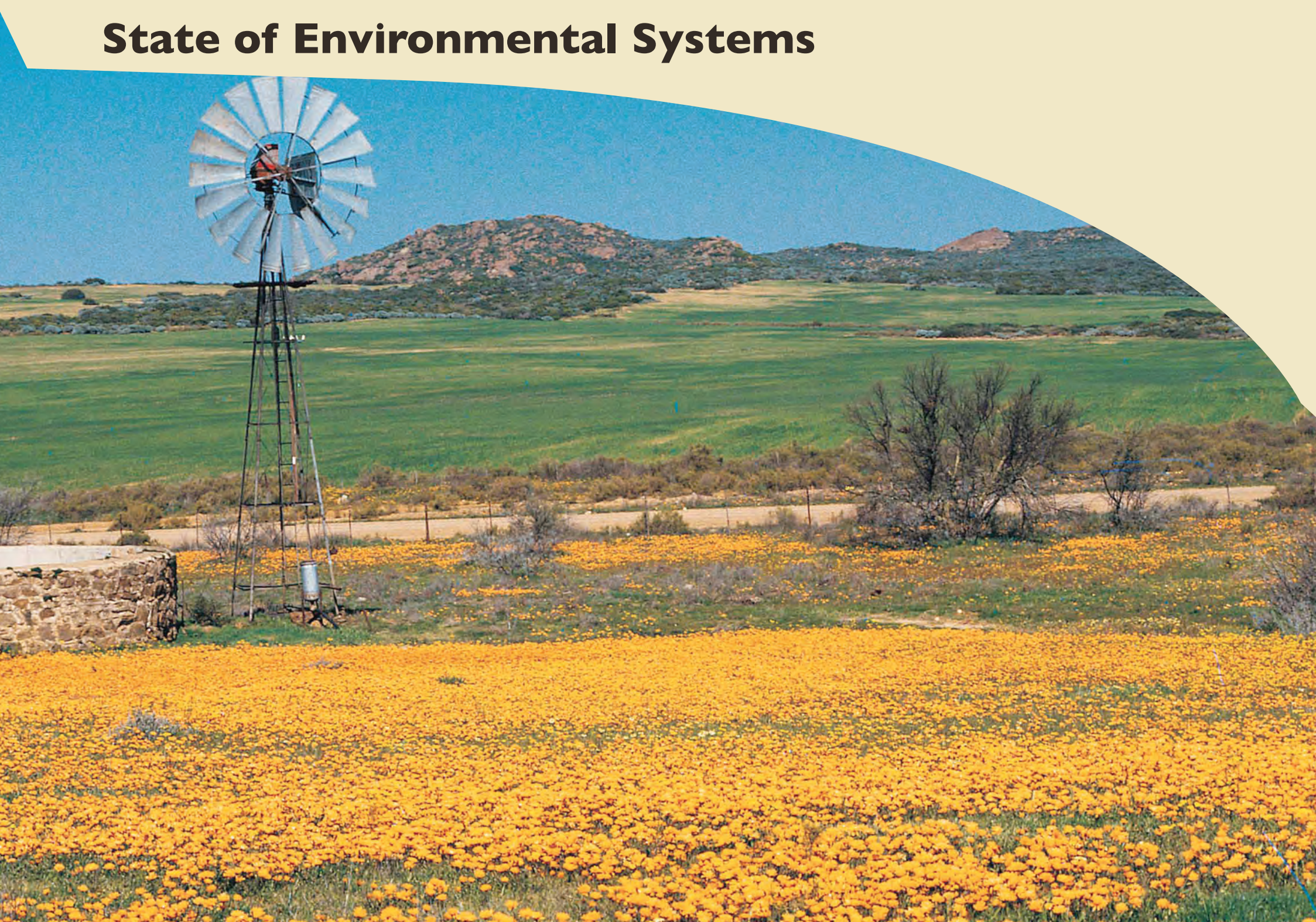
State of Environmental Systems



State of Environmental Systems

Introduction

Environmental sustainability can only be realized if vital environmental systems are maintained at healthy levels. The state or condition of environmental systems and natural resources are affected by both natural conditions and human activities.

Some systems or resources may appear degraded as a result of natural conditions in the environment, whilst others may appear degraded due to human activities such as the release of pollutants, or over-extraction of a particular resource.

State of Environmental Systems

The state of environmental systems should be monitored through time in order to track movement towards or away from environmental sustainability. The state or current condition is affected either by natural or human-induced change. It is only our knowledge of change in the environment that will enable us to manage that change effectively.

Environmental systems and resources include air, water and land, as well as biodiversity. Human activities influence these systems and resources through many different ways, including through industry, human settlements, economic activities and agricultural activities. Natural resource depletion through over-exploitation also contributes to the state of these systems.

Environmental systems do not have an infinite capacity for accommodating wastes and pollution. Certain systems will be able to accommodate higher levels of waste than others, and over-exploitation of a system may reduce its ability to absorb wastes and pollution.

The indicators and variables representing the state of environmental systems are:

- Air quality
    - Domestic fuel burning
- Biodiversity
    - Threatened bird, mammal, amphibian and reptile species (known)
    - Threat and protection status of vegetation types per biome
- Land
    - Degraded and transformed land
- Marine
    - Status of west coast rock lobster
    - Catches of selected marine species (harvesting)
    - Marine protected areas (MPAs)
- Freshwater
    - Available water per capita

- Capacity and levels of dams in South Africa
- Freshwater quality

• Groundwater
- Groundwater quantity
- Groundwater quality

For further information on the state of environmental systems please refer to the following:

South Africa 2002. *Environmental Indicators for National State of the Environment Reporting: South Africa 2002*. Department of Environmental Affairs and Tourism, Pretoria.

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

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 Quality

Variable: 1

Description: Domestic fuel burning

Units: Number of households by energy source.

Source: Statistics South Africa (Stats SA) 2006. *General Household Survey (Statistical release P0318).* http://www.statssa.gov.za

Logic: Domestic fuel burning is a measure of household fuel combustion, including electricity, gas, paraffin, coal, wood, candles and other sources such as animal dung and solar power. This variable is used as a proxy for indoor air pollution (see limitations). Indoor air pollution has deleterious effects, especially on women who cook inside using solid fuels. High exposure to the fumes from solid fuel combustion is dangerous to human health. Solid fuel use has further consequences for over harvesting of woodlands and soil depletion because of dung collection.

Discussion: The significance of domestic fuel burning emissions is enhanced due to three factors:

1. The low level of emissions

2. The coincidence of peak emissions, typically a factor of 10 greater than if total annual emissions were averaged, with periods of poor atmospheric dispersion (i.e. night-time, winter-time)

3. The release of such emissions within high human exposure areas with high contributions to both indoor and outdoor pollution concentrations.

Domestic fuel burning is a significant source of low level fine particulate and sulphur dioxide (SO_2) emissions. This sector also contributes significantly to carbon oxide (CO), total organic carbon (TOC), benzene emissions, and to greenhouse gas emissions, particularly carbon dioxide and methane (CO_2 and CH_4).

A wide array of factors affect the extent of household fuel combustion, such as population growth, availability of electricity, household income, degree of urbanization, and percentage of informal (non-serviced) households.

The percentage of households which continue to burn wood and paraffin for cooking, heating and lighting requirements are given in Tables 1-3 below. It is notable that electricity accounted for 63% for cooking, 50% for heating and 81% for lighting of the total energy consumed by the residential sector during 2006, a marked increase since 2001.

The remainder of the energy consumed was provided largely by the combustion of wood (15% for cooking, and 20% for heating), and paraffin (16% for cooking, 14% for heating, and 3% for lighting). The use of coal has decreased to 2% and 5% for cooking and heating respectively.

The following trends in key drivers associated with domestic fuel burning have been noted:

- Population growth rates are projected to increase by 1.6% in the short term but are expected to reduce to a zero growth rate during the first half of 2010
- The Integrated National Electrification Programme is on-going with it being envisaged that all houses will be electrified by 2010/2011.

Given these trends it is anticipated that domestic fuel burning will persist in the short-term. It is however likely to start to decrease in the medium-term as a result of lower population growth rates and on-going electrification.

Limitations: This is a proxy indicator for indoor air pollution from solid fuel use for which data is currently unavailable.

Table 1: Households by energy source for cooking, 2002–2006

Energy source	Number of Households (1 000's)				
	2002	2003	2004	2005	2006
Electricity from mains	6 664	7 403	7 234	7 800	8 222
Generator	4	*	*	*	12
Gas	237	200	202	235	291
Paraffin	1 928	1 956	1 845	2 145	2 086
Wood	2 430	2 506	2 420	2 117	2 011
Coal	372	343	307	308	271
Other	145	138	186	121	79
Total	**11 780**	**12 546**	**12 194**	**12 726**	**12 972**

Other: Includes non- and un-specified energy sources, solar power, candles and animal dung.
*For all values of 10 000 or lower the sample size is too small for reliable estimates.

Source: Statistics South Africa, *General Household Survey (Statistical release P0318)*, 2002, 2003, 2004, 2005 and 2006

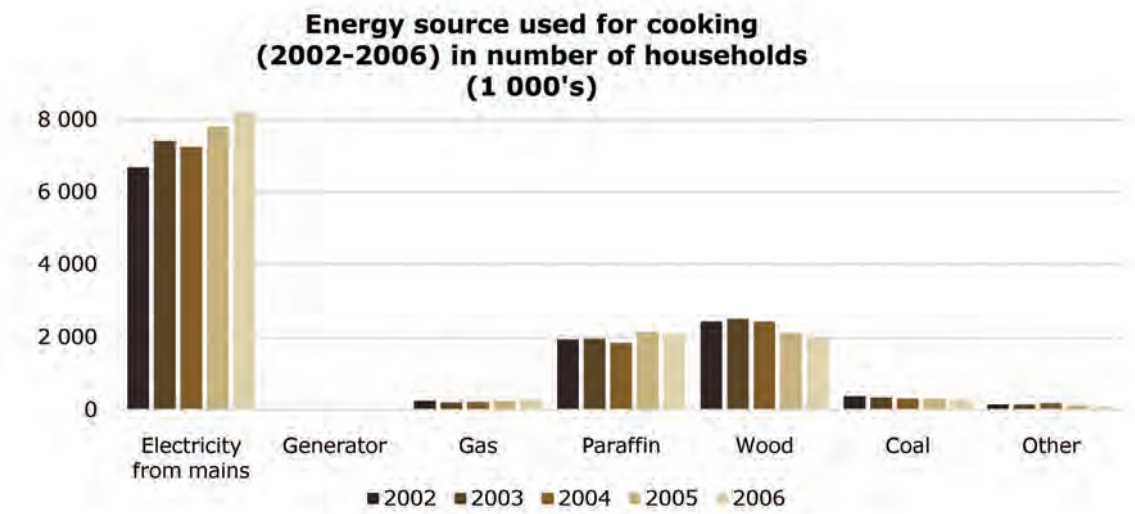


Figure 1: Households by energy source used for cooking (2002–2006)

Source: Statistics South Africa, *General Household Survey (Statistical release P0318)*, 2002, 2003, 2004, 2005 and 2006
http://www.stassa.gov.za

Table 2: Households by energy source for heating, 2002–2006

Energy source	Number of Households (1 000's)				
	2002	**2003**	**2004**	**2005**	**2006**
Electricity from mains	5 878	6 508	6 054	6 387	6 470
Generator	4	*	*	*	7
Gas	73	77	107	91	119
Paraffin	1 342	1 285	1 291	1 579	1 772
Wood	2 916	3 003	3 000	2 613	2 631
Coal	624	585	590	557	599
Other	943	1 088	1 152	1 499	1 374
Total	**11 780**	**12 546**	**12 194**	**12 726**	**12 972**

Other: Includes non- and un-specified energy sources, solar power, candles and animal dung.
*For all values of 10 000 or lower the sample size is too small for reliable estimates.

