2nd South Africa Environment Outlook

A report on the state of the environment

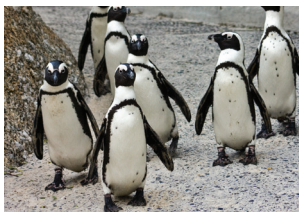
Executive summary









environmental affairs

Department:
Environmental Affairs
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Preface

The 2nd South Africa Environment Outlook (SAEO) report provides a national 'big picture' snapshot of how South Africa is performing in terms of short- and long-term responses to changing conditions and to assess the effects of human interventions and management actions.

The report differs somewhat from its predecessors, in the sense that instead of adopting a scenarios-based approach, the thinking developed around the future environmental state has been crystallized using an 'impact mapping' tool within the trends in environmental data and socio-economic policy directions that have emerged since the advent of democracy in South Africa in 1994. The aim of this approach is to highlight critical areas, where debates and interventions need to occur and which require understanding, co-ordination and co-operation across the different sectors and decision-making levels of society, from the individual and community level to the corporate and government level.

The main report consists of four parts which are structured as follows:

- Part I which is an introductory part which sets the scene for the report. The following chapters have been discussed in detail under Part I: Introduction; What's affecting our environment; Sustainability in South Africa; Governance; and Human Settlements;
- Part II which consists of specialist chapters which discuss the current environmental state in terms of specific themes and identify theme-specific trends in environmental change. The eight specialist chapters are: Land; Biodiversity and Ecosystem Health; Inland Water; Oceans and Coasts; Air Quality; Climate Change; Energy; and Waste Management;
- Part III which is the Environmental Outlook section which shapes the information on environmental trends from the specialist chapters within possible future scenarios in order to anticipate the strategic decisions and actions that need to be taken in order to avoid environmental degradation; and,
- Part IV which explores different options for action to guide policy formulation and decision making processes.

The summarized version of the 2nd SAEO outlines and provides areas of action, key emerging issues and the implementation framework that need to be considered to improve the current state of environment in the country over time.

For more detailed information you are encouraged to read the 2nd SAEO comprehensive report. The following products are available as alternative reading materials.

- Executive summary;
- Internet portal; and,
- Full comprehensive SAEO interactive discs.

All products are available from the Department of Environmental Affairs and on the internet at
http://soer.environment.gov.za/State_of_the_Environment.html

1. INTRODUCTION

In the 21st Century it is becoming evident that concerns around environmental matters are now mainstreaming in terms of political and business decision making. Environmental impacts are no longer a peripheral issue, but as shown in South Africa's most recent (2012) National Development Plan (NDP): Vision 2030 (NPC 2012), environmental issues are included as part of the development agenda. It is a recognition of the inter-connectedness and interdependence of the natural environment, human well-being and the economy.

In 1992, the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in Brazil (often referred to as the Earth Summit), signalled the increasing importance attached to environmental issues at national, regional and global scales. The 1992 UN conference called on national governments to regularly produce 'state of the environment' (SoE) reports in order that environmental information and data could be made more widely available to decision makers and the general public.

South Africa responded to this call and produced the first National State of the Environment report in 1999. A second report, known as the South Africa Environment Outlook (SAEO), was published in 2006. This third report thus continues that response. SoE reports have also been issued within the last 15 years at various sectoral, regional, provincial and local levels in South Africa indicating that environmental issues have permeated all levels of governance in the country.

The 2nd SAEO follows a similar structure (using the Drivers-Pressures-State-Impact-Response (DPSIR) method) to the previous 2006 report. Where this report differs somewhat from its predecessors, however, is that instead of adopting a scenarios based approach, the thinking developed around the future environmental state has been crystallized using an 'impact mapping' tool within the trends in environmental data and socio-economic policy directions that have emerged since the advent of democracy in South Africa in 1994. The aim is to highlight critical areas, or 'tipping points', where debates and interventions need to occur and which require understanding, co-ordination and co-operation across the different sectors and decision-making levels of society, from the individual and community level to the corporate and government level. This co-operative effort is required in order for South Africa to arrest and reverse deteriorating conditions in many of the country's natural environmental indicators.

2. SETTING THE SCENE

The environment is a complex inter-related system that does not conform to man-made boundaries. Ideally, comprehensive monitoring of the environment should take place on an ongoing basis in order to better inform both short and long term responses to changing conditions and to assess the effects of human interventions and management actions. The SAEO provides a national 'big picture' snapshot of how the country is performing in this regard. The value of such report resides in its ability to guide decision making on future policy based on what has been happening in the past.

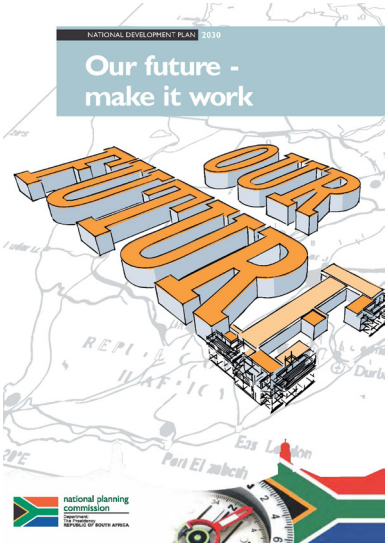
Since no report can ever hope to comprehensively and accurately describe the whole of the environment and all its constituent systems, especially at a national level, representative indicators are used as proxies for the state of the environment and these are analysed in the SAEO.

The SAEO is aimed at providing a non-specialist and user friendly overview of the state of the environment and trends over time. It therefore needs to be useful and accessible to a range of audiences from the non-specialist to key decision-makers. Importantly, it needs to talk to decision-makers whose primary field may not be the environment per se, but who's decision-making will impact on the subsequent state of the environment.

The 2nd SAEO is not only important on a national level, it also contributes to the country's obligations in terms of environmental management at a regional, continental and global level. It is a key reference in the drive towards sustainable development.

The concept of sustainable development emerged out of the environmental sector and is a term now adopted and used by many leaders in society. The 1987 Brundtland Commission definition remains a popular reference point: "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*." This definition recognizes the inter-generational responsibilities of environmental management.

Three dimensions (key areas) underpin the concept of sustainability, the social, economic and environmental spheres. How these dimensions interlock has been the subject of recent debate. An increasingly accepted illustration is the nested model of sustainability (Figure 1) with its hierarchy of the three dimensions. The social dimension at the centre exists within the economic dimensions, whilst both are in turn dependent on functioning ecosystems or the environmental dimension. In other words, the environment provides basic services such as water, air and natural resources on which people depend. Without a functioning and healthy environment, progress in economic and social terms can be threatened. In addition, the nested model of sustainability operates within a governance system which aims to ensure fair allocations of resources, responsibilities and obligations when it comes to development.



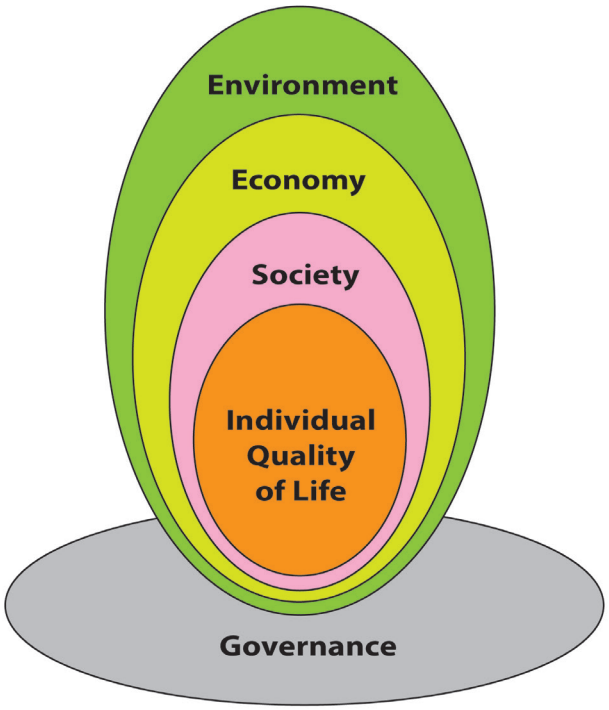


Figure 1: Schematic presentation of the relationships between environment, the economy, society and the individual as the foundation for understanding the concept of sustainability
Sustainability is then expressed as the degree of welfare (well-being) enjoyed by the individual (modified from the National Strategy and Action Plan for Sustainable Development 2010)
Source: DEA (2012)

A further dimension to this model (Figure 2) posits a series of needs and satisfiers in relation to individual human welfare, which could be added as a further central sphere within that of the social sphere in the nested sustainability model. Aspects such as individual health, family, work, recreation, aesthetic, cultural and spiritual values also need to be understood in terms of the wider environment. In effect, it is suggested that not only do the services, materials and benefits that are derived from the natural environment and that are necessary for basic life (clean water and air, food etc.) need to be considered, but also the non-material benefits that enhance quality of life. The sense of general well-being across all these elements requires a healthy and functional biophysical system.

Whilst the understanding of what sustainable development entails matures, so do the means of measuring it. New indexes of human development, human and ecosystem health and sustainable development are being developed and structures, policies and strategies with respect to governance are also being instituted. The understanding of Drivers in the DPSIR framework is also improving with population dynamics, human settlements and patterns of resource production and consumption being the primary drivers rather than wastes and emissions which are in fact Pressures in the DPSIR framework. These concepts, trends and developments are further expanded upon in the SAEO.

