Chapter 8

Inland water

Aquatic ecosystems in South Africa include rivers and streams, estuarine systems, marine systems, wetlands, floodplains, lakes and dams and groundwater systems.

Chapter 8

Contents

8.1 INTRODUCTION

Aquatic ecosystems in South Africa include rivers and streams, estuarine systems, marine systems, wetlands, floodplains, lakes and dams and groundwater systems (Masundire & Mackay 2002). Healthy and functional aquatic ecosystems need a number of different components to ensure their quality and ability to provide ecosystem services for people. These components depend on the type of ecosystem but can include: water (flowing, underground or standing); physical habitats and habitat forms; vegetation; biota; and, biochemical and ecological processes. When ecosystems are maintained in a healthy condition they are able to provide ecosystem services such as the reasonable assurance of water supply, improved water quality and reduced impacts of floods and drought. Aquatic ecosystems that are degraded reduce the amount of water available for use.

South Africa is a water stressed country receiving an average rainfall of 450 mm per year, leading to reduced levels of run-off and availability of surface water (Binns *et al.* 2001; DWA

2011a; UNESCO 2011). Rainfall amounts can vary annually and have large geographic differences in rain. The annual run-off of South Africa's rivers is on average 49,000 million m^3 per year, 50 per cent of which is yielded by mountain catchment areas which account for only eight per cent of the country's surface area. Of this value a per capita water availability of approximately 1,100 m^3 per year can actually be utilized due to the variability of flows and high evaporation rates (Binns, *et al.* 2001; StatsSA 2010).

Overall, South Africa's use of existing water resources comprises 77 per cent surface water, nine per cent of groundwater and 14 per cent of return flows. All of the statistics above point to a water situation where water resources are extremely varied and highly stressed in certain areas. As the custodian for the country's water resources, it is the responsibility of the DWS, through various legislative and water management mechanisms, to ensure the availability of good quality water resources for all current and future inhabitants.

8.2 THE WATER SITUATION IN SOUTH AFRICA

Water availability is not consistent across the South African landscape and varies greatly between different catchments. Similarly, the demands for water differ across sectors and water users, some of whom are more efficient users than others. Particular considerations in South Africa are issues of access to water for all and water reallocation to allow equal opportunities to its use, more efficient use of limited resources and sustainable use of these resources.

High levels of development and human activities, and/or intensive land transformation threatens more than half of our river ecosystem types and two-thirds of wetland ecosystem types (Nel *et al.* 2011).

8.2.1 Water resources

Major river basins of South Africa (Nkomati, Limpopo, Maputo, Orange-Senqu, Thukela and Umbeluzi) are shared with our neighbours Lesotho, Swaziland, Mozambique, Zimbabwe, Botswana and Namibia (Ashton et al. 2008). There are four major transboundary basins containing 40 per cent of available water resources (DWAF 2004). These include the Limpopo Basin which covers South Africa, Botswana, Zimbabwe, and Mozambique, the Komati Basin covering South Africa, Swaziland, and Mozambique, the Maputo/Usuthu Basin covering South Africa, Swaziland and Mozambique, and the Orange basins across Botswana, South Africa, Lesotho and Namibia.

South Africa was divided into 19 WMA to facilitate water resource management, but the National Water Resource Strategy (NWRS 2012) rationalized these to nine WMAs (Map 8.1). Large-scale inter-basin transfers of water between catchments are a further characteristic of the South African water situation. These transfers are necessary to supplement water to metropolitan areas such as Cape Town, Durban, Port Elizabeth and the Gauteng region, some of which are located far away from major water courses.

In a country where water resources are scarce, it is important to understand where and how fresh water is available and where and what demands are placed on it for use. This enables better decision-making around the allocation of water to different users.

Map 8. 1: WMA and provinces of South Africa
Source: DWA (2013)

8.2.2 Water availability

The quantity of water available for direct human use, or to support aquatic ecosystems, depends on the availability and sustainability of the resource. Rainfall, surface flows and groundwater recharge are intimately linked in the hydrological cycle and need to be managed in an integrated way. The quantity of water available for use varies across different catchments depending on a number of conditions. Understanding how the hydrological cycle works aids with understanding how much water may be available and where.

A further important consideration for water availability in South Africa is climatic variability. Rainfall is unevenly spread across the country's catchments. Most of the northern and western part of the country are semi-arid and receive relatively low levels of rainfall. A further complexity to managing South Africa's water resources is that rainfall patterns, and subsequent run-off, are highly seasonal with short wet seasons and long dry seasons in many parts of the country. This is further complicated by high variability in annual flows characterized by floods and droughts. Assured water supplies require the provision of storage dams to bridge periods of low flow.

After allocating enough water in rivers for environmental flow requirements, half of the South African WMAs are in water deficit (i.e. the water requirements exceeds availability) (DWA 2010a; DWAF 2004). This is despite significant transfers into the country from other systems to allow for meeting water requirements. Any major changes in rainfall or water availability (for example from climate change), will severely impact on the water resources available.

The quantity of water that reaches our rivers or the natural mean annual surface runoff (MAR) is estimated to be in the region of 49,000 million cubic metres per annum (Mm^3/a). This includes water that drains naturally into South Africa from Lesotho (about 4,800 Mm^3/a) and Swaziland (about 700 Mm^3/a) (DWAF 2004).

The available yield for surface water was determined to be in the order of 10,000 Mm^3/a in the first edition of the National Water Resource Strategy (DWAF 2004). These figures remain unchanged and are considered the 'available surface water'. Additional water is available, but with assurances of less than two per cent that the water would be available in any given year.

There are approximately 320 major dams in the country, together having a storage capacity of 32,412 Mm^3, equivalent to more than two thirds of the country's mean annual runoff. This total dam storage capacity is a very high percentage and means that additional large dams will become less efficient. In addition, there are thousands of smaller private farm and municipal dams for water storage. Dams have a major impact on aquatic ecosystem integrity and the cumulative impacts of multiple dams can have severe effects on the state of inland waters.

South Africa's available water resources are already being intensively used and controlled. Seven of South Africa's nine provinces rely on inter-basin transfers which provide more than half of their water requirements (van der Merwe-Botha 2009).

A significant volume of the available surface water yield (3,000 Mm^3/a) is moved via inter-basin transfers to areas in the country where requirements exceed supply. An example is the Lesotho Highlands Water Scheme, which supplies water to Gauteng through transfer from the Katse and Mohale dams in Lesotho to the Upper Vaal WMA. The Mzimvubu to Keiskamma WMA is currently the only WMA not subject to inter-basin transfers from outside the area, although there are transfers within the WMA.

The limits to the development of surface water sources have almost been reached and the opportunities for the spatial economic placement of new dams are few (DWA 2010a). The costs of transfers per cubic metre to locations where water is needed are also rising with longer distances and rapidly rising pumping costs.

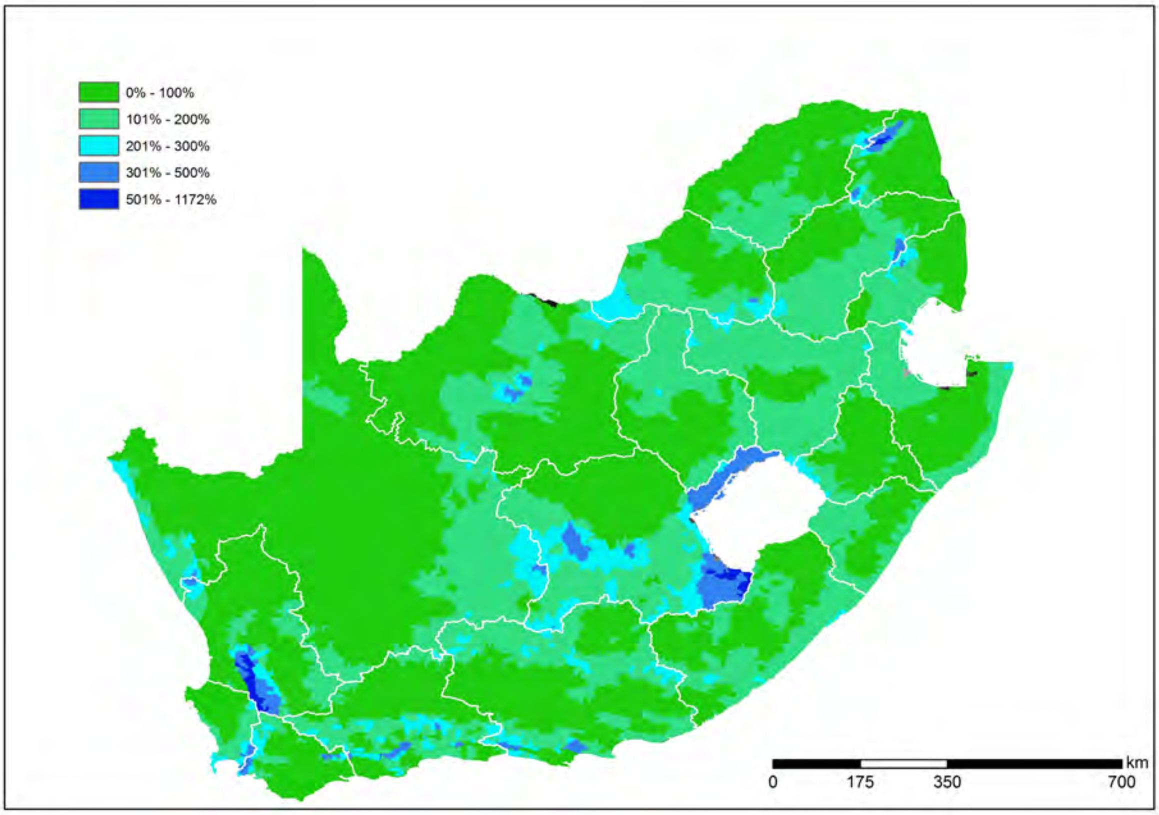
8.2.3 Groundwater availability

It is estimated that the total available renewable groundwater resource in South Africa (the Utilizable Groundwater Exploitable Potential, UGEP) is 10,343 Mm^3/a, or 7,500 Mm^3/a under drought conditions (DWA 2010b). The amount of UGEP varies greatly across WMAs, where some areas have far higher groundwater reserves than others (Table 8.1). As with surface water, groundwater availability varies across the country and some WMAs have more groundwater available for use than others.

