

Information: The Foundation of Sustainable Development

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Preface

The Human Sciences Research Council publishes a number of Occasional Papers series. These are designed to be quick, convenient vehicles for making timely contributions to debates, disseminating interim research findings and otherwise engaging with the broader research community. Publications in the various series are, in general, work-in-progress which may develop into journal articles, chapters in books or other final products. Authors invite comments and suggestions from readers.

About the Author

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Executive Summary

Sustainable development can be defined as the improvement of economic efficiency, the protection and restoration of the environment and the enhancement of the social well-being of people (IISD, 1995). The International Institute for Sustainable Development (IISD) further argues that sustainable development is an integrated process for decision-making that requires information for it to be accomplished. Inherent in the idea of sustainable development are aspects such as democratic values, community participation, international collaboration and strong leadership. A wide diversity of information is required to reflect an integrated approach to sustainable development.

Agenda 21 is the foundational document of sustainable development and sets out a global action plan. The New Partnership for African Development (NEPAD) similarly embraces the need for sustainable development and has formulated actions that have to be taken on the African continent.

This paper proposes the development of an information framework for sustainable development in South Africa and discusses the country's ability to provide the information required to address actions stipulated in Agenda 21.

As part of this framework, indicators needed to implement and monitor sustainable development are discussed and the inherent value of spatial information for the implementation of sustainable development is touched on.

Information: The Foundation of Sustainable Development

Introduction

Sustainable development requires the integration of comprehensive information on the environmental, economic and social dimensions of society. Ideally, the information should provide a perspective of these dimensions of specific countries in a continental or global context, although the effective implementation of sustainable development within countries requires that information is also collected at local and provincial levels. The role of information is being accepted more and more: initiatives such as the Global Knowledge Partnership (GKP) and the African Information Society Initiative (AISI) have recognised the importance of information and knowledge as a tool for sustainable development.

Insight into the importance of information for implementing sustainable development is not new. The founding policy document, Agenda 21, identifies information as a critical component in being able to understand the integration of the environment and development. Information is also needed to implement and monitor sustainable development. Recommendations that consistently come up in Agenda 21 on the use of information for sustainable development include:

- providing decision makers, planners and the general public open and direct access to precise and reliable

information through the use of appropriate electronic and non-electronic formats;

- improving the integration and use of social, economic and environmental information for sustainable development;
- ensuring that the interactions and synergies between the social, economic and environmental dimensions are understood through the development, analysis and modelling of appropriate indicators;
- developing an understanding of international theory and best practices in the development of indicators and the setting up of information systems for sustainable development;
- developing the capacity of especially developing countries to collect, store, integrate, analyse and disseminate information at different spatial levels;
- identifying donor agencies that would be willing to finance the development of such information systems and the associated capacity of developing countries; and
- developing the institutional capacity and ability of decision makers to use the information.

Agenda 21 goes further in making recommendations about the use of information for effective decision-making. Two areas that the policy identifies as being of importance are bridging the gap and improving the availability of information. Bridging the gap refers to the difference between the developed and developing world in terms of availability, quality, coherence, standardisation and accessibility of data.

This paper will discuss the ability of South Africa to address the recommendations set out in Agenda 21. Furthermore, it will examine the New Partnership for African Development (NEPAD) and South Africa's own sustainable development strategy to see how well this country has done in terms of making information available for the implementation and monitoring of sustainable development.

Without a theoretical framework within which an information system is developed, the necessary connectivity between the data sets and components of the information system

cannot be achieved and the system cannot be used optimally. For sustainable development to be achieved in South Africa such an information framework must be developed. This paper will suggest a framework that has been developed by the author in the setting up of spatial information systems in South Africa. In both the Southern Africa Development Community (SADC) and elsewhere in Africa, extensive work has been done by the United Nations Environmental Programme (UNEP) on the development of State of the Environment (SoE) reports for regions and the continent as a whole. This work will be discussed in the context of developing appropriate information systems for sustainable development. Finally, the paper will consider the importance of spatial information for the display and analysis of information required to implement and monitor sustainable development.

The need for a framework

The development of an information system for sustainable development must occur within a framework. The purpose of a framework is to focus attention on the objectives as set out in Agenda 21 and other strategies. Another function of a framework is to develop a more systematic and integrated approach to planning and analysis (UNEP, 1999). The framework also creates the foundation for the development, management and use of the information.

The importance of developing a framework is internationally recognised and many frameworks have already been developed. The most commonly used frameworks include the Driving force-State-Response (DSR), Driving force-Pressure-State-Impact-Response (DPSIR), environmental media, social human capital, environmental-economic-social and The Natural Step (TNS).

The framework used by the United Nations Division for Sustainable Development to construct indicators on sustainable development is the Driving force-State-Response (DSR) framework. *Driving forces* are those human activities,

processes and patterns that affect sustainable development. *State* describes the present condition of the environment in its social, economic and environmental context. *Responses* are the policy actions taken by governments and agencies to address the particular environmental and development problems being faced.

In South Africa the DPSIR framework has been used to develop environmental indicators while in SADC an adaptation of the DPSIR, known as the PSR framework, has been used. The Africa Information Society Initiative (AISI) is a framework that works to build information and communication infrastructure. More specifically, the intention of the AISI framework is to develop institutional, human, information and technology resources for use in building up an information society in Africa. It is felt that this will help to accelerate development plans, stimulate growth, assist with the planning of services and infrastructure and, ultimately, bring about an improvement of the standard of living of people in Africa.

Although many frameworks exist there is an opportunity to build on these or develop new ones for use in creating a more holistic perspective on sustainable development and to focus on its implementation within regions such as South Africa. The framework presented below goes beyond the use of a framework for the development of indicators alone. It incorporates five interrelated influencing dimensions, namely the societal, policy, theoretical, strategic and fundamental information spheres as illustrated in Figure 1 on page 5. Each of these dimensions should guide the development of the building blocks of the information system.

The building blocks of an information system

Policy As has been noted, the main policy guiding the development of an information system for sustainable development in the global context is Agenda 21. NEPAD and South Africa's own sustainable development strategy provide further policy guidelines for the development of an information system to

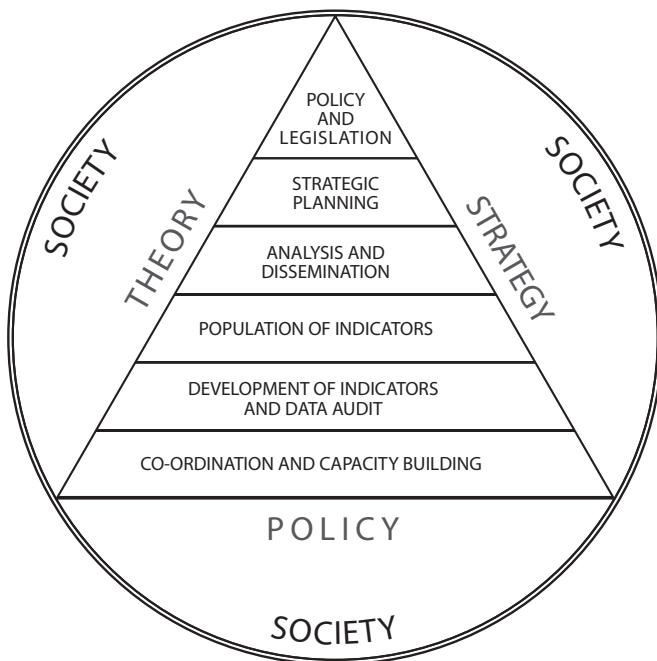


Figure 1: Information framework for sustainable development

address conditions local to this country. This is discussed in more detail below.

