NATIONAL STATE OF THE ENVIRONMENT PROJECT

INLAND WATER

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6 INLAND WATER

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SOUTH AFRICA'S INLAND WATER RESOURCES AT A GLANCE

What are the main issues?

- Essential to life but South Africa is a semi-arid country
- Essential for national socio-economic development and well-being and environmental sustainability
- Over-exploitation and degradation of the resource are having high opportunity costs
- A move to water conservation and water demand management is imperative
- More sustainable management and equitable benefit-sharing has massive beneficial opportunities for the country

What is the condition of our inland water resources?

- We have degraded a significant proportion of our exploitable water resources
- Our river ecosystems are severely degraded and effluent pollution continues to grow
- Almost all exploitable sources have been tapped

What are the main causes of change?

- Rapid, uncontrolled development demands severely impacting resource-base
- Historical supply-side management has lead to degradation and opportunity loss in many cases
- Increasing effluent discharge and pollution
- Decreased fresh water flows and declining quality overall
- Impacts of climate change

What consequences does this have?

- We have less water available, of poorer quality
- Livelihoods and food resources have been lost and will continue to be lost unless we turn the negative cumulative impacts around

How does this affect me?

- Everyone needs to reduce their water consumption
- Water will generally become less available and more expensive, affecting poor people first and most
- Deteriorating water quality will have negative health and recreation impacts

Are there opportunities?

- New, improved understanding and the new legal management framework requires enforcement to reverse unsustainable trends
- With adequate enforcement of new measures, socio-economic benefits can be sustained and grown

How is South Africa responding to issues of concern?

- Improved access to water resources
- National Water Act
- National Water Resources Strategy
- Greater commitment to water conservation and demand-side management

6.1 INTRODUCTION

Fresh water is an essential resource for life on a daily basis for all terrestrial organisms, including humans (Box 6.1). Although water is generally a renewable resource, it requires careful management and protection due to its vulnerability to over-exploitation and susceptibility to pollution. This is particularly the case in South Africa where, in terms of the United Nations definition, South Africa is a water stressed[a] country.

In Sub-Saharan Africa, most fresh water resources are located in transboundary watercourse systems and shared river basins. Management and protection of these shared basins is required through strong commitment to regional collaboration within the Southern African Development Community (SADC). Similarly, the environmental initiatives of the New Partnership for Africa's Development (NEPAD) include a framework for regional co-operation on water resources, as well as processes for ecosystem (including wetlands) restoration, drought relief and combating desertification, sustainable agricultural production and biodiversity conservation. It is thus a key initiative for achieving improved water resources management for social, economic and environmental security in Africa[1].

Besides the use of water itself, the manner in which land is used and pollution from a variety of sources can have a major impact on water resources. The use of water resources affects the functioning of estuaries and coastal waters. Climate change is predicted to affect the amount and distribution of rainfall and rates of evaporation. The complexity of all these interactions must be taken into account in South Africa’s water resource policy and calls for an integrated approach to water management[2]. Aquatic ecosystems rely on both sufficient quantity and suitable quality of water, thus the concept of water-users is not restricted to human demands but also relates to the requirements of South Africa’s (and our neighbouring countries) aquatic ecosystems.

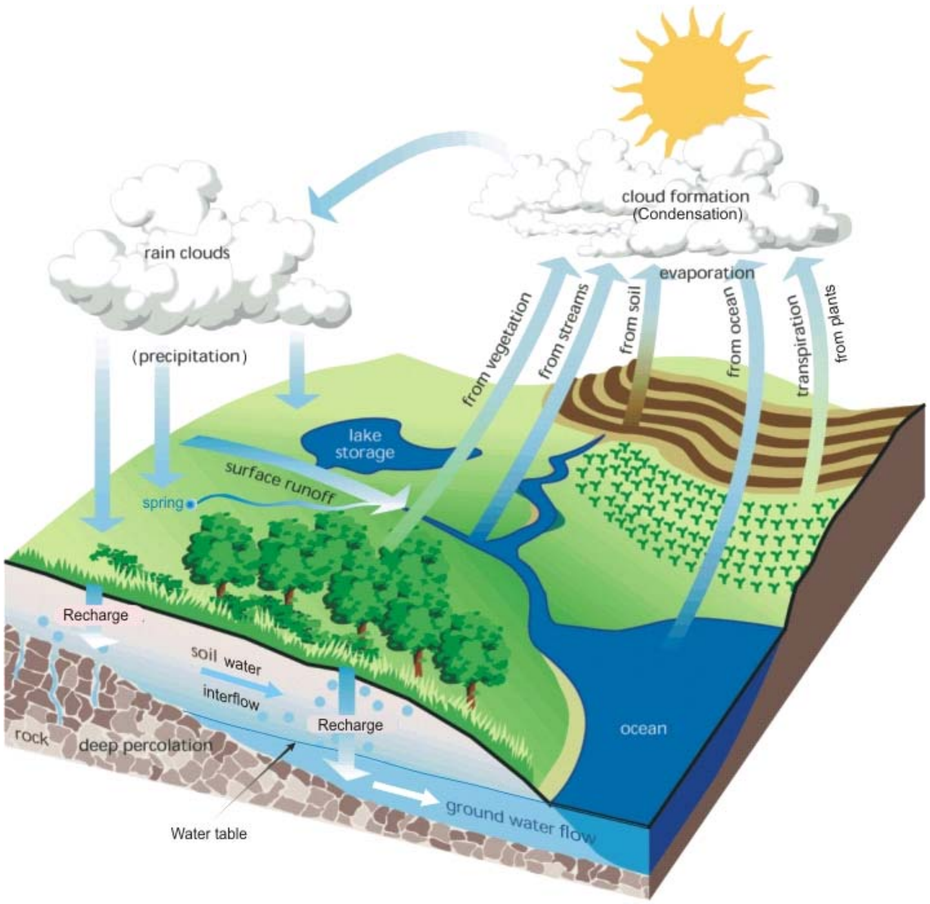
6.2 THE AVAILABILITY OF WATER IN SOUTH AFRICA

How much water can be used for either direct human use or to support aquatic ecosystems is dependent 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 accordingly.

6.2.1 Source and availability of water resources

The average rainfall in the country is about 450 millimetres per year (mm/yr) [3], about half the world average of 860 mm/yr, with a water supply *per capita* of just over 1100 cubic metres (m^3)/year[4]. The geographical distribution of rainfall, and subsequent availability for supply, is highly variable, with the eastern and southern part of the country receiving significantly more rain than the north and western regions. South Africa’s inland water resources are the rivers, dams, lakes, wetlands and subsurface aquifers, which together with natural mechanisms (such as rainfall and evaporation) and anthropogenic influences (such as abstraction and discharges), form the hydrological cycle (Figure 6.1) that controls the quality and quantity of our inland waters. Within the cycle, there are complex interactions between surface and ground water and between the water and the sediments, banks, animals, plants and microbes in rivers, dams and wetlands that must be taken into account in water management. The chemical suitability of the water is dependent on the source of water, the geology of the area, the ecology of the area and human activities.

[a] Availability of less than 1700 m^3/person/yr constitutes water stressed with values below 1000 m^3/person/yr classified as water scarce



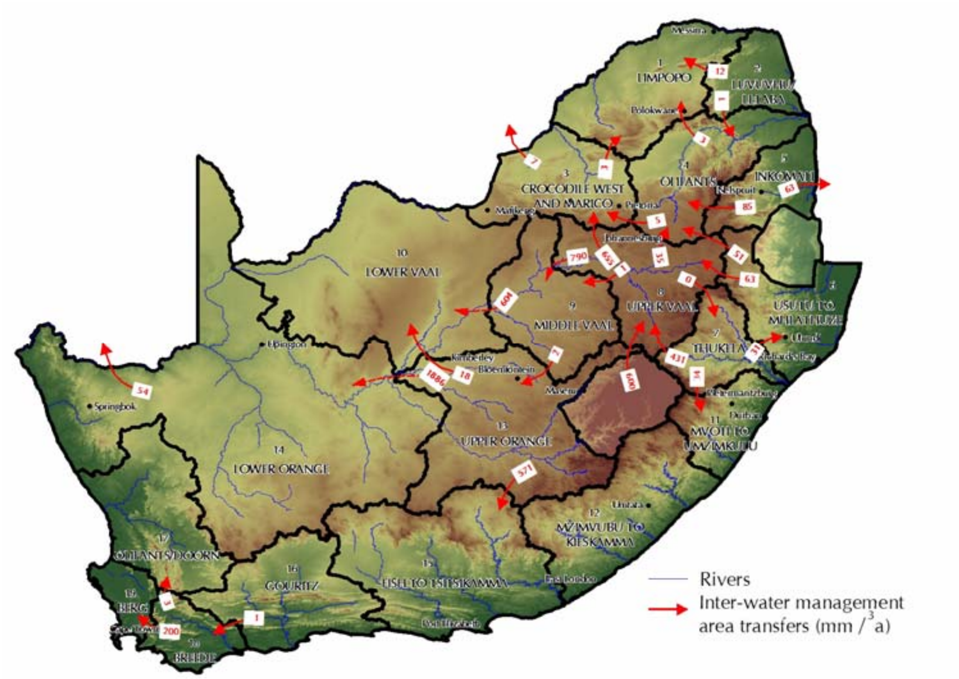
Source: Adapted from WW2010 (2005) [5] *and Parsons (2004)* [6]
Figure 6.1: The hydrological cycle

The majority of South Africa's water requirements are sourced from surface water supplies (rivers and dams). Groundwater makes a contribution to baseflow in the perennial rivers along the eastern escarpment and wetter north eastern parts of the country, and is important in rural areas and areas where surface water is less available, for example the greater Orange River catchment[3]. Ground water occurs in different types of aquifers that range in depth, size and capacity, with groundwater flow generally mimicking surface topography and often closely interacting with surface waters.