Table 8. 1: Utilizable groundwater exploitable potential (UGEP) per WMA

Water Management Area	UGEP (Mm³/a)	Water Management Area	UGEP (Mm³/a)
1 Limpopo	644.3	11 Mvoti to Umzimkulu	704.9
2 Luvubu and Letaba	308.9	12 Mzimvubu to Keiskama	1,385.9
3 Crocodile (West) and Marico	447.8	13 Upper Orange	673.0
4 Olifants	619.2	14 Lower Orange	318.0
5 Inkomati	667.8	15 Fish to Tsitsikama	542.4
6 Usutu to Mhlatuze	862.0	16 Gouritz	279.9
7 Thukela	512.6	17 Olifants/Doorn	157.5
8 Upper Vaal	564.0	18 Breede	362.9
9 Middle Vaal	398.1	19 Berg	249.0
10 Lower Vaal	645.1		
TOTAL	**10,343.4**		

Source: DWA (2010b)



Map 8. 2: High groundwater recharge areas
Source: Nel et al. *(2011)*

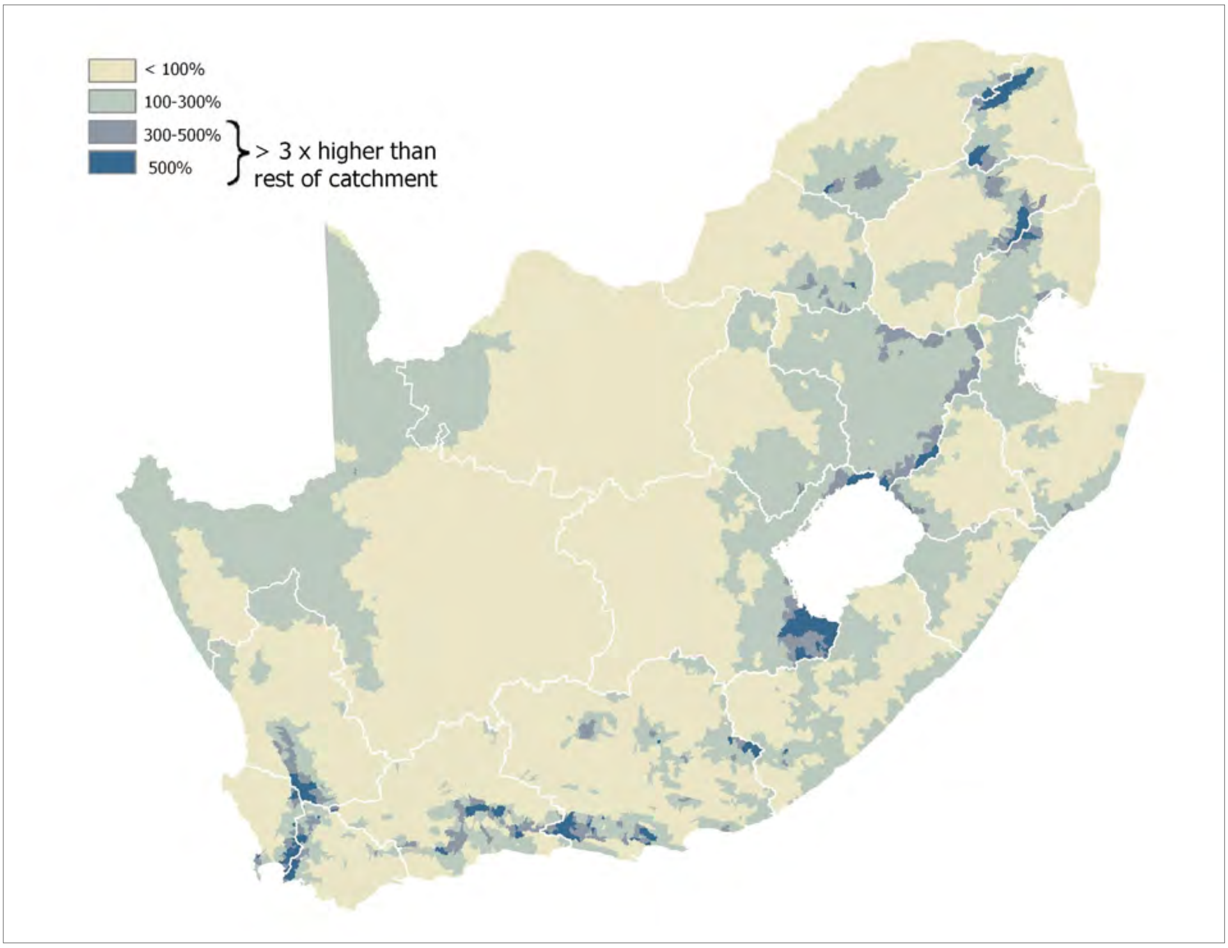
Over the last 60 years groundwater use has increased dramatically from an estimated 700 Mm^3 in 1950, to 1,770 Mm^3 in 2004, (DWA 2010b; StatSA 2010). Groundwater is used for different purposes in various parts of the country. Irrigation is the largest user in many areas, but groundwater is also used for mining on the Highveld, while domestic use in rural areas occurs in KwaZulu-Natal, Western Cape, Eastern Cape, Mpumalanga, and Limpopo (StatSA 2010).

Many small water users are reliant on groundwater access and use (DWA 2010b), making the resource important for livelihoods and marginalized rural communities, particularly in times of drought. The use of groundwater resources, together with adequate maintenance and operation, is therefore an important consideration for future planning and management of freshwater resources in South Africa.

High groundwater recharge areas are sub-quaternary catchments where groundwater recharge is at least three times more than that of the primary catchments (Nel *et al.* 2011). These recharge areas are essential for sustaining river flows particularly in dry periods. Map 8.2 shows spatially where high groundwater recharge areas are, indicated by the blue colouring (shown as groundwater contributions greater than 300 per cent).

8.2.4 High water yield areas

High water-yield areas are the 'water factories' of South Africa and represent those areas where the mean annual run-off is at least three times more per annum than the average for the whole primary catchment (Nel *et al.* 2011). When these areas are in a poor state, they can have a disproportionately large effect on ecosystem services and downstream growth and development. Ideally these areas should be maintained in a good condition where activities that are likely to reduce stream flows or lower water quality are minimized. Only 18 per cent of high water-yield areas have any form of formal protection, despite their strategic importance for water security (Maherry *et al*. 2012). These areas are shown spatially in Map 8.3.



Map 8. 3: High water yield areas in South Africa
Source: Maherry et al. *(2012)*

8.2.5 Water requirements

Data on water-use per sector and surface water availability in South Africa has not had any major revisions since the 2006 SAEO aside from some additional information within Reconciliation Strategy studies which largely focus on urban water supplies. Some updates have been included in the National Accounts: Water Management Areas of South Africa completed by StatsSA and it is this data that is used in this chapter (StatsSA 2010).

Agriculture, and in particular irrigation, is the country's largest water user sector, using about 62 per cent of the available water resources (StatsSA 2010), yet the sector contributes only about 2.5 per cent to the GDP.

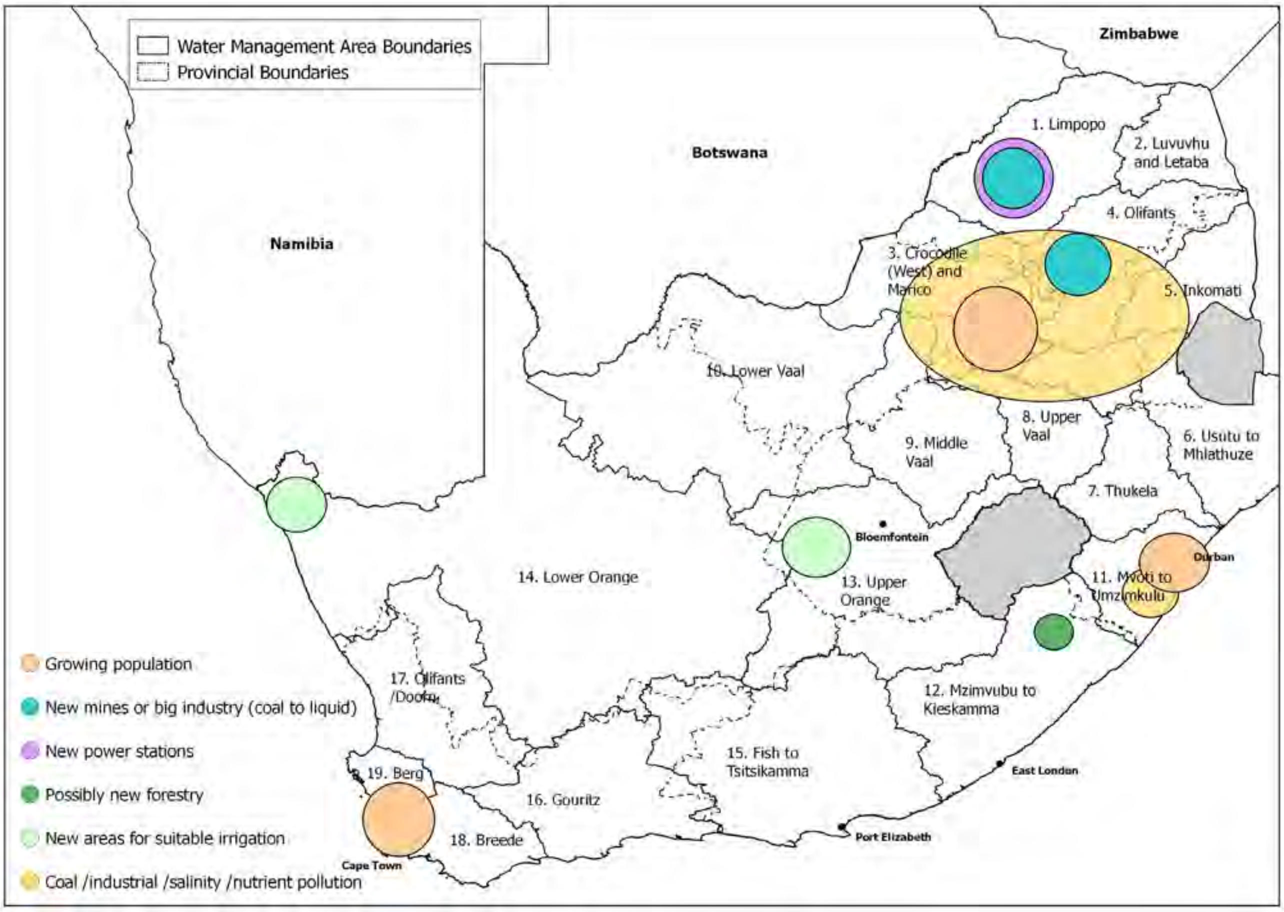
Coal-fired power stations, nuclear stations and even solar power stations all need water to generate electricity. The mining sector uses eight per cent of water available (StatsSA 2010). Although water use by the mining sector accounts for a relatively small portion of the national water budget, it is a major water user in those catchments where mining activities are concentrated. In addition, mining can adversely affect water quality.

