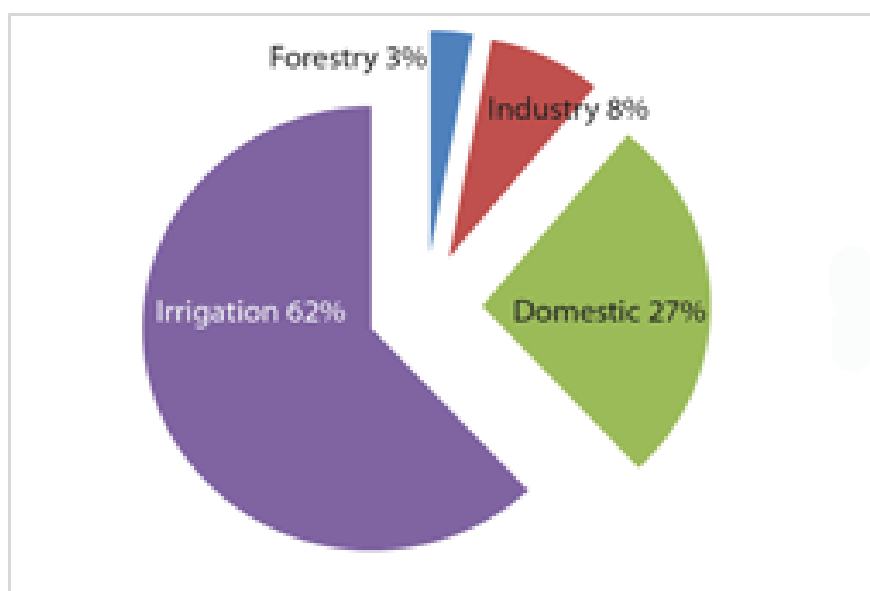


Water

State of the Environment: Issue summary

Water in South Africa - Why is water an issue?

Water supports human life and maintains the environment. Water is central to human dignity and health, social development, as well as economic development (DWA 2004a). Considering the hierarchy of human needs, water is firstly crucial for drinking, health, sanitation and agriculture. Thereafter water is important for industry, power generation, mining operations, tourism and recreation. Having limited natural water resources is one of South Africa's key obstacles to development. Thus, the challenge lies in the efficient and balanced use of the available resources that, together with the benefits from our other natural resources, would create an environment for social and economic well-being.



Water use per sector, Domestic use also includes an industrial use component, e.g. the water supplied by municipalities and water boards for industrial use.

South Africa's average rainfall of 450 mm per annum is far below the global average of 860 mm. The southern and eastern parts of South Africa have higher rainfall than the western and central areas. Climate change forecasts predict reduced runoff in the western parts of the country, increased rainfall variability, and more frequent flood and drought events. The expected reduction in runoff and higher average surface water temperatures will have an effect on water quality, e.g. higher concentrations of pollutants and algal blooming (Archer and Tadross 2009). These predicted changes in water availability in an already water stressed country with a well-developed agricultural sector challenges both water resource planning and mindsets about current and future land-uses.

A positive change in the country is the increase in water supply and provision of sanitation services over the past decade. Simultaneously, water use for development is increasing with almost all available water resources already tapped [allocated].

Population growth puts further pressure on our water resources, challenging the balance between water supply and water demand.

Unfortunately water ecosystems are under tremendous strain, which is aggravated by the poor quality of waste water discharges (malfunctioning and overloaded waste water treatment works, non-compliant mining and industrial effluents and agricultural run-off) and land-use practices. The loss of both quantity and quality of water has adverse effects on river ecosystems as well as on human health. The health of estuaries located at the bottom end of river ecosystems is similarly affected by upstream pollution and the reduction in freshwater inflow.

Wetlands are an equally important aquatic ecosystem, yet an estimated 50% of South Africa's wetlands have either been destroyed or converted. An impaired wetland can no longer provide the ecosystem services such as flood control, improvement in water quality, water storage, and maintenance of biodiversity that nature has assigned to (and demands of) it in a natural state.

Groundwater is part of the natural water cycle; it is linked with surface flows and is not an additional water resource. Since the sustainable use of groundwater resources depends on their regular replenishment in the form of recharge derived from infiltrating rainwater, a reduction in rainfall will necessarily result in reduced recharge and therefore also the quantity of potentially exploitable groundwater. Threats to the quantity and/or quality of our groundwater resources are posed by a variety of natural and anthropogenic factors such as climate change and current and future land use activities.

State-of-River reports highlight alien invasive plants as a further threat to water ecosystems (DWAF 2006). Alien invasive plants spread at a more rapid rate than what existing eradication programmes manage to remove. Alien invasive plants threaten biodiversity by outcompeting natural vegetation. It is estimated that alien plants waste up to 7% of our water resources, and intensify flooding and fires (DWAF 2003).