Source: Statistics South Africa, *General Household Survey (Statistical release P0318)*, 2002, 2003, 2004, 2005 and 2006

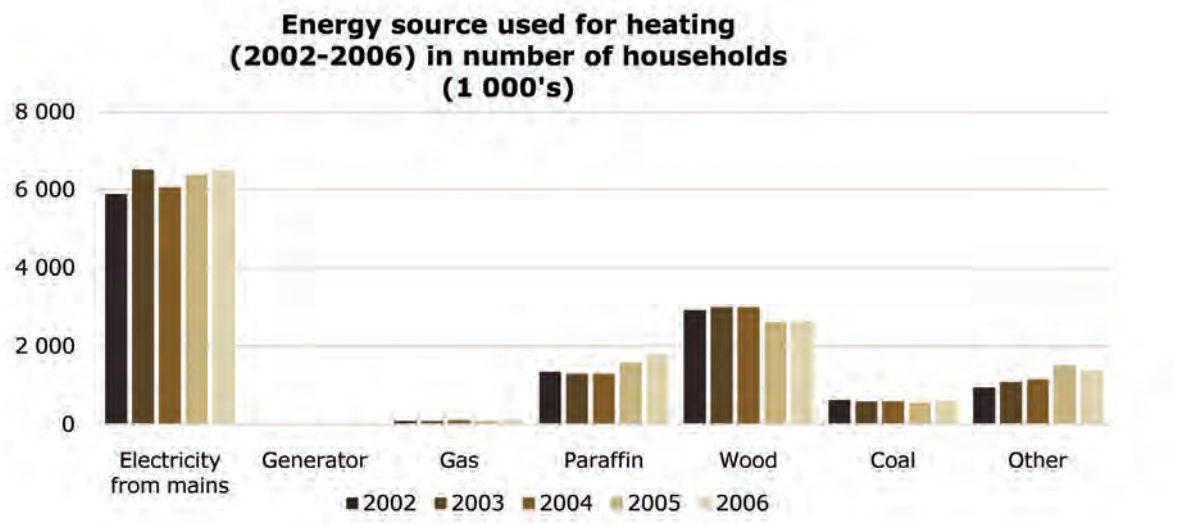


Figure 2: Households by energy source used for heating (2002–2006)

Source: Statistics South Africa, *General Household Survey (Statistical release P0318)*, 2002, 2003, 2004, 2005 and 2006

Table 3: Households by energy source for lighting, 2002–2006

Energy source	Number of Households (1 000's)				
	2002	2003	2004	2005	2006
Electricity from mains	8 975	9 866	9 773	10 203	10 520
Generator	12	11	*	*	9
Gas	20	*	19	*	10
Paraffin	656	570	521	482	449
Candles	2 090	2 060	1 832	1 993	1 925
Other	27	39	49	48	59
Total	**11 780**	**12 546**	**12 194**	**12 726**	**12 972**

Other: Includes non- and un-specified energy sources, solar power, and animal dung.
*For all values of 10 000 or lower the sample size is too small for reliable estimates.

Source: Statistics South Africa, *General Household Survey (Statistical release P0318)*, 2002, 2003, 2004, 2005 and 2006

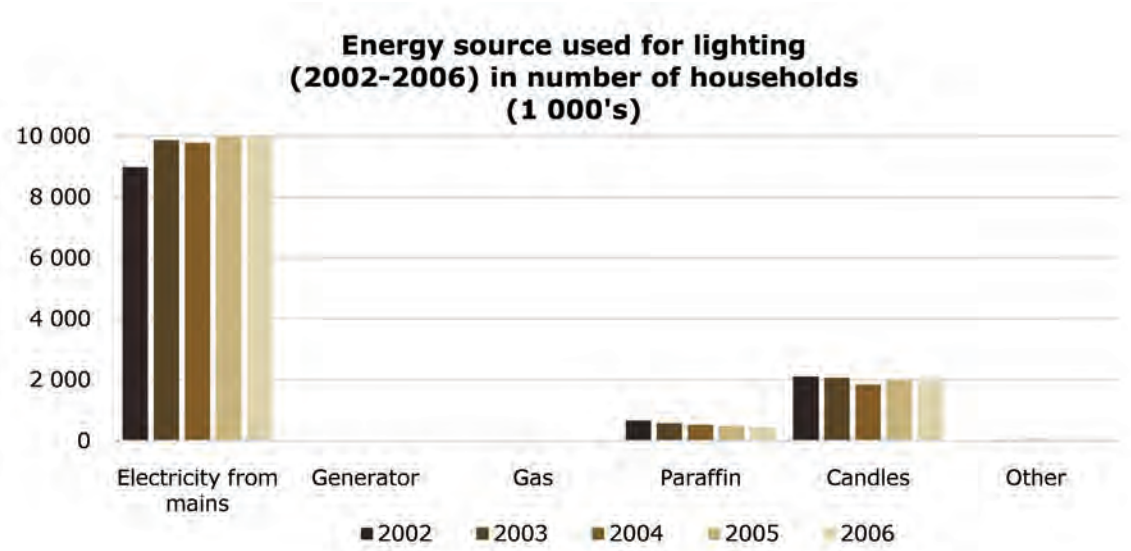


Figure 3: Households by energy source used for lighting (2002–2006)

Source: Statistics South Africa, *General Household Survey (Statistical release P0318)*, 2002, 2003, 2004, 2005 and 2006

Indicator: Biodiversity

Variable: 2

Description: Threatened[1] bird, mammal, amphibian and reptile species (known)

Units: Number of threatened bird, mammal, amphibian and reptile species as percentage of known species of each group in South Africa.

Source: International Union for Conservation of Nature (IUCN). http://www.redlist.org

Logic: This variable is dependent on various ecological and geographical factors not included as indicators in this document. Looking at the percentage of threatened species gives a good indication of the country's success in preserving its biodiversity.

Discussion: South Africa has in excess of 1 000 known species of amphibians, birds, mammals and reptiles. Of these it is estimated that 13.4% are endemic and 6.5% are classified as threatened. In addition to these, South Africa is also host to at least 23 420 species of vascular plants.

Birds

Birds are extremely good indicator species as they are widespread over a variety of ecosystems, are very sensitive to many kinds of environmental changes and have widespread popular appeal. Due to this popular appeal it is easy to mobilize volunteer groups to collect data and thus it is not surprising that this is the best known and documented taxonomic group.

A variety of factors can lead to the detriment of bird species. Some of these include:

- Habitat fragmentation
- Changes in weather conditions
- Incidences of accidental poisoning.

Looking at the total number of threatened bird species (those belonging to groups CR, EN and VU), a total of 36 species are deemed threatened, amounting to 4.63% of the total number of bird species. The percentage of threatened bird species in relation to all bird species in the country gives a good measure of the overall capacity of the country to preserve its biodiversity. This variable is under the control of various measures that are not directly incorporated into the environmental sustainability indicator framework and paints a good picture of the status of the environment as a whole.

The fact that there is only one species on which the data is deficient demonstrates that the monitoring process on the status of bird species is quite good. Looking at the IUCN data for 2000 South Africa ranked 56th out of a total of 136 countries with a total of 3.36% of bird species falling in the threatened category out of all the breeding bird species. The three countries with the highest percentage threatened bird species during 2000 were: Kuwait (35%), Philippines (34.18%) and New Zealand (32.67%)[2].

Mammals

According to data extracted from the Nationmaster website (www.nationmaster.com), using data from the Jacaranda Atlas and the World Resources Institute, South Africa had a total of 30 threatened mammal species in 2000. This amounts to a total percentage of 13.36%. The three countries with the highest number of threatened mammal species were: Indonesia (128; 24.8% total), India (75; 19.23% total) and China (75; 19.03% total)[2].

A multitude of factors can threaten the existence of mammals in South Africa. One of the most important are changes in weather patterns. Unlike birds, the distribution of mammals is restricted and various natural and man-made barriers may prohibit a species from moving to a more suitable habitat once a change has occurred. Similarly human developments have fragmented distribution patterns of species and may be one of the most important causes for the destruction of mammal species.

Amphibians

Amphibians include three different orders of animals and these are the frogs (Anurans), salamanders (Caudata) and the caecilians (Gymnophonia).

Looking at the total number of threatened amphibian species, comprising of groups CR, EN and VU, we see that a total of 21 species can be deemed threatened, amounting to 18.26% of the total number of amphibian species. Amphibian species are more reliant on environmental factors than birds due to the restriction this group has with regards to dispersal. Amphibian species need water to reproduce and when water resources are no longer available extinction is an increasing possibility. Similarly to mammals new developments play a vast role in the threatened status of this species. The most important factors threatening amphibian species[2] are as follows:

- Habitat destruction and fragmentation
- Over exploitation
- Introduced species
- UV–B radiation
- Chemical contaminants
- Disease

Seeing as amphibians are sensitive to all the above mentioned factors they are considered to be good indicator species. Globally there is an estimated total of 6 000+ species of amphibians of which nearly a 1/3 (32%) can be deemed threatened. For more information please visit: http://www.iucnredlist.org/amphibians.

Reptiles

According to the IUCN database a total of 19 reptile species are currently labelled as threatened (out of a total of 44). The threats posed to reptile species are very similar to those imposed on both mammals and amphibians.

Limitations: One of the major limitations to this variable is the frequency with which this variable is measured and the reliability of the data obtained through observational studies. Currently the most reliable data for this variable was obtained from the IUCN website encompassing the trends for a couple of years so a comparison between different time periods is not possible.

Notes: The key to the different assessments are as follows: **EX** - A species is extinct when the last individual of that species has died. **EW** - A species is Extinct in the Wild when it only survives in captivity, cultivation or as a naturalized population (or populations) well outside its previous distributional range. **CR** - A species is Critically Endangered when it is considered to be facing an extremely high risk of extinction in the wild, **EN** - A species is Endangered when it is considered to be facing a very high risk of extinction in the wild, **VU** - A species is considered to be facing a high risk of extinction in the wild, **NT** - A species is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future, **LC** - A species is of Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant species are included in this category, **DD** - A species is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. **STBA** - Still to be assessed, **LR/cd** - Lower risk: Conservation Dependent, **LR/lc** - Lower risk: Least Concern and **LR/nt** - Lower risk: Near Threatened.

1. The term threatened species include all those species that can be classified as Critically Endangered, Endangered or Vulnerable according to the Red data book listing.

2. According to www.nationmaster.com

It is important to note that the section focussing on birds in this variable was assessed in terms of the number of breeding birds in South Africa and does not include the migratory birds.

Table 4: Number of species in each Redbook category

Rating	Birds	Mammals	Amphibians	Reptiles
Extinct	0	2	0	1
Extinct in the wild	0	0	0	0
Critically endangered	0	3	4	2
Endangered	11	11	8	4
Vulnerable	25	15	9	13
Near threatened	30	12	4	0
Least concern	710	141	82	0
Data deficient	1	26	8	2
Still to be assessed	0	0	0	0
Lower risk/conservation dependent	0	31	0	0
Lower risk/least concern	0	50	0	4
Lower risk/near threatened	0	3	0	18
Total	**777**	**294**	**115**	**44**

Source: International Union for Conservation of Nature (IUCN). http://www.redlist.org

Indicator: Biodiversity

Variable: 3

Description: Threat and protection status of vegetation types per biome

Units: Percentage of vegetation types in each biome falling into threat categories and the protection status of these vegetation types.

Source: Driver, A., Maze, K., Rouget, M., Lombard, A. T., Nel, J., Turpie, J.K., Cowling, R.M., Desmet, P., Goodman, P., Harris, J., Jonas, Z., Reyers, B., Sink, K. and Strauss, T. 2005. *National spatial biodiversity conservation in South Africa, Strelitzia 17 (NSBA).* South African National Biodiversity Institute (SANBI), Pretoria.

