Chapter 15

Options for action

The SAEO report provides a platform of information on trends and conditions in the South African environment, which can be used to enable decision and policy makers, resource users, developers, politicians and planners to make more informed decisions concerning environmental impacts.

Chapter 15

Contents

15.1 INTRODUCTION

What has been presented in Parts I and II of this report has been largely focused on the existing state of the South African environment. In presenting the existing state, key environmental issues and concerns have emerged which require some form of response, either to prevent or reduce the negative environmental impacts or to supplement and support the areas where improvements have been noted. The Environmental Outlook, contained in Part III, attempts to determine how these issues are likely to change into the future without intervention. This Part is forward looking and is based on the premise that understanding the environmental prognosis is critical in order for the options for action to be as practical and goal-directed as they can be.

The Environmental Outlook in Part III depicts various possible futures and the specialist chapters in Part II present suggestions for achievable options for action. There are also many existing initiatives that have already been very successful and these should be continued and supported as much as possible. Examples include the introduction of new environmental sector legislation, policy reform, improved compliance and enforcement, and mainstreaming environmental considerations into sector strategies. Nevertheless, it will be prudent to determine what actions to prioritize from this myriad of possible responses, so that the country can optimize future opportunities and drive investment to contribute to the sustainability agenda.

This chapter details responses that should be considered by policy and decision-makers. Previous Environment Outlook reports frame the responses as the need to avoid a negative 'future scenario' and strive for the 'optimal sustainability scenario' for South Africa. This report builds on this and defines sustainability as it is reflected in the state of well-being (health, happiness, prosperity, and general well-being) enjoyed by the individual. This is an important new departure point as it helps determine and contextualize subsequent community and societal responses.

This Options for Action chapter therefore provides guidance for future integrated environmental management and priority areas for action. This document aims to provide an Environmental Outlook that should prompt the incorporation of these considerations into strategic thinking and policy formulation, as well as behavioural change at an individual level.

Importantly, it should be noted that more detailed and specific implementation plans are contained in various sector strategies. These cover a wide range of aspects and include catchment management plans, integrated waste management plans, air quality management plans, etc. Furthermore, the NDP sets out the collective implementation plan in response to the nine identified primary challenges facing South Africa.

The responses in the 2006 SAEO are therefore policy relevant but not policy prescriptive, meaning that the report shies away from specifying detailed policy or implementation responses, but rather highlights key issues and trends that need to be considered. There remains a need, however, for a co-ordinated response to avoid potential areas of conflict and the repetitive or wasteful use of resources.

In summary, Part IV *"…identifies possible options for action to transition towards sustainable development including through increased co-ordination, participation and co-operation required to support the achievement of internationally agreed goals and work towards sustainability at the global level."* (UNEP 2012a).

The previous parts of this SAEO report have examined the past and current state of South Africa's environment and suggested possible responses. This is most evident in Part II which clarifies the responses based on an understanding of the current state of environment. Part III strives to look beyond the current reality to where South Africa should be going and identifies longer-term, strategic responses to alter the trajectory on which it finds itself. Therefore, the Options for Action identify both responses to the current reality, as well as longer-term, strategic responses, where the focus is on what the country should be doing and how to get there and not on what is presently being done.

The chapter is structured to present responses to the tipping points identified in Part III, responses to environmental change and highlights cross cutting and emerging issues within the South African context.

15.1.1 Why South Africa needs to take action?

Before providing the detail about the responses, it is important to understand action is needed and who is responsible for taking action. The SAEO report provides a platform of information on trends and conditions in the South African environment, which can be used to enable decision and policy makers, resource users, developers, politicians and planners to make more informed decisions concerning environmental impacts. The need to take action revolves around three aspects: reversing the overall state of decline of the environment in South Africa; responding to sustainability challenges and the thresholds of South Africa's natural systems at a local scale and planetary boundaries at a global level; and, ensuring continued quality of life improvements by limiting environmental degradation.

This SAEO report shows that the environment in South Africa is generally in a state of decline. There is continued deterioration of the biophysical environment and changing population dynamics, together with economic and social development, which, whilst offering gains in human welfare, is having an impact on the environmental resources and the ecosystem functioning on which people ultimately depend.

South Africa is faced with a number of challenges to achieve environmental sustainability. Increasing land development, industrial and mining activities, population dynamics and urbanization, as well as patterns of consumption create both obstacles and opportunities for the country in managing and using its natural resource base. An increasingly urbanized and growing population requires access to opportunities for work, housing, education, transport, health facilities and recreation. Patterns of consumption in South Africa are also directly linked with high levels of income inequality. Population dynamics include increasing life expectancy (after a period of decline), rapid urbanization, a reduction in household density (more houses for fewer people) and significant changes in the

spending patterns and dynamics of the population (greater demand for goods and services which obviously translates into a greater demand for resources). The country must also respond to climate change challenges, establish viable communities and create people-friendly urban settings in support of sustainability.

Continued mining activity and urban expansion in South Africa has led to encroachment onto important ecosystems and agricultural areas, which have been compounded by unsustainable agricultural practices and poor soil and water management. This has resulted in land degradation, the loss of productive agricultural land and a less effective provision of ecosystem services. As a result, the challenge is to set clear and realistic targets for land use preferences in the fast developing urban and mineral/energy resource-rich areas and areas where intensive agriculture is expanding, coupled to real and enforceable protection and management strategies for areas key to the provision of ecosystem services. Decisions regarding the optimal allocation and use of land also need to take into consideration the various pressures and conflicts related to land use in the country.

South African cities are currently based on an unsustainable urban development model, where cities are characterized by low-density urban sprawl and inefficiencies relating to the use of resources with resultant impacts on pollution and waste generation. Low-density urban sprawl is one of the key drivers of land transformation, along with mining and crop cultivation.

Many of the water resources within South Africa are under stress from an increased demand for human and commercial water consumption, coupled with poor management of water quality and the degradation of river and wetland ecosystems. Poor water quality in the country's rivers and oceans and the loss or degradation of river and wetland ecosystems poses a major threat to future development plans as water availability shrinks. Overburdening and inadequate maintenance of South Africa's water and wastewater infrastructure compounds the problem. Water remains a major issue for South Africa both now and into the long term.

Household fossil fuel burning, vehicle emissions and industrial processes cause high concentrations of air pollutants. In addition to the promulgation of the Air Quality Act, there have been numerous initiatives by government in response to air quality challenges. Air quality management plans have been developed by various municipalities and air quality monitoring provides the necessary sound scientific basis for decision making, compliance assessment against targets and enforcement actions. The control of vehicle emissions has included the phasing out of lead-based additives to petrol, a reduction in the maximum sulphur content of diesel, benzene content of petrol and the introduction of European-derived vehicle emissions regulations for petrol-driven vehicles. In addition, comprehensive vehicle emissions monitoring has been undertaken by numerous metropolitan councils. Air quality is an important issue for South Africa to deal with as it directly impacts on human health and on vegetation via acidic precipitation.

Despite waste minimization, recycling and re-use initiatives and the gradual implementation of the NWMS, much remains to be done to reverse the trend of increasing waste volumes and to improve the reuse or safe disposal of wastes that are generated. Land constraints for the stockpiling and disposal of growing mining, industrial or domestic waste reinforce the negative trend.

One of the greatest environmental challenges facing society today is climate change. Industrialization, urbanization and an increase in use of private vehicle transport, while having social and economic benefits, have resulted in an increase in energy usage and concomitant increase in greenhouse gas emissions, intensifying the natural greenhouse effect at a planetary scale. The potential socio-political impacts of accelerated climate change include public health impacts on poorer communities, particularly on women, children and the vulnerable, as they lack the resources for coping or adapting to shocks. Numerous opportunities are, however, available to respond to these challenges, one of which is the transitioning to a low-carbon or green economy. The South African government has put in place a Green Economy Programme in response to ever-increasing resource utilization, population dynamics, global climate change and unsustainable development.

Overburdening and inadequate maintenance of existing infrastructure can have serious impacts on the environment. High urbanization rates and changing population dynamics have resulted in a continued and increasing need for the provision of basic services (such as electricity, waste removal, housing and sanitation). Inadequate access to basic services can result in poor human health and increasing vulnerability to poor environmental conditions, particularly in marginalized communities. Inadequate access to services also has an impact on the receiving environment and may lead to problems such as indoor air pollution, increased solid waste volumes or dumping, ground water contamination, high counts of *E. coli* in streams used by communities, and cholera.

However, substantial gains have been made in the social sphere in rolling out basic services (housing, water supply, sanitation, electricity etc.) to previously underserviced individuals and communities across South Africa and access to social grants and health services has improved. Good strides have also been made in the promulgation and implementation of new air quality legislation. The provision of improved public transport is also receiving substantial attention as is the introduction of renewable or cleaner energy options.

There is a risk, however, that South Africa may lose these gains if it does not acquire a better understanding of the implications of the overall decline in the state of the biophysical environment. Environmental sustainability is threatened by persistently high levels of poverty, unemployment, inequity and human vulnerability and is now overlain by the potential impacts of accelerated climate change. Many of these aspects are compounded by a limited understanding of the implications of environmental decline, and the slow pace of learning and adapting to limit and contain the negative trajectory. Without the widespread alleviation of poverty, progress towards environmentally sustainable development is unattainable. These challenges thus pose significant threats to the recent development gains made in the country. Part I of this report provides further detail with respect to the concept of sustainability in South Africa.

The NDP (NPC 2012) is the blueprint for South Africa's strategic development until 2030 and seeks to confront poverty and inequality as the two broad obstacles on the road to successful and sustainable economic development. South Africa's issues of poverty and inequality are similar to those in other developing countries where unemployment levels and population growth are high, and where emphasis is placed on poverty eradication through industrial expansion (Butchart *et al.* 2010; CBD 2010).

However, it is recognized that a sustainable form of development can only be realized if the state of ecosystems is not compromised by unsustainable consumption by people and the environmental impacts of industries and cities. For this reason, a sustainable development trajectory is envisaged that will make the most of South Africa's natural resources by improving the efficiency, and reducing the carbon intensity, of the country's economic activities. This will include improvements to infrastructure delivery, especially with regards to addressing historic patterns of inequality, providing more affordable and reliable services (such as quality public transport) to poor communities, and creating employment opportunities in the green economy (NPC 2012).

At a global scale, the concern that human beings are living beyond the capacity of the natural environment is becoming increasingly pervasive. Currently anthropogenic climate change is threatening the ability of planetary scale biophysical systems to maintain a natural equilibrium that has been evident for the past 10,000 years. Part I of this report describes in detail the concept of planetary boundaries. Human activities have become the dominant force determining change in the Earth System and therefore the Options for Action need to directly respond to the threats on these boundaries or thresholds.

Consequently, it is imperative that a range of actions be implemented to address these challenges and limit the causes of degradation, whilst introducing improved policy, planning and decision making processes. These actions should build on what has been achieved previously and focus on long-term goals and objectives.

The currently observed changes to the Earth System are unprecedented in human history. "*Efforts to slow the rate or extent of change – including enhanced resource efficiency and mitigation measures – have resulted in moderate successes but have not succeeded in reversing adverse environmental changes*." (UNEP 2012a). This will have significantly adverse impacts on the quality of life of people (human health and well-being – see Box 15.1), reinforcing the need for action. Human well-being is dependent on the ability of individuals and communities to respond to environmental changes, especially those that increase risks and reduce opportunities for the advancement of human well-being. Because of the complexities of the Earth System, responses need to focus on the root causes, the underlying drivers of environmental changes, rather than only the pressures or symptoms (UNEP 2012b).

Box 15. 1: Impact on human quality of life and well-being

The impacts of complex, non-linear changes in the Earth System are already having serious consequences for human well-being such as:

- Multiple and interacting factors, including droughts combined with socio-economic pressures, affect human security;
- Increases of average temperature above threshold levels in some places has led to signification human health impacts such as increased incidences of malaria;
- Increasing frequency and severity of climatic events, such as floods and droughts, to an unprecedented level affect both natural assets and human security;
- Accelerating changes of temperature and sea level rise are affecting human well-being in some places. For example, they affect the social cohesion of many communities including indigenous and local ones, and sea-level rise poses a threat to some natural assets and the food security of the small island developing states; and
- Substantial biodiversity loss and on-going extinction of species are affecting the provision of ecosystem services, such as, the collapse of a number of fisheries and the loss of species used for medicinal purposes.

Source: GEO-5 UNEP (2012)

It should be reiterated that quality of life improvements are seen more broadly as material improvements in human welfare (well-being) and does not refer to affluence and material possessions. The material improvements in human welfare translates *inter alia*, into reductions in disease burden, improved food security and nutrition, improved accommodation and living environments, improved education and others.

Against the backdrop of these quality of life improvements, is the continued deterioration of the biophysical environment with multiple concerns evident. These concerns include deteriorating water quality, reductions in river health, the almost complete allocation of the country's water resource, and continued loss of habitat with associated reductions in biodiversity. Most of the trends suggest a continued deterioration into the future which, if unchecked, will ultimately undermine the improvements in quality of life that have been gained as living environments deteriorate and

natural resources reduce in quality and availability. Therefore, in order to ensure that sustainability goals are reached, responses need to address these quality of life issues.

15.1.2 Who is responsible for taking action?

All levels of government are responsible for preparing and implementing various initiatives relating to integrated environmental management. As the regulator, government is responsible for the legislative framework in South Africa, regulations, policy decisions and the implementation of these. National government represents the country at an international level and therefore has a responsibility to ensure that action is taken particularly in striving to meet international targets. Government also has a key role in initiating research and technological development programmes. Government has far reaching ability and power to influence policies regarding environmental change and give effect to them, and to ensure that environment considerations are incorporated wherever possible and appropriate. It also has the ability to implement development ideals without compromising the underlying natural resource base and fulfil the constitutional mandate to ensure an environment that is not harmful to human well-being.

The responsibility for implementing these initiatives, however, does not rest on government's shoulders alone. Government (at national, provincial and local level) is not the only structure able to influence and affect how natural resources are utilized and/or conserved. The contribution of a wider set of stakeholders and role-players is paramount to achieving the goals of environmental sustainability. Effective environmental governance therefore requires many sectors of society to participate including government departments, the private sector, educational institutions, NGOs, public benefit organizations (PBOs) and community-based organizations (CBOs). In fact, responsibility cascades back to the individual level. Behavioural change based on individual responsibility and awareness will also fundamentally contribute to less resource use and wastage while enhancing individual quality of life.

As such, local communities are increasingly seen as the most appropriate guardians of their own ecosystems and resources (Millennium Ecosystem Assessment 2005). NGOs have an important role to play in community empowerment, education, acquisition of knowledge, and local community actions to address specific issues. The role of NGOs, PBOs and CBOs is important as a 'watchdog' over the activities and performance of the State, and are increasingly recognized as important role-players in the formulation and application of policy and strategy. These organizations also play a critical role in developing local knowledge and participatory development.

The private sector also has a key role in influencing the causes of environmental change primarily as a major user of natural resources and ecosystem services. Innovation and technological development regarding ecosystem services and the development of new products is a major contribution from the private sector.

Clearly, all actors have an important role and contribution in implementing and propagating behavioural change in pursuance of the sustainability agenda. Annexure 15.A indicates the various actors responsible for implementing actions. Actors include all spheres of government (national, provincial and local), research organizations, business and industry, and civil society.

15.2 RESPONDING TO TIPPING POINTS

Part III identified certain key areas that hold the key to the state of the environment in South Africa in 2030. These critical thresholds in natural systems have been dubbed 'tipping points' because, if correctly managed, they could make the difference between a significant deterioration in environmental quality with the resulting reductions in the quality of life for South Africans versus a more sustainability driven path for South Africa.

Tipping points represent those critical aspects that represent the difference between some measure of success and potentially severe environmental degradation over the next 15 years. The seriousness of the situation cannot be underestimated, and action needs to be initiated immediately to ensure that these issues receive the management attention that is commensurate with the risks they pose. Business as usual will result in continued environmental decline and a decreasing quality of life, but high level co-ordinated interventions could see the tipping points managed effectively enough to prevent such a scenario. Interventions to address the tipping points will likely provide the greatest potential returns socially, economically and environmentally.

As indicated the Environmental Outlook chapter, the four tipping points are water, land transformation and degradation, greenhouse gas emissions and non-renewable resource use, of which water and land are far and away the most critical. The outlook for the South African environment is directly a function of how these critical resources are managed over the next 15 years.

The tipping points have come about not because people have not known about them, but because of current management systems failing. The process of water allocation and decisions to allow mining are obvious concerns where economic interests seem to hold sway regardless of the environmental and social consequences. The key challenge is to elevate these development issues to a higher level than their respective line departments (because mining will continue to be promoted by DMR), the implementation of wet atmospheric emissions control by DEA, and so on and so forth. The problem lies in each department legitimately pursuing its individual mandate but the collective, big picture outcome is the one that seriously threatens the country's environment.

South Africa's planning processes are also too long term, where for example, dams being built today, were actually planned several decades ago. The world is changing rapidly and planning horizons have to be reduced so that planning can be adapted to respond to new information and understanding. South Africa's ability to respond to problems is similarly worrying where a serious environmental threat such as AMD, which has been recognized for decades, has been allowed to occur with limited material action being taken. The action that has been taken is late (decant of AMD started in the West Rand

in 2002) and only a partial solution has been implemented. Compliance and enforcement processes need to be ramped up so that they take less time to stop environmental crimes and transgressions than they do currently.

The time has also come to start making more judicious decisions on how resources are allocated. The first-come-first-served approach that seems to underpin decision-making in South Africa cannot be allowed to continue. Mechanisms are needed to ascertain the return that the country gets for giving up the resources, and where the benefit is outweighed by the environmental cost, then the use of the resources must be denied. This is particularly true of water where the limited amount that remains needs to be allocated in a way that properly reflects its scarcity value.

At the same time, the country needs to move away from the use of GDP as the only indicator of economic growth. National income accounts such as GDP say nothing about the longer-term sustainability of current growth patterns in countries (World Bank 2013) and that is the dilemma facing South Africa. The country must move towards natural capital accounting as the basis for decision-making on allocation of resources and properly value water, land and other non-renewable resources. It is imperative that the country, look at ways of maintaining a strong balance sheet (in respect of natural capital) without just considering the income statement (GDP).

Most importantly decision-makers need to understand that environmental protection is first and foremost about protecting and enhancing the quality of life of people. The tipping points pose an immediate and direct threat to people in respect of jobs, food security, water availability and others. The tipping points must be seen in that light, although the natural environmental consequences of the tipping points are in themselves severe and damaging.

Building on the Sustainability Model described in Environmental Outlook chapter, the responses to the tipping points are depicted in Figure 15.1.

