Strategic Water Source Areas: Vital for South Africa's Water, Food and Energy Security

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ABBREVIATIONS

AMD	Acid mine drainage *- highly polluted and acidic water discharging from mined areas*
MAR	Mean annual runoff *- the average amount of water flowing down our rivers each year*
GVA	Gross value added *- a measure of economic activity*
SWSA-sw	Strategic water source area for surface water
SWSA-gw	Strategic water source area for groundwater
WCWSS	Western Cape Water Supply System *- supplies Cape Town & the Winelands with water*
WSS	Water Supply system *- a system of dams, canals, pipes and reservoirs that supplies water*

SOUTH AFRICA AND ITS WATER

South Africa receives only about half of the world's average mean annual rainfall.

Most of South Africa's water requirments are met from rivers.

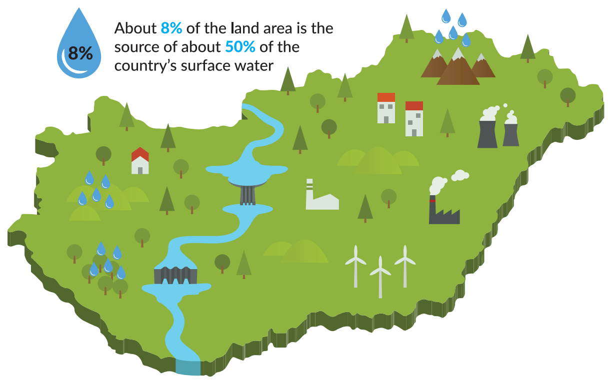
Irrigation is the largest water user in South Africa.

South Africa is a water-scarce country with a mean annual rainfall of just 490 mm per year, half the global average. Evaporation rates are high, and less than 9% of the rainfall reaches our rivers, i.e. becomes mean annual runoff (MAR). The rainfall is very variable and unevenly spread – low in the north and west and high in the east and south. About 8% of the land area of South Africa, Lesotho and Swaziland is the source of about 50% of the MAR – our Strategic Water Source Areas – and settlements often depend on river flows which originate hundreds of kilometres away. In many parts of the country, especially the dry Karoo and Kalahari, people's lives and livelihoods depend largely or entirely on groundwater.

Although South Africa made huge investments in dams and complicated water transfer schemes during the 20th century to secure its water supplies, the country faces major water security challenges. More than 98% of the reliably available surface water is already used, demand outstrips supply in most catchments, and there are serious and growing water quality problems.

Three main factors are decreasing water security. The first is our growing population – from 44.8 million in 2001 to 55.7 million in 2016. This means that in 2016 South Africa had only about 2 440 litres per day per person or 890 m^3/person/year of water available. This is well into what the United Nations calls 'water scarcity'. This may still seem like a lot of water, but only 20-25% of that water is reliably available, including groundwater. And about 75% of the reliably available water is required to grow food, generate electricity, and keep rivers as functioning ecosystems. That leaves about 160 litres/person/day for household use – not a lot.

The second factor is that we have failed to adapt our lifestyles to the reality of how little water there really is – and how variable its supply is. We have failed to adapt our development plans to take into account whether sufficient water is available or how much it really will cost to supply it. Only now are we advocating storing rainwater, residential use of grey water and recycling water, things that are normal in other countries and dry regions. We could have begun that decades ago.



Threats to South Africa's water resources threaten not only our natural ecosystems, but also our very existence.

As South Africa's population grows, so does it demand for water.

A third key factor is that we are not giving enough attention to the protection of our strategic water source areas (SWSAs). Our water sources are vital and can only be protected by wise and effective management of activities on land and in water by everyone as discussed further below. Our lack of forethought is reflected in the fact that 60% of our river ecosystems are threatened (<50% intact), and 23% are critically endangered (<30% intact) and wetlands are even worse at 65% threatened and 48% critically endangered.

WHAT IS A WATER SOURCE AREA AND WHAT MAKES IT STRATEGIC – A SWSA?

A Water Source Area (WSA) is a water catchment or aquifer system that either supplies a relatively large volume of water for its size, or is the primary source of water for a town, city or industrial activity. Strategic Water Source Areas (SWSAs) are defined as areas of land that either: (a) supply a disproportionate (i.e. relatively large) volume of mean annual surface water runoff (i.e. water in streams, rivers and wetlands) in relation to their size and so are considered nationally important; or (b) have relatively high groundwater recharge and groundwater forms a nationally important resource (has high levels of use or settlements depend on it); or (c) areas that meet both criteria (a) and (b). A SWSA is one where the water that is supplied is considered to be of national importance for water security, but there are others which are considered to be sub-nationally important.

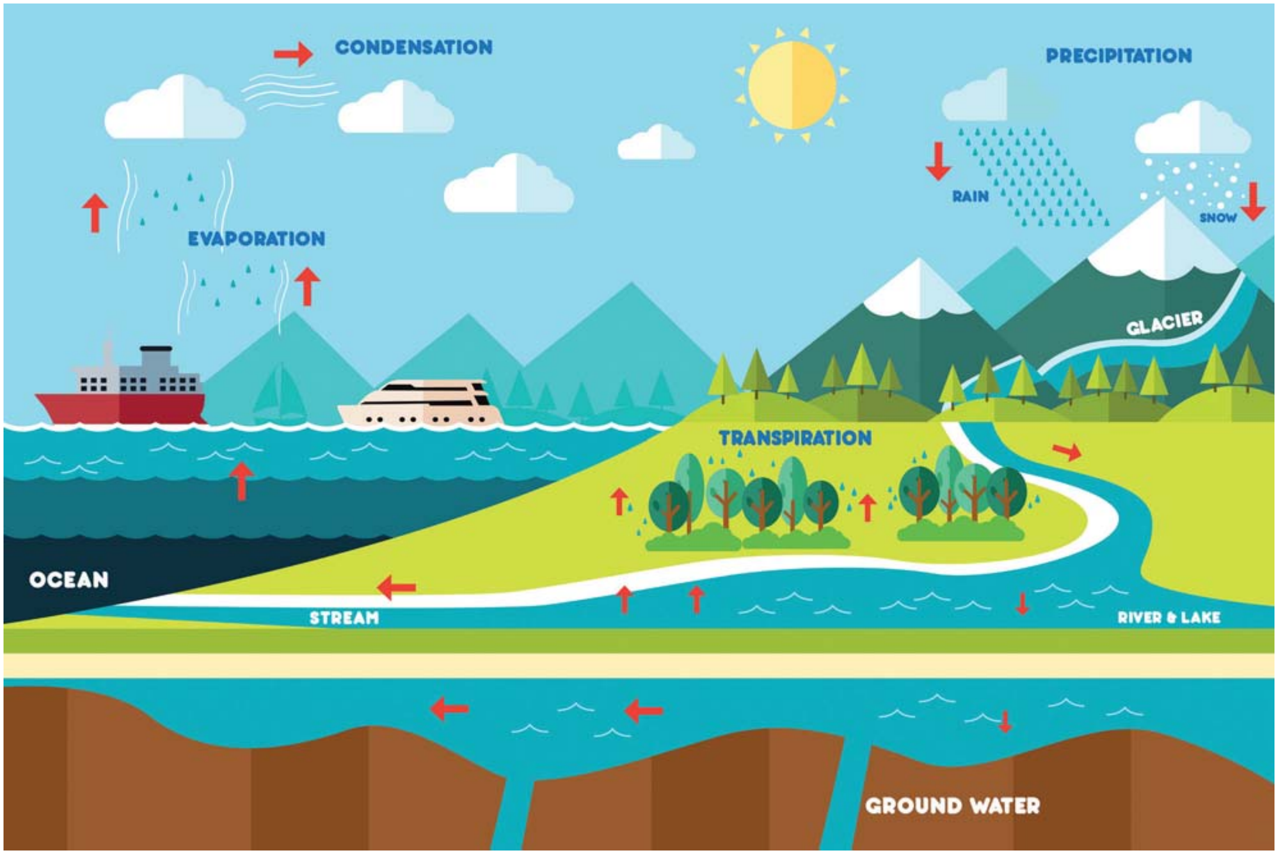
WHAT CAN BE DONE?

We are able to increase our use of groundwater, recycled water and desalination, and to move water around with further transfer schemes, but the technological solutions are finite and increasingly expensive. The maintenance costs of keeping all the existing water infrastructure operating efficiently are estimated at R680 billion over the next decade. And it is evident that we are not meeting the targets for maintenance.

But most of what we have said so far is just about the water coming out of a pipe, it ignores where the water comes from – before its gets into a pipe. How effectively rainwater is conveyed to rivers or into groundwater. What we do or do not do on the land has significant impacts on the amount and quality of water delivered by our water source areas. Protection of the areas that are the sources of our water (e.g. high yielding catchments and rivers) and groundwater (e.g. springs and boreholes) for human settlements, agriculture and industry, is absolutely critical for water security. And if we allow nature to do so, it will keep its ecological infrastructure in our strategic water source areas, in good condition at little or no cost to us.

A hidden bonus provided by intact ecosystems is their greater ability to adapt to the effects of climate change, especially the increasing variability of rainfall. The trends are clear for air temperatures which are rising particularly fast in Africa. Rainfall trends are less predictable, but there are likely to be increases in the wetter eastern parts, decreases in the west and south and decreases in the northern parts of South Africa. These predictions need to be taken seriously because they will affect our water security and how we can respond to the impacts on water security.

GROUND AND SURFACE WATER



The water cycle.

South Africa's strategic water source areas (SWSAs) can be divided into two groups: surface water source areas (SWSA-sw) and groundwater source areas (SWSA-gw). Groundwater and surface water are interwoven – groundwater discharges provide much of the river flow and sustain all perennial rivers during the dry season. This means that all 22 of the SWSA-sw need to have their groundwater resources protected as well.

VITAL STATISTICS FOR SWSAS

There are 22 nationally strategic SWSA-sw which provide 50.4% of the river flows and occupy 9.8% of South Africa, Lesotho and Swaziland. In simple terms: **50% of the water from 10% of the area**. They also sustain water-supply systems for more than 50% of the population, supply cities and towns that generate more than 64% of national economic activity, and supply about 70% of the water used for irrigation. There are nine sub-national SWSA-sw, which include a broad belt along the east coast from Pondoland to Zululand, but these are not discussed further in this booklet.

The 57 SWSA-gw cover about 11% of South Africa, with 37 of these being nationally strategic and covered in this booklet. The SWSA-gw supply 32% of the settlements that get more than half of their supply from groundwater (and house 4% of the national population). They supply 44% of the groundwater for agriculture, and 32% of the groundwater used for industrial purposes in South Africa. Groundwater is also the main source of water for a further 268 settlements in South Africa. Groundwater source areas were not defined for Lesotho or Swaziland because suitable data were not available.

South Africa has a number of major urban centres and economic development nodes. Most of these source a substantial percentage of water from the SWSAs, whether surface or groundwater. This booklet describes the links between a selection of these centres in greater detail and a summary is provided below. In many cases, the water from the SWSAs reaches these centres from quite large distances via a range of water transfer schemes. The Vaal water-supply system is the most complex in the country and supplies water to Gauteng, including large volumes of water from Lesotho.

Lani van Vuuren

The Vaal Dam is one of the main bulk water storage units in the sophisticated Vaal River water supply system.

SUMMARY OF URBAN CENTRES AND THEIR DEPENDENCE ON STRATEGIC WATER SOURCE AREAS

Water supply scheme	Urban centres	Percentage linked to SWSAs	Strategic water source areas
Vaal	Johannesburg, Midrand, Vereeniging, Rustenburg, Secunda and others	70	Maloti Drakensberg (34.5%), Northern Drakensberg, Upper Vaal, Enkangala, Upper Usuthu (36.5%)
Crocodile West	Greater Johannesburg, Pretoria	>50	Including transfer from Vaal WSS and Eastern Karst Belt
Western Cape	Cape Town and Boland towns	100	Boland and Groot Winterhoek (96.8%), Table Mountain (1.6%); Atlantis (1.3%), Albion Springs (0.4%)
KwaZulu-Natal	Durban Metropole, Pinetown, Pietermaritzburg and others	98	Southern Drakensberg (97.8%)
Algoa	Port Elizabeth	91	Tsitsikamma (40.9%), Kouga (22.4%), Maloti Drakensberg (25.3%); Uitenhage Springs (2.3%)
Bloemfontein	Bloemfontein	70	Maloti Drakensberg (70.3%)
Amatole	East London, King Williams Town	92	Amatole (91.1%)
Polokwane	Polokwane	66	Wolkberg (55.3%); Upper Sand (Polokwane) Aquifer System (11%)
Richards Bay	Richards Bay	47	Mfolozi Headwaters (11%); Northern Drakensberg (20.7%); Richards Bay groundwater-fed lakes (15.7%)
Luvuvhu-Letaba	Thohoyandou, Giyani, Tzaneen	100	Soutpansberg (41.9%); Wolkberg (56.1%); Giyani (1.9%)
Mbombela	Nelspruit, White River, Hazyview	100	Mpumalanga Drakensberg (100%)
Mosselbay	Mossel Bay	95	Outeniqua (94.7%)
George and Wilderness	George	100	Outeniqua (100%)
Mthatha	Mthatha	100	Eastern Cape Drakensberg (100%)
Ladysmith	Ladysmith	100	Northern Drakensberg (100%)
Newcastle	Newcastle	100	Northern Drakensberg (80%); Enkangala Drakensberg (20%)
Olifants	Witbank, Groblersdal, Phalaborwa	48	Mpumalanga Drakensberg (40.7%), Wolkberg (7.4%)

IMPACTS OF HUMAN ACTIVITIES

The Table Mountain strategic water source area.

