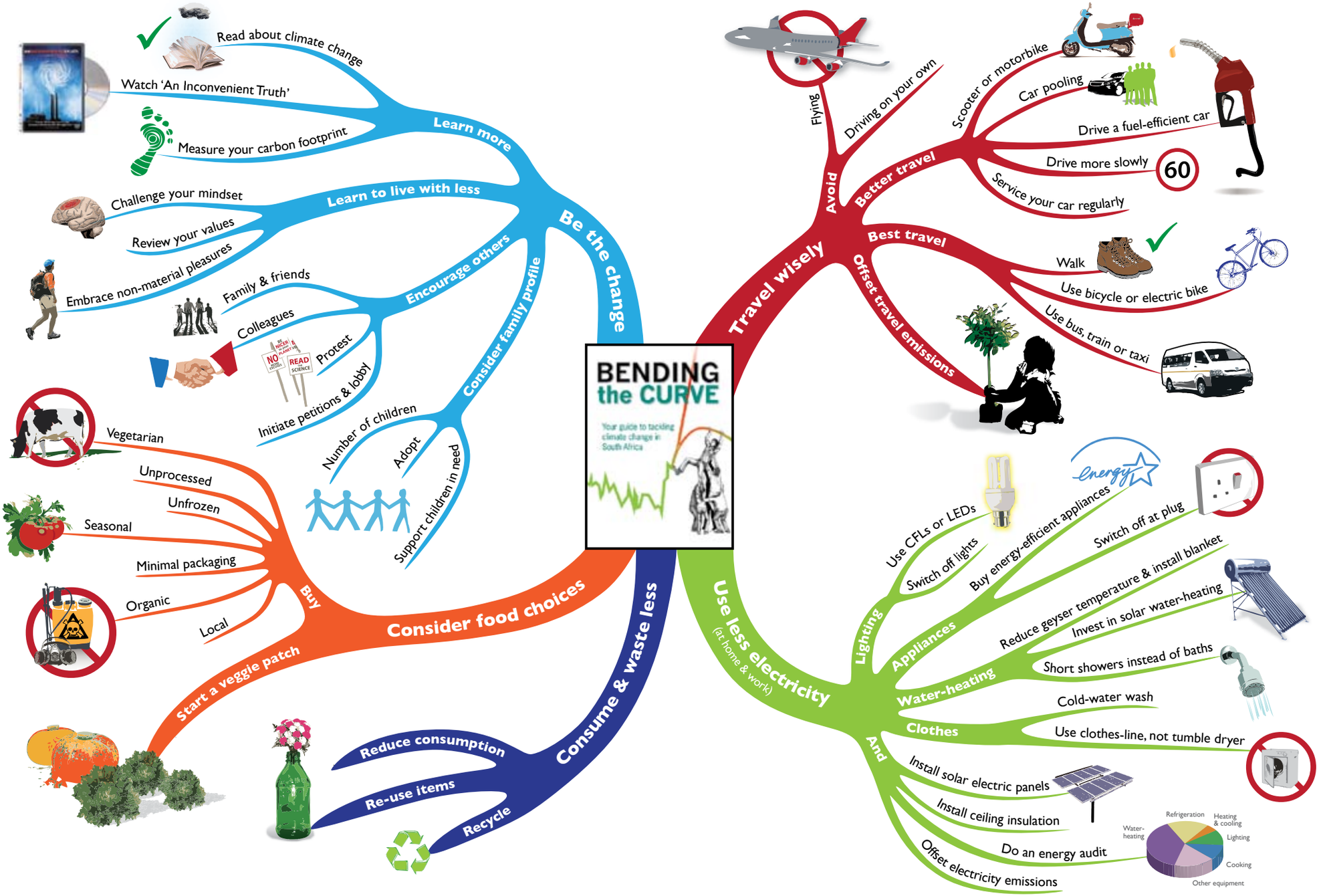
"Essential reading for the climate crisis"
Valli Moosa

Edited by Robert Zipplies
Foreword by Marthinus van Schalkwyk

World greenhouse gas emissions flow chart (the “spaghetti chart”)



Sources & Notes: All data is for 2000. All calculations are based on CO_2 equivalents, using 100-year global warming potentials from the IPCC (1996), based on a total global estimate of 41 755 Mt CO_2 equivalent. Dotted lines represent flows of less than 0.1% of total GHG emissions. Land-use change includes both emissions and absorptions. For more information and detailed descriptions of sector and end-use/activity definitions, as well as data sources, read the World Resources Institute’s “Navigating the Numbers” report at *www.wri.org*. **See Chapter 9 for more information**.



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Click on to purchase the hard copy of *Bending the Curve*, at a special rate (R175/US$35).

Edited by Robert Zipplies
Foreword by Marthinus van Schalkwyk

AFRICA Geographic

Book description:

Climate change is now accepted as a global emergency that poses a very real threat to our lives and livelihoods. Change at almost every level of society is needed, and we as citizens, consumers, family members, employers and employees have our work cut out for us. Co-authored by 24 South African experts, *Bending the Curve* will help you move from deliberation to action.

Kicking off with a brief overview of the most recent climate change and environmental facts as they relate to South Africa, *Bending the Curve* leaps quickly into the practical. Whether you are a parent or farmer, a government or corporate employee, an architect or educator, you will find a wealth of ideas for making profound changes at work and in your personal life that will improve the lives of everyone and help to tackle this scourge. There is no time to lose. Get started now.

ROBERT ZIPPLIES consults to organisations wishing to deepen their environmental and social commitment. Previously, he worked in venture capital, Internet payment systems, management consulting and the steel industry. However, a growing concern about the dire state of our environment and society, and an ongoing search for greater meaning in his work, led him to take up sustainability consulting, where he worked with Incite Sustainability until recently. He spends much of his spare time outdoors, and can often be found hiking and climbing in the mountains around Cape Town.

AUTHOR PHOTOGRAPH: JANINE LESSING

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This book is dedicated to

You who have for so long implored us to take a more sensible path.
You who are committing yourself to reshaping our social norms
and healing our ailing planet.
You who are young and yet to come.
You must bear the brunt of our excesses.

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Acknowledgements

When I developed the concept for this book, I had hoped to have it on the shelves within nine months or so from beginning work. Not so. It has been a mammoth undertaking and the number and diversity of people who have co-authored and otherwise contributed to its creation stand testimony to the enormous effort invested.

I am most greatly indebted to the contributing authors who invested many late nights – all far beyond their and my initial expectations – to write their chapters. My co-authors are deeply committed individuals who, in their professional spheres, campaign for better environmental stewardship, conduct valuable research and work with government, corporations and communities to further sustainability practices. In their private spheres, they live what they preach, striving to reduce their footprints by minimising consumption levels, driving small vehicles, cycling, and using energy and water sparingly. For many of us, this book has further deepened our commitment to live more lightly on our precious planet.

Particular recognition goes to Leonie Joubert, who was originally to co-edit this book, but was then awarded the 2007 Ruth First Fellowship. Despite her many obligations, she dedicated much valuable time to help shape and contribute to this book. Special thanks also goes to Linda Scott and Roger Diamond, who jumped in at late stages to help write additional chapters or parts thereof and assisted on various other fronts.

Bridget Farham did a sterling job of editing the manuscript. Brenda Martin and Jessica Wilson were invaluable in providing comments on draft chapters, which has made this book a more complete and better-rounded read. To the professionals at Africa Geographic – Cindy Armstrong, Judy Beyer, Alessandro Bonora, Peter Borchert and Sarah Borchert, Barbara Breytenbach, amongst others – their support, design and content ideas, editing and proofreading, amongst other contributions, added much value. It was a pleasure to work with such an enthusiastic team.

There are numerous others who contributed design and content ideas, provided reading material and introductions, assisted with writing elements of chapters, proofread or reviewed sections, provided inspiration and ongoing moral support and otherwise gave of their time. These include Lynton Burger, Stephen Davis, Monica Graaff, Jonathon Hanks, Dr John Hanks, Jack Hochfeld, Beau Horgan, Denis Inskip, Ryan Jordan, Barry Kantor, John Ledger, Janine Lessing, Leila Mahomed, Alison McCallum, Ian McCallum, Duncan Miller, Guy Midgeley, Stefanie Midgeley, Natanya Mulholland, Steuart Pennington, Nicola Robins, Daniel Robinson, Bob Scholes, Katya Soggot, Roelien Theron, Sue Taylor, Andrea van Meygaarden, Vera von Lieres, Peter Willis, Christina Wood, Gina Ziervogel and Stephan Zipplies. My sincerest apologies if you should see yourself listed here but don't. Thank you, also, to Buzan's iMindMap for the use of its software in designing the mindmap.

And lastly, considerable gratitude is due to the five main sponsors: AfriSam, De Beers, Eskom, Exxaro and SAB. AngloGold Ashanti and Project 90x2030 also provided essential sponsorship. Writing a book of this nature is something that could not have happened without this financial support.

Message from the sponsors

It is now generally accepted as fact that our use of fossil fuels, as well as our agricultural practices and deforestation, are contributing to dangerous levels of climate change. Managing this issue has become an urgent concern for our global society. Reducing energy consumption and greenhouse gas emissions is an international priority, and it must become an urgent day-to-day consideration for everyone, whether at personal, organisation or government levels. But efforts must not stop there; we must also tackle broader environmental issues, some of which will be exacerbated by climate change, particularly our country's growing water scarcity and the ongoing loss in biodiversity.

In addition, it is our duty as South Africans to assist proactively those in our community who are ill-equipped to cope with the inevitable climatic and economic changes. The 2007 Intergovernmental Panel on Climate Change (IPCC) report highlights the vulnerability of the poorest communities and countries, especially in Africa. Repercussions such as food and water shortages, changing disease patterns and rising temperatures are likely to be felt most acutely by the poor. Their lack of resources and their dependence on their immediate natural environment for food and water supplies place them at most risk.

We must now act collectively, creatively and decisively in responding to climate change, without undermining our ability to continue the urgent work of transforming our society.

Communicating climate change to all sectors is essential to allow appropriate decision-making in business, communities, government and as individuals. We are committed to tackling climate change while continuing to secure economic benefits for our shareholders and the communities in which we operate. We have supported the writing of this book, because we believe that it helps to raise awareness and is an invaluable resource to those committed to reducing our environmental impact.

Author biographies

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Leonie Joubert is a widely published science journalist and author of *Scorched: South Africa's Changing Climate* and *Boiling Point*. Leonie contributed to the 2007 John Platter Wine Guide and co-authored the new Environmental Management Plan (EMP) for the Prince Edward Islands Special Nature Reserve. Leonie has a BA in journalism and media studies (Rhodes), an MPhil in journalism (Stellenbosch) and was the 2007 Ruth First Fellow (Witwatersrand University).

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Stef Raubenheimer is a lawyer (BA, LLB), an arbitrator, mediator, facilitator and trainer and is also CEO of SouthSouthNorth (*www.southsouthnorth.org*), which has played a leading role in climate change since 1999. He facilitates large projects, notably the South African Cabinet-mandated Long Term Mitigation Scenario Planning Project (LTMS). Stef has helped establish several African Designated National Authorities, has undertaken projects for the Development Bank of Southern Africa and is a senior associate of the Cambridge Programme for Industry.

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Linda Scott studied epidemiology and genetics at Oxford University, graduating with an MA in 1981. She has earned an MSc in nutritional medicine at Surrey University and is currently conducting doctoral research with the Desmond Tutu HIV Centre and Surrey University to assess the effect of selenium on HIV disease progression. She has co-authored three books on nutrition and has written widely about the role of nutrition in preventing and treating disease in both professional and lay publications.

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Johan van den Berg is the founder and CEO of CDM Africa, a specialist advisor to CDM project developers, and presently advises nine projects in South Africa, Kenya and Uganda. He has lectured on CDM courses at conferences and universities and facilitated the first international CDM conference in southern Africa. Prior to this, Johan practised as an advocate at the Cape Bar for 10 years, specialising in environmental law. In 2000, he moved full time into climate-change work.

Jeremy Wakeford is an independent energy and sustainability consultant. He has Master's degrees in economics from the universities of Cape Town and Cambridge. Until recently, he was a senior lecturer in the School of Economics at UCT. Jeremy's research emphasis has been energy and sustainable development, with a focus on the socio-economic implications of global oil depletion for South Africa. He is Research Director of the Association for the Study of Peak Oil South Africa.

Harald Winkler is Associate Professor at the University of Cape Town's Energy Research Centre, here writing in his personal capacity. He holds a PhD and MA (UCT) and an MSc in energy and resources (UC Berkeley). He has worked on long-term mitigation scenarios for South Africa and policies for renewable energy and energy efficiency. Harald was a lead author on IPCC AR4 Working Group III on mitigation and sustainable development, and is a member of the country's delegation for the UN Framework Convention on Climate Change negotiations.

Richard Worthington is coordinator of the Sustainable Energy and Climate Change Project (SECCP) at Earthlife Africa (ELA, *www.earthlife.org.za*) in Johannesburg and also coordinates the South African Climate Action Network (SACAN, *www.climatenetwork.org*). ELA is a civil society organisation working on environmental and social justice issues. He has also served on the board of the global Climate Action Network (CAN) from 2003 through 2007. Richard has a BA (University of Witwatersrand) and a BSc (Hon) in energy studies (University of Johannesburg).

Robert Zipplies consults to organisations wishing to deepen their environmental and social commitment. Previously he has worked in venture capital, Internet payment systems, management consulting and the steel industry. However, a growing concern about the state of our environment and society led him to take up sustainability consulting, where, until recently, he worked with Incite Sustainability. He has an MSc in industrial engineering (University of the Witwatersrand) and an MBA (Rotterdam School of Management, Netherlands).

Foreword

Marthinus van Schalkwyk
Minister of Environmental Affairs and Tourism

It is exciting to see a home-grown South African book, such as this, emerging to influence the debate and future course of individual and societal action on climate change. It attests to the gratifying increase in interest and concern on this issue. In this country, world-class research has moved rapidly from the academic arena to that of policy influence – and a book like this injects the findings and ideas that have resulted into the sphere of public response and involvement even more forcefully. I am proud that our government, business and civil society response has placed South Africa amongst the leading voices in the international debate on climate change – *Bending the Curve* will help to raise our response even further.

Whether it is natural disasters, which happen with increasing frequency and severity around the globe, or human conflict arising over the competition for resources, the impacts of climate change are global phenomena that continue to make world headlines. Africa will come under particular pressure due to rising temperatures and shifting weather patterns. But it is sometimes difficult for South Africans to relate these alarming projections to their own lives, and to know what effective options may be available to them.

Let us not delude ourselves. Climate change is here and poses a very real threat to the development of our societies – we know with certainty that this and future generations will live in circumstances dictated by actions taken now. The effects do not respect national boundaries, reminding us that we are part of a global community that must work together to resolve the predicament brought on by two centuries of escalating atmospheric pollution.

Some global leaders have dithered over this issue, while a number of corporate and political voices have downplayed its severity until recently. We now find ourselves with no time to spare. The most recent research available tells us that the "carbon space" is finite. A total of 70% of this has already been used up – largely by developed countries. The dispensation for equitably sharing the remaining 30% of the available "safe" carbon space must recognise historical responsibility for the problem, and the growth imperatives and development aspirations of developing countries.

Climate change with inadequate action would mean a world with increasing flooding, drought, heatwaves, famine and disease. Human suffering, worsening poverty, and even political and economic instability would affect all global citizens. These effects would be exacerbated in South Africa and the rest of Africa, where many people live in informal settlements, on subsistence agricultural land and on the edge of the formal economy. The changes would certainly harm most those who are least able to adapt and least able to afford the impacts. The wealthy no longer have the luxury of closing their minds to the devastating impact of what is happening in the fragile atmosphere that envelops our planet.

We all therefore have a moral obligation to act now to prevent this climate crisis from becoming unmanageable. The science is clear. Global emissions must peak and decline within the next 10 to 15 years. In order to achieve this, each and every one of us will have to make a contribution.

As formidable as the climate crisis is, it presents us with a tremendous opportunity. It gives us the chance now to make a choice to live in greater harmony with our planet and to strive to create a more balanced society. Economic growth and development is not incompatible with ambitious climate policy. There are many opportunities in the emerging carbon-constrained economy to build new industries that turn our comparative advantages into competitive advantages, to create new jobs and new incomes. I encourage South Africans to read this book and to take its recommendations to heart, as its pages are bursting with suggestions about how we can overcome this problem as part of a pro-growth, pro-jobs and pro-development climate policy.

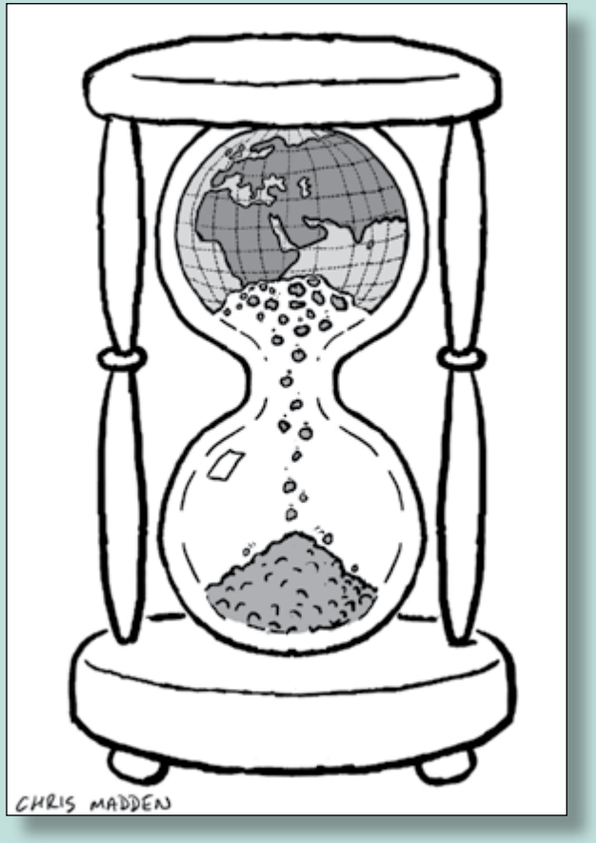
Our government has already committed to putting in place fiscal, regulatory and legislative policies and measures that will pave the way towards a low-carbon economy and society. Corporations must transform their practices and build new climate-friendly industries. Individuals must reduce their carbon footprints and lobby for change.

I appeal to all of you to assist us in our efforts to reduce the emissions caused by ceaseless consumption, flying, driving and use of inefficient electrical appliances. Let us also ensure that we take responsibility for the members of our society who are least to blame for this problem and are ill-equipped to cope with the impending changes – they are the innocent bystanders.

Let us work towards the greater good of all global citizens and our planet.

July 2008

environment & tourism
Department:
Environmental Affairs and Tourism
REPUBLIC OF SOUTH AFRICA



Humanity must act collectively and urgently to change course through leadership at all levels of society. There is no more time for delay.

United Nations Foundation on confronting climate change

1

Introduction

Robert Zipplies

Humanity is gradually awakening to the climate crisis and is starting to take action. However there is little time to spare, and all of us must contribute to this effort. This book explores what we as South Africans, irrespective of our roles in society, need to do about climate change.

Chapters 2 to 6 provide a comprehensive overview of the crisis and include a description of the latest research findings regarding our state of the environment and climate change. This is followed by a review of the broader socio-economic implications and a reflection of what we have done to bring about this crisis.

From here we move on to describe how each of us can become part of the solution, what actions we need to take as a society to prepare for and tackle climate change, what emissions South Africa is responsible for and what national mitigation efforts are required in the energy sector. The remaining chapters then explore the actions that need to be taken by specific sectors of society and with respect to particular issues such as transport and waste. Chapters each begin with a short abstract and end with a "Resources" list of recommended further reading.

In South Africa, when a new dinner-table topic successfully competes with dicussions of crime, corruption, soccer and rugby, we know it is important. 2007 is notable for being the year in which the issue of climate change went mainstream, and we have seen a fast progression in the nature of discussions from "what is it about?" and "are we really the cause?" to the all-important "what do we need to do about it?"

Globally, society has at last reached a stage where it is gradually moving from deliberation to action. In 2007, even the US recommitted to international efforts to reduce emissions, and there is now regular news of major corporations upping their commitment to tackle climate change. While the rich nations have caused the bulk of the problem, major developing nations with high emissions – particularly Brazil, India, China and South Africa – must now also contribute to reducing their outputs. South Africa has undertaken to contribute its fair share. Trevor Manuel's 2008 budget speech was the first that took cognisance of the need to build sustainability thinking into our economy when he talked about issues such as energy efficiency, responsible use of our natural resources and the fact that we cannot sustain economic growth using the same principles and technologies as we have in the past.

> "We have a very small number of years left to fail or to succeed in providing a sustainable future to our species."
>
> *Jacques Cousteau*

There is a growing recognition that our wellbeing as humans and the vitality of our economies are entirely dependent on a healthy environment. Just a few degrees separate us from a world of far greater weather extremes in the form of vicious storms, terrible flooding and cruel droughts. Ecosystems would not be able to support the density and diversity of plant and animal life we see now. The result? A drastic and traumatic decrease in human population numbers in what James Lovelock refers to as a global "cull". This world would be a harsh world to leave to our children. A cooler Earth, as we still have it, makes for a healthier and more hospitable home.

For several generations, we have been conducting a foolhardy global experiment with the only biosphere we have, and this tinkering has now progressed to dangerous levels. You and I, with our insatiable desire to burn greenhouse gas-emitting fossil fuels, plough the lands and cut down forests, are the undisputed cause. While cyclical climate change is a naturally occurring phenomenon, our anthropogenic emissions are boosting the Earth's warming effect to perilous levels and, as a result, are pushing this delicately balanced natural system into an unstable state.

Climate change is unequivocal and very serious, and constitutes a *global emergency*. It is an 11th-hour crisis we can barely feel or fathom yet. The good news is that the science states that if we decide to take bold action quickly, the most severe

consequences of global warming can be avoided, and at a cost that need not significantly inhibit economic development. The bad news is that our existing and planned international efforts are not ambitious enough – there is an unacceptable gap between what is required by science and the actions being taken by global society. If we don't close this gap, we will fail.

We have no choice but to succeed. All of us are compelled to ramp up our efforts dramatically and learn to live in harmony with nature. In this undertaking, we must all recognise our role, each according to our individual and organisational abilities and sphere of influence. And as an energy-hungry society, South Africans have a weighty obligation to mitigate their emissions. Government is responsible for creating policies that encourage a low-carbon economy and allow us to continue to create a more equitable society. Business must find ways to minimise environmental impacts caused by producing and delivering the products and services that we consume. We as individuals are obligated to drive the change in government and business, while each of us – particularly those who are middle- to upper-income earners – strives to reduce our personal consumption levels.

The climate crisis challenges virtually everything we do. We give it little thought when we get water from a tap, brush our teeth, switch on the lights, drive or fly somewhere, and purchase food, products or services. Yet all these activities are dependent on our all-pervasive use of coal, oil and gas and other unsustainable practices. The causes of the problem are deeply embedded in the structures of our economy, society and individual behaviour. Successfully tackling climate change will require a fundamental rethink of how we live our lives. Not only will it necessitate exceptional levels of national and international cooperation, but it will also demand unprecedented levels of commitment from you personally.

We all have a stake in this issue and, as consumers, parents, voters, citizens, employers and employees, we have an obligation to ensure that we make an expedient and just transition to a more sustainable society. This is a situation that requires "all hands on deck".

> "Few will have the greatness to bend history itself; but each of us can work to change a small portion of events, and in the total of all those acts will be written the history of this generation."
>
> *Robert F. Kennedy*

This book, which contains contributions from numerous experts in many disciplines, explores the details of the problem and what we as individuals and a society must do to tackle climate change. Chapters 2 to 6 describe *the crisis* in which we find ourselves. We investigate why a healthy environment is the bedrock of our social, economic and personal wellbeing, before exploring the overall state of our

environment. Then we describe the climate crisis, arguably the most pressing of many environmental issues, and the latest research findings as they relate to South Africa. This is followed by a discussion of possible social and economic repercussions. In *Chapter 6* we review how we got into this mess and end on an upbeat note, describing a possible vision of a more sustainable future.

The remainder of the book focuses on what we need to do to *tackle climate change*. In *Chapter 7*, we consider some of the behavioural issues that must be identified and confronted. Then we describe some overarching strategies for tackling climate change, and move on to investigate the source and nature of South Africa's emissions, before exploring the emission-mitigation options open to us as a nation. *Chapters 11* and onwards explore possible solutions for specific themes and sectors of society, such as you at home, government, the business sector, investors, farmers, civil society, property developers, urban planners, transport, waste and education.

You will note that some chapters are targeted at very specific audiences. I recommend that to obtain a good overview of the most important issues, you read all chapters up to and including *Chapter 11: Your government, our government*, and then dip into the remaining chapters as they are of interest to you. On a cautionary note, you will find that some of the initial chapters are packed with bad news, which may lead to despair and an urge to stick your head in the sand. But bear in mind that there is no better antidote for this state than to roll up your sleeves and get stuck in. This book is bursting with solutions and taking action is guaranteed to help raise your levels of optimism.

While each chapter could constitute a book in itself, collectively they aim to offer a succinct and practical overview of the major issues. Abstracts provide you with a quick overview of the chapter content and "Resources" lists at the end of chapters indicate suggestions for further reading. Key facts are referenced throughout and a references chapter is included at the back of the book. While a few chapters are necessarily more technical, you will find most of them to be easy reads. Where you are left with questions, I can recommend the Internet-based Wikipedia as a great information resource to assist with unknown terminology and concepts.

Please be aware that with so many co-authors – unless one has an overabundance of time for editing – there is some unavoidable overlap in information, a few minor variations in opinion and differences in writing styles. In isolated instances you may notice some discrepancies in data, which does not mean one of the sets is wrong. Data – particularly about greenhouse gas emissions – can vary, depending on when it was compiled, what emission sources are included (e.g. only fossil-fuel emissions or also emissions from deforestation and other sources) and how it is stated (e.g. as CO_2, an equivalent amount of CO_2 or as a carbon equivalent).

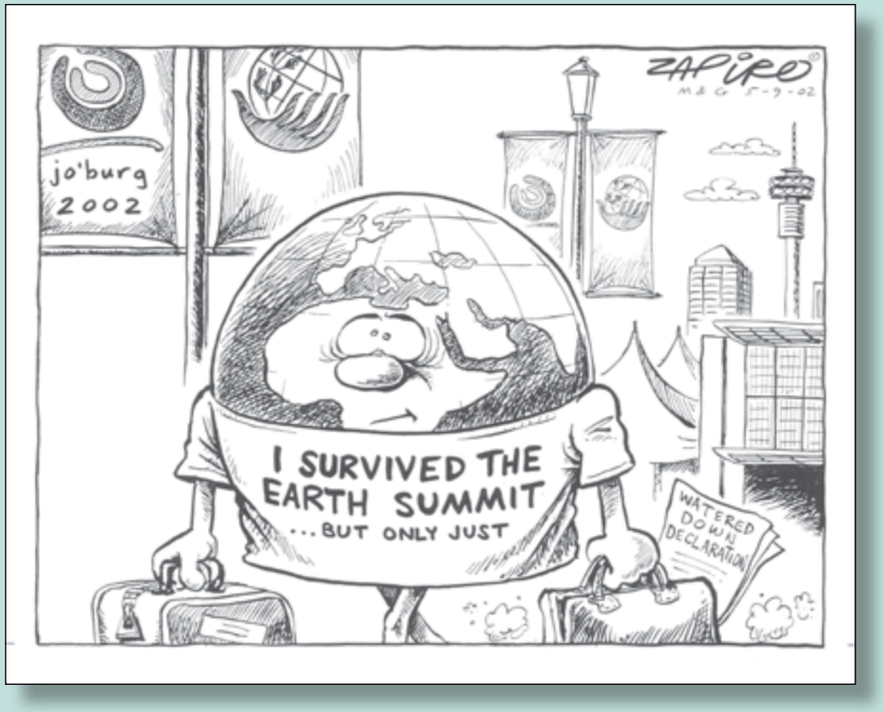
This book has been sponsored by a number of corporations – funding without which it could not have happened – and there is sometimes the impression that such publications pander to specific wishes or objectives of their sponsors. I can assure you that this has not been the case here and we have maintained absolute editorial independence. It must also be said that the purpose of this book is not in any way to put blame on any particular institutions or industry sectors, but to state the facts and describe what needs to be done. We are all part of the problem and we all rely on power utilities, industry and business to supply us with electricity, liquid fuels and the myriad other products and services that we consume on a daily basis. Together we must find the solutions and support those that are the most proactive.

It was just over 25 years ago – I was a teenager – that I first learnt about global warming. My uncle, then a science journalist, explained how burning fossil fuels and deforestation were exacerbating the Earth's natural greenhouse effect, with potentially serious consequences for humanity. This discussion caused me to despair about our future for a while, but, quite naïvely, I felt secure in the knowledge that adults would solve this problem by the time I had grown up. Not a chance! Aghast, I have witnessed the scale of the problem becoming infinitely worse. Now, there is no time to wait for another generation to take action.

Recently I talked to someone whose teenage daughter experiences deep despair and anxiety about climate change. I can't help but wonder how many other young people today worry deeply about the issue and their future. I hope they are not being naïve in their faith that we can succcessfully tackle the problem. Let us not disappoint the next generation.

> "How wonderful it is that nobody need wait a single moment before starting to improve the world."
>
> *Anne Frank*

During times of emergencies, humans are known to put aside their petty political and ideological differences and pursuit of self-interest for the benefit of everyone. This is such a time. Climate change provides us with a common cause and is as much about confronting our personal gremlins of self-interest and short-sighted profiteering, as it is about taking united and just action. We are witnessing a gathering groundswell as millions of people around the world are starting to adapt their personal habits and contribute to institutional change. The speed and success of our efforts to bend the curve on our emissions will determine what kind of planet our children will inherit. I deeply and urgently hope that you too will become an agent for change as we belatedly but inexorably move into the environmental age and begin creating a better future for all. Take action now to help bend the curve.



I see the Earth's declining health as our most important concern, our very lives depending upon a healthy Earth. Our concern for it must come first, because the welfare of the burgeoning masses of humanity demands a healthy planet.

James Lovelock, *The Revenge of Gaia*

2

Healthy environments, healthy people

Morné du Plessis

Before we delve into the detailed findings on climate change in Chapter 4, it is important to put it into perspective as one of a range of environmental issues. For this reason we first describe why healthy ecosystems are essential to our wellbeing and, in the next chapter, what the state of our environment is.

Ecosystems provide us with all that is necessary for us to live – food, fuel, and fresh water, and human life is quite impossible in the absence of any of the benefits and services that ecosystems supply. However, human activities have now become so extensive that all ecosystems on the planet have to some extent been altered by us. When we drive ecosystems over the edge by modifying them, the ecosystem costs often outweigh the benefits. Current decision-making processes generally ignore or underestimate the value of ecosystem services.

By the year 2050 the world will contain three billion more people and the global economy will have increased fourfold, according to some estimates. The result will be a massive increase in demand for biological resources. We are already facing an unsustainable rate of resource depletion and the escalating impact on our ecosystems and the services that they provide will be substantial.

Sustainably supplying the entire human population of 2006 at the then current levels would have required the equivalent of 1.3 times the resources that the Earth could then provide. The current annual escalation in resource use means that each year we draw further on our natural capital or assets (see sidebar entitled "Our five capitals" on page 25). The situation will only continue to deteriorate if no action is taken to turn this around.

It was as late as the 1960s that realisation of the scope and consequences of environmental damage started to lead to widespread concern. The levels at which this damage was apparent started with an appreciation of local concerns, for example, a relatively small-scale pollution incident. Then the scale became national, with concerns about such issues as the provision of water supply. Eventually regional concerns such as the link between burning fossil fuels and the occurrence of acid rain lead to where we are now – an understanding of the reality of global climate change.

Ecosystems: Our life blood

Ecosystems provide us with a variety of benefits or services – provisioning, regulating, cultural and support. To expand: provisioning services are the products we obtain from ecosystems, such as food, fuel, fibre, fresh water and genetic resources. Regulating services are the benefits obtained from the regulation of ecosystem processes, including the maintenance of air quality, climate regulation, erosion control, regulation of disease and water purification. Cultural services are the non-material benefits obtained from ecosystems through spiritual enrichment, cognitive development, recreation and the aesthetic. Supporting services are those necessary for the production of all other ecosystem services, such as primary production of organic compounds, production of oxygen and soil formation. Human life is quite impossible in the absence of any of the benefits and services that ecosystems provide.

Technically, ecosystems are defined as being a dynamic complex of plant, animal, and microorganism communities and their non-living environment that interact as a functional unit, and are spatially explicit entities that have specified boundaries.

In 1935, Tansley defined the ecosystem as a living, or biotic, community or assemblage and its associated physical environment in a specific place. The main components of the ecosystem concept are its abiotic (non-living) and biotic features and the interactions between them. Because the components of the ecosystem are themselves complexes within which there are interactions, a nested hierarchical structure is implied in the basic definition. An ecosystem can be of any size so long as organisms, physical environment and interactions can exist within it. Given this

first characteristic, ecosystems can be as small as a patch of soil supporting plants and microbes; or as large as the entire biosphere of the Earth.

Ecosystems are conceived as spatial units and boundaries are set for many reasons: as a matter of convenience, to follow geomorphological divides, to understand a political entity, to recognize changes in carbon and energy flux rates, or to respond to changes in the frequency of some ecological process of interest. Convenience and physical borders are the most common guidelines for setting ecosystem boundaries.

> It is estimated that the Earth's web of life contains about 100 million species of plants, animals, fungi and microorganisms, and that only some 1.4 million have actually been named.

The ecosystem also has an informal and symbolic use in more general parlance. Metaphorical reference to ecosystems often provides the simplest means of visualising them. Structural metaphors for the ecosystem as a whole include the ecosystem as a machine, the ecosystem as an organism, and the ecosystem as an algorithm. Behavioural metaphors include ecosystems as resilient structures or conversely, as fragile structures. The ecosystem is often used as a metaphorical representation of some place on the Earth's surface. Examples include such uses as "the mangrove ecosystem". This is a powerful use because it focuses attention on specific kinds of places and the generalisations about them. In addition, such metaphorical use can focus on specific sites, as in "the Kruger National Park ecosystem". This more specific spatial metaphor is powerful because it invokes a sense of responsibility and empowerment despite the fact that it is a rather shallow metaphor in the public discourse.

Human activities have now become so extensive that all ecosystems on the planet have to some extent been altered by us. These effects range from local changes in the populations of certain species by harvesting and habitat destruction, to global changes in atmosphere and climate from industrial emissions. Humans are simply another species on Earth and so have always had some effect on the ecosystems of which they are a part. However, the degree to which we can alter these ecosystems has increased dramatically in the past century. These alterations are significantly affecting our welfare now and will do so for generations to come, with serious implications that cannot be ignored.

Ecosystems may forgive, but they never forget

Our welfare depends on the healthy functioning of our ecosystems. Some believe that additional benefits may be gained by modifying ecosystems, either a lot or a little. However, each ecosystem has a threshold beyond which further modification totally changes its state, with consequent different costs and demands. It is often the unseen components of such systems, for example, microorganisms and inconspicuous plants that play a disproportionately major role in ecosystem functioning; not

NATURE SUPPORTING PEOPLE

"It is ... clear that all humans, everywhere, are absolutely dependent on ecosystem services, even if they don't realise it. Even astronauts living in a tiny human-manufactured ecosystem orbiting in space depend immediately on the proper functioning of their life-support systems, and ultimately on the life-support systems on Earth that supplied these for their journey and to which they must return. The immediacy of the connection between ecosystem services and human wellbeing is very obvious to people who live 'close to nature': indigenous peoples, farmers and rural dwellers in general.

It is often ignored by urban populations living in a modern economy, who are usually one or more steps removed from the actual source of the food they eat or the water they drink. This apparent disconnect creates great risks of inappropriate policies and actions, since 'modern' and urban people are often more powerful, politically, economically and in terms of their consumption patterns, than 'traditional' and rural people. Whenever people are separated by space, time or class from the consequences of their actions, there is a tendency to turn them into 'externalities', or costs borne by someone else."

Nature Supporting People: The Southern African Millennium Ecosystem Assessment, 2004.

necessarily the very obvious lack of major predators and their prey in our agricultural landscape.

When we drive ecosystems over the edge by modifying them, the ecosystem costs often outweigh the benefits, resulting in greater losses to people. While the benefits of ecosystem services are often immediately obvious, the losses are often deferred, and can include the removal of future options. For example, when agricultural land use transforms an ecosystem, the potential pathways along which endangered species can adapt or migrate in the face of climate change are cut off. We have removed their options for future adaptation. The most important aspect about the way that ecosystems function is that they behave as a whole and cannot be broken down into pieces that can be thought of in a linear way. They are essentially in a state of dynamic equilibrium.

This is good. Ecosystems are inherently stable. However, their dynamic nature means that this equilibrium can be upset, with the frightening prospect of unpredictable collapse, as has been experienced in a number of fisheries. Ecosystems can be driven through excessive disturbance into a completely different state. Such a state can be rapid and irreversible in terms of its composition, structure and functioning. Western Australia provides a classic example of the over-modification of an ecosystem. Deep-rooted trees and shrubs were removed to establish extensive wheat fields. Initially effective, this massive disturbance of the natural equilibrium of the system led to rising water tables and consequent salinisation of the soil, resulting in a virtual collapse of the wheat industry.

There are many more examples of ecosystem collapse. In terrestrial ecosystems, a significant amount of agricultural land has been degraded in the past half-century by

"I've come on a special mission on behalf of my constituency, the millions of trillions of insects and other small creatures, to make a plea for them. Please keep in mind that if we would wipe out insects from this planet – which we are trying hard to do – the rest of life would disappear within a few months."

E.O. Wilson, biologist and author, at TED 2007 awards, www.ted.com

erosion, salinisation, compaction, nutrient depletion, pollution and urbanisation. In the marine environment, world fisheries are now declining due to overfishing. Other ways in which we have altered ecosystems include changes to the nitrogen, phosphorous, sulphur, and carbon cycles, causing acid rain, algal blooms, and fish kills in rivers and coastal waters, along with contributions to climate change. In many parts of the world, this degradation of ecosystem services is exacerbated by the associated loss of the knowledge and understanding held by local communities – knowledge that sometimes could help to ensure the sustainable use of the ecosystem.

Healthy ecosystems deliver healthy people

Human well-being can be measured by the health of our ecosystems: the availability of the basics required for a good life, freedom of choice and action, health, good social relations and security. In all these contexts, ecosystems are essential for human well-being by providing building materials, food, clean water supplies, recreation, and at a larger level climate regulation. In the past, we have tried to alter ecosystems for our benefit. Agricultural activity is a good example and, indeed, it may seem that our intervention is often highly beneficial. However, we have gone further than this. The industrial revolution in the West started environmental degradation on a large scale, which was not immediately noticed because of the apparent benefits to the broader community in terms of rising standards of living. However, the environmental degradation that has been caused by Western development is now all too apparent as the sustainability of many ecosystems is under threat. The rapid industrial development in China, India and to some extent, South Africa, highlights these impacts because we can see its effects in the here and now. Human intervention in ecosystems can at times exaggerate the benefits to human society. However, recent evidence of escalating human impacts on ecological systems worldwide raises worrisome concerns about the consequences of ecosystem changes that are detrimental to human wellbeing.

Sustainable development is seriously threatened by ever-rising demands being placed on increasingly degraded ecosystems. Human wellbeing is not only affected by shortfalls between ecosystem service supply and demand, but also by the increasing exposure to environmental risk experienced by individuals, communities and nations. Well-managed ecosystems reduce risk and vulnerability, while poorly managed ones increase risks of flooding, drought, crop failure and/

> Ecosystems are capital assets. We don't include them on our balance sheets, but if we did the services they supply would dwarf everything else in value ... ecosystems support human life, and by harming them we harm ourselves. The sooner we realise this and behave accordingly, the better chance we have of meeting human needs sustainably and conserving the diversity of life on Earth.
>
> *Dr Taylor Ricketts, World Wildlife Fund*

or disease – and with these risks – increasing conflict and lack of security. Wealthy people often control access to ecosystem services and, because of their higher levels of disposable income, are better buffered from changes in the availability of those services. For example, even though a number of marine fisheries have been depleted in the past century, the supply of fish to wealthy consumers has not been disrupted because fishing fleets have been able to shift to previously underexploited stocks. By contrast, the poor often lack choices and are highly vulnerable to ecosystem changes that result in famine, drought or floods. Degradation of coastal fishery resources, for instance, results in a decline in protein consumed by the local community since fishers may not have access to alternative sources of fish and community members may not have enough income to purchase fish. Degradation affects their very survival. It is probably true to say that those in the West are living well beyond the means of our planet – cross-subsidised by those who have very little.

In short, ecosystems that are pushed beyond the limits of sustainability will be forced into a state of collapse that in many instances will be irreversible. When such levels of degradation are inflicted on ecosystems, we have essentially removed their capacity to sustain life in the way that they did before. As with any investment, when you bite into your capital (in this case, natural capital), you stand to severely compromise the future returns that you can reasonably expect from it. It is really quite simple: no goose, no egg!

Decisions, decisions, decisions

Decisions concerning ecosystems, their services and their bearing on human well-being are made at a range of organisational levels. Individuals and small groups make decisions at the level of cultivated land or a small woodland. Human communities make decisions concerning ecosystems and their services at the level of municipalities, or within provincial or national government. Finally, society at large makes decisions at the international level by reaching multi-lateral agreements or through international conventions.

It is small wonder then that current decision-making processes often ignore or underestimate the value of ecosystem services. Decision making concerning ecosystems and their services is further complicated by a variety of disciplines, philosophical views, and schools of thought that assess the value of ecosystems differently. It is therefore essential that decision-making structures are brought into line with the scale at which ecosystem services are perceived or delivered. The challenges that climate change brings to decision making are not insignificant. However, without a concerted and united effort at all levels, over all spatial scales and over the short, medium and long term, no-one will ever be able to claim that they did enough for those who follow on after them.

A practical way in which local or national government can contribute to the long-term wellbeing of, and respect displayed towards ecosystems would be to emphasise and, ideally, enforce full-cost accounting of the use of ecosystem services. This means that the "external" cost to society and the environment of, for example, water extraction from river catchments or pollutants released into the atmosphere, needs to be "internalised" in the cost of production so as not to penalise other users or future beneficiaries of such systems.

OUR FIVE CAPITALS*

Robert Zipplies

In planning for the future, most of us aim to grow our capital assets, typically consisting of financial savings, investments and property, while living off our income streams, usually salaries, interest and dividends. Ideally, when we retire, we live off these income streams, without having to draw on our capital resources, which we leave for our children to inherit.

Businesses likewise aim to grow the capital assets of their balance sheets, while covering their day-to-day operating costs with the income streams generated by the capital assets invested in the business. Once a business starts whittling away its capital assets to finance its operating costs, it is an indication of impending financial trouble. Yet this is what we have been doing with our environment – our natural capital, which includes our all-important ecosystems. We are increasingly living off our savings, instead of living off our sustainable income streams or interest earnings.

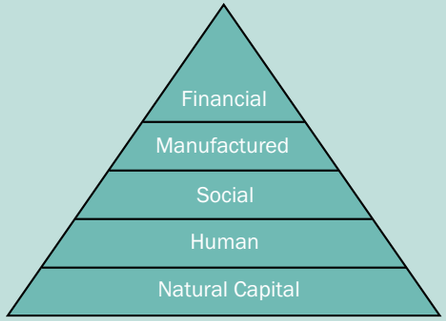
Forum for the Future in the UK (*www.forumforthefuture.org.uk*) developed the "Five Capitals Model" to help explain how our natural capital underpins human wellbeing and assists us to improve the quality of our lives:

- **Natural capital** forms the basis of all life and ecosystems, and is the foundation of our human wellbeing. Natural capital includes renewable resources (such as wood, fisheries, arable land and fresh water), non-renewable resources (such as mineral deposits), sinks (that absorb, neutralise or

recycle wastes) and ecological processes that include regulating our climate and diseases.

- **Human capital** includes our knowledge, skills, health and the motivation necessary to be socially and economically productive in pursuit of a better quality of life. Human capital is enhanced through education, training and health.
- **Social capital** includes the institutions that help us to maintain and develop human capital in trust-based partnership with others. It includes institutions such as families, communities, businesses, government, labour unions, schools and voluntary organisations.
- **Manufactured capital** comprises material goods, or fixed assets that contribute to the production process or the provision of services, rather than being part of the output itself. It includes, for example, tools, machinery, buildings and infrastructure.
- **Financial capital** is the traditional measure of economic progress. It plays an important role in our economy, enabling the other types of capital to be owned and traded, for example, through shares, bonds or banknotes. Unlike the other types of capital, it has no intrinsic value itself but is representative of natural, human, social or manufactured capital.

These capitals are best visualised in the form of a layered pyramid, with natural capital forming its base.



Society is facing a crisis of viability – we have been depleting our stocks of natural capital in a bid to build human, social and, above all, financial and manufactured capital. The result is that the stable base of the pyramid is becoming eroded and, as many of our ecosystems near collapse, has reached a wobbly precariousness. Climate change has now become a further driver of instability.

The challenge for human society is to learn to live in harmony with its ecosystems, the key constituent of our natural capital. The income streams generated by our natural systems are for spending; the capital must remain sacrosanct.

**Adapted by Incite Sustainability from Forum for the Future*

Resources

i. Wikipedia; *www.wikipedia.org*; see "ecosystem", "biodiversity", "ecosystem services" and "food chain"
ii. The Five Capitals; *www.forumforthefuture.org.uk*

"The systematic destruction of the Earth's natural and nature-based resources has reached a point where the economic viability of economies is being challenged and where the bill we hand to our children may prove impossible to pay."

Achim Steiner, Executive Director, United Nations Environment Programme, 2007

3

The state of our environment

Nick King and Yolan Friedmann

The state of South Africa's environment is cause for grave concern. In spite of a broad range of what are considered world-class environmental policies, our environment is seriously degraded and continuing to deteriorate. This is clearly shown by recent assessments of all key indicators, including air quality, biodiversity, energy efficiency, freshwater resources, invasive alien species, land use and land degradation, marine fish stocks and overall consumption patterns. The overall picture is one of a higher-than-average ecological footprint and declining natural resource base, resulting in a low ranking of 93 out of 146 countries with regards to our Environmental Sustainability Index. It is time for action to reverse these trends.

We have not been around very long – if the time-span from the Earth's beginnings is taken to be just one calendar year, then multicellular life on Earth only appeared around the last week of September in that year. The dinosaurs appeared around 12 December and had disappeared by the 26th, and our early hominid ancestors only appeared in the last hour on the 31st. The Industrial Revolution occurred just one second ago – however, in that "one second" we have been able to change almost every natural system that has evolved in the rest of the 364 days, 23 hours and 59 seconds! We may have not been around long, yet our impacts are unequalled by any other living organism, and are of such magnitude (matched only by cataclysmic events such as giant meteorite strikes in the distant past) that this period is now earning its own epochal name, the Anthropocene.

While this book focuses on climate change, it is important to recognise that climate change is simply an outcome of these myriad anthropogenic influences (such as air pollution and deforestation), albeit one that is itself now becoming a major agent of environmental change. In order to address climate change, we need to focus on the underlying causes rather than just the "symptom" of changed climate. The dramatic loss of biodiversity and declining function of the Earth's ecosystems are themselves major threats to the future of the planet and humankind. They are simply being speeded up and exacerbated by the onset of human-induced climate change. Ecosystems, which include human beings, consist of plants, animals and other organisms that interact with each other and their environment, and biodiversity refers to the variety and variability between all forms of life on Earth.

Assessing the planet

As human numbers climb inexorably towards the seven billion mark and beyond, the results of the United Nations Environmental Programme's (UNEP) *Millennium Assessment (MA),* the largest ever review of our planet's life-support systems, published in March 2005[1], make frightening reading. This five-year, US$25-million study, involving over 1 300 scientists from 95 countries, provides incontrovertible proof that the rapidly rising human population and our over-consumption of resources has polluted or over-exploited two-thirds of the ecological systems of our planet, upon which all life depends. The MA findings indicate that of the 24 major life-sustaining ecosystem services assessed, such as fresh water, fisheries, air and water purification and the regulation of regional and local climate, natural hazards, and pests, only four are stable or improving and 15 (around 60%) are declining!

This is most disturbing in that the majority of our planetary life-supporting services have degraded, some precipitously. More worrying still is that the rate of such degradation, despite some localised successes, is ramping up, and far too little attention and resources are being committed to reverse these trends. The report further states that 10% to 30% of mammal, bird and amphibian species are already threatened with extinction, a number that has been seen to increase in the intervening years. Furthermore, global fisheries are rapidly declining due to overfishing, and some

> "When one tugs at a single thing in nature, he finds it attached to the rest of the world."
>
> *John Muir, writer*

40% of agricultural land has been degraded in the past half-century by erosion, salinisation, compaction, nutrient depletion, pollution and urbanisation. The United Nations, in the *Global Environmental Outlook* 4[2] states that "16 000 species are threatened with extinction and the global annual loss of primary forest is 50 000 km^2. By 2025, 1.8 billion people will be affected by water scarcity as availability of fresh water [continues to] decline".

These changes have occurred mainly in the last few decades as the human population has exploded exponentially and our ingenuity has allowed us to exploit deeper, further and faster. "Over the last 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable time in human history, largely to meet rapidly growing demands for food, fresh water, timber, fibre and fuel. This has resulted in a substantial and largely *irreversible* loss in the diversity of life on Earth," the MA report states. Humans are an integral part of ecosystems, which provide a variety of essential benefits to people, including food, fuel, fibre, fresh water, genetic resources, air quality maintenance, climate regulation, erosion control, regulation of human diseases, water purification, spiritual enrichment, recreation, oxygen

AN EXTRAORDINARY BIODIVERSITY

South Africa occupies only 2% of the world's land surface, yet contains a disproportionately large share of global biodiversity, being home to nearly 10% of the planet's plant species and 7% of the reptile, bird and mammal species. The country contains three globally recognised biodiversity hotspots, namely the Cape Floristic Region, the Succulent Karoo, shared with Namibia, and the Maputaland-Pondoland-Albany hotspot, shared with Mozambique and Swaziland. The Cape Floristic Region is the smallest (less than 90 000 km^2) and is the only floral kingdom to occur exclusively within the geographical boundaries of one country. Our extraordinary plant diversity helps rank South Africa as the country with the fifth highest number of plant species in the world. Our seas, which support many livelihoods, include the Atlantic, Indian and Southern Oceans with a wide range of habitats from kelp forests to coral reefs. Additionally our coast is home to 15% of the world's coastal species.[3]

South Africa's extraordinary biodiversity reflects a diversity of climates and terrains that support not only a wide range of mainstays of our economy and cultural heritage but also millions of people whose livelihoods depend directly on the natural resources at their disposal. It is also the reason that ecotourism is the fastest growing sector of our economy.

> "Underground nuclear testing, defoliation of the rain forests, toxic waste ... let's put it this way: If the world were a big apartment, we wouldn't get our deposit back."
>
> *John Ross, writer*

production and soil formation. Thus, our over-exploiting of the very systems on which we depend for life will decrease their ability to support us and will certainly lead to disaster for us all.

South Africa's increasing vulnerability

South Africa contributed to the United Nation's MA by participating in *The Southern African Millennium Assessment* (SAfMA) which was published in 2004. The SAfMA report[4] helped emphasise the vital link between ecosystem services and human wellbeing in southern Africa and was a means of documenting the role and importance of functioning ecosystems. Ecosystem services are the benefits that we derive from our environment, and every one of us, no matter how rich or poor, depends on ecosystem services and biodiversity for life. The SAfMA highlighted that the natural resources which contribute most to human livelihoods are declining in southern Africa, just as they are globally, and many communities are facing increasing vulnerability due to changes in their environment, loss of natural resources and exposure to environmental hazards. Owing to their direct reliance on natural resources for their livelihoods, the poor continue to suffer most from many adverse climate and other environmental changes, and declining environmental health has the greatest effect on those who can least adapt.

In 2007, South Africa published its latest State of the Environment Report, the *South African Environmental Outlook* (SAEO).[5] The SAEO is a scientifically sound, rigorously reviewed assessment of the status and trends of ecosystems and biodiversity in South Africa, and builds on the SAfMA report. However, the SAEO does not confine itself purely to describing the declining state of our environment, but also discusses how this relates to and impacts on people and the economy.

An ecological footprint is a means of measuring human demand on nature and compares consumption of natural resources with the ability of ecosystems to regenerate.

The SAEO identifies the condition of, and trends within, various key sectors of South Africa's environment; alarmingly, all are either deteriorating and/or in a critical condition. While the SAEO again records that South Africa has the third highest level of biodiversity in the world, based on an index of species diversity

and endemism, it also clearly shows that the general state of this biodiversity and ecosystem functioning is poor and declining. Since 1991, the average ecological footprint of South Africans, already over the estimated carrying capacity of our natural resource base, (2.8 hectares per person compared to a global average of 2.3 hectares per person) has increased by a further 2%, rapidly outstripping the global average increase of 0.5%.

While the escalations appear small, we are already "in the red" and thus footprints should be decreasing not increasing if we are to switch to a sustainable way of life. A snapshot of the findings of the SAEO indicates that our report card is not good and points to the fact that there are many urgent issues to address besides climate change:

SOUTH AFRICAN ENVIRONMENTAL OUTLOOK FINDINGS

Air quality
DETERIORATING

Atmospheric pollution is at critical levels. Health problems due to air quality are predicted to increase by 20% over the next decade. Emissions from vehicle exhausts are expected to rise 44% between 2002 and 2011.

Biodiversity
DETERIORATING

Almost 10% of South Africa's birds and frogs, and 20% of our mammals are threatened with extinction. Our marine systems are faring the worst with some West Coast marine systems being critically endangered. It is accepted that South Africa will not reach the 2010 target of halting the loss of biodiversity, as agreed to by the Parties to the Convention on Biological Diversity in 2002, including South Africa.

Climate change, energy efficiency and consumption
DETERIORATING

Despite predictions that climate change will reduce South Africa's already scant rainfall west of the escarpment (the majority of the country), reducing river flows and general water availability, we continue to contribute inequitably and irresponsibly to the drivers of climate change by producing more greenhouse gases per capita than many industrial countries, through our reliance on coal and high-energy industries. Energy consumption in South Africa has increased by 23% since 1992 and carbon dioxide production is increasing by 0.6% per year. South Africa has made small strides towards developing renewable energy supplies but this needs to expand urgently. By 2050 the areas considered to be climatically suitable for our existing terrestrial systems are expected to shrink by 40%.

Environmental governance
SMALL IMPROVEMENTS?

South Africa has made major strides in improving its environmental legislation,

access to information and environmental data, but enforcement, public participation and effective implementation of the legal system require urgent attention to ensure that we have not created a system with bark but no bite.

Freshwater resources
DETERIORATING

Water resources continue to decline in quality and quantity and South Africa will experience a dire shortage of water leading up to 2025, with local shortages already widely occurring. Almost all exploitable sources have been tapped and freshwater flows are decreasing annually, with salinity levels of surface water increasing. Only 18% of our river systems are still intact; 54% are critically endangered. More than 50% of our wetlands have been destroyed and our estuaries are generally in poor condition, are afforded little protection and are declining in health. Too few of our terrestrial (only 6%) and aquatic ecosystems (7% of our rivers, 18% of our wetlands) are formally protected, with our critical water catchment regions lacking urgent intervention and protection.

Invasive alien species
DETERIORATING

The spread of invasive alien species is rapidly increasing with significant negative consequences for terrestrial biodiversity and humans, river flows and aquatic and estuarine biodiversity. Invasive alien plants have invaded over 10 million hectares of the country, reducing waterflows, poisoning livestock and obliterating indigenous species. Over 750 tree species and 8 000 herbaceous species have been introduced. 20% of listed alien plants are categorised as "major invaders", and a further 15% as "emerging invaders".

Land use and degradation
STATIC/DETERIORATING

Development and urbanisation has caused a decline in arable land but details are scant, as is information on land degradation. However, 34% of South Africa's terrestrial ecosystems are classified as threatened (vulnerable, endangered or critically endangered) in the 2005 National Spatial Biodiversity Assessment. These threatened ecosystems lie primarily within the Western Cape's fynbos biome, the central grasslands and the eastern coastal regions of South Africa. The condition of our soils in general is considered dire.

Marine biodiversity and fish stocks
DETERIORATING

Twenty of South Africa's key commercial marine fish species have been over-fished to the point where stocks have collapsed and are no longer viable. Threats to marine biodiversity continue to increase with abalone and line-fish stocks declining rapidly. Although the sardine fishery has recovered well, marine birds continue to be affected by long-line fishing. Coastal development and marine pollution are on the increase. The highly threatened West Coast has no marine protected areas.

Ozone depletion
IMPROVING

CFC production has decreased significantly since 1990, under the auspices of the Montreal Protocol.

Natural resource base
DETERIORATING

The natural resource base is deteriorating rapidly due to over-exploitation and biodiversity loss.

Overall state of the environment
DETERIORATING

With an ecological footprint higher than the global average and a ranking of 93 out of 146 countries with regards to our Environmental Sustainability Index, the state of South Africa's environment is extremely poor, and declining, with most of the drivers of degradation increasing!

It is particularly worrying that the poor people in South Africa, and in particular, those living with Aids, are becoming increasingly vulnerable as a result of the changes in our environment. The poor suffer most from increasing climate variability, declining air and water quality, degraded land and declining natural resources due to over-exploitation, pollution and food insecurity.[6]

Key drivers of current environmental change

Global environmental impacts today can unequivocally be said to be as a result of growing human consumption driven by a continually rising population and existing developmental models. The impacts are driven by factors such as overconsumption and overharvesting, and unsustainable development, trade, habitat fragmentation, land transformation, pollution and disturbance. Collectively, they are causing an overall and rapid decline in the quality of our environment and its life-sustaining ecosystems.

While these drivers unquestionably now include rapidly increasing climate change, it is critical to understand that climate change was predominantly a consequence of human-induced environmental change *before* it became a driver of change itself. Simply put, human use of fossil-fuels has increased the concentrations of so-called greenhouse gases in the atmosphere, leading to unprecedented rising temperatures, or "global warming", with very serious adverse effects on the life-forms on Earth, including humans. Consequently, climate change is now emerging as the greatest threat to biodiversity and human wellbeing globally and is predicted to exacerbate the existing high levels of degradation throughout South Africa.

The primary pressures on the South African environment are little different from those experienced elsewhere on the planet: a rapidly rising human population is driving exponential resource consumption, environmental degradation, waste

production and pollution. In short, we are consuming our natural capital as an unlimited resource, and not managing or using it sustainably as we attempt to close the gap between the development of South Africa and our northern hemisphere counterparts. In particular, our water resources which, in this semi-arid country, are already our most limiting resource, are over-subscribed, and can in no way meet the demands expected by economic policy options such as the government's Accelerated Shared Growth Initiative for South Africa (AsgiSA).

Our unsustainable AsgiSA

Perhaps an admirable strategy in an infinite world, AsgiSA is premised on unlimited natural resources and an environment with a limitless resilience and recuperative ability. Testimony to this thinking is the planting of vast amounts of thirsty biofuel crops in the Eastern and Northern Cape, the Free State, Mpumalanga and KwaZulu-Natal to boost development, as well as the building of massive, inefficient, catchment-depleting dams to support mining. AsgiSA is naïve enough to actually list the Environmental Impact Assessment process in South Africa as a key constraint to our ability to meet its ambitious targets, but does not identify the actual limitations imposed by a finite planet. As such, this overarching development agenda is a recipe for disaster, imposing impossible demands on finite water and land resources and speeding up the irreversible destruction of our environment to create a legacy for future generations in direct opposition to the tenets of sustainable development that our, and many other governments, claim to follow.

> "If we fail to respond [to climate change] in time, the risks include not only major disruption to economic and social activity, but also increasing threat of conflict as rising sea levels and other impacts drive millions to migrate."
>
> *Stern Review on the Economics of Climate Change, 2006*

Responses

Relatively speaking, Africa is the continent least afflicted by environmental ills and, as such, has the greatest potential to seek out and implement solutions immediately. While Africa is, per capita, the poorest, most disease-ridden and most war-afflicted continent,[7] it is also the continent with the smallest population in terms of land area and the continent with its biological wealth most intact. Africa thus has the greatest opportunity to create a new model of human development. The MA and the SAEO have shown southern Africa to be no different from the rest of the world in terms of trends towards ecosystem collapse. The Fourth Intergovernmental Panel on Climate Change Report[8] also makes it clear that Africa is the most vulnerable to climate change because of its geographic location, straddling the equator, and with

SPOTLIGHT ON SOUTH AFRICA'S ENVIRONMENTAL LEGISLATION

What then of South Africa's much-acclaimed new policy framework post-1994? The SAEO shows that, unfortunately, not only has there been a decided lack of implementation and enforcement thereof, but these are increasingly being actively undermined by the very government that shaped them. As an example, everything is in place in both the National Water Act (Act 36 of 1998) and National Water Resources Strategy to address the dire state of our water resources and ensure optimal functioning. However, a decade after promulgation, not a single example exists of actual implementation of the required ecological reserve by the national Department of Water Affairs. It is not just this lack of implementation that is worrying, but the constant attacks on the environmental legislation by politicians and their active undermining of, for example, the National Environmental Management Act (NEMA, Act 108 of 1998), the cornerstone of our sustainability planning policies. The Department of Mineral and Energy Affairs (DME), is arguably the government department responsible for the single greatest contribution to environmental destruction across the country as a result of coal and mineral mining, water and air pollution, and habitat loss. It has increasingly been able to circumvent NEMA and now amendments are proposed that position DME beyond NEMA's jurisdiction for the process of granting approval for mining permits.

It is abundantly evident that the excellent progress made in developing sustainability policy and legislative responses in South Africa since 1994 requires urgent attention at the highest political level. Adequate resources must be focused on implementing these to reverse the rising loss of biodiversity, ecosystem degradation and human vulnerability. Continued lack of implementation and enforcement will soon lead to the rapidly closing window of opportunity slamming shut in our faces.

its multiple additional constraints, such as general poverty and low adaptive capacity. However, the SAfMA study also showed that those trends were less advanced and thus the opportunity to re-direct development models and avoid the more dire consequences of environmental collapse are greater in Africa than anywhere else in the world – if we act quickly.

Our planet is on a high-speed track to devastation, fuelled by massive overconsumption, unsustainable development, poor governance and obscene social, environmental and economic inequity. In South Africa, we see a microcosm of this planetary scenario, as the race for personal wealth and materialism by the elite few rapidly grows. The SAEO indicates clearly that the time for action is now and that the failed Western development models are no longer an option in South Africa. There is a growing parallel environmental impact of our current strategies for accelerated economic growth: the "boom" in our economy since the 1990s is being realised at the cost of an increasingly unsustainable and inequitable ecological footprint, despite the fact that most people are still living in poverty. This is unacceptable

for a developing country with a crucial reliance on its natural resources and ecosystems for its sustainability, yet with an opportunity to develop alternative priorities and models. An urgent shift towards innovative models for equitable, sustainable and appropriate development needs to occur if we are to halt this rapid decline towards irreversible environmental damage and growing social inequity.

Future scenarios and choices

While we have the knowledge to select from a number of options, we do not have the luxury of time to debate such choices much longer – we are at the "tipping point"[9] – and currently we do not have the benefit of a critical mass of office-bearers who understand this. The next few years are critical. We need to set in motion the policies needed to shift our current path from unsustainable to sustainable.

This is not a difficult choice rationally – only politically. The solution to unsustainable management of the Earth demands a move beyond both "business as usual" and "politics as usual". There is nothing usual about the situation humankind is facing and nobody has ever been here before, other than a few isolated communities that met untimely and unpleasant ends by overstepping the ability of their local environments to support their demands.[10] Admittedly, while the elements needed for a sustainable future are well known, they may be difficult to create because they challenge the vested interests of the political and economic elite comprising the status quo.

However, this is not impossible, nor without precedent. Think of the overthrow of apartheid in South Africa and of slavery in the wider world in the 19th century. Both, despite enormous resistance by the entrenched political and economic beneficiaries, were eventually overthrown by a critical mass of societal pressure. This, however, will require courage, vision, innovative thinking around improved resource management, alternative technologies and sustainable solutions and implementation of economic policies that enshrine sustainability, social equity and environmental justice as a central integrated theme.

It is never too late, but the slowness of political machinations and human understanding, coupled with greed and get-rich-quick thinking are decidedly limiting factors. The longer we wait, the bigger, more costly, more painful and more radical the changes we will need to implement. George Monbiot, in his book *Heat: How to Stop the Planet Burning*[11], claims that we are the most privileged generation, living in a world with the greatest technology, most advanced health care and best communication systems.

We are also the most burdened in terms of our responsibility to stem the tide of irreversible damage we are inflicting for future generations. As we enter the second decade of the new millennium, we would do well to remind ourselves of these increasing responsibilities as catalysts of change in a region that requires our urgent leadership to ensure that this change is for the better, for all, including future generations.

Resources

i. Red Data Book of the Mammals of South Africa: A Conservation Assessment; Friedmann Y and Daly B (editors); 2004; Conservation Breeding Specialist Group (CBSG/IUCN), Endangered Wildlife Trust; South Africa

ii. Collapse: How Human Societies Choose to Succeed or Fail; Jared Diamond; 2005; Viking; US

iii. National Spatial Biodiversity Assessment 2004: Priorities for Biodiversity Conservation in South Africa; *Strelitzia* 2005; South African National Biodiversity Institute, Pretoria; *www.sanbi.org/biodiversity/nsba.htm*

iv. Nature Supporting People; The Southern African Millennium Ecosystem Assessment; Biggs R, Reyers B, Bohensky E, Scholes RJ, van Jaarsveld AS, Fabricius C, Lynam T, and Musvoto C; 2004; CSIR; Pretoria; South Africa; *http://researchspace.csir.co.za/dspace/handle/10204/1921*

v. Vision XV: Business, Ecotourism and the Environment; Endangered Wildlife Trust; 2007; Future Publishing; South Africa

vi. Vision XIII: Business, Ecotourism and the Environment; Endangered Wildlife Trust; 2005; Future Publishing; South Africa

vii. Climate Change 2007: Impacts, Adaptations and Vulnerability. Summary for Policymakers; IPCC Fourth Assessment Report; United Nations; *www.ipcc.ch*

viii. The Future of Sustainability. Rethinking Environment and Development in the Twenty-first Century; World Conservation Union (IUCN) Report; 2006; *www.iucn.org*

ix. The Chaos Point: The World at the Crossroads; Ervin Laszlo; 2006; Hampton Roads Publications; US

x. Limits to Growth: The 30-year Update; Meadows DH, Randers J and Meadows D; 2004; Chelsea Green Publ.; Vermont; US

xi. Capitalism as if the World Matters; Jonathon Porritt; 2005; Earthscan Books; London; UK

"February 2nd [2007] will be remembered as the date when uncertainty was removed as to whether humans had anything to do with climate change on this planet. The evidence is on the table, we no longer have to debate that part of it."

Achim Steiner, Executive Director, United Nations Environment Programme

4

Climate change

Our most pressing environmental issue

Leonie Joubert

It's irrefutable – our climate is changing, and it's mostly our fault. This is the overwhelming consensus of the scientific community that has been working through the United Nation's Intergovernmental Panel on Climate Change (IPCC) for the past seven years to update its findings on the matter. The amount of heat-trapping greenhouse gases in our atmosphere is rising, and it's banking away more heat in the ocean-atmospheric system that drives our climate. Temperatures are climbing globally, which is amplifying normal weather patterns to bring more potent storms, droughts, heat waves and floods. Ice and snow is melting faster than normal; the sea level is rising slowly but steadily.

Most importantly, the speed at which these changes are been witnessed seems to be increasing. And scientists tell us that if we keep pushing our foot down on the accelerator pedal by continuing with our current greenhouse gas pollution, the engine that drives our climate is only going to respond in one way: it's going to speed up. And once it gains enough momentum, climatic changes will become irreversible.

We must act immediately to level off and reduce our emissions in order to avoid the potentially catastrophic consequences.

George Monbiot, writing in *Heat*, said that we now find ourselves in the "interstices between ecological collapse and ecological catastrophe". If we push atmospheric greenhouse gas (GHG) concentrations to double pre-industrial levels, Earth would be committed to a rise of about 2 °C to 5 °C in mean temperatures – and this could be reached as soon as between 2030 and 2060. "A warming of 5 °C on a global scale", writes economist Sir Nicholas Stern[A], "would be far outside the experience of human civilisation and comparable to the difference between temperatures during the last ice age and today".[1]

Overwhelming evidence now points to the fact that many of the indicators of climate change, such as rising temperatures, melting glaciers and more intense extreme weather events, are the direct consequence of 250 years of industrial-era GHG emissions. And things are only going to get worse. Much worse.

It takes decades for a unit of GHG to be released into the atmosphere, to work itself into the system, capture its heat along with all the other GHGs, transmit that heat throughout the climatic system and then result in shifting long-term weather trends. This is because of our planet's oceans. Water heats more slowly than air. So even if the air heats up, it takes much longer for that heat to be absorbed by the ocean and redistributed throughout the ocean-climate system.[2] This "lag" or inertia in the system means that the trends of climate-related changes we're witnessing today, such as the rising mean annual temperature across South Africa, are linked to the accumulation of emissions put out before my generation of 30-somethings was born. And all the emissions put out since then have yet to show their hand. Because of this lag, it means that *no matter what we do today* to curb emissions, we are already committed to about a 2 °C increase in average temperature above that of the pre-industrial era. And if we continue "business as usual", we will drive greenhouse gas concentrations to three times the pre-industrial level by 2100, "committing the world to 3 °C to 10 °C warming" writes Stern. We also now know that the climate system tends to lurch between one stable state and another – imagine a steam kettle on a gas ring, where more and more heat is put into the system for several minutes until it suddenly reaches boiling point and the whistle begins to shriek. In Earth's terms, this means we could get stuck in a hotter, far less hospitable climate.

The pollution responsible for these potentially life-threatening shifts in our planetary greenhouse is the result of global energy uses (mostly burning fossil fuels) and changes in land-use practices – particularly agriculture and deforestation – but resulting in very local consequences for different regions of the planet. South Africa will become warmer as a result, with considerable drying on the west of the country while the east will experience more intense seasonal rainfall, resulting in flooding. The extreme weather events, which are entirely natural to our country – heat waves, droughts, flooding – will be amplified by rising temperatures, meaning they will

A. Sir Nicholas Stern is the British academic and economic adviser to the UK government who, in October 2006, released the *Stern Review on the Economics of Climate Change*.

> "Anthropogenic warming and sea level rise would continue for centuries due to the time scales associated with climate processes and feedbacks, even if greenhouse gas concentrations were to be stabilised."
>
> *IPCC Fourth Assessment Report, Working Group 1*[3]

come with greater frequency and intensity. These changes will have serious implications for water and food security in an already water-scarce country. Health issues such as heat stress, salmonella, water-borne diseases such as cholera, and the shifting malaria footprint are anticipated for parts of the country. Socio-political instability is expected as people begin to fight over resources, resulting in social dislocation as climate refugees flee regional crises.

Globally, many scientists agree that we have a five to 20 year window of opportunity in which to reverse this trend, beyond which we may trigger dangerous climate change and commit our planetary life support system to irreversible changes which our species may not be equipped to survive. We need to take action *now*.

What is climate change?

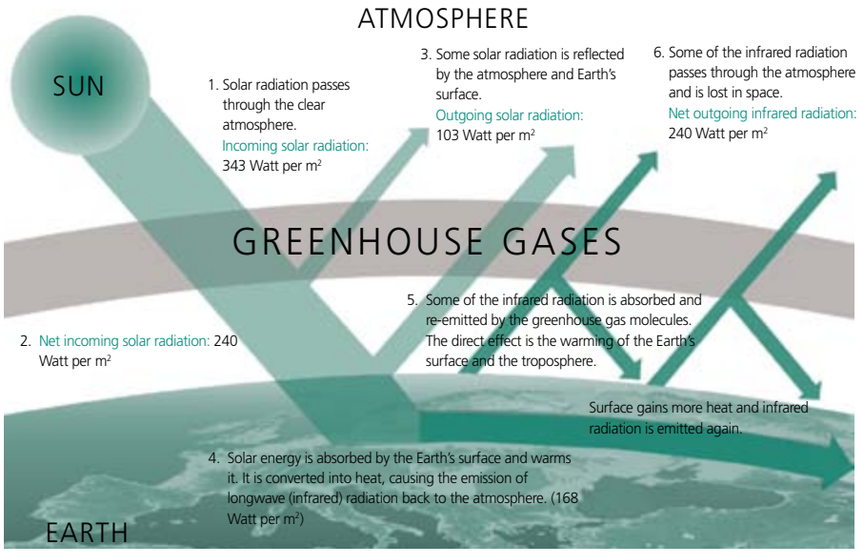
Life in the spinning greenhouse

Before we can talk about changes in climate, we must understand our atmosphere. It is Earth's very atmosphere that makes this world so extraordinary. Our planet is a giant chunk of metal and rock that is hurtling through space at 100 000 km per hour. Shielding this spinning ball is a layer of gas that is improbably thin – only about 100 km deep.

The atmosphere is so thin, relative to the size of the planet, that it has been compared to the layer of varnish on a desk-top globe. Yet this very atmosphere allows life, as we know it, to exist. It protects us from the lifeless vacuum of space, and regulates the amount of heat and light energy with which the Sun constantly bombards us. As the atmosphere and the oceans circulate constantly, they redistribute that energy throughout the system. Held in place by the Earth's gravity, our atmosphere consists mostly of nitrogen (78%), oxygen (21%), and, in much smaller quantities: water vapour, carbon dioxide, carbon monoxide, methane, helium, argon, neon and a few other gases. Some of those – including, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and three trace gases – trap the Sun's heat. These are known as greenhouse gases, and without them Earth would be about 30 °C colder than it is today.

The heat in:heat out ratio

Our climate is kept in balance by the amount of heat that comes into the system, from the Sun, and the amount that the system then releases back out into space.



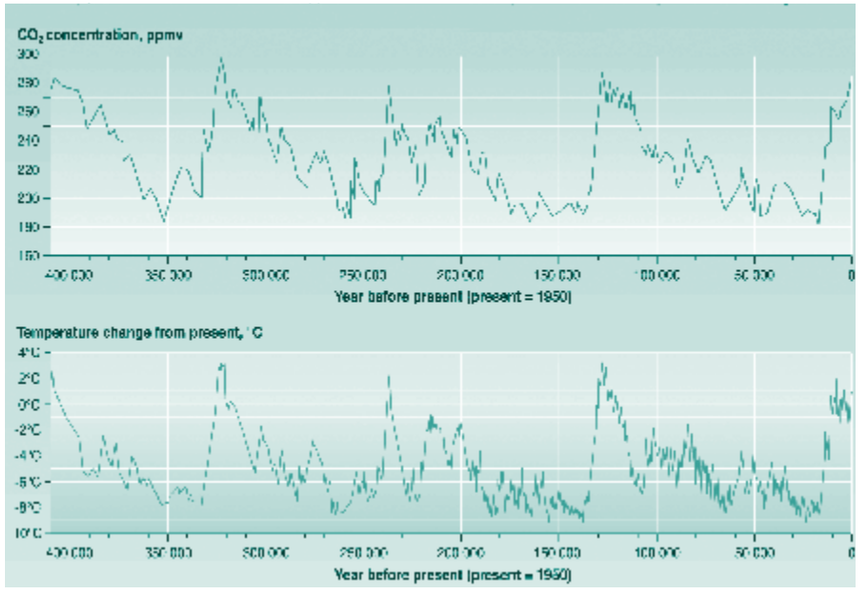
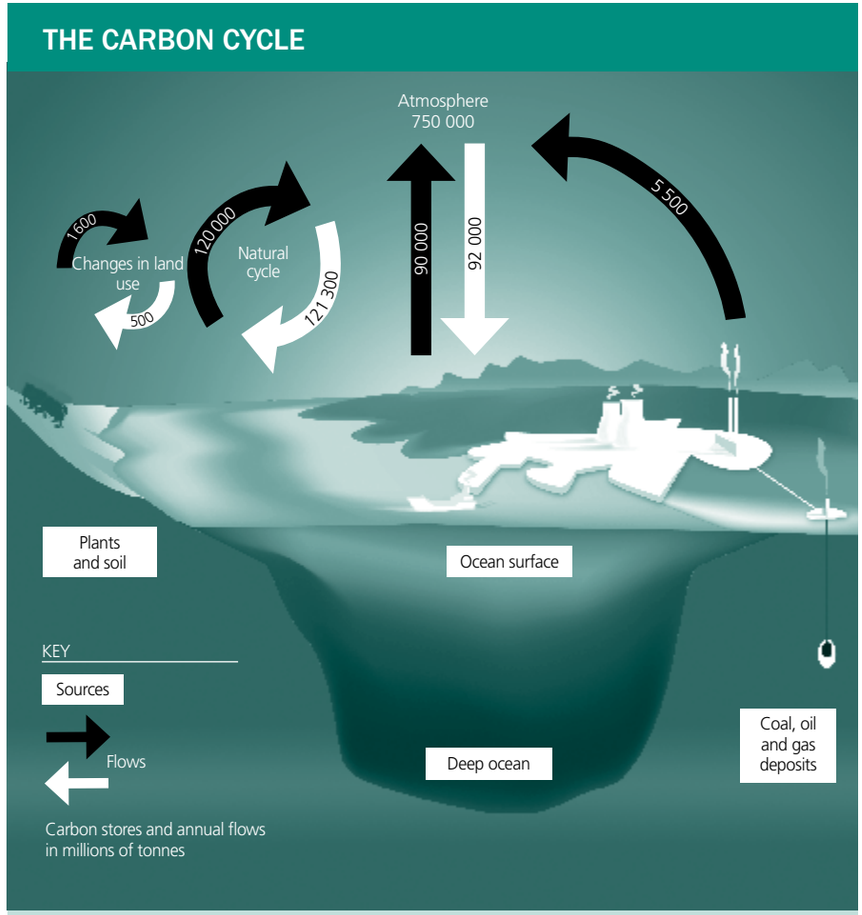


Figure 2: Temperature and CO_2 concentration in the atmosphere over the past 400 000 years

Bubbles of air, captured in Antarctic ice going back annually for the past 400 000 years, show a direct correlation over time between the concentration of CO_2 and temperature. We know, without a shadow of doubt, that if we continue to push up atmospheric carbon, we will only be dragging average temperatures up too.