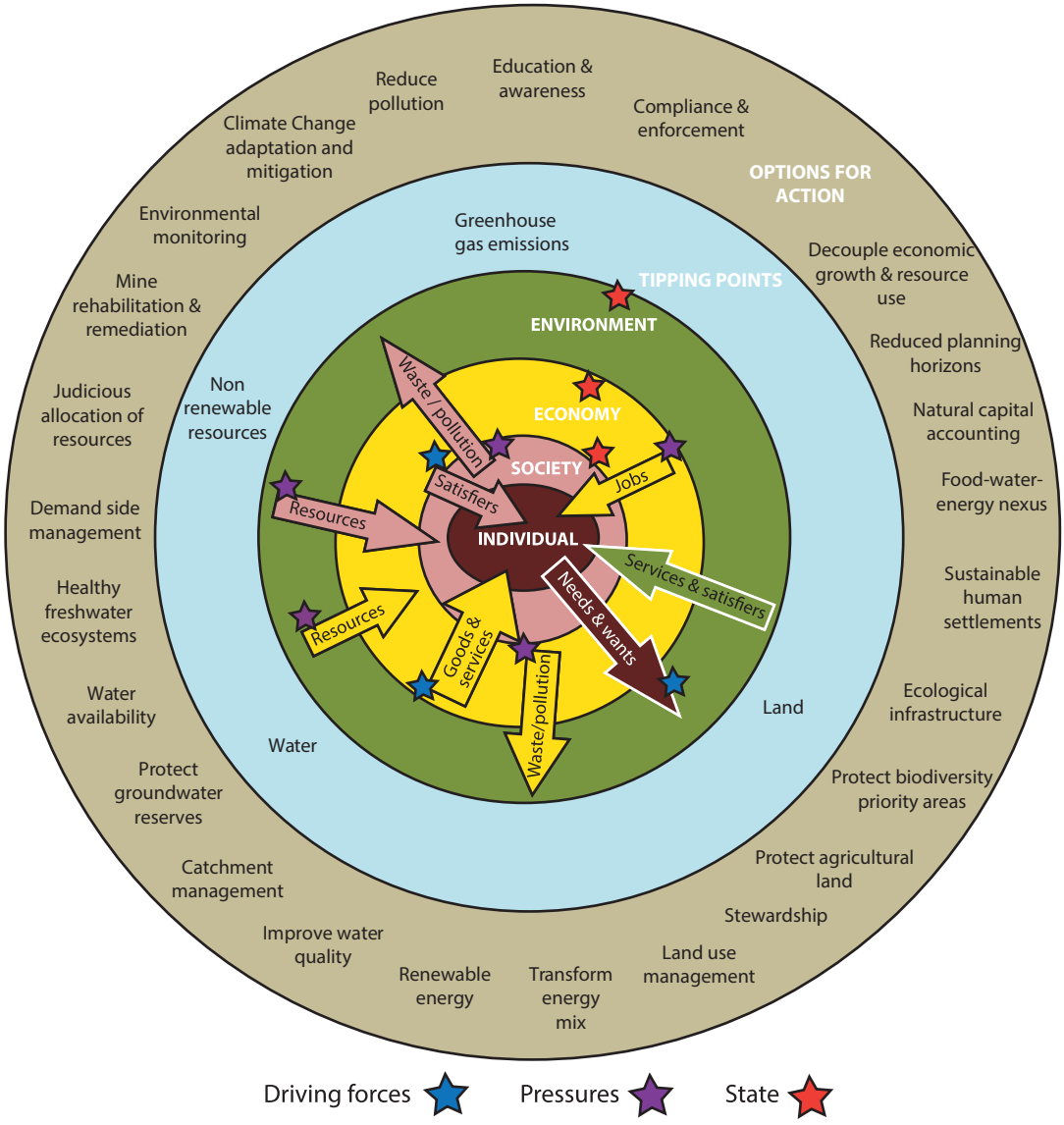

Figure 15. 1: Options for action and tipping points in relation to the sustainability model

15.2.1 Food-water-energy nexus

The tipping points relating to water, land transformation and the depletion of non-renewable resources are best demonstrated through the concept of the 'Food-Water-Energy nexus'.

The food-water-energy nexus is a term developed by the World Economic Forum and refers to the risks to water, food and energy security. Food, water and energy are central to the country's existence and economy. Without careful management of these issues which cut across different sectors and levels of decision-making, South Africa will be unable to embark on a more sustainable development path. The connection and interaction between water, agriculture, the environment, and energy are becoming more important to understand and respond to. The WWF Living Planet Report (2012) demonstrates that if the country fails to recognize these resources in a connected way and do not start managing them holistically, it will transcend the earth's carrying capacity and irreversibly cross ecological thresholds. To address overconsumption begins with the recognition that food, water and energy operate as an interdependent nexus and that the country's food needs will not be met unless the connections between the management of water and energy are regognised. Interventions in one area more often than not have impacts in one or both of the others.

Water security is defined in the MDGs as "*access to safe drinking water and sanitation*" (UNDP 2000). Availability of and access to water for humans and ecosystem functions is important in terms of water security. Energy security is defined as "*access to clean, reliable and affordable energy services for cooking, heating, lighting, communications and productive uses*" and as "*uninterrupted physical availability [of energy] at a price which is affordable, while respecting environment concerns*" (AGECC 2010). Food security is defined by the Food and Agricultural Organization (FAO) as "*availability and access to sufficient, safe and nutritious food to meet the dietary needs and food preferences for an active and healthy life*" (FAO 1996).

Due to the interconnectedness across these three sectors, a key focus is the reduction in the use of these resources and greater policy alignment and coherence. Conventional policy and decision making processes in silos should give way to a nexus-based approach that reduces trade-offs and builds synergies across sectors thereby increasing opportunities for mutually beneficial responses and enhancing the potential for co-operation between and among all sectors (WEF 2011).

Within South Africa, the agricultural sector is the dominant water user, consuming more than 60 per cent of the total water available (Chapter 8: Inland Water). The population of South Africa is growing and the number of households is expanding at three times the population growth rate. This creates a growing demand for more food and rapidly increases water and energy requirements.

Freshwater ecosystems (rivers and wetlands) are South Africa's most threatened ecosystems (NBA 2011), reflecting the fact that they are often heavily used and impacted, both directly and through activities in their catchments. This in turn compromises the ability of these ecosystems to support water security (water quantity, water quality and assurance of supply).

To be able to meet the increasing demands for water, food and energy, a number of changes to how people use and manage water and freshwater ecosystems will be required, accompanied by new means of food and energy production. Supply challenges may limit the ability of the agricultural sector to meet the growth demands and already South Africa imports large amounts of basic food supplies.

The supply of adequate energy to all the economic sectors, including agriculture is fraught with risks and hidden costs. Almost all of the energy use in South Africa comes from coal and non-renewable energy sources, and these have severely degrading effects on the quality of other renewable and non-renewable natural resources. The mining for and use of fossil fuels are associated with land sterilization, permanent loss of potentially productive agricultural land, impacts on water resources, deteriorating air quality and potentially disastrous changes to climatic patterns. This will necessarily compromise the country's ability to produce sufficient food or supply enough water to satisfy the demands of the growing human population unless South Africa drastically changes the nature of the energy that it relies on. It is possible, and indeed imperative, that the country harness renewable, non-polluting forms of energy on a large scale or alternatively use energy in a more efficient manner if South Africa wants to preserve the supply of adequate food and water.

In most instances, a dramatic combination of circumstances lead to rapidly escalating levels of risk and resource depletion. For example, changes in rainfall and water availability may limit, constrain or reduce the amount of water supply. Deteriorating water quality may exacerbate the problem. Many of South Africa's rivers are used to release less contaminated water into already heavily polluted rivers to dilute water quality problems. The combination of an increase in demand for water and a continued reduction in the fitness for use of water, may create a complex problem and severe shortage of water for use.

The water-food-energy nexus is currently playing out in the local context, particularly in Mpumalanga. There is an urgent need for strategic decisions rather than piecemeal decisions which compromise both water security and food security at the expense of a short-term focus on energy generation from coal.

In order to secure these resources (water, energy and food), for the provision of basic needs and improved quality of life, the need for more conscious stewardship as well as an overall reduction in the use of resources has become both more obvious and urgent. In addition, blockages that prevent the use of renewable resources should be consciously removed and unsustainable technologies, practices and business-as-usual solutions challenged.

This complex interaction between water-food-energy is shown in Figure 15.2.

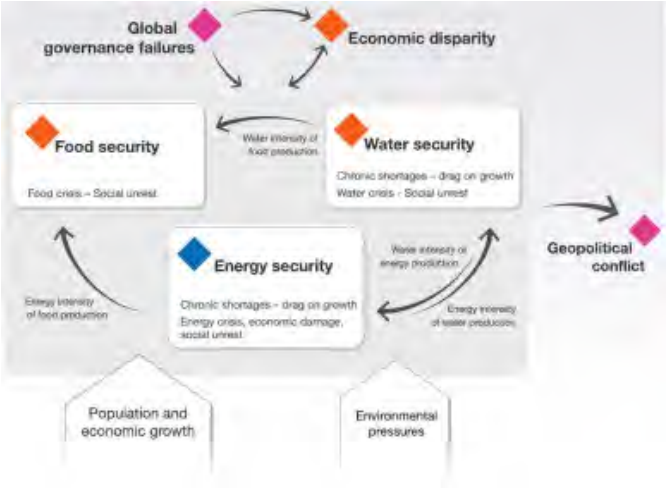

Figure 15. 2: Conceptual diagram of the food-water-energy nexus
Source: Tan (2012)

Water security, food security and energy security are chronic impediments to economic growth and social stability. Production of food requires water and energy as inputs, water extraction, treatment and distribution also require energy, and energy production requires water. Current inflation figures for South Africa demonstrate how food prices are sensitive to the cost of energy inputs through fertilizers, irrigation, and transport and processing.

The South African Water, Energy and Food Forum (SAWEF) aims to foster a greater understanding and management of the dynamic risks posed by the water-energy-food nexus. Due to the efforts of SAWEF, the water-energy-food nexus concept is starting to become embedded in the way South Africa views future challenges. Attention now shifts to understanding how best to manage the nexus challenges and steer us through an increasingly interconnected, resource constrained future. The Forum has become the focus for stimulating debate on the nexus concept, and brings together a wide range of role-players in particular the DWS, NPC, National Treasury, National Energy Commission, Land Bank and Trans-Caledon Tunnel Authority, as well as leading energy State owned entities, leading private sector actors in finance and mining in particular, and several important academic and industry constituencies, including Agri-SA, Programme for Land and Agrarian Studies and United Association of South Africa. The Forum has established connections to similar initiatives taking place globally including the Bonn Group in Germany, the World Economic Forum's Global Agenda Council on Water Security, the UN Secretary General Advisory Board on Water, and the Suez Advisory Committee on Water (AGECC 2010). The Forum aims to stimulate creative ideas in terms of actual projects, approaches, and changed and changing habits to avoid business as usual and to do things differently and use less in the face of resource shortages.

15.2.2 Decoupling economic growth and resource use

Economic growth is dependent on resource availability, and its efficient use. Typically, economic activity and growth relies on ever expanding efforts at extracting natural resources and disposing of wastes without accounting for the full environmental costs of these activities. The South African economy remains largely dependent on the extraction of natural resources. The net result is a progressive deterioration in the quality and functioning of the natural processes that sustain human activities.

However, it is recognized that a sustainable form of development can only be realized if the state of ecosystems is not compromised indefinitely by unsustainable consumption by people, industries and cities. For this reason, a sustainable development trajectory is envisaged that will make the most of South Africa's natural resources by improving the efficiency, and reducing the carbon intensity, of the country's economic activities. This will include improvements to infrastructure delivery, especially with regards to addressing historic patterns of inequality, providing more affordable and reliable services (such as quality public transport) to poor communities, and creating employment opportunities in the green economy (NPC 2012).

To ensure sustainable development, the link between economic activity and environmental deterioration needs to be decoupled. This delinking is possible, despite the wide range of studies and volumes of evidence that show how humans are depleting the natural capital available to them. The decoupling approach attempts to decrease the amount of resources such as water or fossil fuels used to produce economic growth and this is further detailed in Part I of this report.

Linked to this is the critical issue of DSM, which is traditionally seen as reducing the demand by consumers for resources (particularly energy and water, but also land). DSM is introduced through various mechanisms, most often by introducing financial incentives and education and awareness. DSM has numerous benefits including a delay in the investment of further infrastructural capacity, improved economic efficiencies, social development, social equity and importantly, environmental protection through the reduction (or at least a reduction in the growth) of natural resource consumption.

In the South African context, numerous interventions are underway to reduce the demand for key resources, although increased attention is needed to ensure appropriate skills to manage DSM, as well as resources to ensure ongoing asset management.

The cross cutting aspects and key emerging issues (discussed later on in this chapter) have begun to address these issues.

15.2.3 Greenhouse gases

The fourth tipping point relates to greenhouse gas emissions. The prognosis for future greenhouse gas emissions from South Africa is that they are going to increase significantly in the next five years or so as the Kusile and Medupi power stations are commissioned, and with the possibility of a third large scale coal-fired power plant within the next 15 years. At the same time, continued growth in traffic volumes will also contribute to greenhouse gas increase as will a new refinery, especially if such a refinery is based on coal-to-liquid technology. South

Africa will thus continue to be a globally significant emitter of greenhouse gases, especially if viewed per capita.

The LTMS project conducted in 2007 (DEAT 2007) indicates that a business-as-usual emissions scenario is implausible, given trends in global oil pricing, carbon awareness and the consequences of climate change, and that a large part of an aggressive emissions reduction scenario will in fact be beneficial to the local economy. It therefore recommended that a range of mechanisms be employed to achieve a peak-plateau-decline emissions profile. This approach will first reduce the rate at which emissions increase to allow the total emissions to level off around 2025, following which absolute emissions will be reduced to give effect to South Africa's international mitigation commitments (the dark blue band in the Figure 15.3 below). The extent to which South Africa will meet this commitment will depend on the provision of finance, technology and capacity building by developed countries.

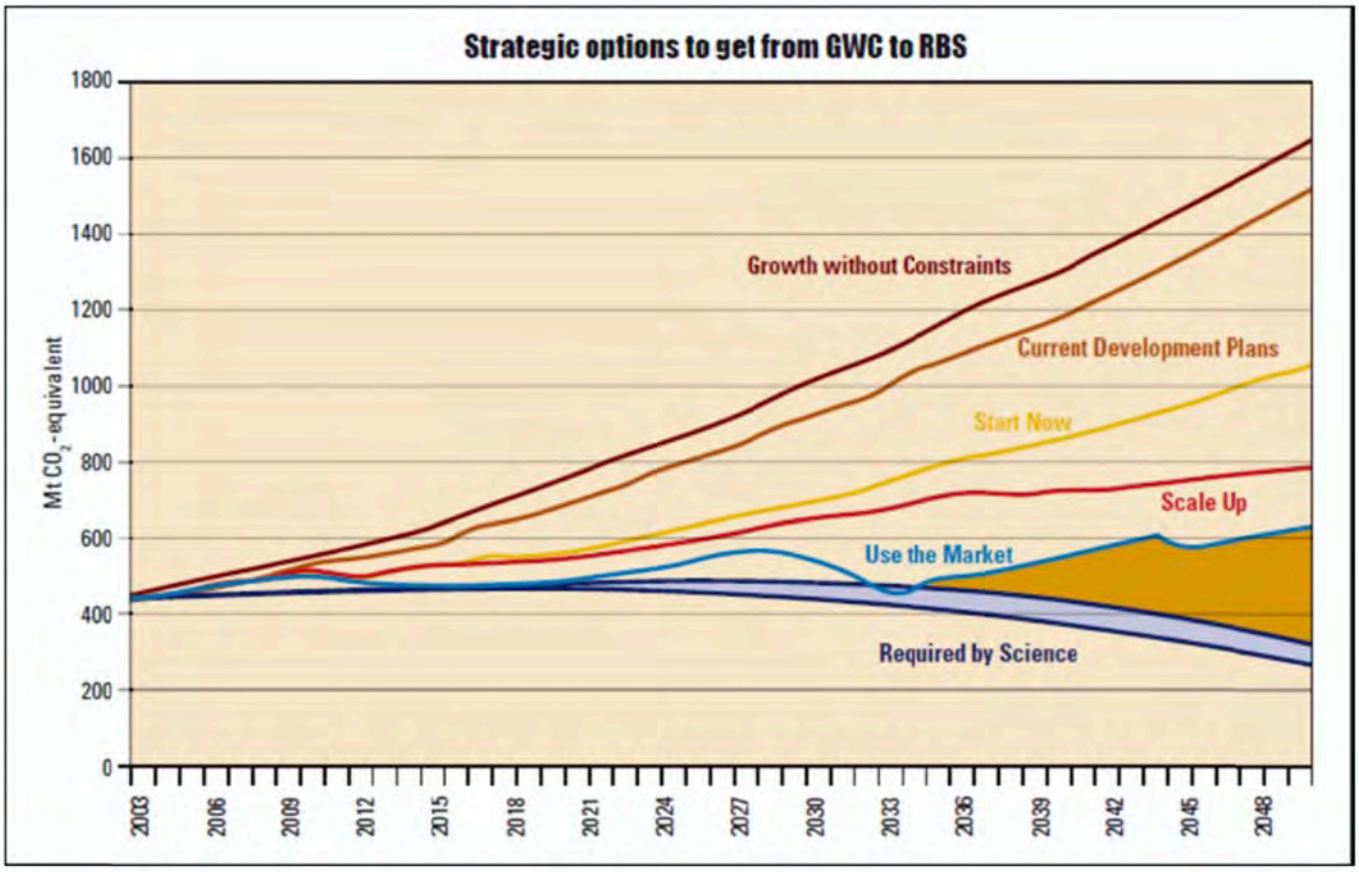

Figure 15. 3: Emissions reduction strategy from the LTMS
Source: Long Term Mitigation Scenarios: Technical Summary

Emissions limits are set at an upper peak in 2025 of 614 Mt carbon dioxide equivalents, and thereafter an upper limit of 428 Mt carbon dioxide equivalents by 2050 (DEA 2011a). The mechanisms to be employed (yellow, red, light blue and orange in Figure 15.3) to reduce the emissions include immediate cost effective (i.e. financially beneficial) measures that bring about savings over the long term, interventions with a low overall cost, but which reduce emissions significantly, market based incentives and disincentives such as taxes, and actions based on future technologies and behavioural change.

Since 2005, government realized that transformation in the energy sector has a major role to play in the reduction of greenhouse gases. The 2005 Energy Efficiency Strategy (DME 2005) therefore set out to strive for affordable energy that minimizes the "*negative effects of energy usage on human health and the environment through sustainable energy development and efficient practices*". The strategy set a target of 12 per cent energy savings by 2015 based purely on achieving energy efficiency improvements specified for different economic sectors. The Strategy was reviewed in 2008 and 2012, but the overall target of a final energy intensity reduction of 12 per cent by 2015 has not been changed (DoE 2012).

The NCCRWP of 2011 (DEA 2011a) committed the country to the peak-plateau-decline emissions trajectory advocated by the LTMS project, and reiterated the Presidential commitment to a 42 per cent deviation below a business as usual scenario by 2025. The policy also identifies various near-term Priority Flagship Programmes to show 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, of which energy efficiency and energy demand management is one that has high potential for emission reductions.

Part of the policy interventions will be sector and subsector specific mitigation targets and plans (to be adopted by 2013). Since the majority of South Africa's emissions arise

from energy supply (electricity and liquid fuels) and energy use (mining, industry and transport sectors), the focus for mitigation actions with the largest emission reduction potential is as follows:

- Shifting to lower-carbon electricity generation options (through the REIPPPP);
- 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.

The next section details the various sectoral responses that were mentioned in the specialist chapters contained in Part II of this report. Many of these responses relate to the tipping points which reinforce the inter-connected and complex nature of many of these challenges.

15.3 RESPONDING TO ENVIRONMENTAL CHANGE

Part II of this report showed how the environment in South Africa has changed since the publication of the 2006 SAEO. It has highlighted a number of areas where it is necessary to tackle specific environmental issues and where the trends are negative and impact on the environment, people and/or the economy.

The responses required relate to the suggested actions highlighted in Part II of this report, and are depicted in a summary table of environmental indicators and trends, and as sector specific responses. The detailed information can be found in Part II of this report.

This section is not intended to provide a comprehensive list of actions to manage or reverse environmental change. A number of sector plans, guides and strategies exist that provide greater levels of details and specific actions, targets and timeframes. The section rather focuses on providing a framework or guide to understand where the focus of intervention should be and how sector plans may be further improved.

15.3.1 Summary of environmental indicators and trends

Table 15.1 reflects the state of South Africa's environment at a glance, showing the trends for each of the indicators per environmental feature. Each trend is indicated as improving (moving in the right direction), deteriorating or increasing (cause for concern), or no improvement or uncertain (largely due to inadequate or outdated data, or where performance is uncertain).

Table 15. 1: Trend analysis per environmental feature

Issue	Indicator	Trend		Notes
Land	Land degradation	Increasing	↓	Continued pressure from land degradation resulting from unemployment, poverty and poor land use management. The situation is worst in Limpopo, KZN and the Eastern Cape. Increase in land degradation is a result of unemployment, poverty and poor land use management.
	Loss of natural habitat	Increasing	↓	Loss of natural areas due to urban expansion, mining and intense agriculture.
	Soil erosion	Deteriorating	↓	70% of South Africa's land surface is affected by erosion of some kind. Soil erosion risk is linked to land degradation - if land degradation increases then so will soil erosion.
	Invasive alien plants	Deteriorating	↓	Over 10% of the SA land surface is infested by invasive alien plants and this is growing at 5% per year. Approximately 20 million ha are invaded and this has increased dramatically since the mid-1990s. Major problem for water availability and the condition of the land. Infestation is growing in severity and extent. 8,750 plant taxa have been introduced to SA of which 161 are serious pest plant species and 601 are invasive/alien animal taxa. The rate of introduction is increasing.
	Land contamination	Uncertain	?	Land contamination results in a decrease in soil productivity. Inadequate data is available to determine performance, but it seems to be deteriorating.
	Deforestation	Increasing	↓	Deforestation (loss of indigenous forests) seems to be stabilising.
	Plantations	Improving/Steady	→	The area under plantations is decreasing at average rate of 0.9% per year, which may positively contribute to meeting biodiversity targets as less land is being transformed to plantations.