Logic: Vegetation types can be grouped into biomes according to shared ecological and climatic characteristics. The protection status of vegetation types in each biome will give a good indication of the overall protection status of a country's biodiversity.

Discussion: Prior to 2005 the SANBI piloted a study to investigate the current threat and protection status of vegetation types in South Africa. Findings from the study showed that 34% of the terrestrial ecosystems of South Africa are currently classed as threatened. 58 Ecosystems (amounting to 13% of the total number of terrestrial ecosystems) are endangered. Most of the ecosystems falling in the endangered category are situated in the savanna and grassland biome. In combination with the assessment of the threat status of ecosystems the study also focused on the protection status of these ecosystems. Currently the forest ecosystem is afforded the greatest protection (about 58% of the total surface area) but at the same time the forest ecosystem is also the most critically endangered. The desert and succulent Karoo biomes are afforded the least protection with 53% and 59% of vegetation types in these biomes (respectively) afforded no protection at all.

Limitations: Assessment of threat status of an ecosystem or vegetation type is dependent on various different measurements and studies such as the national land cover database. These studies are often not performed on a regular basis.

Notes: The conservation status was calculated based on the percentage area remaining and the percentage target set for each natural habitat (LT - Least Threatened, if the remaining natural habitat is >80%, VU - Vulnerable, if remaining natural habitat is <80%, EN - Endangered, if remaining natural habitat is <60%, CE - Critically Endangered, if remaining natural habitat is < target).

The protection status was calculated according to the percentage of its biodiversity target met in type 1 protected area. A well protected area has its full biodiversity target protected, a moderate protected area has more than 50% of its biodiversity target protected, poorly protected areas have between 5% and 50% of their biodiversity target protected, while hardly protected areas have less than 5% of their biodiversity areas protected.

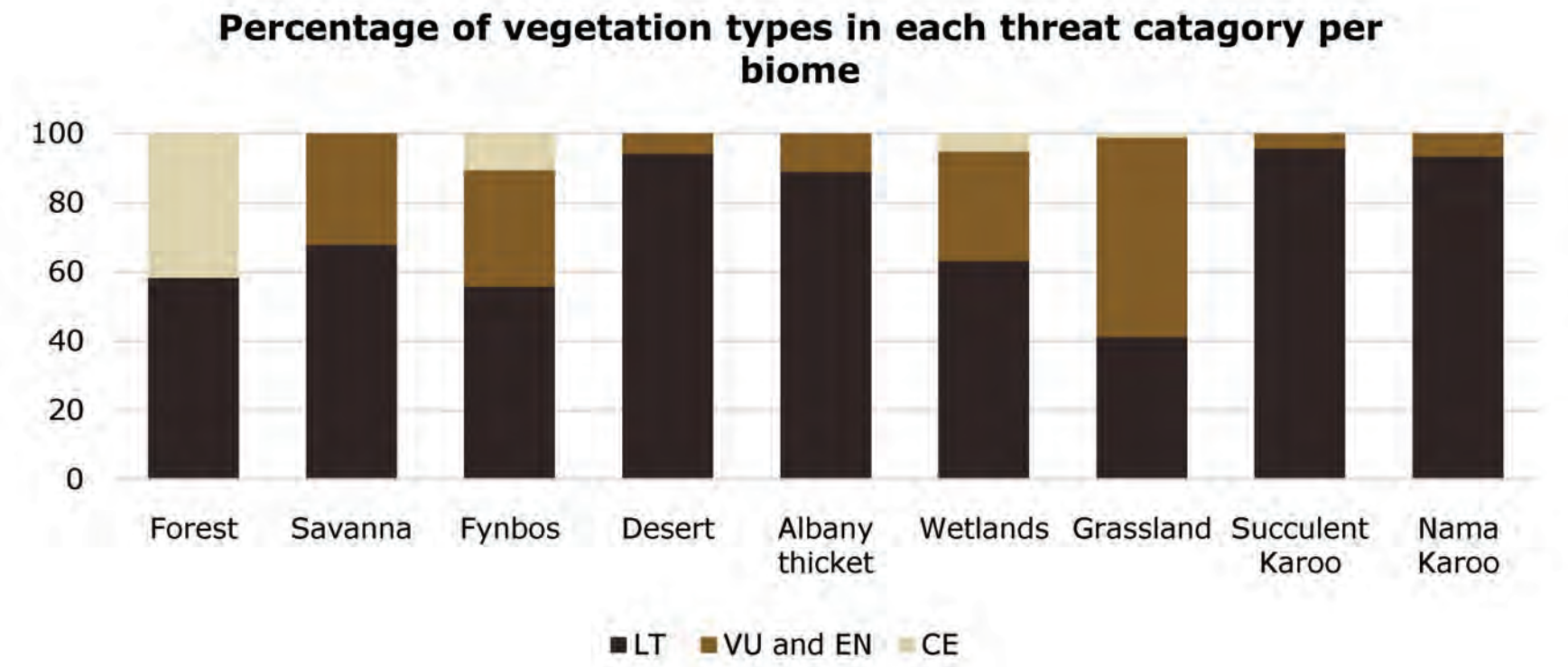


Figure 4: The threat status of vegetation types in the nine biomes of South Africa

Source: Driver, A., Maze, K., Rouget, M., Lombard, A. T., Nel, J., Turpie, J.K., Cowling, R.M., Desmet, P., Goodman, P., Harris, J., Jonas, Z., Reyers, B., Sink, K. and Strauss, T. 2005. *National spatial biodiversity conservation in South Africa, Strelitzia 17 (NSBA)*. South African National Biodiversity Institute (SANBI), Pretoria

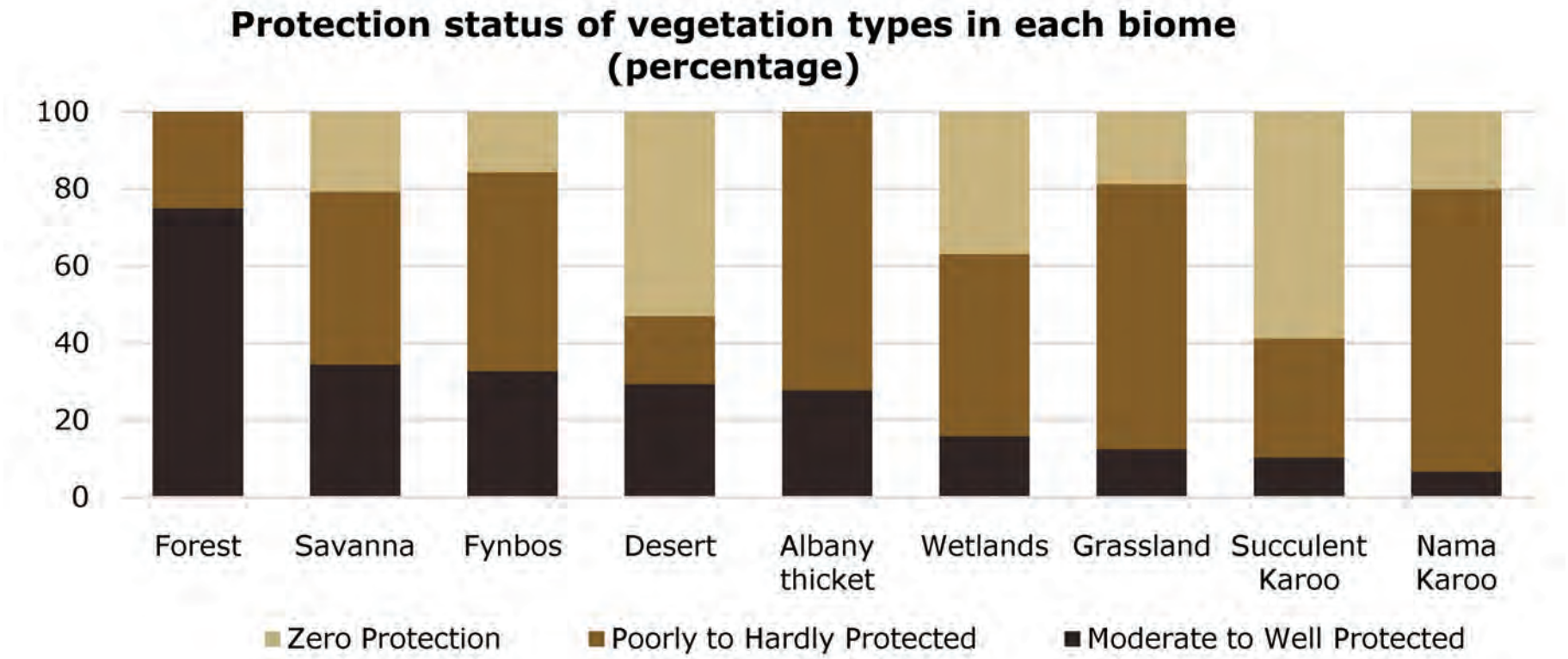


Figure 5: The protection status of the nine biomes of South Africa

Source: Driver, A., Maze, K., Rouget, M., Lombard, A. T., Nel, J., Turpie, J.K., Cowling, R.M., Desmet, P., Goodman, P., Harris, J., Jonas, Z., Reyers, B., Sink, K. and Strauss, T. 2005. *National spatial biodiversity conservation in South Africa, Strelitzia 17 (NSBA)*. South African National Biodiversity Institute (SANBI), Pretoria

Indicator: Land

Variable: 4

Description: Degraded and transformed land

Units: Percentage land degraded and transformed.

Source: Fairbanks, D.H.K. Thompson, W.M. Vink, D.E. Newby T.S. van den Berg H.M. and D.A. Everard. 2000. *The South African Land-cover Characteristics database: a synopsis of the landscape.* South African Journal of Science 96, February 2000.

Gibson, D., Paterson, G. and Newby, T. 2005. *Land: Background Research.* Paper produced for the South Africa Environment Outlook Report on behalf of the Department of Environmental Affairs and Tourism.

Logic: Information regarding the characteristics and spatial distribution of South Africa's land cover is critical for sustainable land-use planning, strategic environmental assessments and global change research. Degraded land may lead to a decline in the productivity of land, as well as the loss of vegetation and resources to support human livelihoods and commercial activities. Land degradation can additionally lead to reduced biodiversity and loss of ecosystem services. Ecosystem functions affected by erosion include plant nutrient supply, nutrient cycling and waste material decomposition.

Discussion: Soil loss together with, compaction, low organic matter, loss of structure, poor drainage, salinisation and acidity problems are all classified as soil degradation and lead to increased soil erosion.

Soil erosion is a naturally occurring process on land and the agents of soil erosion are water and wind, each contributing a significant amount of soil loss. Soil erosion may be a slow process that continues relatively unnoticed, or it may occur at an alarming rate causing serious loss of topsoil. The loss of soil from farmland may be reflected in reduced crop production potential, lower surface water quality and damaged drainage networks. The National Land Cover Database (NLCD) clearly shows that almost 20% of the land in South Africa can be classified as transformed whereas the greatest percentage area is covered by shrub lands and low fynbos (34.5%) followed by grasslands (21.28%).

Limitations: The accuracy of the land cover database range from 51% to 93% depending on the geographic area.

Notes: This indicator seeks to address the Johannesburg Plan of Implementation: Section 41.