Source: UNEP/GRID-Arendal Maps and Graphics Library. 2000. Available at *http://maps.grida.no/go/graphic/temperature-and-co2-concentration-in-the-atmosphere-over-the-past-400-000-years*



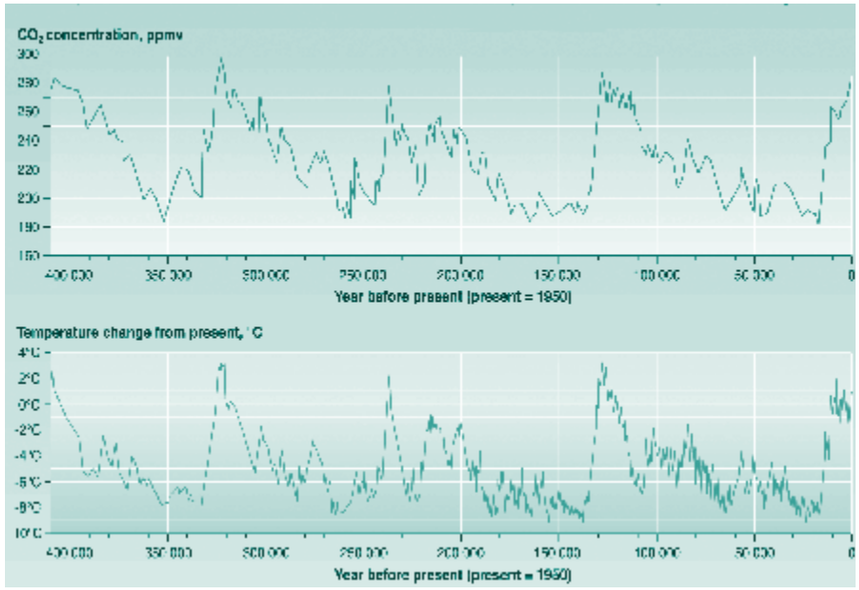
Source: *www.wikipedia.org* "Carbon cycle" and *www.safeclimate.net/business/understanding/carboncycle.php*

Carbon is the foundation stone and driver of life on our planet. All living things contain carbon – it forms millions of known compounds, including the complex chemistry of our DNA. It is the major constituent of soil and the fossil fuels upon which we are so dependent. The element is constantly on the move, and in huge amounts, between organic matter, the soil, the oceans and the atmosphere. This is known as the carbon cycle and it has been in process since life took hold on Earth. The oceans, the atmosphere, the land and all plants and animals act as great carbon reservoirs. The system works pretty well until something comes along to upset it. With the Industrial Revolution and the resulting rapid growth in deforestation and use of fossil fuels, we have been significantly upsetting this aeons-old carbon cycle. We have been releasing much of nature's "stored" carbon into the atmosphere in quantities greater than plants, soils and oceans have been able to reabsorb. We are straining the system.

Thickening the glass of the greenhouse

Earth's climate has always been in a state of flux, forced between warmer and cooler states by natural phenomena such as slight shifts in the planet's orbit (the Milankovitch cycles), volcanic activity and even tectonic movement in the planet's crust. However, human activities are amplifying the natural greenhouse effect by adding more greenhouse gases to the system. It started with the advent of agriculture 10 000 years ago, but increased exponentially with the large-scale deforestation and mass burning of fossil fuels such as coal at the beginning of the Industrial Revolution, and oil since the boom of the vehicle industry nearly a century ago. The expanding human footprint in recent decades has also accelerated other key activities, which cause more greenhouse gases to accumulate: deforestation, agricultural practices (farming of meat, ploughing of land, fertilising crops, mass rice production), industrial processes and the like. Greenhouse gas concentrations have risen markedly since 1750:

- Carbon dioxide, mostly from use of fossil fuels, is up by about 36%. It has increased by 100 parts per million (ppm) from about 280 ppm in the mid-1700s to over 380 ppm (36%) now.[4] Not only is the concentration of CO_2 rising, but the *rate* of increase is speeding up: it took 200 years for CO_2 to rise by the first 50 ppm, but only 30 years to rise by that same amount again. This gas contributes to 77% of the global warming effect. Many thinkers in the field regard 450 parts per million of CO_2 as a line in the sand that we really don't want to cross.
- Methane, mostly from agricultural processes (ruminant flatulence, manure and rice farming), landfills and a bit from energy production, is up by 150%, from 715 parts per billion (ppb) to 1 732 ppb, making its current atmospheric levels "unprecedented in at least the last 650 000 years".[4] Methane accounts for 14% of the global warming effect.
- Nitrous oxide, also agriculture's by-product, is up from 270 ppb to 319 ppb and accounts for 8% of the total warming.
- Sir Nicholas Stern adds up all the greenhouse gases to speak of the total in terms of "CO_2 equivalents" or CO_2e – this, he says, is up to 430 ppm now and is rising at a rate of two ppm per year.[1]



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The science is conclusive – increase the concentration of GHGs, and temperature will climb, resulting in shifts in long-term weather trends globally.

Now for the booby-traps

Already committed to change

As pollution goes, when it involves greenhouse gases, the impacts are not immediately evident compared with, say, dumping noxious waste into a dam where you'd find dead fish and frogs floating to the water's surface soon thereafter. When it comes to the atmospheric system and greenhouse gases, it takes decades between the time the greenhouse gas is released from the exhaust of your car, for instance, until it begins to manifest in rising temperatures that trigger altered climate. So the global impacts we're seeing today are the result of accumulated emissions put out 30 to 40 years ago, and more, while the emissions we are responsible for today will only begin to reveal themselves in changed climate when many of today's young adults are well into their retirement, or beyond. This is known as the lag effect.

That's why climate scientists tell us that even if we halted all emissions in their tracks right now, we would still be committed to a certain amount of change, as much as a 2 °C increase in average temperature with associated consequences of altered climate.

Shifts in climate, we now know, are not always smooth transitions, but are known to lurch from one state to another. There are several "tipping points" that could cause these shifts, which could result in runaway global warming and irreversible change. Should this happen, it would put the problem entirely out of our hands.

Forests, tundras and tipping points

Consider the Arctic – frozen over all year with a huge cap of ice. The very nature of the ice, being white, helps keep the Arctic in its frozen state because it reflects

the Sun's energy back out to space, even in summer. Until recently. Year on year, warming temperatures are causing the ice to retreat further each boreal summer, revealing the darker ocean waters beneath, which allow more of the Sun's energy to be absorbed into the Arctic system. The less ice to reflect away heat, the less chance there is of ice developing; the more dark water to absorb heat, the more ice melts – and so the beast keeps feeding itself. For the first time in our nautical history, ship captains are looking north in anticipation of enough summertime thaw to allow their ships safe passage.

It's basic physics. Light surfaces reflect the Sun's energy; darker surfaces absorb it. The case of the Arctic is a clear example of how this albedo effect feeds into global warming and accelerates the resulting climatic shifts. The high Arctic can expect an increase in warming within the next century that is 40% above the global average.[5]

The frozen tundra: normally, the tundra's deeper soils remain frozen all year round and the permafrost contains vast amounts of frozen methane (the result of vegetation decomposing in a damp, low-oxygen environment similar to that of a wetland, only colder). But the Arctic's rapid warming, described above, is melting this permafrost.

In 2005, *New Scientist* reported that west Siberia's peat bog contains "some 70 billion tonnes of methane, a quarter of all the methane stored on the land surface worldwide."[6] If the bogs dry out as they warm, the methane will oxidise and escape into the air as carbon dioxide. But if the bogs remain wet, as is the case in western Siberia today, then the methane will be released straight into the atmosphere. Should the Arctic's tundra begin to melt irreversibly, the resulting methane release could produce runaway global warming.

Forests are the planet's lungs – trees absorb CO_2, banking it away in their woody parts and roots. As long as a tree is alive, all the CO_2 it captures will remain there. When it dies, and is either burned or rots, the carbon is released back into the atmosphere. Forests, where carbon is captured on a mass scale, are thus key to balancing the amount of CO_2 present in the atmosphere.

The more trees are cut down, the less CO_2 is removed from the atmosphere. According to the World Resources Institute, deforestation accounts for 18.3% of global emissions – that's more than the entire transport sector!

Just as the Arctic's ice helps *maintain* the presence of ice by reflecting heat away, so forests help sustain themselves by creating much of their own rainfall: trees lose water through the pores of their leaves (transpiration) which, when they are in sufficient number as in the case of the Amazon forest, accumulates above the canopy to eventually form clouds, which rain back down onto the forest. But rising temperatures can disrupt this cycle.

George Monbiot summarises the process well: as transpiration decreases due to fewer trees "there is less rainfall to sustain remaining trees, more sunlight reaches the forest floor (drying it and making the forest more susceptible to fires), and less heat is lost through evaporation. The rising temperature and decreasing rainfall kill more trees, and the chain reaction continues".[7]

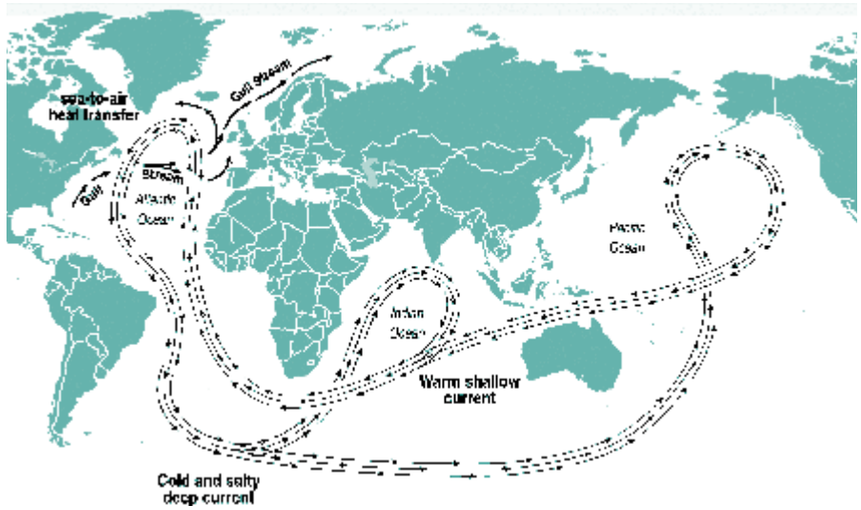


Figure 3: The great ocean conveyor belt

UNEP states that the global conveyor belt, the thermohaline circulation, "is driven primarily by the formation and sinking of deep water (from around 1 500 m to the Antarctic bottom water overlying the bottom of the ocean) in the Norwegian Sea. When the strength of the haline forcing increases due to excess precipitation, runoff, or ice melt, the conveyor belt will weaken or even shut down."

Source: UNEP/GRID-Arendal Maps and Graphics Library. 2000. Available at *http://maps.grida.no/go/graphic/world-ocean-thermohaline-circulation*

The Amazon could be fast approaching a tipping point that will spiral it into irreversible decline, whereupon it has the capacity to release "730 million tonnes of carbon – about 10% of annual manmade emissions – a year for 75 years".[7] Rapid clearing of forests is not unique to the Amazon. In central Africa and parts of Asia, similar processes are at work. The Food and Agricultural Organization (FAO) estimates that, globally, 13 million hectares of forests are lost annually, most of which are converted to agricultural land. The largest losses occur in South America and Africa.[8]

Western Europe's ice age

It sounds counter-intuitive to suggest a mini-ice age in the midst of global warming but Western Europe could be plunged into one if Greenland's ice continues to melt at an accelerated rate. The Gulf Stream is a massive body of warm, salty water that moves from the Gulf of Mexico across the Atlantic and past Scotland, delivering heat to a northern latitude that would otherwise be a great deal colder (compare Europe's climate with Canada's at the same latitude).

When the Gulf Stream arrives at Greenland, evaporation along its journey has caused it to become more salty. Once it reaches high into the North Atlantic, it begins to cool. The saltiness and cold force the current to sink, whereupon it begins a long journey south to the Antarctic along the ocean floor. This is part of the

LAYING THE MYTHS TO REST

Dr Guy Midgley, a key voice in the climate change research community, claims that the denialist movement delayed action on climate change by 20 years! George Monbiot shows convincingly in *Heat* that many of the climate change dissidents are on the payroll of the United States oil industry. The tactics deployed by these "lobbies" are similar to those used by the tobacco industry when it became clear that smoking has serious health risks: create doubt in the public mind by spreading myths about apparent inaccuracies or lack of consensus in the science.

If you want to clear up any confusion, once and for all, about some of the sceptics' arguments – such as the argument about climate change being caused by natural increasing sunspot activity or changing cosmic ray intensity; that climate models can't be trusted or that the science behind claims of observed changes is weak – then here are a few places that will help settle your mind:

- *New Scientist* has Climate change: A guide for the perplexed on *http://environment.newscientist.com/channel/earth/dn11462*
- WWF's How to talk to a climate sceptic: *www.panda.org* (click on Climate Change and then Convince a Sceptic)
- George Monbiot's argument about the sceptics, in *Heat*, is summarised here: *www.monbiot.com* (search for Smoke Behind the Deniers' Fire)
- The Union of Concerned Scientists provides background on some denialist groups: *www.ucsusa.org/global_warming/science/skeptic-organizations.html*
- Spinning straw men: when science writing goes wrong, in *Rhodes Journalism Review*, explores some of the newsroom conventions that explain why journalists sometimes get it wrong: *www.rjr.ru.ac.za/rjrpdf/rjr_no27/Spinning_straw_men.pdf*.
- How to Talk to a Climate Skeptic, see *http://gristmill.grist.org/skeptics*

larger thermohaline circulation, the "global conveyer belt", which distributes energy around the globe and drives the planet's climate.

Flush too much fresh water into the head of the Gulf Stream, and the water becomes less salty and thus won't be forced to sink. This is how the conveyor belt system could be stalled. It has happened in the geological past. Evidence suggests that the Gulf Stream's salinity is decreasing and its circulation slowed by almost a third between 1957 and 2004.[9] It may not happen in our lifetime, but if Greenland, the world's second largest ice cap, dumps too much fresh water into the head of the Gulf Stream, Western Europe could be in for a chilly time.

Filling up the ocean's sinks: carbon "sinks" (vegetation and oceans) strip about 40% of our annual CO_2 emissions from the atmosphere.[10] Our oceans absorb carbon from the atmosphere in two ways. Firstly, marine algae absorb CO_2, just as our plants do on land and, through photosynthesis, turn it into carbohydrates, which

they use to grow. This is how carbon is taken from the atmosphere and diverted into the marine food chain – it is the ocean's absorption of "organic" carbon. The other way, the absorption of "inorganic" carbon, is through a process of gas "dissolving" in water. The resulting chemical reaction decreases the pH of the ocean, pushing it towards a more acidic state.

Between 1750 and 1994, the ocean absorbed about 118 gigatons of human-caused carbon through both these methods.[11] And it's currently absorbing about 2.2 gigatons[11] of carbon every year – that's a nice chunk out of the nine gigatons of carbon that human activities are emitting annually through burning of fossil fuels, producing cement and other industrial processes, and deforestation.[10]

Should our oceans reach a saturation point, beyond which the absorption of atmospheric carbon is slowed or halted, the resulting accelerated accumulation of atmospheric carbon dioxide will speed up temperature hikes and hasten changing climate. RealClimate.org, the reputable climate change education website, reported in November 2007 that "warming in the coming century could be increased by carbon cycle feedbacks, by 25% to 75% or so".[B] The IPCC already states that the rate of absorption is slower now than it was three decades ago.[11]

The climate crisis – our most pressing environmental issue

There is an unequivocal link between increasing the concentration of greenhouse gases in the atmosphere, and a resultant rise in temperature, which is causing an amplification of climatic systems around the globe.

As discussed earlier, greenhouse gas concentrations are notably higher than pre-industrial levels. And, according to the IPCC, consequent "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".[3]

Here are some of the IPCC's most recent findings, which show convincingly that the thin epidermis, our biosphere, is responding to our greenhouse gas pollution.

Ringing in the changes

This is a summary of how the IPCC explains changes in temperature, and the immediate responses from the natural environment.[3]

Temperatures are rising:

- Since 1850, the land surface temperature has climbed by about 0.76 °C and the warming trend appears to be speeding up.

D. Christensen et al, 2007: p 871, "In regions of mean drying, there is generally a proportionally larger decrease in the number of rain days, indicating compensation between intensity and frequency of rain."

- 11 of the past 12 years are among the 12 warmest on record since 1850.
- The lower atmosphere is warming at a similar rate.
- Our oceans are warming, too.
- Since 1961, the IPCC reports that the "average temperature of the global ocean has increased to depths of at least 3 000 m and that the ocean has been absorbing more than 80% of the heat added to the climate system".

Responses to rising temperatures:

- Water vapour: a warmer atmosphere can hold more water vapour, and since the 1980s the average atmospheric water vapour content has increased. This is one of the many canaries in the mine shaft, telling us that we are causing the system to change.
- Sea level: between 1961 and 2003, sea levels rose between 1.3 mm and 2.3 mm per year – but this is speeding up, with more recent rates averaging at 3.1 mm annually. That is accounted for in part by the physical swelling of the ocean as it warms up, by snow cover and glaciers shrinking globally, and the steady dripping away of the Greenland and Antarctic ice sheets.
- Shrinking Arctic ice and tundra: every 10 years, ice covering the Arctic has shrunk by about 2.7% since 1978 (and as much as 7.4% per decade in summer) while the boreal permafrost footprint has shrunk by 7% since 1900 (springtime decrease is 15%).
- Wetter here, drier there: rising temperatures are intensifying natural rainfall patterns in many parts of the globe. The IPCC reports that northern Europe, northern and central Asia and eastern parts of North and South America have seen increased precipitation. Meanwhile drying trends are emerging from southern Africa, parts of southern Asia, the Sahel and the Mediterranean. Long-term trends, however, remain elusive.
- Salt in the ocean: another indicator of change is rising salinity around equatorial oceans, suggesting more evaporation here, while "freshening" of waters closer to the poles suggests more precipitation is falling over the oceans at these latitudes.

Extreme weather events, amplified by naturally occurring weather events, increase the frequency and intensity with which extreme events occur:

- Drought: since the 1970s, droughts have become "more intense and longer… particularly in the tropics and subtropics". This drying, says the IPCC, is linked to "higher temperatures and decreased precipitation", while "changes in sea surface temperatures, wind patterns and decreased snowpack and snow cover" also contribute to drought.
- Intense rain and snow: in a warmer world, more evaporation occurs and the atmosphere can hold a bit more water vapour. The result is an increase in the frequency of heavy rain or snow events. This is already being observed.
- Storms: hotter seas are driving faster and more intense tropical storms, although there doesn't appear to be an increase in the number of such storms.

- More hot weather: we've seen fewer cold snaps (days and nights) and frost events but more hot spells and heat waves, with an increasing tendency towards temperature extremes.

Southern Africa's changing climate

South Africa is already getting hotter, and has been doing so for over four decades. In 2004, scientists examined records from 26 weather stations across the country and calculated about a half degree average increase since 1960 (specifically, an average 0.13 °C increase per decade), with both minimum and maximum average temperatures reflecting the trend.[12] During the period from 1960 to 2003, the trend showed fewer cooler days and more warm days. The signal of climate change is showing itself more strongly in the Western Cape, with about double the average increase in temperature, a phenomenon that our climate change scientists are unable to explain.[C] Rainfall trends in South Africa during this time remain more elusive.

Into the future

The trends that we're already seeing will continue into the future and, in most cases, escalate. The IPCC says that we can expect a warming of about 0.2 °C per decade for the next 20 years. "Even if the concentrations of all greenhouse gases and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1 °C per decade would be expected," say the IPCC authors, further reminding us that we are committed to a degree of change, even if we cut all our emissions today. If we continue on our current emissions course, the changes we witness in our climatic system during the next century will be "larger than those witnessed during the 20th century".[3]

Bear in mind that most of the IPCC predictions are conservative, because scientists received considerable pressure from politicians to tone down the severity of their findings for the 2007 Fourth Assessment Report. Bottom line: the worst case scenario has not been included in the summaries listed below.

Global

Here is a summary of global projected trends:

- Temperature: we know temperature will continue to climb, but predicting the exact amount depends on a how much we curb our emissions and the ongoing refinement of our climate models. The IPCC estimates a warming of between 1.1 °C to 2.9 °C or 2.4 °C to 6.4 °C by the last two decades of this century, depending on which model is used.[3]
- Sea level: will rise by anything from 0.18 m on the conservative end of the spectrum, to 0.59 m. How far inland a rise of over half a metre will intrude depends on the steepness of the land in any given area and storm severity that drives water inland.

C. Hewitson, B, personal communication; Wand, S, personal communication.

- The melting continues: snow cover, sea ice (Arctic and Antarctic), glaciers and permafrost will continue to shrink. Projections have the late-summer Arctic completely ice-free by the end of this century, or much sooner.
- Extreme weather events: extreme precipitation and heat waves will increase in frequency and intensity; more intense typhoons and hurricanes will bring higher wind speeds and greater inundations of rain.
- Wetter here, drier there: continuing the observed precipitation trends, high latitudes will see more rainfall, while subtropical land regions will see less (the IPCC says one scenario puts this decrease by as much as 20% by the end of this century).
- Feedbacks: complicating the predictions is the uncertainty around just how much the booby-traps, mentioned above, will feed into the atmospheric system as the climate warms.

Climate in Africa

Africa will get warmer. In fact, the warming trend for Africa will be 1.5 times greater than the global trend,[13] with temperature increases across the continent of between 3 °C and 4 °C by the end of this century – not good news for a landmass that is regarded as one of the most vulnerable to climate change because of its lack of adaptive capacity. The IPCC climatologists predict that drier areas in the subtropics will warm more than wetter tropical areas.

Zooming in on southern Africa – the trends already being witnessed in parts of the country will continue into the future, according to the climate modellers. The first projections, published in about 2000, suggested an overall regional temperature increase of 3 °C for southern Africa by 2050. This came with regional variations, such as summertime increases for the Northern Cape and central interior of anything from 2.5 °C to 4.5 °C while the coast, where the temperature hike would be moderated by the influence of the ocean, would only climb about 0.5 °C to 1.0 °C by 2050.[14]

The process of reaching these findings has been revised constantly since then. The 2005 *Status Quo Report,*[15] which focused on the Western Cape, puts the regional mercury hike at 1.5 °C along the coast by 2050, while in the interior of the Cape Fold Mountains, the increase will be closer to 2 °C or 3 °C.

The 2007 modelling by the IPCC confirms that there will be a discernable drying to the west of the region, while the east will see increases in summertime rainfall. Climbing temperatures, due to rising greenhouse gas levels, will amplify the extremes in seasonal weather that are natural to the region. This means that droughts, heatwaves and floods will continue to occur with greater frequency and intensity. For instance, a flood or drought with the severity associated with a one-in-50-year event, might hypothetically begin to happen once every 40 or 30 years.

Here is a summary of projected trends:

- Temperature rising: Southern Africa will, on average, be 3.4 °C warmer by 2100, according to the latest IPCC findings. This confirms earlier studies that anticipate a 1 °C to 3 °C rise in average temperature by 2050, relative to the average temperatures between 1960 to 1990. These changes will vary between regions. The interior of the country is expected to warm more than the coastal regions because of the moderating influence of the sea – for instance, the Northern Cape could see an increase of over 4.5 °C. Meanwhile, higher altitudes will warm less than low-lying areas. Average temperatures in the Western Cape are expected to rise by about 1.5 °C along the coast and 2 °C to 3 °C inland of the Cape Fold Mountains by 2050.[15]
- Spring fever: "Season creep" describes how springtime appears to come sooner to parts of the world where plants flower or birds begin courting earlier in the season. But, in southern Africa, it looks as though the spring rains will be delayed, since modelling shows that the greatest seasonal drying in spring (half the total annual reduction in rainfall) will happen from September and November in the summer-rainfall parts of the region. The most warming will happen in spring, too. Consider the implications for crops and any seedlings, whether wild or farmed.
- Drier here, wetter there: The tropical west, far north of South Africa's borders, gets drier in spring and summer, according to some of the models, although this pattern looks as though it will creep south, too.[13]

Meanwhile, the east gets wetter during summer. This phenomenon needs to be clarified, since it refers to greater inundations of rain over shorter periods of time[D], which results in less absorption of moisture by the soil and greater runoff and flooding. Increased rainfall measured in rain gauges in these parts doesn't necessarily translate into salvation from the droughts that will still hit the region. The Drakensberg catchment area, and the "convective region of the central and eastern plateau" will see an increase in summertime rainfall.[16] Even though the latest modelling predicts increased rain in certain parts, such as late-summer rain in the eastern region of the Western Cape or summer rain in the east, this is generally crammed into fewer rain days, meaning that the rains, when they come, will bring an increased likelihood of flooding.

The balance between water coming into the system and water leaving it will be shifted towards an aridification trend in most parts, as heat stress and changed rainfall will probably result in greater runoff, evaporation and drying out of soils. The regional Millennium Ecosystem Assessment states that for every 1 °C that temperature increases, evaporation rate matches it with a 5% increase.[17]

- Western Cape: the storm tracks that bring the Cape its winter rain will continue shifting polewards, taking the rain out to sea instead of allowing it to fall on the continent.[15] The IPCC modellers predict extreme drying in the south-west during winter.[13] Since this is the rainy season for the region, which has the tremendously

D. Christensen et al, 2007: p 871, "In regions of mean drying, there is generally a proportionally larger decrease in the number of rain days, indicating compensation between intensity and frequency of rain."

CLIMATE VERSUS WEATHER

The winter of 2007 felt brutal: severe flooding over the Cape Flats and part of Cape Town's southern suburbs; repeated snowfalls over many parts of the country, including the first big snow in Gauteng since September, 1981; some Free State maize farmers reporting the worst frosts for at least three decades. Hardly in keeping with rising temperatures due to global warming! But there is a big difference between once-off weather events – or a winter filled with them – and climate.

Weather refers to atmospheric conditions (such as temperature, rain, wind) in one place at a specific time. Climate, however, is the combination of all those aspects of weather, from which trends will emerge over a long period of time.

Weather is notoriously chaotic and therefore difficult to predict more than a few days in advance. This, says the IPCC in its Fourth Assessment Report, has led to confusion in the popular mind.

"How could you possibly predict what our climate will be like 50 years from now," you might ask, "if meteorologists can't even predict the weather accurately a fortnight from now?"

This is easily explained by a lovely IPCC analogy: "...while it is impossible to predict the age at which any particular man will die, we can say with high confidence that the average age of death for men in industrialised countries is about 75".

"Another common confusion of these issues," states the IPCC, "is thinking that a cold winter or a cooling spot on the globe is evidence against global warming. There are always extremes of hot and cold, although their frequency and intensity change as climate changes. But when weather is averaged over space and time, the fact that the globe is warming emerges clearly from the data."

valuable Cape Floral Kingdom as well as accounting for 50% of the country's export agriculture, this "desertification" trend has serious implications for the Western Cape province. The earliest modelling for the Cape predicted an average 25% loss of winter rainfall by 2050.[14]

- Living in the extreme: a warmer atmosphere can hold more water vapour, which has to translate into rain at some point. This means an increase in intensity of high-rainfall events in places. Storms moving onto our east coast from the Indian Ocean will probably be more intense and carry more rain.[13]

Consequences of climate change

Climate change will touch every aspect of life on Earth – some for the better (such as opening up more agricultural land in the frozen northern latitudes) – but overwhelmingly for the worse. It will have implications for water supply and food security. Heatwaves and extreme weather events will affect human health, including an increased risk of cholera infection associated with flooding and stagnant water. Vector-borne diseases such as malaria will change their footprint. Weather events

will force mass migration of people. There will be conflict over resources and loss of biodiversity. The ecosystem services upon which we depend, will be undermined.

Six degrees from catastrophe

Written by the World Wide Fund for Nature's (WWF) Peet du Ploy (first published in Africa Geographic*, August 2007).*

Mark Lynas, author of the book *Six Degrees*, describes the global changes our planet will face for each degree rise in temperature that emissions cause.

One of the issues highlighted by scientists, but suppressed through the political process in the IPCC, is that climate change is not just happening, but *accelerating*. Weather patterns are not shifting slowly into a new, stable climate just slightly warmer than before, but are hurtling ever faster into unknown territory.

Potential feedbacks imply that, beyond a certain unknown point, we could be locked into a trajectory of climate change that we can no longer influence. Continued destruction of the Earth's capacity to absorb carbon through deforestation and reflect solar radiation through the loss of reflective ice or snow surfaces, along with the release of previously captured greenhouse gas, such as methane once trapped in melting tundra or emissions from a burning Amazon, would turn the planet into a net source of greenhouse gas, instead of playing its current role as a carbon sink.

This headlong rush may cause a rise in temperatures of 6 °C to 10 °C and plunge the planet into conditions last seen hundreds of millions of years ago, when extinctions occurred on a massive scale.

The world overshot sustainable levels of consumption as far back as the early 1980s. If you're 30 years or younger, the world has been dying for about as long as you've been alive, in the sense that more of it is being consumed than it can produce or replace. For the past two to three decades, we have been "eating into our environmental capital when we should be living off the interest".

Such unchecked over-consumption, particularly of fossil fuels, could spiral into uncontrolled climate change. A global economic crisis would ensue before the end of this century, turning as many as 250 million Africans into climate refugees. Any scenario in which greenhouse gas emissions are not controlled is really only academic. This is not a problem we can leave for our children to fix. While detailed knowledge of climate change due to global warming is only one generation old, ours is the *first and last* generation that can fix it.

Even if we make a concerted effort now, scientists believe that current levels of greenhouse gases already in the system will be responsible for a 2 °C average increase in global temperature. If emissions continue to rise unabated, this may be far higher. What would a hotter world look like?

1 °C hotter

We are already nearly there. Long droughts plague many parts of the world. Summers are increasingly and record-breakingly hotter and longer in Europe and elsewhere.

> Carved into the permafrost of a remote Arctic mountain, a "doomsday vault" housing samples of the world's most important seeds is taking shape to provide mankind with a Noah's Ark of food in the event of a global catastrophe.
>
> *29 August 2007, Agence France-Presse*

Fears of the Gulf Stream slowing or even halting due to Arctic glacial and sea ice melts are raised. Already evidence of polar ice retreat is alarming. In Africa, the tropical ice caps are diminishing – Kilimanjaro's glaciers have shrunk visibly. Loss of the ice caps will be disastrous for the hydrology of tropical Africa. Perversely, parts of Africa will suffer increased flooding as tropical storms take their toll. Low-lying plains such as those in Mozambique will be especially vulnerable, as will the Indian Ocean islands.

2 °C hotter

Droughts bite hard in China's northern heartland, while the south is battered by floods. Greenhouse gases released over the past 100 years or so begin to alter the chemistry of the oceans, which become more acidic, with fatal consequences for corals, already under threat from bleaching, and shelled creatures. European summers are unbearable and the vegetation and crops of Mediterranean countries are beginning to wither and fail. Polar regions could tip into irrevocable meltdowns, as might the ice of great ranges such as the Himalayas and the Andes. Crops fail widely in Africa, where famine becomes endemic. Many of the world's ecosystems fragment and massive die-offs of both plants and animals occur.

3 °C hotter

Countries such as Botswana are regularly devastated by drought; the relative wealth of this country is no match for the eastwards march of the Kalahari Desert. Cattle and crops perish as all of south-western Africa suffers a lack of the most precious commodity of all – water. "Super" El Ninõ events wreak havoc across the globe, which begins to take on the character of Pliocene times, when polar regions were some 15 °C warmer than today. The Amazon dies and Australia burns. Hurricanes of a power not yet experienced rip through countries susceptible to tropical storms. With its glacier water feed gone, the Indus slows to a trickle. Storms ravage Europe and the great coastal cities of the world fight an unequal battle against the rising sea level and storm surges. Conflicts erupt as countries go to war over diminishing food and water shortages.

4 °C hotter

Rising sea levels continue – the Nile and Ganges deltas are but two of the low-lying casualties. Global warming of four degrees would damage the integrity of the

Antarctic's Ross and Ronne ice shelves, and the East Antarctic Ice Sheet would be under assault. The sheet is four kilometres thick and holds enough water to raise sea levels by 50 metres. It is sobering to note that the last time the Earth was four degrees warmer there was no polar ice. Summer temperatures in European cities such as London would soar to 45 °C and the desert conditions of present-day North Africa would reach deep into southern and eastern Europe. Summer will become the season that Europeans dread. As the permafrost of Siberia retreats, huge amounts of carbon, previously locked in the frozen ground, are released into the atmosphere, exacerbating the problems. Humanity becomes increasingly powerless to intervene.

5 °C hotter

An entirely different planet starts emerging. The international community has to cope with massive human migrations towards the few remaining habitable regions of the world. Major dams and irrigation systems will be required to hold and manage water for food production. Methane sequestered in ocean sediment could be released in sudden and huge amounts. Such explosive releases could destabilise submarine slopes, which in turn could give rise to towering tsunamis, making an existence less than 10 metres above sea level very tenuous indeed. Drastic reductions in human population are an unavoidable conclusion in a world some 5 °C warmer than the present – what James Lovelock of Gaia fame refers to as the "cull".

6 °C hotter

Current climate models don't yet deal with such scenarios, so there aren't many clues as to the world our surviving progeny might inherit. Greenhouse episodes in the planet's distant past may hold some insights. Could methane explosions bring our planet to the brink of an extinction similar to that of the end-Permian? And if so, could the human species survive? Conjecture is almost fruitless, for we will have failed dismally, politically, technologically and possible even biologically.

Resources

i. DVD: The 11th Hour – Turning Mankind's Darkest Hour into Its Finest; Narrated by Leonardo DiCaprio; 2007
ii. Real Climate: Climate Science from Climate Scientists; *www.realclimate.org*
iii. The Weather Makers; Tim Flannery; 2006; Atlantic Monthly Press; US
iv. An Inconvenient Truth; Al Gore; Rodale Books; US (or see the DVD)
v. Not for the Faint of Heart, the United Nations' Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report: Working Group (WG) I Report "The Scientific Basis"; WG II Report "Impacts, Adaptation and Vulnerability" and WG III Report "Mitigation of Climate Change"; *www.ipcc.ch*
vi. Scorched: South Africa's Changing Climate; Leonie Joubert; 2006; Wits University Press; South Africa

"The supreme reality of our time is ... the vulnerability of our planet."

John F. Kennedy, 1963

5

Climate change

Our most pressing economic and social issue?

Jeremy Wakeford

It is only within the last 10 millennia or so that modern civilisation, based on technology and agriculture, has blossomed. Rising temperatures and changing weather patterns, unequivocally the consequence of our fossil-fuel-driven economies and unsustainable land-change practices, threaten all of this at a speed that is leaving little time for effective change and adaptation. The effects on ecosystems, human food security and health are likely to be huge. Without timely mitigation and adaptation, many economies are likely to suffer severe damages and competition over scarce resources, which will almost certainly stoke social tensions and conflict on regional and local levels.

Economies and livelihoods under threat

The phenomenal technological developments of the industrial era have lulled many people into a false belief that human beings have mastered their environment. Climate change is beginning to shatter that illusion by showing us how utterly dependent we are on ecological systems and natural resources. Adequate quantities of fresh water, food, energy and other material resources are the preconditions for life. Climate change forcibly demonstrates humans' ability collectively to alter and damage our life-supporting biosphere.

According to the IPCC,[1] "Africa is one of the most vulnerable continents to climate variability and change because of multiple stresses and low adaptive capacity". The richest and most technologically developed countries are better placed to adapt to a changing climate, but they too rely on natural systems and will ultimately pay the price for unsustainable consumption patterns.

CLIMATE CHANGE – OUR BIGGEST MARKET FAILURE

While the environmental threat of climate change has long been understood, the potentially severe economic impacts were not commonly acknowledged until the publication of the Stern Review[2] on the Economics of Climate Change in late 2006. The Stern Review states that: "[t]he scientific evidence points to increasing risks of serious, irreversible impacts from climate change associated with business-as-usual (BAU) paths for emissions". It concludes that: "[o]ur actions over the coming few decades could create risks of major disruption to economic and social activity, later in this century and in the next, on a scale similar to those associated with the great wars and the economic depression of the first half of the 20th century". The Review projects that business-as-usual climate change might lead to a reduction in consumption per person of up to 20% in the future.

Agriculture

The basis of any society is its ability to procure sufficient fresh water and to produce enough food to feed its population. Without this foundation, any economic superstructure and complex social organisation cannot exist. Unfortunately, agriculture is the sector most vulnerable to a changing climate. Although farming in some northern regions might actually benefit from rising temperatures, Brown[3] warns that, in general, climate change is expected to lower crop yields globally. Some important crops – such as maize – are very sensitive to slight changes in average temperatures. Changing rainfall patterns – including more frequent and intense droughts and floods – will also harm agriculture.

Climate-induced food and water shortages are expected to be especially acute in Africa. The IPCC[1] estimates that by 2020, "between 75 and 250 million people are

> "A nation that destroys its soils destroys itself."
>
> *Franklin D. Roosevelt*

projected to be exposed to an increase of water stress due to climate change" and "[i]n some countries, yields from rain-fed agriculture could be reduced by up to 50%". For a continent that has comparatively little irrigation and a large population of subsistence farmers, this is a very serious threat that looks set to bring even greater hardship for millions of Africans already under stress.

In South Africa, we can expect increasing rainfall (and flooding) in the eastern part of the country and decreased rainfall in the west, where it is already dry. We are already witnessing a growing number of crops, such as potatoes, fruit and rooibos, under pressure from changing weather patterns.

Many African countries rely heavily on agricultural commodity exports for their foreign revenues and ability to import essential manufactured goods. Although agricultural products make up less than 8% of South Africa's export revenue, it is nonetheless an important source of foreign exchange, which will be increasingly jeopardised.[4] Half of the country's exported agricultural produce is grown in the Western Cape, which is expected to suffer from severe drying. Most of the country's wheat is also grown in the Western Cape, and already South Africa imports about half of its wheat needs. In 2006 the maize harvest was badly affected by drought.

Fisheries

Both globally and off the southern African coast, wild fish stocks are already under threat from overharvesting and pollution of the oceans. Global warming adds an additional peril in the form of ocean acidification, which could threaten the existence of zooplankton, the basis of the marine food chain. The IPCC[1] also projects that lake fisheries in Africa will be negatively affected by rising water temperatures.

Industry

South Africa is the continent's industrial powerhouse, having long relied on the country's abundant coal reserves for cheap power. This historical advantage is now becoming a great challenge: how to lower the energy and carbon intensity of the economy. Although Eskom, the state-owned electricity supplier, is slowly starting to try out renewable forms of energy, it is in the process of building another coal-fired power station and has plans for one more after that. Eskom also has ambitious plans for expanding nuclear power generation, which has much lower carbon emissions than coal (but more than renewables like solar and wind power because of uranium mining and processing). In any event, current projections are that South Africa will continue its coal dependence for decades, despite the contribution to global warming. The impact this may have on trade with carbon-conscious countries is likely to be negative.

TWIN CHALLENGES: Peak oil & climate change

The oil and other fossil fuels that are contributing to global warming are finite resources subject to depletion. There is mounting evidence that global oil production will reach its inevitable peak and begin to decline within the next few years. At first glance this may seem a good thing for climate mitigation, as oil-based emissions will necessarily contract. However, there is a serious risk that our oil-dependent societies will turn instead to coal and unconventional fossil fuels, which are more polluting. Also, depleting oil is likely to result in more deforestation, both for fuel wood and to make space for biofuel crops. Peak oil and climate change are both immense challenges and need to be tackled together.

Tourism

Tourism is one of the largest foreign and domestic income earners for many African states and in South Africa contributes about 8% to GDP while employing over half a million people. In 2005 the country received over seven million foreign visitors, and the numbers have grown rapidly since then.[4] The destruction of prime tourism destinations as a result of climate-related events and the associated pressures of a growing, stressed human population, could well rob Africa of one of the greatest opportunities the continent has to lift its economic fortunes up by the bootstraps. Of course, tourism may also decrease because of rising flight prices and a growing disapprobation of those who add to atmospheric carbon by flying long-haul to distant holiday destinations. Either way, tourism looks set to be a casualty of climate change.

Coastal inundation

Many coastal areas will suffer additional threats as a result of sea-level rise, although this is generally expected to be gradual, except perhaps on Africa's island states. Even with relatively modest temperature increases, sea-level rise could creep towards one metre by 2100, according to the IPCC.[1] Some recent research, however, warns about climate-tipping points and the possibility of greatly accelerated melting of the Greenland and West Antarctic ice-caps, which could each raise sea levels by several metres.[5] Even the more conservative projections of the IPCC show that low-lying coastal areas in Africa with large populations will be affected, and that the "cost of adaptation could amount to at least 5% to 10% of GDP" later this century. In South Africa, Cape Town could face very particular threats as many suburbs and settlements, as well as industrial sites, are situated on the low-lying Cape Flats. The worst-case scenarios could prove devastating for shipping infrastructure and hence international trade.

Rising social strains

Deepening poverty

Poverty, which is already endemic in Africa, will be exacerbated by the stresses of a changing climate. Even in South Africa, a middle-income country, roughly

half of the population is defined as poor by most measures. The official jobless rate is over 25%. This, combined with the number of people who have given up looking for work, raises the unemployment rate to above 40%.[6] The unemployed and poor are the most vulnerable to the impacts of climate change, lacking the resources and skills required to adapt. In the face of a burgeoning population, intensifying water scarcity and food insecurity paint a bleak picture of the future.

Rising health risks and costs

As described in the previous chapter, several serious diseases are likely to spread further as a result of climate change, including vector-borne diseases like malaria and water-borne ills such as cholera. Climate change also interacts negatively with HIV/Aids via hunger, malnutrition, inadequate water and opportunistic infections. Christian Aid estimates that up to 182 million people will die from climate-related diseases in sub-Saharan Africa by the end of the century.[7] Lack of adequate health care will make many bad health-related situations even worse. Very sick people cannot work, and many of those who don't succumb to illness have to spend precious time, energy and resources caring for those who do. The spread of disease will also place increasing financial burdens on state coffers.

People on the move

Africa has a long history of disaster-related migration and conflict-driven refugee crises. Shifting rainfall patterns and their impact on water and food availability will force many more people to migrate as climate change advances. In the case of South Africa, the country's relatively greater resources already attract hundreds of thousands of immigrants – legal, illegal and refugees – from politically and economically stressed states to the north. Hardships in these countries, exacerbated by climate change, could see an even greater influx of desperate people across South Africa's northern boundaries. The stress of the country's already stretched ability to provide housing, electricity, health, schooling and other essential services could be severely compromised by this additional burden.

AsgiSA: DESIGNED TO FAIL

In 2006 the government unveiled its Accelerated and Shared Growth Initiative for South Africa (AsgiSA), which aims to raise the rate of economic growth to 6% by 2010 and to halve unemployment and poverty by 2014. AsgiSA identifies several "binding constraints" on the economy, but does not include among these environmental limits to growth such as finiteness of resources or climate change impacts. Despite making commitments to sustainable development in numerous other policy documents, AsgiSA stubbornly adheres to the illusion that business-as-usual can proceed indefinitely. Sooner or later, politicians will be forced by circumstances to abandon the Holy Grail of growth. Instead, they should develop and adopt innovative policies designed to promote local economies and livelihoods that work with, rather than against, the environment.

> The blunt truth about the politics of climate change is that no country will want to sacrifice its economy in order to meet this challenge, but all economies know that the only sensible long-term way of developing is to do it on a sustainable basis.
>
> *Tony Blair*

Conflict and instability

All of these social strains will coalesce into intensifying competition over critical resources, especially water and food but also forms of energy, including wood. Currently, Africa is riddled with resource-related conflicts, such as those in Darfur, Nigeria and Somalia. Even societies that appear relatively stable can suddenly erupt into political conflict and violence, such as those that occured in Kenya in January 2008, when dispute over polls left more than 100 people dead. Maintaining social and political stability will be an immense challenge as the continent continues to warm.

Conclusion

Africa's historical contribution to the drivers of climate change is very small, and yet many experts say the continent will be the hardest hit by climate change and the resulting economic knock-on effects. Climate change will bring with it increasing scarcity of food and water; the basic conditions for human life. This in turn will result in displacement of communities and higher rates of regional migration. Competition for resources is likely to result in increasing social tensions and conflict. From a human perspective, climate change is as much an economic and social issue as it is an environmental one. Mitigating and adapting (which are discussed in *Chapter 10: Mitigation is an energy issue*) to a changing climate is a matter of survival for millions of people – not least in Africa – and possibly even for the human race as a whole.

Resources

i. Intergovernmental Panel on Climate Change (IPCC); Fourth Assessment Report, WGII: Climate Change 2007: Impacts, Adaptation and Vulnerability – Summary for Policymakers; *www.ipcc.ch*

ii. Plan B 2.0: Rescuing a Planet under Stress and a Civilization in Trouble; (Chapter 4: Rising Temperatures and Rising Seas); *www.earth-policy.org/Books/PB2/contents.htm*

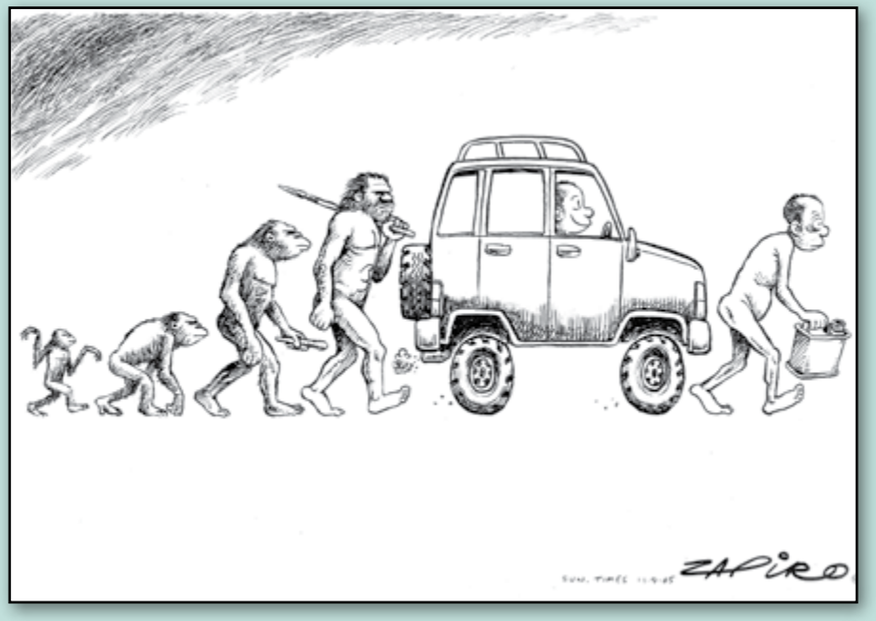
iii. Stern Review on the Economics of Climate Change; HM Treasury, UK; 2006; *www.hm-treasury.gov.uk*

iv. Up in Smoke? Threats from, and Responses to, the Impact of Global Warming on Human Development; *www.neweconomics.org*

v. Boiling Point: People in a Changing Climate; Leonie Joubert; 2008; Wits University Press; South Africa

ACKNOWLEDGEMENT

The author is grateful for contributions from Peter Borchert, Leonie Joubert and Dr Gina Ziervogel, but takes full responsibility for opinions expressed and any errors the chapter may contain.



Civilised man was nearly always able to become master of his environment temporarily. His chief troubles came from his delusions that his temporary mastership was permanent. He thought of himself as 'master of the world', while failing to understand fully the laws of nature.

Tom Dale and Vernon Carter, *Topsoil and Civilisation*

6

Past-Present-Future
How we got into this mess

Robert Zipplies with Peet du Plooy

In the past, many societies collapsed because of self-inflicted, local environmental causes. Modern humans share the same fate as we undermine our supportive ecosystems. Virtually all our individual actions – travelling, purchasing products and services, eating food – are contributing to our precipitous decline. Our ecological and carbon footprints – measures of the sustainability of given lifestyles – are an indication of how excessive and destructive the lives of the wealthier sectors of society are. That said, it is within our power to create a more sustainable and just future if we are each able to make this a personal commitment.

Learning from the past

Situated in the vast oceans of the Pacific, the giant stone heads on Easter Island that look forlornly out to sea are testimony to a once highly productive society. The monolithic statues are evidence of both an incredible human achievement and devastating failure. The Polynesians who settled on Easter Island just over 1 000 years ago achieved an almost unimaginable feat. They navigated across 2 000 kilometres of Pacific Ocean in canoes to find and inhabit this needle-in-a-haystack island – referred to as the "most remote habitable scrap of land in the world". A few hundred years later, the population had swelled to an impressive 15 000 or more. Not long afterwards, the proverbial "last tree" of this once diversely forested island was felled, which precipitated a rapid decline. Trees had helped to bind topsoil, and provided an essential source of wild foods and compost, and wood and bark for building, rope-making, canoes, and cooking and heating. The felled forests resulted in famines and civil wars, contributing to a devastating collapse of this society.

Described in Jared Diamond's book "*Collapse: How Societies Choose to Fail or Survive*",[1] the people of Easter Island denuded an integral constituent of their ecosystems – trees – at a faster rate than they regrew; an example of an unsustainable existence. There must have been tremendous pressure not to cut down the last trees, but who would not if it meant they were able to feed, warm or house their family? Easter Island is by no means an exception and Diamond goes on to describe many other historic cultures that similarly denuded their life-supporting ecosystems: the Norse Greenlanders, the Mayans, other Polynesian islanders, the Anasazi and the Vikings. Easter Island, while an imperfect model, represents a fundamental and long-running trend in the relationship between humans and their natural habitat. Have we learnt? Apparently not!

While the Easter Islanders and others fell into decline, many other societies flourished and progressed to expand their populations, develop new technologies, settle new lands and, eventually, to create our present-day, globally interconnected economic trading system. But underlying this so-called "progress" and

A SOCIETY IN COLLAPSE

Jared Diamond in his bestselling book, "*Collapse: How Societies Choose to Fail or Survive*"[1] discusses eight factors that contributed to the demise of past societies. Our modern world has added four more – the last in this list of 12 factors: deforestation and habitat destruction, soil problems (erosion, salinisation and soil fertility losses), water management problems, overhunting, overfishing, effects of introduced species on native species, human population growth, increased per capita impact of people, human-caused climate change, build-up of toxic chemicals in the environment, energy shortages, and full human utilisation of the Earth's photosynthetic capacity.

our seemingly robust interdependence, we continue to squander our natural resources at an ever increasing speed – and we now discover that planet Earth has become our Easter Island.

Into the present

A global Easter Island

There was a time when we lived in and with nature. We roamed on foot, hunting and gathering for our needs. We only killed or picked as was necessary, and continually migrated with the wild herds and the seasons, allowing the land to rehabilitate. In this epoch, there was no unusable, toxic waste – everything we discarded nourished the land. Human numbers were kept low due to the hardships of nomadic existence, lack of technical innovation and the limited food supplies that nature offered. The only resources we had access to were renewable, and neither our needs nor our numbers caused these to be over-exploited globally.

Then came a turning point – we harnessed fire and acquired agricultural skills. The latter allowed us to improve the reliability and quantity of our food supplies. Fire was used for protection, to keep warm, cook a broader range of foods and work metals into tools and weapons. We raised bigger families and started settling distant territories that had not always been suitable for a nomadic lifestyle. We pursued numerous new activities: acquiring knowledge, learning to read and write, developing innovative types of tools and weapons, and we increasingly dabbled in alchemy – a forerunner to scientific chemistry and the broader pursuit of scientific knowledge as a discipline. Growing food surpluses allowed an ever-greater number of people to pursue specialised professions, such as carpentry, iron-work, governance, academia, geology and medicine. Villages grew into towns and towns into cities.

We altered our surrounding landscape – sometimes a little overzealously. Forests were felled to provide wood and create land for pasture and crops, and rivers were dammed and diverted. From time to time a society would collapse, often facilitated by the environmental havoc it had caused. But there was always another place to move to or another society to continue our progress. We left behind a few ghost settlements, but started many boom towns.

The rate of technological and organisational innovation accelerated – systemised production and mechanisation, development of synthetic chemicals, the steam engine, the birth of the corporation as a vehicle for commercial organisation and production, electricity, the combustion engine, communication and information technologies all speeded us along in our progress.

The pace of our technological progress has been astounding – consider medical treatments, entertainment options, electronic gadgets and choice of mobility that we have at our disposal. These did not exist just a few generations ago. Using motorised ploughing and harvesting technologies, irrigation and new chemicals, we, on the same bit of land, can produce two or three times as much crop output as we did just

50 to 100 years ago.[2]

Today we are able to read books we ordered yesterday on the Internet. Within 16 hours we can relocate to the far side of the globe. We eat olives harvested in Spain, young spinach picked from the slopes of Mt Kenya, kiwi fruits imported from New Zealand and salmon caught in Alaska. But our progress has come at a tremendous cost to nature and some individuals, and, increasingly, to society as a whole!

In our zeal to thrive and progress, we are behaving like bulls in nature's china shop. We convert ever more natural habitat to agricultural land, we burn wood and coal in rapidly escalating quantities; we pave over the landscape to put up more dwellings and factories. The volumes and diversity of our waste, greenhouse gases included, are mushrooming. We now produce in excess of 100 000 synthetic chemicals, of which few have been tested comprehensively and many of which are highly toxic to fauna and flora and, of course, us.[3] Most of these chemicals eventually find their way into our ecosystems and our bodies.

If you look at just about any graph of human-related progress – GDP, development of new technologies, world population, vehicles produced – it turns from a flattish horizontal to a steep slope and, in many cases, to a near-vertical cliff, in a matter of generations or just decades. With this progress comes a downside as undesirable indicators show similar graphic patterns: resource depletion, waste volumes, overfishing, toxicity build-up and greenhouse gas emissions. We are about to find out what lies on the other side of those steep graphs. Scientists will tell you that such growth can only be sustained for a short time – then a stable state needs to be reached or it must again decline, or possibly collapse.

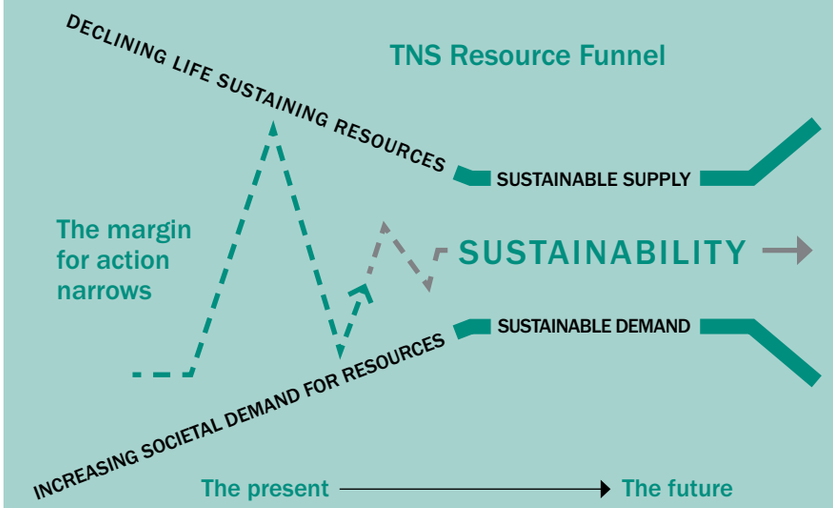
> The manufacture of just one 18-karat gold ring weighing about 28 grams will have in its history 20 tonnes of mining waste that had to be blasted, hauled to the surface, crushed, processed and discarded.[7]

Making the connection

In all that we now do – whether it is driving a car, buying groceries, going on holiday, having a drink, taking a shower, brushing our teeth, speaking on the phone, watching television – we cannot escape our contribution to the destruction. All our actions seem to have far-reaching and drastic consequences. As an example – a 2.3 kg laptop computer generates nine tonnes of waste during manufacture, much of which is toxic. It is astounding to consider that an estimated 94% of extracted raw materials used in the manufacture of durable goods are wasted during the production of the product. If that is not bad enough, we generally don't keep things for very long and 80% of manufactured goods are discarded within six months of production.[4]

Almost without exception, all our products, services and individual actions are

THE LIMITS TO GROWTH



The Natural Step, an international consulting organisation, has developed a useful metaphor that illustrates the limits to growth. Imagine a funnel with two constricting walls. The upper wall represents the diminishing ability of ecosystems to supply us with resources (fresh water, minerals, fossil fuels, forests, agricultural lands, fish, and so on). The lower wall represents society's rising demand for these resources, which we require to produce our food, shelter, clothes and other goods and services. Our demand for more is increasingly conflicting with nature's ability to supply. As a society our objective must be to cut back on our demands and use our ingenuity to prevent the funnel walls from closing entirely, resulting in major ecosystem collapses.

Today's society lives in "bottleneck times" and we need to ensure that we leave a sufficiently wide "tunnel" to allow us to squeeze through to a more sustainable future society. With time, as we adapt our lifestyles and learn to live with less, and as our technologies become more sophisticated, allowing us to produce goods and services with fewer adverse impacts, the walls of the tunnel will open again and allow a less restricted lifestyle – a sustainable future.

Simply- speaking, there are three factors that drive our environmental burden: our individual consumption levels (typically driven by affluence levels), population size and technology. For a more comprehensive discussion of these three issues, see the sidebar entitled "Our environmental burden" in *Chapter 24: Our population size*. There is no doubt that scaling down our consumption levels is essential to tackling the environmental crisis, especially in the shorter-term, until more sophisticated technologies are developed that again allow us to live higher consumption lifestyles. This of course particularly applies to middle- and upper-income earners.

made possible by massive resource extraction, pollution and greenhouse gas emissions. Consider that your toothbrush is made from and shipped to you using fossil fuels. The bowl you eat your breakfast out of was fired using fossil fuels; the cereal we eat was grown and processed using fossil fuels. Even drinking a glass of tap water will have resulted in greenhouse gas emissions by the water authorities to collect, purify and pump it to you. Water UK states that every 1 000 litres of tap water supplied resulted in 0.271 kg of CO_2-equivalent emissions; for bottled water this can be several hundred times higher. To treat the resulting sewage results in almost twice the level of those emissions.[5]

Seemingly, every time we do anything, we are responsible for another flood of little, invisible puffs of greenhouse gases. Every time we flick a switch, we contribute another whisper of emissions as we send an instruction to Eskom to burn more coal on our behalf – that is, if it has the coal or power-generating capacity! Assuming your household consumes 1 000 kWh a month – a typical amount for many upper income households, this equates to 12 000 kWh a year. To generate this electricity, Eskom will have had to burn 6 480 kg of coal, which will have resulted in 11 736 kg of CO_2 being emitted. (Note that one carbon atom combines with two oxygen atoms to create a CO_2 molecule, thus the heavier resulting mass of CO_2.) Additionally, the process of generating this electricity will have required 16 800 litres of water, and will have produced 1 920 kg of waste ash, and caused the emissions of particulate matter and various sulphur and nitrogen gases.[6]

All of this cannot continue. Whereas the 20th century was one of abundance and independence unknown to prior generations, the 21st century brings an intense awareness of our ecological debt. We now need to learn to live without jeopardising our future. We need to connect our choices and actions with their impacts.

Your ecological footprint[A]

Unless you are an astonishingly circumspect urbanite, or you live a life of frugal, rural subsistence – as, of course, many of the world's poor do – you are likely to have an unsustainably large impact on the environment, calculated as the ecological footprint (EF) and measured in hectares per person (a square of 100 m by 100 m is equivalent to one hectare).

The ecological footprint tool allows us to calculate the amount of land and water area required by an individual, a nation or the world's population, to provide the necessary resources and waste-assimilation capabilities to maintain a given consumption level indefinitely. The methodology, which assumes prevailing technological development levels, evaluates the demands we place on the Earth's ecosystems by weighing our consumption of natural resources

A. The information for this section was drawn from the Global Footprint Network (*www.footprintnetwork.org*) and the WWF's 2006 Living Planet Report (*www.panda.org*). To calculate your carbon footprint, see suggested websites at the end of the chapter.

against the Earth's regenerative capacity – its ability to replenish the resources consumed by us.

Since 1961, humanity's impact on our biosphere has tripled, and the 1980s mark the point at which humanity went into ecological deficit; where our ecological footprint began exceeding the planet's bio-capacity, which occurs when we use our natural resources faster than they can regenerate. In 2003, it was estimated that, globally, we required an average of 2.2 hectares per person, while we only had available a total productive area, or bio-capacity, of 1.8 hectares per person. This is the reason that, globally, we find ourselves 25% to 30% in overshoot today. Each nation will differ in its per capita footprint, depending on its resource consumption. It comes as no surprise that the US footprint is 9.6 hectares per capita – it has been calculated that if we all lived like the Americans, we would require about five planets. The Swiss require 5.1, the Chinese 1.6 and South Africans 2.3 hectares, on average. Of course, the wealthier individuals in this country need to consider that the average is significantly reduced due to the low ecological footprints of the many people in low income groups.

We are thus not using the planet's resources responsibly. In order to sustain our rate of consumption, we are liquidating our natural capital – our savings – as opposed to living off the free natural income or interest that is offered to us by the planet (See "Our five capitals" sidebar in *Chapter 2: Healthy environments, healthy people*). The WWF's 2006 Living Planet Report puts it this way: "people are turning resources into waste faster than nature can turn waste back into resources." It now takes about 1.3 years for the Earth to regenerate what we consumed during that year, and each year we are increasingly destroying the biosphere's ability to regenerate itself.

The ecological footprint assesses many components, and includes activities such as fishing, forestry, agriculture, urbanisation and the use of nuclear fuels and fossil fuels. In the richer nations – South Africa included – it is estimated that the carbon footprint caused by the burning of fossil fuels contributes about 50% to the ecological footprint. The carbon footprint is typically measured in kilograms or tonnes of CO_2 resulting from the use of fossil fuels.

The greenhouse gases for which we are individually responsible have many sources. The most obvious ones are travelling by car, bus or plane, and using electricity and gas in and around the home. Less obvious are the indirect or secondary emissions caused during the production, distribution and disposal of all the products and services we purchase and consume.

Now let's take a look at four carbon-emission categories, bearing in mind that individual carbon footprints vary widely, depending on circumstances and preferences. The four illustrative categories include: the carbon destitute, the carbon poor, the carbon savers and the carbon gluttons. A number of Internet-based carbon-footprint calculators were used for this purpose. It is interesting to note that most carbon calculators only take transport and home-energy usage

WHAT IS YOUR CARBON FOOTPRINT?

THE CARBON DESTITUTE (LOW INCOME)

Profile: unemployed rural subsistence lifestyle, no motorised transport, uses public transport on rare occasions, home built using predominantly natural materials sourced locally, no electricity, uses wood for heating and cooking, grows bulk of own food.

CO_2 footprint: 0 to 0.2 tonnes per year.

THE CARBON POOR (LOW INCOME)

Profile: employed urban dweller, no car, uses public transport, walks and cycles, does not fly, low-cost housing, electricity used mostly for lighting, eats little meat, purchases only locally produced foods, very modest other consumption habits.

CO_2 footprint: 1 to 3 tonnes per year.

THE CARBON SAVER (MIDDLE TO HIGH INCOME)

Profile: small car doing 10 000 km annually, two short-haul return flights per year, small residence, uses electricity sparingly, compact fluorescent lights throughout, solar water heater, recycles, purchases mostly local unprocessed foods, eats meat sporadically, regular but prudent consumer of other products and services.

CO_2 footprint: 5 to 8 tonnes per year.

THE CARBON GLUTTON (MIDDLE TO HIGH INCOME)

Profile: large car doing 25 000 km per year, large residence, uses electricity rapaciously, no energy-saving initiatives, 10 short-haul and three long-haul return flights per year, purchases large quantities of processed foods and beverages, regularly purchases latest gadgets, products and services.

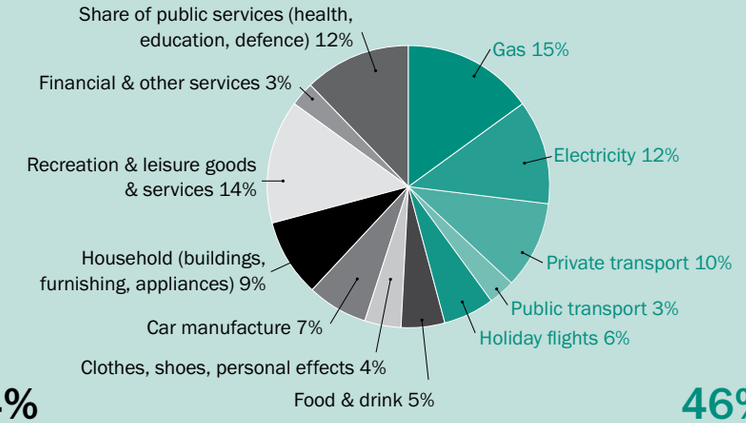
CO_2 footprint: greater than 30 tonnes per year.

To help put these emissions into perspective, consider that activists encourage individuals to reduce their emissions to five tonnes or less in the short term and two tonnes or less in the longer term.

Note that footprint categories are indicative and may vary substantially from person to person.

DON'T FORGET ABOUT SECONDARY EMISSIONS

Secondary emissions caused by the purchase of products and services are often not included in carbon footprint calculations. The University of Surrey in the UK has undertaken research to quantify some of these secondary emissions, which can exceed 50% of personal carbon footprints. While the following breakdown calculates emissions for an average UK citizen, and thus includes a high proportion of gas for heating purposes, it is illustrative in helping us understand the contribution of secondary emissions.[7]



54%
Indirect emissions

46%
Direct emissions

Creating our future

We now find ourselves at a crossroads – the "chaos point"; as Ervin Laszlo calls it – where we are confronted with a choice of two paths.

The first is a route we are accustomed to travelling. It is convenient – for now – and perpetuates business as usual, but only until the environmental backlash forces inevitable economic and social turmoil and conflict. In a Climate Change Truth and Reconciliation Commission of the future, the wealthier members of society will have to face a dark, guilty past, with the poor having been the hapless victims of our excesses. The future along this path is frightening, with a good possibility that we drop out of the evolutionary tree.

The second is the path that challenges our dysfunctional current technologies, economic systems and ways of living. It is inconvenient, because it requires us to change as a society and personally. This path requires short-term discomfort, but gives us a chance to create a more equitable and sustainable society for future generations.

The implications of inaction or limited action are well described in "Six degrees from catastrophe" in *Chapter 4: Climate change: Our most pressing environmental issue*.

IPCC SCENARIOS

To help us predict the impacts of our future emissions, a number of research institutions around the world specialise in modelling climatic changes based on future greenhouse gas emissions. These models, which describe different possible futures based on how we choose to respond to climate change, have grown enormously in sophistication and now demonstrate significant consensus in the findings. The Intergovernmental Panel on Climate Change has developed a range of scenarios to help decision-makers understand the repercussions of the choices taken by society. The scenarios are available at: *www.grida.no/climate/ipcc/emission/index.htm*

It's not a pleasant picture. Let us now put aside the gloom and doom and imagine, instead, the more pleasant scenario – the second path – that we have chosen to create.

The high road – creating a just future for all

While most climate change scenarios look at a future that is 50 to 100 years hence, this can be a little abstract. Let's assume a future just 30 years from now – one that most of us are likely to witness. While we won't have nearly achieved an ecologically neutral state where we have a negligible impact on nature – this is a process likely to take many generations and much evolution in technological know-how – we may have chosen to make significant steps in the right direction. What could this future[B] look like?

It can be summarised as one of committed political and social convergence and effort, which has brought with it a coherent approach to sustainable development and significant progress in reducing our greenhouse gas emissions and tackling many of our other environmental and social woes. Society has understood the repercussions of inaction, and we have opted to collaborate across our diverse political, national, economic and cultural boundaries. Environmental consciousness and community values are triumphing over the race for profit maximisation, personal enrichment and individual wants. We are voluntarily embracing values that lead to resource-friendly personal and social decisions. We are well on the path to reducing humanity's ecological and carbon footprint, and are bringing them within the biosphere's productive capacity.

In recognition of the fact that we only have one biosphere that we are experimenting with, society has committed to pursuing the emission reduction goals advocated by IPCC scientists – not goals that have been watered down by political and corporate negotiations and interests.

We have become more sophisticated about economic development and have learned to decouple growth and development from unsustainable resources usage.

B. This is a future that draws on the IPCC's B1 and A1T storyline and scenario family, WWF's living Planet Report 2006, Greenpeace's "How to Save the Climate" booklet and a dose of personal optimistic projection.

To a significant degree, this has involved our ability to internalise the externalities, thus allowing us to price goods according to how good or bad they are. This means the price of goods and services will not just be based on their direct financial cost, but include the full cost to society and the environment. So while the price of locally grown organic vegetables might only increase marginally to factor in the emissions caused during the ploughing of the field, the price of coconut milk from Thailand or chocolate from Switzerland will increase proportionally to allow for the energy that was required to process and ship the products across the globe. In our future scenario it might still be possible to drive a traditional car, whether fossil-fuel-powered or otherwise, but the price of the vehicle is likely to reflect the huge amount of energy required to build and power such a vehicle.

Internationally, government legislation and financial incentive mechanisms promote resource-efficiency and the rapid transfer and adoption of cleaner technologies within and across national boundaries. Our destructive, energy-intensive, produce–use–discard practices are being replaced by principles such as reduce, re-use and recycle. Closed-loop production, zero waste and cradle-to-cradle product design – where everything is designed for re-use or recycling – have become deeply entrenched. We are learning to replace our destructive processes and technologies with ones that are more benign and that increasingly emulate nature's more elegant processes – so-called bio-mimicry.

A growing number of people have learnt to give credence to the motto of "Less is more" and have reduced their consumption levels. They travel less, live more locally and lead less frenetic lifestyles. They often work from or close to home and have established a community of friends in their neighbourhood. They cycle, walk and, when necessary, take public transport. Many others will have moved to rural settings.

Vastly improved and cheaper telecommunications services allow us to stay in touch with the world.

We have become sensitive to the impacts caused by the products and services we purchase and now buy these according to their impact – standardised labels, such as carbon labelling, assist us in making responsible purchasing decisions. Foods that are not in season, locally produced or fresh, are priced at a significant premium. An increasing amount of cooking is done using solar cookers. Taboos have developed around the acquisition of material possessions not deemed necessary, and members of society are placing growing emphasis on spending their disposable income on worthy causes and low-impact products and services, opting for quality over quantity. Policy efforts are proving effective in addressing income inequality.

Energy generation and supply has seen enormous changes. Most of the remaining traditional fossil-fuel plants now capture their greenhouse gas emissions for storage; so-called carbon capture and storage (CCS). The uptake of renewable energy generation – such as electricity from solar electric (photovoltaic) panels, wind and ocean movement – is growing apace. Economies of scale and appropriate government incentives have significantly lowered their installation and operating costs.

> Barry Lopez writes that if we hope to succeed in the endeavour of protecting natures other than our own, 'it will require that we reimagine our lives . . . It will require of many of us a humanity we've not yet mustered, and a grace we were not aware we desired until we had tasted it'.
>
> *Barbara Kingsolver, in* Small Wonder

Power generation is becoming more widely distributed as lower costs and subsidies are allowing individuals, communities and businesses to set up solar collectors and wind turbines, possibly even ocean-powered generators. Most roofs are now partially covered with photovoltaic and solar water-heating panels. Power is stored in batteries and surplus energy is fed into the grid.

Houses are built using materials that are locally sourced and less energy- and resource-intensive. Products such as Italian marble and German taps may still be available, but at a considerable price premium. All houses are designed so that they require less energy to cool, heat or light. LED lighting has become the norm.

Existing urban settlements are being designed or remodelled to suit public and non-motorised transport and urban densification is increasing dramatically, making municipal service provisions more energy- and cost-efficient.

Generally speaking, economies are becoming more localised again as we have realised the folly of shipping goods around the world at the expense of local jobs and the environment. This is leading to higher employment rates and skills development. While a number of old, energy-intensive industries will have collapsed, new developments – many of them labour intensive, such as the installation of photovoltaic panels and solar water-heating systems, and the refurbishing of old buildings to become more energy efficient – will have created an abundance of new job opportunities.

Historically, mobility has represented some of the biggest gaps between the rich and poor – while the poor walked, the rich jetted around the world. On the high road, the wealthier sector of society has become more climate conscious about their travelling, largely relying on public transport. Enhanced video conferencing and telephone systems allow richer interactions, reducing the need for travel. Most of the vehicles on the road now are either for transporting goods or form part of an extensive and safe public transport system.

The agricultural sector has witnessed phenomenal changes since its adoption of low-impact, organic methods and is employing higher numbers of people per output due to a limited reduction in mechanisation. Energy-intensive produce, such as some red meats, are priced accordingly. The slow-food movement of freshly cooked, healthy meals has seen enormous growth.

And lastly, research is indicating that, on average, people are happier. They are realising that their individual efforts are successfully contributing to global efforts to overcome this previously overwhelming problem. Working towards a better future for all adds meaning to life.

Is this a pipe dream?

Some may feel this vision smacks of unrealistic idealism, but it is a future that is undoubtedly within our grasp, one we have the ability to create for ourselves. The biggest hurdle to its success is the paralysing disconnect in our minds. On one hand, we want to be part of creating a better, sustainable future; on the other hand, we are not willing to make the required changes. The hardest part is not creating this sustainable future, but to bridge this gap in our minds, which is caused by fear – the fear of losing our freedom, our possessions, our way of life. We need to learn to replace this fear with a dream, and to participate actively in building a future that harms no one.

Resources

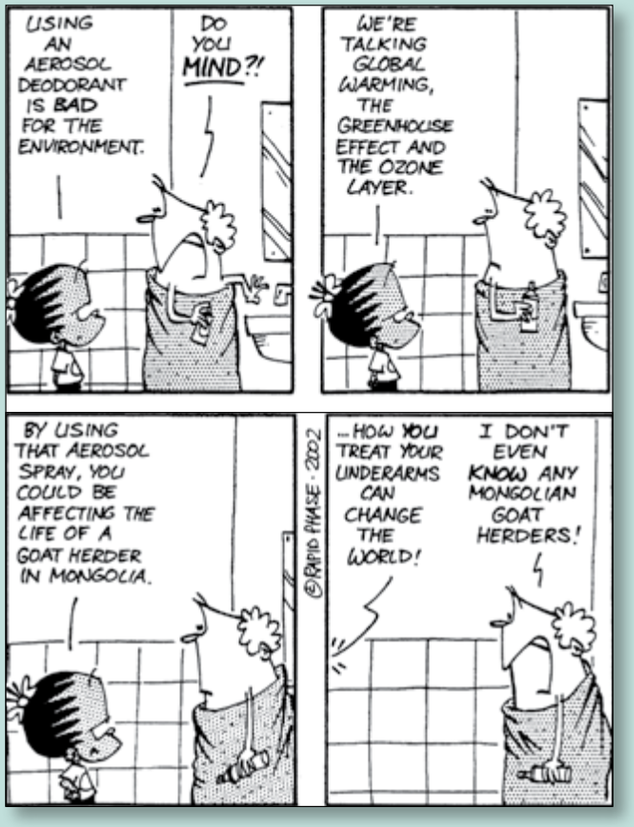
i. Collapse: How Societies Choose to Fail or Survive; Jared Diamond; 2005; Penguin Books; UK

ii. The Revenge of Gaia; James Lovelock; 2006; Penguin Books; UK

iii. Living Planet Report 2006; WWF; *www.panda.org*

iv. Ecological and carbon footprint resources and calculators:

- Wikipedia (*www.wikipedia.org*): See "ecological footprint" and "carbon footprint"
- *www.90x2030.org.za*
- *www.footprintnetwork.org*
- *www.trees.co.za*
- *www.carbonfootprint.com*
- *http://actonco2.direct.gov.uk*
- *www.bp.com* (click on Environment & Society)



Be the change you want to see in the world.

Mahatma Gandhi

7

You are the solution

Robert Zipplies

The realisation of our unfolding ecological disaster, and our perpetual contribution to it, can leave us in emotional turmoil and result in anger, guilt and a sense of disempowerment. However, once we progress from denial and resistance through to exploration and commitment, we reach a point where we are able to contribute productively to the quest to tackle climate change. We become increasingly open to questioning our values and what it takes to satisfy our needs. Progressively we are able to increase our levels of commitment and use our individual spheres of influence, whether at work or at home, to promote practical change.

A spear to the chest

Ray Anderson, the chairman of Interface, one of the world's largest carpet manufacturers, famously stated that it was like a "spear to the chest" when in 1994 he came to the startling and painful realisation that all his actions contributed to "plundering the Earth". A discovery like this would be painful for most people, inducing feelings of guilt, emotional turmoil and anger.

As we progressively deepen our understanding of how our products and services are produced, distributed, consumed and discarded, the realisation of our unfolding ecological disaster becomes clearer. Our use of fossil fuel and wasteful habits seem so all pervasive and deeply entrenched. Whether it is driving a car, buying groceries, going on holiday, having a drink, taking a shower, brushing our teeth, almost without exception, all our products, services and individual actions are made possible by massive extraction of resources, many of which are highly polluting to the environment during production and consumption or when they are discarded.

The complexity of the problem, the immaturity of some of our sustainable technologies – such as storing wind and photovoltaic-generated electricity, the slowness of political and economic progress, and the reluctance of individuals to change explains why many feel a paralysing sense of disempowerment and hopelessness. No wonder then that many bury the need to take action deep in their psyche. It is easier to stick our head in the sand and accuse the Americans, the Chinese, wealthier members of society, industry, government and our need to maintain the status quo, than it is to take responsibility for our part in this calamity. Typical responses include "Why should I change if others are not?" or "This problem is so big; what difference will it make if I recycle my beer bottles, forgo that flight, drive a smaller car or not use my tumble drier?".

Yet, all change begins with individual action – and South Africans have been privileged to witness and participate in the seemingly impossible becoming possible. Through cascading individual action, a movement was born that eventually led to a change in political ideology that is creating a more equitable future for all. This took time and it was painful for many people, but what incredible, sweeping change was created. Similarly, the environmental age is being ushered in, one step at a time. We as South Africans must do our bit in giving meaning and vooma to the maxim of "less is more". How much stuff do we really need to live decent, happy lives?

Consider how the problem arose? Driven by the desire for status, comfort and enjoyment, millions of families worldwide accumulated fridges, TVs, vehicles, appliances, electronic gadgets, second and third bathrooms and geysers and international holidays, at every step leaving a mountain of waste in their wake. This is how the problem arose – one minor purchase at a time. So, to solve it, we must gather energy-saving, green habits into our lives, step by step. We must pressure corporations to develop greener products and government to create new incentives to encourage economy-wide green behaviour.

Another reason often given for personal inaction is that industry and commerce overall are responsible for the bulk of our emissions and environmental

> "When you find yourself in a hole, stop digging."
>
> *Will Rogers, actor and social commentator*

degradation. Consider that possibly as much as 70% or 80% of emissions[A] and waste are a result of commercial activities. But before we point an accusing finger, we must realise that our purchasing behaviour drives these emissions – industry and commerce are producing and delivering the goods and services at our behest. Every time you purchase an aluminium can, consider that to make one tonne of aluminium, it creates 40 to 50 tonnes of waste-rock and 12 to 15 tonnes of toxic red mud.[1] It boggles the mind to realise that a bag of domestic rubbish may have caused 71 bags worth of waste further back along the production chain of mining, logging, agricultural, oil extraction and other industrial activities necessary to transform the raw materials into products.[2] And this doesn't include the greenhouse gas emissions that resulted from this process.

If you feel the spear to the chest, this is a positive development – you are well on your way on this journey of deepening your emotional commitment to taking personal action and also assisting others in dealing with this crisis.