Issue	Indicator	Trend		Notes
Biodiversity and ecosystem health	Loss of natural habitat	Deteriorating	↓	Increasing loss of natural habitat mostly due to the spread of urban areas and encroachment from mining and intensive agriculture.
	Overexploitation of species	Deteriorating	↓	192 plant taxa (out of more than 20,000 plant taxa in South Africa) are threatened by direct use or unsustainable harvesting. 65% of exploited plants are for horticultural purposes and 38% for medicinal purposes. Collector trade and hunting/sport are other problems.
	Threatened species	Deteriorating	↓	There are 13,625 endemic plant taxa in South Africa. One in four plants are now rare or threatened. Five plants have been listed as extinct for the first time. Two-thirds of fish are endemic and increasingly threatened. Marine systems need further research, but birds and marine fish are increasingly threatened.

Issue	Indicator	Trend		Notes
Biodiversity and ecosystem health	Areas under protection	Improving	↑	The National Protected Areas Expansion Strategy aims to raise protected areas from 6.5% of SA's area to 12%. The proportion of land based areas protected in SA increased from nearly 6% in 2004 to 6.5% in 2011. The country is still some way off meeting its protected area targets.
	Terrestrial ecosystems	Deteriorating	↓	There is an increasing loss of natural areas with 30% of grasslands completely transformed. 40% of terrestrial ecosystem types are threatened. Irreversible loss of natural habitat, for example as a result of cultivation, mining, plantations and urban expansion, is the biggest pressure on terrestrial ecosystems.
	Freshwater ecosystems	Deteriorating	↓	58% of river ecosystem types are threatened. Water is a scarce resource and rivers are stressed to meet development targets with the result that many of these systems are highly modified. 65% of wetland ecosystem types are threatened, making wetlands the most threatened ecosystems in SA, especially floodplain wetlands. Currently, 20 Ramsar sites have been declared.
	Marine ecosystems	Deteriorating	↓	29% of coastal and inshore ecosystems and 41% of offshore ecosystems are threatened. The biggest threats to coastal ecosystems are pollution and human development in coastal areas. The biggest threat to marine ecosystems is fishing. Offshore marine ecosystems are the least protected of all.
	Use of GMOs	Increasing	↓	In 2010 2.2 million ha of land were used for the production of GMOs. SA is the 9th largest GMO producer globally and this comprises 98% of our cotton, 78.3% of our maize and 85% of our soya production.
	Ecological footprint	Deteriorating	↓	SA has a footprint of 2.32 global ha per capita, just below the global average of 2.7 global ha per capita, but has an ecological deficit of -1.18 indicating that SA doesn't have the resources to match the demands of its people.
	State funding for biodiversity	Improving (but only slightly)	↑	SANBI funding was increased by a small amount but SANParks funding has declined.

Issue	Indicator	Trend		Notes
Inland water	Water availability	Deteriorating	↓	The amount of water available remains relatively constant except for new inter-basin transfers (e.g. Lesotho Highlands) and ground water access. There is a rapidly increasing demand for water, yet a limited and fully allocated supply. Most catchments are already over-extracted and likely to enter into a negative water balance.
	Water quality	Deteriorating	↓	Increased salinity and pollution from agriculture, mining and urban runoff. Increasing sediment in water from poor land management and soil erosion. Water quality is a problem particularly in urban areas (e.g. Gauteng metropolitan areas and City of Cape Town) where the effects are compounded.

Issue	Indicator	Trend		Notes
Inland water	Trophic state of dams	Deteriorating	↓	A number of dams (12) are hypertrophic with very high nutrient concentrations and serious water quality problems. Some areas have managed to decrease the risk for pollution through effective management.
	Groundwater quality	Deteriorating	↓	Our knowledge of groundwater systems is often limited and problems are as a result of past bad management practices (e.g. mining sector). AMD is a large concern in the old Witwatersrand mining areas and increasing attention is being focused on these issues.
	River health	Deteriorating	↓	Increasing urban, mining and agricultural pressures are impacting on overall river health in SA. Tributaries are generally in a better condition than main stream rivers.
	Wetlands	Deteriorating	↓	The most impacted on wetlands are in urban, agricultural and mining areas.
	Job creation	Improving	↑	Many job opportunities have been created through alien plant removal.
	Freshwater aquaculture	Deteriorating	↓	Increasing aquaculture production, mostly trout and ornamental fish species, is having a negative environmental impact on water quality, habitat and indigenous species.

Issue	Indicator	Trend		Notes
Oceans and coasts	Jobs in fisheries	No improvement	→	There is area for possible additional job creation through beneficiation from fishing industries. There is no real potential to expand fish catches due to over exploitation. The number of jobs has remained steady.
	Oil spill incidents	Very varied over years	?	It is difficult to determine significance as this issue is very dependent on spill size and volume.
	Waste water discharges	Deteriorating	↓	300,000 million litres of untreated and partially treated wastewater are discharged daily into the marine environment. There is an increasing number of discharge points in the surf zone. With limited monitoring of discharge volumes, trends are not accurate but appear to be deteriorating.
	Blue flag beaches	Deteriorating	↓	During 2010, KZN lost six Blue Flag beaches due to poor water quality and cleanliness, three lost status in the Eastern Cape, while the Western Cape has shown improvements in water quality.
	Coastal Clean-up (pollution indicator)	Improving	↑	South Africa rates 7th in the world in the number of volunteers participating in the programme with 106,253 volunteers. The programme has had a major impact on beach clean-up.
	Beach driving	Improving	↑	Beach driving was reported on in 2006 SAEO, but has since been banned and improvements in beach conditions noted.

Issue	Indicator	Trend		Notes
Oceans and coasts	Coastal land transformation	Deteriorating	↓	There is high demand for property in coastal areas results in increasing land transformation. Land cover data is limited so a detailed trend analysis is not possible. 17% of the coast has some form of development within 100 m of the coastline (NBA, 2011). Approximately 30% of the South African population live within 60 km of the coast.
	Fish capture for production	Deteriorating	↓	There is a declining amount of fish catches due to regulation and limited fish stocks. Hake and West Coast rock lobster account for 80% of SA's economic contribution by fisheries. Exploitable hake biomass declined by 2% over last 20 years and rock lobster increased by 2%. 52% of subsistence fisher communities are classed as 'food insecure'. Deteriorating trend due to declining fish stocks.
	Illegal harvesting	Deteriorating	↓	Illegal harvesting blamed for collapse of line fisheries, decline of abalone and Patagonian toothfish stocks and has impacted on the viability of hake and pilchard fisheries. Total allowable catches for abalone dropped from 615 tonnes in 1996 season to 75 tonnes in 2008 and complete closure of fisheries in 2008. The total illegal abalone catch is estimated at 2,000 tonnes per year. Increasing monitoring and compliance has led to better management and control.
	Marine aquaculture	Improving	↑	There is an emerging fisheries sector for mussels, oysters and abalone and some seaweeds. Production has increased by 5.59% from 2000 to 2010 so trend is improving.
	Non-extractive resource use	Improving	↑	Non-extractive resource use is an increasingly lucrative market. Most permits issued for film (movie) industry.
	Coastal and marine mining	Deteriorating	↓	Sand winning has high impacts in coastal areas and large amounts are illegal making it difficult to measure and track. On- and off-shore petroleum and gas exploitation is an emerging area that can cause high impacts, particularly risk of pollution.
	Sea level rise	Deteriorating	↓	All ports are reporting sea level rise. The West Coast sea level is rising by 1.87mm per year, South Coast by 1.47mm per year and East Coast by 2.74mm per year due to ocean dynamics.
	Legislation and policy	Improving	↑	There have been major strides forward in the legislation and policy arena including the enactment of the ICM Act and the enforcement of EMPs and CMPs.
	Expenditure	Improving	↑	Budget allocations to coastal management increasing.

Issue	Indicator	Trend		Notes
Air quality	Indoor and outdoor pollution	Deteriorating	↓	Indoor and outdoor pollution continues to be a problem with SO_2, PM, NO_2, NO_x, VOCs, O_3, and C_6H_6 levels increasing.
	Vehicle emissions	Deteriorating (although lead emissions ceased to be a problem)	↓	The increasing number of vehicles on the road and increased dependency on private vehicles has resulted in increasing fuel consumption and higher overall pollution levels despite improved vehicle emission standards.
	Domestic fuel burning	Improving	↑	Between 2002 and 2010, the use of paraffin declined by 7.2% and use of wood for heating/cooking also declined. There was a decline in the use of coal and gas for cooking accompanied by an increase in electrification and subsequent use of electricity for cooking. However, most poor households still use wood, coal and paraffin for heating resulting in very poor indoor air quality.
	Industrial emissions	Uncertain due to lack of data	?	Poor land use planning has placed residential areas next to industrial areas and can cause air quality problems in these residential areas. Effects can continue well after the industry has shut down (e.g. Gauteng and areas of mine residue).
	Biomass burning	Increasing	↓	Marked increasing trend in fire incidences from eastern to western parts of SA due to various reasons including ecosystem type and function. Fire is a natural process but its effects are complicated and impacts have increased from invasive alien plant species and commercial timber plantations.
	PM_{10} concentrations	Deteriorating	↓	Exceeds air quality standards, especially in residential areas that burn fuels such as paraffin, wood and coal and in some industrial areas. Most problems are experienced in the air quality priority areas.
	Sulphur dioxide	Stable	→	Rarely exceeds air quality standards and does vary across the country but generally improving.
	Nitrogen dioxide and ozone	Increasing	↓	Increasing and exceeding standards at traffic impacted sites, in domestic fuel burning residential areas and industrial areas. Expected to continue to decline due to increasing number of vehicles and traffic congestion problems.
	Carbon monoxide	Stable	→	Levels are generally low and not a priority. Exposure is a problem indoors where there is poor fuel combustion and poor ventilation. A targeted campaign for indoor air quality is needed in domestic fuel burning residential areas.
	Persistent organic pollutants	Largely unknown but potential for deterioration	?	Persistent organic pollutants are a problem in industrial areas (particularly the south Durban industrial basin) with some of the highest POP concentrations in Africa.
	Ozone depleting substances	Deteriorating	↓	HCFC dominate the consumption of ODS. Hydro-fluorocarbons and hydro-fluorocarbon blends are increasing as people look for other options to the use of HCFCs. These all have environmental implications due to their high global warming potential.

Issue	Indicator	Trend		Notes
Air quality	Mercury emissions	Largely unknown but potential for deterioration	?	Coal is the largest source of mercury emissions and coal production is rapidly increasing in SA, increasing the potential for pollution (depending on the effectiveness of air quality pollution methods).

Issue	Indicator	Trend		Notes
Climate change	Greenhouse gas emissions	Increasing	↓	Global emissions are increasing steadily and SA's emissions are increasing in line with international trends. Estimates of a 20% increase in emissions between 2000 and 2010 are seen to be likely. 50% of all emissions are from the energy supply sector indicating the coal-dependant nature of SA. 16% of emissions come from industry and construction, 16% from fugitive emissions from fuel, 9% from transport and the remainder from agriculture and forestry, waste and other minor sources.
	Temperature	Increasing	↓	SA has undergone a general warming over last 40 years and this has accelerated since the mid-1960s. The trends are stronger in the western, north-eastern and extreme eastern parts of the country.
	Rainfall	Seasonal shifts	↓	No real evidence exists of changes in rainfall over South Africa, but there are areas where significant changes in the characteristics of precipitation have occurred. These localised changes include more extreme wet and dry conditions, increases in daily highs for rainfall and significant differences in annual precipitation figures. SA is predicted to become generally drier.

Issue	Indicator	Trend		Notes
Energy	Energy supply	Declining	↓	The total amount of energy produced and consumed is still on the increase, whilst the supply mix remains firmly biased towards the use of coal and oil.
	Energy intensity linked to energy use	Improving	↑	The amount of energy required to produce a unit of value in the economy is steadily decreasing.
	Ash and particle emissions from coal fired power generation	Improving	↑	Modern technologies, increasingly stringent controls and general improvment of environmental responsibility have led to reduced emissions per unit of energy produced. Total emissions may, however, not follow the same trend as they are dependent on the number of power stations in use and the amount of energy being produced.

Issue	Indicator	Trend		Notes
Energy	Air pollution from use of energy in transportation	Uncertain	?	Although emissions per vehicle are being reduced through the application of modern technological advances, the benefits are quickly countered by increases in the numbers of vehicles on the roads. Due to socio-economic influences and human aspirations, it can be assumed that the growth in privately owned vehicles in use will increase rapidly in connection with the growth of the middle income sector.
	Water use and contamination	Uncertain	?	Time-series data is not available, but modern technologies do reduce the amount of water required per unit of energy generated. Nevertheless, the nature of coal mining, the total amount of energy produced, and the consequences for a water stressed country makes this an indicator that could very well be deteriorating.
	Land use and degradation	Increasing	↓	The generation, distribution and use of energy comes with a price for land resources (land sterilisation, visual impacts, ecological impacts, etc.) and is relative to the amount of energy required and consumed. Renewable forms of energy are not exempt.
	Availability of clean or renewable energy	Improving	↑	The roll-out of large-scale renewable energy projects, including both commercial generation facilities and micro-generation installations such as solar water heaters, is taking off and major government support is being leveraged.

Issue	Indicator	Trend		Notes
Waste managment	General waste management	Improving (but there is still rapid growth in waste volumes)	↑	Rapid growth in waste volumes are linked to periods of economic growth. Waste management has a significant impact on the day-to-day lives of people. The increasing number of municipalities participating in waste management operations is a positive trend. Municipalities service nearly 65% of households. General waste production is rising at an average rate of 4.8% in SA and levels are very high in the Free State and Mpumalanga.
	Municipal waste removal	Improving	↑	The percentage of households with access to waste removal services increased from 58% in 2002 to 59% in 2010. Informal settlements and underserviced areas are still problematic and experience unsafe waste disposal activities. This threatens the health of people and ecosystems.

Issue	Indicator	Trend		Notes
Waste management	Illegal dumping of tyres	Increasing	↓	175,000 tonnes per annum of new tyres entering SA, and used tyres, amount to 150,000 tonnes per annum which need to be recycled or disposed of. More than 28 million tyres have been dumped illegally or burnt for the steel wire and the number is expected to increase by 9.3 million per year. This creates a serious air quality problem and is a contributor to problems from particulate matter emissions. This has been identified as a priority area and activities are underway to curb the trend.
	Available hazardous waste landfill space	No change	→	There are 97 hazardous waste sites in SA.
	Available landfill space	No change	→	Over 90% of SA's waste is disposed of in landfill sites. There is a backlog in permitting landfill sites and limited airspace available.
	Health care risk waste	Improving	↑	There are 11 licenced HCRW facilities in SA and these were operating at 80% capacity in 2007. There is a 1.5% growth in waste generation per annum. Facilities also have high levels of downtime due to breakdowns, malfunctions, and planned and unplanned maintenance, all of which affects capacity. Significant progress has been made on a national compliance strategy and to deal with HCRW related issues.
	Pesticides	Deteriorating	↓	Steady and consistent use of fertilizers and pesticides for agricultural production. Initiatives are underway for the disposal of obsolete pesticides.
	Electronic waste	Deteriorating	↓	This is a new but rapidly growing waste type and expected to become a major waste challenge. Dominated by informal private sector initiatives to recycle waste.
	Mining waste	Deteriorating	↓	88% of waste generated is mining waste and has a major impact in SA. Mine waste is contained within waste dumps (slimes and ash dams), decanted in water (AMD) or becomes air pollution.
	Capacity to deal with waste	Improving	↑	Service backlogs are highest in metros and secondary cities. The backlog for solid waste services is 2 million households with 900,000 households not receiving any service. 87% of municipalities do not have the capacity for waste minimisation. 80% of municipalities are initiating recycling activities, but don't have the capacity to keep them going.
	Employment generated	Improving	↑	Recycling creates significant job opportunities in the private sector generating over 100,000 jobs for plastic, glass, cans and paper recycling. This is likely to increase as more waste is recycled.

Issue	Indicator	Trend		Notes
Human settlements	Population	Improving	↑	Life expectancy at birth is now increasing (attributed to the recent role out of anti-retrovirals) and expected to continue increasing. Fertility has declined and death rates have declined.
	Household size	Improving (but increasing number and size)	↑	The average number of households is growing at almost double the population growth rate (changing population dynamics). Household formation is at 3% per year and population growth is at 1% per year. This is attributed to rising divorce rates, declining fertility rates, ageing of the population and increasing childlessness. The average household size has decreased from 4.7 people per house in 1996 to 3.7 in 2011. Therefore, trends are improving, although an increase in the number of households means an increase in resource consumption patterns.
	Migration	No improvement	→	This is linked to urbanisation and has a large impact on human settlements. Most people migrated to Gauteng and Western Cape with the Eastern Cape and Limpopo losing people. Migrants are primarily attracted by employment opportunities to large metros which also have high unemployment rates. A large number of migrants also moving to smaller secondary towns, dense peri-urban areas and rural settlements that offer promise of access to housing and services. These areas often don't have the ability to service the migrants.
	Population density	No improvement	→	Johannesburg has a population density of 20.9 pph and eThekwini 14pph, which is very low compared to large international cities such as London (62pph), and Rio de Janeiro (101pph). Sustainable densities to support public transport are estimated at 50pph. A further complication in SA is that higher densities are frequently on the outskirts of cities.
	Housing	Improving	↑	Flats and townhouses (high-density living) increased by 16% between 2003 and 2008 and the proportion of large units decreased by 18% in that period. High density townhouse developments are creating hard surfaces with limited open space. Lifestyle and golf estates are problematic as they are often in environmentally sensitive areas, cause ecological damage and have high maintenance inputs.
	Subsidized housing	Improving	↑	About 250,000 subsidized housing units have been built per year since 2004, with private housing delivery at 70,000 units per year. An increase in access to housing means an increase in living standards for poorer households. However, a housing backlog still exists.
	Informal housing	Improving	↑	Most informal dwellings are in Gauteng and the Western Cape. The percentage of informal dwellings has decreased by 1.3% from 2007 to 2011 yet SA is still far from the target of eradicating informal settlements by 2014. 13.6% of households live in informal settlements. 50% of informal dwellings are vulnerable to environmental factors.

Issue	Indicator	Trend		Notes
Human settlements	Transport energy use	Increasing	↓	The transport sector is almost entirely dependent on petroleum fuels (98%) and only uses 1.6% of electricity. Road transport consumes 87% of the energy used by the transport sector as a whole. According to SAPIA Annual Report of 2011 (reference), 56% (11,874 million litres) of total fuel consumed in SA was petrol and 44% (9,298 million litres) was diesel. There is a strong correlation between income and the choice of transport mode.
	Water services	Deteriorating	↓	850 waste water treatment plants need maintenance. Unaccounted for water and water losses account for up to 60% of water wasted in some areas.
	Poverty levels	Deteriorating	↓	Poverty levels improved from 2000 to 2006, but increased between 2006 and 2009.
	Access to electricity	Improving	↑	Access to electricity is steadily increasing. Households with access to electricity increased by 4.6% between 2007 and 2011.
	Access to piped water	Improving	↑	Census 2011 (reference) has shown that the number of households with access to water has increased from 84.4% to 91.2% and there are increasing numbers of households that have access to water inside their dwelling.
	Access to sanitation services	Improving	↑	Only 2% of households still use the bucket system for toilets and this system is nearly eliminated. 60% of households have access to flush toilets.

15.3.2 Creating sustainable human settlements

Substantial progress on human settlements has been made in the national policy sphere with the NSSD (DEA 2011b) and Breaking New Ground Policy. There are however inconsistencies, e.g. a lack of commitment, for instance, to sustainable development in both the Municipal Systems Act and the SPLUMA. The aforementioned deficiency has the effect that sustainability concerns do not filter down to land use schemes and municipal by-laws. This makes it rather difficult to establish factually whether human settlements in South Africa are becoming more or less sustainable. On face value, however, it appears as if little is changing.

To undo a legacy of extremely inefficient cities that are sprawling, low-density and mono-functional, and which became entrenched during decades of apartheid, a huge, concerted effort from all role-players is required.

Table 15.2 outlines suggested actions relating to the creation of sustainable human settlements. Box 15.2 provides sustainability measures for new housing developments.

Table 15. 2: Suggested actions – creating sustainable human settlements

Suggested actions - creating sustainable human settlements
• Ensure role-players are adequately informed on low carbon initiatives and sustainable city-building; • Tertiary institutes and the Council for Planners must develop and enforce a programme for continual development for professional planners; • National government to develop comprehensive sustainable planning legislation; • Develop model land use schemes and by laws to serve as a reference for local governments; • Properly implemented compliance and monitoring measures that ensure effectively implemented sustainability objectives. This requires action be taken to implement actions proposed in the NSSD; and, • Incentives to promote the application of renewable energy options, water saving measures, passive building design and other sustainability metrics are initiated at local authority level. Municipal bylaws which require and reward this must be enacted.

