STATE-OF-RIVERS REPORT 6

FREE STATE REGION RIVER SYSTEMS - 2003

Caledon River

High flows in the Orange River downstream of Vanderkloof Dam

Modder River

River Health Programme

Context of this Report

Contributing Organisations

- Department of Water Affairs and Forestry (DWAF)
- Department of Environmental Affairs and Tourism (DEAT)
- Water Research Commission (WRC)
- Department of Tourism, Environmental and Economic Affairs - Free State (DTEEA)
- University of Free State, Centre for Environmental Management (CEM)
- Bloem Water
- Rand Water
- Sedibeng Water
- CSIR Environmentek

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This report is based on the findings of surveys of river systems in the central region of South Africa. These surveys, which took place from 2000 to 2003, were part of the implementation of the River Health Programme in the Free State and Northern Cape.

The surveys extended beyond provincial boundaries to certain adjoining sub-catchments of the Orange-Vaal system. An exception is the southern Gauteng catchment. These highly-polluted streams are the subject of a separate study (see the River Health Programme poster, *Ecological State of Southern Gauteng Rivers*).

This report describes in some detail the organisational partnerships that have driven and sustained river biomonitoring activities at the provincial level since 1996. The Free State team relies heavily on shared responsibility and effective partnerships to achieve river health objectives for all major rivers across a very large study area. Organisational networking and collaboration are gaining importance as we move towards more devolved and co-operative river resource management, and this document includes an assessment of how organisational arrangements support joint river health goals.

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Contents

The River Health Programme

Background

The Department of Water Affairs and Forestry (DWAF) is the custodian of all water resources in South Africa. This makes DWAF responsible for the care and management of water resources to ensure sustainable social and economic development.

A river's ability to continue providing goods and services depends on informed and effective river management. The requirements for sustainable use and development of rivers include an understanding of river health, knowledge of the causes of deterioration, and information about areas of sustained utilisation and unacceptable deterioration. This knowledge is required to set goals and to decide on management actions to achieve desired river health states.

In 1994, DWAF launched the River Health Programme (RHP) to gather information on the health of South Africa's river systems.

Continuous monitoring of our river systems and State-of-River reports on changes in their health, track our progress toward river health goals.

Although DWAF guides the RHP, the programme is a co-operative venture with participants from many government and non-government organisations: DEAT, WRC, DWAF Regions, provincial government departments, universities, conservation agencies, private sector organisations, etc.

The central objective of South Africa's water policy is the equitable, efficient and sustainable use of our water resources. The National Water Act (NWA), Act 36 of 1998, recognises that the best way to achieve this is to manage aquatic ecosystems (including rivers) at the catchment scale and through joint participation by all interested parties. The RHP supports this management process by providing the river health information needed by managers and the participating public to make decisions.

RHP activities and outputs are strongly aligned with national legislation, because the NWA requires the estabishment of monitoring systems including the monitoring of aquatic ecosystem health. The RHP monitoring results, in turn, support other legal principles contained in the National Water Act and the National Environmental Management Act (NEMA), Act 107 0f 1998. For example, RHP results provide evidence of environmental degradation where this may occur.

State-of-Rivers Reporting

State-of-Rivers (SoR) reports are a component of State of the Environment (SOE) reporting, promoted at the United Nations Conference on Environment & Development (UNCED) in Rio de Janeiro in 1992, as an improved source of environmental information for decision-making.

The NEMA is currently being revised to include, amongst other amendments, a requirement for formal State of the Environment assessment and reporting.

SOE reports

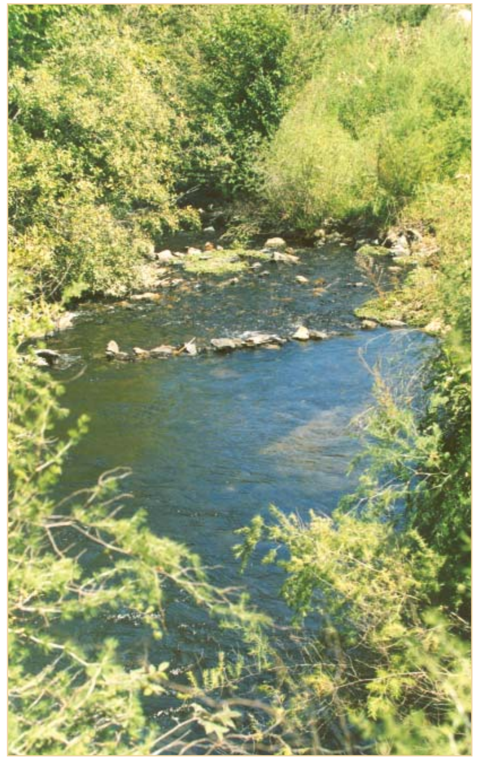
- provide information for better decision-making regarding sustainable development
- compare environmental performances of different areas
- increase public awareness of environment and development issues
- empower individuals and organisations to improve their environment and quality of life for themselves and future generations

SOE reports use the 'Driving-Force-Pressure-State-Impact-Response' framework. This describes the human activities which create pressures on the environment, the current state and trends in environmental conditions, the consequences for sustainability and human livelihoods, and the policies and actions in place to manage the environment. This way of presenting information is comprehensive and easy to understand, especially if specific indicators are used to measure changes in pressures, states and responses.

The RHP has built on the SOE experience and has developed methods for providing information on the ecoqlogical state of rivers to help with environmental decision-making. The SoR process monitors rivers, then packages and disseminates information on river health to managers and decision-makers. In this way, the RHP provides ecologically sound management information while also informing and educating people about the health and importance of their rivers.

River Health information appears in an accessible report format (such as this document) or in a more condensed poster form. Eventually the RHP will cover all South Africa's major river systems. The RHP will also revisit rivers periodically in order to provide information on long-term trends in the health of river systems.

This report is the sixth in the State-of-Rivers series. Previous reports and more information can be found on the RHP web page http://www.csir.co.za/rhp/.



State of Environment reports answer questions such as:

- What changes are taking place in the condition and functioning of the environment?
- What is causing these changes?
- What are the consequences of these changes?
- What is our response and are our actions effective?
- What more can we do to improve the environment including river health and, therefore, the quality and flow of aquatic goods and services from which people benefit?

Indices and Categories

What are River Health Indices?

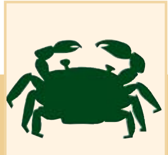
Many physical, chemical and biological factors influence river ecosystem health, e.g. geomorphology, hydrological and hydraulic regimes, water quality, in-stream and riparian habitats and a host of biological processes. For practical purposes, the RHP focuses on selected ecological indicator groups that are representative of the larger ecosystem and are feasible to measure. Complex data that are collected for each indicator group can be summarised and expressed in a format that is easy to understand. The following indices were used to assess the health of the rivers of the Central Region of South Africa:

Index of Habitat Integrity (IHI)

The availability and diversity of habitats are major determinants of the biota that will be found in a specific ecosystem. Knowledge of habitat quality is important in an overall assessment of ecosystem health. The IHI assesses the impact of disturbances such as water abstraction, flow regulation and river channel modification on the riparian zone and in-stream habitats. The IHI icon shows the river and river bank which are colour-coded according to the state of the in-stream and riparian habitat, respectively.

Geomorphological Index (GI)

Geomorphological processes determine the size and shape of river channels, which in turn determine the diversity and quality of habitats for aquatic biota. The geomorphological index assesses the channel condition and channel stability. Channel condition is based on the channel impacts evident in a river reach, e.g. weirs, bridges or dams, and the type of channel, e.g. bedrock or alluvial. Channel stability is based on the potential for erosion of the river banks and bed.

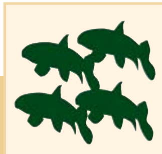


Riparian Vegetation Index (RVI)

Healthy riparian zones maintain the form of the river channel and serve as filters for sediment, nutrients and light. Plant material from the riparian zone is an important source of food for aquatic fauna. The structure and function of riparian vegetation is altered when vegetation removal, cultivation, construction, inundation, erosion, sedimentation and alien vegetation occur within or close to the riparian zone. RVI is a measure of the degree of modification of the riparian zone from its natural state.

South African Scoring System (SASS)

Aquatic invertebrates (e.g. insects, mussels, snails, crabs, worms) require specific habitats and water quality conditions for at least part of their life cycle. Changes in invertebrate community composition and structure reflect changes in river conditions. Invertebrates are good indicators of recent localised conditions in a river. SASS is a relatively simple index, based on invertebrate families found at a site.



Fish Assemblage Integrity Index (FAII)

Fish are good indicators of long-term influences on a river reach and the general habitat conditions within the reach. The number of fish species (indigenous or alien), the different size classes and the health of fish, are all indicators of river health. The FAII is an expression of the degree to which a fish assemblage deviates from its undisturbed condition. The FAII was adapted to make it applicable to rivers with low fish diversities, as in the Free State.

Method used to categorise our rivers

Once river health indices are measured, they need to be interpreted within a framework that allows comparison of the health of monitoring sites and even river systems. An ecoregion classification system was used to delineate ecological boundaries that allow grouping and comparison of the river systems within the study area. More details on the ecoregion classification system can be found on p 16.

The results obtained by applying the biological and habitat indices during river surveys provide the information that determines the health of the river. For standardisation purposes that will also allow for comparison of the health of different river systems, a river health categorisation is used.

Each of the river health categories (below) is associated with a level of ecosystem health. The ecosystem health is linked to the potential of a river system to offer a particular range of goods and services. A 'fair' or 'poor' river may have lost its potential for most of the uses, e.g. tourism, conservation and even agriculture. It might, however be acceptable for a river to be 'fair' if a higher socio-economic return is deemed more important than the loss of some uses. This trade-off should be agreed upon by all involved stakeholders as long as sustainable use is not compromised.

A monitoring team identify fish in order to obtain a FAII score, which is one of the indices of river health.

The Habitat Integrity team ready for takeoff.

River Health Categories

The **present health** of a river is a measure of the present ecological state of the river during the time of the survey and is presented in terms of the river health categories given below.

The **desired health** of a river is an indication of the envisioned future ecological state of the river and is based on ecological considerations, the need for sustainable development and management actions.

River Health Category	Ecological Perspective	Management Perspective
Natural N	No or negligible modification	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

History of the Free State

Rivers and History in the Free State region

For thousands of years, the only human occupants of the region were hunter-gatherers such as the San. In the last millennium or so, Khoikhoi nomadic herders arrived on the scene. Neither group left much of an imprint on their environment.

The tranquillity of this rural backwater was rudely interrupted in the 19th century by tragic inter-tribal warfare and the arrival of Voortrekker farmers trying to escape British rule. Looked at dispassionately from a distance of two centuries, the Difaqane and the Great Trek were simply products of population pressure elsewhere in Africa and Europe, which radically changed the demographics of the region.

Voortrekkers crossed the Orange River into "Transorangia" during the mid-1830s, eventually meeting up on the Vet River in 1837 to decide on a form of constitution or modus operandi. They then spread out again, some settling briefly in part of what is now KwaZulu-Natal, until the British annexed their fledgling republic in 1843. Many returned to Transorangia, only to see Britain annex it in 1848 as the Orange River Sovereignty. Four years later, the British government relented and at the Sand River Convention recognised the independence of the trekkers north of the Vaal River (the Zuid Afrikaansche Republiek), and in 1854 allowed the "Transorangians" to form the Oranje Vrij Staat.

The Vaal River formed the northern boundary of the new state and the Vaal's eastern Klip River tributary became the northeastern border with the Zuid Afrikaansche Republiek. In 1861 the Griquas living between the Riet and Orange Rivers migrated southeast of Lesotho and the Orange River became the southern border. The southeastern borders of the Oranje Vrij Staat were only resolved after two bitter conflicts. The first was with the Sotho people, and the frontier shifted back and forth until 1868 when Britain took control of Basotuland (Lesotho) and fixed the Caledon River as the official border. The second conflict was with the Tswana people at Thaba Nchu, which the Oranje Vrij Staat annexed in 1884. Curiously, this area became nominally independent under the Bantustan laws of the mid-20th century before being re-integrated into the present-day Free State province. Qwa Qwa, a tiny former non-independent black state lying in the headwaters of the Wilge River, on the Lesotho border, never formally separated from the Orange Free State.

The natural borders to the west would logically have followed the Vaal and Orange Rivers to their confluence were it not for the discovery of vast quantities of diamonds in what soon became the mining town, Kimberley. Suddenly, everyone who was anyone had always had an interest in the area and British Lieutenant-Governor Keate, called in to arbitrate, fixed the border about 1° of longitude east of the confluence. Later, the British government admitted that it had not played fair and granted the Oranje Vrij Staat £80 000 in compensation for the land annexed.

In 1900 Britain again annexed the area, this time as the Orange River Colony, and in 1910 it became one of the four provinces of the Union of South Africa. Farming, particularly of maize, took off in earnest in the 1930s. The Vaal-Harts irrigation scheme north of the Free State, a large poverty-relief irrigation scheme, began at this time. After the Second World War, gold mining at Welkom and Virginia became an important part of the economy, also requiring the movement of water across catchment boundaries. In the 1970s Gariep Dam (then called Hendrik Verwoerd) was the first of the structures built to provide water security for irrigation on a grand scale. It was followed by Vanderkloof Dam downstream (formerly P.K. le Roux Dam). During the 1990s Katse Dam on the Senqu River headwaters of the Orange River, in Lesotho, began diverting water to the Vaal Dam for use in Gauteng.

In 1994, the Free State became one of the nine new provinces of South Africa, with its borders virtually unchanged.

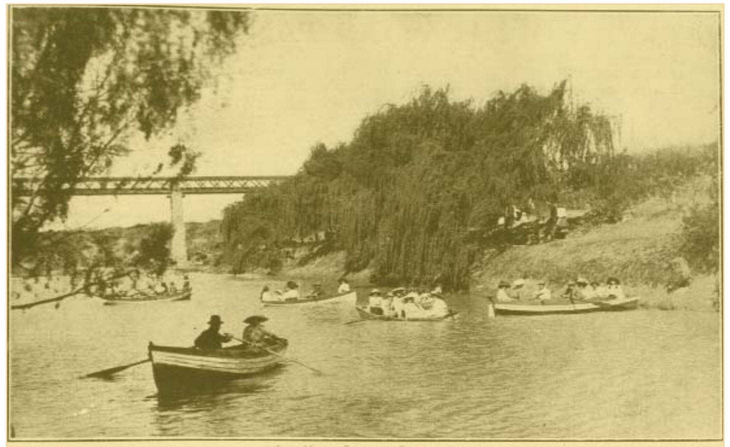
Rivers have been the sites of bloody conflict over land, of symbolic escapes from oppression and of conventions to agree on a fairer dispensation.

The Free State coat of arms neatly encapsulates the natural, economic and political history of the province, and the motto Katleho ka kopano (success through unity) carries a hopeful message for a future without conflict. Of particular interest is the Orange River lily in the centre, the riverine wetland plant *Crinum bulbispermum*. The base of the coat of arms symbolises the flat landscape while the background to the lily consists of three Karoo koppies. Note also the diamonds, mealies (maize) and wheat in the crown.

The Orange River in flood - 1898

Dam in Bloemfontein - 1899

Church Street bridge across Bloemspruit, Bloemfontein - 1904 during flood



Modder River at Glen - 1915

The RHP in the Free State

History of the RHP in the Free State

During the early part of 1996, a group of stakeholders met to discuss the launch and development of the River Health Programme in the Free State. This group included the Department of Tourism, Environmental and Economic Affairs (DTEEA), DWAF regional, the Centre for Environmental Management (CEM) at the University of the Free State, Rand Water, Bloem Water and the Departments of Agriculture, Health, Housing and Education. They listed the rivers in the Free State and prioritised them for biomonitoring.

Biomonitoring started promptly, with DWAF, DTEEA and Rand Water focussing on SASS and fish monitoring.

The CEM was also well positioned for implementation action and they put together a team of aquatic specialists to take on the monitoring of selected rivers. Their expertise includes diverse fields such as geomorphology, riparian vegetation, nutrients, algae, invertebrates, fish and analytical chemistry.

The RHP participants in the Free State have interacted to form a dynamic and committed implementation team with a vision for improving river health.

Today, approximately eight years after the inception of the RHP in the Free State, the team can boast established and growing databases for most of the major rivers in the region, as well as numerous formalised partnerships.

Key drivers of success

The operating model

The Free State team included all the major rivers in the province in the monitoring programme. Each participating organisation took responsibility for one or more rivers.