Table 5: Area (hectares and percentage) covered by different land cover categories

Aggregated land cover class	Land cover category	Area (ha)	%
Cultivated lands	Cultivated permanent - commercial dryland	83 086.8	0.07
	Cultivated permanent - commercial irrigated	416 753.4	0.34
	Cultivated temporary - commercial sugarcane	459 370.0	0.38
	Cultivated temporary - commercial dryland	9 748 150.8	8.00
	Cultivated temporary - commercial irrigation	1 081256.7	0.89
	Cultivated temporary - semi-commercial/subsistence dryland	2 964 630.6	2.43
Degraded lands	Degraded herbland	138.6	0.00
	Degraded forest and woodland	965 723.1	0.79
	Degraded shrubland and low fynbos	563 182.4	0.46
	Degraded thicket & bushland (etc)	2 256 031.7	1.85
	Degraded unimproved grassland	1 862 583.9	1.53
	Dongas and sheet erosion scars	186 513.8	0.15
	Barren rock	260 361.2	0.21
Forest plantations (exotic tree species)	Forest plantations	1 790 269.6	1.47
Urban built-up lands	Commercial	34 476.3	0.03
	Industrial / transport	64 652.0	0.05
	Residential	1 084 164.1	0.89
	Residential (small holdings: bushland)	27 927.5	0.02
	Residential (small holdings: grassland)	134 927.3	0.11
	Residential (small holdings: shrubland)	12 301.6	0.01
	Residential (small holdings: woodland)	40 462.6	0.03
Mines and Quarries	Mines and quarries	175 420.7	0.14
TOTAL degraded and transformed		**24 212 384.7**	**19.86**
TOTAL untransformed / natural		**97 695 404.3**	**80.14**
TOTAL		**121 907 789.0**	**100.00**

Source: Fairbanks, D.H.K. Thompson, W.M. Vink, D.E. Newby T.S. van den Berg H.M. and D.A. Everard. 2000.
The South African Land-cover Characteristics database: a synopsis of the landscape. South African Journal of Science 96, February 2000

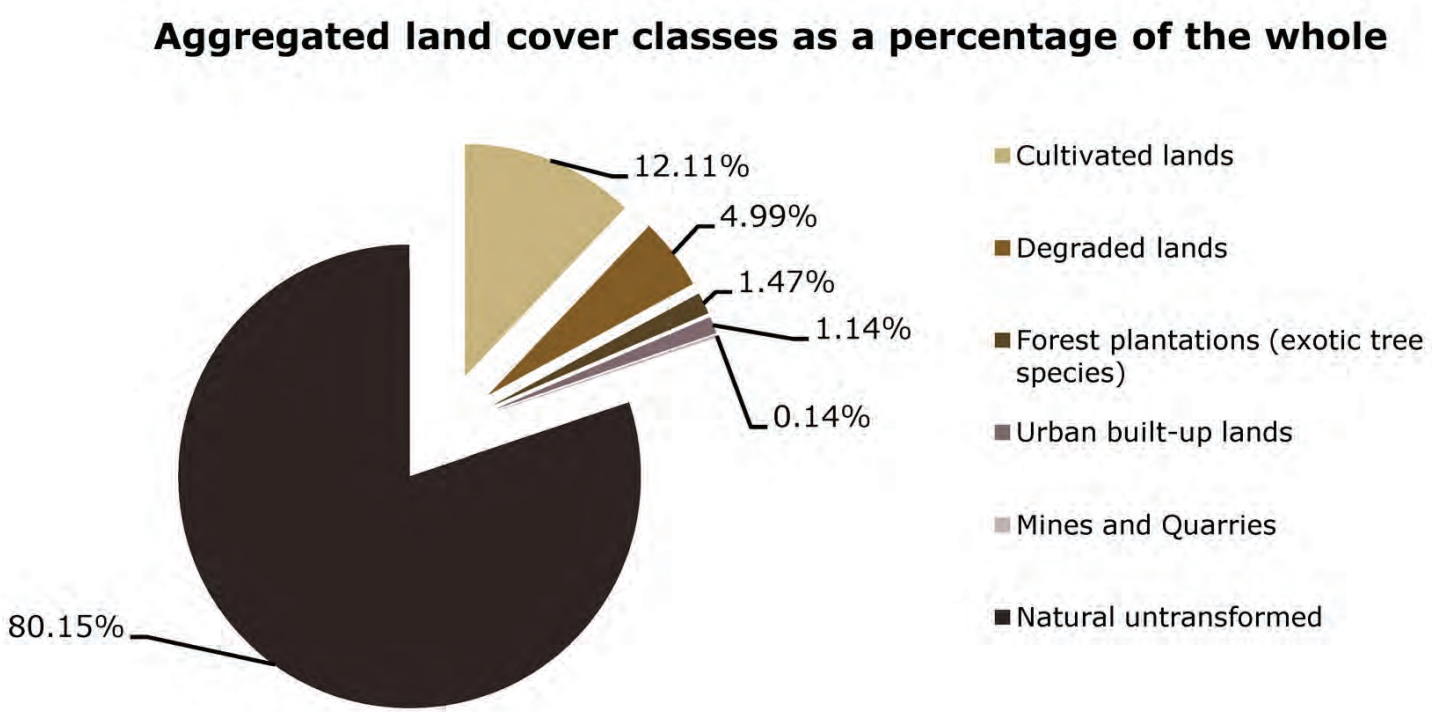


Figure 6: Aggregated land cover classes as a percentage of all land cover classes

Source: Fairbanks, D.H.K. Thompson, W.M. Vink, D.E. Newby T.S. van den Berg H.M. and D.A. Everard. 2000. *The South African Land-cover Characteristics database: a synopsis of the landscape.* South African Journal of Science 96, February 2000

Indicator: Marine

Variable: 5

Description: Status of west coast rock lobster

Units: West coast rock lobster landings (Tons).

Source: Department of Environmental Affairs and Tourism (DEAT) 2005, 2006, 2007. *Fishing Industry Handbook, South Africa, Namibia and Mozambique*, 33rd, 35th and 36th edition.

Griffiths, C.L., van Sittert, L., Best, P.B., Brown, A.C., Clark, B.M., Cook, P.A., Crawford, R.J.M., David, J.H.M, Davies, B.R., Griffiths, M.H., Hutchings, K., Jerardino, A., Kruger, N., Lamberth, S., Leslie, R., Melville-Smith, R., Tarr, R., and van der Lingen, C.D. (2004). *Impacts of Human Activities on Marine Animal Life in the Benguela: a historical overview*. Oceanography and Marine Biology: An Annual Review 42, 303–392.

Tarr, R.J.P., Williams, P.V.G., and MacKenzie, A.J. 1996. *Abalone, sea urchins and rock lobsters: a possible ecological shift may affect traditional fisheries*. South African Journal of Marine Science 17, 319–323.

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

Logic: The west coast rock lobster fishery is one of the oldest fisheries in South Africa. Commercial, subsistence and recreational fisheries all target the rock lobster.

Discussion: The annual rock lobster fishery has been on the decline since the 1960's. During the 1990's a decrease in growth rate and insufficient numbers of juveniles in the population to sustain a healthy fishery further reduced the rock lobster landings to about 50% that of the 1980's. The harvestable biomass is currently estimated at 5% of pre-exploitation levels and the spawning biomass approximately 20% of pristine levels. Despite depletion in the west coast the population has now stabilized. There has however been an increase in rock lobster abundance on the south coast, an area not traditionally considered viable for rock lobster fishing.

Limitations: Information for 1890 to 2000 were obtained form a study conducted by Griffiths *et al.* 2004, whereas information on landings for 2004-2006 were obtained from the Department of Environmental Affairs and Tourism (DEAT) 2005, 2006, 2007. Fishing Industry Handbook, South Africa, Namibia and Mozambique, 33rd, 35th and 36th edition. A direct comparison between the data for these two groupings of years is thus not possible. No information could be obtained for landings during 2001–2004.

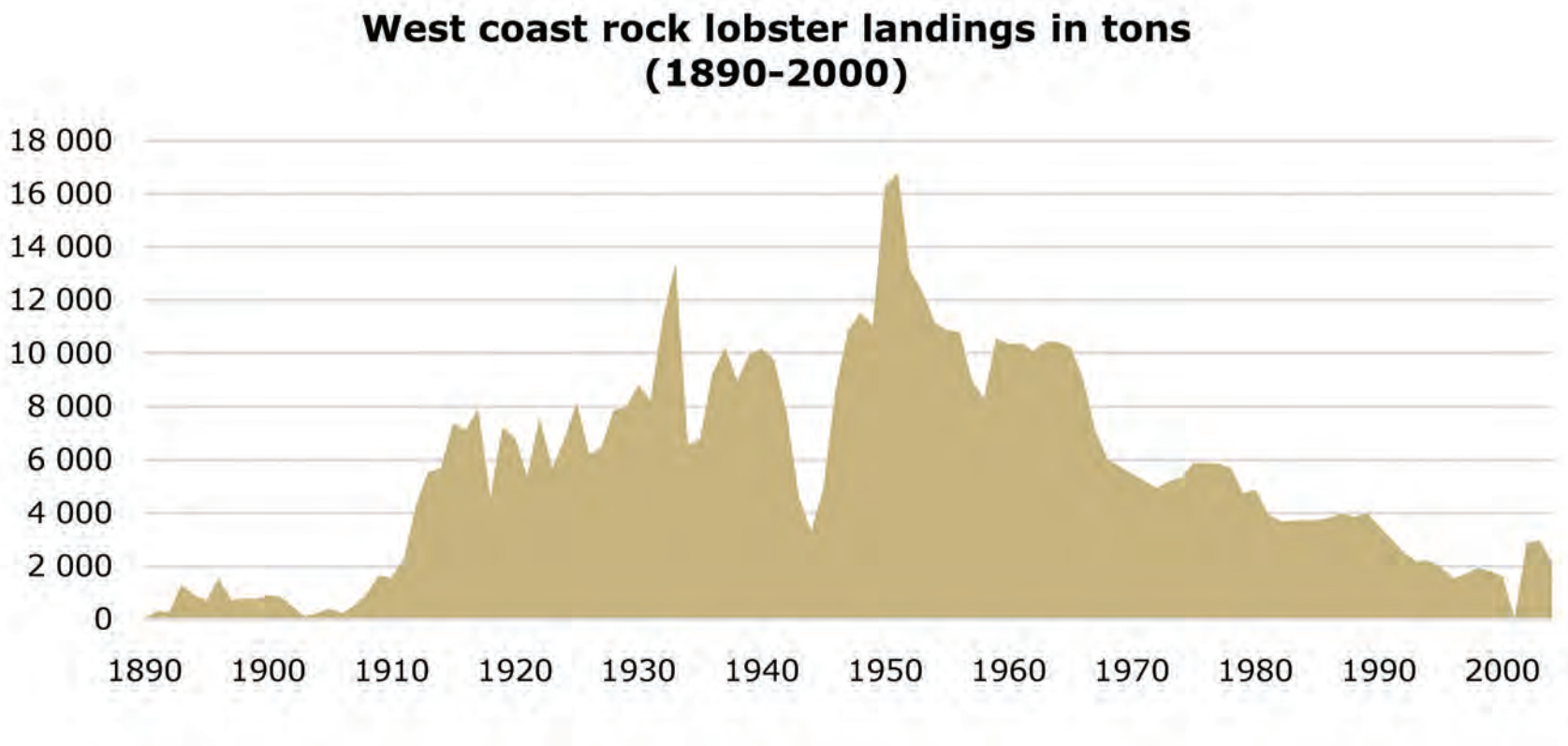


Figure 7: Annual commercial landings of west coast rock lobster (1890–2000)

Source: Griffiths, C.L., van Sittert, L., Best, P.B., Brown, A.C., Clark, B.M., Cook, P.A., Crawford, R.J.M., David, J.H.M, Davies, B.R., Griffiths, M.H., Hutchings, K., Jerardino, A., Kruger, N., Lamberth, S., Leslie, R., Melville-Smith, R., Tarr, R., and van der Lingen, C.D. 2004. Impacts of Human Activities on Marine Animal Life in the Benguela: a historical overview. *Oceanography and Marine Biology: An Annual Review* 42**,** 303–392