Box 15. 2: Sustainability measures for new housing developments

A number of measures can be taken within housing programmes to reduce the environmental impact and create more sustainable settlements. These include:

- New housing tracts should not be located on the urban periphery but should rather be within the existing urban fabric, although not at the expense of existing open space and green lung areas;
- Housing should form part of mixed-use developments, with employment uses (light industry, commercial and business) as an integral part of new communities;
- All buildings (houses, clinics, and schools) must be passively designed and built;
- In poorer communities, local labour must be used for construction, preferably those who are destined to live there;
- Solar water heating systems should be a standard requirement in all buildings, as should rainwater harvesting systems;
- Where possible, communal grey water systems should be implemented to reduce demand on conventional water supplies;
- Ecological storm water management and sustainable urban drainage practices must be obligatory in all developments;
- Streets should be designed and built with pedestrians and cyclists as primary users;
- Sanitation should (where possible) consist of waterless systems (dry-composting); and,
- Electricity demand-management programmes should dictate the planning of bulk networks: building and street lighting could be off-grid if LED lighting is used as standard, solar water heating as standard installations and if cooking could be done by gas.

15.3.3 Sustainable land use and management

There has been enormous pressure on land resources over the last two decades in South Africa. Economic growth and social improvements have come at the expense of natural resources and a loss of ecosystems. Going forward, it will be critical to take actions to improve land and resource management, prevent land degradation and reverse the rate of loss of important ecological services.

Making informed decisions at a national or provincial level on how to balance the demands of different land uses is made difficult by the unavailability of data and an insufficient body of scientific knowledge of the quality and rates of change of land resources. There is a general reliance on old management interventions, which may not sufficiently reflect the current thinking on sustainability.

The actions outlined in Table 15.3 are necessary to make more informed decisions and how best to balance the demands placed on land resources.

Table 15.3: Suggested actions – sustainable land use management

Suggested actions - sustainable land use and management
• Improve understanding of ecosystem services and how land use impacts on these. Land use values do not recognize the non-market value of ecosystem services and overlook the biophysical limits to productivity (or thresholds); • Develop methods to include the value of natural capital into land and economic policies; • Update land cover data in order to accurately represent land cover change; • Support of economic activities in line with agriculture and the green economy can boost the economy and alleviate poverty which is currently being discussed. These debates should be encouraged and linked to how South Africa manages limited high value agricultural areas; and, • Local communities and local value systems must be taken into account when making land use and land management decisions. An integrated approach to balancing land development and land protection is often not easily reconciled at a local level.

15.3.4 Improving freshwater ecosystems and balancing demands for water

Limits to the sustainability of ground and surface water resources are nearing thresholds and as demands for water continue to increase, the water-related stresses on people and ecosystems is escalating. The demand for access and use of water resources in South Africa is increasing as the country develops and this has had an effect on water availability, water quality and the state of freshwater ecosystems. The state of many of South Africa's water resources continues to deteriorate and many river systems are in a state of stress. Major river basins of South Africa are shared with neighbouring countries, making managing water a regional concern.

Freshwater ecosystems are valuable national assets and provide critical and essential services to people and their ability to survive and ultimately prosper. Properly functioning

rivers and wetlands support resilience, buffer the impacts of land based activities, supply and purify water supply and aid with adaptation to climate change. Healthy freshwater ecosystems are essential for water security.

The current state of water points to a need to manage, price, use and allocate water differently to how it has been done in the past. A willingness to change attitudes to water management is needed and to manage water as a scarce resource. Government responses to water management are slowly starting to reflect this but there is a need to prioritise actions for water management.

A large task lies ahead to deal with water quality problems such as AMD, eutrophication and the salinization of resources. Effective treatment of sewage and industrial effluent should be done in a manner that it can be returned to rivers without further compromising water quality. South Africa is making good progress to meet targets for access to safe drinking water, but not as successfully for access to adequate sanitation. The pace of increasing pressure on water resources needs to be matched by equally accelerated improvements in governance and response measures.

Ecosystems are complex, and management of ecosystems needs to acknowledge that ecosystems do not behave predictably. Often the processes being managed are variable, and the end point is not a fixed state or even an equilibrium state. This inherent uncertainty means that those involved in managing freshwater ecosystems need to proceed even though the outcome is not certain, monitor results closely, and adapt actions on the basis of this feedback.

The goal is to move away from a situation where there is "*a gradual decline in the volume of water available per person, progressive worsening of water quality, loss of biological integrity in our aquatic ecosystems, and continually rising costs associated with treating water for people to drink. Ultimately, this will prevent us from achieving social and economic growth and eliminating poverty*." (Ashton 2010).

Taking action for more sustainable water management will require significant co-ordination and effort. Suggested actions are outlined in Table 15.4.

Table 15. 4: Suggested actions – improving freshwater ecosystems and balancing demands for water

Suggested actions - improving freshwater ecosystems and balancing demands for water
• Integrated co-operation and co-ordination is required between all departments (DEA, DWS, DAFF, DMR and DOE) dealing with water allocation and services in order to rectify larger issues of water quality and quantity; • The RHP and the SoE reports must be used by decision makers as they provides a good indicator on the success of implemented management practices and therefore funding for this project must be secured. The River Health Programme should be revitalized; • Improve the water efficacy of human settlements. This is to be achieved by water service authorities and local municipalities turning the tide on high volumes of potable water that are lost through poor infrastructure or inadequate management; • Urgent action is needed to improve the maintenance and operation of current infrastructure, develop new treatment infrastructure in underserviced areas and improve the capacity and skills of staff responsible for these facilities. Less than half of South Africa's waste water treatment works are treating the billions of litres of effluent they receive each day to safe and acceptable standards; • The function and mandates for CMAs provides the framework for Integrated Water Resources Management; • Priority must be given to establishing CMAs as these are important resources that are responsible for breaking down of 'silos' between institutions, as well as across resources and resource management, and are critical to the sustainable use of limited water resources; and, • Implement Catchment Management Strategies that actively engage on land use management practices. Land management practices compromise river and wetland integrity and have cumulative and knock-on effects for downstream users.

15.3.5 Using marine and coastal resources wisely

The 2006 SAEO concluded that the ocean and coastal environment of South Africa was in a moderately healthy state in relation to international trends at the time. Five years later there has been considerable focus and investment in creating appropriate policy and legislative conditions, which has positively influenced several aspects of marine and coastal environments.

These aspects over the last five years have included, amongst others, the expansion of marine protected areas, the creation of operational estuarine management plans, the implementation of the Working for Coasts programmes, improved implementation of the ecosystem approach to fisheries, the establishment of water quality guidelines, the creation and implementation of species management plans and a significant increase in the spend of ocean and coasts research and monitoring. Real gains from these initiatives have been a decrease in seabird mortalities, increases in some island bird populations, improved management of sensitive estuarine habitats and species, and an increase in

the understanding of marine ecosystem functioning and biodiversity distribution. Some aspects of the health of the country's oceans and coasts continue to experience apparent deterioration. Pressures on the oceans and coasts ecosystems are mostly as a result of increased anthropogenic pressures such as pollution from land-based sources and resultant decreases in water quality. Estuaries are examples of habitats that may be susceptible to such pressures. This includes the continuing trend of increased numbers of people residing in coastal areas.

The ability to use and protect marine and coastal resources in a sustainable manner will require the actions outlined in Table 15.5.

Table 15. 5: Suggested actions – using marine and coastal resources wisely

Suggested actions - using marine and coastal resources wisely
• Ensure expansion and enforcement of inshore and offshore marine protected areas. Continual transformation threatens biodiversity and the delivery of natural goods and services and the protected area network of South Africa is insufficient to sustain these processes; • Continual implementation of the ICM and the effective operation of the lead agencies for coastal management in the four coastal provinces to ensure consolidation of the positive trends' and, • Improved management measures, including the development and implementation of ocean- and coastal-specific co-operative governance structures and ICM specific tools, such as coastal setback lines, show a positive trajectory and should start to address the reported deterioration, and improve the overall state of the ocean and coastal environment.

15.3.6 Sustaining biodiversity and ecosystems

Sustaining biodiversity and ecosystem services in the future requires challenging the often misinformed idea that faster economic growth requires a trade-off to be made with protection of the environment. Sound environmental management, integrated planning and co-operative governance will allow South Africa to develop in a manner that supports resilient ecosystems and economies in the face of increasing global change. Healthy, intact ecosystems provide more options to respond to climate change, address poverty and building a stronger and greener economy. Keeping biodiversity intact is a vital prerequisite for any country's economic growth path and sustainable development as it will ensure the continued provision of ecosystem services to people.

Habitat loss, land degradation, poor agricultural practices, unsustainable infrastructure development, exploitation of species, pollution and invasive alien plant species are the most dominant threats to biodiversity. These threats will contribute to a decline in ecosystem services and may lead to food insecurity, increased levels of poverty or vulnerability and ultimately impact on human well-being.

Biodiversity loss and impacts on ecosystem health have continued to show limited areas of reversal. A sustainable balance between biodiversity conservation and development requires a more realistic, people-centred approaches to enhance the wellbeing of all South Africans, the economy and the natural environment. This requires more effective and efficient use of legislation by South African law courts, particularly NEM:BA and its provision for compliance (an obligation) and enforcement (driven by regulations). As it is relatively young legislation, its effectiveness, value and relevance should continue to be used (and tested) by a greater number of environmental legal experts in order to drive up standards and set legal precedents.

The South African legislation on biodiversity places particular importance on the protection, use and management of ecosystems and is moving away from species specific protection. This is to recognize the role and importance of intact and functioning systems that are able to supply ecosystem services to people. This is not to diminish the role of species specific legislation that is still critical for the protection of species under threat and which remains an important consideration. South Africa has a strong suite of legislation that aims to minimise the pressures on biodiversity by addressing habitat loss, land conversion, pollution loading and the illegal trade and use of endangered and protected species.

Strategic objectives for managing and conserving South Africa's biodiversity are set out in the NBSAP and the National Biodiversity Framework. Priority actions for biodiversity have been identified in the NBA and are grouped into three major categories of action. Importantly, these actions apply across terrestrial, freshwater and marine ecosystems and recognize

the integrated approach needed for long term ecosystem resilience. The priority actions are outlined in Table 15.6.

Table 15. 6: Suggested actions – sustaining biodiversity and ecosystems

Suggested actions - sustaining biodiversity and ecosystems
• Prevent loss and degradation of natural habitat in those biodiversity priority areas that are still in good ecological condition and that contribute to provincial and national targets. Biodiversity priority areas for South Africa include: i. Protected areas; ii. Critically endangered and endangered ecosystems; iii. Critical Biodiversity Areas and Ecological Support Areas (these include priority areas identified within Vulnerable and Least Threatened ecosystems); iv. Freshwater Ecosystem Priority Areas and their associated sub-quaternary catchments; v. High water yield areas; vi. Flagship free-flowing rivers; vii. Priority estuaries; viii. Focus areas for land-based protected area expansion; and, ix. Focus areas for offshore protection; • Protect critical ecosystems. Actions focus on consolidating and expanding the protected area network as well as strengthening the effectiveness of existing protected areas. Here, formal protection by law, recognized in terms of the NEM:PAA, including contract protected areas on private or communal land, is needed; • Restore and enhance ecological infrastructure. Actions should focus on active interventions needed to restore those biodiversity priority areas that are currently not in good ecological condition, in order to enhance ecological infrastructure and support delivery of ecosystem services; • Establish an understanding of the economic value of ecological infrastructure and ecosystem services in order to successfully integrate these issues into municipal and other budgets rather than viewing them as emotive concepts; and, • Investment in human capital is essential as a lack of sufficient skilled and experienced people is a key constraint in the biodiversity sector. A HCD Strategy with great potential to contribute to national job creation and development objectives has been initiated.

15.3.7 Managing waste

Waste management is a critical issue for South Africa to deal with now and in the near future. Waste has negative effects on the environment and on human health and the costs of not properly recycling, reusing or disposing of waste can be substantial if not effectively dealt with.

Since the 2006 SAEO, a number of key policy and regulatory instruments have been put in place, including the promulgation of the NEM:WA. These include national policy for the provision of basic refuse removal services to indigent households, national policy on thermal treatment of general and hazardous waste, national domestic waste management collection standards, waste classification and management regulations, waste tyre regulations, regulations on the prohibition of the use, manufacturing, import and export of asbestos and asbestos containing materials, and waste information regulations.

Population growth and urbanization have resulted in increasing waste volumes, particularly for hazardous and industrial waste, general household waste and e-waste. While a number of new policy and legislative mechanisms have been put in place, the implementation of these is proving more challenging. Data collection, reporting on waste volumes and management of increasing waste volumes has proved problematic. In addition, new types of waste need to be understood and properly managed. These include endocrine disrupting chemicals, plastics, nano-materials and chemicals, as well as rapidly increasing types of e-waste.

The NWMS published in 2011 sets out the means to address these challenges and identifies key actions which are framed within eight key goals, each with targets for 2016. Key actions are outlined in Table 15.7 and the roles of players in the waste management field in Box 15.3.

Table 15. 7: Suggested actions – managing waste

Suggested actions - managing waste
• Promote waste minimization, reuse, recycling and recovery of waste: i. 25% of recyclables diverted from landfill sites for re-use, recycling or recovery; ii. All metropolitan municipalities, secondary cities and large towns have initiated separation at source programmes; and, iii. Achievement of waste reduction and recycling targets set in Industry Waste Management Plans for paper and packaging, pesticides, lighting (CFLs) and tyre industries; • Ensure the effective and efficient delivery of waste services. This goal specifically deals with the challenges of service delivery: i. 95% of urban households and 75% of rural households have access to adequate levels of waste collection services; and, ii. 80% of waste disposal sites have permits; • Grow the contribution of the waste sector to the green economy: i. 69,000 new jobs in the waste sector; and, ii. 2,600 additional SMEs and co-operatives participating in waste service delivery and recycling; • Ensure that people are aware of the impact of waste on their health, well-being and the environment by targeting 80% of municipalities and schools to run local awareness campaigns; • Integrate waste management issues in to integrated development planning and local government initiatives. In addition, all waste management facilities should be reporting to national waste management systems in order to develop a better understanding of waste types, volumes and issues; • Land that has been contaminated from waste must be rehabilitated in a manner that meets standards so as not to impact on human health and so that it can be used for another land activity; and, • Monitoring and compliance to waste treatment and management standards is important to control environmental impacts and quality. Monitoring and compliance should be done in line with the specifications in the NEM:WA.

Box 15. 3: Roles of government, private sector and civil society for waste management

The NWMS specifies a number of actions for government, the private sector and civil society to improve waste management in South Africa and comply with the NEM:WA.
Government must:

- Draft legislation, regulations, standards and IWMPs;
- Regulate waste management activities through licences and enforce their conditions;
- Implement the SAWIS;
- Co-ordinate waste management activities using a system of WMOs;
- Give effect to multilateral agreements and ensure proper import and export controls;
- Progressively expand access to at least a basic level of waste services and plan for future needs;
- Facilitate the establishment of a national recycling infrastructure;
- Provide the framework for the remediation of contaminated land; and,
- Work in partnership with the private sector and civil society.

The private sector must:

- Take responsibility for their products throughout the products' life cycles;
- Institute cleaner technology practices and minimize waste generation;
- Establish systems and facilities to take back and recycle waste at the end of their products' lifecycle;
- Develop waste management technologies to ensure that all the waste produced in the country can be managed according to the waste management hierarchy;
- Prepare and implement Industry Waste Management Plans; and,
- Comply with licence conditions and regulations.

Civil society must:

- Separate waste at household level;
- Participate in waste awareness campaigns;
- Participate in recycling initiatives; and,
- Comply with waste regulations, prevent littering, and help to monitor compliance of waste disposal.

15.3.8 Improving air quality

Air quality management is a significant issue in the country which requires efforts from various stakeholders for the achievement of sustainable development, compliance to national standards, international best practice and above all, an environment that is not harmful to health and wellbeing.

Air quality provides an excellent example of where negative trends can be reversed if actions are taken on specific issues. For example, legislation to phase out lead content in fuels has led to a dramatic reduction in the concentrations of lead in the air which would have very negatively affected human health. However, growing urban settlements, industrial plants, private car ownership and continued burning of fuels in poor households continue to cause a decline in air quality.

The direct and indirect effects of air pollution have an impact across the country and a growing concern is the rising level of air pollution, mainly from industrial emissions, domestic use of wood, coal and paraffin, vehicle exhaust emissions, biomass burning and energy production.

Exposure to air pollution results in numerous health problems in people with the effects more pronounced among the elderly and young and also more evident in people of low income. This vulnerability has also been increased by poor land use planning, which has resulted in the location of heavy industrial developments in proximity to high density residential areas. The importance of density in such areas is related to impact amplification due to the low level release of the air pollutants associated with domestic fuel burning. Lack

of access to electricity in rural areas, and the inability to afford electricity among poor urban dwellers, has also resulted in the continued reliance on biomass and coal energy for cooking and space heating. Exposure to this indoor air pollution and the associated health effects are some of the reasons why the elevated PM_{10} levels in most residential household fuel burning areas, are of major concern. The health effects associated with exposure to indoor air pollution also have economic implications due to huge expenditures in the health sector required to combat the impacts.

Other sources of air pollution in the country include airports, waste treatment facilities such as waste water treatment works and landfill sites as they are also associated with greenhouse gas emissions, fuel stations, mine residues, tyre burning, fishmeal production and small combustion facilities, such as boilers.

Key actions are outlined in Table 15.8 to target improvements in air quality management in South Africa and the successful implementation of the NEM:AQA.

Table 15. 8: Suggested actions – improving air auality

Suggested actions - improving air quality
• Continual compliance, monitoring and enforcement of air quality standards to ensure effective implementation of NEM:AQA; • All air quality monitoring stations in South Africa should attain SA National Accreditation System accreditation to ensure good quality data that can be fed into the SAAQIS to enable effective monitoring and reporting; • Provision of real-time air quality data to the public to make air quality monitoring more meaningful. However, this is expected to be fulfilled when Phase III of SAAQIS is implemented. This phase will allow for provision of real-time or near-real time data to SAWS; • Co-operation and co-ordination by various government departments; • Capacity development which is of particular importance in terms of AEL issuing in most provinces and municipalities in the country; • Public participation and environmental education on the effects of poor air quality. This needs to focus particularly on indoor air pollution problems in poorer households who burn wood, paraffin and coal for heating and cooking purposes; • More research is needed on the health effects of air pollution in South Africa and updating of previous studies such as the Burden of Disease Health Study, so that the impacts and cumulative effects of poor air quality on people and the economy can be understood. This will also aid with more targeted actions to address specific health concerns and emerging air quality problems; and, • Co-operation in the implementation of energy efficiency measures to reduce the need for combustion sources in domestic heating.

15.3.9 Moving towards energy efficiency and the transition to a low-carbon future

Energy issues, previously relegated to electricity departments as a service delivery concern, have now moved to the forefront of political, economic and environmental debates in South Africa and much of the world. Energy is central to meeting basic human needs and improving living standards. Households use energy for cooking food, heating water, space heating and lighting in order to satisfy basic human needs. A lack of choice in accessing adequate, reliable, and safe energy services to sustain economic and human development can result in the inability to move out of a poverty trap or can endanger human health and livelihoods.

Many municipalities have now developed Energy or Climate Change Strategies to guide the implementation of renewable energy and energy efficiency. Most cities are undertaking a range of energy efficiency interventions including public building audits and lighting retrofits and energy efficiency awareness campaigns or forums. A few cities are implementing large-scale solar water heater rollout campaigns linked to the availability of the rebate available from Eskom. However, given that efficient water heaters are often the easiest measure to implement, or the 'lowest hanging fruit' among clean energy options, progress remains disappointing. This reflects poorly on South Africa's ability to plan and implement options which have clear financial, social and environmental benefits, and highlights the impact of the capacity constraints faced.

Renewable and efficient energy interventions are starting to find traction in municipalities but are not yet mainstreamed and have not yet substantially reduced the 'dirty' energy and carbon emissions profile of South Africa. Taking such implementation to a scale where they become significant contributors to the energy performance of cities is a current challenge.