Co-ordination and capacity building Whether developing the information system for a country, a region, a continent or the whole planet, it is necessary to co-ordinate the collection, storage, assessment and dissemination of information effectively. There is also the need to develop capacity in the development and use of the information system by planners and decision makers. Areas that also require much research are the development of a culture of effectively using information for decision-making and the development of high-end technologies so that they are accepted as a medium for accessing information.

Development of indicators United Nations agencies use the DSR framework to develop indicators on sustainable development and the 130 indicators (see Appendix) developed by the CSD have been approved for reporting at a national level. It is however often necessary for countries to develop their own set of indicators considering their unique social, economic and environmental characteristics. In South Africa the Department of Environmental Affairs and Tourism (DEAT) has developed 126 environmental indicators and completed an audit of data sets that could be used to populate these indicators.

Population of indicators The audit of data sets by DEAT led to only 53 (42 per cent) indicators being classified as level 1 indicators (that is, immediately suitable for use.) partly because they have sufficient information for them to be used. Concern has been voiced however that the information required to populate the level 1 environmental indicators is difficult to get hold of or is not in a format that enables its easy use. Indicators focusing on the social and economic dimensions of sustainable development still have to be constructed and an audit of suitable data sets and sources completed. Although some of the DEAT's integrated and human settlement indicators could be used as social or economic indicators, a lot of work still needs to be done in developing these indicators within an appropriate framework (such as the DPSIR). In certain government circles the opinion has been voiced that information for social and economic indicators is more readily available than for environmental indicators. This is largely correct if the CSD's social and economic indicators are used and if the figures are required only at a national level. As soon as information is required at a sub-national level, such as provincial or district level, the information becomes more difficult to access, especially for the economic indicators.

Analysis and dissemination The next steps in the development of the information system are to analyse the information and make it available for dissemination. One approach that is

often used in making information more accessible to a broad range of stakeholders is to create fact sheets on each of the sustainable development indicators and to make the information available via the World Wide Web. One of the greatest challenges being faced by many countries in Africa is developing the necessary capacity to analyse the information and present it in a format that makes it readily usable by decision makers and the general public. Decision support systems and interactive web mapping are some of the methods that are being developed to make information more accessible for the implementation and monitoring of sustainable development.

Strategic planning Ultimately, the information system should be used for further strategic planning and for refining policies, protocols and strategies to achieve sustainable development at the national, continental and global levels.

Societal dimensions of sustainable development

The socio-economic, political and environmental characteristics of a country, region or continent are often unique and very complex. These unique features are a consequence of the many historical, political and natural factors that have moulded them. Factors that have to be taken into consideration in understanding the socio-economic character of these societies include the size of the population, population growth rate, population projections, population density and fertility and mortality rates (including and excluding the impact of HIV/Aids). Poverty reduction is one of the priorities of both developed and developing nations. However, poverty is usually a symptom of many other ills in a society and factors such as unemployment, lack of economic growth, environmental degradation and education all have to be considered.

Africa is the only continent where poverty is expected to increase in the next century. Therefore, economic growth, job creation and poverty reduction remain the primary challenges for Africa (UNEP, 1999). Part of the problem is the US\$300

billion debt burden that many African countries currently bear (with 79% of the debt coming from sub-Saharan countries). This debt seriously hampers economic and social development on the continent but it is beginning to be taken seriously by the international community (Colgan, 2001). NEPAD is the mechanism by which African leaders and their countries will implement programmes to reduce poverty and address the many other problems facing the continent. One of the main challenges in this regard is addressing the political instability that has scarred Africa for decades and that has been identified by African leaders and leaders of the developed world as being the priority if NEPAD is to succeed.

According to the Global Environment Outlook 2000 report (UNEP, 1999) competition for resources and declining opportunities are the causes of the political instability, civil unrest and military conflicts that are currently occurring in Africa. Other factors that can be cited as contributing towards these problems are inter-sectoral power struggles, inequality amongst social groups and unequal access to political power. A consequence of these conflicts and wars is the displacement of millions of people to neighbouring countries and the growth of large refugee populations. To overcome these conflicts and bring about peace, it is necessary to instill democratic principles, sustain economic growth and ensure an equitable income distribution.

Since time immemorial, many different regimes and conflicts have moulded the political landscape of the world. Two of the greatest impacts on Africa were the slave trade in 1700s and 1800s and colonisation in the 1880s. The slave trade saw the forced removal of more than 22 million people from Africa. This resulted in the significant destabilisation of certain areas and in some instances the total disintegration of societies. Following the suppression of slavery, the Berlin Conference of 1884–85 paved the way for colonialism in Africa with nearly the whole continent being placed under the control of European countries. The independence of Ghana in 1957 saw the start of political power being given back to the people of

the continent (Carlisle, 1999). During this same period, the indigenous peoples of Africa still did not have political control of their countries. The transfer of political power back to the African people continued up until the early 1990s. South Africa's transition to democracy in 1994 was one of the most recent.

Colonialism left many countries in Africa under-developed and unable to sustain themselves economically. In South Africa, colonialism saw the start of 'separate development' amongst the different race groups. This culminated in the creation of Apartheid that saw people being restricted in their movement, place of residence, and access to education and a reasonable standard of living. This has left a legacy of poverty and unequal access to services and infrastructure that has resulted in many severe environmental conditions throughout the country. This legacy of poverty needs to be understood in a holistic way if South Africa is to be successful in addressing these problems and in implementing sustainable development.

Throughout the world dictatorships have entrenched a vicious cycle of economic decline, reduced capacity and poor governance. It is only in the last two decades that there has been a strong movement towards implementing democratic government systems, which has, in itself, resulted in much conflict and the destruction of nations. The political regimes that exist throughout the world need to be understood if sustainable development is to succeed and consequently, there is a need for information on these issues.

From an environmental perspective, many parts of the world, especially Africa, have seen a steady decline in the terrestrial, freshwater and marine biospheres over the last century. Research has shown that this is mainly a consequence of people being dependent on natural resources to ensure their survival. The social inequalities and the lack of access to basic services has forced people to exploit whatever resources were available.

If we had known as much about sustainable development at the start of this century as we know now, the focus would

probably have been on addressing the social problems that are often the driving forces of environmental change. The environmental challenges for Africa are many and diverse. Those that are on the priority list include environmental degradation, loss of biodiversity, lack of access to water, water scarcity, deforestation and desertification. Poverty is seen as both a cause and a consequence of these environmental problems. However, it is again argued that unemployment and a lack of access to basic services are probably the driving forces of both poverty and environmental degradation.

The above touches on the socio-economic, political and environmental factors that mould the societal characteristics of countries, regions and continents and influence the effective implementation of sustainable development. Comprehensive information systems are required to understand these characteristics and how they interrelate with each other. Many agencies, institutions and governments throughout the world need to collaborate for this information to be forthcoming and integrated into a format that facilitates further analysis. In the African context, the capacity of recognised research institutions will have to be used and developed to assist the continent with the analysis of information for use in implementing and monitoring sustainable development.

