SWAZILAND ENVIRONMENT AUTHORITY
MINISTRY OF TOURISM AND ENVIRONMENTAL AFFAIRS

FINAL DRAFT

SWAZILAND'S STATE OF ENVIRONMENT REPORT 2012

FINAL DRAFT

THE CONSEQUENCES OF INACTION

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1 STATE OF THE ENVIRONMENT REPORTING

1.1 CONTEXT AND PROCESS

State of the Environment (SOE) reporting provides information on the current state of the natural resources, underlying causes of environmental change and the responses to the changes. The aim of SOE reporting is to improve understanding of environment and sustainable development issues; and to contextualize and clarify environmental trends in order to inform decision-making. One of the fundamental characteristics of this sort of reporting is the identification of the linkage between the biophysical and socio-economic considerations within a sustainable development context.

Traditional SOE reports have the objective of providing information on environment state and trends as its key variables. However, over the past three decades this has evolved to include an assessment of the environment in a more integrated manner. Integrated environmental assessment tries to show the cause-and-effect linkages of human and natural actions and their impact on the environment. In turn, it highlights the impacts of the resultant changes in the environment on human well-being.

1.2 METHODOLOGY

The format used for the analysis is the driver-pressure-state-impact-response (DPSIR) framework. This format highlights a chain of causal links starting with driving forces (economic and human activities) through pressures (emissions, waste) to states (physical, chemical and biological) and impacts on ecosystems, human health and functions, eventually leading to political responses (policies, legal and institutional frameworks) (see section 2.8 for greater detail of the DPSIR methodology).

As much as possible, the report has collated, compiled and analysed available data and information to demonstrate positive or negative change. Attempts have also been made to establish a baseline to inform any future assessments.

The report has used data from different sources such as policy and strategic initiatives. By use of the integrated analysis approach, it aims to reinforce the cross-cutting nature of environment management further bringing together differing sectoral mandates in support of sustainable development.

The end result of this assessment will be more than just knowing about the state of the environment. It will provide policy-makers and other stakeholders some guidance on how to better manage the environment.

2 NATIONAL CIRCUMSTANCES

2.1 COUNTRY BACKGROUND

2.1.1 GEOGRAPHICAL AND ENVIRONMENTAL CHARACTERISTICS

The Kingdom of Swaziland is situated in the south-eastern part of Africa between 25° and 28° latitude south and 30° and 33° longitude east. The country covers a land area of 17,364 km^2 and has an elevation range of 60-1,860 masl. Swaziland is landlocked, bounded by the Republic of South Africa on the north, west and south and by Mozambique to the east (Figure 1). Although small in size, Swaziland is characterized by a great variation in landscape, geology, soils, climate and biodiversity.

Figure 1: Map of Swaziland

2.1.2 GOVERNANCE AND ADMINISTRATION

Swaziland is ruled by a King, with legislative powers vested in Parliament. A Cabinet of Ministers and a National Council, whose members are drawn from among the country's traditional leaders, advise the King. Western and traditional Swazi systems of government converge in Parliament, which consists of the House of Assembly and the Senate[1]. The country is divided into four administrative regions: Hhohho, Manzini, Shiselweni and Lubombo. An Administrator, advised by a Regional Council representing the Tinkhundla, heads each regional administration and reports to the Deputy Prime Minister.

2.1.3 POPULATION

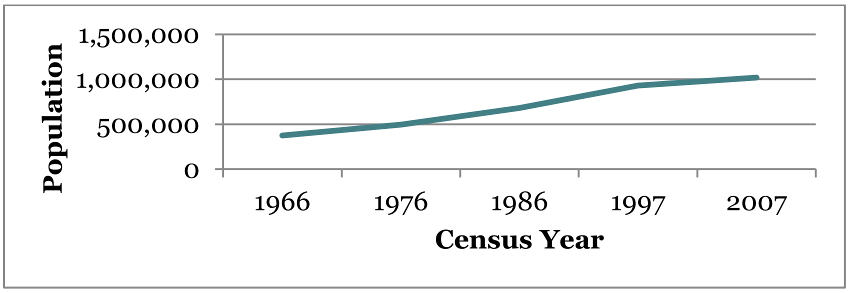
The population of Swaziland in 2007 was estimated at just over 1 million, with an annual growth rate of 0.9% (GOS-CSO, 2010). Table 1 and Figure 2 show that the population has strongly increased since independence in 1966, but that population growth has in general decreased, in particular after 1997. The distribution between male and female is 47.3% versus 52.7%. The population has a high dependency ratio owing to the fact that 52% is composed of people under the age of 20 years.

Table 1: Population and Annual Growth Rate (1966-2007)

Census Year	Total	Annual Growth (%)
1966	374,697	4.8
1976	494,534	2.8
1986	681,059	3.2
1997	929,718	2.9
2007	1,018,449	0.9

Source: GOS-CSO (2010) Population and Housing Census 2007

Figure 2: Population and Annual Growth Rate (1966-2007)



Source: GOS-CSO (2010) Population and Housing Census 2007

The urban population is 22.1% with an average household size of 3.2; for the rural population these figures are 77.9% and 5.2 respectively. Table 2 shows the population density and the distribution over the four administrative regions over the three last census years.

Swaziland has the highest rate of HIV/AIDs and tuberculosis in the world, which has led to a co-epidemic and resulted in the halving of life expectancy from 56 years in 1986 to 32 years in 2007. Over half of Swaziland's population is below 20 years old and there are estimated to be 144,000 orphans and vulnerable children (OVCs). There is evidence that fundamental societal changes are taking place with the majority of children (32%) being brought up by their mother or with no parent (28%) at all; nuclear families are the minority (23%). This, coupled with the high unemployment rate (estimated to be 30%) has created grave concern for the future.

Spatial Distribution of Population Density

The regional population density is shown in Table 2.

Table 2: Population Density by Region (1986-2007)

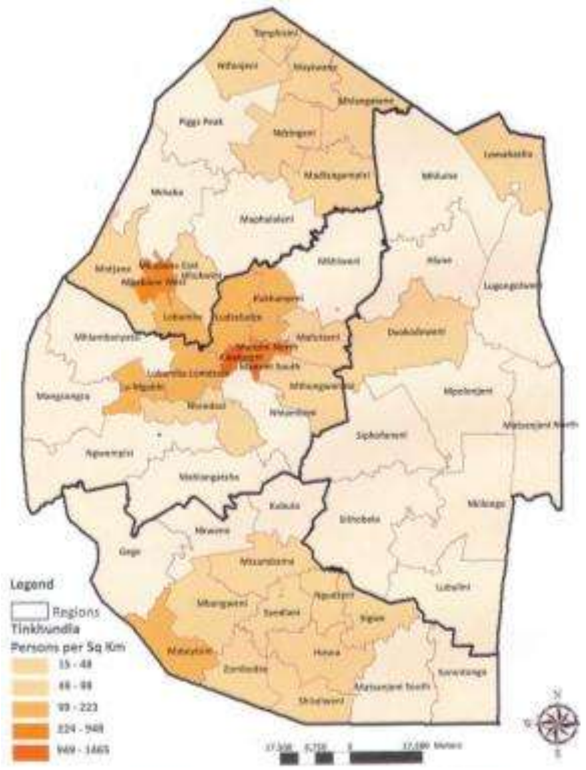
Administrative	Area	Average	Population	Population Density

[1] The House has 55 Inkhundla representatives (or constituency Members of Parliament) and 10 members appointed by the King-in-Council. The Senate consists of 30 members – 10 elected by the House of Assembly and 20 appointed by the King-in-Council. About 360 chiefs provide traditional leadership at the local level, with each chief having his own council (libandla) of deputies (tindvuna). Each Inkhundla represents a number of chiefdoms and has its own council – which includes both elected members and chiefs.Council. About 360 chiefs provide traditional leadership at the local level, with each chief having his own council (libandla) of deputies (tindvuna). Each Inkhundla represents a number of chiefdoms and has its own council – which includes both elected members and chiefs.

Region	(km^2)	Household Size							(people/km^2)		
			1986		1997		2007		1986	1997	2007
			Total	%	Total	%	Total	%			
Hhohho	3,569.4	4.6	178,936	26.2	255,455	27.5	282,734	27.8	50.1	70.7	78.1
Manzini	4,068.4	4.4	192,596	28.3	280,972	30.2	319,530	31.4	47.3	68.4	77.8
Shiselweni	3,779.4	5.5	155,569	22.8	198,978	21.4	208,454	20.5	41.2	52.3	55.1
Lubombo	5,947.1	4.9	153,958	22.6	194,323	20.9	207,731	20.4	25.9	33.3	33.6
Country	17,364.3	4.7	681,059		929,718		1,018,449		39.2	53.6	58.7

Figure 3 and Figure 4 show the spatial distribution of the population density 2007 and the mean annual growth rate over the period 1997-2007 by Tinkhundla. It appears that the growth rates are fairly equally spread over the country, without real extremes, with the exception of some of the Tinkhundla along the border that experience negative growth. Areas with higher growth rates are not necessarily linked anymore with urban areas, as it used to be.

Figure 3: Population Density by Tinkhundla



Source: CSO, 2010: Population and Housing Census 2007

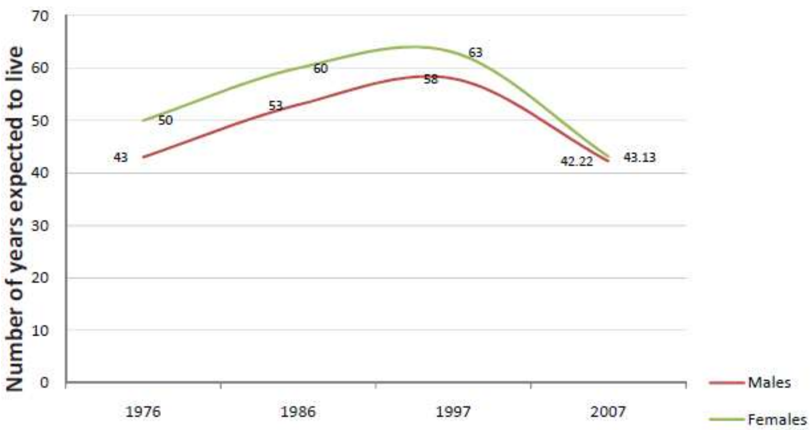
Figure 4: Population Growth Rates by Tinkhundla

Source: CSO, 2010: Population and Housing Census 2007

Life Expectancy

The trend in life expectancy shows a substantial decline from the 1997 values of 58 years for males and 63 years for females. According to the 2007 Population Census (GOS-CSO, 2010) life expectancy declined during the decade by 15.6 years for males and 19.9 years for females. Figure 5 shows that since 1976, Swaziland life expectancy improved steadily from 50 years and 43 years to 63 and 58 for males and females respectively but since the last census, 1997, the life expectancy at birth declined to just above 40 in both sexes. It can be assumed here that this new trend is the result of the great impact the HIV/AIDS epidemic is having on the population of Swaziland.

Figure 5: Life Expectancy (1976-2007)



Source: GOS-CSO, 2010

Mortality trends are used to observe if mortality has been increasing or decreasing in a population. Table 3 shows the trend of CDR for Swaziland since 1986. There was a significant mortality increase for Swaziland between 1997 and 2007 to the level above that of 1986. During the inter-censal period, crude deaths rates increased by 163.7% among females, 116.1% among males and overall there was an increase above 137%. The table also shows that the gap between male and female CDR was almost nonexistent in 2007.

Table 3: Crude Death Rate (1986-2007)

INDICATORS	1986	1991	1997	2007
Crude death rate (CDR)	13	6.8	7.6	18.0
Male CDR	14.5	9.8	8.4	18.2
Female CDR	11.8	7.0	6.8	17.9

Source: GOS-CSO, 2010

2.2 NATIONAL VISION FOR SUSTAINABLE DEVELOPMENT

Swaziland's national policy agenda for sustainable environmental and socio-economic development is set out in a long-term vision, the National Development Strategy (NDS).

The NDS outlines the policy framework in developing the national response to issues of poverty alleviation, food security and the need to maintain an environmentally sustainable framework. The NDS was adopted in 1999 and details the long-term (25 year) vision for the country based on the identification of priority development objectives. The NDS acknowledges Swaziland's international obligations under various international Conventions along with the need for actions in ensuring compliance with these Conventions.

The NDS is the Government of Swaziland's overriding development plan and is supported by the Swaziland Environment Action Plan (SEAP). The NDS outlines Swaziland's developmental goals for the next 25 years and is viewed as the highest-level policy document. The SEAP is the environmental equivalent of the NDS and outlines the environmental development issues relating to Swaziland's sustainable development with recommendations for actions to promote environmentally sustainable development.

The NDS has spawned a variety of ministerial policies, strategies and action plans, all of which more clearly articulate the broad policy statements made in the NDS and SEAP. These policies, strategies and plans build upon a long history of issues addressing environmental protection and management in Swaziland. A large number of early legislative measures (see SEA, 2004a, b, c) represent initial efforts to address issues of environmental protection. These were invariably specific to individual species or activities but served as a precursor to more integrated initiatives aimed more toward sustainable development. As such they all fall within the context of the UN Conventions and reflect the shift in conceptualisation of issues pertaining to the natural environment and sustainable development.

The implementation of a *Poverty Reduction Strategy and Action Plan* (PRSAP) is seen as crucial in achieving the goals of the NDS. As poverty is more prevalent in rural areas, smallholder agricultural development is vital to its alleviation. The revised 2005 PRSAP presents a poverty reduction framework which consists of six pillars: (1) rapid acceleration of economic growth based on broad participation, (2) empowering the poor to generate income and reduce inequalities, (3) fair distribution of the benefits of growth through public expenditure, (4) ensuring food security, (5) improving the quality of life of the poor, and (6) strengthening good governance. The most essential parts of the PRSAP are consolidated under the empowerment of the poor to generate income through (1) improving access to land, (2) increasing income from agriculture, and (3) reducing unemployment. The strategies proposed under the human capital development focus on (1) education, (2) health, (3) food security and nutrition, and (4) safe water and sanitation.

The *National Environment Policy* has been formulated to promote the enhancement, protection and conservation of the environment to attain sustainable development. The *Swaziland Environment Action Plan* (SEAP) was officially approved and endorsed by the government in 1997. The Swaziland Environment Authority, which is an autonomous body within the Ministry of Tourism, Environment and Communications (MTEC), is entrusted with the implementation of the SEAP. The main objectives of the SEAP are to provide an overview of the Swaziland environment, prioritise environmental issues and problems, suggest solutions to these problems, establish a clear indication of the government's priority areas with respect to the environment, establish a framework with coherent direction for future planning and monitoring, and provide a framework for continuous development and policy dialogue. The *Environmental Management Act, 2002* turned the Swaziland Environment Authority (SEA) into a body corporate and established the Swaziland Environment Fund.

Although emerging from the International Convention on Biodiversity, the draft *National Biodiversity Strategy and Action Plan* (BSAP) is an integral part of the SEAP. The purpose of the BSAP is to conserve the biodiversity of Swaziland, encourage the sustainable use of biodiversity, and ensure that the benefits accrued from the use of biodiversity are shared equitably. The BSAP establishes six goals, and makes recommendations towards their achievement. The goals are to: conserve a viable set of representative samples of natural ecosystems, sustainably use of biological resources of natural ecosystems outside protected areas, conserve the genetic base of Swaziland's crop and livestock breeds, minimise risks associated with the use of modified organisms, establish effective institutional, policy and legal frameworks, and enhance public awareness and support for biodiversity conservation.

2.3 SECTORAL CHARACTERISTICS

Sectoral characteristics are presented in four groups: (1) Agriculture, Forestry & Fisheries, (2) Industry, Mining & Transport, (3) Tourism, and (4) Education. Other sectors such as Energy are discussed in the next chapter under the Environmental Themes.

2.3.1 AGRICULTURE, FORESTRY & FISHERIES

2.3.1.1 AGRICULTURE AND FOOD SECURITY

The agricultural sector's share of GDP decreased from over 30% at independence to 13% in 1989 and to 10% in 2009. However, agriculture is more important for Swaziland's population and national economic development than its contribution to GDP suggests. Agricultural output forms the raw material base for about one third of value added within the manufacturing sector and contributes substantially to national export earnings. Agriculture plays a key role in the lives of the majority of the population, since over 70% of the population and households rely on agricultural output as a major source of income and food security, either as small-scale producers or as recipients of income from employment (about 20,000 people) on medium and large-scale farms and estates.

Over the past decade, the country has been affected by a large variation in rainfall and recurring drought. Preliminary analysis suggests that climate change will have an increasingly adverse effect on agricultural production, particularly on smaller households. Land degradation, erosion and uncontrolled bushfires contribute further to the vulnerability of the 78% of the population that reside in rural communities. The result is chronic food insecurity, with many Swazi households dependent on food aid (UNDP, 2010).

Before the 1980s Swaziland was largely self-sufficient in its cereal production. In the 1990s Swaziland produced about 60 percent of its own staple food (maize) requirements, but since 2001 this has in average fallen under 40 percent. In 2007/08 650,000 beneficiaries received emergency food relief, of which most were covered under free food distribution.

The FAO/WFP (2008) Crop and Food Supply Assessment Mission to Swaziland estimated a combined SNL and TDL maize harvest of 64,000 tonnes (about 1.0 t/ha) in 2008, an average production year. Total cereal import requirement in the 2008/09 marketing year was estimated at about 136,000 tonnes, most of which to be imported commercially and the remainder covered by WFP supply, which is 65% of the total cereal utilization estimated at 212,000 tonnes (mainly maize and wheat). About 210,000 people (20% of population) were estimated to be food insecure during the 2008/09 marketing year, of which 150,000 chronically food insecure and 60,000 transitory food insecure, primarily in Lowveld and Lower Middleveld due to rising food prices. According to the Vulnerability Assessment Committee (GOS-VAC, 2010) some 170,000 people in 2009 were in need of food aid in the country.

Due to erratic rainfall performance over the 2011/12 season cereal production was reduced compared to the previous season. The outcome of the 2012 Vulnerability Assessment (GOS-VAC, 2012) shows an increase in the number of people facing food deficits (115,713 compared to around 90,000 recorded in 2011 and around 47,000 in 2010). The estimate for 2012 is likely to increase due to inflationary pressures as the lean/hunger season approaches.

The country's Food Balance Sheet which is composed mainly of cereals (maize, rice and wheat) is a measure by which food availability is determined at the national level. The domestic consumption requirements are measured against domestic availability. Maize availability for the 2012/13 consumption year stands at 76,091MT against a total requirement of 115,400MT. This leaves a shortfall of close to 40,000MT which has to be covered through imports and food aid. Due to the decline in domestic production the overall cereal gap for the current consumption year has also increased. At present food availability is stable but with the forecasted production shortfalls in the major producing countries, food prices will likely go up (GOS-VAC, 2012).

The challenge in agriculture remains, even under deteriorating climatic conditions, to increase productivity and promote increasing cash-income opportunities on SNL so that it contributes to meeting the food, income, employment, and export earnings of the people.

2.3.1.2 AGRICULTURAL CROP PRODUCTION

Agricultural production is very much dependent on climatic conditions and water availability. Overall rainfall in recent years has been erratic and often below normal levels and resulting droughts in parts of the country have been largely responsible for a weak agricultural performance.

Sugar is the most important agricultural produce of Swaziland and the area under sugarcane has continuously increased since the sixties. In 2004 the milestone of 50,000 ha under irrigated sugarcane was achieved, together with reaching a production of sugarcane of 5 million t and 600,000 t of sugar. Total sugar production of the season 2009/2010 was 606,000t. All sugarcane is processed in Swaziland and sugar products form a very important export commodity.

Other important cash crops include citrus and pineapple, both of which have declined: citrus from dropped from over 3,000 ha in 1996 to under 2,000 ha in 2003 now remaining stable at about 1,900 ha in 2009 and pineapple from over 1,500 ha to less than 400 ha.

Cotton used to be widely grown in the 1990s with peaks of over 25,000 ha (on both TDL and SNL), but has very much declined since. The recent re-launching of the local cotton ginnery with an optimum capacity of 15,000 Mt and a guaranteed price of E4/kg provided under government subsidy has presented a leeway for the cotton sector survival. After years of marginal existence, prospects for the industry are positive and production rose in 2008/2009 to 1,500 Mt from 4,000 ha.

The major agro-industrial activities in Swaziland are the sugar industry, the production of pulpwood and the processing of fruit (canned fruit and liquid concentrates). These activities take place in the private sector, with high technology and management levels. Commercial estates generate more than 70% of all agricultural output.

Most of these products are exported, about 50% to South Africa. The sector accounts for approximately 15% of total export earnings. Agricultural raw materials form the basis of about one third of value adding in the manufacturing industry, which contributes about 35% to GDP.

Maize is the most important subsistence crop on SNL, followed by groundnuts, pumpkins, beans, sweet potatoes and vegetables. Sorghum, cowpeas, jugo beans, melons, watermelons, cassava, bananas, peaches and avocados are also produced, but in limited quantities. Although most of these crops are economically not very important, they contribute to the agricultural diversification pattern in Swaziland and hence to food security and nutrition.

Maize production over the period 2002-2009 has dropped to an average 60,000 t/annum from 110,000 Mt/annum over 1995-2000, with fluctuating yields from 0.6 to 1.6 t/ha. Although the statistical record shows inconsistencies, data suggest that the SNL area planted to maize has decreased from levels of 70-80,000 ha in the 1980s to around 60,000 ha in 1990s and around 50,000 ha as from 2003 (see Table 4) (GOS-CSO, 2004; FAO/WFP, 2008; CBS, 2011).

Table 4 Production of Maize on SNL (2000-2010)

Year	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10
Area (Ha 000)	69	58	68	68	54	56	47	47	60	52	58
Yield (t)	113	83	68	69	68	75	67	26	60	71	75
Yield/Ha	1.6	1.4	1.0	1.0	1.3	1.4	1.4	0.6	1.0	1.4	1.3

Source: CSO, CBS

Agricultural development in the future will depend on a number of factors which include: (1) the impact of HIV/AIDS on agricultural development, (2) effects of drought and climate change, (3) government commitment to invest in the sector, (4) availability of an agricultural policy and efficient action plan, (5) improvements in agricultural practices such as ploughing and weeding, (6) improvements in range management and animal production, and (7) improvements in marketing and credit (FAO/GOS-MOAC, 2006).

2.3.1.3 AGRICULTURAL RESEARCH

Agricultural research is the responsibility of MOA's Agricultural Research Division, with its headquarters at Malkerns with outstations at Nhlangano, Luve, Big Bend and Mangcongco. This research activity has been under way for more than 50 years and has tended to focus on those commodities that are not being researched by the private sector[2]. Research has faced various challenges over the years and the facilities have not kept up with the times and the range of research has narrowed. Research is focused on cereals (maize and sorghum), grain legumes, root crops (sweet potato and cassava), horticulture (fruits and vegetables) and food technology. Malkerns Research Station (MRS) is also responsible for the issuing of phytosanitary certificates. MRS is linked into Bionet (the international taxonomic network) and has a gene bank as part of the SADC Plant Genetic Resource Centre. However, there is relatively little plant breeding due to the limited staff resources. Through the International Maize and Wheat Improvement Centre (CIMMYT), MRS is reintroducing open-pollinated varieties (OPVs) of maize, which will allow farmers to save their own seed for the next year – although the quantities presently available are very small. The multiplication of OPVs through using local farmers should be encouraged.

MRS is significantly under-staffed and under-resourced. Given the importance of continuing research in developing a vibrant and diversified agricultural economy equipped to provide practical 'climate proofed' advice to farmers, the Agricultural Research Division must be given a new focus and substantially increased resources.

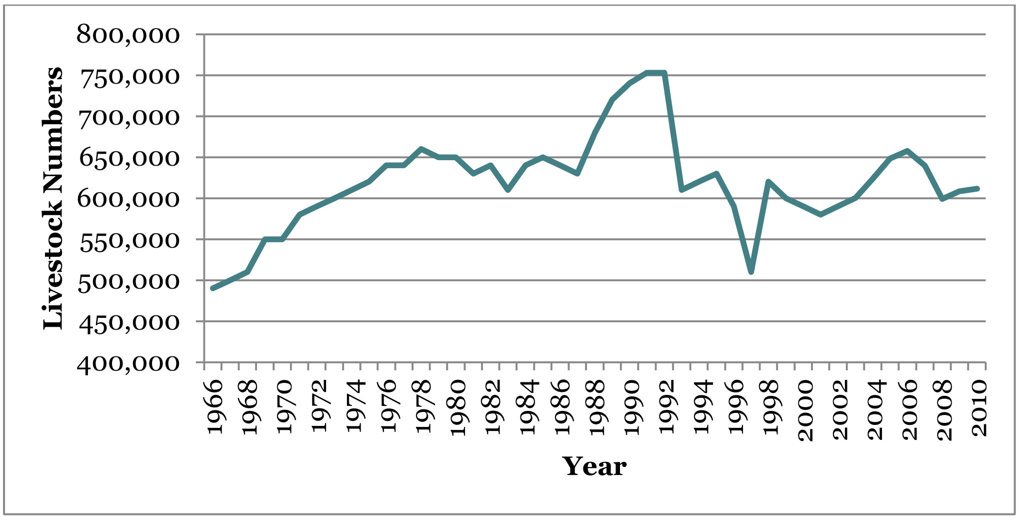
2.3.1.4 LIVESTOCK AND LIVESTOCK PRODUCTION

Livestock production is a major agricultural activity in Swaziland, with small farmers owning about 77% of the total cattle population. The number of livestock has been declining in recent years due to droughts and overgrazing of rangelands resulting in less productivity, and to some extent also because of allocation of land for human settlement and agricultural schemes.

Cattle are the main livestock; other animal species raised in Swaziland are goats, sheep, pigs, equines and poultry. The contribution of the livestock sub-sector to the agricultural sector GDP is about 4%. Beef and other livestock products contribute about 1% to total exports. In Swaziland there are two broad livestock production systems, namely the commercial system and the traditional system. The traditional SNL sector manages about 86% of cattle and 95% of small stock whereas the commercial TDL system carries the rest; the stocking rate on SNL is two times larger than on TDL. Figure 6 shows the development over the past 38 years of the cattle population, which is the largest component of the country's livestock industry. The record shows a gradual and constant increase reaching a peak of 753,00 in 1992, followed by a fast and irregular decrease - mainly as a result of drought, unsustainable management and increasingly degraded rangelands - to 561,000 in 2003; a drop of 25% in 11 years.

[2] Research undertaken by the private sector includes that on sugar, pineapples, citrus etc.

Figure 6: Cattle population (1966-2010)



Source: GOS-Central Statistical Office: Annual Statistical Bulletins 1970-2000; Annual Agriculture Survey, 2003

Goat is the main small stock, numbering about 300,000 in 2000 increasing to 500,000 in 2008. Poultry numbers have increased strongly over recent years.

Table 5: Livestock Census (2000)

Livestock Type	Number
Dairy Cattle	3,292
Non-dairy Cattle	588,288
Sheep	15,755
Goats	297,756
Horses	1,448
Mules & Asses	11,880
Swine	36,826
Poultry	1,703,415
Total	**2,658,660**

Source: GOS-MOAC, 2000. Livestock Census

None of the proposals to commercialise livestock production has been endorsed or implemented (management improvements, dipping fees, etc; Livestock Identification Act of 2001). Livestock production has to grow and must become more competitive for the country to avoid continuous deficits and having to import to cover gaps (GOS-MOAC, 2006).

The major constraints to livestock production have been identified as diseases, breeds and breeding practices, inadequate feed resources, lack of range management and water shortages, under-utilization of market infrastructure, lack of adaptive research, lack of proper livestock census and lack of capital for improved technologies necessary for animal development. Improvement in these areas is also Swaziland's route to minimise the impacts of climate change. Opportunities identified are: i) increased off-take of cattle, poultry and dairy production to meet market demand and reduce imports; ii) improved range management and rehabilitation to prevent overgrazing and to control degradation; iii) improved livestock quality and condition through proper breeding and selection and improved supplementary feed preparation; iv) more effective livestock marketing through better marketing facilities and information; v) strengthening livestock extension activities; and vi) better control of tick and tick-borne and other diseases (FAO/GOS-MOAC, 2005).

2.3.1.5 FISHERIES

According to National Fishery Sector Overview (FAO, 2008) as a landlocked country that shares boarders with South Africa and Mozambique and with no natural lakes, swamps or floodplains that are of a significant importance, the Fisheries Sector contributes to food security. The two major components of the sector are aquaculture and capture fishery.

There is growing interest in angling as a recreational activity and a number of irrigation dams are regularly used by recreational anglers e.g. Van Eck, Lubovane, Luphohlo, Maguga, Mkimkomo, Mnjoli and Sand River dams. There are other smaller dams that are spread all over the country but predominantly in the Lowveld (the ecological zone most prone to drought in the country) for water supply for human and livestock uses. These dams (smaller dams) are normally stocked with *Tilapia* species. This is mainly done to improve the food security (which is always a challenge) of those communities.

The common fish species that are exploited are the tilapias (*T. mossambicus* and *T. rendalli*) and catfish (*Clarius garipinus*). Species that are mainly targeted for sport fishing (angling) include largemouth bass (*Micropterus salmaides*), rainbow trout (*Salmo giardeneri*) and tiger fish (*Hydrocynus vittatus*).

The contribution of capture fishery in particular and the fisheries sector in general to the national economy is negligible because of the limited amounts of fish in the country.

However, aquaculture is making a contribution to food security by improving the nutritional status of the population and income generation.

Aquaculture is encouraged by the government. There are fishponds located all over the country. The most common fish farmed in Swaziland are *Oreochromis mossambicus* (Tilapia) and *Clarias Gaiepinus* (Catfish). Rainbow trout (*Salmo giardeneri*) and the Common carp (*Cyprinus carpio*) are also cultured. The tilapia is sourced locally, while other species are imported from South Africa. In 2007, there were about 40 community ponds around the country stocked with tilapia and catfish.

Capture fishery in Swaziland is very minimal. Seine net fishing is currently prohibited.

The legal frameworks governing the fisheries sector consists of the Freshwater Fisheries Act of 1937 and the Freshwater Fisheries Regulations of 1937. These pieces of legislation need to be urgently updated particularly if fisheries economic importance grows.

2.3.2 INDUSTRY, MINING & TRANSPORT

Mining

The Ministry of Natural Resources and Energy is responsible for coordinating development and operational activities in mining, quarrying, energy, water, and land.[3]

The hosts of minerals in the country include asbestos, coal, quarried stone, soapstone, kaolin, talc, silica, green chert and others. Maloma Colliery is the only active coal mine. Almost all the coal mined in Swaziland is exported to South Africa for use in the metallurgical industries with small amounts sold to Mozambique.

Table 6: Production and Sales of Coal and Quarried Stone (2007-2010)

	2007	2008	2009	2010
Production of coal (Metric Tonnes)	310,570	241,283	129,647	145.3
Sales of coal (E '000)	102.5	119.0	101.1	125.9
Production of quarried stone (m^3)	534,688	207,535	202,319	304,844
Sales of quarried stone (E '000)	12.8	11.0	12.1	19.4

Source: CBS, 2011 Annual Report

Swaziland has been reviewing its mining legislation with the aim of aligning it, *inter alia*, with the SADC Mining Protocol. Holders of mining rights are subject to taxes on properties able to produce precious and non-precious metals to which they hold rights. Three taxes are grouped together: tax on the transfer of mining rights; ground tax on mineral rights; and capital gains tax. The mining subsector does not receive special incentives. However, it benefits from the general incentives available in Swaziland, such as import duty and sales tax concessions.

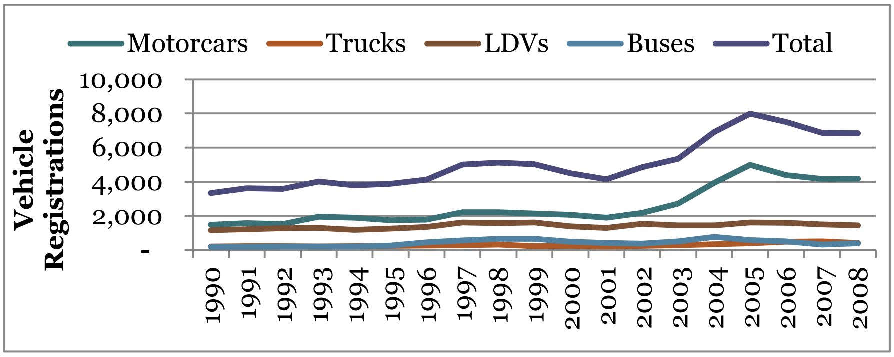
Transport

The Ministry of Public Works and Transport (MPWT) is responsible for the overall running of the subsector, including formulating policies, monitoring their implementation, and administering the institutional and legal

[3] Ministry of Natural Resources and Energy online information. Viewed at: http://www.gov.sz/home.asp?pid=63.

framework. Transport inflation rose by 1.8 % on average in 2009. The Central Motor Registry had registered over 6,000 vehicles by 2008 (Figure 7).

Figure 7: Vehicle Registrations (1990-2008)



Source: Central Motor Registry

The transport system in Swaziland is based principally on road transport: nearly all passengers are conveyed by road on public transport[4], as are a major portion of the goods transported within Swaziland. The bulk of road freight operations continue to be carried out by multinational companies based in Swaziland, with only a few Swazi companies. There are 11 border posts used by freight operators, of which 9 are with South Africa and 2 with Mozambique. Over 90% of goods transported by road in cross-border movements go to South Africa.

Swaziland's rail network is about 300 km long.[5] The Railways Act of 1962 established the parastatal Swaziland Railway to provide transport services for import and export of goods as well as transit cargo. There is very little rail passenger service, although tourist trains have been increasing over the last few years.

Airlink Swaziland, a joint venture between the Government and South African Airways, is the only airline currently operating. There is no significant air freight operation. Swaziland has one international airport, at Matsapha, and there are two other state-owned and nine privately-owned airstrips. The construction of the new aiport, Sikhuphe, is already in progress and close to completion.

The Swaziland Civil Aviation Authority is responsible for the regulation of civil aviation and the establishment and maintenance of aerodromes and air navigation facilities. This includes licensing of air transport operations and maintenance of International Civil Aviation Organization Standards and Recommended Practices. The Authority also negotiates bilateral agreements with other countries. Nonetheless, scheduled air services continue to be operated in terms of memoranda of understanding and diplomatic notes between governments. Swaziland is currently in the process of incorporating international standards as required to open up the activity of the aviation sector internationally.

Transport infrastructure is a key component of an enabling environment for private sector-driven growth and provision of timely and quality social services. Road-based transport is the most dominant mode in Swaziland, due to the country's extensive road network.

It is the aim of the government to ensure the provision of a coordinated transport environment that fosters the safe and competitive operation of commercially viable, financially sustainable, and environmentally friendly transport services and enterprises. This broad goal promises a transport service in which agricultural and industrial products are moved from sources of supply to areas of demand with minimal interruption.

The Government has prioritized the need for a designated public road infrastructure network that ensures provision of adequate, safe, reliable, efficient and economical transport services in order to meet the country's current and future road transport needs and to promote economic growth.

[4] The majority of the population uses public transport.

[5] Rail transport in Swaziland began in 1964 with the opening of the line linking the Nqwenya iron ore mine at KaDake on the border with Mozambique. Operations continued until the mine ceased activities in 1980.

High transport costs and poor access to some parts of the country remain an impediment to economic growth in Swaziland. Poor access roads mainly result from the deteriorating condition of the country's overall good road network, especially in the rural areas and in unplanned urban settlements.

Traffic congestion has increased in Swaziland in recent years following the availability of competitively priced imports from Asia and the Middle East. An increase in traffic congestion increases fuel consumption, negatively impacting both the economy and the environment. Congestion also poses a safety threat to pedestrian traffic.

Transportation corridors have an environmental impact. Road construction programmes have contributed to environmental degradation in various ways. Heavy machinery used in road construction may cause soil erosion. Mitre drains and culverts can also cause erosion when draining water away from the road. Similarly, the shoulders of the roadside can get washed away in the rainy season if they are not properly sealed, further contributing to soil erosion. Construction can also affect soil by modifying surface features: through the creation of borrow pits; slope failure; sedimentation of road-side drains and water bodies; and soil contamination and compaction. Soil related losses include lower crop yields, declining fisheries income because of sedimentation of water bodies and water pollution, and declining property values of roadside households and business sites.

Industry

Industry is supervised and spearheaded by the Ministry of Commerce, Industry and Trade's Industry department. The country has well-serviced industrial sites located strategically central Swaziland and in close proximity to border posts. The industry constitutes mostly of agro-processing including sugarcane, cotton, wood pulp livestock and canned fruit, production of soft drinks concentrates beverages, textiles, tourism and other manufacturing. Manufacturing involves textile and garment production that offers wide range of services and products including weaving, knitting, dyeing and finishing and employs relatively 15,000 Swazis. Sugar, previously known as Swazi gold is a major export of the economy. The tourism industry also remains one of the fastest growing with wide range of investment opportunities. The country imports 80% of its power from South Africa making notable opportunities for power generation in the country. The country has experienced a decline in FDI inflows as there has been stiff competition in the region for FDI attraction. The vibrant recovery of the economy of South Africa weighed heavily on Swaziland's economy owing to the appreciation of both currencies diminishing export returns.

Swaziland is heavily dependent upon South Africa and the Southern Africa Power Pool for its supplies of electricity which enters the country on high voltage lines to substations for local distribution. Some 18,369.21TJ of energy (electricity and liquid fuels) was imported in 2010 of which the industry sector consumed 3,847.64 TJ.

Though the implementation of the EU sugar reform of the cut of 21.6% from the preferential tonnage price was effected in 2009/10, export earnings were higher than anticipated. The cotton industry performed well owing to the increase of 30 c/kg of cotton in 2009/10. The performance of the citrus industry has been largely compromised due to changing climatic conditions as a result of global warming. Climatic variations resulted to the marginal decline of 3.3% of citrus and sales volumes fell by 2.8% in the same year. Amidst the growth of livestock production by 2.3%, in 2009/10, lack of livestock to slaughter contributed to the underperformance of the beef export by a slump of 28% compared to 2008/09 and on the other hand, canned fruit production dropped by 6.1% in 2009/10.

The country remains a member of African Growth and Opportunity Act (AGOA), SACU, COMESA which gives market opportunities that are relatively stable.

2.3.3 TOURISM

Globally, tourism is among the fastest growing industries and the largest generator of income, with international arrivals reaching 924 million in 2008 – a growth of 2%. It is therefore logical that tourism has been identified as having the greatest potential to enhance economic and employment growth in Swaziland.

In Swaziland, 45.3% of visitors came for recreational purposes while 12.7% were on business trips. Others were visiting family and friends and 5.6% were in transit. They spent an average of 2.5 nights in the country – a small increase of 0.26%. The Tourism Research Annual Report 2008 notes that neighbouring countries account for the great majority of visitors with 781,925 arriving from South Africa and 209,139 from Mozambique.

Swaziland has tended to be an overnight destination but during recent years stays have increased to two or three nights with 57% staying for at least one night. The country is a popular weekend and conference venue but relies on South African visitors and on "spillover" by overseas visitors to the region as the country is too small to stand alone as an international destination. Visa requirements and border procedures continue to be addressed to facilitate more convenient entry and departure and there are plans to extend the hours of two main border gates to relieve congestion.

During 2008 the sector's performance was very good with an all-time record of 416,358 guests and revenue increasing by 12.7% to E103.6 million. The development of community-based tourism during recent years has created employment in rural areas, where people previously relied solely on agriculture for their incomes.

The Swaziland Tourism Authority (STA) is a parastatal organisation that began operating in 2001. It was formed under the Tourism Authority Act with the objective of stimulating and expanding the industry through various programs and was officially opened by His Majesty King Mswati III in September 2003. The STA is financed by the Swaziland Government and, until 2005, was also assisted by the European Union. The STA has made significant contributions to the development of community tourism, enabling rural communities to develop tourist attractions on nation land. This is undertaken in a manner that avoids any negative environmental impact.

The Swaziland National Trust Commission (SNTC) was established by an Act of Parliament in 1972. The SNTC is responsible for the preservation and conservation of the Kingdom's cultural and natural heritage through a wide diversity of projects. Activities include operating the National Museum and the King Sobhuza II Memorial Park at Lobomba, and preserving the country's monuments, sites, relics and antiques. SNTC also administers the Malolotja and Mlawula Nature Reserves and the Mantenga Cultural Village and Nature Reserve. The SNTC operates a community outreach programme and is involved in nature reserve management, environmental education and ecological research through the three nature reserves. At Mantenga a traditional homestead provides an experience of authentic Swazi culture through live performances of song and dance.

There is a two-way relationship between tourism and climate change. On the one hand, tourism has an obligation to minimise its adverse impact on the environment and thus on the emission of greenhouse gases which in turn contribute to climate change. On the other hand, it was recognised that changes to the world's climate will have a direct impact on many tourism destinations which could have far reaching implications, not just for the tourism industry, but for other economic sectors.

The World Tourism Organization has identified climate change as a potential threat to long-term tourist markets and destinations (WTO, 2003). It has adopted the 2003 Djerba Declaration on Tourism and Climate Change to assist and guide the tourism sector as it tries to adapt and mitigate climate change.

Tourism has a high per capita consumption of water, energy efficiency and effects on flora and fauna.

Water consumption by tourists is usually far higher than that of local residents and can contribute to localised increases in water stress. Tourists typically consume nine times more water compared to nationals, partly because the use of water by tourists in hotels and resorts is typically very wasteful.

Water is required to grow the plants on which herbivores, birds and so on depend; this in turn creates opportunities for carnivores, which, together with the general flora and fauna, are a key attraction for tourists. The sustainability of this type of wildlife tourism is thus directly dependent on water; changes to water supply, whether seasonal or geographic, affect the abundance and location of flora and fauna which influences the sustainability of various types of tourism. Tourism is thus fully integrated within the issue of water supply, and changes to precipitation caused by climate change will have a direct effect on tourism demand. At the same time, tourism is placing demands on (often water-scarce) dryland areas.

Tourism has the ability to potentially worsen flora and fauna where it takes place in sensitive ecosystems, such as the drylands, coastal and mountain areas.

The tourism industry, including transport companies, hoteliers, tour operators, travel agents and tourist guides need to start to adjust their activities and start initiating more energy-efficient and cleaner technologies and logistics, in order to minimize as much as possible their contribution to climate change.

Tourism is not only affected by climate change, it also contributes to it. The bulk of tourism's contribution to greenhouse gas emissions comes from transport activities. The predominant source of greenhouse gas emissions is road and air transport. Air transport has been estimated to be between two and four times more polluting per passenger carried than road transport. Air transport's polluting effects may be able to be reduced through measures such as improved air traffic control so that in-flight delays can be minimised, and by the use of more fuel efficient engines.

The greater the economic importance of tourism, the greater is the importance of understanding potential impacts and planning for appropriate action. The potential impact of climate change has very important implications for employment, investment and government policies, and for the livelihoods of local residents. It therefore seems essential that the tourism industry should get involved in joint initiatives - with governments, local authorities or the international agencies - in assessing the implications of climate change and its influence on the choice of a leisure travel destination.

Swaziland's tourism sector needs to initiate response measures and assess whether/how climate change has already begun to have an impact on local tourism; prepare physical plans and "hazard maps" of vulnerabilities due to climate change (e.g. growing water shortages in peak periods); co-operate with scientists, physical planners, public authorities and other appropriate specialists to prepare outline plans of the potential impact; define and cost whatever mitigation measures and actions may be appropriate in local circumstances; assess the issue of whether additional/new products need to be introduced to cope with changing circumstances; define and cost the benefits to the tourism industry that might be gained from appropriate remedial measures and from new opportunities that may arise for the industry; adopt an integrated approach to tourism management in order to accommodate medium and long term concerns (such as water shortages) and current needs and investigate the impact of climate change and make preparations for action.

One such local tourist operator who has opted to minimise their energy footprint are the operators of the Hlane Nature Reserve in eastern Swaziland Big Game Parks. The park camp is off-grid and served by 18 X 24V 160 W solar panels connected to 24 X 2V solar cells with a 3kw inverter and 60A solar regulator.

The solar arrays are turned manually several times a day to make maximum use of available sunlight. Their inclination is also adjustable to follow the winter sun low on the horizon, and the summer sun with a steep arc.

The energy produced is used in the camp office to run computers, fridge and lights.

In addition Big Game Parks uses two smaller three-panel systems that provide the home energy requirements for the camp managers at Hlane and Stone Camp, Mkhaya. They use many small one-panel systems at Hlane and Mkhaya that keep VHF radio base stations operating, charge batteries for hand-held VHF radios and provide current for power-fencing systems at Hlane and Mkhaya. Four 140ℓ solar water heaters are used at Hlane Game Reserve and Mkhaya Game Reserve in guest accommodation units.

2.3.4 EDUCATION

Secondary education is divided into two sub-levels: three years of junior secondary and two years of high school. The primary level of schooling lasts for seven years, normally for children aged between six and 13 years, at the end of which children write an external examination set by the Examinations Council of Swaziland (ECOS). The results are used to select children to enter into the junior secondary level. An external examination set by ECOS at the end of junior secondary is written by candidates who wish to qualify to enter high school. From 2007, O-levels were replaced by the Cambridge International General Certificate Secondary Examination (IGCSE), which is a four-year secondary programme. There is another one-year Higher (HIGCSE) or advanced level curriculum for those who qualify to enter. Subject curricula at secondary level are being locally adapted so that new Swaziland (HIGCSE) may be offered in secondary schools.

High school students who qualify to enter tertiary institutions normally go for teacher education in teacher training colleges for a two to three year Certificate to Diploma programme. Some enrol in a technology college for a two to three year Certificate to Diploma programme. Some enter the University of Swaziland for a continuing programme of two more years (from teacher training or technology college), or for a four or five-year degree programme.

Administration of the education system lies with the office of the Minister of Education, who presides over a National Education Board. The Board serves as an advisory board to the Minister. At the district level, a District Advisory Board advises the National Education Board on education matters in that district. At the school level, the Principal Secretary, with the approval of the Minister, establishes a school committee in each school, which looks after the affairs of the school and advises the District Education Advisory Board on matters relating to management or conduct of a school. The Principal Secretary also appoints an Inspector of Schools to ensure proper standards. Schools are inspected by separate inspectors at both the primary and secondary level, and then by a subject inspector. These inspectors observe and listen to the concerns of heads of schools and departments, regarding their development and teaching and learning concerns, and assist in finding solutions. Analysis of reports by inspectors did not form part of this study.

Within the school, the day-to-day management is in the hands of the head teacher and his/her administrative team. Depending on the size of enrolment in a school, one deputy head (per 400 pupils) or more might be entrusted by the head teacher to take on differentiated responsibilities, such as academic or administrative. A head of department is normally appointed when there are four or more teachers in that department. A head of department is the immediate supervisor of a teacher, and has the responsibility of seeing to the teaching and learning needs of the teachers and pupils.

The Teaching Service Commission (2009) reported a total of 7,368 teachers at primary level and 5,086 teachers at secondary level, with shortages of 233 in primary and 518 in secondary government schools. Teacher shortages have arisen because of a shortage of qualified teachers, especially at primary level.

The overall pupil to class ratio was higher at primary level (33:1) than in the secondary level (19:1).

A clear relationship between education and poverty was reported in both the 1995 and 2001 Swaziland Household Income and Expenditure Survey (SHIES) and in recent years the country has taken huge strides towards achieving universal primary education. More steps are required if this crucial development objective is to be achieved.

The net enrolment ratio which is the number of children that are of official primary school-age and enrolled in primary school over the total population of children of official primary school-age, has improved from 79.2% in 2000 to 86.7% in 2007. This widening of access began in 2002 with the introduction of the Orphaned and Vulnerable Children (OVC) initiative. This scheme involves the Government of Swaziland providing bursaries to OVC in order to make school more affordable for them. The launch of the State Funded Primary Education Programme for grades 1 and 2, which saw the government absorb the financial costs of education for these grades. Preliminary data suggests this has led to a significant increase in enrolment, with the number of children in grades 1 and 2 increasing by over 10,000 in 2010.

The proportion of children who started grade 1 and reached grade 7, having not repeated more than twice, has improved from a figure of 71.1% in 2000 to 78.5% in 2007.

The literacy rate of 15 to 24 year olds also termed the youth literacy rate is the percentage of the population aged 15 to 24 that can read and write with understanding a short simple statement in any language. This indicator has risen steadily over the past two decades. It increased from 83.7% in 1986 to 91.7% in 1997 before further improving to around 95.5% in 2007.

2.4 MACRO-ECONOMIC PERFORMANCE

2.4.1 ECONOMIC PERFORMANCE

2.4.1.1 ECONOMIC DEVELOPMENT

Economically Swaziland is highly dependent on South Africa, not only is the Swazi Emalangeni pegged to the South African Rand but South Africa accounts for 90% of Swaziland's imports, 60% of its exports, and 80% of its electricity. Most importantly the Southern Africa Customs Union (SACU) accounts on average for 60% of total government annual revenue.

2.4.1.2 ECONOMIC INDICATORS

The trends of key economic indicators over the period 1999-2009 are shown in Table 7. The economy witnessed rapid growth from the early 1970s to the early 1990s, however after the emergence of South Africa from economic isolation and relocation of investments from Swaziland to South Africa, the economic performance has deteriorated. Gross Domestic Product (GDP) grew by an annual average of 7.6% in the decade 1968-1978 and 5.8% in the period 1979-1989. In the period 1990-2000 the rate declined to 3.4% with the downward trend continuing. After a temporary growth from 2003 till 2007, the expansion of economic activity again lost momentum, with growth dropping to 1.2% in 2009 and negative projection for 2010 (CBS, 2010).

Table 7: Key Economic Indicators (1999-2009)

Indicator	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Real GDP (Factor Cost) E'm at 2000 prices	8,535	8,689	8,791	8,964	9,174	9,436	9,683	10,012	10,365	10,612	10,740
Real GDP growth (%)	2.2	1.8	1.2	1.8	2.2	2.9	2.5	3.3	3.5	2.4	1.2
GDP per Capita E	9,676	10,544	11,324	12,220	12,972	14,154	14,590	17,418	21,126	24,277	25,836
Inflation (%)	5.9	7.3	7.5	11.7	7.4	3.4	4.8	5.3	8.1	12.6	7.5
External Debt E'm	1,964	2,710	3,498	3,031	2,742	2,733	2,750	3,077	3,393	4,135	3,327
Debt Service (% GDP)	1.9	1.8	1.6	2.1	2.0	2.3	1.5	1.6	1.4	1.8	2.1
Stock of foreign direct investment (FDI) E'm	3,423	4,057	4,302	5,248	4,787	5,238	4,972	5,764	6,056	5,043	5,971
GDP at market prices (nominal) E'm	9,457	10,580	11,661	12,904	14,025	15,636	16,433	19,962	21,515	24,947	26,788

Source: GOS-CSO & MOF, CBS

In 2011, the Government launched the Economic Recovery Strategy as a way of spearheading multi-faceted initiatives for economic recovery. This came in the midst of pressure from international organizations such as the International Monetary Fund (IMF) to put in place measures to address the economic and financial problems. However, a further decline of GPD to 0.7% is projected for 2012 (from 2.0% in 2010 and 1.3% in 2011). The levels of growth are not likely to improve quickly until drastic measures for economic recovery are put into place.

Although consumer inflation dropped in 2010 to a relative low of 4.5% (from 7.5% in 2009), there has been a steady increase till 8% at the end of 2011. Pressure on households' access to basic commodities is increasingly becoming difficult.

2.4.1.3 ECONOMIC OUTLOOK

The financial outlook for 2009/10 indicated a budget deficit of E1.28 billion or 5% of GDP. Estimates for 2010/11 indicate a worsening position with the overall budget deficit projected to reach E3.65 billion or 13% of GDP (CBS, 2009 & 2010). The negative turnaround in the fiscal position is a result of a 62% fall in SACU receipts totalling E2.0 billion in 2010/11 compared with E5.2 billion received in 2009/10. Total revenue is projected at E6.6 billion indicating a massive decline of 31% from the previous year's budget. The financial situation has lead to 14% cuts in line ministries' budgets, with the exception of health and education which continue to increase in both relative and absolute terms. Analysis shows that the government's wage bill is the main factor behind the growth in recurrent expenditure, accounting for 48% of total recurrent expenditure.

Table 8: Percentage Sector Contribution to GDP at Basic Prices (2003-2009)

Sector	2003	2004	2005	2006	2007	2008	2009
Agriculture, hunting, forestry and fishing	11.7	11.0	11.3	10.7	10.5	10.4	10.0
Mining and quarrying	0.3	0.3	0.2	0.2	0.1	0.1	0.1
Manufacturing	38.5	37.8	37.1	36.4	36.1	35.8	34.3
Electricity, gas and water supply	1.2	1.2	1.2	1.2	1.2	1.2	1.3
Construction	3.6	4.1	4.2	4.0	4.0	3.8	3.6
Wholesale, retail, hotel and restaurants	8.9	9.4	10.0	10.8	11.5	11.7	12.2
Transport and communication	8.0	8.3	9.2	9.4	9.4	9.8	10.2
Financial intermediation	3.5	3.5	3.5	3.6	3.6	3.6	3.8
Real estates and renting	6.9	6.8	6.7	6.7	6.7	6.9	7.0
Public administration	17.0	17.1	16.0	16.3	16.5	16.4	17.1
Other community and social activities	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total value added	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: GOS-CSO & MOF, CBS

Sector contributions to GDP over the period 2003-09 are presented in Table 8. It shows that there is a gradual but continuing decrease of the contribution from traditional sectors such as agriculture and manufacturing. Nevertheless, to the extent that a large portion of the manufacturing sector is agro-based (mainly sugar, wood pulp and citrus canning), the base of the economy is therefore still agricultural. A meaningful diversification of economic activity areas is necessarily desirable if the country is to reduce its level of vulnerability due to over reliance on climate-sensitive sectors. The value of exports is indicated in Table 9.

Table 9: Value of Domestic Exports by Product (E' million)

	2005	2006	2007	2008
Sugar	1,471	1,901	2,088	2,442
Citrus Fruits	96	117	163	145
Canned Fruit	150	193	212	236
Cotton	7	3	3	3
Meat and Meat products	17	22	26	53
Woodpulp	593	824	685	530
Coal	63	120	103	119
Textiles	1,024	916	954	1,031
Miscellaneous Edibles	3,634	3,757	4,038	4,220
Other	3,351	3,408	4,023	4,180
TOTAL	**10,407**	**11,260**	**12,293**	**12,958**

Source CBS & CSO

2.4.2 GOVERNMENT DEVELOPMENT FRAMEWORK

The primary elements of the national medium- to long-term development framework are the National Development Strategy (NDS) (GOS, 1999) and the Poverty Reduction Strategy and Action Programme (PRSAP) (GOS-MEPD, 2007). All other policies and strategies reflect the vision expressed in the NDS. The NDS covers the period till 2022, the PRSAP till 2015. The PRSAP aims at facilitating sustainable economic growth and poverty reduction through (a) macro-economic stability; (b) good governance; (c) equitable access to productive assets; (d) human capital development; (e) a policy and regulatory climate which stimulates the private sector in order to accelerate job creation, business development and income-generating opportunities; (f) rural development to stimulate agricultural and other non-agricultural activities; and (g) provision of infrastructure, extension services, technology, markets, social services, and financial services.

Swaziland ratified the three Rio Conventions: United Nations Convention on Biological Diversity (UNCBD) (1994); United Nations Convention to Combat Desertification (UNCCD) (1996); United Nations Framework Convention on Climate Change (UNFCCC) (1996). Swaziland has also ratified other important conventions: Convention on the International Trade in Endangered Species of Wild Fauna and Flora (1997); Vienna Convention for the Protection of the Ozone Layer (2005); Montreal Protocol on Substances that Deplete the Ozone Layer (2005); Basel Convention on the Transboundary Movements of Hazardous Wastes and their Disposal (2005); Stockholm Convention on Persistent Organic Pollutants (2006); Cartagena Protocol on Biosafety to Convention on Biological Diversity (2006); Kyoto Protocol (2006).

The Rio Conventions led to the development of the Swaziland Environmental Action Plan (GOS-SEA, 1997) and the Biodiversity Strategy and Action Plan (2001, draft). The Swaziland Environment Authority Act (1992) established the Swaziland Environment Authority (SEA) a parastatal that has the responsibility to protect the environment. Important related sector policies that have been developed include: the National Environment Policy (1999, draft), National Energy Policy (GOS-MNRE, 2002), National Forest Policy (GOS-MOAC, 2002), Solid Waste Management Strategy (GOS-SEA, 2003), Water Policy (draft, GOS-MNRE, 2007), Biodiversity Conservation and Management Policy (draft, GOS-SEA, 2008). Legislation includes the Waste Regulations of 2000, the Flora Protection Act of 2001, the Water Act of 2003, the Disaster Management Act of 2006, the Environment Management Act of 2002, the Biosafety Bill (2006, draft), the Forest Bill (2010, draft), the Biodiversity Conservation and Management Bill (2008, draft) the Water Pollution Control Regulations (2010) and the Air Pollution Control Regulations (2010).

Food security and nutrition-related policies that have been formulated, but not all yet adopted, include the Comprehensive Agricultural Sector Policy; the Food Security Policy; the National Disaster Management Policy that aims to prevent or reduce the impact of disasters on vulnerable communities and groups; and the Swaziland Food and Nutrition Policy (in draft).

The revised National Health Policy (GOS, 2007) addresses the health sector response to the growing disease burden by providing preventive services that are of high quality, relevant, accessible, affordable, equitable and socially acceptable. Several other complementary policies that address the various facets of human development are in place. They include the National Multi-sectoral HIV and AIDS Policy (2006), National Social Welfare Policy (2008), National Youth Policy (2008) and the Orphaned and vulnerable Children Policy (2007). The National Social Development Policy, in particular, provides a framework for improving the quality of life or human well-being through the provision of appropriate social welfare services that are developmental in nature. At the level of Gender Equality, the Constitution, which is an overarching commitment by government, guarantees equal rights between men and women. With the support of the UN system, the country has developed a Gender Policy (UNCT, 2010).

2.5 SOCIO-ECONOMIC CIRCUMSTANCE

2.5.1.1 SOCIO-ECONOMIC INDICATORS

Despite a relatively high per capita income of $5,708 (IMF, 2010), giving it a ranking of 106 out of 181 countries, Swaziland is categorized as a lower middle income country, as it faces socio-economic challenges akin to a least developed country. These include pervasive poverty, high HIV infection rates, environmental fragility exacerbated by climate change, weak governance institutions, gender inequality, and capacity constraints at institutional and human levels. Growth declined from 8% per year during the 1980s, to around 3.5% in 2008, which is below the 5% estimated minimum required growth to impact poverty reduction. To substantially reduce poverty and put the country on a sound footing to achieve the Millennium Development Goals by 2015, much higher growth rates are needed (UNDP, 2010).

According to the Poverty Reduction Strategy and Action Programme (GOS, 2008), 69% of the population live in poverty (less than $1 US income per day). Food insecurity is high, with 25-50% of the population dependent on food aid. According to SHIES (GOS, 2001), 56% of wealth is held by the richest 20% while the poorest 20% own less than 5%. Income distribution remains highly skewed, with an overall Gini coefficient of 0.51. Income inequality of this magnitude is one of the major contributory factors to the high poverty level in the country. Swaziland's target under the MDGs is to half the income inequality from 51% in 2001 to 25% in 2015 (UNCT, 2010).

According to 2007 Population Census (GOS-CSO, 2010) unemployment went up to 40.6% from 22.8% in 1997. Out of the 335,000 economically active people only 199,000 are employed. Unemployment is higher with women than with men (47.4% vs 33.6%). At regional levels Manzini is lowest with 35% and Shiselweni highest with 57%. Youth unemployment (ages 15-24) is three times higher compared with any other age groups.

Swaziland achieved steady progress in its development indices since independence, increasing its Human Development Index (HDI) to a peak in 1995, followed by a decline and relative low in 2005 (141st position among 171 countries ranked), but again followed by a modest rise till 2010 (121st position) (UNDP, 2010a) (see Table 10).

Table 10: Human Development Index (1990-2010)

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010
HDI	0.511	0.523	0.490	0.474	0.477	0.482	0.487	0.492	0.498

Source: UNDP, 2010a.

2.5.1.2 HOUSEHOLD LIVELIHOODS

The rural households' livelihoods are derived from a wide range of activities that are carried-out by different households in different food economy zones, including remittances, food production, small businesses, petty trade wages and salary, which form part of their survival means. The Swaziland Vulnerability Assessment and Analysis (GOS-VAC, 2012) reveals that the most common livelihood mean for households in rural areas is formal salary and or wages, which accounts for almost 20 percent, followed by food crop production and sales at 14 percent, which ties up with small businesses, mainly informal and subsistence in nature. Many households in the rural areas highly depend on remittances as their main source of livelihood at 13 percent, followed by pension at 11 percent and petty trade at 10 percent.

Further according to Vulnerability Assessment 2012, households reported that they did experience shocks that caused a major impact on their livelihoods and food security. About 42% of the households reported that high prices for food affected them, in particular those in peri-urban zones (67%) followed by households in the

Lowveld (52%). Both the peri-urban and Lowveld zones did not produce enough crops and rely heavily on food purchase. The second major shock 23% of the households reported is drought or prolonged dry-spells.

With respect to food consumption score, rural households in Swaziland have on average an adequate consumption score at 84 percent across all the regions, highest in Manzini region (89%) and lowest in Hhohho region (80%).

The 2012 Vulnerability Assessment (GOS-VAC, 2012) revealed that households face food challenges at different months of the consumption period. Food availability and access is relative good during the harvesting period (May to August). Households begin to experience serious food difficulties from August up to April. 32% of rural households reported to have challenges with food access and availability and increasing so as the consumption period progressed. The number facing a livelihoods and cash deficit ranges from about 98,000 to 116,000, being highest for the inflation and no food aid scenario.

2.5.1.3 MILLENNIUM DEVELOPMENT GOALS

Table 11 show a selected overview of Swaziland's progress towards achieving Millennium Development Goals (GOS-MEPD, 2010). Out of the 8 MDGs Swaziland can potentially still meet 5 goals, but meeting either of these will require significant effort over the next few years. However, if some MDGs cannot be completely achieved, there is still the potential to at least achieve part of the goal, as indicated in the table. Unfortunately, Swaziland must not only turn around deteriorating trends in most MDGs but it has significantly less resources in order to do so.

Table 11: Swaziland's Progress towards Achieving MDGs

GOALS / TARGET	WILL THE GOAL / TARGET BE MET
1 ERADICATE EXTREME POVERTY AND HUNGER	***Unlikely***
Halve, between 1990 and 2015, the proportion of people whose income is less than one dollar a day	Unlikely
Halve, between 1990 and 2015, the proportion of people who suffer from hunger	Unlikely
2 ACHIEVE UNIVERSAL PRIMARY EDUCATION	***Potentially***
Ensure, by 2015, that all boys and girls will be able to complete a full course of primary schooling	Potentially
3 PROMOTE GENDER EQUALITY AND EMPOWER WOMEN	***Potentially***
Eliminate gender disparity in primary and secondary education preferably by 2005 and in all levels of education by 2015	Potentially
4 REDUCE CHILD MORTALITY	***Unlikely***
Reduce by two-thirds, between 1990 and 2015, the under-five mortality rate	Unlikely
5 IMPROVE MATERNAL HEALTH	***Unlikely***
Reduce by three-quarters, between 1990 and 2015, the maternal mortality ratio	Unlikely
Achieve by 2015 universal access to reproductive health	Potentially
6 COMBAT HIV/AIDS, MALARIA AND OTHER DISEASES	***Unlikely***
Have halted by 2015 and begun to reverse the spread of HIV/AIDS	Potentially
Achieve by 2010, universal access to treatment for HIV/AIDS for all those who need it.	Potentially
Have halted by 2015 and begun to reverse the incidence of malaria	Likely
Have halted by 2015 and begun to reverse the incidence of tuberculosis	Unlikely
7 ENSURE ENVIRONMENTAL SUSTAINABILITY	***Potentially***
Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources	Potentially
Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation	Potentially
8 DEVELOP A GLOBAL PARTNERSHIP FOR DEVELOPMENT	***Unlikely***
Develop further an open, rule-based, predictable, non-discriminatory trading and financial system	Potentially
In co-operation with developing countries, develop and implement strategies for decent and productive work for youth	Potentially
In co-operation with the private sector, make available the benefits of new technologies, especially information and communications	Unlikely

Source: GOS-MEPD, 2010: Swaziland Millennium Development Goals Progress Report

2.6 STATE OF ENVIRONMENT REPORTING

State of Environment reporting has been a legal requirement in Swaziland since 2002 with the passing of the Environmental Management Act.

Since 2002, environmental legislation mandates the preparation and tabling of a national state of the environment report in Parliament through the Environmental Management Act 2002 (PART IV - INTEGRATED ENVIRONMENTAL MANAGEMENT):

29. (1) The Minister shall within two years of the entry into force of this Act, and every two years thereafter, publish a State of the Environment Report.

(2) The State of the Environment Report shall provide information on the environment in Swaziland and, in particular, on the quality of the environment, and without limiting its generality, shall:

1. describe the quality of the rural and urban environment and the results of environmental quality monitoring programmes;

2. describe any significant adverse effects that have been caused, are being caused and are likely to be caused in the foreseeable future, and where possible identify the causes and trends;

3. indicate the number and nature of the licences issued under the Act and describe how the licensing system is being implemented in order to improve environmental protection, and where applicable, indicate the type and/or quantity or characteristics of pollutants which may lawfully be discharged under these licences in a particular area, and whether, and to what degree this has increased or decreased;

4. describe the monitoring, enforcement and other measures which have been, and are being taken to address the causes of the adverse effects and to improve environmental quality;

5. list all charges laid and convictions entered for contraventions of this Act;

6. with respect to international agreements and negotiations relating to the environment of Swaziland, the regional or the global environment:

a. report on all agreements to which Swaziland is a party, and on their domestic implementation;

b. report on negotiations in which Swaziland has participated since the previous State of the Environment Report; and

c. list all relevant agreements to which Swaziland is not a party and all relevant negotiations in which Swaziland has not participated since the previous State of the Environment Report.

2.7 SWAZILAND'S INTERNATIONAL REPORTING OBLIGATIONS

Swaziland's membership of international organisations also brings with it reporting obligations for various aspects of the condition of the Swazi environment. Swaziland is a member of key international organisations and signatory to many international agreements.

Organisations include:

- Southern African Development Community
- United Nations Environment Programme
- World Meteorological Organization

Swaziland has signed and ratified several international environmental conventions and agreements.

The most important are the three Rio Conventions, which were ratified in 1994 and 1996:

- United Nations Convention on Biological Diversity (UNCBD) (1994)
- United Nations Convention to Combat Desertification (UNCCD) (1996)
- United Nations Framework Convention on Climate Change (UNFCCC) (1996).

Implementation of the commitments and obligations outlined within these UN Conventions has been delegated to the Swaziland Environment Authority. The SEA is responsible for ensuring that national obligations under the UN Conventions are met with the Director of the SEA acknowledged as providing a key link between Swaziland and the international community on environmental issues.

Other important international environmental conventions, protocols and treaties ratified (with year of ratification) by Swaziland include:

- Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on their Destruction (1996)
- Convention on the International Trade in Endangered Species of Wild Fauna and Flora (1997)
- Vienna Convention for the Protection of the Ozone Layer (2005)
- Montreal Protocol on Substances that Deplete the Ozone Layer (2005)
- Basel Convention on the Transboundary Movements of Hazardous Wastes and their Disposal (2005)
- Stockholm Convention on Persistent Organic Pollutants (2006)
- Cartagena Protocol on Biosafety to Convention on Biological Diversity (2006)
- Convention Concerning the Protection of the World Cultural and Natural Heritage (2006)
- Kyoto Protocol (2006)
- Convention on Wetlands of International Importance especially as Waterfowl Habitat – Ramsar Convention (2010)

Other important international conventions and treaties signed but not ratified by Swaziland include:

- Convention on the Conservation of Migratory Species of Wild Animals
- African Convention on the Conservation of Nature and Natural Resources (1968)
- Cooperation Enforcement Operations Directed at Illegal Trade in Wild Fauna and Flora (the
- Lusaka Agreement) (1996)
- The General Transfrontier Conservation and Resource Area Protocol (2000)
- The Lubombo Conservancy-Goba Transfrontier Conservation Area Protocol (2000).

Swaziland has also signed several SADC environmental protocols:

- Protocol on Shared Watercourse Systems (1998)
- Protocol on Energy (1998)
- Protocol on Mining (2000)
- Protocol on Wildlife Conservation and Law Enforcement MOU on Cooperation in Standardisation, Quality (2003)
- Revised Protocol on Shared Watercourses (2003)
- Protocol on Fisheries (2003)
- Protocol on Forestry (2002)
- Declaration on Agriculture and Food Security (2004)

2.8 DPSIR APPROACH

2.8.1 INTEGRATED ENVIRONMENTAL ASSESSMENT: DPSIR FRAMEWORK METHODOLOGY

The DPSIR framework has been widely adopted as a basic tool in the development of strategies for Integrated Environmental Assessment. The DPSIR framework, which distinguished driving forces, pressures, states, impacts and responses, is commonly used by countries in the preparation of State of Environment Reports. However, there no is generally accepted DPSIR format and the application and interpretation of the DPSIR framework varies considerably between users.

The framework is seen as giving a structure within which to present the indicators needed to enable feedback to policy makers on environmental quality and the resulting impact of the political choices made, or to be made in the future (Kristensen, 2004).

According to the DPSIR framework there is a chain of causal links starting with 'driving forces' (economic sectors, human activities) through 'pressures' (emissions, waste) to 'states' (physical, chemical and biological) and 'impacts' on ecosystems, human health and functions, eventually leading to political 'responses' (prioritisation, target setting, indicators). Describing the causal chain from driving forces to impacts and responses is a complex task, and tends to be broken down into sub-tasks, e.g. by considering the pressure-state relationship.

Driving Forces. A 'driving force' is a need. Examples of primary driving forces for an individual are the need for shelter, food and water, while examples of secondary driving forces are the need for mobility, entertainment and culture. For an industrial sector a driving force could be the need to be profitable and to produce at low costs, while for a nation a driving force could be the need to keep unemployment levels low. In a macroeconomic context, production or consumption processes are structured according to economic sectors (e.g. agriculture, energy, industry, transport, households).

Indicators for driving forces describe the social, demographic and economic developments in societies and the corresponding changes in lifestyles, overall levels of consumption and production patterns.

Pressures. Driving forces lead to human activities such as transportation or food production, i.e. result in meeting a need. These human activities exert 'pressures' on the environment, as a result of production or consumption processes, which can be divided into three main types: (i) excessive use of environmental resources, (ii) changes in land use, and (iii) emissions (of chemicals, waste, radiation, noise) to air, water and soil.

Indicators for pressure describe the changes in land use, the use of environmental resources (ecosystems, water, etc), and the production of waste and other pollution as a negative result of these human activities

States. As a result of pressures, the 'state' of the environment is affected; that is, the quality of the various environmental compartments (air, water, soil, etc.) in relation to the functions that these compartments fulfill. The 'state of the environment' is thus the combination of the physical, chemical and biological conditions.

Indicators for state of environment describe the quality of land and soil, water, air and biodiversity (ecosystems) resulting from these pressures, at various levels of abstraction and geographic subdivision.

Impacts. The changes in the physical, chemical or biological state of the environment determine the quality of ecosystems and the welfare of human beings. In other words changes in the state may have environmental or economic 'impacts' on the functioning of ecosystems, their life supporting abilities, and ultimately on human health and on the economic and social performance of society.

Indicators for impacts describe the effects which the environment al changes have on the functioning of important systems or conditions, such as ecosystems, climate, water circulation, economic circumstances and human health and well-being.

Responses. A 'response' by society or policy makers is the result of an undesired impact and can affect any part of the chain between driving forces and impacts.

Indicators for responses describe the actions which are taken collectively or individually to ease or prevent negative environmental impacts, correct environmental damage or conserve natural resources, which may include regulatory action, research, management changes, provision of information, etc.

2.8.2 ENVIRONMENTAL INDICATORS

In preparation for the SOER, a selection of State of Environment Reports (SOERs) from a variety of countries have been consulted, as well as separate reports on the definition and use of environmental indicators. In most cases environmental indicators were specifically defined for application in SOERs, with or without the incorporation of the DPSIR framework. In other cases environmental indicators or sustainability indicators were defined for a more general application (UNDP, 2007; UNSD, 2010; UNEP, 2010; OEDC, 2004; RSA-DEA, 2009).

Over the past ten years, the Republic of South Africa has followed the DPSIR framework and has defined several sets of indicators which contain elements useful for application in the Swaziland SOE reporting. Other consulted SOERs include those of Australia, India, Zambia, Ruanda and New Zealand.

When examining the above mentioned reports and studies, it became clear that the description of the elements of the DPSIR framework in these reports differed widely in detail and accuracy of description. Although key words could easily be identified, full descriptions and detailed definitions of indicators were often unsatisfactory or missing altogether.

Swaziland had already developed several reports selecting and defining environmental indicators using the DPSIR framework and these reports proved useful for the development of the current Swaziland SOER. However, it should be noted that, although the already developed indicators might be very useful and applicable to the Swaziland environment, there was no guarantee that the data required to inform the indicator were available or could be located.

During the course of preparing this SOER, a range of environmental indicators linked to a number of environmental themes and issues to assist has been developed, with the aim to quantify or describe as accurately as possible the state or any other aspect of a particular theme or issue. Environmental indicators are normally linked to one, or sometimes two, specific aspects of an environmental theme or issue. These aspects are linked to the DPSIR framework and most environmental indicators thus relate to e.g. pressure, state or impact rather than to the overall theme or issue.

The environmental indicators which are presented in the text can be classified in various categories, namely:

1. Environmental Indicators for which the required information is readily available and which can be currently applied.
2. Environmental Indicators for which the required information is only partially available or recorded at too few moments in time.
3. Environmental Indicators which one would like to use (the ideal one), for which, however, the required information is not readily available and hence cannot be currently applied.

Many of the EI info for this SOER falls under the second group, and most handicaps are of a temporal nature.

3 ENVIRONMENTAL THEMES

This chapter systematically describes the state of environment following a sequence of environmental themes namely:

Theme 1: LAND, incorporating Land Use and Land Use Change, Soil Erosion and Land Degradation, Forests and Woodlands

Theme 2: WATER, covering Water Quantity and Water Quality

Theme 3: ATMOSPHERE, including Air Quality, Climate and Climate Change, Natural Disasters, Stratospheric Ozone

Theme 4: BIODIVERSITY, covering Change of Biodiversity and Ecosystems, Protection & Conservation,

Theme 5: HUMAN DEVELOPMENT, including Urbanisation, Energy, Waste Management, Health

Each theme and subdivision of theme is described, assessed and analysed following the same methodology, namely the DPSIR approach (Driving Force, Pressure, State, Impact, and Response).

3.1 THEME 1: LAND

Theme 1: LAND is subdivided into three sub-themes: (1) Land Use and Land Use Change, (2) Soil Erosion and Land Degradation, and (3) Forests and Woodlands.

3.1.1 LAND USE AND LAND USE CHANGE

Short statement regarding Land Use and Land Use Change (LULUCF): LULUCF activities are critical for achieving the overall objective of the UNFCCC to avoid ''dangerous interference'' with the global climate system. As reflected in the provisions of UNFCCC, this will require the application of policies that ''cover all relevant sources, sinks and reservoirs of greenhouse gases" (UNFCCC 1992, Article 3.3). The Convention addresses five sectors considered as sources of anthropogenic emissions: industrial processes, energy, agriculture, waste and LULUCF.

3.1.1.1 DRIVING FORCE

The main driving force behind land use is population growth linked with an increasing need for shelter, food and water. Population growth figures and demographic trends are given in Chapter 1. The need for food has grown concurrently, together with distinct dietary changes. Food is produced through agricultural practices. Secondary driving forces exist because of the demand for other commodities from other production uses (see also section 3.1.2 on land degradation).

3.1.1.1.1 ENVIRONMENTAL INDICATORS: DRIVING FORCE AFFECTING LAND USE CHANGE

Environmental indicators measuring the driving forces behind land use include:

Indicator	Measurement	Source	Availability/Reliability
Population growth rate	%	CSO	available every 10yrs
Urban growth rate	%	MHUD	available
Macro-Economic development (including trade)	GDP growth rate & GDP per capita	CBS (annual report)	available
Food production	tonnes/area (ha)	MOA (VAC)	available every 2yrs
Energy consumption	% growth	MNRE Energy Dept	available

3.1.1.2 PRESSURE

Pressures on the environment as a result of the driving forces from the increasing population have led to land use changes. These occur in different ways, from subtle modification of ecosystems as a result of increased extraction of goods to more drastic changes of the land through clearing of natural land and converting to crop, animal and other production.

Land use changes in Swaziland are not recorded in a systematic or comprehensive manner. Limited and specific statistical data are recorded annually within certain sectors such as agriculture. In other sectors such as forestry only few ad hoc inventories have been made. Just one comprehensive national land use inventory has been conducted, in 1994. A few land cover inventories have been made, as part of Southern African exercises, also on an ad hoc basis.

Comprehensive, consistent and reliable land use data are very difficult to obtain and compare, in particular due to land use and land cover categories using different definitions (GOS/FAO, 1994a; GOS-MOAC, 2006; GOS-CSO, 1900-2004; CBS Annual Reports 1995-2009; FAO/GOS-MOAC, 2006). From these combined existing data a number of trends in land use changes could be estimated and constructed. Table 12 provides a summary overview of land use changes and conversion that were estimated to have taken place from 1990 to 2010. As the original data were sourced from land cover and direct land use inventories, the different categories used had to be correlated: Land Use categories industrial forestry plus ranching plus extensive communal grazing plus conservation equate to Land Cover categories forest, woodland, savanna, bushland, grassland. Ecosystems equal ranching plus extensive communal grazing plus conservation.

Table 12: Estimated and Projected Land Use Changes and Conversions (1990-2010)

LAND USE CATEGORY	1990	2000	2010	1990-2010 Change ha/annum (linear)
Industrial Forestry large scale	135,000	121,000	107,000	-1,400
Plantation Forestry small scale, mainly wattle	26,000	28,000	30,000	200
Ranching	340,000	349,000	344,000	200
Extensive Communal Grazing	860,000	898,000	916,000	2,800
Conservation, Parks	58,000	69,000	84,000	1,300
Crop Agriculture Irrigated	45,000	57,000	71,000	1,300
Crop Agriculture small scale rainfed	210,000	150,000	110,000	-5,000
Crop Agriculture large scale rainfed	50,000	30,000	20,000	-1,500
Residential/Industrial	8,000	12,000	16,000	400
Dams	4,000	8,000	12,000	400
Not classified (unaccounted for & balance)	0,000	14,000	28,000	1,450
Total	1736,000	1736,000	1736,000	

Main Sources: GOS/FAO, 1994a (with some minor modifications to accommodate wattle); GOS-MOAC, 2006; GOS-CSO, 1900-2004; CBS Annual Reports 1995-2009; SSA Annual Reports 2000-08; FAO/GOS-MOAC, 2006; GOS-MOA, 2008; FAO, 2010. Most figures rounded off, extreme values eliminated, if needed averaged for nearest 2-4 years, extrapolated for 2010

Most essential with respect to the environment is the change from natural land to one of the production land uses. Ecosystem conversion has been estimated at 2,000 ha per annum which is a permanent loss of ecosystems as it is lost to a land use which is radically different and based on complete clearing of the vegetation. There is some compensation by adding a higher status of conservation through conversions from ranching to nature conservation, but this does not lead to any increase of area.

Until about 1990 an increasing proportion of land was converted to crop land, either rainfed or irrigated, however from the beginning of the 1990, probably triggered by the great drought of 1991/92, this has stopped with respect to rainfed cropping and a reverse process has started as an increasing proportion of rainfed arable land has since been abandoned. The process took place on both SNL and TDL, at both small scale communal and large scale commercial farms and fields. The commercial decrease is largely related to the quick decline in cotton production in the 1990s, the communal desertion is somewhat slower and more gradual.

This abandoned land is largely used for grazing, with a very low management level on communal land and a better management on private land (mainly ranching). What is taking place on such land is a gradual regeneration of vegetation. In most cases this starts with establishment of often dense shrub vegetation of typical invaders such as *Acacia nilotica* or *Dichrostachys cinerea*. With time this may become more varied with regard to grass and woody species and eventually it may again become part of the prevailing ecosystem again, although in modified form. Table 13 shows the main conversions as described above.

Table 13: Main Sectoral and Sub-sectoral Land Conversions (1990-2020)

Old category	New category	1990-2010 Change ha/annum (linear)
Ecosystem (grazing largely)	Irrigated agriculture, residential, dams	2,000
Crop agriculture	Grazing (ranching and communal) (minor irrigation)	6,500

Ranching	Nature conservation (minor irrigation)	1,000
Industrial forestry	In reserve (destination not clear)	1,400

Sources: same as previous table

In terms of expected trends for the next decade 2010-20, ecosystem conversion is expected to probably increase again, crop agriculture conversion to grazing (and eventually partially back to the ecosystem) to continue to decrease, and grazing (ranching) to conservation is expected to remain the same or perhaps increase. The conclusion is that ecosystems continue to lose, however with some compensation by ranching land converted to conservation and also some gradual conversion back from abandoned agricultural crop land.

3.1.1.2.1 ENVIRONMENTAL INDICATORS: PRESSURE ON LAND USE

Indicators for pressure in this section describe the changes in land use. Other related indicators such as on the use of environmental resources (ecosystems, water, etc) are discussed in following sections.

The following conversions, or land use changes (LUCs), would provide most useful environmental indicators (see Table 14):

1. LUC: permanent loss of ecosystem, i.e. conversion to other land use under total clearing; in ha/ annum per ecosystem and total;
2. LUC: conversion to protected area (PA) or conserved land; in ha/ annum per conservation category and total;
3. LUC: abandonment of arable and gradual conversion to nature land (rangeland) and eventually to ecosystem; in ha/annum.

Table 14: Environmental Indicators: Land Use Change from and to Ecosystem & Protection

Environmental Indicator	1990 (1985-1995) Change ha/annum (linear)	2000 (1995-2005) Change ha/annum (linear)	2010 (2005-2015) Change ha/annum (linear)
1. Permanent ecosystem loss	3,000	2,000	3,000
2. LUC to protected & conserved area	0,500	1,500	1,000
3. LUC agric crop to grazing/ecosystem	2,000	7,000	3,000

Sources: same as previous table

A reliable and regularly information base is required for the proposed indicators for pressure. Similar indicators are also needed for describing the State of Land: see next section on State where further details are discussed with respect to the required data sources.[6]

Environmental indicators measuring the pressure behind land use change include:

Indicator	Measurement	Source	Availability/Reliability
LUC: permanent loss of ecosystem	%	SNTC/SEA	outdated
LUC: conversion to protected area (PA) or conserved land	% & ha	SNTC	available & reliable
LUC: abandonment of arable and gradual conversion to nature land	% & ha	MOA	not available

3.1.1.3 STATE

The State of Environment with respect to land use is described through tabular and spatial (quantitative) information on the current land use baseline, focusing on the quality of the land and its condition. Up-to-date and repetitive (at least every 5 years) *National Land Cover Maps based on satellite imagery interpretation* probably provides the best qualitative and quantitative estimate of the current land conditions. More detailed descriptions of the proportion and state of land which is degraded or affected by *desertification* is given in the

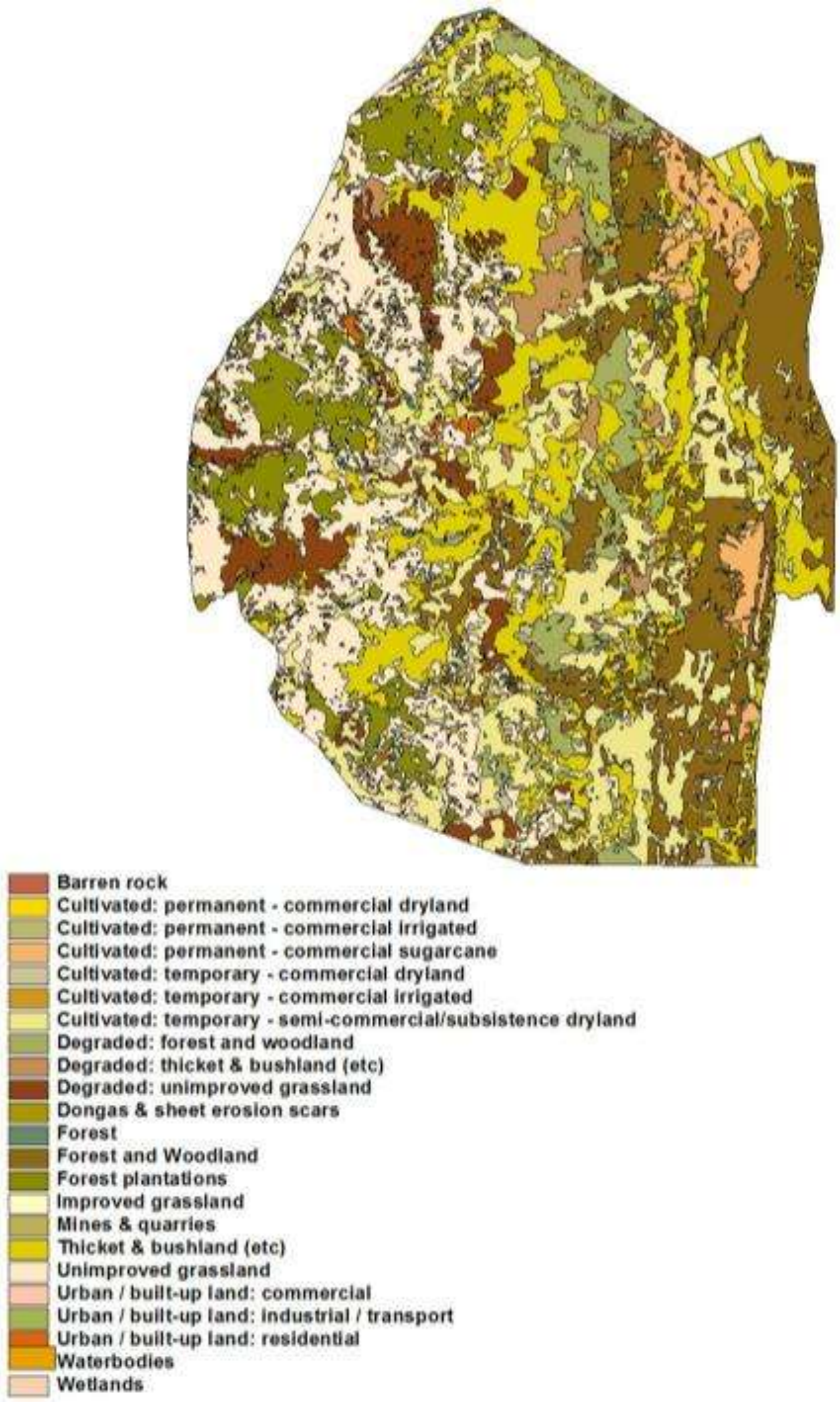
[6] A critical note is to be made: the question here is that these suggested trends are based on few data, which is partly quantified and partly estimated and hence not sufficiently reliable. This type of information can currently not be produced on a repetitive basis (annually, every 5 years). Only few conversions are recorded annually, e.g. into irrigated land.

next section. Of particular importance is the ratio natural land versus agricultural and other human influenced production land. The Land Cover indicator can be linked to the Biodiversity and Human Influence theme.

The periodic recording of Land Cover and Land Cover changes with an agreed and permanent legend facilitates the monitoring of land cover and land use changes. Minimal requirement is recording every five years but in fact updates could easily take place on an annual basis. Although currently there is inadequate and insufficient data available, this is fairly simply remedied since there is a lot of experience available in the sub-region and investments are not required.[7]

[7] Assistance in setting up a land cover facility should be easily obtained through SADC or from RSA where a wealth of data (imagery) is available, which also covers Swaziland. 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 since the 1970s.Spatial data can be obtained from the National Land Cover (NLC) Database – compiled by the ARC, CSIR, DEA&T, DWAF, NDA and SANDF. The land-cover classes mapped within the South African NLC are based on those defined within the 'Standard Land-Cover Classification for Remote Sensing Applications in South Africa' (Thompson, 1996).

Figure 8: Land Cover Map of Swaziland



Source: CSIR, 2000. National Land Cover

This indicator will track changes in land cover by type of land cover class (the proportion of each region covered by forests, wood shrubs and grasses and other categories compared with a baseline figure). This indicator will update the change in structural vegetation forms within land cover regions. The indicator provides data on changes in vegetation structural form over time which will affect carbon and nitrogen cycling, litter and organic matter build-up and loss from soils, wetting and drying of soil and hydrological regimes, as well as relationships between decomposers and consumers.

The land cover inventory and classification based on satellite imagery available in Swaziland and providing useful information in connection with land use and forestry was derived from the National Land Cover 2000 Project implemented by the CSIR South Africa (CSIR, 2000) (see Figure 8).[8]

3.1.1.3.1 ENVIRONMENTAL INDICATORS: STATE OF LAND AND LAND USE

There is a need for a reliable Environmental Indicator measuring the state of land use including narrative information on the current state of land cover and land use. In a National Land Cover Analysis exercise, land use changes would be interpreted from land cover data together with field checks.

Indicator	Measurement	Source	Availability/Reliability
Land Cover and Land Cover changes	type (category) and % (ha)	MNRE (Surveyor General) & MOA (Land Use)	not available

3.1.1.4 IMPACT

Change of land use includes environmental changes, notably in the size and quality of natural ecosystems. The impact from changes in the state of the environment determines the quality of ecosystems and the welfare of human beings. The functioning of ecosystems is directly linked with their life supporting abilities, and ultimately on human health and performance of society.

3.1.1.4.1 ENVIRONMENTAL INDICATORS: IMPACT OF LAND USE CHANGE

Environmental indicators measuring the impact of land use should include:

Indicator	Measurement	Source	Availability/Reliability
Ecosystem goods and services	% change (type, volume, value)	SNTC / UNISWA	not available
Health conditions	% change in number of illnesses related to environment	Min Health	available to some extent

Changes in ecosystem functions (good & services) are recorded mainly as reductions in absolute and relative sense. For details on impacts on changes in ecosystem functions and services reference is made to the sections on land degradation and biodiversity. Health conditions related to environment are described in the section on Human Health.

3.1.1.5 RESPONSE

The systemic and institutional response to the impacts of land use change has been rather limited in recent years.

3.1.1.5.1 SYSTEMIC RESPONSE

Systemic response with respect to regulating land use and land use changes has resulted in sections in a number of policies and pieces of legislation, addressing the issue of land use change and planning. However, a comprehensive land policy still needs to be drafted and endorsed (see also section 3.1.2 on land degradation).

3.1.1.5.2 INSTITUTIONAL RESPONSE

The Land Planning Section (Ministry of Agriculture) was established in 1968 and has a mandate to guide the utilisation of land and water resources. Its mission is to rationalise land resource utilisation for sustainability of future generations. The main objectives of this section are to ensure that land is utilised optimally for its most suitable use and that land is rationally and sustainably utilised.

[8] A recurrent problem with the various land cover, forest and vegetation inventories executed in Swaziland is the lack of standardisation in defining mapping units and legends as well as in the method of mapping. This makes comparison and evaluation difficult and forms a constraint in the interpretation of vulnerability to climate change.

From 1992 till 1998 the Land Planning Section received institutional and logistic support from two subsequent UNDP/FAO projects which resulted in a number of outputs providing a land use planning base. The results of the first project entitled Land Use Planning for Rational Utilization of Land and Water Resources included the agro-ecological zoning of the country (GOS-FAO, 1994) and national mapping of the physiography (landscapes) (Remmelzwaal, 1993), land tenure (Remmelzwaal and Vilakati, 1994) and land use (Remmelzwaal and Dlamini, 1994) as well as various other reports (FAO/UNDP/GOS, 1993-5). The second project named Improving Land Use on Swazi Nation Land specifically focused on the application of the land use planning base which *i.a.* resulted in a Land Use Plan of Ezulwini Valley and adjacent areas (Remmelzwaal, 1998). For other outputs see also the section 3.1.2 on land degradation.

The Land Planning section has continued to produce land use plans, however mostly on a small scale, mostly on community or Tinkhundla level. Integrated land resources management supported by land use plans should form the basis for sustainable land use planning in Swaziland. Important and practical measures, such as data collection and monitoring have to be included on a routine basis.

3.1.1.5.3 ENVIRONMENTAL INDICATORS: RESPONSE TO LAND USE CHANGE

Environmental indicators measuring the response of land use change should include:

Indicator	Measurement	Source	Availability/Reliability
Integrated land resources management	% of land covered	MOA, MNRE	available
Land use plans	number of plans implemented	MOA	available
Land policy	available and endorsed	MOA	not available

3.1.2 SOIL EROSION AND LAND DEGRADATION

Soil erosion and land degradation are recognised as serious problems in Swaziland and form a critical issue for continued sustainable social and economic development and poverty alleviation. The most conspicuous form of land degradation in Swaziland is soil erosion, in particular gully erosion, however also degradation of landscapes, natural vegetation and forests is widely encountered.

Poor management and overgrazing has caused severe human-induced erosion and generally moderate to poor grazing conditions. Almost a third of the country and more than half of all communal grazing land has a serious or very serious erosion status. Certain types of forests are reported to degrade and showing a decrease in regeneration. Climate change is expected to have a further negative effect on land degradation through reduction of vegetation cover and changes in species composition, as well as through increased deforestation, desertification and disaster hazards. Pollution of soil and water is another environment degrading factor.

3.1.2.1 DRIVING FORCE

The driving forces behind soil erosion and land degradation are in fact the same which have led to land use changes (see previous section on land use), namely an increasing population and need for commodities, notably food. Food is produced in Swaziland as well as imported.

Agricultural development in Swaziland aims at increasing animal and crop production, which goes at the expense of natural land. Agriculture occupies by far the largest area of production systems and plays the major role in erosion and land degradation; other activities such as mining and industry are relatively minor but do have an effect on land degradation.

3.1.2.1.1 ENVIRONMENTAL INDICATORS: DRIVING FORCES BEHIND LAND DEGRADATION

Suitable environmental indicators can be selected from agricultural activities that have an impact on the environment. For other production uses such as mining and industry so far no suitable indicators have been identified.

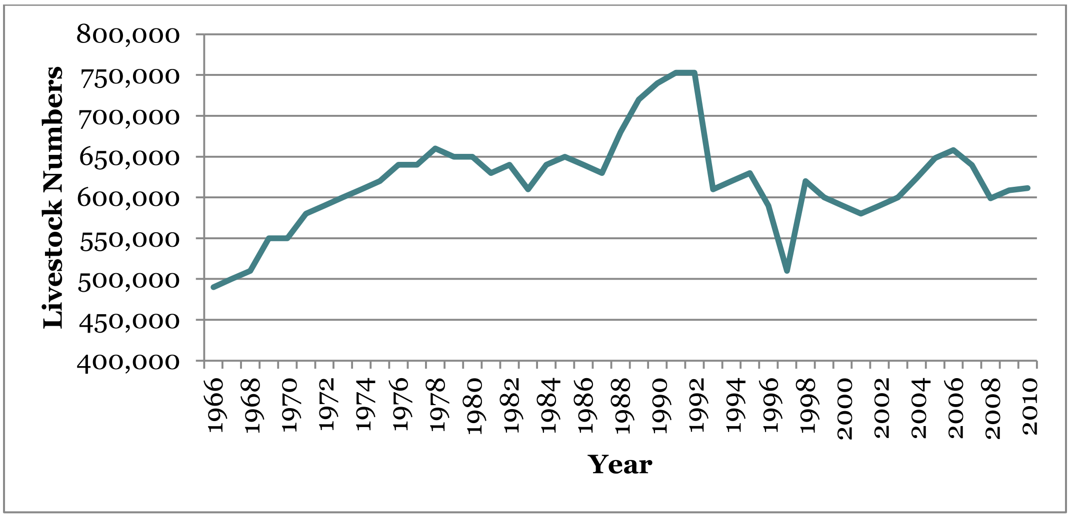
Although in theory there is a wide choice of indicators available from production systems that would indicate production trends in certain sectors, in practice there are not that many that yield a consistent and reliable record and are relevant to factors that affect the environment, such as land use change and interference of livestock grazing with the ecosystems.

The selected environmental indicators with a reliable and sufficiently long record are cattle, maize and sugar production, representing animal and crop production.

Most important and constant of livestock development in Swaziland is cattle. Maize is the most characteristic subsistence crop, but shows an irregular production pattern because as a rainfed crop it is prone to drought. Irrigated agriculture is not influenced by drought and sugarcane is the dominant and well documented commercial crop in Swaziland.

Environmental Indicator for Animal Production: total number of cattle and numbers slaughtered. Cattle are the main livestock; other animal species raised in Swaziland are goats, sheep, pigs, equines and poultry. The contribution of the livestock sub-sector to the agricultural sector GDP is about 4%. Beef and other livestock products contribute about 1% to total exports. In Swaziland there are two broad livestock production systems, namely the commercial system and the traditional system. The traditional SNL sector manages about 86% of cattle and 95% of small stock whereas the commercial TDL system carries the rest; the stocking rate on SNL is two times larger than on TDL. Figure 9shows the development over the past 45 years of the cattle population, which is the largest component of the country's livestock industry. The record shows a gradual and constant increase reaching an absolute peak of 753,000 in 1992, followed by a decrease to around 600,00, mainly as a result of drought, unsustainable management and increasingly degraded rangelands. The development after 2003 shows an upward trend till a relative peak of 658,000 in 2006, followed by again a downward trend to around 600,000 (CBS, 2011). Table 15 shows recent cattle population figures, including numbers slaughtered and deaths. The mortality rate (% death) in recent years has been around 4%.

Figure 9: Cattle Population (1966-2010)



Source: GOS-Central Statistical Office 1975-2010, CBS, 2011 (based onAnnual Statistical Bulletins; Annual Agriculture Surveys)

Table 15: Cattle Population, Slaughtered and Deaths (2003-2010)

Year	Population	Slaughtered	Deaths
2003	600,252	31,377	35,698
2004	623,712	15,803	21,575
2005	648,250	41,892	24,869
2006	657,860	42,743	25,560
2007	639,718	39,339	23,882
2008	598,890	28,155	24,146
2009	608,538	18,454	28,612
2010	611,581	33,317	21,405

Source: CSO, CBS, 2011

Environmental Indicator for Subsistence Crop Production: Production of maize. Maize production over the period 2002-2010 has dropped to an average 60,000 t/annum from 110,000 Mt/annum over 1995-2000, with fluctuating yields from 0.6 to 1.6 t/ha. Although the statistical record shows inconsistencies, data suggest that the SNL area planted to maize has decreased from levels of 70-80,000 ha in the 1980s to around 60,000 ha in 1990s and around 50,000 ha as from 2003 (Table 16) (GOS-CSO, 2004; FAO/WFP, 2008; CBS, 2011).

Table 16: Production of Maize on SNL (2000-2010)

Year	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10
Area (ha 000)	69	58	68	68	54	56	47	47	60	52	58
Yield (t)	113	83	68	69	68	75	67	26	60	71	75
Yield/Ha	1.6	1.4	1.0	1.0	1.3	1.4	1.4	0.6	1.0	1.4	1.3

Source: CSO, CBS 2011

Agricultural development in the future will depend on a number of factors which include: (1) the impact of HIV/AIDS on agricultural development, (2) effects of drought and climate change, (3) government commitment to invest in the sector, (4) availability of an agricultural policy and efficient action plan, (5) improvements in agricultural practices such as ploughing and weeding, (6) improvements in range management and animal production, and (7) improvements in marketing and credit (FAO/GOS-MOAC, 2006).

Environmental Indicator for Commercial Crop Production: Production of sugarcane/sugar and area covered. Sugar is the most important agricultural produce of Swaziland and the area under sugarcane has continuously increased since the sixties. In 2004 the milestone of 50,000 ha under irrigated sugarcane was achieved, together with reaching a production of sugarcane of 5 million t and 600,000 t of sugar. Total sugar production of the season 2009/2010 was 606,000 t. All sugarcane is processed in Swaziland and sugar products form a very important export commodity.

Environmental indicators measuring the driving forces behind land degradation include:

Indicator	Measurement	Source	Availability/Reliability
Changes in population	%	CSO	available every 10yrs
Animal production (represented by cattle)	numbers total and slaughtered	MOA	available with delay
Crop production (represented by maize)	area cultivated & yield total & yield per ha	MOA (VAC)	available with delay
Production of sugarcane	area cultivated, cane yields and sugar produced	SSA	available and reliable

3.1.2.2 PRESSURE

The driving forces of population growth and the corresponding production and consumption exert pressures on the environment. After the land use change described in the previous section, this section describes the over-exploitation of resources, resulting in overgrazing, erosion and land degradation with accompanying emissions consisting of chemicals, waste, leading to air, water and soil pollution.

The pressures that have led to soil erosion and degradation of the environment are primarily related to poor and unsustainable management rather than to the production itself. Over-exploitation of resources has occurred as a result of unsustainable farming and grazing practices, in particular high grazing densities on communal rangeland.

There are several categories of emissions related to land degradation, mainly of chemicals and GHG. These chemicals originate from agricultural and industrial practices (see previous section), largely from the commercial sector, which remain behind in the soil or are drained by water (see theme water). Methane from livestock can be monitored as a GHG (see theme atmosphere).

Pressures from unsustainable management practices in agriculture and other sectors such as forestry, mining, industry and road construction have led to the degradation and depletion of soil resources in Swaziland. Chemical, biological and physical degradation appears through loss of nutrients, trace elements, organic matter, soil flora and fauna, soil structure etc. It may also become apparent through concentration of substances such as salts, acids, heavy metals and other toxic elements, from mining, waste disposal, use of fertilizers and pesticides, dipping chemicals, irrigation, leaf litter from plantations or acid rain. Soil compaction is a degradation phenomenon caused by machinery and cattle traffic, reducing permeability and water holding capacity.

Climate change is an emerging pressure on land and land conditions and is expected to contribute to land degradation in Swaziland. Projected impacts from selected global climate models show a westward shift and shrinking of the current ecosystems of Swaziland and replacement by a very dry type of ecosystem in the eastern part of the country. Aspects of climate change are further discussed under pressure on Biodiversity (section 3.4.2) and the main section on Climate Change (section 3.3.2) under the theme Atmosphere.

The effects of the pressures have an influence on the state of environment and may impact on ecosystems, human health and on the economy (see section under impacts).

3.1.2.2.1 CAUSES OF LAND DEGRADATION

The over-exploitation and unsustainable management of natural resources has been going on for many decades resulting in a steadily degrading environment and declining ecosystem goods and services and loss of many species of plant and animal. Shortcomings in land management and governance are the principal causes that have led to the degradation. These causes are interrelated and include:

- Lack of a national land policy providing the overarching umbrella for sustainable land management
- Lack of enforcement of existing legislation
- Inappropriate or unsustainable land use practices (traffic to dip tanks, low off take, etc)
- Poor environmental awareness and planning
- Inadequate services
- Land tenure system (SNL versus TDL)/ Property rights/ Land access and ownership
- Lack of accountability, in particular on SNL (erosion of no consequence to farmers)
- Conflicts/competition over control of land & natural resources
- Lack of capacity for integrated land use planning and landscape management

Furthermore, climate change as a cause may further degrade soil, land and other natural resource conditions and intensify desertification.

Under the 2005 Constitution, all people have equal access and rights to land. The pressure on land is driven by the growing population and the demand for more land for competing land uses, e.g. agriculture and residential in peri-urban areas, forestry and grazing in the Highveld, transport, tourism, sugarcane and biodiversity conservation in the Lowveld. Mechanisms of land allocation and administration as well as the prevailing land tenure system are not adequate to appropriately deal with the multifaceted physical planning, which is exacerbated by poor chiefdom demarcation and disputes.

Appropriate and sustainable land use planning is critical for sustainable development. Since independence Swaziland has faced many challenges in allocating appropriate land use mostly derived from the traditional chiefs lack of capacity and support to undertake land use planning within their catchments when allocating various forms of land use, e.g. settlements, agriculture, infrastructure. Ad hoc and unplanned land conversions to accommodate commercial agriculture and plantation timber have contributed towards the fragmentation of habitats and biodiversity loss.

The capacity of most stakeholders (private, communities, and local authorities) in integrated landscape management (with conservation, ecotourism, enhancement of carbon stocks and SLM) is insufficient.

3.1.2.2.2 ENVIRONMENTAL INDICATORS: PRESSURE LEADING TO EROSION AND LAND DEGRADATION

Indicators for pressure on land leading to erosion and land degradation describe the excessive use of environmental resources and the production of waste and other pollution as a negative result of these human activities.

The most important indicators relate to overgrazing by livestock and resulting range degradation, expressed grazing densities quality.

Other recommended indicators indicating waste and pollution may include agricultural pesticides and herbicides (total and per unit of agricultural land area) and fertilisers (total and per unit of agricultural land area). Indicators for waste and pollution are also given in the sections on Water, Air Quality and Waste.

The proposed environmental indicator on POPs is internationally recommended: Total annual sales of persistent organic pollutants (POPs) – reported as annual volumes sold for each of the twelve POPs that are listed in the Stockholm Convention on Persistent Organic Pollutants.

Environmental indicators measuring the pressure on land leading to erosion and land degradation should include:

Indicator	Measurement	Source	Availability/Reliability
Overgrazing by livestock	grazing densities (numbers/ha)	MOA	AVAILABLE WITH DELAY
Range degradation	grazing quality (descriptive)	MOA	available with delay
Use of agricultural pesticides & herbicides	totals per type and per unit of agricultural land area	MOA	available with delay
Use of fertilisers	totals per type and per unit of agricultural land area	MOA	available with delay
Total annual sales of persistent organic pollutants (POPs)	quantity	SEA	available and reliable

3.1.2.3 STATE

The overall state is described by quality of soil and land. The quality of the land is affected by processes that resulted from the pressures which emanated from changed land uses. The current state of the land is best indicated by a quantitative description and assessment of the part of the land affected by human induced soil erosion and land degradation.

3.1.2.3.1 OVERVIEW OF EROSION AND DEGRADATION

The section provides a brief introduction to soil erosion and land degradation and a short summary of the status of erosion and land degradation in Swaziland.[9]

In studying and describing erosion, a distinction should be made between natural or geological erosion and human-induced or accelerated erosion. Geological erosion is a normal and natural process in landscape development which is controlled by factors such as relief and erosion base, rainfall and soil erodibility and normally shows a balance with the vegetation cover. Accelerated erosion caused by human activity disturbs this balance and leads to increasing the rate and expansion of erosion, without allowing recovery of surface conditions and vegetation.

Different methods of erosion and land degradation assessment can produce very different results in the severity and distribution of degradation phenomena. The three main options of assessing accelerated or human-induced erosion and land degradation are:

1. the risk at which it may occur (erosion risk, erosion hazard or potential erosion)
2. the rate at which it is occurring (the erosion rate or soil loss)
3. the present status of its appearance (the actual erosion).

All three types of investigations have been applied in Swaziland, however with mixed results. The results of several standard erosion hazard mapping methods were not comparable and showed poor correlation with actual erosion classes determined from surveys. Overall, erosion hazard methods were unsuccessful to quantify the rate of erosion and of little value in realistically assessing erosion risk (JICA/ECS, 1999).There have been some attempts to actually measure erosion rates or soil loss, but not with any conclusive results.