Significant electricity energy efficiency opportunities are located in the mid-to-high-income residential sector in cities and large towns through efficient water heating and lighting mechanisms, as well as in the commercial sector (lighting and heating, ventilation and air-conditioning). Opportunities for savings in lower income residential areas are much less significant, and energy efficiency implementation here contributes to the equity aspect of sustainable systems. While government electricity use is not a major component of total consumption, the efficiency opportunities are significant

(streetlights, traffic lights, pumps, buildings) and can be readily implemented. Industry energy efficiency opportunities, although more difficult to generalize, are significant, particularly in the more industrial cities. Analyses indicate that there are vast energy efficiency opportunities that are cost effective from an end-user perspective. This supports the common wisdom that you get more out of a Rand spent saving energy than a Rand spent generating energy.

The key future objectives of the energy sector in South Africa can be expected to address the issues of energy security, reducing greenhouse gas emissions, reducing energy consumption, increasing sustainability of energy supply and the promotion of integrated planning across all spheres of Government. Key actions are outlined in Table 15.9.

Table 15. 9: Suggested actions – moving towards energy efficiency and the transition to a low-carbon future

Suggested actions - moving towards energy efficiency and the transition to a low-carbon future
• Shifting to low-carbon generation options; • Up-scaling of energy efficiency in all sectors through the implementation of demand-side management programmes, appliance standards and labelling, the introduction of building codes and certification; • Transport-related interventions such as modal shifts of freight to rail and from private to public transport, investment in public transport facilities and non-motorized forms of transport, as well as alternative vehicles and lower carbon fuels; and, • Alignment of policies across the spheres of government.

15.3.10 Building climate resilience

The impact of climate change on society, environment and economy is an important issue facing not only South Africa, but the rest of the world. The majority of peer-reviewed scientific papers and, in particular, the IPCC, agree that unless significant effort is made in the next two to three decades to curb and reduce carbon emissions, there will be a strong likelihood of global warming, where efforts to mitigate carbon emissions will have little or no effect. The impacts of climate change are already being seen in South Africa (such as storm surges in coastal areas, increased intensity of floods), and are projected to intensify over the coming decades.

The only way to effectively address climate change is through an urgent and sustained effort to change how people utilize resources. The objective should be in a very short time frame to move towards an economy that emits substantially lower levels of carbon. This requires strong leadership. There is an onus on all levels of government, from municipal to national, as well as within the international community, to shape legislation, to develop sound policy and drive implementation to support this move.

Dealing with a changing climate and implementing the broad changes required in South Africa requires facing a number of particular challenges. South Africa is the world's twelfth largest carbon dioxide emitter due largely to its heavy dependence on coal, which supplies nearly all of its electricity. In addition, the country has developed an extremely energy-intensive industry sector and produces liquid fuels from coal, making the energy sector the major contributor to South Africa's carbon emissions. The country's cities demonstrate high carbon emissions per capita relative to their level of development.

South Africa will need to adapt to the impacts of climatic changes so as to minimize the effects on key sectors. The extent of the impacts and the consequent need for adaptation, are largely determined by global efforts to reduce greenhouse gas emissions rather than local efforts, given the relatively small local contribution to global emissions.

There is a need to develop actions to address air pollutants that are short term climate forcers, such as black carbon, methane and tropospheric ozone that create warming. These can be a measure to cost-effectively reduce the rate of temperature increase in the short term while having the added benefit of reducing risks to human health and food production.

South Africa needs to respond to the climate change challenge from two perspectives, that of taking on its share of effort in reducing its overall greenhouse gas emissions, whilst at the same time meeting development agendas and ensuring early and appropriate adaptation to the changes to minimize the impacts on the country from inevitable changes in the climate. Substantial effort is required from national, provincial and local government, as well as the private sector and the society as a whole, to achieve the savings and implementation of the adaptation measures required. The costs associated with this effort are expected to be high, although early and appropriate interventions, particularly surrounding adaptation, can contribute to reducing the overall impact and cost of climate

change for the country. At the same time, there are substantial opportunities in moving towards a climate resilient and low emissions economy and society which could be exploited through early action. Once again, early identification and access of such opportunities will maximize the benefit to be gained.

Ecosystem-based adaption is key to responding to the challenges of climate change. This refers to the role of healthy ecosystems as a convenient and cost-effective response to the impacts of climate change, including managing, conserving and restoring ecosystems (rather than treating them as resources to consume or sinks for the disposing of wastes) to buffer humans from the impacts of climate change, instead of relying only on engineered solutions.

This approach is particularly effective in helping society cope with extreme climate events such as droughts, floods and storms. For example, buffers of natural vegetation along riparian corridors and around wetlands have been shown to mitigate floods, reduce erosion and improve water quality. Intact coastal ecosystems such as coastal dunes, mangroves, kelp beds and salt water marshes help to protect settlements and built infrastructure against sea storms. In many cases, ecosystem-based adaptation can work hand in hand with engineered adaptation responses. Ecosystem-based adaptation combines socio-economic benefits, climate change adaptation, and biodiversity and ecosystem conservation, contributing to all three of these outcomes simultaneously (Driver *et al*. 2012). Key actions are outlined in Table 15.10.

Table 15. 10: Suggested actions – building climate resilience

Suggested actions - building climate resilience
• Development of legislation and implementation that results in an economy that emits lower levels of carbon; • Reduce the country's carbon emissions by using alternative energy that does not utilize coal; • Reduce the amount of greenhouse gases that create warming thereby reducing risks to human health and food production; • Ensure early and appropriate adaption to changes to minimize the impacts to the country from inevitable climate changes; and, • Implement ecosystem-based adaptation measures.

15.4 CROSS CUTTING OPTIONS FOR ACTION

The options for action in this section are those aspects that require specific attention but cannot be approached in isolation. "*The complex nature of the environment's systems and the human-environment relationship means that it is crucial to integrate the actions and to promote cross-cutting ones*" (DEAT 2006). Success in addressing these aspects will have profound implications for a number of environmental issues, and as such require specific attention.

15.4.1 Co-operative governance

Governance involves both the determination of strategic direction and the regulation of practice. The aspects of good governance are detailed in Part I of this report. In terms of options for action, co-operative governance is key to both the integration and alignment of policy development, as well as successful policy implementation. The specialist chapters in Part II of this report on many occasions refer to the lack of alignment of policy across different departments (and sometimes even contradictory policy statements), and challenges in policy implementation across different spheres of government and implementation agencies.

Legislative review and policy formulation processes will not result in significant action unless the various actors take responsibility to implement the recommended actions. Environmental management by its very nature cuts across various disciplines, and as such requires an interdisciplinary approach to ensure effective results. This approach will also reduce unintended duplication of efforts by various role-players. A strong focus on co-operative governance, policy alignment and streamlined service delivery is therefore required to give effect to change and successful implementation.

An integrated approach should be the cornerstone to ensuring effective planning and implementation and the ability to respond to infrastructure and service delivery needs in a sustainable manner. An integrated planning approach is one that aligns development actions and removes duplication or conflicts in implementation, and is accepted as the best way to deal with a large number of demands when resources are limited.

Government has an established system of co-operative governance structures across and within all three spheres, local, provincial and national, to address environmental considerations, which is commendable. Co-operation across these spheres is achieved through a variety of intergovernmental forums within the departmental clusters and these structures need to be supported and appropriately resourced. These structures focus mainly on strategic and policy setting matters. Mechanisms to facilitate and promote engagement and interaction between government and its social partners also exist.

It is clear that changes in drivers and pressures will unfold, to some extent at least, in response to government policy and therefore government is crucial in guiding the policy response for improved environmental performance. Good governance

in the environmental sphere is described further in Box 15.4.

Box 15. 4: What is good governance?

The DEA defines good environmental governance as: *"… the processes of decision-making involved in controlling and managing the environment and natural resources. Principles such as inclusivity, representivity, accountability, efficiency, and effectiveness, as well as social equity and justice, are the foundations of good governance. Good environmental governance should reflect our best understanding of the structure, function, processes, and variability that typify natural systems. Without this understanding, it is possible for inappropriate decisions to be made (even with the best possible intentions) that carry disastrous environmental consequences*."

Source: Department of Environment Affairs, State of Environment website (2012)

A key action going forward is to implement strategies to narrow the gap between policy and implementation. This was amplified in an Africa-wide survey of sustainability and performance of cities, where none of the South African cities performed well on quantifiable metrics such as electricity consumption, waste generation and water consumption. Added hereto, they have among the highest carbon dioxide emissions from electricity, mainly because South Africa's electricity is produced mostly from coal. The survey did however find that South African cities *'more than make up for drawbacks on consumption with consistently strong environmental policies'* (Siemens 2011). Therefore the policy environment is in place and robust, yet the actual implementation falls short.

A further consideration is that South Africa currently has a complex spectrum of policies and strategies that do not always speak clearly to each other and cause overlapping mandates, confusion around responsibilities for implementation and monitoring needs. Unfortunately, many such documents end up never making contact with an audience or practitioners outside of the institutions that created them. In the environmental management field, environmental policies and guidelines commonly only get used by individuals within the sector, rather than those people or institutions outside the field that have control over the 'actioning' of the recommendations and controls.

The implementation of policy is critical in a local government context where municipalities have a significant role in driving environmental change. The Municipal Systems Act stipulates the rights and duties of municipal councils which includes the duty to ensure that municipal services are provided to the local community in an equitable, and financially and environmentally sustainable manner. The provision of these services and infrastructure needs to be undertaken in a more environmentally sensitive and responsive manner, namely the provision of ecological or green infrastructure. Section 15.5 of this chapter discusses ecological and green infrastructure in more detail. Local government does require the necessary resources and budgets to be capacitated to deliver on these duties (particularly in rural areas). To this end, increasing demonstration of the value of ecological resources and ecological goods and services is very important. Incorporating the economic value of this natural capital in the municipal budgets will require attention and further investigation.

A body of knowledge exists to address the policy implementation gap and lessons should be applied and supported with the necessary resources and commitment.

15.4.2 Strengthening compliance and enforcement

Significant effort has been spent on improving the governance framework in South Africa over the past two decades. However, these polices and laws remain mere intentions until they are implemented and enforced effectively.

It is internationally recognized that "*from a legal perspective, governance and regulation are largely meaningless without compliance*" (Paterson & Kotzé 2009). Compliance and enforcement are pivotal elements of an effective environmental regulatory regime. The rationale underlying compliance and enforcement, as a collective term, includes "*improving environmental quality, reinforcing the credibility of environmental laws and the institution responsible for their administration, ensuring fairness towards those who willingly comply with the legal requirements, reducing costs and liability associated with non-compliance*" (Paterson & Kotzé 2009).

As the indicators for environmental performance continue their downward trend across many areas of measurement, it is critical that considerable effort be continuously focused on compliance and monitoring to combat environmental crimes and non-compliance. Financial resources, institutional capacity, and stakeholder willingness are crucial to ensure that the downward trends in the quality of the environment are halted and reversed.

In the South African context, the NEMA contains key provisions in terms of environmental compliance and enforcement, and provides for the designation of EMIs, also known as the 'Green Scorpions' who are mandated to enforce compliance with environmental laws. Their powers are potentially wide-ranging, including routine inspections, search and seizure, taking of samples and issuing of compliance notices. Other national environmental statutes contain provisions prescribing sectoral statutory compliance and enforcement mechanisms and/or measures.

In South Africa, compliance monitoring and enforcement has made significant progress since the previous 2006 SAEO through swift intervention and prosecution of non-compliance. Today, the Environmental Management Inspectorate has approximately 1,400 inspectors (including SANParks officials) across all spheres of government and across numerous departments. The EMIs deal with a range of issues from green issues (focusing on the protection and sustainable utilization of biodiversity and compliance to relevant international agreements), to brown issues (focusing on air pollution, waste and developments requiring environmental authorization) and blue issues dealing with marine-related issues, as well as water in close co-operation with DWS. The Environmental Management Inspectorate has developed into a strong network of environmental enforcement officials across spheres of government, and across numerous environmental aspects. All efforts to capacitate and empower the Environmental Management Inspectorate should be strongly supported to ensure the successful implementation of policy and legislation.

15.4.3 Enhancing capacity

Capacity is made up of human resources, finances, administration, infrastructure and institutional systems. To ensure that environmental and sustainability thinking becomes a practical reality in everyday life, additional capacity and skills in these areas are needed in all sectors of society. This requires focused attention on the key areas of education, skills development, and sustainability orientated research and development. In addition, major priorities include building the capacity of local government, multi-sectoral partnerships, and community empowerment.

Developing intellectual capacity in the environmental governance arena is fundamental to achieving sustainability (NPC 2012). This challenge is being met by the DEA that has compiled an ESSP. The plan describes the current status quo with regard to demand and supply of environmental skills, and provides the best available information on scarce and critical skills in the sector at present from a supply and demand perspective. It also identifies new trends influencing skills development needs in the sector (e.g. new socio-ecological issues and directions, such as climate change, mainstreaming of environment into development subjects, new science and technology directions in South Africa, and the green economy) (DEA 2010).

Other initiatives by the HCD address some of the challenges around capacity enhancement, as does the Integrated Youth Development Strategy which specifically addressed the skills requirements and inclusion of youth into the green economy.

Implementation of these strategies and plans needs to follow though, based on the guidance for environmental sector skills development within the national education, training and skills development system. The four objectives for environmental sector skills development include skills development at macro level, addressing scarce and critical skills, measures to ensure a longer term sustainable supply of quality skills, measures to ensure a proactive, transformative and innovative skills development system, human capital development strategy planning at sub-focus and institutional levels, and a system for monitoring and evaluation of skills planning and development (DEA 2010).

15.4.4 Environmental information for decision-making

Achieving environmental sustainability means that global concerns regarding climate change, loss of biodiversity and shortage of basic environmental resources need to be addressed. It is therefore important to maintain a record of key environmental performance areas in order to direct response measures and measure their effectiveness as a contribution towards global targets and commitments. Timely and accurate information is essential for ensuring appropriate responses and policies with regard to environmental change. A good example of such global environmental indicators is the Living Planet Report (WWF 2012). This report is a global scale state of environment report, and tracks aspects such as biodiversity, the human ecological footprint, carbon footprint and water scarcity.

At a more local scale, a worrying trend encountered during the drafting of the specialist chapters was the lack of accurate, up-to-date and consistent data. The gathering of long-term data allows for more informed decision-making, and improved management responses as a result (Box 15.5). Most of the specialist chapters highlighted this as a major concern.

Currently, data inadequacies result in outdated data being analysed and decisions being taken based on insufficient and inappropriate data. Significant improvements are required in data management systems as well as monitoring of performance in a standardized manner.

Box 15.5: Evidence-based policy making requires more reliable data

The lack of reliable and consistent time-series data on the state of the environment is a major barrier to increasing the effectiveness of policies and programmes. Additionally, many of the most important drivers of environmental change, or even their impacts, are not systematically monitored. All countries should undertake to monitor and assess their own environment and integrate social, economic and environmental information to inform decision-making processes. As standardized approaches to data collection are needed, international co-operation and capacity building for collecting data must be strengthened. Improving access to information is also essential.

Source: GEO-5, United Nations Environmental Programme (2012)

Current environmental information and data should also be used to proactively inform decision-making to avoid detrimental environmental impacts. A wealth of information exists that should be easily available and easy to be interpreted so as to have a positive bearing on decisions. A good example is the biodiversity information available on the Biodiversity-GIS (BGIS) website which aims to assist in biodiversity planning and decision making by offering comprehensive and freely

accessible spatial biodiversity planning information. BGIS also provides tools, such as interactive mapping tools, for analysing and applying the available biodiversity information.

15.4.5 Shifting the policy focus

Environmental sustainability has emerged as one of the defining themes in the 21st century business environment. Both public and private sector organizations have had to incorporate sustainability considerations in their policies to factor in emergent issues such as climate change, the triple bottom line, the need to minimize carbon footprints, etc.

The issue, however, is that many of these policy directives focus on addressing the environmental pressures or symptoms. Rather, the focus should be on addressing the underlying forces or drivers that are causing environmental degradation. These drivers include population dynamics, urbanization, consumption patterns, economic activities, governance, technology and innovation, and production methods. Many of these drivers are inter-related and therefore compound the negative effects on the environment and human well-being.

"*Because of the rapid growth in drivers, the complexity of their patterns and dynamics, and their ability to generate unexpected impacts, improved efforts in surveillance and monitoring the drivers may produce tangible benefits. When basic environmental, social and economic data are available and integrated, it becomes feasible to assess the possible environmental impacts of drivers effectively*." (UNEP 2012a).

In a report entitled The Economics of Ecosystems and Biodiversity, ecosystems and biodiversity are defined as the stock of 'natural capital' as they lead to a flow of benefits that support societal and individual well-being and economic prosperity (Institution for European Environmental Policy 2009). However, the gains made in evidence-based policy making will be limited if South Africa does not have good understanding of the value and functioning of this natural capital. Policy makers therefore need to have information on measuring the value of nature in order to assist in policy making. Without ecosystem service indicators, it will be extremely difficult to shift to more appropriate and relevant policies that address the drivers and underlying causes of poor environmental performance.

15.4.6 Science and technology

Science and technology drive both positive and negative effects on the environment. They can drive the development of new technologies that allow more efficient resource use, enable recycling, improve food production, clean water, developing pharmaceuticals, preventing disease and so on. Innovation and scientific advances can also accelerate urbanization, land transformation and increase pollution and waste. Technological advances can also enable the greater exploitation of natural resources (DEAT 2006).

The DST is mandated to drive and deliver new technology-based industries to the South African economy through the development of appropriate strategic road maps for chosen sectors of the economy, including for example energy, space, global health and biotechnology and to also create the appropriate policy and institutional implementation instruments in order to deliver technology products and services for the economy and society. Within the context of a developing country and economy, much of this focus is on promoting international competitiveness and improving the lives and opportunities for South Africans. For the DST, this includes focused interventions and acting as a catalyst for change in terms of productive components of the economy, and targeted toward the development backlog existing among the poorest components of South African society.

In order to meet this need the DST has formulated the *Ten-Year Innovation Plan: towards a knowledge-based economy* (2007). This plan is to run from 2008 to 2018 and is designed to transition South Africa towards a knowledge-based economy. In order to achieve this outcome the DST has set five Grand Challenges, namely:

- The Bioeconomy Strategy (previously Farmer to Pharma);
- Space science and technology;
- Energy security;
- Global change science with a focus on climate change; and,
- Human and social dynamics.

The Global Change Grand Challenge has dynamic linkages with the other grand challenges and hence most appropriate in terms of feeding into the Environment Outlook process. Figure 15.4 is a summary of the Global Change Research Plan that was developed in response to the Global Change Grand Challenge. Included in the Global Change Research Plan are changes to economics, politics, land use, atmospheric conditions and loss of biodiversity. Geosciences are also included as it relates to global change. It also embraces the linked human-ecological system, as the impacts of global change will be experienced at this level and technological innovation where relevant to mitigate the change is also included.

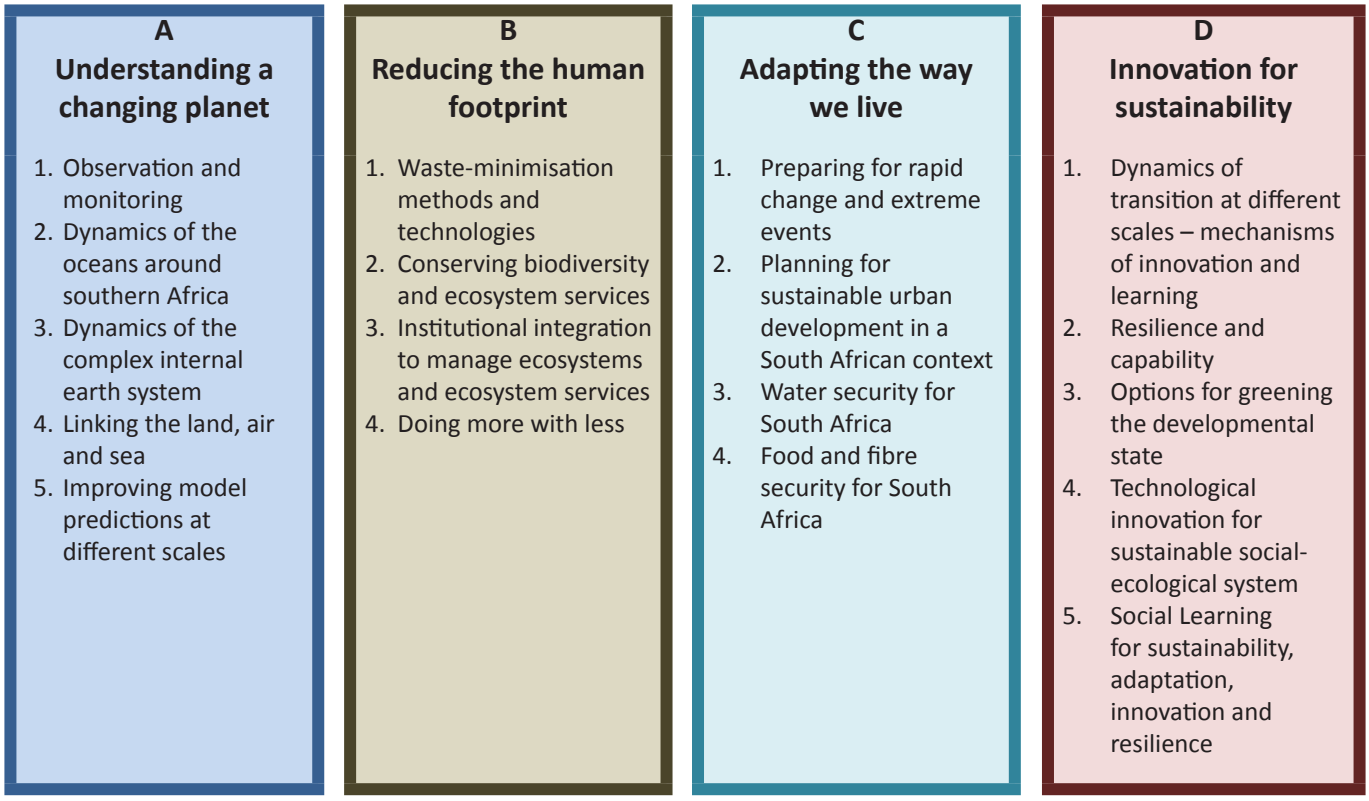

Figure 15. 4: Global change research plan

The knowledge challenges in Figure 15.4 provide thematic focus to the Global Change Research Plan, the research themes within each knowledge area were designed to cover a wide range of options, thus allowing researchers from all disciplines to contribute to the Grand Challenge. The Global Change Research Plan seeks to encourage investigation and improved understanding of Global Change and by so doing to develop practical ways forward.