The journey from denial to commitment

Change that challenges our personal and societal habits, norms and values rarely comes easy, and can be emotionally tumultuous and time consuming. It is useful to understand the psychological process for coming to terms with a crisis such as climate change. The following four steps are adapted from work done by change-management experts Drs Jaffe and Scott:

1. Denial: When you first hear about climate change, a very natural initial reaction is to deny there is a problem or that it will last. Individuals and organisations at this stage will express disbelief, apathy and numbness, and tend to avoid facing their fears, hoping they can remain in the past. The more proactive will scout around for information disproving climate change and may find their way into the sceptic and denialist camps. Assistance to people at this stage can be given by providing factual information.

2. Anger and resistance: Once you begin to comprehend the nature of the problem, the simplest coping mechanism is to resist and avoid taking responsibility. Others display symptoms of depression, problems sleeping, anger and a tendency to defer responsibility onto others in the form of rhetoric about governments, developed nations, Eskom and the neighbour with the big car needing to take action first. Acknowledging these feelings is important for those providing support.

A. Estimate calculated from the World Resources Institute's Emissions Flow Chart in its Navigating the Numbers publication; www.wri.org

3. Exploration and acceptance: When a more open-minded stage is reached, you begin taking an interest in exploring the practical implications, possibilities and options open to you. With time, you will become excited and develop the enthusiasm necessary to make practical changes. This is probably where many readers, governments and corporations currently find themselves. But the situation is urgent, and many hours are often wasted on evaluation and discussion, often in a subconscious ploy to avoid taking the inconvenient actions.

4. Commitment and action: Finally, having felt as though you have gone through the emotional wringer of steadfast denial, numb resistance and tentative exploration, you find yourself arriving at the point where you are prepared to face yourself, your desires and priorities, and start doing your bit. You become results orientated and may find it a relief to replace your emotional turmoil with a commitment to constructive action. You will find other like-minded people. The movement will become self-perpetuating, and soon, hopefully, you will wonder why you didn't get going earlier.

A growing number of people and organisations will discover that the hardest part is not necessarily taking action, but rather the mental hurdle of progressing through the stages prior to commitment. Once you are able to get out of the state of inactive despair, you might find taking positive steps to green your life and encourage the greening of others to be quite therapeutic. It is a little like "finding religion". Of course, this process of change is not always a sequential affair, and it is common for

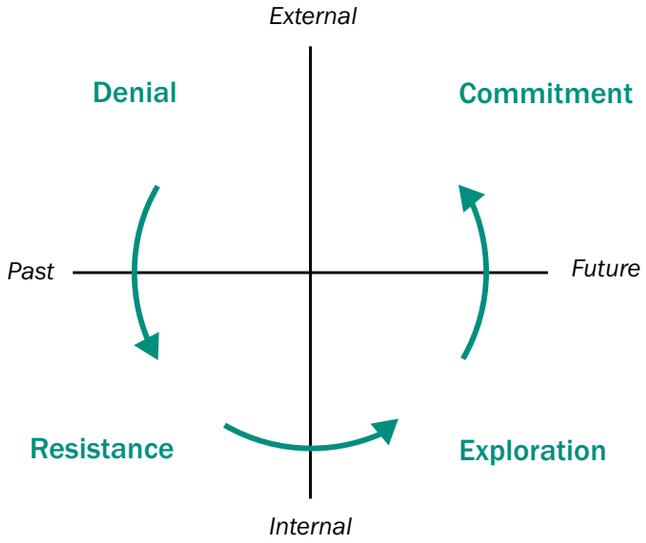


Figure 1: The journey from denial to commitment

> "How you spend your money is how you vote on what exists in the world."
>
> *Vicki Robin,* Your Money or Your Life

steps to be skipped and even to regress, reverting to the language of resistance and denial, before moving forward again. It is an interesting exercise to place yourself, family members, friends and even the organisation you work for on this matrix. It may explain their behaviour and can aid you in helping others.

Consumerism – confronting your monkey

We are all consumers. There will be those that consume reluctantly and frugally – so-called non- or post-materialists, while others will regularly succumb to their urge to acquire yet more.

Consumption is, of course, a necessity, but there is a not-so-clear line between need and greed – greed being redefined by our understanding of the ecological and social impacts caused by our consumption. (See "Satisfying needs" sidebar on page 88). Much of our wanton consumerism is disguised as "necessary": the acquisition of yet another pair of shoes, the latest mobile phone or a personal digital assistant, a trip somewhere exotic, or a new car. Most of us derive some kind of satisfaction from acquiring new things, even if it is the latest Harry Potter we are burning to read. We keep needing to "feed the monkey" of our minds – our ego-aspect we are enslaved to and that always wants more. "I haven't been on an overseas holiday for a while" or "I haven't replaced my cellphone for more than two years" are typical thoughts. You feel the itch – the monkey clamouring for attention, the next fix, the next achievement, the next short-term satisfaction. It can be something fairly benign like going to the movies or buying some delicious imported chocolate, or it can be something much bigger. Of course the more audacious the acquisition or experience – be it building a house, purchasing a fancy car, or going on that once-in-a-lifetime trip to stand on the geographical North Pole – the more delighted the ego. We are all, to some degree, slaves to this insatiable monkey, forever chasing another round of consumption. And we have become masters at justifying our actions – Paul Watson, a Greenpeace co-founder, sums it up beautifully: "We see what we want to see and we rationalise everything else."

Today, we possess and consume several times as much as our parents or grandparents did. Since 1950, the global fish catch has grown more than sixfold, since 1960 cereal consumption has more than doubled and meat consumption more than tripled and, during the past century, global paper consumption has grown more than 20-fold.[3] And, as opposed to several decades ago, many of our modern possessions require more materials from different parts of the globe to manufacture and more power to produce, resulting in toxic waste – just count the number of devices in your house that are electrically operated and are left on standby that were not

in common use 40 years ago. Our generation has undoubtedly lived in the golden years of unrivalled wealth and the ability to satisfy our whims for more goods, services and mobility. This in itself is not a problem, but the conundrum is that our 'improved' standard of living is at the expense of our life-supporting natural environment, other species and our progeny – this last known as "intergenerational tyranny". When we go shopping, we simply do not consider the environmental and ethical impacts of the products and services that we purchase.

SATISFYING NEEDS

The renowned Chilean economist Manfred Max-Neef has developed an elegant description of ways to fulfill fundamental human needs. He calls these *satisfiers* and classifies them according to their ability to satisfy these needs, and to what extent they are neutral, synergistic or destructive in their ability to meet other needs. For example, taking an international flight may satisfy a personal need, but it impacts negatively on our requirement to reduce global greenhouse gas emissions. Ideal satisfiers are synergistic, where in satisfying one need, they simultaneously contribute to meeting others. The installation of a solar water-heating system may be such a synergistic satisfier – it not only meets your need to reduce your dependence on Eskom, it also supports the environmental need to reduce electricity consumption and thus climate changing emissions. For more information about Max-Neef, visit *www.wikipedia.org*.

An all-important question is: "Does a higher income (as a good proxy for consumption) make us happier?" Research studies indicate that once a reasonable level of income is achieved – about $15 000 per annum (just over R100 000, exchange rate dependent) – additional income makes little difference to the average self-reported happiness.[4] This is supported by the European Happy Planet Index, which states that: "people [across Europe] are just as likely to lead satisfied lives whether their levels of consumption are very low or high."[5] The National Bureau of Economic Research in the US reports that "Nations as a whole, at least in the West, do not seem to get happier as they get richer", although they do report – and this is poignant for South Africa – that "wage inequality depresses reported happiness".[6]

What drives this consumption? From an early age, we are conditioned to associate consumption as rewarding and justified – advertising and role models fuel this belief. There seems to be a deep calling that compels us to gain new acquisitions, because of an associated feel-good factor. We have all experienced that little voice in our minds saying: "would life not be different, better, easier if I had this or that?" or "once I have that, the rest will fall into place", be it men, women, money, glory, recognition, or it is a simple "I just want it." Most of us are, in one form or another, addicted consumers. Our ego – the monkey of our mind – continually clamours for more. To a large

extent, we build our identities and base our self-worth on what we have acquired and what we can afford. When we talk about how "well" someone is doing, we typically refer to their state of material and financial wellbeing. We don't hear someone say "you know so and so has really made it in life, they gave everything away for the benefit of others".

Yet the satisfaction of acquiring things is often short-lived. Sometimes it just takes a few minutes, other times longer – typically dependent on the amount of money we spend – before the delight in our new acquisition wears off. This is underpinned by Herzberg's well-known Motivator-Hygiene theory, which states once basic factors, such as job security and status, are satisfied, their ability to motivate wears off rapidly. He found deeper levels of satisfaction to be based on a set of motivators that include responsibility, advancement and personal growth.

An important question is how much direct influence do we have in reducing our personal emissions, given that the institutions – whether commercial or government – are responsible for 70% to 80% of global emissions. An article in *New Scientist*[7] estimates that: "In general, just under half of the emissions for which each of us is responsible come from things over which we have personal control, such as how much we drive and fly and how we heat and power our homes. Of the rest, about 25% of the total arises indirectly through powering our workplaces, about 10% comes from maintaining public infrastructure and government, and about 20% is emitted during the production of the things we buy, including food". This means we – those of us earning enough to choose how we spend our disposable income – have significant control. We are able to determine how much we fly and drive and how we use energy in our homes. And – very importantly – we are able to determine what products and services we buy and how we construct our homes and offices, thus sending signals for change to the broader economic sector.

To help you face that unruly, consumer-driven monkey, ask yourself:

- What destruction will purchasing a particular product have caused during its manufacture and supply, and what damage will it cause in being used and eventually thrown away?
- Are you buying it because you need it or just desire it? Can you do without this product or service, or can you borrow someone else's or buy it second-hand?
- How will a particular item or service enrich your life, contribute to your happiness and add deeper meaning to your life?
- If you feel you need to buy it or consume it, are there alternatives to reduce its impact? For example, a locally made bicycle or fleece polar-tech jersey is likely to have contributed fewer emissions, as the final product and its raw materials have not been shipped back and forth around the world; and, of course, it maintains jobs and money within our economy. Consider, too, the harmful fossil-fuel-derived chemicals contained in shampoo or household cleaners? You are now able to buy locally made, completely organic alternatives.

There is a fine line we must walk in differentiating between "need" and "greed". Given the scientific evidence of our impacts, it can now be argued that much of what we consume today is not born of need, but greed.

Next time you have a birthday, or if you get married, instead of expecting gifts, request friends and family to make a donation to a charitable cause. If they or you feel a physical present is required, ask them for food items, preferably of the local, unprocessed variety.

Taming the monkey is a gradual, personal journey and learning to slow down is a necessary step in this process. Carl Honoré's book, *In Praise of Slow*, discusses the concept of time-sickness and our need to run ever faster. He states, "Inevitably, a life of hurry can become superficial . . . and [we] fail to make real connections with the world or other people". He quotes from Milan Kundera's novel, *Slowness*, "When things happen too fast, nobody can be certain about anything … not even about himself". He goes on to say, "The Slow movement certainly implies a questioning of the untrammelled materialism that drives the global economy".

I wonder how soon the time will come when cyclists are held in higher esteem than people in sports cars, or we boast about the low carbon emissions we caused over the past year.

Challenging our values

Values are a set of fundamental beliefs that help us navigate day-to-day life by providing an indication of what is important to us and what goals are desirable. Values guide us in our actions, thoughts and goals – they typically serve as standards of desirable behaviour – and significantly determine how we, as individuals and a

IS YOUR FAITH ORGANISATION GOING GREEN?

The Southern African Faith Communities' Environment Institute, SAFCEI, is an organisation that represents all the major faiths in southern Africa. It is committed to responsible earthkeeping and its aim is to "support the faith communities in fulfilling their environmental and socio-economic responsibility". The Hartbeespoort Declaration, issued following SAFCEI's inaugural conference in March 2005, highlighted the significant role that faith communities should be playing in nurturing and safeguarding the future of children and the planet. Religious leaders need to be encouraged to emphasise environmental justice and a values-based economic system, which envisions a sustainable future. While honouring the spirit of the respective faiths, SAFCEI's objectives include raising environmental awareness, facilitating the formulation of values based environmental policies and statements, confronting environmental and socio-economic injustices and supporting environmental learning and action-taking.
www.safcei.org.za

> "Looking at the world from other species' point of view is a cure for human self-importance."
>
> *Michael Pollan, writer*

society, interact with each other and our environment. Our values, which are mostly acquired and shaped during our youth, are rarely questioned in later life. It is usually only in moments of emotional and physical duress, and rare moments of epiphanic insight, that we are led to challenge our values.

From a young age we are taught to enhance our positive values, such as integrity, courage and compassion, and to avoid negative values, such as cruelty and selfishness. Largely absent from our values has been a deeper recognition and appreciation of our dependence on nature, its fragility and a realisation that we, cumulatively, have an enormous impact on it. We have for generations and millennia seen the environment as something vast and unlimited. Accordingly we have developed a set of values that does not question our "take, make and throw away" practices. In the days when human numbers were small, we threw away banana peels and coconut shells, which became food for other organisms. Now, our numbers are large and we produce vast mountains of highly damaging waste.

As a society we must reassess some of our values and understand which are constructive and which are destructive in promoting a sustainable and, preferably, equitable and peaceful future. We should slow down, practise frugality, compassion for all living things, keep the wellbeing of future generations in mind when making decisions, and share our scarce resources with those less fortunate. This may be long on idealism, but it has become a necessity. Many people have worked on developing and enhancing their emotional and spiritual intelligence; now we must enhance our ecological intelligence.

Some people may see themselves to be above these basic human frailties and consider themselves great appreciators and supporters of nature. They would like to preserve these natural treasures, not only for themselves and future generations to enjoy, but for their own sake. As a result, they tend to act responsibly in nature. But "responsibly" can be a conveniently fuzzy concept sitting on an ever-shifting continuum dependent on our levels of understanding of our impacts on nature and our personal commitment. While we are in nature we may minimise our impact, treading carefully and not leaving behind any rubbish, but we now realise that the "equipment" we purchase that allows us to explore nature in comfort, and the act of getting there, may be far more destructive to nature than our presence.

There is no doubt that we need to take a fresh look at our values and reprioritise. This is a time of introspection for humanity and we need to establish what is most dear to us – the immediate gratification of our egos, or working towards a greater good. We are creatures who seek meaning in our lives, and much of it must lie with the goal of personally contributing to the creation of an equitable future for all

living things. Maybe we need to link our values more to Herzberg's motivating factors than to his hygiene factors.

When will we begin to admire individuals for how little they choose to have, instead of how much stuff they have acquired? When will we start frowning at someone's talk of a recent overseas holiday or a new, bigger car? When will we recognise those that voluntarily opt to take public transport or cycle to work as opposed to using their gas-guzzler?

Globally, social shifts are happening. In a recent high profile incident, Prince Charles was rapped over the knuckles by the UK's Environment Minister for flying to the US to accept an environmental award – it was felt he should have accepted the award via video conferencing. Prince Charles subsequently committed to reducing his carbon footprint.

A November 2007 poll in 21 countries by BBC World Services indicated that a high number of people are willing to make changes to their lifestyle to help reduce emissions. And as George Monbiot, author of *Heat: How to Stop the Planet Burning*, said so poignantly, "People don't riot for austerity; they riot because they want more, not less. We have to riot for less."

Becoming the change – the power of one

Climate change is undoubtedly the most widespread and complex problem humanity has ever faced. Albert Einstein famously said, "The significant problems we have cannot be solved at the same level of thinking with which we created them."

Our simplistic way of planning and acting repeatedly fails to consider the complex interactions and knock-on effects of individual actions. Combine this with less-

ECOLOGICAL INTELLIGENCE – AN ETHICAL IMPERATIVE

Ian McCallum
Author of Ecological Intelligence: Rediscovering Ourselves in Nature

Discovering the reality of the "web of life" – that the planet is our home and that every living thing is connected – is the first step in the cultivation of an intelligence that is ecological. To become aware of the web is to wake up from a state of ignorance to which you can never return. It is an emotion-charged awareness or, if you prefer, a sense of discovery and perspective that is unique to you. This emotion, this perspective, this sense of discovery, is the kindling of an ethic that is deeply personal. It is to know that legislation is not another name for ethics. What follows is an ethical imperative – the translation of this awareness into action. It is the next step in the exercise of an ecological intelligence. This ethic is not a quotient or a desired level of aspiration but an act. It is a personal act of reciprocity and engagement with the world.

> "Stupidity is relatively harmless, but intelligent stupidity is highly dangerous. This intelligent stupidity, for which one could find countless obvious examples, is threatening our survival as a species."
>
> *Eckhart Tolle, writer*

than-admirable traits, such as our short-sighted, self-centred, impatient approach to technological, social and personal development and this may give us an inkling of what it will take to transcend this issue. With zest we have used our so-called left-brain skills, such as analysis and logic, to create structures that are dooming us to outright failure as a species. It seems that we have been endowed with an abundance of intelligence and industriousness, yet suffer from a severe lack of wisdom to consider the longer-term complexities of our doings. To tackle this issue, we must not only focus on traditional, mechanistic solutions, such as carbon taxes, caps and new policies to promote a change in behaviour, or financial incentives to drive development of clean technologies – while these are all essential, we need to tackle the deeper issues of values and education.

It is ironic that we are now faced with a globally interconnected problem of a magnitude never experienced before. Not only will it require us to challenge our deepest emotional frailties, it will also necessitate levels of collaboration, selfless behaviour, compassion and respect for the lives and future of our own and other species hitherto unknown on such broad level.

Regretfully, humans seem to learn best when they experience pain – this is when we question the status quo of who we are and how we view and interact with the world. This crisis is an opportunity for us to understand our failings better and to question our priorities and values, and seek to evolve into individuals who can contribute to mankind enduring as a species. We need to practise thinking and acting more intuitively and holistically. We need to develop our emotional, ecological and spiritual intelligences in order to enhance our human collective wisdom, allowing us to collaborate towards the common good. A collective intelligence researcher, George Pór, defined the CI phenomenon as "the capacity of human communities to evolve towards higher order complexity and harmony, through such innovation mechanisms as differentiation and integration, competition and collaboration."[8]

Your sphere of influence

How much power does each of us have to change the world? As individuals we interact with human society as consumers, as employers and employees, as voters, and as members of our communities of neighbours, friends, families and areas of special interest, such as political parties, clubs and faith organisations. Within each of these spheres, we have the ability to drive change.

As consumers we need to send strong signals to corporations and governments in the form of changes in purchasing behaviour and, where necessary, boycotts and pe-

titions to demand change. Remember the Brent Spar debacle? Shell would not back down from their plans to sink a disused oil-storage platform in the North Sea until confronted by a growing public outcry and boycotts of Shell petrol stations.

Many other corporations have witnessed this public power. If we all started to return our packaging and toxic products, such as penlight batteries, to our retailers, with the demand that they be recycled, appropriate structures would soon be put in place. If we all began buying smaller cars, we would send signals to the manufacturers about the need for eco-friendlier vehicles, instead of bigger SUVs.

Mass protests are on the increase globally. In August 2007, 600 Swiss citizens showed their concern for global warming, calling on society to do more, by standing in the nude on one of their many diminishing glaciers. When will South Africans get to the point where we feel compelled to stand – whether clothed or not – on our beloved Table Mountain, in Nelson Mandela Square or at the Union Buildings to protest for more action on climate change?

A multitude of people are starting to make small changes. Many of my co-authors serve as examples. For many years, they have been strongly committed to reducing their personal ecological footprints. Some cycle to work, eschew distant holidays, offset their travel emissions, purchase locally grown seasonal fresh foods, recycle, use environmentally friendly building materials for their homes, and are active in their communities – beyond their own work – in spreading the word that we need to scale down.

At work, we can inform our employers that we would prefer to work for a company that cares about society and the environment as much as it does about turning a profit, and we can help them turn green talk into profound green action. Within our communities we can create change, for example by working with neighbours to implement recycling initiatives. In some countries, communities are starting to collaborate to set up their own renewable energy generation, such as wind power. Among friends and family we have the ability to change mindsets and habits.

South Africans – through our recent transition – are aware of the scale of change that can be achieved, no matter how humble and seemingly futile the beginnings may be. Individuals campaigning for the environment, better wages, better HIV/Aids treatment, and employment standards have collectively achieved colossal change, one person at a time. There is much to do and we have our work cut out for us.

PROJECT 90 BY 2030
Dare to change the way you live

Project 90 by 2030 seeks to impact directly on individual South Africans' responses to climate change. Through organised groups, it targets wealthy individuals and challenges them to change the way they live by 90% by the year 2030. In order to achieve its mission, the project has initiated the formation of "90 by 2030 Clubs" nationally. Club membership is generally made up of youth between ages 12 and 18 from middle- to upper-income households, and their families. Clubs are being formed with schools, churches and community forums nationally. After signing up, average club footprints are calculated, the results are loaded into a national database and advice is provided on action to reduce these footprints. An energy audit is conducted every six months to measure progress. Ongoing communication, campaigns and activities aimed at reducing carbon emissions are organised by clubs with the support of the project.
www.project90x2030.org.za

Imperfect solutions

As you start taking action, you will soon discover that some solutions are still immature. CFLs, although environmentally better than traditional incandescent light bulbs, contain toxic mercury. Hybrid vehicles, although better than most of their petrol-fuelled counterparts, still require high levels of energy and scarce resources to produce, and still emit way too much greenhouse gas while being driven.

At other times the necessary infrastructures, policies and laws, incentives and individual habits are lacking. In Cape Town in early 2008, recycling became so popular that the processing facilities could not keep up. These are growing pains – not untypical of changes and growth in a system – and, where possible, they need to be avoided through better planning.

We may be faced with conflicting reports about technologies or methods that are the most environmentally friendly. For example, there is a lot of confusion about the viability of biofuels – they seem to receive a growing amount of justified negative

DOING YOUR BIT

To start living sustainably, consider the following:

1. **Develop your mindset:** Continue reading about climate change and broader ecological issues to understand better what is required. The really tough part is making a profound commitment to change.
2. **Calculate your carbon footprint:** Work at diminishing it.
3. **Use your sphere of influence:** Identify the areas of your life in which you can make a difference, be it at home, at work or within your community.
4. **Become an agent for change:** Be creative, gather support and start doing your bit. Ideas are endless. You could start recycling or get a community recycling programme going; you could encourage others to install a solar water heater; you could change the mindsets of your fellow employees and your employer. Return your packaging to the retailer from which it was purchased; organise a petition or a protest march.
5. **A journey of ongoing improvement:** Recognise your achievements, such as recycling your waste or having opted for a small car instead of a big one. Then continue your journey to reduce your impact.

publicity. Other issues frequently raised are "whether dishwashers use less water and detergent than if dishes are washed by hand" or "does it make sense to scrap your old fuel-inefficient vehicle in favour of a new fuel-saving one?" – given the fact that to produce a new vehicle takes an enormous amount of energy. Answering these questions requires time to dig deeper into the data and necessitates recognition of the possible existence of vested interests. Developing a sustainable society will require small, progressive, "learning-by-doing" steps.

Closing thoughts

Human-caused climate change confronts us with our own shortcomings; to bend the curve on climate change we have to tackle these issues boldly. We have to trade our short-term views for long-term thinking. We have to trade reverence for profit maximisation for the triple bottom line of creating financial value alongside social and environmental value. We have to trade personal greed, materialism and selfishness for low-impact lifestyles. We need to seek fulfilment not in what we possess, but in what we have contributed to a common good.

LIVE EARTH PLEDGES

Over a billion people from around the world came together on Saturday 7/7/07 to watch the Live Earth concerts and support the call to action against climate change. Many of them made a commitment to the following seven pledges:

1. To demand that my country join an international treaty within the next two years that cuts global warming pollution by 90% in developed countries and by more than half worldwide in time for the next generation to inherit a healthy Earth;
2. To take personal action to help solve the climate crisis by reducing my own CO_2 pollution as much as I can and offsetting the rest to become "carbon neutral";
3. To fight for a moratorium on the construction of any new generating facility that burns coal without the capacity to safely trap and store the CO_2;
4. To work for a dramatic increase in the energy efficiency of my home, workplace, school, place of worship and means of transportation;
5. To fight for laws and policies that expand the use of renewable energy sources and reduce dependence on oil and coal;
6. To plant new trees and to join with others in preserving and protecting forests; and,
7. To buy from businesses and support leaders who share my commitment to solving the climate crisis and building a sustainable, just and prosperous world for the 21st century.

Find out more at *www.liveearth.org* and make the pledge at *www.liveearthpledge.org*.

> "The future is not some place we are going to but one we are creating. The paths to it are made, not found, and the activity of making changes both the maker and the destinations..."
>
> *John Scharr, futurist*

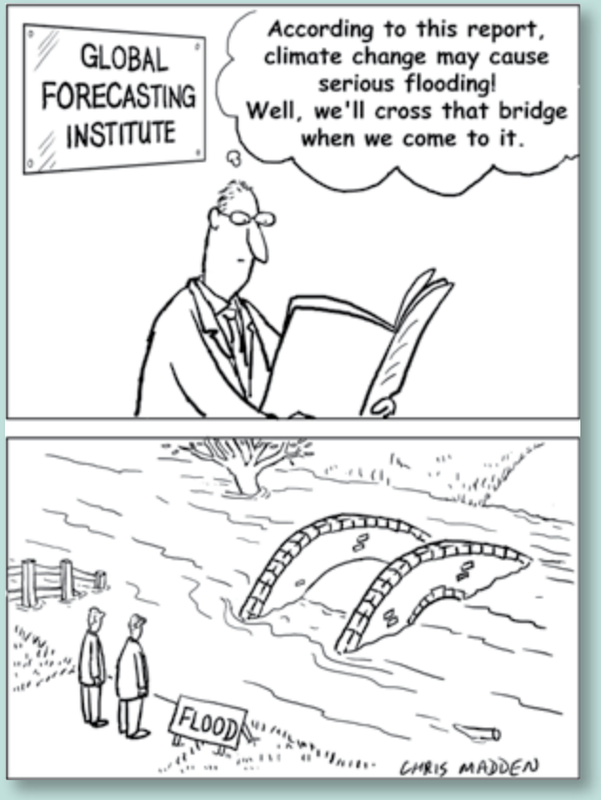
Societal norms evolve continuously and change is usually driven by those that are bold enough to swim against the stream of common behavioural patterns. We all need to challenge and redefine those values and norms that we consider to be part of the problem. Will a time come soon where putting our self-interest – in its ever broadening definition – ahead of the common good becomes unaccceptable? With time, a new set of societal norms will evolve that more deeply consider our common future.

Our corporate, political, spiritual and educational leaders are integral to this process and we would all benefit if self-interested personal enrichment, spreading a personal doctrine and power-mongering were substituted for working towards the real needs of society. To create a post-carbon society we must learn to collaborate more constructively across the divides of political, cultural, religious and economic ideologies. A post-carbon society can only be created if we stop talking about what we don't want to give up and focus on the future we want to create.

Activate a lifestyle change today – this issue is simply too important to leave only to politicians and corporations.

Resources

i. Project 90 by 2030; *www.project90x2030.org.za*
ii. A New Earth: Awakening to Your Life's Purpose; Eckhart Tolle; 2006; Penguin Books; UK
iii. International downshifting week; *www.downshiftingweek.com*
iv. The Simple Living Network; *www.simpleliving.net*
v. 350; *www.350.org*
vi. In Praise of Slow; *www.inpraiseofslow.com*
vii. Slow Food; *www.slowfood.com*
viii. In the UK, voluntary initiatives called CRAGs, or Carbon Rationing Action Groups (*www.carbonrationing.org.uk*), have been launched. These work towards limiting emissions amongst participants.
ix. The Fire Dogs of Climate Change – An Inspirational Call to Action; Sally Andrews; 2009; Findhorn Press; UK
x. The Enviropaedia; *www.enviropaedia.com*; see Sustainable Lifestyle Guide



Our generation's greatest challenges – in environment, demography, poverty and global politics – are also our most exciting opportunity. Ours is the generation that can end extreme poverty, turn the tide against climate change and head off a massive, thoughtless and irreversible extinction of other species. Ours is the generation that can, and must, solve the unresolved conundrum of combining economic wellbeing with environmental sustainability. We will need science, technology and professionalism, but most of all we will need to subdue our fears and cynicism.

Jeffrey Sachs, Director, Earth Institute at Columbia University

8

Tackling the climate crisis

Robert Zipplies

Climate change is a fact we cannot afford to ignore and there are no silver bullets. In this chapter, we take a look at what needs to be done. Mitigating (reducing) greenhouse gas emissions is essential and must start now to avoid climate change becoming unmanageable. This will require modifications to economic, environmental and social structures. We must also adapt to the unavoidable climatic changes that are already being experienced. In addition, specific sectors of society will need to adapt to the unintended consequences, or knock-on effects, of other players in the global economy responding to the climate challenge. Throughout, vulnerable rural and urban communities will require assistance to tackle global warming. If we do this properly, there will be far more winners than losers.

Many people still live in the hope that the climate change problem will be solved easily, and that scientists will discover a fix-all, geo-engineered solution – be it mirrors in space, methods to capture vagrant greenhouse gases mechanically or to induce marine organisms to remove CO_2 from the atmosphere. Another misbelief is that the thousands of scientists who have researched all aspects of this problem have made some collective and colossal mistake interpreting the data, hugely overstating the severity of the problem. There are even those who hope for divine levels of intervention. Here, let us rather focus on the pragmatic solutions.

The previous chapters described the nature of the crisis and indicated the folly of continuing with business-as-usual. While there is a need to improve climate science in order to better understand climate dynamics and its impact on our lives, it is undoubtedly prudent – as has been demonstrated by the IPCC findings and the Stern Report – to take action sooner rather than later.

A frequently asked question is "How do we solve climate change?" The climate crisis is brought about by a complex and interrelated set of environmental, social and economic factors, and the crisis needs to be tackled on a number of fronts.

Not only do we need to reduce our emissions, but we must also begin adapting to the climatic changes already taking place and the inevitable consequences of the biosphere's "lag effect" or thermal inertia. In addition, we must consider the effects on our economy of actions taken by industries and society globally, known as "unintended consequences".

Broadly speaking, there are three response categories to tackle and manage the climate crisis and its broader economic impacts:

1. Mitigating our emissions: Most urgently, we need to tackle the anthropogenic influence on climate change. To do this, we must cut our own greenhouse gas emissions, whether in our personal or professional capacities. These cuts must be sufficiently bold to ensure that they prevent dangerous levels of climate change. We need to stabilise atmospheric greenhouse gas concentrations by first levelling off and then reducing our emission levels. When and at what level the peak and subsequent reductions occur depend on our appetite for personal and societal risk in this global game of dice. Mitigation requires us to reduce the emissions caused by electricity generation, driving and flying, tilling and fertilising our lands, deforestation and our industrial processes and waste. Mitigation is about developing a low-carbon economy that relies on renewable energy sources and encompasses broader ecological and socially sustainable habits.

2. Adapting to climate change: At the same time, we need to prepare for the unavoidable effects of human-induced climate change that are already leading to shifting atmospheric conditions. The agricultural and food sectors are particularly vulnerable and must take changing weather patterns into account when

planning new crops and food products and their distribution. City planners and infrastructure developers must take ocean-level changes and the possibility of more violent storms into consideration. Assistance must be given to the poorer sectors of society most at risk. Wildlife and biodiversity-protection projects must plan around the need of fauna and flora to migrate to new areas.

3. Responding to unintended consequences: The importance of this category is not yet fully understood or appreciated. As nations, corporations and consumers inevitably begin to mitigate and adapt, their policies, and operational and purchasing behaviours will alter. Repercussions of their actions will ripple through virtually all sectors of the interconnected global economy. Where possible, in our personal and professional roles, we must understand and prepare for these changes.

To effectively address climate change, these response categories – which are discussed in more detail below – will require concerted effort by individuals, civil society, business and, above all, government.

Mitigating our emissions – avoiding the unmanageable

In their Fourth Assessment Report, the United Nations IPCC (Intergovernmental Panel on Climate Change) states that, between 1970 and 2004, global greenhouse gas emissions increased by a staggering 70% and continue to grow rapidly.

Mitigation means tackling these emissions, which constitute the anthropogenic aspect of global warming, in an attempt to reduce their negative effects on our climate. This necessitates huge reductions in our greenhouse gas emissions, and the prime culprit – the burning of fossil fuels. Agricultural activities, deforestation, waste and some industrial processes are also significant contributors. Appropriately, mitigation is often referred to as the process of "decarbonising", or creating a "low-carbon" economy. Mitigation is about using less energy, using it more efficiently, using cleaner fuel technologies (such as wind, solar and wave) and changing our economic structure. *Chapters 10* and *11: Mitigation is an energy issue* and *Your government, our government*, discuss mitigation in more detail.

The state of our atmosphere makes mitigation urgent. Our window of opportunity, given our continuing rapacious drive to consume fossil fuels, is closing fast. We have little wriggle-room or time for half-baked measures. Our mitigation initiatives must be comprehensive and quite often our actions must have a strongly altruistic flavour, because of poor economic incentives. Yet, individually, virtually everyone is delaying action. Business tells us that mitigation is too costly, whereas governments often lack an appreciation of the depth of the crisis and have to juggle an assortment of shorter-term priorities clamouring for attention. The result: most unilateral and multilateral policy targets set at government level err on the lax side and currently ensure failure.

> Delaying action to address climate change will increase the environmental and societal consequences as well as the costs.
>
> *Board of Directors, American Association for the Advancement of Science, 2006*

Lest we forget, because of the tipping points, we only have one chance to get this right – if we miss our emission reduction targets by an inch, we miss them by a mile – and this is why a recent United Nations Foundation and Sigma Xi report refers to mitigation as "avoiding the unmanageable".

As indicated in *Chapter 4*, our atmosphere currently contains about 380 ppm of CO_2 and this is increasing by about two ppm per annum. While a very small number of scientists believe it may already be too late to avoid dangerous levels of climate change, we cannot resign ourselves to this possibility and must make every effort to level off and then reduce our atmospheric greenhouse gas concentrations. Many scientists believe that we do not have more than five to 20 years to significantly reduce emissions and the consensus seems to be that it would be prudent to avoid exceeding 450 ppm of CO_2. Going beyond this figure dramatically increases the risk of huge changes in the climate.

The small window of opportunity feels even tighter when we consider our enormous social inertia. Much of our economic growth and the additional infrastructure being installed over the next few years – such as Eskom's new coal-fired power stations or major new office buildings not designed with mitigation in mind – will commit us to an ongoing steep rise in carbon emissions. The more we become dependent on fossil fuels, the more expensive the subsequent financial, social and environmental burden will be. Doing something about climate change is a matter of delayed gratification – carry the pain now, rejoice later. The well-publicised UK Stern Report supports this rationale – it is far cheaper to act now, than to bear the very costly consequences of inaction.

There is, of course, an inequity in all this. While the richer countries have cumulatively emitted much greater quantities of greenhouse gases – and thus have a greater moral obligation to mitigate – the crisis is now so far advanced that we have no choice but for all to mitigate, irrespective of development status. In the group of major developing nations, which also includes Brazil, China and India, South Africa stands out as a disproportionately large emitter on a per capita basis.[1] We cannot shirk our mitigation duty. Consider also that it is in our interests to decarbonise, because a low-carbon economy will fast be the benchmark of a competitive nation. Decarbonising is, like education and skills development, a vital investment in the future of our country. But it is a difficult choice, particularly given our abundant and cheap coal.

What emissions target are we aiming for? In the Kyoto Protocol, participating developed nations agreed that they would reduce their collective emissions by an

average of 5% below their 1990 levels by 2012. Given updates in the science, future protocols are likely to mandate more significant cuts in emissions. George Monbiot[2] argues the need for most developed nations to cut emissions to 90% below present levels by 2030 to be reasonably assured of avoiding dangerous climate change. He then sets out to show how this is possible in the UK without significantly affecting living standards. Others feel Monbiot's target is unnecessarily strict. While the debate continues to rage, prudence dictates that we all cut emissions as much as we can. And, of course, the sooner we begin, the greater the likelihood of our success.

ARE OFFSET MECHANISMS A GOOD WAY TO MITIGATE?

It is becoming popular for businesses and individuals to work towards reducing their contribution to global warming. While first prize is to reduce emission-causing activities – this prevents more greenhouse gases entering the atmosphere – the portion that is unavoidable can be offset, either partially or entirely, to achieve so-called "carbon neutral" status. To do this, whether as an individual or as an organisation, you first calculate the emissions caused by your electricity consumption, travelling and other activities. Then you can decide which activities or how much of your emissions can be offset through one of a growing number of offset organisations. These organisations typically contribute financial resources to projects that plant trees, or support renewable energy, energy conservation or methane-capturing initiatives. Offsetting can be remarkably cheap. As an example, offsetting your portion of the CO_2 emitted as a result of a return flight between Cape Town and Johannesburg costs only about R40.

So, does this mean as long as you offset you can fly, drive and leave the lights burning to your heart's content? Regrettably – as with many good things – it is not that simple. Yes, increased numbers of trees will absorb carbon, but this will take decades. Similarly, there is also a delayed effect in investments in energy-saving projects to reduce fossil fuel consumption. In the meantime, the greenhouse gases we emitted still cause havoc. While offsetting buys us some time and is far better than doing nothing, it should most certainly not be seen as a get-out-of-jail-free licence to continue frivolous consumption.

There is no substitute for reducing your emissions and keeping fossil fuels in the ground where they belong. For this reason, renewable energy and energy-efficiency projects are typically favoured, because they reduce the need for fossil fuels. Given the state of the crisis, we should be reducing our emissions as far as we possibly can, while, in parallel, investing as much as possible in reputable energy-efficiency projects as well as indigenous tree planting and other carbon-capture initiatives.

Internationally there have been some controversies about offsetting projects that have either mismanaged their funds or have invested in inappropriate mitigation projects. It would be wise to review the offset provider of your choice carefully.

Adapting to climate change – managing the unavoidable effects

Speak to some apple, wheat or rooibos farmers in the Western and Northern Cape and they will confirm that changing rainfall and temperature patterns are already having an impact on their crops. These and other farmers need to relocate or adapt their crop types to suit our changing climate.

Then speak to some of the world's major re-insurers and they will point you to data that indicates escalating weather events and related insurance claims. These weather occurrences, they believe, are due to changing weather patterns caused by global warming. To limit their liabilities, affected insurance companies are already reacting by raising premiums and beefing up exclusions.

The building sector – given the long life spans of its developments, is another sector affected. A recent report published by the United Nations Foundation and Sigma Xi proposed that new housing and infrastructural developments should take rising ocean levels, proximity to floodplains and fiercer storms into consideration.[3]

Adaptation encompasses actions that reduce our vulnerability to the inescapable, adverse effects of climate change that are already manifesting and will become more apparent and severe in decades to come. The UN Foundation report refers to adaptation as "managing the unavoidable". With time, many sectors of society will need to adapt to the changing atmospheric and oceanic conditions, including rising water levels, changing currents and increased ocean temperatures. It will be variably hotter, drier and wetter, with extreme weather events such as floods and droughts, as well as shifting plant and animal disease patterns, and changing ecosystems as fauna and flora die, migrate or otherwise adapt to the new conditions. South Africans are likely to face growing water shortages in the west of the country and higher rainfall and flooding in the east of the country. Some health problems, such as malaria, will become more widespread.

Enormous financial, material and people resources will be required to restructure the food-supply chain and help urban settlements to cope with the changes. Fixed assets like farms, buildings, water-treatment plants and other infrastructure are not easily adapted or moved, especially if there is a lack of resources.

The UK's Stern Report suggests that we can "protect our societies and economies from its impacts to some extent [by] providing better information, improving planning and more climate-resilient crops and infrastructure". Generally, it is accepted that poorer countries, due to more limited financial, skills, infrastructural and other resources, are less equipped to adapt and, for this reason, the Stern Report recommends that adaptation efforts should be accelerated and climate change response strategies be integrated into development policy.

Ongoing research will provide more clarity on the nature, severity and timing of future climatic alterations and their effect on society. Astute business managers will regularly monitor the latest research and findings with an eye to understanding how

SUPPORTING THE MOST VULNERABLE

Dr Gina Ziervogel
Environmental and Geographical Science, University of Cape Town

Although climate change is going to be widespread, it is the rural and urban poor who will feel the impacts of climate change most. In southern Africa, many poor households depend directly on natural resources and agriculture and will not have the ability to move or otherwise buy their way out of problems as temperatures rise and flood and drought intensity and frequencies impact agricultural production, water supplies, diseases and infrastructure. Many of these impacts might be less significant to those who have insurance or the ability to change activities.

In rural areas an improvement in early warning systems is needed to provide information about floods and droughts and the type of agricultural responses that might be suited to changing conditions.

Health impacts are likely to be felt by those with few resources who are often unable to afford medicine or transport to health clinics, requiring health-care infrastructures to adapt to changing needs. Malaria is expected to change its range and the prevalence of diseases such as malnutrition, diarrhoea and HIV/AIDS, might become harder to manage.

Unemployed people have fewer financial and other resources that allow them to adapt to climate change. Skills development and employment programmes are thus essential in giving the poorer sectors of society the ability to cope with the impacts of climate change. Skills will need to be developed in sectors that are less vulnerable to climate variability.

changes will affect their operations, physical assets, markets and ability to provide services. In the shorter term, the sectors most urgently requiring adaptation are probably the commercial and subsistence agricultural sectors – food security is at the base of our needs hierarchy.

For public sector policy makers, choosing appropriate adaptation responses and determining their best timing is challenging. They need to consider economics, flexibility, urgency, range of applicability, feasibility and many other factors in selecting and implementing adaptation measures.

Responding to changing market dynamics – managing the knock-on effects

The most comprehensive and far-reaching economic restructuring that humanity has ever seen is getting under way as corporations, governments and individuals begin to mitigate emissions and adapt to changing weather conditions. Many of these measures will have unintended economic and social knock-on effects, which

may be positive or negative. While the nature of these consequences is still speculative, the first are rippling through our societies.

The debate to reduce "food miles" is widely known. Seeking to reduce the energy intensity of food products, including the distance food travels to its market, the debate is likely to have the most effect on suppliers who are far from their market. How will this affect our significant fresh produce exports to Europe? While the UK retailer Marks & Spencer has indicated that they will limit their stocks of foods imported by air, they have indicated they will give imports from developing countries priority. Will such a policy guarantee sales for local producers? Time will tell.

The use of bottled water, whether imported from France or sourced in Franschhoek, is absurd when most of our tap water is perfectly drinkable. Proper investment in water treatment and reticulation ensures that tap water continues to be supplied at costs and emissions several hundred times lower than bottled water. As consumers understand the concept of embodied energy – the amount of energy invested in producing and distributing products – will we see sales of bottled water decline?

The tourism industry could be another unfortunate victim as flight volumes are affected by escalating prices due to rising fuel costs and possible aviation taxes, and as frivolous travel is frowned upon. Could we see potential international tourists opting for a local holiday or a short-flight destination in preference to visiting South Africa?

The sale of SUVs and other high-emission vehicles is a market segment that will certainly see a decline and local motor retailers will shift their focus to eco-friendlier vehicles. While this may be negative for some manufacturers and retailers, and for those SUV owners who will see their vehicle resale value decline, there are likely to be many positive economic impacts. The market for low-emission cars, scooters, public transport systems and electric and pedal bicycles will certainly grow.

Governments will put in place policies that promote beneficial behaviour and technologies, and include carbon taxes and stricter efficiency standards. Corporation managers are "greening" their operations and are putting pressure on their suppliers to do likewise. The number of consumers starting to make climate-conscious purchasing decisions is growing.

There is much conjecture about the nature of these economic shifts. Time will reveal the true measure of how evolving market forces will shape these unintended consequences. As is inevitable during any major restructuring, the associated financial and social pain will result in much kicking and screaming by affected parties, such as labour, consumers and businesses, but change is inevitable.

Government has an obligation not only to create awareness, but also to give a leg-up to sectors of industry that will make an important contribution to the future competitiveness of our economy, such as renewable energy production or emission-reduction technologies. Those sectors that are not able to manage the change or are not seen as essential to a low-carbon society will diminish, while those that are able to reinvent themselves will thrive.

> "Our goal is a delightfully diverse, safe, healthy and just world, with clean air, water, soil and power – economically, equitable, ecologically and elegantly enjoyed."
>
> *William McDonough, architect, urban planner and author*

Closing thoughts

Personal and organisational context will determine the emphasis you give each of these response categories. As a nation, however, we must pursue all three avenues without delay and government must facilitate the process to help us tackle the direct and indirect risks and opportunities that climate change presents.

Government must conduct a society-wide drive to conserve energy, and persuade major energy suppliers – particularly Eskom and Sasol – to reduce their emissions and begin the complex and undeniably costly process of switching to cleaner, renewable energy types. Simultaneously, innovative legislation and policies have to be developed to incentivise our society to adapt to changing atmospheric conditions and respond to the broader, unplanned consequences of a restructuring global economy.

All this must be achieved while continuing to address our transformation objectives of tackling poverty, reducing unemployment, lowering HIV-infection rates, economic growth and black economic empowerment. These objectives may take short-term precedence, yet they have at their foundation the understanding that, if climate change and our response to shifting global economic dynamics is not managed well, we may not be able to attend to these other priorities. There may come a time – possibly sooner than we think – that a sort of drastic economic and social triage will be necessary. Transformation objectives and methods may need to be dramatically adjusted to accommodate new imperatives. In the words of UCT economist, Jeremy Wakeford, "We may be faced with a situation where we are no longer able to economically grow our way out of poverty, but may have to share our way out of it."

Resources

i. Summary for Policymakers of the two IPCC AR4 Synthesis Reports: "Working Group II Report: Impacts, Adaptation and Vulnerability" and "Working Group III Report: Mitigation of Climate Change"; *www.ipcc.ch*

ii. Wikipedia; "Adaptation to global warming"; "Mitigation of global warming" and "Economics of global warming"; *www.wikipedia.org*

iii. Stern Review on the economics of climate change; HM Treasury, UK; 2006; *www.hm-treasury.gov.uk*

. . . there are steps we have to take to change the legacy we will leave our children: adjustments to our growth path we have to make as a global community, as nations working together, as citizens of a shared humanity, in response to the challenge of climate change and environmental responsibility.
We are in these things together – the war on poverty, infrastructure development and financial stability, responding to global warming – we share these obligations: rich and poor, urban and rural, men and women, business and community organisations, labour and government.

Trevor Manuel, budget speech, February 2008

9

Taking on a fair share

The Goliath of Africa's emissions

Harald Winkler and Robert Zipplies

The major greenhouse gases that humanity is responsible for emitting are due predominantly to the burning of fossil fuels, deforestation and agricultural practices. Each of the gases has a different potency, or warming effect. Power-hungry South Africa, with its high number of energy-intensive industries, is a significant global emitter of these gases, the bulk of which are caused by coal-dependent suppliers of energy, such as synthetic fuels and electricity. South Africa's emission profile dictates a moral as well as economic imperative to reduce greenhouse gas emissions.

Measuring and mapping emissions is a complex science – greenhouse gases and their sources, potencies and lifespans vary considerably. However, much research has gone into understanding each of these issues and we now have a good picture of what the gases are, which activities and industry sectors they stem from and what their effect on global warming is.

The spaghetti chart of global emissions[A]

Before we look at South Africa's greenhouse gas (GHG) emissions, we need to review the origin of the key gases and their contribution to global warming. Bear with us – it reads like a chemistry textbook – but the science is important. The three major GHGs attributable to our activity are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) – together, these contribute 99% of the warming effect. The remaining 1% is contributed by trace amounts of fluorinated gases. They include sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs). Together, these six gases are known as the Kyoto gases and fall under the Kyoto Protocol.

Each of the greenhouse gases is emitted in varying quantities, each has different warming potencies – called global warming potential (GWP) – and each has a lifetime varying from about a decade to many thousands of years.

You will notice that CO_2 with a GWP of "1" is, on a molecule-by-molecule basis, the least potent of the greenhouse gases. Yet, because of the large volumes in which it is emitted, it is the biggest contributor to global warming, followed by CH_4 and N_2O.

GLOBAL WARMING POTENTIAL

To allow apple-with-apple comparison of each gas's overall contribution to the global warming effect, its GWP is compared over a standard period of 100 years to that of CO_2, which has a baseline GWP of "1". The potency and contribution to the warming effect of other greenhouse gases are thus expressed as "CO_2 equivalents", an internationally standardised method that allows comparison of their overall contribution to global warming over a 100-year period.[5] Throughout this book, when reference is made to the collective emissions of the major greenhouse gases, this is referred to as CO_2e. Where reference is made only to CO_2 (without the "e"), this refers to the impact of carbon dioxide only.

A. Most of the data in this chapter, unless otherwise indicated, is drawn from the World Resources Institute's "Navigating the Numbers"[1] and their "Climate Analysis Indicators Tool" (CAIT)[2], which are based predominantly on 2000 data, and the most comprehensive survey to date of South African GHG emissions – the GHG inventories for 1990 and 1994, compiled for South Africa's Initial National Communication to the United Nations Framework Convention on Climate Change (UNFCCC)[3,4], which is an international treaty produced at the Rio de Janeiro Earth Summit in 1992. While the quantity emitted will have increased considerably, the emission profile is unlikely to have changed fundamentally since then. South Africa's GHG inventory is currently being updated and the results are expected to be made public late in 2008.

Gas	GWP (over 100 years)	Contribution to global warming
CO_2 (carbon dioxide)	1	77%
CH_4 (methane)	25	14%
N_2O (nitrous oxide)	298	8%
SF_6 (sulfur hexafluoride) HFCs (hydrofluorocarbons) PFCs (perfluorocarbons)	Up to 23 900 Up to 14 800 Up to 17 700	Fluorinated gases have high GWPs, but, due to their low volumes, contribute 1% or less.

Figure 1: Anthropogenic greenhouse gases and their contribution to global warming

Note: The GWP figures reflect the latest updated findings reported in the IPCC's Fourth Assessment Report (AR4), Working Group 1 Report.

A question that now begs answering is "where do these gases originate?" To provide some clarity to this question, the World Resources Institute developed the aptly named spaghetti chart, which goes a long way to help trace each of the six greenhouse gases back to its source. Refer to the fold-out front cover of this book for the chart. The data is based on CO_2e for 2000 and on an annual global emission estimate of 41 755 Mt CO_2e (that is, megatonnes, or millions of tonnes), which equates roughly to about 11 388 megatonnes of carbon equivalents being emitted each year. To explain the chart:

- The Sector column identifies the causes or sources of greenhouse gas emissions. Transportation as a whole generates about 13.5% of greenhouse gases. You will notice that energy-related emissions – caused by burning coal, oil and natural gas – are responsible for about 60% of the global total, with electricity and heat generation and transport the biggest culprits. It is interesting to note that "non-energy" emissions from industrial processes, land-use change, agriculture and waste contribute a significant 40% to global emissions, with deforestation the single largest contributor to non-energy emissions.
- The middle column aggregates all emissions to specific "downstream" activities, or end uses that drive the emissions in the first place. Some of these will be indirect (such as the use of electricity, where the utility creates the emissions but the user consumes the electricity) and some direct (due to tilling and fertilising soil, from industrial processes or generated by the combustion of fossil fuels in vehicles). Note that the operation (thus not construction) of residential and commercial buildings together are responsible for more than 15% of all emissions, road transport for 9.9% and cement production for 4.8%. All industry-related sub-sectors cause about 21% of global emissions.

- The column on the far right indicates the aggregated greenhouse gases by type. CO_2, with 77% of total emissions, is the biggest contributor to the greenhouse effect. This is followed by the five other gases – CH_4, N_2O and the three trace gases – all expressed as CO_2 equivalents. CO_2 is generated predominantly by energy and land-use activities, CH_4 is generated mainly through waste and agricultural operations, with some contributions from oil and gas production, coal mining, and electricity and heat generation. N_2O is generated mainly from agricultural soil-management practices, such as tilling and fertilising.

> "Global GHG emissions have grown since pre-industrial times, with an increase of 70% between 1970 and 2004."
>
> *United Nations IPCC*

The Goliath of Africa's emissions

Why, you may ask, should South Africans do anything about climate change, when our country is such a small emitter compared to the US and China? Yes, the two mega-powers are the world's two biggest emitters, but, taking our emissions per capita – one basis for an equitable means of comparison – we don't look good at all.

The table opposite focuses on carbon dioxide, by various measures. Worldwide human-generated greenhouse gas emissions presently constitute about 41 755 Mt of CO_2e per annum. While South Africa only constitutes about 0.73% of the world's population, according to the 2004 revision of the UN World Prospects, it is responsible for a disproportionate 1.2% of annual global emissions. This places us in the ignominious position of being the world's 19th biggest overall emitter of greenhouse gases on an annual basis, counting the six Kyoto gases – note that this excludes land use, land-use change and forestry (LULUCF).[B] Measured on a per capita basis, this equates to about 9.50 tonnes of CO_2e per capita, placing South Africa in 46th position. Including LULUCF only raises the number to 9.54 tonnes of CO_2e per person, but our ranking drops to an improved 62nd position, as other countries with higher deforestation emissions climb the rankings.

Worldwide, South Africa is ranked significantly above the world average emissions of 5.6 tonnes of CO_2e per capita, excluding LULUCF (6.8 tonnes with LULUCF). By comparison, China emits only 3.9 tonnes per capita and is ranked in 100th position (122nd counting LULUCF), while the US emits 23.1 tonnes CO_2e per person, ranked 12th, or 24.6 tonnes per capita, with LULUCF (ranked 6th in the world). In terms of absolute annual emissions, the US and China are numbers one and two.

B. Land use, land-use change and forestry (LULUCF) all form part of the global carbon cycle by contributing or removing carbon from the atmosphere. LULUCF includes activities such as land clearing for cultivation or pastures, harvest management, deforestation and reforestation.

This number potpourri is complicated, but it is important to realise that South Africa's emissions, and therefore also our share of the global total, depends on what we count or, specifically, whether we count:

- Gases: CO_2 only, or also other gases;
- Sources: energy only, or also deforestation (especially important for CO_2);
- Time-frame: annual emissions, or historical cumulative (or future cumulative, if we are doing projections); and
- Absolute or relative: the total emissions, or compared to the size of a country's population, economy or some other metric.

	CO_2/ capita	CO_2/GDP (Carbon intensity)[C]	Cumulative energy CO_2 emissions from 1950 to 2000		Annual CO_2 emissions, 2000 (energy CO_2 only)	
	tonnes/ capita	kg/1995 US$	$MtCO_2$	% of world total	$MtCO_2$	% of world total
South Africa	6.65	1.65	10 165	1.29%	349	1.46%
Africa	0.89	1.16	13 867	1.75%	920	3.85%
Non-OECD	1.65	1.33	318 117	40.23%	11 103	46.46%
OECD	10.96	0.44	472 635	59.77%	12 793	53.54%
World	3.89	0.68	790 753	100%	23 896	100%

Figure 2: Global CO_2 emissions

Note: 2000 data are for CO_2 only. Emissions from international bunker fuels, land-use change and forestry are excluded. The data on CO_2 from the energy sector are the most reliable and are shown here. Note that non-OECD shares of deforestation emissions are larger, as industrialised countries deforested long ago. Some information in this table is also derived from the Department of Minerals and Energy's integrated energy plan for the Republic of South Africa.[6]

So, depending on what is measured and how we measure it, South Africa's global contribution to climate change varies. Within Africa we are – unsurprisingly – the belching giant.

The table above indicates that South Africans, on average, produce 7.5 times more CO_2 per capita than the average African. Of course there is no such thing as the average South African, given the levels of inequality in our country, which places an even higher emissions burden on wealthier South Africans.

C. Carbon intensity is measured as kg CO_2/$ of GDP, on a power-purchasing parity basis for international comparisons, as in the table.

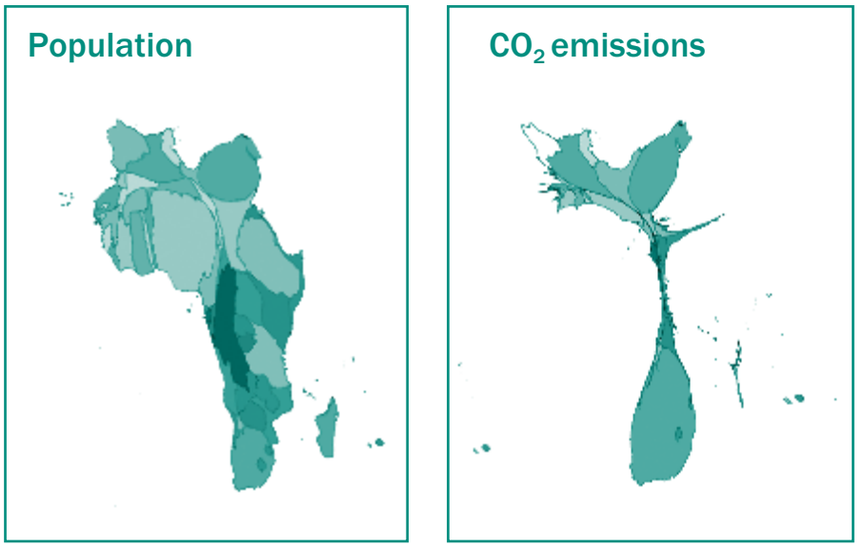
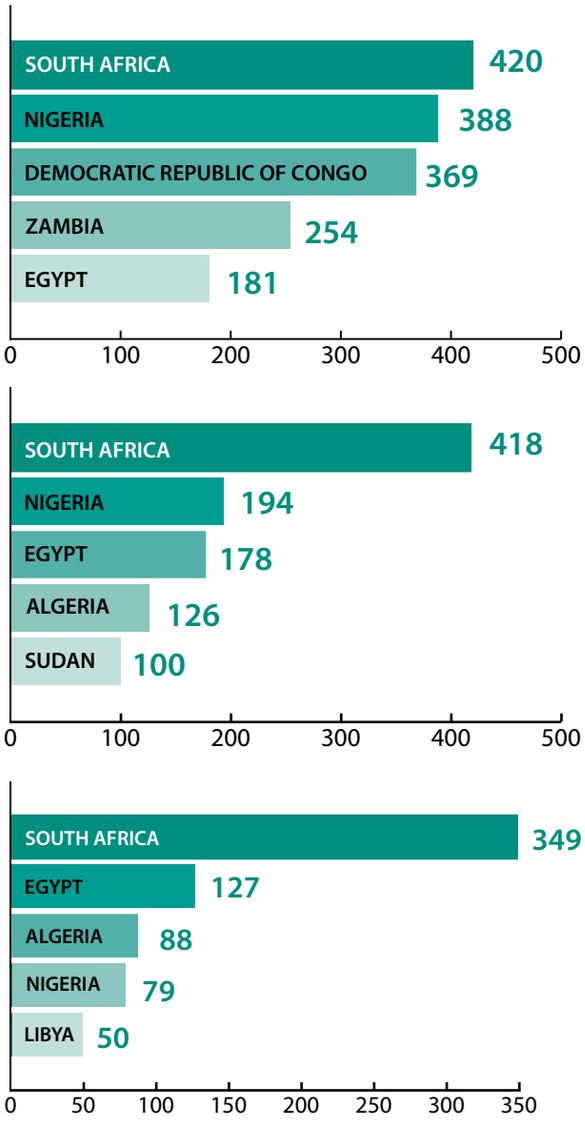


Figure 3: African countries sized by population and amount of CO_2 emissions
Source: www.worldmapper.org; data is for 2002 and 2003, respectively. © Copyright 2006 SASI Group (University of Sheffield) and Mark Newman (University of Michigan)

But even if we take into account the poorer and more rural sectors of society, our emission profile is still very much like that of an industrialised country. Of course, it matters what you count – there are far greater emissions from deforestation in other African countries than there are in South Africa. But even taking into account all sources and gases, including deforestation, South Africans still emit more than twice as much as other African countries. This can be seen in the carbon intensity – the amount of CO_2 emitted per unit of economic output – which is a measure of how efficiently we use our energy to generate income. African and developing countries emit less CO_2 for a unit of GDP – but South Africa emits even more than an average developed OECD country, and our world ranking here is 39th. So not only do we use energy rapaciously, we also use it very inefficiently.

On the African continent, South Africa produced 38% of carbon dioxide emissions from fossil fuel combustion (349 Mt of CO_2 only, in 2000, of Africa's total of 920). But when we add all gases and deforestation, South Africa contributes "only" 12% of the continent's emissions (420 of Africa's 3 368 Mt CO_2e) – still alarming when you consider that the country has just 5% of the continent's population. To make this disproportion graphic, we have resized African countries based on population size – our continent is easily recognisable. Do this based on CO_2 emissions (without LULUCF), and South Africa and a few North African countries expand, while most of the other countries virtually disappear.

Of course, comparing South Africa's ranking to the next biggest African emitters depends on what is counted:



Six gases, with LULUCF:
TOTAL for Africa
3 368 Mt CO_2e
(with LULUCF)
SA share of Africa: 12%

Six gases, without LULUCF:
TOTAL for Africa
1 948 Mt CO_2e
(without LULUCF)
SA share of Africa: 21%

CO_2 from fossil fuel combustion only:
TOTAL for Africa
920.2 Mt CO_2 only
SA share of Africa: 38%

Figure 4: Africa's largest emitters
Source: Climate Analysis Indicators Tool (CAIT), v3.0. 2005. World Resources Institute.

So South Africa, Nigeria and Egypt are among the top five emitters, but DRC and Zambia are only there with LULUCF; otherwise Algeria and Sudan look worse. On energy CO_2 only, Libya appears in the top five.

Our emission profile, which is somewhat atypical for a developing country, means that our responsibility to mitigate is greater. It also implies that major changes in

energy supply and usage will be needed over time. Above all, we will have to become less dependent on fossil fuels as our principal energy source and learn to use energy far more efficiently.

Why does South Africa have a high emissions profile?

The reason is embedded in the structure of our economy, which is centred around the so-called minerals–energy complex. Historically, South Africa's economic and industrial growth was fed by the energy-intensive extractive industries and the early 20th century saw the development of the electricity-supply industry to feed the booming mining sector. As the minerals–energy complex continued to shape the economy, there was an expansion of energy-intensive sectors, such as steel, aluminium, ferrochrome and chemicals, which has resulted in a highly polarised industrial energy-consumption profile. While these industries make up a large share of South Africa's GDP and exports, it is interesting to note that manufacturing (38%) together with mining (16%) uses more than half of our electricity.[7]

The source of our emissions under a magnifying glass

The sectors responsible for South Africa's emissions are not too dissimilar in proportion to the global breakdown in the spaghetti chart. However, around the world, the breakdown of the energy sector (energy supply and energy use) versus non-energy emissions is about 60:40, while South Africa's is about 80:20. The major reason is that we do not have any significant emissions stemming from deforestation. Energy emissions are those that result from the manufacture and use of electricity

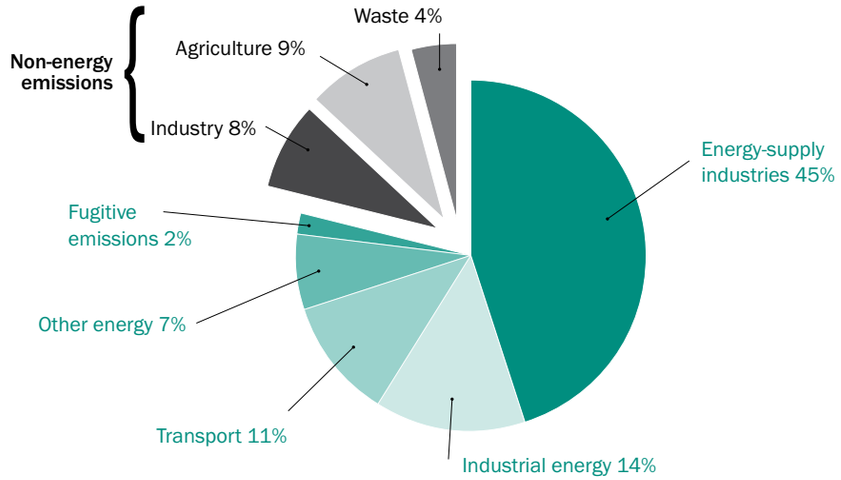


Figure 5: South Africa's emissions profile for CO_2, CH_4 and N_2O (as CO_2 equivalents) in 1994[8]

and fuels – the energy-supply industries. Non-energy emissions result from agricultural, waste or industry processes that do not involve the combustion of fossil fuels. The proportional contribution of each of the three major greenhouse gases to South Africa's emission profile is 83.2% CO_2, 11.4% CH_4 and 5.4% N_2O (stated as CO_2e) relative to the profile at global level seen in the Spaghetti Chart.

Emissions are divided into an energy sector, which consists of energy supply and energy use, and a non-energy sector.

The energy sector

1. Energy-supply industries: The energy-supply industries, notably electricity supplied by Eskom and synthetic fuel from Sasol's coal-to-fuel plants, contribute about 45% of total CO_2e emissions. For CO_2 alone, the share is even higher – around 56% from energy-supply industries. Of this figure, Eskom is responsible for roughly 40% and Sasol's synthetic fuel processes about the remaining 5% – but note that this only constitutes about half of Sasol's total emissions; the remainder are emitted as part of industrial processes.[4]

South Africa's energy economy is heavily dependent on coal. Overall, more than two-thirds of our energy comes from coal – 68% of total primary energy supply in 2004[9] – which is then converted mainly to electricity and petrol and diesel. Almost all our electricity comes from coal-fired power stations – 92% in 2004[10]. Eskom produces electricity at some of the lowest tariffs in the world, from fairly poor quality coal. In this respect, South Africa is not unique – major developing countries like China and India also rely mainly on electricity from coal, as does the US.

The problem is that coal is the most emissions intensive of all the fossil fuels. Natural gas emits, on average, only 56t CO_2 per TJ (a unit of energy), crude oil 73 tonnes, while coal, according to IPCC default factors, emits 94.6 tonnes.[11,12] South African coal, containing lots of ash and with a relatively low heat value, is somewhat worse, at 96.3 tonnes CO_2/TJ.[13] Given the country's relatively low electricity tariffs, there has been little incentive to use energy efficiently.

South Africa is unusual in having a coal-to-fuel industry, which gives our country more energy security – roughly 30% of our liquid fuel comes from synfuels. The flip side is that the coal-to-liquids process developed at Secunda, in Mpumalanga Province, is a high emissions process and emits between 46 and 50 million tonnes of CO_2 per year from a single facility.[7] That is comparable to the annual CO_2 emissions of sizeable countries, and more than Sweden, Uganda or Bulgaria.

2. Industrial energy: This category includes South African industries that burn coal, gas and liquid fuels to generate electricity, for heating and within production processes. These industries also use about 40% of the electricity generated by coal-fired power stations. (Note that this figure includes 37% total electricity, of which 93% is derived from coal.)

3. Transport: These emissions – about 11% of South Africa's total greenhouse gas emissions – stem from fuels used for road, rail and air transport.

4. Other energy: These emissions stem from the use of fossil fuels in the commercial (0.2%), residential (2.0%) and agricultural (4.4%) sectors – calculated from point 3 (above) – and include the burning of gas for heating and cooking, and fuel use for a variety of agricultural processes, such as heating.

5. Fugitive emissions: These emissions are not caused by the combustion of fuels, but arise predominantly from the process of coal mining and, to a much lesser degree, from the production, transmission, storage and distribution of fuels.

Non-energy emissions

Caused by activities other than the burning of fossil fuels.

1. Industrial processes: These contributed about 8.0% of emissions and are a by-product of various production processes – not fuel combustion. The bulk of these emissions is in the form of CO_2 from mineral products, the chemical industry and metal production, with a small proportion due to CH_4 and N_2O emissions from the chemical industry.

2. Agriculture: The agricultural sector contributed 9.3% of non-energy emissions, with just over half of this stemming from CH_4 caused by enteric fermentation and manure management and small amounts due to the burning of savanna and agricultural residues. Just under half of agricultural emissions stem from N_2O emissions, which are principally due to the tilling and fertilisation of agricultural soils, with much smaller amounts stemming from manure management and the burning of savanna and agricultural residues.

3. Waste: This non-energy emission contributes about 4.3% of our total greenhouse gas emissions. Virtually all of this takes the form of CH_4 from solid waste disposal in landfills, with a very small proportion of CH_4 and N_2O coming from waste-water treatment.

4. Land-use change and forestry: This category is not included as South Africa has no incidence of major deforestation. In fact, forest plantations have resulted in forestry being a small carbon sink in South Africa, which means that more carbon is being absorbed by forestry than is being released due to deforestation.

Closing thoughts

South Africa is undeniably the giant of African emissions, particularly in terms of those that are related to the burning of fossil fuels. Even when taking into account

> "South Africa will contribute its fair share towards our common responsibility for the future. Our actions will be measurable, reportable and verifiable. Given the urgency indicated by science, there is no longer a plausible excuse for inaction by any country."
>
> *Marthinus van Schalkwyk, Minister, Department of Environmental Affairs and Tourism*

emissions from deforestation, our country contributes a share of continental emissions three times higher than our population. Globally, South Africa's emissions on a per capita and carbon-intensity basis place the country among the world's bigger emitters. Our emissions in relation to the size of our population and economy are high.

This dictates not only a moral need to mitigate, but also an economic imperative. As global carbon agreements are revised and governments and corporations mitigate their emissions, there will be growing pressure for others to reduce their greenhouse gas emissions – and to set targets in measurable terms. It is essentially a given that the major developing countries, such as South Africa, Brazil, India and China, will be held to account and be expected to reduce their emissions in the climate regime after 2012. We would do well to prepare for this, and to define measurable, reportable and verifiable policies and measures, so that our country does its fair share.

Rather than continuing our historic trends of supporting emissions-intensive sectors, we will need to invest in climate-friendly technologies and turn our society into a low-carbon one. Making such a transition will require bold and far-sighted actions on the behalf of government, a different approach to business, and lifestyle changes for all South Africans.

Resources

i. World Resources Institute; *www.wri.org*; See "Navigating the Numbers" for more information on the spaghetti chart of global emissions.

ii. Republic of South Africa, Initial National Communication under the United Nations Framework Convention on Climate Change; 2004; *www.unfccc.int/resource/docs/natc/zafnc01.pdf*

We have an opportunity over the decade ahead to shift the structure of our economy towards greater energy efficiency, and more responsible use of our natural resources and relevant resource-based knowledge and expertise. Our economic growth over the next decade and beyond cannot be built on the same principles and technologies, the same energy systems and the same transport modes, that we are familiar with today.

Trevor Manuel, budget speech, February 2008

10

Mitigation is an energy issue in South Africa

Harald Winkler

Mitigation is about reducing greenhouse gas emissions – in South Africa that is an energy issue. Most of our emissions come from the supply and use of energy. Given our coal-dominated economy, our emissions per capita and per unit of GDP are high. Three broad areas are key to mitigation. Energy efficiency is the obvious starting point in many ways, saving money over time. Greater efficiency can be achieved in industry, commercial and residential buildings and in the way we move around. Secondly, we need to change our fuel mix so as to be less dependent on coal. This means moving away from coal-fired electricity to other options. Renewable energy stands out as a truly sustainable option. In liquid-fuel supply, we will have to be creative to find new ways to drive our future. Thirdly, and most fundamentally, we need to change our economy from one that rewards emissions-intensive industry to one that develops climate-friendly technology. All of these areas will require bold vision and leadership from South African government, business and civil society.

Why is mitigation an energy issue?

Mitigation of climate change means reducing greenhouse gas emissions. In South Africa, mitigation is an energy issue. We know that South Africa is among the worst emitters globally when measured by emissions per capita or per GDP output (emission intensity). So, even as a developing country, mitigation in South Africa is urgent.

Most emissions result from the supply and use of energy. This accounts for all the solid wedges of the pie chart (Figure 5) in *Chapter 9* – only those slices that have been extracted are non-energy emissions. A similar pattern is seen globally, except in those countries in which deforestation is a major cause of carbon emissions.

Together, energy supply and use account for almost four-fifths of our greenhouse gas emissions. The energy-supply industry uses coal to make electricity (primarily Eskom) and synthetic fuel (Sasol). Energy supply on its own accounts for 45% of our greenhouse gas emissions. But, because we all use energy, emissions from energy use sectors account for a further 35%. Industry burns coal directly, accounting for some 14% of total emissions, while transport is the next largest contributer at 11%.

Mitigation is everyone's responsibility. However, this chapter focuses mainly on government and the major energy producers, and the technologies, policies and investment needed for large-scale mitigation.

Global emissions will need to peak by 2015 and then decline.

Mitigation needs to happen now

There is little time left. The IPCC's latest assessment found that, in order to keep the increase in temperature between 2.0 °C and 2.4 °C (the lowest level assessed), global emissions will need to peak by 2015 and then decline.[1] That doesn't leave us much time.

In the political negotiations, there is increasing talk of a long-term goal of reducing emissions to 50% of 1990 levels by 2050. Developing countries are under pressure to quantify their contribution to mitigation. South Africa's emissions are growing, and to contribute our fair share, we will have to slow that growth, and see emissions levelling off and starting to decline in the not-too-distant future.

In the energy sector we need to focus on three areas of mitigation, all of which apply to South Africa. To elaborate:

- Energy efficiency and conservation (efficiency means using less energy for the same service; conservation is simply reducing demand for energy).
- Changing the fuel mix (moving to lower or noncarbon-emitting sources of energy).
- Making a transition to a low-carbon economy (by shifting economic activity and investment to more climate-friendly sectors).

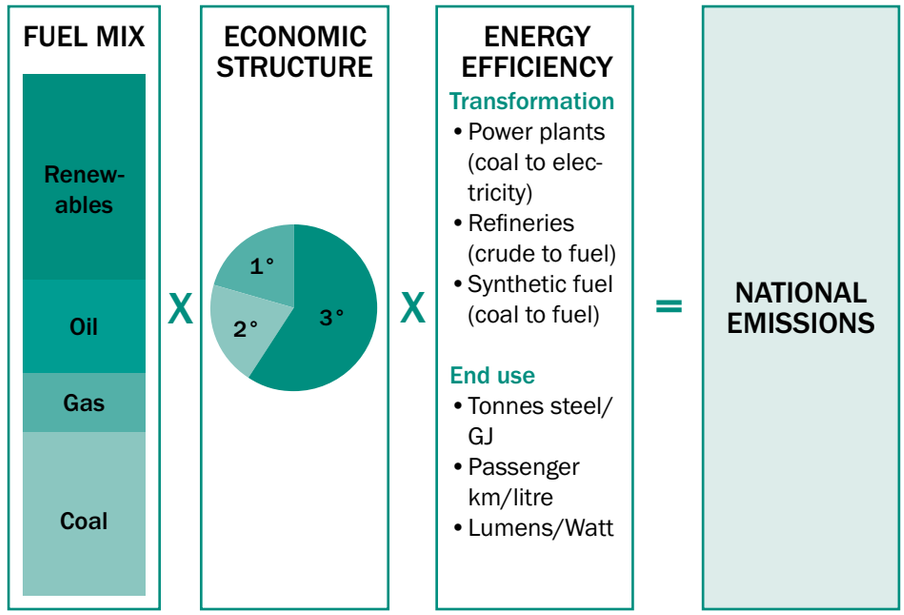


Figure 1: Three broad areas of mitigation

All three areas have different time scales. Energy efficiency pays back within years, sometimes months, and is a clear candidate for immediate action. Changing the fuel mix takes longer, given the decades-long lifetimes of power stations and refineries. Changing the underlying structure of the economy takes longest of all – but is probably the most fundamental change we must make if we are to remain competitive in a carbon-constrained world.

Using energy more efficiently

Energy efficiency is about using less energy to produce the same amount of output; a key short-term option in the fight against climate change. Central to this is the concept that energy efficiency "makes cents". The payback times for energy-efficiency measures are often short. For climate change, this indicates a positive return on mitigation efforts. You have to pay upfront, but, over time, save more money than you put in.

Efficiency can be applied both in sectors that use energy, such as petrol, coal and electricity – sometimes called end-use energy efficiency – but also in energy supply. There are large emission reductions to be achieved in energy supply. Options for efficiency at home or in transport are explored elsewhere.

Very significant savings are possible in buildings – from government, to commercial, to residential. These are also among the most long-lived structures.

Here, some examples of greater efficiency in energy supply and industry make the point.

End-use energy efficiency

An audit carried out by the Energy Research Centre at Volkswagen's Uitenhage plant showed that energy efficiency could reduce energy bills by 16%[2]. The initial outlay would pay for itself in less than one year. The audit even found low-cost measures available that would have saved energy bills of R2-million per year, with payback within one month. For the climate, this would have meant a reduction of 15 000 tonnes of carbon dioxide (CO_2) emissions per year. Why did management not institute the measures?

It turns out that energy consumption is not among key performance indicators because it is not the largest cost factor, even though significant savings could be made. But these savings are not as interesting to Wolfsburg as the number of cars produced per employee. So even though energy efficiency makes sense, it often is not done. VW is not alone in this – in fact, it is so common that the literature asks why people are not "picking up the $20 bills". Stronger policy support for energy efficiency is needed. And companies need to change their management systems to ensure that energy matters – at the bottom line.

South Africa needs an aggressive, comprehensive energy-efficiency agenda.

Supply-side efficiency

Energy can be supplied with greater efficiency. Power stations are a good example. Most of South Africa's existing stations have an "open cycle" – energy comes in (generally in the form of coal), and is transformed into steam, which drives turbines that produce electricity. The waste heat passes out and is lost.

In colder countries, the heat is not treated as waste, but is used for district heating systems. However, even in South Africa, power stations can close this cycle, and build "combined cycle" plants. An open-cycle gas turbine, for example, might typically have an efficiency of 33% – that is, the electricity produced has one-third of the energy content of the fuel input. Combined-cycle gas turbines can achieve 50% efficiency.

This gain does not come without a cost, with combined cycles having higher upfront capital costs – perhaps 50% more for each kW of installed capacity. But since you get more electricity for the same fuel input, the ongoing fuel costs per kWh are lower for combined-cycle systems. Adding together upfront and running costs, combined cycle gas is still somewhat more expensive than coal.

The gains described here assume that the same fuel is used throughout. However, from a climate point of view, the bigger issue is the *type* of fuel you are using.

Policies for efficiency

There is little doubt that South Africa needs an aggressive, comprehensive energy-efficiency agenda, including a more ambitious target to reduce energy consumption, set up a green building industry, promote vehicle efficiency, mandate and enforce strict appliance efficiency standards, and more. Specific policies are needed to promote more efficient use of energy, both at the point of use and in the energy-supply industry:

- Business should make energy-efficiency savings a key performance indicator in evaluating management's performance.
- The National Energy Regulator should only license new coal-fired power stations with a higher efficiency rating than existing subcritical coal-fired plants.
- Local governments should pass congestion charges for vehicles entering central cities, escalating dramatically with vehicle size and weight.
- The Department of Transport should set vehicle fuel efficiency standards, starting with government and commercial fleets. The motor industry should set goals to increase the fuel efficiency of vehicles by 1% per year.
- Government should promote mechanisms to encourage a shift to public transport, including the establishment by cities of multiple-occupancy vehicle lanes on highways, and bus rapid-transit systems.
- The Department of Science and Technology should actively promote research and development of more efficient vehicles; lighter vehicles; and electric, hybrid and hydrogen vehicles.
- The Department of Minerals and Energy should legislate mandatory codes and standards for energy-efficient buildings in government, commercial and residential sectors, reducing commercial building energy consumption in new buildings by 50% by 2020.
- Standards for retro-fitting buildings should require upgrade with a payback of less than seven years.
- Across all spheres and sectors, government should lead the way with a commitment to implement the above agendas for all government buildings.
- The Department of Housing should offer an additional subsidy that enables all new low-cost housing to be built with insulated ceilings and walls, solar water-heaters and compact fluorescent lights.
- Middle- and upper-income housing owners should be required to provide an energy-efficiency certificate as a prerequisite for transfer (of new and existing houses), meeting residential-energy building codes, including a solar water-heater. (The cost of new solar water-heaters should be tax-deductible.)
- Standards South Africa should develop mandatory performance standards for industrial equipment and a mandatory energy-labelling system, which should be driven by legislation.
- The Department of Minerals and Energy should require that all appliances are labelled to provide users with information about their energy efficiency.