An overview of the third type of investigation, the status of the actual erosion, is presented in a comprehensive land degradation study carried out by JICA/ECS (1999). The study shows that the results of the various studies and surveys described are rather inconsistent and sometimes conflicting, in particular when solely based on air photo or satellite interpretation or study of single phenomena only. The study observes that all of the appraised studies agree on the extreme increase of erosion and degradation in the past 20-40 years, coinciding with the increase in cattle numbers, quoted as the number one cause of the problem. The data most reliable to indicate the status of actual erosion are those based on the actual erosion and land degradation assessment (AELDA) (Jansen et al, 1994), the only comprehensive method applied according to the JICA study. This method takes into account a comprehensive set of erosion parameters and combines extensive field recordings with air photo and satellite imagery interpretation.

[9] Overviews are available from a number of reports including Remmelzwaal and McDermott (1997), JICA/ECS (1999), GOS-MOAC (1998) and GOS-MOAC (2000). The two latter reports refer to the first National Action Programme (NAP) submitted to UNCCD and the Analysis and Assessment of the Swaziland National Action Programme to Combat Desertification respectively.

Table 17 shows the erosion status of the agro-ecological zones and the communal rangelands of Swaziland in percentages land affected by serious or very serious erosion (Remmelzwaal and McDermott, 1997). The estimates here are summarized for each of the Agro-ecological Zones (AEZ), however full data are available for the AEZ subdivision into 101 AE units of the country.

Table 17: Erosion Status and Range Conditions of AEZ and Communal Rangelands

Agroecological Zone	**Erosion Status AEZ**	**Status Communal Rangelands**			
	% Serious & Very Serious Erosion	**% of AEZ**	**% Serious & Very Erosion Status**	**% Poor Range Conditions**	**Expected Change of Erosion/Degradation Rate**
Highveld	30	57	55	40	increasing/same
Upper Middleveld	50	67	80	70	increasing
Lower Middleveld	20	54	40	25	same/increasing
Western Lowveld	10	37	30	60	same/increasing
Eastern Lowveld	5	32	10	40	same
Lebombo Range	5	54	10	5	same
Country	**30**	**50**	**55**	**45**	**increasing/same**

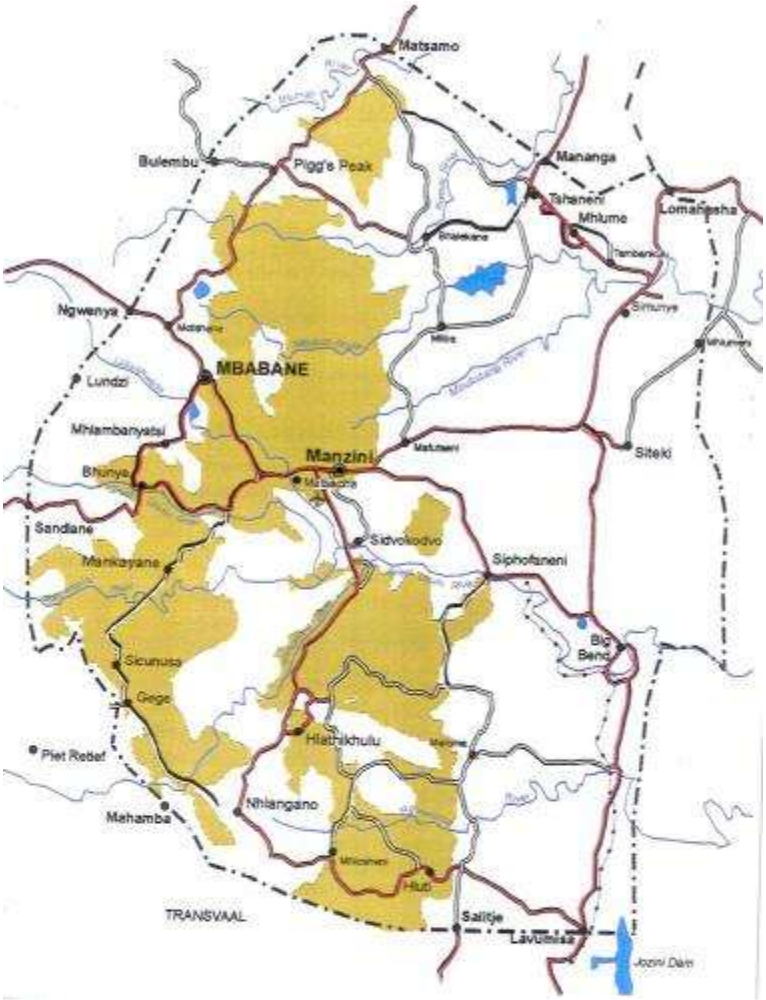
(Source: Remmelzwaal and McDermott, 1997; range conditions estimated by Sweet and Khumalo, 1994)

The type of data as included in AELDA seems most useful for application as Environmental Indicator; however periodic AELDA surveys have not taken place since.

The erosion status relates to soil and terrain conditions, whereas the range degradation takes into account the vegetation cover and composition. The degradation of the rangelands does not necessarily coincide with the overall erosion status; however the high proportion of poor range conditions in the Western and Eastern Lowveld can be linked with the Dryland qualification of these zones, the Middleveld and Highveld being more humid. Figure 10 shows the spatial distribution of land with a serious or very serious status of erosion.

Other aspects of erosion and degradation include rangeland degradation, bush encroachment and invasive alien plant species IAPS. Range conditions were systematically described in 1994 (Sweet and Khumalo) using the AEZ framework (see above Table 17). Bush encroachment was mapped in 1997 (Manyatsi, 1997) and appeared to be largely concentrated on private (TDL) farms in Lowveld and Lower Middleveld. Results of recent IAPS programmes and survey are discussed under the Theme Biodiversity (section 3.4.2.3).

Figure 10: Spatial Distribution of Serious and Very Serious Erosion



Source: JICA/ECS, 1999 (Original Data from Remmelzwaal/FAO 1994)

3.1.2.3.2 ENVIRONMENTAL INDICATORS: STATE OF SOIL AND LAND

The proposed main Environmental Indicator corresponds with the set-up in South Africa where indicator is linked to reporting requirements (NAP) to the United Nations Convention to Combat Desertification, involving a rapid appraisal of land degradation in the country and defining four classes of degradation. The results of the survey form the basis for the Environmental Indicator, which reports on changes in land degradation per type of land unit.[10]

A similar survey action had taken place in Swaziland (Figure 10). Updates can either take place on the basis of repetitive recording of Land Cover data (as recommended in section 3.1.2) but such interpretation need to verified at regular intervals, perhaps every 5 or 10 years, by ground truthing and should involve assessment of actual erosion and land degradation, including the general state of vegetation, and perhaps some other component.

Climate change is a cause for further soil and land degradation, and would contribute to intensifying desertification. A Desertification Indicator can be defined and used for recording the shift of land zones

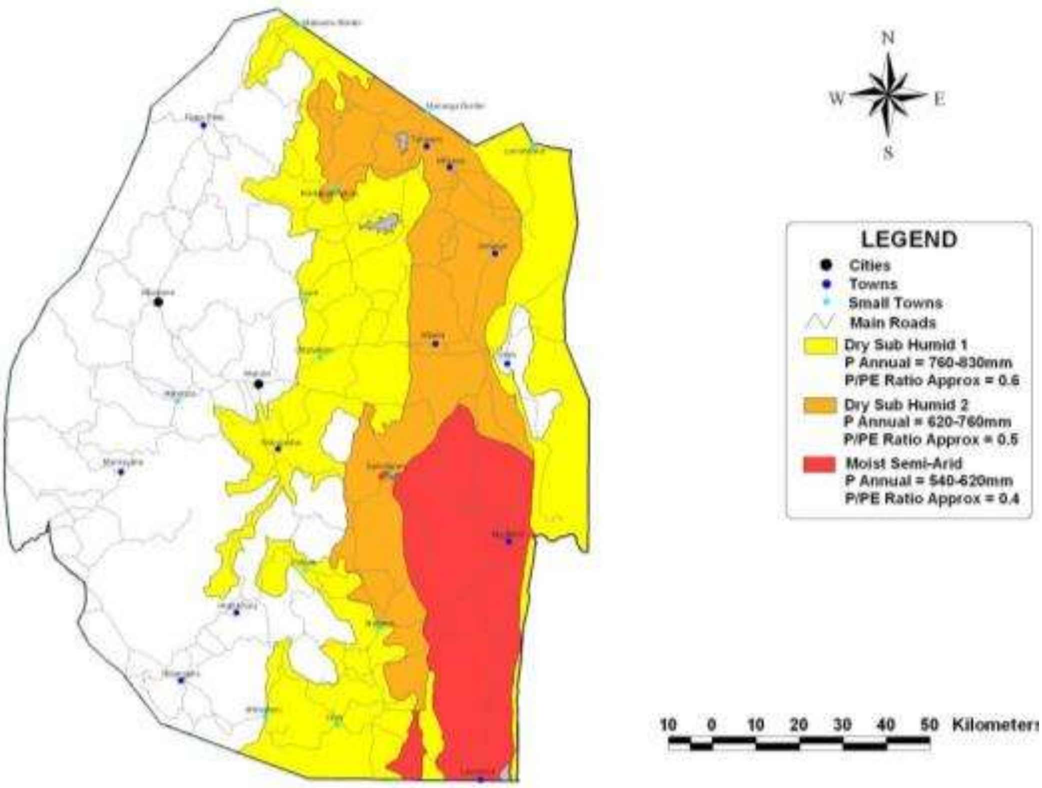
[10] The RSA Environmental Indicator for Land Degradation reports on changes in land degradation per type of land cover. It is related with a corresponding Environmental Indicator for Desertification, which indicator shows the total extent of affected dry land areas (as defined by the UNCCD) over the total area of the country. The Convention defines desertification as "land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors including climatic variation and human activities". Desertification therefore, means "land degradation, loss of soil fertility and structure as well as the erosion of biodiversity in drought prone areas"(UNCCD, 2000). Although land degradation occurs everywhere, it is only defined as desertification when it occurs in dry land areas. Dry land areas are those regions in which the ratio of annual precipitation to potential evapo-transpiration falls within the range of 0.05 to 0.064.

becoming more arid and becoming part of Drylands, by indicating the percentage of land area that falls within the definition of Drylands.

Drylands, as defined by the United Nations Convention to Combat Desertification (UNCCD) comprise land within the arid, semi-arid and dry sub-humid aridity zones of the world. Aridity zones are defined by the Aridity Index, which is the ratio of the precipitation (P) to the potential evapotranspiration (PE); in dryland areas this ratio of P to PE ranges from 0.05 to 0.65.

Drylands are particularly vulnerable to the effects of climate change; hence adaptation is essential in dryland management (GOS/UNDP, 2003). Following the UNCCD definition, drylands in Swaziland cover 944,000 ha or 54% of the country and encompass all of the Lower Middleveld, Eastern and Western Lowveld, as well as parts of the Lubombo Range and Upper Middleveld (Figure 11).

Figure 11: Dryland Zones of Swaziland



Source of map: (GOS/UNDP, 2003)

Table 18 shows the subdivision of the Dryland Zones of Swaziland with the corresponding length of growing period (LGP), precipitation and potential evapotranspiration. The driest zone in Swaziland is the moist semi-arid zone, found in the southern Lowveld. The intermediate dry sub-humid II zone occurs mainly in the northern Lowveld. The most humid part of the Drylands is the dry sub-humid I zone, covering the Lower Middleveld, most of the Lebombo and a small part of the Upper Middleveld.

Table 18: Dryland Zones of Swaziland

Dryland Zone According to CCD Definition	LGP (days)	P (mm)	PE (mm)	P/PE ratio	Area (ha)
Dry sub-humid I	150-179	760-830	1200-1350	0,61 (±0,05)	192,000
Dry sub-humid II	120-149	620-760	1300-1400	0,52 (±0,05)	271,000
Moist semi-arid	100-119	540-620	1300-1400	0,43 (±0,05)	482,000

Source: (GOS/UNDP, 2003)

From land tenure data (Remmelzwaal and Vilakati, 1994) it is estimated that about 54% of the drylands is communal land. Total SNL arable land in the dryland areas in the 1990s was estimated at about 115,000 ha gross (80,000 ha net, corrected for grass strips, infrastructure, homesteads) (GOS/FAO, 1994a), about half the country's total arable land.

Environmental Indicator: Proportion of Eroded and Degraded Land

The indicator should include quantitative estimates and description of trend with details, if possible, on:

- Type and intensity of erosion
- Vegetation degradation
- Soil degradation: chemical and physical degradation; pollution; POPs in soils.

The latter, degradation and depletion of soil resources, is difficult to measure as the causes and effects (see previous section under pressure) are complex and hard to unravel. Soil changes may occur in the state or content of nutrients, trace elements, organic matter, soil flora and fauna, and structure. Pollution in soil and soil water may include salts, acids, heavy metals and other toxic elements, from mining, waste disposal, use of fertilizers and pesticides, dipping chemicals, irrigation etc. *Consistent and coherent Data on soil degradation are most likely not available.*

Environmental Indicator on Desertification: total extent of affected dry land areas (as defined by the UNCCD) over the total area of the country (subdivision: semi-arid and dry sub-humid).

The main actor here to intensify desertification is climate change. There are strong indications that some places in Swaziland have already undergone a substantial rise in temperature, in the order of 3-5 degrees C warmer, which decreases the P/PE ratio (rainfall remaining the same) and gives a shift to a more arid zone.

Other Environmental Indicators related to soil which would be useful however most likely not possible to adequately define and estimate include:

- Soil loss indicator (no comprehensive Swaziland data; very difficult to estimate or quantify)
- Soil salinisation (not useful for Swaziland; local occurrence resulting from irrigation management only)
- Soil acidification (unlikely at large scale over short periods such as 10-30 yrs) industrial forestry and under woodlots, even under gully rehabilitation tree planting (Eucalypt).

Environmental indicators measuring the state of the land in terms of erosion and degradation can include:

Indicator	Measurement	Source	Availability/Reliability
Extent of eroded and degraded land	type, degree and proportion of land unit of measurement	MOA (NAP of CCD)	data outdated (1990s)
Rate of Desertification and definition of Drylands	Aridity Index and % Drylands of Swaziland	MOA	data outdated (1990s
Soil loss	In t/ha; difficult to quantify	UNISWA	not available
Soil salinisation & alkalinisation	EC and ESP (or SAR)	MOA	available in part only – not country-wide
Soil acidification	pH	MOA	indicated by soil maps
Soil pollution	chemical analysis	SEA	not available
Physical soil degradation (loss of structure, compaction)	physical analysis	MAO/SEA	not available

3.1.2.4 IMPACT

The two main impacts resulting from soil erosion and land degradation are on ecosystem goods and services and on human health.

Loss of ecosystem services. The changes in the physical, chemical or biological state of the environment as a result of poor land and natural resources management has impacted on the functioning of ecosystems and the state of human welfare and health. Losses in biodiversity and ecosystem services have resulted in declining livelihoods.

Effects of soil contamination on human health. Contamination of soil and water through improper disposal of waste and improper use of chemicals such as Lindane, Dieldrin, DDT, Gramoxane, Parathion and Malathion is taking place in both urban and rural areas throughout the country, but data on the extent of the contamination are not available. These contaminating substances pose threats to human health.

3.1.2.4.1 ENVIRONMENTAL INDICATORS: IMPACT FROM SOIL EROSION AND LAND DEGRADATION

Environmental indicators measuring the impact of soil erosion and land degradation can include:

Indicator	Measurement	Source	Availability/Reliability
Ecosystem goods and services	% change (type, volume, value)	SNTC / UNISWA	not available
Health conditions	% change in number of illnesses related to environment	Min Health	available to some extent

3.1.2.5 RESPONSE

The response by policy makers and society to address the negative result of the impact from erosion and land degradation includes systemic and institutional aspects.

3.1.2.5.1 SYSTEMIC RESPONSE

The national policy response to land management is linked to the UN Conventions and the Millennium Development Goal 7: Ensure environmental sustainability. The response to land degradation has been to sign and ratify the Convention to Combat Desertification and to prepare the CCD National Action Plan. Countering land degradation is also addressed through policies and strategies such as the Livestock Development Policy (1995), Swaziland Environment Action Plan (1997), Comprehensive Agricultural Sector Policy (2005), National Food Security Policy (2005 draft). However, the most needed policy, a National Land Policy, remains to be endorsed.

3.1.2.5.2 INSTITUTIONAL RESPONSE

The Land Planning Section in MOA is responsible for rational and sustainable land use and addressing land degradation. It is also responsible for drafting and implementing the National Action Plan (NAP) of the Convention to Combat Desertification (CCD).

In the 1990s logistical support was received from UNDP/FAO projects which included mapping and reporting on Actual Erosion and Land Degradation (Jansen et al, 1994) and Sustainable Production and Land Rehabilitation (Remmelzwaal and McDermott, 1997).

The National Action Plan (NAP) of 1998 proposed a strategy to address the primary causes are describes nine priority programme areas:

- Group A: Institutional Arrangements
- Group B: General support, in particular to communities and local leadership
- Group C: Direct support in land management and land rehabilitation
- Group D: Research and technology development
- Group E: Policy support programmes and strategies
- Group F: Risk related support programmes

The GOS have integrated several of these priority areas into national development activities but for the most part they remain under developed and implemented in an ad hoc manner. Reviews of the CCD National Action Plan (NAP) indicated only a limited number of measures taken by government. The NAP implementation is generally not being funded, apart from few interventions by JICA (Improvement of Rural Environment in Degraded Land: 1999, 2003) and the Republic of China (Rehabilitation of Degraded Land). Other government interventions related to land rehabilitation and management remained uncoordinated (EC, 2006).

With the recent establishment of the National Environment Fund a number of erosion and land degradation projects were supported and funded, which resulted in achieving some positive results, such as the sustainable donga rehabilitation at Ngonini and Sihlangwini. Projects currently being implemented include the Gucuka and Zombodze sustainable donga rehabilitation projects.

The Lower Usuthu Smallholder Irrigation Project LUSIP/GEF project is currently being implemented in an area adjacent to the main LUSIP area near Big Bend, with the goal is to contribute to reduce land degradation and protect biodiversity through widespread adoption of sustainable land management practices.

Although systemic capacity with respect to addressing land degradation and introducing sustainable land management is relatively well developed in the country, the corresponding institutional and organization capacity is lagging behind.

3.1.2.5.3 ENVIRONMENTAL INDICATORS: RESPONSE TO SOIL EROSION AND LAND DEGRADATION

Indicators for responses describe the actions which are taken collectively or individually to ease or prevent negative environmental impacts or correct environmental damage.

Environmental indicators measuring the impact of soil erosion and land degradation may include:

Indicator	Measurement	Source	Availability/Reliability
Implementation of CCD National Action Plan (NAP)	successful implementation of projects and programmes	MOA	outdated (NAP currently largely redundant)
National Environment Fund	number of projects successfully implemented	SEA	available and reliable
LUSIP/GEF SLM project	implementation	MOA	not completed (on-going)

3.1.3 FORESTS AND WOODLANDS

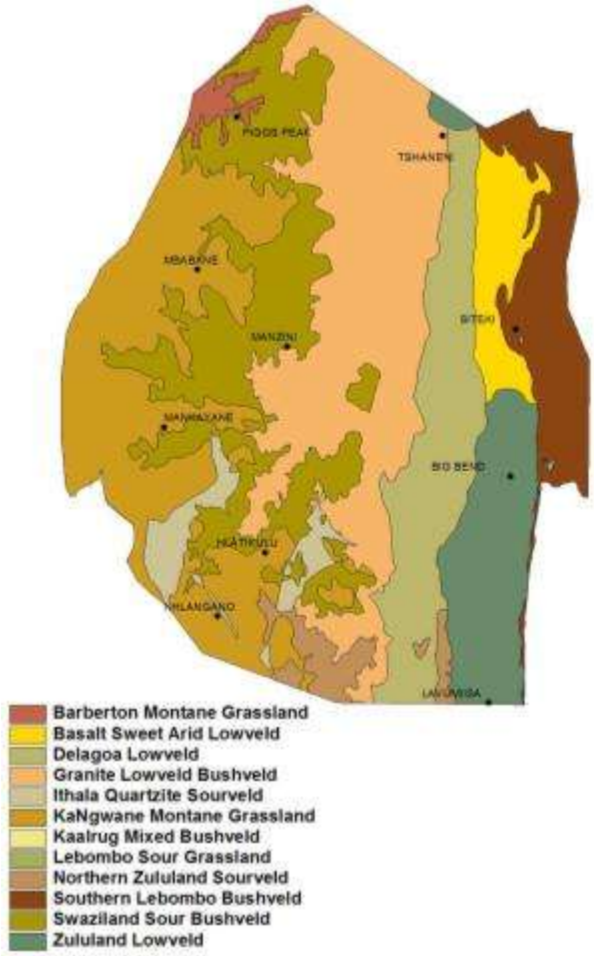
For land cover inventory and classification based on satellite imagery in connection with land use and forestry reference is made to section 3.1.1.3.

This section provides baseline and statistical information on the occurrence of various types of forests and inherent natural vegetation and subsequent modification or degradation. The utilisation of forests and woodland for commercial and non-commercial purposes, as well as the development of industrial forestry is described in Chapter 2.

Several vegetation mapping exercises have been executed over the past 50 years, e.g. by Sweet and Khumalo (1994). The latest vegetation map of Swaziland has been published in the Swaziland Tree Atlas (Dobson and Lotter, 2004) (see Figure 12).

Source: Dobson, L. & Lotter, M., 2004

Figure 12: Vegetation Map of Swaziland



3.1.3.1 DRIVING FORCE

The main driving force behind changes in the coverage and composition of forests and woodlands is the same population growth and need for shelter, food and water as discussed in the previous sections on land use change and land degradation. Secondary driving forces relate to demand for other commodities, *in casu* timber and other commercial tree products but also the need for a variety of timber and non-timber forest products extracted for community forestry uses.

There are two main types of forestry relevant here, namely industrial and community forestry. Industrial forestry is aimed at commercial production, whereas community forestry is largely a subsistence activity, although there is an important element trade. Urban forestry is another small-scale forestry type specifically taking place in urban and peri-urban areas.

3.1.3.1.1 INDUSTRIAL FORESTRY

Swaziland has a large industrial forestry sector, as climatic conditions, particularly in the Highveld, are very conducive for the commercial growing of a specific variety of trees. Trees for commercial production were first planted in 1949, and areas under plantation forest have since steadily expanded till about 1990, covering about 8% of the country. There are two industrial forestry categories of which the first is the large-scale commercial plantation forestry based on pine and eucalyptus production with a high level of management. The other is the wattle (*Acacia mearnsii*) forestry, which started as a small-scale commercial activity (about 2% of total plantation forestry). However, management and distribution of wattle forests have deteriorated over the past years, which have resulted in uncontrolled wattle growth and encroachment of surrounding areas.

The commercially grown plantation species are pine (predominantly *Pinus patula*, but also *P. radiata*, *P. taeda* and *P. elliottii*) and eucalyptus (mainly *Eucalyptus salinga* and *E. grandis*), covering about 80 and 20 percent respectively of the planted area. The productivity is relatively high, about 15-20 m^3/ha per annum for pine.

The main forestry industry players in the country until recently were three South African companies: SAPPI (around Bhunya), Mondi (around Piggs Peak) and Shiselweni Forests. SAPPI owned more than half the plantations in Swaziland and its pulp mill employed about 3000 people directly and indirectly. The trees grown are mainly used to produce unbleached kraft pulp for world markets. SAPPI closed down in January 2010 and the kraft mill, owned and operated by the company, ceased operations. Timber is now being exported directly to mills in South Africa pending the identification of a new investor to take over. The closure was attributed to low prices and lack of raw timber as in 2007 40% of the forest burned down by wild fires (GOS-NMS/SNC, 2010f).

3.1.3.1.2 COMMUNITY FORESTRY

The National Forest Policy of Swaziland (GOS-MOAC, 2002) refers to community forestry as the communal, group and individual participation in the planning, implementation and management of social and economic forestry in the local environment. Community forestry relates to applications such as farm or homestead forestry, agro-forestry, woodlots, and planting and use of trees in conservation, rehabilitation or other rural schemes. It has links with commercial forestry through outgrower schemes on communal land and with urban forestry applied on urban and peri-urban land. Community forestry is also involved with the use and management of natural forests and woodlands as well as with wattle forests within the community boundaries.

Community forestry is currently characterised by a complex setting in terms of land tenure, ownership and user rights, management responsibility and conflict of traditional and modern values. Such issues should be resolved in order to develop community forestry as a self-sustaining activity without reliance on external inputs. In order to develop all aspects of sustainable community forestry, there is an immediate requirement to provide specific services to communities, such as assistance in planning and selection of suitable tree species, provision of seedlings, and training in forest management.

The economic value of annual consumption of main product groups from indigenous forests (foods and drinks, household items, medicinal plants, and fuelwood) was in the 1990s very conservatively estimated at minimally E300 million, medicinal plants accounting for 65% and fuelwood for 28% (FPLP, 2000a). A more realistic current value would be in the order of E1-2 billion, as not all products and services were covered. This indicates the enormous value of non-timber forest product consumption. Benefits are distributed among a large number of the poor rural population. Table 19 gives an overview of the most common groups of non-timber forest products in Swaziland (FPLP, 2000a).

An impact study on the Maguga Dam (Turpie & Albert, 1997- quoted in BSAP, GOS-SEA, 2001) estimated that the total value of aquatic and woodland ecosystem services to the households affected by inundation was between E8 110 and E19 003 per annum. However, when subtracting the mineral resources used from the above, the average annual value was E8070 per household.

Table 19: Main Groups of Non-timber Forest Products in Swaziland

Main Product Group	Description of Use
1. Foods and drinks	Contributing to improve food security & nutritional status in rural communities. High number of species utilised.
2. Household items	Items made from indigenous forests used in all rural households, including kitchen utensils, mats and sweepers.
3. Medicinal plants	Important in primary health care and ceremonies, private use and trade (domestically and exported).
4. Fuelwood	A major source of energy to both rural and urban households. Traded in large amounts throughout the country.
5. Handicrafts	Everyday utensils, also used in traditional ceremonies. Weapons such as sagila. Traded items made for tourists.
6. Fodder & grazing	Primary use of the majority of indigenous forest areas; essential in providing fodder to the country's livestock.
7. Soil conservation	An important function provided by forest and tree vegetation, contributes to maintaining soil fertility.

8. Cultural rituals	Plants used in national ceremonies, bird feathers in traditional head gear. Plants and animals used as indicators.
9. Tourism	Forests and trees provide habitats for animals and plants that attract foreign visitors and generate income.

Source: FPLP (2000a)

The impact of climate change on community forestry cannot be underestimated; there is already evidence that aspects such as regeneration or biomass production and species vulnerability are severely tested.

3.1.3.1.3 ENVIRONMENTAL INDICATORS: DRIVING FORCE BEHIND FOREST AND WOODLAND CHANGE

Environmental indicators measuring the driving forces behind forestry include:

Indicator	Measurement	Source	Availability/Reliability
Changes in population	%	CSO	available
Community extracted timber and non-timber forest products (NTFPs)	description & estimates of volume (ideally the economic value)	Forestry Dept	outdated data
Commercial timber and pulp export	volume and price	Forest Companies	available
Area planted	total ha and % change	Forest Companies & Forestry Dept	available

Table 20 shows the trend of the wood pulp and commercial timber, with comparison to the value of sugar and total exports.

Table 20: Value of Domestic Exports by Product (E' million)

Commodity	2005	2006	2007	2008
Wood pulp	593	824	685	530
Timber				
Sugar	1,471	1,901	2,088	2,442
Total exports	10,407	11,260	12,293	12,958

Source CBS & CSO

3.1.3.2 PRESSURE

These human activities exert 'pressures' on the environment (i) excessive use of environmental resources, (ii) changes in land use, and (iii) emissions (of chemicals, waste, radiation, noise) to air, water and soil.

As already mentioned in section 3.1.1 Land Use Change, the driving forces of population and corresponding consumptive increase have led to LUC from natural forests to other land uses, including industrial forestry plantations. In addition to LUC, the increased demand for forest and wood products has led to increased extraction of these products and has put severe pressure on the forest resources themselves. Apart from extraction, the use also includes grazing, rural settlement and tourism.

Lack of capacity to manage the indigenous forests has led to uncontrolled extraction of timber and non-timber forest products, including fruits, edible plants and vegetables, fuelwood, wood for utensils and craft, medicinal plants, materials for traditional attire, etc.

The result of pressure, accompanied by poor forest management, is a continuing deforestation and forest impoverishment, which means that the natural forest quality is decreasing. The recent strong increase of invasive alien plant species (IAPS) is partly caused by this general forest quantity and quality decrease but the decrease is also further exacerbated by IAPS.

3.1.3.2.1 CAUSES OF DEFORESTATION AND FOREST DEGRADATION

The current deforestation and degradation of the natural forest and woodland areas is caused by a combination of factors such as conversion of land to agriculture and other land uses, uncontrolled extraction of forest products from communal land, large livestock populations and expanding infrastructure development (National Forestry Programme, 2002 draft). The National Forestry Policy of 2002 summarizes the underlying causes and concludes that understanding and addressing the causes forms an essential precondition for the introduction of sustainable forest management. Causes include the following:

- Rapid population growth and pressure on land;
- Poverty and lack of alternative sources of livelihood;
- Inequities in land tenure, access and user rights;
- Lack of influence of stakeholders, in particular women;
- Substitution of forest and woodland by other systems of production and land use;
- Over-exploitation of communal forests & rangelands, including unsustainable extraction of fuelwood and other forest products, partly caused by the high cost of other energy sources (solar, paraffin);
- Inappropriate and uncontrolled burning of forests and rangelands (altered fire regimes);
- Lack of value assigned to forests and forest products;
- Lack of recognition and use of traditional knowledge;
- Lack of capacity to manage forests;
- Illegal trade in forest products;
- Breakdown of traditional leadership and land disputes;
- Inappropriate government policies;
- Poor environmental awareness;
- Poor environmental monitoring;
- Poor enforcement of laws and regulations.

3.1.3.2.2 INDIGENOUS FOREST INCREMENT AND EXTRACTIONS

The balance between increments and wood extractions is an important measure important to determine the status of forest strata in terms of degradation, in this case communal wood extraction from the wattle and indigenous forests. The total volume of wood in indigenous and wattle forests in 1990 was estimated at just over 10 Mm^3. The figure for 1999 was approximately the same. The average standing volume for indigenous forests was 18.5 m^3/ha in 1990, and 15.5 m^3/ha in 1999. The 1999 forest resources assessment (FPLP, 2000) estimated the volume increment per strata to vary between 0.2 m^3/ha for bushveld (lowest) and 8.7 m^3/ha for wattle forest (highest), in average just over 1 m^3/ha. The total annual increment was calculated at 600,000m^3/yr (excluding plantations), almost half coming from wattle.[11]

Annual household fuelwood consumption in Swaziland in the 1990s was generally estimated at between 300,000 to 600,000m^3/yr, constituting 89% of total household energy consumption. The fuelwood comes from indigenous forests and woodlands, including wattle, only to some extent (about 10%) from forest plantations and woodlots.

Lasschuit (1993, 1994) considered the annual wood increment from indigenous and wattle forest insufficient to cover the fuelwood requirement. Using the highest estimate of 600,000m^3/yr and a conversion factor of 0.71 this increment would corresponds to 425,000m^3/yr (Lasschuit, 1993). However, according to Olsen (FPLP, 2000a), such a high converted increment of 425,000 m^3/yr would not support the common perception that deforestation and forest degeneration were widespread problems. Additional wood resources were not taken into the above equation, such as wood collected from plantations and own trees or woodlots. It seems that a general shortage most likely did not occur in the 1990s, however locally it would be possible.

Although there is limited recent spatial and tabular information on extraction and distribution of fuelwood, there are strong indications that the situation by 2010 has dramatically changed from the situation described in the 1990s. The latest population census data (GOS-CSO, 2010) indicate that in 2007 about 53% of the population rely on fuelwood as a primary source of energy. This would constitute a 40% decrease in the use of fuelwood compared to the early 1990s and would bring even the highest estimated extraction under the calculated increment. The figure for fuelwood used in the 2000 GHG inventory (see chapter 2) was 685,000 Kt/yr, which equals 945,000m^3/yr, using the FAO conversion factor of 0.725.

The reason for this decrease may be attributed to the following changes that have taken place in Swaziland over the past 10-15 years: drop of the numbers of cattle (in the order of 20%), significantly reduced population growth, continued migration to urban areas, change in selection of fuel sources, abandoning of arable land,

[11] For comparison, the standing stock of the plantations was estimated at 100 m^3/ha, yielding a total standing volume of 12 mill m^3. The mean annual increment for plantations was estimated at 16 m^3/ha, yielding a total annual increment of plantation forests of 1.96 mill m^3.

and locally improved natural resource management. The combined effect would be a reduced pressure on forest and range resources. When looking at the possible effects of climate change, there might be a dual effect of both increasing biomass production (regrowth) on abandoned land, and decreasing regeneration in some strata or regions.

3.1.3.2.3 ESTIMATES OF DEGRADATION OF NATURAL FORESTS AND WOODLANDS

Degradation of natural forests and woodlands is commonly observed in Swaziland. The 1999 forest resources assessment (FPLP, 2000) suggested a real decrease in the wood volume per hectare in some of the Lower Middleveld and Lowveld forest categories, namely the Moist Savanna and Acacia Savanna, indicating that these strata were under pressure. The CSIR/ARC (1997) land cover survey mapped an area of 94,000 ha of degraded forest & woodland and 37,000 ha of degraded thicket & bushland. Another land cover interpretation from 2000 (GOS-NMS/SNC, 2010) mapped a total degraded area of 129,000 ha (53,000 degraded forest & woodland, 39,000 degraded thicket & bushland and 37,000 degraded grasslands). Some of these categories, in particular grassland and bushland, overlap with rangelands which also show degradation (see land degradation section before).

Uncontrolled veld fires further contribute to forest degradation. Table 21 indicates the extent of veld fires which has recently taken place in Swaziland. In average about 400,000 ha or almost a quarter of the country is annually burnt.

Table 21: Burnt Area from Veld Fires in Swaziland (2000-2007)

Year	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	Average
Burnt Area (ha)	384,124	517,044	457,860	406,562	256,652	434,935	327,217	397,771
Total Land Area (%)	22	30	26	23	15	25	19	23

Source: Dlamini, W.M. (2010, 2010a)

Bush encroachment is rather the opposite from degradation caused by excess extraction, however still a form of degradation. The occurrence of bush encroachment is caused by a lack of browsing and is confined to the Lowveld and the Lower Middleveld with savanna and mixed bush vegetation. Severe encroachment is found in some of the commercial TDL ranches as there are less seasonal fires and relatively little wood extractions compared to SNL.

In contrast to the observed signs of degradation, there may be new and more positive developments relating to the status of forest resources. As mentioned in the previous section, a reduced pressure on forest resources, resulting from decreasing livestock and human populations in at least part of the rural areas, together with improved natural resource management, is probably leading to an improvement with respect to degradation of forest resources.

3.1.3.2.1 ENVIRONMENTAL INDICATORS: PRESSURE ON FORESTS AND WOODLANDS

Environmental indicators measuring the pressure forces on forest resources can include:

Indicator	Measurement	Source	Availability/Reliability
Harvest to regrowth rate / regeneration	percentage	Commercial and communal	partly available
Intensity of forest resource use (actual harvest/productive capacity)	rating	Commercial and communal	partly available
Managed and sustainable extraction of non-wood forest products, including fodder (grass layer and fodder from trees/shrubs); consumptive wildlife utilisation; honey, gum; miscellaneous fruits, roots, edible leaves and mushrooms; medicinal substances; fibres for handicrafts	amounts, value, annual change	Dept Forestry	outdated
Annual wood increment	percentage	Commercial and communal	partly outdated
Bush encroachment	percentage and severity	Commercial livestock farm	outdated
Bush (Veld) fires	frequency, intensity	SNTC/Disaster Management	available
Storms and associated flooding	frequency,	Disaster	available

	intensity	Management	
Drought and climate change	change in climatic parameters	Meteorological Services	available
Invasive Alien Plant Species (IAPS)	areas infested	Dept Forestry	available
Forest ecosystems containing endemic species	% area lost annually	SNTC	available

It should be noted that major modifications and change in the use of forests and woodland are covered by changes in land use (LUC) under section 3.1.1.

3.1.3.3 STATE

The state of environment is described by the quality of forests and woodlands, which can be obtained from land cover based forest resources assessments.

3.1.3.3.1 FOREST RESOURCES ASSESSMENT

Several land cover based forest resources assessments have been carried out to determine the forest cover of Swaziland. The National Forest Inventory of Swaziland (Hesse *et al*, 1990) identified a total of 624,000 ha (36% of Swaziland) consisting of forest of the following combined categories: 135,000 ha plantation, 25,000 wattle, 14,000 ha natural forest, 297,000 ha savanna and 152,000 ha bushveld. The coverage as indicated by the 1999 Forest Resource Assessment (FPLP, 2000) was in total 788,000 ha (45% of Swaziland), consisting of 110,000 ha plantations, 25,000 wattle, 37,000 ha natural forests (highland and riparian), 382,000 ha mixed and Acacia savanna and 233,000 ha bushland. Another land cover exercise (CSIR/ARC, 1997) gave a comparable result however with a higher total of 965,000 ha (55% of Swaziland), due to a large 447,000 ha bushveld/thicket category.[12]

FAO (2010) has summarised and consolidated the above mentioned Swaziland forest data in the Forest Resources Assessment Country Report Swaziland, however converted to standard FAO Forest Resources Assessment (FRA) classification (Table 22). [13]

Table 22: FAO Forest Resources Assessment Classification

Category	Definition
Forest	Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use.
Other wooded land	Land not classified as "Forest", spanning more than 0.5 hectares; with trees higher than 5 meters and a canopy cover of 5-10 percent, or trees able to reach these thresholds in situ; or with a combined cover of shrubs, bushes and trees above 10 percent. It does not include land that is predominantly under agricultural or urban land use.
Other land	All land that is not classified as "Forest" or "Other wooded land".
Other land with tree cover - Subordinate to "Other land"	Land classified as "Other land", spanning more than 0.5 hectares with a canopy cover of more than 10 percent of trees able to reach a height of 5 meters at maturity.
Inland water bodies	Inland water bodies generally include major rivers, lakes and water reservoirs.

Source: FAO, 2010: Global Forest Resources Assessment (FRA)

The FAO (2010) data are presented for baseline years 1990 and 2000 and extrapolated to 2010, as no relevant information from inventories has become available since 2000 (Table 23). The most important trends shown

[12] These assessments indicate that the results of the estimates from inventories have to be handled with care. There are indications that discrepancies are to a large extent due to different assessment and classification methods, rather than caused by actual and rapid changes in forest size and composition. This is especially true for the less wooded forest categories such as savanna and bushland which are apparently differently defined and interpreted, and obviously overlap with rangelands (another land cover category). To complicate matters, it appears that two versions of the 1999 Swaziland Forest Assessment circulate, a preliminary (used by FAO) and a final; the major difference is a much higher % Moister Savanna in the final, offset by lower Bushveld and Plantation %. It should be noted that the primary actual land use in Swaziland in all these natural forest land cover categories is not forestry but grazing.

[13] Correlation between FAO and National 2000 classification is as follows: semi-natural and modified natural forests correspond with forest and savanna (or woodland) respectively; other wooded land corresponds with bushland (or bushveld).

are the decrease of industrial forest from 135,000 ha in 1990 to 107,000 ha in 2010 and increases of natural forests (323,000 to 425,000 ha) and other wooded land (152,000 to 427,000 ha).

Table 23: Estimated Forests and Other Wooded Land Areas (1990-2010)

FRA CATEGORY	1990	2000	2005	2010	AVERAGE ANNUAL CHANGE 1990-2010
Natural Forest (semi-natural)	14 000	31 000	31 000	31 000	
Natural Forest (modified)	323 000	362 000	395 000	425 000	+5,600 ha
Industrial Production Plantations	135 000	121 000	114 000	107 000	-1,400 ha
Total forest (natural & industrial)	*472 000*	*514 000*	*540 000*	*563 000*	+ 4.500 ha
Other Wooded Land (Bushland)	152 000	289 000	358 000	427 000	+13,700 ha
Natural Forest and Bushland	*489 000*	*669 000*	*784 000*	*883 000*	+19,700 ha
Total Forest and Bushland	*624 000*	*790 000*	*898 000*	*990 000*	+ 18,300 ha

Source: FAO (2010), based on assessments by Hesse et al (1990) and Thurland (FPLP, 2000) (preliminary version)

3.1.3.3.1.1 BIOMASS AND CARBON STOCKS

The following data derived from FAO (2010) are relevant to the description of the national circumstances forest resources as well as to carbon estimates.

The growing stock is defined (FAO, 2010) as the volume over bark of all living trees more than X cm in diameter at breast height (or above buttress if these are higher). Includes the stem from ground level or stump height up to a top diameter of Y cm, and may also include branches to a minimum diameter of W cm.

The total volume of the national forest classes as well as the class other wooded land (bushveld) is given in Table 24.

Table 24: Growing Stock Volume

National Classes	Area (ha)	Volume / hectare (m^3/ha)	Total volume (m^3)
Montane and Highland	15,765.0	14.2	223,863.0
Riparian	25,997.0	37.8	982,686.6
Moister Savannah	104,273.0	18.5	1,929,050.5
Acacia Savannah	180,546.0	16.4	2,960,954.4
Dryer Acacia Savannah	35,125.0	16.2	569,025.0
Wattle Forest	28,839.0	16.4	472,959.6
Bushveld (OWL)	275,705.0	11.7	3,225,748.5
Total	**666,250.0**	**18.7**	**12,487,428.6**

Source FAO, 2010; FPLP, 2000 (1999 assessment)

These data can be used for estimation and forecasting the growing stock for the period 1990-2010 (FAO, 2010: FRA 2010 Country Report, Swaziland). Table 25 shows the results of growing stock of Swaziland forests, plantations and other wooded land for the period 1990-2010. According to expert estimates, the volume per hectare in Industrial Plantations is 100 m^3/ha (FPLP, 2000).[14]

Table 25: Growing Stock Forests, Plantations and Other Wooded Land (1990-2010)

FRA Categories	Vol (m^3/ha)	Area (hectares)				Growing Stock (m^3)			
		1990	2000	2005	2010	1990	2000	2005	2010
Forest excl. Plantation	18.3	337 048	396 489	426 210	455 931	6167978	7255749	7799643	8343537
Plantations	100.0	135 034	121 214	114 304	107 394	13503400	12121400	11430400	10739400
Forest	41.1	472 082	517 703	540 514	563 325	19671378	19377149	19230043	19082937
Other Wooded Land	11.7	151 890	289 462	358 248	427 034	1777113	3386705	4191502	4996298

Source FAO, 2010

[14] Comparison between 1990 (Hesse et al, 1990) and 1999 assessment data shows a markedly lower volume in 1999 for Moist Savannah and Acacia Savanna, and a markedly higher volume for Dry Acacia Savannah and Bushveld. The wattle volume is estimated much higher at 64.6 m^3/ha in the 1990 assessment (FPLP, 2000).

The results of the growing stock are summarised in Table 26 as total growing stock of indigenous and commercial species.

Table 26: Total Growing Stock of Indigenous and Commercial Species

Volume (million cubic meters over bark)								
	Forest				Other wooded land			
	1990	2000	2005	2010	1990	2000	2005	2010
Total growing stock	19.7	19.4	19.2	19.1	1.8	3.4	4.2	5.0
... of which coniferous	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
... of which broadleaved	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Growing stock of commercial species	13.5	12.1	11.4	10.7	n/a	n/a	n/a	n/a

Source FAO, 2010

The definitions of the categories of biomass as defined by FAO (2010) are shown in Table 27. The total biomass of forests and other wooded land are shown in Table 28.

Table 27: Categories and Definitions of Biomass

Category	Definition
Above-ground biomass	All living biomass above the soil including stem, stump, branches, bark, seeds, and foliage.
Below-ground biomass	All biomass of live roots. Fine roots of less than 2mm diameter are excluded because these often cannot be distinguished empirically from soil organic matter or litter.
Dead wood	All non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil. Dead wood includes wood lying on the surface, dead roots, and stumps larger than or equal to 10 cm in diameter or any other diameter used by the country.

Source FAO, 2010

As no national biomass data are available, the growing stock data from Table 26 are used as input to calculate the biomass. The following conversion factors were used:

Wood density 0.58; BEF 3.4; R/S ratio 0.24, with the formula: AGB = GS x Wd x BEF and BGS = AGB x R/S ratio.

Table 28: Biomass of Forests and Other Wooded Land

	Biomass (million metric tonnes oven-dry weight)							
	Forest				Other wooded land			
FRA 2010 category	**1990**	**2000**	**2005**	**2010**	**1990**	**2000**	**2005**	**2010**
Above-ground biomass	38.8	38.3	37.9	37.7	3.5	6.7	8.3	9.9
Below-ground biomass	9.3	9.2	9.1	9.0	0.9	1.6	2.0	2.4
Deadwood	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TOTAL	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**

Source FAO, 2010

The biomass data in Table 28 are used to calculate the carbon stock, as follows:
1. Carbon stock is calculated by multiplying the biomass by 0.47.
2. Carbon in the litter is estimated, based on the standard factor of 2.8 (sub-tropical), and
3. Soil carbon is estimated, based on the factor of 19 (warm temperate, dry with sandy soils).

The total carbon stock in both living biomass and in dead wood and litter as well as the soil carbon for the period 1990-2010 is given in Table 29.

Carbon losses due to soil erosion can influence soil C storage on rangelands, both by reducing soil productivity from the eroding sites and potentially increasing it in depositional areas (FAO, 2009). Thus, there is a redistribution of the soil carbon as a result of soil erosion.

Table 29: Carbon Stock in Biomass (1990-2010)

	Carbon (Million metric tonnes)							
	Forest				Other wooded land			
FRA 2010 category	**1990**	**2000**	**2005**	**2010**	**1990**	**2000**	**2005**	**2010**
Carbon in above-ground biomass	18.2	18.0	17.8	17.7	1.7	3.2	3.9	4.6
Carbon in below-ground biomass	4.4	4.3	4.3	4.2	0.4	0.8	0.9	1.1
Sub-total: Living biomass	*22.6*	*22.3*	*22.1*	*22.0*	*2.1*	*3.9*	*4.8*	*5.7*
Carbon in dead wood	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Carbon in litter	1.3	1.5	1.5	1.6	0.4	0.8	1.0	1.2
Sub-total: Dead wood and litter	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*
Soil carbon	9.0	9.8	10.3	10.7	2.9	5.5	6.8	8.1
TOTAL	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Source FAO, 2010; A soil depth of 30cm is used for soil carbon estimates.

It should be noted that the data is based on estimates and there is a need to conduct a study on carbon stock assessment urgently since this data can also be used in addressing the climate change issues for carbon credit projects for the country.

3.1.3.3.2 ENVIRONMENTAL INDICATORS: STATE OF FORESTS AND WOODLANDS

Environmental indicators measuring the state of forest and woodlands can include:

Indicator	Measurement	Source	Availability/Reliability
Total areas of natural forests, plantations and other wooded lands	% change over time	Dept Forestry	outdated 1990s
Total biomass	% change over time		outdated 1990s
Percentage of forests and other wooded lands managed according to a management plan		Commercial forest companies and Communal sources	available-commercial
Forest area under sustainable management	extent, percentage	Commercial & Communal	available-commercial
Growing stock	total, % change over time	Commercial & Communal	available-commercial
Inventory and species coverage, quality and trend of change	coverage, % change	Commercial & Communal	outdated 1990s
Area and volume distribution of forests (by biome) (e.g. volume distribution by major tree species group within each biome, share of disturbed/deteriorated forests in total forest area)(*OECD indicator*)	total coverage, % change over time	Dept Forestry	partly available
Land Cover Indicator: changes in land cover by type of land cover class (the proportion covered by forests, woodland and grasses compared with a baseline)	coverage, % change	Dept Forestry	outdated 1990s

Notes: Trend of change is part of overall land cover change see under LUC (see section 3.1.1); there is also some overlap with the Biodiversity theme (see section 3.4).

3.1.3.4 IMPACTS

Although general impacts from forestry activities often relate to reduced biodiversity and water, the specific impacts from Industrial Forestry and Community Forestry are quite different.

3.1.3.4.1 IMPACTS FROM INDUSTRIAL FORESTRY

The industrial plantations have an impact or effect on a number of important issues (see also 2002 National Forest Policy). These concerns relate to alteration of the landscape, degradation of the soil, high water consumption and effects on vulnerable ecosystems.

Water Consumption. The volume of water used by industrial forestry grossly exceeds the water used by the original natural environment (often grassland); however, reliable and specific estimates of the impact of plantation forestry on the water resources in Swaziland are not available. The current policy is that industrial forestry companies and all other watershed users must apply methods to reduce water consumption and pollution, and establish a balanced use of water by all consumers. A nation-wide mapping of catchment areas, watersheds and watercourses, both inside and outside forest plantation areas, would be required in order to achieve adequate estimates of water consumption. Once efficient and reliable methods to assess the water resources as part of integrated watershed management have been established, the water balance and consumption could be used as an environmental indicator for water use by the industrial forestry sector.

Soil properties. There is evidence that industrial forestry activities have a negative impact on chemical and physical soil properties, such as nutrient status, soil reaction (pH) and soil structure and the threat is that such activities, in particular harvesting and the use of chemicals, may lead to irreversible soil degradation. Although industrial forestry companies to some extent have developed practices to remedy this situation, more needs to be done to reduce the impact on soil compaction, acidification and depleted nutrient status.
Reduced biodiversity and ecosystem functions & services. The impact on biodiversity is inherent to the expansion of the industry and as such inevitable, namely by replacing natural vegetation by monocultures, and to some extent also through invasion of exotic species from the plantation onto adjacent land. Although the larger companies in Swaziland have programmes in place to enhance biodiversity within the plantation - notably in the unplanted areas - and to minimise contamination of adjacent land, but this is not the case with most of the smaller companies and smallholder growers.
Pollution from production and processing. Associated industries produce material such as pulp, chips, logs, timber and bark tannin. Not all have serious polluting effects, but especially the pulp and paper industries use large quantities of water, which return to the environment in polluted form. Without adequate regulation, these effluents impact negatively on both the human and biophysical environment and might even lead to environmental and human health catastrophes.

3.1.3.4.2 IMPACTS FROM COMMUNITY FORESTRY

Unsustainable management of community controlled forest and woodland areas has led to several negative impacts (see also 2002 National Forest Policy). These are caused by excessive extraction of certain species and have resulted in reduced ecosystem functions and services.

1. ***Trade in forest products with proper valuation***. The main Issue is that current trade in natural forest products is uncontrolled and not sufficiently benefiting communities. There is growing concern that an increasing proportion of the revenue and benefits from harvested forest products is taken away by outside traders.
2. ***Critical levels medicinal plants***. The current uncontrolled and unsustainable extraction of medicinal plants has resulted in depletion or critical levels of certain species and is largely attributed to illegal trade and export of plants.
3. ***Shortage of fuelwood***. There are indications of shortage of fuelwood, although estimates of fuelwood consumption are not consistent.
4. ***Increasing depletion of cultural plant species***. There are indications that there is an increasing depletion of certain tree and plant species indispensable in the Swazi culture and tradition.
5. ***Increasing IAPS***. Notwithstanding some initiatives and attempts to eradicate or control IAPS not much has been achieved and IAPS remains a severe threat to biodiversity and ecosystem services.

3.1.3.4.3 ENVIRONMENTAL INDICATORS: IMPACTS FROM FORESTS AND WOODLANDS

Environmental indicators measuring the impacts of forests and woodlands can include:

Indicator	**Measurement**	**Source**	**Availability/Reliability**
Water Consumption	% change in water run off	Dept Water Affairs	not available
Degraded Soil properties	soil compaction and changes in fertility	MOA Research Forest Company Research	not available
Ecosystem goods & services	% change (type, volume, value)	SNTC / UNISWA	not available
Trade in community forest products	% change	Dept Forestry	outdated
Yield of cultural medicinal plant species	% change	Dept Forestry & UNISWA	partly available
Fuel wood availability	% change	Dept Forestry	outdated
IAPS occurrence	% change	Dept Forestry	available

See also impacts under the Biodiversity Theme, overlapping with Forests and Woodlands.

3.1.3.5 RESPONSE

The response to pressures and impacts in the forestry sector is described under systemic and institutional responses. There is an enabling environment with an adequate structure that includes policies and plans, as well as economic, regulatory and accountability frameworks within which institutions and individuals operate.

3.1.3.5.1 SYSTEMIC RESPONSE

The national policy response to forest management is related to the signing and ratifying of the Convention on Biological Diversity. The government has further responding through the development of sectoral policies and strategies.

The main policy and strategy tools developed by the Department of Forestry are the National Forest Policy (NFP; GOS-MOAC, 2002) and the National Forestry Programme (GOS-MOAC, 2002a, draft). The NFP observes that management of natural forests and woodlands remains the most important forestry issue in Swaziland that needs to be addressed now and in the future. A Forest Bill has been drafted in 2010.

The NFP vision is to achieve efficient, profitable and sustainable management and utilisation of forest resources for the benefit of the entire society, and to increase the role of forestry in environmental protection, conservation of plant and animal genetic resources and rehabilitation of degraded land.

All plantation forestry companies and individual growers must comply with the national criteria and indicators for sustainable forest management in Swaziland. This includes that industrial forest companies must develop and introduce forest management practices that minimise soil degradation, in particular the long-term residual effects of fertilisers and pesticides and develop forest management practices that maintain biodiversity at acceptable levels in order to at least partially compensate the effects of monocultures on biodiversity.[15]

The community forestry and natural forests sectors are served with a variety of policy statements which aim to regulate current shortcomings in management aspects such as the use of trees in conservation, management of woodlots and wattle stands, management of fires and protected areas, extraction and valuation of forest products, estimates and regulation of fuelwood, etc.

3.1.3.5.2 INSTITUTIONAL RESPONSE

The Forestry Section was established in 1972 within MOA and moved in 2009 as the Department of Forestry to the Ministry of Tourism and Environmental Affairs. The mission statement is to provide efficient and profitable sustainable management, utilisation, conservation and development of forestry resources. The role of the Department is to ensure that the forestry resources are managed and conserved optimally in order to prevent harmful consequences of exploitation. This entails maintaining a forest resource inventory and monitoring the rate of deforestation, provision of efficient extension services to farmers and undertaking research on propagation of indigenous and exotic tree species.

The Swaziland National Herbarium, administered by the Forestry Department, is the repository of plant material collected in Swaziland. Its mission statement is to accumulate and disseminate botanical information, and to promote sustainable utilisation of the nation's plant heritage.

The response by Government and society to the causes of deforestation and forest degradation which have resulted in the negative impacts as described above (reduced biodiversity and ecosystem functions & services, etc) is in general inadequate. This is primarily due to a lack of organizational capacity, notably functional capabilities of relevant organizations and the access to finances, information, technology, infrastructure and other resources.

3.1.3.5.3 NATIONAL FORESTRY CRITERIA AND INDICATORS

[15] NFP: Regulations such as Environmental Impact Assessments and Environmental Audits describing the joint responsibility of Government and the private sector for establishing strategies for the conservation of the biodiversity and specific habitats will be an important step forward. The principle should be applied that the environmental costs of afforestation are to be borne by the user. Identified management practices include water catchment identification, river course prioritisation, creation of buffer zones, alien plant removal, control of burning regimes, limiting disturbance and preservation of the forest ecotone.

The NFP recognizes the importance of national criteria and indicators for sustainable forest management and the necessity of having available reliable forest resource assessment and data systems as well as the linkage between assessment and indicators.

The NFP expresses the need for a periodic forest resource assessment that will detect changes in forest cover, species distribution, species succession, regeneration, age distribution and other important aspects. The two most recent forest resource assessments, conducted in 1990 and 1999, have provided inconclusive data on the status of the forest resources. Introduction of a reliable methodology that can be repeated within a shorter time interval should be considered to remedy this situation. It is recommended to base the overall framework for guiding this activity on the methodology developed for defining national criteria and indicators for sustainable forest management, following the principles of the Dry-zone Africa Process:

- Criterion 1: Development, maintenance and improvement of forest resources including their contribution to global carbon cycles, with 2 indicators: (1) total areas of natural forests, plantations and other wooded lands (and their change over time), and (2) bio-mass (and its change over time).
- Criterion 2: Conservation and enhancement of biological diversity in forest ecosystems, with in total 13 indicators, divided over 3 groups: (a) ecosystem Indicators, (b) species Indicators, and (c) genetic Indicators (fauna, flora):
- Criterion 3: Maintenance and enhancement of forest ecosystem health, vitality and integrity, with six indicators looking at various aspects such as human interference, fires and IAPS.
- Criterion 4: Maintenance and enhancement of productive functions of forests and other wooded lands, with six indicators focusing on management and sustainable extraction.
- Criterion 5: Maintenance and improvement of environmental and conservation functions of forests and other wooded lands and combating land degradation/desertification, with six indicators quantifying forest coverage in relation to protection, conservation and vulnerability to degradation.
- Criterion 6: Maintenance and enhancement of socio-economic benefits of forests and other wooded lands, with 12 indicators, including the value of wood and non-wood forest products, eco-tourism, and primary and secondary industries.
- Criterion 7: Adequacy and effectiveness of legal, institutional and policy frameworks for sustainable forest management, with nine indicators.

The indicators of Criterion 7 in fact relate to the existence of a series of policies etc which in total gives an indication of the Systemic Capacity and enabling environment that exists in Swaziland. A detailed overview with estimate of the situation is given in Table 30:

Table 30: Environmental Indicators for Response to Forestry Issues

Criterion 7: Adequacy and effectiveness of legal, institutional and policy frameworks for sustainable forest management	
7.1 Existence of a national forest policy in harmony with other relevant sectoral policies.	Available
7.2 Existence of a comprehensive legislative and regulatory framework providing for access to resources, alternative forms of conflict resolution and consideration of land occupancy and cultural rights of local populations.	Partly available
7.3 Existence of institutional, human and financial capacity to implement the national forest policy, and relevant national and international laws, instruments and regulations.	
7.4 Existence of co-ordinated research and development capacity.	
7.5 Existence of monetary and non-monetary incentives for investments in the forestry sector.	
7.6 Value of local expertise, knowledge and technologies.	
7.7 Existence of measures to facilitate the transfer and adaptation of appropriate technologies.	
7.8 Existence of an administrative, policy and legal framework for the effective participation of all stakeholders, i.e. Government, local communities, NGOs and the private sector in forest policy formulation, implementation and monitoring.	
7.9 Existence of a regulatory framework for the regulation of genetically modified organisms.	

3.1.3.5.4 NATIONAL FORESTRY ACTION PROGRAMME

The NFP's issues and policy statements indicated the need for a National Forestry Programme, of which the purpose is to identify the priority problems and formulate an action plan (GOS-MOAC, 2002a, draft). The Forestry Programme covers four forest sectors, namely Natural Forest and Woodlands, Community Forestry, Urban Forestry, and Industrial Forestry, coupled with immediate action and general support programmes, such as data management and human resource development.

The government has responded to problem of Invasive Alien Plant Species (IAPS) by declaring it a national disaster in 2005 and initiating a programme to improve and control the situation. However, due to financial constraints, in 2011 the government has terminated all activities related to IAPS (for further details see section 3.4.5.1.3).

3.1.3.5.5 ENVIRONMENTAL INDICATORS: RESPONSE TO FOREST AND WOODLAND DEGRADATION

Environmental indicators measuring the response to forest and woodland degradation can include:

Indicator	Measurement	Source	Availability/Reliability
National forestry policy and action plans	available & endorsed	Dept Forestry	available (part)
National forestry legislation	available & endorsed	Dept Forestry	not available
Protected forest area	% of total forest area	Dept Forestry/SNTC	available
Harvested area successfully regenerated or afforested	% of total harvested area	Dept Forestry	available
Re-introduction of locally extinct forest species	number of species, area	Dept Forestry	not available (not practiced)

National action programmes are formulated and guided by the National Forestry Programme (NFP). The NFP list has identified lists of indicators of which a selection has been incorporated in the relevant sections on Environmental Indicators (pressure, state, impact, response) in this Forests and Woodlands Subtheme section. Several groups of indicators as listed in the NFP such as Species and Genetic Indicators overlap with biodiversity (2.9 Average number of provenance (and its change over time); 2.10 Number of forest dependent species with reduced range; 2.11 Population levels of key species across their range; 2.12 Number of genetically modified organisms in the forests; 2.13 Degree of management of genetic resources). Other indicators relate to protection, water yield, energy, tourism or soils and are covered in other sections. Only few of the indicators related to the value of forest products and services in general can presently be measured and some have been included in some of the above sections.

3.2 THEME 2: WATER

Water is a very valuable natural resource of Swaziland and a key determinant of economic growth and poverty alleviation and a resource that must be carefully managed as part of the overall development objective of economic development.

All water found naturally in Swaziland is a national resource as declared by the Constitution. Within the context of the Constitutional proclamations any person or community desiring to utilise water for primary purposes shall not be required to obtain a permit since water is considered a resource with an economic as well as a social value.

As the draft Water Policy (GOS-MNRE, 2009c) highlights, water is a limited resource that is used as an input to economic production in a number of inter-related water user sectors. The management of water resources shall recognise the value of water to economic development, emphasising beneficial and efficient use. The principle of allocative efficiency in water resource utilisation is applied in order to maximise the net economic and social benefits and contribution towards poverty reduction. Water has to be used efficiently, with pricing and other mechanisms put in place to encourage allocation of water to uses with higher value with due consideration for social obligations.

All rivers in Swaziland are international rivers and the water that Swaziland can utilise from them is limited by agreements with South Africa and Mozambique. A Tripartite Permanent Technical Committee addresses international water right issues. As a member state, Swaziland recognises the 1995 and 2004 revised SADC Protocol on Shared Watercourse Systems, which resulted from the Dublin Conference and Agenda 21.

3.2.1 DRIVING FORCES

The primary driver of water use is the country's economic development and meeting the water needs of a growing population and economy for water for agricultural, domestic, industrial and environmental uses (see population and economic data in Chapter 1). Economic development is bringing about increases in water demand through the implementation of various irrigation based development projects which could have an adverse effect on water quantity and quality if not properly assessed or implemented.

A secondary driving force or controlling factor is related to managing transboundary rivers to ensure agreed to flows are respected and achieved.

3.2.1.1 ENVIRONMENTAL INDICATORS: DRIVING FORCES AFFECTING WATER QUANTITY AND QUALITY

Indicators for driving forces describe the social, demographic and economic developments in societies and the corresponding changes in lifestyles, overall levels of consumption and production patterns.

Indicator	Measurement	Source	Availability/Reliability
Population growth rate	%	CSO	available, reliable
Macro-Economic development	GDP growth rate & GDP per capita	MEPD, MOF	available, reliable

3.2.2 PRESSURE

Water security and access to good quality water is emerging as an increasingly important and vital issue for Swaziland. Many urban areas are beginning to experience moderate water shortages, brought on by the simultaneous effects of agricultural growth, industrialization and urbanization. Another pressure is the growing competition over shared water resources. These pressures are further aggravated by declining water quality and climate change effects that may heighten shortages (and surpluses) and increasing demand for water from neighbours for their economic development.

Conflict over the allocation of water resources can strain relationships between states sharing the same resources. Into the future, diminishing and degraded water resources could lead to internal instability in the country.[16]

The main pressures on water quantity are the increasing demand for water to supply the industrial, agricultural and domestic sectors along with competition for the finite water supply.

Compounding an already difficult situation in allocating water resources for the different competing sectors is the ever increasing impact of climate change on water. Climate change is an additional pressure that cuts across all demand sectors. The nature and impact of climate changes impact on the country's water resources is still uncertain (see Chapter **Error! Reference source not found.**).

Other specific pressures are being driven by the expansion of invasive alien plant species and from bush encroachment in general. These species interfere with run-off and also use higher volumes of water. Efforts to combat alien invasive plants are complex but government have made attempts to control and eradicate them with little success. Inadequate management of springs, marshes and wetlands as sources of water may compromise their ability to filter and store water for other uses.

Pressures on maintaining good water quality derive from the demand by all growth sectors (industry, agriculture, urban and environment) for good quality water for their respective uses. Such water use often results in the degradation of water quality through the improper treatment and disposal of liquid effluents and contaminated run-off.

Most human activities whether domestic, agricultural or industrial have an influence on water quality. Potential sources of point-source water pollution in Swaziland include agriculture (dipping tanks, feedlots), industry, landfills, wastewater treatment facilities and mining. Potential sources of non-point-source water pollution include forestry, irrigated agriculture, livestock and sanitation.

[16] There is limited data on the water abstractions and distribution systems. An old water use registry exists and this has to be updated and validated through a ground truthing exercise involving all the river basin authorities in Swaziland. Water users have increased hectarages of their irrigated lands and in other instances privately owned lands have changed ownership and these changes are not reflected in the current water use database. The water use verification exercise is planned for the near future but it is likely to be a slow and lengthy process.

3.2.2.1 PRESSURE ON WATER QUANTITY

Demand on water is expected to increase as industry, agriculture and urbanisation use more and more water for their growth purposes. Future demand was modelled in the Integrated Water Resources Master Plan (GOS-MNRE, 2011) from various basins for the years 2005, 2015 and 2025. The findings are presented in the following tables.

Table 31: Estimated Water Demands in the Swaziland Portion of the Lomati River Basin

Water Uses	Water Demand (Mm^3/a)		
	2005	**2015**	**2025**
Urban & rural	3	4	5.5
Livestock and game	0.5	0.5	0.5
Afforestation	22	22	22
River losses	0	0	0
Irrigation	4.5	5	6
Water transfer	0	0	0
	30	**31.5**	**34**

Table 32: Estimated Water Demands in the Swaziland Portion of the Komati River Basin

Water Uses	Water Demand (Mm^3/a)		
	2005	**2015**	**2025**
Urban & rural	5.5	11	15.5
Livestock and game	1.5	1.5	1.5
Afforestation	24	24	24
River losses	15	15	15
Irrigation	203	245	285
Water transfer	8	8	8
	257	**304.5**	**349**

Table 33: Estimated Water Demands in the Swaziland Portion of the Mbuluzi River Basin

Water Uses	Water Demand (Mm^3/a)		
	2005	**2015**	**2025**
Urban & industrial	7.4	9.8	13.1
Other urban supply	4.6	5.8	7.5
Rural supply	0.6	1.1	2.1
Livestock and wildlife	1.2	1.7	2.3
Industrial	10.2	16.5	16.5
Irrigation	229	261	292
Subtotals	**253**	**296**	**334**

Table 34: Estimated Water Demands in the Swaziland Portion of the Usutu River Basin

Water Uses	Water Demand (Mm^3/a)		
	2005	**2015**	**2025**
Urban, rural & Industrial	52	56	59
Livestock	8	8	8
Irrigation	310	525	527
Alien vegetation	6	6	6
Afforestation	103	103	103
Subtotals	**479**	**698**	**703**

Table 35: Estimated Water Demands in the Swaziland Portion of the Ngwavuma River Basin

Water Uses	Water Demand (Mm^3/a)		
	2005	**2015**	**2025**
Urban, rural & Industrial	2	2	2
Livestock	2	2	2
Irrigation	42	43	43
Alien vegetation	1	1	1
Afforestation	4	4	4

Water Uses	Water Demand (Mm^3/a)		
Subtotals	**51**	**52**	**52**

3.2.2.1.1 PRESSURE FROM IRRIGATION

Irrigation is the major user of water in the country and accounts for 96.6% of available supply. Irrigation is extensively used for growing sugarcane, citrus fruits, and vegetables. Due to climatic variables, most of the irrigation activities are located in the Lowveld region which also receives the lowest rainfall. The transformation of farmers from subsistence to commercial agriculturalists necessitates increasing output per unit area of land. Investments in irrigated agriculture targeting former subsistence farmers means that more water will be abstracted as these new irrigation schemes are implemented.

Table 36 presents irrigation areas and their uses.

Table 36: Irrigated Areas and Use (2008)

Producer	2008		
	Sugar	Non-sugar	Total area
RSSC Estate	20,136		20,136
Malkerns out growers	2,000	500	2,500
KDDP out growers	3,500		3,500
Vuvulane out growers	1,212		1,212
Other growers (commercial)	4,670		4,670
Ubombo Estate	8,500		8,500
Others (commercial)	10,000		10,000
Citrus and other spp.	0	3,000	3,000
Other TDL farms	0	2,000	2,000
Other SNL schemes		500	500
Subtotals	**50,018**	**6,000**	**56,018**

Source: GOS-MOA/SWADE, 2008

The key irrigation areas in Swaziland are the:

- Malkerns valley (2,400 ha) in the lower Lusushwana catchment where commercial sugarcane and vegetable production predominate;
- Big Bend area (16,500 ha) in the Lower Usuthu catchment where the large Illovo commercial sugar estate is situated;
- Siphofaneni area (11,500 ha) in the mid-Usutu catchment where the Lower Usuthu Smallholder Irrigation Project (LUSIP) is presently being implemented mostly for sugarcane;
- Nsoko area (3,500 ha) in the lower Ngwavuma catchment where sugarcane production predominates;
- The Simunye, Tambankulu and Mnjoli area (14,850 ha) in the lower Mbuluzi catchment where the RSSC sugar mill is situated;
- The Mhlume area (6,000 ha) in the lower Komati catchment where the RSSC Mhlume sugar mill and estate and the Komati Downstream Development Project is being implemented mostly for sugarcane.

According to GOS-MOA/SWADE (2008) the amount of land under irrigation in the future depends upon the available water (both stored and river flow) and the efficiency with which it is used. Given the existing water storage capacity, by 2015 the area under irrigation could increase by 14,500 ha as the balance of KDDP (3,000 ha) and the whole of LUSIP (11,500 ha) come into production – giving a total area of 70,500 ha. A feasibility study for a dam in the Mkhondvo River Basin has been commissioned, which would irrigate around 4,000 ha. Illovo Ubombo is considering bringing a further 1,500 ha of its land into irrigated cane production, USA Distillers is considering building a dam to irrigate 6,500 ha (to provide feedstock for its plant[17]) and Casquip is considering the irrigation of 500 ha of cassava. There is also the possibility of purchasing water from South Africa to irrigate land in Lavumisa, although there is no certainty about this.

By 2020, at current levels of water efficiency, the irrigable area is likely to be somewhere between 76,000 and 82,000 ha – depending upon if and when the investments noted above take place. Of this, around 60,000 ha will be in sugar cane, 3,000 ha in citrus (and other fruits such as bananas) and 7,000 ha may be growing

[17] Sugar, sugar beet and cassava are being considered

feedstock for ethanol and starch production. This will leave a balance of around 16,500 ha of irrigable land that is uncommitted and for which there will be many demands.

According to GOS-NMS/SNC (2010d) current annual water demand for irrigation is 1,795 Mm^3 with a current supply of 2,706 Mm^3. Data could not be sourced on the rate of growth in demand and for how long the supply could continue to meet demand. Past droughts have revealed how river flows, particularly in winter, do not meet demand and supplemental water is required in the form of storage dams to cover drought and winter demands. Water storage capacity is, according to GOS-NMS/SNC (2010d), 568 Mm^3.

Simulation results without taking into consideration projected water use show that there will be high flows during the summer months and low flows during the winter months under expected climate change (Matondo et al, 2004). The results further revealed that there will be water shortage during the winter months (May to September) in three catchments namely: Mbuluzi, Usutu and Ngwavuma, under climate change conditions. The study revealed that water storage requirements in 2075 to meet projected demands would be 110 Mm^3 in the Usutu basin, 80 Mm^3 in the Mbuluzi basin and 30 Mm^3 in the Ngwavuma basin.

Increase in water use efficiencies in the irrigation sector by the adoption of drip irrigation technologies were also shown to have potential for water saving. Water savings of 323 Mm^3, 553 Mm^3, 197 Mm^3 and 525 Mm^3 in the Komati, Mbuluzi, Ngwavuma and Usutu catchments respectively could be achieved.

Given that 58% of overall water potential is derived from Swaziland and the rest originates in South Africa, upstream water resource development could reduce the water supply availability for Swaziland as well as downstream Mozambique.

3.2.2.1.2 PRESSURE FROM INDUSTRY

Pressure from industry arises from the need for water for specific industrial processes or for factory potable supply. Industrial water demand is estimated to be 9.73 Mm^3/a. Industrial users are mainly confined to designated industrial areas which may or may not be within town boundaries, the largest being the Matsapha Industrial Area.

Water intensive industries have been established in the Matsapha Industrial Area, which add pressure to the demand. One such industry is Swaziland Beverages which uses about 17,000 Kℓ per month. The industry discharges for treatment about 136,000 Kℓ per month.

Other indirect industrial pressures arise from industrial timber plantations that cover some 70,000 ha of mostly western Swaziland. The water use by these plantations is reported to be the equivalent of a steady abstraction rate of $3.17m^3/s$ (GOS-MNRE, 2011).

3.2.2.1.3 PRESSURE FROM URBANISATION

The pressure for water to sustain current and future levels of urbanisation is driven by the need for securing a regular safe supply of water.

Although Swaziland remains a primarily rural country, with approximately 77.9% of the population residing in areas classified as rural (CSO, 2007), that classification masks the fact that a growing portion of the "rural" population live in peri-urban settlements abutting formal urban areas, and at densities similar to those of the formal urban areas.

Safe drinking water and adequate sanitation are crucial for poverty reduction, sustainable development, and for achieving any and every one of the Millennium Development Goals. According to the MDG report, Swaziland has the potential to achieve its MDG Target 7 to reduce by half the proportion of people without sustainable access to safe drinking water and basic sanitation by 2015 (GOS-MEPD, 2010).

According to the Swaziland Millennium Development Goals Progress Report (GOS-MEPD, 2010), more than two-thirds of households have access to improved water sources, more than 50% of households use an improved sanitation facility and three in four households are within 15 minutes of their drinking water supply. About 73% of urban households have water piped into their dwellings or yards, while about 23% of rural households have direct piped water. Rural households also rely on public taps, surface water and dug-protected wells for their drinking water.

Table 37: Per Capita Income and Water Consumption by Source (per Month)

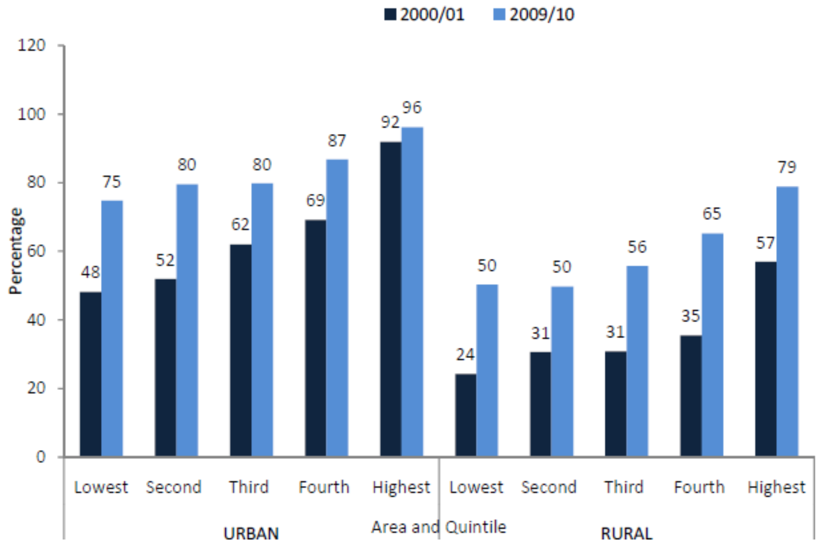
Source of water	Rural		Urban	
	Per capita income (E)	Per capita water consumption (m^3)	Per capita income (E)	Per capita water consumption (m^3)
Private tap water	1,471	3.9	4,952	5.4
Collective tap water	100	2.3	124	1.3
River water	94	2.9	-	-
Average	261	2.7	2,641	5.1

Source: GOS-MEPD, 2010

According to the 2001 Household Income and Expenditure Survey (SHIES) (GOS-MEPD, 2001), 'safe water' comprises of water drawn from: 'piped water into the building', 'piped water but accessible from outside the building', 'borehole', 'protected well' and 'protected spring'. Protection here implies that some protective wall has been erected and that animals such as cows and dogs cannot have access to that well or spring. 'Unsafe water' is water drawn from an unprotected well, unprotected spring and water obtained from the surface. It has to be noted that a household survey like this one is limited in scope and is thus unable to capture information on populations exposed to the use contaminated water and vice versa. Respondents were only asked to state the source where their households draw water from.

In general, urban households have greater access to safe water than rural households. Figure 13 shows that nearly all urban households (9 in 10) regardless of region of location have access to safe water compared with only 6 in 10 of rural households.

Figure 13: Percentage of Households Having Access to Safe Water by Area

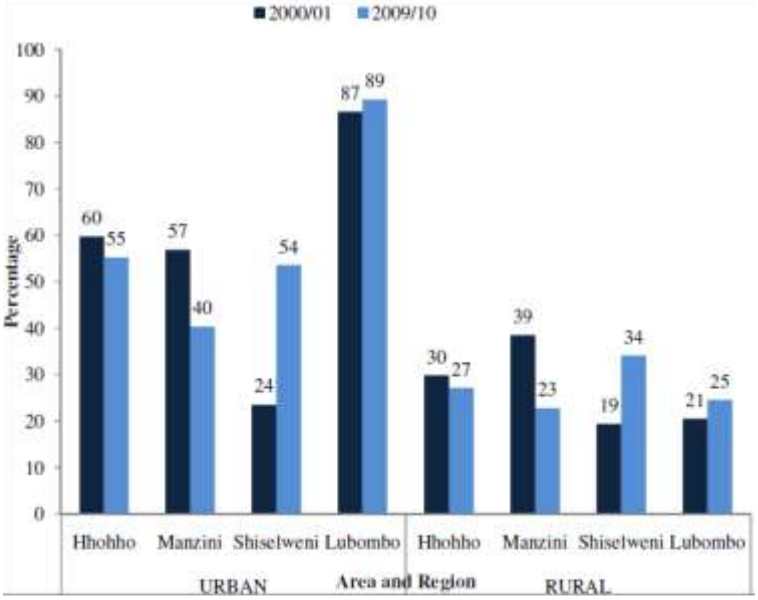


Source: GOS-CSO, 2011

Contrary to achievements made in access to safe water over the past decade, there has been a drop in the standard of sanitation in Swaziland's two most populous regions namely Hhohho and Manzini. The acceptable means of excreta disposal comprise of the flush toilet and the ventilated improved pit privy (VIP) as these meet minimum health standards, thus regarded hygienically safe. Looking at sanitation over the ten year period, Figure 14 shows that the standard has worsened over time, particularly in the urban areas of Manzini and Hhohho regions. This may possibly be a result of growing urban population occurring in slum areas where proper means of excreta disposal are not available.

Sanitation conditions improved significantly in the Shiselweni region particularly in urban areas where the proportion of households using the flush toilet more than doubled over the ten year period. In general urban households have better access to proper sanitation means than rural. Sanitation conditions have remained unchanged in rural areas over the ten year period.

Figure 14: Percentage of Households Using Flush or VIP Toilet, by Area and Region



Source: GOS-CSO, 2011

In predominantly urban areas, Swaziland Water Services Corporation provides treated potable water. SWSC supplies drinking water that is, in terms of quality, amongst the best in the region (SWSC, 2010).

3.2.2.1.4 PRESSURE FROM CLIMATE CHANGE

The spatial availability of water is determined by climatic forces. The hydrological cycle depends on the transfer of heat and moisture from oceans to land. Changes in the heat and moisture of the atmosphere can negatively affect the spatial distribution and volume of water received in any particular point. Immense challenges exist in modelling and predicting how climate changes will affect water.

Climate change presents Swaziland with some potentially serious challenges in the decades ahead. Water is predicted to be the primary medium through which early climate change impacts will be experienced by various sectors and affect sustainable development, jeopardize economic development and poverty reduction efforts - this is stated clearly in the IPCC Technical Paper on Water and Climate Change (IPCC, 2008). Every aspect of the hydrological cycle, and consequently all water in the world, is intimately connected with climate. As the fundamental drivers of the hydrological cycle are affected by increasing climate variability and climate change, they will have large impacts on water resources availability and demand. Water is also critical in relation to climate change mitigation, as many greenhouse gas emissions reduction plans rely on water availability for their long-term success, such as biofuels production, and hydropower development (Water and Climate Coalition, 2010). Swaziland is already experiencing drought related problems during years with low flows. Drought related problems are likely to prevail in winter months in cases where stream flow declines.

The impact of climate change is discussed in more detail in under the section 3.3 on atmosphere.

3.2.2.1.5 PRESSURE FROM INVASIVE ALIEN PLANT SPECIES

The pressures on water quantity are being complicated by the uncontrolled spread of invasive alien plant species that are increasing rapidly in most river basins. The most common are of the *Chromolena* and *Lantana* species (commonly known as *sandanezwe*), guava and black wattle. Consequently, *Chromolena* and *Lantana* have been declared a "national disaster". The impact these alien invasive species have on the environment is reduction in river flows. The net effect is reduction of water for water resource based developments and reduction of biodiversity.

The impact of alien and invasive plants on water supplies has hardly been studied but one study examining the water utilisation in the Komati and Mbuluzi river basins has provided an indication of the impact such plants are having on the national water resource (GOS-MNRE, 2003b). The desktop study indicated that the total area invaded by alien and invasive vegetation in the Komati River Catchment within Swaziland, when condensed to 100% cover, is 9,957 ha, representing 6% of the catchment. The equivalent area for the Mbuluzi River Catchment is 18,765 ha, representing 6.4% of the catchment. About 6.3% of the MAR in the Komati River within Swaziland is used by alien and invasive plant species. The equivalent area for the Mbuluzi River Catchment is 10.6%.

Alien vegetation species that account for most of the stream flow reduction are Wattle (*Acacia mearnsii*), *Chromalaena*, *Eucalyptus* spp and *Lantana*.

In the Komati River Basin, clearing of *Chromalaena* and Wattle would improve streamflow by 7.9Mm^3/a (or 32%). In the Mbuluzi River Catchment, clearing *Chromalaena* and Wattle would improve streamflow by 10.9Mm^3/a (or 22%). Alien vegetation is spreading, and will be consuming increasing amounts of water.

The state of invasive alien plants and their impacts and response is covered in more detail under section 3.4 on biodiversity.

3.2.2.2 PRESSURE ON WATER QUALITY

Water quality seems to be the most important environmental issue of water resources because poor water quality reduces usable water quantity and also negatively affects the aquatic and riverine ecosystems biota.

In general, water quality tends to be good in the headwater, which may be referred to as pristine areas and deteriorates in a downstream direction as a result of human activities such as effluent discharges, abstractions, seepage from agricultural plantations and erosion from overgrazed and bare lands. Deterioration of water quality is mainly due to the addition of chemical, biological and physical pollutants into the water system.

The main pressure on water quality is driven by the various demands placed on the need for good quality water coupled with the discharge of such water used.

Water quality is affected by the use and discharge of usually contaminated water back into the river systems by users of that water.

3.2.2.2.1 PRESSURE FROM AGRICULTURE

The main pollution sources within most river basins are derived from agricultural activities. Pollution from diffuse sources by fertilizers, pesticides, herbicides and other agrochemicals is expected to be on the increase. Another source of agricultural pollution is livestock excreta which has a noticeable impact on organic pollutants.

The agricultural sector has to operate profitably and in order to maintain or increase crop yields, agro-chemicals are required to manage and control fertility, pests and disease. The pressure from the need to maintain or increase crop yields results, where not used appropriately, in the increased use of agro-chemicals which eventually run-off into river systems.

In addition to crop production pressures on water quality, the livestock sector is also contributing to degrading water quality. An increase in smallholder livestock production projects such as poultry, piggery and cattle feedlots and dairy production with little or no environmental controls or monitoring opens up additional sources of pollutants entering the river systems.

The same profitability pressures evident in arable agriculture apply to the livestock sector. More and more chemicals are needed to manage and control unwanted diseases and these in turn can end up in the rivers. Organic pollutants from excreta are also contributing to increasing the organic load of surface water.

3.2.2.2.2 PRESSURE FROM INDUSTRY

The Government of Swaziland strongly promote an increase in manufacturing as part of its economic growth strategy. Manufacturing provides jobs and export revenues vital for the national budget and government development programmes.

In response to governments development programme, numerous manufacturing and processing industries have been established. All such industries require water as either a critical part of its manufacturing or processing process or just to provide for the water needs of staff and cleanliness of its factories and offices.

Although national environmental laws require an assessment of potential impacts arising from industry, for the most part pollution of the environment is a reality.

The pressure to achieve or maintain profitability has at times seen some industries ignore national water quality and treatment requirements. According to the Integrated Water Resources Master Plan (GOS-MNRE, 2011), industrial development has resulted in the steady increase of industrial effluent while effluent treatment is very limited. This has resulted in the increase of inorganic pollutants in river systems that have a negative impact on human and aquatic life. The Lusushwana River is the most polluted river in the country. The Lusushwana River is polluted largely at Matsapha industrial estate. The Usutu, Komati and Mbuluzi rivers show increased levels of pollution from slight increase in dissolved salts as a result of irrigation return flows from irrigated agriculture. Where sewerage systems are present, particularly in urban areas, most industries discharge their effluent into the system, while a few discharge directly into the river systems. This kind of arrangement is pronounced in the Matsapha industrial area.

3.2.2.2.3 PRESSURE FROM URBANISATION

The continued pressure by Swazis to have space to build homes can negatively affect water quality where domestically used water enters the environment un- or poorly treated.

In the main cities and towns of Swaziland water supply and treatment is the mandate of the Swaziland Water Services Corporation (SWSC). All drinking water supplied by SWSC must comply with the WHO Guidelines for Drinking Water (2006). Currently, all of the water supplied by SWSC is derived from surface water, either directly from the rivers which are Black Mbuluzi, Usushwana, Great Usuthu, Mkhondvo, Phophonyane, Mhlambanyatsi, Komati, Ngwempisi, Ngwavuma and Umhlathuzana or from dams such as Magugu, Hawane, Maguga and Sibhowe.

3.2.2.3 ENVIRONMENTAL INDICATORS: PRESSURE ON WATER QUANTITY AND QUALITY

Environmental indicators should indicate the pressure arising from increasing utilisation of water to support the economic and socio-economic growth of the country.

Increasing use of irrigated agriculture combined with the use of agro-chemicals and industrial pollution can compromise water quality.

Indicator	Measurement	Source	Availability/Reliability
Volume of water abstracted for agriculture annually	totals m^3, % change	DWA	available/unreliable
Volume of water abstracted for industrial use annually	totals m^3, % change	DWA	available/unreliable
Volume of water abstracted for domestic use annually	totals m^3, % change	DWA/SWSC	available/unreliable
Volume of water consumed by industrial forests annually	totals m^3, % change	DWA, MTEC (Forestry)	unavailable/unreliable
Agricultural Water Pollution incidents	number	SEA, DWA, SWSC	available/reliable
Industrial Water Pollution incidents	number	SEA, DWA, SWSC	available/reliable
Domestic Water Pollution incidents	number	SEA, DWA, SWSC	available/reliable

3.2.3 STATE

3.2.3.1 STATE OF SURFACE WATER QUANTITY

Surface water resources (annual outflow) of Swaziland are estimated at 4,551 Mm^3/a, of which 1,809 Mm3/a, the annual inflow, originates from South Africa. The difference is 2,706 Mm^3/a runoff generated in Swaziland (about 18% of the total mean annual precipitation).

Swaziland is drained by seven major river systems - the Komati, Lomati, Mbuluzi, Usutu, Ngwavuma, Pongola and Lubombo (see Figure 15). Several of these rivers rise in South Africa and all flow eventually to Mozambique.

The water use in Swaziland is totally dominated by irrigation, accounting for 96% of all demands. The annual water demand for domestic, industrial, livestock farming, and irrigation are: 30 Mm^3/a (1.7%), 17 Mm^3/a (0.9%), 14 Mm^3/a (0.8%) and 1,734 Mm^3/a (96.6%) respectively, in total 1,795 Mm^3/a. Most of the irrigation activities are located in the Lowveld, which is the driest part of the country, often hit by drought, even during years of relatively high rainfall. The late onset of the rainfall season in this region, early cessation of the rains and severe dry spells during the critical crop growth stages often cause crop failure. The industrial forestry sector is also using large amounts of water, however directly derived from rain and substantially reducing runoff.

Figure 15: River Basins of Swaziland

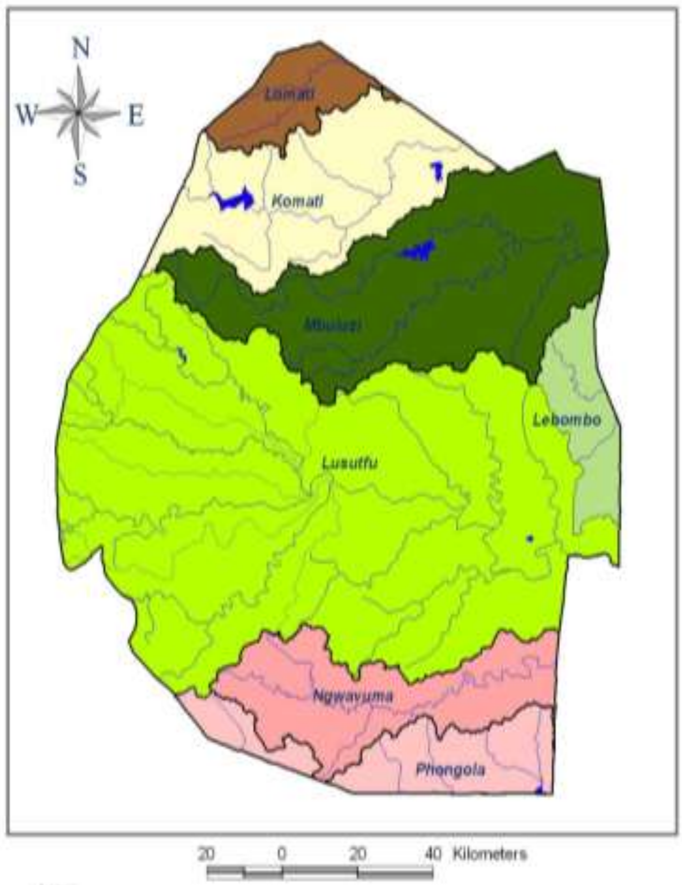


Table 38: Major Drainage Basins of Swaziland and Corresponding Hydrologic Variables

River System	Area (km^2)	Rainfall (mm)	Inflow (naturalised) $\{x\ 10^6\ m^3/a\}$	Outflow (naturalised) $\{x\ 10^6\ m^3/a\}$
Pongola	-	400 -600	Nil	59
Ngwavuma	1,305	600 – 900	Nil	156
Usuthu	12,903	600 – 1,000	896 (386)	2,357 (1,358)
Mbuluzi	3,065	700 – 1,200	Nil	460 (208)
Lomati	931	900 – 1,400	74 (40)	249 (118)
Komati	7,423	800 – 1,400	688 (515)	1,239 (520)
Lubombo	-	800 – 900	Nil	31
Total	-	Mean = 850	1,809	4,551 (2,448)

Source: Swaziland Country Water Partnership, 2007

According to FAO Stat, Swaziland has a total actual renewable water resource of 4.5 billion m3/yr. Of this, 42% or 1.87 billion m^3 originates in South Africa. The seasonal nature of the rainfall makes discharge of surface waters extremely variable. In dry areas such as the Lowveld, while the larger rivers are through-flowing, most watercourses tend to flow only after heavy local rainstorms. Average precipitation is 788 mm/yr. All MARs are incremental i.e. direct runoff from Swaziland catchments. Figures exclude all inflows from South Africa.

Table 39: Estimated Incremental MAR in Swaziland Rivers

River	Mean Annual Runoff (MAR)*
Lomati	120
Komati	373
Mbuluzi	465
Usutu	1 412
Ngwavuma	122
Phongola	135
Total runoff	2 627

Long term mean monthly flow data (m^3/s) from all major river basins in Swaziland is presented in Table 40. The data are derived from the available records from the past twenty years. A number of gauging stations were selected to represent the upper, middle and lower parts of the main river basins (where available). The numbers of the gauging stations (GS) are given in the table below; the location of the stations is indicated on a map (Annex 1).

Table 40: Long Term Mean Monthly Flows of Major Rivers

River Basin	Stage	GS	Long Term Mean Monthly Flows (m^3/s)											
			O	N	D	J	F	M	A	M	J	J	A	S
Ngwavuma	Upper	27	0.88	1.52	1.97	2.96	2.79	1.85	1.82	1.48	0.86	0.84	0.86	0.90
	Middle	8	2.63	3.34	4.88	4.48	6.38	4.75	2.54	1.79	1.67	1.60	1.54	1.66
	Lower	NA												
Usutu*	Upper-L	24	0.79	1.53	1.91	2.43	2.75	2.41	1.61	1.20	0.92	0.81	0.65	0.59
	Upper-U	9	6.15	12.40	17.75	19.95	21.44	15.76	10.76	6.82	5.00	4.51	3.49	3.85
	Upper-N	5	4.28	8.35	12.97	11.94	13.13	10.04	7.43	4.96	3.88	3.87	3.12	3.20
	Upper-M	7	5.94	14.47	20.07	21.27	26.11	17.88	10.84	6.43	4.76	5.18	3.78	3.28
	Middle	6	29.57	50.80	78.44	83.51	91.57	65.51	47.26	30.04	23.49	21.21	16.71	16.68
	Lower	16	16.19	43.57	71.75	76.69	71.04	63.12	27.63	20.74	22.03	19.48	13.65	10.94
Mbuluzi	Upper	4	1.23	1.92	3.02	3.68	4.60	3.85	2.80	1.82	1.30	1.06	0.83	0.77
	Middle	3	4.07	6.62	8.77	10.58	12.81	11.13	8.29	5.66	4.53	3.85	3.39	3.13
	Lower	32	3.33	7.02	11.90	8.82	11.93	10.03	6.83	5.85	5.08	3.55	2.81	3.09
Lomati	Upper	11	2.60	3.62	6.38	8.76	11.62	8.35	5.38	3.56	2.67	2.34	1.93	1.87
	Middle	34	2.11	3.44	5.10	6.45	10.65	8.02	6.57	4.26	2.73	2.18	1.80	1.67
	Lower	NA												
Komati	Upper	29	12.02	18.23	19.87	34.46	41.27	23.42	11.06	6.86	5.24	5.65	4.10	4.26
	Middle	42	0.26	0.39	0.61	0.75	1.91	0.85	0.59	0.35	0.54	0.58	0.51	0.47
	Lower	30	6.67	12.26	23.50	23.99	24.88	22.30	13.54	8.49	5.78	4.33	3.81	3.62

*Usuthu Upper: L-Lusushwana; U-Usuthu; N-Ngwempisi; M-Mkhondvo; Source: Department of Water Affairs; data supplied by DWA in October 2012 specifically for SOER.

Selected monthly river flow data from the major river basins is presented in Annex 2.

3.2.3.2 STATE OF GROUNDWATER QUANTITY

According to the Integrated Water Resources Master Plan (GOS-MNRE, 2011), the geology of Swaziland comprises almost entirely of igneous, metamorphic and sedimentary strata and groundwater aquifers will therefore predominantly be of the so called secondary type, which implies that the aquifers contain virtually no primary permeability and owe their water bearing properties to secondary permeability in which openings are caused by the geological processes of deformation (folding, fracturing and faulting) weathering and unloading as a result of erosion of the overlying strata. Groundwater is fed by infiltration of rainfall and seepage from streams and rivers. About 5% to 20% of the average rainfall accounts for groundwater recharge.

Primary aquifers, which are defined to consist of deposits of sand, gravel and pebbles that are permeable are limited in Swaziland.

The Integrated Water Resources Master Plan identifies that the groundwater resources of Swaziland have potential for exploitation, however these resources are not available in sufficient quantity to allow large scale abstraction, hence virtually all water use (agriculture, industrial and domestic) in Swaziland is based on surface water whilst boreholes supply some domestic water needs with some livestock watering where surface waters are not readily available or accessible.

The most comprehensive national groundwater resource assessment was carried out during the Groundwater Survey Project (1986-1992) which estimated the renewable groundwater resources to be approximately 21 m^3/s. The estimate was based on recharge studies including water balance, water table monitoring and stream baseflow monitoring, as well as general observations of well fields.

The groundwater resources that have the greatest potential for significant exploitation are found mostly in the Highveld and Middleveld, but not in the Lowveld where most aquifers are very poor for groundwater development and water quality in some parts of the Lowveld is limited by high levels of salinity yet this is where water is needed the most. Of this potential, only 6% of the ground water has been tapped through existing boreholes which number over 2000, mostly in Highveld and Middleveld. Average yield from the boreholes is about 1.4 ℓ/s, with some giving rates as high as 20 ℓ/s.

Groundwater recharge in the most critical areas of Swaziland is estimated at 2% in the Lowveld and 5% of annual rainfall in the Lubombo, however elsewhere going up to 20%. There is an increase in demand and use of the groundwater resources by communities in the rural and peri-urban areas.

Borehole drilling is carried out by both the Swaziland Government through the Department of Geological Survey and Mines (DGSM) and the Rural Water Supply Branch (RWSB) and by private drilling contractors.

The DGSM holds borehole data in three recorded forms, these being:

- SWAZIDAT: about 3500 boreholes drilled from 1952 to 1991, which is mainly data from the CIDA drilling programme.
- Electronic (Excel) and paper records: water quality data.
- Electronic (Excel): DGSM borehole records for 1999 – 2006 which is essentially a continuation of the CIDA programme. This data bank contains some 3,000 borehole records including borehole Universal Transverse Mercator co-ordinates, depth, yield, water level and inorganic chemistry. This information is presented in tabular form.

The only groundwater report produced to date is entitled "Groundwater Resources of Swaziland" (GRS). This was a joint project between the then Swaziland Ministry of Natural Resources, Land Use and Energy and the Canadian International Development Agency (CIDA). The publication was produced in 1992. This report provides the baseline on groundwater quantity and location.

Groundwater exploitation is divided into micro and macro schemes. In both cases hydro geological investigations are conducted by the DGSM. Typically the micro schemes comprise of hand pump installation although a few schemes have been equipped with play pump installations (GOS-DWA, 2009).

The larger macro schemes utilising groundwater are nearly all equipped with electric submersible pumps.

3.2.3.2.1 BOREHOLE YIELDS

Borehole records for the RWSB schemes are kept by the DGSM. Pumping test and water quality data for the schemes are kept at RWSB, the former as paper records and the latter as electronic Excel spread sheets.

A large number of boreholes are drilled each year for the private sector. According to the National Water Policy such boreholes require a permit for which a fee is payable. It is difficult to know if any or all of the data pertaining to this work is lodged with the DGSM archive (GOS-DWA, 2009).

The DGSM has compiled data from 946 boreholes (GRS publication) drilled throughout Swaziland from the CIDA funded project. Potential borehole yields abstracted from this work for various hydro-geological units are summarised in Table 41.

Table 41: Borehole Yield Ranges for All Hydro-Geological Units

Hydrogeological Units	Borehole yield range (l/sec)	Percentage of drilled boreholes in range.	Average borehole yield (l/sec)
All	< 0.5	60	1.36
	0.51 to 2.0	20	
	2.01 to 4.0	14	
	>4.01	6	

Source: GOS-DWA, 2009

Borehole yields varied according to the underlying geological formations as follows (GOS-MNRE, 2003b).

Ngwane Gneiss: The most productive geological units are the weathered Ngwane Gneiss and their fault zones. In these units, borehole yields of up to 10ℓ/s can be developed. However, sustainable yields in this geological rock type vary from 2 to 5ℓ/s.

Quaternary Deposits: The quaternary deposits along the Komati River have good potential for groundwater development. In these deposits, borehole yields vary between 5 and 10ℓ/s. However, these deposits are not extensive and hence groundwater development will also be limited.

Granite: Boreholes in the Lochiel Granite and Mswati Granite are developed in the weathered bedrock. Borehole yields are also variable, varying from 0 to 7ℓ/s. Sustainable yield vary between 1 and 3ℓ/s.

Karoo Sediments: The Karoo sediments are very poor for groundwater storage. Most boreholes in these sediments are dry. However, in the geological contacts between the sedimentary rocks and dolerite dykes, boreholes with yields of up to 3ℓ/s can be developed. Sustainable boreholes are discouraging yielding less than a 1ℓ/s.

Basalt: In the weathered basalts and along the basalts and dolerite contacts, boreholes with yields up to 7.0ℓ/s can be developed. Sustainable yields vary between 1 and 3ℓ/s.

Rhyolite: The Lubombo rhyolites are also very poor for groundwater development except where faulted. Borehole yields vary from 0 to 1ℓ/s in the weathered rhyolites, and where faulted, up to 5ℓ/s. Sustainable yields are about 1ℓ/s.

3.2.3.2.2 BOREHOLE USERS

The major categories of borehole usage in Swaziland are probably, in descending order of numbers of boreholes in use:

- Private domestic users
- Community domestic users
- Industrial users
- Agricultural users

The actual number of boreholes operating in each of the above categories is unknown as existing data bases are incomplete or have to date not been fully analysed.

Although it has been estimated that the groundwater resources of Swaziland are substantial based on borehole data and recharge estimates, the large scale abstraction of groundwater for projects having a high water demand are unlikely to be met. Such projects would require extensive and highly productive aquifers to ensure yield and sustainability of the groundwater source and such exceptional conditions are not generally found in Swaziland (GOS-DWA, 2009).

The Ezulwini / Matsapha aquifer situated in the Middleveld, is possibly an exception to this. Although this sub-rock aquifer is by no means continuous throughout its extent it does supply large volumes of groundwater to hotels in the Ezulwini valley and to some industries in the Matsapha industrial area.

Elsewhere groundwater availability is likely to depend on the local development of fractured and weathered rock aquifers which will not in itself be an abundant resource. Groundwater yields and sustainability are generally unlikely to be sufficient for projects requiring a high water demand such as town supply, intensive agriculture, and industry (GOS-DWA, 2009).

In fact hydrogeological studies and test drilling undertaken for the towns of Lomahasha, Hlathikhulu, Lavumisa and Siteki in 1982 concluded that the availability of groundwater in the vicinity of these towns was insufficient for their water requirements. Existing data suggests that groundwater can and will play an important role in the development of Swaziland, but will be best suited in this role to the supply water to low end users which could be categorised as rural human consumption and small industrial enterprises (GOS-DWA, 2009).

The Highveld and Middleveld geographical regions offer the best potential for borehole development. Within these regions expected yields are reasonably high and groundwater quality is predominately good; although water quality decreases in the eastern parts of the Middleveld region. In these areas groundwater can be seen as having sufficient potential for rural and peri-urban water supply, small irrigation and livestock watering schemes as well as water supply for small industry. Supply to towns is unlikely to be feasible (GOS-DWA, 2009).

Population pressures in these areas are generally high so it is expected that there will be some risk of over-exploitation of aquifers and that areas will need to be carefully managed to ensure groundwater quality (GOS-DWA, 2009).

The potential for borehole development in the eastern Middleveld, Lowveld and Eastern Escarpment geographical regions is generally poor as low expected yields and poor water quality will significantly reduce the development potential of these areas (GOS-DWA, 2009).

3.2.3.2.3 BOREHOLE RECHARGE

There have been no detailed hydrogeological studies carried out to determine groundwater recharge potential. Estimates of the yearly recharge potential have been made based on various methods. The DGSM estimates vary from 0.5 to 15%, 1 and 12% and 0.5 to 17% based on the water balance, water table response and stream base flow methods respectively. The water table response method entailed long term monitoring of 50 boreholes situated in all geographical regions during the period 1986 to 1992. The programme and funding ceased when the DGSM was tasked to drill boreholes in drought affected areas from 1992 (GOS-DWA, 2009).

The Joint Maputo River basin Water Resources Study (JMRBS) report (GOS-DWA, 2009) adopted a ceiling figure of 15% for their study based on a rating system incorporating terrain slopes, soil permeability and mean annual rainfall. This gives quantitative values of recharge varying from more than 140 to less than 30mm per annum. The highest figures occur, as one would expect, in the Highveld and the lowest in the Lowveld region; thus matching the trends of highest to lowest yearly rainfall.

3.2.3.3 STATE OF SURFACE WATER QUALITY

In a situation analysis prepared by the Swaziland Country Water Partnership (2007), it observed that the quality of surface water in the country is indicating a general deterioration due to pollution from commercialised agriculture and industries.

Various activities that have an impact on water quality include:

- Irrigation (e.g. Big Bend)
- Distilleries (e.g. Simunye)
- Textiles (e.g. Matsapha)
- Abattoirs (e.g. Manzini)
- Sawmills (e.g. Pigg's Peak)
- Mining (e.g. Ngwenya)
- Landfills (e.g. Mbabane)

The Usutu and other rivers such as the Mbuluzi, Komati and Ngwavuma may be affected by polluted drainage water from the irrigated sugarcane plantations. Intensive agricultural activities especially in the Lowveld have also contributed to some extent to the poor quality of surface water bodies due to application of agro-chemicals and poor land use practices, which inevitably increase the sediment yield.

Limited research carried out on the Mbuluzi River up and down stream of the Simunye/Mhlume sugarcane estate, has shown that return flows have a noticeable impact on river water quality. The research showed that of ten parameters measured (TDS, SS, Na, Ca, Mg, COD, K, EC, SAR, and pH) the results indicated elevated TDS, Na and Mg levels in the drainage streams when compared to the control sites upstream of the Mbuluzi river (Mhlanga B.F.N., Ndlovu L.S., Senzanje A. 2006). The results showed average TDS concentrations of 300-700 mg/ℓ, average Na concentrations of 60-140 mg/ℓ, average Mg concentrations of 48-53 mg/ℓ, COD concentrations of 27-60 mg/ℓ. The results indicate that TDS, Na and Mg concentrations exceeded the Swaziland guidelines for drinking water and the South African standard for irrigation water for infield drainage streams.

In another study on the Komati River looking at aquatic macro-invertebrates as an indicator of ecosystem health, the results showed that macro-invertebrates diversity along the Lower Komati River was high upstream before the sugar-cane fields. However, diversity deteriorates in sites draining the sugar cane fields and picks up again after the fields. This trend implies that even though diversity deteriorates in sites adjacent to the sugar cane fields, which may be due increased nutrient levels, it manages to recover again after the sugar cane fields. The same trend was observed by Mthimkhulu et al (2005) along the Mbuluzi River in Swaziland, where pollution sensitive species disappeared along agricultural fields but re-appeared again after sugar-cane fields. Therefore it can be said that diversity may be affected by sugar cane fields through increase of organic pollution, but it can manage to recover at sites after the sugar-cane fields (Dlamini, 2009).

Leachate from improperly managed solid waste disposal sites in urban and industrial sites eventually invades natural watercourses. Accidental spillages of toxic substances like phenol have been experienced in the past and still continue to occur (Mwendera *et al*, 2002). The risk of pollution loading becomes intolerable during low flow periods, while high gradient watercourses permit good aeration for certain pollutants.

An observation has been made that as a result of waste water discharges from industries in the Matsapha Industrial Area and city of Manzini, water of the Lusushwana River (a tributary of the Usutu River) is frequently of poor quality with COD levels above 200 mg/ℓ. This state of the quality of the water affects the people living downstream of the river and utilising the water.

Water quality data do exist with the DWA but are not yet available in an interpreted form. It is expected that analysed data will become available in the near future from DWA, indicating quality indicators for each major river basin.[18]

3.2.3.4 STATE OF GROUNDWATER QUALITY

Through its publication "Guidelines for Drinking Water in Rural Areas" the Ministry of Natural Resources and Energy (MNRE) considers groundwater to be the most suitable water source for community water supply systems. It cites three reasons for this, these being:

- Firstly groundwater is less susceptible to contamination compared to surface water sources.
- Secondly groundwater abstraction can often be continued during periods of drought long after surface water has been depleted.
- Thirdly the overall quality of groundwater in Swaziland when compared with World Health Organisation (WHO) guidelines is generally considered to be good.