What is being done?

Since 1994 there has been significant progress in the development of policy and a legal framework for dealing with water resources. The promulgation of the National Water Act (Act No. 36 of 1998) called for the development of a range of management tools for the implementation of future water resource management. Institutional restructuring is separating water supply from resource management, including the protection functions. South Africa's main approach in addressing the above is one of integrated water resource management. A key principle is the need to balance protection of water resources with social and economic development. According to the National Water Act, the only two guaranteed entitlements to water are those for the ecological Reserve and for meeting basic human needs.

South Africa's National Water Resource Strategy (DWAF 2004a) describes in detail how to protect, use, develop, conserve, manage and control South Africa's water resources. Apart from the National Water Act (Act 36 of 1998), the National Environmental Management: Integrated Coastal Management Act (Act 24 of 2008) also addresses the mitigation of South Africa's deteriorating estuaries. This act requires the development of a national estuarine management protocol for South Africa, as well as the development of individual estuarine management plans. As part

of a Water Research Commission project on Cooperative Governance a process was initiated to develop a National Estuarine Management Protocol (NEMP) for South Africa (Van Niekerk and Taljaard, 2004). South Africa's estuaries have a diversity of management requirements, often unique to individual systems, and are governed by a variety of authorities, from national to local level. Consequently, it was necessary to develop a flexible, but legally defensible protocol providing guidance to estuarine managers at all levels to develop sound management plans to suit individual systems.

Towards the establishment of individual estuarine management plan, government in collaboration with the CAPE (Cape Action Plan for the Environment and the People) Regional Estuarine Management Programme developed a generic framework for the design and implementation of such plan, a framework which is currently being pilot-tested in estuaries within the Cape Floristic Region under the auspices of the CAPE Regional Estuarine Management Programme.

As part of the country's Water Resource Management Strategy a standard approach for determining the water requirements of aquatic ecosystems, including estuaries, has been developed (and is regularly updated). This method has been used to determine ecological water requirements from a number of estuaries including the Orange, Olifants, Breede, Great Brak, Goukamma, Knysna, Swartvlei, Palmiet Tsitsikamma, Kromme, Seekoei and Swartkop, Thukela and St Lucia estuaries. A major challenge is to ensure that the process is rolled out to all SA systems, and most importantly, to ensure effective implementation.

A wide range of opportunities exists to mitigate in some measure the threats to groundwater that prevail. For example, the development of a National Groundwater Strategy (DWA, 2009b) is built on the premise that "*Groundwater does not play a big enough role as a water resource in South Africa.*" This recognises the potential to grow the water supply function of this resource considerably. The implementation of an Artificial Recharge Strategy (DWA, 2007b) provides a further opportunity in this regard.

Catchment management agencies need to be established for the country's 19 water management areas. Although eight CMAs have been established, most of them are not operational yet (DWA 2009).

The Department of Water Affairs, as custodian of the water resources in the country and in fulfilment of their mandate, has developed and implemented a number of national water resource quality monitoring programmes. Where operational, these monitoring programmes collect, assess and disseminate information on the status of the country's water resources. Several of the national programmes are still under development and not yet operational.

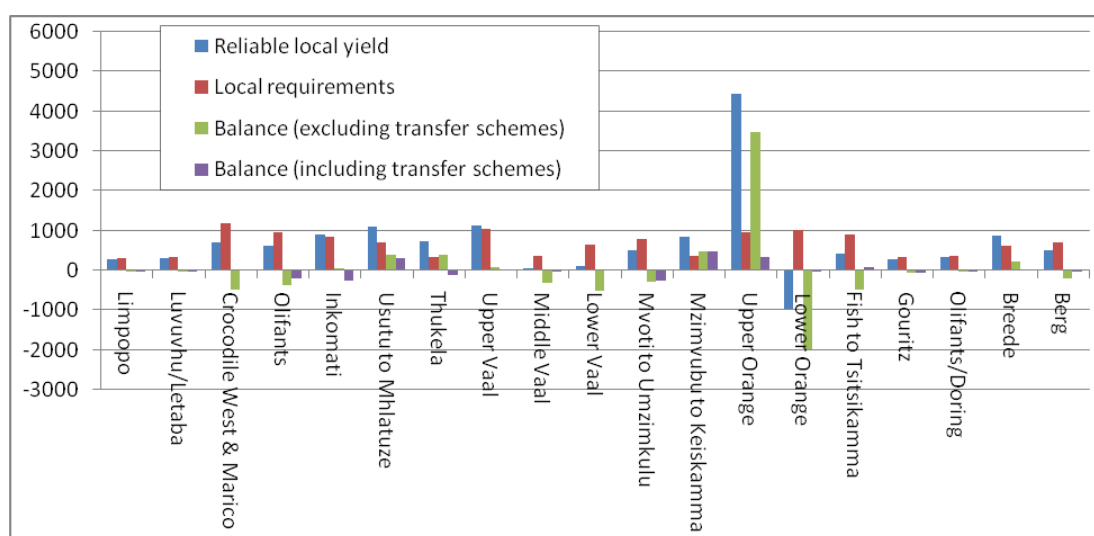
South Africa has made impressive progress with the delivery of basic water supply. Expressed as a percentage of the total number of households for a specific year, access to piped water either within homes or on site have increased from 66% to 71% between 2002 and 2007 (StatsSA). The use of untreated water resources such as rivers, springs, streams and dams for household water supply declined from 11% to 6% between 2002 and 2007 (StatsSA). The Eastern Cape is still the worst off when it comes to households having access to safe water. However, progress was significant with the 55% of households having access to safe water in 2002 increasing to 73% in 2007. To ensure further equitable access, the Free Basic Water policy was instituted in 2001, which mandates that households have the right to 6000 litres of water per month free of charge.