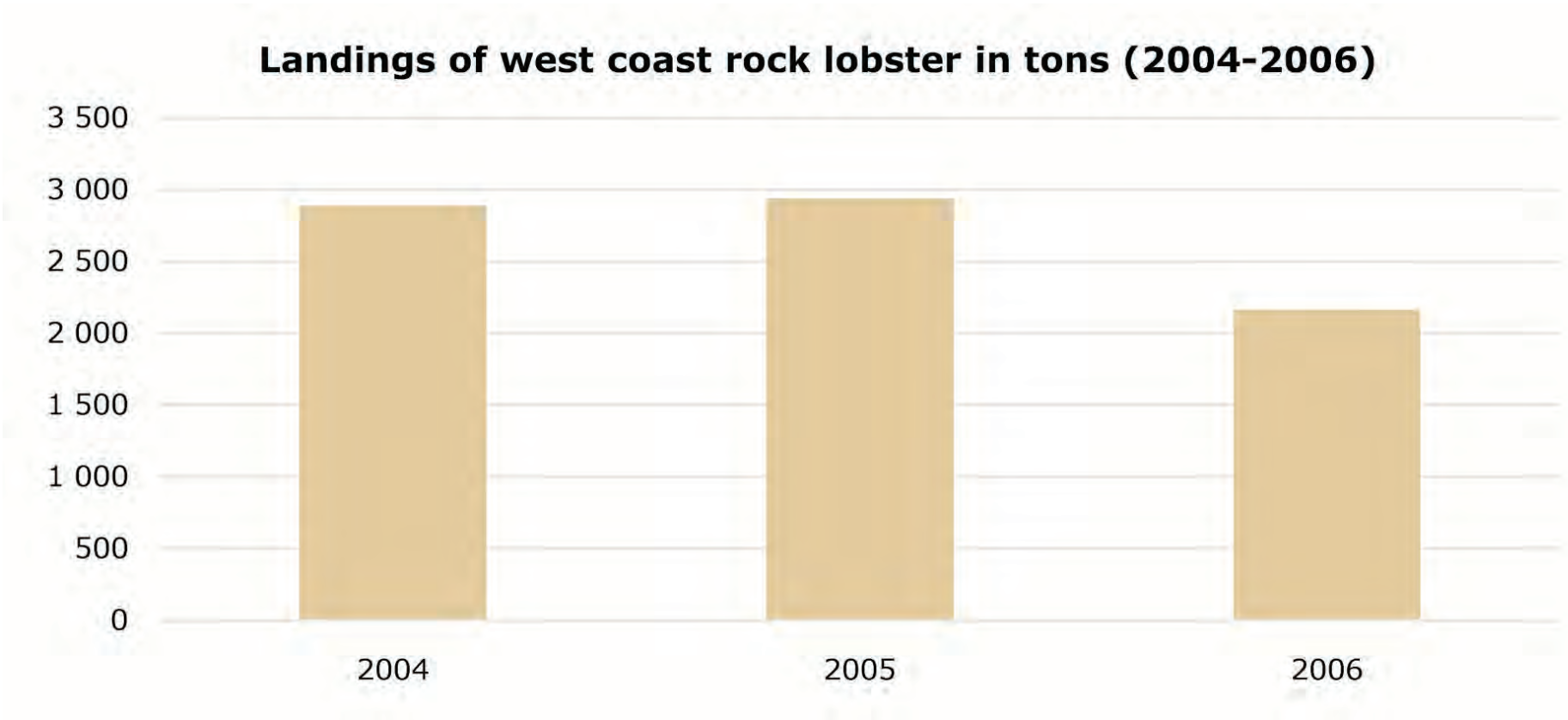


Figure 8: Annual commercial landings of west coast rock lobster (2004–2006)
Source: Department of Environmental Affairs and Tourism (DEAT) 2005, 2006, 2007.
Fishing Industry Handbook, South Africa, Namibia and Mozambique, 33rd, 35th and 36th edition

Indicator: Marine

Variable: 6

Description: Catches of selected marine species (harvesting)

Units: Kilograms per nominal mass harvested.

Source: Department of Environmental Affairs and Tourism (DEAT) 2005, 2006, 2007. *Fishing Industry Handbook, South Africa, Namibia and Mozambique*, 33rd, 35th and 36th edition.

Logic: South Africa is a country rich with marine biodiversity. Although South Africa only covers 2% of the global area it is estimated that a total of 15% of the global marine species occur in its waters.

Discussion: The marine environment contributes considerably to the South African economy. Various factors threaten the biodiversity of the marine component. Some of these factors include: climate change, pollution, invasive alien species and exploitation, to name a few. This variable attempts to investigate the total mass landed during harvesting since 2001 with the main focus on trawl catches (inshore and offshore) as well as pelagic catches and seaweed collection.

The amount of nominal tons caught during deep-sea trawl far surpasses the amount caught during inshore trawling. During 2001 to 2007 the amount of inshore trawl remained fairly constant when compared to the fluctuations in the amount landed during deep-sea trawling.

Notes: The data represented in this indicator only takes into account legal harvesting of marine species. It should be kept in mind that illegal harvesting impact heavily on the state of biodiversity as a whole.

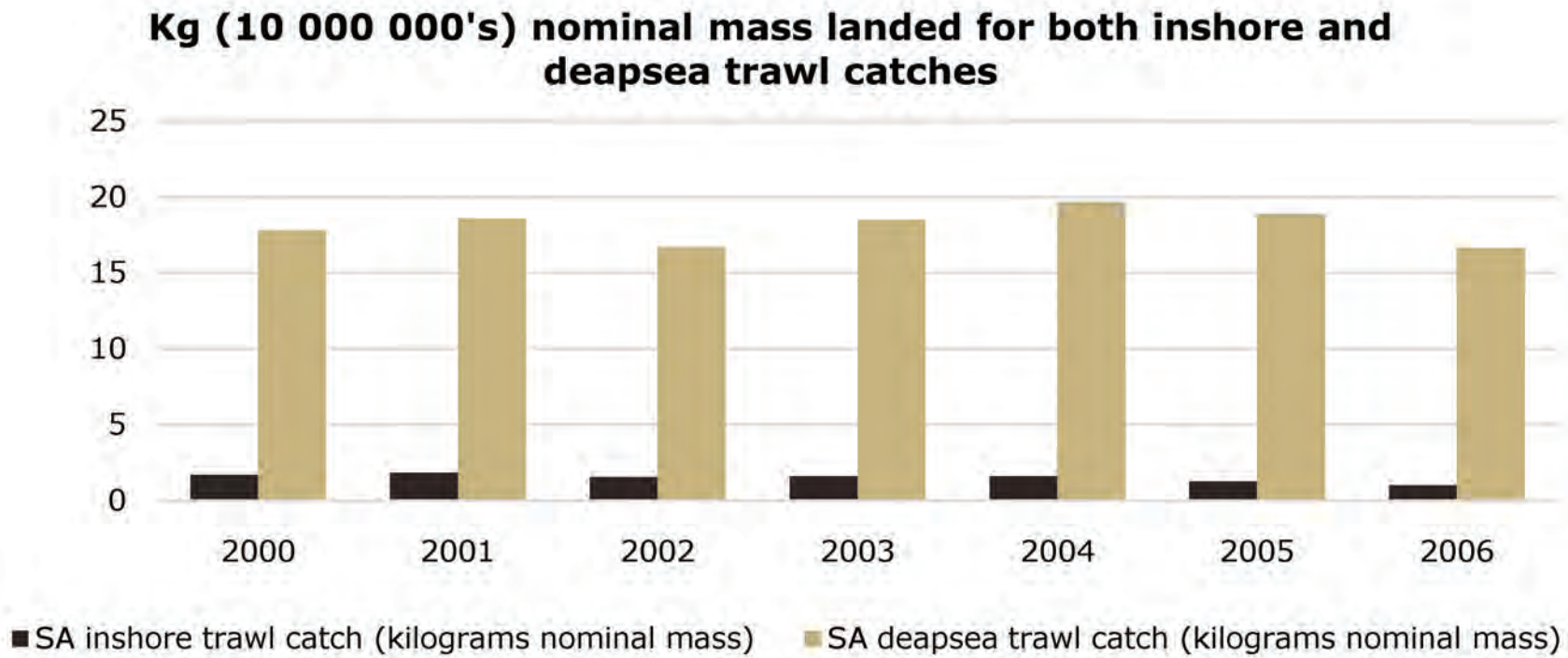


Figure 9: The total amount of nominal mass landed for both inshore and deep-sea trawl catches from 2000 to 2006
Source: Department of Environmental Affairs and Tourism (DEAT) 2005, 2006, 2007.
Fishing Industry Handbook, South Africa, Namibia and Mozambique, 33rd, 35th and 36th edition

Table 6: The total kilogram (nominal mass) of South African pelagic catches and seaweed collection

SA Pelagic catches

	2001	2002	2003	2004
Directed Sardine	172 635	244 743	274 148	365 792
Anchovy	287 512	213 446	25 877	190 093
Bycatch Sardine	18 896	16 141	15 847	8 035
Horse mackarel	916	8 149	1 012	2 048
Round Herring	55 331	54 798	42 529	47 234
Club mackerel	122	82	250	480
Lantern fish	80	23	69	471

SA Seaweed collection

	2001	2002	2003	2004
Kelp Beach Cast	845 233	745 773	1 102 384	1 874 654
Kelp Abalone feed*	5 924 489	5 334 474	5 916 998	4 364 732
Kelpak*	641 375	701 270	957 063	1 168 703
Gelidium	144 997	137 766	113 869	119 143
Gracilari	247 900	65 461	92 215	157 161
* kg/wet others are kg/dry				

Source: Department of Environmental Affairs and Tourism (DEAT) 2005, 2006, 2007. *Fishing Industry Handbook, South Africa, Namibia and Mozambique*, 33rd, 35th and 36th edition

Indicator: Marine

Variable: 7

Description: Marine protected areas (MPAs)

Units: Levels of vulnerability and protection of marine areas.

Source: Driver, A., Maze, K., Rouget, M., Lombard, A. T., Nel, J., Turpie, J.K., Cowling, R.M., Desmet, P., Goodman, P., Harris, J., Jonas, Z., Reyers, B., Sink, K. and Strauss, T. 2005. *National spatial biodiversity conservation in South Africa (NSBA)*, Strelitzia 17. South African National Biodiversity Institute (SANBI), Pretoria.

Logic: The number of marine protected areas represents an investment by the country in marine and biodiversity conservation.

Discussion: Marine protected areas are the marine equivalents of national parks and combines conservation with the development of tourism.

A total of 34 biozones (broad marine ecosystems) have been mapped. These marine ecosystems are under threat from various different sources such as the extraction of living marine resources, pollution and mining. The NSBA has shown that 65% of South Africa's biozones are classified as threatened, of which 12% are critically endangered, 15% endangered and 38% vulnerable. The NSBA's spatial evaluation has further shown that while 23% of the coastline is protected by MPA's only 9% is classified as a no-take zone. These MPA's are not distributed evenly along the coast and subsequently does not represent the full extent of South Africa's marine biodiversity. An example of this fact is that the Namaqua bioregion (west coast) has no registered MPA's while more than 20% of the Delagoa bioregion (on the Mozambique border) is protected. The protection status of the marine biozones in the NSBA shows that 23 of the 34 listed biozones are afforded very little or no protection.