In the long term the main source of groundwater contamination in a borehole will most likely arise from the infiltration of contaminated material from surface and near surface sources. Consequently the importance of proper well design at the well head and the incorporation of a casing and effective grout (sanitary) seal should not be underestimated.

To ensure that the abstracted water from groundwater schemes is and remains potable, current RWSB guidelines suggest minimum water quality test and sanitary inspection be carried out at the frequencies given in the tables below.

Table 42: MNRE Suggested Groundwater Sampling Frequency

Source	Class	Minimum Bacteriological Sampling	Frequency of Physical and Chemical Testing
Borehole with hand pump	A	Once initially, thereafter as situation demands	Once initially, thereafter as situation demands
Borehole and piped supply	B	Once initially, thereafter once per year	Once initially, thereafter once per year

Source: GOS-DWA, 2009

Table 43: MNRE Suggested Minimum Sanitary Inspections per Year

Source	By Community	By Water Supply Agency	By Surveillance Agency

[18] DWA are in the process of digitising raw data. Data from selected river basins were made available for this SOE reporting. A sample of this type of information is given in **Error! Reference source not found.**. The DWA has started collating water quality data for 3 sampling points per basin covering 10 years (2001 -2011). These raw data sets are available at DWA and SEA for further hydrological, statistical and chemical analysis and interpretation (*waterqualitydata.zip*).

Borehole with hand pump	4	1	Once initially, thereafter as situation demands
Borehole and piped supply	1	1	Once initially, thereafter once every 3 years or as situation demands

Source: GOS-DWA, 2009

The quality of groundwater itself depends on the presence (or absence) of two distinct sets of parameters:

- Bacteriological parameters
- Chemical and physical parameters.

The presence of bacteria in groundwater is almost entirely due to the occurrence of introduced bacteria, protozoa and viruses. These pathogenic micro-organisms are readily introduced into the soil mainly through contamination by human and animal faeces in which they exist in large numbers. Bacteriological parameters are determined by measuring the total and faecal coliform count in water samples (GOS-DWA, 2009).

Correct borehole construction and shock chlorination both after drilling and pump installation is usually sufficient to secure groundwater quality with regard to bacteriological contamination.

The chemical and physical nature of groundwater is considered likely to have the most impact with regards to groundwater quality. Soluble chemicals are a natural constituent part of all groundwater. The geological formation through which ground water moves may contribute to an increase in concentration of chemicals to a level where the resource becomes unsuitable for its indented use. A similar situation can arise where contaminants enter the system as a result of human activities. In this case the groundwater can be described as being polluted where such contaminant concentrations attain levels considered to be objectionable. In either case various guidelines have been promulgated to recommend safe concentration limits, and of these the guidelines suggested by the WHO are used Swaziland (GOS-DWA, 2009).

Groundwater chemistry data (CIDA project, GRS) suggests that in terms of the major ions most groundwater comprises, in descending order of concentration, of bicarbonate, chlorine, sodium, calcium and magnesium (no data for sulphate). This order of concentration generally occurs irrespective of geology or climatic region (GOS-DWA, 2009).

However, the overall ion concentrations are least in the granitic and metamorphic rocks which predominately occur in the Highveld and Middleveld and highest (up to 2 to 5 times the concentration) in the sedimentary and volcanic rocks of the Lowveld and Eastern Escarpment regions. This is reflected to some degree by groundwater salinity, a trend that can be mapped through the electrical conductivity of the groundwater which can in broad terms be used as a guide to groundwater quality (GOS-DWA, 2009).

It is reported in the Joint Maputo River Basin Water Resources Study[19] (JMRBS) that this trend is largely observed in the Swaziland aquifers and is mainly due to the groundwater absorbing chemical elements whilst percolating through naturally occurring soil and rock. In fact they further report that there are few instances of land use practice that lead to elevated ion concentrations. The exceptions are mainly areas under intensive commercial agriculture and irrigation, forestry and some abandoned mines (GOS-DWA, 2009).

Analysis of Swaziland groundwater indicates that the chemical constituents most likely to cause quality problems through elevated concentrations are chloride and sodium (salinity), nitrate, iron, manganese and fluoride (GOS-DWA, 2009).

Elevated levels of chloride and sodium (and electrical conductivity) are mostly observed in the Lowveld and the extreme eastern parts of the Middleveld areas. The abundance of these chemicals in the groundwater appears to be associated with the prevailing climatic conditions, where high rates of evapo-transpiration occur and low rates of groundwater flushing prevail. Where levels of chloride in excess of 250 mg/ℓ (WHO) occur the groundwater will be imparted with an undesirable taste which will become increasingly saline as the chloride levels increase (GOS-DWA, 2009).

The highest concentrations of chloride and sodium occur in the sedimentary rocks which stretch in a north to south band through the central and western parts of the Lowveld. In some instances local communities tolerate this chloride and sodium enriched groundwater as it is often the only source of water available (GOS-DWA, 2009).

[19] http://www.dwaf.gov.za/maputobasinatlas/JMRBWRS_Atlas.html

Elevated levels of nitrate may give rise to methaemoglobineamia in infants under the age of one year (WHO). The concentration of nitrates in groundwater in Swaziland is generally below the acceptable limit of 10 mg/ℓ as N (WHO) although higher concentrations may be found in some places. Nitrates often enter the groundwater cycle through pollution by agricultural and industrial activities and through human and animal excreta (GOS-DWA, 2009).

In rural areas high nitrate concentrations may be related in some instances to high population density where on-site sanitation is used. However it should be pointed out that not all of such practices will lead to groundwater pollution as the prevailing hydrogeological and environmental conditions will determine pollution risk. High nitrate levels may also occur where poor borehole construction or lack of maintenance has left boreholes susceptible to the ingress of pollutants (GOS-DWA, 2009).

3.2.3.5 ENVIRONMENTAL INDICATORS: STATE OF WATER QUANTITY AND QUALITY

Environmental indicators indicate the state of water quantity and quality n river basins and as groundwater and could include:

Indicator	Measurement	Source	Availability/Reliability
Mean Annual Runoff	m^3/a	DWA	?
Mean Annual River flow (by river basin)	m^3/a	DWA	?
Standard Parameters as described in the Water Pollution Control Regulations		SEA	?
Total surface water resources available per capita	m^3/person	DWA	?
Total surface water used per sector	m^3/sector	DWA	?
Surface water nutrients	mg/ℓ	DWA	available
Surface water toxicity	mg/ℓ	DWA	available
Groundwater nutrients	mg/ℓ	DWA	available
Registered boreholes	number	DWA	available

3.2.4 IMPACT

Impacts from changes in water quantity and quality are often difficult to separate. Water quality is an important environmental issue of water resources because it adds to the reduction of usable water quantity and also negatively affects the aquatic and riverine ecosystems and biota. It is therefore critical that sustainable levels of water quality be maintained and restored where already compromised. Generally, water quality tends to be good in the headwaters and deteriorates in a downstream direction as a result of human and industrial activities. Changes in the environmental flow of rivers impact strongly on water quantity and quality which influence dependent ecosystems.

Swaziland has continued to grow in terms of economic activity, urban and industrial agglomeration and also in smallholder agricultural activities. The high rate of expansion in industrialization and urbanization is not being matched with adequate waste water treatment facilities and this has negatively impacted on the water quality of the river systems. Deterioration in water quality is mainly due to addition of chemical, biological and physical pollutants in the water systems, which stem from sewage pollution, agricultural fertilisers and pesticides, industrial wastes, mining and soil erosion that enter water courses and change its quality.

Industries including agro-industries require good quality water for a variety of productive and non-productive purposes. A negative change in water quality compromises the ability of industry to produce the goods and services it offers or add costs to production if water requires pre-treatment to remove contaminants.

The main impacts from changes in water quantity and quality relate to:

1. ecosystems
2. human health and well-being
3. agriculture and food security.

3.2.4.1 IMPACT ON ECOSYSTEMS

The impact on ecosystems from changes in water flows is driven by abstractions that reduce the volume of water flowing in a water course and change the ability of the ecosystem to function. Direct impacts are difficult to measure as little work has been carried out on the effects of water abstractions on ecosystem services and functions. What is clear is that as demands on water continue to increase water-related stress on both people and biodiversity is escalating rapidly.

Rivers provide many critical goods and services, including drinking water, power generation, nutrient recycling, organic matter retention, and habitat for many unique plants and animals and recreational activities.

Aquatic ecosystems are regulated by features and processes occurring at a range of spatial scales. At the largest scale, climate, geomorphology, and land use control channel morphology and stream hydrology, thermal regime and water chemistry, and biotic community structure. At finer scales, the availability of suitable habitat and food resources, as well as species interactions regulate organism populations. When superimposed on climate changes, anthropogenic disturbances including land use activities, and species exchanges will undoubtedly alter the way in which aquatic ecosystems respond to change.

A wide range of anthropogenic disturbances can impact on aquatic ecosystems, such as:

- point source discharges (for example, from factories or sewage treatment works)
- non-point source runoff from agriculture, urban or mining areas
- alteration of channel characteristics via sedimentation or siltation
- changes in the stream flow regime through dams or diversions
- removal of riparian zone vegetation
- introduction of exotic or alien species

In order for aquatic ecosystems to function sustainably, water courses need to constantly flow so minimum flow rates that provide the complex mix of biota and chemical interactions are required.

Water abstractions reduce the quantity of water in the rivers and thereby compromise the capacity of aquatic ecosystems to function optimally. The impacts of excessive or unsustainable abstractions include:

- the gradual demise of the river resulting in water shortages (downstream of abstraction point),
- increased risk of flooding due to changes in river bank protection and land use practices and increased physical changes to river morphology from floods that can scour the channel, resulting in mass mortality to algal, invertebrate, and vertebrate species,
- reductions in the number if viable populations of aquatic fauna (fish, snails, invertebrates, etc)
- increasing concentrations of pollution that can negatively affect the biota
- increasing water temperatures that can negatively affect the biota.

Rivers and riverine vegetation provide fish, thatching reeds, medicinal plants, fire wood and more. As long as the river ecosystem is healthy, and people do not harvest too much, a river can provide such natural products forever. Thousands of rural people are dependent on such resources for their livelihoods.

Rivers and streams provide corridors for movement, and suitable homes, for a great variety of species, from invertebrates to fish and birds, amphibians such as frogs, reptiles like crocodiles, and mammals. The streams are also home to numerous specially adapted plants and micro-organisms. The micro-organisms are vital in a river's purification function. Without the plants and animals found in healthy ecosystems, rivers cannot continue to provide their benefits.

Negative changes in water quality as a result of anthropogenic changes (mainly pollution), negatively affects the functioning of aquatic ecosystems impacting upon man's ability to use the water for productive or domestic purposes without the need and expense of treating it.

In the wider competition for water, ecosystems and biodiversity tend to be the first to be impacted upon. Activities that reduce biodiversity jeopardize economic development and human health through losses of useful materials, genetic stocks, and potential medicines. As ecosystems and biodiversity get degraded, their ability to lend resilience to the biosphere declines, and communities and human health suffer.

The decline in the quality of water flow has reduced the productivity of many terrestrial and aquatic ecosystems and led to changes in productivity and the services such ecosystems can provide. In some areas, the degradation of ecosystems has negatively affected fish, agriculture, and grazing and undermined the livelihoods of rural communities relying on these services.

3.2.4.2 IMPACT ON HUMAN HEALTH AND WELL-BEING

Human health and well-being is impacted directly by water supply management and indirectly through effects of these management approaches on the broader range of ecosystem services.

There is a growing recognition that the provision of water supply for drinking and sanitation achieves reductions in poverty through improved health and productivity. In addition, the availability of water is essential to the achievement of many of the Millennium Development Goals, including the eradication of extreme poverty and hunger through improved food production. However, without careful management, increases in water extractions for human development can come at the expense of water needed to sustain ecological systems. The pressures placed on freshwater ecosystems can affect their ability to continue to provide services such as clean water supplies, waste assimilation, climate regulation, and the maintenance of fertile soils, vegetative cover and species diversity.

Water is easily polluted by discharges from human activities and livestock, and dams usually interrupt the flow of rivers, altering fish habitats and upsetting nutrient balances downstream. Habitat loss and degradation, including from unsustainable agriculture and infrastructure development and overgrazing has removed plant cover, impairing the ability of natural systems to circulate and retain water from rainfall. This leads to water shortages, land degradation and loss of productive capacity.

The Millennium Ecosystem Assessment (MEA, 2005) endeavoured to assess the extent of the degradation of ecosystems around the globe. While the available data on the extent of the existing damage to ecosystem health was found to be incomplete, a clear observation was made regarding the disproportionate impact of the degradation of freshwater ecosystems on the lives of the poor, who are most often dependent on environmental services for their health, livelihood security and protection of their homes.

Better management approaches can be developed by using reliable information about the condition of and threats to freshwater ecosystems, as well as their impacts on human well-being.

At the basin level, the interacting processes and balances amongst plant species, climate and water flows regulate the carrying capacity of freshwater ecosystems to withstand human induced alterations. Innovative approaches to management, such as eco-hydrology, focus on understanding and manipulating the interplays between hydrology and biota. These techniques enable managers to control nutrient and pollutant loads in freshwaters and to regulate catchment hydrology that ultimately enhance or maintain ecosystem services and functions that benefit human health and well-being.

Poor water quality continues to pose a major threat to human health. Humans require good quality water to ensure a healthy life. A negative change in water quality increases the risk of disease. In peri-urban and rural areas, where water is seldom treated, negative changes in water quality bring increased risks of exposing water users to disease and poor health. A significant amount of disease could be prevented through better access to safe water supply, adequate sanitation facilities and better hygiene practices.

According to the Swaziland Vulnerability Assessment (GOS-VAC, 2012), an average total of 17% of households indicated that there are environmental hazards near water sources, with a regional distribution of 4% for Hhohho, 17% Manzini, 24% Lubombo and 27% in Shiselweni.

The human health impact of poor water quality is reflected in the incidences of diarrhoea. Out-patient records show the prevalence of four common ailments affecting Swaziland diarrhoea accounted for 84.4% of all out-patients cases.

3.2.4.3 IMPACT ON AGRICULTURE

Water quality impacts on agriculture by compromising the potential productive use of abstracted water. Irrigation water needs to meet minimum water quality standards if is not to negatively affect both the crop and the soil. Highly saline water can destroy a productive soil rendering it unusable without costly rehabilitation. Contaminated water can kill or reduce crop yields by interfering with crop growth processes.

Poor quality water can negatively affect the health of livestock. Bacteria and viruses found in poor quality water, often contaminated by coliform bacteria's. Bacterial polluted water may increase susceptibility or contribute to a variety of livestock disease problems. Water can serve as reservoirs for many different organisms and toxins. The organisms can survive for extended periods of time in surface waters and sediments. Surface water supplies to which livestock have ready access are always potential sources of disease-causing organisms. Fencing cattle out of streams and other surface waters reduces opportunities for exposure. Livestock allowed to drink from surface water sources are potentially at risk from bacteria and cropland runoff containing pesticides. In dairy cows, poor quality water can reduced milk yield and depress milk fat percentage.

Poultry, an important food and revenue sources for mainly rural communities and farmers, are also susceptible to the impacts of poor quality water. Water contaminated with microorganisms and algae can have a profound adverse impact on poultry performance. A major contributing factor to the presence and intensity of bacteria or algae contamination in poultry drinking water is the amount of dissolved nutrients, specifically phosphorus and nitrogen in the water. These nutrients facilitate the growth of bacteria and algae through a biological process known as eutrophication.

Ultimately, the impacts from poor water quantity and quality on crop and animal production also impact on food security, livelihoods, poverty and human health.

3.2.4.4 ENVIRONMENTAL INDICATORS: IMPACTS RESULTING FROM CHANGES IN WATER QUANTITY AND QUALITY

Environmental indicators should indicate the impact on the environment from changed water quantity in river basins and groundwater:

Reference is also made to the corresponding sections under the sub-themes of air quality, urban development and human health.

Indicator	Measurement	Source	Availability/Reliability
Changes in environmental flow	m^3/s	DWA	unavailable
Changes in ecosystem health	% in selected parameters	SNTC	unavailable
Changes in range of ecosystem services and goods (selected)	% change	SNTC	unavailable
Incidences of diarrhoea	number	MOH	available/reliable

3.2.5 RESPONSE

3.2.5.1 REGULATORY RESPONSE

River flows and water quality are regularly monitored by DWA and SWSC as a result of applicable national regulations.

3.2.5.1.1 WATER ALLOCATION AND WATER ABSTRACTION PERMITS

With a finite water resource, allocating available water to the demand sectors faces a complex adjudication process in assessing what sectors warrant, in terms of the potential economic use of the water, a water allocation.

In response to ensuring a rational and practical sharing of available water, Water Abstraction Permits are issued accordance with the provisions of the 2003 Water Act. Water permits for all water users is a mechanism for monitoring and managing the use of water resources (both surface and ground water) in the country.

The responsibility for water allocation and the issuing of permits lies with the Water Apportion Board. In terms of the 2003 Water Act, the powers of the Water Apportionment Board are to be transferred to each River Basin Authority as soon as the River Basin Authorities are established, capacitated and functioning.

The water allocation system prior to the 2003 Water Act was based on area of land, as well as available water in a river close by. The Board allocates water to one irrigated hectare on the theoretical basis of 0.771ℓ/s/ha (24 283 m^3/ha) above 530 meters above sea level and 0.875ℓ/s/ha (27 594 m^3/ha) below 530 metres above sea level, 24 hours per day and 365 days per year irrespective of the crop grown.

The 2003 Water Act introduced volumetric allocation. The National water Authority has endorsed the following volumetric allocations for different crops on the basis of crop water requirement:

- 8,000 m^3 per hectare per annum for irrigation of maize and vegetables
- 10,881 m^3 per hectare per annum for irrigation of sugarcane around Malkerns area
- 13,650 m^3 per hectare per annum for irrigation for irrigation of sugarcane in the north and south regions of the country
- 13,487 m^3 per hectare per annum for irrigation of sugarcane in the LUSIP area

In allocating water within a watercourse, the NWA or RBAs consider the economic development potential associated with the requested water use, between sectors, as well as between countries. The allocation of water at the national level should be in support of development initiatives as well as the National Development Strategy (NDS) and other development initiatives in order to maximise total economic development opportunities. This implies promotion of water efficient uses, with regard to the social development and food security impacts of other uses such as irrigation. This calls for, among other things, formulation and the implementation of appropriate water pricing systems that will reflect the economic and social value of water.

In cases when a drought is declared, the National Water Authority shall issue a rationing notice to all water permit holders to adjust their water abstraction quantities depending on the severity of the prevailing drought situation. The Act states that the rationing notices will be issued in the following order:

Table 44: Water Allocation Priority Table

Water Use Activity	Priority
Irrigation	7
Industrial use	6
Hydropower generation	5
International obligations	4
Natural environment	3
Primary purpose use	2
Domestic (urban and rural)	1

Rationing is implemented in a staggered fashion, whereby irrigated agriculture is rationed first, followed by industrial activities before rationing water for primary purpose. In some cases, this might not be possible due to inherent intertwined nature of industrial use of water and domestic water use. In such situations, which will normally occur in mainly urban areas, more restrictive measures may be imposed ranging from banning the use of hosepipes for washing cars, watering gardens, filling swimming pools and finally, a restriction on actual domestic use of water.

3.2.5.1.2 MONITORING WATER QUANTITY

Surface water flows are monitored by the Department of Water Affairs (DWA) through a network of river gauging stations.

The DWA maintains some 39 operational river gauging stations, well within the standard of WMO of at least 1 hydrometric station for every 1875 km^2 of surface area (see Annex 1). The stations are all operated by automatic recorders, all capturing data in electronic format of water levels, using the float-electronics technology. About 64% of the stations have a record that is over 20 years of data, 30% has over 30 years of data and 8% have over 40 years of data. Only one station has a record that is above 50 years long.

The DWA implements a programme for the rehabilitation of the measuring weirs throughout the country. There is an on-going programme to maintain the accuracy of the measuring weirs which is affected by high siltation rates and vegetation growth in front of the weirs.

3.2.5.1.3 MONITORING WATER QUALITY

Surface water quality is monitored by the DWA in industrial and rural areas, the Swaziland Water Services Corporation in urban areas and Geological Survey for ground water/boreholes.

The Swaziland Environment Authority (SEA) is mandated to monitor water quality through its Water Pollution Control Regulations (2010) however, the regulations are not enforced and no data exists and no prosecutions for polluting water have happened.

The laboratories run by both DWA and SWSC monitor a range of physical and chemical parameters to ensure that water quality meets national minimums described in Schedule One of the Water Pollution Control Regulations.

Water quality data collected by DWA and SWSC is normally not readily available. Data are in the process of being digitised by DWA.

Water quality monitoring consists of a network of sampling sites throughout all the major river basins. Water sampling is done once a month for all the standard sites. However, the frequency is increased for the pollution prone areas.

SWSC Monitoring

For areas served by the SWSC, SWSC operates 23 treatment plants where raw water is treated by a variety of conventional processes including chemical coagulation and flocculation, pH control, clarification, filtration and disinfection to ensure removal of microbiological organisms and the compounds responsible for causing the presence of colour and turbidity. Once treated, the drinking water is distributed to customers via a network of mains and 75 service reservoirs.

SWSC's water quality monitoring program currently covers 159 sampling points that are distributed as follows:

- Raw water: 23
- Treated water: 23
- Distribution water: 60
- Wastewater: 53

SWSC have a laboratory where sampled water is tested.

The monitoring program covers SWSC's raw water sources, treatment plants, service reservoirs and end user points (selected customer taps). In 2009/2010 a total of 5,203 potable water samples collected from all the SWSC service areas across the country were analysed (SWSC, 2010). The overall 2009/2010 annual microbiological and physico-chemical compliance for potable water based on WHO Guidelines for Drinking Water (2006) was reported as 93.0% (SWSC, 2010).

DWA Monitoring

The Laboratory Section of the Department of Water Affairs under the MNRE is responsible for water quality monitoring. The section is responsible for advising the department and interested stakeholders on the water quality situation. Activities of the section include:

- Carrying-out of effluent and water analysis tests
- Water Quality Sampling (there are 81 water sampling points spread throughout the country)
- Documentation and control of laboratory stores
- Documentation and enforcement of laboratory safety procedures
- Advising the water control section and water users on the water quality situation.

3.2.5.2 SYSTEMIC RESPONSE

Policies and Plans

The National Water Policy

The Swaziland National Water Policy (still draft) closely conforms to the policy principles and statements of the SADC Regional Water Policy and it is noted in the policy document that international, continental, regional and national developments have informed policy statements. The policy constitutes a political statement of intent with respect to water resources development and management which is intended to:

- Provide guidance to water managers, legislators and supporting partners.
- Promote integrated planning, development and management of water resources
- Ensure access to previously deprived sectors of society
- Promote sustainable development
- Ensure a minimum in-stream flow requirement to be incorporated into laws and regulations governing the use of the resource.

The Integrated Water Resources Master Plan

The primary objective of the Integrated Water Resources Master Plan is to provide strategic guidance to decision makers and water users on how best to develop and manage the country's water resource within the framework for the implementation of existing policies and legislation. Specific objectives are to:

- Provide relevant information on water situation in the country and its usage for planning purposes
- Provide guidelines for the development and management of water resources
- Point out potential development options for making more water available
- Provide guidelines on equitable and sustainable water usage

The overall goal of the IWRM Plan is to develop and manage water resources in a planned and coordinated manner taking into account the projected requirements of the various economic and social sectors which depend on enhanced availability of sustainable quality water to meet their respective goals.

Legislation

In response to the need to manage the national water resource in a sustainable and equitable manner, the Ministry of Natural Resources and Energy gazetted the Water Act of 2003. The Act establishes a National Water Authority and promotes improved catchment management through stakeholder participation and decentralization of the management of the water resource through River Basin Authorities. The Act also calls for the preparation of a Water Resources Master Plan to equip stakeholders with sustainable water management requirements and options.

In 2006 Swaziland initiated the preparation of its Integrated Water Resources Management Plan (IWRM) in partial fulfilment of the Johannesburg Plan of Implementation with Dutch funding. Though still under preparation, the IWRM Plan is intended to provide crucial guidance to decision-makers and water users on how best to manage the country's water resource.

In response to the need to have good quality water available for use, the SEA gazetted the Water Pollution Control Regulations in 2010 to provide legal guidance on the water quality objectives for Swaziland to ensure a high level of protection for the environment and human health. The Regulations specify effluent discharge standards for physical and microbial parameters, for chemical parameters and for organic pollutants.

3.2.5.2.1 INTERNATIONAL WATERS

Swaziland's response to cooperating on international water matters was the 2003 Water Act which requires that government, through the National Water Authority, are to advise the Minister on international waters matters. The Act formally recognises The Joint Water Commission established by the Governments of Swaziland and the Republic of South Africa, the Komati Basin Water Authority established by the Governments of Swaziland and the Republic of South Africa and similar commissions, committees or authorities which have been or may be established between the Governments of Swaziland, the Republic of South Africa, and the Republic of Mozambique.

Swaziland's commitment to upholding international water interests started in 1992 when the governments of Swaziland and South Africa signed a treaty for the establishment and functioning of the Joint Water Commission. In addition to any other functions or powers conferred on the Commission, it advises the two countries on all technical matters relating to the following:

- The criteria to be adopted in the allocation of the utilizable portion of water resources of common interest between the two countries;
- The investigations for the development of water resources of common interest by the two countries, including the construction, operation and maintenance of any water works;
- The prevention of and exercise of control over, the pollution of water resources of common interest.

Another international body is the Komati Basin Water Authority, which is a bilateral company formed in 1993 under the Treaty on the Development and Utilization of the Water Resources of the Komati River Basin, 1992, entered between the Government of the Kingdom of Swaziland and the Government of the Republic of South Africa. Its purpose is to implement Phase 1 of the Komati River Basin Development Project comprising the design, construction and maintenance of Driekoppes Dam in South Africa and the Maguga Dam in Swaziland. Both the Treaty of the Establishment and Functioning of the Joint Water Commission and the Treaty on the

Development and Utilization of the Water Resources of the Komati River Basin recognize the rights of Mozambique to a reasonable and equitable share of the water resources of shared rivers.

A Tripartite Technical Committee (TCTP), established under the Tripartite Agreements between Swaziland, South Africa and Mozambique, is responsible inter alia for the identification and prioritization of capacity-building challenges and opportunities in the water sectors of the three parties and the establishment of regime allocations.

The member states of the Southern African Development Community signed a protocol on shared watercourses (Protocol on Shared Watercourses in SADC, 2000). The overall objectives of the protocol are to foster closer cooperation for judicious, sustainable and coordinated management, protection and utilization of shared watercourses and to advance the SADC agenda of regional integration and poverty alleviation.

3.2.5.2.2 INTERNATIONAL AGREEMENTS

SADC Regional Water Policy

Water policies exist at the regional and national level. Regional water policy is embodied in the Southern African Development Community (SADC) Regional Water Policy. The principles embodied in this policy are anchored in the following pronouncements:

- SADC Declaration and Treaty
- The Southern African Vision for Water, Life and Environment
- The Revised SADC Protocol on Shared Watercourses
- The "Dublin Principles"

The policy document sets out the factors constraining and the challenges inherent in the effective management of region's water resources.

Joint Water Commission Treaty

The Joint Water Commission Treaty between Swaziland and South Africa was concluded in 1992, and replaced the Joint Permanent Technical Committee which served as a discussion forum on matters of mutual interest since 1979 (DWAF, 2000).

The JWC is intended to act as technical advisor to the two governments on all matters relating to the development and use of shared water resources. The functions of the JWC include:

- Alleviating short-term water shortages on shared rivers during drought periods;
- Undertaking joint or separate investigations of potential water resource developments;
- Developing criteria to be adopted for the allocation of water;
- The prevention and control over pollution and soil erosion, and any other matters pertaining to the development of water resources and the utilisation;
- Acknowledging the interests of Mozambique in any water resource common to the three countries.

Protocol on Shared Water in SADC

All water resources in Swaziland are shared with South Africa (upstream) and/or Mozambique (downstream), so the SADC protocol on shared water applies (SADC, 2000). The overall objectives of this protocol are to foster closer cooperation among member states for equitable, sustainable and coordinated management, protection and optimal utilization of shared watercourses. In terms of the agreement member States are required, inter alia:

- to promote a coordinated, integrated and environmentally sound management and development of shared watercourses;
- to maintain a proper balance between development and conservation;
- to cooperate on all projects that could affect shared resources;
- to share available data on flows, water quality, meteorological and ecological condition;
- to establish shared watercourse agreements and shared watercourse institutions for the management of shared watercourses;
- to promote measures for the protection of the environment and the prevention of all forms of environmental degradation arising from the utilisation of the resources of the shared watercourse systems;

- to assist in the establishment of a list of substances whose introduction into the waters of a shared watercourse system is to be banned or controlled;
- to promote environmental impact assessments of development projects within the shared water-course systems.

Best Joint Utilisation Treaty

The Best Joint Utilisation Treaty was initially an agreement between South Africa and Portugal regarding rivers of mutual interest, which was signed in 1964. Swaziland acceded to the agreement in 1967. Subsequently, the governments of Swaziland, South Africa and Mozambique have reaffirmed their acceptance of this treaty in terms of Joint Water Commissions. The treaty is intended to promote the rational development of water resources of mutual interest.

Mbuluzi Agreement

The Mbuluzi Agreement between Swaziland and Mozambique obligates Swaziland to release, in perpetuity, 40% of flows measured at gauges GS3 (Croydon) and GS10 (Mpisi) during the dry season. The annual cross-border requirement was initially estimated to be 90 Mm^3/a. A subsequent estimated, based on the long-term MARs at GS3 and GS10, suggested a higher figure of 108 Mm^3/a.

Implementation of this agreement has been problematic because of uncertain hydrology and insufficient institutional capacity (Juizi et al, 2006). Flow records at GS32 and the gauge in Mozambique are not good enough to reliably compare annual flows against the requirement. Cross border flows are not given much consideration in deciding on releases from Mnjoli Dam, particularly when water level in the dam is low.

This has never been an issue in the past, as Mozambique did not fully use the resource, but the situation will become more critical in the future. Another shortcoming of this agreement is that it does not promote integrated operation of Mnjoli and Pequenos Libombos Dams, in particular, the control of floods.

Komati Treaty

The bi-national Komati Treaty between Swaziland and South Africa was concluded in 1992. The treaty established the Komati Basin Water Authority (KOBWA), responsible for the design, construction, operation and maintenance of Maguga and Driekoppies Dams, subject to approval by the JWC. The agreement recognises the Helsinki Rules and the rights of Mozambique.

The agreement recognises "The right of the Republic of Mozambique to a reasonable and equitable share in the use of the waters of the Inkomati River Basin …" (Article (5)), but leaves it for further negotiations in future. Furthermore, Mozambique is directly affected through reduction of water quantities, but the Treaty does not quantify nor clarify how this "right" is to be effected to satisfy Mozambique water requirements.

Pigg's Peak Agreement

The tri-national Pigg's Peak Agreement concerns the use and development of the Komati River Basin. The purpose of the treaty is to implement Phase 1 of the Komati River Basin Development Project, comprising the design, construction and maintenance of Driekoppies Dam in South Africa and the Maguga Dam in Swaziland.

The Swaziland contribution to a minimum flow amounts to 0.35 m^3/s, of which 0.21 m^3/s is to be derived from the Komati River and 0.14 m^3/s from the Lomati River. Long-term water allocation issues on the Incomati River Basin are being discussed by the TPTC through the Incomati System Task Group (ISOTG). Whatever the outcome, the net effect is that the Swaziland share would diminish from its present levels; the exact amount is subject to the on-going negotiations.

Inco-Maputo Interim Agreement

The tri-national Inco-Maputo Interim Agreement concerns the Incomati and Maputo River Catchments only, i.e. Komati, Incomati, Sabie, Crocodile, Lomati, Usuthu and Pongola Rivers and their tributaries (TPTC Inco-Maputo Agreement, 2002a). The agreement is based on the Revised SADC Protocol on Shared Watercourses, and reflects the principle of equitable and reasonable utilization of shared watercourses for economic and social purposes between the three countries, as well as ensuring protection of the environment. The main objective of the agreement is to promote cooperation between the countries and to ensure the protection and sustainable utilisation of the shared water resources. The agreement covers a wide spectrum of aspects, including exchange and access to information, drought and flood controls, water quality and pollution prevention, incidents of accidental pollution and other emergency situations. The agreement also guarantees the water supply for Maputo for the foreseeable future.

The agreement describes the availability of water in the two basins, and quantifies allocations for each country in terms of priority supplies (i.e. water for urban, domestic, livestock and industrial use), irrigation requirements and afforestation. The agreement concerns not only the quantity of water, but also the quality and reliability of flows to sustain the watercourses and their associated ecosystems, including the estuary. The agreement was signed at the world summit in Johannesburg in August 2002. The value of the agreement lies in the setting out of baseline data on current water use in the Incomati and Maputo Basins for each country and the estimation of future requirements for Mozambique. The future requirements are subject to further studies to generate the required information to establish a comprehensive agreement. The water allocation figures stated in the Agreement are in close agreement with those established for the Komati Basin Treaty with South Africa. These figures will be applicable following commissioning of Driekoppies and Maguga Dams and the coming into effect of the Inco-Maputo Agreement which "shall remain in force until 2010 or until superseded for the relevant watercourse by comprehensive water agreements in the Incomati and Maputo watercourses supported by joint studies, whichever is the earlier".

The intention of this interim agreement is partly to fulfil the requirements of the Pigg's Peak Agreement (see above) where 2 m^3/s were to be delivered at the border to meet Mozambique's water requirements on the Komati River upstream of the confluence with the Sabie River. Any water contributed by Swaziland to satisfy the requirements of the Pigg's Peak Agreement would reduce Swaziland's net water allocation under the Komati Basin Treaty. The removal of this amount of water would impact negatively on water availability to Swaziland. The situation would apply during the validity of the Inco-Maputo Interim Agreement, or until comprehensive long-term water allocation agreement is negotiated for the Komati and Maputo River Basins.

The tri-national Inco-Maputo Interim Agreement is supported by a resolution concerning water quality management goals and criteria, the exchange of and access to information and data among the three countries, and a framework for capacity building within the three countries (TPTC Inco-Maputo Agreement, 2002b). The resolution provides, inter alia, short-term water quality guidelines, and a management plan for the exchange of information on water quality, hydrometrics and other relevant data.

The agreement was signed in Maputo in August 2002. The city of Maputo, including Matola and the Machava Industrial Zone, currently abstracts about 39 Mm^3/annum from the Mbuluzi River at Boane (Consultec, 1998). Projected demands for the year 2017 range between 162 and 263 Mm3/a (Consultec, 1998). Clearly, there is not enough water in the Mbuluzi River to supply this demand, and water resources from the Mbuluzi River were expected to be exhausted by the year 2007 (Consultec, 1998).

3.2.5.2.3 INSTITUTIONAL RESPONSE

National Water Authority

In response to the need to manage the national water resource in a sustainable and equitable manner, the Ministry of Natural Resources and Energy gazetted through the Water Act of 2003, created a National Water Authority (NWA).

The NWA is composed of representatives from key government ministries, from industry, from water users associations and individuals on Swazi Nation Land. The Department of Water Affairs is secretariat for the NWA.

According to Section 3 of Water Act of 2003, the National Water Authority is a body corporate capable of suing and being sued in its corporate name, and with the full power and authority to do all things which may be required or which reasonably appear to be required for or incidental to the carrying out of its objects and the performance of its duties and obligations. The NWA was formed in April 2003 in accordance the Act. The Authority advises the minister responsible for water affairs and it also provides direction on water issues such as policy development and other related issues in the land.

The functions of the NWA are to (Section 8 of the Act):

a) prepare, and update, the Water Resources Master Plan;
b) advise the Minister on the appointments of persons to serve in the Joint Water Commissions any other international or national water commission;

c) advise the Minister on the promulgation of regulations with respect to the setting of fees or charges for covering operation, cost and maintenance of government works, application fees, fees for appeals or charges for use of water;
d) oversee the work of and provide policy criteria and direction to the Board and Project Boards (PBs), River Basin Authorities (RBAs), and task forces and to approve their budgets before they are submitted to the Minister;
e) advise the Minister on policy directions relating to water affairs;
f) co-ordinate the work of different boards, water sector agencies and international water commissions;
g) recommend policy with respect to the issue, renewal, amendment or cancellation of permits;
h) hear appeals to the Board, as provided in section 32;
i) monitor and recommend policy direction and guidelines to the Swaziland member of the Tripartite Permanent Technical Committee (TPTC) and the Joint Water Commission (JWC) and any other international water commission;
j) review and consider recommendations from the TPTC, JWC and any other international water commission and make recommendations thereon to the Minister;
k) determine the proper management of works and ensure that periodic safety inspections are made of all works
l) consider, approve, amend or reject water development proposals.
m) recommend to the Minister the adoption of water quality objectives;
n) recommend to the Minister time limits for renewal of permits;
o) cause to be maintained, expanded and continued, the collection of hydrological, meteorological or other water related data and to arrange for the collecting and making available to the Authority, to the Board and to the public of all such data as may be obtained; and
p) do such other things as the Minister may in writing assign to the Authority

Department of Water Affairs (DWA)

One of the key institutions to be established under the Water Act of 2003 (Section 18(1) – (3)) is the Department of Water Affairs (DWA). The process of establishing DWA is currently underway. The Department of Water Affairs will be established within the Ministry responsible for water affairs according to section 8(1). The DWA will be headed by a Director, and will consist of professional, technical, administrative, clerical and other staff as may be required. The responsibilities of the DWA will be to:

a) provide technical support and advice to the NWA as per section 17(4);
b) arrange for provision of technical advice and co-operation from and with other Ministries;
c) designate inspectors for purposes of carrying out the Act;
d) ensure prosecution of violators of the Act; and
e) be the secretariat of the NWA as per section 18(3);
f) monitor surface, ground-water and water releases from and to international borders as per international law and any agreements between Swaziland and its neighbouring states;
g) monitor surface and groundwater quality to control water pollution;
h) ensure that projects that are dependent on water resources are fully supported through the provision of adequate water supplies;
i) seek international agreements that ensure an equitable water apportionment with neighbouring states, in compliance with international law;
j) periodically review Swaziland's surface and groundwater balances; in the light of developments that have taken place in Swaziland and upstream;
k) implement the national Water Resources Master Plan (WRMP) (a National Water Resources Strategy) and other water strategies water policies as approved by the NWA;
l) develop and implement drought and flood management strategies; and
m) coordinate water management for equitable allocation, utilisation and sustainability of water resources by River Basin Authorities, other government departments and non-governmental organisations.

River Basin Authorities

A river basin authority (RBA) is a statutory body established in terms of the Water Act and it is a body corporate capable of suing and being sued in its own name and it has such other powers as a body corporate may have (*Section 33(4)* of Water Act of 2003). According to *Section 33(1)* of the Water Act, the Minister responsible for water affairs shall, within five years of coming into force of the Act, establish, upon the recommendation of the National Water Authority and subject to *Subsection (7)*, five River Basin Authorities by notice in the Gazette. The RBAs are established to implement a management plan under the Water Resources Master Plan dealing with a specific geographical basin area (*Section 33(2)*). The river basins for which Authorities are established are Komati, Lomati (Mlumati), Usuthu (Usutu), Umbeluzi (Imbuluzi) and Ngwavuma (Mwendera and Manyatsi, 2007).

The functions of the RBAs are to:

a) keep database of basin info (water availability & demand) and monitor and record water changes in basin;
b) issue, amend and renew or suspend water permits;
c) impose water restrictions in times of shortage;
d) investigate need for water resources development and advise NWA on need to appoint Project Boards;
e) arbitrate user disputes;
f) monitor and control water quality and enforce effluent regulations;
g) investigate need for inter-basin transfers, negotiate and advise NWA;
h) levy and collect rates and charge to defray part or all costs of RBA upon approval of NWA;
i) have authority over Irrigation Districts, Project Boards and User Associations

The objects of an RBA are to conform to and to implement the Integrated Water Resources Master Plan, and to advise the National Authority on basin issues (*Section 33(6)* of the Act).

RBAs were gazetted in 2010 but remain ineffective due to lack of funding.[20]

3.2.5.2.4 INVESTMENT RESPONSE

Construction of Dams

The Government of Swaziland has over many years invested heavily in water storage dams for domestic water supplies and for irrigation. The main dams are described in Table 45.

Table 45: Main Storage Dams in Swaziland

Name	Capacity (10^6 m^3)	Surface area (Ha)	Date established	River System
Hendrick Van Eck	10.4	124.0	1969	Usutu
Lavumisa dam	0.35	27.22	1996	Pongola
Luphohlo dam	23.6	120.0	1984	Usutu
Maguga dam	332	1042.0	2001	Komati
Mnjoli dam	153	1500.0	1980	Mbuluzi
Mnkinkomo weir	3.2	-	1963	Usutu
Lubovane dam	155	1390	2009	Usutu
Nyetane dam	6.0	-	Raised 1992	Usutu
Sand River dam	50	590	1965	Komati
Sivunga dam	6.9	110	1972	Usutu
Hawane dam	2.75	70	1984	Mbuluzi

Source: Adapted from Mwendera *et.al*. 2002.

A total of 11 major dams store water for irrigation, domestic and industrial purposes exist in the country, with combined storage capacity of 743.2 x 10^6 m^3.

Construction of Small Earth Dams

Small earth dams have been used for several decades in rural areas to provide domestic, crop and livestock water. Under an EU project in the late 1990's over 25 dams were constructed. Under the Swaziland Agricultural Development Project (FAO/EU) 10 medium to large earth dams will be constructed or rehabilitated with downstream infrastructure to store runoff water for domestic, crops and livestock uses (3 sites selected for rehabilitation and 7 new sites identified for a further feasibility studies) (FAO Office of Evaluation (OED), 2011)

Rainwater Harvesting

[20] According to DWA, the establishment of RBAs has been delayed by factors such as difficulties convening stakeholder and other meetings, organisational and bureaucratic constraints, lack of human skills and lack of commitment among interim RBA committees.

Rainwater harvesting has largely been carried out on an ad-hoc basis in the country, with little or no formal support through established policy or institutions. Rainwater harvesting has largely been the private preserve of individual rural homesteads. This has for the most part been influenced by the variations and seasonality of rainfall in the country and the effects of recurring or extended droughts, particularly in recent years.

Improving rainwater harvesting during periods of sufficient rainfall will have to be a major priority of water resources development as it will ultimately contribute to increasing the reserves of "green water" from which it has been determined that most of the biomass is derived.

Rural homesteads utilize rainwater harvesting to the extent that they can. However, they do not receive adequate institutional support for their efforts. Promoting rainwater harvesting coupled with other inputs such as marketing and strategic storage facilities will enhance productivity from rain-fed agriculture thus effectively contributing to self-sufficiency in food production and ultimately food security, which includes adequate nutrition.

3.2.5.3 ENVIRONMENTAL INDICATORS: RESPONSE TO CHANGES IN WATER QUANTITY AND QUALITY

Environmental indicators to measure the response to water quantity and quality on the environment are:

Indicator	Measurement	Source	Availability/Reliability
Finalisation and Implementation of the IWRM Plan	finalisation and implementation	DWA	not available
Regional and international agreements signed	number	DWA	available
Establishment and functioning of RBA	number	NWA	available
Infringements of the Water Pollution Control Regulations	number	SEA, SWSC	unavailable
New legislation encompassing water management and treatment	number	SEA	available

3.3 THEME 3: ATMOSPHERE

The theme Atmosphere contains sections on air quality, climate and climate change, natural disasters and stratospheric ozone.

3.3.1 AIR QUALITY

3.3.1.1 DRIVING FORCE

The main driving force affecting air quality is the need of a growing population for the consumption of various commodities and a corresponding demanding lifestyle or better living standards. In a macroeconomic context, production or consumption processes can be structured according to economic sectors, e.g. agriculture, energy, industry, transport, households.

3.3.1.1.1 ENVIRONMENTAL INDICATORS: DRIVING FORCE AFFECTING AIR QUALITY

Environmental indicators related to air quality are:

Indicator	Measurement	Source	Availability/Reliability
Population growth rate	%	CBS	available
Macro-Economic development	GDP growth rate & GDP per capita	MEPD	available
Energy consumption	% growth	MNRE	available
Urbanisation (urban growth rate)	%	MHUD	available
Number of polluting industries	numbers	Annual emission reports, SEA	limited

3.3.1.2 PRESSURE

Pressure is the result of meeting human needs through industrial and energy production processes and other activities such as transport and using the atmosphere for emissions resulting in air pollution and GHG increases.

Air pollution is considered to be the emission of chemical substances (pollutants) into the atmosphere that have the potential to cause negative impacts on the environment. There are two main factors contributing to air quality:

- Those factors causing a pollutant either to be emitted or formed; and
- Those factors causing a pollutant either to be dispersed or removed from the atmosphere

Anthropogenic and natural sources of air pollution include a variety of industrial and mining processes, in particular coal-fired power generation, paper and pulp processing, transport, etc as well as veld fires and other biomass burning such as in agriculture. Also insufficient control of burning and other waste disposal and domestic use of fossil fuels and tobacco contribute to air pollution. Different pollutants are associated with each activity, ranging from volatile organic compounds and heavy metals through to dust and odours.

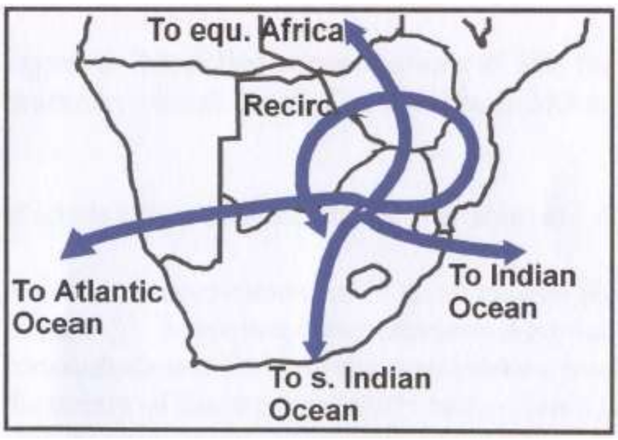
3.3.1.2.1 INDUSTRIAL PRODUCTION AND COMBUSTION CAUSING AMBIENT AIR POLLUTION

Ambient (outdoor) air quality is generally expected to be worse in urban and industrialised areas compared to rural areas. Industrial production in Swaziland is limited to a few industries, mainly producing sugar, food and drinks. Swaziland does not have large and strongly polluting industries, such as power stations or chemical and metal industries.

Most industrial production processes, including the transport of materials and produce, are energy intensive and can generate significant pollution and waste. Also the development of supportive infrastructure and the treatment or disposal of different types of waste may contribute to pollution. Poorly managed processing will generate a range of by-products which may be hazardous to the environment if not properly treated. Industrial processes also deliver greenhouse gas emissions (see next section on climate change).

Combined industrial activities will have an effect on ambient air pollution, however it will be difficult to separate local effects from pollution derived from South African industrial sources. Significant atmospheric sources occur from coal-fired power stations mines in neighbouring South African provinces, notably Mpumalanga. Due to trans-boundary air movements these will affect and most likely dominate air quality of Swaziland (Figure 16).

Figure 16: Main Transport Pathways out of the South African Highveld



Of the 11 operational coal-fired power stations in South Africa, 8 are found in Mpumalanga province, contributing roughly 70% of the total electricity generated in South Africa. Much of the demand for electricity in Southern Africa, including Swaziland, thus generates ambient air quality impacts that are felt largely in Mpumalanga and the surrounding areas.

The Mpumalanga Province State of the Environment Report (RSA Mpumalanga Province, 2003) notes that ambient air quality in Mpumalanga is influenced by regional air movements, which are responsible for the distribution of air pollutants both within the province and between neighbouring provinces and countries. Air quality impacts are governed by the distribution of air pollutants, with impacts sometimes being experienced some distance from the pollution source.

Five possible pollutant transport pathways do occur from the SA Highveld, two most important of these routes being the direct transport towards the Indian Ocean and the recirculation over the sub-continents, both running over Swaziland (Scholes, 2002). These pathways relate to frequently occurring wind patterns in the region, with westerly winds favouring the import of pollution from neighbouring Mpumalanga into Swaziland. Westerly winds may also dominate when a high pressure system is located to the north (Limpopo province and Zimbabwe) or when a low pressure system is found in the SE part of South Africa.

Ambient air quality can be greatly affected by specific climatic conditions. Swaziland and neighbouring Mpumalanga experience distinct weather patterns in summer and winter that affect the dispersal of pollutants in the atmosphere. In the summer months, unstable conditions result in mixing of air and rapid dispersion of pollutants in the atmosphere. Summer rainfall also removes pollutants through wet deposition. In contrast, the winter months are characterised by atmospheric stability caused by a persistent high pressure system. This high pressure system results in subsidence, causing clear skies and pronounced temperature inversions at night. The temperature inversion layer keeps the air pollutants trapped in the lower atmosphere, causing increasingly poor air quality. Conditions in the winter months are highly unfavourable for the dispersion of atmospheric pollutants (Preston-Whyte and Tyson, 1988).

Emissions at low levels (such as from veld burning, households or vehicles) will not disperse much at night because of the atmospheric stability, causing high concentrations of pollutants at ground level despite the relatively low emissions quantities. Day time low level emissions are readily mixed into the convective layer close to the earth's surface.

Ozone formed in the lower atmosphere (troposphere) is one of the gasses contributing to air pollution and GHG. Its position and significance is different from the ozone occurring in the ozone layer in the stratospheric part of the atmosphere (see the last section of the Theme Atmosphere).

Ozone in the troposphere is formed when sunlight causes complex photochemical reactions involving oxides of nitrogen (NOx), volatile organic hydrocarbons (VOC) and carbon monoxide that originate chiefly from gasoline engines and burning of other fossil fuels. Woody vegetation is another major source of VOCs. NOx and VOCs can be transported long distances by regional weather patterns before they react to create ozone in the atmosphere, where it can persist for several weeks.

Everywhere where economic development has led to the increased use of fossil fuel for industry, electricity generation, or transport, ambient concentration of ozone has risen. This is due to the increased emissions of nitrogen oxides and volatile organic compounds (VOCs) leading to the formation of ozone. This process of ozone pollution, which started in the U.S. around 1960 and a decade later in Europe is now becoming a pressing problem in rapidly industrialising developing countries.

Transport in general is a major source of air pollution: sources include road vehicle exhaust emissions, airport and air traffic releases, emissions from filling station, etc. The recent growth of road transportation expressed by the number of cars has increased Swaziland's power contribution to air pollution. The main pressure on air quality in urban areas is the continued increase in population and cars.

3.3.1.2.2 BURNING OF BIOMASS CAUSING AMBIENT AIR POLLUTION

Along with industrial sources of air pollutants, a second group of polluting activities is related to the burning or natural decomposition of natural biomass residues. The most important factor here is fires (veld fires and forest fires).

Each year, people set fire in many parts of Swaziland to create and maintain farmland and grazing areas. They use fire to keep unwanted plants from invading crop or rangeland, to drive grazing animals away from areas more suitable for crops, to remove crop stubble and return nutrients to the soil, and to convert natural ecosystems to agricultural land. The burning over the course of the year, in response to the country's rainy and dry seasons.

These wildfires, or anthropogenic fires, resulting from the intervention of humans and purposeful or accidental ignitions are becoming increasingly frequent, are the most damaging type of fires leading to land degradation and loss of biodiversity.

Also natural fires contribute to burning of savanna and other land. Natural fires occur seasonally and are typically ignited by lightning; such fires often actually maintain the biodiversity or indigenous flora and fauna of that area.

The massive burning that occurs in Africa each year creates carbon dioxide and aerosol particles, both of which play a role in global climate change. Finally, the smoke and accompanying gases and particles create a public health hazard; during an area's burning season, the amounts of ground-level ozone and other air pollutants can become hazardous to human health.

A further important factor here is the burning of sugarcane in the field before the actual processing starts. In the Swazi sugar industry sugarcane is harvested largely by hand and before harvesting the field is first set on fire. Some 47,000 ha of land is covered in sugarcane. Apart from CO2, the burning of the sugarcane crop produces large amounts of particles and toxic gases. Fine particles (PM2.5) are the major cause of reduced visibility in parts of the Lowveld can be carried by the wind and settle on soil or in water altering nutrient balances and increasing acidity of the system. In a study by Andrea et al. (1998), two sugar cane fields of 12 and 43.7 ha area located near Big Bend, Swaziland and were due to be burned, were set on fire. The fires burned very intensively with large flames and consumed about 25 tons of dry mass per hectare.

Another important component is the fugitive releases from commercial agriculture including crop and livestock farming as well as from landfills.

3.3.1.2.3 ENERGY USE CAUSING INDOOR AIR POLLUTION

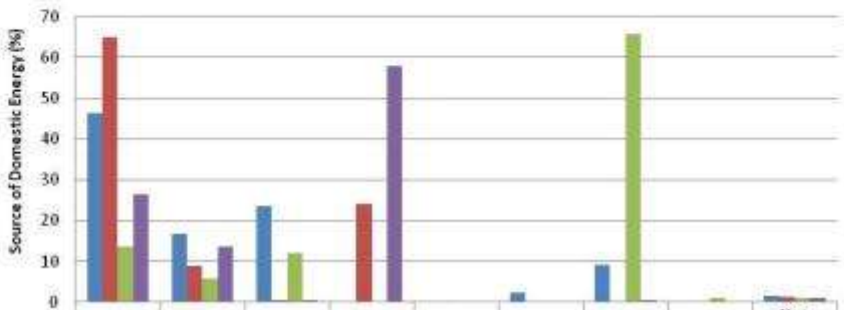
Information on trends in household energy use in Swaziland derived from the 2007 population census provides an insight into domestic reliance on fossil fuels, potentially contributing to poor indoor air quality.

Table 46: Rural Household Energy Source for Cooking (1997 & 2007)

Energy Source for Cooking	% Usage in Rural Households (1997)	% Usage in Rural Households (2007)
Wood Fuel	81	65.7
Electricity	5	26.5
Paraffin	4	13.6
LPG	4	0.5

Figure 17 shows the percentage of households in rural settings using various different types of energy for cooking from two census years. The rural energy use trends do appear to have changed significantly since 1997. The percentage of rural people using wood and gas decreased from 1997 to 2007, but the use of by electricity and paraffin increased over the same period.

Figure 17: Domestic Sources of Energy for Cooking and Lighting (2007)



	Electricity	Paraffin	Gas	Candle	Solar	Coal	Wood	Other	Not Reported
Urban Cooking (%)	46.4	16.8	23.5			2.4	9	0.3	1.6
Urban Lighting (%)	65	8.9	0.5	24.1	0.1		0.1	0.1	1.2
Rural Cooking (%)	13.6	5.8	12		0.2		65.7	1	0.9
Rural Lighting (%)	26.5	13.6	0.5	57.8	0.2		0.4	0.1	0.9

Source: GOS-CSO, 2010

Figure 17 shows domestic sources of energy in 2007 for cooking and lighting in both rural and urban areas. The data indicate that in rural areas there is a far greater reliance on energy sources other than electricity. These sources include candles, paraffin and wood. The energy sources favoured in rural areas are not 'clean' fuels and their continued use will invariably lead to indoor air quality problems. The extent of these potential indoor air quality problems depends on a number of factors, including the rate of use of the energy sources, housing structure, local climate and other potential sources of pollution.

3.3.1.2.4 ENVIRONMENTAL INDICATORS: PRESSURE ON AIR QUALITY

Environmental indicators indicating the pressure on air quality relate to production and other processes that cause air pollution.

Indicator	Measurement	Source	Availability/Reliability
Ambient (outdoor) air pollution			
Air emissions of pollutants from industrial production	µg/m^3 (parameters in Air Pollution Control Regulations)	Industries/SEA	?
Electricity generation from coal-fired power stations (8) in Mpumalanga	quantity of electricity	SEC	available
Number of vehicles (diesel/petrol)	numbers	Central Motor Registry	available
Petroleum usage	quantity in ℓ	MNRE Energy Dept	available
Waste burning and landfills	quantity burnt (t)	Municipal councils, landfill managers	unavailable
Cane biomass burning	quantity (mass)	Sugar industry	available
Veld biomass burning (veldfires)	number of occurrences, area (ha), biomass quantity	SNTC	part available
Complaints on air pollution	number	SEA	
Indoor air pollution			
Changes in household sources of energy	%	Census (CSO), Energy Balance	available
Household air pollutants emitted by various technology used for cooking, lighting, space heating, appliances, water heating	µg/m^3 (different stove types: charcoal, electric, LPG, paraffin, wood & open fire)	SEA, MNRE ED (Energy Balance report)	available
Energy units consumed (per month)	candle – number; wood – kg; disposable batteries – no; electricity – kWh; LPG – kg; paraffin litres; charcoal - kg	SEA, MNRE ED (Energy Balance report)	Available

3.3.1.3 STATE

As a result of no consistent monitoring of air quality in Swaziland it is not possible to present a national state of air quality but from the above pressures and drivers and recognising monitoring work carried out in South Africa and other regional countries one can expect that ambient air quality does change and is very location specific, i.e. areas around Matsapha and sugar mills is likely to have greater concentrations of air pollution.

Due to Swaziland's proximity to Mpumalanga Province in South Africa and the regional wind patterns, one can expect that to some extent outdoor air quality will be influenced by emissions derived from processes in South Africa notably from the coal fired power stations operated by Eskom.

Pollutants which are important for monitoring purposes due to their resulting in widespread exposures and risks are: inhalable particulates (PM10), nitrogen dioxide, ozone, and benzene. PM10 concentrations have been shown to be elevated across the country with significant exceedances of human health limits. Increasing emphasis is being placed on PM10 due to the issuing of linear dose-response curves for this pollutant by health organisations such as the World Health Organisation and the implementation of very strict limits for this pollutant by European and Australasian countries.

Increases in nitrogen dioxide in the atmosphere will be related to vehicle use activities. Anomalies in nitrogen oxide concentrations can be expected in areas where there is a high usage of vehicles like the major urban centres of Manzini, Matsapha and Mbabane.

Other pollutants which are likely to require increased attention in the future include: persistent organic pollutants such as dioxins and furans, finer particulate fractions, e.g. PM2.5, particulate concentrations < 2.5 µm diameter, and indoor air pollutants which are unrelated to fuel burning for cooking and space heating (e.g. formaldehyde and radon).

Indoor ambient air quality has not been measured in Swaziland. It is expected that in rural households using wood or paraffin for cooking, indoor air quality will be above prescribed limits. Pollutants that should be monitored include sulphur dioxide, nitrous oxide, carbon monoxide, non-methane volatile organic compounds, and particulate matter.

The Air Pollution Information Network for Africa (APINA, 2008) undertook a comprehensive inventory of air pollution in Malawi as part of Swedish International Development Agency (SIDA) funded regional project covering Tanzania, Zambia, Malawi, Mozambique, Zimbabwe, Botswana and South Africa. The inventory identified carbon monoxide as the largest pollutant in terms of the total anthropogenic emissions, seconded by non-methane volatile organic compounds (NMVOC). In terms of percentage composition of the various pollutants, the highest was CO at 73% and the lowest was SO2 at 1%. The major contributors of both CO and NMVOC were the manufacture of solid fuels (charcoal production), transport, combustion in other sectors and burning of crop residues. The contributions made by other pollutants are small.

Approximately 76% of global particulate matter air pollution occurs indoor and in developing countries (Fullerton et. al., 2008). The major source of indoor air pollution is the use of solid fuels such firewood, charcoal and coal (Fullerton et. al., 2008).

3.3.1.3.1 ENVIRONMENTAL INDICATORS: STATE OF AIR QUALITY

Environmental indicators showing the state of air quality are:

Indicator	Measurement	Source	Availability/Reliability
Ambient air pollution	concentrations of scheduled pollutants (air pollution control regulations)	SEA	unavailable
Indoor air pollution	concentrations of scheduled pollutants common indoors (air pollution control regulations)	SEA	unavailable
Unintended Persistent Organic Pollutants	PPM, PPB	SEA	POPs NIP (unreliable estimates)

3.3.1.4 IMPACT

The pressures on air quality and resulting pollution lead to impacts being exerted on the natural, social, and economic environment. There are two main categories of impacts from poor air quality, namely impacts on human health and on ecosystems, including flora and fauna. Impacts from air quality on ecosystems are difficult to separate from other impacts and hence difficult to measure. Air pollution may result in acid rain, accelerated corrosion on structures and contribute to loss of productivity of plant species.

3.3.1.4.1 IMPACT OF GROUND-LEVEL OZONE ON HUMAN HEALTH AND CROPS

Breathing ground-level ozone can result in a number of health effects that are observed in broad segments of the population. Some of these effects include:

- Induction of respiratory symptoms
- Decrements in lung function
- Inflammation of airways

Respiratory symptoms can include: (1) Coughing, (2) Throat irritation, (3) Pain, burning, or discomfort in the chest when taking a deep breath, and (4) Chest tightness, wheezing, or shortness of breath.

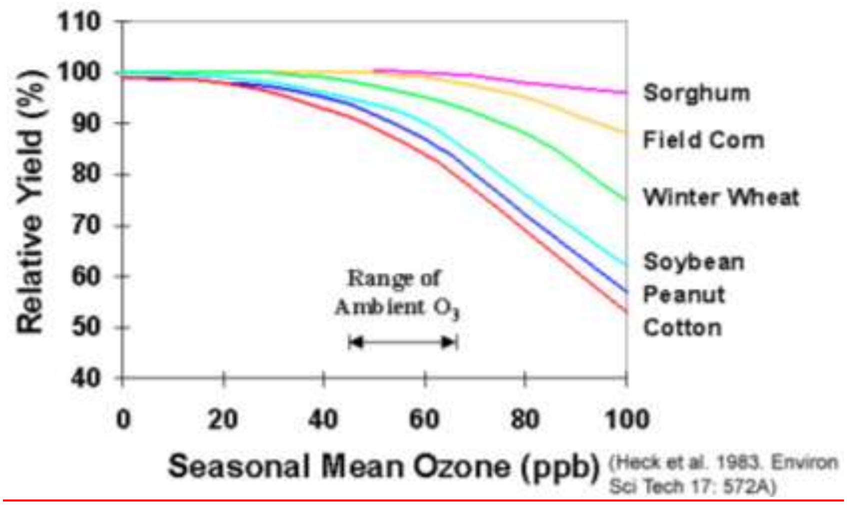
In addition to these effects, evidence from observational studies strongly indicates that higher daily ozone concentrations are associated with increased asthma attacks, increased hospital admissions, increased daily mortality, and other markers of morbidity. The consistency and coherence of the evidence for effects upon asthmatics suggests that ozone can make asthma symptoms worse and can increase sensitivity to asthma triggers.

Ozone at elevated concentrations can cause damage to agricultural crops. The mechanism is probably as follows: ozone penetrates the leaves and needles of vegetation by way of the stomata (openings in the leaves, which allow the exchange of carbon dioxide and water vapor between the inside of the leaves and the outside ambient atmosphere); ozone is then deposited on the water layer on the cells inside the leaves and forms free radicals and ions which affect the cells.

Some agricultural crops, such as tobacco and spinach, are very sensitive to damage by ozone, while others are more resistant. Ecosystems, such as forests, are damaged by the same mechanism. Ozone enters leaves through stomata during normal gas exchange. As a strong oxidant, ozone (or secondary products resulting from oxidation by ozone such as reactive oxygen species) causes several types of symptoms including chlorosis and necrosis. It is almost impossible to tell whether foliar chlorosis or necrosis in the field is caused by ozone or normal senescence. Several additional symptom types are commonly associated with ozone exposure, however. These include flecks (tiny light-tan irregular spots less than 1 mm diameter), stipples (small darkly pigmented areas approximately 2-4 mm diameter), bronzing, and reddening.

Field research to measure effects of seasonal exposure to ozone on crop yield has been in progress for more than 40 years (Figure 18). Most of this research utilized open-top field chambers in which growth conditions are similar to outside conditions. The most extensive research on crop loss was performed from 1980 to 1987 at five locations in the USA as part of the National Crop Loss Assessment Network (NCLAN). At each location, numerous chambers were used to expose plants to ozone treatments spanning the range of concentrations that occur in different areas of the world. The NCLAN focused on the most important agronomic crops nationally.

Figure 18: Effect of Ozone on Crop Yield



3.3.1.4.2 GENERAL IMPACT OF AIR QUALITY ON HUMAN HEALTH

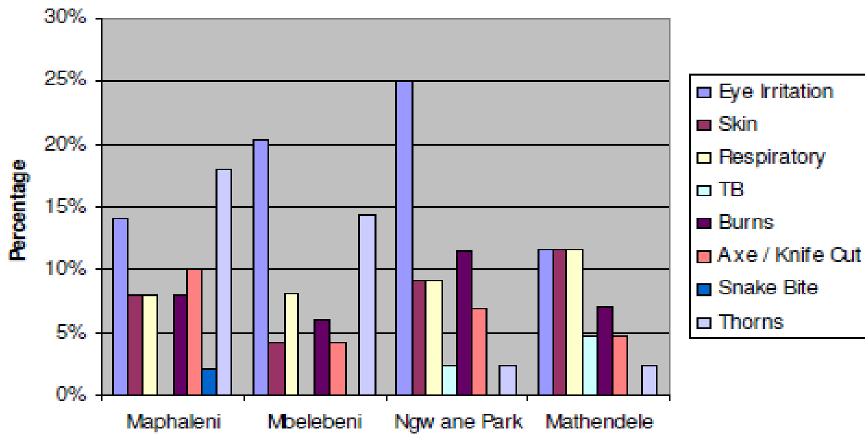
According to studies by the World Health Organisation (2008), air pollution causes 2.4 million deaths per year globally. Respiratory diseases such as asthma and pneumonia may be used as biological barometer of the state of air in a given area.

According to the Air Pollution Information Network – Africa (APINA) indoor air pollution is a threat to the wellbeing of populations in the developing countries. Various studies conducted in Malawi and elsewhere clearly show that indoor air pollution is one of the major causes of morbidity and mortality affecting the poorer sector of the population especially women and children (Fullerton et. al., 2008). Apart from the inability to afford alternative energy sources, some households cook in poorly ventilated houses thereby exposing the family members to gaseous and particulate emissions. Without documented evidence to support their cases, such negative impacts on people's health and their sources of livelihoods pass unnoticed and, therefore, not captured in the national statistics.

In a national survey to assess household energy use in rural and peri-urban areas in Swaziland to provide baseline data and highlight key issues for country wide household energy conservation programme the survey identified a wide range of issues and opportunities to improve energy use efficiencies when using biomass for cooking (GTZ/ProBEC, 2008). The study provided detailed information on household characteristics, household income, patterns of existing energy use in the survey areas, particularly related to how wood fuel is sourced and used, and also on cooking habits and how this could relate to potential stove use.

Figure 19 indicates that eye issues are one of the major concerns from wood fuel use. This is clearly due to too much smoke from poor combustion and poor ventilation. However it was also noted that not many respondents were fully aware that any respiratory issues are due to the smoke. The issues related to thorns are restricted to rural areas, where there is much greater collection of firewood. The range of health issues from smoke related through to burns and knife/ axe injuries indicate that any programme for wood fuel would be best served if it was accompanied by a comprehensive health and safety programme for fires.

Figure 19: Health Issues from Wood Fuel Use



Based on the survey results and the outputs from the focus group discussions, the study identified the key strategies for a long term energy conservation programme that included:

- Awareness raising on energy conservation and related issues
- Sustainable fuel wood supply and management
- Wood efficient stoves for rural areas
    - Dissemination
    - Availability
    - Distribution
    - Manufacture
    - Use (including kitchen ventilation and safety)
- Alternative fuels for peri-urban areas, such as biomass briquettes.

3.3.1.4.3 ENVIRONMENTAL INDICATORS: IMPACTS OF AIR QUALITY

Environmental Indicators for measuring the impact of air quality include:

Indicator	Measurement	Source	Availability/Reliability
Incidence of Acute Respiratory Illnesses (ARI)	numbers	MHSW	available
Incidence of allergies linked to air quality (e.g. asthma)	numbers	MHSW	available
Quarterly clinic admissions for respiratory infections by type of infection	numbers	MHSW	available
Incidence of forest reduction due to acid rain and other deposition	descriptive first	SEA	unavailable
Crop reduction due to troposphere ozone	%	SEA	unavailable

3.3.1.5 RESPONSE

The overall response to monitoring and regulating air quality is considered inadequate despite gazetting the Air Pollution Control Regulations in 2010 and acceding to the Stockholm Convention on POPs.

3.3.1.5.1 SYSTEMIC RESPONSE

Legislation

Environment Management Act, 2002

This is Swaziland's principal legislation on the protection of human health and the environment. The Environment Management Act (EMA) is a framework piece of legislation whose fundamental purpose is the protection and management of the environment. The enactment of the EMA together with the establishment under it of the Swaziland Environment Authority (SEA) gave birth to a process of producing a coherent body of environmental pieces of legislation. In this regard, the SEA has and shall continue to be pivotal in giving direction to air quality monitoring, and the development of POPs management plans and activities, including ensuring that sector-specific legislation on POPs is properly interlinked with other national enactments. This Act further controls the management and disposal of waste through the Waste Regulations, 2000, the undertaking of EIAs through the Environmental Audit, Assessment and Review Regulations, 2000, the control of pollution through the Air Pollution Control Regulations of 2010.

Air Pollution Control Regulations, 2010

This is Swaziland's principal piece of legislation on the regulation of air quality. The regulations require the Meteorological Service to monitor air quality in a range of areas which are representative of typical population exposure in order to assess compliance with the air quality objectives on a national basis. The Meteorological Service is required to submit to the Authority an annual report concerning air quality in Swaziland which must include the results of the air quality monitoring undertaken and must summarise cases of non-compliance with any air quality objective. To date the Meteorological Service has not undertaken any monitoring of air quality. [21]

Atmospheric pollution from industrial and human activities contributes to reducing air quality. Swaziland has gazetted the Air Pollution Control Regulations (GOS-SEA, 2010) to monitor and control air quality. The regulations provide air quality objectives and measurable parameters that entities emitting pollutants into the atmosphere must comply with and include the substances as listed as follows:

SO2	Pb (Lead)	Benzene	NOx	PM10	CO	PAHs	NO2	O3 (Ozone)	1,3-Butadiene

Grass Fires Act, 1955

This Act prescribes for a general prohibition against the burning of grass, whether accidentally or wilfully. Grass fires can only be lit and set upon issuance of a permit by the Director of Agriculture or a duly appointed nominee of the Ingwenyama in the case of Swazi Nation Land. This Act predates the country's signing of the Stockholm Convention. Its relevance to air quality is demonstrated by the country's willingness to control the setting of fires, in general, which aspect is now known to contribute in the formation of dioxins and furans.

Policies

In 2009 the Ministry of Natural Resources and Energy developed the National Energy Policy Implementation Strategy (NEPIS), which is aimed at raising awareness on the efficient use of biomass through fuel efficient stoves. Stove efficiency is the optimization of combustion and maximizing heat transfer in wood stoves, therefore utilizing minimal wood and reducing smoke emission. The ProBEC is one of the activities under this strategy and it enables rural communities to:

- reduce deforestation and land degradation due to the reduced demand for wood
- reduce indoor pollution due to reduced smoke
- enhance local income generation during the manufacture of the stoves
- encourage use of local material such as bricks, mortar and steel when making the stoves to adapt to the changing climate.

International Agreements

[21] The country has one ambient air quality monitoring station, which has been taken to the field but could not capture correct data and efforts are being made to repair it for use in monitoring air quality. Section 5 of the Regulations requires operators who routinely emit to monitor their emissions and submit to the SEA. Since the APC Regulations do not have emissions standards yet, the South African standards are used as the reference for Swaziland.

Stockholm Convention on Persistent Organic Pollutants was adopted in 2001 in response to the urgent need for global action to protect human health and the environment from the adverse effects of POPs. The convention seeks to eliminate or restrict production and use of all intentionally produced POPs. In addition, it also seeks the continued minimization and where possible, elimination of all releases of un-intentionally produced POPs. The Convention entered into force in 2004 and Swaziland acceded to the Convention in 2006.

Although the country is a signatory of the Stockholm Convention on POPs and has developed its National Implementation Plan (NIP) for the safe management of Persistent Organic Pollutants (POPs) the country has made little progress in implementing the plan.

3.3.1.5.2 INSTITUTIONAL RESPONSE

Swaziland's intuitional response to air quality has been limited. Although the Swaziland Environment Authority have the legal mandate to monitor air quality together with the Meteorological Service under the Air Pollution Control Regulations, the SEA and Meteorological Service have yet to implement their legally required activities.

In a broader sense, the Energy Department implemented a project under ProBEC (Programme for Basic Energy and Conservation)[22]. The Programme concentrated on low-income household energy, in particular, the promotion of the efficient use of energy devices primarily associated with cooking such as wood-fired and charcoal stoves, solar cookers and heat retention devices.

3.3.1.5.3 ENVIRONMENTAL INDICATORS: RESPONSE TO AIR QUALITY DETERIORATION

Environmental indicators indicating the response to air quality deterioration include the following:

Indicator	**Measurement**	**Source**	**Availability/Reliability**
Legislation and policy	number & relevance	SEA	available
Programs aimed at reducing pollution	number & relevance	MNRE	available
Market share of unleaded petrol	%	Oil companies/MNRE	available
Share of biofuel in petrol/diesel	%	Oil companies/MNRE	available
Energy efficient low emission stoves	% of all stoves	MNRE	unavailable
Waste disposal incinerators	number	Relevant institutions	available

3.3.2 CLIMATE AND CLIMATE CHANGE

Climate is the average prevailing weather conditions for a specific geographical region over a period usually exceeding 30 years.

According to United Nations Framework Convention on Climate Change (UNFCCC), climate change is attributable to anthropogenic (human induced) emissions, such as carbon dioxide from fossil fuel use, which alter the composition of the global atmosphere. Climate change, which implies long term or permanent shifts in weather pattern covering a wide region, is often confused with climate variability which is short term and often localized (UNEP, 2002).

According to the IPCC Fourth Assessment Report (IPPC, 2007), warming of the climate system is unequivocal, as it is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. For this reason, the United Nations Framework Convention on Climate Change (UNFCCC) is increasingly concerned about the threat of global climate change and associated impacts of changes in rainfall and extreme weather events. It is therefore the objective of the UNFCCC to achieve stabilisation of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

Climate change represents one of the most urgent threats to mankind's continued existence on this planet. Efforts to curb the key sources of GHG face many international hurdles so while world leaders' debate and discuss the challenges and solution, the world continues to warm.

Climate change is already affecting Africa and global warming is anticipated to be more intense in Africa than in the rest of the world. According to IPCC, the average rise in temperature between 1980/99 and 2080/99

[22] URL http://www.probec.org/

would be between 3 and 4°C for the continent as a whole, 1.5 times greater than at global level. The challenge of ensuring food security and habitats for biodiversity for African countries and populations is increasing further in a context of adaptation to climate change with more severe and numerous extreme events. However, rural people have always been facing climate variability and developed many valuable techniques and livelihood responses which can be enhanced or adapted for climate change adaptation and mitigation.

Climate plays a central role in agriculture which is the main stay of the Swazi economy and community livelihood. However, due to anthropological activities, climate change is becoming a reality. Extreme weather events like heavy rainfall or too little rainfall are becoming more frequent and are impacting on human wellbeing. These events may culminate into disasters like torrential rains, drought, floods, landslides and epidemics.

3.3.2.1 DRIVING FORCE

The main driving force leading to climate change is the need of a growing population for increased production and consumption.

3.3.2.1.1 ENVIRONMENTAL INDICATORS: DRIVING FORCES BEHIND CLIMATE CHANGE

Environmental indicators indicating the driving forces related to climate change include the following:

Indicator	Measurement	Source	Availability/Reliability
Population growth rate	%	CBS	available
Human consumption (food and non-food)	% growth	MEPD	available
Industrial production	% growth	MEPD	available
Energy consumption	% growth	MNRE	available

3.3.2.2 PRESSURE

The pressure on the current climate contributing to climate change is principally and directly controlled by the emission of greenhouse gasses into the atmosphere, which emission primarily results from the demand and use of fossil fuels (mainly petroleum and coal).

Indirect pressures are related to land clearance to make way for other forms of land use and the burning of solid waste and biomass.

3.3.2.2.1 EMISSIONS FROM USING FOSSIL FUEL

Industrial Processes and Product Use (IPPU) covers greenhouse gas emissions occurring from industrial processes, from the use of greenhouse gases in products, and from non-energy uses of fossil fuel carbon.

Greenhouse gas emissions are produced from a wide variety of industrial activities. The main emission sources are released from industrial processes that chemically or physically transform materials (for example, the blast furnace in the iron and steel industry, ammonia and other chemical products manufactured from fossil fuels used as chemical feedstock and the cement industry are notable examples of industrial processes that release a significant amount of CO2). During these processes, many different greenhouse gases, including carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs), can be produced.

In addition, greenhouse gases often are used in products such as refrigerators, foams or aerosol cans. For example, HFCs are used as alternatives to ozone depleting substances (ODS) in various types of product applications.

Activities leading to greenhouse gas emissions in this sector include the following: mineral products, chemical industry, metal production, production of pulp and food, production of halocarbons and sulphur hexafluoride, consumption of halocarbons and sulphur hexafluoride, solvent and other product use, paint application, degreasing and dry cleaning, Chemical products, manufacture and processing and other GHG emissions from the use of anaesthetic, and propellant. Industrial processes in Swaziland are restricted to a number of industries that produce mainly sugar, refrigerators, food and drinks.

3.3.2.2.2 EMISSIONS FROM LAND USE, CLEARANCE AND FORESTRY

The second main group of activities which influence carbon emission and stock cover land use activities, including agriculture, forestry and land clearance. In the GHG Inventory this is defined as the Agriculture, Forestry and Other Land Use (AFOLU) Sector; emissions and removals on managed land are taken as a proxy for anthropogenic emissions and removals, and inter-annual variations in natural background emissions and removals, though these can be significant, are assumed to average out over time.

In the Greenhouse Gases (GHG) Inventory Report (GOS-NMS/SNC, 2008) routine GHG calculation in the AFOLU sector are shown for each sub-sector. Lack of data or differences in interpretation have resulted in calculated GHG values which in some cases are debatable. The most important sub-sectors are the following.

Methane emissions were calculated from domestic livestock and poultry in Swaziland. Only general population statistics were available, not any further detailed information about live weights and age distributions of the livestock.

The draft GHG report mentions with respect to burning of savannah that data about actual savanna area burnt is lacking. It was then estimated that 80% of the savanna was burnt in 2000 because of the high rate of uncontrolled veld fires. Data from Dlamini (2010, 2010a) indicate that these estimates were too high; the average for the period 2000-2007 was 23% (22% in 2000) (see also section 3.3.3 on natural disasters).

Data required for the calculation of annually burnt agricultural crop residues were obtained from the Central Statistics Office, the Swaziland Sugar Association and Swaziland Fruit Canners (pineapples). Sugar cane is burnt before harvesting. Up to 2002, pineapple residues were burnt after harvesting. Cotton residues are burnt after harvesting for pest control. Some of the other crops are seldom burnt prior to ploughing.

Under the heading of change in soil carbon in mineral soil and carbon loss from organic soils, the emission of greenhouse gases from agricultural soils was duly estimated following the IPCC guidelines. The gases emitted from agricultural soils include N_2O, CO_2 and CH_4. Emphasis here is on calculation of N_2O gases from agricultural soils, whereas CO_2 calculation is done in the Land Use and Forestry section. The questionable part here is the reclassification of the existing and classified soil mapping units into the required categories of high activity soils, low activity soils, sandy soils and wet soils. This is not correct for most transfers: for the Highveld soil (low activity rather than high activity), the sandy soils (very rare in Swaziland) and wet soils (not positioned as indicated). Also volcanic soils (non-existing in Swaziland) and Histosols are wrongly interpreted.

Still in the same GHG Inventory Report (GOS-NMS/SNC, 2008), under the heading of Change in Forest and Other Woody Biomass Stock several doubtful assumptions are made: (1) some natural forests and woody trees regrowth was occurring, estimated at 0.5% of total area of natural forests and woodlands, (2) only some natural forests and woodlands were still actively growing, estimated at 10%, while the rest had stopped growing and to uptake carbon. Under the heading of Forest and Grassland Conversion and Abandonment of Managed Lands again several doubtful conversion assumptions are made; also the reported increase of the forestation rate of 1.2% per annum with corresponding CO_2 uptake by trees seems not funded on reliable data.

The overall conclusion is that in the AFOLU sector a variety of processes leading to GHG emissions and carbon sequestrations are definitely taking place, very relevant to climate change. However, necessary corrections and adjustments have to be made in the estimates.

3.3.2.2.3 PRESSURES SUMMARISED IN NATIONAL GREENHOUSE GAS INVENTORY

As a Party to the United Nations Framework Convention on Climate Change (UNFCCC), Swaziland is required to produce and regularly update National Greenhouse Gas Inventories. To date, National Greenhouse Gas Inventories have been produced for the years 1994 and 2000: Second National Communication (SNC) to the IPCC.

Anthropogenic emissions and removals means that greenhouse gas emissions and removals included in national inventories are a result of human activities. The distinction between natural and anthropogenic emissions and removals follows straightforwardly from the data used to quantify human activity. In the Agriculture, Forestry and Other Land Use (AFOLU) Sector, emissions and removals on managed land are taken as a proxy for anthropogenic emissions and removals, and inter-annual variations in natural background emissions and removals, though these can be significant, are assumed to average out over time.

National Inventory of Anthropogenic Emissions

The calculated emissions and removals of GHGs for 2000 were based on the Revised 1996 IPCC Guidelines. The source categories included energy, industrial processes, agriculture, land use change and forestry, and waste.

For the year 2000, total GHG emissions for Swaziland were estimated at 19.8 million tonnes of CO_2 equivalent.

The major contributing emissions are presented below. Results of this inventory indicate that Swaziland is a net source of GHGs as a result of traditional use of forest base and less carbon uptake on the overall.

Table 47: Sources of Greenhouse Gas Emissions

SOURCE	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Energy	1,172.33	121.17	40.30				1,333.80
Industrial Processes				9,053.20		10.30	9,063.50
Agriculture		849.41	753.50				1,602.91
Land Use Change and Forestry	1,102.19	2.94					1,105.13
Waste	559.06	366.82	5,731.90				6,657.78
TOTAL	**2,833.58**	**1,340.34**	**6,525.70**	**9,053.20**	**0.00**	**10.30**	**19,763.12**

Emissions from the energy sector are presented below.

Table 48: GHG Emissions from the energy sector

Energy	CO_2	CH_4	N_2O	NO_x	CO	NMVOCs	SO_2*
	CO2 equivalent						
Total Emissions	**1,172.33**	**5.77**	**0.13**	**11.62**	**155.65**	**13.35**	**6.22**
A. Fuel Combustion							
1. Energy industries	2.21	0.00	0.00	0.01	0.00	0.00	
2. Manufacturing and construction	464.38	0.65	0.09	3.48	72.45	1.09	
3. Agriculture	14.69	0.00	0.00	0.22	0.19	0.04	
4. Transport	553.48	0.09	0.00	6.86	33.22	6.28	
5. Commerce and institutional	5.02	0.00	0.00	0.00	0.09	0.01	
6. Residential	132.55	3.15	0.04	1.05	49.70	5.93	
B. Fugitive emissions from fuels							
1. Solid fuels (coal mining)		1.88					

Emissions from Industrial Processes and Product Use are presented below.

Table 49: GHG Emissions from Industrial Processes and Product Use

Industry	Type of gas	Quantity Gg	Gg CO_2 equiv.	Percentage
Road paving with Asphalt	NMVOC	82.5		77.9
Food and drink	NMVOC	10.65		10.1
Paper and Pulp	SO_2	4.19		5.4
Consumption of HFC/PFC : Refrigeration (3.03), Aerosols (5.25), Solvents, (1.34)	HFC	6.96	9,053.2	6.6

Emissions from the agricultural sector are presented below.

Table 50: GHG Emissions from the Agricultural Sector

Agriculture	CH_4 (Gg)	N2O (Gg)	NOx (Gg)	CO (Gg)
A. Enteric Fermentation	20.69			
B. Manure Management	0.73		0.76	
C. Rice Cultivation	0.0004			
D. Agricultural Soils		1.82		
E. Prescribed Burning of Savannas	3.85	0.05	1.72	101.12
F. Field Burning of Agricultural Residues	7.15	0.23	8.38	150.17
TOTAL	**32.43**	**2.10**	**10.86**	**251.29**

CO2 emissions from Land Use Change and Forestry are presented below.

Table 51: GHG Emissions from Land Use Change and Forestry

Land Use Change and Forestry	2000 (CO2)
On site burning (biomass)	31.35
On site decay	105.2
Off site burning	15.7
Commercial harvest	2098.3
Traditional use	1445
Liming of soil	0.51
Change in soil carbon in mineral soil	47.7
Carbon loss from organic soils	100.8
TOTAL SOURCE	**3809.6**
SINKS	
Carbon uptake by trees	2568.8
Carbon uptake in abandoned areas	138.6
TOTAL SINKS	**2707.4**
BALANCE	-1102.2

Emissions from waste are presented below.

Table 52: GHG Emissions from Waste

Waste	CH4	N20	CO2	Total
Open Burning of Wastes	9.81	17.3	559.06	586.17
Wastewater Facilities	7.6577			7.6577
Indirect Emissions		1.19		1.19
TOTAL	**17.4677**	**18.49**	**559.06**	**595.0177**

3.3.2.2.4 ENVIRONMENTAL INDICATORS: PRESSURES CONTRIBUTING TO CLIMATE CHANGE

Environmental indicators on pressure contributing to climate change can include:

Indicator	Measurement	Source	Availability/Reliability
Emissions from the energy sector	tonnes of CO_2 equivalent	SMS	available
Emissions from the industrial processes and product use	tonnes of CO_2 equivalent	SMS	available
Emissions from the agricultural sector	tonnes of CO_2 equivalent	SMS	available
CO2 emissions from land use change and forestry	tonnes of CO_2 equivalent	SMS	available
Emissions from waste	tonnes of CO_2 equivalent	SMS	available

3.3.2.3 STATE

The state of environment in this section refers to the current state of the climate and trends in climate change.

3.3.2.3.1 BASELINE CLIMATE CHARACTERISATION

The generally accepted Swaziland baseline climatic characterisation period is 1961-1990.

Swaziland does not have sufficiently long instrumental climate data to reliably construct past climates. As a result the wider temperature record for Africa south of the equator is used to present the climate of the twentieth century for the sub-region. Such an analysis shows a warming of almost 1°C between 1900 and 1980 and an average warming of 0.05°C per decade over the almost 100 year period (EC, 2006).

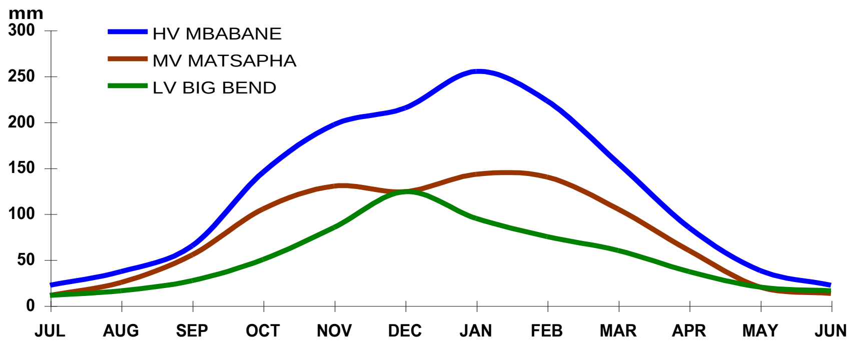
Swaziland lies at the transition of major climates zones, as it is influenced by air masses from different origin: equatorial convergence zone, subtropical eastern continental moist maritime (with occasional cyclones), dry continental tropical and marine west Mediterranean (winter rains, with occasional snow).

The overall climatic characterization of Swaziland is subtropical with summer rains and distinct seasons. Higher and lower physiographic zones show different climatic conditions, ranging from sub-humid and temperate in the Highveld to semi-arid and warm in the Lowveld (Table 53).[23] The mean annual rainfall ranges from 1,450 mm in the Highveld to 550 mm in the Lowveld, however substantial annual variations occur, leading to both drought and floods (Figure 21). Figure 20 shows mean monthly rainfall for the stations Mbabane, Matasapha and Big Bend, representative for Highveld, Upper Middleveld and Earstern Lowveld respectively. Rainfall figures of the zones are overlapping, which is caused by the overall higher rainfall in the northern part of the country (Figure 21). Figure 22 shows mean annual temperature.

Table 53: Climatic Classification Based on Long Term Averages (1961-1990)

Physiographic or Agro-ecological Zone	Mean Temperature (°C)			Rainfall (mm)	Köppen Classification
	Annual	January	July	Mean Annual	
Highveld	17	20	12	850-1450	Cwb
Upper Middleveld	20	24	15	800-1000	Cwa
Lower Middleveld	21	25	16	650-800	Cwa
Western Lowveld	22	26	18	625-725	BSh
Eastern Lowveld	22	27	17	550-625	BSh
Lubombo Ridge	21	26	17	700-825	Cwa

Figure 20: Mean Monthly Rainfall for Mbabane, Matsapha, Big Bend



[23] According to the Köppen climate classification, four agro-ecological zones have a warm temperate rainy climate (C), with a dry season in winter and a cool or hot summer. The Lowveld zones have a dry and hot steppe climate (B). It is expected that climate change will expand the B climate to Lower Middleveld and Lubombo, thus giving the major part of the country a hot steppe type climate.

Figure 21: Distribution of Mean Annual Rainfall

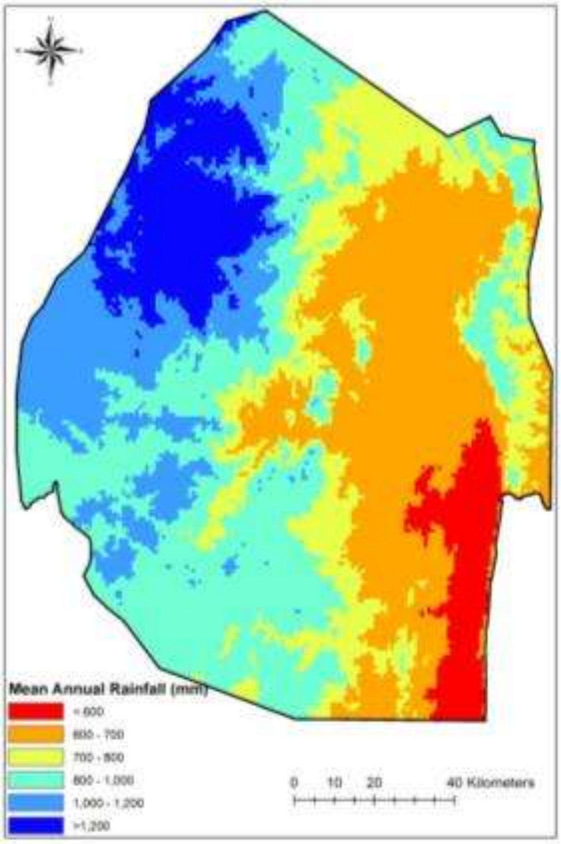
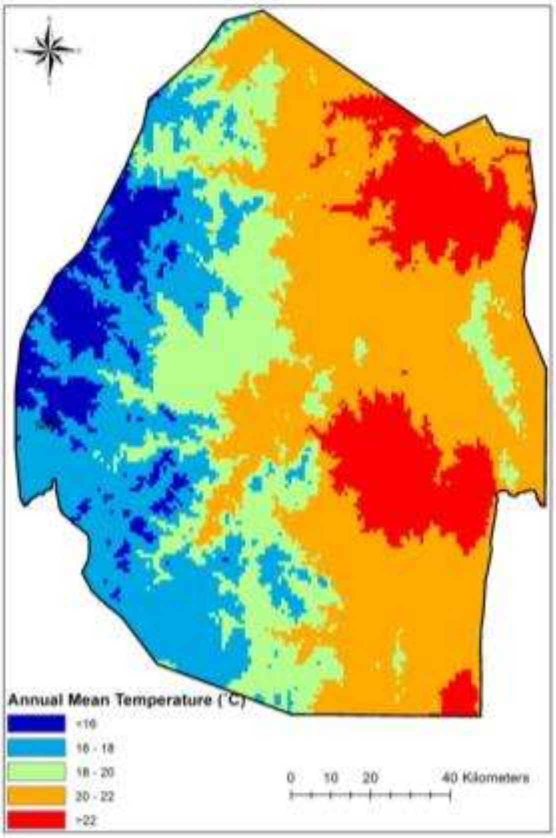


Figure 22: Distribution of Mean Annual Temperature



3.3.2.3.2 HISTORIC EVIDENCE OF CLIMATE CHANGE AND PROJECTIONS

Climate analysis has been carried out for Swaziland using statistically downscaled General Circulation Model (GCM) data, one based on three GCMs (GOS-NMS/SNC, 2010) and another based on seven GCMs (Tadross and Asante, 2009).

Considering that the Swaziland baseline period is 1960-1990, two major analyses were carried out extending the baseline from 1960 to 2000 or 2005. The results of these two analyses do not corroborate each other. The 1960-2000 analysis (GOS-NMS/SNC, 2010c) concluded that there were no significant temperature changes over the period, however the 1960-2005 analysis (Tadross and Asante, 2009) indicated significant increases for most stations in both mean minimum and mean maximum temperatures, ranging from 2 to 5^{o}C for different seasons and stations.

For the Future A period 2046-2065 the mean temperature is projected by both main analyses to be about 2°C higher as compared to the current estimate.

One of the analyses (GOS-NMS/SNC, 2010c) indicated a further rise of the temperature of about 2°C from Future A 2046-2065 to Future B period 2081-2100, in total about 4°C higher as compared to the current estimate.

The mean annual rainfall is projected to remain quite constant over the period till 2100, with only slight increases in specific parts of the country. As a result of higher projected temperatures the potential evapotranspiration is expected to increase.

3.3.2.3.3 ENVIRONMENTAL INDICATORS: STATE OF CLIMATE AND FACTORS INDUCING CLIMATE CHANGE

Environmental Indicators indicating climate change are to be selected from updated climatic records and modelling applied to these data.

Indicator	Measurement	Source	Availability/Reliability

Historic evidence of climate change	^{0}C and mm & description	SMS Research	available
Mean annual temperature	^{0}C	SMS Research	available
Mean minimum and mean maximum temperatures	^{0}C	SMS Research	available
Annual and monthly precipitation	mm	SMS Research	available
Frequency of extreme events	number, category, description	SMS Research	available

3.3.2.4 IMPACT

Climate change will in particular impact on the vulnerable elements of the environment and society. According to the First and Second National Communication (GOS-MPWT, 2002, 2012), climate change are poised to severely affect the natural environment and socio-economic sectors of Swaziland, notably biodiversity, ecosystems, forests, water, agriculture, land use and land conditions in general, but also human health, socio-economic factors and livelihoods, in particular in the Lowveld and Lubombo.

3.3.2.4.1 IMPACT ON ECOSYSTEM FUNCTIONS

Ecosystem functions primarily represent biodiversity, water and forest conditions.

Biodiversity and ecosystems. Key biodiversity impacts from climate change include westerly shifting of ecosystem boundaries, with increases in aridity in the eastern parts of the country and local extinctions due to changed climate and inability of plants to migrate and animals may be constrained by infrastructure. Species that are most vulnerable to extinction will be those with small populations, slow rates of dispersal, restrictive elevation, climate requirements, and/or those whose habitat is limited or occurs in patches. Consequently the climate change impacts on ecosystem services and goods.

Forestry**.** The major climatic hazards that threaten the forestry sector are extended droughts, which lead to reduced forest productivity, land degradation and loss of soil fertility, as well as forest fires. For example, plantation fires in 2007 destroyed 20,280 Ha of pine and eucalypt forest. Forest fires are generally caused by human activities such as honey collection and result in smoke haze, pollution, loss of seedlings and biodiversity.

Water quantity and quality. More variable precipitation is expected to occur, with an increase in the frequency and intensity of both floods and droughts. At the same time, higher temperatures are hastening rates of evaporation of surface waters that provide fresh water for many populations. Lack of fresh water compromises hygiene, thus increasing rates of diarrhoeal disease. In extreme cases, water scarcity results in drought and famine. Water is an essential resource for human, animal, agricultural and industrial use, and for the maintenance of ecosystems. Floods would affect water quality through contamination and also affect human health.

Impact on women. In particular women will be affected as they bear most of the burden in activities that are most impacted by adverse climate, including walking longer distances in search of water, firewood and are regularly exposed to and inhale harmful emissions from fire places. Women also play a key role of ensuring that food is available to the family, especially their children. Women also carry the responsibility of caring for the sick members of the immediate and extended families.

3.3.2.4.2 IMPACT ON AGRICULTURE AND BIOMASS PRODUCTION FOR ENERGY

With respect to agriculture, rising temperatures and changing patterns of rainfall are projected to decrease crop yields – including industrial raw materials -, shift production seasons, pest and disease patterns, and modify the set of feasible crops affecting production, prices, incomes and food security.

Swaziland's food security and peoples livelihoods depend on rain-fed agriculture. Persistent droughts and erratic rainfall would result in decreasing crop yields, leading to food shortages, hunger and malnutrition.

Concerning biomass production for energy, about 78% of Swaziland's energy supply is generated by biomass (wood chips and bagasse), mainly from the sugar sector. The biomass sub-sector is very sensitive to climate change as the growing conditions needed for the supply of cane and or wood chips could change leading to challenges to find alternative fuel sources or convert biomass boilers to other energy types.

The current and future impact of climate change can be simulated through modelling. The results of such modelling of the effects on agriculture as well as energy as presented and discussed in Chapter 4 Future Outlook.

3.3.2.4.3 IMPACT ON HEALTH

Direct and indirect effects arising from climate change on the health sector include:

- Adverse climate induced changes will increase the vulnerability of Swaziland and contribute to the national burden of diseases and health care management.
- Many of the major diseases transmitted by water and by insect vectors are highly sensitive to climatic conditions and weather extremes.
- Climate change threatens to slow, halt or reverse current progress against many of these infections.

Direct impacts are perceived to include heat stroke and heat related phenomena especially to the ageing sector of population, skin cancers, and eye cataracts. With more variable rainfall, loss of life and injuries from inland flooding would increase. Indirect effects are mainly linked to population growth (economically and physically) which would reflect by increasing shortages of water supply effects including possible increases in vector borne diseases especially malaria and schistosomiasis (bilharzia), increase in endemic morbidity and mortality due to diarrhoeal diseases and malnutrition, especially where there is sustained /prolonged drought.

Cases of death from malaria have shown dramatic declines in recent years due to interventions, but warmer temperatures and altered rainfall patterns are likely to expand old habitats or create new ones for disease-carrying organisms such as malaria mosquitoes. Out-patient records show the prevalence of four common ailments affecting the nation. Diarrhoea accounted for 84.4% of all out-patients cases, malnutrition 3.2%, bilharzias 3.4% and malaria 7.5%.

Food insecurity, malnutrition and under-nutrition increase the severity of many infectious diseases, particularly among children.

3.3.2.4.4 ENVIRONMENTAL INDICATORS: IMPACT OF CLIMATE CHANGE

Environmental Indicators have to represent ecosystem functioning, human health and other social factors (food security, poverty) and economic impacts. Effects on food security and poverty will be indirect and difficult to measure separately as a sole impact of climate change, and not, for instance, as the effect of drought or any other circumstance.

Indicator	Measurement	Source	Availability/Reliability
Economic – agriculture, food and energy production	production (t) employment	MEPD, CBS, CSO, MoA	available
Food insecurity	% population	CSO	SHIES reports
Malnutrition	% population	CSO	SHIES reports
Poverty	% population	CSO, Poverty Unit	available
Health: Casualties from heat waves and other extreme weather events	numbers	MHSW,	not available
Morbidity & mortality resulting from changing patterns of life-threatening vector-borne diseases (malaria & other existing or emerging infectious diseases)	numbers	National Malaria Control Programme MHSW	available
Ecosystem and forest change	%, area		
Change of ecosystem products	%, area		
Change of Biodiversity: Species	numbers, %		
Change of water flow	%		
Impact on energy sources (per category)	%		

3.3.2.5 RESPONSE

The overall response to climate change is currently considered inadequate.

Although a substantial amount of work has been done in establishing future climate scenarios the lack of any government policy or programme to introduce adaptation into government programmes illustrates the low priority government appears to have to address this issue.

3.3.2.5.1 INVESTMENT AND ACTION

Investment responses to climate change include measures and action in the agricultural and water sector, many of them aiming at reducing water consumption and water efficiency.

Although the impacts of climate change are already being felt in the biodiversity sector in Swaziland, there have been only few initiatives (mainly studies) targeted specifically at biodiversity adaptation to climate change (see Theme Biodiversity 3.4).

Climate Change Adaptation Initiatives in Agriculture

The single most important event taken place in the part of Swaziland most affected by drought and climate change is the development of large- and medium scale irrigated agriculture, coupled with the cultivation of sugarcane. This has had a significant impact on the development of the Lowveld and the livelihood of its population. Some other adaptation initiatives are given in Table 54.

Table 54: Adaptation Initiatives for Crop Production

Measure	Description
Promoting irrigated agriculture through large-, medium and small-scale dams	Komati Downstream Development Project Lower Usuthu Smallholder Irrigation Project
Introducing conservation agriculture24	Name: Shewula COSPE Project : adopting zero or low tillage to protect soils from heat, drought and intense rainfall
Diversifying the range of crops grow (to reduce the risk of failure)	Large scale production of cassava for starch
Converting to development other than rainfed agriculture: e.g. grazing, conservation, eco-tourism, hunting	Options include: extensive grazing, nature & biodiversity conservation, eco-tourism, e.g. Shewula COSPE Project, Nisela, Ecotourism (Pigs Peak)

Climate Change Adaptation Initiatives in Water

The Government of Swaziland and all sectors dependent upon consistent seasonal stream flows and good water quality have been for some time aware of the threats of climate to changes in flows and quality. Recent adaptation measures are given in Table 55.

Table 55: Recent Adaptation Measures for Water

Integrated Water Resources Master Plan
To improve overall governance of water the country embarked upon the development of an Integrated Water Resources Master Plan in 2008. The IWRM is intended to broaden awareness of water issues and promote sustainable utilisation of the resource. Climate change issues have been included in the IWRM Plan which is in draft pending a stakeholder consultation exercise expected in mid 2012. The integration of IWRM into national development plans and the PRS&AP is a key component of the national IWRM planning work. In practice, this requires understanding national development priorities and building on existing national planning processes. With support from the Swaziland Water Partnership, the sector has a trusted and credible neutral platform for dialogue and stakeholder involvement in development processes.
Small Earth Dams
Small earth dams have been used for several decades in rural areas to provide domestic, crop and livestock water. Under an EU project in the late 1990's over 25 dams were constructed. Under the Swaziland Agricultural Development Project (FAO/EU) 8 medium to large earth dams will be constructed with downstream infrastructure to store runoff water for domestic, crops and livestock uses.
Establishment of five River Basins Authorities
The Dept of Water Affairs (MNRE) established, under the 2003 Water Act, River Basin Authority's to better plan and mange basin water resources. Some RBAs have started developing management plans to ensure more effective utilise and management of water resources in their basins. Climate change adaptation is central to these initiatives through increasing irrigation water use efficiencies, water distribution infrastructure improvements, water accounts, expansion of domestic or community water schemes, catchment management, alien plant eradication and others.
Conversion of irrigation systems to drip

[24] Conservation Agriculture is a term encompassing farming practices which have three key characteristics: 1. minimal mechanical soil disturbance (i.e. no tillage and direct seeding); 2. Maintenance of a mulch of carbon-rich organic matter covering and feeding the soil (e.g. straw and/or other crop residues including cover crops) and 3. Rotations or sequences and associations of crops including trees which could include nitrogen-fixing legumes (FAO, 2010b).

Integrated Water Resources Master Plan
RSSC are implementing a programme of converting sprinkler irrigated fields to drip irrigation. As well as improving water use efficiencies the conversions allow for water savings that can be used for further expansion of the hectares under cane.

3.3.2.5.2 SYSTEMIC RESPONSE

Legislation

None

Policies

Although there is no dedicated policy to climate change, policies and strategies to counter the impacts of climate change were included in a number of important government policies.

- Climate change concerns were taken into account comprehensively in the Comprehensive Agricultural Sector Policy (CASP; GOS-MOAC, 2005, the National Food Security Policy for Swaziland (GOS-MOAC, 2006), Biodiversity Conservation and Management Policy National (draft, GOS-SEA, 2007), the National Biofuels Development Strategy and Action Plan (GOS-MNRE, 2008) and the draft National Energy Policy Implementation Strategy (GOS-MNRE, 2009).
- The National Disaster Management Policy, formulated in 1999, targets drought relief strategies and other natural disasters. The policy proposes the preparation of a Sustainable Disaster Management Programme and a National Disaster Management Plan to implement the policy.
- Concerns related to drought, land degradation and biodiversity were presented in a number of sector policies, including the National Forest Policy, Energy Policy, Water Policy (Draft), Waste Regulations (notably the sustainable control and collection of emission of methane from land fill).

3.3.2.5.3 INSTITUTIONAL RESPONSE

Without a national climate change policy or action plan, steps to integrate climate change into development programmes and projects is restricted. Integration is currently dependent upon the foresight of individuals or consultants formulating programmes and projects to include climate change adaptation or mitigation measures.

Since the publication of its First National Communication (GOS-MPWT, 2002), Swaziland has undertaken a number of activities that can broadly be presented as addressing the needs of climatic change:

- In September 2010 the Ministry of Tourism and Environmental Affairs established a National Climate Change Committee (NCCC) comprised of various government ministerial representatives and will be responsible for developing and coordinating programmes and projects aimed at addressing climate change in line with the country's development priorities.
- The Focal Point has on a number of occasions addressed media questions on climate change and its impact on Swaziland. Through these press briefings, balanced and rational information has been placed in the public domain.
- Government has established a Designated National Authority to handle and manage CDM projects applications and processes.
- Government has embarked upon the collection of baseline data on solar and wind to facilitate an assessment of their viability nationally.
- Through the University research on drought tolerant food crops has been undertaken and continues. Partnerships with regional seed companies and research institutions have helped fast-track research efforts.
- With the assistance of GEF, Government has submitted a project proposal to GEF to solicit support for a study on the transboundary impacts of climate change on water resources.

3.3.2.5.4 ENVIRONMENTAL INDICATORS: RESPONSE TO CLIMATE CHANGE

Environmental Indicators related to response to climate change may include the following.

Indicator	Measurement	Source	Availability/Reliability
Programme Monitoring report	number	Implementing agencies	available

Economic and fiscal instruments	levies	SEA	not available
Introduction of biofuel	% market	MNRE Dept Energy	
Climate change adaptation measures	number & relevance	Meteorological Services, SEA	
Climate change mitigation measures	number & relevance	Meteorological Services, SEA	
Climate change policy	availability	Meteorological Services, SEA	not available

3.3.3 NATURAL DISASTERS

Natural disasters can be classified as geophysical, meteorological, climatological and hydrological disasters. Geophysical disasters are related to events taking place in the earth, such as earthquakes or volcanic eruptions. Meteorological and climatological disasters are both related to atmospheric conditions, the first one to extreme weather events, e.g. a severe storm, and the second to extreme climate variations, e.g. a severe drought. Hydrological disasters, typically expressed by extreme flooding, are normally associated with the occurrence of another natural disaster, but may also be caused by concurrent or sequential events, e.g. a storm and a dam burst.