The theory of sustainable development

Theoretical constructs provide an important foundation for the development of an information system. The reason for this is that theoretical constructs attempt to make sense of the complexities that occur in a society by delving into its depths and pulling out the nuances that need to be considered. Theory enables a better understanding of the type of information that is needed to bring about the successful implementation and monitoring of sustainable development. This not to say that sustainable development is the only theoretical construct that can or should be used for development in Africa. There are theorists who believe that Africa needs to formulate its own

development paradigm that considers the unique socio-economic, political and environmental character of the continent. Furthermore, consideration must also be given to the unique socio-economic, political and environmental factors that occur in African countries, as this will require the collection and analysis of specific information in order to conceptualise the most appropriate strategies for development.

Sustainable development theory can be traced back to economic development theory, which simply defined is the analysis of the economic progress of countries, taking into consideration sociological, anthropological, historical, political and even ideological factors. Early theorists argued that government involvement is a critical component of economic development whether it is in planning, construction of services and infrastructure or managing the demands of the population. The focus of government in terms of human capital is on providing education, health facilities and population development. Part of economic development would be the alleviation of poverty, unemployment and inequalities.

More recently, scholars have suggested that the involvement of governments has thwarted economic development. This is because the huge government bureaucracies and state regulations have made developing economies inefficient, suffocated private investment and controlled pricing. This has resulted in the drive for privatisation of state assets (e.g. telecommunications, energy, transport) and has seen the emergence of government agencies to act as regulators of these industries. This is now largely accepted as the norm, but the debate still rages as to whether this is of real economic benefit, especially in African countries where there is such a need for job creation and the addressing of inequalities. With the environmental crisis surfacing in the 1980s, the importance of sustainable development came to the fore (Centre for Policy Analysis, 2001).

Sustainable development can be defined as the improvement of economic efficiency, the protection and restoration of the environment and the enhancement of the social well-being

of people (IISD, 1995). What one can see from this is that sustainable development is a continuation of the principles of economic development but with more emphasis on the social well-being of people and the introduction of the environment as a major component. The IISD further argues that sustainable development is an integrated process for decision-making that requires information for it to be accomplished. Inherent in the idea of sustainable development is that it is a long-term solution, incorporating aspects such as democratic values, community participation, international collaboration and strong leadership. Agenda 21 is the foundational document of sustainable development and sets out a global action plan to address issues such as air quality, resource use and poverty.

One of the principles of sustainable development is to be proactive in identifying existing problems or preventing new problems before they start. Another principle is that the full cost of using resources (e.g. water, land, forests) must be taken into consideration to ensure that they are not over exploited (IISD, 1995). The idea behind this principle is that market forces are better able to ensure sustainable development and use of the world's resources than are government institutions. This particular issue is still open to much debate considering the effects that globalisation has had, especially on developing countries.

Sustainable development is an integrated approach and, therefore, information from a variety of different sources is required. Consequently, much effort has been put into the construction of sustainable development indicators as they are 'central to the monitoring and reporting of progress towards sustainable development' and help focus on achieving 'a better quality of life for everyone, now and for generations to come' (DEFRA, 2001). Jesinghaus (1999) in his work on developing indicators for the European Union showed through his 'information iceberg' that initially there is the development of a plethora of indicators and that these eventually dwindle down to a core set of three to five indicators. In addition, there is the development of new composite indicators that provide a

more usable and better overall perspective of sustainable development issues. Part of the process of developing indicators is the identification of international benchmarks or targets.

Policy frameworks

As has been mentioned, Agenda 21 is the global policy framework that guides the implementation of sustainable development. However, the preamble to Agenda 21 clearly states that it is the responsibility of national governments to formulate their own strategies, plans, policies and processes to implement sustainable development. In Africa, the most prominent and recent policy framework on sustainable development is the New Partnership for African Development (NEPAD) and, therefore, its standpoint on what needs to be done on the African continent will be discussed. Africa and South Africa's capacity to, and progress in developing information systems for sustainable development will be discussed in the light of these policies.

Information requirements for sustainable development can be categorised into the social, economic and environmental. In each of these categories, distinct themes have been identified and are discussed separately in the different chapters of Agenda 21. The CSD has developed the 130 indicators to focus on the status and driving forces that are causing changes to these themes as well as on what policy responses are being implemented. Agenda 21 covers a wide range of social themes including combating poverty; demographic dynamics and sustainability; promoting education, public awareness and training; protecting and promoting human health and promoting sustainable human settlement development. Economic themes that would require information for sustainable development include international cooperation, changing consumption patterns, financial resources and mechanisms and transfer of environmentally sound technology, co-operation and capacity building. Environmental indicators developed by the CSD cover aspects such as: protecting the quality and supply of

freshwater resources; protecting oceans, seas and coastal areas; using integrated approaches to planning and managing land resources; ensuring sustainable mountain development; conserving biological diversity; using environmentally sound management of biotechnology; protecting the atmosphere; and managing solid waste, sewage, toxic chemicals, hazardous wastes and radioactive wastes.

South Africa and Agenda 21 Since as early as 1992 South Africa has actively participated in global sustainable development initiatives and published a country report in the same year entitled 'Building the foundation for sustainable development in South Africa'. The report describes the state of the environment in South Africa, highlights challenges to sustainable development and provides an action plan for its implementation in the country. Since 1994, sustainable development has been integrally incorporated into all new policies in South Africa and South Africa has continued to show its commitment to sustainable development by submitting country reports in 1997, 1998 and 1999 that describe its progress in the implementation of Agenda 21. Furthermore, the South African government has worked with the CSD on the testing of the indicators for sustainable development and submitted its report in 1998. In 1999 a State of the Environment Report (SoE) was published and in 2000 a programme was implemented for the development of a set of environmental indicators for use in monitoring the environmental component of sustainable development.

Although South Africa is well positioned in terms of environmental indicators, it still has some way to go in coordinating the development of social and economic indicators. There is no doubt that South Africa is well endowed with information that can be used to populate the indicators but the challenge still remains to undertake this in a co-ordinated way and to present the different data sets in a standardised format that enables them to be readily used. For certain data sets to be readily available for use in decision-making in South Africa requires

their further development and annual updating, especially in the social and economic themes. A further challenge is the presentation of the information at a spatial level that enables integration of different data sets. Sense needs to be made of the situation at a more local level to allow targeted responses to be made by government and other agencies. To accomplish this will require government and agencies in South Africa to develop innovative ways of updating information on a regular basis and reporting on sustainable development.

Although South Africa has many research and academic institutions, there is limited capacity in the country to undertake sophisticated analysis and modelling of information so that it can be incorporated into the process of decision-making and policy formulation. Furthermore, South Africa is still in the process of debating whether information collected by the state should be made freely available even though the Freedom of Access to Information Act provides clear guidelines in this regard. A mechanism by which the information can be accessed by all stakeholders in the public and private sectors still has to be developed, although, at the present time, several initiatives are attempting to bring about a co-ordinated approach to the provision of information for decision-making in government. It is vital however that lessons are learnt from international best practice and that one central body is identified or created for collecting, storing, analysing and disseminating information, especially spatial information (Schwabe et al, 1997).

