MPUMALANGA PROVINCE

STATE OF ENVIRONMENT REPORT

KEY ENVIRONMENTAL INDICATORS 2002

Indicator Report

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Executive Summary

This report represents the **Indicator Report** on the Key Environmental Indicators to be presented in the 2002 Mpumalanga State of the Environment Report. The report has been prepared by CSIR for Mpumalanga Department of Agriculture, Conservation and Environment (DACE).

Chapter 1 provides an introduction to the report while Chapter 2 provides background information on environmental indicators and is essentially a summary of the information presented in the Indicators Background Information Document. Chapter 3 outlines the methodology used in selecting the Mpumalanga Key Environmental Indicators (KEI's). Chapter 4 presents the list of KEI's while Chapter 5 describes the interpretation and uses of the KEI's. Chapter 6 then provides the way forward, presenting steps to compiling the 2002 Mpumalanga State of the Environment Report.

CSIR, Pretoria

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1. INTRODUCTION

The Mpumalanga Department of Agriculture, Conservation and Environment (DACE) has commissioned the CSIR to undertake their Provincial State of the Environment Report study. This study comprises a four-phased approach. This report is the second of two reports compiled for Phase 2: Indicator Development.

This report represents the **Indicator Report** and presents the proposed Key Environmental Indicators (KEI's) that will be used in the 2002 Mpumalanga State of the Environment Report. The methodology explaining the development of this indicator set is covered in detail in this report, as well as the use and interpretation of the indicators in reporting themes that are linked to the key environmental issues identified in Phase 1 of the study.

The report provides a brief background to the development of environmental indicators, it outlines the methodology used in this study to select and develop the Mpumalanga KEI's, the KEI's are then listed and further explained. In addition, the process for compiling the 2002 Mpumalanga SOE Report is explained.

2. BACKGROUND

Indicators

The word *indicator* is defined in the Concise Oxford Dictionary as something that "points out" and "gives information on the current situation". The goal of environmental indicators is therefore to communicate specific information about the environment and about the human activities that affect the environment. The term 'environment' is used here in an holistic way, and it encompasses the **social**, **economic**, **institutional** and **biophysical** components of our environment. The indicator set described in this document outlines environmental indicators that describe social, economic, institutional and biophysical aspects of the state of the environment in Mpumalanga Province. The indicators presented here will be used to compile the 2002 Mpumalanga Province State of the Environment Report.

Purpose of the indicators

The purpose of using indicators in state of the environment reporting is:

- to monitor and assess conditions and trends on a national, regional and global scale;
- to compare situations;
- to assess the effectiveness of policy-making;
- to mark progress against a stated benchmark;
- to track changes in public attitude and behaviour;
- to ensure understanding, participation and transparency in information transfer between interested and affected parties;
- to forecast and project trends; and
- to provide early warning information (Walmsley and Pretorius, 1996).

Indicator framework

Indicators used in state of the environment reporting are often organised into a structured or coherent framework. There are a variety of reasons why indicator frameworks are useful. An indicator framework:

- guides the data and information collection process;
- suggests a logical grouping of related information;
- promotes interpretation and integration; and
- helps identify data collection needs and data gaps.

The environmental indicators being developed for Mpumalanga Province have been developed according to the P-S-I-R framework, using environmental issues as a base. The P-S-I-R framework uses indicators to describe the pressures, state, impacts and responses surrounding certain environmental issues. An environmental issue can be defined as a topic of strategic concern that will influence the sustainability of the province. It is important to realise that not all issues are equally important at any given moment, and that the issues being considered will change over time.

It should also be noted that not all issues will necessarily have one indicator per component of the P-S-I-R framework. In some cases, there may therefore be fewer than 4 indicators per issue, while in other cases there may be more. In addition, the framework and ultimately the list of indicators selected should remain flexible and open-ended. This will allow new indicators to be added if necessary, should a new issue become a priority. It is recommended that a large portion of the indicators remain fairly consistent from year to year to allow for the analysis of trends, and to see the effects of decisions taken using the indicators.

Selection criteria

The primary function of an environmental indicator is to enable the exchange of information. In this way an indicator set helps in understanding the current state of an environmental system and the trends in that system. A good environmental indicator:

- has an agreed, scientifically sound meaning;
- represents something of importance to society;
- is easily understood;
- has a sound and practical measurement process;
- helps focus information to answer important questions; and
- assists decision-making by being effective and cost-efficient to use.

In order for indicators to remain relevant they must meet certain suitability criteria. The criteria may not all be met in each indicator that is proposed, however it is desirable that as many criteria as possible are met in each indicator.

The criteria used in this project are as follows (they are not listed in any particular order):

- The indicator should be relevant to the key environmental issues that have been identified as a priority for Mpumalanga Province;
- The indicator must be based on credible data that are readily available and cost effective to collect;
- The indicator must be simply presented in a way that is easily understood by the user; and
- The indicator must display trends or change over time.

These criteria were also expanded into a set of questions asked during the indicator selection process. The questions help to guide the selection of the most suitable indicators, and are listed below:

- Which key issue (raised during the stakeholder workshops) does the indicator address?
- Are there data available for this indicator?
- Are the data considered credible?
- Have the data been verified? If so, by whom?
- Are the data cost effective? (Does the quality of the data justify the expense?)
- Can the indicator be presented in a simple way, free of technical jargon?
- Can graphics be used in the illustration of the indicator?
- Are sufficient historical data available to show trends?

Indicator presentation

The appropriate presentation of indicators influences the extent to which the indicators are used in the decision-making process. There are a variety of ways in which indicators can be presented. Based on studies of previous work, a template has been designed for the presentation of indicators in the 2002 Mpumalanga State of the Environment Report. The template was presented previously in the Key Environmental Indicators Background Information Document (Mpumalanga Province, 2002a).

3. METHODOLOGY FOR SELECTING INDICATORS

The methodology for selecting indicators for Mpumalanga Province followed a distinct path as highlighted in Figure 1 below.