3.3.3.1 DRIVING FORCE

Natural climatic and geological events such as extreme weather events and geophysical disturbances may be seen as the driving forces behind natural disaster, including earthquakes, drought, extreme wind, extreme rainfall, extreme temperature, etc, however following the definitions of driving forces in chapter 2, natural events should not be considered driving forces.

However there are relationships and interactions between these natural events and anthropogenic driving forces as seen operating with most of the other themes discussed in previous sections, such as increasing population and production which contribute to increased pressure on the climate, and resulting in climate change increased occurrence of natural disasters.

3.3.3.1.1 ENVIRONMENTAL INDICATORS: DRIVING FORCE BEHIND NATURAL DISASTERS

Environmental indicators that reflect anthropogenic driving forces that may contribute to occurrence of natural disasters include:

Indicator	**Measurement**	**Source**	**Availability/Reliability**
Population growth	numbers, %	CSO Census	available
Industrial growth	numbers, %	MEPD reports	available

3.3.3.2 PRESSURE

Describing pressure on natural disasters is not a useful tool as it is not very relevant or applicable. Most natural disasters were present on the earth long before any significant anthropogenic driving force or pressure took place. Climate change may to some extent be seen as a possible pressure on some kind of disasters. This is indicated under the impact of climate change (see section 3.3.2.4).

3.3.3.2.1 ENVIRONMENTAL INDICATORS: PRESSURE ON NATURAL DISASTERS

Environmental indicators that may indirectly be linked to pressure on natural disasters include:

Indicator	**Measurement**	**Source**	**Availability/Reliability**
GHG emissions	tonnes of CO_2 equivalent	SNC	available

3.3.3.3 STATE

Globally, the number of reported weather-related natural disasters is mounting rapidly. Reports of natural catastrophes have more than tripled since the 1960s. In 2007, 14 out of 15 "flash appeals" for emergency humanitarian assistance were for floods, droughts and storms - five times higher than in any previous year. In Swaziland natural disasters have affected many people over the years (Table 56).

Table 56: Summary of Major National Disasters (1983-2008)

Type of Disaster	Drought		Floods and Storms		Epidemics	
Type of Impact	Affected	Deaths	Affected	Deaths	Affected	Deaths
Number of People	1,630,000	500	913,535	-	2,228	142

Source: EM-DAT: The OFDA/CRED International Disaster Database, Université catholique de Louvain, Belgium. Data version: v11.08

The most frequently occurring natural disasters in Swaziland are meteorological and climatological disasters, followed by hydrological disasters. Geophysical disasters may occur, however very infrequently. There is no record of severe geophysical disasters like strong earthquakes in the country. Meteorological disasters most frequently occurring are storms with or without lightning, however very often with lightning. Swaziland is one of the countries with the highest incidence of lightning. Storms may result in floods and lightning may be followed by fires, ignited by the lightning. The most commonly occurring type of climatological disaster is drought.

3.3.3.3.1 OCCURRENCE OF VELD FIRES AND LIGHTNING

Not all fires are natural fires which could not be prevented. The majority of fires are caused by people; these anthropogenic fires are lit deliberately to take advantage of the dry conditions to prepare land or for any other purpose. Anthropogenic fires, resulting from purposeful or accidental ignitions, are becoming increasingly frequent and damaging, leading to land degradation and loss of biodiversity (see also section on air quality).

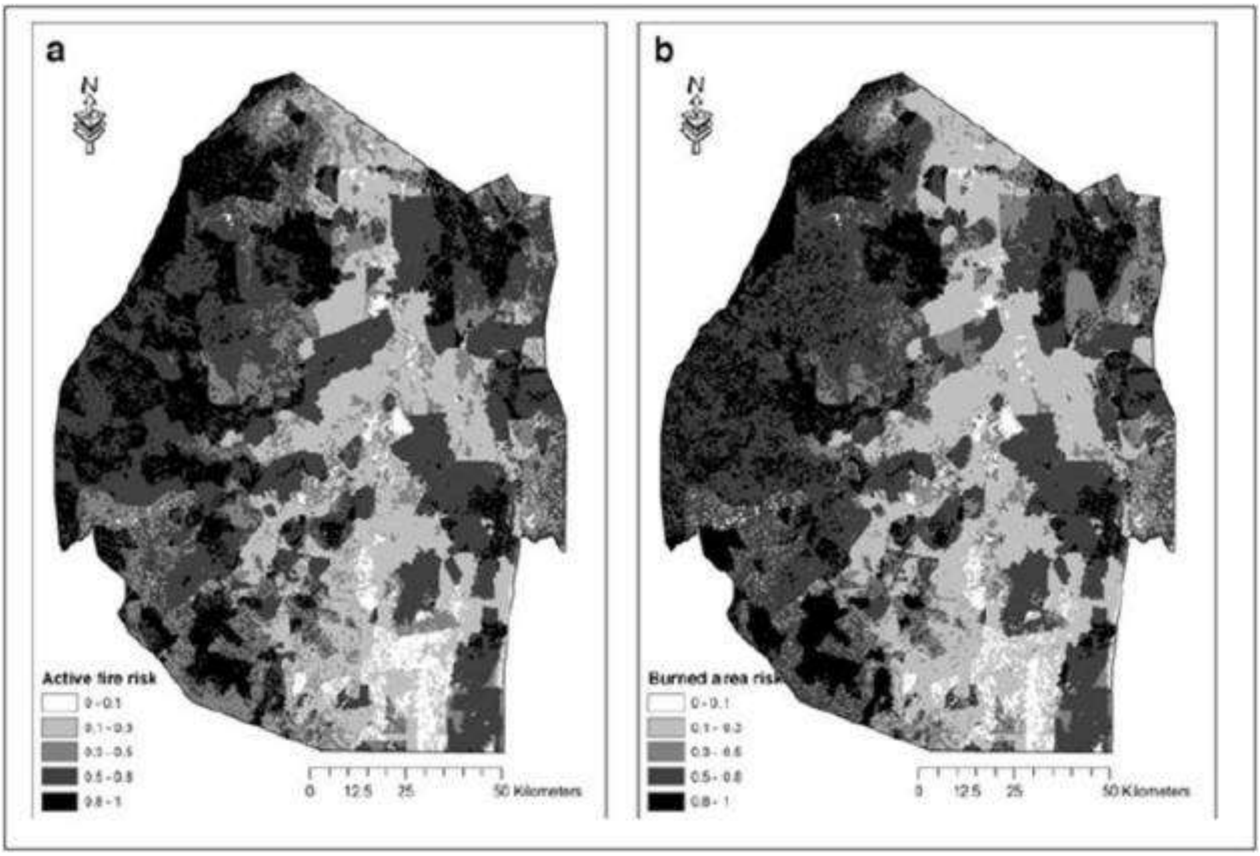
Using fire data based on the number of veld fire incidents reported to the Swaziland National Fire and Emergency Services (SNFES), together with 10-year fire data from the Moderate Resolution Imaging Spectroradiometer (MODIS) on-board Aqua and Terra, it shows that most fires occur in the grasslands, bushveld, mixed woodlands and plantations. The fire season shows a 6-month duration that runs from May to October, which is in agreement with observations for the rest of southern Africa (Korontzi et al., 2003). This temporal pattern follows the cadence of rainfall, thus rhythmically alternates between the wet and dry seasons.

Figure 23: MODIS Aqua Satellite Images 28 July 2007 (a) and 31 August 2008 (b)

Figure 23 illustrates the spatial occurrence of fires and burnt areas in the country as determined by the MODIS sensor. This geographic distribution of the fires illustrates the spatial pattern of the current burning practices, land use and the landscape in the country. The most evident clusters of fires are on the western part of the country largely from grassland fires and plantation forest fires where the Peak Timbers and Sappi Usuthu companies reportedly lost tens of millions of US dollars worth of property. The country's plantation forests have a very high fire hazard during the winter months, especially from July through to October. These fires result mainly from uncontrolled honey collection and arson fires due to strained social relations between the forest companies and the neighboring communities (Dlamini, 2005).

Both the burnt area and active fire data from MODIS reveal that the fire season typically runs from May to October/November with a peak in August, which is an indicator of the country's temporal forest fire risk profile. Using the normalized difference vegetation index (NDVI) as an estimate of vegetation water stress, and hence fire risk, Dlamini (2007) reported a negative NDVI deviation trend from the 2001-2007 mean due to the persistence of the El Nino-like conditions which results in increasing forest fire risk. The persistent low values of NDVI obtained in the periods of 2006-2007 could, therefore, have been indicative of the looming disasters as manifested by the biggest fires ever recorded in the country. This illustrates the effects of the El Nino, especially considering the high risk associated with the phyto-physiognomy of grasslands and plantation forests in the areas affected.

Figure 24: Fire Risk Distribution in Swaziland



Source: Dlamini, 2010

Findings from satellite-detected fire data also reveal that over three quarters (77.11%) of all active fires detected represent only three land cover classes (thickets/bushland, grasslands and plantation forests) which account for almost a similar proportion (73%) of the total land surface area. Sugarcane burning is also discernable accounting for 7.57%, 5.94%, and 9.76% of all the fires detected by ATSR/AATSR, MODIS and TRMM VIRS, respectively.

Table 57: Fires Detected by ATSR/AATSR, MODIS and TRMM VIRS per Land Cover Class

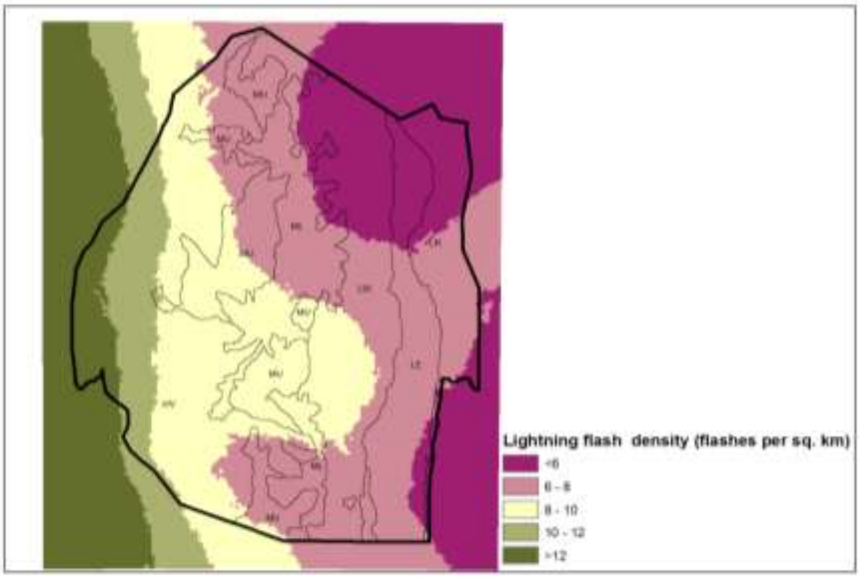
LAND COVER TYPE	ATSR/AATSR	MODIS	TRMM
Built-up areas	0.59	2.04	1.01
Cultivated areas - dryland	4.01	5.37	1.01
Cultivated areas - irrigated	1.78	1.36	1.01
Forest/Woodlands	3.41	4.17	1.01
Grassland	13.80	18.85	16.50
Plantation forests	23.00	13.79	33.33
Sugarcane	7.57	5.94	9.76
Thickets/Bushland	42.43	44.22	31.99
Water/Bare/Others	0.45	0.87	1.68

Wetlands	2.97	3.39	2.69

Source: Dlamini, 2010b

The zones of high lightning activity reveal a spatial pattern that runs parallel to the altitudinal variations with a relatively significant level of activity located in the elevated areas (see Figure 25).

Figure 25: Spatial Distribution of Average Lightning Flash Density in Swaziland, 2006-2010



3.3.3.3.2 ENVIRONMENTAL INDICATORS: STATE OF NATURAL DISASTERS

Environmental indicators that measure the state of natural disasters may include:

Indicator	Measurement	Source	Availability/Reliability
Damaging floods	numbers, frequency, extent	MET	available
Occurrence of lightning	numbers, frequency, extent	MET	available
Occurrence of fires	numbers, frequency, extent	AMESD data	available
Vulnerability to natural disasters/hazards	no of environmentally sensitive areas	Vulnerability Assessment Report (NDMA)	available
Population living in hazard prone areas	percentage	Vulnerability Assessment Report (NDMA)	available
Occurrence of drought	numbers	MET/NDMA	available
Frequency of crop failure	yield per area	MoA, Vulnerability Assessment Report (NDMA)	available
Human and economic loss due to natural disasters	numbers	MoA, Vulnerability Assessment Report (NDMA), Police reports,	available

3.3.3.4 IMPACT

The main impacts of disasters are on ecosystems (natural environment) and on human health and well-being.

3.3.3.4.1 IMPACTS FROM VELD FIRES ON AIR QUALITY, ECOSYSTEMS AND SOCIETY

In Swaziland, fire is recognized as a management tool both in the forestry and agricultural sectors and is often used to facilitate pasture regeneration and in clearing vegetation for farming and settlements (GOS-MOAC, 2002). Most of the burning that takes place in the wooded areas and grasslands is aimed at improving grazing conditions (Dlamini, 2005). However, there is evidence that these fires are used recklessly and proper fire regimes for Swaziland are not yet fully known. To minimize losses due to fires, forest plantations have been designed with networks of fire breaks, which are burnt annually (especially between June and July) to provide a clean belt around the compartments. Some protected areas also implement an early dry season burning policy in the form of fire belts and block burns to counter stray fires and to reduce fuel load, at the same time facilitating the removal of moribund vegetation. This is done between the months of June and September (pers. obs.). Even with these precautions, protected areas are not spared from fires. One such protected area, Malolotja Nature Reserve in the north-eastern part of the country, experiences regular dry season fires, most of which originate from poachers and neighbouring communities.

The country's industrial timber plantations have a very high fire hazard for the winter months, especially from July through to October. Fires in industrial timber plantations result mainly from uncontrolled honey collection and arson fires due to strained social relations between the forest companies and the neighbouring communities (Dlamini, 2005). Millions of dollars worth of forest plantations has been lost over the years as a result of forest fires. The wildland-urban interface problems are also more commonplace now than in the recent past. Urban development towards wilderness areas in such cities as Mbabane and Manzini and other towns has exposed people and property to fires and increased the risk of damage due to fires. Such fires are more complex to fight, due to the mixture of different fuels and structures in the interface.

The outdated Grassland Fires Act of 1955 stipulates that the burning of grass or other vegetation on land not cultivated or needed for cultivation requires the issue of a permit from the Director of Agriculture. The Act does not, however, apply to cultivated land such as forestry or sugarcane plantations. The National Forest Policy of 2002, however, proposed that local Fire Prevention Units should be established in all chiefdoms and on all private farms. Such bodies are to be tasked with developing fire prevention and fire fighting strategies, in close co-operation with neighbouring land users and the traditional and national authorities. The Swaziland National Trust Commission Act of 1972 prohibits wilful or negligent cause of veld fire in a park or reserve. The Game Act of 1991, on the other hand, prohibits wilful or negligent cause of veld fires in protected areas. The Private Forests Act of 1951 has few sections relating to forest fires and forest management. It establishes the legal need for fire belts around private forests. It is evident that the various pieces of legislation related to wild fire management are fragmented and outdated resulting in the negligent use of fire resulting in uncontrolled wildfires. The lack of an effective policy and institutional framework for wildfires is of serious concern. The adverse impacts of fires in Swaziland have been recently experienced, with the event of the July 2007 disaster when a series of fires raged through Swaziland and were ultimately declared a national disaster (Dlamini, 2007).

Wildfires can have noticeable effects on air quality. Widespread smoke from these fires is evidence of the amount of emissions released into the atmosphere and it covered a large portion of the country resulting in intense air pollution and reducing visibility in many areas. The health impacts are not known yet but it is evident from Figure 26 that there were significant emissions from the smoke. Burnt areas provide opportunity for invasive alien species to establish.

Figure 26: Satellite Image Showing Extent of Smoke from Wildfires

Source: Dlamini, 2007 (MODIS Aqua image for 28 July 2007)

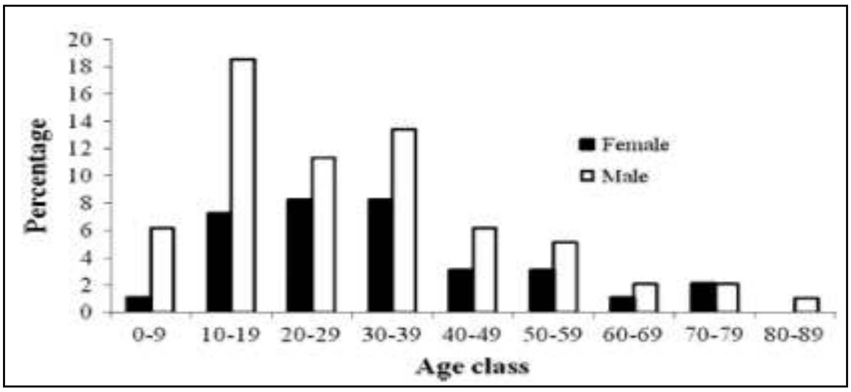
The social and economic effects of forest fires characteristically manifest through property loss (e.g., buildings, personal property, and timber), fire-fighting costs, injuries, and loss of life. The fires pose a serious threat to the survival and sustainability of the forestry industry as a whole. The July 2007 and August 2008 wildfires put at stake the jobs of hundreds of workers and the profitability of the plantation companies, Peak Timbers and Sappi Usuthu and other smaller companies. Reports from the Swaziland government indicated that some homesteads lost entire homes (169), property, food and cattle, goats and chickens in the fires including the loss of two lives, more than a dozen injuries and a total of 938 people affected (Dlamini, 2007; MORDYA, 2007).

The plantation forest industry lost an estimated R465 million (US$45 million) of forests 20,280 ha of plantation forest, mainly pine and eucalyptus (for sawlogs and pulpwood) comprising of 19,000 ha and 1,240 ha of forests planted with pine and eucalyptus, respectively. In addition to the direct losses, the livelihoods of ±8000 employees and their dependents resulting from the 728 direct and 4,368 indirect job losses incurred have been put at risk. The national economy will also be severely affected with the ultimate closure of Sappi Usuthu and downscaling of operations of Peak Timbers.

3.3.3.4.2 IMPACTS FROM LIGHTNING ON HEALTH AND SOCIETY

A majority of lightning casualty reports occurred in the afternoon and early evening mainly between 1200 and 1800h local time which coincide with the typical Swazi summer afternoon thunderstorms. They show a steady increase toward a maximum at 1600h, followed by a decrease after the maximum.

Figure 27: Distribution of Lightning Fatalities in Swaziland by Age and Sex, 2000–2007



Source: Dlamini, 2009

Quantification and mapping of lightning has become a very important area of research throughout the world as a result of the effect of lightning on telecommunications, power utilities, aviation and the insurance industry, among other socioeconomic impacts. The destructive nature of lightning affects equipment like power installations, TV, internet, among others, the damage of which has not been quantified. Revenue losses due to the loss of life and livestock have also not been quantified. Herds of cattle and goats have been reportedly killed in various incidents in the country involving a single lightning strike. An investigation to analyze the human lightning fatalities in Swaziland was undertaken by Dlamini (2009) for the period 2000-2007 where a total of 123 victims were identified from the records of the Royal Swaziland Police Service and the local printed media. An annual average fatality rate of 15.5 people per million, the highest recorded rate in the world, was obtained. The results also revealed that 66% of the victims were male, most (67%) of them were within the 10-39 age group with an average age of 28 years. Lightning fatalities occurred from September to May mainly in the afternoon (1400-1800h). Deaths most commonly occurred indoors inside rural houses (17%), whilst walking (16%) and under a tree (14%). The incidents resulted in multiple fatalities in 22% of the cases with an average of 1.4 casualties per incident.

3.3.3.4.3 IMPACT FROM OTHER NATURAL DISASTERS ON HEALTH AND SOCIETY

The main national health concerns related to the occurrence of natural disasters include bilharzia, diarrhoea, malaria, deaths from drowning and lightening fatalities, thermal heat mortality and UV related skin cancer.

Extreme air temperatures as occurring in heat waves are a direct contributor to heat stress and possible deaths from cardiovascular and respiratory diseases, particularly among elderly people. High temperatures also raise the levels of ozone and other air pollutants that exacerbate cardiovascular and respiratory diseases, and pollen and other aeroallergens that trigger asthma.

Large flood waters cause contamination of freshwater supplies and also create opportunities for breeding of disease carrying insects such as mosquitoes. Floods accelerate the spread of disease and bring a whole set of health risks including death to vulnerable communities.

Increases in the frequency and severity of flooding and storms will also result in the destruction of homes, medical facilities and other essential services, impacting particularly on people in rural areas and other marginal living conditions. The consequent destruction of homes and communities will eventually force unprotected populations to seek safer ground, often increasing environmental and social pressures in their new locations.

3.3.3.4.4 ENVIRONMENTAL INDICATORS: IMPACT FROM NATURAL DISASTERS

Environmental indicators that measure the impact of natural disasters include:

Indicator	Measurement	Source	Availability/Reliability
Deaths by lightning	numbers	Police reports	available
Deaths in heat waves	numbers	Police reports	available
Extend of flood damage	area damage	Vulnerability Assessment Report (NDMA), MoA	available
Human distress resulting from disasters	% and cost	MOH	data availability not confirmed
Population food insecure (from drought)	%	Vulnerability Assessment Report (NDMA), MoA	available
Increase of IAPS	% increase of IAPS in burnt areas	Dept of Forestry, IAPS survey report	

3.3.3.5 RESPONSE

3.3.3.5.1 SYSTEMIC RESPONSE

Legislation

Disaster Management Act, 2006

This act concerns integrated and coordinated disaster management approach and provides for the institutional mechanism, including structures, functions, authorities and responsibilities of major actors. However, its weak points, include the following: providing for declaration of 'disasters', but specifying what is to be done in 'emergencies', granting executive jurisdiction of the National Disaster Management Authority over disaster management activities of Ministries but investing it with advisory/supervisory roles.

Policies

National Disaster Management Policy, 1999

The National Multi-sectoral Bushfire Contingency Plan

Beginning in 2009, a national multi-sectoral bushfires contingency planning process was put in place with the help of the United Nations Development Programme (UNDP) and was necessitated by recent (July 2007 and August/September 2008) fires that resulted in severe socio-economic and environmental impacts to the country. The 2009 National Multisectoral Bushfire Contingency Plan was prepared under the guidance of the need for timely and coordinated emergency preparedness and response system underpinned by participation of multisectoral stakeholders. It aims to articulate a timely national emergency preparedness and response system for prevention and controlling fire disasters in Swaziland and is divided in three phases i.e. before the bushfire emergency, during and after.

Swaziland Disaster Risk Reduction National Action Plan - 2008 to 2015

The vision of the disaster management system is that by 2022, Swaziland has a functional national disaster risk management system that minimizes community vulnerability to hazards and effectively prevents and mitigates the impact of disasters within the context of sustainable development.

In line with the Swaziland Vision and Mission for Disaster Risk Management System, the Swaziland Disaster Management Act, the DRR Framework, the Hyogo Framework for Action and the Africa Regional Strategy for Disaster Risk Reduction, the National Action Plan has the following five objectives:

1. To create an effective and functional legal and institutional framework on DRR
2. To improve risk identification mechanisms in the country
3. To enhance information and knowledge management for disaster risk management
4. To improve national risk management applications for poverty and disaster risk reduction
5. To establish /strengthen disaster preparedness and emergency response practices

3.3.3.5.2 INSTITUTIONAL RESPONSE

National Disaster Management Authority

The National Disaster Management Authority (NDMA) is designated as the principal institution for disaster management at the national level of government. Its objective is "to promote an integrated and coordinated system of disaster management focused on decreasing vulnerability and increasing preparedness and mitigation capacity." The Agency is expected to establish ad hoc Technical Working Groups in 9 key areas.

A TCP Project funded by FAO has been initiated by the MTEA to respond to the need for a harmonized institutional framework (national fire legislation, policy and strategy) that enables the establishment of appropriate fire management across all land tenures and uses in Swaziland. Building on and integrating existing fire management initiatives (i.e. Bushfires Contingency Plan) the framework will enable the decentralization of fire management decision-making and implementation to stakeholders (including community) to promote ownership and collective fire management responsibility throughout Swaziland.

It is expected that FAO will provide the technical assistance to build the capacity of government, private and community stakeholders to implement integrated fire management, through the institutional framework, that complements the environment, people, land use and resources. The Project will assist Swaziland to align fire management with international and regional commitments, networks and initiatives, including the Southern African Development Community Regional Fire Management Program (2010), SADC Protocol on Forestry (2002) and FAO Fire Management: Voluntary Guidelines – Principles and Strategic Actions (2006).

Subsequently, a MoU on co-operation in the management of wildfires and other forestry development issues was signed between the Government of the Republic of South Africa and the Government of Swaziland in 2011. The objectives of the MoU are to expand and continuously explore best strategies for co-operation between the Parties in the following areas:

- measures to facilitate sustainable management and combating of cross border wild fires;
- sharing of available resources;
- technical and scientific information exchange in forestry management issues; and
- measures to facilitate Sustainable Forest Development.

3.3.3.5.3 ENVIRONMENTAL INDICATORS: RESPONSE TO NATURAL DISASTERS

Environmental indicators that measure the impact of natural disasters include:

Indicator	Measurement	Source	Availability/Reliability
Policies	numbers	NDM Policy	available
Programmes	numbers	NDMA	available

3.3.4 STRATOSPHERIC OZONE

The issue of depletion of the stratospheric ozone layer was one of the first global environmental emergencies faced by UNEP. The stratospheric ozone layer protects the earth from excessive UV-B radiation from the sun. The atmosphere next to earth up to about 10 kilometres is called troposphere and stratosphere is above the troposphere, up to about 50 kilometres. The thin layer of ozone has been formed in the stratosphere by the action of solar radiation on normal oxygen. It is continuously formed and destroyed through natural processes leading to a natural balance.

This ozone layer filters out excessive ultra-violet radiation from the sun and protects all life on earth from adverse effects. Its depletion has many adverse effects of increase in skin cancers and eye-cataracts, loss of immunity, lesser productivity of plants, deterioration of plastics etc. Ozone formed in the troposphere is discussed under the general section on Air Quality.

3.3.4.1 DRIVING FORCE

Similar to the driving force behind the pressure on air quality, the driving force behind the depletion of ozone is the need of a growing population for various commodities, consumption and demanding lifestyle and hence industrial production.

3.3.4.1.1 ENVIRONMENTAL INDICATORS: DRIVING FORCE TOWARDS STRATOSPHERIC OZONE DEPLETION

Environmental indicators that measure the driving force toward depletion of the ozone layer include:

Indicator	Measurement	Source	Availability/Reliability
Population , economic and industrial growth	population growth, GDP	SHIES report	available

3.3.4.2 PRESSURE

The pressure on the stratospheric ozone layer is based on the consumption of ozone depleting substances (ODS) and using the atmosphere for emission of these ODS is resulting in depletion of the ozone layer which forms part of the stratosphere (outer atmosphere) and lies between 10 and 50 km above the Earth surface.

The ozone layer is very important to humans and other ecosystems in general because it naturally limits the ultraviolet-B (medium wave) rays of the sun from reaching the earth's surface. Over the years, it was observed that 'holes' were being formed within the ozone layer resulting in excess UV-B reaching the earth surface.

A group of man-made gaseous chemicals known as organohalogen compounds which are used in refrigeration, pesticides and coolants react with ozone when released into the atmosphere. Examples of halogens are Chlorofluorocarbons (CFCs) and bromofuorocarbons (BFC).

Through the Montreal Protocol the use of ozone depleting substances were banned. It is important to note that due to the strengthening and adoption of the Montreal Protocol, reports indicate that the concentration of ozone in the atmosphere is stabilizing and the ozone layer will fully recover.

3.3.4.2.1 ENVIRONMENTAL INDICATORS: PRESSURE ON THE STRATOSPHERIC OZONE LAYER

Environmental indicators of pressure on the ozone layer in the stratosphere include:

Indicator	Measurement	Source	Availability/Reliability
Increased Imports of ODS	metric tonnes	SEA reports	available
Illegal imports	number of cases	SEA reports	unreliable

3.3.4.3 STATE

The concentration of ozone in the stratosphere is continually measured and monitored by satellites.

The amount of ozone in the stratosphere (upper atmosphere) matters because it absorbs most of the sun's harmful ultraviolet B radiation. Overall, the concentration of ozone in the stratosphere over Australia and New Zealand may have started to increase since the year 2000. The ozone 'hole' over Antarctica has been at its current size of 25 million km^2 since the mid-1990s, following two decades of rapid growth. At the same time, there has been a 1 per cent a year decrease in the erythemal ultraviolet index (a measure of skin cancer potential) over the southern part of Australia since 1998 (CSIRO, 2005c). These datasets show marked variability, making interpretation difficult.

3.3.4.3.1 ENVIRONMENTAL INDICATORS: STATE OF THE STRATOSPHERIC OZONE LAYER

Environmental indicators that measure the state of ozone in the atmosphere include:

Indicator	Measurement	Source	Availability/Reliability
Stratospheric Ozone	Dobson units	Ozone Secretariat	available
Ozone depletion (Ozone Hole)	DU, km	Ozone Secretariat	available
Atmospheric concentration of ODS	DU	Ozone Secretariat	available
Amount of HCFC imported	metric tonnes	SEA	available
Amount of Methylbromide imported	metric tonnes	SEA	available

3.3.4.4 IMPACT

The main concerns from Stratospheric Ozone Depletion (the holes in the ozone layer) regard impacts from excess ultraviolet B radiation on human health, (causing skin cancer and cataracts) and to a lesser degree on vegetation.

3.3.4.4.1 ENVIRONMENTAL INDICATORS: IMPACT FROM STRATOSPHERIC OZONE DEPLETION

Environmental indicators that measure the impact from stratospheric ozone depletion include:

Indicator	Measurement	Source	Availability/Reliability
Skin cancer	number of cases, %	Min Health (Annual report)	available
Cataracts	number of cases	Min Health	available

3.3.4.5 RESPONSE

International Response to stratospheric ozone depletion was followed by systemic and institutional response in Swaziland.

3.3.4.5.1 INTERNATIONAL RESPONSE: THE VIENNA CONVENTION & MONTREAL PROTOCOL

The Vienna Convention for the Protection of the Ozone Layer is a Multilateral Environmental Agreement. It was agreed upon at the Vienna Conference of 1985 and entered into force in 1988. It has been ratified by 196 states.

Swaziland ratified both the Vienna Convention on the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer in 1992. All the amendments to the Protocol were ratified in 2005.

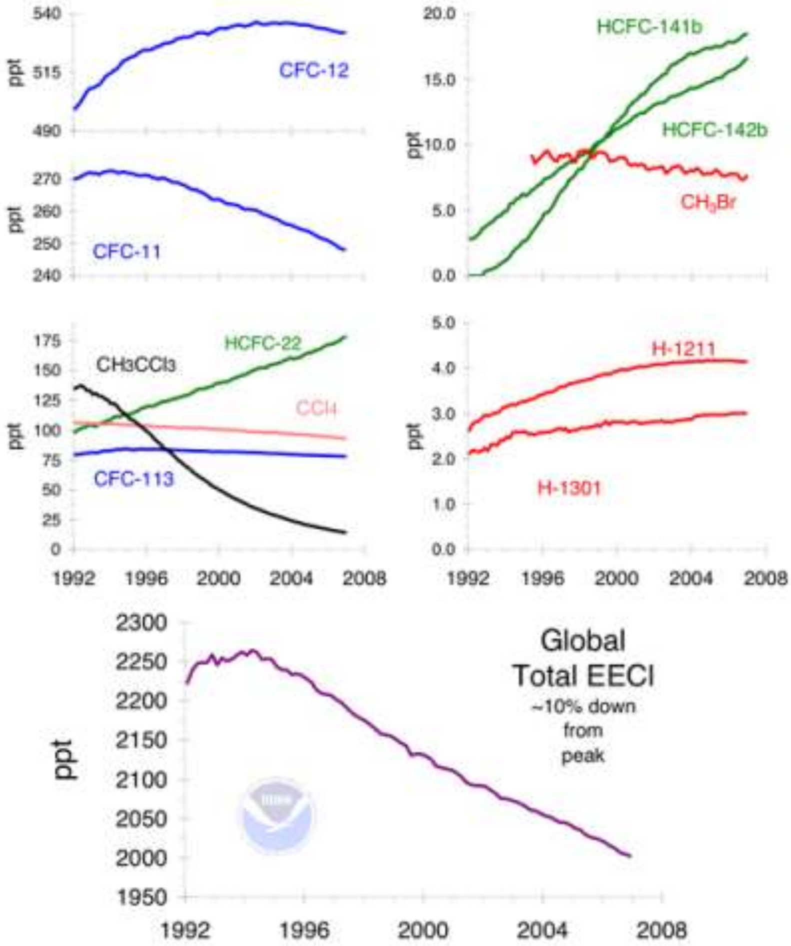
The Montreal Protocol on Substances That Deplete the Ozone Layer (a protocol to the Vienna Convention for the Protection of the Ozone Layer) is an international treaty designed to protect the ozone layer by phasing out the production of numerous substances believed to be responsible for ozone depletion.

The treaty is structured around several groups of halogenated hydrocarbons that have been shown to play a role in ozone depletion. All of these ozone depleting substances contain either chlorine or bromine (substances containing only fluorine do not harm the ozone layer).

The main objective of the Multilateral Fund for the Implementation of the Montreal Protocol is to assist developing country parties to the Montreal Protocol whose annual per capita consumption and production of ozone depleting substances (ODS) is less than 0.3 kg to comply with the control measures of the Protocol.

Since the Montreal Protocol came into effect, the atmospheric concentrations of the most important chlorofluorocarbons and related chlorinated hydrocarbons have either levelled off or decreased (Figure 28).

Figure 28: Ozone-depleting Gas Trends



Source: NASA

Halon concentrations have continued to increase, as the halons presently stored in fire extinguishers are released, but their rate of increase has slowed and their abundances are expected to begin to decline by about 2020. Also, the concentration of the HCFCs increased drastically at least partly because for many uses CFCs (e.g. used as solvents or refrigerating agents) were substituted with HCFCs. While there have been reports of attempts by individuals to circumvent the ban, e.g. by smuggling CFCs from undeveloped to developed nations, the overall level of compliance has been high. In consequence, the Montreal Protocol has often been called the most successful international environmental agreement to date. In a 2001 report, NASA found the ozone thinning over Antarctica had remained the same thickness for the previous three years; however in 2003 the ozone hole grew to its second largest size. The most recent (2006) scientific evaluation of the effects of the Montreal Protocol states, "The Montreal Protocol is working: There is clear evidence of a decrease in the atmospheric burden of ozone-depleting substances and some early signs of stratospheric ozone recovery."

Unfortunately, the hydrochlorofluorocarbons, or HCFCs, and hydrofluorocarbons, or HFCs, are now thought to contribute to anthropogenic global warming. On a molecule-for-molecule basis, these compounds are up to 10,000 times more potent greenhouse gases than carbon dioxide. The Montreal Protocol currently calls for a complete phase-out of HCFCs by 2030, but does not place any restriction on HFCs. Since the CFCs themselves are equally powerful greenhouse gases, the mere substitution of HFCs for CFCs does not significantly increase the rate of anthropogenic global warming, but over time a steady increase in their use could increase the danger that human activity will change the climate.

At present there are 95 chemicals controlled by the Protocol, which include:

Chlorofluorocarbons

- CFCs, Halons, Hydrobromofluorocarbons
- HBFCs, Other fully halogenated CFCs, Carbon tetrachloride, 1,1,1 trichloroethane

- methyl-chloroform,

Hydrochlorofluorocarbons

- HCFCs, Hydrobromoflourocarbons
- HBFCs and Methyl Bromide.

Control measures for Chemicals

For developed countries: Phase-out of halons by 1994; Phase-out of CFCs, carbon tetrachloride, methyl chloroform and HBFCs by 1996; Phase-out of Methyl Bromide by 2005; Phase-out of HCFCs by 2030.

For developing countries: Phase-out of HBFCs by 1996; Phase-out of CFCs, Halons and Carbon tetrachloride by 2010; Methyl Chloroform and Methyl Bromide by 2015; HCFCs by 2040.

Implementation of Control Measures by Developing Countries

The Montreal Protocol allowed a grace period for developing countries in recognition of the fact that time will be needed for them to obtain and introduce alternative technologies. During this period they are allowed to increase their consumption to meet their basic domestic needs. They will have to implement the control measures from 1 July 1999. A number of countries, particularly in Asia and Latin America have been increasing their consumption in step with their high rates of economic growth. A time has come now for them to stop this increase and begin reversing the trend. The Multilateral Fund has been, and will be, of great help to these countries. It has to be remembered that the phase-out by the industrialized countries represents a phase-out only 20 per cent of the world population and that the ozone layer protection is assured only if the remaining 80 per cent of the world in developing countries follows suit. This is a crucial challenge for the next 10 years.

3.3.4.5.2 SYSTEMIC RESPONSE

Legislation

Ozone Depleting Substances Regulations, 2003

These regulations regulate licensing of imports and exports of ozone depleting substances as well as monitoring their use in the country.

Policies

None

3.3.4.5.3 INSTITUTIONAL RESPONSE

The country programme (CP) for Swaziland was approved at the 15th Executive Committee (ExCom) Meeting in January 1994. Following this the country established the National Ozone Unit (NOU) in the then Ministry of Tourism, Environment and Communications in 2001. The NOU is now under the Swaziland Environment Authority. Funding is from the Multilateral Fund through Implementing Agencies; UNDP and UNEP.

A number of activities outlined in the country programme have been undertaken since the establishment of the unit. The country then promulgated the Ozone Depleting Substances (ODS) Regulations in 2003, effectively putting in place the licensing and quota system for all ODS imports. This implies that the country has been monitoring and reporting imports of all ODS. These Regulations have recently been amended to strengthen the monitoring of ODS imports.

While the Montreal Protocol has enhanced efforts to decrease the consumption of Ozone Depleting Substances to less than 10 percent globally, there remains a challenge of sustenance of the initiated programs at national level. A continuity of the interventions can only be ensured by the stewardship and enhanced capacities of the national institutions and expertise to sustain initially targeted outcomes. Swaziland through the Swaziland Environmental Authority (SEA) has established the National Ozone Unit.

The regulatory frameworks however cannot be effective without people-owned institutions to drive compliance. The newly established Refrigeration Association made up by national technicians working in the refrigeration and air conditioning sector is a secured development avenue.

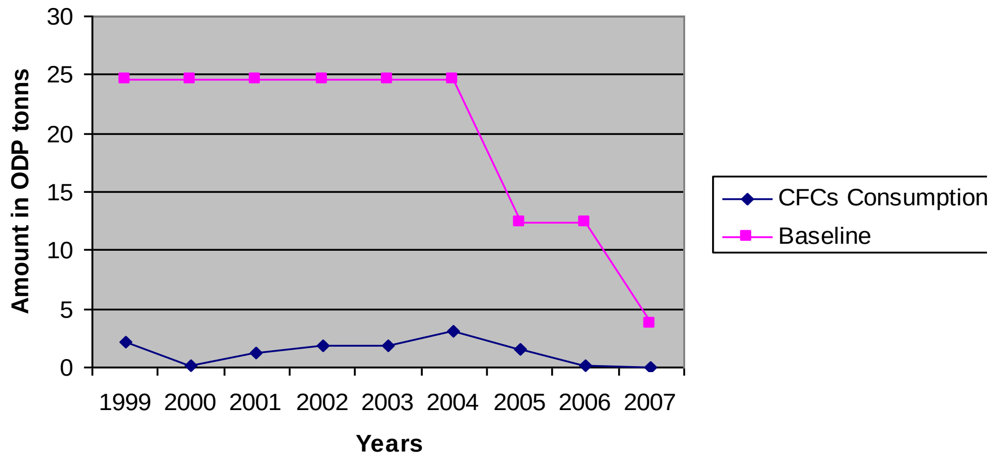
Implementation of the Montreal Protocol. Swaziland has been in compliance with the ODS phase out schedules set out under the Montreal Protocol and initiatives are in place to ensure that the country is in compliance with the 2010 CFC total phase out schedule as prescribed under the Montreal Protocol.

The Protocol through the Refrigerant Management Plan tries to phase out refrigerants; hence the Regulations also try to address this under the Second Schedule of the 2003 Ozone Depleting Substances Regulations, which have been recently gazetted. The Regulations entail a licensing system on the import and export of ozone depleting substances as a means of regulating the transfer of such substances which can leave the country with adverse impacts. This will in turn help the SEA to improve its monitoring exercises to end users of these substances.

The Department of Customs and Excise play an important role in determining the end users of these for ease of monitoring by the Authority. Through training sessions awareness has been raised on the existence of the draft Regulations and its aims. The department has also been taught the methods of data collection to be produced on SEA's demand. This is because these are based at the entry points of the country and has been targeted to obtained good data for the ozone unit.

The regulations are already in use as the Customs Department liaises with the Authority's Ozone Unit constantly. The Authority has now started to design the permit to be issued, which will also have a bearing on the SEA parent law.

Figure 29: CFC Consumption in ODP Tons



Source: Swaziland Environment Authority

The country has implemented these projects: Methylbromide (MBr) Phase-out and the Refrigerant Management Plan (RMP). The most recent MBr survey conducted in 2010 confirmed that all agricultural applications of the substance had been replaced by alternative substances. The country is only remaining with the exempted quarantine and pre-shipment uses. The RMP introduced recovery and recycling of refrigerants (R&R). The end of this project unveiled the need for continuous training of refrigeration and air conditioning technicians on good practices and introduction of new non-ODS technologies.

The Terminal Phase-out Management Plan (TPMP) implementation is nearing its completion. Through this project 300 refrigeration technicians have been trained on good refrigeration practices and handling of hydrocarbon technology. About 130 customs officers have also been trained on monitoring of ODS at entry and means of combating illegal trade and smuggling. Institutions offering refrigeration courses have been strengthened with equipment to enhance their training. These activities combined public awareness have assisted the country to attain complete phase out of CFCs in 2007, before the 1st January 2010 target date. Swaziland has also been in compliance with the phase out schedule of the Montreal Protocol,

The CFC trend, depicted in Figure 29, indicates that there was a steady decrease of CFC use in the country up until 2003 where there was a sharp increase. However, the country was able to reduce almost by half the following year. It is important to note that this happened before the implementation of the ODS regulation, which was put in place in the same year, 2003 and was within the freeze requirements.

The next phase-out plan of hydrochlorofluorocarbons (HCFCs) is about to commence as the project proposal has already been approved. HCFCs were introduced in the country in the early 1990s as an alternative to CFCs. However because they also destroy the ozone layer, the Montreal protocol provides for their replacement. The country's baseline for HCFC reduction is the 2009 consumption of 103.72 metric tons (9.5 ODP tonnes). This figure will gradually be reduced by 10% and 35% by 2015 and 2020 respectively. Total eradication of HCFCs has a target to 2030. Presently the major HCFCs in the country are HCFC-141b (pre-polyol) used in foam production in the manufacture of refrigerators; and HCFC-22, which is used in the servicing sector.

The recent survey conducted in 2010 showed the below trend (Table 58) in the consumption of ODS.

Table 58: Trend in Consumption of ODS (2008-2010)

Year	HCFC 22	HCFC (Pre-Blended polyol)	Methylbromide	Total
2010	28.62	31.14	0.30	60.06
2009	34.10	69.62	0.30	103.72
2008	31.58	62.58	0.10	94.26

Source: Swaziland Environment Authority

3.3.4.5.4 ENVIRONMENTAL INDICATORS: RESPONSE TO OZONE DEPLETION

Environmental indicators that measure to response to Ozone Depletion include:

Indicator	Measurement	Source	Availability/Reliability
Affiliation to international treaties	ratification	SEA	available
Policies and legislation	regulations	SEA	available

3.4 THEME 4: BIODIVERSITY

Biodiversity is defined as the variability of life expressed at the ecosystem, species and genetic levels. This variability is the essence of life and the basis of existence of all life forms. Plants and animals can be used in a variety of ways. Through domestication and direct harvesting from the wild, people derive food, medicines and a wealth of raw materials.

Swaziland is relatively rich in biodiversity. For a country with a land area of 17,364km^2, Swaziland has an inordinately large plant and animal diversity. More than 14 phyla have been recorded, or are suspected to occur. Some groups of fauna found in Swaziland such as the invertebrates have not been completely surveyed. Although Swaziland's vertebrates have been well documented (813 species comprising 445 genera in 144 families), only the distribution and status of the country's birds are satisfactorily known. A total of 3,678 plant taxa have been recorded in the country and there is a great possibility that there may be undescribed species. Twelve endemic plants and a single endemic reptile are known to occur in the country.

The biodiversity resources of Swaziland have great cultural and economic significance. The presence of indigenous biological resources and their diversity provides a wide range of direct benefits because they generate products which are used for subsistence income and employment purposes. In addition the diverse flora and fauna of Swaziland has a variety of recreational and aesthetic values, while the introduced plants and animals constitute the basis of Swaziland's agriculture, e.g. sugarcane and pine. All domesticated crops and animals result from human management of biological diversity, which is constantly responding to new challenges to maintain and increase productivity. A rapidly growing global human population and changing consumption patterns have stimulated the evolution of agriculture from traditional to modern, intensive systems. Therefore, the importance of biodiversity is not confined to functioning natural ecosystems but also its contribution to the wider economy.

The acknowledged wide diversity of flora and fauna and in particular the domesticated plant and animal species have played a major in Swaziland's economic development post-independence and the policies and strategies the country has implemented have had direct and indirect impacts on biodiversity.

In spite of the country having such a rich biodiversity, the diversity of the species found in the country has been greatly reduced over the past century due in a large part by the influence of man. For example, the numerous large mammal species that once roamed the grasslands and savannas in large numbers are now generally extinct or are found in low numbers in the wild or within protected areas (Monadjem *et al.* 2003). These threats are not unique to the large mammals as many other species face an uncertain future in the country. For example, 89 species of vertebrates and 305 species of plants are currently listed as threatened or near threatened in national Red Data Lists (Monadjem *et al.*, 2003; Dlamini & Dlamini, 2002).

This section assesses the country's natural biodiversity in terms of changes to its spatial distribution and composition (*change of biodiversity*) and also how this biodiversity is managed and protected.

3.4.1 DRIVING FORCE

The main driving force behind the change in Swaziland's biodiversity is the demands placed upon it by a growing population and increased resource extractions, in particular for traditional medicines, and its need for land for agriculture, settlements and other land uses (see land conversions covered under Theme 1 Land Use Changes).

3.4.1.1 RESOURCE EXTRACTION

The driving force of resource extraction is leading to dramatic changes in the country's biodiversity and its spatial distribution and leading to declines or extinctions of some species. The floral diversity has supported and stimulated a growing demand for plant based traditional medicines as well as its utilisation in national traditional ceremonies.

Medicinal plants are the most important group of non-timber forest products (see also section 3.1.3); as they represent a significant economic good and combined with the demand have a high social value. Traditional medicine is widely used in Swaziland. There are over 10,000 traditional healers in the country with a practitioner to population ratio of 1:100, while that of medical doctors to the total population is 1:10 000 (Mdluli, 2002). Traditional medicinal plants are used at household level to treat common and minor ailments. In an article from IRIN in February 2003[25], the Swaziland branch of the Traditional Healers Association of South Africa estimates that about 3,000 traditional healers are at work in the country. Exact figures are hard to establish, because customarily healers work independently, and do not belong to any professional group. IRIN also reports that a World Health Organisation survey in the 1990s found that a majority of Swazis use traditional healers as their primary source of health care, despite a growing network of health clinics and private physicians.

The demand by Swazi's as well as regional cultures for traditional medicines derived from indigenous plant and animal species has become a major industry with all local markets having large stocks of material to sell and quite a large amount being exported.

The medicinal sector is currently unregulated and so statistics around the quantities used and key markets is not well known. The findings from one study on the role of traditional medicine estimated that some 219 tonnes of medicinal plant material were consumed every year in Swaziland with a value of some E27 million (NBSAP: GOS-SEA, 2001). This high level of utilisation excludes products that are traded and exported into the region which are suggested to far exceed local consumption levels.

Contributing towards the decline is the country's high levels of rural poverty and poor health. Although studies have shown that 'rich' people also utilise traditional medicine, for the rural poor they often have little choice but to use comparatively cheaper remedies to common ailments. The relatively poor ratio of doctors to people and the spatial distribution of clinics (often near formalised settlements) make a visit to a formal medical facility impossible whereas a traditional healer is reported to be usually much closer.

Based on the results from botanical surveys and interviews with harvesters and users, it is reported that the country has a good knowledge of the major floral species used by traditional healers. Knowing what and where the medicinal plants and animals could be used to better manage their utilisation and thus protect, for future generations, the country's natural heritage (National Forestry Policy; GOS-MOAC, 2002).

Cultural ceremonies are also a user of the country's biodiversity. The annual hunt, '*butimba*', usually held in the last week of August, targets a variety of antelope species. This hunt is a cultural event whereby all adult Swazi males with licensed firearms go out on a hunting expedition accompanied by the King. The hunt is

[25] http://www.irinnews.org/Report/32780/SWAZILAND-Traditional-healers-new-partners-against-HIV-AIDS

carried out in an area surrounding Hlane Game Park and focuses mainly on surplus common game. No records are kept of animals killed during the national hunt.

Culturally important ceremonies, like the *Umhlanga* and *Incwala*, both utilise important plants and plant materials. During the Incwala it is tradition that *Lusekwane* (sickle bush/*Dichrostachys cinerea*) is harvested by unmarried male youths from a variety of places where it occurs in large quantities. It is then placed in the national cattle byre/kraal after which the elders weave the branches in between the poles of the "inhlambelo" - the king's private sanctuary. The *Umhlanga* ceremony or Reed Dance is an eight day ceremony during which girls cut reeds from designated areas where they grow and present them to the queen mother and then dance. Over utilisation of these species combined with little or no formal protection is increasing the likelihood of these plant species becoming threatened or even extinct (National Forestry Policy; GOS-MOAC, 2002).

3.4.1.2 ENVIRONMENTAL INDICATORS: DRIVING FORCES AFFECTING BIODIVERSITY

Environmental indicators to measure the driving force behind changes in biodiversity include:

Indicator	Measurement	Source	Availability/Reliability
Value of annual extraction of medicinal products from indigenous species	E	No source	not available
Quantity of exported medicinal products from indigenous species	Kg	Phytosanitary Unit Malkerns	may be available
Number of identified plant sources	numbers	Research SIREMIFOP	may be available
Sustainable yield of identified plant sources	Kg/yr	No source	not available

It should be noted that there are no systematic statistics of extraction and trade in medicinal products from indigenous species and also not on the sustainable yield of commonly used sources of reed for ceremonies.

3.4.2 PRESSURE

The key pressure behind the country's changing biodiversity is the uncontrolled and unsustainable extraction of medicinal plants as described above which is resulting in a reduction in the quantity and spatial distribution of certain species. Other pressures on the country's biodiversity are driven by increasing land transformation for agriculture, afforestation, urbanisation, alien plant invasion, bush encroachment, veld fires and soil erosion (see also relevant sections on land use change 3.1.1, forestry 3.1.3, natural disasters 3.3.3).

Although Swaziland is still very rich in biodiversity, the pressure on ecosystem and biodiversity have resulted in a seriously diminished biodiversity base as evidenced by the increasing number of species in the Red Data Lists.

Table 59 shows a number of major pressures to each of the four recognised ecosystem.

Table 59: Major Ecosystem Pressures

Pressure	Grassland	Savanna	Forest	Aquatic
Excessive resource harvesting	•	•	•	•
Afforestation (land conversion: exotic plantations)	•			
Rain fed cropping (land conversion)	•			
Sugar cane cropping (land conversion)		•		
Urbanisation (land conversion)	•	•	•	
Land degradation by livestock grazing & trampling	•			•
Soil Erosion	•			•
Alien plant invasion	•	•	•	•
Bush encroachment		•		
Pollution				•

Source NBSAP, GOS-SEA 2001

3.4.2.1 EXCESSIVE USE OF BIODIVERSITY RESOURCES

Harvesting of the biodiversity is increasing to unsustainable levels. Most plant and animal species typically used for medicinal purposes, construction and food have become locally extinct or very rare in many. Medicinal plants such as *Aloe kniphofioides* (aloe), *Bowiea volubilis* (climbing onion), *Prunus africana* (red stinkwood) and *Siphonochilus aethiopicus* (natal ginger) are on the national Red Data list while the majority of threatened fish, reptile, bird and mammal species are only found in protected areas (Dlamini & Dlamini, 2002; Monadjem et al. 2003).

The extraction and sale of the biodiversity is often viewed as an opportunity to broaden economic options particularly for the rural poor. Harvesters realise that the economic value of certain species can supplement household income. Studies have not been done or publicised on the sustainable yield of commonly used medicinal plants but given the significant demands by the population for traditional medicines and the increasing costs of particular species, it is unlikely to be sustainable.

3.4.2.1.1 EXTRACTION OF PLANT SPECIES

Compounding the pressure driven by the extraction of wild flora is its illegal trade and export (GOS-MOAC, 2002). A similar pressure, sanctioned by cultural traditions, is driven by the use of traditionally important plants used in cultural activities and ceremonies. Certain tree species used for building cattle kraals, are reported to be being overexploited with no programme (traditional or controlled) to propagate and replace lost plants through re-planting programmes.

Current and predicted future pressures on the country's flora will and is resulting in the rapid degradation and reduction in size of important natural habitats and the diversity of species that inhabit them. Frequent grassland fires, climate change, alien species invasions, modification of catchments and hydrological systems for irrigation, nutrient loading and pollution, overexploitation of resources, etc. are all compounding the decline in the country's biological diversity.

The relative significance and magnitude of these pressures differs considerably amongst ecosystems, but all are likely to contribute to the continued decline of species' populations and loss of biodiversity over the next few decades. Anthropogenic activities currently dominate all ecosystem functions in Swaziland largely dictated by the land tenure and land use systems. Non-forest timber products are also in growing demand for fuel and timber mostly in rural areas. Although the standard of housing has improved since independence from traditional thatch and wood to cement blocks and galvanised iron roof sheeting, rural poverty continues to exclude sections of society from building more modern houses and they continue to build traditional structures using plant products.

3.4.2.1.2 EXTRACTION OF ANIMAL SPECIES

The killing of wild animals outside formally protected areas continues to reduce the spatial distribution and number of these animals. The gratuitous killing and indirect killing of many animal species, eg snakes, bats, amphibians is very common in the country. Animals, mostly antelope species, are hunted for the pot and for sale with the result that many animal populations, particularly on Swazi Nation Land, have been reduced to local extinction. Poaching of wild animals within the existing protected areas network is widespread.

Formalised hunting of animals is permitted through provisions of the Game Act. The Game Act administered by Big Game Parks and hunting of common species, as defined by the Act, is permitted from May 1 to August 31. Controlled hunting takes place on private farms and game reserves. There is no systematic published record of game animal species hunted but there are various places where hunting is permitted. While trophies animals are hunted, the main attraction is impala for biltong or supplying butcheries. Formalised hunting areas are stocked with a variety of animals and the stocks are carefully managed. Certain species of game are classified by the Act as Common Game and may be hunted by a landowner or a person given authority by the land owner. In the case of SNL the same applies but the Chiefs consent must be obtained. There are some rules and regulations laid out in the Game Act, such as no hunting at night, or from a vehicle and the type of weapon permitted.

If trophies are to be exported, then a permit is required from the Ministry of Agriculture, and if CITES protected, a CITES permit is required from BGP. Culling requires a special permit obtainable on a case by case basis from BGP. At the end of the hunting season, the land owner is required to complete the permit detailing number, sex, and species hunted and where the meat and or trophies went to, and return the data to BGP who compile national data.

To control and regulate hunting and game ranching, the Swaziland Game Ranchers Association was established. The economic value to the country through controlled hunting for trophy and biltong species is estimated to be under E1 million (pers comm Swaziland Game Ranchers Association). Revenue from game meat sales derived from culling and live game sales is estimated to slightly above E1 million per annum.

Sport hunting of rhino is permitted in Swaziland. CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) has long provided for the sport hunting of white rhinoceros as a legal avenue of trade, and the current annotation accompanying the Appendix II listing of the C. s. simum populations in South Africa and Swaziland specifically allows for the export of hunting trophies and "live animals to appropriate and acceptable destinations". Information from CITES on trade in animals in Swaziland is given in Table 66.

Poaching is the illegal taking of wild plants or animals; the law concerned may be e.g. the law of property or local or international conservation and wildlife management laws. Violations of hunting laws and regulations are normally punishable by law and, collectively, such violations are known as poaching. Although statistics on the scale of poaching in Swaziland are difficult to come by, there is some information (see Table 60 and Table 61).

Table 60: Number of Poaching Incidents

Year	Malolotja	Mlawula
2007	21	16
2008	19	12
2009	18	12
2010	19	16

Source: SNTC; Note: These figures show lower rate of arrests due to reduced visibility in the Lowveld bushes. For all the figures, these are gross underestimates of the real problem as only an estimated 50% were arrested.

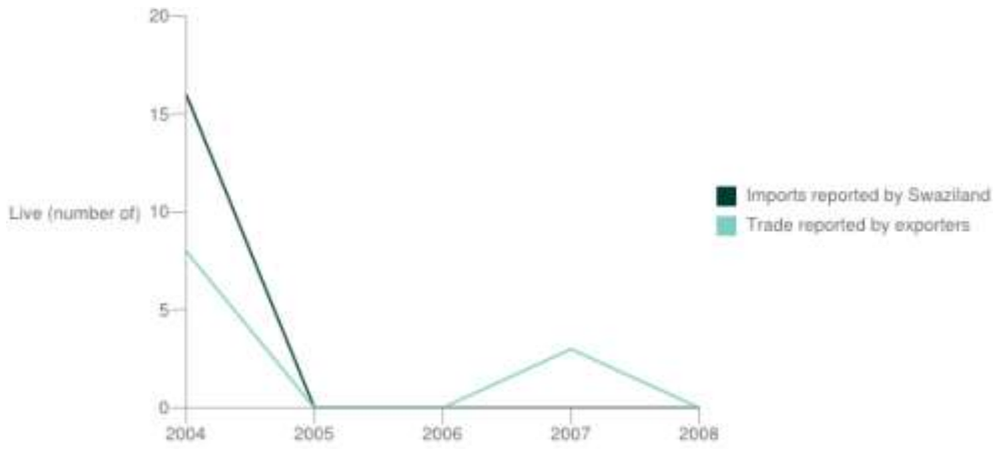
Poaching in reserves is widespread. Antelope have been hunted out of Swazi Nation Land and as a consequence stocks in protected areas are now facing heavy poaching pressure despite anti-poaching laws that have been enacted. Certain animal species are also targeted for traditional medicinal use. Increased incidents of poaching animals and unauthorised harvesting of plant materials within protected areas compromise the overall effectiveness of protected areas.

Table 61: Percentage Species Targeted by Poachers

Species	%
Baboon	2
Blue wildebeest	31
Bush pig	3
Bushbuck	1
Impala	37
Kudu	8
Mountain reedbuck	3
Warthog	13
Zebra	3
Total	100

Rhino have been the target of poaching for many years in Swaziland. The country has a small rhino population, namely 89 white and 18 black rhinos, as reported by TRAFFIC in 2009. During the so called "rhino war" between 1988-1992, Swaziland lost almost 80% of its rhinos to poachers, incidents were on average once every two weeks, but with some occurring up to 3 times a day. After the enactment of the amended Game Act, incidents dropped dramatically. The last reported incident of a rhino being poached was in June 2011 - nearly 20 years since the last incident. Poachers reportedly shot and killed a white rhino.

Table 62: Trade in Mammals in Swaziland 2004-08



Source: CITES Trade Data Dashboard (http://cites-dashboards.unep-wcmc.org/national?id=SZ)

3.4.2.2 CHANGE OF NATURAL HABITAT

The conversion of natural habitats to other uses is a significant cause of biodiversity loss in Swaziland. Land use change alters or destroys natural habitat, frequently with secondary consequences of degradation and fragmentation of remaining habitats, all of which result in losses of biodiversity, decline in ecosystem health, and changes in the provision of ecosystem services. Along rivers, the removal of riparian vegetation for cultivation and to create access to rivers, for example, undermines the ecological integrity of fresh water ecosystems because of the important role of such vegetation in maintaining channel stability and as a source of food (through leaf-fall, for instance) into the aquatic system. Degradation of habitat quality through inappropriate land-use management (such as overgrazing) also occurs in these ecosystems. Changes to biodiversity related to land use change (LUC) are further described in section 3.1.1.

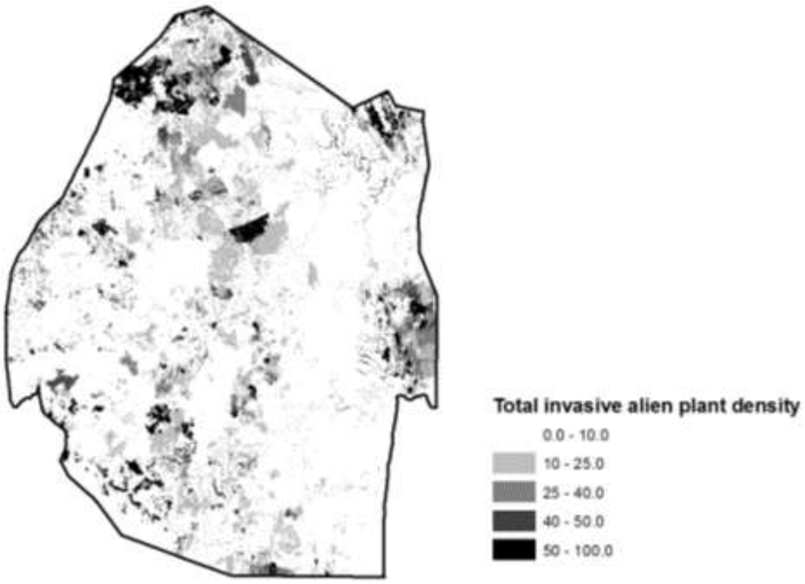
A number of industrial and mining ventures within or adjacent to the protected areas network are proposed. Iron ore mining operations at Ngwenya which is within the Malolotja Nature Reserve were restarted in 2010. A green chert deposit also within the Malolotja Nature Reserve could be exploited in the future. Such operations do not only pose a direct threat to biodiversity within the reserves but also reduce the protected areas network further.

3.4.2.3 INVASIVE ALIEN PLANT AND ANIMAL SPECIES

Globalization has resulted in a world where travel and transport of goods are fast, easy, and increasing, thus facilitating the effortless spread of species among countries and continents. While not all alien species thrive in their new environments, some do, becoming invasive by spreading at the expense of indigenous species and causing significant changes to habitats and ecosystem functioning. One of the main reasons why alien species flourish is that they are no longer controlled by their natural predators and pathogens (diseases) with which they have co-evolved in their natural range. On the other hand, indigenous species are at a competitive disadvantage when they encounter these alien species, with which they have no evolutionary history and are thereby easily out-competed.

Over the past decade, habitats in Swaziland have been increasingly invaded by alien species displacing indigenous species that are unable to out-compete the new species. This invasion is applying pressure on local biodiversity resulting in significant changes in species diversity and distribution. Invasive alien plant species (IAPS) species such as Chromolaena (*Chromolaena odorata*) out-compete local species and have changed the ecosystems and habitats such that some indigenous species can no longer survive. The aquatic ecosystems are further threatened by black wattle (*Acacia mearnsii*), eucalyptus (*Eucalyptus grandis*) and others which are now invading the waterways and drainage lines.

Figure 30: Combined IAPS Species Infestation Map Based on Density



Source: Mapped from datasets by Kotzéet al. (2010)

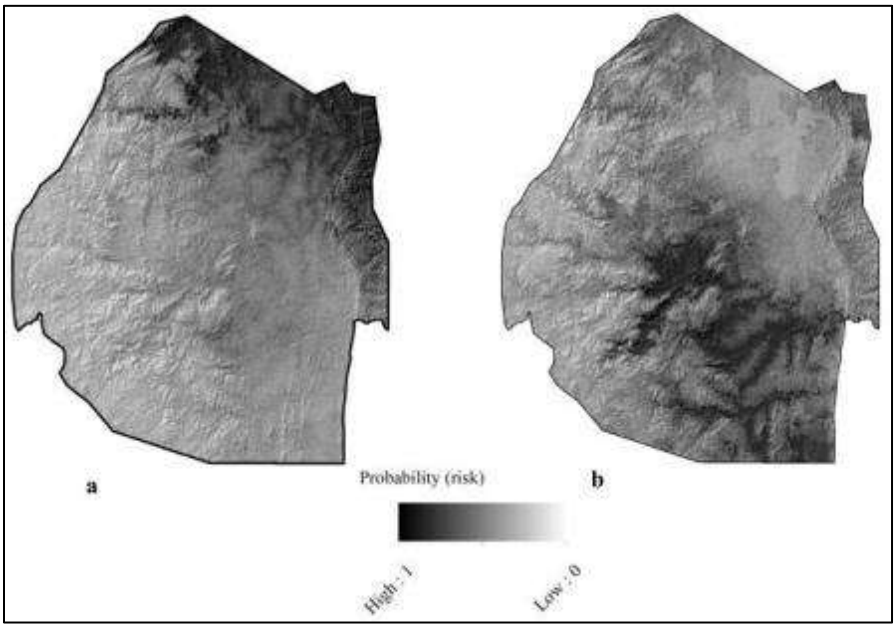
Invasive alien plants species (IAPS) are also invading the country's protected areas, especially Mlawula Nature Reserve, Hlane Game Park, Mbuluzi Nature Reserve and Mkhaya Game Park where significant resources are now dedicated to clearing and controlling these plants to allow the indigenious species to re-establish. Common IAPS are *Chromolaena odorata*, *Parthenium hysterophorus* and *Lantana camara*.

In a study entitled "Surveying and Mapping the Distribution and Intensity of Infestation of Selected Category 1 Invasive Alien Plant Species (IAPS) in Swaziland" (GOS-MTEA, Forestry Section, 2009) 16 IAPS were found to have invaded almost 80% of Swaziland (equivalent on a condensed density of 184,995 ha). The economic cost of clearing this large scale invasion has been estimated to be E665 million (GOS-MTEA, Forestry Section, 2009). The spatial distribution of these common IAPS is presented in Figure 30. The most common species of alien plants found in the country are presented in Table 63.

Table 63: Common Species of Alien Plants Found in Swaziland

Species name	Common name
Rubus spp.	Bramble
Solanum mauritianum	Bugweed
Chromolaena odorata	Chromolaena
Eucalyptus spp.	Eucalypts
Psidium guajava	Guava
Jacaranda mimosifolia	Jacaranda
Lantana camara	Lantana
Caesalpinia decapetala	Mauritius Thorn
Opuntia spp	Opuntia
Pinus spp.	Pine
Cereus jamacaru	Queen of the Night
Ricinus communis	Ricinus
Senna didymobotrya	Senna
Sesbania punicea	Sesbania
Melia azedarach	Syringa
Acacia mearnsii	Wattle
Pathenium hystephorus	

Figure 31: Prediction of Invasion Risk of (a) Chromolaena odorata & (b) Lantana camara



Source: Dlamini , W (in prep)

Invasions in aquatic systems from exotic fish species, such as the rainbow trout (*Onychorhynchus mykiss*) and the largemouth bass (*Micropterus salmoides*) can have devastating effects on local fish populations. The introduced red claw lobster (*Cherax quadricarinatus*) in the Sand River Dam near Mhlume is reported to be adversely affecting dam wall and canal structures as well as local waterways.

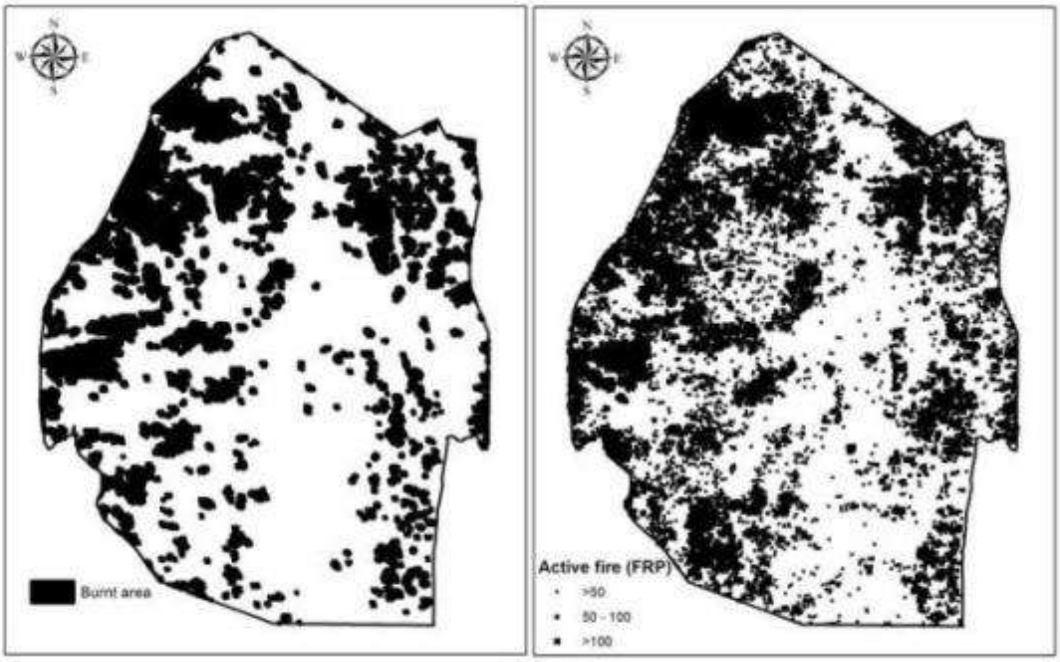
3.4.2.4 WILDFIRES

The burning of veld is an increasing pressure on biological diversity and ecosystems. Each year, people set fire in many parts of Swaziland to create and maintain farmland and grazing areas. They use fire to keep unwanted plants from invading crop or rangeland, to drive grazing animals away from areas more suitable for crops, to remove crop stubble and return nutrients to the soil, and to convert natural ecosystems to agricultural land.

Figure 30 shows seasonal fire patterns based on fires detected by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra and Aqua satellites. A temporal analysis of the both the MODIS active fire and burnt area data in Figure 32 shows a general increasing trend in the number of fires and anomalously high fire incidents in 2007 and 2008.[26]

[26] The maps might be showing active fires from harvesting of cane fields.

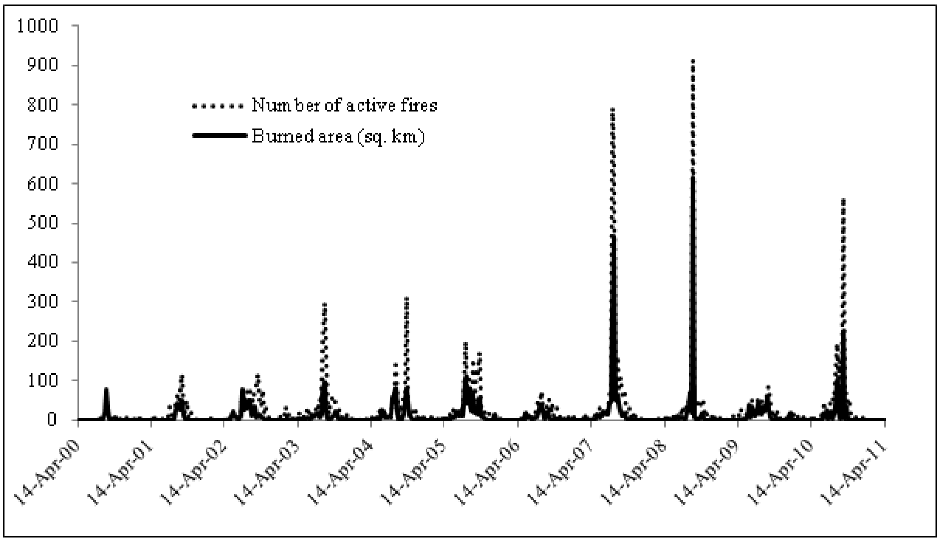
Figure 32: MODIS Active Burnt Area and Active Fires April 2000-March 2011



Source: Dlamini , W (in prep)

Although fires are a part of the natural cycle of the seasonally dry grasslands and savannas of the country, there is increasing concern about the intensity and frequency of burning. The frequency with which fires return to previously burned areas helps to determine the species of plants (and therefore animals) that can survive. When the fire-return interval is too short, the land may become degraded and unusable for farming or grazing. In semi-arid areas, land degradation through overuse of fire or through overgrazing can create pockets of desert. The massive burning that occurs in Africa each year creates carbon dioxide and aerosol particles, both of which play a role in global climate change. Finally, the smoke and accompanying gases and particles create a public health hazard; during an area's burning season, the amounts of ground-level ozone and other air pollutants can become hazardous to human health.

Figure 33: Temporal Variation in MODIS Active Fires and Burnt Area April 2000 - March 2011



Source: Dlamini , W (in prep)

Fires are also an important ecological factor, having a number of effects on the terrestrial and atmospheric environments. Scholes et al (1996) observed that in savannas, fire suppression can cause increase in woody plants with respect to grass plants (bush encroachment), while repeated late dry-season fires can lead to a decrease in woody vegetation and an increase in grasslands. Altering burning frequency, together with climatic and edaphic factors, has been observed to modify accumulation rates of carbon in biomass and soil and influence species composition and spatial distribution of forest ecosystems (Bond *et al*., 2003). Impoverished soils, in turn, produce less biomass and render natural regeneration less successful exposing the soil surface to excessive runoff and the erosion of upper layers. This may lower infiltration and keep the water table deeper, making the growth period shorter and eliminating drought susceptible vegetation and degrading wildlife habitat.

There is very little fire management within communities where most of the uncontrolled fires occur. In communal lands (SNL), grasslands typically are burnt annually in the dry season. This results in a flush of green grass at a time when the food supply of livestock is low. However, as mentioned above, annual burning has been shown to reduce the biodiversity of grasslands.

Fire is also used in honey collection to disperse the bees to allow for the collection of the hive. It has been observed that the fires are often left unattended and lead to disastrous consequences, especially in areas surrounding plantation forests. Overgrazing coupled with poor fire management have resulted in bush encroachment and alien plant invasion over large communal areas. In Swaziland, about 25% of the country's land surface is cumulatively burnt every year. In the period 2000–2010, approximately 10,603 fires have burnt 14,206 km^2 of land.

3.4.2.5 LIVING MODIFIED ORGANISMS

Changes to the country's biodiversity may also be a challenge through the anticipated introduction of living modified organisms (LMOs). The introduction of living modified organisms into environment poses a serious threat to the country's biological diversity. In particular wild plants and local crop varieties risk acquiring the engineered traits, giving rise to strains of plants with a fitness advantage over their neighbours. This could severely disrupt local ecosystems. Any release of living modified organisms into the natural environment - either through seed or commodity import – is a risk to the country's biological heritage, cultural roots, and food security.

Pressure on local biological diversity is threatened by the accidental release of living modified organisms, mostly food crops like maize, which, through natural reproductive mechanisms, could result in engineered traits being transferred to wild plant populations or the insects or pests that feed off these plants.

There are implications of living modified organisms entering the natural habitats as there is a risk that they could become problematic weeds due to resistant genes as well as the potential transfer of transgenes to wild crop relatives and landraces.

The country's main trading partner, i.e. South Africa, has commercialized GMOs and Swaziland is thus increasingly exposed to the potential risk of unintentional and illegal transboundary movements of LMOs that could possibly be a threat to the environment and human health. A number of applications are received from industry for the importation of genetically modified maize intended for food, feed or processing within the country.

3.4.2.6 CLIMATE CHANGE

Climate change is an emerging pressure on biodiversity and is expected to drive changes in biodiversity distribution in Swaziland (see also section 3.3.2).

Current warming of the global atmosphere has been linked to the 30% increase in atmospheric carbon dioxide concentration since the start of the industrial revolution. This increase in carbon dioxide concentration is happening 10 times faster than the pre-industrial revolution.

The Intergovernmental Panel on Climate Change (IPCC) states that global average surface temperatures have increased, global mean sea level is rising, and the concentration of ozone in the stratosphere has decreased. Annual average precipitation has also changed and the intensity and frequency of extreme weather events seem to have increased.

Projected impacts on ecosystems from selected global climate models show a westward shift and shrinking of both the grassland and savanna ecosystem types of Swaziland. The country is projected to see the introduction of a tropical very dry forest type of ecosystem in the eastern part of the country replacing half of the current subtropical ecosystem. Modelling of climate change (GOS-NMS/SNC, 2010[27]) has suggested that it is likely to induce the following changes:

- Large-scale vegetation (habitat) and species shifts particularly grasslands and Lebombo bushveld
- A re-arrangement of current plant communities and ecosystems resulting in significant changes in habitat quality.
- A general expansion of sour bushveld species ranges westwards and
- Loss of ecosystems resulting in significant changes in habitat availability

Climate change may have beneficial or negative impacts on the populations of some species. Some of those species negatively impacted by climate change are important for their traditional and cultural uses. Biome-level studies in the region (e.g. Rutherford *et al*., 1999; Midgley *et al*., 2001; Broennimann *et al*., 2006; Scheiter & Higgins, 2009; Dlamini, 2011) indicate that heat-adapted woody alien invasive species and deciduous woody species are likely favoured by warming conditions than grassland and other vegetation (and some of those species negatively impacted by climate change are important for their traditional and cultural uses). Also in Swaziland research is being conducted on the possible impacts of climate change on vegetation and avifauna (Dlamini, 2001; Monadjem, pers comm). It is anticipated that these research initiatives will provide the impetus and direction for future adaptation of species and biodiversity in Swaziland. Reference is also made to results of climate change modelling in (Chapter 4 Outlook, sections 4.3.2.2 and 4.4.2).

3.4.2.7 ENVIRONMENTAL INDICATORS: PRESSURES ON BIODIVERSITY

Environmental indicators showing the pressure on biodiversity include (some overlap with state):

Indicator	**Measurement**	**Source**	**Availability/Reliability**
Ecosystem change	ha & % change	Satellite image interpretation (SNTC / MTEA / UNISWA)	done but outdated
Habitat fragmentation	ha	Surveys (SNTC / UNISWA, Dept Forestry, SEA (EIA Reviews)	locally; no national coverage
Extraction rates of flora	kg/ha	Surveys (SNTC / UNISWA)	not available
Hunting permits issued	number	Permits issued by BGP	available
Species hunted	number	Returns submitted to BGP from permit holders	available
Poaching from PAs	numbers and species	SNTC	available not known
IAPS occurrence and abundance	species, area (ha) and intensity	Aerial and ground surveys Forestry Department	available and reliable
Permits issued for LMOs	number of permits and quantities lmos	SEA - Biosafety Advisory Committee	available
Area planted with LMOs	ha per species	SEA - Biosafety Advisory Committee	not available; most likely in future

3.4.3 STATE

Swaziland supports a diverse assemblage of habitats and contains a significant portion of southern Africa's plant and animal species. The eastern part of Swaziland forms part of the Maputaland Centre of Plant Diversity (one of the world's hotspots of floral, as well as faunal, species richness and endemism), while the western part falls within another area of global significance, the Drakensberg Escarpment Endemic Bird Area.

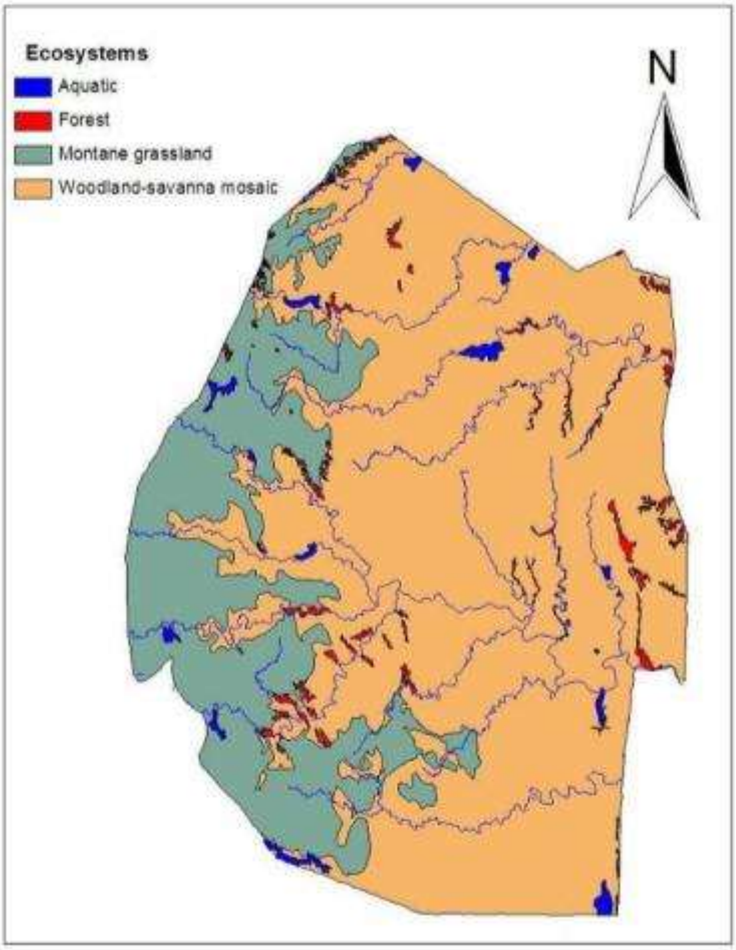
3.4.3.1 STATUS OF ECOSYSTEMS

Swaziland has adopted the ecosystem approach (as adopted by the United Nations Convention on Biological Diversity) in biodiversity conservation, which means that ecosystems form the framework for the planning and implementation of conservation and sustainable use strategies.

[27] A Vulnerability and Adaptation Assessment of Swaziland's Biodiversity. SNC Vulnerability and Adaptation Technical Working Group. Prepared by W.M. Dlamini. Ministry of Tourism and Environmental Affairs, Department of Meteorology, National Climate Office, Mbabane.

The four recognised ecosystems of Swaziland are (1) montane grasslands, (2) savanna-woodland mosaic, (3) forests, and (4) aquatic systems (Figure 34).

Figure 34: Ecosystems Map of Swaziland



The savanna-woodland mosaic is the dominant ecosystem, covering the central and lower parts of the country, followed by the montane grasslands, predominantly occurring in the Highveld and the two other as minor zonal systems. The savanna ecosystem is currently the best protected (5%), while only 2% of each of the other three ecosystems is protected. Plants and animals are not uniformly distributed across the four ecosystems and species composition varies greatly between them. The extent covered by each ecosystem and representation in the protected area network are shown in Table 64.

Table 64: Extent and Protection Status of Ecosystems of Swaziland

Ecosystem	Grassland		Savanna		Forest		Aquatic		Total	
	km^2	%	km^2	%	km^2	%	km^2	%	km^2	%
Extent of coverage	7,990	46	8,327	48	870	5	213	1	17,400	100
Area formally protected	190	2	426	5	20	2	4	2	640	4
Area informally protected	4	0	426	2	3	0	3	1	174	1

Source: NBSAP (2002) based on: Roques & Dobson (in lit.) and Deal *et al.* (2000)

The establishment of protected areas is one of the most successful and widely used methods of conserving biodiversity in-situ. In-situ conservation refers to the conservation of indigenous species in their natural habitats. The basic role of protected areas is to protect biodiversity from unnatural processes that threaten its existence in the wild.

There are a total of six gazetted protected areas in Swaziland and a number of other areas effectively managed for conservation but not legally declared protected. The gazetted areas cover 86% of the conservation area network. Three of the protected areas are controlled by the Swaziland National Trust Commission (Malolotja, Mlawula and Mantenga), and the three others by Big Game Parks (Mlilwane, Hlane and Mkhaya). These six relatively small protected areas do not cover an adequately representative proportion of Swaziland's ecosystems and habitats; however they do conserve a good proportion of the countries vertebrate species.

The last area to be formally protected happened in 1994, Mantenga Nature Reserve, and no additional areas have been proclaimed. In 2000 informally protected areas covered an additional 1 % of the country and this is estimated to have slightly increased.

Approximately 25% of each of the terrestrial ecosystem has been lost to some form of other land use: a total of 4,280 km^2 of biodiversity rich ecosystems have been converted to industrial timber plantations, sugarcane plantations and urban areas.

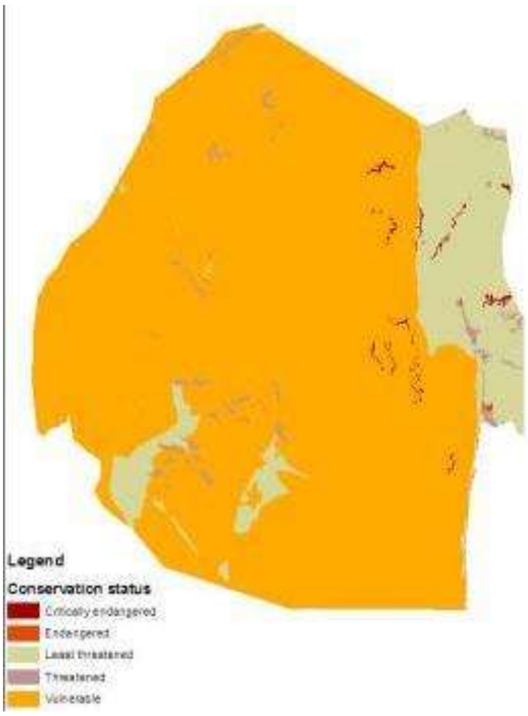
Aquatic water systems in particular are under threat from agricultural development as wetlands are drained for development (agriculture, roads and housing) or are negatively affected by changes within their catchment. The other three ecosystems are also faced with similar threats.

Overexploitation of plant genetic resources from wetlands and terrestrial habitats pose a challenge to the natural plant regeneration. This has resulted in diminishing resources and reduced resilience of ecosystems.

The South African National Spatial Biodiversity Assessment (NSBA) assessed the state of terrestrial ecosystems, including those in Swaziland, in relation to the pressures outlined above (Figure 35). It categorizes ecosystems into four classes of threat based on their degree of habitat loss, relative to the biodiversity targets that have been set for these ecosystems. These classes of threat align with those used internationally for assessing the extinction risk of species.

1. Least threatened ecosystems are still largely intact (>80% natural habitat).
2. Vulnerable ecosystems are reasonably intact (<80% and >60% natural habitat), but are nearing the threshold beyond which they will start to lose ecosystem functioning.
3. Endangered ecosystems have lost significant amounts of their natural habitat (<60% but still containing more natural habitat than the biodiversity target), which impairs their functioning.
4. Critically endangered ecosystems have so little natural habitat left that their functioning has been severely impaired (they have less natural habitat than their biodiversity targets), and species associated with this ecosystem class are in decline or becoming locally extinct.

Figure 35: Conservation Status Swaziland



Source: Rutherford MC, Mucina L, and Powrie LW., 2006.

3.4.3.2 STATUS OF SPECIES DIVERSITY

Current knowledge of the biodiversity of Swaziland is patchy and incomplete. The country's diversity is poorly monitored as a consequence of a number of factors. From the literature it is apparent that there has never been a comprehensive survey of the country's biodiversity with only certain groups having been studied scientifically, e.g. birds. Several ecologically important species remain unstudied. With no national surveys, the distribution and ranges of many species have not been mapped and information such as population sizes, ranges and trends and similar information have not been determined for a large number of species. This means many species could be under threat of extinction but are not protected or categorized as threatened.

3.4.3.2.1 SPECIES RECORDS

Almost nothing is known about the lower plants of Swaziland. The higher plants have received greater attention and are thus better known. Twenty-two families of *Pteridophytes* (ferns) have been recorded from Swaziland in at least 45 genera and 94 species. The gymnosperms (cone-bearing plants) and angiosperms (flowering plants) have been extensively surveyed in Swaziland (Braun *et al*., 2004; Dlamini and Dlamini, 2002).

Over 3,400 species have been recorded in Swaziland which represents almost 14 % of the taxa recorded from the southern African region. There are also many areas in Swaziland which have not been adequately sampled, and thus little is known about the distribution of plant species within Swaziland. Currently, there are 39 species recognised as either being endemic to Swaziland, or as having global conservation status (Dlamini and Dlamini, 2002).

With the exception of the vertebrates, the animals of Swaziland have not been comprehensively surveyed. At least 14 phyla have been recorded (Monadjem, 1997), or are suspected to occur, within the boundaries of Swaziland.

Of the invertebrate phyla, only the arthropods have received some attention from researchers and private collectors (Monadjem, 1997). In total, 270 families and approximately 1,300 genera of arthropods have been recorded from Swaziland. The total number of species, however, remains unknown due to the taxonomic difficulties inherent in this diverse group. Furthermore, the arthropods have not been fully surveyed. In fact, the only arthropod order to have been intensively surveyed is that of the Lepidoptera (moths and butterflies) (Monadjem, 1997).

Swaziland's vertebrates have been well documented and, to date, 813 species (445 genera in 144 families) have been recorded in Swaziland (Monadjem, 1997). Currently, only one species of vertebrate is known to be endemic to Swaziland (thick-tailed Gecko, *Afroedura major*), while 92 species are listed as threatened (Table 69). There are probably some endemic species of invertebrates, but they have not yet been described. Three species of butterfly are listed as threatened (Monadjem, 1997).

Of the four major ecosystems in the country (Figure 32), the grassland ecosystem has the highest number of species and the highest number of threatened and endemic species. The forest and the aquatic ecosystems have the highest number of species per unit area. The aquatic ecosystem is also the least studied in the country. The savanna ecosystem is ranked third most important (GOS-SEA, 2001) while the first ranked ecosystem (grassland) faces the greatest number of threats (Table 65). Representation in the protected area network is disproportionate and is not in any way related to the number of species the ecosystem harbours or its importance ranking. It is also not related to the number of endemic or threatened species that ecosystems provide habitats for.

Table 65: Species Diversity by Ecosystem

Species	Grassland	%	Savanna	%	Forest	%	Aquatic	%	Total
Flora:									
Trees	78	17.0	261	57.0	115	25.1	4	0.9	458
Grasses	130	54.2	103	42.9	3	1.3	4	1.7	240
Plant resource species	158	32.9	256	53.3	55	11.5	11	2.3	480
Exotics	32	43.8	30	41.1	2	2.7	9	12.3	73
Total	398	31.8	650	52.0	175	14.0	28	2.2	1,251
Fauna (vertebrates):									
Fish	0	0.0	0	0.0	0	0.0	51	100.0	51
Amphibians	9	15.8	10	17.5	1	1.8	37	64.9	57

Species	Grassland	%	Savanna	%	Forest	%	Aquatic	%	Total
Reptiles	51	34.9	76	52.1	12	8.2	7	4.8	146
Birds	138	22.4	290	47.1	91	14.8	97	15.7	616
Mammals	49	31.0	95	60.1	13	8.2	1	0.6	158
Total	247	24.0	471	45.8	117	11.	193	18.8	1,028
Threatened:									
Flora	161	55.3	71	24.4	53	18.2	6	2.1	291
Fauna (vertebrates)	44	32.1	51	37.2	15	10.9	27	19.7	137
Endemics:									
Flora	13	72.2	2	11.1	3	16.7	0	0.0	18
Fauna (vertebrates)	1	100.0	0	0.0	0	0.0	0	0.0	1
Southern African endemics (birds)	26	50.0	13	25.0	12	23.1	1	1.9	52

Source: GOS-SEA, 2001

3.4.3.2.2 THREATENED SPECIES

The loss of species is in part a direct consequence of the loss or alteration of ecosystems and habitats. Many species in Swaziland have declining populations, some of which have already gone extinct (GOS-SEA, 2009). Swaziland has produced two recent Red Data Lists; one for plants and one for vertebrates.

A total of 132 species of vertebrates are listed threatened (Monadjem et al. 2003), representing between 9-20% of the total numbers of fishes, amphibians, reptiles and birds occurring in Swaziland, but a significant 38% of the mammalian fauna (Table 66).

Table 66: Biodiversity Threat Categories

	Number of species				
Threat category	**Fishes**	**Amphibians**	**Reptiles**	**Birds**	**Mammals**
Regionally Extinct	0	1 (2%)	0	7 (1%)	3 (1%)
Critically endangered	3	0	0	1	0
Endangered	1	0	0	12	3
Vulnerable	2	0	2	14	6
Sub-total (threatened)	6 (10%)	0	2 (2%)	27 (5%)	9 (7%)
Sub-total (others)	5	3	12	21	36
Total	11 (18%)	4 (9%)	14 (13%)	55 (11%)	48 (37%)

Source: GOS-SEA, 2001; Note: Values in brackets represent the percentage of the total indigenous fauna occurring in Swaziland.

Many species are now extinct or facing extinction in the country, especially on SNL (GOS-SEA, 2009). The bulk of bird, mammal and tree populations are now confined to protected areas (GOS-SEA, 2009). A total of 305 species of plants were in the Red Data List for the country (Dlamini & Dlamini, 2002), representing 9% of the total plant species richness. Of these, 62 species (2%) are threatened (Critically Endangered, Endangered or Vulnerable), while 155 species are data deficient.

Table 67: Proportions of Selected Species within Proclaimed Areas*

Taxa	Number of species	% of species
Trees	644	73
Threatened trees	68	40
Endemic plants	20	50
Mammals	125	87
Threatened mammals	37	97
Birds	479	92
Threatened birds	52	90

Source: GOS-SEA, 2001; *Includes the following areas formally protected by law: Malolotja, Mlilwane, Mantenga, Mlawula and Hlane.

The result of a fish biodiversity survey carried out in 1991, 1992, 1994 and 2001 determined the occurrence of 60 species in Swaziland, of which six exotic and the others indigenous (Boycott 1992a, 1992b, 2001; Hyslop 1991, 1994). A red data list was produced indicating that three species were critically endangered, one endangered and two vulnerable. Certain rare fish species are threatened to become extinct (*Opsaridium peringueyi* and various *Chiloglanis* spp).

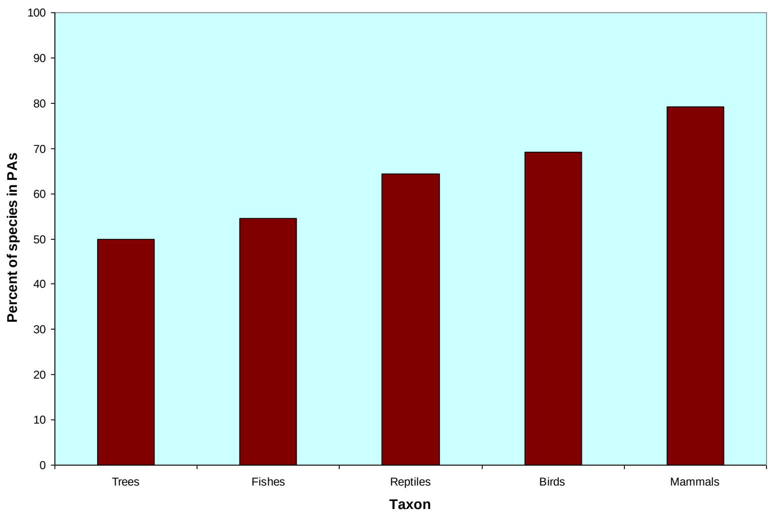
Only half of the country's threatened trees species are found within reserves, the rest are on private farms and SNL (GOS-SEA, 2003). Those on SNL are virtually unprotected and this is attested to by the size of the trees species population found on SNL.[28] Furthermore, the institutions that are supposed to be custodians and enforcers of the legislation are generally under-funded and lack human resources in crucial areas (GOS-SEA, 2003).

Although the National Biodiversity Strategy and Action Plan (NBSAP) (GOS-SEA, 2001) calls for the protection of threatened and endemic species, the first step in this process of identifying threatened species has not been completed as Red Data Lists have been prepared for only two groups of organisms: vertebrates and higher plants. For groups that have not been completely surveyed, such as the invertebrates and lower plants. Indications, based on land use change patterns suggest that these numbers of species under threat have changed for the worse.

Threatened Species in Protected Areas

An indication of how effective conservation areas really are is the proportion of threatened species occurring within them. This information is available for trees and vertebrates. Only 50% of red data listed tree species are currently found in protected areas, compared with almost 80% of threatened mammals. This either suggests that the location of protected areas is biased towards mammals, or that mammals are disproportionately threatened. The reality is that it is probably a combination of both these factors.

Figure 36: Percent of Red Data Listed Species Occurring in Protected Areas in Swaziland



Source: Loffler & Loffler (2005) and Monadjem et al. (2003)

3.4.3.2.3 ETHNO-BOTANICAL SURVEYS OF MEDICINAL PLANTS

Already in the 1970s, the Department of Chemistry at the University of Swaziland decided to examine the scientific basis for this traditional medical system. In the process of researching drugs derived from medicinal plants, researchers began to understand the important cultural heritage that supported this system. The work has involved analyses of medicinal plants collected by rural people familiar within the traditional medical system. A key part of the studies are the ethno-botanical surveys of medicinal plants administered by traditional medical practitioners (TMP's) and the taxonomic identification of plant species by taxonomists. Chemical screening and extraction of possible active constituents is also conducted with TMPs as an integral part of the laboratory team. Today, this work is housed in the Swaziland Institute for Research in Traditional Medicine, Medicinal and Indigenous Food Plants to carry out research on medicinal plants and explore the scientific bases of the use of traditional plants for therapeutic purposes. Among the species of flora studied are

[28] Tree species in private farms are protected through the goodwill of the land owner as there is no effective legislation that protects them (but the Flora Protection Act does give some protection even on private farms). Existing legislation only effectively protects species in proclaimed protected areas, it does not cover private farms and does not afford any protection on Swazi Nation Land.

plants of pharmacological interest and plants of pest-repellent value[29]. The institute has carried out research on the endemic disease Schistosomiasis or Bilharzia that infects 25% of the Swazi population. Plants such as *Phytolacca dodecandra* and *Urginea epigea* have been identified as indigenous plants with high molluscicidal activities. The institute aims at addressing the use of traditional medicine and its alignment with modern health by emphasizing the conservation of plant biodiversity for the purpose of the cultivation of indigenous medicinal and food plants.

In a recent research paper from the Swaziland Institute for Research in Traditional Medicine, Medicinal and Indigenous Food Plants (Amusan et al, 2007), some sixty one medicinal plants from thirty five families were identified resulting from ethnobotanical surveys of the Manzini and Shiselweni regions and interviews with Traditional Medical Practitioners (TMP). The plants were used for treating thirty one diseases which included among others; abdominal cramps, asthma, back ache, cardiac problems, chest pains, cough, diarrhoea, headache, menorrhagia, snake bite, stomach ache, urino-genital problems and HIV/AIDS related symptoms. The paper concludes that the habit of collecting medicinal plants from the wild for the practice of herbal medicine has serious implication on the conservation of the biodiversity of the country. The practice is quite unsustainable and can lead to the extinction. An example from this study was that of *H. hemerocallidea* which was used as an all purpose medicine. The plant has become endangered species because its bulb was being dug and commercialised by many people without any thought of conservation. The plant has been over exploited by many in traditional medicine in the country. It was said to be one of the plants very much in high demand by many people because of the HIV/AIDS pandemic in the country.

The infusion or decoction of the dried bulb was used for treating many ailments. People should be encouraged to cultivate medicinal plants and harvest them in a sustainable manner. Many of the plants especially those whose underground stems were used in this study for preparing remedies could be cultivated in gardens from where herbalists could do their collection and replant the species rather going to wild.

The conclusions that can be drawn from this study are that plant resources are used widely for health care in Swaziland, that the TMPs in Swaziland are knowledgeable and their indigenous knowledge on plants and diseases could be explored in the search for bioactive compounds and that there should be awareness campaigns especially among the TMPs of the need for the conservation of biodiversity.

3.4.3.3 ENVIRONMENTAL INDICATORS: STATE OF BIODIVERSITY

Environmental indicators showing the status of biodiversity are:

Indicator	Measurement	Source	Availability/Reliability
Ecosystem change	Ha & % change	Satellite image interpretation (SNTC / MTEA / UNISWA)	done but outdated
Rate of habitat change & loss	Ha/year	SNTC/UNISWA SEA (EIA Reviews)	out-dated data
Species diversity by ecosystem	number, composition & % change	Surveys (SNTC / UNISWA / Forestry)	available only within PAs
Species condition by ecosystem	number	Surveys (SNTC / UNISWA / Forestry)	not known
Number of species on Red Data Lists	number of species	Surveys (SNTC)	available but perhaps not up to date
Annual change of species on Red Data Lists	number of species	Surveys (SNTC)	only done in PAs
Change in number of extinct species	number of species	Surveys (SNTC)	Not available

3.4.4 IMPACT

The loss of biodiversity and the resulting change within the ecosystems will impact upon the provision of ecosystem goods and services, both the quantity and quality. The rural poor are especially vulnerable as they have to travel long distances to acquire these resources to sustain their livelihoods.

[29] http://www.ecdc.net.cn/events/innovative07/innov07_014.htm

Undesirable environmental trends related to biodiversity and ecosystem degradation lead to the following impacts on the society, in a sequence where the components are interactive and impacting on each other. Loss of biodiversity leads to changed ecosystems, which leads to changes and diminishment of ecosystem services, which lead in turn to a decrease in the harvesting of natural products, which leads in turn to decreased coping mechanisms to disasters, which leads in turn to increase in food insecurity, which leads in turn to impoverishment of livelihoods and ultimately into poor health conditions.

Two specific pressures on biodiversity and ecosystems, which also lead to impacts on ecosystem services and health, are invasive plant species and wildfires. Invasive alien plants species (IAPS) use a significant portion of the country's water resources, much more than the original vegetation they have replaced. Wildfires may accelerate the rate of decline in the diversity or certain habitats, species and their spatial distribution and subsequently decreasing ecosystem services.

3.4.4.1.1 ENVIRONMENTAL INDICATORS: IMPACT OF BIODIVERSITY CHANGE

Environmental indicators showing impact of biodiversity change are:

Indicator	Measurement	Source	Availability/Reliability
Ecosystem goods and services	% change (type, volume, value)	SNTC / UNISWA	not available
Health conditions	% change in number of illnesses related to environment	Min Health	available to some extent

3.4.5 RESPONSE

In response to the pressures driving biodiversity change, Swaziland has undertaken several measures, including investment, systemic and institutional responses.

3.4.5.1 INVESTMENT AND ACTION

3.4.5.1.1 NATURE CONSERVATION AND PROTECTED AREAS

The main response to the need to protect and manage the biological resources of Swaziland has been the proclamation of nature reserves and protected areas[30], which process already started in the beginning of the 20th century and can be considered as the start of investment and action response. Conservation became formalised in the 1970s with the proclamation of Protected Areas (PAs), backed up by legal and institutional instruments. Details of the history and extent of nature conservation and in particular protected areas are given in Annex 4.

Protected areas are the cornerstone of biodiversity conservation; they maintain key habitats, allow for species migration and movement, and ensure the maintenance of natural processes across the landscape. The state of protected areas is described in the previous section 3.4.3. An initial assessment of protection worthy areas in Swaziland was done in 1972 (Grimwood, 1973), which was a first step towards developing a plan for creating a pattern of National Parks representative of all of the main regions and ecosystems of Swaziland. Subsequent new assessments have added to the list of protection-worthy areas.

The last preliminary field assessment of protection-worthy areas of Swaziland was done in 2002 (Roques *et al*, 2002) based on field surveys and rapid assessment techniques, resulting in 44 areas identified, of which 16 of high priority (see Figure 37). With only about 4% of the country under protection (dominated by the northern regions), Swaziland has the potential to set aside more land for parks and reserves. Proclamation of some or all

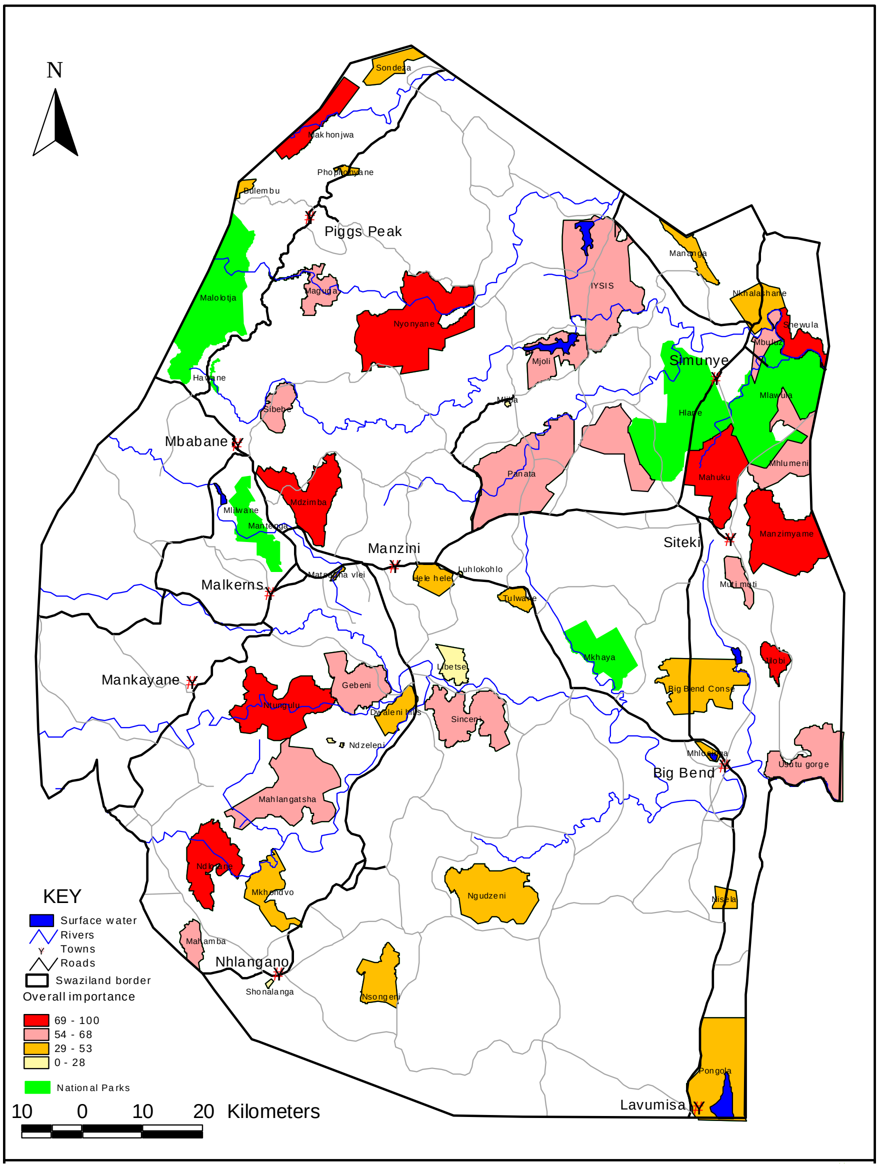
[30] The term "protected area" is shorthand for a sometimes bewildering array of land and water designations, of which some of the best known are national park, nature reserve, wilderness area, wildlife management area and landscape protected area but can also include such approaches as community conserved areas. More importantly, the term embraces a wide range of different management approaches, from highly protected sites where few if any people are allowed to enter, through parks where the emphasis is on conservation but visitors are welcome, to much less restrictive approaches where conservation is integrated into the traditional (and sometimes not so traditional) human lifestyles or even takes place alongside limited sustainable resource extraction. Some protected areas ban activities like food collecting, hunting or extraction of natural resources while for others it is an accepted and even a necessary part of management.

the protection worthy areas identified would go a long way to improving the representativeness of protected areas across different landscapes.

