Reducing Environmental Stresses

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Introduction

Environmental sustainability can only be realised if levels of human impacts are low enough not to cause harm to environmental systems. As the level of pollution increases in environmental systems, so the capacity of those systems to absorb pollution is reduced.

At some point, the stresses placed on environmental systems are too large, and the system presents symptoms and signs of degradation. This happens when the 'carrying capacity' of the environmental system has been reached.

Stresses on Environmental Systems

Stresses to environmental systems can be human-induced or natural. Extreme weather events such as droughts and floods can place stress on environmental systems, resulting in the system being more susceptible to damage. Human-induced stresses generally result from pollution and wastes. Environmental systems show a threshold for assimilating a certain amount of waste products. Once that threshold has been reached, it is highly likely that the system will present with damage, which may or may not recover with time. Examples of human-induced stresses include pesticides and fertilizers contaminating water sources, air emissions such as lead and sulphur dioxide, and household waste disposal in landfills.

Stresses to environmental systems can be trans-boundary in nature, and are generally dynamic in space and time. Trans-boundary stresses would occur when the pollution of one country is transmitted into the territory of another country where impacts are experienced. Transmission can occur for example via water flow or air circulation.

The indicators and variables representing stresses on environmental systems are:

- Air pollution
  - Coal consumption
  - Vehicles in use per populated area
- Ecosystem stress
  - Invasion of alien species
- Population pressure
  - Percentage change in projected population, 1950–2050
  - Total fertility rate (TFR)
  - Migration
- Waste and consumption pressures
  - Ecological footprint

  - Energy use
  - Grazing capacity
- Water stress
  - Fertilizer sales
  - Water stress

For further information on environmental stresses please refer to the following:

United Nations Environment Programme 2004. *Global Environment Outlook 3.* http://www.unep.org/geo/

United Nations Environment Programme. *Global Environment Outlook.* http://www.unep.org/geo/

United Nations Environment Programme. *Africa Environment Outlook.* http://www.unep.org/dewa/Africa/

Indicator: Air pollution

Variable: 13

Description: Coal consumption

Units: Terrajoule coal consumed.

Source: Department of Minerals and Energy Affairs (DME) 2006. *Digest of South African Energy Statistics.*
South Africa Government Information: www.info.gov.za

Logic: Coal fired power stations emit higher CO_2 levels and other air pollutants than natural gas or oil fired plants, and the energy produced is more carbon intensive.

Discussion: South Africa's indigenous energy resource base is dominated by coal. Internationally, coal is the most widely used primary fuel, accounting for about 36% of the total fuel consumption of the world's electricity production. About 77% of South Africa's primary energy needs are provided by coal - coal is relied on for the generation of most of the country's electricity and a significant proportion of its liquid fuels. This is unlikely to change significantly in the next two decades, owing to the relative lack of suitable alternatives to coal as an energy source. In addition to the extensive use of coal in the domestic economy, some 28% of South Africa's production is exported internationally, mainly through the Richards Bay Coal Terminal, making South Africa the fourth-largest coal exporting country in the world (www.info.gov.za).

Of the run-of-mine coal produced, 21% goes to the export market, and 21% is used for local demand (excluding power station coal) (DME Digest 2006). The remainder of South Africa's coal production feeds the various local industries: some 62% is used for electricity generation, 23% for petrochemical industries, 8% for the general industry, 4% for the metallurgical industry, and 4% is purchased by merchants and sold locally or exported. The beneficiation of coal, particularly for export, results in more than 65 mega-ton (Mt) of coal discards being produced annually, and this figure could reach 2 000 Mt by the year 2020. South Africa has around 28.6 billion tons of recoverable coal reserves (GCIS, Pocket Guide to South Africa 2005)[1]. With the present production rate, there should be more than 50 years of coal supply left (www.info.gov.za).

Environmental concerns pose the main challenge to coal as energy source. Not only does the burning of coal cause air pollution, but the mining activities to extract coal also impact negatively on the environment. Acid drainage occurs from coal mine dumps. Furthermore, coal is used by about 950 000 households countrywide. This causes indoor air-pollution problems, which have a serious health impact. It has been found that in some cases, especially regarding particulate matter, exposure can exceed World Health Organization (WHO) standards (180 $mg.m^3$) by factors of six to seven during winter, and two to three in summer. A national programme has been established to introduce low smoke alternatives into the townships (www.info.gov.za).

Since 1994, the overall consumption of coal increased by just over 22% and the consumption for electricity generation increased by over 27% in the same period.

Notes:

1. Figures for coal reserves vary. According to the GCIS pocket guide, reserves are about 28.6 billion tons, enough for 50 years of supply. According to Energy Policies for sustainable development in South Africa, 2006, South Africa's coal reserves were estimated at 53 billion tons in 2002, and that with the present production rate there should be almost 200 years of coal supply left. According to the latest natural resource accounts report for minerals, published by Statistics South Africa in 2004 (Report no. 04-05-02; 1980 to 2001), in 2001 there was 246 years left to depletion, given current rate of extraction and proven resources. (Quoted from: Energy accounts for South Africa, 1995-2001).

2. According to Stats in Brief 2006, the number of household using coal as energy source for cooking was 308 000 in 2005, and 557 000 for heating. It may be that the statistics provided in www.info.gov.za added the above figures into one statistic which may be misleading.

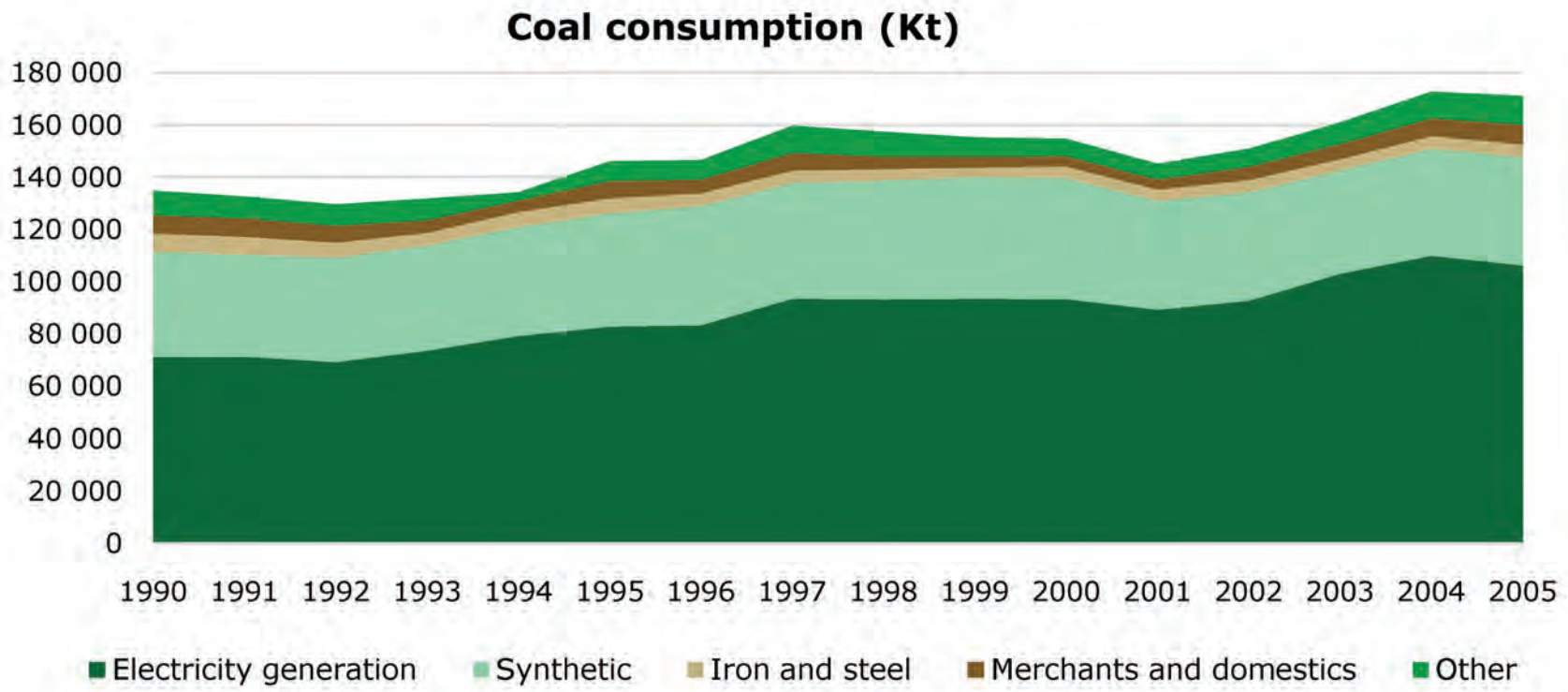

Figure 16: Coal consumption (Kt) in various sectors in South Africa from 1990 to 2005
Source: *Digest of South African Energy Statistics 2006.* National Energy Balances

