



Global Terrestrial Observing System

**Regional Implementation Plan
for
Southern Africa**

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Executive Summary

This report was compiled, on the invitation of the Global Terrestrial Observing System (GTOS) International Secretariat, by 11 environmental information specialists from southern Africa, with the assistance of two specialists from international organizations. The specialists covered the fields of climate, atmosphere, hydrology, terrestrial ecology, desertification and biodiversity, and have a wide experience of the Southern African Development Community (SADC) region (see Annex 1). During 1999, country assessments were made of user needs in both the scientific and policy communities. This process led to the identification of a wide range of experts and expertise in each country and formed the basis for organizing a workshop to review the GTOS programme, and its relevance to country priorities. The expert working group convened in Pretoria in February 2000 to consider the viability, role and establishment of a southern African regional component of the Global Terrestrial Observation System (GTOS-SAF).

Their findings are that:

There is a unique, unfilled and useful regional niche for GTOS in southern Africa, provided that it recognizes, builds on and links to the existing environmental information providers and users in the region.

Its key role should be that of a data broker. Facilitating the movement of information laterally (between disciplines, and between nations in the region) and vertically (from the national scale, to the regional scale and global scale, and *vice versa*). This would involve improving the availability, analysis and communication of information relating to changes in land quality, loss of biodiversity, pollution, climate change and freshwater systems from regional to global scales.

SAf would also need to perform 'added-value' activities of its own, in order to survive in the current competitive funding environment. Examples of added-value could be actions in supporting the periodic regional State of the Environment Reports, briefing papers, and regional syntheses in relation to meeting some of the data and information requirements of the international environmental conventions.

The most sensible geographical range for SAf would be the SADC countries. The most viable mode of operation in southern Africa will be to seek formal recognition by the environmental components of SADC, in particular the SADC-Environment and Land Management Sector (ELMS) and SADC-Food, Agriculture and Natural Resources (FANR). SAf should also attempt to be fully integrated into the SADC-ELMS and FANR programme of action and, if possible, co-locate with their activities.

It is the recommendation of the group that GTOS proceed to establish a pilot regional SAf, by undertaking the following actions:

Prepare a submission to SADC-ELMS and SADC-FANR presenting its proposed activities in the region, pointing out the close alignment with the stated aims of SADC, and requesting recognition as an approved project of SADC, as well as requesting whatever non-financial support is appropriate.

Establish a SAf internet site and load it with information regarding the sources of relevant information for the region through the use of an information management system.

Assist with the formation of a regional consortium to develop proposals to suitable funding agencies for two initial activities.

1. The development of a regional land cover information system.
2. The collation and analysis of data in support of regional State of Environment Reporting.

Background

During the twentieth century it has become apparent that the collective and cumulative consequences of human activities are altering the environment at both a local and global scale. These changes are of a type and magnitude that could threaten the capacity of the biosphere to support life and limit the options for further human development. Recognizing this, the nations of the world have agreed to several treaties. They have also created a number of organizations, whose aim is to understand, monitor and regulate changes in the environment, with the intention to avoid actions which are detrimental to the global environment and to sustainable development.

It is among the functions of governments to advance the well-being of their citizens and to protect the natural resources within their territorial jurisdiction. To this end, all nations have systems to monitor the state of their own environment. These systems operate with varying degrees of effectiveness, comprehensiveness and compatibility with the systems operated by neighbouring countries. There is an important class of environmental issues which are manifested at scales greater than single nations, that is, at the scale of regions or the entire globe. It is only possible to understand and manage these issues through cooperative action between nations.

Five international organizations¹ recognized the need for an improved operational mechanism to supply information relevant to the detection, mitigation and avoidance of environmental problems, particularly at scales greater than individual nations. This need is exemplified by the information demands imposed by environmental treaties such as the UN Framework Convention on Climate Change, the Convention to Combat Desertification, and the Convention on Biological Diversity. To address this need a Global Observing System is being developed, which for practical reasons consists of three coordinated and integrated subsystems: a Global Climate Observing System, a Global Ocean Observing System and a Global Terrestrial Observing System. Each of these systems is being implemented, according to their own schedule and operational plan.

The Global Terrestrial Operating System (GTOS) was launched in 1996 and is developing through a number of initiatives. An important activity is the initiation of a

¹ The United Nations Food and Agriculture Organization (which also hosts the GTOS Secretariat), the United Nations Environment Programme, the International Council of Scientific Unions, the World Meteorological Organization, and the United Nations Education, Scientific and Cultural Organization

set of global- and regional-scale pilot projects. One such project is an exploration of the feasibility of, and requirements for, a Global Terrestrial Observing System in southern Africa ('GTOS-SAf'). A survey of regional needs and existing Environmental Information Systems was commissioned. With this survey as background, an expert group was convened to recommend to GTOS how it might proceed with implementation in the region.

Mandate of this Report

The recommendations which follow were drafted by a southern African expert group, on the request of the Global Terrestrial Observation System International Secretariat. The group (Annex 1) was selected to cover both the range of environmental disciplines within the scope of GTOS, and the geographical distribution of the SAf project, covering Botswana, Namibia, South Africa, Zimbabwe and the Southern African Development Community environmental bodies. The views of the participants are based on their expertise, and not in the form of representatives of the organizations or countries from which they were drawn. The recommendations are not binding on their institutions or governments, and not even to GTOS. The objective is to provide GTOS with a considered opinion, rooted in regional experience, regarding the role that GTOS could play in southern Africa, and how it might implement such a role.

The Mission and Goals of SAf

It is the opinion of the expert group that the mission of GTOS-SAf should be:

To enhance the access by policy-makers, resource managers, researchers and others to the information needed to detect, understand and respond to changes in the capacity of southern African land and water systems to sustain development. It will achieve this by:

- 1. building on existing environmental information systems and expertise;**
- 2. working with other initiatives where appropriate;**
- 3. focusing on the SADC region, and**
- 4. concentrating on the issues of biodiversity, pollutants, climate change, and food.**

The goal should be to establish, within a five-year period, the system and structures necessary to give effect to this aim. The attributes and principles of this system should include the following:

- It must complement, and not replace, national environmental information systems and their components. In general, the collection of primary environmental data is a national responsibility. SAf can play a role in promoting common regional standards, the exchange of data between nations, and regional re-analysis and synthesis.

- SAf could have a role in the dissemination at the national or local level of data and information which is by nature regional or global. Examples of such information include certain types of atmospheric analyses and space-based remote sensing data. SAf could also have a role in initiating the collection of such data where it does not already exist.
- SAf must strive for the most efficient and effective solution to the provision of environmental information needs at the regional level. This can only be achieved by coordination and collaboration with existing and future institutions with compatible missions.
- The SAf system should be compatible with, and allied to, similar systems in other regions of the world, in order to facilitate the agglomeration of regional environmental information at the global scale, and the dissemination of global information to the region.
- SAf must ensure its financial sustainability by adding value, clearly in excess of the costs of its operation, and being acknowledged to do so by its sponsoring stakeholders. It needs to generate unique, identifiable products with wide utility.

An initial set of objectives could include the following:

- **Establish an inventory of land, water and atmosphere observing systems in the region and their contents and conditions of use.**
- **Develop and strengthen linkages between activities related to land, water and atmosphere observing systems.**
- **Identify inadequacies in existing environmental information systems and recommend remedial actions.**
- **Enhance the quality, availability and continuity of environmental information by promoting a process of assessment and improvement of data acquisition, analysis, storage, dissemination, and communication.**
- **Facilitate the production of a regional land cover information system.**
- **Contribute to ongoing State of Environment Reporting by assisting with the collation, analysis and interpretation of key environmental indicators.**
- **Develop the human capacity to sustain the initiative.**

Sphere of Activity

SAf should cover the geographical domain of the members of the SADC. This consists of Angola, Boswana, the Democratic Republic of the Congo, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe. These form a politically and economically consistent unit, and with the exception of Mauritius, are geographically contiguous. These countries

are also reasonably consistent from a drainage, climatological and biological perspective. No other southern African footprint makes much sense for SAf.

Initial implementation may focus, for practical reasons, on a smaller group of countries having well-developed national EIS (Environmental Information Systems). The cluster of Botswana, Namibia, South Africa and Zimbabwe is an obvious entry point. To gain essential regional political support SAf will need to move beyond this starter group within a few years.

If SAf is to operate on a multinational basis anywhere in the SADC region, it will be undesirable (and probably impossible) to do so without the explicit endorsement and collaboration of SADC bodies (specifically ELMS and FANR) charged with environmental responsibilities.

Rationale for SAf

There is a clear need for improved environmental management in southern Africa, including better access to environmental information. The populations and economies in southern Africa are growing, and with growth comes greater pressure on the environment. The majority of the population is poor, and most are rural; thus there is a high dependence on the environment for livelihoods. The institutions for environmental monitoring and management are generally young (post-colonial, in many cases), under-funded, under-skilled and typically have little political influence. Environmental regulations, where they exist, are often either permissive or not enforced.

A large number of organizations already exists in this field (see Annex 2, Survey of EIS in Botswana, Namibia, South Africa and Zimbabwe prepared as part of this project, Scholes *et al.* 2000). They range from those which have statutory responsibility for environmental information, to local, national and international NGOs. Given this complexity, in what way will SAf be of assistance rather than hindrance or diversion in attaining the mission of environmental sustainability in southern Africa?

It can only do so by:

- **Focusing on those things where it can make a unique contribution.**
- **Being closely needs-oriented.**
- **Adding much more value than it subtracts from the shared funding pool.**
- **Making the task of the stakeholders easier rather than more difficult.**

Value addition is possible through the following mechanisms.

- **Economies of scale.** It is nearly always easier, and an order of magnitude cheaper, to perform certain activities at a regional level rather than individually or country-by-country. Examples include operations which are computer intensive rather than labour-intensive (such as the analysis of remote sensing data), or operations which

require a large initial capital investment (such as advanced chemical analyses), but which would be under-utilized at the national scale.

- **Harmonization and data sharing.** Pooled data typically has greater value than isolated data, by virtue of a larger sample size and the wider range of environments that it spans. Pooling can only be achieved if the data are comparable, which requires harmonization.
- **Synthesis.** Synthesis is the process whereby new information emerges from the analysis of existing, separate datasets. It therefore goes beyond summarization, to the generation of new understandings, resulting from synergies between previously isolated pieces of information. Synthesis activities are recognized as one of the most cost-effective ways to deliver new knowledge at this point in environmental science.
- **Additional analysis.** The residual value of datasets can be released by analysis. Unanalysed data is worthless. Few institutions in the region have the resources to fully realise the information content in their data sets.
- **Leveraging international intellectual, financial and technological resources.** The international community has access to resources currently hard to access by national EIS. These include intellectual property (e.g. models and remotely sensed data), funding sources, and technology (methods of analysis, new instruments).

Core Activities of SAf

Who are likely to be the SAf stakeholders?

A stakeholder is any person or group of people who can affect the outcome of a project in a significant way. ‘Stakeholder’ is not synonymous with ‘beneficiary’, ‘user’ or ‘client’, although these three groupings are usually also important stakeholders. The five key groups of SAf stakeholders are likely to be:

- National environmental officials;
- Environmental non-governmental organizations in the region;
- SADC environmental authorities;
- Global environmental information holders;
- Global environmental data users.

In addition, there are a number of interested and affected parties, who include, amongst others:

- Citizens of southern Africa, with an interest in the environment;
- Learners at high school and university level;

- Research workers in the field of the environment;
- Consultants on development and environmental impacts;
- Companies operating in southern Africa, or planning to do so.

The main interests and needs of the key stakeholder group are outlined Table 1.

What kind of information should SAf deal with?

GTOS International, the parent body of SAf, defines its domain as including the following issues: land quality, freshwater resources, climate change, biodiversity and pollution. The following regional environmental issues qualify for attention by SAf.

- Water quantity and quality in shared river systems and aquifers.
- Factors which influence the regional or global climate system or which are indices of its state.
- The chemical composition of air masses which cross national boundaries.
- The population status of organisms naturally-occurring in southern Africa, which migrate or disperse across national boundaries.
- The distribution of alien organisms which have the biotic potential to invade neighbouring countries.
- The population status and trend of organisms and ecosystems whose natural distribution occurs in more than one southern African country, and which is endangered within one or more countries.
- The capacity of ecosystems (including agro-ecosystems) to provide food and fibre sufficient for the needs of the region.
- The transport of hazardous material between countries in the region, whether by design or accident.

Table 1 The main interests and needs of the key SAf stakeholder group

Stakeholder	Why Important to GTOS	Needs
National environmental officials e.g. civil servants in depts. of Environment, Water, Agriculture, etc.	Holders of the primary data Decision-makers Source of decision information Guidance on key issues	Acknowledgement Comparative data from neighbouring countries Regional data Technical support and training in some cases
Environmental NGOs	Data sources and users 'Competition' if not coordinated	Funding or support for funding Easily accessible synthesised information outside of their core area Permanent archives
SADC environmental authorities, e.g. FANR, ELMS	Gate holders to SADC Source of decision information to SADC	Technical support Demonstration of impact Readily accessible regional information
Global data holders, e.g. CEOS, WMO	Sources of global data, e.g. satellite images, models, atmospheric analyses etc.	Locally validated data, 'ground truth', demonstration of impact
Global data users	Leverage for globally sourced funding Guidance on key issues	Consistent, reliable regional data on global issues

This is not necessarily an exclusive list, but future additions should pass the following tests:

- Regionality (i.e. it should be of more than local interest, and apply to more than one nation in the region).
- Relevance (i.e. it should help satisfy a demonstrable need).
- Fit with the GTOS mandate.

What part of the Environmental Information System spectrum should SAf occupy?

EIS activities and the role that SAf may have are shown in Table 2.

The core role of SAf should be that of a data broker, re-packager and interpreter. The primary data collectors are national agencies, or in the case of certain global datasets, international agencies. SAf must assemble, in easily accessible and readily interpretable form, the information needed for informed decision-making on the topics identified above. It needs to do this in a timely manner, which requires that it

maintains continuously updated products relating to the main issues. This would enable SAf to undertake special assessments, if necessary, on demand.

Key to the envisaged role of SAf is the function of the information broker. This involves knowing who needs what sort of information, who has it, and what is necessary to bring them together. This includes both technical competencies in understanding data and its exchange, and legal, financial and political competencies in negotiating its availability. Several organizations (e.g. SARDC and Netwise) intend to operate as regional metadata (data about data) collectors: in other words, to know who has what data, rather than to maintain the data themselves. There is no harm in GTOS contributing to this role as well, provided that it focuses on its main areas and avoids competition and duplication where possible. By itself metadata is insufficient for SAf. SAf will need to deal in data itself.

This core role of SAf should consist of identifying and sourcing the necessary data, converting it into compatible formats, units, regions and time periods. It should also include quality checking the data, combining it and subsetting it for the various users, and ensuring that it reaches them timelessly and in understandable form. SAf must also add value to data through interpretation and meta-analysis. Graphical display, trend analysis, threshold detection, spatial mapping, compilation of indicators and summarization are all activities which SAf should undertake.

Communication, both in the sense of facilitating the electronic movement of data to and from national and global sources, and in the sense of raising the awareness and understanding of local, national and regional stakeholders in environmental issues, is an essential SAf role.

GTOS should not accept responsibility for primary data collection, unless such data, are by their nature principally of regional or global rather than national importance and therefore unlikely to be collected by nations individually, are critical for the GTOS mission, and are not likely to be collected by any other agency.

The role of harmonizer of national-level EIS is logically a SADC responsibility, but SAf could play an important supportive role. There is significant cost- saving potential through promoting the use of a single set of database systems and exchange formats throughout the region.

Given the uneven status of national EIS in the region, SAf may need to play, at least initially, other roles as well. It may need to act as an advocate for sustained and increased national funding for EIS. It may need to take a catalytic role in encouraging the establishment or upgrading of certain data categories at national level. It may consider a training role as part of its quest to improve standards and harmonization.

Table 2 The characterization of the activities of environmental information systems and the possible role of SAf. Note that the activities do not necessarily follow in exactly this linear sequence.

Activity	GTOS role
Design of the observing system	Large potential role, drawing on GHOST and TOPC work, publicizing best practices, promoting standards and harmonization.
Primary data collection and quality control	Limited role: may act as a proxy regional source for some global data products, e.g. remotely-sensed products.
Data analysis	Significant role here, particularly in the distillation of SoER indicators at a regional level.
Data communication	Key GTOS role: maintenance of quality metadata, facilitation of data flows through IT, negotiating use agreements.
Data storage	Not a preferred GTOS role: performed by DAACs and WDC at global scale, and nations at national scale, but there may be a critical need at regional scale which SAf might fill by default.
Data synthesis	Important SAf role, combining variables in new ways to add value, and combining national datasets into regional ones.
Reporting	In general, this role is well filled by other regional organizations (IUCN, IMERCSA). The GTOS role is to ensure that the analysed data are in easily accessible form.
Interpretation	In general, this step will be done by groups closer to the end users. In some cases, such as interpretations in support of the conventions, SAf may be the appropriate organization to do the interpretation.
Revision of observing system	Important GTOS role: gap analysis and remediation; continuous reassessment of inputs and indicators for effectiveness, sensitivity and efficiency.

What kind of products should SAf generate?

The primary SAf products should be internet-based, with supplementary paper and CD-ROM products. SAf should maintain a state-of-the-art website of regional environmental information, as well as a gateway to datasets (which may be held elsewhere, or by SAf), archival material and reports. The content should be current, but not real-time. A delay of about six months would be acceptable; delays of up to several years are likely. The scale of spatial products should in general be 1:1 million or broader. Scales more detailed than this are conventionally regarded as a national prerogative.

The availability and bandwidth of Internet services in the region is currently variable, but growing rapidly. Key decision-makers already have access to the web but at present this is not the preferred data source in most cases. There is a trend towards a wider use of the web in the future. The products in other media should be derived from the primary product, for reasons of efficiency and consistency. They should be intended for specific purposes or audiences for whom the internet is either inaccessible or inappropriate. CD-ROM can act as a bridging technology, since it can supply a web-like interface and capability, but with high access speeds and a sense of ownership. The disadvantage is that the information becomes dated, so the CD-ROM needs to be updated and circulated on a regular basis. Annually is probably sufficient in the SAf context.

Substantive paper reports have the advantage of being easily and securely archived in existing libraries, and rapidly consulted without computers or web skills. If well printed, bound, issued with ISDN numbers and lodged in accessible libraries, they retain a credibility as reference material not yet attained by web products. HTML technology means that they can be easily derived from web material. SAf should aim at an annual report, of perhaps 30 pages, highly graphical and tabular and in colour, reporting on trends in the main indicators. In addition, it should aim at a more substantive, book-length analysis and synthesis once every five years, preferably in coordination with region 'state of the environment' exercises.

One-page briefing notes, tightly focused on a topical issue, and written specifically for decision-makers, are highly valued by busy politicians and top civil servants. They provide high exposure, but must be timely, unbiased, to-the-point and targeted. SAf should produce such documents one month before major SADC meetings (with some environmental content), and before meetings of the global environmental treaty bodies: Climate Change, Desertification and Biodiversity. These briefing notes should be disseminated by direct mailing, fax, e-mail, internet and by having printed copies at the meeting venues.

SAf should consider producing a numbered series of technical reports (in both electronic and paper form) covering environmental information standards, methods and training materials.

Maps and posters are very suitable for a broader audience. Their primary role is communication and education.

The SAf participants should be encouraged to publish information in the open, in peer-reviewed international scientific publications. This will serve to enhance the credibility and increase the exposure of SAf, while developing the careers of the authors.

Initial Projects

The following projects and activities would serve to demonstrate SAf capacity and establish its credentials.

1. Data brokerage

SAf could undertake to be a facilitator of access to environmental information in the region. The specific actions it could take in this regard include:

- Maintaining a database of players in the environmental information arena, identifying which organizations collect information, the type of information and how it can be obtained.
- Assisting with the negotiating of agreements for the exchange of data.
- Developing translation software to convert data in different national formats into a common format.