This requires the South African government to set aside sufficient financial resources to develop the institutional capacity required to co-ordinate its information needs, to bring appropriate research institutions and other government bodies into the process and for mechanisms to be implemented that enable the collection, storage, analysis and dissemination of national statistics. Financial resources will also be required to develop the capacity of government officials to use the information and for decision makers to be made aware of what information is available and how it can be used for

implementing and monitoring sustainable development. There is no doubt that overseas development agencies will have to play a critical role in providing financial support to accomplish the above, but more importantly to assist with providing access to international expertise and high level technologies (e.g. satellite imagery, GIS and modelling software).

Although South Africa does not have a sustainable development strategy per se it has committed itself to the implementation of sustainable development principles in all its policies and legislation. The National Environmental Management Act of 1998 mandates the DEAT to prepare an Annual Performance Report on Sustainable Development to meet the government's commitment to Agenda 21. The intention of this report is to co-ordinate the input from all government departments in terms of the set of guidelines provided by CSD on sustainable development reporting and to reflect on the performance of the South African government in terms of the objectives of Agenda 21. An examination of South Africa's sustainable development report on the CSD web page (<http://www.un.org/esa/agenda21/natlinfo/countr/safrica/index.htm>) shows out-of-date information for the country with, for example, the Reconstruction and Development Programme (RDP) being identified as the government's strategy to address poverty in South Africa.

Table 1 on page 8 was extracted from the CSD web page and modified to show how the information needed to populate indicators has generally improved in South Africa compared to what is presented in its sustainable development report. The greatest improvement in the provision of information has been for social indicators. This can mainly be attributed to the capturing of South Africa's 1991, 1996 and 2001 censuses, into GIS which enables a detailed picture of social issues to be obtained at different spatial levels. It also provides the means by which different data sets can be integrated so that sustainable development indicators (e.g. population density) can be populated with information. The importance of surveys, such as the October Household Survey

(OHS) and the Labour Force Survey (LFS), conducted by Statistics South Africa (Stats SA) cannot be over emphasised as sources of information for sustainable development. If it is to continue to provide such information Stats SA will have to greatly increase its ability to service the information needs of all the sustainable development indicators and substantial funding from government will be required for the necessary data to be collected.

Information systems in Africa Africa has made dramatic strides in the last decade in the development of information systems for reporting on sustainable development, especially on the environment. Two of the more prominent initiatives that have contributed to this are the Global Environmental Outlook (GEO) and Environmental Information System Network for Africa (EIS-Africa). (See Table 1 pages 24–25)

The GEO process implemented by UNEP has seen the implementation of SoE reporting in all regions of Africa and in many countries on the continent. In 2000 and May 2002, two GEO reports were published. In addition, the African Ministerial Conference on the Environment (AMCEN) was mandated by UNEP to develop an Africa Environment Outlook (AEO) report for the WSSD conference in August 2002. SADC produced a SoE report in 1994 and a new one is in the process of being compiled by the Southern African Research and Documentation Centre's (SARDC) IMERCSA programme in Zimbabwe. Although these initiatives have created a solid foundation from which Africa can tackle sustainable development, there is still a long way to go in the provision of sufficient information, especially on the social and economic indicators that can be spatially displayed and presented at sub-national levels. This lack of information is because not all African countries have had the institutional capacity and/or the availability of information to contribute to their region's SoE report. At the Africa GIS conference held in Nairobi, Kenya in 2001, it was again apparent that many African countries do not have the basic information that they require for them to

Table 1: Suitable sources of information for monitoring sustainable development in South Africa

Agenda 21 chapters	Very good	Good	Some good data but many gaps	Poor
2 International co-operation and trade		●	○	
3 Combating poverty	●			○
4 Changing consumption patterns				○
5 Demographic dynamics and sustainability		●		○
6 Human health	●		○	
7 Human settlements	●		○	○
8 Integrating E & D in decision-making				○
9 Protection of the atmosphere				○
10 Integrated planning and management of land resources	●			
11 Combating deforestation				○
12 Combating desertification and drought	●		○	
13 Sustainable mountain development				○
14 Sustainable agriculture and rural development				○
15 Conservation of biological diversity	●		○	
16 Biotechnology				○
17 Oceans, seas, coastal areas and their living resources	●		○	
18 Freshwater resources				○
19 Toxic chemicals				○
20 Hazardous wastes				○
21 Solid wastes				○
22 Radioactive wastes				○

Agenda 21 chapters	Very good	Good	Some good data but many gaps	Poor
24 Women in sustainable development				o
25 Children and youth				o
26 Indigenous people				o
27 Non-governmental organisations			o	
28 Local authorities			o	
29 Workers and trade unions			o	
30 Business and industry			o	
31 Scientific and technological community			o	
32 Farmers			o	
33 Financial resources and mechanisms			o	
34 Technology, co-operation and capacity-building			o	
35 Science for sustainable development			o	●
36 Education, public awareness and training	●		o	
37 International co-operation for capacity-building			o	●
38 International institutional arrangements			o	
39 International legal instruments			o	
40 Information for decision-making			o	

Key: ● Present situation
○ Past situation

effectively implement and monitor sustainable development. An examination of the CSD's web page shows that in terms of sustainable development, less than half of the SADC countries have reports on social, economic and environmental issues (e.g. poverty).

The need for information in Africa and specifically in SADC has seen the development of two new initiatives. The Africa

Environmental Information Network (EIN) has been mandated by AMCEN to UNEP in recognition that the continent requires more information if it is to effectively implement sustainable development. The objective of the EIN is to develop a framework within which there can be the coordination and harmonisation of regional and national information management initiatives, including developing a data infrastructure, encouraging the exchange of information in standardised formats and developing the capacity of governments and institutions in Africa. The other initiative is one that is being led by the SARDC and the Human Sciences Research Council (HSRC) in South Africa that will create a development GIS at a sub-national level for all SADC member states. In terms of development, information will be collected on social factors (e.g. poverty, education, population, employment, etc) and access to services and infrastructure (e.g. education, health, policing, roads, etc). Furthermore, the ability to integrate past censuses conducted in SADC countries into GIS will be investigated and a pilot study implemented in Zimbabwe to see how effectively that country's last census can be captured into GIS.

Of the 53 African countries listed on the CSD's web page, only 25 (47%) have registered sustainable development reports. This is felt to be a reflection of the lack of institutional capacity and suitable information sources in these African countries. Many socio-economic and political factors including wars, political conflict, famine and poverty have contributed to some countries not having developed sustainable development reports or the necessary data infrastructure. Much work is still required to develop data sets so that sustainable development indicators can be populated. One of the first steps is to understand the framework within which this information must be collected. Much of the discussion in this paper is about a framework that incorporates the societal, policy, theory, strategic and information system dimensions, as illustrated in Figure 1.

NEPAD and sustainable development The primary objectives of NEPAD are to eradicate poverty, to put Africa on a

sustainable development path, to address the underdevelopment found throughout the continent and to ensure that Africa is accepted as an integral part of the globalising world. Although globalisation has seen the continued exploitation of Africa's resource wealth, the intention of embracing globalisation is to manage Africa's integration and to ensure that the benefits of globalisation, such as economic prosperity and poverty reduction, are turned into benefits for the continent. It is recognised that similar continental programmes have been implemented in the past and these have failed. It is suggested that this is because African leaders at the time did not want to take ownership of the process as it suited them better to only have their own national interests at heart. Now there is a new set of circumstances with the wide-spread democratisation of African states and the influence of globalisation that is acting as an imperative for NEPAD to succeed.