Table 9: Consumption of coal (Kt)

Year	Electricity generation	Town gas	Iron and steel	Merchants and domestic	Industry	Mining	Metallurgical	Synthetic	Transport	Total (Kt)	Total consumption Terrajoule[a]	Total primary energy[b] supply TJ
1990	71 251	116	6 953	6 963	6 174	452	2 533	40 287	69	134 797	2 709 420	-
1991	71 287	49	6 826	7 095	6 075	422	1 696	39 120	36	132 604	2 665 340	-
1992	69 271	45	5 791	6 451	6 177	506	1 370	39 960	9	129 580	2 604 558	2 990 691
1993	73 595	45	4 937	4 823	5 457	470	2 142	40 249	94	131 812	2 649 421	3 028 745
1994	79 247	62	5 767	4 415	517	388	2 003	41 734	42	134 174	2 696 897	3 117 230
1995	82 821	60	5 822	6 674	5 172	603	1 509	43 356	54	146 071	2 936 027	3 243 737
1996	83 374	10	4 877	5 269	5 557	506	1 313	45 640	17	146 564	2 945 936	3 299 787
1997	93 535	-	4 725	6 787	7 325	1 257	1 719	44 329	2	159 679	3 209 548	3 370 254
1998	93 262	37	4 350	4 749	6 272	1 517	1 620	45 544	23	157 374	3 163 217	3 268 198
1999	93 487	0.4	3 678	4 268	5 076	764	1 406	46 559	-	155 238	3 120 284	3 413 499
2000	93 367	0	4 465	3 920	5 175	145	1 272	46 335	-	154 680	3 109 068	3 425 725
2001	89 274	0	4 373	3 802	3 387	1 528	1 073	41 682	2	145 122	2 916 952	3 065 619
2002	92 726	0	4 728	5 026	4 287	1 508	1 079	41 515	-	150 870	3 032 487	2 961 026
2003	103 074	0	4 325	5 780	5 050	1 416	1 685	39 582	-	160 912	3 234 331	3 277 600
2004	109 974	0	4 816	6 774	6 644	1 499	1 953	41 051	-	172 712	3 471 511	3 573 343
2005	106 209	0	4 903	7 513	6 808	2 113	2 129	41 445	0	171 120	3 439 512	3 651 726

a. Calorific values calculated based on conversion factors on p59 of the above publication. Standard conversion factor of 20.1 Mj/kg was used. See also International Energy Agency for statistics for 2004.
http://www.iea.org/Textbase/stats/renewdata.asp?COUNTRY CODE=ZA

b. From p3 of Digest of *South African Energy Statistics 2006*. The values for Tj differ somewhat from above calculation but this may be due to the fact that the table deals with total supply, whereas the above table deals with total consumption. Difference is less than 3%.
(Other includes sectors such as the Metallurgical, Town gas, Mining, Transport and Industry)

Source: Adapted from the Digest of *South African Energy Statistics 2006*. The National Energy Balances

Indicator Air pollution

Variable: 14

Description: Vehicles in use per populated area

Units: Number of registered vehicles (excluding caravans and trailers) per populated land area (at 5 or more persons per square km).

Sources: 2002–2006: http://www.fleetwatch.co.za/Tw2006/info/LiveVehicle.htm.

1998–2001: Live vehicle population as per the National Traffic Information System (NaTIS)[1].

Center for International Earth Science Information Network (CIESIN), Columbia University; and Centro Internacional de Agricultura Tropical (CIAT). 2005. Gridded Population of the World Version 3 (GPWv3): Population Density Grids. Palisades, NY: Socioeconomic Data and Applications Center (SEDAC), Columbia University. Available at http://sedac.ciesin.columbia.edu/gpw. Data downloaded 19 November 2008.

Logic: This is a proxy measure of air pollution from the transportation sector, which is a large sector in terms of energy use. This sector has experienced a growth rate of 20% since 1998.

Discussion: Negative impacts on the environment occur on a regular basis. Some environmental impacts are more proportional to population growth than others. Transportation's impact on the environment is not strictly proportional to population, but is also affected by affluence and technology.

Environmental impacts linked to the transportation sector are vast and include: air pollution, greenhouse gas emissions, the use of raw materials and energy to manufacture cars, and the loss of wildlife habitat and fragmentation to develop road networks. With increases in South Africa's population, there has been expansion in the number of vehicles on the road. This in turn, has increased pressure on the environment and on the human health.

The total number of vehicles increased by nearly 6% from 2006 to 2007. On a provincial percentage basis the biggest increase was in Mpumalanga where the vehicle population increased by 7.4%. On a percentage basis, the biggest increase per vehicle type was for motorcycles which increased by 10.05%. Light duty vehicles (LDVs) smaller than 3.5 ton forms 20% of vehicles on our roads, and does not include minibuses that is a significant portion at 3.0%.

According to the World Health Organization (WHO), vehicle effects on health result from both engine emissions and fuel. As economies develop, vehicles will contribute between 25% to 40% of most pollutants; this figure increases in urban settings.

Particulate matter is one of the main pollutants from vehicle emissions. The effects of exposure to particular matter on health have been associated with hospitalization for respiratory or cardiovascular diseases and exacerbation of respiratory diseases, such as asthma. The health effects depend on particle size and chemical composition. The impact of wet and dry deposition of particular matter on eco-systems may cause damage to plants, metal surfaces, fabrics and buildings. Depending on the chemical composition, particulate matter can contaminate soil and water. Carbon monoxide (CO) is a colourless, odourless and poisonous gas, produced by incomplete combustion of carbon fuels. When carbon monoxide enters the bloodstream it reduces the delivery of oxygen to the body's tissues and cells, because the haemoglobin in the red blood cells has a higher affinity for CO than for oxygen. Exposure to nitrogen dioxide increases the risk to respiratory infections. Nitrogen oxides (NO_x) play an important role in the atmospheric reactions that create ozone (O_3) and acid rain. Acid rain causes acidification of dams and rivers, damages trees and crops as well as buildings and statues.

Environmental degradation through vehicle emissions is a dire reality in South Africa, especially in urban metropolitan areas. Even though emissions are generated by a variety of sources (e.g. energy, industrial processes, agriculture, waste, household coal and wood burning, etc.), research has shown that the emissions generated by transport is the dominant or a major air pollutant relating to carbon dioxide (CO_2), carbon oxide (CO), nitrogen oxide (NO_x), and non-methane volatile organic compounds (NMVOC) (van Tienhoven 1999:2)[2].

At a regional scale, photochemical haze is an increasing phenomenon in the larger cities such as Johannesburg and Pretoria with vehicle emissions considered to be the major contributor (Annegarn 1997)[2]. The brown haze prevalent in Cape Town is also attributed to vehicle emissions with vehicle pollution making up more than 65% of the total (diesel-powered vehicles 48%; petrol-powered vehicles 17%) (Van Dyk 2003:8)[2].