Since the quality of water has a direct influence on the quantity of usable water, as well as the cost involved in purifying water for consumption, action is needed to ensure the best use of this precious resource. Improved agricultural and land management practices, and improved operational management of waste water treatment works is needed to improve the quality of water resources in South Africa. Land use activities such as mining also pose a threat to groundwater resources in terms of both quantity and quality. Whilst operational mines often need to implement dewatering programmes in order to keep active working areas dry and safe from flooding, defunct mines pose a potential threat to the quality of surface and groundwater resources from the release of acidic mine water into the environment. This threat is particularly relevant to coal and gold mines. The technology already exists to treat the large volumes of very poor quality mine water to an acceptable standard for reuse as industrial process water or even drinking water.

The financial resources, institutional capacity, and willingness of all stakeholders will be required to reverse the generally downward trend in availability and quality of our water resources. As a water-stressed country with high levels of poverty, and faced with the imminent effects of climate change, it is critical that concerted action is taken.

Challenges

Current demands for water are being met mainly through large engineering projects requiring substantial capital investments in infrastructure. Although there is a theoretical surplus for the country as a whole, and taking current transfers between water management areas into consideration, 10 of the current 19 water management areas experience deficits in available water. The shortfalls are alleviated through the transfer of significant volumes of water between water management areas, which have a direct impact on the ecology of these systems.



Available water per water management area (in million cubic metres), excluding and including current water transfers schemes.

According to the National Water Resources Strategy (DWAF 2004a), estimates are that careful management should be able to ensure sufficient water to meet all needs in the near future. However, in many cases, the ecological Reserve environmental water requirements of many rivers are not being met. The role of climate change on water availability should not be underestimated and it is estimated that South Africa could run into a water deficit by 2025 (DWAF 2004a). Potential alternatives for resource supplementation include desalination of seawater, importation of water from the Zambezi River, and towing of icebergs. Given that these alternatives are not currently cost-effective, we need to improve our water conservation activities and put additional effort and resources into water demand management. We also need to promote reuse of treated sewage or mine water by industry.

While rivers and dams supply most of South Africa's water needs, groundwater is important in rural and arid areas. By far the majority of the 12 million people supplied with water since 1994 have been supplied from groundwater resources. The quantity of groundwater available is difficult to estimate. This is due to a lack of understanding of the interrelationship of ground and surface water, the rate with which groundwater is recharged and its invisible nature. The integrity of groundwater as a viable resource suffers from a perception of unreliability that stems from negative experiences based on poor management that resulted in over-abstraction of the resource in some areas. The lack of trust in groundwater as a reliable resource (DWA, 2009a) has created a resistance toward the development of groundwater for water supply purposes. Data is urgently needed on usage and recharge rates, to ensure sustainable groundwater use.

However, it is not the groundwater resource that is to blame, but the poor understanding of factors that impact on the sustainable utilisation of the resource that is displayed by groundwater users. The DWAF (2007a) recognises that bringing about a change in mindset and attitudes towards groundwater at all levels should be an objective of the National Groundwater Strategy. The fact remains, however, that groundwater is often more readily available and cheaper to supply than surface water, its sustainability depending on moderation in use, coupled with monitoring and protection (DWAF, 2007a).