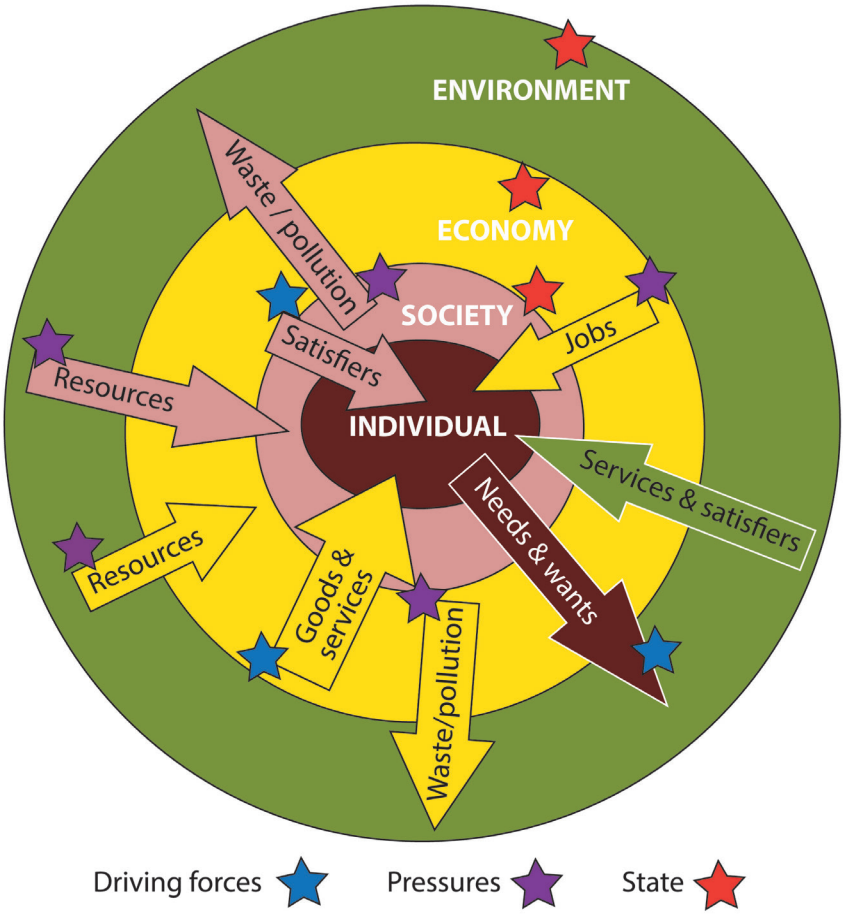


Figure 2: The inter-connectedness of the environment, the economy, society and the individual using the DPSIR method
Source: 2nd SAEO development team

3. TRENDS IN THE STATE OF ENVIRONMENT

The SAEO spotlights current trends and the existing state of the environment in South Africa via specialist Chapters, and shows that the biophysical environment in South Africa is generally in a state of decline as was the case in 2006. The trends are summarized in Table 1, while some key aspects are highlighted below. More detail can be found in the specialist Chapters of the main report.

3.1 Human settlements

On the most basic level, the interaction of human settlements on the environment is that it extracts non-renewable natural resources on the one hand while on the other, it produces waste products and pollution that have to be absorbed by the natural environment. As the population grows, urbanizes and consumes more, the impact of human settlements on the natural environment increases. In South Africa, as in the rest of the world, these processes present a considerable challenge to governments and much effort is placed on making human settlements sustainable.

Urban and rural sprawl, housing demand, modes and character of transportation and basic service infrastructure, are the physical elements of human settlements that have the most noticeable impact on the natural environment and are the focus for the creation of more sustainable human settlements with a reduced ecological footprint.

The challenge is even greater in South Africa where the apartheid legacy left the country with a distorted settlement form that amplifies unsustainability and to change the historical settlement form remains one of the most challenging issues facing the government.

Nevertheless, significant strides have been made in the creation of more sustainable human settlements that would limit the potentially negative impacts on the environment. The most significant intervention has been the shift in settlement planning legislation and policy to a normative approach, the development of environmental legislation and the inclusion of environmental and sustainability considerations into planning legislation. Significant planning legislation includes the Spatial Planning and Land Use Management Act (No 16 of 2013) (SPLUMA), Breaking New Ground and a key strategy which includes the NDP.

The shift from sprawling, mono-functional, low density and car-dependent settlements to higher density, integrated, low-carbon and sustainable settlements is difficult due to the legacy of past urban patterns and investment. Most progress has been made in settlement structure (higher density, integrated, fully developed with social facilities etc. settlements that are well-located in terms of access to jobs and facilities); urban transport (the introduction of a number of Bus Rapid Transport (BRT) systems in various cities as well as policies for Non-Motorized Transport); and protection of environmentally sensitive areas and ecological corridors (hardly any formal settlement development still takes place within ecologically sensitive areas, due to stringent environment legislation that is integrated into planning processes). The National Environmental Management Act (No 107 of 1998) (NEMA) Regulations have completely changed planning approaches and processes, and have probably been the most successful at integrating environmental issues with development actions.

Furthermore, access of all communities to engineering services, such as water, electricity, sanitation, and solid waste collection has improved dramatically, thereby lessening the direct impact of settlements on the environment through the treatment of raw sewage.

South Africa faces the daunting challenge of limiting its impact on the environment by a growing population that is concentrated in a number of large settlements and whose demands and consumption patterns are increasing. It does not only deal with technical issues such as residential densities and transport options, but is intrinsically linked to demographic, economic and cultural factors. In order to save the environment issues such as poverty, mass consumption, investment models and pre-conceived ideas need to be addressed.

3.2 Land

With regard to land cover and utilization, there appear to be certain macro trends, particularly in the areas of urbanization, mining and agriculture. These trends are manifested by rural to urban migration (including pressure on available land and services in urban and peri-urban areas), mining (environmental legacy of old mining areas and adequate management of new mining developments), and agriculture (pressures on water availability and productivity as new agricultural ventures attempt to deal with land redistribution). These trends are happening at such a speed that accurate data and statistics on land use types and their distribution cannot be readily captured or updated.

Continued mining activity and urbanization in South Africa and its subsequent land requirements are encroaching onto important conservation, water source and agricultural areas, resulting in the loss of productive agricultural land and the less effective provision of ecosystem services. Compounding this is unsustainable agricultural practices and crop mono-culture in certain areas that results in a loss of biodiversity and poor soil and water management.

3.2.1 Land cover

There has been an outright loss of natural habitat over 18 per cent of South Africa's land surface, mostly as a result of the cultivation of crops (such as maize, wheat and sugar cane), but also as a result of mining, forestry plantations and urban development (Driver *et al.* 2012). In some regions, the percentage is much higher and the rates of loss are alarming. For example, in North West, Gauteng and KwaZulu-Natal (KZN), if loss of natural habitat continues at current rates, there will be little natural vegetation left outside protected areas in these provinces by about 2050.

3.2.2 Urbanization

Urban growth in South Africa is accelerating. Concerns about the expanding urban area in South Africa is underlined by the ecological footprint and impact on the environment associated with urban land use activities.

With the high influx of people into cities, provision of services like access to clean water, sanitation, and affordable energy for the poor has also become increasingly important. Most of the urban and peri-urban settlements in South Africa are faced with the challenge of informal housing, illegal electricity connections, safety and land tenure.

3.2.3 Mining

The mining industry has long been recognized as an important sector in South Africa despite the fact that it is now only the sixth largest contributor to total Gross Domestic Product (GDP). It is still regarded as a cornerstone of the economy and the largest employer. South Africa's mineral industry is based mainly on gold, diamonds, coal and, more recently, Platinum Group Metals, and still makes an important contribution to the national economy.

The legacy of mining from historic gold and coal operations have fallen to the State with regard to managing, rehabilitating and funding their residual and considerable environmental impacts. Mining ventures in new coal reserves, Platinum Group Metals and other precious minerals are mushrooming and require adoption and funding of the new environmental regulatory requirements to avoid repeating the mistakes of the past.

3.2.4 Agriculture

The total land area of South Africa is 127 million hectares of which 82 per cent (100 million hectares) is agricultural land. Only 14 per cent of agricultural land (14 million hectares) receives sufficient rainfall for arable crop production, while the remainder is used for extensive grazing, forestry, and wildlife/nature conservation. Only 1.35 million hectares (less than ten per cent of total arable land) are under irrigation, but this land produces a significant proportion of the country's total agricultural output, notably in horticultural and vegetable production and viticulture (FAO 2005).

In summary, 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.

3.3 Biodiversity and ecosystem health

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.

Biodiversity loss and impacts on ecosystem health have intensified since the publication of the 2006 South Africa Environment Outlook (2006 SAEO). The priorities for biodiversity loss and ecosystem health are captured in a detailed account of outputs, actions and indicators in the South African government's Delivery Agreement for Outcome 10 (DEA 2010). Expanding the protected area network in poorly protected or threatened land-based and marine ecosystems is a priority in Outcome 10.

A sustainable balance between biodiversity conservation and development requires more realistic, people-centred approaches to enhance the well-being of all South Africans, the economy and the natural environment. This requires more effective and efficient use of existing legislation by South African law courts, particularly the National Environmental Management: Biodiversity Act (No 10 of 2004) (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.

South Africa is in the fortunate position of having a vast wealth of biodiversity assets and ecosystems and much of it is still relatively intact (Driver *et al.* 2012). The National Biodiversity Assessment (NBA) of 2011 confirmed that although South Africa takes up two per cent of the planets land resource, it is home to six per cent of the world's plant

and mammal species, eight per cent of bird species and five per cent of reptile species. South Africa also has a large range of habitats, ecosystems and landscapes as it is made up of nine terrestrial biomes, 30 freshwater eco-regions and six marine eco-regions. In addition, the country is home to three globally recognized biodiversity hotspots.

The main findings of the NBA of 2011 are that wetlands are the most threatened of all the ecosystems in the country and particular management and conservation efforts must be directed towards them. The NBA also found that the rate of loss of natural habitat is higher than others in some parts of the country and if this trend continues, there will be no natural habitat left outside protected areas by 2050 in some provinces.

The drivers of biodiversity loss and ecosystem health are essentially macro-type activities involving people, and are usually of a socio-economic nature and are therefore complex (CBD 2010; WWF 2012). They include loss of natural habitat, for example as a result of cultivation, mining, timber plantations, urban sprawl and coastal ribbon developments; invasive alien species; over-abstraction of water and alteration of flow in the freshwater environment; overharvesting especially in the marine environment; pollution; climate change and so forth. These drivers influence the quality of ecosystems, affect their functionality and alter the rate at which ecosystems deliver goods and services. It has also been found that an important contributing factor to the loss of biodiversity and ecosystems is the difficulty in putting a price on the ecosystem services, which means that their value is not properly and fully taken into account in market transactions and that they are often under-valued or ignored in development planning and decision making processes (Driver *et al.* 2012).

3.3.1 Terrestrial ecosystems

The main pressure on the country's terrestrial ecosystems is the loss of natural habitat due to land cover change as a result of human activities i.e. cultivation, mining, forest plantations and urban expansion. According to the NBA of 2011, 40 per cent of terrestrial ecosystem types are threatened (nine per cent Critically Endangered, 11 per cent Endangered and 19 per cent Vulnerable) (Driver *et al.* 2012). The assessment also found that the Indian Ocean Coastal Belt, Grassland, Fynbos and Forest biomes have the highest proportions of threatened ecosystem types (Figure 3). The Grassland and Fynbos biomes have large numbers of ecosystem types and make up 24 per cent and 6 per cent of the country respectively. The Indian Ocean Coastal Belt and Forest biomes have small numbers of ecosystem types and make up a small proportion of the country, with Forest accounting for less than one per cent of South Africa's land area. It has been noted that deteriorating terrestrial ecosystems are located mainly in areas of high economic activity.