Box 6.1: Services provided by inland waters

- Essential for human life both directly (for drinking) and indirectly (e.g. provision of water for livestock and watering of dryland and irrigated crops; overall floral and faunal life).
- Crucial for maintenance of ecosystem health, both terrestrial and aquatic as well as biodiversity.
- Provides habitat for many flora and fauna both within the water itself and along the riparian corridors and wetlands associated with the water resource.
- Enables livelihoods (indirectly, and directly e.g. fishermen, farmers, forestry, recreation, reed use for thatching and basket making).
- Facilitates power generation (for cooling in coal- and gas-fired stations and as the power source in hydro-electric power stations).
- Water is a key raw material for industry and mining.
- Transport and storage medium for raw water supply and removal of waste – these may be integrally linked in water short areas such as Gauteng.
- Enables the movement of sediment by erosion and deposition with subsequent sculpting of the land, provision of sand to the coastal zone (e.g. beaches) and provision of rich silts onto floodplains.
- Wetlands and other aquatic ecosystems provide storage capacity, trap sediments, provide opportunities for groundwater recharge and flood attenuation, as well as being able to assimilate some pollutants (including nutrient and toxic materials).
- Linked to these services are issues of health, poverty, climate change, afforestation, desertification and land use change.

Water resources are presently amalgamated into 19 Water Management Areas (WMAs) covering the country (Map 6.1) A significant amount of water transfer between these WMAs, both national and international, occurs (see Section 6.2.2.)



Source: DWAF (2004)[3]

Map 6.1: Water management areas and inter-basin transfers

Table 6.1 indicates the local yield[b], local demand and transfers in and transfers out for each of the WMAs. The local yield is calculated from the contribution from both natural resources and usable return flows (irrigation, urban and mining/industrial). The table also indicates the percentage population and economic activity, represented by gross domestic product[c] (GDP) in the different WMAs. Deficits in available water exist in over half the WMAs, but there is a theoretical surplus for the country as a whole.

Table 6.1: Water Management Area ecological reserve and yields (million m^3/a), and the percentage population and Gross Domestic Product

Water management area	% Population	% GDP	Ecological Reserve	Local yield (4)	Local demand	Transfer in (3)	Transfer out (3)	Balance (1,2)
1 Limpopo	3.5	1.3	156	281	322	18	0	(23)
2 Luvuvhu/Letaba	3.7	0.9	224	310	333	0	13	(36)
3 Crocodile West/ Marico	13.0	24.0	164	716	1 184	519	10	41
4 Olifants	6.1	5.3	460	609	967	172	8	(194)
5 Inkomati	3.5	1.2	1 008	897	844	0	311	(258)
6 Usutu to Mhlatuze	5.1	1.8	1 192	1 110	717	40	114	319
7 Thukela	3.5	1.6	859	737	334	0	506	(103)
8 Upper Vaal	13.3	19.3	299	1 130	1 045	1 311	1 379	17
9 Middle Vaal	3.4	3.8	109	50	369	829	502	8
10 Lower Vaal	2.8	1.8	49	126	643	548	0	31
11 Mvoti to Umzimkulu	12.5	11.4	1 160	523	798	34	0	(241)
12 Mzimvubu to Keiskamma	10.2	3.5	1 122	854	374	0	0	480
13 Upper Orange	4.9	5.3	1 349	4 447	968	2	3 149	332
14 Lower Orange	0.8	0.7	69	(962)	1028	2035	24	(9)
15 Fish to Tsisikamma	3.8	4.0	243	418	898	575	0	95
16 Gouritz	1.0	0.9	325	275	337	0	1	(63)
17 Olifants/Doring	0.2	0.3	156	335	373	3	0	(35)
18 Breede	0.9	0.8	384	866	633	1	196	38
19 Berg	8.0	11.8	217	505	704	194	0	(5)
Total for country	**100**	**100**	**9 545**	**13 227**	**12 871**			

Source: DWAF (2004)[3] – note timeframe for population and GDP not specified in the NWRS so assumed to be from 2001 census data

1. Brackets around numbers indicated negative balance or deficit.
2. Surpluses in the Vaal and Orange WMAs are shown in the most upstream WMA they become available
3. Transfers of water may include transfers between WMAs, as well as to or from neighbouring countries. Yields transferred from one WMA to another may also not be numerically the same in the source and recipient WMA. For this reason, the addition of transfers into and out of WMAs does not necessarily correspond to the country total. The transfer of water from Lesotho to South Africa is reflected in the table as being from the Upper Orange WMA.
4. The yield takes into account the volume required for the ecological component of the Reserve, river losses, alien vegetation, rainfed sugar and urban runoff

Although the yield indicated in Table 6.1 takes account of the estimated allowance for protection of aquatic ecosystems (ecological reserve), there is generally incomplete understanding of the functioning and habitat requirements of these systems[3]. Variability exists between different catchments, with estimates of requirements needed to sustain the aquatic ecosystem part of the Reserve[d] varying from 12% of the total river flow in drier parts of the country to 30%. Estuarine requirements are also poorly understood[3]. Some of the reported deficits reflect that the allowances for the ecological component of the reserve are not being met with current levels of use.

[b] The yield is the volume of water that can be abstracted at a certain rate over a specified period of time for supply purposes

[c] GDP: Gross Domestic Product is the total market value of all the goods and services produced within the borders of a nation during a year.

[d] The Reserve is the volume and quality of water required for basic human needs and maintenance of aquatic ecosystems

Most of the 9 million people supplied with basic water since 1994 have been supplied from groundwater resources[6]. However, the hard-rock nature of South Africa's geology and water quality constraints mean that only about 20% of groundwater occurs in major aquifer systems that can be used for large-scale supply, for example to small towns[3].

Estimates of groundwater available for development indicate potential for expansion, but as recharge, a key parameter in understanding and quantifying groundwater resources, is difficult to quantify, a precise assessment of the availability of groundwater is difficult[6]. Almost 98% of aquifers in South Africa are classified as secondary (flow occurs largely through fissures, cracks and fractures). Major secondary fractured aquifers include those of the Table Mountain Group and the Karoo Supergroup. Significant primary aquifers (flow occurs through the original pore space in the geological material) occur on the Cape Flats, along the Zululand coast, and in some major river channels such as the Crocodile River in Limpopo Province.

6.2.2 Pressures on water use and demand

Given the multiple and sometimes competing uses of water, the National White Paper on Water Policy[2] highlighted the need for integrated management that would ensure access to water for the growing sectors of the economy but equally not damage the ecosystems from which the water was derived. It emphasized the importance of ensuring that our neighbours have access to their legitimate share of the resource. South Africa's main legislation relating to water resources is therefore based on this integrated approach to managing quality and quantity of surface waters, groundwaters and aquatic environments. The need to protect water resources is balanced with the need to use water for social and economic development and therefore stakeholder involvement is an explicit requirement of the National Water Act No 36 of 1998 (NWA).

6.2.2.1 Increased urbanization and industrialization

The post-apartheid transformation taking place in the country has led to improved standards of living for many South Africans, including an increased demand for water. The water requirements for the different water-use sectors estimated for 1996 and 2000 are given in Table 6.2. The values are standardized to 98% assurance of supply[e].

The NWRS looked at different scenarios relating to growth in population and gross geographic product[f]. The base scenario (using a GDP growth of 1.5% per year) does not show a pronounced difference from the year 2000 situation. Using both the base case and the high growth scenario (using a GDP growth of 4%), the country is likely to end up with a deficit of between 234 million m^3/a and 2 044 million m^3/a by 2025.