Cleaner fuel mix

A history of dependency on coal

Historically, South Africans are dependent on coal, in particular for synthetic fuels and electricity. We need a cleaner fuel for both. This is not a new ambition. Since 1998, one of our five main energy-policy goals has been "securing supply through diversity". And, because of climate change, that diversity needs to have a direction – it must be cleaner. In making choices about a cleaner fuel mix, we have to consider new options.

Currently, the fuels used for electricity generation are dominated massively by coal. Eskom burns about 110 million tonnes of coal per year, with environmental implications of 963 g of CO_2 emitted for each kWh used, according to its own statistics.[3] This is comparable to the carbon intensity of electricity production in China, but is about a quarter higher than other African countries, a third higher than developing countries in general and over 40% higher than the world average. If we continue to do this, then our emissions will rise with growing demand. However, Eskom has stated repeatedly that it intends to reduce the share of electricity generated from coal.

Coal use can be improved. For as long as we continue to rely on coal, we should at least build more efficient power stations. These include a number of options. Power stations currently using steam at super-critical temperatures increase efficiency from around 34.5% to perhaps 36% – this may improve to 40% in future. Integrated gasification combined cycle (IGCC) has efficiencies close to 50%. A few percentage points save a whole lot of carbon, but they won't solve our greenhouse gas emissions problem. To achieve dramatic reductions in emissions, IGCC must be combined with carbon capture and storage (CCS).

Carbon capture and storage

Given our dependence on coal, CO_2 capture and storage (CCS) needs to be investigated. CCS is a method of capturing CO_2, transporting it and then storing it in geological formations, either on land or in riskier marine-storage locations. As an end-of-pipe solution, it puts waste below the ground.

Carbon capture is possible through processes such as oxy-fuel combustion, pre-combustion processing or post-combustion capture. In the case of Sasol's synfuel process, the gasification process already produces concentrated streams of CO_2 (although only half of their total emissions). After initial capture of the gas, the CO_2 needs to be transported to a suitable storage site for injection. Monitoring CO_2 after injecting it into a storage area is important to ensure permanent storage and safety for human health and the environment. Regulatory frameworks are required to allocate responsibilities properly.

CCS on power stations is possible, but will incur costs of capture – which are probably more than half of the total costs of CCS. Adding CCS to power plants will incur an energy penalty, since the efficiency of the process is somewhat reduced.

Once captured, CO_2 can be kept in storage areas such as geological formations. The gas can be trapped physically below impermeable rock, dissolved or ionised in groundwater, retained in pore spaces, or absorbed by organic matter in coal and oil shale.

Compared to other mitigation options, the local sustainable development benefits of CCS seem small. But if the problems that CCS faces can be solved, it does have the potential to turn a whole industry that has been seen as part of the problem into part of the solution. In the long run, we have no choice but to switch to other energy-generation technologies as our fossil fuel supplies dwindle.

Nuclear

Nuclear power, like any other energy technology, needs to solve its problems. Nuclear power does not generate greenhouse gas emissions in its operation – and its life-cycle emissions are much lower than those of coal, according to the IPCC. Some of the problems faced by nuclear power are specific to uranium – notably the disposal of toxic waste with a half-life of thousands of years. And, since highly radioactive material is extremely dangerous, ensuring safety of material across the entire chain is essential. Particularly high standards of maintenance are needed to avoid the risk of nuclear accidents.

All this raises the overall costs of nuclear power. It necessitates large added investment, which links to the economics, since the industry itself should pay these costs and not pass them on to the public. This brings into focus the key issue that nuclear has in common with all alternatives to coal – is it economically competitive? The Pebble Bed Modular Reactor (PBMR) company will claim its reactors will be cost-effective – but the regulator's last published electricity-expansion plan did not include the technology. New plans seem to focus more on conventional nuclear reactors.[4]

> Increasing the shares of renewable energy technologies could create 21% more jobs.

Renewable energy technologies

Renewable energy technologies for electricity generation range from solar thermal plants, wind turbines and advanced biomass to others that have not been implemented commercially, such as wave and tidal energy. The key challenge here is cost. Undeniably, current capital costs of renewables are higher than for coal plants. Even taking into account lower operating costs, since no fuel needs to be bought, the overall costs of generating electricity are higher and give a different cost structure, with high initial outlays being a key obstacle. Taking all together, wind is still significantly more expensive in c/kWh, which is the unit used when combining all costs in a single measure. Developers of wind farms, for example, would need to be paid around ZAR 0.50/kWh, when bulk tariffs are around ZAR 0.12.

Three factors make renewables more attractive. One is that costs have been coming down rapidly, as is typical of new technologies. To some extent, our future options depend on the speed at which other countries achieve economies of scale and "buy down" the cost, particularly of solar power, which is by far our largest resource.

The second is to include the external costs, which are social and environmental burdens not captured by market transactions. For example, the health effects of air pollution from coal-fired power stations are not paid for directly by generators. The cost is borne by society. Renewable energy technologies avoid emissions of local air pollutants – and of greenhouse gases, which is the largest externality of all.

Employment is the third factor.[5] Figure 2 shows the number of jobs created from different sources. Increasing the shares of renewable energy technologies in the grid, based on this data, could create 21% more jobs in 2020 than the current mix (52 000 instead of 43 000). Shifting entirely to renewables would raise it by 33% (57 000 jobs in 2020). The jobs created would not only require highly skilled and highly paid engineers; a significant proportion would be employment for low-skilled workers.

Investing in renewable energy technologies may well be worthwhile in the long run to attain energy that has very few environmental impacts.

Several policy instruments have been used in other parts of the world to promote renewable energy – fixing the price, determining a set quantity, or trying a combination of regulatory and market instruments.

The favoured approach in Europe has been feed-in tariffs, which guarantee prices for developers. Renewable portfolio standards are popular in the US. Texas set a standard of 2 000 MW that had to come from renewables. The UK converted an earlier "non-fossil" obligation into a renewables obligation, combining the setting of a target with a tendering process. South Africa has set a target of 10 000 GWh renewable energy contribution to final energy consumption by 2013.

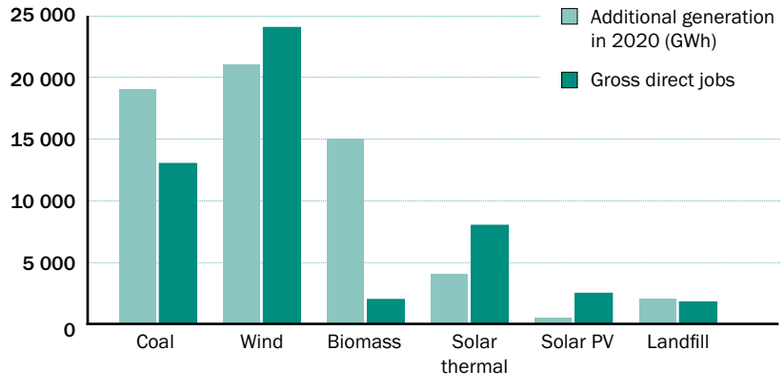


Figure 2: Summary of jobs against electricity generation for coal and renewable energy technologies in 2020[5]
Source: "Employment Potential of Renewable Energy in South Africa"; Agama Energy; 2003

Irrespective of how the "target" for renewable energy is set, some measures are important, such as power purchase agreements, access to the grid and creating markets for green electricity.

Sounds complicated? Well, it is. Some trade-off between environmental and economic goals is necessary, since the win-win options such as conservation and efficiency do not replace the need for new supply. And, in this equation, social dimensions must be taken into account. Job creation is a priority, with technologies that can create more jobs, such as renewables[5], being particularly attractive.

Taking action

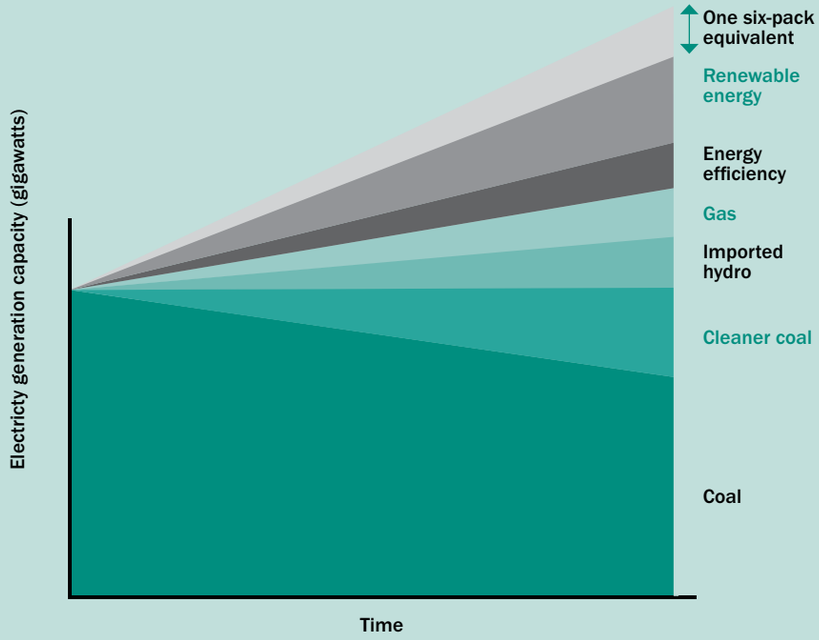
And yet, some fairly simple choices can be presented. Figure 3 invites you to think of the new capacity of 20 000 MW over 20 years as a set of "wedges" on top of existing capacity. This capacity could be met by six new coal-fired power stations. These pulverised fuel stations, known as "six-packs", have a capacity of around 3 600 MW each. However, if three of the six were replaced by other options in the next two decades, this would represent a major shift in South Africa's energy development path.

Each wedge could build up gradually over the initial 20 years. If, for example, one "six-pack equivalent" could be completely avoided by efficiency, another produced from a mix of renewables, and another from imported gas, significant institutional capacity would have been developed in the local electricity supply industry. Longer-term goals of three six-packs over 30 years, and five over 50 years, might seem achievable.

Changes in the next two decades will be critical in shaping not only energy policy, but also South Africa's response to climate change mitigation. If South Africa were to get serious about mitigation, it would quickly become not a question of which of these wedges we choose, but how to pursue them all. This is a great challenge, but, at the same time, the need to replace major infrastructure offers the opportunity to change direction.[6]

Energy producers who supply our liquid fuels have fewer obvious choices. Currently, South Africa's transport systems rely overwhelmingly on petrol and diesel, which provide about 87% of transport fuel needs[7], even though the country produces almost no crude oil of its own. If we stopped importing crude oil, refining it and adding about another third from synfuels – what would fuel our public, commercial and private transport?

In theory, hydrogen seems an attractive option. But hydrogen is merely an energy carrier, not a source – in other words, it cannot be mined, but must be generated from sources like coal or water, using electricity. If hydrogen were stripped from hydrocarbons (like coal), then the carbon remains would quickly form CO_2. From a climate point of view, there would be little benefit. Alternatively, water can be split into hydrogen and oxygen – but this process takes lots more energy than it produces. If you used free renewable energy to split water, that would be a good system.



Wedge options, some of which have the potential to constitute several wedges:

- Renewable energy: Concentrated solar power, wind, biomass, small hydro and wave power.
- Energy efficiency: From efficiency in industry, commercial buildings and vehicles.
- Gas: Offers a cleaner-burning alternative to coal, but supply is limited.
- Imported hydro: Could be large hydro, e.g. from Inga Falls in the Congo; depends on political stability.
- Cleaner coal: Includes more efficient coal-fired power stations, as well as CCS.

Figure 3: Wedges of electricity capacity equivalent to one 'six-pack' each over 20 years

But it would have to wait until renewables were cheap enough for hydrolysis, which will probably only occur some time in the future.

The emissions generated by synthetic fuel production could be reduced substantially if CCS technology were used to reduce the greenhouse gases emitted during the coal-to-liquids (CTL) process. Sasol's CTL process produces about half its CO_2 in concentrated streams. Effectively, the capture has already been done. And, while the costs of CCS are still fairly uncertain, we do know that more than half of the outlay is likely to go to capture. The main challenge for CTL is whether CCS can be developed on a large enough scale and at an acceptable cost. The current scale of the largest existing CCS project (the Sleipner project) is 1.0 Mt carbon dioxide per year, the next planned location will store 2.0 Mt, which is less than a tenth of the concentrated emissions at Secunda, and around 1% of Eskom's more dilute emissions.[8]

The Brazilian ethanol programme is an example of the successful promotion of a climate-friendly industry. The Brazilian biofuels programme is estimated to have avoided 600 million tons of CO_2 (Mt CO_2) between 1975 and 2005. Total emissions in Brazil would otherwise have been 10% higher. They have developed a competitive advantage not only in fuel production, but also in the vehicles that use the fuels.

Growing our own fuels

Biofuels are attracting a lot of attention. However, South Africa is no Brazil – its water resources are more limited. Only 13% of the land area is arable, and producing crops for energy comes into competition with food production and reduces the land left to biodiversity. The crops themselves are also significant. Sugar crops are the most land-efficient in replacing energy based on fossil fuels. Starch crops, such as maize (corn), potatoes, wheat and rye, replace significantly less fossil energy. But growing sugar cane also competes with the sugar market, and maize is critical to food security. While this should not rule out biofuel production, care needs to be taken in designing a biofuel programme. Biofuels can contribute to addressing transport-related greenhouse gas emissions, but are no silver bullets. *Chapter 18: You the farmer*, includes a further discussion on biofuels.

Electric vehicles may offer a surprisingly attractive option. Studies show that even in coal-dominated grids like our own, electric vehicles can still reduce emissions.[9,10] Converting electricity into motive power is more efficient than the process in internal combustion engines. Issues remain, however, about batteries, extending ranges and the price of vehicles. From a climate point of view, moving to electric vehicles would mean that our mitigation efforts would rely even more heavily on reducing emissions from the electricity sector.

The big options in transport are not technology based. Shifting from private to public transport reduces energy consumption and hence emissions per passenger-kilometre massively. This would require large investments in clean, affordable and safe public infrastructure.

Finally, we need changes in behaviour – traffic demand management; multi-occupancy vehicle lanes; bus rapid transit systems; as well as smaller cars, cycling, and the use of public transport. For more details see *Chapter 17: Our transport*.

Policies to promote a cleaner fuel mix

Aggressive action is needed to move South Africa's coal-based energy economy toward renewable energy sources in both the electricity and liquid fuel sector. While other sources may be needed in the transitional period, in the long term, renewable energy is the most sustainable option – together with using less energy.

South Africa should implement its long-standing policy goal of diversifying energy supply in the electricity sector:

- Government should set a more ambitious target for renewable energy of 27% by 2030 and 50% of electricity generated by 2050. A Renewable Portfolio Standard should be given legislative effect and enforced through licensing procedures overseen by the regulator.
- Eskom should implement its pledge to reduce the percentage of electricity generated from coal-fired power plants by 10% by 2012, with a further reduction of 1% each year thereafter.
- To start this process, Treasury should commit public spending on a range of renewable energy technologies for electricity generation to match the public spending on the PBMR nuclear reactor and potential future spend on conventional pressurised-water nuclear reactors.
- The nuclear industry should pay for all its costs, including safety, waste disposal and decommissioning.
- The Department of Minerals and Energy should make a feed-in tariff available to zero-carbon electricity-generating sources, and distributors should be required to buy all such electricity generated in their distribution areas.
- Progressive businesses should pay a premium for electricity from renewable energy sources. Firms should be allowed to trade renewable energy certificates.

In the liquid-fuel sector:

- Government (Science and Technology, Minerals and Energy) should adopt a technology standard of "zero net carbon from liquid fuels by 2025".
- Diversity of liquid-fuel supply should be promoted, including the limited use of biofuels within sustainable limits.
- No further coal-to-liquid plants should be built, unless CO_2 CCS technology resolves its problems and proves viable at scale.

Industrial policy needs to favour those sectors that use less energy per unit of economic output.

Structural changes to the economy

Energy-efficiency measures and a changed fuel mix alone will not solve the climate problem. The IPCC has made clear that other sectors need to change as well. Amending development paths is a major contribution to mitigating climate change.[11]

From an energy-intensive to a climate-friendly economy

Perhaps the most difficult, but also most fundamental, approach to mitigation is to divert our economy away from its energy-intensive path. Instead of investing in energy-intensive sectors, South Africa should move towards a low-carbon economy.

Industrial policy needs to favour those sectors that use less energy per unit of economic output.

Energy-intensive industries have been at the heart of the South African economy[12], which industrialised around our abundant resources. Many of these industries were established on the basis of low energy prices, although some – notably mining – are inherently energy-intensive. For example, low electricity prices have been used to attract aluminium smelters, which import their feedstock from elsewhere, and export most of the final product.

Redefining our competitive advantage

Over time, most economies shift from primary and secondary sectors to tertiary ones. South Africa's GDP has already moved from mining through manufacturing to services, which has resulted in a decrease in energy intensity. Yet current policy still tends to define competitive advantage around energy-intensive sectors. Our concept of competitive advantage was built around low energy prices, with investments going to minerals beneficiation and processing sectors. The challenge of climate change requires South Africa to redefine our competitive advantage.

Easy to say, but what might that entail? One dimension would be to focus on parts of the economy that are not as sensitive to energy price rises. Specific policies that can help build a low-carbon society have been studied. A transition to a low-carbon economy in South Africa might involve shifting incentives – removing incentives for attracting energy-intensive investments and using the resources freed up to promote lower-carbon industries.

The Department of Trade and Industry's (DTI) Developmental Electricity Pricing Programme (DEPP) aims "to attract industrial investment projects to the Republic, which would in the absence of DEPP not invest in the Republic, through providing them with electricity tariffs that will … enable an internal rate of return (IRR) that will ensure that the applicant can invest in South Africa"[13]. The policy is explicitly focused on facilitating "beneficiation of downstream industries". Essentially, the DEPP seems to be saying "come and invest in South Africa, and we will match any electricity price you can find elsewhere". Currently, our electricity mix implies large greenhouse gas emissions.

In a low-carbon economy, the DTI would need to re-think such incentives – phasing out those that are associated with emissions-intensive processes and establishing incentives for climate-friendly industries. The DTI has taken a decision to integrate climate change into its industrial policy – it remains to be seen whether this is carried into concrete actions.

Another prong of a low-carbon strategy would be to shift industrial development into new areas, particularly those that create employment and make use of local resources. Much as Brazil has become a world leader in biofuels (see page 133), South Africa could seek to build a competitive advantage in climate-friendly technologies. The aim would be to become a market leader, with the support of government.

South Africa should look to its resource endowments, such as its excellent solar-energy resources, but also consider where it can compete. How about becoming world leaders in energy-efficient design and materials for low-cost housing? South African inventors have already made breakthroughs in photovoltaic technology – the challenge is to build on this and create businesses around the replication of such developments.

Governments are often considered poor at choosing technology winners. So a programme of this nature might not pick a single development, but spread public investment across a portfolio of zero-carbon technologies. That in itself would be a departure from current patterns of public spending, which have invested significantly more in nuclear power than in renewables.

Government has spent hundreds of millions of rands supporting the development of the PBMR. In his 2007 budget speech, Trevor Manuel indicated a "commitment to finance 51% of the capital requirements of the PBMR project over the next three years [which] amounts to R6 billion".[14] Government, through DME, also offers a once-off capital grant through the Renewable Energy Finance and Subsidy Office (REFSO). But the scheme is limited to 1 MW electricity plants, with a total subsidy of R250 000 per facility. A key element of a transition to a low-carbon economy would be equal public funding for each of a range of zero-carbon technologies.

Climate change requires urgent action, but changing the structure of the economy is a long-term task. A low-carbon economy will not emerge overnight. So energy-intensive industries will continue to exist, and a comprehensive strategy will have to include transition for these sectors and the workers in them. Policies that could assist energy-intensive industry would include promoting higher value-added sectors, as well as ambitious energy-efficiency targets (since the potential for energy savings is greater). This issue may need an international perspective, asking the question where energy-intensive industries might best be located. The climate might benefit more if aluminium smelters stay in Canada (whose electricity on average has emissions of around 200 g CO_2/kWh compared to South Africa's 960 g), rather than being constructed by Alcan in our country.

Policies for a low-carbon economy

Cross-cutting policies and actions need to promote a transition to a low-carbon economy and society. Broadly, these will require a shift in economic and industrial policy, which should also be based on full cost accounting and the internalising of external costs.

If we count the full cost of using natural resources and ecosystem services, lots more will follow. More specifically, policies should include the use of both regulatory and economic instruments. For example:

- In future, the Department of Environmental Affairs and Tourism (DEAT) will have to play an even greater coordinating role in tackling climate change effectively – but ultimately it is a challenge for government as a whole. DEAT should coordinate activities across a wide range of government departments, in so far as their line functions have implications for emissions. The Inter-Ministerial Committee on Climate Change should be strengthened to achieve the policy coherence required for a transition to a low-carbon society. Climate change needs to be coordinated from within the Presidency and integrally involves business leaders, particularly from the largest emitters.
- Government (Minerals and Energy, Environment) should implement the commitment in the 1998 White Paper on Energy Policy to establish national targets for reducing energy-related emissions.
- Government should adopt a long-term climate policy and legislative package in which such national targets should be defined with several parameters: a year (not later than 2020) in which emissions would peak, the level at which they should peak (not too much above our current 450 Mt) and the level to which emissions would decline by 2050 (substantially below current levels).
- The climate policy should be supported by a Strategic Fund for Energy for Sustainable Development, moving financial resources towards options that are sustainable in the long term and which build South Africa's competitive advantage in climate-friendly technologies.
- The National Treasury should implement proposals for environmental fiscal reform, including a tax on air pollutants, a fuel input tax or a carbon tax.
- Government (Treasury, Environment and others) should develop and implement plans for a domestic cap-and-trade system.
- The Department of Trade and Industry should switch to incentivising low- and zero-carbon industries. Climate change should be integrated in its industrial policy framework.

> "Together, rich and poor, developed and developing, North and South can and must truly hold hands and address the challenges of climate change and sustainable development; work together to defeat poverty and underdevelopment and ensure that every human being is saved from the indecencies and humiliations that are attached to the poor."
>
> *Thabo Mbeki, UN General Assembly, September 2007*

In conclusion

We need an interaction of policy, investment, technology and institutions to rise to the challenge of mitigation in South Africa. In the short term, we can do much more by using energy more efficiently. A massive up-scaling of effort in this area is needed – with the promise that these measures pay back within short periods of time. It is possible to cut carbon emissions while saving money. It's the obvious place to start.

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In the medium-term, we need to change our fuel mix. Changing electricity generation away from coal is not a unique challenge – China, India and the US have a similar task ahead of them. The options are well known – renewable energy, nuclear power, perhaps some gas, and importing hydropower if there's stability in the DRC. We have to build new capacity in the next few decades. This is a mitigation opportunity. If we can make five of the six wedges we need by 2025 using something other than coal, that would make an impressive dent in our emissions. If we can clean up the coal that we continue to use in the meantime with CCS technology, we can turn a major part of the problem into a valuable part of the solution.

A cleaner fuel mix and structural changes to the economy will require a huge, concerted effort. And government needs to show vision and leadership to initiate such an effort. In addition, business needs to demonstrate that it can be forward-thinking and proactively engage in developing climate-friendly technologies. And, critically, civil society – as taxpayers, consumers, shareholders, voters and activists – must raise the awareness and exert the pressure needed to bring about a movement for climate change.

In the long-term, we have to think about structural changes. These won't come easily after a long history of defining our competitive advantage around energy-intensive sectors. Climate change is a long-term problem that requires short-term action. South Africa needs to start on a transition to a low-carbon economy and society now.

Resources:

i. Key international climate change institutions:
   - Intergovernmental Panel on Climate Change (IPCC); *www.ipcc.ch*
   - United Nations Framework Convention on Climate Change (UNFCCC); *www.unfccc.int*

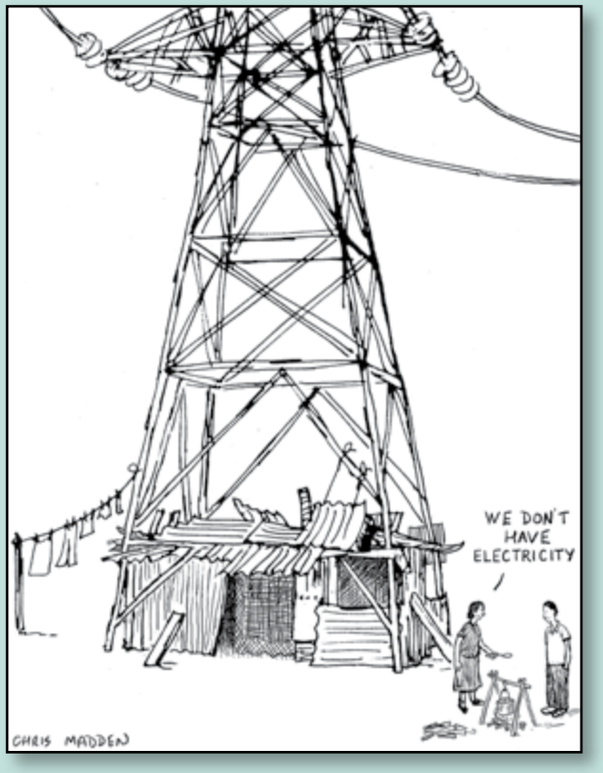
ii. Key South African documents on climate policy:
   - South Africa: Initial National Communication under the UNFCCC; *www.unfccc.int/resource/docs/natc/zafnc01.pdf*
   - South African Response Strategy; *www.environment.gov.za/*
   - Air Quality Act (No. 39 of 2004); *www.gov.za*
   - Long Term Mitigation Scenario planning (LTMS); *www.erc.uct.ac.za*

iii. Renewable energy and energy efficiency:
   - SA Renewable Energy Resource Database; *www.sabregen.co.za*
   - White paper on renewable energy; *www.dme.gov.za*

iv. CDM projects in South Africa:
   - Designated National Authority (CDM office); *www.dme.gov.za*
   - SouthSouthNorth; *www.southsouthnorth.org*

v. CDM projects internationally:
   - Official CDM website; *http://cdm.unfccc.int*
   - CDM projects pipeline; *www.cd4cdm.org/*

vi. Data set on emissions and more:
   - Climate Analysis Indicators Tool (CAIT) World Resources Institute; *http://cait.wri.org*



The challenges of sustainable development – protecting the environment, stabilising the world's population, narrowing the gaps of rich and poor and ending extreme poverty – will render passé the very idea of competing nation-states that scramble for markets, power and resources.

Jeffrey Sachs, Director, Earth Institute, Columbia University, US

11

Your government, our government

Stef Raubenheimer

Government has a key role in shaping the policy that will drive the efforts to both mitigate emissions of greenhouse gases and adapt to the impacts of climate change. This internal policy framework must also match its commitments to mitigation in the international framework to stabilise climate change. In addition, government may take advantage of international assistance in adaptation efforts, as well as in financial and technological flows aimed at the arrival of a de-carbonised economy. This is a gigantic set of activities and, to add to the effort required, alignment with stakeholders in industry, labour and civil society is also demanded.

Three areas of focus emerge for South Africa: an energy plan that provides fuel for the economy but does not create a carbon liability; a transport plan that provides a low-carbon mobility framework and avoids the growing peril of skyrocketing fuel prices and the arrival of peak oil; and, finally, a plan to keep sectors like agriculture afloat as climate impacts, mostly related to water stress, begin to bite. This requires a bold, aligned strategy. Has our government got what it takes?

Spare a thought for government

It's a fact that all the small things we do in our lives generally have consequences for the climate. From the moment we wake up we are doing things that have a "carbon footprint". That includes eating the morning toast, or warming up water to bath the baby. If we committed to reducing the footprint of each of our actions, our current resources would still constrain us immensely. In South Africa we would still have to buy coal-based electricity to power that TV. We'd still have to commute in petroldriven transport. As consumers we can, and should, do our bit for climate change, but it will only be a small fraction of the effort that science requires in order to stabilise the climate. We need to realise this: our private actions, while relevant, will not achieve the scale of emissions reduction that is the eventual goal.

If we turn to the suppliers of the commodities, fuel and services we consume and say: "Your emissions dwarf ours, so do something about it; supply us with renewable energy, build us electric vehicles", we could start to influence larger changes. Corporations are driven by market conditions and by regulation: they need to show return on investment to shareholders and value to their clients, while staying within the law. The cement factories and the refineries, the electricity utility – all the large emitters, need these forces, regulation and the market to change before they will adapt. The problem is that market conditions lag behind the required pace of change. This is because climate change is, by its nature, slow to manifest and does so in a delayed fashion. South African wine will eventually have to be carbon neutral because market conditions in the UK will demand this. But this timing and the timing required by science are not remotely in step. The increments of change driven by the market are more than often far below those required by science. Hence the market is also insensitive to the scale of change required.

The challenges of pace and scale mean that we now need government to look to science, commit to its findings, and, by fast-tracking the regulatory environment, kick-start the market. This places an immense burden on government.

Spare a thought for government: climate change is the biggest challenge we face as a global community and government has to be central in dealing with it. But it's a 50-year problem squaring up against an army of three- to five-year ones. And they're big ones at that: HIV, crime, housing, health, education and social support. These are the problems that move voters.

So what does it take to make a government act on climate change, and what is it that it must achieve? What are the motivators? What needs to be done? In this chapter, we cast a sympathetic but critical eye on the role of government, and the South African challenge in particular. This chapter also gives you, the citizen of South Africa, a sense of how South Africa is performing in the climate change races.

South Africa: compared to the rest of the world

China and the US are the biggest emitters in the supply of greenhouse gases in the world.[A] South Africa's emissions are *tiny* compared to both – on one level. The world produces around 49 000 000 000 tonnes of CO_2e per annum and South Africa produces around 440 000 000 tonnes (still climbing).[1] Hence, on a per capita basis, we produce more than we should. Per capita per GDP we are even worse. *Chapter 9: Taking on a fair share* provides more comparative information.

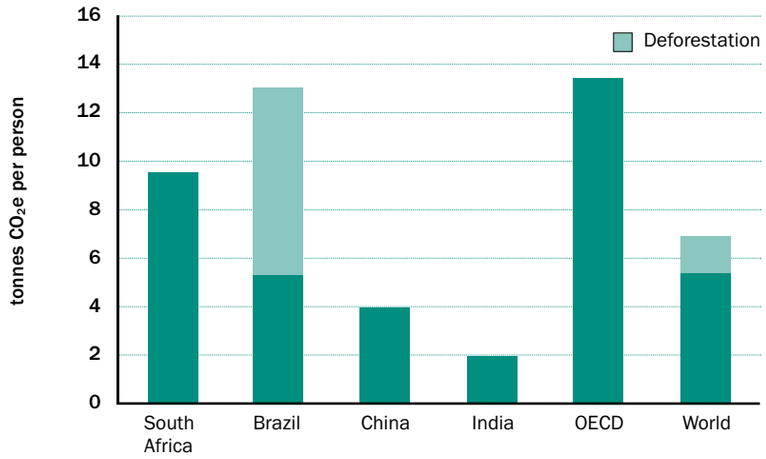


Figure 1: Emissions per capita
Source: Long Term Mitigation Scenario planning (LTMS) report.

Take a look at the following diagrams:

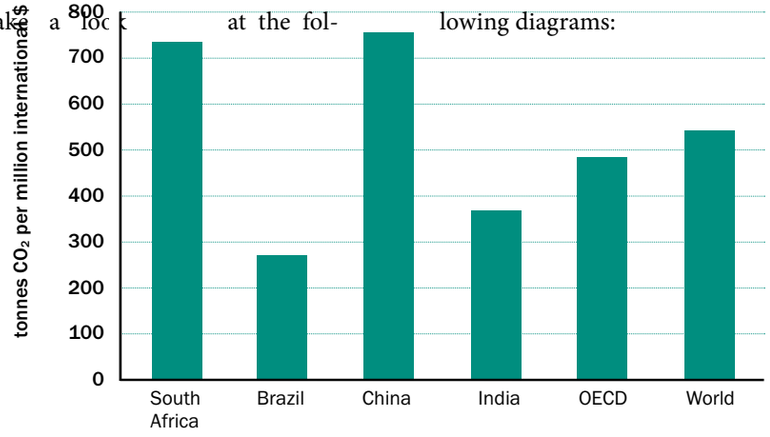


Figure 2: Emissions intensity
Source: Long Term Mitigation Scenario planning (LTMS) report.

A. US 21%, China 22% (of supply, not historical emissions, where the US is still in the lead); World Resources Institute; *http://cait.wri.org/*[2]

These show both particularly high per capita emissions and an emission intensity (the amount of CO_2 we emit for each product we produce) comparable with China's.

Like China[3], which is commissioning a new coal-fired power station every week, we have a lot of coal and rely on it to drive our economy, which is based mainly on primary and extractive industries. So in some ways we can compare ourselves to China: we are modernising, growing, urbanising, and we need electricity to fuel growth and employment. Like China, we are in the frontline when it comes to the climate change debate.

> Climate change has become so important it can topple governments.

International politics and commitments

Until 2012 the modest initial cuts in the emissions of greenhouse gases agreed to in the Kyoto Protocol belong to the developed world only – at least those in that world who signed up (the US and Australia did not; Australia now has). The principle was, quite correctly, that the stock of greenhouse gases in the atmosphere was put up there mainly by the developed world over the last century; hence they should be the first to cut emissions.[B] With Kyoto the developed world agreed to mandatory cuts in greenhouse gases by 2012. These cuts were modest, in fact, far below what science actually requires.

The developing countries, including Brazil, India, China and South Africa (now known as the BRICS), have signed Kyoto, but have no mandatory emissions cuts, at least not for this "first commitment period" to 2012.[C,4]

The Kyoto deal was made more than 10 years ago now, at a time when there was a great deal of uncertainty in climate science. The feeling was that we had some time and leisure to try a small step first. But Kyoto struggled into life with strong opposition from the US and Australia. The large oil companies also spent significant amounts of money maintaining a culture of doubt about the science of climate change, doing so successfully enough to convince some powerful people that there was nothing to worry about. In this process, 20 valuable years were lost. During this

B. Both the existing stock and the ongoing supply of greenhouse gas is important: once in the atmosphere, CO_2 has a greenhouse gas effect for around 100 years, so gas emitted back in 1920 is still doing its work.

C. Go to *www.unfccc.int* to read the full treaty.

time, science showed just why those 20 years had been so valuable.

The critical years – 2006 and 2007 – saw everything changing rapidly. First, the science was effectively "put to bed".[5] Not only to bed: scientists started revealing that they might be telling the story rather conservatively, and that things might be worse than their inherently cautious predictions. Second, we saw the first real climate change manifestations: hurricane Katrina, ice melting at unprecedented rates, floods in Mexico, fires in California. The economist Sir Nicholas Stern published an authoritative report[6] on the costs of action and inaction that persuaded the world that climate change was also an economic issue. From a fringe issue, in the domain of the "greenies", climate change was suddenly the main issue at the 2007 World Economic Forum in Davos. It is, at the time of writing in early 2008, so important that it can topple governments, such as happened recently in Australia.

For developing countries, especially the heavily emitting BRICS, this has meant that the security blanket of differentiated responsibilities might be lifted sooner rather than later. On a simple calculation of stock and supply of greenhouse gases, these countries should be allowed to increase their emissions for some time yet, and it would be unfair to determine otherwise. The problem is that this fairness or equity is now counterbalanced by the urgency and size of the problem: in short, fairness is a luxury we cannot afford, especially given the population size of China and India. We need a compromise. First, the US and Australia must sign up to mandatory cuts in emissions. Second, the developed world must agree to the scale of the cuts needed by 2050: as a group, they will need to emit at least 60% (more like 80%) less than their emissions in 2000. The third is that the BRICS must eventually show how they plan to get their emissions to peak and then decline within a reasonable time and to an appropriate level. This level would be more or less 30% to 50% below the 2000 level. Such a combined effort would not avoid some pretty drastic climate change impacts, but would keep us away from "catastrophic" changes.

The most recent negotiations on a future Kyoto occurred in Bali in December 2007, and were aimed at agreeing a roadmap[7] for the negotiations that must necessarily lead up to this eventual consensus. South Africa went to the Bali negotiations in the full knowledge that it would have to take up its obligations. With exactly this position, it became a key to the US capitulation. With great difficulty, the US was finally brought to the table.

In short, South Africa stood on the international stage and declared its intentions with some authority. It will now have to back this up with a lot of internal planning.

First steps for South Africa

So, one of the motivators is certainly going to be international pressure. If the US does adopt a target, South Africa will have to follow that route. What this means is that the South African government will have to anticipate a reality far in the future, and plan accordingly. Divining the eventual outcome of international negotiations that have never been easy is tough in itself, but much worse

SOUTH AFRICA DID US PROUD AT THE CONFERENCE IN BALI

At the UN Climate Change Conference in Bali in December 2007, South Africa and Brazil played leading roles, stating their readiness to begin negotiations on greater actions for themselves. They also presented specific ideas in many areas of how the negotiations could be shaped. The Indian position also evolved from one of full-on opposition to negotiations for developing country mitigation, to one of acceptance and agreement. On the final Saturday, the South African Minister made it clear that developing countries were ready to move, and that they expected the US to take on its responsibility as well.[D,8]

would be, at great expense, to create a South Africa that is obsolete in the face of a carbon constraint. We would become a country of stranded assets.

A second motivator is the firming of the scientific evidence. There are still those who make it their (anecdotal) daily business to remind us that the ice is thickening in Moldova and that sunspots or Earth wobbles are the real cause, but, frankly, this is now seen as lunatic fringe stuff, and should be blamed on the media obsessed with giving airspace to the "opposing view" (even if that is from the flat Earth society!).

Let us turn to the domestic situation, and examine motivators there. We are a country preoccupied with conspicuous consumption. The rich are consuming furiously. The poor, in contrast, are agitating for better services, housing and energy. Are South Africans worried about climate change? This is far from anyone's mind. So the voters aren't exactly concerned. They will not, as has happened in Australia, put pressure on government until we experience a crippling climate-related catastrophe, such as the widespread drought that occured in Australia. As the energy crisis deepens in early 2008, most South Africans are merely concerned with the provision of a constant and reliable electricity supply, and not much has been said to link the crisis to our emissions.

In contrast, business is beginning to take notice. Unlike the individual energy user, who, if he has it, wants it all the time, industry must look at larger, more long-term solutions. Power supply is far more important to big and small business than pure convenience. Business is calling for solutions. And it is beginning to call on government to work with it to solve *both* problems: energy and climate change. The trick now is for government and the business sector to link the two properly.

So where is government on this?

D. See Jennifer Morgan's paper at *http://www.e3g.org/index.php/programmes/climate-articles/towards-a-new-global-climate-deal/*

On the climate change front, South Africa's government's work in the Department of Environment and Tourism (DEAT) is extraordinary. Its role in the international arena is laudable. The 2008 Budget is spearheading alignment. The Department of Science and Technology is applying vigour to the issues of research and technology. But where the three crunch issues arise, in industrial policy, energy generation and transport, the sense of alignment with climate change objectives is missing. The Department of Trade and Industry's strategy to lure energy-intensive industries to SA, and the continued centralisation of energy generation in SA are two examples of this.

DEAT has led on the issue of climate change and has reacted in a number of ways: first, by taking a leadership and bridge-building role at the international negotiations; second, by measuring, researching and assessing the local problem; and third, by starting to look at options.

South Africa is currently setting up its inventory of greenhouse gas emissions, a process that is critical for all our future plans. This entails getting an exact picture of the sources and quantities of our greenhouse gas emissions, year on year.

The cabinet-driven Long Term Mitigation Scenario (LTMS) planning study is the largest government programme of its sort currently under way. Set up to consider the massive challenge of climate change mitigation, it also makes reference to the challenges of adaptation. The LTMS focuses on two things: the scale of the emissions mitigation challenge, and its cost/benefit to the economy. This process uses advanced modelling programmes to determine our emissions profile over the next 40 years, given the growing population and our growth and development targets. This research shows that eventually our emissions will quadruple over current emissions if left unconstrained, and, if driven by a successful economy, will be able to meet its energy needs (based on AsgiSA). Of course, our real emissions may fall below this "business as usual" scenario, and early 2008 already saw a markedly different reality to the model. According to climate change scientists, we can contrast the business as usual/no constraints path with what we actually need – a scenario in which emissions drop 30% to 40% of current emissions. This exposes the size of the challenge, followed by suggestions in the stakeholder-driven LTMS research for the possible actions that could close the gap.

The LTMS process will be completed by mid-2008. It is aimed at assisting government negotiators in the 2008 and 2009 climate negotiations, as well as informing South African stakeholders on our outlook for climate change, and will start the policy building process.

It has already been reported[9] that the growth-without-constraints scenario is not tenable or viable as a policy option for South Africa, and that both government and the business leaders who met under the LTMS process in late 2007 are committed to the target set, in the long term, by science. This is extremely encouraging, and appears to be the first step in setting a comprehensive climate change policy for South Africa. See *Chapter 14: You the civil society organisation* for proposed LTMS policy objectives.

Put simply, this government will, in the long run, stand or fall by the success or failure it brings to this issue.

The work by the DEAT and the environment ministry has been a great start to the overall strategy. The 2008 budget begins to build on this work. The LTMS and inventory underline the principle of "measure and understand first", and the approach taken in Bali is on the button. It essentially declares that South Africa will take up its share of the burden of mitigating global emissions. So, what is the next step? This is where things don't look so clear.

Without intending to, the LTMS results arrived in the middle of a deepening crisis: the energy predicament currently afflicting South Africa. Depending on which way you look at it, this ongoing event, which can only be described as a great example of some appallingly poor planning, is either critical (we can't build the coal or nuclear power plants fast enough to catch up with the growing demand) or an opportunity (save on demand aggressively, and start by thinking clearly).

Commitment and leadership

While the first steps are good ones, the overall planning of the South African economy is not yet fully aligned and the true leadership challenge has not yet been articulated. The overall goal (which the president should state to the nation) is simple: we will develop a plan that provides our economy with sufficient energy to promote growth, incentivises aggressive demand-side reduction, and, at the same time, sets us on a trajectory to reduce our emissions by around 30% by 2050, hence avoiding the creation of stranded assets. An alignment between the treasury, Eskom, DME, DPE and DEAT on this fundamental goal should be evident, as it must be pursued vigorously. And the full set of policies, from aggressive promotion of energy efficiency to extensive incentivisation of the privatised generation of renewable energy and co-generation, must be a co-developed plan between government and energy stakeholders. The mix of electricity generation between coal, nuclear and renewables should be stated clearly and planned so as to set up an emissions trajectory that peaks in 2025 and declines to -30% in 2050. Finally, it must be recognised that we have two years to plan and describe this national agenda (or at least make a good start): 2008 and 2009. This is because by 2009 we will, as a country, need to make some kind of greenhouse gas commitment to the world community, and we should only do so if we have confidence in our domestic ability to deliver on such a commitment.

Tall order? Yes certainly. This is by far the biggest challenge faced by the current government. Put simply, it will stand or fall by the success or failure it brings to this issue, so central is government to our economy, our society and our standing and

CLIMATE CHANGE IS IN EVERY DEPARTMENT'S DOMAIN

Climate change is about two issues: reducing emissions, and coping with the impacts that are increasingly being felt. These issues affect all departments in government. Here are some examples:

- Famine, waterborne diseases and malaria will spread, and the Department of Health will need to have plans to deal with escalating public health issues.
- The Department of Home Affairs will see climate refugees streaming in from the north, as drought makes life unbearable there.
- The Department of Housing must consider huge energy-efficiency steps in housing provision, and Transport has a particularly large challenge in totally redefining both the reasons for and the way we move, and the technologies to facilitate both.
- The Department of Minerals and Energy has the greatest responsibility – to provide carbon-free electricity to the nation, and to decentralise energy and the grid so that the market can take up opportunities currently held by one utility.
- Science and Technology will have to lead in promoting the various technologies that will be central to the post-carbon economy. It will also need to promote the development of the science that underpins this, and the capacity of our nation to deliver these technologies at scale and at pace.
- The National Treasury must provide the budget and financial mechanisms, such as subsidies and taxes, for all of these plans.
- The Department of Agriculture will have to consider the changes in rainfall patterns predicted for South Africa and adapt crops and practices accordingly.
- The Department of Education must consider climate change as part of the school curriculum, and business will have to go back to school on this issue too.
- The Department of Communications will have to ensure that broadband and the Internet become a preferred alternative to human movement and communication.
- The Department of Trade and Industry's policies will have to be "climate proof" and will have to prepare the economy for a new direction away from heavy energy use.
- The Department of Water Affairs will need to prepare for shifts in availability of fresh water.

The departmental efforts will have to be coordinated as part of a plan that will reach the emissions reductions that have been agreed, as well as build robustness in the face of climate impacts. This coordination will become cardinal.

Leaving the issue of climate change entirely within the remit of the Department of Environmental Affairs and Tourism will be a big mistake, although its current preparatory work is excellent. Climate change is not a purely environmental issue.

Coordination of the climate plan is a meta-departmental matter and will require its own ministry or be a matter within the Presidency. Our president must place this issue among the five greatest challenges that demand our attention as a nation.

performance in the world arena.

The future climate change strategy for our country will perhaps be the most controversial ever, and may become a veritable battleground of interests. The scale of the challenge on one hand, faced with the interests of emitters on the other, are potentially on a direct collision course. Look at the figures: South Africa currently produces around 440 megatonnes of CO_2 each year. It will probably see these emissions doubling by around 2025 if it meets its demand with coal and petrol. Then comes the full challenge: the emissions will have to plateau around this point, and then decline by 500 or so megatonnes over the next 25 years, arriving at around 380 megatonnes by 2050. Pulling this off will require a extraordinarily clever mixture of policy packages – from government-driven action to taxes and incentives, from carbon trading to domestic allocations – aggressively introduced by a government and totally supported by the large corporates and other emitters. When one considers that with no coal whatsoever in the system by 2050 – unless its emissions are totally captured and stored effectively – we only reach across half the gap, one rapidly realises how large the challenge is. This is indeed about leadership, alignment and total commitment.

Our government needs us to roll up our sleeves, and gear our country up for the biggest revolution we have ever imagined, one that re-invents the way we produce, consume and live, and consider our place in the world. That is the level of commitment needed. It needs to turn the current energy crisis into a virtue and an opportunity.

The three fronts

Adaptation

This apparently simple term has been ruffled up so much that most of us still don't know exactly what it means, at least technically. In its simplest and possibly best form, adaptation comprises two types of activities. One is the "resilience" action, which helps us to cope better with the potentially damaging effects of extreme climatic events, and the other is "acclimation" actions, which are strategies to cope with the more gradual changes that scientific modelling show to be imminent.

In South Africa, both these activities will have to be driven, to a large extent, by government, and will mostly be concerned with the management of one thing, water. The government will have to consider carefully, for example:

- Acclimation actions needed for the predicted rise in sea level (there is a large range in these predictions). Rising ocean levels may, in 100 years or more, affect low-lying and densely populated areas of the Western Cape, as well as our national harbours.
- Acclimation actions needed to harvest, store and recycle water far more efficiently in those areas that will become more water stressed, such as the central and western areas.
- Resilience actions in the case of communities in semi-desert areas of the southern Cape, where more extreme forms of flooding are likely to occur.

And so on. These actions are both about policy and strategy development and about prohibitions on building in areas prone to flooding, or excessive development where water is scarce. Many adaptation issues are local and practical, and require financial resources and an enormous amount of know-how and skills. Hence, local government will have to build the capacity to take on the climate challenge. Efforts are being made to create international adaptation funds and the rules to access them, but, frankly, these are going to be dwarfed by the extent of the impact of climate change. The best approach is to plan, plan and plan ahead and take concerted action. We have good science in this country, a good sense of what impacts await us, and some branches of government, such as the Western Cape provincial government, are moving ahead well under some inspired leadership.[10]

How much adaptation will South Africa have to undertake, or, seen another way, how big is the challenge facing our government? We need to study this in greater detail. We need to know, in the face of different global emissions scenarios, what the climate impacts for South Africa will be, and what the costs of dealing with these impacts are. In a sense, much like the mitigation scenarios research, we now need to consider the adaptation scenarios. For one thing, we need to match the *cost of action against the possible costs of inaction*.

Adaptation is really a close collaboration between the research community[E] and *all* arms of government and needs to start involving communities and businesses.

> Our government has been very slow in dealing aggressively with carbon efficiency.

By all accounts, we as a country have the tools required for this collaboration, and the intent is certainly there.

The issue of adaptation, the response to the impacts of climate change, is also a complex diplomatic one. This is simply because climate change impacts felt by South Africa in the present and future are predominantly *not* as a result of our own emissions. We have to persuade the world to reduce its emissions in order to minimise the impacts we will feel, and, in order to justify that demand, we too, will have to mitigate our emissions – this is the to and fro of diplomacy that will have to play itself out, and this is the real link between our adaptation and our mitigation.[F]

Mitigation

We have already seen that adapting on its own is like sticking your fingers in a leaking dyke: when the 11th hole appears, you are in trouble. We have to go to the cause,

E. See *www.sanbi.org/frames/gcrg.htm* for some examples.
F. Some useful material can be found at *www.wwf.org.za/what_we_do/climate_change/*

MOVING TO THE POST-CARBON ECONOMY IN SOUTH AFRICA

In the longer run, perhaps the biggest challenge for our government is not so much the promoting of energy efficiency through policies, taxes and incentives (all of which are now on the cards), ensuring a coordinated energy strategy with a sufficient supply of low-carbon energy supply (as it is we are woefully behind on renewable energy), and running a coordinated adaptation programme. The biggest challenge for South Africa may well be acknowledging that the emissions-reduction target that science requires by 2050 will require a fundamental change in the economy. Currently, the country's economy is based on mining and resources, and many jobs and taxes depend on those sectors. In the 2008 budget, the Finance Minister had the following to say:

"We have an opportunity over the decade ahead to shift the structure of our economy towards greater energy efficiency, and more responsible use of our natural resources and relevant resource-based knowledge and expertise. Our economic growth over the next decade and beyond cannot be built on the same principles and technologies, energy systems and transport modes that we are familiar with today. Over the longer term, the shift towards a more energy-efficient economy will be positive for employment creation ..."

What is this "new economy" and do we stand a chance of playing a part in it? Well, certainly not at the moment. We still have leaders that have no confidence in any economy other than the current extractive one, but more importantly, the post-carbon economy will need human capacity levels that are currently beyond us. There seem to be two roads to the post-carbon economy: a simplified, rural and less consumptive one (such as that of Cuba), or a high-technology one (such as is practised in Scandinavian countries). If we are committed to the high-technology route, we need to recognise our targets. First, there will need to be *no* coal in the power system (from 97% today) by 2050, unless its emissions can be captured. Second, liquid fuel usage will have to be reduced significantly unless it is fuel produced from coal with all emissions stored. Put quite simply, at the centralised level, we will have to rely on an energy system that is vastly different from the one we have today. Will we see nuclear and renewables only? Probably.

In addition, the South African grid will have to be decentralised, with all South Africans being both producers and consumers of power. Micro-production of power (starting with solar water-heaters and moving on to the likes of thin-film PV panels) will be the norm, and will be backed by a more efficient demand and a sophisticated grid. Of course, the micro solutions, such as more efficient computers will play a greater role, but it's in the big emissions departments that the real breakthroughs will be needed: energy supply and human movement. In the first, renewable technologies as well as nuclear (if you are not opposed to the latter) are the current answers. The development of human capacity to build and run the power stations of the future, as well as vastly more efficient grids and distribution systems, will yield thousands of new jobs and skills. Carbon capture and storage (if feasible) will help to keep coal in the system, and is all-important. Clip-on pebble-bed modular reactors may also provide local solutions for power-hungry applications, as long as the objections to nuclear energy are allayed, and the technology proves to be affordable. In the area of human movement, it is necessary to design and develop efficient electric or hybrid vehicles that will convey us on roads, and to develop mass transport systems that will keep us off them!

The LTMS process identified four interventions for the post-carbon economy: new resources (gas, waves, etc.); new technologies (research and development budgets needed); human behaviour changes (such as having two time zones); and the new economy itself, which sees GDP coming increasingly from-low carbon activities. Now all we need is the leadership to get us there.

Here's a simple example: a solar water-heater on every new house would hardly dent the property development market, installation would create lots of jobs, and the units would save tonnes of CO_2 (about two to five tonnes per home, depending on their size). Yet we are only now seeing the first steps towards this goal. We could avoid the construction of a coal power station if we installed solar water-heaters on a large scale. Our government has been very slow in dealing aggressively with carbon efficiency. This has changed in 2008, but hardly by intention. The pace of the introduction of efficiency drivers, both through policy and enforcement, and with incentives, needs drastic acceleration.

Transport (cars, trains and buses and so on) is the next big challenge. A major emission mitigation plan will have to be driven by government, a plan whose complexity will range from emissions taxes through to the delivery of better public transport and the applications of massive new transport technologies.

Switching the energy source required to power our economy is the big daddy of mitigation, and gets us right into the heart of the coal/nuclear/renewables debate. Some may want to solve the problem with renewables. We have a lot of sun and new technologies in solar energy are looking very promising, but there are problems. Nuclear has its adherents and its detractors. Coal will be around for some time, and can be burnt more efficiently, but it can never be "clean" unless fully captured and stored. So what is a government to do in the face of an energy-demanding nation?

As was pointed out earlier in this chapter, the first duty is to disabuse South Africa of the notion that a bit of efficiency and a few modest targets are going to do the trick. The South African government must recognise the post-carbon economy that will doubtless be firmly in place by mid-century, and start retooling the energy supply for it right away.

New technologies and clean electricity alone may be dwarfed by our own lifestyle changes. The methods our government can use to regulate or incentivise social practices may reveal ways to create huge emission reductions. The government could

simply help people to want less, and to support local business and industry. It can regulate banks, which extend credit that drives consumerism, which is not climate friendly. Internet shopping and video-conferencing save carbon, so government could control telecommunications operators who uphold expensive Internet connections. It can re-organise the way we trade and buy, move and sleep (yes, a time difference may have a energy-saving effect). These forms of social policy formulation need much further investigation.

The mitigation challenge facing South Africa is to get three areas to coalesce into a coherent vision if the country is to succeed in formulating and implementing a plan of action that is economically risk-averse and internationally aligned to the world effort on climate change. These are:

- Identifying and deploying, at scale, appropriate technologies, and removing the physical and capacity barriers to this deployment.
- Determining the investments required, pinpointing the sources, mechanisms and quantum required.

WHAT IS THE SA GOVERNMENT DOING ABOUT CLIMATE CHANGE?

On the international front, South Africa has a well-resourced and top-rate negotiation team that attends and is integral to numerous international meetings, most of which culminate in the UN Framework Convention on Climate Change annual meeting. The respected South African delegation, which was instrumental in dragging the US to the table in Bali, has its work cut out leading to the all-important 2009 Copenhagen event.

On the domestic front, there are some national policies, such as the Renewable Energy Targets and the Energy Efficiency Accord, that make some contribution to greenhouse gas reduction, but a really aligned and effective strategy is yet to be developed. The first steps in achieving this are under way and include:

- The Long Term Mitigation Scenario planning project, which is currently laying the foundations for a Climate Policy for South Africa, and will conclude its work in mid-2008, when it will set the trajectory and timeline for our emissions reductions by 2050.
- The South African Climate Policy process, which will see each government department and the various sectors translating the overall direction adopted in the LTMS process into sectoral targets and actions (this will be detailed and extensive work, where the word *alignment* will be most critical, and where government and industry sectors will be in deep dialogue.
- Inventory and reporting: the National Greenhouse Gas inventory is under development. It is critical as a yearly measurement of our real progress in reaching our ultimate reduction target.
- The National Climate Change Committee is a multi-party reporting and discussion forum that meets regularly and covers all the sectors
- South Africa is active in the Clean Development Mechanism and the government, through the designated national authority, assesses project applications for their contribution to the country's sustainable development.
- The responses to the energy crisis, although not overtly driven by climate change concerns, will in fact contribute through greater efficiency, demand-side management and austerity to emissions reductions: from this perspective the energy crisis is the best thing that could have happened to South Africa!
- On the adaptation front, excellent scientific work on climate impacts is being translated into government intervention: government has a response strategy and, although this will require continuous refinement as the science refines its knowledge on impacts, there is good effort so far on this issue.
- At a provincial level, excellent work is being done by certain provinces, notably the Western Cape.
- Cities are waking up to the climate change issue and, although just starting, are showing good initiative.

This is a commendable list of activities, but let us not deceive ourselves: government actions are just at the beginning of the road, and the deep commitment that is vital at leadership level simply has not arrived yet.

This is a presidential matter. It was heartening to see the 2008 budget approach the issue with vigour, but, so far, climate change is not an overt priority that is managed meta-departmentally through the presidency, which is where responsibility for this task should be vested.

- Fast-tracking the policy frameworks that will offer the most effective incentives for technology and capital providers.[11]

Government is concerned primarily with the third element, but has a major role in all three areas.

Response measures

As markets and other governments respond to climate change issues, they will have an impact on South Africa as well. Our government needs to understand and assess what the most important areas of response required by South African stakeholders will be. Climate change is about risk to the economy, and the anticipation of risk.

Without the people; with the people

We have pointed out that the consuming electorate seems to have little concern for climate change. This is especially true of the rich, who are all-consuming or invest without much, if any concern, for efficiencies. Clearly our government needs, like a

> People are hoping for a solution which is 'based on the principle of common but differentiated responsibilities' and 'strikes the delicate balance between globally inclusive action and the need to eradicate poverty'.
>
> *Ban Ki-moon, Secretary-General, United Nations addressing climate change negotiators in Bangkok, March 2008*

good doctor, to tell us to go to the gym and eat less fat. This is tough. It's tougher when you don't do that well with certain other critical messages. Any way you look at it, it's tricky to legislate for austerity. But it's also not really that difficult to invert the process: by avoiding the doom-and-gloom content of most climate messages and concentrating on the "what you should be doing" suggestions, government can cast its message as a bold and progressive one, and one that will be held with pride. We can become a climate change leader in the world. We won't crack all the riddles, but our nation can win the esteem of the world, and become one of the first post-carbon economies.

All this needs some marketing. South Africans must start to think about climate change in the way that people in Europe do. This applies to both rich, high-emitting South Africans and those who aspire to consume more, as well as to those who at all ends of the economic spectrum may be affected by the anticipated impacts of climate change. This includes all water and energy users. And it requires of government a clear and continuous communication campaign.

Climate change should be in the school curriculum, so that our children become motivated and inspire recalcitrant parents. The message, from the president to the teachers, should be that we have a plan, and although some of it is as yet unclear, we are en route. Our universities should be encouraged to throw resources at the new and promising technologies we will need, and integrate sustainability thinking into all educational streams, whether accounting or economics, political studies or urban planning.

In conclusion

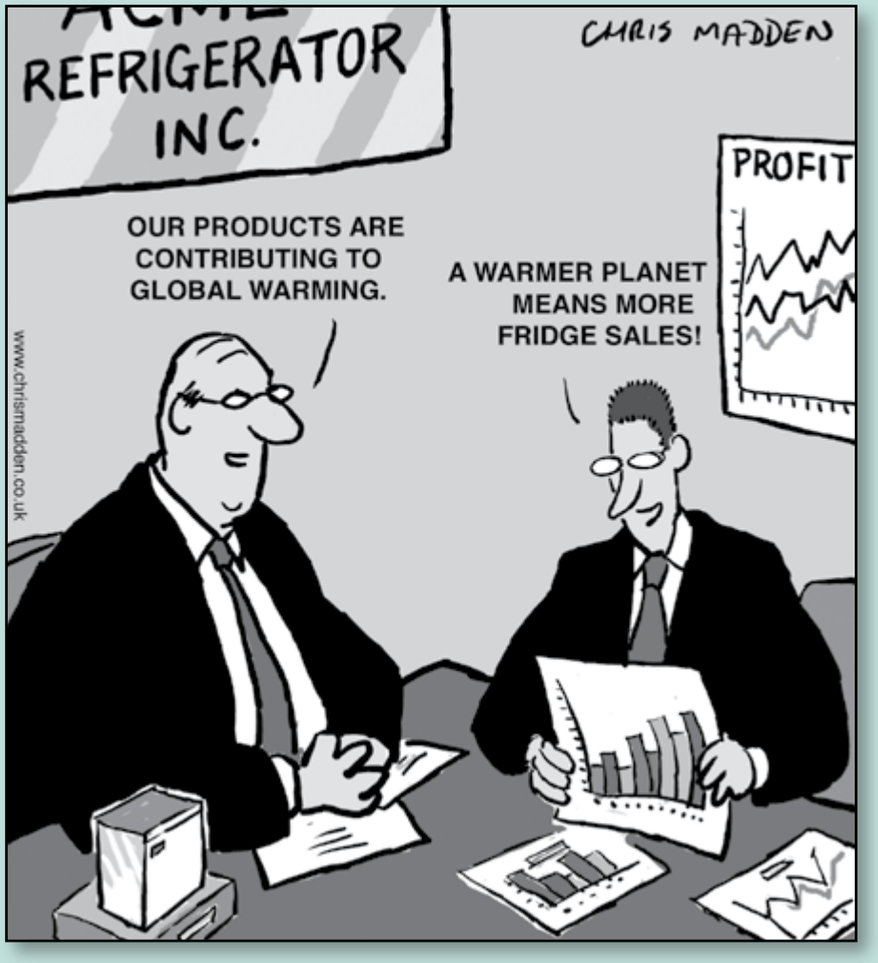
Those who argue that the market will solve climate change are on a hiding to nowhere: the market is driven by motivators who are antagonistic to climate change solutions, at least in the short term. The market will change in time, and there is much space for dialogues and deals between government and business to cooperate and debate the full nature of the solution and then chase it down with vigour. But the market will only change fundamentally if drivers from government and from consumers shift the focus from fossil fuels to low-carbon energy, and from inefficient operations with a high return to more modest, but sustainable, initiatives. Consumers, at least at this point in history, appear to inflate this market, unconcerned that their rate of consumption is unsustainable. They then have children,

whom they hope will have a happy life. This delectable naïveté is just the way we all are: hence the special custodial role that government must adopt.

Who knows, we may still see that we progress from the pessimism we feel when confronted with climate science to a new optimism. This optimism will stand on two shoulders: one will be our government's announcing that it has helped the international community to reach consensus on a meaningful agreement that will avoid catastrophic impacts of climate change; the other will be a domestic plan that motiates South Africans to create a new society with its prosperity based on a competitive post-carbon economy and values that are non-negotiable in their respect for the Earth on which we are so dependant.

Resources

i. Long Term Mitigation Scenario planning (LTMS); *www.erc.uct.ac.za*
ii. United Nations Framework Convention on Climate Change; *www.unfccc.int*
iii. Intergovernmental Panel on Climate Change; *www.ipcc.ch*
iv. Stern Review; *www.en.wikipedia.org/wiki/Stern_Review*
v. The Bali Roadmap; *www.unfccc.int/meetings/cop_13/items/4049.php*
vi. Indalo Yethu; South Africa's Environmental Campaign, can assist government departments with environmental initiatives; *www.indaloyethu.co.za*



...climate change represents the largest single environmental challenge this century. It will have an impact on all aspects of modern life. It is therefore a major issue for our customers and our staff, as well as for every organisation on the planet, no matter how large or how small.

Sir John Bond, Chairman HSBC Group (HSBC was the first major bank to go "carbon neutral")

12

You the business

Robert Zipplies

Climate change is contributing to a steady decline in the ecosystem services that underpin our economic and social wellbeing. With the growing imperative to de-carbonise the global economy, dramatic shifts in regulations and business and consumer behaviour are being witnessed. These will affect all businesses, irrespective of size, industry sector and location. To protect and grow profitability and shareholder value, businesses must manage the risk by dramatically reducing their emissions and other environmental impacts, adapting to climatic and socio-economic changes, and tapping into the emerging opportunities of the rapidly growing "green" market. Developing a response to climate change should be integrated in an overarching corporate sustainability strategy.

In 2005, when Lee Scott, the CEO of Wal-Mart, publicly committed the corporation to take on the challenges of the environment and climate change, the world listened. The world's largest corporation was saying it recognised its obligation to reduce its ecological footprint and "green" its supply-chain. Wal-Mart, with 1.8 million employees, 60 000 suppliers and more than 100 million weekly customers, has clout in changing mindsets and practices. Many major corporations are now rising to the challenge and we regularly hear about their ambitious environmental targets.

There simply is no escaping the effects of climate change. No matter where you are located or how large or small your business, the repercussions of climate change are certain to affect it eventually. It is leading to inexorable changes in our weather patterns and is contributing to a steady decline in the health of our ecosystems – our natural capital – which provide our economy with essential resources and services, such as arable land, fish stocks, stable weather patterns, biodiversity and tourism opportunities. See the sidebar on "Five capitals" in *Chapter 2: Healthy environments, healthy people*.

We too, as South Africans, now urgently need to de-carbonise and "green" our society. The drivers of business competitiveness evolve continuously and the "green revolution" is reshaping our global economic landscape profoundly. Driven by necessity, we are now shifting into a more circumspect phase of our economic development – the environmental age – where we seek to improve on our "take, make and throw away" practices of the industrial age and learn to live in balance with nature. South African businesses must be part of this process. As an economy, we have a dual challenge: to transform our society while, in parallel, embracing the environmental imperatives. Otherwise, in time, we will undermine our ability to compete in a de-carbonising global market-place and to finance the all-important transformation process.

> "If sustainability is to be achieved, we will have to rethink virtually all of our industrial processes"
>
> *Edgar S. Woolard, Former CEO of Du Pont*

Industry emissions

Rough estimates indicate that 70% to 80% of all global emissions, whether energy-related or not, are due to commercial activities of one form or another. There are, however, a handful of industries that are particularly heavy emitters – see diagram opposite. Globally it is estimated that industry is responsible for about 21% of all greenhouse gas emissions.[1] Note that electricity generation is excluded as an industry here. This figure includes direct CO_2 emissions from the combustion of fossil fuels (49%), indirect CO_2 emissions from electricity and heat usage (35%), and CO_2 and non-CO_2 emissions resulting from industrial processes (16%), such as the

manufacture of cement and some chemicals. The disproportionately large emitters tend to be chemicals and petrochemicals, cement, iron and steel, and the non-ferrous metals (e.g. aluminium) industries, with machinery, food and tobacco and paper, pulp and printing also being major contributors. (See also *Chapter 9: Taking on a fair share: the Goliath of Africa's emissions.*)

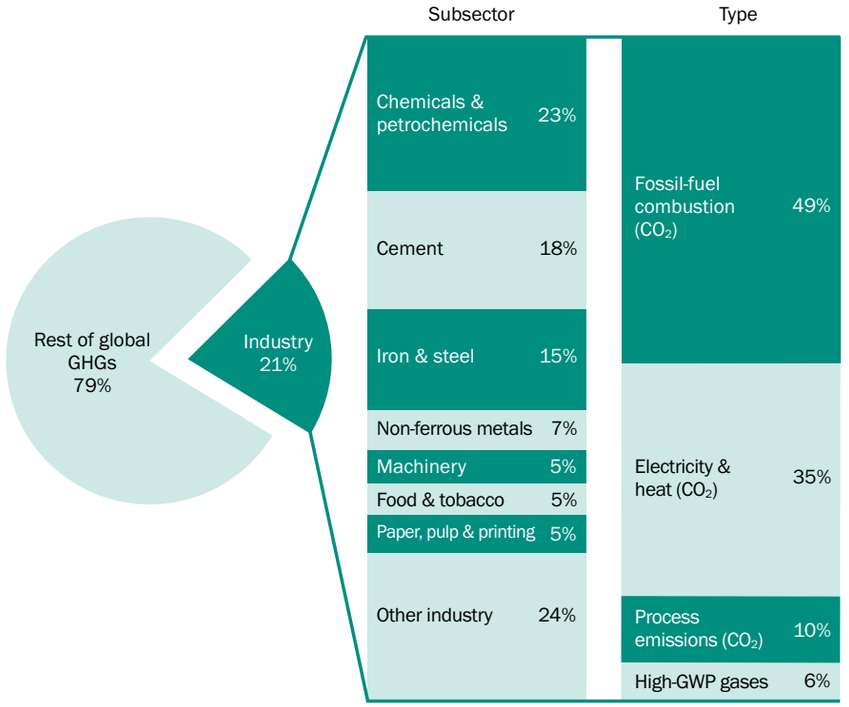


Figure 1: Greenhouse gas emissions from industry
Source: World Resources Institute. Navigating the Numbers. *www.wri.org*

While these industries have a major obligation to reduce their emissions, they are not the sole culprits. We are all users of their products. Every time we purchase a beverage can or make another addition to our homes, we stimulate the demand for steel, aluminium or cement. These industries are now under growing pressure to search out new technologies and they must collaborate with government to ensure appropriate incentives are put in place that encourage and reward investment in emission-reducing infrastructure.

Some industries are collaborating with each other to reduce emissions. An example is the International Aluminium Institute, which includes 26 member companies that are collectively responsible for 80% of global primary aluminium production. They have set themselves targets for reducing emissions.

THE GREATEST MARKET FAILURE

Our current economic system encourages companies, in their bid for profit maximisation, to push costs, where possible, onto others. This process of "externalisation" has become a liability for a society in which negative social and environmental impacts are borne by others, and may result in poor worker health and environmental pollution.

In his bestselling book, *The Corporation*, Joel Bakan discusses externalisation: "Throughout the economy today, the regulatory system often fails because of lax regulations and ineffective enforcement. Until that changes, we shall continue to suffer unnecessary disasters and harm to people, communities and the environment."

Progressively, this detrimental social and environmental passing of the buck is being "internalised" by regulation, enforcement and governance codes, and through investor, consumer, supplier and peer-group pressures. Corporations are held ever more accountable for all their impacts. In the US, for example, recent law suits have forced major American power companies to cut carbon emissions and motor manufacturers to improve fuel efficiencies.

Towards a sustainable economy

A business's mandate is to create an attractive return for shareholders, without which business-viability is threatened. To ensure competitiveness, good business practice thus encourages regular evaluation and fine-tuning of operational strategies.

While climate change was first identified as an environmental and economic risk many decades ago, it was long suppressed by powerful lobbyists with vested interests. This has changed, and environmental considerations are becoming integral to assessing business and investment risk, and its flip-side, new business opportunities. Organisations such as the Global Reporting Initiative, FTSE4Good and JSE's Socially Responsible Investment Index, and a growing number of fund managers, are including climate change and other environmental performance indicators in their assessments of business performance. In response, visionary leaders, in a bid to protect and grow business value, are starting to realign their business strategies to the changing economic reality.

The UK-commissioned Stern Report[2] calls climate change "the greatest market failure ever witnessed" and points out that global economic growth is fundamentally unsustainable (see box, above). The report, which is a comprehensive economic assessment of climate change by the UK Treasury, indicates that the benefits of early action considerably outweigh the costs and that the cost of curbing emissions would be around 1% of world GDP, while unabated climate change could cost the world more than 20% of GDP.

We are now on the cusp of a period of fundamental, global economic change. The governments of developed nations are already implementing carbon-limiting policies, such as the pricing of carbon through trading schemes and taxes, technology policies and energy-efficiency measures. The major developing nations are expected to follow suit. South Africa, given its size and growth status, is a disproportionately high emitter of greenhouse gases. In response, our cabinet is conducting ongoing climate change scenario planning processes to determine the repercussions for the country and the best possible regulatory actions. (See *Chapter 11: Your government, our government*.)

Investors, who see carbon emissions as a growing liability, are starting to use a variety of mechanisms, such as the Carbon Disclosure Project (see box, below), the Equator Principles and the United Nations Environment Programme Finance Initiative, to compel companies to report their carbon footprint and to indicate how they are managing emission-related risks.

Internationally, corporate support to tackle climate change is growing apace. Early in 2007, some 90 major international corporations and organisations, including Air France, Citigroup, Eskom and General Electric, issued a joint statement[3] that called on all governments to set ambitious targets to reduce greenhouse gas emissions and to drive energy efficiency. They called climate change "an urgent problem that requires global action".

THE CARBON DISCLOSURE PROJECT COMES TO AFRICA

In a bid to manage their investment risk better, some 300-plus institutional investors, representing over US$41-trillion funds under management, have, since 2002 examined the emissions and climate change risks, opportunities and response strategies of the major corporations in which they invest. In 2007, the CDP was extended to include the JSE's top 40 businesses. It was found that South African corporations need to play catch-up in reporting their CO_2 emissions and setting emissions management targets. The 2008 CDP was expanded to include the JSE's top 100.

Change is sweeping across boardrooms, with corporations such as Tesco, General Electric, News Corporation and Wal-Mart now regularly announcing ambitious adaptation and mitigation strategies. Not only are they reducing the emission of greenhouse gases, they are also addressing many related issues, such as water consumption, resource usage and packaging. These initiatives are driven by consumer and investor pressure as well as a desire to protect and grow business value by venturing into new business territory, offering new services, stimulating innovation, motivating employees and growing the customer base. How will such practices affect South Africa's business sector and government as the repercussions ripple through the global economy?

What are the implications for your business?

No business is likely to be exempt from the weather-related impacts of climate change. Nor will businesses be able to evade the response measures adopted by countries, industry sectors and commerce who, in turn, will place pressure on other enterprises to reduce their emissions. The National Business Initiative states that climate change "... is now recognised as a serious threat which could have significantly adverse effects on the competitiveness and effectiveness of South African business". The nature of the impacts on businesses will depend on their size, location, industry sector, supply chain characteristics, energy consumption profile, and investor, customer and supplier pressures.

Physical impacts

While the severity and timing of physical impacts are uncertain, there will be an escalation in temperatures, severe storms, drought, floods, sea-level rises and an ongoing deterioration in the ability of our interconnected ecosystems to provide the services necessary to our economic health. The sectors most likely to be affected include agriculture, fisheries, forestry, health care, insurance, real estate and tourism, "because of their dependence on the physical environment, human health, water and weather – all are directly affected by climate change".[4] Some of these industries are already starting to feel the financial pain of shifting weather patterns and deteriorating ecosystems.

The global insurance industry, having witnessed significant increases in weather-related losses and claims, has responded by beefing up exclusions and, in some cases, has ceased insurance in high-risk areas.[5] Insurers are also introducing policies aimed at encouraging sustainable behaviour. An example is Allianz AG's Fireman's Fund, which aims to promote the development of energy-saving and emission-reducing "green" buildings; another includes "pay-as-you-drive" insurance, which allows car owners who drive less to save on vehicle insurance.[6]

Agricultural sectors, too, are feeling the financial pain. An above-average rise in temperature in the Western Cape during the past four decades is already undermining the quality of crop for some soft-fruit farmers.[7] Here, the shrinking wheat footprint is linked to changing weather patterns, and potato and rooibos crops have been identified as the most vulnerable to the changing trends. How will this affect downstream business sectors, such as food processors, retailers and restaurants, which are dependent on consistent agricultural supplies?

The impact of changing market dynamics

As the climate change issue works its way up corporate and political agendas, mitigation and adaptation response measures are being implemented by governments and businesses. The measures may include new regulations, reputation and litigation issues, and supply-chain pressures, and may be regional, national, international or industry-sector specific. Businesses must evaluate the repercussions particular

to their operations and trading relationships. Most at risk in the short-term tend to be those causing high emissions (e.g. mining, heavy industry and power utilities). However, those with lower environmental impacts are not exempt, and are increasingly assessed on their spheres of influence or ability, through the use of their products and services, to encourage mitigation and adaptation behaviour in others.

Regulatory pressure

Many national and regional governments, typically in developed countries, are now implementing or debating policy mechanisms for reducing greenhouse gas emissions. This may take the form of higher taxes on fossil fuels or emission trading (cap-and-trade), energy-efficiency standards or policies to ensure use of cleaner technologies. All of these measures serve to put a price on carbon emissions, thus reducing fossil fuel consumption. While these mechanisms will affect the carbon-intensive industries such as mining, oil and gas, heavy industry and technology the most, all businesses are likely to feel the effects as the costs ripple through all economic sectors, threatening profit margins. To date, South Africa does not have regulations to limit carbon emissions at a broad level, but we are likely to see these emerge soon at local and national levels.

Reputation and litigation pressure

Awareness is growing among corporations and consumers about social and environmental issues, such as climate change. Local[8] and international surveys indicate that consumers expect companies to do more for society and the environment, and that they spend their money with those that do.

Individual companies and industry representative organisations, such as the World Business Council for Sustainable Development, are exerting pressure on their peers to improve their levels of corporate citizenship. A well-known example is the Responsible Care Global Charter, which encourages continual health, safety and environmental improvements in the world's chemical industry. More recently, a number of international banks, despite their relatively low social and environmental impacts, launched the Equator Principles, a set of voluntary guidelines to be followed by members of the banking community wanting to invest in or finance projects that meet specific social and environmental requirements. The Principles are now applied to approximately 80% of global project lending. While there has been some criticism that the guidlines do not sufficiently address climate change, project exposure to physical climate risk and energy intensity is being assessed.

Ignoring these shifting imperatives has and will continue to lead to the risk of litigation by stakeholders. In the US, five major power companies are facing a lawsuit filed by eight states and New York City demanding that they cut their greenhouse gas emissions. California has sued six car manufacturers for damages because of their contribution to the damage of the state's weather, public health and economy.

Supply-chain pressures

Voluntary corporate governance codes, such as the King Report, sustainability indices, such as the JSE SRI Index, and the Global Reporting Initiative are placing pressure on companies to use their influence to improve the social and environmental behaviour of their suppliers and distributors. Two major UK retailers, Marks & Spencer and Tesco, recently announced their intention to "carbon label" products, thus indicating the greenhouse gas emissions that result from the production, transport and consumption of the item. This will help consumers to make climate-sensitive purchasing choices and is likely to have profound consequences for many suppliers, especially those that supply foods with a high embodied-energy content, which indicates the energy required to produce and distribute the food. Some local retailers are considering similar initiatives. Will it soon be seen as a luxury to consume imported foods? How will this affect our import and export industries? Will they need to demonstrate that they are able to produce and supply their products energy-competitively?

