NATIONAL CORE SET OF ENVIRONMENTAL INDICATORS

PHASE 3 : SELECTION OF INDICATORS
LAND USE

PREPARED FOR:

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Phase 3 : Indicator Selection

This specialist report represents the output of Phase 3 of the National Environmental Indicators Programme for State of Environment Reporting in South Africa.

Specialist Report 3, Vol. 1: Inland Water
Specialist Report 3, Vol. 2: Marine, Coastal & Estuarine
Specialist Report 3, Vol. 3: Biodiversity & Natural Heritage
Specialist Report 3, Vol. 4: Land Use
Specialist Report 3, Vol. 5: Human Well-being
Specialist Report 3, Vol. 6: Atmosphere & Climate
Specialist Report 3, Vol. 7: Waste Management
Specialist Report 3, Vol. 8: Integrated & Environmental Management

Cover picture: Gary Marneweck

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BACKGROUND

This report is one in a series of 8 specialist reports produced as part of Phase 3 of the National Environmental Indicators Programme. This Programme was initiated by the South African National Department of Environmental Affairs and Tourism (DEA&T) to develop national environmental indicators for the State of the Environment reporting in South Africa. Environmental indicators are described in Box 1 below.

The specialist reports contain information on the individual indicators selected for use in South Africa.

BOX 1: ENVIRONMENTAL INDICATORS

The term "indicator" stems from the Latin verb "*indicare*" meaning to disclose or point out. Indicators provide a means of communicating information about progress towards sustainable development in a significant and simplified manner. They focus and condense information about complex issues for management, monitoring and reporting, principally for decision-making. An indicator will provide a signal to an issue of greater importance or make more evident a trend or phenomenon that is not immediately detectable. In this regard an indicator's relevance extends beyond what is actually being reflected to a larger issue of interest.

An indicator set assists in understanding the current state of an environmental system and trends in that system. However, like any form of information, there are limitations to their use. The acceptability of any indicator depends on the availability and confidence of the data, as well as the interpretation of the indicator. Interpretation is particularly important, as indicators tend to provide the essence of a situation rather than the whole picture. The establishment of thresholds can assist in interpretation, but only in cases where scientifically valid or legal thresholds exist.

The indicators presented here are grouped in the DPSIR framework. The definitions relating to the individual components of this framework are outlined in Box 2 below.

BOX 2: DPSIR DEFINITIONS

Driving forces are the human influences and activities that, when combined with environmental conditions, underpin environmental change. Indicators for driving forces describe the social, demographic and economic developments in societies and the corresponding changes in lifestyles, overall levels of consumption and production patterns.
Pressures are exerted on resources and ecosystems as a result of human activities (i.e. driving forces), and include consumption and waste generation patterns and trends.
State refers to the condition of the environment resulting from pressures (e.g. level of air pollution, land degradation or deforestation).
Impacts are the results of pressures on the current state of the environment, which occur in a certain sequence. For instance, air pollution may cause global warming (primary effect), which may in turn cause an increase in temperature (secondary effect), which may provoke a rise of sea level (tertiary impact), which could result in a loss of biodiversity and thus impact on human health and well-being.
Responses are the societal actions taken collectively or individually to ease or prevent negative environmental impacts, correct environmental damage or conserve natural resources. Responses may include regulatory action, environmental or research expenditure, public opinion and consumer preferences, changes in management strategy, and provision of environmental information.

INTRODUCTION

South Africa has a diversity and richness of natural resources, including plant and animal resources that rank amongst the most diverse in the world. This diversity is under pressure from a growing population and increasing consumption rates that result in rapid conversion of natural habitat to agriculture, forestry, mining activities and human settlements (Ballance, 2001). Some plant and animal species are threatened with extinction due to excessive harvesting for medicinal, ornamental, and horticultural purposes. Invasion and domination by alien species of plants and animals is a major problem in South Africa. Alien organisms out-compete indigenous species by using more resources (space, light, water, food) leading to a reduction (sometimes even local extinction) of indigenous populations, and alteration of the physical components of the ecosystems (Ballance, 2001). Degradation of vegetation and soils is also a widespread problem in South Africa. This has largely been a result of the apartheid political system, where large numbers of black people were denied access to prime agricultural land, and were forced into small areas of marginal land, whilst commercial white farmers were given subsidies for agro-chemicals and monoculture was encouraged. These driving forces were exacerbated by the rapid population growth over the last 30 years, and the drive for increasing agricultural exports (Ballance, 2001).

Degradation and loss of species, habitats and ecological functions not only threatens the long term sustainability of natural systems, but also the capacity of all terrestrial systems to support human livelihoods and lifestyles (Ballance, 2001).

The major land uses in South Africa are agriculture, commercial forestry and mining. Most of the land area (86%) of South Africa is used for crop cultivation or grazing of livestock, while less than 10% of the area is conserved (DEA&T, 1999).

Agriculture is a generator of wealth and constitutes one of the key industries in the country's economy (NDA, 2000). Agriculture contributed 3.2% to the gross domestic product of South Africa in the year 2000. The agricultural sector is also an important earner of foreign exchange. In 2000, agricultural exports resulted in foreign exchange to the value of R14 573 million (NDA, 2000).

It is estimated that six million South Africans are dependent on agriculture for a livelihood, with primary agriculture offering the largest employment opportunities in the country.

Commercial forestry is also an important land use in South Africa. South Africa produced 15.6 million cubic metres of roundwood during 1998/1999 from 1.4 million hectares of plantation forests (FOA, 2001). The forest products industry contributed 9.2% to the gross value of manufacturing output for South Africa in 1998/1999 and the export value of the industry is approximately R6.7 billion (FOA, 2001).

Terrestrial mining in South Africa contributes some 16% towards the country’s gross domestic product through sales of minerals and mineral products. Total mineral sales for 1999 amounted to R94.7 billion, of which 77.3% were from export revenues and the remainder from gold. The South African mining sector employed 466 144 people in 1998. These people were employed on 703 mines to produce 53 different minerals. The

mining industry, together with those industries that supply goods and services to it, collectively support more than 10 million people (CSIR, 2001).

It is clear that South Africa is dependent on its terrestrial resources to sustain its population and to contribute to the country's economic growth. South Africa's terrestrial systems are, however, fragile and must be managed carefully. Over 90% of the country falls within the United Nations definition of "affected drylands", which are extraordinarily dry areas where rainfall is low, and potential evaporation is high (UNCCD, 1994). It is therefore essential that a set of relevant indicators that address the most important land issues be developed to ensure that South Africa's land resources are managed in a sustainable manner. The issues that are addressed in this theme are land use and land condition.

DESCRIPTION OF ISSUES

Land Use

Decades of inequitable land and development policies have shaped current land use patterns in South Africa and have resulted in severe land degradation. As a result of these policies, large numbers of people were forced into subsistence lifestyles and many of these people are still highly dependent on natural resources to meet their nutritional, medicinal, housing and energy needs (Ballance, 2001). The indicators that have been selected for this issue aim to address concerns around land use in South Africa. These indicators examine current land usage patterns and land productivity in South Africa.

Land Condition

South Africa is a semi-arid country where drought and desertification are real threats to food security (Ballance, 2001). Due to the fragility of South Africa's terrestrial systems, they must be managed carefully. The consequences of land degradation include declining productivity and diversity of resources to support human livelihoods and commercial activities, as well as reduced biodiversity and loss of ecosystem services such as water and air quality regulation. Degraded systems are also less able to cope with change. Global climate change in South Africa is likely to increase temperatures and variability of rainfall, leading to an expansion of the more arid vegetation types, and less suitability for dryland cropping. This scenario may result in South Africa becoming more dependent on imports for food security (Ballance, 2001).

The indicators addressed in this theme focus on the important issues relating to the condition of South Africa's terrestrial resources.

The Land Use study originally included issues related to Human Settlements and Waste Management. During the selection of indicators it became apparent that these two issues were worthy of complete studies on their own. It was therefore decided that these two issues be developed into full specialist studies, each with their own specialist report and set of indicators. These studies are now known as the Human Well-being study (Specialist report 3, Vol. 5) and the Waste Management study (Specialist report 3, Vol. 7).

See Appendix 1 for Issues Diagrams based on the DPSIR framework.