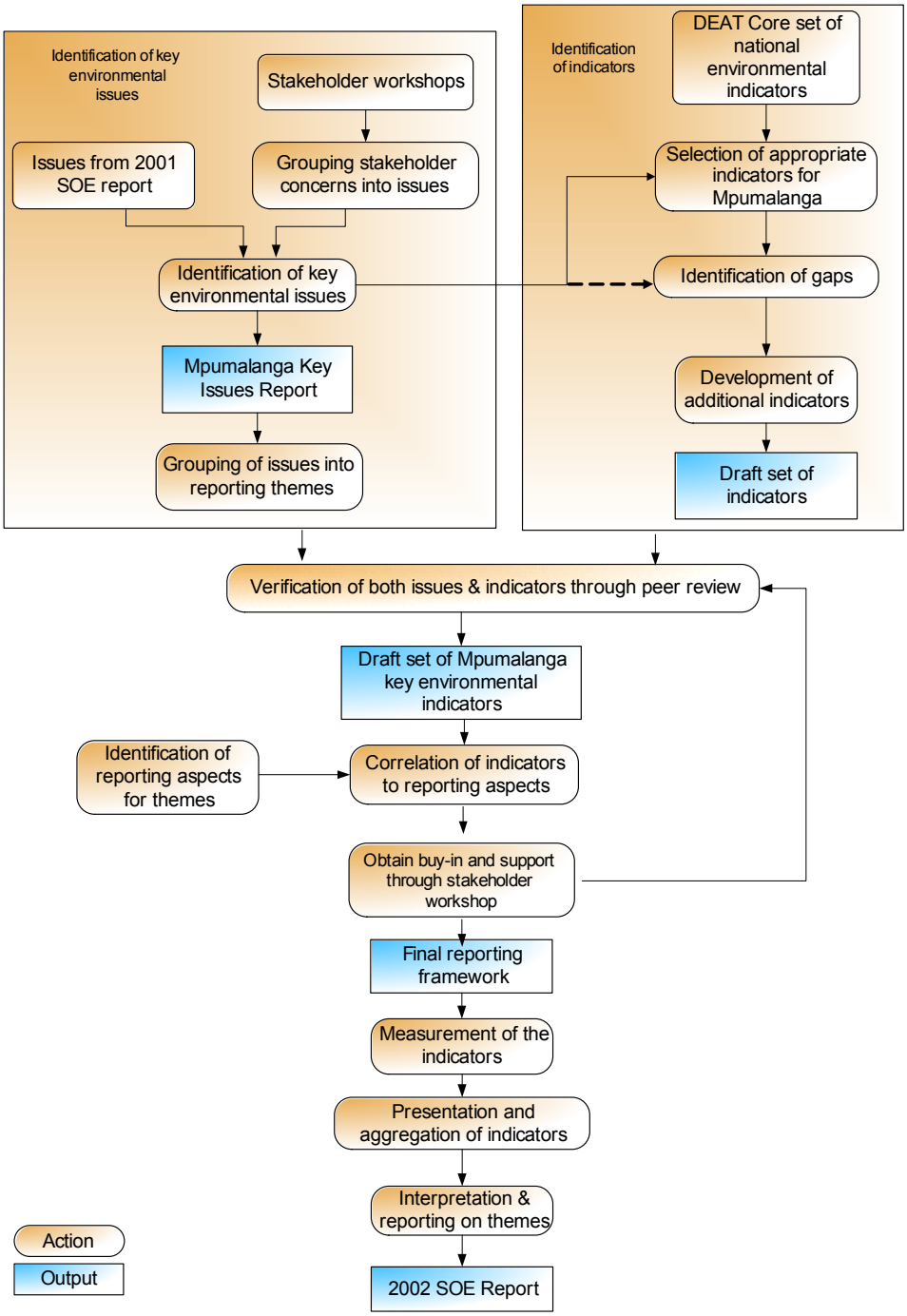

Figure 1: Flow diagram showing the methodology used to select Mpumalanga's Key Environmental Indicators

The first part of the methodology involved two distinct pathways, firstly a pathway to identify the key environmental issues in Mpumalanga (on the left hand side of the diagram), and secondly a pathway to identify the indicators to be considered for use in Mpumalanga (on the right hand side of the diagram).

The issues pathway began with several stakeholder workshops held in the province at which stakeholders were asked to give their concerns about the environment in Mpumalanga. The stakeholder concerns were then grouped into more generic issues. The 2001 Mpumalanga State of the Environment Report (Mpumalanga Province, 2002b) provided additional information on issues that were not raised at the workshops. A list of key environmental issues was formulated and presented in the Mpumalanga Identification of Key Environmental Issues Report (Mpumalanga Province, 2002c). Once the key issues were known, reporting themes were identified for use in the 2002 State of the Environment Report.

At the same time the indicator pathway proceeded as follows: the DEAT core set of national environmental indicators was used as a starting point to select indicators that matched the key environmental issues identified through the stakeholder workshops and the 2001 SOE Report. Appropriate indicators were selected from the national set and gaps identified through the use of key environmental issues already developed. Additional indicators were then developed to fill the gaps. A draft set of indicators was then compiled. Matrices showing the linkages between the core indicators and key environmental issues are collated in Appendix 1.

At this point the issues pathway and indicator pathway were merged into a single pathway for the remaining tasks. Both the list of issues and draft indicators were subjected to peer review in order to verify their comprehensiveness.

It was then considered necessary to identify the aspects that should be discussed within each reporting theme. Aspects can be defined as key elements of a reporting theme that tell us something about that resource or social condition. For example, the key elements to discuss when reporting on water in the province are water quality and water quantity. Measures of these elements or aspects will be the set of indicators proposed such as surface water nutrients and water usage per sector. Another example would be as follows: in assessing poverty and vulnerability, the key aspects or elements that must be discussed will be around education, health, income and assets. Two indicators that would be used to measure these aspects would be adult literacy rate and household income. These aspects are derived from literature and discussions with specialists in the field.

The aspects were then correlated with the indicators to check that the indicators had been placed correctly into the different reporting themes. The aspects also created a small amount of overlap between some reporting themes, with certain indicators appearing in more than one theme. This overlap is considered necessary to provide an holistic picture of the reporting themes.

The reporting themes (and their associated indicators) were then discussed further in another stakeholder workshop held on the 5 November 2002 in Nelspruit. The main objective of the workshop was to obtain buy-in and support for the indicators. The stakeholders present at the workshop expressed their support for the indicators presented, and identified ways in which the indicator set could be improved upon (see Appendix 2 for a brief summary of the workshop). (A feedback loop was provided in the process should the stakeholders not show support for the indicators presented to them.) The comments received from stakeholders during the workshop were then used to enhance the final indicators set, and the final reporting framework was determined. Supporting data for each indicator will then be collected where available, and used to compile the 2002 Mpumalanga State of Environment Report. The 2002 SOE Report will form the output for the third phase of the project.

4. MPUMALANGA KEY ENVIRONMENTAL INDICATORS (KEI's)

The final set of Mpumalanga province Key Environmental Indicators are listed in Box 1 below. These indicators have been selected for reporting on several key environmental issues highlighted through earlier stages of this project (Mpumalanga Province, 2002c). The indicators presented here have been refined through stakeholder inputs provided at a workshop held in Nelspruit during November 2002.