Limitations: The Gridded Population of the World dataset was used to calculate the total land area inhabited with a population density greater than 5 persons per square km. This dataset only contains population densities up to the year 2000, and uses a grid of 2.5 arc-minutes resolution.

A comparison per province is only possible from 2002 onwards.

Notes: 1. Prior to 2002 the data is not available on the internet. The datasets in the National State of Environment Report (2006) obtained from NaTIS does not give a breakdown per province.

2. Article from Mercedes Benz South Africa.
http://216.239.59.104/search?q=cache:BhZTlCcV9XQJ:www.mercedesbenz.co.za/buses/downloads/Industryissue_Imiesaarticle.pdf

3. Department of Environmental Affairs and Tourism (DEAT) 2006. *The National Air Quality Management Programme (NAQMP) Output C.4 Initial State of Air Report*. http://www.environment.gov.za/HotIssues/2006/air_quality2006/doc/SoA%20Report-Draft%201.pdf

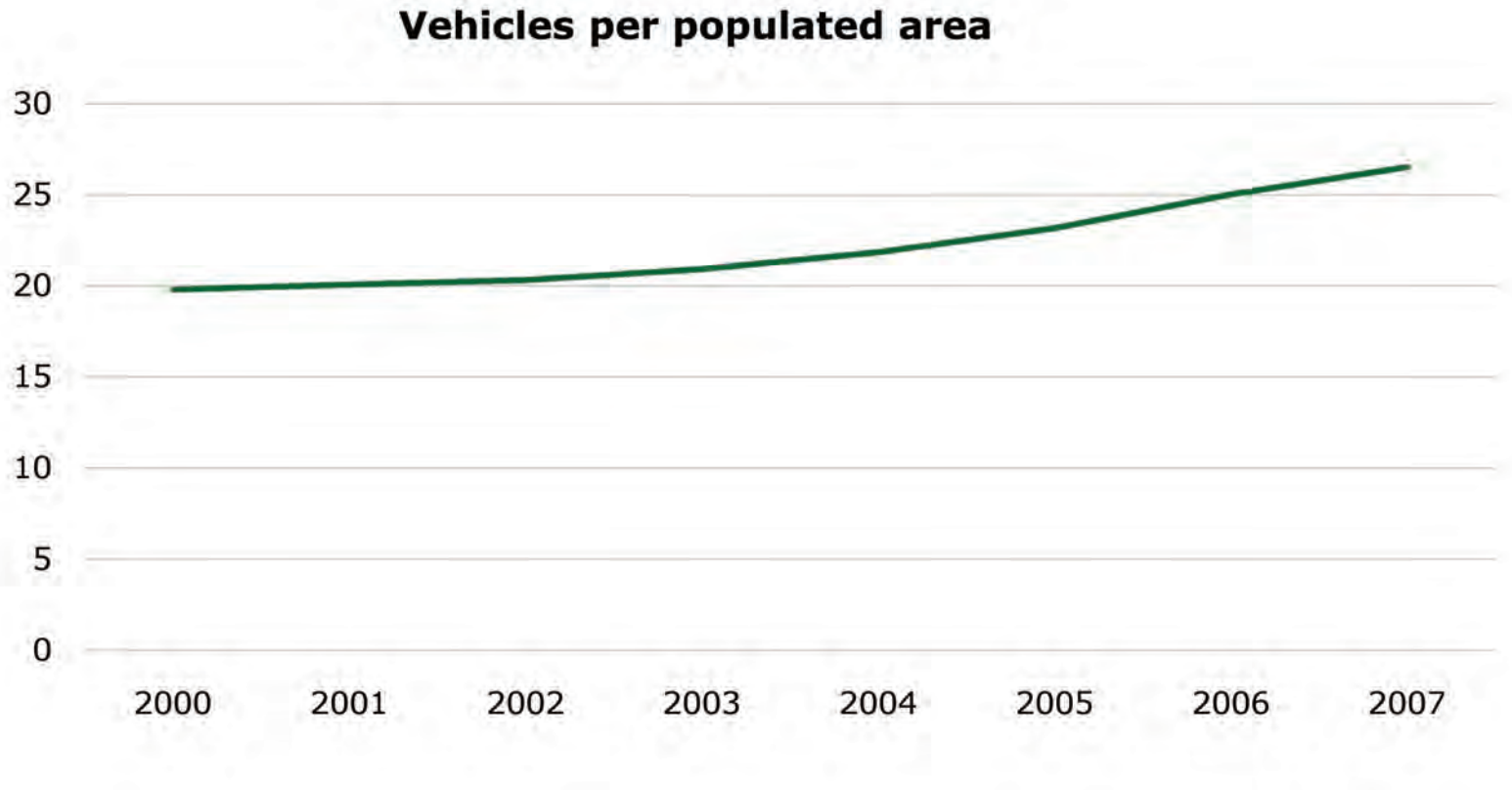

Figure 17: Total number of vehicles per populated area
Source: 2002–2006: http://www.fleetwatch.co.za/Tw2006/info/LiveVehicle.htm

1998–2001: Live vehicle population as per the National Traffic Information System (NaTIS)[1]

Center for International Earth Science Information Network (CIESIN), Columbia University; and Centro Internacional de Agricultura Tropical (CIAT). 2005. Gridded Population of the World Version 3 (GPWv3): Population Density Grids. Palisades, NY: Socioeconomic Data and Applications Center (SEDAC), Columbia University. Available at http://sedac.ciesin.columbia.edu/gpw. Data downloaded 19 November 2008

Table 10: Vehicle population, 1999–2007

	1999	2000	2001	2002	2003	2004	2005	2006	2007
Motocars and station wagons	3 847 952	3 913 470	3 977 255	4 035 774	4 154 593	4 307 943	4 307 943	4 890 206	5 160 844
Minibus	252 977	248 837	244 598	240 296	241 938	245 753	255 647	266 175	276 599
Buses, bus trains, midibuses	25 741	25 943	25 820	26 390	27 221	28 834	31 963	36 772	39 941
Motorcycles, quadracycles, tricycles	156 848	158 958	158 958	158 356	162 871	188 320	233 083	280 693	312 046
LVD's, panel vans, other light load vehicles (smaller than or equal to 3.5 ton)	1 261 815	1 297 383	1 332 591	1 354 669	1 406 217	1 464 171	1 561 507	1 688 418	1 822 829
Trucks (bigger than 3.5 ton)	227 468	226 937	225 134	225 329	231 302	242 436	258 867	279 780	302 955
Other self propelled vehicles	182 148	178 788	173 367	172 207	173 182	199 782	203 349	211 000	199 883
Total	**6 049 964**	**6 137 723**	**6 213 021**	**6 397 324**	**6 397 324**	**6 677 239**	**7 083 309**	**7 653 044**	**8 115 597**

1998–2001: Live vehicle population as per the National Traffic Information System (NaTIS).
Source: 2002–2006: http://www.fleetwatch.co.za/Tw2006/info/LiveVehicle.htm

Indicator: Ecosystem stress

Variable: 15

Description: Invasion of alien species

Units: Number of hectares cleared by the Working for Water programme.

Source: Department of Water Affairs and Forestry (DWAF) and Working for Water website: www.dwaf.gov.za

Logic: This variable measures the extent to which a country seeks sustainable management practices. Invasive plant species have a detrimental effect on a country's environment and improved management practices will aim to combat/lessen this effect.

Discussion: Introduced species have the potential to alter ecosystems and landscapes to the detriment of endemic fauna and flora. Invasive species have major social, economic, and environmental impacts including:

- Declines in the abundance and diversity of native flora
- Increased soil erosion and sedimentation of natural waterways and water bodies
- Competition with endemic species for sustenance and habitat
- Consumption of seedlings and plant materials, reducing the capacity for the ecosystem to regenerate itself
- Increased spread and establishment of weeds
- Decreased abundance and diversities of aquatic and terrestrial invertebrates
- Decreased and agricultural productivity by reducing the availability of feed for stock
- Damage to fences and other infrastructure.