SUMMARY TABLE OF INDICATORS

Issue	Indicator	Number	Type	Level	Frequency
Land use	Land cover	LU01	S	2	5 yearly
	Land productivity versus potential	LU02	S	3	5 yearly
Land condition	Desertification	LU03	S	1	5 yearly
	Soil loss	LU04	S	1	Annual
	Soil acidification	LU05	I	3	5 yearly
	Soil salinisation	LU06	I	3	5 yearly
	Land degradation	LU07	P	3	5 yearly
	Persistent organic pollutants	LU08	P	3	Annual
Dormant Indicators	Wasted and degraded land in mining zones		S	2	5 yearly
	Quality of mining operations		R	1	Annual
	Enforcement of the Conservation of Agricultural Resources Act (Act 43 of 1989)		R	1	Annual
	Permanent loss of agriculturally productive land		S	3	5 yearly
	Land degradation per GDP in the agricultural sector		P	1	Annual
	Wasted and degraded land in mining zones per GDP in the mining sector		S	2	Annual

Type: refers to the position of the indicator in the DPSIR framework. D: Driving Force, P: Pressure, S: State, I: Impact, R: Response. Level: refers to the availability of data. Level 1: adequate data available, Level 2: inadequate data available, Level 3: no data available. Frequency: refers to the desired frequency of reporting rather than the frequency of monitoring or measurement.

FACT SHEET DEFINITIONS

The fact sheets contain certain terminology, which requires clarification. The definitions for this terminology are provided below:

Indicator Levels
Level 1: adequate data are available now for all components of the indicator and can be used to support the indicator without significant additional costs.
Level 2: the indicator is presently feasible, but cannot be provided without additional investment in the data collection process.
Level 3: no data currently exist for the indicator, and there is no immediate intention to collect the data.

Selection Criteria

1. The indicator must be based on good quality data that are available at a reasonable cost.
2. The indicator should provide information that measures something that is important to decision makers.
3. The information can be presented in a way that is easily understood and appealing to the target audience.
4. The indicator must relate to goals, targets or objectives.
5. The indicator must provide timely information (to allow for response).
6. The indicator must be able to detect small changes in the system.
7. The indicator must be relevant to policy and management needs within the South African context. The indicator must therefore be associated with one or several environmental policy issues.
8. The indicator must be based on data that are accurate, reliable, statistically sound and scientifically valid. Metadata should define the quality of the data in the data set and include information on sensitivity, uncertainty, variability, precision, accuracy and error.
9. The data must be available and accessible, particularly in the long term.
10. The indicator must be based on data of the correct spatial and temporal extent. Sufficient historical data must be available to identify trends over time.
11. The data collection process should have minimal environmental impact.

FACT SHEETS

INDICATOR THEME	Land Use
INDICATOR ISSUE	Land use
INDICATOR NAME	**LU01** Land cover

Type: Driving Force / Pressure / **State** / Impact / Response

Linkages: This indicator can be linked to the Biodiversity & Natural Heritage theme and the Waste Management theme. It can also be linked to the Convention to Combat Desertification.

Indicator Level

Level 1	**Level 2 X**	Level 3

Selection Criteria met by the Indicator

	1	2	3	4	5	6	7	8	9	10	11
Criteria met fully		**X**	**X**				**X**	**X**	**X**	**X**	**X**
Criteria met partially	**X**			**X**	**X**						
Criteria not met						**X**					

Description of the Indicator

This indicator will track changes in land cover by type of land cover class (the proportion of each region covered by forests, wood shrubs and grasses compared with a baseline figure). This indicator will update the change in structural vegetation forms within land cover regions.

Units Percentage
Spatial scale National
Frequency 5 Yearly
Confidence High

Reason for Selecting the Indicator

Changes in vegetation structural form over time will affect carbon and nitrogen cycling, litter and organic matter build-up and loss from soils, wetting and drying of soil and hydrological regimes, as well as relationships between decomposers and consumers.

Data Sources

- **Data acquisition:** Spatial data can be obtained from the National Land Cover (NLC) Database – compiled by the ARC, CSIR, DEA&T, DWAF, NDA and SANDF. The land cover of South Africa, in 27 classes, has been mapped at 1:250 000 scale using 1996 Satellite imagery (Scholes *et al.*, 2001). The data are held by a consortium consisting of the CSIR (Environmentek), ARC (Institute of Soil, Climate and Water) and the SA National Defence Force. For the next year the data can be purchased from the consortium, after which they will become public domain. A 1:1M scale product is already in the public domain.

The intention is to repeat this exercise approximately once every five years, although the responsibility and funding arrangements have not been established. The land-cover classes mapped within the NLC are based exclusively on those defined within the '*Standard Land-Cover Classification for Remote Sensing Applications in South Africa'* (Thompson, 1996).

The Department of Land Affairs (Directorate of Survey) commissions aerial photograph coverage of South Africa on a rolling ten-year basis (Scholes *et al.* 2001). Several private aerial survey companies maintain large archives of aerial photographs. The CSIR (Satellite Applications Centre, Hartebeeshoek) has the ability to download data from all the major current environmental satellites (the Meteosat, Landsat, NOAA and SPOT series), for all of southern Africa, and has extensive archives of NOAA and Landsat data since the 1970s. The Institute of Soil, Climate and Water has daily NOAA AVHRR coverage of South Africa for the past decade and these data are used to develop 10-daily vegetation greenness (NDVI) maps, which form part of the drought management system (Scholes *et al.* 2001). Land Cover data are available free of charge from the CSIR Satellite Applications Centre (R750 handling fee). Details of the methodology of data acquisition can be found in Thompson, 1999 and can be found at http://www.sac.co.za/geoinfo/nlc_report.htm.

- **Limitations:** Some of these data, particularly the historic data, are not available in electronic format. Most of the recent data are available electronically, and can be used in conjunction with the historic data. Land cover data are in a GIS format but do not show any changes that have occurred due to a lack of historical data.

Example

This indicator can be represented in the form of a map e.g. a map of South Africa indicating percentage of land cover per type of land cover class.

Needs

Land cover data may not be collected every 5 years, but it is recommended for SOE Reporting that these data be regularly updated to track land cover change. Recommendations have been made that the NLC exercise be repeated to detect any change in the data since 1996.

Reference List

Scholes, M.J., van der Merwe, M.R., and van Tienhoven, A.M., 2001. Environmental Information Systems in Southern Africa. A survey conducted on behalf of the Global Terrestrial Observing System. CSIR Environmentek, Pretoria

Thompson, M.W., 1996. A standard land-cover classification scheme for remote sensing applications in South Africa. SA Jnl of Science, Vol 92, January 1996, pp 34-42. United Nations Convention to Combat Desertification, 1994.

Thompson, M.W., 1999. South African national land-cover database project data users manual final report (phase1, 2 and 3). CSIR Division of Water, Environment and Forestry Technology. Report Number ENV/P/C 98136 version 3.1. February 1999.

INDICATOR THEME	Land Use
INDICATOR ISSUE	Land use
INDICATOR NAME	**LU02** Land productivity vs. potential

Type: Driving Force / Pressure / **State** / Impact / Response

Linkages: This indicator can be linked to the Biodiversity & Natural Heritage theme. It can also be linked to the Convention to Combat Desertification.

Indicator Level

Level 1	Level 2	**Level 3 X**

Selection Criteria met by the Indicator

	1	2	3	4	5	6	7	8	9	10	11
Criteria met fully			**X**		**X**	**X**	**X**				
Criteria met partially	**X**	**X**		**X**				**X**	**X**	**X**	**X**
Criteria not met											

Description of the Indicator

This indicator will report on the actual productivity of land compared with the calculated net primary productivity of total standing vegetation (kg/m^2/yr).

Units Kg/m^2/yr
Spatial scale National
Frequency 5 Yearly
Confidence Low

Reason for Selecting the Indicator

Various uses of nature are competing for space. Land used for production cannot be used for roads, forests or grazing and vice versa. Productive land is a constantly changing resource. Climatic variation, natural disasters and human intervention are continually at work changing the boundaries of productive land that include arable land, pasture land and forests. Arable land is, in ecological terms the most productive land as it grows the largest amount of plant biomass (http://www.ecouncil.ac.cr). According to the FAO nearly all of the best arable land in the world is under cultivation. However, approximately 10 million hectares of this land is abandoned annually due to serious degradation. As a result, only 0.25 hectares per capita worldwide of such highly productive land is remaining. Arable land is also lost to urbanisation but the total area under cultivation is rising annually due to deforestation. Pasture land which is used for grazing and animal farming and the remaining forestland is significantly less productive than arable land. Grazing is the single greatest pressure on the land area used for pastoral activities and farmed livestock production (Hamblin, 1998). The effects of overgrazing include accelerated erosion and deterioration of natural vegetation. The loss of productive land can be attributed largely to the destruction of forests, which is not compensated by the fraction transformed in arable land or pasture land. (http://www.idrc.ca).

Data Sources

- **Data acquisition:** Net primary productivity of biomass provides the essential baseline of the relative productivity of all ecosystems. Monotonic trends in primary productivity accompany major changes to vegetation cover and land use, which may be distinguished from annual fluctuations resulting from wetter and drier years. This information is essential to assessing the potential productivity of particular ecosystems against which their actual performance can be compared under different systems of managed land use (Hamblin, 1998). The Department of Agriculture is presently mapping the agricultural potential of land in South Africa. Data will be available in a map form and are available free of charge from NDA.
- **Limitations**: Unknown.