Box 1: Key Environmental Indicators for Mpumalanga province

Electricity generation from coal-fired power stations
Trends in household energy use per energy type
Ambient sulphur dioxide concentration
Ambient particulate concentration
Quarterly clinic admissions for respiratory infections by type of infection
Total general waste produced per capita per year
Total hazardous waste produced per sector per year
Available landfill lifespan
Expenditure on waste management per capita per year
Total volume of waste reduced, re-used & recycled per type of waste per year
Household income
Adult literacy rate
Life expectancy
Unemployment rate
Notifiable diseases
HIV/AIDS prevalence
Level of service provision
Population growth rate
Urban rural distribution
Land use
Desertification
Soil loss
Land degradation
Soil acidification
Threatened and extinct species per taxonomic group
Endemic species per taxonomic group
Distribution and abundance of selected alien species
Visitors to conserved areas
Areas of conservation importance
Resource use: medicinal plants
Total surface water used per sector
Total surface water resources available per capita
Surface water nutrients
Surface water toxicity
Groundwater nutrients
Budgetary allocation to environmental management, education & awareness per capita
Voluntary adoption of environmental management systems
IDP commitment to environment
Government capacity for environmental management
Monitoring of implementation & compliance

Although the indicators have been presented above as a single list, many of the indicators can be used to provide information on a number of broad environmental issues.

For the purposes of the 2002 Mpumalanga State of the Environment Report the indicators will be presented via 'reporting themes'. These reporting themes are as follows:

- Poverty and vulnerability;
- Environmental management and governance;
- Water;
- Waste management;
- Air;
- Biodiversity; and
- Land.

For the most part the indicators can be grouped neatly into the different reporting themes, however a certain amount of overlap does occur in some cases. For example, the indicator reporting on the distribution and abundance of selected alien species will be reported in the Biodiversity theme, as well as the Water and Land themes. In each case the indicator can be used to complete a picture that will tell a certain story about that reporting theme. The table below shows the reporting themes, with core indicators that relate specifically to certain themes, and then additional indicators that will be used when reporting to provide a complete or holistic picture of the state of the environment in that particular theme.

Table 1: Reporting themes, core indicators and additional indicators

Reporting Theme	Core Indicators	Additional Indicators
Environmental Management & Governance	Budgetary allocation to environmental management, education & awareness per capita	Expenditure on waste management per capita per year
	Voluntary adoption of environmental management systems	Total volume of waste re-used, reduced & recycled per type of waste per year
	IDP commitment to environment	Areas of conservation importance
	Government capacity for environmental management	_
	Monitoring of implementation & compliance	_
Waste Management	Total general waste produced per capita per year	Level of service provision – refuse removal & sanitation
	Total hazardous waste produced per sector per year	Government capacity for environmental management
	Available landfill lifespan	–
	Expenditure on waste management per capita per year	_

	Total volume of waste re-used, reduced & recycled per type of waste per year	_
Air Quality	Electricity generation from coal-fired power stations	Level of service provision – energy
	Trends in household energy use per energy type	Soil acidification
	Ambient sulphur dioxide concentration	_
	Ambient particulate concentration	_
	Quarterly clinic admissions for respiratory infections by type of infection	_
Poverty & Vulnerability	Household income	Trends in household energy use per energy type
	Adult literacy rate	Quarterly clinic admissions for respiratory infections by type of infection
	Life expectancy	Resource use: medicinal plants
	Unemployment rate	–
	Notifiable diseases	–
	HIV/AIDS prevalence	–
	Level of service provision	–
	Population growth rate	–
	Urban-rural distribution	–
Biodiversity	Threatened and extinct species per taxonomic group	Land use
	Endemic species per taxonomic group	Desertification
	Distribution and abundance of selected alien species	Soil loss
	Areas of conservation importance	Surface water toxicity
	Visitors to conserved areas	Surface water nutrients
	Resource use: medicinal plants	Ground water nutrients
	–	Household income
	–	Unemployment rate
Land	Land use	Areas of conservation importance
	Desertification	Distribution and abundance of selected alien species
	Soil loss	–
	Land degradation	–
	Soil acidification	–
Water	Total surface water used per sector	Notifiable diseases
	Total surface water resources available per capita	Level of service provision – sanitation & water
	Surface water nutrients	Land use
	Surface water toxicity	Soil acidification
	Groundwater nutrients	Distribution and abundance of selected alien species

5. INTERPRETATION AND USE OF MPUMALANGA KEI's

Reporting Theme: Poverty and vulnerability

People who rely on environmental resources for their livelihood depend on two basic functions of the environment – that of a 'source' of resources and that of a 'sink' for pollution. Environmental degradation of natural, social and economic resources threaten the livelihood of many people, especially those who are already impoverished.

Poverty and vulnerability are inextricably linked, but they are not the same. Lack of financial resources or lack of *access* to financial resources is what makes a person poor, but it is the lack of access to other resources or coping mechanisms that make someone vulnerable to environmental change. While poverty can be measured by income (Chambers, 1995), vulnerability is measured by indicators other than monetary or income-based, such as health status or education levels.

Elements of society that tell us something about poverty and vulnerability are: income; education; health and assets. The core indicators for the poverty and vulnerability theme therefore include:

- Household income;
- Unemployment rate;
- Adult literacy rate;
- Life expectancy;
- Notifiable diseases;
- HIV/AIDS prevalence;
- Levels of service provision;
- Population growth rate; and
- Urban rural distribution.

The **Household income** indicator is a measurement of poverty (poverty rate) at the household level. When viewed against the poverty line, the proportion of households whose living standards fall below the poverty line can be established. This will indicate how widespread poverty is in the province.

Levels of employment within Mpumalanga will also provide an indication of the level of poverty and inequality in the province. The **Unemployment rate** indicator can display the state of unemployment in urban and non-urban areas as well as rates of unemployment between males and females. Although unemployment is a significant contributor to poverty, it should be noted, that a high employment rate does not necessarily mean that individuals are receiving a living wage. This indicator should therefore be coupled with the indicator of household income.

The **Adult literacy rate** indicator is a state indicator which provides a measure of the stock of literate persons within the adult population who are capable of using written words in daily life (Botha, 2002). The literacy of a population is critical for promoting and communicating the need to improve and address environmental and development issues. It facilitates the achievement of environmental and ethical awareness, values, and skills (CSD, 2001). Disparity in the literacy rate for men and women can also be shown and improvement of literacy in the province can be determined over time.

The **Life expectancy** indicator measures the average number of additional years a person could expect to live if current or prevailing mortality trends were to continue for the rest of that person's life (Botha, 2002). Life expectancy at birth is an indicator of mortality conditions and, by proxy, of health conditions (CSD, 2001). The mortality condition of the province's people can therefore be determined as well as an indication of health and social development.