Table 6.2: Water demand (million m^3/a) for different sectors in 1996 and 2000

Water use sector	1996	2000
Irrigation	12 344	7 920 (1)
Afforestation		428 (2)
Urban	2 171	2 897 (3)
Rural		574 (3)
Mining/bulk industrial	1 598	755
Power generation		297 (4)
Total	**16 113**	**12 871**

1) There are significant uncertainties regarding quantities abstracted for irrigation and DWAF indicates that this sector will be receiving particular attention in future
2) Quantities given refer to impact on yield only – incremental water use by forestry plantations in excess of natural vegetation is estimated at 1 460 million m^3/a
3) Includes basic human needs at 25 litres per person per day
4) Includes water for thermal power generation only since water for hydropower is generally available for other uses

[e] A 98% assurance of supply means that under the variable rainfall and supply conditions in South Africa, an abstractor can obtain a viable supply 98% of the time.
[f] Gross geographic product is the GDP within defined geographic boundaries

Source: 1996 values from DWAF (1997a)[7] and 2000 values from DWAF (2004)[3]. In DWAF (2004), it is noted that discrepancies with previous data exist (particularly for irrigation and afforestation) due to changes in the primary assumptions, revised definitions, standardization of yield/assurance and new sources of data becoming available. The apparent reduction in demand is therefore considered an artefact of the data processing and not reflective of the actual situation.

The identified potential water available for supply (through the construction of new storage dams and the use of groundwater) is 5 410 million m^3/a, so water is not currently considered by the DWAF to be a limiting factor to economic growth[3]. However, considering that the effects of climate change on water availability have not been taken into account in the above analysis, and also that allocations for the ecological reserve have not yet been implemented, the deficits mentioned above are likely to increase. Further, it is questionable whether the further development of water resources is realistic given unequal geographic distribution of water resources and the associated technological requirements to correct this, and the capacity constraints of the DWAF. Such development will need to be responsibly managed to ensure protection of aquatic ecosystems and other ecological systems, and human settlements. Issues to be considered include the implications of transfer of water between areas (for example changes in flows, transfer of species, different chemistries), variable rainfall across the country and over time, loss of land with agricultural potential or areas of high biodiversity including aquatic systems; and climate change, which could exacerbate potential problems. Currently we discharge approximately 500 million m^3/pa of wastewater directly into the sea, a significant loss of and opportunity cost to this critical resource.

6.2.2.2 Land use changes

Changing patterns of land use (refer to Land Chapter) affect water flows and water availability in four main ways. Firstly, urbanization results in both increased impervious surfaces increasing the volume of runoff entering surface waters and reducing the volume recharging groundwater or, conversely, resulting in the introduction of new sources of recharge, namely leaking pipes or underground storage tanks and excessive irrigation of gardens and parks[6]. Secondly, the hydrological patterns (flow speed and volumes) are significantly altered by human activities including construction of dams, weirs, and bridges, canalization or diversion of watercourses, and mining within watercourses. Thirdly, land disturbance including overgrazing results in erosion with increased sediment loads entering watercourses. The material tends to settle where water moves slowly, such as dams, thereby degrading ecosystems, further reducing the storage capacity of these facilities and changing the flow dynamics of a river. Lastly, in South Africa alien vegetation generally utilizes greater volumes of water than indigenous vegetation, potentially resulting in reduced yields in affected areas. In some areas, alien vegetation has been estimated to reduce stream flows by up to 10%[8]. Removal of alien vegetation in the North West and Limpopo Provinces has resulted in a 20m rise in the water table over a 30 year period[6].

6.2.2.3 Policy and regulation

Although some of the structures and tools required to regulate South Africa's water resources are in place (through the terms of the National Water Policy 1997, NWA and Water Services Act No. 108 of 1997, amongst others), lack of capacity and financial resources within the regulating bodies have historically resulted in variable management and a lack of widespread enforcement. Water supply organizations should strive to supply water efficiently and effectively, minimize water losses (for example through leaking reticulation systems) and promote water conservation and water demand management (WC/WDM) among their consumers[3].

A key step in assisting DWAF with identifying and controlling water abstraction is provided by the NWA. It requires all existing water users to be registered. The time period for registration has now passed, so effectively, all users not covered by Schedule 1 of the Act, a

General Authorization or registered/licensed by DWAF, are taking water illegally. Based on the priority of the water-stressed nature of the WMAs, DWAF is in the process of issuing all the registered users with a water-use licence stipulating the volumes to be abstracted and the conditions applicable to the abstractor. Allocation of water not already in use, and re-allocation of water to achieve equity and beneficial use will form part of the licensing process. Guidelines have been developed to facilitate the equitable allocation and re-allocation of water[9]. It is considered imperative that DWAF take strong action against illegal abstractors.

6.2.2.4 Climate change

The South African study on water resource management and climate change[10] indicates that climate change is expected to alter hydrological systems and water resources in Southern Africa and reduce the availability of water.

In general, rising temperatures and increasing variability of rainfall will affect surface waters, increasing drought in some regions and floods in others, as well as on groundwater recharge. There is likely to be a general decrease of 5-10% of present rainfall[10]. Recent models using a local scale response to climate change, indicate more wetting in the east than the above models[11]. In general, wetting is expected over the eastern half of the country, particularly in the east coast regions where topography plays a significant role in wetting. In the Eastern Cape interior portions of the province are experiencing increased late summer rainfall. Drying is expected in the west of the country, particularly around the Western Cape, which appears to be facing a shorter rainfall season, and in the far northern area of the country in Limpopo province. Models indicate that the western half of South Africa could experience a 10% reduction in runoff by 2015[10].

6.2.3 Impacts of inadequate water resources management

Reductions in flow arising from some of the pressures indicated above can result in increased variability in availability, resulting in reduced levels of assurance of supply and thus increasing the cost of water to downstream users. The demand for scarce resources could lead to conflicts between different users. For example, the different users in the Olifants River WMA, with a deficit of 194 million m^3/a (Table 6.1) including plantations, irrigated farmlands, domestic and mining, have resulted in a significant stream-flow reduction. This has had negative affects on downstream aquatic ecosystems (many of which are found in conservation areas such as the Kruger National Park) and neighbouring countries (Mozambique and Swaziland).

Over-abstraction of groundwater (where abstraction exceeds recharge) by certain users, especially where recharge rates are low e.g. North West Province, could lower the groundwater such that groundwater is not available to other users[12]. Even if these activities are stopped, it could be many years before natural levels can be re-established.

Infrequent large events, such as prolonged droughts and severe floods, can reduce the availability of clean water, cause significant damage to infrastructure (for example bridges, weirs and dams) and lead to a loss of crops and livestock. Often, the effects of these major events last for several years, increasing the risk of people moving away from their traditional homes. The risk of such events is likely to increase because of climate change.

Further development of currently under-developed resources (for example in WMA 11 Mvoti to Umzimkulu, 12 Mzimvubu to Keiskamma and 13 Upper Orange) for water supply could result in about 5 400 million m^3/a being made available in the future[3]. However, this has significant economic (dams/pipelines are capitally expensive), social (loss of land and livelihoods) and environmental (loss of habitat and changes to aquatic ecosystems) implications. Each option will need to be thoroughly investigated through conducting environmental impact and socio-economic assessments to ensure long-term benefits to all stakeholders. Such an investigation is underway for the Olifants River Water Resources Development Project, which includes upgrades to the Flag Boshielo Dam and proposed construction of the De Hoop Dam[13].

6.2.4 Current management of water resources

The Minister of Water Affairs and Forestry, as the public trustee of the nation's water resources, has overall responsibility for all aspects of water resource management, though the Minister has delegated many of her powers to the relevant institutions. DWAF is currently responsible for implementing the requirements of the NWA, though its role will progressively change to focus on policy and strategy issues because the NWA requires the establishment of water management institutions, which include:

- Catchment Management Agencies (expected to be in place country-wide by 2011) that will manage water resources within specific WMAs and co-ordinate water related activities of the water users and other water management institutions;
- Water-User Associations as co-operative associations of individual users (for example irrigation boards);
- international institutions for managing international obligations - there are a number of bi-lateral and multi-lateral commissions with overall co-operation taking place within the framework of the SADC Protocol on Shared Water Courses (came into force in September 2003) including:
  - Botswana/RSA Joint Permanent Technical Water Committee;
  - Lesotho Highlands Water Commission;
  - Limpopo Basin Permanent Technical Committee;
  - Mozambique/RSA Joint Water Commission;
  - Orange/Senqu River Basin Commission;
  - Permanent Water Commission;
  - Swaziland/RSA Joint Water Commission;
  - Swaziland/Mozambique/RSA Tripartite Permanent Technical Committee.