Commercial forestry is practiced on the Escarpment.

Nearly 70% of the 22 SWSA-sw is still natural vegetation with commercial forest plantations the next most important land-cover, and then cultivation. The proportions vary widely between them: Table Mountain is almost 43% built-up, 40% of the Mpumalanga Drakensberg is under commercial forest plantations and 31% of the Upper Vaal is dryland cultivation.

The proportion of the SWSA-gw under natural vegetation is slightly greater, with more dryland cultivation and much less under plantations. Much of the natural land is used as natural rangelands and much of this vegetation has been degraded, resulting in soil loss and bush encroachment which alter the water balance. The Cape Peninsula and Cape Flats are about 60% built-up, 48% of the West Coast Aquifer is under cultivation (3% under irrigation), and 41% of the Richards Bay groundwater-fed estuary is under commercial plantations.

Cultivation has the greatest potential impact. Unwise tillage and other agricultural practices can result in significant soil loss, which then sediments up wetlands, rivers and dams. Cultivated agriculture uses fertilizers, herbicides and pesticides, all of which can pollute water sources. Most of the natural vegetation outside protected areas is used as rangelands, and unwise herding and grazing practices can initiate soil erosion, which then becomes a self-reinforcing process, ultimately leading to decreased land productivity and reductions in dry season river flows.

Although mining occupies less than 1% of the SWSAs, it can have disproportionate impacts. Current and future coal mining affect a number of SWSAs, notably the Upper Vaal (surface water), Enkangala Drakensberg (surface water) Kroonstad. Certain forms of coal mining expose minerals which acidify the water, resulting in

Mining presents a pollution threat to some of South Africa's source water areas.

acid main drainage and significant impacts on water quality. Several of the SWSAs overlap areas identified as having potential for shale gas extraction and with mineral provinces. There are already hundreds of abandoned mines which are affecting water quality and quantity and we do not need to add to that problem.

The SWSAs are working landscapes, where human activities can adversely affect their health. These activities are necessary for society (e.g. food and timber production) but they do result in impacts from cultivation, degradation, mining, urban development, altered fire regimes and invasive alien plants. Although these impacts will alter the quantity and quality of water SWSAs provide, they are also necessary for the production of food and other activities. We need to continue those activities but we can ask some important questions:

- For existing activities: Is that activity at all appropriate in an SWSA? If it is, how can it be planned and managed to avoid or minimise its impacts on water quantity and quality in that SWSA?
- For proposed activities: What impacts could they have on water quality and quantity? Are they acceptable? If they are, how can they be planned and managed to avoid or minimise their impacts on water quantity and quality in that SWSA?

LEGAL MEASURES FOR THEIR PROTECTION

There are a number legal tools and measures which can be used for protecting WSAs or parts of WSAs:

Section 24(2A), National Environmental Management Act

- In terms of this section, the Minister of Environmental Affairs may restrict or prohibit environmental authorities from granting environmental authorisation for specified activities such as mining, forestry and agriculture in specified geographical areas when such restriction or prohibition is necessary to ensure the protection of the environment, the conservation of resources or sustainable development.

Water and Sanitation Draft Bill

- The National Water Act currently does not have a tool that allows the Minister of Water & Sanitation to protect an area that is important for water security and supply, i.e. an SWSA. However, the 2013 SWSAs were been incorporated in the 2013 National Water Resource Strategy and are being incorporated into the National Water and Sanitation Master Plan.

Section 49, Mineral & Petroleum Resources Development Act

- This section authorises the Minister of Mineral Resources to restrict or prohibit the granting of rights for mining, prospecting, exploration or production operations in specified geographical locations for a specified period of time. One of the factors the Minister must consider when exercising his or her power in terms of this section is the need to ensure that the development of the nation's mineral or petroleum resources is sustainable.

Chapter 4 of the Biodiversity Act

- The Minister of Environmental Affairs may declare specified ecosystems as ecosystems that are threatened or in need of protection. Specified activities may not be conducted in such ecosystems without environmental authorisation from a competent authority.

Protected Areas Act

- The Minister of Environmental Affairs, or an MEC responsible for environmental affairs in a province, may declare a specified geographical area as a protected area in terms of this Act. Protected areas include national parks, special nature reserves, nature reserves and protected environments. Varying degrees of protection are afforded to the different types of protected areas. Prospecting, mining, exploration and production operations are prohibited in most protected areas. Each protected area must have a management plan. A management plan may limit or prohibit specified activities in a protected area.

Chapter 3 of the National Water Act

- The National Water Act compels the Minister of Water and Sanitation to set resource quality objectives for every significant water resource in South Africa. The Minister is also obliged to determine the reserve for every significant water resource. The reserve is the minimum quality and quantity of water necessary to meet basic human needs and protect aquatic ecosystems. The reserve and the resource quality objectives may not be exceeded.

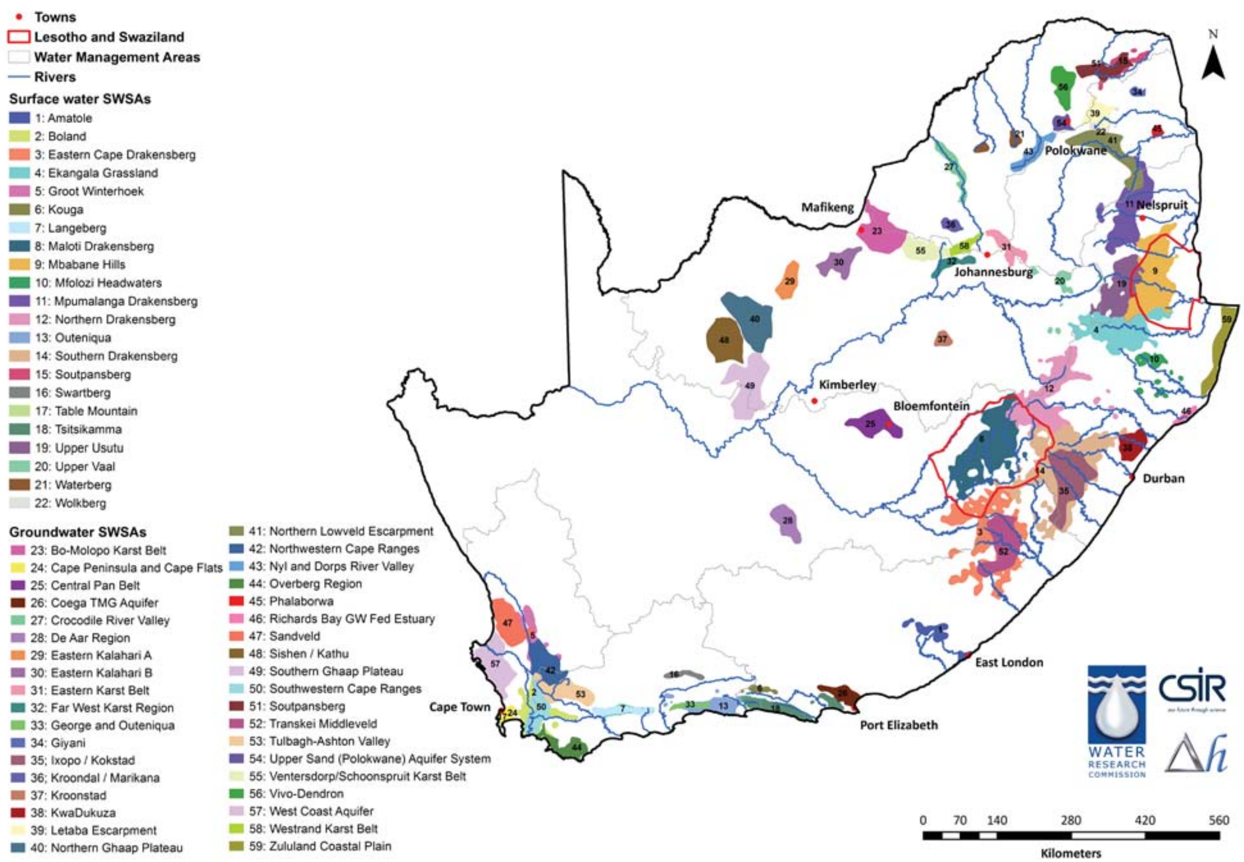
Spatial Planning and Land Use Management Act

- This Act deals with land use planning by municipalities. It makes provision for principles that guide municipal land use planning decisions. It also regulates the content and legal effect of spatial development frameworks and land use schemes. In terms of the Act, municipal land use planning decisions may not be inconsistent with applicable spatial development frameworks. It also provides that land may not be used for purposes other than the purposes for which it is zoned in terms of an applicable land use scheme.
-

Management actions which are consistent with these legal tools and will protect the quantity and quality of water produced by SWSAs include:

- Maintaining healthy functioning riparian zones and wetlands to regulate water quantity and quality, including protecting them from adjacent land-uses with suitable buffer strips;
- Ensuring good agricultural management, which leads to soil conservation that supports the water cycle and minimises adverse impacts;
- Avoiding activities that reduce stream flow through water abstraction (e.g. irrigated agriculture) or by decreasing stream flows (e.g. forestry plantations) and, where this is not possible, ensuring strict regulation of these activities;

- Avoiding activities that reduce infiltration (e.g. soil degradation, construction of areas with hard surfaces; unwise land cultivation practices), and where this is not possible ensuring judicious planning and regulation of these activities;
- Ensuring that other activities that adversely affect water quality (e.g. some forms of mining, discharges of pollutants, polluted storm water, malfunctioning waste water treatment plants) are effectively managed and that the impacts of proposed new activities are properly assessed and avoided or mitigated, or not permitted where this cannot be achieved;
- Clearing invasive alien plants to protect ecosystem structure and function and enhance stream flows; and
- Restoring the hydrological functioning of degraded landscapes



The strategic water source areas of South Africa, Lesotho and Swaziland showing each area with its name and the overlaps between surface and groundwater source area.

CAPE TOWN'S WATER SECURITY – TIED TO THE BOLAND

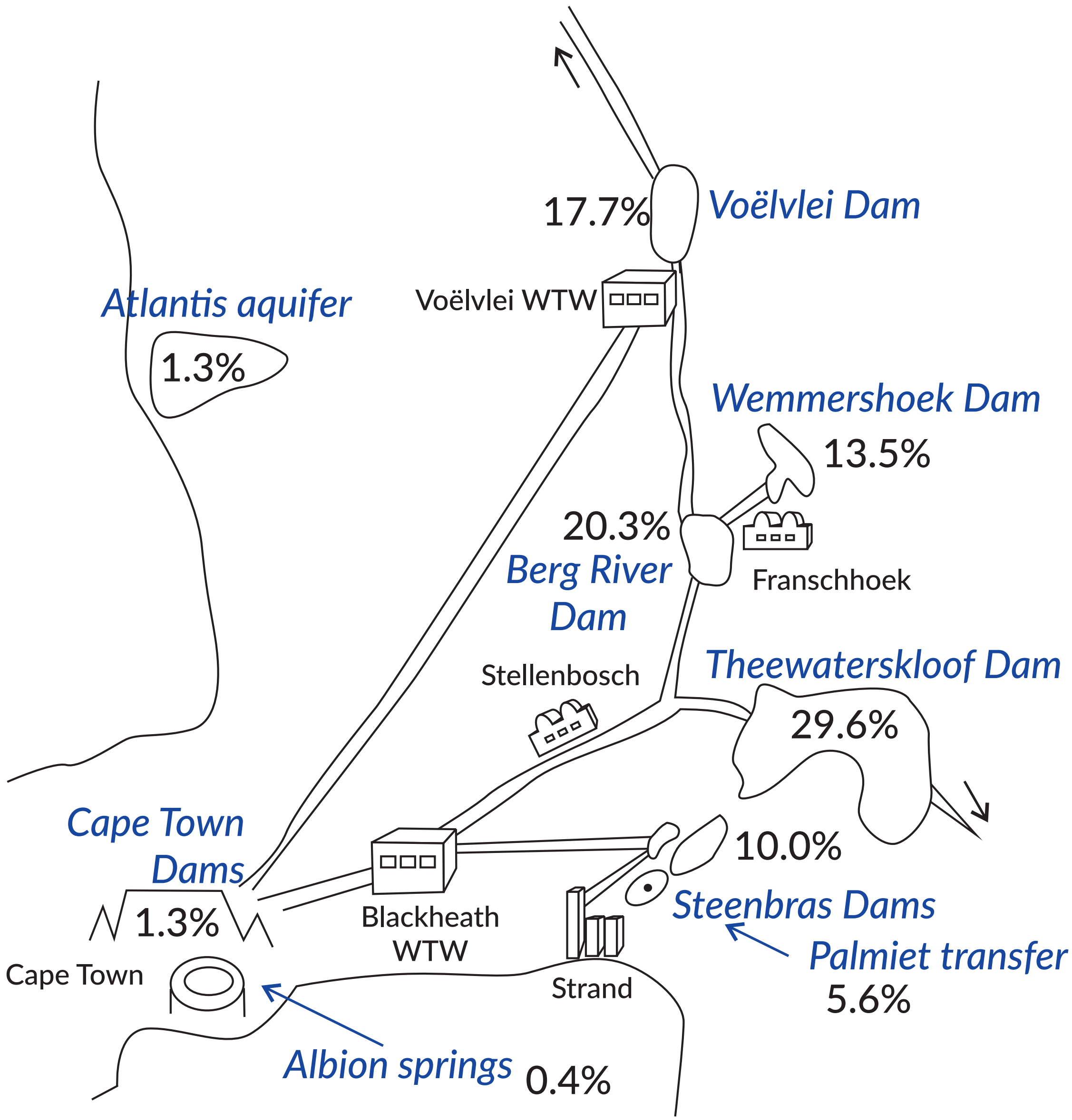
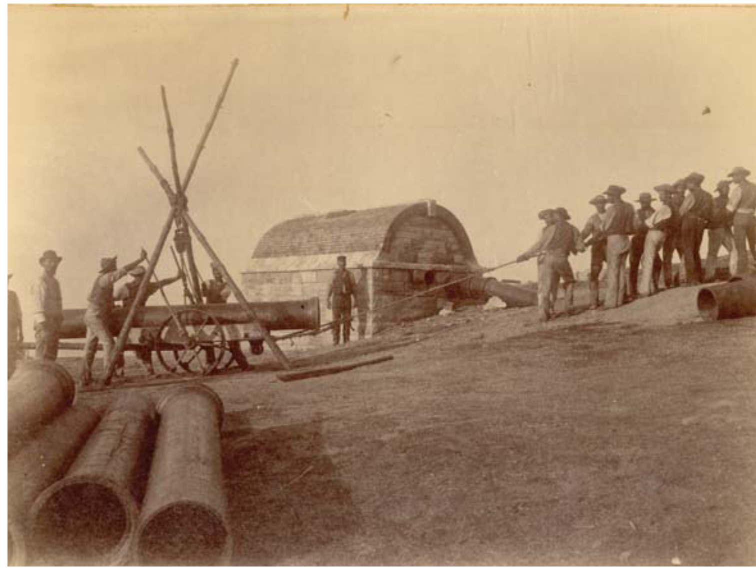


Diagram of the Boland SWSA and the Western Cape WSS.