Another health indicator is **Prevalence of HIV/AIDS**. This measures the percentage of the population estimated to be HIV positive. HIV/AIDS places increased demands on financial and institutional resources. It reduces the workforce, fractures and impoverishes families, orphans millions and shreds the fabric of communities (Aids Brief for Development Personnel, 1999, cited in Botha, 2002). HIV/AIDS not only adds to poverty but poverty can increase one's vulnerability to contract the disease.

The indicator **Notifiable diseases** will address four of the notifiable diseases reported in Mpumalanga, namely typhoid, malaria, cholera and tuberculosis. Cases of these diseases are reported to the Health Department by health care facilities in the province (DOH, 2002). Cholera and typhoid are both water-borne diseases that can be linked to the provision of sanitation and water supply. Malaria is linked to climate change, while tuberculosis can be directly linked with conditions of poverty and overcrowding (MRC, 1999).

Reports have shown that the poorest communities often have the poorest service provision (Thomas, *et al,* 1999). Another core indicator that can be used to understand levels of poverty and vulnerability in the province includes **Level of service provision**. This indicator will track the provision of services such as energy, housing, waste, water and sanitation in different local authorities in the province. Access to services is cited as a local factor having an impact on the conditions of life in communities in South Africa. The provision of services could therefore rapidly transform both the urban and rural environments, providing relief particularly to those living in poverty (DACST, 2002). However, to be successful, those services need to be socially acceptable, economically affordable and should not compromise the natural environment's capacity as a resource source or sink. A lack of services may also compromise the health status of both an individual and a community. This indicator will provide us with an indication of the equitable nature of service provision in the province.

The indicator **Population growth rate** is a pressure indicator which describes the percentage increase in population size in the province and can be used to determine how fast the size of the population is changing (Botha, 2002). Population growth rate can be linked to the indicator on unemployment to show whether the demand for jobs may increase and can also be linked to the indicators on level of service provision to show whether there will be a greater demand for services in the future.

The indicator **Urban rural distribution** describes the percentage of people living in urban and rural areas. This measure may be used together with indicators on household income, literacy, unemployment, notifiable diseases and level of service provision to show the distribution of income, education, health and access to services between urban and rural populations.

Measures of poverty are a very significant consideration of sustainable development. In assessing the state of the environment in Mpumalanga , it is necessary to consider all the elements of the natural and social environment, including poor and impoverished individuals.

Reporting Theme: Environmental management and governance

The characteristics or elements of good governance have been described as:

- Participation;
- The rule of law;
- Transparent;
- Equitable;
- Effective and efficient;
- Accountable; and
- Having a strategic vision (UNDP, 2002).

The indicators selected below seek to measure these characteristics in Mpumalanga Province. The environmental management and governance core indicators are as follows:

- Budgetary allocation to environmental management, education and awareness per capita;
- Government capacity for environmental management;
- IDP commitment to environment;
- Voluntary adoption of environmental management systems; and
- Monitoring of implementation and compliance.

Budgetary allocation to environmental management, education and awareness is a response indicator reporting on provincial and local government financial commitment to environmental management, education and awareness raising. The provision of adequate financial resources for environmental management, education

and awareness shows the political commitment to these issues. Many of the policy failures for environmental management and education relate to the constraints of implementation. These constraints tend to be rooted in a lack of financial resources and political commitment. Indirectly, this indicator will also tell us how provincial and local government prioritises environmental management, education and awareness in relation to other issues. Environmental education and awareness is an important component of this indicator as increased environmental education and awareness raising may lead to increased involvement and empowerment of people in environmental issues (DEAT, 2002a). This indicator also allows one to measure the effectiveness and efficiency of government. The presence of a strategic vision will guide expenditure and patterns will emerge, the expenditure patterns will highlight the presence or absence of a strategic vision.

In addition to measuring the financial commitment of government to environmental management, measuring governments' capacity to fulfill their role is vital. The indicator **Government capacity for environmental management** will track this capacity through monitoring the number of environmental management posts identified as necessary vs. the number of posts actually filled. This indicator will reflect both human resource and capacity constraints within government to implement environmental management. A lack of capacity is a serious inhibitor of implementation and monitoring of the environmental management policies, plans and programs. It must be remembered that the filling of all government posts does not completely reflect the ability of government staff to meet the environmental management needs of the province. Other factors such as insufficiently advertised posts, over-utilisation of staff and inequitable distribution of staff may be overlooked (DEAT, 2002a). The indicator will also provide information on the capacity of government to keep the rule of law.

Local level commitment to environmental management can be measured through the indicator **IDP commitment to the environment**. This is a state indicator that will track the commitment to the environment displayed by local authorities in their IDP documents. The indicator will measure commitment to the environment through the following questions (Morris, 2002):

1. Does the IDP show an understanding of the policy and legislative framework surrounding *environment*?
2. Does the IDP show an understanding of the implications of the above policy and legislative framework for the municipality and their day-to-day operations?
3. Does the IDP provide a structure and mechanisms for the responsibility and accountability of environmental issues?
4. Does the IDP provide an understanding of the environmental issues in the municipality, and the opportunities and constraints those issues may present?
5. Does the IDP provide Localised Strategic Environmental Guidelines for the development of strategies?
6. Is there an Integrated Environmental Program (IEP)?

7. Does the Medium Term Expenditure Framework (MTEF) provide a budget for the IEP?
8. Is there an Integrated Waste Management Plan (IWMP)?
9. Does the MTEF provide a budget for the IWMP?
10. Have any projects related to the following been identified?
    a) Sanitation and water
    b) Energy
    c) Integrated land and human settlement planning
    d) Environmental health
    e) Integrated pollution and waste management
    f) Biodiversity and sensitive areas
    g) Parks and open space
    h) Community based natural resource management
11. Does the MTEF provide budgets for the above projects?
12. Does the IDP specify how the EIA legislation will be complied with during the lifetime of the projects listed?
13. Throughout the IDP, is the *environment* considered in an holistic manner, or does it merely relate to conservation or 'green' issues?

The above indicator will also provide information on the transparency of the local government planning process, and the presence of an environmentally related strategic vision. Participation through the IDP process could be assumed through this indicator, although this is not necessarily always the case.

Private sector commitment to environmental management can be gauged through the indicator **Voluntary adoption of environmental management systems**. This indicator reflects corporate institutional support for environmental management. By adopting environmental management systems as part of their business processes, companies are investing in environmental management. These environmental management systems promote operating practices that protect the environment and strive for continuous improvement. The voluntary adoption of these systems reflects a commitment to the protection of the environment (DEAT, 2002a). This indicator will highlight corporate accountability and transparency. In addition, the presence or absence of a strategic vision will become clear once the indicator is being monitored. The systems to be included when reporting on this indicator include:

- ISO 14001;
- Eco-Management and Audit Scheme (EMAS);
- British Standard 7750 (BS7750);
- Responsible Care ®; and
- Forest Stewardship Council (FSC) certification.