Opportunities abound

Climate change must not only be viewed with anxiety and pessimism. As with any sweeping changes, there are always opportunities for business growth and an entire universe of new ideas and technologies is awaiting development. These products and services will typically assist others to consume less electricity and coal, gas and liquid fuels. Sales of low-energy and low-impact products and services are likely to mushroom as regulations and customer awareness drive demand. Visionary companies will adapt their operations and business models, help educate their consumers about responsible purchasing behaviour and work with governments to develop regulatory mechanisms suitable to stimulate corporate activity to produce low-impact offerings and enter new markets.

Venture capitalists around the world are recognising the potential for good returns and have started tapping into the burgeoning green market. One of its most famous protagonists, John Doerr, who backed companies like Google and Amazon, calls the emerging demand for sustainable technologies the "mother of all markets".

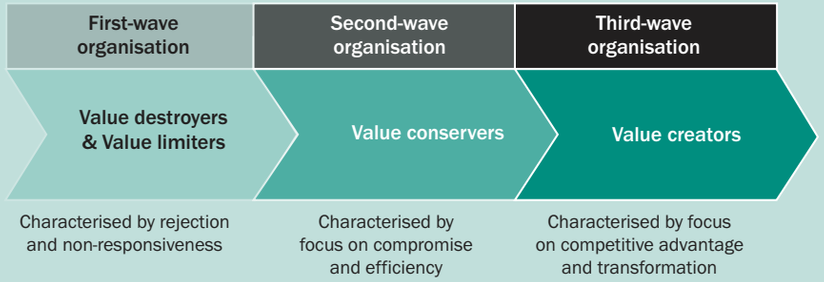
De-carbonising operations are already allowing companies to set themselves apart and strengthen their brand, employee loyalty and customer relationships. New markets are evolving, centred principally on low-emission and emission-reducing technologies, as well as those that offer protection against climatic changes. The financial institution Citigroup Investment Research has published a study identifying 74 companies in 21 industries that are likely to profit from climate change-related strategies.[9] A report by Lehman Brothers states: "The firms that will prosper in a climate-changed world will ... be those that are early to recognise its importance and its inexorability; foresee at least some of the implications for their industry; and take appropriate steps well in advance".[10] Success in the environmental age will depend on a company's ability to develop business models that help protect natural resources.

Software and communication technology providers who, for example, offer state-of-the art video-conferencing and connectivity services that reduce the need for physical travel are likely to see an increase in demand. Are we soon to see convention centres marketing themselves not only as attractive physical venues, but

Clean-tech investment outstrips opportunities

Analysis by New Energy Finance estimates that US$18.1-billion of venture capital was invested in clean technology in 2006, a 67% increase over the previous year.

WHERE ON THE SUSTAINABILITY SPECTRUM ARE YOU?



The sustainability spectrum

Adapted from "To whose profit? Building a Business Case for Sustainability"; WWF; 2004.

- *Value destroyers and value limiters* are companies opposed to or ignorant of climate change and broader sustainability issues and are, as a result, non-responsive and risk destroying or limiting value.
- *Value conservers* include the majority of companies. They tend to manage risk, cost and reputation issues by focusing on compliance and efficiency activities.
- *Value creators* are those that proactively focus on new sources of business value, by developing processes, products and services that are ecologically and socially sound.

The very ethos of corporate citizenship dictates moving beyond the sphere of influence in the workplace and focusing on the creation of a better social, environmental and economic reality for all stakeholders. However, it is a rare breed of company that is able to maintain the stream of enthusiasm and innovation required to contribute consistently to society at all levels.

It does not come as a surprise that companies with the longest life expectancy tend to be those that show a sensitivity to the world around them, an ability to learn and adapt, a tolerance of new ideas and approaches and a strong sense of cohesion and company identity. Many long-lived companies have changed business focus entirely at least once, and we are likely to see quite a few similar corporate changes in the coming decades.

also as those with the most advanced technologies that allow speakers and listeners to attend virtually?

In addition, businesses that contribute significantly to greenhouse gas emissions, whether through the direct or indirect burning of fossil fuels or other industrial processes, can seek financing for emission reduction programmes as part of the Kyoto Protocol's Cleaner Development Mechanism, or CDM. (See *Chapter 25: Carbon revenues for Africa*.)

How should your business respond?

Business response to climate change should depend on the nature and timing of the physical and non-physical impacts relevant to each enterprise, and will be further influenced by corporate values and strategic objectives. Climate change issues are deeply interrelated with broader social, environmental and economic aspects and, for this reason, a response strategy must be integrated with the organisation's overall sustainable development strategy. Three response categories need to be considered in order to protect business value.

A SIGN OF REGULATIONS TO COME

In Europe, product take-back legislation is gradually being enforced, requiring manufacturers to take back used products for recycling. Motor-car manufacturers are expected to have to recycle 85% or more of their vehicles by 2015.

a. Mitigating emissions – a source of carbon assets

Mitigation necessitates the reduction of an organisation's carbon emissions and overall ecological footprint. All businesses, irrespective of emission levels, are likely to be urged to demonstrate emission reductions within their own operations and those of their supply and distribution chains. Pressure will come through increased resource costs, regulations and stakeholder influence.

Mitigation can be achieved by reducing energy-intensive inputs and waste; implementing efficiency programmes; redesigning operations and using new technologies and alternative inputs; product life-cycle analysis; applying "cradle-to-cradle" or "waste equals food" thinking; purchasing "green energy" (such as wind-generated electricity); and, as a last resort, carbon offsetting.

Carbon-reduction initiatives will result in the creation of business value through enhanced operational efficiencies and may possibly lead to lower costs or the ability to trade emission credits. Greening a business will also help to raise employee motivation and customer loyalty.

Businesses committing to significant capital investments must assess whether their planned investments will entrench their outdated high-emission infrastructure, compromising their ability to compete in a greener market, or whether their investments can be altered to assist in decarbonising their businesses, thus adding

long-term value. Commercial and residential buildings, for example, can be built in such a way that they require less energy and water to operate – see *Chapter 16: You the architect amd property developer*. Such "green" buildings will lease and sell at a premium.

b. Adaptation to a changing climate

Changes to the physical climate are already a reality and the rate of change is likely to escalate. Organisations need to understand how climate change will affect their physical assets, markets, operations, supply chains, and how they should respond to each of these impacts.

In southern Africa, we are likely to face growing water shortages, more extreme weather events, higher temperatures and an expansion of vector-borne diseases, such as malaria, leading to a rise in health problems, which may affect companies through high levels of illness in the workforce. Ongoing research will provide more clarity on the nature, severity and timing of climatic events and how these are likely to affect industry.

> "Tackling carbon exposure is more than good environmental stewardship; it could also protect a company's share price in the near term and create a long-term competitive advantage."
>
> *McKinsey Quarterly, 2004, Number 4*

c. Responding to changing market dynamics

Companies will feel the repercussions of response measures adopted by governments, businesses and consumers. These may include new local or international government regulations, industry guidelines, revised standards set by trading partners and changing consumer purchasing habits. The nature of these measures will change repeatedly as we gain a better understanding of the impacts of climate change on our economy and as response measures are implemented, tested and adapted. Carbon labelling of products by UK retailers may have an impact on foods exported from Africa. International tourism and travel may be affected by escalating flight prices, due to carbon taxes and fuel price increases, and a growing reticence to fly. This will – sooner or later – have an impact on the aviation and tourism industries.

What are some progressive overseas corporations doing?

A growing number of corporations, such as Wal-Mart, Tesco and General Electric, are among the early movers in committing to green strategies and have set themselves targets for reducing their greenhouse gas emissions. They are not only doing this to manage risk, but also because they see the competitive advantage of providing low-impact products and services and thus building value.

- General Electric's Ecomagination campaign seeks not only to grow revenue streams from green technologies, but also to encourage its businesses to reduce their own carbon footprints.
- The retail bank HSBC expects to attract new customers by positioning itself as a leading green bank by having gone "carbon neutral", which means it strives to reduce its carbon emissions and offset the remainder.
- Tesco, the UK's biggest supermarket chain, has committed to providing products with carbon labels, which will help environmentally conscious customers to select products based on the carbon emissions created during production and distribution. Tesco has also committed to halving energy use across its stores by 2008, by optimising their processes, using more efficient equipment and purchasing green energy.
- The UK retailer Marks & Spencer has committed to become carbon neutral by 2012 and plans to cease sending waste to landfill, by recycling and composting, doubling the amount of food sourced locally, minimising food imported by air and using biofuels in half its truck fleet.
- In 2007, Rupert Murdoch's News Corporation committed to going carbon neutral by 2010 and to use its enormous media influence to "inspire its audiences" to reduce their carbon footprints.
- Not only will Google be climate neutral by 2008, it also offers cash incentives to employees to purchase hybrids, uses solar electric panels and is leading industry initiatives to improve personal computer and server system efficiencies.

Interface is one of the world's major carpet producers. Since 1994, when the company started climbing "Mount Sustainability", it has cut fossil-fuel dependence by 45% and its use of water and landfills by as much as 80%.

How are local businesses responding to climate change?

Although there have been very few high-profile commitments by local companies, for some time a number of South African organisations have been developing and implementing strategic responses to the challenges of global warming. Several – predominantly in the natural resources and petrochemicals sector – have published annual audited accounts of their greenhouse gas emissions for a few years. They have recently been joined by companies such as Pick n Pay and Woolworths in agreeing specific targets and commitments for monitoring and/or reducing their carbon emissions.

Around 30 of South Africa's largest companies and business associations have voluntarily committed to the National Business Initiative's "Energy Efficiency Accord", and a high percentage of the JSE Top 40 companies

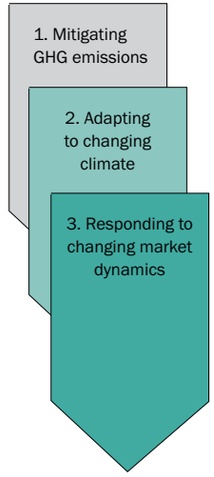
have participated in the international Carbon Disclosure Project. In addition to the slowly increasing evidence of improved climate change governance practices, several local businesses, including Highveld Steel, Mondi, Petro-SA, Sappi, Sasol and South African Breweries, have been successful in drawing on funds that were offered by the Kyoto Protocol's CDM.

However, with only 11 projects that have been registered, South Africa trails other major developing countries in utilising this useful financial resource to reduce its carbon footprint.

Developing a climate change response strategy[A]

To develop a response policy to climate change that forms part of an all-encompassing sustainability strategy, each of the previously mentioned response categories should be considered in conjunction with the process that is outlined below.

Assess climate change risks and opportunities:



a. Appoint board and management responsibility for climate change.
b. Measure and benchmark greenhouse gas emissions.
   i. Detail emission types, sources and quantities.
   ii. Review opportunities for reducing in-house, upstream or downstream emissions.
c. Understand your business case for action.
   i. Determine short- and long-term risks and opportunities in acting/not acting. Assess how stakeholders are likely to react.
   ii. Evaluate physical, regulatory and financial risk exposure.
   iii. Assess strategic, brand and product opportunities.
d. Engage stakeholders to obtain input in determining the nature of response strategies. Review strategies used by competitors and recognised success stories.

Implement an action plan:

a. Create policies and procedures to reduce climate risk and increase value.
b. Establish energy efficiency plans and targets.
c. Develop and implement an action plan to achieve set emission reduction milestones.
d. Participate proactively in industry and government policy dialogues to create mechanisms that incentivise businesses to de-carbonise their operations and adapt to climate change.

A. Adapted from "Managing the Risks and Opportunities of Climate Change", 2006.[11]

Evaluate, adapt and report:

a. Regularly evaluate performance against response strategy targets.
b. Adapt and fine-tune strategies, taking into account performance and changing market realities.
c. Publicly report on strategies and performance against targets.

Closing thoughts

Our move into the environmental age is irrevocable. Proactive players, prepared to adapt and reinvent themselves, stand to be more resilient and to benefit from the changing circumstances. Research indicates that companies with a strong focus on sustainability issues are likely to demonstrate better business performance[12] and increased revenues[13] due to stronger customer appeal and retention, enhanced brand value, improved operational efficiencies, identification of new business opportunities and the ability to attract and retain talented employees. Simply put, these companies tend to be better, happier and more profitable places to work. Yet the playing field is not level – there is only so much a proactive company can accomplish within the rules of the game. Outdated legislation does not always favour the first movers and they may find themselves constrained. If they invest too heavily in green strategies, they are likely to risk their ability to compete in the market place. This is where business and government must work together to develop economic regulations that level the playing field by creating incentives for businesses to invest in sustainability and emissions-reducing projects.

Resources

i. World Business Council for Sustainable Development (WBCSD); *www.wbcsd.org* (see "Energy & Climate" focus area)
ii. National Business Initiative (NBI) – regional partner of the WBCSD; *www.nbi.org.za*
iii. CERES – Investors and Environmentalists for Sustainable Prosperity; *www.ceres.org*. See the following documents:
   - Governance and Climate Change: Making the Connection
   - Managing the Risks and Opportunities of Climate Change: A Practical Toolkit for Corporate Leaders
   - Global Framework for Climate Risk Disclosure: A Statement of Investor Expectations for Comprehensive Corporate Disclosure
iv. The Global Reporting Initiative (GRI) G3 guidelines for reporting on climate change related risks; *www.globalreporting.org*
v. Hot Climate, Cool Commerce: A Service Sector Guide to Greenhouse Gas Management; World Resources Institute; *www.wri.org*
vi. Greenhouse Gas Protocol (GHG Protocol) is a widely used tool for quantifying and managing greenhouse gas emissions; *www.ghgprotocol.org*

vii. To Whose Profit?: Evolution, Building Sustainable Corporate Strategy; WWF; *www.wwf.org*
viii. Carbon Disclosure Project; *www.cdproject.net* (see South African CDP report)
ix. 3C – Combat Climate Change – A Business Leader's Initiative; *www.combatclimatechange.org*
x. The World's Top Sustainable Stocks; *www.sustainablebusiness.com*
xi. Indalo Yethu, South Africa's Environmental Campaign; *www.indaloyethu.co.za*

Climate change is a problem of prosperity, and of unexamined processes and making investment decisions, which may have made sense yesterday, but don't make sense for tomorrow.

Bill Clinton, Former US President

13

You the investor

Amanda Dinan and William Frater

The financial impacts of climate change are likely to be large. Fund and asset managers are currently required to have a relatively short-term view, looking for quarterly and annual returns for their clients. So far, this has meant that few people in the industry are taking cognisance of the long-term financial consequences of the changing climate. However, an increasing realisation of the potential impacts has led to shareholder action and, in turn, investment portfolios that specifically look at the risks to companies in the face of climate change. As an individual investor, you must insist that your fund or asset manager should take this into account when putting together any investment portfolio.

Climate change is the most significant economic issue of our time. In 2006, the Stern Review described the phenomenon as "the greatest and widest-ranging market failure ever seen".[1] The risks are unique, affecting all countries and markets. No industry is exempt. In addition, the financial impacts of climate change may not follow any currently established pattern of economic advantage.

The European- and UK-based insurance and re-insurance houses began evaluating the issue early, showing strong exposure. The underlying weather risk in Britain alone is rising between 2% and 4% per annum, potentially leading to underpricing by as much as 30% because of the time lags between historic data used to set prices and future claims.[2] The larger banking and investment houses have been reviewing the issue for the last decade or so, assessing sector and geographic vulnerability, factoring in the potential impact of carbon emissions on earnings since the European Emissions Trading Scheme (ETS) and other Kyoto-related financial mechanisms were first mooted. However, many of the conclusions reached remain open-ended. While costs and opportunities associated with carbon trading can be tangible, the points at which greenhouse gas emission caps become a significant cost to production or trigger the strong financial openings presented by the carbon market have yet to become attractive buy-and-sell factors for investors.

The actuarial projections on which contributions for retirement needs are based fail to consider the financial consequences of climate change.

So, while there is strong consensus that we need to take immediate and drastic action to reduce emissions and the risks posed by climate change, there is little consensus on the range, extent and time scale of impacts and the adaptation measures that will be required. For financial markets, these uncertainties are challenging. This is an industry where long-term is defined as three years, yet climate change adaptation and mitigation activities will take place over decades. A fund manager's prime objective is to keep pension-fund clients satisfied by consistently meeting quarterly and annual performance targets. For the average fund manager, climate change risks are too uncertain and long term to factor into investment decisions.

How is climate change an investment risk?

When people put money aside for the future, they either invest funds themselves or through intermediaries to attain returns that are sufficient to ensure that they can meet their future financial obligations. There are two issues here. How much money will someone need for the future and how can that person ensure sufficient investment returns to meet these requirements?

How much money will I need in the future?

The actuarial projections on which contributions for retirement needs are based

fail to consider the financial consequences of climate change. The ramifications of this include fluctuations in future property values in relation to climate change vulnerability, rising insurance and healthcare costs, and food scarcity and more expensive fuel.

How can I ensure that my investments meet my return requirements in this changing environment?

There is no absolute answer to this question. However, fund and asset managers need to adopt a long-term perspective that includes a clear policy that acknowledges long-term climate change risk. There is a host of investment issues, including geographic climatic vulnerabilities, increased energy costs and water scarcity, as well as carbon emission risks and opportunities.

What is an appropriate response from the institutional investor and fund manager?

The industry needs a massive mind-shift from short-term profit-taking to long-term ownership. The South African investment industry currently has very little understanding of the relationship between economic wellbeing and environmental functioning. This must change.

Long-term investors must start to examine the wider implications of climate change and evaluate companies and sectors that have high exposure, such as excessive emissions, an increased level of vulnerability to environmental change or an advanced likelihood of being affected by the consequences of broader economic changes. These implications include:

- Rising costs and an inflationary environment across the spectrum of industries, such as shipping, aviation and road transport, agricultural production and loss of arable land.
- A general climate of erratic weather events and environmental changes such as drought, ice melt and flood (e.g. sea ice melt has implications for shipping, including the opening of previously restricted routes but introducing increased safety concerns caused by an increased incidence of icebergs).
- Increasing scarcity of resources such as water, food products and other raw materials. An example of this is the increased frequency of fires, which affects timber availability.
- Changing consumer demand as public awareness increases.
- Changing taxation, regulatory and financial incentives.
- Shifts in the global trade regimes (e.g. high carbon impacts that are not effectively costed will be regarded as a subsidy, attracting higher tariffs).

A good investment-risk manager will look at his or her entire portfolio, carefully examining each company invested in to assess its level of risk and the mitigation measures it is taking. A long-term perspective is critical. For example, preparing for

climate change regulatory risk on an operational level means investing in reduced resource use, such as increased energy efficiency, a reduction in water usage, alternative technologies, processing of waste into energy by-products, and shortening of supply chains. Inevitably this will mean higher short-term capital expenditure and low short-term return – a deterrent for investment because investors place little importance on long-term value, and incentive structures are geared towards retrospective improvements in financial performance.

As carbon pricing becomes more prevalent, this will affect company tax rates, lowering company earnings. Businesses that have invested in demand-side reduction will be taxed less and will consequently yield greater returns to shareholders.

How has the investment industry responded?

There is no clear international view on the financial significance of a company's carbon footprint or direct climate change-related impacts. So, the climate change-related shareholder action from within the industry has concentrated on exerting pressure on companies to improve disclosure on climate change-related risk. High profile campaigns have been mounted by investors to force companies to disclose their total emissions and climate change response strategies. For example, the campaign against Exxon Mobil, which received the backing of 31% of shareholders, or some 1.4 billion shares – non-binding votes – increased the moral pressure on management to improve disclosure.[3]

The South African investor

In South Africa, this shareholder communication has yet to take place publicly, although a few asset managers may directly address these issues with companies. Most South African fund managers assume that they will respond to climate change once legislation is passed, with many still advocating that climate change is not a significant investment risk – dangerous short-term thinking.[4]

The power of the shareholder

Investors, whether saving in an account or contributing to a pension scheme, have a powerful tool that can be used to promote change. Fund managers ultimately have two choices – sell, or hold the share and engage with the company to bring about change. As climate change impacts and mitigation requirements strengthen, investors' perceptions of increased risk will reduce their appetite for a company's shares.

Inevitably, the company will then trade at a discount to its peers, with two significant consequences for management. First, management is frequently incentivised through stock options, and a lower share price will affect their pockets. Second, trading at a discount makes a company a target for takeover, affecting management's job security.

A large portion of an individual investor's money is allocated to large-index tracker funds via pension funds, which have limited ability to sell companies that are seen

THE SOUTH AFRICAN INVESTOR

South Africa will inevitably have an obligation to reduce carbon emissions. The parties to the United Nations Framework Convention on Climate Change (UNFCCC) are expected to agree on binding targets for reductions in greenhouse gas emissions by wealthier developing countries after 2012 (as developed: Annexure 1 – countries are currently obliged to do). So, domestic industries are likely to have emissions capped, with limits placed on the amount of electricity and fuel they consume. If current per capita emissions are used to determine the target reductions for developing countries, this may place onerous requirements on South Africa,[5] with its high proportion of energy-intensive extractive and mineral processing industries. (See *Chapter 9: Taking on a fair share: the Goliath of Africa's emissions*).

A reduction in energy intensity is a clear route to reducing greenhouse gas emissions, as is trading the Certified Emissions Reductions or "carbon credits". An example of the tangible benefits is the 115 MW waste-gas-to-energy project being developed at Mittal Steel, where several hundred million rands have been invested on the back of the Clean Development Mechanism (CDM). In addition, Mittal now benefits from enhanced power-supply security, a reduced carbon and environmental footprint and an enhanced public image. For high-emitting companies in the metals, mining and fuel industries, undertaking CDM projects has the additional advantage of mitigating risks of future regulation. These projects highlight the complexities of reducing an emissions profile and lower the cost of reducing the footprint. See *Chapter 25: Carbon revenues for Africa*, for more details on carbon revenue opportunities.

Most South African fund managers are not aware of these issues, and assume that the financial sector will respond once government has undertaken clear climate change commitments and business requirements are legislated.

to be more risky or have inferior management. If fund managers are concerned about long-term risk, their only option is shareholder activism. Fund managers may engage with the company's management and request better disclosure on mitigation and adaptation responses to climate change, or they may use shareholder rights. Even actively managed funds may choose to engage with management if they see that the value of their investment can be enhanced by the leadership embracing change.

Internationally, it is acknowledged that environmental, social and governance issues contribute significantly to a company's long-term value. The Principles for Responsible Investment (PRI), launched in May 2006, which pulled together more than US$10-trillion in global investments (including the 20 largest asset owners in the world), incorporated this view into mainstream investment management. The Carbon Disclosure Project (CDP) has united 300 global financial

RENEWABLE ENERGY

The receptiveness and level of understanding of the role that renewable energies, co-generation and the like will play in the South African economy has shifted dramatically over the last few years. Rolling blackouts, suggesting shortfalls in power-generating capacity, have raised government awareness of the need to address climate change. This has led to initiatives from local authorities, such as the Nelson Mandela Bay Metro, Cape Town Metropolitan Council and eThekweni Metro, that are investigating the improvement of energy security through solar-, wind- and methane-capture initiatives. At the time of writing, these are not necessarily cost-effective strategies. This should change once large-scale projects are commissioned, such as the Cape Town Metro bylaw on solar water-heaters and the income streams from CER sales through CDM become more accessible.

institutions representing some US$41-trillion in managed assets. Both the PRI and the CDP seek information from companies about their existing impacts and the actions that they are taking to address them. The PRI goes one step further, requiring managers to engage actively with companies and incorporate these issues into their voting strategies.

The mushrooming green market

There are numerous opportunities to invest in enterprises that are adjusting to the challenges of climate change by developing new technologies or by being exposed to sectors that have a lower impact. These, currently novel, investment opportunities will eventually become part of institutional fund-investment strategies and are likely to be high performers as regulators and as the market becomes more aware of climate change challenges.

What can you do?

As an individual investor, the starting point for action is to ask questions. Is your fund manager aware of climate change as a long-term risk? Ask him/her to explain how the company factors climate change into investment decision-making and, if it is not, how it intends to address this issue in the future.

Resources

i. Principles for responsible investment; *www.unpri.org*
ii. CERES – Investors and environmentalists for sustainable prosperity; *www.ceres.org*
iii. Carbon disclosure project; *www.cdproject.net*
iv. World Business Council for Sustainable Development; *www.wbcsd.org*

v. Climate Change & the Financial Sector: An Agenda for Action; *www.wwf.org.uk/filelibrary/pdf/allianz_rep_0605.pdf*
vi. The Carbon Principles: *http://carbonprinciples.org*

Never doubt that a small group of thoughtful, committed citizens can change the world: indeed it's the only thing that ever has.

Margaret Mead

14

You the civil society organisation

Richard Worthington

The repercussions of climate change will be so multifaceted that civil society organisations may have problems achieving their objectives. Regardless of the focus of a particular organisation – be it health, education, poverty alleviation or children's rights – the effects of climate change will impact on it sooner or later. They will need to consider ways both to mitigate greenhouse gas emissions and adapt to changes in climate and/or the unintended consequences of worldwide responses to climate change.

Civil society organisations (CSOs) active in South Africa range from community-based self-help groups and faith-based organisations to advocacy groups and large charities. While CSOs vary considerably in their degree of formality, autonomy and power, they are all characterised by voluntary collective action focused around shared interests, purposes and values, and run on a not-for-profit basis. This means that they are distinct from state and commercial institutions, although these boundaries can become quite blurred, with some CSOs being established to enable the work of the state (by running poverty alleviation or home-based care programmes, for example) or to further commercial interests (through highly publicised corporate foundations or policy think-tanks).

While many CSOs are not involved in any kind of advocacy work, all should consider joining forces in lobbying for local, national and international action to mitigate climate change. There is widespread civil society agreement that global warming should be kept below 2 °C – relative to the global average before the industrial revolution. Some experts claim that it is too late to keep below this temperature, but this pessimistic opinion assumes an inadequate short-term response. Science shows that sufficient universal effort would give us reasonable odds of success. This requires a legally binding multilateral system, which means building political will throughout the world.

While many CSOs are not involved in any kind of advocacy work, all should consider joining forces in lobbying for local, national and international action to mitigate climate change.

Why does climate change matter to your CSO?

It is easy to see how climate change will affect some CSOs more than others. For instance, those organisations that are focused on promoting food security or poverty alleviation through agricultural projects will need to make plans to adapt to the fact that large parts of South Africa are becoming warmer and drier, other parts are getting wetter and more prone to flooding, and the timing of essential rainfall is changing. In addition, CSOs that promote employment opportunities through tourism activities could be strongly affected by declining international tourism caused by rising air-travel prices and the negative impact of climate change on South Africa's biodiversity and unique biomes.

What of CSOs focused on health? Tens of thousands of deaths in Europe have already been attributed to recent heat waves, and people suffering ill-health, including those with HIV and Aids, will be increasingly vulnerable to heat stress. Because of consistently higher temperatures in recent decades, diseases such as malaria have started to spread beyond their traditional geographical limits. As a result, it is estimated that there may be a fourfold increase in South Africans at risk of malaria

within the next ten years, increasing the number of related deaths, negatively affecting the economy and tourist industry, and costing the country an additional R1-billion a year.[1] It is a question of when, not if, climate change will affect your organisation.

Ways to integrate climate change into your core activities

The responses you choose will depend on your organisation's focus and objectives, and how they are affected. Mitigation is arguably the most pressing short-term issue in order to avoid more drastic climate change consequences later on. The longer you ignore the problem, the more it will impact on your organisation and its achievements and objectives.

Mitigation

There are several ways in which a CSO can contribute to the reduction of greenhouse gas emissions and mitigate climate change:

- Join one of the umbrella climate change organisations (described later) to help with the lobbying of government and industry, and to promote specific environmental and/or social objectives.
- Inform the public about climate change and encourage positive action. This can be done through campaigns in communities, schools and churches, for example, or by promoting public participation in events such as the Global Day of Action on Climate Change (*www.earthlife.org.za*) or Project 90 by 2030 *(www.project90x2030.org.za)*.
- Scrutinise project developments by reviewing environmental impact assessment procedures, and questioning the Clean Development Mechanism (CDM) approval process (see *Chapter 25: Carbon revenues for Africa*) and the methodologies of companies offering voluntary emissions offsets. As climate change initiatives gather momentum, a growing number of people and organisations will attempt to cash in on related opportunities. The role of civil society is to assist in ensuring projects are managed appropriately.
- Keep track of your own organisation's carbon footprint, the measure of your greenhouse gas emissions (see *Chapter 6* for suggested carbon calculators). All CSOs should become aware of the impacts of their own operations on ecosystems, from local to the global level. The range of measures advocated for individuals, from reducing electricity usage to minimising car and air travel, should be adopted at an institutional level as well.
- Work cooperatively with industry and the government through mechanisms such as the Integrated Development Planning (IDP) process. IDP is compulsory for all municipalities and involves both the municipalities and their citizens in shaping new developments. Other CSOs take a more radical and confrontational approach, actively campaigning against the development of large-scale fossil-fuel projects, for example. You need to choose the approach that best fits the aims and values of your

CAUTION: OFFSETTING

Offsetting emissions needs to be approached with great caution, as there are many initiatives that do not assure sustainable carbon sequestration, while some forest "protection" projects have deprived indigenous people of their traditional resource base. Always check the details of offset initiatives. No endorsement of the providers mentioned here is intended.

organisation and is the most likely to result in positive change.

- Support a carbon-offset (sequestration) programme, for example, an energy-efficiency programme or a reforestation project, to help reduce the quantity of unavoidable carbon-dioxide emissions. Food and Trees for Africa and Climate Action Partnership (CAP) offer tree-planting programmes for this purpose. (See the sidebar in *Chapter 8* on offset mechanisms).

Adaptation

As climate change is the most indiscriminate issue in the world today, even people making a negligible contribution to the problem will have to adapt to its impacts. These people, such as the urban and rural poor, subsistence farmers and marginalised communities are, in many cases, the most vulnerable to the effects of climate change.

A growing number of CSOs are initiating "adaptation" projects, which focus on the vulnerability of different human communities, livelihoods or biomes to accelerating climate variability and change, and help to develop or enable coping strategies. While this area of work is in its infancy, all human activity needs to be informed by the anticipated impacts and risks arising from climate change.

CSOs should familiarise themselves with the climate change projections for the areas in which their projects are based in order to develop long-term adaptation strategies.

Coping with national and international response measures

As countries all over the world start to initiate mitigation policies to reduce greenhouse gas emissions, their actions, like ripples in a pond, are causing economic repercussions elsewhere. Many of these responses could have a greater impact on CSOs and business in South Africa than the physical effects of climate change itself. This means that the possible unintended consequences of climate change response measures must also be taken into account.

For example, CSOs that generate income through the sale of foods or handicrafts overseas could be affected by growing consumer and retail resistance to buying goods transported by air. Carbon footprint or food-mile measures (the total distance a food has travelled from production to retail outlet) are increasingly being included on many food labels overseas, effectively placing exports from developing countries at a disadvantage.

The growth of international travel will also have to be checked to keep global warming below 2 °C, and tourism organisations will need to target local markets instead.

At present, environmental CSOs throughout the world are woefully underfunded, considering the extreme nature of the crisis. In the UK, for example, these organisations received less than 2% of all charitable grants and only 5% of private donations in 2007. This could change as the effects of climate change become more obvious and severe, resulting in the diversion of funding away from other CSOs.

All CSOs must evaluate the effect of emerging trends on their core activities. Ideally, they should adopt strategies such as the development of local markets for their goods or services, or changing from the production of perishable foods that need to be air-freighted overseas to those that can be exported via more energy-efficient sea freight.

The Goedgedacht Trust, working to uplift rural communities in the West Coast/Swartland area of the Western Cape, has, for several years, promoted the planting of drought-resistant, food-bearing trees such as olives and, more recently, pomegranates and figs, in anticipation of climate change in the area. This is an example of an adaptation strategy.

The crux of the matter

At the national level, CSOs need to highlight and counter the direct damage and future risks of short-term decision-making, such as the perpetuation of South Africa's dependence on fossil fuels and the encouraging of luxury consumption. This can be achieved by:

- Greater CSO participation in policy-making and the promotion of government and business accountability at all levels. This should have a direct impact on how the national budget is allocated and taxes are levied.
- Increased communications from CSOs about the environmental costs of high-consumption lifestyles.

At the international level, South African CSOs need to:

- Demand that all countries participate in a legally binding multilateral climate regime, taking on quantified commitments appropriate to their historic responsibility and respective capabilities.
- Assert the right of developing countries to sustainable development, supported by measures to disseminate the best available technologies (intellectual property rights are currently a barrier to de-linking economic growth from increasing emissions).
- Demand adequate financial support for adaptation strategies to counter the consequences of the emissions of industrialised nations.

> Let us be good stewards of the Earth we inherited. All of us have to share the Earth's fragile ecosystems and precious resources, and each of us has a role to play in preserving them. If we are to go on living together on this Earth, we must all be responsible for it.
>
> *Kofi Annan, former UN Secretary-General*

Where to hang your CSO hat

There are three key South African climate change umbrella organisations, each with a different geographical and activity focus. If your CSO is ready to get involved, we suggest you collaborate with one or more of the following institutions.

South African Climate Action Network

The South African Climate Action Network (SACAN) is an association of like-minded CSOs and individuals working on national climate change issues. The network, which officially started in 2001, has grown considerably and in 2008 had 19 member organisations. These range from small community-based groups in Sasolburg and Boipatong that fight for their right to clean air, to large organisations with a regional focus, such as the Southern Africa Faith Communities Environmental Institute and Earthlife Africa. As a local chapter of the global Climate Action Network (CAN), which consists of over 400 member organisations worldwide, SACAN works to promote government, business and individual action to limit human-induced climate change to ecologically sustainable levels and to reduce vulnerability to climate impacts. CAN has four regional nodes in Africa.

SACAN is focused on driving policy change through campaigns, lobbying and advocacy, as well as building capacity at a local level and raising public awareness. SACAN is represented on the National Climate Change Committee (NCCC), which has the task of giving input to national policy development, and has formalised commitments within the Midrand Plan of Action adopted at the National Climate Change Conference in 2005. There is considerable overlap of membership with participants of the South African civil society Energy Caucus, a common platform initiated by the Sustainable Energy and Climate Change Project (SECCP) in 2002. The Caucus includes a range of CSOs and some trade unions, including the National Union of Mineworkers and COSATU. It is committed to a just transition to sustainable energy. Visit SACAN and SECCP at *www.earthlifeafrica.org.za* and CAN at *www.climatenetwork.org*.

Climate Action Partnership

The Climate Action Partnership (CAP) is an American-based alliance of conservation organisations with six members in the South African chapter and a primary focus on the protection of biodiversity hotspots. The South African members are

SOUTH AFRICA'S LONG-TERM MITIGATION SCENARIOS

The key conclusion from the Long Term Mitigation Scenarios (LTMS) process (also see *Chapter 11: Your government, our government*), which is a Cabinet-mandated quantification and costing of South Africa's mitigation potential, is that the only viable scenario for our economy is "Required by Science" – an emissions trajectory consistent with IPCC science, but assuming some latitude for South Africa as a developing country.

In July 2008, the Department of Environmental Affairs and Tourism prepared a briefing for Cabinet, which included submissions from SACAN and Business Unity South Africa (BUSA) in response to the LTMS. SACAN welcomed the LTMS documentation as a sound foundation to the development of policy, as a matter of urgency, and proposed a number of key objectives. Among these objectives were the following:

- Low-carbon development must be a defining feature of sustainable economic growth.
- Stabilisation of national emissions in 2015 should be an objective for all government planning.
- The renewable energy target must be revised and disaggregated, with specific targets being set for different energy carriers, including that 15% of electricity be derived from renewable sources by 2020, and a total of 25 million m^2 of solar water-heating (SWH) be installed by 2020.
- Financing of SWH installations should be on a par with the funding of a new coal-fired power station, as SWH can displace electricity demand at the same scale (up to 5 000 MW).
- Mandatory measures for energy efficiency and conservation must be implemented.
- A revenue-neutral, gradually escalating carbon tax must be introduced. The tax revenue should be used to contain food-price escalation and to increase access to clean and appropriate energy services and safe and affordable public transport.
- The electrification of transport modes must be encouraged to reduce the use of liquid hydrocarbon fuel.
- No new coal-to-liquid plants should be built.
- No new coal-fired electricity plants should be built without carbon capture and storage.
- The renewable electricity generation technologies – solar thermal, photovoltaic and wind – should each receive investments equal to those invested in nuclear power generation.
- Long-term targets must ensure that:
  i. 35% of electricity supply is from renewable resources by 2030 and electricity should form 50% of primary energy supply;
  ii. 90% of electricity supply is from renewable resources by 2050 and electricity should form about 70% of primary energy supply; and
  iii. National emissions are reduced to 150 megatonnes (Mt) CO_2e/annum by 2050, which would imply 2.5 tonnes CO_2e/person/annum for a population of 60 million.

Conservation International, Endangered Wildlife Trust, Wildlife and Environmental Society of South Africa (WESSA), Wildlands Conservation Trust, Botanical Society of South Africa and the Wilderness Foundation South Africa. CAP was formed in recognition of the imminent threat of climate change to South Africa's unique biodiversity as well as food and job security. Its main objectives include raising public, corporate and government awareness, providing a platform for debate, and supporting mitigation and adaptation projects that contribute to biodiversity conservation, poverty alleviation and rural development.

CAP-SA believes that climate change presents a major opportunity to address poverty and steer South African development in a sustainable direction. Reforestation as part of carbon-offset projects is, for example, emerging as a new and viable livelihood option for communities. These projects not only restore natural forest ecosystems and conserve biodiversity, but also provide jobs and skills and innumerable other benefits.

For more information contact one of the organisers at:

- *www.conservation.org*
- *www.ewt.org.za*
- *www.wildlands.co.za*
- *www.wessa.org.za*
- *www.botanicalsociety.org.za*
- *www.wildernessfoundation.co.za*

The Durban Group for Climate Justice

The Durban Group represents an international network of organisations and individuals opposed to carbon trading, with a declaration that identifies "putting a value on carbon" as part of the problem, rather than a solution to climate change. The group is committed to building a global grassroots movement for climate justice. Despite the tensions between this position and support for the Kyoto Protocol, some organisations, such as groundWork and Earthlife Africa, participate in both this and the CAN network, an indication of both the complexity and subtleties of their common quest for climate justice.

Visit The Durban Group at *www.carbontradewatch.org*

Conclusion

With our government prioritising economic development and international competitiveness, it is incumbent upon CSOs to build political will and a sense of urgency to avert a climatic catastrophe. From sharing information and promoting incentives to participating in action to force offenders to reduce emissions, there are a myriad avenues for advancing effective climate change responses. If there is a single theme to unite us all, it is, perhaps, that the longer we defer fundamental action, the greater will be the attrition on the human (and all other) species and the reversal of development, making a mockery of any short-term economic growth we make now.

A key challenge in raising popular awareness is to reflect accurately some truly grim realities without prompting fatalism or despair. There is still a fair chance that we can avoid a climate catastrophe, but further warming and more severe impacts are locked into the system because of our collective emissions to date. It is important to empower as one informs, but an effective response will, by necessity, involve profound shifts in power relationships throughout the world. An equitable response to climate change would not only avoid or defer climate change impacts, it would have many co-benefits for the majority of humanity through the necessary participation of all tiers of all economies in a system that recognises the limits to the carrying capacity of our beautiful, but highly threatened, planet.

Resources

i. WWF-SA; *www.wwf.org.za*; The Climate Change Programme of WWF-SA engages consumers, government, business and industry to promote climate change response at local, national and international levels and is a key component of the WWF International "New Global Climate Deal", a network initiative to ensure an effective and equitable post-2012 multilateral agreement.

ii. Earthlife Africa; *www.earthlife.org.za*; Earthlife Africa is a membership-driven organisation of environmental and social justice activists, founded to mobilise civil society around environmental issues in relation to people.

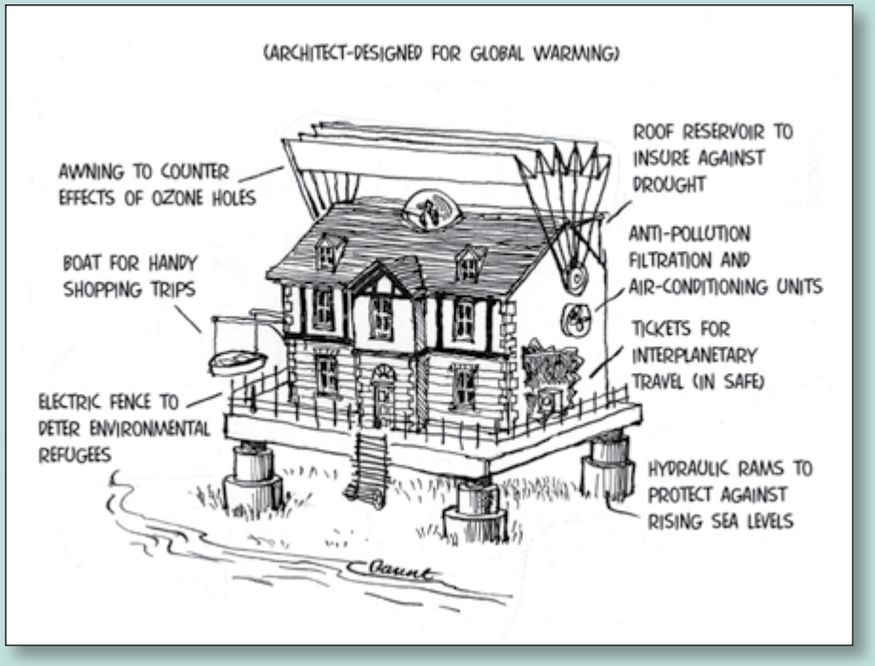
iii. groundWork; *www.groundwork.org.za*; This organisation seeks to improve the quality of life of vulnerable people in southern Africa through assisting civil society to have a greater impact on environmental governance.

iv. Goedgedacht Trust; *www.goedgedacht.org.za*; The philosophy of the Trust is to "Build people, strengthen community and promote democracy". In response to a range of rural needs, an increasing number of programmes and projects have been included under the umbrella of the Trust, including The Olive Path out of Poverty.

v. Friends of the Earth International; *www.foei.org*; This is the world's largest grassroots environmental network, uniting 70 national member groups and some 5 000 local activist groups on every continent. With over two million members and supporters around the world, the organisation campaigns about today's most urgent environmental and social issues.

vi. Environmental Monitoring Group; *www.emg.org.za*; EMG aims to encourage the development of environmental policies, practices and actions that lead to a deeper, more human and more sustainable relationship with each other and the natural environment.

vii. Indalo Yethu, South Africa's Environmental Campaign; *www.indaloyethu.co.za*; Indalo Yethu helps network numerous sustainable development initiatives.



Working with sustainable solutions is an opportunity to embrace local craftsmanship and new technology with a human and emotional approach. Sustainable design is not about trend, but is here to stay – it's inevitable.

Thomas Lykke, designer

15

You the architect and property developer

Andy Horn and Duncan Miller

Global warming presents a double challenge to designers of the built environment. They have to reduce the exorbitant carbon costs of conventional construction, and design buildings and human spaces that are sustainable, energy efficient and socially beneficial. The informed choice of materials is important to reduce the carbon footprint of buildings and to make their operation efficient. Holistic design principles are crucial in designing human environments that operate in symbiosis with natural cycles. Building designs that produce zero carbon emissions and that are not dependent on electrical heating, cooling and air conditioning exist already. The recently formed South African Green Building Council is in the process of defining building standards, and the new criteria for commercial buildings should be in place in 2008.

On the day-to-day scale of human preoccupations, climate change is gradual, so the tendency is, even for informed individuals, to do nothing, or to make cosmetic changes to their lifestyles in the vain hope that global salvation will come from elsewhere. It will not. Two levels of intervention urgently need to be put into practice. First, people need to reduce their production of carbon dioxide (CO_2) and other greenhouse gases. This includes reducing the emissions that are associated with the construction of structures and human environments, as well as those generated from human activities within them. Second, planners need to realise that considerable climatic changes are inevitable, and they must take into account the predictable consequences, such as increased temperatures, flash fires, storm frequency and severity, sea level rise and coastal erosion.

Buildings are a major source of global greenhouse gas emissions, both in the process of manufacturing their constructional materials such as bricks, cement, steel and fittings, and also in their subsequent operation in terms of heating, cooling and lighting. Depending on how the numbers are collated and which sources are used, estimates of energy involved in the construction industry vary, but the building sector consumes between 30% and 45% of our global energy production, with about 20% in the construction of buildings and 80% in their lifetime operation.[1] Another estimate states that the operation of buildings accounts for about 15% of global greenhouse gas emissions,[2] so there is considerable latitude in these estimates.

Nevertheless, because buildings generally have a relatively long lifespan, poor design locks us in to high emissions. So how we build and operate residential, commercial and industrial structures can contribute significantly to the control and reduction of global warming. The necessary design principles and technologies already exist for creating low-emission buildings, many of which involve minimal or no extra cost, and offer higher long-term resale and social value. Most developers and architects are simply unaware of the extent of their responsibility to future generations in terms of climate change.

> With environmental understanding as yet undeveloped in our local building industry, green architecture as a set of design principles has not yet taken root in this country.

The high carbon footprint of our buildings

The energy required for the construction process and to manufacture building materials, the so-called embodied energy of buildings, varies with the choice of structural components. In conventional buildings, much energy, with the greenhouse gas emissions associated with its generation, is employed to manufacture building materials such as cement, steel and aluminium. The production of cement alone is responsible for around 7% (depending on sources, this estimate may vary from about 4% to just under 10%) of current global CO_2 emissions, and world production is growing by 5% per annum.[3] This presents a serious hurdle to meeting

emissions reduction targets. Steel comes a close second, and is responsible for some 3% to 4% of global industrial greenhouse gas emissions, as estimated by the industry itself.[4] The cement, steel, aluminium and brick industries are scrambling to reduce energy consumption in their production lines and to develop useful applications for their waste by-products, such as fly ash.

The energy required to operate buildings depends on their geographic location and design. In general, South Africa does not experience the harsh winters that occur in northern hemisphere countries, so our heating requirements are comparatively low. However, this is supplanted by our growing need for air conditioning. With our industrial and commercial growth, and the burgeoning South African middle class, there is an increasing demand for electricity-powered air conditioning. Lighting for cavernous new malls and factories also drives up demand for electricity, which is produced mainly from burning relatively low-grade coal. In South Africa, the per capita CO_2 output is among the highest in the world, largely due to our profligate and inefficient usage of cheap electricity.

Holistic design – a manifesto for a greener architecture

In view of the present world crises – global warming, population expansion and natural resource depletion – there is an urgent need to align development and architecture with the concept of sustainability. In South Africa there is an unprecedented call for the provision of housing and development infrastructure. Green technologies reduce impacts on the environment, and investment in green technologies, more often than not, is justified by lower subsequent operating costs. With environmental understanding being as yet undeveloped in our local building industry, green architecture as a set of design principles has not yet taken root. Seeking an integrated approach, the manifesto[5] proposes six areas intrinsic to designing for sustainability.

A holistic approach is required for green architecture. Holism seeks to understand the interconnections between the various parts that make up that whole. This overarching principle embodies an attempt to embrace all of the active principles in a mutually beneficial manner. Holism, like nature, is cyclical. It seeks to find ways to encourage reduction, repair or re-use, and recycling at every level. This includes not simply the recycling of waste, but also recycling of energy, water and all the other resources that a building consumes within its lifespan. Holism looks at overall long-term benefits and effects, rather than only the superficial short-term gains.

While diversity is important to a holistic approach to design, it is less concerned with the quantity of diverse elements, but rather with the number of beneficial connections made between these components. It is vital that green building should reduce the carbon footprint of construction and occupation, and simultaneously build for a future that may involve greater extremes of weather, higher occupation density and reduced access to scarce resources.

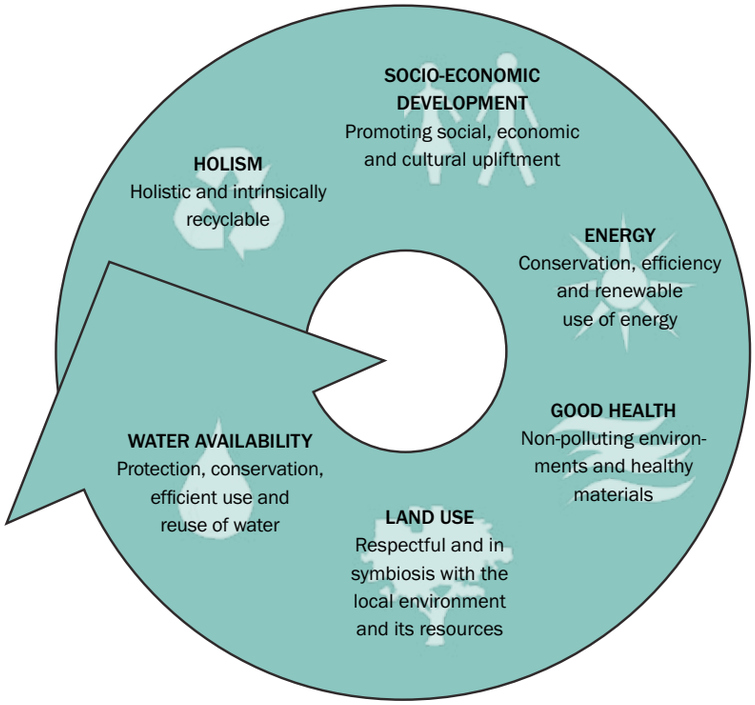


Figure 1: Six principles of holistic design
Source: Eco Design Architects, Andy Horn

Socio-economic development aims to promote social, economic and cultural upliftment by taking into consideration the consequences and opportunities for local people and their communities before, during and after the construction phase. This must necessarily be consensual and consultative, and sensitive to local history and culture. Community interests, including the creation of local job opportunities and use of locally manufactured products, must be balanced with short-term, profit-motivated developer interests.

Land use must be respectful and in symbiosis with the local environment and its resources, including during the building process, so that soil and habitat are affected as little as possible. The beneficial use of local resources and natural construction materials, and the incorporation of existing buildings and infrastructure, should be maximised. Sunlight is a free source of energy for lighting, heating, cooling and electricity generation. Wind can be used for cooling and natural ventilation, and, in appropriate locations, is a source of renewable energy. Vegetation provides protection from the elements and acts as an excellent climate moderator. Urban food gardens can convert concrete jungles into productive landscapes.

Water availability is under threat due to increasing population, wasteful consumption, pollution and climate change. It is vital that buildings are designed to make use of alternative water sources with rainwater-harvesting systems, and the recycling of waste waters. In addition, efficiency measures such as low-volume dual-flush toilets or, even better, multi-flushing devices, water-efficient shower-heads and tap-aerators that reduce water consumption should be installed. Power generation also consumes water, with each kWh generated using over one litre of water.

The good health of people and the environment should not be jeopardised. Green architecture avoids using polluting materials and activities – which have been shown to cause "sick building syndrome" – and creates regenerative rather than degenerative systems. This minimises the global and localised risks to planetary cycles of air, land and water, and reduces the potential health risks for the users of buildings, construction workers and the people involved in the production of materials. The benefits of such office spaces include reduced absenteeism and increased productivity.

Energy conservation is crucial in mitigating climate change caused by global warming. It involves using less energy, using it more efficiently and, where possible, using cleaner, renewable sources of energy. While initial investments to improve efficiency may be higher, they pay their way in the long run and increase the value of buildings. Steps that can be taken include:

- Minimising the use of materials with high embodied energy, such as concrete, aluminium and steel.
- Reducing the transport costs of materials by using local products and building methods appropriate to the area.
- Avoiding the designing of deep-plan offices, which require artificial lighting and ventilation.
- Maximising natural light and ventilation.
- Orientating buildings for good solar access. However, overheating of internal spaces should be avoided by designing them with appropriate sun-shielding that excludes high-angled summer sun, and welcomes lower-angled winter sun.
- Installing of good insulation. Roof linings should be sound and the south sides of buildings protected.
- Office-block designs should expose the underside of concrete slabs and internal masonry to act as heat sinks and re-radiation sources. The heat that builds up in materials of high thermal mass over the day is ventilated at night, and can cool in time to re-absorb the next day's heat loads.
- Installation of energy-saving illumination with low-wattage LED lighting and intelligent switching systems, which only provide illumination when a room is occupied.
- Installation of solar water-heaters. Existing geysers should be fitted with timing devices and geyser blankets, and pipes should be lagged.

- Fitment of water-efficient shower-heads.
- The preservation of embodied energy by considering the possibilities for conservation and adaptive re-use of existing buildings, as well as the dismantling of building elements for re-use or for reconstituting into new material.
- The creation of pedestrian- and bike-friendly, community-orientated neighbourhoods.
- Usage of heat exchangers to recycle waste heat.
- Utilisation of heat pumps for water heating purposes.
- Installation of absorption chillers with solar heat-collectors to run air-conditioning systems.

BP head office – a case study

In 2002, BP embarked on a quest to build new southern African head offices, designed in accordance with their four brand values "Innovation, Progressive, Performance and Green". The brief called for a low-rise campus-type sustainable building set in a green environment on the selected Portswood site on Cape Town's V&A Waterfront. The result was a three-storey building that demonstrated resource efficiency and expressing green architecture. The exterior was designed to maximise the use of natural light, while excluding unwanted heat and glare. Rooftop thermal solar panels heat water and photovoltaic cells generate 10% of the building's elec-tricity. Local and recycled materials were used extensively and construction waste was recycled.

Optimum use is made of natural light, with skylights and reflective light shelves. Lighting energy is saved by ensuring that lights are used less and that energy-efficient bulbs are used. The control of public areas is achieved with timers that are set to provide complementary lighting at selected times of the day. The lighting installation was 40% more expensive than a standard installation, but effects a 65% operational cost saving.

The indoor climate is regulated by three identical systems located in each wing of the building. The systems are made of conventional building elements and can operate on economy cycle and passive extraction when weather conditions are appropriate. There are three operating weather modes, namely cold, hot and intermediate, which can be used, depending on the difference in outside climate conditions and the desired level of indoor comfort.

Local materials were used extensively. Excavated rock was recycled in gabions and stone walls. Recycled slag cement components were used in the concrete structure. The parking garage has a roof garden, which moderates local climate by retaining heat energy and reducing glare and, through evaporation of moisture, helps to cool the surrounding air, therefore saving on air-conditioning costs. A 1.3 million litre rainwater-storage tank, located in the basement, contains sufficient irrigation water for the hot, dry summer months, while also supplying water for flushing toilets.

MICK PEARCE – A LEADING GEO-CLIMATIC ARCHITECT

Green building design is not new. Termites have been building well-ventilated underground cities for millennia. Their construction method inspired award-winning architect Mick Pearce's design of the Eastgate Centre office complex and shopping mall in Harare, Zimbabwe. This 1996 building exemplifies architectural bionics, in which principles from living organisms are transferred into engineering.

The heavy masonry exterior walls, derived from local traditional building design, act as both insulators and heat sinks. The Eastgate Centre keeps its interior uniformly cool by using the mass of the building as insulation and taking advantage of the changing external temperature. During the day, fans draw fresh air from the atrium and blow it through hollow spaces under the floors. From there, it moves into each office through baseboard vents. Warming and rising, it is expelled through 48 brick funnels. During the night, the fans send air through the building seven times an hour to cool the hollow floors without refrigerated air-conditioning. The ventilation costs one-tenth that of a comparable air-conditioned building.

Mick Pearce's design philosophy encompasses planetary resources. "I have become increasingly interested in the development of a new relationship between the City and Nature in which man's relationship with Nature is changing. This has a wide-ranging influence on my architecture. I am also convinced that the mindless burning of fossil fuels, which I call 'burning diamonds', is having a disastrous effect on the planet's natural, social and economic environment.

We should instead be using the vast resource of fossil remains for higher-state energy transfer processes to produce hydrocarbon materials like carbon fibre, while at the same time moving towards using the renewable energy which will give rise to a new solar age."

www.architectsforpeace.org/mickprofile.html

Water consumption is 75% lower than that of a similar conventional building.

A monitoring system displays the amount of energy produced by the solar power array and consumed by the building, the amount of CO_2 emissions saved from being released into the atmosphere, and water stored and saved. The projected annual energy consumption is still above the target level of 115 kWh/m^2, but ongoing refinement of the heating, lighting and power systems is expected to reduce usage to the desired level. The building achieves a 30% reduction in electricity consumption over conventional buildings, but, with ongoing technology developments, even greater reductions are possible today.

BP has shown that with appropriate design and at no additional outlay for construction (if one excludes the cost of the photovoltaic panels), A-grade office space can be created with flexible operating conditions that are responsive to environmental changes, significantly reduced dependence on external electricity and water supplies, lower embodied energy and operating costs, and are more stimulating and

YOUR DREAM GREEN HOME

Linda Graaff
Enarchi Architects

Listed below are a few ideas to explore when you build or renovate your existing home. These help reduce the energy required to build and operate the dwelling, and can make it a friendlier space in which to live.

- Orientate the building with adequate openings on the north façade to maximise natural daylight and sun. This minimises your electricity needs for lighting and heating. If you have large windows or doors on the west side of the house, place shading devices or a deep undercover terrace to prevent the hot afternoon sun from overheating your house in summer.
- As a general rule, wherever timber is used, it should be recycled or be sustainably harvested wood from local sources. All imported woods should be strictly avoided.
- If you have an ecologically sensitive site, it is preferable to use a framed construction made from timber or recycled steel for minimum impact.
- An alternative load-bearing type of wall-construction is another option. Such walls are made from straw bales, rammed earth, mud brick or natural stone. These materials require less energy to produce and do not adversely affect the house's lifespan. Keep the use of cement or concrete to a minimum, as it has a very high embodied energy. A combination of framed and load-bearing construction options can be used to achieve an interesting design (see *www.swarch.co.uk* for innovative examples).
- Generally roofs, windows and doors should be made from natural materials that have a low embodied energy or are recycled or recyclable, e.g. timber, slate, thatch, reeds.
- The floors could be made from timber. Another option for flooring is natural slate built on a "geothermal heating" system; an effective way of keeping the temperature in the house comfortable without using electricity.
- Wherever possible use non-toxic finishes that have a low embodied energy, e.g. sisal and coir carpets, bamboo, and non-toxic natural paints.
- Insulate your walls (in a framed construction) and roof/ceiling with recycled paper insulation or a mineral wool that is eco-friendly.
- Use solar water-heating, water tanks to catch rainwater, and low-volume shower and tap fittings. Recycle your grey water either for the garden or flushing toilets, or consider a composting toilet.

productive human environments.

The future of low carbon footprint building

The global construction industry accounts for 100 million jobs, and 10% of global gross domestic product. It uses 50% of all resources, 45% of all energy consumed, and 40% of all water.[6] This means that the industry has a major responsibility to tackle the issue

of global warming, to reduce the carbon footprint of existing and new buildings, and to design for sustainable occupancy and operation. Green architecture still tends to be seen as a fad, relegated to the pages of trendy lifestyle magazines, rather than as a necessary and fundamental change in direction for the profession.

South Africa is in the process of defining green building standards, based on Australia's Green Star Rating System. The new standards for commercial buildings are to be in place in 2008. The government is retro-fitting all of its 1 600 buildings, with a target of reducing energy consumption in SA by 12% by 2015.[6] This provides a clear lead to the building sector. Global experience has shown that the cost of construction to the highest levels of green compliance should be no more than a few per cent higher than conventional construction, with significantly reduced operating costs. South African conditions are different from those in the northern hemisphere countries, which have been pioneering standards for green building, so the development of our own practices and standards is appropriate. Nevertheless, many of the principles are common and overseas experience provides a resource to supplement locally available information on green building. Details are available on the websites listed under Resources.

One of the most far reaching, holistic design philosophies is the idea of "cradle-to-cradle" design. One of its leading proponents, William McDonough, feels that: "When designers employ the intelligence of natural systems – the effectiveness of nutrient cycling, the abundance of the Sun's energy – they can create products, industrial systems, buildings, even regional plans that allow nature and commerce to co-exist fruitfully".[7] This paradigm is based on the principle that everything can be recycled; that design should take into account the manufacture, distribution, use, decommissioning, recycling, re-fabrication, and re-use of all products. This is the antithesis of our "cradle-to-grave" throwaway culture.

Green buildings, constructed with local, energy-efficient materials, can be price competitive, retain their value because of reduced maintenance and satisfied owners and occupants, be significantly cheaper to run and have reduced environmental impact. Zero emissions house designs are already available,[8] as are so-called "Passiv Haus" designs, which require minimal or no electrical heating, cooling or air-conditioning, even in the coldest areas of Europe.[9]

The carbon footprint of new constructions can be reduced by the judicious choice of materials, including traditional ones like locally grown wood, straw bales, earth and mud bricks, and thatch. New low-energy materials and processes currently under development will revolutionise construction, and designers need to keep technologically up-to-date to take advantage of these innovations. For instance, so-called "geopolymeric" cement holds promise as the building material of the future. It can be made from waste materials like fly-ash and requires only 10% of the energy needed to produce Portland cement.[10]

In conclusion

As the public becomes more aware of the causes and effects of climate change driven

by global warming, architects will find themselves in consumerpressure

> I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait 'til oil and coal run out before we tackle that.
>
> *Thomas Edison*

to comply with green design principles. Those ahead of the game will benefit most from this shift in public demand.

Green architecture is not a style, trend or a vernacular; nor is it new. Most of the necessary technologies have been around for a long time, but their implementation requires a mind-shift by government, customers, architects, developers and builders to create more efficient buildings.[11] Once their viewpoint has changed, they will construct buildings that are friendlier to people and the environment, will cost less to operate, and, consequently, will have a higher resale value. Green architecture is a climatically, geographically and culturally appropriate discipline, combining the best of both old and new technology. At its core is the principle of respect and caring for the Earth and our society.

The present state of architecture and development generally continues to perpetuate the inward spiral of high levels of resource consumption, pollution and wastefulness that have characterised the past century, and lock us into expensive and destructive operational costs leading to ongoing high emissions. We have the ability to affect the environment to an unprecedented extent, and aggravate or mitigate global warming.

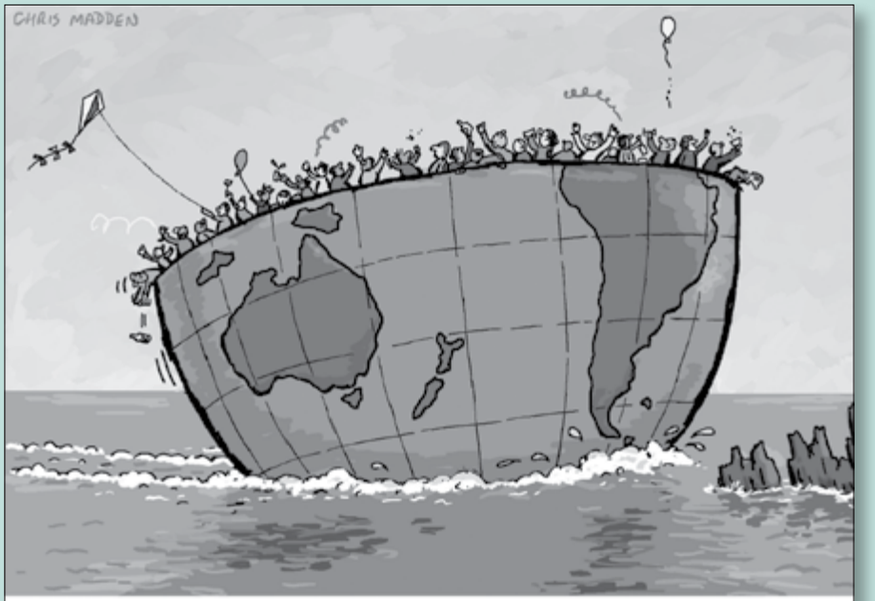
There needs to be a radical shift from the design of degenerative environments to the creation of regenerative ones. Statutory structures need to encourage movement beyond purely focusing on high profits, to establish mechanisms to better help tie capital to promoting sustainable development and environmental responsibility. This would be possible with such interventions as tax incentives, subsidies, and interest-free loans for sustainable design. With the predictable increase in the costs of conventional energy, green building will become more immediately economically attractive. A key factor that architects and designers must keep in mind is favouring labour-based processes over industrial ones, which rely on high levels of mechanisation, pollution and emission of greenhouse gases. It is vitally important that green architecture should show a vision, and become an inspiration for moving society in

the direction of sustainability and responsible custodianship of the environment.

Resources

These websites offer a wealth of ideas and facts on sustainable property design:

i. Green Building Council of South Africa; *www.gbcsa.org.za*
ii. Sustainable Home Design; *www.sustainablehomedesign.co.za*
iii. Green Building Resource Centre; *www.greenbuilding.co.za*
iv. Building Green; *www.buildinggreentv.com*
v. Green Building Magazine; *www.buildingforafuture.co.uk*
vi. Writings by William McDonough; *www.mcdonough.com/writings_architecture.htm*
vii. Intergovernmental Panel on Climate Change; *www.ipcc.ch/publications_and_data/ar4/wg3/en/contents.html* (Chapter 6)
viii. Rocky Mountain Institute; *www.rmi.org*
ix. Sustainable Urban Resources Forum; *www.sustainableneighbourhoods.co.za*
x. GreenHouse Project; *www.greenhouse.org.za*
xi. Eco Design Architects; *www.ecodesignarchitects.co.za*
xii. City of Cape Town; Green Building Guidelines; *www.capetown.gov.za*



THE SHIP OF FOOLS AND THE ROCKS OF SHORT-TERM ECONOMIC PLANNING

. . . we need to re-create our cities and implement similar interlocking and symbiotic systems and processes that will ultimately result in no waste, no carbon and zero Earth-impact. Buildings and transportation together make up approximately 70 per cent of the world's CO_2 emissions, and it is in our cities that the vast majority of buildings exist. It is, therefore, inconceivable that urban designers, the architects of our new social structure, do not take this into account. In the future, our cities will need to be carbon-free and dense with carbon-negative buildings.

Guy Battle, *The Endless City*

16

You the urban planner

Mark Swilling, Martin de Wit, Lisa Thompson-Smeddle

Sustainable urban development is rarely adequately defined or implemented. Municipalities battle with infrastructure problems such as traffic congestion, increasing emissions and rising water and energy prices, often as a result of poor planning in the past. And the solutions commonly contribute to the underlying problem. As a result, ecosystem services are in danger of rapidly degrading. Urban planners can respond to these challenges by planning around climate change, shifting energy use, spatial and infrastructural planning and better transport systems to reduce reliance on personal transport.

Climate change and sustainable cities

South African cities are largely powered by fossil fuels. Most of the energy is supplied by carbon-intensive coal-fired power plants in Mpumalanga, Gauteng, Limpopo, North-West and Free State provinces. Liquid fuels, whether imported from oil-producing countries or from coal-to-liquid plants such as Sasol, account for most of the balance. With rapid rates of urbanisation and increasing economic and income growth, the pressure on the energy system will only increase if no sustainable options are found to decouple growth and development from greenhouse gas emissions. Urban planners, who often have no choice but to work within the boundaries of our current fossil-fuel dependent society, can still make a meaningful contribution towards reducing our carbon footprint.

The underlying assumption of this chapter is that the rapidly changing global context will have substantial material consequences that local government will have to address. With rapid rates of urbanisation, sustainable urban development has become a buzzword, but rarely is it adequately defined or implemented. Many problems that are rooted in unsustainable resource use are now top of the agenda throughout the majority of South African municipalities. These include:

- Traffic congestion.
- Rising emissions and air pollution.
- Increased water and energy prices.
- Declining food security.
- Rising building costs.
- Brimming landfills.
- Polluted rivers.
- Degraded environments.
- Overflowing sewage treatment plants.

Currently, the solution is usually to upgrade conventional infrastructure, for example by broadening roads and so increasing traffic volumes, which simply exacerbates the problem.

> Reducing our carbon footprint tackles poverty eradication at the same time as reducing environmental impacts.

Taken together, these trends combine to give a picture of a highly unequal urbanised world connected to rapidly degrading ecosystem services, with looming threats triggered by climate change, high oil prices and food insecurities. Increasingly, these issues are found at local levels and are, not surprisingly, dealt with by

local governments who, in some cases, are starting to lead the way in responding to the crisis of sustainability. This has led to major internationally networked local government coalitions that coordinate knowledge about responses. The first effects of the crisis will be experienced in arenas such as food supply, industry (there will be economic and employment upheavals as some industries decline and others grow), weather extremes and continued energy supply.

Ultimately, the challenge of sustainable development in the current global conjuncture is not only about reducing our ecological and carbon footprints, but also about addressing poverty and inequality. One approach is called "dematerialism" or "reducing our carbon footprint". This tackles poverty eradication at the same time as reducing environmental impacts by decoupling our production and consumption systems and their management from rising levels of resource use. Entire communities can now meet all their material needs by:

- Re-using all their solid and liquid wastes.
- Using renewable energy instead of fossil fuels to meet most of their needs.
- Renewing rather than degrading soils for food production.
- Cleaning rather than polluting the air.
- Preserving instead of cutting down forests and natural vegetation.
- Under- and not over-exploiting water supplies.
- Conserving instead of exploiting other living species (in particular marine species).

The response to climate change in urban settings needs to be analysed and acted upon against the reality of resource- and material-intensive economies, poverty and inequality.

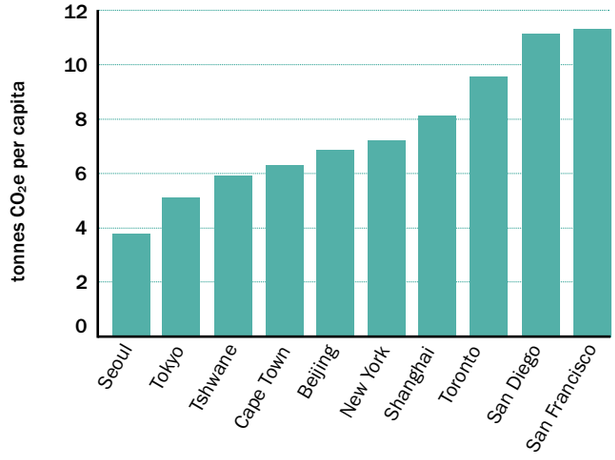


Figure 1: tonnes CO_2e per capita in selected cities
Source: References 1, 2, 3, 4 and 5

Greenhouse gas emissions

Not all cities are the same. When we look at greenhouse gas emissions in various cities worldwide it is clear that emissions per capita differ widely, largely reflecting differences in the sources of energy and lifestyle choices. This is illustrated in Figure 1; cities with higher economic wealth than those in South Africa can either have much higher (San Francisco, San Diego, Toronto) or much lower (Seoul, Tokyo) greenhouse gas emissions per capita. The good news is that there appears to be room for choices to be made, regardless of the level of income.

With higher levels of development, some of these choices will occur naturally through changes in economic structures. As cities start to diversify their economies, the sources of greenhouse gases shift from industrial to commercial activities. In Tokyo, for example, the share of total greenhouse gas emissions in industry has been declining from 35% in 1970 to 10% in 1998.[3] The residential share has also decreased, but much less so, to around 17% in 1998. However, the share of the commercial sector increased from around 16% in 1970 to 37% in 1998.

The City of New York shows a similar high contribution from the commercial sector, but with a proportionally higher share from the residential sector and a lower share from transport when compared to Tokyo. In comparison, Tshwane and the Western Cape[A] have a much higher sectoral contribution from industry of around 40%, but with the commercial sector contributing 10% or less. With sustained economic growth, a shift in sources of greenhouse gases from industrial to commercial activities is likely to continue.

A parallel diversification away from carbon-intensive energy sources needs to take

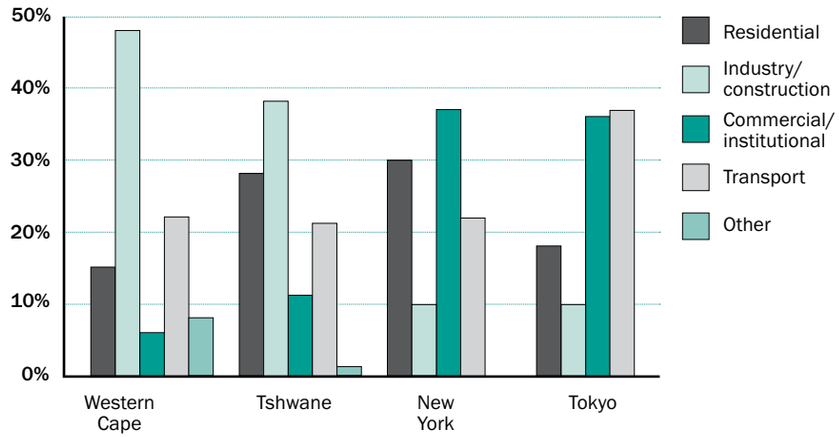


Figure 2: Greenhouse gas emissions by sector
Source: References 1, 2, 3, 5 and 7

A. City of Cape Town data was not available, but as the city accounts for almost 80% of all economic activity in the province, provincial data is used as a proxy.

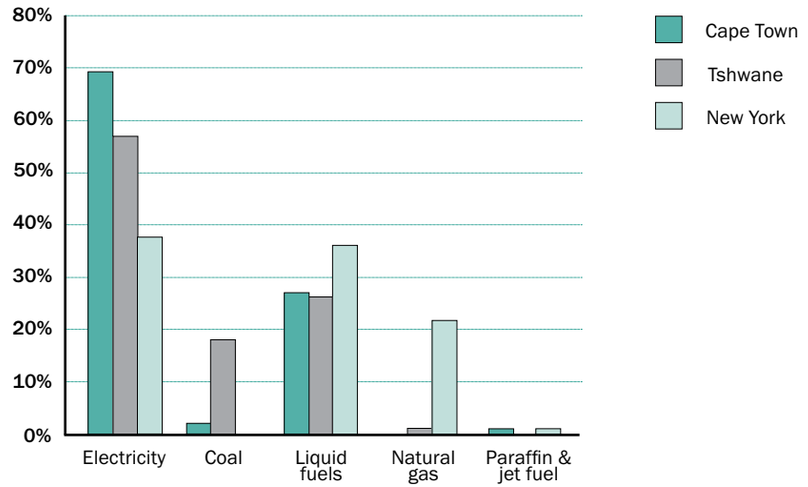


Figure 3: Greenhouse gas emissions by source
Source: References 1, 2, 3, 5 and 7

place before a meaningful reduction can be achieved. In 1994, the energy sector, which includes mainly electricity generation and liquid fuels, was responsible for 78% – electricity generation alone was responsible for 40% – of South Africa's total greenhouse gas emissions.[6] In cities, most greenhouse gas emissions are also from electricity, followed by liquid fuels (Figure 3). This is not only peculiar to South African cities, but is also a feature of a highly developed metropolis such as New York, where natural gas is another significant source. A long-term strategy focused mainly on electricity and liquid fuels is likely to be able to target most of the greenhouse gas emissions in cities.

However, there is an important caveat. Eskom supplies most of the electricity to South African cities, effectively taking control of greenhouse gas emissions from power generation outside the domain of these cities. Demand-side measures, such as improving energy-use efficiency and supporting alternative sources of energy, remain options within the control of urban planners.

Responding to climate change

The response to climate change is a form of risk management. Building sea dykes in areas vulnerable to rising sea levels is a form of risk management. Other risks can be reduced through building regulations, integrated planning for appropriate water and energy systems that are suitably priced, weather and flood forecasting, and the conservation of natural resources. Climate risks can also be spread or shared by using insurance and hedging, as well as through disaster relief. In some cases, we may be forced to accept the risk that climate change poses, such as abandoning land and infrastructure and relocation.

The urban poor often live in places where they are most vulnerable to sea-level rise, floods and extreme weather.

Several of these climate risk-management options are already or will be included in market operations. Examples are the increased use of air-conditioning, or insurance against natural hazards. Other options to address climate risks, however, would need initial support from city governments, such as subsidies for solar water-heating technologies or educational campaigns. Governments will also need to ensure that risk-management options don't result in higher emissions elsewhere, such as from the increased use of air conditioners. Yet other options are direct government responsibilities, such as coping with extreme events through disaster management, or research and development on climate change mitigation, adaptation and response for the public good.

Responses to climate change can be categorised broadly into: adaptation to changing weather conditions; mitigation of our greenhouse gas emissions; and responding to unintended consequences, which, as explained before, are the social and economic repercussions experienced as a result of consumers, governments and corporations responding to climate change.

Adaptation: Adaptive capacity is the ability of a system to adjust to climate change, including climate variability and extremes, to moderate potential damages, to take advantage of opportunities or to cope with the consequences.[8] The poorer classes are least likely to cope with increased stresses from climate change and this will necessitate social security intervention.

Mitigation: Mitigation responses and strategies are those that aim to reduce the amount of greenhouse gas emissions. There are already several technologically feasible mitigation options available to reduce these emissions in cities.

Unintended consequences: With the rise in globalisation and connectivity, it has become considerably easier for cities across the world to connect, trade and exchange ideas. These forces will come under renewed pressure as rising levels of greenhouse gases and associated climatic changes lead to increased costs of fossil-fuel-driven communications and travel. As the price of carbon rises, whether through carbon taxes, cap-and-trade systems such as in the European Union, or through direct regulation, the costs of electricity and liquid fuels powering most of our cities will also escalate. This will create new opportunities in the business of energy saving. The development of alternative energies will ultimately change the way we travel and work and place a renewed focus on higher density living.

CAPE TOWN AT THE VANGUARD OF TACKLING CLIMATE CHANGE

With respect to energy, South Africans are among the highest contributors to rising levels of CO_2 emissions – now over nine tonnes/person/annum. Total greenhouse gas emissions in the City of Cape Town are estimated to be 19.5 million tonnes of CO_2 equivalents or around 5% of the country's emissions – the city is home to around 8% of the country's population.

Mitigation responses that have been examined are: solid waste and bulk water-supply management, fleet and property management, household interventions and street-lighting interventions, which in total could save an estimated 239 000 tonnes of CO_2e emissions and an estimated monetary saving of R37-million. Some 92% of Cape Town's energy comes from imported non-renewable fossil fuels: 33% from coal via the electricity grid, 3% from burning coal and 56% from oil (petrol and diesel). Only 1% is renewable, i.e. from wood. The City of Cape Town has set a high renewable energy target of 15% by 2014 and 30% by 2020. The Draft Solar Water Heater Bylaw aims to introduce legislation that requires all new houses larger than 100 m^2 to be fitted with solar water-heaters. Energy-saving CFL light bulbs are to replace regular lighting at all City-owned houses and flats by 2010, and it has been proposed that insulated ceilings be installed in all new and existing subsidised homes by 2020 to help reduce the need for heating. [4, 9, 10, 11]

Climate change: What can urban planners do?

Restructuring cities and preparing them for rising oil prices, hotter climates, limited freshwater supplies, rapidly escalating costs of grid electricity, fished-out seas, degrading soils and increasingly limited landfill space will become a national priority for all developing countries. Many developing countries – such as Brazil and China – are already tackling these challenges, and there are several options and suggestions available to urban planners. These focus on adaptation and resilience, energy use, spatial planning and transport systems.

Adaptation and resilience

- The planning and development of new and existing settlements needs to take account of a changing climate. The urban poor often live in places where they are most vulnerable to sea-level rise, floods and extreme weather.
- Urban planners need to focus on improving the socio-economic resilience of communities in response to climatic events by planning and designing for spatial and digital accessibility and connectivity.