The establishment of these institutions often involves extensive stakeholder consultation, which though essential in ensuring all views are considered, has contributed to delays in getting the necessary systems in place. Other responses to managing water resources are discussed below.

6.2.4.1 National Water Resource Strategy

A number of management mechanisms have been identified and adopted by DWAF as part of its NWRS. These measures are described below but apply equally to the sections on fitness for use and freshwater ecology. In addition to the strategies described below and institutional measures mentioned above, the NWRS indicates the need for water-related disaster management (floods, drought, dam-failure and pollution incidents) to be incorporated into the overall framework required by the National Disaster Management Act No. 57 of 2002.

The strategies proposed are broadly separated into 'resource- and 'source-directed' controls. Resource-directed measures focus on the overall health or condition of the aquatic ecosystem, from which the water is abstracted, and measures its ecological status. The key measure here is the grouping of water resources in terms of the national water resources classification system (indicating the degree of modification of the resource with each class representing a different level of protection), the Reserve[g] and resource quality objectives (which take into account the biological, chemical and physical attributes of the resource, as well as the user requirements). Specific actions in terms of resource-directed measures that require attention at national level in respect of water quality management include the following:

- formulation of objectives for managing sources of pollution and associated single-source interventions;
- benchmarking water resource quality;

[7] The Reserve is the volume and quality of water required for basic human needs and maintenance of aquatic ecosystems

- identification of emerging threats to the water resource and prioritization for action;
- establishing priorities in relation to, for instance, remediation of water resources and degraded land as a focus for regulation using source-directed controls.

Source-directed controls are focused on the use of the water resource and are intended to achieve the desired level of protection (as required by resource-directed measures). These can be further broken down into controls relating to:

- water use – licensing, water user associations and specific regulations (for example protection of water resources from mining activities is specified in Regulation GN704);
- water conservation and demand management – benchmarking for efficient water use, sector specific plans, control of invasive alien vegetation (for example the Working for Water programme, which has the added benefit of job creation; this is more fully reported on in the Biodiversity Chapter) and communication, community awareness and education plans;
- water pricing – water use charges combined with financial assistance where necessary.

6.2.4.2 Data and information availability

The availability of reliable data and information is critical for planning purposes. The monitoring and information systems that are in place, or proposed, include:

- **flow monitoring** at 800 stations (some of these are combined with off-takes or outlets, reservoir water level recording and meteorological stations) – this represents one station per 1 500 km^2. The target set by the World Meteorological Organization is 1 per 1 000 km^2, so the DWAF plans for another 500 to 1 000 stations to be developed over the next 20 to 25 years;
- **surface water quality** but with additional emphasis on microbial, toxicological and radioactivity monitoring (physico-chemical, eutrophication, biological and estuary monitoring are fairly well established);
- **groundwater** monitoring (because of its previous ‘private’ status was not monitored extensively in the past) will include monitoring of water levels and of physical, chemical and biological aspects of the water (initially only physical and chemical data will be collected but eventually monitoring will be expanded to include microbial, toxicity and radioactivity data);
- preparation of a **national scale map** indicating which river reaches are dependent on groundwater recharge and the quantification of groundwater use have been recommended;
- **water use registration and authorizations** to control the registration/application process, invoicing and links to other databases.

6.2.4.3 Water Resources of South Africa 2005 Project

The Water Research Commission (WRC), which is the major freshwater research institute in South Africa, has funded and published reports on many aspects of water resource management and has ongoing projects in five key strategic areas[14]. The first, Water Resource Management, includes the key Water Resources of South Africa 2005 Project, which is updating hydrological, meteorological, geohydrological (groundwater) and some water chemistry information for catchments in South Africa. The updated database (expected to be completed in March 2007) will form the baseline for national water availability studies into the future. The other key strategic areas are Water Utilization in Agriculture, Water Use and Waste Management and Water-Centred Knowledge and Water-Linked Ecosystems[14].

6.3 FITNESS FOR USE: WATER QUALITY

The fitness for use of water by either humans or aquatic organisms is dependent not only by its availability but also by the physical and chemical nature of the water. Different users and ecosystems have differing water quality requirements, which can be affected by natural processes, diffuse and point source discharges or by the diversion, storage or inter-catchment transfer of water.

The physico-chemical requirements of some users (including domestic, irrigation, livestock watering, recreation and aquatic ecosystems) have been defined in the Water Quality Guidelines produced by DWAF (1996)[15]. The Reserve Determination Process being undertaken by DWAF for each water resource indicates basic requirements for human needs, aquatic ecosystem maintenance and international obligations. For each resource, the Reserve specifies required flow, physico-chemical quality (ground and surface water) and biological quality (surface waters only).

Reduced fitness for use is generally associated with the activities of humans but can result naturally due to, for example, underlying geology (higher mineral content), biological processes (evapotranspiration, changes in pH or breakdown of organic matter from the soil), atmospheric deposition and evaporation (with consequent increase in salinity). Pollution of a resource occurs when too much of an undesirable or harmful substance is discharged into, or onto, the resource, resulting in the natural assimilative capacity of the resource being exceeded and rendering it less fit for subsequent use[h]. Often water used by industry or urban areas is returned to the resource for reuse by other users, but it may be returned in a degraded, unfit state.

Pollution of water resources occurs in the form of either point-source releases (for example discharges from sewage works and industrial activities) or diffuse inputs via air, land or surface runoff (for example, on-site sanitation can lead to high levels of nitrogen pollution in groundwater). Accidental spillage or waste releases can also be a potential problem. Examples would include spills of hazardous material during transport and litter from urban areas. The typical pollutants found in South Africa and the impacts of these on fitness for use are described in Box 6.2. The pollution of surface waters is generally more noticeable than groundwater pollution, the latter being more difficult to detect and to remedy than surface water[3]. Contamination of aquifers and subsurface discharge into surface water bodies is recognized as a problem. For example, over-irrigation and irrigation in areas underlain by naturally saline soils and rocks resulted in saline water discharging into the Breede River via the subsurface[6].

[h] the NWA definition focuses on reduced fitness for use and does not take into account the assimilative capacity of the water resource

Box 6.2: Water quality problems in South Africa

- *Salinity* refers to the quantity of total dissolved inorganic solids or salts in the water. Increased salinity can lead to salinization of irrigated soils, reduction in crop yields, increased scale formation and corrosion in domestic and industrial water pipes and changes in the biotic communities. Salinity can arise naturally or from activities such as mining, industry and agriculture. Humans can generally tolerate moderate salinity, though it may make the water taste salty (less than 1000 milligrams per litre (mg/l)). High salinity (in excess of 3 000 mg/l) can result in intestinal and renal illnesses and death. Due to the lack of dilution capacity, salinity is often the major limiting factor in determining fitness for use compared to other, wetter countries.
- *Water borne diseases* such as diarrhoea, dysentery, skin infections, intestinal worms, cholera, trachoma and schistosomiasis (bilharzia) arise from bacteria and parasites. These are generally associated with poor sanitation practices.
- *Low oxygen levels* occur when bacteria in the water breakdown organic matter, but in doing so use oxygen, which is required by other components of the aquatic ecosystem. Organic matter from animals, humans or plants can occur naturally in water as well as from poor waste disposal practices.
- *Eutrophication* is due to an accumulation of nutrients (mostly nitrogen and phosphorus compounds) in water. Of importance is the imbalance in the nitrogen:phosphate ratio where too much phosphorus will favour the development of potentially toxic Cyanobacteria. Anthropogenically increased levels of nutrients in water generally arise from domestic waste treatment, over-application of fertilizers and some industrial and mining processes. Nutrients such as ammonia and nitrate can be toxic at high concentrations (fish are particularly sensitive to ammonia) and can lead to excessive plant and algal production (for example the water hyacinth problem in Hartebeesport Dam in the 1970s and 80s), with the consequent reduction in oxygen levels when plants or algae die (see above) and, in some cases, toxin production.
- *Suspended solids* are sediments carried by the water and arise from excessive erosion, destruction of riparian vegetation, construction activities, over-grazing, as well as industrial or domestic discharges. Large quantities of suspended solids either in the water or sedimented-out can result in alteration of the habitat of some aquatic organisms with consequent changes in the composition of the stream-bed community, reduced spawning in fish by changing the stream bed characteristics and reducing their feeding efficiency (reduced visibility), blocked respiratory organs of fish and other aquatic animals, impeded gaseous exchange in plants, and increased turbidity reducing or preventing photosynthesis in plants.
- *Hydrocarbons* can have toxic effects and can block/smother the respiratory organs of aquatic animals. Hydrocarbons come from/are derived from fuels (oil, petrol and diesel), oils and grease (including food production).
- *Acidification* occurs when the pH of the water is reduced as a result of mining, industry, acid rain, waste disposal or some natural biological processes (for example in the fynbos region of the South West Cape). Lowering of the pH can mobilize metals such as cadmium and lead, which in turn can have toxic or other detrimental effects on aquatic ecosystems and water users.
- *Litter* takes many forms both inorganic (plastics, cans etc) and organic (vegetation, paper etc). It is unsightly, can degrade to release toxins or deoxygenate water resources, and physically can block watercourses resulting in reduced flows downstream and flooding upstream.
- *Other quality problems* that are being recognized as important but still requiring further investigation include endocrine disruptors, persistent or complex organic compounds (for example herbicides and pesticides), trace elements and radioactive materials.