This driving force for extension of protected and conservation areas is principally generated by preservation of the national heritage but also by eco-tourism opportunities including the private sector and communities and is further promoted and supported by the international conventions (CBD) and the IUCN. Given their many benefits, protected areas are important instruments for meeting CBD targets of significantly reducing the rate of biodiversity loss by 2010. There is an urgent need to take action to improve the coverage, representativeness and management of protected areas nationally, regionally and globally.

Climate change has been identified as a key risk factor for protected areas. Changing temperatures and hydrological regimes in addition to a potential increase in extreme events is likely to affect the local ecosystems and biodiversity. Natural hazards may also increase in some areas as a result of climate change. At the same time, the role of natural areas as potential carbon sinks and providers of vital services makes their existence even more relevant in the face of climate change.

Figure 37: Distribution of Protection-worthy Areas with Importance Category



Source: Roques et al, 2002

Biodiversity should be conserved both for its value as a local livelihoods resource and as a national and global public good. The practical reasons have been acknowledged for a long time and recognize the fact that protected areas, corridor and other conservation efforts co-exists with poverty. Inclusion of biodiversity conservation in school curricula is important in the overall response process.[31]

3.4.5.1.2 TRANSFRONTIER CONSERVATION AREAS PROGRAMME

In response to the pressure to improve the ecological benefits of PAs, the SNTC has joined the Transfrontier Conservation Areas (TFCA) Programme that has been born out of the Peace Park Foundation's vision to establish a network of transfrontier conservation areas in southern Africa and signed agreements with South Africa and Mozambique to implement the Lubombo Transfrontier Conservation Area, covering 4,195 square kilometres, of which 2,783 km^2 (66%) in Mozambique, 1,095 km^2 (26%) in South Africa, and 317 km^2 (8%) in Swaziland.

The total concept of the peace park actually covers 5 distinct transfrontier conservations areas between South Africa, Mozambique and Swaziland, which are:

- Lubombo-Goba Transfrontier Conservation Area (Mozambique and Swaziland).
- Usuthu-Tembe-Futi Transfrontier Conservation Area (Swaziland, South Africa and Mozambique).
- Ponta do Ouro-Kosi Bay Transfrontier Conservation Area (Mozambique and South Africa).
- Nsubane Pongola Transfrontier Conservation Area (South Africa and Swaziland).
- Songimvelo-Malolotja Transfrontier Conservation Area (South Africa and Swaziland).

The TFCA aims at expanding and conserving landscapes through an integrated conservation and development approach that emphasizes the importance of ecosystem goods and services. The TFCA aims at expanding and conserving landscapes through an integrated conservation and development approach that emphasizes the importance of ecosystems. This initiative, which is locally being implemented under the auspices of the SNTC, is a joint programme of Swaziland and its neighbours, South Africa and Mozambique.

3.4.5.1.3 CONTROL OF INVASIVE ALIEN PLANT SPECIES

The Government of Swaziland realizing the threats and impacts of alien invasive plant species (IAPS) has taken an initiative to address the problem of IAPS. In 2003, the problem of the proliferation of IAPS was noted in the Northern Hhohho region. The Government responded by instituting different task teams to map a way forward on how to address the problem. In 2005/2006 the Government of Swaziland declared IAPS a national disaster followed by a proposal to engage contactors to clear AIPS. The proposal was approved by government and between 2006 and 2009 engaged contractors cleared about 15000 ha. This entailed first clearing and followed by three follow-up controls on cleared sites.

In 2008/2009 the project was restructured to include:

- Creating public awareness
- Surveying and mapping of the intensity and distribution of selected IAPS
- Field combating operation and
- Formulation of a National Strategy to control and manage IAPS
- Review of a draft Forest Bill of 2002 to in-cooperate the control and management and IAPS.

The project outputs were: (1) survey data set, (2) map of selected IAPS in Swaziland including species accounts, brief description of species, spatial distribution and intensity of infestation. In addition two documents were produced: A draft National Strategy for the Control and Management of IAPS and a draft Forestry Bill of 2010.

In 2010/2011 the project was restricted following a Parliament resolution that communities should be engaged at Tinkhundla level to clear IAPS instead of engaging contractors. The Ministry of Tourism and Environmental Affairs had administrative difficulties in implementing the Parliament resolution due to existing government procurement procedures and regulations. As a result, the project stalled and failed to receive financial

[31] Environment and biodiversity conservation topics are part of the school's curriculum and many schools boast vibrant environment clubs. Departments like Biological Sciences and Geography, Environmental Science and Planning at the University of Swaziland have very active conservation clubs. The national radio and television station in the country also now regularly feature conservation in their programming. Conservation is further discussed at tinkhundla (community) meetings where in some areas issues like conservation agriculture are taught. The Ministry of Tourism is at the forefront in some biodiversity conservation initiatives as a way to boost tourism. One of these is the Hloba Swaziland campaign.

allocation in the 2011/2012 financial year due to the country's financial constraints and the extension of the programme has been postponed.

3.4.5.2 INTERNATIONAL AGREEMENTS

Conventions and Protocols

The Convention on Biological Diversity. The country is party to the Convention on Biological Diversity (CBD) and is obliged to uphold and implement the guiding articles, protocols and decisions of the Convention and its Secretariat.[32]

The Convention on Biological Diversity has established a global target for the protection of 10% of each of the world's ecological regions by 2010. In 2004, parties to the Convention on Biological Diversity (CBD) adopted the most comprehensive and specific protected area commitments ever agreed to by the international community. These commitments, which comprise the CBD Programme of Work on Protected Areas (PoWPA), seeks to establish and maintain "comprehensive, effectively managed and ecologically representative systems of protected areas" that, collectively, will significantly reduce the rate of loss of global biodiversity. The implementation of the PoWPA is thus expected to contribute to the three objectives of the CBD, the CBD's Strategic Plan 2011-2020, the Aichi-Targets, and the Millennium Development Goals.

In a report on progress towards the CBD's 2010 and 2012 targets for protected area coverage, the UNEP World Conservation Monitoring Centre (UNEP-WCMC) reported on progress on one of the key PoWPA goals: the establishment of a global network of comprehensive, representative and effectively managed national and regional protected area systems in the terrestrial realm by 2010 and in the marine realm by 2012. The report identified *i.a.* that nationally designated protected areas cover 12.2% of the world's land area but that only a minority of countries have 10% or more of their terrestrial areas covered by PAs.[33]

CITES. Swaziland joined the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1997. CITES is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

Cartagena Protocol on Biosafety. Swaziland acceded to the Cartagena Protocol on Biosafety (CPB) in 2006. This Protocol is an international legally binding treaty which sets procedures and mechanisms to be applied in the transboundary movements of living modified organisms (LMOs), i.e. living organisms which possess a novel combination of genetic material obtained through the use of modern biotechnology (genetic modification) and may have adverse effects to biological diversity and human health.

As a Party to the CPB, the country has an obligation to domesticate the international treaty by developing a national framework in harmony with the protocol. Due to the country's rich biodiversity, Swaziland has an obligation to regulate and monitor the introduction and development of LMOs as well as to ensure that its biodiversity and humans are protected from any possible adverse effects of modern biotechnology. This is in line with the precautionary principle which Swaziland subscribes to.

Access and Benefit Sharing (ABS) relate to bio-prospecting involving indigenous biological resources. ABS are defined as (1) the acquisition of biological resources, their derivatives, community knowledge, innovations, technologies or practices, and (2) the sharing of whatever gains, monetary and non-monetary, that accrues from the utilisation of these biological resources, knowledge, innovations, technologies or practices.

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[32] Article 8 of the Convention on in-situ conservation guides a party's obligations on protected area goals (http://www.cbd.int/convention/articles/?a=cbd-08).

[33] • Nationally designated protected areas cover 12.2% of the world's land area, 5.9% of the world's territorial seas, but only 0.5% of the world's extraterritorial seas.

• 45% of 236 countries and territories have 10% or more of their terrestrial areas covered by protected areas, but only 14% of 194 countries and territories have 10% or more of their marine areas covered by protected areas.

• 13.5% of the world's forest area is included in nationally protected areas; however, 46% of the 670 WWF terrestrial ecoregions with forest cover have less than 10% of their forest areas protected.

• 46% of the 821 terrestrial ecoregions analyzed and 82% of the 232 marine ecoregions have less than 10% of their area protected.

The 2002 Bonn Guidelines on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising out of their Utilization sought to provide voluntary guidance for parties in developing national strategies, legislation etc. The Bonn guidelines also provide a list of monetary and non-monetary benefits.

In 2010, the parties to the CBD adopted the ***Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization***. The Nagoya Protocol is intended to create greater legal certainty and transparency for both providers and users of genetic resources by:

- Establishing more predictable conditions for access to genetic resources.
- Helping to ensure benefit-sharing when genetic resources leave the contracting party providing the genetic resources

By helping to ensure benefit-sharing, the Nagoya Protocol creates incentives to conserve and sustainably use genetic resources, and therefore enhances the contribution of biodiversity to development and human well-being. Further information on ABS is given in Annex 5.

Aichi Biodiversity Targets

At the tenth meeting of the Conference of the Parties, held in October 2010 in Nagoya, Japan, the Parties adopted a revised and updated Strategic Plan for Biodiversity, including the Aichi Biodiversity Targets, for the 2011-2020 period (http://www.cbd.int/sp/targets/). Some examples of the Aichi Biodiversity Targets are:

- At least halve and, where feasible, bring close to zero the rate of loss of natural habitats, including forests
- Establish a conservation target of 17% of terrestrial and inland water areas and 10% of marine and coastal areas
- Restore at least 15% of degraded areas through conservation and restoration activities
- Make special efforts to reduce the pressures faced by coral reefs

Despite the best efforts of government around the world to reduce the decline in biodiversity, the Global Biodiversity Outlook 3[34] points out that hardly any of the targets agreed by the world's Governments in 2002, "to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on Earth", had been met.

There are multiple indications of continuing decline in biodiversity in all three of its main components - genes, species and ecosystems - including:

- Species which have been assessed for extinction risk are on average moving closer to extinction. Amphibians face the greatest risk and coral species are deteriorating most rapidly in status. Nearly a quarter of plant species are estimated to be threatened with extinction.
- The abundance of vertebrate species, based on assessed populations, fell by nearly a third on average between 1970 and 2006, and continues to fall globally, with especially severe declines in the tropics and among freshwater species.
- Natural habitats in most parts of the world continue to decline in extent and integrity, although there has been significant progress in slowing the rate of loss for tropical forests and mangroves, in some regions. Freshwater wetlands, sea ice habitats, salt marshes, coral reefs, seagrass beds and shellfish reefs are all showing serious declines.
- Extensive fragmentation and degradation of forests, rivers and other ecosystems have also led to loss of biodiversity and ecosystem services.
- Crop and livestock genetic diversity continues to decline in agricultural systems.
- The five principal pressures directly driving biodiversity loss (habitat change, overexploitation, pollution, invasive alien species and climate change) are either constant or increasing in intensity.

[34] Secretariat of the Convention on Biological Diversity (2010) Global Biodiversity Outlook 3. Montréal, 94 pages. Web http://www.cbd.int/gbo3/

- The ecological footprint of humanity exceeds the biological capacity of the Earth by a wider margin than at the time the 2010 target was agreed.

Missing the 2010 target has serious implications for human societies. Biodiversity underpins a wide range of services that support economies, food production systems and secure living conditions. The loss of biodiversity (at the genetic, species and ecosystem levels) also affects human health in many ways.

The Global Biodiversity Outlook 3 shows that the population of wild vertebrate species fell by an average of nearly one- third (31%) globally between 1970 and 2006, with the decline especially severe in the tropics (59%) and in freshwater ecosystems (41%). Tropical forests continue to be lost at a rapid rate, although deforestation has recently slowed in some countries. Net loss of forests has slowed substantially in the past decade, largely due to forest expansion in temperate regions.

This global background on the world's state of environment, illustrates the importance of continued action in Swaziland by relevant agencies to conserve our remaining biodiversity and protect and manage it better to ensure future generations have access to it.

3.4.5.3 SYSTEMIC RESPONSE

The systemic response to address the pressure on biodiversity includes legislation, policies and action plans.

Legislation

Current legislation impacting upon the conservation and management of biodiversity is spread across several ministries. The Biodiversity Needs Assessment Report (GOS-SEA, 2003) detailed the country's existing legislation and identified where legal conflicts could arise.

The assessment identified that some of the legislation is also old and outdated and in need of updating to bring it in line with international expectations and obligations (see overview in Table 68). For example, the National Trust Commission Act, the Game Act and the Flora Protection Act all empower different individuals or groups of individuals to proclaim reserves though there is no clarity as to who has supreme authority. Existing laws do not effectively protect all the biodiversity in the country especially on Swazi Nation Land.

Table 68: List of Legislation Relating to Biodiversity Conservation and Management

Acts impacting upon Biodiversity Conservation	Housing institution
The Swaziland National Trust Commission (Amendment) Bill of 2009 The Biosafety Bill of 2009 The Biodiversity Management and Conservation Bill of 2007 The Access and Benefit Sharing Bill of 2006 The Environment Management Act of 2002 The Swaziland Tourism Authority Act of 2001 The Environment Audit, Assessment and Review Regulations of 2000 The Swaziland Environmental Authority Act of 1992 The National Trust Commission Act of 1972 (amended in 1973) The National Trust Commission Regulations of 1972 The Forest Preservation Act of 1910 The Forest Bill (2010)	Ministry of Tourism and Environmental Affairs
The Flora Protection Act of 2001 The Wild Mushroom Control Order of 1973 The Plant Control Act of 1981 (which repealed The Plant Protection Act of 1959 and the Noxious Weeds and Wild Mushrooms Acts) The Grass Fires Act of 1955 The Private Forests Act of 1951 The Protection of Fresh Water Fish Act of 1937 The Fresh Water Fish Regulations of 1937 (amended 1952 and replaced 1973) The Noxious Weeds Act of 1929 The Noxious Weeds Control Regulations of 1929 The Wild Birds Protection Act of 1914	Ministry of Agriculture
The Water Act of 2002 The Natural Resources Act of 1951 The Natural Resources (Public Stream Banks) Regulations of 1951	Ministry of Natural Resources and Energy
The Game Act of 1953 (amended 1991 and 1993)	King's Office/Ministry of Justice

Acts impacting upon Biodiversity Conservation	Housing institution
The Non-bailable Offences Order of 1993	
The Swazi Administration Order of 1998	Deputy Prime Minister's Office

There is need to harmonize the various pieces of legislation and bring them up to date with international standards as well as with international conventions and agreements that the country is signatory to or to develop an overarching act that meets the needs and expectations of all stakeholders.

Current legislation and procedures for the integration of additional protection-worthy areas as well as the management of existing protected areas creates makes it difficult to bring protection-worthy areas into legal protection. However the SNTC Act is being amended to cater for this. Further the final enactment of the Biodiversity Management Act would also help.

Important pieces of legislation related to nature protection include the following:

***Environment Management Act*.** The Environment Management Act of 2002 is the supreme environmental law and is intended to provide and promote the enhancement, protection and conservation of the environment and the sustainable management of natural resources. It also turned the Swaziland Environment Authority (SEA) into a body corporate and established the National Environment Fund. In terms of this Act, the SEA has the power to halt any and all developments that have not been adequately scrutinised for their environmental impact. Any policy, bill, regulation, programme or plan requires a Strategic Environmental Assessment. The Act provides for public participation, and sets out regulations for a register of environmental information, requests for environmental information, public review and hearings, orders and prosecutions initiate by the public, civil actions and other regulations.

Environmental Audit and Assessment Review Regulations (EAARR). The EAARR of 2000 are important as they function as key response to land conversions. As has been described earlier, the conversion of habitats to make way for a range of other land uses is increasing the rate of decline in the diversity of certain habitats, species and their spatial distribution. Enforcement of the EAARR is essential to control land conversions.

Game Act. Swaziland's response to combat poaching, particularly fauna, is the Game Act. The Game Act of 1953 was amended in April 1991 with the Game Amendment Act – passed by Parliament, ratified by the King.

Since the passing of the amendments of 1991 there has been a concomitant decrease in poaching in the Big Game Parks (T.E. Reilly, personal communication). It would thus appear that the Game Act is serving its function (which is the protection of wild game). The Game Act, however, does not list (and therefore does not protect) any species of reptiles (other than crocodiles and pythons), amphibians, fish or invertebrates. These latter groups, thus, do not currently enjoy any formal protection in Swaziland. Enforcement of the Game Act is restricted by the increasing costs of conservation and protection in general and by the specific costs of staff and patrols within protected areas in particular. Annex 6: Game Act provides further details of the Game Act.

Flora Protection Act. The illegal harvesting of flora is covered under this Act of 1952. This act provides legal protection to a small group of plants (30 genera and species). This Act has now been revised, passed by Parliament and is currently awaiting the signature of the King. The new and improved Flora Protection Bill provides protection for over 200 species, with harsh punishment for offenders (up to E2 500 fine or 2 years in prison). It remains to be seen whether this new Act will be enforced. The Act also makes provisions for the establishment of botanical gardens.

***Protection of Fresh Water Fish Act*.** The protection of fish is covered by this Act of 1937 which provides some protection to indigenous species of fish by stipulating a "close season" during which time fishing is not permitted (Section 3), and also by prohibiting the capture of fish by certain destructive means (Sections 8 and 9). However, no formal protection is given to specially threatened species or species whose populations within Swaziland are currently on the decline. Enforcement of the act is sporadic and no convictions or fines have been applied to people fishing at the wrong place or time.

Access and Benefit Sharing Bill. The pressure to share benefits of a commercial nature has resulted in the drafting of the Access and Benefit Sharing Bill of 2006 to establish and confirm Swaziland's sovereignty over its genetic resources, issues of access and benefit-sharing and other matters incidental thereto.

Acts to Regulate Conservation

At present in Swaziland there are three laws that permit areas to be set aside for conservation, the SNTC Act of 1972, the Game Act of 1953 amended in 1991 and 1993, and the Flora Protection Act of 2000. The SNTC Act refers to National Parks (all land owned by the state), Nature Reserves (at least some of the land not owned by the state) and National Monuments. The Game Act refers to Game Reserves and Wildlife Sanctuaries. The Flora Protection Act refers to Flora Reserves and Botanical Gardens.

The Game Act and Flora Protection Act focus on specific components of biodiversity (game and plants) rather than specific geographic areas containing biodiversity of other important ecosystem attributes. Both contain lists of specially protected animals and plants with restrictions on activities that threaten the survival of these. Both are applicable throughout the country and can therefore be enforced anywhere. Although areas can be designated for conservation under these acts, the objectives of doing such are not clearly specified and there is little explicit restriction on activities within these areas. On the other hand, the SNTC Act focuses on specific geographical areas. It was developed specifically to set aside areas for conservation and gives the strongest power to conserve areas and the broadest inclusion of all components of biodiversity.

With an increasing recognition that community participation and benefits from conservation have generally been overlooked when setting aside land for conservation, and there is a demand by such communities to have controlled access to areas that provide important traditional, cultural, medicinal and life supporting assets, there is an urgent need for the existing laws to broaden the protection state to allow for some form of mixed use whilst still protecting critical species or habitats.

A review of the existing laws searching for harmonisation and fairness would indicate a need to recognise lower categories (IUCN V and VI) of conservation area. Without this, Swaziland is unlikely to succeed in achieving its goals for biodiversity conservation and community benefit sharing.

The IUCN has identified six different protected area categories, based on management objectives. The categories facilitate planning of protected areas and protected area systems, improve information management about protected areas, provide tools to help plan systems of protected areas with a range of management objectives and governance types and help regulate activities in protected areas (IUCN, 1994).[35] There are advantages to using the internationally accepted IUCN guidelines for protected area categories as a basis for proposing categories of protected areas relevant to the needs of the people and environment of Swaziland.

IUCN category 1 areas (strict wilderness or scientific reserves) would not be appropriate in Swaziland given its economic and social needs. Otherwise, a Swaziland equivalent for each of the IUCN categories would ensure that representative and productive landscapes are given some form of protection and management. Category V protected areas e.g. recognise the value of human interactions with nature, and the role that humans have had in shaping many of the world's ecosystems. They are 'lived-in, working landscapes' that promote and support traditional livelihoods and cultures as well as protection of biodiversity. Category V areas can accommodate diverse management regimes including customary laws governing resource management.

The inadequate scope in the existing legislation for different categories of protected area restricts opportunities for declaring and managing such areas. In addition there are inadequate incentives and facilitation measures for communities and the private sector to invest in establishing and managing conservation areas and an inadequate capacity and resources within institutions tasked with managing and protecting biodiversity; current management and financial needs of existing protected areas not being met.

All of the gazetted six protected areas have been proclaimed under the SNTC Act of 1972. The current SNTC Act does not recognise the different categories and thus all protected areas prohibit consumptive human

[35] IUCN 1994. Guidelines for Protected Area Management Categories. IUCN, Gland, Switzerland and Cambridge, UK:

Category Ia Strict Nature Reserve: protected area managed mainly for science.

Category Ib Wilderness Area: protected area managed mainly for wilderness protection.

Category II National Park: protected area managed mainly for ecosystem protection and recreation.

Category III Natural Monument: protected area managed mainly for conservation of specific natural features.

Category IV Habitat/Species Management Area: protected area managed mainly for conservation through management intervention.

Category V Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation and recreation.

Category VI Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural ecosystems.

activities which communities living near these PAs strongly object. The draft SNTC Amendment Bill of 2009 (and also the draft Biodiversity Management and Conservation Bill of 2007) now recognise the IUCN system and if enacted, would allow for the gazetting of lower categories which would appease communities and allow for greater benefit sharing from the resources within the PAs. The draft Bill has identified three additional categories of protection: a protected landscape, a managed resource protected area and special reserves.

Adopting the IUCN system of categorisation for protected areas based on their management objectives is also key to the application of the Access and Benefit Sharing (ABS) guidelines (see section 3.4.5.2). This system recognises that while some protected areas (e.g., those in Categories I and II) are more strictly protected against consumptive human activities, others (e.g. those in Categories V and VI) allow for certain types of intervention such as the sustainable use of natural resources.

Though not a direct response to conservation management, the SEA did gazette the ***Environmental Audit, Assessment and Review Regulations*** in 2002 to ensure that a wide range of projects that affect biodiversity and other impacts on the natural world are adequately investigated and mitigation developed to reduce or minimise adverse impacts. Through the EIA process, biodiversity impact assessments are conducted to quantify the impact on biodiversity arising from a particular project. Currently the EIA process, administered by the SEA, does not adequately tackle the issue of cumulative impacts arising from the implementation of several similar projects, notably sugarcane expansion projects that cumulatively can heavily impact on habitats and critical ecosystem services.

Policy, Strategies and Action Plans

Biodiversity related policy and action plans include the following:

- Swaziland Environmental Action Plan (1997)
- National Biodiversity Strategy and Action Plan (draft) (2001)
- Biotechnology and Biosafety Policy (2005)
- Biodiversity Conservation and Management Policy (draft)(2007)

Swaziland Environmental Action Plan

In response to the Rio agreements, Swaziland in 1997 developed the Swaziland Environmental Action Plan (SEAP) which provides a framework for integrating environmental considerations into national economic and social development programmes and plans. In 1999 Swaziland developed the overarching (draft) National Environmental Policy (NEP) in order to promote sustainable social and economic development through the sound management of the environment. The policy provides for the conservation of biodiversity through the sustainable utilisation of the country's biological diversity (ecosystems, genetic resources and species) for the preservation of the National Heritage.

The SEAP has as its main objectives (1) to provide a state-of-knowledge overview of the environmental conditions in the country; (2) to identify, prioritise and where possible quantify environmental problems; (3) to propose solutions to immediate environmental problems in the form of programmes and projects, and institutional and legislative reforms; (4) to establish a clear indication of government's priority areas with respect to the environment so as to guide and give proper orientation to donor intervention in this field; (5) to establish a framework which provides coherent direction for the process of environmental monitoring and action planning in the future; (6) to provide a framework for continuous development and environmental policy dialogue within the country and with donor partners.

Management and use of biodiversity is one of the five major programme areas. The SEAP seeks to achieve a sustainable balance in the use of land, water and other natural resources between production systems, rural settlements and protection of the environment; and to maintain and improve biodiversity of indigenous and introduced systems in agricultural systems.

National Biodiversity Strategy and Action Plan

The 2001 draft NBSAP has as principal objectives (1) to conserve the biodiversity of Swaziland, (2) to encourage the sustainable use of biodiversity, and (3) to ensure that the benefits accrued from the use of biodiversity are shared equitably. The NBSAP establishes six goals, and makes recommendations towards their achievement. The goals are to: (1) to conserve a viable set of representative samples of natural ecosystems; (2) to, sustainably use of the biological resources of natural ecosystems outside protected areas; (3) to, conserve the genetic base of Swaziland's crop and livestock breeds; (4) to, minimise risks associated with the use of modified organisms; (5) to, establish effective institutional, policy and legal frameworks; , and (6) to enhance public awareness and support for biodiversity conservation. The priority areas identified in the NBSAP are not associated with indicators and as such, there is no basis for measuring progress in implementation.

Biotechnology and Biosafety Policy

The objectives of the Biotechnology and Biosafety Policy (2005) are to:

- support the safe application of biotechnology and its products to enhance the socio-economic development of the country whilst minimising, as far as possible, any adverse effects on human and animal health as well as the environment;
- ensure effective control of the transboundary movement of genetically modified organisms and products thereof resulting from modern biotechnology;
- help ensure an adequate level of biotechnology development within the country.

Annex 7 provides further information on the and Biosafety Policy

Although Swaziland has put in place legislation, policies, strategies and programmes to facilitate biodiversity conservation and sustainable use, biodiversity conservation continues to face constraints in enforcing legislation, finding community support and securing financial and technical resources.

There are a number of priority issues that must be implemented first if Swaziland is to make strides in biodiversity conservation. In this recognition, Swaziland through the ***National Capacity Self Assessment*** (NCSA) (GOS-SEA-NCSA, 2005, a, b, c, d) process identified national biodiversity priority issues which are similar to those identified in the National Biodiversity Strategy and Action Plan. Both the NBSAP and NCSA identified priority areas have been synthesized and are here grouped into six priority areas. These priority areas will assist Swaziland achieve the revised biodiversity 2020 targets when implemented together with NBSAP strategies.

3.4.5.4 INSTITUTIONAL RESPONSE

The main institutions with responsibility for biodiversity conservation are the Swaziland National Trust Commission (SNTC) and the Swaziland Environment Authority (SEA), both housed in the Ministry of Tourism and Environmental Affairs (MTEA).

Other important institutions include the Big Game Parks, Forestry Section, Fisheries Section, National Plant Genetic Resource Centre (NPGRC) and Swaziland National Herbarium. Some other institutions have policies and actions which may impact directly and often significantly on biodiversity in the country but lack mandates for biodiversity conservation or its sustainable use. These are Land Use Planning Section, Animal Production Division (in particular Rangeland Section), Dalcrue Holdings (Tibiyo Taka Ngwane) and Water Resources Branch. They all manage extensive tracts of natural habitat supporting a rich array of biodiversity but do not proactively manage these areas for conservation. For a comprehensive list of institutions with responsibility for biodiversity conservation see Annex 8.

The institutions with primary mandates for biodiversity conservation in Swaziland are generally inadequately funded and/or staffed, and do not have strong legislative support (Biodiversity Needs Assessment, GOS 2003).

3.4.5.4.1 SWAZILAND ENVIRONMENT AUTHORITY

The Swaziland Environment Authority (SEA) is the supreme institution responsible for the environment. Established in 1992 it remains an effective regulatory institution that coordinates many other supporting institutions. The SEA is responsible for environmental policy making, legislation, planning, environmental protection, monitoring and enforcement using provisions of the Environment Management Act of 2002. The Environment Management Act turned the SEA into a body corporate and established the National Environment Fund. In terms of this Act, the SEA has the power to halt any and all developments that have not been adequately scrutinised for their environmental impact.

3.4.5.4.2 SWAZILAND NATIONAL TRUST COMMISSION

The Swaziland National Trust Commission was created in 1972 by Act No. 9 of 1972, with later amendments, made effective from 27 July 1973. The declared mission of the SNTC is to conserve Swaziland's natural and cultural heritage through sustainable utilisation of natural resources and promotion of environmental awareness throughout the country.

Within the SNTC a Wildlife and Parks Department was created for the conservation of Swaziland's natural heritage. The department is responsible for conserving the country's natural ecosystems, its plant and animal life, and promoting the wise utilisation of these resources. Its objectives are:

- to establish and maintain national parks, nature reserves and other protected areas
- to create and promote environmental awareness within the general public
- to promote conservation activities outside protected areas, and to advise, promote and facilitate community managed activities that improve the quality of life while reducing undesirable impacts on the environment
- to promote and provide advice on ecological research and monitoring.

The SNTC recognises that the cost of managing protected areas far exceeds the revenue derived from them through tourism and other sources of revenue. With a declining budget allocation, the SNTC has explored ways to raise additional revenue.

The SNTC has drafted an amendment bill to the SNTC Act that would allow the SNTC to grant concessions to utilize the natural and cultural heritage resources to other public or private enterprises and to attach conditions to such utilization. The bill also allows for the SNTC to engage in trading activities of a commercial nature and to earn revenue, utilizing the natural, cultural and heritage resources or the assets held or controlled by the Commission. To test the application of concessions, the SNTC has partnered with a private company to manage Malolotja and Mantenga Nature Reserves with other SNTC managed parks being considered once the bill is approved.

Despite these efforts, Swaziland is lagging behind other countries in the region in attracting private investment in conservation management and tourism and more still needs to be done to encourage private investment and to involve more communities in profitably managing their natural resources.

In response to the widen the management objectives and governance types of PAs, the draft SNTC Amendment Bill also proposes changes to the existing definition of protected area to allow for a wider range of protection and the sustainable utilisation of natural resources. In addition to the current categories governing protection the draft Bill has identified three additional categories of protection – a protected landscape, a managed resource protected area and special reserves. In addition a broader defined protection category, similar to the IUCN category Managed Resource Protected Area is allowed for.

3.4.5.5 ENVIRONMENTAL INDICATORS: RESPONSE TO BIODIVERSITY CHANGE

Environmental sustainability is one of the Millennium Development Goals (MDG7) and an important indicator to measure environmental sustainability is the percentage of area under protection.

Environmental indicators showing the response to biodiversity change include:

Indicator	Measurement	Source	Availability/Reliability
Increase of area legally protected Total and by ecological region in two categories: 1-Formally protected; 2-Informally protected	ha and %	SNTC	available
Financial benefits arising from PA and conservation	E	SNTC	available
New legislation focusing on biodiversity, esp. Proclamation of overarching legislation to regulate biodiversity protection and management	number and relevance	Surveys: SNTC, SEA	available
Number of new policy initiatives focusing on biodiversity management	number	Surveys: SNTC, SEA	available
Number of public awareness campaigns or initiatives focusing on environmental conservation	number	Surveys: SNTC, SEA	available
Area of land cleared of IAPS	clearing records (ha)	Dept Forestry MOA, others	available but no maintenance records
Financial resources devoted to IAPS management	E	SNTC / MTEA	available

3.5 THEME 5: HUMAN DEVELOPMENT

The subjects discussed under Theme 5 Human Development differ from Themes 1 to 4 in their relationship to the environment. The first four themes deal with environmental entities or compartments which are integral parts of the natural environment, whereas Theme 5 relates to developments brought about by man, which are not part of the natural environment. In other words, this section on Human Development is focusing on effects resulting from the expansion of mankind, which are superimposed on the existing natural environment.

For reasons of convenience the subjects presented in this chapter are arranged and discussed following the components of the DPSIR framework used in the previous sections, notwithstanding the fact that not all of these human development components relate to or fit the DPSIR framework.

The human development as described in the following sections recognises and discusses the influence of the population on the natural environment and focuses on a number of important aspects of human development as they affect the environment. Reference is made to population and other relevant trends described in Chapter 1.

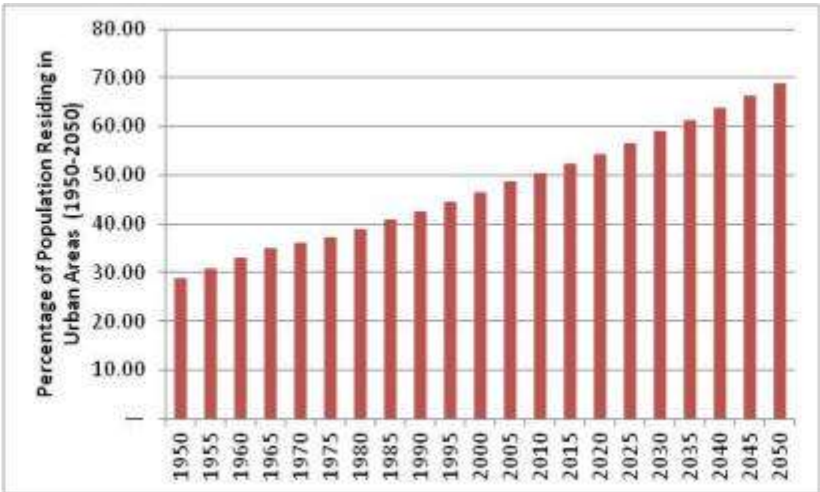
The effects on the environment as a result of human development are described under the following headings:

- Urbanization
- Energy
- Waste
- Human Health

3.5.1 URBANIZATION

Urbanisation is the physical growth of urban areas as a result of global change. The United Nations projected that half of the world's population would live in urban areas at the end of 2010.

Figure 38: Percentage of World Population Residing in Urban Areas (1950-2050)



Source: United Nations, Department of Economic and Social Affairs, Population Division (2010). World Urbanization Prospects: The 2009 Revision.

Urbanization is closely linked to modernization, industrialization, and the sociological process of rationalization. Urbanization can describe a specific condition at a set time, i.e. the proportion of total population or area in cities or towns, or the term can describe the increase of this proportion over time. So the term urbanization can represent the level of urban relative to overall population, or it can represent the rate at which the urban proportion is increasing.

Urbanization occurs naturally from individual and corporate efforts to reduce time and expense in commuting and transportation while improving opportunities for jobs, education, housing, and transportation. Living in cities permits individuals and families to take advantage of the opportunities of proximity, diversity, and marketplace competition.

People move into cities to seek economic opportunities. A major contributing factor is known as "rural flight". In rural areas, often on small family farms, it is difficult to improve one's standard of living beyond basic sustenance. Farm living is dependent on unpredictable environmental conditions, and in times of drought, flood or pestilence, survival becomes extremely problematic. In modern times, industrialization of agriculture has negatively affected the economy of small and middle-sized farms and strongly reduced the size of the rural labour market.

Cities are peculiar territorial units, source of phenomena relevant from the statistical and environmental point of view. As complex and dynamic entities, cities with urbanisation are causing congestion problems, leading for example to air and noise pollution, drinking water shortage, inadequate municipal and industrial waste disposal. In order to detect emerging trends in urban development and the environmental consequences of such growth, it is necessary to collect information related to the different aspects of the state of the urban environment and to translate them into an adequate format, with the purpose of generating awareness among people, policy planners, administrators and legislators: indicators can serve this purpose.

3.5.1.1 DRIVING FORCE

The primary driver of urbanization is economic development. It is reinforced by a number of push factors that cause people to migrate from rural areas, such as climate variability (e.g. low rainfall), conflict, and a desire for access to basic services such as education and health that can improve quality of life.

In general, the more rapid a country's economic growth, the faster it urbanizes. Urban areas account for a large percentage of the Gross Domestic Product (GDP) in most countries. The industrial and service sectors of the economy are usually located in urban areas, due to the easy access these areas offer to a mixture of the following services and resources:

Jobs and employment are the main drivers behind the movement from rural to urban areas. Drought conditions in the drier regions have reduced farming opportunities. Educational facilities tend to be better in urban areas and children may seek to stay with relatives or friends in town. Rapid growth in peri-urban areas is a result of people seeking cheaper and more available land, escaping municipal rates, as well as opportunities for small scale farming such as the keeping of goats and poultry and small garden plots.

3.5.1.1.1 ENVIRONMENTAL INDICATORS: DRIVING FORCE FOR URBANISATION

Environmental indicators showing the driving force for urbanisation include:

Indicator	**Measurement**	**Source**	**Availability/Reliability**
Population growth rate	%	CSO	census every 10 years
Macro-Economic development	GDP growth rate & GDP per capita	MEPD	available and reliable

3.5.1.2 PRESSURE

The pressure on urban development is the result of meeting the needs of a growing population.

Swaziland remains a primarily rural country, with approximately 78% of the population residing in areas classified as rural (CSO, 2007). However, that classification masks the fact that a growing portion of the "rural" population live in peri-urban settlements abutting formal urban areas, and at densities similar to those of the formal urban areas. As elsewhere in southern Africa, there is considerable migration from rural to urban areas, brought about by challenges in agriculture caused by inadequate labour related to the HIV/AIDS crisis and a serious drought in the mid-2000s, and encouraged by better services and job opportunities in urban areas.

3.5.1.2.1 PERI-URBAN DEVELOPMENT

The history of human settlements in Swaziland is highly complex and characterized by problematic land tenure issues dating from colonial times when the administration of rural and urban communities in Swaziland ran along parallel but separate tracks, with 'traditional' values and systems in the rural Swazi Nation Land (SNL) land and 'western' administrations in the urban title deed areas. This duality is the root cause of many of the country's land access and tenure challenges persisting today. These challenges are particularly difficult to address in the peri-urban domain, resulting in serious environmental and health risks to a significant part of Swaziland's population.

Urban areas are typically surrounded by Swazi Nation Land (SNL). As urban areas inexorably expand onto these areas, problems of control arise. These peri-urban areas have been growing rapidly in Swaziland for a number of reasons, and reflect movement both from rural areas, with people looking for greater employment opportunities or for those already employed moving away from urban settlements to escape rates and controls of urban authorities. Peri-urban densification represents a great environmental challenge within the Human Settlements sector.

The severity of the problem of peri-urban areas and industrial development has been recognized by the Swaziland Government, and articulately expressed in the PRSAP.

A steady increase in urban migration has led to the mushrooming of sub-standard houses on peri-urban land (predominantly SNL) in a very haphazard and unplanned manner. The mushrooming of low cost structures on the outskirts of the country's major towns has skipped the control of local authorities and no one seems to have control or authority over the development of these areas. Moreover, due to the financial gains now attached to land in the outskirts of urban areas, farmland is being sold for the construction of houses and the remaining hectarage, if any, cannot be used for any meaningful and gainful farming activity. This situation has led to increased congestion, poor sanitation and a lot of hunger and malnutrition due to limited potential for income generation on the remaining portions of land. Another factor that has contributed to the congestion and unplanned housing development has also been inadequate synchrony in the location of industries, development of human settlements, and provision of social services. New factories have been constructed without due consideration to the social services, infrastructure and welfare of workers.

While traditional systems of land use and allocation may be sufficient in rural areas, they generally are not able to address the needs in peri-urban areas that are absorbing migration from rural areas and rural growth points, which are developing organically around key crossroads or service areas. The problem is particularly acute in peri-urban areas, which are generally the only place where rural migrants can settle, given limited land availability in formal urban areas and high construction and land-use standards, which in many cases preclude the development of affordable housing. In contrast, migrants can relatively easily – and cheaply – find land in traditionally governed areas on the edge of cities, where residents with existing rights of use are able, with permission from the local chief, to sub-divide and allocate their own land.

To date, 42 Rapidly Growing Settlements have been identified by the Government (PADCO, 2003) irrespective of their land tenure or institutional arrangements.

3.5.1.2.2 FORMAL URBAN DEVELOPMENT

Although urban areas can offer advantages that can make sustainability more likely, e.g. a greater concentration of people limits the need for land and makes the provision of basic services more viable, urban areas also consume more water, food, energy and durable goods and have an impact far beyond the urban boundaries. Urban sprawl is furthermore linked to the loss of biodiversity and the pollution of land, water and air. The rapid influx of people into already overcrowded urban areas with large service delivery backlogs has led to the formation of informal settlements in vulnerable locations, on the banks of streams, on steep hillsides or wetlands. It is estimated that up to half of all informal dwellings can be classified as vulnerable to environmental factors. The absence of accessible basic services in overcrowded areas is associated with negative health outcomes and accelerated environmental degradation, mostly as a consequence of the collection of local resources for energy, and localised pollution.

Urban areas have their own environmental challenges. Swaziland benefits from a reasonably strong institutional and regulatory framework for addressing specific urban environmental challenges. Problems relate more to inadequate human and financial resources to implement plans and planning processes, and environmental assessment procedures and regulations. Revenue streams are affected by a weak system of cost recovery, which in turn reduces the ability of municipalities to address environmental issues through strategic planning and monitoring and control mechanisms.

3.5.1.2.3 ENVIRONMENTAL INDICATORS: PRESSURE ON URBANISATION

Environmental indicators showing the pressure on urbanisation include:

Indicator	Measurement	Source	Availability/Reliability
Urban residents in informal settlements (growth rate)	numbers & %	CSO & Municipalities	available and reliable
Trends in population density in urban areas	numbers & %	CSO & Municipalities	unvailable
Trends in population density in peri-urban areas	numbers & %	CSO & Municipalities	unvailable
Employment in urban versus rural areas	numbers & %	CSO & Tinkhundla	unvailable
Urban residents with formal housing (Growth rate)	numbers & %	CSO & Municipalities	available and reliable
Building permits approved	numbers annually	Municipalities & MHUD (Urban Govt)	available and reliable

3.5.1.3 STATE

Although not really part of state of environment, this section describes the state of the urban development as it relates to its impact upon the environment.

The fundamental components of human settlements include adequate and affordable shelter, safe and affordable drinking water, and appropriate and affordable management systems for domestic and industrial waste (UN-HABITAT, 2010).Demographic Aspects of Urbanisation

The residence categories of the population of Swaziland are given in Table 69 below, illustrating that the population of Swaziland is predominately rural. In 1986 the urban population stood at 22.7% and increased marginally to 23.1% in 1997. In 2007 the urban population decreased marginally to 22.1%.

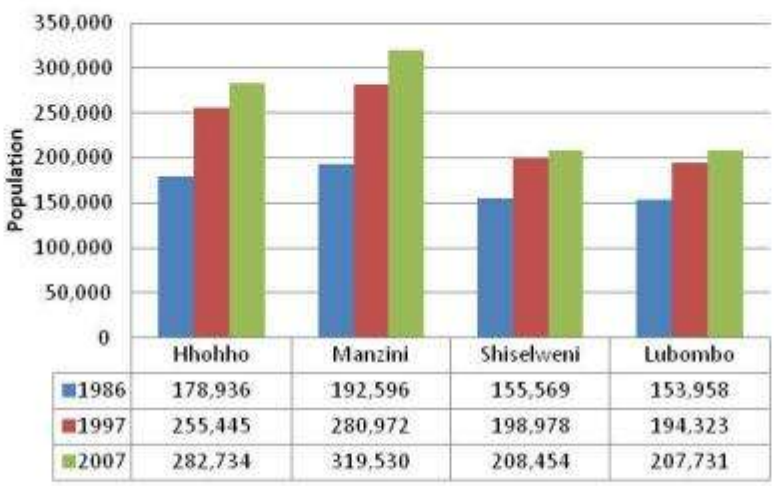
Table 69: Population by Rural and Urban Residence, 2007

	Numbers			Percentage		
Year	**1986**	**1997**	**2007**	**1986**	**1997**	**2007**
Urban	154,979	214,428	225,293	22.7	23.1	22.1
Rural	526,080	715,290	793,156	77.1	76.9	77.9
Total	681,059	929,718	1,018,449	100	100	100

3.5.1.3.1 REGIONAL POPULATION DISTRIBUTION PATTERN

The regional population distribution pattern is uneven, but shows a steady increase in the Manzini and Hhohho regions from 1986 to 2007. The regional population distribution (Figure 39) shows that the Manzini region continues to be most populated in Swaziland whilst the least populated continues to be Lubombo region. The proportions of both Hhohho and Manzini regions continues to increase whilst the proportions for the Lubombo and Shiselweni regions decreases and this could be attributed to the fact that the Manzini and Hhohho regions have more economic activities than the other two regions.

Figure 39: Population Distribution by Region

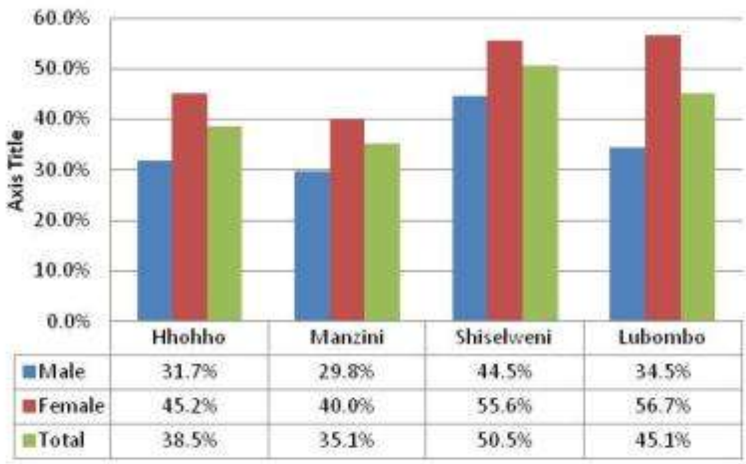


Source: GOS-CSO, 2010

Urban areas are traditionally considered centres for employment – a key driving force for rural to urban migration. The Population Census (GOS-CSO, 2010) captured unemployment rates and the data reveals that female unemployment is much higher than that of males (47.4% compared to 33.6 %) and the unemployment rate for both sexes is 40.6%. This implies that females find it harder to find paid employment than their male counterparts. This situation is not unique to Swaziland and is common in many other developing countries.

The urban areas have an unemployment rate of 14.6% for males and 25.9% for females compared to 40% and 53% respectively for the rural areas. At the regional level the rates range from 35% in the Manzini region to 51% in the Shiselweni region. The highest unemployment rate is 57% for females in the Lubombo region.

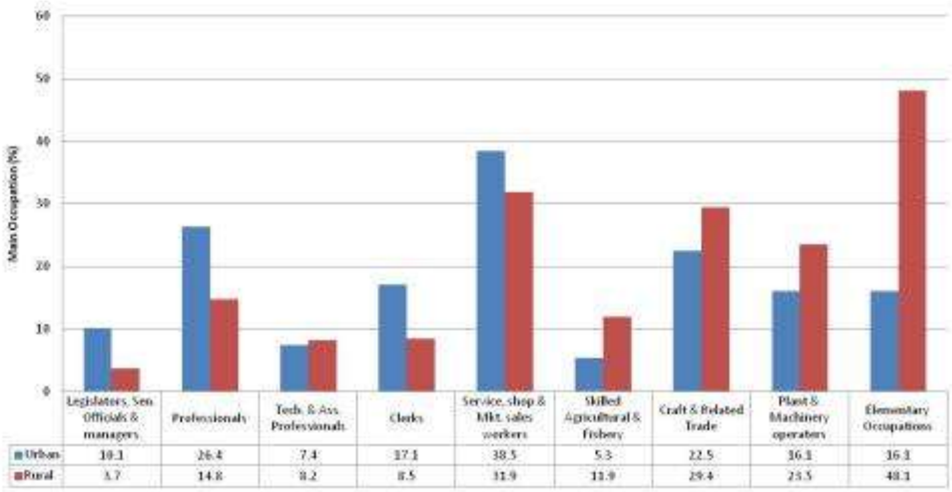
Figure 40: National Unemployment Rates (%)



Source: GOS-CSO, 2010

A large proportion, close to a quarter, of the population is engaged in elementary occupations (24%), followed by service, shop and market sales workers (17%). Craft and related trade workers constitute 13%. These occupations together form the majority of the country's occupations.

Figure 41: Distribution of Main Occupations (Rural / Urban)



Source: GOS-CSO, 2010

The quality of housing is often used as a measure of the standard of living of a country and one of the most leading indicators of development. Better housing conditions are essential for human survivorship. Following food and clothing, the International Labour Organization (ILO) classifies housing as a basic need. Therefore, the absence of any of these three basic needs poses a danger to human life.

3.5.1.3.2 QUALITY OF URBAN HOUSING

In the face of the high rate of urbanization, Swaziland urban landscape has seen the emergence and growth of informal settlements. These areas exhibit all the classic signs of rapid and unplanned urbanization, characterised by congested housing and horrendous living conditions, devoid of safe and adequate water, proper sanitation and other basic services. The increased demand for shelter has largely been met by self-help substandard buildings and the renting of rooms within households on unsurveyed 'plots'. With such settlements accounting for about 60% of the urban population, there is an imperative need for improvement of these settlements.

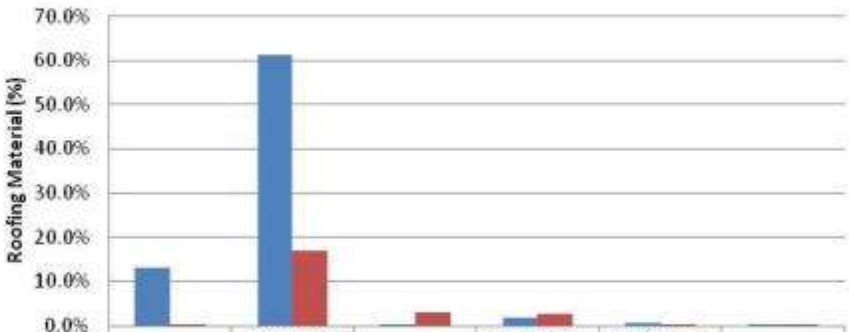
The occupation of Government land by informal settlements is attributable to a colonially inherited statute, the Crown Lands (Temporary Occupation) Act 22/1964. It makes provision for the granting of permits of specified areas of what was at the time of its promulgation Crown (Government) land, mostly within the capital, Mbabane. Permits were renewable one year at a time and allowed the holder to build a temporary building. Although no new permits have been issued for some time, the Act remains on the statute book. The Act included provisions allowing for the permits to be revoked. The Act also prohibited encroachment on Crown land not designated for such temporary occupation.

It further specifically precluded the building of permanent housing, premised on the fact that all Swazis are entitled to a rural homestead, and this was considered the permanent and main residence of those migrating to the urban areas. The expectation was that those migrating to the urban areas for employment would on retirement or earlier return to their rural home. This resulted in the creation of the informal settlements in which the majority of urban residents now live, notably within Mbabane (Aitken, 1995).

Deepening poverty, influenced by factors such as rising unemployment, has exacerbated the unsatisfactory housing conditions. The 2007 Population and Housing Census (GOS-CSO, 2010) analysed census responses to questions on housing characteristics defined by their roofing, wall and floor materials to provide an indication of the state of housing.

It can be seen from Figure 42 that the most commonly used material for roofing in the country are corrugated iron sheets where more than half of the households reside in housing units with such roof. This proportion is even higher in rural areas than in urban areas.

Figure 42: Main Roofing Material

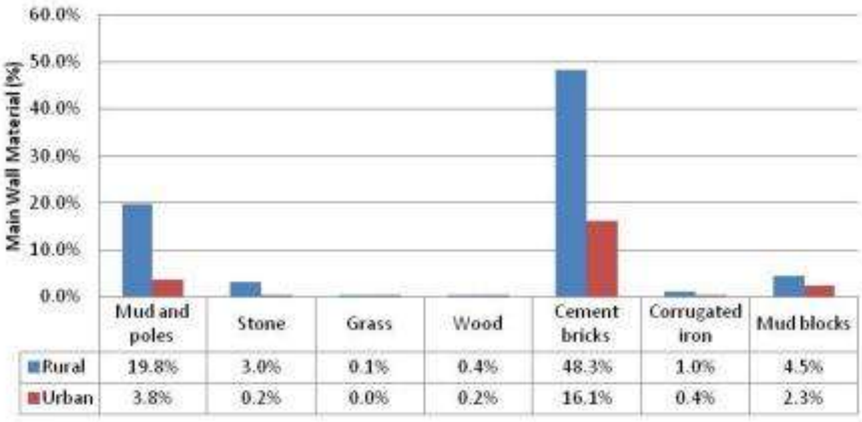


	Grass	Corrugated Iron	Asbestos	Tiles, slate, concrete	Traditional hut	Other
Rural	13.2%	61.2%	0.2%	1.8%	0.6%	0.1%
Urban	0.2%	17.0%	2.9%	2.6%	0.1%	0.0%

Source: GOS-CSO, 2010

With respect to materials used for the construction of walls (Figure 43), cement bricks/blocks, mud and poles, as well as mud blocks predominate in the country. Close to 63 % of households live in dwellings with walls made of cement bricks/blocks, while 23 % reside in dwellings with walls made of mud and poles and about 7 % reside in dwellings made of mud blocks. In urban areas, cement blocks/bricks constitute 69% and mud and poles contribute 16%. On the other hand in rural areas cement blocks/bricks constitute 61% and mud and poles contribute 25%.

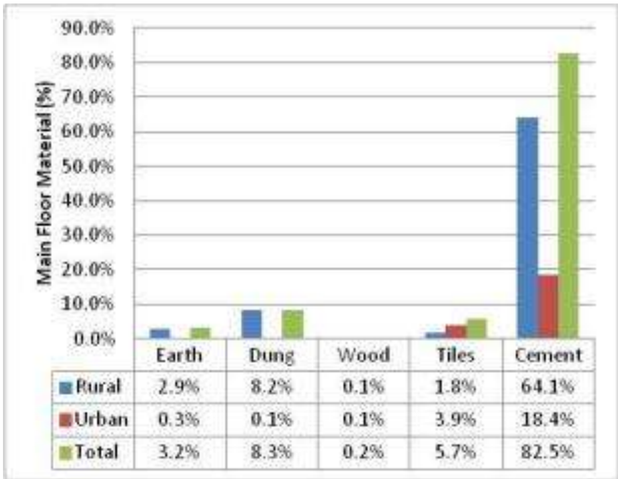
Figure 43: Main Wall Material



Source: GOS-CSO, 2010

With respect to materials used for the floor in the whole country, cement is the most common material. Figure 44 shows that about 64 % of the households occupy dwellings with this type of floor. This proportion is even higher in rural areas about 81 % compared to 79 % urban households. Housing units with earth and dung floors are most predominant in the rural areas.

Figure 44: Main Floor Material



Source: GOS-CSO, 2010

3.5.1.3.3 ENVIRONMENTAL INDICATORS: STATE OF URBAN ENVIRONMENT

Environmental indicators relevant to the state of urban environment include:

Indicator	Measurement	Source	Availability/Reliability
Change in urban area	area (ha), % change	MHUD	unavailable
Urban living conditions: infrastructure, housing, roads, public transport, traffic,	descriptive, numbers	MHUD, City Councils	unavailable
Access to services: water, sewage, electricity, telephone, internet	numbers, % population	MHUD, SEC, SWSC, City Councils	available
Urban environment quality: green areas, urban forestry, urban biodiversity	totals, %	MHUD, City Councils	unavailable

3.5.1.4 IMPACT

Urbanisation certainly has impacts on the natural environment and human health, and may also have an impact on social behaviour and patterns, e.g. urban poverty compared to rural, crime in urban areas compared to rural, urban consumption patterns (energy, water, food etc) compared to rural.

Rural-urban migration is resulting in an expansion of informal settlements surrounding main urban areas. These emerging unplanned settlements can have dramatic impacts on the environment though land clearing, deforestation for building materials, pollution of water course from poor sanitation arrangements and social problems arising from poverty. Informal settlements lack many of the amenities associated with urban areas like potable piped water, sewerage management and electricity. The rate of increase in population in peri-urban areas places immense strain on local authorities that often lack resources to implement long term strategies to deal with the population influx.

3.5.1.4.1 IMPACT ON THE NATURAL ENVIRONMENT

The natural environment is composed of biodiversity within functioning ecosystems. Urbanisation sees an increasing conflict with the natural environment as it clears land for settlements and source water and energy to sustain the livelihoods within the urban areas. Peri-urban developments typical of many of Swaziland's major towns and cities have seen a marked increase in environmental and social problems. Urbanisation reduces biodiversity through urban expansion and development and reduces and degrades ecosystem functions and services. Pollution, land degradation and increasing areas dominated by alien invasive plants.

Biodiversity issues are reported on under Theme 4 and should be read in conjunction with this section.

Increased housing developments associated with urbanisation, directly affects the soils' physical characteristics thus lowering water infiltration and increasing runoff and soil erosion with increased potential for floods. Roofing of housing complexes and paving of roads and other access routes has reduced the surface area available for soil infiltration. During the rainy season much of the run-off flows to the waterways below with minimal infiltration which is one of the main ground water recharge pathways.

The major environmental impact of human settlements especially in urban areas is existence of slums particularly in unplanned/squatter settlements which bring their own specific impacts on the environment and wellbeing of residents.

Other impacts arising from urbanisation include:

- Increased non-point source water pollution
- Increased air pollution
- Increased storm runoff rates and downstream flooding because paved areas impair the landscape's ability to absorb run-off; erosion and water quality degradation
- Loss of agricultural land to housing infrastructure
- Loss of wetlands which are filled or disrupted to accommodate urban infrastructure
- Concentration of populations in peri-urban areas that are unplanned and generally have poor sanitary conditions.

3.5.1.4.2 IMPACT ON ECOSYSTEM HEALTH

Environmental impacts of expanding urban areas manifest in impacts on the flora and fauna of the affected areas. The Mbabane State of Environment Report prepared in 2008 (Mbabane City Council, 2008) identified some trends in the capital's environment. Invasive alien plants were noted as having detrimental impacts on indigenous flora caused by changes in land use as natural areas are cleared for urban expansion and infrastructure development. The Parks Department of the Mbabane City Council is mandated to maintain the city's open areas and the general improvement of the athletics of the city. The Council undertook a programme to reintroduce indigenous ornamentals in CBD and the removal of alien species.

The mostly widely visible invasive alien species in Mbabane are wattle (*Acacia mearnsii*), gum (*Eucalyptus spp*), guava (*Psidium guajava*), syringe (*Melia azedarach*), bug weed, Tickberry (*Lantana camara*), *Solanum mauritianum* and *Tagetes minuta*, which occupy most of the wetlands. These have overtaken the indigenous species. Gum and acacia are found on the banks of Mbabane River and surrounding streams. Some varieties of pine (*Pinus* spp) and varieties of gum dominate the Mbabane and Polinjane River valleys.

Fauna in urban areas is not well documented as most of it has been affected by land use change as a result of various urban development activities. Any wild fauna spotted in the urban area will mainly be smaller mammals such as rodents and mongoose as larger mammals can only be found in national parks and game reserves, which are located outside the local authority boundaries. Birdlife is often very good and variable in sub-urban areas.

3.5.1.4.3 IMPACT ON HUMAN HEALTH CONDITIONS

In recent years, urbanization has emerged as an increasingly important factor in the spread of the disease. Health issues are also dealt with in the sub-chapter on Health.

Sanitation

In the 2007 population census it was revealed that 62% of all households do not access a safe toilet facility. About 16% of households in Swaziland have no toilet facility. Instead, they utilize the bush and other unknown type. Only 13% of the households in the country use flush toilet facility. There are notable differences between urban and rural areas. 45% of the households in urban areas use flush toilet while the corresponding rural percentage is less than 4%. 19% of the rural households use the bush as against 2% in the urban areas. 64% of the country use latrines (pit or VIP) with 71.4% in rural areas and 39.3% in urban areas.

Pit latrines are the standard method of sanitation. They are generally inadequate from the hygienic point of view, and can be improved by the provision of ventilation pipes and correct slab design. In particular, sanitary conditions are unsatisfactory when they are shared by a large number of families, a problem caused in part by the difficult and extremely rocky terrain and soil conditions.

Water

Potable good quality water is a critical resource for human existence. Where water quality degrades due to pollution health problems emerge. The Government of Swaziland continues to make efforts to bring potable water to an increasing number of people in rural and urban areas but it remains a challenge particularly in the rural areas where settlement s patterns are not conducive to large distribution systems.

A distinguishing feature of informal settlements in Swaziland is that they have not been formally denied access to water. This is provided by the Swaziland Water Services Corporation (SWSC), which responds to market demands as far as it can. Thus, a substantial number of residents in informal settlements can obtain water from a tap within a reasonable walking distance. These taps are metered, and the normal arrangement is that the person in whose name the meter is registered has a duty to collect the costs required to pay the bill. Where this system does not operate successfully, the water is cut off.

People also use water from springs and rivers. Springs serve as the main source of water for most of the poor families, and a supplemental source for the relatively well-to-do households. Of interest is the fact that some households collaborated to install pipes so as to have a continuous supply of spring water to their houses.

Sources of water differ markedly between urban and rural areas. The proportion of households that have piped water into the house in rural areas is 4.8% and in urban areas this is 47.9%. The proportion of households that use unprotected water sources (well, river, rain water) in rural areas is 34.2% and in urban areas is 5.6%. The proportion of households that use a borehole or protected spring as a water source in rural areas is 12.9% and in urban areas is 2.2%.

The proportion of rural households with access to safe drinking water is 74.2% whereas in urban areas the proportion is 25.8%. The proportion of rural households that access unsafe water is 88.1% whereas in urban areas the proportion is 11.9%.

Figure 45: Distribution of Households by Main Source of Water for Drinking

Main water source	Number			Percent		
	Total	Male	Female	Total	Male	Female
Total	**212195**	**113397**	**98798**	**100.0**	**100.0**	**100.0**
Piped into housing	30869	19154	11715	14.5	16.9	11.9
Piped into yard, plot	53552	30478	23074	25.2	26.9	23.4
Community stand pipe	27275	13713	13562	12.9	12.1	13.7
Unprotected well	22484	10956	11528	10.6	9.7	11.7
Protected well	6473	3188	3285	3.1	2.8	3.3
Borehole	11982	5785	6197	5.6	5.1	6.3
Spring (protected)	10098	4990	5108	4.8	4.4	5.2
River, canal	3214	1695	1519	1.5	1.5	1.5
Rain water	33403	16306	17097	15.7	14.4	17.3
Tanker truck	1527	830	697	0.7	0.7	0.7
Bottled water	3746	2148	1598	1.8	1.9	1.6
Not Reported	7572	4154	3418	3.6	3.7	3.5

3.5.1.4.4 ENVIRONMENTAL INDICATORS: IMPACT OF URBANISATION ON ENVIRONMENTAL AND HEALTH CONDITIONS

Environmental indicators on the impacts of urbanisation can include the following:

Indicator	Measurement	Source	Availability/Reliability
Area still covered by ecosystem and green areas within urban area	area (ha) & % change	SNTC, municipalities	not available
Change in area still covered by ecosystem within peri-urban area	area (ha) & % change	SNTC, municipalities	not available
Change in area affected by IAPS in urban and in peri-urban areas	number, species, area (ha), % change	City Councils	
Acces to safe water	% of urban population % of peri-urban population	MOH	available
Access to sanitation	% of urban population % of peri-urban population	MOH	available
Volumes of waste disposed (urban)	t	Municipalities	not available
Water related disease incidence	number	MOH	available
Waste related disease incidence	number	MOH	available
Urban poverty compared to rural	%	CSO	available
Urban crime compared to rural	%	RSP	available

3.5.1.5 RESPONSE

3.5.1.5.1 INVESTMENT RESPONSE

In response to the impacts of urbanisation, government and local authorities have developed plans to address the key impacts arising from both formal and informal urbanisation.

The Swaziland Urban Development Project (UDP)

Preparation of the UDP began in 1989; it became effective in 1996 and closed in 2005. GOS continued to implement the project after its official closure as a Bank supported project. The objectives of the project were to:

- Provide a basis for sustainable urban development through emphasizing policy reform and institutional development

- Pilot land reform, particularly development and housing solutions for moderate and low-income urban households
- Address critical infrastructure needs, including water, sanitation, waste disposal and roads.

Every component of the UDP has directly or indirectly contributed to urban environmental sustainability. Physically, the bulk infrastructure and residential upgrading have both improved the natural, built and human urban environments, while the institutional and policy reform component has resulted in improved local governance. The UDP has enshrined environmental sustainability in all its wide-ranging activities and components; In Mbabane and Manzini the proportion has fallen from + 37% in 2000 to 21%in 2005; between 2000 & 2007, the UDP will have completed upgrading for 40,000 people.

Mbabane Finance and Upgrading Project (MFUP)

Mbabane City Council completed the MFUP in 2000. The project prepared a comprehensive upgrading plan for the remaining nine informal settlements in Mbabane, with a fully costed budget together with detailed data on incomes and expenditure, employment, upgrading priorities, affordability and willingness to pay for services, an agreed institutional analysis and implementation plan. The MUFP draws heavily on experience (positive and negative) gained on the UDP, and takes on board the lessons learned.

For a number of reasons Manzini has been slower to get to grips with the upgrading of its informal settlement. Only in 2006 is it finally starting the phased implementation of its sole UDP upgrading component, Moneni.

The increasing challenge, however, lies in the peri-urban areas. In the Mbabane / Manzini corridor these are currently estimated to support a population in the order of 75,000 but this could well have risen to 100,000 by 2015.

In response to the increasing threat of alien species and general decline in biodiversity in urban areas, many city councils have demarcated public parks that enhance biodiversity through tree and shrub planting, habitat restoration in riverine areas in particular and improved recreational space/facilities for the urban population to enjoy.

Areas within urban areas worthy of protection have not been identified though such exists in all urban areas. As a result sensitive and potentially botanically diverse areas have been lost or altered as a result of increasing rates of urbanisation. Virgin lands and wetlands in and around cities are steadily changing to residential areas.

The Mbabane SOE (Mbabane City Council, 2008) suggested that the increasing loss of biodiversity through urban expansion is a result of poor communication and planning between the Ministry of Housing and Urban Development, the Mbabane City Council, the Swaziland Environmental Authority and developers in the allocation of land for development projects. The lack of consultation has led to conflicting interests in development at the expense of natural areas.

The impact of this expansion is not only a decline in the biodiversity within cities but knock on effects in terms of ecosystem functioning and services.

The loss of ground cover in urban areas encourages flooding, which can damage infrastructure and affect businesses. Flooding within the Mbabane CBD has occurred on a number of occasions leading to loss of business and slight infrastructural damage. The Mbabane City Council has tried to reduce the occurrence of flooding by implementing and improving its stormwater management system.

Additional efforts needed by local authorities for improved catchment management and increased conservation of natural areas are supported by the enforcement of by-laws to protect the remaining indigenous biodiversity or areas of high importance to protect urban areas from flooding and the enforcement of EIA legislation. However the lack of strategic urban planning by many local authorities that includes environmental considerations as well as economic instruments is leading to the gradual and irreversible change in land use in urban areas that are detrimental to important ecosystem functions and services.

Improvements to peri-urban settlements using international funds have taken place over the past 10 years. Informal areas have been upgraded with piped water, sanitation, electricity and roads. This has led to improvements in health and given residents improved access.

Government has also enacted various legal instruments to regulate and manage urban areas. Some of the laws are considered to be outdated and in needing review and improvement recognising advances in urban planning, building and health.

3.5.1.5.2 SYSTEMIC RESPONSE

Legislation

Historically, a lack of clear policies and weak institutional capacity and difficulties in obtaining land for development, have exacerbated urbanization problems. Private and public sector developers (like the Swaziland National Housing Board) provide housing but this is limited and available only to the middle and upper income households. A total of 79 legislative instruments related to land issues have been identified. Some of the key pieces of legislation are:

Urban Government Act of 1969

This Act provides the basis for the establishment of local authorities in Swaziland as a primary legal instrument defining the parameters under which city councils conduct their affairs. The act outlines the duties and powers of Councils; makes provision for meetings of Councils and Committees, Management Committees and staff; designates towns, land, streets and public places; and the administration and audit of Council accounts.

Town Planning Act of 1961

This act makes provision for the preparation and carrying out of town planning schemes in declared urban areas. It establishes the Town Planning Board, its functions, powers and duties. It authorizes the preparation of town planning schemes, the approval of schemes, variation of schemes, enforcement of schemes and compensation for injurious affection.

Human Settlements Authority Act of 1988

The act established the Human Settlements Authority and its Objects and functions. It provides policy support to Government and the orderly development of human settlements by allowing for and outlining procedures for the establishment of Human Settlements. It also makes provision for the development human settlement development plans, the revocation or modification of development plans and finance mechanisms for the supply and maintenance of improved shelter and infrastructure.

Swaziland Environment Authority Act of 1992

The act provides a broad mandate for environmental management by the Swaziland Environment Authority. Translating from these have been the environment audit, assessment and review regulations, the National Environment Policy, waste management guidelines and a National Environment Action Plan.

Environment Management Act of 2002

The act is intended to provide and promote the enhancement, protection and conservation of the environment and the sustainable management of natural resources. It also turned the Swaziland Environment Authority (SEA) into a body corporate and established the National Environment Fund. In terms of the Act, the SEA has the power to halt any and all developments that have not been adequately scrutinized for their environmental impact. Any policy, bill, regulation, program or plan requires a Strategic Environment Assessment. The Act provides for public participation, and sets out regulations for the registering of environmental information, requests for environmental information, public review, public hearings, findings of public hearings, public participation in licensing decisions, order and prosecutions initiated by the public, civil actions and other regulations. The Act is the supreme environmental law and the implementation of any non-environmental piece of legislation, e.g. the Roads Act, where it is considered to have a direct or indirect environmental impact falls under the provision of the Environmental Management Act.

The Waste Regulations of 2000

This provides regulations for the management of solid waste and liquid waste disposed on land or water.

With regard to urban management there are a number of Acts affecting urban authorities. The 1961 Town Planning Act established the fairly complex and tortuous arrangement for establishing townships, a process that has to be followed for legalizing all new residential developments within their jurisdictions, including presently unplanned, informal settlements.

The Building Act of 1968 establishes standards for construction that are considered by many to be extremely high, inappropriate and unaffordable by most urban dwellers.

The Rating Act of 1967 allows strict control of local property rates by central government, which can severely limit the ability of town and city councils to deliver and maintain infrastructure and services. More recently, the two city councils have prepared Strategic Development Plans, which have identified priorities and are assisting efforts to address critical issues such as the informal settlements, servicing, cost recovery and funding for development and operations and maintenance.

The Town Planning Act of 1961 makes provision for the preparation and carrying out of town planning schemes, which allow the coordinated development of urban areas.

The Human Settlements Act of 1988: Controls the orderly development of existing and future urban settlements; and the establishment of human settlements, housing schemes and private housing schemes.

The Buildings Act of 1969: Restricts the construction of illegal structures, and highlights the need for the provision of means for the removal and disposal of all waste material within and in the vicinity of a building. The regulating authority is the Ministry of Public Works and Transport.

The Public Health Act of 1978: Requires local authorities to deal with nuisances and specifically to prevent pollution of any supply, which the public in their district has a right to use, and does use for drinking or domestic purposes, and to purify such polluted supply. The regulating authority is the Ministry of Health and Social Welfare.

Policies

The National Housing Policy, 2001

Swaziland faces pressing challenges in its human settlements as a result of a past rapid population growth (the rate of population increase has slowed due to HIV/AIDS), continuing rapid urbanisation, deepening poverty and limited resources to manage urban growth and deliver services. Government's response to these challenges has been to focus on policy regulation and institutional development and investment programs. The policy vision underlying this housing policy is that 'all Swazi households should have access to affordable shelter and services'.

The key housing policy issues derive from increasing poverty and difficulties in managing urban growth and, in particular, the lack of access to basic services.

The housing policy focus areas are:

- improving the efficiency of the operations of the housing market in urban areas;
- normalising the housing market in relation to Government-owned housing, rental and interest rate subsidies and Government land holdings;
- developing urban informal areas for low-income households and in a manner that makes them more attractive to low-income households than peri-urban areas;
- incorporating peri-urban areas within Mbabane and Manzini; ensuring that all households acquire access to the services required to ensure health and safety - water, sanitation and waste removal - and that a basic level of water consumption be provided for free to low-income households;
- reallocating resources devoted to housing in order to be able to subsidise land and services for low-income households;
- changing the manner in which services are financed in order to reduce their cost; and ensuring that service providers are committed to providing all households will the services noted above and to doing so in a manner that is equitable and fair and standardised.

Other relevant policies include:

1. The National Physical Development Plan (NPDP) 1996
2. Draft National Land Policy 1999
3. Urban Government Policy 1996
4. Draft Peri Urban Growth Policy 1997
5. National Solid Waste Management Strategy 2003.

3.5.1.5.3 INSTITUTIONAL RESPONSE

Ministry of Housing and Urban Development

Swaziland only began to address problems of land, servicing and housing in urban areas in the mid 1980s. It was during this time that the Swaziland National Housing Board (SNHB) and the Human Settlement Authority (HSA) were created, together with a number of sector policies and legislation. In response to a growing need to respond in an organized manner to improving the environment for the rapidly growing urban areas, the Ministry of Housing and Urban Development was created in 1992. The most significant urban problems at that time were considered to be (i) lack of available land for low-cost development in urban areas and (ii) insecure and unbankable land tenure on Swazi Nation Land (SNL) beyond the urban areas (Lowsby 2007). These challenges had to be overcome to provide adequate land for the growing urban populations. Peri-urban areas were expanding onto SNL at a rapid rate, overwhelming the capacity of the traditional authorities responsible for them to meet the needs of the population in terms of basic services. Therefore the need to bring peri-urban areas on SNL under formal, planned and secure administration was considered (and remains) a serious challenge. The recently approved constitution introduces the concept of an integrated local governance system, which brings hope for improved local planning and development, while a change in the legal framework to allow for the signing of 99-year leases by occupants holds promise for improved security of tenure. The shift in focus from infrastructure problems to land ownership policies has reframed the urban issues.

3.5.1.5.4 ENVIRONMENTAL INDICATORS: RESPONSE TO URBANISATION

Environmental Indicators on response to urbanisation may include the following:

Indicator	**Measurement**	**Source**	**Availability/Reliability**
Environmental measures within urban areas (green areas, ecosystems, biodiversity)	description, % change	City councils	not available
Progress of delivering safe water and sanitation	description, % change	City councils	not available
Quantity of waste disposed	t	City councils	not available
New acts and regulation passed	number	MHUD	available

3.5.2 ENERGY

According to the National Energy Policy (GOS-MNRE, 2003) the pattern of production and use of energy reflects the country's high dependence on imports of electricity and petroleum. This dependence is due to the limited development of national energy generation capacity beyond hydro schemes and cogeneration plants in the sugar sector.

Energy is a vital commodity in all the sectors of society and is the engine for economic growth for the development of the country. The vision of the National Energy Policy has been formulated as "Ensuring that the development goals of the country are met through the sustainable supply and use of energy for the benefit of all the citizens of the country". This vision underlines the importance of the availability and accessibility of energy to cater for the development needs of the Swazi nation. Energy should be affordable and the national energy resources should be harnessed with optimum efficiency, whilst ensuring due attention to environmental concerns.

In terms of energy resources, Swaziland has reportedly substantial coal reserves and untapped hydropower resources, and its sugar and wood based industries produce large volumes of biomass residues that have considerable potential to supplement imported electricity needs. Successful tapping of these indigenous resources in an environmentally sound manner can contribute towards increased generation of electricity, creating employment, providing support businesses and reducing poverty. An over-reliance on wood fuel in rural areas has seen these resources diminish to such an extent that it is now a serious problem to collect firewood in some areas.

The energy sector comprises the following main sub-sectors namely: petroleum products (petrol, diesel, paraffin and liquefied petroleum gas (LPG), solid fuels (coal), electricity, renewable energy (hydro, wind and solar) and biomass (wood fuel, wood waste and bagasse).

Swaziland satisfies its petroleum products demand through 100% imports. Petroleum products are procured from South Africa where they are refined or sourced from international markets. A Biofuel Strategy and Action Plan (GOS-MNRE, 2009) seeks to introduce biofuel blending of petrol using locally produced fuel grade ethanol derived from sugarcane molasses. Studies are ongoing as to how introduce this product to market.

The two main renewable sources of energy used in Swaziland are biomass and hydroelectric power. Solar and wind energy are still limited to household scale however the Energy Department is supporting an on-going study on wind potential with measurement sites at Nhlangano, Siteki, Piggs Peak, Luve and Sithobela.

3.5.2.1 DRIVING FORCE

The main driving force behind the use of energy is associated with the need of a growing population and economy to energise its development and provide for its consumption lifestyle. This coincides with the general trend of urbanisation, reflected by a higher consumption of energy in urban areas compared to rural.

3.5.2.1.1 ENVIRONMENTAL INDICATORS: DRIVING FORCE AFFECTING ENERGY

Environmental indicators to measure the driving forces behind energy use and production can include:

Indicator	Measurement	Source	Availability/Reliability
Population growth	numbers, % change	CSO census data	available and reliable
Urbanisation	numbers, % change	CSO census data	available and reliable
Industrialization (commerce, industry)	consuption (kW)	MNRE, MCIT	available and reliable
Agriculture (irrigated agriculture)	consuption (kW)	MNRE, MCIT	available and reliable

3.5.2.2 PRESSURE

The pressure on energy is the increasing energy needs and demands from key developing sectors: agriculture, industry, commerce, transport and domestic. The energy consumption as recorded in the energy balances for 2008 and 2010 per sector is shown in Table 70). The data show large fluctuations for some of the sectors.[36]

Table 70: National Energy Consumption (TJ) in 2008 and 2010

Energy Consumption	2008		2010	
Sector	TJ	%	TJ	%
Industry	37,177	62	3,848	10
Transport	4,651	8	4,463	12
Agriculture	1,007	2	9,883	27
Commerce	1,037	2	4,881	13
Residential	16,237	27	13,664	37
Total Domestic Consumption	60,119	101	36,930	100

Source: MNRE Energy Department Energy Balance 2010

In 1999, the industrial sector had the largest demand for energy namely 55% of the total demand, followed by residential at 18%, the transport sector at 18% and the agricultural sector with 3% only.

3.5.2.2.1 PRESSURE FROM AGRICULTURE

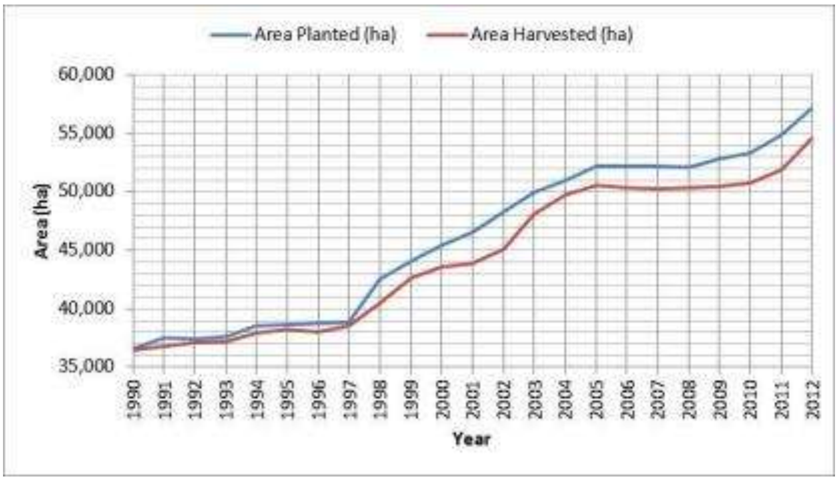
Agriculture plays a critical role in the economy of the country, both as a food provider and as a major contributor to exports. The pressure on energy derives from the need for the agriculture sector for energy to fuel its activities that includes irrigation and liquid fuels for transport. The agricultural sector is the second largest consumer of energy and is responsible for about 27% of the total energy use in 2010.

The increasing expansion of irrigated agriculture through the Komati Downstream Development Project (KDDP) and Lower Usutu Smallholder Irrigation Project (LUSIP) project as well as expansions driven by the various sugar producers is increasing the pressure on electrical and fuel energy.

Sugarcane expansion has seen a steady increase since the start of cane farming in the 1950's to a current (2012) area of 57,103 Ha (Figure 46). The increase in planted area is associated by an increase in energy use.

[36] Some of the fluctuations can be explained by changes in definitions of sectoral use, e.g. agro-industry under agriculture or industry, shifts from commerce to industry. Also the strongly fluctuating use of coal, woodchips and biofuels in certain industries may mave influenced the totals.What would be most informative is the trends in energy consumption through graphs which show total and per sector trends using a permanent standard set of parameters. Such data sets are not yet available.

Figure 46: Area planted to Sugarcane



3.5.2.2.2 PRESSURE FROM INDUSTRY

The pressure on energy is driven by the ever increasing need for industry to energise its activities, which includes use of machinery, processing, hot water generation, lighting and use of appliances. The industrial sector is the fifth largest consumer of energy and is responsible for over 10% of the total energy use in 2010. The industrial sector is dominated by export orientated agro-based production.

Supply of commercial fuels to this sector has progressively improved, but concerns still remain regarding the reliability of electricity supply. Power outages within this sector, even for a short period, can result in losses of production however this situation is improving as a result of the on-going system-strengthening programme by the Swaziland Electricity Company. The increasing cost of energy, particularly electricity is also a matter of concern to industry (Figure 49).

Figure 47: Industry Energy Consumption (1999)

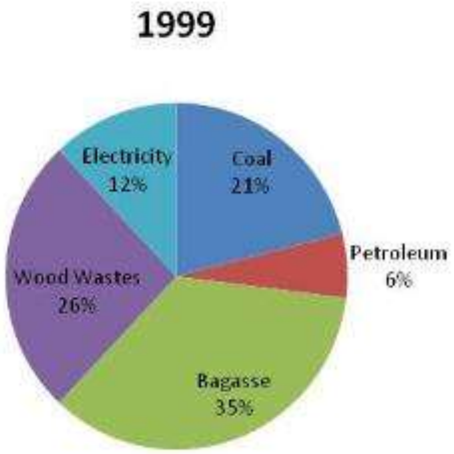


Figure 48: Industry Energy Consumption (2008)

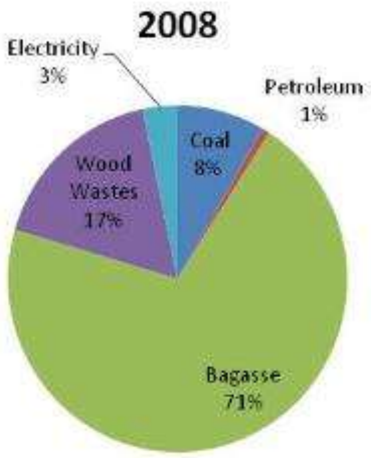
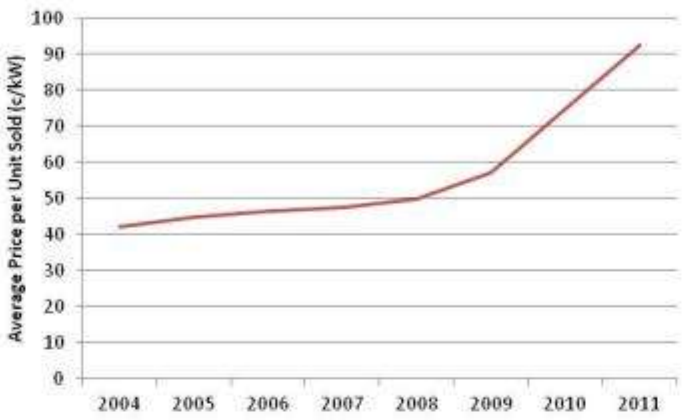


Figure 49: Average Electricity Price per Unit (c/kW)



Source: SEB, 2010

3.5.2.2.3 PRESSURE FROM COMMERCE

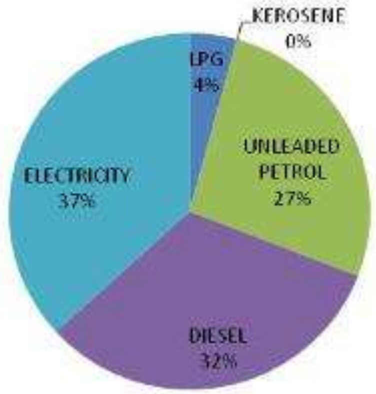
The commerce sector comprises a large range of energy users including offices (both Government and private), retail, education, health care facilities and catering. Data on the energy usage patterns in this sector is very poor. In general this sector is well supplied with energy carriers.

The commerce sector is the third largest consumer of energy and is responsible for about 13% of the total energy use in 2010 (Figure 50).

The pressure on energy from this sector derives from the activities within the commerce sector require energy to energise their operations and services including heating, ventilation and air conditioning, hot water generation, lighting and appliances.

There has been a significant growth in the garment textile sector over the past 10 years. This increase and the high level of electrification of equipment will add to the pressure on energy supply. Prior to Swaziland qualifying for AGOA in January 2001, the textile industry was not a major energy user but following the AGOA, more than 22 textile firms have become established. Energy uses in textile factories are mostly machinery, lighting, ironing and washing. The textile companies do not currently generate their own electricity.

Figure 50: Energy Consumption by Commerce 2008 (TJ)



Source: GOS-MNRE, 2008

3.5.2.2.4 PRESSURE FROM TRANSPORT

The transport sector is crucial to Swaziland to support its economy. Goods and services require transport infrastructure to operate competitively in the region. The pressure on energy derives from commerce and industry to transport raw materials and finished goods to markets as well as public and private transport energy needs.

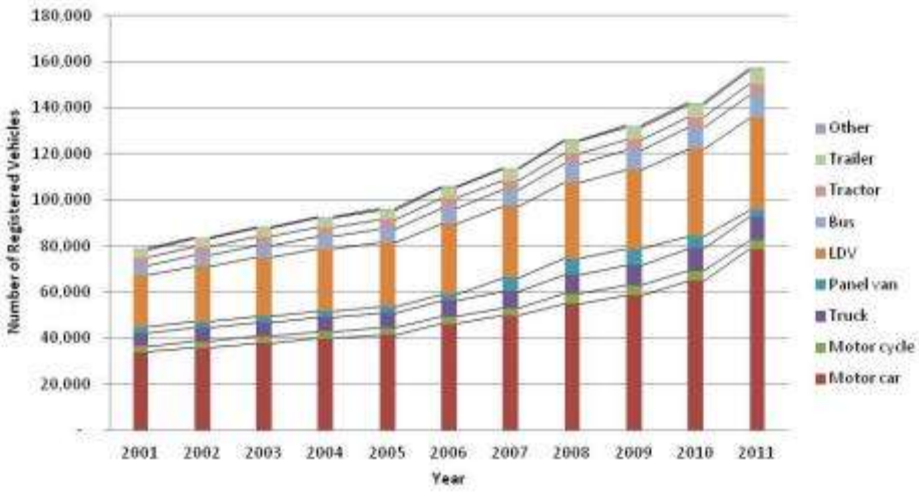
In general, transportation in Swaziland consists of several travel modes, but the dominant modes are road travel (passenger transport) and freight (goods transport). Modes of road transport for passengers in the country include the conventional bus, midi-bus, mini-bus, sedan taxi and private car. However, in regional and international terms, car ownership levels are still very low and the majority of the population use public transport.

The transport system in Swaziland is based principally on road transport: nearly all passengers are conveyed by road on public transport, as are a major portion of the goods transported. The bulk of road freight operations continue to be carried out by multinational companies based in Swaziland, with only a few Swazi companies. There are 11 border posts used by freight operators, of which 9 are with South Africa and 2 with Mozambique. Over 90% of goods transported by road in cross-border movements go to South Africa.

The transport sector is the fourth largest consumer of energy and is responsible for about 12% of the total energy use in 2010. The transport sector is the dominant consumer of petroleum fuels. Out of the 4,463.30 TJ of imported petroleum products in 2010, about 4,443.54 TJ was used by the transport sector (GOS-MNRE, Energy Balance 2010).

The Ministry of Public Works and Transport (MPWT) is responsible for the overall running of the transport sector, including formulating policies, monitoring their implementation, and administering the institutional and legal framework. The Central Motor Registry had registered over 157,000 vehicles by 2011 (Figure 51).

Figure 51: Vehicle Registrations (2001-2011)



Source: Central Motor Registry

Pressure on energy is also increasing as more and more vehicles register to be used on public roads. Over the past ten years or so, there has been a steady increase in the number of registered vehicles which has increased the national consumption of fuel (Figure 52) with a notable decline in 2011 due to the effects of the economic recession that might be curtailing vehicle use, more fuel efficient vehicles that require less fuel or fewer trips requiring less fuel.

Figure 52: Number of Vehicles and Fuel Sold

Source: GOS-MNRE, 2008 & Central Motor Registry

Table 71 presents fuel consumption data for the period 2000 to 2010.

Table 71: Fuel Consumption (2000-2010)

YEAR	97/LRP (ℓ)	ULP (ℓ)	Diesel (ℓ)	Paraffin (ℓ)	Total Volumes (ℓ)
2000	102,719,772	9,404,185	122,138,008	14,735,016	248,998,981
2001	88,000,038	10,497,304	107,729,834	11,322,388	217,551,565
2002	110,637,422	14,929,593	87,861,186	10,294,806	223,725,009
2003	88,050,182	20,265,161	109,894,342	10,106,689	228,318,377
2004	85,989,291	25,976,776	109,339,660	9,778,171	231,085,902
2005	80,381,284	35,619,455	116,344,346	8,970,900	241,317,990
2006	48,546,170	64,467,023	118,077,133	8,422,601	239,514,933
2007	11,939,154	103,181,186	121,516,065	8,183,392	244,821,804
2008	13,472,000	102,343,000	108,698,000	6,478,000	230,993,008

YEAR	97/LRP (ℓ)	ULP (ℓ)	Diesel (ℓ)	Paraffin (ℓ)	Total Volumes (ℓ)
2009	15,137,053	113,319,559	118,066,433	6,476,098	252,999,143
2010	17,049,629	116,235,121	123,455,539	5,960,011	262,702,310

3.5.2.2.5 PRESSURE FROM RESIDENTIAL

Access to clean modern energy is vital for every household, for improved standards of living, improved health and safety, and providing opportunities for economic and social development. Out of all other forms of energy, wood fuel is still the most used form of energy in many households. Most rural households use wood as their primary source of energy i.e. cooking and heating, even if those households have access to electricity. In urban areas, preference is for electricity.

The pressure on energy derives from the residential sector's need for energy for cooking, water heating, lighting and the running of appliances.

In 2010, the residential sector was the largest consumer of energy and is responsible for about 37% of the total energy use.

Pressure on energy is increasing in rural areas as Government rolls out its Rural Electrification programme that seeks to link key sub-sectors with electricity notably clinics, health centres, schools and public administration centres. Access to electricity in rural areas has received and continues to receive substantial financial support from both the Government of Swaziland and the Government of Taiwan through their support for the Rural Electrification Programme.

The Rural Electrification Programme and the Swaziland Electricity Company (SEC) Power System Strengthening Programme seeks to increase the number of consumers connected to the national grid. The objective of the rural electrification programme is to stimulate rural investment and encourage enterprises that depend upon electricity, e.g. hammer mills, shops, welding centres etc. There have been no surveys of the economic and livelihood benefits derived from rural electrification, but anecdotal opinion is that it has brought change to most rural areas and opened up opportunities for enterprise. The one challenge is the increasing price of electricity which can adversely affect enterprises with small profit margins.

Rural Households

In 2007 about 78% of the total population, equivalent to almost 800,000 people, live in rural areas (GOS-CSO, 2010). Data on energy use in rural areas is limited and discontinuous. It is known however, that most energy in rural areas is used for household purposes, predominantly for cooking and lighting.

Traditional fuels, firewood in particular, are still dominant in cooking and heating in rural areas and account for 66% of rural homesteads energy use, according to the 2007 census (GOS-CSO, 2010) and 53% for the overall population. Table 72 shows a decrease in the use of wood fuel in rural areas from 81% to 66% in 10 years.

Table 72: Energy Source for Cooking in Rural Households 1997 and 2007

Energy Source for Cooking	Usage in Rural Households (1997 Census Data)	Usage in Rural Households (2007 Census Data)
Wood Fuel	81%	66%
Electricity	5%	14%
Paraffin	4%	6%
LPG	4%	12%

Source: GOS-CSO, 2010

The major source of energy for lighting for rural households was candle at 58%, followed by electricity at 26%; for urban households candles were 24% and electricity 65% (GOS-CSO, 2010).

The main source of energy for cooking for all households was wood at 53%, followed by electricity at 21% and gas at 15%. For rural households, wood was 66%, followed by electricity at 14% and gas at 12%. For urban households, the major source for cooking was electricity at 46%, followed by gas at 23% and paraffin at 17%.

A sustainable supply of fuelwood will have to be maintained to meet the needs of poor households. Fuelwood use is declining in urban areas. Fuelwood cost, availability and convenience including pollution are the major reasons for phasing out fuelwood use in urban households.

Rural areas have generally lower electrification rates than urban areas because distances to villages are longer and houses are more dispersed raising connection costs. Fuelwood can be collected "free of charge" in most rural areas and this is a further incentive not to switch to electricity which has to be paid for.

Urban Households

About 22% of the total population and the equivalent of approximately 226,000 people live in urban areas (GOS-CSO, 2010). In major urban areas and company towns, an estimated 65% of households use electricity. Paraffin and LPG are still used as cooking fuels for lower income households. Wood fuel is a minor and declining fuel in urban centres, and is used for both cooking and for space heating. Distribution of energy to households, primarily coal and LPG in company town still persists. There are however, indications that LPG and electricity are gradually displacing coal in company towns.

Electricity is the most preferred energy carrier for end-users in urban areas. Frequent power cuts especially under severe weather conditions are the major concern of households. The tariff system, which allows cross-subsidies between consumer categories, results in relatively low electricity prices for households. However, this is still unaffordable to many households.

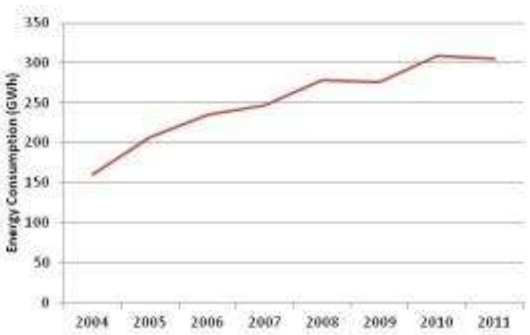
Consumption has been growing steadily as reflected in Figure 53. Such growth exerts a pressure on the supply infrastructure. A slight decline in consumption in 2011 reflects the effects of the economic recession affecting Swaziland or the introduction of pre-paid electricity meters which has made users more aware of their consumption with many being more careful in its use. Electricity consumption by the domestic sector is presented in Table 73 and Figure 53.

Table 73: Electricity Consumption Domestic Sector

Year	Domestic (GWh)
2004	160.6
2005	207.4
2006	234.7
2007	246.4
2008	278.5
2009	275.7
2010	308
2011	304.6

Source: SEC, 2011

Figure 53: Electricity Consumption Domestic Sector



Source: SEC, 2011

3.5.2.2.6 ENVIRONMENTAL INDICATORS: PRESSURES ON ENERGY

Environmental indicators to measure the pressure on energy use and production can include:

Indicator	Measurement	Source	Availability/Reliability
Energy proportion for agriculture	TJ, % change	MNRE Energy Balance	available / reliable
Energy proportion for industry	TJ, % change	MNRE Energy Balance	available / reliable
Energy proportion for commerce	TJ, % change	MNRE Energy Balance	available / reliable
Energy proportion for transport	TJ, % change	MNRE Energy Balance	available / reliable

Energy proportion for residential	TJ, % change	MNRE Energy Balance	available / reliable
New SEC consumers	number	SEC	available / reliable
Area of new irrigation	ha	MOA, DWA	available / unreliable
Number of new rural enterprises	number	MEPD, MOF	available / unreliable

3.5.2.3 STATE

In the DPSIR framework the section under state normally describes the state of a particular compartment of the environment, such as water or biodiversity. Energy may not be considered part of the environment, at least not in all forms. However, most sources of energy relate originally to natural resources, such as fossil fuels, biomass or wind. For matters of convenience this section of State is used for describing the state of energy as it is currently occurs in Swaziland. Information on users and side-effects are described under pressure and impact respectively.

The major sources of energy in use in Swaziland are: electricity, petroleum products, coal, biomass waste and other renewable sources of energy. The only renewable energy sources locally used for power generation are biomass (bagasse and wood chips) and hydro. Potential exists for solar and wind.

3.5.2.3.1 ENERGY BALANCE

From the National Energy Balance (GOS-MNRE, 2012) the proportion of energy sources to national energy supply for the years 2008-2009-2010 is presented in Table 74 and Table 75. Full details of the energy balances of 2008 and 2010 are given in Annex 9.

Table 74: National Energy Supply 2008-2010 (TJ)

	2008	2009	2010
Coal	9,247.07	10,490.49	15,305.29
LPG	96.04	0.00	242.93
Aviation Fuel	255.34	237.13	389.84
Petrol	3,442.74	3,241.93	3,288.34
Diesel	3,994.02	3,655.69	4,281.30
Natural Gas	0.00	0.00	3,483.15
Hydro	230.40	1,036.80	1,037.16
Solar	0.00	0.00	0.25
Bagasse	24,828.50	17,820.00	4,329.56
Wastes	25,240.24	4.03	12,824.49
Boilers	20,700.00	71.48	128.01
Electricity	4,515.54	3,273.84	5,496.14

Source: GOS-MNRE Energy Dept. National Energy Balance

Table 75: National Energy Supply and Use 2008 – 2010 (TJ)

	2008	2009	2010
TOTAL DOMESTIC SUPPLY	93,805.37	32,208.66	37,225.70
Indigenous Production	61,738.17	27,520.92	31,312.12
Other Sources	21,244.00	0.00	64.00
Total Imports	16,006.23	13,226.94	18,369.21
Total Exports	-5,183.03	-8,539.20	-12,519.63
TOTAL CONSUMPTION	**86,435.87**	**9,455.41**	**36,929.87**

Source: GOS-MNRE, Energy Dept. National Energy Balance

The above tables show considerable fluctuation in energy supply and consumption over the three years presented. It is not apparent what the reasons are behind these fluctuations but clearly there are issues with the methodology and definitions used that result in the unsatisfactory overviews of the energy balance of the country.

The types of energy used reflect the socio-economic conditions and rural-urban dichotomy of Swaziland. For instance, most of the coal and electricity are used by industrial consumers, companies, town and urban dwellers; whereas most rural households satisfy their basic energy requirements from fuel wood which is collected from within the area surrounding the homestead.

Bagasse is a waste product of the sugar industry in Swaziland. It is used by the industries for electricity and steam generation. The electricity is used in the sugar plants and also distributed to surrounding company towns, but no electricity is sold to the national grid presently, due to a lack of incentives. Low efficiency conversion techniques are used.

3.5.2.3.2 SOURCES OF ENERGY SUPPLY

The supply of conventional energy in the country can be broken down into the following sources:

- Electricity: mostly imported from the Republic of South Africa and Mozambique but with local supplies from Illovo co-generation plant and local hydro power stations.
- Petroleum products (diesel, petrol, paraffin, heavy fuel oil, LPG)
- Coal (bituminous, imported from RSA): coal is used in sugar belt and industry as an energy source to fire boilers.
- Biomass (wood, bagasse, and molasses for bio-ethanol): bagasse is produced as waste by the sugar industry and used for cogeneration. The use of bagasse helps to combat the emission of greenhouse gases (GHG). Wood-fuel includes waste from wood-processing industries.

The proportions of the main types of energy supply in 2005, 2008 and 2010 are presented in Table 76. The percentages show considerable fluctuations.

Table 76: Percentage Primary Energy Supply by Source (2005-2010)

Main Source	2005	2008	2010
Electricity	7	8	11
Petroleum Products	21	15	19
Coal	38	6	20
Biomass	34	71	50
	100	100	100

Source: GOS-MNRE, 2012

3.5.2.3.3 ELECTRICITY

Swaziland imports 80% of its electricity from Eskom, a South African electricity utility company, and 10% from Electricidade de Mozambique (EdM) of Mozambique.

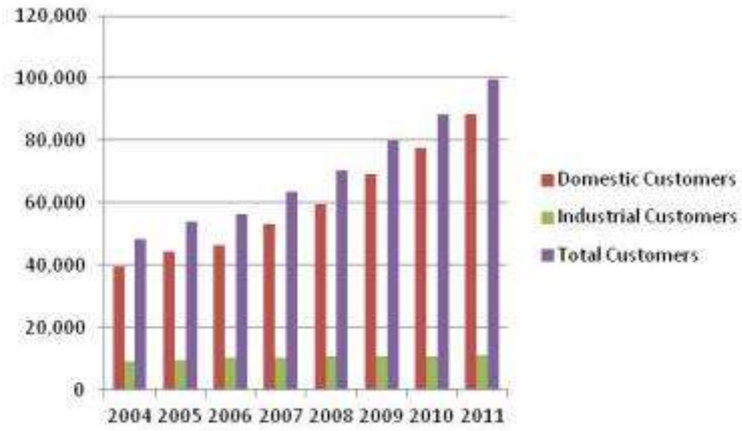
Swaziland's electricity is mainly supplied by the Swaziland Electricity Company (SEC), established in 2007.[37] The SEC owns a majority of the country's power stations consisting of four hydro stations (61 MW) and 9 MW diesel generators. According to SEC Annual Report for 2010, Swaziland has an electrification rate of 46% (65% urban, 25% rural).

As a result of potential capacity constraints in South Africa, ESKOM have put a cap on increasing the existing power sales to Swaziland in the future. This has put pressure on the Government of Swaziland to investigate alternative sources of electricity supply. There is presently a feasibility study underway to review the possibility for coal fired power generation.

SEC has seen steady annual increases in electricity connections as illustrated in Figure 54 (includes rural and urban areas).

[37] The Swaziland Electricity Company (SEC) established in terms of section 3 of the Swaziland Electricity Company Act, 2007 (Act No. 1 of 2007) (SEC Act). SEC is the successor to the Swaziland Electricity Board (SEB) which was established in terms of the Electricity Act, 1963 (Act No. 10 of 1963). The Electricity Act, 2007 (Act No. 3 of 2007) repealed the Electricity Act, 1963. In terms of the SEC Act, SEC is supposed to operate under a licence issued by the Swaziland Energy Regulatory Authority (SERA) established in terms of the Energy Regulatory Act, 2007 (Act No. 2 of 2007).

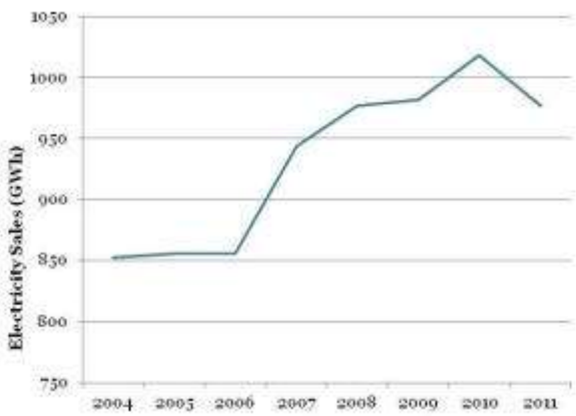
Figure 54: SEC Domestic and Industrial Customer Connections



Source: SEC, 2011

Figure 55 presents the sale of electricity generated by SEC.

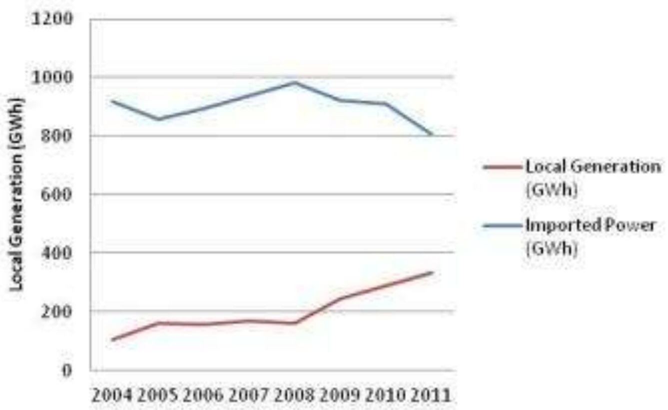
Figure 55: Electricity Sales (GWh) 2004-2011



In 2010, Illovo Sugar began generating electricity for sale into the national grid using bagasse as its main fuel source. The other sugar mills (Simunye and Mhlume owned by the Royal Swaziland Sugar Corporation) also generate electricity but this is used internally within the mill and to support its residential areas and irrigation infrastructure. The sugar industry uses bagasse, wood chips and coal as fuel. The use of coal in the sugar industry is decreasing as wood chips and bagasse become available year round.

From Figure 56 below, the gradual increase in locally generated electricity compared with imported electricity shows how locally generated electricity is displacing imported power.

Figure 56: Local Electricity Generation (2004-2011)



Source: SEC, 2010

A substantial amount (almost 25%) of energy used in the country is supplied by self-generators. The sugar industry remains a net buyer of power from SEC though their reliance on SEC for electricity is declining as they increase their cogeneration capacity.

Some of the key characteristics of electricity demand and supply are:

- Electricity demand 204MW 2010.
- The total Swaziland installed generation capacity owned by public (SEC) and self-producers (sugar and paper industries) is 150 MW consisting of 90 MW thermal power generation (bagasse, waste products, coal, and diesel) and 60 MW hydro generators.
- The Maguga Hydro station with a capacity of 20 MW was commissioned in 2001 and officially opened in 2011. The other local hydro power plants include Ezulwini, which contributes 20 MW to the national grid, Dwaleni at 21 MW and Mbabane at 50 kW. The Ezulwini hydro plant is currently not in operation.
- Power is transmitted through 132 kV and 400 kV transmission lines. The 400kV transmission lines are owned by the Motraco Transmission Company. SEC has one third interest in the Motraco Transmission Company, registered in Mozambique. Motraco's principal role is the supply of energy to Mozal Aluminium Smelters in Mozambique and the wheeling of electric energy to the Electricidade de Mozambique, Swaziland Electricity Company and Eskom, South Africa.
- Power is distributed through a 66kV and 11 kV lines.
- Transmission system losses amounts to 4% and distribution losses was 10.6% in the 2010 financial year.

The 2007 Electricity Act allows for independent power generators to sell electricity to the national grid. Several companies are investigating the opportunities this brings about for private generation.

3.5.2.3.4 FOSSIL FUELS

Petroleum

Swaziland has no oil reserves so it imports petroleum products from the Republic of South African through international companies. The oil companies distribute the products to filling stations and to commercial users. Petroleum products account for 8% of the total energy supply in the country.

The Government considers the supply of petroleum products to be of strategic importance. Therefore prices of petrol, diesel and illuminating paraffin are subject to regulation. MNRE is responsible for managing the pricing of petroleum products to ensure that fuel prices remain affordable for both industrial and domestic use. Government is investigating other alternative routes to import petroleum products to ensure security of supply. The drafting of the Petroleum Act, which is presently underway, aims to consolidate relevant petroleum legislation into one piece of legislation. MNRE is in the process of ensuring adequate commercial storage is in place to ensure availability of supply.

The basic cost of fuel at the pump is determined periodically by the MNRE. The Basic Fuel Price (BFP) of the product to the port of Durban, deemed to be purchased from Arab Gulf, Mediterranean and Singapore, influences the cost of landed fuel at Matsapha (import parity). Additionally, Government imposes the following taxes and levies: Fuel Tax, Customs and Excise Duty, Fuel Oil Levy and MVA (third party insurance). The profit margins for the industry and retailers, other costs related to handling, transportation and storage of the products are added, finally giving the retail price at the pump. The main influences on the calculated prices are the international oil prices and the exchange rate between US $ and the Lilangeni. The same pricing model BFP is used in all SACU member countries.

