A Systematic Review of South Africa's Policy Response to Climate Change.

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Submitted in fulfilment for the degree of

MASTERS IN ENVIRONMENTAL SCIENCES, at the

North-West University, Mafikeng Campus,

Republic of South-Africa.

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I declare that:

A Systematic Review of South Africa's Policy Response to Climate Change is my own work, original work. It is being submitted for the degree of Masters in Environmental Science, at the North-West University, Mafikeng Campus, Republic of South-Africa and that this work was not previously submitted by me for a degree at another university.

Leon Rodney Kenny

ABSTRACT

This study reviews the policies that the South-African government has put in place in response to climate change in order to establish their appropriateness in addressing the issue's of climate change within the South-African context. A systematic review design was followed for this study which involves the formulation of a research question, a search for relevant literature, selection of studies to be included, critical appraisal, data extraction and analysis, and synthesizing of data followed by the formulation of a conclusion statement and contextualization of these statements. The purpose was to collect data and identify high-quality relevant studies and to synthesize the findings in such a rigorous and comprehensive way that a contextualized picture of the current best available evidence is provided. The findings of this study indicate that climate change policies do not hamper national priorities but in actual fact, they are designed to address issues of economic feasibility. They advance the priorities such as poverty alleviation, infrastructure development, job creation, rural development, foreign investment, human resource development, improved health and economic growth. The study is significance in a way that it shows how South Africa should strive to ensure that current and future climate change policies are inclusive, fair and effective. They should reflect a balance between adaptation and mitigation responses and recognize that solving the climate problem will only be possible if developing countries' priorities of eradicating poverty and promoting sustainable development are taken into consideration.

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Abbreviations

APP	Asia Pacific Partnership
CDM	Clean Development Mechanism
DEAT	Department of Environmental Affairs and Tourism
DME	Department of Mineral and Energy
GHG	Greenhouse Gases
IPCC	Intergovernmental Panel on Climate Change
LDC	Least Developed Countries
LTMS	Long-term Mitigation Scenario
NCCC	National Committee on Climate Change
NCCWP	National Climate Change White Paper
NCCR	National Climate Change Response
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
WMO	World Meteorological Organization

Chapter 1: BACKGROUND

1.1 Introduction

South Africa is a signatory to both the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol (UNEP 2010). As such, South Africa recognizes the grave risks posed to our planet by global warming and is committed to playing its part as a global citizen to take necessary actions to respond to the challenges of climate change. In particular, South Africa finds itself in a situation in which it is both a high emitter of greenhouse gases as well as a country predicted to experience the impacts of climate change in a severe manner. Over the past decade, South Africa has participated in the UNFCCC processes, done a substantial amount of work to meet its commitments in terms of the Convention and the Protocol and has also taken forward the challenge of determining what national action is necessary to address climate change (IPCC 2007).

Specifically, South Africa produced an initial Greenhouse Gas Inventory (base year 1990) in 2004, and has now updated this and is completing its second Greenhouse Gas Inventory (base year 2000). It has produced a first National Communication that was submitted to the UNFCCC and is currently undertaking a second iteration of this for submission to the UNFCCC in 2010. It is an active participant in the Clean Development Mechanism (CDM) and now has a portfolio of projects at various stages in the CDM pipeline. Over the past few years, the profile and significance of climate change issues has increased globally and in our own country. Within Government, climate change is regularly discussed at a Cabinet level and an Inter-Ministerial Committee on Climate Change and is supported by an Inter-governmental Committee on Climate Change at an official level (Solomon 2007). In addition, there is a National Committee on Climate Change (NCCC) which is a multi-stakeholder forum in which work around climate change is consulted and information shared.

It is accepted that climate change is a national priority of a cross-cutting nature, with implications for a wide range of ministries across government and across all spheres of Government. Government's work on Climate Change is an action item on the Government Programme of Action. In October 2005, a national Climate Change Conference was held that was attended by a large number of Ministers. At this conference, it was agreed that a participatory climate change policy development process would take place, following the conclusion of, among others, a detailed scenario building process to map out how South Africa can meet its UNFCCC Article 2 commitment to greenhouse gas stabilization whilst sustaining its priorities of poverty alleviation and job creation (IPCC 2001).

In line with these agreements, the Long-term Mitigation Scenario (LTMS) process was initiated in 2006 and was concluded in July 2008. The LTMS was a participatory and research based scenario

building process that focused on identifying South Africa's emissions trajectory and formulating a range of potential strategies that would allow South Africa to reduce its emissions over time in a way that is appropriate to its national circumstances and its capabilities. The LTMS conclusions were taken to Cabinet in July 2008. Following this, a number of decision were taken that provide an overarching framework for the development of a Climate Change Response Policy for South Africa (Accord 2011).

These decisions included the Greenhouse Gas Emission Reductions and Limits: South Africa would follow a peak, stabilization and decline greenhouse gas trajectory over the next 60 years. This will mean that emissions will peak during the period 2025 to 2035, will stabilize until the 2050 to 2060 period and will then decline. To build on strengthen or scale up existing initiatives: Existing initiatives around energy efficiency, renewable energy, the development of "green" industries, and on-going research into climate friendly ways of doing business should be deepened, extended and scaled up to achieve a greater impact. Implement the Business Unusual Call for Action: South Africa must prioritize investment in research and technology development that would make a major impact on greenhouse gas emissions (Campbell 2010). This would include investments in R&D for electric and hybrid vehicles, new solar technologies, clean coal technologies, carbon capture and storage and participation in a range of other national and international initiatives that could achieve breakthroughs in achieving low carbon ways of doing business. Vulnerability and Adaptation: South Africa's vulnerability to the impacts of climate change means that across government and society, we need to understand the potential impacts of climate change and be prepared to meet the resultant challenges. In preparing for the future, a decision was taken to launch a policy development process that would result in a national Climate Change Response Policy in the form of a White Paper (Toth 2001).

1.2. Rationale

The South African government regards climate change as one of the greatest threats to our planet and to our people. The South African government also believes that climate change, if un-mitigated, also has the potential to undo or undermine many of the positive advances made in meeting South Africa's own development goals and the Millennium Development Goals (RSA 2010a; 2010b; 2010c). During the National Climate Change Conference in 2005, it was agreed that a participatory climate change policy development process was to be initiated following the conclusion of, among others, a detailed scenario building process to map out how South Africa can meet its United Nations Framework Convention on Climate Change (UNFCCC) Article 2 commitment to greenhouse gas stabilization whilst ensuring its focus on poverty alleviation and job creation. In line with these agreements, the

Long-term Mitigation Scenario (LTMS) process was initiated in 2006 and was concluded in July 2008 (Brown 2007).

1.3. Research Problem

Global climate change is possibly the greatest environmental challenge facing the world this century. Although often referred to as 'global warming', global climate change is more about serious disruptions of the entire world's weather and climate patterns, including impacts on rainfall, extreme weather events and sea level rise, rather than just moderate temperature increases. The developing world faces greater challenges than the developed world, both in terms of the impacts of climate change and the capacity to respond to it. According to the IPCC Third Assessment Report, climate change is already happening, and will continue to happen even if global greenhouse gas emissions are curtailed significantly in the short to medium term (UNEP 2010). There is now more confidence that global climate change is a threat to sustainable development, especially in developing countries, and could undermine global poverty alleviation efforts and have severe implications for food security, clean water, energy supply, environmental health and human settlements. Acknowledging the overall vulnerability of South Africa to climate change impacts, it will thus be necessary to carry out adaptation measures in this country.

According to the National Climate Change Response Strategy for South Africa (RSA, 2004), the South African Country Studies Programme identified the health sector, maize production, plant and animal biodiversity, water resources, and rangelands as areas of highest vulnerability to climate change and these are the areas that need to be targeted for adaptation measures. With regard to vital industries, the mining and energy sectors are particularly vulnerable to climate change mitigation measures. Further, the South African economy is vulnerable to the possible response measures implemented by developed countries since the economy is highly dependent on income generated from the production, processing, export and consumption of coal. This vulnerability extends across virtually all facets of the mining and energy sectors.

During his budget speech to parliament on 20 May 2008, the Minister of Environmental Affairs and Tourism announced a National Climate Summit and Science Conference for early 2009 (RSA 2009) and noted that this Summit would formally launch the policy process that would translate Cabinet's climate change policy decisions and directives into fiscal, regulatory and legislative packages as well as sectoral implementation plans. The Minister also noted that the National Summit will involve the key government departments, industry, labour, NGO's and others. Following the July 2008 Cabinet

Lekgotla, a policy development programme for the development of the National Climate Change Response Policy was announced along with government's directions for the National Climate Change Response Policy (RSA 2009).

1.4 Research Aim and Objectives

1.4.1 Aim of study

The aim of the study was to review the policies that the South African government has put in place in response to climate change in order to establish their appropriateness in addressing the problems of climate change.

1.4.2 Objectives

The following objectives of the proposed study are outlined:

- To determine the relevance of climate change policies in the South-African context.
- To determine the limitations of each policy.
- To determine the strengths of each policy.
- To describe the programmes generated by the policies.
- To generate recommendations to the Department of Environmental affairs (DEA) on the basis of the findings.

1.4.3 Research question

The key research question states that: Is South Africa's climate change policies are designed to address issues of relevance and feasibility. This requires a critical analysis of the White paper on Climate Change, Climate Change Response Strategy and the IPCC Synthetic Report for Policy Makers using south Africa as the point of reference.

1.5 Definition of Concepts

Climate Change-is a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years. It may be a change in average weather conditions or the distribution of events around that average (e.g., more or fewer extreme weather events). Climate change may be limited to a specific region or may occur across the whole Earth.

Environmental Monitoring: describes the processes and activities that need to take place to characterize and monitor the quality of the environment.

Feasibility- aims to objectively and rationally uncover the strengths and weaknesses of the existing business or proposed venture, opportunities and threats as presented by the environment, the resources required to carry through, and ultimately the prospects for success.

Global Warming-refers to the rising average temperature of the Earth's atmosphere and oceans and its projected continuation.

Green house gases-(sometimes abbreviated **GHG)** are gases in the atmosphere that absorb and emit radiation within the thermal infra-red range.

Impact-is described as an influence or effect on a particular matter.

Ozone Depletion-describes two distinct but related phenomena observed since the late 1970s: a steady decline of about 4% per decade in the total volume of ozone in the Earth's stratosphere (the ozone layer), and a much larger springtime decrease in the stratospheric ozone over the Earth's polar regions.

Policy Analysis-determining which of the various alternative policies will most achieve a given set of goals in light of the relations between the policies and the goals.

Policy Framework-is a logical structure that is established to organize policy documentation into groupings and categories that make it easier for employees to find and understand the contents of various policy documents. Policy frameworks can also be used to help in the planning and development of the policies for an organization.

Policy-A policy is typically described as a principle or rule to guide decisions and achieve rational outcome(s).

Relevance- In information science and information retrieval, denotes how well a retrieved document or a set of documents meets the information needs of the user.

Strategy-refers to a plan of action designed to achieve a particular goal.

UNO Conventions-United Nations Office representing a formal meeting of members, representatives, or delegates, as of a political party, fraternal society, profession, or industry.

Chapter 2: LITERATURE REVIEW

2.1 Introduction

South Africa recognizes that the carbon space is finite and some 70% of the "safe" carbon space has already been used up, largely due to the development pathways taken by industrialized countries in the past. At the same time, South Africa acknowledges that the solution to the climate change crisis requires some concerted actions on a global scale and that all countries share a responsibility for the future. Therefore, it is important to agree on an effective international regime to deal with the global climate challenge in a way that equitably shares the remaining carbon "development" space as well as sharing both past and future responsibilities for climate stabilization (Goering, 2005; Bolin, 1995). In this context, South Africa is committed to work towards the achievement of a global agreement on climate change that ensures a balance between climate action and sustainable development (RSA, 1998a, 1998b; 1998c; 1998d), and one that prioritizes both adaptation and mitigation and has high levels of ambition in order to avoid dangerous and irreversible climate changes.

For South Africa, a central part of this agreement would be the requirement for all developed countries to take the lead by making deep legally binding quantified emission reduction commitments with a mid-term target towards the upper end of the ranges of 25% - 40% below 1990 levels by 2020 and 85% to 90% below 1990 levels by 2050 (UNEP 2010). In turn, South Africa would play its own part in reducing its greenhouse gas emission by ensuring that as a developing country, it will undertake mitigation actions in a manner that is appropriate to our national circumstances, including our sustainable development objectives and our imperative to address poverty eradication and achieve economic growth. In line with the principle of equity, these actions need to be underpinned by the requirement for the international community to make commitments regarding the necessary financial, technical and capacity building support to enable implementation of these mitigation actions (Forster 2007). Furthermore, South Africa would want to see equivalent levels of support for adaptation action, including financing, technology transfer and capacity building, and being a central part of such a deal (Busby 2010).

Climate change mitigation interventions should be informed by, and monitored and measured against a " peak, plateau and decline" emission trajectory where greenhouse gas emissions stop growing (start of plateau) in 2020-25 and begin declining in absolute terms (end of plateau) in 2030-35. The LTMS conclusions demonstrate that there is a considerable room for reduction in greenhouse gas emissions in the South African economy. To achieve this, requires a conscious commitment to a transition towards a low carbon economy, with the concomitant shifts away from coal fired energy towards nuclear and

renewable, as well as the introduction of far-reaching energy efficiency measures (RSA 2003). It is important to note that an essential condition for this to happen would be the provision of finance and technology by the international community to support national initiatives. This is currently being negotiated by the UNFCC and it is important to note that any interventions supported by international finance and technology would need to be monitored, reported on and verified, and a similar set of conditions would apply to the finance and technology that is provided (IPCC 2007).

In order to achieve this, South Africa must establish a regulatory framework and set of partnerships to ensure that there is an accurate measurement of greenhouse gas emissions by the various sectors and that these measurements are regularly updated and the results made known (Sayne 2011). The latest Greenhouse Gas Inventory presented at this conference, the 2009 National Climate Change Response Policy development Summit, is the first step in this process. The existing agreement with Business Unity South Africa on industry greenhouse gas reporting as well as its participation in the GHG inventory work, lays the basis for further work to agree on a South African GHG reporting system that lays the basis for emission reduction plans to be developed in specific economic and industrial sectors (Fisher 2007).

South Africa's current energy supply crisis has created an opportunity for a thorough transformation in the way that the economy and society are powered. Additionally, green jobs and economic initiatives are being proposed worldwide as a key element of an economic recovery strategy. South Africa, along with the rest of the world, must make the transition to a climate resilient and low-carbon economy and society by balancing its mitigation and adaptation response and, in the long-term, by redefining its competitive advantage and structurally transforming its economy through a shift from an energy-intensive to a climate-friendly path as part of a pro-growth, pro-development and pro-jobs strategy (Sterman 2007).

Deriving from the LTMS conclusions as well as South Africa's current need to reduce pressure on grid electricity until new capacity is on stream, the renewable energy sector should be identified as a key "business unusual" growth sector and policies and measures would need to be put in place to meet a more ambitious national target for renewable energy. This is consistent with the policy approach being taken by the Department of Mineral and Energy Affairs in relation to wind power and initiatives by the Department of Trade and Industry to facilitate a much larger roll out of solar thermal power than what presently exists. Similarly, the imminent announcement by the national electricity regulator of a feed-in-tariff for renewable, should go a long way to creating a framework that would allow for significant expansion of this sector (DME 2008).

Other important initiatives in this regard, work being done to set "Green Building" Standards, as well as plans to retrofit existing buildings and industrial facilities with energy efficient and clean technologies (Smith 2009; Meehl 2007). The transport sector is yet another key "business unusual" growth sector and policies and measures are being put in place to substantially reduce the GHG emissions from this sector. These measures include the various national, provincial and local initiatives around a modal shift in passenger transport, the regeneration of the rail network, and the work being done to reduce vehicle emissions (IPCC 2001; Watson 2001).

2.2 Policy response in the USA

The United States, although a signatory to the Kyoto Protocol, has neither ratified nor withdrawn from the protocol. In 1997, the US Senate voted unanimously under the Byrd–Hagel Resolution that it was not the sense of the senate that the United States should be a signatory to the Kyoto Protocol. In 2001, former National Security Adviser Condoleezza Rice stated that the Protocol "is not acceptable to the Administration or Congress" (Dunlap 2009).

In March 2001, the Bush Administration announced that it would not implement the Kyoto Protocol, an international treaty signed in 1997 in Kyoto, Japan that would require nations to reduce their greenhouse gas emissions, claiming that ratifying the treaty would create economic setbacks in the US and does not put enough pressure to limit emissions from developing nations (Yanda 2009). In February 2002, Bush announced his alternative to the Kyoto Protocol, by bringing forth a plan to reduce the intensity of greenhouse gasses by 18 percent over 10 years (Huebert 2011). The intensity of greenhouse gasses specifically is the ratio of greenhouse gas emissions and economic output, meaning that under this plan, emissions would still continue to grow, but at a slower pace. Bush stated that this plan would prevent the release of 500 million metric tons of greenhouse gases, which is about the equivalent of 70 million cars from the road. This target would achieve this goal by providing tax credits to businesses that use renewable energy sources (Kamenetz 2007).

President Obama said in 2010 that it was time for the United States "to aggressively accelerate" its transition from oil to alternative sources of energy and vowed to push for quick action on climate change legislation, seeking to harness the deepening anger over the oil spill in the Gulf of Mexico (Rodrigues de Brito 2012). The 2010 United States federal budget proposed to support clean energy development with a 10-year investment of US $15 billion per year, generated from the sale of greenhouse gas (GHG) emissions credits. Under the proposed cap-and-trade program, all GHG

emissions credits would be auctioned off, generating an estimated $78.7 billion in additional revenue in FY 2012, steadily increasing to $83 billion by FY 2019 (Hatzigeorgopoulos 2012).

2.2.1 State and regional policy

Across the country, regional organizations, states and cities are achieving real emissions reductions and gaining valuable policy experience as they take action on climate change. These actions include increasing renewable energy generation, selling agricultural carbon sequestration credits, and encouraging efficient energy use. The US Climate Change Science Program is a joint program of over twenty US cabinet departments and federal agencies, all working together to investigate climate change. States and municipalities often function as "policy laboratories", developing initiatives that serve as models for federal action (Swain 2011). This has been especially true with environmental regulation - most federal environmental laws have been based on state models. In addition, state actions can have a significant impact on emissions, because many individual states emit high levels of greenhouse gases. Texas, for example, emits more than France, while California's emissions exceed those of Brazil. State actions are also important because states have a primary jurisdiction over many areas - such as electric generation, agriculture, and land use - that are critical to addressing climate change. Many states are participating in Regional climate change initiatives, such as the Regional Greenhouse Gas Initiative in the Northeastern United States, the Western Governors' Association (WGA) Clean and Diversified Energy Initiative, and the Southwest Climate Change Initiative (Dunlap 2009).

2.3 Response from the Least Developed Countries

The Least Developed Countries (LDCs) are a group of 49 of the world's poorest countries. They have contributed least to the emission of greenhouse gases (GHGs) but they are most vulnerable to the effects of climate change (Stark 2011). This is due to their location in some of the most vulnerable regions of the world and their low capacities to adapt to these changes. Adaptation to climate change has become an important policy priority in the international negotiations on climate change in recent years. However, it has yet to become a major policy issue within developing countries, especially the LDCs. Example of two LDCs are, namely Bangladesh and Mali, where progress has been made regarding identifying potential adaptation options (Berenter 2012). For example, Bangladesh already has effective disaster response systems, and strategies to deal with reduced freshwater availability, and Mali has a well-developed programme for providing agro-hydro-meteorological assistance to communities in times of drought. However, much remains to be done in terms of mainstreaming

adaptation to climate change within the national policymaking processes of these countries. Policymakers need targeting and, to facilitate this, scientific research must be translated into appropriate language and timescales (Saleemul 2010).

Emissions of greenhouse gases have a global impact, unlike some other forms of pollution. Whether they are emitted in Asia, Africa, Europe, or the Americas, they rapidly disperse evenly across the globe. This is one reason why efforts to address climate change have been through international collaboration and agreement (Evans 2012). The principal forum for international climate change action has been the United Nations, which has led to the Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. However and more recently, other international approaches have been put in place, the Asia Pacific Partnership and agreements under the G8, starting with their 2005 meeting in Gleneagles, UK (Hamza 2012). Although climate change agreements have been reached through international approaches, the policy measures to meet the obligations and objectives set by such agreements have been implemented at the national or regional level (Hendrix 2011).

2.4 The UN Climate Change Negotiations

In 1988, the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) set up the Intergovernmental Panel on Climate Change (IPCC), an expert body that would assess scientific information on climate change. As a reaction to the concerns raised in the IPCC's First Assessment Report, the UN General Assembly established the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change. The UN Framework Convention on Climate Change (UNFCCC) was adopted in May 1992 and entered into force in 1994. The convention included the commitment to stabilize greenhouse gas emissions at 1990 levels by 2000 (Birkmann 2011).

The first Convention of the Parties to the UNFCCC (COP 1) was held in 1995. Negotiations at this and two subsequent COPs led to agreement on the Kyoto Protocol in 1997. The Kyoto Protocol set out specific commitments by individual developed countries to reduced emissions by an average of 5.2% below 1990 levels by the period 2008-2012. However, it would take three further meetings until the "Marrakesh Accords" were agreed, which provide sufficient detail on the procedures for pursuing objectives set out in the Kyoto Protocol (Dunlap 2009).

The Kyoto Protocol involved several decisions:

- By 2012, developed countries would reduce their collective emissions by 5.2% from 1990 levels, each country being committed to a particular figure.
- The emissions covered by the Protocol are not only carbon dioxide, but also methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride.
- These commitments would be reckoned on a net basis, considering sinks as well as sources, and each country must credibly measure its contribution and meet its commitment.
- Countries may fulfill their commitments jointly (such as with regional agreements) and they may improve the efficiency of compliance through "flexibility mechanisms".

In order for the Kyoto Protocol to enter into force and become legally binding, it had to be ratified by at least 55 countries and for those ratifying countries to include enough Annex I (developed) countries to represent at least 55% of the total emissions from those Annex 1 countries in 1990 (Holland 2011). In 2001, the US Government (which had earlier signed the Protocol) announced that it would not ratify the Protocol. As the USA emits more than a quarter of all greenhouse gas emissions from developed countries, this put the ratification of the Protocol in jeopardy. Australia also declared that it would not ratify, though it would pursue emission reductions as agreed (Kamenetz 2007).

Eventually, entry into force then solely depended on the decision of Russia, another large greenhouse gas emitter. After some delay, Russia notified the United Nations of its decision to ratify the Protocol in November 2004 and 90 days later, on February 19, 2005, the Protocol finally came into force. Australia subsequently ratified the Protocol in December 2007 (Mabey 2010).

While countries that are party to the Protocol are expected to rely mainly on reducing their own emissions domestically, three "flexibility mechanisms" were identified to improve the economic efficiency of reductions and make it easier for parties to comply. The three mechanisms are emissions trading; Joint Implementation and the Clean Development Mechanism (Taenzler 2010). Emissions Trading: A market-based approach to achieving environmental objectives that allow those countries or entities reducing greenhouse gas emissions below what is required to use or trade the excess reductions to offset emissions at another source, inside or outside the country. In general, trading can occur at the domestic, regional (EU), international and intra-company levels. A precedent is the USA acid rain program, which successfully trades permits for sulfur dioxide (Maclellan 2009). Joint Implementation (JI): A project-based mechanism, whereby one developed country - with emissions caps - can work with another to reduce emissions or enhance sinks, and share the resulting emission reduction units accordingly (Chafe 2007). The Clean Development Mechanism (CDM): A project-based mechanism

where certified projects proposed by developed countries - or companies from those countries - can be used to reduce emissions in developing countries. The developed country - or company - earns certified emission reduction units, which may be used against the country's own reduction commitment. CDM is primarily focused on development aid and secondly on emission reduction (EC 2009).

2.5 Europe

In many respects, Europe has been a leader in promoting action on climate change (Kuperman 2011). In March 2007, the European Council endorsed the European Commission's Strategic Energy Review and agreed on a unilateral cut of 20% in EU greenhouse gas emissions by 2020, relative to 1990 levels. The previous commitment was 8% reduction by 2012. This will require strengthening and extending carbon trading arrangements as well as deploying low- or zero-carbon technology (Grätz 2011). The European Council also endorsed the objective of making a 30% reduction in greenhouse gas emissions by 2020 and said that it would commit to this 30% target if other developed countries committed to (unspecified) comparable reductions in emissions and the more advanced developing countries (e.g. India, Brazil, China) "contributed adequately according to their responsibilities and respective capabilities" (Mazo 2010). French President Chirac described the outcome as "one of the great moments of European history. "The European Council also set a target of meeting 20% of EU energy needs from renewables, leaving individual countries to decide their own policies in such a way as to allow nuclear power as part of their energy mix to be taken into consideration in allocating individual countries targets for renewables (Feakin 2010). The Council noted "the European Commission's assessment of the contribution of nuclear energy in meeting the growing concerns about safety of energy supply and CO2 emission reductions" and it acknowledged the role of nuclear energy "as a low CO2-emitting energy source" (Kamenetz 2007).

2.6 Asia Pacific Partnership (APP)

The Asia-Pacific Partnership on Clean Development and Climate, now known informally as APP, is a non-treaty partnership established by Australia, India, Japan, China, South Korea and the United States in July 2005. The Partnership involves countries that account for about half of the world's population and more than half of the world's economy, energy use, and greenhouse gas emissions. In October 2007, Canada joined APP (Barnett 2007).

The objectives of the partnership include:

- To work together and with private companies to expand markets for investment and trade in cleaner, more efficient energy technologies, goods, and services in key sectors (Haldén 2008).
- To work with multilateral development banks on financing for initiatives and programs identified by the task forces that will expand the use of technologies and practices designed to promote objectives of the Partnership.
- To work on areas of collaboration including Energy Efficiency, Methane Capture and Use, Rural/Village Energy Systems, Clean Coal, Civilian Nuclear Power, Advanced Transportation, Liquefied Natural Gas, Geothermal, Building and Home Construction/Operation, Bioenergy, Agriculture/Forestry, Hydropower, Wind Power and Solar Power (CSIS 2007).

At the inaugural meeting of the (then) AP6 held in Sydney in January 2006, it was agreed that task forces would be established to work on:

1. Accelerating the deployment of coal gasification and other clean coal technologies, particularly in those Partner countries with plentiful coal resources and rapidly increasing energy demand.
2. Expanding the use of renewables to provide lower-cost, clean power in areas without access to modern energy services.
3. Encouraging the power sectors in each Partner country to improve the efficiency and reliability of their electric power systems.
4. Developing and deploying advanced manufacturing processes for cleaner aluminium, cement, and steel production (3 separate taskforces).
5. Strengthening adoption and use of building and appliance efficiency standards, using proven market approaches.
6. Capturing and using coal-bed methane as a clean energy source, and adopting new techniques and technologies to improve safety and reduce emissions in the mining sector (Paskal 2007).

By mid 2007 the eight public-private sector Task Forces had identified 18 Flagship projects in the above areas (Drexhage 2008).

When APP was first announced some parties, including some EU governments and green groups, expressed suspicions that APP was being established as a rival to the United Nations process. However, efforts have been made on both sides to portray APP as complementary to the UNFCCC, rather than a competitor (Lumerman 2011). This was particularly important for Japan, which is a member of APP and an Annex I Party under the Kyoto Protocol. Critics of APP point to the fact that participating countries have made no commitments in terms of emissions targets. However, with only

seven countries participating, compared with the hundreds under the UN system, and without the bureaucracy that the UNFCCC negotiations have established, the APP was, its supporters argued, perhaps better placed to help develop the technology solutions that will help reduce greenhouse gas emissions (Kamenetz 2007).

However, it appears that much of the APP in its original format is reaching a close. The 9th Policy and Implementation Committee meeting in 2011 in Bangkok, Thailand, was concluded in one morning (Carius 2008). The APP Power Generation and Transmission Task Force was transitioned into a new "Global Superior Energy Performance Partnership (GSEP)" that will form part of the Clean Energy Ministerial that had been established in 2010. The Clean Energy Ministerial initiative includes representatives from 24 governments representing 70% of global GDP and 80% of global greenhouse gas emissions. The 2010 meeting was held in Washington, DC, the 2011 meeting was held in the UAE and subsequent annual meetings are planned in the UK, India and South Korea (Dunlap 2009).

Chapter 3 METHODS OF INVESTIGATION

3.1 Research design

A systematic review design was followed in this study. The specific steps of the systematic review involved the following: formulation of a research question, a search for relevant literature, selection of studies to be included, critical appraisal, data extraction and analysis, and synthesizing of data (Magarey 2001:377), followed by the formulation of the conclusion statement and contextualization of these statements (ADA 2008:59-65). The purpose of the systematic review was to collect data and identify high-quality relevant studies and to synthesize the findings in such a rigorous and comprehensive way that a comprehensive picture of the current best available evidence is provided (Badr 2007:79). The procedures for systematic review follow that of Kitchenham (2004) and Zaza et al., (2000), built around Planning the Review, Conducting the Review, Reporting the Review with sub-components centered on specification of the rationale, development of a review protocol, selection of base studies, quality assurance, data extraction, monitoring and data synthesis.

3.2 Approach

Each of the objectives of the study was built into a specific step of the conventional systematic review procedures but these are adapted for the particular focus of the study, which is a set of climate change policies. This means that the survey of relevant documents that are inputs eventually into the analysis stage is restricted both by the specific duration and by the number of actual polices in place in South Africa.

3.3 Data sources

Data for this study was in the form of specific government policies passed on in the period 2004-2011 that address the issue of climate change and its impact. The principal policy here was the Climate Change Response White Paper (DEAT 2011). This was reinforced with reference to the Climate Change Response Strategy (2004). The third policy document from the Inter-governmental panel on Climate Change (IPCC), Synthesis Report for Policy Makers (IPCC 2007) which is a compressed version of the 4th Assessment Report (AR4). These documents are open-access sources already in the public domain.

3.4 Specification of review question

There is now more confidence that global climate change is a threat to sustainable development, especially in developing countries, and could undermine global poverty alleviation efforts and have

severe implications for food security, clean water, energy supply, environmental health and human settlements. Acknowledging the overall vulnerability of South Africa to climate change impacts, it will thus be necessary to carry out adaptation measures in this country. Thus there was a need to review the policies that South Africa has put in place in response to climate change in order to determine its appropriateness in the South African context. The question that forms the focus of this study is stated as: "What is the state of South Africa's policy response to climate change?"

3.5 Relevant literature search

This included identifying and classifying literature by searching and selecting relevant studies to be included by means of identifying possible sources from electronic databases and search engines by stating the inclusion and exclusion criteria beforehand ensuring that the boundaries of the review question mentioned above in 3.4 are clearly defined. In the context of the research problem and the review question, the specific documents of interest were identified in section 3.3. The focus of literature survey, earlier carried out in chapter two of the study was on contemporary literature focusing on climate change at different scales of resolution with a particular interest on how South Africa fits into the global context of the IPCC.

3.6 Selection of studies

The nature of this study does not include a focus on a comparative study of contemporary literature on either climate change or on state policy positions. Instead, its focus is on how through policy development South Africa is responding to climate change. The focus in 3.2 is retained but in the discussion of results, research work on climate change policy is reviewed to benchmark the findings of this particular study.

3.7 Critical appraisal

The in-depth appraisal of the relevant research to exclude low-quality studies and strengthen the evidence by determining methodological quality and rigor for inclusion in the final sample (CEBC 2009:4). To this end, sources will therefore include specifically high-quality research papers that have been published in peer-review journals covering the period 2000-2012 with a focus at the level of nation states and dealing with climate change responses. In terms of exclusion criteria, apart from government policy documents and those emanating from UNEP and the IPCC, no other non-peer reviewed sources is included in the discussion section of the study. Through this approach, it is

possible to benchmark the findings against recent cutting-edge research and simultaneously ensure reliability.

3.8 Data extraction

Involves the design of an evaluation criteria built around (i) relevance, (ii) efficiency, (iii) effectiveness (iv) financial feasibility and a specification of a coding system for the various categories. This involves a specification of measurement units for each of these three parameters that cumulatively define the scope of policy impact with regard to critical appraisal instrument for reviews, RCTs, cohort studies and qualitative research aligned to those in CASP (2006). The next step is to involve an audit of the Climate Change Response White Paper (2011) appearing as Appendix A, backed by the Climate Change Response Strategy (Appendix B), the IPCC Synthesis Report for Policy Makers (IPCC 2007) (Appendix C).

3.9 Data analysis

For each of the five objectives of the study, the data required is specified, the method of analysis and the rationale thereof.

Objective 1: Relevance of Climate Change Policies

The relevance of a policy is measured in terms of whether or not it addresses the national needs of South Africa as a country we thus need to establish whether the specific policy formulation meets the requirements of a similar UNEP policy statement dealing with that particular facet of climate change - **Appendix C**. Each policy is therefore tested at two levels: the national scale and the global scale represented by UNEP guidelines. The resulting data was tabulated and graphically generated using excel.

Objective 2: Policy limitations

The Evaluation Criteria is established based on financial feasibility. The focus is on South Africa's white paper on climate change response, since it includes a broad cross section of critical sections in earlier policies in Appendices A and B. Limitations are identified by analyzing the policy in terms of whether it is feasible in implementing those programmes and or subprograms that deal with the facet of Climate Change.

Objective 3: Policy strengths

Addressing this objective involves combined findings from objectives 1 and 2 and, criterion (iii). Effectiveness is measured in terms of the extent to which the necessary legislative environment, institutional setup and resource deployment are aligned to ensure success in addressing the specific goals of the policy. The focus is on South Africa's white paper on climate change response, since it includes a broad cross section of critical sections in earlier policies in Appendices A.

Objective 4: Profile of programmes

Findings from objectives 1, 2 and 3 is used in describing what programmes have to be put in place in response to the climate change policies in South Africa. "What programmes generated by these policies show evidence of these two objectives as measured in terms of resource deployment (efficiency) and addressing particular facets of the climate change white paper – **Appendix A?"**. For feasibility, results is supplemented with national accounts data on environmental protection from the 2004/2005 financial year to the 2012/2013 financial year. An estimate of the financial demands on the national fiscus arising out of the cost of environmental protection was compared to actual government allocation across the same time period. A criterion for programme evaluation is developed that specifies key performance areas (KPA) in quantifiable deliverables and used to measure the performance of these programmes. Economic feasibility is expressed in terms of tracing actual national budgetary allocation for climate change mitigation for the period 2004-2012 against the DEA's funding for individual climate-change programmes.

Objective 5: Recommendations

The findings from objectives 1, 2, 3 and 4 on the basis of which, a conclusion was made and used to highlight generate recommendations once again tied to the objectives of the study.

3.10 Concluding statements

This step involved a development of a conclusion based on the findings and as a response to the specific objectives of the study.

Chapter 4: RESULTS AND DISCUSSIONS

4.1 Introduction

Having ratified both the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol, South-Africa needs continued meaningfully engagement in the current multilateral negotiations to further strengthen and enhance the international response to the climate change crisis. The Government specifically aims to continue its efforts to strengthen and ensure the full implementation of the UNFCCC and its Kyoto Protocol through additional multi-lateral rules based and legally-binding international agreements that will come into force after 2012. These should effectively limit the average global temperature increase to below a maximum of 2°C above preindustrial levels. In so doing, South Africa should strive to ensure that such agreements are inclusive, fair and effective; reflect a balance between adaptation and mitigation responses; and recognize that solving the climate problem is only going to be possible if developing countries' priorities of eradicating poverty and promoting sustainable development are taken into consideration (NCCR White Paper, 2010).

4.2 Policy relevance

The relevance of a policy is measured in terms of whether or not it addresses the national needs of South Africa as a country. These are ensuring that the policies are consistent with national priorities, including poverty alleviation, access to basic amenities including infrastructure development, job creation, rural development, foreign investment, human resource development and improved health, leading to sustainable economic growth. Table 1 below is built on Key Specific Areas in which certain national priorities are being addressed in order to establish their relevance in the South African context. A comparison is made between the national scale and the global scale as indicated through UNEP guidelines. This makes it to determine whether the priorities as indicated at the global scale reflects that as represented at the national scale. The policies are such that they do not undermine any advancement made in achieving the Millennium Development Goals. In table 1, the following apply: Policy I: National Climate Change Response White Paper, 2011, Policy II: National Climate Change Response Strategy, 2004, Policy III: IPCC Synthesis Report for Policy Makers, 2007 as represented as per UNEP guidelines. In the last column of the table, comments by the author are indicated in respect of specific areas and measurements are indicated.

Table 1: Relevance Assessment Criteria.

POLICIES		KEY SPECIFIC AREAS (ISSUES BEING ADRESSED)	MEASUREMENT	COMMENT
NATIONAL SCALE	Policy I	• Poverty Alleviation • Infrastructure Development • Job Creation • Rural development • Foreign Investment • Human Resource Development • Improved Health • Economic Growth	• Short- to medium-term objective is to limit employment contraction to those areas of the economy where excessive carbon intensity is considered unsustainable, whilst promoting and expanding the green economy sectors. • The medium- to long-term objective of the National Climate Change Response Policy is to promote investment in human and productive resources and so enable sustainable growth in green sectors.	Practical interventions is informed by accurate assessments of the capacity o various sectors to adapt to a lower-carbon environment. Net job creation i a key performance indicator, as well as baseline vulnerability measures and sectoral actions to improve resilience against job losses. This should enable the monitoring of and reporting on progress made.
	Policy II	• Support of national objectives and sustainable development • Adaption • Developing a sustainable energy programme • International obligations • Interdepartmental response • Government/Industry partnerships • Related education, training, awareness and capacity building • Related research, development and demonstration • Inventories of greenhouse gases and air pollutants • Accessing and managing financial resources for climate change	• Ensuring that the strategy is consistent with national priorities, including poverty alleviation, access to basic amenities including infrastructure development, job creation, rural development, foreign investment, human resource development and improved health, leading to sustainable economic Growth and the alignment with the need to consistently use locally available resources	Response measures should include addressing issues of urban and peri-urban planning in relation to both passenger and commercial transport
* GLOBAL	Policy III	• social and economic development • Adaptation and mitigation • Infrastructure Development • Renewable energy development • Fund allocation	• Greater cooperative efforts and expansion of market mechanisms should help to reduce global costs for achieving a given level of mitigation, or improve environmental effectiveness. Effort scan include diverse elements such as emissions targets; sectoral, local, sub-national and regional actions; RD&D programmes; adopting common policies; implementing development-oriented actions; or expanding financing instruments.	Making development more sustainabl can enhance mitigation and adaptiv capacities, reduce emissions an reduce vulnerability, but there may b barriers to implementation. It is ver likely that climate change can slow th pace of progress towards sustainabl development. Over the next half century, climate change could imped achievement of the Millenniun Development Goals.

(Sources: NCCRWP 2011, NCCRS 2004, IPCC Synthesis Report 2007).

Table 2: Comparison of policies.

KEY FACTOR	NATIONAL SCALE	GLOBAL SCALE	COMMENT
	Policy I and II	**Policy III**	
Millennium Development Goals	• Poverty Alleviation • Infrastructure Development • Job Creation • Rural development • Foreign Investment • Human Resource Development • Improved Health • Economic Growth	• Eradicating extreme poverty and hunger • Combating HIV/AIDS, malaria, and other diseases • Ensuring environmental sustainability, • Developing a global partnership for development	Progress towards reaching the goals has been uneven. Some countries have achieved many of the goals, while others are not on track to realize any.
Adaptation Efforts	It should be noted that, although DEAT supports the suggested interventions in principle, much of the work comes under the jurisdiction of other government departments, and within all spheres of government.	Adaptive capacity is intimately connected to social and economic development but is unevenly distributed across and within societies.	The capacity to adapt is dynamic and is influenced by a society's productive base, including natural and man-made capital assets, social networks and entitlements, human capital and institutions, governance, national income, health and technology.
Mitigation Efforts	Mitigation action requires a long-term shift in the national economic/industrial base away from dependence on natural resource export and primary minerals beneficiation to manufacturing and other value-adding activities.	The mitigation of greenhouse gases can be undertaken in many ways, including the introduction of renewable energy resources, fuel switching and energization, domestic and industrial efficiency programmes, energy efficient housing, transport, agricultural and forestry schemes and non-biological carbon sequestration.	Additional adaptation measures is required to reduce the adverse impacts of projected climate change and variability, regardless of the scale of mitigation undertaken over the next two to three decades.
Accepting the challenge	Climate change is an issue for all South Africans and government realizes that the objectives set out in this White Paper can only be fully realized with the active participation of all stakeholders. The government is committed to substantive engagement and, where appropriate, partnerships with stakeholders from industry, business, labor and civil society in a manner that enhances coordination.	Climate change requires urgent global action in the short-term, to fulfill long-term goals. Mandatory targets, subject to revision as new information emerges and other government carrots and sticks can and indeed must be used to stimulate this sense of urgency	*It is* necessary to look beyond the Kyoto Protocol because South Africa stage of development is beyond the principles of the Kyoto protocol.

Table 2 represents the comparison of the Climate Change Policies at the national scale against that at a global scale and as is represented by the UNEP guidelines. The indication of key factors is needed in order to determine a link between these policies to establish whether national policies are in actual fact relevant in South-Africa. The analysis of each policy draws out those key specific national priorities in SA that the policy is addressing in order to achieve both our own development goals and at the same time creating an environment economic growth.

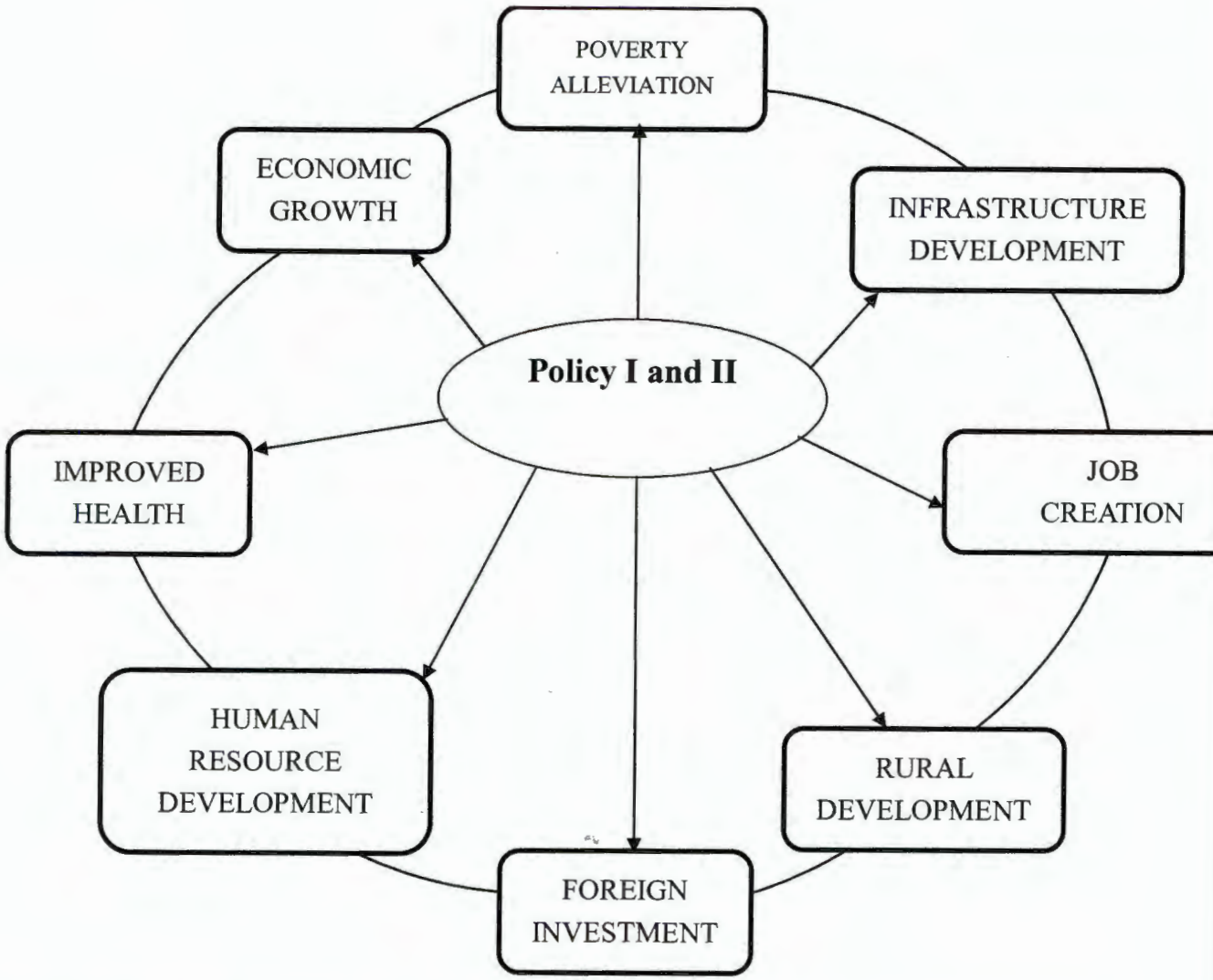


Figure 1: Climate change mitigation and national priorities. The link between the policies and the South African national priorities.

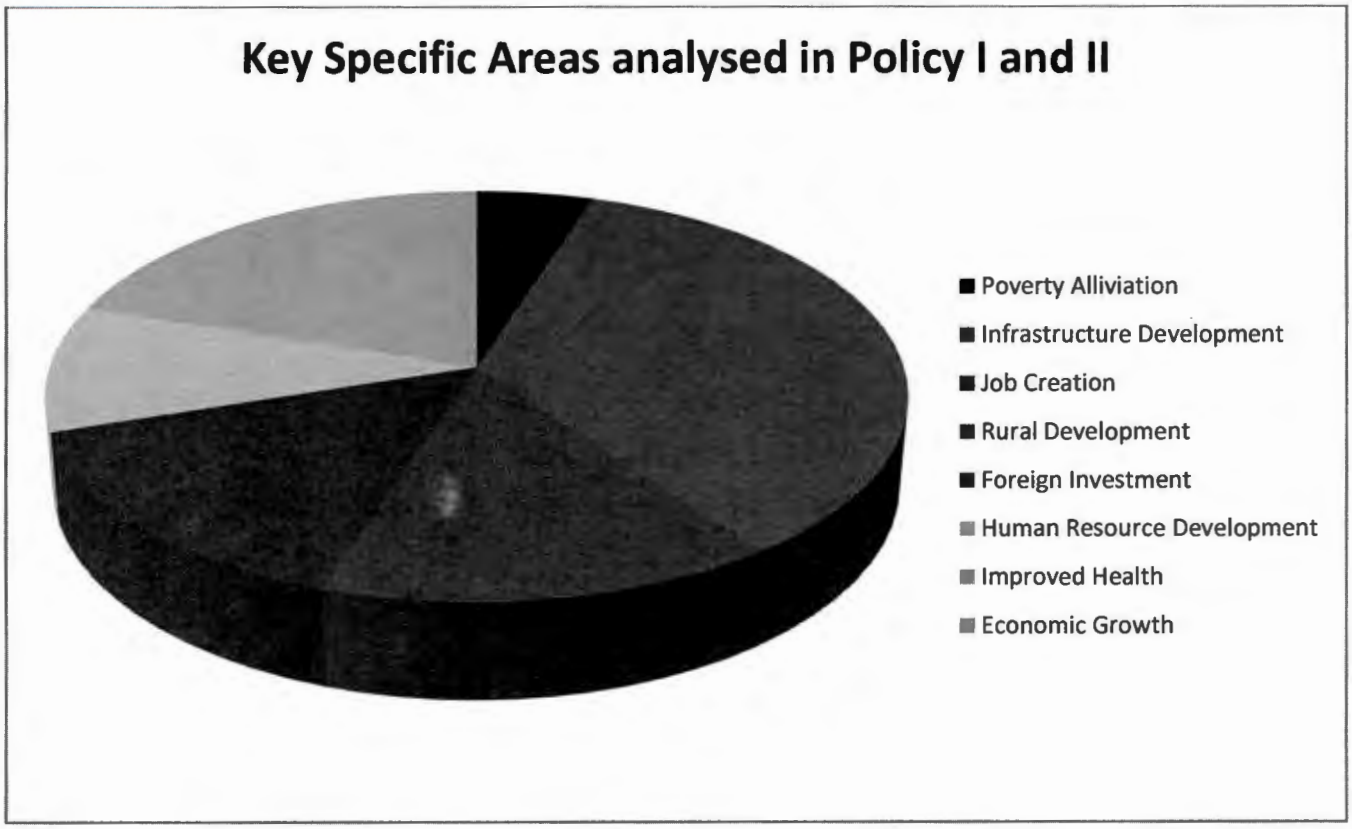


Figure 2: Relative weighting of key specific areas addressed in policy 1 and policy II.

Through policy analysis, it is the author's view, as indicated in figure 2, that policy 1 and II place more emphasis on infrastructure development as this is most important in developing a structure that needs to ultimately filter down to poverty alleviation. In developing such a structure, the road map is put in place that allows for human resource development and the attraction of foreign investment. Once the top structures are in place, this is followed by better living (economic growth) and resulting in improved health for all. These above aspects are just some of the most important key specific priorities that could lead to job creation, poverty alleviation etc. Hence infrastructure development accumulated the majority of the graph and poverty alleviation the least.

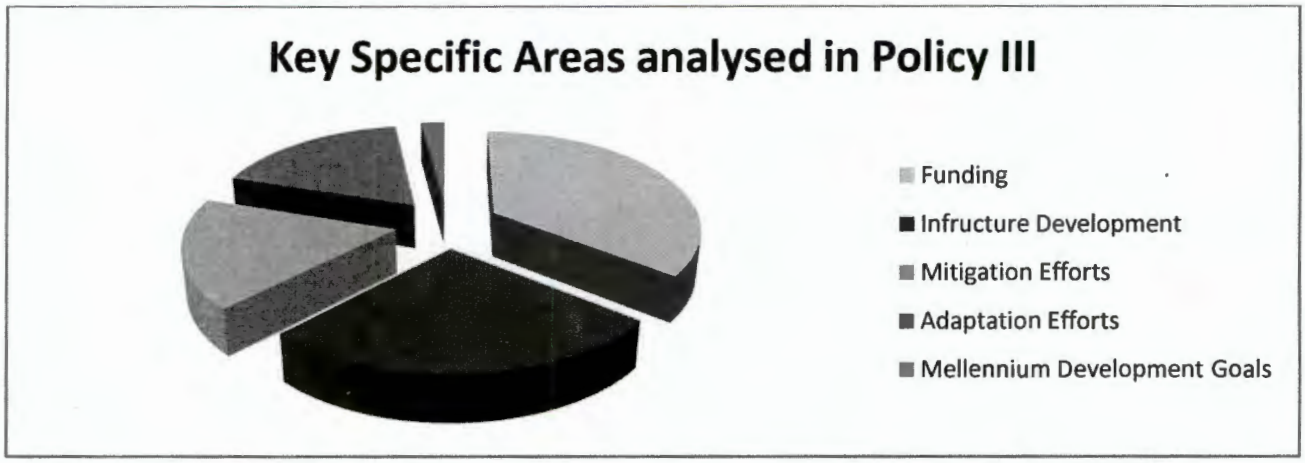


Figure 3: Relative weighting as addressed in policy III (representation of the global policy as per UNEP guidelines).

The major factor that this policy emphasizes, figure 3, is funding because with funding the pathway to economic growth, especially for developing countries and least developed countries, can be achieved. The achievement towards the Millennium Development Goals and that of mitigation and adaptation efforts could only be successful if mechanisms for financial sources are put in place. However those mechanisms whether they be education and training, research and development, technology and science development, do need some form of funding. Once this has been done, the foundation for infrastructure is placed and this filters to the achievement of the Millennium development Goals.

Climate change responses that improve resilience could positively impact the rate of employment in South Africa. For example, adaptation strategies could create new jobs to which workers can migrate from sectors affected by mitigation strategies. These responses reduce the impact of job losses and promote job creation during the shift towards the new green economy. The NGP is a clear policy signal of the intention to develop South Africa's economy in a manner that harnesses our natural resources whilst developing and expanding less carbon-intensive sectors towards a greener' economy. Thus the policy is relevant in South Africa because aims to create jobs and act as mechanisms in poverty alleviation. The National Employment Vulnerability Assessment (NEVA) and Sector Jobs Resilience Plans (SJRP) are job creating programmes used to facilitate the policy relevance and are mechanisms that ensure job creation.

National Employment Vulnerability Assessment (NEVA)

The Economic Development Ministry plans to publish the NEVA and so establishes a National Employment Vulnerability Baseline (NEVB). The purpose of which is to inform the prioritization of mitigation and adaptation interventions and establish timeframes for addressing potentially vulnerable sectors. The NEVA should be able to assess the impact on jobs of climate change and climate change responses by sector and location to understand what job-related interventions may be required and where they may be required. The vulnerability assessments should also incorporate relevant aspects of similar assessments that may have been made in other sectors such as biodiversity, human settlements and disaster management. According to the NCCR 2010, the NEVA is reviewed on a regular basis that gives sufficient time for interventions to be effective but is sufficiently often to make proactive changes as and when necessary.