6.3.1 State of our water quality in South Africa

Numerous water monitoring programmes are undertaken by the different tiers of government. Examples include DWAF's national water quality and microbial monitoring programmes, the River Health Programme (see Section 6.4.1) and monitoring by Local Authorities and service providers. The WRC has funded a number of research initiatives investigating collation of information from these different sources into DWAF's Water Management System (WMS) database, the Water Resources of South Africa 2005 Project described in 6.2.4.3, being one such initiative.

Currently, water samples from about 1 600 surface water sites and 450 groundwater sites across the country are being collected, analysed and the results added to the WMS. In 2002, DWAF published the National Water Resource Quality Status Report[16]. The study used data from over 150 representative sites (selected from the WMS) to determine the suitability (from a physico-chemical perspective) of surface water resources for domestic, irrigation and recreational uses. Other than aquatic ecology, these uses generally have the most stringent requirements. The results were based on data collected between 1996 and 2000, so are relatively outdated. However, the report is likely to be updated in 2006/7 using 2001 to 2005 data[17].

The restriction on the fitness for use posed by the physico-chemical water quality of the different WMA with respect to domestic, irrigation and recreational use is given in Table 6.3. The data are consolidated for each WMA and so do not show the inherent vulnerability present within these large areas. The table also includes the conservation status, as determined by the National Spatial Biodiversity Assessment[18] (see Section 6.4).

Table 6.3: Physico-chemical restrictions on fitness for use in the different WMAs

WMA	Domestic Use	Irrigation (1)				Recreation (2)	Conservation status
		SAR	EC	pH	Cl		
1 Limpopo	No restrictions						3
2 Luvuvhu/Letaba	No restrictions			(+)			3
3 Crocodile West/ Marico	No restrictions			(+)		X	2
4 Olifants	Fluoride		L	(+)		X	2
5 Inkomati	No restrictions						3
6 Usutu to Mhlatuze	Chloride		L	(+)	L		5
7 Thukela	No restrictions					X	5
8 Upper Vaal	Sulphates					X	1
9 Middle Vaal	No restrictions					X	1
10 Lower Vaal	No restrictions					X	4
11 Mvoti to Umzimkulu	No restrictions					X	4
12 Mzimvubu to Keiskamma	No restrictions			(+)		X	1
13 Upper Orange	Total Dissolved Salts (TDS), Sodium			(+)			3
14 Lower Orange	TDS, Sodium	L	L	(+)	M	X	4
15 Fish to Tsitsikamma	TDS, Calcium, Sulphates, Chloride, Sodium	L	LMH	(-) (+)	LMH	X	2
16 Gouritz	TDS, Calcium, Sulphates, Magnesium, Chloride, Sodium, Potassium	LM	H	(-)	H		1
17 Olifants/Doring	No restrictions						2
18 Breede	Chloride		L		L	X	1
19 Berg	No restrictions						1

Source: Adapted from DWAF (2004)[3]

Note: The data are based on 156 sites for the period 1996 to 2000 and the median concentration for each variable.

Key

1) Irrigation use: a symbol indicates that the water quality indicator is outside the target water quality range for irrigation use at some locations in the WMA. L, M and H means Low, Medium or High risk, (+) = alkaline and (-) = acidic. SAR = Sodium

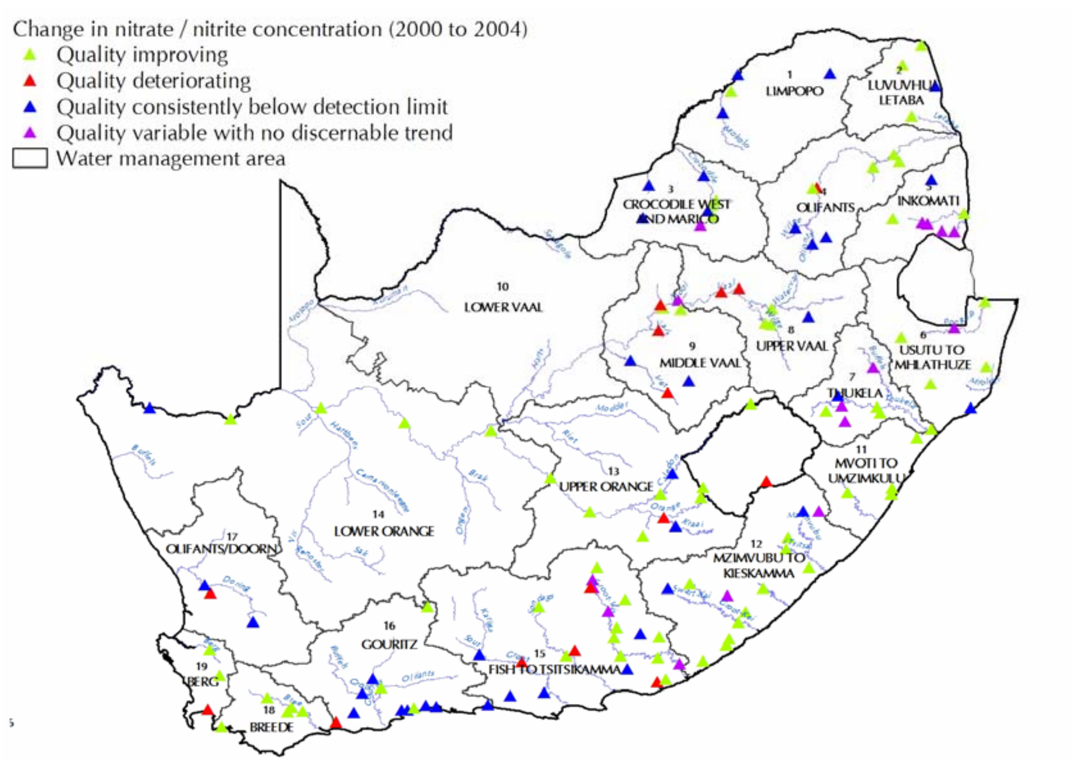
Absorption Ratio; EC = Electrical Conductivity; pH = an indication of acidity / alkalinity; Cl = Chloride (note that as there are multiple sites within the WMA, the risk may vary from stretch to stretch)

2) Recreational use: X indicates that the water quality indicator is occasionally outside the acceptable levels for recreational use at some locations because toxic cyanobacteria[i] have been found. Microbial contamination may also limit use but there were insufficient valid data to comment on this at a catchment scale.

3) Conservation status: 1 indicates an urgent need for conservation attention from a biodiversity perspective and 5 the lowest need (takes the percentage of critically endangered or endangered lengths compared to the total length in that WMA).