The MNRE monitors international pricing conditions as well as each product's slate position on a monthly basis. Proposals for changes in the prices of regulated products are discussed and recommended by the Fuel Pricing Committee. The Committee comprises representatives from Government Ministries, the petroleum sector and consumer interests. The Fuel Price Controller, in consultation with the Minister for Natural

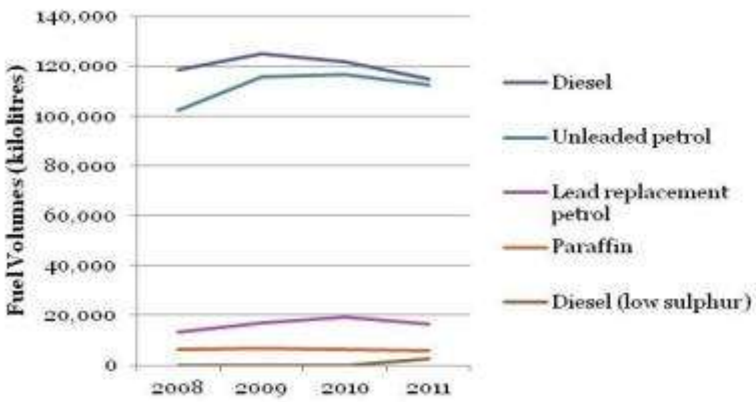
Resources and Energy, approves prices based on the Committee's recommendations. One of the roles of the Ministry is to protect the interests of consumers and to ensure access to affordable petroleum products.

The number of retail stations is controlled through the Petrol Rationalisation Committee. The committee has the objective of controlling the number of retail outlets so as to maintain economic viability in the industry while also encouraging high service standards for the consumer and public.

There are five private companies which supply the country with petroleum products (Galp Petroleum, Exel Swaziland, Engen Swaziland, Chevron Swaziland and Total Swaziland.) These companies hold stocks of less than eight days. This situation is critical to the economy should there be a disruption in supply. Government therefore adopted a pre-feasibility study (2006) to undertake the establishment of a 60 days storage depot for petrol and diesel. The depot has yet to be built.

Sales of fuels are presented in Figure 57.

Figure 57: Liquid Fuel Sales (kℓ) 2008-2011



The price of illuminating paraffin is monitored because it is a fuel for low-income groups. The market sets prices of the other petroleum products such as lubricating oil, jet fuel, heavy fuel oil and LPG. The price of LPG is at present not regulated even though mainly low-income households use it.

Coal

The Swaziland coal reserves consist of semi-anthracite and anthracite coal, which have a high energy content and low content of volatiles and sulphur. While anthracitic coal can be used for power generation, it is presently more valuable if sold for industrial purposes. Domestic anthracitic coal is therefore exported for use in the metallurgical and cement industries, while cheaper bituminous coal is imported from South Africa for use as a fuel.

The mining of coal is currently one of the major activities in the mining sector in Swaziland. After recording negative growth in the past years, coal recorded positive growth in the year 2010. Coal production from Maloma Coal Mine increased by 12.5 percent from 129,647 metric tonnes in 2009 to 145,903 metric tonnes in 2010 (CBS, 2011). South Africa continues to be the largest buyer of coal mined in Swaziland, with small amounts sold to Mozambique. Maloma exports all of its anthracite production, which fluctuates considerably due to market conditions. EmaSwati Coal Mine, based at Mpaka, was closed mainly due to the low international prices for lower grade coal. Other potential mining areas are at Mhlume, Hlane, Lubhuku, St Philips and Mpaka.

3.5.2.3.5 RENEWABLE ENERGY

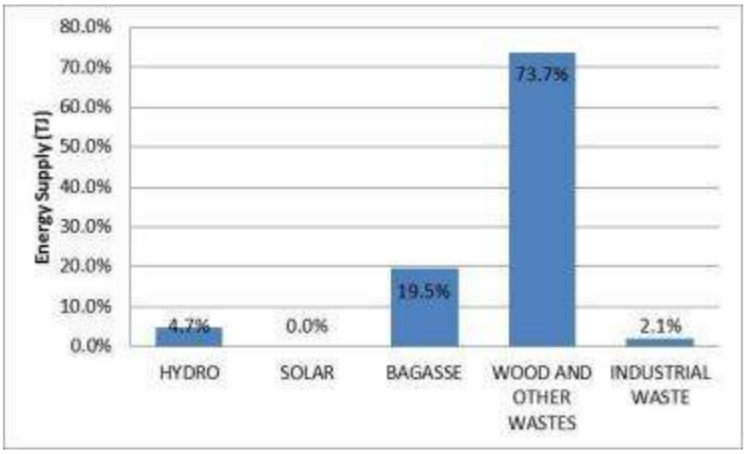
Renewable energy offers an almost unlimited supply of energy if one considers the energy needs of mankind compared to all other forms of energy (GOS-MNRE, 2009). There is a significant scope for increased renewable energy use in Swaziland. Everyone in the energy sector is aware that renewable energy will play an important role in the world's energy supply in the near future to address environmental concerns and energy security.

Renewable energy is therefore a key to the sustainable use of energy. Swaziland has several renewable energy resources including biomass (wood fuel and bagasse), solar, and hydro energy. Renewable energy and waste accounts for around 60% of the total energy supply in the country (national mix) and this energy is mostly produced and used in the industrial sector. The production by type is shown in Table 77 and the breakdown in percentages in Figure 58. The production in 2010 is dominated by wood and other wastes, accounting for almost three quarters of renewable energy production.

Table 77: Renewable Energy Production by Type (2010)

Type of Renewable Energy	Energy (TJ)
HYDRO	1,037.16
SOLAR	0.25
BAGASSE	4,329.56
WOOD AND OTHER WASTES	16,346.91
INDUSTRIAL WASTE	458.01
Total Renewables	**22,171.89**

Figure 58: Renewable Energy Supply: Percentage by Type (2010)



A Renewable Energy Action Plan was developed by MNRE in 1997, indicating a long-term programme for the development of renewable energy. A number of activities in the plan have already been undertaken but there are still activities requiring attention, particularly in the area of biomass energy and quality assurance of renewable energy technologies.

From 1992 to 1995, the MNRE established a solar pilot project mainly to electrify clinics and schools. Several street lighting, solar water heating and vaccine refrigeration systems were also installed through the project. The project also installed four solar water-pumping schemes in different regions of the country. The project results indicated that there is sufficient solar irradiation in many areas throughout the country.

Other initiatives include the World Bank sponsored Solar Market Development Project in 1998 and the UNESCO funded Mphaphati Solar Village Project in 1999, the installation of solar water heaters at Matsapha National High and Matsapha Prison and the distribution of solar LED lanterns to 5,000 students in 50 schools.

Types of renewable energy produced and supplied are discussed in the following text.

Bagasse

The sugar mills located in the Lowveld have recognised the energy potential of bagasse and wood chips to produce electricity for internal use with excess sold to the national grid.

Ubombo Sugar, a unit of Associated British Foods, launched a cogeneration plant in 2011 that sells up to 10GWh of electricity to the national grid. The plant uses not only bagasse but also tops and trash from the cane (green harvesting). The co-generation power plant will enable the factory and estates to become self-sufficient in electricity consumption. The company has installed a 25MW turbo alternator. In addition, agreement has been reached with the Swaziland Electricity Company to supply power into the national grid for 48 weeks of the year. Ubombo is seeking to earn carbon credits through registration of the co-generation project under the Clean Development Mechanism. The entire project cost R1.510 billion. The co-generation plant will allow Ubombo Sugar to generate 210 GWh of power with a surplus capacity potential of about 14 MW. The company signed a Power Purchase Agreement with SEC to export about 55 GWh into the national grid for 15 year duration.

Royal Swaziland Sugar Corporation is also looking into launching their own expansion of their cogeneration unit and will be using woodchips.

In 2007 Ubombo Sugar generated 79.6 GWh, Simunye 69.6 GWh, and Mhlume 129.3 GWh from combination of biomass and coal.

According to a report prepared by the Restructuring and Diversification Management Unit (GOS-RDMU, 2009) supplemented by information from the SSA, all bagasse produced from the milling of sugarcane is used for steam production in the sugar industry. In 2010/11 some 200,135 tonnes of bagasse were produced by the three mills (Table 78).

Table 78: Bagasse Production (t) 2006-2011

Producer	2006/7	2007/8	2008/9	2009/10	2010/11
Simunye	62,807	66,404	57,190	60,738	65,710
Mhlume	47,274	49,900	51,794	55,754	53,982
Ubombo	78,235	78,235	71,669	76,514	80,443
Total	**188,316**	**194,539**	**180,653**	**193,006**	**200,135**

Source: SSA

Bagasse is the fibre of the sugar cane which remains after the milling process. Bagasse covers approximately 85% of the energy demand of all three sugar mills and is currently combusted together with coal and small amounts of trash in the boilers. An example of the fuel mix at the RSSC Simunye mill is presented in Table 79.

Table 79: Fuel Sources Used at RSSC

Year	Coal (tons)			Woodchips (tons)			Bagasse (tons)		
	Simunye	Mhlume	Total	Simunye	Mhlume	Total	Simunye	Mhlume	Total
2005	7,226	21,454	28,680	0	0	0	505,484	383,908	889,392
2006	9,882	32,521	42,403	0	0	0	504,059	358,830	862,889
2007	15,651	31,003	46,654	0	0	0	551,678	377,630	929,308
2008	32,536	44,927	77,463	0	0	0	480,455	409,201	889,656
2009	21,345	26,372	47,717	33,659	22,124	55,783	475,455	398,491	873,946
2010	11,544	7,021	18,565	51,773	71,766	123,539	486,675	392,407	879,082
2011	11,303	10,020	21,323	27,556	52,249	79,805	542,353	473,866	1,016,219

Molasses

Molasses, another by-product in the sugar industry, is used for ethanol production. In 2011/12, the Swazi sugar industry produced 235,041 tonnes of molasses. Only less than 1% of produced molasses is sold as animal fodder. RSSC uses the molasses from Mhlume and Simunye for ethanol production in its own distillery at Simunye. Ubombo sells the molasses to USA distillers for ethanol production. Almost all ethanol produced in Swaziland is sold as portable alcohol to the EU, Western Africa and the SACU market. Table 80 shows the sales of molasses. The amount of available molasses would only increase in case of an expansion of the sugar production and more sugar cane input, respectively.

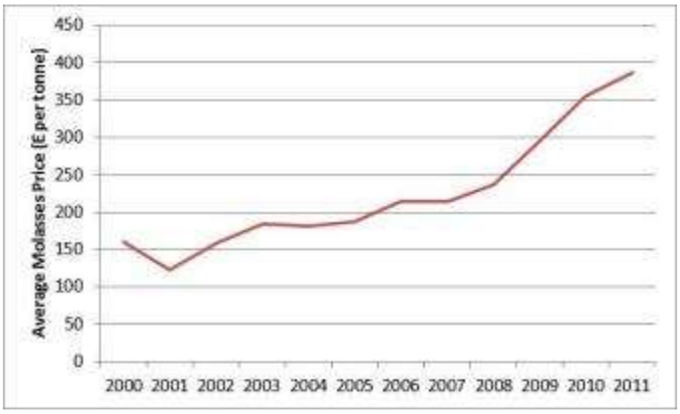
Table 80: Sales of Molasses (tonnes)

Year	Mhlume Mill	Simunye Mill	Ubombo Mill	Total
2006/07	47,602	62,482	78,235	188,319
2007/08	49,900	66,404	78,028	194,332
2008/09	51,794	57,190	71,669	180,653
2009/10	55,756	60,738	76,514	193,008
2010/11	53,982	65,710	80,443	200,134
2011/12	60,814	69,876	104,351	235,041
2012/13*	60,943	66,177	100,501	227,621

Source: SSA

Molasses is not solely available for energy use as it is currently used as a source for ethanol production which is financially more attractive. The SSA reports (SSA, 2010) that molasses sales amounted to 200,134 tons up from 192,941 tons in the previous year, while the sales revenue amounted to E71 million from E57 million in the previous year; an increase of 24,5%. The steep increase in revenue was as a result of SSA's strategy to move from a subsidised pricing of the molasses to a market-related one, in line with the drive to maximize revenues for growers and millers. The cost of molasses has steadily been increasing (Figure 59).

Figure 59: Price of Molasses in Swaziland (2000 - 2011)



Source: SSA

Ethanol

The national Biofuel Strategy and Action Plan (GOS-MNRE, 2009) seeks to promote fuel grade ethanol for blending in petrol. The MNRE Energy Department are in the process of establishing an institutional and legal framework to allow for petrol blending using locally sourced ethanol. Currently only the RSSC distillery is capable of producing fuel grade ethanol.

According to a report by the RDMU (GOS-RDMU, 2009), the current overall potential for producing ethanol from total sugarcane in Swaziland is about 400 million litres per annum, based on the actual sugar cane production. It would easily be possible to meet the E10 (10% ethanol blend with petrol) ethanol requirement using the existing molasses feedstock. Its current production (RSSC and USA Distillers) is approximately 60 million litres hydrous ethanol (96.5% purity), which needs to be converted to anhydrous ethanol (99% purity of ethanol). A 10% ethanol blending of petrol for transportation (E10) in Swaziland would require approximately 12 million litres of ethanol. RSSC produced, blended and dispensed with great success 10,000 litres of E10 fuel to ten RSSC vehicles in 2007.

RSSC installed ethanol production capacity is 32m litres/year. RSSC ethanol production from 2004 to 2012 is presented in Table 81. The fuel grade determined in 2008 was 2,444.

Table 81: Ethanol Production

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012
Production (1000 L)	13,101	13,660	13,062	9,100	24,152	25,853	25,100	28,500	29,857

Source: RSSC

Swaziland's sugar industry has a potential to diversify its commodities by producing ethanol as fuel. A decision to develop and implement a project for producing ethanol as fuel has to take into consideration the future price developments of fossil fuel, sugar and ethanol for the beverage market.

Swaziland's biofuel strategy (GOS-MNRE, 2009) is to initially develop its existing bioethanol sector which is derived from molasses whilst at the same time create an enabling legislative and institutional framework that allows for blending, oversight and management and empowerment of rural farmers with tried and to be tested technologies and crops.

Environmental benefits of using E10 nationally include contributions towards reducing ground-level ozone forming emissions, reduction in harmful greenhouse gases (E10 can reduce greenhouse gases by up to 3.9%.), 30% reduction in carbon monoxide emissions and a decrease in exhaust Volatile Organic Compounds of around 7%.

According to current technology and prices it can be stated that at a sugar price of above E2.59 per kg sugar it would be more profitable to sell sugar than ethanol.

Vinasse Biogas Potential

Vinasse remains when the ethanol has been extracted from the molasses. Each litre of produced ethanol leaves approximately 10 litres of vinasse with a brix of 13%. Vinasse holds a COD content of 30,000 mg/l (30 kg per m^3). In Swaziland approximately 600 million litres of vinasse were produced in the ethanol production last year. Total vinasse in Swaziland contains a biogas potential of 500,000 m^3 and 950 GJ of energy potential.

Biogas could be produced by an anaerobic bio digester. Produced biogas contains approximately 60-70% of methane which could be used for energy purposes. However, the Swazi sugar industry is more interested in evaporating the vinasse up to 40% brix to produce the so-called Condensed Molasses Solids (CMS) and to use this as an alternative fertilizer as it also contains inorganic chemicals. Nevertheless, as prices for fertilizers such as urea and ammonia increased, CMS prices also went up dramatically. In 2005, Ubombo already carried out a CMS study and identified a cost saving potential of approximately E320/Ha by using CMS instead of granular fertilizer.

Wood Fuel

In 2007 biomass, especially wood fuel, constituted about 53% of the residential energy consumed (CSO, 2010; down from 81% in 1997). Consumption is higher in rural areas (about 66%) and much lower in urban areas. Wood fuel supply, mainly through indigenous forests and woodlands, is declining due to the unsustainable management of the resource.

To improve the effectiveness of available wood fuel, Government has been involved in a number of initiatives to promote efficient wood stoves primarily through the private sector and collaboration with the Ministry of Agriculture, eg ProBEC project.

A pilot programme was initiated to look at the small-scale manufacture of fuel briquettes made from wood waste and sawdust. Its current status could not be determined.

Hydro

Hydro power plants with a total capacity of 60.6 MW are being operated by SEC in various sites in the country (Table 82). However, the potential for mini or micro hydro plants has not been fully exploited. A resource assessment of the potential for application of these small plants has been completed and indicates priority areas where a more detailed feasibility should be focused.

Table 82: SEC Hydro Capacity

Station	Installed Capacity (MW)
Ezulwini Hydro Power Station	20.0
Edwaleni Hydro Power Station	15.0
Maguga Power Station	19.5
Maguduza Hydro Power Station	5.6
Mbabane Hydro Power Station	0.5
Total	60.6

Source: SEC, 2010

The SEC is assessing the hydro potential of other sites around the country including the Lower Maguduza and Ngwempisi Schemes. The Lower Maguduza Feasibility Study is already completed. It is said to be viable scheme provided that in the financial and economic evaluations it is considered purely a peaking station. The Ngwempisi scheme is at tender stage for the feasibility study. The Lower Maguduza is a low head scheme of 2 sets at 10 MW each. This implies high volumetric flows at 18m^3/s per set. The actual power station is some 4km away, hence the huge conveyance costs.

Installed hydro capacity represents some 5% of locally generated electricity.

Wind

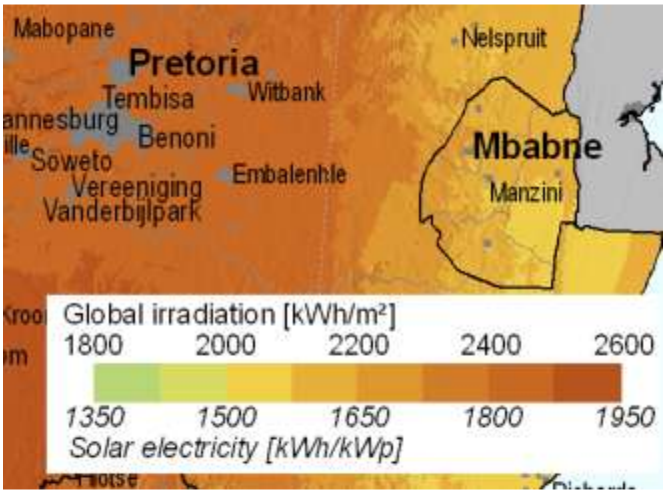
Wind resource measurement at 10, 20 and 30 metre levels are in progress and will assist in mapping the wind regime and providing estimates of the wind power potential in the country. Generally in Swaziland, wind speeds are relatively low and grid-connected wind power generation is unlikely to be a major option. However, there could be a potential for micro wind turbines (e.g. for battery charging) and for off-grid applications. On the other hand, wind pumps have been in use in Swaziland for a number of years by farmers for water pumping and irrigation. This application seems to hold the greatest potential for wind energy in Swaziland, especially since mean speeds slightly below 4m/s could be sufficient for their viable deployment.

Solar

Swaziland's wind and solar regime is not well documented as limited data is available. However, a long-term resource measurement programme has been established. Five sets of measuring equipment were installed at National Meteorological Services (MET) and Rural Development Area (RDA) sites around the country in early 2001 (Nhlangano, Siteki, Piggs Peak, Luve and Sithobela), to ascertain the wind and solar resource status (GOS-MNRE, 2003). Preliminary indications are that annual solar averages are very favourable and lie between 2000 to 2200 kWh/m^2 per day. The most popular use of solar energy has been in solar photovoltaic (PV) systems. The estimated installed capacity of solar PV is 56 kW peak mainly in private residential systems, telecommunication systems and signalling systems on the railways.

The EU's Institute for Energy and Transport[38] (IET) (one of the 7 scientific Institutes of the Joint Research Centre (JRC) of the European Commission.) published a study in 2012 mapping the potential of renewable energy sources in Africa (Huld et al, 2005). The report analysed the continent's current energy consumption and assesses potential of renewable energy sources - solar, wind, biomass and hydropower - and their cost efficiency and environmental sustainability. The map of Africa's solar electricity potential, for example, based on the JRC's Photovoltaic Geographical Information System (PVGIS), shows that Swaziland has the potential to produce over 2,000 kWh/m^2.

Figure 60: Solar Potential over Swaziland



Adapted from Huld T., Šúri M., Dunlop E., Albuisson M, Wald L., 2005.

In 2001 the Bulembu Ministries Swaziland secured funding to establish a Photovoltaic Grid-tied System generating 22.5kW, 7.5kW per phase to supply the energy generated from the sun via the PV modules for use in the community. The project uses 216 Bosch Solar Energy Dunnschicht 110W solar panels and 9 inverters. By attaching the Grid-tied PV System to the local grid, the entire town of Bulembu is now off-line. The total grid size area is some 628 m^2.

3.5.2.3.6 ENVIRONMENTAL INDICATORS: STATE OF ENERGY

Environmental indicators to measure the state of energy production and supply can include:

Indicator	Measurement	Source	Availability/Reliability
Quantity of hydro generated electricty	TJ	MNRE – Dept. Energy	Available and reliable
Quantity of solar generated electricty	TJ	MNRE – Dept. Energy	Available and reliable
Quantity of biomass generated electricty	TJ	MNRE – Dept. Energy	Available and reliable
Quantity of wind generated electricty	TJ	MNRE – Dept. Energy	Available and reliable
Electricity sales	GWh	SEC	Available and reliable
Liquid fuel sales	kℓ	MNRE – Dept. Energy	Available and reliable
Biomass consumed	tonnes	Forestry/CSO	Unavailable
Bagasse consumed	tonnes	SSA	Available and reliable

[38] http://iet.jrc.ec.europa.eu/

3.5.2.4 IMPACTS

The changes in the state of the environment brought about by energy production and use may impact on the quality of ecosystems and the welfare of human beings.

3.5.2.4.1 IMPACTS ON ECOSYSTEMS

Pressure on supply of energy and the resulting state of certain sectors of the environment have an impact on ecosystems. Impacts on ecosystems take primarily place through land use change and excessive use of resources, notably extraction of fuel wood from forests and woodlands.

Land Use Change

Land use change is caused by land take for energy infrastructure and dams for hydro power development.

Land Take from Power Line Corridors

Swaziland has approximately 333 km of 132kV power lines, 869 km of 66kV line and 8,367 km of 11kV lines (SEB, 2011). The 132 and 66 kV power lines require restricted use corridors of some 16-20m which prohibits anyone from utilising the land under the line. There is no reserve under the 11 kV lines. This length of line represents some Ha of land excluded for use – be it productive uses like arable agriculture or for settlement purposes.

Table 83: Cumulative Land Take for Electricity Transmission Lines

Year	132kV (km)	Land Take (Ha)	66kV (km)	Land Take (Ha)	11kV (km)*	Total Land Take (Ha)
2004	329	526	828	1,325	4,847	1,851
2005	329	526	828	1,325	5,018	1,851
2006	329	526	828	1,325	6,183	1,851
2007	329	526	828	1,325	6,766	1,851
2008	329	526	836	1,338	7,077	1,864
2009	329	526	846	1,354	7,437	1,880
2010	333	533	869	1,390	8,011	1,923
2011	333	533	869	1,390	8,367	1,923

Source: Swaziland Electricity Company Annual Report 2010/11; * excluding rural lines

Apart from land taken by power line corridors, other impacts relate to their visual impact on the landscape. The 132 and 66 kV lines are large pylon structures that cross the country and are clearly visible.

Land Take for Electricity Substations and Depots

Electrical power requires substations to step down the high voltages for further distribution. Substations require land and thus exclude other productive land uses.

Land Take for Large Dams & Canal Infrastructure for Hydro Schemes

Swaziland has constructed two reservoirs to generate electricity whilst also providing water storage for irrigation: Luphlohlo and Maguga. The surface area of the Luphohlo dam is 120 Ha and Maguga dam is 1,042 Ha.

Government is investigating the use of other water storage dams used mainly for the supply of irrigation water to generate electricity using mini-hydroelectric power stations. The Lubovane and Mnjoli dams both have a small potential to generate electricity from released water (3 - 7 MW).

Land take from Mnjoli Dam is 1,500 Ha and the Lubovane dam is 1,390 Ha.

Run of river abstraction for the Dwaleni hydro also has impacts arising from the abstraction of water from the river and the reduction (if only temporarily) of river flow, the canals to transport the water to the hydro plant and the hydro plant itself.

The use of canals to transport water from river abstraction points to the hydro power stations takes up land that could otherwise be sued for other purposes. Mini-hydro from water being discharged into canals for irrigation is unlikely to have any notable impacts beyond the connectivity to the grid.

Extraction of Fuel Wood

The section on forests and woodlands describes as as one of the causes of forest degradation the over-exploitation of communal forests and rangelands, including unsustainable extraction of fuelwood and other forest products, which is partly caused by the high cost of other energy sources such as electricity, solar and paraffin.

Annual household fuelwood consumption in Swaziland in the early 1990s was generally estimated at between 300,000 to 600,000m^3/yr, or in the order of 90% of total household energy consumption - the fuelwood largely being derived from indigenous forests and woodlands and wattle (Lasschuit, 1993). Although later reports (including census) indicate a reduction of fuel wood extraction, the extraction is still considered substantial and unsustainable in places, leading to serious impacts on the state and condition of forests and woodlands.

The changes in the biological state of the environment impact on the functioning of ecosystems and the state of human welfare and health. Losses in biodiversity and ecosystem services will eventually result in declining livelihoods.

3.5.2.4.2 IMPACTS ON AIR QUALITY AND CLIMATE

Energy use by industry, agriculture, transport, residential and other processes or activities using energy are contributing to national greenhouse gas (GHG) emissions which in turn impact upon climate change (Table 84).

Table 84: Summary of GHG Emissions for Swaziland (2000)

SOURCE	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Land Use Change and Forestry	1,102.19	2.94					1,105.13
Energy	1,172.33	121.17	40.3				1,333.80
Agriculture		849.41	753.5				1,602.91
Waste	559.06	366.82	5,731.90				6,657.78
Industrial Processes				9,053.20		10.3	9,063.50
TOTAL	**2,833.58**	**1,340.34**	**6,525.70**	**9,053.20**	**0.00**	**10.30**	**19,763.12**

Source: Second National Communication (GOS-NMS, 2012)

Certain forms of energy use also impact on air quality, in particular combustion and burning of biomass and other substances. Pollutants arising from these processes include a variety of substances, including sulphur dioxide (SO2), nitrogen oxides (NOx), hydrofluorocarbons (HFCs), volatile organic compounds (VOC), dioxine, particulate matter, etc.

Impacts are discussed according to the sectoral use and summaries of emissions.

Impact from Energy Use in Agriculture

The impact from energy use in agriculture is driven by the need to energise farm equipment (pumps, irrigation systems), product processing and farm transport. Emissions from energy for agriculture include the emissions arising from the burning of bagasse, wood chips, coal and field burning of agricultural residues. According to the Second National Communication (GOS-NMS, 2012), agriculture was the third largest contributor of GHG with indirect NxO emissions totalling around 753 Gg and CH4 emissions around 850 Gg.

Bagasse is the matted cellulose fibre residue from sugarcane that has been processed in a sugar mill. Previously, bagasse was burned as a means of solid waste disposal. However, as the cost of fuel oil, natural gas, and electricity has increased, bagasse has come to be regarded as a fuel rather than refuse. Bagasse is a fuel of varying composition, consistency, and heating value. These characteristics depend on the climate, type of soil upon which the cane is grown, variety of cane, harvesting method, amount of cane washing, and the efficiency of the milling plant.

The most significant pollutant emitted by bagasse-fired boilers is particulate matter, caused by the turbulent movement of combustion gases with respect to the burning bagasse and resultant ash. Emissions of sulphur dioxide (SO2) and nitrogen oxides (NOx) are lower than conventional fossil fuels due to the characteristically low levels of sulphur and nitrogen associated with bagasse.

According to the National Implementation Plan for the safe management of Persistent Organic Pollutants (POPs) (GOS-SEA, 2010) the use of sugarcane bagasse as an energy source is a major contributor of

Polychlorinated Dibenzo-p-dioxins (PCDDs) and Dibenzofurans (PCDFs) emitting some 11.11 g TEQ annually representing some 81% of national emissions.

Mechanical collectors and wet scrubbers are commonly used to control particulate emissions from bagasse-fired boilers. Mechanical collectors may be installed in single cyclone, double cyclone, or multiple cyclone (i. e., multiclone) arrangements. The reported PM collection efficiency for mechanical collectors is 20 to 60 percent. Due to the abrasive nature of bagasse fly ash, mechanical collector performance may deteriorate over time due to erosion if the system is not well maintained.

The most widely used wet scrubbers for bagasse-fired boilers are impingement and venture scrubbers. Impingement scrubbers normally operate at gas-side pressure drops of 5 to 15 inches of water; typical pressure drops for venturi scrubbers are over 15 inches of water. Impingement scrubbers are in greater use due to their lower energy requirements and fewer operating and maintenance problems. Reported PM collection efficiencies for both scrubber types are 90 percent or greater.

Gaseous emissions (e. g., SO2, NOx, CO, and organics) may also be absorbed to a significant extent in a wet scrubber.

Fabric filters and electrostatic precipitators have not been used to a significant extent for controlling PM from bagasse-fired boilers because both are relatively costly compared to other controloptions. Fabric filters also pose a potential fire hazard.

Emissions from the burning of biomass (wood chips) contributes towards global climate change. According to Envirochem Services Inc. (2008), the combustion of wood can result in number of potential pollutants depending on the contaminants in the fuel and the type and completeness of combustion process. The US EPA has identified 90 organic compounds (or groups of compounds), and 26 trace elements (metals) in the emissions from wood combustion.

The primary air contaminants are particulate matter (PM), oxides of nitrogen (NOx), carbon monoxide (CO), and sulphur dioxide (SO2). Depending on the source (or process), volatile organic compounds (VOC) and hazardous air pollutants including PAH, dioxins and furans may also be released.

The combustion of wood can form a variety of particulates that include:

- carbon particles and soot;
- unburned wood dust;
- polyaromatic hydrocarbons (PAH) compounds;
- semi-volatile organic compounds (e.g., tars and condensables); and,
- ash (minerals, metals, dirt).

As the efficiency of wood combustion equipment increases with improving technologies, the amount of larger particles (unburned fuel and wood dust, char and carbon) in the emissions will decrease. This will result in the emissions from modern high efficiency combustors not only being lower, but also of a smaller size fraction.

The size of the uncontrolled particles formed during efficient wood combustion is relatively small, with about:

- >90% less than 10 microns (μm) in diameter (PM10) and therefore inhalable; and
- >75 % less than 2.5 microns in diameter (PM2.5), which are capable of penetrating deep into the lungs. For this reason, fine particulate matter is commonly also considered a hazardous air pollutant. Health effects research has, however, shown that the composition of the particle may be as important as size.

Oxides of nitrogen (NOx), primarily nitric oxide (NO) and nitrogen dioxide (NO2), are formed by the oxidation of nitrogen, both in the fuel and in the air, with the fuel nitrogen being more reactive. Nitrous oxide (N2O) is also present in lesser amounts and is important from a global warming perspective.

The presence of carbon monoxide (CO) and volatile organic compounds (VOC) indicates incomplete combustion. Formation of CO is caused by the incomplete combustion of the carbon atoms, while the presence of VOC indicates incomplete breakdown of the organic components.

Wood is essentially a low-sulphur fuel with emissions of sulphur oxides (primarily sulphur dioxide) estimated at 10.8 g/GJ by the USEPA. Although it is possible to further reduce this with flue gas scrubbing, this process is almost never applied to wood fuel, and may be even counterproductive with the scrubbing energy costs offsetting potential reductions in SOx.

Wood is composed of cross-linked aromatics —primarily phenyl propane terpines, resin acids, fatty acids, and phenols and cellulose (polysaccharides). If during the combustion process the lignin and/or extractives are incompletely oxidized, they can be partially broken down into products of incomplete combustion (PIC), such as Polyaromatic Hydrocarbons (PAH).

Impact from Energy Use in Industry, Commerce and Mining

The impact from energy in industry is driven by the need to energise industrial operations, product processing, shops, offices, public buildings and transport.

Energy use by industry is a contributor to national greenhouse gas emissions. The burning of fossil fuels has a wide range of impacts ranging from GHG emissions leading to global warming, to pollution due to spills, to the increasing need for more roads to loss of land for storage to safety risks of transport and filling.

GHG emissions are produced from a wide variety of industry and commerce activities. During these processes, many different greenhouse gases, including carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs) and per fluorocarbons (PFCs), are produced. According to the Second National Communication (GOS-NMS, 2012), industry and industrial processes was the largest contributor of GHG with HFC emissions totalling 9,053.20 Gg, and SF6 emissions totalling 10.3 Gg.

Coal has a great many issues relating to the extraction of the coal but also GHG emissions when burnt. If the coal is for a thermal power station the impacts increase significantly. Pollution associated with the mining, energy and industry sector include air, water and noise.

Mining operations are renowned for fuelling air pollution through the emission of dust particles and noxious gases into the atmosphere. The main sources of dust in mining are drilling, blasting, crushing and screening processes that sieve minerals into several desired sizes. The coal sourced from Maloma and Mpaka has an average sulphur content of <1 percent. This releases sulphur dioxide into the air and may lead to acid rain formation.

However, with the low level of emission of these gases in mines in Swaziland, its impact is likely to be minimal.

The discharge of wastes from mines generally causes pollution of surface and ground water resources. The same is true of used oils and greases from workshops from industries. Not only does water pollution have serious repercussions on aquatic life, but also polluted water may be fatal to downstream users who use such water bodies as sources of water supply for domestic consumption.

Spillage of fuels during storage and transportation has oftentimes resulted in the pollution of water bodies and soils. Although no data was found to support this observation, it is likely that fuel spillages do occur and do enter the environment with resulting detrimental impacts.

Impact from Energy Use in Transport

The impact on transport from energy is driven by the need for energy to fuel all vehicular transport.

Increasing consumption of liquid fuels drives increasing emissions that contribute towards climate change. According to the Second National Communication (GOS-NMS, 2012), transport emissions totalled some 1,889.17 Gg with direct CO2 emissions totalling around 1,725.81 Gg and CH4 emissions around 123.06 Gg (Table 85).

Table 85: National GHG Transport Emissions

GREENHOUSE GAS SOURCE AND SINK	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
CATEGORIES	CO_2 equivalent (Gg)						
Fuel Combustion	1,172.33	81.69	40.3				1,294.32
Transport	553.48	1.89	0				555.37

Source: Second National Communication (GOS-NMS, 2012)

Impact from Energy Use in Residential Areas

The impact from energy use in residential areas is driven by the need to energise residential and urban areas.

Energy use in urban areas is a contributor to national greenhouse gas emissions which feed climate change. According to the Second National Communication (GOS-NMS, 2012), residential growth contributes some 216.12 Gg of emissions (Table 86). Emissions from urban areas also include those related to waste disposal and treatment.

Table 86: National GHG Residential and Waste Emissions

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**CO_2**	**CH_4**	**N_2O**	**HFCs**	**PFCs**	**SF_6**	**Total**
	CO_2 equivalent (Gg)						
Household	137.57	66.15	12.4				216.12
A. Solid Waste Disposal on Land		206.01					206.01
B. Wastewater Handling		160.81					160.81
C. Waste Incineration	559.06	0.0156	5,363				5,922.08
D. Indirect emissions			368.9				368.9

Source: Second National Communication (GOS-NMS, 2012)

3.5.2.4.3 IMPACT ON ECONOMIC CIRCUMSTANCES AND HUMAN HEALTH

Impacts from energy may be twofold: (1) an irregular or insufficient supply of energy may have a negative effect on economic circumstances and living conditions, or (2) production or use of energy leads to pollution of land, air or water.

The agriculture sector, notably the sugar sub-sector, is investing heavily in electricity production to satisfy both internal (company) needs and sales to the grid. Insufficient energy (electricity or liquid fuels) would negatively affect agricultural operations and hence have a negative effect on the economy and incomes.

The industry sector has seen a modest expansion that drives the demand for ever increasing supplies of energy. Insufficient energy (electricity or liquid fuels) would negatively affect industry, general economics and livelihoods.

Similarly, insufficient energy (electricity or liquid fuels) would also negatively affect commerce, transport and urban areas.

Human health and well-being would be impacted upon by the combined effect of impacts from energy on air quality, climate change, land use change, ecosystems and economic circumstances. However, it would be difficult to measure the effects on human health separate from other impacts as described in the above sections on land use, atmosphere (climate change) and biodiversity.

The use of coal for indoor space heating can cause health problems. Local anthracitic coal is a low smoke fuel compared to imported low quality bituminous coal and therefore not as damaging.

3.5.2.4.4 ENVIRONMENTAL INDICATORS: IMPACTS FROM ENERGY USE

Indicators for impacts describe the effects which the environmental changes have on the functioning of important systems or conditions, such as ecosystems, climate, economic circumstances and human health and well-being.

Some impacts from energy are measurable, such as emissions or land use change, but others are not measuble as direct impacts from energy use, such as changes in health and ecosystems. Reference is made to the environmental indicators for impact under the sections of land, water and atmosphere.

Environmental indicators to measure the impacts of energy use and production can include:

Indicator	**Measurement**	**Source**	**Availability/Reliability**
Changes in GHG emissions - agriculture	Gg & % change	MTEA – Nat Meteo S	available / unreliable
Changes in GHG emissions - industry	Gg & % change	MTEA – Nat Meteo S	available / unreliable
Changes in GHG emissions - commerce	Gg & % change	MTEA – Nat Meteo S	available / unreliable
Changes in GHG emissions - transport	Gg & % change	MTEA – Nat Meteo S	available / unreliable
Changes in GHG emissions - residential	Gg & % change	MTEA – Nat Meteo S	available / unreliable
Fuel wood extraction from natural forests & woodlands	Kg, m^3	MNRE – Dept Energy MTEA – Dept Forestry	unreliable

Conversion of land for energy infrastructure	Area and % of ecosystems	SEC	unavailable

3.5.2.5 RESPONSE

3.5.2.5.1 INVESTMENT RESPONSE

Rural Electrification

Rural Electrification is a high priority issue in Swaziland. Access to adequate energy supplies is a key element of Government's rural development strategy. The aim of Government is to provide a climate and infrastructure that will progressively maximise the quality of life and energy security of the people of Swaziland and make the best of the country's natural resources. The Ministry therefore is developing plans to extend the electricity grid and provide access to electricity to all areas of the country. This is seen as an essential component towards the social and economic upliftment of all citizens of the country (GOS-MNRE, 2003).

In the rural areas of Swaziland, the vast majority of homesteads and a large number of public facilities are without adequate access to electricity. This can be attributed to the high costs of extending distribution lines to dispersed communities in rural areas. Rural Electrification is a non-viable activity for any electricity utility especially if the densities of households are low, as is the case in Swaziland. With the present rate of electrification the situation will remain unsatisfactory for the rural population for many years. The low connection rate in rural areas was mainly due to the high capital costs in paying for the infrastructure. In 1999, less than 5% of rural communities had access to grid electricity, which results in a prevailing marginalisation of rural people. It improved to 25% in 2010, and expected to be higher to date due to further connections of group schemes under the Rural Electrification project and the Rural Development Fund. Furthermore, social and economic development in rural areas may also slow down the current trend of migration to urban areas (GOS-MNRE, 2003).

The Government has been addressing the problem of rural electrification for the last decade through a number of studies and programmes. Rural electrification includes all areas of the country not presently covered by an electricity grid infrastructure and where grid extension is deemed not viable on purely commercial terms. Rural electrification may also cover electrification of peri-urban areas, where appropriate (GOS-MNRE, 2003).

An overall prioritisation strategy has been adopted through consultation with stakeholders, as a methodology for extending the grid to rural communities and increasing access. The first priority is to extend the grid to schools, health care facilities and other essential public services, followed by agricultural, commercial and industrial development areas. Prioritisation also takes account of areas with a high potential for economic development, where appropriate.

The ongoing Rural Electrification Programme with the financial support from the ROC on Taiwan promotes the electrification of rural schools, health centres and clinics, development centres and many other important rural areas. According to the Ministry of Education and Training (MOET), 674 schools are situated in rural areas. Out of these, 332 schools, or 49% of all schools, have benefited so far from the Rural Electrification Programme.

On the other hand there are 122 clinics situated in rural areas according to data obtained from the Ministry of Health and Social Welfare. Of these, 13 clinics benefited frorm the Rural Electrification Programme. The small number is due to the fact that most clinics are immediattly electrified after construction, since some of the medicines kept in health centers need refrigeration and also some equipment need electricity to use. GOS-MOH, 2010 states that all health facilities (99.6%) have electricity available except for one privately owned in the Lubombo region.

Power backup in-case of power interruptions for facilities still remains poor as only 24.2% overall reported to have a backup (Table 87. The number of facilities with power back up increased in the Hhohho (25.4% from 17.2% in 2008) and Shiselweni regions 29.7% from 17.6% in 2008, while a decrease was noted for Lubombo 24.5% from 35.6% in 2008 and Manzini 21.2% from 30.0% in 2008 respectively.

Table 87: Facilities with Electricity and Back-up System by Region 2010

Region	Number health facilities	Electricity Availability		Back Up System availability	
	#	#	%	#	%

Hhohho	71	71	100.0%	18	25.4%
Lubombo	53	52	98.1%	13	24.5%
Manzini	104	104	100.0%	22	21.2%
Shiselweni	37	37	100.0%	11	29.7%
Total	265	264	99.6%	64	24.2%

Source: GOS-MOH, 2010

Mini and Micro Hydro Power Study and Pilot Programme

The Ministry is planning to undertake the final design and construction supervision of a mini-hydroelectric power station utilizing the water being released from the Mnjoli dam for irrigation purposes and downstream.

Besides producing hydro–power the final design controls must be designed to meet the water flow requirements of the sugar estate and consequently the final designs must be to the approval of RSSC (Royal Swaziland Sugar Corporation) as well as the Ministry.

The feasibility study recommends the development of up to 0.5MW from the river discharge pipe; however the final design requires a complete review of the data to establish the optimum power generation scenario. There are numerous restraints on the scheme especially with regard to irrigation needs of the sugar estates and all these issues must be addressed in preparing the final design.

Wind Measuring Equipment along the Lubombo Plateau

Following the initial results from the Wind and Solar Resource Data collected from the five measuring sites (2002) installed under the National Energy Policy Project formulation, there is strong indication that the Lubombo Plateau holds a potential for a "Wind Farm" (The erection of a number of wind turbines in a small area for the generation of electricity, to be connected to the national grid or act as an off-grid system). It is imperative that more data should be collected along the Plateau, at least two measuring sites to be installed one North of Siteki on the Mbuluzi River Gorge and Maphungwane/Mambane Area. The project will also cover the rehabilitation of the five wind-measuring sites in the country installed in 2002/3.

Energy Efficiency in Public Buildings

The aim of the project is to conserve energy within Public institutions resulting in both environmental and economic benefits to the country. This will be achieved through installation of energy saving technologies that will provide a model for energy savings to industry, commercial sector and the domestic sector.

Feasibility Study for Solar Energy

This project aims at assessing the solar regime in the country and providing the basis for the promotion and development of the solar energy sector particularly the use of PV solar home systems (lighting, water pumping and other uses). Practical demonstration of solar application through pilot projects at selected technical institutions or rural communities as well as capacity building with regard to procurement, installation, testing, system sizing, maintenance and continuous monitoring and evaluation will pave the way for the development of technical specifications for standards and awareness on the potential and availability of solar resources and identification of most appropriate forms of dissemination and implementation.

Promotion of Wood-Saving Stoves for Demand Side Energy

There is an amount of E805, 000.00 from local and donor fundsavailable for undertaking promotional activities of wood-saving stoves, for demand side energy.

Independent Power Producer Policy and Feed in Tariff Framework

The electricity sector has been deregulated allowing other players to produce power for the country. The most feasible alternative to imported electricity is generation from renewable energy, a new and growing field in the country. Currently only an energy policy exists, which has a section on renewable however there is a need to a more focused IPP policy and FIT to guide the investment in renewable and other alternative sources of power. This policy tools aim to create an enabling environment while also introducing some level of transparency and predictability in issue of power pricing going into the future.

Development of Standards for Petroleum Products, Bioethanol, Solar Systems

The Ministry, through SWASA has seen it fit to develop standards to ensure uniformity and quality in all areas of its mandate. These standards include petroleum products and their installations, bioethanol, energy management, solar systems. Though standards are voluntary by nature, the Ministry intends to make them enforceable through incorporation and citation in legislation. The standards are being developed with the involvement of all key players in the different thematic areas.

3.5.2.5.2 SYSTEMIC RESPONSE

Legislation

The Swaziland Electricity Company Act, 2005

This Act provides for the establishment of the Swaziland Electricity Company as a company under the Swaziland Company Act of 1912, for the exercise and performance by the company of the powers and functions presently performed by the Swaziland Electricity Board relating to generation, transmission, distribution, and supply of electricity.

The Energy Regulatory Authority Act, 2005

The objective of this Act is to establish an Energy Regulatory Authority which will oversee all matters relating to the generation, transmission, distribution and supply of electricity.

The Electricity Act, 2005

The objective of this Act is to provide for the regulation of the generation, transmission, distribution and supply of electricity.

Policies

The Renewable Energy Programme and Action Plan, 1997

The Renewable Energy Programme and Action Plan provided a long-term programme for the development of renewable energy in the country. A number of activities in the plan have already been undertaken but there are still activities requiring attention, particularly in the area of biomass energy and quality assurance of renewable energy technologies. This programme however is generally outdated and a number of the activities have yet to be carried out, mainly due to issues of funding.

National Energy Policy, 2003

The overall aim of the policy is to improve the accessibility of energy to all households at affordable prices. An emphasis is placed on sustainability and environmental concerns and a number of the specific policy statements outlined in the policy relate to promoting the use of renewable and sustainable forms of energy, particularly in the rural areas.

Poverty Reduction Strategy and Action Programme, 2008

Volumes 1 & 2 of the PRSAP dedicate 3 pages each to 'Ensuring Sustainable Energy'. There are four key actions identified:

- Development of community woodlots;
- Encouragement of forestation and reforestation;
- Research into affordable, safe and environmentally friendly household energy; and
- Expand rural electrification programme and improve access to the poor.

National Energy Policy Implementation Strategy, 2009

The Strategy is aimed at providing clearly identified targets and actions for the existing individual energy policies and implementation plan. The strategy identifies the relevant stakeholders who are expected to lead the implementation and approximate costs of the individual projects. In addition, the Strategy identifies a number of priority projects and provides detailed proposals to enable the Government of Swaziland to identify funding requirements.

National Biofuels Development Action Plan (NBDAP), 2009

The purpose of the NBDS is to provide guidance to the Government of Swaziland and other stakeholders to develop and nurture a biofuel industry in Swaziland, exploiting the country's opportunities and overcoming its key challenges. The draft NBDAP seeks to exploit national opportunities to grow, process and utilise crops for contributing to national liquid fuel uses. The sugar sector offers the most immediate prospects for bio-ethanol from the processing and refining of sugar utilising the by-product molasses.

Draft Petroleum Bill

This Bill aims to consolidate the numerous pieces of energy legislation that are currently in place and outdated, dealing with petroleum products. Its scope will cover importation, sale, distribution, service stations, quality standards, tariffs and licencing. The scope has also been expanded to include biofuels and other petroleum related fuels.

3.5.2.5.3 INSTITUTIONAL RESPONSE

Institutional framework

Energy Department (MNRE)

The Energy Department is mandated to effectively and efficiently manage the national energy resources and to work towards affordable and sustainable energy provision for all the people of the Kingdom of Swaziland, whilst ensuring the international competitiveness of the energy sector as a whole.

The Department is composed of several units:

The Renewable Energy Unit specialises in solar, wind, micro-hydro, biomass, biogas and any others which fall within New and Renewable Sources of Energy (NRSE). It is also tasked with maintaining links with the Atomic Energy Agency. The unit is responsible for the development, monitoring and evaluation of pilot and resulting projects, along with market-development programmes in all sub-sectors of NRSE. Swaziland's vast tracts of commercial forests and long-established timber industry produce woodchip-waste which is being utilised on an ever expanding scale. Bagasse from sugarcane processing is also in great supply, thanks to another of Swaziland's premier industries. A feasibility study on bio-diesel production includes an investigation into the amount of investment required to cost efficiently produce this more eco-friendly alternative.

The Conventional Fuels Unit is also known as the Non-Renewable Energy Unit and deals with issues relating primarily to coal, natural gas and electricity, plus the need to formulate appropriate responses to matters of energy-efficiency and conservation. General functions of the unit include implementing the National Energy Policy and supervising the Swaziland Electricity Company (SEC), along with coordinating the latter's activities. The unit runs and manages a tariff model, conducts research into suitable equipment for the utilisation of locally mined non-bituminous anthracitic coal with environmentally acceptable results and devises energy-efficiency standards for coal-burners in order to minimise pollution. It is also tasked with improving accessibility to electricity and facilitating the development of electrification programmes throughout the kingdom.

Also under the Conventional Fuels Unit is the Rural Electrification Unit which embarked during 2010 on Phase Eight of its ongoing programme funded with assistance from the Republic of China- Taiwan. It incorporates homesteads and small business ventures, as well as government institutions such as schools, clinics and youth centres.

The Petroleum Unit enforces laws governing the structure of pricing and profit margins enjoyed by oil companies operating within Swaziland, as well as controlling the number of retail outlets/service stations. A fuel-inspection system counteracts the potential smuggling of untaxed petroleum products: petrol, diesel, fuel oil, paraffin, LPG, jet fuel and various lubricants. Diesel is the primary backup driver of Swaziland's electricity-generating turbines. Additional fuel-wagons purchased by Swaziland Railway in 2009 are helping to maintain ready availability of petrol and diesel.

The Energy Planning Unit carries out its mandate by means of analysis, data and information management, collating of energy statistics, creating energy models and carrying out project appraisals while generating energy-forecasts. It furthermore coordinates international and regional issues via avenues such as the Global Energy Information System, the World Energy Council and its affiliated Africa Energy Information Networks, as well as the SADC Energy Planning Network.

Swaziland Energy Regulatory Authority (SERA)

SERA has been mandated to process licence applications, modify or vary licences, enforce compliance standards, approve tariffs, monitor the performance and efficiency of licensed operators, adjudicate concerns raised by consumers and promote economic efficiency in the energy industry. Promulgated by the Ministry of Natural Resources and Energy in the name of improved operations to ensure optimal utilisation of resources, the Act of 2007 supports the position that investment in energy development in a sustainable manner can eradicate poverty while having profit-making potential for parties involved in such undertakings.

Entities seeking to generate, transmit, distribute, export and supply electricity are thus required to be licensed by the ERA. Its mandate declares that the Authority act in a just manner administratively when hearing applications for new licences and make reasonable decisions within a procedurally fair process, with determining factors disclosed if so required.

Renewable Energy Association of Swaziland (REASWA)

A Renewable Energy Association of Swaziland (REASWA) was established in 1998 under an EU programme to develop a regional renewable energy information network (Southern African Renewable Energy Information Network). Since then, it has operated through an executive committee comprising of persons from industry, academia and Government. It has carried out various activities during this time, in particular studies and workshops on the issue of gender and energy.

3.5.2.5.4 INTERNATIONAL COOPERATION

The International Energy Agency (IEA)

Swaziland is not a member of this international organisation.

World Energy Council (WEC)

The mission of the WEC's is to "To promote the sustainable supply and use of energy for the greatest benefit of all people". This mission is carried out through the Objects, which were approved at WEC's founding in 1924 and modified over the years to adapt to the changing energy industry and the changes within WEC. WEC's objects (the "Objects") as they exist today are to promote the sustainable supply and use of energy for the greatest benefit of all people. WEC has a Member Committee in 93 countries world-wide. WEC's publications include an annual country-by-country Energy and Climate Policy Assessment, the Survey of Energy Resources.

International Renewable Energy Agency (IRENA)

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation dedicated to renewable energy. In accordance with its Statute, IRENA's objective is to "promote the widespread and increased adoption and the sustainable use of all forms of renewable energy". This concerns all forms of energy produced from renewable sources in a sustainable manner, which include bioenergy, geothermal energy, hydropower, ocean, solar, and wind energy. Swaziland's membership in IRENA provides an opportunity to benefit from the wealth of experience from other member states, as well as the published resources and specialist knowledge in all fields of renewable energy that is available, to ultimately increase the adoption of renewable energy technology in the country.

SADC Protocol on Energy

The International Renewable Energy Agency (IRENA) - Mandated by governments worldwide, IRENA's mission is to promote the widespread and increased adoption and sustainable use of all forms of renewable energy. IRENA's Member States pledge to advance renewables in their own national policies and programs, and to promote, both domestically and through international cooperation, the transition to a sustainable and secure energy supply.

Other partnerships and cooperation are achieved through membership of the following initiatives:

- Framework for Sustainable Biofuels (2010)
- The Africa-EU Energy Partnership
- Renewable Energy and Energy Efficiency Partnership (REEEP)
- Regional Electricity Regulators Association of Southern Africa (RERA)
- African Energy Commission (AFREC)
- Sustainable Energy Society of Southern Africa (SESSA)

- SADC Renewable Energy Strategy and Action Plan (RESAP)
- SADC Framework for Sustainable Biofuel Use and Production.

3.5.2.5.5 ENVIRONMENTAL INDICATORS: RESPONSE TO REGULATING ENERGY

Environmental indicators to measure the response to regulating energy can include:

Indicator	Measurement	Source	Availability/Reliability
New Legislation promulgated	number	MNRE	available
Energy related policies	number	MNRE	available
Energy efficieny and renewable energy projects	number	MNRE-Energy, REASWA, SEC, Private sector	available
Research on energy	number	UNISWA, MNRE - Energy	available
Greenhouse Gas Inventory	report	MET / SEA	unreliable

3.5.3 WASTE

This section focuses on waste, in particular solid waste, of which the production and handling is seen as a pressure and burden on the environment. Waste management is the response to the unwanted pressures and resulting impacts from waste on society and the environment.

Waste is a combination of all the materials our industries and society uses, from complex and carcinogenic industrial and agricultural chemicals to grass clippings and orange peels. The municipal waste stream is made up primarily of paper. The comparative percentages of various components of the waste stream will change and vary as our society changes and varies. It is anticipated that the percentage of plastics in the waste stream will continue to grow as more uses are found for the convenient and lightweight material. Other changes in the general composition of the waste stream can be expected. In the future, the recyclability or reusability of a product may be a factor in whether the product is purchased by consumers or even allowed on the market by regulators.

Waste management is the process by which waste (unwanted products of the home, business or industry) are collected, stored, transported, treated, disposed of, recycled or reused. Most waste can be categorised as either general waste or special waste. General waste is waste that, due to its composition and characteristics, does not pose a significant threat to public health or the environment, if managed properly. Special waste is hazardous with the potential, even in low concentrations, to have significant adverse effects on public health and/or the environment.

The growing waste management problem in Swaziland can be seen as a symptom of many factors, including industrialisation, consumption patterns, urbanisation and population growth. The absence of waste management information has precluded strategic planning in the past. This has prevented the implementation of appropriate remedial action such as changes in behavioural patterns, establishment of waste infrastructure and the development of required legislation in order to prevent, recycle and eventually handle waste that must be collected, treated and disposed.

3.5.3.1 DRIVING FORCE

The driving forces behind waste management are population growth and the need for economic growth and corresponding consumptive lifestyles that generate significant quantities of waste materials.

Economic development usually comes with increases in industrialisation or production and processing. Within these activities increasing amounts of waste materials and products are generated. Human populations are significant generators of waste. The more prosperous the population the more waste is generated. Urban and economically active people produce more waste than rural poor people.

3.5.3.1.1 ENVIRONMENTAL INDICATORS: DRIVING FORCE BEHIND WASTE PRODUCTION

Environmental indicators measuring the driving forces behind waste management can include:

Indicator	Measurement	Source	Availability/Reliability
Population growth rate	% change	CSO	available / reliable

Indicator	Measurement	Source	Availability/Reliability
Macro-economic development	GDP growth rate & per capita	MEPD, MOF	available / reliable
Urbanisation (growth rate)	number, % change	CSO	available / reliable
Peri-urban growth rate	number, % change	CSO	available / reliable
Industrialisation growth rate	number, %	MEPD, MOF	available / reliable

3.5.3.2 PRESSURE

The DPSIR framework clearly indicates that waste is a pressure on the environment. Society produces large quantities of waste. According to recent estimates from landfill data by the Mbabane City Council, 11,000t of municipal waste is generated annually by residents and businesses in Mbabane and surrounding areas.

According to earlier data, the country generates over 86,000 tonnes/year of general solid waste every year (National Solid Waste Management Strategy, 2000). This is about 0.2kg per person per day. These figures include general wastes generated and disposed of at designated sites at that time, and do not include waste generated at rural settings. Systematic measurement (monitoring) and reporting of waste quantities have not been forthcoming from the information suppliers, i.e. municipalities, agriculture and industries, making it impossible to present accurate records. However, all indications point towards strongly increasing quantities of waste.

Urbanisation and waste generation are inextricably linked. All urban areas produce a variety of waste streams. Household waste is commonly biodegradable kitchen waste, packaging plastics, non-packaging paper and cardboard, packaging glass and packaging paper and cardboard. As urban populations grow, the volume of waste generated increases. In Swaziland local urban government authorities are mandated by law to collect, treat and dispose of solid waste. In rural areas not serviced by municipal authorities, waste management is ad hoc and often an increasing threat to the environment (land and water).

Industries generate waste products that need to be safely disposed of. As Swaziland's economic growth increased and more and more companies established in the main industrial areas of the country and the volumes of waste have increased. Although no data is readily available that describes the observation, the pressure on the environment from poor waste disposal and storage methodologies is increasing.

The pressure on the environment from the need for the safe disposal, treatment and storage of waste is reflected in the need for appropriate disposal and storage facilities to prevent waste streams entering and polluting the environment.

3.5.3.2.1 ENVIRONMENTAL INDICATORS: PRESSURE LEADING TO WASTE PRODUCTION

Environmental indicators measuring the pressure from waste should primarily reflect the production of waste. Waste can be categorised according to the source of the waste, such as industrial, agricultural, domestic, etc. Waste is also categorised into hazardous and non-hazerdous waste. General waste and domestic waste are used interchangeably to mean non-hazardous waste. Hazardous waste is derived from various sourses: health care institutions, industries, households, etc.

Environmental indicators measuring the pressure from waste may include:

Indicator	Measurement	Source	Availability/Reliability
Total quantity general waste (non-hazardous)	T/annum; also per income group	SEA, municipalities, private sector (facility operators)	unavailable / unreliable
Total quantity hazardous waste (from health care, industrial, domestic, etc)	T/annum	SEA, municipalities, EHD, Private & Public Health Care Facilities; industries	partly available /partly reliable
Health care risk waste (hazardous)	T/annum	SEA, municipalities, EHD, Private & Public Health Care Facilities	partly available /partly reliable
Industrial hazardous waste, incl hydrocarbon waste generation	T/annum	SEA, municipalities, industries	unavailable / unreliable
Total quantity industrial waste	T/annum	SEA, private sector	unavailable / unreliable
Total quantity agricultural waste	T/annum	SEA, private sector	partly available / unreliable
Total quantity municipal waste	T/annum; also per income group	SEA, municipalities, private sector	partly available / unreliable

3.5.3.3 STATE

Following the DPSIR framework, the subsection on state is normally reserved for describing the State of the Environment, i.e. the relevant compartment of the environment discussed in the section. In this section under the heading of waste, the description of the state of waste is not considered relevant or appropriate, as waste is not part of the natural environment, but rather a polluting element. As waste is a pressure on the environment, it cannot be a state of environment at the same time. Following this concept, the next subsection on impact is appropriate in the DPSIR context as it describes the impact that the production or handling of waste may have on society or environment. Logically, the response to waste production is waste management, which completes the section on waste.

3.5.3.3.1 ENVIRONMENTAL INDICATORS: STATE OF WASTE

Environmental indicators measuring the state of waste are not relevant in the context of the DPSIR.

Indicator	Measurement	Source	Availability/Reliability
Not applicable			

3.5.3.4 IMPACT

As Swaziland's population density and the rate of urbanization rise, waste management poses an ever increasing challenge to protect the environment. In future, waste management is expected to become more difficult and costly for government, authorities and urban residents. Various types of non-decomposable wastes are generated in cities, which, if not properly managed, negatively affect the aesthetic value of the environment and increase the prevalence of long-term pollution.

Managing increasingly large volumes of waste produced in the country is a problem in itself. However, the environmental and health impacts of improperly managing waste are the key concerns for the public. If not properly managed, waste can cause a variety of impacts. Protecting the environment over the long term is the major challenge for waste management design professionals today.

Although waste management services are in place in some areas, such as the declared urban areas, there is a growing problem of litter and illegal dumping of household and demolition waste and waste collection coverage rarely exceeds 50-60%.

3.5.3.4.1 IMPACT FROM LANDFILLS

Landfills are the preferred national solution to waste management and can give rise to a large number of adverse impacts from landfill operations. Damage occurrence can include infrastructure (e.g., damage to access roads by heavy vehicles); pollution of the local environment (such as contamination of groundwater and/or aquifers by leakage and residual soil contamination during landfill usage, as well as after landfill closure); off-gassing of methane generated by decaying organic wastes (methane is a greenhouse gas many times more potent than carbon dioxide, and can itself be a danger to inhabitants of an area); harbouring of disease vectors such as rats and flies, particularly from improperly operated landfills, injuries to wildlife; and simple nuisance problems (e.g., dust, odour, vermin, or noise pollution). This list is growing steadily as time passes.

In Swaziland, landfills are regulated by the Swaziland Environment Authority using the Waste Management Regulations that establishes minimum guidelines on landfills and operations. Some local authorities have found it difficult to construct new landfills due to planning obstructions or public opposition due to the perceived negative impacts poorly managed landfills have had. In Swaziland most landfills are publicly funded with public (municipal) and private operators.

Groundwater pollution

Of major concern is groundwater pollution. Pollutants in waste can cause health and other environmental problems if allowed to enter the surface and groundwater. Chemical reactions during degradation of material in a landfill can allow pollutants such as metals to become soluble and to migrate, if not contained, into surrounding water supplies. Today's landfill designs seek to contain these waste materials and to monitor the groundwater to ensure that containment is secure.

Air Pollution

As wastes degrade in a landfill, methane, an odourless explosive gas, is produced as a product of decomposition. Unless methane is controlled, it can build up in a landfill and migrate to nearby structures, creating a threat of explosion. Methane can also kill vegetation needed to keep the landfill from having erosion problems. Other toxic gases may also be created during waste decomposition in a landfill. Increasingly, these toxic gases are the subject of concern for landfill operators and regulatory authorities.

Workers' safety is a key concern in the analysis of the air quality around landfills. Protecting the health and safety of workers at waste facilities is a focus of national health and safety regulations. Municipalities are making stronger efforts to analyse the risk to waste workers and to provide protection from exposure to contaminants. Poor landfill operation can also cause the creation of nuisance conditions which will result in poor public relations with neighbours and the nearby community. Odour problems, air pollution from landfill fires, windblown paper, and noise can all rise to unacceptable levels if not addressed quickly. Proper landfill operation can eliminate or significantly diminish these problems.

3.5.3.4.2 EMISSIONS FROM WASTE WATER AND OPEN BURNING OF WASTES

Haphazard waste collection and high collection costs have led to considerable use of waste burning as a means of managing solid waste in particular in rural areas, although to some extent also in urban and peri-urban areas. Open burning is described as the combustion of unwanted combustible materials such as paper, wood, plastic, etc in open air or dumps were smoke and other emissions are released directly into the air without passing through a chimney or stack. Waste burned in the open is normally dealt with as aggregate wastes rather than classified as hazardous, medical, household, etc because their profiles are unknown.

Given in Table 88 is a summary of emissions from the waste sector, from waste water and open burning (GOS-MTEA-NMS, 2012).

Table 88: Summary of Emissions from Waste (1994-2007)

	SWDs	WWD Cent	WWD Pit Latrines	WWD Cent, Sludge	WWD Pit Latrine Sludge	IEs	Open Burning of Wastes		
	CH_4	CH_4	CH_4	CH_4	CH_4	N_2O	CH_4	N_2O	CO_2
1994	8.60	0.0063	0.0005	2.2	4.48	18.42	0.00066	15.26	493.0
1995	8.88	0.0065	0.0005	2.3	4.61	18.42	0.00068	15.71	507.44
1996	9.17	0.0067	0.0005	2.4	4.75	11.48	0.00070	16.16	522.08
1997	9.59	0.0070	0.0005	2.5	4.97	4.0	0.00073	16.91	546.46
1998	9.31	0.0068	0.0005	2.43	4.82	3.26	0.00071	16.43	530.71
1999	9.56	0.0070	0.0005	2.49	4.95	2.53	0.00073	16.86	544.57
2000	9.81	0.0072	0.0005	2.57	5.08	1.19	0.00075	17.30	559.06
2001	10.07	0.0073	0.0006	2.63	5.21	6.22	0.00075	17.76	573.84
2002	10.33	0.0075	0.0006	2.70	5.35	5.99	0.00079	18.21	588.42
2003	10.57	0.0077	0.0006	2.76	5.48	6.64	0.00081	18.65	602.43
2004	10.80	0.0079	0.0006	2.82	5.60	7.30	0.00083	19.05	615.51
2005	11.02	0.0080	0.0006	2.88	5.71	4.76	0.00084	19.43	627.58
2006	11.21	0.0082	0.0006	2.93	5.81	38.70	0.00086	19.77	638.58
2007	9.26	0.0075	0.0006	2.30	5.35	4.36	0.00079	18.24	589.25

SWDs (Solid waste disposal sites); WWD Cent (Wastewater Domestic, Central); WWD Pit Latrines (Wastewater Domestic, Pit Latrines); IEs (Indirect Emissions); CH_4 (Methane Emissions); N_2O (Nitrous Oxide Emissions); CO_2 (Carbon Dioxide Emissions)

The major emission has been carbon dioxide, whose only source has been open burning of wastes. Figure 61 demonstrates that at least 96% of emissions are carbon dioxide from open burning. This has steadily increased over the years with a dip in 2007. This could be attributed to the fear of fire damage after the massive destruction of property and forests in 2006. There has also been an extension of waste collection to peri-urban areas, but the costs of waste collection have been prohibitive thus having no effect on the practice of waste burning as a means of waste management.

Figure 61: Waste Emissions by Source

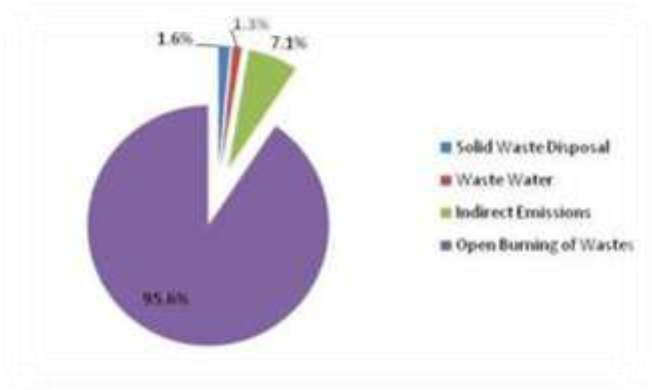


Table 89: Emissions by Gas from Waste

Gas	Amount	%
Total CH4	246.4	3
Total CO2	7938.9	93
Total N2O	379.0	4

Table 89 indicates the emission of gasses from waste, which is dominated by CO_2. Emissions of methane come from a wide variety of activities. The greatest contributor to methane emissions consistently over the years has been solid waste disposal sites. Pit latrine sludge can also generate considerable emissions. Emissions from pit latrines have basically been stable at 0.0005 Gg of methane, rising only in 2001 to stabilize at 0.0006 Gg. This could be attributed to an increased number of pit latrines and or use of the Smart Toilet product. Methane emissions though have fluctuated, rising with waste collection in urban areas.

3.5.3.4.3 ENVIRONMENTAL INDICATORS: IMPACTS FROM WASTE

Pollution from toxic gasses and substances derived from waste in landfills and other dump areas will impact on air and groundwater quality. See also the sections on air quality and water quality.

Pollutants in waste can cause health and other environmental problems if allowed to enter water and air. Effects on human health and ecosystems are difficult to measure in isolation from other sources of pollutants, unless locally measured.

Environmental indicators measuring the impacts of waste management can include:

Indicator	Measurement	Source	Availability/Reliability
Abatement notices	number	SEA	available / reliable
Air quality around landfills	standard parameters	SEA	unavailable / unreliable
Water quality around landfills	standard parameters	SEA	unavailable / unreliable
Incidences of leachate contamination	number	SEA	unavailable / unreliable
Open burning of waste	amount, % change	NMS, SEA	available

3.5.3.5 RESPONSE

3.5.3.5.1 INVESTMENT RESPONSE

3.5.3.5.1.1 WASTE MANAGEMENT SOLUTIONS

Landfills

The major response to waste management in Swaziland is the use of landfills for disposal, treatment and storage of collected waste. In recent years, recycling of selected waste streams has started. Landfills are also known as tips, dumps or rubbish dumps. Landfills are sites for the disposal of waste materials by burial and are the oldest form of waste treatment. Historically, landfills have been the most common methods of organized waste disposal and remain so in many places around the world.

Most landfills are used for waste management purposes, such as the temporary storage, consolidation and transfer, or processing of waste material (sorting, treatment, or recycling). Because old landfills were developed more to provide cheap disposal alternatives than to protect the environment, many have leaked and with inadequate maintenance or management the leachate (a liquid that has dissolved or entrained environmentally harmful substances which may then enter the environment). Leachate from a landfill varies widely in composition depending on the age of the landfill and the type of waste that contains. But newer landfills are designed to contain waste products and to protect the environment over the long term. Although other methods of managing waste, including recycling, composting, and incineration, are being instituted by communities around the country, access to a landfill remains a necessity for everyone.

Alternatives to Landfills

The alternatives to landfills are waste reduction and recycling strategies. The increasing concern about the environmental impacts of landfilling has caused waste managers and planners to investigate alternatives to landfills. However, landfilling still remains the major form of waste disposal in the country. Although there are no specific statistics available in the country, it is suspected that something like 80% of all municipal solid waste ends up in the landfill. Of the remainder, something less than 10% is currently recycled, incinerated or composted.

The lack of equipment is acknowledged as one reason for this, but there are also other reasons that are linked to limited management, little innovation in terms of approaches, and the lack of general public awareness concerning waste and littering. Some urban local government institutions do not operate any waste collection systems and in most local authorities it would be unrealistic to impose 100% cost-recovery rates on the waste generators, whether they are citizens, commercial or industrial enterprises. It should be noted that hazardous components of household waste, such as lead acid batteries, fluorescent tubes, car oil and tyres, are currently not addressed.

Recycling activities

Waste represents wasted money, in terms of the original cost of the materials, the costs of disposal, and also the potential value of the material as a recyclable and reusable resource and can be an additional burden to businesses and urban dwellers.

According to (Mbabane City Council, 2008), the impact of recycled waste can be gauged in terms of a) employment creation at recycling centres; b) reduction in the amount of waste disposed of at the landfill thus prolonging the lifespan of the landfill; and c) promoting the production of economically usable commodities such as aluminium pots.

According to the draft Municipal Council of Mbabane Waste Management Strategy (WMS) recycling activities are currently taking place within the municipality driven mainly by economic forces and implemented primarily by the private sector.[39] Increasingly certain waste streams are being recycled. Notable streams are paper, plastic and metals.

There are also community and schools recycling centres (e.g. Msunduza, MDS Primary, John Wesley Primary, St Mark's Primary and St. Francis High). There is however considerable scope to extend these activities although proactive legislation and incentives need to be put in place to promote recycling.

According to reports from the Mbabane City Council an estimated 7 tonnes of clear glass is separated at the landfill weekly and sold to Ngwenya glass. About 720 kg of cans, 86 kg of plastic as well as 2.8 tonnes of scrap metal are also separated for recycling weekly. The metal scrap is sold to Sidwashini Buy Back Centre. At the Reclaim Buy Back Centre, about 5.16 tonnes of scrap are reused by small scale metal artisans to make three-legged pots and other utensils. These are later resold to communities at reasonable prices depending on the size of the utensil sought.

[39] The draft strategy identified a number of private recycling companies operating in Mbabane including AMZ Investments, Sheffield Road, and Goodflo Scrap Metal Recycling in Sidwashini. These companies mainly recycle paper, cans, glass, plastic and scrap metal. Diesel Electric Bosch (operating along Sheffield Road) recycles used car batteries whilst Bandag (Sheffield Road) recycles old tyres. Ngwenya Glass recycles glass. Paper and plastic wraps are respectively given to recycling agents mainly based in Matsapha. Other companies actively in recycling include Com X Media Agency, Swazi Trails and Legends Backpackers Lodge, Bandag Tyres, Leites Toyota, PWC Auditors (office paper and ink cartridges), Adventure Sports (bicycle tyres), and Resource 360 Company (bulky waste from the landfill site).

According to the annual report from the Mbabane City Council (2008), the recycling of waste has prompted various actions from the MCC, NGOs and other civil society groups as follows: a) The MCC has responded to the recycling of waste by the extensions of leasehold for buy back centres. By having tenure, the centres can operate more efficiently and sustain employment. b) There are increased waste minimization campaigns by NGOs e.g. Yonge Nawe so that the practice is sustained. c) A Waste Information Centre (WIC) has been established to promote further waste paper and plastics recycling and reuse. d) Community waste initiative groups have been formed for income generation and support as a result of waste recycling endeavours. e) Waste recycling has promoted the participation of schools in support of the initiative. [40]

Health Care Waste

Health Care Risk Waste from hospitals, health care facilities and clinics is an area of particular concern. Currently, most health facilities have no separation of waste at source resulting in the mixing of hazardous health care risk waste, such as scalpels and remains of items used for medical treatment, with general waste items such as paper. The current handling methods increase the risk of staff members involved in waste management contracting infectious diseases, including HIV/AIDS.

The NSWMS presented institutional responsibilities and strategies for health care waste management. It is unclear how successful the strategies have been, but within the Manzini and Mbabane urban areas, the local authorities have put in place collection and disposal mechanisms to handle Health Care Waste.

Hazardous health care risk waste should be disposed of separately from general waste.

Disposal of Hazardous Waste

Hazardous waste is not only derived from health care facilities, but also resulting from industrial and domestic activeties. Commercial and industrial waste may be hazardous but there are few, if any, specially designated facilities for the treatment and disposal of hazardous waste substances in Swaziland. Part of this problem is addressed by exporting waste to neighbouring countries where appropriate facilities are available. Such a practice is permitted under the Basel Convention which Swaziland ratified in 2005. The Basel Convention imposes specific requirements on Swaziland pertaining to the movement of hazardous waste to South Africa and elsewhere since the country does not have a hazardous waste facility. All hazardous waste generated in Swaziland is exported to South Africa and Asia.

The exportation of waste however, should not be pursued without looking into the scope for adoption of cleaner production and waste minimisation approaches within commerce and industry. A pro-active approach by these sectors is required.

3.5.3.5.1.2 WASTE MANAGEMENT IN URBAN AREAS

Mbabane

The main landfill site in Mbabane is the Mahwala landfill. It was commissioned in 1998 with an estimated total waste carrying capacity of 277,400 tonnes. It is being filled up at a rate of 5% annually hence has an estimated life span of +20years. The estimated amount of waste that has been deposited at the site so far has reached the half way mark of 138,700 tones. If the current rate of depositing approximately 38 tonnes of waste per day remains constant, the landfill can be expected to remain in use for the next 10 years. However, if the current population growth rate of Mbabane is maintained at 0.38%, it means more landfill waste will be generated and the landfill can only be expected to have a lifespan of less than 10 years from now.

[40] Proposed indicators for four recyclable commodities: (1) Oil: indicators measure the amount of used oil collected in recycling and reduction efforts. The indicators will measure declines or gains in the amount collected if measured for a minimum of three years. Additionally, it should be determined how much used oil is available that is not recycled every year; (2) Tires: indicators measure the amount of tires collected for recycling. Tires can be a source for products made with fiber construction. A rate of change in the number of tires collected can be established if the indicator is measured for a minimum of three years. Additionally, it should be determined how many tires are available annually that can be recycled; (3) Batteries: If made a condition those retailers who sell batteries to accept old batteries in return. The lead component of lead-acid batteries can be recovered. The indicator measures the number of batteries collected; hence, a reduction to the waste stream. It should be determined how many batteries are thrown out annually. This will allow for the indicator to be used in measuring progress toward recovering disposed batteries; (4) White Goods: indicator measures the amount of white goods collected for recycling and diverted from landfill space. A trend can be established if measured for a minimum of three years. Additionally, the tonnage of white goods thrown away annually should be determined. This will allow for the indicator to be used in measuring progress toward recovering a higher percentage of the white goods available annually.

The landfill site is well managed in that it is fenced, has a weigh bridge for incoming waste, a separation platform as well as a compaction machine. Its operations are well monitored. In addition it has a waste data base making it possible to store and extract waste information. Apart from solid waste, leachate is extracted and collected into a lagoon with a capacity of 4,500 m^3. The volume of leachate collected increases when it rains and this varies depending on the amount of rainfall received by Mbabane.

In Mbabane, it is estimated that some 10,000 tonnes were taken to the Mahwala landfill site in 2008 (all waste streams) and 11,000 tons in 2009 and in 2010, 11,232 tons.

Problems with the weighbridge prevented consistent record keeping of waste disposed of.

Table 90: Waste Disposed at Mahwala Landfill Site, Mbabane

Year	Estimated Waste Disposed (tons)
2008	10 000
2009	11 000
2010	11 232
2011	

Approved Landfills

Apart from the Mbabane landfill, other approved landfills include:

- Matsapha Landfill
- Piggs Peak Landfill
- Simunye Landfill
- Sappi Usutu Landfill

Waste Management in Company Towns

Two of the above mentioned landfills are in company towns, namely the Simunye and Sappi Usutu Landfills.

Some of the company towns such as Big Bend, Simunye, Mhlume, Bhunya, and Bulembu have industrial, commercial, residential and medical facilities that resemble both a formal urban settlement and an industrial site/estate environment. Waste management is the responsibility of the respective companies and they utilise various strategy's to collect and dispose of solid waste. Several company towns have invested significantly to ensure appropriate waste management operations.

Company towns are urbanised areas that are not under the jurisdiction of the Ministry of Housing and Urban Development. These towns have been established through economic development such as the sugar industry and forestry. Industrial, commercial, residential and medical facilities have been established within the Company towns. Currently, Company Towns are not under the jurisdiction (physical planning and/or waste management planning) of any ministry. Waste management services are independent of the government.

Non-approved Dump Sites

Non-approved dump sites are found in the following cities, towns and other areas:

- Manzini City Council Waste Dump Site
- Mankayane Town Waste Dump Site
- Nhlanago Town Waste Dump Site
- Lavumisa Town Waste Dump Site
- Vuvulane Town Waste Dump Site
- Siteki Town Waste Dump Site
- Huthi Waste Dump Sites
- Malkerns /Mahlanya Waste Dump Sites
- Mahamba Waste Dump Sites
- UNISWA Luyengo Waste Dump Site.

3.5.3.5.1.3 WASTE MANAGEMENT IN NON-URBAN AREAS

Rural and Peri-Urban Areas

The Ministry of Tinkhundla Administration (MTA) is legally responsible for Tinkhundla, Regional Administrations and Community Development and consequently considered responsible for the monitoring and control of the Waste Regulations 2002 with respect to domestic waste generated in the rural and peri-urban areas, although these responsibilities have no legal basis.

A number of geographical areas within the jurisdiction of the MTA are densely populated settlements in the peri-urban areas, where waste management systems and services are often limited. It is difficult to access these areas with modern/conventional waste collection equipment and alternative approaches have not been pursued. In addition, these settlements are typically located on Swazi Nation Land, where residents do not pay rates or fees that could be used for the financing of waste management services. The institutional framework also typically comprises an Inkhundla Office, which has no technical capacity to operate waste management services. The residents in these areas are divided on their understanding of whether they are entitled to waste management services and if/how they should pay for it. Waste management issues are also not placed high on the agenda.

The management of waste for peri-urban and rural areas poses a significant institutional challenge. The general authority to manage land in these areas follows traditional structures.[41]

Waste Control Areas (WCAs)

The Waste Regulations 2000 and the Environment Management Act 2002 do provide for the declaration of *Waste Control Areas*, for which a waste management plan and waste management system must be implemented. This provision, however, has to date not been applied. *Waste Control Areas* are to be declared when the disposal of waste in any non-urban area is resulting in an adverse effect, or there is a significant risk that it will result in an adverse effect. The Minister for the Environment may, by notice in the Gazette, designate the area as a waste control area.[42]

Three Waste Control Areas (Buhleni, Kwaluseni and Lobamba) have been capacitated with equipment to transport waste as well as waste disposal facilities. Siphofaneni will receive equipment and facilities in 2012 while at Lomahasha the construction of the waste disposal facility has been completed and at Mpaka the facility is underconstruction and is expected to be completed by the end of 2012. The legal declaration of the WCAs has not been done and the offices of the Surveyor General and Attorney General are being consulted on the modalities (gazetting etc).

Empowerment of Communities

In anticipation of WCA development, the Swaziland Environment Authority is empowering communities in non-urban areas to implement appropriate solid waste management practices. To achieve this, the SEA has put in place solid waste management systems in Siphofaneni, Kwaluseni, Lobamba, Lomahasha, Mpaka and Buhleni that include the construction of appropriate solid waste disposal sites, provision of tractors for the transportation of the waste and training of the community on waste management.

The launching of Hloba Swaziland Campaign and implementation of cleanup activities in selected TiNkhundla is an important intitiative providing employment opportunities to community members through the collection and transportation of solid waste.

3.5.3.5.2 SYSTEMIC RESPONSE

[41] Chiefs therefore have a big role in ensuring proper waste management in their chiefdoms. Every chiefdom fall under a specific iNkhundla Therefore the Ministry responsible for tiNkhundla also has a role. The responsibility of enforcing waste management in Swazi Nation Land is therefore that of the Chiefs as they have control of the land and the people under their respective jurisdiction. The TiNkhundla structures therefore provides the link between the central government and the traditional structures for purposes of organizational and administrative support as well as ensuring budgeting for waste management in Swazi Nation Land by the Government. The Swaziland Environment Authority works with the Chiefs in enforcing the Waste Regulations by providing the necessary support and taking appropriate actions for violators.

[42] Within Waste Controlled Areas, local authorities (traditional or public) are required to plan for the management of waste in the waste control area that conforms to the requirements of the SEA and must designate one or more local waste disposal sites or local waste collection sites within each waste control area along with guidelines on their use and must report at least annually to the SEA on the implementation of its waste management plan.

The principle piece of legislation with respect to waste and waste management is the Waste Regulations, 2000. Waste management is addressed to varying degrees by the following legislation:

- Swaziland Constitution, 2005
- Town Planning Act, 1965
- Town Planning Act, 1961
- Human Settlements Act 1988
- Human Settlements Authority Act, 1989
- The Urban Government Act, 1969
- The Urban Government Regulations, 1969
- The Building Act, 1968
- Public Health Act, 1978
- Swaziland Environment Authority Act, 1992
- The Environment Management Act, 2002
- Waste Regulations, 2000
- Environmental Audit, Assessment and Review Regulations, 2000
- Air Pollution Control Regulations, 2010
- Water Pollution Control Regulations, 2010
- Water Act, 2003
- Litter Regulations, 2011
- Draft Plastic Regulations, 2012.

3.5.3.5.2.1 THE WASTE REGULATIONS, 2000

The Waste Regulations of 2000 regulate the management of solid waste and liquid wastes disposed of on land and are binding also on the state. The Waste Regulations provide definitions of the different classes of waste including the minimum requirements for the management of each type of waste. The Regulations provide guidelines for the management of waste in urban areas, in waste control areas, the construction and operation of waste disposal facilities, recovery of waste, and many other aspects related to waste handling and disposal.

The Waste Regulations place the responsibility of waste management to the generator of the waste and the owner of the premises where the waste is found. This is an extremely important element in the success of solid waste management as this distributed the burden particularly the cost of waste management to all persons involved. As a result everybody is obliged to play their respective roles to keep Swaziland clean.

Another very important element contained in the strategy is the identification and allocation of responsibilities for managing waste within the existing responsibility framework for Government Ministries.

3.5.3.5.2.2 THE NATIONAL SOLID WASTE MANAGEMENT STRATEGY

At a strategic level, waste management is addressed by the National Solid Waste Management Strategy (NSWMS), which is a strategy subsidiary to the National Environmental Policy and the Environmental Management Act 2002 and serves as an enabling mechanism for the implementation and enforcement of the Waste Regulations 2000. The strategy therefore subscribes to the vision, principles, goals and regulatory approaches as set out in the above documents. The NSWMS applies to all government institutions, society at large and to all activities that impact on waste management. The fundamental approach to this strategy is to prevent and minimise waste and to control and remediate impacts. Through the strategy, the management of waste will be undertaken in a holistic, planned and integrated way and will extend over the entire waste cycle, including generation, prevention, recycling, collection, transportation, treatment and disposal.

The National Solid Waste Management Strategy was developed in 2002/03 by the SEA, and in 2009 presented by the MTEA to Cabinet and adopted. The MTEA implements the NSWMS through the SEA. The strategy is a long term plan for addressing key issues and problems of waste management in Swaziland.

Certain areas that are growth points such as Siphofaneni, Mpaka, Lomahasha and others, were identified and they presents a special waste management problem because of the economic activities taking place in such areas. The NSWMS and the Waste Regulations 2000 have provided means for dealing with such places through the provision for the declaration of Waste Control Areas (WCAs) by the Minister responsible for the Environment.

MTEA has taken steps to address the following constraints in waste management:

- Fragmented and reactive approach to waste issues
- Inadequate waste planning
- Poor management of hazardous waste
- Inadequate waste collection services
- Lack of appropriate waste disposal sites
- Existing waste services not run on a cost recovery basis
- Solid waste management not a priority in many sectors
- Regulations inadequately enforced.

The institutional framework proposed in the strategy clearly identifies the roles and responsibilities of the various government agencies and institutions.

3.5.3.5.2.3 THE BASEL CONVENTION

At the international level, transportation across borders of hazardous waste is addressed by the *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal* which Swaziland ratified in 2005. The country has however, never submitted a National Report to the Basal Secretariat.

The overarching objective of the Basel Convention is to protect human health and the environment against the adverse effects of hazardous wastes. Its scope of application covers a wide range of wastes defined as "hazardous wastes" based on their origin and/or composition and their characteristics, as well as two types of wastes defined as "other wastes" - household waste and incinerator ash.

The provisions of the Convention centre on the following principal aims:

- the reduction of hazardous waste generation and the promotion of environmentally sound management of hazardous wastes, wherever the place of disposal;
- the restriction of transboundary movements of hazardous wastes except where it is perceived to be in accordance with the principles of environmentally sound management; and
- a regulatory system applying to cases where transboundary movements are permissible.

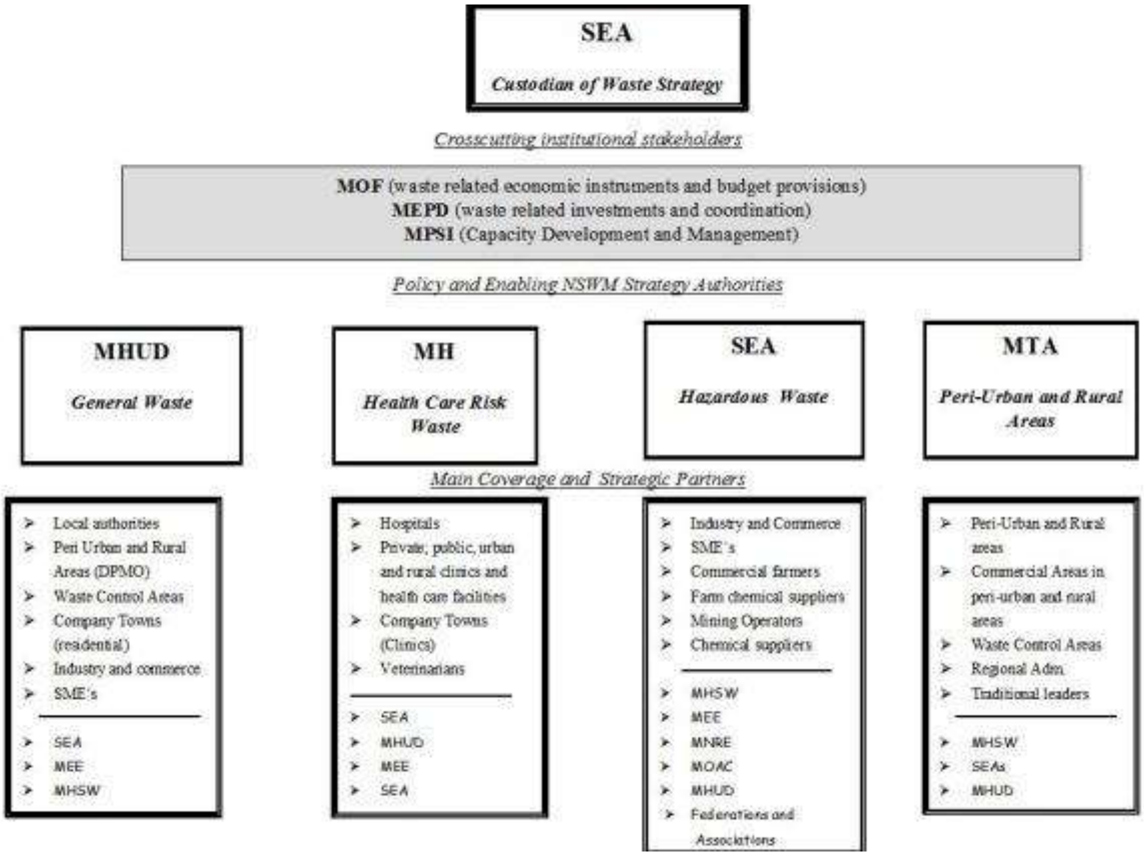
The first aim is addressed through a number of general provisions requiring States to observe the fundamental principles of environmentally sound waste management (article 4). A number of prohibitions are designed to attain the second aim: hazardous wastes may not be exported to Antarctica, to a State not party to the Basel Convention, or to a party having banned the import of hazardous wastes (article 4). Parties may, however, enter into bilateral or multilateral agreements on hazardous waste management with other parties or with non-parties, provided that such agreements are "no less environmentally sound" than the Basel Convention (article 11). In all cases where transboundary movement is not, in principle, prohibited, it may take place only if it represents an environmentally sound solution, if the principles of environmentally sound management and non-discrimination are observed and if it is carried out in accordance with the Convention's regulatory system.

3.5.3.5.3 INSTITUTIONAL RESPONSE

Although good attempts have been made to rectify the problems at the urban local government level and through the establishment of private initiatives on recycling, there is currently a lack of institutional waste management capacity at all levels in Swaziland. This is reflected at both national and local authority level as skills deficiencies, lack of implementing waste management initiatives, financial shortages and inadequate institutional structures. Moreover, little monitoring and enforcement of existing legislation takes place due to the overlapping allocation of responsibilities amongst the various authorities.

Responsibility for management of waste streams at national level should be dependent upon the ultimate institutional mandate of the ministry. For example, the Ministry of Health (MOH) is responsible for monitoring and control of Health Care Risk Waste i.e. medical waste generated from hospitals, health centres and clinics and medical retailers while the Ministry of Housing and Urban Development (MHUD) is the national principal agent for management of household and commercial waste under the auspices of the urban local government bodies such as City Councils, Town Councils and Town Boards. In general, the Swaziland Environment Authority (SEA) is the national coordinating body for development of environmental laws, policies, strategies, setting up environmental regulations, and ensuring enforcement of these. In principle implementation and enforcement of these laws often demand cooperation, collaboration or coordination between different ministries, departments including other non-state stakeholders.

Figure 62: Overview of Institutional Arrangements for Waste Management in Swaziland



Source: Solid Waste Management Strategy (GOS-SEA, 2003b)

The Ministry of Tourism and Environmental Affairs: The MTEA works through the Swaziland Environment Authority. The primary role of the SEA is that of enforcement of the legislation ensuring that waste is managed in accordance with the existing law and taking appropriate actions for violators. The SEA is therefore a key driver for the implementation of the waste management strategy.

The Swaziland Environment Authority (SEA)

The SEA is the conceptual lead agency for waste management. This includes enforcement of the regulations issued by the Authority, co-ordination of the activities of the other ministries with waste management functions, development of waste management policies and strategies, and setting of standards. Under the National Solid Waste Management Strategy, the SEA is tasked with the direct monitoring of hazardous wastes. Consideration of conflict of interest for some line ministries in promoting their respective sectors has also been made for example industry and agriculture. Monitoring of wastes from these sectors is the responsibility of the SEA. The SEA is also responsible for waste management of those institutions and economic agents that are not covered by the above, such as hotels.

The Ministry of Housing and Urban Development

The MHUD is identified as the National one-stop agency for knowledge and matters pertaining to general waste from all sources. This Ministry already has the mandate to declare and regulate the affairs of urban areas. This then makes it the agency that should have the technical knowledge required to advise and monitor waste management issues and resource allocation for municipal councils and Town Boards. This knowledge can then be extended to other Ministries that have to manage general waste.

The MHUD is responsible for the monitoring and control of household and commercial waste management, undertaken by the urban local government bodies, such as City Councils, Town Councils and Town Boards. Their responsibilities are outlined in the Urban Management Act of 1969 and the Environment Management Act 2002.

There is no specific section or department within the MHUD that has responsibility over environmental management issues. However, the associated functional responsibilities are commonly understood to be vested with the Health Inspectors. Monitoring and support to local authorities on environmental management issues or policies is limited.

A local authority means a City Council, a Town Council or a Town Board "declared" under the Urban Government Act. The obligations of local authorities with regard to waste management are defined in the Environment Management Act 2002 and the Waste Regulations 2000. These obligations have however, not been sufficiently communicated to the local authorities, in particular the Town Councils and the Town Boards. The current financial constraints experienced by many local authorities make it difficult for them to prioritise waste management services over and above a minimum of waste collection services.

The Building and Housing Act also makes provision for MHUD to declare an area a "Controlled Area" even when it is located in Swazi Nation Land. This provision only requires a "Structural Plan" to be put in place, but the declaration could be dovetailed with the provision made for the declaration of "Waste Control Areas", described in Waste Regulations 2000 and the Environment Management Act 2002.

Company Towns are urbanised areas that are not under the jurisdiction of the Ministry of Housing and Urban Development. These towns have been established through economic development such as the sugar industry and industrial forestry. Industrial, commercial, residential and medical facilities have been established within the Company Towns. Currently, Company Towns are not under the jurisdiction (physical planning and/or waste management planning) of any ministry. Waste management services are independent of the government.

There are 12 Local Authorities (under the MHUD umbrella) with a responsibity for waste management, notably collection and disposal. These are: Mbabane City Council, Manzini City Council, Matsapha Municipal Council, Ezulwini Municipal Council, Mankayane Town Board, Siteteki Town Council, Nhlangano Town Council, Vuvulane Town Council, Ngwenya Town Board, Hlatikhulu Town Board, Lavumisa Town Board, Piggs Peak Town Council.

The Ministry of Health

The MOH is seen as the one-stop agency for knowledge and matters pertaining to Health Care Risk Waste. The Ministry also has to enforce the Management of Health Care Risk waste throughout the country. The Swaziland Environment Authority monitors the performance of this ministry regarding the management of this type of waste.

The MOH is responsible for all issues relating to public health and specifically for the monitoring and control of the Waste Regulations, 2000 with respect to Health Care Waste generated from hospitals, health centres, clinics and medical retailers. Furthermore, the Ministry is responsible for regulating, enforcing and monitoring health standards, including solid waste management issues, related to food supplies intended for human consumption.

Health officers, both at national government and local government level, do not have a specific legal mandate to enforce improved medical waste management. This has resulted in a lack of proposals for interventions and requests for supporting budgets for improvements of medical waste management. Improved o-ordination between the MOH and the SEA is required to remedy this situation, with a focus on a proactive approach.

Ministry of Tinkhundla Administration

The MTA is legally responsible for Tinkhundlas, Regional Administrations and Community Development. Consequently, the Ministry is considered to be responsible for the monitoring and control of the Waste Regulations 2002 with respect to domestic waste generated in the rural and peri-urban areas, although these responsibilities have no legal basis (see section 3.5.3.5.1.3 on waste management in non-urban areas).

The Ministry of Commerce, Industry and Trade

The MCIT is responsible for monitoring and control of the implementation of the Waste Regulations 2000 in the Industrial Estates. It is generally understood, that this responsibility includes not only the Matsapha

Industrial Estate and other industrial estates, but also in the Company Towns. There is currently no dedicated unit or staff group within MCIT assigned enforce waste legislation or to advise and monitor environmental management issues or policies within the industrial and commercial sector. The industrial and commercial sector is also uncertain about the duties and responsibilities of the different government institutions and requires guidance with regard to which department they should approach to assist with environmental and waste management issues.

Ministry of Agriculture

The MOA is generally perceived to be responsible for the monitoring and control of wastes generated as a result of agricultural practices and their control and compliance with the Waste Regulations 2000. This responsibility is however not explicitly defined in the regulations.

The responsibility is mainly confined to the disposal of used agrochemical containers. The monitoring and enforcement of wastes generated from the processing of agricultural products, is the responsibility of the other ministries as discussed above. MOA officers at national and local government level do not have specific responsibilities and mandates to enforce improved agricultural waste management. This has resulted in limited improvements in the management of agricultural wastes.

Ministry of Natural Resources and Energy

The MNRE is responsible for authorisations under the Mining Act. This responsibility includes: Mineral Exploration, Industrial Minerals, Mapping, Fossil Fuels, Groundwater Resources, Drilling and the Laboratory. MNRE is generally considered to be responsible for waste generated as a result of mining practices. Mining waste is however, not specifically addressed within the legal mandate of the ministry.

Ministry of Public Works and Transport

The MPWT has the jurisdiction over public roads. The maintenance of roads must not be limited to construction and physical repairs. Ensuring the cleanness of the main public roads must be part of the road maintenance. In collaboration with the SEA and the police force, violators can be dealt with accordingly.

Ministry of Finance and the Ministry of Economic Planning and Development

These Ministries play a central role in identifying, designing, approving and implementing economic instruments to support specific waste management initiatives. Economic instruments may include possible taxes on plastic bags, import duties and levies on waste and waste generating packages as well as the introduction of incentives for the general public and industry. Most importantly these ministries hold the key responsibility to ensure that budget provisions are made to support legally founded responsibilities for waste management.

3.5.3.5.4 ENVIRONMENTAL INDICATORS: RESPONSE TO WASTE MANAGEMENT

Environmental indicators measuring the response to waste management can include:

Indicator	Measurement	Source	Availability/Reliability
Approved landfills	number approved	SEA	available / reliable
Waste Control Areas declared	number declared	SEA	available / reliable
Construction & operation waste disposal facility: landfill, WCA; Available landfill lifespan (airspace)[43]	number constructed & operational capacity; vol (m^3) available air space	SEA, municipalities & facility operators	available / part reliable
General waste correctly disposed[44]	T/annum	SEA, municipalities, WCA's, private sector	available / not reliable

[43] Number of Landfills: These indicator measures the status and number of landfills. The number of landfills available for waste is critical for successful waste management. This indicator will highlight the need for waste reduction and recycling. It will relate trends in the status and number of landfills if measured for a minimum of three years. Tracking progress with this indicator will depend on what the goal is: to reduce or increase the number of landfills or reduce the need for landfills. This will allow for the medium to long-term planning of landfill sites and treatment facilities.

[44] Volume and/or weight of solid waste to landfills and other sites; the indicator measures the volume of solid waste entering landfills, and gives number of landfills and dump sites available to handle waste generation.

Indicator	Measurement	Source	Availability/Reliability
Hazardous waste correctly disposed (trans-boundary transfer)	T/annum	SEA (Basel Focal Pt), transport companies	available / reliable
Health Care Risk Waste Correctly Treated and Disposed	T/annum	MOH, Private Health Care Facilities	part available / part reliable
Proportion of waste recycled (retrieved/salvaged from landfills)	T/annum & %	SEA, municipalities, Landfill & WCA operators; recyclers	not available
Value of recyclables	E	Industry recyclers	not available
Govt expenditure on waste management	total & % budget	MOF	available / reliable
Municipal/Local expenditure on waste management	total & % budget	Municipalities	available / reliable
Municipal/Local capacity of waste collection	volume & area covered	Municipalities	available / reliable
Special Waste Management Licences	numbers issued	SEA	available / reliable
Special Waste Carrier Licences	numbers issued	SEA	available / reliable
Waste Management Licences	numbers issued	SEA	available / reliable
Solid Waste Management Plans	number	SEA	available / reliable
Abatement Notices	number	SEA	available / reliable

3.5.4 HUMAN HEALTH

Swaziland faces many challenges in the health sector among which limited capacity in terms of human and financial resources is one, and weak information systems particularly in relation to monitoring and evaluation of different priority health programmes is another.

3.5.4.1 DRIVING FORCE

Primary driving forces for an individual are the need for shelter, food and water. With an increasing population these driving forces translate to increasing urbanisation, production and consumption. Although an individual driving force might be the desire to stay healthy, this desire might be compromised by other needs, e.g. consumption, that conflict with this desire.

The primary driver for the state could be the need to maintain an economic healthy population and healthy environment that is unpolluted and able to provide essential goods and services to people.

The primary focus in this section is on the identification and analysis of the forces that lead to pressure on the environmental compartment discussed here, namely human health. The interest is in forces or pressures deriving from environmental factors, and not pressures from e.g. genetic factors.

In other words, the attention here is in the first place on the negative environmental factors (forces, pressures) that lead to compromised health conditions. Some of these factors are complex, e.g. the interrelated forces of sexual behaviour and circumstantial conditions that may lead to HIV/AIDS. In other cases, as with malaria or bilharzia, the determining factor is the general environmental conditions, not even necessary disturbed, however often aggravated by natural disasters.

The most generally applicable driving forces however (as indicated above), are industrialisation and consumption that lead to changes in living conditions and quality of air and water (see next section under pressure).

3.5.4.1.1 ENVIRONMENTAL INDICATORS: DRIVING FORCE BEHIND HUMAN HEALTH

Environmental indicators measuring the driving forces behind human health can include:

Indicator	Measurement	Source	Availability/Reliability
Population growth rate	%	CSO	available every 10yrs
Urban growth rate	%	MHUD	available
Industrial production	% change	MEPD, CSO	available
Consumption patterns	% change	MEPD, CSO	part available

3.5.4.2 PRESSURE

As a result of the driving forces described above, major pressures on health derive from changes in environmental conditions (air, soil, water), which encourage disease and poor health. These pressures include:

- Diminishing general environmental conditions
- Diminishing ecosystem goods and services, in particular medicinal plants
- Deteriorating housing and living conditions
- Contamination of water quality (water pollution)
- Contamination of air quality (air pollution)
- Contamination of soil quality (soil pollution)
- Increasing occurrence of natural disasters, in particular floods.

Many of these impacts are similar or relate to impacts that were described earlier in this report under the impacts section of e.g. water (section 3.2.4), atmosphere (3.3.1.4), biodiversity (3.4.4), urbanisation (3.5.1.4), waste (3.5.3.4).

With respect to the type of living areas, environmental degradation has increased incidences of floods, pollution and poor sanitation and hygiene especially in the rural areas. In urban areas, rural-urban migration has resulted in over-crowding and large populations living in slum like situations which are not provided with water and sanitation facilities. This has created an environment conductive for communicable diseases such as malaria, cholera etc. These diseases are among the major causes of admission in hospitals and deaths.

Additional pressures derive from typical environmental health areas and situations, such as food safety and hygiene (general foods, meat, water, sanitation, etc), health care waste management, control of insects and rodents as well as occupational health and safety.

3.5.4.2.1 ENVIRONMENTAL INDICATORS: PRESSURE ON HUMAN HEALTH

As mentioned above, environmental indicators applicable to this section relate to environmental indicators identified in the relevant impacts section of land, water, atmosphere, biodiversity, urbanisation, and waste. There is no need to repeat all of these, in particular the ones on pollution; however several can be added or repeated to emphasise focus on health impacts.

Environmental indicators measuring the pressure on human health can include:

Indicator	Measurement	Source	Availability/Reliability
Ecosystem goods & services, in particular medicinal plants	% change	Dept Forestry	probably not available
Natural disasters: floods	% change	Nat Met Services	available
Urban living conditions	descriptive	MHUD	part available
Urban population densities	numbers/area	MHUD, MOH, CSO	available
Rural population densities	numbers/area	MHUD, MOH, CSO	available
Food safety and hygiene	parameters	MOH, CSO	available

3.5.4.3 STATE

This section on state of health relates to current general health aspects of the population; however it focuses on health aspects which relate to environmental conditions.

Both communicable and non-communicable diseases continue to be a major challenge for the country. According to Health Statistics Reports, upper respiratory conditions are by far the leading outpatient conditions. The burden of communicable diseases is similarly reflected in the leading causes of inpatient morbidity and mortality, with AIDS and TB together accounting for admissions and a third of deaths. Others are gastro-enteritis, colitis and pneumonia. The most cited reasons for admission include pulmonary tuberculosis, malaria, gastro-enteritis, colitis and pneumonia. On the other hand diabetes mellitus, a non-communicable disease was reportedly among the top ten (10) leading cause of inpatient admission in 2009 (HMIS Report, 2009).

3.5.4.3.1 HIV AND AIDS

In the absence of a cure for HIV, prevention remains the cornerstone especially in the country where the prevalence remains unacceptably high. In this regard, Swaziland has adopted several HIV prevention strategies in an effort to reduce the incidence from the current 3% to 2.3% by 2014 as enshrined in the National Multi-sectoral Strategic Framework (NSF). These include the health education, provision of male and female condoms, PEP, provision of sexually transmitted infections services, the provision of Male Circumcision services and promotion of safer sex practices.

In Swaziland, prevention has focused on building comprehensive knowledge of HIV and AIDS in the population at large with the aim of preventing new infections.

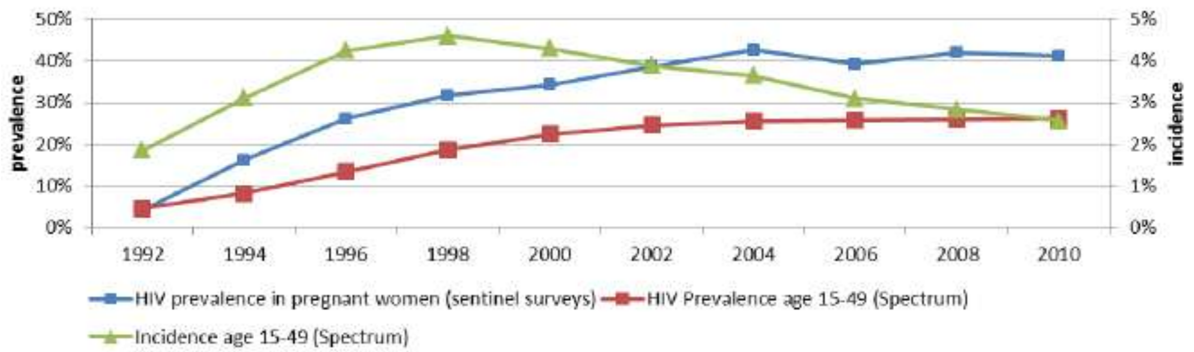
Condom use constitutes one of the main measures to prevent HIV transmission. The impact of condoms on HIV prevention depends on several parameters that include condom marketing, accessibility and correct and consistent use. In general, male condoms are more available compared to female condom with 84.5% and 67.2% of facilities respectively that reported having condoms.

Universal access to antiretroviral therapy is one of the goals of the response to HIV and AIDS epidemic. By the end of September 2010, 55,296 (64.1%) people were actively on treatment comprising of 49,907 adults and 5,389 children (MOH 3rd Quarter M&E Report). Using the eligibility criteria of CD4 cell count 350 cut off point, about 77,156 are in need of ART and projected that 97,108 people will be in need of ART by 2015, out of the 198,668 of adults who will be living with HIV/AIDS (HIV Projection Report 2010).