The indicator **Monitoring of implementation and compliance** will track the implementation of environmental management plans approved through the EIA approval process. The indicator seeks to address those developments that, having undertaken an Environmental Impact Assessment (EIA), do not adhere to the specifications laid out in the attached environmental management plan. The

indicator will therefore display compliance to the EIA approval conditions. The indicator cannot currently be displayed due to a lack of information and data, however the method for future data collected will be provided in the Implementation Plan.

Reporting Theme: Water

Freshwater is essential to support human life, ecosystems, and economic development (CSD, 2001). The indicators are selected to cover both water quality and water quantity issues.

The indicators used to report on water in the province include:

- Total surface water resources available per capita;
- Total surface water used per sector;
- Surface water nutrients;
- Surface water toxicity; and
- Groundwater nutrients.

Management of water resources is critical in a water stressed country such as South Africa. It is necessary to monitor both the use and availability of water in the province. **Total surface water resources available per capita** is a measure of the availability of surface water for the entire population of the province. When viewed against thresholds for water scarcity, this indicator can show which water management agencies are stressed and which are not. **Total surface water used per sector** is a pressure indicator which measures the amount of water used by the urban and domestic sectors, irrigation, forestry, mining and ecological processes. Water "use" includes both the consumption and the utilisation of water.

In terms of water quality, two indicators which indicate the state of water quality of both surface water and groundwater include **Surface water nutrients** and **Groundwater nutrients.** Major water quality problems stem from sewage pollution, the intensive agricultural use of fertilizers and pesticides, industrial wastes, saltwater intrusion, and soil erosion (CSD, 2001). Surface water nutrients which are routinely monitored are levels of total inorganic nitrogen and orthophosphate. High nitrate levels in drinking water are dangerous to human health, and cause algae growth and eutrophication in waterways (CSD, 2001). By monitoring the ratio of total inorganic nitrogen to orthophosphate together with the absolute orthophosphate concentration, the potential for eutrophication will be determined.

The indicator **Surface water toxicity** measures the potential impact of impaired water quality on people and ecosystems. This indicator highlights the percentage exceedance of surface waters from South African Water Quality Guideline values (DWAF, 1996a and 1996b) to give an indication of the toxicity of surface waters.

Apart from ensuring good surface water quality, it is necessary to protect the integrity of groundwater reserves. Ineffective sewage disposal results in an increase in the nitrate concentrations in groundwater and the presence of potentially harmful microorganisms. Farming practices often result in increased nitrate concentration in groundwater, through the application of fertilizers (CSD, 2001). The indicator **Ground water nutrients** measures nutrients in ground water expressed as the concentration of nitrates and nitrites (mg/l NOx-N).

Reporting Theme: Waste management

When reporting on waste management, the following reporting elements should be highlighted:

- The production of waste;
- The disposal of waste;
- The treatment of waste;
- The reduction of waste; and
- Expenditure on waste management.

Reporting on these elements will enable one to understand the current waste management situation in Mpumalanga province (Godfrey, *pers comm*. 2002). The approach to integrated pollution and waste management spelled out in the White Paper on Integrated Pollution and Waste Management (DEAT, 2000) requires a shift from control to prevention. The shift to pollution prevention will:

- Minimise and/or avoid the creation of pollutants and waste;
- Minimise and/or avoid the transfer of pollutants from one medium to another;
- Accelerate the reduction and/or the elimination of pollutants;
- Minimise health risks and impact;
- Promote the development of pollution prevention technologies;
- Use energy, materials and resources more efficiently;
- Minimise the need for costly enforcement;
- Limit future liability with greater certainty;
- Limit costly clean-up practices;
- Promote a more competitive economy;
- Reduce human impact on the environment;
- Enhance the quality of life, and
- Ensure intergenerational equity.

The core indicators for waste management include:

- Total general waste produced per capita per year;
- Total hazardous waste produced per sector per year;
- Available landfill lifespan;
- Expenditure on waste management per capita per year; and

- Total volume of waste reduced, re-used and recycled per type of waste per year.

The consideration of waste can be broadly split into two main issues, waste generation and waste reduction. The indicators **Total general waste produced per capita per year** and **Total hazardous waste produced per sector per year** will address the issue of waste generation. The two indicators will consider the annual generation of general waste (primarily domestic) and hazardous waste (primarily health care and industrial). In the case of domestic waste a 'per capita' generation rate is needed for comparison purposes. In the case of hazardous waste, a 'per sector' rate is required for management purposes. General waste is waste that does not pose a significant threat to man and the environment if managed properly. It includes waste paper, metals, glass, plastic, organic and inert materials generated through domestic, commercial and industrial activities (DEAT, 2002b). Hazardous waste is defined in the National Waste Management Strategy as "waste that has potential even in low concentrations, to have a significant adverse effect on the public health or the environment" (DEAT, 2002b). Information on these indicators could be limited by the fact that waste sites in Mpumalanga province appear not to have weigh-bridges.

Available landfill lifespan considers the issue of waste generation, however it looks more closely at the rate at which landfill space is being used, and the average number of years each landfill can continue to be used at current rates. The information supplied by this indicator is critical to the planning of new landfill sites in the province. Trends in the incoming volumes of waste will also provide some indication of trends in waste generation and reduction, although it will not be known which trend is having the greater influence.

The fourth indicator considers **Expenditure on waste management per capita per year**. This indicator measures the municipal response to waste management. From this indicator one could infer the amount of waste in municipal areas based on how much money is spent per person each year to clean it up. However, those municipalities where little money is spent do not necessarily have small amounts of waste to collect.

Lastly, waste reduction is measured directly through the **Total volume of waste reduced, re-used and recycled per type of waste per year**. This indicator should ideally report on waste reduction and re-use in addition to recycling, although at present information is available only for recycling. Recycling is an alternative to disposing of waste in landfills, thereby reducing pressure on the available space in landfills. Recycling of waste may reduce pressure on natural resources. Recycling is also a means of job creation and generation of income, especially among low income groups (DEAT, 2002b).

Reporting Theme: Air quality

The factors contributing to air quality have been summarised as follows:

- Those factors causing a pollutant either to be emitted or formed; and
- Those factors causing a pollutant either to be dispersed or removed from the atmosphere (HEW, 2001).

Atmospheric emissions impact on all forms of life, with both the biophysical and social environments being affected (DACST, 2002).

The core indicators selected for measuring air quality in Mpumalanga include:

- Electricity generation from coal-fired power stations;
- Trends in household energy use per energy type;
- Ambient sulphur dioxide concentration;
- Ambient particulate concentration; and
- Quarterly clinic admissions for respiratory infections by type of infection.