Commercial forestry occurs in areas which have sufficient rainfall such as Mpumalanga, KwaZulu-Natal and the Eastern and Western Cape. Plantation forestry is an important water user, and is regulated as a 'stream flow reduction activity' (DWA 2010a).

8.2.6 Future water requirements

Future pressures on water resources are expected to arise from a growing (and urbanizing) population, development of new mines and power stations, forestry and irrigation development, as well as pressures resulting from poor water quality and management. Many of these pressures are specific to particular areas of South Africa (Map 8.4).

At a national level, the DWS uses information on how much water is available for use measured against how much water is required to attempt to reconcile its use. Data currently available is based on the 2000 water supply-and-demand statistics and was included in the 2006 SAEO. Only slight modifications to this have taken place to include new data and planning of available water resources (StatsSA 2010). It is expected that future growth in water requirements will be largely concentrated in the main metropolitan centres, however this does not take reconciliation strategies into account.



Map 8. 4: Future possible pressures on the water resources due to possible developments in different sectors
Source: DWA (2011d)

8.3 FITNESS FOR USE: WATER QUALITY

Water quality refers to the physical, chemical and biological characteristics of water with regard to how suitable the water is for its intended use (DWA 2011b). According to the National Water Act, water quality relates to all the aspects of a water resource, including in-stream flow (quantity, pattern, timing, water level and assurance), natural water quality (physical, chemical and biological characteristics), in-stream and riparian habitat (character and condition) and aquatic biota (characteristics, condition and distribution).

8.3.1 Water quality problems

South Africa is faced with water quality challenges which are mainly induced by human activity. However, it is also important to note that there are water quality challenges which result from natural causes. The anthropogenic problems are associated with industries that produce chemical waste, mines that introduce metals to water resources, waste water treatment works that discharge untreated or poorly treated effluents introducing excessive nutrients, phosphates and coliforms, and agriculture which uses pesticides, herbicides and fertilizers introducing salts and other toxic substances into the water.

The commonly occurring water quality problems are summarized below (Ashton 2009; DWA 2011b; DWA 2010c; van der Merwe-Botha 2010).

8.3.1.1 Salinity

Total dissolved solids (TDS) are used as an indicator of the amount of various inorganic salts dissolved in water and are used to determine the state of water resources. Salinity is the quantity of total dissolved inorganic solids, or salts, present in water. Dissolved salts in freshwater systems come from agricultural return flows and urban and industrial run-off. Increased salinity of water leads to reduced crop yields, scale formation and corrosion of water pipes and changes in freshwater biotic communities (DEAT 2006). High levels of salinity are a major limiting factor in the fitness for use of water. Salinization is a persistent water quality problem throughout most of South Africa.

Some river systems are naturally saline due to geological conditions, for example in the Northern, Western and Eastern Cape. In some areas groundwater shows high levels of salinity which are above the recommended concentrations for human use (Ashton 2009). In these cases the aquatic ecosystems have naturally adapted to the salinity levels.

8.3.1.2 Eutrophication

Eutrophication refers to the enrichment of water with nutrients (nitrates and phosphates). This encourages the growth of microscopic green plants and algae and can promote the growth of cyanobacteria, presenting a toxic threat to aquatic fauna and human users of the water (DEAT 2006). Eutrophication causes the depletion of oxygen in water which can lead to mass mortalities of biota. Sources of nutrients in our water resources result from domestic waste water treatment, application of fertilizers on crops, and industrial and mining processes.

8.3.1.3 Micro-pollutants

Serious incidents of health impacts to people and animals have occurred through uncontrolled exposure to these micro-pollutants. This has resulted in increased attention focusing on pollution through metals, carcinogens, synthetic chemicals, pharmaceuticals, veterinary and illicit drugs (Ashton 2009; Olujimi 2010). Pollution of this type tends to be highly localized and associated with specific industries or activities. Further, ingredients in cosmetics, personal care products and food supplements may concentrate endocrine disrupting chemicals in the environment. These pollutants may also enter water through accidental spills and via stormwater runoff after rainfall events.

Aquatic biodiversity is particularly at risk from micro pollutants and endocrine disrupting chemicals since the aquatic environment provides a sink for hormonally-active chemicals, including industrial chemicals, pesticides, organochlorides, pharmaceuticals, natural and synthetic oestrogens or phytoestrogens (Olujimi 2010; van der Merwe-Botha 2010).

8.3.1.4 Microbiological pollutants

Water contaminated by bacteria is the medium for the spread of diseases such as dysentery, cholera, skin infections, and typhoid. Many of these diseases can be attributed to poor sanitation practices arising from poorly maintained, or a lack of adequate sanitation infrastructure and is a widespread problem in South Africa (DEA 2006; DWAF 2004).

8.3.1.5 Sediment

Run-off from land-based activities such as agriculture or poorly designed developments (e.g. untarred roads), will carry sediment into rivers. Secondary effects of the increased sediment load are that the useful lifespan of dams is decreased due to a loss of storage capacity, the lifespan of pumps and pipes is diminished and the integrity of rivers is compromised through sedimentation. Sedimentation can have substantial economic implications in terms of infrastructure maintenance costs as well as increased costs to manage the water resource.

8.3.2 State of water quality in South Africa

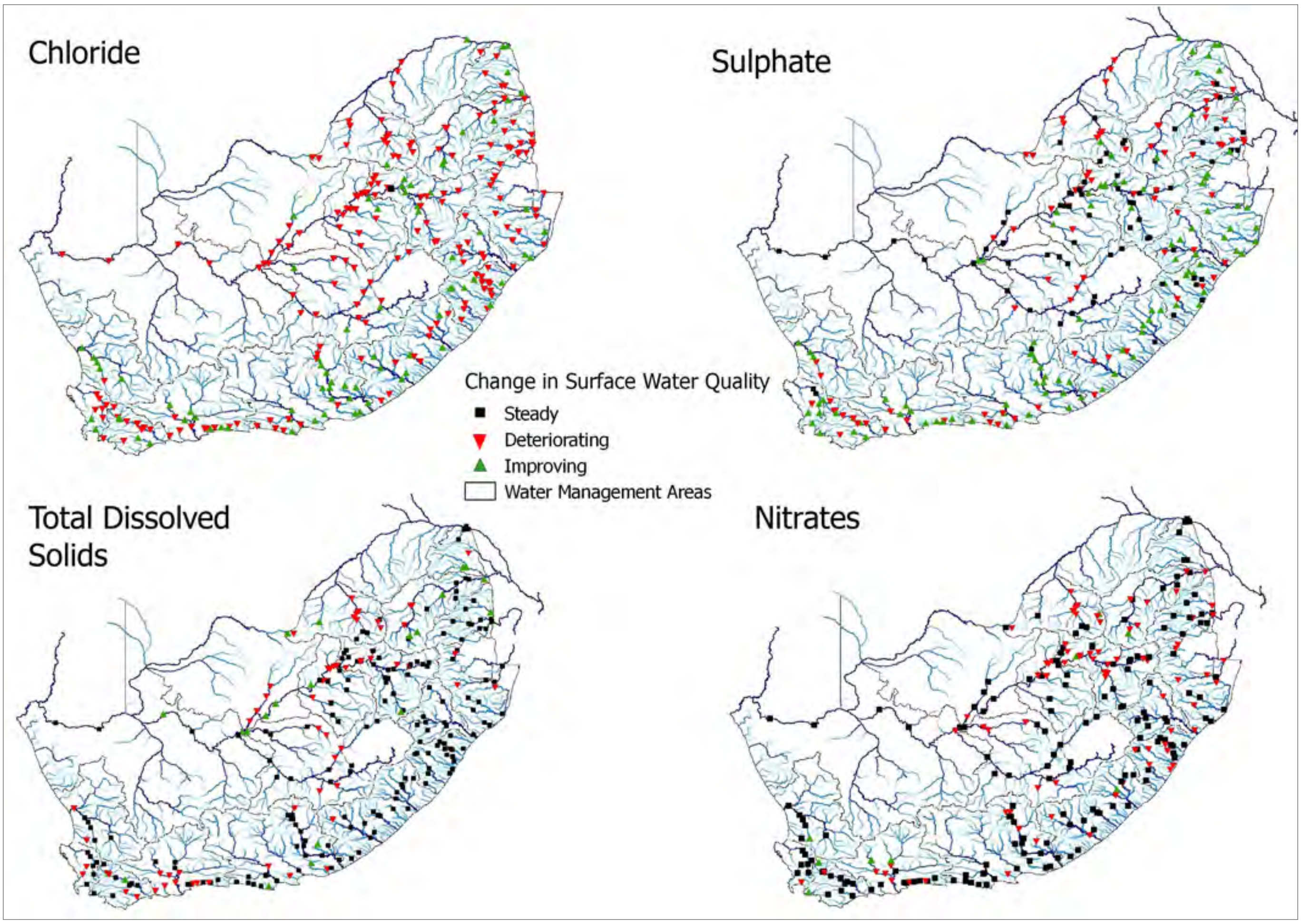
Data from the National Chemical Monitoring Programme was used for determining the ten-year medians and trends in water chemistry for samples of surface water (DWA: Resource Quality Services). Map 8.5 shows four indicator variables (chloride, sulphate, total dissolved solids and nitrates) from 2003 to 2012. The colours arbitrarily show the classification according to the 1996 guidelines for drinking water, although this may not be the primary water use at each site. Where enough data points are available for trend analysis, small triangles show an increase to a worse class or decrease to a better class. Round markers indicate that the variable stayed within the guideline range represented by the marker colour.