Invasive species often enter the country through human influence (both directly and indirectly). While it is relatively easy to determine the extent to which exotic plants invade natural areas, the impact of exotic animals on native communities and on those species with which they compete directly is often less obvious.

It is estimated that alien plant species consume 3 300 million cubic meters of water annually amounting to about 7% of South Africa's total runoff. Most invasive alien species form a highly combustible mass leading to increase incidences of veld fires.

Invasive alien species are a concern in all biomes and ecosystems across South Africa. It is currently estimated that of the 9 000 introduced species in South Africa approximately 198 (covering about 10% of the country) can be deemed invasive. Invasive alien species have very serious negative impacts on the biodiversity and economy of South Africa. Woody invasive alien species, mainly from Australia and South America use considerably more water than indigenous South African vegetation.

The Working for Water (WfW) program was launched in 1995[1] and its purpose was to eliminate alien plant species from invaded areas in partnership with communities (to whom job opportunities are provided) and various government departments.

There are 11 regions where the WfW program is currently underway in South Africa and these are the following:

- Western Cape
- Eastern Cape
- Mpumalanga
- KwaZulu-Natal
- Limpopo
- SANParks
- Gauteng
- North-West
- Northern Cape
- Free State
- Cape Nature.

Apart from focusing their efforts on the clearing of invasive plant species the WfW also focuses on various community upliftment programs such as the education of the community in matters as HIV and AIDS. The clearing of invasive alien species is done by a number of different avenues:

- Mechanical methods
- Chemical methods
- Biological control
- Integrated methods (encompassing all three above mentioned methods).

There are generally three major steps when controlling invasive species and these are:

- The initial control (a drastic reduction of the population)
- Follow-up control (control of seedlings etc.)
- Maintenance control.

Notes: 1. For a detailed description of the Working for Water program please visit the Department of Water affairs and Forestry website at: http://www.dwaf.gov.za/wfw

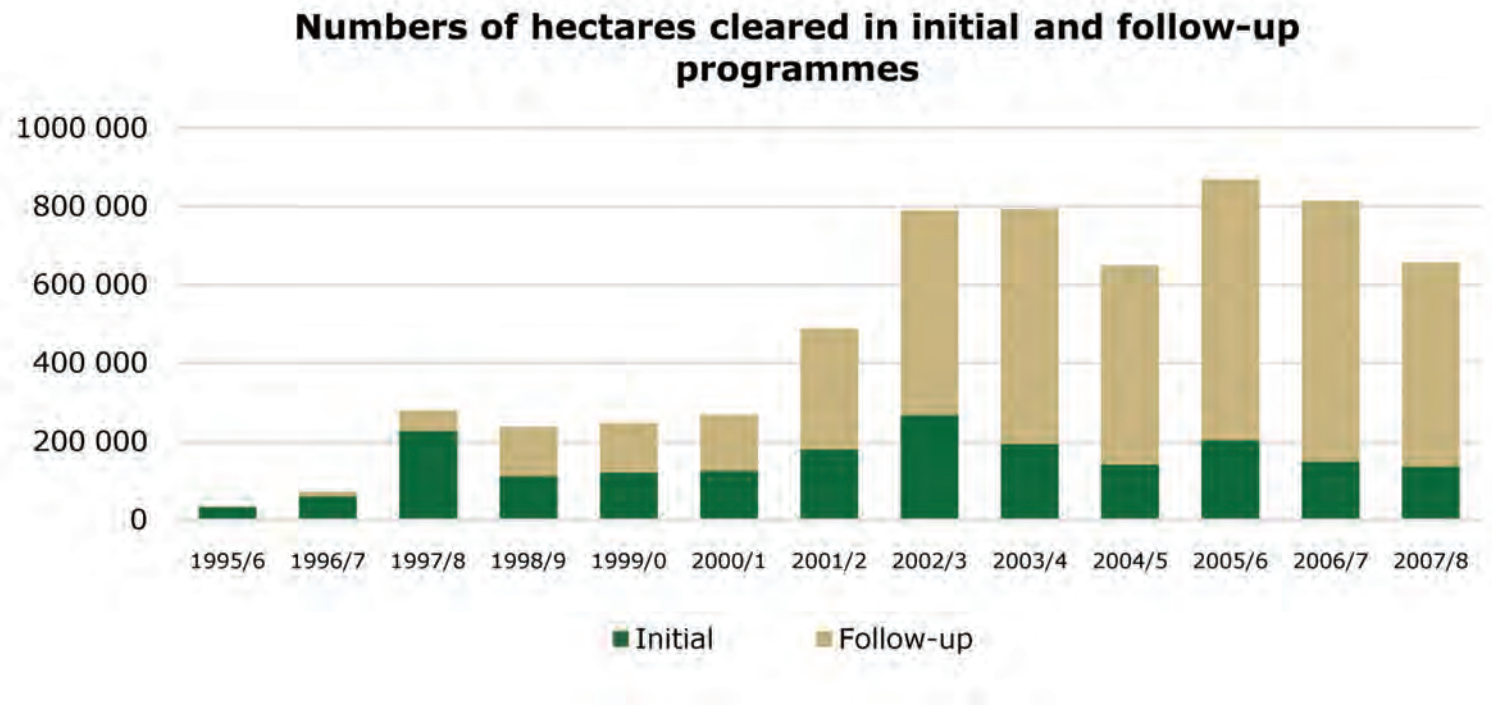

Figure 18: Number of hectares cleared in initial and follow-up attempts by the Working for Water programme
Source: Department of Water Affairs and Forestry. http://www.dwaf.gov.za

Indicator: Population pressure

Variable: 16

Description: Percentage change in projected population, 1950–2050

Units: Percentage change in projected population, 1950–2050.

Sources: Statistics South Africa (Stats SA) 2008. *Mid-year population estimates, 2006.* Statistical release P0302. http://www.stassa.gov.za

Bureau of Market Research, University of South Africa. *Population and Household Projections, 2001-2021.* Media release 2007-05-23.

Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2006 Revision and World Urbanization Prospects: The 2005 Revision, http://esa.un.org/unpp, Thursday, November 27, 2008; 2:31:40 AM.

Logic: The projected change in population provides an indication of the trajectory of population change, which has an impact on a country's per capita natural resource availability and environmental conditions.

Discussion: According to Statistics South Africa, the 2008 mid-year population is estimated at 48.7 million. The statistical release P0302, uses the cohort-component methodology to estimate the 2007 mid-year population of South Africa. These estimates explicitly account for HIV and AIDS.

Fifty-two percent (approximately 25.2 million) of the population is female. Gauteng has the largest share of the South African population. Just over 21.5% of the population live in this province. Life expectancy at birth is estimated at approximately 50.3 years for males and 53.9 years for females. The estimated overall HIV-prevalence rate is approximately 11%. The HIV positive population is estimated at approximately 5.35 million.

The common wisdom two decades ago was that the population would grow steadily into the new millennium, albeit at a declining rate. HIV and AIDS have prompted a serious revision of earlier projections, however, with the prospect of a declining population becoming ever more likely. At best, population projections are based on assumptions and scenarios, and HIV and AIDS has added a layer of complexity to the calculations. For projections to assess the impact of HIV and AIDS, forecasts of prevalence are needed (that is, forecasts of the proportion of the country's total population that is infected at any particular time), as well as forecasts of when prevalence is likely to peak and trends in AIDS-related deaths.

Limitations: To project the population until 2050, assumptions regarding future trends in fertility, mortality, levels of HIV/AIDS and international migration are made. There seems to be some agreement between the projections made by the Bureau of Market Research at the University of South Africa, and those made by the Population Division of the Department of Social Affairs of the UN. The projections by the US Census Bureau shows a lower population in the outer years.