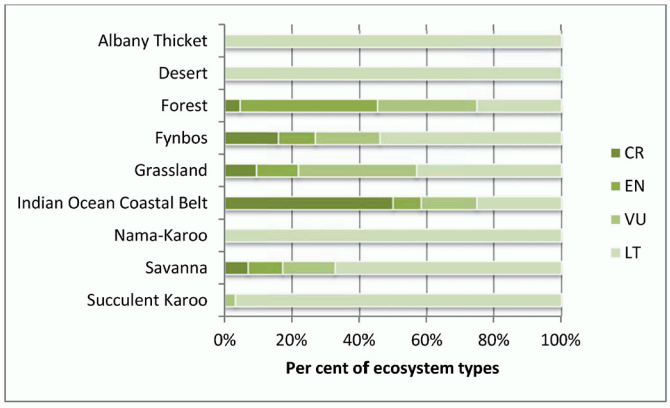


Figure 3: Ecosystem threat status for terrestrial ecosystem types
CR: Critically Endangered, EN: Endangered, VU: Vulnerable, LT: Least Threatened
Source: Driver et al. *(2012)*

3.3.2 River ecosystems

River ecosystems are vital for supplying fresh water, South Africa's most scarce natural resource. River ecosystems in South Africa vary from sub-tropical in the north-east to semi-arid and arid in the interior, and to cool temperate rivers of the Fynbos biome. There are 223 river ecosystem types that represent the diversity of rivers in South Africa which have been identified based on soil, geology, vegetation, climate, flow and the slope of the river channel.

The main pressure faced by river ecosystems is the abstraction of water from rivers and other alterations to the timing and quantity of flows, for example as a result of dams or transfer schemes between catchments. In addition, pollution of rivers is a serious and growing problem, often exacerbated by the destruction of natural vegetation along river banks, which results in irreversible damage to rivers and their ability to provide ecosystem services. Over 60 per cent of water in South Africa is used for irrigation. Primary agriculture contributes eight per cent of total employment in South Africa, as well as providing a social welfare net to the most vulnerable in society, especially in rural areas. 57 per cent of river types are threatened (25 per cent Critically Endangered, 19 per cent Endangered and 13 per cent Vulnerable) (Driver *et al.* 2012). Only 35 per cent of main rivers, 52 per cent of tributaries and 47 per cent of both are in good condition. It has been found that main rivers work harder and are more heavily impacted by human activities than tributaries (Figure 4).

River ecosystem types in lowland areas are more highly threatened than those in higher-lying areas. This reflects intensive cultivation activities and urban developments that are concentrated on lowlands, and the cumulative impacts on rivers as they flow from source areas to the sea.

Only 14 per cent of river ecosystem types are well protected. Some 50 per cent of South Africa's large river systems that lie in protected areas are degraded by upstream activities before entering the protected area. However, rivers that flow through protected areas are often in better condition downstream of the protected area than upstream highlighting the positive impact that good land management can have on river condition and the important role of land-based protected areas in protecting rivers (Driver *et al.* 2012).

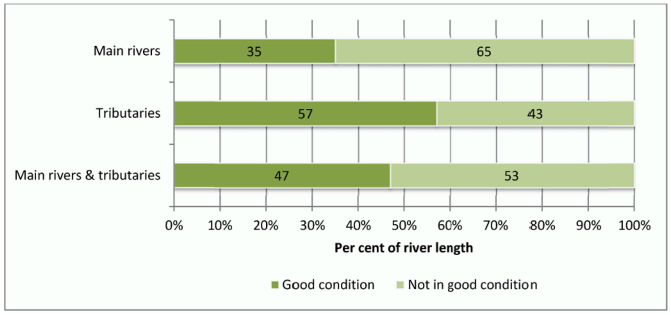


Figure 4: Percentage of river length in good ecological condition
Source: Driver et al. *(2012)*

3.3.3 Wetland ecosystems

The most prevalent on-site causes of wetland loss and degradation are cultivation (e.g. sugar cane, fruit orchards, wheat), urban development, dam construction and poor grazing management causing erosion.

Wetlands constitute about 2.4 per cent (2.9 million hectares) of South Africa's surface area and some 300,000 wetlands have been mapped (Nel & Driver 2012). Although wetlands are more resilient than many other ecosystems, they are the most threatened ecosystem in South Africa (Driver *et al.* 2012). 65 per cent of wetland types have been identified as threatened (48 per cent are Critically Endangered, 12 per cent are Endangered and five per cent are Vulnerable) (Figure 5). Floodplain wetlands have the highest proportion of Critically Endangered ecosystem types (Driver *et al.* 2012).

South Africa's wetland and estuarine ecosystems have been found to be more highly threatened than its river ecosystems. The majority of healthy, intact wetlands are located in the northern and interior areas (plateau) of South Africa (Figure 5).

Only 11 per cent of wetland ecosystem types are considered to be well protected. A total of 71 per cent is not under any form of protection, which clearly calls for greater representation in efforts to expand the protected area network in South Africa (Driver *et al.* 2012).

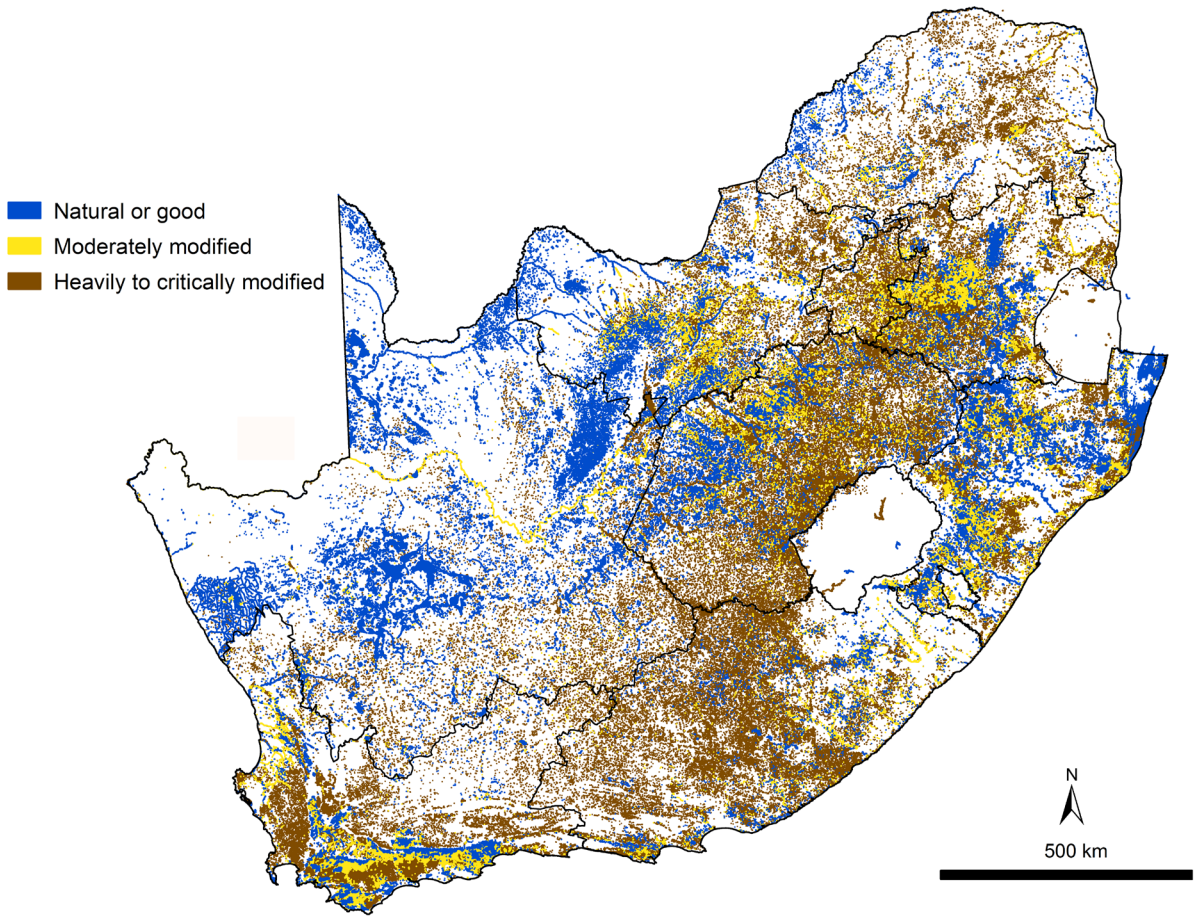


Figure 5 : The condition of South Africa's wetland ecosystems
The colours show Blue = Natural or good, yellow = Moderately modified, brown = Heavily to critically modified
Source: Nel et al. *(2011)*

By mid-2012, 20 South African wetlands were designated as Wetlands of International Importance (Ramsar Sites, as per the Ramsar Convention). Collectively, their surface area totals 553,178 ha. Of these, 18 are formally protected.

3.3.4 Estuarine ecosystems

Estuaries face multiple pressures from human activities, often resulting from development too close to the estuary as well as the cumulative impacts of land uses throughout the catchment that feeds the estuary. Some 291 estuaries (170,000 ha) exist along South Africa's coast, with most located along Indian Ocean waters (Van Niekerk & Turpie 2012). Due to low and variable rainfall, estuaries are typically small, geographically restricted and sometimes closed to the sea. Out of a total of South Africa's 20 Ramsar Sites, seven are estuaries.

Estuaries provide important nursery grounds for marine and estuarine biota. They supply fresh water and nutrients to the sea, which is necessary for marine food webs.

Of concern is that 82 per cent of estuarine ecosystem types are degraded. A total of 43 per cent of estuaries are threatened (39 per cent of estuarine ecosystem types are Critically Endangered, two per cent are Endangered and two per cent are Vulnerable) (Driver *et al.* 2012). A total of 59 per cent have no protection, eight per cent are partially protected and the remainder (33 per cent) are well protected. The NBA of 2011 (Driver *et al.* 2012) has identified 120 estuaries as priorities through the first ever National Estuary Biodiversity Plan (NEBP), which recommends their full or partial protection for these priority estuaries.

3.3.5 Marine and coastal ecosystems

Pressures on marine and coastal ecosystems are multiple, and tend to be more intense along the coast and inshore, which are more accessible to people than the open ocean. For coastal and inshore ecosystem types, 59 per cent are threatened (24 per cent Critically Endangered, ten per cent Endangered and 25 per cent Vulnerable), compared with 41 per cent of offshore ecosystem types (11 per cent Critically Endangered, eight per cent Endangered and 22 per cent Vulnerable (Sink *et al.* 2012)). The greatest pressure on marine ecosystems is fishing. Other pressures include invasive alien species, mining, shipping, waste water discharge especially around cities and coastal settlements, and reduction in the flow of fresh water from rivers to the marine and coastal environment. These pressures tend to be more intense in coastal and inshore ecosystems, which are more accessible to human activities, and along the shelf edge, which is highly productive for fisheries. A map showing the ecological condition of the marine and coastal environment shows that large areas in the marine environment are good or fair, while some areas are heavily impacted in particular habitat types (Figure 6).