Theewaterskloof Dam.



Pipes being conveyed for the construction of the Woodhead Reservoir on top of Table Mountain. The dam was built in 1897.

The grape industry is a significant employer in the Western Cape.

The Cape Town Metropole and its neighbouring towns obtain their water from a combination of the Western Cape Water Supply System (WCWSS) and their own sources, including groundwater. This system includes the Theewaterskloof Dam in the Breede River system, five other major storage dams and the use of groundwater by Saldanha and Atlantis, among others.

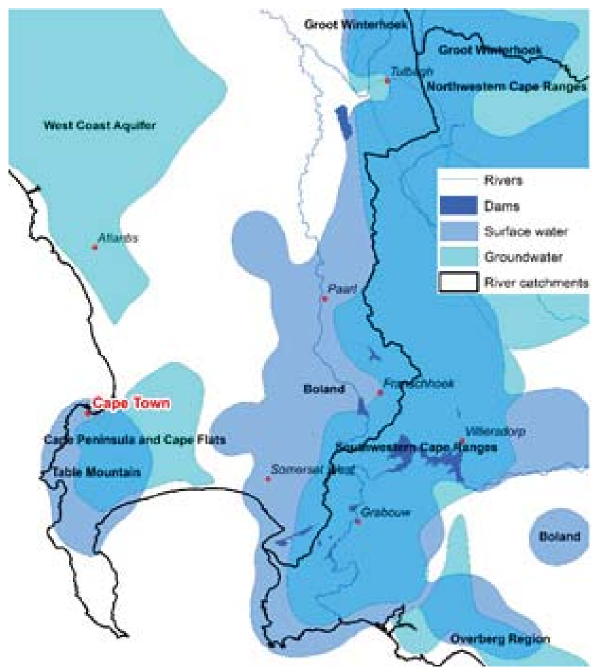
In 2011, the population of Cape Town and its surrounding towns was more than 4.2 million people (8.2% of the total population), with about 3.7 million living within the metropole (4 million in 2016). Regional economic activity (Gross Value Added) was worth R196 billion in 2011, 12% of the national economy, second after Gauteng and more than 70% of the total for the Western Cape. The production, processing and export of deciduous fruit and wine is the second most important business and an important employer in the rural areas. The Cape's montane landscapes, most of which are SWSAs, are key tourist attractions. Water supplied to the Saldanha area supports 75 000 people and a GVA of R2.2 billion. This includes groundwater from the West Coast Aquifer. Direct groundwater use by agriculture and industry from the Cape Peninsula and Cape Flats Aquifer, Southwestern Cape Ranges and West Coast aquifer is about 42 million m^3/year and supports an agricultural GVA of about R0.7 billion.

City of Cape Town

Wemmershoek Dam.

Mountains and water

One of the key reasons for the colonisation of Cape Town was the ready supply of water from the perennial streams and springs on the face of the Table Mountain SWSA, which are sustained by outflows from the Cape Peninsula and Cape Flats aquifer. These are said to be why the Khoen gave the name "Camissa" (Sweet waters) to Table Mountain. Water provided by these SWSAs maintained Cape Town until the 1890s when water from the Disa River was redirected to Cape Town. Although five dams were built on Table Mountain water shortages compelled the city to add the Steenbras Dam in 1921 and the Wemmershoek Dam in 1957, both located in the Boland SWSA. Together with Voëlvlei (added in 1952 to provide water to the suburbs northern suburbs and West Coast), these developments were the first phases of the WCWSS. Voëlvlei Dam gets most of its water from the Klein Berg and 24 Rivers whose catchments are in part of the Groot Wintershoek SWSA. The next major step was the Theewaterskloof Dam and a series of tunnels to transfer water to Cape Town and to the Berg River system in 1980. The final step was to add the Berg River Dam, which came online in 2009.



Mean annual rainfall in Cape Town SWSAs

Name	MAR (million m³)	Percent of national MAR	MAR (m³ per ha)	Area (ha)
Boland	2 182	4.41	3588	608 300
Groot Winterhoek	1 002	2.02	1931	519 079
Table Mountain	127	0.26	2730	46 467

Name	Recharge (million m³/year)	National recharge (%)	Area (ha)
Southwestern Cape Ranges	2749	1.8%	274 908
Cape Peninsula and Cape Flats	599	0.2%	59 950
Northwestern Cape Ranges	3638	0.8%	363 828

For various reasons, probably mainly cost and health related, the abundant groundwater resources of the Cape Flats aquifer remained largely untapped except by farmers. The one exception was Atlantis which relies primarily on groundwater, and groundwater recycling, a system which has kept this town's 67 000 inhabitants supplied for 40 years. Perversely, the city constructed drainage systems to lower the water table across most of the Cape Flats and converted them to urban and industrial areas, a process that is still continuing. Cape Town still has problems every winter when rising groundwater floods some of the informal settlements – an irony, given the current water shortages.

The Cape Town area is very well endowed with water: Boland provides 4.4% and all three together more than 6.5% of the national MAR; Boland has the greatest runoff per ha of all SWSAs (9 times the national average), followed by Table Mountain. The flows in the perennial rivers draining the Boland SWSA are sustained by groundwater from the sandstone and granite aquifers of Southwestern Cape Ranges SWSA **– 12% of the MAR is baseflow from groundwater**. Likewise, the Northwestern Cape Ranges aquifers sustain the perennial Klein Berg and 24 Rivers. Springs on the Cape Peninsula still supply water from its aquifer, the best known being the Albion Springs in Newlands which provide about 2.8 million litres/day.

In total, the City of Cape Town gets 98.4% of its water from three SWSA-sw: Boland (±80%), Groot Winterhoek and Table Mountain and the underlying SWSA-gw: Cape Peninsula and Cape Flats, Southwestern and Northwestern Cape Ranges. The Cape Peninsula aquifer sustains the Albion Springs and the West Coast Aquifer supplies Atlantis.

The City Region and neighbouring areas get all their water from SWSAs.

How well are these sources protected?

The Table Mountain and Cape Peninsula and Cape Flats SWSAs cover 90 025 ha with only 17 704 ha (19.7%) in formally protected areas and additional 44 ha in a private nature reserve. Most of this area is in the Table Mountain National Park, with only Zandvlei, False Bay Park, Driftsands and Tygerberg Nature Reserve protecting the Cape Flats aquifer portion. The Boland and Southwestern Cape Ranges cover 634 359 ha and are better protected, with 289 784 ha (45.7%) in protected areas. The extensive protected areas in the Boland and Groot Winterhoek mountains are the result of wise forethought. Large sections of private mountain land were proclaimed under the Mountain Catchment Areas Act in the 1970s.

Boland	Natural (71.7%)	Plantations (2.3%)
Waterbodies (1.9%)	Cultivated dryland (6.7%)	Urban (2.7%)
Wetlands (2.0%)	Cultivated irrigated (12.5%)	Mining (<0.1%)
Table Mountain	Natural (48.0%)	Plantations (2.3%)
Waterbodies (2.0%)	Cultivated dryland (1.3%)	Urban (43.2%)
Wetlands (2.0%)	Cultivated irrigated (1.0%)	Mining (0.6%)

What are the impacts of human activities?

The land cover in the Boland and the Table Mountain SWSAs differs considerably. Most of the Boland is natural vegetation, but Table Mountain is evenly split between natural and transformed areas, with urban (and light industrial) areas being more than 40% and plantations being replaced by fynbos. Both Table Mountain and Boland have relatively high proportions of wetlands. Close to 20% of Boland is under cultivation, especially irrigated orchards (apples, stone fruit and grapes) around Paarl, Franschhoek and Stellenbosch which can affect water quality. Invasive alien plants, mainly pines and wattles, have invaded all of the catchments in the Boland SWSA to some degree. They are especially dense around the Theewaterskloof Dam. These invasions are reducing the flows of water into the storage dams which, in turn, reduce the yields of the Western Cape Water Supply System. Large dams can compensate for such losses to a degree because they can store the high winter MAR. But, during drought periods those impacts are felt more acutely because the trees dry out the soil so that more rain is needed to re-wet the soils before river flows respond to rainfall.

Current levels of invasion are estimated to be reducing the yield of the WCWSS by about 38 million m³/year or more than 60 days of water at a consumption of 600 Ml per day!

Southwestern Cape Ranges	Natural (80%)	Plantations (2.7%)
Waterbodies (2.7%)	Cultivated dryland (1.3%)	Urban (0.5%)
Wetlands (2%)	Cultivated irrigated (9.2%)	Mining (<0.1%)
Cape Peninsula and Cape Flats	Natural (32%)	Plantations (1.5%)
Waterbodies (1%)	Cultivated dryland (1.5%)	Urban (60%)
Wetlands (1.7%)	Cultivated irrigated (1.9%)	Mining (0.4%)
West Coast Aquifer	Natural (49.1%)	Plantations (0.2%)
Waterbodies (0.5%)	Cultivated dryland (44.8%)	Urban (0.8%)
Wetlands (1.7%)	Cultivated irrigated (2.7%)	Mining (0.1%)

The groundwater source areas are similar to their overlapping surface water areas, especially the Southwestern Cape Ranges, which are the heart of the Boland SWSA. The Cape Peninsula and Cape Flats aquifer is mostly urban, which is a concern given that 48% of this aquifer (essentially the deep sands) has a very high vulnerability to contamination from pollution on the surface, particularly waterborne pollutants, and a further 23% is high.

An apple orchard in the Graboux area. Most orchards in this area are irrigated.

The removal of alien invasive plants are making way for the restoration of fynbos.

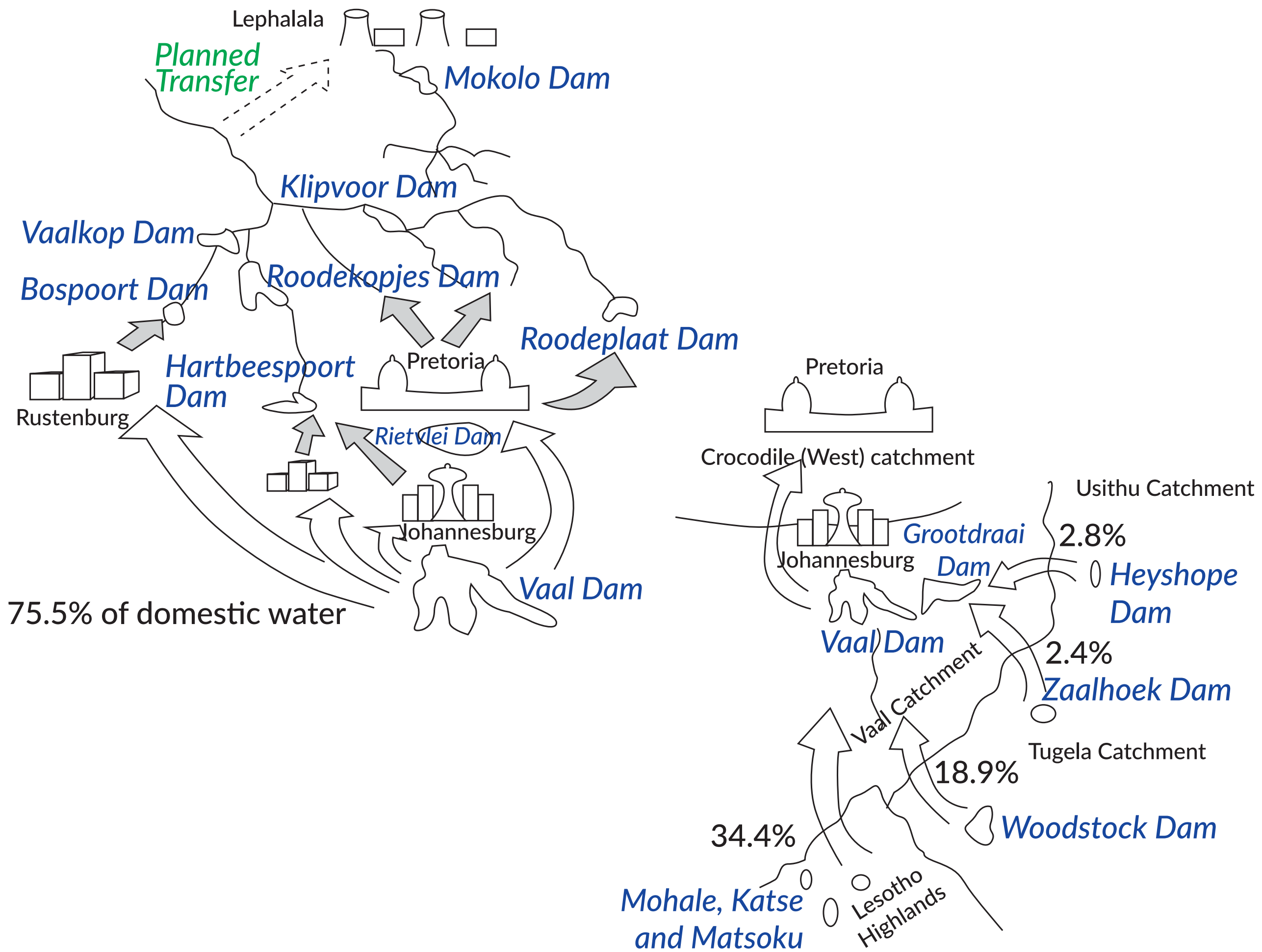
Opportunities provided by SWSAs to increase water security