The results only show large changes, so visible trends such as the sulphate and total dissolved solids increase in the Olifants WMA are cause for concern as they most likely reflect the effects of mining activities. Increases in salinity at coastal sites are, however, often the natural result of seawater mixing in estuaries. The large changes in salinity evident along the Great Fish River are the result of transferring low-salinity water from the Orange River system into a naturally saline environment.

At the scale of the maps in Map 8.5, many local water chemistry problems remain hidden; regional and local planners need to make a much more detailed study of local data in the context of water users and pollution sources. For example, Map 8.5 does not show recorded microbial pathogens, trace metals or organic compounds, which may be of great importance at the local scale.

When compared to the results of the 2006 SAEO, it can be seen that water quality condition is continuing to deteriorate. Areas such as the Vaal, Crocodile and Olifants River systems are severely affected by salinity, which could be attributed to mining activities. However, some areas (coastal regions) have high salinity due to seawater intrusion. Compounded effects from agriculture, industrial development (including mining) and urban development have had a large effect on the quality of water and its fitness for use.

The main contributors to faecal pollution are a lack of proper sanitation facilities, rapid increase of unserviced informal settlements and ageing and overloaded municipal infrastructure. Faecal contamination is increasingly becoming a country-wide problem and poses a health risk to humans. Using water contaminated with faecal pollution can result in the transmission of water-borne diseases, such as cholera. It is therefore imperative for the users to partially treat the water before use.



Map 8. 5: Surface water quality trends for Chloride, Sulphate, Total Dissolved Solids and Nitrates for the period 2003 to 2012
Data are selected from DWA's WMS database, resampled and gap–filled to a regular monthly time series, then subjected to Mann Kendall seasonal decomposition of time series and loess trend line fitting. Visual inspection of the seasonal, trend and irregular component graph, in comparison with a time series plot of the regular data against the raw data in relation to the median value, yields the class value and any changes to a higher or lower class. The analyst makes a subjective decision as to whether a site has stayed the same, moved up by one or more classes or down by one or more classes during the period of analysis. The maps provide an overview of the information, so a study of the original time series plots is important for a more careful evaluation of the behaviour of the variable at each site.
Source: DWA National Water Quality Monitoring System 'Top 333 Sites' 2005 to 2010

8.3.3 Trophic states of major dams

Water resources that are very rich in nutrients are referred to as eutrophic. Eutrophication in South Africa is mainly caused by inadequately treated sewerage effluents that are discharged into river systems. Other sources of high nutrient loads resulting in eutrophication include industrial effluents, agriculture, households, and urban and road surface runoff (Harding 2011; Oberholster & Ashton 2008).

The DWS National Eutrophication Monitoring Programmes uses chlorophyll and phosphorus levels to assess the status of dams. Dams are classified as either mesotrophic, oligotrophic, eutrophic or hypertrophic (Table 8.2 and Table 8.3).

Data from the monitoring programme indicates that some dams are severely impacted, particularly those in the urbanized areas. A number of dams are classified as hypertrophic namely, Hartebeespoort, Bon Accord, Bospoort, Roodeplaat, Roodekopjes, Glen Alpine, Mutshedzi, Albasini, Bronkhorstspruit, Spitskop, Nagle and Shongweni Dams.

Hypertrophic dams are defined as those that have a very high nutrient concentration and water quality problems are serious and may be continuous (DWAF 2002). Rietvlei Dam and Vaalkop Dam have been classified as eutrophic with a serious and significant risk of algal productivity. Map 8.6 shows the location and trophic status of major impoundments in South Africa and a definition of each trophic level is provided in Table 8.2. The classifications of the trophic levels is provided in Table 8.3.

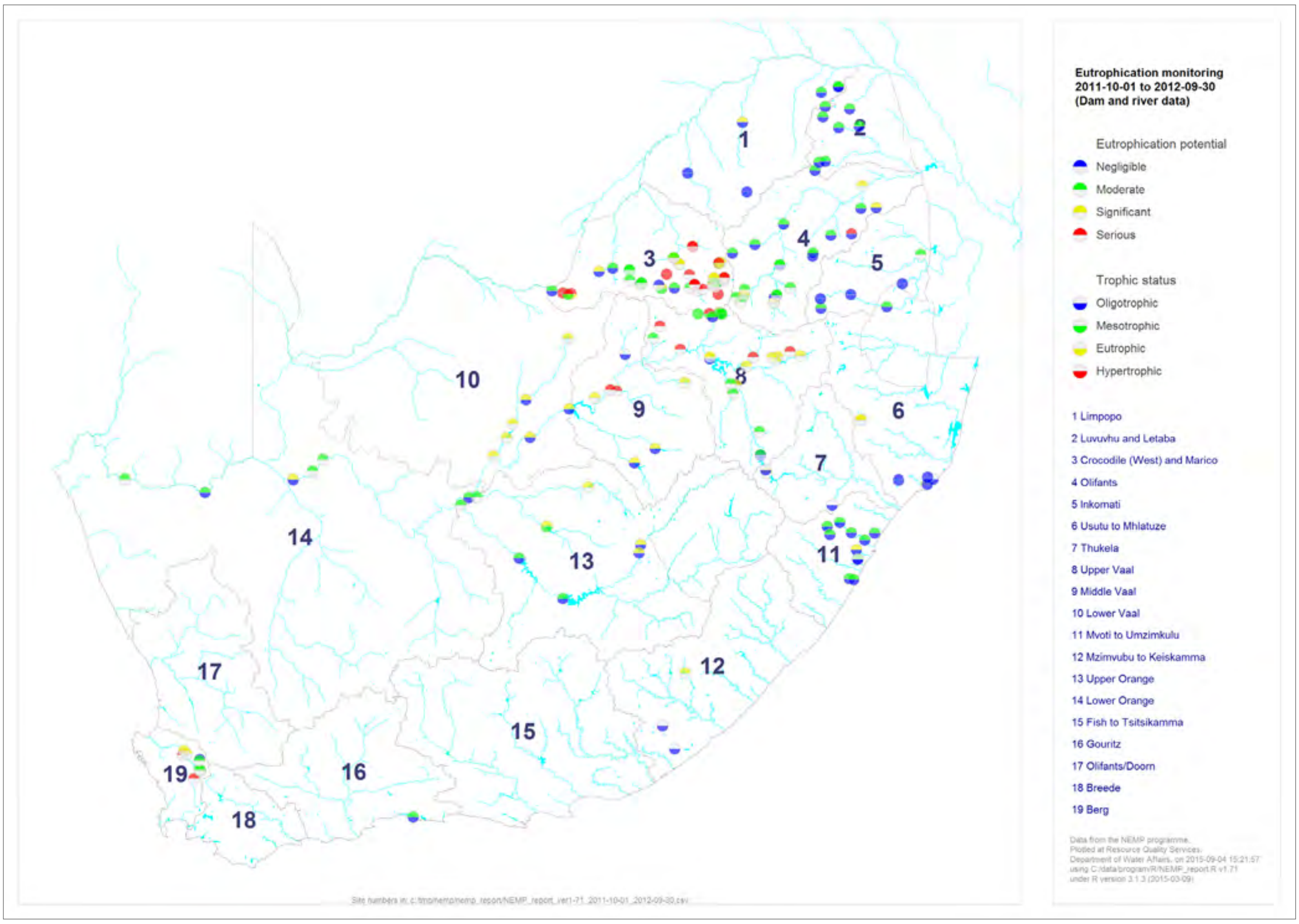
Table 8. 2: Definitions of trophic status

Mesotrophic	Intermediate levels of nutrients, fairly productive in terms of aquatic animal and plant life and showing emerging signs of water quality problems.
Eutrophic	Rich in nutrients, very productive in terms of aquatic animal and plant life and showing increasing signs of water quality problems.
Hypertrophic	Very high nutrient concentrations where plant growth is determined by physical factors. Water quality problems are serious and can be continuous.

Source: DWAF (2002)

Table 8. 3: The classification of the trophic status

Mean annual chlorophyll a (µg/l)	**Current trophic status**			
	0<X ≤10	10 < X ≤ 20	20 < X ≤ 30	>30
	Oligotrophic (low)	Mesotrophic (moderate)	Eutrophic (significant)	Hypertrophic (serious)
% of time chlorophyll a > 30 µg/l	**Current nuisance value of algal bloom productivity**			
	0	0 ≤ X ≤ 8	8 < X ≤ 50	> 50
	negligible	moderate	significant	serious
Mean annual total phosphorus	**Potential for algal and plant productivity**			
	X ≤ 0.015	0.015 < X ≤ 0.047	0.047 < X ≤ 0.130	>0.130
	negligible	moderate	significant	serious



Map 8. 6: Trophic status of major impoundments where water quality problems are present
Source: DWAF (2012)

Table 8. 4: Trophic status of water selected dams in South Africa

Dam name	Description of status and risk*
Bon Accord, Bospoort, Roodeplaat, Roodekopjes, Bronkhorstspruit and Shongweni Dams	Hypertrophic, serious and decreasing risk for potential and current algal productivity.
Hartbeespoort and Klipvoor Dams	Hypertrophic, serious and increasing risk for potential and current algal productivity.
Nagle, Glen Alpine, Mutshedzi, Albasini and Spitskop Dams	Hypertrophic, significant and decreasing risk for potential and current algal productivity.
Rietvlei and Vaalkop Dams	Eutrophic, serious and decreasing risk for potential and current algal productivity.
Cooke S Lake, Olifantsnek and Koster River Dams	Mesotrophic, serious and decreasing risk for potential and current algal productivity.
Mzinto, Albert Falls, Hazelmere, Nsami, Bloemhof and Egmont Dams	Mesotrophic, significant and decreasing risk for potential and current algal productivity.
Blyderivierspoort Dam and Vaalharts Barrage	Oligotrophic, significant and decreasing risk for potential and current algal productivity.
Welbedacht, Modimola, Umtata, Henley, Nungwana, Maguga, Midmar, Jericho, Lake Mzingazi, Nandoni, Rhenosterkop, Tonteldoos, Vlugkraal, Buffelskloof, Flag Boshielo, Ohrigstaddam, Lindleyspoort, Middelburg, Vaal, Boskop, Taung, Koppies, Sterkfontein, Knellpoort, Gariep, Vanderkloof, Disaneng, Boegoeberg, Bulshoek, Voelvlei, Misverstand and Gubu Dams	Oligotrophic, serious and no change in risk for potential and current algal productivity.
Lotlamoreng, Rust de Winter, Loskop, Kalkfontein and Clanwilliam Dams	Oligotrophic, serious and increasing risk for potential and current algal productivity.