2. State of the environment reporting indicator collation

SoER (State of Environmental Reporting) is currently taking place at both national and regional level. This has highlighted the unavailability of indicator data, despite the large quantities of primary data that are collected in the region. SAf could occupy a useful niche by acting as the regional collator of relevant primary data, and synthesiser of the data into easily understood, quantified indicators for further use by the SoER process. These indicators should be tailored to address, in particular, issues relating to climate change, land cover change, loss of biodiversity and loss of the capacity of the system to deliver food, freshwater and other natural resources and benefits. In this way GTOS will have both regional relevance and global utility.

3. Data repository for relevant regional-scale limited-period experiments

There is currently no regional archive for the data produced (at great effort and expense) by limited-duration projects. Examples of such projects currently underway include assessment of the Zambezi Basin, and the SAFARI 2000 regional air chemistry and circulation experiment. These data have value beyond the immediate objectives and timeframes of the projects, which are producing them. This value needs to be preserved and exploited by making the data available in-region, on an ongoing basis.

4. Regional land cover information system

Several SADC countries have recently completed national land cover maps at 1:250 000 scale, and these have been generalized and combined at 1:1 M scale. The missing areas could be patched with the global 1 km land cover dataset or similar products derived from MODIS data. The land cover data is of great relevance to the information needs of the UN Framework Convention on Climate Change, the Convention on Biodiversity, and the Convention on Combating Desertification. Its usefulness for these and other applications would be greatly enhanced if it were made available in a system also containing:

- Data coverage of land cover class attribute data (for instance, biomass, fire frequency, biodiversity);

- Data coverage of driver variables of land cover change (such as population, rainfall and soil quality);
- Subsequent land cover maps, allowing cover change to be mapped.

5. Short-duration synthesis activities

In general, the major information constraint in the region is in making data available and comprehensible, rather than collecting it. A series of targeted workshop activities, each with the objective of producing a synthesis volume, could go a long way towards bringing information into the public domain while building networks and providing due acknowledgement to those who collected the data. Two examples of potential synthesis activities are:

Dynamics of land cover change, based on area case studies;

Guidelines for river health assessment systems.

6. Formalization of a regional Long- Term Ecological Research site network

A GTOS partner organization, ILTER (International Long Term Ecological Research site network) has initiated discussions within several SADC countries regarding the development and regional networking of LTER sites. Namibia has already registered as an ILTER partner, and South Africa is in an advanced state of planning to do so. This will provide an on-the-ground observation network, which GTOS can both benefit from and institutionally support and promote. The sort of activities SAf could perform would be to promote best-practice methodologies and data exchange standards, as well as convening regional meetings to make the network a reality.

Governance of SAf

The details of SAf governance will depend on the institutional arrangements which are made to house it, but in principle SAf should have a Governing Body, with approximately the following composition:

- Four regionally-based technical representatives, who should be spread to the greatest degree possible across disciplinary areas and geographical expertise. They should not represent nations or organizations, but provide input based on their individual technical capacity.
- A representative of SADC-FANR.
- A representative of SADC-ELMS.
- A representative of GTOS International.

The SAf director would attend the Governing Body meetings *ex officio*. Meetings should be no less frequent than once every two years, and last about a week, with

frequent e-mail 'virtual' meetings in between. A typical model would be that the representatives of SADC and GTOS International would pay their own travel and attendance costs, while the technical representatives travel and subsistence would be covered by SAf, and their time costs by their home institutions.

The first task of the Governing Body would be to prepare a 10-15 year business plan, especially outlining the potential benefits and financial liabilities to SADC member states.

Organization of SAf

An analysis of the proposed work plan, outlined below, suggests that the minimum core staffing for SAf would consist of a director, environmental analyst and a electronic communications specialist (see Table 3).

There would probably be a need for secretarial support as well, which could be shared. Other functions, needed on a discontinuous basis, could be contracted out, for example, journalistic capacity, bookkeeping, GIS, and desktop publishing.

Since a staff of three would tend to become very isolated if on their own, it is strongly recommended that they be co-located with an existing SADC environmental organization. This could result in considerable synergy and critical mass benefits, as well as cost saving on shared office infrastructure. SAf should remain financially and institutionally independent.

However, partnerships can provide distinct advantages in developing the GTOS programme. Some possibilities would be in association with SADC-FANR in Harare, or nearby to the SADC secretariat in Gaborone, or in association with an environmental NGO (IUCN-ROSA or WWF), or a UN office (e.g. FAO or UNEP).

Relationship with Other Organizations

Given the complexity of the task, and the large number of other organizations engaged in it, SAf will inevitably have to operate in a collaborative, networked fashion where it only has direct control of a relatively small core function. SAf must strive to have influence over a wider set of players and activities, and must be aware of and take into account an even wider set of organizations and data. The central 'influence' group consists of at least:

- Global GTOS;
- ILTER (International Long-Term Ecological Research network);
- SADC environmental structures;
- Regional environment and development NGOs;

National Government Departments with Environmental Responsibilities: Funding of SAf

Seed funding for initial activities (such as website development and proposal consortium meetings) is probably available from GTOS international.

During its first phase, SAf has a good chance of being able to secure project-related funding from international donors, provided it has clear and needed products in mind. During this time the GTOS board would need to develop a 10-15 year business plan outlining its strategy for ensuring continuation funding.

Continued financial viability will be strongly dependent on swiftly demonstrating the usefulness of the organizations to all its stakeholders. Start-up costs may be obtainable from the international donor community, but SAf would need to migrate to a regional financial support base within ten years for long-term survival.

Table 3 The suggested minimum core staff for SAf

Position	Key attributes
Director	Technical and political credibility in the region, good networking and communication skills, administrative and financial skills, ability to create and lead consortia, willingness and capability to nurture successors
Environmental analyst	Environmental data analysis experience in the southern African context, and statistical, graphical and spatial analysis and communication skills.
Electronic communications specialist	Demonstrated ability to design, install, maintain, operate and upgrade electronic communication systems, including e-mail, Web servers and online databases.

Table 4: Short-term action plan

What	When	Who
Draft a collaboration proposal for SADC.	2 months	GTOS Intl. office
Build and maintain an interest network in the region through informal communication.	3 months	Continuation group: Bob Scholes, Jeff Tschirley, SADC ELMS and FANR
Sign an MOU with SADC and appoint a Governing Body.	12 months	GTOS Intl.
Establish a working group/consortium of interested parties to develop one or more project proposals.	-	-
Establish a web presence and an online directory of organizations and initiatives in the land, water and atmosphere observation and information arena in southern Africa.	Complete within 12 months	Use hardware and expertise in existing organizations, e.g. FAO, Rome
Develop Business plan and secure 2-year initial activity funding.	18 months	Governing Body
Run a rapid, regional synthesis activity to raise awareness and demonstrate capability (see examples above).	Complete within 2 years of funding	co-opted interested parties
Get papers on observing systems, particularly into regional journals.	Published within 30 months	Start up working group

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**A Survey of Environmental Information Systems
in Southern Africa**

by

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1. Introduction

Background

The Global Terrestrial Observing System (GTOS) is an international collaborative effort aimed at providing policy-makers, resource managers and researchers with access to the data they need to detect, quantify, locate, understand and warn of changes in the capacity of terrestrial ecosystems to support sustainable development. GTOS is sponsored by the Food and Agriculture Organization of the United Nations (FAO), the International Council of Scientific Unions (ICSU), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Environment Programme (UNEP), and the World Meteorological Organization (WMO).

GTOS, as it completed its planning phase and moved into implementation, identified southern Africa as one of a few potential locations for a pilot implementation programme. The first step is to identify the regional issues and needs, what systems already exist, and who are the key players. This report was commissioned by GTOS for this purpose. It deals with environmental information systems (EIS) in Botswana, Namibia, South Africa and Zimbabwe, as well as overarching regional systems within the Southern African Development Community (SADC) organizations. The environment is taken to mean the land surface and its biota, freshwater and its biota, and the near-ground atmosphere. It includes systems highly modified by human activity, such as agriculture and urban areas.

Purpose of the Report

The purposes of this report is to describe:

1. The existing environmental data collection systems in each country, in terms of who is responsible for them, what data are collected, how the data are made available, and who uses them.
2. The current and projected environmental information needs in each country, in terms of who the users are, the types of information they need, and their preferred mode of supply.

This report will serve as input into the next phase of GTOS planning, which is for regional stakeholders to make recommendations to GTOS regarding the implementation of the system in southern Africa.

Summary of Findings

1. There are numerous environmental information systems in the southern African countries surveyed (Botswana, Namibia, South Africa and Zimbabwe) and a high, although uneven, level of activity in EIS.
2. Despite the substantial resources going into EIS (it is probably in excess of US\$100 million, regionally, including salaries), the needs of users are still not being met in many respects. The principle problems relate to the conversion of raw data into information, and making this information accessible where, when and in the form needed. Most agencies are significantly behind schedule in bringing out periodic summary products.
3. This failure in the delivery chain is at least partly due to a failure by the data collectors and holders to view the data users as 'clients', leading to a poor understanding of their needs. There is seldom a direct and rapid feedback from user dissatisfaction to remedial action. The resulting poor information service ultimately leads to the loss of support for the data agency and represents a threat to its continued existence.
4. In the longer term, this lack of 'service orientation' probably contributes to the strain which most of the agencies report in meeting ever more complex information demands on a shrinking budget.
5. There is little integration of information systems at a national level, and even less at a regional level.
6. There are significant gaps in the systems: for instance, air quality and land quality are poorly covered in all the countries surveyed.
7. Topics which are relatively well covered in most countries include water quality, biodiversity and climate (including drought impacts).
8. There are many instances of 'best practice', which could be regionally and globally shared.
9. There is significant duplication of effort at the regional scale in the areas of the acquisition and processing of regional-scale satellite remote sensing products, and the independent development of national information systems, for instance in the areas of hydrology, groundwater and biodiversity tracking.

The countries surveyed almost certainly constitute the bulk of the EIS activity in the SADC region, but should not be considered a complete or representative sample. The EIS in the remaining SADC countries (Angola, Democratic Republic of Congo, Lesotho, Malawi, Mauritius, Mozambique, Swaziland, Tanzania, and Zambia) are generally less well developed than in the surveyed countries.

Acronyms and Abbreviations Used Widely in the Report

If an acronym cannot be found in this list, consult the country-specific acronym lists in each chapter.

AVHRR	Advanced Very High Resolution Radiometer
CBD	Convention on Biological Diversity
CCD	Convention on Combating Desertification
CITES	Convention on International Trade in Endangered Species
CoP	Conference of the Parties (of the UNFCCC, CBD and CCD)
FAO	Food and Agricultural Organization of the United Nations
GAW	Global Atmosphere Watch (a programme of the WMO)
GDCs	Global Data Centres
GDP	Gross Domestic Product
GIS	Geographic Information System
GTOS	Global Terrestrial Observing System
ICSU	International Council of Scientific Unions
ILTER	International Long-Term Ecological Research
IPCC	Intergovernmental Panel on Climate Change
NDVI	Normalized Difference Vegetation Index
NGO	Non-governmental organization
NOAA	National Oceanic and Atmospheric Administration (of the USA)
OSS	Observatoire du Sahara et du Sahel
PRECIS	National Herbarium Pretoria (PRE) Computerized Information Service
RAMSAR	Ramsar intergovernmental treaty on wetlands and migratory species
SPOT	Satellite pour observation de la terre
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
WHYCOS	World Hydrological Cycle Observing System

2. Botswana

Acronyms used in Botswana

BRIMP	Botswana Range Inventory and Monitoring Project
DFID	Department for International Development (United Kingdom)
FRIEND	Flow Regimes from International Experimental and Network Data
NCS	National Conservation Strategy

Country Profile

Land Surface

Land Area: 582 000 sq km
Formally conserved area: 17%
Area transformed by cultivation: 2%

Demographics

Population: 1 630 000
Urban percentage: 28%
Population growth rate: 2.45%

Economy

GDP in 1998: US\$4 864 million at current prices
GDP Growth rate (1993-1998): 4.8% (at constant prices)
Contribution to GDP by tourism and hunting: 3% (1998)
Contribution to GDP by agriculture: 3.1% (1998)
Contribution to GDP by mining: 37.6% (1998)

Governance

Political system: Parliamentary democracy
Environmental governance: Principally at a national level

Climate

Arid, ranging from 650 mm (rainfall) per annum in the northeast to less than 250 mm in the southwest.

Landform and geology

Botswana is a flat country, dominated by the Kalahari sand sheet, which covers the underlying geology for over more than 80% of the surface area. As a result, there are few permanent surface waters, although there are many features reflecting a moister past.

Biota

With the exception of the wetlands associated with the Okavango Delta, the Savuti Marsh and Linyanti River in the north, the entire country falls within the savanna biome. The tree density and height varies greatly, from low, sparse shrubs (frequently *Acacia* species) in the extremely arid regions, to 15 m tall, near-closed canopy *Baikaea plurijuga* woodlands in the moist areas. Substantial

areas in the north-central region are covered by stands of *Colophospermum mopane*. There are several treeless areas (arid grasslands), typically associated with ancient drainage lines or lake floors, and large areas of saline pans, which are unvegetated. Crop agriculture is confined to a relatively small area (300 000 ha) on the eastern and northern margin of the country, off the Kalahari sands and in areas with rainfall above 450 mm. The principal crops are maize, sorghum, millet and pulses.

This vegetation historically supported a large, migratory ungulate community, with attendant predators. Although this community is still mostly intact and numerous, due to the large areas set aside for conservation, its migratory behaviour has been greatly reduced by the erection of veterinary fences and the encroachment of cattle into former wildlife habitats.

Numerically, the biodiversity is moderate, since the underlying geology is fairly uniform and the climate occupies a narrow range. Nevertheless, due to its spectacular nature, it is a major focus of the tourism industry, which is the third-largest (and rapidly growing) component of the GNP (after mining and livestock). It is highly likely that tourism will dominate the economy at some future stage.

Major Environmental Issues

Pollution and toxicity

Botswana is a lightly industrialized country with a relatively sparse population. As such, air pollution is not perceived to be a major problem at present. As in other countries in the region, widespread vegetation fires and dust in the dry winter months establish a moderately high background level of aerosols and ozone. A copper smelter located at Selibi-Pikwe is a significant source of sulphur dioxide. Vehicle use within the capital, Gaborone, and the towns of Francistown and Maun is increasing, and could be a future source of air pollutants. The national development strategy, which includes increased light industry, could lead to greater air pollution impacts in the future.

Biodiversity preservation

Botswana has the largest fraction of land area under formal conservation of any country in the world. The preservation of the large mammal and bird biota, as well as the unique landscapes of the Kalahari, the Okavango Delta, and the Chobe area, are especially important to the continued growth of the tourism sector. The principle tension is between wildlife and domestic livestock. Areas which were formerly very sparsely inhabited and lightly used, due to lack of water, geographic isolation and the presence of cattle diseases, are now becoming accessible to cattle raisers due to the development of new roads, boreholes and veterinary services.

Land quality

The arable land area in Botswana is small, due to the low rainfall and the sandy, infertile soils, which prevail over most of the country. Maintenance of the productive potential of this scarce resource is a key issue: soil erosion and bush encroachment (and its opposite, depletion of woody cover) are perceived as significant threats.

Freshwater resources

Botswana is generally an arid country, with little surface water except in the far north. Much of the country depends on groundwater. Major issues are the rate of groundwater replenishment relative to the rate of extraction, and groundwater quality. The quality and quantity of inflows to the Okavango delta are also key variables.

Climate change

Recurrent droughts are a major feature of life in Botswana. Climate variability and any changes in variability or trends in aridity would be of major importance to Botswana.

Status of National Environmental Observing Systems

Institutional framework

Government Organizations		
Ministry	Department	EIS Functions
Ministry of Transport and Works	Meteorological Department	Collects, analyses and disseminates weather data
Ministry of Agriculture	Agricultural Resources Board	Wide powers, especially around drought interventions and fires
	Dept. of Agricultural Planning and Statistics	Collects and publishes (annually) data on agricultural inputs and outputs
	Department of National Parks and Wildlife	Aerial survey of wildlife
	Botswana Range Inventory and Monitoring Project (BRIMP)	Vegetation inventory and monitoring of rangeland condition
Ministry of Mineral Resources and Water Affairs	Dept. of Water Affairs	Monitoring ground and surface waters, quantity and quality
	Dept. of Mines, Air pollution control division	Air quality
Ministry of Local Government, Lands and Housing	National Conservation Strategy Advisory Board	Coordination between government departments on sustainable development
Ministry of Health	Environmental Health Unit	Hazardous waste, human health issues
Ministry of Finance	Central Statistics Office	Economic and population statistics
Parastatal Organizations		
Botswana Power Generation Corporation	Operates the only thermal power station in Botswana	
Non-governmental Organizations		
Kalahari Conservation Society	Wildlife and birds	
Veld Products	Community-based natural resource management	

Analysis of existing sites

The tier definitions applied below follow those of GTOS

Name of site Responsible agency	Latitude	Longitude	Comments
Tier 2: Long-term, permanently staffed sites conducting advanced observations on many variables, often with experimentation			
Harry Oppenheimer Okavango Research Centre (U Botswana)	19.92 S	23.59 E	Recently established, has a flux tower operated in conjunction with the Max Plank Institute. Operate throughout the Okavango delta and surrounds
Tier 3: Long-term, staffed sites routinely observing a core set of variables (research stations)			
Sebele Agricultural College	24.45 S	25.55 E	Agricultural research station; mainly livestock research
Savuti wildlife research station	18.38 S	24.05 E	Wildlife research within the Chobe National Park and surrounds
Daily weather stations	Gaborone, Francistown, Maun and Ghanzi		Weather variables only
Tier 4: Locations which are periodically visited			
BRIMP monitoring plots	Nationwide		Currently 300, perhaps 600 in a few years time
Hydrological weirs	North and east		10 (4 of which are part of WHYCOS)
Monitored well fields	Nationwide		17 (increasing to 30), automatic
Weather stations	Nationwide		400 (20 automatic)

National networking

The Office for the Coordination of the National Conservation Strategy is the body with the formal mandate to ensure that environmental activities are coordinated across sectors. This is a relatively new office, and as yet there is not a great deal of evidence of national networking of environmental information systems. The scientific and technical community in Botswana is relatively small, and highly concentrated in Gaborone. Therefore most people involved in environmental observations know of the other players in the field.

International networking

Botswana is a signatory of the UN Framework Convention on Climate Change, the Convention on Biological Diversity and the Convention for Combating Desertification, among other international environmental treaties. The hydrological network is linked to FRIEND and HYCOS, and the climate network contributes to WMO.

Legal framework for data handling

Almost all environmental data in Botswana are held by government agencies and in principle most of it is in the public domain, and available on request to other Botswana Government agencies, citizens of Botswana, consultants and researchers with *bona fide* reasons to use it. There is considerable sensitivity regarding its use by researchers and other organizations based outside of Botswana, based largely on a concern that the agencies which collected it will not be adequately recognized, or that the data will be used inappropriately.

Use of environmental information

The principle users of environmental information in Botswana are the Government departments themselves, for purposes of planning and regulation; consultants engaged in planning work in Botswana; and researchers, largely based at the University of Botswana.

Sectoral Environmental Information Systems

Weather and climate

The Meteorological Department in the Ministry of Transport and Works operates a network of about 400 rainfall stations and 14 temperature and humidity stations. The geographical coverage is sparse in the central Kalahari, which has few inhabitants and few roads. Data is measured daily on paper forms and submitted on a monthly basis to the head office in Gaborone, where they are entered onto the CLICOM database. Hourly surface meteorological data is measured at Gaborone, Ghanzi, Maun and Francistown, and upper-air soundings daily at Gaborone, Tsabong, Letsekane and Maun.

The earliest rainfall record is from 1909. The major part of the network was established after 1930, with the temperature stations added after 1958.

In addition to the above, there are 20 automatic weather stations (11 operated by the meteorological office, and nine by the Department of Hydrology). They collect temperature, wind, humidity, solar radiation and rainfall data hourly, and download the information *via* satellite. These stations are designed to fill the information gaps in the sparsely populated parts of the country, and only require servicing once every two years.

The Meteorological Department has a Meteosat and NOAA receiver, and has collected these data for four years. They have investigated the use of Cold Cloud Duration for rainfall estimation in remote areas.

Water resources

Surface water resources

Quantity of flow

The Department of Water Affairs (Ministry of Mineral Resources and Water Affairs) has operated a network of gauging stations on rivers and impoundments since 1969.