Cape Town is a major city located squarely within two nationally strategic water source areas. Almost all its water comes from SWSAs that are not under its direct jurisdiction. The reliably available water in the WCWSS is already allocated to the city, towns and farming so increasing their share will compromise others. It has a largely unexploited groundwater source within its boundaries which is highly vulnerable to pollution from farming and poor sanitation and stormwater management in its informal settlements. The high water storage capacity of the aquifer gives it a low drought vulnerability, making it potentially a key source provided the water quality can be protected. It is in a high rainfall area so rainwater harvesting for non-potable uses and gardens and water sensitive design, including artificial recharge, can be used to minimise water requirements from the WCWSS.

Considerable investment is currently going into expanding the use of desalination, recycling and groundwater to ensure water security during the current drought and for future supply. There are many opportunities and much more that could be done if Cape Town rises to the challenge of becoming a truly water-wise city in a Strategic Water Source Area.

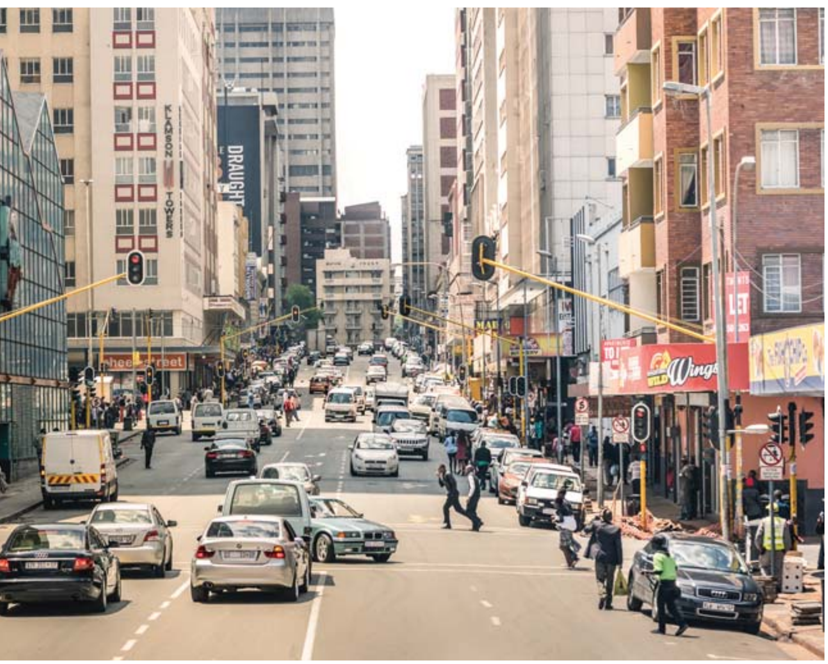
The WCWSS also supplies irrigation water to the Boland and to parts of the Breede River catchment. Unlike the city, farmers are not in a position to supplement their water supplies by desalination, and they are in direct competition with the city for water. And water allocation priorities will place people before crops during droughts. However, when agriculture experiences water shortages, the ripples affect the entire economy. Many of the irrigation schemes depend on run of river flows, on farm dams and on groundwater use. And all these water sources are directly affected by the ecological state of the SWSA catchments, much of wich has been invaded by pines and wattles. The alien plant invaded land is partially government and partially privately owned, with most of the SWSAs being privately owned. Clearing these invasions would be of direct benefit to the farmers as well as the City. So it would make sense for both government and the private sector to form a partnership to ensure that the invaded areas are restored to fynbos as soon as possible.


GAUTENG AND THE DRAKENSBERG – A DISTANT BUT CRITICAL CONNECTION



The Vaal WSS (right) and the Crocodile WSS (left).

The Vaal River.



Gauteng is the country's most populous province.

Gauteng province is the home of the largest urban and industrial complex in South Africa, but it is not well-endowed with water. The 2013 study which found that 8% of the land provides 50% of the surface water only identified a small portion of the Upper Wilge River as an SWSA in the Vaal River catchment. Huge investments have been made in the Vaal water supply system and the linked Crocodile West water supply system to overcome this natural deficiency. These water-supply systems also provide water to a number of other towns, power stations and irrigation schemes, but are too detailed to describe here. The Gauteng City Region, which includes Johannesburg, Pretoria, East and West Rand had a population of about 13.19 million (25.5% of the population) and a GVA of R587 billion (36.1%) in 2011. The other urban regions which the Vaal water-supply system supports through releases into the Vaal River below the dam or by transfers in or out of the Vaal, bringing the total to **more than 30% of the population and 41% of the GVA of the country**. Additional water transfers from the Tugela and Usutu Rivers into the Vaal River system also supply power stations in this catchment and in the Olifants River catchment, and a transfer via Crocodile-West WSS will also supply water to the Medupi Power Station. So water from these SWSAs is vital for the generation of power for the country.

Areas served by the Vaal River WSS

Urban region	Population (2011 millions)	GVA (2011, billion)
Gauteng City	13.19	586.5
Rustenburg	0.49	24.2
Potchefstroom-Klerksdorp	0.51	14.1
Welkom-Kroonstad	0.44	11.6
Kimberley	0.23	6.9
Bethlehem-Harrismith-Phuthadithjaba	0.40	7.5
Witbank-Secunda	0.53	20.8

Gold and water

The early settlers and gold miners of Johannesburg found sufficient water in the springs and rivers, which flowed from the Witwatersrand. By 1905, this was supplemented with groundwater from the Far West Karst Belt SWSA at Zuurbekom. Demand induced by rapid expansion of the population, mining and industry led to the addition of the Vaal Barrage in 1923 and Vaal Dam in 1948. Growing demand led to the construction of a major transfer scheme from the Tugela in the Northern Drakensberg SWSA in 1974 to supplement supplies in the Vaal WSS. The final major supplement was in 1998 with transfers from the Maloti and Northern Drakensberg SWSAs from dams in northern Lesotho.

Pretoria also started with groundwater from the Fountains and other springs and streams flowing from the Eastern Karst Belt SWSA. These sources sustained the city until 1935 and still provide a proportion of its water. The Rietvlei Dam on the Hennops River, whose sources are springs in the Eastern Karst Belt SWSA, was completed in 1934. In the 1940s Pretoria was linked to the Vaal via a transfer from Rand Water who supplied Johannesburg. The wells at Zuurbekom and the Vaal Barrage are no longer used because of water quality problems. The Fountains and other springs in Pretoria still supply very high quality water because the source areas have been effectively protected, unlike Johannesburg's!

The Vaal WSS is linked to five SWSA-sw via complicated water transfer schemes, mainly involving the Drakensberg. Between them they produce 14% of the national MAR, with most of this coming from the Maloti and Northern Drakensberg (which has the second highest MAR per ha nationally). The Upper Vaal itself produces only a relatively low MAR, but the Northern

Most of South Africa's power stations are provided with water from the Vaal River system.

The Sterkfontein and Driekloof dams form part of the water transfer system that transfers water from the Tugela to the Vaal River.

Drakensberg feeds the Wilge River and thus the Vaal Dam. The moderate rainfall on the Highveld gives the Karst aquifers a relatively low recharge but they have a high storage capacity, making them a valuable water source.

Polluted water flowing from closed mining operations is a significant challenge to Gauteng's water services.

Name	Protected (%)	Total area (ha)
Enkangala Grassland	8.4	858 216
Northern Drakensberg	7.93	1 030 156
Maloti Drakensberg (RSA)	35.63	10 851
Upper Usutu	0.53	619 058
Upper Vaal	0.00	140 053
Eastern Karst Belt	3.48	198 390
Far West Karst Region	5.82	138 207
Westrand Karst Belt	26.37	108 994

Most of the water for Vaal WSS is supplied by the Vaal River itself, transfers from the Maloti Drakensberg (34.4%) and the Northern Drakensberg SWSA (18.9%). **The SWSA-sw linked to the Vaal WSS supplies about 71% of the water.** A large proportion of the Vaal WSS water is then transferred to the Crocodile West WSS to supply northern Johannesburg, Midrand, Pretoria and Rustenburg. The transferred water (68.9% of the total) is combined with water from the Crocodile WSS to meet domestic (including commercial) requirements (64.4%), bulk industry mining and power (10.8%) and irrigated agriculture (24.8%). The Eastern Karst Belt SWSA directly supplies 3%, including the Pretoria Fountains, but most of the rivers around Pretoria begin as springs connected to this aquifer, and dams on these rivers yield 20.8% of the supply. About 50% of the Crocodile WSS water is from SWSAs.

Name	MAR (million m^3)	Percent of national MAR	Area (ha)
Enkangala Drakensberg	1 412	2.85	858 216
Maloti Drakensberg	2 232	4.51	1 200 344
Northern Drakensberg	2 448	4.94	1 030 156
Upper Usutu	722	1.46	619 058
Upper Vaal	122	0.25	140 053
Name	**Recharge (million m^3/year)**	**National recharge (%)**	**Area (ha)**
Eastern Karst Belt	1984	0.3%	198 390
Far West Karst Region	1382	0.2%	138 207
Westrand Karst Belt	1090	0.2%	108 994

Groundwater use by agriculture and industry from the Eastern Kart Belt, Far West Karst Region and Westrand Karst Belt SWSAs is about 120 million m^3/year (66% for agriculture) and the GVA about R338 billion in 2011. This emphasises the value of this high quality water source and of adequately protecting it!

How well are the SWSAs protected?

The Vaal River system includes portions of the Northern Drakensberg, Enkangala Grassland, Upper Usutu and the Upper Vaal SWSA-sw and a set of karst SWSA-gw in Gauteng, two of which cross the watershed into the Crocodile West catchment. The Upper Vaal has no protected areas at all, the best protected is the Westrand Karst Belt (Cradle of Humankind) followed by the Enkangala Grassland and the Northern Drakensberg. Almost all the Maloti Drakensberg is located in Lesotho, so the protected area in South Africa is based on a less than 10% of the total area of this SWSA. Fortunately the northern montane area of Lesotho is not suited to intensive land uses but degradation of the grasslands may affect water quality.

What are the impacts of human activities?

All three of the Drakensberg escarpment SWSAs are still largely under natural vegetation, with extensive forest plantations and cultivated lands in the Enkangala and cultivated grasslands in the Northern Drakensberg. These grasslands are used as natural rangelands and have become degraded in many areas due to overgrazing and frequent fires. Degradation is particularly extensive in the upper Tugela River catchment in the Northern Drakensberg. Both Enkangala and Northern Drakensberg SWSAs have extensive, dense rural settlements, often associated with severe vegetation degradation and erosion.

Close to 40% of the Upper Usutu grassland has been converted to commercial forestry plantations which do reduce river flows, but are regulated to limit their water-use provided the afforestation permit conditions are complied with. Dryland cultivation is the main activity in the Upper Vaal with the natural grasslands being intensively used as rangelands. All these SWSAs except the Maloti have overlaps with coal fields that are currently being mined, with most of the Upper Vaal overlapping with coalfields. Alien plant invasions do reduce runoff in the SWSAs with the greatest reductions being in the Enkangala (4.3% and Maloti Drakensberg (9.6%). The reductions in the Maloti Drakensberg are mainly in western Lesotho and affect flows in the Caledon River and Senqu River rather than the ones that supply the Lesotho Highlands transfers. They do, however, affect water supplies downstream, including those to Bloemfontein.