Only nine per cent of coastal and inshore ecosystem types are well protected, though much of the remainder has some form of protection with only 16 per cent not protected at all. In the offshore environment, only four per cent of ecosystem types are well protected and 69 per cent are not protected at all (Driver *et al.* 2012) (Figure 7). On the whole however, South Africa's coastline is regarded as well protected compared to most other developing countries (Griffiths *et al.* 2010).

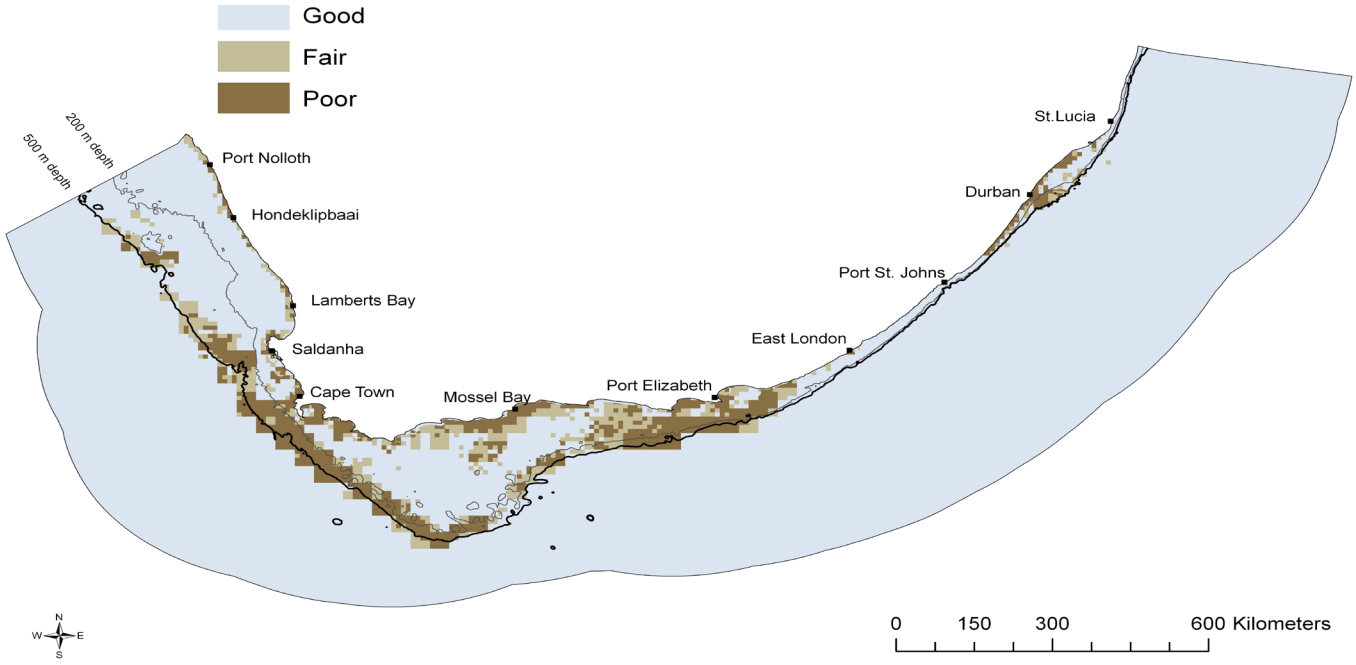


Figure 6: Ecological condition in the coastal, inshore and offshore benthic (seabed) environment
Source: Driver et al. *(2012)*

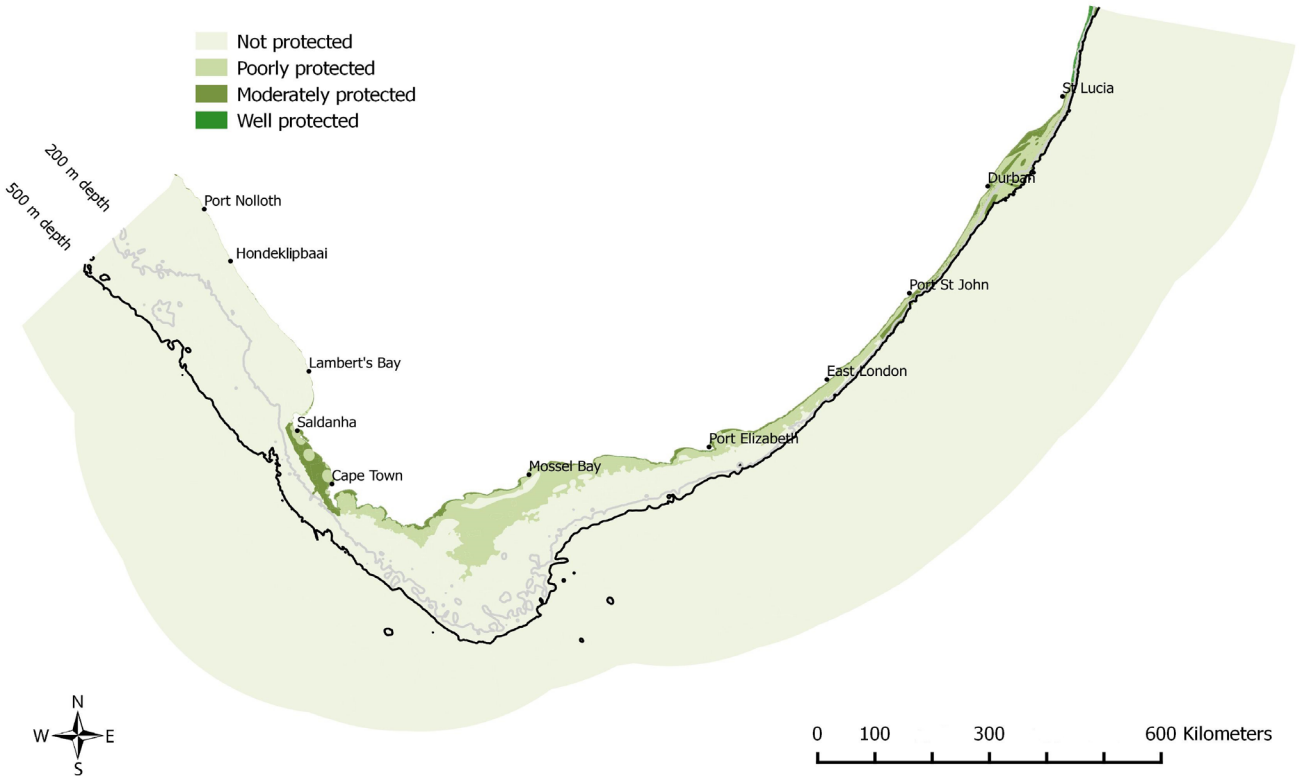


Figure 7: Ecosystem protection levels for coastal, inshore and offshore benthic habitat types, showing clearly that almost no offshore ecosystems are well protected
Source: Driver et al. *(2012)*

3.3.6 Invasive alien plant species

It is estimated that almost 9,000 plant species have been introduced so far to South Africa. Of these, about 161 species are deemed invasive, covering ten per cent of the country. Since the invasive plants grow by an estimated five per cent a year, their presence has dramatic effects on native species and ecosystems, as well as economic activities in the area. In particular, alien plant species generally consume more water than native species, which poses a major problem to many of the country's ecosystems, agriculture, and local economies. In fact, it is estimated that alien plant species consume as much as seven per cent of South Africa's total runoff (DEA 2011a).

3.3.7 Ecological footprints

Ecological footprints are a tool that reflects renewable resources people consume against bio-capacity (ability for renewable resources to regenerate) (Global Footprint Network 2011). They aggregate calculations for a cropland footprint, grazing footprint, forest footprint, fishing ground footprint, carbon footprint and built-up land. The measurement unit for ecological footprints is the amount of global hectares (g/ha) affected by humans per capita of a country.

The world's average bio-capacity is 1.8 g/ha per person. This means that globally, there is an ecological deficit of 0.9 g/ha per person (6,000 million people on earth in total). If a country has insufficient ecological resources to match the demands of people, then it is an ecological debtor country (high over-consumption).

Although South Africa's ecological footprint is below the global average of 2.7 g/ha, the country is in ecological deficit (-1.18 g/ha) (Table 2). In comparing ecological footprints, South Africa compares poorly to Brazil which has a population size almost four times larger, and to Australia which has half the South African population size.

Table 2: Ecological footprint of countries

Country	Population size (millions)	Ecological footprint*	Bio-capacity*	Ecological remainder*
Ecuador	13.34	1.89	2.33	0.44
Australia	20.85	6.84	14.71	7.87
South Africa	49.70	2.32	1.14	-1.18
UK	61.30	4.89	1.34	-3.55
Brazil	190.20	2.91	8.98	6.07
US	308.67	8.00	3.87	-4.13
India	1,164.67	0.91	0.51	-0.40
China	1,336.55	2.21	0.98	-1.23

**g/ha per person*
Source: Global Footprint Network (2011)

3.4 Inland water

The increased demand for water, coupled with poor management of water distribution, the water quality in South Africa'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 water and wastewater infrastructure compounds the problem.

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

A large task lies ahead to deal with water quality problems such as acid mine drainage, eutrophication and salinization of resources. The Green and Blue Drop reports also highlight the inability of some regions to effectively treat sewage and industrial effluent in a manner that it can be returned to rivers without further compromising water quality.

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).

3.4.1 Water availability

Overall, South Africa's use of existing water resources comprises 77 per cent of surface water, nine per cent of groundwater and 14 per cent of return flows. All of the statistics above point to a water situation where water resources are extremely varied and highly stressed in certain areas. Rainfall amounts can vary annually and there can be large geographic differences in rainfall. The annual runoff of South Africa's rivers is on average 49,000 million cubic metres per year, 50 per cent of which is yielded by mountain catchment areas. Of this value, a per capita water availability of approximately 1,100 m^3 per year can actually be utilized due to the variability of flows and high evaporation rates (Binns *et al.* 2001; StatsSA 2010).

After allocating enough water in rivers for environmental flow requirements, half of the South African Water Management Areas (WMAs) are in water deficit (i.e. the water requirements exceeds availability) (DWAF 2004; DWA 2010a). This is despite significant transfers in from other systems to allow for meeting water requirements. Any major changes in rainfall or water availability (for example from climate change) will severely impact on the available water resources.

There are approximately 320 major dams in the country, together having a storage capacity of 32,412 Mm^3, equivalent to more than two thirds of the country's mean annual runoff. This total dam storage capacity is a very high percentage and means that additional large dams will become less efficient. In addition, there are thousands of smaller private farm and municipal dams for water storage. Dams have a major impact on aquatic ecosystem integrity and the cumulative impacts of multiple dams can have severe effects on the state of inland waters.