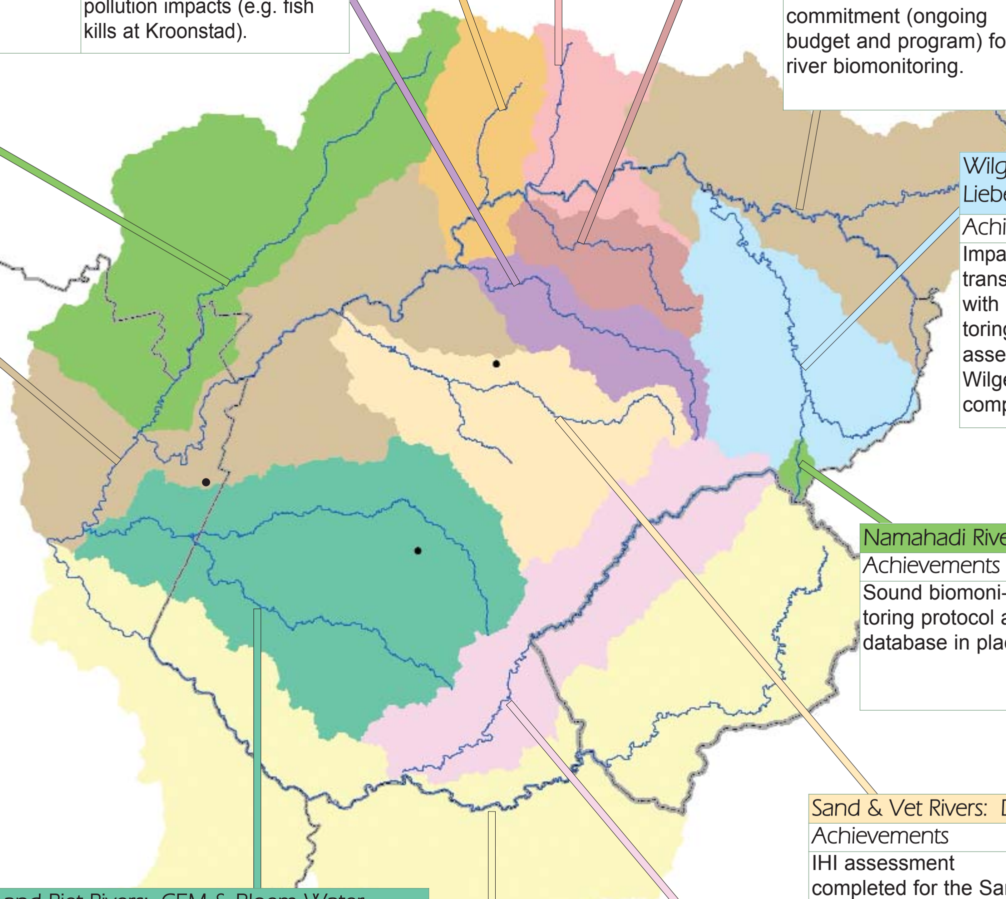
The choice of this model meant that a biomonitoring exercise for the entire province's rivers would require careful allocation of responsibility followed by committed and sustained action. Each participating institution acknowledged their common interest and the need to work together, making effective use of existing capacity in support of a united provincial initiative.

The team therefore chose an operating model to match their collective vision as well as to accommodate the objectives of each participating institution. The various organisations discovered that they have been able to achieve much more collectively than they would have individually. DWAF (Free State region), provincial DTEEA, Rand Water and the CEM together chose sampling sites, set up methodologies and apportioned responsibility for monitoring different catchments. Bloem Water has been farsighted in the funding of biomonitoring by the CEM in the southern Free State and the Bloem Water Chair of Water Environmental Management in the CEM. Partnerships like this have been the key to the success of the river health monitoring in the Free State.

Appropriate leadership

River health champions operate at various levels using a variety of leadership styles. Provincial DWAF and DTEEA strongly support the RHP initiative, while at the operational level, each participating organisation has led activities in its designated rivers and supported active collaboration. The seamless leadership shared by DTEEA and DWAF regional makes for a formidable provincial co-ordinating team. At all levels, leaders promote collaboration, open-mindedness, constructive discussion, joint leadership and respect for others' perspectives. They build and support the relationships that provide impetus for a joint river health implementation process.

Without this approach, the chosen operating model, with different organisations monitoring different rivers, may not have worked. The Free State team's firm belief in the benefits of healthy rivers has strengthened voluntary participation and co-operation and it provides the tenacity and energy required to sustain an implementation process over the long term.



Skoonspruit: DWAF regional & DTEEA

Achievements	Goals
IHI assessment completed. SASS and FAII biomonitoring ongoing. Aerial video of river completed.	To extend programme to include other indices, such as the RVI, GI, etc. State-of-Rivers brochure by December 2006, with focus on abstraction.

Mooi River

Achievements	Goals
None	To develop a combined program with the North West River Health Programme

Renoster River: DTEEA

Achievements	Goals
IHI assessment completed.	To identify partners for river biomonitoring and management and design more structured approach to biomonitoring routine.

Vals River: DWAF regional & DTEEA

Achievements	Goals
IHI assessment completed. SASS and FAII biomonitoring ongoing.	To extend programme to include other indices (RVI, GI, etc.). To test the use of artificial substrates for SASS and to link river health results explicitly to point-source pollution impacts (e.g. fish kills at Kroonstad).

Upper Vaal & Klip Rivers: Rand Water

Achievements	Goals
Awareness of the role of bio-monitoring at catchment forum level and high-level Rand Water resource commitment (ongoing budget and program) for river biomonitoring.	To produce State-of-Rivers booklet; to incorporate other partners (esp. mines and industry) to strengthen collaborative monitoring strategy and to make the benefits of biomonitoring explicit to partners. Develop biomonitoring strategy for Klip River.

Harts River: CEM & Sedibeng Water

Achievements	Goals
Full biomonitoring programme and database in place.	To incorporate River Health results into Sedibeng Water's Environmental Management system. To strengthen the monitoring network.

Vaal River: DWAF regional and DTEEA

Achievements	Goals
Preliminary IHI assessment completed. SASS and FAII biomonitoring ongoing.	To extend programme and to include other indices, such as RVI, GI, etc. To encourage the formation and strengthening of partnerships in co-ordinated fashion, e.g. with mines, for strengthening the monitoring network.

Wilge, Elands, Ash River & Liebenbergsvlei: Rand Water

Achievements	Goals
Impacts of Katse transfer shown with biomonitoring. IHI assessment of Wilge River completed.	To develop a strategy for biomonitoring of river tributaries and describing impacts of increased flows during the dry season. To develop partnerships with industry.

Namahadi River: CEM & Sedibeng Water

Achievements	Goals
Sound biomonitoring protocol and database in place.	To incorporate Namahadi biomonitoring results into Sedibeng Water's Environmental Management plan.

Sand & Vet Rivers: DWAF regional & DTEEA

Achievements	Goals
IHI assessment completed for the Sand River. Biomonitoring capacity built in Sedibeng Water	To strengthen biomonitoring capacity and partnerships via high degree of awareness created by catchment forum activity.

Modder and Riet Rivers: CEM & Bloem Water

Achievements	Goals
State-of-Rivers poster 2002. Full biomonitoring programme and database in place. IHI assessment completed.	To strengthen partnership with Mangaung Municipality and incorporation of RHP indicators into municipal State of Environment Report by close of 2004.

Caledon River: CEM & Bloem Water

Achievements	Goals
Aerial video and IHI assessment completed.	To expand biomonitoring to include SASS and fish. To strengthen partnership with Bloem Water and extend to include Naledi Municipality.

Orange & Kraai Rivers: DWAF Regional & DTEEA

Achievements	Goals
Aerial video and IHI assessment completed for Orange River. Biomonitoring sites have been identified.	To develop a broadbase monitoring programme for the Orange and Kraai rivers. To produce a State-of-Rivers report by December 2005. To encourage closer collaboration with agricultural and tourism partners, especially for improved custodianship of near-pristine rivers such as the Kraai.

Organisational Arrangements

The Free State Team and Their Vision

The Provincial Department of Tourism, Environmental and Economic Affairs (DTEEA) leads the River Health Programme in the province, with support in decision-making and monitoring activities from the regional DWAF office, the University of the Free State and three Water Boards: Bloem Water, Rand Water and Sedibeng Water. However, many more players, at different levels of governance, contribute to the programme. The success of the programme in the Free State is based on the realisation that participants are collectively responsible for the sustainable management and utilisation of natural resources. This synergy is apparent in the diagram on the facing page.

The diagram on the right shows how the Free State River Health Vision interacts with the visions of the River Health Programme and the Department of Water Affairs and Forestry.

DWAF VISION (extract)

To serve people by:

Conserving, managing and developing water resources in a scientific and environmentally sustainable manner to meet social and economic needs	Educating the people of South Africa on ways to manage, conserve and sustain our water resources.	Co-operating with all spheres of government, in order to achieve the best and most integrated development in our country and in our region.

RIVER HEALTH PROGRAMME VISION (extract)

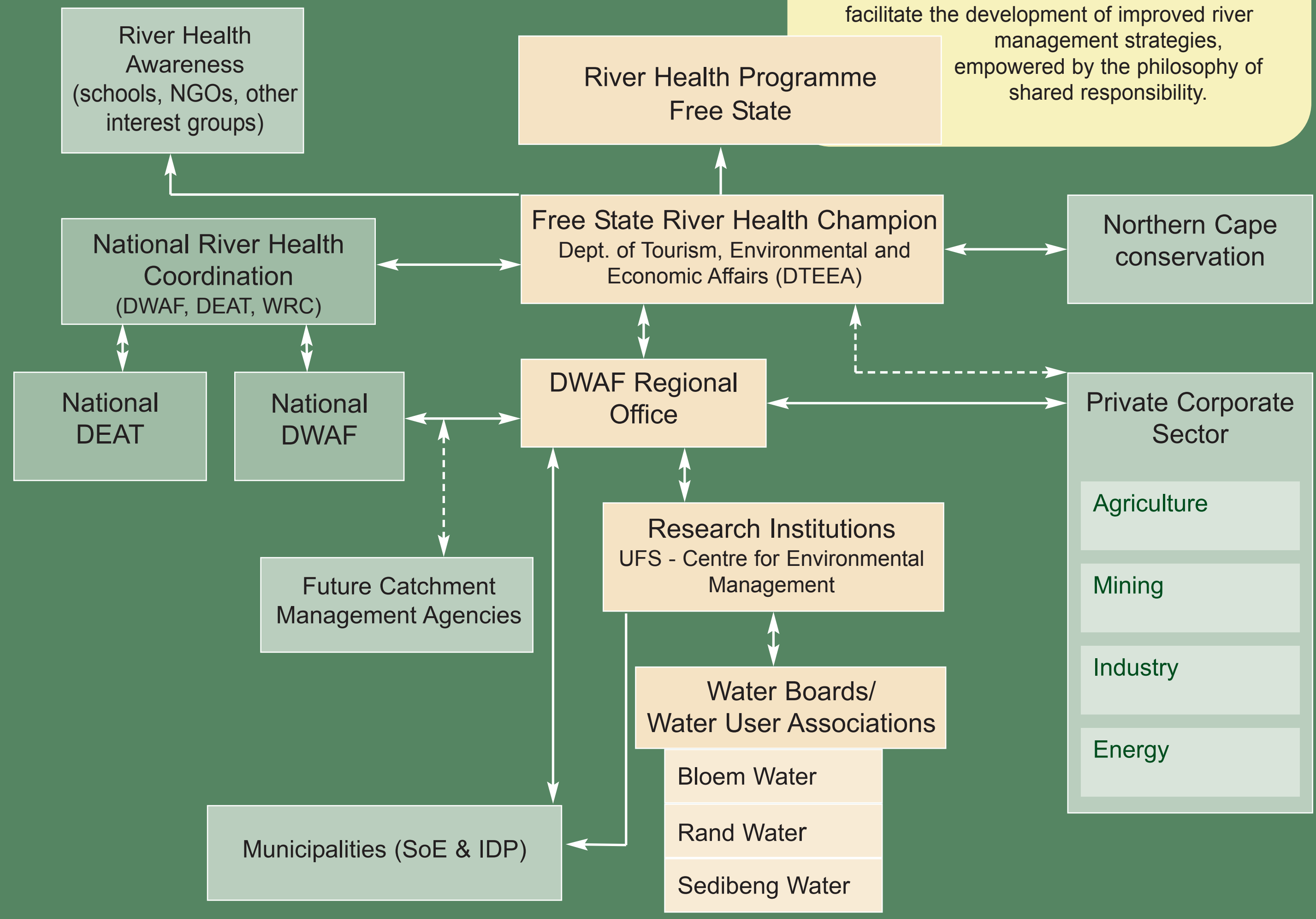
To monitor, assess and report on the ecological state of our river systems in an objective and scientifically sound manner.

State-of-Rivers reporting: to assist ecologically sound management of rivers to deliver an optimal range of goods and services to society.	State-of-Rivers reporting: to inform and educate South Africans about the state of our rivers and the importance of wise use and management of river resources.	Biomonitoring information supports selected legal principles of the NEMA and the NWA.	To support the development of teams and governance structures required for effective and co-operative river resource management.

FREE STATE RIVER HEALTH VISION

To develop, maintain, assess and customise a river biomonitoring programme in each river catchment with the aim of identifying impacted river reaches and addressing these impacts by facilitating the development of improved river management strategies, empowered by the philosophy of shared responsibility and the concept of buying into the strategy by all role players.

Our vision is a river biomonitoring programme in each river catchment; to identify impacted river reaches; to address these impacts; to facilitate the development of improved river management strategies, empowered by the philosophy of shared responsibility.



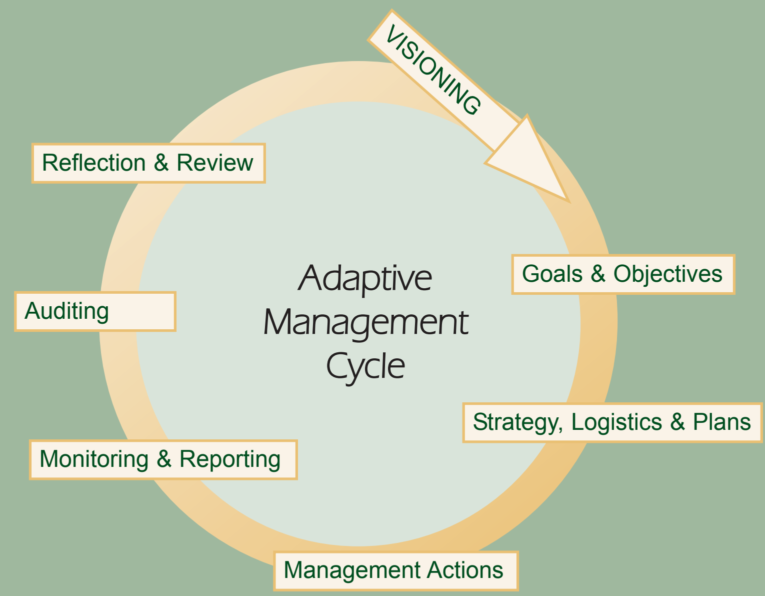
The RHP and Governance

Governance is the process whereby individuals and institutions within society, both public and private, manage their common concerns. In the context of biomonitoring and river management, a governance framework helps all participants manage their common river health concerns effectively. It defines the rules of resource management, the entities that control these rules, and the relationships between them.

The resource manager's day-to-day tasks are influenced by a collection of interactions with operations management, policy development, regulation, allocation, resource user preferences, auditing, law enforcement and all the related institutions responsible for executing these activities. These institutions range from national government to provincial DWAF and DTEEA, local government, catchment management forums, agriculture, mining, business, water user associations and individuals.

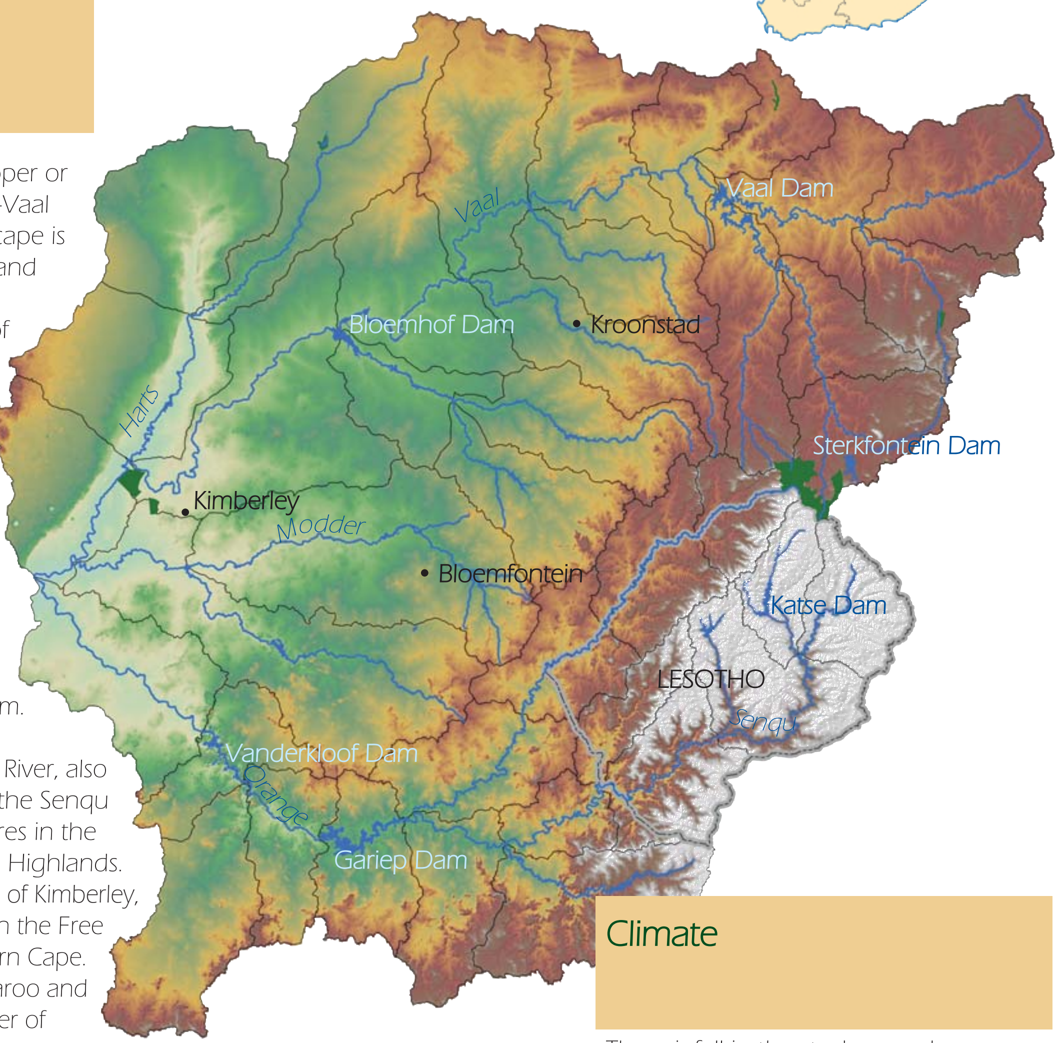
River management is necessarily complex, so several institutions need to interact in order to reach appropriate decisions. Governance of a shared resource implies that each participant needs to understand and respect the others' interests, in order to manage their collective interest in river health.