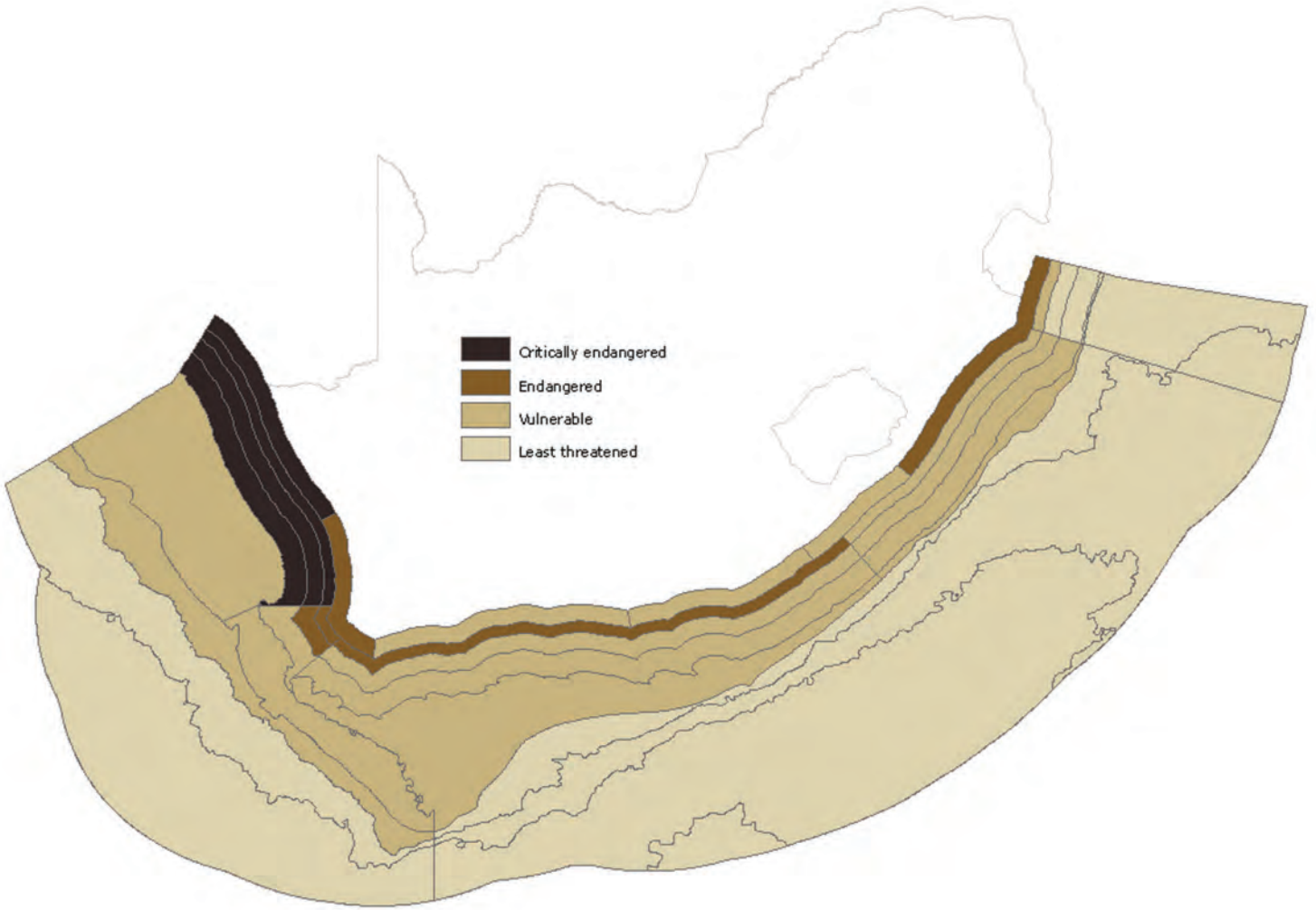


Figure 10: The current threat status of biozones in South African waters

Source: Driver, A., Maze, K., Rouget, M., Lombard, A. T., Nel, J., Turpie, J.K., Cowling, R.M., Desmet, P., Goodman, P., Harris, J., Jonas, Z., Reyers, B., Sink, K. and Strauss, T. 2005. *National spatial biodiversity conservation in South Africa (NSBA)*, Strelitzia 17. South African National Biodiversity Institute (SANBI), Pretoria

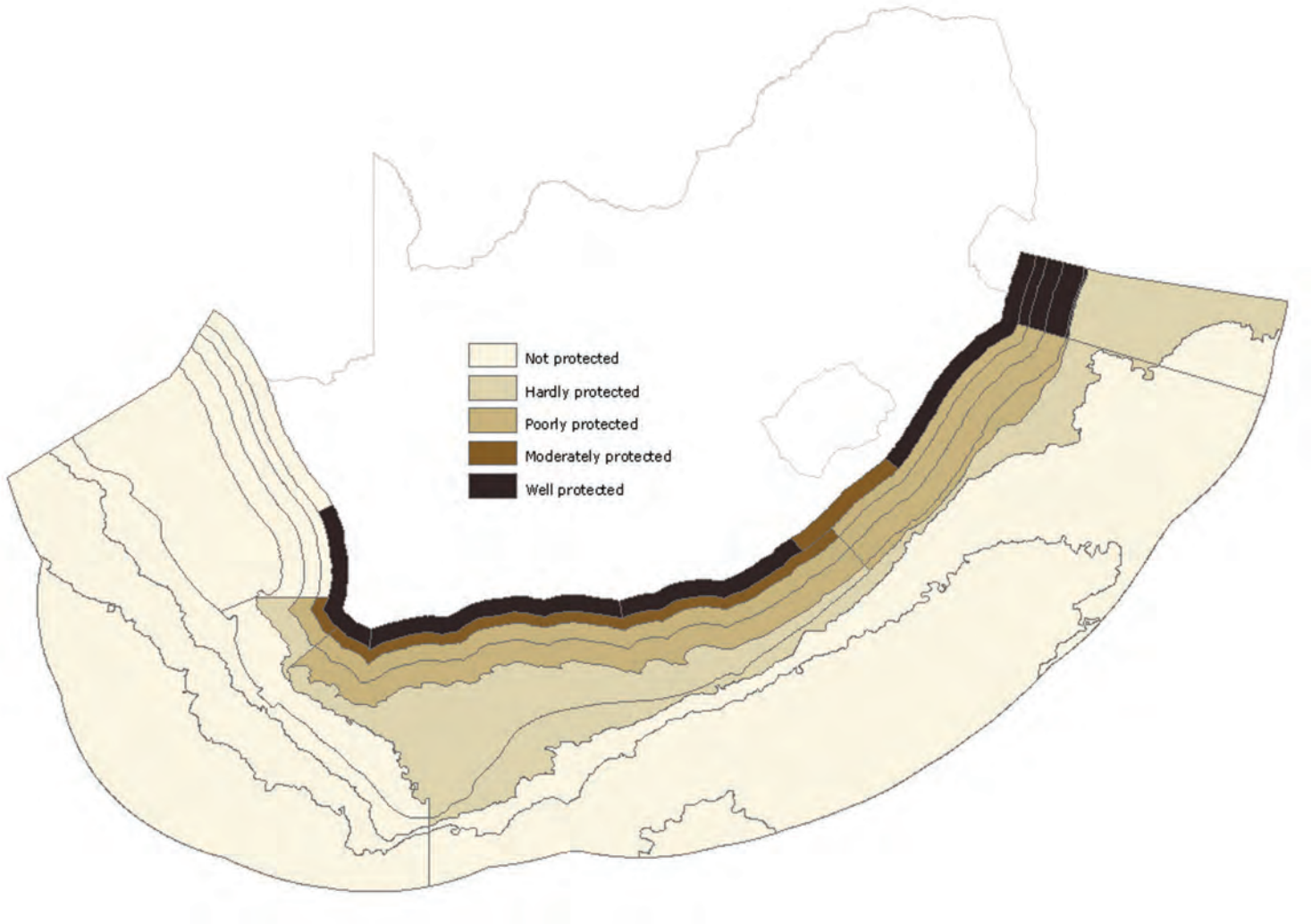


Figure 11: The current protection status of biozones in South African waters

Source: Driver, A., Maze, K., Rouget, M., Lombard, A. T., Nel, J., Turpie, J.K., Cowling, R.M., Desmet, P., Goodman, P., Harris, J., Jonas, Z., Reyers, B., Sink, K. and Strauss, T. 2005. *National spatial biodiversity conservation in South Africa (NSBA)*, Strelitzia 17. South African National Biodiversity Institute (SANBI), Pretoria

Indicator: Freshwater

Variable: 8

Description: Available water per capita

Units: Availability of water in m^3 per capita.

Source: Food and Agricultural organization of the United Nations: AQUASTAT available at: http://www.fao.org/nr/water/aquastat/water_res/index.stm.

United Nations (UN) 2002: *World Population Prospects: The 2002 Revision and World Urbanization Prospects:* The 2001 Revision. United Nations Population Division, New York. http://esa.un.org/unpp

Scholes, R.J. and Biggs, R. 2004. Ecosystem services in South Africa: A regional assessment. Millennium Ecosystem Assessment. Council for Scientific and Industrial Research, Pretoria.

Biggs, R. Bohensky, E. Desanker, P.V. Fabricius, C. Lynam, T. Misselhorn, A.A. Musvoto, C. Mutale, M. Reyers, B. Scholes, R.J. Shikongo, S. and van Jaarsveld, A.S. 2004. *Nature supporting people:* The South African Millennium Ecosystem Assessment – Integrated report. Council for Scientific and Industrial Research, Pretoria.

Logic: The per capita volume of available water resources for a country is an important indicator of environmental services and the ability to support the needs of the population.

Discussion: An average supply of freshwater of acceptable quality is vital to life and is a basic human right. The United Nations has set a target of 1 000 m^3 per person per year to satisfy a country's water needs. South Africa is a water scarce country with an annual precipitation in order of 500 mm per year. This value is low compared to the world average of 860 mm per year[1]; in fact South Africa is ranked as one of the 20 most water scarce countries in the world.

The total water availability is calculated as the sum of all the internal renewable water resources. This includes resources such as freshwater and groundwater. The availability of water in 2001 was estimated at 1 156 m^3/capita/year. This value is marginally higher than the minimum value of 1 000 m^3/capita/year as suggested by the United Nations. The water availability of countries in Southern Africa is provided in table 7.

Limitations: Information contained in this variable was calculated as the total renewable water resources divided by the population number. Estimated water availability for 2030 was calculated using projected population numbers obtained from the United Nations. During the calculation of the estimated water availability for 2030 the only change in calculation was based on the population number. The total water resources amount remained constant from the calculated value in 2001.

Notes: 1. DWAF 2004; National Water Resources Strategy, Pretoria.

This indicator addresses the Johannesburg Plan of Implementation: Section 25.

Table 7: Estimated population and water availability (m^3 /capita) in Southern African countries in 2001 and 2030

Country	Estimated population in 2001 (million)	Water availability in 2001 (m^3/ capita)	Estimated population in 2030 (million)	Water availability in 2030 (m^3/ capita)
Angola	13.5	13 620	28.6	6 436
Botswana	1.7	8 471	1.6	9 219
Burundi	6.9	519	13.7	264
Congo	3.1	268 387	7.6	110 082
Dem. Rep. Congo	52.4	24 508	107.0	11 992
Equatorial Guinea	0.5	55 319	0.9	29 279
Gabon	1.3	130 159	2.0	80 235
Kenya	30.7	982	41.1	734
Lesotho	2.1	1 467	1.6	1 943
Malawi	10.5	1 641	19.8	871
Mozambique	18.1	11 960	26.6	8 118
Namibia	1.8	10 022	2.4	7 419
Rwanda	7.9	656	13.5	387
South Africa	43.2	1 156	42.2	1 186
Swaziland	1.1	4 215	1.0	4 422
Tanzania	34.5	2 642	56.9	1 599
Uganda	22.8	2 896	64.0	1 032
Zambia	10.3	10 233	15.2	6 910
Zimbabwe	12.8	1 560	12.8	1 566

Source: Scholes, R.J. and Biggs, R. 2004. *Ecosystem services in South Africa: A regional assessment.* Millennium Ecosystem Assessment. Council for Scientific and Industrial Research, Pretoria

Biggs, R. Bohensky, E. Desanker, P.V. Fabricius, C. Lynam, T. Misselhorn, A.A. Musvoto, C. Mutale, M. Reyers, B. Scholes, R.J. Shikongo, S. and van Jaarsveld, A.S. 2004. *Nature supporting people:* The South African Millennium Ecosystem Assessment – Integrated report. Council for Scientific and Industrial Research, Pretoria

Indicator: Freshwater

Variable: 9

Description: Capacity and levels of dams in South Africa

Units: The capacity and levels (m^3) of dams in South Africa (2000–2006).