Summer seasonal data from the National Eutrophication Monitoring Programme 2004 to 2010
** Refer to Table 8.2 for the trend explanation*
Source: DWAF (2012)

Of concern is the dams that have been classified with a serious (>0.13 mean annual TP mg/l) or significant ($0.047<x\geq0.13$ mean annual TP mg/l) risk of algal productivity. This would be expected with high nutrient loads. The trophic status of selected dams in South Africa is presented in Table 8.4.

8.3.4 Impacts of eutrophication

Eutrophication is a major cause of water pollution and leads to multiple effects, including:

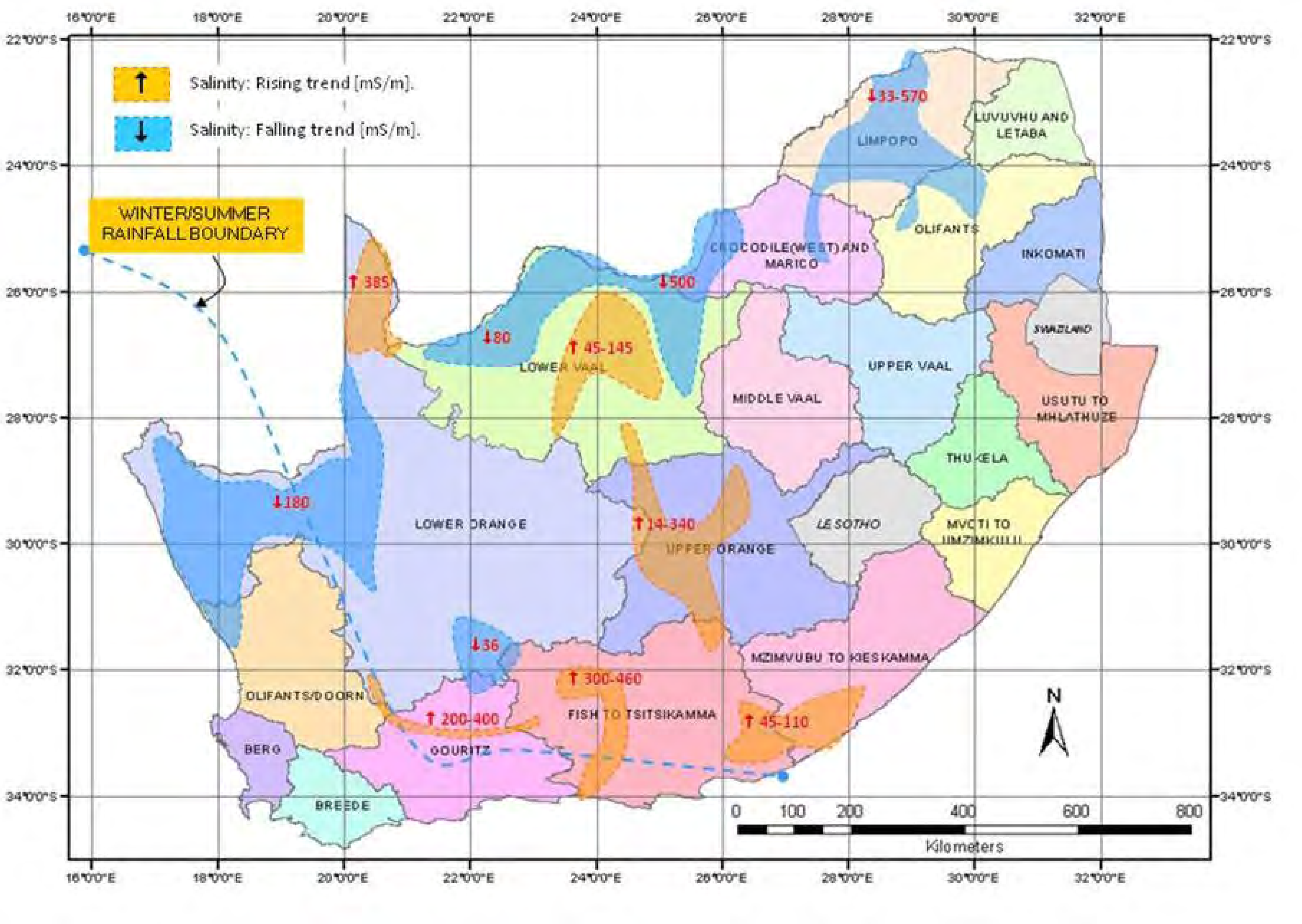
- Excessive growth of aquatic plants and/or algae can result in ecosystem degradation and decrease of aquatic species due to the depletion of dissolved oxygen;
- The presence of algal toxins poses direct threats to human and animal health, via consumption or exposure. Cyanobacterial toxins may be taken up by fish rendering their consumption a health risk;
- The recreational value of a lake or dam deteriorates;
- Eutrophication increases the cost of drinking water treatment; and,
- The ingested toxins cause reactions ranging from respiratory difficulties, gastrointestinal symptoms, skin rashes, ear pain and eye irritation to liver and nerve damage (Harding 2011; Oberholster & Ashton 2008).

Algal toxins pose a direct threat to human and animal health. Exposure may occur through direct contact with the water or using the water for laundry, personal hygiene or cultural practices. Consumption of contaminated water includes water for cooking and drinking, as well as through consumption of fish that have been exposed to the algae. The toxins cause reactions ranging from respiratory difficulties, gastrointestinal symptoms, skin rashes, ear pain and eye irritation to liver and nerve damage (Harding 2011; Oberholster & Ashton 2008).

8.3.5 Groundwater quality

Groundwater pollution and over-abstraction are serious problems in certain parts of South Africa. Poor and deteriorating groundwater quality is widespread and can be attributed to diverse sources in sectors such as mining, industrial activities, effluent from municipal wastewater treatment works, storm water runoff from urban, especially informal, settlements where adequate sanitation facilities are often lacking, return flows from irrigated areas, effluent discharge from industries and various other sources (DWA 2010b).

The quality of groundwater is classified as generally good potable drinking water with little or no need for treatment at large scale. However there are areas where salinity levels are increasing (Map 8.7), resulting in deteriorating quality.



Map 8. 7: Groundwater salinity trends for South Africa in 2012
Source: DWAF (2012)

Some groundwater resources have been relatively poorly managed in the past. The major reason has been a lack of a structured approach to management, and a lack of knowledge and information about groundwater (DWA 2010b). Management is often focused on the long-term sustainability of the resource in terms of quantity or yield, whereas water quality is often neglected in many areas where groundwater is the sole source of water supply.

8.3.6 Acid mine drainage

AMD has become a major challenge in South Africa especially in the Witwatersrand, as the impacts of over a century of active mining are now starting to be felt. AMD is a legacy issue and is essentially ownerless and litigation attempts around liabilities have not been successful.

AMD refers to the highly acidic waters (with high concentrations of metals, sulphides, and salts) resulting from mining activity. AMD results from drainage from underground mine shafts, run-off and discharge from open pits and mine waste dumps, tailings and ore stockpiles (CSIR 2009). The threat from mine water pollution is long-term as AMD production can continue for many years after mines close and tailings dams are decommissioned (Oelofse 2008). Examples given by Oelofse (2008) include post-closure decant from defunct coal mines of approximately 62 Ml/d and about 50 Ml/d of acid mine water discharged into the Olifants River Catchment (Maree *et al.* 2004).

The challenge is not specific to the Witwatersrand, where low pH mine water containing high concentrations of heavy metals and radionuclide's, decants uncontrolled into the Western, Central and Eastern Basins' surface water systems, but also poses a risk to all extensively mined areas of South Africa, including the platinum and coal belts.

Research further shows that groundwater in mining areas of Johannesburg is heavily contaminated, contains AMD and has high concentrations of heavy metals. In cases where the water table is near the surface, the upper 20 cm of soil profiles have shown severe contamination by heavy metals. Polluted groundwater is being discharged into streams and contributes up to 20 per cent of the stream flow (Oelofse 2008).

Decanting of AMD through groundwater basins on the Witwatersrand (Western, Central and Eastern Basins) first appeared in 2002 in boreholes and later in open and abandoned mineshafts (McCarthy 2011). Existing pumping infrastructure installed within the Western Basin is inadequate to effectively control the rate at which water is decanting

(Council of Geoscience 2010). The majority of decanting water drains into the Tweelopie Spruit, a tributary of the Crocodile River, and to a lesser extent the Wonderfonteinspruit. Impacts from flooding of underground voids include increased seismic activity and contamination of shallow groundwater resources and geotechnical impacts close to the surface. Where the water surfaces, it will pollute surface-water resources and devastate ecological systems. Indirect impacts on the ecological systems may also result, for example, pumping of underground acid water at the Grootvlei Mine in the Eastern Basin results in water being discharged into the Ramsar-listed Blesbokspruit wetland.

The rise in acid water levels has the potential to trigger seismic activity. This is confirmed by studies (Durrheim *et al.* 2006; Goldbach 2009) which found that rising water levels in the mine voids lead to an increase in seismic activity, similar to that experienced during active mining.

The Report to the Inter-Ministerial Committee on Acid Mine Drainage (DWA 2010d) identified a number of common sources of water entering the underground workings and compounding the problem. These are:

- Direct recharge by rainfall falling onto open mine workings;
- Groundwater, recharged and infiltration after rainfall;
- Surface streams that lose water directly to mine openings;
- Enhanced water seepage from tailings; and,
- Water loss from sewage and storm water reticulation systems.

AMD is a problem not only for gold mining, but also impacts along the coal and platinum belts of Mpumalanga, North-West and Free State. AMD originates from different places, and river catchment areas cross provincial boundaries, thus highlighting the need for cross-border water management. A debate is under way at a national level about the allocation of management obligations and the most appropriate mitigation options.

An associated legacy which is largely overlooked is the impact of erosion of polluted slime dams sediments into watercourses. There are more than 100 slime dams in the Witwatersrand area alone, many of which are long abandoned and receiving no maintenance.