Governance is a people-centred process and is essentially about relationships between individuals and institutions that have common goals relating to river health. The effective management of river resources requires co-operation between role players, because of diverse and conflicting interests; therefore it becomes almost impossible for any one organisation to achieve its river management goals by working in isolation. The adaptive river resource management process aims to bring this diversity together - to build a shared vision and to design management and monitoring strategies that support the achievement of that vision.



Overview of the Study Area

Terrain



The study area comprises the upper or eastern one-third of the Orange-Vaal drainage basin. While the landscape is mostly flat, lying between 1000 and 1500 metres in elevation, many tributaries originate at altitudes of nearly 3000 metres in the Drakensberg highlands. The study area completely contains the Free State province, and incorporates portions of Gauteng, Mpumalanga, North-West Province, the Northern Cape and the Eastern Cape. The Kingdom of Lesotho appears on the map for completeness, because it is the source of much of the runoff for the Orange-Vaal System.

The 2420-kilometre-long Orange River, also known as the Gariep, begins as the Senqu River at an altitude of 3 000 metres in the Maluti mountains of the Lesotho Highlands. From the Lesotho border to south of Kimberley, it is the natural boundary between the Free State and the Eastern and Northern Cape. It traverses the increasingly arid Karoo and Kalahari, forms the southern border of Namibia and enters the Atlantic Ocean at Alexander Bay, where its delta wetland is a declared Ramsar site. The last 1250-kilometre stretch of the Orange receives no appreciable inflow from its tributaries.

The Vaal River and its tributaries drain about 20% of the Orange-Vaal basin. The source of the main stem is near Breyten (Mpumalanga) at 1770 metres and the main tributaries originate near Harrismith and Bethlehem along the Eastern Escarpment Mountains, where the annual rainfall is 700mm. The Vaal forms 775 kilometres of the northern border of the Free State, from Meyerville in the east to north of Kimberley in the west. Finally, 1425 kilometres from its source, it joins the Orange River.

Tributaries of the upper Vaal include the eastern Klip River and the Wilge River, which joins the Vaal River in Vaal Dam. Tributaries of the Wilge River include the Liebenbergsvlei and Namahadi rivers. The stretch of the Vaal River between Vaal Dam and Bloemhof Dam receives water from southern Gauteng's polluted streams and the Skoonspruit, Renoster and Vals rivers. The Vet River joins the Vaal at Bloemhof Dam. Further downstream, the Harts flows in from the north and the Riet from the east. The Riet and its tributary, the Modder, originate in the mountainous area south of Bloemfontein, at an altitude of about 1500 metres.

River flow in this region is strongly seasonal, with most runoff occurring during the summer rains. The flat gradient encourages the formation of pools, meanders and pans.

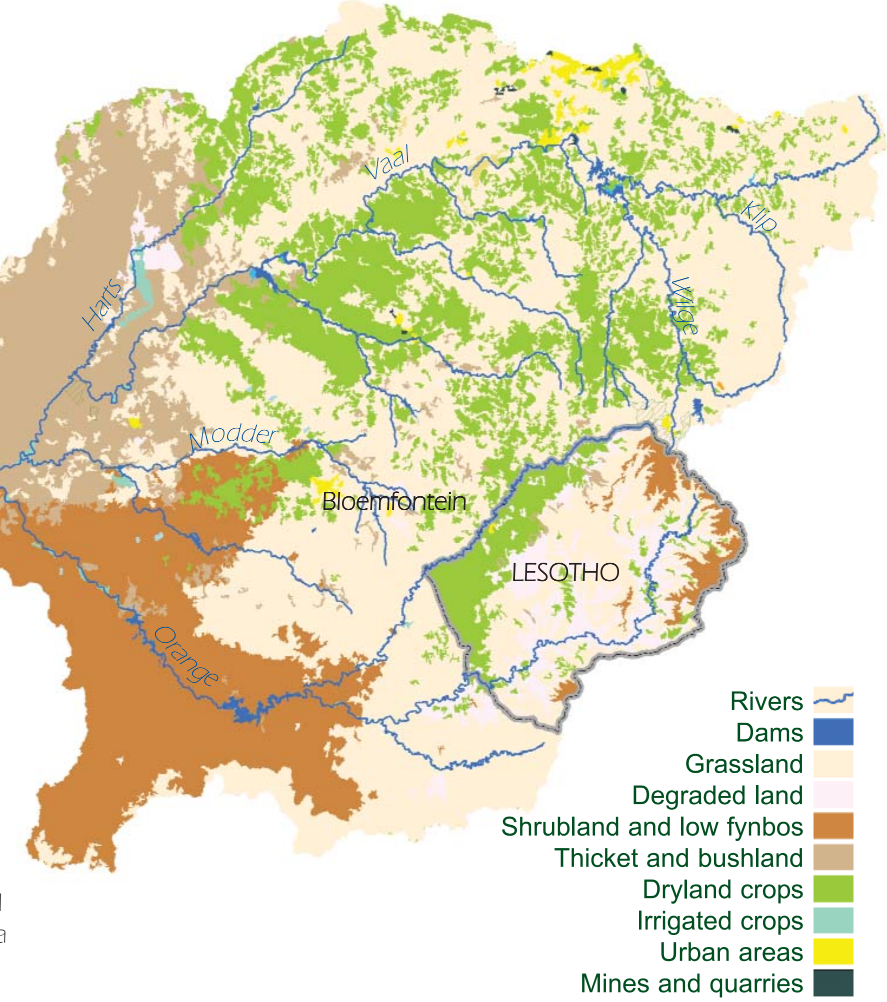
Climate

The rainfall in the study area shows a marked east-west gradient, with annual figures of 1000mm in Lesotho, 700mm in the eastern Free State and 300mm in the west. Most precipitation occurs during summer thunderstorms, while snow sometimes occurs on the mountains in the east. Frost is common during the cold winter nights.

The evaporation gradient is the reverse of the rainfall gradient, with rates of 1 300mm per year in the east, to 2 600mm per year in the west.

The mean daily maximum temperature in summer is 34°C and the mean daily minimum in winter is 0°C. In Bloemfontein, roughly in the centre of the area, the summer average is 22°C and the winter average is 10°C with a range of –2 to 31°C.

Land-use



Rural
Small nature reserves, including private game reserves and conservancies, mostly about 10 to 100 km², are scattered throughout the study area, often close to or around major dams.

The upper Wilge catchment, between Clarens and Phuthaditjhaba, mainly within the Dihlabeng Local Municipality, attracts many tourists from within South Africa and abroad. The unusual landscape consists of basalt and sandstone cliffs contrasting with the rolling foothills. The 18000-hectare Sterkfontein Dam nature reserve offers hiking, watersport and fishing and the Qwa Qwa nature park includes the Basotho Cultural Village. The Golden Gate Highlands National Park conserves the habitat of many species, including the rare bearded vulture (lammergeier) and bald ibis, the Cape vulture and eland. Golden Gate and Qwa Qwa parks are merging into a single national park, eventually to become part of a more than 5000-square-kilometre Maloti-Drakensberg Transfrontier Conservation Area incorporating the highest mountains in southern Africa. DEAT, DWAF and Rand Water are all contributing to the upliftment of the area through tourism, poverty relief and alien vegetation clearance projects.

Apart from a few coalmines, agriculture dominates the land-use in the Klip River catchment, to the detriment of the wetlands. Seekoeivlei, a remnant of the Klip floodplain with its characteristic oxbows, is protected under the Ramsar agreement.

In the western portion of the study area, the landscape becomes flatter and dryer, covered with grasslands and maize fields. Wheat and maize farming dominates the central and northern regions of the study area. Sheep, cattle and game farming is popular in the southern and south-westerly regions.

Urban
The largest urban agglomeration in the study area is Mangaung Local Municipality, comprising Bloemfontein (Free State provincial capital), Botshabelo and Thaba Nchu. Most other large urban areas are associated with mineral exploitation. Kimberley (Northern Cape provincial capital) is famous for the huge excavations during the diamond rush of the 1880s. Klerksdorp is the gold mining centre of North-West and Welkom of the Free State. Sasolburg and Secunda in the northeast are renowned for pioneering work in the production of fuel and other chemical products from coal.

Social profile

The total population of the Free State is almost 3 million. Sesotho is the dominant mother tongue (64%), followed by Afrikaans, isiXhosa, Setswana, isiZulu and English.

About half of the Free State population has access to water-borne sanitation systems. Less than 10% of the population in the Wilge Catchment have access to full sanitation and clean water supply systems. Almost 45% of the residents in the greater Mangaung area have waterborne sanitation but 15% are without any formal sanitation system.

Economic profile

Mining, agriculture and manufacturing drive the economy of the study area.

Gold production dominates the mining sector and the Free State contributes almost a third of South Africa's gold production. Large coal deposits in the northeast support power generation and chemical industries.

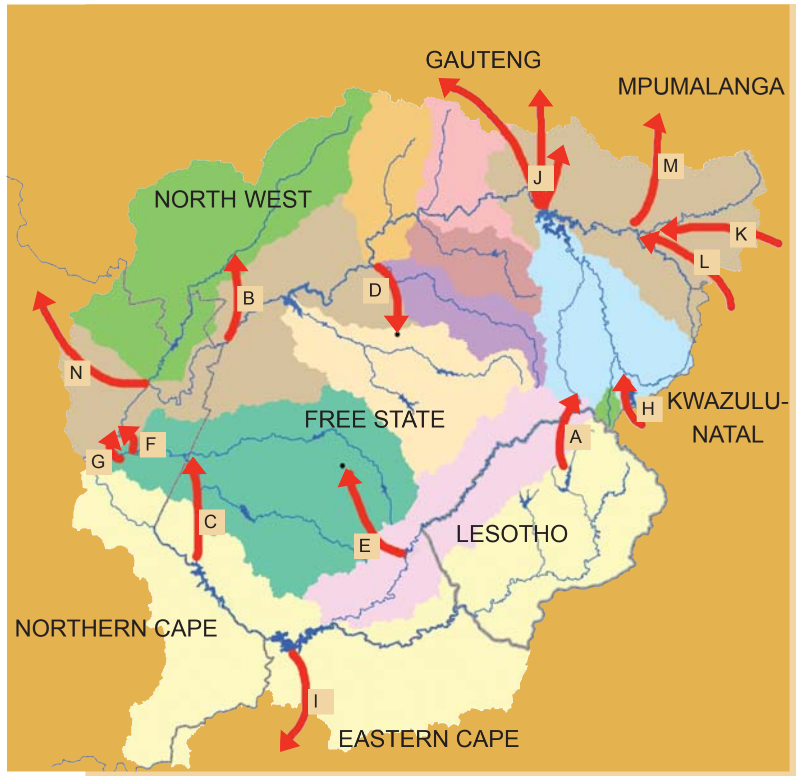
In the Free State, agriculture uses about 90% of the surface area. Except for the Bloemfontein, Welkom and Kimberley (Northern Cape) areas, where manufacturing and mining contributes significantly, agriculture is the main contributor to the Gross Geographic Product of the study area.

Water Supply Development Priorities

Possible developments to ensure a reliable water supply along the Orange River include:

- Raising the Gariep Dam wall
- Building a dam at Torquay, downstream of the Vanderkloof Dam
- Building a new Boegoeberg Dam, near the existing dam
- Building a dam at Vioolsdrift

The catchments downstream of Vanderkloof Dam are arid: even the inflow from the Vaal River is intermittent and unreliable because of activities in the Vaal catchment. Any damming and diversion of water must therefore occur in a well-planned manner, so as not to affect development and the environment. DWAF should assess the environmental flow requirements of major rivers in the Free State before building any additional dams.



Water transfers between river basins: economic necessity or ecological disaster?

The population centres of South Africa have developed around areas of mineral wealth and trade opportunity, rather than where fresh water is readily available. Advanced engineering works have provided a solution by tapping remote water sources, and inter-basin transfers are now a feature of our modified hydrology: without them, our current level of economic activity would be impossible. In addition, during times of drought, they can provide emergency assistance. That said, we must be aware that these systems have costs and impacts beyond their construction, operation and maintenance, for example:

- reduction in available water in the source basin
- disruption of flow patterns in source and receiving basins
- alteration of species composition in aquatic systems
- transfer of alien and indigenous species.

For these reasons, the Department of Water Affairs and Forestry has guidelines for the transfer of water between catchments:

- the national government controls inter-basin transfers
- the source catchment has priority for water provision
- transfers must confer an overall benefit
- transfers must not disrupt environmental integrity
- water use in source and receiving catchments must be efficient
- the receiving system cannot transfer water solely for the Ecological Reserve
- users must bear the costs of transferring water
- users do not pay the source catchment unless it is outside the country.

These requirements will often create conflict, and any inter-basin scheme is necessarily a compromise. To complicate matters, many of the existing systems were completed long before these specifications came into effect. In such cases, management for optimal river health is even more difficult.

Water transfers between river basins: how much and where?

The Orange-Vaal system drains nearly half of South Africa. In such a large area, we can distinguish between intra-basin transfer (between basins within the Orange-Vaal system) and inter-basin transfer (into and out of the Orange-Vaal system). Intra-basin water moves around within the system and inter-basin water is imported or exported.

Note that water management in the Vaal is so tight that only rare high flows ever reach the Orange.

Intra-basin transfers

	Transfer (may include more than one scheme)	Volume* (million cubic metres/year)	Main Purpose
A	Lesotho-Vaal System	457	Urban**
B	Vaal-Harts	419	Irrigation
C	Orange-Riet	181	Irrigation
D	Vaal-Sand/Vet	59	Irrigation, urban
E	Caledon-Modder	59	Urban
F	Riet-Vaal (at Douglas)	30	Irrigation
G	Orange-Vaal (at Douglas)	18	Irrigation

Inter-basin transfers

	Transfer	Volume*	Main Purpose
H	Western Thukela - Vaal	736	Pumped storage, urban
I	Orange-Fish	575	Irrigation, urban
J	Vaal-Crocodile (Limpopo)	514	Urban
K	Assegaai-Vaal	63	Power station cooling
L	Eastern Thukela - Vaal	55	Power station cooling
M	Vaal-Olifants (Limpopo)	36	Power station cooling
N	Vaal-Molopo	4	Stock watering

* Approximate: volume varies according to year of reporting.
** Urban includes domestic and industrial use

Signatures of River Biodiversity

The CSIR and DWAF have set up a national river conservation planning initiative to determine which rivers should be selected to conserve South Africa's freshwater biodiversity. The initiative includes the development of policy and a systematic planning tool for selecting and prioritising rivers.

Principles of conservation planning include connectivity, representivity, complementarity and persistence of biodiversity features.

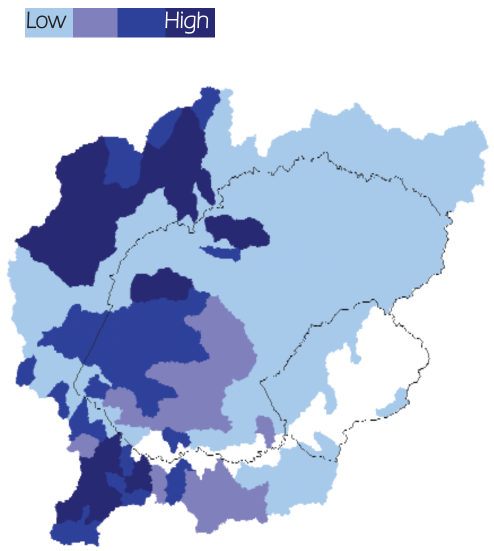
Systematic conservation planning uses physical surrogates to describe biodiversity and delineate its spatial pattern. Two important physical surrogates used in South Africa are hydrology and geomorphology. The signatures for these are the hydrological index and geomorphic provinces.