6.3.2 Trends of water quality

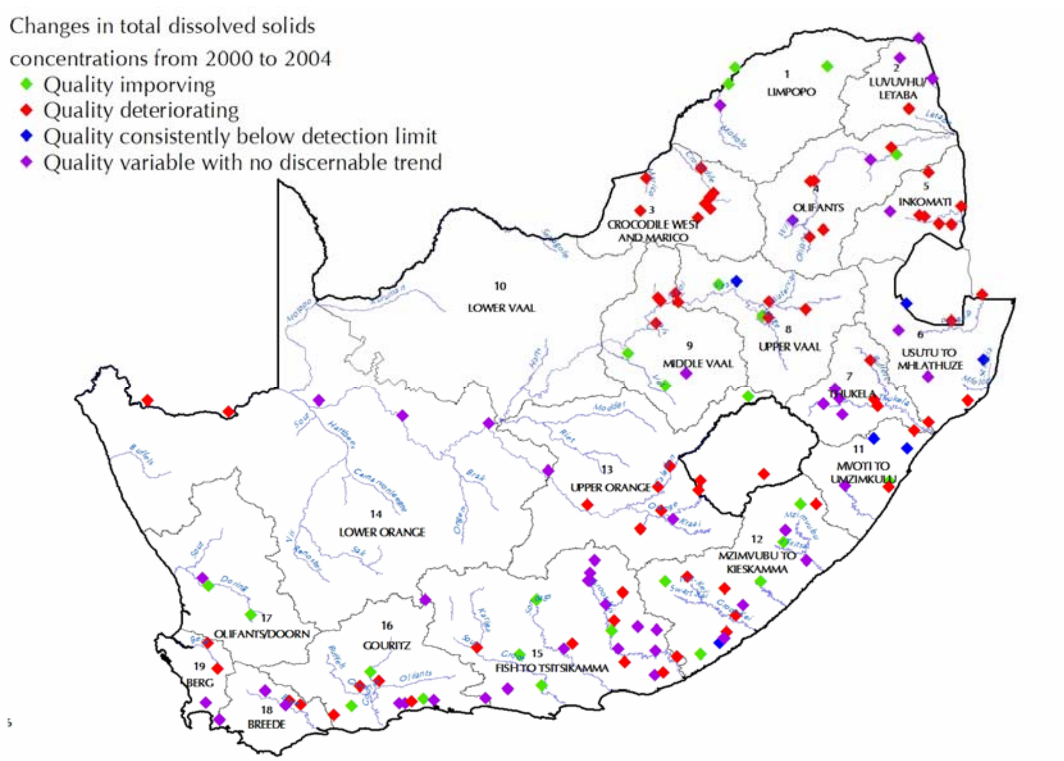
The results above provide an indication of the spatial variation in water quality of surface water resources. For an indication of the temporal changes, median values from the WMS for the years 2000 to 2004 were assessed to determine the percentage change over time for nitrate/nitrite (an indicator of the nutrient status) and total dissolved solids (an indicator of salinity). The results appear to indicate that nitrate levels are largely consistent or improving with only 10% of sites showing a deteriorating trend (Map 6.2). However, nitrate levels are linked to the levels of organic matter in the water, the level of dissolved oxygen and the pH so without a detailed assessment of all these factors a firm conclusion cannot be drawn. Conversely, salinity levels are generally variable or on the increase for 46% and only 17% of sites showing a deteriorating and improving trend respectively (Map 6.3).



Source: Brendan Hohls, DWAF

Map 6.2: Surface water quality trends for nitrate at 150 Water Management

[i] Cyanobacteria or "blue-green algae" are natural inhabitants of many inland waters, estuaries and the sea. In still waters, such as lakes, ponds, canals and reservoirs, they may multiply sufficiently in summer months to discolour the water, so that it appears green, blue-green or greenish brown. They may be toxic to humans and livestock.



Source: Brendan Hohls, DWAF

Map 6.3: Surface water quality trends for salinity at 150 Water Management System sampling sites

Although some information exists on groundwater quality, the data are difficult to interpret and present because, unlike the surface water data, groundwater data are not spatially well spread. Further, data density is poor (making valid statistical analysis difficult), specific locations and geohydrological settings of the sampling points are not always available, and the data have not been collected in a systematic way.

Estimates of the load of pollutants contributed by point-source discharges to water resources are currently not generally available. This is because not all water users have been registered or licensed and where they have been, the volume and quality indicated generally represents the total allowed rather than actual quantities being released. Eventually the volume and quality information collected by the discharger will be collected in the WMS. Estimating loads from diffuse sources is even more difficult, as this is dependent on so many factors including rainfall volumes, runoff factors, permeability values and the nature of the pollutant, though some catchment based investigations have been undertaken (for example the Upper Vaal).

6.3.3 Effects of human activities

The pressures exerted by human activities on water resource quality are summarized below from the NWRS and many other sources too numerous to mention:

- **Industry and mining:** Mining can result in changes of pH (acidity or alkalinity of the water), increased salinity, increased metals content and increased sediment loads.

Industrial contributions are more varied, depending on the nature of the industry but include chemicals, toxins, nutrients, salinity and sediments.

- **Increased urbanization and poor standards in waste water management:** In some cases, there may be little or no treatment of waste water (for example in informal settlements), or where treatment is available, the reticulation systems have insufficient capacity or are poorly maintained resulting in uncontrolled releases (for example sewer overflows) to the natural environment. In addition, urban runoff can contain high organic and nutrient loads leading to problems in urban streams and impoundments. This results in increased nutrient and organic loads and microbial contamination. An urgent need exists for adequate and improved urban waste water treatment systems to reduce this negative impact and the opportunity costs on our critical inland water resources.
- **Agricultural drainage:** This includes irrigation return flows and seepage, which may contain salts, nutrients (fertilizers) or agro-chemicals (including herbicides and pesticides), and runoff or effluent from animal husbandry areas such as feedlots, piggeries, dairies or chicken farms, which are also sources of contamination.
- **Waste disposal:** Industry, mining and urban development are resulting in increased waste production and the need for additional and improved waste management facilities (refer to Human Settlements Chapter). Although techniques for the containment of waste are available and being applied to new facilities, historically waste residues (industry and mining) and landfill sites (domestic) had no formal lining systems, resulting in contaminated leachate entering water resources.
- **Land use**: Increasing the extent of impervious surfaces in urban areas reduces the recharge to groundwater, potentially resulting in increased concentrations in the underlying aquifers. Overgrazing and clearance of natural vegetation increases the risk of erosion and subsequent quantities of sediments entering surface waters.
- **Delays in classifying water resources:** Each resource needs to be adequately classified from a quality perspective. A shortfall in reliable and statistically sound monitoring data and lack of capacity has delayed this process, resulting in water use licences not being issued or licences being issued with inappropriate conditions.

6.3.4 Consequences of poor quality

Pollution of water resources can result in reduced fitness for use as indicated in Table 6.3. This can affect the resource directly by making the water less suitable for consumption, use in food production or any other identified use, depending on the extent, severity and temporal nature of the pollution. It can also affect the resource indirectly by prohibiting recreational activities in badly affected water bodies. Overall, the services described in Box 6.1 will be limited by the quality of the water in the system under consideration. The nature of these direct and indirect impacts on humans and the aquatic ecosystems are described in Box 6.2.

A consequence of these impacts is that water may need to be treated in some way before it can be used. This results in increased water supply costs due to the need for often difficult and/or expensive treatment. This is particularly relevant for water with elevated salinity (for example contaminated with mine wastewater), which generally has to be removed by some type of desalination process. Although potable quality water can be produced (depending on the type of process), the treatment may result in a highly saline waste material that then requires disposal elsewhere at yet another additional cost and potential environmental risk.

Eutrophication is an impact directly associated with nutrient loading (Box 6.2). It can take thousands of years to occur naturally but it can be caused in a short period of time as a direct result of human activity. Classification of the trophic status of dams and lakes is indicated in Table 6.4. The number of dams within each trophic status, as monitored by DWAF (a total of 76 dams and lakes are currently monitored), is also given. Where possible, a comparison is made between the trophic status of the dams during the period 1990 to 2000[19] (DWAF 2003). Of the 34 dams, 18 had improved in status (became less eutrophic), 11 stayed the same and 5 deteriorated (though the paucity of data may mean this comparison is invalid).

Generally, the dams or lakes with higher trophic status are located near urban areas such as Gauteng, Durban and Bloemfontein or highly-exploited rivers (e. g. Crocodile West, Vaal and Umgeni).

Table 6.4: Trophic status of South African dams (October 2002 to September 2003)

Trophic status	Description	Number of dams or lakes
Oligotrophic	Low in nutrients and not productive in terms of aquatic animal and plant life.	40
Mesotrophic	Intermediate levels of nutrients, fairly productive in terms of aquatic animal and plant life and showing emerging signs of water quality problems.	18
Eutrophic	Rich in nutrients, very productive in terms of aquatic animal and plant life and showing increasing signs of water quality problems.	9
Hypertrophic	Very high nutrient concentrations where plant growth is determined by physical factors. Water quality problems are serious and can be continuous, with consequent constraints on biological activity.	9

Source: DWAF (2003)[19]

In Section 6.2.4, the responses covered by the NWRS and organizations such as the WRC are discussed. Many of these responses are equally relevant for ensuring water quality is appropriate for its intended use. For point-source pollution risks, the water use licensing process is critical. The NWA classifies both discharges and waste disposal as water uses that require regulation. DWAF is in the process of registering and licensing all such water uses. The water use licence or general authorization will specify the conditions with which the user must comply.