There are approximately ten recorded stations, some of which have automatic chart recorders, which are visited daily, weekly or monthly. There are four WHYCOS stations that are installed or planned, which will collect water level data on a continuous basis, and download it *via* satellite link. These stations form part of the FRIEND network coordinated by the Institute of Hydrology (UK).

The data are captured in an electronic database called HYDATA, in Gaborone. The users are mainly consultants and researchers, to whom it is supplied free of charge on request.

Water quality

A new and sophisticated water analysis laboratory is located at Water Affairs in Gaborone. Samples are drawn weekly from about 87 stations nationwide and analysed for inorganic chemical constituents.

Groundwater resources

Every borehole that is drilled in Botswana must submit a drill record, after which a borehole certificate is issued. In the process, the location, depth to water, casing type, Total Dissolved Solids (TDS) and pump test data are recorded in an electronic database maintained by the Department of Water Affairs, but shared with Geological Services. This database was begun in 1992. About a fifth of the boreholes are privately owned. Drilling is now done by private contractors, who require a registration number and must provide the drill logs to the Government.

Seventeen well fields (which will increase to 30) are monitored for water table levels and major ion chemistry. The water yield of each well in the well field is recorded monthly. The depth records of the 17 boreholes are automatically recorded and reported *via* satellite. The data originally went into the WELLMON database, which this is now too small, so a new database is now under development. The main users are the Ministry itself, and managers and consultants in the water sector. The monitoring of individual boreholes is now the responsibility of local Government.

The wells around mining areas are monitored for pollutants by the mining companies themselves. Water Affairs supervises this process.

Land cover, Land use, Land quality

Vegetation

The Botswana Range Inventory and Monitoring Project (BRIMP), a unit established in 1996 and initially funded by a DFID grant and located in the Ministry of Agriculture, is re-mapping and sampling the vegetation of Botswana. Approximately 20% of the task is complete. Ground data on species composition and cover is captured from 30x30 m permanent plots, of which 300 have been collected. The data are captured in GIS format.

Land use

Land use maps are produced in the planning office of the Department of Parks and Wildlife. Databases of hunting licenses and returns are maintained and used by the Department in setting annual hunting quotas. The Department of Local Government and Lands periodically compiles a national land use map at 1:1M scale.

Degradation

BRIMP also generates various degradation maps and datasets, based on ground monitoring and the interpretation of Landsat images, specifically aimed at addressing desertification questions.

Soils

The soils of Botswana were surveyed by the FAO in 1979 at a reconnaissance scale of 1:250 000 (or 1:1M in the central Kalahari). In the process, 3 500 profiles were captured in a computer database, which can be used by specialists and consultants. An ongoing survey at 1:50 000 is taking place within the agricultural areas. There is a soil analysis laboratory at Sebele research station. No monitoring of soil quality occurs.

Agricultural productivity

Area planted with crops and forests, crop and plantation forest yields, and livestock

The Department of Agricultural Planning and Statistics (Ministry of Agriculture) is responsible for all agricultural statistics. In this task it collaborates closely with the Central Statistics Office of the Ministry of Finance, which is responsible for trade statistics and the decadal national census. Agricultural surveys are conducted annually, on the basis of a sampling frame established in 1992. There are about 50 enumerators in the field on a continuous basis, each responsible for a district. In addition, there are ten data entry and analysis staff in Gaborone. Data on livestock numbers, area planted and crop yields are collected, as well as input costs and farming practices. Livestock data mostly come from dipping records. The 1995/6 survey was published at the end of 1999. The data are disseminated as an annual report, to about 400 users inside and out of Government. A nominal fee is charged.

In a separate study, a sample of 200 farmers is being followed for 15 years, for in-depth analysis.

The Department also coordinates the National Early Warning System, which completes a food balance sheet every three months, and monitors (with Water Affairs) rainfall (with the Meteorological office) and water availability for people and livestock. The nutritional levels of children under five, obtained from the Department of Health, is used as a key indicator.

Pesticides

The Environmental Health Unit (Dept. of Health) maintains a database of hazardous chemicals manufactured in, or imported to, Botswana. The Department of Agriculture maintains a database of pesticide use in Botswana.

Indigenous biological resources

Plant resources

‘Veld products’ (plant-derived natural resources) are important for subsistence in the rural areas. An NGO, Veld Products Research, and several USAID projects have focused on community based natural resource management, including innovative methods for community-based monitoring of the resource. Data on these aspects are only available for certain localities.

Animal resources

The Department of Parks and Wildlife has conducted aerial surveys to count wildlife since 1979. These surveys have been countrywide since 1989, and were conducted twice annually up to 1995. They are now flown annually, in the dry season. The sampling intensity ranges from 4 to 10%, depending on the wildlife density. This requires ten wildlife biologists, and takes two months using two aircraft. All animals are counted, including livestock. The main users of the data, other than the Department itself, are wildlife area concession holders.

Biodiversity

Conserved areas

The planning section of the Department of Parks and Wildlife keeps a database of conserved areas.

Rare and endangered species

It is not known if there is a specific responsibility for the maintenance of these data.

Plants, mammals, birds, fish, reptiles, amphibians and invertebrates

There does not appear to be a centralized authority for all or any one of these taxa. Specialists are located in the University of Botswana and the Department of Parks and Wildlife. There are several active NGOs (Kalahari Conservation Society, Okavango Wilderness Society, Botswana Society), which bring together both specialists and amateurs.

Air quality

The air pollution control division of the Department of Mines is responsible for air quality. A small number of bubbler samplers for SO₂ have operated since the mid-1970s. Total suspended aerosols have been measured since the 1990s. A new air quality network is proposed, consisting of 17 sites in ten towns, at which SO₂ (14 sites), NO_x (nine sites), CO (four sites), O₃ (four sites), particulates (two sites) and hydrocarbons (one site) will be monitored on a continuous basis. The first samplers were commissioned in June 1999.

Precipitation chemistry is measured at Maun.

Ancillary data: economic activity and population statistics

The Central Statistics Office, in the Department of Finance, is responsible for population and economic activity data. National censuses are conducted once every ten years.

User Needs Assessment

Data and information needs

The National Conservation Strategy (NCS) coordinating office is a key information user. It is responsible for promotion of sustainable development, and is driving a legislative reform programme, as well as instituting Environmental Impact Assessments for major projects, Strategic Environmental Assessments, and State of the Environment Reporting. The availability of data for these purposes is at present untested. The NCS is an agency within the Ministry of Local Government, Lands and Housing. There is debate about whether NCS should not be in the Ministry of Finances (to facilitate one-point licensing of new enterprises) or a possible Ministry of the Environment (to try to unify the fragmented environmental responsibilities, currently distributed over at least five ministries). NCS was created by a White Paper (number 1 of 1990), and is broadly responsible for the coordination of a strategy leading to sustainable development. NCS maintains close linkages to the line function ministries, and in particular to the Agricultural Board and the Land Board.

The first SoER is to be undertaken this year (following failed attempts in the past). It will be performed by contractors, under the supervision of the NCS. Although the White Paper calls for a biennial SoER, in practice it is likely to be every 5 to 10 years.

It is the opinion of the NCS that it is not too early for the principal products of observation systems to be Internet-based. A distributed clearing-house type of data structure is preferred, with the main role of the central hub being meta-data maintenance and quality assurance. The main users are thought to be all levels of governance (from local to national) and consultants.

Another major information user is the Agricultural Resources Board. It receives maps of the area burned by vegetation fires, and drought stress indicators. Both types of map are generated by BRIMP from NOAA AVHRR data, on a quarterly basis, in the form of coarse (national) scale maps. Originally these products were delivered ten-daily, but this was found to lead to information overload. The map legends are kept simple (above average, average, below average) and have been effective in influencing the allocation of drought interventions. The maps are backed up by sociological information derived on the ground, relating to impacts.

From the perspective of an environmental lawyer closely associated with environmental policy-making and legislation in Botswana, there is not a large public demand for environmental information in Botswana. This is attributed to a low public awareness of environmental issues. People working within a sector generally have access to information through their networks of personal contacts.

Environmental legislation in Botswana is strongly influenced by the needs of international conventions, such as those on waste management, biodiversity, desertification and climate change.

Requirements raised by potential users of GTOS

None.

Key Stakeholders

Organization	Person contacted	Areas of interest
National Conservation Strategy Private Bag 0068 Gaborone, Botswana tel: +267-302 050 fax: +267-302 051	Mr Stevie Monna	Coordination of sustainable development
Ministry of Water Affairs, Department of Hydrology Private Bag 0029 Gaborone, Botswana tel: +267-351 601 fax: +267-030 508	Mr Muzila	Surface water flow and chemistry
Ministry of Water Affairs, Department of Groundwater Private Bag 0029 Gaborone, Botswana tel: +267-351 601 fax: +267-030 508	Dr Thomas Reikel Mr Alfred Adams	Groundwater availability and quality
Department of Wildlife and National Parks PO Box 131 Gaborone, Botswana tel: +267-373 433 fax: +267-312 354 e-mail: dwnpbots@global.bw	Mrs Rapelang Mojaphoko Direct tel:+267-371 405	Aerial wildlife census
Botswana Museum Private Bag 00114 Gaborone, Botswana tel: +267-374 616 fax: +267-302 797	Miss T Pule	Did not believe that the Botswana Museum was the right institution to engage with GTOS
Division of Mines Private Bag 49 Gaborone, Botswana tel: +267-365 7000 fax: +267-352 141 e-mail: cmatale@gov.bw	Mr Choma Matale	Air quality
Dept. of Meteorological Services PO Box 10100 Gaborone, Botswana tel: +267-356 284 fax: +267-356 282	Ms Ramothwa	Communication by letter; expressed interest in GTOS

Key stakeholders continued

Organization	Person contacted	Areas of interest
Kalahari Conservation Society PO Box 859 Gaborone, Botswana tel: +267-374 557	Mr Wazha Tema	Biodiversity, protected areas
Ministry of Health Private Bag 00269 Gaborone, Botswana tel: +267-352 000 fax: +267-350 100	Mr Denis Bella Tel: +267-581850/3	Human health issues; hazardous materials
Ministry of Agriculture Private Bag 003 Gaborone, Botswana tel: +267-350 603/4 fax: +267-375 805	Dr Gakale Mr HK Sigwele Mr TD Mafoko	Agricultural Statistics Soil survey
Ministry of Agriculture, BRIMP PO Box 710 Gaborone, Botswana tel: +267-350 500 fax: +267-307 057 e-mail: brimp@info.bw	Mr Raymond Kwerepe Dr Greg Stewart Hill	Range inventory and monitoring
University of Botswana, Dept. of Environmental Sciences Private Bag 0022 Gaborone, Botswana tel: +267-355 0000 fax: +267-356 591	Prof Mosisi Nkambwe Direct tel: +267-355 2533	General environmental information
Consultant Private Bag 15 Jwaneng, Botswana tel and fax +267-382 023 cell: 7210 7301	Ms Nancy Basinyi- Moyo	Environmental law

3. Namibia

Acronyms used in Namibia

CRIAA	Centre for Research Information Africa Action
DEA	Department of Environment Affairs
DRFN	Desert Research Foundation of Namibia
DSSS	Division of Specialist Support Services (of the Ministry of Environment)

Country Profile

Land Surface

Land Area: 824 269 sq km
Formally conserved area: 12.4 % or 102 209 sq km
Area transformed by cultivation: 1%

Demographics

Population: 1 680 000
Urban percentage: 37%
Population growth rate: 3.1%

Economy

GDP in 1998: US\$ 3 059 million at current prices
GDP Growth rate (1993-1998): 2.85 at constant prices
Contribution to GDP by tourism and hunting: 7%
Contribution to GDP by crop agriculture: 7.8%

Governance

Political system: Parliamentary democracy, power largely centralized at national level
Environmental governance: largely at a national level.

Climate

Namibia is one of the driest countries in the world. There is a gradient of increasing aridity from east to west (as the cold Benguela ocean current is approached), and from north to south. Only a relatively small area in the north of the country receives sufficient rainfall to support crop agriculture. This is where most of the rural population is concentrated, and where the only permanent rivers occur (except the Orange river, which forms the southern boundary with South Africa).

Biota

The natural vegetation ranges from woodlands in the north, through thorn savannas, to shrublands and deserts in the south and west. The biotic diversity is relatively rich, containing both karroid and tropical elements, as well as Namibian endemics.

Major Environmental Issues

Pollution and toxicity

Air pollution is not currently considered an important issue in Namibia. There are few industrial sources (those that exist are connected to mining and smelting activities, and are generally remote from populated areas). Vehicle density and use in the urban areas is not currently sufficient to lead to major problems. The north of the country does experience high background ozone levels due to vegetation burning, and aerosols from this source and mineral dust can be high elsewhere as well. Water pollution is a concern, given the relative scarcity of potable water in the country.

Biodiversity preservation

Namibia, like most other southern African countries, relies on its natural landscape and biota as a tourism draw-card. The biota is rich, by global standards, and relatively well-preserved. There is increasing awareness of its economic potential for bioprospecting.

Land quality

Land degradation and desertification, especially in the populous north, is a key issue. The increase in woody plant density in the north-central area has historically been a major concern.

Freshwater resources

The availability of water for human, livestock, industrial and agricultural use is probably the top environmental issue in Namibia. Quantity and quality are both very important. There is significant dependence on groundwater. All the major rivers are peripherally located, and are shared with neighbouring countries. For example, plans to bring water southward from the Okavango River have raised concerns in Botswana.

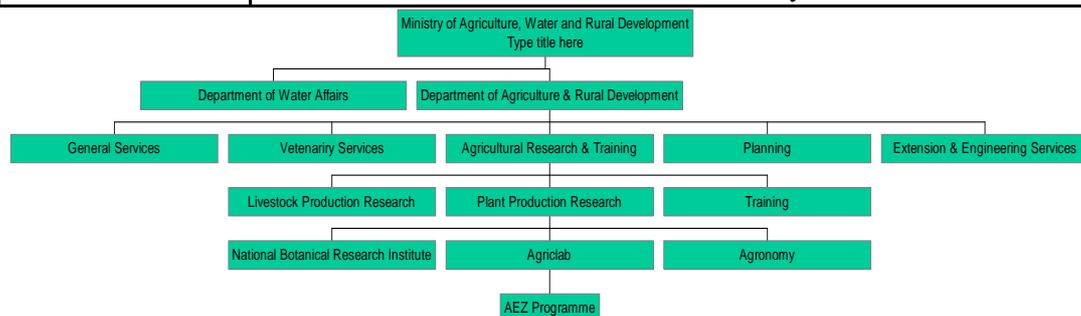
Climate change

Namibia is extremely sensitive to changes in either the amount of rainfall, or its interannual variability. Decreases in rainfall, or increases in interannual variability, would greatly exacerbate existing development challenges; increases in rainfall would make them easier to overcome.

Status of National Environmental Observing Systems

Institutional framework

Government Organizations		
Ministry	Department	Functions
Ministry of Transport	Division of Meteorological Services	Collects, analyses and disseminates weather data
Ministry of Agriculture, Water and Rural Development (see organigram below)	Dept. of Rural Planning	Rural census and socioeconomic data
	Dept. of Agriculture	Research stations, soils data
	Dept. of Water Affairs: Divisions of 1) Hydrology, 2) Geohydrology and 3) Water and Environment	Water quantity and quality above and below ground
	National Botanical Institute	Plant biodiversity and plant resources
Ministry of Environment	Department of Environment Affairs	Environmental treaties, environmental impact studies, regulations
	Directorate of Specialist Services	Biodiversity data, environmental atlases and profiles
	Etosha Research Centre	Ecological research especially relating to wildlife, NOAA receiver
Ministry of Education	Namibia Museum	Biodiversity data
Parastatal Organizations		
Namwater	Supply of water, principally to urban areas. Monitor yield and quality of well fields	
Non-governmental Organizations		
Desert Research Foundation of Namibia	Operates the Gobabeb site, active in environmental education, monitoring and management throughout Namibia, hosts Netwise, a directory of southern African environmental organizations, coordinates desertification work	
Namibia Nature Foundation	Biodiversity and communal resource management	
NEPRU	Economic data	
CRIAA	Was involved in national emissions inventory	



Analysis of existing sites

Name of site Responsible agency	Latitude	Longitude	Comments
Tier 2: Long-term, permanently staffed sites conducting advanced observations on many variables, often with experimentation			
Gobabeb desert research station	~23.6 S	~15.5	All aspects of desert biology
Etosha research centre	19.10 S	15.54 E	Principally wildlife related and focussed on the Etosha National Park
Tier 3: Long-term, staffed sites routinely observing a core set of variables (research stations)			
Gelap Oost Kalahari Sandveld Sonop Uitkoms Omajena Neudamm Mashari Ugongu Tsumas Hardap	All major agricultural zones are represented	Agricultural research stations administered by the Department of Agriculture. Some rationalization may occur in the near future	
Tier 4: Locations which are periodically visited			
Hydrological weirs	120 (4 affiliated to WHYCOS)		
Wetland sites	Several hundred, nationally, visited once every several years		
Permanent sample plots	About 50, south and central to measure bush encroachment and shrub productivity, some forestry plots in the north		

National networking

Effective national networks exist, both informally and formally (coordinated by the DEA, the Ministry of Agriculture and the DRFN, see NETWISE [Southern African Network of Environmental Oriented Organizations] at www.netwise.org.na). The number of environmental practitioners is small, and concentrated in Windhoek. This has not led to a high degree of functional integration of datasets or electronic databases; with the possible exception of the environmental atlas under construction at DEA.

International networking

Namibia is a signatory of the UN Framework Convention on Climate Change, the Convention on Biological Diversity and the Convention for Combating Desertification, among other international environmental treaties. The hydrological network is linked to WHYCOS, and the climate network contributes to WMO. The herbarium is a part of SABONET, and the faunal biodiversity specialists are active in IUCN regional working groups. The DRFN has been active in the efforts to establish ILTER in southern Africa.

Legal framework for data handling

The data held by Government agencies is in principle in the public domain, except where this would be a breach of confidentiality with respect to individual landowners. Data is provided on request, free of charge, to users with a legitimate reason to have it. This is not necessarily restricted to citizens of Namibia. The Department of Finance has initiated a policy of cost recovery on value-added databases (for example, special analyses of climate data), but this is not yet in force.

There is no overall policy with respect to the significant amounts of data held by NGOs. In the case of the DRFN, the policy is primarily publication in the peer-reviewed scientific literature. DRFN and other NGOs conduct contractual research, so data resulting from these activities is presumably subject to negotiation between potential users and the contractual parties. Most of the NGOs are short of funding, so data may not always be available at no expense.

Use of environmental information

The principle users of information are the Government Departments themselves, and consultants acting on their behalf. Researchers, mostly based at the Technical College and University or in the several technical or development-oriented NGOs, are the third major category. Several data suppliers listed individual landowners as significant data users.

Sectoral Environmental Information Systems

Weather and climate

The national weather service coordinates a network of about 900 daily rainfall stations operated by volunteer observers. Only about 300 of these are active, down from a peak of about 400 in the 1960s. The oldest station dates from 1893, with the major growth in the network occurring in the 1930s. The rainfall is recorded daily, and reported either ten-daily (100 selected stations who report by telephone) or monthly, on paper. There are 17 synoptic stations, half staffed by the weather service itself, recording temperature, humidity and winds three-hourly between 0600 and 2000 (two are 24-hour stations). They report three-hourly, *via* telex, fax or e-mail.

The service has experimented with 15 automatic weather stations, now largely abandoned due to maintenance problems.

The service has both Meteosat and NOAA receivers, and archives the data daily.

The data since 1997 are managed in the CLICOM database. Some efforts have been made to capture the historical data, but the volume of paper-based data exceeds the weather service budget for entering it.

The service publishes a ten-daily summary bulletin (called WHOT) covering rainfall, temperature and sea surface temperature. It is provided free of charge to about 350 recipients, including Government officials, aid agencies, researchers, farmers and economists. Daily forecasts are published on a web site, and broadcast on television from an on-site studio. Other information requests are received and serviced, free of charge, *via* letters, e-mails, personal visits and telephonic enquiries. Treasury policy is moving towards cost recovery for weather and climate products.