Sector Jobs Resilience Plans (SJRPs)

Informed by sectoral work carried out by the Departments of Mineral Resources, Economic Development and Trade and Industry, SJRPs must explore the synergy between mitigation and adaptation strategies and the potential for sustainable net job creation in each sector. The goal is to understand the risk relationship between technology and investment and so focusing investments on sectors where government involvement and skills development reduce initial barriers to creating jobs. As technologies show commercial viability with time and their risk profiles improve, projects may be auctioned off to investors as a test of the risk appetite of the market. The purpose is to implement mechanisms that reduce risk, showcase alternative lower-carbon interventions, build capacity and develop skills. Such interventions focus on public sector programmes to incentivize employment creation for those most vulnerable to climate change and is a precursor to creating sustainable investments and jobs. These programmes include the expansions of existing poverty alleviation job creation programmes, such as the Expanded Public Works and the National Youth Service and also the promotion of job creation incentives in new, green industries, especially targeting the youth. Also the tapping of Sector Education and Training Authorities (SETAs) to aggressively develop and fund mentorship (including learnerships and internships) programmes (NCCR White Paper 2010).

Timing of Interventions

The following high-level timeline for the Climate Change Response Policy with regard to net job creation provides an overview of the strategic activities required:

Short-Term

Establishing links with business and industry, research bodies, institutions, NGOs and local communities that can provide relevant data and methodologies for the establishment of the NEVB. Develop a cooperative governance framework for establishing the capability to assess employment vulnerability, including how to determine the cost of reducing vulnerability. This also includes the conducting of the NEVA to inform interventions required to enable a pro-jobs approach in the climate change response measures contained in the various sector plans.

Short- to Medium-Term

Involves the design of a SJRP framework for a pro-jobs approach to implementing climate change response strategies and the development of the SJRP's in consultation with stakeholders from all NEDLAC constituencies. The establishment of links with responsible Ministries to integrate the outcomes of the NEVA and SJRPs into their sector plans and also to establish a system to monitor jobs resilience.

On the basis of the findings of objective 1, the policy is thus relevant in the South-African context because it addresses the national needs of the country and these are ensuring that the policies are consistent with national priorities, including poverty alleviation, access to basic amenities including infrastructure development, job creation, rural development, foreign investment, human resource development and improved health, leading to sustainable economic growth and at the same time it protects the environment.

4.3 Policy limitations

It is generally held that non-annex I countries are much more vulnerable to economic disruption through the imposition of climate change mitigation measures than are the developed countries. It should also be borne in mind that non-annex I countries are not required, in terms of the Kyoto Protocol, to adopt emission reduction or limitation targets, either of a voluntary or binding nature. However, climate change mitigation policies may promote sustainable development if they are designed to be consistent with broader societal objectives and, at the same time, they may offer substantial opportunities. This is a particularly important issue for South Africa and Southern Africa. Some mitigation actions may yield extensive benefits in areas outside of climate change such as health, employment opportunities and reducing negative environmental impacts. However, the costs incurred by such actions may be excessive and render the actions unattractive. Differences in the distribution of

technological, natural and financial resources among and within nations and regions, as well as differences in mitigation costs, are important considerations in the analysis of climate change mitigation options. Further, the challenge of addressing climate change raises an important issue of equity, namely the extent to which the impacts of climate change or mitigation policies create or exacerbate inequities, both within and across nations and regions. Global greenhouse gas stabilization require that a future global capital stock is less carbon-intensive. This has immediate implications for near-term investment decisions, especially in developing countries like South Africa for which an argument can be made that there is a need to become less carbon intensive. An immediate and sustained commitment to research and development is required if low-emission, low-cost substitutes are to be available when they become attractive investment opportunities (CCP 2010).

Table 3: Evaluation Assessment criteria for financial feasibility. (Source: DEA Annual Report 2006-2012).

TIME FRAME	SUBPROGRAMME ORGANISATION	OUTPUT	MEASURE/ INDICATION	ACHIEVEMENT	AMOUNT ALLOCATED
2006/2007	Air Quality Management and Climate Change	Improved air quality in priority areas	Effective air quality monitoring systems operational in Vaal Triangle	The first National Priority Area was declared (Vaal Triangle) in April 2006 • Six monitoring stations have been purchased, sites identified and installation completed • Priority Area Governance Committee established	150 R/m
2008/2009	Air quality management System and Climate change (CC) policy.	Policy development process initiated	SAAQIS reports	Policy development process initiated	268 R/m
2009/2010	national mitigation and adaptation response to climate change	Climate Change Response Strategy developed	National Climate Change Response Policy published	National Climate Change Response Green Paper published	200 R/m
2010/2011	Climate Change	Respond and adapt to Climate Change Impacts.	National Climate Change Response Green Paper published in March 2011.	Four adaptation plans developed for following sectors: Biodiversity, Water, Agriculture and Forestry.	463 R/m
2011/2012	Climate Change	Number of sector plans identifying climate change impacts and adaptation frameworks integrated into national sector	Percentage climate change policy interventions implemented	National Climate Change Response White Paper approved by Cabinet and gazette.	200 R/m

Table 4: National budget and the allocation to DEAT.

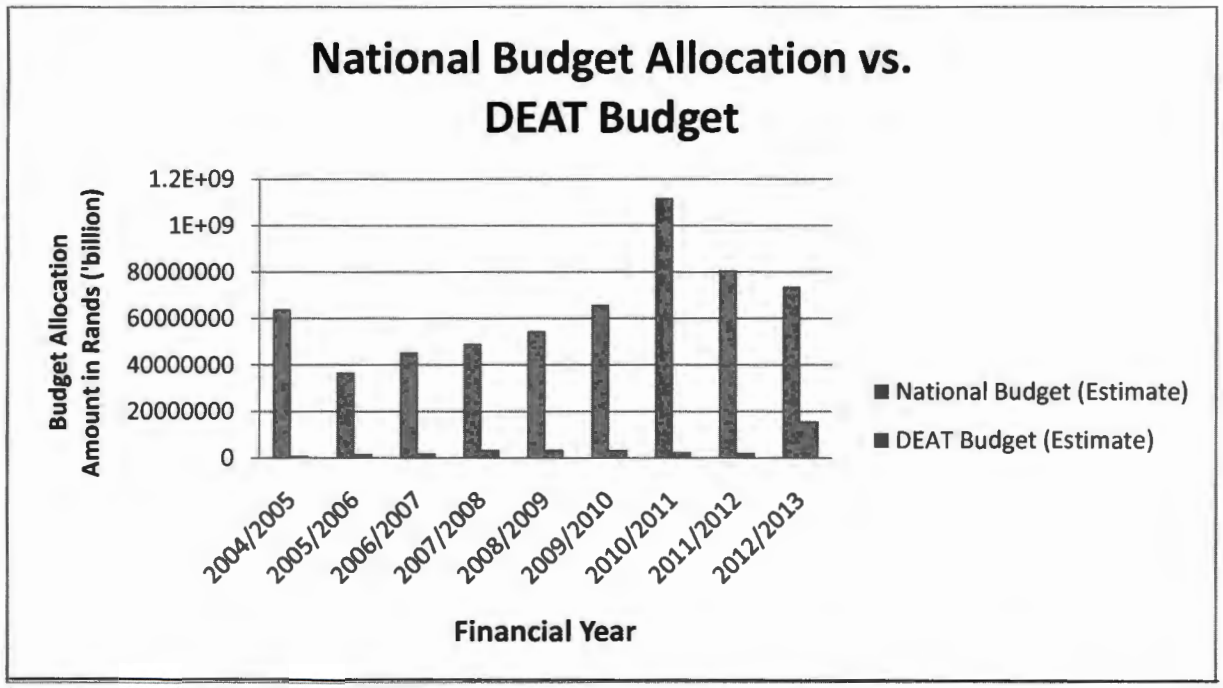
FINANCIAL YEAR	NATIONAL BUDGET (ESTIMATE)	Allocation to DEAT (ESTIMATE)	Allocation to climate change programmes/subprograms from DEAT	Allocation relative to DEAT budget (percentage)
2004/2005	640 R/b	2 R/b	150 R/m	7.5%
2005/2006	369 R/b	18 R/b	180 R/m	1%
2006/2007	456 R/b	2.6 R/b	320 R/m	12%
2007/2008	492 R/b	3.5 R/b	295 R/m	8.4%
2008/2009	547 R/b	2 R/b	268 R/m	13.4%
2009/2010	659 R/b	3.2 R/b	200 R/m	6.25%
2010/2011	690 R/b	2.5 R/b	463 R/m	17.44%
2011/2012	889 R/b	2.6 R/b	200 R/m	7.6%
2012/2013	739 R/b	5.5R/b	800 R/m	14.5%

Note: R/b=billion rand; R/m=million rand; R/t=thousands rand.

Comparison table between the national budget and the allocation to the DEA and allocations to the climate change programmes. The sources for these amounts are derived from the annual budget speech from the financial year 2004/2005 to 2012/2013 and supplemented by the Department of Environmental Affairs and Tourism Annual Report for the period 2004-2005.

The results indicate grid fluctuation. The unusual high percentage of 17.44% for 2010/2011 financial year coincided with the COP17 conference and the allocation to the Green Fund, and the low percentage of 1% coincided with the global recession.

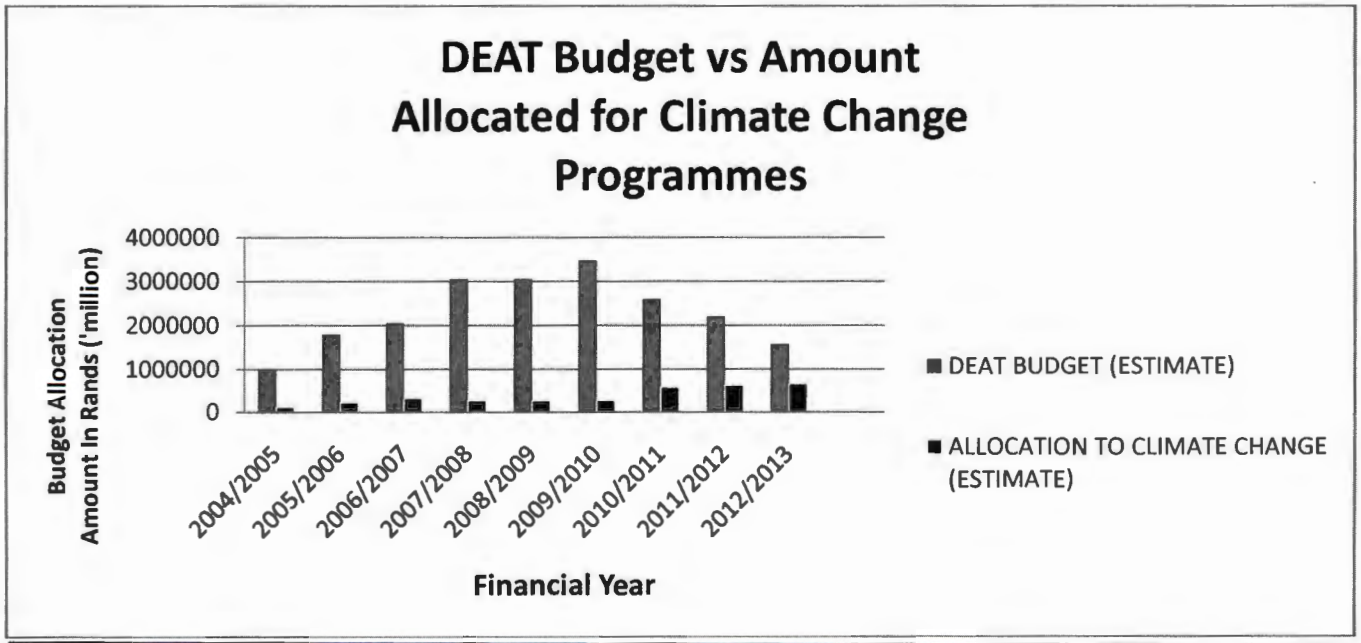
Figure 4: **National budget allocation vs the DEAT budget.**



(Source: Author)

A schematic comparison between the National Budget and the amount allocated to the Department of Environmental Affairs and Tourism from financial year 2004/2005 to 2012/2013. The limited amount allocated to the climate change programmes indicates that Govt and DEAT do not yet see climate mitigation as a critical priority requiring greater funding.

Figure 5: DEAT budget vs amount allocated for climate change programmes.



(Source: Author)

Figure 5 indicates a schematic comparison between the Department of Environmental Affairs and Tourism and the amount allocated for Climate Change's related programmes or sub programmes. The results indicate that not much funds are being allocated to such programmes as compared to the DEAT budget. However, there is an increase of funds from the 2004/2005 financial year and this is an indication that much emphasis is being placed or rather given to the issue of climate change, but there still lacks a great amount of foreign donors to such a programme. The 2009/2010 financial year sees a great allocation of funds to climate change The figure shows a steady increase of funds allocated to climate change programmes over the years. This could be owed to education and training, the potential for a green economy, national awareness programmes and funding from government, investors and donors.

There is costs associated with South Africa's adaptation and green house gases emission reduction efforts, implying a significant short and long-term social and economic benefit, including improved international competitiveness, that result from a transition to a lower-carbon economy and society. Furthermore, the costs of early action is far less than the costs of delay and inaction. These costs could include the direct costs/benefits related to taking mitigation actions for climate change and the costs incurred in adapting to the physical changes that result from climate change. The indirect costs incurred in the loss of markets in the rest of the world as a result of their mitigation actions that they have taken.

All states in the Southern African sub-region face the challenges of rural and urban poverty, limited water or access to water resources, food insecurity, and other development challenges. Thus, although countries of the sub-region may have differing developmental priorities, they often face similar risks due to climate change and may also have similar adaptation needs. South Africa should therefore strive to develop climate change adaptation strategies based on risk and vulnerability reduction, in collaboration with its neighbors where appropriate, and seek to share resources, technology and learning to coordinate a regional response. A regional approach that achieves climate resilience should have significant socio-economic benefits for South Africa, including a smaller risk of unmanaged regional migration.

At the international level, South Africa should engage vigorously in the multilateral climate change negotiations, to ensure a fair and effective outcome that is in accordance with the principles of equity, common but differentiated responsibility, and respective capabilities, and that provides developing countries with sufficient time and development space for the required economic transition to lower-carbon economies. At the national level, the challenge is to effectively manage and reduce the economic risks, and build on and optimize the potential opportunities, and to ensure a smooth and just

transition to a climate-resilient, equitable and internationally competitive lower-carbon economy and society.

In conclusion to the objective, the limiting factor for any successful programmes and policy, would be funding. For without funding, one could not maintain and improve the programmes and they would not be successful. If government and the DEAT could provide the required funds for climate change then the policy would be successful in the long term. After all, prevention is cheaper then cure. Therefore, there is presently no other alternative policy(s) that could be passed that offers the potential of addressing that facet of climate change better and at a potentially lower cost. After all, prevention is better than cure.

4.4 Policy strengths

The strength of the policy lies in the structure that is developed and one that makes it easy for the implementation and the future management of the policy. The climate change policies effectively and efficiently manages inevitable climate change impacts through interventions that build a structure for the implementation of the policy that sustains South Africa's social, economic and environmental resilience and emergency response capacity. They also makes a fair contribution to the global effort to stabilize greenhouse gas (GHG) concentrations in the atmosphere at a level that avoids dangerous anthropogenic interference with the climate system within a timeframe that enables economic, social and environmental development to proceed in a sustainable manner.

Responding to climate change is expensive and requires a comprehensive resource package and resource deployment. South Africa is therefore committed to mobilizing the resources that are necessary for both mitigation and adaptation. This includes financial resources, technical cooperation and technology transfers at domestic, sub-regional, regional, and international levels. Roles and institutional arrangements must assist in the consistent implementation of the National Climate Change Response Policy and require a long-term framework for institutional coordination to: coordinate research and development and promote innovation, coordinate adaptation and mitigation actions, measure, report and verify climate change responses and to facilitate and promote the use of carbon trading and off-set schemes.

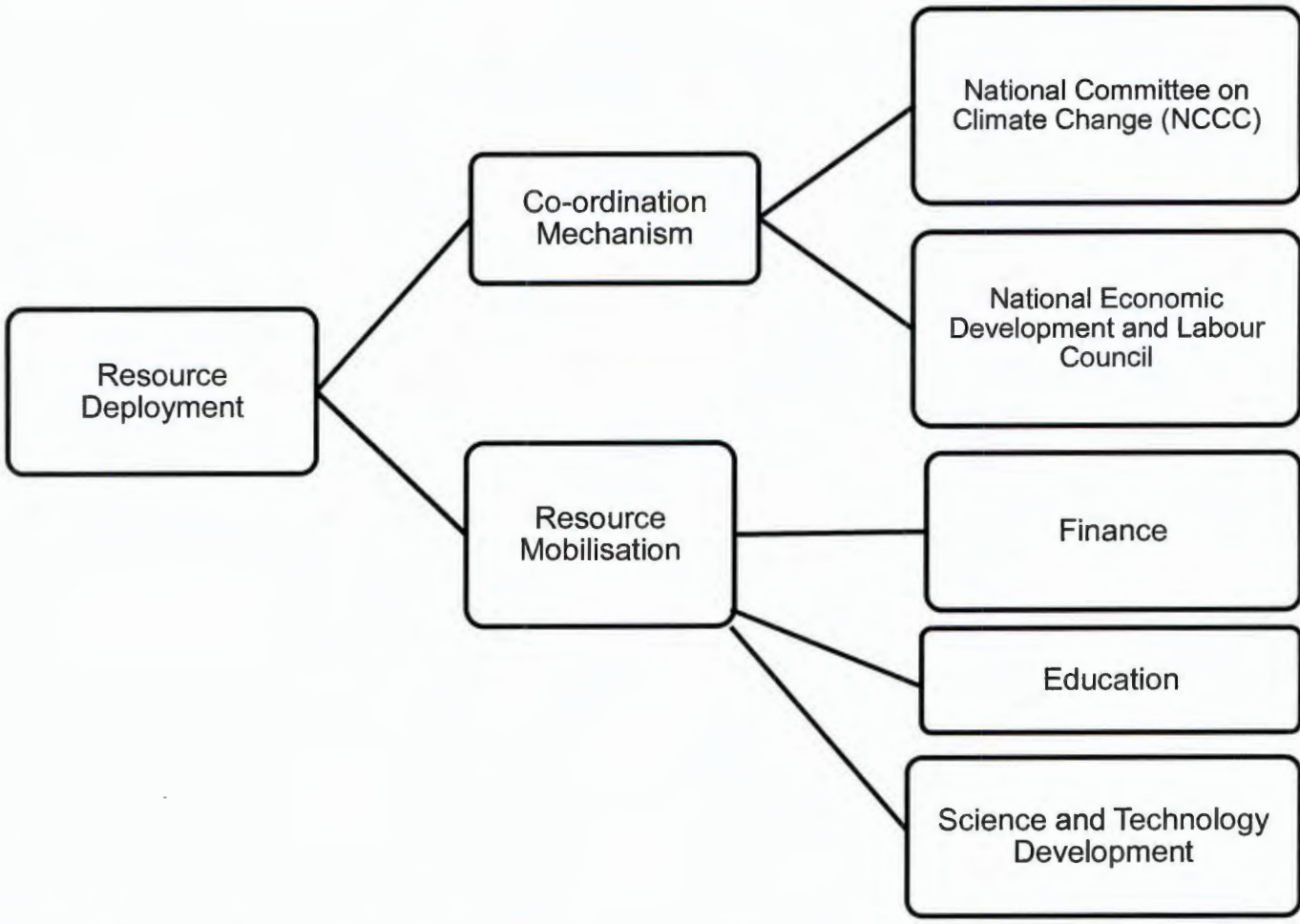


Figure 6: Structure indicating resource deployment

(Source: NCCWP 2010, section 11).

The following mechanisms are used to coordinate policies with stakeholders. The NCCC has been set up to consult with stakeholders from key sectors that impact on or are impacted by climate change. The Committee advises on matters relating to national responsibilities with respect to climate change, and in particular in relation to the UNFCCC and the Kyoto protocol. It also advises on the implementation of climate change-related activities. NEDLAC serves as the forum where government comes together with organized business, labor and community groupings on a national level, and this platform ensures that climate change policy implementation is balanced and meets the needs of all sectors of the economy. NEDLAC has indicated that climate change should be a key component of its agenda.

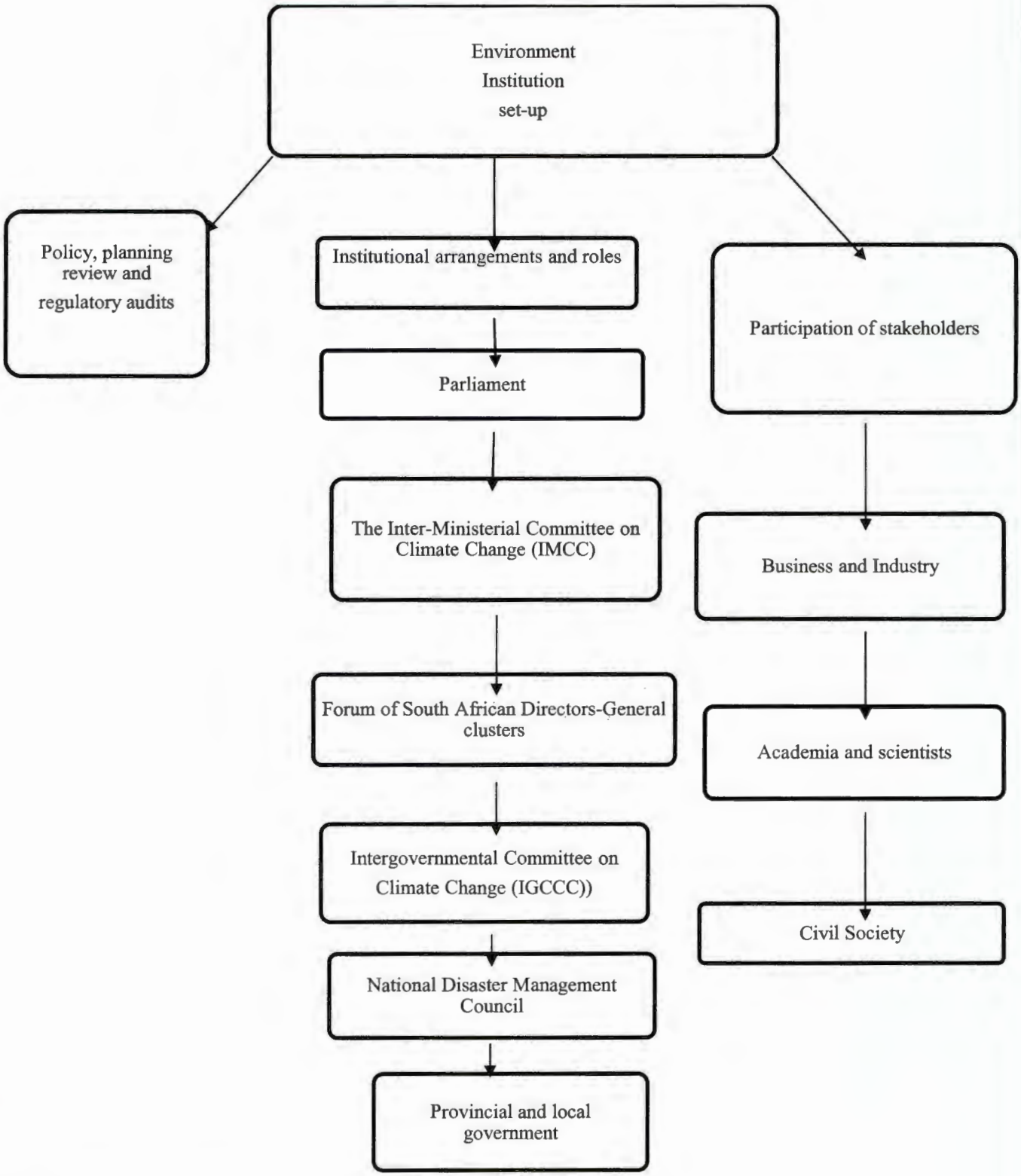


Figure 7: Co-ordination structure.

(Source: NCCRS, 2004; NCCWP, 2011, IPCC Synthesis Report 2007).

For the effective implementation of policies and actions, proper structuring is central to achieving climate resilience and in this respect, a comprehensive review of all government legislation, policy, strategies, plans and regulatory frameworks need not underpin the successful implementation of the National Climate Change Response Policy. The consistent implementation of the policy requires a long-term framework for institutional coordination to coordinate research and development and promote innovation., coordinate adaptation and mitigation actions, measure, report and verify climate change responses and to facilitate and promote the use of carbon trading and off-set schemes. Parliament should oversee the development and implementation of the National Climate Change Response Policy through the Portfolio Committees through government departments.

The strategic, multi-faceted and cross-cutting nature of climate-resilient development requires a coordination committee at executive (Cabinet) level that coordinates and aligns climate change response actions with national policies and legislation. To this end, the IMCCC shall oversee all aspects of the implementation of this White Paper. The national climate change response actions shall be guided by strategic leadership of the relevant Forum of South African Directors-General clusters based on their different mandates The IGCCC has been established to operationalise cooperative governance in the area of climate change. Accordingly, the IGCCC brings together the relevant national and provincial departments and organized local government. The IGCCC therefore has a key role to play in the review of the National Climate Change Response Policy as well as its implementation.

The National Disaster Management Council is responsible for ensuring that the National Framework for Disaster Risk Management provides clear guidance across all spheres and sectors of government for managing climate change-related risk and for ensuring that an effective communications strategy is in place for early warnings to vulnerable communities with respect to extreme weather events such as flooding and droughts. The environment is a concurrent function between provincial and national governments, and provinces should coordinate provincial adaptation and mitigation responses across their own line departments, as well as between municipalities within the province. Each province is expected to develop a climate response strategy, which evaluates provincial climate risks and impacts and seeks to give effect to the National Climate Change Response Policy at provincial level. Local government plays a crucial role in building climate resilience through planning human settlements and urban development. It is also responsible for the provision of municipal infrastructure and services; water and energy demand management; and local disaster response, amongst others. Climate change

considerations and constraints are integrated into municipal development planning tools such as Integrated Development Plans, and municipal service delivery programmes.

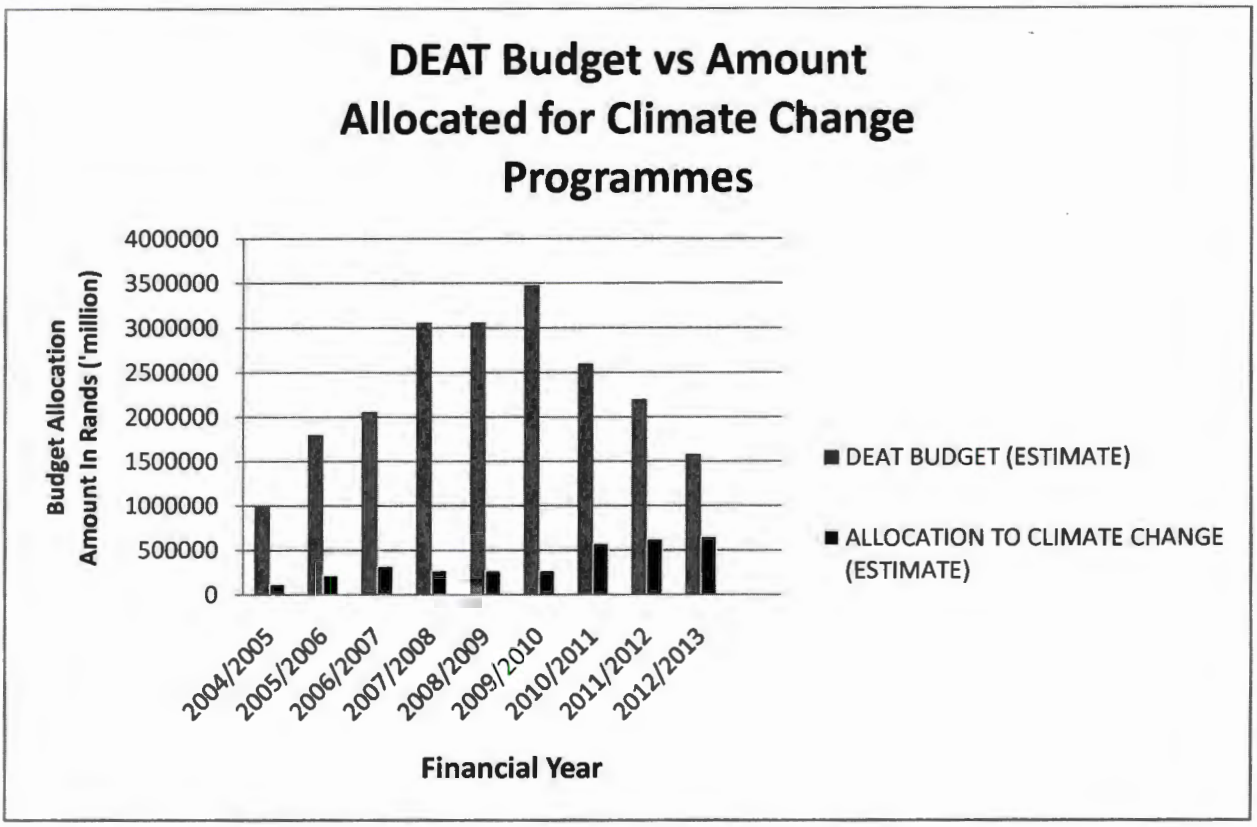
The South African Government accepted the conclusions of the Intergovernmental Panel on Climate Change (IPCC) in its Fourth Assessment Report, that warming of the climate system is unequivocal and that the increase in GHG concentrations as a result of human activity is primarily responsible for this warming trend. The stabilization of the GHG concentrations in the atmosphere at a level that prevents dangerous interference with the climate system requires the implementation of a sufficiently ambitious and effective global agreement on GHG emission reductions. In this context, as a responsible global citizen and in keeping with its developing country status, its capability and its share of responsibility for the problem, South Africa is committed to making a fair contribution to the global effort to reduce GHG emissions. At the same time, the country must ensure that the necessary climate change-related investments contribute to building South Africa's future economic competitiveness. In terms of objective 3, the government has put in place an effect structure in managing climate change efforts.

4.5 Climate change programmes

4.5.1 Introduction

According to the National Climate Change Policy, the government has identified an initial list of Near-term Priority Flagship Programmes, covering both adaptation and mitigation measures. The mitigation programmes cover the major emitting sectors, have relatively well-known mitigation outcomes and implementation processes, and are either very cost-effective and have significant co-benefits or have technology development benefits. The Flagship Programmes also utilize, test and/or demonstrate a suite of policy interventions including regulatory measures, market-based instruments, tax incentives and fiscal subsidies, and information and awareness initiatives. Regulatory measures include renewable energy and energy efficiency targets complemented by appropriate standards; market-based instruments including the electricity generation levy and taxes on motor vehicle emissions and incandescent light bulbs; tax incentives and fiscal subsidies are targeted at various programmes that support climate change mitigation and adaptation objectives; and information and awareness initiatives including the motor vehicle emissions labeling scheme. These programmes should have realization for local sustainable development benefits, including employment, poverty alleviation, industrial development, reduction in local air pollution and others.

Figure 8: DEAT budget and allocation to climate change programmes.



(Source: Author)

The Department of Environmental Affairs and Tourism's budget and the amount allocated to climate change and its related programmes/sub programmes. This graph shows a steady increase of fund allocation from the financial year of 2004/2005 to that of 2012/2013. This just indicates that there is a need to allocate funds to such programmes for both adaptation and mitigation efforts. The increase of fund allocation could be owed due to the fact that the Climate Change programmes could have potential economic advantages and help in developing economic growth. From the author's point of view, the peak period is between 2007/2008 to 2010/2011 financial year, this could be an indication of the coincidence towards the green fund and the COP17 conference.

Table 5: Evaluation criteria for relevance and effectiveness.

PROGRAMME	KEY PERFORMANCE AREA	FEASABILITY (Relevance and effectiveness)	Role to Climate change Mitigation/adaptation	COMMENT
The Climate Change Response Public Works Flagship Programme	*Working for Water *Working on Fire, *Working for Energy	Has proven effective in building climate resilience and relieving poverty because it includes the consolidation and expansion of the Expanded Public Works Programme	*Planting of Spekboom reduce CO2 emissions *Re-establishment of thicket Biome in Eastern Cape Contributes to building climate resilience	*Expansion of programmes provides job opportunities and thus poverty alleviation * The large scale planting of Spekboom on degraded public and private land helps in reduction of CO_2.
The Water Conservation and Demand Management Flagship Programme	Includes implementation of the National Water Conservation and Water Demand Management Strategy	Implementation is in the industry, mining, power generation, agriculture and water services sectors.	The accelerated provision of rainwater harvesting tanks in rural and low-income settlements should also form part of this programme.	It should provide a opportunity for infrastructure development and service delivery
The Renewable Energy Flagship Programme	Includes the drive for the deployment of renewable energy technologies.	is informed by enhanced domestic manufacturing potential and the implementation of energy efficiency and renewable energy plans by local government.	DoE solar water heating programme is expanded through, amongst others, the promotion of the domestic supply of products for solar heating with support from the DTI to build local manufacturing capacity	It should provide opportunity for technological enhancement, build upon local capacity, thus developing local human resource capital
The Energy Efficiency and Energy Demand Management Flagship Programme	*Energy efficiency is set for all new government buildings. *Regulation of commercial and residential building standards to enforce green building construction practices. *The development of appropriate initiatives, incentives and regulations is finalized by the DoE and the DTI.	A government building energy efficiency programme led by the DPW that initiates energy and emissions audits of all government buildings and facilities is developed.	DoE needs to continue to develop and facilitate an aggressive energy efficiency programme	It should provide job opportunities, skills development and expertise
The Transport Flagship Programme	*development of an enhanced of a public transport programme *rail re-capitalization programme encourage new efficient-vehicle technologies	DoT should facilitate the development of an enhanced public transport programme to promote lower-carbon mobility in five metros and in ten smaller cities and create an	It should encourage new efficient-vehicle technologies with less Carbon emissions	This new transport emerging market has the potential to provide jobs and skills.

		Efficient Vehicles Programme with interventions that result in measurable improvements in the average efficiency of the South African vehicle fleet by 2020.		
The Waste Management Flagship Programme	Develop and implement a detailed Waste-Related GHG Emission Mitigation Action Plan aimed at measurable GHG reductions aligned with any sectoral carbon budgets that may be set	Led by the DEA the Programme must establish the GHG mitigation potential of the waste management sector including, investigating waste-to-energy opportunities available within the solid-, semi-solid- and liquid-waste management sectors, especially the generation, capture, conversion and/ or use of methane emissions.	Waste is generated into alternative "cleaner" form of energy	This Action Plan must also detail the development and implementation of any policy, legislation and/or regulations required to facilitate the implementation of the plan.
The Carbon Capture and Sequestration Flagship Programme	Storing of the process emissions from an existing high carbon emissions facility	Led by the DoE in partnership with the South African Energy Research Institute ,thus uses local capacity	This programme form key in that it should implement strategies to reduce high carbon emissions	This could improve research and technology methods
The Adaptation Research Flagship Programme	Includes sectoral adaptation requirements and costs and identify adaptation strategies	Led by the South African National Biodiversity Institute, the design and roll-out of a national and regional research programme, thus uses local capacity	Assessment of climate change vulnerabilities in the sub-region, with a detailed scenario planning process to define potential sub-regional response strategies should be initiated.	This programme should identify areas of highest vulnerability which need to be targeted for adaptation measures.

(Source: National Climate Change Response White Paper 2011: Section 8).

Table 5 is based on current policy analysis that indicates that unemployment is a key issue for South Africa and is a critical vulnerability that could be worsened by climate change. Severe income distortions further limit many people's ability to build resilience to climate change impacts. Climate change and responses thereto, will effect employment, job creation and living standards and, in many instances, this affect may be negative. Vulnerable low-income households and the marginalized unemployed are going to face the most severe impacts unless urgent steps are taken to reduce South Africa's vulnerability to climate and economic shocks. Adaptation could create new jobs to which

workers can migrate from sectors affected by mitigation strategies. The climate change response programmes attempt to reduce the impact of job losses and promote job creation during the shift towards the new green economy. The research hypothesis in chapter 1 advances the view that, "South Africa's climate change policies are designed to address issues of economic feasibility". The null hypothesis states the opposite: these policies are not feasible.

Chapter 5: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

According to the IPCC Third Assessment Report, climate change is already happening, and will continue to happen even if global greenhouse gas emissions are curtailed significantly in the short to medium term. There is now more confidence that global climate change is a threat to sustainable development, especially in developing countries, and could undermine global poverty alleviation efforts and have severe implications for food security, clean water, energy supply, environmental health and human settlements. The South African Country Studies Programme identified the health sector, maize production, plant and animal biodiversity, water resources, and rangelands as areas of highest vulnerability to climate change and these are the areas that need to be targeted for adaptation measures. With regard to vital industries, the mining and energy sectors are particularly vulnerable to climate change mitigation measures. Further, the South African economy is vulnerable to the possible response measures implemented by developed countries, since the economy is highly dependent on income generated from the production, processing, export and consumption of coal. This vulnerability extends across virtually all facets of the mining and energy sectors.

Even though the Department of Environmental Affairs and Tourism has been designated as the leading department for climate change response in South Africa, it is recognized that this is an issue that has effects for diverse activities in other government departments. Thus the national climate change strategy requires that many government departments work together in a coordinated manner, to ensure that response measures are properly directed, acceptable to all and carried out with a national focus. General awareness within government on the likely impacts of climate change is somewhat limited in those departments not directly involved with the issue. In order to adapt to climate change, and to prepare adequately for the likely impacts, capacity has to be built. This should ensure that the policies formulated must adequately address climate change adaptation. Further, it is important that the available skills and competencies within government are efficiently harnessed. Officials in other departments often do not see climate change as a priority and some even see it as working against national development priorities. Government is more concerned with the aspect that South Africa has a huge backlog of service delivery, where the performance of each department is measured by how effective and efficient it is on service delivery. Therefore, climate change needs to be addressed in such a way as to assist these departments to achieve their service delivery objectives through the so-called "win-win" or "no regrets" measures.

5.2 Recommendations

5.2.1 Management and monitoring of a sustainable energy programme

The managing and monitoring of climate change response programme are critical to ensure their effective implementation and success. South Africa has a tendency of implementing programmes but in the long run fail to manage and/or monitor them. It is thus very crucial for the management and monitoring of the climate change related programmes to ensure their success.

As a non-annex I country, South Africa is not required to reduce its emissions of greenhouse gases. However, the economy is highly dependent on fossil fuels and the country can be judged to be a significant emitter due to the relatively high values that can be derived for emissions intensity and emissions per capita. Such calculations put us as one of the world's top 15 most energy intensive economies, with a significant contribution to greenhouse emissions at a continental level. There could be benefits to be derived from adopting a future strategy that is designed to move the economy towards a cleaner development path. This requires continued attention to the process that is currently being developed to access investment through the Clean Development Mechanism of the Kyoto Protocol, technology transfer and donor funding opportunities. The Department of Minerals and Energy has developed a white paper on renewable energy and clean energy development, together with an energy efficiency programme, to support diversification towards a less carbon intensive energy economy.

5.2.2 Meeting international obligations

As a signatory to the UNFCCC, South Africa has to fulfill certain obligations which include the preparation and the periodic updating of its national inventory of greenhouse gas emissions and sinks. Where appropriate, regional programmes need to be formulated and implemented to mitigate and facilitate adequate adaptation methods to climate change. There should be co-operation in preparing for adaptation to the impacts of climate change and taking climate change considerations into account in the relevant social, economic and environmental policies and actions with a view to minimizing adverse effects on the economy, on public health and on the quality of the environment.

South Africa should thus conform to international best-practices to ensure that its adaptation and mitigation efforts are at par with international standards.

5.2.3 Climate change related education and training

Climate change is a relatively new issue in South Africa due to the prior isolation of this country from international events. Education, training and public awareness thus lag behind the requisite standards. The raising of public awareness on climate-related issues should be promoted by the government

through the Department of Environmental Affairs and Tourism (DEAT) and the South African Weather Services. Presentations and exhibitions should be used as a mechanism to promote awareness of climate change, for example through the National Atmospheric Week, World Environment Day and World Meteorological Day promotions. Publications should also be used to highlight important environmental issues. Television stations such as the SABC and e.TV should also have programmes on climate change, because these channels can be accessed across the country unlike the pay-channels such as the national geographic on DSTV.

5.2.4 Management and access of financial resources

An effective programme and implementation for climate change response requires access to public sector funding and funding from government related institutions, such as the Development Bank of South Africa. Further, as a developing country, South Africa can access assistance from developed country partners to meet its obligations under the convention and, further, participate in the global mitigation of climate change. This requires a framework to access and manage the climate change financial resources on offer as donor funding. Once funding has being acquired, it will help South Africa achieve its sustainable development objectives while also fulfilling the need to respond to climate change. South Africa should also aim to develop and maintain an investment friendly climate that attracts investment opportunities from developed countries in climate change related projects in South Africa, primarily through the Department of Trade and Industry and thus enabling access to appropriate funds, as feasible, for implementation of the climate change programmes. In particular for adaptation purposes, the government should be able to effectively coordinate climate change donor funds that are procured for South Africa and to use the public sector and financing institutions linked to government, such as the Industrial Development Corporation and the Development Bank of South Africa to fund climate change projects.

5.2.5 Human resources

An efficient and effective response to climate change requires all of us to change our behavior, especially when it comes to the use of fossil fuels and energy usage in general. We need to do things differently, to use different technologies and need to be far more sensitive to, and vigilant of, the changes happening around us. This implies to the need for new areas of education, the need for new levels of awareness, the need to build new skills, knowledge and expertise. Also implied is the need to provide re-skilling for people whose livelihoods are completely changed. To meet this challenge, South Africa should ensure that climate change and specifically the required response to climate change, is

included in all relevant aspects of our formal education curricula in order to ensure that future generations are fully prepared for a rapidly changing planet and the transition to a low-carbon society and economy. Also to ensure that all government sectoral climate change response strategies and action plans include sections on education, awareness and outreach and human resource development. Ensuring the compilation and publishing of a review on the jobs most threatened by climate change and climate change responses and providing a strategy on how these people may be shielded against potential job losses including, but not limited to, re-training and re-skilling programmes for re deployment into new and/or emerging sectors.

The focus now turns to the research question advanced in chapter 1 on whether South Africa's climate change policies are designed to address issues of economic feasibility. The findings on the individual four objectives consistently indicate that the policies are relevant and appropriate to the changing priority needs of the country given the management structure that is already in place for climate change mitigation.

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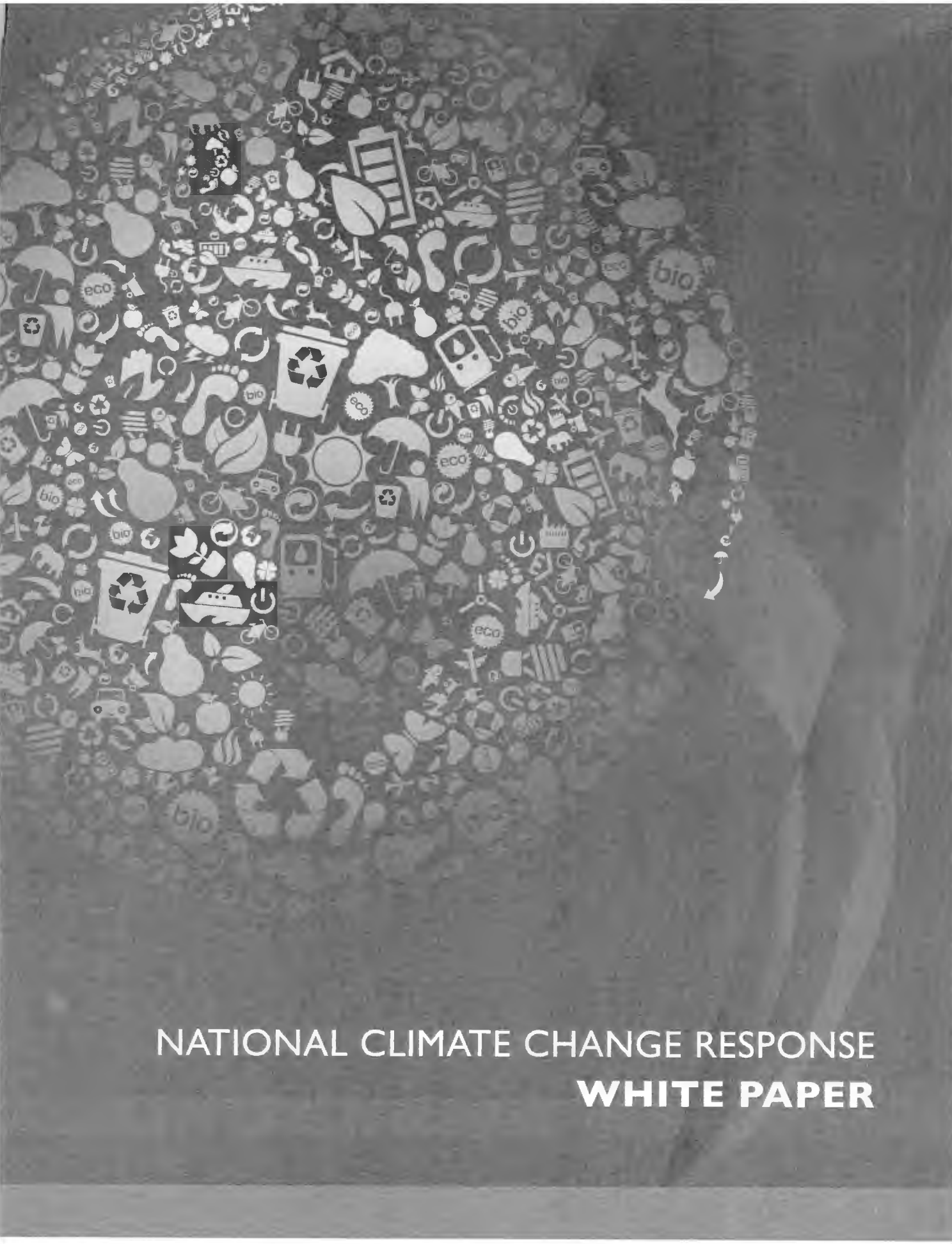

NATIONAL CLIMATE CHANGE RESPONSE
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LIST OF ABREVIATIONS

CDM	Clean Development Mechanism
DBSA	Development Bank of Southern Africa
DoE	Department of Energy
DEA	Department of Environmental Affairs
DST	Department of Science and Technology
DTI	Department of Trade and Industry
GDP	Gross Domestic Product
GHG	Greenhouse gas
GHGs	Greenhouse gases
IGCCC	Intergovernmental Committee on Climate Change
IMCCC	Inter-Ministerial Committee on Climate Change
IPCC	Intergovernmental Panel on Climate Change
IRP 2010	Integrated Resource Plan for Electricity Generation 2010
MDGs	Millennium Development Goals
MRV	Measure, report and verify
NCCC	National Committee on Climate Change
NEDLAC	National Economic Development and Labour Council
NEMA	National Environmental Management Act
NEVA	National Employment Vulnerability Assessments
NEVB	National Employment Vulnerability Baseline
NGO	Non-Governmental Organisation
NGP	New Growth Path
NRF	National Research Foundation
SAAQIS	South African Air Quality Information System
SARVA	South African Risk and Vulnerability Atlas
SETA	Sector Education and Training Authority
SJRPs	Sector Jobs Resilience Plans
UNFCCC	United Nations Framework Convention on Climate Change

EXECUTIVE SUMMARY

Climate change is already a measurable reality and along with other developing countries, South Africa is especially vulnerable to its impacts. This White Paper presents the South African Government's vision for an effective climate change response and the long-term, just transition to a climate-resilient and lower-carbon economy and society. South Africa's response to climate change has two objectives:

- Effectively manage inevitable climate change impacts through interventions that build and sustain South Africa's social, economic and environmental resilience and emergency response capacity.
- Make a fair contribution to the global effort to stabilise greenhouse gas (GHG) concentrations in the atmosphere at a level that avoids dangerous anthropogenic interference with the climate system within a timeframe that enables economic, social and environmental development to proceed in a sustainable manner.

This response is guided by principles set out in the Constitution, the Bill of Rights, the National Environmental Management Act, the Millennium Declaration and the United Nations Framework Convention on Climate Change. These principles are detailed in section 3.

The overall strategic approach for South Africa's climate change response is needs driven and customised; developmental; transformational, empowering and participatory; dynamic and evidence-based; balanced and cost effective; and integrated and aligned.

In terms of strategic priorities, the White Paper sets out South Africa's climate change response strategy to achieve the National Climate Change Response Objective in a manner consistent with the outlined principles and approach and which is structured around the following strategic priorities: risk reduction and management; mitigation actions with significant outcomes; sectoral responses; policy and regulatory alignment; informed decision making and planning; integrated planning; technology research, development and innovation; facilitated behaviour change; behaviour change through choice; and resource mobilisation.

See section 4 for details of the elements of the response policy.

In terms of adaptation, the National Climate Change Response includes a risk-based process to identify and prioritise short- and medium-term adaptation interventions to be addressed in sector plans. The process will also identify the adaptation responses that require coordination between sectors and departments and it will be reviewed every five years. For the immediate future, sectors that need particular attention are water, agriculture and forestry, health, biodiversity and human settlements. Resilience to climate variability and climate change-related extreme weather events will be the basis for South Africa's future approach to disaster management and we will use region-wide approaches where appropriate.

Section 5 expands on the adaptation part of the response policy.

South Africa's approach to mitigation, which is addressed by section 6 of the response policy, balances the country's contribution as a responsible global citizen to the international effort to curb global emissions with the economic and social opportunities presented by the transition to a lower-carbon economy as well as with the requirement that the country successfully tackles the development challenges facing it.

The key elements in the overall approach to mitigation will be:

- Using a National GHG Emissions Trajectory Range, against which the collective outcome of all mitigation actions will be measured;
- Defining desired emission reduction outcomes for each significant sector and sub-sector of the economy based on an in-depth assessment of the mitigation potential, best available mitigation options, science, evidence and a full assessment of the costs and benefits;
- Adopting a carbon budget approach to provide for flexibility and least-cost mechanisms for companies in relevant sectors and/or sub-sectors and, where appropriate, translating carbon budgets into company level desired emission reduction outcomes.
- Requiring companies and economic sectors or sub-sectors for which desired emission reduction outcomes have been established to prepare and submit mitigation plans that set out how they intend to achieve the desired emission reduction outcomes.
- Developing and implementing a wide range and mix of different types of mitigation approaches, policies, measures and actions that optimise the

mitigation outcomes as well as job creation and other sustainable developmental benefits. This optimal mix of mitigation actions will be developed to achieve the defined desired emission reduction outcomes for each sector and sub-sector of the economy by ensuring that actions are specifically tailored to the potential, best available solutions and other relevant conditions related to the specific sector, sub-sector or organisation concerned;

- The deployment of a range of economic instruments to support the system of desired emissions reduction outcomes, including the appropriate pricing of carbon and economic incentives, as well as the possible use of emissions offset or emission reduction trading mechanisms for those relevant sectors, sub-sectors, companies or entities where a carbon budget approach has been selected.
- A national system of data collection to provide detailed, complete, accurate and up-to-date emissions data in the form of a Greenhouse Gas Inventory and a Monitoring and Evaluation System to support the analysis of the impact of mitigation measures.

In addition to the direct physical impacts of climate change, there are also secondary economic impacts where South Africa may be economically vulnerable to response measures - measures taken both internationally and nationally, to reduce GHG emissions. As discussed in section 7, Government will take a multi-pronged approach to addressing and managing response measures, especially in respect of those that may have negative economic impacts.

A suite of Near-term Priority Flagship Programmes consisting of both new initiatives and the scaling up of existing initiatives will be implemented while the first sectoral desired emission reduction outcomes and carbon budgets are being developed and initial adaptation interventions prioritised. This component is addressed in section 8.

For job creation, as described in section 9, the National Climate Change Response aims to limit jobs contraction to those areas of the economy where excessive carbon intensity is unsustainable, whilst promoting and expanding the green economy sectors. The National Climate Change Response also aims to promote investment in human and productive resources that will grow the green economy. To do this, Government will assess the vulnerability of the different economic sectors to climate change and develop Sector Job Resilience Plans.

To mainstream climate-resilient development, section 10 notes that all Government departments and state-owned enterprises will need to review the policies, strategies, legislation, regulations and plans falling within their jurisdictions to ensure full alignment with the National Climate Change Response within two years of the publication of this policy. On the basis of the outcome of these reviews, government will determine what adjustments need to be made to achieve alignment with the goals and objectives of the National Climate Change Response, and will identify any additional legislative or regulatory measures that are needed. The National Climate Change Response itself will be reviewed every five years from the publication of this policy.

All sectors of the South African society will take part in the effort to mainstream climate-resilient development. Existing institutional arrangements, such as the Cabinet Clusters, the National Planning Commission, the Forum of South African Directors-General, the Parliamentary Portfolio Committee on Water and Environment Affairs, the Inter-Ministerial Committee on Climate Change, the Intergovernmental Committee on Climate Change and the multi-stakeholder National Committee on Climate Change will be used to drive this new policy direction.

Government departments will start communicating with citizens about climate change to inform and educate them and to influence their behavioural choices. This includes setting up and maintaining early warning systems so that people can take specific actions to reduce risks to themselves, their households and property.