Human activities and developments posing a potential threat to estuaries and the valuable services provided by these systems can be divided into the following three broad categories (Van Niekerk & Taljaard 2003, Turpie 2002, Breen & McKenzie 2001, Boyd *et al.* 2000, Morant & Quinn 1999, Smith & Cullinan 2000, Glazewski 2000, Prochazka & Griffiths 2000): land use and infrastructure development; water quantity and quality (water supply/demand and pollution; and, exploitation of living resources. Similar to other countries, the fragmentation of estuarine management among the different national, provincial and local government agencies poses the biggest challenge to protecting estuaries, which is managing human activities and developments impacting on estuaries.

The quality, quantity, and sustainability of water resources will depend on concerted efforts between water management, land management, industry and mining. This underlines the need for an integrated approach to land and water management. New management tools that promote the principles of integrated and participatory management include the establishment of catchment management agencies and water user associations. Examples of greater participation in policy review include the three-year multi-stakeholder process on prioritising the World Commission on Dams findings in South Africa, and the ongoing multi-stakeholder process to assess water services delivery.

Local government is responsible for the water-supply function, the management of effluent discharge, and has key responsibilities for integrated local development. Given that this is the sphere of government most lacking in capacity and resources, and that water catchments transcend municipal boundaries, very limited progress has been made in integrating water and development planning. An area that needs attention is the legal and institutional arrangement regarding monitoring and enforcement.

In terms of the sustainable management of water resources, it is crucial to have monitoring programmes in place that are scientifically sound, and that monitor and assess certain stable indices and variables at carefully determined intervals. It is equally important that monitoring takes place over the long term in order to gather sufficient data to determine trends and to develop predictive models for water resource planning purposes. Although different spheres of government (i.e. national, provincial and local) have implemented several monitoring programmes, monitoring should be coordinated, and findings should be well documented and communicated to all stakeholders. Appropriate action should be taken timeously to minimise risk to both human and environmental health. Action should include prevention as well as remedial clean-up and rehabilitation.

Although the Department of Water Affairs is the custodian of the country's water resources, many government departments and agencies have overlapping mandates related to water resources management in South Africa. Many of these agencies tend to operate in isolation, partly because they are distributed among several spheres of government. As a result, many inconsistencies and gaps exist in the water resource management and regulation framework which contributes to the current downward trend in the state of our water resources. Since all of these agencies face similar challenges with regards to human resource turnover and insufficient funding, effective coordination and cooperation efforts are necessary to not only address these challenges, but to ensure that our water resources are sufficiently conserved and protected.

Indicators

Resource quality

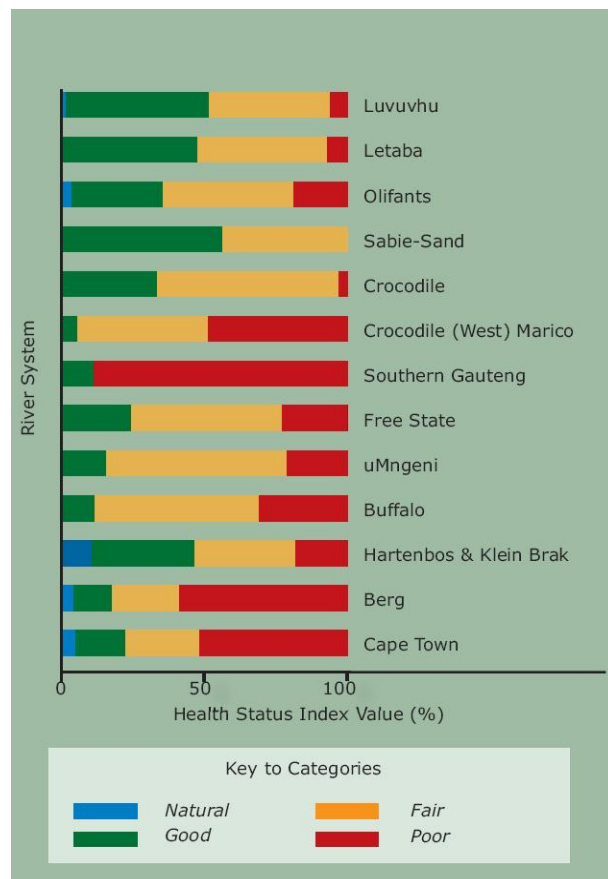
Resource quality includes the biotic (biota and riparian vegetation) and the abiotic (physical, chemical and hydrological) characteristics of a water resource. The quality or condition of water resources is affected or changed due to a variety of environmental pressures in the catchment in which the water resource is situated. In order to understand how and to what extent water resources are being impacted, it is necessary to identify and monitor indicators representative of the main components of a water resource which can provide quantitative and qualitative information on the condition of these resources. This information is necessary from a water resource planning and management point of view to know whether the water is sufficient and or suitable for specific uses, whether users are complying with water quality criteria and objectives, and whether management actions that have been implemented are effective or not.