Example

National base maps of net primary productivity could be presented, against which values of actual productivity (i.e. total grazing pressure or crop yields) could be mapped.

Needs

Unknown.

Reference List

http://www.ecouncil.ac.cr/rio/focus/report/english/footprint/biological.html. Biological Productivity Available on this Plant. (28 September 2001).

http://www.idrc.ca/institution/clock_e.html. The IDRC resource clock. (28 September 2001)

Hamblin, A, 1998. Environmental Indicators for National State of the Environment Report – The Land. Australian State of the Environment Report. http://www.ea.gov.au/soe/ . (5 September 2001).

INDICATOR THEME	Land Use
INDICATOR ISSUE	Land condition
INDICATOR NAME	**LU03** Desertification

Type: Driving Force / Pressure / **State** / Impact / Response

Linkages: This indicator can be linked to the Biodiversity & Natural Heritage theme. It can also be linked to other indicators in this theme i.e. LU01: Land cover, LU04: Soil loss and LU07: Land degradation. It can be linked to the Convention to Combat Desertification. It is also related to the CSD indicator 'Land affected by desertification'.

Indicator Level

Level 1 X	Level 2	Level 3

Selection Criteria met by the Indicator

	1	2	3	4	5	6	7	8	9	10	11
Criteria met fully		**X**	**X**				**X**	**X**	**X**	**X**	**X**
Criteria met partially	**X**			**X**							
Criteria not met					**X**	**X**					

Description of the Indicator

This indicator shows the total extent of affected dry land areas (as defined by the UNCCD) over the total area of the country.

Units km^2 and percentage
Spatial scale National
Frequency 5 Yearly
Confidence Medium

Reason for Selecting the Indicator

South Africa became a signatory to the United Nations Convention to Combat Desertification (UNCCD) in January 1995 and ratified it in September 1997 (Hoffman & Ashwell, 2001). The Convention defines desertification as "*land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors including climatic variation and human activities*". Desertification therefore, means "*land degradation, loss of soil fertility and structure as well as the erosion of biodiversity in drought prone areas*" (UNCCD, 2000). Although land degradation occurs everywhere, it is only defined as desertification when it occurs in dry land areas. Affected dry lands are those regions in which the ratio of mean annual precipitation to potential evapo-transpiration falls within the range of 0.05 to 0.65. Ninety-one percent of South Africa's land surface falls into this category (Hoffman & Ashwell, 2001).

Major causes of desertification are: unsuitable, poverty-induced agricultural practices; monocultures; the use of agrochemicals; the neglect of traditional knowledge; overgrazing; deforestation; over-pumping of water from boreholes; salinisation and

climate change (UNCCD, 2000). Land degradation in dry land areas results in increasing amounts of unproductive land. At the socio-economic level social and cultural structures deteriorate, food security is lost, migration becomes prevalent as incomes prove increasingly inadequate and debts grow (UNCCD, 2000).

As a full member of the UNCCD, South Africa has an international obligation to develop a National Action Programme (NAP) to combat desertification. According to the UNCCD, the specific aims of the NAP are to secure environments, improve food security, reduce poverty and create alternative livelihoods for communities living in dry lands (Hoffman & Ashwell, 2001).

Data Sources

- **Data acquisition:** Data can be obtained from the School of Bioresources Engineering and Environmental Hydrology, University of Natal – Pietermaritzburg and CSIR Environmentek. There are also numerous publications where data for this indicator can be sourced e.g. Schulze, R.E., Maharaj, M., Lynch, S.D., Howe, B.J. and Melvil-Thomson, B. 1997. *South African Atlas of Agrohydrology and Climatology*. Water Research Commission, Pretoria. These data (mean annual precipitation and potential evapo-transpiration for the whole of South Africa are available from the School of Bioresources Engineering and Environmental Hydrology, University of Natal – Pietermaritzburg on CD Rom for R500 (as a special concession to DEA&T data will be made available free of charge).
- **Limitations:** Unknown.

Example

This indicator can be presented as a table indicating the percentage of land area that falls into each aridity zone (see Table LU3.1 below). Aridity is calculated as a ratio of mean annual precipitation to potential evapo-transpiration and can be sourced in published data free of charge (e.g. Hoffman & Ashwell, 2001). These data can also be reported on in the form of a map indicating the distribution of the UNCCD aridity classes in South Africa.

Table LU3.1: Percentage of land area in each aridity zone in South Africa

Aridity zone	**Hyper-arid**	**Arid**	**Semi-arid**	**Dry sub-humid**	**Humid**
MAP:PET	<0.05	0.05-0.2	0.2-0.5	0.5-0.65	>0.65
% of SA	8%	47%	39%	5%	1%
		Affected drylands			

Source: Hoffman & Ashwell, 2001

Needs

Unknown.

Reference List

Hoffman, T. & Ashwell, A. 2001. *Nature Divided: Land Degradation in South Africa*. University of Cape Town Press, Cape Town.

UNCCD, 2000. The United Nations Convention to Combat Desertification. ILEIA Newsletter, March 2000.

INDICATOR THEME	Land Use
INDICATOR ISSUE	Land condition
INDICATOR NAME	**LU04** Soil loss

Type: Driving Force / Pressure / **State** / Impact / Response

Linkages: This indicator can be linked to the Biodiversity & Natural Heritage theme. It is also linked to the Convention to Combat Desertification.

Indicator Level

Level 1 X	Level 2	Level 3

Selection Criteria met by the Indicator

	1	2	3	4	5	6	7	8	9	10	11
Criteria met fully	**X**	**X**	**X**				**X**	**X**	**X**	**X**	**X**
Criteria met partially				**X**	**X**	**X**					
Criteria not met											

Description of the Indicator

This indicator gives a measure of how much soil is lost per year due to water erosion. Rates of national soil erosion are virtually impossible to measure accurately and very difficult to estimate. Many studies have been done on soil erosion, but these have been done at specific places in South Africa, and do not give a true overall impression of what the national situation is.

Units Tonnes per hectare (t/ha)
Spatial scale National
Frequency Annual
Confidence High

Reason for Selecting the Indicator

Soil loss may lead to a decline in productivity of land and loss of vegetation and resources to support human livelihoods and commercial activities. Soil loss may also lead to reduced biodiversity and loss of ecosystem services. The most important ecosystem functions affected by erosion are plant nutrient supply, nutrient cycling and sequestration, and waste material decomposition (Hamblin, 1998). Reduction in nutrient supply directly reduces primary productivity and thus the vegetation cover, which in turn affects habitats, climatic conditions and erosion control. Soil erosion can be seen as a symptom of underdevelopment (i.e. poverty, inequality and exploitation) and as a cause of underdevelopment. A reduced ability to produce, invest one's profit and increase productivity contributes to increasing poverty and can lead to desertification, drought, floods and famine.

Data Sources

- **Data acquisition:** The NDA has produced an Erosion Prediction Map of South Africa using long-term satellite data from the National Oceanographic and Atmospheric Administration (NOAA) satellites in a GIS based soil loss model (RUSLE). The NOAA data gives an indication of the vegetation cover for a specific year. The vegetation cover data was integrated with rainfall erosivity and sediment delivery potential data. These data sets can be obtained from the NDA and are available free of charge.
- **Limitations:** Direct surface soil loss is difficult to assess at the continental and regional scales required for national reporting. Localised studies may not be representative of large areas. The accuracy of an erosion prediction map using NOAA-AVHRR satellite data in a GIS model will depend on the model that is used and the reliability of the input data.