Energy use

- Change to less carbon-intensive sources of energy, such as solar water-heating.
- Increase efficiency of electricity use, such as incandescent lightning.
- Intervene in street lighting (e.g. by using light-emitting diodes, which are more

efficient than incandescent lights).
- In green-fields urban design, encourage practices that minimise the use of energy for constructing new urban settlements and are energy conservative to operate.
- Design greener buildings (also see *Chapter 15: You the architect and property developer*). Following the example of the German government, direct state subsidies are required to finance the implementation of renewable energy sources and the conversion of buildings. As in the US, Japan and Germany, provision of subsidies for installing solar PV (via panels or solar roof tiles) will be necessary for the first few years, after which they will be phased out as an economy of scale is built.

Spatial and infrastructural planning

- Promote urban densification to reduce the energy required for travel and service provision.
- Develop urban carbon sequestration (e.g. tree planting on streets).
- Implement and pass by-laws that build on the Green Building Guidelines formulated and circulated by the City of Cape Town
- Promote urban densification and hard urban-edge policies to prevent further urban sprawl, which will help protect agricultural land and conservation areas; encourage development of protected biodiversity corridors to allow movement of threatened fauna and flora.
- Return commerce to the "high street" as the spinal cord of community building. Discourage the construction of malls, which are generally far removed from residential areas, are car-centred and are highly energy-inefficient.
- Move to a zero waste system by implementing processes that recycle and re-use all solid and liquid wastes – usable products from these wastes include biogas, compost, water, and a wide range of materials, from plastics and paper to metals and building materials. These, in turn, trigger new value chains and employment-creating businesses. See *Chapter 21: Our waste*.

Transport systems

- Establish a broad set of measures to prevent transport-related air pollution and reduce consumption of petrol and diesel. This would include investment in public transport via integrated bus, rail and taxi systems.
- Also see *Chapter 17: Our transport*.

Resources

i. The Cities for Climate Protection (CCP) Campaign assists cities to reduce environmental impacts and enhance urban livability; *www.iclei.org*

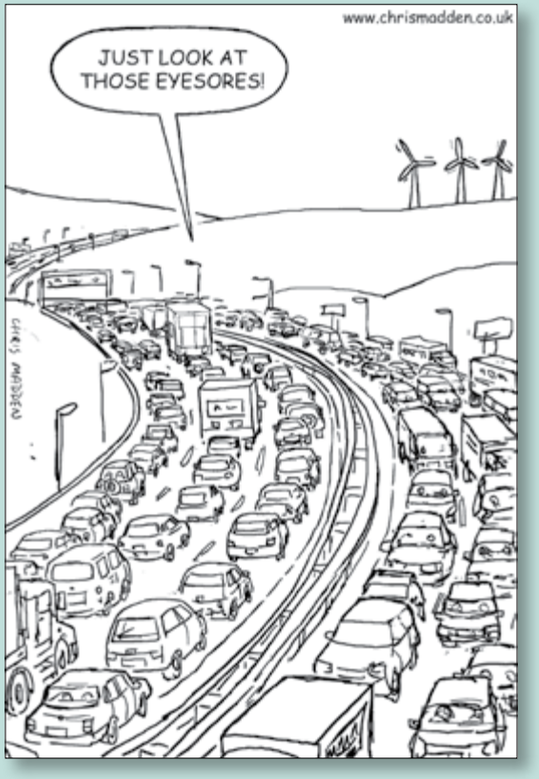
ii. The "End of Suburbia" and "Escape from Suburbia" documentaries investigate the implications of oil dependency on our suburban lifestyle; *www.endofsuburbia.com* & *www.escapefromsuburbia.com*

iii. Architect and designer William McDonough talks about sustainable cities in China and his "cradle to cradle" design philosophy; *www.ted.com/index.php/talks/view/id/104*

iv. Climate Change Response Strategy and Action Plan for the Western Cape; *www.capegateway.gov.za/Text/2007/10/climate_change_strategy_final_draft_june2007.pdf*

v. Sustainable Urban Resources Forum; *www.sustainableneighbourhoods.co.za*

vi. Transition Towns WIKI; *www.transitiontowns.org*



Every time I see an adult on a bicycle, I no longer despair for the future of the human race.

H.G. Wells, writer

17

Our transport

Gordon Pirie

Transport is one of the biggest contributors to greenhouse gas emissions. Motor-vehicle use and flying are the two worst culprits. Both forms of transport are increasingly used in South Africa and will continue to grow in popularity unless individuals, corporations and governments make a concerted effort to provide and use alternative transport. Unlike private motor-vehicle transport, public transport, cycling and walking are environmentally sustainable. They are also affordable for both the country and its poorer populations. Reliance on public transport need not slow economic development. Strategies for reducing transport GHG emissions include "ecodriving", providing clean, safe and efficient rapid bus transport, implementing carbon offsets, reinvesting in public transport, making private motor vehicle use and flying more expensive, shifting freight from road to rail, and restructuring our cities so they are less saturated with and less dependent on motor vehicles.

The crisis of transport and global warming

Jeremy Clarkson, a well-known British motoring commentator, has said that if cars were invented today they would be banned. They cause an alarming number of deaths and environmental damage. While other forms of transport may kill fewer people, they, too, are environmentally destructive and unsustainable.

The unprecedented mobility of people and goods is intimately connected to global warming. Millions of people travel more often, further and faster than ever before. Car use is increasing, and cheap airfares enable more people to fly almost anywhere on a whim. Your choices of where to go are far wider than those available to your grandparents. Consumption of products shipped and flown around the globe is rising. Mobility has become a way of life and is now assumed to be a basic right.

The "small world" that advanced transport has made possible has come at a high environmental cost. Our hypermobility is accompanied by an illusion of progress and freedom that is not sustainable either in its wasteful use of our finite fossil-fuel supplies or in its adverse impact on climate.

Transport is linked with climate change in two ways. First, CO_2 emissions from the manufacture and use of transport, and the energy it consumes, damage the atmosphere. We have to mitigate these effects. Second, extreme weather events, associated with the climate change that transport has helped to create, damage its infrastructure, hamper communications, are expensive to repair, and curtail economic and social activity. Adapting transport to changing ocean levels and weather conditions and their effects will become increasingly necessary.

> "Your grandchildren will likely find it incredible – or even sinful – that you burned up a gallon of gasoline to fetch a pack of cigarettes!"
>
> *Paul MacCready Jr, aeronautical engineer*

Transport is one of the largest and fastest-growing sources of global greenhouse gas emissions: the World Resources Institute indicates that it accounts for approximately 13.5% of total greenhouse gas emissions (principally CO_2), while other estimates put it as high as 25%. Over the past decade, transport greenhouse gas emissions have increased at a faster rate than those of any other energy-using sector.[1]

The polluting share of transport is lower in developing countries where there is less mechanised transport; the polluting effect of transport is increasing fastest in the rapidly growing cities of the developing world. In South Africa, car ownership is rising swiftly; motor-vehicle fleets are ageing and are, therefore, proportionately more polluting. Unfortunately, cycling, walking and using public transport are sometimes not safe or are deemed unfashionable.

Road-based motor vehicles (buses, taxis, cars, trucks) account for most transport emissions worldwide: estimates range between 65% and 75%. In metropolitan areas

where there is little mass public transport by rail or tram, as is the case in most South African cities, the contribution of motor vehicles to pollution is even higher. The share of freight and passenger transport in vehicle emissions is difficult to establish, but patterns of petrol and diesel sales are useful indicators. In each of the past three years, petrol consumption (mostly by passenger vehicles) in South Africa has accounted for between 55% and 58% of the total road-based energy use (and emissions). Diesel consumption (mostly by freight vehicles) accounts for the balance, averaging 43% per annum.[2]

Ocean shipping and aviation account for the balance of greenhouse gas emissions, with shipping carrying approximately 90% of international commodity trade by volume. However, shipping per volume, results in fewer emissions than aviation. Aviation is the fastest-growing transport sector: as evidenced by the sheer number of new low-cost carriers servicing booming air-travel markets. The contribution of aircraft to global warming is particularly serious at high altitude. Aircraft exhausts in the stratosphere are estimated to have a warming effect approximately three times higher than if they were ground-level emissions. Unlike other types of transport, there appear to be very few ways in which the climate change effect of aircraft can be mitigated by engineering advances.[3] The option of preventive legislation or polluter charging is hampered by the trans-border nature of much commercial flying.

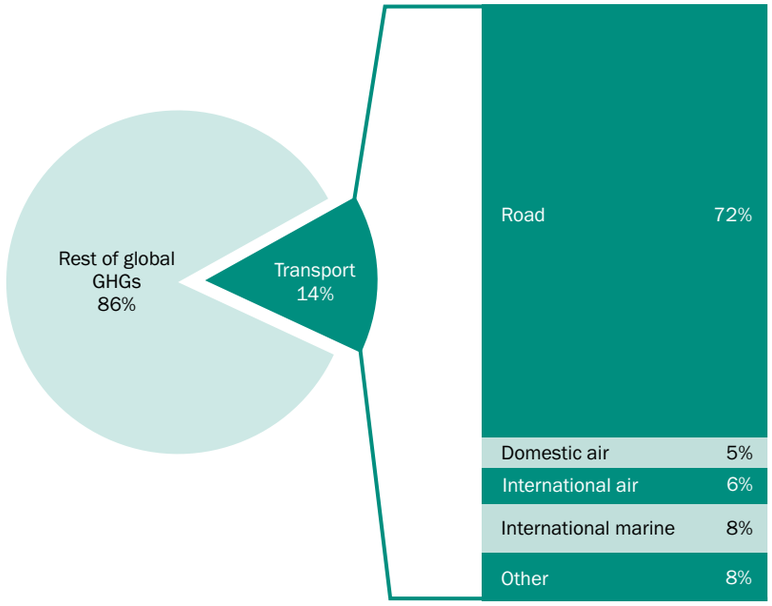


Figure 1: Greenhouse gases from transportation
Source: Navigating the Numbers. 2005. World Resources Institute. *www.wri.org*

South Africa – the land of the road

The size of South Africa and the widespread distribution of its major cities necessitate long-distance travel. Historically, low population densities have not been to the advantage of public transport, especially in competition with private motor vehicles. The declining presence of reliable and useful intercity and urban public transport means that mobile South Africans generate a considerable amount of greenhouse gas emissions. Increasing reliance on motor vehicles makes the country very vulnerable to fuel price rises.

Estimates about the global warming effect of transport in South Africa are that the country's transport sector accounts for about 10% of total emissions (all six Kyoto Protocol greenhouse gases) and approximately 15% of CO_2 emissions – the figures exclude pollution from production of synthetic fuels and motor vehicles.[4] Recent escalation of domestic air travel and the massive increase in the number of new and used vehicles on South African roads are likely to have raised that share. Much of the growth in motorisation in South Africa's far-flung informal settlements will have compounded emissions by effectively prolonging the lives of old cars. Typically, these have higher emissions per kilometre than modern vehicles.

The people who can afford private cars enjoy the personal comfort, convenience and prestige that they offer compared with buses, taxis and trains. Flying is faster and safer than overland long-distance transport. But continued use of these heavily polluting forms of transport ignores their climatic effects and elevates immediate personal gratification above long-term national or global considerations. As unpleasant as the thought is, unnecessary driving and flying are selfish in light of what we now know about climate change.

There are those who hope that the environmental damage caused by transport will be resolved by scientists and engineers who will discover affordable alternative fuels and be able to enhance efficiencies by designing cleaner-burning and more aerodynamic vehicles. Even if miracle technologies are found, can South Africans trust key decision-makers with the courage to force vested interests in the transport sector (for example, motor manufacturers and retailers, fuel retailers, road builders, airport operators and property developers) to discourage actions that stimulate rather than reduce transport use? In the short term, there is no better solution to reducing emissions than by altering your own travel where possible, and for government to promote the use of smaller, more efficient vehicles.

MOTOR MANIA IN SOUTH AFRICA

Currently, approximately 50 000 new vehicles operate on our roads each month, significantly increasing emissions and aggravating traffic congestion. Rising personal incomes have enabled more South Africans to buy cars, use them more frequently on a single-occupancy basis and travel further. Improvements in engine efficiency have been nullified to some degree by the prolonged life of used motor vehicles, and by the number of sports utility vehicles (SUVs) used as runabouts. More than 150 000 of these have been sold in South Africa since 2001. While the image of SUVs is socially "cool", their environmental impact is the opposite.

It's up to you

Instead of passively hoping that others will resolve the adverse effects of transport on global warming, you should consider joining the growing number of people who are taking positive steps to reduce their own personal impacts on climate change. There is no time to lose.

Inform yourself about the contribution that travel makes to your personal carbon footprint (see sidebar and *Chapter 6: Past-Present-Future*). To identify and compare the carbon emissions of your road and air travel, use one of several Internet-based carbon calculators (these can yield varying results due to differences in underlying assumptions). Knowing your transport-related greenhouse gas emissions is the basis for reducing them through more efficient travel. As a last resort, the calculations can show you how to reduce your transport emissions by purchasing carbon offsets. The calculations also guide corporations and governments engaging in carbon emissions trading.

The two main areas of personal transport in which you can make an environmental difference are road transport and flying.

GREENING YOUR TRANSPORT

You can "compensate" for car and aeroplane travel by planting trees that absorb CO_2 or investing in energy efficiency projects. According to a South African carbon calculator (available at *www.trees.co.za*), for every two return air journeys between Cape Town and Johannesburg, you would need to plant one tree to absorb the portion of aircraft emissions for which you are responsible. For every return flight between Cape Town and London, you would need to plant two trees to absorb the per-passenger 2 057 kg of CO_2 produced.

A growing number of airlines allow you to calculate the per-passenger monetary cost of investing in green projects to offset carbon emissions and request voluntary payments by passengers when booking online. For an example of money savings from smarter driving and car-model rankings according to their carbon efficiency, see *actonco2.direct.gov.uk*.

To change your car use habits:

- Eliminate unnecessary motor-vehicle travel.
- Share car journeys wherever possible: each shared journey eliminates an unnecessary trip.
- Consolidate your daily or weekly activities to reduce car outings.
- If owning and driving a car are unavoidable, purchase a vehicle and use a fuel that is branded "green". A lightweight carbon-fibre vehicle chassis will use less fuel; unfortunately, they are still in development and are extremely expensive.

- Use public transport – as demand increases, public operators will respond positively to a growing market.
- Walk or cycle instead of taking the car – the exercise is healthy and the presence of more people on the streets makes them safer and creates more sociable neighbourhoods.
- Shop locally and avoid travelling far to buy products – become aware of the "food miles" you generate and consume.
- Consider small, light forms of transport for local urban travel, including electric cars, motor- or electric scooters and bicycles.
- Find a place to live that does not force you to use a car to get to and from work.

Become an "eco-driver":[5]

- Avoid sudden braking and rapid acceleration. Both can add 30% to your fuel use.
- Reduce driving speeds: did you know that driving at 100 kph as opposed to 120 kph uses approximately 25% less fuel?
- Avoid leaving an engine idling.
- Operate your motor vehicle for maximum performance – tune the engine regularly, inflate tyres correctly and minimise vehicle load (do not use a car boot as storage space). Under-inflated tyres can add 20% to fuel use. Roof racks and bull bars can increase fuel consumption by 5%.
- Use your vehicle radio and a map or GPS device to help you choose the least congested and shortest route.
- Use your air conditioner sparingly – it can increase fuel consumption by approximately 10%.

Campaign for better public transport:

- Lobby your municipality to install cycle lanes, and urge public authorities to provide public transport that is convenient, safe, reliable and affordable.
- Vote for public representatives who will campaign for better public transport.
- Find ways of working for and helping to organise information and pressure groups.

Reduce your flying:

- Cut back severely on the number and length of business and holiday flights.
- Consider the number of car trips you would have to forego in order to neutralise the greenhouse gas emissions from a single air journey, and think twice before jetting off to meetings, conferences and on holiday.
- Cancel your credit cards that earn loyalty points you can only spend on air travel.

The curtailment of the freedoms and privileges associated with private cars and flying is easier to accept if you remember that both forms of transport aggravate global warming and will affect people's lives and biodiversity in even the most remote corners of the planet.

GO ELECTRIC

Electric bicycles are ideal for urban transport. They take the sweat out of cycling and are ideal for commuters who are not cycling fit or have longer distances to travel to work. At a fraction of the price of a car, electric bikes offer silent, ultra-low emissions transport. They have a range up to 60 kilometres on a single plug-in charge through the mains, and consume just ZAR 0.40 worth of electricity per 100 kilometres. In the UK, all bikes purchased for cycling to and from work qualify for zero tax. *www.cyclescheme.co.uk*

Greening business transport

Small and medium-sized businesses, as well as large corporations, must all get involved in restraining unsustainable transport use. Environmentally conscious firms are now looking carefully at equipping, replacing and using their vehicle fleets to achieve maximum fuel-efficiencies. In addition, there is now a climatic and moral imperative (and a public relations boost) to making supply and delivery chains shorter and less haphazard. Environmental responsibility adds to and complements corporate social responsibility. "Green" logistics solutions focus on minimising the carbon footprint of business travel and on greening commodity supply chains.

Businesses can also make an environmental impact at the level of employee transport. Companies should:

- Find an alternative to company car schemes and allowances.
- Maximise persons per vehicle by purchasing a dedicated staff bus.
- Provide a space where employees can publicise travel times and routes for car-sharing.
- Provide bicycle lock-ups, changing rooms and showers at workplaces.
- Subsidise employees who use public transport (instead of paying for on-site parking).
- Enable certain employees to work from home occasionally.
- Prioritise video conferencing so that business meetings can be held without employees flying long distances.
- Lobby for better public passenger transport.
- Lobby for better rail freight transport; in 2001 it was estimated that 44 million tonnes of road freight traffic on South Africa's eight main intercity corridors could revert to rail and save 500 million litres of diesel fuel per annum.[6]
- Stop offering air tickets as rewards to high-achieving office staff and sales personnel, and end consumer brand-loyalty reward programmes that promote air travel. As the pleasure and esteem of air travel wears thin, it should not be difficult to divert the illusory benefits of air-miles programmes and their variants into more responsible and sustainable channels.

FOOD MILES

Food distribution accounts for 25% of road freight in the UK, and food transport by air has experienced the most rapid growth. Retailers are under pressure to reduce the distances from which they source supplies. TESCO, Britain's largest retailer, labels imports landed by air so that consumers can choose to avoid them. It uses a 50% biodiesel blend for its delivery fleet, and has replaced 28 trucks with a dedicated train that annually saves eight-million truck kilometres. The company's dedicated canal distribution service between warehouses reduces road use, and the train saves 14 500 truck journeys every year. *www.tesco.com/greenerliving*

Organised business in South Africa (including motor manufacturers, oil companies and airlines) can play a crucial role in its own future sustainability by building partnerships with government, educational establishments and transport-user groups to share information and best practice in the arena of transport energy and emissions.

A first step might be to commission software to enable firms to conduct green transport audits, set reduction targets and design route optimisation: as much as 75% of a company's carbon footprint can come from transportation. In logistics firms, this may be even higher.

Government must set the standard

It is vital for South African government and transport authorities to take a visible lead in the race to improve public transport and end private motor-vehicle dependency. Some work has started: the Gautrain project, which will ultimately link Johannesburg and Pretoria, aims to relieve motorway congestion by offering a workable public transport alternative; dedicated bus and taxi lanes on motorways are intended to promote smoother, more rapid journeys; taxi recapitalisation is designed to offer a safer, more fuel-efficient alternative to private vehicles.

Unnecessary urban car use in inner cities can be reduced by introducing area licencing and congestion charging. Creating unitary metropolitan transport authorities with a tough, enforceable environmental mandate helps. Powers should extend to rigorous enforcement of motor-vehicle speed limits and emissions standards. Emissions penalties will hit low-income households and individuals and people who use older vehicles hardest – the provision of affordable and accessible public or non-motorised transport is imperative for poor people.

A crucial challenge for government is to raise public consciousness about transport emissions. Running awareness campaigns, awarding prizes and holding events such as car-free days all promote progressive attitudes towards non-motorised transport. They also help to reverse the prestige of private car ownership and use,

and enable civil society to express and reinforce green credentials. All vehicles could be required to carry a visible carbon-emissions rating on their paintwork, much like a health warning on cigarette packets.

The steps that national government can take to ameliorate transport-related emissions include:

- Legislating for alternative and cleaner fuels. South Africa's extensive reliance on coal-based fuels (approximately 40% of all transport fuel consumed) results in more GHG emissions than are released by oil-based fuels. However, even if the coal-to-fuel process can be made cleaner, it will still be essential to reduce the amount of oil-based petrol (56%) used in South Africa's transport.[4]
- Requiring manufacturers to fit catalytic converters to vehicle exhausts.
- Experimenting with alternative and hybrid transport power sources, such as electric, gas-electric, hydrogen and solar.
- Legislating for and providing capacity to (re)test all motor vehicles annually to ensure adherence to emission standards.
- Taxing vehicle purchase and use in proportion to the pollution caused.
- Implementing a zoned road freight-vehicle emissions tax in urban areas. (*www.tfl.gov.uk/lez*).

However, if vehicle numbers and vehicle use are not curtailed, the success of such policy fixes is at risk. Essential complementary strategies to slow or reverse GHG emissions must help people to switch from private cars to public transport, to make fewer trips, and to switch road freight back to rail. One estimate is that a 3% traffic shift from road to rail would yield 10% savings in transport emissions.[7]

The imperative for improving public transport is to counteract its negative reputation. The fact that public transport is often unpleasant, uncomfortable, dangerous, inefficient, slow and inconveniently timed and routed are valid arguments for not using it.

The South African government needs to promote public transport by:

- Upgrading decayed transport systems and creating incentives that encourage people to use them. As in other developing countries, rapid bus carriers will be the most affordable and cost-effective, and several times more energy-efficient than urban car travel.

REDUCING CORPORATE EMISSIONS

The world's largest parcel shipper (UPS) reduces fuel use by its aircraft fleet (which makes it the world's eighth-largest airline) by carrying minimal fuel on aircraft, slowing flights, using ground electrical power for stationary aircraft, and limiting engine use during taxiing. UPS is expanding its alternative-fuels truck fleet and has been training its drivers in methods to reduce driving-related emissions. *www.sustainability.ups.com*

- Providing high-capacity, fast, regular bus services that connect attractive, clean and safe bus stations, as well as prepaid rail and taxi services that operate along densely settled corridors and link to feeder bus services. This "hub-and-spoke" solution is more flexible and cost-effective than massive and rigid "line-haul" projects such as the Gautrain. Mass public transport can help to improve local air quality and public health, and slick public services can enhance workplace productivity by reducing absenteeism.
- Integration between different forms of transport needs to be enhanced. This would include park-and-ride facilities; integrated ticketing systems for bus, train and taxi; allowing bicycles on trains – as is the case in many European countries.

Various levels of government also need to promote non-motorised transport. Construction of a network of cycle paths in cities is an obvious example of a scheme that can save transport energy, lessen greenhouse gas emissions, reduce congestion and promote public health. Coupled with schemes for purchasing, renting, subsidising and donating bicycles (South Africa's "Bicycle Empowerment Network" is a prototype: *www.benbikes.org.za*), cycling projects can help alleviate poverty. Estimates from Britain suggest that if each of the country's 6.6 million commuters who travel less than 8 km each day were to cycle to work, there would be 44 million tonnes less CO_2 generated annually.[8]

Governments must also play a crucial role in lessening transport GHG emissions and energy use by increasing urban residential densities (see *Chapter 16: You the urban planner*). Doing so will help to create a passenger market for economically viable public transport and will stop the urban sprawl that obliges the majority of South African commuters to make lengthy work trips. The challenge is to build compact, dense cities in which it is easier for people to perform their daily tasks safely and comfortably without having to use a motor car for every trip. Public facilities should be sited in transit-friendly locations. The charges should be raised for short-term car parking in areas served by public transport, and the number of onstreet parking spaces reduced annually. A moratorium on the development of residential estates and shopping malls on the edges of cities would help revive inner-city neighbourhoods and reduce the need for travel. As environmentalists are urging in other countries, similar prohibitions should apply to the construction of new airports, motorways and inner-city parking garages.

Closing thoughts

The urgent and radical action needed to limit the increase of transport emissions requires individual and public awareness and then enlightened governmental and corporate leadership. South Africa does not yet have the record of public environmental protest about green transport issues that is so evident elsewhere. This needs to start. Foreign campaign and activist websites are informative and inspiring (e.g. *www.foe.org.uk/campaigns/transport/index.html*; *www.aef.org.uk*; *www.enoughsenough.org*).

Resources

i. Environmentally Sustainable Transport and Climate Change; Experiences and lessons from community initiatives; UNDP; *http://sgp.undp.org/*
ii. UK Department for Transport; *www.dft.gov.uk/pgr/sustainable*
iii. Institute for Transportation and Development Policy; *www.itdp.org*
iv. Sustrans; *www.sustrans.org.uk*
v. Working Group III Report "Mitigation of Climate Change"; Chapter 5; Transport and Its Infrastructure; IPCC; *www.ipcc.ch*
vi. Climate Change Mitigation in the Urban Transport Sector: Priorities for the World Bank; World Bank; *www.itdp.org*
vii. State of the World 2007: Our Urban Future; *www.worldwatch.org/node/4752*
viii. World Business Council for Sustainable Development; *www.wbcsd.org*; see following and other documents under "Mobility" and "Publications":
  - Mobility 2030: Meeting the Challenges to Sustainability.
  - Mobility 2001 – World Mobility at the End of the Twentieth Century and Its Sustainability.
ix. George Monbiot; *www.monbiot.com;* see "Transport".

A wider view sees agriculture as having to fulfil at least three tasks: to keep man in touch with living nature, of which he is and remains a highly vulnerable part; to humanise and ennoble man's wider habitat; and to bring forth the foodstuffs and other materials that are needed for a becoming life. I do not believe that a civilisation that recognises only the third of these tasks, and that pursues it with such ruthlessness and violence that the other two tasks are not merely neglected but systematically counteracted, has any chance of long-term survival.

E.F. Schumacher, *Small is Beautiful: A Study of Economics as if People Mattered*

18

You the Farmer

Linda Scott with Leonie Joubert

Agriculture in South Africa is not only a contributor to climate change; it is also highly vulnerable to the effects of shifting climate conditions. While it is impossible to predict with certainty what the effects will be, it is expected that changing rainfall patterns, along with increasing frequency and intensity of drought in some areas and flooding in others, will seriously compromise the productivity of many farms, both subsistence and commercial. In addition, increasing temperatures and heat waves will make the growth of certain crops difficult, as many may be close to their ceiling of maximum temperature tolerance. There is much, however, that farmers can do to reduce both agriculture's contribution to climate change and adapt to changing weather patterns.

Facts and figures about agriculture in South Africa

South Africa is currently self-sufficient in virtually all major agricultural products, although in bad rainfall years there is a shortfall in the production of crops such as wheat. In good rainfall years, the country becomes a net food exporter. Agricultural production is remarkably diverse, thanks to the many different climatic and agricultural conditions. The major crops include maize, wheat, sugar cane and sorghum, and the minor ones are peanuts, sunflowers, dry beans, tobacco and potatoes. Important fruits, especially for export, include apples, citrus, grapes, pears and peaches. The total number of livestock includes 29 million sheep, 13.6 million cattle and 6.6 million goats[1] and are the most important financial contributor to the agricultural sector.[2]

Agriculture uses an estimated 86% of land, of which 70.5% is under permanent pasture (natural veld), 13% under cultivation and 2.5% for settlements. The main form of agricultural production involves medium- to large-scale farms, accounting for 90% of all agricultural land. These operations are generally capital intensive and commercially orientated, producing a surplus for sale. Conversely, the remaining small-scale farms tend to be labour intensive (worked by 86% of the farming population), used for subsistence only and reliant on traditional agricultural methods.[1] However, increasing population growth and other land-use requirements have steadily eroded the amount of agricultural land that is available per capita. This average has dropped from 0.86 ha per person in 1970 to 0.5 in 1980. It is expected to decrease to 0.2 ha by 2050.[2]

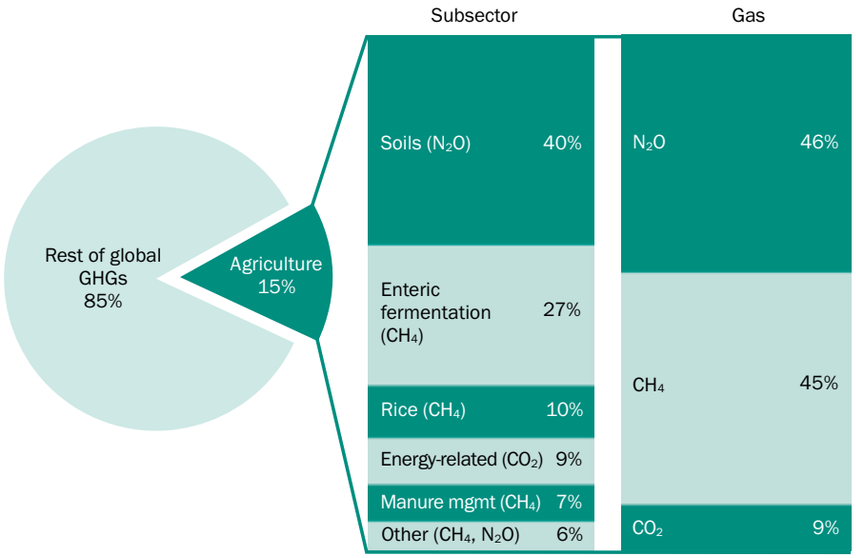


Figure 1: Greenhouse gas production associated with global agriculture
Source: Navigating the Numbers. 2005. World Resources Institute. *www.wri.org*

As can be seen from Figure 1, agriculture worldwide contributes about 15% to global emissions, although in South Africa it is currently responsible for only 7% of the country's greenhouse gas emissions (down from 12% in 1990). All gases are measured in carbon dioxide (CO_2) equivalents. This is particularly important when assessing agriculture's contribution as it is mainly in the form of nitrous oxide (N_2O) and methane (CH_4), both of which have a much greater warming potential than CO_2.[3,4,5]

Nitrous oxide (N_2O)

An estimated 75% of global sources of N_2O derives from agriculture. Around 80% of N_2O production in South Africa is attributable to agriculture. While N_2O is produced naturally as part of the nitrogen cycle, intensive agricultural activities, combined with the widespread use of synthetic nitrogen fertilisers, have increased its production dramatically. The main agricultural sources of N_2O come from:

- Synthetic nitrogen fertilisers.
- Manure – through manure-management processes and application as fertiliser.
- Extensive leguminous cropping (e.g. soybeans, alfalfa, clover) leading to an increase in biological nitrogen fixation and N_2O production.

Methane (CH_4)

Livestock's role in CH_4 emission is a well-publicised fact. Ruminants (cattle, sheep and goats) ferment plant material in their rumens, producing large amounts of CH_4 (one to 500 litres per cow each day), which is then released into the atmosphere through burping and flatulence (non-ruminant animals and humans thankfully produce only small amounts of CH_4 from their digestive processes!). Together with CH_4 emission from all types of manure, domesticated livestock now accounts for 35% to 40% of global and South African CH_4 emissions. Wetland rice cultivation in other parts of the world releases substantial quantities of CH_4 due to anaerobic fermentation of organic matter in the flooded fields.

Carbon dioxide (CO_2)

Agricultural CO_2 production represents 1.4% of global CO_2 production and is a result of:

- Fertiliser manufacture.
- Agricultural machinery (tractors, farm-processing equipment etc).
- Irrigation.
- Transport to and from the farm.
- Cold storage and cold chain management from packhouse to consumer.

All these activities use fossil fuels, directly or indirectly. Agriculture also contributes to CO_2 production through land clearing and burning activities. This is, however, included under emission figures for land-use change and represents a substantial 18% of global CO_2 production.

Water is the big issue in South Africa

Rainfall is distributed very unevenly across South Africa, with humid, subtropical conditions to the east and dry, near-desert conditions to the west. The average rainfall across this water-stressed country is only 450 mm per year (well below the global average of 860 mm), and this is compounded by a comparatively high rate of evaporation.[1] A mere one-tenth of the country receives more than 750 mm. KwaZulu-Natal is the wettest province and the Northern Cape the driest. Furthermore, substantial groundwater reserves are under siege as the water is being drawn out through boreholes at a much faster rate than it is being replenished.

The availability of rain- and groundwater have dictated the distribution of agriculture across the country – and the success of this industry means that it now uses over 62% of South Africa's water resources. The natural availability of water across the country is variable as a result of highly seasonal rains, with a relatively low stream flow in South African rivers for most of the year, limiting the proportion that can be reliably used. A low rainfall, compounded by forestry and agricultural land use, means that only 9% of precipitation reaches the rivers, compared with the world average of around 30%.[6]

The country's ability to feed itself in the future remains critically dependent on the availability of water, which is increasingly coming under pressure. South Africa is expected to use up its available water resources by 2030, as a result of normal population and economic growth. If you add the anticipated effects of climate change to that equation, then the management of this limited life-giving resource should be uppermost on everyone's agenda.[2] An analysis of water losses due to climate change stated that the following can be expected to happen:[7]

SYNTHETIC FERTILISER AND THE GREEN REVOLUTION

All living organisms require nitrogen, a constituent of protein, to survive and grow. Humans and animals eat plants to obtain it, and plants take it up through the soil. The nitrogen pool available to plants is very limited under natural conditions. This restricts ecosystem development and, in the past, constituted a natural restraint on global food production and, therefore, population growth. The invention of the Haber-Bosch synthetic fertiliser process in the early 1900s dramatically altered these natural restraints. Through synthetic fertiliser application, the rate of nitrogen entering the ground-based nitrogen cycle has doubled and now supplies 40% of the nitrogen that is taken up by crops. However, the uptake of the element is inefficient (only 50% is absorbed), and the excess enters the nitrogen cascade, producing a variety of nitrogen compounds (in addition to N_2O) that pollute and damage many ecosystems. So, while synthetic nitrogen fertilisers have increased crop production, the environmental price for this development has been high.

- The country's main rivers will lose runoff or will become less predictable. The catchment outflow of some of the main rivers (the Orange and Mgeni, for example) may reduce by 12% to 20% by 2050.
- Dams in the Western Cape will increasingly silt up as drought and more intense and frequent fires destroy vegetation, causing widespread erosion. This will exacerbate the province's already stretched storage capacity.

Together with emissions from all types of manure, domesticated livestock now accounts for 35% to 40% of global and South African CH_4 emissions.

Growing food in a hotter country

Regional climate change scenarios remain uncertain, although projected temperature changes (an increase of at least 1 °C to 3 °C within the next 30 to 50 years, with the strongest effect on the daily minimum temperatures) can be made with a higher level of confidence than projected rainfall changes. Rising atmospheric levels of greenhouse gases are predicted to make the north-western and south-western regions of South Africa progressively hotter and drier, with less predictable rains and increasing periods of drought. Other parts (the northern and eastern regions) will also become hotter but wetter, with potential changes in the intensity and seasonality of the rainfall.

The main gas responsible for climate change, CO_2, is something of a wild card in the agricultural stakes. Higher atmospheric levels are expected to trigger faster growth rates as plants use CO_2 to make food. However, the benefits to crops and pasture from CO_2 fertilisation may be counteracted by the additional pressures caused by increasing temperatures, aridification and drought. These burdens are expected to be much more intense in the drier western area, making many areas unsuitable for any type of agriculture.

Because maize is the regional staple food (50% of the subcontinent's maize is grown in South Africa), it has received the greatest attention from climate change modellers. As the population of South Africa is expected to climb from today's estimated 47.9 million (mid-2007, StatsSA) to over 51.5 million by 2021 (Unisa 2007), maize production will need to expand considerably to feed this population.

Yet, because of climate change, the national harvest may drop by as much as 10% to 20% over the next 50 years. The production of other important crops, such as wheat and sugar cane, is likely to suffer similar reductions. Horticulture (including viticulture), which comprises over 50% of the Western Cape's agricultural production (as well as over 50% of South Africa's agricultural exports), will also be highly vulnerable.

All soft fruits in marginal areas will suffer, especially apples, as heat stress and insufficient cold conditions in winter degrade fruit quality.[1,7]

The continued success of the livestock sector depends on the productivity of pastures. Rising CO_2 levels may make rangelands in the east more productive, but in the Karoo and western parts, where vegetation is scrubbier, CO_2 fertilisation is expected to have minimal impact. Productivity will therefore decrease in these areas, resulting in a slump in the overall sector.[1,7]

The frequency and intensity of fires are likely to increase, which will have an impact on pasture availability.[2]

Another area of concern for agriculture is the expected expansion of the range of certain pest species, including migrants like the brown locust, into areas that were previously free of them. Livestock disease outbreaks, such as foot and mouth, could also become more widespread and frequent.[2]

Adaptation strategies for a changing climate

As very little research has been conducted on the effect of climate change on the country's agriculture, preparing an adaptation strategy remains largely in the realm of educated guesswork, with the priority being given to the wise use of water and switching to more drought-resistant crops. Farmers also need to familiarise themselves with the expected climate change projections for their areas and make plans accordingly. The following strategies should be considered:

More crop per drop. Drip irrigation is the most efficient means to deliver water directly to plant roots, but it is costly to install. Government subsidies or tax rebates are needed to encourage this practice. Other forms of irrigation are wasteful (current losses are estimated to be 30% to 40% of the demand) and should be phased out and replaced with dry-land farming. Changes in planting dates of annual crops, row spacing and planting density could counter reduced water availability and practices such as conservation tilling, furrow dyking, terracing, contouring and planting of windbreaks will help to increase infiltration and reduce water and wind erosion and evapotranspiration (the amount of water vapour lost into the atmosphere through plant transpiration and evaporation).[6]

Appropriate crop and cultivar choices. These need to take into account current climatic realities and future climate change predictions. Farmers must select the right cultivar for their particular area, or consider changing crops. For instance, western maize plantings are expected to suffer most from heat and drought conditions, so farmers may have to switch to more drought-resistant crops such as millet or sorghum. Hardier trees such as olives, figs and pomegranates should also be considered. Adaptability will depend on how marginal the land is at the outset and whether other crops or cultivars can be found to suit the microclimate of particular farms.

Improved soil health. This helps to improve resilience of crops to drought and heat stresses (see "Soil as a carbon sink" on page 237).

BACK TO NATURE – THE CAPE'S BEST ADAPTATION STRATEGY

South Africa is ranked third in the world in terms of biological diversity. The Western Cape has one of the most diverse and prized floral communities on the planet, covering only 4% of southern Africa but home to 45% (9 000) of the subcontinent's plant species.[2] So where non-indigenous crops begin to fail, farmers could turn to the natural environment. Sustainable harvesting of fynbos for wild flowers and thatch may be viable alternatives. Ecotourism is already a strong provincial sector and could be a viable alternative for a struggling farmer. However, this means that farmers must cease ploughing up the tracts of fynbos that exist on their properties. The Western Cape government is already considering offering tax relief to farmers who conserve the natural vegetation.

Land-use change. Marginal croplands could also be converted to grazing lands, planted with harvestable indigenous plants or returned to their natural state. For instance, in the Western Cape, the commercial fynbos cut-flower industry has excellent growth potential, as does the ecotourism industry. In areas where agriculture may become impossible, such as the Northern Cape, farmers could consider "farming" sunlight by putting up multiple solar-thermal collectors to generate electricity, which they could then sell to Eskom. This system has been practised successfully in California for many years, and could both provide a viable income and mitigate climate change. Its success is dependent on the national utility adapting its business model to allow private initiatives to be suppliers to the national grid.

Adopt sustainable agricultural practices. These include permaculture, organic farming and zero-waste agriculture (see relevant sections in this chapter).

Weather forecasts. Farmers need to make greater use of reliable daily, weekly and seasonal weather forecasts, including early warning systems, for management and planning purposes.

Improved breeding programmes. A much stronger national breeding programme is required to produce hardier cultivars and livestock.

The urban and rural poor will be the most vulnerable to the effects of climate change and an increasingly volatile food supply. Reduced productivity of subsistence farms combined with rising food prices will lead to even greater levels of food insecurity. Government and civil society organisations need to provide both financial and training support to enable effective adaptation strategies. For instance, the Goedgedacht Trust, working to uplift disadvantaged rural communities in the West Coast/

Swartland area of the Western Cape, has for several years promoted the planting of drought-resistant, food-bearing trees such as olives, and, more recently, pomegranates and figs, in anticipation of climate change in this area. Other initiatives, such as the promotion of urban agriculture, are required to increase levels of food security amongst the urban poor (see "Urban agriculture" sidebar in *Chapter 19: Your food*).

PERMACULTURE – AGRICULTURAL AND CULTURAL SUSTAINABILITY

Permaculture is a form of permanent agriculture that is ecologically sound, highly efficient and sustainable long-term. The method uses the natural qualities of plants and animals, combined with the natural characteristics of landscapes and structures, to design perennial agricultural systems that will support life in both rural and urban environments, using the smallest area possible and causing the least damage to the Earth's ecosystems. Permaculture incorporates many aspects of organic farming as well as other sustainable farming practices.

Why go organic?

Organic farming is a sustainable and ecologically sound form of agriculture as it largely excludes synthetic inputs – fertilisers, pesticides and herbicides – and uses compost, mulches, green manure, cover crops, mineral rock powders and other biological measures to maintain soil fertility and natural pest control. Charges that such farming has lower yields than conventional agriculture have been refuted by several peer-reviewed, published studies. And there is mounting evidence to suggest the Green Revolution, chiefly reliant on synthetic fertilisers and chemical pesticides, may have run its course.

Increasing signs of soil infertility, chemical pollution of land and water resources, pesticide resistance and declining yields in some areas suggest that conventional agricultural methods may not be sustainable in the long term.[8,9] All farmers need to adopt at least some natural or organic methods to restore soil fertility and carbon retention and increase plant resistance. Organic farming methods help to mitigate climate change for the following reasons:

- Less N_2O is produced because synthetic fertilisers, the main source, are not used.
- It is less energy intensive, principally because of the absence of synthetic fertilisers. The manufacture of fertiliser is responsible for the largest source of CO_2 in agriculture and is the greatest energy input in conventional farming.
- Organic matter is conserved, which helps to maintain the soil's carbon content and to prevent it from being released into the atmosphere as CO_2 (see "Soil as a carbon sink" on page 235).

The great English agronomist, Albert Howard, wrote in his landmark book *The Soil and Health* that we should approach "the whole problem of health in soil, plant, animal and man as one great subject". Diversifying field use leads to fewer chemicals and healthier soils, and, in turn, a sound ecosystem.

Responding to changing market dynamics

Increasing international consumer resistance to high embodied-energy and/or air-freighted foodstuffs and beverages will have an adverse impact on food-exporting nations like South Africa, which is geographically distant from its main markets. Farmers will have to be more proactive to maintain export destinations. In one of the most progressive moves to emerge from the wine industry, Backsberg Wine Estate in the Western Cape has become carbon neutral. The estate offsets its full production and transport carbon emissions (including transport to overseas markets) through a local tree-planting initiative. It has also reduced its total carbon emissions by becoming more energy efficient and using biofuels made from used cooking oil. However, all the major horticultural industries need to assess and reduce their carbon footprints, as is happening in the Western Cape, so that solutions can be developed and applied throughout the industry.

However, caution must be observed when considering carbon offset programmes – these need to be carefully screened to ensure they offer true offsets and don't cause further problems, such as planting trees in water-scarce environments.

Mitigating agricultural emissions

Despite significant potential for mitigation in agriculture, there is very little progress in implementing these measures on a global scale. It is widely agreed that policy and economic incentives, educational programmes and the promotion of innovative technologies are needed to encourage widespread change and cooperation. Globally, agricultural CH_4 and N_2O emissions increased by nearly 17% from 1990 to 2005 as a result of increased use of nitrogen fertilisers and rising livestock production. It is expected that agricultural greenhouse gas emission rates will continue to escalate, fuelled by population growth and an increased demand for food, especially animal-based food.

Many mitigation options use current technologies and can be implemented immediately, but technological innovations will increasingly play a part in future measures. Soil carbon sequestration (enhanced sinks) has the highest potential followed by mitigation of CH_4 and N_2O emissions from soils.[4,10]

Measures that will reduce CO_2 emissions are:

- *Increased carbon storage in soil and plant matter* – the following best practices increase carbon storage potential: low or zero-tillage, nutrient management,

rotational grazing and improved forage control, implementation of crop rotation and cover crops, the establishment of riparian buffers and the restoration of degraded land (see "Soil as a carbon sink").

- *Improved energy efficiency* – through energy-saving practices such as the use of less fertiliser, conservation tillage methods and more energy-efficient machinery.
- *Land-use change* – through conversion of cropland to grassland and/or agroforestry.
- *Reduced burning of agricultural residues.*
- *Reduced frequency of fires.*

CH_4 emissions can be reduced by:

- *Improved livestock feeding practices* – the bulk of agricultural emissions come from enteric fermentation in ruminant livestock. Microorganisms break down complex carbohydrates into simple sugars, releasing CH_4 in the process. Up to 7% of livestock feed can be lost as CH_4, so increasing digestive efficiency can help save the planet as well as costs. This can be achieved by increasing the percentage of highly digestible feed matter and correcting nutrient deficiencies.
- *Improved livestock manure management* – manure stored in central tanks or lagoons releases CH_4 during anaerobic decomposition. Technology is now available to capture this excess and use it as energy, thereby reducing electricity costs and CO_2-related production (see "Zero-waste agriculture").

N_2O emissions can be reduced by:

- *Appropriate application of nitrogen fertiliser* – nitrogen field-sampling tests can determine crop requirements to avoid over-application. Nitrification inhibitors can also be used with fertilisers. Improving field drainage and avoiding soil compaction will help to reduce N_2O emissions.
- *Organic farming* – no synthetic nitrogen fertilisers are used in this method of farming.

Agricultural mitigation measures often have synergy with sustainable development policies in other spheres, including social, environmental and economic spheres. Strategies such as zero-waste agriculture, which simultaneously address climate change and issues such as poverty alleviation and job creation, are clearly in the best national interest.

Zero-waste agriculture – the future of farming

Zero-waste agriculture is a totally sustainable form of agriculture in which the waste of each process becomes the feedstock for the next stage of an integrated cycle. This cycle produces food, energy and nutrients utilising plants, animals and microorganisms. At the centre of most zero-waste agricultural systems is a biogas digester, which produces fertiliser used on crops and biogas for heat and energy generation.

The advantages of zero-waste agriculture are:

- Optimal food production in an ecologically sustainable manner.
- Minimal water consumption through recycling and reduced evaporation rates.
- Energy security through the harvesting of methane – biofuels can also be made from algae. Grown in shallow ponds that are fed by the digester effluent and the high-protein waste left after the oil extraction, the algae makes excellent animal feed.
- Much lower greenhouse gas production compared with conventional agricultural practices.
- Increased long-term cost effectivity.

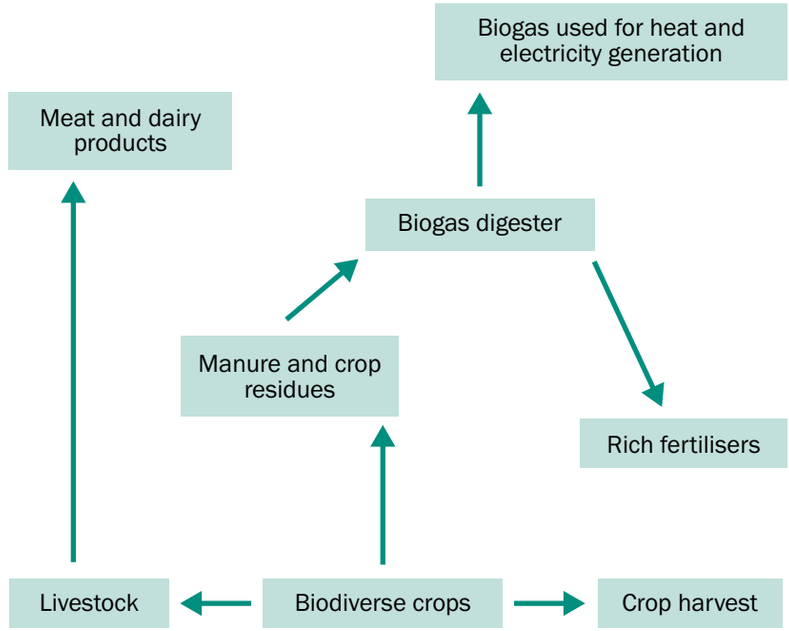


Figure 2: A basic diagram of the zero-waste agricultural system

Soil as a carbon sink

People usually think of trees when considering carbon storage, but soil is actually the largest carbon reservoir in the terrestrial biosphere (oceans are the biggest reservoir overall). While estimates vary considerably, soils contain between two to three times the carbon in the atmosphere and three to four times the carbon stored in all the world's vegetation.

How farmers manage their soils determines whether they become net emitters or absorbers of carbon. Carbon rotates continually between all living things, the

soil, the atmosphere, rivers and oceans. People, wood and organic soil matter are made up of 18%, 50% and 58% carbon respectively. When CO_2 is removed from the atmosphere and stored in part of our biosphere, for example in trees or soils, it is described as sequestered. These storage locations are referred to as carbon sinks.

Multiple benefits accrue from high-carbon soils, including improvements in soil structure, water infiltration rates, moisture retention, buffering of soil temperatures, nitrogen and sulphur sequestration, trace element availability, biodiversity and productivity. All farmers should regard soil carbon as their most valuable asset and adopt practices to conserve it.

Groundcover management is important in determining whether soils provide a net loss or a net gain of atmospheric carbon. Groundcover includes plants, plant litter and crop stubble. Methods such as zero tillage and pasture cropping maximise the amount of carbon stored in the soil. They also reduce soil erosion and water requirements.

Zero tillage (direct drilling) is widely practised in the US and Brazil and involves seeding uncultivated soil, as well as rotating crops and constantly covering the soil with crop residues. Specialised seeding machines are required, which previously inhibited farmers from adopting this practice.

Cheaper machines are now available and zero tillage has spread, because of its many advantages over conventional cropping, especially for degraded agricultural land. Pasture cropping is a relatively new land-management technique by which crops are sown into perennial (usually indigenous) pastures. It has similar benefits to zero-tillage methods.

In the US, the Intergovernmental Panel on Climate Change (IPCC) estimated that zero-tillage systems save 300 kg carbon/hectare/year, while reduced-tillage systems save 100 kg carbon and conventional tillage systems deliver a net loss of 100 kg carbon to the atmosphere.[10]

Crop-based biofuels – courting with disaster?

As global consumption of petroleum outpaces the world's production capacity and climate change is seen as a reality, attention has focused increasingly on alternative sources of energy. The production of biofuels from crops is one such alternative. South Africa's Industrial Development Corporation and Central Energy Fund selected five towns across the country to take part in a R3.2 billion biofuels project that started in 2007. Together Hoedspruit and Ogies in Mpumalanga, Makhathini and the Pondoland region in KwaZulu-Natal, and Cradock in the Eastern Cape are expected to produce a billion litres of biofuels per year and contribute 1.3% to South Africa's GDP.

Sugar cane, sugar beets, sweet sorghum and cassava will be purchased from local farmers and used to produce the biofuels. The government's Accelerated and Shared Growth Initiative for South Africa (AsgiSA), which aims to increase economic growth and reduce unemployment and poverty, has identified the bio-fuels

ALGAE – A MIRACLE BIOFUEL?

Biofuels from the humble *Chlorella* algae may be a viable alternative. Algae farms require much less water and land than crops, and grow up to 40 times faster. They have the potential to deliver 10–100 times more energy per unit of land compared with current energy crops. Moreover algae can thrive in brackish or even wastewater and don't require arable land either, so resources are not diverted from food production.

Oil extraction is currently difficult and expensive but genetic engineers are working on creating more suitable strains that will produce the oil on a continuous basis. Algae farms hold a lot of promise and may just be the answer for farmers whose land is no longer arable and have scant water resources. The new generation of biofuel technology based on non-food cellulosic biomass (such as wheat and maize straw and wood from alien trees) or waste material (used vegetable oils) also shows much potential.

sector as a priority. However biofuels are, at best, only a short-term solution for both South Africa and the world because:

- The cultivation of plants by conventional agricultural methods contributes substantially to greenhouse gas emissions and the whole production process is itself energy intensive. The production of biofuels releases twice as much N_2O as previously calculated (3% to 5% versus the original IPCC value of 2%). Biofuels derived from certain plants, such as maize and rapeseed, actually generate more greenhouse gases (50% and 70% respectively) than fossil fuels when the whole life cycle of production and use is considered.[11]
- There is already insufficient agricultural land and water to meet rising food demand, so diverting these resources to biofuel production will only exacerbate the situation. The production of maize for biofuel, for example, has now overtaken the production of maize for food in the US.
- Using crops such as maize for biofuel production will increase the price of staple foods as well as the costs of livestock production, presenting a direct threat to food security for the urban and rural poor. It takes the same amount of maize to feed one person for a year as it does to fill the tank of a large car. This is why maize has been excluded from the South African government's recent biofuels strategy.
- Several biofuel projects have led to serious deforestation in certain areas, creating more greenhouse gases and losing valuable carbon sinks and biodiversity, as well as taking away traditional livelihoods. The production of palm oil in Indonesia for biodiesel is a case in point.
- The cost of transporting feed stocks to processing plants makes biofuel production viable only on a local scale.

Measures designed to reduce greenhouse gases therefore need to be thoroughly assessed, ecologically as well as socially and economically, before being hailed and widely adopted as a solution.

The spreading alien thirst

Alien plants have already invaded around 10 million hectares, or nearly 7% of the South African countryside and are expected to penetrate indigenous ecosystems affected by climate change stresses. Water consumption by alien plants is expected to double by 2015, further jeopardising our scarce water resources. The government has prioritised clearing, control and eradication of these plants. The Working for Water programme, launched in 1995, is designed to increase access to available surface water by clearing invaders from rivers and water-catchment areas, while also providing jobs and social upliftment. However, a more aggressive eradication programme is required to make a significant impact and conserve our limited water resources.[12,13]

Alien plants	Annual water use in millions of cubic metres (m^3)
Black wattle (*Acacia mearnsii*)	576.58
Rooikrans (*Acacia cyclops*)	487.63
Silver wattle (*Acacia dealbata*)	248.32
Pine species	231.53
Eucalyptus species	213.98
Mesquite (*Prosopis* species)	191.94
Port Jackson (*Acacia saligna*)	171.13
Pride-of-India/Chinaberry (*Melia azedarach*)	164.91
Bugweed/Wild tobacco (*Solanum mauritianum*)	139.97
Lantana (*Lantana camara*)	97.14
Triffid weed (*Chromolaena odorata*)	68.26
Hakea species	66.30

Figure 3: The "dirty dozen" plant invaders
Source: See references 12 and 13

GENETIC MODIFICATION (GM)

Genetic modification is an extremely controversial topic. South Africa is the only country in Africa to grow GM crops commercially, and it is the eighth-largest producer in the world. These crops include maize, soya and cotton, with over 50% of maize and soya production being GM. While GM crops can be associated with reduced greenhouse gas emissions (through diminished herbicide and pesticide use and reduced tillage) and can provide higher yields, their benefits as well as their health and environmental safety profile have not been unequivocally established. Widespread safety concerns keep being identified, and GM foods are banned in many countries.

Paying farmers to protect the environment

The United Nations Food and Agricultural Organisation (UNFAO) has declared that paying for environmental services will become an important way to make sure that the ever-increasing demand for food does not destroy the planet.[14]
Incentives are needed to encourage:

- The storage of carbon in plants and soils.
- Water conservation.
- Nature conservation and less-damaging agricultural practices.

Agricultural carbon sequestration projects also offer farmers a way to enter the carbon-trading market, using their land as a source of carbon offsets which can be traded internationally. This development could ensure more extensive farmer involvement in effective mitigation practices throughout the world.

Deforestation is estimated to produce at least 18% of greenhouse gas emissions worldwide, so paying poorer countries not to clear forests for agriculture is another possible option. This approach, which is highly relevant to those countries that still have large forests, would have to be weighed against the possibility that food production could be reduced and that such schemes may benefit relatively wealthy landowners more than the rural poor.

The role of government

There is much that can be done in the agricultural sector, but it will require decisive and sustained government intervention to create change on a broad scale in the minds and practices of our farmers.

The Department of Agriculture exercises control over the use of South Africa's natural agricultural resources, and legislation provides for the conservation of these resources through maintenance of the land's production potential, combating and preventing erosion, protecting vegetation and eradicating invader plants. LandCare is an additional government-supported initiative designed to promote sustainable land management.

Policies and adaptive measures to combat climate change are being developed within the framework of national priorities, which include poverty alleviation, provision of basic services to all South Africans, equity, employment creation and economic growth. Government-level responses will need to include: appropriate legislation to enforce mitigation strategies, educational programmes to encourage and support change (including the adoption of new technologies), and financial incentives (as subsidies and/or tax rebates) to aid both commercial and subsistence farmers in adapting to the changing environment.

The Department of Water Affairs and Forestry ensures equitable access, beneficial utilisation and environmentally sustainable practices. Stricter legislation may also be required to ensure the responsible use of water, including the regulation of private boreholes in order to protect groundwater supplies. Uneven distribution of water resources in southern Africa, coupled with the advent of more frequent droughts and floods, has already caused hardship for many people, particularly the poor. If periods of drought intensify, as predicted, the impact on water resources and agriculture will become significant. The government, therefore, needs to prioritise water-usage planning for the future.

> "Many organic practices simply make sense, regardless of what overall agricultural system is used. Far from being a quaint throwback to an earlier time, organic agriculture is proving to be a serious contender in modern farming and a more environmentally sustainable system over the long term."
>
> *David Suzuki, environmental activist*

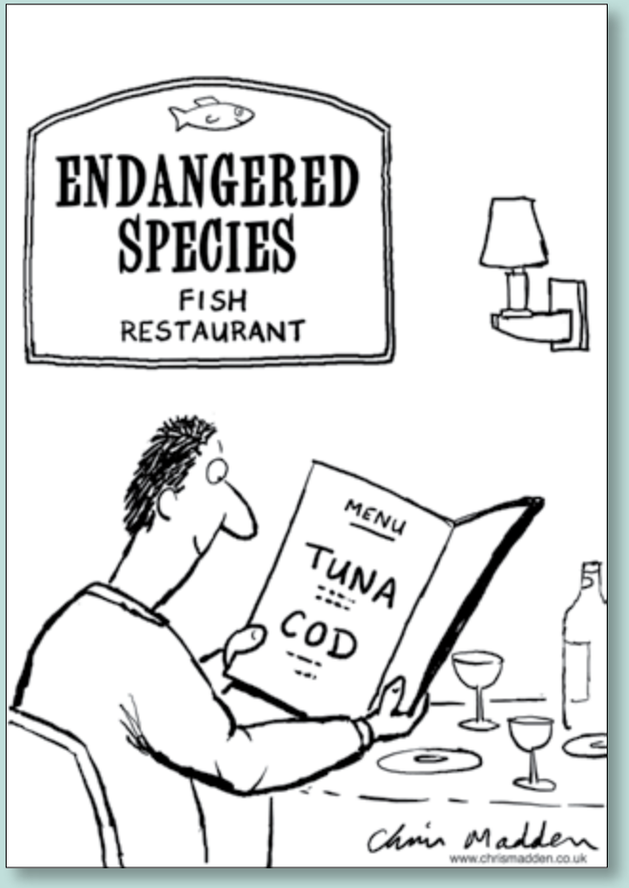
In conclusion

In the words of Jacques Diouf, UNFAO Director-General: "Farming has the potential to degrade the Earth's land, water, atmosphere and biological resources – or to enhance them – depending on the decisions made by the more than two billion people whose livelihoods depend directly on crops, livestock, fisheries or forests". As we enter the epoch of human-induced climate change, the role of farmers, as producers of food and custodians of much of the earth's surface area, will become critical to our continued survival.

Resources

i. Algae fuels; *www.en.wikipedia.org/wiki/Algae_fuel*
ii. Biofuels; *www.en.wikipedia.org/wiki/Biofuel*
iii. Farming carbon; *www.amazingcarbon.com*

iv. Soil Association; *www.soilassociation.org*
v. Third World Network; *www.twnside.org.sg*
vi. Zero-Waste Agriculture; *www.en.wikipedia.org/wiki/Zero_waste_agriculture*



Eat food. Not too much. Mostly plants.
That, more or less, is the short answer to the supposedly incredibly complicated and confusing question of what we humans should eat in order to be maximally healthy. A little meat won't kill you, though it's better approached as a side dish than as a main. And you're much better off eating whole fresh foods than processed food products. That's what I mean by the recommendation to eat 'food'.

Michael Pollan, author of *Omnivore's Dilemma* and *In Defense of Food*

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Your food
How green is your plate?

Linda Scott

Our relationship with our food and the environment has gone horrifyingly wrong and, in both cases, it has been due to overconsumption – of food calories on one hand and of fossil fuels on the other. In South Africa, almost half of the population is either overweight or obese. The carbon footprint of our changing diets has grown in proportion to our body size as we eat more animal foods (meat, poultry, seafood, eggs and dairy products), as well as highly processed and imported foods. Escalating health issues related to the change in eating patterns reinforce the reasons that these developments are not sustainable long-term. This chapter explores the relationship of our food to both climate change and health, and investigates how to improve the situation on both fronts. Happily, green food choices are also healthy food choices.

What influences our food choices?

Our food choices are largely determined by the following:

Income and availability. People in industrialised countries generally have a surfeit of available finance and the foods to spend it on, and are eating and drinking too much. In addition, their diet is usually the wrong sort. This has resulted in an increased incidence of the "diseases of affluence": obesity, heart disease, stroke, diabetes, common cancers (breast, prostate and large bowel) and various auto-immune disorders.

Multimedia advertising. The advertising budget for processed foods and drinks (convenience meals, snack foods, soft drinks and so on) has increased exponentially in recent decades. Advertised foods are usually high in fat and/or sugar and sodium, and their increased consumption has been a major contributing factor to the worldwide obesity epidemic in both adults and children. These foods generally require more energy in their production and so have a higher environmental toll as well.

Cultural food mores. Essentially, people grow up liking the diet they were raised on, so children should be exposed to a wide variety of wholesome foods from an early age to encourage a lifetime of good eating habits.

The food-supply chain – teasing out the environmental cost of our food

Agriculture contributes as much as the entire transport industry to global greenhouse gas emissions, but this does not include emissions that are associated with food processing, and transport to retail outlets and to our plates. All stages of the food-supply chain illustrated below give off greenhouse gases and therefore contribute to climate change.

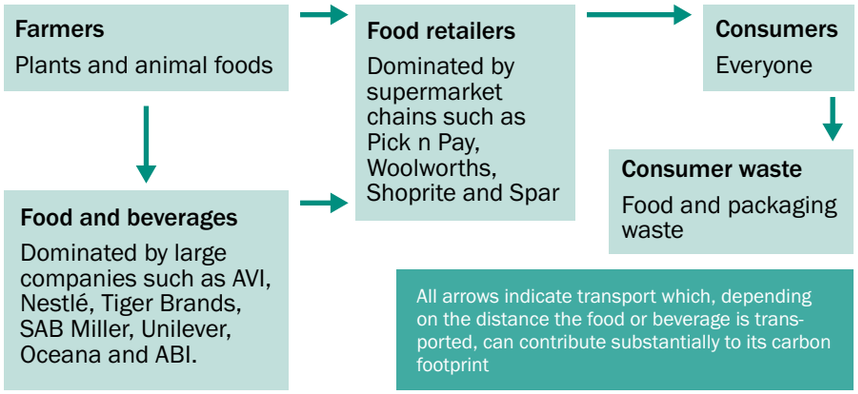

Figure 1: Food-supply chain

Farmers

Of the approximately 15% that agriculture contributes to global greenhouse gas emissions, 46% is in the form of nitrous oxide (N_2O), 45% as methane (CH_4), and 9% as carbon dioxide (CO_2).[1]

N_2O – agriculture is responsible for approximately 75% of the global N_2O production, with synthetic fertilisers contributing the lion's share.
CH_4 – ruminant livestock (such as cattle, sheep and goats) and general livestock manure are the main sources of CH_4, and contribute a hefty 35% to 40% of global CH_4 emissions.
CO_2 – agriculture represents nearly 1.4% of global CO_2 production because of the use of fossil fuels to:

- Manufacture and transport fertilisers (and other chemical applications).
- Produce and transport seed and animal feed.
- Run agricultural machinery and tractors.
- Irrigate crops.
- Transport food to retail markets and food processors.

Food and beverage manufacturers

This stage contributes CO_2 from the use of fossil fuels to:

- Process plant and animal foods (e.g. grain milling, bread manufacture, meat and milk processing, and food canning, bottling and freezing).
- Produce packaging materials (glass, plastic, paper, cardboard and aluminium/tin cans).
- Package foodstuffs and beverages.
- Transport materials to manufacturers and finished products to retail outlets.

Food retailers

Greenhouse gas emissions include CO_2 from transport (between warehouses and retail outlets) and electricity for retail outlets and storage facilities to power lighting, air conditioning, refrigerators, freezers and so on.

Consumers

We, as consumers, can add substantially to the overall footprint of a product, depending on how far and how often we travel to do our shopping and the transport we use to get there.

Waste

An often overlooked aspect of the total greenhouse gas production of the food-supply chain, the disposal of our food waste and packaging contributes CO_2 from transport and CH_4 from decomposition in landfills.

Carbon footprint or food miles – measuring the environmental impact of our food

A food's carbon footprint is defined as the total amount of CO_2 and other greenhouse gases emitted over the full life cycle of its production, and is usually expressed as grams of CO_2 equivalents. A food's carbon footprint should include all the greenhouse gas emissions detailed above as well as the transport emissions incurred throughout the food-supply chain.

This makes it a better measure than food miles, which simply reflect the total distance a food has travelled from the time of its production until the point of sale. In addition, food miles do not take into account the method of transport. While estimates vary, depending on refrigeration requirements and the type of ship or aeroplane, air transport pumps out considerably more CO_2 (40 to 200 times) per food mile than shipping or road transport.

WALKERS CRISPS – A SIGN OF THINGS TO COME

Walkers Crisps is the first food producer in the world to include a full carbon footprint on its labels, and many more companies, including Coca-Cola and Cadbury, are set to follow. The UK Carbon Trust calculated that 78 g of carbon equivalents are given off in the production of a 33 g packet of crisps throughout the entire food-supply chain. This figure is largely meaningless, however, until it can be directly compared with similar foods or given some form of carbon rating per calorie, weight or volume, for example. It also does not include the unknown emissions relating to the final distribution stages, including the distance the consumer travels to purchase the item. This "local loop" can add substantially to the overall carbon footprint.

New labelling directions

Present labelling requirements in South Africa ask for: name and product description, ingredient list (descending in order of quantity), manufacturer's name and address, nutritional information and claims, use and storage instructions, and weight or volume. Consumer surveys throughout the world suggest that a growing number of people want additional information, including the full carbon footprint (incorporating food miles), how the food was produced (organic, free range, Fairtrade and so on) and its health effects.

Some inconvenient truths about animal food

An estimated two billion people worldwide live on a combined animal and plant diet, and four billion on a primarily plant-based diet. Increasing global prosperity, however, is driving demand for all types of animal foods (meat, poultry, seafoods, eggs and dairy products) and the livestock sector is the fastest-growing agricultural sub-sector. A high average consumption of such foods is not sustainable in the long term because:

- The average fossil fuel cost of producing animal protein is more than 11 times that of plant protein production.[2]

WHY THE FULL CARBON FOOTPRINT NEEDS TO BE ASSESSED

Several UK studies have shown that the carbon footprints of foods grown locally in greenhouses may be higher than those of imported varieties grown under natural conditions, even allowing for transport costs. A New Zealand study showed that some of its livestock products, after factoring in shipping emissions, still had lower overall carbon footprints than similar foods produced in the UK. This is because less energy-intensive fertilisers and grain concentrates are used in the New Zealand livestock industry.[3] If farm employee energy inputs (driving to work and so on) and tillage methods are considered as well as electricity inputs, fertiliser type and livestock feeding methods, the carbon footprints of foods grown in developing countries shrink further in comparison with those from industrialised countries. And then even air-freighted goods might start to compare favourably. Decisions based purely on food miles could therefore have disastrous impacts for developing-nation farmers and major food-exporting nations, and not lead to any significant environmental gains.

- Livestock and its manure already contribute 5.1% of global greenhouse gas emissions.[1] A 2007 United Nations Food and Agricultural Organisation report estimated that the livestock industry alone, combined with the land-use change of clearing forest for more pasture and feed crops, now generates more greenhouse gases than the entire transport industry.[4]
- Production of animal protein to feed people is highly inefficient as it takes at least 6 kg of plant protein to create 1 kg of animal protein. Livestock is now being fed about half of the total world grain production, up from 20% in 1950. The amount of grain currently fed to US livestock is sufficient to feed some 840 million people, nearly three times the present US population and the approximate number of people estimated to be suffering from hunger worldwide.[3]
- An omnivorous diet requires at least three times more land than a vegetarian diet;[5] livestock now uses 30% of the Earth's land surface.[4]
- Producing 1 kg of animal protein requires about 100 times more water, an increasingly scarce resource, than a similar quantity of plant protein.[3]
- The livestock sector is a major source of water and land degradation as well as a driver of deforestation. In Latin America alone, 70% of former forests in the Amazon have been turned over to grazing.[4]

The statistics in Figure 2 relate to average production methods in the US, but can vary substantially depending on production and feeding methods. For instance, if lambs and cattle are raised primarily on pasture, as is typical in South Africa, the energy costs are halved, making egg protein the most energy intensive.[3] However, lamb and beef are still the least environmentally sustainable foods on several counts – high fossil energy inputs, CH_4 production (in the case of ruminant animals) and land hungry

(beef production requires 17 times more land than milk and 70 times more than vegetable production).[5] Put another way, a Japanese study showed that a kilogram of steak could be responsible for as many greenhouse gases as driving a car for three hours while leaving all the lights on back at home.[6]

Source of protein	Ratio of fossil energy input to protein output (kcal)
Lamb	57:1
Beef	40:1
Eggs	39:1
Pork	14:1
Dairy (milk)	14:1
Turkey	10:1
Chicken (broilers)	4:1
Maize	2:1

Figure 2: Relative energy costs of producing different proteins
Sustainability of meat-based and plant-based diets and the environment. American Journal of Clinical Nutrition. 2003.
Source: See reference 3.

How much land does a person need?

A Netherlands study[5] calculated the amount of land required to sustain a person on different types of diets:

- 700 square metres – for a varied vegan diet of potatoes, fruits, vegetables, grains and legumes.
- 1 400 square metres – for a vegetarian diet consisting of the above but with half the daily calorie requirement derived from milk and eggs.
- 3 500 square metres – for a mixed diet including meat, milk, eggs, grains, legumes, potatoes, fruits and vegetables.

Animal protein – high health and environmental cost

Reducing animal protein consumption can also be good for your health. The China Study, the most comprehensive research undertaken into the relationship between diet and disease, demonstrated that a whole-food, primarily plant-based diet is

the healthiest. The incidence of many Western diseases, including cancer and heart disease, is directly related to animal protein consumption. Animal protein consumption is also shown to have a greater negative impact on cholesterol levels than saturated fat or dietary cholesterol intake.[7] So, what is better for our planet is also better for us.

We should all be reducing our animal protein consumption, keeping total protein consumption to about 10% of our calorie intake, or at recommended daily intake levels of approximately 1 g per kilogram body weight. A 350 g steak contains around 90 g protein, providing at least 1 512 kilojoules (kJ). This is already 20 g more than a 70 kg man's *total* protein requirement for a day, over 16% of his calorie requirement if he is sedentary (9 240 kJ/day) and 14% if he is moderately active (10 920 kJ/day). We should also reduce our total intake of fat (to less than 30% of our calorie requirement) and high-sugar foods.

Check your food labels

Remember that 1 g of protein or carbohydrate provides 16.8 kJ and 1 g fat provides 37.8 kJ. Alcohol is also relatively calorie dense with 1 g providing 29.4 kJ. Many commonly consumed foods contain very high levels of fat and/or added sugar (e.g. 40% sugar in some breakfast cereals). Use the following figure as a guide to making healthier choices.

Per 100 g serving	Too high	Acceptable
Total fat	20 g plus (>20%)	3 g or less (<3%)
Saturated fat (mostly derived from animal foods)	5 g plus (>5%)	1 g or less (<1%)
Sugar	10 g plus (>10%)	2 g or less (<2%)

Figure 3: Recommended levels of fat and sugar content for processed foods

Organic solutions

The market for organic food is growing at a rate of between 20% and 30% worldwide, including in South Africa. Consumers cite both health and climate change as reasons for choosing organic products, and are not deterred by the higher price tags.

Organic farming is a more sustainable form of agriculture than conventional farming and addresses climate change for the following reasons:[8]

- Significantly less N_2O is produced because synthetic fertilisers, the main source, are not used.

- It is less energy intensive, also because of the absence of synthetic fertilisers. The manufacture of fertiliser is responsible for the largest source of CO_2 in agriculture and is the biggest energy input in conventional farming. UK government calculations show an energy reduction of 38%, 35% and 29% for organic milk, beef and wheat production respectively.
- Organic matter is conserved, which helps to maintain soil carbon content and prevent it from being released into the atmosphere as CO_2.

As no pesticides, herbicides, growth hormones, antibiotics or other additives are used in the production of organic foods, it is also better for our health. While the yield of organic crops may be lower than conventional crops (depending on crop type and methods used), this needs to be weighed up against the obvious environmental and health benefits, and can be simply addressed by eating less animal-based food.

BACKSBERG ESTATE – A WELCOME SOUTH AFRICAN INITIATIVE

Backsberg Estate in the Western Cape recently became the first wine producer in South Africa, and one of only three in the world, to become carbon neutral. Combining a range of energy-saving initiatives with a tree-planting programme in the nearby village of Klapmuts, this estate has managed to offset the carbon emissions associated with its wine production and transport to retailers around the world. Its tree-planting programme is managed by Food and Trees for Africa, an NGO that drives a national carbon-offsetting programme.

The power of change in the food-supply chain

Consumers are ultimately the most powerful factor in driving change, because nothing will be produced that is not sold. It's that simple. Consumers can force change throughout the food-supply chain by buying only sustainable foods and packaging. Ethical consumer movements have been powerful in driving change overseas, but they are not yet well developed in South Africa.

Retailers are in a powerful position to effect changes both in food-production and consumer-buying habits by the type of foods they stock and promote. The phenomenal success of *Fairtrade* organisations and organic retailers such as *Starbucks* demonstrates the power of the retailer to encourage change in both directions. In South Africa, the decision taken by retailer Woolworths to stock only certified badger-friendly honey encouraged immediate change in the honey industry, and educated consumers. Farmers, by converting to environmentally sustainable and ethical farming practices, also help to increase awareness throughout the rest of the supply chain. Food and beverage producers can drive positive change by setting an example. They can reduce food additives and overall packaging, and use only returnable, recyclable or biodegradable containers.

Raising retail standards

Marks & Spencer, UK, recently unveiled the most ambitious sustainability plan of all retailers worldwide. The CEO, Stuart Rose, announced, "We are calling this Plan A, because there is no Plan B". The supermarket chain aims, by 2012, to achieve the following:

- Become carbon neutral.
- Send no waste to landfill.
- Extend sustainable sourcing.
- Set new standards in ethical trading.
- Help customers and employees live a healthier lifestyle.

In South Africa, both Woolworths and Pick n Pay have launched sustainability programmes which have components aimed at addressing climate change. Both programmes, however, fall well short of the example set by Marks & Spencer, and South African consumers need to lobby for greater change and monitor retailers' commitments. We should be demanding:

- Energy-efficient retail stores and carbon-offset programmes.
- Most foodstuffs, beverages and household products to be locally sourced.
- An emphasis on fresh produce in season.
- A carbon footprint rating for all products with details of food origin, trade practices and agricultural methods.
- More foods offered in bulk and/or refillable containers.
- All types of packaging to be minimised and, where necessary, to be reusable, recyclable or biodegradable.
- Recycling depots for all food containers.

Ethical issues surrounding food

The following ethical concerns are affecting the way consumers choose their food:

- Free range. There is a growing groundswell of consumer revulsion against intensive factory farming methods that deprive animals of their natural living conditions, habits and food sources.

- Fairtrade. This is characterised by the following principles: creation of opportunities for economically disadvantaged producers, transparency and accountability, capacity building, payment of a fair price, gender equality, safe and healthy working conditions and environmental protection.

- Local versus imported. As people in industrialised countries are encouraged to switch to locally produced food, farmers in developing countries will increasingly suffer. Measures to support alternative, sustainable livelihoods for affected farmers

GREENCHOICE

The South African branches of the WWF and Conservation International (CI) identified a need to bring all current and emerging agricultural business and biodiversity initiatives under one umbrella in order to strengthen and promote sustainable food production in South Africa. The newly formed alliance, which is working with all sectors of the supply chain, aims to:

- Provide a forum for existing and emerging initiatives, to promote and facilitate knowledge and lesson sharing in order to strengthen the initiative's impact across the value chain (from producer to consumer).
- Provide a single point of engagement and a clear message on biodiversity best practice for retailers, processors and producers.
- Provide consumer awareness campaigns around sustainable food products.
- Provide an information resource.
- Support gap identification for the development of new initiatives.
- Provide technical, communications and outreach support to initiatives.
- Provide best-practice models for the agricultural industry.
- Enhance overall sustainable production in South Africa.

The GreenChoice alliance can be contacted via the CI and WWF offices.

need to be implemented in tandem with such moves.

- Animal-endangered foods. The health benefits of fish, especially those that are rich in omega-3 fatty acids, such as salmon, tuna and mackerel, have been widely promoted, putting further strain on already overexploited commercial fish species. Before you next buy fish or order it in a restaurant, first check its conservation status with the South African Sustainable Seafood Initiative (SASSI – see *www.panda.org.za/sassi* or sms the fish name to 079 499 8795 to check its status), and encourage restaurants and retail outlets to stock fish from sustainable fisheries only.

- Genetic modification (GM). South Africa is the eighth-largest producer of commercial GM crops in the world. These crops include maize (over half the national maize crop is GM), soya and cotton. While the scientific consensus is that GM foods pose a "very low" risk to human and animal health and the environment, the long-term effects are still largely unknown. The guiding principle "Absence of evidence of harm is *not* evidence of absence of harm" should still prevail until long-term safety is unequivocally demonstrated. South African legislation, like that in the US, states that GM foods must only be labelled if they differ in composition and nutritional value from the corresponding non-GM food. In Europe, all GM foods must be labelled so that consumers are given the right to choose.

- Chemical food additives. While some additives are necessary to prevent food spoiling, many are added to disguise inferior-quality food and increase visual appeal. Several of these chemicals are associated with widespread health problems, from respiratory disorders to attention-deficit hyperactivity disorder. Certain colourants and sodium benzoate, a common preservative, have been shown to increase significantly boisterous impulsive behaviour and concentration problems in young children who have no history of hyperactivity.[9]

How to minimise your food's carbon footprint and maximise your health

It is difficult to gauge accurately the footprint of food and drink items without information about production methods and transport. Until labels supply some measure of the total carbon footprint, these rules can guide you to the greenest choices:

- Buy local. This also supports local jobs, agriculture and industry. Everyone should limit the purchase of imported goods, especially if there is a local equivalent. Too many ships are passing one another carrying similar goods such as meats, cheeses, seafoods and wines.