Aquatic ecosystem health

The health of an aquatic ecosystem is determined by a multitude of factors. By measuring the biotic and habitat components of aquatic ecosystems, one is able to assess the overall condition or health of these systems. The health of an aquatic

ecosystem indicates its ability to support a natural array of biota and relates directly to the ability and capacity of a system to provide a variety of goods and services to society. Since aquatic organisms are adapted to live within certain environmental conditions, changes within their environment, e.g. adverse impacts on their habitat, are portrayed by the composition and abundance characteristics of a specific biological community. Indicators that are typically used in river health assessments (including DWA's National Aquatic Ecosystem Health Monitoring Programme for rivers) are diatoms, benthic macro-invertebrates, fish, in-stream habitat and riparian vegetation (DWAF, 2006). Data gathered for each of these components are expressed as a single assessment condition, referred to as the EcoStatus.

Various river systems have in the past, and are currently being monitored as part of the national River Health Programme. Between 1998 and 2005 thirteen of these systems have been assessed and reported on in State-of-Rivers reports. An analysis of the data collected shows that 1.6% of the rivers studied are in an overall Natural state, 26.6% in a Good state, 42.8% in a Fair state and 29% of the rivers are in a Poor state. The graph below provides a summary of the EcoStatus of all river systems reported on by the River Health Programme for this period (DWAF, 2006). The data are based on the sampled lengths of each river.



The EcoStatus of river systems reported by the River Health Programme by the year 2004 (DWAF 2006).

Water Quality

The water quality of inland water resources in South Africa is declining rapidly mainly due to increased pollution caused by industrial development, urbanisation,

afforestation, mining, agriculture and power generation (Ashton, 2008). Freshwater resources are as a result particularly threatened by salinisation, eutrophication, disease causing micro-organisms and acidification caused by a variety of land use practices (Oberholster et al., 2009).

The quality of groundwater is generally of a high standard and suitable for drinking water purposes without much treatment, if any. However, areas of naturally occurring brack water or where elevated concentrations of nitrate and/or fluoride are present, impose a limitation on the use of groundwater for this purpose. Woodford et al. (undated) suggest that this limitation reduces the 19000 million m³/a of potentially exploitable groundwater to some 14800 million m³/a of potable groundwater.

Salinisation

Salinisation is a persistent water quality problem in South Africa. While water with a high salt content could be due to the surrounding geology and soil types, salinity generally increases with land use practices. Salinity refers to the amount of specific dissolved inorganic compounds in the water (Oberholster et al., 2009). Electrical conductivity (EC), which can also be expressed as total dissolved salts (TDS), is used as an indicator of salinity. Irrigation water with high salt content reduces both the yields and quality of crop and fruit. It also causes corrosion of pipes, increases the requirement for pre-treatment for selected industrial uses and negatively affects aquatic biota.

Potential health risks associated with salinity is generally higher in the Western and Eastern Cape where waters may have a naturally high salinity due to geological formations (DWAF, 2008). Mainly due to extensive agricultural and irrigation practices, specific high-risk areas in South Africa are the lower Vaal River, from Bloemhof Dam downstream to the confluence with the Orange River (Van Rensburg et al., 2008).

Eutrophication and algal blooms

Eutrophication, which is a major water quality problem in South Africa, refers to the process whereby excessive algal and macrophyte growth is encouraged as a result of the enrichment of water with plant nutrients, particularly nitrate and phosphate forms (NO₂, NO₃, NH₄, PO₄, orthophosphates).

Eutrophication in rivers and reservoirs is caused by inadequate treatment of domestic and industrial effluents, runoff from informal settlements, as well as agricultural return flows (Ashton, 2009). It is estimated that approximately 42% of dams monitored in the country either are seriously impacted or have the potential to develop significant eutrophication problems (DWAF, 2008). The water management area worst affected is Crocodile (West) Marico.

The development and prevalence of Cyanobacterial blooms (blue-green algae) particularly during summer months, is associated with high levels of eutrophication in rivers as well as reservoirs (Ashton, 2009). Cyanobacteria can produce toxins that negatively affect humans, livestock and native aquatic flora and fauna and can in extreme instances, result in death. Excessive growth of toxic blue-green algae furthermore causes problems with water purification due to the presence of toxic metabolites as well as taste- and odour-causing compounds (Oberholster, 2009).

Acidification

The pH occurring in natural waters are largely a result of surrounding geological and atmospheric influences. Although freshwater resources in South Africa are generally well buffered, acidification due to certain anthropogenic influences, can lower pH values which inevitably results in elevated concentrations of total dissolved salts, as well as increased concentrations of metal ions (principally iron, manganese, aluminium, cadmium and zinc) which may directly affect aquatic flora and fauna (Ashton, 2009; Oberholster et al., 2009b). Acid mine drainage (AMD) which refers to the outflow of acidic water from (usually abandoned) metal mines or coal mines, is a major contributor to the lowering of the pH of water resources.