8.4 FRESHWATER ECOSYSTEMS

8.4.1 State of aquatic ecosystems

Aquatic ecosystem health refers to the condition or 'resource quality' of water resources, as well as to its distinct dependant biota, within the in-stream, wetland and riparian habitats (Karr, 1999). The National Water Act clearly identifies the relationship between aquatic ecosystem health and the ability to secure ecologically sustainable development and use of the water resources. Aquatic health status is measured by its ecosystem state through bio-monitoring, flow monitoring and water quality assessments which provide an indication of the state of ecosystem, its response to drivers of change, ecosystem service provision and use of the resource.

Development and refinement of standardized bio-monitoring indices (WET-Health, Estuary-Health and River Health) has led to an ever more accurate understanding of the dynamics and value of the economic, social and ecological needs of water resources.

Pressures are created on these systems by impacts such as pollution, soil erosion or deposition, extraction of water, afforestation, shifting distribution patterns of fauna and flora, large dams, inter-basin transfers and the introduction of invasive alien species. These factors are leading to wide-spread and rapid deterioration of freshwater ecosystems in South Africa (Driver *et al.* 2004; Nel *et al.* 2011; SAEON 2011).

8.4.1.1 River health indicators of ecological change

Healthy rivers provide goods and services (water supply, natural products, breakdown of pollutants, conservation, flood attenuation, recreation and spiritual value), which contribute to human welfare and economic growth, as well as sustaining freshwater and terrestrial biodiversity (RHP 2005). Using these ecosystem goods and services in an irresponsible or unsustainable manner has a negative impact on the status of the river health and its available future use resource quality.

The results of the River Health Programme (RHP) (Box 8.1), which monitors the state of rivers, provides a very good indication of our human use impacts as well as the value of our management actions to secure our water resources for future generations. Table 8.5 shows the ecological (eco-status) and management perspective of river condition against which rivers are scored.

Box 8. 1: Adopt-a-River Programme

Moving beyond the civic and civil institutes, the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP) leads the implementation of the RHP and the 'Adopt-a-River Programme', which essentially provides a framework for public interest in contributing to the protection of inland water resources via supporting local clean-up events, local monitoring projects and contributing to capacity building of school learners and for women empowerment. The Adopt-a-River Programme has been rolled out to regional and local government level with implementation occurring at many of the pilot rivers in the country: Western Cape (Eerste and Doring Rivers), Gauteng (Jukskei and Klip Rivers), Mpumalanga (Olifants River), Limpopo (Levubu and Mokolo Rivers), Eastern Cape (Umtata and Buffalo Rivers), KZN (Umsunduzi, Isipingo and Pongola Rivers), Free State (Modder and Riet Rivers), Northern Cape (Harts River) and North-West (Crocodile River). The focus of the programme is now not only on awareness-building of school learners and the public, but also capacity building (monitoring, river safety, health and skills development), job creation (temporary employment of the poor during clean-up events and utilization of locals by local water boards as monitoring champions), as well as of women empowerment and ownership.

Table 8. 5: River health categories

Category	Ecological perspective	Management perspective
Natural (N)	No or negligible impact.	Relatively little human impact.
Good (G)	Biodiversity and integrity largely intact.	Some human-related disturbance but ecosystems essentially in good state.
Fair (F)	Sensitive species may be lost, with tolerant or opportunistic species dominating.	Multiple disturbances associated with the need for socio-economic development.
Poor (P)	Mostly only tolerant species present; alien species invasion; disrupted population dynamics; species are often diseased.	High human densities or extensive resource exploitation.

Source: DWAF (1999)

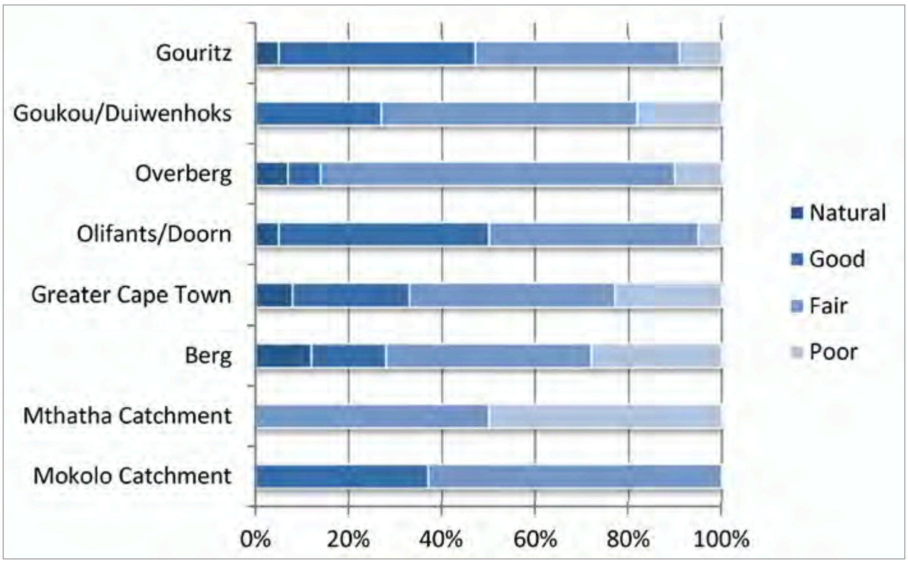


Figure 8. 1: Eco-status of River Health Surveys reported on from 2005 to 2006
Source: DWAF (2006)

General trends from these surveys indicate that the systems assessed generally have a good to fair river health condition in their upper reaches and tributaries (with the exception of the Gauteng and Mpumalanga regions), and fair to poor conditions in the lower reaches, with most rivers in highly urbanized areas, such as Gauteng, being in poor condition. Further information can be obtained from the RHP website (http://www.dwaf.gov.za/iwqs/rhp/index.html).

Changes to the condition of a river can be attributed to abstraction of water and changes in flow (for example as a result of dams and weirs), pollution, destruction of river bank, loss of natural vegetation within the catchment (for example as a result of urban expansion, cultivation and mining) and invasive alien plants. When the condition of a river declines it will disturb the ecological functioning of rivers and its ability to provide ecosystem services to surrounding communities (Nel *et al*. 2011).

To date, eco-status surveys of rivers have been done on a limited number of river systems in South Africa. All the assessments show that river systems are mostly in a fair to poor condition, and rivers have experienced extensive modifications by people (DWAF 2006). Figure 8.1 shows that of the rivers assessed, only in very few cases are rivers in a natural condition.

8.4.1.2 Wetlands

Wetlands are defined in the National Water Act as "*land which is transitional between terrestrial and aquatic systems, where the water table is usually at or near the surface, or the land is periodically covered with shallow water or would support vegetation typically adapted to life in saturated soils*". The NBA (NBA 2011) calculated that wetlands make up only 2.4 per cent of the country's area and this relatively small area provides a disproportionately high value of ecological infrastructure providing critical ecosystem services such as water purification and flood regulation (Driver et al. 2012). The NBA further concluded that in many areas of South Africa the "*outright loss of wetlands is estimated to be more than 50 per cent of the original wetland area*" (Driver et al. 2012).

Wetlands are extremely valuable natural resources, with high environmental, economic, aesthetic, spiritual, cultural and recreational value. Wetlands provide significant habitat refugia to biota, as well as essential livelihood services to humans rendering water storage, supply and treatment services. As an example, wetlands have the ability to remove nutrients associated with agricultural runoff, thus helping regulate the nutrient levels in water bodies and preventing groundwater contamination. Wetland destruction will result in increased eutrophication of water bodies (de Villiers & Thiart 2007).

Wetland resources are often underappreciated resulting in inadequate management thereof, unwise exploitation and poor wetland integrity (UNESCO 2011). The main pressures on wetland ecosystems are diverse and include most land development activities such as cultivation, urban development, mining, dam construction and poor grazing management, combined with broader catchment impacts such as disruption of freshwater flows, pollutants and sediment from surrounding land uses (Driver *et al.* 2012).

Our understanding of wetlands and how to manage them has increased significantly in recent years. This has been supported by significant wetland classification projects such as the National Wetlands Inventory Project and the National Spatial Biodiversity Assessment (NSBA) which provides an estimate of the extent, diversity and condition of our wetland resources (Driver *et al.* 2004). This information formed a basis for the NFEPA atlas and provides the basis for wetland ecosystem status assessments (health, services and importance) and sensitivity (vulnerability) for the purpose of effective ecological and management implementation (DWAF 1999 & 2007; Kotze *et al.* 2005; Nel *et al.* 2011; SANBI 2009).

The ecological status of wetlands is discussed in Chapter 7: Biodiversity and Ecosystem Health.

8.4.2 Impacts of freshwater aquaculture

Freshwater aquaculture production has increased between 2006 and 2010, recording an increase of 234.65 tonnes or 11.6 per cent (DAFF 2011). Trout (*Oncorhynchus mykiss* and *Salmo trutta*) are the most cultured freshwater species in South Africa, followed by the culturing of ornamental species. The freshwater species cultured in 2010 included trout, tilapia (*Oreochromis mossambicus*), catfish (*Clarias gariepinus*), carp (*Cyprinus carpio and Ctenopharyngodon idella*), mullet (*Liza richardsonii*), largemouth bass (*Micropterus salmoides*), marron crayfish (*Cherax tenuimanus*), Atlantic salmon (*Salmo salar*) and a number of ornamental species (DAFF 2011).

Aquaculture may result in negative consequences on freshwater ecosystems such as the loss or alteration of natural habitats, the introduction of exotic species, threats to species biodiversity, changes in water quality, and the introduction and spread of disease (DAFF 2011).

8.4.3 Free-flowing rivers

Free-flowing rivers are defined as rivers which have not been dammed, and flow undisturbed from source to confluence with another large river, or the sea (Nel *et al.* 2011). They are important from an environmental perspective and often contain the least impacted and most pristine examples of rivers. An important criterion is that they are free of dams, thereby allowing river species to move freely up- and downstream. Free-flowing rivers should be considered for inclusion when planning further expansion of protected areas.