Hydrological Index

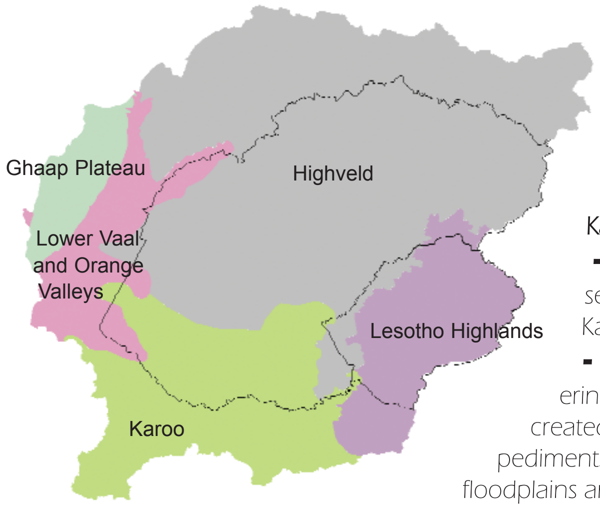
The hydrological index is an index of hydrological variability. A hydrological index close to 1 represents areas of low hydrological variability (commonly perennial rivers). An index of greater than 50 indicates semi-arid areas characterised by high variability (periodic or ephemeral rivers).

The hydrological index for rivers in the Free State ranges from 1 to 90.

Hydrological Variability



Geomorphic Provinces of the Free State



Geomorphic provinces

Geomorphic provinces signify areas of similar landforms that reflect comparable climatic, erosional and tectonic forces.

The Free State province is represented by the five geomorphic provinces below.

The Lesotho Highlands

- rugged topography with deeply incised valleys cut by the headwaters of the Orange River
- river longitudinal profiles are steep, with discontinuities at changes in rock type
- low hydrological variability

Lower Vaal and Orange Valleys

- Vaal and Orange rivers re-incising their valleys following tectonic uplift during the Miocene and Pliocene
- channels above and below the Vaal-Orange confluence are strongly controlled by pre-Karoo valleys that influence present-day processes
- river longitudinal profiles are flat, with discontinuities at changes in rock type
- well-preserved alluvial terraces contain important fossil and archaeological remains
- low hydrological variability down to Vaal-Orange confluence, greater variability downstream

Karoo

- underlain by flat-lying sedimentary rocks of the Karoo Supergroup
- long periods of weathering and erosion have created gentle, multi-concave pediments, broad valleys, braided floodplains and flat, concave river longitudinal profiles interrupted by dolerite intrusions
- large pans, some filled by groundwater, others following the line of ancient river beds
- hydrological variability increases westwards

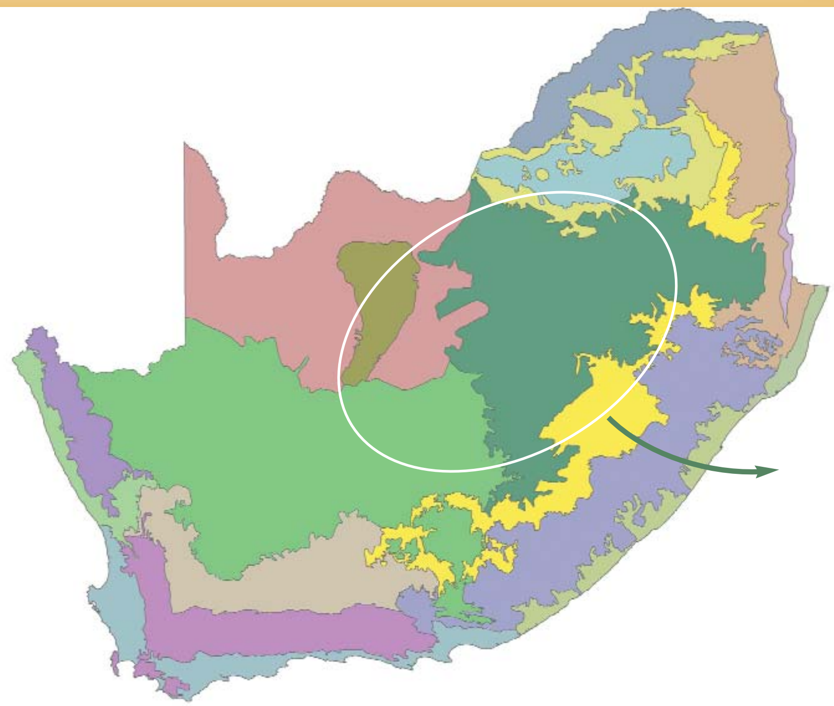
Ghaap Plateau

- remnant of the African erosion surface
- underlain by dolomitic rock
- low relief
- sub-surface drainage
- springs around the edge of the plateau result from karst weathering and groundwater recharge
- very high hydrological variability

Highveld

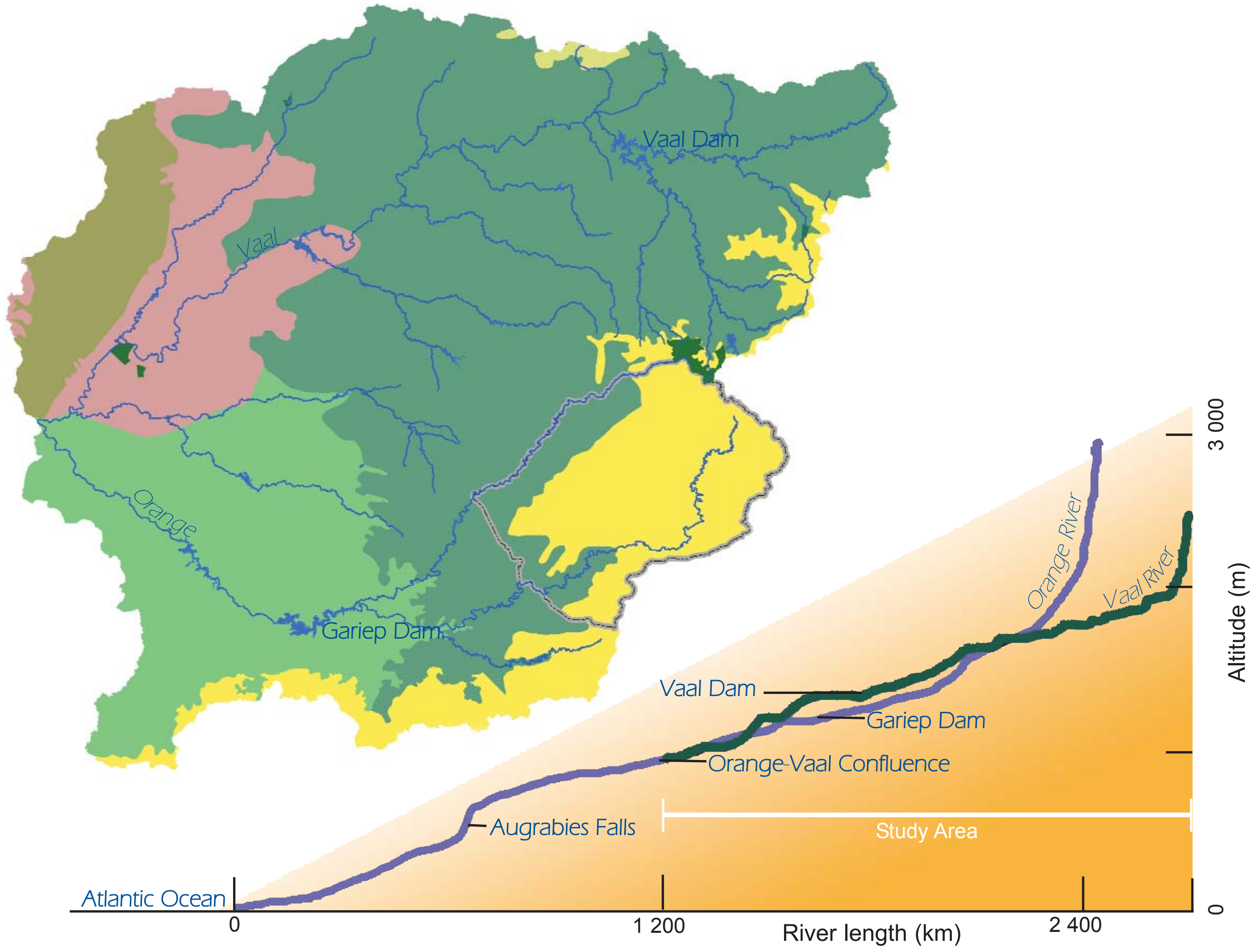
- gentle undulating to flat topography and shallow, open valleys that reflect the African erosion surface
- river longitudinal profiles are gentle, stepped at dolerite sills
- many rivers have well-developed meander belts
- frequent pans in western Free State have created small, contiguous endorheic basins
- numerous dry valleys and gravel terraces reflect ancient drainage lines (especially along the right bank of the Vaal River)
- low hydrological variability
- semi-arid

Ecoregion Characteristics



Defining ecoregions is part of the process of classifying South Africa's river ecosystems according to broad similarities. The first level delineation of ecoregions (Level 1) was derived from terrain, vegetation, altitude, rainfall, runoff variability, air temperature, geology and soil characteristics. DWAF is in the process of subdividing Level 1 ecoregions into more detailed Level II ecoregions.

For this report, the preliminary Level 1 classification groups river reaches into areas of broad ecological similarity. Since ecoregions represent units of ecological similarity they provide convenient boundaries within which to select reference conditions, carry out ecological assessments and set goals for desired states of the river ecosystem.



18. Ghaap Plateau

Landscape:	Plains with low relief; hills with moderate relief
Vegetation:	Kalahari plateau bushveld (dominate) and Kalahari plains thorn bushveld
Altitude:	900 - 1 700 m
Rainfall	Mid to very late summer
MAP:	200 to 500 mm
MAR:	<5 to 40 mm
Temperature:	-6 to 40ºC (mean annual 19ºC)
Geology:	Sand and quartzite
Soils:	Sand-loam and sand-clay-loam.

17. Southern Kalahari

Landscape:	Plains with low to moderate relief; hills with low and moderate relief
Vegetation:	Kalahari bushveld types
Altitude:	700 - 1 900 m
Rainfall	Late to very late summer
MAP:	0 to 500 mm
MAR:	<5 to 40 mm
Temperature:	-8 to 41ºC (mean annual 19ºC)
Geology:	Sand, sandstone, tillite, quartzite, schist and biotite granite
Soils:	Loam-sand, sand-loam, sand-clay-loam and sand-clay

14. Nama Karoo

Landscape:	Plains with low to moderate relief; Hills with moderate to high relief
Vegetation:	Nama karoo types
Altitude:	500 - 1 700 m
Rainfall	Late to very late summer to winter
MAP:	0 to 500 mm
MAR:	<5 to 40 mm
Temperature:	-9 to 40ºC (mean annual 20 ºC)
Geology:	Mudstone, sandstone, tillite, quartzitic sand-stone, sand, quartzite, and schist
Soils:	Sand-clay-loam, sand-clay, sand-loam, clay-loam, and loam-sand

7. Highveld

Landscape:	Plains and hills with low and moderate relief
Vegetation:	Grasslands
Altitude:	1 100 - 2 100 m
Rainfall	Early to late summer
MAP:	400 to1 000 mm
MAR:	5 to >250 mm
Temperature:	-11 to 41ºC (mean annual 18ºC)
Geology:	Sandstone, quartzite, mudstone, basalt and biotite granite.
Soils:	Sand-clay-loam, clay, sand-clay, sand-loam, loam-sand

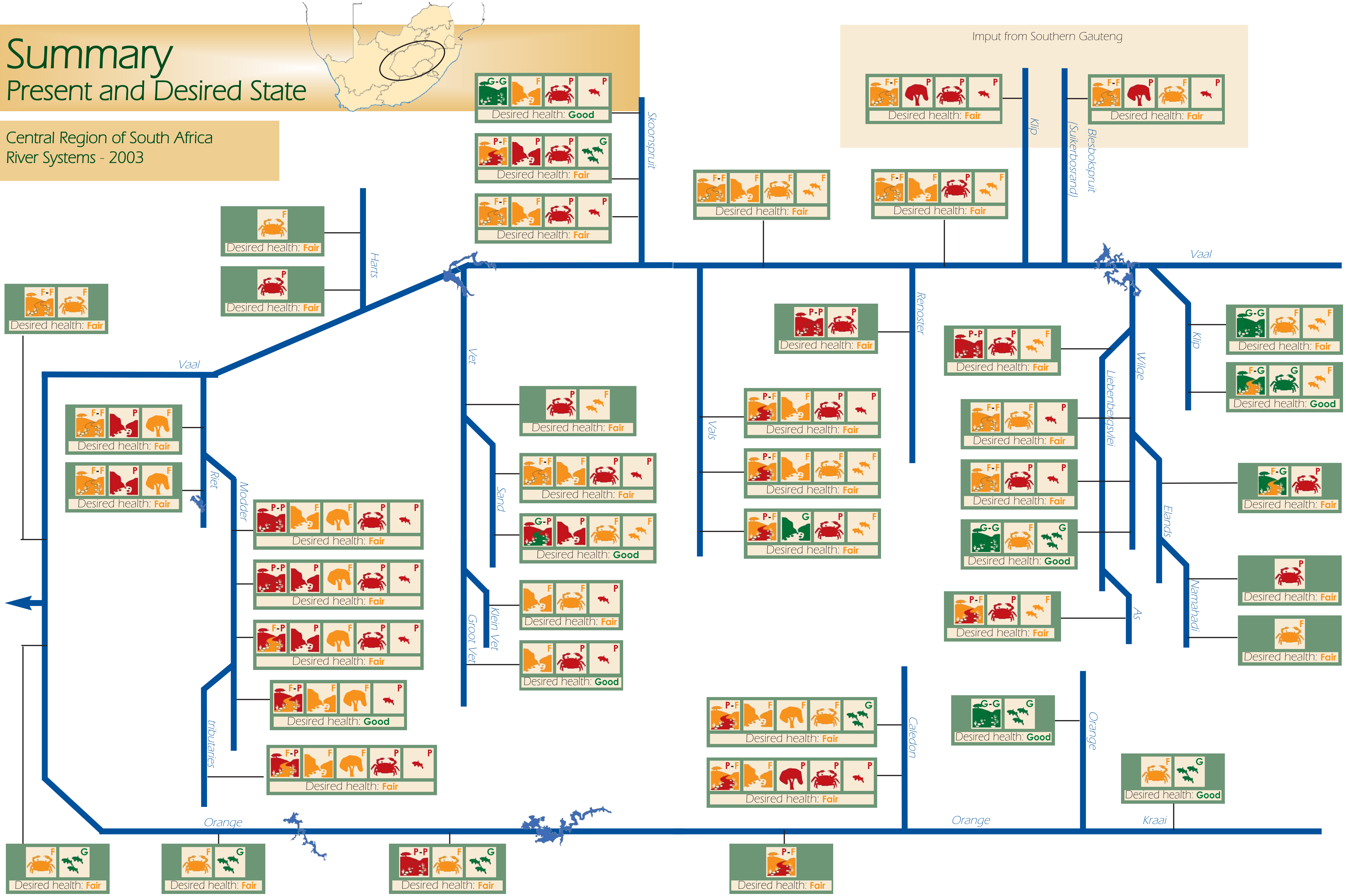
4. Great Escarpment Mountains

Landscape:	High and low mountains with high relief
Vegetation:	Mountain grassland types with patches afromontane forest
Altitude:	300 - > 3 500 m
Rainfall	Early to very late summer
MAP*:	300 to > 1 000 mm
MAR:	20 to >250 mm
Temperature:	-8 to 39ºC (mean annual 18ºC)
Geology:	Quartzite, quartzitic sandstone, sandstone and mudstone
Soils:	Sand-clay-loam, sand-loam and sand-clay

* Includes snowfall

Summary
Present and Desired State

Central Region of South Africa
River Systems - 2003



Summary (continued)

What is the health of the rivers in the Free State Region?

The overall health assessments of the rivers in the Free State region catchments are fair to poor. Some of the upper reaches are good to fair, deteriorating downstream as the impact of human activities becomes more evident.

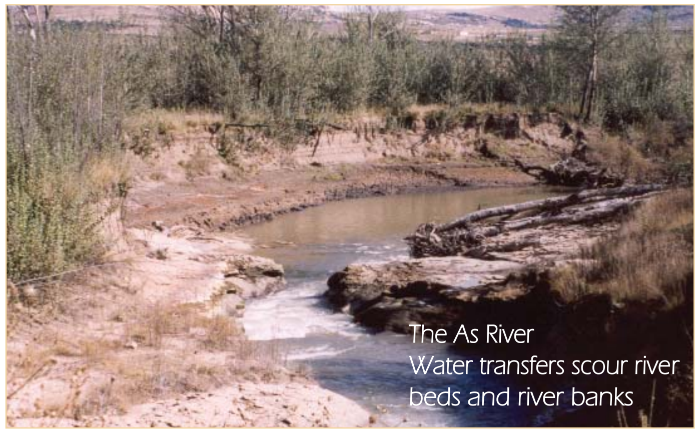
Most of the rivers in the study area have no flow during the dry winter months.

Sand River

What drives the changes and puts pressure on river health?