Table 11: Estimated annual population growth, 2001–2021

Year	Total population[1]	Total population[2]
2001	45 554 529	45 143 037
2002	46 091 390	45 714 468
2003	46 538 650	46 279 073
2004	46 921 637	46 836 426
2005	47 240 698	47 390 900
2006	47 505 716	47 850 700
2007	47 724 148	-
2008	47 923 339	-
2009	48 107 661	-
2010	48 294 921	-
2011	48 487 755	-
2012	48 690 604	-
2013	48 914 812	-
2014	49 159 622	-
2015	49 432 128	-
2016	49 723 624	-
2017	50 037 957	-
2018	50 380 822	-
2019	50 747 665	-
2020	51 138 490	-
2021	51 549 834	-

Source: 1. Bureau of Market Research, University of South Africa. *Population and Household Projections, 2001–2021.* Media release 2007-05-23;
2. Statistics South Africa (Stats SA) 2006. *Mid-year population estimates, 2006.* Statistical release P0302

Table 12: Population growth 1950–2050

Year	Total population	Growth rate %	Growth rate period
1950	45 554 529		
1955	46 091 390	2.49	1950-1955
1960	46 538 650	2.61	1955-1960
1965	46 921 637	2.78	1960-1965
1970	47 240 698	2.71	1965-1970
1975	47 505 716	2.84	1970-1975
1980	47 724 148	2.63	1975-1980
1985	47 923 339	2.67	1980-1985
1990	48 107 661	2.19	1985-1990
1995	48 294 921	2.69	1990-1995
2000	48 487 755	1.88	1995-2000
2005	48 690 604	1.12	2000-2005
2010	48 914 812	0.56	2005-2010
2015	49 159 622	0.40	2010-2015
2020	49 432 128	0.41	2015-2020
2025	49 723 624	0.40	2020-2025
2030	50 037 957	0.36	2025-2030
2035	50 380 822	0.29	2030-2035
2040	50 747 665	0.23	2035-2040
2045	51 138 490	0.18	2045-2050
2050	51 549 834	0.17	2040-2045

Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2006 Revision and World Urbanization Prospects: The 2005 Revision, http://esa.un.org/unpp, Thursday, November 27, 2008; 2:31:40 AM

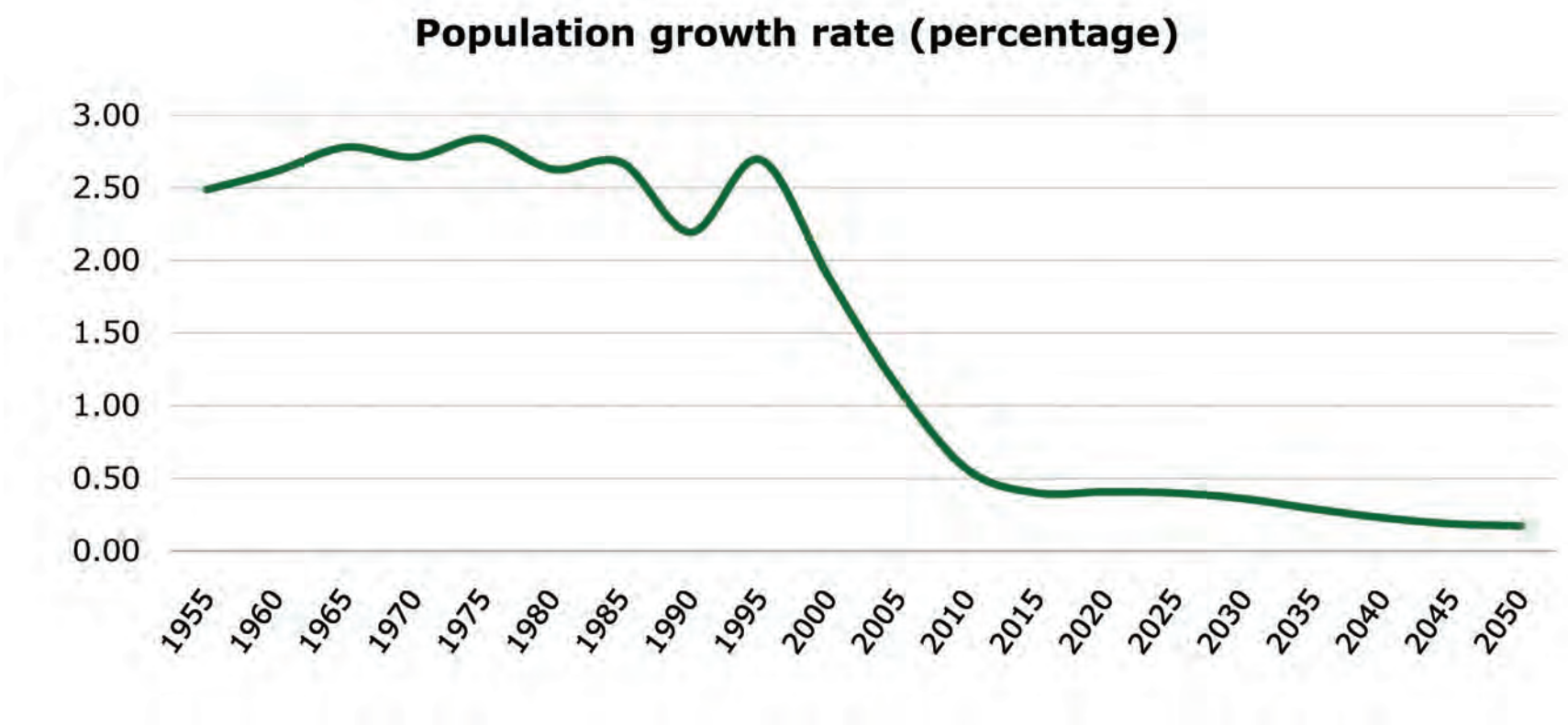

Figure 19: Population growth rate (1950–2050)

Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2006 Revision and World Urbanization Prospects: The 2005 Revision, http://esa.un.org/unpp , Thursday, November 27, 2008; 2:31:40 AM

Indicator: Population pressure

Variable: 17

Description: Total fertility rate (TFR)

Units: Average number of children per woman.

Source: Statistics South Africa (Stats SA) 2008. *Mid-year population estimates, 2008.* Statistical release P0302.

Statistics South Africa (Stats SA) 2008. *Community survey (revised version).* Statistical release P0301.
http://www.statssa.gov.za

Logic: Fertility contributes significantly to population growth, and thus to pressures on natural resources.

Discussion: This entry gives a figure for the average number of children that would be born per woman if all women lived to the end of their childbearing years and bore children according to a given fertility rate at each age.

South Africa's experience in the fertility transition is among the most advanced in sub-Saharan Africa. South Africa displays demographic regimes that are typical of both developed and developing worlds. These tend to be linked to socio-economic divisions along racial and urban-rural lines.

Dropping fertility is due partly to social and economic trends, including economic growth in South Africa, urbanization, social mobility, and migration. Empowerment of women in terms of education, family planning, and access to jobs has contributed to driving fertility down. In 1998, South African women had an average of 2.9 children. There was a notable difference between urban and rural populations, with urban women having an average of 2.3 children each, and rural women averaging 3.9 children each[1]. Fertility declined to an average of 2.5 children per woman in 2007.

Notes: 1. Department of Health (DOH) 1998. *South African Demographic and Health Survey.* Pretoria.