The first indicator is a pressure indicator that considers **Electricity generation from coal-fired power stations**. The generation of electricity through coal-fired power stations in South Africa takes place predominantly in Mpumalanga province (Eskom, 2002). Much of the demand for electricity in the country thus generates ambient or outdoor air quality impacts that are felt largely in Mpumalanga. In addition, the generation of electricity from coal-fired power stations results in ambient air quality impacts such as the emission of particulates (Eskom, 2002).

In addition to knowing the potential for air quality impacts on the ambient environment, it is important to understand any potential impacts on the indoor air quality in communities in the province. Indoor air quality can be greatly affected by many different factors, including the dominant household energy source. Many households in Mpumalanga remain without electricity, approximately 50% of the black population do not use electricity while only 1% of the white population does not. In addition, there are urban/rural disparities in electricity use. The most common urban energy source is electricity while in rural areas the most common energy sources include candles, paraffin and wood (Statistics SA, 2001; CSS, 1998). The indicator **Trends in household energy use per energy type** will track trends in household energy use, and will also provide an indication of the indoor air quality environment in those homes not using electricity as an energy source.

Two indicators have been selected to monitor air quality, firstly **Ambient sulphur dioxide concentration**, and secondly **Ambient particulate concentration**. When monitoring air quality in Mpumalanga, the levels and spatial distribution of pollutants will constantly fluctuate in response to changing atmospheric conditions (Preston-Whyte and Tyson, 1988). Knowing the atmospheric levels of air pollution is also important for understanding the impacts of these pollutants on human and ecological health. The concentrations of these pollutants will provide an indication of how air quality is affecting the incidence of acute respiratory infections, particularly in children

and the elderly (MRC, 2001; MRC, 2000). This can also be verified through the indicator **Quarterly clinic admissions for respiratory infections by type of infection**.

Reporting Theme: Biodiversity

The core indicators for the biodiversity reporting theme include:

- Threatened and extinct species per taxonomic group;
- Endemic species per taxonomic group;
- Distribution and abundance of selected alien species;
- Resource use: Medicinal plants;
- Areas of conservation importance; and
- Visitors to conserved areas.

According to the United Nations Convention of Biological Diversity, biological diversity or biodiversity is defined as "the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (UNCBD, 1992). Due to the difficulties of measuring numbers and differences at the genetic level, the species and the ecosystem level are the most commonly measured and monitored levels.

Biodiversity is vital and contributes widely to a variety of environmental services, *inter alia* regulation of the gaseous composition of the atmosphere, protection of coastal zones, regulation of the hydrological cycle and climate, generation and conservation of fertile soils, dispersal and breakdown of wastes, pollination of many crops, and absorption of pollutants (UNEP, 2002). The reporting theme Biodiversity aims to address biodiversity at the species and ecosystem levels. The indicators: threatened and extinct species per taxonomic group; endemic species per taxonomic group; and distribution and abundance of selected alien species, all report at the species level but because species are influenced by and influence their surrounding environment, these indicators also implicitly report on ecosystem status and integrity (Smith, 1990). The areas of conservation importance indicator and the land use indicator from the Land reporting theme describe biodiversity explicitly at ecosystem level. The mapped categories from the land use indicator that are relevant to this reporting theme provide a current state of natural vegetation in the province. The relevant categories are as follows: woodland; forest; thicket; shrubland; herbland; wetlands and waterbodies (Thompson, 1999).

Humans are the ultimate threat to biodiversity through their increasing population growth, high levels of consumption and inefficient use of resources. They threaten biodiversity in four main ways: land / urban development; production of waste and pollutants; overexploitation of resources and through the introduction of alien species (UNEP, 2002; WRI, 2000). Poverty has often been blamed for environment degradation and biodiversity loss, especially in developing countries, however it is often the

economic, social and political setting which creates the root causes of poverty and environmental degradation. The central tenet of the sustainable development concept supports this assertion, where political governance, social, economic and environmental considerations are inextricably linked (Fakir, 2002).

Over the past three decades, decline and extinction of species has emerged as a major global environmental issue. Reductions in species' numbers or extinctions is not only a loss of the intrinsic value of the species but may also impact on the collective species' ability to provide valuable ecosystem services such as water purification, erosion control and flood attenuation (UNEP, 2002). The **Threatened and extinct species per taxonomic group** indicator reports on the number of species categorized according to the IUCN classification as extinct, critically endangered, endangered, vulnerable and near threatened per taxonomic group. This is reported as a percentage of the known (described) or estimated indigenous species in that taxonomic group for Mpumalanga province. The **Endemic species per taxonomic group** indicator measures the number of endemic species or species that are restricted to the province. Endemic species are important because their conservation is the sole responsibility of the people in the region in which they occur. A threatened endemic should be a conservation priority (Begon *et al*., 1990). Another threat to biodiversity is that of introduced alien (invasive) species especially in sensitive and already degraded ecosystems (UNEP, 2002). The **Distribution and abundance of selected alien species** indicator provides summary data on the numbers of invading alien species in Mpumalanga province. Data for this indicator are available from the Working for Water programme, which is a multi-departmental initiative led by the Departments of Water Affairs and Forestry, Environmental Affairs and Tourism and Agriculture that aims to sustainably control invading alien species. The objectives of the programme are to *inter alia* enhance water security, improve the ecological integrity of natural systems and restore the productive potential of the land (DWAF, 2001). The trade in medicinal plants is another important issue that affects biodiversity integrity in Mpumalanga Province, where the current levels of demand exceed the supply (Emery *et al*., 2002). The **Resource use: Medicinal plants** indicator measures the distribution of medicinal plants in the Province according to their conservation status and popularity as medicinal plants in trade.

The focus of conservation action, in terms of biodiversity protection, has shifted from protecting individual species to conserving habitats and ecosystems. The designation of protected areas, such as national parks, is one of the most widely used approaches for conserving habitats (UNEP, 2002). The **Areas of conservation importance** indicator measures the conservation value of the land as an aggregated index of important communities and important species that occur within Mpumalanga Province (Emery *et al*., 2002). These sites of intrinsic biodiversity value will be overlaid with the boundaries of protected areas in order to assess those areas of conservation importance that are not formally protected by the State. Protected areas are those that are protected under the Mpumalanga Nature Conservation Act of 1998 and the National Parks Act of 1976, thus private nature and game reserves will not be included in the analysis of this indicator.

The richness and diversity of ecosystems in Mpumalanga underpins a flourishing tourism industry, which contributes significantly to the provincial and national economy. The **Visitors to conserved areas** indicator measures the annual number of visitors utilising conserved areas and thus the potential tourism value of these sites.