The immediate thought that one has when reading through the NEPAD document is that for the objectives and goals to be accomplished requires extensive information for all African countries to understand their present socio-economic, political and environmental situations. Only then can strategies be implemented and targets set to achieve the goals of NEPAD. In addition, it will not be sufficient to obtain the information only at a national level. Information will be required at a sub-national level (e.g. district), and in some instances at an even lower level, so that disparities within countries can be shown and the most needy areas in Africa identified. What also comes to mind is that much work is required in the development of infrastructure to provide the necessary information for decision-making so that the goals that are set out in NEPAD can be achieved by the year 2015. The planning and development of the information infrastructure needs to be done in the immediate short term so that strategies for achieving goals set out in NEPAD can be implemented as soon as possible.

To succeed with NEPAD requires that the process be driven by African leaders as part of a consultative and participative process involving all African nations as well as the people of

the continent. If African countries are unable to collaborate and present a united front then the intentions of NEPAD will never be achieved. A solid foundation must be set for NEPAD to succeed and these factors include having stability in all countries on the continent, which means that the present wars and political conflicts have to be addressed. Democracy is felt to be the founding principle to ensure human rights and accountability of the government to the people. Good governance in terms of economic, financial, judicial and development policies is a necessity. It is also accepted that the capacity of African nations needs to be developed through education and training programmes to ensure that the necessary skills exist to implement NEPAD effectively.

For NEPAD to accomplish its goals many things need to be done. The priority sectors that have been identified are:

- provision and maintenance of services and infrastructure (e.g. roads, electricity, water, sanitation, police, formal housing);
- provision of information and communications technology (e.g. radio, television, telephones, cellular networks, internet connections and hubs);
- provision of education and health services and the development of skills;
- effective agricultural programmes; and
- development of local and international export markets.

Funding from a variety of different sources will be required for the implementation of NEPAD. This includes generating revenue through taxation in each of the African countries; encouraging savings by governments as well as the people, increasing the flow and efficient use of international funding and encouraging investment in Africa by the private sector. Financial policies will have to be put in place to make sure that revenue generated by African countries is used as efficiently as possible. One of the major obstacles that African leaders are presently addressing with the international community is debt relief. These

are all required if NEPAD is to achieve the goals that have been set. The goals to be achieved by the year 2015 include:

- generating an average gross domestic product (GDP) growth rate of above 7% per annum;
- reducing the proportion of people living in extreme poverty by half;
- enrolling all children of school-going age in primary schools;
- eliminating gender disparities in primary and secondary education enrolment;
- reducing infant and child mortality ratios by two-thirds;
- reducing maternal mortality ratios by three-quarters;
- providing access for all who need reproductive health services; and
- implementing national strategies for sustainable development by 2005, to reverse the loss of environmental resources.

What the above brings to the fore is the amount of information required to have an understanding of what the situation is in all the countries of Africa. This information is needed to identify priority areas so that the true disparities are reflected and appropriate projects or programmes implemented. The monitoring of progress at a country, regional and continental level also requires information.

Identifying core data sets

The essence of an information model is to identify within a framework the core data sets that are needed to populate the sustainable development indicators. In terms of sustainable development, this is a relatively easy task because Agenda 21 and the CSD indicators give a clear picture as to what data sets are needed. Without a doubt, socio-economic information from a country's census is the most important data set (see Figure 2 on page 24). This is because it contains data that is needed to populate most of the social indicators and is often used to define the extent of use of economic and environmental

resources by the people (eg. infrastructure expenditure per capita, per capita consumption of fossil fuel by motor vehicle transport). If a country is unable to draw on this type of information at a national or sub-national level then they are unable to report on their progress with sustainable development.

This also means that they are not informed about the extent to which their population has access to services and infrastructure (e.g. water, telephones, education, etc) or the extent of poverty within the country. In South Africa, the 1991 and 1996 census information has enabled the country to report on its progress with sustainable development. However, many countries in Africa are not as fortunate in being able to harness their census information for sustainable development purposes, especially in a spatial format. These countries require urgent assistance to develop their capacity and data infrastructure for more effective decision-making. This remains one of the greatest challenges facing NEPAD in being able to achieve its goals by 2015.

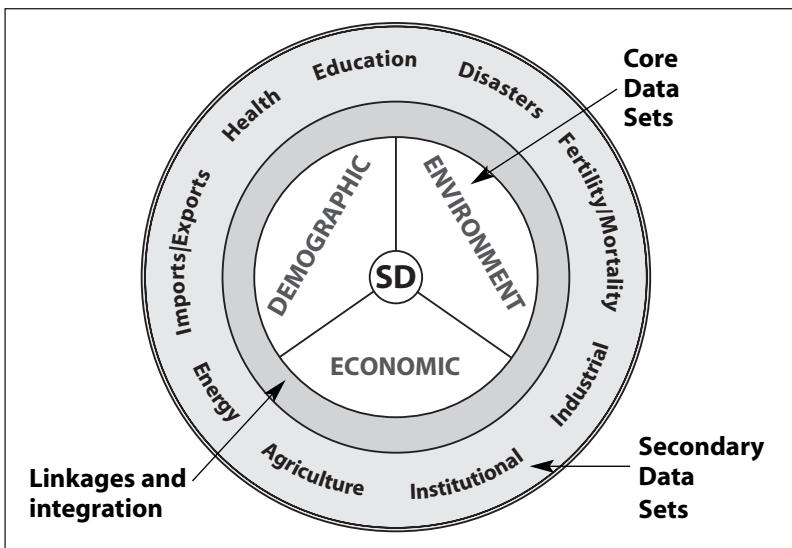


Figure 2: Using census results as core and secondary data sets in a data model for sustainable development

The conducting of national representative household surveys is another approach that can be used to collect data to populate social, economic and environmental indicators. However, these surveys are dependent on the country undertaking a regular census to enable them to design a national representative sample and to weight the results so that a statistically accurate picture of the population can be obtained at a spatial level that allows sustainable development to be implemented and monitored at a localised level. For this to be accomplished requires financial resources for the development of the data infrastructure (i.e. census, social surveys) and the use of modelling techniques to present the information at a localised level. Social surveys can be useful to monitor the extent of unemployment, poverty, demographics of the population, education, access to services, health status and many more factors.

The use of Geographical Information Systems (GIS) and remote sensing cannot be over emphasised. This is because many of the data sets that are needed to populate the indicators have a geographical context that needs to be understood in terms of the population and use of resources. A classic example is having an understanding of the geographic location of schools to determine whether all people of school going age have access to such facilities. GIS and remote sensing is a technology that allows an understanding to be developed of the distribution of a country's natural, service and infrastructural resources, including mineral deposits, vegetation, agriculture, transport networks and water schemes. It also allows the integration of data sets to determine their relationship between them so that the influence of the one on the other can be understood. A good example of this is population growth in coastal zones and the extent of land degradation caused by human settlements, wood fuel collecting or agricultural practices. GIS is not only a powerful tool for developing an audit of a country's social, economic and environmental resources but it also enables their quantification and the definition of their condition.