The impact of human activities on Gauteng's SWSAS-sw

SWSA-sw	Water-bodies	Wetlands	Natural	Cultivated (dryland)	Cultivated (irrigated)	Plantation / woodlot	Mining	Urban	Coal field overlap (%)	MAR reduction (%)
Enkangala Drakensberg (RSA)	0.32	2.44	73.80	9.05	0.49	12.30	0.01	1.57	42.13	4.31
Maloti Drakensberg (RSA)	0.00	0.47	97.24	2.21	0.00	0.08	0.00	0.00	0.00	9.64
Northern Drakensberg (RSA)	0.82	1.50	80.96	9.31	1.31	2.34	0.03	3.72	8.6	1.57
Upper Usutu	1.20	5.59	44.82	7.27	0.33	38.35	0.13	2.32	20.38	3.04
Upper Vaal	0.21	3.83	62.85	30.85	0.06	0.40	0.04	1.75	85.49	2.21

Human activities potentially have much greater impacts on the Karst SWSAs as they have a medium to high vulnerability to surface pollution: Eastern Karst Belt 31% moderate, 27% high; Far West Karst Region 50% and 44% and Westrand Karst Belt 43% and 33% respectively. All three have extensive dryland cultivation and some irrigated crop production. Urban and industrial development are particularly extensive in the Eastern Karst Belt, but also cover relatively high proportions of the other Karst SWSAs. Mining occupies a relatively small proportion of the landscape but has disproportionate impacts on water quality, especially shallow open cast mining which results in acid mine drainage. About 40.5% of the Eastern Karst Belt overlaps with the Witbank coalfields, so unwise expansion of mines in this area could have significant impacts on water quality in this SWSA.

The impact of human activities on Gauteng's SWSAS-gw

SWSA-gw	Water-bodies	Wetlands	Natural	Cultivated (dryland)	Cultivated (irrigated)	Plantation / woodlot	Mining	Urban	Coal field overlap (%)
Eastern Karst Belt	0.56	4.28	39.65	28.66	3.57	2.00	2.00	19.27	40.5
Far West Karst Region	0.33	3.07	69.76	16.18	1.59	1.12	1.52	6.44	0.0
Westrand Karst Belt	0.05	1.67	58.51	29.14	4.85	0.84	0.45	4.50	0.0

All of the SWSAs linked to the Vaal WSS still have extensive areas of wetlands and their protection should be given a high priority.

The Eastern and Westrand Karst Belt aquifers have a low to moderate vulnerability to droughts, but the Far Western Karst Region is moderately vulnerable. All of these SWSAs also overlap, with important mineral provinces, notably gold and uranium. Gauteng has many abandoned mines which have not had effective environmental management. Together with poor management of industrial pollution and dysfunctional water treatment plants, this has had significant impacts on many of the rivers and aquifers previously used as water sources.

The potential for pollution the Karst aquifers with acid mine drainage (AMD) from abandoned gold and other mines has been known for decades. There have been many years of evasion of responsibilities and failures to act which almost resulted in a major environmental and human health disaster.

The Eastern Karst Belt and Far West Karst Region have small proportions (1 and 19% respectively) under license for shale gas exploration and great care needs to be taken to avoid a repetition of the AMD story.

The Karst rock formations were intruded by dolerites, forming dykes, which divide them into compartments and are often associated with springs where the water table reaches the soil surface. In some cases the role of the dyke is played by contact zones with other hard rock formations. The numerous caves found in the Cradle of Humankind were formed by the dissolution of dolomites. The solubility of dolomites makes them susceptible to the formation of sinkholes where too much groundwater has been used, there is water leakage from pipes or reservoirs or other sources of water that result in dissolution. The risk of sinkhole formation is quite high in these SWSAs and needs to be taken into account when planning developments.

Opportunities provided by SWSAs to increase water security

Unlike Cape Town, Durban and Port Elizabeth, Gauteng has no ocean that it can desalinate. The next phase of the Lesotho Highlands scheme is the last major source of water that can be linked into the Vaal WSS to improve water security. It will take until 2025 or later to complete, but even this will only improve water security for a limited period of time. The 2015/16 drought saw Gauteng come close to running short of water in what was not a severe or even a multi-year drought. Water levels in the dams in Lesotho were reduced to critical levels, and water was released from the Sterkfontein Dam, the Vaal Water Supply System's strategic reserve. Clearly, people's attitude to water and especially water wastage has to change. If necessary, that means stopping the water supply to their taps and compelling them to collect water. We can also begin by teaching children about how precious our water is so they can become water activists. Then we need to ensure that we manage the water distribution systems and repair leaking pipes. This includes the big transfer schemes that are vital for water security. One way to do this is to insist that water service providers publish information on how well their water is managed. We also need to drastically reduce pollution of the water we have by being more efficient in cleaning up water and re-using water for non-potable purposes.

Business also needs to play its part because poor water security is a direct risk to them. Sewage is actually a valuable resource, both for the water and the many substances that can be extracted from it and re-used. Biorefinery technologies are developing rapidly and are a business opportunity just waiting to be grasped.

We need to start to thinking about water just like we are learning to think about energy. The rapid expansion of renewable energy and decreasing cost of distributed systems, are forcing us to rethink building large power stations. Solar water heaters have only recently become common in South Africa, despite being used for decades in other countries. There will always be a need for systems with large water storage capacities to improve water security, but we are only beginning to explore and adopt small water systems. The fears and costs can put people off investing in rainwater capture and grey-water systems, or make it affordable only by the rich and well-educated. But it need not be so – we just have to think beyond the tap.

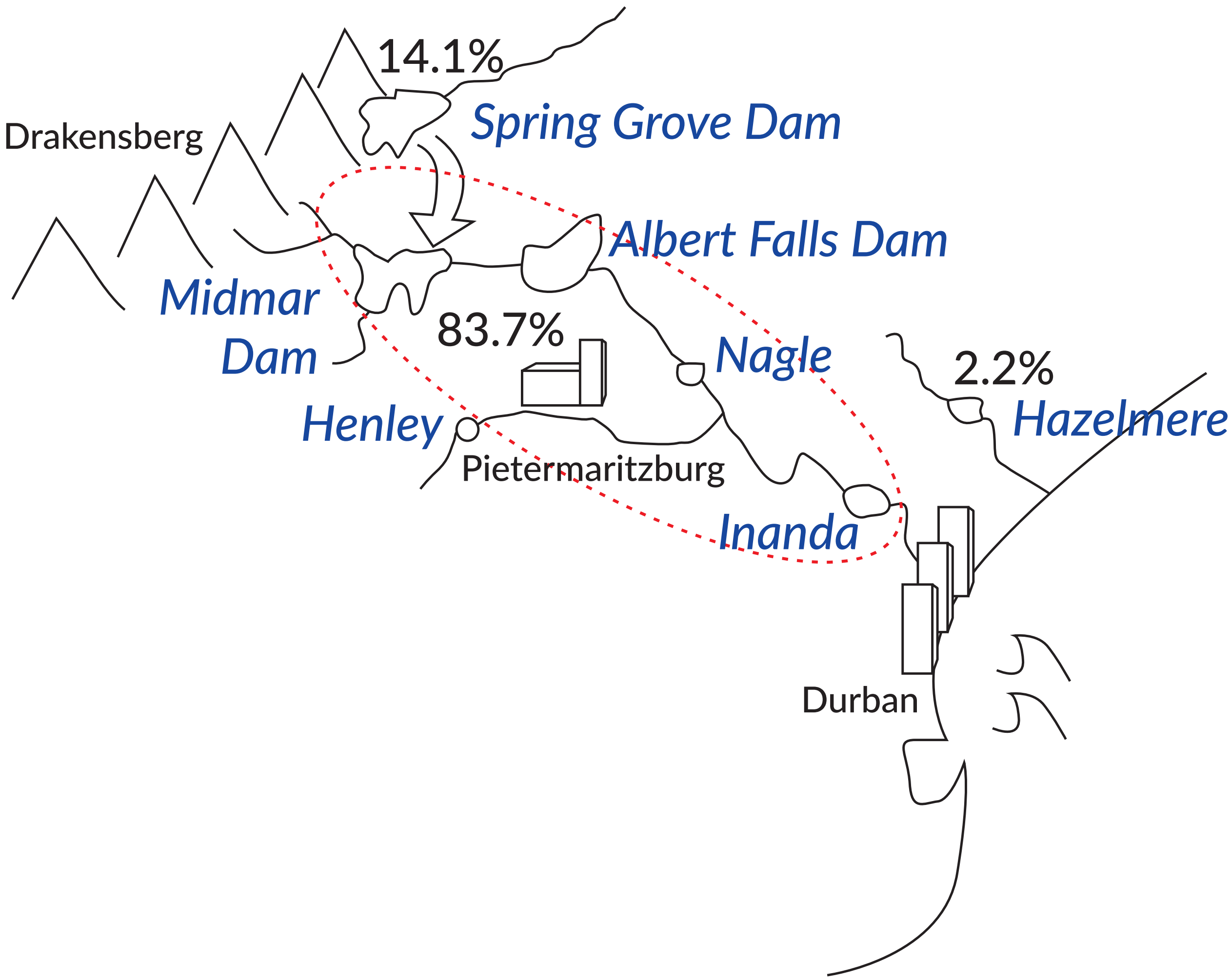
Think and care about what comes before the tap and after the tap.

TCTA

A complicated series of water transfer schemes brings water to Gauteng from as far as Lesotho.

For nearly a century Pretoria's Fountains were the city's only supply of freshwater.

DURBAN-PIETERMARITZBURG - A CLOSE CONNECTION AND A ROLE FOR ECOLOGICAL INFRASTRUCTURE



KwaZulu-Natal Coastal Metropolitan Area water supply.

The SWSAs serving the Durban-Pietermaritzburg area

Name	MAR (million m^3)	Percent of national MAR	MAR (m^3 per ha)	Area (ha)
Southern Drakensberg	4 317	8.72	2135	2 022 513
Name	Recharge (million m^3/ year)	National recharge (%)	Area (ha)	
Ixopo / Kokstad	7150	2.3%	714 956	

The KwaZulu-Natal Coastal Metropolitan Area water-supply system supplies the city of Pietermaritzburg and the Durban Metropole (eThekwini). In 2011, this regional economic centre had a population of 4.37 million people (8.4% of the total population), mainly in eThekwini, and generated a GVA of R174 billion (10.7% of the national GVA). In contrast to Gauteng, this is a relatively well-watered part of South Africa. The surface water is supplied by the Southern Drakensberg SWSA, which is sustained by groundwater discharges from the Ixopo / Kokstad SWSA (15% of the MAR). The Southern Drakensberg SWSA-sw provides more water than any other SWSA – equivalent to 8.7% of the surface water in South Africa, Lesotho and Swaziland. The Ixopo / Kokstad SWSA has greatest volume of recharge of all the groundwater SWSAs.

Most of the water for Pietermaritzburg and eThekwini comes from dams on the Umgeni River system, supplemented by water from Spring Grove Dam in the Tugela catchment and Hazelmere Dam on the Mdloti River. In total, 97.8% of their water comes from the Southern Drakensberg SWSA-sw, with the balance from the Zululand Coast sub-national WSA-sw. The Southern Drakensberg SWSA overlaps with the northern region of the Ixopo / Kokstad SWSA which is an important source of groundwater for many rural settlements and some towns (e.g. Bulwer, Carisbrooke, Richmond) in this region. About 0.46 million m^3/year of groundwater is extracted for agricultural and industrial use and generates a GVA of R2.88 million.

The port city of Durban.

The Howick Falls on the Umgeni River near Pietermaritzburg.

DWS

Midmar Dam is one of the main dams supplying water to the Pietermaritzburg-Durban area.

How well are the SWSAs protected?

Only 11.8% of the Southern Drakensberg and the overlap with the Ixopo / Kokstad SWSA fall in protected areas.

What are the impacts of human activities?

Fortunately, most of these two SWSAs is still under natural vegetation, with mainly montane grasslands in the upper parts of the catchments. The Midlands are heavily developed though, and this is where most of the commercial forest plantations and cultivated lands are located. There are extensive urban areas, mainly dense rural settlements, as both the major urban centres sustained by water from these SWSAs fall outside the boundaries of the SWSAs. The headwaters of the uMgeni catchment, which is the source of most of the water, is grassland but land degradation is increasing sediment loss into the dams in this catchment and also altering water yields. Pollution from dense rural settlements is also having significant impacts on water quality. Alien plant invasions are estimated to reduce the MAR in the Southern Drakensberg by 87.78 million m^3/year or 2.32%. This is almost certainly an underestimate given the extensive riparian invasions by wattles which have a very high water use.

The Ixopo / Kokstad SWSA does overlap with the aluminium and nickel mineral fields, but these are not being mined at present. About 9% of this SWSA falls within a shale gas exploration permit area. The vulnerability of the aquifers in this SWSA is low to moderate, while the drought risk is moderate to low, making them a reliable water supply.