Epidemiology review indicates an increase in HIV prevalence among pregnant women, from 3.9% in 1992 to 41.1% in 2010. The 2010 Antenatal Care sentinel surveillance survey showed that prevalence has stabilised between 42% and 41% and that HIV prevalence is highest among those aged 30-34 years (53.8%) and lowest among those aged 15-19 years (20.4%).

Figure 63 shows HIV prevalence rate and incidence.

Figure 63: HIV Prevalence and incidence



Source: GOS 2012 - Swaziland Country Report On Monitoring the Political Declaration on HIV and Aids

Swaziland began the roll-out of antiretroviral treatment (ART) and prevention of mother-to-child transmission (PMTCT) in 2003, and has showed remarkable progress. Currently, ART coverage is at 43% of those in need, and 72% of the HIV positive pregnant women were reached with PMTCT. HIV-testing however coverage remains low, only 16% of the people know their HIV status.

Voluntary Counselling and Testing (VCTs) and the treatment of people living with HIV has increased.

For people living with HIV AIDs and relying on a variety of drugs to stabilise their condition, access to nutritious food and clean water are imperative. Anecdotal evidence indicates that though there have been improvements in access to clean water, access to nutritious food remains a challenge and can compromise the effectiveness of the drugs prescribed.

3.5.4.3.2 TUBERCULOSIS

TB and the Environment

TB has been linked with environmental risk factors that go hand-in-hand with poverty such as poorly ventilated housing infrastructure, tobacco smoke, malnutrition, overcrowded living conditions, and excessive alcohol use.

TB patients, especially those from the rural areas seek medical attention from traditional healers before attending hospitals for modern chemotherapy. This means that most rural patients start TB treatment when the disease has advanced. Such patients do not respond to medication quickly and this contributes to the high mortality rate.

Tuberculosis has become one of the re-emerging diseases and remains a major public health problem in Swaziland. It is one of the top causes of morbidity and the leading cause of mortality in adults since 1997. Available evidence indicates that the current TB epidemic, both in terms of morbidity and mortality, is fuelled by the generalized and high prevalence of HIV in the country, with a an incidence rate of 1257 cases per 100 000 population and a TB-HIV co-infection rate of 82% which is a direct result of the high HIV prevalence in the country.

Table 91: Facilities Providing TB Treatment Services by Type of Facility (2010)

Facility Type	Total Number of Facilities	Facilities providing TB Screening		Facilities providing TB Treatment	
		#	%	#	%
National Referral Hospital	3	2	66.7	2	66.7
Regional Hospital	5	5	100.0	5	100.0
Hospital	4	4	100.0	4	100.0
Health Centre	5	5	100.0	5	100.0
Public Health Unit	8	4	50.0	0	0.0
Clinic with Maternity	25	21	84.0	11	44.0
Clinic without Maternity	186	111	59.7	57	30.6
Specialized Clinic	29	9	31.0	2	6.9
Total	265	161	60.8	86	32.5

Source: GOS-MOH, 2010

HIV is strong risk factor for developing the tuberculosis (TB) disease in those with latent or new Mycobacterium tuberculosis infection. The risk of developing TB is between 20 and 37 times greater in people living with HIV than among those who do not have HIV infection. TB is responsible for more than a quarter of deaths in people living with HIV.

TB screening services are currently offered in over 60% of the country's health facilities a majority of whom are clinics without maternity (59.7%). All regional hospitals and health facilities including health centres provide TB screening to their patients (Table 91).

TB treatment services are now being provided in over 30% of industry owned facilities, 22.7% of NGO based facilities, 38.2% of mission owned and an impressive 19.5% of privately owned facilities.

In 2010, 11057 new confirmed TB cases were reported and the incidence has increased from 300 per 100,000 people in 1990 to 1,257 per 100,000 people in 2010. According to the National TB Programme annual report (2010), 88% of TB patients have been tested for HIV and of these, 82% tested positive to HIV.

3.5.4.3.3 MALARIA

Malaria, like TB and HIV, has resulted in the high burden of diseases globally and regionally. Malaria is a major problem throughout the SADC region. About 74% of the people in this region live in malarious areas of which 18 million (18%) are children under five and 4 million (4%) are pregnant women, who are at risk for contracting the disease either seasonally or throughout the year. Malaria remains a major contributor to morbidity and mortality.

In Swaziland, malaria transmission is most prevalent along the eastern, northern and southern borders, occurs mainly in the rainy season between November and May with a peak in February and March and is most intense in the Lubombo region than Hhohho, Manzini and Shiselweni regions. Swaziland has made significant progress on malaria control over the past 5 years evidenced by the reduction in clinical malaria cases from 49.5 to 18 per 1000 of the population at risk in 2007 compared to 2002.

Between July 2011-June 2012, Swaziland had 300 confirmed malaria cases, of which 100 were determined to be locally transmitted (Ministry of Health First Quarter Performance Report 2012/13).

Table 92: Regional Disaggregation of Facilities Providing Malaria Services (2010)

Regions	Health Facilities	Facilities Offering Malaria Diagnosis

		#	%
Hhohho	71	44	62
Lubombo	53	38	71.7
Manzini	104	43	41.3
Shiselweni	37	22	59.5
Total	265	147	55.5

Source: GOS-MOH, 2010

3.5.4.3.4 BILHARZIA (SCHISTOSOMIASIS)

All rivers in Swaziland harbour the fresh water snails (intermediate host) that transmit bilharzia. The prevalence rate in the country is above 50% in the vulnerable age group of 6 – 15 years. The worms survive for about 30 – 50 years in the human body (the final host), thus bilharzia worm attacks is not only restricted to the above vulnerable age group only but also in the adult group. The only early visible sign of worm infection is blood in urine and in stool which immediately subsides with and or without treatment thus the person thinks is healed or free, leading to the disease complications in the body.

Urinary bilharzia is the most common type in Swaziland. Three species are prevalent in Swaziland: *S. mansoni*, which causes intestinal schistosomiasis, *S. haematobium*, which causes urinary schistosomiasis, and *S. matheei*. Infection is through the skin following contact with snail infested aquatic environment/water. Schistosomiasis is primarily a rural disease associated with daily activities related to water contact such as farming, rice growing, fishing, bathing and recreation.

In Swaziland, the intermediate snail host for *S. haematobium* is Bulinus (*Physopsis*) *africanus*, which is common in the Middleveld (approximately between 400 and 800m asl) and Lowveld (approximately lower than 400m asl) but is found only rarely in the Highveld (approximately higher than 800m asl). The intermediate snail host for *S. mansoni* is *Biomphalaria pfeifferi*, which is prevalent in the Lowveld. The *Lymnaea natalensis* snail, an intermediate host for the cattle liver fluke, was also included in the project because of the cultural and commercial importance of cattle in Swaziland.

The incidence of bilharzia is presented in Table 93.

Table 93: Bilharzia Incidence (1999-2011)

Year	Total Suspected Cases	Positive	Negative	% Positive
1999	2033	1644	389	81%
2000	1825	1418	408	78%
2001	2066	1363	705	66%
2002	1950	1531	419	79%
2003	1825	1116	709	61%
2004	2742	1658	1084	60%
2005	2616	1634	982	62%
2006	2354	1794	560	76%
2007	2042	1800	243	88%
2008	3400	2890	510	85%
2009	3470	2893	577	83%
2010	1674	1120	554	67%
2011	1550	1083	467	70%

Source: National Bilharzia &Worms control Program (NBWCP)

3.5.4.3.5 ENVIRONMENTAL INDICATORS: STATE OF HUMAN HEALTH

Environmental indicators measuring the state of human health can include:

Indicator	Measurement	Source	Availability/Reliability
Human health statistics	various	MOH Annual Statistics	available / reliable
Prevalence of HIV AIDS	%	MOH / NERCHA	available / reliable
Prevalence of malaria	%	National Malaria Control Programme	available / reliable

Indicator	Measurement	Source	Availability/Reliability
Prevalence of bilharzia	%	National Bilharzia & Worms Control Program	available / reliable
Prevalence of TB	%	MOH / NERCHA	available / reliable
Prevalence of waterborne diseases	%	MOH	unavailable / reliable
Respiratory infections	number of cases	MOH Annual Statistics	available / reliable
Diarrhoea	number of cases	MOH Annual Statistics	available / reliable

3.5.4.4 IMPACTS

Changed health conditions resulting from environmental pressure do impact on society in general through increasing cost of health care and on societal and individual relationships in particular through changed dependencies, stigmatism, etc. Health conditions will affect general well being and happiness.

Impacts from health are measurable on the labour force and hence on agricultural and industrial production. In reverse, it affects income and poverty. This applies to all diseases but especially to HIV and AIDS infections, which in addition have a seriously negative impact on the environment, through the loss of human capacity for environmental management and the aggravation of poverty and associated over-harvesting of natural resources. A minor but significant impact comes from the increasing use of drugs packaged in a variety of materials from plastic to paper which waste material is often indiscriminately discarded, contributing to urban and rural litter and unsanitary disposal.

3.5.4.4.1 ENVIRONMENTAL INDICATORS: IMPACTS FROM HUMAN HEALTH CONDITIONS

Environmental indicators measuring the impacts of human health can include:

Indicator	Measurement	Source	Availability/Reliability
Cost of increased health care, in particular environmental health care	budget	MOH	available
Impact of production from reduced labour force	percentage	DWA, MEPD	available / reliable
Social and economic impact from floods and other disasters	various	DWA, MEPD	available / reliable

3.5.4.5 RESPONSE

Society expects health authorities to provide basic health care for the population whilst at the same time improving the environmental and living conditions of the population that prevents infection.

3.5.4.5.1 INVESTMENT RESPONSE

Primary Health Care

The formal health sector is based on the concepts of primary health care and decentralization. Its infrastructure is made up of 7 government hospital (1 National Referral hospital which also services as a Regional hospital and 2 specialized referral hospitals, 2 mission hospitals and 1 industry supported hospital. There are also 8 public health units, 12 health centres, 76 clinics and 187 outreach sites. The first Intensive Care Unit was opened in the country at the National Referral Hospital in the year 1998, followed by the Renal Unit in 2003. RFM hospital has also recently opened their ICU and renal unit. Hlathikhulu Government Hospital will soon be having a renal unit also opened in their facility.

The health system is based on the concept of primary, health care, secondary health care and tertiary levels. At primary level there are community based healthcare workers, clinics, and outreach services. At secondary level, there health centres (which offer inpatient and outpatient). They also serve as referral points for primary levels. The Tertiary level comprises of hospitals, specialized hospitals and national referral hospitals.

The sector is serviced by a workforce of 275 doctors, 3,074 staff nurses, 275 nurse assistants, pharmacists and a number of allied health professionals and support staff, whose work is supplemented by approximately 4,000 rural health motivators, home based carers and community birth attendants.

According to the most recent health statistics report there a 198.2 bed needs per 100,000 people in the country, with Manzini having the largest ratio (287.3) followed by Hhohho (235.9) then, Lubombo (127.1) and Shiselweni (81.6).

TB and HIV and AIDS continue to be a challenge in Swaziland. The incidence Tuberculosis has increased from 300 per 100,000 people in 1990 to over 1,000 per 100,000 people. It is also estimated that there about 230,000 people living with HIV and AIDS (PLWHA) and over 17,000 of those PLWHA have had access to ART. In improving the health status of the population, the health sector continues to realize progress in control and management of diseases and in the promotion of healthy living through curative services and various public health programmes.

According to the National Health Policy, up to 85% of the population lives within a radius of 8 kilometers from a health facility. However, the quality and availability of health services is affected by the distribution of resources. There is ample evidence to suggest that the distribution of health resources tends to favor urban over rural based populations. According to the WHO situational analysis of the health workforce in Swaziland (2004) the ratio of doctors and nurses to the population was 1: 5 953 and 1: 356, respectively.

Health Service Availability Mapping

According to GOS-MOH, 2010, Service Availability Mapping is a tool for the management of health programmes and planning for their improvement, the mission of the health sector, as articulated in the National Health Policy (2007), is to provide preventive services that are accessible, acceptable, affordable and socially and culturally relevant to all citizens of the country, based on the Primary Health Care strategy.

The same document recognizes the burden posed by both communicable and non-communicable diseases on the health system and has identified key strategic areas to focus on in achieving the mission. Among these is ensuring that high quality health care services are made available within an 8km radius to every person.

The Health Sector service delivery system is loosely organized in a four-tier system comprising of three national referral hospitals, five regional hospitals, primary health care facilities (health centres, public health units and clinics with and without maternity, and community based care (RHM's, faith-based health care providers, TBA's, volunteers and traditional practitioners). It is at the clinics and Public Health Units that the health service delivery interfaces with the community.

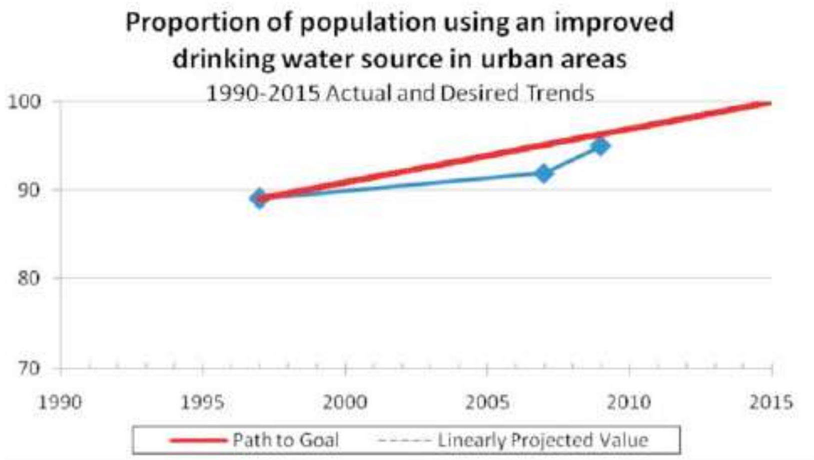
Services provided in the health sector include preventive, curative and rehabilitative services. Allopathic medicine is the cornerstone of the health sector services delivery, though clients also utilize traditional and/or faith based practitioners for different ailments.

Access to Improved Water Sources

National efforts to address the provision of water and sanitation to communities have been successful with on-going activities to meet the MDG goals on water and sanitation (see also section ... on urbanisation).

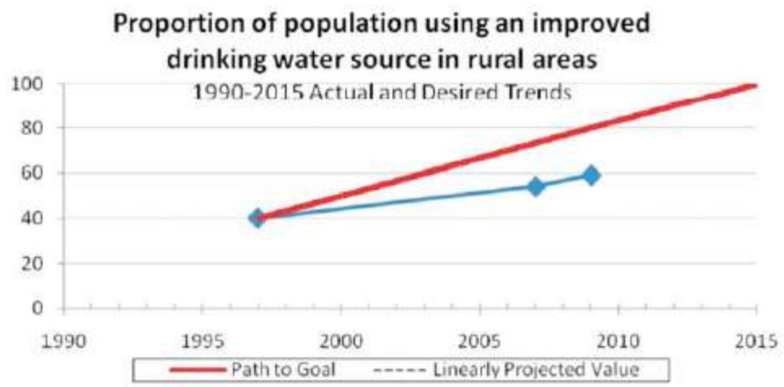
According to the MDG Progress Report (GOS-MEPD, 2010) more than two-thirds of households have access to improved water sources and three in four households are within 15 minutes of their drinking water supply. About 73% of urban households have water piped into their dwellings or yards, while about 23% of rural households have direct piped water. Rural households also rely on public taps, surface water and dug-protected wells for their drinking water. Access to safe drinking water in rural areas has been improving since 1997 from 40% to 54% in 2007 and 59% in 2009. The situation in Swaziland for urban and rural areas is shown in Figure 64 and Figure 65.

Figure 64: Proportion of Population Using Improved Drinking Water Sources in Urban Areas



Source: GOS-MEPD, 2010

Figure 65: Proportion of Population Using Improved Drinking Water Sources in Rural Areas



Source: GOS-MEPD, 2010

National Response to HIV and AIDS

Swaziland began the roll-out of antiretroviral treatment (ART) and prevention of mother-to-child transmission (PMTCT) in 2003, and has showed remarkable progress. Currently, ART coverage is at 43% of those in need, and 72% of the HIV positive pregnant women were reached with PMTCT. HIV-testing however coverage remains low, only 16% of the people know their HIV status.

The national response in Swaziland is coordinated by the National Emergency Response Council (NERCHA) since 2001, and the health sector response is coordinated by Swaziland National AIDS Programme (SNAP). The National HIV and AIDS policy was approved by the cabinet in 1998 and the national response is guided by a National Strategic Framework on HIV and AIDS (2009-14). The country has devolved 3 National HIV strategies. The first national multisectoral strategy for the period 2000-2005, the second strategic plan covered the period 2006-2008 and the current National Multisectoral Strategic Framework 2009-2014.

HIV Prevention remains critical to the national response to HIV and AIDS. Effective prevention interventions are selected on the basis of empirical evidence of their efficacy in preventing new infections. This includes interventions that are designed to reduce exposure to HIV, reduce the probability of transmission when exposed, and influence change in societal norms, values and practices that tend to impact on peoples' ability to adopt key prevention behaviours.

National Response to Bilharzia

In 2009, the National Bilharzia & Worms Control Program (NBWCP) with support from WHO funding, was started. The core mandate for the NBWCP is to control morbidity with de-worming for the schistosomiasis and soil transmitted helminthiasis. Through de-worming, worms in the human body are destroyed into a reduced number that will not harm proper functioning of body systems and organs. The de-worming treatment is done through repeated single dose and high effective drugs of choice which can be safely distributed to age groups at risk.

The programme aims at reducing the prevalence to less than 1% by 2013 for all children entering school with the guidance of WHO standard which requires that m if 20% of children in school are infected then all school aged children should be offered mass treatment annually and that if 50 % infected the whole community should be treated.

National Response to Malaria

In 2007, during the third session of the African Union (AU) Conference of Ministers of Health, member states launched the Africa Malaria Elimination Campaign. Following suit, the Southern Africa Development Community (SADC) similarly pledged to eliminate malaria from Southern Africa, identifying four countries with the greatest potential to eliminate malaria by 2015 (Botswana, Namibia, South Africa and Swaziland), as well as longer-term elimination goals among neighbouring countries to the north with relatively higher transmission of malaria (Angola, Mozambique, Zambia and Zimbabwe). The Government is formulating a National Malaria Elimination Strategic Plan to address the human health impact of malaria.

Swaziland has made significant progress in reducing malaria morbidity and mortality and sits at the cusp of elimination. Since 2000, malaria incidence declined from by nearly 90%. With this progress, Swaziland has already exceeded the Millennium Development Goal on malaria and Roll Back Malaria's Abuja targets. The country's achievement was the result of scaled-up vector control interventions within Swaziland and the impact of the successful regional malaria control collaboration, the Lubombo Spatial Development Initiative (LSDI), with neighbouring Mozambique and South Africa. The LSDI, an economic development initiative that included a component to reduce malaria, is frequently referenced as a best practice by the global malaria community because it exemplified the impact that regional collaboration in malaria control can have on dramatically decreasing malaria morbidity and mortality. The progress attributed to LSDI has led Swaziland to commit to elimination by 2015.

Swaziland is fostering an environment for technical advancement to improve the impact of malaria interventions. The country has implemented a robust malaria surveillance programme, aided by Geographic Information Systems (GIS), to track malaria cases and prevent onward transmission. Surveillance work is supported by the deployment of new, innovative diagnostic methods, including DNA PCR, to ensure that all malaria cases are found, diagnosed, and treated. The country is documenting the use of these methods and sharing with our neighbouring countries to improve the regional response to malaria.

3.5.4.5.2 SYSTEMIC RESPONSE

Legislation

Public Health Act, 1978

Swaziland National Nutrition Council Act, 1945

Air Quality Regulations, 2010

Policy, Plans and Strategy

National Health Policy, 2007

The main thematic areas of focus in the Health Policy are: Organization and Management, Human Resources, Quality Assurance, Health Financing, Infrastructure Development and Equipment Management, and Service Provision. The National Health Policy identifies health promotion including environmental health as the cornerstone of the health system and puts premium on prevention and control of priority communicable and non-communicable prevalent diseases.

National Pharmaceutical Policy, 2011

The National Pharmaceutical Policy charts the way forward to address problems in the provision of pharmaceutical services in Swaziland. The SNPP is therefore a commitment to a goal and a guide for action.

The key policy areas addressed in this document include the following:

- Strengthening the central pharmaceutical administration;

- Developing and enacting enabling pharmaceutical legislation and regulations;
- Strengthening the national medicine supply system;
- Pharmaceutical human resources development;
- Establishment of a Pharmacy Council and a Medicines Regulatory Authority;
- Quality assurance;
- HIV and AIDS;
- Rational medicine use;
- Local Production and Patents and;
- Traditional medicine.

National Health Sector Strategic Plan (NHSSP 2008-2013)

The primary purpose of the National Health Sector Strategic Plan (NHSSP) is to guide the MOH and its partners in the implementation of the National Health Policy. The Strategic Plan conveys the prospects for improving the health status of all the people of Swaziland and provides a coherent and system wide framework for intervention planning and performance measurement over the next five years. As a management tool, the Strategic Plan seeks to enable the MOH to manage change and reforms within the sector in a structured and predictable way. In this respect, the Strategic Plan commits the entire health sector to the same objectives, processes and accountability standards. More importantly, the Plan provides an enabling framework for forging and sustaining strategic partnerships and cooperation among various stakeholders within and outside the health sector.

While there is no doubt that HIV/AIDS and TB co-infection remains a key priority for the country, the NHSSP underlines the need for an integrated and comprehensive approach to the number of current as well as emerging and re-emerging health challenges that are likely to affect the population. For instance, it is deemed that HIV/AIDS and TB survival will severely challenge the country in the near future and this remains one of the main issues the NHSSP tries to address anticipating needs and planning for actions based on evidence of successes and/or cultural financial appropriateness.

The purpose of the NHSSP is to:

1. Reverse the downward trend in health outcomes and improve the health status of the Swazi population ;
2. Accelerate the achievement of the health related MDGs and poverty reduction strategies;
3. Guide the needed health sector reforms;
4. Provide a coherent framework for sector wide intervention planning and resource targeting over the next five years;
5. Guide the coordinated participation of all stakeholders and Development partners towards the achievement of stated objectives; and
6. Provide a framework for monitoring and evaluating the performance of the sector at all levels.

The NHSSP intends to establish a comprehensive and multi-sectoral environmental health framework to ensure a safe and sustainable environment for the promotion and sustenance of good health and quality of life for all people in Swaziland. In particular, the NHSSP seeks to contribute to a significant reduction in morbidity and mortality due to environment-related conditions and diseases. The national targets to be achieved by the end of 2013 are:

- To increase safe water supply from 59% to >80%.
- To increase improved sanitation facilities from 52% to >80%
- All regions carrying out regular drinking water quality surveillance activities
- To increase safe waste disposal including human excreta facilities from 25% to >60% of households
- Environmental Health Act and subsidiary legislation in place and being fully enforced.

National Malaria Elimination Strategic Plan

Swaziland's strategy to transition from a control programme to an elimination programme focuses on four major intervention areas. These include: (1) effective case management through definitive diagnosis and effective treatment, (2) integrated vector management, particularly in combining the use of indoor residual spraying (IRS) and long-lasting insecticide-treated bed nets (LLINs), (3) a strong disease surveillance system, and (4) a comprehensive information, education, and communication (IEC) campaign.

Health Care Waste Management Plan (HCWM)

A Health Care Waste Management Plan (HCWMP) has been prepared which provides proper guidelines for comprehensive health care waste management to prevent, reduce and mitigate environmental health impacts on facility staff and the public caused by poor health care waste management. The approach of the HCWMP involves reinforcing the national legal framework for HCWM in Swaziland, improving and strengthening of the institutional arrangements, improving HCWM in health facilities, providing training for health care staff and other health care waste practitioners on acceptable waste management practices, raising awareness among the general public on risks associated with health care waste handling, and development of a monitoring system for the implementation of the HCWMP. The Project will support preparation of ESMPs for each of the three categories of health care facilities to be rehabilitated in line with the framework provided in the Environmental and Social Management Framework (ESMF) prepared for the project. The ESMP reports will also spell out the specific requirement for each site or health facility.

School Health Programme (SHP)

School Health partnered with MTN-Swaziland and Mcmillan-Swaziland to deliver health services to six primary schools in the country during 21 days of yellow care. The schools were mainly enyatsini, Etjeni in the shiselweni region, Ntondozi, Ngwempisi Farm in Manzini, Dvumani in the Lubombo and Mlumati in the Hhohho region. Services that were provided were health education, medical screening, treatments, referrals, oral health services, mental health services and Environmental health assessments. There were 2,800 children screened, 1,500 treated and 50 referred. All the schools were not adhering to the minimum Environmental health standards. McMillan was distributing educational books by initiating mobile libraries in the schools.

Rural Health Motivator (RHM) Programme

The Rural Health Motivators Program has continued to train RHMs on Community Based Growth Monitoring and Promotion (CBGM&P) in five Tinkhundlas. A total of 1006 RHMs and care givers have been trained on Community Health Information System (CHIS) in thirteen Tinkhundlas within the first quarter of 2012.

3.5.4.5.3 INSTITUTIONAL RESPONSE

Ministry of Health (MOH)

The Health Ministry seeks to improve the health status of the people of Swaziland by providing preventive, promotive, curative and rehabilitative services that are of high quality, relevant, accessible, affordable, equitable and socially acceptable.

The ministry's vision is to ensure that "By the year 2015, the Sector shall have developed into an efficient and effective managerial population of people that live longer, healthier and socially fulfilling lives. As such, the country's health indicators shall compare favourably to those of countries with a similar level of human development".

The core objectives of the Ministry are to:

- Reduce morbidity, disability and mortality due to preventable health and social conditions.
- Ensure equal access to public health and essential clinical and social services by all people in the country.
- Increase investment in cost-effective health services.
- Ensure user satisfaction with health services

Environmental Health Department (MOH – EHD)

The EHD is responsible for protecting public health and upholding the maintenance of healthy environments. Environmental health officers perform complex environmental health problems and understand how to formulate effective solutions. This may involve education, health promotion, giving advice or enforcement and/or working with other agencies. Environmental Health Officers are responsible for key performance areas such as, food safety, meat hygiene, water, sanitation, and hygiene, occupational health and safety, health promotion, environmental pollution control, health care waste management, the control of insects and rodents, carrying out inspections for the licensing of trade premises, children's environmental health etc.

Centre for Emergency Preparedness and Disaster Risk Management for Health

The MOH has established a functional Centre for Emergency Preparedness and Disaster Risk Management for Health which coordinates planning, preparedness and response to health emergencies and ensures that the health sector is adequately prepared to deal with all types of emergencies/disasters, monitors outbreaks and global disease trends, assess public health risks during emergencies and provide Emergency Medical Services (EMS).

National TB Hospital

The National TB hospital continues to provide services to majority of drug resistant TB cases in the country since its inception in 2009. Although there have been achievements, there are still some challenges particularly those relating to infrastructure and human resources. The hospital is still operating without a pharmacist and at the moment only one pharmacy technician attends to all drug management issues. The uncompleted block of ward is also still to be completed and the laboratory is still without air conditioning system. The home based care team is still in need of a means of transport dedicated for community based activities.

3.5.4.5.4 ENVIRONMENTAL INDICATORS: RESPONSE TO HUMAN HEALTH

Environmental indicators measuring the response to human health can include:

Indicator	Measurement	Source	Availability/Reliability
Progress reports of National Health Sector Strategic Plan	reports	MOH	available / reliable
Enactment of new legislation	number	MOH	available / reliable
Development of environmental health policy	approval	MOH	available / reliable
Strategies targeting human health developed	number	MOH	available / reliable
Proportion of population using improved drinking water sources in urban areas	% change	MOH annual stats	available / reliable
Proportion of population using improved drinking water sources in rural areas	% change	MOH annual stats	available / reliable

4 CHAPTER 4 FUTURE OUTLOOK

4.1 FUTURE OUTLOOK: LAND

Theme 1: LAND is subdivided into three sub-themes: (1) Land Use & Land Use Change, (2) Soil Erosion and Land Degradation, and (3) Forests and Woodlands.

4.1.1 FUTURE TREND BASED ON STATUS QUO

Extrapolation of the current state and trend in the environment assuming a status quo situation - which means business as usual - will evolve to a future trend not different from the present one and will continue showing the same negative impacts on the environment as described in the previous chapter on State of the Environment.

4.1.1.1 LAND USE AND LAND USE CHANGE

The continued utilisation of land to satisfy the ever increasing demands of a growing population and expanding economy is leading to widespread degradation and land conversions that are currently unplanned and to a large extent unregulated.

Under a business as usual scenario the identified pressures and impacts will remain the same, such as biodiversity loss, increased greenhouse gas emissions, reduced water sources and increased soil erosion.

With regard to land use and land use change, the negative trends and impacts that are expected to continue are in the first place the current ecosystem conversions which are estimated at 2,000 ha per annum. This is a permanent loss of ecosystems, as natural land is converted to a land use which is radically different and first complete cleared of vegetation, such as land used for irrigated agriculture, dams, industrial, and residential. Although since the 1990s there is an increasing proportion of rainfed arable land being abandoned and converted to grazing, this is not really restoring biodiversity.

4.1.1.2 SOIL EROSION AND LAND DEGRADATION

With regard soil erosion and land degradation, the current main pressure derives from the over-exploitation of resources, resulting in overgrazing, erosion and land degradation with accompanying emissions consisting of chemicals and waste, leading to air, water and soil pollution.

The trends that are expected to continue relate to the further expansion of the area affected by erosion and degradation. The main indicators for the state of land degradation are (1) the extent of eroded and degraded land, including description of the type and degree of the erosion and degradation, and (2) the rate of desertification, expressed by the % change of the Drylands of Swaziland, using the definition of Drylands Aridity Index. The latter index is also useful to measure effects of climate change. Map and reports on actual erosion and land degradation are restricted and outdated and no current provisions exist to update inventories. The National Action Plan of the Convention to Combat Desertification is currently not functional, hence only limited rehabilitation measures are implemented.

The estimated and projected degradation of communal rangelands (Table 94) shows the extrapolation of the current trend of degradation in communal grazing land which under a business as usual scenario is becoming increasingly more eroded and permanently degraded. The extrapolation is based on the data presented in section 3.1.2.3 on the state of land degradation and can be used as an indicator for continuing land degradation.

To facilitate the estimate, all seriously and moderately degraded land is considered to be found within the communal grazing area (communal rangelands covering 50% of the country). Some moderately eroded or degraded land is found in arable land areas and private ranching areas, but this is insignificant compared to the communal grazing land.[45] The total of moderate and severe degradation together with wasteland was

[45] The key which has been used to determine the erosion status is quite complex however the most relevant estimates relate to the percentage class of the unit affected by erosion and the severity of it. The status of very serious and serious erosion applies to land with >25% moderately sheet erosion or a lower percentage coupled with severe gully erosion. On a country basis this can be translated to 20%

estimated at 210,000 ha (1990) and is estimated to have increase with 20,000 ha per 10 years to 250,000 (2010).

Table 94: Estimated and Projected Degradation of Communal Rangelands (ha) (1990-2020)

LAND USE CATEGORY	1990	2000	2010	2020
Extensive Communal Grazing: no-slight degradation	650,000	673,000	676,000	639,000
Extensive Communal Grazing: moderate degradation	70,000	75,000	80,000	85,000
Extensive Communal Grazing: severe degradation	110,000	115,000	120,000	125,000
Extensive Communal Grazing: wasteland	30,000	35,000	40,000	45,000

Without intervention, the land degradation resulting from poor land management is expected to continue to impact on the functioning of ecosystems and the state of human welfare and health.

4.1.1.3 FORESTS AND WOODLANDS

Chapter 3 describes the increasing threats to the natural forest and woodlands through land conversions and over-exploitation as well as invasive alien plant species. There is currently no change in the trend of clearing forests and woodland to make way for agricultural land, in particular for the production of sugarcane.

Under a business as usual scenario the identified pressures on forests and woodland will remain the same, and will result in further biodiversity loss.

Without intervention also the current impacts are expected to continue, namely reduced biodiversity and ecosystem functions (in particular with respect to medicinal and cultural plant species) with excessive water consumption, soil degradation and pollution as added impacts from industrial forests.

The unsustainable situation in the forestry section is to a large extent related to lack of essential data related to forest inventory, data collection and monitoring, which prevents reliable estimates of current forest resources and linked environmental indicators.

The lack of implementation and updating of the draft National Forestry Programme and the delay in enacting the Forestry Bill have further contributed to the continuation of the business as usual situation.

4.1.2 FUTURE TREND BASED ON POSITIVE RESPONSE

To avoid a situation as described in the previous section assuming continuation of the current trend, intervention will be necessary. The responses to support positive change have to include improvement of currently not existing or outdated pieces of legislation and policy.

Responses should also preferably be based on recognised international initiatives and principles on land management. Through participation and membership Swaziland is already linked to such international fora.

4.1.2.1 LAND USE AND LAND USE CHANGE

Responses required improving the situation with respect to policies and legislation relevant to land management and land use include the formulation of a comprehensive land policy and land act based on sustainable and rational land use.

As indicated in Chaper 3, land use change patterns analysis (spatial and temporal) is an essential requirement to monitor land use change and is to be applied to form a knowledge management and planning system for the land and landscapes of Swaziland.

1.2. Updated and aligned biodiversity and ecological data sets, including species spatial distribution, as well as climate, land use, land cover and forest inventory data, including data on carbon stocks and land degradation, provide for the creation of a national natural resources accounting system

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of the land actually affected by moderate or severe sheet erosion and 5% actually affected by severe or extreme gully erosion, accounting to approximately 110,000 and 30,000 ha respectively. These two sub-categories of the extensive communal grazing are called severe degradation and wasteland. Moderate erosion can also calculated from the original data available per AE unit, in average 25% of all AE units, with an actually affected 4% of the communal rangelands, accounting to approximately 70,000 ha. The remainder of the communal rangelands are classified as having slight to no degradation. The calculated figures can most likely be considered underestimated.

Important issues such as food security can be readdressed through new approaches, taking into account present and future impacts of land conversions and climate change. The following example is applicable to agriculture but also valid for other production sectors.

Positive response to future needs for food production and security

Preserving and enhancing food security requires agricultural production systems to change in the direction of higher productivity and also lower output variability in the face of climate risk and risks of an agro-ecological and socio-economic nature. In order to stabilize output and income, production systems must become more resilient, i.e. more capable of performing well in the face of disruptive events. More productive and resilient agriculture requires transformations in the management of natural resources (e.g. land, water, soil nutrients, and genetic resources) and higher efficiency in the use of these resources and inputs for production. Transitioning to such systems could also generate significant mitigation benefits by increasing carbon sinks, as well as reducing emissions per unit of agricultural product.

Transformations are needed in both commercial and subsistence agricultural systems, but with significant differences in priorities and capacity. In commercial systems, increasing efficiency and reducing emissions, as well as other negative environmental impacts, are key concerns. In Swaziland, where agriculture is critical for economic development, transforming smallholder systems is not only important for food security but also for poverty reduction, as well as for aggregate growth and structural change. Increasing productivity to achieve food security is clearly a priority, which is projected to entail a significant increase in emissions from the agricultural sector in developing countries (IPCC, 2007a). Achieving the needed levels of growth, but on a lower emissions trajectory will require a concerted effort to maximize synergies and minimize tradeoffs between productivity and mitigation. Ensuring that institutions and incentives are in place to achieve climate-smart transitions, as well as adequate financial resources, is thus essential to meeting these challenges. In this context mitigation finance can play a key function in leveraging other investments to support activities that generate synergies.

The question to be asked is how can we manage our agriculturally productive landscapes not just to supply food for the 1 million living in Swaziland over the next few decades, but how to do so in ways that also secure our water needs, conserve biodiversity, manage climate change, support commercial agricultural and sustain rural livelihoods?

Ad hoc strategic planning for agricultural has taken place over the past decades through the formulation of policies, strategies and a variety of programmes. For the most part these good intentioned activities have been ignored as the government embarks on donor supported initiatives focusing often on selected or specific interventions and has not taken a broad outlook at the inter-relationships between supporting and promoting, for example, sorghum production without analysing the impact of this on ecosystem services, biodiversity conservation, land use planning etc.

An integrated landscape strategy that acknowledges the diverse demands on our lands, and the limitations of narrow sectoral approaches, is clearly an important priority for our future.

Such a strategy would promote and support:

- Agricultural practices that have positive impacts on ecosystem services;
- Ecosystem management strategies that encompass the role of farmlands as well as natural areas;
- Social and cultural norms and institutions supporting sustainable food systems;
- Markets and policies that make these systems financially viable and sustainable;
- Governance systems that enable the diverse stakeholders in the products and services of our land base to define, negotiate, and implement a coherent vision.

New directions and approaches are available which enhance rural livelihoods, conserve biodiversity and ecosystem services and develop more sustainable and productive agricultural systems in line with global commitments, e.g. the Programmes of Work on Agricultural Biodiversity and Protected Areas, the principles of the Ecosystem Approach, the Global Strategy on Plant Conservation agreed by the parties to the Convention on Biological Diversity, the International Treaty on Plant Genetic Resources for Food and Agriculture, further integrating eco-agriculture into other major conventions including the United Nations Convention on Combating Desertification (UNCCD), United Nations Framework Convention on Climate Change (UNFCCC), and the Wetlands Convention (RAMSAR).

Action is needed at all scales, from farm fields and forest patches to international policy. But the landscape is the scale where the interfaces of multiple demands on land and resources must be negotiated and managed. Foresters and conservationists are accustomed to thinking in terms of landscapes, but typically in relation to the forests and protected areas under their direct control. Farmers and agricultural businesses think more in terms of farms, fields, and supply chains. Thus it can be a struggle to collaborate in complex, multi-use landscape mosaics.

All over the world, innovative leaders are collaborating across sectors and across social groups to address landscape-level challenges and opportunities. Farmers and farming communities are acting collectively to make their landscapes more productive and conserve ecosystems critical to their livelihoods. Non-governmental organizations and governments are partnering with farmers to restore degraded landscapes, develop wildlife corridors, manage critical watersheds, and more recently to make agricultural landscapes more resilient to climate change. Market actors are embracing eco-standards for agricultural products that contribute to sustainable landscapes, and developing programs to reward farmers and farming communities for stewardship of ecosystem services in their croplands, forests, rangelands and wetlands. New models of territorial development and urban-rural food sheds are seeking ways to link agriculture and ecosystem management within broader strategies for social and economic development.

Current Swaziland policies and institutions have to accommodate these innovative initiatives. Integrated agricultural landscapes and modernised farming practices provide viable pathways for sustainable development in places where food production, ecosystem health, and human wellbeing can be achieved simultaneously.

Table 95 provides an overview of the required responses to support positive change, listed according to future policy actions, future legislative actions and future institutional actions.

4.1.2.2 SOIL EROSION AND LAND DEGRADATION

Many of the most important habitats for wild biodiversity, watersheds, forest products, bio-energy, and stores of carbon (from vegetation and soils) are located in predominantly agricultural lands - not just "marginal lands". The current trend of degradation of these agriculturally used lands (arable land and rangeland) has to be reversed. Is has become very clear that the communal grazing areas are most affected and sensitive to erosion and degradation.

Positive responses already identified in the SEAP (1997) are still valid:

- To update inventories and information systems and monitor degradation through established systems (AELDA), including analysis of causes, applying appropriate tools such as remote sensing and Geographic Information Systems
- To determine suitable and sustainable production systems to replace systems leading to degradation of the environment, taking into account the specific conditions in the various agro-ecological zones.

An integrated knowledge and data management systems for natural resources management needs urgently to be developed in order to be able to define sustainable land management practices which should result in reduction in degraded rangeland, forests and woodland and also provide options to integrate with biodiversity management of protected areas and priority landscapes (see also under Theme 3 Biodiversity).

There is also a need to improve legislation and policies, which include legislation on sustainable range management (notably the carrying capacity of the land), and a reviewed and improved livestock policy, together with diversification within the livestock sector.

Table 95 provides an overview of the required responses to support positive change, listed according to future policy actions, future legislative actions and future institutional actions.

4.1.2.3 FORESTS AND WOODLANDS

The current issues in the Forestry sector indicate a need for a review of the Forest Policy and enacting of the Forest Bill. Subsequently there will also be a need to review the National Forestry Programme, which is the vehicle to identify priority problems and formulate an action plan. The National Forestry Programme is comprehensive and covers four forest sectors, namely Natural Forest and Woodlands, Community Forestry, Urban Forestry, and Industrial Forestry. It is to focus on immediate action as well as on general support programmes, such as data management.

The forestry sector is in need of essential data related to forest inventory, data collection and monitoring.[46]

Immediate invention is required to update the forest resource assessment using the appropriate tools of satellite image interpretation combined with forest sampling and analysis. This could also be done in conjunction with general land cover analysis (through regular land cover updates also to be used for land cover and land use change analysis - see under LUC, Chapter 3).

There is a need to implement priority action plans as identified in various forestry strategies and programmes. The SEAP (1997) lists strategies and priority actions proposals which are still relevant, e.g.:

- To classify and map vegetation and forest types, including the status of degradation, using an appropriate land cover classification system, and to evaluate and demarcate areas suitable for the various systems of forest practice such as production forests, protection and conservation forests, mixed range or multiple use forests (including agro-forestry), community forests (including woodlots and wattle), establishment of botanical gardens, amenity and recreation and landscape scenery for eco-tourism
- To eradicate invasive alien plant species threatening other land uses (encroaching arable land and rangelands)
- To prepare management plans for all forest operations, for specific forest sites and/or ecosystems, and include provisions on the protection and maintenance of adjacent and interconnected sites and ecosystems.

Monitoring climate change impact on forests and ecosystems

Climate change is a most prominent threat to natural forests and woodlands. Increasing climatic variability will have having a profound effect on the landscapes, ecosystems, forests and savannas of Swaziland. Future climate scenarios are pessimistic in terms of the key climate variables that directly and indirectly affect forestry and agriculture. Adaption measures will have to include better tree and crop varieties that cope better with climate change, increasing the utilisation of available rainfall or water.

The use of remote sensing technologies is widespread and can provide a near real-time snapshot of existing land conditions. It can inform critical decision making on agricultural planning, natural resource management and biodiversity management. It can be used to help foresters and farmers prepare for droughts, floods, pests and bushfires. Data generated can cover water, rainfall estimates, soil moisture and plant health.[47]

Table 95 provides an overview of the required responses to support positive change, listed according to future policy actions, future legislative actions and future institutional actions.

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[46] According to NFP the primary responsibility for the Ministry responsible for forestry is to provide data on the extent, volume, growth rates and status of the forest resource. The Ministry responsible for forestry has demonstrated its capacity to carry out inventories and is in a position to update data as an ongoing activity. Modern techniques including remote sensing and Geographic Information Systems (GIS) should be used to monitor deforestation and afforestation. The vegetation classification can be further upgraded with thematic maps, satellite imagery and the latest aerial photography. It is recommended to concentrate activities on the following three areas: (1) Review of forest vegetation types and classification, (2) Continuous Forest Inventory (CFI), (3) Establishment of Permanent Sample Plots (PSPs).

47 The equipment and software is often expensive but increasingly ready-processed data is increasingly being made available for free. The National Meteorological Service and the University are both well placed to source, interpret and provide relevant data to stakeholders or sectors provided they get the support and resources. Remote sensing technology has extensive potential for environmental monitoring and management. Combined with GIS, remote sensing can help communities map and protect their natural resources, gain recognition of land rights and monitor the impacts of development projects. Remote sensing can be used to assess deforestation rates identifying areas under greatest threat so proactive interventions can be implemented to manage these conversions. It can be used to help with land use planning for agricultural projects by analysing how to fit the project into existing systems without harming biodiversity.

Table 95: Summary of Future Outlook of State of Land

ISSUE	ASSUMING STATUS QUO (BUSINESS AS USUAL)		REQUIRED RESPONSES TO SUPPORT POSITIVE CHANGE		
	Future Trend	Future Extrapolated Impact	Future Policy Action	Future Legislative Action	Future Institutional Action
Land Use and Land Use Change	• Virgin land converted to commercial agriculture • More arable land converted to settlements • Increase in conflicts and competition for lands • Increased livestock populations • Climate change	• Land and water pollution (agrochemical, waste) resulting in reduced health conditions • Loss of biodiversity habitats and species resulting in reduced ecosystem goods and services • Increased soil erosion with impact on run off and drainage system	• Formulate and implement a sustainable land management policy • Prioritize and plan major land uses based on agro-ecological zoning approach, and in a holistic, cross-sectoral way	• Draft and enact land use legislation • Develop a Land Act supportive of sustainable land management	• Capacitate and strengthen land use planning section • Explore options for secure land management • Strengthen integration, implementation and monitoring of EIAs for land development • Review and strengthen land tenure and property right arrangement • Develop an integrated land information management system, including spatial information on land cover and land use • Strengthen capacity for sustainable land management
Soil Erosion & Land Degradation	• Increasing rate of soil erosion • Decreasing soil fertility • More erosion and dongas from infrastructure and road development • More pressure and more erosion on rangelands because of shrinking rangelands area and moderate increase in livestock numbers • More extreme weather events	• Loss of biodiversity habitats resulting in reduced ecosystem goods and services • Reduced food production & increasing food insecurity • Loss of arable land • Damage to property and infrastructure • Reduced health conditions • More siltation in rivers	• Ensure the land policy accommodates positive policy actions to address land degradation • Strengthen compliance enforcement on rural roads • Review and update the livestock policy • Review the SISA ranch strategy to promote and commercialisation and reduce pressure on SNL	• Develop regulations on sustainable land management • Improve enforcement of all environmental legislation • Draft and enact legislation on sustainable range management (carrying capacity)	• Strengthen community based organisations for sustainable community based land management • Update inventories and monitoring of erosion and land degradation using remote sensing and GIS • Capitalising of the national environment fund • Improve inter-ministerial coordination on soil erosion • Improve communal grazing practices, dipping, watering • Strengthen community based conservation farming • Address chiefdom boundary disputes

ISSUE	ASSUMING STATUS QUO (BUSINESS AS USUAL)		REQUIRED RESPONSES TO SUPPORT POSITIVE CHANGE		
	Future Trend	**Future Extrapolated Impact**	**Future Policy Action**	**Future Legislative Action**	**Future Institutional Action**
					• Strengthen capacity of the range management in MOA • Promote diversification within the livestock sector
Forests and Woodlands	• Decline in forest and woodland areas (general deforestation) • Afforestation efforts not enough • Impoverishment of forests and woodlands	• Loss of habitat • Loss of medicinal plants • More alien invasive plants • Decreasing ecosystem goods and services • Increasing illegal and foreign trade in community forest products • Decrease of fuel wood	• Review the forest policy • Review and update the national forestry programme • Review the NBSAP	• Finalise and enact the forest bill	• Capacitate the Forestry dept to implement the Forest Act and Prepare management plans for all forest operations • Strengthen afforestation and reforestation activities in communities • Undertake regular forest resource assessments and monitor changes (including climate change) through remote sensing • Eradicate invasive alien plant species

4.2 FUTURE OUTLOOK: WATER

Water is a very valuable natural resource of Swaziland and a key determinant of economic growth and poverty alleviation and a resource that must be carefully managed as part of the overall development objective of economic development.

Water is a limited resource that is used as an input to economic production in a number of economically important inter-related water user sectors.

4.2.1 FUTURE TREND BASED ON STATUS QUO

Extrapolation of the current state and trend in water assuming a status quo situation - which means business as usual - will evolve to a future trend not different from the present one and will continue showing the same negative impacts on the environment as described in the previous chapter on State of Water.

The future trend in water will be one of continued poor management with the resulting impact of inadequate river flows and below national water quality standards.

The continued absence and implementation of an approved Integrated Water Resource Management Strategy will continue to negatively affect water availability and quality.

The inadequacy of flow records requires urgent intervention to improve future planning. Measures for the upgrading and rehabilitation of hydrological infrastructure and to improve hydrological data acquisition are recommended. The ability to monitor water use in the water stressed river basins and to track usage trends against predictions is essential. A unified and integrated computer-based management information system is required to facilitate the collection, storage, retrieval and processing of data.

4.2.2 FUTURE TREND BASED ON POSITIVE RESPONSE

The future trend in water management can only be realised through strategic level interventions. The Integrated Water Resources Master Plan describes the full range of interventions required to improve the future situation.

The flowing activities will contribute towards to improved water management and result in sustainable water management to the benefit of all users.

Water Productivity and Efficiency

Improvements in water productivity and efficiency can be achieved through improved on-farm water management or more efficient technologies. Guidelines, regulations or mechanisms that deal with questions of how and where water saved as a result of improved practices and/or higher application efficiencies should be utilized or reallocated need to be prepared. Sustainable water productivity and efficiency in irrigation water application should be maximised and appropriate irrigation technology and management techniques be adopted.

Strategic interventions required include:

- Develop strategies and mechanisms for improved and dynamic water allocation in order to increase irrigation application efficiency.
- Establish an appropriate water allocation system, taking into account soil characteristics and topographic conditions.
- Develop procedures to assist Irrigation Districts and Water User Associations to prepare water permit applications, to identify options for and encourage flexible intra-group water allocations that increase water productivity as required and allowed by the Water Act.
- Advocate the use of water saving irrigation technology and sustainable water management practices.
- Introduce water measuring devices to be installed by all water permit holders. This must be a pre-condition for issuing new water permits.

Sustainable Water Allocations

Into the future it will be critical for Swaziland to know at all times its water balance, i.e. the amount of water that is utilised in the country versus its entitlement as per transboundary water sharing agreements. Water availability is not adequate for every user, even though its use is supposedly regulated through the issue of irrigation permits. During the months of peak irrigation demand, the water allocations outstrip the available amount of water in the river.

The previous system used to allocate water (flow rate) tended to over-allocate water, moreover, it makes it difficult to regulate or schedule water abstractions. The 2003 Water Act introduced a volumetric allocation and all permits based on flow rate were converted to volumes in 2010.

Issuing of water permits for all water users should be a mechanism for monitoring and managing the use of water (both surface and ground water) in the country. Informal trading with irrigation water permits is often leading to disputes rather than to the improved allocation expected from a permit-based allocation system.

Strategic Interventions include:

- Apply crop water requirement and climatic factors whenever allocating water for irrigation purposes. These shall determine the quantity of water to be allocated with strict adherence to good irrigation practice and efficiency.
- Monitor and manage water use through a system of Water Abstraction Permits which will be issued in accordance with current water governing legislations (Water Act and/or regulations).
- Undertake a study to recommend realistic and reasonable conversion factor for various crops. This should consider realistic crop water requirements for all crops in the various climatic regions of the country.
- Establish procedures to tie water permits to defined land parcels and subject any permit holder who fails to use or abuses permit to the provisions of the 2003 Water Act.
- Regulate irrigation water abstractions via the appropriate institutions and agencies.
- Prioritise water allocation criteria to maximise economic production per drop of water.
- Develop incentive mechanisms to promote improvement in existing firms to increase productivity with less utilisation of water.
- Develop and implement intensive education and awareness campaigns on water utilisation efficiencies and water productivity.

Water Quality

Water quality is the most important environmental issue of water resources because it adds to the reduction of usable water quantity and also negatively affects the aquatic and riverine ecosystems and biota. It is therefore critical that sustainable levels of water quality be maintained and restored where already compromised.

The growth in industrial and agricultural developments has led to noticeable deterioration resulting from pollution and denudation of river banks. Deterioration in water quality is mainly due to addition of chemical, biological and physical pollutants in the water systems.

To ensure good water quality for productive uses into the future, it is essential that DWA and others publish their water quality results in an annual publically available report.

Strategic Intervention required includes:

- Enforce the minimum standards of river and drinking water quality that conform to the Water Pollution Control Regulations (2010). River Basin Authorities should be capacitated to ensure the enforcement of these regulations.
- Allocate irrigation water permits on the basis of appropriate technical, hydrological and economic considerations.
- Consider both the water quantity and quality when issuing water permits for irrigation.
- Publish water quality data in publically available reports

Catchment Management

Although the 2003 Water Act regulates catchments management through River Basin Authorities, the country's catchments are not well managed. Wetlands are not appropriately used and protected. Like rivers, wetlands are a habitat of diverse flora and fauna species. Reduced flows due to water allocation or uncontrolled use thereof pose a threat to these assets. The construction of water infrastructure does not adequately provide for their (wetlands') sustenance. This has a serious impact in the river systems both from geo-morphological and ecological perspectives. The net effect of this is high levels of silt in the rivers and reservoirs. Often the water available is less than the water allocated resulting in the depletion of environmental flows. In the river systems the ecology becomes degraded and water ceases to flow in some rivers in longer periods even in traditionally known perennial streams (e.g. the Ngwavuma River). Water consuming alien invasive species are spreading in some catchments resulting in the reduction of water resources available for irrigation. Current unsustainable irrigation practices in catchments heavily erode and degrade the soil and results in the siltation of water bodies.

Strategic Interventions required include:

- Identify, evaluate, demonstrate and promote effective catchments management practices.
- Implement catchments management and protection according to the provisions of the 2003 Water Act through appropriate institutions such as River Basin Authorities.
- Integration of land-use management activities, proper population resettlement and water resources planning activities.
- Enforce soil and water conservation measures in irrigated areas, require the use of appropriate drainage, and promote the adoption of soil erosion mitigation measures.
- Integrated approach to catchment management activities, an ensuring sustainable land-use activities.
- Capacitate rural communities with catchment management information on the importance of protecting the natural environment from water pollution practices.
- Protect wetlands and restrict their use as sources of irrigation water according to existing sustainable natural resources and environmental rules and regulations.
- Establish programmes to remove and control alien invasive species from infested watersheds.

Public Participation in Water Resources Management

Historically, water management in Swaziland was a centralised and almost exclusive role of the Government. The private sector and civil society were excluded from holistic planning and management of water resources in the country, yet stakeholder involvement and participation is key to IWRM. The Water Act advocates for mainstreaming of stakeholders in water resources management. However, the strategy to ensure effective stakeholder contribution and capacitation is not yet in place. Government does collaborate with NGOs and some private sector partners in several initiatives on water resources planning and development and management, but there is no clear guiding policy to ensure an effective and sustainable collaboration among these institutions. All levels of water resource management in Swaziland should embrace meaningful and empowered participation by all stakeholders.

Strategic Interventions required include:

- Government should create an environment that enables all stakeholders (government, civic organisations, private sector and NGOs) to play a meaningful role in the development and management of water resources in the country.
- Stakeholders should ultimately be educated on water resources development and management issues such that they ultimately form and finance their own water management structures. The effective participation should transcend transboundary river institutions.
- Develop a strategy to ensure effective stakeholder involvement. Such should include ensuring that budget(s) for new projects include a component for effective stakeholder consultations.
- Develop guidelines to direct, enhance and sustain collaboration between Government, NGOs, Private Sector and Communities in water resources planning, development and management. The same holds for effective gender and civil society mainstreaming in water resources planning and management issues.

Degradation of the Ecological Environment and Related Resources

The natural environment is recognized as a legitimate water user. Like all other users it requires water of a sufficient quantity and quality. Presently, the state of the environmental protection in the country is not good in relation to both quantity and quality factors.

Strategic Interventions required includes:

- Development of countrywide eco-classification of river basin reaches.
- A reasonable environmental water allocation should be defined and maintained in all the country's rivers.
- Abandoned mines and boreholes should be well protected to prevent groundwater pollution.

- Institute bio-monitoring programme and accredit national laboratory to facilitate real control of polluting activities in the country. The introduction of monitoring of vital parameters that are presently not monitored should be ensured.

Return Flow and Run-off

Irrigation activities result in return flows into the country's rivers. This is more pronounced in flood irrigated fields. Return flows may be viewed as positive and as negative. While return flows tend to raise the flow into the watercourses, the water is generally of a lower quality than before abstraction. If return flows are high yet the catchment area of influence is large, as in the lower Mbuluzi River Basin (some 77 MCM), the return flow pose a management complexity to the resource users as they do not quite well understand how much of this is normal catchment run-off and how much is due to return-flows.

Strategic Interventions required include:

- Develop an understanding in relation to the quality impact of return flows versus the volume for the various types of major uses.
- Use of efficient irrigation technologies.

Water Conservation and Water Efficiency

With the demand quickly rising to exceed the available resource and cost of providing additional storage facilities exorbitantly high, the solution in the short and medium terms may lie in addressing the demand side of the equation, instead of focussing on the supply side only. Swaziland still has several kilometres of unlined canals and huge unaccounted water loss in urban and peri-urban centres. There is still vast scope of improvement in the technology choices in some of the irrigated land in the country.

There is absence of proper incentives for water conservation in the country. Present water conservation is a result of water using entities purposing to expand the scope of business operations through using the additional water saved from allocation.

Strategic Interventions required include:

- Develop attractive incentives for water conservation and demand management.
- Set high level of efficiency in water use as one of the main objectives of the River Basin Authorities, Water User Districts and Associations which are being established by the Water Act.
- Undertake vigorous initiatives to encourage all water users to minimize losses, lining those unlined canals, closely monitoring leakages in reticulation systems in urban areas.
- Development of penalty mechanisms to discourage wasteful systems, building from those proposed in the new Water Act.

Valuing Water

Economic instruments are recognized as an essential component for efficient and sustainable management of resource. However, economic instruments are very often politically difficult to implement.

Strategic Interventions required include:

- Develop pricing mechanisms for irrigation, urban and rural water supply systems that include the full cost of providing it. These should include the costs not only of the infrastructure, operations and maintenance, capital servicing, and other financial costs, but also the broader economic, ecological and social costs incurred in the process of acquiring, transporting and delivering it. At the same time, these pricing mechanisms have to be adjusted to ensure universal service provision, and especially to cater to the special needs of the poor and underserved.
- Develop fiscal incentives like rebates on excise, customs and other duties, or tax exemptions for industrial operations that adopt pollution prevention and treatment measures, particularly for systems aimed at zero emission.
- Provide incentives to domestic water suppliers that integrate water reuse and recycling measures in their operations.
- Devise fiscal instruments such as taxes, penalties on industrial polluters for discharging effluents in water bodies based on the 'Polluter Pays' principle enshrined in the Environmental Management Act, 2002.

Water Demand Management

More than 95% of the country's water use is dedicated to commercial irrigated agriculture. Future water resources developments for irrigated and commercial agriculture shall be planned in an integrated manner with other sectors in the spirit of integrated water resource development and management.

With increasing water consumption and limited options for increased supply, water conservation and water demand management (WC/WDM) measures would assist in efficiently and cost-effectively utilizing available water. Furthermore, the SADC Revised Protocol on Shared Water Resources and associated guidelines and policies, require conservation and economy of use of the water resources of shared watercourses.

The potential for achieving significant water savings through WC/WDM in the larger urban areas should be established by means of water balances. Water supply authorities should aim to minimize leakage from bulk mains, reservoirs and towers and distribution networks and should incorporate the principles of WC/WDM into their management and operations philosophy. Measures should be adopted to encourage consumers to follow practices that promote water conservation, including appropriate tariffs and building regulations/ water supply bylaws that require use of water-saving technology. There is however limited scope for WC/WDM in rural settlements.

Wastewater Reuse

The increasing adoption of water-borne sewerage systems in urban and peri-urban areas will have a significant impact on residential water demand as well as resulting in increased volumes of wastewater effluent. Treated wastewater is a potential resource that can be reused thus conserving fresh water resources and improving security of supply. Reuse may also be ecologically advantageous by reducing the quantity of effluent and mass of residual pollutants being discharged into the river system. The major portion of the return wastewater flows occur in the Usutu river basin. These wastewaters are currently discharged into the local water courses and are probably already taken into account in the estimation of available water resources.

Details of the existing wastewater treatment plants, their location, plant treatment capacity and volume of wastewater currently being treated are given in the report. In general where analyses are available, the effluents discharged to local water courses do not comply with the effluents standards.

The typical characteristics of various biological treatment processes and the typical effluent qualities that can be expected using these processes are given in the report, as are the effluent discharge standards for effluents from wastewater treatment plants in Swaziland together with the South African General and Special Standards for comparison. In general the Swaziland discharge standards should be achievable using the biological filter process but are unlikely to be achieved with pond systems particularly where the pond systems are required to treat industrial effluents.

Water reuse by industry is dependent on a number of factors. Potential industrial reuse in Swaziland includes use as cooling water and for ash removal in thermal power stations, process water, produce washing, plant and equipment washing, transportation of materials and classification of ores. Water quality requirements for water reuse in different applications are presented.

Reuse of wastewater in irrigation can be classified into two general categories, urban irrigation involving the irrigation of golf courses, sports fields and parks and irrigation of crops. Standards for the irrigation of reclaimed wastewater from different treatment process on various crops are recommended. The effluents from the existing wastewater treatment plants would require further treatment before being of acceptable quality for irrigation use.

A number of diseases such as cholera, dysentery, typhoid and paratyphoid fevers, gastroenteritis and hepatitis can be transmitted by water. However properly treated and disinfected water should be completely free from pathogens.

The constituents of concern in reclaimed water for agricultural irrigation are salinity, sodium, trace elements, excessive chlorine residual and nutrients. Sensitivity is generally a function of a given plant's tolerance to these constituents encountered in the root zone or deposited on the foliage. Information is presented in the report on the salt tolerance of various crops and on the recommended maximum levels of trace heavy metals in treated wastewater used for irrigation.

The direct use of treated effluents to supplement potable water supplies requires high treatment standards with multi-barrier treatment systems and plants with high levels of process reliability. Such plants are expensive to construct and operate and should be considered as a last resort only when all alternative potable water sources have been exhausted. This situation is unlikely to arise in Swaziland within the planning horizons of this report.

Wastewater reuse opportunities are discussed and potential reuse is identified including industrial reuse, urban irrigation and the irrigation of crops and in horticulture.

For the chosen treatment process to reliably meet discharge standards, or end use standards in the case where wastewater is to be reused, strict quantity and quality limits must be applied to the wastewater discharged into the sewer system. Details of the effects and specific types of pollution arising from various industrial waste discharges are given as well as examples of typical discharge standards.

Construction of New Storage Dams

As the country's river systems are fully allocated to various water using activities, the government is undertaking a programme of identifying and planning for additional large water storage dams. The DWA in consultation with major stakeholders has identified and prioritised some large water infrastructure projects as follows:

Ethemba Dam

A feasibility study has been completed to inform the construction of the Ethemba dam on the Mkhondvo River (Knight Piesold, 2011). The purpose of the dam is to provide irrigation water as well as for domestic and other commercial activities. Government is looking for funding to construct this dam to alleviate the water situation of the Usuthu basin.

Nondvo Dam

A pre-feasibility study to inform the construction of the identified Nondvo dam on the Lusushwana River has been carried out. A feasibility study is now required. The dam will be used to supply domestic water to the Mbabane-Ezulwini- Manzini corridor as well as for the supply of water for irrigation of 800ha. The dam site was identified by the Joint Maputo River Basin Study which was conducted by the three riparian countries of South Africa, Mozambique and Swaziland.

Mpakeni Dam

The Mpakeni dam site has been identified on the Ngwavuma River. The Ngwavuma River is the most over-allocated in terms of the existing irrigation with the result that periodic shortages of irrigation water supply occur. This problem has caused the river to deteriorate into a category D (largely modified) from an environmental perspective. A pre-feasibility study to inform the construction of the identified Mpakeni dam is required.

Table 96 provides an overview of the required responses to support positive change, listed according to future policy actions, future legislative actions and future institutional actions.

Table 96: Summary of Future Outlook of State of Water

ASSUMING STATUS QUO (BUSINESS AS USUAL)		REQUIRED RESPONSES TO SUPPORT POSITIVE CHANGE		
Future Trend	**Future Extrapolated Impact**	**Future Policy Action**	**Future Legislative Action**	**Future Institutional Action**
• Increased demand for good quality water for urban and productive uses • Increased pollution of rivers from industrial, urban and agricultural contamination • Increasing cost for treating water for productive and urban use • Increases in illegal water abstractions • Increased pressure on natural aquatic ecosystems • Increasing need for water storage for irrigation and hydro power • Water remains a free resource • Conflicts with neighbouring states over water	• Decreased crop yields • Increased pressure on water resources to supply urban areas • Increased non-point source water pollution • Increased losses of aquatic biodiversity • Increased environmental impacts from new dams for irrigation and hydro power • Misuse of a free resource creating localised shortages • Security responses to water shortages	• Review and update the Water Policy • Develop a Water Pricing Policy • Finalise and implement the Integrated Water Resources Master Plan • Develop Catchment Management Plans for each basin • Develop funding strategies for water resource management	• Review water legislation to improve sustainable use and supply • Develop Water Pricing regulations	• Guidelines, regulations or mechanisms on improving water productivity and efficiency • Develop strategies and mechanisms for improved and dynamic water allocation in order to increase irrigation application efficiency • Monitor and manage water use through a system of Water Abstraction Permits • Enforce the minimum standards of river and drinking water quality that conform to the Water Pollution Control Regulations (2010) • Set and enforce and monitor quality standards for any return flows from irrigation • Promote amongst water users effective catchments management practices • Establish programmes to remove and control alien invasive species from infested watersheds • Address the threats of climate change and develop adaptation strategies • Promote wider adoption of soil and water conservation measures and implement community-based programmes for the rehabilitation of degraded land. • Develop databases and geographical information systems to store and display bio-physical, social and economic information pertaining to land use planning • Develop countrywide eco-classification of river basin reaches for

ASSUMING STATUS QUO (BUSINESS AS USUAL)		REQUIRED RESPONSES TO SUPPORT POSITIVE CHANGE		
Future Trend	**Future Extrapolated Impact**	**Future Policy Action**	**Future Legislative Action**	**Future Institutional Action**
				environmental water allocations • Design and implement a bio-monitoring programme for wetlands and rivers • Develop incentive mechanisms to promote improvements in water use productivity • Develop incentives for water conservation and demand management measures

4.3 FUTURE OUTLOOK: ATMOSPHERE

Theme 3 is subdivided into four subthemes: Air, Climate and Climate Change, Natural Disasters and Stratospheric Ozone

4.3.1 FUTURE TREND BASED ON STATUS QUO

Extrapolation of the current state and trends which take currently place in the atmosphere, notably with regard to air quality, climate change, natural disasters and stratospheric ozone depletion, assuming a status quo situation (business as usual) will evolve to a future trend not substantially different from the present one and will continue showing the same negative impacts on the environment.

4.3.1.1 AIR QUALITY

Industrial and other production processes are principally responsible for using the atmosphere for emissions resulting in air pollution. Sources of air pollution in Swaziland include processes such as paper and pulp production, energy, veld fires, agricultural biomass and waste burning as well as domestic use of fossil and other fuels. Also vehicle exhausts fumes have been identified as a source of air pollution though their significance has not been determined.

Although measures are taken Swaziland to reduce GHG emissions (see next section on climate change), there are in most sectors apart from energy no clear signs that firm measures are taken to substantially reduce these air polluting emissions.

Although air quality is not considered a serious problem in Swaziland, poor quality air coming from South Africa has the potential to mask local emissions. The significance of this polluted air on national air quality is not known.

Despite the Air Pollution Control Regulations being issued in 2010, it would appear from information gathered that they are not being applied. The Swaziland Meteorological Service has been mandated under the Regulations to monitor air quality. To date the Meteorological Service has not started to implement the regulations.

Based on these shortcomings, the current trends in air quality and impacts are expected to continue and to further impact on the environment and human health conditions. Responses which are required to improve the situation need to focus on reducing emissions and monitoring air quality.

4.3.1.2 CLIMATE AND CLIMATE CHANGE

It is seen as critical for government to recognise the challenges climate changes will bring to Swaziland and the impacts of such changes on all aspects of its economy.

The trends and impacts from climate change on the environment are expected to continue; these are in the first place temperature increases and irregular rainfall patterns, followed by impacts on ecosystems and human conditions, in particular health.

As the causes of climate change relate to major global events, Swaziland is not expected to curb the current trends; however the response can be improved through adaptation and mitigation measures.

Swaziland's agriculturally-based economy is vulnerable to increased climate variability and climate change, with potentially huge social and economic impacts for the sustainable development of the country. This vulnerability is exacerbated by existing developmental challenges (endemic poverty, ecosystem degradation, limited access to capital, infrastructure, etc.) (GEF/IFAD/GOS, 2009).

Also other sectors such as industry and energy, as well as environmental and human health conditions remain vulnerable to climate change.

Swaziland is aware that GHG emissions reduction is the only measure that could ensure the mitigation of global warming and climate change. Mitigation measures are proposed in national plans. Mitigation measures are already taken in the energy sector and focus on developing and expanding the use of renewable sources of energy and increasing energy efficiency. Sugar companies are in the process to replace coal by bagasse and cane trash (cogeneration conversion).

Whilst these positive responses have been initiated, more mitigation measures need be taken to counteract the effects of climate change. In many sectors the current situation can be largely considered business as usual and it expected that effects of climate change will continue to strongly impact conditions in Swaziland.

Systemic response through policy and legislation is largely missing. Although some efforts have been made to set up structures to guide response processes, e.g. SNC, also the institutional capacity is still under-developed. In summary, current response and interventions with respect to climate change mitigation and adaptation are not considered sufficient.

4.3.1.3 NATURAL DISASTERS

Most of the natural disasters occurring in Swaziland are meteorological and climatological disasters, both of which are related to atmospheric conditions, the first one to extreme weather events, e.g. a severe storm, and the second to extreme climate variations, e.g. a severe drought. Hydrological disasters, typically expressed by extreme flooding, are normally associated with the occurrence of another natural disaster, but may also be caused by concurrent or sequential events, such as a severe storm.

There are indications that the frequency and severity of natural disasters in increasing in the past decades. However, convincing evidence is not always easily found as some disasters may be difficult to measure in size and impact. It is thought that climate change is having an impact on the occurrence of natural disasters.

As natural disasters are difficult to prevent or avoid, it is expected that current trends of disasters and their impact on the environment will continue in the future.

The same applies to impacts from floods, storms, floods, veld fires and lightning on air quality, ecosystems and health. Although frequencies and impacts are increasingly and reliably recorded with respect to these events, impacts can often not be avoided and are expected to continue.

This is despite the many efforts made by the Government. Government's systemic response includes legislation and policies such as the Disaster Management Act (2006) and the National Disaster Management Policy (1999) and the Swaziland Disaster Risk Reduction National Action Plan - 2008 to 2015. The National Disaster Management Authority is the main institutional response. The National Multisectoral Bushfire Contingency Plan is currently being prepared.

The vision of the disaster management system is that by 2022, Swaziland has a functional national disaster risk management system that minimizes community vulnerability to hazards and effectively prevents and mitigates the impact of disasters within the context of sustainable development.

The stakeholders in the SOE retreat of 22 to 23 August 2012 concluded that Swaziland continues to be extremely vulnerable to the impacts of natural disasters and that more casualties could be expected. The main cause identified was inadequate preparedness and poor response to disasters.

4.3.1.4 STRATOSPHERIC OZONE

Swaziland ratified both the Vienna Convention on the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer in 1992. All the amendments to the Protocol were ratified in 2005.

The Montreal Protocol (a protocol to the Vienna Convention for the Protection of the Ozone Layer) is an international treaty designed to protect the ozone layer by phasing out the production of numerous substances believed to be responsible for ozone depletion.

The Montreal Protocol has often been called the most successful international environmental agreement to date. Recent scientific evaluation of the effects of the Montreal Protocol has stated that the Montreal Protocol is working and that there is clear evidence of a decrease in the atmospheric burden of ozone-depleting substances and some early signs of stratospheric ozone recovery.

Swaziland has been in compliance with the ODS phase out schedules set out under the Montreal Protocol and initiatives are in place to ensure that the country is in compliance with the 2010 CFC total phase out schedule.

With regard stratospheric ozone, the trends and impacts have improved over the past 10 years. Based on the positive trends and reduced impacts from stratospheric ozone the effects on the environment are expected to further decrease.

4.3.2 FUTURE TREND BASED ON POSITIVE RESPONSE

To avoid a situation as described in the previous section assuming continuation of the current trend, intervention will be necessary. The responses to support positive change have to include improvement of currently not existing or outdated pieces of legislation and policy.

Responses should also preferably be based on recognised international initiatives and principles related to the atmosphere. Through participation and membership Swaziland is already linked to or participating in such international fora.

4.3.2.1 AIR QUALITY

Government has developed a biofuel action plan which if implemented would blend diesel and petrol with processed organic matter like ethanol. The introduction of biofuels would decrease a wide range of emissions. Biodiesel contains no sulphur and eliminates sulphur dioxide emissions, which contributes to acid rain (B100 reduces sulphur dioxide by 100%; B20 by 20%). Biodiesel also reduces the Ames mutagenicity of diesel particulate matter by 50% over conventional diesel fuel. Reduced emissions of hydrocarbons, carbon monoxide and particulate matter, which all cause smog, irritation and health problems, notably particulate matter capable of entering human lungs, would contribute to improved air quality.

Government's support for improved cookstoves that arose from the ProBEC project is another route to reduce emissions particularly indoor air pollution. Government is encouraged to continue the work of ProBEC and support the continued introduction of improved cook stoves into rural areas.

Air quality is not consistently monitored so an effective air quality management system should be strengthened under reviewed and improved Air Pollution Control Regulations. Additional effort is required of the SEA to publish and strengthen ambient air quality standards, emission limits, emission testing and informative guidelines for air quality monitoring. Using capacity within UNISWA, the SEA is encouraged to develop air quality models to identify probably dispersion patterns and components of pollutants. The SEA is also encouraged to exploring the possibility of establishing a joint air pollution monitoring commission with RSA and Mozambique. Institutional response by SEA should include the development of a fully fledged Air Pollution Unit.

The SEA is also encouraged to standardise monitoring methods, emissions inventories, modelling approaches and source, emissions, air quality and meteorological data reporting.

4.3.2.2 CLIMATE AND CLIMATE CHANGE

The stakeholders in the SOE retreat of 22 to 23 August 2012 concluded that Swaziland continues to be extremely vulnerable to the impacts of climate change, with current interventions for mitigation and adaptation remaining uncoordinated.

A positive systemic response need to be made by formulating a National Climate Change Strategy and Action Plan. MTEA also needs to establish a clear institutional structure for coordination of climate change activities (based on the formulation of a CC strategy).

Chapter 3 section 3.3.2.4 distinguishes three main sectors where the impact of climate change is most strongly felt: (1) ecosystem functions (biodiversity, water, forests), (2) agriculture and energy (from biomass), and (3) human health.

In this section below, the same sectors are reviewed or analysed for (1) vulnerability and adaptation, and (2) mitigation. Suggestions or recommendations are made to improve the situation through positive responses. Much of the adaptation and mitigation information is obtained from the Second National Communication (SNC: GOS-MTEA-NMS, 2012). The current and future impact of climate change can be simulated through modelling. The SNC presents information obtained from modelling, which results can be used for determining approaches and measures for adaptation and mitigation (GOS-NMS-SNC, 2012a - f).

Impact of Land Use Change: Source or Sink

Sustainable management of land use, land use change and forestry (LULUCF) is necessary as a means to protect carbon stocks and reduce GHG emissions. Sustainable land management determines whether land is or may become a source (of emissions) or a sink (of carbon). Crops or crop plantations established on forested land or carbon rich soils will normally be characterised by the release of greenhouse gases stemming from land-use change. All land which is cleared of indigenous or natural vegetation will initially behave as a source. The clearing of virgin land of its natural vegetation can release large quantities of CO2 as the organic matter breaks down thus negating any significant contribution towards reducing GHG emissions. Forest, woodland or rangeland which is being degraded will act as a source.

However, land use changes in a reverse direction, such as from relatively lightly vegetated cropland or rangeland to plantation forest, would in most cases be a net sink of carbon. In general, perennial crop species with large root structures which replace annual shallow rooting crops could potentially increase the amount of carbon stored in soils if these root systems remained in the soil after harvesting. The use of low input agricultural practices, such as conservation agriculture, and high diversity systems on degraded lands could result in carbon being sequestered as a result of rising soil organic matter. If tree or energy crop plantations are established on degraded sites, the sequestration of carbon could be increased, thereby mitigating the impacts of climate change.

Ecosystem Functions

Main ecosystem functions considered here are biodiversity, water and forests.

Biodiversity

The effects of climate change on the distribution of bioclimatic envelopes which currently characterize centres of plant endemism identified in Swaziland were studied. Results derived from modelling presented in the SNC (GOS-NMS-SNC, 2012b) include an estimate of the proportion of these areas of centres of endemism that would remain within their bioclimatic limits. These centres are also associated with high floristic richness and endemism. Results show that all the Maputaland and Barbeton centres of endemism respectively retain only about 53% and 18% of their current bioclimatic envelope within the period 2046-2065. All these centres experience elements of novel bioclimate which is likely to result in the potential loss of 48% to a complete loss of the country's near endemic tree species.

Adaptation strategies are needed to coordinate the activities of different institutions to address the impacts of climate change on biodiversity, and these should be an important step in coordinating national, regional and local governments' climate change impacts and adaptation programs. As well, actions identified will be integrated into the development of broader biodiversity policies and programs.

The threat of climate change to plant biodiversity in the country's key nature reserves represents a range of situations. An analysis was carried out on the range of bioclimatic parameters currently found in these reserves in relation to the range expected under the three climate change scenarios, in order to identify bioclimatic changes significant enough to introduce a novel bioclimate over the entire reserve area. Due to the small size of the country's protected areas, the results show how most of the reserves in the Highveld experience completely novel, and more stressful, levels of all the bioclimatic parameters during the 2050s. The north-eastern complex of protected areas (Hlane, Mlawula, Shewula and Mbuluzi) show possible immediate shifts, albeit on a lower probability, particularly Mlawula and parts of Hlane with the montane grassland protected area (Malolotja) also losing almost half of its bioclimate extent between 2046 and 2065. These changes will have impacts on the tourism industry in Swaziland, particularly wildlife tourism, thereby exacerbating the socio-economic impacts of climate change.

The objective of the proposed *adaptation strategy* is to:

- identify priority areas for research and monitoring, and improve understanding of potential climate change impacts on biodiversity to a point where specific strategies can be developed;
- use existing knowledge about the possible impacts of climate change and draw from ecological principles to review and amend current biodiversity conservation policies and strategies;
- improve communication about the impacts of climate change on biodiversity between researchers, resources managers and decision makers;

- raise community awareness of the potentially significant and specific impacts of climate change on biodiversity.

Water

Water is predicted to be the primary medium through which early climate change impacts will be experienced by various sectors and affect sustainable development, jeopardize economic development and poverty reduction efforts - this is stated clearly in the IPCC Technical Paper on Water and Climate Change (IPCC, 2008). *Adaptation to increasing climate variability and climate change* in the water sector needs to be guided by principles of: adaptations within broader development context; improving governance; building resilience; and addressing the economic and financial aspects; improving and sharing knowledge and information.

All rivers in Swaziland are international rivers and the water that Swaziland can utilise from them is limited by agreements with South Africa and Mozambique. Surface water resources (annual outflow) of Swaziland are estimated at 4551 mcm, of which 1,809 mcm, the annual inflow, originates from South Africa. The difference is 2,706 mcm runoff generated in Swaziland (about 18% of the total mean annual precipitation). Water demand exceeds sustainable supply. The annual water demand for domestic, industrial, livestock farming, and irrigation are: 30 mcm (1.7%), 17 mcm (0.9%), 14 mcm (0.8%) and 1,734 mcm (96.6%) respectively. Therefore, the total annual water demand is 1,795 mcm.

An analysis of the modelling results indicates that the water resources in Swaziland are possibly not vulnerable to climate change however, regional and global indications are for more variability in rainfall and thus runoff and stream flow so it remains critical that the water resource is managed in a more responsible manner with the expectation that the variability may affect critical sectors dependent upon water. Adaptation remains an important focus.

Forestry

Industrial forests and the natural forests and woodlands are characterised by different vulnerability with respect to impacts of climate change. This relates to the different nature and management levels. Industrial forests in Swaziland are well managed and in a relatively strong position to cope with climate change and adapt to it. The natural forests and woodlands are generally poorly managed and missing the capacity to deal with the effects of climate change.

Changes in the composition, structure and productivity of ecosystems will not only affect the sustainability of organisms that are associated with the ecosystems but may also lead to effects on the national economy they support (Feenstra *et al*., 1998, in FNC: GOS-MPWT, 2002).

Industrial Forests. Possible impacts on industrial forests, exposing the vulnerability, include the following:

- Shifts in the location and optimum growing size of species and shifts in species composition and size of the forest estate
- Changes in the production of timber or non-timber products
- Changes in the type, location and intensity of pests and diseases outbreaks
- Changes in the fire regime
- Increase or decrease in amount of carbon stored in forest ecosystem.

Community Forestry. In order to make community forestry sustainable in the future, the rural population needs to be helped to understand the causes and likely consequences of climate change, but also to adapt their livelihoods to cope with the changes that will occur in the ecosystems, in particular with respect to functions and products (GEF/IFAD/GOS, 2009).

Changes are likely to occur in the predominance or availability of products such as: timber, fuelwood, fruits (dietary supplement, brewing), edible animal and plant products (honey, insects, mushrooms, etc) and other plant products (roots, bulbs, leaves, bark, etc) for medicinal and cultural purposes.

Suggested Adaptation Initiatives in Industrial Forests. It is stated in the national forest policy (GOS-MOAC, 2002) that all plantation companies and growers must comply with the national criteria and indicators for sustainable forest management in Swaziland. This will become more relevant with climate change. In particular the policy statements on environmental sustainability (effects on water consumption, biodiversity and soils) are applicable. Apart from the vulnerability of industrial forestry as described above, also in these areas adaptation measures have to be taken. Suggested initiatives are summarised in Table 97.

Table 97: Suggested Adaptation Initiatives in Industrial Forestry

Measure	Description
Investigating the effects on environmental sustainability	Study the possible effects of a changed climate on environmental sustainability and formulate adaptation strategy
Diversifying the range of trees and the purpose and selecting suitable species	Select and change to species which are better adapted to the effects of climate change, in particular changed water availability
Commercial forest management practices.	Commercial forest companies and individual growers develop and introduce forest management practices that maintain biodiversity.
Sustainable expansion of industrial forest areas	Expand to locations in Highveld with still sufficient rainfall and low potential for other agricultural use (if a viable option)
Changing location	(does not seem a viable option)
Adapting fire response	Formulate new fire management procedures in order to cope with changed fire risk

Suggested Adaptation Initiatives in Natural Forestry. The national forest policy aims at safe guiding the forest resources of the country. The action plan and legal background (Forest Bill) are not yet operational, leading to continued poor management of the forests. The policy calls for the organisation of Natural Resource Management Committees and recognises the effects of threats to the biodiversity and conservation of natural forests and woodland. Threats include drought and climate change, as well as invasion of alien plants, the herbivory regime, and the fire regime, all likely to be influenced by climate change. Table 98 presents selected adaptation initiatives in natural forestry.

Table 98: Suggested Adaptation Initiatives in Natural Forestry

Measure	Description
Improving community forest management and coping mechanisms	Establish sustainable community-based forest management in each chiefdom through Natural Resource Management Committees
Improving conservation and sustainable use of culturally and medically important species in order to avoid depletion	Promote conservation and sustainable use and participation in biodiversity conservation through tourism and eco-tourism initiatives
Analysis of current and changing ecosystem functions and forest products	Adapt to functions and products that are likely to predominate in changed ecosystems as a result of climate change
Diversifying the range of forest products and selecting drought resistant species	Test usefulness of forest products not yet used
Selection of suitable tree species suitable for each ecological zone	Select suitable tree species on the basis of community needs for each of the ecological zones with research for specific tree species meeting specific situations.
Adapting control of IAPS	Design alien invasive plant species control and eradication program using a variety of methods, including mechanical clearing, the use of herbicides and biological control.
Adapting control of veld fires (Integrated fire management framework)	Integrated fire management framework involving assessment of laws and policies, fire prevention and education, fire preparedness and response, ecosystem restoration, recovery and maintenance and adaptive management, research and information.
Adapting to decreased forest functions and products	Investigate the options for alternative livelihoods to compensate for diminished supply of forest products

Forestry Mitigation

Forestry mitigation to climate change should aim at terrestrial carbon storage which would reduce atmospheric accumulation and thus delay its impact on global change. The four forestry options that can be used to mitigate climate change are forest protection, forest regeneration, reforestation for bioenergy and reforestation through rotation. The forest protection option is the most viable one in terms of mitigation potential, initial costs of investment, and net present value of costs (GOS-NMS/SNC, 2010f). The Forestry Department of MTEA, together with the SNTC is responsible for ensuring that the forest resources are managed and conserved optimally in order to prevent any harmful consequences from exploitation.

Agriculture and Biomass Production for Energy

Agriculture

Vulnerability is different for rainfed and irrigated cultivation. Irrigated agriculture may be adversely affected by less water available in rivers, however different predictions exist (see section 3.2.3 on water availability). It is assumed that irrigated agriculture will most likely be less vulnerable compared to rainfed agriculture as the efficiency of water storage and use is expected to be improved continuously.

Rural populations involved in agriculture already experience economic vulnerability, with reduced value of their commodities, increased costs of inputs and limited access to markets. For rural farmers living in dryland areas the scenario worsens because their ability to deal with the difficult years will diminish as the difficult years become more frequent and severe; they are exceedingly vulnerable to climatic shocks and change.

Without adaptation in management practices, changes towards a hotter, drier climate will lead to increased soil degradation, particularly affecting topsoils and to a lesser extent the subsoil. The hotter, drier conditions will produce generally less biomass and hence, without adaptation measures, reduce the supply of organic matter to the topsoil; the existing levels of organic matter will be lost due to higher temperatures, leading to a double loss.

Communal extensive grazing with its reliance on grass biomass production will be severely affected by the predicted climate changes for Swaziland. Even more extensive land degradation is likely to occur if current rangeland management practices are not improved or changed to adapt to the increasingly variable and changing climate. In the medium-term, humid ecosystems are likely to shrink in size and shift westwards in Swaziland, depending on their internal resilience.

Response. The single most important event taken place in the part of Swaziland most affected by drought and climate change is the development of large and medium scale irrigated agriculture, coupled with the cultivation of sugarcane. This has had a significant impact on the development of the Lowveld and the livelihood of its population. The irrigation development is currently expected to further increase with the implementation of the Komati Downstream Development Project and the Lower Usuthu Smallholder Irrigation Project (LUSIP), both aimed at improving the living standards of the rural farming communities by providing water and technical assistance to farmers to enter the sugarcane growing market.

If crop cultivation and livestock keeping are to be sustainable in the future, local land users need to be helped to understand the causes and likely consequences of climate change, but also to adapt their livelihoods to cope with the changes. Initiatives were suggested and formulated in a number of policy documents and project proposals, including the CASP and sub-sector policies, National Food Security Policy and Programme, the Drylands Development Programme (GOS-UNDP, 2003), several GEF & IFAD projects (GEF/IFAD/GOS, 2009), and the Agricultural Diversification study (GOS-MOA, 2008).

Livestock are an irreplaceable source of livelihoods for the poor. Rangelands (mainly grasslands and savanna) form the basis for livestock production and cover more than half of the country. Improving pastoralists' capacities to cope with degradation and drought, and promoting sustainable and integrated management of croplands, rangelands and water resources requires a combination of measures. These can include adaptive management approaches, social organization and development of locally adapted regulations for resource access, and tenurial arrangements that cover the common property resources upon which millions of poor people depend for their livelihoods. Healthy grasslands, livestock and associated livelihoods constitute a win-win option for addressing climate change in fragile dryland areas where livestock grazing remains the most rational strategy for maintaining the wellbeing of communities. Despite increasing vulnerability, livestock grazing of grasslands is unique in simultaneously being able to secure livelihoods, conserve ecosystem services, promote wildlife conservation and honour cultural values and traditions.

Modelling: Impact of Climate Change on Agricultural Production

The SNC provides information on modelling to indicate the impact of climate change on agricultural crop production. Crop yields under present and projected climatic conditions were simulated using the Decision Support System for Agrotechnology Transfer soft ware (DSSAT). DSSAT requires data input of daily precipitation, maximum and minimum air temperature and solar radiation (Thorp et al, 2008). Simulations were done for three crops: maize, sorghum and beans. These crops were chosen for the following reasons: maize is the staple food crop for Swaziland; sorghum is drought tolerant with the potential to substitute maize;

beans are a common food crop complementarily to maize (GOS-NMS/SNC, 2010a).[48] The simulations were done for three sites representing the three regions: Piggs Peak for the Highveld, Matsapha for the Middleveld and Big Bend for the Lowveld. Estimates of actual crop yields for the selected stations were obtained from regional 2001/02 statistics (GOS-CSO, 2003).

The results indicated that for both baseline and future scenarios that early December planting of maize offers a better yield prospect than planting in October. June, August or February planting will result in lower yields compared to October and December planting and should be discouraged at all times.[49]

The model results also suggested that in Highveld and Upper Middleveld moderate to strong improvements in projected maize yields (up to 7 t/ha) may be expected in the second half of the century due to climate change, for both December and October planting. For the Lowveld little change is expected. Baseline outcomes are surprising as they indicate that with December planting highest yields can currently be achieved in Matsapha, followed by Big Bend in second position and Piggs Peak in third. The model results for the two other crops investigated are less conclusive than for maize.[50]

In conclusion, according to the model, climatic change will affect different crops differently in the period 2046-2065 and the period 2081-2100: [51]

- Maize yields will be higher when planted in the first week of December compared to mid October. Yields in all stations are projected to be considerably higher than the baseline.
- Bean yields will be higher when planted in October compared to January. Yields in Matsapha are projected to be higher than the baseline but lower in Piggs Peak and Big Bend.
- Sorghum yields will be higher when planted in January compared to mid October, however with quite close results in the 2081-2100 period. Yields in Matsapha and Piggs Peak are projected to be slightly lower than the baseline, in Big Bend little change.

Agriculture Mitigation

Governments' objective to mitigate emissions from the agriculture sector is to promote sustainable land management to keep the carbon in the soil. Healthy, balanced soils fix significant amounts of organic matter, with high carbon content, and can hold these stocks for long time periods, provided the soil is not disturbed too much. This is one of the foundations of 'conservation farming', which minimises or even eliminates the tilling of soil from year to year between cropping cycles.

Energy

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[48] Crop production conditions such as fertilization, weeding, pest and disease control were considered optimal for the simulations, in other words, farming under high management level. The simulations projected yields for two periods: 2046 to 2065 and 2081 to 2100. The modelling output included harvest yield, biomass, stalk yield and nitrogen content of the crops. Simulations were done using climatic patterns derived from three climatic models: cccma_cgcm3, gfdl_cm2, and a model specifically prepared; the first two considering the specific regions, the last one the whole country. The simulations were also done to determine the effect of planting season on yields for the three crops.

[49] In the First National Communication (GOS-MPWT, 2002) the general prediction for maize production was that most of the country would be unsuitable, since yields were estimated to decrease considerably, which could to some extent be remedied by changing the planting season to August.

50 Some outcomes show rather large differences between models and station, especially with beans. The beans model indicates that projected beans yields are expected to decrease by some 10-60% in Big Bend and Piggs Peak for both the 2046-2065 and 2081-2100 periods. However, more than 50% increased yields are projected for Matsapha in 2046-2065 with October planted beans.

The models indicate that baseline sorghum yields are about 10-20% higher when planted in January compared to October. Projected sorghum yields show little change in Big Bend for both planting times and future periods. Projected sorghum yields in Matsapha and Piggs Peak are about 10-20% lower for January planting over both periods. However, moderately to strongly increased yields of 15-45% are projected for Matsapha and Piggs Peak over both periods with October planted sorghum, with the result that in the 2081-2100 period yields will be higher than with January planting, however still (slightly) lower than January baseline.

51 Critical note: The results of this modelling and similar modelling done for the First National Communication for the year 1994 may have to be considered unrealistic and faulty and unsuitable for any adaptation strategy. The result that higher maize yields can be expected in the second half of this century in all agro-ecological zones in Swaziland is not consistent with other predictions made, either in general for southern Africa or more specifically for Swaziland. When also considering the not so likely result of a similar exercise for the FNC 1994, namely the recommendation to shift planting dates to August, one may doubt the reliability of the results of the modelling, either caused by wrong data input or by the modelling procedure, or both. This may also be coupled with the inconsistent results for the other crops and the close results of all three different stations (currently highly unlikely) in contrasting zones, at least for some of the planting dates.

The vulnerability of Swaziland to climate change affecting energy is restricted to the security of supply from renewable energy sources – biomass and hydro. Countries reliant on hydropower are especially vulnerable to changes in rainfall. River-flow rates and water availability are inevitably affected by variations in rainfall, resulting in an unreliable electricity supply. An increase in irrigation will place further pressure on river-flow rates and volumes. During times of low rainfall, reduced river flows reduce the hydropower output, leaving no alternative but to import a significant proportion of their power. The decline in the use of wood for cooking is likely to be a result of increased electricity access in rural areas as part of Government's Rural Electrification Programme that brings electricity infrastructure to rural Government institutions.

In response to the current situation, including the impacts from climate change, the Government of Swaziland is in the process of implementing the 2003 National Energy Policy (GOS-MNRE, 2003) through the 2009 Energy Policy Implementation Strategy and Action Plan (GOS-MNRE, 2009b) with overall objectives of supporting programmes that promote the utilisation of renewable energy resources for electricity production and encourages the wider use of solar water heaters for residential and commercial buildings through promotional means and support for private sector initiatives (see also sections 3.5.2 and 4.5.2 on energy).

Energy Mitigation

Mitigation of emissions from energy focuses on developing and expanding the use of renewable sources of energy whilst reducing energy use and increasing energy efficiency. Household photovoltaic systems, solar water heaters, wind, hydro and biomass are all available and are being developed at different speeds.

While the Royal Swaziland Sugar Corporation are investigating the possibility of using sugar cane trash to completely replace coal usage within their mills using only bagasse and cane trash as their primary energy source, Illovo Sugar has undertaken a E1.510 billion cogeneration conversion process within its mill to fully utilise biomass for electricity generation. This initiative is accompanied by a new harvesting technique that requires the harvesting of sugarcane without burning, as is the current practice. This ensures the maximum amount of biomass is available to the mill. The co-generation plant will function as a power station that can operate both independently (when it will be electrically isolated from the Swaziland Electricity Company utility) and in "export mode" (when it will be electrically coupled to the Swaziland Electricity Company) to satisfy the broad range of operational circumstances that occur at the Factory during both the crop and the off-crop sessions.

Human Health

Comprehensive studies of the vulnerability of Swaziland's population to the impacts of climate change on human health are still lacking. The main limitations are the non-availability of relevant data and information and expert analysis to identify critically important trends and interventions (see section 3.3.2.4.3 on climate change impacts).

Protecting health from global environmental change requires management at many levels, from the social and economic drivers of environmental change, to the resulting hazards and exposures for human populations. The changing climate will inevitably affect the basic requirements for maintaining health: clean air and water, sufficient food and adequate shelter.

Catastrophic weather events, variable climates that affect food and water supplies, ecosystem changes are all associated with global warming and pose health risks. Climate and weather already exert strong influences on health: increased deaths from heat waves and disasters such as floods, as well as changing patterns of life-threatening vector-borne diseases such as malaria and other existing and emerging infectious diseases are observed. Continuing climate change will affect, in profoundly adverse ways, some of the most fundamental determinants of health: food, air and water. Areas with weak health will be the least able to cope without assistance to prepare and respond.

Strengthening of public health services needs to be a central component of adaptation to climate change. The international health community already has a wealth of experience in protecting people from climate-sensitive hazards, and proven, cost-effective health interventions are already available to counter the most urgent of these. Broadening the coverage of available interventions would greatly improve health now. Coupled with forward planning, it would also reduce vulnerability to climate changes as they unfold in the future. Poverty alleviation is critical to reducing vulnerability – but public health measures are also required. There is abundant evidence that countries with a higher level of economic development tend to have better health, including reduced vulnerability to many climate-sensitive diseases.

4.3.2.3 NATURAL DISASTERS

Considering the still inadequate response to the occurrence of natural disasters as described in section 3.3.4.5, the governments needs to step up the response in order to reduce impacts and casualties. In particular the preparedness needs to be improved.

Perhaps the vision of the disaster management system, namely that by 2022 Swaziland has a functional national disaster risk management system, needs to be reconsidered in view of the urgent need for better preparedness.

In terms of systemic response, the Disaster Management Act needs to be finalised and enacted. Institutional improvements required to become fully operational include the establishment of a fully fledged Disaster Management Unit and the upgrading of the early warning system.

4.3.2.4 STRATOSPHERIC OZONE

As reported before, the trends in stratospheric ozone have significantly improved over the past 10 years. For that reason the negative impacts from stratospheric ozone on the environment are expected to further decrease.

Swaziland has contributed to this success as the country has been in compliance with the ODS phase out schedules set out under the Montreal Protocol and all relevant initiatives.

In order to increase efficiency of control and monitoring, there is a need to review and improve the ODS regulations. Another proposal is to gazet border personnel as certified environmental inspectors.

Table 99 provides an overview of the required responses to support positive change, listed according to future policy actions, future legislative actions and future institutional actions.

Table 99: Summary of Future Outlook of State of Atmosphere

ISSUE	ASSUMING STATUS QUO (BUSINESS AS USUAL)		REQUIRED RESPONSES TO SUPPORT POSITIVE CHANGE		
	Future Trend	Future Extrapolated Impact	Future Policy Action	Future Legislative Action	Future Institutional Action
Air Quality	• Air Quality continues to be unmonitored • Institutional set-up for air quality monitoring continues to be poor • Fragmented interventions	• Increase in health impacts associated with air pollution • Poor awareness on health impacts from energy sources which cause air pollution	• Preparing and finalising energy technology policy •	• Revision of Air Pollution Regulations to include emission standards as well as on institutional set-up	• SEA to develop a fully fledged Air Pollution Unit • Revitalisation of Waste and Pollution control Committee • Exploring the possibility of establishing a joint air pollution monitoring commission with RSA and Mozambique • Energy Dept, SEA, SMS to form coalition for awareness raising on air quality
Climate and Climate Change	• Unccordinated interventions for mitigation and adaptation	• Swaziland extremely vulnerable to impacts climate change • Increase of casualties from extremes of Climate Change • Increased invasion of alien species • Food Security unachievable • Escalating poverty & food aid dependance	• Preparing and finalising National Climate Change Strategy and Action Plan	• Revision of Grass Fire Act and its transfer from MOA to MTEA • Introduction of Carbon Tax for all emmitting activities (Industry and vehicles)	• MTEA to establish a clear institutional structure for coordination of climate change activities (based on formulation CC strategy)
Natural Disasters	• Inadequate preparedness and poor response to disasters	• More vulnerability to disasters and more casualities	•	• Finalising and enacting Disaster Management Act	• Establish fully fledged Disaster Management Unit • Operational Early Warning System
Stratospheric Ozone	• By 2030 ODS eliminated	•	•	• Revision of ODS regulations to increase monitoring and control	• Gazetting border personnel as certified environmental inspectors

4.4 FUTURE OUTLOOK: BIODIVERSITY

4.4.1 FUTURE TREND BASED ON STATUS QUO

Biodiversity has been the basis for people's livelihoods for generations because direct and indirect services are derived from it. The National Biodiversity Strategy and Action Plan (NBSAP: GOS-SEA, 2001) reported decline and extinction of wild animal species and populations as well as indigenous plant species due to deforestation, poaching, encroachment, uncontrolled bush fires and selective use of species.

The situation has not improved to date because biodiversity is still under threat or pressure from habitat loss, invasive alien plants, over-harvesting, undervaluation of biodiversity, lack of comprehensive ABS mechanisms, pollution and climate change. Hence, the future outlook for conservation and protected areas as important cornerstones for sustainable development is uncertain.

Extrapolation of the current state and trend in biodiversity, assuming a status quo situation, will evolve to a future trend not different from the present one and will continue showing the same negative impacts on the environment.

Without the intervention the current trends and impacts are expected to continue, such as the drastic declines in many species as reflected in the Red Data Lists (reference) and habitat fragmentation.

Continuation of the current ad hoc implementation or lack of key pieces of legislation and policies will result in further unplanned and poorly coordinated efforts to mesh together areas of high biodiversity value with reductions in poverty.

The continuation of business as usual will continue to impact on the resilience of critical ecosystems to provide essential goods and services and also impact on food security and general health conditions.

4.4.2 FUTURE TREND BASED ON POSITIVE RESPONSE

Intervention in several key areas will be necessary in order to avoid a situation as described in the above section assuming continuation of the current trend.

Responses should also preferably be based on recognised international initiatives and principles of biodiversity management, such as the Convention on Biological Diversity. Swaziland is already linked to an array of Conventions and other international arrangements.

Positive responses are required to address the following issues:

- Policy and Legal Framework (essential parts currently not existing, conflicting or outdated)
- Adaptation Strategies to Address the Impacts of Climate Change
- Control of IAPS in Protected Areas
- Management, Planning and Monitoring
- Community Benefits and Livelihood Strategies
- New Financing Mechanisms
- New CBD Strategic Goals for Conservation
- New Proposed Swaziland Conservation Targets

Policy and Legal Framework

Biodiversity is crucial to the reduction of poverty as a direct result of the basic goods and ecosystem services it provides and as an integral part of important development sectors such as agriculture, forestry and tourism.

Hence, biodiversity conservation policies and legal frameworks should ensure that threats to biodiversity conservation are adequately addressed. Policy and institutional framework strategies should include harnessing the greater potential that biodiversity has to increase its contribution to GDP and sustained economic growth through improved livelihoods and women and youth empowerment.

There is a need to mainstream biodiversity into key economic and development sectoral policy implementation such as land, agriculture, forestry, energy, mining, business and trade in order to address negative impacts that can hinder significant reduction of biodiversity loss, e.g. by 2015 as the MDG target.

Biodiversity conservation policy and programme implementation requires concerted efforts and the combined strength of all sectors of society in Swaziland. There is need to have policy implementation alliances at local, national, regional and international levels between policy makers, civil society, indigenous and local communities and business and the private sector.

Mainstreaming of Climate Change and Adaptation Strategies to Address Impacts

In the first place there is a need to mainstream climate change issues into biodiversity conservation policies and programmes, including all MDG priority areas that depend on biodiversity and ecosystem services. There is need to come up with policy implementation strategies that address threats of climate change to biodiversity but also strategies that use biodiversity to adapt to climate change impacts on human wellbeing.

Adaptation strategies are needed to coordinate the activities of different jurisdictions to address the impacts of climate change on biodiversity, and these should be an important step in coordinating national, regional and local governments' climate change impacts and adaptation programs. As well, actions identified will be integrated into the development of broader biodiversity policies and programs. Proposed adaptation actions proposed are aimed at reducing the impacts of climate change on each of these ecosystems, and promoting *in situ* conservation of species and ecological communities to facilitate their natural adaptation, but also including the use of high-cost *ex situ* interventions such as translocation and captive breeding. Key strategies include promoting ecological connectivity to aid migration and dispersal of species, protecting refuges and creating specific management zones around important habitats. Suggested adaptation measures are as follows:

- Improve the understanding of the impacts of climate change on biodiversity
- Increase awareness of climate change impacts and our capacity to respond
- Minimise the impacts of climate change on aquatic and semi-aquatic species, communities and ecosystems
- Minimise the impacts of climate change on indigenous terrestrial species, communities and ecosystems
- Minimise the impact of alien and invasive organisms on biodiversity in future climates
- Factor the impacts of climate change on biodiversity into natural resource management and land-use planning

Control of IAPS in Protected Areas

The work on control and clearance of IAPS as reported in Chapter 3 need to be continued. There is a further need to create legislation and a strategy for the control and management of IAPS. This requires funding not only for the strategy creation but also for the development of inventories and maps and for the actual control and monitoring. The need to effect management plans that cater for control of alien invasive species in the current network of nature reserves was already highlighted in BSAP (2001) and this has not been met to date.

The estimated cost to clear the current infestation of alien plants amounts to almost R700 million per year, which is, approximately 3% loss of the country's GDP.

Management, Planning and Monitoring

Into the future users and managers of biodiversity need to consider the following measures:

- Strengthened protected area management, including clear demarcation of boundaries and enforcement
- Provision of new, alternative livelihoods, such as nature-based tourism, or harvesting of non-timber forest products (NTFPs)
- Introduction of modified land use practices, including livestock management, agricultural diversification, and social forestry
- Environmental awareness programs, including community outreach
- Social organization and community development
- Participatory conservation and development planning and monitoring
- Recognition of land tenure and other use rights
- Sustainable financing for protected areas and community development.

A key lesson from the failure to meet the 2010 biodiversity target is that the urgency of a change of direction must be conveyed to decision-makers beyond the constituency so far involved in the biodiversity convention.

Systematic proofing of policies for their impact on biodiversity and ecosystem services would ensure not only that biodiversity was better protected, but that climate change itself was more effectively addressed. Conservation of biodiversity, and, where necessary restoration of ecosystems, can be cost effective interventions for both mitigation of and adaptation to climate change, often with substantial co-benefits.

Community Benefits and Livelihood Strategies

Promotion of alternative livelihood strategies is a common element of many projects and is likely to remain so. Community benefits and small grants are a good way to engage a broad range of stakeholders and elicit support for conservation projects. Yet the challenges in linking support for livelihood strategies to conservation are manifold, including identification of suitable alternatives to current practices, appropriate targeting of beneficiaries to reduce threats, capacity building, and sustainability beyond the project lifetime. Too often, project managers focus more on delivery of grants and economic opportunities rather than on the causal linkages between threats and biodiversity outcomes. Even if livelihoods improve for some beneficiaries, it may not lead to a reduction in threats.

Promoting new livelihood opportunities is just one way to benefit local communities. Other strategies may be more effective in encouraging long-term support for protected areas and/or changing economic behavior in the production landscape. These include:

- Community benefits through sharing park visitor fees. This is well-illustrated in India and Madagascar studies and especially appropriate where protected areas have high tourism potential and revenue-sharing arrangements;
- Establishment of community funds for conservation. This can be especially effective and sustainable when linked to co-funding contributions raised by the communities themselves and to reciprocal and monitorable conservation commitments from the involved communities;
- Direct payments for biodiversity conservation or protection of other ecosystem services, such as watershed protection or carbon sequestration.

Opportunities arising from wider PPP are gaining prominence around conservation and eco-tourism and co-management approaches should be introduced in areas where there is an opportunity to do so. Such initiatives should reduce human-conservation conflicts like poaching and over harvesting. Communities should be rewarded for looking after biodiversity and be made more aware of how the costs and benefits for natural resources are determined and how they may benefit.

There have been positive approaches to combat poverty and promote biodiversity conservation by encouraging communities to engage in income generating activities such as honey and marula juice production and the rearing of selected wild animal species e.g. kudu. There have been new entrants into the eco-tourism sector that combine conservation with accommodation, awareness raising and community development, e.g. in the Phopanyane Nature Reserve. Such initiatives need be continued.

New Financing Mechanisms

Most protected areas lack adequate regular budget even for management activities, yet ICDP projects often leave local communities with the expectation that the protected area authority will continue as a development provider. Projects need to be much more rigorous in defining exit strategies and identifying post-project sources of sustainable financing, both for protected area management needs and appropriate local development, including innovative payments for ecosystem services and direct conservation payments based on performance. Such approaches require a careful cost-benefit analysis and a funding source for long-term financial commitments.

New CBD Strategic Goals for Conservation

In decision X/2, the Conference of the Parties to the Convention on Biological Diversity adopted the Strategic Plan for Biodiversity 2011-2020, in which twenty headline ***Aichi Biodiversity Targets*** for 2015 or 2020 are organized under five strategic goals. In the same decision, the Conference of the Parties urged Parties to develop national and regional targets, using the Strategic Plan as a flexible framework. Under target 11, the Parties agreed that:

"By 2020, at least 17 per cent of terrestrial and inland water areas, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes".