The other two core data sets are economic and environmental information. Both are effectively collected using social surveys and GIS or remote sensing. However, economic information also needs a country's government to maintain a set of national accounts or a statistical system. This system is developed on a set of indicators and individual government departments, parastatals or a central statistical agency usually collect this information. Examples of this information include infrastructure expenditure, Gross Domestic Product (GDP), Rand value of exported goods by sector, Rand value of international funding and participation in international protocols. This information can also be collected by the use of surveys. In South Africa, Stats SA has this as one of their primary responsibilities and is currently developing such a statistical system.

Another method that can be used to collect this information is the use of monitoring techniques. Monitoring often uses high-end technologies (e.g. water and pollution meters) to measure a particular factor. In South Africa the water authorities use a network of such systems to measure water levels, water pollution and the use of water resources. Monitoring is also the approach that has to be used to measure factors such as oil pollution, discharges into the water, salinisation, use of pesticides, air pollution, waste disposal and their impact on the people and the environment. Monitoring often requires the use of modelling techniques to understand the situation at a national or sub-national level. Similar to social surveys, monitoring also uses sampling techniques to determine the extent of particular factors (e.g. defining the extent of threatened species, available fisheries). It is also often regulated by the use of licences that can often be a source of information for monitoring sustainable development. In the African situation, the challenge is to develop innovative techniques that will empower the people and enable them to monitor their own environment. Although the core data sets provide most of the information needed to address issues associated with sustainable development, other secondary data sets are also required.

The secondary data sets are needed to provide the context or a more holistic picture of sustainable development. In addition, the secondary data sets form linkages with the core data sets that necessitate that they are fully integrated. This enhances the overall use of the information model (Chorley, 1988). These data sets include education, health, disasters, energy, fertility and mortality, industrial, agricultural and institutional information (see figure 2 on page 24).

The development of such an information model is a huge challenge if one considers that through a consultative process with African countries there needs to be acceptance in principle of the need for the development of a spatial information framework and model. National institutions to co-ordinate this on behalf of African countries must also be identified or, alternatively, a single organisation will have to be formed to represent the interests of all African nations. Concerted efforts will then have to be made by national institutions to gather the information that has been identified. The problem here is that these institutions often do not have the necessary funds to undertake this work and, therefore, funding will have to be obtained from national budgets or from donor agencies. The lesson to be learnt from other research in the information field is that the development of the spatial information system for Africa will only happen if a conscious and deliberate decision is made by all of its leaders (De Man, 1988). This will require strong leadership from the African nations.

Spatial information: a powerful descriptor

This paper would not be complete without stating why spatial or geo information is so necessary when attempting to implement and monitor sustainable development. The reason is that most of the information needed to populate the sustainable development indicators has a geographic or spatial context. Geographic Information Systems (GIS) the technology that is used to display geo information and allow for more sophisticated spatial analyses. An examination of the many websites

throughout the world that focus on sustainable development shows that spatial information is crucial.

One of the main reasons why information on sustainable development should be in a spatial format is that it allows the social, economic and environmental status of areas to be graphically displayed. In addition the extent of the problem can be shown using classification techniques. Having an understanding of the geographic location provides a perspective of the social, economic and environmental circumstances that prevail in that area. By mapping information on a regular basis, trends in relation to certain sustainable development issues can be determined (eg. changes in land condition). Another powerful function of spatial information is that it allows different types of information to be collected from diverse sources (eg. satellite images, aerial photographs, maps, field surveys, social surveys, etc) and integrated. For example, information on land use collected from satellite imagery can be integrated with population statistics from censuses to gain a better understanding of what socio-demographic factors are causing land degradation.

GIS technology also allows information to be integrated from different scales and aggregated to a common spatial unit of analysis. This is probably the most powerful function of GIS. This ability allows further statistical analysis to be done to determine the relationship between different factors. For example, it has been shown that land degradation in KwaZulu-Natal in South Africa is mainly a result of the economic dependency of the population. In other words, the higher the extent of unemployment in an area the greater the chance of the people being dependent on the exploitation of natural resources for their survival. This could only be accurately determined with the use of spatial information.

This ability to integrate data at different spatial levels also enables the creation of new data sets that are needed to populate sustainable development indicators. For example, to define the arable land per capita requires an understanding of the

geographic distribution of arable land and the aggregation of population statistics to this level to calculate the number of people living in arable areas. The full sophistication of using spatial information and GIS technology is shown when land is classified in terms of its suitability for different functions, such as agriculture, urban development, conservation or tourism. This requires the integration and modelling of many layers of information including soils, land terrain, climate, existing land use, infrastructure and the population characteristics of the area, to mention a few.

Having information in a spatial context also enables the ‘what if’ scenarios to be tested. For example, having an understanding of the amount of funds allocated to build a water reservoir enables one to define the capacity of the facility and knowing where it is to be located allows one to calculate how many people in that area will have access to water. In another example of modelling, knowing the direction and impact area of a hurricane allows one to determine the number of people that may potentially be affected by it. Probably one of the greatest strengths of spatial information is that it allows the quantification of the economic principle of supply and demand. A classic example of where supply and demand will have to be tested is in NEPAD achieving its goal of having all children of school going age in primary school. This will require knowledge of the distribution of the population of school going age at a localised level (demand) and an understanding of the distribution and capacity of primary schools (supply) to ensure that supply meets demand.

One of the most powerful and widely used functions of spatial information and GIS is the production of thematic maps. According to a study undertaken by Landis (1993) amongst GIS users, the production of maps is the most used function of a GIS. Maps are a powerful medium in showing the social, economic and environmental status of countries, regions or continents and showing what driving forces or pressures cause these problems. Maps can also be used to show how governments are responding to these particular problems

by showing the location of sustainable development programmes implemented by them.

The querying of spatial features and databases associated with layers of spatial information adds another dimension to the usefulness of GIS. A classic example of a query of a database would be the selection of primary schools that have more than 1 000 pupils. All the primary schools that meet this criterion will then be highlighted and summary statistics associated with them can then be retrieved from the database. A spatial query might be the selection of all districts in South Africa where more than 40% of the population lives below the bread line.

The future use of GIS for implementing and monitoring sustainable development will require that certain conditions be present. Firstly, there must be the commitment of decision makers to use spatial information and allocate sufficient resources to coordinate the collection, storage, analysis and dissemination of spatial information. International donor agencies will have to assist by providing financial resources, expertise and appropriate technology to accomplish this, especially in Africa. Secondly, decision-support tools will have to be developed that will make the spatial information easy to use but at the same time have sufficient GIS functionality to fully analyse the information for decision-making purposes (Grimshaw, 1999). Considering the need for information in South Africa and other countries on the African continent, decision-support tools will have to be developed for use on the World Wide Web to ensure cost-effective collection and dissemination of information.

Conclusion

There is no doubt that to implement and monitor sustainable development requires information. Information is needed to populate the indicators that have been developed either by the CSD or by individual countries so that they can report on their progress in implementing sustainable development. More importantly, information is needed to ensure that economic

efficiency is achieved, the environment is protected and, where necessary, restored and that the social well-being of people is enhanced. To successfully develop an information system to support this effort requires its formulation within an appropriate framework. In this paper it is argued that the framework consists of five main dimensions namely, the societal, policy, theory, strategic planning and information systems. Within any society there are distinct socio-economic, political and environmental characteristics that need to be taken into consideration when implementing sustainable development.