6.3.5 Industrial and research initiatives to management water resources

From an industry specific perspective, a large number of initiatives have been developed to minimize risks. A few examples include:

- implementation of environmental management systems, such as ISO14001, that seek continuous improvement in environmental management;
- guidelines for the implementation of Clean Technologies have been developed for the textile, metal finishing, food and fishing industries, amongst others;
- the Chemical and Allied Industries Association's Responsible Care Programme is a commitment by the chemical industry to the responsible management of chemical products from the cradle to the grave so as to avoid harm to people and the environment;
- water and wastewater benchmarking by a number of industries as part of the WRC's NATSURV project[20].

Research institutions such as the Water Research Commission are developing appropriate technologies for the treatment and management of wastewaters. For example, significant progress has made on the use of biological processes to reduce sulphate levels in mine-contaminated waters and nutrient removal in domestic waste water treatment.

6.4 AQUATIC ECOSYSTEM INTEGRITY

The integrity of aquatic ecosystems will be dependent on both the availability of surface, subsurface (soil water interflow) and groundwater resources, and the quality of those resources, as well as all activities in the catchment. Riparian zones create a buffer between terrestrial and aquatic ecosystems, assisting in the protection of rivers from the effects of activities in the catchment, and stabilize river banks. These zones are typically sustained by both surface and subsurface water with groundwater playing a critical role during dry periods. For example, during summer fish survive in groundwater-fed pools when surface flow ceases in the Doring River[6]. Generally, less disturbed ecosystems are found in many of the smaller tributaries of perennial rivers. According to the NWA, aquatic ecosystem integrity has been given equal status with the requirements of basic human needs. This recognizes the benefits provided by these ecosystems as being essential for human well-being (Box 6.1).

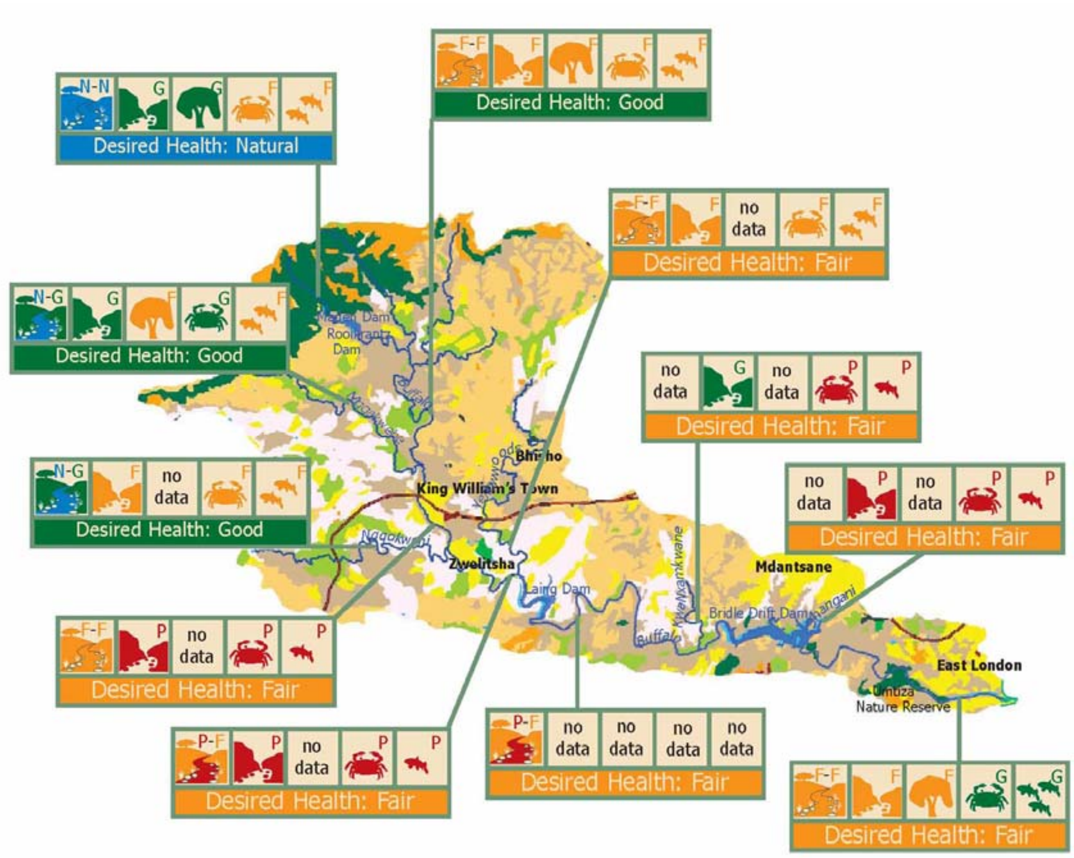
6.4.1 River Health

As indicated in the previous sections, the quantity and quality of available water is fairly well known but even if there is flow and the quality appears acceptable, the aquatic ecosystems may be affected. To enable a better understanding of these systems, DWAF initiated the River Health Programme in 1994. A model of shared ownership was advocated during the design phases of the programme, to ensure that a critical level of institutional participation was achieved. Subsequently, the Department of Environmental Affairs and Tourism (DEAT) and the WRC, together with the DWAF, became joint national custodians of the programme. At a provincial and local level, Provincial Champions and Provincial Implementation Teams are responsible for implementation initiatives.

The suite of tools and methods used to provide a picture of individual river health include:

- **The Index of Habitat Integrity:** assesses the impact of disturbance such as water abstraction, flow regulation and river channel modification on the riparian zone and instream habitats;
- **The Geomorphological Index:** assesses river channel conditions and channel stability (channel conditions are based on physical structure such as weirs, bridges or dams, and the type of channel such as bedrock or alluvial – channel stability is based on the potential for erosion);
- **The Riparian Vegetation Index:** determines the status of riparian vegetation based on a number of criteria including specifies composition, structure and extent of cover, presence of juvenile indigenous species, cover of invasive alien species and human influences;
- **The South African Scoring System (SASS)**: based on the presence of families of aquatic invertebrate fauna and their sensitivity to water quality changes;
- **The Fish Assemblage Integrity Index (FAII)**: assesses fish assemblages in homogenous fish habitat segments with the results expressed as a ratio of observed conditions to the theoretical near natural conditions.

The River Health Programme monitoring is ongoing and to date rivers that have been assessed include the Buffalo and Berg Rivers, the Vaal and Orange Rivers (in the Free State), the Diep, Hout Bay, Lourens, Palmiet, Hartenbos, Klein Brak, Umgeni, Letaba Luvuvhu, Crocodile, Sabie, Sand and Olifants (in Mpumalanga) Rivers. In general, the systems that have been assessed indicate good to fair conditions in the upper reaches and tributaries and fair to poor conditions in the lower reaches, with most rivers in highly urbanized areas, such as Gauteng, being in poor condition. The assessments include many of the tributaries, resulting in highly variable status within individual catchments, and with the multiple indicators, trying to obtain an overall picture of the state of South Africa's rivers is complex. River health is therefore best portrayed per river system and an example is given in Figure 6.2 for the Buffalo River. Results for other river systems and further information can be obtained from the River Health Programme web site (http://www.csir.co.za/rhp/). An assessment of the integrity and conservation status of rivers is presented in the Biodiversity and Ecosystem Health Chapter.



Source: Wilma Strydom (CSIR), River Health Programme
Figure 6.2: River Health in the Buffalo River in the Eastern Cape

6.4.2 Wetlands

Wetlands are defined in the NWA 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*". Wetlands play a critical role in the storage of water, reducing flooding and river sediment loads, maintaining perennial river-flows, improving water quality, as well as providing endemic wildlife habitats. Wetlands also provide extensive harvestable resources, for example potable water, fish, water-fowl, reeds for weaving, and medicinal plants. During drier months, groundwater is generally the only source of water for many of these ecosystems[6] and lowering the water-table via over-abstraction can seriously harm wetlands and their ability to contribute to overall water supply.

South Africa is a founding member of the Ramsar Convention on Wetlands, becoming the fifth Contracting Party in 1975. The South African Wetlands Conservation Programme was implemented to enable South Africa to meet our obligations as a contracting party and to promote the conservation of wetlands throughout southern Africa. Since 1975, South Africa has had 17 sites included on the Ramsar List of Wetlands of International Importance (**REFER TO 1st MAP showing wetlands**). According to the Ramsar Information Pack (http://www.ramsar.org), "*These [wetland] functions, values and attributes can only be maintained if the ecological processes of wetlands are allowed to continue functioning. Unfortunately, and in spite of important progress made in recent decades, wetlands continue to* *be among the world's most threatened ecosystems, owing mainly to ongoing drainage, conversion, pollution and over-exploitation of their resources*". It is estimated that 50% of our wetlands have been destroyed or converted (refer to Biodiversity Chapter), and this ongoing lack of recognition and degradation of our wetland systems constitutes a significant opportunity cost in a semi-arid country such as South Africa.