Main concerns in the study area include:

- Urban, peri-urban and informal developments - urban and informal settlement runoff, point source discharges, illegal disposal of sewage effluent, poor maintenance and exceeding capacity of water treatment works
- Rural settlements - unplanned expansion, overgrazing, gardens in riparian zone and overgrazing of riparian vegetation. Removal of natural vegetation destabilises river banks
- Mining operations - gold and coal mining, diamond diggings and sand mining - destroys river banks and wetlands
- Industries - pollution of water resources
- Agriculture - water abstraction, irrigation return flows, fertiliser use, ploughing of the floodplains, over-grazing and other inappropriate farming practices
- Damming of the rivers - unnatural flow regime
- Artificial structures - roads, bridges, weirs and dams disrupt natural river flow and cause loss of natural habitat
- Transfer schemes - scouring of river beds where water is released, transfer of species
- Alien vegetation in riparian zone - invasion and water loss
- Alien fish species - stocking and transfer between catchments



The As River
Water transfers scour river beds and river banks

What can be done?

Management actions related to the following are recommended:

- Implement catchment management strategies
- Manage and license water use
- Expand the biomonitoring capacity
- Manage sewage works effectively and efficiently - upgrade sewage treatment works and test sewage effluent for compliance
- Identify sources of pollution and enforce the law
- Zone and license mining activities
- Combine and co-operate River Health Programme initiatives within neighbouring provinces
- Control releases from water transfer schemes in such a way as to minimise habitat degradation; consider alternative methods of transfer
- Manage releases from dams (also farm dams and weirs) to simulate natural flow patterns; consider the building of new dams carefully (EIA)
- Build fishways that would allow migration of fish into new impoundments
- Plan new town and township developments carefully - they should not impinge on rivers. Water should be used efficiently
- Determine environmental flow requirements and implement the ecological reserve
- Implement alternative farming methods e.g. camp system where cattle are allowed to graze the riparian zone for short periods only. Use efficient irrigation methods and improved farming practices
- Eradicate invasive alien plants and rehabilitate degraded riparian habitats
- Stop the stocking of alien fish. Indigenous species should not be translocated outside their natural distribution range

Expand the biomonitoring capacity

Upgrade water treatment plants where necessary.

What are the consequences of poor river health?

River health is an integrated measure of the conditions that are necessary for proper river functioning. A river that functions well has the ability to supply good quality water as well as other services which include food for humans and animals, medicinal plants, building materials, self purification, flood as well as erosion control, cultural value and tourism and recreation. Healthy rivers also support a diverse variety of animal and plant life.

When river health deteriorates, some or all of these functions and services are compromised or even lost. When, for example, water quality declines, it may become unfit for human consumption. In more advanced stages of deterioration, it may become unfit for irrigation and industrial processes. This results in escalating water purification costs. Insufficient good quality water constrains socio-economic development.

Typical 'workhorse' rivers have fair river health scores. When river health deteriorates, becoming poor, river functions and services are lost. This impacts on the sustainability of the river ecosystem and long-term environmental, economic and social security.

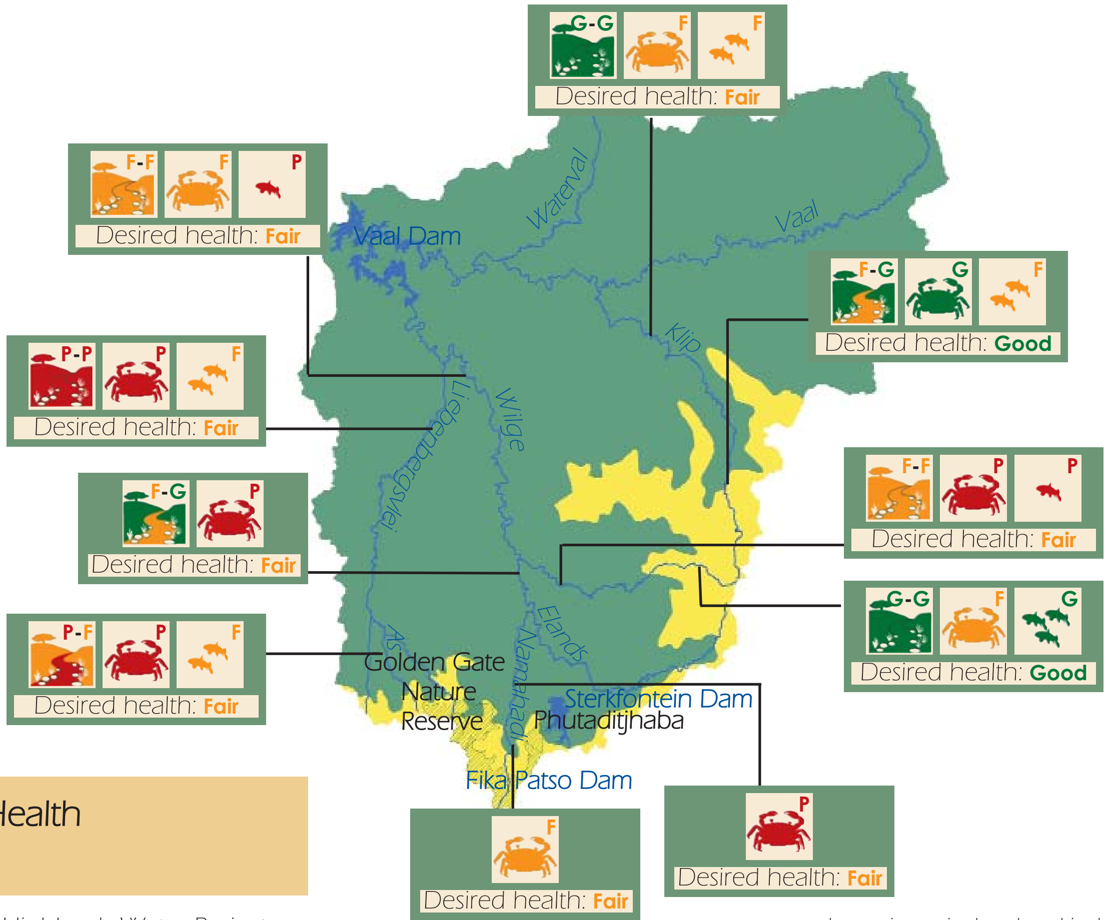
Upper Vaal Catchment

The four rivers that feed the Vaal Dam are the Liebenbergsvlei, Wilge, Klip and Vaal rivers, their catchments covering 42 000 square kilometres. The Vaal River rises north of Ermelo in Mpumalanga. The Klip River originates near the town of Memel in the Drakensberg highlands, which separate the Wilge River from the Vaal River. The highest altitude in the upper Vaal catchment is about 2 200m above sea level. The Liebenbergsvlei originates in the Drakensberg mountains in the Clarens region near Bethlehem and the Wilge River in the mountains beyond Harrismith. The Namahadi River, a tributary to the Wilge River, has its source in the high Maloti Mountains near Golden Gate National Park in the eastern Free State.

The largest part of the catchment lies in the Free State Province (60%) with the rest in Gauteng and Mpumalanga. Important dams in the area are the Grootdraai, Vaal, Saulspoort and Sterkfontein dams.

Natural grassland comprises almost 64% of the Vaal Dam catchment and it is utilised for livestock grazing by commercial and small-scale farmers. Commercial dryland farming takes up more than 32% and irrigation less than 1% of the land-use in this area. Agricultural activities in the Wilge catchment include the production of cereals, e.g maize. Irish potato, sunflower and peach orchards are common. Other land-uses include formal and informal settlements, industrial areas and coal mining. About 340 square kilometres of natural habitat is conserved in the Golden Gate and adjacent Qwa Qwa National Park.

The Working for Water Programme is very active in the mountainous upper regions of the Wilge River near Harrismith and is also involved in the Seekoevlei Wetland at Memel.



Present Health

The Lesotho Highlands Water Project releases 14 cubic metres per second into the As-Liebenbergsvlei-Wilge River. This modified flow has resulted in degradation and habitat destuction in the receiving rivers. Weirs are modified to slow the velocity of the water, prevent further damage to the habitat and allow for fish migration.

The overall health of the Klip River is good to fair and the Wilge is fair to poor, deteriorating downstream, because of large scale agricultural activities. The health of the Elands River is also fair to poor.

The upper Vaal tributaries play an important role in the water supply for domestic, agricultural and industrial users in the area. The marginal riparian vegetation consists of grassland at most sites.

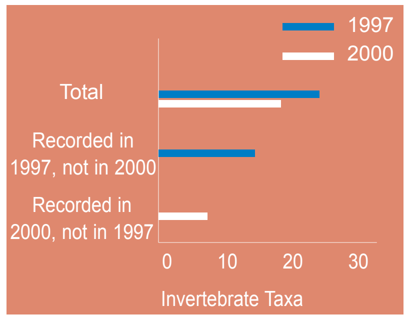
The Namahadi River headwaters are fair, but the health deteriorates downstream. The naturally low habitat diversity restricts the availability for invertebrates and results in low scores.

Driving Forces

- Urban and informal developments - runoff and point source discharges e.g. municipal sewage discharges, seepage from rubbish dumps
- Industries - industrial effluent from Phutaditjhaba
- Coal and gold mining - polluted seepage and water abstraction
- Agriculture - seepage and return flows
- Water transfer schemes - modified flows

Management Recommendations

- Manage the operation of water works to ensure that all effluent that is discharged is of a quality that meets acceptable standards
- Identify sources of pollution and enforce the law.
- Communicate and create awareness through stakeholder meetings. Thirteen catchment forums exist in the upper Vaal.
- Clear alien vegetation from wetlands
- Ensure that flow releases from dams simulate natural flow patterns and natural water temperatures by releasing surface water.
- Manage water transfer schemes in such a way as to minimise soil erosion and habitat degradation. Consider the use of pipes to tranfer water between systems.



The number of taxa sampled in the As River declined between 1997 and 2000. During this period the water releases from Lesotho began. Opportunistic species now flourish and sensitive species are no longer found.

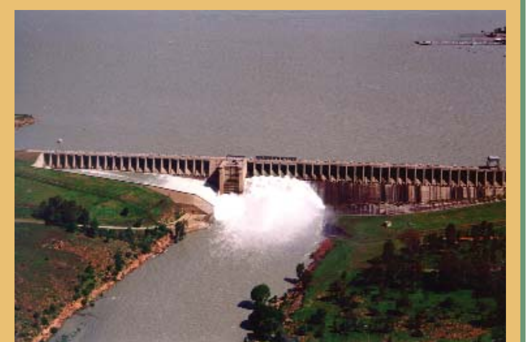
The Namahadi River, tributary of the Wilge River in north-eastern Free State, with the typical basalt-capped, sandstone mountains in the background. This is one of the few sites with good habitat diversity.

The Katse Dam is the source of the water for the Lesotho Highlands Water Project.

The National Environmental Management Act (NEMA) requires an Environmental Impact Assessment (EIA) before any new dam can be built.

The Vaal Dam has a capacity of 2603 million cubic metres. The dam has 60 crest gates and a flood storage capacity of 25% above the 100% full supply level. To date the highest peak inflow of 4800 cumecs was experienced during February 1996.

The wall is long and low. The dam has a very large surface area to volume ratio resulting in high evaporation losses.



Vaal, Harts & Skoonspruit Catchments

This stretch of the Vaal River has two off-takes for major water suppliers. Sedibeng Water abstracts water from the Vaal River downstream of the Vaal - Vals confluence at Balkfontein. The MidVaal Water Company, the main supplier to urban areas in the North West Goldfields, abstracts water from the Vaal River upstream of Orkney.

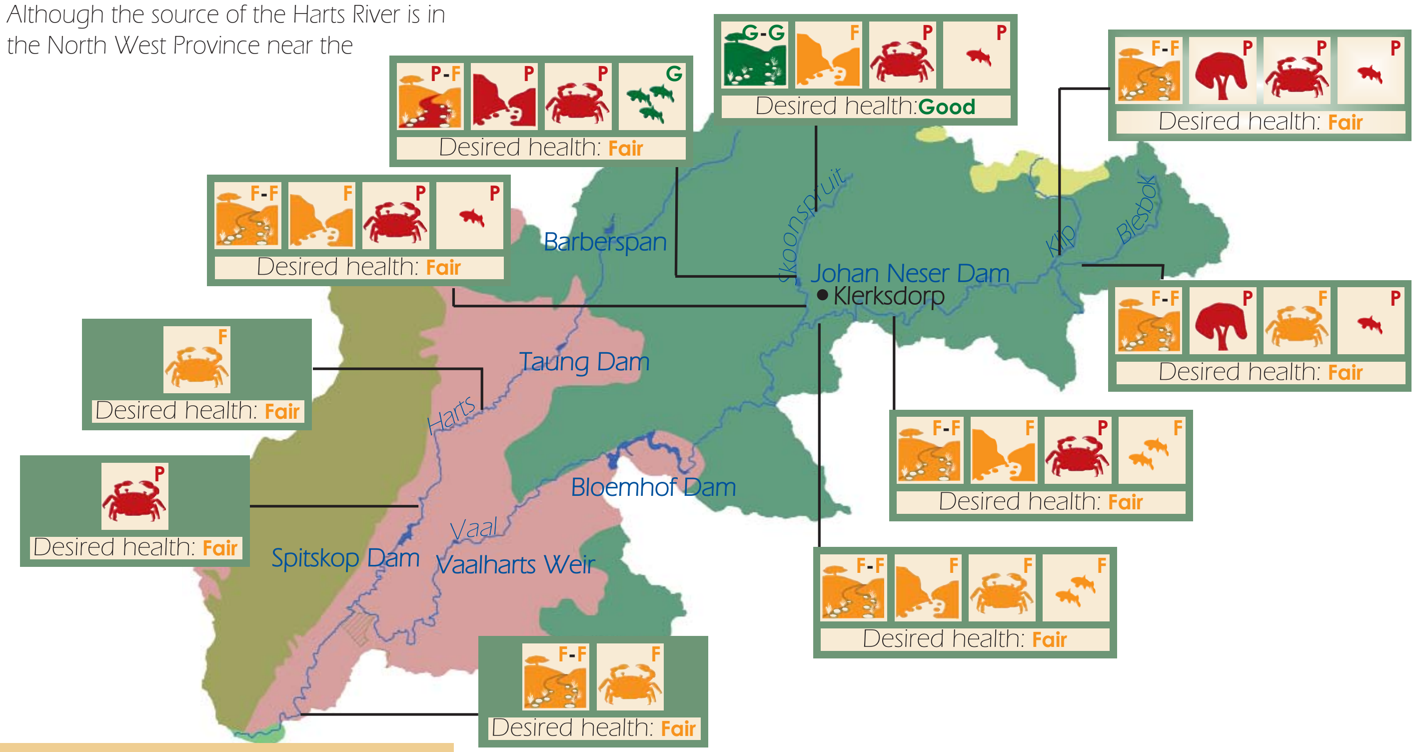
Bloemhof Dam is situated on the stretch of the Vaal River between the Free State and the North West and is also fed by the Vet River (p28). This nutrient rich dam is an angling mecca. In excess of 600 tons of fish, mainly carp and barbel are harvested per year.

Although the source of the Harts River is in the North West Province near the town of Lichtenburg, the larger part of the catchment is situated in the Northern Cape Province. The Harts River flows in a south-westerly direction via Barberspan and Taung Dam to Spitskop Dam, after which it flows into the Vaal River near Delportshoop.

The Harts River plays an important role in the water supply to domestic and agricultural users in the area. Land use in the area is predominantly urban (both formal and informal) and agriculture (irrigated land as well as stock watering). Industrial users receive water from the Vaalharts irrigation scheme.

The Skoonspruit (sometimes spelt Schoonspruit) drains part of the south eastern region of the North West Province and enters the Vaal River downstream of the Vaal Dam near the town of Orkney. Dolomitic springs provide base flow to the upper reaches of the Skoonspruit.

Natural habitat comprises almost 70% of this region. Commercial dryland farming takes up about 25% and irrigation less than 2% of the land-use. Gold mining dominates the economy in the Skoonspruit catchment. Degraded areas cover about 2% of the area. Vlei areas occur in the upper Skoonspruit catchment.



Present Health

The overall health of the middle and lower Vaal River is fair to poor. The Vaal River downstream of the Vaal Barrage is impacted and controlled by activities and effluent discharges from southern Gauteng. The Klip River and Blesbok Spruit systems drain large areas of southern Gauteng affected by urban development, mining, industrialisastion and farming.

The overall health of the lower Harts River is fair to poor. Good rains flush the Taung Dam, but all the sediment is trapped in the Spitskop Dam. This resuts in the dam becoming relatively shallow and nutrient rich. Urban runoff in the Pampierstad area and return flows from the Vaalharts irrigation scheme affect the health of the Harts River. Areas downstream of Taung Dam have diverse habitats and diverse marginal vegetation.

Despite the dolomitic springs which feed the river, the upper Skoonspruit is in a poor condition and the RHP team is investigating the reason for this. The Johan Neser dam overflows most of the time and fish scores below the dam are good. The health of the lower Skoonspruit varies according to flow rates. During the rainy season, fish are abundant in the turbid, high flows. No fish are sampled during low flows when treated effluent is the main source of water in this section of the river.