Key programmes and initiatives comprising the global change knowledge generation system include the:

- South African Earth Observation Network (SAEON): SAEON is a research facility that establishes and maintains nodes (environmental observatories, field stations or sites) linked by an information management network to serve as research and education platforms for long-term studies of ecosystems that will provide for incremental advances in the understanding of ecosystems and the ability to detect, predict and react to environmental change;
- African Earth Observation Network (AEON): AEON is a centre for Earth Systems Science (ESS) that provides a research and educational environment to seek consilient knowledge amongst earth and life sciences, engineering, resource economics and the human sciences. AEON is forging Earth Stewardship into a science that can sustain the planet and its people;
- Applied Centre for Climate and Earth Systems Studies (ACCESS): ACCESS is a consortium of several agencies, researcher councils, research programmes, universities and research groups who have combined efforts to deliver a range of outputs aligned to the DSTs Global Change Grand Challenge. It is a platform for integrated and end-to-end research and education, services and training outputs and outcomes related to the opportunities and challenges emanating from a varying and changing environment, collectively referred to as Earth Systems Science;
- South African National Space Agency (SANSA): Established by an Act of Parliament (Act 36 of 2008), SANSA promotes and co-ordinates the use of space and co-operation in space-related activities, fosters research in space science, advances scientific engineering through human capital and supports the creation of an environment conducive to industrial development in space technologies within the framework of national government policy;
- South African Risk and Vulnerability Atlas (SARVA): SARVA is an atlas of local environmental risks and vulnerabilities in the global change context. It comprises a spatial database system and repository of local environmental risks-related case studies. It is aimed at equipping decision-makers with information on the impact and risk associated with global change in the region;
- Global Change, Society and Sustainability Research Programme (GCSSRP): It is a large-scale research programme focusing on socio-ecological dimensions and designed primarily to generate information for decision-making by policy makers; and,
- Foundational Biodiversity Information Programme (FBIP): A new integrated programme intended to generate and disseminate foundational biodiversity information and related datasets to support socio-economic development of South Africa. Enjoying the support of the DST, the programme brings together various biodiversity and natural resources projects into a more coherent programme that responds to some of the national priorities.

Research indicates that "*government departments and agencies are faced with issues of increasing socio-ecological complexities around environmental sustainability and global change, which requires them to make decisions that have the*

potential to impact greatly on society and economics. As a result, they are under increasing pressure to develop policies that consider a wide spectrum of scientific and indigenous knowledge. It is acknowledged that in South Africa, as elsewhere, a gap typically exists between the scientific or research community and the policymaking community, due to a number of underlying reasons at both ends. This gap often results in a unidirectional 'push of evidence' by researchers to policymakers, with a hope that policymakers will take up these findings and use them in policy identification, formulation or implementation. To support the uptake of evidence in policy, it is also important to stimulate an environment of 'evidence pull' by the policy community from the research community, as well as increasing the dialogue between these communities" (Godfrey *et al*. 2010).

There is therefore a dire need to bridge the gap between science and policy so as to ensure the 'uptake of evidence' in policy development and implementation. Suggestions include the need for institutional mechanisms, such as knowledge-brokering offices, both within research organizations and government departments, and the importance of researchers involving policymakers from the onset of their research process, with a continuous dialogue between the two parties, both during and after the research, as a means of increasing the likelihood of research uptake (Godfrey *et al*. 2010).

The DEA, in a proactive collaborative effort, developed the R,D&E framework. This document addresses the need for "*a common framework for the collection of solid evidence that can be used in support of environment sector policy decisions and for the achievement of sector priorities*". The framework seeks to respond to the pressing environmental issues by developing "*a more rigorous approach that gathers, critically appraises and uses high quality research evidence to inform policy-making and professional practice*" (DEA 2012a). Importantly, Outcome 10, Environment Sector Plan and SAEO priorities are used to identify evidence needs and likely future developments.

The framework emphasizes that the transfer of knowledge between researchers and policy makers in the environmental sector needs to be strengthened. "*Policy-makers and researchers need to work more closely together by means of established, regular and trusting interaction and dialogue. Through the DEA, a central knowledge management system (web-based data system) will be developed to help facilitate interactions among key stakeholders from the science and the policy domains. Various fora will be used to facilitate the sector science-policy interface and evidence based policy-making. These fora include the internal co-ordinating forum, the existing intergovernmental forum, theme specific fora and the multi-stakeholders forum*." (DEA 2012a).

This environment sector R,D&E framework will be implemented in phases, where biodiversity, waste management, climate change, air quality, and oceans and coasts have been identified to initiate immediate implementation. These areas were selected based on the MoU between the DEA and the DST for initial implementation (DEA 2012a).

Through the five-year Environment Outlook, the state of environment is described to inform on improvement or degradation of the South African environment relative to its desired state as defined in Section 24 of the Constitution. Environmental issues arising from the SAEO stimulate new research as well as setting the agenda for the sector through Outcome 10 and Sector Plan priorities. Hence, it is through the interactions between Outcome 10, the Sector Plan and the priorities identified in the SAEO that new targets are set and sector evidence-based policy-making is enhanced (Figure 15.5).

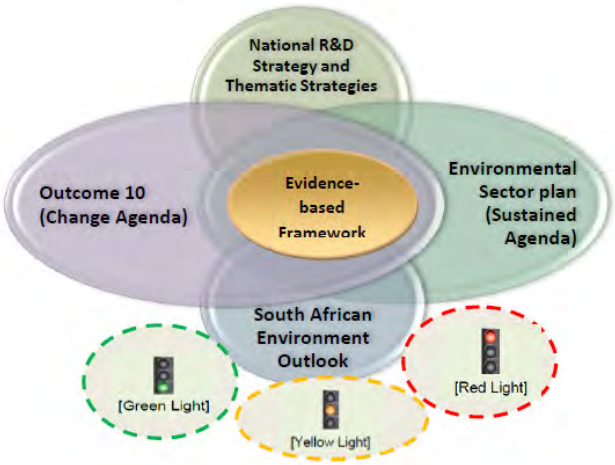

Figure 15. 5: Linking the South African Environment Outlook with environment sector R,D&E priorities

Within the context of a rapidly globalizing world, South Africa must harness its science and technology to promote its global competitiveness. In so doing, significant gains should be made in reducing inequalities and creating wealth, improving the lives of all South Africans, developing human resources and working towards environmental sustainability.

Means of achieving this are scientific research efforts to promote energy and material efficiency, cleaner production and eco-efficiency. Cleaner production is defined by the United Nations as "*the continuous application of an integrated preventive strategy applied to processes, products and services so as to increase eco-efficiency and reduce risks to humans and the environment*" (National Cleaner Production Centre 2012). Cleaner production involves simple strategies ranging from good housekeeping to more technology-driven strategies such as new product or process design and technology transfer. This is a holistic and integrated approach to environmental protection because it addresses the challenges of sustainable development at several levels.

The DEA is currently in the process of finalizing the SCP framework. The aim of the Framework is to prioritize and scale-up national SCP implementation programmes, align the sustainable consumption and production into the national sustainable development policies, create awareness on the national SCP policy framework and implementation initiatives and monitor progress on national SCP programmes.

The Strategy is envisioned to support sustainable development and the improvement of the quality of life of all South Africans through a structured approach to integrated pollution and waste management that utilizes the economic, regulatory and technical principles and tools of cleaner production for the effective reduction of resource usage and minimization of the

impacts of pollution and waste on the natural environment and on human health.

Cleaner production has demonstrated itself as an effective component towards the realization of the concept of sustainable development. In a developing country such as South Africa, the environmental concerns have to be balanced by considerations for economic growth and job creation. Cleaner production typically results in a 'win-win' strategy for protecting the environment and reducing the potential risks to the environment and human health, without underplaying the importance of economic development (National Cleaner Production Centre 2012).

15.5 KEY EMERGING ISSUES

Emerging environmental issues are those where there is a growing realization of their significance and challenging nature, and where the knowledge and ability to address these is still maturing. These issues form part of the current environmental debates and are critical in understanding and resolving the tipping points. Three key emerging issues have been identified namely, shifting to renewable energy sources and changing the energy mix, transitioning to a green economy, and demonstrating the value of ecological infrastructure.

15.5.1 Renewable energy and changing the energy mix

Energy use in South Africa is characterized by a high dependence on cheap and abundantly available coal and non-renewable resources and this needs to change. In 2011, for primary energy consumption, coal accounted for 71.1 per cent of total primary energy supply, followed by oil (12.8 per cent), and combustibles, renewables and waste (10.4 per cent). South Africa's energy balance also includes relatively small shares of natural gas, nuclear, and hydroelectricity (IEA 2011). South Africa is well endowed with renewable and low-carbon energy sources with the potential to produce energy from biomass, wind, solar, small-scale hydro and waste, though these resources remain largely unexploited and should be in future.

The food-water-energy nexus, discussed in Section 2 of this chapter, demonstrated the inter-connection and interaction between water, agriculture, energy and the environment. Without managing these resources holistically, South Africa will likely cross ecological thresholds and the earth's carrying capacity (the tipping points). This will also require addressing wastage and overconsumption. Significant changes in how the country manages both water and energy consumption will be required.

It is within this context, that the DoE's Renewable Energy White Paper Policy stipulates that a target of 10,000 GWh by 2013 is to be produced from renewable energy sources. The Renewable Energy Directorate is monitoring and evaluating the renewable energy power production for the achievement of the ten-year target and the development of policies, regulations and strategies to create an enabling environment for the development and uptake of renewable energy. Similarly, the 2010 IRP states targets for each renewable energy type. According to the IRP 2010-2030, renewable energy will contribute 18.2 GW by 2030 (about 42 percent), wind will contribute 8.4 GW, solar photovoltaic will contribute 8.4 GW, CSP will contribute 1 GW, and 'others' will contribute 0.4 GW of new build.

Furthermore, the introduction of REIPPPP in the energy market has the potential to alter the energy type away from coal-based supplies. This however will require a shift in approach and intensity and how the energy market works in South Africa to more effectively change the direction in which it is set.

The reality is that large-scale internal shifts in policy direction, policy alignment, economic structure and development planning will be required if the existing inter-linkages between mining of coal, energy intensive industry and inefficient energy use are to be broken and a renewable energy industry allowed to arise.

15.5.2 Green economy

One of the key actions for the transformation of society into a more environmentally sustainable form is to develop an economy based on green principles. Such a green economy will put sustainable development in action by marginalizing economic activities that have unsustainable environmental costs, and using environmentally responsible development activities to solve social and economic ills more effectively than business-as-usual practices.

It includes proactive investment in environmentally and socially responsible or green technologies, recognition of human rights, and restructuring of governance systems to promote green procurement and operations. In addition, the nature-based economy (such as tourism and ecotourism) can also make a significant contribution to the green economy

through the creation of long-term jobs, supporting rural development while protecting and enhancing ecological functioning.

While still viewed as a key emerging issue, much has been done since 2010 to address this in South Africa. Commitment to the green economy can be seen from the high-level multi-stakeholder National Green Economy Summit held in May 2010, co-ordinated by the DEA in partnership with economic cluster departments. National Treasury has since, over 2012/13, established the R800 million-Green Fund which has subsequently been increased by a further R300 million.

At a strategic level, the green economy has been highlighted in the NDP which indicates that: "*Shifting to a green economy, including to a low-carbon economy, is shifting to a more sustainable economic growth and development path in the long term...*" (NPC 2012).

In the report entitled Programmes in Support of Transitioning South Africa to a Green Economy (DBSA 2011) "*greening the South African economy represents a critical lever for bringing about the structural transformation needed for a more equitable and inclusive economy*". It further states that "*co-ordinated activity is required to achieve the envisaged economic shifts to transition the country to a low-carbon and greener economy, with the ultimate objective of a carbon-neutral economy by 2050*".

Green economy commitment is supported by various strategic policies and strategies such as the National Strategy for Sustainable Development and Action Plan (2011), NDP (NPC 2012), National Skills Development Strategy III, Ten Tear Innovation Plan, New Growth Path (2010), Green Economy Accord (2011), Industrial Policy Action Plan, IRP (2010), NCCRWP (2011) and the Development Indicators among others.

South Africa identified nine focus areas to pursue and explore the opportunities in the green economy. These are: (i) resource conservation and management; (ii) sustainable waste management practices; (iii) water management; (iv) environmental sustainability (greening and legacy, major events and tourism, research, skills, financing and investments); (v) green buildings and the built environment, (vi) sustainable transport and infrastructure; (vii) clean energy and energy efficiency, (viii) agriculture, food production and forestry; and, (ix) sustainable consumption and production.

The green economy holds the promise of creating many new jobs and so fostering a green economy will also fulfil the national development agenda. The UNEP advocates that investment in the green economy could realize a further growth in real GDP of over two per cent by 2030 relative to 2012 (UNEP 2011).

The South African government has identified greater labour absorption in its planning as a means to overcome income disparities and contribute to economic growth (NPC 2012). The DBSA (2011) highlights that the bulk of the jobs related to the green economy are likely to come from natural resource management, many more than from, for example, renewable energy generation or technologies for reducing emissions. A key requirement is that the national skills development strategy be aligned with the requirements of the green economy. A target has also been set to generate 20,000 MWh of renewable energy by 2030 (NPC 2012).

To further the transition to the green economic, the DEA, as commissioned by the UNEP, recently prepared a report aimed at assessing potential opportunities and options to promote a green economy, with a focus on key economic sectors set out by South Africa's NDP. It presents a modelling exercise that compares a scenario of investments directed to 'business-as-usual' with scenarios of investments allocated to four critical sectors for a transition to a green economy in South Africa, namely: natural resource management, agriculture, transport and energy. The findings from this assessment, using the parameters of economic growth, poverty, employment, resource efficiency and climate change, show that the strengthening of natural resource management and environmental protection is fundamental for sustained economic growth and well-being (UNEP 2013).

15.5.3 Ecological infrastructure

Ecosystems and ecosystem services provide a foundation for economic growth (jobs), social development (service delivery) and human well-being (a better life). So jobs, service delivery and improved livelihoods are dependent on ecological service provision. Chapters 7: Biodiversity and Ecosystem Health, 8: Inland Water, and 9: Oceans and Coasts have shown how these ecosystems provide services such as clean water, food, medicine, fibre, climate regulation, flood and coastal erosion protection. The Chapters also show that if these ecosystems are impacted beyond their thresholds to provide these services then there are negative socio-economic impacts.

Infrastructure is the physical and organizational structures necessary for communities and individuals to access the services and facilities for economic development. Infrastructure is critical for growth and development in South Africa. The Municipal Systems Act stipulates the rights and duties of municipal councils which includes the duty to ensure that municipal services are provided to the local community in an equitable, and financially and environmentally sustainable manner. Local government is central to the provision of these services and infrastructure and therefore has a significant role in driving environmental change through the implementation of more environmentally sensitive and responsive manner, namely ecological infrastructure.

'Ecological infrastructure' is the planned and managed networks of ecosystems and biodiversity that maintains the provision of ecosystem services to society and so enabling development. Ecological infrastructure is defined by SANBI as functioning ecosystems that deliver valuable services to people, such as fresh water, climate regulation, soil formation and disaster risk reduction. It is the nature-based equivalent of built or hard infrastructure, and is just as important for providing services and underpinning socio-economic development. Ecological infrastructure provides cost effective, long-term solutions to service delivery (SANBI 2012).

Our knowledge and understanding of biodiversity is improving and allows us to acknowledge the sustainable use of ecological infrastructure and biodiversity assets that will support a range of economic activities. Ecological infrastructure does this by supporting built infrastructure and the built environment, and in so doing contributes to the goals of the green economy.

Ecological infrastructure can be thought of as an interconnected network of open spaces and natural areas and may include wetlands, healthy catchments and protected areas that assist to manage stormwater, reduce flooding risks and improve water quality. South Africa has abundant ecological infrastructure, providing opportunities to support development and unlock economic potential. Because ecological infrastructure is largely free, its value is seldom captured in market transactions and people tend to underinvest in it. Nevertheless, it is usually more cost effective to restore the ecosystems concerned than to keep repairing or replacing the built infrastructure. Investing in ecological infrastructure enhances investments in built infrastructure (SANBI 2012).

In a recently published special edition of Engineering News, it was stated that *"… strategic investment into a country's ecological infrastructure can enhance and extend the life of existing built infrastructure and reduce the need for additional human-made infrastructure, while offering considerable job-creation potential. For this reason, experts are calling for an institutionalized acknowledgment of the services acquired from South Africa's ecological infrastructure and for this to be included in the National Development Plan (NDP) and the country's growth and development policies*." (Engineering News 2013).

Furthermore, ecological infrastructure supports rural development and helps us cope with changes in climate and creates long term jobs. SANBI argues that "*well managed ecological infrastructure can buffer human settlements and built infrastructure against the extreme events that are likely with climate change, playing a crucial and cost effective role in disaster risk reduction. For example, coastal ecosystems such as dunes, mangroves and kelp beds reduce the impact of storm surges on coastal settlements. In contrast, hardening of the coastline puts people and property at greater risk*." (SANBI 2012). With regard to job creation it is argued that "*healthy ecological infrastructure supports a range of economic sectors, directly and indirectly. Restoring and maintaining ecological infrastructure creates jobs as it's usually a labour intensive endeavour. Many of the jobs would be in the poorest parts of the country with the least access to other employment opportunities.*" (SANBI 2012).

The Green Jobs Report by the IDC and DBSA (2011) highlights that "*the bulk of the jobs related to the green economy are likely to come from natural resource management – many more than from, for example, renewable energy generation or technologies for reducing emissions*." (SANBI 2012).

In moving forward, a number of key actions are outlined to unlock the potential of ecological infrastructure, and these include (SANBI 2012):

- Scale up investments in restoring and maintaining ecological infrastructure, with a focus on the highest value ecological assets. To date the approach in South Africa has tended to be piecemeal, so the country hasn't realized the full benefits. Figure 15.6 reflects the types of interventions and the benefits that can be derived from investing in ecological infrastructure;
- Build on natural resource management programmes such as Working for Water and Working for Wetlands. There are models and methods for doing what's required. Should the approach in investing in ecological infrastructure be seen as a long-term endeavour, the jobs created needn't be short-term contractual employment; and,
- Plan and manage ecological infrastructure networks strategically, rather than leaving their configuration and persistence to chance. There is an excellent scientific body of knowledge to guide this.