South Africa has only 62 free-flowing rivers, or sections of free flowing rivers, which constitute four per cent of our river length, and of these, only 25 are longer than 100 km (Nel *et al.* 2011). Free-flowing rivers have become a very rare feature in the South African landscape as most of our rivers are already dammed or largely modified. This is evident in Gauteng and the Free State which do not have any free flowing rivers left. NFEPA has identified 19 flagship free-flowing stretches of rivers that should be kept free-flowing (Nel *et al.* 2011).

8.4.4 Invasive alien plants

Invasive alien plants (IAPs) pose a direct threat not only to South Africa's biological diversity, but also to water security, ecological functioning of natural systems and productive land use. It is estimated that at least 10 million hectares of land in South Africa has been invaded by IAPs with an estimated water use of 3,303 million m^3 per annum (Le Maitre *et al.* 2000). IAP surveys undertaken by the Agricultural Research Commission (ARC) show that IAPs are concentrated in urban and agricultural landscapes and infestation densities are highest in Gauteng, Mpumalanga, KZN and the Eastern and Western Cape. The implications for IAP management, or the lack of management, correlate strongly to water resource availability and fitness for use.

8.5 RESPONSES

Given the variability of surface water run-off, South Africa relies on dams and transfer schemes to ensure a reliable supply of water to locations of high economic activity. Water reconciliation programmes aim to strategically address economic, industrial, agricultural, ecological, domestic and sustainable water provision requirements. The outputs of these policy studies seek to support and align to existing programmes and different water users through co-operative governance mechanisms. These initiatives include programmes for eradication of alien invasive terrestrial and aquatic plants under the WfW programme, the treatment and re-use of wastewater, the implementation of desalination plants (Chapter 9: Oceans and Coasts), and implementation of strategic augmentation and transfer schemes.

8.5.1 Challenges to effective water management

South Africa faces a number of current and emerging issues related to effective water resource management. Whilst there is potential for development of groundwater resources in rural areas, surface water resources are already constrained and in some catchments potential water shortages are predicted for the future. The water quality challenge is linked to the variability of the available water quantity in South Africa as well as human impacts and poor management of the resource. Climate change, and possible further variability in water supplies, may add another layer of complexity to the problem.

A secure and safe water supply is essential for economic development. The Free Basic Water Programme aims to ensure that poor households receive 6,000 litres of free basic water per month and free basic sanitation services. Significant progress is being made to ensure access to water supply and sanitation services at all schools and clinics and in rural areas and informal settlements. Access to clean drinking water, along with access to health facilities and services, plays a major role in addressing water-related diseases and improving the health and quality of life of all people (UNESCO 2011).

South Africa's challenge is that it must continue to increase economic development to reduce poverty levels and improve livelihoods. An additional complexity to this challenge is that most of this economic development will happen in the established metropolitan areas where water resources are often already oversubscribed creating a spatial disconnect between where the water resources are and where they are needed (DWA 2009; DWAF 2004).

8.5.2 Catchment management agencies

For integrated water resource management to occur, and as part of implementing the National Water Act, Catchment Management Agencies (CMAs) must be established in South Africa. CMAs are intended to decentralize governance of water resources from national to a water management area level. By 2011, only four of the 19 planned CMAs had been established, a process which was taking a long time to implement. These 19 CMAs may be rationalised to nine, which will align with the new nine WMAs. This is supported by various infrastructure, finance, capacity-building and management programmes. Currently almost three per cent of the national budget is allocated to water governance, and additional funds are provided for specific water-related programmes and infrastructure development (DWA 2011a).

8.5.3 Protecting and managing freshwater resources

8.5.3.1 Resource directed measures

Water resource protection is legislated in South Africa through the implementation of the National Water Act and incorporates two complementary strategies: Resource-directed Measures and, Source-directed Controls.

Resource-directed measures (RDMs) aim to achieve a balance between protecting the water resources and utilizing the water resources for social and economic development. RDM comprises three main measures, namely: classifying water resources using a promulgated Classification System for Water Resources; the determination and implementation of the Ecological Reserve (ecological water requirements); and, the setting of Resource Quality Objectives (RQOs). The Water Resource Classification System (WRCS) was formally established in September 2010 whereby water resources were categorized according to specific management classes that represented a management vision of a particular catchment. The WRCS defines three management classes, from resources that are minimally-used to heavily-used. The classification of water resources represents the first stage in the protection of water resources and determines the quantity and quality of water required for ecosystem functioning as well as maintaining economic activity that relies on a particular water resource. The WRCS is being progressively implemented in major river systems such as the Vaal, Olifants, and Olifants-Doorn where proposed classes have been determined. Other river systems where classification of water resources has commenced is the Crocodile (West) Marico, Mokolo and Matlabas catchment, the Letaba and Mvoti to Umzimkulu WMAs.

Source directed measures (SDM) are measures to protect water resources (for example rivers and wetlands) by preventing and/or minimizing potential polluting activities, and limiting impacts to acceptable levels as defined through RDM, through imposing regulatory controls (e.g. water use authorizations, regulations, best practice guidelines, etc.) and by providing incentives.

8.5.3.2 Ecological state of freshwater systems

DWS is finalizing a desktop Present Ecological Study (to determine the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) assessment for the whole country (sub-quaternary reaches). Although it is a desktop assessment, the project makes efficient use of available and local expert knowledge.

The PES assessment is based on anthropogenic changes to the physical divers of the system (e.g. hydrology, geomorphology and physio-chemical conditions).

The DWS is also considering innovative approaches to river health monitoring with limited resources. This includes real time monitoring of variables such as flow, pH, electrical conductivity and temperature to set thresholds of concern and flag problems when these are exceeded.

8.5.3.3 Freshwater ecosystem priority areas

Freshwater Ecosystem Priority Areas (FEPAs) describe the *"strategic spatial priorities for conserving freshwater ecosystems and supporting sustainable use of water resources"* (Nel *et al.* 2011). River and wetland FEPAs are available for the whole of South Africa and identify those freshwater ecosystem resources that are a priority for management in a natural or near-natural condition for continued provision of essential ecosystem services. These are presented as maps depicting the current knowledge for freshwater ecosystems, and are being continuously updated as new data or knowledge becomes available.

FEPAs should inform the process of catchment planning, water resource classification, reserve determination, setting and monitoring of RQOs, as well as facilitating water-use license applications (Nel *et al.* 2011).

In order to meet ecological targets identified within the NBA and to maintain the provision of ecosystem services, rivers and wetlands identified as FEPAs should remain in a good ecological condition (natural or near-natural) (Driver *et al.* 2012; Nel *et al.* 2011). Wetlands and estuaries identified as FEPAs should be afforded the best attainable ecological condition. The state of river ecosystems inside FEPAs is presented in Chapter 9: Biodiversity and Ecosystems Health.

> *"By treating less than a quarter (22%) of our rivers as priority areas, to be maintained in a natural or near-natural state, South Africa will be able to conserve examples of its diverse freshwater ecosystems while contributing to sustainable development of water resources in the country."*
> *Source: NFEPA Atlas (2011)*

8.5.3.4 Invasive alien species

In terms of its broader mandate, the WfW programme also facilitates skills development by implementing on-the-job capacity building, alien plants awareness and job creation to historically disadvantaged individuals, in particular women, youth and people with disabilities, as well as contributing to social development awareness campaigns, such as those around HIV and AIDS. The WfW programme has spent R3.2 billion between 1995 and 2008 on controlling the spread of IASs (van Wilgen *et al.* 2012).

The IAP survey concludes that the programme has not been entirely successful in preventing the loss of ecosystem services at a national scale and those overall negative impacts of invasive alien plants may continue to grow. However, progress has been made with the mechanical clearing of some species and others have been reduced in extent and impact.

It is estimated that without the IAP control programmes run by WfW, the annual economic losses from alien plant invasions may be as high as R41.7 billion , as opposed to the current estimated loss of R6.7 billion (van Wilgen *et al.* 2012). Importantly, WfW has served as a successful job creation programme and has created 20,000 employment opportunities annually over the 15-year period it has been running (Figure 8.2).

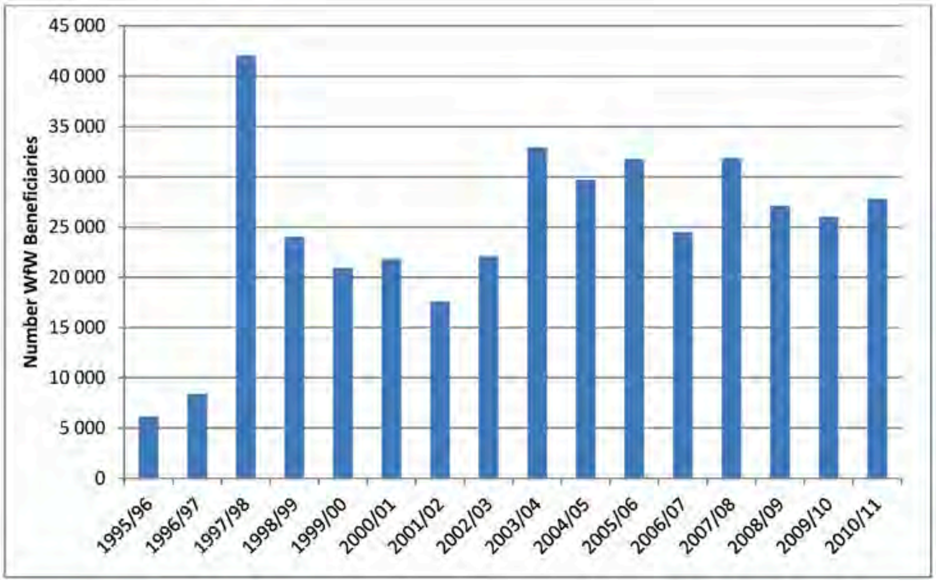


Figure 8. 2: WfW Programme: National statistics for job creation (number of beneficiaries) during alien plant clearing operations

Source: WfW Annual report statistics (2010 to 2011)

8.5.4 Ensuring water fit for use

8.5.4.1 Blue Drop status

In September of 2008, the Minister of the then Department of Water Affairs and Forestry (DWAF) introduced the concept of the Blue Drop Certification Programme for drinking water quality management regulation and the Green Drop Certification Programme for wastewater quality management regulation. Together, these two incentive-based regulation programmes form a holistic and transparent approach to drinking water quality management and wastewater quality management for future generations and the health of our natural environment.