Driving Forces

- Urban and informal developments - runoff and point source discharges e.g. municipal sewage discharges
- Diamond mining operations - sedimentation and habitat modification of the Skoonspruit and Vaal river banks
- Gold mining operations - mine seepage in the Vaal River and several tributaries such as the Bamboes and Makwassie spruits
- Agriculture - abstraction from the Skoonspruit and nutrient-rich irrigation return flows at the Vaalharts scheme

Management Recommendtions

- Compliance monitoring of all sewage effluent discharges
- Manage mining activities through the issuing of water use and effluent discharge licenses
- Initiate a combined hyacinth clean-up programme with the mines and municipalities in the Skoonspruit area
- Identify all polluters in the region
- Manage water use, and thus reduce over-irrigation, through the issuing of water abstraction licences. No new schemes should be set up until a water balance has been set up.
- Monitor the Harts River downstream of Spitskop Dam as well as upstream of Taung Dam
- Develop a River Health Programme for the area that includes combined initiatives between Free State, North West and Gauteng Provinces
- Manage water releases from the Barrage to benefit the Vaal River downstream

The Harts River downstream of Taung Dam.

Abstraction of water for irrigation. Section 21 of the National Water Act (No. 36 of 1998) stipulates that water users must register and apply for water use licences. The list of uses includes:
- taking water from a water course;
- storing water;
- engaging in a controlled activity such as using water containing waste for irrigation of land.

A mine tailings dam in the Vaal River catchment. According to the National Water Act, discharging waste or water containing waste into a water resource should be registered and licensed. This also applies to waste material that is allowed to drain passively into a water resource.

The Bloemhof Dam has a capacity of 1264 million cubic metres. The dam has 20 crest gates and a flood storage capacity of 18% above the 100% full supply level. The highest peak inflow of 6200 cumecs was experienced during March 1988.

Vals & Renoster Catchments

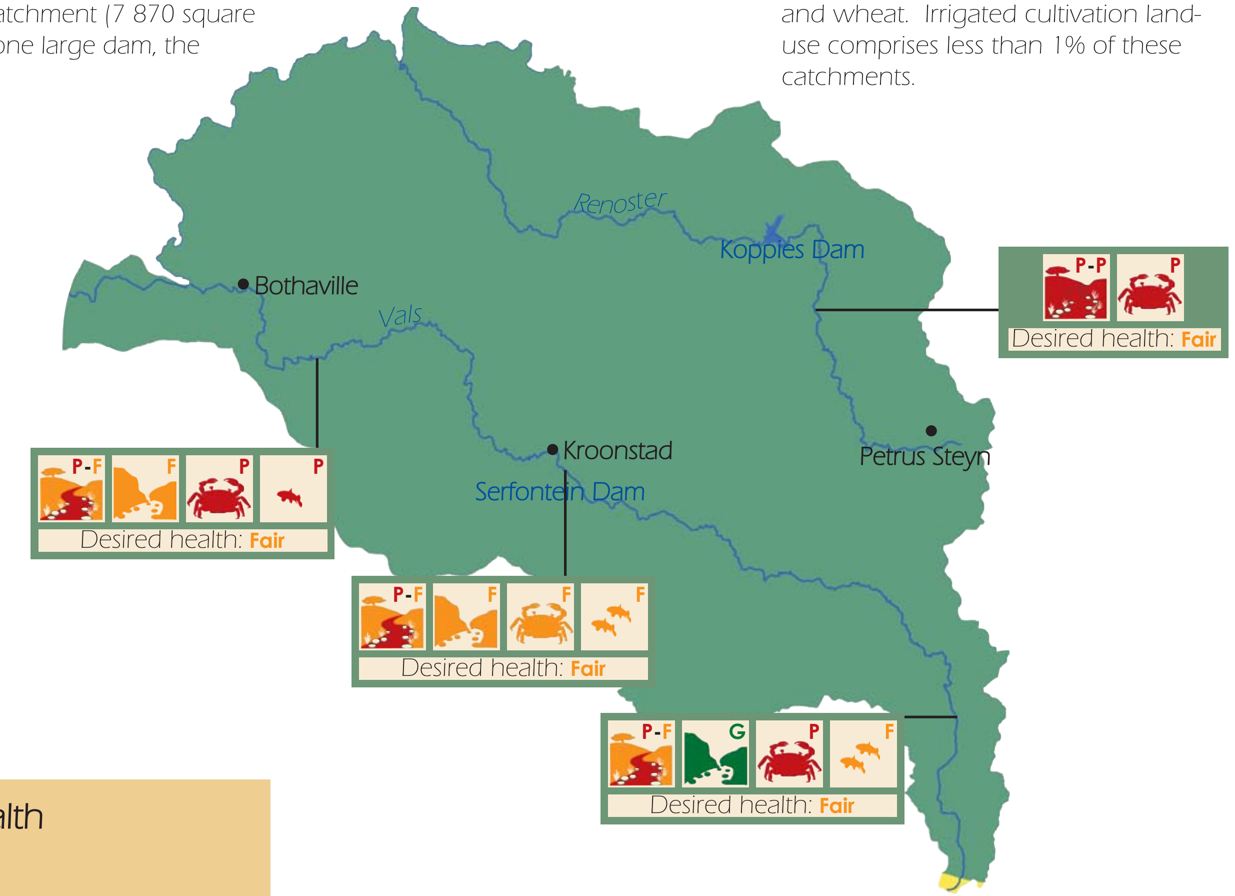
The 6 650-square-kilometre Renoster River catchment has a population of about 100 000 of which almost two thirds live in urban areas.

Koppies Dam, the only large dam on the Renoster River, was constructed primarily for irrigation purposes. Tributaries of the Renoster River include the Rietspruit, Doring, Geluk and Eland Rivers.

The Vals River catchment (7 870 square kilometres) has one large dam, the Serfontein Dam, near Kroonstad. There are many smaller weirs along its length resulting in unnatural flows. The Vals catchment has a total population of 190 000, of which more than half live in urban areas.

Urban water user requirements consist mainly of water for Kroonstad. Most of the other water users are irrigation, with a smaller component for rural domestic supplies and stock watering.

About 60% of the land-use in the Renoster and Vals river catchments comprises natural grassland that is used for cattle grazing. Waterbodies and urban developments comprise less than 1% of the catchments. The remainder of the land-use is dryland cultivated crops, predominantly maize and wheat. Irrigated cultivation land-use comprises less than 1% of these catchments.



Present Health

During the wet summer months, the Renoster River is transformed into a turbid stream and during the dry summer months the river is reduced to a series of small pools. There is almost no flow in this relatively small river downstream of Koppies Dam. Koppies Dam and several weirs significantly reduce the amount of runoff that flows to the lower reaches of the river. Minimal water is thus available to maintain the functioning of the system downstream of Koppies Dam. These dams also act as barriers to the movement of fish and invertebrates. Largemouth yellowfish and rockbarbel are very scarce as they tend to favour large rivers such as the Orange, Vaal, Caledon and Kraai rivers.

The upper reaches of the Vals River are in good health, almost natural, with flows during rainy periods. Shallow areas dry out during dry periods. The low flows lead to poor SASS scores. Deep pools are the only refugia for fish populations during dry periods. Species sampled include the chubbyhead barb and the juveniles of larger fish species such as smallmouth yellowfish, moggel and the Orange River mudfish species.

Several large weirs regulate the flow regime of the Vals River. Downstream of Kroonstad the river deteriorates due to water abstraction and sewage effluent discharges.

The overall health of the Vals River is poor; habitat availability is poor and many invasive alien plants are present.

Driving Forces

- Urban development - Petrus Steyn Town and Mamafubedu township in the upper Renoster River catchment with their consequent influences such as pollution and overgrazing, lead to increased turbidity and sedimentation. Water abstraction for domestic use at Kwakwatsi Waterworks reduces the river flow significantly and magnifies the seasonal variability of river flows.
- Agriculture - farming practises such as crop cultivation on the river bank and overgrazing of the river vegetation leads to erosion and siltation. Excessive use of fertiliser causes eutrophication.
- Alien plants - blue gum trees, poplars and willows invade the riparian habitat, reducing the naturally occurring aquatic biodiversity and result in increased erosion and significant water loss via evapotranspiration. The aquatic fern, *Azolla*, invades in-stream habitats and can cover the surface of standing, nutrient rich pools.

The improper disposal of sewage such as overflows of the Kroonstad sewage works is not only a human health risk, but causes eutrophication which leads to fish kills. According to the National Water Act (No. 36 of 1998) sewage treatment works must be registered and licensed as water users.

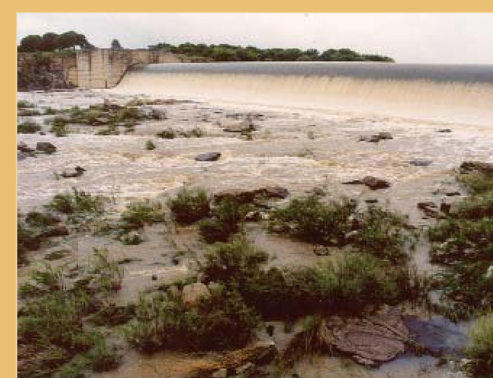
Management Recommendations

- Manage sewage works effectively and efficiently
- Plan urban developments so as not to impinge on the rivers
- Determine Environmental Flow Requirements (EFR) and develop an ongoing monitoring programme
- Manage water flows throughout the length of the river - release water to maintain the aquatic ecosystem below Koppies Dam
- Implement alternative farming methods - protect riparian vegetation by implementing the camp system whereby cattle are only allowed to graze the riparian zone for a short period of time
- Zone cultivated fields - ensure that riparian zones are not encroached upon: this should result in less fertiliser entering rivers during rainy periods
- Rehabilitate degraded riparian habitats - they should maintain their natural function
- Eradicate invasive alien plants, especially in the riparian zone. Working for Water should implement programmes to control invasive alien trees
- Control alien species (such as *Azolla*) with biological agents

Research on Artificial Substrates

Stream habitat has been modified to such an extent that one weir follows the next with no stones in current. These deep water flowing habitats can only be sampled for macroinvertebrates using artificial substrates. Nylon mesh bags filled with rocks and suspended in the river create such artificial sampling sites, which invertebrates colonise.

Construction of Koppies Dam was completed in 1912. In 1979 the dam wall was raised to 5,94m, increasing the capacity to more than 47 million cubic metres. The length of the dam wall is 2,4km. Water is released through a canal system back to the original river channel. No water is released downstream of the dam except during natural flooding events.



Sand & Vet Catchments

The population in the Sand-Vet catchment area is concentrated in the main urban areas of Welkom and Virginia. The Welkom area is the gold mining capital of the Free State. Of the almost 600 000 people in the Sand-Vet area, more than two thirds live in urban areas.

About 52% of the 7 500 square kilometres of the Sand River catchment comprises grassland and bossieveld. Dryland crops cover 42% and urban areas almost 2%.

Natural grassland and bossieveld cover 66% of the upper and 33% of the lower Vet River catchment. Dryland crops cover 31% of the upper and 63% of the lower catchment, while the total irrigated area is less than 1%. Dams, wetlands and pans cover 3% of the Vet River catchment and urban areas 1%.

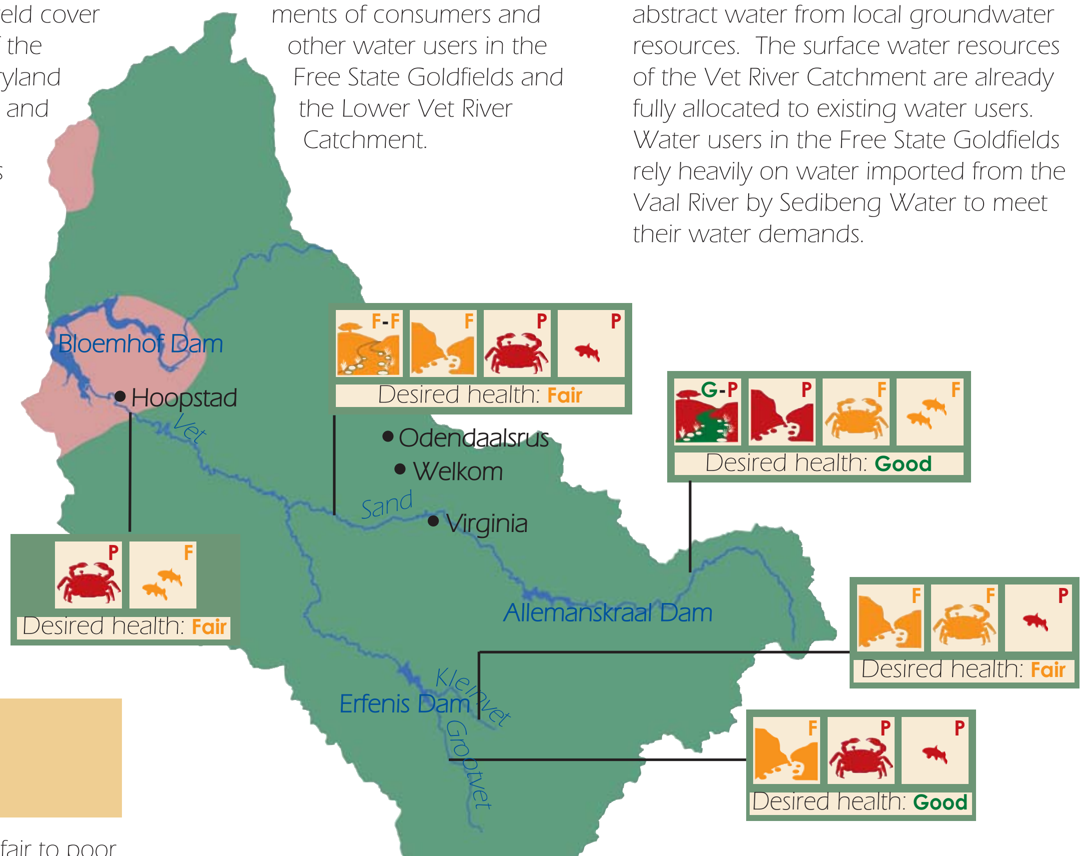
The future demography of the Sand-Vet area will be largely influenced by economic opportunities and potential. Urban populations in this area may decline as a result of the anticipated decline in mining activity in the area and a lack of other economic stimulants.

Major dams in this area are the Allemanskraal Dam on the Sand River and Erfenis Dam on the Vet River.

The Sand-Vet Government Water Scheme (GWS) and Sedibeng Water are currently meeting the requirements of consumers and other water users in the Free State Goldfields and the Lower Vet River Catchment.

The Sand-Vet GWS supplies water via a system of canals fed by Allemanskraal and Erfenis Dams. Sedibeng Water obtains most of its raw water from the Vaal River; the remainder is abstracted via a canal from the Sand River system. The Welkom-Virginia area is the main urban centre supplied by Sedibeng Water. The Sand-Vet GWS is the most important irrigation area in the Middle Vaal Water Management Area.

Water in this region is used mainly for irrigation, mining and domestic purposes. A number of towns also abstract water from local groundwater resources. The surface water resources of the Vet River Catchment are already fully allocated to existing water users. Water users in the Free State Goldfields rely heavily on water imported from the Vaal River by Sedibeng Water to meet their water demands.



Present Health

The Sand-Vet River system is in fair to poor health. This small river system is heavily regulated and impacted by catchment activities. Very little or no flow is released out of the dams for environmental requirements, because of the great demand for irrigation and domestic use.

Canals transfer water to irrigation schemes and the nearby towns of Welkom, Virginia, Odendaalsrus and Hoopstad. In some sections of these rivers, the entire flow during the dry winter months is made up of treated sewage effluent, increasing the obligation for sewage treatment works to operate efficiently. This flow is sometimes supplemented with irrigation return flows and industrial effluent. Water seepage through the Allemanskraal Dam wall provides base flow that sustains the aquatic habitats for a short distance downstream.

The reaches above the Allemanskraal and Erfenis dams have flow only during the summer rains. During the dry months, some reaches dry up. Others maintain a slight flow, sufficient to sustain the pools that serve as refugia for fish. Fish health is good to fair during the summer rainy season. During winter low flows, salt encrusts the rocks in the middle reach while the upper reaches are often dry.

Driving Forces

- Mining activities and irrigation return flows are the major contributing factors to the high salt concentrations in the rivers.
- Agriculture and urban development - water abstracted from the various canal systems is used by the Sand/Vet Irrigation scheme, as well as for domestic supply by Sedibeng Water
- Sewage works in the area are notorious for spills caused by poor maintenance and under-capacity.
- Alien fish species - stocking of bass has displaced indigenous fish species including red data species such as the largemouth yellowfish

Management Recommendations

- Compliance monitoring of sewage works - develop methods to reduce sewage work failures
- Broad-based monitoring of the Sand/Vet rivers, including the riparian vegetation (RVI)
- Identify the source of the excessive salt built-up in the Welkom area
- Implement the catchment management strategy
- Determine and implement ecological reserve and apply environmental flow requirements
- Assess the distribution and impact of bass and bluegill sunfish in the catchment - DTEEA should initiate awareness programmes

The Sand River at the Meloding sampling site near Virginia.

Mining activities have several impacts on water resources. According to the National Water Act (No. 36 of 1998) all water users must register and apply for water use licences. These water uses include:
- storing water
- engaging in a stream flow reduction activity
- discharging waste or water containing waste
- disposing of waste in a manner which may detrimentally impact on a water resource
- altering of bed, banks, course or characteristics of a river
- impeding or diverting river flow

The Sand/Vet Catchment Management Committee

The National Water Act makes provision for the establishment of Catchment Management Agencies in 19 different Catchment Management Areas in South Africa. The philosophy behind this is to eventually transfer responsibilities for the management of all water resources in a catchment to the users in that catchment.