Table 13: Estimated total fertility rates, 2001–2007

Year	African	Colored	Indian / Asian	White	South African
2001	3.10	2.35	1.98	1.73	2.86
2002	3.07	2.33	1.92	1.73	2.84
2003	3.04	2.32	1.89	1.72	2.82
2004	3.01	2.30	1.87	1.72	2.80
2005	2.98	2.28	1.88	1.73	2.78
2006	2.92	2.27	1.88	1.73	2.78
2007	2.70	2.30	1.40	1.40	2.50

Source: Statistics South Africa (Stats SA) 2008. *Mid-year population estimates, 2008.* Statistical release P0302

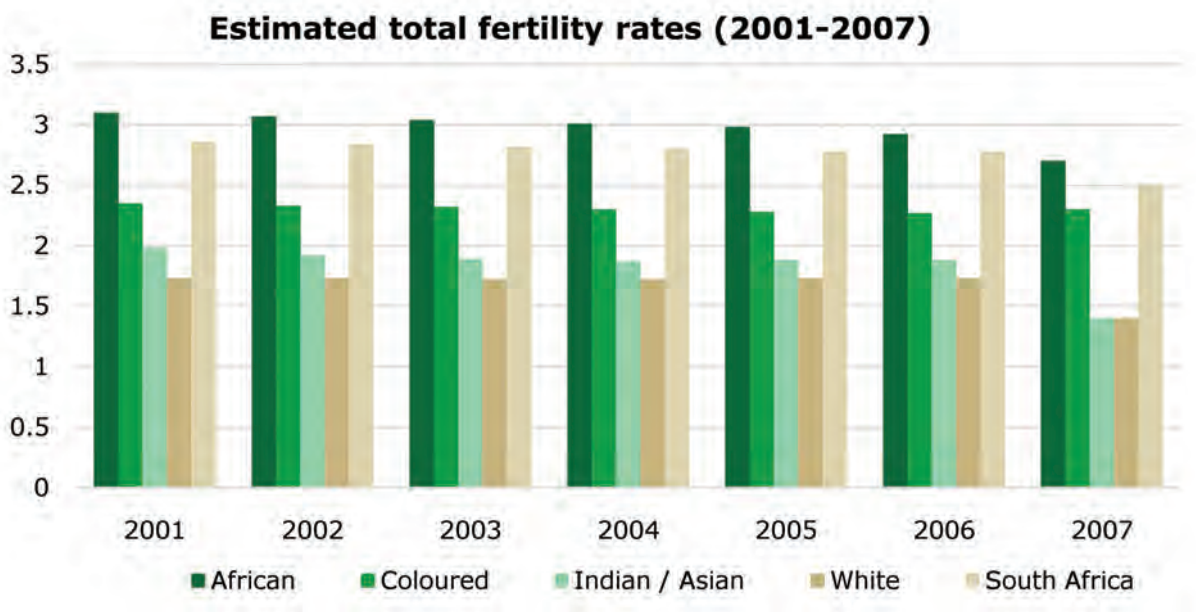

Figure 20: Estimated total fertility rates in South Africa (2001–2007)

Source: Statistics South Africa (Stats SA) 2008. *Mid-year population estimates, 2008.* Statistical release P0302

Indicator: Population pressure

Variable: 18

Description: Migration

Units: Number of people.

Source: Statistics South Africa (Stats SA) 2007. *Mid year population estimates 2007.*

South African Cities Network 2006. *State of the Cities report 2006.*
www.info.gov.za

Logic: Migration (Inter-city, inter-provincial and rural-to-urban migration) can create additional demands for water resources, energy supplies, waste disposal sites, housing and biological resources. This variable aims to investigate the migration patterns between provinces in South Africa between 2001 and 2006 and furthermore provides some predictions on future migration trends between provinces (2006-2011).

Discussion: Internal migration is a direct response to opportunities and hardships. People generally migrate in an attempt to secure employment and opportunities in another place where they think their chances to earn a decent income will be better, and to provide a better future for their families.

Immigration is sometimes also seen to be a problem for secondary reasons. Casual observers often view urbanization (i.e the increase of the population in urban areas) as a cause of unemployment. This happens despite evidence that it is often merely a case of rural unemployment being transferred to the cities and towns through emigration from rural areas.

Surveys performed by Statistics South Africa show that both the Gauteng and the Western Cape provinces had a net immigration rate throughout the period 2001 – 2006. Of the current 53 district and metropolitan municipalities only 19 experienced a net immigration rate while the remaining 34 municipalities experienced a net emigration. Whilst all the municipalities in the Gauteng province and the Western Cape province experienced a net immigration, the Free State province experienced a net emigration trend. The 2001 census has shown that South Africa had an urbanization level of 56.25%. There is a great variation in the level of urbanization among the nine provinces of South Africa. The highest levels of urbanization were found in the Gauteng province (96%), Western Cape (90%) and Northern Cape (80%). In most cases immigration was linked to areas with a strong metropolitan area or secondary city.

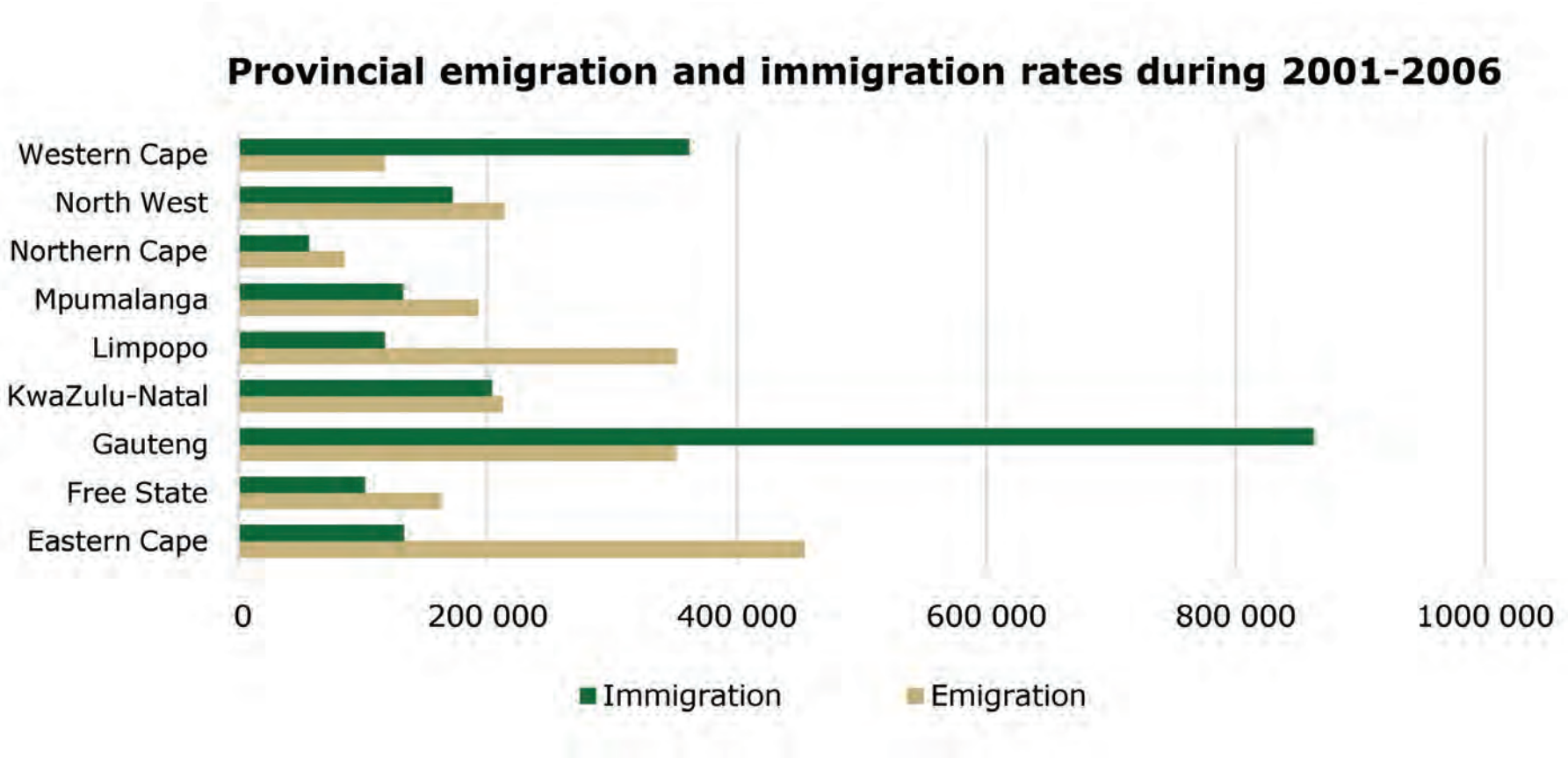

Figure 21: Provincial emigration and immigration rates during 2001 to 2006
Source: South African Cities Network 2006. *State of the Cities report 2006*