The Witwatersrand region in South Africa, although renowned for its gold production, experiences severe water quality problems mainly associated with AMD due to intensive past and present mining operations. Groundwater resources are heavily contaminated and acidified as a result of oxidation of pyrite (FeS₂) contained within tailings dumps, and has elevated concentrations of heavy metals. The polluted groundwater in the region is of particular concern since it is discharging into streams in the area and contributes up to 20% of stream discharge, causing a lowering of pH of the stream water while most of the metal load is precipitated (Oberholster, 2009).

The coal mining industry which is South Africa's second largest mining sector is largely situated on the Highveld and in the Waterberg areas. All of the coal ore bodies contain high levels of iron pyrite and all the coal mines are characterized by acid mine drainage (AMD). Associated environmental risks from these coal fields include surface and groundwater pollution in the form of heavy metal uptake in the environment, the degradation of soil quality and the harming of aquatic fauna and flora (Adler and Rascher, 2007).

Disease causing micro-organisms

Microbiological quality is the presence of disease causing micro-organisms and parasites in water, mainly due to poorly operated waste water treatment works, and runoff from land contaminated with human and animal faecal wastes. Faecal pollution of water resources causes the spread of diseases such as dysentery, cholera and typhoid (Momba et al., 2004) and poses a further risk to crops that are irrigated with this polluted water.

Babies, young children, the elderly and people that experience immune deficiencies, are particularly vulnerable when exposed to microbiologically polluted water. According to Bradshaw et al (2003), diarrhoea is the third most important cause of death after HIV/AIDS and low weight in children under the age of five.

Areas that are currently monitored by the Department of Water Affairs show that the Crocodile (West) and Marico, Mvoti to Umzimkulu and Mzimvubu to Keiskamma WMAs (DWAFA, 2008) are the most severely affected water management areas, while the highest potential health risk areas of surface water due to faecal pollution, include Kokstad, Matatiele, Maclear, Port St. Johns, Olifants River, Phokwane, Lebowakgomo, Ga-Rankuwa, Tolwane River, Tswane River, Makapaanstat, Apies River, Elands River, Klein Letaba, Phuthaditjaba, Mafikeng, Buffels River, Newcastle, Dundee, Ulundi Esigodini, Nsikazi River, Matsulu and Ngodini. The health risk in these areas is due to high numbers of people, major shortage of proper sanitation infrastructure and a lack of purified water for domestic use (NMMP, 2000).

Water Quantity (Water availability)