A total of 162 municipalities and 914 water supply infrastructure network systems were assessed in 2011, i.e. all municipalities and systems within South Africa (DWA 2011c). This exceeds the Outcomes 10 target (targets set by national government) of 810 systems to be assessed by 2014. Not only has the number of municipalities and water supply systems assessed improved, but a gradual improvement has been recorded across the country.

In 2009, the National Blue Drop score was recorded at 51.4 per cent, in 2010 the status improved to 67.2 per cent, and 72.9 per cent in 2011 (DWA 2011c). This shows a marked improvement in the quality of water supplied by Water Service Authorities. Table 8.6 shows the various aspects assessed for national certification, the outcomes over the past three years and as well as a performance trend.

In 2011, the number of systems found to be 'excellent' increased to 66 from 38 Blue Drop awards in 2010. Despite the national improvement in performance, not all provinces showed a positive trend. This can be attributed to a number of factors, including increasingly rigorous requirements for the assessment, a growing demand for water, inadequate maintenance and operational deficiencies. These declines also have implications for maintaining potable water quality.

The Blue Drop scores are presented per province, over the past three years as percentages, in Table 8.7. Amongst these scores, the Western Cape produced the highest number (29). However, in the Eastern Cape, North West and Mpumalanga scores have dropped from those recorded in 2010 to 2011.

Table 8. 6: Comparative analysis of Blue Drop Status at a national level

Blue Drop Comparative Analysis:	2009	2010	2011
Number of municipalities assessed	107	153	162
Number of water supply systems assessed	402	787	914
Number of Blue Drop scores ≥50%	183 (45.5%)	370 (47.0%)	536 (58.7%)
Number of Blue Drop scores <50%	219 (54.5%)	417 (53.0%)	378 (41.3%)
Number of Blue Drop awards	25	38	66
National Blue Drop score	51.4%	67.2%	72.9%

Source: DWA (2011c)

Table 8. 7: A comparison of provincial blue drop scores as percentages

Province	2009	2010	2011	Performance trend
Gauteng	74.4	85.54	95.1	↑
Western Cape	No data	No data	94.09	↑
KwaZulu-Natal	73	65.91	80.49	↑
Eastern Cape	54.33	79.4	77.33	↓
Free State	40.03	48.5	64.01	↑
Limpopo	40.82	54.95	64	↑
North West	39.97	66.01	62.25	↓
Northern Cape	28.3	46.87	62.07	↑
Mpumalanga	51	65.42	56.5	↓

Key: ↑ = Improved ↓ = Deteriorating

Source: DWA (2011c)

8.5.4.2 Green Drop status

The Green Drop Certification Programme focuses on regulating and improving wastewater quality management in the country. The Green Drop assessment assesses the entire functioning of municipal wastewater services, with a specific focus on the risks to wastewater treatment. In this manner the Green Drop Certification Programme allows for identification, quantification and management of risks according to potential impact on the water resource and to ensure a prioritized list of municipal systems that are not functioning optimally. It is important to note that there is no direct correlation between Green Drop reporting and ecological integrity.

A total of 156 municipalities and 821 wastewater systems were assessed in 2010, compared to 98 municipalities and 444 systems in 2009; this exceeds the Delivery Agreement Outcomes 10 target for wastewater treatment works assessed by 2014, which includes 700 systems. Table 8.8 shows the national performance of waste water treatment works from 2009 to 2011 as a comparative analysis and performance trend.

The number of Green Drop scores greater than 50 per cent in 2011 has decreased to 44 per cent. This trend is as a result of the 377 ‘first time’ systems that were assessed, many of which achieved low Green Drop scores, very similar to the 2009 results.

The Green Drop report uses a cumulative risk rating to describe the risk to waste water infrastructure being able to perform its treatment of waste water to the required standard (DWA 2011d). It is calculated by looking at the design capacity of each plant linked to operational flows and capacity, as well as the non-compliance trends for effluent quality discharged to the receiving water body and compliance with the required technical skills to operate the plant. While the national picture looks stable to slightly negative, there are a number of plants that require urgent intervention. Unless those plants drastically improve their operations, the results will not show a positive risk profile for the country, and the health of the receiving environment will remain under threat.

Table 8. 8: National Green Drop comparative analysis

Performance category	2009	2010/11	Performance trend
Number of municipalities assessed	98	156 (100%)	↑
Number of wastewater systems assessed	444	821	↑
Average Green Drop Score	37%	45%	↑
Number of Green Drop Scores ≥50%	216 (49%)	361 (44%)	↓
Number of Green Drop Scores <50%	228 (51%)	460 (56%)	↓
Average Site Inspection Score	33	40	↑
Provincial Green Drop Score	N/A	51.40%	N/A

Key: ↑ = Improved ↓= Deteriorating N/A = Not applicable

Data source: DWA (2011d)

8.5.5 Water use licensing

Section 21 of the National Water Act defines the 11 different water uses which require licensing. Water uses are only permissible in one of a few ways namely, either under Schedule 1, as an existing lawful use, in terms of a general authorization or through a licence under the National Water Act. The Minister has the sole jurisdiction to authorize new water uses as defined in Section 21. All authorized water uses need to be registered on the DWS Water Authorization and Registration Management System (WARMS) database.

Apart from these water uses, Section 21 makes provision for a non-inclusive list of permissible water uses, which require regulation by an authorization application process for a water use licence authorization (WULA).

Compulsory registration and licensing for water use in South Africa has become a regulatory mandate through the National Water Act. Over the last decade the task of registering and licensing water use applications has grown rapidly and placed strain on the DWS to process the applications, resulting in a backlog of licenses that still need to be processed. Table 8.9 provides a list of the approved and pending water use license applications.

Project Letsema was initiated to fast track the processing of the current WULA backlog faced by the DWS. To date it is estimated that 4,000 WULAs have been finalized by the project. The project has identified weaknesses in the WULA evaluation process and provided a clear basis for DWS to streamline its evaluation approach to prevent a similar backlog situation arising in the future. Importantly, the requirement for a critical mass of DWS officials required for the WULA evaluation process nationally and regionally, is now recognized, as is the need for WULA applicants to properly compile their submissions to the DWS for its timeous attention.

Table 8. 9: Approved and pending applications under section 21 of the National Water Act

Current office name	Total applications
Approved water use license applications	
Eastern Cape	247
Free State	188
Gauteng	47
KwaZulu-Natal	2,068
Lower Orange - Northern Cape (Upington)	48
Lower Vaal - Northern Cape (Kimberley)	92
Mpumalanga	95
North West	7
Western Cape	17
TOTAL	**2,809**
Applications still to be processed	
Eastern Cape	128
Free State	74
Gauteng	60
KwaZulu-Natal	316
Limpopo	18
Lower Orange - Northern Cape (Upington)	34
Lower Vaal - Northern Cape (Kimberley)	127
Mpumalanga	466
North West	251
Western Cape	133
TOTAL	**1,607**

Source: DWA National Register of Water Use WARMS database

8.5.6 Management of groundwater resources

There is still considerable potential for development of groundwater resources in South Africa, but not in all regions. Groundwater exploitation is an option for smaller towns and agriculture as well as for larger cities such as Cape Town and Nelson Mandela Bay Municipality (DWA 2010c). A 2010 National Groundwater Strategy is available for South Africa to guide its use and protection. Proper operation, maintenance and management plans need to be developed and implemented for each municipality to ensure sustainable use of its groundwater resources.

8.5.7 Vulnerability and climate change

Water sources are not evenly distributed in the country, and as water availability becomes more limited this could result in the migration of people to areas of greater water availability, placing further pressure on major water resources. As natural disasters increase, this could increase the number of destitute individuals migrating to urban areas, exacerbating pressures on natural resources, increasing pollution and disease outbreaks (Zietsman 2011).

During times of drought often one of the first responses in South Africa is to drill boreholes and make use of groundwater. A climate change adaptation response strategy for South Africa should include groundwater considerations in its responses given its ability to relieve water stress in some areas. The advantage of groundwater is that it experiences much lower evaporation and slower declines during drought periods and will therefore be less directly and more slowly impacted by a changing climate (DWA 2011e). However, since rainfall is the main source of recharge to aquifers, in the long term climate change can have dramatic impacts on groundwater resources. Sustainable management of the groundwater resources as an integral part of a municipality's available water resources needs to be stressed.

All South Africans depend on water resources and the healthy functioning of ecosystems for life-supporting services and resources as well as for resilience to natural variability (SAEON 2011). The degradation of water sources as a result of nutrient loading, and consequently eutrophication, will be exacerbated by climate change in frequency and duration. Increasing nutrient loading and blooms of cyanobacteria will also result in progressive outbreaks in health associated risks. This will negatively impact on all South Africans, while rural communities will be most impacted as they rely on ecosystem goods and services as a direct lifeline for natural resources for harvesting, agricultural practices, consumption and other livelihood strategies.

Freshwater ecosystems have an important role to play in ecosystem-based adaptation to climate change, which focuses on managing, conserving and restoring ecosystems to buffer humans from the impacts of climate change, instead of relying only on engineered solutions. This approach can help society cope with the effects of increased variability in rainfall, such as droughts, floods and storms. For example, buffers of natural vegetation along riparian corridors and around wetlands have been shown to mitigate floods, reduce erosion and improve water quality (NBA 2011).

8.6 CONCLUSION

The demand for access and use of water resources in South Africa is increasing as the country develops and this has had an effect on water availability, water quality and the state of aquatic ecosystems. The state of many of our water resources continues to deteriorate and many river systems are in a state of stress. Major river basins of South Africa are shared with neighbouring countries, making managing water a regional concern. The current state of water points to a need to manage, use and allocate water differently to how it has been done in the past. A willingness to change attitudes to water management is needed and to manage water as a scarce resource. Government responses to water management are slowly starting to reflect this.

A large task lies ahead to deal with water quality problems such as AMD, eutrophication and salinization of resources. The Green- and Blue Drop reports also highlight the inability of some regions to effectively treat sewage and industrial effluent in a manner that it can be returned to rivers without further compromising water quality.

The goal is to move away from a situation where there is *"a gradual decline in the volume of water available per person, progressive worsening of water quality, loss of biological integrity in our aquatic ecosystems, and continually rising costs associated with treating water for people to drink. Ultimately, this will prevent us from achieving social and economic growth and eliminating poverty".* (Ashton 2010).

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