Agenda 21 and country specific strategies are the driving forces that see the focused implementation and monitoring of sustainable development. In the African context, the New Partnership for African Development (NEPAD) provides this focus. These strategies also provide the mechanisms by which sustainable development can be achieved. The theory of sustainable development provides further guidelines on what needs to be accomplished and why. By knowing this, a much more comprehensive and integrated information system can be developed, which needs to be coordinated at a country, regional or continental level and the capacity of individuals built to collect, analyse and disseminate the information. It is felt that only then will individual countries, regions or the African continent be able to effectively implement and monitor sustainable development.

Indicators of sustainable development are core to the development of the information system. The CSD has developed 130 sustainable development indicators and because of the different frameworks within which continents, regions or countries implement sustainable development it is usually the case that they develop their own set of indicators. In the South African context, a set of environmental indicators has been developed but social and economic indicators still have to be developed within an appropriate framework. Fortunately, there is much information available in South Africa for the implementing and monitoring of sustainable development. However, one of the greatest needs is to bring about the

coordination of these efforts so that there is no duplication and there is the efficient presenting of information for its effective use in decision making. It is argued that in contrast many countries in Africa still have a long way to go in having all the necessary information to populate the sustainable development indicators for implementation and reporting purposes. A prominent role that international agencies can play is in providing the necessary finances to enable Africans to create the necessary data sets and provide expertise that can be used to develop the capacity of people on the continent.

The value of spatial information as part of any information system that is developed for the implementation and monitoring of sustainable development has been emphasised. The factors that make spatial or geo information important can be reflected upon in Figures 3, 4 and 5. These maps show spatial information for sustainable development indicators from each of the three themes, namely, social, economic and

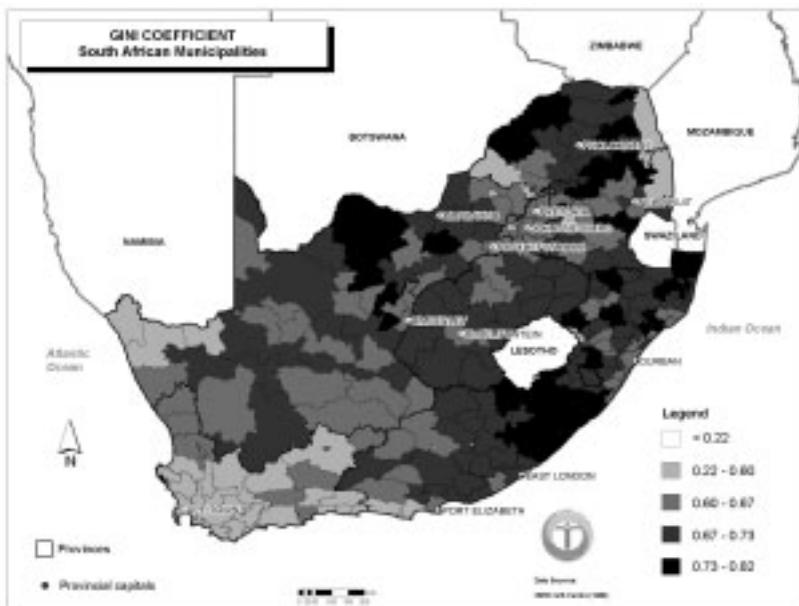


Figure 3: Gini coefficient at municipality level in South Africa

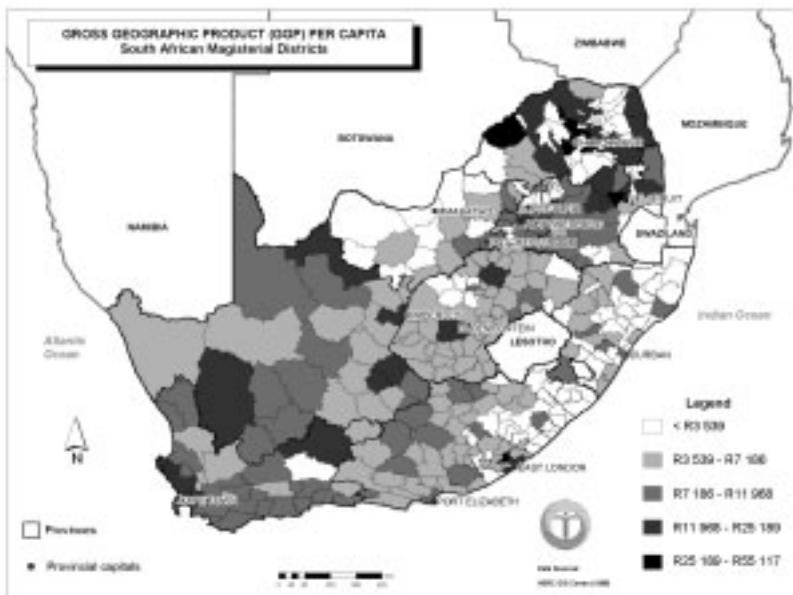


Figure 4: Gross Geographic Product (GGP) at a magisterial district level in South Africa

environmental. The social indicator that is shown is the Gini coefficient (Figure 3), which is an indication of the income inequality in a country and, in this instance, it is presented at a municipality level in South Africa.

The Gross Geographic Product (GGP) per capita is the economic indicator illustrated in Figure 4. This map shows the ability of spatial information to be presented at different levels and is a good example of how economic (i.e. GGP) and social (i.e. population size) information can be integrated to create new indicators.

The final map shows the extent of land degradation in South Africa at a magisterial district level and demonstrates that more qualitative type information can also be represented in maps.

Finally, it can be concluded that South Africa is well on its way to developing an information system for sustainable development. This is reflected in the many reports it has submitted

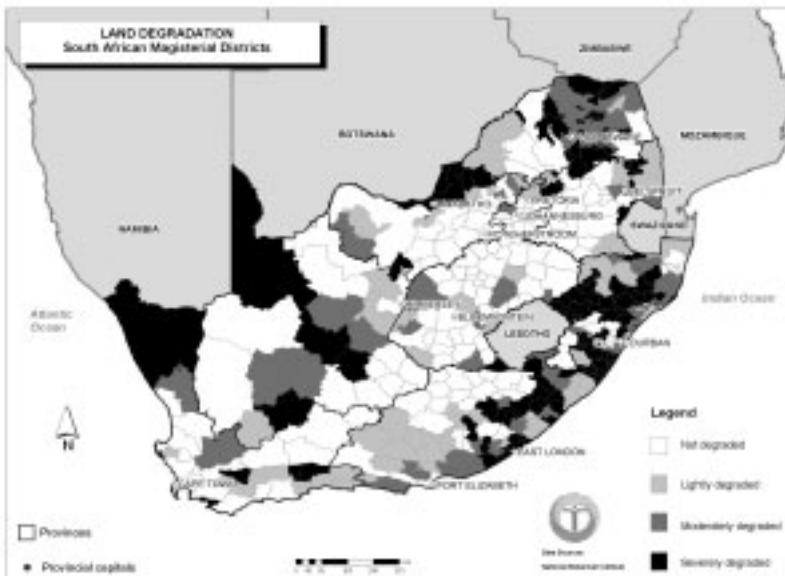


Figure 5: Land degradation at a magisterial district level in South Africa

to the CSD and the programmes that have been implemented in the country. SADC is also on its way but much work still has to be done on the gathering of data sets that can be used to populate the indicators that have been developed for this region, especially for the social and economic components. Africa like SADC has implemented processes (e.g. Africa Environmental Information Network) that will hopefully enable the gathering of the necessary information it requires for implementing and reporting on sustainable development in the future. If there was one data set that African countries should focus on immediately it must be the capturing of their census at a localised level into a spatial information system. This will enable many of the sustainable development indicators to be populated and will contribute significantly to Africa achieving its NEPAD goals by 2015.