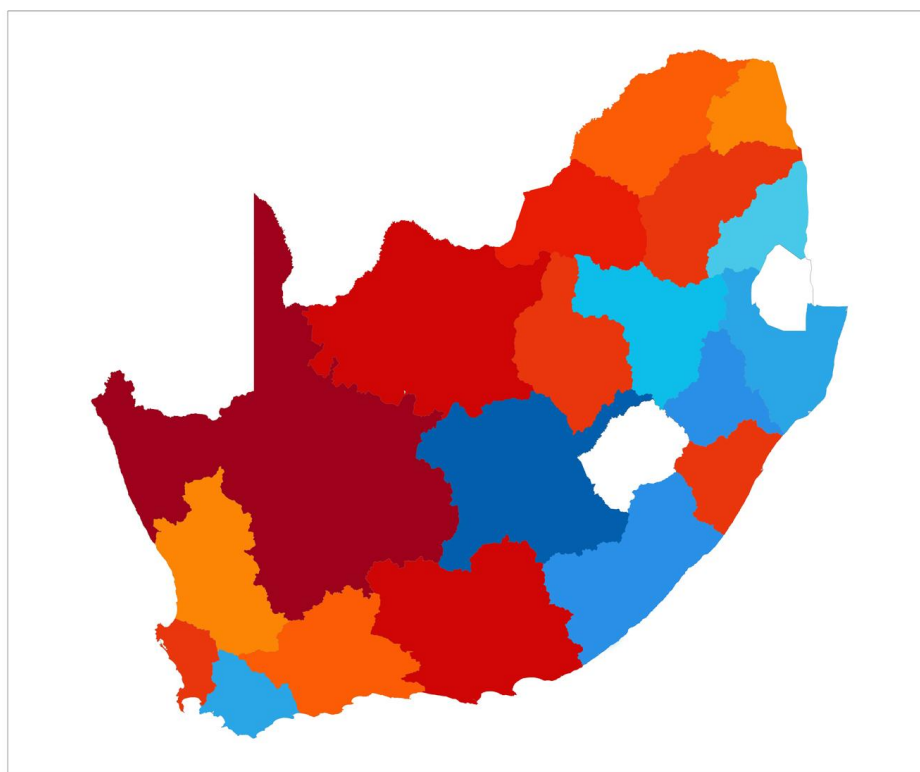
Available freshwater per capita

South Africa's average rainfall of 450 mm per year is much less than the global average of 860 mm per year. It is estimated that the country's mean annual runoff is 43 500 Mm³ (million cubic metres) per annum (excluding the 4 800 Mm³ from Swaziland and the 700 Mm³ from Lesotho). While the total available yield is 13 227 Mm³/a, the total water use requirements are 12 871 Mm³/a (year 2000 figures) (DWAF 2004a).

About 70% of the mean annual runoff is impounded (about 34 000 Mm³ or 34 billion m³) in South Africa's larger dams resulting in about 700 m³ of freshwater per capita. This is a rough estimate which does not factor in aspects such as siltation of dams and drought periods.

Areas of water stress

Water resources in South Africa are unevenly distributed. Since the most water resources are not necessarily in the densely populated or economic developed areas, it leads to water stress in some areas. Calculations show that 10 of the 19 water management areas in the country cannot supply in the respective areas' water demand. Water transfers between river systems, dam capacity and periods of drought all determine the amount of water available in a specific water management area.

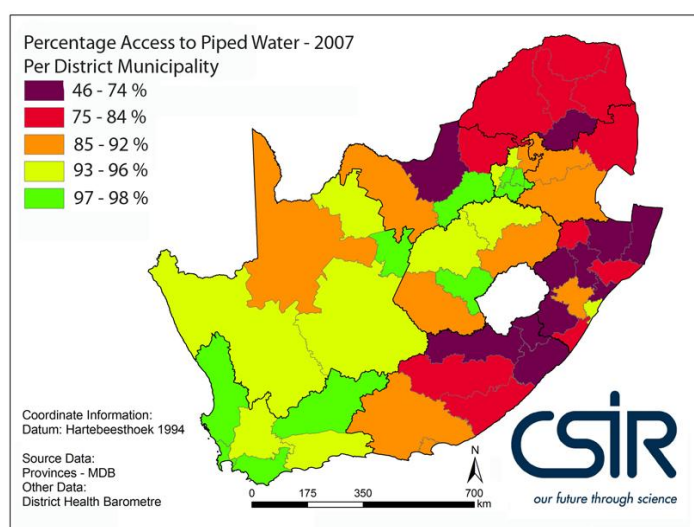


Water management areas that experience water stress (total water requirement exceeds average yield, excluding transfer schemes) are indicated in the orange and red shades.

Access to water

The number of households with access to piped water, either within their homes or on site, has increased from 7.6 million in 2002 to 9.4 million in 2007 (Stats SA) and represents 71.3% of all households in South Africa. A further 2.75 million households receive water in one of the following ways: on-site borehole, rainwater, neighbours, communal tap or water-carrier/tanker. The remaining 1.03 million households get water from off-site boreholes, rivers, springs, streams and dams. The latter decreased from 1.63 million households in 2002 to 1.03 million households in 2007 (Stats SA). Projections from 2001 Census data indicate that by 2009 about 85% of the population would have received water services: 62% above RDP level (in-house or in-yard water supply), 18% at RDP level (25 litres per day per person within 200 metres of a household), and 5% below RDP level (a standpipe more than 200 metres from a household). Unfortunately, both the weighting factors used for the Census 2001 magisterial districts data and the growth rate figures for the water services provision have error factors.

It is estimated by the Department of Water Affairs (DWA, 2002) that groundwater provides in 15% of the total volume of potable water used in South Africa. Small as this contribution may seem, it represents the only source of water for more than 300 towns and 65% of the population (Woodford et al., undated). The DWA (2004b) estimated total groundwater use at some 1 770 Mm³/a, 64% of which was used in the agricultural sector for irrigation purposes. Against this background, the under-utilisation of the country's groundwater resources is put in perspective by the estimated 19 000 Mm³/a of potentially exploitable groundwater, of which an estimated 10 350 Mm³/a is considered utilisable (Woodford et al., undated).



Percentage of households with access to piped water per District Municipality in 2007.