South Africa's available water resources are therefore already being intensively used and controlled. Seven of the nine provinces of South Africa rely on inter-basin transfers and in these provinces more than half the water is provided by inter-basin transfers (van der Merwe-Botha 2009).

The limits to the development of surface water sources have almost been reached and the opportunities for the spatial economic placement of new dams are few (DWA 2010a). The costs of transfers per cubic meter to locations where water is needed are also rising with longer distances and rapidly rising pumping costs.

3.4.2 Fitness for use

South Africa is faced with water quality challenges which are mainly induced by human activity. However, it is also important to note that there are those water quality challenges which result from natural causes. The anthropogenic problems are associated with industries that produce chemical waste; mines that introduce metals to water resources; wastewater treatment works that discharge untreated or poorly treated effluents introducing excessive nutrients, phosphates and coliforms; and agriculture that uses pesticides, herbicides and fertilizers introducing salts and other toxic substances into the water.

When compared to the results within the 2006 SAEO, it can be seen that water quality condition is continuing to deteriorate. Areas such as the Vaal, Crocodile and Olifants River systems are severely affected by salinity, which could be attributed to mining activities. However, some areas (coastal regions) have high salinity due to seawater intrusion. Compound effects from agriculture, industrial development (including mining) and urban development have had a large effect on the quality of water and its fitness for use.

The main contributors to faecal pollution are a lack of proper sanitation facilities, rapid increase of un-serviced informal settlements and ageing and overloaded municipal infrastructure. Faecal contamination is increasingly becoming a country-wide problem and poses health risk to humans. Using water contaminated with faecal pollution can result in the transmission of water-borne diseases, such as cholera. It is therefore imperative for the users to partially treat the water before use.

Water resources that are very rich in nutrients are referred to as eutrophic. Eutrophication in South Africa is mainly caused by inadequately treated sewerage effluents that are discharged into river systems. Other sources of high nutrient loads resulting in eutrophication include industrial effluents, agriculture, household wastes, and urban and road surface runoff (Harding 2011; Oberholster & Ashton 2008).

Groundwater pollution and over-abstraction are serious problems in certain parts of South Africa. Poor and deteriorating groundwater quality is widespread and can be attributed to diverse sources in sectors such as mining, industrial activities, effluent from municipal wastewater treatment works, storm water runoff from urban and especially informal settlements (where adequate sanitation facilities are often lacking), return flows from irrigated areas, effluent discharge from industries and various other sources (DWA 2010b).

The quality of groundwater is classified as generally good potable drinking water with little or no need for treatment at a large scale. However there are areas where salinity levels are increasing, resulting in a deterioration in quality.

3.4.3 River health

Healthy rivers provide goods and services (water supply, natural products, breakdown of pollutants, conservation, flood attenuation, recreational and spiritual value), which contribute to human welfare and economic growth, as well as sustaining biodiversity (RHP 2005). Using these ecosystem goods and services in an irresponsible or unsustainable manner has a negative impact on the status of river health and its available future use in terms of resource quality.

The results of the River Health Programme provide a very good indication of human use impacts as well as the value of management actions to secure water resources for future generations.

To date, eco-status surveys of rivers have been done on a limited number of river systems in South Africa. All the assessments show that river systems are mostly only in a fair to poor condition, and rivers have experienced extensive modifications by people (DWAF 2006). Figure 8 shows that for the rivers assessed, only in very few cases are rivers in a natural condition.

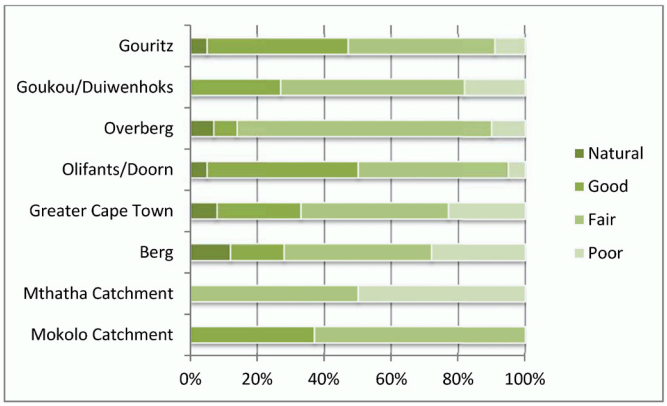


Figure 8: Eco-status of River Health Surveys reported on from 2005 to 2006
Source: DWAF (2006)

General trends from these surveys indicate that river systems assessed usually have a good to fair river health condition in their upper reaches and tributaries (with the exception of the Gauteng and Mpumalanga regions), and fair to poor conditions in their lower reaches, with most rivers in highly urbanized areas, such as Gauteng, being in poor condition.

Changes to the condition of a river can be attributed to the loss of natural vegetation, urban expansion, cultivation and mining within a river's catchment area. When the condition of a river declines, it will disturb the ecological functioning of rivers and their ability to provide ecological services to surrounding communities (Nel *et al.* 2011).

3.5 Oceans and coasts

South Africa's oceans and coasts are simultaneously extensive, complex, productive and sensitive (DEAT 2000). The increasing reliance of the growing human population on the resources provided by oceans and coasts has resulted in a diminished ability of the natural environment to provide food, to assimilate waste and to regulate natural cycles. This, in turn, is a contributing driver of change in the marine and coastal environment (Pauw 2011).

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, apparent deterioration in the health of South Africa's oceans and coasts is again evident, suggesting that the state of this environment is now better classified as marginally healthy. The deterioration is mostly as a result of increased anthropogenic pressures such as pollution from land-based sources and resultant decreases in coastal water quality, especially in estuaries. This includes the continuing transformation of natural coastal areas resulting from population pressure and urbanization. This, in turn, has adverse consequences for biodiversity and the continued delivery of natural goods and services. Illegal extraction rates of abalone (*Haliotis* spp.) in particular are noted.

It is also noted that this health assessment is based on select evidence or indicators. However, offshore areas falling within South Africa's national jurisdiction are largely unexplored or assessed. This represents a very large spatial area which the DEA has committed to incrementally include in its long-term monitoring programme (DEA 2013b).

The protected areas network for South Africa's oceans and coasts is currently insufficient to sustain biodiversity and ecological processes. Such expansion of both inshore and offshore marine protected areas has been included in the DEA multi-year strategic planning document (DEA 2013b).

South Africa's commercial fisheries are controlled via restricting the total amount permitted to be caught by the permit holder (total allowable catch); restricting the amount of effort (vessels, fishermen or hours) applied to a particular fishery (total applied effort), or a combination of the two. This could include restricting vessel numbers or gear, crew numbers or sea days (or a combination thereof) (WWF 2011). South Africa is however making progress in terms of adopting an Ecosystem Approach to Fisheries Management. Extensive research has been conducted on target species of the small pelagic fishery, in terms of community dynamics and the development of biological and spatial ecosystem indicators (Sink *et al.* 2012) to ensure maintenance and sustainable use of the healthy pelagic fish resources.

While the commercial fisheries industry is said to be well-managed, with current and reliable catch and research data collected annually, decades of over-fishing and other factors are impacting on the industry, with numerous species categorized as 'collapsed', and others as over-exploited (DAFF 2012; Sink *et al.* 2012).

Revenue from commercial fishery exports in 2008 was estimated at R3.1 hundred million (DAFF 2010). In 2009, South Africa exported approximately R560 million worth of fish and fishery products worldwide (TRAFFIC 2010, cited in WWF 2011). The squid fishery alone generates R500 million in foreign revenue per annum and is one of the country's most valuable fisheries (DAFF 2010b, cited in WWF 2011). The industry contributes approximately one-half per cent of South Africa's GDP (DAFF 2010b, cited in WWF 2011). The central role that commercial fishing plays in the generation of capital and the sustaining of livelihoods is highlighted by the fact that the industry supports approximately 30,000 jobs directly and some 81,000 indirectly (UNOPS 2011).

The status of commonly caught commercially important linefish species versus the status of South African marine resources generally is detailed in Figure 9 (WWF 2011) and is a further indication of the impact of the industry on these resources.

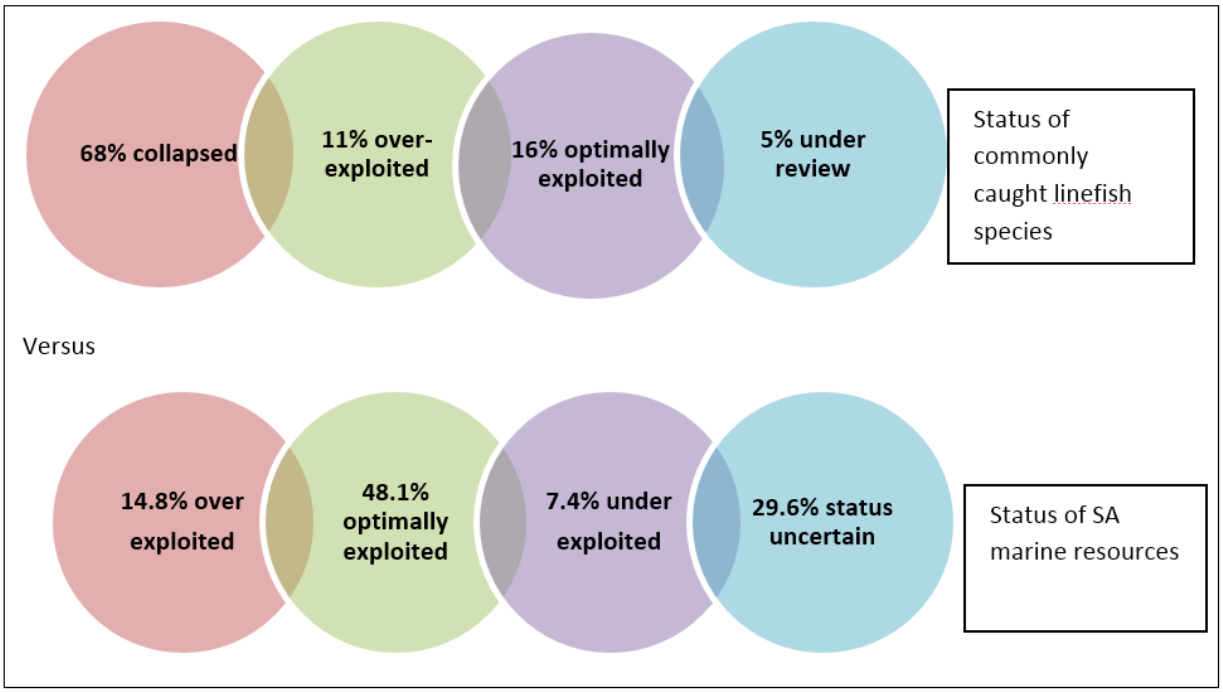


Figure 9: Status of commonly caught linefish species versus the status of South African marine resources in general as at 2011
Source: Adapted from WWF (2011)

Legislative and institutional responses to drivers of change in ocean and coastal areas have continued the positive trend noted in the 2006 SAEO. Most significantly, integrated coastal management has been legally established as the management paradigm for sustainable coastal development with the enactment of the National Environmental Management: Integrated Coastal Management Act (No 24 of 2008) NEM: ICM Act (ICM Act), the establishment of lead agencies for coastal management in all four coastal provinces, and the steady increase in project-specific funding for managing coastal activities since 2006.