Example

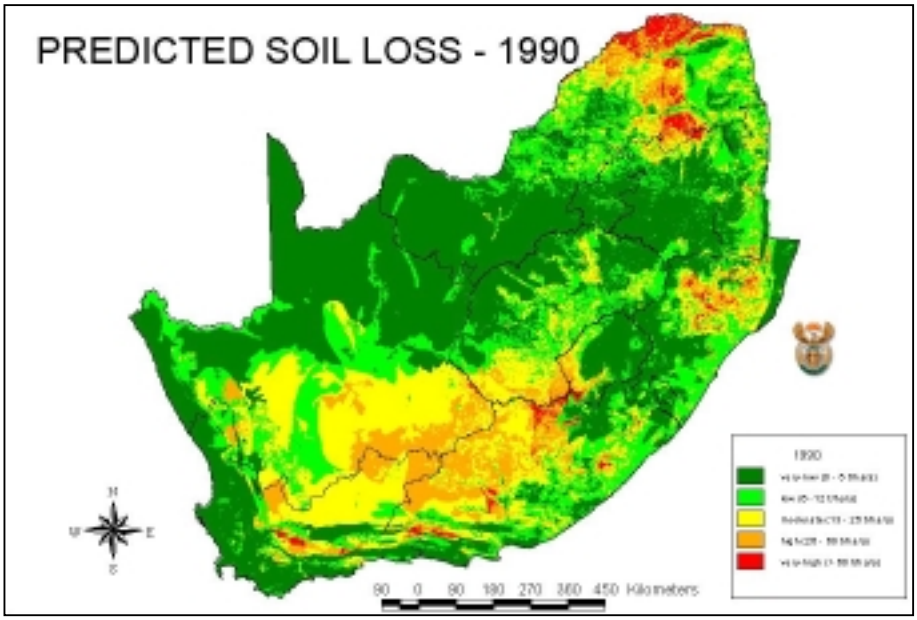


Figure LU4.1: Predicted soil loss in South Africa in the year 1990. (NDA, 2002)

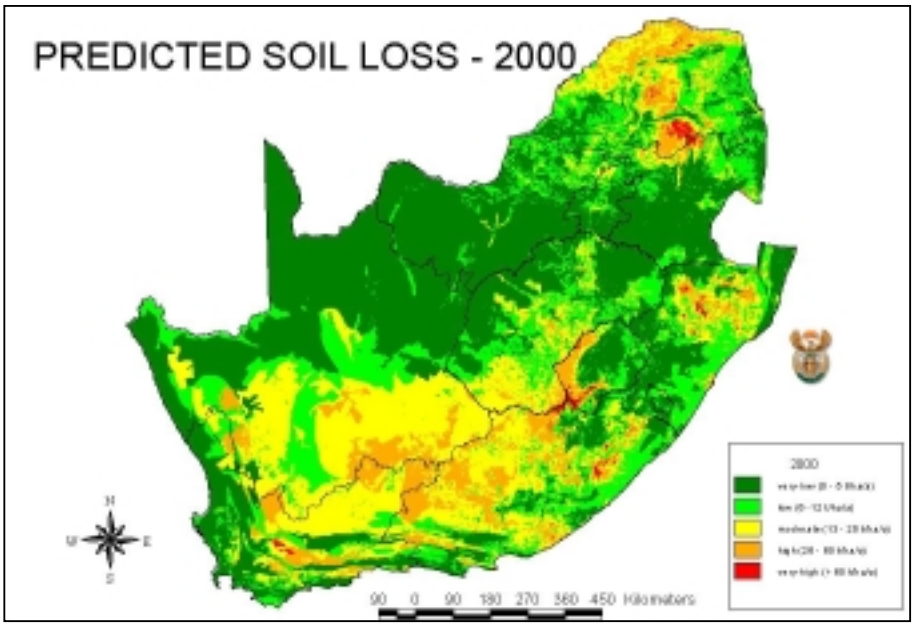


Figure LU4.2: Predicted soil loss for South Africa in the year 2000. (NDA, 2002)

Needs

The NOAA derived soil loss model can be refined by using higher resolution satellite data (MODIS) and by incorporating more detailed soil erodability and terrain data. Various other soil models could also be investigated.

Reference List

Hamblin, A, 1998. Environmental Indicators for National State of the Environment Report – The Land. Australian State of the Environment Report. http://www.ea.gov.au/soe/ . (5 September 2001).

National Department of Agriculture. 2002. Personal Communication.

INDICATOR THEME	Land Use
INDICATOR ISSUE	Land condition
INDICATOR NAME	**LU05** Soil acidification

Type: Driving Force / Pressure / State / **Impact** / Response

Linkages: This indicator can be linked to the Atmosphere & Climate, Waste Management, Inland Water and Biodiversity & Natural Heritage themes. It is also linked to the Convention to Combat Desertification.

Indicator Level

Level 1	Level 2 X	**Level 3 X**

Selection Criteria met by the Indicator

	1	2	3	4	5	6	7	8	9	10	11
Criteria met fully											
Criteria met partially	**X**	**X**		**X**			**X**	**X**	**X**	**X**	**X**
Criteria not met			**X**		**X**	**X**					

Description of the Indicator

This indicator measures the acidification of soils at selected sites in South Africa. The degree of acidity of a soil can be expressed as a pH value.

Units Soil pH
Spatial scale Local
Frequency 5 Yearly
Confidence Medium

Reason for Selecting the Indicator

Soil acidification is a process by which soil pH decreases over time. There are no visible signs of the problem, apart from a decline in yields (The State of Queensland Department of Natural Resources and Mines, 2001). Soil acidification of both natural and anthropogenic origin can be attributed to two processes: the addition of acids, typically of atmospheric origin (carbonic, nitric, sulphuric) and the removal of bases, by leaching or biomass accumulation (Du Toit, 1992). The rate of soil acidification is potentially highest in the agricultural sector, where it is associated mainly with the liberal use of ammonia fertilizers and the production of forage legumes. Studies have shown that the afforestation of grassland with fast growing alien tree species may have the potential to increase the rate of natural soil acidification by a larger margin than atmospheric acid deposition (Fey *et al*, 1990; Du Toit, 1993).

Data Sources

- **Data acquisition:** Existing data can be obtained from a series of studies carried out by the CSIR on the effect of air pollution on South Africa's forest plantations. The findings of this research were synthesized into a report which can be obtained from CSIR Environmentek: Olbrich, K. A. 1995. *Air Pollution Impacts*

on South African Commercial Forests: A Research Synthesis: 1990-1995 and Strategy for the Future. Report No. FOR-DEA 00874. CSIR Environmentek also has other reports which may contain data which can be used to report on this indicator. Data can also be obtained from the Institute for Soil Climate and Water in Pretoria. Information can also be obtained from the University of Stellenbosch. The costs associated with collecting new data for this indicator are unknown.

- **Limitations:** Unknown.

Example
This indicator can be reported as a table comparing the soil acidity at a particular site over a period of time.

Needs
Unknown.

Reference List
Du Toit, B. 1992. *Soil Acidification under Pinus patula in the Eastern Transvaal and Natal – Progress Report*. CSIR Environmentek, Report No. FOR-DEA 00451.

Du Toit, B. 1993. *Soil Acidification Under Forest Plantations and the Determination of the Acid Neutralising Capacity of Soils*. M Sc Agric Thesis, Department of Agronomy, Faculty of Agriculture, University of Natal, Pietermaritzburg.

Fey, M. V., Manson, A. D. and Schütte R. 1990. Acidification of the pedosphere. *South African Journal of Science* 86: 403 – 406.

The State of Queensland Department of Natural Resources and Mines. 2001. *NRM Facts L45 Soil Acidification*. (http://www.nrm.qld.gov.au/resourcenet/fact_sheets/pdf/land/LM45w.pdf 21 March 2002)

INDICATOR THEME	Land Use
INDICATOR ISSUE	Land condition
INDICATOR NAME	**LU06** Soil salinisation

Type: Driving Force / Pressure / State / **Impact** / Response

Linkages: This indicator can be linked to the Inland Water and Biodiversity & Natural Heritage themes. It is also linked to the Convention to Combat Desertification. The indicator is similar to the Commission for Sustainable Development indicator 'Area affected by salinisation and water-logging'.

Indicator Level

Level 1	Level 2	**Level 3 X**

Selection Criteria met by the Indicator

	1	2	3	4	5	6	7	8	9	10	11
Criteria met fully											
Criteria met partially		**X**		**X**			**X**				**X**
Criteria not met	**X**		**X**		**X**	**X**		**X**	**X**	**X**	

Description of the Indicator

This indicator reports on the salinisation of soils at selected sites in South Africa. Soil salinisation can be measured as soil resistance (ohms) or electrical conductivity (millisiemens per metre)

Units ohms or mS m^{-1}
Spatial scale Local
Frequency 5 Yearly
Confidence Low

Reason for Selecting the Indicator

Salinisation is the build up of inorganic salts within the soil to an extent that causes degradation of vegetation and soils. Irrigation salinisation is caused by excess water from irrigation which raises the water table (Australian Museum Fact Sheets, 2002). Introduced crops generally have different water use characteristics than indigenous vegetation and allow more rainfall to enter the groundwater. If more water is added than can be accommodated in the aquifer, the groundwater level will rise, bringing with it salts, in the form of saline groundwater. The effect of rising water tables and soil salinisation are decreased agricultural production, decline in ecosystem health, and infrastructure damage (New South Wales EPA, 2002). The irrigated croplands in the arid western areas of South Africa are susceptible to salinisation because of high levels of evaporation (Hoffman & Ashwell, 2001).

Data Sources

- **Data acquisition:** Data can be obtained from the ARC Institute for Soil, Climate and Water in Pretoria. Costs are unknown.
- **Limitations:** Unknown.