The impact of human activities on the SWAs serving Durban-Pietermaritzburg

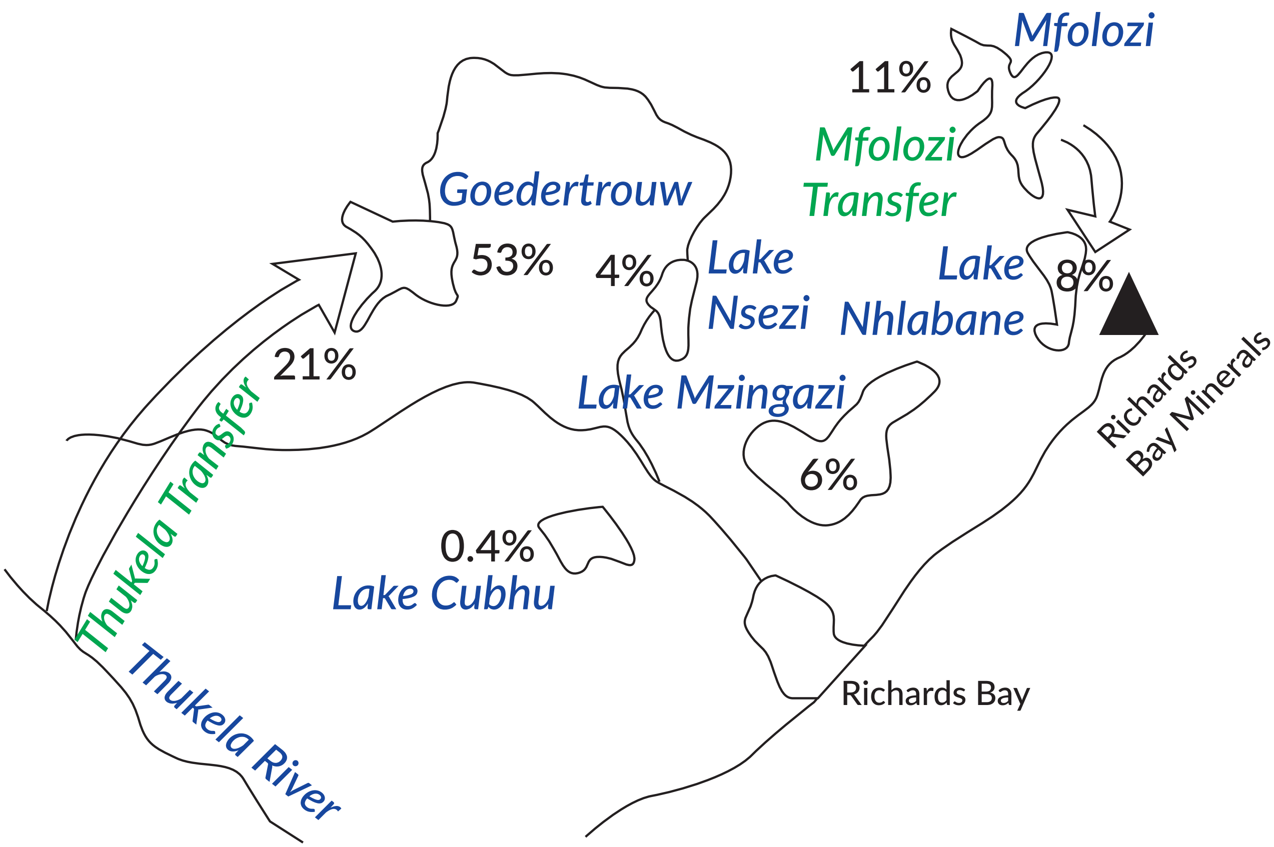
SWSA	Water-bodies	Wetlands	Natural	Cultivated (dryland)	Cultivated (irrigated)	Plantation / woodlot	Mining	Urban
Southern Drakensberg	0.49	2.45	60.97	12.03	2.14	15.67	0.00	6.24
Ixopo / Kokstad	0.26	2.37	57.62	13.07	1.33	18.42	0.00	6.94

Opportunities provided by SWSAs to increase water security

Although the Southern Drakensberg and Ixopo / Kokstad SWSA are relatively well-watered, water availability is affected by periodic and extended droughts. The current demand for water in the uMgeni catchment (406 million m^3/year) exceeds the available yield (381 million m^3/year), which is why water is transferred in from the Mooi River and an expansion of this transfer is underway. Some 22% of the water is allocated to the ecological reserve to maintain the river ecosystems and their ability to protect water flows and quality. Commercial plantations are estimated to use 11% and irrigated agriculture 8% so, together with at least 2% for invasions, this comes to another 20%. Although water security is a growing issue in the Umgeni catchment, there is still water available from the Mooi and from other river systems in the Southern Drakensberg SWSA. A more pressing and significant issue in this catchment is water quality, particularly sediments from degraded grasslands, unwise agricultural practices, dense rural settlements, and runoff pollution from the rural settlements and informal urban areas. In the uMgeni River, a key source of pollution is the rural settlements in the uMnsunduze (Duzi) catchment and the same applies to other catchments in this SWSA.

This is where restoration of ecological infrastructure makes a lot of sense, whether it involves restoring grassland or implementing water-sensitive design principles in dense settlements and more formal urban and industrial settings. A healthy grassland is associated with healthy soils: good grass canopy and basal cover reduces raindrop impact and channels water to the soil surface where it can infiltrate, replenish soil water storage and recharge groundwater. The groundwater is then released over time, sustaining springs and streams in the dry season. Rainwater tanks and urban drainage structures designed to slow and direct rainwater to cultivated allotments can meet food security needs while reducing flooding. Water-wise land management practices can also reduce soil erosion and the expansion of dongas that threaten houses and lives. Polluted runoff can be channelled to wetlands after passing through solid waste traps. The wetland plants, in turn, can be harvested and used for various domestic purposes. Restored rivers can play a key role in improving water quality for everyone living downstream.

RICHARDS BAY - ROLE OF A COASTAL AQUIFER



The Richards Bay water supply scheme.

Richards Bay began as a large lagoon at the mouth of the Mhlatuze River which provided a natural harbour. It is in a relatively high rainfall area and situated on a relatively flat coastal sand plain. The vegetation was a mixture of forest, woodland and grassland, including swamp forest and mangroves, and characterised by a number of lakes and wetlands which are sustained by groundwater. It remained a small harbour town until it was developed as a deep water port in the 1970s, mainly for coal exports. The exports have expanded to include fertiliser, iron ore, titanium and other heavy minerals, granite, ferrochrome, paper pulp, woodchips and phosphoric acid, as well as aluminium. Richards Bay is a fast-developing city. In 2011, the population of the town and its surrounds was about 0.44 million people and the GVA about R14.2 billion. Bulk industry uses about 96% of all the water that is supplied. About 0.49 million m^3/year of groundwater is used by agriculture and generates a GVA of R10.4 million.

Richards Bay gets its water from coastal lakes and a water transfer scheme. The lakes, Lake Nsezi, Lake Chuba and Lake Msingazi, are characterised by strong groundwater surface water interactions, with about 6% of the yield of the lakes being derived from that groundwater. The lakes are situated within the Richard's Bay groundwater-fed Lakes SWSA. Water from the Mfolozi is transferred to Lake Nhlabane and provided to Richards Bay Minerals. Some of this water comes from the Mfolozi Headwaters SWSA. Although the Mfolozi Headwaters SWSA is small and comprises eight sections, it will clearly be important to protect this water source area for the water security of Richards Bay, Empangeni and other settlements.

There is an additional transfer from the Thukela River into Goedertrouw Dam from a weir about 100 km from the river mouth. If river flows are low then dam releases from Spioenkop Dam in the Upper Tugela can be used to make up the shortfall. The water in the Tugela comes mainly from Northern Drakensberg, but also from the Southern Drakensberg SWSA.

The Richards Bay SWSAs

Name	MAR (million m^3)	Percent of national MAR	MAR (m^3 per ha)	Area (ha)
Mfolozi Headwaters	277	0.56	1438	192 500
Name	Recharge (million m^3/a)	National recharge (%)	Area (ha)	
Richards Bay GW Fed Lakes	606	0.3%	60 574	

(For details of the Northern and Southern Drakensberg SWSAs see Durban-Pietermaritzburg.)

Despite all these schemes, Richards Bay experienced water shortages and had to severely restrict water supplies in 2016 after experiencing drought conditions from 2014 onwards. An important contributing factor was the low levels in the Goedertrouw Dam, which could not be adequately met using the Thukela transfer. A desalination plant was commissioned in 2017, but its importance was diminished by high rainfall in 2017. Provided the plant is properly maintained, desalinated water will be important for ensuring water security during future droughts.

How well are the SWSAs protected?

Only 1 039 ha (1.7%) of the Richards Bay Groundwater Fed Lakes is within the protected Richards Bay Nature Reserve which protects a portion of the Mhlatuze estuary. Only about 7.1% of the Mfolozi Headwaters is protected.

What are the impacts of human activities?

At 23%, the Richards Bay Groundwater Fed Lakes SWSA has the lowest proportion of natural vegetation of the SWSAs. It also has a high percentage under plantations (41%) and formal residential and industrial areas (17%), as well as a substantial proportion under irrigated sugarcane (11%). The extensive plantations are mainly eucalypts, which is a concern as it is likely that the trees are able to access groundwater and are lowering the water table in the planted area. The lowering of the water table, in turn, could reduce inflows into the lakes, especially during droughts. This SWSA is characterised by a very high (67%) and high vulnerability (15%) which, makes it very susceptible to pollution from industrial and urban sources. The low drought vulnerability makes this aquifer a valuable water source during droughts. Much of this SWSA overlaps with important mineral sand deposits, and the mining of these sands can alter the water holding capacity. About 33% of the area falls within a shale gas exploration permit, and care will be needed to ensure that the aquifer in the overlying sands are adequately protected from pollution.

The Mfolozi Headwaters SWSA is mainly under natural vegetation, but there are extensive areas under commercial forest plantations, cultivation and dense rural settlements. About 18.7% of this SWSA overlaps with the Nongoma and Somkele (3.7%) and Vryheid (15.0) coal fields, both of which are being mined already. Invasive alien plants are reducing the MAR from this SWSA by about 2.7% (4.4 million m^3/year). The Mfolozi catchment has extensive invasions and water production could be increased by about 19.3 million m^3/year by clearing these invasions.

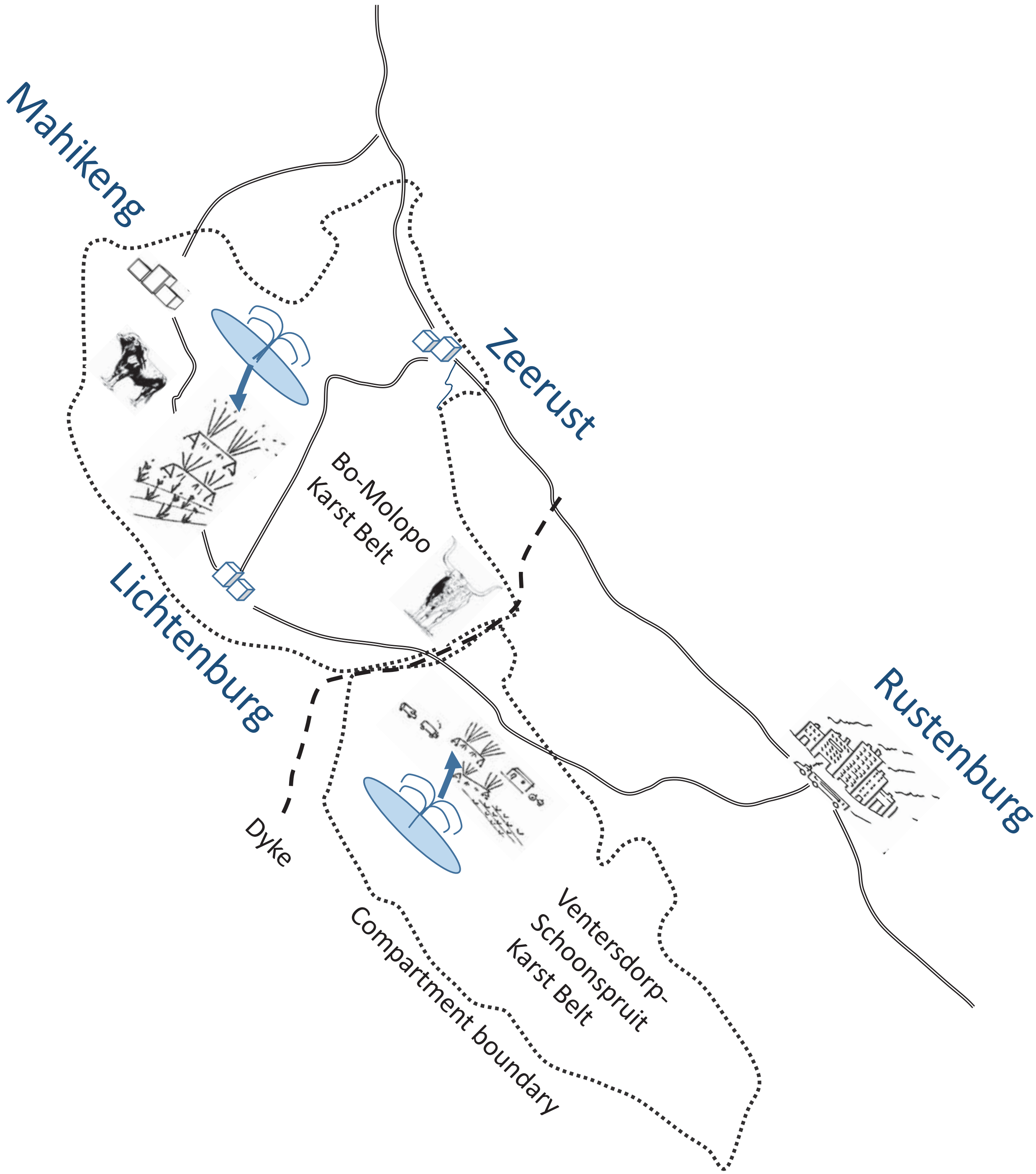
Human impacts on the Richard Bay SWSAs

Name	Water-bodies	Wetlands	Natural	Cultivated (dryland)	Cultivated (irrigated)	Plantation / woodlot	Mining	Urban
Richards Bay groundwater-fed estuary	4.60	1.31	23.06	1.44	11.38	40.66	0.29	17.27
Mfolozi Headwaters	0.04	0.36	67.34	8.14	0.47	17.58	0.02	6.05

Opportunities provided by SWSAs to increase water security

The water supply for Richard's Bay historically depended on the Mhlatuze River as well as water from the lakes in the Richards Bay Groundwater Fed Lakes SWSA. About a third of the water now comes from the Tugela and Mfolozi Rivers. Nevertheless, the deep, sandy formations that store the groundwater that feeds the lakes remain an important water source. The recent drought demonstrated the importance of managing this water source properly to ensure that its low drought vulnerability is used to maintain water security. This SWSA is very vulnerable to surface pollution so managing water discharges from industry, stormwater and wastewater works is crucial so that these pollution sources do not contaminate this important water source. Richards Bay could also learn from Atlantis, where the aquifer is recharged with treated stormwater and wastewater in a way that maximises the protection of the wellfield from pollution and also reduces the potential for seawater intrusion. The impacts of the extensive commercial forest plantations on the aquifer also need to be assessed to see how much groundwater is being used. Selective clearing of the plantations and restoration of grasslands significantly increase recharge and improve water security and would be much less costly than desalination.