The protection of wetlands therefore needs to combine water resource management (as discussed in Sections 6.2.4 and 6.3.5) with land use management strategies. To date, implementation has been weak due to fragmented institutional arrangements, confusion about overlapping jurisdiction and areas of responsibility, and lack of appropriate management strategies that mainstream wetlands in the water and natural resource sectors[21]. To assist in rectifying these historical problems, the WRC has produced "Guidelines for Integrating the Protection, Conservation and Management of Wetlands into Catchment Management Planning"[21].

6.4.3 Impacts on aquatic ecosystems water resource potential

The pressures on water availability and fitness for use are pressures directly on aquatic ecosystems. In addition, the transgression of biogeographical barriers arising from inter-basin transfers and other forms of flow manipulation, have transported non-endemic species into new catchments. At least four indigenous fish species have been introduced to the Great Fish River from the Orange River, the Smallmouth Yellowfish, the Orange River Mudfish, the Sharptooth Catfish and the Rock Barble[22]. These species are putting severe competitive pressure on the endemic fish species.

Organisms in many aquatic ecosystems are generally adapted to the highly variable flows and, in some cases, the variable water quality of South African systems. However, with the increased control of flows by means of dams, changes in habitat and increasing pollution loads, these natural cycles have been dramatically altered, with a resultant loss of biodiversity and the introduction or increase of invasive species. Degradation of aquatic ecosystems has implications for food security and associated economic activities.

Disturbance and loss of wetlands and over-abstraction of groundwater, reduces storage capacity, water purification ability and fish and wildlife habitats provided by these systems. The loss of storage capacity results in greater peak flows (floods) and longer low or no-flow periods, bringing significant opportunity costs as well as direct financial costs of for example flood damage and lack of water in dry seasons.

6.4.4 Management of aquatic ecosystems

The responses reported for water availability and fitness for use (Sections 6.2.4 and 6.3.5) will assist in addressing the problems of aquatic ecosystem integrity. For maximum value as a water management tool, the results of the River Health Programme and the further development of the Spatial Biodiversity Assessment need to be co-ordinated to cover the whole of the country. Particular attention needs to be paid to maintaining the status of the tributaries, which provide refuges for biodiversity (so that areas subject to toxic events can be successfully recolonized), and the riparian corridors between them (linear linkages maintained via the main stem rivers will allow migration of both aquatic and terrestrial fauna) to ensure conservation status can be sustained or improved. The River Health programme has identified management priorities for each river system that has been assessed and it is the responsibility of the Provincial Implementation Teams to identify and implement actions to deal with these priorities (Box 6.3).

Where aquatic ecosystems are dependent on groundwater, mechanisms need to be put in place to ensure that groundwater abstraction does not unduly negatively affect those ecosystems. To minimize the negative consequences, which may have economic implications, of the transfer and mixing of previously isolated biota during inter-basin transfers, extensive investigations of the feasibility of such schemes must be undertaken.

Box 6.3: Inland water resources: priorities for action

The quality, quantity and sustainability of water resources are fully dependent on good land management practices within catchments. The fate of the country's water resources therefore relies on an integrated approach to managing water and land, to achieve ecological and socio-economic sustainability. The National Spatial Biodiversity Assessment (2004) has indicated a number of priority actions, including:

1. Integrate land and water policy and management, as a basis for integrated management strategies.
2. Feed information from all relevant assessments into DWAF's Water Resource Classification System and Catchment Management Strategies, to determine how many, and which rivers need to be managed in a natural or moderately impacted state.
3. For main streams that are heavily impacted, determine, implement and monitor ecological reserves.
4. Integrate rivers into bioregional plans and programmes, and fine-scale biodiversity assessments.

Source: Adapted from Driver et al (2005)[23].

Against the background of the above context, several opportunities for improved water management emerge. These prospects are presented in Box 6.4 below.

Box 6.4: Opportunities for improved water resource management

- Potential alternative resource supplementation for future consideration include: desalination of seawater; importation of water from the Zambezi; rainfall augmentation by cloud seeding; shipping fresh water from the mouths of major rivers and towing of icebergs. Some of these may seem like something out of a science fiction movie but the technology is generally available, albeit not currently cost effective. Therefore, in the short term, the emphasis needs to be placed on WC/WDM and reuse of treated sewage or mine water by industry, which in the short to medium term will give a higher return on investment.
- There is a need for improved agricultural and land management practices that will require input from the different government bodies, as well as stakeholders involved in farming and managing the land. Two good examples already exist:
  - The Working for Water Programme aims to increase water availability whilst also providing benefits to biodiversity, land use management and social upliftment. The Programme is a partnership between DWAF, DEAT and the National Department of Agriculture.
  - Although irrigated areas have increased, the demand for irrigation water has remained about the same. This appears to be the result of better consultation within the agricultural sector, better irrigation practices and scheduling, gradual increase in tariffs (with associated reduction in subsidies), introduction of compulsory licensing and better training of irrigators (UNCSD 2004).
- Of the 6 000 million m^3/yr of groundwater potentially available as a resource, only about 1 100 million m^3/yr is currently being utilized[3]. This suggests opportunity for further exploitation, particularly in the rural areas previously not supplied. According to the NWRS, optimal management and utilization of groundwater will require improved capacity to assess potential and monitor trends, and a better understanding of interactions between surface water and ecological functions.
- Water quality monitoring is being undertaken by a range of institutions throughout South Africa including DWAF, local municipalities, research organizations and industry. There has historically been a lack of co-ordination between these institutions resulting in over-assessment in some areas and a lack of data in others. Opportunities exist to ensure that the data are collected in a consistent manner suitable for incorporation into a single national database.
- Although some clean technology and water conservation/demand management programmes for specific sectors are in place, there is opportunity for much greater programme development by other sectors.
- South Africa as a whole needs to move onto a water conservation/ demand management philosophy right across the spectrum of water resources management, with immediate effect.

6.5 CONCLUSION

The demand on South Africa's scarce water resources is increasing and by 2025 at the latest there is projected to be a deficit in available water. The water quality of the resources appears to be variable with overall deterioration. These, and other issues, have increased pressure on South Africa's aquatic ecosystems, including wetlands. The multitude of demands (ecological, domestic, industrial and agricultural) need to be balanced equitably and the recently released NWRS is seen by DWAF as the main driver for ensuring the balance can be achieved.

According to DWAF however, there should be sufficient water of suitable quality to meet South Africa's expectations with respect to maintaining a strong economy, improved social standards and healthy aquatic ecosystems for the near future[3]. This is provided the resources are carefully managed and wisely allocated and utilized in line with the NWRS. There is a need for all water-use sectors to focus on the water and waste management hierarchy, which states that minimization at source is the first priority, followed by maximising reuse or recycling as far as possible, treating to a suitable standard and only if necessary disposing or discharging to the environment.

All stakeholders have a role to play and some of the things that every South African can do to protect this valuable resource are highlighted in Box 6.5. Additional roles and educational materials/posters can be sourced from sites such as http://www.randwater.co.za and http://www.wildlifesociety.org.za, amongst others.

The final question remains whether the government and other stakeholders, including the general public, will be able, and willing, to implement the strategies and policies that have been recently introduced. Financial resources, institutional capacity and stakeholder willingness will all be crucial in ensuring the general downward trends in availability and quality of our water resources are reversed. A general national move to water-use reduction and conservation is required, and adequate resources need to be mobilized to fund a public awareness and education programme in this regard (Box 6.5).

Box 6.5: What are some of the things you, as an individual, can do to protect our Inland Waters?

- Do not throw waste (for example oil, paint, rubbish) into the sewer or storm water systems;
- Do not dispose of waste into your streams, rivers or dams;
- Report unlawful discharge of liquid waste by industry to your local authority or the Department of Water Affairs and Forestry;
- Report leaking water (from broken taps or pipes) or sewer pipes to your local authority;
- Use rain water for domestic and garden purposes by catching and storing runoff;
- Use water from your household activities (cleaning of eating utensils or bathing) to water the garden;
- Water your garden early in the morning or late in the afternoon to minimize evaporation; preferably, plant a water-friendly indigenous garden;
- Do not leave taps dripping, get them repaired;
- Shower rather than take a bath;
- Support water saving practices at work (e.g. do not leaves taps or hosepipes running);
- Adhere to water saving programmes for your area;
- Take part in environmental programmes in your area (for example Working for Water); and
- Spread the idea of water conservation!

For information about water wise initiatives and practices visit www.randwater.co.za

Source: Adapted from Mogale City Local Municipality State of the Environment Report 2003 (SEF 2003)[24]

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