Example

This indicator can be reported as a table comparing the soil salinity at a particular site over a period of time.

Needs

Unknown.

Reference List

Australian Museum Fact Sheets. 2002. Salinisation – One of Our Biggest Environmental Problems. Available at: http://www.amonline.net.au/factsheets/salinisation.htm (21 March 2002)

Hoffman, T. & Ashwell, A. 2001. *Nature Divided: Land Degradation in South Africa*. University of Cape Town Press, Cape Town.

New South Wales EPA. 2002. State of Environment Report. *Soil Salinity: The Issue*. Available at: http://www.epa.nsw.gov.au/soe/97/ch2/3_1.htm (21 March 2002)

Dr Freddie Ellis, University of Stellenbosch, Faculty of Agricultural and Forestry Sciences.

INDICATOR THEME	Land Use
INDICATOR ISSUE	Land Condition
INDICATOR NAME	**LU07** Land degradation

Type: Driving Force **/ Pressure** / State / Impact / Response

Linkages: This indicator can be linked to the Biodiversity & Natural Heritage and Inland Water themes. This indicator is linked to South Africa's reporting requirements to the United Nations Convention to Combat Desertification.

Indicator Level

Level 1	Level 2	**Level 3 X**

Selection Criteria met by the Indicator

	1	2	3	4	5	6	7	8	9	10	11
Criteria met fully		**X**	**X**	**X**	**X**		**X**				**X**
Criteria met partially						**X**		**X**	**X**	**X**	
Criteria not met	**X**										

Description of the Indicator
This indicator will report on changes in land degradation per type of land cover.

Units Percent
Spatial scale National
Frequency 5 Yearly
Confidence Medium

Reason for Selecting the Indicator
South Africa became a signatory to the United Nations Convention to Combat Desertification in January 1995 and the ratification thereof was finally formalised on 30 September 1997 (Lutsch, undated). The term desertification falsely evokes the image of advancing deserts. The Convention defines desertification as "*land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors including climatic variation and human activities*". Desertification therefore, means "*land degradation, loss of soil fertility and structure as well as the erosion of biodiversity in drought prone areas*" (UNCCD, 2000). Although land degradation occurs everywhere, it is only defined as desertification when it occurs in dry land areas. Dry land areas are those regions in which the ratio of annual precipitation to potential evapo-transpiration falls within the range of 0.05 to 0.064. In South Africa the UN Environmental Programme calculated that 91% of the country is arid, semi-arid or dry sub-humid and is therefore prone to desertification (Lutsch, undated). A recent study done by the NBI suggests that land in 25% of magisterial districts in South Africa is already severely degraded (Lutsch, undated).

Major causes of desertification are: unsuitable, poverty-induced agricultural practices; monocultures; the use of agrochemicals; the neglect of traditional knowledge;

overgrazing; deforestation; over-pumping; salinisation and climate change (UNCCD, 2000). Land degradation in dry-land areas results in increasing amounts of unproductive land. At the socio-economic level social and cultural structures deteriorate, food security is lost, migration becomes prevalent as incomes prove increasingly inadequate and debts grow (UNCCD, 2000).

Data Sources

- **Data acquisition:** As part of South Africa's obligation to the UN Convention to Combat Desertification, a National Action Programme (NAP) must be developed to address the problems of land degradation in the country. As a first step on this path, a national assessment of the problem was conducted by the NBI. This was done through a rapid appraisal of land degradation in 35 agricultural regions of the country and involving more than 400 agricultural professionals. A total of 367 magisterial districts were assessed. A Soil Degradation Index (SDI) and Vegetation Degradation Index (VDI) were added together to form a simple Combined Degradation Index (CDI). The NBI report showing the SDI, VDI and CDI for South Africa can be obtained from their website at http://www.nbi.ac.za/landdeg/index.html. The costs associated with repeating this exercise are expected to be high.
- **Limitations:** It is unclear whether these data will be monitored on an ongoing basis.

Example

The SDI, VDI and CDI for South Africa were displayed using maps. However, these data do not meet the reporting requirements of the indicator as it shows the extent of land degradation by Municipality rather than by land cover type.

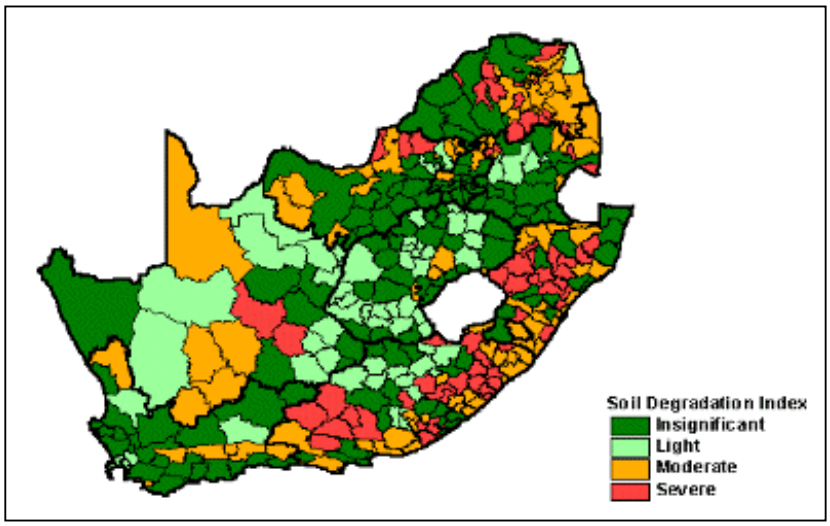


Figure LU7.1: Soil degradation index for South Africa (NBI, 2000).

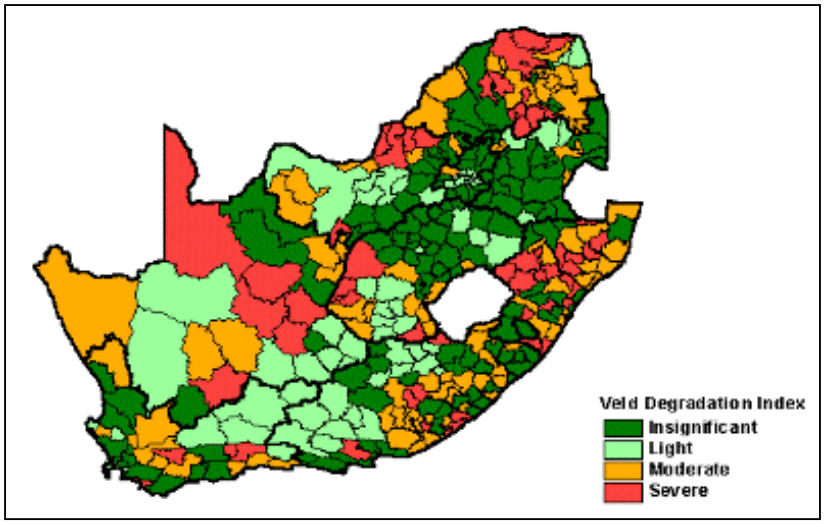


Figure LU7.2: Vegetation degradation index for South Africa (NBI, 2000).

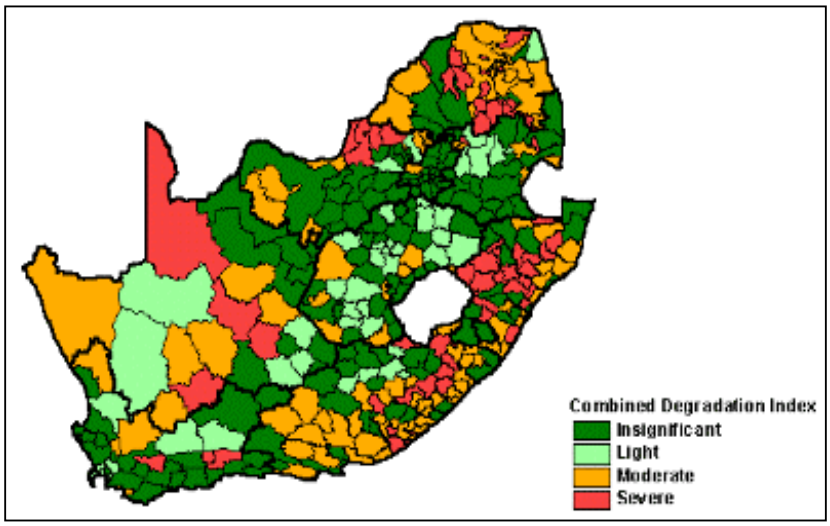


Figure LU7.3: Land degradation index for South Africa (NBI, 2000).

Needs
Unknown

Reference List
UNCCD, 2000. The United Nations Convention to Combat Desertification. ILEIA Newsletter, March 2000.

Lutsch, W., undated. The convention to combat desertification and the role of South Africa in the Global Context. Taken from http://www.globesa.org. (10 October 2001).