- Eat less energy-intensive animal foods and remember that a plant-based whole-food diet is the healthiest.

- Buy fruits and vegetables in season. Seasonal produce is cheaper and fresher. Because of cold storage, hot housing and imports, many consumers have lost track of fruit and vegetable seasons. Use cost and widespread availability as guides to what is in season locally.

- Buy certified organic. Organic farming produces fewer greenhouse gases and is better for the environment and our health. Organic food is also non-GM, free of pesticides and additives and is significantly richer in a wide variety of nutrients, as confirmed by early results of a recent definitive study.[10]

- Buy unprocessed foods. These additive-free products are usually less energy intensive than processed foods, and are richer in nutrients and dietary fibre. In short, they are healthier for you.

- Make your own food and rediscover the pleasure of home cooking and shared family meals. Double up on quantities where you can, and freeze or store the excess, especially in the case of food items that require long cooking times.

- Grow your own food as this will reduce greenhouse gas emissions, especially if

you also compost your food waste.

- Choose products with minimal packaging and in recyclable containers. If this is impossible, demonstrate your disapproval by handing back excess packaging and containers that cannot be recycled.

- Say "no" to plastic shopping bags as their manufacture contributes to greenhouse gas production, and they clog up landfills and blight our environment.

Bottled water – a growing environmental problem

Two decades ago, most South Africans would not have dreamed of paying for their drinking water. It would have been like paying for their air. Now the market for bottled water is growing at a rate of 25% a year, surpassing all other beverages. However, because of the high environmental cost of bottling and transporting water, this practice should be reserved for occasions where tap water is not safe to drink. South African tap water is considered among the best in the world.

Use a water filter at home to further improve the quality of your drinking water, and always take a bottle with you when you go out to avoid having to buy water.

Conclusion

URBAN AGRICULTURE AND COMMUNITY INITIATIVES

As energy and food costs rise worldwide, more crops are being grown within urban perimeters. People are growing food in urban community gardens, allotments, back yards, patios, containers of all descriptions and on rooftops and balconies. This helps to provide jobs, promote food security, improve nutrition, recycle organic waste, improve microclimates, save money and energy, and reduce greenhouse gas emission. After the Soviet Union's collapse in 1991 precipitated an oil and food crisis in Cuba, urban agriculture boomed. In Havana alone, 8% of urban land is now dedicated to agriculture and is worked by 18 000 gardeners, who produce fruit and vegetables and raise livestock. Urban agriculture movements are starting to spread throughout major industrialised cities.[11,12]

"...urban agriculture makes sense on ecological, social, and economic grounds virtually everywhere on Earth. Governments should see it as an idea whose time has come." (W. Rees, originator of "Ecological Footprint" concept.)

Many local farmers, especially organic farmers, now deliver weekly boxes of fresh vegetables and fruit, and sometimes dairy products, to city dwellers. This practice is growing in major South African cities and worldwide.

THE ROLE OF GOVERNMENT?

In line with increasing global awareness about climate change and government action elsewhere, the South African government can be expected to introduce tighter legislation around the following issues:

- Energy-saving technology and fossil fuel alternatives.
- Packaging and waste management (see *Declaration on Waste Management 2001*[13]).
- Labelling information concerning health benefits, food origin and production methods.
- Land and water usage.
- Biodiversity protection programmes.

To help promote a sustainable environment and good health, we all need to reassess our food choices seriously so that we can simultaneously trim our growing carbon footprints and our girths. As consumers, South Africans need to exercise our full power to drive rapid change throughout the food-supply chain by buying only "green" foods and beverages. The message will not be ignored, as it will hit retailers and producers where it hurts most – in the pocket.

Resources

i. Carbon Trust; *www.carbontrust.co.uk*
ii. Compassion in World Farming (CIWF); *www.ciwf.org.uk*
iii. Food and Trees for Africa; *www.trees.co.za*
iv. Food Ethics Council; *www.foodethicscouncil.org*
v. GM Watch; *www.gmwatch.org*
vi. Greening the Value Chain; *www.sustbrands.co.za/downloads/CS_valueChain.pdf*
vii. Soil Association; *www.soilassociation.org*
viii. Sustain: the alliance for better food and farming; *www.sustainweb.org*
ix. South African Sustainable Seafood Initiative; *www.panda.org.za/sassi*
x. Urban Sprout; *www.urbansprout.co.za*

Being frugal does not mean being cheap!
It means being economical and avoiding waste.

Catherine Pulsifer, writer

20

You at home

Roger Diamond and Robert Zipplies

Not only is your home the place in which you indirectly trigger much of your carbon footprint; it is also the area over which you have most control. It is therefore the ideal place to start reducing your carbon output and learning to live lighter. From electricity and water usage to your choice of furniture and pets, this chapter explains the relevance of every area and shows you how to get climate-smart in your own home.

Introduction

Our home is the hub of our lives. This is where we relax, sleep and raise our families. It is also the place where we reflect on the state of the world and our place in it. For many of us, our homes are an integral statement about ourselves, how we live our lives and what is important to us. The choices we make at home largely determine the impact we have on the world. The type of house we live in, the furnishings and technical mod-cons we choose, the food we cook, the gardens we keep – they are all a reflection of how we choose to impact on the environment and each other. Consider the purchase of some standard tap fittings – we can opt for something made in Germany or Italy, or we can choose a locally manufactured, Proudly South African product. We can select a normal showerhead or its water-saving equivalent; a sophisticated faucet that is big and chunky, or a simple, small faucet that required less material and energy to produce. Our choices in the home reflect our consciousness of our ecological and carbon footprint. If you have not already done so, it is useful at this stage to read more about footprints: see *Chapter 6: Past-Present-Future: How we got into this mess*.

This chapter will discuss in detail a number of the key choices we can make at home and at work, such as electricity consumption, choice of garden and use of chemicals at home. Other issues, such as food, waste disposal and designing eco-friendly homes, are only briefly touched on as they are discussed in more detail in other chapters.

The rands and sense of electricity usage[A]

When there's another electricity cut at home, your frustration with Eskom's unreliable power supply escalates a further two notches. You reach for the Yellow Pages in search of a small, petrol-powered generator. Then, rather inconveniently, you remember Al Gore's award-winning movie and his message of cataclysmic climate change. You redirect your thinking patterns to vague visions of electricity-generating windmills and solar panels. Coming back to Earth, you wonder what the pragmatic opportunities are for reducing your electricity consumption. Let's take a look.

By using less electricity, you will not only reduce your carbon footprint, but you can also save money, particularly as our era of cheap electricity comes to an end. Also, the less power South Africans use, the less likely we are to experience power cuts. Since many people are not only driven by the common good, but also need to consider the financial implications of their choices, this section considers three categories of electricity-reducing options: first-rate investments, irresolute investments and altruistic investments. Before we dive into reviewing the options for reducing our electricity-related carbon footprint, let's investigate how most of our electricity is consumed at home.

A. This section was first published in *Personal Finance* magazine, 4th Quarter 2007, and has been adapted and abridged for this chapter.

Electricity usage breakdown

A study conducted by Eskom[1] for suburban households reveals a number of interesting facts. Your geyser gobbles by far the greatest amount of electricity – about 30%, followed by space heating, lighting, cooking, and the fridge and freezer. Other electrical devices, from toasters and vacuum cleaners to stereos and hairdriers, cumulatively also draw a lot of power, particularly when left in standby or sleep mode (see discussion below). Note that these figures indicate average usage, and may vary dramatically between households. The largest variation is probably experienced in heating – households in colder cities and those that are poorly insulated are likely to consume more electricity to keep out the winter chill.

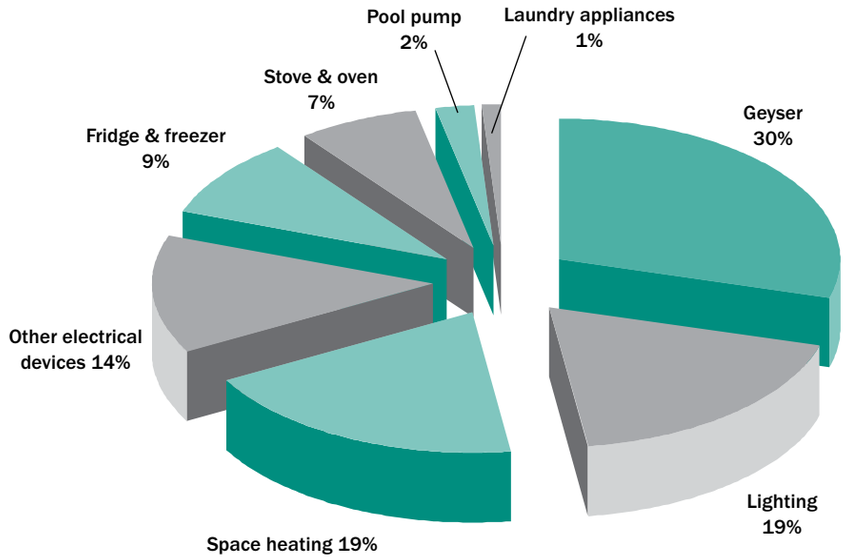

Figure 1: Average electricity breakdown for suburban residences
Source: Demand Side Management End Use Study. Eskom. 2006.

Finding consistent information about average monthly household electricity use has almost proved to be "mission impossible". However, discussions held with colleagues, Eskom staff and energy researchers, and a review of various studies, indicate that a medium- to high-income home will consume on average between 800 and 1 200 kilowatt hours (kWh) a month.

Given that the average medium- to high-income household consists of 3.5 people, the consumption range converts to between about 230 kWh and 340 kWh per person per month. One unit of electricity equals one kWh, which, in early 2008, cost approximately 45 cents a kWh (including VAT and service charges) in Cape

Town. (Note that electricity costs vary by region, usage and service agreement.) This equates to between R103 and R153 in electricity consumption per person each month. Many households may consume significantly more than this per person. Low-consumption (less than 450 kWh a month) and low-income households, depending on the region, qualify for 50 kWh (50 units) of free electricity.

It is an eye-opener to realise that for every 1 000 kWh of electricity saved, you prevent about 540 kg of coal being burnt, 1 300 litres of water being used, and the release of about 970 kg of climate-change-causing CO_2 and almost 9 kg of acid-rain-causing sulphur dioxide.[2]

First-rate investments

This category of investments is a "must-do" – not only will it reduce your carbon guilt, it will also save you lots of money.

Energy-efficient lighting – the quick return

Traditional incandescent light bulbs are shamefully uneconomical, with about 90% of the electricity converted to heat instead of light. Compact fluorescent light bulbs (CFLs) are far more energy efficient. Yes, they are not dimmable and they take time to reach full brightness, but they save you electricity, money and you can use them with a warm feeling in your heart.

While the cost of CFLs is about four times greater than that of incandescent light bulbs (R20 as opposed to R5), they consume about 20% of the electricity of an incandescent bulb and last about six times as long. This means that they will pay for themselves within a matter of months, if used regularly, and their longer life means you replace them less often.

So, throw out all your incandescent bulbs now and replace them with CFLs. Some countries, such as Australia, are going so far as to ban the sale of incandescent light bulbs altogether.

The real downside of CFLs is their mercury content. So keep your burnt-out CFLs until appropriate recycling processes are found and encourage your local retailers and municipality to create recycling systems.

Solar water-heating – the big return

Solar water-heaters are an old idea that is finally gaining momentum – to harness the power of the sun to heat water using a roof-mounted, heat-absorbing plate. The heated water is fed into a special solar geyser that stores and, when necessary, uses electricity to further heat the water to the desired temperature – typically when there is a succession of cloudy days or when extra hot water is required. There are two main types of solar water-heating panels on the market:

Flat-plate collectors: With this system, a thin, black metal sheet, covered by clear glass or plastic to improve heat retention, absorbs and transfers the Sun's energy to the water.

Evacuated tubes: This system consists of a set of heat-absorbing glass tubes, which contain a vacuum that reduces heat loss. More evacuated tubes are now sold globally than flat-plate collectors. While marginally more efficient, evacuated tubes in hot areas can overheat the water, thus activating the pressure-release valve from time to time and increasing wear and tear. The glass tubes are also more fragile, which may pose a problem in areas where hail is frequent.

Systems can either be *direct* or *indirect*. Indirect systems are important in areas where temperatures can fall below freezing, as the solar panels are filled with an antifreeze mixture, which prevents possible bursting of pipes. The absorbed heat is then transferred to the water via a so-called heat-exchanger. In a direct system, the water itself passes through the solar-collector panels and is heated by the Sun – this is appropriate for most parts of South Africa.

The panels need to have a northward angle, so as to maximise heat absorption, and, ideally, the geyser should be placed higher than the panels to obviate the need for a circulation pump. Solar-powered pumps are available. The system lifespan is between 20 and 25 years, and sometimes longer. If you would like to support local industry and reduce transport-related emissions, purchase a system that is locally manufactured – currently all evacuated-tube systems are imported.

Switching to solar water-heating is a financial no-brainer. Although the cost of the system is fairly high – typically between R10 000 and R25 000 for residential systems, depending on size – the payback period is generally between four and 10 years. There is usually not a significant difference in price between the flat-plate and evacuated-tube systems. The payback can be further reduced with subsidies – of which we are likely to see an increasing number in a bid to reduce national electricity usage. In low-cost housing projects, low-pressure water-heating systems can be installed for as little as about R5 000.

While solar water-heaters can save as much as 30% to 40%[3] of a residential energy bill, variability in water consumption and the availability of sunlight makes calculating an accurate payback period confounding. A Namibian residential study[4] demonstrated that, depending on usage patterns, a break-even point was reached in about five years. Of course, the higher the water consumption, the shorter the payback period. In 2005, a South African study indicated that a 2 m x 2 m solar water panel can recover R700 a year (R1 225 for a 4 m x 4 m panel), assuming an electricity cost of 35 cents a kWh.[5] Of course, this recovery will improve as electricity costs increase.

There are a number of other cost- and electricity-saving ideas to implement, irrespective of whether or not you opt to go the solar-heating route:

- Wrap your geyser and the inlet and outlet pipes in a geyser blanket and insulation material. Some high-end geysers may not require wrapping – check this with your geyser supplier or plumber. A geyser blanket should not cost more than about

> Live simply, that others might simply live.
>
> *Elizabeth Seton*

R200 and should pay for itself within a few months.

- Turn down the thermostat on your geyser to about 55 °C. This will cost you a short, if daring and dirty, climb into your ceiling and will save you many rands a month. Remember to switch off the electricity at the mains before you fiddle with the thermostat.
- Install a timer switch that activates your geyser for only a few hours each day. This means the element is not switched on every time you wash your hands with warm water. A timer switch, including the installation fee, should cost you no more than R1 000.
- Also install a water-saving showerhead, which fragments the water into smaller droplets and can, depending on the manufacturer's claims, reduce your hot-water consumption by an impressive 50% to 80%. The impact on your daily showering experience is virtually non-existent. The cost of the showerhead is between R150 and R350.

Solar cookers

Solar cookers use reflectors to concentrate and trap the Sun's energy to cook food. Depending on the Sun's intensity and the type of stove, temperatures of over 200 °C can be achieved for some parabolic cookers. Although a solar cooker can cost anything from a few hundred to over a thousand rand, it does not require any fuel and thus costs nothing to operate.

A compact, entry-level solar cooker, which costs under R300, is ideal for slow-cooking lentils, rice and stews, and even for baking bread. If used regularly, it is likely to save you a rand or two every few days and can thus pay for itself within just a few years of regular use.

The hotbox

This is a must for every kitchen. A hotbox is made from two nonflammable, insulated bags (resembling mini beanbags) and works like this: you place semi-cooked, hot food into the hotbox and the retained heat will complete the cooking process. You can also use it to keep food warm for many hours.

A hotbox works amazingly well for rice, pulses, stews, porridges and many other dishes. To cook plain rice, for example, heat the saucepan with the rice and water on the stove and let it boil for a few minutes before transferring it to the hotbox, where the cooking process is completed without any additional heating (or personal attention) being required.

The results demonstrate that hotboxes can save you more than half of the electricity required for cooking a particular dish. A hotbox will set you back a

mere R150 to R250.

Standby losses

Electrical equipment, such as the television, hi-fi, computer, DVD player, microwave and many others, when left in standby mode, continue to draw energy. An international study revealed that standby power can consume between 3% and 10% of home and office electricity use.[6] In the UK, the BBC reported that electrical devices left on standby consume the equivalent output of about two power stations, and result in CO_2 emissions every year equivalent to a mind-boggling 1.4 million long-haul flights.[7] To save electricity, switch off your devices at the plug. When you buy new gadgets, compare energy efficiencies before deciding which one to purchase.

The washing line

Yes, you read correctly, your washing line can save you electricity if you use it instead of your tumble dryer. South Africa is generally blessed with good weather. Whenever possible, dry your clothes on a washing line outside, or on a clothes horse indoors when the weather is bad.

Irresolute investments

This category of investments is a "should do" – it will reduce your carbon guilt and may also save you money. Evaluate options on a case-by-case basis, taking payback periods, environmental considerations and your personal climate change commitment into account.

Appliances

South African consumers do not have a tradition of insisting on energy-efficient appliances. Yet appliances such as fridges and washing machines are large energy guzzlers. In many developed nations, manufacturers are encouraged to improve efficiencies, and in Europe appliances are graded according to the European Union energy label. An A-rated fridge, for example, can be many times more efficient than an older fridge and thus less costly to operate.

Working out the cost and environmental benefit of replacing an appliance is not an easy task, because it depends entirely on the efficiency of the old unit, the efficiency of the desired new one and the amount of energy and resources that were required to produce and distribute it.

For example, studies have shown that washing dishes in hot water by hand requires more water and electricity than modern, efficient dishwashers. However, these studies are rarely clear-cut. Do they consider the lower electrical energy cost for warming the water if you have a solar water-heater? From an environmental perspective, do they consider the materials and energy required to manufacture and distribute the dishwasher? From a financial point of view, do they consider only the cost of the actual washing process (water, electricity,

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detergent) or do they also factor in the cost of purchasing the dishwasher?

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detergent) or do they also factor in the cost of purchasing the dishwasher?

Saving water to save energy

The water–energy link

Use of water results in several direct and indirect contributions to greenhouse gases, the most significant being the energy used in creating and operating a public water supply. First, water must either be collected in a reservoir or pumped from an aquifer. Although reservoirs are generally far more energy intensive to build than boreholes, the latter are also expensive and require a constant stream of energy to pump water to the surface. Surface water from dams is the major source of water in South Africa and, in some cases, it also needs to be pumped uphill – such as from the Vaal Dam to Gauteng. From there, the water needs to be purified and directed through an underground pipeline network to reservoirs that store clean water above the altitude of the users, to generate water pressure. All this equipment, pumping and purification uses energy and raw materials, and so generates greenhouse gases.

Although exact figures vary for countries and regions, in Britain it takes about 0.27 kWh of electricity to purify, pump and pipe 1 000 litres of water to a home.[8] In South Africa, this would result in about 270 g of carbon dioxide being emitted.

METHANE FROM DAMS

Another major source of greenhouse gas emissions from public water supply is from the vegetation in reservoirs, both the original plants that were drowned and river supplied material, which then rots anaerobically and releases methane. Long suspected to be significant by environmentalists, a recent paper in *Bioscience*[9] estimates that up to 20% of anthropogenic methane originates from reservoirs.

Reducing the quantity of water you use at home is therefore not only vital to help preserve the remaining rivers and estuaries in our water-stressed country, but is also part of the urgent need to address climate change. Before we look at reducing water consumption, it may be useful to understand where water is typically used in a medium- to high-income household: for a house *without* a garden, the toilet uses 37%, bath and shower 32%, washing machine 17%, and cooking, drinking and washing dishes 14% of total consumption. Households with gardens, on average, use 46% of their water on the garden.[10] We will now examine the ways in which you can cut down your consumption of water.

Reducing water consumption

Reducing water consumption involves both behavioural changes and capital investments. On the downside, simply changing technology will not automatically result in lower usage – it is still possible to misuse a water-efficient device, like washing three plates and a spoon in the latest low-water-use dishwasher! On the upside,

behavioural changes are free and can have a significant impact immediately. Take for example a dishwasher or washing machine that can be replaced, at great cost, with a waterwise model. If your machine is in good order, instead of wasting the embodied energy (the resources and power required for production) of a working device by throwing it away, optimise your use of it by loading it fully and dosing it correctly.

Behaviour

Similarly, optimise your showers, baths and so on. Delight in the joy of water but don't be wasteful. Treasure each drop and you will get more pleasure from using less. A handy hint for those who run a sink full of cold water for rinsing dishes is to use the still-clean water to rinse hands, wash fruit and then stack dirty dishes, allowing them to soak, thus reducing the water, heat and detergent needed when washing. Dishes immersed in water also keep odours and flies at bay.

Technology

Once you decide to install new technology, think about the following recommendations. Low-flow showerheads reduce water consumption by 50% to 80% – reductions based on manufacturers' claims – and still offer a satisfying shower. Tap aerators provide a soft, bubble-filled stream of water and cut water flow dramatically. Toilets should be multiflush or dual flush – the former can be retrofitted to an existing single flush cistern for a few hundred rands; dual flush requires a new cistern. Oversized cisterns can have their flush volume reduced by simply placing a brick or bottle inside the unit. In fact, a City of Cape Town water bylaw[10] demands that all new homes be fitted with water-saving fittings – toilets may not have a cistern capacity of more than nine litres, showerheads may not deliver more than 10 litres per minute and so on. If you are dedicated enough and live outside the city's sewered area, go for a composting toilet, which doesn't require any water to operate.

Dishwashers and washing machines use varying amounts of water – in general, the less water used, the less energy is needed to heat it. Always investigate this data before making a purchase and, if the data is not available, buy another brand! The largest water wasters are twin-tub or top-loading washing machines. Front loaders use a fraction of the water and energy and are generally kinder to clothes and more effective at cleaning.

Gardens can be the biggest water users in your home, so optimising the delivery of water to where it is needed, at the roots of a plant, will save water. Drip irrigation uses the least water, as little as 10% of other systems, particularly if buried. Better yet, plant indigenous species to save water and revel in South Africa's unrivalled botanical treasure trove.

Reusing and recycling water

For those prepared to take the effort, some bucket-by-bucket actions can save water, such as using bath or shower water to clean and flush the toilet or water the garden. For those who prefer automation, the answer is a grey-water system that will collect your shower/bath/basin water for irrigating your garden. Installation costs vary significantly, based on system functionality. Typical hazards are clogging, odours or disagreeing with plants. That said, a well-installed and -operated system can provide a lot of nutrient-filled water for your garden, although it is not recommended for fynbos gardens which prefer low nutrient levels. You should also avoid wetting edible plant parts.

> "He who knows what sweets and virtues are in the ground, the waters, the plants, the heavens, and how to come at these enchantments, is the rich and royal man."
>
> *Ralph Waldo Emerson*

Alternative water sources

Rainwater

Harvesting rainwater is simpler, cheaper and less prone to hazards than a grey-water system, but it is limited in that rain is mostly seasonal in South Africa. However, even if your rainwater tank storage is insufficient to water your garden over the dry season, every litre of water used from it is virtually carbon-free and eases demand on finding new water sources, with their attendant environmental impacts. You can also utilise rainwater for other uses, such as flushing your toilet, although legally one should not use it for drinking purposes. Perhaps the biggest challenge with a rainwater system is placing the tank high enough to create pressure, so as to avoid the added hassle of a pump, or the need to use buckets for watering.

Groundwater

Certain areas in the country have shallow, easily obtained, good quality groundwater, ideal for watering gardens. The cost of installing a borehole or wellpoint will depend upon the depth to groundwater and the rock type. Be aware though that groundwater use may have an ecological impact, so first dig into understanding these, before digging into the ground! Consult a hydrogeologist in your regional Department of Water Affairs and Forestry office or an independent groundwater consultant for further advice. The satisfaction experienced when harvesting rainwater off your roof or groundwater from the Earth beneath your house is as empowering as using the Sun's energy.

The waste–energy link

There are three major ways in which waste contributes to climate change: methane emissions from landfills or CO_2 emissions from burning and incinerating waste; emissions from transporting waste; and the embodied energy of an object that is lost when that item is thrown away. For these reasons, it is imperative that we reduce our waste generation or find ways to reuse or recycle our waste. Refer to *Chapter 21: Our waste* for an explanation of waste habits in our society and suggestions to improve those habits. One of the most direct waste-generating activities is the renovation or alteration of one's home. The opportunity therefore exists to minimise this impact by reusing or recycling the demolished portions of your home. As an example, the 2010 Soccer World Cup stadium currently being built in Green Point, Cape Town, is adjacent to the site of a previous and smaller stadium that was completely demolished. The rubble generated was crushed and incorporated into concrete for the new stadium.

Other home products and activities

Food

As covered extensively in *Chapter 19: Your food*, what we eat can make an environmental impact akin to all our travelling or more. So remember to buy local, in season, organic, plant-based and less-processed foods. Not only will they lower your contribution to climate change, but in some cases be cheaper, healthier and tastier!

Household chemicals

As with water and waste, production of chemicals enacts a toll on resource and energy usage and hence adds to climate change. Many chemicals use oil derivatives as the raw ingredients in their production, but certain minerals or metals are also needed.

For example, to produce bleach or pool chemicals, chlorine is needed, which is manufactured from salt (sodium chloride) created by evaporation of sea water. To make wood preservatives such as copper chrome arsenate (CCA) or tributyl tin oxide (TBTO) requires a cocktail of metals, all derived from hard rock-mining operations, which, in turn, use vast amounts of energy. There is unfortunately no quick way of knowing how energy-intensive or toxic various household goods are, especially considering the thousands of products and chemicals involved. If you would like to pursue this area further, consult the Resources list at the end of this chapter.

Cleaning and maintenance

Cleaning and maintaining your home can be done with very little or no chemical aid, but the general rule is that the less chemical assistance you use, the more frequent the cleaning needs to be. The answer is to reach a balance where regular maintenance and cleaning with mild and less toxic chemicals prevent the desperate action required once the problem is severe. As an example, wood preservatives such as those mentioned above can be avoided through regular oiling of wood with a relatively natural mixture of linseed oil and genuine turpentine, which will keep pests away and weatherproofs your wood beautifully.

However, removal of stubborn grease or stains requires some chemical assistance. It is important to ensure that you use the optimal amount and are not overdosing. In many cases, there are simple, home-made cleaning mixtures that use vinegar, lemon juice, borax and other basic ingredients to produce pleasant yet effective cleaners. Refer to page 25 of the *Smart Living Handbook* (see Resources) for recipes for these mixtures.

Furnishings

Whether choosing couches and cupboards, cutlery or crockery to furnish your home, there are two major aspects to consider. The first is the choice of materials or products, and the second is the treatment or maintenance of these. The latter relates to the above section on chemicals and the principles are the same. Any materials that require harsh chemicals for their maintenance or cleaning are to be avoided. For instance, curtains that may only be dry-cleaned should be passed over due to the use and release of benzine (in essence, high quality petrol) used by dry-cleaners.

For materials and products, long-lasting, natural and locally sourced materials are optimal – they reduce transport emissions and support our local economy. Buying imported Indonesian or Balinese furniture is, in all likelihood, sponsoring the deforestation of Borneo or other islands. Instead, select South African-made solid-wood furniture of plantation pine or karri (red gum), or managed indigenous timber such as yellowwood or stinkwood. You may pay more, but the quality of workmanship is generally higher and the forests from which the wood is sourced are re-established or maintained, unlike most tropical rainforest logging.

However, if you do purchase imported timber, make sure that it is Forest Stewardship Council approved.

Green building design

Although largely covered in *Chapter 15: You the architect and property developer*, the value of implementing green building design principles is so great that key aspects will be repeated here. As pointed out in that chapter, poor building design and materials lock you into wasteful practices throughout the life of that building, during operation and maintenance.

> We don't need to increase our goods nearly as much as we need to scale down our wants. Not wanting something is as good as possessing it.
>
> *Donald Horban*

When designing a home, one of the most crucial considerations is aspect, or direction. By orienting a home northwards, walls and openings collect low-angle, gentle winter sun, while the near-vertical summer sun passes by with little effect, assuming the roof is insulated. Reasonably deep eaves assist in keeping out intense summer sunshine. Other key considerations are the heights and levels for grey-water or rainwater systems, roof angles and directions for solar panels and the distance from the geyser to the taps. Further energy-saving measures are insulation, double glazing, placement of indoor fireplaces on internal walls and having a washing/drying area that gets winter sunlight.

When selecting building materials, consider their origin, in source and manufacture. Also know how durable the material is and be aware of the maintenance costs – instead of wood, rather use stone for garden paving or "polywood" for decking. On the other hand, bear in mind the insulating properties of materials, for instance the relative warmth of wooden flooring or carpet instead of ceramic or rock. Choose secondhand products like antique lampshades and furniture, or those with recycled content, such as isotherm insulation. Avoid products with hazardous chemical components, for instance in carpet dyes or paints and sealers.

Just in case you think this is an impossible wishlist and that either you will not achieve these goals or your house will end up like a hippie hovel, here is just one example of a superior material that is an all-round winner: coir. Coir is natural coconut fibre that is woven to form carpets that are attractive, highly durable, fadeproof, sound-damping, cool in summer and warm in winter, static free (for the Highveld), damp, mould and pest resistant, and best of all, come from a waste product from the food industry – coconut husks.[11] Other product winners include natural materials, like bamboo for indoor flooring, "polywood" planks for outdoor decking, plant oils for treating wood and water-based paints for indoor or outdoor use.

Biodiversity

South Africa covers only 0.8% of the world's land area, yet contains almost 8% of the world's reptiles, birds and mammals. It is home to some 10% of the planet's plants and 15% of its coastal marine species.[12] It is the third most biodiverse country on Earth, after Brazil and Indonesia. A heritage such as this is a global treat and responsibility. For those lucky enough to own a patch of ground, making garden showpieces of this heritage is undeniably the ethical thing to do. If that is not enough encouragement, the science of climate change tells us that our gardens

need to be waterwise and our ecosystems strengthened by making urban areas more natural.

The principle is very simple – plant local. That means plants that would have occurred in your region. Due to the lack of trees in many parts of South Africa, it may be necessary to resort to trees that are indigenous to other parts of the country, but preference should be given to the most local. In practice, our gardens may face certain directions and have unnaturally windy, shady or sunny areas, and so the detailed selection of suitable plants is more challenging. But if the right plants are chosen, they will do better and require less maintenance and watering than exotic species.

By planting indigenous you will be making the first step towards favouring other local species, particularly insects, other invertebrates (or in proudly South African English, *goggas*), geckos, frogs and birds. A balance of these creatures helps keep pests in check. Remember also to limit your use of artificial chemicals in the garden by using organic techniques – many examples are provided on the Internet. Natural compost – home-made, of course – makes for stronger plants that are more pest resistant and so precludes the use of both fertiliser and pesticides.

Pets

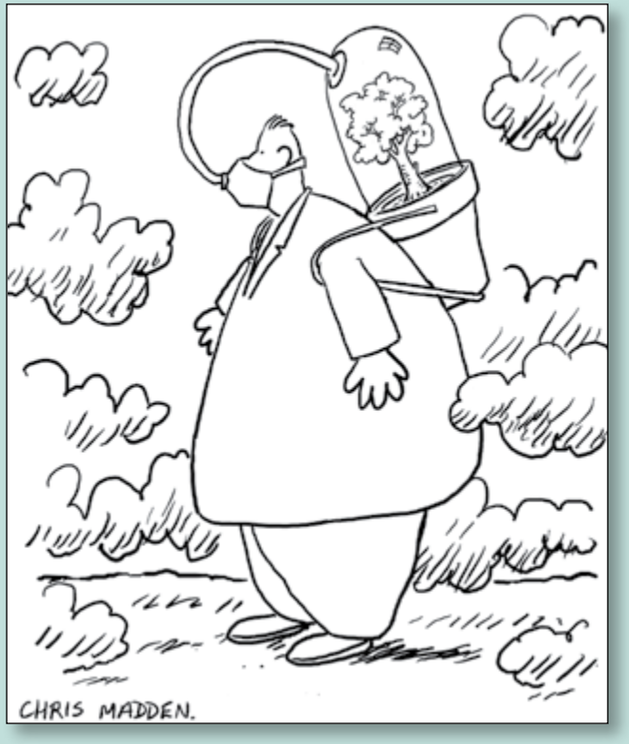
Pets play an important role in many people's lives, but they have an ecological impact too, not only from manufacture of pet foods that use resources and energy. Predators like cats and dogs also hunt and harass other animals, and leave territorial spray that may discourage certain animals from taking up residence in your garden. If you do have pets, try to limit their impact.

Closing thoughts

It can be argued that individual households cumulatively have more power to change the world's carbon footprint than industry and commerce do. The home-owner's choices trigger a chain of events upstream and downstream of the home, through the economy and environment. Purchasing habits drive those events and determine how and what industry and commerce produce and how our waste is disposed. Both technological and behavioural changes are needed to reduce our consumption levels and allow us to tread ever more lightly. Make a statement about your commitment – and make your home part of this.

Resources

i. Smart Living Handbook; *www.capetown.gov.za* (click on 'Residents' and then 'Environment')
ii. Help Solve the Electricity Crisis – Power of One; *www.powerofone.org.za*
iii. The City of Cape Town is planning to offer renewable electricity supplied by the Darling Wind Farm project; *www.capetown.gov.za*.
iv. Sustainable Energy Society of Southern Africa provides a listing of local solar water-heater suppliers; *www.sessa.org.za*
v. How to Save the Climate; *www.greenpeace.org/international/press/reports/how-to-save-the-climate-pers*
vi. Forest Stewardship Council; *www.fsc.org*
vii. Sustainable Home Design; *www.sustainablehomedesign.co.za*
viii. The Good Shopping Guide – helps you to source ethically and environmentally responsible products; *www.gooshing.co.uk*
ix. *The Story of Stuff* is a video clip that provides an entertaining overview of our personal material flows; *www.storyofstuff.com*
x. Green your Life with Urban Sprout; *www.urbansprout.co.za*
xi. Cleaning up our Chemical Homes; *www.greenpeace.org.uk/toxics/chemicalhome*
xii. United States Environmental Protection Agency offers information on toxic chemicals; *www.epa.gov/ebtpages/humanhealth.html*



Waste equals food, whether it's food for the Earth, or for a closed industrial cycle. We manufacture products that go from cradle to grave. We want to manufacture them from cradle to cradle.

William McDonough, sustainability architect

21

Our waste

Roger Diamond

Natural systems are cyclical and all waste becomes food. Humans, on the other hand, produce excessive quanities of waste, most of which is not reused, is toxic and exists in complex mixtures. Solid waste generates greenhouse gases, mainly as methane from landfills and carbon dioxide from burning. The embodied energy of waste – a potentially valuable resource – is lost when it is burnt or buried. Reducing, reusing and recycling will assist in decreasing greenhouse gas emissions from waste. Ultimately, product design and production with cradle-to-cradle management in mind will move our society towards zero waste.

The waste paradox

Nothing is waste, yet everything is

Waste is a point of view. Take a walk down your street and you may find a neighbour cutting a tree and throwing away the branches and leaves. To her that is waste, but to you, it could be firewood and future compost. One person's waste is another's resources.

Waste = food

Our planet, Sun and solar system are made from the waste products of a supernova that occurred more than four-and-a-half billion years ago. Our bodies are made of elements and chemicals that have been cycled through countless millions of organisms over the ages, and the wastes that we secrete, excrete and exfoliate will make their way back into the ecosystems of the future. Nature and life are the ultimate recyclers.

When we understand this, we will realise that food and waste are one and the same. When a tree no longer needs a leaf, it is dropped to the ground, where bacteria and fungi get into action and make a meal of the leaf. They, in turn, die and release their nutrients to the soil from where the same or any other tree can take up the nutrients again. This highly simplified example can be extended across whole ecosystems and in fact the entire biosphere – the living envelope around the Earth's surface.

The problem with your waste

Natural systems are cyclical and therefore sustainable, as all waste becomes food. Waste can therefore be seen as a human construct, due to three key differences in our activities compared to those in nature.

1. Human systems are linear. Natural resources are dug up, cut down, fished out or cropped off the land, then processed, packaged, sold, used and finally dumped. They are not returned to a place where they can be recycled, either by humans or by nature. Exceptions do exist – some 66% of beverage tins[1] and around 14% of glass bottles and jars[2] are recycled in South Africa.

2. The quantities of waste produced by humans are so great that the processing capacity of ecosystems can be exceeded. It may be possible for you to compost your organic waste in your garden, but when the organic waste stream of several million people all converges on one place, composting becomes an impossible task.

3. The quality of waste, in terms of complexity and toxicity, can make it almost impossible to recycle, either industrially or naturally. People often ask me the question "Is this recyclable?" and I sometimes give the simple answer "Everything is recyclable, but it's a question of time and energy." Put another way, this means that even a pile of dead television sets can be thoroughly dismantled, processed and used to create useful products, but the energy (and time and knowledge) required to do so is immense. The same goes for medical waste, e-waste and other complex and toxic refuse. The problem lies in the fact that humans have created artificial or synthetic compounds that do not occur in nature.

Synthetic compounds may be perfectly harmless and easily absorbed by the environment, but others may be very toxic and/or persistent. Examples of highly toxic compounds are herbicides and pesticides, while persistent compounds include plastics such as PVC (used for pipes, gutters, credit cards) and PET (used for beverage and food bottles, fabrics). Some nuclear waste is both long-lived and toxic.

Items that are both persistent and toxic are known as POPs – persistent organic pollutants – these include PCBs, used in large electrical transformers, and DDT, still used by some countries, including South Africa, to tackle malaria. The Stockholm Convention regulates POPs and South Africa has ratified this convention in an attempt to ban many of these compounds.[3]

To summarise, humans generate mountains of waste that include a combination of complex components that are toxic and hard to recycle or biodegrade. As a result, humans attempt to remove their solid waste stream from the biosphere by putting it in landfills, the term for engineered dump sites.

E-WASTE

The beloved "e" of our times has found its way into the world of waste too. In this case the "e" stands not only for electronic but also electrical. E-waste, also known as WEEE (waste electrical and electronic equipment), consists of the following:

- Electronic – computers, telephones, televisions, printers, etc.
- Electrical – fridges, toasters, vacuum cleaners, light bulbs, batteries, etc.

E-waste is a problem. Growing in volume rapidly, it comprises mixed and toxic waste: fluorescent bulbs with mercury; batteries with cadmium, nickel, lithium and other chemicals; electrical equipment containing plastics like PVC (polyvinyl chloride) or ABS (acrylonitrile butadiene styrene), with flame-retardant rare earth elements; traditional cathode-ray tube televisions and monitors with hundreds of grams of lead each, and so on.

Few companies have the ability or desire to dismantle and recycle these components, so Extended Producer Responsibility (see side bar on page 284) is the obvious way to tackle e-waste. In South Africa, a few companies have started to recycle e-waste, some in a more environmentally responsible manner than others. See Resources to check the current situation.

Waste and climate change

So this all makes sense and you are nodding in agreement, but what does it have to do with climate change? The answer is manifold.

The main link between waste and climate change is very simple. Landfills, where the bulk of municipal waste ends up, produce methane (CH_4) – a greenhouse gas that is about 25 times more powerful than carbon dioxide (CO_2). They contain organic materials like food scraps, paper and garden waste, which, in the oxygen-deprived environment of a landfill, get decomposed by bacteria that give off CH_4 as a waste product.

Many of the municipal refuse sites in South Africa, particularly in the rural areas, are run as open dumps where the waste is burnt regularly. This releases not only smoke, toxic compounds and metals to the air, but also produces the most common greenhouse gas, CO_2. Incinerators similarly produce emissions that include CO_2.

Figure 1 describes the contributions made by waste to anthropogenic greenhouse gas emissions. However, it leaves out incineration. With burning being so prevalent throughout the developing world, and countries such as Japan and Germany incinerating large percentages of their waste, CO_2 from this practice is a significant contributor to the total greenhouse gas inventory.[4]

Most importantly though, taking useful items and burying them in the ground is not terribly clever. Although figures vary for each material, recycling an item generally takes less energy and water and produces less waste than starting from virgin material. Throwing something away loses all the energy used to make that item, known as its "embodied" energy.

> Of all the raw resources consumed, 94% end up as waste and just 6% as product.

Embodied energy

Embodied energy is not easy to calculate, as it includes not only the direct energy and water used and waste generated, but also the indirect inputs and outputs. For example, when painting a motor car on an assembly line, little waste is generated in the motor-car factory. However, in the paint factory, both energy and water are used and waste is produced. Honda North America has reduced its landfilled waste from 17 kg per car produced in 2001, down to 6 kg per car in 2006. Both these amounts are extremely low and, although a commendable effort, this is mainly because all indirect wastes are ignored, such as that from the iron-ore mines, coal mines, steel mills, component manufacture and so on. Clearly, in this case, the direct wastes are not giving a full picture of the embodied energy.[5]

Although the amount will vary for each product, it is estimated that of all the raw resources consumed, 94% end up as waste and just 6% as product.[6] Add to this the fact that much of that product could be packaging and the figure will be even more dire.

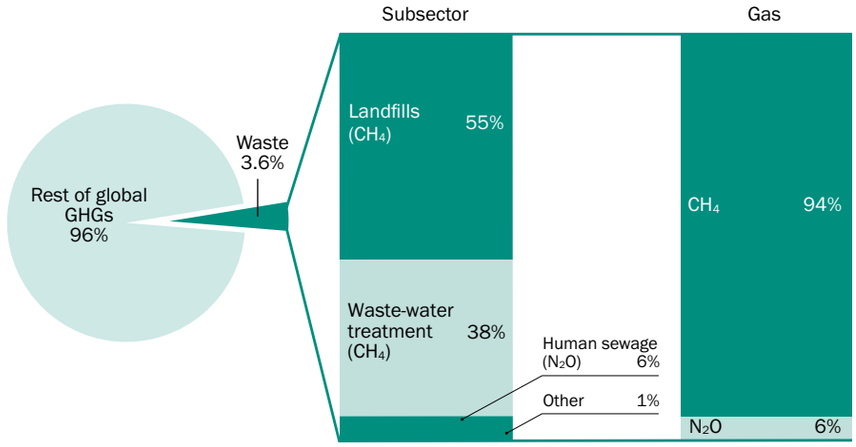


Figure 1: Greenhouse gases from waste

Note: This diagram ignores incineration, a minor contributor, and burning, a significant but hard to estimate fraction – burning most often occurs illegally and informally.

Source: Navigating the Numbers. 2005. World Resources Institute. www.wri.org

Mitigating waste impacts

Having demonstrated the nature of our wasteful society and how this contributes to climate change, we will try to show you how you can adapt your lifestyle to reduce the negative effects of waste, whether at home, in the office or in industry.

Reduce – reuse – recycle

This is the mantra of waste management, and rightfully so. But what do these terms actually mean?

Reduce – avoid the use of an item or product, or reduce the amount that you use. Alternatively, find a less hazardous option or, if possible, one with lower embodied energy. For example, when building a deck or walkway, avoid the need for sandpaper and toxic varnishes by using planks made of recycled plastic that require no treatment and are long lasting.

Reuse – instead of discarding an item, reuse it in its current form. For example, reuse glass and clear plastic food jars or bottles as containers in the home.

Recycle – collect items for reprocessing into other useful objects. For example, most of your household packaging – bottles, jars, cans, tubs, boxes and wrappers – can be collected and sent for recycling into other products. This is far better than making the item from virgin materials, although it still involves a significant amount of

energy and other resources.

Cradle-to-cradle thinking

If we follow these three principles, can we use up all our waste, thereby negating the need for landfills or incinerators? In essence, yes, but practically it is not that simple. The main problem is that the waste generated by society is mixed and was not designed with sustainability in mind. We need to use a life-cycle approach to the things we make and to design products with reuse in mind – this technique, called cradle-to-cradle thinking,[7] is useful in trying to get human systems to become cyclical. Calculation of embodied energies, life-cycle analysis and cradle-to-cradle management are all related techniques that are commonly used in reducing waste impacts and can help in the move towards sustainability.

Interface Carpets of Georgia, US, is a global leader in this area. The company uses recycled materials, designs products so that they are easier to recycle, aims at materials and processes that avoid use of hazardous substances and looks at their suppliers to reduce their environmental impacts.[8] Cape Brick in Cape Town manufactures

WHAT YOU SEE IS NOT WHAT YOU GET

Once you apply this simple principle you will never be able to look at anything in the same way. Take an apple as an example – you may buy the apple to eat, but in buying it you are actually supporting the entire apple-growing and -selling machine.

This translates into all the impacts of the shop, the distributor and the farmer, and even further back to the impacts of the shop owner and all the staff and their families, and the same for the distributor and farmer. These impacts may include:

- Use of water taken from a river or the ground.
- Use of fertilisers and pesticides, and their possible pollution effects.
- Farmland that has replaced natural veld.
- Fuel usage and wear and tear on trucks during farming and distribution.
- Electricity usage for cold storage.
- Packaging for transport and display.
- Electricity, water and waste at retail outlet.
- Your direct impacts of carrier bags and driving to and from the shop.
- The apple waste itself.

As you can see, the apple waste is certainly a very small percentage of the total impact, much of which can be classified as waste too – the packaging is obvious, but also the distribution truck components and farm implements that wear out and get thrown away, and further afield, the piles of mining waste, fly ash and emissions as a result of electricity generation. If you think you are buying just an apple, think again! Every time you buy something, you actually buy a tiny piece of the global economic machine.

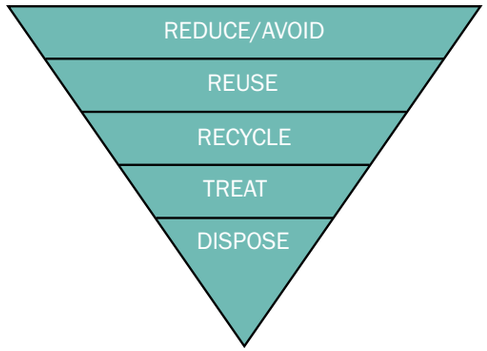


Figure 2: The waste-minimisation hierarchy

Note: The waste minimisation hierarchy includes treatment and disposal, the current state of most waste management. The diagram emphasises that although treatment and disposal are still options, they should be seen as the last resort after having used the three Rs to deal with the bulk of our waste.

cement bricks using more than 90% recycled crushed aggregate (RCA). Use of RCA avoids the energy consumption generated by the mining of various materials like sand and limestone, and any processing, which in the case of cement is particularly emissions intensive. Use of RCA also reduces the transport energy, as most of the building rubble comes from just a few kilometres away, whereas most quarries are 50 to 100 km distant.[9]

Moving towards zero waste

Zero waste is more of a philosophy than an absolute or realistically attainable goal and encourages the progressive reduction and eventual possible elimination of waste. The Institute for Zero Waste Africa (IZWA), based in Durban, is active in lobbying and promoting zero waste. Individuals or households, businesses and industries should all be tackling their miniature mountains (or not so miniature, as the case may be) of waste along the lines of the following examples:

Your household

In our household of two people, we have managed to reduce our waste stream to a few kilograms every month. Follow these tips to reduce the waste generated in your home:

At the shop

- Buy from outlets that sell unpackaged goods – select what you need and put it into a reusable bag or a plain paper or plastic bag. (Print ink contains toxic compounds and makes recycling harder.)
- Avoid prepackaged vegetables and fruit – weigh large single items such as butternut or aubergine without a bag – take a box with you to the fruit and vegetable

shop, to avoid having to take a new box or set of plastic bags.
- Remove and leave behind extremely large packages, such as cereal boxes, in the supermarket to encourage less packaging.

At home
- Wash all bottles, jars and tubs, and reuse them as paint pots, seedling planters, storage containers for food in the kitchen or to hold office or school lunches.
- Send waste glass, metal, paper, cardboard and plastic for recycling.
- Use candle stubs, waste cardboard and paper, or vegetable oil to start your braai.
- Use old clothes as rags or give them away to those who have less.
- Make compost with kitchen scraps and garden waste.

During building
- Knock cement off old bricks to clean them for reuse. Crush old bricks and concrete to incorporate as aggregate in new concrete.
- Strip and sand down old timber to reuse – it will make a feature of the old wood.
- Reuse strip ceiling boards as fascia boards and eaves.
- Buy only locally produced products and locally grown timber.

At the office
Paper
- Printers and photocopiers should all have duplex abilities and staff must know how to use them.
- Fax machines must not automatically print a confirmation page.
- Reuse paper that has been printed on one side only.
- Purchase paper with a recycled content (its print quality is as good as that on virgin fibre).
- Collect all used paper for recycling.

Stationery
- Buy refillable pens and pencils, and computer CDs without cases.
- Return packaging to the suppliers.
- Refill printer cartridges.

Waste
- Provide bins for collection of mixed recyclables, such as cooldrink tins and water bottles.
- Electronic-waste contains many toxic materials. Contact recyclers well in advance to plan your disposal/recycling options.

Purchasing
- Establish a green procurement policy. This can target all suppliers and include

items such as returnable packaging and non-hazardous cleaning chemicals.

Education
- Make staff aware of waste reduction and create a reward-based programme with reported statistics to keep up enthusiasm.

In industry
Great variation exists within industry and any waste-reduction programme will have to be tailored, but here are a few generic tactics:
- Reduce, reuse and recycling must be at the core of the approach – less raw material, water and electricity usage may lead to considerable cost savings.
- Learn about cleaner production: optimising operation by reducing wastage.
- Create waste inventories for all parts of your organisation.
- Have several disposal systems – solid wastes like office paper can go directly to recyclers and solid wastes like scrap metals and wood can be taken to a sorting depot before being reused or given to recyclers.
- Effluents may need to be piped into different systems and treated accordingly – the water should be cleaned up and sent back to the plant for reuse.
- Strive for continuous improvement – optimise operations, research problem wastes and then either minimise or treat and find markets for various by-products.
- Form local industrial waste-minimisation clubs to share ideas and trade wastes.

The future
Landfills and laws, recycling and regulations
The government will increasingly regulate waste and its related greenhouse gas emissions, and their primary target will be landfills. Landfills emitting CH_4 will become unacceptable, so making use of the CH_4 will be essential. Lowest on the list of actions is to collect and pipe the gas to a flare, combusting it to less harmful CO_2. A step better is to use the flare to heat water and create steam that will drive a turbine and generate electricity, especially if the CH_4 can be accumulated during the day and flared at peak electricity demand time during the evening.

This procedure is in operation at three landfills in Durban and is planned for the Bellville South landfill in Cape Town. Generating electricity allows cost recovery for the installation of the collection and flaring system. The Durban project is estimated to earn R8-million per year in electricity sales.[10] A final option is to bottle or pipe the gas for industry use, but the cost of compressing CH_4 may detract from this option.

Throwing away the embodied energy in waste will become environmentally and possibly economically unaffordable. Recycling will be the first big move away from current practice. Cape Town has started experimenting with a two bin system (one for recyclables, one for waste) in several suburbs. Private companies in Johannesburg and Cape Town have recently started offering services to residents willing to pay a small fee to have their recyclables removed. These initiatives are likely to ex-

pand and see legislation backing them up.

Current recycling rates in Johannesburg are 8% prior to landfill and a further 1.5% from salvagers on the landfills.[11] There is vast room for improvement, not only in percentages recovered, but also in the methods. Recovering materials from mixed waste streams, especially on landfills, is dirty and undignified work, and also demands more thorough washing of certain recyclables.

Recycling will become compulsory as a minimum for packaging and other high value/volume commodities such as tyres and e-waste. Reusable packaging and minimisation of packaging waste will become standard goals and governments are likely to set stiff reduction targets for manufacturers and retailers.

Private industry

Consumers are going to have to stand up for their future and support retailers and manufacturers that reduce environmental impacts. Industry will have to adjust its current approach to packaging as this becomes an unwanted item. Using recycled materials in manufacturing may appease some, while reducing packaging to a bare minimum may give a product an advantage. There may be a resurgence in returnable packaging. This would require the market to homogenise containers in order to achieve economies of scale required for returnable packaging.

Hazardous wastes such as e-waste will have to be returned, most likely to the retailers. Those businesses that make it easier for their customers to drop off unwanted wastes will likely see customer loyalty work in their favour.

Individuals

Undoubtedly, the world is getting more complex. Individuals will have to worry

EXTENDED PRODUCER RESPONSIBILITY (EPR)

EPR is a method of enforcing Cradle-to-Cradle thinking and ensures that firms that manufacture and sell products are accountable for the appropriate reuse, recycling or disposal of products after their useful life. The National Environmental Management: Waste Management Bill (a draft) contains reference to EPR and it allows the Minister of Environmental Affairs and Tourism to draft regulations that will make EPR a fact of life for industry sectors. Likely sectors to see legislation aimed at them are high volume/value/toxic waste streams *and* those industries that are not self regulating. Proactive sectors include glass, beverage cans and PET plastic. They have formed various types of companies and voluntary agreements, collecting levies in some cases and stimulating recycling in their sectors. Industries who don't get their act together may see the government intervene in a way that may not be optimal for the industries concerned - witness the plastic bag agreement of 2002 that caused major disruptions in that sector.

not only about where to obtain their supplies, but also where to take their waste. Waste-disposal fees are likely to climb, yet recyclables may cross-subsidise waste removal. Your waste bin and the pile of recyclables next to it will become a loved or hated thing, depending on your ability to adapt to the coming changes in waste management. Be prepared.

Conclusion

All waste must equal food, yet little of what we throw away gets eaten by anything, whether animal or machine. A shift will have to occur on all fronts, with government pushing, the public pulling and industry performing, until all waste finds its way back into something beneficial. We need to create industrial ecology, thinking cradle to cradle, creating cyclical systems like nature does and reducing our waste stream in quantity and hazardous nature. We all make waste so we all need to shift our ways. If we do, we may just be able to hold back the winds of climate change.

Resources

i. The Institute of Waste Management South Africa; *www.iwmsa.co.za*
ii. The California Integrated Waste Management Board; *www.ciwmb.ca.gov*; an excellent resource on progressive waste-management policies, ideas and practices.
iii. Western Australian Zero Waste campaign; *www.zerowastewa.com.au*
iv. The e-Waste Association of South Africa (eWASA); *www.e-waste.org.za*
v. Cradle to Cradle – Remaking the Way We Make Things; William McDonough & Michael Braungart; 2002; North Point Press.

Education is the most powerful weapon that you can use to change the world.

Nelson Mandela

22

You the educator

Tess Fairweather

Mankind's transition from the Information Age to the Environmental Age is being driven by urgent necessity. The success of this transition from wilful violation of our planet to sustainable society will depend largely on educators taking a leadership role to equip us and the next generation with the appropriate skills. In this context, "educator" is used in the broader sense, whether active in schools, tertiary institutions, commercial settings or civil society organisations. The media too plays an important role in education by creating awareness. Government has the role of both educator and facilitator of environmental education throughout society. This is a call to educators: show us, lead us, teach us!

Environmental education should be integral to all curricula rather than a separate discipline. Signatories to the International Ubuntu Declaration at the 2002 World Summit for Sustainable Development in Gauteng called for the introduction of sustainable development into curricula at all levels of education. As Hans von Ginkel, Rector of the United Nations University, said, "Sustainable development should be part of all regular education, not treated as a separate subject or taught at a certain stage."[1]

This understanding of environmental education and the realisation that it should be integral to all streams of learning was clarified at two United Nations conferences that were held in the 1970s. The Belgrade Charter stated that: "Environmental education, properly understood, should constitute a comprehensive lifelong education, one responsive to changes in a rapidly changing world. It should prepare the individual for life through an understanding of the major problems of the contemporary world, and the provision of skills and attributes needed to play a productive role towards improving life and protecting the environment with due regard given to ethical values."

The subsequent Tbilisi Declaration stated the objectives of environmental education to be:[2]

- Awareness: to help social groups and individuals acquire an awareness and sensitivity to the total environment and its allied problems.
- Knowledge: to help social groups and individuals gain a variety of experience in and acquire a basic understanding of the environment and its associated problems.
- Attitudes: to help social groups and individuals acquire a set of values and feelings of concern for the environment and the motivation to participate actively in environmental improvement and protection.
- Skills: to help social groups and individuals acquire the skills to identify and solve environmental problems.
- Participation: to provide social groups and individuals with an opportunity to be actively involved at all levels in working towards resolution of environmental problems.

> "... the task of education would be, first and foremost, the transmission of ideas of value, of what to do with our lives. There is no doubt also the need to transmit know-how, but this must take second place, for it is obviously somewhat foolhardy to put great powers into the hands of people without making sure that they have a reasonable idea of what to do with them... More education can help us only if it produces more wisdom."
>
> *E.F. Schumacher,* Small is Beautiful:
> A Study of Economics as if People Mattered

Pedagogy – the art of teaching

All educators need to become adept at empowering scholars and students to learn through their heads, hearts and hands. Learners not only need to comprehend the climate and broader environmental crisis intellectually, they also need to learn how to internalise and deal with it emotionally, and learn the practical skills required to adapt to a changing environment.

Educational institutions and educators must lead by example; by living what they teach. The complexity of the educator's mission is addressed by The Environmental Education Project of the Institute for Global Environmental Strategies and the Global Development Research Centre.[3] They assert that environmental education must be planned and implemented systematically across many disciplines, sectors and ecosystems. They encourage a fundamental reorientation of the pedagogical approach, replacing existing teaching methods with activities and issue-based approaches to field work, case studies, skills development and learning through participation. Learning about sustainability can take place in formal and informal settings.

Best practices include:

- Revising curricula: existing curricula must be reviewed regularly and revised in the context of a fast changing understanding of our environmental needs and options.
- Utilise traditional communication: folklore, folk songs, story-telling and traditional events are powerful tools to raise people's awareness.
- Forge partnerships: partnerships between educational institutions and the broader community are key to advancing sustainability education.
- Multicultural perspectives: achieving sustainability – particularly within our rainbow nation – is dependent upon an understanding of diverse cultural perspectives and approaches to problem solving.
- Empowerment: lifelong learning, interdisciplinary approaches, systems thinking, partnerships and multicultural perspectives empower individuals and institutions to contribute to sustainability.

A GLOBAL COMMUNITY AT WORK

The GLOBE Programme is an environmental education initiative that links students, teachers and scientists in more than 100 countries and allows the students to measure the local environment at their school. Such community-based initiatives can be a powerful way to effect change. See *www.globe.org.uk*

Educational institutions and sectors

A multitude of institutions and sectors in our society have an educational focus. Their challenge is to understand how best they can integrate environmental thinking and skills development into their educational activities.

Schools

Creating a better future for our youth and imbuing them with a sense of environmental knowledge and sensitivity is one of the highest ideals to pursue. In the words of the United Kingdom's National Association for Environmental Education (NAEE): "Environmental Education is crucial in helping young people to become responsible and caring citizens. It can provide the motivation to care about the major ecological and sustainability issues that affect the future of our planet."[4]

We spend our formative years at school and this is where a formal awareness of environmental education should be entrenched. Some practical examples include:

- Storytelling and role-playing, which can teach children about the webs of life and our place in the ecosystem.
- Maximising the use of eco-friendly toys and materials.
- The mantra of reduce, reuse and recycle (see *Chapter 21: Our waste*), which should become as natural as breathing.
- Where possible, stories, role models, heroes and heroines that enshrine a sustainable world.
- Encouraging children to educate their parents – "Recycling is easy". Make school collection points reward these initiatives.
- Interschool competitions. These can drive everything from recycling to the best sustainability project or essay.
- School gardens, which are a good way to feed children and show the need to care for our planet.
- Annual tree-planting expeditions to help underline the need to reduce our greenhouse gases.
- Teachers should set personal examples in leading sustainable lives.

SUPPORTING ENVIRONMENTAL EDUCATION

The UK's National Association for Environmental Education (NAEE) supports schools and other educational institutions in integrating environmental education into their curricula. Amongst many other services, the NAEE offers practical support by providing teaching materials and ideas, and also organises conferences to facilitate an exchange of views and ideas. See *www.naee.org.uk*

Tertiary education

Tertiary education institutions are the incubators of tomorrow's decision makers. Our future leaders need to have an environmental sensitivity that allows them to integrate sustainability thinking into every facet of our society and economy. Students need to understand that without saving the planet there is no sustainable future for humanity. Environmental knowledge, initiative and innovation must be encouraged in all disciplines.

Media as educator

The media have immense power. It is time for every web-portal, newspaper and magazine, filmmaker and broadcaster to promulgate sustainability. Even the conservative Rupert Murdoch has committed to make his News Corporation carbon neutral by 2010 and to weave environmental issues and themes into his newspapers, TV shows, movies and online properties. "Climate change poses clear, catastrophic threats," Murdoch said. "We may not agree on the extent, but we certainly can't afford the risk of inaction."

Industry as educator

Commercial decision-makers must accept responsibility and use their considerable powers of persuasion to educate customers, employees and broader stakeholder communities about common environmental imperatives, if only to do so better than their competitors. If people in the remotest corners of the Earth know where to buy Coca-Cola or cellphone time, it should be equally easy to spread knowledge about action against fossil fuel emissions and deforestation at the same time.

Religious education

The Southern African Faith Communities' Environment Institute is a rare and shining example of multi-denominational organisations that work together to raise environmental awareness, confront environmental injustices and facilitate environmental responsibility and action. See *www.safcei.org.za*

The role of government in education

Not only does the South African Constitution enshrine the right to an environment that is not detrimental to health or wellbeing, but government policies and legislation across most sectors emphasise the need to protect the South African environment and to promote, through education, a sustainable environment for the benefit of present and future generations.

Of course, government, to a significant degree, determines our educational content and the manner in which education is delivered. In the face of limited resources, government must find ways to better leverage education as a powerful tool to tackle the multiple scourges of global climate change by appropriately equipping, motivating and rewarding our teachers.

> "Must we always teach our children with books? Let them look at the stars and the mountains above. Let them look at the waters and the trees and flowers on Earth. Then they will begin to think, and to think is the beginning of a real education."
>
> *David Polis*

> Nature has been for me, as long as I remember, a source of solace, inspiration, adventure, and delight; a home, a teacher, a companion.
>
> *Lorraine Anderson, writer*

Conclusion

Educators have a choice: they can choose to look on in dismay at the growing environmental crisis, or they can seize this opportunity to play a necessary role in helping shape a better future for all.

The educators' role is to give the learner a thirst for a holistic understanding of our role in causing global warming and collectively tackling the issue. This global crisis should give our young people confidence in their ability to use their varying skills to make a difference.

This is a call to educators: show us, lead us, teach us. Reclaim your role as leaders in society and play an integral part in creating a better future for all. And government, you have the duty to enable education institutions and teachers to equip our society for change.

Resources

Numerous resources exist that can help you the educator instil environmental thinking and action among your learners:

ii. Regional Environmental Education Programme; *www.sadc-reep.org.za*
ii. Global Development Research Centre; *www.gdrc.org*
iii. Education for Sustainable Development; *www.unesco.org/education/desd*
iv. The National Association for Environmental Education (UK); *www.naee.org.uk*
v. Schumacher College; *www.schumachercollege.org.uk/learning-resources*
vi. Australian Association for Environmental Education; *www.aaee.org.au*
vii. Schools For a Sustainable Future; *www.sfsf.com.au*
viii. Department of Environment and Tourism; *www.environment.gov.za/ClimateChange2005/Resources_schools.htm*
ix. Centre for Ecoliteracy; *www.ecoliteracy.org*
x. Seed – Transforming Learning through Permaculture; *www.seed.org.za*
xi. Project 90 by 2030; *www.project90x2030.org.za*
xii. Earth Education; *www.eartheducation.org*
xiii. Foundation for Environmental Education; *www.fee-international.org*
xiv. Ferry Beach Ecology School; *www.fbes.org*
xv. Backyard Nature; *www.backyardnature.net*
xvi. The Journal of Environmental Education; *www.heldref.org*
xvii. Sustainability Institute; *www.sustainabilityinstitute.net*

xviii. Indalo Yethu, South Africa's Environmental Campaign; *www.indaloyethu.co.za*

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Tell me and I'll forget,
Show me and I may not remember,
Involve me and I'll understand.

Native American proverb

You the parent

Andrew Janisch

Parents want the best for their children, and living a sustainable lifestyle that leaves a healthy Earth is the very least we can do for them. Children pick up core values and habits from birth and, by the time they are 10 or 11, will have internalised these. That makes it crucial to introduce a lifestyle based on sustainability as early as possible. And the best way to do this is to live a sustainable lifestyle yourself: conserve water, reuse, recycle, resist consumerism, eat sensibly and sustainably and save energy. Above all, lead by example. This chapter provides many fun-filled ideas to help your children understand the implications of their actions and reduce your family's ecological footprint.

As parents, we want the very best for our children, and yet, ironically, we still continue to live unsustainable lifestyles that threaten the future of the planet that they will inherit from us.

The core goal of a sustainable lifestyle is to leave the world for future generations in the same way that we found it – if not better. And the most effective approach to this dilemma is the "do as I do" parenting style. One of the best gifts we can give our children, and the world they will live in, is the habit and value system that comes from a sustainable lifestyle. By changing their outlook, we will change the outlook of the future.

Research in human development has shown that by the time a child is 10 or 11, all the rule systems he or she have been exposed to since birth will have been internalised as core habits and values.[1] So it is crucial to introduce a lifestyle based on sustainability as early as possible.

This is not to say that older children are not able to change! Many sustainable practices strike a common chord with the essence of our humanity, and are also intuitive.

> Our children are constantly bombarded by marketing messages that promote wasteful and unsustainable habits and values.

Through living by example and involving your children, you will reconnect them to the Earth, teach them to be grateful for what they have and encourage them to develop a sense of responsibility for their natural inheritance. You will also empower them to realise that they have the ability to make a difference and that, although things are likely to get worse before they improve, they can participate in creating a better future.

Our children are constantly bombarded with marketing messages that promote wasteful and unsustainable habits and values via the media, their role models and their peers. While it is impossible to avoid this entirely, making changes where we can, especially in our homes, will go some way towards engendering spiritually, emotionally and physically grounded children. By doing this, you are simultaneously reducing the amount of greenhouse gases produced by your family through its day-to-day functioning, and minimising your personal impact on climate change. It's a win–win situation.

Let's look at some of the areas in which changes can be made and, by involving your children, getting them to live those changes. (This chapter provides many practical examples. For further inspiration, please refer to other chapters, such as *You at home* and *Our waste*.)

Many of the activities will require a change in habits, which can be difficult. But turning these changes into exciting learning activities will make your children wonder why they weren't doing things this way before.

PLAYING MATHS GAMES

Maths games provide the opportunity not only to improve your children's number-crunching skills, but also to develop an appreciation of the impact and cumulative effect of specific activities (e.g. flushing a toilet or leaving a light burning).

If you waste one litre of water per day when brushing your teeth, and 10 million other children in South Africa do the same, how much water is wasted in a year? (Using an average swimming pool as 100 000 litres gives a good reference point for comparison.)

An average shower uses around 15 litres per minute, whereas an average bath uses 110 litres. If you shower for three minutes instead of five, how much water can you save? How much will you save in a year?

Toilet cistern sizes may vary from five to 15 litres – calculate the size of your cistern. How many times do you flush it every day? Multiply this number by the size of your cistern to calculate your daily water usage. Examine how you can reduce this amount by using the "mellow yellow technique", installing a dual-flush toilet or using a milk carton. Work out the amount of water saved per month. Compare this to your metered monthly water consumption and calculate how much money you could save by using less water. You could create a template that your children can fill in. For more water-saving games, see *www.tlfe.org.uk/solveit*

From the outset, it might be useful to have an incentive scheme set up, such as a Green Star Chart for younger children or an achievement list for their older siblings. Keep track of the family's diminishing environmental footprint, so that everyone can take pride in their progress. It is important to develop a sense of "it is good to do the right thing" and that "less can be more".

Every time your child shows that he or she has acted in a sustainable way, reward with praise, a star or a kudo. After 20 stars, reward them with a special trip or some seeds to plant in their own garden – but be sure to make it a "sustainable" reward. After 100 stars do something non-consumerist, like going on a camping trip. This will turn even the most mundane tasks into a game and set the children a target to focus on. If you would rather not use a reward system, keep the momentum by showing encouragement and support and, of course, leading by example. Follow in the steps of Gandhi and "be the change you want to see in the world".

In many of the suggestions that follow, I refer to maths games (see sidebar above and page 302), which have been conceived to help make the actions real and put them into context. By creating degrees of scale, kids will soon realise the impact their collective bad habits can have. These games may need some parental input, depending on the age of the child.

"Water've" you got to lose?

Besides water being a precious resource, the process of purifying and pumping it to your home is very energy intensive, making it a contributor to climate change. Here are a few guidelines to help children to reduce water wastage:

Action	Suggestions
Don't let the water run while brushing teeth.	Play a maths game instead.
Practice selective toilet flushing.	Kids love a rhyme (and toilet humour) and won't forget this one: "If it's yellow let it mellow, if it's brown flush it down!" Play a maths game.
Share bath water or rather have a short shower.	Reward with a green star. Play a maths game.
Wash dishes with the sink plugged.	Reward with a green star.
Reduce the volume of water in your toilet cistern by inserting a suitably sized milk carton filled with water.	Decorate the carton as a hippo, a whale or an elephant. Play a maths game.

Parents leading by example:

- Install rainwater tanks.
- Install grey water systems.
- Fit low-flow showerheads.
- Install low-pressure geysers.
- Use dual-flush toilets.
- Insulate hot-water pipes.
- Plant an indigenous, water-wise garden.

Don't waste it – reduce, reuse, recycle

Remember the three Rs (see *Chapter 21: Our waste*):

- Reduce – the amount of waste entering the home by purchasing goods with minimal packaging.
- Reuse – waste products wherever possible.
- Recycle – paper, glass, metal, plastic, building materials.

Reduce, reuse, recycle. Reduce, reuse, recycle. Let the phrase become a mantra. Then apply it; they'll get it. Throwing away something for the landfill should be the last resort. Huge quantities of greenhouse gases are produced in our landfills every year, and cities can't keep up with their growing waste crises. Massive

> "Treat the Earth well: it was not given to you by your parents, it was loaned to you by your children. We do not inherit the Earth from our ancestors, we borrow it from our children."
>
> *Ancient Native American proverb*

amounts of money and energy are used to transport this waste out of cities. It's easy to create a simple waste-sorting system – compostables (all organic matter), recyclables (glass, plastic, paper, cans) and the rest. Here are some good ideas:

Action	Suggestions
Create compost from organic waste generated in the house.	Start a worm farm. The kids will be fascinated and enjoy hours of afternoon fun. Older kids can earn extra pocket money selling compost to neighbours, and by collecting their organic waste for a mini composting business.
Keep used lids, jars, toilet rolls, bottles.	Make toys and creative gifts, then recycle.
Keep old paper with printing on one side only.	Use for drawings, paper aeroplanes, school projects, general scrap use.
Visit a landfill site in your area.	Quite an eye opener and a very educational experience.

Parents leading by example:

- Buy products with minimal or recyclable packaging.
- Buy good quality, long-lasting goods wherever possible.
- Recycle habitually.

Our precious, yet energy-intensive food

Large amounts of greenhouse gases are produced in the processing, packaging, refrigeration, transporting and storing of food. Livestock farms are massive producers of methane (CH_4), a greenhouse gas 25 times more potent than carbon dioxide (CO_2). A recent UN report indicates that nearly one-fifth of greenhouse gas emissions come from the livestock sector.[2]

Here are some steps you can take to lower the real cost of your food:

Action	Suggestions
Cut down on meat.	Introduce at least two vegetarian meals per week.
Grow your own food.	Give your children their own veggie patch and really get them involved. This is an exceptionally rewarding experience for the whole family.
Keep it local, keep it seasonal.	Make a wall chart of seasonal fruit and veggies, buy local organic if possible, buy from your children's garden.
Make your own yoghurt and fruit juice.	Rewarding and great fun for the whole family.
Keep your own chickens.	Fun for the kids, fresh eggs, composting – don't need a rooster! Check your city's bylaws though ...
Plant a deciduous fruit tree near your north-facing windows.	Teach kids the benefit of shade in summer, and sun in winter. The fruit harvest is a bonus.

Parents leading by example:

- Buy organic produce at the local farmers' market, or have a weekly box delivered.
- Make your own muesli or granola.
- Find out if you can volunteer for organic farms in your area.
- Do a vegetarian or raw food cooking course.

Bite back at consumerism

It's everywhere these days – in the media, in shops and in our social circles, creating the need for more. TV, movies and computer games perpetuate unsustainable stereotypes. Big business tells us and our children what we want and what we can't possibly do without, creating a culture of high turnover disposable products, where items can become obsolete within a matter of months, thus encouraging new purchases. This throwaway culture has a huge impact on climate change from an energy and waste perspective. It's a tough task keeping our children grounded in this context.

Getting home the message "You are enough" is the key – helping them to understand that their happiness and success is not dependent on material possessions

Action	Suggestions
Buy locally produced items.	Teach kids the value of supporting local industry over multi-national brands.
Go for a walk in a beautiful place rather than visiting the mall.	Teach kids and their friends to appreciate the simple things – a walk on the beach, in the veld, in a park, finding a good spot to watch the sun set or to look at the stars.
Encourage understanding of nature.	Explain how ecosystems function and how they provide essential economic inputs. (See *Chapter 2: Healthy environments, healthy people*, and consult Wikipedia.)
Encourage family games and chat times instead of TV, movies and computer games.	Use these as great bonding opportunities. Our addiction to modern technology has impacted on family interaction.
Encourage creative and imaginative play. No toys needed!	Imaginative play is more empowering and developmental than the latest toy.
Have clothes-swap parties.	Great fun for kids and adults, and a good way to recycle clothes.
Deliver clothes to orphanages, shelters, crèches.	Clothes are energy-intensive products. Pass old clothes on to a needy cause, making this an educational experience for your child.
Make creative presents.	Make your own cards and presents. Or you can give presents that have a sustainability value: like a solar oven, or seeds and gardening implements.
Go cloth for nappies.	All nappies have an environmental impact. However, by using cloth ones, it's up to you, rather than the manufacturer, how big that impact will be. You can minimise the impact of cloth nappies by washing them in cool water with an eco-friendly detergent and allowing them to dry outdoors.

Parents leading by example:

- Buy sustainable products.
- Buy second-hand instead of new items.
- Have things fixed.
- Don't watch too much TV.
- Continue using something, even if it is out-of-date or "unfashionable".
- Enjoy nature often.

is one of the biggest gifts to give children. Children need to feel that it's cool to be green and responsible, rather than materialistic. However, making them aware that feelings of true happiness and high self-esteem won't come from cool clothes, gadgets and toys and having wealthy parents is a real challenge. These beliefs come from somewhere deeper, and children need to understand that being true to sustainable values and "doing what is right" is a source of self-esteem. When it comes to buying goods, they need to be made aware of how their choices can influence change. Recent advertising research in the US indicates that children have an increasing influence on what their parents buy (go to www.mediafamily.org/facts/facts_childadv.shtml). Youngsters should be taught to make responsible purchasing choices by considering the impact of their purchase on the environment.

Switch on to energy saving

The biggest contributer to climate change in our lifestyle is our overuse of energy in all its forms: electricity, fuel for transport, coal, gas and wood. Children need to understand the link between their actions, such as switching on the light, and their associated impacts, such as the amount of CO_2 that is produced when coal is burnt to provide electricity.

Action	Suggestions
Reduce petrol and diesel use. Ride a bike or walk; take a train or bus; set up lift clubs.	Buy bikes for the family – great fun and good exercise, or walk to the shop for small purchases; use safe public transport – kids love trains and buses. Form lift clubs. Play a maths game.
Turn off all appliances in stand-by mode.	Play a game with young children to see if they can find appliances in the house that need to be switched off (including the ones in "stand-by" mode). Play a maths game.
Use blankets instead of heaters.	Excellent for snuggling, tunnelling and bonding!
Turn off lights in unused rooms.	Play a maths game.
Encourage creative and imaginative play. No toys needed!	Play a maths game. Reward with a green star.
Encourage energy activism.	Get your child or his or her school to write a letter to Eskom asking how they plan to reduce carbon emissions from their coal-fired power stations, and increase the use of renewable sources of energy (*www.eskom.co.za*). Write a letter to your local politician asking what the city is doing about climate change. Join local, national or international green youth organisations. Start a campaign at your school to cut electricity and transport fuel consumption by 10%.

Parents leading by example:

- Install a solar water-heater.
- Install energy-efficient lightbulbs.
- Cook with gas and hotboxes.
- Walk, cycle, or use a lift club or public transport wherever possible.
- Get electricity from photovoltaic (PV) panels on your roof.

Ideas for emission-saving maths games:

- One litre of petrol produces 2.3 kg of CO_2 and a small family car typically uses 8 litres/100 km. How much CO_2 is produced in a trip to school and back?
- Stand-by blues: A TV in stand-by mode creates 20 kg CO_2/year, a DVD player 44 kg/year, a computer 9 kg/year, a cellphone charger (plugged but not used) 10.5 kg/year.[3] How much can you save in your house/year by turning these off?
- To keep a 100W light bulb on for 1 hour costs about 5c. How much can we save in a year by turning lights off? Place a pocket-money incentive on proactively switching off lights.

Calculate your carbon footprint

For an assessment of how your family or school is doing in carbon emissions, a

ALIGNMENT WITH THE STARS

More and more celebrities are showing their support for sustainability. Encourage your children to check out what these celebs are saying and doing. These high-profile stars do have an effect on how young people see the world – finding out about these role models and what they are getting up to sustainability-wise can be inspirational to our kids.

The Internet is the best place to source this information, and several websites are very helpful:

- Watch the short films at *www.leonardodicaprio.org*
- See what George Clooney, Daryl Hannah and even Queen Elizabeth II are doing about green issues at *www.goodcommonsense.net/26greenculture.html*
- Visit the green celeb gossip site *www.ecorazzi.com/*

> "It is the supreme art of the teacher to awaken joy in creative expression and knowledge."
>
> *Albert Einstein*

simple carbon calculator will do the trick. See *Chapter 6: Past-Present-Future: How we got into this mess*, or go to Project 90 by 2030 (*www.project90x2030.org.za*) and download the site's CO_2 calculator. Alternatively, go to the Food and Trees for Africa website (*www.trees.co.za*) and click on the CO_2 calculator – it helps you to calculate the number of trees you need to plant per year to offset the carbon produced through your lifestyle.

Reap what you sow for generations to come...

Hopefully, the practical suggestions and information in this chapter will inspire you and your children to start living a more sustainable lifestyle. Changing the way you live now will positively affect future generations through inherited knowledge. Start today with one action. Then add another as you go. Take the first step now!