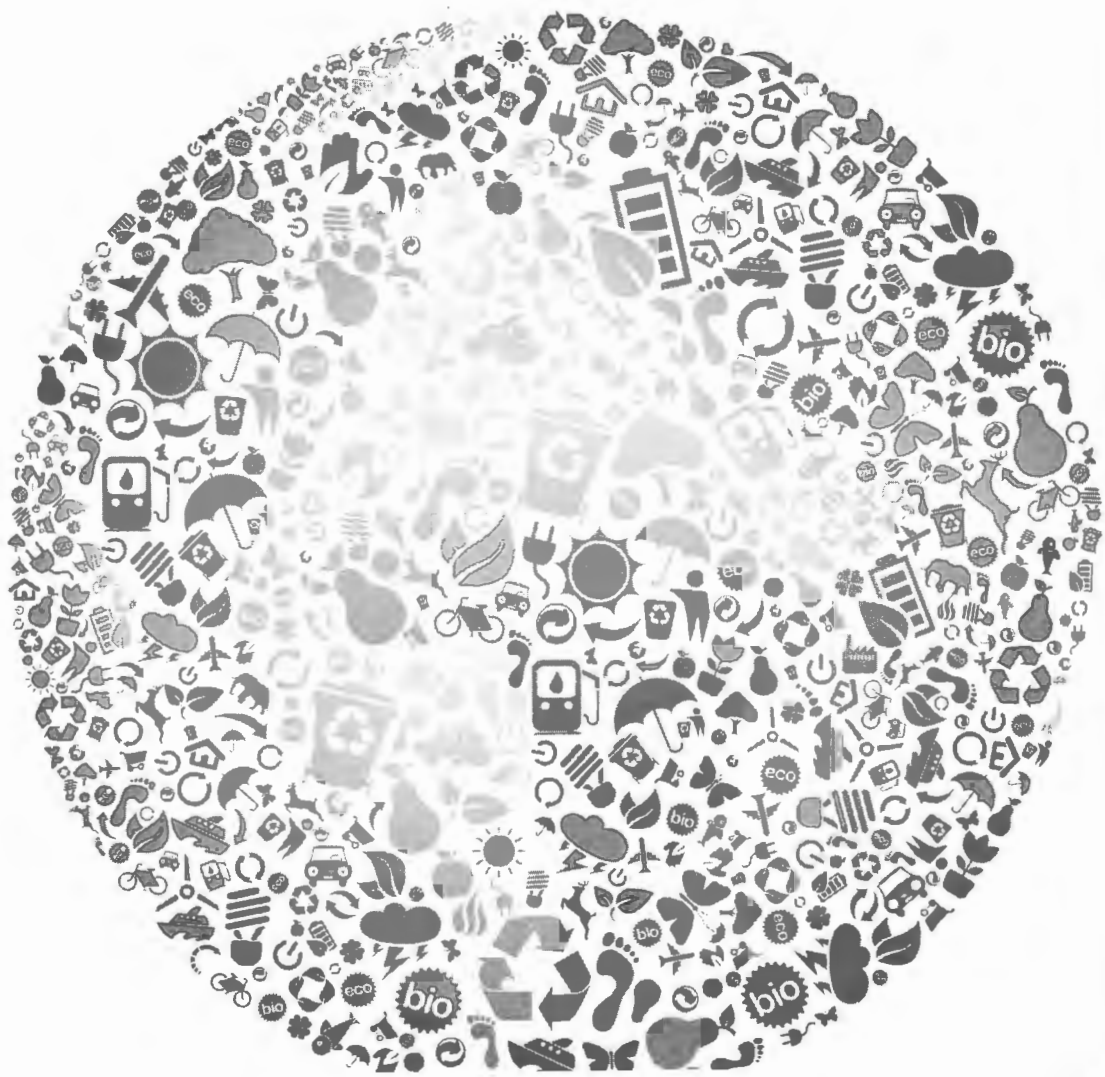
South Africa needs to mobilise financial, human and knowledge resources to effectively address climate change. To this end, Government will use existing financial institutions and instruments and it will help to develop new ones. This includes international financial assistance specifically for climate change response actions. During the initial period of transition to a climate-resilient and lower-carbon economy and society, Government will establish an interim climate finance coordination mechanism to secure the necessary resources for priority programmes.

See section 11 for further details on resource mobilisation.

To formulate effective responses to climate change, South Africa needs a country-wide monitoring system to measure climate variables at scales appropriate to the institutions that must implement climate change responses.

To monitor the success of responses to climate change, and to replicate the ones that have worked well, we need to measure their cost, outcome and impact. To this end, South Africa will, within two years of the publication of this policy, design and publish a draft Climate Change Response Monitoring and Evaluation System. Although the Climate Change Response Monitoring and Evaluation System will be based on South African scientific measurement standards and will be undertaken through the Presidency's Outcomes-Based System, it is expected that the system will evolve with international Measuring, Reporting and Verification requirements.

Section 12 details the systems needed to monitor and evaluate climate change and our responses to it.



1. INTRODUCTION

The phenomenon known as "climate change", the focus of this policy, refers to an ongoing trend of changes in the earth's general weather conditions as a result of an average rise in the temperature of the earth's surface often referred to as global warming. This rise in the average global temperature is due, primarily, to the increased concentration of gases known as greenhouse gases (GHGs) in the atmosphere that are emitted by human activities. These gases intensify a natural phenomenon called the "greenhouse effect" by forming an insulating layer in the atmosphere that reduces the amount of the sun's heat that radiates back into space and therefore has the effect of making the earth warmer.

While weather changes on a daily basis, climate represents the statistical distribution of weather patterns over time, and on a global scale has changed only very slowly in the past – usually over periods of tens of thousands of years or even millions of years which allows time for the earth's bio-physical systems to adapt naturally to the changing climatic conditions. Currently, the global climate is changing much more rapidly as a result of global warming, leading to, among others, the melting of polar and glacier ice, sea-level rise, ocean acidification, changes in rainfall and snowfall patterns, more frequent floods and droughts and increased frequency and intensity of extreme weather events, such as tornadoes, hurricanes and cyclones. The rapid rate of this climate change does not allow the earth's bio-physical systems to adapt to these changes naturally.

Evidence of rapid climate change, including more frequent and intense weather systems and greater climate variability, has already been observed and includes:

- increases in the average global temperature; with the past decade being the hottest on record;
- rises in the average global sea level;
- changes in average rainfall patterns, with some regions experiencing higher rainfall (e.g. Northern Europe) and other areas experiencing drying (e.g. the Sahel and southern Africa);
- increased frequency of heavy rainfall and extreme weather events over most land areas; and
- more intense and longer droughts, particularly in the tropics and subtropics.

GHGs are emitted from, and are reabsorbed by, a variety of natural sources, but the rate at which human economies and societies are emitting these gases far exceeds the capacity of natural ecosystems to reabsorb them. Increased industrial activity since the mid-18th century has led to a rapid increase in the atmospheric concentration of GHGs such as carbon dioxide, methane and nitrous oxide, in large part due to the burning of fossil fuels derived from oil, coal and natural gas. We also know that land-based human activities, such as forest clearing and unsustainable agricultural practices, are not only increasing GHG emissions from these sources, but are also reducing the earth's natural ability to absorb GHGs. The evidence that current global warming is due to human activities associated with industrialisation and modern agriculture is overwhelming.

The rate of change to the earth's climate exceeds the ability of all types of ecosystems (marine, coastal, freshwater, and terrestrial) to adapt as well as compromising their ability to function effectively. Ecosystems provide important services to society, such as the formation of soil; the provision of food, fresh water, wood, fibre and fuel; the regulation of climate, floods and the spread of disease; protection from storm surges and floods; and a range of cultural, spiritual, educational and recreational services. The protection of biodiversity, habitats and ecosystems is essential to the maintenance of these services, which is a key pillar for sustainable development.

It is acknowledged that Africa, as a whole, has contributed least to GHG concentrations in the atmosphere, but also faces some of the worst consequences and generally has the least capacity to cope with climate change impacts. However, it is also recognised that South Africa is a relatively significant contributor to global climate change with significant GHG emission levels from its energy-intensive, fossil-fuel powered economy. On the other hand, South Africa is extremely vulnerable and exposed to the impacts of climate change due to our socio-economic and environmental context. Climate variability, including the increased frequency and intensity of extreme weather events, will disproportionately affect the poor. South Africa is already a water-stressed country and we face future drying trends and weather variability with cycles of droughts and sudden excessive rains. We have to urgently strengthen the resilience of our society and economy to such climate change impacts and to develop and implement policies, measures, mechanisms and infrastructure that protect the most vulnerable.

The science is clear that action to address the causes and impacts of climate change by a single country or small group of countries will not be successful. This is a global

problem requiring a global solution through the concerted and cooperative efforts of all countries. Should multi-lateral international action not effectively limit the average global temperature increase to below 2°C above pre-industrial levels, the potential impacts on South Africa in the medium- to long-term are significant and potentially catastrophic. Even under emission scenarios that are more conservative than current international emission trends, it has been predicted that by mid-century the South African coast will warm by around 1 to 2°C and the interior by around 2 to 3°C. By 2100, warming is projected to reach around 3 to 4°C along the coast, and 6 to 7°C in the interior. With such temperature increases, life as we know it will change completely: parts of the country will be much drier and increased evaporation will ensure an overall decrease in water availability. This will significantly affect human health, agriculture, other water-intensive economic sectors such as the mining and electricity-generation sectors as well as the environment in general. Increased occurrence and severity of veld and forest fires; extreme weather events; and floods and droughts will also have significant impacts. Sea-level rise will negatively impact the coast and coastal infrastructure. Mass extinctions of endemic plant and animal species will greatly reduce South Africa's biodiversity with consequent impacts on eco-system services.

Against this national context, the South African Government:

- Accepts the conclusions of the Intergovernmental Panel on Climate Change (IPCC) in its Fourth Assessment Report, that warming of the climate system is unequivocal and that the increase in GHG concentrations as a result of human activity is primarily responsible for this warming trend.
- Regards climate change as one of the greatest threats to sustainable development and believes that climate change, if unmitigated, has the potential to undo or undermine many of the positive advances made in meeting South Africa's own development goals and the Millennium Development Goals (MDGs).
- Having ratified both the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol, will continue to meaningfully engage in the current multilateral negotiations to further strengthen and enhance the international response to the climate change crisis. The Government specifically aims to continue its efforts to strengthen and ensure the full implementation of the UNFCCC and its Kyoto Protocol through additional multi-lateral rules-based and legally-binding international agreements that will come into force after 2012. These should effectively limit the average global temperature increase to below a maximum of 2°C above pre-industrial levels. In so doing, South Africa will strive to ensure that such agreements are inclusive, fair and effective; reflect a balance between adaptation and mitigation responses; and recognise that solving the climate problem will only be possible if developing countries' priorities of eradicating poverty and promoting sustainable development are taken into consideration.
- Notwithstanding these ongoing international negotiations, reaffirms that, in terms of the provisions of Articles 4, 5, 6 and 12 of the UNFCCC as well as Article 10 of the Kyoto Protocol, South Africa already has existing international legally binding obligations to:
  - Formulate, implement, publish and regularly update policies, measures and programmes to mitigate its emission of GHGs and adapt to the adverse effects of inevitable climate change;
  - Monitor and periodically report to the international community the country's GHG inventory; steps taken and envisaged to implement the UNFCCC; and any other information relevant to the achievement of the objective of the UNFCCC, including information relevant for the calculation of global emission trends;
  - Sustainably manage, conserve and enhance GHG sinks and reservoirs, including terrestrial, coastal and marine ecosystems, biomass, forests and oceans;
  - Develop climate change response plans to address integrated coastal zone, water resources, agriculture, and land protection and rehabilitation;
  - Mainstream climate change considerations into social, economic and environmental policy;
  - Promote and cooperate in the development, application, diffusion and transfer of GHG emission mitigation technologies, practices and processes;
  - Further develop and support research and systematic observation organisations, networks and programmes as well as efforts to strengthen systematic observation, research and technical

capacities, including promoting research and systematic observation in areas beyond national jurisdiction; and

- Develop and implement education, training and public awareness programmes on climate change and its effects to promote and facilitate scientific, technical and managerial skills as well as public access to information, public awareness of and participation in addressing climate change.

Government also acknowledges that:

- Notwithstanding the effectiveness of any strengthened international response to the climate change crisis, a certain amount of climate change is already observed and further climate change will be inevitable due to the slow response (or inertia) of the climate system to changes in the concentration of GHGs in the atmosphere. Therefore South Africa will have to adapt to these impacts by managing its climate and weather-related risks, reducing its vulnerability and increasing the resilience of our society and economy to the adverse effects of climate change and variability;

- The stabilisation of GHG concentrations in the atmosphere at a level that prevents dangerous interference with the climate system requires the implementation of a sufficiently ambitious and effective global agreement on GHG emission reductions. In this context, as a responsible global citizen, and in keeping with its developing country status, its capability and its share of responsibility for the problem, South Africa is committed to making a fair contribution to the global effort to reduce GHG emissions. At the same time, the country must ensure that the necessary climate change-related investments contribute to building South Africa's future economic competitiveness and economic growth and contribute to its over-riding national priorities for sustainable development, job creation, improving public and environmental health and poverty eradication; and

- That although there will be costs associated with South Africa's adaptation and GHG emission reduction efforts, there will also be significant short and long-term social and economic benefits, including improved international competitiveness, that will result from a transition to a lower-carbon economy and society. Furthermore, various economic studies have shown that the costs of early action will be far less than the costs of delay and inaction.

Given the cross-cutting nature of climate change impacts and responses, Government further recognises that an effective response to climate change requires national policy to ensure a coordinated, coherent, efficient and effective response to the global challenge of climate change.

The policy outlined in this White Paper embodies South Africa's commitment to a fair contribution to stabilising global GHG concentrations in the atmosphere and to protecting the country and its people from the impacts of inevitable climate change. It presents the vision for an effective climate change response and the long-term transition to a climate-resilient, equitable and internationally competitive lower-carbon economy and society – a vision premised on Government's commitment to sustainable development and a better life for all.

2. NATIONAL CLIMATE CHANGE RESPONSE OBJECTIVE

South Africa will build the climate resilience of the country, its economy and its people and manage the transition to a climate-resilient, equitable and internationally competitive lower-carbon economy and society in a manner that simultaneously addresses South Africa's over-riding national priorities for sustainable development, job creation, improved public and environmental health, poverty eradication, and social equality. In this regard, South Africa will:

- Effectively manage inevitable climate change impacts through interventions that build and sustain South Africa's social, economic and environmental resilience and emergency response capacity.
- Make a fair contribution to the global effort to stabilise GHG concentrations in the atmosphere at a level that avoids dangerous anthropogenic interference with the climate system within a timeframe that enables economic, social and environmental development to proceed in a sustainable manner.

3. PRINCIPLES

The achievement of South Africa's climate change response objective is guided by the principles set out in the Constitution, the Bill of Rights, the National Environmental Management Act (NEMA), the MDGs and the UNFCCC. The principles include, amongst others:

- ***Common but differentiated responsibilities and respective capabilities*** – aligning our domestic measures to reduce the country's GHG emissions and adapt to the adverse effects of climate change with our unique national circumstances, stage of development and capacity to act.
- ***Equity*** – ensuring a fair allocation of effort, cost and benefits in the context of the need to address disproportionate vulnerabilities, responsibilities, capabilities, disparities and inequalities.
- ***Special needs and circumstances*** – considering the special needs and circumstances of localities and people that are particularly vulnerable to the adverse effects of climate change, including vulnerable groups such as women, and especially poor and/or rural women; children, especially infants and child-headed families; the aged; the sick; and the physically challenged.
- ***Uplifting the poor and vulnerable*** – climate change policies and measures should address the needs of the poor and vulnerable and ensure human dignity, whilst endeavouring to attain environmental, social and economic sustainability.
- ***Intra- and Inter-generational sustainability*** – managing our ecological, social and economic resources and capital responsibly for current and future generations.
- ***The Precautionary Principle*** – applying a risk-averse and cautious approach, which takes into account the limits of current knowledge about the consequences of decisions and actions.
- ***The Polluter Pays Principle*** – those responsible for harming the environment paying the costs of remedying pollution and environmental degradation and supporting any consequent adaptive response that may be required.
- ***Informed participation*** – enhancing public awareness and understanding of climate change causes and impacts to promote participation and action at all levels.
- ***Economic, social and ecological pillars of sustainable development*** – recognising that a robust and sustainable economy and a healthy society depends on the services that well-functioning ecosystems provide, and that enhancing the sustainability of the economic, social and ecological services is an integral component of an effective and efficient climate change response.

4. THE SOUTH AFRICAN CLIMATE CHANGE RESPONSE STRATEGY

Responses to climate change have been commonly categorised as either aimed at reducing the rate at which climate is changing to levels that occur naturally (and especially reducing the atmospheric concentrations of GHGs, so-called "mitigation") or responding to the adverse effects of climate change ("adaptation"). In addition, there is also the issue of managing any unintended negative consequences of climate change policies and measures, widely referred to as "response measures", on other countries. However, an effective South African climate change response requires economic, social and environmental interventions that integrate mitigation and adaptation elements within a developmental framework. Furthermore, an effective South African climate change response also requires the management of any response measures generated by our action as well as being able to respond to the response measures of other countries that have negative consequences for our country. Categorising responses as either mitigation or adaptation responses can obscure the real and potential positive combined impact of these responses. Thus, although this policy still retains the mitigation and adaptation categories for the sake of clarity, the policy also reflects a strategic approach referred to as "climate change resilient development".

For further clarity, the climate change response makes use of the following time-bound planning horizons:

- ***Short-term*** – five years from date of publication of the policy.
- ***Medium-term*** – twenty years from date of publication of the policy.
- ***Long-term*** – a planning horizon that extends to 2050.

4.1 Overall Approach

Climate change resilient development refers to all interventions – mitigation, adaptation or both – that contribute to a fair and effective global solution to the climate change challenge while simultaneously building and maintaining South Africa's international competitiveness, its social, environmental and economic resilience to the adverse effects of global climate change, and any unintended consequences of global climate change response measures. In this regard, the policy develops a "win-win" strategic approach that is:

- ***Needs-driven and customised*** – Employing a wide range of different types of adaptation and mitigation approaches, policies, measures, programmes, interventions and actions consistent with the principles outlined above, but in particular, that meet the special needs and circumstances of those most vulnerable as well as being specifically tailored to the potential, best available solutions and other relevant conditions related to the specific actor, organisation, sector or sub-sector concerned;
- ***Developmental*** – Prioritising climate change responses that have both significant mitigation and adaptation benefits and that also have significant economic growth, job creation, public health, risk management and poverty alleviation benefits;
- ***Transformational, empowering and participatory*** – Implementing policies and measures to address climate change at a "scale of economy" that enables and supports the required level of innovation, sector and skills development, finance and investment flows needed to reap the full benefit of a transition to a lower-carbon, efficient, job-creating, equitable and competitive economy. The transition will necessarily be supported and enabled by policies and measures to empower and promote the participation of all citizens through changing their behaviour to more sustainable lifestyles and livelihoods. This policy is therefore part of the broader social and economic transformation as envisaged by the New Growth Path (NGP) and is fundamentally underpinned by a major shift towards sustainable consumption and production patterns, which decouples growth and development from any negative impacts on the environment and society;
- ***Dynamic and evidence-based*** – Recognising that this policy has not been developed in a vacuum and many sectors have already researched and have experience in implementing policies and measures to address the challenges of climate change. Therefore, this policy takes an approach of:
  - Immediate implementation of Near-term Priority Flagship Programmes comprising of –
    - o Continued implementation of existing successful policies and measures with only policy alignment and integration intervention as required;

  - Scaled-up roll-out of those existing successful policies and measures, which have successfully completed a demonstration phase, where feasible;
  - Implementation of proven "no-regret policies and measures" in the immediate and near-term (e.g. best available technologies and best practices), particularly those that are well researched or understood, have socio-economic developmental and job creation benefits, and have negative-cost, zero-cost or low-cost implications for the economy and society;
- Simultaneously, further researching, consulting on, developing and demonstrating the detail of additional policies and measures consistent with the provisions of this policy, for implementation in the short-, medium- and longer-term, as and when ready; and
- Rigorously monitoring and evaluating the effectiveness of implemented policies and measures with a view to improving efficiency through adjustments or discarding those that are ineffective;

- ***Balanced and cost effective*** – Implementing a balanced approach to both climate change mitigation and adaptation responses in terms of cost-benefit, prioritisation, focus, action and resource allocation; and
- ***Integrated and aligned*** – Providing for the integration of sector-related climate change responses into the relevant sector planning processes and their developmental policies and measures. Where cross-cutting climate change responses are called for, this policy provides for their inclusion in, and consideration by, the relevant National, Provincial and/or Local planning regime as well as coherent alignment with the relevant policies and legislation.

4.2 Strategic Priorities

This White Paper sets out South Africa's climate change response strategy to achieve the National Climate Change Response Objective in a manner consistent with the principles and approach outlined above and which is structured around the following strategic priorities:

- ***Risk reduction and management*** – prioritise near-term adaptation interventions that address immediate and observed threats to the economy, ecosystem services and the health and well-being of South Africans while researching and developing short-, medium- and longer-term climate resilience, risk and vulnerability management policies and measures.
- ***Mitigation actions with significant outcomes*** – prioritise cost effective and beneficial mitigation policies, measures and interventions that significantly contribute to the country's deviation from the GHG emission "business as usual trajectory" as measured against a benchmark "peak, plateau and decline" GHG emission trajectory where GHG emissions peak between 2020 and 2025, plateau for approximately a decade and begin declining in absolute terms thereafter.
- ***Sectoral responses*** – prioritise, in accordance with the provisions of this policy, the requirement for all key actors, organisations or participants in relevant sectors or sub-sectors to prepare, submit, implement, monitor and report the implementation of detailed climate change response strategies and action plans that clearly articulate their roles, responsibilities, policies, measures, and interventions or actions to contribute to the achievement of the National Climate Change Response Objective in a measurable way.
- ***Policy and regulatory alignment*** – firstly, prioritise interventions already envisaged by national policies, legislation or strategies that have climate change co-benefits, particularly those that also contribute

towards the national priorities of job creation, poverty alleviation or have other positive socio-economic benefits. Secondly, review existing national policies, legislation or strategies, with a view to optimising and maximising the climate change co-benefits of their interventions. Thirdly, integrate into the relevant existing or new policies, legislation or strategies those climate change response interventions that stimulate new economic activities as well as those that improve the efficiency and competitive advantage of existing activities.

- ***Integrated planning*** – prioritise the mainstreaming of climate change considerations and responses into all relevant sector, national, provincial and local planning regimes such as, but not limited to, the Industrial Policy Action Plan, Integrated Resource Plan for Electricity Generation, Provincial Growth and Development Plans, and Integrated Development Plans.
- ***Informed decision-making and planning*** – prioritise research, systemic observation, knowledge generation, information management and early warning systems that increase our ability to measure and predict climate change and the implications of its adverse effects on the economy, society and the environment.
- ***Technology research, development and innovation*** – prioritise cooperation and the promotion of research, investment in and/or acquisition of adaptation, lower-carbon and energy-efficient technologies, practices and processes for employment by existing or new sectors or sub-sectors.
- ***Facilitated behaviour change*** – prioritise the use of incentives and disincentives, including regulatory, economic and fiscal measures, to promote behaviour change towards a lower-carbon society and economy.
- ***Behaviour change through choice*** – prioritise education, training and public awareness programmes to build the general public's awareness of climate change so as to empower all South Africans to make informed choices that contribute to an economy and society that is resilient to climate change.
- ***Resource mobilisation*** – prioritise the development of comprehensive resource and investment mobilisation strategies, capacities, mechanisms or instruments that support and enable implementation of climate change responses at the scale required, including, but not limited to, public and private financial resources, incentives, non-market and market-based instruments, technical cooperation and partnership agreements, and technology transfers at domestic, sub-regional, regional, and international levels.

5. ADAPTATION

5.1 Overall approach

All states in the Southern African sub-region face the challenges of rural and urban poverty, limited water or access to water resources, food insecurity, and other development challenges. Thus, although countries of the sub-region may have differing developmental priorities, they often face similar risks due to climate change and may also have similar adaptation needs. South Africa will therefore strive to develop climate change adaptation strategies based on risk and vulnerability reduction, in collaboration with its neighbours where appropriate, and seek to share resources, technology and learning to coordinate a regional response. A regional approach that achieves climate resilience will have significant socio-economic benefits for South Africa, including a smaller risk of unmanaged regional migration.

A leading international assessment of the effects of climate change on the global economy, the Stern Review, estimates that damages from unmitigated climate change could range between 5% and 20% of global Gross Domestic Product (GDP) annually by 2100. In the absence of effective adaptation responses, such levels of damages would certainly threaten and even reverse many development gains made in South Africa.

Future climate trends are uncertain and the uncertainty rises steeply over the longer-term. Objectives for adaptation must therefore be able to adjust to changing circumstances and time-frames. For this reason, South Africa needs to plan flexibly for a wide range of possible responses over the medium- to long-term. We also need focused monitoring and evaluation systems to update our knowledge of how rapidly the change is occurring and the effectiveness of adaptation responses. Section 12 contains more information about these monitoring and evaluation systems.

A key feature of adaptation responses is that they have a much stronger local context than do mitigation responses and their benefits may appear much faster and are often more tangible, such as an improvement in local environmental quality, for instance. Effective adaptation responses can also potentially create many jobs, particularly "green jobs", and could contribute significantly to sustainable development goals. Well planned adaptation responses can thus be effectively integrated with sustainable development policies.

Effective planning and coordination of an integrated adaptation response will require:

- Early warning and forecasting for disaster risk reduction.
- Medium-term (decade-scale) climate forecasting to identify potential resource challenges well in advance.
- Long-term climate projections that define the range of future climate conditions.

These need to be reinforced by research, capacity development, and technology development, and to respond to the needs of disaster risk reduction in the short-term, and integrated resource and development planning in the medium- and long-term.

Government departments have begun working on sectoral adaptation responses, and these include job creation and growth strategies, especially in the green economy, as well as the protection and support of vulnerable groups. As a first step in ensuring that appropriate adaptation responses are mainstreamed into sectoral plans, a sub-committee of the Intergovernmental Committee on Climate Change (IGCCC) will be established to perform climate risk analyses on all sectoral plans, informed by the various sectoral adaptation responses, within two years of the publication of this Policy, this process will result in –

- The identification and prioritisation of key short- and medium-term adaptation interventions that must be addressed in sector plans; and
- The identification of adaptation responses that require coordination between specific sectors and/or departments.

Using the results of this analysis, adaptation strategies will be integrated into sectoral plans, including:

- The National Water Resource Strategy, as well as reconciliation strategies for particular catchments and water supply systems.
- The Strategic Plan for South African Agriculture.
- The National Biodiversity Strategy and Action Plan, as well as provincial biodiversity sector plans and local bioregional plans.
- The Department of Health Strategic Plan.
- The Comprehensive Plan for the Development of Sustainable Human Settlements.
- National Framework for Disaster Risk Management

In addition to a refinement of top-down approaches, developing more detailed bottom-up approaches informed by the responses of local communities and local government will deliver results with a higher degree of confidence than is currently possible.

5.2 Water

South Africa is a water scarce country with a highly variable climate and has one of the lowest run-offs in the world – a situation that is likely to be significantly exacerbated by the effects of climate change. Uniquely, South Africa shares four of its major river systems with six neighbouring countries. These four shared catchments amount to approximately 60% of South Africa's surface area and approximately 40% of the average total river flow.

Based on current projections South Africa will exceed the limits of economically viable land-based water resources by 2050. The adequate supply of water for many areas can be sustained only if immediate actions are taken to stave off imminent shortages. The water sector must balance the allocation of limited water resources amongst major users (agriculture, domestic urban use and industry), whilst addressing the need to ensure fair access to water for all South Africa's people as well as a sufficient ecological allocation to maintain the integrity of ecosystems and thereby the services they provide.

Although Government has provided basic water services to an estimated additional nine million people since 1994, they are mostly in urban areas. In many rural areas, lack of reticulated water and sanitation means that people rely on generally poorly managed local resources such as ground water, springs and rivers that are vulnerable to pollution and drought. Poor communities who are dependent on natural water resources cannot control the quality of their water or store the water supply in bulk.

While there is a degree of uncertainty as to the net effects of climate change on water availability, rainfall is expected to become more variable, with an increase of extreme events such as flooding and droughts resulting in a much more variable runoff regime. Downscaled climate modelling suggests that the western and interior parts of the country are likely to become drier, and the eastern parts of the country wetter. Increased rainfall intensity will exacerbate scouring in rivers and sedimentation in dams, potentially impacting on water supply and treatment infrastructure. Higher temperatures, combined with higher carbon dioxide levels, will contribute to increased growth of algae as well as faster evaporation rates negatively impacting water resources.

Water availability is a key climate change-related vulnerability and negative impacts on the availability of water will be felt by people, ecosystems and the economy. As a result, climate change poses significant additional risks for water security, which in turn has knock-on effects on those sectors highly reliant on water such as agriculture, electricity generation as well as some mining and industrial activities. Thus, this set of vulnerabilities must be considered and integrated into both short- and medium-term water sector planning approaches.

In the short term, the development of a climate change response for the water sector through the National Water Resource Strategy plays a key role in government's Integrated Water Resource Planning process and will inform the ongoing maintenance of the water balance reconciliation strategies for water management areas that have recently been developed for water supply systems for up to 75% of the country's population, and the areas which together generate well over 80% of the national GDP.

In the medium to long term, the Water for Growth and Development Framework, which has a 2030 planning horizon, aims to balance the critical role of water in terms of both poverty alleviation (ensuring the constitutional right to a reliable and safe water supply) and economic development (be it for domestic, industry, mining, agricultural or forestry use). Water vulnerability and response must also be adequately factored into this framework document.

A two-pronged approach will be followed in which, firstly, in the short-term, climate change is used as the catalyst for addressing urgent short comings in the water sector and implementing effective, efficient and sustainable water resources and services management measures. Secondly, a long-term strategic focus on planning, adaptation and the smart implementation of new concepts and proactive approaches to managing water resources. To this end, the key elements of the National Climate Change Response Policy for the water sector include:

5.2.1 Integrating climate change considerations in the short-, medium- and long-term water planning processes across relevant sectors such as agriculture, industry, economic development, health, science and technology.

5.2.2 Sustaining state-of-the-art, water-related research and capacity development in all aspects of climate change in order to ensure the availability of relevant high quality, complete and current data, and tools with which to analyse the data.

5.2.3 Ensuring that water adaptation measures are managed from a regional perspective given the trans-boundary nature of our major rivers.

5.2.4 Implementing best catchment and water management practices to ensure the greatest degree of water security and resource protection under changing climatic conditions and, in particular, investment in water conservation and water demand management.

5.2.5 Exploring new and unused resources, particularly groundwater, re-use of effluent, and desalination.

5.2.6 Reducing the vulnerability and enhancement of the resilience to water-related impacts of climate change in communities and sectors at greatest risk

5.2.7 Providing human, legal, regulatory, institutional, governance and financial resources and capacity to deal with the long-term effects of climate change

5.2.8 Undertaking focused monitoring and research in order to ensure the efficacy of water adaptation approaches over the long-term.

5.3 Agriculture and commercial forestry

Climate change significantly impacts agriculture and commercial forestry and they have significant potential for adaptation. Globally, agriculture is a key contributor to climate change, being responsible for about 14% of all GHG emissions. In both the agriculture and commercial forestry sectors synergy and overlap exists between adaptation and mitigation measures, and climate-resilient sectoral plans have the potential to directly address the plight of those most impacted by climate change – the rural poor. Furthermore, in these sectors climate resilience addresses issues of strategic national importance: food security, water, health, and land reform. Agriculture is the largest consumer of water (through irrigation) and is vulnerable to changes in water availability, increased water pollution (particularly from toxic algal or bacterial blooms) and soil erosion from more intense rainfall events and increased evapotranspiration. Under-resourced, small-scale and subsistence farmers are particularly vulnerable to the impacts of climate change.

At the same time, conventional, commercial input-intensive agriculture has a range of negative environmental, social and economic externalities, which increasingly render it an unsustainable model. However, commercial agriculture remains a significant contributor to GDP and employment. Its full contribution, with multipliers, comprises up to 12% of GDP and 30% of national employment. Crop failures can therefore have a significant economic impact. A climate-resilient agricultural response depends on the recognition that agriculture should provide not only food, but also a range of other environmental and socio-economic benefits. The appropriate use of small-scale labour-intensive agriculture techniques and models could reverse the present decrease in agricultural jobs; contribute to empowerment goals; promote food security; conserve soil quality and structure; and contribute to biodiversity.

Modelling of climate change scenarios is vital to informing land-use planning decisions in agriculture that determine the mix of livestock and crop cultivation, as well as the types of crops that are likely to be commercially viable.

Commercial forestry in the form of alien plantations reduces streamflow and so impacts scarce water resources. It also reduces biodiversity. However, plantations function as carbon sinks that reduce the amount of GHGs in the atmosphere.

To build resilience to climate change, the priorities for agriculture and commercial forestry are to:

5.3.1 Integrate agriculture and forestry into climate-resilient rural development planning to address job creation, food security and livelihoods with a particular emphasis on building climate resilience through leveraging synergies between adaptation and mitigation.

5.3.2 Using the results of available risk and vulnerability studies, develop and update short-, medium- and long-term adaptation scenarios to identify climate-resilient land-uses. This will support the agricultural industry's proactive efforts to exploit new agricultural opportunities, new areas and new crops and it will reduce the impacts of climate change on existing agricultural potential.

5.3.3 Invest in and improve research into water, nutrient and soil conservation technologies and techniques, climate-resistant crops and livestock,

as well as agricultural production, ownership, and financing models to promote the development of "climate-smart agriculture" that lowers agricultural emissions, is more resilient to climate changes, and boosts agricultural yields.

5.3.4 Use early warning systems to give timely warnings of adverse weather and possibly related pests and disease occurrence. This will also provide up-to-date information and decision support tools to assess the vulnerability of farmers and inform farm management decisions.

5.3.5 Invest in education and awareness programmes in rural areas and link these to agricultural extension activities to enable both subsistence and commercial producers to understand, respond and adapt to the challenges of climate change.

5.4 Health

The South African health sector is one of the five key priorities of government. A significant proportion of South Africans, and in particular the poor, already have serious and complex health challenges compounded by poor living conditions. These include amongst the world's highest rates of tuberculosis and HIV infection. In particular parts of the country, the coverage of vector-borne diseases like malaria, rift valley fever and schistosomiasis may spread due to climate change, requiring a concomitant expansion of public health initiatives to combat these diseases. The links between the environment, food security and the infectious profiles of communities and regions have been well established.

Within this context, the extreme weather events and increased climate variability associated with climate change provides a number of significant compounding factors that negatively affect the health and resilience of vulnerable communities:

- The negative impacts of climate change on the socio-economic standing of the most vulnerable communities, and the consequences in terms of food security and the nutritional status of individuals within these communities threatens to further undermine their resistance to diseases such as HIV/AIDS and tuberculosis.
- The links between weather and disease are well established – for instance, studies have shown a strong association between extreme weather events such as droughts and flooding and the incidence of water borne diseases such as cholera.
- Furthermore, direct physical temperature stresses pose particular risks for children, the elderly and socio-economically vulnerable communities. South African data from the past four decades indicates an increase in the number of hotter days and nights and therefore an increased risk of casualties from heat stress.
- Women, as primary care-givers, are put under additional strain looking after sick and elderly household members whilst maintaining a household. This leaves them less time to earn a livelihood putting cyclical pressure on them as they often neglect their own health in prioritising the health of others.
- In densely populated urban areas, air pollution resulting primarily from the burning of fossil fuels may have serious health effects. Whilst South Africa's air quality is generally good, stagnant air episodes in cities can create extremely poor air quality conditions and there are indications that climate change may increase the number and intensity of such events.

In response to these challenges, South Africa will integrate climate change considerations into health sector plans to:

5.4.1 Reduce the incidence of respiratory diseases and improve air quality through reducing ambient particulate matter, ozone, and sulphur dioxide concentrations by legislative and other measures to ensure full compliance with National Ambient Air Quality Standards by 2020. In this regard, the use of legislative and other measures that also have the co-benefit of reducing GHG emissions will be prioritised. Progress in this regard will be published on the South African Air Quality Information System (SAAQIS).

5.4.2 Recognising that the nutritional status of individuals is key to building resilience to environmental health threats, ensure that food security and sound nutritional policies form part of an integrated approach to health adaptation strategies.

5.4.3 Develop and roll-out public awareness campaigns on the health risks of high temperatures and appropriate responses including improved ventilation and

promotion of behaviours that minimise exposure to high temperatures, namely "avoidance behaviour".

5.4.4 Design and implement "Heat-Health" action plans including plans in respect of emergency medical services, improved climate-sensitive disease surveillance and control, safe water and improved sanitation.

5.4.5 Strengthen information and knowledge of linkages between disease and climate change through research.

5.4.6 Develop a health data-capturing system that records data both at spatial and temporal scales and that ensures that information collected can be imported into multiple-risk systems such as the South African Risk and Vulnerability Atlas (SARVA).

5.4.7 Improve the bio-safety of the current malaria control strategy. Although the current strategy, which includes the use of the persistent organic pollutant, DDT, has proven effective in reducing the incidence of malaria, there are significant concerns about its long-term impacts on environmental and human health.

5.4.8 Strengthen the awareness programme on malaria and cholera outbreaks.

5.5 Biodiversity and ecosystems

Climate change will compound the pressures on already stressed ecosystems that have resulted from the unsustainable use and inadequate management of many of South Africa's ecosystems and so potentially reduce the quantity and quality of the services that ecosystems currently provide. These critical services underpin South Africa's socio-economic activities. Stressed ecosystems will compromise one of the key responses available to the country to adapt to climate change: using ecosystem services to help society adapt to climate change, known as „ecosystem-based adaptation'.

Although South Africa has a conceptual understanding of the possible impacts of climate change on many of its key biodiversity assets, a comprehensive and quantitative evaluation of various climate change, and climate change impact, scenarios has yet to be undertaken for all significant ecosystems, especially with respect to the services they provide.

Notwithstanding the uncertainty alluded to above, projected climate change impacts on biodiversity assets are likely to include although are not limited to:

- Roughly 30% of endemic terrestrial species in South Africa may be at an increasingly high risk of extinction by the latter half of this century if climate change is not mitigated.
- Marine ecosystems and species are at risk from changes in water temperature, ocean acidification and from changes in ocean currents such as West Coast upwelling and Agulhas current strengthening. Change in South Africa's marine and coastal environment is already being observed and this change has already had significant impacts on the fisheries sector and on the local economy of small-scale and subsistence fishing communities along the West Coast.
- Changes in rainfall patterns and temperatures, and rising atmospheric carbon dioxide levels could shift the distribution of South African terrestrial biomes with many implications for species diversity, ecosystem processes such as wildfires, and critical ecosystem services such as water yield and grazing biomass.
- Increasing frequency of extreme rainfall events will influence runoff quality and quantity in complex ways, significantly affecting the marine and estuarine environment. Reduced water flow will increase the salinity of estuaries, affecting the breeding grounds and nursery areas of many marine species. Coastal estuaries will also be vulnerable to long-term sea-level rise.
- Rising atmospheric carbon dioxide has poorly known direct effects on ecosystems. It may be increasing the cover of shrubs and trees in Grassland and Savannah Biomes, with mixed effects on biodiversity and possible positive implications for carbon sequestration.
- Additional stresses to biodiversity resulting from climate change include wildfire frequency (which appears to already show climate change-related increases in the Fynbos Biome), and the prevalence of invasive alien species. These stresses combined with reduced and fragmented habitats will further increase the vulnerability of biodiversity to climate change.

In response to these challenges, South Africa will integrate climate change into the management of biodiversity and ecosystem services as follows:

5.5.1 Strengthen biodiversity management and research institutions so that they can monitor, assess and respond effectively to existing anthropogenic pressures together with the additional pressures that climate change presents.

5.5.2 Conserve, rehabilitate and restore natural systems that improve resilience to climate change impacts or that reduce impacts. For example, mangrove forests reduce storm surge impacts and riparian vegetation and wetland ecosystems reduce the potential impact of floods. Opportunities to conserve biodiversity and extend the conservation estate through the development of carbon off-set programmes will be actively developed, such as those presented by the preservation of Spekboom as part of the Eastern Cape Thicket Biome.

5.5.3 Prioritise impact assessments and adaptation planning that takes into account the full range of possible climate outcomes, in conjunction with plausible scenarios of other stresses.

5.5.4 Prioritise climate change research into marine and terrestrial biodiversity and ecosystem services, and institute effective monitoring to enhance the understanding and forecasting of critical future threats. Monitoring efforts at national and sub-national scale, supported by experimental studies that quantify future risks to biodiversity and that improve projections of impacts, will help to design and refine adaptation responses.

5.5.5 Enhance existing programmes to combat the spread of terrestrial and marine alien and invasive species, especially in cases where such infestations worsen the impacts of climate change.

5.5.6 Expand the protected area network (in line with the National Protected Area Expansion Strategy) where it improves climate change resilience, and manage threatened biomes, ecosystems, and species in ways that will minimise the risks of species extinction. A regulatory framework to support investment in conservation or land rehabilitation as a way of offsetting the environmental impacts of new property developments will be explored.

5.5.7 Encourage partnerships for effective management of areas not under formal protection, especially freshwater ecosystem priority areas, critical biodiversity areas, ecological support areas and threatened ecosystems.

5.5.8 In the medium-term, expand existing gene banks to conserve critically endangered species that show increasing vulnerability to climate change trends.

5.6 Human Settlements – Urban Settlements

More than 60% of South Africa's population live in urban areas, which cover only 1.5% of South Africa's surface area. The average growth rate for urban areas is consistently higher than the population growth rate. Urban areas are functionally more efficient, with lower per capita costs of services and land requirements for human settlement, but urban areas consume more resources and have an impact far beyond their urban boundaries. Urban sprawl reduces biodiversity and it pollutes land, water and air. Informal settlements are vulnerable to environmental and health risks because dwellings are in areas prone to disasters and that lack basic services.

Urban human settlements face the following climate change challenges:

- Climate change may exacerbate the problems caused by poor urban management. For example, poor storm water drainage systems and urban-induced soil erosion result in flash flooding. Increased storm intensity due to climate change would exacerbate such problems.
- Cities are particularly vulnerable to climate change because they are slow to adapt to changes in the environment and they have entrenched dependencies on specific delivery mechanisms for critical services.
- The effective management of the interface between urban residents and their surrounding environment producing sustainable social-ecological systems needs to the addressed. Similarly the concept of climate resilience in the context of urban social-ecological systems needs to be further developed.
- South Africa's cities still reflect apartheid planning with the poorest communities tending to live far away from services and employment. Our cities are relatively spread out and these two factors contribute to increased transport emissions.

- Water demand in urban centres is growing rapidly, placing undue stress on water supply systems. Investment in waste water treatment works has not remained in line with the growth in demand and use.
- Informal settlements are vulnerable to floods and fires, exacerbated by their location in flood- or ponding-prone areas and on sand dunes; inferior building materials; and inadequate road access for emergency vehicles.
- Cities and dense urban settlements consume large amounts of energy.

In response to these challenges, South Africa will:

5.6.1 Investigate how to leverage opportunities presented by urban densification to build climate-resilient urban infrastructure and promote behavioural change as part of urban planning and growth management.

5.6.2 In the implementation of low-cost housing, ensure access to affordable lower-carbon public transport systems, incorporate thermal efficiency into designs and use climate-resilient technologies.

5.6.3 Develop effective information, monitoring and assessment tools to evaluate the resilience of our cities and towns to climate change and assist urban planners in identifying priorities for scaling-up climate change responses. Strengthen and enhance decision support tools and systems such as the *Toolkit for Integrated Planning* and develop geographic information systems that include, but not limited to, asset management components for public infrastructure.

5.6.4 Encourage and develop water-sensitive urban design to capture water in the urban landscape and to minimise pollution, erosion and disturbance. Urban infrastructure planning must account for water supply constraints and impacts of extreme weather-related events.

5.6.5 Acknowledging the current modelling limitations, encourage and support the appropriate down-scaling of climate models to provincial and, where possible, metropolitan and district levels to provide climate information at a scale that can be integrated into medium- and long-term spatial development plans and information systems.

5.6.6 Ensure that land-use zoning regulations are enforced and that urban land-use planning considers the impacts of climate change and the need to sustain ecosystem services when considering settlements and infrastructure development proposals.

5.7 Human Settlements – Rural Settlements

Over nineteen million, or 39%, of South Africans live in rural areas. Eighty percent of rural areas are commercial farming areas with low population densities, and 20% are former "homelands" where the agricultural sector has been undermined, settlements are often densely populated, and people are poor and largely reliant on urban remittances and social welfare for their livelihoods. Small-scale and homestead food production are practiced in rural areas on both high potential and marginal agricultural land, with roughly 1.3 million small-scale farm units. Seventy percent of the country's poorest households live on small-scale farms and few of them produce enough food to feed themselves throughout the year.

Rural human settlements face the following climate change challenges:

- Small-scale and subsistence food production is particularly vulnerable to climate variability, relying mostly on dryland food production with limited capital to invest in soil fertilisation, seed and weed, pest and disease control.
- Climate change, in particular changes in production systems and climate change-related damage and crop failures, is likely to negatively affect employment in rural areas.
- Spatial planning needs to address historical inequalities in land distribution without compromising the ability of the agricultural sector to contribute to food security.
- Rural communities with the highest dependence on natural water sources are in KwaZulu-Natal, the Eastern Cape and Limpopo. The former two will probably experience more flooding and water contamination. In addition to these, Limpopo will probably experience more droughts. These are areas with some of the poorest communities and under-resourced municipalities with limited capacity and skills to adapt to changing conditions.

- Rural areas are under-represented in the climate monitoring network despite the fact that they are likely to be the soonest and most greatly negatively affected by climate change.

In response to these challenges, South Africa will:

5.7.1 Educate subsistence and small-scale farmers on the potential risks of climate change, and support them to develop adaptation strategies with on-farm demonstration and experimentation. Adaptation strategies will include conservation agriculture practices including water harvesting and crop rotation, and will prioritise indigenous knowledge and local adaptive responses.

5.7.2 Empower local communities, particularly women who are often primary producers, in the process of designing and implementing adaptation strategies.

5.7.3 Design and implement economic and livelihood diversification programmes in rural areas.

5.7.4 Within the country's research and development system, prioritise technologies for climate change adaptation within rural areas, including low water-use irrigation systems, improved roll-out of rainwater harvesting strategies, and drought-resistant seed varieties.

5.7.5 Target adaptation programmes to build resilience among the most vulnerable sections of the rural population and ensure that disaster management architecture includes the provision of safety nets for rural communities most vulnerable to the impacts of climate change. This includes enhancing their knowledge of sustainable environmental conditions and optimising the ecosystem services that these provide.

5.8 Human Settlements – Coastal Settlements

Coastal human settlements are the most vulnerable to an increase in sea-level rise due to climate change. Coastal areas provide habitation, work, and recreation to approximately 40% of the South African people. A significant proportion of South Africa's metropolitan areas, including numerous towns and smaller settlements, are situated along the coastline. These areas also host high volumes of local and international tourists annually. A network of infrastructural installations and communication links along the coast, built by public and private enterprises, service the needs of the inhabitants, tourists and other entities in the coastal zone. The attraction of lifestyle and development opportunities in coastal area is leading to significant migration to the coast, with additional settlements and services in areas that are not immune to the impacts of climate change.

The 3,650 km South African coastline is generally exposed to moderate to strong wave action and provides little natural shelter to storms from the sea. With climate change expected to increase both the frequency and intensity of storms, the South African coastline will become increasingly vulnerable to storm surges, coastal erosion, sea-level rise and extreme weather events. A continual assessment of coastal defences, particularly at harbours, estuaries and lagoons, and along low-lying coastal land, will be needed to reduce damage in high risk areas.

In addition to the climate change impacts listed for urban and rural areas above, further impacts for coastal areas include:

- Flooding and coastal erosion that result in the loss of coastal infrastructure (including breakwaters, roads and public amenities), habitat and ecosystem goods and services. Predicted rises in sea level may further exacerbate these impacts.
- Increased frequency and intensity of coastal storms, which includes seasonal cyclone activity on the east coast. Estuaries are particularly vulnerable.

Increased coastal development and inappropriate land and catchment management will exacerbate these impacts.

In response to these challenges, South Africa will:

5.8.1 Ensure that national, provincial and municipal coastal management plans incorporate relevant climate information and geographic information systems and adopt a risk-based approach to planning that anticipates the consequences of the continued migration of communities into high risk coastal areas.

5.8.2 Take account of the potential impact of sea-level rise and intense weather events, such as storm surges, on infrastructure development and investment in coastal areas, particularly in terms of the location of the high-water mark and coastal set-back lines

that demarcate the areas in which development is prohibited or controlled. Government will review and amend the legislation to deal with adjustments of coastal set-back lines that affect the status of existing public and private infrastructure.

5.8.3 Protect and rehabilitate natural systems that act as important coastal defences, such as mangrove swamps, offshore reefs and coastal dunes.

5.8.4 Develop Disaster Risk Management plans that take into account the potential consequences of climate change along the coast, particularly the increased incidence of extreme weather events.

5.8.5 Support ongoing research to determine the impacts of climate change on artisanal fishing communities and livelihoods in coastal areas that are directly connected to coastal and marine resources and identify appropriate responses.

5.9 Disaster risk reduction and management

Disaster risk reduction and management are short-term adaptations to climate change because both address vulnerability to climate change-related impacts. Resilience to climate change-related extreme events, such as heat waves, floods, droughts, wildfires and storm surges, will be the basis for South Africa's future approach to disaster management. Extreme weather events often cross country borders and impact on the region as a whole. As such a region-wide approach to disaster management is often needed.

South Africa's Disaster Management Act sets out a comprehensive approach to disaster management and it identifies the roles and responsibilities of key institutions and disaster management agencies. In addition, the Act establishes a National Disaster Management Centre whose role is to address disaster prevention, coordinate disaster management agencies and capacity across government and to ensure that critical information is disseminated speedily.

Climate change will require more effective disaster management to deal with the increased number of extreme weather events. The increase in extreme events will strain public resources due to the need to declare and support disaster areas in an immediate crisis as well as during long-term recovery.

In response to these challenges, South Africa will:

5.9.1 Continue to develop and improve its early warning systems for weather and climate (especially severe weather events) and pest infestation events and to ensure that these warnings reach potentially affected populations timeously. To this end, we will investigate and implement plans to use the mass media and appropriate information and communication technologies to alert vulnerable populations.

5.9.2 Seek to collaborate with our neighbouring states to share early warning systems with regional applications and benefits.

5.9.3 Continue to promote the development of Risk and Vulnerability Service Centres at universities, which will, in turn, support resource-constrained municipalities.

5.9.4 Facilitate increased use of seasonal climate forecasts among key stakeholders such as those in the water and agricultural sectors.

5.9.5 Maintain, update and enhance the SARVA as a tool that provinces and municipalities may use to inform their climate change adaptation planning.

5.9.6 Collaborate with social networks such as community organisations, non-governmental organisations (NGOs), women and farmers' organisations, and the Adaptation Network to help raise awareness and to transfer technology and build capacity.

5.9.7 Develop mechanisms for the poor to recover after disasters, including micro-insurance.

6. MITIGATION

6.1 Overall approach to mitigation

South Africa's approach to mitigation is informed by two contexts: first, its contribution as a responsible global citizen to the international effort to curb global emissions; and second, its successful management of the development and poverty eradication challenges it faces. The National Climate Change Response is intended to promote adaptation and mitigation measures that will make development more sustainable, both in socio-economic and environmental terms.

South Africa recognises that stabilisation of GHG concentrations in the atmosphere at a level that prevents dangerous anthropogenic interference with the climate system will require effective international co-operation. We therefore regard mitigation as a national priority and are committed to actively engaging in international negotiations under the UNFCCC and its Kyoto Protocol, which South Africa has ratified.

As a responsible global citizen and as a global citizen with moral as well as legal obligations under the UNFCCC and its Kyoto Protocol, South Africa is committed to contributing its fair share to global GHG mitigation efforts in order to keep the temperature increase well below 2°C. In this regard, on 6 December 2009, the President announced that South Africa will implement mitigation actions that will collectively result in a 34% and a 42% deviation below its „Business As Usual' emissions growth trajectory by 2020 and 2025 respectively. In accordance with Article 4.7 of the UNFCCC, the extent to which this outcome can be achieved depends on the extent to which developed countries meet their commitment to provide financial, capacity-building, technology development and technology transfer support to developing countries. With financial, technology and capacity-building support, this level of effort will enable South Africa's GHG emissions to peak between 2020 and 2025, plateau for approximately a decade and decline in absolute terms thereafter.

To this end, the key elements in the overall approach to mitigation include:

6.1.1 ***Setting the performance benchmark*** – Using the National GHG Emissions Trajectory Range, against which the collective outcome of all mitigation actions will be measured. Section 6.4 contains more information about the emissions trajectory.