NBI. 2000. Land Degradation in South Africa. Taken from http://www.nbi.ac.za/landdeg/index.html

INDICATOR THEME	Land Use
INDICATOR ISSUE	Land condition
INDICATOR NAME	**LU08** Persistent organic pollutants

Type: Driving Force / **Pressure** / State / Impact / Response

Linkages: This indicator can be linked to the Waste Management; Marine, Coastal & Estuarine; Inland Water and Biodiversity & Natural Heritage themes. It is linked to the Stockholm Convention on Persistent Organic Pollutants. This indicator is also linked to the CSD indicator 'Use of agricultural pesticides'.

Indicator Level

Level 1	Level 2	**Level 3 X**

Selection Criteria met by the Indicator

	1	2	3	4	5	6	7	8	9	10	11
Criteria met fully		**X**		**X**							**X**
Criteria met partially			**X**		**X**	**X**	**X**				
Criteria not met	**X**							**X**	**X**	**X**	

Description of the Indicator

Total annual sales of persistent organic pollutants (POPs) – reported as annual volumes sold for each of the twelve POPs that are listed in the Stockholm Convention on Persistent Organic Pollutants and the total Rand value of each of the twelve POPs that are listed in the Convention.

Units m^3/POP/year and Rand value/POP/year
Spatial scale National
Frequency Annual
Confidence Low

Reason for Selecting the Indicator

South Africa is a signatory to the Stockholm Convention on Persistent Organic Pollutants. The Stockholm Convention sets out control measures covering the production, import, export, disposal and use of an initial list of twelve POPs grouped into three categories: 1) pesticides: aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex and toxaphene; 2) industrial chemicals: hexachlorobenzene (HCB) and polychlorinated biphenyls (PCBs); and 3) unintended by-products: dioxins and furans. The control provisions call for: eliminating production and use of intentionally produced POPs; eliminating unintentionally produced POPs, where feasible; and managing and disposing of POPs wastes in an environmentally sound manner. Parties to the Convention are required to promote best available techniques and practices for replacing existing POPs while preventing the development of new POPs. The treaty calls for substitution involving the use of safer chemicals and processes to prevent unintentionally produced POPs.

Data Sources

- **Data acquisition**: Data for the two POPs that are related to the agricultural sector can be obtained from the Crop Protection and Animal Health Association AVCASA. Costs are unknown.
- **Limitations**: The data availability on the use of POPs in South Africa is limited.

Example

This indicator can be represented as bar graphs or trend lines indicating the total volume and total Rand value of each POP sold annually.

Needs

A national study on the use of POPs and the availability of data on POPs needs to be commissioned.

Reference List

IISD Website: http://www.iisd.ca/linkages/chemical/popsd/index.html (22 March 2002)

DORMANT INDICATORS

Dormant indicators are those indicators that were identified during the indicator development process as indicators that should be included in the set of National Environmental Indicators, but due to lack of data or knowledge with regard to how to implement or calculate the indicators accurately, have been excluded from the current set of indicators. It is envisaged that some of the dormant indicators will be included in the set once more information becomes available.

INDICATOR THEME	
INDICATOR ISSUE	
INDICATOR NAME	**DORMANT** Wasted and degraded land in mining zones

Type: Driving Force / Pressure / **State** / Impact / Response

Linkages: This indicator can be linked to the Inland Water and Waste Management themes.

Indicator Level

Level 1	**Level 2 X**	Level 3

Selection Criteria met by the Indicator

	1	2	3	4	5	6	7	8	9	10	11
Criteria met fully		**X**	**X**				**X**		**X**		**X**
Criteria met partially				**X**		**X**					
Criteria not met	**X**				**X**			**X**		**X**	

Description of the Indicator

The percentage of land in mining zones which has been degraded and remains as wasteland due to mining impacts, relative to the total area under mining. Before measuring this indicator it will be necessary to agree upon a definition of wasteland. Some of the definitions that are used to describe wasteland include *barren or uncultivated land* (Collegiate Dictionary), *uninhabited wilderness that is worthless for cultivation* (Webster Gateway) and *land that is not productive or developed* (Oxford Dictionary).

Units Percentage
Spatial scale National
Frequency 5 yearly
Confidence High

Reason for Selecting the Indicator

The mining sector in South Africa is, by the very nature of its activity, impacting on the biophysical, social and economic environment. Particular areas where the impacts of mining are at a large enough scale to drive environmental change include pollution and waste generation (rock and tailings). Some of the impacts of mining on the land are soil erosion, toxic soil pollution (Radon), alteration of the land, land alienation from waste

rock piles and disposal areas and the generation of dangerous areas that pose health risks and possible loss of life (i.e. shafts, pits etc) (CSIR, 2001). Surface mining methods may drive environmental change of the affected land surface through changes in topography and surface drainage with a resulting increase in soil erosion, compaction, subsidence and reduced agricultural capacity. Changes may also occur in the topsoil characteristics with the potential for increased acidity and salt content, development of nutrient deficiencies or imbalances, surface crustiness or desiccation, and changes in land use.

Data Sources

- **Data acquisition:** The DME is developing a MINACT System that will make these data available in future. MINACT should be operational in the next 18 months with GIS mapping of relevant data following in subsequent years. The data which are available from this system are limited to registration of licences, general information on the applicants and whether or not an EMS has been developed. DME hopes to expand the system in future to include other important data i.e. degraded land in mining areas.
- **Limitations:** No historical data will be available and information will only become available once the MINACT system has been developed.

Example

The table below is a possible method of reporting on the indicator of the land that would be wasteland in mining zones relative to the total area under mining.

	Mining		**Prospecting**	
	1999	2000	1999	2000
Total area (ha)	177001	177247.8	1238.36	1548.02
Wasted or degraded (ha)	3540.0206	1772.478	24.7672	15.4802
Percentage	2%	1%	2%	1%

Needs

Research is being done by the Department of Minerals and Energy.

Reference List

CSIR, 2001. Drivers of Environmental Change - Mining. Available at: (http://www.environment.gov.za/soer/nsoer/drivers/general/Mining.doc) (August 2001).

Collegiate Dictionary. Taken from http://www.m-w.com/cgi-bin/dictionary (10 October 2001).

Oxford Dictionary. Taken from http://www.askoxford.com/dictionary (10 October 2001).

Webster Gateway. Taken from http://work.ucsd.edu:5141/cgi-bin/ (10 October 2001)

INDICATOR THEME	
INDICATOR ISSUE	
INDICATOR NAME	**DORMANT** Quality of mining operations

Type: Driving Force / Pressure / State / Impact / **Response**

Linkages: This indicator can be linked to the Inland Water theme.

Indicator Level

Level 1 X	Level 2	Level 3

Selection Criteria met by the Indicator

	1	2	3	4	5	6	7	8	9	10	11
Criteria met fully	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Criteria met partially											
Criteria not met											

Description of the Indicator

The number of mine sites with ongoing and final rehabilitation programmes that are effective and operational, relative to the total number of registered and located sites, per reporting period.

Units Percentage
Spatial scale National
Frequency Annual
Confidence High

Reason for Selecting the Indicator

Mining sites are potential areas of both surface and groundwater contamination, through acid drainage which can mobilize metals and absorb toxic gases, and from treatment processing on-site (Australian State of the Environment Report). In order to comply with the National Environmental Management Act (NEMA), 1998 (Act 107 of 1998) the DME has developed environmental management regulatory measures to ensure the South African mining industry complies with national principles, norms and standards (Department of Mineral and Energy, 1999). In terms of the Minerals Act, 1991 (Act 50 of 1991) mining operations must be in possession of an Environmental Management Programme (EMP) having been approved by the authorities and which must be implemented throughout the life of a mine. The requirement for monitoring and performance assessment of environmental management by mines completes the last link in the chain for an integrated and cradle-to-grave environmental management system. Guidelines for the preparation of EMPs were compiled (DME, 1992), and were intended to assist and guide entrepreneurs and mine owners to compile EMPs in accordance with procedures and norms acceptable to all concerned with a view to leaving a useful heritage to future generations after the mineral resources have been extracted.

Data Sources

- **Data acquisition:** The Department of Minerals and Energy process and monitor, on a yearly basis, the number of EMPs submitted and approved for mining and prospecting activities. Typically, mining impact management and mitigation measures include adhering to Best Practice Guidelines developed for a range of mining activities. These include: water quality management, investigating alternative locations for infrastructure and waste disposal sites, the adoption of different mining and beneficiation technologies, the use of cleaner production technologies, recycling of water and specific materials, pollution control measures, rehabilitation and landscaping, and the acquisition of additional property to compensate for habitat loss (CSIR, 2001). Data are published on a yearly basis in the Department of Minerals and Energy's Annual Report that can be obtained on request from the department.
- **Limitations:** Reports are only published in approximately the middle of the year following data capture. The DME does not have the number of registered / licensed mining and prospecting sites on hand.