Reporting Theme: Land

The core indicators for the land reporting theme include:

- Land use;
- Desertification;
- Soil loss;
- Land degradation; and
- Soil acidification.

The **Land use** indicator is a state indicator, the categories of which are those derived by the CSIR for the National Land Cover Database (Thompson, 1999). The categories provide a baseline or current state of land use in the province. The categories can be linked to some of the key environmental issues and indicators that were identified for the Mpumalanga Province (Table 2).

Table 2: Land use indicator categories and related issue/sector/indicator

Mapped Category	Related Issue / Indicator
Woodland Forest Thicket Shrubland and low Fynbos Herbland	Increase / decrease of biodiversity on spatial scale of habitat
Wetlands Waterbodies	Increase / decrease in extent of aquatic ecosystems
Unimproved grassland Improved grassland Forest plantations Cultivated land	Growth/Decline in Agriculture and Forestry sector
Barren rock Dongas & sheet erosion scars Degraded natural land	Soil loss Land Degradation
Urban - residential Urban – commercial Urban - industrial / transport	Urban – rural ratios (area) Growth / decline in Industry / transport /commercial / residential sectors
Mines & quarries	Growth / decline in Mining sector

The UN Convention to Combat Desertification (UNCCD) defines desertification as 'land degradation in arid, semi-arid and dry sub-humid areas' brought about by factors such as climatic variations and human activities (UNCCD, 2001). The **Desertification** indicator shows the total extent of affected dry land areas (as defined by the UNCCD) over the total area of the country (and therefore Mpumalanga province). Aridity is calculated as a ratio of mean annual precipitation to potential evapo-transpiration. As the percentage of land area that falls within the UNCCD categories changes, e.g. if more land is classified as arid over time this could result in increased soil loss. As aridity increases so vegetative cover decreases, increasing the susceptibility of soil to erosion (Brady & Weil, 2000).

The **Soil loss** indicator is a measure of how much soil is lost per year due to water erosion. Soil loss / erosion is a major factor in land degradation and has severe effects on soil functions, such as the soil's ability to act as a buffer and filter for pollutants, its role in the hydrological and nitrogen cycle, and its ability to provide habitat and support biodiversity (UNEP, 2002). Typically, there is a lag period where the effects of an aridity change and therefore soil loss may only be observed in for example, a change of agricultural practices or reduction in habitat distribution, years after the change has occurred.

South Africa's obligation to the UN Convention to Combat Desertification requires that a National Action Programme (NAP) be developed in order to address the problems of land degradation. A national assessment was undertaken by the National Botanical Institute in 1999, comprising the development of a 'Combined Degradation Index'. 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 and a Soil Degradation Index (SDI) and Vegetation Degradation Index (VDI) were developed and aggregated to form a Combined Degradation Index (CDI) (Hoffman *et al*., 1999). The **Land degradation** indicator is based on these three indices.

Land degradation leads to a significant reduction of the productive capacity of land. Human activities contributing to land degradation include unsuitable agricultural land use, poor soil and water management practices, deforestation, removal of natural vegetation, frequent use of heavy machinery, overgrazing, improper crop rotation and poor irrigation practices (UNEP, 2002). Those activities that involve clearing or disturbance of natural vegetation typically create a pathway for alien invasive plant species, impacting on natural species biodiversity (Smith, 1990).

Land degradation reduces the productivity of land, requiring farmers to apply more fertilizers and other chemicals that help check falling productivity. This has a spin-off impact on surface and ground water quality (Davis & Day, 1998), as well as soil quality (Brady & Weil, 2000). The increasing usage of chemical fertilizers brings about significant changes in soil pH (Brady & Weil, 2000). The **Soil acidification** indicator measures the acidification of soils at selected sites in South Africa (and therefore Mpumalanga province). The degree of acidity of a soil can be expressed as a pH

value. The degree of soil acidity has been described as a master variable that affects nearly all soil properties – chemical, biological and physical. This variable controls plant nutrient availability and microbial reactions in the soils. It affects the rigour of natural vegetation growth and determines which cultivated crops will thrive or deteriorate in a given area. Soil pH also determines the fate of many soil pollutants, affecting their breakdown and possible movement from the soil into groundwater and streams (Brady & Weil, 2000).

In order to achieve the sustainable use of land resources; good governance, land and soil policies and legislation, and continued effort to build up the capacities of land resource planners, farmers and managers at local and national levels is necessary.

6. THE WAY FORWARD: COMPILING THE 2002 MPUMALANGA SOE REPORT

The purpose of this study is to compile the 2002 Mpumalanga State of the Environment Report using the Mpumalanga Key Environmental Indicators as an entry point. This report represents the second of two outputs for Phase 2: Indicator Development. The Key Environmental Indicators that have been selected are outlined and discussed in this report. The indicators have gone through a rigorous selection and approval process involving both experts and stakeholders, and are presented in this report in the form they will be used in the 2002 SOE Report.

Since this report represents the end of Phase 2, several tasks must still be undertaken in order to complete the project. These tasks are as follows (see Figure 1: Flow diagram showing the methodology used to select Mpumalanga's Key Environmental Indicators).

- Measure the indicators by collecting and compiling the latest provincial and local municipal data;
- Presentation and aggregation of the indicators in the draft 2002 Mpumalanga SOE Report;
- Interpretation and reporting on the themes in the draft 2002 Mpumalanga SOE Report;
- Client review of the draft 2002 Mpumalanga SOE Report, and
- Completion of the 2002 Mpumalanga SOE Report.

Through these tasks the 2002 Mpumalanga State of the Environment Report will be completed. In addition to the above, the project calls for a Local Authority State of the Environment Training Programme. This training programme is planned for early 2003. The completion of the training programme will result in the project drawing to a close.

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8. APPENDIX 1

The matrices in this section show the linkages between the core indicators selected in each reporting theme and the key environmental issues raised by the stakeholders. The key environmental indicators have been grouped into reporting themes. Cross-tabulation of the indicators and issues shows the number of issues each indicator will address.