Wetlands

Wetlands, often referred to as marshes and vlei's, provide many ecosystem services such as flood attenuation, stream flow regulation, water purification, carbon storage, and the recharge of aquifers. Wetlands are rich in biodiversity. Specially adapted plants support a wide range of insect and animal life. Wetlands also provide animal grazing as well as food and building and crafts material to people. Since the "health and well-being of people is intricately linked to the state of their environment", healthy

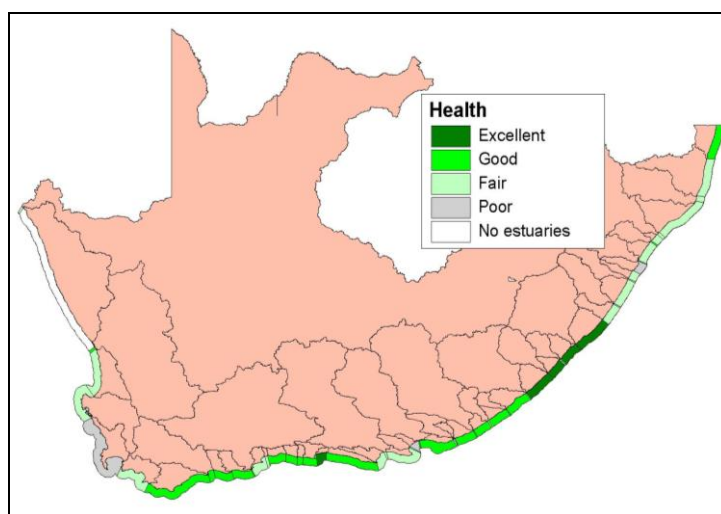
wetlands play an important role in the health of people, especially those whose livelihoods depend on them.

According to the National Wetland Inventory, South Africa's more than 120 000 wetlands cover about 7% of its surface area. Nineteen of these wetlands, with a total surface area of almost 544 000 hectares, are listed as Ramsar sites. Since 1999, three wetlands were added to the list of Ramsar sites, namely the Makulele Wetlands in Limpopo Province, the Prince Edward Islands and Verloren Valei Nature Reserve in Mpumalanga.

(Source: <http://www.ramsar.org>
Wetlands Portal – All about Wetlands <http://wetlands.sanbi.org>)

Estuaries

Estuaries are sensitive ecosystems that provide many goods and services (Van Niekerk and Taljaard 2003, Costanza *et al.*, 1997; Mander *et al.* 2001; Mander, 2001). Estuaries provide shelter for marine life, are important for biodiversity and are a focal area for coastal development (Clark *et al.*, 2002). The most recent estuary assessment showed that the health status of six out of 27 estuaries declined over the past decade (Whitfield 1995, 2000, Turpie, 2004). However, by the year 2004, the majority of estuaries were still considered to be in a good state, with 28% of the estuaries in an excellent state, 32% in a good state, 25% fair and 15% poor (Turpie, 2004). The distribution of South Africa's estuaries in terms of their health status is illustrated below.



The health status of South African estuaries (Map and information from Turpie, 2004)

While pollution and habitat destruction is impacting on the health of estuaries in urban areas, the deterioration in health of the more rural estuaries is mainly the result of reduction in freshwater inflow. Pollution from agriculture activities can also not be excluded. Estuaries act as purifying systems where nutrients from the catchment are absorbed resulting in cleaner water entering the sea. This nutrient removal function is manifested in excessive weed growth or phytoplankton blooms in estuaries, rather than in the adjacent marine environment. This is particularly evident during low flow periods (dry seasons) when the river flow entering the estuaries may contain high concentrations of nutrients (for example, due to agricultural irrigation return flows) as well as the water having longer residence times within the estuaries.

Conclusion

The shortfalls in water available per water management area and between river systems are alleviated through the transfer of significant volumes of water. This has a direct negative impact on the ecology of these systems, with in many cases, the ecological Reserve not being met. The ecological water requirements should also be determined and implemented for all estuaries. The biggest challenge to protecting water resources, including estuaries, is the fragmentation of the managing responsibilities amongst the different national, provincial and local government agencies – some lacking in capacity and resources.

The solution to the water deficit in many water management areas is not necessarily more dams and more transfer schemes, but the improvement of water conservation and water re-use activities, as well as water demand management. Groundwater is an important water resource in rural and arid areas. The understanding of the factors that impact on the sustainable utilisation of groundwater needs to improve.

South Africa's fresh water quality is rapidly declining due to increased pollution caused by industrial development, urbanisation, afforestation, mining, agriculture and power generation. The development of management plans should take cognisance of both socio-economic good (job creation, economic growth) and environmental sustainability (biodiversity conservation, ecosystem health).

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Notes

1. Spelling of EcoStatus and ecological Reserve is correct
2. All diagrams are supplied separately to ensure best resolution in final product
3. DEA is welcome to extract from and shorten this document as needed

[Note: to change Northern Province to Limpopo on website
<http://soer.deat.gov.za/themes.aspx?m=425>]