Improved management measures, including the development and implementation of ocean- and coastal-specific co-operative governance structures and integrated coastal management-specific tools, such as coastal setback lines, show a positive trajectory and should assist in addressing the reported deterioration, and improve the overall state of the ocean and coastal environment.

3.6 Air quality

South Africa faces many environmental challenges and pollution, and associated problems, which are endemic to developing countries. 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. This concern is further exacerbated by the fact that it is proposed that compliance to the National Ambient Air Quality Standards be achieved by the year 2020. Adding to the environmental challenges in South Africa is the problem of trans-boundary air pollution, which further exacerbates the air pollution and environmental challenges due to its complexity and associated effects.

Air pollution and health impact studies in South Africa reflect that air pollution exposure results in numerous health problems in the general population with the effects more pronounced among the elderly and young. The vulnerability to air pollution is also more evident in people of low income status. 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 unaffordability of 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 Particulate Matter (PM_{10}) levels, which exceed the National Ambient Air Quality Standards 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.

Although sulphur dioxide (SO_2) concentrations in some residential and industrial areas exceed the thresholds, the exceedances are less frequent and dependant on the type of fuels and type of industry. In general, a reduction in industrial sulphur dioxide emissions has been noted in areas such as the eThekwini and Cape Town metropolitan areas.

Exceedances of nitrogen dioxide (NO_2) and ozone (O_3) thresholds due to vehicles are recorded in some metropolitan areas in the country and this is an issue of concern, especially given the increasing vehicle numbers in the country and the ageing national fleet. The rapid growth in vehicle numbers has also been associated with an increase in fuel consumption and a significant increase in emissions from the transport sector. Other cross cutting issues related to air pollution from the transport sector include health implications, smog (especially in urban areas), greenhouse gases and climate change.

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. Emerging pollutants of concern include particulate matter ($PM_{2.5}$), volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), chrome metals (C_6H_6) and mercury (Hg).

Due to global air pollution problems such as climate change, persistent organic pollutants and stratospheric ozone depletion caused mainly by transboundary pollutants, air quality management in South Africa has also been focused on an international level. The country is a party to various global treaties such as the United Nations Framework Convention on Climate Change, the Kyoto Protocol, Montreal Protocol and

the Stockholm Convention in a bid to reduce the impacts of air pollution on the atmosphere - a shared global resource.

It is apparent that 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 well-being.

3.7 Climate change

Greenhouse gases, including carbon dioxide and methane, are a natural component of the atmosphere, and are released and absorbed through the biosphere and oceans. An overwhelming body of scientific evidence has shown, however, that levels of greenhouse gases in the atmosphere are rising. This rise has primarily been linked to increased emissions due to human economic activity, driven by demand for energy, goods and services, and to the conversion of natural ecosystems to intensive land use.

Climate change was considered along with air quality and stratospheric ozone depletion in the 2006 SAEO in Chapter 8: Atmosphere. The chapter considers historical trends in concentrations of greenhouse gas emissions, and trends in South Africa's greenhouse gas emissions. Projections of future temperature and rainfall, and potential impacts of climate change on health, water resources, rangelands, maize, forestry and biodiversity were discussed. South Africa's response to climate change is presented in Chapter 11: Climate Change of the 2nd SAEO.

Since the 2006 SAEO, local and global research has advanced understanding of the projected impacts of climate change and the associated adaptation needs, as well as the extent of the mitigation challenge. The climate change agenda has risen substantially in global and national importance and the topic has thus been given a dedicated chapter in this 2nd SAEO report.

The impacts of climate change are already being seen in South Africa, and are projected to intensify over the coming decades. These impacts vary across the country, but are projected to include changes to long-term temperature and rainfall patterns. An increase in extreme weather events including floods and droughts is also projected. The projected knock-on impacts of both long-term changes and extreme weather events include those for agriculture, biodiversity and ecosystem services, water, oceans and marine environments, health, livelihoods, employment, access to resources and infrastructure.

South Africa needs to respond to the climate change challenge from two perspectives, being 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 in order to minimize the impacts on the country from inevitable changes to 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.

3.7.1 Temperature

South Africa has experienced general warming over the last 40 years (DEAT 2009; Kruger *et al.* 2012; Kruger & Sekele 2012). The local warming trend in many areas of South Africa is roughly double the mean global temperature trend, which suggests that increased warming has been evident since the latter part of the 20th century (Hansen *et al.* 2001; Lugina *et al.* 2005; Smith & Reynolds 2005).

In general, warm extremes increased while cold extremes decreased, with relatively stronger trends in the western, north-eastern and eastern parts of the country (Figure 10). These observations are in general agreement with previous temperature trend studies for the region, which show a general warming trend, but with weaker trends in the central parts of South Africa (Kruger & Shongwe 2004; New *et al.* 2006).

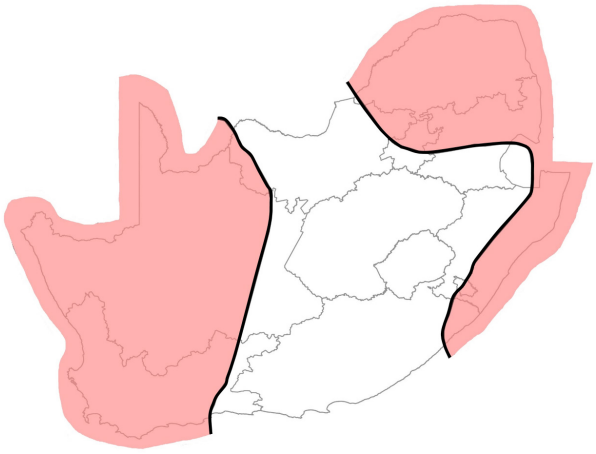


Figure 10: Summary of the most recent temperature trend analysis
The shaded areas indicate regions where warming was relatively stronger during the period 1962 to 2009.
Source: Kruger and Sekele (2012)

3.7.2 Rainfall

Between 1910 and 2004 there are some areas where significant changes in certain characteristics of precipitation have occurred (Kruger 2006). Such localized changes include increases and decreases in annual precipitation, increases in the longest annual dry spell (indicating more extreme dry seasons), increases in the longest annual wet spells (indicating more extreme wet seasons), and increases in high daily precipitation amounts. In terms of individual rainfall events, it has been suggested that there are parts of the country which have experienced an increased number of days of relatively high or extreme precipitation amounts (Kruger 2006).

3.8 Energy

Energy is vital for human livelihood and underpins all aspects of life: the dependence on different forms of energy to run one's lives and the ability to live, the food consumed and the energy used in the course of daily lives. Energy is defined as "*the ability or power to work or make an effort and the capacity for vigorous activity*" (Oxford Dictionary 2000). So why is energy so important? Since the advent of the industrial revolution, human dependence on fossil fuels in the production of energy for work, for leisure, for transport, for technology and for the production of food, has increased exponentially. Energy is critical to sustainable development, to poverty alleviation and to economic development as well as environmental sustainability, and as such is complex and cuts across a range of fields.

For more than 100 years, South Africa's economy has been built around a minerals-energy complex that continues to dwarf all other areas of economic activity. In fact, the energy-supply sector of South Africa has been dominated by coal from as early as 1880 when the Kimberley diamond fields were supplied with coal from the Vereeniging area (Winkler 2009). Mining and energy have previously gone hand-in-hand in South Africa, not only because mining is an energy intense activity, but also because mining offered the country access to energy embedded in the locally abundant coal reserves.

The South African economy is fossil fuel dependent – "... *coal accounts for three-quarters of primary energy supply, and for over 90 percent of electricity generation*..." (Winkler 2009). Coal and other fossil fuels use, including coal-derived synthetic fuels, results in high levels of gaseous emissions and such energy systems are dependent on extensive feedstock supply lines and distribution networks. South Africa is ranked among the world's top 15 largest carbon dioxide emitters, largely due to its heavy dependence on coal which supplies 92 per cent of the country's electricity (CDIAC 2012; DME 2010; Eberhard 2011). Energy production and consumption therefore places considerable pressure on the environment in that they generate greenhouse gas emissions, thereby causing climate change. Furthermore, they cause air pollution, alter land use patterns and consume water resources. These effects impact on climate change, cause damage to natural ecosystems and the environment, and are hazardous to human health and hinder sustainable development (Modi *et al.* 2005).

Historically, South Africa has always considered itself blessed with an abundance of easily accessible and cheap coal. This meant that energy generation was cheap, that sufficient energy could be provided to a growing energy-hungry economy and resulted in South Africa developing an energy intensive industry sector known as the minerals-energy complex. In retrospect though, the coal 'wealth' could rather be seen as a 'resource curse'. Leading analysts such as Winkler *et al.* (2005) argue that the low cost of commercial energy did not offer the country an important economic edge, but rather led to inefficient energy use, accelerated national reserve depletion and resulted in significant pollution. It also made South Africa one of the highest greenhouse gas emitters in the world. The 'low' cost was artificial, since most of the social and environmental costs were externalized and therefore not paid for by the energy sector. Figure 11 shows that the bulk (73.59 per cent) of the local energy supply (local generation and imports) is obtained from coal.