6.1.2 ***Identifying desired sectoral mitigation contributions*** – Defining desired emission reduction outcomes for each sector and sub-sector of the economy within two years of the publication of this policy-based on an in-depth assessment of the mitigation potential, best available mitigation options, science, evidence and a full assessment of the costs and benefits. Where appropriate, these desired emission reduction outcomes will be cascaded to individual company or entity level;

6.1.3 ***Defining Carbon Budgets for significant GHG emitting sectors and/or sub-sectors*** – Adopting a carbon budget approach to provide for flexibility and least-cost mechanisms for companies in relevant sectors and/or sub-sectors. The initial Carbon Budgets for significant GHG emitting sectors and/or sub-sectors will be drawn up and adopted within two years of the publication of this policy and revised as required based on monitoring and evaluation results, technological advances or new science, evidence and information. A mechanism and process to translate the Carbon Budgets for each relevant sector and/or sub-sector into company level desired emission reduction outcomes will be developed and implemented within three years of the publication of this policy for companies above a minimum emissions threshold. Section 6.5 contains more information about the carbon budget approach.

6.1.4 ***Mitigation Plans*** – Requiring companies and economic sectors or sub-sectors for whom desired emission reduction outcomes have been established to prepare and submit mitigation plans that set out how they intend to achieve the desired emission reduction outcomes.

6.1.5 ***The use of different types of mitigation approaches, policies, measures and actions*** – Developing and implementing a wide range and mix of different types of mitigation approaches, policies, measures and actions that optimise the mitigation outcomes as well as job creation and other sustainable developmental benefits. This optimal mix of mitigation actions will be developed to achieve the defined desired emission reduction outcomes for each sector and sub-sector of the economy by ensuring that actions are specifically tailored to the best available solutions and other relevant conditions related to the specific sector, sub-sector or organisation concerned;

6.1.6 ***Using the market*** – Deploying a range of economic instruments to support the system of desired emissions reduction outcomes, including the appropriate pricing of carbon and economic incentives, as well as the possible use of emissions offset or emission reduction trading mechanisms for those relevant sectors, sub-sectors, companies or entities where a carbon budget approach has been selected.

6.1.7 ***Monitoring and evaluation*** – Establishing a national system of data collection to provide detailed, complete, accurate and up-to-date emissions data in the form of a Greenhouse Gas Inventory and a Monitoring and Evaluation System to support the analysis of the impact of mitigation measures. Section 6.7 contains more information about emissions data collection and section 12 expands on the proposed Climate Change Response Monitoring and Evaluation System.

6.2 South Africa's emissions

South Africa has relatively high emissions for a developing country, measured either per capita or by GHG intensity (emissions per unit of GDP). By any measure, South Africa is a significant emitter of GHGs.

The energy intensity of the South African economy, largely due to the significance of mining and minerals processing in the economy and our coal-intensive energy system, has resulted in an emissions profile that differs substantially from that of other developing countries at a similar stage of development as measured by the Human Development Index. Since coal is the most emissions-intensive energy carrier, South Africas economy is very emissions-intensive. Furthermore, emissions from land-use change (primarily deforestation) contribute a significantly smaller share to our emission profile than for many other developing countries. In 2000, average energy use emissions for developing countries constituted 49% of total emissions, whereas South Africas energy use emissions constituted just under 80% of total emissions. Even in some fast-developing countries with a similar reliance on coal for energy, energy use emissions are lower than South Africa.

In terms of South Africas latest Greenhouse Gas Inventory (base year 2000), the majority of South Africas energy emissions arose from electricity generation, which constituted around half of South Africa's energy emissions and just under 40% of total emissions in 2000. Transportation and energy used in industry contributed just under 10% each of total emissions and industrial process emissions constituted around 14% of total emissions. Emissions from agriculture and land-use change in South Africa constitute only around 5% of emissions, compared to an average of 44% in developing countries as a whole.

6.3 Mitigation potential

Currently available analyses indicate that, unchecked by climate mitigation action, South Africa's emissions could grow rapidly by as much as fourfold by 2050. The majority of South Africa's emissions arise from energy supply (electricity and liquid fuels) and use (mining, industry and transport), and mitigation actions with the largest emission reduction potential focus on these areas. The cost of mitigation actions varies significantly, and published analyses of these costs is likely to require further refinement, especially at sectoral, sub-sectoral and individual organisation levels.

Unlike in other developing countries, South Africa has limited opportunities to cut emissions by tackling deforestation, a sector in which near-term emission reductions are more easily achieved through regulatory policies and enforcement type measures and are therefore relatively inexpensive. While opportunities for mitigation of emissions from non-energy sources do exist, large mitigation contributions will have to come from reduced emissions from energy generation and use. The main opportunities for mitigation consist of energy efficiency, demand management and moving to a less emissions-intensive energy mix, with consequent economic benefits of improved efficiency and competitiveness as well as incentivising economic growth in sectors with lower energy intensities.

Policy decisions on new infrastructure investments must consider climate change impacts to avoid the lock-in of emissions-intensive technologies into the future. However, in the short-term, due to the stock and stage in the economic lifecycle of existing infrastructure and plant, the most promising mitigation options are primarily energy efficiency and demand side management, coupled with increasing investment in a renewable energy programme in the electricity sector. In addition, in the short term, the emergence of bio-fuels and a suite of non-energy mitigation options, such as afforestation, are also important.

A mix of economic instruments, including market-based instruments such as carbon taxes and emissions trading schemes, and incentives, complemented by appropriate regulatory policy measures are essential to driving and facilitating mitigation efforts and creating incentives for mitigation actions across a wide range of key economic sectors. Section 10.7 provides further details on the application of market-based policy instruments.

In the medium-term, the mitigation options with the biggest mitigation potential are:

- shifting to lower-carbon electricity generation options;
- significant upscaling of energy efficiency applications, especially industrial energy efficiency and energy efficiency in public, commercial and residential buildings and in transport; and
- promoting transport-related interventions including transport modal shifts (road to rail, private to public transport) and switches to alternative vehicles (e.g. electric and hybrid vehicles) and lower-carbon fuels.
- In the short and medium term, several other options are available with a smaller mitigation potential, including:
- carbon capture and storage in the synthetic fuels industry;
- options for mitigating non-energy emissions in agriculture and land-use; and
- transitioning the society and economy to more sustainable consumption and production patterns.

In our long-term planning, information (nationally and internationally) about the outcome of mitigation options, technology development, and other new information, may suggest additional mitigation actions.

This policy identifies or sets up processes to identify the optimal combination of actions sufficient to meet the National Climate Change Response Objective. Factors to be considered include not only the mitigation potential, the incremental and direct cost of measures, but also the broader impact on socio-economic development indicators (such as employment and income distribution), our international competitiveness, the cost to poor households and any negative consequences for key economic sectors.

6.4 The Benchmark National GHG Emissions Trajectory Range

In 2008, in the context of South Africa's moral and legal obligation to make a fair contribution to the global mitigation effort under the UNFCCC and its Kyoto Protocol, Cabinet fully considered the Long Term Mitigation Scenario study of the country's mitigation potential. This led to the announcement that South Africa's emissions should peak in the period from 2020 to 2025, remain stable for around a decade, and decline thereafter in absolute terms. The President confirmed this strategic policy direction at the 2009 National Climate Summit and further detailed this as a South African undertaking in the context of all legal obligations under the UNFCCC and its Kyoto Protocol prior to the international UNFCCC Climate Change Conference in 2009 (see 6.1 above). This strategic policy direction and international undertaking has informed a National GHG Emissions Trajectory Range, projected to 2050, to be used as the benchmark against which the efficacy of mitigation action will be measured.

The benchmark National GHG Emissions Trajectory Range:

6.4.1 Reflects South Africa's fair contribution to the global effort to limit anthropogenic climate change to well below a maximum of 2oC above pre-industrial levels.

6.4.2 Details the "peak, plateau and decline trajectory" used as the initial benchmark against which the efficacy of mitigation actions will be measured (see the document published by the Department of Environmental Affairs (DEA) in 2011 entitled "Defining South Africa's Peak, Plateau and Decline Greenhouse Gas Emission Trajectory"). In summary:

- South Africa's GHG emissions peak in the period 2020 to 2025 in a range with a lower limit of 398 Megatonnes (109 kg) (Mt) CO_2-eq and upper limits of 583 Mt CO_2-eq and 614 Mt CO_2-eq for 2020 and 2025 respectively.
- South Africa's GHG emissions will plateau for up to ten years after the peak within the range with a lower limit of 398 Mt CO_2-eq and upper limit of 614 Mt CO_2-eq.
- From 2036 onwards, emissions will decline in absolute terms to a range with lower limit of 212 Mt CO_2-eq and upper limit of 428 Mt CO_2-eq by 2050.

6.4.3 Defines an initial National GHG Emissions Trajectory Range, which may be reviewed in the light of monitoring and evaluation results, technological advances or new science, evidence and information.

6.5 The Carbon Budget Approach

Recognising that due to the current emissions-intense structure of the economy, many sectors require a flexible mitigation approach, which enables the development and use of lowest-cost options such as offset and other types of market-based mechanisms. For such sectors, a Carbon Budget (CB) approach is adopted that specifies desired emission reduction outcomes consistent with the benchmark national GHG emissions range trajectory. To this end, CBs will be drawn up within two years of the publication of this policy for relevant economic sectors and subsectors, particularly in the major energy supply (electricity and liquid fuels) and use (mining, industry and transport) sectors. These CBs will be updated as required based on monitoring and evaluation results, technological advances or new science, evidence and information. The CBs will be released in conjunction with the National Climate Change Response Monitoring and Evaluation System, which includes an enhanced National Greenhouse Gas Inventory process.

The CB process will identify an optimal combination of mitigation actions at the least cost to-and with the most sustainable development benefits for-the relevant sector and national economy to enable and support the achievement of the desired emission reduction outcomes consistent with the benchmark National GHG Emissions Trajectory Range. Government will actively consult with industry and other key stakeholders in the development of CBs and approaches, mechanisms and outcomes.

The process to draw up or to review the CBs will consist of the following steps:

6.5.1 Review of the contributions making up the national emissions trajectory informed by historical emissions and trends and the most recent and best available scientific evidence and information.

6.5.2 Identification of a portfolio of enabling mitigation programmes and measures, including economy-wide measures and instruments, such as a carbon tax and incentives to industry and households, and the financial resources available to support them.

6.5.3 Analysis of :

- current and future emissions trends by sector and sub-sector,
- the timing, scale, cost and risk of different mitigation actions for each economic sector and sub-sector, and
- the economy-wide implications of mitigation actions, in particular on jobs.

6.5.4 Development of desired emission reduction outcomes for each sector and sub-sector of the economy. These will include short-, medium- and long-term CBs for sectors and sub-sectors where a CB approach is relevant. In respect of significant point-source emissions, the CBs will be cascaded down to sub-sectors and, ultimately, companies whose emissions are above a specified threshold.

6.5.5 Consultation with:

- The National Treasury, the Departments of Trade and Industry and Economic Development on the implementation of fiscal measures, incentives and other support measures, such as the carbon tax, including an assessment of the measures' effectiveness and benefits, and any other key parameters.
- Any other relevant entity about other means of implementation that may be required.
- Stakeholders, in particular organised business and labour.

6.5.6 The IGCCC will establish a process to provide analytical resources to support the development of the CB approach.

6.6 Sectoral mitigation and lower-carbon development strategies

Under the leadership of the relevant national sector government department, each significantly emitting economic sector or sub-sector will be required to formulate mitigation and lower-carbon development strategies. These strategies will specify a suite of mitigation programmes and measures appropriate to that sector or sub-sector. They will also provide measurable and verifiable indicators for each programme and measure to monitor their implementation and outcome. These strategies

will outline how to implement the proposed mitigation programmes via existing implementation mechanisms, such as the IRP 2010, or via modified or new mechanisms (see 10.1.2). For example, in respect of industrial emissions, approved mitigation plans will conform to the Air Quality Management Act's requirements for Pollution Prevention Plans prepared by identified industries and sectors.

6.7 GHG emissions inventory

Accurate, complete and up-to-date data is the foundation of an effective response. Two essential elements for the definition of desired emission reduction outcomes and the development of CBs are emissions data and data to monitor the outcome of specific mitigation actions. This section details the GHG Emissions Inventory and section 12 details the climate change monitoring and modelling requirements, as well as the evaluation of mitigation actions.

The DEA in partnership with the South African Weather Service, the host of the SAAQIS, will prepare a GHG Emissions Inventory annually. The inventory will conform to the IPCC's 2006 or later guidelines, and will be periodically reviewed by an international team of experts. The inventory will also undertake and report analyses of emissions trends, including detailed reporting on changes in emissions intensity in the economy and a comparison of actual GHG emissions against the benchmark national GHG emission trajectory range described in section 6.4.

As is currently contemplated by the DEA, reporting of emissions data will be made mandatory for entities (companies and installations) that emit more than 0.1 Mt of GHGs annually, or that consume electricity which results in more than 0.1 Mt of emissions from the electricity sector. Qualifying entities will also be obliged to report energy use by energy carrier and other data as may be prescribed. The emissions inventory will be a web-based GHG Emission Reporting System and will form part of the National Atmospheric Emission Inventory component of the SAAQIS. It will be developed, tested and commissioned within two years of the publication of this policy.

7. MANAGING RESPONSE MEASURES

As mentioned in section 4, in addition to the direct physical impacts of climate change, there are also secondary economic impacts. As a significant global emitter with a heavy reliance on coal-based energy, South Africa may be economically vulnerable to measures taken both internationally and nationally, to reduce GHG emissions. The sectors that are particularly vulnerable are those that are emissions-intensive, and trade-exposed, and may include iron and steel, non-ferrous metals, chemicals and petrochemicals, mining and quarrying, machinery and manufacturing, some agricultural exports, as well as transport services and tourism. Potential economic risks emerge from the impacts of climate change regulation, the application of trade barriers, a shift in consumer preferences, and a shift in investor priorities. There are, however, also economic opportunities that arise from new or expanded markets, enhanced efficiencies and improved competitiveness, development of lower-carbon infrastructure with strong socio-economic benefits, and the development of a national environmental goods and services sector.

Government will take a multi-pronged approach to addressing and managing response measures, especially in respect of response measures that may have negative economic impacts. At the international level, South Africa will engage vigorously in the multilateral climate change negotiations, to ensure a fair and effective outcome that is in accordance with the principles of equity, common but differentiated responsibility, and respective capabilities, and that provides developing countries with sufficient time and development space for the required economic transition to lower-carbon economies. At the national level, the challenge will be to effectively manage and reduce the economic risks, and build on and optimise the potential opportunities, and to ensure a smooth and just transition to a climate-resilient, equitable and internationally competitive lower-carbon economy and society.

8. NEAR-TERM PRIORITY FLAGSHIP PROGRAMMES

A set of Near-term Priority Flagship Programmes will be implemented as an integral part of this policy informed by several important factors including the urgency of acting on mitigation and adaptation responses as soon as possible as well as the fact that many sectors have already researched and have experience in implementing policies and measures to address the challenges of climate change. The initial desired emission reduction outcomes, the carbon budgets and the initial adaptation intervention prioritisation process will be completed within two years of the publication of this policy. These programmes will include both the scaling-up of existing climate change initiatives and new initiatives that are ready to come on-stream.

The Inter-Ministerial Committee (IMCCC) (section 10.2.2) and the IGCCC sub-committee (section 10.2.3) will take responsibility for the development and oversight of the Near-term Priority Flagship Programmes. The appropriate line function Ministry will elaborate on each Near-term Priority Flagship Programme and the responsible Minister will establish teams to create a framework for each programme. Frameworks will consist of the following:

- A programme for implementation.
- A detailed analysis of mitigation or adaptation outcomes expected to result from the programme.
- A proposal for realising local sustainable development benefits, including employment, poverty alleviation, industrial development, reduction in local air pollution and others.
- A well-defined reporting format, which will include a set of relevant indicators, and a proposal to establish an annual reporting process.

Based on current analysis, government has identified an initial list of Near-term Priority Flagship Programmes, covering both adaptation and mitigation measures. The mitigation programmes cover the major emitting sectors, have relatively well-known mitigation outcomes and implementation processes, and are either very cost-effective and have significant co-benefits or have technology development benefits. The Flagship Programmes also utilise, test and/or demonstrate a suite of policy interventions including regulatory measures, market-based instruments, tax incentives and fiscal subsidies, and information and awareness initiatives. Regulatory measures include renewable energy and energy efficiency targets complemented by appropriate standards; market-based instruments including the electricity generation levy and taxes on motor vehicle emissions and incandescent light bulbs; tax incentives and fiscal subsidies are targeted at various programmes that support climate change mitigation and adaptation objectives; and information and awareness initiatives including the motor vehicle emissions labelling scheme.

The following Near-term Priority Flagship Programmes will be implemented with immediate effect:

8.1 The Climate Change Response Public Works Flagship Programme

The Climate Change Response Public Works Flagship Programme includes the consolidation and expansion of the Expanded Public Works Programme and its sector components such as the Non-State Sector's Community Works Programme and the suite of Environment and Culture Sector programmes including Working for Water, Working on Fire, and Working for Energy as these have proven effective in building climate resilience and relieving poverty. An example of the biodiversity impacts derived from Expanded Public Works Programme investment is the large-scale planting of the Spekboom on degraded public and private land, thereby re-establishing portions of the Thicket Biome in the Eastern Cape.

8.2 The Water Conservation and Demand Management Flagship Programme

The Water Conservation and Demand Management Flagship Programme includes the accelerated implementation of the National Water Conservation and Water Demand Management Strategy in the industry, mining, power generation, agriculture and water services sectors. The accelerated provision of rainwater harvesting tanks in rural and low-income settlements will also form part of this programme.

8.3 The Renewable Energy Flagship Programme

The Renewable Energy Flagship Programme is inclusive of a scaled-up renewable energy programme, based on the current programme specified in the IRP 2010 and using, for example, the evolving South African Renewables Initiative led by the Department of Public Enterprise and Department of Trade and Industry (DTI), as a driver for the deployment of renewable energy technologies. The programme will be informed by enhanced domestic manufacturing potential

and the implementation of energy efficiency and renewable energy plans by local government.

Furthermore, the Department of Energy's (DoE) solar water heating programme will be expanded through, amongst others, the promotion of the domestic supply of products for solar heating with support from the DTI to build local manufacturing capacity.

8.4 The Energy Efficiency and Energy Demand Management Flagship Programme

As part of the Energy Efficiency and Energy Demand Management Flagship Programme, the DoE will continue to develop and facilitate an aggressive energy efficiency programme in industry, building on the experience of Eskom's Demand Side Management programme and the DTI's National Cleaner Production Centre, and covering non-electricity energy efficiency as well. A structured programme will be established with appropriate initiatives, incentives and regulation, and a well-resourced information collection and dissemination process.

A residential energy efficiency programme will also be included, consisting of two parts:

- The development of appropriate initiatives, incentives and regulations will be finalised by the DoE and the DTI. Furthermore, the development of energy specifications for low-income housing will be determined through the National Sustainable Settlements Facility under the Department of Human Settlements.
- Regulation of commercial and residential building standards to enforce green building construction practices. The National Regulator for Compulsory Specifications in conjunction with the National Home Builders Registration Council will ensure that building construction and operation conform to green building requirements, including measures such as controlled ventilation, using recycled material, solar power, etc.

A government building energy efficiency programme led by the Department of Public Works that initiates energy and emissions audits of all government buildings and facilities will be developed. It will develop comparable indicators and benchmarks, and make appropriate interventions. The programme will include lead programmes for key government buildings, including Parliament and the main government buildings in Pretoria. Ambitious goals for energy efficiency will be set for all new government buildings.

8.5 The Transport Flagship Programme

As part of the Transport Flagship Programme, the Department of Transport will facilitate the development of an enhanced public transport programme to promote lower-carbon mobility in five metros and in ten smaller cities and create an Efficient Vehicles Programme with interventions that result in measurable improvements in the average efficiency of the South African vehicle fleet by 2020.

Furthermore, the planned rail re-capitalisation programme is considered an important component of this Flagship Programme in so far as it will facilitate both passenger modal shifts and the shift of freight from road to rail.

Initially led by the Department of Transport, the programme will also include a Government Vehicle Efficiency Programme that will measurably improve the efficiency of the government vehicle fleet by 2020. It will encourage new efficient-vehicle technologies, such as electric vehicles, by setting procurement objectives for acquiring such vehicles.

8.6 The Waste Management Flagship Programme

Led by the DEA, the Waste Management Flagship Programme will establish the GHG mitigation potential of the waste management sector including, but not limited to, investigating waste-to-energy opportunities available within the solid-, semi-solid- and liquid-waste management sectors, especially the generation, capture, conversion and/or use of methane emissions. This information will be used to develop and implement a detailed Waste-Related GHG Emission Mitigation Action Plan aimed at measurable GHG reductions aligned with any sectoral carbon budgets that may be set. This Action Plan will also detail the development and implementation of any policy, legislation and/or regulations required to facilitate the implementation of the plan.

8.7 The Carbon Capture and Sequestration Flagship Programme

Led by the DoE in partnership with the South African Energy Research Institute, the programme includes, among other initiatives, the development of a Carbon Capture and Sequestration Demonstration Plant to store the process emissions from an existing high carbon emissions facility.

8.8 The Adaptation Research Flagship Programme

Led by the South African National Biodiversity Institute, the design and roll-out of a national and regional research programme to scope sectoral adaptation requirements and costs and identify adaptation strategies with cross-sectoral linkages and benefits, including an assessment of climate change vulnerabilities in the sub-region, with a detailed scenario planning process to define potential sub-regional response strategies.

9. JOB CREATION

Unemployment is a key issue for South Africa and is a critical vulnerability that could be severely worsened by climate change. Severe income distortions further limit many people's ability to build resilience to climate change impacts. Climate change and responses thereto, will affect employment, job creation and living standards and, in many instances, this affect may be negative. Vulnerable low-income households and the marginalised unemployed will face the most severe impacts unless urgent steps are taken to reduce South Africa's vulnerability to climate and economic shocks.

At the same time climate change responses that improve resilience could positively impact employment in South Africa. For example, adaptation could create new jobs to which workers can migrate from sectors affected by mitigation strategies. The climate change response will attempt to reduce the impact of job losses and promote job creation during the shift towards the new green economy.

The NGP is a clear policy signal of the intention to develop South Africa's economy in a manner that harnesses our natural resources whilst developing and expanding less carbon-intensive sectors towards a „greener' economy.

9.1 Policy outcomes

In terms of job creation, the short- to medium-term objective of the National Climate Change Response Policy is to limit employment contraction to those areas of the economy where excessive carbon intensity is considered unsustainable, whilst promoting and expanding the green economy sectors. Growth in new sectors alone will be no guarantee of net job creation and government will promote conditions that will increase the mobility of labour and capital out of carbon intensive sectors to greener productive sectors.

The medium- to long-term objective of the National Climate Change Response Policy will be to promote investment in human and productive resources and so enable sustainable growth in green sectors. Investors will be incentivised to reallocate capital to lower-carbon investments. Practical interventions will be informed by accurate assessments of the capacity of various sectors to adapt to a lower-carbon environment. Net job creation will be a key performance indicator, as well as baseline vulnerability measures and sectoral actions to improve resilience against job losses. This will enable the monitoring of and reporting on progress made.

9.2 Policy Instruments

The National Employment Vulnerability Assessment (NEVA) and Sector Jobs Resilience Plans (SJRP) will be used to move employment from a carbon intensive economy to a lower-carbon economy.

9.2.1 National Employment Vulnerability Assessment (NEVA)

The Ministry for Economic Development will publish the NEVA and so establish a National Employment Vulnerability Baseline (NEVB). The purpose of the NEVB will be to inform the prioritisation of mitigation and adaptation interventions and establish timeframes for addressing potentially vulnerable sectors.

The NEVA will assess the impact on jobs of climate change and climate change responses by sector and location to understand what job-related interventions may be required and where they may be required. The vulnerability assessments should also incorporate relevant aspects of similar assessments that may have been made in other sectors such as biodiversity, human settlements and disaster management. The NEVA will be reviewed on a regular basis that gives sufficient time for interventions to be effective but is sufficiently often to make proactive changes as and when necessary.

9.2.2 Sector Jobs Resilience Plans (SJRPs)

Informed by sectoral work carried out by, for example the Departments of Mineral Resources, Economic Development and Trade and Industry, SJRPs will explore the synergy between mitigation and adaptation strategies and the potential for sustainable net job creation in each sector. The goal will be to understand the risk relationship between technology and investment and so focus investments on sectors where government involvement and skills development will reduce initial barriers to creating jobs. As technologies show commercial viability with time and their risk profiles improve, projects may be auctioned off to investors as a test of the risk appetite of the market. The purpose will be to implement mechanisms that reduce risk, showcase alternative lower-carbon interventions, build capacity and develop skills. Such interventions will focus on public sector programmes to incentivise employment creation for those most vulnerable to climate change and will be a precursor to creating sustainable investments and jobs. These programmes include:

- Expanding existing poverty alleviation job creation programmes, such as the Expanded Public Works Programme and the National Youth Service.
- Promoting job creation incentives in new, green industries, especially targeting the youth.
- Tapping Sector Education and Training Authorities (SETAs) to aggressively develop and fund mentorship (including learnerships and internships) programmes.

9.3 Timing of Interventions

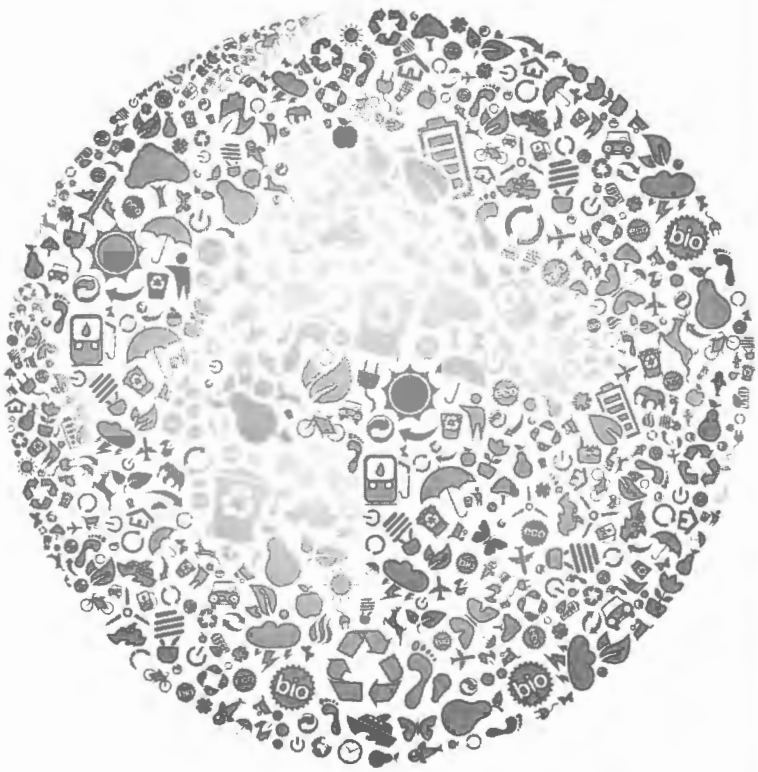
The following high-level timeline for the Climate Change Response Policy with regard to net job creation provides an overview of the strategic activities required:

9.3.1 Short-Term

- Establish links with business and industry, research bodies, institutions, NGOs and local communities that can provide relevant data and methodologies for the establishment of the NEVB.
- Develop a cooperative governance framework for establishing the capability to assess employment vulnerability, including how to determine the cost of reducing vulnerability.
- Conduct the NEVA to inform interventions required to enable a pro-jobs approach in the climate change response measures contained in the various sector plans.

9.3.2 Short- to Medium-Term

- Design a SJRP framework for a pro-jobs approach to implementing climate change response strategies.
- Develop SJRPs in consultation with stakeholders from all NEDLAC constituencies.
- Establish links with responsible Ministries to integrate the outcomes of the NEVA and SJRPs into their sector plans.
- Establish a system to monitor jobs resilience.



10. MAINSTREAMING CLIMATE-RESILIENT DEVELOPMENT

10.1 Policy and planning review and regulatory audits

Coordination and alignment of policies and actions is central to achieving climate resilience and in this respect, a comprehensive review of all government legislation, policy, strategies, plans and regulatory frameworks will underpin the successful implementation of the National Climate Change Response Policy.

The review will be undertaken in terms of Outcome 10, which forms the basis of the Minister for Environmental Affairs' delivery agreement with the President, and the purpose of the review will be to provide an implementation protocol for Output 2:

"Output 2: reduce greenhouse gas emission, climate change impacts and improved air/atmospheric quality"

Achieving climate change resilient development requires both horizontal and vertical integration of climate change into government planning, and needs to involve all sectors of society. Adaptation to climate change and mitigation of GHG emissions offer opportunities to foster a new kind of economic development that is sustainable and that will improve the distribution of resultant economic gains. The NGP, released by the Department of Economic Development, provides a significant opportunity in this regard. However this new direction requires that climate policy becomes an integral part of the country's development strategy and that economic policy tools are developed to assess the costs and benefits of proposed policy measures and to periodically evaluate policy effectiveness in terms of its economic, social and environmental impacts.

To achieve this, South Africa will:

10.1.1 Undertake an audit of existing policy and legislation to ensure alignment with the objectives of the National Climate Change Response Policy and promote the integration of climate change resilience into all sectoral planning instruments.

10.1.2 Ensure that the prioritised adaptation interventions (5.1), the benchmark national GHG emission trajectory range (6.4), sector and sub-sector desired emission reduction outcomes and CBs (6.5) and sectoral mitigation and lower-carbon development strategies are fully integrated into all relevant sector plans as and when these plans are reviewed, revised and/or updated;

10.1.3 Undertake a review of the National Climate Change Response Policy together with a review of progress in the implementation of the policy every five years. Coordinated by IGCCC, this review will describe progress, gaps and proposed adjustments in terms of, but not limited to, priorities and desired outcomes over the short-, medium- and long-term, roles and responsibilities, and institutional arrangements. The planning horizon for a revised National Climate Change Response Policy should be, at least, 40 years and should include:

- Sectoral adaptation strategies based on sectoral plans and risk analyses.
- Sector and sub-sector desired emission reduction outcomes and CBs to be reviewed on a two-year cycle.
- The identification of economic sectors that may provide increasing job opportunities and, where practical, sector-based strategies for migrating jobs from carbon-intensive sectors of the economy to lower-carbon sectors to offset possible climate change and climate change response-related job losses. See section 9 for details.
- A description of the resource requirements and how to mobilise them (section 11.1 contains details of options), and the deployment of market-based instruments (section 10.7 describes some market-based instruments options).

10.2 Roles and institutional arrangements

The consistent implementation of the National Climate Change Response Policy requires a long-term framework for institutional coordination to:

- Coordinate research and development and promote innovation.
- Coordinate adaptation and mitigation actions.
- Measure, report and verify climate change responses.
- Facilitate and promote the use of carbon trading and off-set schemes.

This section describes the roles and institutional arrangements within the public sector, and section 8.3 describes the roles of private sector partners and institutional arrangements for coordination with stakeholders.

All three spheres of government play important roles in addressing climate change.

National government takes the lead in: formulating the climate response policy; amending and promulgating legislation to deal with climate change; establishing and administering the regulatory framework for managing emission reductions; considering and implementing market-based instruments such as carbon taxes in the short-term whilst investigating the appropriateness of emissions trading schemes as a longer-term intervention; allocating resources and incentives through the Medium-Term Expenditure Framework; and participating in international negotiations on climate change. Line function National Departments will integrate climate change into their policies and programmes, and will manage Near-term Priority Flagship Programmes to build climate resilience.

10.2.1 Parliament

Parliament will oversee the development and implementation of the National Climate Change Response Policy through the Portfolio Committees, and in particular the Committees on Water and Environmental Affairs; Energy; Agriculture, Forestry and Fisheries; Trade and Industry; Mining; Science and Technology; and Transport.

The Portfolio Committees will review legislation to determine the legal requirements to support the institutional and regulatory arrangements proposed in this White Paper, and to ensure policy and legislative alignment. The Committees will work with the DEA and the IMCCC to draft any Bills, or an amendment to NEMA, that may be required within three years of the publication of this policy.

The Portfolio Committees may undertake public hearings on the National Climate Change Response Policy, and any of its components.

10.2.2 The Inter-Ministerial Committee on Climate Change (IMCCC)

The strategic, multi-faceted and cross-cutting nature of climate-resilient development requires a coordination committee at executive (Cabinet) level that will coordinate and align climate change response actions with national policies and legislation. To this end, the IMCCC shall oversee all aspects of the implementation of this White Paper.

In particular, the Minister of the Environment will chair the IMCCC, which will oversee the implementation of the National Climate Change Response Policy, including the sectoral desired emission reduction outcomes and carbon budgets development process and adaptation intervention prioritisation process. The IMCCC will mandate an interdepartmental task team, a sub-committee of the IGCCC, to manage the review of the National Climate Change Response Policy. Technical, analytical and administrative capacity to the IMCCC and interdepartmental task team will be provided by a secretariat based in the DEA. The DEA may co-opt any required skills from other Government departments (including provincial and local government), agencies or from outside government.

The secretariat will publish input assumptions, data and intermediate technical analyses undertaken during the National Climate Change Response Policy review processes on a dedicated website. The DEA will hold public consultations at key points in the National Climate Change Response Policy review process, including consultations on methodology and assumptions for any key technical analyses.

10.2.3 Forum of South African Directors-General clusters

The national climate change response actions shall be guided by strategic leadership of the relevant Forum of South African Directors-General clusters based on their different mandates: the Economic Sectors and Employment Cluster on issues that have a strong bearing of economic growth and employment creation; the Infrastructure cluster on all infrastructure-related aspects of this policy; and the International Cooperation Cluster on international engagements.

10.2.4 Intergovernmental Committee on Climate Change (IGCCC)

Chapter 3 of the Constitution enjoins government agencies to operate in accordance with the principles of cooperative government and intergovernmental relations. These include the exchange of information, consultation, agreement, assistance and support as key features of cooperative government.

The IGCCC has been established to operationalise cooperative governance in the area of climate change. Accordingly the IGCCC brings together the relevant national and provincial departments and organised local government. The IGCCC therefore has a key role to play in

the review of the National Climate Change Response Policy as well as its implementation.

10.2.5 National Disaster Management Council

The National Disaster Management Council will be responsible for ensuring that the National Framework for Disaster Risk Management provides clear guidance across all spheres and sectors of government for managing climate change-related risk and for ensuring that an effective communications strategy is in place for early warnings to vulnerable communities with respect to extreme weather events such as flooding and droughts.

10.2.6 Provincial and local government

The environment is a concurrent function between provincial and national government, and provinces will coordinate provincial adaptation and mitigation responses across their own line departments, as well as between municipalities within the province. Each province will develop a climate response strategy, which evaluates provincial climate risks and impacts and seeks to give effect to the National Climate Change Response Policy at provincial level.

Local government plays a crucial role in building climate resilience through planning human settlements and urban development; the provision of municipal infrastructure and services; water and energy demand management; and local disaster response, amongst others. Climate change considerations and constraints will be integrated into municipal development planning tools such as Integrated Development Plans, and municipal service delivery programmes.

At the same time the mandate for local government to take on various specific climate change-related issues is not always clear, and it may be useful to assign specific powers for mitigation and adaptation actions such as coastal management, infrastructure management and natural resource stewardship, some of which fall within the jurisdictions of other spheres of government. A critical review of the policy and legislation relating to local government functions and powers with respect to climate change is required.The Department of Cooperative Governance and Traditional Affairs will lead such a process.

The fiscal mechanisms to support local government capital and operating expenditures currently do not incentivise municipalities to mainstream effective climate change responses into local government activities. National Treasury will lead a process to re-examine the current fiscal measures and the appropriate incentives for adaptation and mitigation measures by local government.

Programmes to build capacity for local and provincial governments' climate response strategies will be prioritised, and a climate change toolkit will be prepared for provincial and local government practitioners.

There is a critical need for best-practice knowledge-sharing across provinces and municipalities to take advantage of innovative models in climate change adaptation and mitigation. This will be coordinated by the DEA and Department of Cooperative Governance and Traditional Affairs.

In terms of inter-governmental coordination, the Ministerial political forum (MINMEC) and Outcome 10 Delivery Forum (MINTECH) set up through the Intergovernmental Relations Act facilitate a high level of policy and strategy coherence among the three spheres of government, and will be used to guide climate change work across the three spheres.

The South African Local Government Association, as a body mandated to support, represent and advise local government action, will continue to actively participate in the inter-governmental system, and ensure the integration of climate adaptation and mitigation actions into local government plans and programmes, and lobby for the necessary regulatory measures and resources to support local government in this regard.

10.3 Partnering with stakeholders

Climate change is an issue for all South Africans and government realises that the objectives set out in this White Paper can only be fully realised with the active participation of all stakeholders. The government is committed to substantive engagement and, where appropriate, partnerships with stakeholders from industry, business, labour and civil society in a manner that enhances coordination.

10.3.1 Business and Industry

As both a significant contributor to GHG emissions and effective climate change response actions, lower-carbon products and services and "green" jobs, business and industry have a fundamental role in South Africa's climate

change response. Thus, government will continue to forge and maintain effective partnerships with business and industry to ensure that their capacity is harnessed in driving the transition to a climate-resilient, equitable and internationally competitive, lower-carbon economy and society.

Government also recognises the importance of private sector funding in achieving national climate change response actions and will work with the financial sector to explore the most appropriate mechanisms to achieve efficient funding flows.

Business and industry have already contributed to the development of the National Greenhouse Gas Inventory by voluntarily submitting GHG data to Government. It is intended to build on these voluntary initiatives to develop the mandatory reporting system for GHG emissions (see 6.7).

Government will also continue to encourage voluntary reporting initiatives established and maintained by a variety of organised business associations.

10.3.2 Civil Society

The role of citizens and organised groupings within civil society are important to the success of a national effort. Civil society needs to critically evaluate, comment on and respond to the initiatives of government and the private sector. They must continue to raise public awareness, and motivate individuals, institutions and authorities to take actions that reduce GHG emissions and that adapt to the adverse impacts of climate change. Civil society organisations that work directly with communities and particularly with the urban and rural poor and with women are an important conduit for ensuring that climate information is timeously communicated and to inform government and research institutions of vulnerable groupings' climate change-related issues.

10.3.3 Academia and scientists

The climate change science and academic community must work together to improve projections of climate change, its impacts, key vulnerabilities in affected sectors and communities. They need to explore appropriate mitigation and adaptation responses; continue to build capacity in climate change science; and inform government and the public of climate change-related socio-economic challenges and opportunities.

10.4 Coordination Mechanisms

The following mechanisms will be used to coordinate climate change activities and consult on climate change policies with stakeholders:

10.4.1 National Committee on Climate Change (NCCC)

The NCCC has been set up to consult with stakeholders from key sectors that impact on or are impacted by climate change. The Committee advises on matters relating to national responsibilities with respect to climate change, and in particular in relation to the UNFCCC and the Kyoto protocol. It also advises on the implementation of climate change-related activities.

Government will consider proposals for increasing the functions of the NCCC beyond the current communication function and to formalise its status as an advisory council with statutory powers and responsibilities.

10.4.2 National Economic Development and Labour Council (NEDLAC)

NEDLAC serves as the forum where government comes together with organised business, labour and community groupings on a national level, and this platform will ensure that climate change policy implementation is balanced and meets the needs of all sectors of the economy. NEDLAC has indicated that climate change should be a key component of its agenda.

10.5 Communication and behaviour change

Developing climate resilience requires all of us to change our behaviour and become conscious of our individual carbon footprints. A nuanced approached to communication will be followed, recognising that a communication strategy aimed at individuals and communities with the largest carbon footprints (the urban wealthy) needs to be very different from a communication strategy aimed at the individuals and communities most vulnerable to climate change impacts (the rural poor). It is also recognised that people will only make climate-friendly decisions if they have convenient, reliable and safe climate-friendly alternatives and if they know about these options.

One of the important communication challenges is to disseminate information to interested and affected people

as quickly as possible and to ensure that the information is in a format that is accessible and useful to the target audience. This is especially important for early warning systems where people need to take specific actions to reduce risks to themselves, their households and property.

To meet these challenges, South Africa will:

10.5.1 Empower all residents with information about the potential impacts of climate change and climate change resilience actions, emphasising the information needs of those most vulnerable to climate change.

10.5.2 Ensure that all relevant climate change information systems implement effective communication strategies to ensure that information reaches the target audiences efficiently and effectively. This includes exploring and developing new and novel ways of communicating, especially to people who are illiterate and/or have no access to telephonic or other forms of electronic communication.

10.5.3 Ensure that all government climate change response strategies and actions plans include sections on education, awareness, outreach and human resource development.

10.5.4 Design, develop and roll-out a climate change awareness campaign that make all South Africans more aware of the challenge of climate change and the need for appropriate responses and choices at individual and community level.

10.6 Regulatory measures

Sectoral legislation already provides an extensive regulatory framework for the actions of Government departments, agencies, business and civil society. To ensure that climate change considerations and the climate change responses outlined in this White Paper are fully mainstreamed into the work of all three spheres of government, all Government departments and all state-owned enterprises will review the policies, strategies, regulations and plans falling within their jurisdiction on a regular basis to ensure full alignment with the National Climate Change Response Policy.

Local government plays a particularly important role in implementing adaptation and mitigation actions, some of which extend beyond the existing Constitutional and legislative mandate of local government. In the review process mentioned above, particular attention will be paid to local government legislation, and the Department of Cooperative Governance and Traditional Affairs will lead a review of local government legislation in this regard.

South Africa will use Section 29(1) of the Air Quality Act to manage GHG emissions from all significant industrial sources (those responsible for more than 0.1% of total emissions for the sector) in line with approved mitigation plans that conform to the Act's requirements for pollution prevention plans prepared by identified industries and sectors. The synergy between prevention measures to reduce conventional air pollutants and GHG mitigation will be used in a holistic approach to manage air quality.

10.7 Market-based instruments

In 2006, Government published a draft Environmental Fiscal Reform Policy Paper entitled A *Framework for Considering Market-Based Instruments to Support Environmental Fiscal Reform in South Africa.* This policy paper recognised the role for environmentally-related taxes to complement existing regulatory policy interventions and address environmental problems such as climate change. Government has since introduced the following climate change-related measures: the electricity generation levy; motor vehicle emissions tax; the levy on incandescent light bulbs complemented by a range of tax incentive measures to support renewable energy investments (depreciation allowances for renewable electricity generation and biofuels production); investments in projects under the Clean Development Mechanism (CDM) (that is, income tax exemption for revenues from the sale of certified emission reduction units resulting from CDM projects); biodiversity conservation and management; and the proposed energy efficiency savings tax allowances. As part of the process of exploring more comprehensive reforms for addressing climate change, the National Treasury published the carbon tax discussion paper entitled *Reducing Greenhouse Gas Emissions: The Carbon Tax Option* for public comments in December 2010. The paper elaborated on the role for carbon taxes as a policy measure to stimulate behaviour changes among producers and consumers in favour of less energy intensive, lower-carbon emitting alternatives.

10.7.1 Carbon Pricing

In economic terms, environmental resources can be largely classfied as a "public good" which are accessible by all and can be consumed in infinite quantities. Climate change and

its effects are the result of GHG emissions that impose external costs or an "externality" on society. In most cases, these negative external damage costs of an economic activity are not reflected in the prices of goods and services, often resulting in their under-pricing and an over- or mis-allocation of resources.

Accordingly, the prices of environmental goods and services that generate excessive levels of GHG emissions should be adjusted to reflect the full costs of production and consumption. Carbon taxes can help to internalise these negative externalities and create the correct incentives to stimulate behavioural changes among producers and consumer in favour of cleaner, lower-carbon technologies, promoting the uptake of energy efficiency measures and research, development and technology innovation.

In this context, the National Treasury will continue to develop carbon tax policy and the following key considerations will inform this process:

- The tax rate should, over time, be equivalent to the marginal external damage costs of GHGs to affect appropriate incentives. However, in the absence of an international climate change agreement and therefore a global emissions pricing system, a partial, rather than full, internalisation of the externality will be considered as an interim measure.
- Technical and administrative feasibility – consideration will be given to whether the tax applies to carbon emissions or a proxy for such emissions (e.g. fuel inputs or outputs). Should a proxy tax base be used, the levy of the tax according to the carbon content of fossil fuels will be considered.
- Distributional implications – measures will be taken, either in tax design or through complementary expenditure programmes, to offset the burden such a tax will place on poor households.
- Competitiveness – to address potential negative impacts on industry competitiveness, the introduction of carbon taxes at initial low rates with a commitment to phased-in increasing levels of taxation over a specific period will be considered; which would grant taxpayers an opportunity to adjust to the new tax.
- A phased implementation of the tax towards comprehensive coverage of all economic sectors is believed to be desirable and will be considered.
- The minimisation of the potential regressive impacts on the poor and the protection of the competitiveness of key industries will be considered. Furthermore, revenue recycling to minimise the costs of the tax through, for example, some form of tax shifting will be considered. However, although the full earmarking of revenues is not regarded as being in line with sound fiscal policy principles, some form of on-budget funding for specific environmental programmes will be considered.
- Relief measures, if any, will be considered by these will be regarded as being minimal and temporary.

Although a carbon tax does not set a fixed quantitative limit on GHG emissions over the short-term, such a tax - at an appropriate level and phased-in over a period to the "correct" level - will provide a strong price signal to both producers and consumers to change their behaviour over the medium- to long-term. The National Treasury's carbon tax policy will seek to primarily stimulate behaviour change through the price mechanism, and as a secondary benefit, generate a revenue stream that may allow fiscal decisions over time that support climate change policy and broader sustainable development objectives.

10.7.2 Carbon Markets

Carbon markets are mechanisms for exchanging emission reductions between entities, thereby optimising efficiency and minimising cost in controlling pollution levels. They include both cap-and-trade mechanisms (in which mandatory limitations on emissions create markets in which polluters trade emissions allowances) and offset schemes where actors voluntarily pay compensation for emissions.

In respect of carbon markets, the National Treasury will investigate the feasibility of an emissions trading scheme as a medium- to long-term response to climate change.

10.7.3 Incentives

Incentives, including regulatory, economic and fiscal measures, encourage and reward efforts to curb GHG emissions. They can apply to a broad range of sectors. Some existing incentives include lower fuel taxes on cleaner fuels and energy efficiency incentives. Further incentive measures will be explored as part of a suite of policy instruments to promote climate resilience, including job creation incentives in new, green industries, especially for the youth.

Government recognises the important role for market-based instruments that create fiscal incentives and disincentives to support climate change policy objectives. Thus, South Africa will employ market-based instruments as part of a suite of policy interventions to support the transition to a lower-carbon economy. These instruments will be designed to incentivise behaviour change at the individual, institutional and macro-economic levels for a climate-resilient South Africa contributing to a diversification of our energy mix, drive people to implement far-reaching energy efficiency measures, achieve passenger modal shifts, and generate investments in new and cleaner technologies and industries.

11. RESOURCE MOBILISATION

Responding to climate change is expensive and will require a comprehensive resource package. South Africa is therefore committed to mobilising the resources that are necessary for both mitigation and adaptation. This includes financial resources, technical cooperation and technology transfers at domestic, sub-regional, regional, and international levels.

Estimates for the cost of responding to climate change indicate that between 1% to 2.5% of global GDP will need to be spent on mitigation and 1.5% to 3% of GDP in Africa will need to be spent on adaptation by 2030. Impacts (and benefits) will be unevenly distributed across countries and between sectors. The cost of adaptation is likely to increase in future years.

South Africa's resource mobilisation strategy will be informed by the mainstreaming of climate change into the planning and decision-making of government, private sector and civil society. Government aims to:

- Create an enabling environment whereby government, private sector and civil society collectively respond to the economic and social changes necessary for climate-resilient development and job creation, providing for the economic and social upliftment of the people of South Africa, while minimising negative impacts on future development.
- Promote the green economy as an effective investment in climate change response and secure resources to support climate change and green economy interventions.
- Consolidate and extend existing initiatives towards a climate-resilient economy. Thus, the Near-term Priority Flagship Programmes mentioned in section 8 will form the foundation for the next phase in the transition to a lower-carbon and climate-resilient economy and society. However, Government will endeavour to continuously evaluate its priorities to adjust to the dynamic nature of the socio-economic transformation envisaged.

11.1 Finance

As a developing country, South Africa recognises that international resources (as envisaged under the UNFCCC) need to complement domestic resources to finance the cost of transition to a climate-resilient society. Hence, Government will actively pursue the mobilisation and effective use of these international resources.

Further, Government recognises that improved finance policy coordination is critical to creating a sustainable climate finance architecture for South Africa. New market-based instruments as well as environment-related financial reforms in the private and public sectors will seek to fundamentally transform South Africa into a climate-resilient economy and society.

11.1.1 The role of financial institutions

South Africa recognises that financial institutions are important intermediaries to allocate and transfer capital between different economic activities. Government acknowledges and supports initiatives by the South African banks to integrate environmental considerations into their decision-making frameworks. The different distribution channels in the financial system, such as public finance, banks (including development finance and microfinance institutions), investors and insurers, are important development partners for Government in the following ways:

- Public finance can support climate change through the procurement of sustainable technologies by Government as well as developing catalytic projects and programmes.
- The development finance system in South Africa is critical to integrating development with climate change. Development finance institutions, such as the Development Bank of Southern Africa (DBSA), Industrial Development Corporation, Land Bank and Khula Enterprises can incubate climate-resilient development. This is particularly true for climate-proofing of infrastructure and industrial processes; designing and testing new financing instruments; localising and rolling out of sustainable technologies; and unlocking new economic opportunities through enterprise development and job creation. Further, these institutions serve an important role in building technical capacity and knowledge platforms to mobilise action at regional, provincial and local level.
- Private banks and microfinance institutions support a range of corporate and entrepreneurial ventures that could contribute to climate change resilience.

- Investors such as asset managers, venture capital and private equity firms are essential for both long-term and early-stage investments.
- Insurers are essential for risk mitigation and innovative climate change-related products.
- International and corporate grant-providers are necessary to support the comprehensive financing package necessary for the scale of mitigation and adaptation interventions that South Africa needs.

Different types of financial institutions should work together in a coordinated manner to blend different forms of capital.

11.1.2 Mobilising finance

The emerging climate change response finance options include grants for research and development; project development and technical cooperation; and commercial finance through debt and equity, concessionary finance, risk insurance, specialised environmental funds and new capital market innovations, such as green and climate bonds. These options may be extended by integrating financing for biodiversity and other environmental resources, such as payment for ecosystem goods and services, for example. By necessity, South Africa's climate finance strategy will comprise a comprehensive suite of measures to create and maintain a long-term funding framework for mitigation and adaptation actions and to trigger swift and urgent action towards climate-resilient development.

Government will:

11.1.2.a Continue to proactively contribute to the technical and institutional reform debates of the UNFCCC financing measures to ensure that developing and least-developed countries such as those in the Southern African Development Community region can access the additional and necessary resources in a fair, transparent and timely manner.

11.1.2.b Make every effort to attract and secure additional international resources through official development assistance and bilateral development agencies. Government will ensure that such climate change-related contributions are directed to national, provincial and local government development priorities.

11.1.2.c Create a transitional climate finance system to support the implementation of the priority mitigation and adaptation actions identified in sections 5 and 6. See section 11.1.3 for details.

11.1.2.d Create a transitional tracking facility for climate finance mechanisms and climate responses that will monitor and coordinate existing climate finance flows.

11.1.2.e Partner with domestic financial institutions to fast-track and mainstream climate-resilient development (i.e. mitigation and adaptation).

11.1.2.f Support donor organisations in their efforts to apply funding towards climate change-related pilot programmes and activities.

11.1.2.g Promote the development of, and investment in, a climate-resilient region and work with regional partners to create and maintain interdependent economic and social opportunities that reduce the region's dependency on climate vulnerable sectors.

11.1.3 The Immediate Transition

During the immediate transition period between the publication of this Policy and the evolution of appropriate climate financing systems and institutions, Government will establish an interim climate finance coordination mechanism to secure the necessary resources for mitigation and adaptation priority programmes identified in sections 5, 6 and 8. The mechanism will match the resources to the priority programmes, including grants, concessionary debt and risk insurance products.

The mechanism will also contain a climate finance tracking facility to track the use and impact of funds. Government will determine the terms of reference for the mechanism in consultation with the private sector and civil society.

The National Treasury will identify the initial custodian of the coordination mechanism.

11.1.4 Financing the National Climate Change Response Policy

Stable, well governed institutions are critical to funding South Africa's transition path to climate-resilient development. In pursuit of a long-term funding framework for climate finance, Government will:

11.1.4.a Promote fair, transparent and timely access to international and domestic resources for both mitigation and adaptation actions by the public and private sectors as well as civil society.

11.1.4.b Mainstream climate change response into the fiscal budgetary process and so integrate the climate change response programmes at national, provincial and local government and at development finance institutions and state-owned entities.

11.1.4.c Enable the local development finance institutions to create and implement long-term climate-resilient investment programmes. This includes project development, financial and risk insurance products, technical assistance and capacity-building within their mandates.

11.1.4.d Identify opportunities in the existing financial regulations governing the domestic finance sector to enhance the financial sector's capacity to mainstream climate change in risk and investment decisions.

11.1.4.e Establish and/or support public platforms to assimilate and disseminate climate science, finance, technology and other related research and information to enable effective decisions about risk and investment.

11.1.4.f Develop a climate finance strategy that contextualises and integrates existing and emerging policy and financing instruments, including addressing the role of market-based measures to achieve the desired economic and social changes.