Water resources

Surface water resources

Quantity of flow

The Division of Hydrology in the Department of Water Affairs operates a network of 120 river flow stations. Two of these are automatic, satellite-downloading WHYCOS stations, with two more planned and a further one not yet sited. The rest have chart recorders, and are serviced three-monthly. The digital database in which the flow records are stored goes back to 1940, with most records dating from the 1970s. The number of sites is declining.

The water level in impoundments is reported weekly, or more frequently in flood times.

The main users are water resource planners in the Department itself, consultants, researchers and the water supply parastatal, Namwater. The data are provided in a variety of formats, depending on user needs, at no cost.

The Division also has about 20 rainfall intensity recording stations. The evaporation pan network has been discontinued.

Water quality

The recent creation of Namwater as a separate entity from the Department has led to some confusion regarding who is responsible for what monitoring. The responsibility for database maintenance is apparently with the Department, but the water analysis is done on contract to them by Namwater. There does not seem to be a systematic sampling programme. Data principally originates from specific projects and from compliance monitoring. The data are currently stored in a paper filing system. An electronic database is planned.

Water processing plants are required to do their own quality checks, and are supposed to submit the data, but seldom do.

Groundwater resources

Size of resource

The Division of Groundwater has an electronic database on boreholes dating from the early 1980s, and mostly populated with data from a survey conducted in the 1950s and 1960s on commercial farms. It is estimated that about 60% of Namibian boreholes are recorded in this database, which has the location, depth to water and geological details.

The database is not very functional, and a new one is being created, to be operational in 2000. It will include pump tests.

The water level is monitored in about 900 boreholes. Ninety of these have automatic (chart) recorders, while the rest are manually recorded monthly or three-monthly. In future, electrical conductivity data will be collected as well. Namwater maintains a database of the amount of water extracted from production well fields under its control.

The main database users are consultants and the public at large, particularly in connection with the purchase of farms. It is regarded as a public domain database.

Land cover, Land use, Land quality

The Agroecological Zone project of the Department of Agriculture has published a map of areas which have similar potential for use, based on climate, topography and soils. These are available as a GIS coverage, and ongoing work hopes to improve the internal detail.

Vegetation

The only existing vegetation or landcover map is the small-scale one drawn in the 1970s. Several efforts are underway in various parts of the country and by various organizations to update it. Within the National Botanical Research Institute a very detailed plot-sampling process has been underway for three years, which should eventually lead to a national map. At the current rate of collection (about 300 sites per year) this objective will take another two decades.

The DEA has a programme of developing 'Environmental Profiles', region by region. One is published and several others are nearly complete. The whole country will be complete by 2002, providing a national atlas. The profiles are GIS-based, and include soils, climate, landcover (largely based on aerial photography), population, livestock density, land use and other information. At present the main output is in the form of published documents (large format books, in colour), but an electronic information system is under consideration.

Degradation

The DEA has been active in mapping fires using NOAA data, particularly in the northern part of the country. Daily NDVI 'greenness' data is collected to estimate carrying capacity (AEZ and NBRI). Bush encroachment was seen as a major threat to the livestock industry. A network of 200 permanent sample plots of 500 m² each was established by the Department of Agriculture, and is resurveyed every three years. Basal area and stem counts in four height classes are recorded. A further 37 sites are monitored for sheep and goat carrying capacity in the south of the country. The AEZ project plans to carry out erosion hazard mapping.

Soils

A soil survey was begun in 1998. It will be conducted at 1:1M scale nationally, with 1:250 000 and 1:100 000 cover in the more agriculturally-productive parts in the north. A pedon database is part of this survey.

Agricultural productivity

Area planted with crops and crop yields

Statistics on the area planted with various crops are collected by the Agronomy Board. The Namibian Agricultural Union also keeps this type of information. The Directorate of Planning in the Ministry of Agriculture has data on crop yields.

Agricultural inputs: fertilizers and pesticides

The Department of Agriculture maintains a register of agricultural chemicals, but there does not appear to be a database of pesticide usage.

Livestock numbers

The base data is provided by the Division of Veterinary Services (Department of Agriculture). It originates from six-monthly stock inspections on commercial farms, and the vaccination records in communal areas. This information is regarded as confidential.

Indigenous biological resources

Plant resources

The National Botanical Research Institute has responsibility for information on Namibian plant resources. It operates a herbarium with about 78 000 accessions and has a professional staff of seven. A survey of medicinal and useful plants has been undertaken, with a view to protecting the resource from overexploitation and theft of genetic material. To supplement the mapping of species distribution based on herbarium records, which tend to under-represent the distribution of common, easily identified and frequently very useful species, a tree atlasing project is currently underway. It uses about 500 lay volunteers (of which 150 are active, and 50 contribute the bulk of the records). The project is planned to take two years, and is funded by GTZ. It is estimated that 15% of the ¼ degree latitude squares in Namibia have been adequately sampled, and 50% have not been visited by botanists at all. The output of this project will be a printed atlas, as well as CD-ROM-based electronic databases. It is aimed at professional botanists, farmers and the public.

A vegetation inventory of Namibia is in progress, with collaboration from the University of Cologne. It is based on 1000 m² sample plots, surveyed using the Braun-Blanquet methodology. The data is captured in a database called TurboVeg (developed and used in South Africa), which allows tabulation, sorting and some statistical manipulation. In three years, 900 plots have been surveyed. Comprehensive national coverage is estimated to require about 10 000 plots.

Animal resources

The Division of Specialist Support Services maintains databases on farm permits issued for wildlife culling, and trophy and hunting statistics. The results of questionnaires sent to landowners, covering predators and large animals, are captured in databases. The users are primarily in the Ministry itself, and the databases are not entirely in the public domain. The databases are principally in the form of spreadsheets and Microsoft Access databases.

A separate database monitors accidents between vehicles and animals. Animal mortalities in the water canal in the north of the country are recorded in a database maintained by Namwater.

The Ecological Research Centre located at Etosha has conducted aerial wildlife surveys throughout the country since the mid-1960s. This is not a systematic national survey, but driven by particular project requirements. All large mammals are counted.

Freshwater fisheries

Some data are maintained by the Division of Fisheries, which has a station at Hardap Dam.

Biodiversity

Conserved areas

GIS datasets on the boundaries of conservation areas are maintained by the DEA.

Rare and endangered species

Red data books have been completed, or are in an advanced state, for most of the main taxa. The recently completed biodiversity country study, linked to the Convention on Biological Diversity, has been a major impetus for this work, which was able to build on a relatively good data record and the existence of a core of skilled specialists from several institutions. The Biodiversity coordinator is located in the DEA.

Problem species

The National Botanical Institute has a database on alien plants. DSSS has databases, built from questionnaire surveys, of problem animals.

Plants

The National Botanical Research Institute has a database of every plant species, alien and introduced, known to occur in Namibia (4 239 species, of which 592 are endemic).

Mammals, birds, fish, reptiles and amphibians

DSSS maintains an electronic database of the voucher specimens of all Namibian mammals, reptiles and amphibians. Very comprehensive databases of bird distributions are maintained by Ornithologists in the Division.

Invertebrates

The Namibia Museum operates an innovative scheme for the transfer of data from the written collection records of its vast collection of insects, arachnids and other invertebrates, to electronic form. It is running a programme called Insect@thon, which recruits corporate sponsors and secondary-schoolchildren to digitize the data. The sponsors help to provide schools, even in deep rural areas, with computers and Internet access, in return for the entry of data. The interface screens through which the data entry is performed are specially designed to be simple, self-checking, interactive and fun. Data capture occurs during day-long supervised sessions, where teams of scholars compete with each other for school prizes. Quality control of the entered data is performed by specialists at the museum – this is regarded as a much more productive use of their time than the data capture itself. The scheme has numerous other advantages, including service provision to the schools, educational outreach, publicity for the sponsors and skills development among the participants.

The record-keeping effort at the Museum is geared towards the use of advanced Information and Communication Technology. The entire collection list is on the web, and accessible to anyone. Specialist amateurs, for example butterfly collectors, are encouraged to enter their own collection information on password-protected pages. Claris Filemaker is used for the database construction, because it is relatively cheap, is well supported locally, and is HTML compatible.

A significant outstanding problem is that an estimated 80% of Namibian collections are in non-Namibian museums, and not even collection lists are available to the

Namibians. They hope, through digitizing their own records and placing them in the public domain, to shame the much better resourced institutions in Europe and America to do the same.

Aquatic biota and habitats

The Division of Water and the Environment in the Department of Water Affairs maintains a database of wetlands, rivers and pools, which includes their location, description and biota. It used to address RAMSAR convention-related questions. DSSS of the Ministry of Environment has a GIS-based database on the four RAMSAR sites, and other prospective wetland sites of interest, containing physical descriptions, lists of species, and estimates of populations for bird populations.

Air quality

There is currently no systematic air quality monitoring. The DEA has a meta-database, which lists the commitments that major developments have made to conducting ongoing environmental monitoring and reporting, when development permits were issued.

Ancillary data: economic activity and population statistics

The National Planning Commission performs population censuses. An NGO, NEPRO, is regarded as one of the best sources of economic indicators.

User Needs Assessment

Data and information needs

The biodiversity coordination unit and the recently formed desertification coordination unit are likely to be key data users. Organizations conducting environmental impact assessments (that will be required by Namibian law) are already major data users.

The Namibian experience shows two examples of how a relatively simple communication device can be highly effective in influencing environmental policy. The first is the ten-daily 'WHOT' bulletin produced by the Meteorological Services, which summarizes rainfall, temperatures and satellite-derived greenness and sea surface temperatures over the immediate past period. It is widely used by policy-makers, resource managers and farmers alike. The second is the briefing papers produced by DRFN. They are targeted at (and often solicited by) the members of the National Assembly, and deal simply but non-trivially with environmental issues that the assembly will debate in the near future. They are based on in-depth work done by the DRFN and others, but are written by a professional writer. They are each a few pages in length, and have a circulation list of several hundred.

Requirements raised by potential users of GTOS

Specialists in the DSSS pointed out the useful role GTOS could play as a regional clearing-house for regional biodiversity information. The policy implications of threats to a species which only occurs within one country are quite different to those raised by declining numbers of a species which only have a part of their distribution in the country, and are well-represented elsewhere. At present the regional distribution has to be gleaned in a laborious and haphazard fashion, by addressing requests to neighbouring countries.

Key Stakeholders

Organization	Person visited	Type of data
Ministry of Agric., Water and Rural Development (see flow diagram) National Botanical Research Institute Private Bag 13184 Windhoek, Namibia tel: +264-61-202 2167	Dr Gillian Maggs-Kölling	Herbarium, plant collection records, genetic resources
	Barbara Curtis	Tree Atlas
	Benjamin Strohbach	Vegetation survey
Desert Research Foundation of Namibia PO Box 20232 Windhoek, Namibia Tel: +264-61-22 9855 e-mail: drfn@drfn.org.na	Joh Henschel	<ul style="list-style-type: none"> • Weather data • River flow • Welwichia growth data • Groundwater data (on an hourly scale) • NETWISE (Southern African Network of Environmental Oriented Organizations) maintained by DRFN (www.netwise.org.na).
Ministry of Transport : Meteorological Services Private Bag 13224 Windhoek, Namibia tel: +264-61-208 2174	Franz Uirab	<ul style="list-style-type: none"> • Rainfall data • Climatic data • Synoptic data • Temperature • Sea surface temperatures
Ministry Agric., Water, Rural Development: Agricultural Department (see flow diagram) Private Bag 13184 Windhoek, Namibia tel: +264-61-208 7111 fax: +264-61-208 7768 e-mail: sardep@iafrica.com.na	Louis Du Pisani Marina Coetzee FW Bester Bertus Kruger (now with NNF)	<ul style="list-style-type: none"> • AEZ database • Soils database • Commercial farms database - database with contact details of owners of 11 000 commercial farms as well as boundaries

Key stakeholders continued

Organization	Person visited	Type of data
Ministry of Agric., Water and Rural Development: Rural Development - Directorate Planning Private Bag 13184 Windhoek, Namibia tel: +264-61-208 7111 fax: +264-61-208 7768 e-mail: sardep@iafrica.com.na	Manfred Menjengua	Gender disaggregated system FIVIMS Nutritional survey
Ministry of Environment and Tourism (MET) – 3 Divisions: Division of Environment Affairs (DEA) Resource Management (RM) Specialist Support Services (SSS) Private Bag 13306 Windhoek, Namibia tel: +264-61-24 9015 fax: +264-61-24 0339	John Mendolsohn (DEA) Phoebe Barnard (RM) Mike Griffin (DSSS)	<i>DSSS & RM databases:</i> Aerial surveys Scientific research permits Farm permits Farms Trophy and hunting statistics Farm questionnaires Animal related traffic accidents Mammals & amphibians Wetlands Mining database <i>DEA databases:</i> Profiles Atlases
Ministry of Environment and Tourism National Museum PO Box 1203 Windhoek, Namibia tel: +264-61-29 34 351 fax: +264-61-22 86 36 e-mail: insect@thon	Eryn Griffen Joris Komen	Reptiles Amphibians Fish Invertebrates
Ministry of Agriculture, Water and Rural Development: Dept. of Water Affairs : Hydrology Division (see flow diagram) Private Bag 13193 Windhoek, Namibia tel: +264-61 208 7111 fax: +264-61 208 7160		Flow database Groundwater database
Ministry of Agriculture, Water and Rural Development: Dept. of Water Affairs : Pollution Control and Water Quality Division (see flow diagram) Private Bag 13193 Windhoek tel: +264 61 208 7111 fax: +264 61 208 7160	Guido van Langehove Chris Christelis Cynthia Afrikaner Shirley Bethunie	Water flows Groundwater Water quality Wetlands

4. South Africa

Acronyms Used in South Africa

AGIS	Agricultural Geographic Information System
ARC	Agricultural Research Council
CCWR	Computing Centre for Water Research
CSIR	Formerly the Council for Scientific and Industrial Research, now legally known simply by its acronym
DEAT	Department of Environmental Affairs and Tourism
DWAF	Department of Water Affairs and Forestry
ENPAT	An environmental information database operated by DEAT, designed to assist in the spatial location of developments so that they do not impinge on important sites
GAW	Global Atmosphere Watch (a programme of the WMO)
ISCW	Institute of Soil, Climate and Water (part of ARC)
IWQS	Institute of Water Quality Studies (part of DWAF)
NBI	National Botanical Institute
NEC	National Energy Commission
NILU	Norwegian Institute for Air Research
PRECIS	National Herbarium Pretoria (PRE) Computerized Information Service
REGIS	A groundwater information system under development by DWAF
RWB	Rand Water Board
SABONET	Southern African Botanical Diversity Network
SAPAI	South African Plant Invader Atlas
SAWB	South African Weather Bureau (currently part of DEAT)
UWB	Umgeni Water Board

Country Profile

Land Surface

Land Area: 121 907 789 ha

Formally conserved area: 6 700 000 ha or 6%

Area transformed by cultivation: 14 753 247 ha or 12.1%

Demographics

Population: 42 000 000 (1998 est)

Urban percentage: 51%

Population growth rate: 2.2%

Economy

GDP in 1998: US\$116 659 million (at current prices)

GDP Growth rate (1993-1998): 2.06 % at constant 1990 prices

Contribution to GDP by tourism: 3.6% (1996)

Contribution to GDP by agriculture: 4.7% (1996)

Contribution to GDP by forestry: 4.4% (1996)

Contribution to GDP by mining: 10% (1996)

Governance

Political system: Federal parliamentary democracy

Provinces: Eastern Cape, Free State, Gauteng, KwaZulu-Natal, Mpumalanga, Northern, Northern Cape, North West, Western Cape

Environmental governance: constitutionally a provincial issue, except for international treaties, national parks, and issues which cross provincial boundaries

Climate

South Africa has a predominantly dry (Mean Annual Rainfall = 550 mm) and warm (Mean Annual Temperature = 18°C) climate with great regional deviations. Rainfall decreases from the east coast to the west, and from high to low altitudes. The highest mean rainfall is over 1500 mm, and the lowest is around 50 mm. Temperatures decrease with increasing latitude and altitude. In the northern regions daytime temperatures frequently exceed 30°C in summer, while the southern mountains and plateaus frequently have night-time temperatures below 0°C in winter.

Biota

Six biomes: Savanna, Grassland, Nama Karoo (semi-desert shrubland), Succulent Karoo, Fynbos (sclerophyllous thicket) and Forest. The plant and animal biodiversity is exceptionally high.

Major Environmental Issues

Pollution and toxicity

South Africa is the major industrialized country in the SADC region. Emissions from power generation and petrochemical industries are concentrated especially in the 'highveld' area of Mpumalanga and Gauteng provinces, but health-endangering levels are seldom encountered at ground level. A combination of coal smoke, dust and vehicle emissions can lead to health-limits being exceeded in the major urban centres (especially indoors in low-income housing). Water pollution, especially that originating from mining operations, is a significant issue on many of the river systems. The management and disposal of toxic wastes is a matter of national concern.

Biodiversity preservation

South Africa has about 10% of the global plant biodiversity, and high levels in other taxa as well. The tourism industry is strongly correlated with natural landscapes and wildlife. There is increasing national focus on the exploitation of biodiversity for pharmaceutical and other products. The key threats are habitat loss and fragmentation, and climate change.

Land quality

Only 13% of South Africa is arable, and almost all of this is already used. Loss of productive capacity through erosion, salinization, acidification and compositional changes in rangelands are key concerns. Competition for land between agriculture, forestry, nature conservation, urban settlement and mining is an issue.

Freshwater resources

The availability of water of acceptable quality is predicted to be the single greatest and most urgent developmental constraint facing South Africa. Virtually all the surface waters are already committed for use, and water is imported from neighbouring countries. Groundwater resources are quite limited; maintaining their quality and using them sustainably is a key issue.

Climate change

South Africa is in general an arid, hot country. Future climate changes have the potential to have profound impacts, either positively or negatively. In particular, the impacts on crop agriculture, water resources, human health and biodiversity in the Cape Floral kingdom are key concerns.

Status of National Environmental Observing Systems

Institutional framework

Government Organizations		
Ministry/Department	Organization	Functions
Department of Environmental Affairs and Tourism	South African Weather Bureau	Collects, analyses and disseminates weather data
	National Botanical Institute	Plant distribution and biodiversity
	Directorate of Environmental Information	Air quality, national heritage sites, ENPAT, wetlands, biodiversity
Department of Water Affairs and Forestry	Dept. of Water Affairs: Hydrology	Surface water flows and volumes
	Dept. of Water Affairs: Groundwater	Aquifers
	Dept. of Forestry: Commercial forestry	Area of plantations, permits
	Dept. of Forestry: Conservation forestry	Area of indigenous forests and woodlands, biodiversity
	Institute of Water Quality Research	Water quality
Department of Agriculture	Directorate of Statistics	Planted area, yield
National Parks Board; Provincial Parks Boards	Mammal data, vegetation data	
Eskom (Electricity supply commission)	Databases on air quality and precipitation chemistry	
Agricultural Research Council	Land cover, soil databases, agrometeorology, NOAA-NDVI archive	
CSIR	Some air quality and water quality databases, land cover, research catchments, Landsat archive	
Non-governmental Organizations		
WWF	Principally a fundraiser and lobbyist for biodiversity conservation and natural resource management	
Endangered Wildlife Trust	Rare and endangered species, not a major data holder	
Forest Owners Association	Area and yield of plantation forests	
Many other environmental NGOs	There are an estimated 700 environmental NGOs in South Africa, ranging from activist groups to natural history societies. Some have significant data holdings (especially regarding biodiversity), but most are primarily data users	

Analysis of existing sites

Name of site Responsible agency	Latitude	Longitude	Comments
Tier 2: Long-term, permanently staffed sites conducting advanced observations on many variables, often with experimentation			
Skukuza	23.02 S	31.50 E	Recently established flux measuring site; many other variables measured in the surrounding Kruger national Park
Marion Island	46.55 S	37.45 E	Weather, ornithology, marine and terrestrial ecology
Tier 3: Long-term, staffed sites routinely observing a core set of variables (research stations)			
Ecological and agricultural research sites	57 recorded in a survey conducted by ILTER; nationally distributed		
GAW station, Cape Point	CO ₂ , N ₂ O, CFC's, O ₃ , CH ₄ , and a variety of other gases		
Tier 4: Locations which are periodically visited			
Hydrological wiers	800 plus 280 reservoirs, nationally but concentrated in the east		
River health sites	Several hundred, presently in Mpumalanga, will expand nationally		
Permanent sample plots	CSIR has 14 in forests, 50 in woodlands Forage Research Institute has several hundred in grassland and shrublands		

National networking

The National Research Foundation (NRF) has the primary mandate for both national and international scientific networking. The Department of Environment Affairs has the mandate to coordinate environmental observation systems, but to date has not been very active in this field. There are many national professional associations (botanists, ecologists, foresters, meteorologists, range scientists, zoologists, to name a few) of varying levels of activity, which serve to maintain national and regional networks.