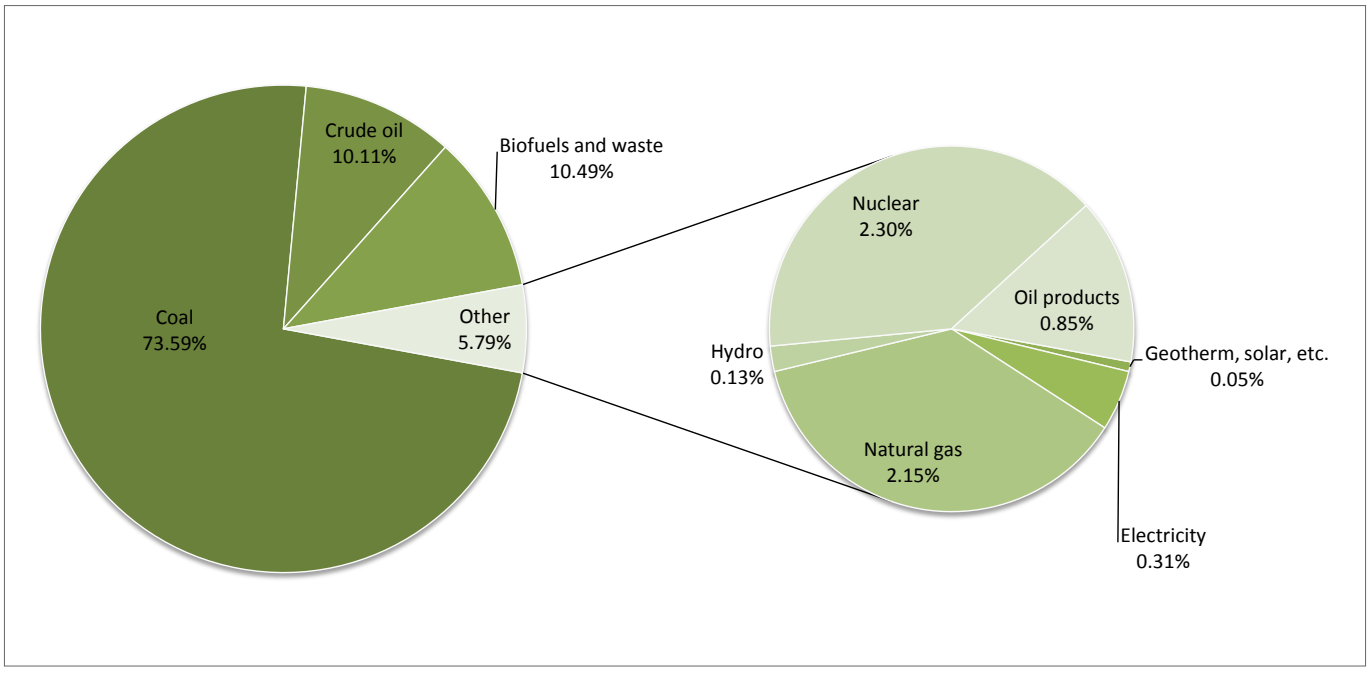


Figure 11: Domestic energy supply 2010
Source: IEA (2012)

According to the IEA (2012), the energy consumption per sector in South Africa in 2010 shows 36 per cent consumed by industry, 22 per cent by transport and 24 per cent by the residential sector of which most is urban and falls in the mid to high income group (Figure 12).

South Africa's growing energy needs also impact negatively on the country's natural resources and natural environment. The heavy reliance on non-renewable energy resources means the environmental footprint in exploiting these resources will manifest itself for some time to come.

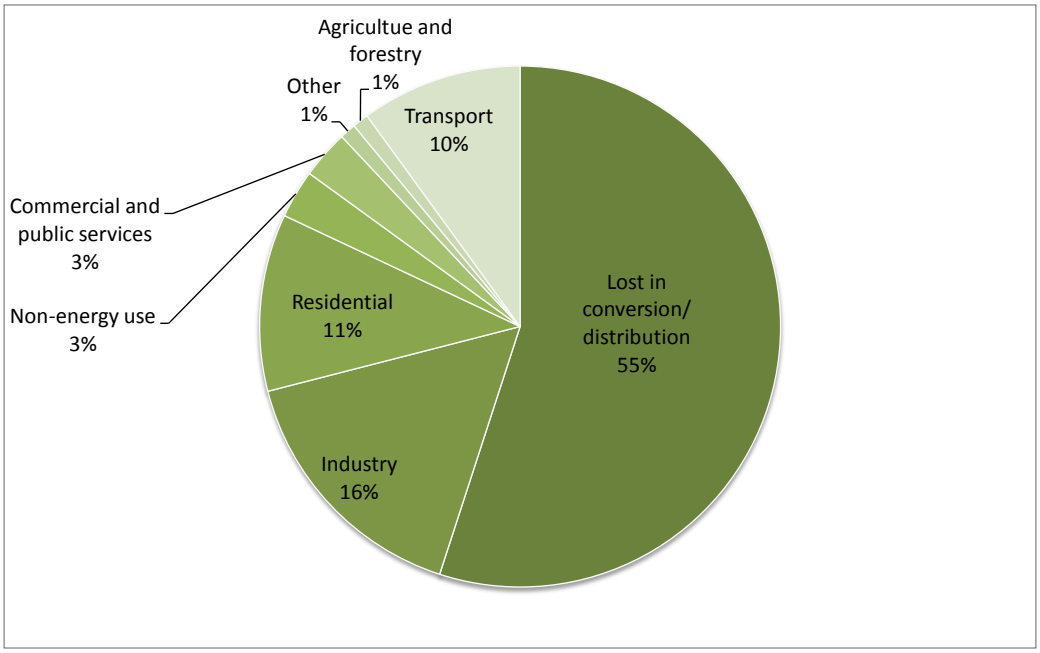


Figure 12: Final energy consumption by sector for 2010
Source: IEA (2012)

3.9 Waste management

South Africa's commitment to sustainable development has a number of implications for waste management and attention must be given to raw material use, product design, resource efficiency, waste prevention and minimization where avoidance is impossible.

Economic development, growing population and increasing rates of urbanization in South Africa have resulted in increased waste generation which requires establishing and implementing effective waste management policies and programmes. A number of issues continue to be challenges for effective waste management. These include ineffective data collection systems and lack of compliance and enforcement capacity; lack of education and awareness amongst stakeholders within the waste sector; operational costs for management of waste; support for waste reduction at local government level; availability of suitable land for waste disposal, and lack of structured incentives for reduction, recycling and/or re-use of waste (DEA 2009).

Municipal solid waste constitutes a large percentage of the total waste generated in urban and rural areas. Municipalities are the key players in dealing with waste. A total of around 239 municipalities perform solid waste management functions servicing around 8.4 million households, or around 64 per cent of all households.

South Africa has experienced rapid growth in waste volumes, associated with a prolonged period of economic growth. During the last decade, general waste generation rose to nearly 67 million cubic metres, or by 62 per cent. This represents an annual average growth rate of around five per cent.

The big metropolitan municipalities continue to allocate more budget, appoint better qualified staff, and have well organized structures to deliver waste services. However, there is still a strong need for continued strengthening and expansion of waste services to reach people without access to such services. The overall backlog in the provision of solid waste services is around two million households, with some 900,000 households not receiving any service. The service backlogs are highest in metropolitan areas and secondary cities.

Waste management services rely heavily on landfills for the disposal of waste, as over 90 per cent of all South Africa's waste is disposed of at landfill sites. The reliance on waste disposal by landfills has limited the incentive to devise alternative methods of dealing with waste. Furthermore, an urgent need for addressing the backlog in the licensing of landfill sites exists.

For hazardous waste, a general lack of adequate reliable information exists making quantifying mass balance for hazardous wastes difficult. An indication of the status of hazardous waste in South Africa can be sourced from Provincial Hazardous Waste Management Plans. However, only four provinces have completed Provincial Integrated Hazardous Waste Management Plans. It was found that in Gauteng, almost all hazardous waste generated is disposed to landfills, and that in Western Cape and North West most hazardous waste generated is unaccounted for in relation to treatment or landfilling. There was no data for Mpumalanga.

Electronic waste (e-waste) is a relatively new waste category for which there is currently a lack of formal disposal mechanisms. Due to the many hazardous components and materials used in the manufacture of electronic goods, including mercury, brominated flame retardants, and cadmium, this is considered a hazardous waste stream. There is significant job creation potential in the recycling of e-waste, and several initiatives have and are being set up. The hazardous nature of this waste stream and the small margins of profit generated must be carefully considered when encouraging the recycling of waste electrical and electronic equipment (DEA 2011b).

Some municipalities have begun waste-to-energy schemes. eThekwini is extracting landfill gas and generating electricity from the Marianhill and Bisasar Road landfills, and Johannesburg has piloted energy generation from incinerating health care risk waste. Energy recovery schemes are incentivized by the potential to generate carbon credits and their associated revenues. It is estimated that landfill energy plants can have a capacity of between 20 and 50 megawatts, with a life-of-plant of 30 years (DEA 2011b). Landfill gas projects can be seen as a means of dealing with historic disposal of organic waste and resultant landfill gas generation.

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

3.10 Positive gains

The picture is not all gloomy, however, as substantial gains have recently been made in the social sphere in rolling out basic services (housing, water supply, sanitation, electricity etc.) to previously unserved individuals and communities across South Africa, whilst access to social grants and health services has also improved. Good strides have also been made in promulgating and implementing new air quality legislation. The provision of improved public transport is also receiving substantial attention, as witnessed by the government driven roll-out of Bus Rapid Transit (BRT) Systems in the major cities of South Africa, the Gautrain rail system in Gauteng and the national taxi recapitalization programme.

There is a risk, nevertheless, that South Africa may lose these social 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.

Table 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). Acid Mine Drainage (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 Eoast 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	↓	Hydro chlorofluorocarbons (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 licensed 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 people per hectare (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 the SAPIA Annual Report of 2011 (SAPIA 2011), 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 (StatsSA 2012) 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.

4. LOOKING TO THE FUTURE

The SAEO engages with the existing state of the environment in order to suggest how current trends may develop further given the policies, strategies and actions South Africa has in place at present and future intentions in terms of development and governance.

Deviating from the approach followed in previous national SoE report, this report uses 'impact mapping' in a relationship rather than spatial sense, as a tool to project how present environmental impacts and trends may further manifest.

For example, a change in the ambient concentration of sulphur dioxide will constitute an impact (a change in atmospheric quality), but the change will potentially result in other changes such as increased human respiratory disease, reduced visibility, acidification of rain and soil etc. Each of these changes will bring about other changes such as acidification of the soil resulting in changes in land productivity, vegetation cover and so forth. And so the relationships continue. Environmental impacts thus seldom manifest in isolation, but rather in a series of changes throughout the environmental (including social and economic) system. This chain reaction renders environmental assessment extremely complicated and challenging.

The idea of the importance of individual human quality of life referred to earlier is premised on the principle that if society collapses, the welfare of the individual will be reduced, that if the economy collapses, then society will be significantly weakened and if the environment collapses, then the economy will be damaged. Thus, to avoid this domino effect, and for individual quality of life to be maximized, environment, economy and society must be in the best possible state without compromising each other. The role of governance is to ensure that there is equity in the system.

Within the sustainability and DPSIR framework described here, the fundamental drivers are the needs and wants of individuals. These may be expressed in numerous ways, but the needs and wants are serviced or met by society, the economy and the natural environment. Therefore, as the fundamental driver, individuals' needs and wants manifest as a range of activities (also drivers) that are geared towards responding to the demand for products and services that come from people.