Source: Department of Water Affairs and Forestry (DWAF) 2004. National Water Resources Strategy, 1st Edition.

Department of Water Affairs and Forestry (DWAF): Georequests.

Logic: The per capita volume of available water resources for a country is an important indicator of environmental services and the ability to support the needs of the population.

Discussion: Surface water and groundwater are being degraded in almost all regions of the world by intensive agriculture and rapid urbanization. Despite the fact that people have shown resourcefulness in their utilization of water resources as is evidenced by the dramatic global increases in irrigated agriculture and wide spread dam and reservoir developments; more than 40% of the world's population still live in conditions of water stress. With the current population growth projection, this percentage is estimated to grow to almost 50% by 2025 (World Resources Institute, 2000. www.wri.org).

The average rainfall in South Africa is 450 mm per year. This value is less than half of the world's average rainfall[1], adding up to a potential supply of 1 100 million m^3 pa^2. Inland water resources include:

1. Rivers
2. Dams
3. Lakes
4. Wetlands and aquifers.

Currently there are 19 WMA's in South Africa hosting a total of 320 major dams with a total capacity of 32 400 million m^3.

Limitations: It is important to note that water is continuously shunted from one area to another and even across borders. The values obtained from the DWAF should thus be taken as relative amounts rather than absolute amounts.

Notes: 1. DWAF 2004; National Water Resources Strategy, Pretoria.

2. Scholes, R.J. and Biggs, R. 2004. *Ecosystem services in South Africa: A regional assessment*. Millennium Ecosystem Assessment. Council for Scientific and Industrial Research, Pretoria.

This indicator addresses the Johannesburg Plan of Implementation: Section 25.

Table 8: Average levels of dams in South Africa (2000–2006)

	2000	2001	2002	2003	2004	2005	2006
Level (10^6 m^3)	26 766 44	26 411 33	26 588 88	26 588 88	18 151 80	20 080 80	26 513 58
% Full	89.5	88.4	88.9	88.9	60.4	65.4	85.8

Source: Department of Water Affairs and Forestry (DWAF): Georequests

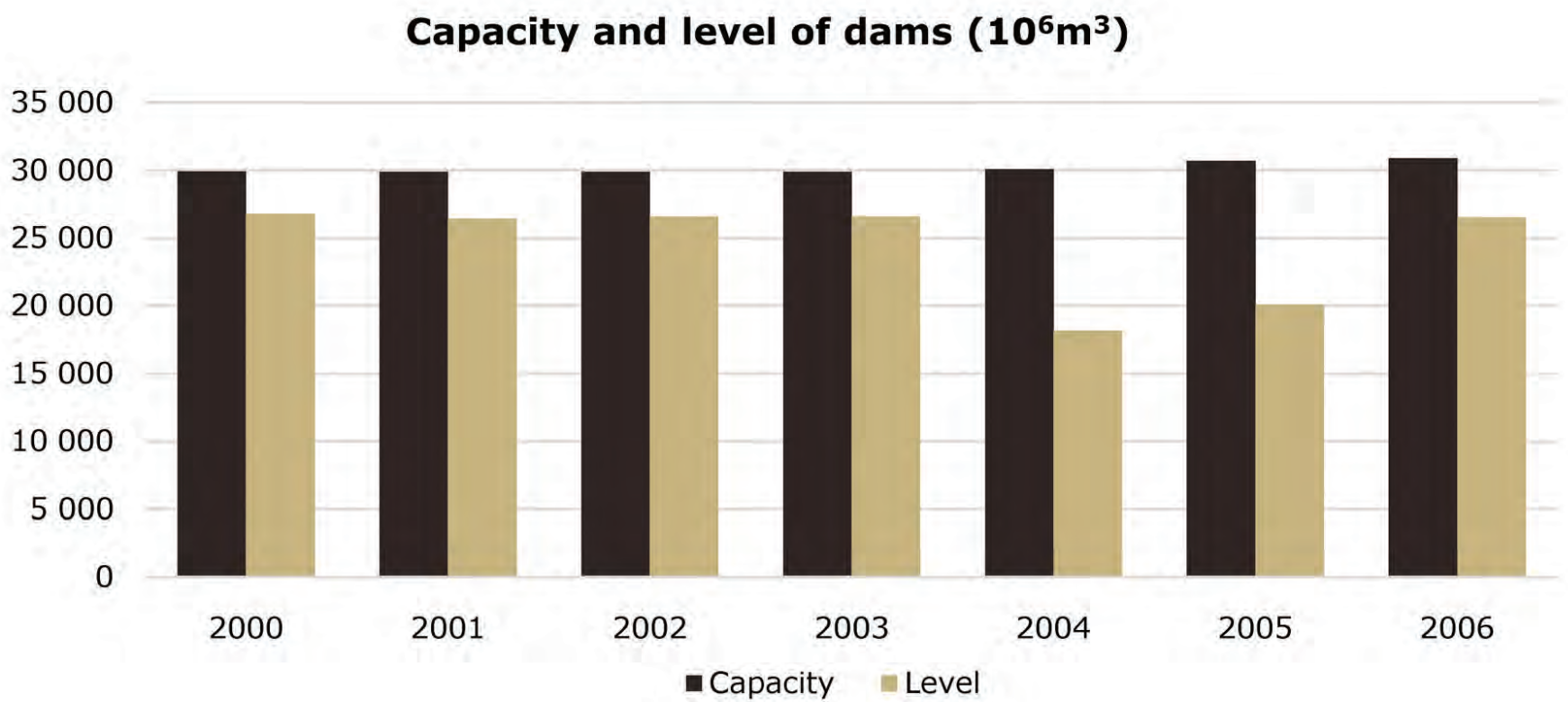


Figure 12: Total capacity and level (10^6 m^3) of dams in South Africa
Source: Department of Water Affairs and Forestry (DWAF): Georequests

Indicator: Freshwater

Variable: 10

Description: Freshwater quality

Units: Water quality is measured in terms of eutrophication with the measured variables being Ortho-phosphate (PO^4 – mg/l), Chlorophill A (μg/l) and total Phosphate (P – mg/l).

Source: Department of Water Affairs and Forestry (DWAF) 2004. *National Water Resources Strategy*, 1st Edition.

Department of Water Affairs and Forestry (DWAF) 1999-2005. National Water Quality Monitoring Data.

Department of Water Affairs and Forestry (DWAF): Georequests.

Logic: The enrichment of surface water with dissolved nutrients has the potential to stimulate primary production and thereby increase the potential for eutrophication which severely affects the functioning of aquatic ecosystems.

Discussion: A manual compiled by the national eutrophic monitoring group has defined eutrophication as the following:

"Eutrophication is the process of excessive nutrient enrichment of waters that typically results in problems associated with marcophyte, algal of cyanobacterial growth."

The trophic status of a water body can be placed in one of the following categories:

- Oligotrophic – low in nutrients and not productive in terms of aquatic animal and plant life.
- Mesotrophic – intermediate levels of nutrients, fairly productive in terms of aquatic animal and plant life, showing emerging signs of water quality problems.
- Eutrophic – Rich in nutrients, very productive in terms of aquatic animal and plant life, showing increase signs of water quality problems.
- Hypertrophic – Very high nutrient concentration. Plant growth is determined by physical factors. Water quality problems are serious.

The trophic status of a water body is associated with the phosphorus and chlorophyll A concentration of that water body.

Current trophic status		
Mean annual Chlorophyll A (μg/l)		
	0 < x ≤ 10	Oligotrophic (low)
	10 < x ≤ 20	Mesotrophic (moderate)
	> 30	Hypertrophic
Potential for algal and plant production		
Mean annual Phosphorous (mg/l)		
	x ≤ 0.015	Negligible
	0.015 < x ≤ 0.047	Moderate
	0.048 < x ≤ 0.130	Significant
	> 0.130	Serious

Limitations: Due to a lack in frequency of measurement information for all the water management areas is not available for years 2000 to 2006. Only those water management areas that have large enough sample sizes where included in the analyses.

Notes: 1. DWAF 2004; National Water Resources Strategy, Pretoria.

2. Scholes, R.J. and Biggs, R. 2004. *Ecosystem services in South Africa: A regional assessment.* Millennium Ecosystem Assessment. Council for Scientific and Industrial Research, Pretoria.

This indicator addresses the Johannesburg Plan of Implementation: Section 25.

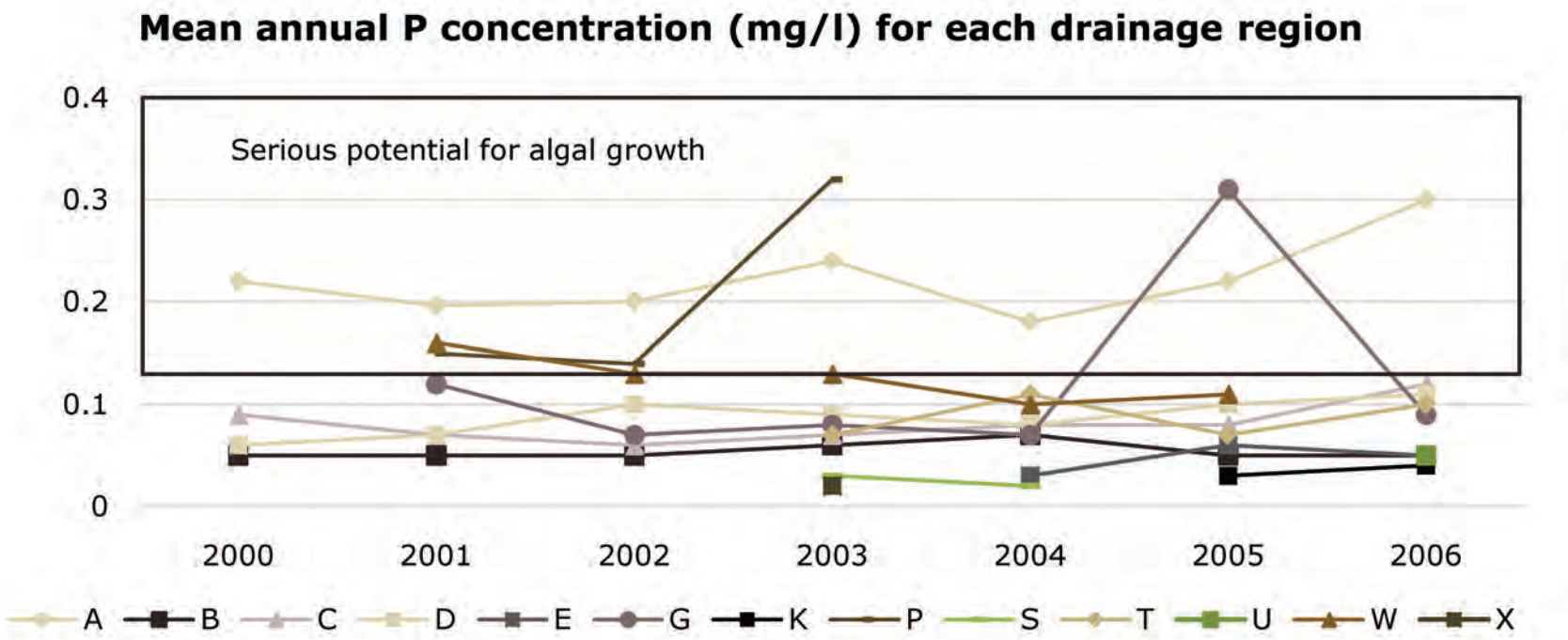


Figure 13: Mean annual phosphorus concentration (mg/l) for each drainage region from 2000 to 2006
Source: Department of Water Affairs and Forestry (DWAF): Georequests