The Ministers of Finance, Economic Development, and Water and Environmental Affairs will appoint a multi-stakeholder working group to oversee the realisation of these actions within three years of the publication of this policy.

11.2 Education

Climate change is a relatively new issue that has cross-disciplinary and cross-sectoral implications in South Africa. Understanding the concept as well as the options to mitigate it and adapt to it is fundamental to future development pathways and the wellbeing of South African society. This will require systematic interventions to empower and capacitate people. We need to mainstream climate change knowledge into education and training curricula. Climate change education should be part of the broader framework of education for sustainable development, and should equip South African citizens to re-orient society towards social, economic and ecological sustainability.

To meet this challenge, South Africa will:

11.2.1 Ensure that a holistic understanding of climate change and related issues (specifically the required response to climate change) is included in all relevant aspects of formal education curricula. This will prepare future generations for a rapidly changing planet and the transition to a lower-carbon society and economy.

11.2.2 Include climate change elements in the review of the National Skills Development Strategy and ensure that all SETAs add climate change to priority skills development programmes in the formal, informal and non-formal sectors of the education and training system. This will be accompanied by requisite resource reallocation.

11.2.3 Establish incentives for research and training such as bursaries to encourage students and scholars to research and study climate change.

11.2.4 Ensure that the building of knowledge and expertise in new and emerging economic sectors is considered in all tertiary education curricula and relevant formal and informal training.

11.2.5 Establish a robust research agenda that, amongst others, focuses on quantitative research on the labour requirements for the green transition as well as on other societal adaptation strategies and needs.

11.2.6 Encourage tertiary and research institutions to develop national monitoring, reporting and verification guidelines for a climate-resilient South Africa. These guidelines would focus on mitigation and adaptation actions such as land-use practises and change.

11.3 Science and technology development

South Africa needs a robust and highly functional climate change science and technology platform to enable the development and implementation of appropriate actions to minimise the negative impacts of climate change on

the economy and the people of South Africa. With such a platform, South Africa can become a significant global player in the green economy. More specifically, South Africa should aim to be a leading supplier of climate change knowledge, technologies and services.

- The decision at a national level to adopt innovations depends on the benefits users expect from the innovations as well as on the expected costs to research and master them. In addition, a country needs the technological capability to imitate, adapt and absorb foreign technologies into local productive activities. This capability influences the relative costs and benefits of adopting new technologies.
- For South Africa to enhance its international competitiveness in climate change response science and technology, it needs sound science, a robust technology base and sound human capital in this arena. To achieve this vision, the following measures will be implemented:

11.3.1 Highly informed decision-making

A new governance arrangement will be instituted comprising a Chief Scientific Advisor to the Minister of Science and Technology. The Minister of Science and Technology, with the advice of the Chief Scientific Advisor, will establish and constitute a Scientific Advisory Council. The Council will consist of a wide range of expertise to cover the spectrum of South Africa's climate change response requirements. The Chief Scientific Advisor will chair this Council. The Advisory Council will produce a biennial report to the Cabinet on the state of climate change science and technology in South Africa. It will be developed into an institution with a good international record that can give scientific advice and it will bring the scientific community closer to decision-makers and implementers.

11.3.2 Medium- and long-term planning

An analysis of the state of climate change science and technology reveals that the current scientific output, technology development, intellectual property and the pool of high level skills are inadequate to support a robust climate change response. Because the response to climate change is so complex, Government and the scientific community will conduct a climate change foresight exercise. Such an exercise will deliver the following:

- A human capital development plan for climate science and technology informed by the country's climate change response requirements and the outcomes of the National Employment Vulnerability Baseline and Assessments as well as the Sector Jobs Resilience Plan.
- A complementary science and technology plan for climate change in partnership with the Department of Science and Technology (DST).
- A climate change technology roadmap.

To address the funding needed to support climate change research and development, the DST will conduct a feasibility study into the development of a specialised funding agency: the Climate Change Science Council. In parallel to this study, the DEA will engage the relevant partners in the DST, National Research Foundation (NRF), the Technology Innovation Agency and the DTI to develop the following R&D funding instruments:

- Climate Change Research Chairs in the family of the DST/NRF South African Research Chairs Initiative.
- A Climate Change component within the current NRF-administered Technology and Human Resources and Innovation Programme sponsored by the DTI.
- Climate Change Centres of Excellence to develop much higher levels of climate change science and produce more PhDs and Post-Doctoral fellows in this area and to develop intellectual property and technologies that will make South Africa a global leader in climate change science.
- Research and innovation partnerships in the area of climate change resilience.

11.3.3 Technology transfer

Technology transfer continues to be very prominent in the multilateral environmental agreements in general, and in climate change-related agreements in particular. A national capacity to optimally engage climate change-related technology for South Africa, both as a recipient as well as donor to other developing countries, will be developed.

12. MONITORING AND EVALUATION

Measurement and monitoring of climate change responses is critical to ensure their effective implementation. South Africa's efforts in this regard will be coordinated through the cooperative governance mechanisms reflected in section 10. The DEA as the responsible coordinating department will define review mechanisms as well as a process to develop this White Paper into a suite of regulatory and legislative instruments where required.

12.1 Monitoring Climate Change

Given the nature and implications of climate change and the economic and social implications of effective climate change responses, decisions must be based on accurate, current and complete information in order to reduce risk and ensure that interventions are effective. South Africa will:

12.1.1 Ensure that nation-wide climate change and atmosphere monitoring systems are maintained and enhanced where necessary, including through monitoring networks at appropriate spatial density and frequency that monitor, among others, rainfall, ambient air temperature, humidity, soil moisture, wind and solar radiation, lightning, extreme weather event characteristics and their impacts, selected atmospheric GHGs, gas fluxes from selected vegetation, soil and marine carbon pools, sea levels, sea surface temperature, ocean current behaviour and acidity. Data analysis, synthesis, archiving, interpretation and dissemination will be a key component of this effort.

12.1.2 Ensure that climate change impacts are monitored at appropriate spatial density and frequency, where feasible, of changes in spatial distribution and incidence of climate-sensitive diseases; ecosystems and the goods and services they supply; key species responses (including invasive alien species); wildfire hydrology and water resources; and agricultural and forestry production.

12.1.3 Establish a monitoring system for gathering information (with bottom-up inputs where possible) and reporting progress on the implementation of adaptation actions.

12.1.4 Identify the key role-players involved in monitoring and measuring these indicators. Describe how these role-players will share and report information on observed climate change.

12.1.5 In line with internationally agreed reporting requirements, include a summary of climate change impacts and adaptation actions in the National Communication, which highlights new areas of concern and areas in which observations do not align with modelled projections.

12.2 Medium- and long-term modelling

Adaptation requires proactive interventions that minimise projected climate change impacts. To achieve this, medium- and long-term climate projections that represent the full range of possible climate outcomes must be available. They include the risk and scale of projected impacts, the costs and benefits of possible responses, and the risks of their failure. Because local authorities will plan and implement many of the climate change responses, predictions need to be at a level that they can use. To this end, South Africa will:

12.2.1 Within two years of the publication of this policy, finalise, publish and start implementing the 10-year Global Change Research Plan for South Africa, especially those elements of the plan that increases South Africa's modelling capacity for climate and impacts projections and vulnerability assessments.

12.2.2 Within two years of the publication of this policy, compile and publish a strategy to continuously update and maintain the SARVA, using the full range of medium- and long-term climate modelling results and the full range of possible risks.

12.2.3 Within two years of the publication of this policy, develop and pilot a methodology to downscale climate information and comprehensive impact assessments to specific geographical areas, including provinces and municipalities. This methodology will avoid inappropriate treatment of fine-scale information as indicating greater certainty in climate outcomes, allow for plans that can respond to unfolding climate trends, and lower the risk of mal-adaptation.

12.2.4 Roll out the downscaling work within two years of the publication of this policy onwards, with appropriate monitoring and evaluation safeguards.

12.2.5 Ensure that all National Communications submitted as part of South Africa's UNFCCC commitments contain the most up to date medium- and

long-term modelling results and appropriately downscaled risk and impact assessments.

12.3 Monitoring responses

To monitor the success of responses to climate change and to replicate the ones that have worked well, we need to measure their cost, outcome and impact. To this end, South Africa will, within two years of the publication of this policy, design and publish a draft Climate Change Response Monitoring and Evaluation System. The system will evolve with international measuring, reporting and verification (MRV) requirements.

12.3.1 An outcomes-based system

Monitoring and evaluation of the Country's climate change programme shall be undertaken through the outcomes-based system that the Presidency has established and shall be reported through the delivery forums for these outcomes. As part of its overall responsibility to review progress across government and across the outcomes, the Department of Performance Monitoring and Evaluation in the Presidency will make sure that climate change implementation is properly integrated across Government. Reporting on climate responsibilities and adaptation measures will consequently be integrated into the Programme of Action and the Ministerial delivery agreements, as well as the quarterly reporting requirements of government at all levels. Key outcomes include:

- Outcome 4: Decent employment through inclusive growth;
- Outcome 5: A skilled and capable workforce to support an inclusive growth path;
- Outcome 7: Vibrant, fair and sustainable rural communities and food security for all;
- Outcome 8: Sustainable human settlements and an improved quality of household life;
- Outcome 9: Responsive, accountable, effective and efficient local government system;
- Outcome 10: Environmental assets and natural resources that are well protected and continually enhanced;
- Outcome 11: Creating A better South Africa and Contributing to a Better (and Safer) Africa and a better World;

12.3.2 Mitigation

South Africa's climate change mitigation interventions will be monitored and measured against the National Emissions Trajectory Range (see section 6.4).

Furthermore, the implementation of objectives and measures specified in the Carbon Budget and sectoral mitigation strategies will be measured, reported and verified to assess progress in their implementation. The Climate Change Response Monitoring and Evaluation System will assess indicators defined in the Carbon Budget and sectoral mitigation strategies (see section 6.5), which may include indicators of implementation, local sustainable development benefits and the impact of programmes and measures on emissions. The monitoring process will be implemented through sectoral implementation mechanisms, and will be coordinated and overseen by the DEA, which will publish the outcomes of the monitoring process annually.

An international climate deal is likely to include an international MRV system that will monitor and report on mitigation actions in developing countries. South Africa will use the National Communication reporting requirements of the UNFCCC for this.

13. CONCLUSION

Amongst a range of environmental constraints that are of necessity playing an increasing role in social development planning, climate change represents the most urgent and far-reaching challenge of our time. While every country will have to develop its own adaptive responses to the effects of climate change, mitigating climate change to ensure the disruption caused to human and natural systems is within manageable parameters can only arise out of a global response. Furthermore, responding to climate change is a cross-generational challenge. The effects of action or inaction will not be felt immediately, but will have significant consequences for future generations.

It is within this context, and informed by an appropriate sense of urgency, that the South African government has developed this National Climate Change Response Policy. The current plan represents the first iteration of South Africa's ongoing efforts to adapt to climate change and contribute to the global mitigation effort. In terms of our contribution to the global mitigation effort, the decision to institute sectoral desired emission reduction outcomes and carbon budgets is momentous – it represents a concrete and practical commitment by South Africa.

Realising this commitment will require sustained effort and cooperation from all spheres of government, the private sector and civil society formations, and ultimately will depend on decisions by individual citizens to embrace climate-friendly lifestyles and habits. Everyone is a stakeholder in this plan, and the level of engagement from the public in the process of drafting the National Climate Change Response suggests that there is no shortage of the requisite will to make the far-reaching changes that are required. Government wishes to thank all stakeholders for their contributions to this process, and more importantly, for their commitment to building a climate-resilient South Africa for the current and future generations.

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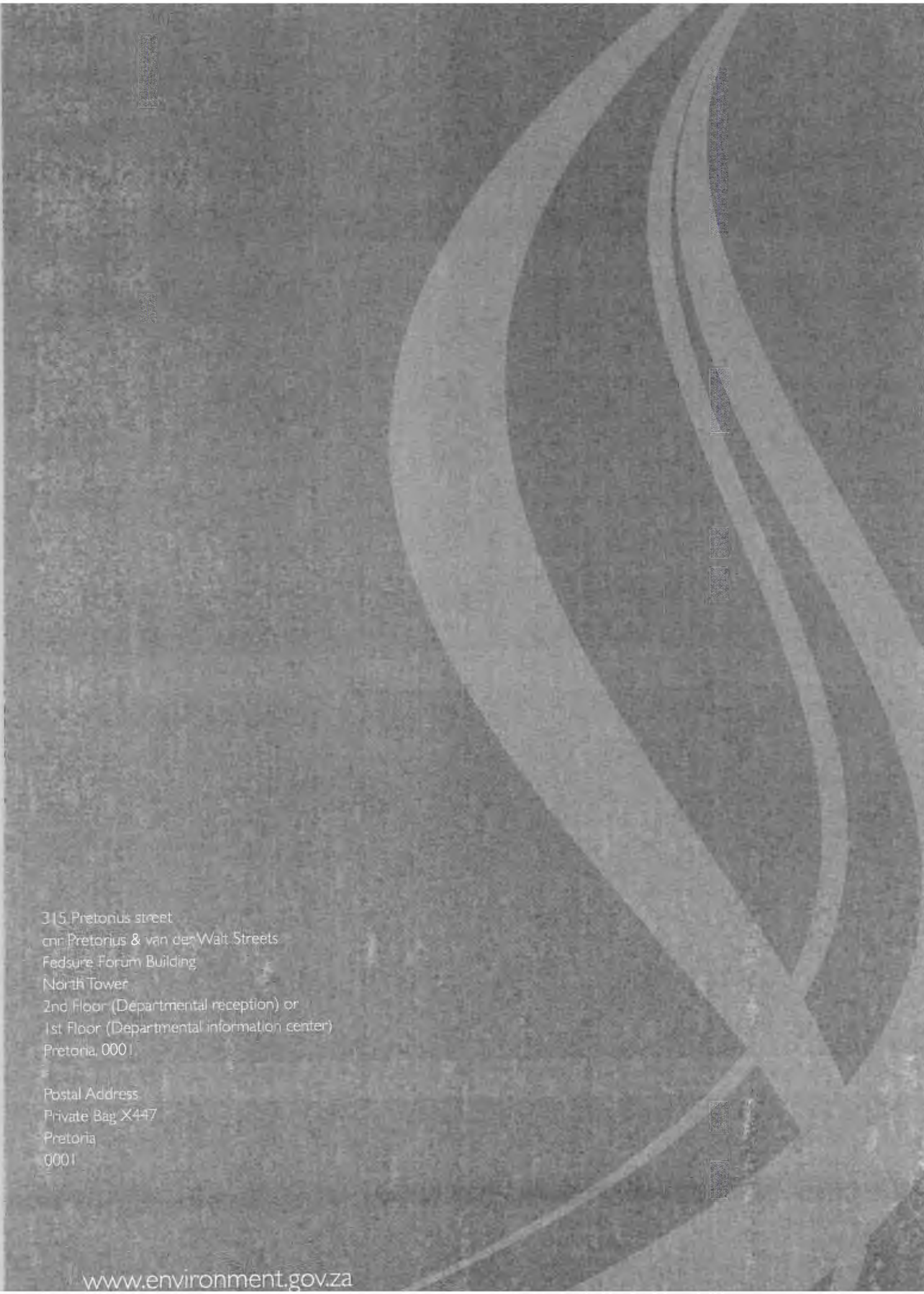

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A NATIONAL CLIMATE CHANGE RESPONSE STRATEGY

FOR SOUTH AFRICA

September 2004

DEPARTMENT OF ENVIRONMENTAL AFFAIRS AND TOURISM

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EXECUTIVE SUMMARY

Global climate change is possibly the greatest environmental challenge facing the world this century. Although often referred to as 'global warming', global climate change is more about serious disruptions of the entire world's weather and climate patterns, including impacts on rainfall, extreme weather events and sea level rise, rather than just moderate temperature increases. The developing world faces greater challenges than the developed world, both in terms of the impacts of climate change and the capacity to respond to it.

Concerned with the implications of global climate change, several governments came together in 1988 and formed the Intergovernmental Panel on Climate Change (IPCC). This led to the United Nations Framework Convention on Climate Change (UNFCCC), which was tabled in 1992 at the United Nations Conference on Environment and Development. The stated objective of the UNFCCC is to achieve stabilisation of the concentrations of greenhouse gases in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. The South African Government ratified the UNFCCC in August 1997.

It was soon recognised that the commitments set out in the UNFCCC were inadequate for achieving its ultimate objective and this led to the adoption of the Kyoto Protocol in 1997, after much international negotiation. The South African Government acceded to the Kyoto Protocol in July 2002. In order to fulfil the requirements of the UNFCCC, South Africa has prepared an Initial National Communication to the UNFCCC, in accordance with Article 12 of the Convention. In addition, detailed South African Country Studies reports have been compiled on a sectoral basis. Using the results of this work, together with information from the IPCC Third Assessment Report, the Department of Environmental Affairs and Tourism has developed a national climate change response strategy.

The objective of this strategy is to support the policies and principles laid out in the Government White Paper on Integrated Pollution and Waste Management, as well as other national policies including those relating to energy, agriculture and water.

The strategies outlined in this document are designed to address issues that have been identified as priorities for dealing with climate change in South Africa. Whereas the national strategy must recognise international realities, including the growing pressure for quantified commitments of some kind by developing countries, including South Africa, it must be seen within the context of the present economic realties of the country and the inequitable distribution of global wealth. Thus the point of departure reflected in this strategy is achievement of national and sustainable development objectives, whilst simultaneously responding to climate change.

To this end, the strategy highlights the following as key issues and problems:

Supporting national and sustainable development

Sustainable development can be defined as development which meets present needs without compromising the ability of future generations to meet their needs. It encompasses the social, environmental and economic dimensions of development. Thus South Africa's position is to view climate change response as offering just one specific avenue of opportunity for achieving the sustainable development objectives of the national policies and legislation that are concerned with both development and environment issues. At the same time, international action on climate change can be viewed as a significant vehicle to redress the historic, inequitable and unsustainable north/south divide of the world's economy and prosperity. In support of this objective, South Africa's national climate

change response programme strongly supports the New Partnership for African Development initiative. There are many benefits to be derived in integrating climate change response programmes across national and regional boundaries, to serve common areas of interest and to maximise the utility of available resources.

Adapting to Climate Change

According to the IPCC Third Assessment Report, climate change is already happening, and will continue to happen even if global greenhouse gas emissions are curtailed significantly in the short to medium term. There is now more confidence that global climate change is a threat to sustainable development, especially in developing countries, and could undermine global poverty alleviation efforts and have severe implications for food security, clean water, energy supply, environmental health and human settlements. Acknowledging the overall vulnerability of South Africa to climate change impacts, it will thus be necessary to carry out adaptation measures in this country. The South African Country Studies Programme identified the health sector, maize production, plant and animal biodiversity, water resources, and rangelands as areas of highest vulnerability to climate change and these are the areas that need to be targeted for adaptation measures. With regard to vital industries, the mining and energy sectors are particularly vulnerable to climate change mitigation measures. Further, the South African economy is vulnerable to the possible response measures implemented by developed (annex 1) countries, since the economy is highly dependent on income generated from the production, processing, export and consumption of coal. This vulnerability extends across virtually all facets of the mining and energy sectors.

Developing a sustainable energy programme

South Africa, as a non-annex I country, is not required to reduce its emissions of greenhouse gases. However, the South African economy is highly dependent on fossil fuels and the country can be judged to be a significant emitter due to the relatively high values that can be derived for emissions intensity and emissions per capita. Such calculations put South Africa as one the world's top 15 most energy intensive economies, with a significant contribution to greenhouse emissions at a continental level. There could be benefits to be derived from adopting a future strategy that is designed to move the economy towards a cleaner development path. This will require continued attention to the process that is currently being developed to access investment through the Clean Development Mechanism of the Kyoto Protocol, technology transfer and donor funding opportunities. However, even given this scenario, emissions can still be expected to increase with economic development, albeit at a smaller pace than would have happened without intervention. The Department of Minerals and Energy has developed a white paper on renewable energy and clean energy development, together with an energy efficiency programme, to support diversification towards a less carbon intensive energy economy.

Meeting international obligations

South Africa, as a signatory to the UNFCCC, has to fulfil certain obligations including:

- Prepare and periodically update a national inventory of greenhouse gas emissions and sinks.
- Formulate and implement national and, where appropriate, regional programmes to mitigate climate change and facilitate adequate adaptation to climate change.
- Promote and cooperate in the development, application and diffusion of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases.
- Promote sustainable management, and promote and cooperate in the conservation and enhancement of sinks and reservoirs of all greenhouse gases.
- Cooperate in preparing for adaptation to the impacts of climate change.

- Take climate change considerations into account in the relevant social, economic and environmental policies and actions with a view to minimising adverse effects on the economy, on public health and on the quality of the environment.
- Promote and cooperate in scientific, technological, technical, socio-economic and other research, systematic observation and development of data archives related to the climate system and intended to further the understanding and to reduce or eliminate uncertainties.
- Promote and cooperate in the full, open and prompt exchange of relevant scientific, technological, technical, socio-economic and legal information related to the climate system and climate change.
- Promote and cooperate in education, training and public awareness related to climate change.

The integration of climate change response in government

Although the Department of Environmental Affairs and Tourism has been designated as the lead agency for climate change response in South Africa, it is recognized that this is a cross cutting issue that has ramifications for diverse activities in other government departments. A national climate change strategy will thus require that many government departments work together in a coordinated manner, to ensure that response measures are properly directed, acceptable to all and carried out with a national focus. General awareness within government on the likely impacts of climate change is somewhat limited in those departments not directly involved with the issue. In order to adapt to climate change, and to prepare adequately for the likely impacts, capacity has to be built. This will ensure that the policies formulated will adequately address climate change adaptation. Further, it is important that the available skills and competencies within government are efficiently harnessed. Officials in other departments, within all spheres of government, often do not see climate change as a priority and some even see it as working against national development priorities. They are concerned that South Africa has a huge backlog of service delivery where the performance of each department is measured by how effective and efficient it is on service delivery. Therefore climate change needs to be addressed in such a way as to assist these departments to achieve their service delivery objectives i.e. through so-called "win-win" or "no regrets" measures.

Domestic legal obligations

South Africa currently has a number of laws relating to the protection and management of the environment. The overarching legislation is contained within the provisions of the National Environmental Management Act of 1998. Climate change is referred to explicitly in the White Paper on Integrated Pollution and Waste Management of 2000, and referenced in the White Paper on a National Water Policy for South Africa, 1997. It is also specifically addressed in the Government's imminent National Water Resource Strategy. Climate change is not addressed in current air quality legislation. The impending National Environmental Management: Air Quality Act will, however, specifically contain provisions for greenhouse gas emissions.

Climate change related education and training

Climate change is a relatively new issue in South Africa due to the prior isolation of this country from international events. Education, training and public awareness thus lag behind the requisite standards. The raising of public awareness on climate-related issues is promoted by the government through the Department of Environmental Affairs and Tourism (DEAT) and the South African Weather Services. Presentations and exhibitions are used as a mechanism to promote awareness of climate change, for example through the National Atmospheric Week, World Environment Day and World Meteorological Day promotions. Publications, such as the Environmental Education fact sheets, are produced by DEAT, and highlight important environmental issues.

Research development and demonstration

Technological change holds the key to meeting long-term climate change challenges. Climate change research needs to be properly coordinated and the benefits optimised to meet the needs of policy makers in South and Southern Africa. Attention needs to be focussed on projects that will assist with mitigation of, and adaptation to, climate change and address specific areas of vulnerability. Further, development and demonstration projects are required to show the advantages and acceptability of a variety of technologies related to climate change. Where appropriate, relevant local research should be structured to support the work of IGBP and the IPCC.

Inventories of greenhouse gases and air pollutants

Several organizations, including local governments and major energy, chemical and metallurgical undertakings, have undertaken long term air quality monitoring projects using modern continuously monitoring ambient air quality instrumentation. However there is a need to put in place a national ambient air quality monitoring network and information handling system in order to obtain an integrated database of air pollution data for purposes of air quality management and greenhouse gas inventories. It is envisaged that this information management system will already contain emissions data for various sources of air pollutants. Greenhouse gas inventories could be handled using the same system, to great advantage.

Accessing and managing financial resources for climate change

An effective programme for climate change response will require that South Africa has access to public sector funding and funding from government related institutions, such as the Development Bank of South Africa. Further, as a developing country, South Africa can access assistance from developed country partners to meet its obligations under the convention and, further, participate in the global mitigation of climate change. This requires a framework to access and manage the climate change financial resources on offer as donor funding.

The various elements of the response strategy described thus far have been translated into tangible strategies and actions to be implemented by government. It is thought that these actions will help South Africa achieve sustainable development objectives, while also fulfilling the need to respond to climate change.

A number of principles and factors guided the conception of this strategy and should be included in its implementation, including:

- Ensuring that the strategy is consistent with national priorities, including poverty alleviation, access to basic amenities including infrastructure development, job creation, rural development, foreign investment, human resource development and improved health, leading to sustainable economic growth;
- Ensuring alignment with the need to consistently use locally available resources;
- Ensuring compliance with international obligations;
- Recognizing that climate change is a cross cutting issue that demands integration across the work programmes of several government departments and stakeholders, and across many sectors of industry, business and the community;
- Focussing on those areas that promote sustainable development;
- Promoting programmes that will build capacity, raise awareness and improve education in climate change issues;

- Encouraging programmes that will harness existing national technological competencies;
- Reviewing the strategy constantly in the light of national priorities and international trends;
- Recognizing that South Africa's emissions will continue to increase as development is realised.

A number of key interventions have been proposed in this document that cut across the entire spectrum of possibilities for climate change response actions. Through the implementation of this national climate change response programme, South Africa will avail itself of the potential advantages that could stem from international action on climate change, whilst at the same time minimising its vulnerability to such events. To achieve this end, priority will be given to the following key interventions, although others appear in the key actions list in this document:

a) Rapidly develop the DNA function within the Department of Minerals and Energy to facilitate the forwarding of CDM project proposals to the Executive Board for approval without undue delay.
b) Perform a technology needs analysis for South Africa that builds on and integrates existing knowledge, through the Department of Science and Technology.
c) Access appropriate funds, as feasible, for implementation of the climate change programme, in particular for adaptation purposes.
d) Use the public sector and financing institutions linked to government, such as the Industrial Development Corporation and the Development Bank of South Africa to fund climate change projects.
e) Accelerate the process of education, training and awareness of climate change and its impacts to speed up the implementation of response actions.
f) Ensure the cooperation and buy-in of all stakeholders to climate change response through the NCCC and GCCC, to facilitate a coordinated national programme.
g) Harness the efforts of all stakeholders to achieve the objectives of the Government's White Paper on Renewable Energy (2003) and the Energy Efficiency Strategy, promoting a sustainable development path through coordinated government policy.
h) Implement sustainable industrial development through coordinated policies, strategies and incentives through the Department of Trade and Industry and the various industry sectors.
i) Accelerate water resource management and contingency planning through the Department of Water Affairs and Forestry.
j) Adapt agricultural, rangeland and forestry practices appropriately through the Departments of Agriculture and Water Affairs and Forestry.
k) Maintain an appropriate attendance at UNFCCC and related meetings.
l) Set a time frame for action, with specific milestones and responsibilities, to formulate appropriate national policies and measures for climate change action and develop a practicable plan of implementation.

The strategy contained in this document describes a broad framework for action and, as such, represents a starting point for such action. Detailed action plans with defined time-scales will be formulated meaningfully on a case by case basis, in the context of the ever changing political backdrop to climate change, technological progress and the robustness of the assumptions about what can be expected to transpire from the international negotiation process, together with the relevant commitments that are likely to flow from them. While it is extremely important to understand the reality and constraints of the South African economy, no door is closed to any action based on sound economic principles, which can bring tangible benefits to the country and its people. Both physical and economic vulnerability are duly acknowledged. There is no doubt that the next few decades will see major changes, not the least of which will be technological progress. History teaches us that what is far-fetched today will be common practice tomorrow. Thus the developed nations of the world, with their immense capital reserves, need to be encouraged to develop appropriate technologies to mitigate

global climate change. South Africa, as an integral part of the developing world, is always willing to accept new developments as they become appropriate to achieving its national goals and objectives.

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1. INTRODUCTION

1.1 The nature and factual basis of climate change

Global climate change is possibly the greatest environmental challenge facing the world this century. Concerned with the implications of global climate change, several governments came together in 1988 and formed the International Panel on Climate Change (IPCC). This led to the United Nations Framework Convention on Climate Change (UNFCCC), which was tabled in 1992 at the United Nations Conference on Environment and Development. The South African Government ratified the UNFCCC in August 1997. The stated objective of the UNFCCC is to achieve stabilisation of the concentrations of greenhouse gases in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. To provide a sound scientific base for climate change, the International Geosphere-Biosphere Programme (IGBP) was set up to undertake and review research information for the IPCC. The IGBP secretariat is housed within the Swedish Royal Academy of Sciences and, although contributions to the IGBP are voluntary and are often made on a country by country basis, the programme provides much of the science that appears in the periodic IPCC assessment reports.

Although often referred to as 'global warming', global climate change is more about serious disruptions of the entire world's weather and climate patterns, including impacts on rainfall, extreme weather events and sea level rise, rather than just moderate temperature increases. The developing world faces greater challenges than the developed world, both in terms of the impact of climate change and the capacity to respond to it. On the other hand, by far the biggest contributions to global climate change come from the wealthy developed countries of the Northern Hemisphere.

There is an ever-increasing consensus amongst the scientific community that global climate change is a physical reality. There are still, however, wide ranges of uncertainty. Despite the uncertainties, it is generally believed that the observable human induced climate change signature is starting to emerge as a recognizable trend. There is a whole range of diverse scientific data to support this view. Similarly, there is little argument about whether there will be global climate change impacts. It is rather the size of the impacts and their implications that remain uncertain. However, the political community is of a somewhat more diverse opinion as world opinion is still very much divided. The natural resources are in the poorer, developing countries, which are exploited by the richer developed countries. These latter have already depleted their own natural resources but have the majority of the financial means. There is thus an inevitable conflict of interest.

The three most important greenhouse gases are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). The atmospheric concentration of CO_2 has increased by over 30% since the start of the industrial era, predominately due to fossil-fuel combustion and deforestation, with the atmospheric concentrations of CH_4 increasing by about 150% in the same period. The concentration of N_2O has increased by 16%. This has been accompanied by an increase in global surface temperature of 0.6±0.2°C. There has also been an observed decrease in snow cover and land-ice extent. Precipitation is increasing over the landmasses in the middle and high latitudes of the Northern Hemisphere. Over the sub-tropics, land-surface rainfall has decreased on average. Global mean sea level rise during the 20th century has been 1.5 mm/yr and this is continuing. Further there are indications of an increase in the number of extreme weather events being experienced. These observed changes are largely in line with the predictions from a variety of models, many of which have seen very rapid development in recent years with the advent of cheap and available computing power. Further, current evidence suggests that most of the observed warming over the last 50 years is likely to have been due to human activities.

Under a business as usual scenario, models indicate that likely surface temperature rises by 2100 will be in the range 1.4^0 to 5.8^{0}C, dependent on latitude and longitude. Precipitation extremes are projected to increase, together with the frequency of extreme inter-annual variability. Mean and peak precipitation intensities from tropical cyclones are likely to increase appreciably. More hot days and heat waves are very likely over nearly all land areas. Increases in daily minimum temperature can also be expected. There is projected to be a general drying of the mid-continental areas during summer. Glaciers and ice caps are expected to continue their widespread retreat during the 21st century and Northern Hemisphere snow cover and sea ice are projected to decrease further. Projections of global average sea level rise from 1990 to 2100 lie in the range 0.11 to 0.77 m.

For Southern Africa, sub-continental warming is predicted to be greatest in the northern regions. Temperature increases in the range of between 1^{0}C and 3^{0}C can be expected by the mid 21st century, with the highest rises in the most arid parts of the country. Of greater consequence for South Africa, as a semi-arid country, is the prediction that a broad reduction of rainfall in the range 5% to 10% can be expected in the summer rainfall region. This will be accompanied by an increasing incidence of both droughts and floods, with prolonged dry spells being followed by intense storms. A marginal increase in early winter rainfall is predicted for the winter rainfall region of the country.

1.2 The need for a national climate change response strategy

The need for a national climate change policy for South Africa was identified as an urgent requirement during the preparations for the ratification of the UNFCCC in 1997. A process to develop such a policy was thus instituted under the auspices of the National Committee for Climate Change (NCCC), a non-statutory stakeholder body set up in 1994 to advise the Minister on climate change issues and chaired by the Department of Environmental Affairs and Tourism (DEAT). A discussion document was subsequently produced and a workshop was held to which all stakeholders were invited to obtain the requisite input to the policy formulation process. The need to produce an action-oriented response strategy document was clearly identified at this workshop, rather than a specific policy white paper on climate change, as had originally been envisaged. The strategy was to broadly support the Policies and Principles laid out in the Government White Paper on Integrated Pollution and Waste Management as well as other national policies including those relating to energy, agriculture and water.

Climate change is a truly cross cutting issue that can affect the entire economy as well as many specific sectors including energy, transport, agriculture, forestry, water resources management and provision of water services, and health. A national climate change response strategy will promote integration between the programmes of the various government departments involved to maximise the benefits to the country as a whole, while minimising negative impacts. Further, as climate change response actions can potentially act as a significant factor in boosting sustainable economic and social development, a national strategy specifically designed to bring this about is clearly in the national interest, supporting the major objectives of the government including poverty alleviation and the creation of jobs.

1.3 Structure of the strategy document

The document is divided into five main sections, reflecting its primary objective. That is, it is a strategic document that clearly indicates the steps or actions to be taken by the government and other players to respond at a national level to the challenges posed by climate change.

In Chapter 1, the nature of climate change is introduced and the changes that can be expected to happen in a physical sense, both globally and locally, are explored. This leads on to the justification for regarding climate change as a serious challenge for South Africa and setting the scene for a national approach, so that the country may maximise any pursuant benefits and minimise negative impacts.

In Chapter 2, the international perspectives of climate change are reviewed and the obligations of the various parties under the UNFCCC and the associated Kyoto Protocol are examined, emphasising South Africa's status as a developing country and the reduced level of commitments for such parties compared to those for the developed country parties. South Africa's specific vulnerabilities are examined together with the possible economic consequences of climate change, both those directly incurred and those resulting from actions and impacts in other countries.

The key issues and problems related to climate change response in South Africa are examined in Chapter 3. The various adaptation and possible mitigation options for South Africa are explored, with emphasis on those actions that are likely to derive benefits in the area of sustainable development for the country. These issues are addressed in Chapter 4, by proposing a number of strategic objectives, actions and interventions. The main conclusions of the report and a list of key actions, which highlight the priority areas of the strategy and the role of other stakeholders, are given in Chapters 5 and 6.

2. INTERNATIONAL COMMITMENTS, VULNERABILITY AND SOCIO-ECONOMIC IMPLICATIONS OF CLIMATE CHANGE IN SOUTH AFRICA

2.1 Commitments under the UNFCCC

In terms of the UNFCCC, there are general commitments applicable to all parties. However, the developed countries, designated as annex I countries in terms of the convention, have specific extra commitments applicable only to them. In terms of the principles embodied in the convention, in developing countries, such as South Africa, the specific development needs and vulnerabilities should be taken into account, recognizing that economic development in such countries is essential.

As a developing country, South Africa is mandated to provide the prescribed data in the emission inventory and submit periodic national communications to the UNFCCC secretariat, although there are several other contributions that can be made which are essentially of a voluntary nature. Climate change response measures must be consistent with the national development needs and government priorities. Sustainable environmental management principles must be an integral part of such measures. Coastal zone management, water resources, agriculture, and measures for the protection and rehabilitation of areas affected by drought and desertification, as well as floods, need to be incorporated. Plans and measures need to minimise adverse effects on the economy, public health and the quality of the environment. South Africa needs to promote and cooperate in scientific, technological, technical, socio-economic and other research. Further, systematic observation to establish climate baselines, both nationally and throughout the region, needs to be undertaken. Training and public awareness at all levels related to climate change needs to be encouraged and prioritised.

Finally, South Africa needs to vigorously pursue the opportunities latent in the requirements that developed countries assist developing countries in their climate change response actions. This should be used as a vehicle to maximise the development benefits for South Africa, and the Southern African region as a whole, and to put in place suitable adaptation measures, ensuring a minimum of disruption while maximising the return on any internal resources that are used.

2.2 South African vulnerability

Measurable changes in climate can be expected to have significant effects on various sectors of South African society and the economy. These potential impacts have been explored in the South African Country Studies for a time horizon of 50 years, using a series of general circulation model (GCM) simulations. The potential effects of a changed climate within 50 years and possible adaptation strategies were identified for the following sectors: human health; maize production; plant biodiversity; water resources; rangelands; and animal taxa. Further, urban air pollution from low-level sources, such as domestic emissions, will become a greater problem, due to the enhanced occurrence of temperature inversions resulting from climate change. These inversions serve to trap the smoke from such sources near ground level giving rise to excessive ambient concentrations.

Health impacts can be expected from increases in temperature and changes in rainfall patterns. These include an increase in the occurrence of strokes, skin rashes, dehydration and the incidence of non-melanoma skin cancers. As a result of ecosystem changes, climate change may also bring about indirect health impacts such as an increase in the incidence of water-borne diseases. The occurrence of vector-borne diseases such as malaria could also increase if there is a significant extension of the malaria prone areas, as has been predicted in the projected climate change scenarios for South Africa as presented in the first national communication.

With regard to water resources, South Africa's rainfall is already highly variable in spatial distribution and unpredictable, both within and between years. Much of the country is arid or semi-arid and the whole country is subject to droughts and floods. Bulk water supplies are largely provided via a system of large storage dams and interbasin water transfer schemes and such infrastructure takes years to develop. Thus a reduction in the amount or reliability of rainfall, or an increase in evaporation would exacerbate the already serious lack of surface and ground water resources. Water availability in the arid and semi-arid regions, which cover nearly half of South Africa, is particularly sensitive to changes in precipitation. Desertification, which is already a problem in South Africa, could be exacerbated by climate change. Furthermore, climate change may alter the magnitude, timing and distribution of storms that produce flood events.

Seventy percent of the land surface of South Africa consists of natural and semi-natural ecosystems which provide rangelands for large herbivore species. Modelling suggests a general aridification of this type of land, especially where such rangelands are already marginal. Fodder production can be expected to be impacted, affecting marginal costs of ranching. Further, tree encroachment into the grassland areas is likely to increase due to the elevated CO_2 concentrations and the increase in temperature. The frequency of fire outbreaks is predicted to increase significantly.

About 70% of total grain production in South Africa consists of maize. Crop yield modelling predicts that, under a hotter drier climate, maize production will decrease by up to 20%, mostly in the drier western regions. Further, speciality crops grown in specific environmentally favourable areas may also be at risk, since both rainfall and temperature effects may cause significant changes in areas uniquely suitable for such specialised production. In addition, an increase in pests and diseases would also have a detrimental effect on the agricultural sector and invasive plants could become a greater problem.

The South African forestry sector is sensitive to climate change as it is based on plantations of non-indigenous species, located in relatively marginal areas, which comprise about 1.5% of the land area of the country. In addition to the effects of climate change, factors such as land availability, water demand, as well as environmental and socio-economic conditions will also affect this sector. Modelling predicts that climate change will affect the optimal areas for the country's major tree crop species, and impact on the marginal costs associated with planting in sub-optimal areas.

Biodiversity is important for South Africa because of its key role in maintaining ecosystem functioning, its proven economic value for tourism and its role in supporting subsistence lifestyles. Climate change modelling suggests a reduction of the area covered by the current biomes by up to 55% in the next 50 years. The largest losses are predicted to occur in the western, central and northern parts of the country. Species composition is expected to change, which may also lead to significant changes in the vegetation structure in some biomes, and, in some extreme cases, even leading to total species loss. With regard to animal taxa, climate modelling predicts that most animal species will become increasingly concentrated in the proximity of the higher altitude eastern escarpment regions, with significant losses in the arid regions of the country. Some species are predicted to become extinct.

Marine biodiversity is not expected to be impacted by the predicted ranges for rise in sea level. However, the predicted rise in sea surface temperature would result in the migration of species residing along the coast. Further, the changes in sea temperature may increase the intensity and frequency of upwelling events. This would cause alterations of near-shore currents, which can be expected to have the most significant impact on rocky shore ecosystems in South Africa. The nutrient and larval supply to the coast would be affected, thus influencing the community structures. In addition, studies have

indicated that there would be an increase in the occurrences of the harmful 'red tide' events on the west coast which cause mass mortalities of fish, shellfish, marine mammals, seabirds and other animals, and can result in illness and death in persons who eat contaminated seafood.

2.3 Economic implications

National economic matters fall within the competence of the National Treasury and thus all measures or actions that may ultimately impact on such issues will, as a matter of course, be referred in detail to this department.

According to information received from various Government Departments, the direct costs of employing officials for implementing climate change response ranges from no direct incremental costs, as the work is essentially seen as part of the ongoing work of the department concerned, to R1.6 million, which would involve the direct employment of three mid-level officials. For instance the Department of Trade and Industry (DTI) estimates that, to implement the strategy, it will require a minimum of R600 000 per annum, which includes remuneration to a champion to coordinate climate change matters within the department. It is assumed that this person will be available to attend the international and national meetings on behalf of the department and liaise with industries with regard to energy efficiency and other mitigation measures. A realistic estimate for all involved departments would be in the region of R5 million total.

On a holistic basis, there are three important dimensions to the economic implications of climate change in developing countries.

- The direct costs/benefits related to taking mitigation actions for climate change.
- The costs incurred in adapting to the physical changes that result from climate change.
- The indirect costs incurred in the loss of markets in the rest of the world as a result of their mitigative actions.

It is generally held that non-annex I countries are much more vulnerable to economic disruption through the imposition of climate change mitigation measures than are the developed countries. It must also be borne in mind that non-annex I countries are not required, in terms of the Kyoto Protocol, to adopt emission reduction or limitation targets, either of a voluntary or binding nature. However, climate change mitigation policies may promote sustainable development if they are designed to be consistent with broader societal objectives and, at the same time, they may offer substantial opportunities. This is a particularly important concept for South and Southern Africa. Some mitigation actions may yield extensive benefits in areas outside of climate change such as health, employment opportunities and reducing negative environmental impacts. However, the costs incurred by such actions may be excessive and render the actions unattractive. Differences in the distribution of technological, natural and financial resources among and within nations and regions, as well as differences in mitigation costs, are important considerations in the analysis of climate change mitigation options. Further, the challenge of addressing climate change raises an important issue of equity, namely the extent to which the impacts of climate change or mitigation policies create or exacerbate inequities, both within and across nations and regions. Global greenhouse gas stabilization will require that future global capital stock is less carbon-intensive. This has immediate implications for near-term investment decisions, especially in developing countries like South Africa for which an argument can be made that there is a need to become less carbon intensive. An immediate and sustained commitment to research and development is required if low-emission, low-cost substitutes are to be available when they become attractive investment opportunities. Research and development programmes to establish alternative, more efficient and sustainable applications for fossil fuels are needed. This includes research into, *inter alia*, clean coal technologies and the non-energy uses for fossil fuels. Some mitigation policies could

lead to net overall economic benefits, implying that the gains from many sectors could outweigh the losses for coal and other fossil fuels, and energy-intensive industries. These possibilities, including energy efficiency programmes and low emission and efficient supply side technologies, would tend to look attractive for non-annex I countries who need to develop and diversify their economies. This will require an enhanced transfer of technology to fossil fuel dependent non-annex 1 countries such as South Africa.

Although there may be costs incurred in adapting to the physical changes that result from climate change, such actions could also lead to sustainable development benefits that could be achieved, even if climate change were not a factor. Water saving schemes offers just one example. Such benefits need to be identified and actions that promote them should be facilitated through whatever means are available as though they were specifically aimed at adapting to climate change. This will assist in maximising benefits and minimising any economic impacts that could be potentially incurred in climate change adaptation actions.

Emission constraints in annex I countries can be expected to have significant impacts on non-annex I countries like South Africa, as a major coal exporting country. There will also be significant direct impacts. Other items specific to non-annex I countries are a potential slow down in global trade in carbon intensive products that are reliant on coal as the primary energy source. The coal reliant countries, such as South Africa, are particularly vulnerable. This vulnerability extends to almost the whole of the mining and energy sectors. However, this could be offset to some extent through opportunities to establish relatively high energy intensity industries in non-annex I countries and it can be argued that the relocation of energy intensive industries from annex 1 to non-annex 1 countries should be promoted, but that such relocations should be accompanied by the transfer of best available technologies. However, it can also be argued that this is undesirable as it could lead to increased exploitation of limited natural resources and may give rise to negative environmental impacts in terms of additional stresses to existing biomes and an increase in the generation of pollution and waste. Further, such actions may do little to alleviate the problem of unemployment through labour-intensive development. However, the development of new fossil fuel export markets amongst non-annex 1 countries could be encouraged. Annex I parties should commit themselves to reduce emissions from fossil fuels in terms of the convention and the protocol and should initially concentrate on domestic actions that will not negatively impact on the market for fossil fuels from developing countries. Further these commitments should focus primarily on the reduction of fossil fuel utilisation in and among annex 1 countries. Regional centres of excellence should be promoted that can provide focal points for data collection, the analysis of impacts, economic modelling, the secondment of both annex 1 and non-annex 1 persons, the pooling of information and capacity building.

3. KEY ISSUES AND PROBLEMS

In this chapter, the key issues and problems which the proposed climate change response strategy needs to address are identified.

3.1 Supporting national objectives and sustainable development

The South African Government's national priorities include, *inter alia*, the creation of employment, the alleviation of poverty and the provision of housing, which implies a commitment to the process of sustainable development and advancement. Thus South Africa's position is to view climate change response as an opportunity for achieving these aims. At the same time, international action on climate change can be viewed as a significant vehicle to redress the historic, inequitable and unsustainable north/south divide of the world's economy and prosperity. In support of this objective, South Africa's national climate change response programme must also strongly support the New Partnership for Africa's Development initiative. There are many benefits to be derived in integrating climate change response programmes across national and regional boundaries, to serve common areas of interest and to maximise the utility of available resources.

3.2 Adapting to climate change

According to the IPCC Third Assessment Report, climate change is already happening, and will continue to happen, even if global greenhouse gas emissions are curtailed significantly. There is now more confidence that global climate change is a threat to sustainable development, especially in developing countries, and could undermine global poverty alleviation efforts and have severe implication for food security, clean water, energy supply, environmental health and human settlements.

Acknowledging the overall vulnerability of South Africa to climate change impacts, it will thus be necessary to carry out adaptation measures in this country. The South African Country Studies Programme identified the health sector, maize production, plant and animal biodiversity, water resources, and rangelands as areas of highest vulnerability to climate change and these are the areas that need to be targeted for adaptation measures. Further, in addition to the physical concerns, over an appropriate period of time adaptation measures may require the development and implementation of low greenhouse gas emitting technologies and waste strategies, localisation of production, creation of sustainable and adaptable livelihoods, benchmarks and targets for progress to a less carbon and energy intensive economy.

With regard to South Africa's vital industries, the mining and energy sectors are particularly vulnerable with respect to climate change. In addition, the economy is vulnerable to the possible response measures implemented by annex 1 countries, since it is highly dependent on income generated from the production, processing, export and consumption of coal.

3.3 Developing a sustainable energy programme

South Africa, as a non-annex I country, is not required to reduce its emissions of greenhouse gases. However, the South African economy is highly dependent on fossil fuels and the country can be judged to be a significant emitter due to the relatively high values that can be derived for emissions intensity and emissions per capita. Such calculations put South Africa as one the world's top 15 most energy intensive economies, with a significant contribution to greenhouse emissions at a continental level. There could be benefits to be derived from adopting a future strategy that is designed to move the economy towards a cleaner development path. This will further require development of a strategy to

access investment through the Clean Development Mechanism (CDM) of the Kyoto Protocol, technology transfer and donor funding opportunities. However, even given this scenario, emissions can still be expected to increase with economic development, albeit at a smaller pace than would have happened without intervention.

To date the Department of Minerals and Energy (DME) is involved in a number of programmes to reduce emissions intensity. An energy-efficiency awareness campaign was initiated by the DME in 1996 to raise public awareness of the need to implement energy efficient measures in the home. This campaign was in response to a survey, conducted at the time that found that 60 percent of consumers were not aware of the need and reasons for conserving energy. Training and capacity building on energy efficiency is also being conducted by the Household Energy Action Training (HEAT) programme. The aim of the programme is to develop a household-energy capacity building and communication strategy. A joint project with the International Institute for Energy Conservation-Africa (IIEC-Africa), the Minerals and Energy Education and Training Institute (MEETI) and PEER-Africa, an environmental and engineering firm, will address delivery organizations on energy and environmental issues in the housing sector. PEER-Africa is presently involved in appropriate technology transfer and capacity building in low-income communities. A white paper on renewable energy and clean energy development was developed by DME and was approved by Cabinet in 2003. This sets a target of 10 000 GWh renewable energy contribution to final energy consumption by 2012, in addition to the existing renewable energy contribution of 67 829 GWh/annum, which represents about 9% of the national total consumption and includes present contributions from various sources of biomass.

3.4 Meeting international obligations

As previously mentioned, South Africa, as a party to the UNFCCC, has to fulfil certain obligations which include the following:

- Prepare and periodically update a national inventory of greenhouse gas emissions and sinks.
- Formulate and implement national and, where appropriate, regional programmes to mitigate climate change and facilitate adequate adaptation to climate change.
- Promote and cooperate in the development, application and diffusion of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases.
- Promote sustainable management, and promote and cooperate in the conservation and enhancement of sinks and reservoirs of all greenhouse gases.
- Cooperate in preparing for adaptation to the impacts of climate change.
- Take climate change considerations into account in the relevant social, economic and environmental policies and actions with a view to minimising adverse effects on the economy, on public health and on the quality of the environment.
- Promote and cooperate in scientific, technological, technical, socio-economic and other research, systematic observation and development of data archives related to the climate system and intended to further the understanding and to reduce or eliminate uncertainties.
- Promote and cooperate in the full, open and prompt exchange of relevant scientific, technological, technical, socio-economic and legal information related to the climate system and climate change.
- Promote and cooperate in education, training and public awareness related to climate change.

There are no formal commitments to the IPCC but, where, appropriate, South Africans are encouraged to make meaningful contributions within this structure. Similarly, where possible, relevant local research should be structured to support the work of IGBP.

3.5 The integration of climate change response in government

Although DEAT has been designated as the lead agency for climate change response in South Africa, it is recognized that this is a cross cutting issue that has ramifications for diverse activities in other government departments. This will require the effective coordination amongst the various government departments that are involved in, or may be impacted by, climate change to ensure that response measures are properly directed, acceptable to all and carried out with a national focus. General awareness within government on the likely impacts of climate change is somewhat limited to those departments directly involved with the issues. In order to adapt to climate change, and to prepare adequately for the likely impacts, capacity has to be built. This will ensure that the policies formulated will adequately address climate change adaptation. Further, it is important that the available skills and competencies within government are efficiently harnessed. Officials in other departments, within all spheres of government, often do not see climate change as a priority and some even see it as working against national development priorities. They are concerned that South Africa has a huge backlog of service delivery where the performance of each department is measured by how effective and efficient it is on service delivery. Therefore climate change needs to be addressed in such a way as to assist these departments to achieve their service delivery objectives i.e. through so-called "win-win" or "no regrets" measures.

3.6 Government/Industry partnerships

Awareness and capacity within government on many aspects of climate change is limited, particularly in those departments not directly involved with the issues concerned. There is, however, capacity within various sectors of business and industry that could be harnessed in developing and implementing a practical and effective national climate change programme. Many industries, such as the energy and chemical sectors, are currently involved in the development of growth strategies. Further, it has been widely recognized that environmental performance and, in particular, cleaner production technology can represent a significant competitiveness factor for industry. Thus industry/business involvement should not be limited in nature or only have a role though capacity building in government. Appropriate government/industry partnerships should be encouraged and developed.

3.7 Domestic legal provisions

South Africa currently has a number of laws relating to the protection and management of the environment. The overarching legislation is contained within the provisions of the National Environmental Management Act of 1998. Climate change is referred to explicitly in the White Paper on Integrated Pollution and Waste Management of 2000, and referenced in the White Paper on a National Water Policy for South Africa, 1997. It is also specifically addressed in the Government's imminent National Water Resource Strategy. Climate change is not addressed in current air quality legislation. The impending National Environmental Management: Air Quality Act will, however, specifically contain provisions for greenhouse gas emissions.

3.8 Climate change related education, training, awareness and capacity building

Climate change is a relatively new issue in South Africa due to the prior isolation of this country from international events. Education, training and public awareness thus lag behind the requisite standards. Similarly, government has not got the necessary capacity to deal with climate change on an effective basis. Industry is better placed regarding technical skills. However, these skills are not usually specifically available for climate change related activities.

3.9 Climate change related research, development and demonstration

Climate change research needs to be properly coordinated and the benefits optimised to meet the needs of policy makers in South and Southern Africa. Attention needs to be focussed on projects that will assist with mitigation of and adaptation to climate change and address specific areas of vulnerability. Further, development and demonstration projects are required to show the advantages and acceptability of a variety of technologies related to climate change. There are some solid foundations in this area on which to build including, *inter alia*, renewable energy demonstration projects and the South African Environmental Observation Network (SAEON) programme, which is administered through ring-fenced grant funding by the National Research Foundation (NRF) and is well under way with the first site in the Lowveld area, with the Kruger Park as the core and adjacent sites offering some 6000 hectares under observation.