International networking

South Africa is a signatory to the UN Framework Convention on Climate Change, the Convention on Biological Diversity, and the Convention for Combating Desertification, as well as several other environmental treaties. It is a member of the WHYCOS network, and the weather data is fed into the WMO network. The plant biodiversity specialists are linked through SABONET, and the faunal biodiversity specialists are active in IUCN working groups. Climate change researchers are active in IGBP and the IPCC. The NRF has taken the lead in stimulating an ILTER activity in southern Africa, which is presently under discussion.

Legal framework for data handling

There is a range of data ownership and availability in South Africa, summarized below. The Freedom of Information Act, scheduled to be passed in February 2000, will probably place all Government-held (and a large part of privately-held)

environmental data in the public domain. No legal distinction is drawn between users inside and outside South Africa. In practice, access to the databases often requires effort by the data custodians, and when resources are limited South African users are likely to get preference, especially if the data requests are large. Restricted access is frequently not a legal issue but an ethical one of giving due acknowledgement to the people and organizations which have collected and prepared the data.

The parastatal organizations are financially separate from the government, and operate on a cost-recovery basis. In some cases this extends to use of data they have collected.

Category	Examples
Data collected, but effectively unavailable outside of those involved in its collection since it is regarded as proprietary or confidential	Air quality data
Data freely exchanged through personal networks within a subject field, through telephonic, e-mail or written requests	Invertebrate biodiversity data
Data available to authorized government users only	Permit/license data in relation to gaseous emissions and water effluents
Public domain. Direct electronic access to database by authorized users in government, and extracts available in electronic or paper format to other users on request free or at nominal cost	Meteorological data Demographic data Economic data Hydrological data Water quality data
Semi-public domain. Direct electronic access to database by authorized users in Government, and extracts available in electronic or paper format to other users on request at cost recovery rates	Soil data National Land Cover Data (until 2001, then free) Plant biodiversity data
Database directly available to registered users inside and outside Government at no cost	Meteorological and hydrological data through CCWR
Data directly and freely available through Internet access (without password protection)	State of Environment Report, Global Atmosphere Watch data (held in international Global Data Centres)
Data summaries in public domain. Publications available free, or at nominal cost, or at commercial rates	Bird atlas, climatological summaries, agricultural statistics

Use of environmental information

The major users are Government agencies involved in environmental management, at all three levels of Government (national, provincial and local). Consultants, working on contract to Government or to the private sector are next. Researchers, principally nationally-based in the research councils and universities, but also internationally-based, are the third major category. Private citizens make up a minor part of the use.

Sectoral Environmental Information Systems

Weather and climate

The South African Weather Bureau, the Institute of Soil, Climate and Water (part of the Agricultural Research Council) and the Department of Water Affairs and Forestry all operate large networks of weather stations and maintain national databases. The reasons given for this triplication are that the purposes for which the data are intended are different, and as a result the variables and station locations criteria differ (Table 4). The SAWB stations, found mainly in urban areas, originated in support of shipping and flying and collect data on variables related to upper air atmospheric conditions and weather forecasting. The ISCW stations are rural and focus on variables important to agriculture. The DWAF stations serve the needs of hydrological planners. The databases each contain the data from the other systems, with a delay of about one year. Several other organizations either collect weather information themselves or on behalf of the SAWB or the ISCW.

The oldest weather records date from the mid-nineteenth century, but a reasonably extensive network was only achieved in the 1920s. The number of stations peaked in the 1960s (several thousand stations are in the databases, but not all were active at once), and is now decreasing. An increasing proportion are now automatic, with data being collected every five or sixty minutes and databases being updated daily. The automated stations tend to collect a fuller set of variables than the average manual station, including radiation, wind, humidity, temperature and rainfall.

Weather and climate data are available in the following forms:

Printed reports principally contain climatological summaries or variables not in frequent demand. Examples are the WB series, from the Government Printer.

Printouts from the SAWB database may be requested for any station, period and time resolution. They are delivered by mail or by fax on demand.

Electronic access is by registered users only. For example, The Computer Centre for Water Research operates a combined weather and hydrological database for use by researchers, which can deliver daily data for any site in South Africa, from the beginning of the record to a time approximately three years before the present.

Both the ISCW and the SAWB intend making basic climatological summary data freely available through the Internet, with value added products (such as near real-time disease outbreak indices) available through themselves or third-party service providers for a fee.

The ISCW network costs approximately R5 million per year to operate (excluding capital expenditure). This level of funding is just enough to permit continued operation, with no room for necessary enhancements or development, and minimal spending on calibration and maintenance.

Table 4. The near surface weather data collection network in South Africa

Variable	No. of stations	Comment
Daily rainfall total (Manual)	600 300 350	SAWB Daily reporting ISCW Monthly reporting DWAF
Daily maximum and minimum temperature (manual)	300	SAWB
Hourly or 5-minute rainfall	150	ISCW automatic stations Some SAWB automatic stations
Hourly or 5-minute air temperature		
Soil temperature		
Atmospheric humidity		
Wind speed and direction		
Net or total solar radiation	11 solarimeters 135 sunshine recorders	SAWB radiation network largely discontinued. PAR recorded by ISCW
Pan evaporation	350 S-Pans 600 A-Pans	DWAF ISCW

Water resources

Surface water resources

Quantity of flow

A system of hydrological weirs has been established by the Department of Water Affairs: Directorate Hydrology over a period of many decades, starting in 1916. The characteristics of river flow in southern Africa are such that flow monitoring using a calibrated river cross-section and a water level recorder is not feasible in most cases. As a result, virtually all of the recording stations require custom-built structures, which cost from R100 000 to R1 million each to build, and around R30 000 per station per year to maintain. These costs have risen steeply in recent years, making significant expansion of this system unaffordable. There are currently about 2 000 measuring points, of which about 800 'families' are actively gauged. A 'family' may be a single weir, or several weirs associated with the inputs and outputs from a single reservoir. These numbers have been relatively stable since 1980. The records are height-time charts, 60% recorded using mechanical chart recorders, and 40% electronically. Within 12 months about 75% will be electronic. The time resolution is around 12 minutes. The structures are re-calibrated on average once every five years.

In addition to the weirs, data on water volume (from height and capacity), inflow, outflow, evaporation and losses are collected for 280 reservoirs (good quality data is available for 250 of these). These data allow water balance calculations, which are used to create a separate database of 'virtual' flow records. These are useful because they are well integrated and continuous. The rainfall data comes from the DWAF rainfall stations, mostly co-located at dams. The data are available within about six months of collection. For water management purposes a 'short-circuit' weekly telephonic and fax system is used to gather current dam level data. Dam capacity is

re-surveyed about once every five years, but this may even be done annually in high-sedimentation areas.

The weirs are maintained by the provincial offices of DWAF, and the water-level data are captured and quality-controlled there. Within about three months of data collection, the data are forwarded to the head office of DWAF. The data, partly integrated with rainfall and water quality data, are stored in a centralized database (about 6 GB currently) maintained by DWAF in Pretoria. About 15% of the flow records are unusable at any given moment. About two thirds of these represent temporary unavailability or delayed processing, while one third are permanently lost or damaged. Online access to this database is by DWAF officials only, but in principle it is viewed as a public domain dataset. Data requests, predominantly by water planners and consultants, are satisfied through e-mail, magnetic media or fax, at no cost to the user. There are a few hundred users of the system, of which about 70% are external to DWAF. A printed summary of hydrological data 1960-1990 is available as a book.

Regional water managers all have their own information systems in addition to the national system, which they help to maintain. The national system is mainly used for planning purposes, while the local systems are used for management. For instance, a local irrigation board (now, in terms of the Water Act, a Water Users Association) may have several tens or hundreds of weirs, gauges and meters of its own. These data are not standardized and generally not archived.

A WHYCOS pilot scheme is operating on the Vaal River catchment, integrating about 50 recording rainfall stations, weather radar and recording weirs, all linked with a near real-time communication system. There is a flood disaster control room for the Orange and Vaal river systems, which also provides disaster support in other catchments where needed. It draws on data from the same basic system, but uses telephonic links to shortcut it in emergency situations. In other words, during a actual or potential flood, the regional offices send personnel out to weirs and dams as frequently as necessary, and they report their observations by telephone to the control room.

The research catchments at Jonkershoek, Cathedral Peak and Mokubulaan, formerly operated by the South African Forestry Research Institute (which became the Division of Forest Science, CSIR, which in turn became Environmentek, CSIR), are now, along with their historical data, part of the DWAF national system, but are not currently operated as research catchments.

This system costs about R80 million to maintain at a central level, and an additional R40 million regionally, excluding the water quality components. At this level it is seriously under-funded.

Water quality

The National Groundwater Database is maintained by DWAF; Directorate Groundwater. It contains records of boreholes, with information about their precise location, the geology of the aquifer they tap, the depth to water where intercepted and the pumping test (recharge rate). This dataset consists of over 180 000 records (many of which are for 'dry holes' which did not intercept the water table). They almost all originate from Government drilling programmes, which are estimated to represent only 15-20% of all the boreholes drilled. They are neither systematically nor randomly distributed, but focus on areas where there was a need for groundwater investigations - typically small towns in arid areas.

Prior to 1985, the information system consisted of a series of technical reports. Since then, systematic groundwater mapping at a national and provincial scale has been undertaken and an electronic database has been established. This is currently being converted into a new, more user-focused database, modelled on the REGIS database developed by TNO (the Dutch research organization)². 'REGIS Africa' is much closer to a full environmental information system than a borehole database, since it includes recharge models as part of the integrated system. Within a year it will be operating as stand-alone regional databases, linked to each other and users in an Internet environment. It will also be linked to compatible local scale municipal and agricultural databases currently operating as prototypes.

Where repeated measurements of depth to the water table or recharge rate have been made, they are included in the groundwater database, providing a limited capacity for trend analysis. There are about 200 autographic depth gauges and a further 800 which are measured manually. Of the latter 200 are measured monthly and 600 every six months. They are mostly confined to groundwater dependent towns in the former 'white' areas of the country. The hydrochemical database maintained by IWQS (see next section), contains samples taken from boreholes as well as samples from rivers and dams, but the databases are not integrated so it is hard to link a particular borehole with its water chemistry data. This problem is recognized, and will be solved with the implementation of the REGIS system.

The data in the system can be requested by anyone and is generally provided as an electronic file, on request. It is typically used by groundwater consultants and researchers. In future it will be web-based.

Groundwater resources

Size of resource

There are 1 800 'water quality control points' in the national river and reservoir network, of which 865 are routinely sampled by the National Water Quality Network, typically on a bi-weekly to monthly basis. This network is currently the subject of an optimization study, which may result in decreases in sampling intensity in some areas, and increases in others. A further 846 control points are involved in 48 regional or purpose-specific monitoring programmes. The sampling is largely undertaken by the

²Not to be confused with the Regis geographical information system used in some institutions in South Africa, now largely replaced by ArcInfo.

staff who service the water flow network, with some volunteers used in areas not routinely monitored by hydrology staff. The samples are collected in re-usable plastic bottles, which are mailed to Pretoria. The increasing automation of the flow network is causing a problem, since the weirs no longer require bi-weekly visits. Of the water quality variables, only electroconductivity and water temperature lend themselves to automated data collection under South African river conditions. There are currently 46 loggers in operation for this purpose.

The chemical analyses are undertaken by the Institute for Water Quality Studies, which is part of DWAF. The laboratories are highly quality-controlled, and internationally and nationally certified. Approximately 3 000 samples are processed monthly. Turn-around time is approximately three months, between sample collection and entry of the verified data in the database.

The water quality database is partially integrated with the river flow and groundwater databases. The data are currently co-located with the flow and groundwater data on the Government mainframe computer, but will move to a server at IWQS in the near future. They are considered public domain, but are not directly available to the public due to security considerations on the Government server. Historical water quality data are available on a CD-ROM. Main users of the water quality data are DWAF (for regulatory and planning purposes), engineering consultants and researchers.

Table 5. Summary of the water quality variables collected. Samples for the different clusters are collected using different protocols and sampling equipment. Within a cluster, various groups of variables can be analysed, depending on the intent.

Cluster	Variables	Groups
Macro determinants	Ca, Cl, DOC, EC, F, K, Kjeldahl-N, Mg, Na, NH ₄ , NO ₂ , NO ₃ , pH, PO ₄ , SO ₄ , Si, Total Alkalinity, Total P, TDS	1. Drinking water, corrosion, TDS 2. Nitrogen and Phosphorus 3. Plant nutrients 4. Hardness 5. Sodium Absorption Ratio 6. Acid mine effluent
Trace metals	Al, Ar, B, Ba, Be, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Se, Sr, Ti, V, Zn, Zr	1a: Screening 1b: Scanning 2. Common metals
Bacteriology	<i>Escherichia coli</i> , faecal coliform, faecal streptococci, faecal <i>Clostridia</i> , Total coliform, Standard Plate Count	1. Drinking water 2. Faecal contamination
Biology	algal identification, suspended solids, chlorophyll a, phaeophytin a	1. Eutrophication
Toxicity	Crustacea (<i>Daphnia pulex</i>), fish (<i>Poecilia reticulata/Tilapia</i>), bacteria <i>Pseudomonas putida</i> , algae (<i>Selenastrum capricornutum</i>).	1. Toxicity

Groundwater samples are chemically analysed for about 400 sites nationally, on a monthly basis. The current locations are somewhat *ad hoc*, but since 1994 this has been progressively rationalized on the basis of groundwater provinces. The analyses include the major cations and anions, as well as trace metals. Organic contamination is not included.

The data collected by the IWQS represents probably only 20% of the water quality data collected nationally. The rest are collected by the two large water supply corporations (Rand Water Board and Umgeni Water Board); local authorities, in connection with water treatment and sewerage treatment; industries, in connection with their effluent release license requirements; mines, etc. The analyses are performed by commercial laboratories, and although some data (excluding RWB and UWB data) are provided to DWAF, they do not find their way into any formal database.

Faunal indicators of water quality are collected by the National River Health System. It was initiated in 1993, and currently has about 100 sample locations, all in the province of Mpumalanga. The target is about 600 nationally, of which about a third will be 'reference' sites, selected because of their relatively natural state, and monitored intensively but infrequently. The sites are unmarked (but geolocated) and are frequently on private land. The target is about 20 sites per major river system, with a good distribution across the 18 riverine ecoregions and approximately 100 subregions.

Indicators are collected in five groups:

- benthic invertebrates (water quality indicator, about every 4 months);
- fish communities (about once every three years);
- riparian vegetation;
- habitat (periodic helicopter videography of the river along its length, plus site visits);
- geomorphological and hydrological indices.

The system will be implemented by province, usually (but not always) by the provincial-level nature conservation/environment officials. The data system is designed and provided by a private sector company, Soft Craft Systems, in conjunction with private sector consultants, Southern Waters. It is a Microsoft Access database, distributed to the provincial users on CD-ROM, where it is stand-alone. Approximately annually, the provincial centres will send a diskette or e-mail update back to a central database. The National Water Information System (DWAF) will be updated from this central source annually. The principal intended use of the River Health System is the determination and monitoring of the 'ecological reserve', a minimum flow quantity required to be left in all rivers by the Water Act of 1998. The users are water resource managers and policy-makers.

Groundwater quality

See above, under surface water quality.

Land cover, Land use, Land quality

Vegetation

The land cover of South Africa, in 27 classes, has been mapped at 1:250 000 scale using 1996 Satellite imagery. 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. It is intended to repeat this exercise approximately once every five years, although the responsibility and funding arrangements have not been established.

The Department of Land Affairs (Directorate of Survey) commissions aerial photograph coverage of all of South Africa on a rolling ten-year basis. Several private aerial survey companies maintain large archives of air photos. 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 ten-daily vegetation greenness (NDVI) maps, which form part of the drought management system.

Georeferenced land use at a national scale must be inferred from the land cover map, read in conjunction with information from Statistics South Africa and the Department of Agriculture (Directorate Statistical Information). Both of the latter data sources are available, at best, at magisterial district level.

Degradation

The Department of Agriculture (Directorate Agricultural Land and Resource Management) has a system of approximately 50 inspectors distributed at district level, whose task it is to implement the Resource Conservation Act (43 of 1983). This involves conducting inspections of land suspected to be in the process of degradation, and filing reports on these inspections. This information is not captured electronically.

Soils

There is currently no observation system in South Africa to monitor soil fertility, physical state, carbon content, toxicity or biodiversity. The approximately 50 000 Land Type Survey pedon samples are electronically databased and the soil samples are physically archived at the ISCW, and could form the basis of such a system, although there are currently no plans to do so.

Agricultural productivity

Area planted to crops and forests

The Department of Agriculture (Directorate Statistical Information) collects data on the area planted to crops, and produces monthly forecasts of crop yield during the growing season. They also collect data on farm enterprise economics, such as market prices and the prices of various farming inputs. The data are collected by questionnaires, sent on a monthly to quarterly basis to several thousand farmers within

each production sector (e.g. maize, wheat, livestock). The response rate is approximately 50%, and the yield forecast data generally prove to be within 10% of the yields recorded by independent methods. The sample of farmers represents a large fraction (about half) of the total farming population, weighted on a yield basis, but is probably no longer an unbiased sample since it is based on the Agricultural Census of 1981. The demise of the single-channel agricultural marketing boards has made it significantly more difficult to collect accurate yield statistics. For certain commodities, only the trends are captured by the surveys, and the absolute quantities are calculated by multiplying the relative change by the baseline determined by the 1981 or subsequent surveys. Inputs from small-scale farmers, principally in the former homeland regions, are performed on an expert-opinion basis by extension workers in those areas. For cereal crops, questionnaires are sent out on a monthly basis throughout the growing season, and the projected yields are available within weeks of the survey date, in the form of a faxed report. The data are stored on a large centralized database. Annual data are released in the form of a publication, *Agricultural Statistics*, of which a few hundred copies are sold (R25 each) per year, largely to financial institutions. It is also available as an electronic document or spreadsheet. A web site is planned.

The agricultural statistics are collected at a direct cost of approximately R4.5 million per year, by about 20 agricultural economists and eight administrative staff.

Crop and plantation forest yields

The Forest Owners Association produce an annual summary of areas planted, species planted and timber, pulp and pole production by the South African plantation forestry industry, based largely on data collected by the Department of Water Affairs and Forestry and by the members of the Association. Wood harvest from indigenous forests is small, and does not form part of this summary.

Agricultural inputs: fertilizers and pesticides

Within the Department of Agriculture, the Registrar, as defined by Act 36 of 1947, maintains a list of all agricultural chemicals (pesticides, herbicides, etc.), which have been approved for given uses in South Africa. Approval requires testing of the efficacy of the product for its claimed purpose, and determination of its toxicity. After registration, no record is kept of the quantity or location of use. Information of this nature is maintained by the agricultural chemicals supply and manufacturing industry, but is not in the public domain.

Livestock numbers

Livestock data are collected by the Department of Agriculture through the same basic mechanism outlined above. Around 5 000 pastoralists are surveyed quarterly regarding the current size of the cattle, sheep, goat, pig, horse and donkey herds and poultry flocks, as well as sales and/or slaughterings per annum. Data on slaughterings are also obtained from the major abattoirs, but with deregulation in this sector these no longer represent an overwhelming majority of the processors. Data on livestock are also collected by the Directorate Animal Health, and the Bureau for Market Research, University of South Africa.