The Sand and Vet Rivers are part of the Middle Vaal Catchment Management Area. In September 1997 a Catchment Management Plan was developed for the Sand and Vet Rivers. One of the major recommendations was to establish a committee with representatives from all the stakeholder groups in the catchment to drive the implementation of the Catchment Management Plan.

In 1998 the committee was established and since then has met at quarterly intervals to discuss relevant issues and plan future actions.

The Catchment Management Committee is a precursor to the Catchment Management Forum which will eventually lead to the establishment of a Catchment Management Agency. The mission of this Catchment Management Committee is to advise the Department of Water Affairs and Forestry on the management of surface and ground water resources within the Sand-Vet catchment. This should be done in a manner that supports the water requirements of each sector, thus promoting the prosperity of the area; and simultaneously protects the resources and environments in order to achieve sustainability.

Modder & Riet Catchments

The Modder River catchment comprises an area of about 17 400 square kilometres. The Modder River, with its source at an altitude of 1 600 metres in the hills near Dewetsdorp, joins the Riet River at Ritchie (1 340 metres). Above Rustfontein Dam several small tributaries join the Modder River. Below Rustfontein Dam, the tributaries that originate in densely populated areas around Botshabelo are the Klein Modder River, Sepane Spruit, Koring Spruit and Koranna Spruit. Dams in the Modder River include the Rustfontein and Krugersdrift dams.

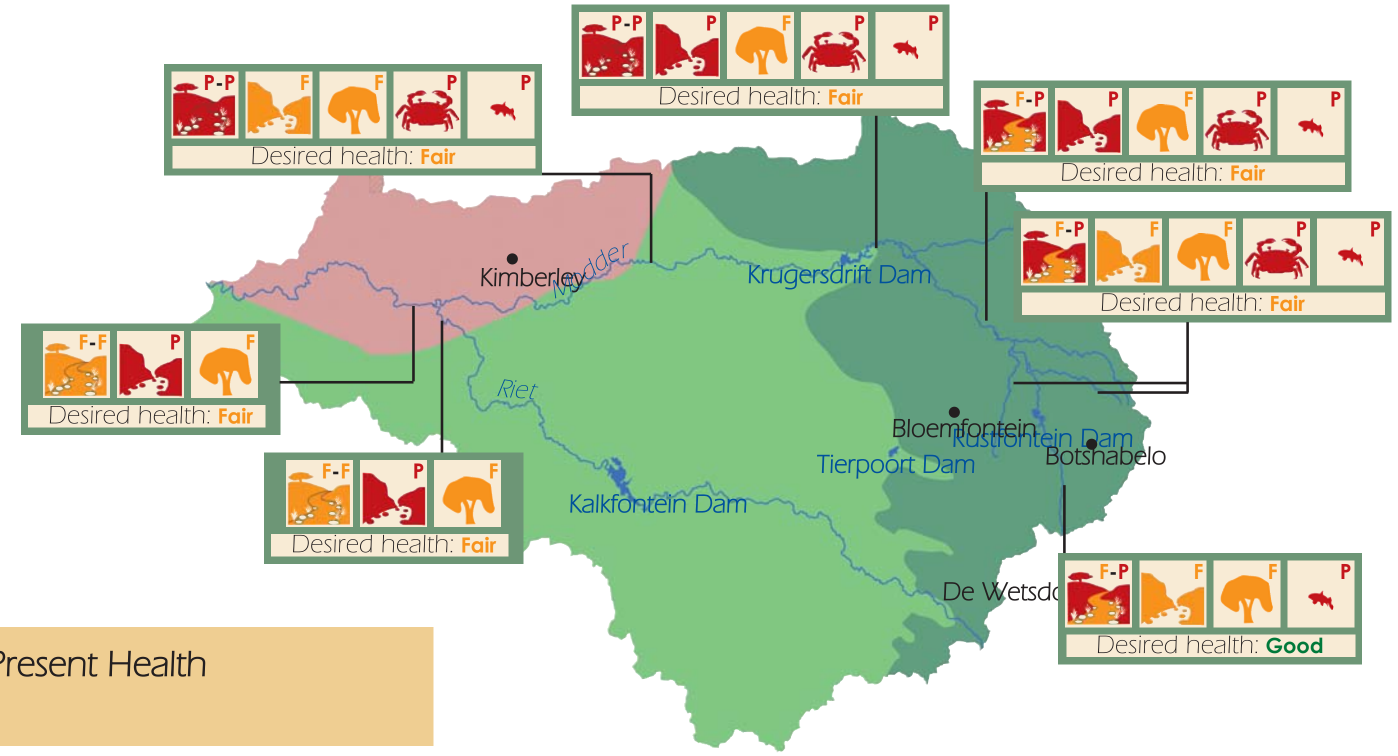
Most of the natural runoff into the Modder River is from areas located above the confluence of the Modder and Klein Modder. The rest of the Modder River catchment is relatively flat and very little runoff occurs. Numerous pans are found in the low-gradient western half of the Modder River catchment. These pans are filled in the summer after rainfall but hardly ever overflow. This area therefore contributes very little to the run-off into the river.

Agricultural practices such as grazing contribute less to erosion and sediment yield than horticulture does. For the Riet and Modder River catchments, much of the area is used for cattle and game farming in the west and sheep farming towards the east (up to 75% of the land-use is natural grassland and bossieveld).

Dryland agricultural activities make up some 21% of the land-use, with urban areas covering 2% of the area.

The Local Municipality of Mangaung, comprising Bloemfontein, Botshabelo and Thaba Nchu, is spread out along the upper and middle reaches of the Modder River.

Domestic, agricultural and industrial water users are heavily reliant on the Modder River. According to some estimates they are already exploiting the Modder River to the limits of sustainability.



Present Health

The overall health of the Modder River is poor. Numerous natural and anthropogenic (human) influences have accelerated changes in the structural, species composition and functional characteristics of the vegetation along the river as reflected in the driving forces.

The common reed (*Phragmites australis*) encroaches on rivers downstream of weirs and dams, where the current is not strong enough to dislodge the rhizome mat. Areas of sediment deposition are particularly favourable to the establishment of reed beds.

The fish population of the Modder River is fair to poor. The Orange River mudfish is the most widespread fiish species.

Largemouth yellowfish have been sampled in dams.

Alien fish species include the common carp and the mosquito fish.

Many alien plant species occur in the riparian zone along the Modder River. Some of these alien species are invasive and a cause for concern.

Driving Forces

- Extensive agriculture - irrigation (water abstraction), ploughing of the floodplains, over-grazing and incorrect farming practices
- Artificial structures - road construction, bridges, weirs, dams, etc.
- Urban development - abstraction, stormwater runoff and treated sewage discharges, illegal disposal of sewage effluent, mainly due to poor maintenance and exceeding the capacity of sewage treatment works
- Sand mining and diamond diggings

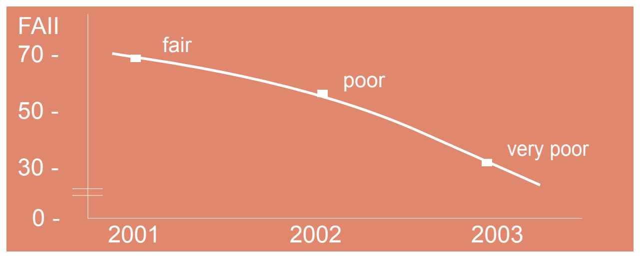
The Rustfontein Dam inflow, southwest of Botshabelo.

Excessive sewage loads entering sewage treatment works that are either too small, or are operated inefficiently, result in poor levels of treatment, such as in the upper Modder River near Dewetsdorp (above). If this effluent is then discharged into a river system it can cause a wide variety of problems. It is an offence to pollute a water resource (NWA, Section 151).

A mine tailings dam in the Riet River catchment. According to the National Water Act (No. 36 of 1998), a water user must apply for a water use licence at the DWAF Regional office.

Management Recommendations

- Finalise the Catchment Management Strategy and implement it as soon as possible
- Improve sewage treatment methods and ensure consistent application.
- Reduce phosphate and nitrate loads to control eutrophication - identify point and diffuse sources
- Control alien riparian vegetation
- Establish Environmental Flow Requirements
- Conduct EIAs for all new mining developments and rehabilitate mining areas
- License irrigation schemes



According to fish monitoring data, the fish population has showed an alarming deterioration in the upper Modder River since 2001.

Slaking Bloemfontein's Thirst

In 1896 the municipality of Bloemfontein looked to the Modder River to satisfy the city's growing demand for water, and built a weir at Sannaspos. This was followed by Mazelspoort Dam (1904), Mocke's Dam (1913) and Rustfontein Dam (1955). In 1975 Bloemfontein began drawing water from the Caledon River via a 107-kilometre pipeline, supplemented in 1999 by the Novo Caledon-Modder transfer scheme.

Keeping it Clean

To ensure that good-quality water returns to the Modder River, the Mangaung Local Municipality operates six sewage treatment works that together discharge more than 100 million litres of treated effluent into the Modder River and its tributaries daily.

Orange, Caledon & Kraai Catchments

The Orange River originates in Lesotho as the Senqu River and contributes close to 60% of surface water yield in the Upper Orange Water Management Area (WMA). Large transfer schemes characterize this catchment, with 70% of the yield transferred to other WMAs.

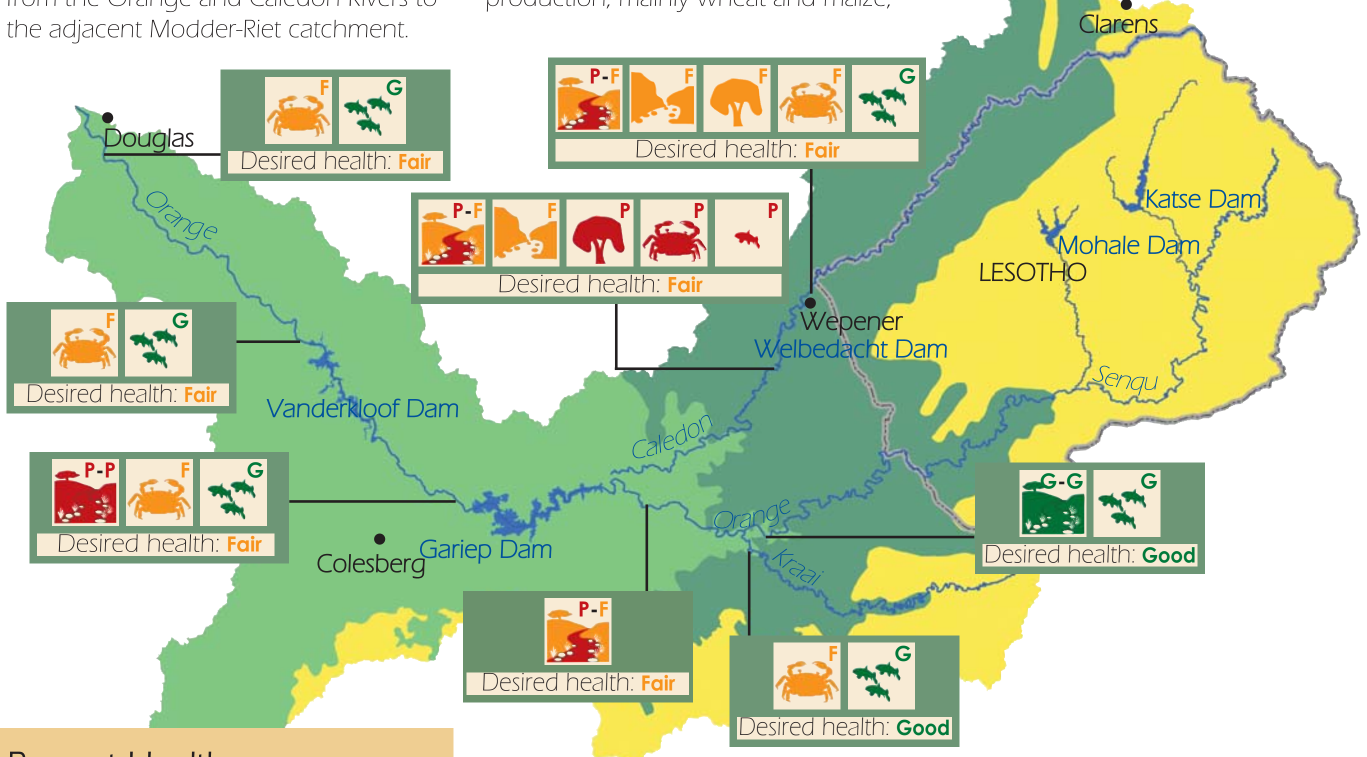
Transfers out of the Upper Orange WMA include transfers to the Upper Vaal WMA (Lesotho Highlands Water Project), to the Fish/Tsitsikamma WMA (Orange-Fish Tunnel) and to the Lower Vaal WMA (Orange-Vaal Transfer) and from the Orange and Caledon Rivers to the adjacent Modder-Riet catchment.

Major dams on the Orange River include the Katse, Mohale, Gariep and Vanderkloof dams. The Welbedacht Dam on the Caledon River is downstream of the town of Wepener.

Major towns in this almost 75 000 square kilometre area include Wepener, close to Lesotho's border, and Colesberg in the Northern Cape.

About 60% of the 22 000 square kilometres of the Caledon catchment is grassland and bossieveld. Dryland crop production, mainly wheat and maize, comprises almost 33% of the catchment. Stock grazing is the main land-use for the Orange and Kraai River catchments.

The lower Orange River and tributaries are in the process of being monitored by Northern Cape Department of Agriculture, Land Reform, Environment and Conservation. This monitoring programme is developed in conjunction with the Free State River Health Programme.



Present Health

The overall health of the Caledon River is fair upstream of the Welbedacht Dam and poor downstream. The Caledon catchment has almost 100% grassland cover but poor management practices-result in high sediment yields. The slope as well as the erodability of the soils in the upper Caledon catchment lead to increased sediment deposition.

The Katse Dam and other dams in Lesotho take a great deal of the water from the upper Orange River system. Other than this reduced flow in the Orange River, the available habitat upstream of the Gariep Dam is relatively unimpacted and the overall health of this reach is good. Ten indigenous fish species have been recorded here, of which the largemouth yellowfish and rockbarbel flourish. Alien species are carp, trout, bass and bluegill sunfish.

The cold, sediment-poor water released from the Gariep Dam has a scouring effect on the river downstream of the dam wall and existing sandbanks have been scoured. The cold water prevents spawning of fish except during late January. The habitat in this area consists of rocky rapids/riffles and deep pools. Flow patterns in the Orange River are dependent on water releases from the Gariep as well as Vanderkloof dams by Eskom. Reed beds form in sheltered areas.

The upper Kraai River is in near natural health. The stocking of trout is one of the few problems. Ten indigenous fish species with healthy populations occur and the flow regime is natural. Below Barkly East the health of the river deteriorates slightly due to the inflow of treated sewage effluent. Turbidity increases during rainy periods due to poor farming practices.

Driving Forces

- Damming - Gariep, Vanderkloof, Katse and Mohale dams have changed the lower Orange River into a highly regulated system. The resultant unnatural flow patterns are a major contributing factor in the changing habitat and the outbreak of blackfly downstream of the Gariep and Vanderkloof dams.
- Agriculture - over-grazing and incorrect farming practices on erodable soils in the mountain catchment areas lead to siltation
- Urban development - water abstraction and sewage effluent spills (Barkly East and Aliwal North)
- Alien fish species, e.g. trout in upper Kraai River, compete with and predate on indigenous fish species.

The Caledon River near Reddersburg.

Management Recommendations

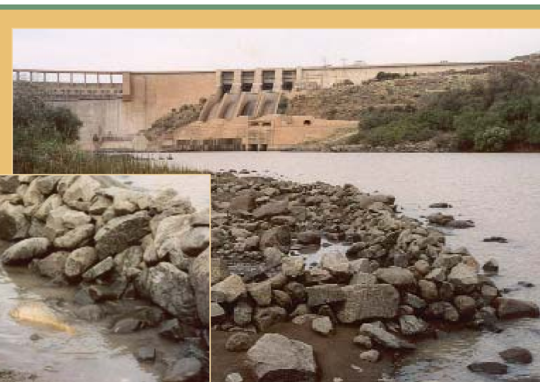
- Consider the building of any new dams carefully
- Ensure that releases from in-stream dams simulate natural flow patterns.
- Investigate methods to compensate for the effects of the release of cold water from the bottom of Gariep Dam for power generation - normal summer water temperatures favour fish spawning
- Stop the stocking of alien fish through the implementation of the international yellowfish conservation initiative
- Establish environmental flow requirements for the Orange and Kraai rivers - include releases from the Katse Dam into the Orange River

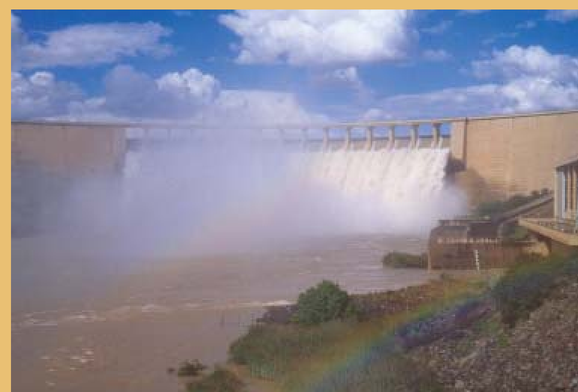
State Fish Hatchery

The only operational, state managed, fish hatchery that focusses on research and development of indigenous fish species is situated near Gariep Dam. Results from the research provide in-depth information regarding the breeding biology of these indigenous species. This information is used when developing in-stream flow requirements for different rivers.