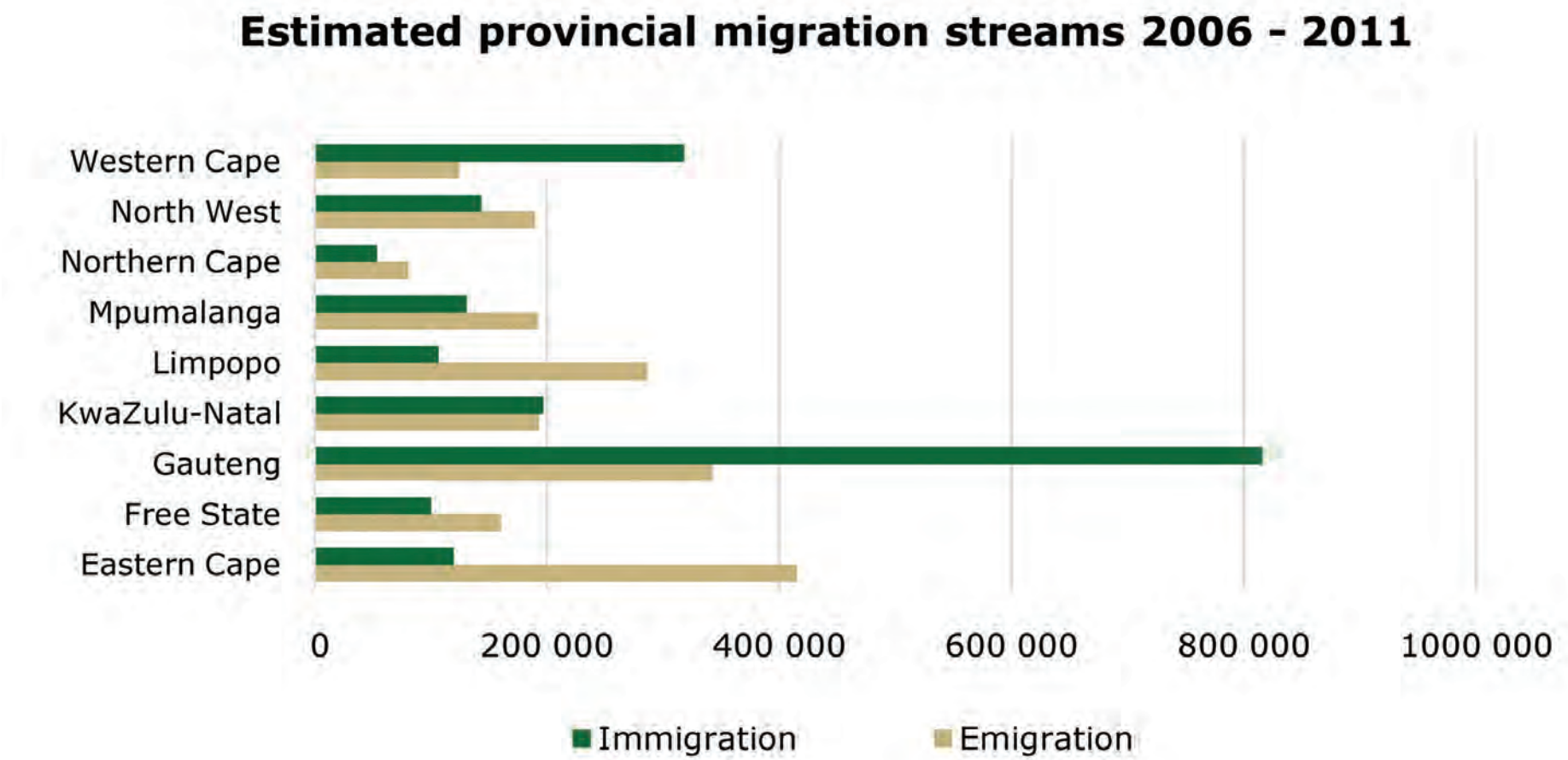

Figure 22: Estimated provincial migration streams (2006–2011)
Source: South African Cities Network 2006. *State of the Cities report 2006*

Table 14: Estimated provincial migration streams, 2001–2006

Province in 2001	Province in 2006											
	Eastern Cape	Free State	Gauteng	KwaZulu-Natal	Limpopo	Mpumalanga	Northern Cape	North West	Western Cape	Emmigration	Immigration	Net
Eastern Cape	-	21 232	108 822	68 971	8 399	12 540	5 451	33 117	195 910	454 442	132 945	-321 497
Free State	13 245	-	71 553	11 867	5 926	8 578	8 531	26 859	15 951	162 510	101 510	-61 035
Gauteng	40 317	28 396	-	65 960	49 213	40 097	8 135	53 548	65 240	350 905	862 365	511 459
KwaZulu-Natal	20 989	9 300	116 645	-	7 748	19 819	2 419	10 163	24 949	212 032	203 291	-8 741
Limpopo	5 349	5 113	263 231	9 837	-	38 370	2 177	20 832	6 358	351 267	117 592	-233 675
Mpumalanga	5 816	7 374	109 733	23 000	25 978	-	1 907	10 823	8 101	192 732	132 050	-60 682
Northern Cape	4 727	10 222	15 351	2 635	2 531	1 975	-	11 816	35 899	85 156	56 156	-28 423
North West	7 633	13 464	138 037	8 589	8 589	6 857	15 398	-	9 068	213 534	171 713	-41 821
Western Cape	34 869	6 374	38 993	12 432	12 432	3 814	12 715	4 555	-	117 060	361 476	244 416

Source: South African Cities Network 2006. *State of the Cities report 2006*

Table 15: Estimated provincial migration streams, 2006-2011

Province in 2006	Province in 2006											
	Eastern Cape	Free State	Gauteng	KwaZulu-Natal	Limpopo	Mpumalanga	Northern Cape	North West	Western Cape	Emmigration	Immigration	Net
Eastern Cape	-	15 341	137 659	62 160	6 096	9 089	5 464	20 626	158 706	415 141	119 676	-295 465
Free State	12 075	-	76 909	10 868	5 964	8 642	8 586	21 055	16 062	160 161	100 208	-59 953
Gauteng	35 706	31 126	-	70 419	43 020	43 933	7 130	46 956	64 273	342 563	815 663	473 100
KwaZulu-Natal	15 320	11 068	112 992	-	50949	16 513	2 563	5 975	22 309	192 689	196 696	4 007
Limpopo	3 638	5 219	201 637	6 683	-	39 153	2 220	21 250	6 486	286 286	106 406	-179 880
Mpumalanga	5 429	7 624	113 605	19 630	24 444	-	1 970	11 194	8 350	192 246	130 458	-61 788
Northern Cape	3 627	9 473	17 391	2 437	2 343	1 826	-	10 948	32 425	80 470	53 366	-27 104
North West	7 779	13 249	111 948	9 392	14 897	7 054	15 894	-	9 322	189 535	143 092	-46 443
Western Cape	36 102	7 108	43 522	15 107	3 693	4 248	9 539	5 088	-	124 407	317 933	193 524

Source: South African Cities Network 2006. *State of the Cities report 2006*

Indicator: Waste and consumption pressures

Variable: 19

Description: Ecological footprint

Units: Hectares of biological productive land required per capita.

Source: Redefining Progress, Ecological Footprint of Nations 2006.
Living Planet Report 2008.
Living Planet Report 2006.
Living Planet Report 2004.
Living Planet Report 2002.
Living Planet Report 2000.