There is a significant wildlife population in South Africa (amounting, in one estimate, to about 6% of the national livestock herd), much of which is under some degree of active management. Wildlife within national or provincial parks is censused to

varying degrees of accuracy and completeness, approximately annually. Wildlife on private property, which probably exceeds that on public land, is also generally counted every few years for management purposes. There is no coordinated data source or methodology. Some of the data are available on request for research purposes. Hunting and culling licenses are issued by provincial authorities, who maintain a register of applications, which is a good index of demand, but not of harvest.

Indigenous biological resources

Plant resources

The National Botanical Institute is the main custodian of this information. It is well networked with all the herbaria in South Africa, and increasingly with herbaria throughout southern Africa, through the SABONET project. The South African data on plant distribution is stored in a series of linked databases, loosely referred to as PRECIS. This began in the 1970s, as a single centralized database, from which a range of semi-stand alone databases were subsequently generated, and which are now in the process of re-integration. The architecture is thus a combination of centralized and distributed databases.

The core of the PRECIS system is the taxon database, which records the currently recognized scientific names, synonyms and common names for all African plants. It is complete for South Africa, nearly complete for southern Africa, and partly complete for the rest of Africa, and currently contains 56 000 records. It also records, or is linked to databases, which record the conservation status of the taxon at provincial, national and global scale.

The taxon database is linked to the specimen database, which records the species and collector's location (to the nearest 1/4 degree grid square, but more accurately for more recent records) of all herbarium accessions, along with a variety of information about the habitat, growth form, etc., gleaned from collectors notes. There are currently 750 000 records in the database, of which the majority are from South Africa, but an increasing fraction are from the SABONET participant countries (Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, Swaziland, Zambia and Zimbabwe). This data resource is used about 50% internally by the NBI, and otherwise by university based systematic and ecological researchers, conservation authorities, and planners, implementers and policy-makers in the Departments of Agriculture and DEAT. A small fraction (<5%) of the use is from outside of South Africa.

The Garden Records Database is similar to specimen-PRECIS, but records the origin of live material grown in the National Botanical Garden system. It contains about 75 000 records.

The Medicinal Plants Database contains extensive data on the uses, pharmacology, cultivation and conservation of about 250 species known to have medicinal uses.

The Flora Database contains plant descriptions of the type that appear in published Floras.

There are at least two family-specific databases (the Protea Atlas and the Erica Database), which contain distributional data and information on specimen characteristics. There are also databases of cultivated plants and aquatic plants.

Potential users contact the NBI by letter or e-mail with their request, and are quoted a price. The price covers a part of the cost of servicing the request. NBI regards the PRECIS database as their intellectual property and thus not in the public domain, but are mindful of their custodial responsibility to other organizations and society in setting access costs at an affordable level. The main products are distribution maps for a given species, or species lists for given regions. Products can be provided in raw data form or as publication-ready maps, and are sent by e-mail or surface mail. A number of publications (books and lists), based on the database, have been produced and are sold for little more than the cost of printing. There are plans for future products on CD-ROM, and eventual direct Internet public access to at least the upper levels of the data hierarchy (highly aggregated and summarized data), and possible direct but pre-authorized access to the middle levels (slightly processed data).

Plot-scale botanical survey data is maintained by the Grasslands Research Institute, a part of the ARC. This database originated with the notes taken during the seminal botanical ('veld type') survey conducted by Acocks fifty years ago, and has been subsequently expanded. It currently contains about 10 000 records, consisting of geographical location (only reasonably precise for about 1/3 of the records), the species present and their approximate degree of cover. The dataset grows at a rate of approximately 200 sites per year, on an *ad hoc* basis, depending on where research is being undertaken. Access to this data for research purposes is encouraged, but a handling fee may be charged to cover the expense of retrieval. A partly overlapping dataset is maintained by the NBI at Kirstenbosch.

The level of indigenous plant resource use is not systematically surveyed or recorded by any organization on the national scale, although there are provincial scale studies and research projects covering some aspects. The Department of Agriculture (Directorate Agricultural Land and Resource Management) has responsibility for the grazing resource (which occupies about 80% of the surface area of South Africa), and is developing a framework information system, called AGIS. The Department of Water Affairs and Forestry has responsibility for woodland and forest resources, but as yet has no information system. Indigenous forests are small in area and are generally strictly conserved. Fuelwood from woodlands represents about 80% of the domestic energy needs of nearly half the households in South Africa, but is only monitored on an *ad hoc* basis through occasional research projects. Medicinal plant harvesting is a widespread activity, which is becoming increasingly commercialized and threatens the persistence of some populations of the target plants. Data on traditional uses of plants and their pharmacological properties are maintained by several organizations, including the NBI and CSIR. Such data are increasingly sensitive and valuable given their potential for drug development.

Animal resources

The centres of information on animal resources are widely distributed among universities, museums, conservation bodies and research institutions. Almost all of them are to some degree based on digital databases, although there is no common standard and only a limited degree of inter-operability. In practice, the community is

relatively close-knit, and know among themselves who has what kind of information. Table 6 contains an overview of the major taxa and institutions.

Table 6. Institutions taking the lead role with respect to information about animal taxa in South Africa. Even in these relatively large and stable institutions, the subject information is typically vested in one or a few individuals. Knowing who those individuals are is the key to information access. The institutional knowledge base is frequently highly susceptible to the loss of these specialists.

Taxon	Institutions	Comments
Mammals	University of Pretoria (Mammal Research Institute) Transvaal Museum South African Museum Amatola Museum SA Parks Board Kwazulu-Natal Conservation Service	
Birds	University of Cape Town (Percy FitzPatrick Institute of African Ornithology: Avian Demography Unit) Transvaal Museum	Bird Atlas
Amphibia	Avian Demography Unit (see above)	Frog Atlas
Reptiles	Transvaal Museum	
Freshwater fish	Rhodes University (JLB Smith Institute of Ichthyology) Rand Afrikaans University	
Insects	SA Museum Agricultural Research Council (Plant Protection Research Institute)	National Collection of Insects Termites and economically important insects
Freshwater molluscs	Natal Museum	
Arachnids	Plant Protection Research Institute	Spiders, mites, ticks
Nematodes	Plant Protection Research Institute	

The coverage and detail varies greatly between taxa, from extremely complete in the case of large mammals and birds, to sparse in the case of invertebrates. This is despite the existence of very large collections in the latter case, and is simply a reflection of the huge diversity in this taxon.

Freshwater fisheries

South Africa does not have major commercial freshwater fisheries. Recreational (and to a small degree, subsistence) fishing is widespread on South African rivers and dams, but no harvest records are kept.

Biodiversity

Conserved areas

The DEAT maintains a GIS-based database on the boundaries of all formal, state controlled conservation lands (national parks, water catchments, national forests, marine reserves, and areas set aside for conservation by local authorities). The completeness of the data varies from high, at the national scale, to variable at the provincial scale, to low at the local authority scale.

The location of declared and proposed RAMSAR wetlands is also on this database. A separate database of all known wetlands in South Africa (in seven ecological categories, e.g. riverine, lacustrine, estuarine, palustrine, etc.) is currently in preparation as a research project. At present it contains 1 300 records.

The DEAT database also contains the locations of National Heritage Sites (privately-owned land deemed of environmental, scenic or cultural value, volunteered by the owner and afforded a degree of legal protection). There are currently about 120 of these sites. Other forms of private sector conservation (private nature reserves, game farms, conservancies, etc.) are not recorded. Some estimates are that privately conserved land represents twice the area covered by formally protected lands.

The database contains little information other than the boundary vector and date of proclamation. Some biological information is available by overlaying with other georeferenced datasets, such as the national vegetation map.

Further information on these databases can be found on the DEAT website www.gov.za/envweb.

Rare and endangered species

The responsibility for the maintenance of lists of rare and endangered species (Red Data books) lies with the DEAT (Biodiversity). Red Data books covering the major taxa were compiled during the 1980s by the then Foundation for Research Development (now the National Research Foundation), drawing on experts in the academic, conservation and private sectors. These will be updated for the DEAT soon, on a contractual basis - the contractor has not yet been identified. The Red Data books contain information on the species, its status, and known localities, as well as brief notes regarding its biology and the nature of the threats against it.

Red Data book information is captured in ENPAT, a GIS system owned by the DEAT and designed to facilitate planning work by identifying the location of environmentally sensitive areas. The data base is incomplete, given that the data are at least a decade old, and may be spatially imprecise. The custodians of information on endangered species are usually reluctant to reveal their exact location.

In practice, when information is needed regarding the likelihood that a given development will threaten endangered species, enquiries are made through a loose network of local specialists, who may be located in museums, conservation authorities, provincial government, academia, research institutes or non-governmental organizations.

Traffic, an NGO specializing in the CITES agreement, has offices in Johannesburg and Malawi. It is a leading source of information on trade in endangered species. Along with its own information gathering systems, it relies on the register of permits granted for the export and import of live organisms and plant and animal products.

Pest and problem organisms

The Plant Protection Research Institute maintains the South African Plant Invader Atlas (SAPIA). This project uses a combination of systematic surveys and information from a network of volunteers to track the distribution and abundance of approximately 1 300 declared weed species. The information is in a digital database and is made available on request as distribution maps (1/4 degree resolution). It is also distributed to the public in the form of books and pamphlets.

The Department of Agriculture (Directorate Agricultural Land and Resource Management) is responsible for two major indigenous pest species that have the capacity to have a large impact on agriculture at the local scale. Brown locusts periodically form large swarms in the arid parts of the country. There are 50 district locust control officers (who have other duties as well) who receive telephonic information from a network of farmers. They note the date, location and size of outbreaks, along with the measures taken to control them. This information becomes part of a database in the Directorate. There is no direct way of assessing the damage caused by locusts.

The redbilled quelia is a finch-like bird, which can occur in flocks of millions. In principle the quelia information system is similar to that for locusts, except that it lacks the district officers, and is thus much more dependent on volunteers.

A system for monitoring blackfly along the Orange River is currently being established.

Animal disease information is maintained by both the Department of Agriculture (Directorate Animal Health) and the Onderstepoort Veterinary Research Institute. An electronic database is maintained containing the reports of district veterinary officers, who are supported by a network of veterinary technicians.

Plants, mammals, birds, fish, reptiles, amphibians and invertebrates

Electronic databases exist, or are under preparation, on most of these taxa. The lead is being taken by a wide variety of organizations (see table above). The sophistication of the databases, level of completeness and degree of access available outside the organization varies greatly.

Air quality

There is no systematic, national air quality monitoring programme in South Africa, nor is there a centralized, accessible database from which trends and spatial patterns

can be derived. There are a variety of networks operated sporadically by research initiatives, local authorities or major emission producers. Some of these data are in electronic form, and in principle available on request.

In terms of the Air Pollution Prevention Act (1966), operators of 'listed processes' must seek licenses for the emissions which they produce. The licenses, and more recently the Environmental Impact Assessments required by the National Environmental Management Act, specify the projected emissions. These are periodically updated in reports to the Chief Air Pollution Control Officer of the DEAT, and are in principle in a database. Most major emitters are audited with in-flue gas monitors. These data are not publicly available.

The national electricity utility, Eskom, has operated monitoring stations for ambient concentrations of SO₂, NO_x, O₃ and particulate matter in areas around and downwind of its major generating plants (principally in Mpumalanga province) for about a decade. These data are sometimes made available for research purposes, and summaries are published annually. Other major corporations have monitoring networks around their plants. These data are seldom available. Eskom, in collaboration with a number of other organizations and the DEAT has operated a wet deposition monitoring network covering most of the northern part of the country. These data are available on request.

The SAWB, in collaboration with the Fraunhofer Institute, operates a Global Atmosphere Watch station at Cape Point. It records, on a continuous basis, a variety of globally important trace gases (Table 7). As one of the few stations in the southern hemisphere, it is of critical importance in global measurement and modelling of the atmosphere. The main users of the data are the international research community, since it is mainly relevant to global issues such as ozone depletion and greenhouse gases. Data series are published in the peer-reviewed scientific literature, particularly the Journal of Geophysical Research. In future the data will be lodged with the Global Data Centre for Greenhouse Gases (Tokyo) and for ozone depleting substances, with the Norwegian Institute for Air Research (NILU), where they will be in the public domain. This has not yet occurred, due to the problems of getting the data into the format and standards required by the GDCs. The methane data has been lodged with NOAA and CDIAC-ONRL. At present the data are on desktop computers, in Microsoft Access format, with CD-ROM archiving, at the GAW office in Stellenbosch. They are made available on request, if considered of acceptable quality and as long as prior use does not prevent publication by the GAW station staff.

Various local authorities (particularly in the larger metropolitan areas and industrial centres) operate air quality sensors, including for SO₂, NO_x, O₃ and particles. These data are in principle available from the local authorities, but exist in many different formats and systems. The monitoring systems are constrained by severe financial and operating skill limitations.

Various research initiatives have collected air quality data for limited periods, at particular locations. The results are available in summary form as publications and reports. In some cases the base data have been preserved in electronic form. The main ones are;

- Study in Cape Town on lead levels;

- Study in the Vaal Triangle on particulates in low-income housing areas, in relation to respiratory problems;
- Study in Middelburg on SO_x ;
- High altitude monitoring station at Ben McDhui, measuring aerosols in the free troposphere.

Table 7. Summary of the variables recorded at the Cape Point Global Atmosphere Watch station

Category	Gas	Comments
Greenhouse gases	Carbon dioxide (CO ₂)	1991 – present
	Methane (CH ₄)	1983 – present
	Nitrous oxide (N ₂ O)	1991 – present
	Tropospheric ozone (O ₃)	1991 – present
Ozone depleters	Carbon monoxide (CO)	Since 1978, data not available due to international calibration issues
	Freon 11 (CFCl ₃)	1979 – present
	Freon 12 (CCl ₂ F ₂)	1992 – present
	Freon 113 (CCl ₂ FCClF ₂)	
	Methyl chloroform (CH ₃ CCl ₃)	1986 - present
	Carbon tetrachloride (CCl ₄)	1980 – present
	Non methane hydrocarbon	Flask sampled every 6 weeks, analysed by Fraunhofer Institute
Radioactive tracers	⁸⁵ Krypton 85	With Univ. of Freiburg, now suspended
	²²² Radon	With Australian Nuclear Science and Technology Organization and SA-German Bilateral Agreement
	-emitters (Be, ²¹⁰ Pb)	With US Dept. of Energy, now discontinued
Meteorological variables	wind speed and direction	
	pressure	
	temperature	
	global and diffuse radiation	
	UV-B and UV-A radiation	

Ancillary data: economic activity and population statistics

A national census is carried out approximately once every five years by Statistics South Africa. The information, which includes demographic variables (total population, gender, age structure, fertility) as well as other indicators (education, income) is available within about three years of the date of census, at the magisterial district, provincial or national scales. Data summaries are released as press releases, publications (nominally priced), fax-on-demand, telephonic enquiries, e-mail or *via* the Internet (<http://www.css.gov.za>). Larger volumes of more detailed data can be purchased at nominal cost from Statistics South Africa, and are supplied on tape or other magnetic media.

Standard economic indicators (GDP, producer price indices) are collected and published on a quarterly basis by Statistics South Africa. They are reported by magisterial district and by economic subsector, and are based on a 10% sample (on an economic activity basis). Every three to six years a complete census of registered companies takes place. The data are in principle available free of charge, although a nominal charge is made for some publications or for data, which is not readily accessible.

User Needs Assessment

Data and information needs

The preference of almost all data users interviewed is for direct Internet access to summarized information, backed up by access if necessary to the primary data on which it is based. Almost all of the data suppliers expressed an intent to move in the direction of supply through the Internet, but few have actually achieved it.

State of the Environment Reporting

The Department of Environment and Tourism is committed to bringing out State of Environment Reports for South Africa on a regular basis. The first one was produced in 1999. A DIPSR (driver-impact-pressure-state-response) format was followed, with the intention of using internationally developed Sustainable Development indicators as far as possible. It is divided into seven sectors: climate and atmosphere; freshwater; marine and coastal; land and biodiversity; social; economic, and political. The sector chapters were written by consultants in the private sector, research institutes and academia, and coordinated by the CSIR. They all reported substantial difficulty in obtaining time series data of suitable indicators. In most cases isolated and fragmented datasets were known to exist, which were sometimes in the public domain. The data, which in principle is in the public domain, is not always actually accessible, and is seldom worked into summary form. Integration of the datasets from the various sectors was extremely difficult. The State of Environment Report will primarily be available on the web, with paper copies for those without Internet access.

State of the Forests

The Department of Water Affairs and Forestry is currently producing the first State of the Forests report for South Africa. Recent changes in the Forest Act bring open-canopy woodlands under the ambit of DWAF for the first time. These woodlands occupy about 20-30% of the land surface of South Africa and are an important source of fuelwood, browse, medicinal plants, craft timber and fruits, as well as wildlife

habitat. Previously only closed canopy indigenous forests (0.3% of the land surface) and plantations of exotic species (1.4%) were considered the responsibility of the Department. This change is in line with the definition of forests used by the FAO in its periodic forest cover surveys, in which South Africa did not participate prior to 1994. As a result of these changes, there is now a need for forest cover and use information, which is inadequately served by information systems. The National Land Cover map, completed in 1999, is an indispensable resource for this purpose.

Climate Change

As a signatory to the UNFCCC, South Africa is obliged to supply certain information relating to emissions of greenhouse gases to the UNFCCC Secretariat, within three years of ratification, and on a regular basis thereafter. Since South Africa ratified the convention in August 1997, the national submission is due by October 2000. A country study was undertaken under the supervision of the National Climate Change Committee (constituted by the DEAT). The various parts of the inventory were performed by consultants in the private sector, academia and research institutes. The IPCC guidelines define the inventory procedure, and thus the data requirements. It was possible to do a reasonably comprehensive and accurate inventory for the reference year (1990), largely because the South African emissions are so strongly dominated by CO₂ from the energy and industry sectors and in particular, coal consumption. Accurate, centralized data were available on coal and oil consumption from the annual reports of the National Energy Commission. The NEC was abolished in 1992, and the information gathering role reverted to the Department of Minerals and Energy. For recent years, the data are much less easy to access and use. The land use and forestry related CO₂ sources and sinks were harder to estimate, but are quantitatively small. Repetition of the National Land Cover Map would greatly assist, as would the development of a national soil carbon map.

For methane emissions, the principle sources are ruminant animals, for which the Department of Agriculture livestock statistics were essential; coal mining, for which data were relatively easily available; and municipal wastes for which data were poorly available. Data on fertilizer use, made available by the Fertilizer Society of South Africa (an industrial body) were essential for estimating nitrous oxide emissions. Estimates of sulphur dioxide, nitric oxide, carbon monoxide, particulates and non-methane volatile organic carbon, are included in the IPCC guidelines and were attempted in the country study, but may not be obligatory in national communications from non-Annex 2 countries. The lack of a centralized, public domain data source for emissions of SO₂, NO_x and particulates meant that the inventory had to rely on default emission factors, which are highly uncertain, and in some cases, unknown. Given that national communications to the UNFCCC are a recurring requirement, the establishment of a data system to support the process and make it more cost efficient should be a high priority.

The next phase of the climate change country studies was to conduct impact and vulnerability studies. Key areas were hydrology (water supply), forestry, agriculture, rangelands and health. The data needed to undertake these studies were relatively available to the specialists who conducted them, especially given that the impact and vulnerability studies will not be repeated on a frequent basis.

The final phase of the Country Study was adaptation and mitigation studies. They were also partly data-limited. Development of the economic scenarios, and their integration with biophysical drivers have emerged as an issue.

Desertification

The South African Secretariat for the Convention on Combating Desertification (CCD) is located in DEAT. Countries, which are signatories to the Convention, are required to report to the Convention Conference of Parties periodically on subjects defined by the CoP. The structure and methodology of these reports is not defined, as it is in the UNFCCC, so the data needs are much less clear. The South African Secretariat is in contact with the Observatoire du Sahara et du Sahel (OSS) with a view to adapting their experience and information systems in developing a desertification information system for South Africa. Since the core of the Convention relates to the loss of production potential of the land, it is clear that the biophysical side of the observation system would need data which address this issue, such as reliable meteorological records, hydrological records, satellite-derived vegetation indices over a long period of time, vegetation monitoring data, livestock numbers and productivity, crop productivity and inputs, and sediment yields of catchments. Most of these datasets are currently available, but not integrated or available through a central point of access.

A national survey has been carried out by Dr Timm Hoffman of NBI regarding the perceptions of landowners with respect to desertification and degradation.