Taking this a step further, the needs and wants of individuals are provided in varying degrees by society, the economy and the environment. The economy responds by using resources (including land) to provide goods and services to the individuals. In providing these goods and services, the economy also produces waste and pollution (which goes back to the environment), but also provides jobs and incomes. Society also requires resources (including land) that are drawn from the environment and also produces waste and pollution which goes back to the environment. Society in turn responds to the needs and wants of individuals by providing certain satisfiers such as values, identity, relationships etc. Finally, the environment responds to the individual needs and wants by providing services (a living environment) and satisfiers (such as scenic beauty). It thus stands to reason that the degree to which the environment can respond to needs and wants is a function of the quality of that environment, which in turn is a function of how the environment is used (and impacted) by the economy and society.

The aforementioned relationships and interactions can be depicted using an impact map that summarizes some of the key relationships between the variables that make up the natural environment, society and the economy. Taking the drivers in the DPSIR framework, and present government polices as inputs to the impact mapping exercise, it is then possible to predict where pressures on the environment will occur and what state of the environment will result in response.

Certain key issues have emerged from the impact mapping exercise conducted in producing the 2nd SAEO. These issues have been dubbed 'tipping points'. If correctly managed, addressing these 'tipping points' could make the difference between significant environmental deterioration versus a more sustainability driven path for South Africa. The 'tipping points' have also been highlighted because they represent, against the backdrop of multiple environmental management interventions, those few targeted areas that will likely provide the greatest potential returns on the management intervention.

The 'tipping points' in order of importance are:

- Water;
- Land degradation;
- Greenhouse gas emissions; and,
- Non-renewable resources.

It is clear from the impact mapping exercise conducted that water availability is close to a 'tipping point' (with 98 per cent of the resource already allocated) and several key economic activities, notably mining and electricity generation, still requiring significant additional water over the next 15 years. The prospect of a drought and a progressive deterioration in water quality in the available water will compound the problem. As water availability decreases, it is likely that economic activities may take preference over the ecological reserve resulting in a further deterioration of river systems and the ecological services provided by those river systems. Increasing water scarcity will in turn place pressure on groundwater resources, which may themselves be threatened by decreased runoff from climate change and the polluted runoff from mine waste dumps.

The progressive transformation of land also poses a significant threat. Further urbanization and mining will result in a loss of biodiversity and agricultural land. The planned expansion of mining and poor track record of mine rehabilitation in South Africa, and the need to locate increasing numbers of city migrants as close to work opportunities as possible, will likely exacerbate the demand for land regardless of its environmental sensitivity. The consequential environmental losses will undermine the quality of life improvements that may manifest from improved job creation and basic service delivery.

Greenhouse gas emissions will increase as the Medupi and Kusile power stations are commissioned. With the prospect of a third coal-fired power station, a new liquid fuels refinery and increasing traffic volumes, South Africa will remain a globally significant per capita producer of greenhouse gases.

Water and mineral resource use in particular are considered a 'tipping point' because there appear to be no realistic plans at present to reign in the continued use of these resources and no serious consideration is yet being given to inter-generational equity in terms of preserving the resources for future generations.

These 'tipping points' highlight those critical areas that represent the difference between embarking on a more sustainable path or, most likely, compromising the future of one's children. Action needs to be initiated promptly and urgently to ensure these issues receive the management attention they deserve and that is commensurate with the risks they pose. Current management systems are failing in this regard with economic interests often holding sway regardless of the environmental and social consequences.

A key challenge is to elevate these critical issues or 'tipping points' to a higher level than line departments, perhaps by using a cluster or nexus management approach as adopted already elsewhere in national government. Judicious decisions on how resources are allocated in addressing the 'tipping points' will be required. Moving towards natural capital accounting as a basis for decision making and to properly value non-renewable resources will be imperative instead of relying only on indicators such as gross domestic product.

5. AREAS FOR ACTION

In responding to the outcomes of the impact mapping exercise, options for action in the environmental management field have been developed (Annexure A) that focus in particular on the findings of the specialist investigations undertaken for this SAEO and the 'tipping points' identified from the 'impact mapping' exercise (Figure 13).

A series of possible actions have been recommended from the compilation of the 2nd SAEO and these have been tied to government's current 12 Outcomes Based Programme, viz: improved education; long and healthy human lives; safety; 'decent' employment through inclusive economic growth; a skilled and capable workforce; an efficient, competitive and responsive economic infrastructure network; sustainable rural communities and a secure food supply; sustainable urban settlements and an improved quality of life; a responsive, accountable, effective and efficient local government system; environmental assets and natural resources that are well protected and continually enhanced; a better and safer South Africa in a better world; and, an efficient, effective and development oriented public service and an empowered, fair and inclusive citizenship.

The highlighted Outcome is clearly the most important for sustainable environmental management, but because the environment is a cross-cutting matter, proposed environmental actions can and have been applied to all the 12 Outcomes.

Some key areas in terms of action (and linked to the identified 'tipping points') requiring attention in the environmental management field, however, have emerged. These may require making some uncomfortable trade-offs in the future if South Africa is to avoid crossing certain environmental thresholds, and include:

- The food-water-energy nexus;
- Renewable energy and changing the energy mix;
- The green economy; and,
- Ecological infrastructure.

Developed by the World Economic Forum, the term 'food-water-energy nexus' refers to the risks of security around the provision of these essential resources. 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, energy and the environment are becoming important to better understand. Without managing these resources holistically, South Africa will likely cross ecological thresholds and the earth's carrying capacity. This will also require addressing wastage and overconsumption. Significant changes in how the country manages both water and energy consumption will be required.

South Africa's dependency on coal and non-renewable resources for its energy needs will also need to change. Although a start has been made in introducing renewable energy supplies, a shift in approach and intensity is going to be required to more effectively change the direction in which the country is set.

Developing a 'green economy' will mean marginalizing economic activities that have unsustainable environmental costs and adopting more responsible development activities that also help create employment. Such steps will include investment in environmentally and socially responsible technologies, the application and recognition of human rights and the restructuring of governance systems to promote 'green' procurement and operations. Bio-prospecting and ecosystem services are emerging as important economic activities that contribute to the green and biodiversity economy.

Ecosystem services provide a foundation for economic growth (jobs), social development (service delivery) and human well-being (a better quality of life). So these are dependent on protected ecological service provision. The specialist chapters in this SAEO demonstrate how the country's natural environment provides services such as clean water, food and fibre, medicine, climate regulation, flood protection and other needs the country often takes for granted. These specialist studies also show that if these services are impacted by human activities beyond their thresholds to provide these services, then there are negative socio-economic impacts, particularly for the poor.

Investing more in ecological infrastructure can enhance the life of the human-built infrastructure and offer employment in the process. Ecological infrastructure is best thought of as an interconnected network of natural areas and open spaces that holds valuable natural and biodiverse assets to help meet the basic needs for life and a meaningful existence.

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.

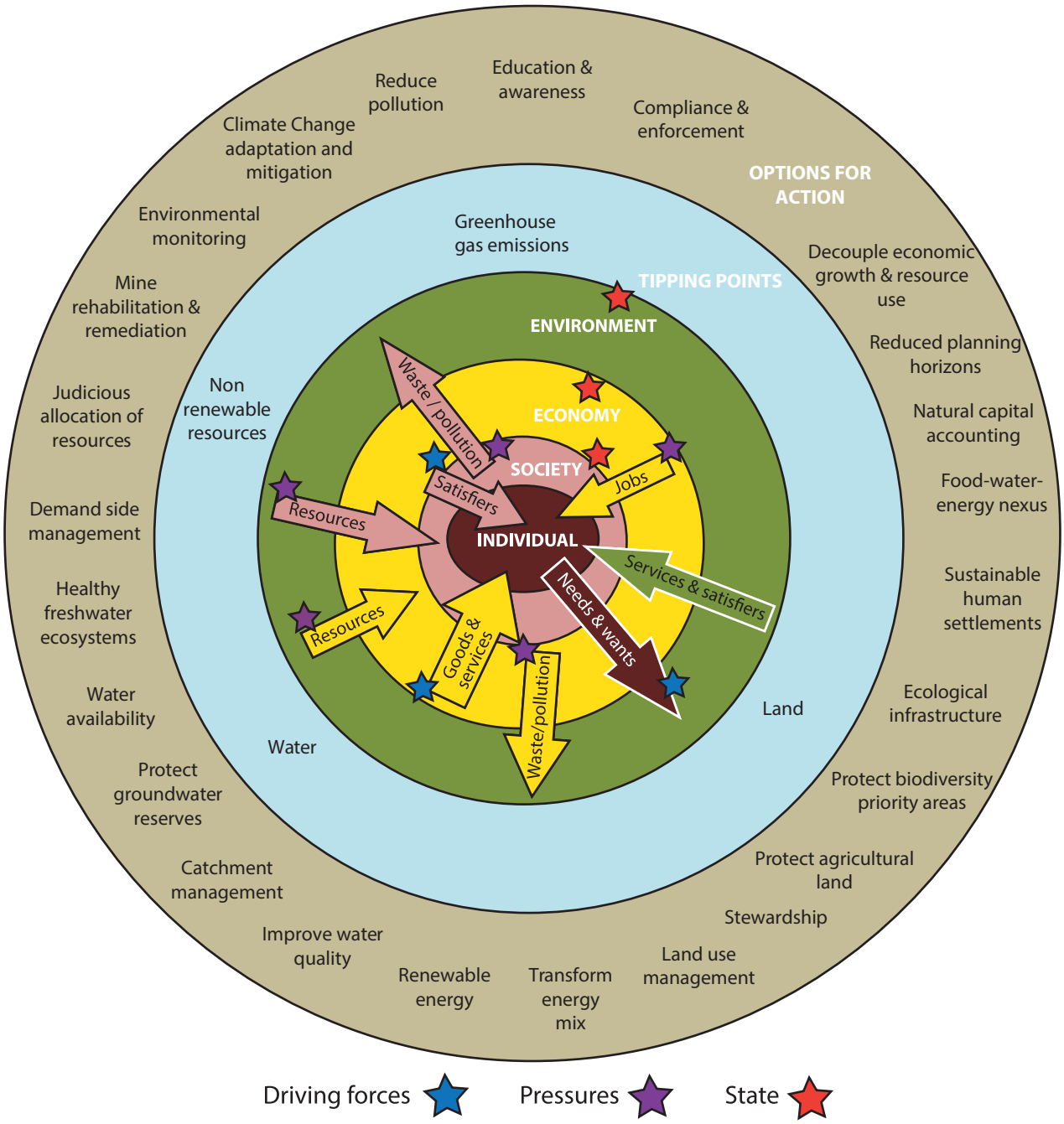


Figure 13: Options for action and tipping points in relation to the sustainability model

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ANNEXURE 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 Rivers Health Programme assessments to cover all catchments and incorporating the results of this and the National Spatial Biodiversity Assessment into water resources planning (GN, R). • The River Health Programme 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 National Environmrntal Management: Protected Areas Act (No57 of 2003), 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 National Environmental Management: Waste Act (No 57 of 2008) (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 out-sourced 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).

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