3.10 Inventories of greenhouse gases and air pollutants

Several organizations, including local governments and major energy, chemical and metallurgical undertakings, have undertaken long term air quality monitoring projects using modern continuously monitoring ambient air quality instrumentation. However there is a need to put in place a national ambient air quality information handling system in order to obtain an integrated database of air pollution data for purposes of air quality management and greenhouse gas inventory. It is envisaged that this information management system will already contain emissions data for various sources of air pollutants. Greenhouse gas inventories could be handled using the same system, to great advantage.

3.11 Accessing and managing financial resources for climate change

Currently, South Africa is experiencing financial constraints. This makes it difficult for the country to implement policies that are appropriate in its pursuance of its own national objectives and service delivery. South Africa, as a developing country, would be able to meet its obligations under the convention and contribute to the global mitigation of climate change through assistance from developed country parties. This requires a framework to access and manage the climate change financial resources on offer as donor funding.

4. STRATEGIC OBJECTIVES, PRINCIPLES AND PROPOSALS

A number of important issues and priorities in respect of global climate change and South Africa have been discussed in Chapter 3. In this Chapter we have sought to translate those priority factors into tangible strategies and actions to be implemented by government. It is thought that these actions will, in no uncertain terms, help South Africa achieve sustainable development objectives, while also fulfilling the need to respond to climate change.

4.1 Principles for the national climate change response strategy

A number of principles and factors guided the conception of this strategy and should be included in its implementation, including those contained in the National Environmental Management Act of 1998 and the importance of equity on the national and international scale. These are:

- Ensuring that the strategy is consistent with national priorities, including poverty alleviation, access to basic amenities including infrastructure development, job creation, rural development, foreign investment, human resource development and improved health, leading to sustainable economic growth;
- Ensuring alignment with the need to consistently use locally available resources;
- Ensuring compliance with international obligations;
- Recognizing that climate change is a cross cutting issue that demands integration across the work programmes of other departments and stakeholders, and across many sectors of industry, business and the community;
- Focussing on those areas that promote sustainable development;
- Promoting programmes that will build capacity, raise awareness and improve education in climate change issues;
- Encouraging programmes that will harness existing national technological competencies;
- Reviewing the strategy constantly in the light of national priorities and international trends;
- Recognizing that South Africa's emissions will continue to increase as development is realised.

In devising this strategy, an integrated approach was followed. The framework of interventions thus takes into account the policies and programmes of other government departments, and the fact that South Africa is a developing country. This should ensure that the principles of sustainable development are adequately served and do not conflict with existing development policies.

4.2 National objectives and sustainable development

In the non-annex I countries, such as South Africa, economic and social development remain critical issues. Thus the national climate change response strategy must, as far as possible, seek to promote the primary government objectives, which include job creation, the provision of basic services and infrastructure development, the alleviation of poverty, and the provision of housing. These priorities are also generally compatible with the principles of sustainable development as defined in the Rio Declaration of 1992.

Objective: Create a synergy between national government objectives, sustainable development and climate change.

There is a considerable degree of compatibility between national government objectives, sustainable development and climate change. The linkages need to be established to maximise the overall benefits to the country that can be obtained from climate change response. It is clearly stated in the IPCC Third

Assessment Report that sustainable development objectives are achievable that also benefit climate change mitigation, even if climate change was not the primary reason for taking such actions.

Intervention: Include climate change issues in sustainable development policies, indicators and criteria for South Africa which are consistent with any such indicators and criteria that are required by the DNA for CDM projects.

Indicators and criteria are needed which denote whether particularly development pathways lead to sustainability. Such criteria can be unique to South Africa and their development will require careful thought and stakeholder participation. Project proposals should be evaluated on sustainability criteria that have been formulated or adapted specifically for South Africa. In general, projects and proposals need to be evaluated holistically and any cross cutting issues must be identified and taken into account. Projects and proposals should be specifically screened to ensure that they promote national development objectives, even though they may also serve foreign and international interests as well.

The objectives of other environmental conventions and protocols, including the United Nations Convention on Biodiversity (UNCBD), the United Nations Convention to Combat Desertification (UNCCD), the Vienna Convention for the Protection of the Ozone Layer and the Ramsar Convention also need to be considered. Further, provision should be made for reporting of significant greenhouse gas emissions by public and private sources in terms of the agreed sustainable development indicators.

4.3 Institutional arrangements

Objective: To enable the relevant national government departments to address climate change issues in South Africa.

South Africa is no longer isolated internationally and is expected to take a leading role in the development of the Southern Africa region, and in the continent as a whole. This will require a strong and vigorous domestic climate change programme with the appropriate institutional capacity and arrangements. Due to the historic lack of participation in world affairs, including climate change issues, South Africa, to some extent, has not developed the capacity to achieve this. As a net result, there has been a lack of integration in climate change response between the various departments and non-government stakeholders, who all have their own specific objectives. The functional operational components for government response to climate change issues are illustrated in Figure 4.3.1. However, these various functions could continue to be carried out in several different departments, as appropriate, provided that there is proper communication and coordination. The important role of coordination between departments cannot be over-emphasised. One of the prime reasons for establishing the Government Committee for Climate Change (GCCC) was to facilitate this process.

Intervention: Ensure that the relevant national government directorates and sub-directorates have the capacity to carry out their assigned functions regarding climate change response, including the CDM.

Government needs to establish a procedure for the registration, coordination and reporting on climate change related projects to be undertaken using donor funding. To assist with this, a list of donor agencies needs to be maintained on a project information management system, with specific donor country interests and potential funds available. Project endorsement should be given on the grounds of non-duplication, economic benefits, social benefits and overall feasibility. If necessary, projects could be given priority ratings according to the severity of the required adaptation to avoid climate change impacts. Technical feasibility should also be adjudicated. Technology transfer and demonstration projects need to be encouraged.

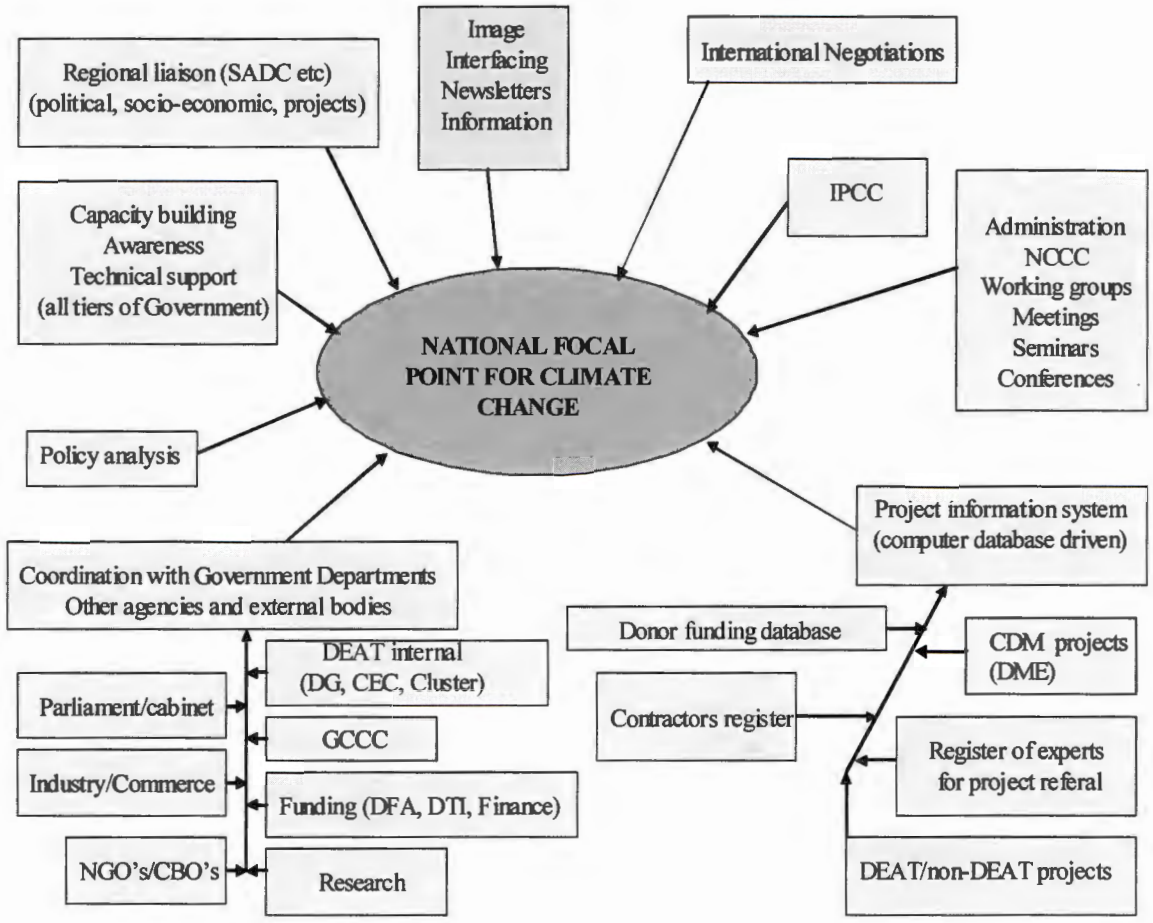

FIGURE 4.3.1: FUNCTIONAL OPERATIONAL COMPONENTS FOR GOVERNMENT RESPONSE TO CLIMATE CHANGE ISSUES

A technology needs assessment for climate change related projects in all sectors should be undertaken through the Department of Science and Technology (DST) and this must make extensive reference to the National Advanced Manufacturing and Technology Strategy (AMTS) for South Africa, produced by the CSIR for the National Advisory Council on Innovation (NACI), a body which advises the Minister of Science and Technology.

This process could be broad enough to cover related areas such as capacity building and could be assisted through United Nations Development Programme projects. DEAT will ensure that all South Africa's obligations in terms of the UNFCCC and Kyoto Protocol are adequately carried out, including the submission of the greenhouse gas inventory, assessed in the prescribed manner and presented in the correct format, and the National Communications.

Intervention: Establish procedures for CDM projects.

Government urgently needs to establish procedures for the registration, coordination and reporting on projects to be undertaken through the CDM. Detailed discussions have been held between high-level delegations from DEAT, DTI and DME. The following mechanisms are proposed, are being developed or have already been instituted.

a) A CDM secretariat is being set up within DME and it is envisaged that the Director General of DME will act, for legal purposes, as the Designated National Authority (DNA) in terms of the Kyoto Protocol, in which capacity he will have full signing authority and the associated accountability.

b) The DNA will be advised by a steering committee, chaired jointly by DME, DEAT and the DTI. It is, however, essential that other departments (for example the Department of Foreign Affairs) be permanently represented on the committee, as should other stakeholders, including civil society.

c) The CDM secretariat will introduce proposals to the steering committee who will make recommendations to the DNA. The DNA will issue letters of approval.

d) DTI would provide guidance on possible trade and investment implications of projects and will assist in the marketing of potential CDM projects in South Africa.

e) DTI will be instrumental in ensuring that, where possible, the CDM is used to support national trade and investment measures.

f) The CDM secretariat would provide a single point of entry for all information pertaining to the CDM, and would be able to advise on all aspects of the necessary South African and international processes and requirements.

g) The secretariat would be responsible for the registration of all projects, but not for actual project management, which would be the responsibility of the project developers.

h) The secretariat would serve as a focal point to the CDM Executive Board, as set up under the Kyoto Protocol, and deal with correspondence from this Board.

i) The secretariat would also provide input into the negotiating process on the CDM, through the NCCC.

j) The arrangements could be considered as interim with the possibility of them being reviewed in light of performance achieved, status of the Kyoto Protocol negotiations and the future scale of the CDM market.

It should be understood up-front that CDM primarily presents a range of commercial opportunities, both big and small. This could be a very important source of foreign direct investment, thus it is essential that the DTI participate fully in the process. Contracting organizations from the recipient country can

range from large private corporations, parastatals and the smaller commercial operations of academic institutes and consultancies aligned with NGOs. The actual range of potential projects is very large and can not be covered in detail here. However, as just a few examples, they could encompass fuel switching from coal to gas, clean coal technologies, energy efficient housing, the use of renewable energy resources or the production of electricity from landfill gas, as well as numerous other applications. The identification of suitable projects could be assisted by the results of the technology needs analysis referred to elsewhere in this document.

The overall governance and coordination of CDM is through the CDM Executive Board established under the Kyoto Protocol. The responsibility for constituting and appointing the Executive Board lies with the UNFCCC conference of parties/meeting of parties structures. There are mechanisms to ensure equitable regional representation and a balance between developed and developing nation representation. The Executive Board is mandated with the administration of an adaptation fund to oversee allocations to adaptation projects, specifically for the poorest and most vulnerable nations, with the prioritisation of funding in accordance with criteria established from the vulnerability assessments submitted to the UNFCCC conference of parties. Figure 4.3.2 shows a complete CDM start-up process and the route that could be followed for the national programme using the CDM secretariat.

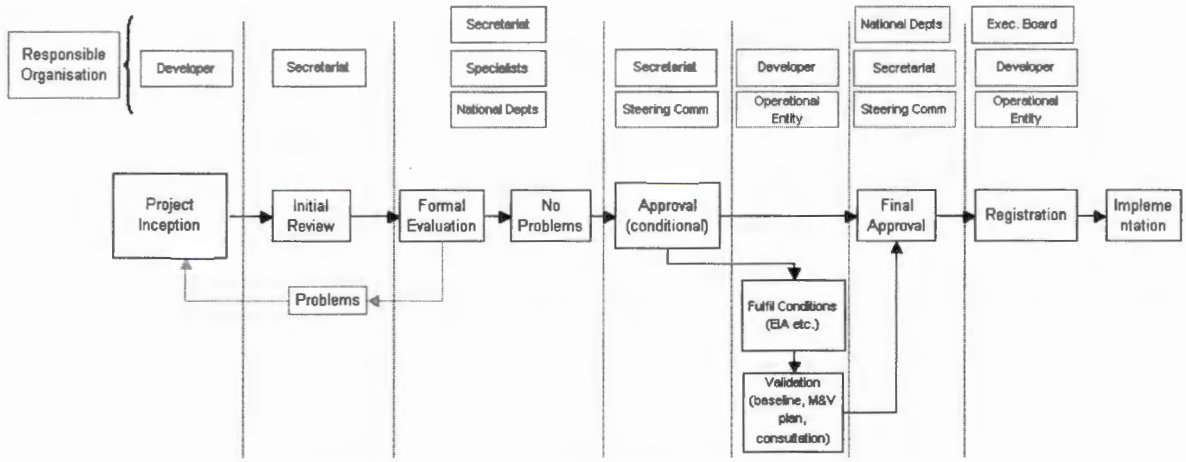

Figure 4.3.2: Process for initiating CDM projects

All information should be entered into a project information management system. However, the Secretariat could keep all proprietary information confidential at all stages. The detailed evaluation of greenhouse gas reductions needs to be done according to standard methodologies as laid down by the Executive Board and through the Designated Operational Entities (DOEs) mandated by the Board. On applying for pre-approval, a 2-month turn around time, or shorter, should be guaranteed. The project should be evaluated for economic benefits, social benefits, and technological feasibility.

The public will be consulted on the sustainable development criteria, which can be unique for South Africa. The process for the application of these criteria will be specified. The primary role of the CDM process is to assess projects against these sustainable development criteria, but those responsible will require the necessary information in order for them to do this. Technical feasibility could be evaluated through using specific members of an expert panel who have been chosen for their technical competence and willingness to respond rapidly. It is doubtful whether adequate capacity in this area would normally reside within the DNA and/or the steering committee or secretariat. However, the composition and role of this panel will need to be clearly defined as to the required level of their assessment and their terms of reference should be limited to that of acting in an advisory capacity only.

The expert panel would not be required to sit formally and review projects. Projects could be referred to the appropriate experts by Email. In cases that require an Environmental Impact Assessment (EIA), then a process of public participation will, in any event, need to be conducted and various stakeholders consulted. This type of process should not be duplicated, as it will inevitably result in the process becoming even lengthier.

It should be noted that the risk with regards to obtaining approval of EIA's is borne by the project developers and the EIA could be carried out in advance of the CDM approval process should the project developer wish to do so. In addition the initiation or carrying out of an EIA should not be considered as invalidating the proposed project on the grounds that it represents "business as usual".

The application for full approval should contain complete project specifications and a detailed account of the proposal for verifying the emissions reductions. The CDM Executive Board in Washington is likely to make approval conditional upon continued achievement of requirements. This process should not take longer than 14 weeks from start to finish, preferably much less, excluding the time taken to process the EIA, where necessary.

The allocation of certified emission reductions has not as yet been finalised. However, it is widely thought that ownership would essentially remain with the project developers to give the incentive to carry out CDM projects, with governments retaining overall custodianship of the national interests. It is expected that the CDM Executive Board would maintain a CDM registry and that South Africa, as the host party, as well as the project participants would have registry accounts into which certified emission reductions would be transferred directly by the CDM Executive Board.

4.4 Adaptation

Adaptation will be essential in South Africa due to its particularly vulnerable status in terms of the negative impacts of climate change as well as response measures. It should be noted that, although DEAT supports the suggested interventions in principle, much of the work comes under the jurisdiction of other government departments, and within all spheres of government. Further, it is emphasised that many of the suggested interventions would give rise to benefits that would assist the current development situation in South Africa, even if climate change were not a factor. These endeavours must be encouraged in no uncertain terms. Thus, as already discussed, climate change adaptation could become a mainstay of sustainable development and suitable donor funding secured for such work.

Objective: Offset South Africa's vulnerability to climate change.

Modelling suggests that there will be significant climate change impacts in South Africa, even if global emissions were to be reduced in accordance with the Kyoto Protocol. These impacts include general warming, disruption of established rainfall patterns and an increase in the frequency of occurrence of extreme weather events affecting a wide variety of sectors.

The community water supply and sanitation projects currently being undertaken by the Department of Water Affairs and Forestry (DWAF) will contribute to the prevention of infection by water-borne diseases such as cholera, scistosomiasis and gastro-enteritis by reducing reliance on untreated water supplies. However, climate change impacts may offset the progress and this will need to be monitored.

Intervention: Extension of health protection and health promotion measures.

Current monitoring and forecasting systems to warn of disease outbreaks need to be extended and upgraded to counteract possible climate change health impacts and enable prior planning for effective sustainable interventions, as do disease prevention programmes and personal protective devices. For instance, the use of bed nets and personal protective devices, which have proved successful in preventing the contraction of malaria from mosquito bites, will have to be increased. Treatment facilities and proactive preventative measures will need to be extended according to impact forecasts. Increased surveillance, monitoring and control of areas that are prone to, and will be affected by diseases such as malaria and Bilharzia will also be required, as will controls in the affected areas by the use of spraying programmes and other conventional measures. Health promotion programmes could also play a useful role in combating the impacts of climate change.

The Community Water Supply and Sanitation projects currently being undertaken by the Department of Water Affairs and Forestry will contribute to the prevention of infection by schistosomiasis over time. However, climate change impacts may offset the progress and this will need to be monitored, as will the incidences of water borne disease such as cholera.

Intervention: Water resource management and contingency planning.

Strategies for managing South Africa's water resources have been developed to take account of the country's variable and unpredictable climate and the resulting limited availability of unevenly distributed water. The strategies, which are described in the National Water Resource Strategy, scheduled to be established in terms of the National Water Act, 1998, during 2004, are sufficiently flexible to accommodate the anticipated effects of climate change without the need for special programmes or projects. However, the effects are likely to manifest themselves at different times in different parts of the country, and to vary in magnitude from area to area. A better understanding of these issues is expected from an ongoing research programme funded and managed by the Water Research Commission, which will facilitate prioritising intensified interventions in areas where the effects are greatest and/or will occur soonest. It will be necessary to improve meteorological and hydrological monitoring systems to detect the onset and development of the effects of climate change on water resources.

Approaches to water resources management that will facilitate adaptation to a changed climate can be broadly divided into strategic resource management, flexibility in water use allocations, water demand management and water conservation measures, contingency planning for extreme events such as floods and droughts, communication, optimising the operation of existing infrastructure and constructing new infrastructure.

Comprehensive and integrated planning across river catchments will allow for co-ordinated solutions, using an appropriate mix of demand and supply-side interventions, to the problems of water quantity, water quality and water supply by addressing the effects of population growth, economic growth and development, and the consequent changes in the demand for water. The management of water resources needs to be more closely integrated with water services provision via local government's integrated development planning process, particularly the water services development plans.

Replacing in-perpetuity riparian water rights with a system of time-bound administrative authorisations to use water that are subject to regular review will provide flexibility to adjust water allocations to account for changes in the availability of water. Additional flexibility will be provided by allowing water

users to trade water use authorisations, either permanently to move water from lower to higher value uses, or temporarily as a short-term coping strategy

The demand for water may be reduced in all user sectors through a range of measures that encourage efficient water use. These include implementing the pricing strategy for water use charges prescribed in the National Water Act, promoting the use of water-efficient technologies and practices, mandatory water auditing and accounting, and education in water conservation and demand management. However, although successful adoption of measures to reduce water use in the long term by increasing the efficiency of use is desirable, it could limit the extent to which users can accommodate any short-term restrictions on water use that may be necessary during times of drought without prejudicing productivity or reducing standards of living.

Water conservation measures such as clearing alien invasive vegetation from infested catchments will increase the amount of surface water runoff and recharge to groundwater, whilst water harvesting in agriculture and homes, especially those in rural areas, could reduce reliance on supplemental irrigation by optimising the effectiveness of rainfall. There is significant potential in the domestic and agricultural sectors for minimising wastage by reducing leakage from piped and open channel distribution systems.

Contingency plans for extreme events such as droughts and floods will be embodied in the disaster management framework prepared in terms of the National Disaster Management Act. The current monitoring and forecasting systems for droughts and floods would need to be improved and baselines established.

Operating procedures for all infrastructures, including inter-basin transfer schemes will be reviewed and revised where necessary to ensure optimum efficiency. The need for modifications to existing infrastructure or the construction of new infrastructure will continue to be investigated.

Public consultation programmes, mandatory under the National Water Act for all significant implementation interventions, need to put greater emphasis on making water users and the public aware of the implications of climate change. Programmes such as the Disaster Mitigation for Sustainable Livelihoods Programme, which educates communities on drought mitigation, need to be promoted and encouraged in communities.

Intervention: Adaptation of rangeland practices.

Suggested adaptation strategies for South African rangelands include improved monitoring and forecasting systems for fire hazard and droughts. These will be beneficial, even without climate change occurring. Specific intervention to adjust stocking rates are unlikely, since farmers already adjust their stocking rates in response to climatic and market conditions. Due to a possible decline in the carbon/nitrogen ratio in forage, as a result of the elevated CO_2 concentrations, it is possible that a wider use of nitrogen containing forage supplements may be needed, although this could lead to an excessive nitrate loading in the water courses and would therefore need monitoring closely. Further, although the use of feed supplements may increase livestock production and decrease methane emissions, there may be an increase in the net cost of animal production. Higher temperatures may favour those breeds that have a higher heat tolerance. Climate change may also affect the frequency and spatial extent of livestock disease outbreaks, such as foot and mouth disease. Additional preventative measures, which would support existing restrictions, would be useful in controlling such diseases.

Alternative land use and a decreased dependency on ranching may be necessary to combat the effects of climate change on organised agriculture. Agricultural management practices that recognise drought as part of a highly variable climate, rather than a natural disaster, should be encouraged. Farmers should be provided with information on climatic conditions, and incentives should be given to those farmers who adopt sound practices for drought management, and therefore do not rely on drought relief funds. Land use planning can be used to identify trends in land use that would be advantageous in the event of climate change. Suitable measures could be incorporated in national agricultural policy.

Intervention: Adaptation in agriculture.

Adaptation measures should include changes in agricultural management practices, such as a change in planting dates, row spacing, planting density and cultivar choice, and other measures, which would counteract the effects of limited moisture. Irrigation is currently used to supplement low levels of precipitation but this could become very expensive and less effective, giving conditions of increasing aridity. This would require a phasing out of irrigation farming and a relocation of the production areas eastwards, if practicable. To reduce the risk of famine, marginal production areas could be kept economically viable by, for example, decreasing input costs or planting drought resistant crops, such as sorghum or millet. Alternatively, land use could be changed to grazing.

A reduction of reliance on industrialised mono-cropping and diversification of the range of crops cultivated will reduce vulnerability as well as creating jobs and potentially reducing irrigation needs. Development of more and better heat and drought resistant crops would help fulfil current and future national food demand by improving production efficiencies in marginal areas, with immediate effect.

Seed banks that maintain a variety of seed types that preserve biological diversity and provide farmers with an opportunity to make informed choices could be used to counteract the effects of climate change, maintain food security and establish possibilities for profitable specialisation. This should be adopted as a priority and needs to maximise the role of local communities.

Many current agricultural practices, such as conservation tilling, furrow dyking, terracing, contouring, and planting vegetation as windbreaks, protect fields from water and wind erosion and assist in retaining moisture by reducing evaporation and increasing water infiltration. Management practices that reduce dependence on irrigation would reduce water consumption without reducing crop yields, and would allow for greater resiliency in adapting to future climate changes. Such methods include water harvesting. The reduced use of some pesticides could directly reduce greenhouse gas emissions and also reduce water pollution, thus contributing to both adaptation and mitigation.

Intervention: Changes in forestry practices.

More temperature tolerant cultivars within the current tree species could be selected, but it is more probable that more lucrative uses for the land, such as sub-tropical fruits, may compete for the land currently under tree plantations. Genetic engineering could be used to develop more heat and drought resistant hybrids, which would allow the forestry industry to counter the threat of climate change and also to maintain current production areas. However, it should be noted that current commercial forests make extensive use of exotic species, a practice that may influence biodiversity and other climate change sensitive factors such as excessive water use and soil properties. Further, community based forestry, using indigenous species and knowledge, has demonstrable benefits. In addition, a smaller scale approach can generate more employment, and may also be more compatible with a diversity of

crops/species, thus serving adaptation and reducing vulnerability. The benefits of all approaches need to be carefully evaluated as a matter of urgency and an appropriate action plan developed.

Intervention: Protecting plant biodiversity

Existing plant cover will have to be managed, since successful regeneration will become more difficult in some areas. A biodiversity monitoring network of areas that combine those at risk to future climate change with current high biodiversity and security of land tenure could be established in order to implement changes and management practices in the identified areas. In addition, sensitive indicator species could be identified to serve as warning entities.

Ex-situ conservation and seed banks are already important conservation tools in South Africa and may become more important in the future as a means of propagating species. However, it will probably be impossible to conserve all species, necessitating the implementation of mechanisms to prioritise intervention. These mechanisms may include the development of a cost benefit analysis based on considerations such as potential importance, genetic variation and uniqueness. For particular species, intensive rescue efforts might be warranted to the point where wild species are effectively "gardened". Conservation planning is required to ensure that a 10 percent conservation requirement is implemented for each vegetation type.

Intervention: Protection of animal biodiversity

Adaptation options for maintaining animal diversity could include the implementation of a conservation area network that would buffer the effects of climate change. The establishment of a species inventory and distribution monitoring network would focus attention on potential detector species as a point of departure and highlight areas most likely to be susceptible to climate change, the western arid zone and the escarpment areas being the most vulnerable. Land use practices and land use patterns outside conservation areas should be adapted to minimise the negative impacts of climate change on biodiversity conservation and future dispersal probabilities.

Intervention: Protecting marine biodiversity

As for plants and land animals, the establishment of a biodiversity monitoring network could be used to identify those species that will be impacted by climate change and may assist in the identification of species that could be used as indicator species.

Intervention: Formulate actions that will offset the economic vulnerability of South Africa to climate change response measures.

Intensive economic modelling studies and scenario analyses should be undertaken to establish the areas of specific economic vulnerability to climate change response measures that may critically affect South Africa. Informed policy can then be formulated to meet the challenges posed by this threat and ensure continued national economic growth. Such policy can be expected to cut across many sectors of the economy and will have to be formulated through a collaboration of many government departments, in association with a wide variety of stakeholders and interest groups.

4.5 Mitigation

Mitigation efforts should form an integral part of sustainable development and, in particular, cleaner production strategies. Mitigation action requires a long-term shift in the national economic/industrial base away from dependence on natural resource export and primary minerals beneficiation to manufacturing and other value-adding activities. To be successful, climate change action will eventually require a reversal of the global devaluation of natural resources, including energy. In this regard, a comprehensive national climate change strategy should ultimately address macro-economic considerations and not limit itself to a sector-by-sector approach. However, this is beyond the scope of the current document.

It is re-emphasized that, as a non-annex I country, South Africa is not required to meet any specific emission reduction or limitation targets in terms of its commitments under the UNFCCC or the Kyoto protocol. However, a consideration of possible mitigation options is useful and it can point the way in which trends could emerge in the future. The mitigation measures suggested in this section are based on those described in the National Communications and Country Studies documents. Thus the section is not exhaustive and many other mitigation measures may become apparent as programmes proceed. However, the mitigation measures described have, to some extent, been evaluated against current data and may thus be considered to be realistic. Further, it should be noted that, although DEAT may support the suggested measures in principle, much of the work comes under the jurisdiction of other national government departments, and within other spheres of government.

Objective: Create a national greenhouse gas mitigation plan that furthers the process of sustainable development in South Africa in the light of CDM, technology transfer, donor funding and capacity building opportunities.

The mitigation of greenhouse gases can be undertaken in many ways, including, *inter alia*, the introduction of renewable energy resources, fuel switching and energisation, domestic and industrial efficiency programmes, energy efficient housing, transport, agricultural and forestry schemes and non-biological carbon sequestration. As the South African economy is particularly dependent on coal, diversification measures that reduce this dependency should be considered, providing that such measures make economic sense and promote sustainable development. Such actions will require a comprehensive technology needs analysis to be undertaken for South Africa. This is an important component of any national strategy, as it will enable South Africa to capitalize on any financial support that may be offered for such activities, as well as feeding into and supporting capacity building initiatives.

DME and the industrial sector, amongst others, should drive renewable energy and energy efficiency programmes. A potential barrier to adopting both energy efficiency and renewable energy programmes in South Africa is the relatively low base cost of primary energy.

A collation of existing information on energy efficiency programmes in all sectors needs to be initiated, to gain knowledge of areas where such programmes are likely to bring benefits by way of lower consumer energy costs, making them attractive from an investment point of view.

The global uptake of renewable energy has been slow in many developed countries, where the cost of primary energy is considerably higher than in South Africa. Further, renewable energy schemes often need to have backup systems, as their availability can potentially be very low. However, there are niche applications that would favour such schemes and projects in this area should be facilitated. Further, research should be supported into the cost effective large-scale bulk supply of energy from

renewable resources, in support of DME's target of an additional 10 000 GWh of renewable energy supply by 2012. In particular, demonstration and technology transfer projects need to be facilitated. Further, the 10 000 GWh target should be critically reviewed on a regular basis to bring it into line with current developments and knowledge.

Intervention: The efforts of all stakeholders will be harnessed to achieve the objectives of the Government's White Paper on Renewable Energy (2003) and the Energy Efficiency Strategy, promoting a sustainable development path through coordinated government policy.

The energy sector includes emissions from the actual energy industries themselves, together with emissions related to energy use in the industrial, transport, commercial, residential, agriculture, forestry and fishing sectors. This sector is the largest source of greenhouse gases in South Africa, accounting for about half of the total emissions. A large proportion of these emissions emanate from the widespread use of South Africa's abundant coal stocks, and it can be safely assumed that coal will continue to be the primary energy source for many decades to come. The electricity industry alone has billions of Rands invested in coal fired generating plant, much of which has an expected operational life expectancy of two or more decades. Using reported current book asset values, the cost of stranding a single 3600MW power station would amount to about R3 billion. Worse, the station would cost of the order of R40 billion to replace with a similar fossil fuel plant, with approximately 70% of this amount required in foreign currency. Further, any costs incurred in moving to novel technologies would be additional to this. It is thus unlikely that the national economy would be unable to afford the large scale stranding of such assets. However, it should be recognised that where social benefits can be shown to be achievable through implementing non-fossil based energy developments, these should be encouraged where economically feasible.

The following mitigation technologies, and tools to promote mitigation, could be used:

- Integrated energy planning (IEP) at the national level, as well as within specific industrial sectors, would help to ensure the optimum overall mix of energy sources. In the electricity sector, IEP studies have shown that significant emission mitigation could be obtained through both demand side management and through an efficient supply side mix. This could include full cost accounting principles for planning and decision-making, when, and if, such practices become commonly used in the developed world.
- Analysis of net energy balances and the externalised costs of energy sector activities when, and if, such practices become commonly used in the developed world.
- Implement the Government's energy efficiency strategy.
- The development of energy efficiency guidelines and standards.
- Waste avoidance and efficiency promotion in industrial applications, including the mining and energy sectors.
- Clean coal technologies can be expected to be part of the energy mix for the medium-term future, given the abundant coal reserves in South Africa.
- Renewable energy sources are currently being investigated for both bulk and remote stand alone supply purposes. These include wind power, solar power and biomass, all of which can be expected to fulfil niche market applications in the future. The size of the niche market is expected to grow substantially in the longer term and developments taking place in the developed countries, largely subsidised by their governments, may well eventually become attractive alternatives for South Africa, given substantial economic growth and the assistance required to invest in such technologies.
- Although there are virtually no non-greenhouse gas emitting technologies if the full life-cycle of any facility is taken into account, energy sources which have zero, or low, greenhouse gas emissions

during their operational phase, such as hydro and nuclear power, can make a significant contribution to greenhouse gas mitigation.

- Technologies to promote increased efficiency in coal fired power stations are currently being developed, including supercritical steam technology, integrated gasification combined cycle systems, and fluidised bed technology using discard coal.
- Effective demand side management can be used to deliver energy more efficiently by reducing peak requirements on the system.
- Natural gas has now been found in relatively small, but commercially exploitable, quantities off the South African coast. A possible emission mitigation option would be to switch from coal to natural gas as the primary energy resource for the manufacture of synthetic liquid fuels. This would also reduce refinery emissions.
- Importing energy, particularly gas and hydroelectricity, from countries in the region could serve both as a mitigation option and a stimulus to regional development.
- Mitigation in the commercial and residential sectors can be achieved through energy efficiency and fuel switching. The design of housing and buildings is the most important factor determining energy consumption. Fuel switching options include the use of solar water heating, switching from coal to natural gas for boilers and from coal to natural gas for heating. Energy efficiency programmes could include the retrofitting of efficient heating, ventilation and cooling systems, efficient lighting systems and solar hot water heaters, as well as the efficient use of energy for lighting and hot water in the home. Similarly, in the commercial sector the greatest reduction of greenhouse gas emissions would be achieved by the implementation of energy efficient buildings and retrofitting efficient heating, ventilation and cooling systems. It has been the practice in a number of countries for governments to offer financial incentives for energy efficiency improvement schemes, based on government policy in this regard.

As a word of caution, it is emphasised that these options are not ranked in order of preference and that any technology can only be effectively implemented should it be economically and technically viable, using accepted criteria for such an assessment. This should be a pre-condition for granting Government support to any activity. Whereas it can be strongly argued that government, principally through DME and DTI, should create market conditions in favour of renewable energy and energy efficiency to attract foreign and local investment, the burden of proof that such an approach would be successful on a large scale rests with the proponents of such schemes. Indeed, such a policy would be admirable, and should be encouraged, on an appropriate scale that caters for specific niche applications. However, the South African economy, unlike those of the major developed countries, would not easily be able to recover if such schemes were to be adopted widely and then proved unviable, hindering, rather than promoting, essential investment and development.

Intervention: Initiating the Government's joint implementation strategy for the control of exhaust emissions from road-going vehicles.

Based on a Cabinet decision of 2000, DEAT and DME have been drafting and finalizing a joint implementation strategy for the control of exhaust emissions from road-going vehicles in South Africa. Although this primary deals with the removal of lead from petrol and an increased quantity of the sulphur from diesel by 2006, in the process other undesirable components are removed from the fuels and the subsequent emissions. It can be expected that this will be finalised in the near future.

Intervention: Implement a transport sector mitigation programme through the National Department of Transport, in conjunction with the Government's energy efficiency strategy (2003) and the joint implementation strategy for the control of exhaust emissions from road-going vehicles.

Significant mitigation benefits can be found in the transport sector, given the alignment of objectives for controlling climate change emissions and those related strictly to transportation service improvement. The transport sector accounted for about 19 percent of South Africa's greenhouse gas emissions in 2000. The transport sector is the most rapidly growing source of greenhouse gas emissions in South Africa, and is the second most significant source of greenhouse gas emissions in most middle and high income countries. Energy intensity in this sector in South Africa is particularly high due to the extensive use of synthetic fuels, and their production process.

Response measures should include addressing issues of urban and peri-urban planning in relation to both passenger and commercial transport. On the passenger transport side, the most significant challenge is to improve the currently inadequate public transport system significantly enough to retain most of the 86% of daily commuters it currently carries. This challenge is being addressed by the National Department of Transport (NDOT) through a number of initiatives. In terms of emissions from the commercial side of the sector – particularly freight transport, further research is required into the range of policy options for influencing transport modes, and their economic and practical implications for South Africa. Mitigation options include public transport initiatives, energy efficiency improvements, fuel switching and new propulsion technologies.

- Fuel switching could include liquefied petroleum gas, biochemical fuels, compressed natural gas, and electric and hybrid electric propulsion technology.
- Travel demand management offers significant opportunity to mitigate growth of emissions from private car users.
- The management of public transport systems must be radically improved. Measures include provision of new vehicles, security on public transport and in non-motorised transport use, integration of modes and their timetables/services, the introduction of clear information and customer service training, increased maintenance of vehicles, stops and stations, and formalization of the minibus taxi sector.
- Municipalities and operators should be encouraged to introduce a wide variety of more efficient public transport propulsion systems and pilot alternative fuel use. These technologies and systems include bus rapid transit and bio fuels.
- Non-motorised transport can be encouraged through appropriate planning, provision of infrastructure, and marketing of these emissions-free, low cost modes.

Intervention: Develop and implement an appropriate coal-mining sector mitigation programme through the Department of Minerals and Energy and the mining industry.

In the coal mining industry, methane emissions are directly linked to the volume of coal mined and the methods used in the mining. South African coal beds, however, contain relatively little methane, so the mitigation potential is somewhat limited in this country. Methods of limiting overall emissions of methane include:

- Adopting higher extraction ratios underground, as pillar methods of mining leave considerable quantities of coal not mined in the form of support pillars from which methane diffuses into the atmosphere. Ash filling could be employed to facilitate this.
- The extraction of remnant pillars that are readily accessible by opencasting would stabilise the under-mined ground permanently and would prevent spontaneous combustion.

- Improved coal utilisation resulting from improved coal washing will result in a reduced discard coal fraction.
- Improved combustion technology to burn discards that are presently not combustible due to the high ash content leading to excessive erosion of boiler internals.
- Removal of emitted methane prior to mining by draining through holes drilled from the surface can be practical and, in addition, the methane could be used for local heating applications.
- Catalytic combustion of methane to produce carbon dioxide and water with possible recovery of the generated heat.
- Prevention of spontaneous combustion of coal in abandoned mines and discard dumps and extinguishing underground fires.

Intervention: Implement sustainable industrial development through coordinated policies, strategies and incentives through the Department of Trade and Industry and the various industry sectors.

Mitigation options have been investigated for various industries, excluding those that are specifically part of the energy sector. The list of options is not exhaustive but serves as an example of what could be achieved and in which areas it might be useful to focus. The following suggestions have been advanced:

- Development of energy efficiency standards for particular sectors and/or products.
- The cement industry has already started to reduce emissions by implementing a strategy of using industrial waste products in combination with cement. The dilution of cement clinker with selected industrial waste materials such as granulated slag, fly ash, silica fume or milled limestone has the effect of reducing the net emissions per ton of cementitious material used. Other measures being considered are the reduction of energy consumption by additional pre-heating stages and pre-calcining of the feed. A further mitigating option is to phase out existing wet process clinker kilns.
- In the ferroalloys industries, two mitigating options have been considered. A potential significant reduction of emissions could be achieved by optimisation of the process conditions, an option that could be considered in many other industries as well. A long-term option is to recover the carbon dioxide off-gas from the furnace to pre-heat the raw materials or to generate electricity.
- Globally the chemical industry is considered to be responsible for 20% of greenhouse gas emissions. In South Africa, energy consumption in the sector is receiving attention and improvements in energy efficiency may be possible, particularly for steam production, but also for other processes. The industry is currently undergoing major consolidation and restructuring worldwide and, as a result, companies are likely to focus on a more limited range of products and to promote research into new technologies. It is expected that new production technology developed for these processes will include cleaner technology, which will assist in minimising greenhouse gas emissions. This should be encouraged. Further, there are many more greenhouse gases than the six listed in the Kyoto Protocol that are by products of the chemical industry. These should be defined to allow the industry to address them.
- In the pulp and paper industry, upgrading or replacing recovery boilers increases the boiler capacity and the energy values of higher black-liquor solids. The useful realisation of energy, through the incineration of organic residuals reclaimed from spent cooking liquor, has significant potential in terms of increased energy efficiency levels. The technology used in the recovery process is expensive and introducing any improvement in the efficiency of existing technology would involve significant capital expenditure. More feasible options include efficiency improvements and recycling of paper.
- For the aluminium industry, the substitution of raw materials with secondary recycled materials can reduce energy consumption during the production of aluminium by up to 95%.

Intervention: Reduce greenhouse gas emissions in the agricultural sector through the National Department of Agriculture.

Mitigating options that could be considered for the agricultural sector include the following:

- Optimisation of the herd sex, age and breed would allow the national herd to be reduced while maintaining the same level of production. Supplementing the feed with high protein forage would reduce the methane production from enteric fermentation and increase productivity.
- Extending feedlot manure management to include anaerobic digestion and the collection and use of the methane gas produced.
- Promoting the use of game in place of beef production.
- Avoiding the burning of agricultural residues, including those from sugar cane plantations, even where such methods are accepted management practice.
- Reduction of the frequency of fires by enhanced fire management practices.
- Promoting savannah thickening over substantial areas.
- Effectively managing soil organic matter.
- Adopting minimum tillage methods.
- Exploring synergies between adaptation and mitigation measures in the areas of agricultural product diversification and the application of more socially beneficial agro-technologies such as permaculture to provide sustainable livelihoods.

Intervention: Facilitate the establishment and extension of forest schemes through the Department of Water Affairs and Forestry and the forestry industry.

Afforestation schemes could be planted, within the limitations for land-use, land-use change and forestry defined in the Kyoto Protocol, and provided that such schemes do not compromise other commitments and requirements under any of the environmental conventions and treaties and do not compromise other environmental objectives, such as the need to promote biodiversity.

Intervention: Optimise waste management practices to minimise the emissions of greenhouse gases and develop a government position, through all relevant departments and all spheres of government and industry, to implement a waste sector mitigation programme.

Waste avoidance and minimisation should be given priority, with full recognition of the in-built energy of materials entering the waste stream. Re-use and recycling should be vigorously encouraged.

The quantity of waste requiring disposal at landfill sites is currently increasing as a result of urbanisation, with a consequent increase in the methane gas generated. As a possible mitigation measure, mechanisms are currently under investigation to promote sustainable recycling of post-consumer waste in order to minimise the amount of recyclable material that is currently disposed of in landfills. Further, as it stands, collection of the methane gas generated at the landfill sites is limited. Pilot studies are being conducted to collect the biogas and refine it, using membrane technology, so that it can be used as a fuel. Composting needs to be encouraged as a useful mitigation strategy.

The national climate change response strategy must broadly recognize and incorporate the relevant initiatives being undertaken by all relevant government departments and agencies, such as the National Cleaner Production Centre, which has been developed under the mandate of DTI. Such schemes can be used to promote the implementation of environmentally friendly technologies and include initiatives to prevent and minimise industrial waste production. Further, through proposed initiatives from the Department of Health (DoH), which incorporate health directed undertakings within all spheres of

government and industry in the waste disposal sector, climate benefits can be linked advantageously to public health benefits.

4.6 International concerns

As South Africa is now an active player in the international arena in many areas, it is important that national climate change response plans are acceptable to the broader global community. At the very least, this means demonstrated adherence to all international treaties, conventions and protocols to which South Africa is a party. However, being seen to be taking a leading role amongst the ranks of the developing countries could considerably enhance South Africa's standing in the international community. This is particularly true with regard to the UNFCCC, as South Africa stands to gain from the potential sustainable development benefits stemming from the Kyoto Protocol. Further, there is considerable potential for greater regional co-operation in Southern Africa, with sensitivity to the needs and opportunities of Least Developed Countries.

Objective: Optimise South Africa's potential to benefit from climate change mitigation by suitable international response and positioning.

To ensure appropriate access to the Kyoto Mechanisms, and other development funding, South Africa generally aligns itself with the Group of 77 and China negotiating bloc (G77+China). However, as one of the leading nations in the Africa Group, this will often take precedent if there is disagreement with the G77+China. It is important to note that it is unlikely that South Africa can take the position of the annex I and annex II countries ahead of the needs expressed by the G77+China, or the Africa Group, unless this action is specifically advantageous for South Africa. Further, South Africa must take the lead and express its concern for issues that are related specifically to its own economy and development, such as the dependency on coal.

Intervention: Maintain an appropriate attendance at UNFCCC and related meetings.

Continued attendance at the UNFCCC conference of parties and other related meetings is crucial. The Minister of Environmental Affairs and Tourism has the authority to choose the composition of the delegation. However, it is expected that the NCCC will advise the Minister in this regard. It is essential to include delegates from government departments other than DEAT in the delegation and appropriate representation will be proposed by the relevant Directors General and communicated via the NCCC. A full time negotiator could also be included in the Delegation. The inclusion in the delegation of representatives from other stakeholder groups, such as business, NGO's and labour, has provided considerable advantages in the past and this practice should continue. It will be incumbent on DEAT to operationalise any relevant actions coming out of the conference of parties meetings and, where appropriate, to enlist the cooperation of other government departments, provincial and local government and non-government entities.

4.7 Cross-cutting issues within government

There is an urgent need for all involved national government departments, other spheres of government and non-government institutions to work on a cooperative basis to deal with climate change issues. As for most environmental issues, intervention in one sector can sometimes produce an unforeseen and often unwanted response in another. Whereas DEAT has been designated as the lead agency for climate change, it should see its role as one of a coordinator, specifically providing appropriate input into the polices and actions that are the jurisdiction of other government departments, to ensure that

inter-sectoral linkages are identified and considered. Further, a high level of inter-departmental co-operation within government will greatly assist the non-governmental sectors in their interactions with government.

Objective: To ensure that government departments in all spheres work together on a cooperative basis in dealing with climate change.

A national strategy requires that all government departments and institutions that may be involved must work in a coordinated manner, to ensure that response measures are properly directed, acceptable to all and carried out with a national focus. This participation can be encouraged through regular dialogue at an individual level as well as through the use of existing government interdepartmental structures such as the Committee for Environmental Coordination (CEC). The GCCC was also set up, within government, as a forum to deal specifically with such matters at an appropriate level. This is specifically aimed at directorate level participation to ensure the operationalisation of programmes and actions. Other government departments are also represented officially on the NCCC.

Intervention: Use the Government Committee for Climate Change to consolidate the government position.

DEAT should facilitate the full participation of provincial and local governments in climate change directed projects, within the boundaries of their specific jurisdictions. This will ensure that response measures are properly directed, acceptable to all and carried out with a focus appropriate to local communities. As for other national departments, this participation can be facilitated through regular dialogue at an individual level as well as through the use of existing government structures that facilitate inter-tier communications, such as the MINMEC committee, which provides the interface between the Minister and the Provincial Members of the Executive Councils and MINTECH, which is technical committee that advises MINMEC and comprises of the Director-General of the Department of Environmental Affairs and Tourism and the relevant provincial department heads. Certain provincial governments are already officially represented at the NCCC and the further involvement of provincial and local government in climate change matters should be actively solicited.

4.8 Legislation

It is current thinking that a specific Act of Parliament to deal with climate change issues in South Africa is not warranted by present circumstances. However, specific amendments can be made to other laws that embrace environmental issues such that climate change provisions are included. Further, any new laws should provide for climate change issues as appropriate.

Objective: Ensure that South African environmental law provides for climate change issues.

It is unlikely that legal provisions should prescribe specific methods and principles by which climate change adaptation and mitigation actions should be brought about. Rather, legal provisions would set out the broad objectives of providing for climate change actions with the established linkages to other sectors.

Intervention: Use the ongoing law reform process to ensure that climate change issues are provided for in South African legislation.

There are currently several environmental law reform initiatives under way and the opportunity to use this for incorporating climate change provisions in these laws should be used. It is the government's intention that greenhouse gas emissions and inventories will be specifically dealt with in the impending National Environmental Management: Air Quality Act.

4.9 Education, training, awareness and capacity building

Education, training and public awareness regarding climate change lag behind the requisite standards in South Africa for historic reasons. This matter warrants immediate action across the whole spectrum of national activities, both within and outside the government sector.

Objective: Improve the level of education, training and awareness regarding climate change in South Africa and capacitate the government and other sectors to deal with climate change issues effectively to the benefit of the country.

In addressing this objective, existing skills need to be used where possible, together with a degree of retraining and orientation to rectify the situation. This area is one in which international donor funding can be used to maximum advantage. The experience of the donor countries should be extremely valuable in shortening the learning curve and speeding up the operationalisation of the action plans.

Intervention: Accelerate the process of relevant education, training, awareness and capacity building in South Africa to speed up the implementation of climate change response.

Climate change activities should be incorporated into educational curricula at primary, secondary and tertiary levels, in order to broaden public awareness of the issue. In this regard climate change needs to be seen as an integral part of modules on the environment and sustainable development. Industries can be encouraged to develop their own in-house training programmes and share these through industry associations, chambers of commerce and other relevant associations and institutions. DEAT should undertake a needs analysis for education and training requirements, together with the National Department of Education (DoE), within all spheres of government and formulate suitable plans accordingly for the government sector. Extensive use can be made of donor funding for actualisation of education and training needs on a national basis. Particular emphasis should be placed on 'training the trainer' programmes, through suitable interaction with overseas experts in the field and institutions. Certain tertiary education establishments could be selected to develop, or extend, 'centres of excellence' in environmental education, specifically including climate change and sustainable development, to ensure continuity of the education process. This could also be encouraged in privately funded institutions.

Regarding capacity building, there is an ill-defined dividing line separating the optimum amount of internal expertise in government and what should be bought in as a contracted service. The problem is obscured by the fact that some industrial concerns have an amount of technical expertise that far exceeds the government's in-house capabilities. If national government has a lack of expertise, there is a much greater problem at provincial and local government levels. Further, national departments, other than DEAT, who are involved in climate change related work, also lack the necessary expertise in some critical areas. A needs analysis should be undertaken that looks at the optimum staffing level for the national climate change response function within national government departments and for provincial and local governments. Further, cooperation with industry needs to be facilitated, as it is both

necessary and desirable to make full use of available expertise. Industry should be prepared to second suitable personnel to DEAT, DME, DST and other departments for specific purposes and vice-versa, building up working relationships, knowledge and broad competency between the parties. In addition, all contract work awarded to consultants should be viewed as a vehicle for training and skilling government officials and the necessary arrangements to facilitate this should be built into the contract as appropriate.

Capacity building projects should be largely funded through donor aid organizations. By building capacity, the numerous opportunities available via climate change response projects can be readily accessed for the benefit of the country as a whole, as well as for specific communities and regions. Further, appropriate adaptation measures can be undertaken, reducing the impacts of climate change on South Africa.

4.10 Research, development and demonstration

The effective coordination of climate change research in South and Southern Africa would have many benefits, not the least being the effective use of limited scientific resources. Attention needs to be focussed on projects that will assist with adaptation to climate change and address specific areas of vulnerability. Further, development and demonstration projects are required to show the advantages and acceptability of a variety of technologies related to climate change. An appropriate national research programme would provide for public participation, particularly in identifying opportunities and priorities, and must provide for transparency through a project information management system. This responsibility could be assigned to DST, either directly or through its agency, the NRF.

Objective: Ensure that there is an effective and integrated programme of climate change research, development and demonstration in South Africa.

Although DEAT is the lead agency for climate change, the department should, nonetheless, not be directly involved in research projects in its own right. It should rather function as a coordinator, ensuring that research is conducted for the national benefit in an efficient and effective manner and the results are passed on to the proper institutions. A national project information management system, as proposed, could be used to great advantage to ensure the forwarding of research information to the IPCC, for inclusion in its periodic assessment reports, and to IGBP participants. This way, the value of the research can be effectively realised.

Intervention: Set up a database of climate change related research, development and demonstration projects and integrate the research, development and demonstration programme for South and Southern Africa.

Government should ensure that projects concerned with systematic observation and climate research are carried out for South Africa, and for the Southern African Region in general. Such projects will concentrate on the areas of defining vulnerability and improved forecasting skills, in addition to building up a reliable database of information. The appropriate Southern African Development Community (SADC) structures in this regard need to be engaged and, if necessary, reviewed. The DST's SAEON programme, referred to above, is already making a vital contribution in this area. The Kruger Park site draws on some thirteen years of environmental data held by the Agricultural Research Council (ARC) and the South African Weather Services (SAWS). Fynbos ecological sites are currently being examined as the programme is further rolled out. Strong links need to be maintained with international groups working under the auspices of the IGBP and other organizations. This will guarantee an optimum return on investment for South Africa for climate related scientific projects.