Biodiversity

The South African Secretariat for the Convention on Biodiversity is located in DEAT. Occasional reports to the Convention CoP are required, but do not as yet have a recurrent content, and therefore the future data needs are not clear. South Africa is relatively well served with biodiversity data for plants, mammals, birds, reptiles and amphibia. Data on invertebrates is much less complete, but still very substantial in comparison with other countries. The Secretariat maintains a web-site related to biodiversity issues.

Requirements raised by potential users of GTOS

None.

Key Stakeholders

Organization	Person contacted	Areas of interest
South African Weather Bureau (Department of Environmental Affairs) Private Bag X97 Pretoria 0001, South Africa tel: +27-12-309 3001 fax: +27-12-309 3121	Mr Gerhard Schulze, Mr Mike Laing e-mail: schulze@cirrus.sawb.gov.za mvlaing@cirrus.sawb.gov.za	Weather data
	Mr Ernst Brunke Environmentek, CSIR PO Box 320 Stellenbosch 7999, South Africa tel: +27-21-888 2400 fax: +27-21-888 2693 e-mail: ebrunke@csir.co.za	Global Atmosphere Watch
Institute for Soil, Climate and Water Private Bag X79 Pretoria 0001, South Africa tel: +27-12-310 2500 fax: +27-12-323 1157	Dr Koos Eloff Tel: +27-12-310 2502 e-mail: j_elloff@igkw2.agric.za	Soils
	Mr Karl Monnik tel: +27-12-310 2542 e-mail: k_monnik@igkw2.agric.za	Agricultural climate
	Terry Newby Tel: +27-12-310 2587 e-mail: terry@igkw2.agric.za	Remote sensing
National Botanical Institute Private Bag X101 Pretoria 0001, South Africa tel: +27-12-804 3200 fax: +27-12-804 3211	Mr Trevor Arnold e-mail: tha@nbipre.nbi.ac.za	Herbaria, National gardens, Desertification monitoring, Rare and endangered species
Institute for Water Quality Studies Private Bag X313 Pretoria 0001, South Africa tel: +27-12-808 0374 fax: +27-12-808 2702	Mr Uli Looser, Dr Philip Kempster e-mail: ecl@dwaf-hri.pwv.gov.za ebp@dwaf-hri.pwv.gov.za	Water analysis
CSIR PO Box 395, Pretoria 0001, South Africa tel: +27-12-841 2911 fax: +27-12-841 3789	Dr Charles Shackleton tel: +27-12-841 3639 fax: +27-12-841 2689 e-mail: cshackle@csir.co.za	Woodland and forest production plots
	Mr Dirk Roux tel: +27-12-841 2695 fax: +27-12-841 2689 e-mail: droux@csir.co.za	

Key stakeholders continued

Organization	Person contacted	Areas of interest
CSIR continued	Dr Colin Everson CSIR, c/o Agrometeorology, School of Applied and Environmental Sciences, University of Natal, Private Bag X01, Scottsville 3209 tel: +27-331-260 5446 fax: +27-331-260 5266 e-mail: ceverson@csir.co.za	Research catchments
	Mr Trevor Harrison, Mr Colin Archibald PO Box 17001, Congella 4013 tel: +27-31-261 8161 fax: +27-31-261 2509 e-mail: tharrison@csir.co.za carchiba@csir.co.za	Estuarine biota
Rhodes University, JLB Smith Institute of Ichthyology PO Box 94 Grahamstown, South Africa tel: +27-46-636 1002 fax: +27-46-622 2403	Tom Hecht	Aquaculture, inland fisheries
Rand Water PO Box 1127 Johannesburg 2000, South Africa tel: +27-11-682 0911 fax: +27-11-682 0444	Ralph Heath tel: +27-11-682 0749	Water quality
Umgeni Water PO Box 9 Pietermaritzburg 3200, South Africa tel: +27-331-341 1111 fax: +27-331-341 1167	Dr Chris Dickens/Wayne Schaffer tel: +27-331-341 1275	
Department of Water Affairs and Forestry Private Bag X313 Pretoria 0001, South Africa tel: +27-12-336 7500 fax: +27-12-326 2715	Mr Herman Keuris, Ms Estelle van Niekerk (Directorate Hydrology) e-mail: sga@dwaf.pwv.gov.za scm@dwaf.pwv.gov.za	River flow, dam storage
	Mr Eberhard Braune (Directorate Groundwater) e-mail: waa@dwaf.pwv.gov.za	Groundwater

Key stakeholders continued

Organization	Person contacted	Areas of interest
Mpumalanga Department of Environmental Affairs Private Bag X11233 Nelspruit, South Africa tel: +27-13-759 400 fax: +27-13-759 4048	Johan Engelbrecht (Lydenburg)	Water quality
Northern Province Environmental Affairs tel: +27-15-295 3025 fax: +27-15-291 2654	Mick Angliss (Giyani)	River health
Department of Environment Affairs Private Bag X447 Pretoria 0001, South Africa tel: +27-12-310 3911 fax: +27-12-322 2682	Mr Paul McLons (Directorate Environmental Quality and Protection)	Air quality
	Mrs Wilma Lutsch (CCD Secretariat)	Desertification
	Dr Gert Willemse (Biodiversity Secretariat)	Biodiversity
	Mr Lungi Mbanga, Mr Festus Luboyera (FCCC Secretariat)	Climate change
Eskom TRI PO Box 1091 Johannesburg 2000, South Africa tel: +27-11- 800 8111 fax: +27-11-800 4299	Gerhard Held	Rainwater chemistry Air quality
Free State Department of Nature Conservation tel: +27-51-448 1224	Pierre de Villiers	Freshwater biota
South African National Parks: Kruger National Park: Scientific Services Private Bag X402 Skukuza 1350, South Africa tel: +27-13-735 5611	Andrew Deacon	Freshwater biota
	Harry Biggs	Wildlife
	Holger Ekhardt	Habitats
Endangered Wildlife Trust Private Bag X11 Parkview, South Africa tel: +27-11-86 1102 fax: +27-11-486 1506	Dr John Ledger	Biodiversity

Key stakeholders continued

Organization	Person contacted	Areas of interest
World Wide Fund for Nature, Stellenbosch PO Box 456 Stellenbosch 7599, South Africa tel: +27-21-887 2801 fax: +27-21-887 9517	Dr Ian MacDonald	Rare and endangered species
Gauteng Department of Nature Conservation PO Box 8769 Johannesburg 2000, South Africa tel: +27-11-333 2106 fax: +27-11-337 2292		Air quality Water quality
Department Agriculture: Directorate Agricultural Statistics Private Bag X246 Pretoria 0001, South Africa tel: +27-12-319 6524		Food and fibre production
Department of Agriculture: Directorate Animal Production and Health Private Bag X138 Pretoria 0001, South Africa tel: +27-12-319 7411	Dr Ungerer	Veterinary control disease
Statistics South Africa Private Bag X44 Pretoria 0001, South Africa tel: +27-12-310 8911 fax: +27-12-310 8500	Rene Stasser tel: +27-12-310 8351	Population, economic data
Agricultural Research Council: Plant Protection Research Institute Private Bag X134 Pretoria 0001, South Africa tel: +27-12-808 0952 fax: +27-12-808 1489	Dr Helmut Zimmerman tel: +27-12-329 3269	Insect pests and weeds
Water Research Commission PO Box 824 Pretoria 0001, South Africa tel: +27-12-330 0340 fax: +27-12-331 2565	Dr George Green, Hugo Maaren	
GIS Business Solutions Private Bag X48 Halfway House, South Africa tel: +27-12-348 3292 fax: +27-12-348 3276/6814	Willem van der Riet	ENPAT

5. Zimbabwe

Acronyms Used in Zimbabwe

DRSS	Department of Research and Specialist Services
ERCSA	Environment Resource Centre for Southern Africa
ERSI	Environment and Remote Sensing Institute
PSP	Permanent sample plots
SARDC	Southern African Research and Documentation Centre
SIRDC	Scientific Industrial Research and Development Council
SoER	State of Environment Report
WWF-SA	Worldwide Fund for Nature (southern Africa)

Country Profile

Land Surface

Land Area	391, 109 km ²
Area formally conserved	7.9%
Area transformed by cultivation	13% (including permanent pastures)

Demographics

Population	12.05 million (1997 estimate)
Urban percentage	32%
Population growth rate	2.4%

Economy

GDP in 1998: US\$ 8 235m at current prices
GDP Growth rate (1993-1998): 2.8 at constant prices
Contribution to GDP by tourism and hunting: large
Contribution to GDP by crop agriculture and livestock: 22% (1996)
Contribution to GDP by forestry: small from commercial forestry, but locally significant from use of the woodlands for craftwork.

Governance

Political system: Parliamentary democracy, most power held centrally
Provinces: Matabeleland North, Matabeleland South, Mashonaland Central, Mashonaland East, Mashonaland West, Masvingo, Midlands, Manicaland.
Environmental issues are predominantly handled at national level.

Climate

Zimbabwe is generally dry and warm. The diurnal average surface temperatures vary from 15°C in July to 22°C in January. Average summer precipitation varies from 400 mm in the south to about 900 mm in the mountainous north-east. In winter the average precipitation is less than 70 mm. Annual average rainfall is between 400 and 700 mm.

Biota

Three biomes: Savanna, Grassland, and Forest, with savanna (including woodlands) predominating.

Major Environmental Issues**Pollution and toxicity**

Zimbabwe is the second most industrialized country in SADC, after South Africa. Industries are concentrated around Harare, with ore smelters located close to the ore sources (principally along the Great Dyke). A combination of vehicle emissions, dust and smoke from domestic fires is a potential air quality concern in larger cities such as Harare. Water is not generally abundant, and the maintenance of water quality is a serious issue.

Biodiversity preservation

Zimbabwe has a rich biotic heritage and is highly dependent on tourism. It has a long history of biodiversity preservation, through the national parks, forest reserves and innovative community-based sustainable-use schemes such as CAMPFIRE. Nevertheless, the natural resources are under pressure from a growing population with limited economic alternatives.

Land quality

Of the four countries in this survey, Zimbabwe has the greatest fraction of its land area in good quality agricultural land. The economy of Zimbabwe has a large agricultural component, and the majority of people are dependent on the land. The distribution of people and productive agricultural resources is uneven, leading to problems of land degradation where large numbers of people and livestock are concentrated on marginal lands.

Freshwater resources

The Zambezi River in the north is one of the largest rivers in Africa, but does not currently supply water to the rest of the country, which is water-scarce in most parts. The geology is generally not conducive to large groundwater supplies.

Climate change

Like the rest of southern Africa, Zimbabwe is strongly influenced by fluctuations in rainfall. An improvement in the water balance as a result of climate change would be a great benefit; increase water stress, on the other hand, would be a substantial development challenge.

Status of National Environmental Observing Systems

Institutional framework

Government Organizations		
Ministry	Department	Functions
Ministry of Transport	Meteorological office	Collects, analyses and disseminates weather data
Ministry of Mines, Environment and Tourism	Dept. of National Parks and Wildlife Management	Wildlife, biodiversity
	Division of Mines	Air pollution, waste
Ministry of Lands and Agriculture	Dept. Research and Specialist Services	Soils, veterinary services, survey, agricultural and livestock research
Ministry of Water Resources	Dept. of Water Development	Surface and groundwater hydrology
Parastatal organizations		
University of Zimbabwe; several departments and the Institute for Environmental Studies	Education and research; coordinating centre for environmental training in SADC	
Forestry Commission	Natural and plantation forests and woodlands	
Scientific Industrial Research and Development Council	Remote sensing laboratory	
Non-governmental Organizations		
Southern African Research and Documentation Centre	State of environment studies, strictly speaking a SADC organization rather than a Zimbabwean one	
Many others	Many small NGOs active in the environmental field, ranging from natural history societies to environmental activist groups. Few major data holdings	

Analysis of existing sites

Name of site Responsible agency	Longitude	Latitude	Comments
Tier 2: Long-term, permanently staffed sites conducting advanced observations on many variables, often with experimentation			
None known			Several of the tier 3 sites have the potential to become tier 2 sites
Tier 3: Long-term, staffed sites routinely observing a core set of variables (research stations)			
Matopos DRSS	~20.1 S	~28.4 E	Agricultural research station and adjacent national park, long-term fire trials and bush clearing trials. ICRISAT sorghum research station
Marondera DRSS	18.11 S	31.33 E	Agricultural research station, specializing in maize, tobacco and horticulture, some long-term miombo woodland studies
Makoholi DRSS	~20 S	~31 E	Agricultural research station, specializing in livestock
Chesa forestry research station Forestry commission			Various research projects related to woodland management
Kariba Univ. of Zimbabwe	16.31 S	28.50 E	Fisheries research station
Sengwa National Parks	~17 S	~28 E	Ecological research station, now largely dormant
Tier 4: Locations which are periodically visited			
Forestry Commission	Concentrated in national forest reserves in the northwest		Permanent sample plots for woodland growth and mortality
Parks and Wildlife	National		Designated national water bodies

National networking

It is unclear which Government agency has the mandate to coordinate environmental information systems in Zimbabwe. The Institute of Environmental Studies at the University of Zimbabwe has taken a lead in establishing a SADC regional network for training in environmental issues. The environmental technical community is small, and well networked through personal contacts.

International networking

Zimbabwe is a signatory of the UN Framework Convention on Climate Change, the Convention on Biodiversity and the Convention for Combating Desertification, as well as many other international environmental treaties. It is the location of the head office of several SADC-region networks, such as those operated by FAO, IUCN, and SADC Food Security.

Legal framework for data handling

Much of the Government-held data is in principle public domain, but accessing it is not easy. Organizations such as the Meteorological Service charge for weather data, other than the standard summaries and forecasts. The national land cover map held by the Forestry Commission is available in the public domain at 1:1 million scale, but the 1:250 000 product is sold (at a price considerably below cost recovery). There is significant resistance to access by non-Zimbabweans, based largely on a feeling that national efforts in data collection are being exploited without due sharing of the credit or cost of collection, or that the data may be used in ways not to the national benefit.

Sectoral Environmental Information Systems

Weather and climate

Meteorological information has been collected on a regular basis since the 1950s although earlier records exist since 1869. Daily rainfall data are collected from 120 stations, and reported by telephone to either the Harare or Bulawayo offices of Meteorological Services. Additional synoptic data such as temperature and relative humidity are collected from 64 stations and reported monthly. In addition, about 1 200 rainfall records are submitted monthly on a voluntary basis by various individuals and organizations. There is a two-week delay in the compilation and capture of the data. Data are captured in the WMO CLIMCOM database. Early records are still in paper or punch card format. Staff shortages have constrained the production of the annual report for the Meteorological Services. Routine data outputs are readily available but there is a charge for unusual or specific information requirements. A ten-daily and monthly summary is mailed to users. The meteorological service has a web page with current forecasts.

Users of the data include the Food Early Warning System (FEWS) of FAO, aviation authorities, the general public and the agricultural sector. Additional rainfall and temperature data are collected by the Forestry Commission and the Department of Water Resources for their own use.

Water resources

Water resource information for Zimbabwe is available in the form of the SADC Water Resource Database on CD-ROM. The database covers the SADC region and includes surface water bodies, watersheds, rivers and aquatic species distribution. Some basic water quality parameters are included where data are available.

Surface water resources

Quantity of flow

A network of gauging stations and weirs records dam levels and the amount of flow in rivers. Dam levels are recorded twice a week, and telephoned through to the central Hydrology Office in Harare where the amount of water in each dam is calculated and summed for each province. The change in water volume is monitored weekly for each of the important national dams. Automatic gauging stations (approximately 10 data loggers and 200 chart recorders) on the key river systems capture runoff data (flow/second). The daily average is sent to the central data processing office where records are maintained. The sediment load of certain rivers is also monitored to a limited extent.

At the local catchment level, abstraction of water from dams and rivers is monitored by catchment authorities.

Water quality

River water quality is monitored routinely by provincial pollution control officers. A network of sampling sites is visited at least every three months, although the ideal frequency is monthly. Chemical analyses, which include common inorganic ions, are performed by the Water Quality Analysis Laboratory in Harare. The laboratory maintains computerized records of the samples and provides the pollution control officers with paper copies. Trend analysis is difficult and tedious to perform thus monitoring and control of pollution appears to occur when there is a pollution incident. A summary 'State of the River' report is produced each year.

Non-routine studies include some monitoring of the effects of chemical weed control on water quality as well as some monitoring by mines and industry.

Groundwater resources

Size of resource

Geophysical information and geographical location are captured whenever a new borehole is drilled. Although over 16 000 boreholes are recorded in Zimbabwe, the total number of boreholes is estimated to be in the region of 50 000. Information captured in the Department of Water Resources groundwater database includes water levels and quality, the nature of the geological formation and the results of pumping tests. Water levels are monitored on a monthly basis in order to optimize rates of abstraction by users. The geophysical and hydrogeological features of the principal aquifers are reported on an *ad hoc* basis - primarily as investigations into a portion of the aquifer are completed.

Groundwater quality

See above, under water quality

Land cover, Land use, Land quality

The Zimbabwe Land Reform Programme has stimulated the digitization of commercial farm boundaries at a scale of 1: 250 000 in order to produce a National Land Inventory.

Vegetation

Land cover and land use change for southern Africa has also been mapped by the WWF southern Africa regional office using Landsat images and aerial photos. Vegetation change is mapped by the Office of the Surveyor General (data from mid-fifties to mid- nineties).

Soils

The soils of Zimbabwe were mapped at a scale of 1:1 000 000 in 1978/1979. Although there is large uncertainty with respect to the accuracy of the information for some areas, this map is generally widely used to provide soils information for the country. Plans to accurately map soils at the 1: 50 000 scale for the entire country have only been achieved for the Banket area. All soil data held by the Chemistry and Soil Research Institute is captured and stored in a computerised system, which cannot be manipulated to perform searches on particular fields.

The communal areas (also known as the Tribal Trust areas) of Zimbabwe have been mapped at a scale of 1: 250 000 in a Physical Resources Inventory. The information is presented as land units, which represent a combination of features such as geology, erosion, soils and land use.

A project under the auspices of the FAO and UNEP aims to update the 1979 soils map with information from the communal lands study. Information will be digitized and contribute to revision of the 1:1 000 000 Soil Map of the World.

Soils are also mapped at various scales for clients such as the Department of National Parks and Wildlife Management and Department of Agriculture. However, these data are only available with the permission of the client.

Agricultural productivity

Crop and plantation areas and yields

Agricultural statistics are collected by the Central Statistics Office, as well as the individual farmers cooperatives for each of the commercial crops.

The Forestry Commission is responsible for conducting an annual survey of the plantation timber production and processing in Zimbabwe. Questionnaires are sent out to registered plantation owners and roundwood processors. Information is requested on tree ages, areas under commercial species, new afforestation, loss of plantation areas and causes, as well as production of wood-based products. The information is compiled in a survey report, which is also provided to the FAO. However, the last

survey was conducted in 1992/1993. The Timber Producers Federation, based in Mutare, also conducts *ad hoc* surveys on forest production.

Agricultural inputs: fertilizers and pesticides

Not known.

Livestock numbers and diseases

Livestock data are collected as part of the large mammal aerial survey conducted annually by WWF and the Department of National Parks and Wildlife Management. The Central Statistics Office holds information on livestock numbers for both commercial and communal farms.

Disease outbreaks for both livestock and wild life are tracked by the Department of Veterinary Services.

Indigenous biological resources

Plant resources

The conservation and exploitation of indigenous forest products in demarcated forests is the responsibility of the Forestry Commission. The Indigenous Resources division estimates the amount of timber removed on a yearly basis, but there is no central data collection process.

The Forest Extension Services conduct inventories of forests in communal lands for District Information Management Systems in order to understand the rate of timber abstraction from these areas.

Forest areas are mapped on a scale of 1:250 000 in a land cover mapping initiative for the country (VEGRIS). No detailed species data are captured - only vegetation structure (for example, woodland, bushland, grassland, forest plantation).

Research on approximately 50 permanent sample plots (PSPs) has been ongoing since the 1930s. Plot sizes range from 0.4 to 12 hectares. Individual trees are marked and their diameter growth tracked at three-year intervals. Since 1993 height measurements have been included. The PSP information is captured digitally, and is available to interested parties for research purposes, planning of harvesting schedules and to aid the Indigenous Resources Division with conservation and exploitation decisions.