BO-MOLOPO AND VENTERSDORP/ SCHOONSPRUIT - AN IMPORTANT DOLOMITIC AQUIFER


Mahikeng
Zeerust
Bo-Molopo
Karst Belt
Lichtenburg
Rustenburg
Dyke
Compartment boundary
Ventersdorp-
Schoonspruit
Karst Belt

The Bo-Molopo and Ventersdorp/Schoonspruit karst (or dolomitic) SWSAs are located in North West Province. This is a relatively sparsely populated area except for Mafikeng, which had a population of about 259 279 in 2001 and a GVA of R7.29 billion. About 71% of the town's water comes from Grootfontein – a spring in the Molopo / Grootfontein Compartment of the Bo-Molopo SWSA. The total population supported in Mafikeng and rural settlements within the Bo-Molopo is about 325 127 people and the Ventersdorp/Schoonspruit supplies Grootpan Water Supply Scheme, which in turn, supplies about 1 669 people.

This is an arid area which generally receives less than 500 mm and in some parts less than 400 mm of rainfall per year and is subject to extended droughts. However, karst aquifers potentially have a high recharge because the soils are coarse and porous, allowing much of the rainwater to reach and recharge the groundwater. The karst (dolomitic) formations are fairly easily dissolved in water, forming a series of connected underground cavities which can store and transmit a lot of water. The dolomites are intruded by dolerites, forming dykes, which divide them into compartments. Compartments can also be formed by contacts with other hard rock formations. The compartment boundaries are often associated with springs where the water table reaches the soil surface. There are no records of damaging sinkholes in these Karst SWSAs, but it is a risk that needs to be taken into account in planning.

The Karst aquifers are the sources of many springs which form the sources or sustain the rivers that flow from or through these SWSAs. Many of the rivers in this area have their origins in the SWSAs. The baseflow contribution to these rivers is about 5% for the Bo-Molopo and about 16% for the Ventersdorp/ Schoonspruit SWSA.

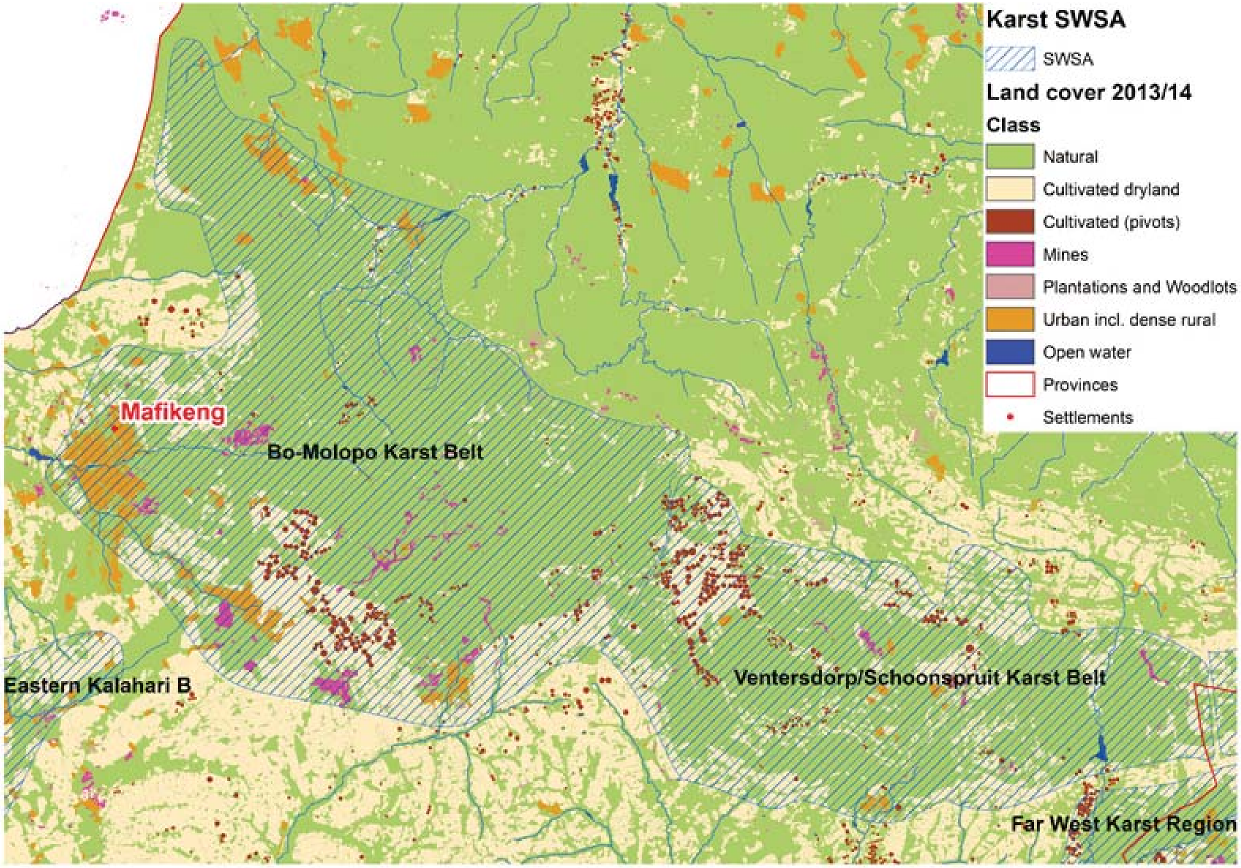
Details of the SWSAs

Name	Recharge (million m^3/a)	National recharge (%)	Area (ha)
Ventersdorp/Schoonspruit Karst Belt	2875	0.3%	287 508
Bo-Molopo Karst Belt	5268	0.4%	526 763

Main water use applications in the SWSAs

Name	Agricultural groundwater (GW) use (WARMS, million m^3/year)	Industrial GW Use (WARMS, million m^3/year)	Agricultural GW use as a % total water use	Industrial GW use as a % total water use	Agricultural GW contribution to GVA (R millions)
Bo-Molopo Karst Belt	57.46	6.08	96	43	165.54
Ventersdorp/Schoon-spruit Karst Belt	54.30	1.15	97	98	98.57

Groundwater is important for both agriculture and industry, with more than 100 million m^3/year being used by agriculture, primarily for vegetables and other annual crop production and large volumes used by industry, including mining and also for bottled water. The GVA generated from groundwater by agriculture totals more than R264 million each year, and is very important for the local economy.



The Bo-Molopo and Ventersdorp/Schoonspruit Karst Belt SWSAs in Northwest Province showing the land cover in 2013/14.

How well are the SWSAs protected?

There are few protected areas in these two SWSAs. In the Bo Molopo the protected areas amount to 18 511 ha (2.5%) and 14 163 ha (4.9%) in the Ventersdorp/Schoonspruit Karst Belt.One of these reserves specifically protects the source of the Malmanieloop and two fall in the Schoonspruit catchment.

What are the impacts of human activities?

A high proportion of both the SWSAs is still under natural vegetation, with dryland cultivation (mainly maize) being the main land-use practice after extensive rangeland grazing by livestock (cattle, sheep). Wetlands represent a small proportion of the landscape but are ecologically important. Although irrigated agriculture only makes up a small proportion of the land, most of the irrigated agriculture is intensive, with short-term crops such as tobacco and sunflowers. Urban areas, including dense rural settlement and mining, are more important in the Bo-Molopo where Mafikeng is situated.

Impact of human activities on the SWSAs

Name	Water-bodies	Wetlands	Natural	Cultivated (dryland)	Cultivated (irrigated)	Plantation / woodlot	Mining	Urban
Bo-Molopo Karst Belt	0.05	0.18	75.60	16.65	1.56	0.16	1.31	4.50
Ventersdorp/ Schoonspruit Karst Belt	0.08	0.50	69.62	25.15	3.49	0.17	0.35	0.65

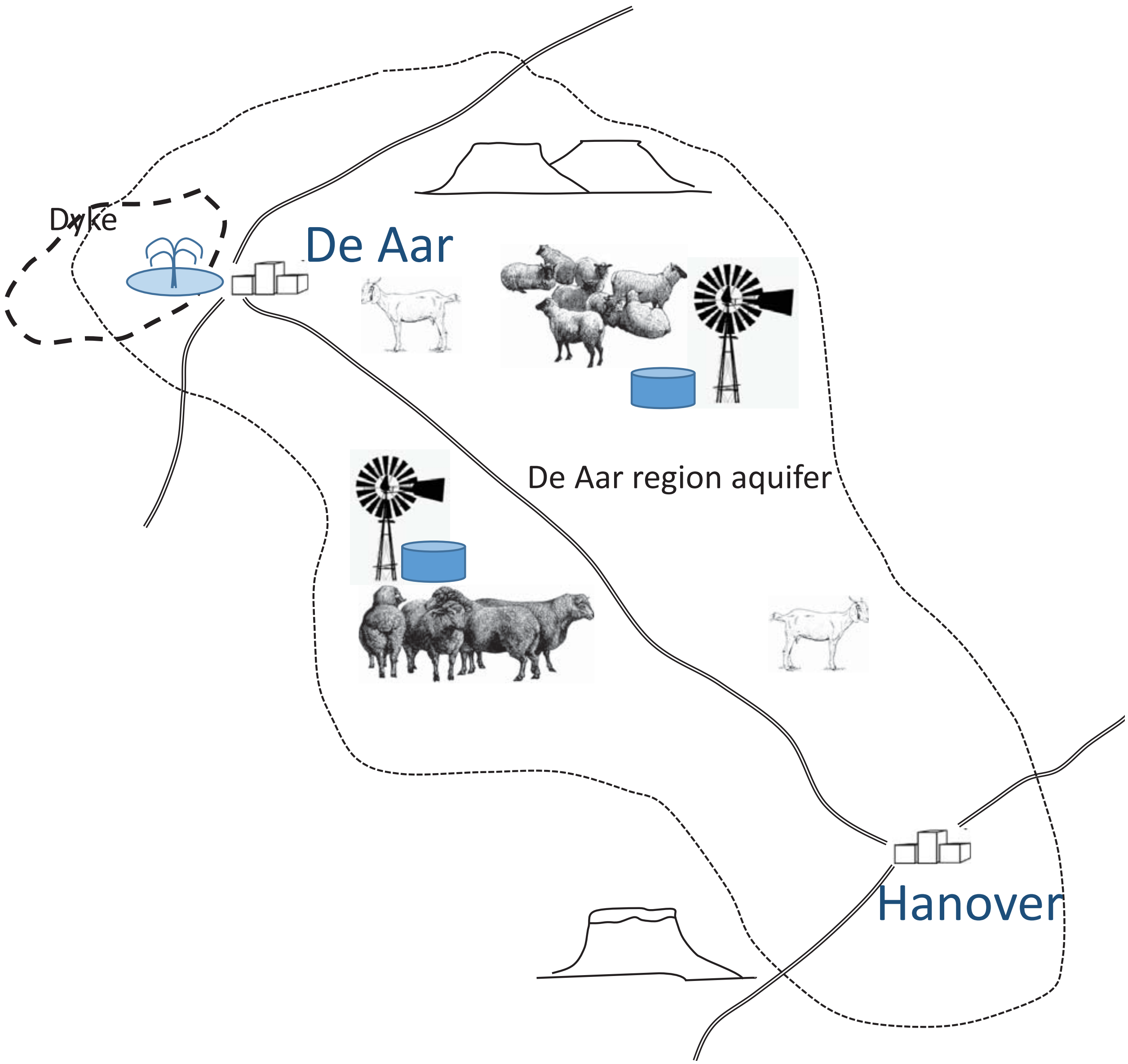
The main mineral provinces represented in these SWSAs are diamonds, andalusite, manganese, lead and limestone, with the Ventersdorp/Schoonspruit SWSA including a portion of the gold-bearing Witwatersrand Basin.

More than 60% of both of these Karst Belt SWSAs is rated as having a high vulnerability to surface pollution and a further 14% of the Bo-Molopo and 27% of the Ventersdorp/Schoonspruit are rated as moderate vulnerability. No areas were rated as having very high vulnerability. About 82% of the Bo-Molopo is rated as having a low to moderate drought vulnerability and the balance is moderate, compared with 97% and 3% respectively for the Ventersdorp/Schoonspruit SWSA.