4.11 Air quality management

Air pollution is a major problem in South Africa for a variety of reasons, but particularly in urban areas as a result of domestic coal use. This can affect all sectors of the population and many people are subjected to excessive air pollution levels for their entire lives, with the resultant toll on health and productivity. Much can be done to alleviate the situation and many of the possible solutions also have benefits regarding the emissions of greenhouse gases. Further, global warming will enhance the occurrence of surface temperature inversions thus exacerbating urban pollution.

Objective: Identify and put in place an information handling system that incorporates greenhouse gas data.

DEAT is the department that is responsible for ensuring that air quality in South Africa is managed to an acceptable level. As DEAT is already setting controls on emissions to atmosphere, it is a relatively simple task to include greenhouse gas emissions under the same umbrella. The same is true regarding the issue of demonstrating compliance with any regulations that may be promulgated for greenhouse gas emissions.

Intervention: Introduce greenhouse gas emissions into air quality legislation and put in place a national information handling system that incorporates greenhouse gas data alongside air pollution data.

DEAT is in an ideal situation to ensure that these measures are carried out effectively as it already has the required mandate in the area of air quality management. Present initiatives to manage air quality through ambient air quality standards will assist the matter greatly. The projected air pollution information handling system will also act as an ideal platform for drawing up the necessary greenhouse gas inventory reports for periodic submission to the UNFCCC, and the system should be designed from the outset to accommodate both greenhouse gas and air pollution data.

4.12 Accessing and managing financial resources for climate change

In addition to ensuring that adequate resources are available for the various government departments to carry out the tasks required of them in meeting climate change, South Africa is a developing country that will benefit from the financial opportunities made available through UNFCCC provisions. A strategy to access these funds is required and this includes being ready by putting appropriate systems and institutions in place. It must be noted that there is stiff competition between developing countries to attract climate change related funds with China and Latin America likely to get the biggest slice, especially CDM investment.

Objective: Ensure that South Africa gets the best possible access to available climate change funding.

South Africa, as a developing country, will be able to meet its obligations under the convention and mitigate climate change through assistance from developed country parties, providing that appropriate access to funding can be secured. However, it is important to realise that such funding must result in projects that are in line with South Africa's domestic sustainable development needs.

Intervention: Ensure that an investment friendly climate is developed and maintained to attract developed country partners to invest in climate change related projects in South Africa.

This will create a means to tackle projects with a wide range of social and economic benefits that would not be possible without such assistance.

Intervention: Coordination of Climate Change donor funds that are procured for South Africa.

South Africa receives funding from several sources and it is vitally important that these funds are effectively coordinated to serve domestic needs and at the same time satisfy the aspirations of the donor parties, even if each department retains its own responsibility for the administration of such funds.

Intervention: Involve the public sector and financing institutions linked to government, such as the Industrial Development Corporation and the Development Bank of South Africa.

In addition to NGOs and business, role-players that should be explicitly involved and who could bring funding to climate change response action include the public sector, through the Department of Public Enterprises and financing institutions linked to government, such as the Industrial Development Corporation (IDC) and the Development Bank of South Africa (DBSA).

5. CONCLUSION

It is noted that the strategy is firstly aimed at government and its associated institutions, including all public sector funding and implementing agencies. As a result, the material in each section is divided into those categories that are the primary means by which government can influence the development of climate change response in South Africa and maximise the derived benefits. These include the legal framework, the funding mechanisms, the creation of new infrastructure and institutional arrangements and the encouragement of research. In each of these fields, government has a number of instruments with which to achieve certain outcomes and this report outlines both the desired outcomes and the interventions by which such outcomes can be achieved.

However, it must be clearly understood that government alone cannot carry out the tasks identified in this document. Success will only be achieved through the total involvement of the private and non-governmental sectors. The national climate change response strategy thus needs to be owned by them as much as by the government sector if it is to represent a truly national course of action. Rather than regarding this document as a rigid prescription for what has to be done, it should be modified to accommodate new ideas and directions as the need arises, and when such issues are identified by any of the stakeholders, not just government.

The overall implementation of the strategy will require substantial financial and other resources. As climate change is a cross cutting issue, various sources of funds can be tapped. In addition donor funding is available for various aspects of climate change work. South Africa needs to develop a framework to effectively access and manage these funds. While it is extremely important to understand the reality and constraints of the South African economy, no door must be closed to any action based on sound economic principles, which can bring tangible benefits to the country and its people. Both physical and economic vulnerability are relevant.

6. KEY ACTIONS

A number of key interventions have been proposed in this document that cut across the entire spectrum of possibilities for climate change response actions. Through the implementation of this national climate change response programme, South Africa will avail itself of the potential advantages that could stem from international action on climate change, whilst at the same time minimising its vulnerability to such events. The following key actions will be taken to achieve this end:

a) Rapidly develop the DNA function within the Department of Minerals and Energy to facilitate the forwarding of CDM project proposals to the Executive Board for approval without undue delay.
b) Perform a technology needs analysis for South Africa that builds on and integrates existing knowledge, through the Department of Science and Technology.
c) Set up a contemporary database of climate change related research, development and demonstration projects for South Africa.
d) Develop and maintain an investment friendly climate to attract developed country partners to invest in climate change related projects in South Africa, primarily through the Department of Trade and Industry.
e) Access appropriate funds, as feasible, for implementation of the climate change programme, in particular for adaptation purposes.
f) Effectively coordinate climate change donor funds that are procured for South Africa.
g) Use the public sector and financing institutions linked to government, such as the Industrial Development Corporation and the Development Bank of South Africa to fund climate change projects.
h) Accelerate the process of education, training and awareness of climate change and its impacts to speed up the implementation of response actions.
i) Ensure the cooperation and buy-in of all stakeholders to climate change response through the NCCC and GCCC, to facilitate a coordinated national programme.
j) Harness the efforts of all stakeholders to achieve the objectives of the Government's White Paper on Renewable Energy (2003) and the Energy Efficiency Strategy, promoting a sustainable development path through coordinated government policy.
k) Implement a transport sector mitigation programme, in conjunction with the Government's energy efficiency strategy and the joint implementation strategy for the control of exhaust emissions from road-going vehicles, through the National Department of Transport.
l) Implement sustainable industrial development through coordinated policies, strategies and incentives through the Department of Trade and Industry and the various industry sectors.
m) Extend health protection and promotion measures to counter climate change related impacts through the Department of Health.
n) Accelerate water resource management and contingency planning through the Department of Water Affairs and Forestry.
o) Adapt agricultural, rangeland and forestry practices appropriately through the Departments of Agriculture and Water Affairs and Forestry.
p) Develop protection plans for plant, animal and marine biodiversity.
q) Develop and implement an appropriate coal-mining sector mitigation programme through the Department of Minerals and Energy and the mining industry.
r) Optimise waste management practices to minimise the emissions of greenhouse gases and develop a government position, through all relevant departments and all spheres of government and industry, to implement a waste sector mitigation programme.
s) Maintain an appropriate attendance at UNFCCC and related meetings.
t) Use the ongoing law reform process to ensure that climate change issues are provided for in South African legislation.

u) Introduce greenhouse gas emissions into air quality legislation and put in place a national ambient information handling system that incorporates greenhouse gas data alongside air pollution data.
v) Set a time frame for action, with specific milestones and responsibilities, to formulate appropriate national policies and measures for climate change action and develop a practicable plan of implementation.

COMMONLY USED ABBREVIATIONS

AGBM	Ad-hoc Group on the Berlin Mandate
AIJ	Activities to be Implemented Jointly
AMTS	Advanced Manufacturing and Technology Strategy
AOGCM	Atmosphere Ocean General Circulation Model
ARC	Agricultural Research Council
BAPA	Buenos Aires Plan of Action
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CH_4	Methane
CO_2	Carbon Dioxide
CONNEPP	Consultative National Environmental Policy Process
CoP	Conference of the Parties (to the UNFCCC)
CSIR	Council for Scientific and Industrial Research
DEAT	Department of Environmental Affairs and Tourism
DME	Department of Minerals and Energy
DOE	Department of Education
DOH	Department of Health
DST	Department of Science and Technology
DTI	Department of Trade and Industry
DWAF	Department of Water Affairs and Forestry
EIT	Economy in Transition
ENSO	El Niño Southern Oscillation (climate pattern)
ET	Emissions Trading
FDI	Foreign Direct Investment
G77+China	Group of 77 developing countries together with China
GCC	Global Climate Change
GCCC	Government Committee for Climate Change
GCM	General Circulation Model
GDP	Gross Domestic Product
GEAR	Growth, Employment and Redistribution (government macro-economic policy)
GHG	Greenhouse gas
GTZ	Deutsche Gesellschaft für Technische Zuzammenarbeit (German Association for Technical Cooperation)
HCFC	Hyrochlorofluorocarbon
HFC	Hydrolfluorocarbon
ICCC	Interdepartmental Committee on Climate Change
IEP	Integrated Energy Planning
IGBP	International Geosphere Biosphere Programme
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
KP	The Kyoto Protocol to the UNFCCC
LULUCF	Land-Use, Land-Use Change and Forestry
MINMEC	Combined National/Provincial and Local Government Committee
MINTECH	Technical arm of MINMEC
MoP	Meeting of the Parties (to the Kyoto Protocol)
N_2O	Nitrous Oxide
NACI	National Advisory Council on Innovation
NAPAC	National Air Pollution Advisory Committee

NCCC	National Committee for Climate Change
NDOT	National Department of Transport
NEMA	National Environmental Management Act
NGO	Non-Governmental Organization
NEPAD	New Partnership for Africa's Development
O_2	Oxygen
O_3	Ozone
OE	Operational Entity
PFC	Perfluorocarbon
QELRO	Quantified Emission Limitation or Reduction Objective
RCM	Regional Climate Model
SAA	South African Airways
SABS	South African Bureau of Standards
SADC	Southern African Development Community
SANAP	The South African National Antarctic Programme
SASAS	South African Society for Atmospheric Sciences
SESSA	Sustainable Energy Society of South Africa
SDI	Spatial Development Initiative
SF_6	Sulphurhexafluoride
SAWS	South African Weather Services
TAR	Third Assessment Report (of the IPCC)
THC	Thermohaline Circulation
UNCBD	United Nations Convention on Biodiversity
UNCCD	United Nations Convention to Combat Desertification
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
UV	Ultraviolet
VCPOL	Vienna Convention for the Protection of the Ozone Layer
WAIS	West Antarctic Ice Sheet
WHO	World Health Organization

BIBLIOGRAPHY

This document has been prepared using the references listed below. These are mainly summary type documents that, in turn, contain detailed references to the actual work performed by the individual contributors, the volumes of work being published worldwide on climate change being truly prolific. Thus only the references to the key documents used are given here. In the case of the specialist readers, they are challenged to follow the leads given in the summary documents, and on the myriad climate change web sites, to follow their own lines of enquiry in depth.

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Climate Change 2007: Synthesis Report

Summary for Policymakers

An Assessment of the Intergovernmental Panel on Climate Change

This summary, approved in detail at IPCC Plenary XXVII (Valencia, Spain, 12-17 November 2007), represents the formally agreed statement of the IPCC concerning key findings and uncertainties contained in the Working Group contributions to the Fourth Assessment Report.

Based on a draft prepared by:

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Introduction

This Synthesis Report is based on the assessment carried out by the three Working Groups of the Intergovernmental Panel on Climate Change (IPCC). It provides an integrated view of climate change as the final part of the IPCC's Fourth Assessment Report (AR4).

A complete elaboration of the Topics covered in this summary can be found in this Synthesis Report and in the underlying reports of the three Working Groups.

1. Observed changes in climate and their effects

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 (Figure SPM.1). *{1.1}*

Eleven of the last twelve years (1995-2006) rank among the twelve warmest years in the instrumental record of global surface temperature (since 1850). The 100-year linear trend (1906-2005) of 0.74 [0.56 to 0.92]°C[1] is larger than the corresponding trend of 0.6 [0.4 to 0.8]°C (1901-2000) given in the Third Assessment Report (TAR) (Figure SPM.1). The temperature increase is widespread over the globe and is greater at higher northern latitudes. Land regions have warmed faster than the oceans (Figures SPM.2, SPM.4). *{1.1, 1.2}*

Rising sea level is consistent with warming (Figure SPM.1). Global average sea level has risen since 1961 at an average rate of 1.8 [1.3 to 2.3] mm/yr and since 1993 at 3.1 [2.4 to 3.8] mm/yr, with contributions from thermal expansion, melting glaciers and ice caps, and the polar ice sheets. Whether the faster rate for 1993 to 2003 reflects decadal variation or an increase in the longer-term trend is unclear. *{1.1}*

Observed decreases in snow and ice extent are also consistent with warming (Figure SPM.1). Satellite data since 1978 show that annual average Arctic sea ice extent has shrunk by 2.7 [2.1 to 3.3]% per decade, with larger decreases in summer of 7.4 [5.0 to 9.8]% per decade. Mountain glaciers and snow cover on average have declined in both hemispheres. *{1.1}*

From 1900 to 2005, precipitation increased significantly in eastern parts of North and South America, northern Europe and northern and central Asia but declined in the Sahel, the Mediterranean, southern Africa and parts of southern Asia. Globally, the area affected by drought has *likely*[2] increased since the 1970s. *{1.1}*

It is *very likely* that over the past 50 years: cold days, cold nights and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent. It is *likely* that: heat waves have become more frequent over most land areas, the frequency of heavy precipitation events has increased over most areas, and since 1975 the incidence of extreme high sea level[3] has increased worldwide. *{1.1}*

There is observational evidence of an increase in intense tropical cyclone activity in the North Atlantic since about 1970, with limited evidence of increases elsewhere. There is no clear trend in the annual numbers of tropical cyclones. It is difficult to ascertain longer-term trends in cyclone activity, particularly prior to 1970. *{1.1}*

Average Northern Hemisphere temperatures during the second half of the 20th century were *very likely* higher than during any other 50-year period in the last 500 years and *likely* the highest in at least the past 1300 years. *{1.1}*

Observational evidence[4] from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases. *{1.2}*

Changes in snow, ice and frozen ground have with *high confidence* increased the number and size of glacial lakes, increased ground instability in mountain and other permafrost regions and led to changes in some Arctic and Antarctic ecosystems. *{1.2}*

There is *high confidence* that some hydrological systems have also been affected through increased runoff and earlier spring peak discharge in many glacier- and snow-fed rivers and through effects on thermal structure and water quality of warming rivers and lakes. *{1.2}*

In terrestrial ecosystems, earlier timing of spring events and poleward and upward shifts in plant and animal ranges are with *very high confidence* linked to recent warming. In some marine and freshwater systems, shifts in ranges and changes in algal, plankton and fish abundance are with *high confidence* associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation. *{1.2}*

Of the more than 29,000 observational data series, from 75 studies, that show significant change in many physical and biological systems, more than 89% are consistent with the direction of change expected as a response to warming (Fig-

[1] Numbers in square brackets indicate a 90% uncertainty interval around a best estimate, i.e. there is an estimated 5% likelihood that the value could be above the range given in square brackets and 5% likelihood that the value could be below that range. Uncertainty intervals are not necessarily symmetric around the corresponding best estimate.

[2] Words in italics represent calibrated expressions of uncertainty and confidence. Relevant terms are explained in the Box 'Treatment of uncertainty' in the Introduction of this Synthesis Report.

[3] Excluding tsunamis, which are not due to climate change. Extreme high sea level depends on average sea level and on regional weather systems. It is defined here as the highest 1% of hourly values of observed sea level at a station for a given reference period.

[4] Based largely on data sets that cover the period since 1970.

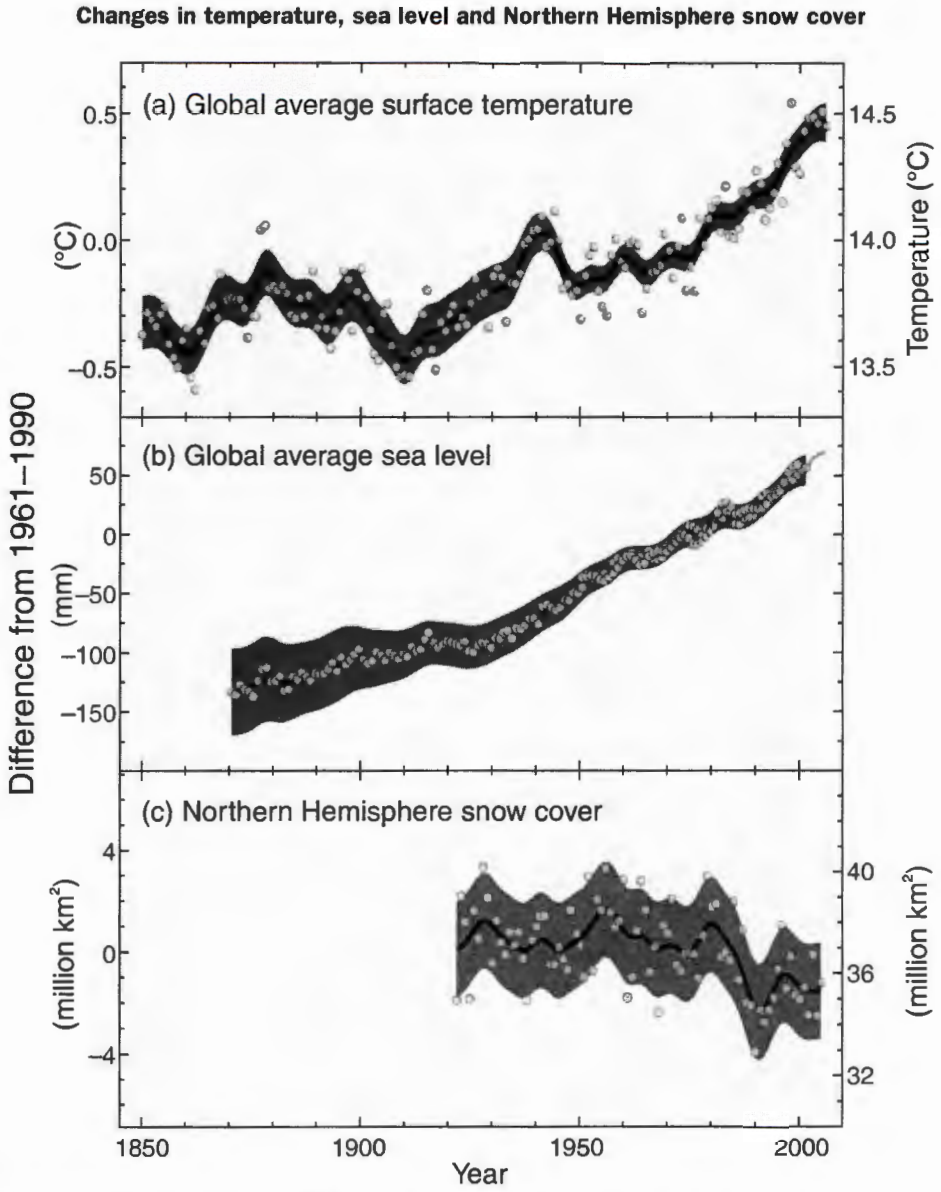


Figure SPM.1. *Observed changes in (a) global average surface temperature; (b) global average sea level from tide gauge (blue) and satellite (red) data and (c) Northern Hemisphere snow cover for March-April. All differences are relative to corresponding averages for the period 1961-1990. Smoothed curves represent decadal averaged values while circles show yearly values. The shaded areas are the uncertainty intervals estimated from a comprehensive analysis of known uncertainties (a and b) and from the time series (c). {Figure 1.1}*

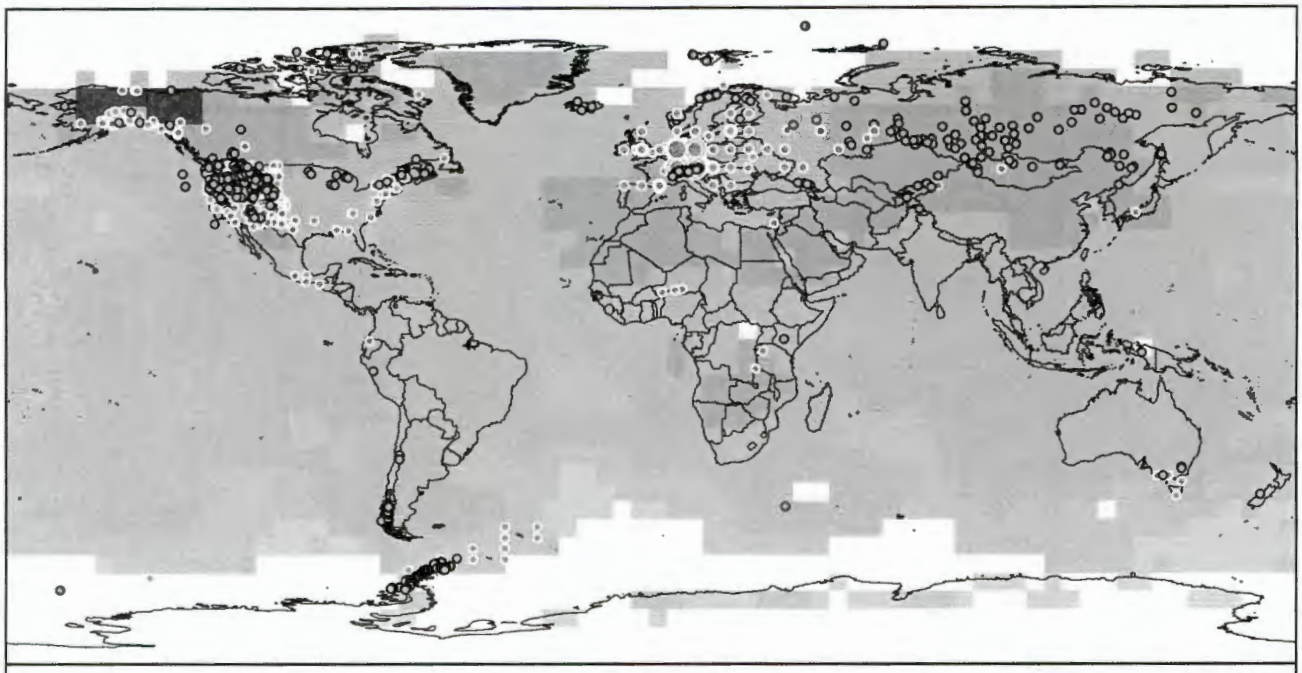
ure SPM.2). However, there is a notable lack of geographic balance in data and literature on observed changes, with marked scarcity in developing countries. *{1.2, 1.3}*

There is *medium confidence* that other effects of regional climate change on natural and human environments are emerging, although many are difficult to discern due to adaptation and non-climatic drivers. ***{1.2}***

They include effects of temperature increases on: *{1.2}*

- agricultural and forestry management at Northern Hemisphere higher latitudes, such as earlier spring planting of crops, and alterations in disturbance regimes of forests due to fires and pests
- some aspects of human health, such as heat-related mortality in Europe, changes in infectious disease vectors in some areas, and allergenic pollen in Northern Hemisphere high and mid-latitudes
- some human activities in the Arctic (e.g. hunting and travel over snow and ice) and in lower-elevation alpine areas (such as mountain sports).

Changes in physical and biological systems and surface temperature 1970-2004



NAM	LA	EUR (28,115)	AFR	AS	ANZ	PR*	TER (28,586)	MFW**	GLO (28,671)
355 / 455	53 / 5	119	5 / 2	106 / 8	6 / 0	120 / 24	764	1 / 85	765
94% / 92%	98% / 100%	94% / 89%	100% / 100%	96% / 100%	100% / –	91% / 100%	94% / 90%	100% / 99%	94% / 90%

Observed data series

- Physical systems (snow, ice and frozen ground; hydrology; coastal processes)
- Biological systems (terrestrial, marine, and freshwater)

Physical	Biological
Number of significant observed changes	Number of significant observed changes
Percentage of significant changes consistent with warming	Percentage of significant changes consistent with warming

Europe ***

- 1-30
- 31-100
- 101-800
- 801-1,200
- 1,201 -7,500

Temperature change °C
1970-2004

-1.0 -0.2 0.2 1.0 2.0 3.5

* Polar regions include also observed changes in marine and freshwater biological systems.

** Marine and freshwater includes observed changes at sites and large areas in oceans, small islands and continents. Locations of large-area marine changes are not shown on the map.

*** Circles in Europe represent 1 to 7,500 data series.

Figure SPM.2. *Locations of significant changes in data series of physical systems (snow, ice and frozen ground; hydrology; and coastal processes) and biological systems (terrestrial, marine and freshwater biological systems), are shown together with surface air temperature changes over the period 1970-2004. A subset of about 29,000 data series was selected from about 80,000 data series from 577 studies. These met the following criteria: (1) ending in 1990 or later; (2) spanning a period of at least 20 years; and (3) showing a significant change in either direction, as assessed in individual studies. These data series are from about 75 studies (of which about 70 are new since the TAR) and contain about 29,000 data series, of which about 28,000 are from European studies. White areas do not contain sufficient observational climate data to estimate a temperature trend. The 2 x 2 boxes show the total number of data series with significant changes (top row) and the percentage of those consistent with warming (bottom row) for (i) continental regions: North America (NAM), Latin America (LA), Europe (EUR), Africa (AFR), Asia (AS), Australia and New Zealand (ANZ), and Polar Regions (PR) and (ii) global-scale: Terrestrial (TER), Marine and Freshwater (MFW), and Global (GLO). The numbers of studies from the seven regional boxes (NAM, EUR, AFR, AS, ANZ, PR) do not add up to the global (GLO) totals because numbers from regions except Polar do not include the numbers related to Marine and Freshwater (MFW) systems. Locations of large-area marine changes are not shown on the map. {Figure 1.2}*

2. Causes of change

Changes in atmospheric concentrations of greenhouse gases (GHGs) and aerosols, land cover and solar radiation alter the energy balance of the climate system. *{2.2}*

Global GHG emissions due to human activities have grown since pre-industrial times, with an increase of 70% between 1970 and 2004 (Figure SPM.3).[5] *{2.1}*

Carbon dioxide (CO_2) is the most important anthropogenic GHG. Its annual emissions grew by about 80% between 1970 and 2004. The long-term trend of declining CO_2 emissions per unit of energy supplied reversed after 2000. *{2.1}*

Global atmospheric concentrations of CO_2, methane (CH_4) and nitrous oxide (N_2O) have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years. *{2.2}*

Atmospheric concentrations of CO_2 (379ppm) and CH_4 (1774ppb) in 2005 exceed by far the natural range over the last 650,000 years. Global increases in CO_2 concentrations are due primarily to fossil fuel use, with land-use change providing another significant but smaller contribution. It is *very likely* that the observed increase in CH_4 concentration is predominantly due to agriculture and fossil fuel use. CH_4 growth rates have declined since the early 1990s, consistent with total emissions (sum of anthropogenic and natural sources) being nearly constant during this period. The increase in N_2O concentration is primarily due to agriculture. *{2.2}*

There is *very high confidence* that the net effect of human activities since 1750 has been one of warming.[6] *{2.2}*

Most of the observed increase in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic GHG concentrations.[7] It is *likely* that there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica) (Figure SPM.4). *{2.4}*

During the past 50 years, the sum of solar and volcanic forcings would *likely* have produced cooling. Observed patterns of warming and their changes are simulated only by models that include anthropogenic forcings. Difficulties remain in simulating and attributing observed temperature changes at smaller than continental scales. *{2.4}*

Global anthropogenic GHG emissions

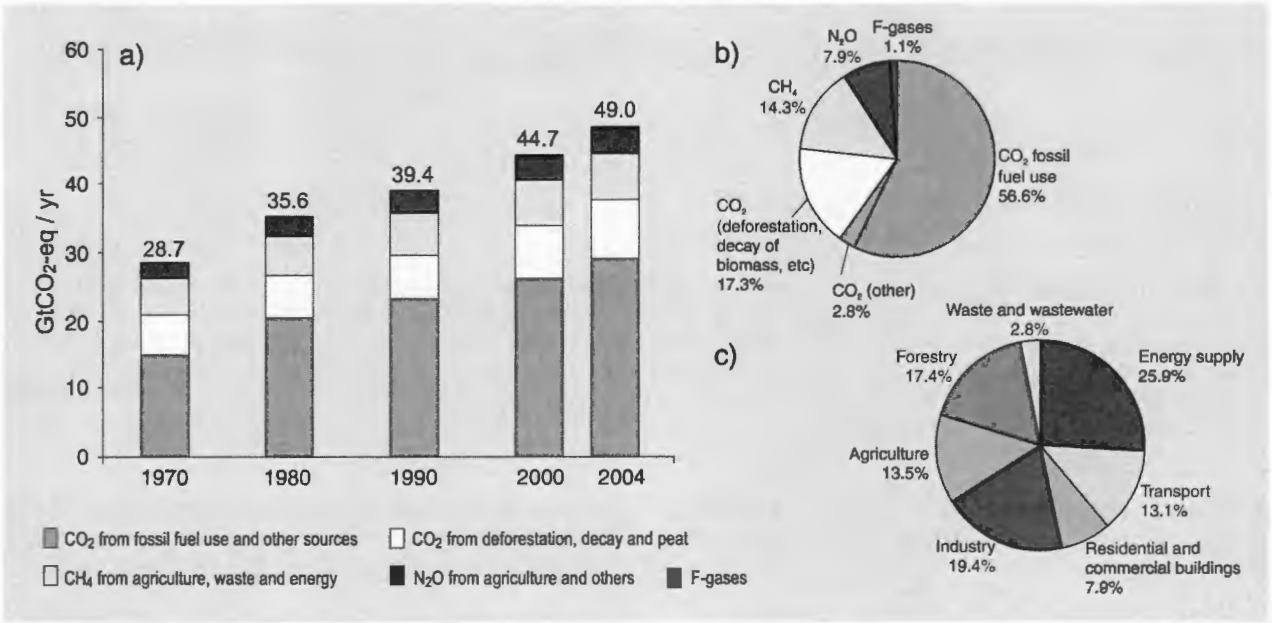


Figure SPM.3. *(a) Global annual emissions of anthropogenic GHGs from 1970 to 2004.[5] (b) Share of different anthropogenic GHGs in total emissions in 2004 in terms of carbon dioxide equivalents (CO_2-eq). (c) Share of different sectors in total anthropogenic GHG emissions in 2004 in terms of CO_2-eq. (Forestry includes deforestation.) {Figure 2.1}*

[5] Includes only carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphurhexafluoride (SF_6), whose emissions are covered by the United Nations Framework Convention on Climate Change (UNFCCC). These GHGs are weighted by their 100-year Global Warming Potentials, using values consistent with reporting under the UNFCCC.

[6] Increases in GHGs tend to warm the surface while the net effect of increases in aerosols tends to cool it. The net effect due to human activities since the pre-industrial era is one of warming (+1.6 [+0.6 to +2.4] W/m²). In comparison, changes in solar irradiance are estimated to have caused a small warming effect (+0.12 [+0.06 to +0.30] W/m²).

[7] Consideration of remaining uncertainty is based on current methodologies.

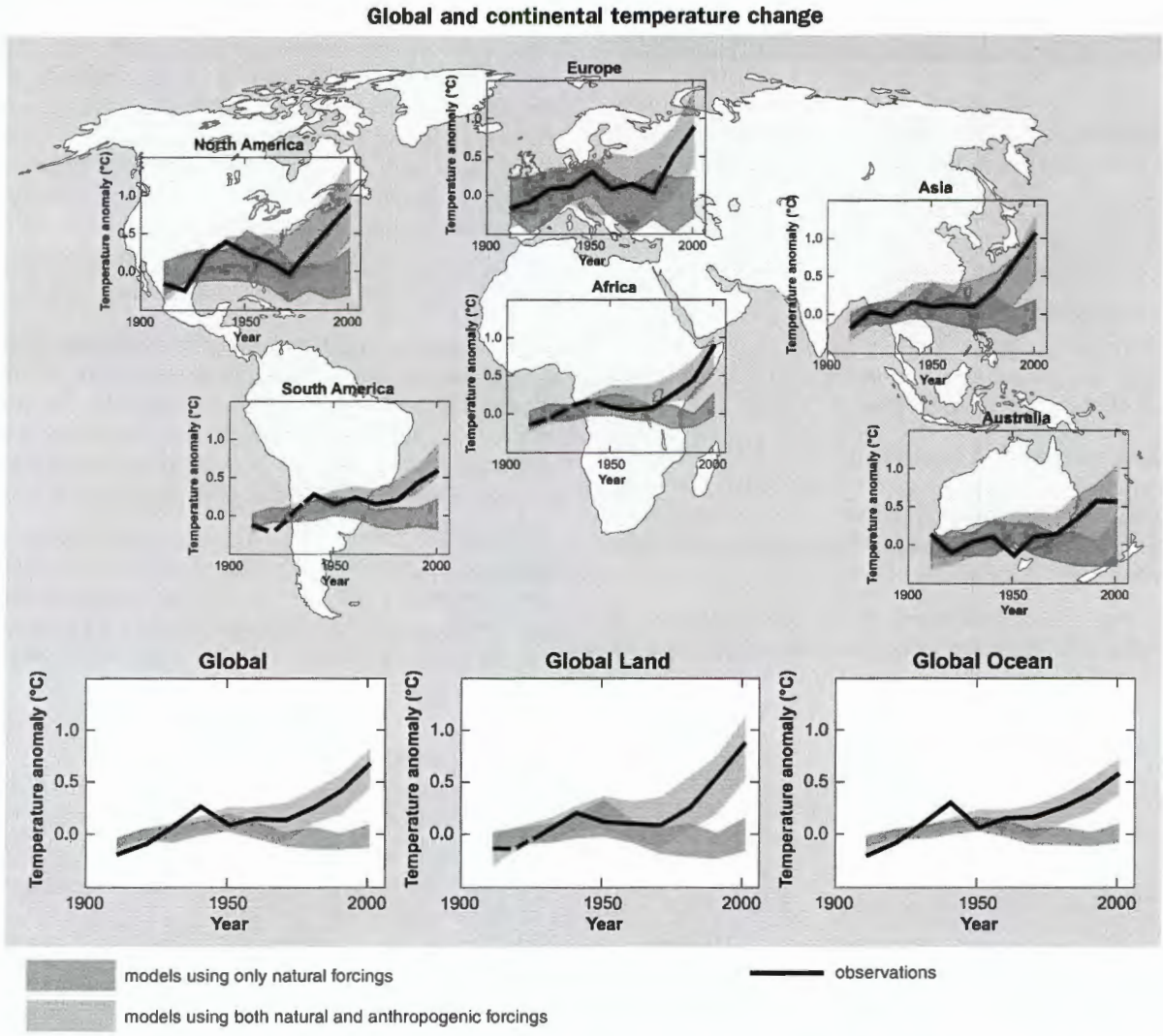


Figure SPM.4. *Comparison of observed continental- and global-scale changes in surface temperature with results simulated by climate models using either natural or both natural and anthropogenic forcings. Decadal averages of observations are shown for the period 1906-2005 (black line) plotted against the centre of the decade and relative to the corresponding average for the period 1901-1950. Lines are dashed where spatial coverage is less than 50%. Blue shaded bands show the 5 to 95% range for 19 simulations from five climate models using only the natural forcings due to solar activity and volcanoes. Red shaded bands show the 5 to 95% range for 58 simulations from 14 climate models using both natural and anthropogenic forcings. {Figure 2.5}*

Advances since the TAR show that discernible human influences extend beyond average temperature to other aspects of climate. *{2.4}*

Human influences have: *{2.4}*

- *very likely* contributed to sea level rise during the latter half of the 20th century
- *likely* contributed to changes in wind patterns, affecting extra-tropical storm tracks and temperature patterns
- *likely* increased temperatures of extreme hot nights, cold nights and cold days
- *more likely than not* increased risk of heat waves, area affected by drought since the 1970s and frequency of heavy precipitation events.

Anthropogenic warming over the last three decades has *likely* had a discernible influence at the global scale on observed changes in many physical and biological systems. *{2.4}*

Spatial agreement between regions of significant warming across the globe and locations of significant observed changes in many systems consistent with warming is *very unlikely* to be due solely to natural variability. Several modelling studies have linked some specific responses in physical and biological systems to anthropogenic warming. *{2.4}*

More complete attribution of observed natural system responses to anthropogenic warming is currently prevented by the short time scales of many impact studies, greater natural climate variability at regional scales, contributions of non-climate factors and limited spatial coverage of studies. *{2.4}*

3. Projected climate change and its impacts

There is *high agreement* and *much evidence* that with current climate change mitigation policies and related sustainable development practices, global GHG emissions will continue to grow over the next few decades. *{3.1}*

The IPCC Special Report on Emissions Scenarios (SRES, 2000) projects an increase of global GHG emissions by 25 to 90% (CO_2-eq) between 2000 and 2030 (Figure SPM.5), with fossil fuels maintaining their dominant position in the global energy mix to 2030 and beyond. More recent scenarios without additional emissions mitigation are comparable in range.[8,9] *{3.1}*

Continued GHG emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would *very likely* be larger than those observed during the 20th century (Table SPM.1, Figure SPM.5). *{3.2.1}*

For the next two decades a warming of about 0.2°C per decade is projected for a range of SRES emissions scenarios. Even if the concentrations of all GHGs and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected. Afterwards, temperature projections increasingly depend on specific emissions scenarios. *{3.2}*

The range of projections (Table SPM.1) is broadly consistent with the TAR, but uncertainties and upper ranges for temperature are larger mainly because the broader range of available models suggests stronger climate-carbon cycle feedbacks. Warming reduces terrestrial and ocean uptake of atmospheric CO_2, increasing the fraction of anthropogenic emissions remaining in the atmosphere. The strength of this feedback effect varies markedly among models. *{2.3, 3.2.1}*

Because understanding of some important effects driving sea level rise is too limited, this report does not assess the likelihood, nor provide a best estimate or an upper bound for sea level rise. Table SPM.1 shows model-based projections

Scenarios for GHG emissions from 2000 to 2100 (in the absence of additional climate policies) and projections of surface temperatures

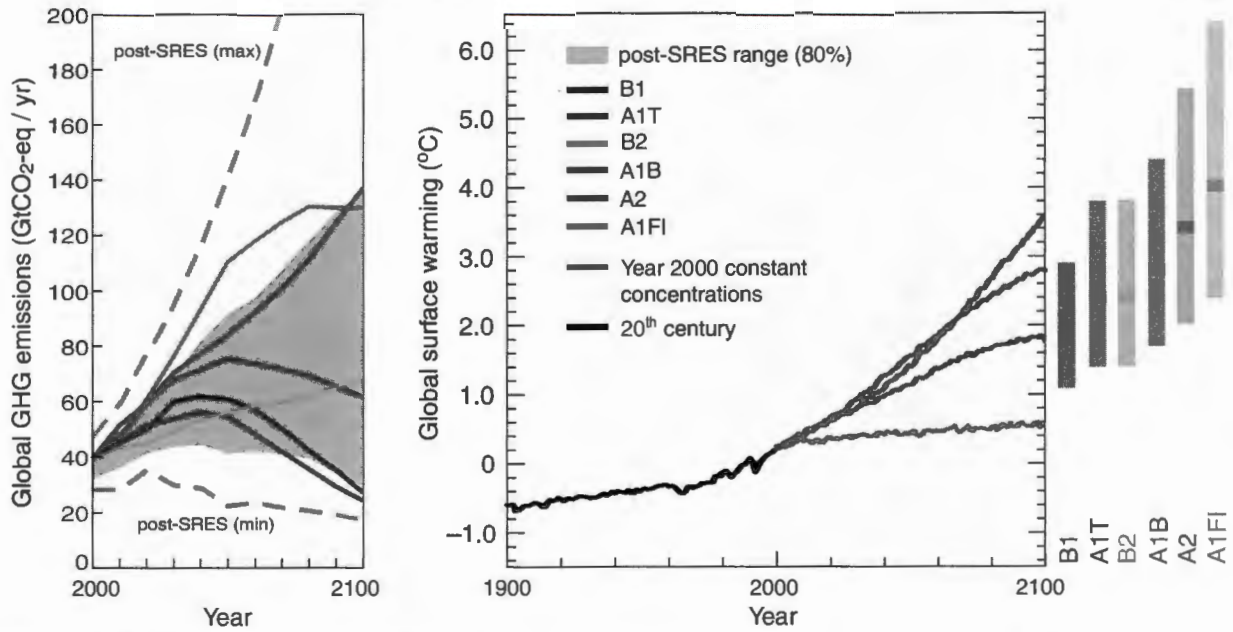


Figure SPM.5. Left Panel: *Global GHG emissions (in $GtCO_2$-eq) in the absence of climate policies: six illustrative SRES marker scenarios (coloured lines) and the 80th percentile range of recent scenarios published since SRES (post-SRES) (gray shaded area). Dashed lines show the full range of post-SRES scenarios. The emissions include CO_2, CH_4, N_2O and F-gases.* ***Right Panel:*** *Solid lines are multi-model global averages of surface warming for scenarios A2, A1B and B1, shown as continuations of the 20th-century simulations. These projections also take into account emissions of short-lived GHGs and aerosols. The pink line is not a scenario, but is for Atmosphere-Ocean General Circulation Model (AOGCM) simulations where atmospheric concentrations are held constant at year 2000 values. The bars at the right of the figure indicate the best estimate (solid line within each bar) and the likely range assessed for the six SRES marker scenarios at 2090-2099. All temperatures are relative to the period 1980-1999. {Figures 3.1 and 3.2}*

[8] For an explanation of SRES emissions scenarios, see Box 'SRES scenarios' in Topic 3 of this Synthesis Report. These scenarios do not include additional climate policies above current ones; more recent studies differ with respect to UNFCCC and Kyoto Protocol inclusion.

[9] Emission pathways of mitigation scenarios are discussed in Section 5.

Table SPM.1. Projected global average surface warming and sea level rise at the end of the 21st century. {Table 3.1}

Case	Temperature change (°C at 2090-2099 relative to 1980-1999) [a, d]		Sea level rise (m at 2090-2099 relative to 1980-1999)
	Best estimate	*Likely* range	Model-based range excluding future rapid dynamical changes in ice flow
Constant year 2000 concentrations[b]	0.6	0.3 – 0.9	Not available
B1 scenario	1.8	1.1 – 2.9	0.18 – 0.38
A1T scenario	2.4	1.4 – 3.8	0.20 – 0.45
B2 scenario	2.4	1.4 – 3.8	0.20 – 0.43
A1B scenario	2.8	1.7 – 4.4	0.21 – 0.48
A2 scenario	3.4	2.0 – 5.4	0.23 – 0.51
A1FI scenario	4.0	2.4 – 6.4	0.26 – 0.59

Notes:

a) Temperatures are assessed best estimates and *likely* uncertainty ranges from a hierarchy of models of varying complexity as well as observational constraints.

b) Year 2000 constant composition is derived from Atmosphere-Ocean General Circulation Models (AOGCMs) only.

c) All scenarios above are six SRES marker scenarios. Approximate CO_2-eq concentrations corresponding to the computed radiative forcing due to anthropogenic GHGs and aerosols in 2100 (see p. 823 of the Working Group I TAR) for the SRES B1, AIT, B2, A1B, A2 and A1FI illustrative marker scenarios are about 600, 700, 800, 850, 1250 and 1550ppm, respectively.

d) Temperature changes are expressed as the difference from the period 1980-1999. To express the change relative to the period 1850-1899 add 0.5°C.

of global average sea level rise for 2090-2099.[10] The projections do not include uncertainties in climate-carbon cycle feedbacks nor the full effects of changes in ice sheet flow, therefore the upper values of the ranges are not to be considered upper bounds for sea level rise. They include a contribution from increased Greenland and Antarctic ice flow at the rates observed for 1993-2003, but this could increase or decrease in the future.[11] *{3.2.1}*

There is now higher confidence than in the TAR in projected patterns of warming and other regional-scale features, including changes in wind patterns, precipitation and some aspects of extremes and sea ice. ***{3.2.2}***

Regional-scale changes include: *{3.2.2}*

- warming greatest over land and at most high northern latitudes and least over Southern Ocean and parts of the North Atlantic Ocean, continuing recent observed trends (Figure SPM.6)
- contraction of snow cover area, increases in thaw depth over most permafrost regions and decrease in sea ice extent; in some projections using SRES scenarios, Arctic late-summer sea ice disappears almost entirely by the latter part of the 21st century
- *very likely* increase in frequency of hot extremes, heat waves and heavy precipitation
- *likely* increase in tropical cyclone intensity; less confidence in global decrease of tropical cyclone numbers
- poleward shift of extra-tropical storm tracks with consequent changes in wind, precipitation and temperature patterns
- *very likely* precipitation increases in high latitudes and *likely* decreases in most subtropical land regions, continuing observed recent trends.

There is *high confidence* that by mid-century, annual river runoff and water availability are projected to increase at high latitudes (and in some tropical wet areas) and decrease in some dry regions in the mid-latitudes and tropics. There is also *high confidence* that many semi-arid areas (e.g. Mediterranean Basin, western United States, southern Africa and north-eastern Brazil) will suffer a decrease in water resources due to climate change. *{3.3.1, Figure 3.5}*

Studies since the TAR have enabled more systematic understanding of the timing and magnitude of impacts related to differing amounts and rates of climate change. ***{3.3.1, 3.3.2}***

Figure SPM.7 presents examples of this new information for systems and sectors. The top panel shows impacts increasing with increasing temperature change. Their estimated magnitude and timing is also affected by development pathway (lower panel). *{3.3.1}*

Examples of some projected impacts for different regions are given in Table SPM.2.

[10] TAR projections were made for 2100, whereas the projections for this report are for 2090-2099. The TAR would have had similar ranges to those in Table SPM.1 if it had treated uncertainties in the same way.

[11] For discussion of the longer term, see material below.

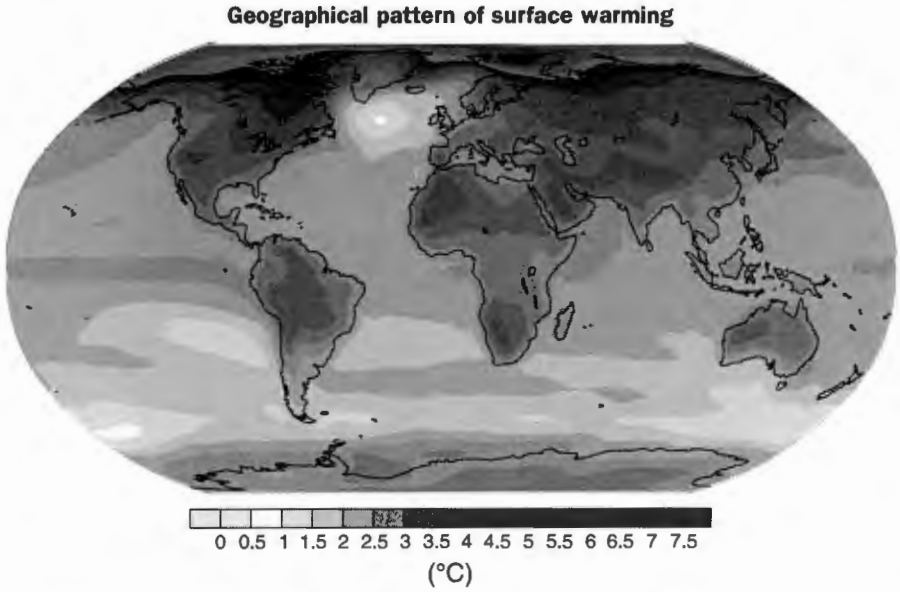


Figure SPM.6. *Projected surface temperature changes for the late 21st century (2090-2099). The map shows the multi-AOGCM average projection for the A1B SRES scenario. Temperatures are relative to the period 1980-1999. {Figure 3.2}*

Some systems, sectors and regions are *likely* to be especially affected by climate change.[12] *{3.3.3}*

Systems and sectors: *{3.3.3}*

- particular ecosystems:
  - terrestrial: tundra, boreal forest and mountain regions because of sensitivity to warming; mediterranean-type ecosystems because of reduction in rainfall; and tropical rainforests where precipitation declines
  - coastal: mangroves and salt marshes, due to multiple stresses
  - marine: coral reefs due to multiple stresses; the sea ice biome because of sensitivity to warming
- water resources in some dry regions at mid-latitudes[13] and in the dry tropics, due to changes in rainfall and evapotranspiration, and in areas dependent on snow and ice melt
- agriculture in low latitudes, due to reduced water availability
- low-lying coastal systems, due to threat of sea level rise and increased risk from extreme weather events
- human health in populations with low adaptive capacity.

Regions: *{3.3.3}*

- the Arctic, because of the impacts of high rates of projected warming on natural systems and human communities
- Africa, because of low adaptive capacity and projected climate change impacts
- small islands, where there is high exposure of population and infrastructure to projected climate change impacts
- Asian and African megadeltas, due to large populations and high exposure to sea level rise, storm surges and river flooding.

Within other areas, even those with high incomes, some people (such as the poor, young children and the elderly) can be particularly at risk, and also some areas and some activities. *{3.3.3}*

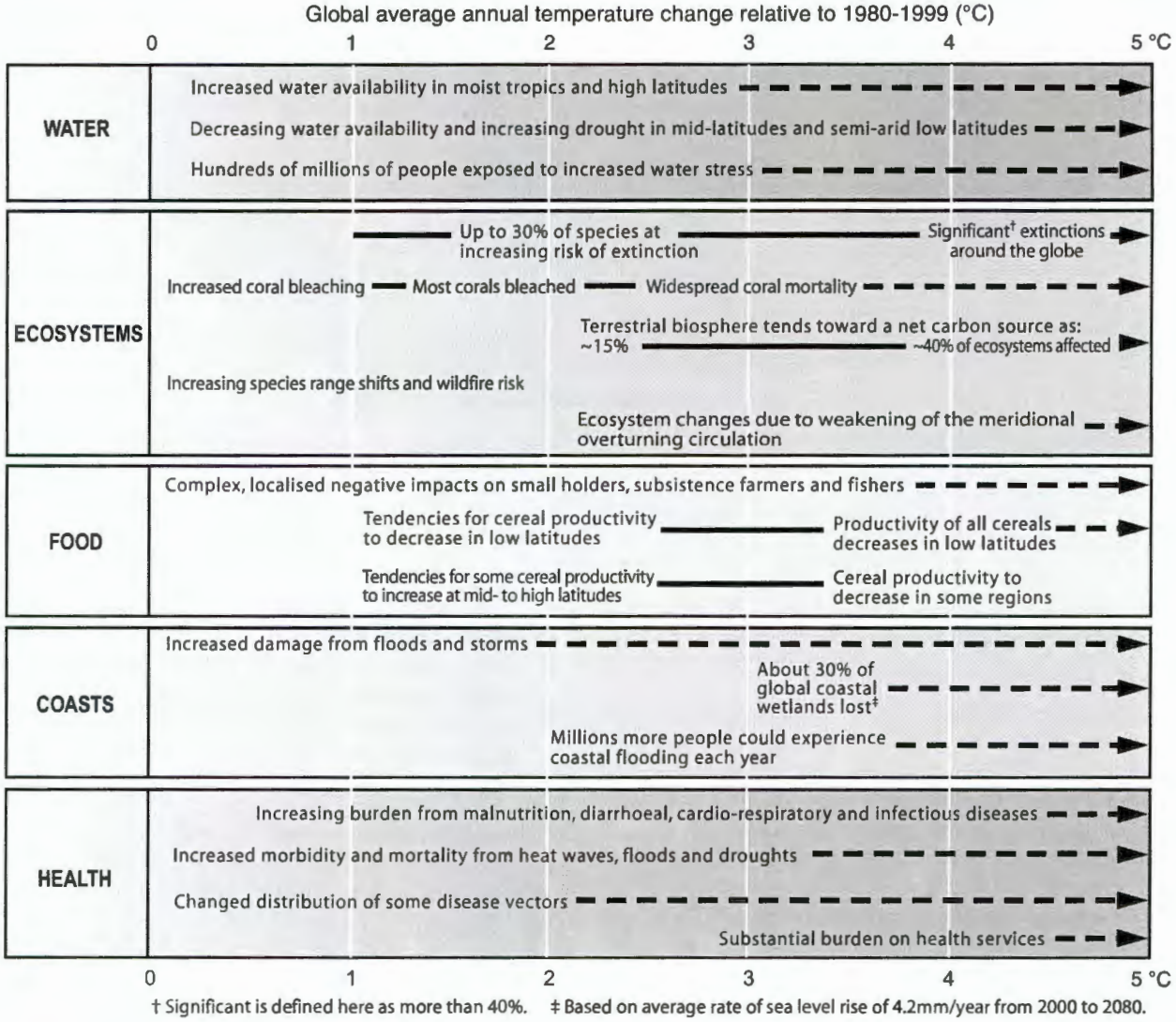
Ocean acidification

The uptake of anthropogenic carbon since 1750 has led to the ocean becoming more acidic with an average decrease in pH of 0.1 units. Increasing atmospheric CO_2 concentrations lead to further acidification. Projections based on SRES scenarios give a reduction in average global surface ocean pH of between 0.14 and 0.35 units over the 21st century. While the effects of observed ocean acidification on the marine biosphere are as yet undocumented, the progressive acidification of oceans is expected to have negative impacts on marine shell-forming organisms (e.g. corals) and their dependent species. *{3.3.4}*

[12] Identified on the basis of expert judgement of the assessed literature and considering the magnitude, timing and projected rate of climate change, sensitivity and adaptive capacity.