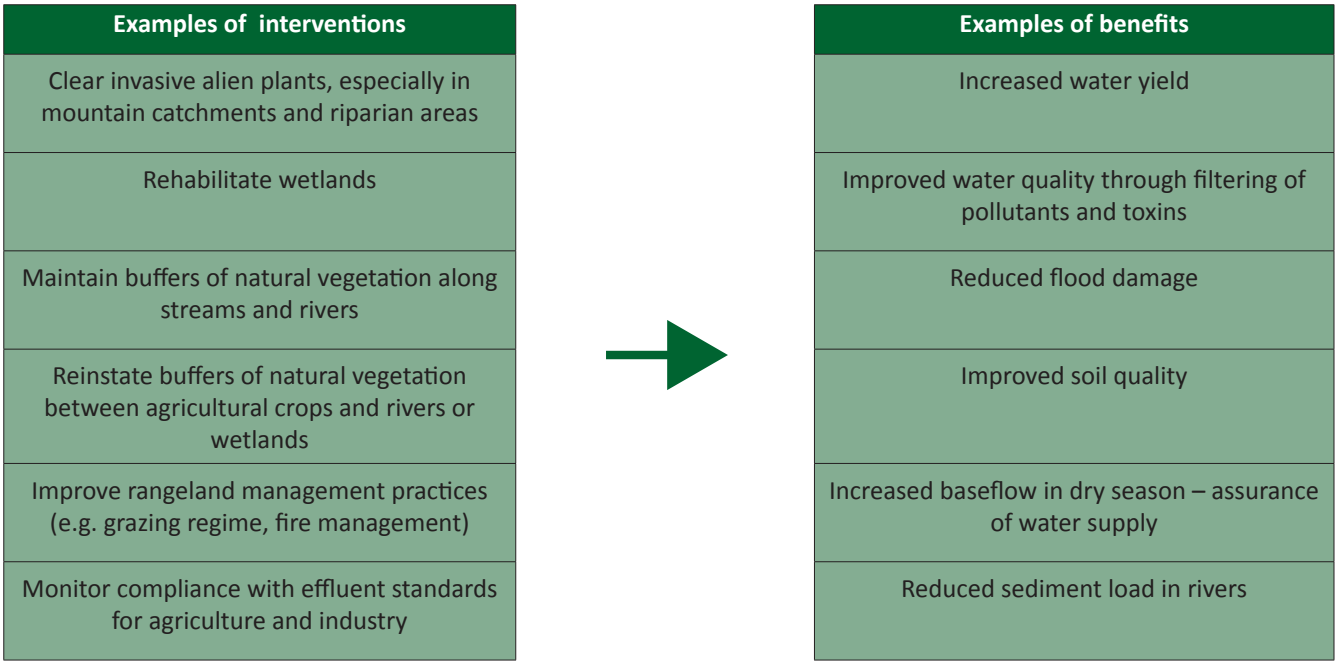

Figure 15. 6: Interventions and benefits from investing in ecological infrastructure
Source: SANBI (2012)

15.6 CONCLUSION

The opportunity exists for South Africa to actively pursue a developmental path that is environmentally sustainable. While the overall picture is of environmental decline, there are many positive signs and success stories. In most cases, these successes have also led to increased economic growth and social well-being.

The options for action should be considered by policy and decision-makers to avoid a negative future scenario characterized by continued depletion of natural resources, and strive for sustainability embedded in all activities so as to improve the quality of life for all those living in South Africa. This SAEO provides a roadmap for future integrated environmental management and provides strategic guidance on priority areas for action.

The responses in the SAEO are therefore policy relevant but not policy prescriptive meaning that the SAEO does not specify detailed policy responses but rather highlights key issues and trends that need to be addressed.

It will be necessary going forward, therefore, to integrate these key environmental issues and actions into all the country's decision-making processes and institutions. It will be important for everybody to understand a little about the role the environment plays in their everyday lives, whilst those with more in-depth environmental knowledge will need to apply this in assisting others in their specialist fields. Most importantly, decision-makers need to acknowledge that environmental management is first and foremost about protecting and enhancing the quality of life of people. A cross-cutting and holistic approach to environmental matters and environmental management will be required in terms of ensuring co-operative and co-ordinated governance, since the goal of an equitable and fair life for all human beings ultimately depends on it.

15.7 REFERENCES

1. AGECC (UN Secretary General's Advisory Group on Energy and Climate Change), (2010). *Summary Report and Recommendations*. UN Secretary General's Advisory Group on Energy and Climate Change.

2. Ashton, P.J. (2010). The Road Ahead. In CSIR (2010) *A CSIR perspective on water in South Africa – 2010*. CSIR, Pretoria.

3. DBSA (2011). *Programmes in Support of Transitioning South Africa to a green economy, Development Planning Division Working Paper Series No. 24*. Development Bank of Southern Africa. http://www.dbsa.org/Research/DPD%20Working%20papers%20documents/DPD%20No24.pdf?AspxAutoDetectCookieSupport=1.

4. DEA (Department of Environmental Affairs), (2010). *Environmental Sector Skills Plan for South Africa: A systems approach to human capacity development and sector skills planning, Summary Document*. Department of Environmental Affairs, Pretoria.

5. DEA (Department of Environmental Affairs), (2011a). *National Strategy for Sustainable Development and Action Plan (NSSD 1) 2011-2014*. Department of Environmental Affairs, Pretoria.

6. DEA (Department of Environmental Affairs), (2011b). *National Climate Change Response Strategy White Paper*. Department of Environmental Affairs, Pretoria.

7. DEAT (Department of Environmental Affairs and Tourism), (2006). *South Africa Environment Outlook. A report on the state of the environment*. Department of Environmental Affairs and Tourism, Pretoria.

8. DEAT (Department of Environmental Affairs and Tourism), (2007). *Scenario Building Team. Long Term Mitigation Scenarios: Technical Summary*. Department of Environment Affairs and Tourism, Pretoria.

9. DoE (Department of Energy), (2012). *Draft Second National Energy Efficiency Strategy Review, Department of Energy*., Pretoria.

10. DME (Department of Minerals and Energy), (2005). *Energy Efficiency Strategy of the Republic of South Africa*. Department of Minerals and Energy, Pretoria.

11. Driver, A., Sink, K.J., Nel, J.N., Holness, S., van Niekerk, L., Daniels, F., Jonas, Z., Majiedt, P.A., Harris, L. and Maze, K. (2011). *National Biodiversity Assessment 2011: An assessment of South Africa's biodiversity and ecosystems. Synthesis Report*. South African National Biodiversity Institute and Department of Environmental Affairs, Pretoria.

12. Engineering News (2013). Special Edition. 1 February 2013.

13. FAO (Food and Agriculture Organization), (1996). *Rome Declaration on World Food Security and World Food Summit Plan of Action*. World Food Summit 13–17 November 1996, Rome.

14. Godfrey, L., Funke, N. and Mbizvo, C. (2010). *Bridging the science–policy interface: A new era for South African research and the role of knowledge brokering*.

15. IEA (International Energy Agency), (2011). *World Energy Outlook 2011*. International Energy Agency, Paris.

16. IRP (Integrated Resource Plan), (2010). *Integrated Resource Plan for Electricity 2010-2030*. The Department of Energy, Pretoria.

17. Millennium Ecosystem Assessment (2005). *Ecosystems and human well-being: a framework for assessment.* Millennium Ecosystem Assessment, Island Press, Washington.

18. National Cleaner Production Centre (2012). http://www.enviropaedia.com.

19. NPC (National Planning Commission), (2012). *National Development Plan 2030: Our future – make it work*. National Planning Commission, Pretoria.

20. Paterson, A. and Kotzé, L. *Environmental Compliance and Enforcement in South Africa, Legal Perspective*. Juta 2009.

21. Siemens Economist Intelligence Unit (2011). *African Green City Index: Assessing the environmental performance of Africa's major cities*. A research project conducted by the Economist Intelligence Unit, sponsored by Siemens. http://www.siemens.com/entry/cc/en/greencityindex.htm.

22. SANBI (South African National Biodiversity Institute), (2012). *Fact sheet on ecological infrastructure*. SANBI, Cape Town.

23. Tan, D. (2012). *Agriculture: A Prosperous Ever After*. China Water Risk. http://chinawaterrisk.org/resources/analysis-reviews/agriculture-a-prosperous-ever-after/.

24. UNDP (United Nations Development Programme), (2000). *United Nations Millennium Declaration.* United Nations Development Programme.

25. UNEP (2011). *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication - A Synthesis for Policy Makers*. United Nations Environmental Programme. www.unep.org/greeneconomy. Viewed 30 October 2012.

26. UNEP (United Nations Environmental Programme), (2012a). *GEO-5 – Global Environmental Outlook: Summary for Policy Makers*. United Nations Environment Programme, Nairobi.

27. UNEP (United Nations Environmental Programme), (2012b). *GEO-5 – Global Environmental Outlook*. United Nations Environment Programme, Nairobi.

28. UNEP (United Nations Environmental Programme), (2013). *Green Economy Scoping Study: South African Green Economy Modelling Report (SAGEM) – Focus on Natural Resource Management, Agriculture, Transport and Energy Sectors*. United Nations Environmental Programme.

29. WWF (World Wide Fund for Nature), (2012). *Living Planet Report 2012. Biodiversity, Biocapacity and Better Choices*. World Wildlife Fund, Global Footprint Network, ZSL Living Conservation.

15.8 ANNEXURE 15. A: Implementation framework

Actors responsible for implementing actions are indicated in brackets in bold next to the suggested action. The following codes apply: GN = national government; GP = provincial government; GL = local government; R = research; B = business and industry; C = civil society.

Creating sustainable human settlements		
Integrated planning and service provision	Social and behavioural (S)	• Encourage sustainable human settlements and interdepartmental co-operation for infrastructure development (GN, GP, GL). • Ensure role-players are adequately informed on low carbon initiatives and sustainable city-building (GN, GP, GL, B, C).
	Knowledge and cognitive (K)	• Develop and enforce a programme for continual development for professional planners (as is required of the other built environment professions) by tertiary institutes and the Council for Planners (GN, GP, GL, B). • Implement the 'Breaking New Ground' policy (GN, GP, GL, B). • Adhere to the Green Building Council of South Africa's Green Star SA green buildings accreditation scheme, the Department of Housing's Red Book Guidelines, the Green Professionals Programme of the International Institute of Energy Conservation and municipal or provincial commitments towards greener building standards (GN, GP, GL, B).
	Institutional and legal (I)	• Implement sustainable human settlement strategies that promote diverse communities via densification; mixed land-use regulations; shortening the distance between home and work; linking home and work via public transport, pedestrian and cycling routes; enhancing the quality of the natural environment; and improving the safety and accessibility of settlements (GN, GP, GL, B). • Improve co-ordination of urban development strategies, including housing delivery, infrastructure construction, social services, safety, health and transportation (GN, GP, GL). • Include sustainability criteria into all spatial and integrated planning, e.g. IDPs and PGDSs, and project formulation and selection of public and private funding of infrastructure projects (GN, GP, GL). • Integrate planning legislation with the objectives of sustainable development. Policies are in place but not all the necessary legislation and regulations (GN, GP, GL). • Develop model land use schemes and by-laws to serve as reference for local governments (GN, GP, GL). • Implement compliance and monitoring measures that ensure effectively implemented sustainability objectives as proposed in the National Strategy for Sustainable Development (NSSD) (GN, GP, GL).
	Economic and incentives (E)	• Promote incentives for the application of renewable energy options, water saving measures, passive building design and other sustainability metrics are initiated at local authority level. Municipal bylaws which require and reward this must be enacted (GN, GP, GL, B).
	Technological (T)	-

Creating sustainable human settlements		
Infrastructure: buildings, transport, energy	Social and behavioural (S)	-
	Knowledge and cognitive (K)	• Increase investment into sustainability science and technologies that link directly to the infrastructure programme (GN, B, R).
	Institutional and legal (I)	• Develop and design guidelines and information resources to support the built environment and design professions to incorporate sustainability criteria into the design of infrastructure and buildings (GN, B). • Ensure there is a balance between private sector investments in the energy sector, with a rapid escalation in public sector investments in new generation and transmission capacity, including renewable energy and coal-based generation (GN).
	Economic and incentives (E)	• Ensure the potential for long-term economic and ecological sustainability by promoting investment incentives that favour investments in fixed assets that reinforce the overall vision, mission and principles of the NSSD (GN, B, C). • Increase investment in public transportation, including freight by rail and passenger transport via rail, bus and mini-bus. The provision of new services, the upgrading of existing services and the gradual conversion to bio-fuels should be top priorities (GN, GP, GL, B). • Give consideration to the introduction of a 'feed-in tariff' that will create a market for localised electricity generation that can be sold into the grid at an agreed tariff (GN). • Promote changes in taxation, investment incentives, and other fiscal interventions, plus 'licence-to-operate' mechanisms, which reinforce market trends towards more sustainable production and consumption (GN, B, C).
	Technological (T)	• Build durable, appropriate and green housing adhering to building standards (B, GL).
Sustainable land use and management		
Land use	Social and behavioural (S)	-
	Knowledge and cognitive (K)	• Institute a land-resources monitoring and assessment programme to give timely, accurate, and periodic information needed on the condition and trends in the land resource, which should feed into the National Action Programme on Land Degradation (GN, R). • Improve understanding of ecosystem services provided by natural capital and ensure this is incorporate into policy (GN, R, C). • Develop an updated land-cover data set in order to accurately represent land transformation and which can be compared to older data (GN). • Implement revised policy guidelines for the integration of environmental planning into the land reform process and guidelines for incorporating environmental considerations into Integrated Development Plans (GN, GP, GL).

Sustainable land use and management		
Land use	Institutional and legal (I)	• Apply the precautionary principle with respect to GMOs, including regulations to ensure public access to all relevant information (GN, B). • Develop methods to include the demonstration of the value of natural capital into land and economic policies (GN, GP, GL and B).
	Economic and incentives (E)	• Improve access to and support from financial institutions for emerging farmers (B, GN).
	Technological (T)	-
Access to land	Social and behavioural (S)	-
	Knowledge and cognitive (K)	-
	Institutional and legal (I)	• Increase extension support to beneficiaries of the land reform programme and improve institutional capacity for implementing the programme and developing in beneficiaries the skills they need for successful and sustainable land management (GN, B). • Formulate and implement a plan to deal with the issue of land administration in communal areas (GN, GP, GL).
	Economic and incentives (E)	• Support of economic activities in line with agriculture and green economy which can boost the economy and alleviate poverty. These debates should be encouraged and linked to how limited high value agricultural areas are managed (ALL).
	Technological (T)	-
Land degradation and desertification	Social and behavioural (S)	• Support capacity building initiatives for sustainable land management (GN, B). • Develop targeted education and awareness initiatives on the benefits of using alternative sources of energy to lessen the dependence on biomass (GN, GP).
	Knowledge and cognitive (K)	• Develop rigorous desertification indicators and mapping methodologies (R).
	Institutional and legal (I)	• Fast track the roll-out of the National Action Programme to Combat Land Degradation (GN). • Take local communities and local value systems into account when making land-use and land management decisions (GL, C).
	Economic and incentives (E)	-
	Technological (T)	• Develop and institute a large-scale land rejuvenation programme that prioritises and supports conservation farming methods (GN).

Improving freshwater ecosystems and balancing demands for water		
Water scarcity and service delivery	**Social and behavioural (S)**	• Extend capacity to fully implement the Water Services Strategic Framework in consultation with all key partners (GN). • Raise awareness and encourage water conservation in all sectors of society (G, B, C). • Improve the maintenance and operation of current infrastructure, develop new treatment infrastructure in underserviced areas and improve the capacity and skills of staff responsible for these facilities. Less than half of South Africa's waste water treatment works are treating the billions of litres of effluent they receive each day to safe and acceptable standards (GN, GP, GL).
	Knowledge and cognitive (K)	• Review water management in the agricultural sector, taking into account irrigation systems, use of aquifers and rivers, and develop a strategy for more efficient and sustainable use of water in the sector (GN, B). • Implement Catchment Management Strategies that actively engage on land use management practices. Land management practices are compromising river and wetland integrity and has cumulative and knock-on effects for downstream users.
	Institutional and legal (I)	• Strengthen co-operation with the Department of Provincial and Local Government and the South African Local Government Association (SALGA) to ensure the effective adoption of water services responsibilities by local government (GN, GP, GL). • Integrated co-operation and co-ordination is required between the departments of Environmental Affairs, Agriculture. Fisheries and Forestry, Water Affairs, Mineral Resources and Energy) dealing with water allocation and services in order to rectify larger issues of water quality and quantity (GN, GP, GL). • Priority must be given to establishing all 19 CMAs as these are important resources that are responsible for breaking down of (silos) between institutions, as well as across resources and resource management, critical to sustainable use of limited water resources (GN, GP).
	Economic and incentives (E)	• Fast track implementation of tariff structures to reward water demand management (GN, GL). • Encourage municipalities through financial incentives to maintain water supply infrastructure (GN, GL). • Improve the water efficacy of human settlements. This is to be achieved by water service authorities and local municipalities turning the tide on high volumes of potable water that are lost through poor infrastructure or inadequate management (GL, C).
	Technological (T)	-
Water quality	Social and behavioural (S)	• Scale up public awareness campaigns to reduce littering and uncontrolled waste disposal as well as the costs of water pollution (GL, C).

Improving freshwater ecosystems and balancing demands for water		
Water quality	Knowledge and cognitive (K)	• Standardize and consolidate monitoring results nationally for both surface and groundwater (GN, R).
	Institutional and legal (I)	• Enforce the polluter-pays principal for water pollution incidences (GN, GP).
	Economic and incentives (E)	• Fast-track the implementation of Department of Water and Sanitation's Discharge Charge System and implement incentives for reducing consumption, including amendments to by-laws, building regulations and regulations governing the re-use of grey water and treated sewage (GN, GL).
	Technological (T)	• Promote and extend the use of cleaner production in industries producing solid, liquid and airborne wastes (GN, B, C).
Degradation of aquatic ecosystems	Social and behavioural (S)	• Increase the focus on conserving and raising awareness of freshwater biodiversity (GN).
	Knowledge and cognitive (K)	• Strengthen links between the monitoring and assessment of water resources and planning and policy, including extending the RHP assessments to cover all catchments and incorporating the results of this and the National Spatial Biodiversity Assessment into water resources planning (GN, R). • The RHP and the SoE reports to be used by decision makers as these provide a good indicator on the success of implemented management practices (GN, GP, GL, R). • Develop a comprehensive wetlands inventory at a regional scale that can be used for informed land use planning and environmental authorizations (GN, R).
	Institutional and legal (I)	• Improve land management throughout catchments so that it does not compromise the integrity of river and wetland systems (B, C, GN, GP, GL). • Ensure the establishment of catchment management agencies in the most important catchments. Provide additional resources and build capacity in the CMAs, and in the IDP process for integrated land and water management, which should incorporate and enforce the 'polluter pays' principle (GN, GL, C, B).
	Economic and incentives (E)	• Continue the discussion proposed by the environmental fiscal reform policy paper, and promote the use of economic instruments such as charges, taxes and incentives to encourage natural resource management and pollution reduction (GN, B, C).
	Technological (T)	-

Using marine and coastal resources wisely		
Over-exploitation of stocks	**Social and behavioural (S)**	• Increase the focus on conserving and raising awareness of coastal biodiversity and marine resources (GN, GP, GL, C).
	Knowledge and cognitive (K)	-
	Institutional and legal (I)	• Ensure that Line-fish Management Protocol policies are implemented and enforced to ensure recovery of collapsed stocks (GN). • Implement the provisions of the Integrated Coastal Management Act (GN, GP, GL).
	Economic and incentives (E)	• Promote the non-consumptive use of marine and coastal resources by growing the tourism potential of scuba diving, whale watching, and marine safaris (GN, B, C).
	Technological (T)	-
Habitat degradation	**Social and behavioural (S)**	-
	Knowledge and cognitive (K)	-
	Institutional and legal (I)	• Improve the planning and monitoring of development in coastal areas, as a concerted effort is urgently required to improve the sustainability of developments, including golfing estates (GL, GP, GN, B, C). • Improve management measures, including the development and implementation of ocean- and coastal-specific co-operative governance structures and ICM specific tools, such as coastal setback lines (GN, GP, GL, C).
	Economic and incentives (E)	-
	Technological (T)	-
Protection and management	**Social and behavioural (S)**	-
	Knowledge and cognitive (K)	-
	Institutional and legal (I)	• Management efforts should give attention to the West Coast and KZN coastlines, in addition to the current efforts being placed on the Western, Northern and Eastern Cape coasts (GN). • Ensure the expansion and enforcement of inshore and offshore marine protected areas as continued transformation threatens biodiversity and the delivery of natural goods and services and the protected areas network of SA is insufficient to sustain these processes (GN, GP). • Implement the ICM and ensure the effective operation of the lead agencies for coastal management in the four coastal provinces to ensure the ongoing consolidation of positive trends (GN, GP, GL).
	Economic and incentives (E)	-
	Technological (T)	-

Sustaining biodiversity and ecosystems		
Over-exploitation, habitat degradation and loss	**Social and behavioural (S)**	• Develop targeted awareness campaigns for sectors having the largest impact on biodiversity, e.g. agriculture, forestry and mining (GN, B, C). • Make the case to demonstrate the value of biodiversity, including the links between biodiversity and socio-economic development, and disseminate it among decision-makers and the public (ALL).
	Knowledge and cognitive (K)	• Update land cover data on a properly comparable basis (R, GN). • Ongoing implementation of multi-sectoral bioregional programmes that link biodiversity conservation with socio-economic development such as CAPE, SKEP, STEP, the National Grasslands Biodiversity Programme, transfrontier parks and world heritage sites, the Coast Care and Blue Flag Beach Programmes as well as world heritage sites.
	Institutional and legal (I)	• Work with production sectors that are major land users (such as agriculture, infrastructure, property development, forestry and mining), to develop and implement sector-specific wise practice guidelines (GN, B, C). • Ensure that land-use planning and decision making adequately incorporate biodiversity considerations, particularly in the case of SDFs and IDPs at local level, and EIAs (GL, GP, GN).
	Economic and incentives (E)	• Increase the use of co-management agreements with communities and business to improve sustainable management of ecosystems (B, C, GN, GP, GL). • Establish an understanding of the economic value of ecological infrastructure and ecosystem goods and services in order to successfully integrate these issues into the municipal budget (GN, GP, GL, C).
	Technological (T)	-
Protected areas	**Social and behavioural (S)**	-
	Knowledge and cognitive (K)	• Develop and implement a register of protected areas (GN, GP, GL). • Prevent loss and degradation of natural habitat in those biodiversity priority areas that are still in good ecological condition and that contribute to provincial and national targets (GN, GP, GL, C).
	Institutional and legal (I)	• Expand the protected area network to incorporate a representative sample of SA's biodiversity as well as key ecological processes (GN, GP, GL). • Focus on actions that will consolidate and expand the protected area network as well as strengthen the effectiveness of existing protected areas. Here, formal protection by law, recognised in terms of the NEM:PAA, including contract protected areas on private or communal land is needed (GN, GP, GL, C).