Example

The table below gives some indication of how this indicator may be presented in a State of Environment report.

	Mining		Prospecting	
	1999	2000	1999	2000
Submitted EMPs (this reporting period)	612	620	629	634
Approved EMPs (this reporting period)	536	550	373	388
Approved EMPs (total)	7000	7550	1000	1388
Number of registered and located sites	14000	14400	3000	3120
Percentage	50 %	52 %	33 %	44 %

Needs

Unknown.

Reference List

Department of Minerals and Energy, 1999. Annual Report: 1999. Department of Minerals and Energy, Pretoria.

Department of Minerals and Energy, 1992. *Aide Memoir for the Preparation of Environmental Management Programme Reports for Prospecting and Mining*. Department of Minerals and Energy, Pretoria.

CSIR, 2001. Drivers of Environmental Change - Mining. (http://www.environment.gov.za/soer/nsoer/drivers/general/Mining.doc) August 2001.

INDICATOR THEME	
INDICATOR ISSUE	
INDICATOR NAME	**DORMANT** Enforcement of the Conservation of Agricultural Resources Act (Act 43 of 1983)

Type: Driving Force / Pressure / State / Impact / **Response**

Linkages: This indicator can be linked to the Biodiversity theme.

Indicator Level

Level 1 X	Level 2	Level 3

Selection Criteria met by the Indicator

	1	2	3	4	5	6	7	8	9	10	11
Criteria met fully	**X**			**X**			**X**	**X**	**X**	**X**	**X**
Criteria met partially		**X**	**X**		**X**	**X**					
Criteria not met											

Description of the Indicator

This indicator is based on the number of directives and prosecutions by the Inspectorate of the National Department of Agriculture (NDA) enforcing the Conservation of Agricultural Resources Act (Act 43 of 1983). It gives an indication of some of the measures that are being taken by the NDA to prevent the degradation of soil and natural veld.

Units Number of directives or prosecutions per year
Spatial scale Provincial
Frequency Annual
Confidence High

Reason for Selecting the Indicator

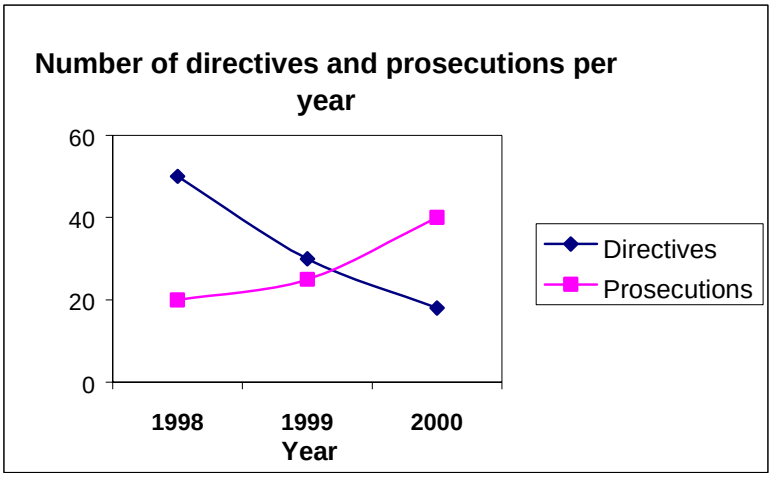
Land degradation could lead to a decline in productivity and diversity of resources to support human livelihoods and commercial activities, as well as reduced biodiversity and loss of ecosystem services such as water and air quality regulation. A major function of the Department of Agriculture in South Africa is the conservation of natural resources. The protection of our natural agricultural resources is vital for household food security. The Conservation of Agricultural Resources Act controls the utilisation of the country's agricultural land. Land used for agriculture comprises 84% of the country's total area. The effectiveness of this legislation will determine the country's ability to feed its ever-increasing population, while greater demands are being made to use agricultural land for nonagricultural purposes. Law enforcement should go hand in hand with an awareness of the need for conservation. This indicator shows some of the measures the NDA is taking to prevent the degradation of soil and natural veld (NDA, http://www.nda.agric.za/).

Data Sources

- **Data acquisition:** Data for this indicator can be obtained from the NDA.
- **Limitations**: Unknown.

Example

The graph below is an example of how this indicator can be represented. **Fictitious data** were used in this example, however the data for this indicator can be obtained from the NDA.



Needs

Unknown.

Reference List

Conservation of Agricultural Resources Act (Act 43 of 1983). National Department of Agriculture, Pretoria.

National Department of Agriculture. General Information on Agriculture in South Africa. Taken from http://www.nda.agric.za/ (28 September 2001).

INDICATOR THEME	
INDICATOR ISSUE	
INDICATOR NAME	**DORMANT** Permanent loss of agriculturally productive land

Type: Driving Force / Pressure / **State** / Impact / Response

Linkages: This indicator can be linked to the Biodiversity theme. This indicator is linked to South Africa's reporting requirements to the UN Convention to Combat Desertification.

Indicator Level

Level 1	Level 2	**Level 3 X**

Selection Criteria met by the Indicator

	1	2	3	4	5	6	7	8	9	10	11
Criteria met fully			**X**		**X**	**X**	**X**				
Criteria met partially	**X**	**X**		**X**				**X**	**X**	**X**	**X**
Criteria not met											

Description of the Indicator
The amount of agricultural land that is not covered by stubble, debris, crop or other plant material as a percentage of the total area of land under agriculture.

Units Percent
Spatial scale National
Frequency 5 yearly
Confidence Low

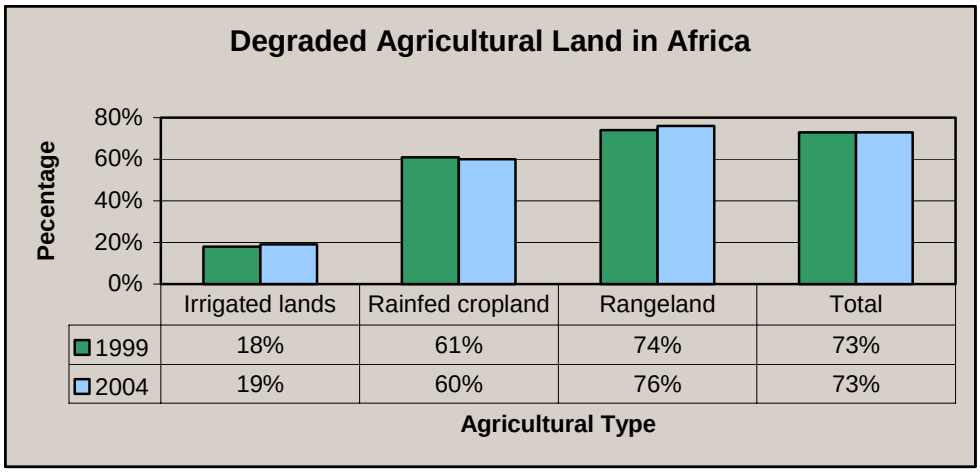
Reason for Selecting the Indicator
According to Agenda 21, desertification is land degradation in arid, semi-arid and dry subhumid areas resulting from various factors, including climatic variations and human activities. Some people prefer the term "land degradation" over "desertification" as the latter brings to mind deserts and complete devastation and not the range of land degradation that actually exists (http://www.ciesin.org). Land degradation, or the progressive weakening of the physical, biological and economic potential of the land, is a serious threat to overall productivity and therefore to the livelihoods of people who live on the land (http://www.idrc.ca/media/edesert.html). Land degradation erodes diversity of plant and animal life and the diversity of the people, as they are forced to move and change their lifestyles, culture and knowledge. Farmland loss, habitat loss, and encroaching development are topics of critical importance. Loss of productive agricultural lands and the hidden costs of urban sprawl are just a few of the issues rural and semi-rural communities struggle with every day. Even more disturbing than the potential reduction in food productivity is the possible loss of plant, animal and human diversity that makes up the building blocks of life. In the future, technological advances might enable society to produce more food despite the loss of arable land, but technology cannot yet create genetic material -it can only synthesize it.

Data Sources

- **Data acquisition:** As part of South Africa's obligation to the UN Convention to Combat Desertification, a National Action Programme (NAP) must be developed in order to address the problems of land degradation in the country. As a first step to address this obligation, a national assessment of the problem was conducted by the NBI. This was done through a rapid appraisal of land degradation in 35 agricultural regions of the country and involved more than 400 agricultural professionals. A total of 367 magisterial districts were assessed. A Soil Degradation Index (SDI) and Vegetation Degradation Index (VDI) were assimilated to form a simple Combined Degradation Index (CDI). The NBI report showing the SDI, VDI and CDI for South Africa can be obtained from their website at http://www.nbi.ac.za/landdeg/index.html
- **Limitations**: It is unclear whether the Combined Degradation Index could be separated into Land Degradation per land use type i.e. agriculture.