Resources

i. Project 90x2030 Club Initiative: Are you concerned about the planet? Then start a club at your school that encourages everyone to modify their lifestyles to reduce their impact on climate change and the environment. Visit *www.project90x2030.org.za*

ii. The Jane Goodall Foundation website encourages young people to make a change in their communities and to link into a global network of similar-minded individuals. Useful info for both parents and educators is provided. See *www.rootsandshoots.org*

iii. A good starting point for your green questions is *www.treehugger.com*

iv. A great interactive website with videos, games, activities and stories is *www.kids.nationalgeographic.com*

v. For information about the Youth State of Environment Report from the National Youth Commission, go to *http://soer.deat.gov.za/97.html*

vi. A good site to see what kids around the world are doing to fight climate change is *www.coolkidsforacoolclimate.com/*

vii. YouthXchange helps trainers and individuals promote sustainable consumption patterns among young consumers. See *www.youthxchange.net*

"The most effective personal climate change strategy is limiting the number of children one has. The most effective national and global climate change strategy is limiting the size of the population."

The Optimum Population Trust, UK

Our population size

Robert Zipplies with Niël Roux

Often referred to as *the most underdiscussed environmental problem*, our population size (and its consumption patterns) are unsustainable. As population numbers and living standards rise, this is leading to increasingly dangerous environmental impacts. We need to reduce our population size and consumption levels voluntarily, otherwise it is likely to occur eventually through cataclysmic events. It is estimated that South Africa – given its current levels of greenhouse gas emissions and resource consumption – can only sustainably support about 14 million people; the population is currently an estimated 48 million. The issue of population is a topic that needs to be addressed urgently as part of developing a sustainable future. Parents can choose to have fewer children and adopt or otherwise support orphans. Civil society organisations, especially faith communities, need to encourage smaller families. Government must take a variety of actions to discourage high fertility rates, such as offering better education, investment in women's development and creating better access to reproductive health services. All of us need to give our children more support, love and education and a better appreciation of sustainable values.

Introduction

The impact of the world's 6.6 billion people[1] on the environment is unprecedented. The exact relationship between population dynamics and the environment is, however, more complex than merely stating a positive relationship between size and impact. The 20th century saw enormous population growth, economic "development" and environmental change. A fourfold growth in the global population to 6.1 billion at the end of the century[2] was accompanied by an increase of between 20 and 40 times in the real gross domestic product.[3] Although this increase allowed us to support this inflated population at vastly higher standards of living, it left a disastrous environmental toll in its wake. Current patterns of population growth and consumption are therefore clearly not sustainable.

> 20% of the world's people living in the highest-income countries account for 86% of total private consumption expenditures, whereas the poorest 20% account for a paltry 1.3%.

An understanding of the extent to which changes in population growth will impact on the environment requires knowledge of the composition of global population growth and consumption. According to the UNDP,[4] 20% of the world's people living in the highest-income countries account for 86% of total private consumption expenditures, whereas the poorest 20% account for a paltry 1.3%. However, as much as 70% of all population growth takes place in poorer, developing countries. And it follows that developed countries are often the major culprits when it comes to global environmental impact. So population growth alone cannot be held responsible for global environmental problems. However, the rapid increase in population in developing countries is becoming more urgent as the demand for consumer goods expands in those regions. The increasingly unsustainable use of the Earth's physical environment necessitates curbing this growth and consumption across all population groups.

The choice to have children is considered an unquestionable human right and the urge to procreate has both deep-seated biological and emotional roots. This makes rational discussion of this contentious topic difficult, especially when further confounded by issues of poverty and cultural and religious differences. Furthermore, our economic system is based on continual, if unsustainable, growth and does not cope well with the economic repercussions of shrinking population groups, as some European countries are discovering. It is for good reason that politicians tend to steer away from the subject of population size and growth. Yet the issue is central to tackling climate change and achieving environmental sustainability, and must be a key element in the debate. Few environmental or political organisations are actively addressing population growth, at our common peril. To quote Africa Geographic's Peter Borchert: "It is a taboo subject that offends political, social and religious

correctness and so it is swept under the table, making a mockery of deliberations around notions of sustainable development."

Almost a century ago, when the world population was just under two billion people, Gandhi famously stated that "the Earth provides enough to satisfy every man's need, but not every man's greed". This probably held true at the time – our numbers were small enough for the Earth's resources to supply every person's modest needs, if not their greed. However, on the back of cheap fossil-fuel energy, mechanisation and better health, our population has more than tripled to an overcrowded 6.6 billion. Depending on how one defines "every man's need", there may soon not be enough resources to satisfy even modest needs.

Our population time-bomb

Our numbers, given our current, unsustainable consumption levels – as unequal as they are, are simply too great. This is an unequivocal reality. We are sitting on a population and consumption time-bomb that is tipping us over the edge of environmental sustainability and political stability. We are progressively destroying the ecosystems we depend on for food, water, shelter and pleasure, and we are in so-called ecological overshoot; consuming our resources at 25% to 30% faster than they are able to replenish themselves[5] (also see *Chapters 2* and *3: Healthy environments, healthy people* and *The state of our environment*). As of today, we would need Earth to be 1.3 times its current size to satisfy our current population and consumption patterns, and this figure becomes greater every year as we continue pushing our ecosystems towards collapse. If all humanity aims for the living standards of an average European or North American person, we would need between three and five planets. Some estimates put these figures even higher.

Even though the rate of global population growth is slowing, six million people are born every month – enough to populate Johannesburg and Pretoria. It is estimated that by 2050, 9.2 billion people[6] will be jostling for shrinking natural resources such as water and food. The greatest population increases will occur in Asia and Africa; Europe is the only continent where population size has started to decline in a number of countries. If our goal is to halt or reverse climate change, improve living and health standards, and ensure social and political stability around the world, we must strive for lower national population numbers.

While few have dared to suggest a sustainable human population size, the Optimum Population Trust (OPT) in the UK estimates that the Earth's carrying capacity is probably not more than two to three billion, which is less than half our present population. The eminent scientist James Lovelock suggests that "we would be wise to aim at a stabilised population of about half to one billion, and then we would be free to live in many different ways without harming Gaia" (his name for the Earth and its ecosystem). For South Africa, OPT estimates a sustainable carrying capacity of 33 million people if we scale down our consumption habits to more modest lifestyles. At present consumption patterns, South Africa can only support about

22 million people sustainably, and, if greenhouse gas emissions and climate change are taken into account, the population size should be no larger than about 14 million.[7] This is about 30% of our present population. Yet our numbers continue to grow at a moderately rapid 1% – enough to double the population within 70 years, if sustained. While our growth rate is slowing, the United Nations World Population Prospectus estimates that South Africa's population size – in a medium scenario – will reach just over 55 million people by 2050[8]; other scenarios and sources place the peak at higher levels. These various estimates, while not foolproof, help us paint a picture of our future and serve to spotlight our tragic collision with the environment. It is evident that population growth and size must be tackled as an urgent environmental issue.

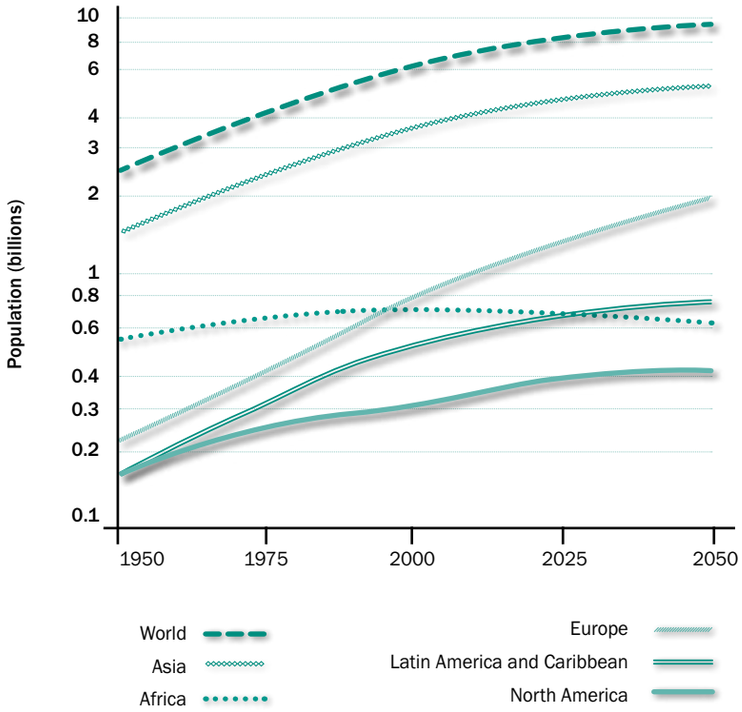


Figure 1: World population evolutions
Sources: www.wikipedia.com; http://esa.un.org/unpp

What can we do about our population size?

Mankind will only endure if we become sensitive to the carrying capacity and health of the Earth's life-supporting ecosystems and adapt our resource usage and fertility rates accordingly.

OUR ENVIRONMENTAL BURDEN (EB) = P x A x T

The global environmental burden (EB) caused by our human activities is determined by the product of three factors: population size (P), affluence (A) and technology (T); affluence being an indication of consumption levels and living standards, and technology being the way that we create economic wealth. For humans to endure as a sustainable society, we will need to vastly reduce the environmental burden to achieve a state of responsive stability. There are three options for achieving this: reducing population size, reducing our consumption levels (decoupling affluence from consumption) or making deep-seated changes to the way we use technology to create the goods and services required for our wellbeing.

Yet our population continues to grow rapidly, while we continue to raise affluence and thus consumption levels. In 1997, it was estimated that technology would need to "improve twentyfold merely to keep the planet at its current levels of environmental burden". Our subsequent and growing understanding of climate change has strengthened our realisation that technology is highly unlikely to reduce our environmental burden and save the day. Given enough time – possibly many generations – it may be that technology will allow us to reduce our environmental impacts and greenhouse gas emissions to sustainable levels in a comfortable manner. However, in the shorter term, it will be difficult, if not impossible, to address the environmental crisis without also tackling the other two issues. As we continue to work on changing how we use technology to provide us with the necessary basic inputs, we must also work on reducing our per-capita consumption and population size.

This highly simplified, yet elegant formula was developed almost four decades ago. Professor Stuart Hart expanded on this earlier work in an award-winning article in 1997 called *Beyond Greening: Strategies for a Sustainable World,* published in the Harvard Business Review.[9]

We have two options – and hoping for a miraculous technological panacea is not one of them. The first option is to do nothing, which will in all likelihood mean that circumstances beyond our control will force a far more traumatic decline in population numbers. This may include ecological catastrophes, food shortages, wars over scarce resources and epidemics – all unpleasant scenarios that James Lovelock, in his book *Revenge of Gaia*, refers to as "the cull". The second option is for humanity to lessen proactively and gradually its impact on the environment by reducing population size and consumption habits. To avoid precipitating natural disasters, mankind must learn to adapt its numbers and behaviour proactively to ensure that we live within the Earth's carrying capacity. Let's take a closer look at how we can gradually and humanely reduce our numbers.

> Human activity is an inherent part of the environment in which we live, and the challenges of population and environment will increasingly be to improve the wellbeing and quality of life of people while ensuring developmental sustainability in the long run.
>
> *International Conference of Population and Development. Cairo, 1994*

You the parent

Having children is an enormous responsibility and parents have a deep sense of duty to do the best for their offspring. We now need to learn to do this sustainably. Here are some ideas of what you can do as a parent or prospective parent:

- Focus on educating your children about the environmental issues they are facing and what needs to be done. Teach them to live with less. For more ideas, see *Chapters 22* and *23: You the educator* and *You the parent*.
- Less is more – you can make a conscious decision to have fewer children and later in life, and you can invest more of your time and resources in giving them a better education.
- Discuss the environmental–population problem within your social and professional circles. It is a sensitive issue, but the harm of inaction far outweighs the difficulty of discussing it. Help people understand the linkages between population, individual consumption and environmental health and our survival as a species.
- Encourage government and the media to educate people about issues of population growth, consumption and environmental sustainability and what to do about it.
- Support or adopt children in need. South Africa and its neighbouring states have a desperately high number of children in need – whether orphans or not (South Africa alone has more than 600 000 orphans).[10] These children are in need of everything – better homes, education, love, guidance, mentorship. What can you do to help them?
  i. You can adopt an orphan or act as a foster parent. For more information, contact Child Welfare South Africa at *www.childwelfaresa.org.za*.
  ii. You can also choose to support orphans and children in need through donations or giving of your time or skills. Or contact Child Welfare South Africa or Big Brothers Big Sisters of South Africa (*www.bbbssa.org.za*), which is an organisation that matches needy young people between the ages of six and 18 years with adult volunteers in one-on-one relationships to maximise their potential. Other such organisations exist.

You the civil society organisation

Civil society organisations, such as not-for-profits and faith communities, need to assist in spreading the message of "less is more". (See *Chapter 14: You the civil society organisation*). Faith communities are progressively changing their attitude towards the issues of population and care of the environment.

You the government

Judging by the prevailing dialogue on economic development and goals to raise living standards, it is apparent that most economic planners have not yet come to terms with the fact that their goals are just not possible unless they boldly address resource usage and population issues.

Stabilising the world population and its impact on the environment depends as much on providing family planning programmes as it does on investing in the well-being and developmental needs of people around the globe. Proven means of reducing fertility levels, which were developed at the 1994 International Conference on Population and Development (ICPD) in Cairo in 1994, include:

- Provision of universal access to affordable and quality reproductive health services.
- Enabling couples to make real choices about family size through a series of social investments, such as work opportunities and skills investments.
- Addressing high rates of infant mortality.
- Providing universal access to primary education and closing the "gender gap" in education.
- Investment in women's development, allowing them to make real fertility-related choices.
- Improving the social status, as well as education and work opportunities for young women.

Some governments have begun to understand the threat population size poses to a peaceful, sustainable society and are overcoming their fear of addressing these prickly issues to put in place programmes to reduce and even reverse population growth.

> Condoms and [contraceptive] pills are as much an emblem of sustainability as bicycles and windmills.
>
> *Lester Brown, Earth Policy Institute*

Of the 380 women around the world who become pregnant every minute, 190 did not plan to do so.[11] According to the Earth Policy Institute, "filling the family planning gap may be the most urgent item on the global agenda. The benefits are enormous and the costs are minimal." They go on to describe the savings incurred: "shifting to smaller families brings generous economic dividends. For Bangladesh, analysts concluded that US$62 spent by the government to prevent an unwanted birth saved US$615 in expenditures on other social services. Investing in reproductive health and family planning leaves more fiscal resources per child for education and health care, thus accelerating the escape from poverty."[12]

DEFUSING IRAN'S POPULATION BOMB

While Iran may be a controversial country for a variety of reasons, there are lessons to be learnt from its population management programme. In 1979, the Ayatollah Khomeini dismantled family planning programmes and advocated large families; fertility levels rose dramatically to a point close to the biological maximum. When the repercussions of this policy started straining economic and environmental resources, the government, in 1989, launched a campaign to stabilise the population. Family planning programmes were put in place; various government ministries and media encouraged smaller families; female literacy and education was promoted; rural populations were given access to health services and family planning; and religious leaders crusaded for smaller families. Iran is now the only country that mandates couples to take family planning classes prior to marriage. Within little more than a decade, the average family size was decreased from seven to less than three.

As in many of these matters, it comes down to political vision and will. Any delays in dealing with the growth and impact of the South African population will necessitate far more drastic interventions at a later stage. The most competitive and sustainable nations on Earth are likely to be those that have smaller and stable, yet well-educated and -resourced populations.

Closing thoughts

Over the next few decades we are likely to add several more billion people to this planet, yet we must still work out how to nourish and care for our present population. Fertility rates and population size are issues that must be addressed sensitively and constructively as part of our broader economic and environmental objectives. Otherwise there may very soon come a time where the free choice of parents to have children is no longer plausible and their right to choose is rescinded in the face of diminishing natural resources.

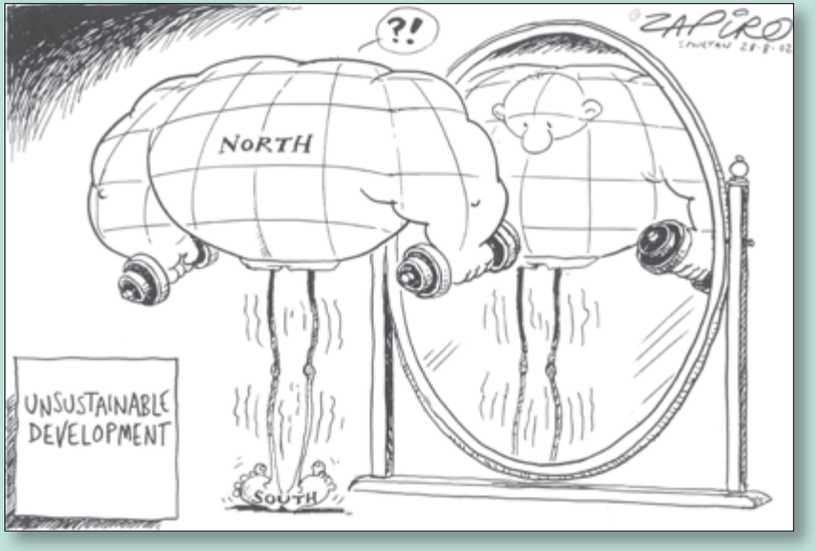
Consider that every human not born saves an average of 3.9 tonnes of CO_2 emissions per annum; in South Africa, this figure climbs to 6.6 tonnes per annum. The unborn child of middle- to upper-income bracket parents would save considerably more. Let's have fewer children, and give those that we have and can support more love, attention, education and an appreciation of the values that will help create a sustainable world. Let's start discussing and acting on the issue – fairly, equitably and for the love of our children and their children.

In the words of the OPT: " . . .while greener technologies and reduced consumption both have a vital role to play, treating population growth as a "given" . . . is a failure of courage and leadership in the face of a planetary emergency. "

When will our South African political, community and spiritual leaders drive a quest for smaller families?

Resources

i. Optimum Population Trust; *www.optimumpopulation.org*
ii. Wikipedia: Overpopulation; *www.en.wikipedia.org/wiki/Overpopulation*
iii. World Population Balance; *www.worldpopulationbalance.org*
iv. World Population Awareness; *www.overpopulation.org*
v. The Voluntary Human Extinction Movement; *www.vhemt.org*



Statistically, Africa is a slow starter in CDM projects – due in part to a lack of understanding of the whole concept, red tape, and the fact that the governments have been slow to act.

www.urbansprout.co.za

Carbon revenues for Africa

Johan van den Berg

The Clean Development Mechanism (CDM) could be a pot of gold at the foot of the rainbow nation, bringing sustainable development, technology transfer and foreign investment. The CDM has the potential to provide an attractive source of additional revenues for many organisations in South Africa. The opportunity also exists to integrate broader social and economic development objectives into some projects. Government must play a more proactive role in facilitating local CDM projects.

The necessity for carbon trading

Avoiding further climate change requires that we vastly reduce our greenhouse gas emissions by consuming less fossil fuel by, for example, driving and flying less, switching to cleaner fossil fuels such as gas, using the fuels more efficiently, and, ideally, switching to renewable, non-polluting fuel sources, such as wind and the Sun.

Unfortunately, changing to cleaner technologies can be expensive. However, carbon treaties and carbon-trading mechanisms provide a means of incentivising investment in these technologies. For example, wind power requires an electricity price of about ZAR 0.75/kWh to make a wind farm viable, while most residential owners pay, on a retail basis after a profit by the local authority and depending on the municipality, around ZAR 0.45/kWh for coal-based grid electricity. Large industrial users pay as little as ZAR 0.15/kWh directly from Eskom. There is a moral incentive, but often little financial reward, for change. When an energy provider must choose between building a wind farm or a coal-fired power plant, the coal plant will, at current electricity prices, over its lifetime, be cheaper to build, operate and maintain than the wind farm. Likewise, in other industries, the clean option (such as double-glazed windows in buildings) is usually the more expensive one.

An international carbon treaty – the Kyoto Protocol – has been established very successfully, creating a mechanism that provides an additional revenue stream that helps to bridge this gap and make clean energy a cheaper option.

The Kyoto Protocol

A carbon treaty is an international convention aimed at addressing climate change. The United Nations Framework Convention on Climate Change (UNFCCC), established in 1992 was the first of these. The Kyoto Protocol, which was set up under the UNFCCC in 1997, gives some teeth to its overall aim of addressing climate change.

The developed world has been burning large amounts of fossil fuel since the industrial revolution and has used this to drive its progress.[1] The developing world, on the other hand, has contributed little to the emissions now causing climate change. Per capita emissions are generally much lower in the developing world, although South Africa is an anomaly. This is the reason that the international treaties that deal with climate change do not treat all countries the same. The developed countries (for example, Europe, Japan, Canada, US, Australia) need to lower their emissions over time; the developing world can still increase its emissions to create work, welfare and catch up with the developed world in terms of standards of living. The idea of the Protocol – signed and ratified by 174 nations[2] – is that developed countries use their wealth and technology to implement clean solutions at an early stage and then quickly transfer this technology to the developing world. This would hopefully enable the developing world to make a step-change in technology. The best analogy is to think of going straight to a mobile phone without using a fixed line.

Kyoto asks that, by 2012, developed countries will have lowered their emissions by an average of 5% below 1990 levels. This target seems modest in the context of recent studies, which show that a global emissions cut of much more is required to avoid dangerous climate change, and that even if the developed country Kyoto participants stopped emitting *altogether*, it would not be sufficient. For this reason, it is imperative to include the US in the post-2012 Kyoto regime, and to lower emissions in the larger developing countries like China, India, Brazil and South Africa, by binding or voluntary emission targets.

In the medium term, however, there is no incentive for a developing country to install clean energy as it is generally substantially more expensive and neither national nor international law requires it.

Flexible mechanisms such as the CDM, which was set up under the Kyoto Protocol, provide that incentive by creating possibilities for developing countries to benefit from emission reductions.

The European Union Emission Trading Scheme (EU ETS) is a cap-and-trade system implemented in the EU with more than 10 000 participants. CDM credits can be sold into the ETS. For details go to *www.en.wikipedia.org/wiki/European_Union_Emission_Trading_Scheme*

How developing countries can benefit from reducing emissions

Essentially, it doesn't matter where emissions reductions take place – one tonne of carbon dioxide (CO_2) is one tonne of CO_2, wherever it is emitted. So the Kyoto Protocol set up a flexible mechanism that allows for a developed country to reach its target in part by effecting emissions-reduction project activities in a developing country. For example, if it is cheaper to reduce emissions in South Africa, a corporate or government entity within a country such as Denmark may offer financial assistance to a project in South Africa in exchange for the Certified Emissions Reductions, or credits, that are created by the project. This will allow Denmark to achieve the reductions agreed as part of the Kyoto Protocol. This idea now also covers the private sector. Companies can choose to limit emissions and earn money from this as a commercial pursuit similar to any other.

As an example: While a coal-fired power station in Denmark can be altered to run on less-polluting natural gas, the same can be done less expensively in South Africa. South Africa has no obligation to lower emissions and so, in exchange for financial assistance from Denmark, it can provide that country with a certificate stating that a certain quantum of emissions has been avoided. This certificate, together with the emissions reductions actually achieved in Denmark, can be used to prove that the country's target has been reached.

In practice, what frequently happens is that the South African entity takes the ini-

tiative, develops the project and only starts looking for a buyer later. Both the buyer and seller could be brought together through brokers or other intermediaries.

The net result of such a project is that South Africa gets technology transfer and direct foreign investment while Denmark achieves its target in the most cost-effective manner. This mutually beneficial trade-off is the basis of the CDM.[A] The international emissions trading market was worth a substantial €24-billion in 2006. About 75% of this was transacted within the ETS, which only applies to countries within the EU, while the remaining €6-billion represented the trade in CDM credits.

How CDM unlocks an additional revenue stream

The CDM was created as a mechanism under the Kyoto Protocol to assist developed countries reach the targets they have been set to reduce global concentrations of greenhouse gases. The host country government is required to certify that the project assists it to achieve sustainable development. The other major requirement is that the project owner, or developer, is able to prove that the income from CDM will be used for a project that otherwise would have relied on a dirtier, cheaper option (called additionality).

CDM is thus not the cream on top of an already profitable project, but the revenue stream that takes the project over its last hurdle. CDM is not money for nothing, but is capital that helps to boost return on investment and so turn marginal or negative-return projects into positive-return projects. Simultaneously, this allows companies to invest in cleaner or more efficient technology and processes than they would otherwise have done.

For example: The developer of power plants calculates that it needs another five cents income per kWh for the power that will be produced to make a wind farm more profitable than a coal-fired power plant. The South African grid produces about 1 kg of CO_2 for every kWh of electricity produced.[3] A 5 MW wind farm is likely to produce about 12 million kWh per annum, and the emissions avoided from building a wind-generation plant as opposed to a coal-fired plant will thus be 12 000 tonnes (1 kg x 12 million kWh). The developer then has 12 000 carbon credits to sell that derive directly from undertaking the clean development activities. If he can realise a price of €6/tonne (at ZAR 10/€), he has extra annual income of ZAR 720 000 – more than ZAR 0.06/kWh. The wind farm has now become cheaper to build than the coal-fired plant, potentially reducing the extent to which South Africa is locked into coal-fired generation for another 30 to 40 years.

Suppose a developed country has a power plant in which emissions need to be lowered in terms of EU legislation. This process might cost €30 per tonne at home or €20 per tonne to buy an emissions reduction from its neighbour in Europe. If turning to a South African company, this could result in the price paid drifting towards

A. A full discussion of CDM is beyond the scope of this chapter. For more details, see *http://cdm.unfccc.int/index.html*. For a full bibliography covering various CDM topics, including hyperlinks, go to *www.cdmafrica.org/publications.htm*

€15, depending on risk factors, making the wind farm more profitable still. So, the developed world entity has achieved its target, while the South African company, having no target, is also compliant. Limiting emissions has been achieved at the lowest possible cost.

Is there a downside?

Several concerns have been raised in connection with the CDM. The first is that the Kyoto Protocol only provides very low targets for developed countries, far below what science tells us would be required to avoid dangerous climate change. One must realise, however, that the Kyoto Protocol dates from 1997 and is being renegotiated for the post-2012 period, and is a tentative first step in the regulation of global emissions. The low targets are reflected in low carbon prices, and these should increase as targets become more onerous and increase competition and urgency for emission reduction credits (CERs).

A more fundamental criticism is that CDM projects do not actually amount to a net reduction of global emissions, but are, at best, climate neutral – they allow someone else to emit more. This criticism, if reformulated, shows the jury to still be out – the CDM is climate neutral on a project level. However, this is not a valid criticism, as the mechanism is supposed by definition and design to be climate neutral. No distinct CDM project is supposed to limit emissions on a global level. It was created to enable developing countries to reach their targets as cheaply as possible and to allow technology transfer to developing countries. In this respect it has been very successful. The developed country targets as set by the Kyoto Protocol are what will limit emissions and the CDM is a tool to contribute to that. The acid test for the CDM is whether the developed countries do, in fact, reach their binding targets by 2012. CDM stands and falls with the UNFCCC and the Kyoto Protocol. Furthermore, with regard to freeing up money for mitigation efforts by seeking out cheaper options and putting developing countries on a cleaner development path, the CDM certainly does limit emissions, even if this effect is hard to quantify.

As with all new market mechanisms, the CDM is open to abuse and has on occasion been abused. However, the validation criteria and oversight are very stringent, with some perplexed African project developers calling them "impossible". The ongoing challenge is to ensure the legitimacy of the system without creating a Byzantine CDM bureaucracy that makes it very hard for new entrants to develop projects successfully, and which wastes precious resources on transaction costs that could have been spent on further mitigation.

A final theoretical concern is that emissions reductions, which are the easiest and cheapest to produce and are known as "low-hanging fruit", are the first to be focused on for CDM project activities. This means that reducing emissions in the future, when South Africa has its own targets to meet, may be more difficult and expensive. Whether this transpires will depend on where South Africa's base year is set. If it is 1990, as it is in developed countries, the criticism will

fall away, as foreign investment would then have paid for emissions reductions that we would otherwise have had to pay for ourselves.

To summarise, CDM represents a real and immediate breakthrough for business and South Africa as a country, by providing an opportunity to acquire clean technologies and support our sustainable development objectives. However, as it stands today, the mechanism is not a fix-all that will deliver the high rate of emissions reductions which the science is now demanding of us.

CDM in South Africa – an opportunity not yet taken

Globally, the success of the CDM has been astounding. An estimated Ð17 billion in clean, sustainable investment was leveraged by the mechanism between 2002 and 2006.[4] With a total of 839 projects now registered internationally, it is likely this figure may already have doubled. These projects will avoid emitting over one billion tonnes of CO_2e by 2012, worth about €10 billion. As a high emissions economy that uses its energy very inefficiently, there is significant scope for South Africa to leverage direct foreign investment through the CDM. However, thus far, there are only 12 such projects in this country.

Our low electricity price, less than optimal regulatory framework and general inertia have prevented us from taking up this opportunity to the full extent. Eventually, South Africa will inevitably be forced by international treaty to clean up its act and invest in clean technology, so we need to tap into this cheap source of capital and develop as many CDM projects as possible. To date, we have failed to recognise what the CDM can do for us and that there is a limited window of opportunity.

KUYASA LOW-COST HOUSING CDM PROJECT

Barry Kantor
www.southsouthnorth.org

SouthSouthNorth (SSN), a non-governmental organisation, has helped the City of Cape Town to design a CDM project that will reduce greenhouse gas emissions and help poor communities throughout South Africa. Reconstruction and Development Programme (RDP) houses have been built by the South African government to house homeless people, but these have no hot water, ceilings or ceiling insulation. The project will install ceilings and ceiling insulation, compact fluorescent lamps and solar water-heaters in thousands of RDP houses, using finance from the CDM revenue stream to contribute to the cost. Not only will the homeowners benefit from having access to hot water and cheaper heating bills, but also, more importantly, from reduced exposure to indoor fires, which are responsible for harmful respiratory diseases. This undertaking is the first CDM project to have been registered in all of Africa and also the first to be accredited by the Gold Standard Board in Switzerland for its rigour and overwhelmingly positive contributions to economic, social and environmental sustainable development. SSN has been inundated with requests to purchase the emissions reductions that derive from this project, which would achieve the highest price in the carbon market. The reason for this is that the project's rigour is uncontested – it has the backing of the Gold Standard and, as no sector of society is likely to oppose it, it lacks any risks to a potential purchaser. Most importantly, the project will contribute enormously to improving the plight of poor people in South Africa.

SUGGESTED GOVERNMENT POLICY

In order to create a market beyond 2012, when the Kyoto commitments lapse, and to extend the CDM window while uncertainty about the post-Kyoto programme is cleared up, government should offer to buy post-2012 credits as the buyer of last resort. This will make South Africa a prime international CDM destination. Also, without the credits, the South African government would have to pay for the infrastructure itself. Setting up the Central Energy Fund's CEF Carbon is a step in this direction.

Instead of taxing CDM projects, government should consider tax incentives for them as, by definition, these projects leverage direct foreign investment into sustainable development and this should be encouraged.

The National Energy Regulator is looking at a feed-in tariff for renewable energy. This would effectively enable producers of green power to get a premium for their electricity; a concept to be encouraged. At present, renewable energy in South Africa is not viable even with CDM, given our very low electricity prices.

How can you access CDM funding?

CDM is a rigorous, audited process that functions on both national and international levels. It can take 12 months or more to implement at a cost ranging from ZAR 250 000 to ZAR 800 000. But projects can yield €7 to €15 per tonne of carbon emissions avoided, depending on how it is sold and where the risk lies in terms of the sales agreement.

On a big flare gas-to-energy project, this might mean ZAR 50-million per annum in earnings from the CDM, while a large pig farmer might leverage an income of ZAR 2.5-million per annum for investing in a better manure-management system. The time frame for CDM investment paybacks typically varies from a few months to five years. The most important question that project developers and professional advisers need to ask themselves occasionally is "what about CDM?". This new tool can yield significant benefits, but, if not considered in time, will slip away irrevocably.

Case studies

Some examples will illustrate what CDM can do:

- At PetroSA in Mossel Bay, the waste-water works generates methane gas that has

been flared for 18 years, which could have supplied 1 500 average households with electricity during that time. With CDM funds, this will now be turned into electricity by a developer and be sold back to PetroSA. The estimated CDM value is ZAR 2-million per annum for 10 years; it makes an otherwise unviable project viable. A total ZAR 27-million of investment into clean energy was leveraged through the CDM as banks are willing to lend to projects once the mechanism is in place.

- At Kanhym pig farm in Mpumalanga, the pig slurry was digested anaerobically, creating about 30 000 tonnes of methane-based carbon emissions annually. A project to capture the methane and generate electricity from it will receive an estimated ZAR 2-million per annum from credits; this offers a revenue stream from pig waste.

Voluntary schemes and offsetting

CDM deals with emissions sold to entities in the developed world that have legal obligations to limit emissions (the compliance market). However, if individuals or companies without legal obligations wish to reduce emissions for moral reasons, the process is referred to as offsetting, for which they purchase "voluntary emissions reductions" (VERs). For example, a person flying abroad who wants to reduce the contribution of the aircraft's burning fuel to climate change, can offset their emissions by paying money to an agency that will use it to support a project that will "save" emissions, in the way that a wind farm does. VERs don't need to go through the same robust auditing process as CDM credits and are issued under different protocols with varying levels of stringency.

However, offsetting schemes have been criticised for their low standards and for failing to foster sustainable development. Moreover, it will take time before the emissions are removed and the damage done during this period is usually not accounted for. At present, there is a strong move towards the adoption of uniform, high standards, such as the Gold Standard and the Voluntary Carbon Standard, which are aimed at maintaining strong additionality and sustainable development benefits in the VER market. These command higher prices, but also higher transaction costs.

Projects with high sustainable development value, especially where there is a human-interest story attached, are able to attract a premium on the price. An example is the case whereby poor communities receive direct benefits from the provision of renewable energy, such as solar systems being installed in homes in remote villages in Bangladesh, eliminating the dangerous use of kerosene indoors.

Another, local example can be seen at Letaba Estates in Limpopo, where a citrus farm is burning about 8 000 tonnes of coal per annum to make citrus juice concentrate. With the help of VERs that have been sold to the international football body FIFA to neutralise emissions from the 2006 World Cup in Germany, the farm will switch to burning the wood-waste and sawdust from surrounding sawmills, so limiting emissions and avoiding the pollution that occurs when sawdust is heaped in the area. This project thus falls outside the CDM arena.

CDM credits are sometimes used for offsetting. Should this happen, an individual

CDM project would lead to a net gain for the global environment even beyond the confines of the UNFCCC and Kyoto Protocol as the saving would be "retired" or torn up, thus not allowing anyone to emit a similar quantity elsewhere.

What companies can do

Companies can undertake energy and CDM audits to establish their potential to develop CDM projects. There is definite potential in the following sectors: Extractive industries and smelters, mining and metals, cement manufacturers, fertiliser industry, any intensive electricity users, landfill sites and municipal waterworks.

The following screening questionnaire can be used for potential CDM projects (a "yes" anywhere indicates potential):

- Are any of the major greenhouse gases presently emitted by the plant or process or will any be emitted by the new project AND is it technically possible to change the process so that emissions of these gases are limited or neutralised?
- Is renewable energy generated as a main function or as a spin-off from the project or can it be generated?
- Will, or can, the project result in electricity being fed into the grid?
- Will present use of grid electricity be discontinued or scaled down as a result of the project, or is there the potential to do so?
- Will the project implement cleaner coal-fired electricity generation, or change a coal-based feedstock with a natural gas, bio-diesel or methanol feedstock?
- Will the project use a non-fossil-fuel-based feedstock (e.g. sewage/landfill waste/biomass) to replace a fossil-fuel-based feedstock?
- Will the project lead to more efficient use of energy?
- Will the project lead to the afforestation or reforestation of land?

In addition to the above screens, it is also necessary to screen the sustainable development contribution of the project. This can be done by ensuring that there is no negative environmental, social or economic aspect to the project and that there is at least some additional environmental, social or economic benefit. A popular screening methodology is the one developed by the so-called Gold Standard (*www.cdmgoldstandard.org*).

Resources

i. A bibliography and links are available at *www.cdmafrica.org/publications.htm*
ii. Climate Change: Stories from the Developing World; Margie Orford; ITDG Publishing (2004)
iii. Wikipedia; *www.en.wikipedia.org/wiki/Clean_Development_Mechanism*
iv. Glossary of CDM terms; *http://cdm.unfccc.int/Reference/glossary.html*
v. Guidance for small-scale CDM projects; *http://cdm.unfccc.int/Reference/Guidclarif/index.html*
vi. World Bank Carbon Finance Unit's State and Trends of the Carbon Market;

Everywhere people ask: 'What can I actually do?' The answer is as simple as it is disconcerting: we can, each of us, work to put our inner house in order. The guidance we need for this work cannot be found in science or technology, the value of which depends utterly on the ends they serve; but it can still be found in the traditional wisdom of mankind.

E.F. Schumacher, *Small is Beautiful: A Study of Economics as if People Mattered*

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Afterword

Robert Zipplies

Quite regularly, I hike up into the beautiful and unspoilt mountains around Cape Town. Here I go to reflect, regenerate and escape the chaos of civilisation. Nature provides solace from the disappointments of humanity and I find myself deeply fulfilled and in humble awe when I look at the astounding beauty, intricacy and economy of nature's workings – the product of many hundreds of millions of years of evolutionary work.

Humans are the boorish and bungling newcomers, and we have much to learn from nature. I am most starkly reminded of this whenever I return from nature to so-called civilisation and what we consider to be an advanced state of development and organisation. We have no idea of how to behave and live in a civilised or advanced manner – we are the bulls in nature's china shop. Our cars, factories, homes and offices, power stations, ships and the barren dust bowls of our agricultural lands are testimony to our inability to appreciate nature's workings and our dependence on it. Add to this our long list of social and economic ills, and you realise how terribly deficient in wisdom we are. At times like this I am darkly pessimistic and I think we have picked up too much speed in our race to the bottom for us to make a timeous U-turn.

Then, at other times, I feel a surge of optimism. I am particularly buoyed by the rising groundswell of people who are starting to take action. Many are changing their lives and are seeking vocations within government and commerce where they can promote change. These individuals are prepared to learn new skills and a new vocabulary, take salary cuts, opt for smaller families – adopt a few orphans, share cars, cycle, use public transport, reduce electricity consumption, live more locally and generally work at putting the public good ahead of their personal enrichment. They are finding ways to live richer, more fulfilling lives with less, and are the vanguard that is redefining our societal norms.

It is a ceaseless task to learn how to become greener and more responsible, and we must encourage others to change their lives and organisations. You and I have the consumer power to call for real change. We must give government, our energy producers and businesses the mandate to do more by perpetually pressurising them.

We must demand that national and international climate and other environmental initiatives are not watered down to suit political and commercial needs; currently we are committing ourselves to failure. Environmental targets must meet, or preferably exceed, those demanded by science, and the greater the margin of safety, the higher our chances of success in this global game of dice.

Reflecting on the contents of this book and its varied chapters, there is certainly no shortage of technologies and methodologies at our disposal to help us to reduce our ecological footprint substantially. But we – particularly those of us with economic choices – find ourselves restrained by the deep-seated fear of losing our plush way of life. We lack the conviction to overcome our deep-seated insecurities and fears to make the necessary changes, whether in our personal lives, within the businesses we work or at government level.

We must each grow our confidence in our abilities and courage as individuals to create and call for fundamental change that will progressively redefine our social norms. It is also our duty to nurture a new generation of political, commercial and civil society leaders who are more visionary and selfless at heart and are able to help us conquer our fears while shepherding us into a new era.

The author Marianne Williamson eloquently writes about overcoming fear and discovering the ability to create positive change:

Our deepest fear is not that we are inadequate. Our deepest fear is that we are powerful beyond measure. It is our light, not our darkness, that most frightens us.
… Your playing small does not serve the world.
There is nothing enlightened about shrinking so that other people won't feel insecure around you.
We were all meant to shine as children do.
It's not just in some of us; it is in everyone. And as we let our own light shine, we unconsciously give other people permission to do the same. As we are liberated from our own fear, our presence automatically liberates others.

Humanity finds itself at a defining moment in its existence. What is required is nothing less than a revolution at personal, national and international level – a revolution in what we value and how we respond to and overcome our social, economic and environmental ills. Ideological, cultural and religious differences have to be put aside to allow humanity to develop a united front. And, throughout, we need to keep the interests of the most vulnerable members of our society close at heart. This means that the time has arrived for middle- and upper-income earners to learn to live with less so that we can reduce our overall environmental burden and improve the lives and education of the poorest members of our society. Humans can be astoundingly resourceful and united in times of need. We must develop the awareness, collective intelligence, altruism and humility that allows us to transcend our

current status of parasitic organism to one that lives symbiotically with its own constituents as well as its host, our biosphere.

In all that you and I do in our lives, we must ask ourselves whose interests we are serving and how we can do things better, more lightly, more justly and more sensitively. Do we really need that new experience or acquisition, or will we all ultimately be better served by giving more of our resources to those who would really benefit most?

Individual and collective happiness is undoubtedly one of our highest aspirations, and we need to ask ourselves again and again: "what makes us happy?" Is it the items we so rapaciously accumulate and consume in our delusional belief that we have every right to do so; or is it the little pleasures in life that don't need to cost anything and through which we can find a better, more lasting happiness. The philosopher Nietzsche puts it beautifully: "For happiness, how little suffices for happiness! … The least thing precisely, the gentlest thing, the lightest thing, a lizard's rustling, a breath, a whisk, an eye glance – little maketh up the best happiness."

I sometimes imagine millions of years into the future, wondering what will have become of our species. Will we have caused our own demise, and will a distant intelligent being – an ancestor of one of the species we did not knock out of the evolutionary tree – dig up our bones, artefacts and monolithic structures and say, "here was Earth's first intelligent species that managed, knowingly, to wipe itself out"? Or will we have continued to adapt and evolve successfully, so that one of our distant, and possibly very different, ancestors will dig up our remains and say, "thankfully for us, here is a species that got it right"?

The choice is yours and mine.

References

Chapter 3: The state of our environment

1. MA 2005. *Millennium Ecosystem Assessment – Ecosystems and Human Wellbeing: Synthesis*. Island Press, Washington DC. www.maweb.org (accessed April 2008).
2. GEO 2007. *Global Environmental Outlook 4*. United Nations Environment Programme, Nairobi. www.unep.org/publications (accessed April 2008).
3. Driver A, Maze K, Rouget M, Lombard, Nel J, Turpie JK, Cowling RM, Desmet P, Goodman P, Harris J, Jonas Z, Reyers B, Sink K & Strauss T. National Spatial Biodiversity Assessment 2004: Priorities for Biodiversity Conservation in South Africa. *Strelitzia* 2005. South African National Biodiversity Institute, Pretoria, South Africa.
4. Biggs R, Reyers B, Bohensky E, Scholes RJ, van Jaarsveld AS, Fabricius C, Lynam T and Musvoto C. 2004. *Nature Supporting People: The Southern African Millennium Ecosystem Assessment*. CSIR, Pretoria, South Africa. www.millenniumassessment.org/en/SGA.Safma.aspx (accessed April 2008).
5. Department of Environmental Affairs and Tourism. 2006. *South Africa Environment Outlook. A Report on the State of the Environment*. Department of Environmental Affairs and Tourism, Pretoria, South Africa. http://soer.deat.gov.za (accessed April 2008).
6. WRI 2005. *The Wealth of the Poor: Managing Ecosystems to Fight Poverty*. World Resources Institute, Washington DC.
7. UNDP 2005. *Human Development Report*. United Nations Development Programme, New York.
8. IPCC 2007. *Climate Change 2007: Impacts, Adaptations and Vulnerability. Summary for Policymakers*. IPCC Fourth Assessment Report, United Nations.
9. Lazlo E. 2006. *The Chaos Point: The World at the Cross-roads*. Hampton Roads Publications, US.
10. Diamond J. 2005. *Collapse: How Human Societies Choose to Fail or Succeed*. Viking Press, US.
11. Monbiot G. 2006. *Heat: How to Stop the Planet Burning*. Allen Lane, Penguin Books, UK.

Chapter 4: Climate change: our most pressing environmental issue

1. *Stern Review on the Economics of Climate Change*. 30 October 2006. HM Treasury, UK. www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm (accessed July 2007).
2. Meehl GA, Stocker TF, Collins WD, Friedlingstein P, Gaye AT, Gregory JM, Kitoh A, Knutti R, Murphy JM, Noda A, Raper SCB, Watterson IG, Weaver AJ & Zhao ZC. 2007: Global Climate Projections. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M & Miller HL. (Eds.). Cambridge University Press, Cambridge, UK.
3. IPCC, 2007: Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate*. Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M & Miller HL (Eds.). Cambridge University Press, Cambridge, UK.
4. Forster P, Ramaswamy V, Artaxo P, Berntsen T, Betts R, Fahey DW, Haywood J, Lean J, Lowe DC, Myhre G, Nganga J, Prinn R, Raga G, Schulz M & Van Dorland R. 2007: Changes in Atmospheric Constituents and in Radiative Forcing. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M and Miller HL (Eds.). Cambridge University Press, Cambridge, UK.

5. Rehfisch MM. & Crick HQP. 2003. Predicting the Impact of Climatic Change on Arctic Breeding Waders. *Wader Study Group Bulletin*, 100: 86–100.
6. Pearce F. 2005. Climate Warning as Siberia Melts. *New Scientist*. 11 August 2005: p 12.
7. Monbiot G. 2006. *Heat: How to Stop the Planet Burning*. Allen Lane, Penguin Books, UK.
8. Easterling WE, Aggarwal PK, Batima P, Brander KM, Erda L, Howden SM, Kirilenko A, Morton J, Soussana JF, Schmidhuber J & Tubiello FN. 2007: Food, Fibre and Forest Products. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Parry ML, Canziani OF, Palutikof JP, van der Linden PJ and Hanson CE (Eds.). Cambridge University Press, Cambridge, UK.
9. Bryden HL, Longworth HR and Cunningham SA. 2005. Slowing of the Atlantic Meridional Overturning Circulation at 25°. *Nature*. 438: 685.
10. Denman KL, Brasseur G, Chidthaisong A, Ciais P, Cox PM, Dickinson RE, Hauglustaine D, Heinze C, Holland E. Jacob D, Lohmann U, Ramachandran S, Da Silva Dias PL, Wofsy SC & Zhang X. 2007. Couplings between Changes in the Climate System and Biogeochemistry. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M & Miller HL (Eds.). Cambridge University Press, Cambridge, UK.
11. Bindoff NL, Willebrand J, Artale V, Cazenave A, Gregory J, Gulev S, Hanawa K, Le Quéré C, Levitus S, Nojiri Y, Shum CK, Talley LD & Unnikrishnan A. 2007: Observations: Oceanic Climate Change and Sea Level. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M & Miller HL (Eds.). Cambridge University Press, Cambridge, UK.
12. Kruger AC & Shongwe S. 2004. Temperature Trends in South Africa: 1960–2003. *International Journal of Climatology*. 24: 1929–1945.
13. Christensen JH, Hewitson B, Busuioc A, Chen A, Gao X, Held I, Jones R, Kolli RK, Kwon WT, Laprise R, Magaña Rueda V, Mearns L, Menéndez CG, Räisänen J, Rinke A, Sarr A & Whetton P. 2007. Regional Climate Projections. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M & Miller HL (Eds.). Cambridge University Press, Cambridge, UK.
14. National Botanical Institute. 2001. *The Heat is On: Impacts of Climate Change on Plant Diversity in South Africa*. (Brochure).
15. Midgley GF, Chapman RA, Hewitson B, Johnston P, De Wit M, Ziervogel G, Mukheibir P, Van Niekerk L, Tadross M, Van Wilgen BW, Kgope B, Morant PD, Theron A, Scholes RJ & Forsyth GG. 2005. *A Status Quo, Vulnerability and Adaptation Assessment of the Physical and Socio-economic Effects of Climate Change in the Western Cape*. Report to the Western Cape Government, Cape Town. CSIR Report No. ENV-S-C 2005-073, Stellenbosch, South Africa.
16. Hewitson B. & Crane R. 2006. *Consensus between GCM Climate Change Projections with Empirical Downscaling: Precipitation Downscaling over South Africa*. International Journal of Climatology. 10: 1315-1337.
17. Scholes R. & Biggs R (Eds.). 2004. *Ecosystem Services in Southern Africa: A Regional Assessment*. A Contribution to the Millennium Ecosystem Assessment, prepared by the Regional-Scale Team of the Southern African Millennium Ecosystem Assessment. Council for Scientific and Industrial Research, Pretoria, South Africa.

Chapter 5: Climate change: our most pressing social and economic issue?

1. Intergovernmental Panel on Climate Change (IPCC). 2007. *Fourth Assessment Report. WGII: Climate Change 2007: Impacts, Adaptation and Vulnerability – Summary for Policymakers.* www.ipcc.ch (accessed January 2008).
2. *Stern Review on the Economics of Climate Change*. 30 October 2006. HM Treasury, UK. www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm (accessed January 2008).
3. Brown L. 2006. *Plan B 2.0: Rescuing a Planet Under Stress and a Civilization in Trouble*. New York: Norton WW. (Chapter 4: Rising Temperatures and Rising Seas). www.earth-policy.org/Books/PB2/contents.htm (accessed January 2008).
4. Government Communication and Information Service (GCIS). 2006. *Pocket Guide to South Africa.* www.gcis.gov.za/ (accessed January 2008).
5. Hansen J, Sato M, Kharecha P, Russell G, Lea DW & Siddall M. 2007. Climate Change and Trace Gases. *Philosophical Transactions of Royal Society A*. 365: 1925–1954.
6. Statistics South Africa (StatsSA). 2007. *Labour Force Survey, March 2007*. StatsSA, Pretoria. www.statssa.org (accessed January 2008).
7. New Economics Foundation (NEF). 2007. *Africa – Up in Smoke 2*. London: New Economics Foundation. www.neweconomics.org (accessed January 2008).

Chapter 6: Past-Present-Future: How we got into this mess

1. Diamond J. 2005. *Collapse: How Societies Choose to Fail or Succeed.* Penguin Books, UK.
2. Wright B & Pardey P. 2002. *Agricultural R&D, Productivity, and Global Food Prospects*. University of California Berkeley and University of Minnesota. www.plantbiotech.jbpub.com/pdf/chrispeels_Ch02_022-051.pdf (accessed March 2008).
3. Leonard A. 2007. *The Story of Stuff: Annie Leonard Footnoted Script*. www.storyofstuff.com (accessed February 2008).
4. Hawken P, Lovins A & Lovins L. 1999. *Natural Capitalism: Creating the Next Industrial Revolution*. Little Brown Company, US.
5. Water UK. *Sustainability Indicators 2006/07*. www.water.org.uk/home/policy/reports (accessed February 2008).
6. Calculations were based on data derived from Eskom's 2006 Annual Report. www.eskom.co.za (accessed February 2007).
7. Rowlatt J. 22 February 2006. *My Carbon Footprint*. http://news.bbc.co.uk/2/hi/programmes/newsnight/4741392.stm (accessed March 2008).

Chapter 7: You are the solution

1. *Mining Waste Generated from Aluminium*. UNEP/GRID-Arendal library of graphics. http://maps.grida.no/go/graphic/mining_waste_generated_from_aluminium_production (accessed February 2008).
2. Hawken P, Lovins A & Lovins L. 1999. *Natural Capitalism: Creating the Next Industrial Revolution*. Little Brown Company, US.
3. *Earth Trends Environmental Information*. World Resources Institute. http://earthtrends.wri.org/ (accessed February 2008).
4. Wikipedia. *Happiness Economics*. www.wikipedia.org (accessed February 2008).
5. *The Happy Planet Index*. 2007. www.happyplanetindex.org/ (accessed February 2008).
6. The National Bureau of Economic Research. www.nber.org/digest/jan06/w11416.html (accessed February 2008).

7. Pearce F. 2007. Why Bother Going Green? *New Scientist*. 17 November 2007.
8. Wikipedia. *Collective Intelligence*. www.wikipedia.org (accessed February 2008).

Chapter 8: Tackling the climate crisis

1. Baumert KA, Herzog T & Pershing J. 2005. *Navigating the Numbers: Greenhouse Gas Data and International Climate Policy*. World Resources Institute (www.wri.org), Washington DC, US. http://pdf.wri.org/navigating_numbers_front.pdf (accessed April 2008).
2. Monbiot G. 2006. *Heat: How to Stop the Planet Burning*. Allen Lane, Penguin Books, UK. www.turnuptheheat.org (accessed April 2008).
3. *Confronting Climate Change: Avoiding the Unmanageable and Managing the Unavoidable*. February 2007. United Nations Foundation and Sigma Xi, Washington DC, US. www.unfoundation.org/SEG/ (accessed November 2007).

Chapter 9: Taking on a fair share: the Goliath of Africa's emissions

1. Baumert KA, Herzog T & Pershing J. 2005. *Navigating the Numbers: Greenhouse Gas Data and International Climate Policy.* World Resources Institute (www.wri.org), Washington DC, US. http://pdf.wri.org/navigating_numbers_front.pdf (accessed April 2008).
2. WRI (World Resources Institute). 2005. *Climate Analysis Indicators Tool (CAIT)*. version 3.0: Washington DC, US.
3. Van der Merwe MR & Scholes RJ. 1998. *South African Greenhouse Gas Emissions Inventory for the Years 1990 and 1994*. National Committee on Climate Change, Pretoria, South Africa.
4. RSA (Republic of South Africa). 2004. *South Africa: Initial National Communication under the United Nations Framework Convention on Climate Change*. Submitted at COP-9: Pretoria.
5. IPCC (Intergovernmental Panel on Climate Change). 2007. *Climate Change 2007: The Physical Science Basis. Technical Summary.* Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Geneva.
6. DME (Department of Minerals and Energy). 2003. *Integrated Energy Plan for the Republic of South Africa*. Pretoria. www.dme.gov.za/pdfs/energy/planning/integrated_energy_plan_dec03.pdf (accessed April 2008).
7. NER (National Electricity Regulator). 2004. *Electricity Supply Statistics for South Africa 2004*. NER, Pretoria, South Africa.
8. Winkler H (Ed.). 2006. *Energy Policies for Sustainable Development in South Africa: Options for the Future*. Davidson O *et al* (Eds.). Energy Research Centre, Cape Town, South Africa.
9. DME (Department of Minerals and Energy). 2004. *South African National Energy Balance*. DME, Pretoria, South Africa.
10. Intergovernmental Panel on Climate Change (IPCC). 1996. *Revised 1996 Guidelines for National Greenhouse Gas Inventories*. Organisation for Economic Co-operation and Development, Paris, France.
11. Intergovernmental Panel on Climate Change (IPCC). 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories.* Prepared by the National Greenhouse Gas Inventories Programme. Eggleston HS, Buendia L, Miwa K, Ngara T & Tanabe K *et al* (Eds.). Institute for Global Environmental Strategies, Kanagawa, Japan.
12. Lloyd PJD & Trikam A. 2004. *The Determination of Emission Factors for South African Power Stations*. Energy Research Centre, University of Cape Town, South Africa.
13. Sasol. 2004. *Sustainable Development Report 2002–2004*. Sasol, Johannesburg, South Africa.

Chapter 10: Mitigation is an energy issue in South Africa

1. IPCC (Intergovernmental Panel on Climate Change). 2007. *Climate Change 2007: Mitigation of Climate Change. Summary for Policy Makers.* Contribution of Working Group iii to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva.
2. ERI (Energy Research Institute). 2000. *Volkswagen SA: Energy Audit. Management Summary, the 3e Strategy.* Energy Efficiency Earnings Series, University of Cape Town, South Africa.
3. Eskom. 2005. *Annual Report: Building Capacity, Embracing the Future*. Eskom Holdings: Sandton, South Africa.
4. NER (National Electricity Regulator). 2004. *National Integrated Resource Plan 2 (NIRP2) 2003/4.* National Electricity Regulator, Pretoria, South Africa.
5. AGAMA (Agama Energy). 2003. *Employment Potential of Renewable Energy in South Africa*. Commissioned by Sustainable Energy and Climate Change Partnership, a Project of Earthlife Africa Johannesburg, in Partnership with WWF, Denmark. SECCP, Johannesburg, South Africa.
6. Winkler H. 2006. *Energy Policies for Sustainable Development in South Africa's Residential and Electricity Sectors: Implications for Mitigating Climate Change*. PhD Thesis, Energy Research Centre, University of Cape Town, South Africa.
7. Winkler H. 2006. *Energy Policies for Sustainable Development in South Africa: Options for the Future.* Davidson O, Winkler H, Kenny A, Prasad G, Sparks D, Howells M, Alfstad T, Mwakasonda S, Cowan B & Visagie E (Eds.). Energy Research Centre, Cape Town, South Africa.
8. IPCC (Intergovernmental Panel on Climate Change). 2005. *Special Report on Carbon Dioxide Capture and Storage.* Metz B, Davidson OD, de Coninck H, Loos M & Meyer LM (Eds). Geneva.
9. EPRI & NRDC (Electric Power Research Institute & Natural Resources Defense Council). 2007. *Environmental Assessment of Plug-in Hybrid Electric Vehicles*. Volume 1: Nationwide Greenhouse Gas Emissions.
10. Johansson B & Ahman M. 2002. A Comparison of Technologies for Carbon-Neutral Passenger Transport. *Transportation Research Part D.* 2002; 7: 175–196.
11. Sathaye J, Najam A, Cocklin C, Heller T, Lecocq F, Llanes-Regueiro J, Pan J, Petschel-Held G, Rayner S, Robinson J, Schaeffer R, Sokona Y, Swart R & Winkler H. 2007. Sustainable Development and Mitigation. In *Climate Change 2007: Mitigation, Contribution of Working Group iii to the IPCC Fourth Assessment Report.* Metz B, Davidson OD, Bosch P, Dave R & Meyer LM (Eds.). Cambridge University Press, Cambridge, UK.
12. DME (Department of Minerals and Energy, Energy Research Centre, Eskom). 2002. *Energy Outlook for South Africa: 2002.* Pretoria, South Africa.
13. DTI (Department of Trade and Industry). 2005. *Developmental Electricity Pricing Programme*: Pretoria, South Africa.
14. Manuel, T. 2007. Budget Speech, 21 February, Parliament, Cape Town, South Africa.

Chapter 11: Your government, our government

1. LTMS Report (in press). www.erc.uct.ac.za/Projects/ltms.htm (accessed April 2008).
2. World Resources Institute. *Climate Analysis Indicators Tool*. http://cait.wri.org/ (accessed Apr. 2008).
3. *China and Climate Change*. www.pewclimate.org/policy_center/international_policy/china.cfm (accessed April 2008).
4. United Nations Framework Convention on Climate Change. www.unfccc.int (accessed April 2008).
5. Intergovernmental Panel on Climate Change. www.ipcc.ch (accessed April 2008).
6. The Stern Review on the Economics of Climate Change. 2006. http://en.wikipedia.org/wiki/Stern_Review (accessed April 2008).

7. The United Nations Climate Change Conference in Bali. 2007. http://unfccc.int/meetings/cop_13/items/4049.php (see the roadmap) (accessed April 2008).
8. Morgan J. 2008. *Towards a New Global Climate Deal*. www.e3g.org/index.php/programmes/climate-articles/towards-a-new-global-climate-deal/ (accessed April 2008).
9. *Business Times*. www.busrep.co.za/index.php?fArticleId=4196895 (accessed April 2008).
10. *A Climate Change Strategy for the Western Cape*. 2007. www.capegateway.gov.za/Text/2007/10/climate_change_strategy_final_draft_june2007.pdf (accessed April 2008).
11. *Scaling up: Global Technology Deployment to Stabilize Emissions*. 2007. www.wri.org/publication/scaling-up (accessed April 2008).

Chapter 12: You the business

1. Baumert A, Herzog T & Pershing J. *Navigating the Numbers: Greenhouse Data and International Climate Policy* 2005. World Resources Institute. www.wri.org (accessed April 2008).
2. *Stern Review on the Economics of Climate Change.* 30 October 2006. HM Treasury, UK. www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm (accessed May 2007).
3. *The Path to Climate Sustainability: A Joint Statement by the Global Round Table on Climate Change.* 20 February 2007. The Earth Institute. www.earth.columbia.edu/grocc/grocc4_ statement.html (accessed May 2007). See also www.combatclimatechange.org (accessed April 2008).
4. *Framing Climate Risk in Portfolio Management.* May 2005. Ceres and WRI. www.ceres.org/pub/ (accessed May 2007).
5. How Many Planets? A Survey of the Global Environment. 6 July 2002. *The Economist.*
6. Insurance Companies take on Global Warming. 24 August 2006. *Fortune.* http://money.cnn.com/2006/08/22/news/economy/pluggedin_gunther.fortune/index.htm (accessed April 2008).
7. Turpie J, Winkler H, Spalding-Fecher R & Midley G. 2002. *Economic Impacts of Climate Change in South Africa: A Preliminary Analysis of Unmitigated Damage Costs.* University of Cape Town, South Africa.
8. *CSR Brand Sustainability.* November 2006. Bateleur Research Solutions.
9. Kerschner E & Geraghty M. 19 January 2007. *Climatic Consequences: Investment Implications of a Changing Climate.* Citigroup Global Markets Inc.
10. Llewellyn J. February 2007. *The Business of Climate Change.* Lehman Brothers. www.lehman.com (accessed April 2008).
11. *Managing the Risks and Opportunities of Climate Change: A Practical Toolkit for Corporate Leaders.* January 2006. Ceres.
12. Pearce B Roche P & Chater N. *Sustainability Pays.* 2002. Co-operative Insurance Society. Data drawn from more than 400 research papers.
13. *Buried Treasure: Uncovering the Business Case for Corporate Sustainability.* 2001. Sustainability and UNEP.

Chapter 13: You the investor

1. *Stern Review on the Economics of Climate Change.* 30 October 2006. HM Treasury, UK. www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm (accessed July 2007)
2. Dlugolecki A, Lafeld S. 2005. *Climate Change & the Financial Sector: An Agenda for Action.* Allianz AG and WWF International. www.wwf.org.uk/filelibrary/pdf/allianz_rep_0605.pdf (accessed November 2007).

3. *Resolved: Public Corporations Shall Take Us Seriously*. 2007. Dashka Slater. New York Times, 12 August 2007. www.nytimes.com/2007/08/12/magazine/12exxon-t.html? (accessed April 2008).
4. The 2007 UNEP Review. *The State of Responsible Investment in South Africa*.
5. Winkler H, Spalding-Fecher R, Tyani L. 2002. *Comparing Developing Countries under Potential Carbon Allocation Schemes*. Climate Policy. Elsevier Science.

Chapter 14: You the civil society organisation

1. Turpie J, Winkler H, Spalding-Fecher R & Midgley G. 2002. *Economic Impacts of Climate Change in South Africa: A Preliminary Analysis of Unmitigated Damage Cost.* University of Cape Town, South Africa. www.fitzpatrick.uct.ac.za/pdf/turpie02.pdf (accessed October 2007).

Chapter 15: You the architect and property developer

1. *Buildings Can Play a Key Role in Combating Climate Change*. UNEP Press Release, 29 March 2007. www.unep.org/Documents.Multilingual/Default.asp?DocumentID=502&ArticleID=5545&l=en (accessed November 2007).
2. Baumert K, Herzog T & Pershing J. 2005. *Navigating the Numbers: Greenhouse Gas Data and International Climate Policy.* Montreal: World Resources Institute. www.wri.org/publication/navigating-the-numbers (accessed November 2007).
3. McCloud RS. *Ordinary Portland Cement with Extraordinarily High CO_2 Emissions: What Can be Done to Reduce Them? Building for a Future*. Autumn 2005: 30-33. www.buildingforafuture.co.uk/autumn05/ordinary_portland_cement.pdf (accessed November 2007).
4. *Global Approach for Steel to Address Climate Change.* 9 October 2007. International Iron and Steel Institute. www.worldsteel.org/?action=newsdetail&id=215 (accessed November 2007).
5. Horn A. *Practising Green Architecture.* www.ecodesignarchitects.co.za/manifesto.htm (accessed March 2008).
6. Haggard K. *Green Building Conference and Exhibition Report 2007.* www.greenbuilding.co.za/index.php?option=com_content&task=view&id=155&Itemid=42 (accessed November 2007).
7. www.mcdonough.com/cradle_to_cradle.htm (accessed November 2007).
8. www.metaefficient.com/archives/architecture-and-building/a_zero_emission_house.html (accessed November 2007).
9. www.passivhaus.org.uk/ (accessed November 2007).
10. www.geopolymer.org/applications/global-warming (accessed November 2007).
11. Lovins A. 2005. *Energy End-Use Efficiency.* www.rmi.org/images/PDFs/Energy/E05-16_EnergyEndUseEff.pdf (accessed November 2007).

Chapter 16: You the urban planner

(Note that most of these references can be found online and were accessed between September and November 2007).

1. City of Cape Town, 2006. *Sustainability Report 2006.* Cape Town, South Africa.
2. City of New York, 2007. *Inventory of New York City Greenhouse Gas Emissions.* Office of Long-Term Planning and Sustainability, April 2007.
3. Institute for Global Environmental Strategies (IGES). 2004. *Urban Energy Use and Greenhouse Gas Emissions in Asian Mega-Cities. Policies for a Sustainable Future.* Urban Environmental Management Project, IGES.
4. City of Cape Town and Sustainable Energy Africa, 2003. *State of Energy Report.* City of Cape Town and Sustainable Energy Africa.

5. Tshwane Municipality, 2006. *Development of the Tshwane Sustainable Energy and Climate Change Strategy*. City of Tshwane, South Africa.
6. DEAT, 2000. South Africa. *Initial National Communication under the United Nations Framework Convention on Climate Change*. DEAT, Pretoria, South Africa.
7. Department Environmental Affairs and Development Planning (DEADP), 2007. *Sustainable Energy Strategy for the Western Cape*. Draft summary document, May 2007.
8. UNFCCC, 2005. *Compendium on Methods and Tools to Evaluate Impacts of, and Vulnerability and Adaptation to, Climate Change.* Final draft report 1/2/2005.
9. SAPIA, 2005. *Annual Report*. www.sapia.org.za/pubs/2005_ARep/index.htm
10. Sustainable Energy Africa, 2006. *State of Cities Report South Africa.* Sustainable Energy Africa. Tshwane Municipality Energy Strategy 2006. Pretoria, South Africa.
11. City of Cape Town and Sustainable Energy Africa, 2003. *Cities of Climate Protection Campaign: Greenhouse Gas Inventory*. City of Cape Town, South Africa.

Chapter 17: Our transport

1. Wright L & Fulton L. 2005. Climate Change Mitigation and Transport in Developing Nations. *Transport Reviews*. 25: 691-717.
2. Data for 2005–2007 from the South African Petroleum Industry Association. www.rtcc.org (accessed April 2008).
3. Monbiot G. 2006. *Heat: How to Stop the Planet Burning.* Allen Lane, Penguin Books, UK.
4. Prozzi JP, Naude C & Sperling D. 2002: *Transportation in Developing Countries: Greenhouse Gas Scenarios for South Africa.* Arlington: Pew Centre on Global Climate Change.
5. Information from: www.carboncalculator.co.uk/reductions_transport.php (accessed April 2008).
6. Data for 2001 from the Rail-Road Association of South Africa.
7. Winkler H, Alfsted T, Howells M. 2005. *South African Energy Policies for Sustainable Development.* University of Cape Town Energy Research Centre. Cape Town, South Africa.
8. www.sustainable-development.gov.uk (accessed April 2008).

Chapter 18: You the farmer

1. Benhin JKA. 2006. *Climate Change and South African Agriculture.* CEEPA Discussion Paper No. 21. Centre for Environmental Economics and Policy in Africa, University of Pretoria, South Africa.
2. South Africa. Initial National Communication under the United Nations Framework. Convention on Climate Change. October 2000.
3. *Green House Gases and Where They Come From. 2000.* World Resources Institute. www.wri.org/climate/topic_content.cfm?cid=4177 (accessed October 2007).
4. *Agriculture and Climate Change: Greenhouse Gas Mitigation Opportunities and the 2007 Farm Bill.* 2007. World Resources Institute. www.wri.org/policynotes (accessed December 2007).
5. Steinfeld H, Gerber P, Wassenaar T, Castel V, Rosales M & de Haan C. 2006. *Livestock's Long Shadow.* www.virtualcentre.org/en/library/key_pub/longshad/A0701E00.htm (accessed October 2007).
6. Mukheibir P. 2005 *Local Water Resource Management Strategies for Adaptation to Climate-Induced Impacts in South Africa.* Prepared for the workshop: *Rural Development and the Role of Food, Water and Biomass: Opportunities for Development and Climate.* November 2005. Energy Research Centre, University of Cape Town, South Africa.
7. Turpie J, Winkler H, Spalding-Fecher R & Midley G. 2002. *Economic Impacts of Climate Change in South Africa: A Preliminary Analysis of Unmitigated Damage Costs*. Southern Waters Ecological

Research & Consulting & Energy & Development Research Centre, University of Cape Town, South Africa.

8. Li Ching L. *Organic Agriculture Fights Back.* ISIS/TWN. www.twnside.org.sg/climatepre.htm (accessed January 2008).
9. Pearce F. 20-year Study Backs Organic Farming. *New Scientist* May 2002. www.newscientist.com/news/news.jsp?id=ns99992351 (accessed January 2008).
10. Intergovernmental Panel on Climate Change. www.mnp.nl/ipcc/pages_media/AR4-chapters.html (accessed November 2007).
11. *Rapeseed Biofuel: More Greenhouse Gas than Petrol.* www.biofuels-news.com/news/rapeseed_biofuel.html (accessed April 2008).
12. Le Maitre DC, Versfeld DB & Chapman RA. 2000. The Impact of Invading Alien Plants on Surface Water Resources in South Africa: A Preliminary Assessment. *Water SA*. 26: 397-408.
13. Le Maitre DC, Van Wildgen BW, Gelderblom DM, Bailey C, Chapman RA & Nel JA. 2002. Invasive Alien Trees and Water Resources in South Africa: Case Studies of the Costs and Benefits of Management. *Forest Ecology and Management.* 160: 143-159.
14. UNFAO State of Food and Agriculture 2007. www.fao.org/catalog/inter-e.htm ftp://ftp.fao.org/docrep/fao/010/a1200e/a1200e00.pdf (accessed November 2007).

Chapter 19: Your food

1. *Green House Gases and Where They Come From.* 2000. World Resources Institute. www.wri.org/climate/topic_content.cfm?cid=4177 (accessed October 2007).
2. Pimental D. & Pimental M. Sustainability of Meat-based and Plant-based Diets and the Environment. *American Journal of Clinical Nutrition.* 2003; 78 (suppl): 660S-3S.
3. Saunders C, Barber B & Taylor G. July 2006. *Food Miles – Comparative Energy/Emissions Performance of New Zealand's Agriculture Industry.* Lincoln University, New Zealand. www.lincoln.ac.nz/story_images/2328_RR285_s9760.pdf (accessed October 2007).
4. Steinfeld H, Gerber P, Wassenaar T, Castel V, Rosales M & de Haan C. 2006. *Livestock's Long Shadow.* www.virtualcentre.org/en/library/key_pub/longshad/A0701E00.htm (accessed Oct. 2007).
5. Gerbens-Leenes PW, Nonhebel S & Ivens WP. 2002. A Method to Determine Land Requirements Relating to Food Consumption Patterns. *Agriculture, Ecosystems & Environment*. 2002; 90: 47-58.
6. *Meat is Murder on the Environment.* 18 July 2007. *New Scientist*. http://environment.newscientist.com/article/mg19526134.500 (accessed October 2007).
7. Campbell TC & Campbell II TM. 2006. *The China Study.* Benbella Books, US.
8. *Climate Change and Agriculture.* July 2006 Information Sheet (Version 7). Soil Association, UK. www.soilassociation.org/web/sa/saweb.nsf/library?OpenForm (accessed October 2007).
9. McCann D, Barrett A, Cooper A, Crumpler D, Dalen L, Grimshaw K, Kitchen E, Lok K, Porteous L, Prince E, Sonug-Barke E, Warner JO & Stevenson J. *Food Additives and Hyperactive Behaviour in 3-year-old and 8/9-year-old Children in the Community: a Randomised, Double-blinded, Placebo-controlled Trial. Lancet.* 2007 (E-pub. ahead of print) Abstract: www.ncbi.nlm.nih.gov/sites/entrez (accessed October 2007).
10. Organic Food is Healthier: Study. October 30 2007. *The Guardian*, UK. www.guardian.co.uk/science/2007/oct/29/organics.sciencenews (accessed October 2007).
11. Henn P. 2000. *User Benefits of Urban Agriculture in Havana, Cuba.* www.cityfarmer.org/havanaBenefit.html (accessed October 2007).
12. Mouget LJA. 2006. *Growing Better Cities: Urban Agriculture for Sustainable Development.* International Development Research Centre. www.idrc.ca/openebooks/226-0/ (accessed October 2007).

13. *The Polokwane Declaration on Waste Management.* 2001. SA Govt. www.environment.gov.za/ProjProg/WasteMgmt/Polokwane_declare.htm (accessed October 2007).

Chapter 20: You at home

1. Gildenhuys A & Statistics South Africa. 2006. *Demand Side Management End Use Study.* Eskom.
2. *Eskom 2006. Annual Report.* www.eskom.co.za (accessed March 2008).
3. The range was obtained based on discussions with Eskom staff, solar water-heating installers and various studies.
4. Electricity Control Board. *Demand Side Management Study for Namibia: Report 2.* November 2006. www.ecb.org.na (accessed February 2008).
5. Sureman W & Ledger J. June 2005. Economic and Environmental Benefits of Solar Heating in South Africa. *Energize Magazine.*
6. Bertoldi P, Aebischer B & Edlington C. ETC. *Standby Power Use: How Big is the Problem? What Policies and Technical Solutions Can Address It?* http://standby.lbl.gov/ACEEE/StandbyPaper.pdf (accessed March 2008).
7. Kinver M. 22 January 2006. *TV 'Sleep' Button Stands Accused.* BBC News. www.bbc.co.uk (accessed March 2008).
8. Water UK. *Sustainability Indicators 2006/07.* www.water.org.uk/home/policy/reports (accessed February 2008).
9. St Louis VL, Kelly CA, Duchemin E, Rudd JWM & Rosenberg DM. Reservoir Surfaces as Sources of Greenhouse Gases to the Atmosphere: A Global Estimate. *Bioscience 2000*; 50: 766-775.
10. *Smart Living Handbook.* 2007. City of Cape Town. www.capetown.gov.za – click on "Residents" and "Environment" (accessed March 2008).
11. Hall L. 2007. *Coir.* www.madehow.com/Volume-6/coir.html (accessed March 2008).
12. *The Biodiversity of South Africa 2002: Indicators, Trends and Human Impacts.* Endangered Wildlife Trust. Struik Publishers, South Africa.

Chapter 21: Our waste

1. www.collectacan.co.za/can_recovery/ (accessed August 2007).
2. www.consol.co.za/html/glassrecycling.aspx (accessed August 2007).
3. www.pops.int (accessed September 2007).
4. *Gas Emissions from Waste Disposal.* www.vitalgraphics.net/waste2 (accessed September 2007).
5. *Honda 2006 North American Environmental Report.* http://corporate.honda.com/environment/ (accessed July 2007).
6. *The Big Waste Factory.* www.vitalgraphics.net/waste2 (accessed September 2007).
7. www.mcdonough.com/cradle_to_cradle.htm (accessed October 2007).
8. www.interfacesustainability.com/pdf/climatechangefrontpagelink.pdf (accessed September 2007).
9. www.capebrick.com/recycle.html (accessed September 2007).
10. www.dme.gov.za/pdfs/energy/cabeere/case_ethekwini.pdf (accessed October 2007).
11. Venter L, Borland J & Wieckers HNS. *Waste Recycling: Benefit of Burden.* Wastecon 2000, Durban. www.dnw.co.za/documents.html (accessed September 2007).

Chapter 22: You the educator

(All accessed December 2007)

1. The Ubuntu Declaration on Education and Science and Technology for Sustainable Development.

2002. Signed at the World Summit for Sustainable Development in Johannesburg 2002. www.environment.gov.za/Sustdev/documents/pdf/UbuntuDeclaration.pdf
2. Foundations of Environmental Education. North American Association for Environmental Education. http://eelink.net/pages/Perspectives-+Foundations+of+EE
3. Institute for Global Environmental Strategies (IGES). www.iges.or.jp/en/pub/eLearning/ee/resources_educators.htm. The Global Development Research Centre (GDRC). www.gdrc.org/uem/ee/
4. The National Association for Environmental Education (UK). www.naee.org.uk

Chapter 23: You the parent

1. Costanzo P & Shaw M. 1966. Conformity as a Function of Age Level. *Child Development*. 37: 967-975.
2. UN Food and Agriculture Organisation. *Livestock a Major Threat to Environment*. 29 November 2006. www.fao.org/newsroom/en/news/2006/1000448/ (accessed November 2007).
3. Alcraft R. & Count JI. 2006. *A Step by Step Guide to Climate Bliss*. Penguin Books, UK.

Chapter 24: Our population size

1. Wikipedia – World Population. www.wikipedia.org (accessed 19 March 2007).
2. United Nations. 2001. *World Population Prospects: The 2000 Revision.*
3. United Nations. 2001. *Population, Environment and Development: The Concise Report.* United Nations, New York.
4. United Nations Development Programme. 1998. *Human Development Report.* Oxford University Press, New York.
5. *Humanity's Ecological Footprint.* 24 October 2006. WWF. www.panda.org/news_facts/publications/living_planet_report/footprint/index.cfm (accessed 30 November 2007).
6. United Nations Population Division. *World Population Prospects: The 2006 Revision Population Database.* http://esa.un.org/unpp/ (accessed August 2007).
7. *Sustainable Populations by Country.* Optimum Population Trust. www.optimumpopulation.org/opt.sustainable.numbers.html (accessed 30 November 2007).
8. *World Population Prospects: The 2006 Revision Population Database.* United Nations Population Division. http://esa.un.org/unpp/ (accessed 30 November 2007).
9. Hart S. Beyond Greening: Strategies for a Sustainable World. *Harvard Business Review.* January to February 1997: 66–76.
10. Children Count. www.childrencount.ci.org.za/content.asp?TopLinkID=6&PageID=18 (accessed 3 August 2007).
11. Obaid T. *Responding to Events, Building the Global Community.* 2 October 2001. United Nations Population Fund. www.unfpa.org/news/news.cfm?ID=287&Language=1 (accessed 30 Nov. 2007).
12. Brown L. *Stabilizing Population.* Earth Policy Institute. 2006. www.earth-policy.org/Books/PB2/PB2ch7_ss3.htm (accessed 30 November 2007).

Chapter 25: Carbon revenues for Africa

1. For more details see: www.cdmafrica.org/kyotooverview.htm
2. http://en.wikipedia.org/wiki/List_of_Kyoto_Protocol_signatories
3. As per the CDM Tool used to calculate the emission factor for an electricity system: http://cdm.unfccc.int/methodologies/Tools/EB35_repan12_Tool_grid_emission.pdf
4. See http://carbonfinance.org/docs/Carbon_Trends_2007-_FINAL_-_May_2.pdf

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