Opportunities provided by SWSAs to increase water security

The primary focus of efforts to protect these SWSAs should be on water quality management to avoid or minimise pollution of these key water sources in this arid region by mining, agriculture and industry, as well as by wastewater from urban areas. A high proportion of the population, especially in rural areas, is still dependent on the pit toilet system, which could lead to pollution of the groundwater. Addressing this issue should be given a high priority given the dependence on groundwater in rural water supply systems. The use of rangelands for grazing or game farming should not affect water quality provided appropriate stocking rates are maintained. Bush encroachment could increase transpiration losses and reduce recharge, and is a problem in parts of North West Province. Its importance and impacts in this area need to be assessed. The provincial government believes that intensification of rural agriculture for food security and establishment of cattle feedlots are important opportunities for growing the agricultural sector. The potential impacts of these activities on the SWSAs, especially on water quality, must be adequately assessed and managed to ensure that the high quality of the water from these SWSAs is not compromised. The low drought vulnerability of the Bo-Molopo is important for water security of Mafikeng and the dense rural settlements, so the groundwater needs to be properly managed to ensure that this benefit is safeguarded.

DE AAR REGION – A KAROO AQUIFER


Dyke
De Aar
De Aar region aquifer
Hanover

The De Aar Region SWSA is situated in the Great Karoo, and covers a broad region from De Aar towards Hanover. The area has a hot climate, with daily maximum temperatures in summer reaching 32°C (extreme 40°C) and cold winters, with minimums of around 1°C (extreme -8°C) and a mean annual rainfall of about 196 mm, falling mainly in summer. The name De Aar (the artery,) refers to the springs where the first farms, and later, the town, were established. The main railway from Cape Town to the north passes through De Aar so it became an important railway junction for lines to the east as well. Although the importance of the railways has declined, the town remains an important regional commercial centre for agriculture despite being off the N1. The original springs sustained the town for a few years, but were later supplemented with groundwater from Burgerville about 34 km away. Additional boreholes were added later to keep the town supplied with water.

In 2011, the population of De Aar comprised about 26 445 people and Hanover about 3 812. Agriculture and industry use about 0.76 million m^3/year of groundwater, mainly for cattle and sheep, and generated a GVA of about R20.16 million in 2011.

The De Aar Region SWSA is situated in the Karoo and the geology is characterised by the fine sediments of the Karoo Group which were intruded by dolerites which formed dykes (more or less vertical) and sills (more or less horizontal). In some cases the dykes form more or less complete circles. The dolerites are more resistant to erosion than the fine sediments so the outcrops form ridges or lines of low hills and also the typical flat-topped Karoo koppies.

The fine-grained Karoo sediments hold very little water, but they have been fractured. These fractures can hold and transmit relatively large quantities of water. The dolerite intrusions heated and broke up the sedimentary layers, leading to increased weathering of the rocks at the contact. The weathering increased the groundwater storage capacity and transmissivity in these contacts. The dykes are impermeable and act like dams for the groundwater. This is why they are often associated with springs where groundwater flows reach the surface. This makes them important water sources in this area. The SWSA gets an annual recharge of about 2 475 million m^3/year, which equates to about 10 mm.

The De Aar SWSA

Name	Recharge (million m^3/year)	National recharge (%)	Area (ha)
De Aar Region	2 475	0.1%	247 462

How well is this SWSA protected?

Only about 0.13% of this SWSA is in a protected area. Such low levels of protection are typical of the Nama Karoo where only 1.7% is in protected areas.

What are the impacts of human activities?

The land cover in the SWSA is essentially all natural vegetation, Northern Upper Karoo shrublands, dominated by low shrubs, grasses and succulents on the plains and taller shrubs on the dolerite outcrops. Taller woody vegetation, includes thorny tree species (e.g. ***Senegalia*** (*Acacia*) ***mellifera*** subsp. ***detinens***) and ***Searsia*** (*Rhus*) which occurs along the water courses and in floodplains. Much of the natural vegetation has been degraded following a long history of overgrazing. The impacts of this on recharge are not known, but the overgrazing has led to extensive sheet and rill erosion, soil loss and sedimentation of rivers and farm dams. The invasive alien tree species Mesquite (*Prosopis* species) was introduced to the area more than 100 years ago, and these trees are particularly prevalent on the river floodplains. They can have substantial impacts on groundwater resources in floodplain settings where their roots can access the groundwater, but more investigations are needed to determine if they also affect the source areas and flows from springs. The aquifer is almost all rated as having a moderate (98%) groundwater vulnerability to surface pollution with only 2% of the SWSA having a low vulnerability.

Land use activity in the De Aar SWSA

Name	Water-bodies	Wetlands	Natural	Cultivated (dryland)	Cultivated (irrigated)	Plantation / woodlot	Mining	Urban
De Aar Region	0.04	0.43	98.24	0.28	0.01	0.01	0.18	0.81

Opportunities provided by SWSAs to increase water security

Sustained supplies of groundwater are critical for towns and agriculture in this SWSA. Recharge is low so it is very important to manage rangelands and any relatively high recharge areas or settings (e.g. dyke contact zones) to ensure that recharge is optimised. Recharge zones for the current water sources (e.g. springs, well fields) could be excluded from grazing to allow the vegetation to recover and potentially increase recharge. About 96% of the SWSA is moderately vulnerable to drought, with 4% having high to very high vulnerability to drought. This means that groundwater needs to be carefully managed and used conservatively to maximise drought resilience. The possibility of managing rainwater to optimise groundwater recharge and increase water security is worth assessing. The current projections for rainfall are that the rainfall in the Nama Karoo is likely to decrease. If that proves to be the case, then investments in optimising groundwater recharge, including managed recharge, will be important for maintaining water security.

SUMMARY OF THE KEY STATISTICS FOR THE NATIONAL SWSAS

SURFACE WATER STRATEGIC WATER SOURCE AREAS

Name	MAR (million m³)	Percent of national MAR	MAR (m³ per ha)	Natural	Cultivated
Amatole	333	0.67	1662	75.67	7.27
Boland	2 182	4.41	3588	75.68	19.20
Eastern Cape Drakensberg	2 673	5.4	1671	77.74	12.10
Ekangala Grassland	1 412	2.85	1646	76.56	9.54
Groot Winterhoek	1 002	2.02	1931	87.94	11.63
Kouga	77	0.16	1262	99.90	0.09
Langeberg	343	0.69	1989	79.68	17.19
Maloti Drakensberg	2232	4.51	1859	97.71	2.21
Mbabane Hills	2237	4.52	2234	61.46	4.27
Mfolozi Headwaters	277	0.56	1438	67.74	8.61
Mpumalanga Drakensberg	1 929	3.90	2304	54.64	3.88
Northern Drakensberg	2 448	4.94	2376	83.28	10.62
Outeniqua	580	1.17	1929	73.56	9.20
Southern Drakensberg	4 317	8.72	2135	63.91	14.17
Soutpansberg	532	1.07	2267	65.42	10.16
Swartberg	96	0.19	1239	95.95	4.04
Table Mountain	127	0.26	2730	51.87	2.30
Tsitsikamma	708	1.43	2203	77.22	13.20
Upper Usutu	722	1.46	1166	51.61	7.60
Upper Vaal	122	0.25	872	66.89	30.91
Waterberg	99	0.20	957	92.90	6.95
Wolkberg	506	1.02	1937	70.38	8.21

Plantation / woodlot	Mining	Urban	Formal protection (%)	Conservation Area (%)	Area (km^2)
10.38	0.01	6.68	1.89	0.00	2 001
2.33	0.04	2.73	45.22	0.70	6 083
3.65	0.01	6.5	1.03	0.00	15 997
12.3	0.01	1.57	7.75	0.65	8 582
0.25	0.01	0.18	60.92	0.89	5 191
0.00	0.00	0.00	72.05	4.10	613
2.72	0.01	0.40	47.09	0.03	1 722
0.08	0.00	0.00	0.32	0.00	12 003
32.13	0.05	2.09	4.58	0.11	10 015
17.58	0.02	6.05	7.05	0.00	1 925
39.36	0.09	2.03	8.40	3.71	8 374
2.34	0.03	3.72	7.70	0.23	10 302
14.22	0.01	2.99	30.02	0.37	3 005
15.67	0.00	6.24	11.73	0.08	20 225
8.68	0.02	15.72	1.81	1.09	2 345
0.00	0.00	0.00	64.50	0.00	775
2.09	0.56	43.19	29.34	0.02	465
7.97	0.00	1.60	28.67	0.15	3 213
38.35	0.13	2.32	0.03	0.50	6 191
0.40	0.04	1.75	0.00	0.00	1 401
0.06	0.01	0.07	14.38	2.94	1 033
17.59	0.03	3.78	17.18	0.16	2 614

GROUNDWATER STRATEGIC WATER SOURCE AREAS

Name	Recharge (million m^3/a)	National recharge (%)	Natural	Cultivated	
Bo-Molopo Karst Belt	5268	15.09	75.83	18.21	
Cape Peninsula and Cape Flats	599	1.72	34.71	3.37	
Central Pan Belt	3368	9.65	52.41	38.15	
Coega TMG Aquifer	1682	4.82	88.38	2.43	
Crocodile River Valley	2163	6.20	82.32	15.73	
De Aar Region	2475	7.09	98.71	0.29	
Eastern Kalahari A	2010	5.76	60.28	37.22	
Eastern Kalahari B	2656	7.61	51.23	42.73	
Eastern Karst Belt	1984	5.68	44.49	32.23	
Far West Karst Region	1382	3.96	73.16	17.77	
George and Outeniqua	727	2.08	81.96	7.87	
Giyani	438	1.25	75.10	14.55	
Ixopo / Kokstad	7150	20.48	60.25	14.40	
Kroondal / Marikana	795	2.28	66.66	15.48	
Kroonstad	799	2.29	62.84	31.39	
KwaDukuza	2352	6.74	55.77	22.16	
Letaba Escarpment	2151	6.16	61.36	16.30	
Northern Ghaap Plateau	6274	17.97	97.57	0.25	
Northern Lowveld Escarpment	5168	14.80	85.72	3.37	
Northwestern Cape Ranges	3638	10.42	83.86	15.66	
Nyl and Dorps River Valley	2036	5.83	77.36	18.37	
Overberg Region	2261	6.48	71.71	27.32	
Phalaborwa	433	1.24	85.19	0.89	
Richards Bay GW Fed Estuary	606	1.74	28.97	12.82	
Sandveld	4010	11.49	61.12	38.66	
Sishen / Kathu	4827	13.83	97.28	0.04	
Southern Ghaap Plateau	6542	18.74	98.79	0.08	
Southwestern Cape Ranges	2749	7.87	84.35	12.45	
Soutpansberg	2573	7.37	68.66	9.41	
Transkei Middleveld	5607	16.06	72.34	14.69	
Tulbagh-Ashton Valley	3560	10.20	82.62	15.92	
Upper Sand (Polokwane) Aquifer System	966	2.77	74.66	6.07	

	Plantation / woodlot	Mining	Urban	Formal protection (%)	Conservation area (%)	Area (km²)
	0.16	1.31	4.50	1.87	1.64	5 265
	1.52	0.39	60.01	12.00	0.05	608
	0.48	0.28	8.69	0.56	3.06	3 366
	0.05	0.61	8.53	17.83	0.58	1 681
	0.03	1.26	0.67	0.31	19.36	2 161
	0.01	0.18	0.81	0.13	0.00	2 477
	0.02	0.01	2.47	0.00	0.00	2 012
	0.04	0.28	5.72	0.00	0.00	2 656
	2.00	2.00	19.27	3.48	0.00	1 983
	1.12	1.52	6.44	5.82	0.00	1 381
	9.27	0.00	0.89	31.77	0.00	730
	0.05	0.17	10.13	2.78	0.00	439
	18.42	0.00	6.94	8.70	0.22	7 157
	1.23	5.64	11.01	11.58	0.00	795
	0.95	0.04	4.79	0.00	6.74	799
	2.42	0.00	19.64	0.00	0.00	2 359
	15.78	0.05	6.52	3.08	0.03	2 155
	0.01	0.06	2.11	0.32	0.00	6 277
	7.11	0.09	3.70	18.35	0.67	5 178
	0.23	0.01	0.24	47.84	0.54	3 681
	0.06	0.19	4.01	15.92	7.91	2 036
	0.36	0.03	0.58	11.71	1.97	2 279
	0.06	10.51	3.34	29.97	6.73	434
	40.66	0.29	17.27	1.71	0.00	609
	0.12	0.02	0.08	3.37	0.46	4 066
	0.00	2.36	0.32	0.00	0.00	4 841
	0.00	0.81	0.32	0.12	0.00	6 556
	2.65	0.03	0.51	63.81	0.74	2 783
	9.02	0.02	12.88	1.45	0.88	2 577
	4.90	0.01	8.07	0.00	0.00	5 605
	0.54	0.04	0.88	30.74	1.13	3 597
	0.06	0.66	18.55	1.86	2.86	966

Name	Recharge (million m^3/a)	National recharge (%)	Natural	Cultivated	
Ventersdorp/Schoonspruit Karst Belt	2875	8.23	70.20	28.64	
Vivo-Dendron	2555	7.32	80.96	18.14	
West Coast Aquifer	4586	13.14	51.38	47.46	
Westrand Karst Belt	1090	3.12	60.23	33.99	
Zululand Coastal Plain	3305	9.47	73.69	3.27	

The main sources that informed this documents are:

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- WWF. (2013). An introduction to South Africa's Water Source Areas. World Wildlife Fund South Africa, Cape Town

	Plantation / woodlot	Mining	Urban	Formal protection (%)	Conservation area (%)	Area (km^2)
	0.17	0.35	0.65	1.51	3.41	2 873
	0.02	0.05	0.83	1.16	17.25	2 557
	0.22	0.14	0.80	5.32	1.94	4 657
	0.84	0.45	4.50	26.37	0.00	1 089
	13.91	0.01	9.12	40.13	0.00	3 323