Sustaining biodiversity and ecosystems		
Protected areas	**Economic and incentives (E)**	• Invest in human capital as there is a lack of sufficient skilled and experienced people is a key constraint in the biodiversity sector. In addition, the implementation of the Human Capital Development Strategy has great potential to contribute to national job creation and development objectives (GP, GN, GL).
	Technological (T)	-
Invasive alien species	**Social and behavioural (S)**	• Assist local government to develop appropriate alien plant management plans (R).
	Knowledge and cognitive (K)	-
	Institutional and legal (I)	• Prevent and control the impact of invasive alien species. This requires co-ordination and alignment of resource allocation and implementation strategies between the multiple institutions involved in preventing invasive alien species from entering the country and in controlling invasive alien species already present (GN, B, R, GL).
	Economic and incentives (E)	-
	Technological (T)	-
Managing waste		
Integrated waste management	**Social and behavioural (S)**	• Hold competitions to reward waste recycling programmes (GL, C, B).
	Knowledge and cognitive (K)	• Focus on the collection of waste generation data, for general and hazardous waste (GN, GP, GL).
	Institutional and legal (I)	• Implement Integrated Waste Management Plans to reduce wastes (GP, GL).
	Economic and incentives (E)	• Apply incentives for improving resource use efficiency and waste recycling programmes (GN).
	Technological (T)	• Increase the number of hazardous waste sites (GN, GP, GL).
Waste minimisation, reuse, recycling and recovery of waste	**Social and behavioural (S)**	• 80% of municipalities and schools to run local awareness campaigns to make people aware of the impact of waste on their health, well-being and the environment (GN, GP, GL, C).
	Knowledge and cognitive (K)	-
	Institutional and legal (I)	• Target 25% of recyclables to be diverted from landfill sites for re-use, recycling or recovery (ALL). • Initiation of separation at source programmes by all metropolitan municipalities, secondary cities and large towns (GN, GP, GL).
	Economic and incentives (E)	-
	Technological (T)	-

Managing waste		
Grow the contribution of the waste sector to the green economy	**Social and behavioural (S)**	-
	Knowledge and cognitive (K)	-
	Institutional and legal (I)	• Establish 2,600 additional SMEs and co-operatives participating in waste service delivery and recycling (GN, GP, GN, B).
	Economic and incentives (E)	• Target the creation of 69,000 new jobs in the waste sector (GL, B).
	Technological (T)	-
Effective and efficient delivery of waste services	**Social and behavioural (S)**	-
	Knowledge and cognitive (K)	-
	Institutional and legal (I)	• Implement actions to meet the following targets as per the National Waste Management Strategy: 95% of urban households and 75% of rural households have access to adequate levels of waste collection services; and 80% of waste disposal sites have permits (GN, GP, GL, B). • Monitoring and compliance to waste treatment and management standards is important to control environmental impacts and quality. Monitoring and compliance should be done in line with the specifications in the NEM:WA (GN, GP, GL, B).
	Economic and incentives (E)	• Rehabilitate land that has been contaminated from waste in a manner that meets standards so as not to impact on human health and so that it can be used for another land activity (GN, GP, GL).
	Technological (T)	-
Improving air quality		
Improving air quality	**Social and behavioural (S)**	• Institute a public awareness campaign about the health and safety risks of using coal and wood for heating and cooking (GN, C).
	Knowledge and cognitive (K)	• Ensure adequate funding for the establishment of the national air quality monitoring system, and air quality management plans at local level (GN, GL).
	Institutional and legal (I)	• Adopt revised air quality limits (GN). • Develop and implement a transport policy that supports efforts to reduce vehicle emissions (GN, GP). • Continual compliance, monitoring and enforcement of air quality standards to ensure effective implementation of National Environmental Management: Air Quality Act (No 39 of 2004) (GN, GP, GL).
	Economic and incentives (E)	• Put in place a regulatory framework that stimulates market incentives and disincentives to create markets for renewable energy generation, cleaner technology and energy efficiency, with a commitment by major cities to employment growth in an expanding alternative energy sector (GN, GL).
	Technological (T)	• Roll out the Implementation Strategy for the Control of Exhaust Emissions and integrate policing with vehicle roadworthiness, and adopt Euro technologies for new vehicles and reduce the sulphur, benzene and aromatics content of fuels (GN, B).

Improving air quality		
Air quality monitoring	**Social and behavioural (S)**	• Public participation and environmental education on the effects of poor air quality. This needs to particularly focus on indoor air pollution problems in poorer households who burn wood, paraffin and coal for heating and cooking purposes (GN, GP, GL, C).
	Knowledge and cognitive (K)	• Provide real-time air quality data to the public to make air quality monitoring more meaningful. However, this is expected to be fulfilled when Phase III of SA Air Quality Information System (SAAQIS) is implemented. This phase will allow for provision of real-time or near-real time data to SAWS (GN, GP, GL). • Further research on the health effects of air pollution in SA and updating of previous studies such as the Burden of Disease Health Study, so that the impacts and cumulative effects of poor air quality on people and the economy can be understood. This will also aid with more targeted actions to address specific health concerns and emerging air quality problems (R).
	Institutional and legal (I)	• Capacity development which is of particular importance in terms of atmospheric emissions licence issuing in most provinces and municipalities in the country (GN, GP, GL).
	Economic and incentives (E)	-
	Technological (T)	• SANAS accreditation of all air quality monitoring stations in SA to ensure good quality data that can be fed into the SAAQIS to enable effective monitoring and reporting (GN, GP, GL).
Moving towards energy efficiency and the transition to a low-carbon future		
Energy efficiency	**Social and behavioural (S)**	• Shift to low-carbon generation options (GN, GP, GL, B, C).
	Knowledge and cognitive (K)	• Increase renewable energy generation capacity to the 2nd National Integrated Resource Plan for Energy led by the National Energy Regulator (GN, GP, GL). • Give effect to the national teaching and research programme within the university sector to build SA's capacity to develop alternative renewable and sustainable energy resources via the South African National Energy Research Initiative of the Central Energy Fund (R).
	Institutional and legal (I)	• Align policies across the spheres of government (GN, GP, GL). • Implement transport-related interventions such as modal shifts of freight to rail, and from private to public transport, as well as alternative vehicles and lower carbon fuels (GN, GP, GL, C).
	Economic and incentives (E)	• Approve proposals from Independent Power Producers to supply renewable energy to Eskom (B). • Roll-out of large scale solar-water heating which is actively supported by Eskom and the Department of Energy, as well as provincial and local authorities (GN, GP, GL, B).
	Technological (T)	• Upscale of energy efficiency in all sectors (GN, GP, GL, R). • Co-operate in the implementation of energy efficiency measures to reduce need for combustion sources in domestic heating (GN, GP, GL, R). • Investigate innovative responses in renewable technologies in wind energy, solar energy, biomass and wave/tidal energy (R).

Building climate resilience		
Climate change	**Social and behavioural (S)**	• Implement a communication strategy alerting the general public to the potential outcomes of climate change (C, GN).
	Knowledge and cognitive (K)	• Ensure adequate funding and capacity for research on climate change and its impacts on society and the environment in order to guarantee appropriate strategies and policies are developed, including funding increases for renewable energy and energy efficiency interventions (GN, R, B). • Apply ecosystem based measures to respond to challenges of climate change (GN, GP, GL, B, C).
	Institutional and legal (I)	• Establish appropriate adaptation strategies for the socio-economic and biophysical environments, linked to national development initiatives such as the National Climate Change Response Strategy, the Integrated Sustainable Rural Development Programme and the Urban Renewal Programme, the Extended Public Works Programme. These adaptation strategies should be integrated into Provincial Growth and Development Strategies, Integrated Development Plans, and conservation management plans (GN, GP, GL, B, C).
	Economic and incentives (E)	• Put in place a new regulatory framework that stimulates market incentives and disincentives to create markets for renewable energy generation, cleaner technology and energy efficiency, with a commitment by major cities to employment growth in an expanding alternative energy sector (GN).
	Technological (T)	• Reduce the dependence on fossil fuels through a focused drive to develop cost effective alternative sources of energy, including solar, wind, wave, hydrogen, nuclear and biomass. Particular attention should be paid to developing and implementing incentives to promote energy efficiency, renewable energy and solar-water heaters (B, GN, GL, R). • Invest in clean coal production technologies capable of sequestrating and/or reusing CO^2 (B, GN, R).
Mitigation measures	**Social and behavioural (S)**	-
	Knowledge and cognitive (K)	-
	Institutional and legal (I)	• Continued implementation of the long term mitigation scenarios that have been proposed (GN, GP, GL and B). • Implement the mitigation measures contained in the commitments of Output 2 in Outcomes 10 with regard to Reduction of Co_2 and Renewable Energy Development (GN, GP, GL). • Ensure measures suggested in the National Climate Change Response White Paper are carried out, including the various adaptation plans for sectors (GN, GP, GL).
	Economic and incentives (E)	-
	Technological (T)	-

Cross-cutting themes		
Co-operative governance	**Social and behavioural (S)**	• Support mechanisms to facilitate and promote engagement and interaction between government and its social partners (B, C).
	Knowledge and cognitive (K)	• Effect regulatory and institutional reforms to give statutory effect to sustainable development, land use management, regulate resource use, and support implementation (GN, GP, GL). • Integrated approach to policy formulation and implementation (ALL). • Strengthen initiatives to narrow the gap between policy and implementation (ALL).
	Institutional and legal (I)	• Continued operation of the established system of co-operative governance structures across and within all three spheres – local, provincial and national (GN, GP, GL).
	Economic and incentives (E)	• "Green procurement" policies have been adopted and implemented across various institutions in both the public and private sectors, whilst market-based instruments to support environmental sustainability are being pursued from a government finances perspective (GN, GP, GL, B).
	Technological (T)	-
Strengthening compliance and enforcement	**Social and behavioural (S)**	• Train the judiciary in principles of environmental management and sustainable development and build legal capacity within the national and provincial environmental departments (GN, GP). • Education and awareness regarding compliance with environmental legislation (GL, B and C).
	Knowledge and cognitive (K)	• Ongoing resourcing of the Environmental Management Inspectors (EMI) across all spheres and sectors of government (GN, GP, GL).
	Institutional and legal (I)	• Improve capacity within regulatory authorities to effectively manage, implement and review the various integrated environmental management procedures and tools (GN, GP). • Ensure appropriate, adequate, and continuous training for EMIs (GN, GP). • Renew focus on the implementation of multi- and bilateral agreements to improve regional and international governance (GN).
	Economic and incentives (E)	-
	Technological (T)	-

Cross-cutting themes		
Enhancing capacity	**Social and behavioural (S)**	• Target and develop civil society education and awareness campaigns around the value of natural capital for human well-being (ALL). • Roll out a national environmental capacity-building programme for local government at an appropriately senior level to embed environmental considerations in municipal strategies and plans (GN, GP, GL). • Make the capacity building of officials a component of outsourced projects, through 'on the job' training by including officials as part of the project team and through guideline documents or tool kits that can be used for similar projects in future (GN, GP, GL).
	Knowledge and cognitive (K)	• Increase investment into sustainability-focused research and development particularly in land rejuvenation and conservation farming, energy efficiency in building techniques and industrial manufacturing processes (GN, R, B). • Implement the four objectives of the Environmental Sector Skills Plan (ESSP) (GN, GP, GL). • Establish partnerships to develop the access to information and the skills that non-governmental and community-based organizations, including women, youth and vulnerable groups, need to participate in technical debates (GN, GP,GL, C). • Implement the recommendations in the Human Capital Development, and Integrated Youth Development Strategies (GN, GP, GL, B).
	Institutional and legal (I)	• Mainstream sustainable development principles into the National Skills Development Programme (GN). • Implementation of the ESSP (GN, GP, GL). • Improve the planning and implementation of environmental sustainability principles within existing education policy and improve the effectiveness of environmental education campaigns, particularly among the youth (GN).
	Economic and incentives (E)	-
	Technological (T)	• Increase investment in and extend the application of information and communication technology to support capacity building in integrated planning, particularly at local government level (GN, GL, R, B). • Develop a system for monitoring and evaluation of skills planning and development (GN, GP, GL, R, B).

Cross-cutting themes		
Environmental information for decision-making	**Social and behavioural (S)**	-
	Knowledge and cognitive (K)	• Integrate the collection, management, and sharing of information and reports on environmental and other related matters across all government departments and research institutions, particularly in the case of important cross-cutting data sets (R, GN, B). • Develop data collection and monitoring initiatives that target priority environmental issues (e.g. air and water emissions, land degradation and desertification, water quality and availability, cultural heritage, human vulnerability, and effectiveness of governance). Data collection should inform environmental reporting requirements (R, GN). • Continue the development and review of appropriate environmental indicators and indices that feed into policy development and decision-making (GN, GP, GL, R). • Use existing information and data to proactively inform decision making to avoid negative environmental impact (ALL).
	Institutional and legal (I)	• Develop mechanisms to promote the appropriate translation of environmental science and research into practical policy and into usable and understandable information for the public and closer collaboration between scientists and policymakers and between scientists and civil society (R, GN, C). • Improve access to environmental information in accordance with pertinent legislation, such as the Promotion of Access to Information Act (No 2 of 2000) (ALL). • Conduct regular integrated environmental assessments, surveys and inventories (R, GN, GP, GL, B). • Ensure the collection of quantitative data to improve the efficacy of Government policies and strategies (GN, GP, GL).
	Economic and incentives (E)	-
	Technological (T)	• Use appropriate technologies, such as remote sensing, GIS and the internet, to provide access to information and to build accessible and integrated environmental information systems (GN, GP, GL).
Shifting the policy focus	**Social and behavioural (S)**	• Promote understanding of the value and functioning of this natural capital to ensure that gains made in evidence-based policy making will be limited (ALL).
	Knowledge and cognitive (K)	-
	Institutional and legal (I)	• Determine ecosystem service indicators in order to shift to more appropriate and relevant policies that address the drivers and underlying causes of poor environmental performance (GN, GP, GL, R).
	Economic and incentives (E)	-
	Technological (T)	-

Cross-cutting themes		
Science and technology	**Social and behavioural (S)**	• Policy-makers and researchers to work more closely together by means of established, regular and trusting interaction and dialogue (GN, GP, GL, R).
	Knowledge and cognitive (K)	• Develop the central knowledge management system (web-based data system) to help facilitate interactions among key stakeholders from the science and the policy domains (GN, GP, GL, R). • Roll out the recommendations of the National Sustainable Consumption and Production (SCP) Framework (GN, GP, GL, R).
	Institutional and legal (I)	• Implement the Environment Sector Research, Development and Evidence (R,D&E) Framework (GN, GP, GL, R).
	Economic and incentives (E)	-
	Technological (T)	• Immediately implement the R,D&E Framework for biodiversity, waste management, climate change, air quality, and oceans and coasts (GN, GP, GL, R).
Key emerging issues		
Renewable energy and changing the energy mix	**Social and behavioural (S)**	• Shift to produce energy from biomass, wind, solar, small-scale hydro and waste (GN, GP, GL, B, C).
	Knowledge and cognitive (K)	• Shift to lower-carbon electricity generation options (such as through the Renewable Energy Independent Power Producer Procurement Programme (REIPPP)) (GN, GP, GL, B). • Promote 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 (GN, GP, GL, B).
	Institutional and legal (I)	• Implement provisions of the DoE's Renewable Energy White Paper Policy, and 2010 Integrated Resource Plan (IRP) targets (GN, GP, GL, B).
	Economic and incentives (E)	• Establish REIPPPPs in the energy market as these have the potential to shift in the energy type away from coal based supplies, and create jobs (GN, GP, GL, B, C).
	Technological (T)	• Upscale energy efficiency applications, especially industrial energy efficiency and energy efficiency in public, commercial and residential buildings (GN, GP, GL, R).
Key emerging issues		
Green economy	**Social and behavioural (S)**	• Promote the 'Green Economy' by marginalising economic activities that have unsustainable environmental costs, and using environmentally responsible development activities to solve social and economic ills better than business-as-usual practices (GN, GP, GL, B, C). • Enhance the contribution of the ecological economy to the green economy (ALL). • Ensure that the National Skills Development Strategy is aligned with the requirements of the green economy (GN, GP, GL, B, C).

Key emerging issues		
Green economy	**Knowledge and cognitive (K)**	• Advance the nine green economy focus areas, namely Resource conservation and management, Sustainable waste management practices, Water management, Environmental sustainability (greening & legacy - major events & tourism, research, skills, financing and investments), Green buildings and the built environment, Sustainable transport and infrastructure, Clean energy and energy efficiency, Agriculture, food production and forestry, and Sustainable consumption and production (ALL). • Consider the assessment of the impacts of green economy investments in selected sectors pertaining to SA's economy as recommended in the SA Green Economy Model (SAGEM) - specifically focusing on natural resource management, agriculture, transport and energy (GN, GP, GL, B).
	Institutional and legal (I)	• Support for the transition to a green economy through the implementation of various strategic policies and strategies such as the National Strategy for Sustainable Development and Action Plan (2011), National Development Plan - Vision 2030 (2012), National Skills Development Strategy III, Ten Tear Innovation Plan, New Growth Path (2010), Green Economy Accord (2011), Industrial Policy Action Plan, Integrated Resource Plan (2010), National Climate Change Response White Paper (2011) and the Development Indicators among others.
	Economic and incentives (E)	-
	Technological (T)	• Proactive investment in environmentally and socially responsible or 'green' technologies (GN, B, R).
Ecological infrastructure	**Social and behavioural (S)**	• Build on natural resource management programmes such as the Working for … Programmes such as Working for Water and Working for Wetlands (GN, GP, GL, C). • Enhance ecological infrastructure to support rural development, cope with changes in climate and create long term jobs (GN, GP, GL, C).
	Knowledge and cognitive (K)	-
	Institutional and legal (I)	• Ensure well managed ecological infrastructure that can buffer human settlements and built infrastructure against the extreme events that are likely with climate change, playing a crucial and cost effective role in disaster risk reduction (GN, GP, GL). • Plan and manage ecological infrastructure networks strategically (GN, GP, GL).
	Economic and incentives (E)	• Use ecological infrastructure to support development and unlock economic potential (GN, GP, GL, B). • Invest in ecological infrastructure as a long-term endeavour to create jobs that needn't be short-term contractual employment (GN, GP, GL, B).
	Technological (T)	• Scale up investments in restoring and maintaining ecological infrastructure, with a focus on the highest value ecological assets (GN, GP, GL, B).