Example

Mapping could be used to show the location and increase or decrease in bare area (loss of agriculturally productive land) by province or vegetation area. Trends could be shown using bar charts or trend lines.



(Source: http://www.idrc.ca/media/edesert.html).

Needs

Unknown.

Reference List

http://www.ciesin.org/docs/002-186/002-186.html. Global Desertification Dimensions and costs. (28 September 2001).

http://www.idrc.ca/media/edesert.html. (29 September 2001).

INDICATOR THEME	
INDICATOR ISSUE	
INDICATOR NAME	**DORMANT** Land degradation per GDP in the agricultural sector

Type: Driving Force / **Pressure** / State / Impact / Response

Linkages: Land Use

Indicator Level

Level 1 X	Level 2	Level 3

Selection Criteria met by the Indicator

	1	2	3	4	5	6	7	8	9	10	11
Criteria met fully	**X**	**X**	**X**		**X**		**X**	**X**	**X**	**X**	**X**
Criteria met partially				**X**		**X**					
Criteria not met											

Description of the Indicator

This indicator will provide information on the decoupling between the agricultural contribution to GDP and land degradation. This means, should the ratio decline over time, the agricultural sector is impacting less on land degradation.

Units	Tonnes soil lost / Rand value
Spatial scale	Sectoral
Frequency	Annual
Confidence	Medium

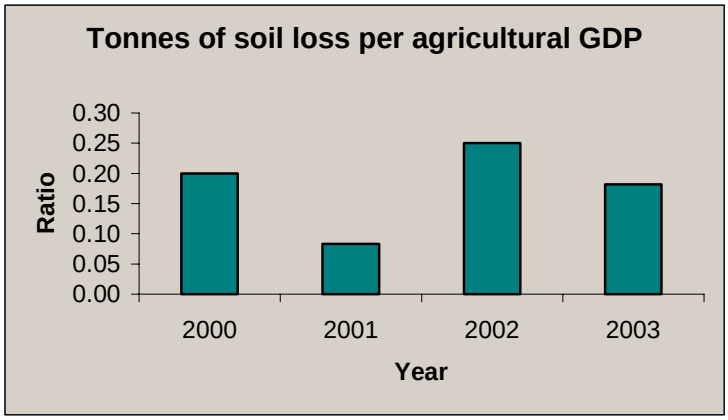
Reason for Selecting the Indicator

Land degradation is an important factor in agricultural production. The loss of soil will have a long term impact on the sustainability of agricultural production in general and the challenge is to achieve both a rising agricultural output and declining amount of fertile soils.

Data Sources

- **Data acquisition:** National Department of Agriculture erosion prediction map (see LU04), SA Reserve bank for mining GDP data (http://www.resbank.co.za)
- **Limitations:** None.

Example
This example is based on **fictional data**.



Needs
Economic information split between agricultural, forestry and fisheries sectors.

Reference List
South African Reserve Bank,
http://www.resbank.co.za/Economics/qbuljun01/PDF/na.pdf. Access: 5 September 2001

INDICATOR THEME	
INDICATOR ISSUE	
INDICATOR NAME	**DORMANT** Wasted and degraded land in mining zones per GDP in the mining sector

Type: Driving Force / Pressure / **State** / Impact / Response

Linkages: Land Use

Indicator Level

Level 1	**Level 2 X**	Level 3

Selection Criteria met by the Indicator

	1	2	3	4	5	6	7	8	9	10	11
Criteria met fully		**X**	**X**	**X**			**X**		**X**		**X**
Criteria met partially					**X**			**X**			
Criteria not met	**X**					**X**				**X**	

Description of the Indicator

This indicator will provide information on the decoupling between mining GDP and wasted and degraded areas. This means, should the ratio decline over time, the mining sector is impacting less on wasted and degraded land.

Units	% of land / Rand value
Spatial scale	Sectoral
Frequency	Annual
Confidence	Medium

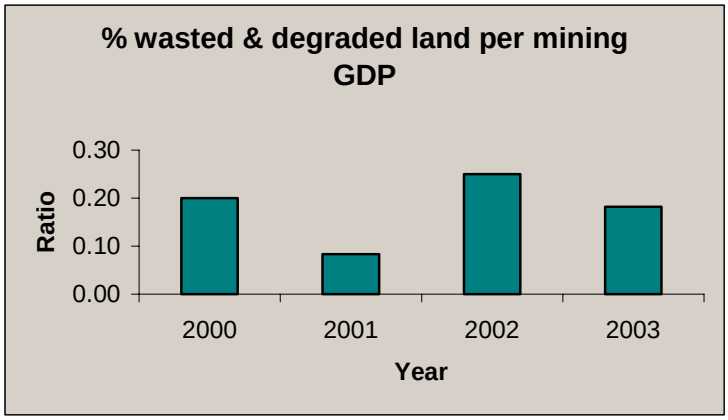
Reason for Selecting the Indicator

Market failure does occur as external costs of wasted and degraded land have historically not been included in mining operations. However, with policy requirements on rehabilitation of mines, the question is whether these external costs are effectively internalised through the policy mechanism.

Data Sources

- **Data acquisition:** MINACT system from DME for wasted and degraded land, SA Reserve bank for mining GDP data (http://www.resbank.co.za).
- **Limitations**: None

Example
The following example is based on **fictional data**.



Needs
Unknown

Reference List
South African Reserve Bank,
http://www.resbank.co.za/Economics/qbuljun01/PDF/na.pdf. Access: 5 September 2001

ADDITIONAL INDICATORS WHICH WERE CONSIDERED

Indicator Name	Reason for Rejection at this stage
Restrictive Regulations	This indicator is very difficult to measure
Areas of forested land	Addressed through the indicator LU01.
Percentage of land managers using agreed best practices per land use	This indicator is very difficult to measure
Reduction in emissions of land pollutants	This indicator is very difficult to measure
Percentage land lost due to rising sea levels	Permanent loss of land due to sea level rise is difficult to measure and the effects of sea level rise are felt 50 yrs after climate change has taken place.
People per km^2	Addressed indirectly in the Human Well-being report.
No. of residential sites without minimum sanitation levels	Addressed in the Human well-being report through indicator HW14
No. of contaminated sites	Addressed indirectly in the Waste Management report through the indicator WM03 & WM07.
No. of management plans per land use sector	Not applicable to all sectors
Type and extent of infrastructure per land use	Rejected, a large amount of data will need to be collected and collated in order to report on this indicator. This is currently considered unnecessary
No. of permits granted to change land use	Rejected, will be addressed indirectly through LU01
No. or percentage of effective integrated land use plans	Addressed indirectly through the indicator EM05
Extent of soil contamination from agricultural inputs	Addressed through the indicators LU07, LU05, LU06
Amount of biocides in the environment	Addressed indirectly through the indicators LU05, LU06, LU07.
Extent of managed indigenous forest	Addressed indirectly through the indicator LU01
Extent of protected indigenous forest	Addressed indirectly through the indicator LU01
Percentage of companies per sector implementing waste legislation	Waste legislation is not yet in place. This indicator can be tracked indirectly through the indicator Corporate environmental responsibility.
No. of companies per sector implementing ISO 14 001 system	This indicator can be tracked indirectly through the indicator EM07
No or percentage of farmers adhering to recommended stocking rates per ecological region/biome	Rejected, will be indirectly addressed through LU03
Percentage of degraded land taken out of production per sector	Addressed indirectly through the indicator LU07

LIST OF STAKEHOLDERS

Name	Organisation
A. Ferreira	DME
H. Naude	DME
D. Berliner	ECO-Logic Environmental Consulting
S. Makhaye	Chamber of Mines
H. D. Naude	DME, Directorate: Mine Rehabilitation
P. Nelson	ESKOM
D. Pretorius	National Department of Agriculture

LIST OF ACRONYMS

ARC	Agricultural Research Council
DEAT	Department of Environment and Tourism
DME	Department of Minerals and Energy
DPSIR	Driving Forces; Pressures; State; Impacts & Response
DWAF	Department of Water Affairs and Forestry
EMP	Environmental Management Plan
FAO	Food and Agriculture Organisation of the United Nations
FOA	Forest Owners Association
NBI	National Botanical Institute
NDA	National Department of Agriculture
NEMA	National Environmental Management Act
NLC	National Land Cover
NOAA	National Oceanographic and Atmospheric Administration
SANDF	South African National Defence Force
UNCCD	United Nations Convention to Combat Desertification

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APPENDIX 1: ISSUES DIAGRAMS