	Key Environmental Indicators – Air Quality				
	Electricity generation from coal-fired power stations	Trends in household energy use per energy type	Ambient sulphur dioxide concentration	Quarterly clinic admissions for respiratory infections by type of infection	Ambient particulate concentration
Key Environmental Issues					
Air pollution	X	X	X	X	X
Visibility (saw dust, fires, burning)	X	X			X
Pollen					
Greenhouse gases	X				
Domestic coal use		X	X	X	X
Vehicle emissions			X		X
Dirt roads					X
Asbestos					
Coal dumps	X		X	X	X
Abandoned mines				X	X
Industrial & other emissions	X	X	X	X	X
Respiratory health problems	X	X	X	X	X
Odours			X		
Reliance on coal for electricity generation	X		X		X
Ambient particulate concentration	X	X		X	X

	Key Environmental Indicators – Waste Management				
	Total general waste produced per capita per year	Total hazardous waste produced per sector per year	Available landfill lifespan	Expenditure on waste management per capita per year	Total volume of waste reduced, re-used & recycled per type of waste per year
Key Environmental Issues					
Waste generation	X	X	X	X	X
Waste management	X	X	X	X	X
Permitting of landfills			X		
Inadequate land for landfills	X		X		X
Hazardous waste		X			
Contamination of water	X	X	X		
People living near waste sites					
Sewage facilities					
Private waste sites		X			
Landfill site suitability			X		
Waste separation at collection points					X
Waste minimization	X	X	X		X
Adequate waste collection services	X			X	
Hazardous waste transport		X			
Holfontein hazardous waste site			X		
Control of CH_4 emissions from landfills		X	X		
Illegal dumping	X	X	X		

	Key Environmental Indicators – Environmental Management				
	Budgetary allocation to environmental management, education & awareness per capita	Voluntary adoption of environmental management systems	Government capacity for environmental management	IDP commitment to environment	Monitoring of implementation & compliance
Key Environmental Issues					
Uncoordinated approach to the EIA process				X	X
Uncoordinated conservation and land use planning			X	X	X
Control of illegal activities	X	X	X	X	X
Government capacity to fulfill their monitoring role	X	X	X	X	X
Government capacity to control activities	X	X	X	X	X
Government capacity for implementation of policies, plans & programs	X		X	X	X
Overlapping roles of national, provincial and local government departments			X	X	X
Private sector support for environmental management		X			

	Key Environmental Indicators – Poverty and Vulnerability							
	Household income	Adult literacy rate	Life expectancy	Unemployment rate	Notifiable diseases (cholera, typhoid, malaria & TB)	HIV/AIDS prevalence	Population growth rate	Urban/rural distribution
Key Environmental Issues								
Health	X		X		X	X		
Poverty	X	X	X	X		X	X	X
HDI	X	X	X	X		X		
Malaria			X		X			
Cholera			X		X			
Typhoid			X		X			
HIV/AIDS			X			X	X	
Literacy rate	X	X						
Unemployment	X	X		X				
Provision of services & infrastructure					X			X
Human settlements	X				X			X
Health care provision/access	X		X	X	X	X	X	
Education		X			X	X		X
Economic development and growth	X	X		X	X	X	X	X

	Key Environmental Indicators – Biodiversity				
	Threatened and extinct species per taxonomic group	Endemic species per taxonomic group	Distribution and abundance of selected alien species	Areas of conservation importance	Visitors to conserved areas
Key Environmental Issue					
Spread of alien species			X		
Loss of biodiversity	X	X		X	
Encroachment of agriculture onto natural land				*	
Bio-prospecting					
Habitat fragmentation				*	
Riparian destruction				*	
Deforestation	X	X		*	
Wetland destruction	X			*	
Decreasing natural vegetation			X	*	
Reduction of resource base	X		X	*	
Impacts of tourism on natural resources					
Resource value of protected areas					X
Curio trade					
Muti trade					

*Note: addressed through the Land use indicator

	Key Environmental Indicators – Land				
	Land use	Desertification	Soil loss	Land degradation	Soil Acidification
Key Environmental Issue					
Degradation of soil resources		X	X	X	X
Soil erosion			X		
Soil quality		X	X		X
Land degradation				X	X
Overgrazing		X	X	X	
Degradation of natural resources	X	X	X		
Conflicts over land use	X				
Land invasions					
Encroachment of agriculture onto natural land	X			X	
Increasing urbanisation	X				
Increasing industrialisation	X				
Afforestation	X			X	X

	Key Environmental Indicators – Inland water				
	Total surface water used per sector	Total surface water resources per capita	Surface water nutrients	Surface water toxicity	Groundwater nutrients
Key Environmental Issues					
Water quality			X	X	X
Water consumption	X				
Access to water		X			
Sanitation			X	X	X
Alien fish species*					
Alien plant species*					
Acid mine drainage			X	X	X
PH			X	X	X
Sulphates				X	
Heavy metals				X	
Biological pollution			X	X	X
Payment for water					
Wetland destruction*					
Agricultural pollution			X	X	X
Water consumption by forestry	X				
Sand mining in rivers					
Cross-boundary water transfer					
Stream piracy					
Abandoned mines			X	X	X
Pesticides and herbicides			X	X	X
Intensity of water use per sector	X				

*Note: These indicators are to address the issues around ***water quality*** and ***water consumption***. Issues around ecosystem integrity are to be covered through the biodiversity/terrestrial and land cover indicators.

9. APPENDIX 2

The Key Environmental Indicators were developed through a rigorous process involving both experts and stakeholders. In order to present the initial draft set of indicators to the stakeholders, a workshop was held in Nelspruit on 5 November 2002. Stakeholders were invited to attend by Mpumalanga Department of Agriculture, Conservation and Environment (DACE). The stakeholders present represented a broad spectrum of local, provincial and national government departments, Mpumalanga Parks Board, various non-governmental organizations and environmental consultants.

The workshop agenda is presented below:

- Introduction
- Objectives
- Project overview
- Background on indicators
- Discussion and queries
- Presentation of the draft Mpumalanga indicators
- Breakaway sessions – focused workshop of each theme with smaller stakeholder groups
- Feedback session on the draft Mpumalanga indicators

The objectives of the workshop were as follows:

- To ensure a participative project process ;
- To build understanding of the process of indicator development;
- To present the draft set of indicators to stakeholders;
- To obtain feedback on the draft set of indicators; and
- To allow stakeholders the opportunity to assist in further developing the indicators.

The main outcomes of the workshop were captured during the day, and are outlined below with a few comments on each reporting theme:

- Stakeholders readily understood the concepts presented to them;
- The draft set of indicators presented on 5 November 2002 was accepted by the stakeholders, with a few changes to be made;
- It was recommended that a chapter on driving forces be included in the 2002 SOE Report since no 'driving force' indicators have been selected;
- A request was made that a 'responses' section in the SOE Report be investigated, this would include existing and potential future responses for the province;
- The Poverty & Vulnerability indicators were accepted with a few changes;
- The Air Quality indicators were accepted with the knowledge that data may be very limited;
- The Waste Management indicators were accepted with few changes;

- The Environmental Management & Governance indicators were altered to better reflect the information required to report on this theme;
- The Water indicators were not covered in this workshop since no stakeholders could provide adequate expertise. The water indicators were therefore reviewed in a separate meeting with DWAF representatives from their Mpumalanga office;
- The Biodiversity indicators were a few minor changes and additions; and
- The Land indicators were accepted.