[13] Including arid and semi-arid regions.

Examples of impacts associated with global average temperature change (Impacts will vary by extent of adaptation, rate of temperature change and socio-economic pathway)



† Significant is defined here as more than 40%. ‡ Based on average rate of sea level rise of 4.2mm/year from 2000 to 2080.

Warming by 2090-2099 relative to 1980-1999 for non-mitigation scenarios

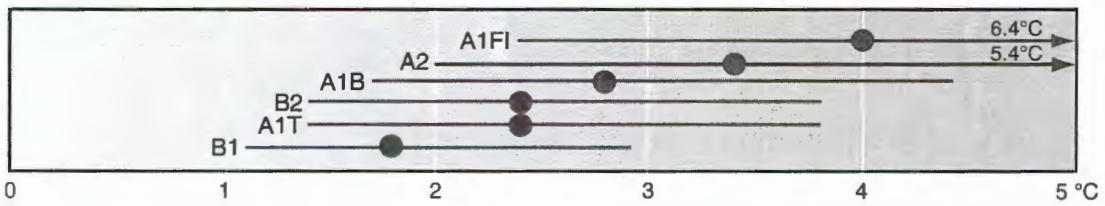


Figure SPM.7. Examples of impacts associated with projected global average surface warming. ***Upper panel:*** *Illustrative examples of global impacts projected for climate changes (and sea level and atmospheric CO_2 where relevant) associated with different amounts of increase in global average surface temperature in the 21st century. The black lines link impacts; broken-line arrows indicate impacts continuing with increasing temperature. Entries are placed so that the left-hand side of text indicates the approximate level of warming that is associated with the onset of a given impact. Quantitative entries for water scarcity and flooding represent the additional impacts of climate change relative to the conditions projected across the range of SRES scenarios A1FI, A2, B1 and B2. Adaptation to climate change is not included in these estimations. Confidence levels for all statements are* high. ***Lower panel:*** *Dots and bars indicate the best estimate and* likely *ranges of warming assessed for the six SRES marker scenarios for 2090-2099 relative to 1980-1999. {Figure 3.6}*

Table SPM.2. Examples of some projected regional impacts. {3.3.2}

Africa	• By 2020, between 75 and 250 million of people are projected to be exposed to increased water stress due to climate change. • By 2020, in some countries, yields from rain-fed agriculture could be reduced by up to 50%. Agricultural production, including access to food, in many African countries is projected to be severely compromised. This would further adversely affect food security and exacerbate malnutrition. • Towards the end of the 21st century, projected sea level rise will affect low-lying coastal areas with large populations. The cost of adaptation could amount to at least 5 to 10% of Gross Domestic Product (GDP). • By 2080, an increase of 5 to 8% of arid and semi-arid land in Africa is projected under a range of climate scenarios (TS).
Asia	• By the 2050s, freshwater availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease. • Coastal areas, especially heavily populated megadelta regions in South, East and South-East Asia, will be at greatest risk due to increased flooding from the sea and, in some megadeltas, flooding from the rivers. • Climate change is projected to compound the pressures on natural resources and the environment associated with rapid urbanisation, industrialisation and economic development. • Endemic morbidity and mortality due to diarrhoeal disease primarily associated with floods and droughts are expected to rise in East, South and South-East Asia due to projected changes in the hydrological cycle.
Australia and New Zealand	• By 2020, significant loss of biodiversity is projected to occur in some ecologically rich sites, including the Great Barrier Reef and Queensland Wet Tropics. • By 2030, water security problems are projected to intensify in southern and eastern Australia and, in New Zealand, in Northland and some eastern regions. • By 2030, production from agriculture and forestry is projected to decline over much of southern and eastern Australia, and over parts of eastern New Zealand, due to increased drought and fire. However, in New Zealand, initial benefits are projected in some other regions. • By 2050, ongoing coastal development and population growth in some areas of Australia and New Zealand are projected to exacerbate risks from sea level rise and increases in the severity and frequency of storms and coastal flooding.
Europe	• Climate change is expected to magnify regional differences in Europe's natural resources and assets. Negative impacts will include increased risk of inland flash floods and more frequent coastal flooding and increased erosion (due to storminess and sea level rise). • Mountainous areas will face glacier retreat, reduced snow cover and winter tourism, and extensive species losses (in some areas up to 60% under high emissions scenarios by 2080). • In southern Europe, climate change is projected to worsen conditions (high temperatures and drought) in a region already vulnerable to climate variability, and to reduce water availability, hydropower potential, summer tourism and, in general, crop productivity. • Climate change is also projected to increase the health risks due to heat waves and the frequency of wildfires.
Latin America	• By mid-century, increases in temperature and associated decreases in soil water are projected to lead to gradual replacement of tropical forest by savanna in eastern Amazonia. Semi-arid vegetation will tend to be replaced by arid-land vegetation. • There is a risk of significant biodiversity loss through species extinction in many areas of tropical Latin America. • Productivity of some important crops is projected to decrease and livestock productivity to decline, with adverse consequences for food security. In temperate zones, soybean yields are projected to increase. Overall, the number of people at risk of hunger is projected to increase (TS; *medium confidence*). • Changes in precipitation patterns and the disappearance of glaciers are projected to significantly affect water availability for human consumption, agriculture and energy generation.
North America	• Warming in western mountains is projected to cause decreased snowpack, more winter flooding and reduced summer flows, exacerbating competition for over-allocated water resources. • In the early decades of the century, moderate climate change is projected to increase aggregate yields of rain-fed agriculture by 5 to 20%, but with important variability among regions. Major challenges are projected for crops that are near the warm end of their suitable range or which depend on highly utilised water resources. • Cities that currently experience heat waves are expected to be further challenged by an increased number, intensity and duration of heat waves during the course of the century, with potential for adverse health impacts. • Coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution.

continued...

Table SPM.2. continued...

Polar Regions	• The main projected biophysical effects are reductions in thickness and extent of glaciers, ice sheets and sea ice, and changes in natural ecosystems with detrimental effects on many organisms including migratory birds, mammals and higher predators. • For human communities in the Arctic, impacts, particularly those resulting from changing snow and ice conditions, are projected to be mixed. • Detrimental impacts would include those on infrastructure and traditional indigenous ways of life. • In both polar regions, specific ecosystems and habitats are projected to be vulnerable, as climatic barriers to species invasions are lowered.
Small Islands	• Sea level rise is expected to exacerbate inundation, storm surge, erosion and other coastal hazards, thus threatening vital infrastructure, settlements and facilities that support the livelihood of island communities. • Deterioration in coastal conditions, for example through erosion of beaches and coral bleaching, is expected to affect local resources. • By mid-century, climate change is expected to reduce water resources in many small islands, e.g. in the Caribbean and Pacific, to the point where they become insufficient to meet demand during low-rainfall periods. • With higher temperatures, increased invasion by non-native species is expected to occur, particularly on mid- and high-latitude islands.

Note:
Unless stated explicitly, all entries are from Working Group II SPM text, and are either *very high confidence* or *high confidence* statements, reflecting different sectors (agriculture, ecosystems, water, coasts, health, industry and settlements). The Working Group II SPM refers to the source of the statements, timelines and temperatures. The magnitude and timing of impacts that will ultimately be realised will vary with the amount and rate of climate change, emissions scenarios, development pathways and adaptation.

Altered frequencies and intensities of extreme weather, together with sea level rise, are expected to have mostly adverse effects on natural and human systems. *{3.3.5}*

Examples for selected extremes and sectors are shown in Table SPM.3.

Anthropogenic warming and sea level rise would continue for centuries due to the time scales associated with climate processes and feedbacks, even if GHG concentrations were to be stabilised. *{3.2.3}*

Estimated long-term (multi-century) warming corresponding to the six AR4 Working Group III stabilisation categories is shown in Figure SPM.8.

Contraction of the Greenland ice sheet is projected to continue to contribute to sea level rise after 2100. Current models suggest virtually complete elimination of the Greenland ice sheet and a resulting contribution to sea level rise of about 7m if global average warming were sustained for millennia in excess of 1.9 to 4.6°C relative to pre-industrial values. The corresponding future temperatures in Greenland are comparable to those inferred for the last interglacial period 125,000 years ago, when palaeoclimatic information suggests reductions of polar land ice extent and 4 to 6m of sea level rise. *{3.2.3}*

Current global model studies project that the Antarctic ice sheet will remain too cold for widespread surface melting and gain mass due to increased snowfall. However, net loss of ice mass could occur if dynamical ice discharge dominates the ice sheet mass balance. *{3.2.3}*

Estimated multi-century warming relative to 1980-1999 for AR4 stabilisation categories

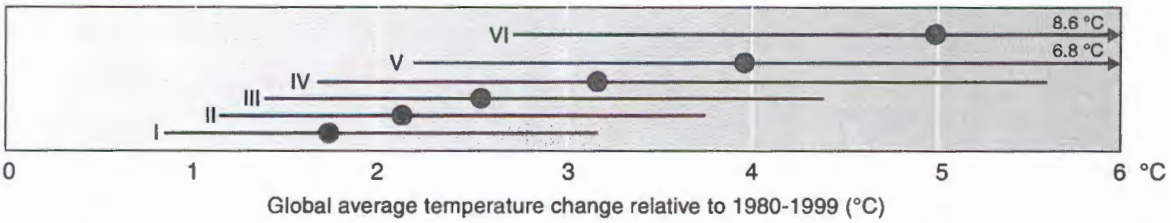


Figure SPM.8. *Estimated long-term (multi-century) warming corresponding to the six AR4 Working Group III stabilisation categories (Table SPM.6). The temperature scale has been shifted by -0.5°C compared to Table SPM.6 to account approximately for the warming between pre-industrial and 1980-1999. For most stabilisation levels global average temperature is approaching the equilibrium level over a few centuries. For GHG emissions scenarios that lead to stabilisation at levels comparable to SRES B1 and A1B by 2100 (600 and 850ppm CO_2-eq; category IV and V), assessed models project that about 65 to 70% of the estimated global equilibrium temperature increase, assuming a climate sensitivity of 3°C, would be realised at the time of stabilisation. For the much lower stabilisation scenarios (category I and II, Figure SPM.11), the equilibrium temperature may be reached earlier. (Figure 3.4)*

Table SPM.3. *Examples of possible impacts of climate change due to changes in extreme weather and climate events, based on projections to the mid- to late 21st century. These do not take into account any changes or developments in adaptive capacity. The likelihood estimates in column two relate to the phenomena listed in column one. {Table 3.2}*

Phenomenon[a] and direction of trend	Likelihood of future trends based on projections for 21st century using SRES scenarios	Examples of major projected impacts by sector			
		Agriculture, forestry and ecosystems	Water resources	Human health	Industry, settlement and society
Over most land areas, warmer and fewer cold days and nights, warmer and more frequent hot days and nights	*Virtually certain*[b]	Increased yields in colder environments; decreased yields in warmer environments; increased insect outbreaks	Effects on water resources relying on snowmelt; effects on some water supplies	Reduced human mortality from decreased cold exposure	Reduced energy demand for heating; increased demand for cooling; declining air quality in cities; reduced disruption to transport due to snow, ice; effects on winter tourism
Warm spells/heat waves. Frequency increases over most land areas	*Very likely*	Reduced yields in warmer regions due to heat stress; increased danger of wildfire	Increased water demand; water quality problems, e.g. algal blooms	Increased risk of heat-related mortality, especially for the elderly, chronically sick, very young and socially isolated	Reduction in quality of life for people in warm areas without appropriate housing; impacts on the elderly, very young and poor
Heavy precipitation events. Frequency increases over most areas	*Very likely*	Damage to crops; soil erosion, inability to cultivate land due to waterlogging of soils	Adverse effects on quality of surface and groundwater; contamination of water supply; water scarcity may be relieved	Increased risk of deaths, injuries and infectious, respiratory and skin diseases	Disruption of settlements, commerce, transport and societies due to flooding: pressures on urban and rural infrastructures; loss of property
Area affected by drought increases	*Likely*	Land degradation; lower yields/crop damage and failure; increased livestock deaths; increased risk of wildfire	More widespread water stress	Increased risk of food and water shortage; increased risk of malnutrition; increased risk of water- and food-borne diseases	Water shortage for settlements, industry and societies; reduced hydropower generation potentials; potential for population migration
Intense tropical cyclone activity increases	*Likely*	Damage to crops; windthrow (uprooting) of trees; damage to coral reefs	Power outages causing disruption of public water supply	Increased risk of deaths, injuries, water- and food-borne diseases; post-traumatic stress disorders	Disruption by flood and high winds; withdrawal of risk coverage in vulnerable areas by private insurers; potential for population migrations; loss of property
Increased incidence of extreme high sea level (excludes tsunamis)[c]	*Likely*[d]	Salinisation of irrigation water, estuaries and fresh-water systems	Decreased fresh-water availability due to saltwater intrusion	Increased risk of deaths and injuries by drowning in floods; migration-related health effects	Costs of coastal protection versus costs of land-use relocation; potential for movement of populations and infrastructure; also see tropical cyclones above

Notes:
a) See Working Group I Table 3.7 for further details regarding definitions.
b) Warming of the most extreme days and nights each year.
c) Extreme high sea level depends on average sea level and on regional weather systems. It is defined as the highest 1% of hourly values of observed sea level at a station for a given reference period.
d) In all scenarios, the projected global average sea level at 2100 is higher than in the reference period. The effect of changes in regional weather systems on sea level extremes has not been assessed.

Anthropogenic warming could lead to some impacts that are abrupt or irreversible, depending upon the rate and magnitude of the climate change. *{3.4}*

Partial loss of ice sheets on polar land could imply metres of sea level rise, major changes in coastlines and inundation of low-lying areas, with greatest effects in river deltas and low-lying islands. Such changes are projected to occur over millennial time scales, but more rapid sea level rise on century time scales cannot be excluded. *{3.4}*

Climate change is *likely* to lead to some irreversible impacts. There is *medium confidence* that approximately 20 to 30% of species assessed so far are *likely* to be at increased risk of extinction if increases in global average warming exceed 1.5 to 2.5°C (relative to 1980-1999). As global average

temperature increase exceeds about 3.5°C, model projections suggest significant extinctions (40 to 70% of species assessed) around the globe. *{3.4}*

Based on current model simulations, the meridional overturning circulation (MOC) of the Atlantic Ocean will *very likely* slow down during the 21st century; nevertheless temperatures over the Atlantic and Europe are projected to increase. The MOC is *very unlikely* to undergo a large abrupt transition during the 21st century. Longer-term MOC changes cannot be assessed with confidence. Impacts of large-scale and persistent changes in the MOC are *likely* to include changes in marine ecosystem productivity, fisheries, ocean CO_2 uptake, oceanic oxygen concentrations and terrestrial vegetation. Changes in terrestrial and ocean CO_2 uptake may feed back on the climate system. *{3.4}*

4. Adaptation and mitigation options[14]

A wide array of adaptation options is available, but more extensive adaptation than is currently occurring is required to reduce vulnerability to climate change. There are barriers, limits and costs, which are not fully understood. *{4.2}*

Societies have a long record of managing the impacts of weather- and climate-related events. Nevertheless, additional adaptation measures will be required to reduce the adverse impacts of projected climate change and variability, regardless of the scale of mitigation undertaken over the next two to three decades. Moreover, vulnerability to climate change can be exacerbated by other stresses. These arise from, for example, current climate hazards, poverty and unequal access to resources, food insecurity, trends in economic globalisation, conflict and incidence of diseases such as HIV/AIDS. *{4.2}*

Some planned adaptation to climate change is already occurring on a limited basis. Adaptation can reduce vulnerability, especially when it is embedded within broader sectoral initiatives (Table SPM.4). There is *high confidence* that there are viable adaptation options that can be implemented in some sectors at low cost, and/or with high benefit-cost ratios. However, comprehensive estimates of global costs and benefits of adaptation are limited. *{4.2, Table 4.1}*

Adaptive capacity is intimately connected to social and economic development but is unevenly distributed across and within societies. *{4.2}*

A range of barriers limits both the implementation and effectiveness of adaptation measures. The capacity to adapt is dynamic and is influenced by a society's productive base, including natural and man-made capital assets, social networks and entitlements, human capital and institutions, governance, national income, health and technology. Even societies with high adaptive capacity remain vulnerable to climate change, variability and extremes. *{4.2}*

Both bottom-up and top-down studies indicate that there is *high agreement* and *much evidence* of substantial economic potential for the mitigation of global GHG emissions over the coming decades that could offset the projected growth of global emissions or reduce emissions below current levels (Figures SPM.9, SPM.10).[15] While top-down and bottom-up studies are in line at the global level (Figure SPM.9) there are considerable differences at the sectoral level. *{4.3}*

No single technology can provide all of the mitigation potential in any sector. The economic mitigation potential, which is generally greater than the market mitigation potential, can only be achieved when adequate policies are in place and barriers removed (Table SPM.5). *{4.3}*

Bottom-up studies suggest that mitigation opportunities with net negative costs have the potential to reduce emissions by around 6 $GtCO_2$-eq/yr in 2030, realising which requires dealing with implementation barriers. *{4.3}*

[14] While this Section deals with adaptation and mitigation separately, these responses can be complementary. This theme is discussed in Section 5.

[15] The concept of **'mitigation potential'** has been developed to assess the scale of GHG reductions that could be made, relative to emission baselines, for a given level of carbon price (expressed in cost per unit of carbon dioxide equivalent emissions avoided or reduced). Mitigation potential is further differentiated in terms of 'market mitigation potential' and 'economic mitigation potential'.

Market mitigation potential is the mitigation potential based on private costs and private discount rates (reflecting the perspective of private consumers and companies), which might be expected to occur under forecast market conditions, including policies and measures currently in place, noting that barriers limit actual uptake.

Economic mitigation potential is the mitigation potential that takes into account social costs and benefits and social discount rates (reflecting the perspective of society; social discount rates are lower than those used by private investors), assuming that market efficiency is improved by policies and measures and barriers are removed.

Mitigation potential is estimated using different types of approaches. ***Bottom-up studies*** are based on assessment of mitigation options, emphasising specific technologies and regulations. They are typically sectoral studies taking the macro-economy as unchanged. ***Top-down studies*** assess the economy-wide potential of mitigation options. They use globally consistent frameworks and aggregated information about mitigation options and capture macro-economic and market feedbacks.

Table SPM.4. Selected examples of planned adaptation by sector. {Table 4.1}

Sector	Adaptation option/strategy	Underlying policy framework	**Key constraints and opportunities to implementation** (Normal font = constraints; *italics = opportunities*)
Water	Expanded rainwater harvesting; water storage and conservation techniques; water re-use; desalination; water-use and irrigation efficiency	National water policies and integrated water resources management; water-related hazards management	Financial, human resources and physical barriers; *integrated water resources management; synergies with other sectors*
Agriculture	Adjustment of planting dates and crop variety; crop relocation; improved land management, e.g. erosion control and soil protection through tree planting	R&D policies; institutional reform; land tenure and land reform; training; capacity building; crop insurance; financial incentives, e.g. subsidies and tax credits	Technological and financial constraints; access to new varieties; markets; *longer growing season in higher latitudes; revenues from 'new' products*
Infrastructure/ settlement (including coastal zones)	Relocation; seawalls and storm surge barriers; dune reinforcement; land acquisition and creation of marshlands/wetlands as buffer against sea level rise and flooding; protection of existing natural barriers	Standards and regulations that integrate climate change considerations into design; land-use policies; building codes; insurance	Financial and technological barriers; availability of relocation space; *integrated policies and management; synergies with sustainable development goals*
Human health	Heat-health action plans; emergency medical services; improved climate-sensitive disease surveillance and control; safe water and improved sanitation	Public health policies that recognise climate risk; strengthened health services; regional and international cooperation	Limits to human tolerance (vulnerable groups); knowledge limitations; financial capacity; *upgraded health services; improved quality of life*
Tourism	Diversification of tourism attractions and revenues; shifting ski slopes to higher altitudes and glaciers; artificial snow-making	Integrated planning (e.g. carrying capacity; linkages with other sectors); financial incentives, e.g. subsidies and tax credits	Appeal/marketing of new attractions; financial and logistical challenges; potential adverse impact on other sectors (e.g. artificial snow-making may increase energy use); *revenues from 'new' attractions; involvement of wider group of stakeholders*
Transport	Ralignment/relocation; design standards and planning for roads, rail and other infrastructure to cope with warming and drainage	Integrating climate change considerations into national transport policy; investment in R&D for special situations, e.g. permafrost areas	Financial and technological barriers; availability of less vulnerable routes; *improved technologies and integration with key sectors (e.g. energy)*
Energy	Strengthening of overhead transmission and distribution infrastructure; underground cabling for utilities; energy efficiency; use of renewable sources; reduced dependence on single sources of energy	National energy policies, regulations, and fiscal and financial incentives to encourage use of alternative sources; incorporating climate change in design standards	Access to viable alternatives; financial and technological barriers; acceptance of new technologies; *stimulation of new technologies; use of local resources*

Note:
Other examples from many sectors would include early warning systems.

Future energy infrastructure investment decisions, expected to exceed US$20 trillion[16] between 2005 and 2030, will have long-term impacts on GHG emissions, because of the long lifetimes of energy plants and other infrastructure capital stock. The widespread diffusion of low-carbon technologies may take many decades, even if early investments in these technologies are made attractive. Initial estimates show that returning global energy-related CO_2 emissions to 2005 levels by 2030 would require a large shift in investment patterns, although the net additional investment required ranges from negligible to 5 to 10%. *{4.3}*

[16] 20 trillion = 20,000 billion = 20×10^{12}

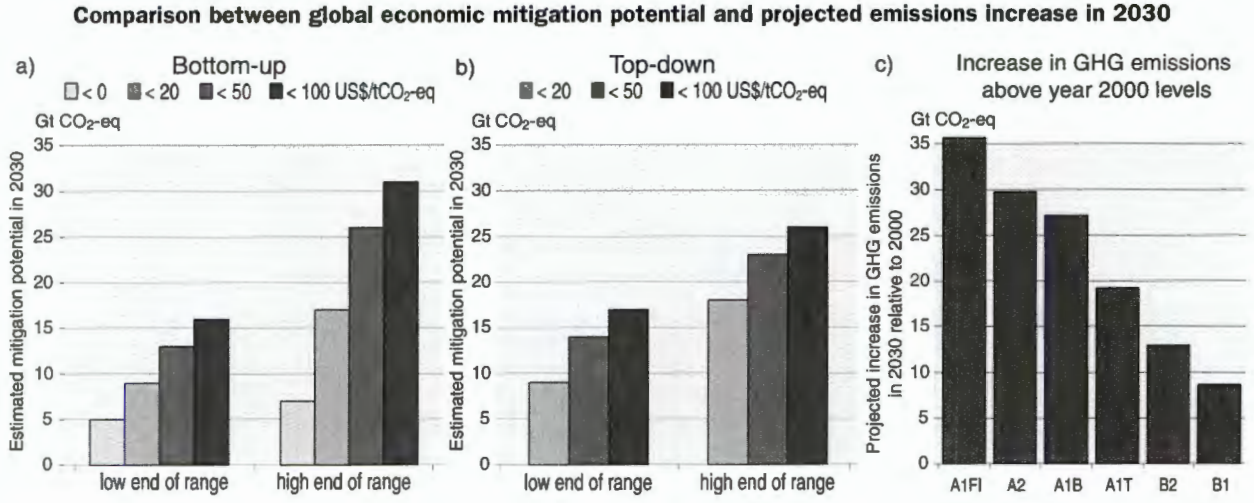


Figure SPM.9. *Global economic mitigation potential in 2030 estimated from bottom-up (Panel a) and top-down (Panel b) studies, compared with the projected emissions increases from SRES scenarios relative to year 2000 GHG emissions of 40.8 $GtCO_2$-eq (Panel c). Note: GHG emissions in 2000 are exclusive of emissions of decay of above ground biomass that remains after logging and deforestation and from peat fires and drained peat soils, to ensure consistency with the SRES emission results. {Figure 4.1}*

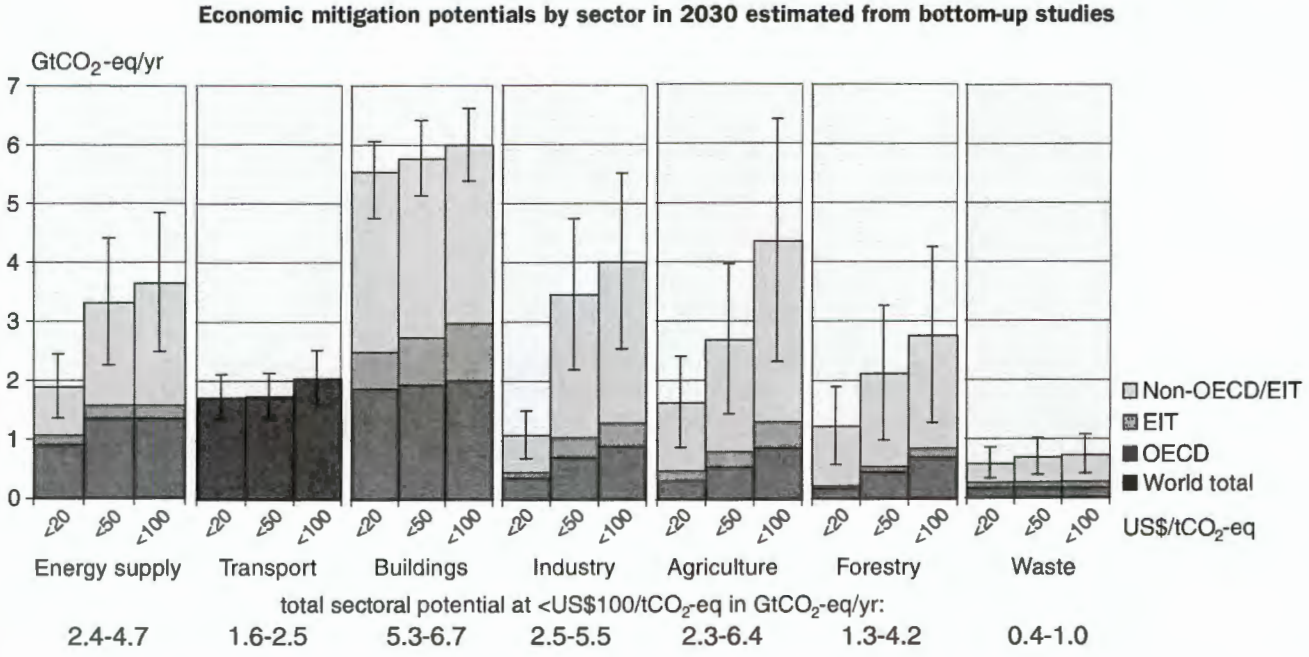


Figure SPM.10. *Estimated economic mitigation potential by sector in 2030 from bottom-up studies, compared to the respective baselines assumed in the sector assessments. The potentials do not include non-technical options such as lifestyle changes. {Figure 4.2}*

Notes:

a) The ranges for global economic potentials as assessed in each sector are shown by vertical lines. The ranges are based on end-use allocations of emissions, meaning that emissions of electricity use are counted towards the end-use sectors and not to the energy supply sector.
b) The estimated potentials have been constrained by the availability of studies particularly at high carbon price levels.
c) Sectors used different baselines. For industry, the SRES B2 baseline was taken, for energy supply and transport, the World Energy Outlook (WEO) 2004 baseline was used; the building sector is based on a baseline in between SRES B2 and A1B; for waste, SRES A1B driving forces were used to construct a waste-specific baseline; agriculture and forestry used baselines that mostly used B2 driving forces.
d) Only global totals for transport are shown because international aviation is included.
e) Categories excluded are: non-CO_2 emissions in buildings and transport, part of material efficiency options, heat production and co-generation in energy supply, heavy duty vehicles, shipping and high-occupancy passenger transport, most high-cost options for buildings, wastewater treatment, emission reduction from coal mines and gas pipelines, and fluorinated gases from energy supply and transport. The underestimation of the total economic potential from these emissions is of the order of 10 to 15%.

Table SPM.5 *Selected examples of key sectoral mitigation technologies, policies and measures, constraints and opportunities. {Table 4.2}*

Sector	Key mitigation technologies and practices currently commercially available. *Key mitigation technologies and practices projected to be commercialised before 2030 shown in italics.*	Policies, measures and instruments shown to be environmentally effective	Key constraints or opportunities (Normal font = constraints; *italics = opportunities*)
Energy supply	Improved supply and distribution efficiency; fuel switching from coal to gas; nuclear power; renewable heat and power (hydropower, solar, wind, geothermal and bioenergy); combined heat and power; early applications of carbon dioxide capture and storage (CCS) (e.g. storage of removed CO_2 from natural gas); *CCS for gas, biomass and coal-fired electricity generating facilities; advanced nuclear power; advanced renewable energy, including tidal and wave energy, concentrating solar, and solar photovoltaics*	Reduction of fossil fuel subsidies; taxes or carbon charges on fossil fuels	Resistance by vested interests may make them difficult to implement
		Feed-in tariffs for renewable energy technologies; renewable energy obligations; producer subsidies	*May be appropriate to create markets for low-emissions technologies*
Transport	More fuel-efficient vehicles; hybrid vehicles; cleaner diesel vehicles; biofuels; modal shifts from road transport to rail and public transport systems; non-motorised transport (cycling, walking); land-use and transport planning; *second generation biofuels; higher efficiency aircraft; advanced electric and hybrid vehicles with more powerful and reliable batteries*	Mandatory fuel economy; biofuel blending and CO_2 standards for road transport	Partial coverage of vehicle fleet may limit effectiveness
		Taxes on vehicle purchase, registration, use and motor fuels; road and parking pricing	Effectiveness may drop with higher incomes
		Influence mobility needs through land-use regulations and infrastructure planning; investment in attractive public transport facilities and non-motorised forms of transport	*Particularly appropriate for countries that are building up their transportation systems*
Buildings	Efficient lighting and daylighting; more efficient electrical appliances and heating and cooling devices; improved cook stoves, improved insulation; passive and active solar design for heating and cooling; alternative refrigeration fluids, recovery and recycling of fluorinated gases; *integrated design of commercial buildings including technologies, such as intelligent meters that provide feedback and control; solar photovoltaics integrated in buildings*	Appliance standards and labelling	Periodic revision of standards needed
		Building codes and certification	*Attractive for new buildings.* Enforcement can be difficult
		Demand-side management programmes	Need for regulations so that utilities may profit
		Public sector leadership programmes, including procurement	*Government purchasing can expand demand for energy-efficient products*
		Incentives for energy service companies (ESCOs)	*Success factor: Access to third party financing*
Industry	More efficient end-use electrical equipment; heat and power recovery; material recycling and substitution; control of non-CO_2 gas emissions; and a wide array of process-specific technologies; *advanced energy efficiency; CCS for cement, ammonia, and iron manufacture; inert electrodes for aluminium manufacture*	Provision of benchmark information; performance standards; subsidies; tax credits	*May be appropriate to stimulate technology uptake.* Stability of national policy important in view of international competitiveness
		Tradable permits	Predictable allocation mechanisms and stable price signals important for investments
		Voluntary agreements	Success factors include: clear targets, a baseline scenario, third-party involvement in design and review and formal provisions of monitoring, close cooperation between government and industry
Agriculture	Improved crop and grazing land management to increase soil carbon storage; restoration of cultivated peaty soils and degraded lands; improved rice cultivation techniques and livestock and manure management to reduce CH_4 emissions; improved nitrogen fertiliser application techniques to reduce N_2O emissions; dedicated energy crops to replace fossil fuel use; improved energy efficiency; *improvements of crop yields*	Financial incentives and regulations for improved land management; maintaining soil carbon content; efficient use of fertilisers and irrigation	*May encourage synergy with sustainable development and with reducing vulnerability to climate change, thereby overcoming barriers to implementation*
Forestry/ forests	Afforestation; reforestation; forest management; reduced deforestation; harvested wood product management; use of forestry products for bioenergy to replace fossil fuel use; *tree species improvement to increase biomass productivity and carbon sequestration; improved remote sensing technologies for analysis of vegetation/soil carbon sequestration potential and mapping land-use change*	Financial incentives (national and international) to increase forest area, to reduce deforestation and to maintain and manage forests; land-use regulation and enforcement	Constraints include lack of investment capital and land tenure issues. *Can help poverty alleviation*
Waste	Landfill CH_4 recovery; waste incineration with energy recovery; composting of organic waste; controlled wastewater treatment; recycling and waste minimisation; *biocovers and biofilters to optimise CH_4 oxidation*	Financial incentives for improved waste and wastewater management	*May stimulate technology diffusion*
		Renewable energy incentives or obligations	Local availability of low-cost fuel
		Waste management regulations	Most effectively applied at national level with enforcement strategies

A wide variety of policies and instruments are available to governments to create the incentives for mitigation action. Their applicability depends on national circumstances and sectoral context (Table SPM.5). *{4.3}*

They include integrating climate policies in wider development policies, regulations and standards, taxes and charges, tradable permits, financial incentives, voluntary agreements, information instruments, and research, development and demonstration (RD&D). *{4.3}*

An effective carbon-price signal could realise significant mitigation potential in all sectors. Modelling studies show that global carbon prices rising to US$20-80/tCO$_2$-eq by 2030 are consistent with stabilisation at around 550ppm CO$_2$-eq by 2100. For the same stabilisation level, induced technological change may lower these price ranges to US$5-65/tCO$_2$-eq in 2030.[17] *{4.3}*

There is *high agreement* and *much evidence* that mitigation actions can result in near-term co-benefits (e.g. improved health due to reduced air pollution) that may offset a substantial fraction of mitigation costs. *{4.3}*

There is *high agreement* and *medium evidence* that Annex I countries' actions may affect the global economy and global emissions, although the scale of carbon leakage remains uncertain.[18] *{4.3}*

Fossil fuel exporting nations (in both Annex I and non-Annex I countries) may expect, as indicated in the TAR, lower demand and prices and lower GDP growth due to mitigation policies. The extent of this spillover depends strongly on assumptions related to policy decisions and oil market conditions. *{4.3}*

There is also *high agreement* and *medium evidence* that changes in lifestyle, behaviour patterns and management practices can contribute to climate change mitigation across all sectors. *{4.3}*

Many options for reducing global GHG emissions through international cooperation exist. There is *high agreement* and *much evidence* that notable achievements of the UNFCCC and its Kyoto Protocol are the establishment of a global response to climate change, stimulation of an array of national policies, and the creation of an international carbon market and new institutional mechanisms that may provide the foundation for future mitigation efforts. Progress has also been made in addressing adaptation within the UNFCCC and additional international initiatives have been suggested. *{4.5}*

Greater cooperative efforts and expansion of market mechanisms will help to reduce global costs for achieving a given level of mitigation, or will improve environmental effectiveness. Efforts can include diverse elements such as emissions targets; sectoral, local, sub-national and regional actions; RD&D programmes; adopting common policies; implementing development-oriented actions; or expanding financing instruments. *{4.5}*

In several sectors, climate response options can be implemented to realise synergies and avoid conflicts with other dimensions of sustainable development. Decisions about macroeconomic and other non-climate policies can significantly affect emissions, adaptive capacity and vulnerability. *{4.4, 5.8}*

Making development more sustainable can enhance mitigative and adaptive capacities, reduce emissions and reduce vulnerability, but there may be barriers to implementation. On the other hand, it is *very likely* that climate change can slow the pace of progress towards sustainable development. Over the next half-century, climate change could impede achievement of the Millennium Development Goals. *{5.8}*

5. The long-term perspective

Determining what constitutes "dangerous anthropogenic interference with the climate system" in relation to Article 2 of the UNFCCC involves value judgements. Science can support informed decisions on this issue, including by providing criteria for judging which vulnerabilities might be labelled 'key'. *{Box 'Key Vulnerabilities and Article 2 of the UNFCCC', Topic 5}*

Key vulnerabilities[19] may be associated with many climate-sensitive systems, including food supply, infrastructure, health, water resources, coastal systems, ecosystems, global biogeochemical cycles, ice sheets and modes of oceanic and atmospheric circulation. *{Box 'Key Vulnerabilities and Article 2 of the UNFCCC', Topic 5}*

[17] Studies on mitigation portfolios and macro-economic costs assessed in this report are based on top-down modelling. Most models use a global least-cost approach to mitigation portfolios, with universal emissions trading, assuming transparent markets, no transaction cost, and thus perfect implementation of mitigation measures throughout the 21st century. Costs are given for a specific point in time. Global modelled costs will increase if some regions, sectors (e.g. land use), options or gases are excluded. Global modelled costs will decrease with lower baselines, use of revenues from carbon taxes and auctioned permits, and if induced technological learning is included. These models do not consider climate benefits and generally also co-benefits of mitigation measures, or equity issues. Significant progress has been achieved in applying approaches based on induced technological change to stabilisation studies; however, conceptual issues remain. In the models that consider induced technological change, projected costs for a given stabilisation level are reduced; the reductions are greater at lower stabilisation level.

[18] Further details may be found in Topic 4 of this Synthesis Report.

[19] Key vulnerabilities can be identified based on a number of criteria in the literature, including magnitude, timing, persistence/reversibility, the potential for adaptation, distributional aspects, likelihood and 'importance' of the impacts.

The five 'reasons for concern' identified in the TAR remain a viable framework to consider key vulnerabilities. These 'reasons' are assessed here to be stronger than in the TAR. Many risks are identified with higher confidence. Some risks are projected to be larger or to occur at lower increases in temperature. Understanding about the relationship between impacts (the basis for 'reasons for concern' in the TAR) and vulnerability (that includes the ability to adapt to impacts) has improved. *{5.2}*

This is due to more precise identification of the circumstances that make systems, sectors and regions especially vulnerable and growing evidence of the risks of very large impacts on multiple-century time scales. *{5.2}*

- ***Risks to unique and threatened systems.*** There is new and stronger evidence of observed impacts of climate change on unique and vulnerable systems (such as polar and high mountain communities and ecosystems), with increasing levels of adverse impacts as temperatures increase further. An increasing risk of species extinction and coral reef damage is projected with higher confidence than in the TAR as warming proceeds. There is *medium confidence* that approximately 20 to 30% of plant and animal species assessed so far are *likely* to be at increased risk of extinction if increases in global average temperature exceed 1.5 to 2.5°C over 1980-1999 levels. Confidence has increased that a 1 to 2°C increase in global mean temperature above 1990 levels (about 1.5 to 2.5°C above pre-industrial) poses significant risks to many unique and threatened systems including many biodiversity hotspots. Corals are vulnerable to thermal stress and have low adaptive capacity. Increases in sea surface temperature of about 1 to 3°C are projected to result in more frequent coral bleaching events and widespread mortality, unless there is thermal adaptation or acclimatisation by corals. Increasing vulnerability of indigenous communities in the Arctic and small island communities to warming is projected. *{5.2}*
- ***Risks of extreme weather events.*** Responses to some recent extreme events reveal higher levels of vulnerability than the TAR. There is now higher confidence in the projected increases in droughts, heat waves and floods, as well as their adverse impacts. *{5.2}*
- ***Distribution of impacts and vulnerabilities.*** There are sharp differences across regions and those in the weakest economic position are often the most vulnerable to climate change. There is increasing evidence of greater vulnerability of specific groups such as the poor and elderly not only in developing but also in developed countries. Moreover, there is increased evidence that low-latitude and less developed areas generally face greater risk, for example in dry areas and megadeltas. *{5.2}*
- ***Aggregate impacts.*** Compared to the TAR, initial net market-based benefits from climate change are projected to peak at a lower magnitude of warming, while damages would be higher for larger magnitudes of warming. The net costs of impacts of increased warming are projected to increase over time. *{5.2}*
- ***Risks of large-scale singularities.*** There is *high confidence* that global warming over many centuries would lead to a sea level rise contribution from thermal expansion alone that is projected to be much larger than observed over the 20th century, with loss of coastal area and associated impacts. There is better understanding than in the TAR that the risk of additional contributions to sea level rise from both the Greenland and possibly Antarctic ice sheets may be larger than projected by ice sheet models and could occur on century time scales. This is because ice dynamical processes seen in recent observations but not fully included in ice sheet models assessed in the AR4 could increase the rate of ice loss. *{5.2}*

There is *high confidence* that neither adaptation nor mitigation alone can avoid all climate change impacts; however, they can complement each other and together can significantly reduce the risks of climate change. *{5.3}*

Adaptation is necessary in the short and longer term to address impacts resulting from the warming that would occur even for the lowest stabilisation scenarios assessed. There are barriers, limits and costs, but these are not fully understood. Unmitigated climate change would, in the long term, be *likely* to exceed the capacity of natural, managed and human systems to adapt. The time at which such limits could be reached will vary between sectors and regions. Early mitigation actions would avoid further locking in carbon intensive infrastructure and reduce climate change and associated adaptation needs. *{5.2, 5.3}*

Many impacts can be reduced, delayed or avoided by mitigation. Mitigation efforts and investments over the next two to three decades will have a large impact on opportunities to achieve lower stabilisation levels. Delayed emission reductions significantly constrain the opportunities to achieve lower stabilisation levels and increase the risk of more severe climate change impacts. *{5.3, 5.4, 5.7}*

In order to stabilise the concentration of GHGs in the atmosphere, emissions would need to peak and decline thereafter. The lower the stabilisation level, the more quickly this peak and decline would need to occur.[20] *{5.4}*

Table SPM.6 and Figure SPM.11 summarise the required emission levels for different groups of stabilisation concentrations and the resulting equilibrium global warming and long-

[20] For the lowest mitigation scenario category assessed, emissions would need to peak by 2015, and for the highest, by 2090 (see Table SPM.6). Scenarios that use alternative emission pathways show substantial differences in the rate of global climate change.

term sea level rise due to thermal expansion only.[21] The timing and level of mitigation to reach a given temperature stabilisation level is earlier and more stringent if climate sensitivity is high than if it is low. *[5.4, 5.7]*

Sea level rise under warming is inevitable. Thermal expansion would continue for many centuries after GHG concentrations have stabilised, for any of the stabilisation levels assessed, causing an eventual sea level rise much larger than projected for the 21st century. The eventual contributions from Greenland ice sheet loss could be several metres, and larger than from thermal expansion, should warming in excess of 1.9 to 4.6°C above pre-industrial be sustained over many centuries. The long time scales of thermal expansion and ice sheet response to warming imply that stabilisation of GHG concentrations at or above present levels would not stabilise sea level for many centuries. *[5.3, 5.4]*

There is *high agreement* and *much evidence* that all stabilisation levels assessed can be achieved by deployment of a portfolio of technologies that are either currently available or expected to be commercialised in coming decades, assuming appropriate and effective incentives are in place for their development, acquisition, deployment and diffusion and addressing related barriers. *[5.5]*

All assessed stabilisation scenarios indicate that 60 to 80% of the reductions would come from energy supply and use and industrial processes, with energy efficiency playing a key role in many scenarios. Including non-CO_2 and CO_2 land-use and forestry mitigation options provides greater flexibility and cost-effectiveness. Low stabilisation levels require early investments and substantially more rapid diffusion and commercialisation of advanced low-emissions technologies. *[5.5]*

Without substantial investment flows and effective technology transfer, it may be difficult to achieve emission reduction at a significant scale. Mobilising financing of incremental costs of low-carbon technologies is important. *[5.5]*

Table SPM.6. *Characteristics of post-TAR stabilisation scenarios and resulting long-term equilibrium global average temperature and the sea level rise component from thermal expansion only.[a] {Table 5.1}*

Category	CO_2 concentration at stabilisation (2005 = 379 ppm)[b]	CO_2-equivalent concentration at stabilisation including GHGs and aerosols (2005 = 375 ppm)[b]	Peaking year for CO_2 emissions[a,c]	Change in global CO_2 emissions in 2050 (percent of 2000 emissions)[a,c]	Global average temperature increase above pre-industrial at equilibrium, using 'best estimate' climate sensitivity[d, e]	Global average sea level rise above pre-industrial at equilibrium from thermal expansion only'[f]	Number of assessed scenarios
	ppm	ppm	year	percent	°C	metres	
I	350 – 400	445 – 490	2000 – 2015	-85 to -50	2.0 – 2.4	0.4 – 1.4	6
II	400 – 440	490 – 535	2000 – 2020	-60 to -30	2.4 – 2.8	0.5 – 1.7	18
III	440 – 485	535 – 590	2010 – 2030	-30 to +5	2.8 – 3.2	0.6 – 1.9	21
IV	485 – 570	590 – 710	2020 – 2060	+10 to +60	3.2 – 4.0	0.6 – 2.4	118
V	570 – 660	710 – 855	2050 – 2080	+25 to +85	4.0 – 4.9	0.8 – 2.9	9
VI	660 – 790	855 – 1130	2060 – 2090	+90 to +140	4.9 – 6.1	1.0 – 3.7	5

Notes:

a) The emission reductions to meet a particular stabilisation level reported in the mitigation studies assessed here might be underestimated due to missing carbon cycle feedbacks (see also Topic 2.3).

b) Atmospheric CO_2 concentrations were 379ppm in 2005. The best estimate of total CO_2-eq concentration in 2005 for all long-lived GHGs is about 455ppm, while the corresponding value including the net effect of all anthropogenic forcing agents is 375ppm CO_2-eq.

c) Ranges correspond to the 15th to 85th percentile of the post-TAR scenario distribution. CO_2 emissions are shown so multi-gas scenarios can be compared with CO_2-only scenarios (see Figure SPM.3).

d) The best estimate of climate sensitivity is 3°C.

e) Note that global average temperature at equilibrium is different from expected global average temperature at the time of stabilisation of GHG concentrations due to the inertia of the climate system. For the majority of scenarios assessed, stabilisation of GHG concentrations occurs between 2100 and 2150 (see also Footnote 21).

f) Equilibrium sea level rise is for the contribution from ocean thermal expansion only and does not reach equilibrium for at least many centuries. These values have been estimated using relatively simple climate models (one low-resolution AOGCM and several EMICs based on the best estimate of 3°C climate sensitivity) and do not include contributions from melting ice sheets, glaciers and ice caps. Long-term thermal expansion is projected to result in 0.2 to 0.6m per degree Celsius of global average warming above pre-industrial. (AOGCM refers to Atmosphere-Ocean General Circulation Model and EMICs to Earth System Models of Intermediate Complexity.)

[21] Estimates for the evolution of temperature over the course of this century are not available in the AR4 for the stabilisation scenarios. For most stabilisation levels, global average temperature is approaching the equilibrium level over a few centuries. For the much lower stabilisation scenarios (category I and II, Figure SPM.11), the equilibrium temperature may be reached earlier.

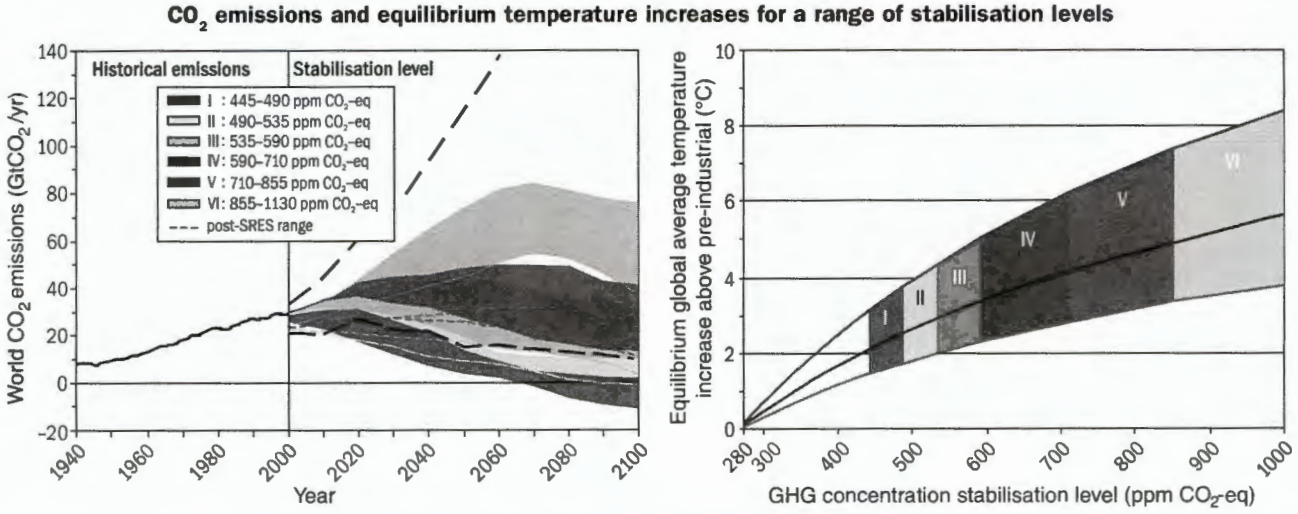


Figure SPM.11. *Global CO_2 emissions for 1940 to 2000 and emissions ranges for categories of stabilisation scenarios from 2000 to 2100 (left-hand panel); and the corresponding relationship between the stabilisation target and the* likely *equilibrium global average temperature increase above pre-industrial (right-hand panel). Approaching equilibrium can take several centuries, especially for scenarios with higher levels of stabilisation. Coloured shadings show stabilisation scenarios grouped according to different targets (stabilisation category I to VI). The right-hand panel shows ranges of global average temperature change above pre-industrial, using (i) 'best estimate' climate sensitivity of 3°C (black line in middle of shaded area), (ii) upper bound of* likely *range of climate sensitivity of 4.5°C (red line at top of shaded area) (iii) lower bound of* likely *range of climate sensitivity of 2°C (blue line at bottom of shaded area). Black dashed lines in the left panel give the emissions range of recent baseline scenarios published since the SRES (2000). Emissions ranges of the stabilisation scenarios comprise CO_2-only and multigas scenarios and correspond to the 10th to 90th percentile of the full scenario distribution. Note: CO_2 emissions in most models do not include emissions from decay of above ground biomass that remains after logging and deforestation, and from peat fires and drained peat soils. {Figure 5.1}*

The macro-economic costs of mitigation generally rise with the stringency of the stabilisation target (Table SPM.7). For specific countries and sectors, costs vary considerably from the global average.[22] *{5.6}*

In 2050, global average macro-economic costs for mitigation towards stabilisation between 710 and 445ppm CO_2-eq are between a 1% gain and 5.5% decrease of global GDP (Table SPM.7). This corresponds to slowing average annual global GDP growth by less than 0.12 percentage points. *{5.6}*

Table SPM.7. *Estimated global macro-economic costs in 2030 and 2050. Costs are relative to the baseline for least-cost trajectories towards different long-term stabilisation levels. {Table 5.2}*

Stabilisation levels (ppm CO_2-eq)	Median GDP reduction[a] (%)		Range of GDP reduction[b] (%)		Reduction of average annual GDP growth rates (percentage points)[c,e]	
	2030	2050	2030	2050	2030	2050
445 – 535[d]	Not available		< 3	< 5.5	< 0.12	< 0.12
535 – 590	0.6	1.3	0.2 to 2.5	slightly negative to 4	< 0.1	< 0.1
590 – 710	0.2	0.5	-0.6 to 1.2	-1 to 2	< 0.06	< 0.05

Notes:
Values given in this table correspond to the full literature across all baselines and mitigation scenarios that provide GDP numbers.
a) Global GDP based on market exchange rates.
b) The 10th and 90th percentile range of the analysed data are given where applicable. Negative values indicate GDP gain. The first row (445-535ppm CO_2-eq) gives the upper bound estimate of the literature only.
c) The calculation of the reduction of the annual growth rate is based on the average reduction during the assessed period that would result in the indicated GDP decrease by 2030 and 2050 respectively.
d) The number of studies is relatively small and they generally use low baselines. High emissions baselines generally lead to higher costs.
e) The values correspond to the highest estimate for GDP reduction shown in column three.

[22] See Footnote 17 for more detail on cost estimates and model assumptions.

Responding to climate change involves an iterative risk management process that includes both adaptation and mitigation and takes into account climate change damages, co-benefits, sustainability, equity and attitudes to risk. *{5.1}*

Impacts of climate change are *very likely* to impose net annual costs, which will increase over time as global temperatures increase. Peer-reviewed estimates of the social cost of carbon[23] in 2005 average US$12 per tonne of CO_2, but the range from 100 estimates is large (-$3 to $95/t$CO_2$). This is due in large part to differences in assumptions regarding climate sensitivity, response lags, the treatment of risk and equity, economic and non-economic impacts, the inclusion of potentially catastrophic losses and discount rates. Aggregate estimates of costs mask significant differences in impacts across sectors, regions and populations and *very likely* underestimate damage costs because they cannot include many non-quantifiable impacts. *{5.7}*

Limited and early analytical results from integrated analyses of the costs and benefits of mitigation indicate that they are broadly comparable in magnitude, but do not as yet permit an unambiguous determination of an emissions pathway or stabilisation level where benefits exceed costs. *{5.7}*

Climate sensitivity is a key uncertainty for mitigation scenarios for specific temperature levels. *{5.4}*

Choices about the scale and timing of GHG mitigation involve balancing the economic costs of more rapid emission reductions now against the corresponding medium-term and long-term climate risks of delay. *{5.7}*

[23] Net economic costs of damages from climate change aggregated across the globe and discounted to the specified year.