New Proposed Swaziland Conservation Targets

The total land area set aside for the conservation and management of biodiversity and ecosystem components is below the target set in the BSAP (>10%) as well as from the guidance issued by the CBD under its Programme of Work on Protected Areas (PoWPA).

Swaziland needs new site-level, new spatial and new sectoral strategies, together with reviewed and revised national targets and indicators. Table 100 presents an outline of a proposed strategy.

Table 100: Proposed Medium-term Conservation Strategy Outline and Targets

Description of strategy	Proposed national target(s)	Potential indicators
Swaziland – Site-level strategy		
Revise all protected area management plans to include climate adaptation and mitigation activities/strategies	By 2015, at least 75% of all protected areas plans are revised and include climate change response strategies	% of protected areas with revised climate change-responsive management plans
Swaziland – Spatial strategy		
Increase protected area and transboundary conservation areas coverage across the country to improve/enhance climate change resilience for all major habitats/ecosystems.	By 2020, 11% of the country is protected and at least 10% of each major habitat/ecosystem is protected	% of total land area protected and % of each habitat under protection
Swaziland – Sectoral strategy		
Increase ecosystem-based approaches and protection-worthy areas into the National Adaptation Plan of Action (NAPA) and climate change strategy	Target 2: By 2015, Swaziland's climate change response strategies (e.g. NAPA) fully incorporate ecosystem-based resilience such as establishing carbon sinks and controlling invasive species	Budget allocation to ecosystem-based approaches to climate change adaptation: amount of carbon stored / captured by different ecosystems & % reduction of total land area under alien plant invasion

Table 101 provides an overview of the required responses to support positive change, listed according to future policy actions, future legislative actions and future institutional actions.

Table 101: Summary of Future Outlook of State of Biodiversity

ASSUMING STATUS QUO (BUSINESS AS USUAL)		REQUIRED RESPONSES TO SUPPORT POSITIVE CHANGE		
Future Trend	**Future Extrapolated Impact**	**Future Policy Action**	**Future Legislative Action**	**Future Institutional Action**
• Increasing habitat fragmentation (LUC: urbanization & Irrigation agriculture • Excessive resource extraction (medicinal plants, wood etc) • Increased erosion & land degradation caused by overgrazing • Increased IAPS infestation • Legal import of LMO due to Biosafety Act • Increasing poaching (Human-animal conflict) • Game ranch hunting • Increased pressure on PAs from mineral extraction and commercialisation • Continuation of climate change	• Loss of indigenous species and distribution pattern • Compromised ecosystem resilience and reduced goods and services • Increase in number of red data species • Impact on wetlands & aquatic life • Depletion of water resources • More PAs forced to be financially inclined impact on financial and human capacity • Pollution and contamination impacting on human health	• Finalising the biodiversity policy • Finalising the IAPS strategy and strengthening of IAPS programmes • Revision of NBSAP to adopt the Aichi targets • Finalising the Land Policy • Strengthening of the AMESD and other Wildfires programmes • Strengthening and increasing PA area network by the on-going GEF/IFAD project under SWADE • Finalising Wildlife Policy • Declaration of more PAs in line with CBD targets	• Finalising and enacting the Forest Bill • Finalising and enacting the Biodiversity Management Bill • Finalising and enacting the ABS Bill • Review of the Flora Protection Act • Promulgation of various Regulations under Biosafety Act • Accession to the two Nagoya Protocols • Adoption of SNTC amendment • Accession to all Conventions that promote conservation	• Strengthening of Forestry dept (financial and human capacity) • Enacted Biodiversity Bill requires capacitated Biodiversity Management Unit • Strengthening of the BPIC • Wildlife Unit • Increasing public awareness and participation on conservation

4.5 FUTURE OUTLOOK: HUMAN DEVELOPMENT

In the context of the state of human development the environmental impacts and changes are considered in terms of:

- Urbanization
- Energy
- Waste
- Human Health

The role and influence of human development on critical environmental indicators has been discussed in previous chapters and all show increasing negative trends on their environmental impact and development.

4.5.1 URBANISATION

Urbanisation is the physical growth of urban areas as a result of global change. Such change can have negative impacts on the bio-physical environment from land and water pollution to loss of biodiversity and changes in ecosystem services.

Swaziland remains a primarily rural country, with approximately 78% of the population residing in areas classified as rural (CSO, 2007). However, that classification masks the fact that a growing portion of the "rural" population live in peri-urban settlements abutting formal urban areas, and at densities similar to those of the formal urban areas.

4.5.1.1 FUTURE TREND BASED ON STATUS QUO

Extrapolation of the current state and trend in urbanisation assuming a status quo situation - which means business as usual - will evolve to a future trend not different from the present one and will continue showing the same negative impacts on the environment as described in the previous chapter on Urbanisation.

The continued expansion of urban areas to meet the needs and aspirations of the population is leading to challenges in providing essential services to residents.

The slow implementation of the Housing Policy and the lack of resources to plan its implementation are seen as having a detrimental impact on the environment. Peri-urban sprawl continues to increase.

4.5.1.2 FUTURE TREND BASED ON POSITIVE RESPONSE

At the 4th Session of the African Ministerial Conference on Housing and Urban Development (Nairobi, 20–23 March 2012), ministers agreed that cities are hubs for development opportunities and poverty reduction and therefore the level of human development is correlated to the rate of urbanization in all regions of the world. The urban economy provides more job opportunities than rural areas and facilitates synergies among productive actors, including between the formal and informal sectors and between rural production and urban markets. However cities have often been growing with little consideration for vulnerability to climate change and other environmental risks and without coherent land policies. Urban development cannot be left only to individual and private initiatives. Governments have to guide the urbanization process and support the related economic growth and in the meantime combat social disparities and environmental degradation which often accompany this growth. They need therefore to strengthen their planning capacities and to ensure that basic social services and environmental infrastructure become accessible and affordable to all.

Although urban areas in Swaziland have developed planning schemes these have not focused on the real needs of urban expansion and governance. Future plans have to focus on urban extensions and municipal revitalization and has to take the existing settlement pattern into account.

Conventional urban planning or master planning almost passed away in the mid-1980s, particularly in Africa. Many reasons to explain this decline:

- In terms of process, master plans were designed by bureaucrats and experts, generally under-estimating the political, economic and social dynamics of the city. City planning was a top-down technocratic exercise, similar to economic planning.

- In terms of product, urban plans were essentially spatial zoning and land-use maps, not associated with investment planning and resource mobilization.
- In terms of implementation, urban planning was generally blind on institutional issues such as the relationship among ministries, and between central and local governments. It did not associate long-term goals with daily city management constraints and short-term priorities.
- In terms of strategy, urban planning tried to go around the need for policy and legal reforms, and often unquestioningly accepted existing situations. Consequently, it failed to address the root-causes of many urban problems. As a result of these limitations, many Master Plans were simply not implemented.

The current national debt crisis could see government slashing social spending, including on basic services, in order to balance the budget. Urban planning needs to follow a strategic integrated planning approach encompassing "affordable participatory planning". Such a process of participatory planning should mobilise civil society and political organizations in the definition of the vision ("the city we want") and priority areas ("hotspots") through popular consultations, but it should go beyond the vision and identify precise and scheduled actions. The strategy should preferably be associated with a review/reform of urban governance legislation, rules and practices to ensure they are relevant and effective.

UN-HABITAT Ten Steps

Two reports of UN-HABITAT could provide a useful basis for improving urban planning. The first one is the Global Report on Human Settlements (GRHS) 2009, entitled "Planning Sustainable Cities" [UN-HABITAT, Global Report on Human Settlements (GRHS) 2009: Planning Sustainable Cities, Nairobi]. It highlights the need to revisit urban planning and to understand the diversity of urban contexts. It recommends adopting innovative approaches: strategic spatial planning, departmental integration, regularisation of informal areas, participatory processes and Public-Private Partnerships (PPP). It also recommends linking the "green" and "brown" agendas in cities though comprehensive sets of plans covering all basic services, linking particularly public transport and land-use.

The second document is a short guide on Citywide Strategic Planning (2010) [UN-HABITAT and GLTN, Citywide Strategic Planning, a Step by Step Guide, 2010] which describes ten steps in the urban planning process:

(1) Political support and leadership
(2) Institutional responsibility for managing the process
(3) Common understanding of the goals and steps
(4) Organizing the process
(5) Studies and analyses
(6) Consultations (workshops) on the vision and objectives of the Plan
(7) Participatory preparation of the Citywide Strategic Plan, including an overall medium-term Action Plan
(8) Formalization and endorsement of the Citywide Strategic Plan
(9) Marketing the Plan
(10) Implementing and monitoring.

Urban Planning in Swaziland

Urban areas in Swaziland need to be planned in a way commensurate to the current availability of resources and capacities. It is clear that the structure and balance of private and public spaces established today will influence the future urban pattern, quality of services and economic activities. Present planning decisions have always a bearing on access to services in the immediate future and for generations to come.

Although urban governance faces many challenges, climate change is increasingly threatening the long-term sustainability of many urban areas. As such *climate change* should be seen as an incentive and an opportunity for better urban planning and management. Mitigation responses (to reduce urban emissions) and adaptation responses (to reduce city vulnerability) requires forward-planning and improved services. Swaziland needs to focus on adaptation as part of strategic urban planning and drastically increase infrastructure investments in water supply, sanitation, waste management, transport and communication facilities, energy, primary health and emergency services, primary education and public safety. There is no need for autonomous climate change adaptation programmes but there is need for urban development plans within which measures for climate change adaptation are integrated.

The main challenge is to move from the current low density pattern of urban development to an energy efficient "compact city" by adopting strategies for realizing smarter and more sustainable urban development.

Combating urban sprawl to reduce energy consumption should become a goal of policy-makers and planners. This will also facilitate the provision of infrastructure and services. The reliance on private motorized transport, the continuous cooling of office buildings and shopping centres, the lack of alternative sources of energy and of incentives to the development of renewable energy all combine to increase the environmental footprint of urban areas. The consumption and production patterns we see today are becoming more unsustainable. While mature technologies exist in the building sector for increased energy efficiency and reduced GHG emissions, they need to be promoted by revised building codes and sometimes by financial incentives.

Guiding rapid urban growth and subsequent urban sprawl is an increasingly difficult challenge in most of our urban areas. It can be addressed by applying strategic planning approach and developing adequate governance structures beyond current administrative city limits in order to avoid discrepancies in urban management capacities and resources between official urban areas and surrounding informal developments.

Municipalities need to identify technical and financial assistance to transition towards more sustainable and efficient urbanisation. Agencies such as UN-HABITAT can provide technical assistance to African countries in integrating climate change into urban planning and management, focusing on the urban poverty aspects of climate change, supporting national–local policy dialogues, and channelling lessons learnt into global policy reform on cities and climate change.

Challenges to be faced by municipalities and central government include how to support non-marketable infrastructure (roads, drainage, landfills etc.) which rely on national funding. How can municipalities strengthen land and property taxation to make funds available for urban improvements? Climate change mitigation and adaptation provisions must be mainstreamed in urban plans with special attention to reducing the vulnerability of the poor. How to promote cities which are both energy-efficient and resilient? Which priorities?

Our cities need a longer-term and broader vision of the use of urban space to reduce poverty and promote sustainability. This includes an explicit concern with the land needs of the poor. For poor families, having an adequate piece of land with access to water, sewage, power and transport on which they can construct their homes and improve their lives is essential: Providing it requires a new and proactive approach. Planning for such spatial and infrastructure requirements, keeping in mind poor women's multiple roles and needs, will greatly improve the welfare of poor families. This kind of people-centred development knits together the social fabric and encourages economic growth that includes the poor.

Improving Urban Governance

To improve urban governance to ensure urban economic development thrives, inter-departmental collaboration (among ministries) is required on both urban planning and the provision of basic services. Strengthening the relationship between the MHUD, Ministry of Finance, Ministry of Economic Planning and Development, and provincial and local authorities should be a common goal of the MHUD and their local authorities.

The introduction of the Tinkhundla Regional Administration Bill will require municipal capacities (for all sizes of towns) to be developed if the decentralization envisaged within the Act is to succeed. The MHUD will need to contribute to the creation or streamlining of the required governance structures and provide technical expertise in their fields of competence.

Sustainability and environmental management (considering the city as an ecosystem) should be a component of urban planning at all levels. Reducing vulnerability to climate change and promoting energy savings should become major goals of the urban environment planning and management agenda. The MHUD should take the lead in vulnerability assessments of the built environment, in collaboration with the Swaziland Environment Authority.

The provision of water and sanitation in urban and peri-urban areas has to remain a key priority, but the focus should be more placed on improved sanitation, particularly in informal areas. A strong investment in public toilets should be considered, taking the operation and maintenance factor into account and recognizing the importance of community participation and ownership.

The need for improved mobility and reduced traffic congestion constitutes a major challenge. As more vehicles use the existing road network congestion in Manzini and Mbabane is increasing. New facilities for pedestrians and even cyclists and increased investments in public transport should be planned as a top priority. MHUD and the Ministry of Public Works and Transport need to work together in this crucial area.

Green Building

It is recommended that the MHUD and relevant partners that models of Green Building Councils and the associated green rating systems be developed and considered that cater for the different needs and specificities of our diverse urban characteristics through collaborating with different countries.

To achieve maximum success the country needs to plan to ensure professionals in green or sustainable building are developed. In addition MHUD and Ministry of Education should explore the introduction of green building practices in the education system in order to increase public awareness and skills to spread green practices.

Green buildings have an improved environmental performance over standard buildings through all phases of their lifecycle which begins with design and construction and moves through operations and to the end of life, including deconstruction and demolition. A green building will also have features that make it healthier for its occupants, such as increased daylight and fresh air and non-toxic materials. By reducing the amount of energy and water and other resources they use, green buildings are consistently less expensive to operate and become more valuable in the marketplace.

In addition to tangible environmental benefits, green buildings have demonstrable social benefits and studies have indicated that the quality of the indoor environment in these buildings directly benefits the occupant. On average, students in green schools score higher on tests, workers in green buildings have lower absenteeism and are more productive while patients in green hospitals have faster healing times.

Green Building Councils (GBCs) are not-for-profit, member-based organizations that seek to transform the building industry towards sustainability through encouraging the adoption of green building practices. Their primary methods to achieve their goals are the implementation of green building rating tools, education and advocacy. Currently, there are some 60 GBCs in various stages of development around the world, with 20 being fully 'established'. While at present there is only one established GBC in Africa – in South Africa – this is slowly changing, with three new councils in their early stages of development in Morocco, Mauritius and Egypt. The World Green Building Council is the umbrella organization and governing body for these GBCs.

One of the fundamental activities of most Green Building Councils (GBCs) is the implementation of green building rating tools. These tools put forth a range of environmental performance criteria including, but not limited to energy, water and resource usage, ecological impacts, transportation, indoor environmental quality and construction processes.

Building operations are estimated to be responsible for 6 East African officials discus affordable housing, 25-40% of energy consumption in developed nations and 56% of the energy used in sub-Saharan Africa is by residential buildings alone. There is a direct correlation between this energy consumption and climate change: the UNEP Sustainable Buildings & Climate Initiative (UNEP-SBCI) indicates that 40% of global carbon dioxide (CO2) emissions come from the built environment.

For Swaziland as with all countries trying to reduce energy and environmental resource consumption the introduction of green building technologies, reinforced through legislation and institutional building, green building could make a noticeable difference to the way our housing and offices use energy and water.

Table 102 provides an overview of the required responses to support positive change, listed according to future policy actions, future legislative actions and future institutional actions.

Table 102: Summary of Future Outlook of State of Urbanisation

<table>
<tr><th colspan="2">ASSUMING STATUS QUO (BUSINESS AS USUAL)</th><th colspan="3">REQUIRED RESPONSES TO SUPPORT POSITIVE CHANGE</th></tr>
<tr><th>Future Trend</th><th>Future Extrapolated Impact</th><th>Future Policy Action</th><th>Future Legislative Action</th><th>Future Institutional Action</th></tr>
<tr><td>• Increased demand for land for urban infrastructure
• Increased demand on urban services for water, sanitation and waste treatment
• Increasing cost for urban administration
• Increases in peri-urban settlements</td><td>• Increased air pollution from petroleum energy use
• Increased pressure on natural forests and woodlands to fuel peri-urban growth
• Increased pressure on water resources to supply urban areas
• Increased non-point source water pollution
• Increased storm runoff rates contributing to urban flooding</td><td>• Review and update the Housing Policy
• Review and update the Urban Government Policy
• Review and update the Peri Urban Growth Policy</td><td>• Review building legislation to improve sustainable technologies and building practices</td><td>• Develop a GIS-based land information system of land use and land ownership in urban and peri-urban areas and in rural growth nodes
• Develop a Peri Urban Growth Strategy
• Develop Green Building guidelines
• Capacitate municipalities to manage urban areas
• Develop strategies to secure water supplies to urban areas
• Develop strategies to secure sanitation services to urban areas</td></tr>
</table>

4.5.2 ENERGY

4.5.2.1 FUTURE TREND BASED ON STATUS QUO

Extrapolation of the current state and trend in energy assuming a status quo situation - which means business as usual - will evolve to a future trend not different from the present one and will continue showing the same negative impacts on the environment as described in the previous chapter on State of the Environment.

The continued use of energy to satisfy the ever increasing demands of a growing population and expanding economy is leading to increases in greenhouse gas emissions that contribute towards global warming and climate change.

Associated with the increase in energy use is an emerging trend in the energy sector to move towards a greater proportion of locally generated renewable energy. The sugar sector is leading the way in utilising biomass by-products to generate electricity for internal use as well as feeding the national power requirements. Other players, e.g. the Bulembu Ministries, are seeing the potential in solar energy and have installed a 25kW solar array to supply a proportion of their electricity needs.

The following factors are at the core of the great potential of the solar energy market:

- Solar energy is a free and virtually unlimited resource. Swaziland has high levels of productive sunlight, with an average of 4 kWh per meter per day, which is sufficient for most designs of photovoltaic cells and thermal solar conversion or collection devices.
- Solar energy technology has been tested and proven to be economically competitive with some conventional technologies, especially in rural areas which are far from the national grid.
- Solar energy has the economic potential to contribute to security of supply, raising the quality of life among the rural and urban poor through expanding access to electricity and critical services.
- Expanding the use of solar energy forms a key component of programs aimed at slowing deforestation and desertification which are driven by rapid population increase dependent on forests to meet their fuel wood supplies.
- Solar energy is virtually non-polluting and reduces CO2 emissions resulting from the production and use of fossil fuels, such as coal and petroleum products.

Petroleum products, the emissions from which are of global concern, will remain the primary source of liquid energy to fuel vehicles and the transport network of the country. Into the future with no active measures or interventions to reduce petroleum use, volumes of fuel used in the country will continue to increase. The draft Petroleum Bill seeks to open the liquid fuel sector to a greater proportion of biofuel through the use of ethanol blended petrol.

Swaziland's continued reliance on imported electricity for which it has little control over the cost will expose the economy to economic shocks as electricity costs increase. Local generation, for which costs can be controlled to some extent, will continue to remain a priority and government will continue to investigate alternative means of generation that reduce dependence on external electricity suppliers whilst stimulating local businesses to play a greater role

Government is committed to implementing the National Development Strategy under which poverty reduction is a priority by improving access to energy for the whole population in urban, peri-urban and rural areas, make electricity available in rural areas so as to improve socio-economic development and welfare, and promote sustainable wood fuel management. For economic growth government will continue to promote the productive use of electricity in rural areas in order to facilitate socio-economic development by partnering with SEC to connect rural growth centres to the national grid.

Under a business as usual scenario the identified pressures and impacts will remain the same, such as increased greenhouse gas emissions and pressures on air quality.

The slow implementation of the National Energy Policy Implementation Strategy 2009 (MNRE, 2009) due to capacity as well as financial constraints will leave important proposed changes in the energy sector unimplemented.

4.5.2.2 FUTURE TREND BASED ON POSITIVE RESPONSE

To meet national aspirations for a sustainable future, energy systems must be transformed.

Government has in place supportive policies and strategies that have the power to change the energy sector in a positive direction if implemented. Financial and institutional challenges remain the key threat to the implementation. However, the need to improve energy security whilst at the same time promoting local generation can be achieved through strategies outlined in the Energy Policy and the National Energy Policy Implementation Strategy.

The future increase in renewable energy capacity in the country is expected to improve. Greater participation by private sector in energy generation through the introduction of feed-in tariffs will encourage private sector involvement, however, to manage this, guidelines and regulations will be required to ensure a level and competitive playing field. Government through the energy regulator will improve the involvement of independent power producers that use renewable energy sources.

If renewable energy capacity is to be increased, the introduction of a range of resources, appliances, and equipment will be required and many more people and organizations will have to be in the business of providing energy access to an increasing number of people in ways that are more complementary to each other than today.

The shift to a greater proportion of renewable energy will match a gradual decrease in harmful air emissions that compromise air quality in places and contribute to global climate change. Cleaner energies are being promoted globally and Swaziland has the opportunity to tap into the skills and knowledge base of international players to ensure meaning full and positive change.

The amount of investment needed to achieve the changes in the national energy mix is substantial. So far investments have been far below needs. International funds, public/private partnerships, bank finance at multilateral, bilateral, and local levels, and targeted subsidies will all be vital. In the initial stages public money is particularly important as the financial returns in supplying energy to low-income families are not attractive to commercial operations.

Much of the finance earmarked to improve energy access is spent on large-scale electricity infrastructure, generation, grid, and regional interconnection projects. Sadly these projects often fail to directly address the energy needs of poor communities for cleaner cooking and mechanical services – as well as ignoring the contribution of decentralized and renewable electrification. To solve this issue a significant proportion of large funds must be made accessible as local-level financing. This can include financing to community initiatives, enterprises, and consumers – often through local banks and microfinance, and credit and loan schemes.

For a large proportion of the country's rural population, the ability to earn a living depends heavily on access to energy. Having lighting after dark so a shop can stay open for longer, or fuel for an engine to mill grain or a pump to irrigate land, can be the difference between earning a decent livelihood or not, between escaping a subsistence lifestyle and the cycle of poverty, or not. It is this direct connection between energy and poverty reduction, the first Millennium Development Goal, which is typically amongst the most mentioned in discourses on energy poverty, but the least understood in practice.

To reduce both costs and harmful emissions, improvements in energy efficiency has to play a major role. There have been no studies on the potential for energy efficiency increases within the key demand sectors, but the rising cost of energy will drive improvements. Government may have to in the future formulate national targets to facilitate improvements.

To improve national energy security Government will have to introduce a broad portfolio of supply-side options, focusing on low-carbon energy from non-combustible renewables including bioenergy This requires the further development of storage, conversion and end-use technologies and infrastructures, such as smart and super grids and, in general, a rapid decarbonisation of energy systems.

Universal access to electricity and clean cooking technologies has to receive urgent priority, but this will be difficult to achieve and will require global partnerships and concentrated efforts.

In the building sector, achieving rapid improvement of thermal integrity through establishing standards for new constructions and retrofitting, along with improved appliances and innovative business models (such as energy service companies), holds the potential to reduce energy demand dramatically.

In the industry sector, energy demand may be reduced substantially by the widespread adoption of the best available technology, the retrofit of existing plants, optimization of material flows and enhanced recycling.

The continued promotion of the country's hydro potential needs to be continued.

There is a need to establish an institutional framework that can mobilize, co-ordinate and facilitate private and public initiatives for renewable energy/technologies usage in rural areas. A review of the existing policy, legal and institutional frameworks that are clear and unambiguous for the effective promotion of clean energy initiatives will be required.

Table 103 provides an overview of the required responses to support positive change, listed according to future policy actions, future legislative actions and future institutional actions.

Table 103: Summary of Future Outlook of State of Energy

ASSUMING STATUS QUO (BUSINESS AS USUAL)		REQUIRED RESPONSES TO SUPPORT POSITIVE CHANGE		
Future Trend	**Future Extrapolated Impact**	**Future Policy Action**	**Future Legislative Action**	**Future Institutional Action**
• Increased demand of modern energy • Decrease in fuel wood use • Increase in energy prices • Increase of the share percentage of renewable energy • Bioethanol introduced • Improved energy efficiency in all demand sectors • Removal of metal based fuels • Increased risk of petroleum product shortages due to limited refinery capacity in RSA	• Increased air pollution from petroleum energy use • Decreased pressure on natural forests and woodlands • Increased pressure on water resources due to increased hydropower production • Increased participation of the private sector in renewable energy • Increased proportion of renewable energies in the national energy mix	• Strategy on energy efficiency improvements for all demand sectors • Strategy for establishing national renewable energy targets • Resource mobilisation plan for updating Energy Policy and development of an Energy Integrated Resource Plan • Strategy for adoption on biofuels including guidelines and sustainability criteria • Development of Independent Power Producer Policy and Feed In Tariffs • Amendments to the Energy Regulatory Act to broaden its regulatory powers over other forms of energy	• Changes to national Building Act to incorporate energy efficiency improvements in all new buildings • Adoption of the Petroleum Bill that addresses the introduction of biofuel • Develop adequate standards of solar energy technology	• Capacitate the Swaziland Energy Regulator to strengthen its oversight • Strengthen institutional framework of Energy Dept to provide for changes in energy markets due to private sector participation

4.5.3 WASTE

Waste management is the process by which unwanted products (waste) of the home, business or industry are collected, stored, transported, treated, disposed of, recycled or reused.

4.5.3.1 FUTURE TREND BASED ON STATUS QUO

Extrapolation of the current state and trend in the waste production and management assuming a status quo situation, which means business as usual, will evolve to a future trend not different from the present one and will continue showing the same negative impacts on the environment.

The impacts and challenges arising from inadequate application of waste management are expected to continue into the future.

The country has a fairly robust legislative and institutional framework to address the core needs of a sustainable waste management system. The Waste Regulations of 2000 provide the legal framework for waste management but the inadequate implementation of the regulations has seen and will continue to see increasing challenges in protecting the environment from the adverse impacts of waste disposal, collection and storage.

The continued reliance on landfills to dispose and store waste is both costly in terms of construction and management costs and costly in terms of undesirable impacts of this type of disposal.

The National Solid Waste Management Strategy remains a robust enabling mechanism for the implementation and enforcement of the Waste Regulations 2000 but has not been mainstreamed into the waste sector. Without adequate financial and capacity resources the strategy will remain moribund and the urgent and environmentally beneficial objectives of the strategy not achieved.

Municipal authorities will remain challenged in implementing strategies targeting waste management as long as adequate resources are not provided to address some of the key environmental and health impacts arising from improper waste management.

In recent years, recycling of some waste streams has been initiated in a direct response to the value recycled goods have in the market. This sector would benefit from greater support and the setting of targets and a better defined enabling framework.

Challenges discussed in the section on waste are likely to remain. The continued inadequate monitoring and data collection of waste and its impacts will lead to ever increasing threats to human development and environmental health.

Protecting the public from the potential environmental and health impacts of poor waste management practices has become a national mandate enshrined under the Waste Regulations of 2000. Improved technology for collecting, processing, and disposing waste is being driven by the public and responsible businesses. Unless the future proves that our society can manage waste better than in the past, public opposition will continue to grow, costs will continue to rise, and the call for tighter and tighter restrictions will grow louder.

4.5.3.2 FUTURE TREND BASED ON POSITIVE RESPONSE

To avoid a situation as described in the previous section assuming continuation of the current trend, interventions will be necessary. The responses to support positive change have to include the improvement and or implementation of currently not existing or inadequate pieces of legislation and policy.

Responses to waste management at the legal and institutional level are more than satisfactory to address the urgent needs in this sector. If resources are secured to fund the implementation of the many sub-strategies presented in the National Solid Waste Management Strategy and capacity strengthened in regulatory and implementing agencies, positive change can be expected.

The strategic approach applied for the development of the Waste Management Strategy was based on the internationally recognised waste hierarchy, which includes Waste Prevention, Recycling, Collection and

Transport, Treatment and Disposal. The environmental and human health benefits that would emerge from the strategy would provide significant improvements in how waste is classified and managed.

In Government planning it is envisaged that implementation of The National Solid Waste Management Strategy NSWMS) will focus on the following key issues and corresponding strategies:

Waste Management Planning Strategy

Local waste management plans have to be developed for all the types of land in Swaziland i.e. Swazi Nation Land, Title Deed Land, Urban Areas, Company Towns, Peri-Urban areas, Growth Points such as Siphofaneni, Buhleni, Lomahasha etc.

In line with the Waste Regulations 2000, the strategy confirms the necessity to declare certain areas as Waste Control Areas (section 12 of the Waste Regulations 2000). An appropriate waste management system has to be developed and put in place before an area is declared a waste Management Control Area. Of note is that this section puts the responsibility for Waste Control Areas to "the competent authority" (organ of Government) responsible for rural development. Therefore the waste management planning strategy is not voluntary but a legal requirement (Section 31 of the Waste Regulation 2000). This is incorporated in the institutional framework to be presented below

Waste Minimization Strategy

This strategy aims at ensuring that the quantity of waste to be managed is small. This is an important strategy as it has positive implications on the efficiency and cost of managing waste. This strategy entails waste prevention and recycling.Waste prevention has technical implications for industry as it requires modification of production processes as well as choosing environmentally friendly and less toxic input material.

Waste prevention also entails a bold decision to be taken such as banning shopping plastic bags. Recycling is driven by economic factors. For recycling to work it has to make economic sense for those who are involved in it. Primarily there must be markets for the recycled waste. Presently it is the crap metal that makes economic sense to a larger extent with the other recyclables gaining momentum but needs to be regulated to address theft of such items as electric cables and copper wires.

Waste Collection and Transportation Strategy

This is a very important stage of waste management. The strategy recognizes the fact that in declared urban areas there is formal waste management systems while in rural areas and peri- urban areas there is no formal waste management systems. The development of an effective waste collection system in non urban areas requires the involvement of the TiNkhundla centers as well as government and the chiefs as the authorities in charge of the land. The advantage of the chiefs is that they have powers over their subjects and therefore enforcement will be greatly facilitated. This is addressed in the institutional framework.

Waste Disposal Strategy

Waste disposal is a critical stage of waste management. A number of problems associated with the availability of waste disposal facilities were noted during the development of the strategy. These include the non availability of land for waste disposal, lack of appropriate disposal sites even in urban areas except for Pigg's Peak, Matsapha and Mbabane and lack of designated waste disposal sites even though this is a requirement of the Waste Regulations 2000 (Section 12 (2) (b)) . In line with the Waste Regulations 2000, the strategy therefore requires the designation of waste disposal sites. This implies that all chiefdoms must identify areas to be developed and designated as waste disposal facilities. This will be done in collaboration with the Ministry of Housing and Urban Development whose role is outlined in the institutional framework below, the Ministry responsible for TiNkhundla and the Ministry of Tourism and Environment through the Swaziland Environment Authority.

As mentioned above the strategy recognizes both technical and financial capacity limitations of the various settlement types in the country. With this understanding, four types of disposal facilities are recommended. These are:

- Sanitary Landfills
- Local Control Disposal Facilities
- Hazardous Waste Disposal Facilities
- Homestead Backyard Pits.

Institutional Framework for Waste Management

During the development of the institutional framework, it was noted that the primary responsibility for waste management lies with the generator of the waste, the owner of the premises with the waste problem or the entity or organization that has authority over the area in question. This is contained in Section 9, 10, 11, and 12 of the Waste Regulations 2000.

For a successful, efficient and sustainable implementation of the strategy an institutional framework has been identified as a strategy intervention. In so doing a realistic approach has been taken by working within the existing portfolios. It has been recognized that the allocation of institutional portfolios and responsibilities for National Government Agencies with regards to waste management must be seen in view of their existing portfolios. It has been also recognized that the current mandates may not be specific on waste management issues hence adjustments may have to be made.

However it is important to consider that Ministries assigned waste management responsibilities in the Environment Management Act 2002, Waste Regulations 2000, and the Environmental Audit, Review and Assessment Regulations, must consider this issue during their Strategic and Action Planning process. This will ensure that waste management responsibilities are taken into account in terms of organizational design and staffing. The success of the implementation of the strategy is highly dependent on the efficient functioning of the specified institutional framework in the strategy.

Table 104 provides an overview of the required responses to support positive change, listed according to future policy actions, future legislative actions and future institutional actions.

Table 104: Summary of Future Outlook of State of Waste

STATUS QUO (BUSINESS AS USUAL)		REQUIRED RESPONSES TO SUPPORT POSITIVE CHANGE		
Future Trend	**Future Extrapolated Impact**	**Future Policy Action**	**Future Legislative Action**	**Future Institutional Action**
• Increasing negative environmental impact from improperly managed waste • Increasing need for broader waste collection and haulage logistics • Increasing litter in public areas and peri- urban and rural communities (aesthetics) • Increasing volumes of waste requiring treatment & disposal facilities • Over reliance on landfills as the most cost effective treatment method • Increasing importance of recycling and waste avoidance strategies • Ad hoc implementation of the Waste Regulations	• Increasing land and water pollution • Challenges in decommissioning full landfills • Increasing threats to human health from pollution • Increasing threats to air quality • Increasing threats to water quality from landfill leachate	• Strengthen the implementation of the National Solid Waste Management Strategy • Municipalities to formulate and implement appropriate waste strategies • Develop National Health Care Risk Waste management guidelines • Develop landfill development and management guidelines	• Review and strengthen Waste Regulations	• Develop guidelines for waste management approaches in rural and peri-urban areas • Undertake an assessment of regional solid waste treatment facilities needs • Organise and strengthen the existing recycling industry to make provision for further recycling of both general and hazardous waste, through the implementation of awareness, information and training campaigns, support for the Waste Minimisation Centre, recycling centres, new regulatory and incentive instruments and the implementation of new specific recycling activities • Strengthen internal institutional arrangements and responsibilities for local waste management planning for urban local government (City Councils, Town Councils & Boards) • Increase the coverage and efficiency of collection of general waste in formal and informal urban areas, waste control areas, peri-urban and rural areas and, where possible, by means of income generating collection approaches and the use of transfer stations, e.g. the Hloba Swaziland Campaign. • Undertake and assessment of the need for a national Hazardous Waste Disposal facility • Review the financial mechanisms for cost recovery from waste management • Develop and implement a Waste Information System (WIS) for general and hazardous waste • Develop and implement a Registration System for Special Wastes (RSSW) for the registration, transport and monitoring of hazardous waste • Develop and implement a Waste Categorisation System to define and categorise different waste types that will enable waste planners to manage

STATUS QUO (BUSINESS AS USUAL)		REQUIRED RESPONSES TO SUPPORT POSITIVE CHANGE		
Future Trend	**Future Extrapolated Impact**	**Future Policy Action**	**Future Legislative Action**	**Future Institutional Action**
				waste more effectively. • Develop waste management incentives for waste reduction and recycling • Develop and implement local Waste Management Plans (urban & rural areas) • Identify and make available affordable and appropriate technological options and supporting incentives that will minimise the generation of waste • Strengthen inter-municipal co-operation to reduce costs and optimise available resources for waste management (sharing facilities) • Develop and implement a coherent solid waste management disposal and remediation system for general and hazardous wastes from all sources

4.5.4 HUMAN HEALTH

Swaziland faces many challenges in the human health sector among which limited capacity in terms of human and financial resources is one, and weak information systems particularly in relation to monitoring and evaluation of different priority health programmes is another.

4.5.4.1 FUTURE TREND BASED ON STATUS QUO

Extrapolation of the current state and trend in human health assuming a status quo situation, which means business as usual, will evolve to a future trend not different from the present one and will continue showing the same negative impacts on the environment.

The impacts and challenges arising from maintaining a healthy population are expected to continue into the future.

A degrading environment negatively affects the health of people and the trends described in the chapters on land, water, atmosphere and biodiversity converge to directly impact upon human health.

The climate outlook is for increasingly frequent flooding leading to increased breeding of mosquitoes that transmit malaria. Water pollution due to flooding and rapid urbanization increases the risk of cholera outbreaks. Expanding irrigation projects and unabated environmental degradation change the endemic pattern of bilharzias and other water bourne diseases.

Tuberculosis is strongly linked to overcrowding mostly as a result of urban sprawl due to increase in population. In the short to medium term, therefore, it appears that Swaziland continues with existing response programmes for all major diseases affecting the country.

4.5.4.2 FUTURE TREND BASED ON POSITIVE RESPONSE

The existing environmental conditions influence Swaziland's disease burden greatly and changes in the environmental conditions have changed the pattern of disease burden dramatically. The implementation of supportive policies and strategies in the protection and management of the environment should see a positive impact on human health.

Managing peri-urban growth will remain a challenge into the future. As difficult as it may be, government needs to improve the socio-economic conditions of its population through the implementation of the Poverty Reduction Strategy and Action Plan.

The implementation of the National Health Sector Strategic Plan (NHSSP 2008-2013) will improve the health condition of the population.

Table 105 provides an overview of the required responses to support positive change, listed according to future policy actions, future legislative actions and future institutional actions.

Table 105: Summary of Future Outlook of State of Human Health

STATUS QUO (BUSINESS AS USUAL)		REQUIRED RESPONSES TO SUPPORT POSITIVE CHANGE		
Future Trend	**Future Extrapolated Impact**	**Future Policy Action**	**Future Legislative Action**	**Future Institutional Action**
• Increasing negative environmental health impact from pollution • Increasing need for health services • Increasing medical volumes of waste requiring treatment & disposal facilities	• Increases in cases of diarrhoea, dysentery, cholera, and typhoid, food borne diseases, bilharzias, intestinal worms, malaria, skin infections and others are traceable to environmental-related contamination and the use of unsafe drinking water and sanitation	• Review and update the Environmental Health Policy to protect public health safety from various environmental, industrial and chemical health hazards • Develop a National Environmental Health Strategy • Develop a Health Care Risk Waste Management (HCRWM) Policy • Formulate a strategy and an action plan for HCRWM	• Develop and enact a Public Health Act • Develop and enact an Environmental Health Act • Develop regulations and guidelines for implementing the Environmental Health Policy and Health Care Risk Waste Management Policy • Develop a Food Safety Act and Strategy	• Develop a comprehensive and multi-sectoral environmental health framework to ensure a safe and sustainable environment for the promotion and sustenance of good health and quality of life for all people in Swaziland, contributing to a significant reduction in morbidity and mortality due to environment related conditions and diseases with special focus on children's needs • Mobilize and organize communities to support and participate in various water and sanitation program intervention • Conduct regular water sampling and analyses/ testing in all regions • Promote though local institutions, periodic clean-ups of the rural environment to prevent vector breeding sites • Strengthen the WATSAN program to support improvement and development of water and sanitation facilities including Ventilated Improved Pit (VIP) latrines and micro water systems, such as springs, wells and boreholes • Integrate sanitation and hygiene in school health and educational programs • Train community environmental health workers on Participatory Hygiene and Sanitation Transformation (PHAST) approach to promotion of improved water – sanitation - hygiene behaviour

STATUS QUO (BUSINESS AS USUAL)		REQUIRED RESPONSES TO SUPPORT POSITIVE CHANGE		
Future Trend	**Future Extrapolated Impact**	**Future Policy Action**	**Future Legislative Action**	**Future Institutional Action**
				• Train health care workers on water quality surveillance techniques • Establish a medical waste management and disposal system in all health care facilities • Strengthen capacity of MOH Environmental Health Unit and regional health service to effectively facilitate and coordinate all environmental health research and information management activities • Establish a comprehensive Environmental Health Management Information System (EHMIS) and database • Periodically assess air pollution levels at source in accordance with SEA air quality regulations

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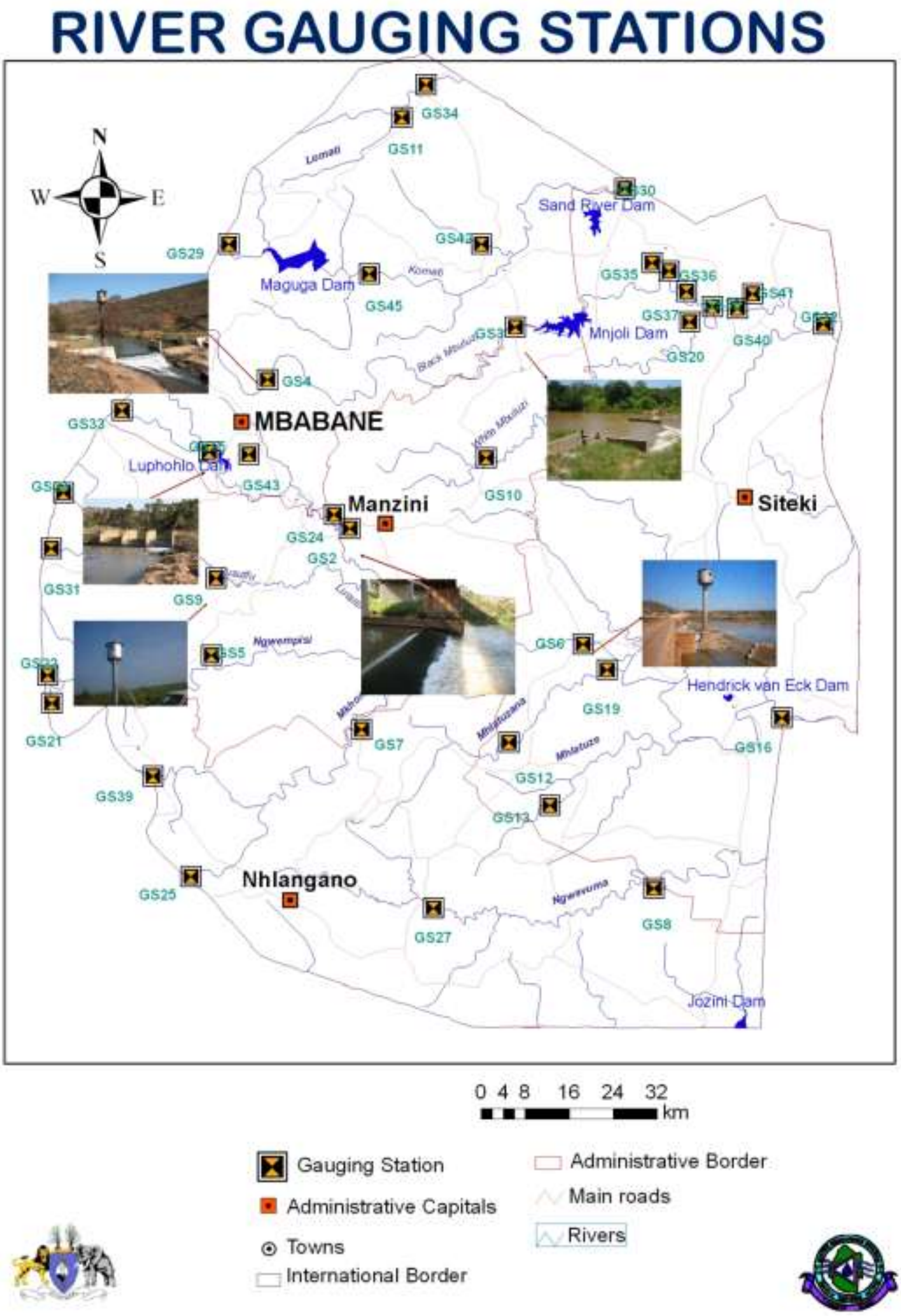
ANNEXES

Annex 1: Map of River Gauging Stations



Annex 2: Selected Monthly River Flow Data

Monthly River Flows - Ngwavuma (1990/91-2010/11)

Year		GS	Average monthly river flows (m^3/s)											
			O	N	D	J	F	M	A	M	J	J	A	S
2010/11	Upper	27	0.89	2.47	2.57	2.61	1.44	1.31	1.87	1.16	NR	NR	NR	NR
	Middle	8	0.82	2.38	2.58	3.10	1.14	1.25	1.87	0.61	NR	NR	NR	NR
	Lower	NA												
2005/06	Upper	27	0.38	1.61	0.72	1.21	1.46	1.99	1.79	NR	NR	NR	NR	NR
	Middle	8	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Lower													
2000/01	Upper	27	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Middle	8	25.49	13.65	15.88	10.84	13.22	12.88	NR	NR	8.74	7.73	4.62	3.51
	Lower	NA												
1995/96	Upper	27	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Middle	8	1.45	1.51	14.62	12.37	18.01	15.54	5.51	5.47	2.76	2.75	2.30	1.24
	Lower	NA												
1990/91	Upper	27	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	1.09
	Middle	8	1.19	0.94	2.12	8.04	14.35	8.93	2.31	3.27	3.14	2.76	1.62	1.37
	Lower	NA												

Monthly River Flows - Usutu (1990/91-2010/11)

Year		GS	Average monthly river flows (m^3/s)											
			O	N	D	J	F	M	A	M	J	J	A	S
2010/11	Upper-L	24	0.34	1.82	3.15	3.56	1.72	2.23	2.57	1.62	1.31	1.17	1.04	0.72
	Upper-U	9	7.24	21.15	43.74	77.47	28.30	6.98	13.97	NR	NR	NR	NR	NR
	Upper-N	5	3.72	9.34	14.27	20.37	6.76	5.15	4.17	3.60	3.36	2.97	NR	NR
	Upper-M	7	2.08	NR	NR	93.92	17.70	9.15	15.64	15.62	NR	NR	5.34	2.32
	Middle	6	12.96	41.47	116.6	187.1	63.32	33.10	44.52	21.44	16.35	15.69	14.80	8.84
	Lower	16	11.88	47.60	114.2	194.1	42.51	38.14	32.26	12.50	NR	NR	NR	5.50
2005/06	Upper-L	24	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Upper-U	9	10.28	6.52	NR	12.55	16.85	39.68	NR	NR	NR	NR	NR	NR
	Upper-N	5	3.81	NR	NR	4.57	10.25	19.56	NR	NR	NR	NR	NR	NR
	Upper-M	7	NR	12.98	5.53	41.48	84.00	60.46	NR	NR	NR	NR	NR	NR
	Middle	6	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Lower	16	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2000/01	Upper-L	24	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Upper-U	9	6.46	32.82	50.44	19.34	11.83	32.22	28.31	22.61	16.91	11.20	5.57	3.65
	Upper-N	5	7.70	3.10	15.02	8.32	NR	NR	NR	NR	3.75	3.52	3.12	2.58
	Upper-M	7	12.25	45.95	48.06	26.76	15.25	8.21	12.00	6.22	5.37	4.52	3.61	3.55
	Middle	6	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Lower	16	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1995/96	Upper-L	24	0.34	0.73	0.71	NR	6.84	3.40	1.97	2.06	1.90	1.81	0.80	0.50
	Upper-U	9	NR	NR	NR	NR	NR	NR	NR	10.83	7.03	6.29	4.53	2.67
	Upper-N	5	1.27	2.44	14.81	13.79	38.14	36.60	9.09	6.48	4.37	3.87	3.24	2.70
	Upper-M	7	2.02	4.84	26.37	23.98	50.59	76.84	21.71	13.96	6.73	5.99	4.81	3.16
	Middle	6	10.01	21.33	55.78	148.0	NR	NR	NR	NR	NR	NR	NR	NR
	Lower	16	NR	17.28	126.6	106.2	200.0	191.5	NR	NR	34.03	27.76	20.28	12.48
1990/91	Upper-L	24	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Upper-U	9	2.02	5.93	8.56	24.0	27.37	22.24	11.94	7.93	6.48	5.26	3.49	2.47
	Upper-N	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Upper-M	7	2.77	2.86	8.37	22.18	55.47	25.29	12.24	6.69	6.15	4.34	3.61	3.28
	Middle	6	17.72	22.73	38.59	127.1	183.4	119.6	70.45	42.99	36.27	31.15	25.05	21.02
	Lower	16	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

*Usuthu Upper: L-Lusushwana; U-Usuthu; N-Ngwempisi; M-Mkhondvo

Monthly River Flows - Mbuluzi (1990/91-2010/11)

Year		GS	Average monthly river flows (m^3/s)											
			O	N	D	J	F	M	A	M	J	J	A	S
2010/11	Upper	4	1.41	2.63	5.12	8.23	4.52	3.58	4.20	2.85	NR	NR	NR	NR
	Middle	3	2.46	12.60	20.25	28.21	9.77	11.17	16.27	8.26	NR	NR	5.53	5.46
	Lower	32	1.90	6.77	26.50	22.18	10.03	4.46	6.19	4.85	2.52	2.52	NR	NR
2005/06	Upper	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Middle	3	4.80	4.60	4.33	6.97	14.97	19.26	7.56	NR	NR	NR	NR	NR
	Lower	32	0.77	2.28	0.34	2.59	4.65	26.33	8.54	NR	NR	NR	NR	NR
2000/01	Upper	4	1.79	4.79	5.69	5.61	NR	4.20	4.93	2.76	1.88	1.46	1.12	0.89

Year		GS	Average monthly river flows (m^3/s)											
			O	N	D	J	F	M	A	M	J	J	A	S
	Middle	3	NR	NR	NR	NR	NR	NR	NR	NR	NR	5.64	4.72	3.31
	Lower	32	NR	NR	NR	NR	NR	NR	NR	NR	45.60	11.92	10.40	8.48
1995/96	Upper	4	0.48	1.38	4.38	6.71	11.40	7.13	3.84	2.97	1.99	1.78	1.41	NR
	Middle	3	2.19	3.62	4.91	3.58	11.04	6.33	4.85	4.96	6.20	4.43	4.58	4.38
	Lower	32	NR	2.37	18.39	2.85	1.71	36.30	16.27	7.39	4.16	3.31	2.51	1.24
1990/91	Upper	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Middle	3	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Lower	32	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Monthly River Flows - Lomati (1990/91-2010/11)

Year		GS	Average monthly river flows (m^3/s)											
			O	N	D	J	F	M	A	M	J	J	A	S
2010/11	Upper	11												
	Middle	34	3.61	11.72	22.84	21.65	17.75	15.63	21.79	14.83	NR	NR	NR	5.57
	Lower	NA												
2005/06	Upper	11												
	Middle	34	0.25	0.77	1.88	7.55	NR	NR	NR	NR	NR	NR	NR	NR
	Lower	NA												
2000/01	Upper	11												
	Middle	34	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Lower	NA												
1995/96	Upper	11												
	Middle	34	1.43	1.98	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Lower	NA												
1990/91	Upper	11												
	Middle	34	1.29	1.17	3.95	13.44	11.96	11.35	5.17	2.87	2.49	3.01	1.75	1.74
	Lower	NA												

Monthly River Flows - Komati (1990/91-2010/11)

Year		GS	Average monthly river flows (m^3/s)											
			O	N	D	J	F	M	A	M	J	J	A	S
2010/11	Upper	29	C	L	O	S	E	D						
	Middle	42	0.16	0.49	2.28	2.48	0.81	1.19	0.90	0.37	0.21	NR	NR	0.10
	Lower	30	8.92	9.18	42.02	147.1	52.44	23.51	31.67	17.77	16.56	NR	0.47	1.92
2005/06	Upper	29	C	L	O	S	E	D						
	Middle	42	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Lower	30	NR	NR	NR	NR	13.77	57.26	NR	NR	NR	NR	NR	NR
2000/01	Upper	29	C	L	O	S	E	D						
	Middle	42	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Lower	30	NR	32.13	94.87	44.78	35.35	26.52	32.94	22.06	14.31	9.49	5.61	2.55
1995/96	Upper	29	C	L	O	S	E	D						
	Middle	42	0.02	0.13	0.35	1.66	1.20	1.85	0.42	0.80	0.31	0.23	0.21	0.13
	Lower	30	0.49	0.33	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1990/91	Upper	29	C	L	O	S	E	D						
	Middle	42	0.21	0.12	0.31	1.77	2.53	1.03	0.45	0.31	0.30	0.25	0.18	0.14
	Lower	30	6.41	5.94	10.98	38.61	63.71	61.53	19.27	16.05	15.43	10.81	6.81	5.34

Annex 3: Selected Water Quality Data from Usutu River (Sidvokodvo)

Date	Turb Ntu	Ecom us/cm	Ds;ppm	Ss; ppm	Ts; ppm	Temp	Do; ppm	PH	Cl; ppm	SO4; ppm	Fe; ppm	COD; ppm	NO3; ppm	PO4; ppm	NH4; ppm	TA; ppm	TH; ppm	FL; ppm	CU:ppm
13-03-02	19	18,34	7	-	-	-	-	7,51	-	-	-	31,39	-	-	-	-	-	-	-
04-04-02	10	22,3	9	-	62	-	-	-	-	-	-	11,62	-	-	-	-	-	-	-
05-07-02	11	23,3	11	-	88	-	-	7,47	-	-	-	11,54	-	-	-	-	-	-	-
06-04-02	11	26	12	136	-	-	-	-	10	-	-	-	-	-	-	-	38	-	-
23-09-02	24,1	10	10	-	100	-	-	7	9	-	-	242,17	-	-	-	-	-	-	-
24-10-02	7	6,15	2	-	108	-	-	8,45	-	-	-	16	-	-	-	-	-	-	-
04-03-02	-	-	-	-	2448	-	-	8	-	-	-	9,24	-	-	-	-	-	-	-
05-12-02	-	-	-	-	96	-	-	-	-	-	-	9,36	-	-	-	-	-	-	-
15-09-03	8	32,8	12	-	162		-	-	17	-	-	45,12	-	-	-	-	43	-	-
10-06-03	-	-	-	-	154	-	-	-	-	-	-	N0	-	-	-	-	-	-	-
01-12-04	-	12,5	5	383	388	-	-	7,2	14	-	-	19,2	-	-	-	-	-	-	-
02-10-04	-	17,15	7	-	197	-	-	7,2	-	-	-	42,6	-	-	-	-	-	-	-
03-11-04	30	18,1	7	41	48	-	-	7,2	-	-	-	12	-	-	-	-	-	-	-
22-04-04	18	18,95	7	41	6	-	-	7,6	7	-	-	1,1	-	-	-	-	-	-	-
06-01-04	9	201,6	41	61	102	-	-	7,6	20	-	-	16,5	-	-	-	-	-	-	-
29-06-04	8	97,8	39	47	86	-	-	8	22	-	-	4,74	-	-	-	6	40	-	-
29-04-04	20	96,8	39	57	96	-	-	7,4	-	-	-	20	-	-	-	20	8	-	-
28-08-04	9	69,5	28	52	80	-	-	8	18	-	-	0	-	-	-	5	43	-	-
16-09-04	7	98,5	40	20	60	-	-	7,6	17	-	-	16	-	-	-	6	37	-	-
18-10-04	8	-	-	-	71	25	-	8	-	-	-	16,3	-	-	-	69	44	-	-
11-10-04	17	117,6	47	67	114	17	-	7,6	12	-	-	51,4	-	-	-	54,5	41	-	-
21-12-04	45	94,1	38	118	156	30	-	7,2	9	-	-	-	-	-	-	50	33	-	-
24-02-05	71	66,2	26	142	168	28	-	7,2	7	-	-	-	-	-	-	26,5	12	-	-
30-03-05	-	100,1	40	8	48	27	-	6,8	23	-	-	-	-	-	-	51	3	-	-
05-05-05	19	67,5	28	70	98	20	-	7,4	-	-	-	-	-	-	-	30	74	-	-
08-04-05	6	82	33	-	-	19	-	7,6	12	-	-	-	-	-	-	50	30	-	-
27-09-05	4	123,3	49	-	40	26	-	7,6	14	-	-	-	-	-	-	70	26	-	-
10-11-05	5	117,5	46	50	98	24	-	7,4	-	-	-	-	-	-	-	60	-	-	-
15-11-05	11	105,3	43	13	56	26	-	7,2	-	-	-	-	-	-	-	50	17	-	-
01-09-06	65	90,7	36	198	234	26	-	7,4	10	-	0,07	-	-	0,89	-	41,5	13	-	0,7
16-02-06	58	61,7	25	145	165	30	-	7,4	18	-	0,1	-	0,03	0,27	0,19	-	22	0,88	0,39
15-03-06	24	71,1	29	-	-	25	-	7,4	-	-	0,1	-	<0.01	0,1	0,16	14	14	1,03	0,32
13-04-06	97	68,3	27	-	-	22	-	7,4	-	-	-	-	-	-	-	-	-	-	-
22-05-06	-	-	-	-	-	17	-	7,4	-	-	-	-	-	-	-	-	-	-	-
07-10-06	8	109,3	38	-	-	14	-	<6.5	-	-	0,03	-	-	0,64	-	<5	-	-	-
10-03-06	10	126,8	49	-	-	23	-	<6.5	-	-	0,14	-	-	<0.05	-	25	39	-	-
30-11-06	15	94,1	37	1263	1300	28	-	7,68	-	-	0,09	23,4	-	0,24	-	27	23	<2	-
17-04-07	25	94,6	37	41	78	23	-	-	22	-	-	27,4	-	<0.05	<0.02	-	-	1,34	<0.05
21-06-07	24	110,9	40	-	74	14	-	-	1,7	6,1	0,09	11,9	-	-	0,09	-	-	0,06	-
23-10-07	24	131,8	52	-	54	25,4	9,85	7,58	-	-	-	7,94	0,01	-	0,13	30	35	-	-
12-06-07	75	79,3	30	-	-	26,4	5,75	7,62	15,6	57,8	-	-	0,12	-	0,37	110	-	-	3,15
17-04-08	-	-	-	-	-	25,7	6,2	-	6,4	0,6	-	7,75	0,03	0,97	0,16	29	25	-	-
05-06-08	-	85,5	41	-	-	19,7	3,02	-	-	-	-	7,08	-	0,81	0,14	41	9	-	-
14-07-08	21	130,7	21	-	-	15	13,72	-	-	-	-	40	-	-	-	26	-	-	-
16-09-08	-	-	-	-	-	21,9	2,89	7,3	-	-	-	-	-	3,21	0,03	20	-	-	-
10-05-08	32,5	-	-	-	-	15	-	7,32	-	-	-	-	-	0,39	0,06	24	16	-	-
18-12-08	-	82,2	-	-	-	24	-	7	-	-	-	-	-	0,38	0,19	-	11	-	-
20-03-09	36	63,5	-	-	-	21,7	5,5	7,86	-	-	-	46,9	-	1,42	0,24	-	-	-	-
28-04-09	18	64	-	-	-	23	6,2	-	-	-	-	-	-	-	-	-	-	-	-
21-05-09	-	-	-	-	-	21	6,9	-	-	-	-	-	-	-	-	-	-	-	-
18-11-09	64	-	-	-	-	19	-	-	-	-	-	48,1	-	-	-	-	-	-	-
18-01-10	50	53,6	-	-	-	25	-	-	3	B	B	43,32	-	-	-	-	-	-	-
04-10-10	43	143,2	71,7	-	-	24	-	7,25	6	-	-	24	-	-	-	-	-	-	-
19-07-10	24	244	120	-	-	15	-	7,25	-	-	-	-	-	-	-	-	-	-	-
09-09-10	22	96,2	48,2	-	-	19	-	7,28	5	-	-	16	-	-	-	-	-	-	-
11-02-10	71	87,4	43,6	-	196	25	-	-	6	-	-	11,9	-	-	-	-	-	-	-
30-11-10	89	-	-	-	-	24	-	-	4	-	-	27,9	-	-	-	-	-	-	-
26-01-11	152	53,2	26,5	-	232	26	-	-	-	-	-	15,8	-	-	-	-	-	-	-
15-02-11	50	70,2	35,1	-	-	25	-	-	-	-	-	19,16	-	-	-	-	-	-	-
24-05-12	51	70,5	42,9	-	132	19	-	7,39	6,3	-	-	19,6	-	-	-	-	-	-	-
03-09-12	21	73,9	36,9	-	-	25	-	7,19	-	-	-	42,1	-	-	-	-	-	-	-
17-07-12	11	138,1	68,6	-	-	12	-	7,39	-	-	-	11,4	-	0,16	-	47	-	-	-

Annex 4: Protected Areas

Recognition of the need to protect and manage the country's biological assets emerged post independence when it became obvious that the country's biodiversity was being threatened by economic development and unsustainable use. Large areas of habitat were being converted to timber plantations and irrigated agriculture that displaced existing fauna and cleared its flora. Urbanisation and associated infrastructure also began to affect biodiversity. Pre-independence, the hunting of wild animals was common place but this was leading to a decline in numbers.

The setting aside of natural areas and the active protection of biodiversity for their inherent environmental benefit was a global environmental movement led by people who saw the intrinsic value of wildlife and the need to protect as well as research populations of flora and fauna. These early pioneers advocated for the sustainable management of resources and stewardship of the environment through changes in public policy and individual behaviour. The roots of the modern environmental movement can be traced to attempts in nineteenth-century Europe and North America to expose the costs of environmental negligence, notably disease, as well as widespread air and water pollution, but only after the Second World War did a wider awareness begin to emerge. Scientific research drew attention to existing and hypothetical threats to the environment and humanity from environmental degradation.

In 1972, the United Nations Conference on the Human Environment was held in Stockholm, and for the first time united the representatives of multiple governments in discussion relating to the state of the global environment. This conference led directly to the creation of government environmental agencies and the UN Environment Program.

Following the United Nations Conference on the Human Environment the formalised conservation and management of Swaziland's natural heritage began with the establishment of the Swaziland National Trust Commission in 1972 by Act No. 9 of 1972, with later amendments, made effective from 27 July 1973. The declared mission of the SNTC is to conserve Swaziland's natural and cultural heritage through sustainable utilisation of natural resources and promotion of environmental awareness throughout the country.

Within the SNTC a Wildlife and Parks Department was created for the conservation of Swaziland's natural heritage. The department is responsible for conserving the country's natural ecosystems, its plant and animal life, and promoting the wise utilisation of these resources. Its objectives are:

- to establish and maintain national parks, nature reserves and other protected areas
- to create and promote environmental awareness within the general public
- to promote conservation activities outside protected areas, and to advise, promote and facilitate community managed activities that improve the quality of life while reducing undesirable impacts on the environment
- to promote and provide advice on ecological research and monitoring.

According to the International Union for the Conservation of Nature (IUCN), a protected area refers to a clearly defined geographical space, recognised, dedicated and managed through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.

Protected areas are the cornerstone of biodiversity conservation; they maintain key habitats, provide refugia, allow for species migration and movement, and ensure the maintenance of natural processes across the landscape. Globally, protected areas provide livelihoods for nearly 1.1 billion people, are the primary source of drinking water for over a third of the world's largest cities and are a major factor in ensuring global food security. Well managed protected areas harbouring participatory and equitable governance mechanisms yield significant benefits far beyond their boundaries, which can be translated into cumulative advantages across a national economy and contribute to poverty reduction and sustainable development including achievement of the Millennium Development Goals. As the detrimental impact of climate change threatens the planet, protected areas provide a convenient solution to an inconvenient truth. Better managed, better connected, better governed and better financed protected areas are recognized as the key to both mitigation and adaptation responses to climate change (CBD Available at http://www.cbd.int/protected/overview/ (accessed 9 February 2012).

Protected and Protection-worthy Areas in Swaziland

In 1905 Swaziland's first reserve, at Hlatikulu, was proclaimed, and in 1907 it's second, Ubombo, specifically to preserve large mammal species. Up until 1917, these areas covered well over 10% of the country and appeared to be achieving their objectives. Thereafter, an outbreak of Nagana and economic recession resulted in the majority of the area being de-proclaimed owing to the threat game posed to the livestock industry. By 1922 both reserves had been entirely de-proclaimed to allow for economic development (Hackel and Carruthers, 1993).

After the de-proclamation of these nature reserves, large mammals began to disappear at an alarming rate, and it was then that it was realized that there was an urgent need for the declaration of protected areas to salvage the remaining population of large mammals and protect biodiversity.

Forty years later, following the near decimation of Swaziland's large mammals, the country's first reserve, Mlilwane Wildlife Sanctuary, was proclaimed under the Game Act of 1953. Later in 1967, Hlane Game Reserve was proclaimed under the same act. In 1972 the Swaziland National Trust Commission (SNTC) was formed specifically to conserve areas and features representative of Swaziland's' natural and cultural heritage. As part of the establishment of SNTC, an initial assessment of protection worthy areas in Swaziland was done in 1972 (Grimwood, 1973). This report was a first step towards developing a plan for creating "a pattern of [National] parks representative of all of the four main regions of Swaziland and covering as many as possible of the various ecosystems of each of them" (Grimwood, 1973). Grimwood's work involved approximately four months of aerial and field based investigation. Grimwood's report identified six protection-worthy areas in addition to Mlilwane and Hlane, as well as proposing extensions to these two existing reserves. Following this report, one of the proposed areas was proclaimed, Malolotja Nature Reserve, in 1977.

A second survey of national protection worthy areas was commissioned by SNTC in 1978 (Reilly, 1979). The survey identified 31 protection worthy areas, including Mlilwane, Hlane and Malolotja, which, if all proclaimed, would have resulted in protection of 9.47% of the country' land area. Of this, 58% was proposed as National Parks, 13% as Nature Reserves, 24% as National Landscapes and 5% as National Wetlands. Only one of the 31 areas proposed was proclaimed, Mlawula Nature Reserve, in 1980. A fifth reserve, Mkhaya Game Reserve, was proclaimed in 1985 although it was not identified in the survey as being protection worthy. Two areas adjacent to existing reserves, Hawane (Malolotja) and Mantenga (Mlilwane) have since been proclaimed in 1992 and 1994 respectively.

As part of a National Forest Policy and Legislation Project run by the Forestry Section of the Ministry of Agriculture, another avenue for setting aside areas for the conservation of flora was created through the Flora Protection Act of 2000. This Forest Policy and Legislation Project commissioned a desk-top assessment of protection worthy areas in 2000 (Deall et al, 2000). This identified 11 areas in addition to the 30 previously identified (excluding proclaimed areas), and did a preliminary desk-top prioritisation of these 41 areas in terms of their conservation value.

In 2002, using funding from the GEF, the SNTC embarked upon another survey to identify protection worthy areas (Roques et al, 2002: A Preliminary Field Assessment of Protection worthy Areas of Swaziland). Using field surveys and rapid assessment techniques 44 areas were identified - 16 areas of high priority, 24 additional areas of importance and 4 areas that were considered not so important (see map in main text on Biodiversity).

With just 3.7% of the country under protection (representing the northern regions only), Swaziland has the potential to set aside more land for parks and reserves. Proclamation of some or all the protection worthy areas identified during the field survey in 2002 would go a long way to improving the representativeness of protected areas across different landscapes.

Since the last protected area was proclaimed in 1994, international targets set by the CBD to protect 10% of representative ecosystems have been passed onto parties to implement. The PWA survey, that identified 44 potential areas worthy of protection, recognised that Swaziland's existing PA network inadequately represents the grassland, forest and aquatic ecosystems.

Roques also recognised that the size of existing protected areas is too small to adequately enable natural ecosystem functioning, and consequently not sufficiently resilient towards change in conditions – in particular climate change - and not competitive in attracting eco-tourism investment.

Protected areas are important tools for the conservation of biological diversity and are cornerstones of sustainable development strategies. Aside from their environmental benefits, they can also generate significant economic resources. As such protected areas are crucial for attaining the objectives of the Convention on Biological Diversity and meeting the CBD 2020 Biodiversity Target and the Millennium Development Goals.

Expansion or proclamation of new PAs is compromised by governments' development plans and investments, such as roads, agriculture and mining, that have not been adequately informed of the natural potential of the sites. With no long term strategy to expanded the country's PA network and weak mechanisms for dialogue with conservation authorities during the planning stages, potential PA areas are compromised with physical development creating fragmentation of habitats that are difficult to protect and manage.

Unfortunately, despite the significant monetary and non-monetary values of protected areas their importance remains poorly understood and greatly undervalued. As a result protected areas, in many instances, do not receive adequate financing or resources, making their effective management a challenging task

The apparent lack of political will to support conservation and PAs year in year out, undermines the potential of conservation to provide the numerous ecological and social benefits that PAs can achieve. Government needs reminding about the vital services PAs can provide like catchment protection for water supplies, habitats for potentially useful insects, safeguarding cultural assets, homelands for indigenous peoples, supporting local and national economies, sequestering carbon, providing natural products, research and education and the human spirit.

Expansion of the country's PAs is not a luxury but critical to the long-term development of the country. Protected areas are economic engines. They provide for life's jobs and livelihoods as a traditional destination for the global tourism industry. Outdoor recreational industries have sprung up and are critical to regional economies e.g. the canopy tour offered in the Malolotja Nature Reserve. Significant employment is dependent on parks and protected areas. At the same time these areas protect resources of immense economic value such as water. The pharmaceutical industry has benefited greatly from the genetic diversity of species and safeguarding species in protected areas will ensure the possibility of discovery of future medicines.

Protected areas bring tremendous cultural, ecological, spiritual, and scientific benefits to society. They are critical to preserving global biodiversity and stemming the extinction crisis. Today there are more than 100,000 protected areas worldwide comprising about 12 percent of the Earth's surface. The development of a network of protected areas throughout the world is one of the greatest conservation achievements of the twentieth century, yet coverage is inconsistent across countries and eco-regions, and many areas are facing major threats to their viability.

It is now well established in academic literature and in broad international policy frameworks that there are both practical and ethical reasons for protected areas and other conservation initiatives to endeavour to contribute to poverty reduction. "Biodiversity should be conserved both for its value as a local livelihoods resource and as a national and global public good". The practical reasons have been acknowledged for a long time and recognize the fact that protected areas, corridor and other conservation efforts co-exists with poverty.

Annex 5: Access and Benefit Sharing (ABS)

Access to Resources and Benefits from Protected Areas

It has been suggested that there is unequal access to biodiversity and biodiversity resources by communities living outside PAs or communities displaced for the proclamation of a PA and that benefits from conservation and PA management are not shared equitably or readily available to affected communities.

The equitable sharing of the benefits and costs of conservation in protected areas is a goal in line with the democratization of conservation processes and advances in frameworks of social participation (Rivas et al, 2006). The hypothesis is that the more benefits from protected areas are generated and distributed and the more costs are reduced; the more possibilities there are of conserving natural systems over the long run. In addition, experience shows there are greater chances that local communities will support the areas if these provide continual benefits (SCDB, 2004)

Equitable benefit sharing is considered an important mechanism to support: the fight against poverty slowing of biodiversity loss the exercise of collective and individual human rights, and recognition of society's role in reaching conservation goals.

Sharing not only refers to the benefits from access and use of genetic resources, but to the use of traditional knowledge, innovations and, in general, to relevant practices for the conservation of biodiversity and sustainable use of its components. Equitable sharing also involves the distribution of power through participatory mechanisms of governance.

It should be emphasized that the equitable sharing of costs and benefits probably will not bring about solutions where everyone wins and no one has to make sacrifices. However, a transparent participatory process makes it likely that the solution reached is the best one possible for conservation and collective interests.

The services and benefits provided by protected areas to local communities, countries and the international community are divided into three categories:

- Provision: natural resources that local communities use directly in economic activities, such as food, fibers and fuels
- Regulatory: services that support regulation of the climate, protection of water sources, coastal protection, and carbon sequestration
- Cultural: religious, aesthetic, heritage and educational values

These benefits are multiple, direct and indirect, tangible and intangible, and complex. Many are difficult to quantify since they are not translated into market values. In practical terms, this can make it difficult to apply principles of equity and fairness to aspects of protected area management. Thanks to advances in the economic valuation of biodiversity, however, some benefits have been quantified. This makes it possible to establish mechanisms whereby local communities participate in the direct benefits, thus compensating communities for costs that they may have to assume as a result of management policies in the protected areas.

Though no studies on benefit sharing from PAs in Swaziland can be found in the literature, it is safe to assume that communities living near protected areas or their buffer zones can benefit in various ways:

- Allocation of income generated from entrance fees
- Direct sale of visitor services (e.g., lodging, food, guides, transportation)
- Direct sale of products (e.g., agricultural and fish products, handcrafts)
- Employment in lodges and hotels

Sharing benefits in one or several of these ways has been shown in the literature to have contributed to reduce levels of poverty in local communities. Also, the reinvestment of such income has strengthened their capacity to manage tourism as a sustainable activity, as well as reduce pressure on non- sustainable activities such as industrial extractive activities or even poaching. Tourism has also contributed to awareness about the goods and services the protected areas generate, along with traditional knowledge and practices.

Allocating tracts of land, large and small, for biodiversity conservation and sustainable use of resources needs to be reconciled at the local level with the livelihoods, opportunities and empowerment of the poor. In other words, 'protected areas should not exist as islands, divorced from the social, cultural and economic context in which they are located' (Recommendation 5.29, Vth IUCN World Parks Congress). Furthermore, unless they become more relevant to countries' development strategies and the rights and needs of local people, many protected areas will come under increasing threat.

Key to achieving this is to adopt the IUCN system of categorisation for protected areas based on their management objectives. This system recognises that while some protected areas (e.g., those in Categories I and II) are more strictly protected against consumptive human activities, others (e.g. those in Categories V and VI) allow for certain types of intervention such as the sustainable use of natural resources.

The current SNTC Act does not recognise the different categories and thus all protected areas prohibit consumptive human activities which communities living near these PAs strongly object. The solution would be to amend the SNTC Act to enable the proclamation of lower categories of protection that do allow for consumptive human activities. A draft SNTC Amendment Bill now recognises the IUCN system and if enacted, would allow for the gazetting of lower categories which would appease communities and allow for greater benefit sharing from the resources within the PAs.

Category V protected areas recognise the value of human interactions with nature, and the role that humans have had in shaping many of the world's ecosystems. They are 'lived-in, working landscapes' that promote and support traditional livelihoods and cultures as well as protection of biodiversity. Category V areas can accommodate diverse management regimes including customary laws governing resource management.

Protected areas can provide a wide range of goods and services to people living in and around them, and to society as a whole. The Millennium Ecosystem Assessment (MEA), released in 2005, divides these services into four categories (MEA, 2003). The first category, provisioning services, includes the services that yield natural products such as food, fresh water, fuel wood and herbal medicines that have direct use value to rural communities. In theory, these products would only be legally accessible to local people living in and around those protected areas that allow the sustainable harvesting of such resources (for example, extractive reserves and those with IUCN Category IV, V and VI management objectives). However, even the most strictly protected areas could provide additional food security for surrounding communities in times of famine.

Current attempts to ensure that local communities derive benefits from protected areas involve approaches such as integrated conservation and development projects, inclusive management approaches, and creating opportunities for biodiversity conservation within the wider rural landscape in the form of community conservation areas.

ABS Policy: Access to Genetic Resources and Sharing of Benefits Arising from their Utilization

Access and Benefit Sharing (ABS) relate to bio-prospecting involving indigenous biological resources. ABS are defined as (1) the acquisition of biological resources, their derivatives, community knowledge, innovations, technologies or practices, and (2) the sharing of whatever gains, monetary and non-monetary, that accrues from the utilisation of these biological resources, knowledge, innovations, technologies or practices.

The 2002 Bonn Guidelines on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising out of their Utilization sought to provide voluntary guidance for parties in developing national strategies, legislation etc. The Bonn guidelines also provide a list of monetary and non-monetary benefits.

In the draft Environmental Policy (GOS-SEA, 2007) the Access and Benefit Sharing policy part is supported by four sub-pillars, namely (1) Indigenous Knowledge and Property Rights, (2) Bio-prospecting, (3) Access to Genetic Resources, and (4) Equal Sharing of Benefits.

The Environmental Policy recognised that there is a lack of protection for local communities with respect to biological resources and the communities' rights to access and sharing of benefits derived from genetic material found in the country including within PAs. Swaziland does not have any legal instrument which can protect communities from outside exploitation of indigenous knowledge of the medicinal or other beneficial properties of plants they may have been utilising for many generations. The policy also recognised that there was no national legislation to protect national, community and individual intellectual property rights with respect to biodiversity resources and their use and commercialisation.

The "fair and equitable sharing of the benefits arising out of the utilization of genetic resources" is one of the three overall objectives of the Convention on Biological Diversity (CBD) along with the conservation of biodiversity and the sustainable use of the components of biodiversity. The CBD, in its Article 15, sets out principles and obligations of Parties related to access to genetic resources and the fair and equitable sharing of benefits arising out of the utilization of genetic resources, on the basis of prior informed consent and mutually agreed terms.

The CBD establishes that a person or institution seeking access to genetic resources in a foreign country should seek the prior informed consent of the country in which the resource is located. Moreover, the person or institution must also negotiate and agree on the terms and conditions of access and use of this resource. This includes the sharing of benefits arising from the use of this resource with the provider as a prerequisite for access to the genetic resource and its use.

Genetic resources, whether from plant, animal or micro-organisms, are used for a variety of purposes ranging from basic research to the development of products. Users of genetic resources include research and academic institutions, and private companies operating in various sectors such as pharmaceuticals, agriculture, horticulture, cosmetics and biotechnology. In some cases, traditional knowledge associated with genetic resources that comes from indigenous and local communities (ILCs) provides valuable information to researchers regarding the particular properties and value of these resources and their potential use for the development of, for example, new medicines or cosmetics. According to article 8j of the CBD: Parties shall respect, preserve and promote the knowledge, innovations and practices of ILCs relevant to biological diversity, with the approval and involvement of the holders of such knowledge and encourage the equitable sharing of benefits arising from its use.

Benefits derived from the use of genetic resources may include the sharing of the results of research and development carried out on genetic resources, the transfer of technologies which make use of those resources, and participation in biotechnological research activities. Benefits may also be monetary when products based on genetic resources are commercialised.

The Bonn Guidelines provided some clarity to the development of national regimes and contractual arrangements for access and benefit-sharing and to the implementation of the objectives of the CBD. These voluntary guidelines guide both providers and users of genetic resources in the implementation of the access and benefit-sharing provisions of the Convention.

In 2010, the parties to the CBD adopted the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization. The Nagoya Protocol is intended to create greater legal certainty and transparency for both providers and users of genetic resources by:

- Establishing more predictable conditions for access to genetic resources.
- Helping to ensure benefit-sharing when genetic resources leave the contracting party providing the genetic resources.

By helping to ensure benefit-sharing, the Nagoya Protocol creates incentives to conserve and sustainably use genetic resources, and therefore enhances the contribution of biodiversity to development and human well-being.

The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity is an international agreement which aims at sharing the benefits arising from the utilization of genetic resources in a fair and equitable way, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding, thereby contributing to the conservation of biological diversity and the sustainable use of its components. It was adopted by the Conference of the Parties to the Convention on Biological Diversity at its tenth meeting on 29 October 2010 in Nagoya, Japan.

Annex 6: Game Act

Swaziland's response to combat poaching, particularly fauna, is the Game Act. The Game Act of 1953 was amended in April 1991 with the Game Amendment Act – passed by Parliament, ratified by the King.

Since the passing of the amendments of 1991 there has been a concomitant decrease in poaching in the Big Game Parks (T.E. Reilly, personal communication). It would thus appear that the Game Act is serving its function (which is the protection of wild game). The Game Act, however, does not list (and therefore does not protect) any species of reptiles (other than crocodiles and pythons), amphibians, fish or invertebrates. These latter groups, thus, do not currently enjoy any formal protection in Swaziland.

The salient features of the Game Act are:

First Schedule – Specially Protected Game (rhino, elephant, lion) – 5 years minimum mandatory imprisonment, without the option of a fine PLUS replacement of the animal taken or its value compensated, failing which an additional 2 years imprisonment;

Second Schedule – Royal Game – Mandatory minimum sentence of E4000,00 or 2 years imprisonment, PLUS replacement of the animal taken or its value compensated, with provision that the fine imposed may not be less than the value of the animal taken;

Third Schedule – Common Game – Minimum of E60,000 or 6 months imprisonment, PLUS replacement value of the animal taken;

Values of each species are gazetted for each Schedule;

Section 28 reads – "No sentence or part of any sentence may be suspended by the court" and "any vehicle, gun or other apparatus may be released by the court unless the accused is acquitted"

Mandatory minimum prison sentence of 12 months without the option of a fine for any official, including a judicial official, convicted of frustrating or defeating the ends of justice;

Rangers may search and arrest without a warrant; may use all reasonable force necessary to affect arrest; may bear arms and use them in life threatening circumstances; and in doing any of the above in the course of duty, rangers are not liable to prosecution; (This became necessary when arrested poachers invariably and as a matter of course, brought their own fictitious charges of assault against arresting rangers, who were then prioritised and called to trial while poaching cases were relegated to the back of the queue).

The Game Act currently sits with the King's Office.

Points to consider:

- The responsibility for wildlife in Swaziland has traditionally always been vested in the King. This responsibility became legally formalised with the responsibilities for the Game Act and CITES placed under his direct control in the King's Office by legal notice 142 of 1998.
- The Game Act, enacted by the Nation's elected representatives to Parliament in spite of a law society petition against it, has legal application Kingdom wide – inside and outside Parks and Nature Reserves.
- The Chief Officer in the King's Office assumes all the roles previously designated to the responsible Minister under the Act
- Big Game Parks has been delegated by the Head of State to administer the Game Act, CITES and all international Conventions/Agreements on Nature Conservation, under the governing control of the King through the King's Office.
- The Swaziland National Trust Commission (SNTC) authority and jurisdiction is limited to the boundaries of its own Nature Reserves and institutions (SNTC Act 1972). There is no other legislation at variance with this. The SNTC Act has legal application only inside its own properties.
- Game Rangers gazetted under the provisions of the SNTC Act have powers only within the boundaries of their own Parks and institutions (such rangers are gazetted by the Minister of Tourism).
- Game Rangers gazetted under the Game Act or appointed by Royal Warrant have powers Kingdom wide (such game rangers can only be gazetted by order of the Head of State through the King's Office).

The BSAP list several strategies to control the illegal harvesting of biological resources through enhanced law-enforcement (addresses obstacle 8) and includes:

- Train potential law-enforcement agents e.g. rangers and extension officers.
- Involve Interpol in curbing illegal export of biodiversity components.
- Establish a national law-enforcing unit which would be mobile and move between protected areas.
- Bring to the attention of the Law Society of Swaziland the backlog of "poaching" cases in the courts of law.

Annex 7: Biosafety Act and Policy

Swaziland acceded to the Cartagena Protocol on Biosafety (CPB) in 2006. This Protocol is an international legally binding treaty which sets procedures and mechanisms to be applied in the transboundary movements of living modified organisms (LMOs), i.e. living organisms which possess a novel combination of genetic material obtained through the use of modern biotechnology (genetic modification) and may have adverse effects to biological diversity and human health.

As a Party to the CPB, the country has an obligation to domesticate the international treaty by developing a national framework in harmony with the protocol. Due to the country's rich biodiversity, Swaziland has an obligation to regulate and monitor the introduction and development of LMOs as well as to ensure that its biodiversity and humans are protected from any possible adverse effects of modern biotechnology. This is in line with the precautionary principle which Swaziland subscribes to.

The Government of Swaziland with support from UNEP-GEF, from 2003 to 2005 developed a Biosafety Policy and a Biosafety Bill of 2009. The Bill outlines procedures for handling LMOs and a public participation procedure in the management of modern biotechnology practices in Swaziland. The principal objective of the Biosafety Bill is to ensure an adequate level of protection in the field of safe transfer, handling and use of GMOs resulting from modern biotechnology that may have adverse effects on the conservation and sustainable use of biological diversity, taking into account human health. The bill's enactment into law will enable Swaziland implement the Cartagena Protocol on Biosafety.

In the absence of a law, given the current status of the Biosafety Bill, administrative procedures in line with Annex II of the Cartagena Protocol on Biosafety (CPB) are used to address these applications. Administrative and current phytosanitary regulations are applied in the handling, transportation, packaging and identification of these (Article 18 of the CPB). In its authorisation permit for Living Modified Organisms intended for direct use as Food or Feed or for Processing (LMO-FFPs), Swaziland has set up conditions for all imports of LMOs into the country. Consignments need to be transported in sealed containers from the loading zone to point of delivery in order to avoid spillages and unintentional release into the environment. These consignments are accompanied by appropriate documentation from their point of origin

In dealing with the applications for LMO-FFPs, the Swaziland Environmental Authority, as the Biosafety focal point, subjects all applicants to provide existing risk assessment summaries (Article 15 of the CPB). No risk assessments have been carried in the country, primarily due to the fact that Swaziland lacks capacity to undertake this process. This highlights the need for the necessary capacity to be enhanced. While the relevant legislation is under development, it is pertinent that capacity to undertake risk assessment is built so that decisions made in future are science based.

While there are no reported cases of unintentional transboundary movements, the possibility of such occurrences is duly acknowledged. The country is thus gearing itself towards putting contingency mechanisms to promptly deal with them. Further, existing relations with neighbouring states would enable cooperative measures during unintentional transboundary movements of LMOs. Further to this, the Biosafety focal point's efforts in creating public awareness and participation on biosafety issues are targeted towards minimising such occurrences.

The Regional Agricultural and Environmental Initiatives Network – Africa (RAEIN-Africa), in partnership with the Government of Swaziland, has facilitated the creation of a Public Awareness and Participation Platform on Biosafety (PAPP). The platform's aim is to facilitate appropriate public awareness and participatory mechanisms. Its activities have created a combination of interventions targeted at key stakeholders who are at different levels of influence and different sectors. Ultimately, the focussed activities, based on in-depth knowledge of biotechnology and biosafety, are to ensure that the public is able to make informed contributions on decision making processes on biosafety issues. Additionally, an informed public would contribute significantly towards minimising the illegal transboundary movements of LMOs since people would recognise the significance of regulated movements of LMOs.

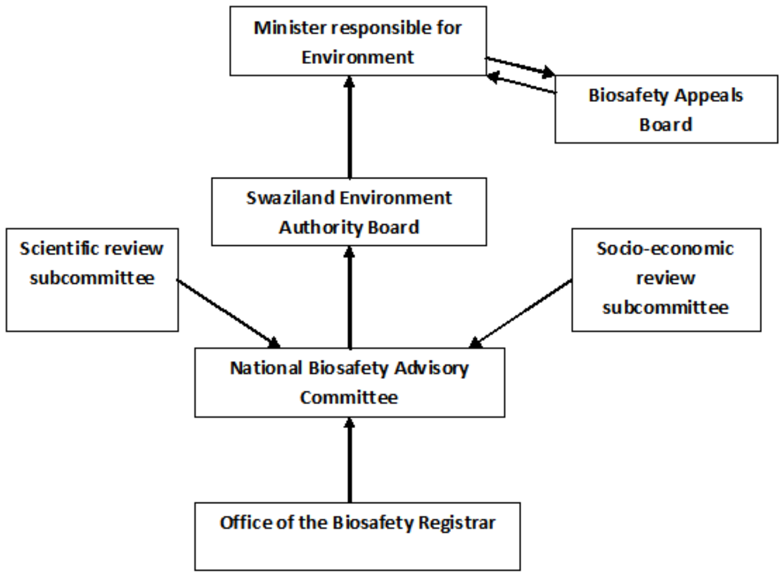
In 2011, the Swaziland Environment Authority prepared and submitted the country's Second National Report on the Implementation of the Cartagena Protocol on Biosafety (CPB) (GOS/SEA, 2011) and has since initiated the establishment of a Biosafety Clearing House.

The SEA is designated as both the National Competent Authority and the Focal Point for the implementation of the CPB and Act. A multi-stakeholder institution, the National Biosafety Advisory Committee, is to be established for evaluating applications for authorising imports and development of GMOs in the country. The institutional arrangement for regulation of biotechnology is depicted in the figure below.

The objectives of the Biotechnology Policy (2005) are described in GOS/SEA, 2011:

- To support the safe application of biotechnology and its products to enhance the socio-economic development of the country whilst minimising, as far as possible, any adverse effects on human and animal health as well as the environment;
- To ensure effective control of the transboundary movement of genetically modified organisms and products thereof resulting from modern biotechnology;
- To help ensure an adequate level of biotechnology development within the country.

Schematic representation of institutional arrangement for regulation of biotechnology



The Government of Swaziland recognizes the urgent need to build up its capacity for biotechnology research and risk assessment with a view to creating a critical mass of skilled scientists and to enable her to meaningfully participate in regional networking activities in this area. In this regards the government has committed to:

- To training a number of locals in the key areas already identified to MSc level within the region or if be beyond the region.
- To creating an environment that will be conducive to encouraging individuals with relevant expertise in stakeholder institutions to seek PhD training in fields related to biotechnology and risk assessment.

Priority will be given for training in the field of:

- Plant biotechnology
- Animal biotechnology
- Industrial biotechnology and,
- Environmental biotechnology

Public Awareness and Participation

An ad hoc biosafety awareness committee was established by the SEA in 2005 to conduct public awareness activities. This Public Awareness and Participation Platform (PAPP) has conducted awareness workshops to a number of stakeholders, some are listed below and exercise is ongoing. The focus of these workshops was to introduce biotechnology and biosafety, outline the processes followed in formulating a Biotechnology and Biosafety Policy and formulated a draft Bill on Biosafety. Stakeholders reached during the PAPP included: Journalists, Government officials, Food consortia, Customs officials, MOA Extension officers.

Annex 8: Institutions with Responsibility for Biodiversity Conservation

The Assessment of Capacity Building Needs for Implementation of General Measures for In Situ and Ex Situ Conservation and Sustainable Use of Biodiversity (GOS-SEA, 2003) produced an overview of the key actors directly or indirectly mandated to manage biodiversity or components of biodiversity as they relate to management and planning are the following.

Ministry of Tourism and Environmental Affairs

*Forestry Section (Department of Forestry).*This section was established in 1972 within MOA but was moved in 2009 under the portfolio of Ministry of Tourism and Environmental Affairs. The mission statement of the Forestry Section is to "provide efficient and profitable sustainable management, utilisation, conservation and development of forestry resources". The mandate of this section includes advising on all forest policy matters, promoting tree planting by rural communities for fuel wood, nature conservation and the supply of timber.

Hence, the role of the Forestry Section is to ensure that the forestry resources are managed and conserved optimally in order to prevent harmful consequences of exploitation. This entails maintaining a forest resource inventory and monitoring the rate of deforestation, provision of efficient extension services to farmers and undertaking research on propagation of indigenous and exotic tree species. The Forestry Section has the following three broad objectives, which are to:

- provide forestry extension services to farmers;
- ensure sustainable management and use of forest resources; and
- conduct inventories and monitoring of forest resources.

The draft National Forest Policy (2002) seeks to greatly improve the capacity of this Section for development of community forestry and sustainable management of natural forests and woodlands in Swaziland. The main objectives are to:

- improve the access to land for utilisation and development of forest resources and secure the tenure of forests and trees,
- promote the rational and sustainable use of land and achieve a sustainable balance between forestry and other uses of the land and water resources,
- improve the forest productivity and supply of multiple forest products and services by maintaining the forest areas,
- improve income and living conditions, and alleviate poverty,
- conserve the biodiversity of forest resources and encourage its sustainable use and ensure that benefits accrued are shared equitably,
- promote the integration of forestry into urban development, and
- enhance the national capacity to manage and develop the forestry sector in collaboration with other stakeholders.

Swaziland National Herbarium. The Swaziland National Herbarium, established in 1956, is under the Forestry Section and is the repository of plant material collected in Swaziland. At present the Herbarium is administered by the Forestry Section but is physically located at the Malkerns Research Station. Its mission statement is to "accumulate and disseminate botanical information, and to promote sustainable utilisation of the nation's plant heritage". Its mandate is to "conduct taxonomic surveys of flora in Swaziland and to assist in its conservation". The objectives of this institution are to:

- conduct floristic surveys;
- conserve plants and their habitats; and
- raise public awareness about the importance of plants.

Ministry of Agriculture

MOA has a number of departments, divisions and sections that are currently responsible for the conservation and management of biodiversity in the country. These include Forestry (including the Swaziland National Herbarium), Fisheries, Land Use Planning, Animal Production and the National Plant Genetic Resources Centre.

Fisheries Section (Department of Agriculture). This section was established in 1972. The main function of the Fisheries Section is aquaculture and fisheries management. Its mission statement is to "enable Swaziland to achieve food security through sustainable fish production and exploitation". The objectives of the institution are to:

- promote fish production; and
- manage the exploitation of fish resources in Swaziland.

Land Use Planning Section (Department of Agriculture). This section was established in 1968 and has a mandate to "guide the utilisation of land and water resources". Its mission is to "rationalise land resource utilisation for sustainability of future generations". The main objectives of this section are to:

- ensure that land is utilised optimally for its most suitable use; and
- ensure that land is utilised both rationally and sustainably.

Animal Production Division (Department of Veterinary and Livestock Services). This division was established in the 1950s. The mandate of this division is to promote animal production in the country. The mandate of the Department of Veterinary and Livestock Services is to prevent the spread of animal diseases and equip livestock producers with adequate knowledge, skill and technical know- how on the efficient management of all resources that will ensure profitable returns and an efficient and sustainable livestock industry. One of the objectives of the National Livestock Policy was to "develop and maintain a high level of range, pasture and soil conservation and management practices through community livestock group schemes and technology transfer".

The Farm Animal Genetic Resources Management Program (FAnGR) was launched in 2000 and is involved with the conservation and management of farm animal genetic resources. The current focus of this unit is characterisation of local breeds of cattle, chickens, goat and sheep. Its three objectives are: 1) to build a data bank comprising the characterisation information; 2) to identify those characteristics of farm animals which require preservation; and 3) to develop breeding programmes which make better use of genetic characteristics of the animals identified. The latter is to be conducted with the direct participation of local communities.

National Plant Genetic Resources Centre (Malkerns Research Station). The National Plant Genetic Resources Centre (NPGRC) was established in 1992. This centre, situated at the Malkerns Research Station, is responsible for the collection, conservation, documentation and characterisation of plant genetic resources in Swaziland, with an emphasis on indigenous crops and crop relatives. Its mandate is to "conserve crop and wild plant genetic resources and ensure their sustainable utilisation". The main objectives are to:

- collect, conserve, characterise, rejuvenate and document indigenous and exotic plant resources material; and
- distribute material to end users (e.g. researchers and farmers).

Ministry of Natural Resources and Energy

Water Resources Branch. The mandate of this organisation is to "monitor and apportion surface water in Swaziland". Its objectives are to:

- ensure that there is sufficient water flow in the country;
- ensure that available surface water is used economical; and
- advise the Water Apportionment Board of the quality and quantity of available water within Swaziland.

Deputy Prime Minister's Office

Community Development Section. This section was established in 1965 and its mission statement is to "serve as a channel between Government of Swaziland and the communities in identifying and prioritising their needs". The objectives of this section are to:

- assist communities to organise themselves for socio-economic activities; and
- improve the social and economic status of these communities.

Tibiyo Taka Ngwane

Dalcrue Agricultural Holdings. This company was established in 2000 with a mandate to "develop and promote agricultural projects". Its mission statement is to "create and maximize returns by engaging in agricultural activities. Its main objectives are to:

- contribute to the acceleration of economic growth and activity in Swaziland; and
- achieve and sustain a return on assets.

Private Sector

Big Game Parks. Big Game Parks was established in 1960. It has a mandate to "administer and manage the Game Act, CITES and all other international conventions/agreements on wildlife" pertaining to Swaziland. The mission of Big Game Parks is to:

- promote environmental literacy;
- develop, conserve and expand her land base to increase scale, ecological viability and protected biodiversity;
- achieve and sustain optimal economic viability in order to facilitate a safe and secure future for Swaziland's historically beleaguered wildlife within representative habitats;
- promote and marry eco-tourism with all other ethical components of environmentally friendly land use and to develop these collectively as justification against contesting land use;
- uphold and sustain the highest levels of conservation integrity, discipline, conservation ethics and rule of law as necessary elements to conserve nature and natural resources; and
- propound the necessity for limits to growth, thereby keeping options open for a better quality of life for future generations of wildlife and people.

Big Game Parks currently manages three protected areas namely: Hlane Royal National Park, Mlilwane Wildlife Sanctuary and Mkhaya Game Reserve.

Nisela Safaris. This game reserve was established in 1997 with a mandate "for Nisela Farms to develop a tourist venue using its conservation strategy". Its mission is "to conserve and create a natural environment for all people". Its primary objective is to:

- create a venue where people from all walks of life have the opportunity to enjoy wildlife.

Livestock Section, Inyoni Yami Swaziland Irrigation Scheme (IYSIS). This cattle ranch was established in 1983, although the cattle ranch existed prior to this under a different company. The objectives of this ranch are to:

- produce and market beef efficiently and sustainably; and
- to conserve wildlife.

Lubombo Conservancy. This conservancy was established in 1999 with a mission to promote the "long-term conservation of the ecosystems of north-eastern Swaziland, and more generally the Lubombo region, through a process of cooperative nature conservation management, and the development of conservation-based opportunities which create benefits, and contribute to improvement of the quality of life of all the people in the region". Its objectives are to:

- promote the cooperative management of the ecosystems and ecosystem processes of north-eastern Swaziland;
- re-establish species which formerly occurred in the area, and to restore damaged or degraded areas;
- promote sustainable management of natural resources;
- promote the appropriate development and management of nature-based tourism;
- contribute to development of employment and conservation-based community development opportunities;
- contribute to the improvement of the quality of life of local communities;
- promote the incorporation of Swazi heritage, folklore and customs into conservation and tourism activities; and
- promote transfrontier cooperation for conservation and development with adjacent areas in Mozambique.

Big Bend/Mhlosinga Conservancy. This conservancy was established in 1996 with a mission to "protect, regulate and improve the quality of wildlife within the conservancy area". Its objectives are to:

- secure and protect all flora and wildlife in the area; and
- proliferate all indigenous wildlife species in the area.

Non-governmental Organisations

Yonge Nawe Environmental Action Group. This Non-Governmental Organisation (NGO) was established in 1987 with a mission to "make the connection between environment, people and sustainable development". Its objectives are to:

- increase awareness, commitment and value on environmental issues and conservation practices; and

- lobby environmental concern within development agencies, policy and legislative organs when funding or planning development.

Natural History Society of Swaziland (NHSS)/Conservation Trust of Swaziland. NHSS was established in 1978 and Conservation Trust in 1988. These two organisations amalgamated in 2002. Their combined objectives are to:

- foster and aid financially the conservation, preservation and proper use of the environment, flora, fauna and antiquities in Swaziland; and
- promote conservation education.

Shewula Trust

This trust was established in 1999 and has the mission to "establish a nature reserve and other developmental projects for the benefit of the Shewula Community through a process of nature conservation management and the development of conservation opportunities". Its objectives are to:

- establish a nature reserve and encourage nature conservation activities;
- promote the incorporation of Swazi heritage, folklore and customs into conservation and tourism activities;
- promote nature based tourism; and
- participate in the promotion of transfrontier cooperation for conservation.

University of Swaziland

Department of Biological Sciences. This department offers a Master of Science in Environmental Resource Management. This M.Sc. programme was initiated in 2002 and its mandate is to "provide an integrated approach to the training of students in the field of conservation and management of environmental resources". Its objectives are to:

- develop human resources, both within Swaziland and regionally, in the field of environmental resource management;
- provide a framework for sustainable environmental management through scientific research and experimentation;
- broaden awareness of the issues on environmental resources; and
- help candidates use the acquired knowledge to contribute to conservation, sustainable utilization and appropriate management of environmental resources.

Swaziland Institute for Research in Traditional Medicine, Medicinal and Indigenous Food Plants (SIREMIFOP). This institute was established in 2000. Its mission is to "serve as Swaziland's leading institution for the design, coordination and execution of multi-disciplinary research in traditional medicine, and indigenous wild edible and medicinal plants. It strives to combine the expertise of scientists and Traditional Medicinal Practitioners (TMPs) with a view to producing derived pharmaceuticals and promoting the use of traditional medicine in national health care, and to create general awareness regarding indigenous food plants. Its objectives are to:

- promote ethno-botanical surveys for documentation;
- provide a forum for the meeting of researchers with nutritionists and TMPs;
- create a seed bank for seeds of under-utilised fruits and vegetables;
- conduct plant propagation studies;
- isolate and identify bioactive plant compounds;
- develop these isolated compounds into medicinal drugs;
- set up staff profiles of relevant experts;
- organise in-service training programmes;
- work towards making traditional medicine a safe and acceptable alternative system of health care;
- promote understanding of intellectual property rights pertaining to the conservation and protection of traditional knowledge; and
- provide a forum for international scientists to consult, lecture and conduct research on medicinal and food plants.

National Biodiversity Database Unit (NBDU). This organisation was initiated in 1999. Its mission is to "conserve biodiversity through conducting goal orientated research, managing information and facilitating conservation projects". Its objectives fall within two broad categories of research and information management and conservation projects:

Research and information management:

- collection and collation of biodiversity information;
- database management;
- analysis of biodiversity data for conservation application;
- report on biodiversity information;
- support the publication of biodiversity information;
- collaborate with and advise other institutions involved in biodiversity management and regulation.

Conservation projects:

- identify and prioritise conservation projects;
- develop project proposals and conservation action plans;
- source funding for priority conservation projects;
- implement priority conservation projects;
- monitor and evaluate conservation projects.

Institutions with Mandates Pertaining to Biodiversity

Institution	**Predominant mandate with respect to biodiversity**		
	Conservation/management		Awareness/training/research
	In situ	*Ex situ*	
SNTC	●		●
SEA	●		
Forestry Section	●		●
Fisheries Section	●		
National Plant Genetic Resources Centre		●	
Swaziland National Herbarium		●	
Big Game Parks	●		
Shewula Trust	●		
Nisela Safaris	●		
IYSIS Cattle Ranch	●		
Lubombo Conservancy	●		
Big Bend Conservancy	●		
Yonge Nawe			●
UNISWA M.Sc.			●
SIREMIFOP			●
NBDU			●
NHSS			●

Source: GOS-SEA, 2003

Annex 9: Swaziland Energy Balance 2010

	BITUMINOUS COAL	ANTHRACITE	LPG	KEROSENE	AVIATION GASOLINE	LEAD REPLACEMENT PETROL	UNLEADED PETROL	DIESEL	FURNACE OIL / HFO	LUBRICANTS	NONSPEC PETROLEUM	NATURAL GAS	HYDRO	SOLAR	BAGASSE	WOOD AND OTHER WASTES	INDUSTRIAL WASTE	ELECTRICITY	OTHER HEAT	BOILERS	TOTAL
INDIGENOUS PRODUCTION	-	8,539.20	-	-	-	-	-	-	-	-	-	-	1,037.16	0.25	4,329.56	16,346.91	458.01	601.03	-	-	31,312.12
FROM OTHER SOURCES	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	64.00	64.00
IMPORT	7,223.97	-	242.93	292.87	6.49	585.64	2,597.79	4,508.80	10.31	0.59	0.02	-	-	-	-	-	-	2,899.80	-	-	18,369.21
EXPORT	-	-8,539.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-3,980.43	-	-	-	-	-12,519.63
DOMESTIC SUPPLY	**7,223.97**	**-**	**242.93**	**292.87**	**6.49**	**585.64**	**2,597.79**	**4,508.80**	**10.31**	**0.59**	**0.02**	**-**	**1,037.16**	**0.25**	**4,329.56**	**12,366.48**	**458.01**	**3,500.83**	**-**	**64.00**	**37,225.70**
STATISTICAL DIFFERENCES	-11.63	-	-	-84.59	-10.11	-	-104.90	218.65	-0.24	0.10	-18.28	-	-	-	20.95	-	-	-99.71	0.04	-0.03	-89.75
Transformation	**-469.51**	**-**	**-**	**-4.22**	**-**	**-**	**-**	**-8.85**	**-**	**-**	**-**	**-**	**-1,037.16**	**-**	**-4,308.61**	**-**	**-**	**-1,895.60**	**-0.04**	**-63.97**	**-7,787.96**
PUBLIC ELECTRICITY PLANT	-	-	-	-	-	-	-	-	-	-	-	-	-1,037.16	-	-	-	-	-1,080.00	-	-	-2,117.16
AUTOPRODUCER ELECT. PLANT	-355.68	-	-	-	-	-	-	-2.60	-	-	-	-	-	-	-4,308.61	-	-	-815.60	-	-0.08	-5,482.57
PUBLIC HEAT PLANT	-	-	-	-4.22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.04	-	-4.26
AUTOPRODUCER HEAT PLANT	-51.33	-	-	-	-	-	-	-6.25	-	-	-	-	-	-	-	-	-	-	-	-63.89	-121.47
NON-SPECIFIED	-62.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-62.50
FINAL ENERGY USE	**6,766.09**	**-**	**242.93**	**373.24**	**16.60**	**585.64**	**2,702.70**	**4,281.30**	**10.54**	**0.49**	**18.30**	**3,483.15**	**-**	**0.25**	**-**	**12,366.48**	**458.01**	**5,496.14**	**-**	**128.01**	**36,929.87**
TOTAL INDUSTRY	**51.33**	**-**	**0.04**	**10.20**	**4.36**	**-**	**2.15**	**268.30**	**0.24**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**458.01**	**2,925.00**	**-**	**128.01**	**3,847.64**
IRON AND STEEL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	61.99	-	-	61.99
NON-METALLIC MINERALS	-	-	-	-	-	-	-	12.31	-	-	-	-	-	-	-	-	-	600.48	-	-	612.79
TRANSPORT EQUIPMENT	-	-	-	10.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10.04
MACHINERY	-	-	0.03	-	-	-	-	0.75	-	-	-	-	-	-	-	-	-	572.40	-	-	573.18
FOOD AND TOBACCO	51.33	-	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	465.84	-	-	517.18
WOOD AND WOOD PRODUCTS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	458.01	292.61	-	-	750.62
CONSTRUCTION	-	-	-	0.16	4.36	-	2.15	249.00	0.24	-	-	-	-	-	-	-	-	931.68	-	-	1,187.59
NON-SPECIFIED	-	-	-	-	-	-	-	6.25	-	-	-	-	-	-	-	-	-	-	-	128.01	134.26
OTHER	**6,714.76**	**-**	**242.89**	**350.28**	**4.98**	**-**	**1,146.11**	**1,710.20**	**10.30**	**0.11**	**18.29**	**3,483.15**	**-**	**0.25**	**-**	**12,366.48**	**-**	**2,571.14**	**-**	**-**	**28,618.94**
AGRICULTURE	6,714.76	-	0.09	80.57	4.18	-	121.81	474.97	-	-	-	681.62	-	-	-	-	-	1,804.79	-	-	9,882.79
COMMERCE AND PUBLIC SERVICES	-	-	-	185.92	0.80	-	1,019.60	1,221.64	10.30	0.09	2.39	2,440.74	-	-	-	-	-	-	-	-	4,881.48
RESIDENTIAL	-	-	242.80	83.78	-	-	3.25	8.71	-	-	-	338.54	-	0.25	-	12,366.48	-	620.26	-	-	13,664.07

	BITUMINOUS COAL	ANTHRACITE	LPG	KEROSENE	AVIATION GASOLINE	LEAD REPLACEMENT PETROL	UNLEADED PETROL	DIESEL	FURNACE OIL / HFO	LUBRICANTS	NONSPEC PETROLEUM	NATURAL GAS	HYDRO	SOLAR	BAGASSE	WOOD AND OTHER WASTES	INDUSTRIAL WASTE	ELECTRICITY	OTHER HEAT	BOILERS	TOTAL
NON-SPECIFIED	-	-	-	-	-	-	1.45	4.88	-	0.02	15.90	22.25	-	-	-	-	-	146.09	-	-	190.59
												-									
TRANSPORT	**-**	**-**	**-**	**12.77**	**7.26**	**585.64**	**1,554.44**	**2,302.80**	**-**	**0.38**	**0.01**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**4,463.30**
ROAD	-	-	-	-	0.27	585.64	1,554.44	2,302.80	-	0.38	0.01	-	-	-	-	-	-	-	-	-	4,443.54
RAIL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DOMESTIC AIR TRANSPORT	-	-	-	-	6.99	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.99
NON-SPECIFIED	-	-	-	12.77	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.77
MEMO Sectors	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-593.83**	**-**	**-**	-593.83
NON-ENERGY USE	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-593.83**	**-**	**-**	-593.83
INDUSTRY / TRANSFORM. / ENERGY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-593.83	-	-	-593.83