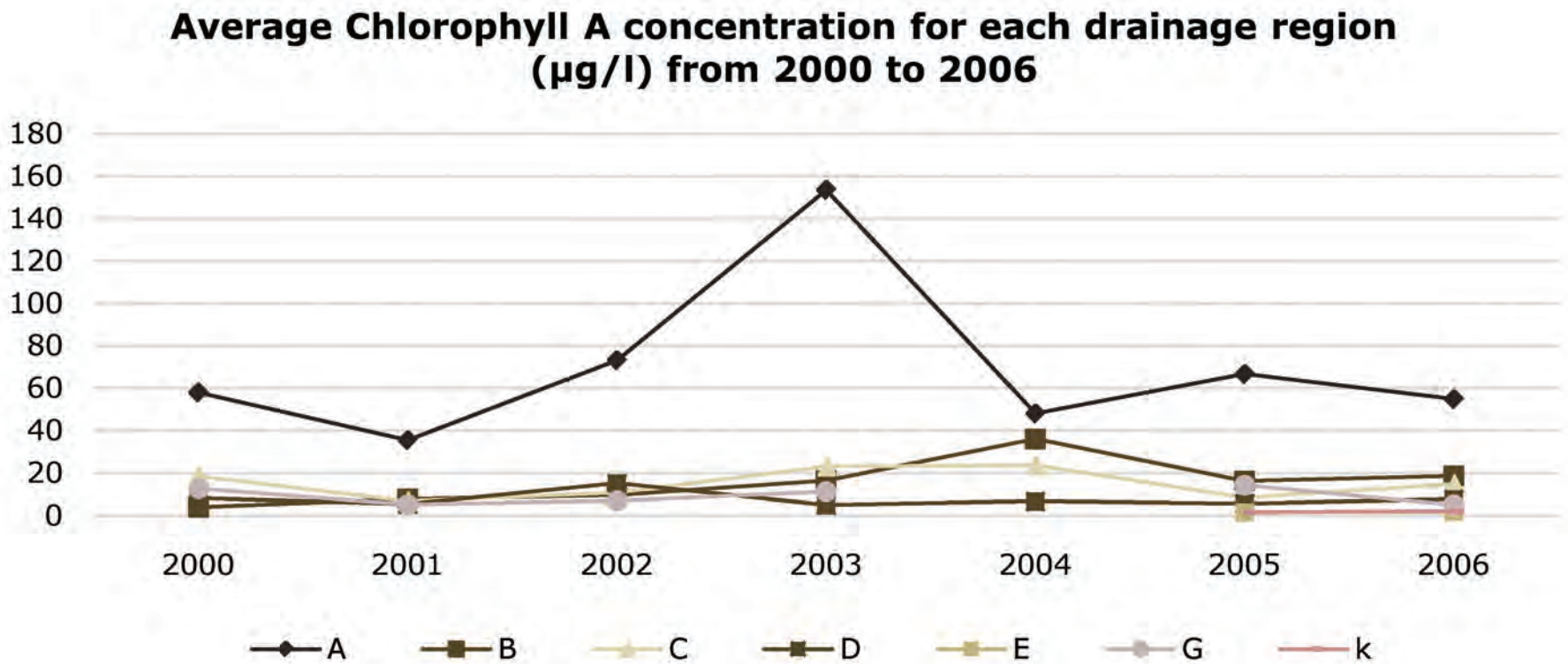


Figure 14: Average Chlorophyll A concentration for each drainage region measured from 2000 to 2006
Source: Department of Water Affairs and Forestry (DWAF): Georequests

Indicator: Groundwater

Variable: 11

Description: Groundwater quantity

Units: Average number of litres per second available from monitoring boreholes.

Source: Department of Water Affairs and Forestry (DWAF): Georequests.

Logic: Groundwater is an important part of the picture of a country's water resources. The more groundwater of good quality available per capita, the higher the probability that a country can sustainably manage its groundwater resources, e.g. for agricultural production.

Discussion: South Africa is a drought prone country with an annual precipitation of about 500 mm. This is very low when compared to the world average of 860 mm. About 21% of the country's surface area receives less than 200 mm precipitation per year. Globally South Africa is ranked among the 20 most water scarce countries in the world. In terms of South Africa's overall water consumption; groundwater contributes some 15% of the total volume consumed. This percentage belies the fact that over 300 towns and 65% of the population are entirely dependent upon this resource for their water supply.

Data on the output of monitoring boreholes in South Africa are available from the Department of Water Affairs and Forestry. These monitoring boreholes are situated all over South Africa. Looking at the changes in borehole levels over a long period may give a good indication of the usage of ground water as well as the replenishing rates of this water resource. In South Africa ground water is used extensively in rural and arid areas. Generally these resources are quite limited due to the fact that a lot of the underlying geology in the country is composed of hard rock. In South Africa there are 6 major aquifers[1], as follows:

1. Dolomites
2. Table Mountain Group Sandstone
3. Coastal sand deposits
4. Basement granites

5. Karoo dolerites

6. Alluvium along perennial rivers.

Available data suggests that there is a total of approximately 235 000 million m^3 per annum stored in the country of which 10 000 million – 16 000 million m^3 is available per annum for use during an average rainfall year and 7 000 million m^3 during drought[2].

A total of 841 monitoring points exist in South Africa where the ground water level is measured in litres per second (l/s). The average l/s measured at all the points from 01/04/2006 to 30/04/2007 equalled 20.8346 l/s. Looking at the average l/s measured at all the points for the last 10 years (1997–2007) the number was slightly higher at 21.1901 l/s.

Limitations: The initial intention of this variable was to calculate the amount of groundwater available in terms of thousand cubic meters per capita. Unfortunately data was not available in this format and thus we opted for the current format.

Notes: 1. Department of Environmental Affairs and Tourism (DEAT) 2006. *South Africa Environment Outlook.* A report on the state of the environment. Department of Environmental Affairs and Tourism, Pretoria.

2. DWAF 2004. *Groundwater Resource Assessment II – Task 1D,* Groundwater Identification, DWAF Pretoria.

Indicator: Groundwater

Variable: 12

Description: Groundwater quality

Units: Total Dissolved Solids (TDS) (mg/l).

Source: Department of Water Affairs and Forestry's (DWAF) Water Management System (WMS).

Department of Water Affairs and Forestry (DWAF). *South African water quality guidelines,* volume 1: Domestic use, 2nd Edition, 1996.

Logic: The more groundwater of good quality available per capita, the higher the probability that a country can sustainably manage its groundwater resources, e.g. for agricultural production. The TDS is a measure of the amount of various inorganic salts dissolved in the water.

Discussion: The electrical conductivity is directly proportional to the TDS, and the TDS can be calculated by using a conversion factor. The conversion factor generally lies between 5.5 and 7.5 and in this particular case 6.5 was used. The TDS is not only a measure of the total amount of inorganic salts dissolved in the water but is also closely related to other water quality constituents such as total hardness and corrosion.

The interpretations of TDS values are varied. Low concentrations of TDS may have a flat insipid taste. The health effects associated with higher TDS value are minimal at a concentration value between (2 000 and 3 000 mg/TDS). In contrast to this higher concentration of TDS (> 3 000 mg/TDS) may have an unpleasant taste and may also negatively affect the kidneys. Results from the nine different provinces show that the general ground water quality of South Africa is in a good state as it only exceeded the 2 000 mg/TDS once during the period of 2000 and 2001 in the Eastern Cape.

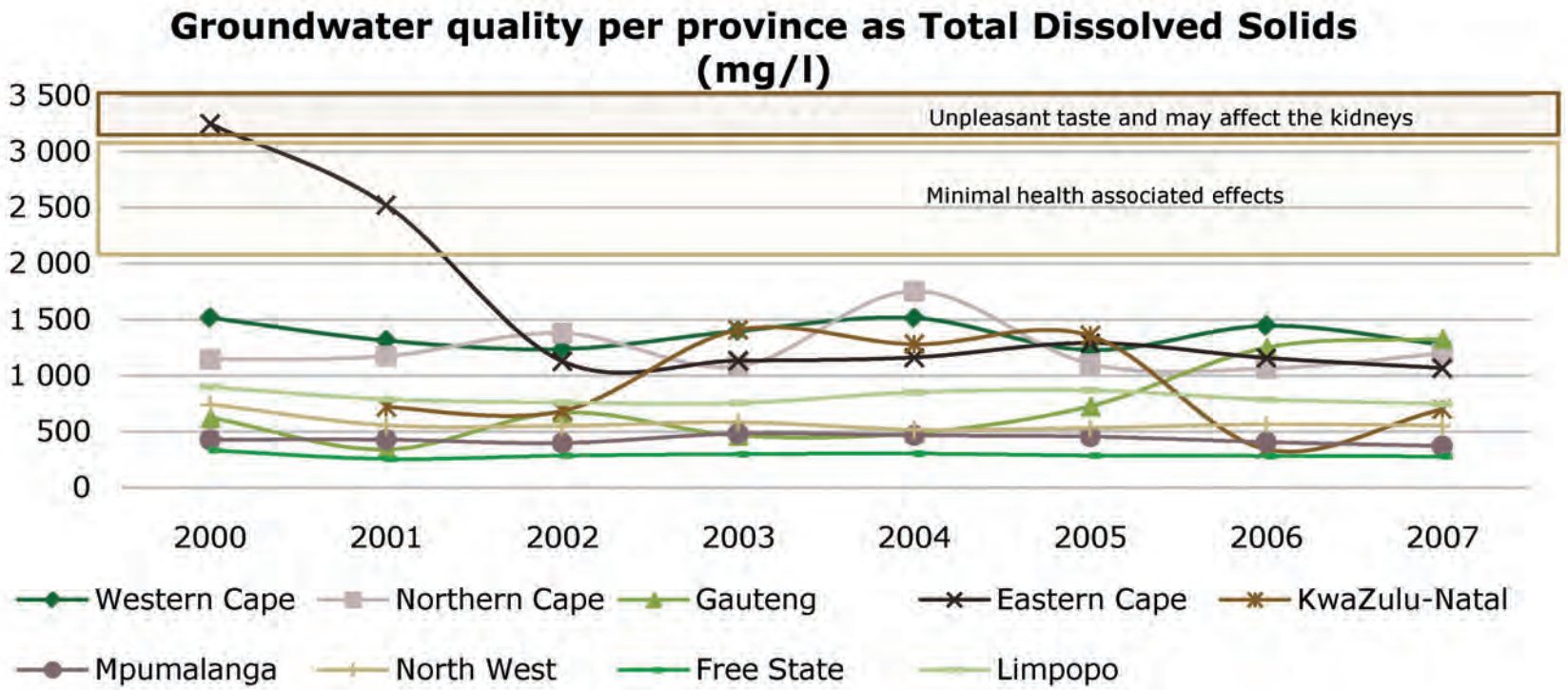


Figure 15: Ground water quality of the nine provinces in South Africa measured from 2000–2007. All values measured in Electrical Conductivity and then calculated in terms of Total Dissolved Solids

Source: Department of Water Affairs and Forestry's (DWAF) Water Management System (WMS)

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