Logic: The Ecological Footprint is a measure of how much land and water area a human population requires to produce the resources it consumes and to absorb its wastes under prevailing consumption levels and technology.

Discussion: The Ecological Footprint measures how much land and water area a human population requires to produce the resources it consumes and to absorb its wastes under prevailing consumption levels and technology. The footprint of a country includes all the cropland, grazing land, forest, and fishing grounds required to produce the food, fibre, and timber it consumes, to absorb the wastes emitted in generating the energy it uses, and to provide space for its infrastructure. People consume resources and ecological services from all over the world, so their footprint is the sum of these areas, wherever they may be on the planet.

Results from Ecological Footprint analysis shed light on a country's ecological performance. For example, the National Footprint Accounts (NFA) identify whether or not a country's Ecological Footprint[1] exceeds its biological capacity[2]. A country has an ecological reserve if its Footprint is smaller than its biological capacity. Otherwise it runs an ecological deficit.

The latest available data (for the year 2005) suggest that the Ecological Footprint per person in South Africa is 2.1 global hectares which is somewhat higher than average for Africa (1.4 hectares per person) and somewhat lower than the global average of 2.7 hectares per person. The global Ecological Footprint increased to 17.5 billion global hectares in 2005, or 2.7 global hectares per person. The total biocapacity in 2005 equalled 13.6 billion hectares, or 2.1 hectares per person.

The Ecological Footprint per person in South Africa is lower than the global average but higher than the average for Africa (2.1 hectares per person in South Africa compared to a global average of 2.7 hectares per person, and 1.4 global hectares per person for Africa). Currently South Africa has an ecological reserve of 0.1 global hectares per capita meaning that the biological capacity exceeds the Ecological Footprint by 4.7 million global hectares.

South Africa's carbon footprint comprises almost 50% of our total footprint, followed by our cropland footprint (almost 21% of total footprint) and grazing footprint (11% of total footprint).

Limitations: The national figure masks regional differences. The Ecological Footprint methodology is still under development which makes comparisons with previously published data difficult.

Notes:

1. A country's Ecological Footprint is determined by its population, the amount consumed by its average resident, and the resource intensity used in providing the goods and services consumed. It includes the area required to meet people's consumption from cropland (food, animal feed, fibre, and oil); grassland and pasture (grazing of animals for meat, hides, wool, and milk); fishing grounds (fish and seafood); and forest (wood, wood fibre, pulp, and fuel wood). It also estimates the area required to absorb the CO_2 released when fossil fuels are burned, less the amount taken up by the oceans. The footprint of nuclear power, about 4% of the global footprint, is included by estimating the footprint for the equivalent amount of energy from fossil fuels. The area used for a country's infrastructure, including hydropower, is included as the built-up land footprint component.

2. A country's bio-capacity is a function of the number and type of biologically productive hectares within its borders, and their average yields. More intensive management can boost yields, but if additional resources are used this also increases the footprint.

3. A global hectare is a hectare with world-average ability to produce resources and absorb wastes.

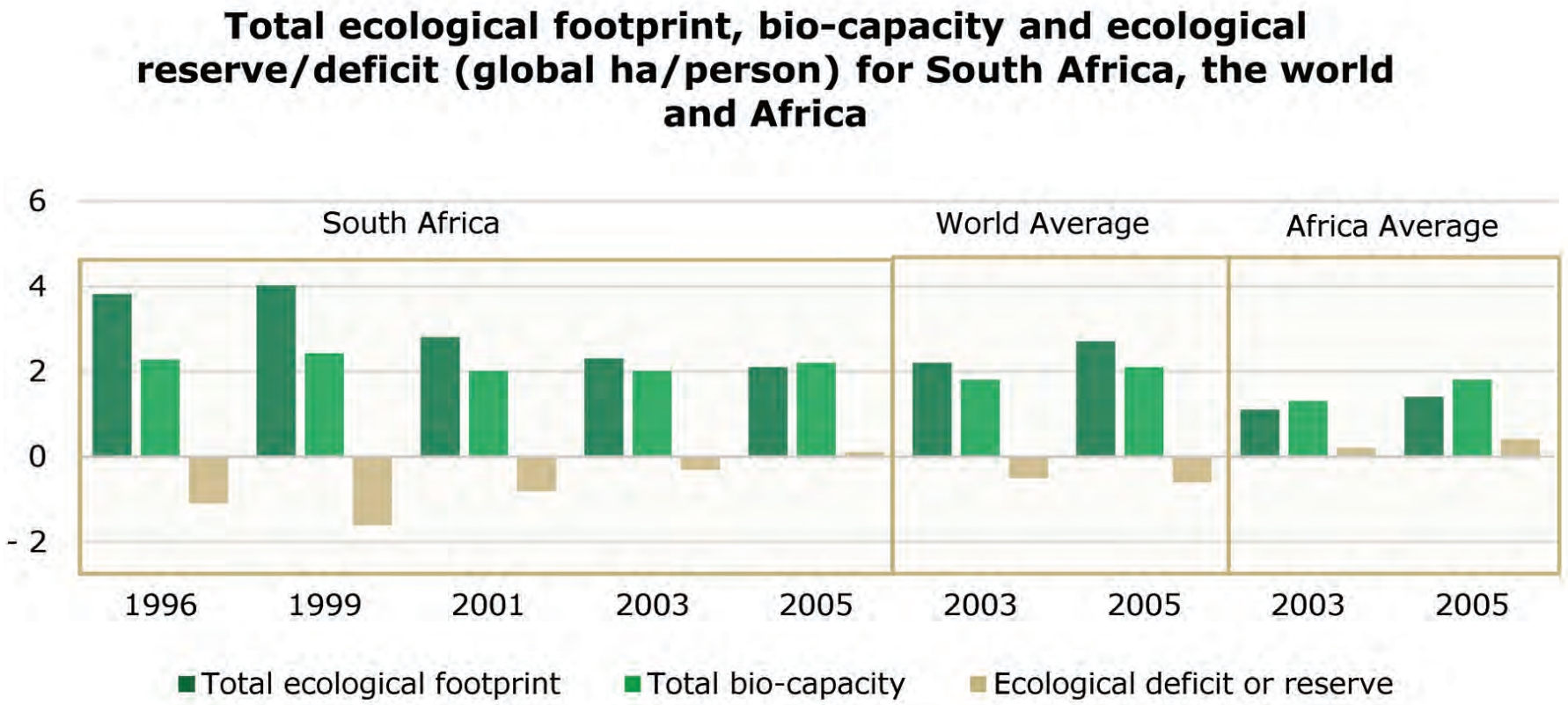

Figure 23: South Africa's ecological footprint, bio-capacity and ecological reserve or deficit compared to that of the world and Africa
Source: Living Planet Report 2008; Living Planet Report 2006; Living Planet Report 2004; Living Planet Report 2002; Living Planet Report 2000

Table 16: Ecological Footprint (global hectares per person, in 2003)

Year	Total Ecological footprint (Global ha/person)	Total bio-capacity (Global ha/person)	Ecological deficit (-) or reserve (Global ha/person)
SA 2005	2.1	2.2	0.1
SA 2003	2.3	2.0	-0.3
SA 2001	2.8	2.0	-0.8
SA 1999	4.02	2.42	-1.60
SA 1996	3.81	2.27	-1.09
World average 2005	2.7	2.1	-0.6
Africa average 2005	1.4	1.8	0.4

Note: Freshwater is not included in the Ecological Footprint because the demand for and use of this resource cannot be expressed in terms of the global hectares that make up the footprint. It is nonetheless critical to both human and ecosystem health. South Africa currently withdraws about 25% from the available water, most by the agricultural sector. (Living Planet Report 2006, p13).

Note: Value for SA for 1999 replaced in data tables with 2001 data which shows footprint in 2001 to be 2.19.

Source: Living Planet Report 2008; Living Planet Report 2006; Living Planet report 2004; Living Planet Report 2002; Living Planet Report 2000