Appendix

Working list of Indicators of sustainable development

Chapters of agenda 21	Driving force indicators	State indicators	Response indicators
Category: social			
Chapter 3: Combating poverty	Unemployment rate	Head count index of poverty Poverty gap index Squared poverty gap index Gini index of income inequality Ratio of average female wage to male wage	
Chapter 5: Demographic dynamics and sustainability	Population growth rate Net migration rate Total fertility rate	Population density	
Chapter 36: Promoting education, public awareness and training	Rate of change of school-age population Primary school enrolment ratio (gross and net) Secondary school enrolment ratio (gross and net) Adult literacy rate	Children reaching grade 5 of primary education School life expectancy Difference between male and female school enrolment ratios Women per hundred men in the labour force	GDP spent on education

Chapters of agenda 21	Driving force indicators	State indicators	Response indicators
Category: social (contd.)			
Chapter 6: Protecting and promoting human health		Basic sanitation: Percent of population with adequate excreta disposal facilities Access to safe drinking water Life expectancy at birth Adequate birth weight Infant mortality rate Maternal mortality rate Nutritional status of children	Immunisation against infectious childhood diseases Contraceptive prevalence Proportion of potentially hazardous chemicals monitored in food National health expenditure devoted to local health care Total national health expenditure related to GNP
Chapter 7: Promoting sustainable human settlement development	Rate of growth of urban population Per capita consumption of fossil fuel by motor vehicle transport Human and economic loss due to natural disasters	Percentage of population in urban areas Area and population of urban formal and informal settlements Floor area per person House price to income ratio	Infrastructure expenditure per capita

Chapters of agenda 21	Driving force indicators	State indicators	Response indicators
Category: economic			
Chapter 2: International cooperation to accelerate sustainable development in countries and related domestic policies	GDP per capita Net investment share in GDP Sum of exports and imports as a percent of GDP	Environmentally adjusted Net Domestic Product Share of manufactured goods in total merchandise exports	
Chapter 4: Changing consumption patterns	Annual energy consumption Share of natural-resource intensive industries in manufacturing value added	Proven mineral reserves Proven fossil fuel energy reserves Lifetime of proven energy reserves Intensity of material use Share of manufacturing value-added in GDP Share of consumption of renewable energy resources	
Chapter 33: Financial resources and mechanisms	Net resources transfer / GNP Total ODA given or received as a percentage of GNP	Debt / GNP Debt service / export	Environmental protection expenditures as a percent of GDP Amount of new or additional funding for sustainable development
Chapter 34: Transfer of environmentally sound technology, cooperation and capacity-building	Capital goods imports Foreign direct investments	Share of environmentally sound capital goods imports	Technical cooperation grants

Chapters of agenda 21	Driving force indicators	State indicators	Response indicators
Category: environmental			
Chapter 18: Protection of the quality and supply of freshwater resources	Annual withdrawals of ground and surface water Domestic consumption of water per capita	Groundwater reserves Concentration of faecal coliform in fresh water Biochemical oxygen demand in water bodies	Waste-water treatment coverage Density of hydrological networks
Chapter 17: Protection of the oceans, all kinds of seas and coastal areas	Population growth in coastal areas Discharges of oil into coastal waters Releases of nitrogen and phosphorus to coastal waters	Maximum sustained yield for fisheries Algae index	
Chapter 10: Integrated approach to the planning and management of land resources	Land use change	Changes in land condition	Decentralised local-level natural resource management
Chapter 12: Managing fragile ecosystems: combating desertification and drought	Population living below poverty line in dryland areas	National monthly rainfall index Satellite derived vegetation index Land affected by desertification	
Chapter 13: Managing fragile ecosystems: sustainable mountain development	Population change in mountain areas	Sustainable use of natural resources in mountain areas Welfare of mountain populations	

Chapters of agenda 21	Driving force indicators	State indicators	Response indicators
Category: environmental (contd.)			
Chapter 14: Promoting sustainable agriculture and rural development	Use of agricultural pesticides Use of fertilisers Irrigation percent of arable land Energy use in agriculture	Arable land per capita-Area affected by salinisation and waterlogging	Agricultural education
Chapter 11: Combating deforestation	Wood harvesting intensity	Forest area change	Managed forest area ratio Protected forest area as a percent of total forest area
Chapter 15: Conservation of biological diversity		Threatened species as a percent of total native species	Protected area as a percent of total area
Chapter 16: Environmentally sound management of biotechnology			R & D expenditure for biotechnology Existence of national biosafety regulations or guidelines
Chapter 9: Protection of the atmosphere	Emissions of greenhouse gasses Emissions of sulphur oxides Emissions of nitrogen oxides Consumption of ozone depleting substances	Ambient concentrations of pollutants in urban areas	Expenditure on air pollution abatement

Chapters of agenda 21	Driving force indicators	State indicators	Response indicators
Category: environmental (contd.)			
Chapter 21: Environmentally sound management of solid wastes and sewage-related issues	Generation of industrial and municipal solid waste Household waste disposed per capita		Expenditure on waste management Waste recycling and reuse Municipal waste disposal
Chapter 19: Environmentally sound management of toxic chemicals		Chemically induced acute poisonings	Number of chemicals banned or severely restricted
Chapter 20: Environmentally sound management of hazardous wastes	Generation of hazardous wastes Imports and exports of hazardous wastes	Area of land contaminated by hazardous wastes	Expenditure on hazardous waste treatment
Chapter 22: Safe and environmentally sound management of radioactive wastes	Generation of radioactive wastes		

Chapters of agenda 21	Driving force indicators	State indicators	Response indicators
Category: institutional			
Chapter 8: Integrating environment and development in decision-making			<p>Sustainable development strategies</p> <p>Programme of integrated environmental and economic accounting</p> <p>Mandated Environmental Impact Assessment</p> <p>National councils for sustainable development</p>
Chapter 35: Science for sustainable development		Potential scientists and engineers per million population	<p>Scientists and engineers engaged in R & D per million population</p> <p>Expenditure on R & D as a percentage of GDP</p>
Chapter 37: National mechanisms and international cooperation for capacity-building in developing countries			
Chapter 38: International institutional arrangements			

Chapters of agenda 21	Driving force indicators	State indicators	Response indicators
Category: institutional (contd.)			
Chapter 39: International legal instruments and mechanisms			Ratification of global agreements Implementation of ratified global agreements
Chapter 40: Information for decision-making		Main telephone lines per 100 inhabitants Access to information	Programmes for national environmental statistics
Chapter 23–32: Strengthening the role of major groups			Representation of major groups in national councils for sustainable development Representatives of ethnic minorities and indigenous people in national councils for sustainable development Contribution of NGOs to sustainable development

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