Animal resources

Statistics on wild animal numbers are maintained by the Department of National Parks and Wildlife Management in order to set hunting quotas and understand the effects of hunting on animal populations. Data are provided by National Parks game scouts, district councils and private land owners throughout the year. Annual reports on hunting statistics for the National Parks are available within the Department.

Population studies of crocodiles are conducted in order to monitor their rate of utilization. Statistics on the number of eggs collected and number of crocodiles released are passed to CITES from the Department of National Parks and Wildlife Management.

Freshwater fisheries

Yearly statistics on fishing activities since the 1970s are available. The information is provided by the commercial fishing companies operating on Lake Kariba and recently information for both Zambia and Zimbabwe have been compiled in a single report. Data include the number of fish caught, their weight and value, the number of fishermen, rare species and so forth. Data are recorded monthly for pelagic stocks. The capture of larger fish species near the shoreline is also monitored.

Biodiversity

Conserved areas

The boundaries of National Parks are available in digital format from a variety of sources. A wetlands inventory for the Zambezi Basin resides with the Biodiversity Foundation in Bulawayo. The WWF maintains a database with all farm boundaries on it, particularly in relation to conservation on private lands.

Rare and endangered species

The WWF southern Africa regional programme assists with an annual aerial census of large mammals in communal areas and national parks. Rare and endangered species such as rhinos are individually monitored by game scouts and farmers and the data sent to the Department of National Parks and Wildlife Management. Distribution data for the endangered and endemic plants of the Miombo are collected by the National Herbarium.

Problem organisms: weeds, pests and diseases

Ad hoc studies on water-borne diseases such as bilharzia have been conducted collaboratively by the Departments of National Parks and Wildlife Management, and Health. Aquatic weed control studies are also conducted by the Department of National Parks and Wildlife Management. Data are not readily accessible.

Plants

The National Herbarium in Harare has a comprehensive collection and is linked to the SABONET system.

Mammals, birds, reptiles and amphibians

The National Museum in Bulawayo is a key repository of information and expertise. A long history of amateur naturalists in societies such as the Ornithological Society of Zimbabwe has also contributed to a relatively well-known and documented mammal and bird fauna. The Department of National Parks and wildlife has data on large mammals, as does the WWF (especially for privately-held land).

Fish

The monitoring of aquatic systems in Zimbabwe is generally conducted on an *ad hoc* basis with particular emphasis placed on water bodies of national importance such as Lake Kariba. No routine monitoring of limnological parameters is currently undertaken, nor are there any biomonitoring programmes underway.

An aquatic species distribution database is currently available for the SADC region as part of the SADC Water Resource Database. At present the database is limited to fish species for which distribution data were derived from Skelton's 'Complete guide to freshwater fishes in southern Africa'. There is a collaborative effort underway to

update the fish distribution information using museum records from the southern African region.

Air quality

There is no systematic, national air quality monitoring programme in Zimbabwe, nor is there a centralized, accessible database from which trends and spatial patterns can be derived.

Air quality has been measured at eight stations in Harare for the past twenty to thirty years, but information on the study has apparently never been published. A few mining and industrial operations reportedly monitor their emissions, but data are not readily available.

Ancillary data: economic activity and population statistics

The Central Statistics Office collects demographical information from census data. The last census was conducted in 1992.

User Needs Assessment

Data and information needs

State of the Environment Reporting

The SoER database for Zimbabwe is a 1:1 000 000 spatial coverage of the country, termed the Integrated Resource Information System (IRIS). The themes captured thus far are climate, temperature, agroecological zones, ecological zones, vegetation classification, geology, soils, erosion hazard, land use patterns, hydrological zones, transport networks, airport locations, mining activities and administrative boundaries. A SoER document for Zimbabwe is available. It is envisaged that future SoER reports for Zimbabwe will be available both on the Web and as paper documents. The Zimbabwe SoE report will be updated every five years and will be based on regularly updated District Profiles.

District profiles are currently under development in a pilot project in the province of Mashonaland East. So far, information has been compiled for eight districts in the province. Detailed information at the 1:50 000 scale is/will be collected to provide the input for the national SoE. In addition, the information will support the district authorities in their management of natural resources.

The ERCSA section of SARDC assists with State of the Environment reporting for the SADC region (Lesotho and Malawi) and even further afield (the Gambia and Eritrea).

A SoER for the Zambezi River Basin is currently underway which spans eight countries and focuses on issues such as gender, pollution, energy and biodiversity.

State of the Forests

The Forest Resources Assessment 2000 (FAR2000) Programme is an initiative of the FAO Forestry which aims to report on the state of the world's forests for the year 2000. The Zimbabwe Forest Commission will be responsible for providing the relevant information.

Climate Change

Meteorological data is accessible to track patterns of climate change in Zimbabwe. Systems such as the Drought Monitoring System and the Food Early Warning System are also used on a local scale to provide climate information. However, these generally provide historical information instead of predictive information, which would be more useful for crop planning purposes.

Desertification

Biophysical data to support the Convention on Combating Desertification is the responsibility of the Department of Natural Resources. Land use change and land cover change are important information sources but appear to be scattered across a variety of organizations (DNR, Forestry Commission, WWF-SA).

Biodiversity

The Department of Natural Resources would be the responsible agent for collating and providing biodiversity information. However, apart from regular information on large mammals, which is supplied to the DNP&WM, biodiversity data for other taxa is scattered across museums, educational institutes and individual researchers.

Requirements raised by potential users of GTOS

None.

Key Stakeholders

Organization	Person contacted	Areas of interest
ALCOM - Aquatic Resource Management for Local Community Development Programme (Located in Fisheries Research Unit, National Parks Complex, Sandringham Drive, Harare) PO Box 3730 Harare, Zimbabwe tel: +263-4-724985/734797 fax:+263-4-736847 e-mail: ALCOM@harare.iafrica.com	Mr Lieven Verheust	Water resources
Department of Mines, Environment and Tourism (cnr Samora Machel/Jason Nyerere) Pbag 7753, Causeway Harare, Zimbabwe tel: +263-4- 757 881/74	Ms Mukahanana	
Department of National Parks and Wildlife Management PO Box CY 140, Causeway Harare, Zimbabwe tel: +263-4-707624/708344 cell: 011 605 224	Mr K Moyo	Wildlife utilization
	Dr Richard M Gurure	Aquatic ecology
Department of Natural Resources Block one, office 72, Makombe Building, Cnr Herbert.Chitepo Ave/Harare St., Causeway Harare, Zimbabwe tel:+263-4-705 671/705 661 e-mail: dnrnatr@cst.co.zw	Mr Robert Mkwanda	Environmental information management
	Mr Simon Bere	Application development specialist
Department of Research and Specialist Services – Chemistry and Soil Research Institute PO Box CY 550, Causeway Harare, Zimbabwe tel: +263-4-704531/41 fax:+263-4-728317	Mr Julian Spurway	Section Head: Pedology and soil survey
	Mr Moyo	Pedology and soil survey
Department of Water Development (Kurima House 3 rd Floor, (opp. Mutual Centre), Harare St., Harare) PO Box CY 726, Causeway Harare, Zimbabwe	Mr Musariri	Surface hydrology

Key stakeholders continued

Organization	Person contacted	Areas of interest
Department of Water Resources (Kurima House 3 rd Floor, (opp. Mutual Centre), Harare St., Harare) Private Bag 7767, Causeway Harare, Zimbabwe	Ms Mawango	Pollution Control Officer
	Mr L Sengayi	Groundwater
Environment and Remote Sensing Institute (ERSI) - Scientific Industrial Research and Development Council (SIRDC) Hatcliff, Zimbabwe tel: +263-4-860 320/1-9	Ms Sharon Gomez	
Environment Resource Centre for Southern Africa – Southern African Research and Documentation Centre (15 Downie Avenue, Belgravia) PO Box 5690 Harare, Zimbabwe tel: + 263-4-737301 fax: +263-4-738693	Lovemore Sola e-mail: Isola@imercsa.sardc.net	Head of Environmental Programme
Food and Agriculture Organization of the United Nations – Sub-regional Office for Southern and Eastern Africa (6 th Floor, Old Mutual Centre, cnr Third St/ Jason Moyo) PO Box 3730 Harare, Zimbabwe tel: +263-4-791 407/20 fax: +263-4-703497	Owen Hughes e-mail: Owen.Hughes@fao.org	Integrated Resources Management Officer
	Michel Laverdiere e-mail: Michel.Laverdiere@fao.org	Forest Conservation Officer
	Mark A. Smulders e-mail: Mark.Smulders@fao.org	Food Systems Economist
Forestry Commission (Forest Research Centre, 1 Orange Grove Drive, Highlands) PO Box HG595, Highlands Harare, Zimbabwe tel: + 263-4-496878/9 or 498 436 fax:+263-4-497070 e-mail: frchigh@harare.iafrica.com	Mr Chemist M. Gumbie	Forest biometry

Key stakeholders continued

Organization	Person contacted	Areas of interest
Meteorological Services (Cnr Gaul Ave/ Hudson St., Harare) PO Box BE150 Belvedere, Zimbabwe tel: +263-4-774 893/890 cell: 011 208459	Dr MC Zinyowera	
Office of the Surveyor General (Electra House, Cnr Jason Nyerere/Samora Machel Ave, Harare)	Mr Ruben Mavimu	
SADC - Food, Agriculture and Natural Resource Office and Food Security Unit (43 Robson Manyika St (Cnr 2nd St.), Merchant House, 3 rd Floor) PO Box 4046 Harare, Zimbabwe tel:+263-4-796 847 fax:+263-4-795 345	Mr R Mugwara	
University of Zimbabwe PO Box MP 167 Mount Pleasant Harare, Zimbabwe tel: +263-4-303 211 fax: +263-4-333 407	Ms Kathy Verbeck Department of Soil Science tel:+263-4-303 211 x1412	Soil science
	Dr Barnibus Chipindu E-mail: chipindu@compcentre.uz.ac.zw Department of Physics tel: +263-4-303211 x1926	Meteorology and air pollution
	Mr Dan Semayo Institute for Environmental Studies	Data structures
WWF Southern Africa Regional Programme office, (10 Lanark Rd (Cnr 2nd St.) PO Box 745 Harare, Zimbabwe tel: +263-4- 730 599	Dr David Cumming e-mail: dcumming@wwf.org.zw	Conservation

6. Southern African Development Community Region

Soon after commencing this study it became apparent that there were several important Environmental Information Systems, which operated regionally rather than nationally. Although not in the original brief, this chapter was added to discuss these systems. If GTOS is to operate regionally, it has much to learn from the organizations already occupying this niche.

Some of the regional systems operate under the organizational umbrella of SADC itself. Most are independent organizations, but frequently have formal recognition from SADC. Several are the regional branches of international bodies, such as the FAO, IUCN or WWF. This chapter is therefore not a survey of SADC the organization, but of EIS operating in the SADC region, and specifically that part of it covered by Botswana, Namibia, South Africa and Zimbabwe.

Acronyms Used Regionally

ALCOM	Aquatic resource development for local communities (FAO)
APINA	Acid Precipitation Information Network in Africa
ELMS	Environment and Land Management Sector (of SADC)
FAO	Food and Agriculture Organization of the United Nations
IUCN	World Conservation Union
SADC	Southern African Development Community
WWF	Worldwide Fund for Nature

Status of Regional Environmental Observing Systems

Institutional framework

SADC

The 14-nation Southern Africa Development Community was established in 1980 as SADC. Its mission is to promote regional cooperation in economic development. SADC has adopted a Programme of Action covering cooperation in various sectors. Delegation of authority in SADC is on a sectoral basis. That is to say, each SADC member state has responsibility for the coordination of one or two sectors. In addition, there is a secretariat located in Gaborone, Botswana.

Several SADC sectors impinge on the environment. There are two sector coordinating units (SCU) dealing with agriculture: Agricultural Research is located in Botswana, while Food Security is located in Zimbabwe, Ministry of Lands and Agriculture. The Inland Fisheries, Forestry and Wildlife SCU is in Malawi (marine fisheries is coordinated by Namibia). These sectors listed above are themselves coordinated as a cluster by the Food, Agriculture and Natural Resources (FANR) development unit, under the mandate of Zimbabwe. The main objective of FANR is that adequate food be available to meet the needs of individual households and the total population of the region as a whole. Food security thus includes both supply and access.

The Environment, Lands Management Sector (ELMS) and the Water Sector coordinating units, both located in Lesotho, are not part of FANR. The logic is that the FANR cluster has to do with the use of the environment, while ELMS is to do with its protection. To avoid conflicts of interest the sectors are kept separate. ELMS must also span across the environmental aspects of the activities of all the other (non-Natural Resource) sectors, such as Transport, Communication, etc. ELMS is responsible for the EIS network in the SADC region. In 1996 it was decided to give some of the EIS responsibilities to other SADC institutions. The technical responsibility was given to FANR, largely because of the experience gained by the SADC Regional Remote Sensing Unit (RRSU) located there. Within FANR, a SADC EIS Technical Unit (SETU) was established with funding from UNEP.

Since August 1999 SADC has reorganized its original decentralized structure. It became clear that sectoral programme of action was in some cases not well matched to the Member State resources. The present 18 SCUs will be replaced with five Planning and Coordination Directorates. Under this structure the FANR development unit has responsibility for Livestock Production and Animal Disease Control, Forestry, Wildlife, Marine and Inland Fisheries, Agricultural Research and Training, the Crop Sector and Food Security.

The RRSU facilitates training programmes and technical support in the field of remote sensing and GIS in support of early warning for food security and natural resources management. The RRSU operates a Meteosat PDUS receiving station, which is located at the Zimbabwe Meteorological Department. The Meteosat data are used by the Central Forecasting Unit of the ZMD. They also derive cloud duration images and rainfall estimates from it, used to monitor the rainfall situation over SADC in near-real time. Data is distributed to all SADC member states. At a regional level it is used by the Regional Early Warning Unit (REWU), the Drought Monitoring Centre (a Belgian-funded activity managed by the ZMD on behalf of the WMO, and currently under the authority of the Transport and Communications sector, which focuses on long-term forecasts, based primarily on statistical interpretation of El Niño/Southern Oscillation signals), and the Food Early Warning System supported by USAID, but also located at FANR. The RRSU also receives NOAA-AVHRR data and processes them to produce maps of Normalised Difference Vegetation Index (NDVI), which are distributed in the same way as the rainfall estimates.

In 1994 the RRSU started a number of activities in order to create a unique regional vector database. The RRSU spatial data is made available, together with satellite images and climate statistics, on CD-ROM. The CD can be viewed using customized software (WinDisp). While the main focus of the RRSU is on early warning for food security, it has become clear that the activities, databases and outputs are beneficial for a wide range of environmental uses. RRSU is now regarded as one of the major spatial data sources in southern Africa. Consequently the RRSU is involved in several initiatives to harmonize and improve spatial structures within the SADC region.

In 1996, SETU in collaboration with IUCN-ROSA and IMERCSA conducted a regional survey to assess the status of EIS in SADC member states, and collected information for a meta-database. Since 1999, no further funding has been available for SETU. After consultation with ELMS, FANR, IMERCSA, IUCN, and UNEP, it was

decided to transform SETU into a Programme managed by RRSU on behalf of ELMS and FANR.

The SADC EIS Training and Education System (SETES) also commenced in 1996, in parallel with STU. It was coordinated by the University of Botswana.

SADC FANR consists of several units and projects. Overall it has about 35 professional staff and ten support staff. The central part of the programme is the Regional Early Warning Unit (REWU), which is assisted by RRSU. These two units are the core of the Regional Early Warning System (REWS). Each SADC member state has a National Early Warning System, supported by a National Early Warning Unit.

UN Organizations

The Food and Agriculture Organization (FAO) has a mission of alleviating poverty and hunger through promoting agriculture development. It has a regional office in Harare, with many programmes. One of its objectives is to act as a clearing-house for information on agriculture. This includes the annual, global State of Food and Agriculture and the biennial State of the World's Forests and State of the World's Fisheries and the decadal World Food Survey.

ALCOM (Aquatic Resource Management for Local Development) is an FAO programme based in Harare. It has produced a SADC region water resource database, which has information on 18 000 surface water features, 1 157 watersheds, 40 000 river stretches and 233 fish species. The database is available as a CD-ROM.

International NGOs

The World Wide Fund for nature is an international NGO organized into 24 national offices. WWF-SA has strong presences in Harare, Stellenbosch (near Cape Town) and Windhoek. It concentrates on biodiversity and natural resource management issues (increasingly, by the communities themselves). It does not see itself as a data providing organization, but in many instances has been forced to establish databases to assist in its own mission.

The International Union for the Conservation of Nature Regional Office for southern Africa (IUCN-ROSA) has as its mission to influence, encourage and assist societies to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and socially sustainable. It has offices in Botswana, Namibia, Mozambique, and South Africa, as well. It runs a number of programmes, including one on Environmental Information and Communication, as well as special projects, mostly to do with wetlands and networking.

Regional networking

APINA (the Acid Precipitation Information Network of Africa) is a body devoted to linking air pollution specialists and policy-makers, especially in southern Africa.

SATREN (Southern African Network for Training on the Environment) is a network coordinated by the Institute for Environmental Studies in Zimbabwe, to bring together universities and other institutions in providing training on the environment.

International networking

SADC itself is an international network, so there is much activity in this arena. Two examples are the SADC Rural Development Hub, which will start operations in April 2000, and the Global Water Partnership. The Global Water Partnership (and its southern African network, SATAC) aims to support the implementation of Integrated Water Resource management in southern Africa. It has a secretariat at IUCN-ROSA. It assists the SADC Water Sector Coordination Unit. It includes an objective of building and reinforcing mechanisms for sharing information and experience.

Key Stakeholders

Organization	Person contacted	Areas of interest
APINA	Prof. Stephen Simukanga Associate Professor, Department of Metallurgy and Mineral Processing, School of Mines University of Zambia, P.O. Box 32379 Lusaka, Zambia tel: +260-1-294086/290746 cell: + 260-1-763555 fax: +260-1-294086/ 290057/ 253952	Trans-boundary air pollution
IUCN ROSA PO Box 745 Harare, Zimbabwe tel: +263 4 706261, 728266/7 fax: +263 4 720738	Yemi Katerere yek@iucnrosa.org.zw	Biodiversity and sustainable resource use
FAO – Sub-regional Office for Southern And Eastern Africa (6 th Floor, Old Mutual Centre, cnr Third St/Jason Moyo) PO Box 3730 Harare, Zimbabwe tel: +263-4-791 407/20 fax: +263-4-703497	Owen Hughes e-mail: Owen.Hughes@fao.org	Agriculture and forestry
	Michel Laverdiere e-mail:Michel.Laverdiere@fao.org	
	Mark A. Smulders e-mail: Mark.Smulders@fao.org	
SADC ELMS Private Bag A284 Maseru 100, Lesotho tel: +266-312 158 fax: +266-310 190 e-mail: sadcelms@lesoff.co.za	Ms Nthabiseng Majara	Land use, land quality

Key stakeholders continued

Organization	Person contacted	Areas of interest
SADC Water Sector Coordinating Unit	Mr E.M. Mokuoane Mr Michael Mutale	Water resources and their quality

<p>Private Bag A440 Maseru 100, Lesotho tel +266 313160/320720 fax: +266 310465 e-mail: sadcwscu@lesoff.co.za</p>		
<p>SADC FANR P.O. Box 4046 Harare, Zimbabwe tel: +263-4-736 051/2 or 796 847/8</p>	<p>Mr Camille van der Harten (no longer at SADC FANR)</p>	<p>Agricultural research and agricultural production</p>
<p>WWF</p>	<p>WWF Southern Africa Regional Programme office, 10 Lanark Rd (Cnr 2nd St.) PO Box 745, Harare, Zimbabwe Tel: +263-4- 730 599 Dr David Cumming e-mail: dcumming@wwf.org.zw</p> <hr/> <p>WWF South Africa PO Box 456 Stellenbosch, 7599, South Africa tel: +27 (21) 887 2801 fax: +27 (21) 887 9517 e-mail: gbaard@wwfsa.org.za Ian MacDonald</p>	<p>Biodiversity</p>