The National Environmental Act (NEMA) requires an Environmental Impact Assessment (EIA) before any new dam can be built. Size and site restrictions should be enforced.

Subsistence fishing has taken on new dimensions - including the illegal building of stone 'kraals' to trap fish when Eskom releases water in pulses from the dam.





The Gariep Dam (left), the largest dam on the Orange River and in the RSA, has a capacity of 5341 million cubic metres. The highest peak inflow experienced to date was 11600 cumecs during February 1988.

The Vanderkloof Dam has a capacity of 3171 million cubic metres. To date, the highest peak inflow of 6700 cumecs was experienced during February 1988. Both the Vanderkloof and Gariep dams are used for hydro-electric power generation.

Water Quality & Algae

Water Quality

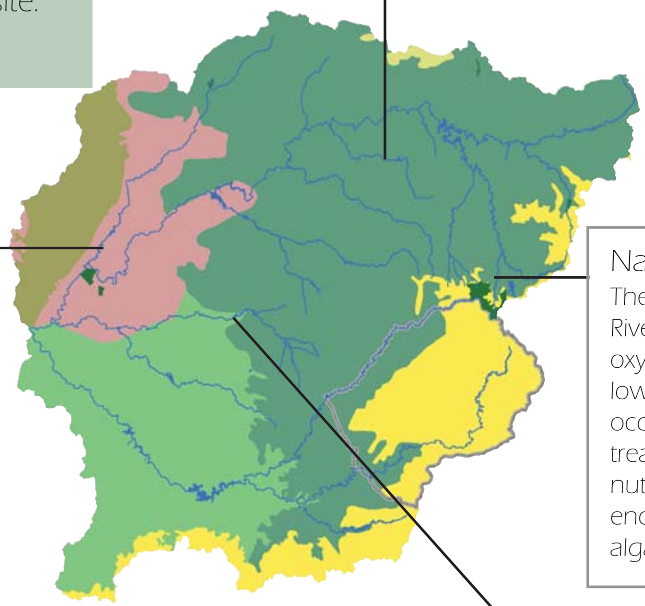
Water quality analysis provides an assessment of the suitability of water for aquatic ecosystems and human use. For the RHP, phosphate, nitrate, nitrite, ammonia, suspended solids, dissolved oxygen, pH and conductivity were measured in a sample from each monitoring site.

Renoster River

Silt loads in the Renoster River above Koppies Dam were low and the pH slightly alkaline. The dam contained excessive amounts of phosphate at times, and this tendency continued downstream. Algal populations responded to the higher nutrient concentrations by forming nuisance-blooms.

Harts River

The Harts River pH was neutral and the oxygen levels good. Dissolved nitrogen, phosphate and salt concentrations were high in the downstream reaches of the river, where algae also reached nuisance levels at certain times.



Namahadi River

The headwaters of the Wilge River were generally well oxygenated, with neutral pH and low turbidity. Exceptions occurred downstream of sewage treatment works, where high nutrient concentrations encouraged excessive growth of algae.

Algal growth in the Harts River near Pampierstad.

Modder River

The average phosphate concentrations in the Modder River were high and at most sites exceed the limit for eutrophication. Extremely high phosphate concentrations (>1 mgP/L) at Bishop's Weir and Glen, downstream of Bloemfontein, probably originated from sewage treatment works. The inorganic nitrogen concentration in the study area was also high, causing unacceptable water quality conditions in the lower Modder River. Massive algal blooms occur in these parts of the Modder River.

Algae

Normally, algae are an essential component of life in water bodies. However, they respond rapidly and predictably to nutrient enrichment. Excessive growth in eutrophic systems results in the algal blooms that have become a very visible water quality problem in South Africa.

The Cyanobacteria, or "blue-green algae", are a particular nuisance in eutrophic storage reservoirs for drinking water supply, because they cause taste and odour problems, and sometimes even toxicity.

Algae and Fish Kills

Although nutrients are essential to the health of aquatic ecosystems, excessive nutrient loadings can impair water quality and habitat by encouraging the growth of aquatic weeds and algae. See the Trophic Status box for the four broad classifications of trophic status.

When large numbers of plants die and decay, they deplete the dissolved oxygen in the water. One of the results is an increase in the number of fish kills.

Certain species of Cyanobacteria or "blue-green algae" occasionally produce toxins that kill livestock and fish. They can also affect human health.

Trophic status classification

Oligotrophic	Low in nutrients and not over-productive in terms of aquatic animal and plant life.
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 such as water turbulence and light availability. Water quality problems are serious and can be continuous.

Vleis & Pans

What is a Wetland?

The word "wetland" includes a wide variety of damp habitats, from estuaries to temporary pans. Wetlands form in those parts of the landscape that are saturated for long enough and often enough to change the morphology of the soil and the communities of plants and animals that live on and in those soils.

The National Water Act defines wetlands as being 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, and which normally supports vegetation adapted to life in saturated soil.

What kind of Wetlands do we have in the Free State?

Wetlands are commonly referred to as marshes or vleis in the Free State. For this report, we will limit our discussion to vleis and pans of the kind that you are likely to encounter in the Free State and vicinity.

The wetlands of the wetter northeastern Free State, especially in the Vaal Dam catchment, are typically the well-watered, marshy type that we know as vleis. In the drier west, seasonal pans predominate. Vleis may be temporarily, seasonally or permanently saturated, ranging from palustrine (saturated soil) to lacustrine (pond or lake). Each vlei is unique and dynamic. Good agricultural practices are essential for the retention of this type of wetland.

Topographical maps show that the area covered by this report has about 13 750 pans greater than one hectare in size (the eight largest each exceed 1000 hectares). Many pans occur on former drainage lines, or areas that are not often flooded. Others are in areas of closed drainage, with no outflow (endorheic pans). The high evaporation rate combined with the shallowness

of the water result in many pans containing enough salt residues for commercial exploitation.

Pans dry out seasonally, so the organisms living in them need to be able to survive wet and dry conditions. Species eminently adapted to this regime are the fairy shrimps, tadpole shrimps and clam shrimps, all members of the euphyllopod (true leaf-legged) crustacean group. Their drought-resistant eggs survive in the dry mud of a pan until the next rains, whereupon they rapidly develop and produce the next generation of eggs before the water evaporates and the cycle is repeated.

Why are Wetlands Important?

Wetlands perform a variety of hydrological functions such as water purification, stream flow regulation, ground water exchange and reduction of flood peaks. They also have social and biological value: many people rely on specific wetland plants for handcrafts and cultural events, and three of South Africa's critically endangered bird species are dependent on wetlands for their survival.

Why are Pans important?

The value of pans is ecological. Their special ecosystems support all manner of panveld plants and animals, including aquatic invertebrates, amphibians and reptiles, small and large mammals, local birds and large flocks of migratory birds.

Threats to our Wetlands

The two major threats to wetlands are lack of conservation and incorrect exploitation.

- While pans are common, there is no panveld nature reserve in this area to conserve representative types of pan.
- The correct utilisation of pans and vleis enhances their value, and their wise and sustainable utilisation is encouraged. Unfortunately, many disturbances that threaten wetlands are related to inappropriate activities that include drainage, overgrazing, damming, ploughing, mining, polluting, infilling, catchment modification and urban encroachment.

Rehabilitation of a wetland

Advancement of an active erosion area is prevented by sloping the erosion area and then covering it with hyson-cells. Subsurface water seeps through the concrete filled honey comb-shaped hyson-cells.

What is the Current State of our Wetlands?

As yet, no nationally co-ordinated system to monitor or assess the condition of wetlands exists. South Africa may already have lost about half of its wetlands: while we do not know the original number, nor the state of those remaining, we do know that they are threatened and that we continue to lose them.

DEAT is currently compiling a national inventory of wetlands, an important component of South Africa's obligations under the Ramsar Convention on Wetlands. South Africa is also obliged to include wetland preservation in national conservation programmes and land-use planning, and to advocate the wise use of wetlands. By the mid-2004, the first round of mapping of the location of Free State wetlands should be complete.

What is being Done?

The Free State Department of Tourism, Environmental & Economic Affairs will typically use the spatial data of the National Wetland Inventory to identify key wetlands for field study of:

- wetland type
- wetland use
- catchment land-use
- disturbance
- species composition
- threats

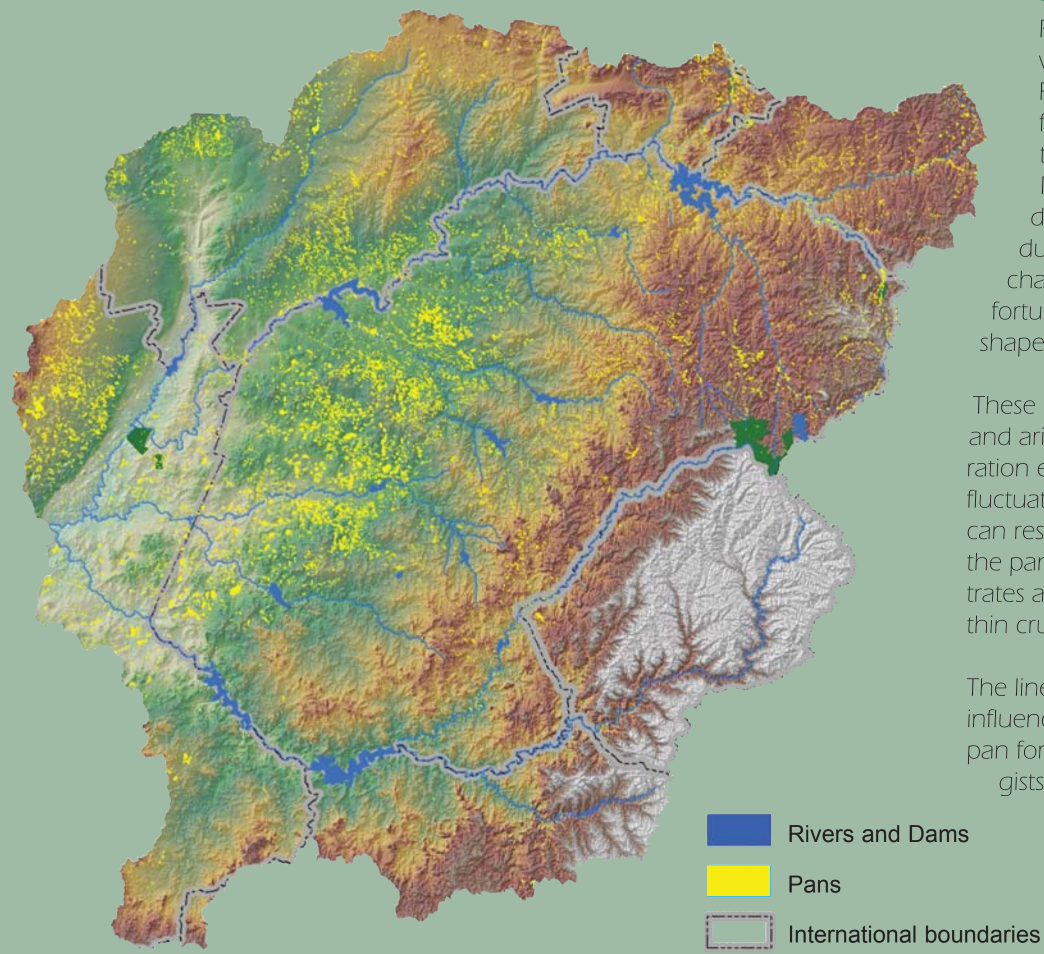
Scientists are also developing a monitoring system for wetlands that will allow them to deduce wetland status and changes from plant indicator species and communities.

Wetland Information Management System (WIMS)

To ensure that data contributes to the effective and efficient management of wetlands, the Department of Tourism, Environmental & Economic Affairs is developing a comprehensive wetland information system (WIMS). The WIMS will integrate geographical and descriptive data to help evaluate the functions and values of wetlands. The Department of Tourism, Environmental & Economic Affairs will use these evaluations to

- determine wetland functions
- target areas for protection
- identify wetlands for further study

This information will enhance planning and management actions, not only of wetlands, but also the catchments in which they lie.



Pans

Pans are confined mainly to the drier western part of South Africa. Favourable rock types for pan formation include shale outcrops of the Dwyka formation or Ecca group. Pans could be the result of a disruption in the drainage patterns due to tectonic action, climatic changes through geological times, or fortuitous structures such as basin-shaped dolerite sills.

These ephemeral lakes occur in semi-arid and arid regions where the annual evaporation exceeds precipitation. Seasonal fluctuations of shallow groundwater levels can result in seepage of groundwater into the pan floor, where it evaporates, concentrates and becomes saline, often leaving a thin crust of salt.

The linear distribution of pans suggests the influence of pre-existing river systems on pan formation. For example, some geologists link the formation of the pans of the northwestern Free State to differential disruption of the ancient Kimberley River that used to flow through the area.

Glossary

Alien species Fauna and flora introduced intentionally or by accident from other countries. Not all alien species are invasive or undesirable.

Aquatic biomonitoring The monitoring of the condition of organisms in rivers, wetlands and lakes in order to gauge the overall quality of the aquatic environment.

Aquatic Invertebrates A broad collective term for the insects, larvae, crustacea and other small animal life inhabiting rivers and lakes: "invertebrate" means "lacking a backbone" and excludes amphibians, fish, birds and mammals.

Biodiversity The structure, composition and functions of living organisms, and the ecological complexity of habitats in which they occur.

Biota are plants and animals.

Desired health An indication of the envisioned ecological state of the river determined by considering the ecological importance and sensitivity of the specific river ecosystems.

Ecological sensitivity refers to the ability of a specific ecosystem to tolerate disturbances and to recover from certain impacts. Lack of sensitivity, however, does not always infer the ability to recover.

Ecologically sound Maintaining the integrity of interrelations between living things and their surroundings.

Ecosystem A natural system in which living organisms interact with their surroundings through the processes of production, consumption and decomposition: an aquatic ecosystem could range in scale from a puddle of water to a whole lake.

Environmental flow requirement (EFR) The flow needed to maintain a river in a pre-determined state of health.

Environmental impact assessment (EIA) Investigation of the actual and potential impacts of a proposed action or development on an area.

Fauna The collective term for animals living in a particular area.

Flora The collective term for plants growing in a particular area.

Geomorphology The study of the structure of physical features of the earth especially in relation to the underlying geological structure.

Hotspot refers to an area where high levels of species richness, endemism as well as threat to their survival, coincide.

Indigenous species Fauna and flora occurring naturally in an area.

In-stream refers to "within the river channel".

MAP (Mean Annual Precipitation) Average rainfall (including snow, hail and fog condensation) over a year.

MAR (Mean Annual Runoff) Average yearly available stream flow at a point in the river which has been calculated over a long period of time (usually 50 years or more), assuming a constant level of development.

nMAR (natural Mean Annual Runoff) Average yearly available stream flow at a point in the river which has been calculated over a long period of time (usually 50 years or more), in undeveloped conditions.

Present health A measure of the present ecological state of the river during the time of the survey. This is expressed as a river health category that reflects how much the river has changed from its natural state.

Refugia Places where individual organisms can escape the effects of disruption of their environment until conditions improve: refugia include patches of damp mud and entire river channels.

Riparian habitat refers to the habitat on the river bank.

Riparian zone The area adjacent to a river or water body that forms part of the river ecosystem. The riparian zone plays an essential role in the functioning of the river ecosystem. It is characterised by frequent inundation or sufficient flooding to support vegetation distinct from the surrounding area.

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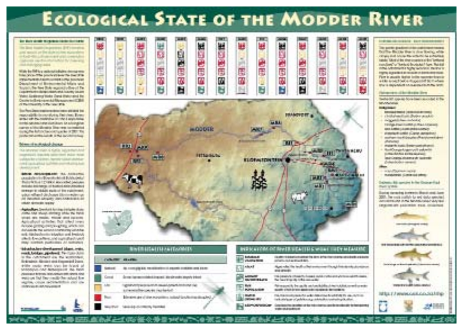
Highlights, Challenges and Opportunities

Less than a decade ago, the Free State River Health team set out to achieve an ambitious task: to set up biomonitoring protocols for all the rivers in the Free State and surrounds, to link biomonitoring results to water resource management, and to develop and sustain the networks required to support these activities. Already, much of this is happening. All major rivers in the area have a biomonitoring protocol (some will be expanded to include the full suite of indices, or more sampling sites) and many have a well-populated database. In some cases, biomonitoring results have helped to influence management decisions. River health reporting achievements include a poster, a communication for rural communities and this State-of-Rivers report. Strong working partnerships exist between regional DTEEA, regional DWAF, the Centre for Environmental Management at the University of the Free State and the local Water Boards. There are also signs that relationships with municipalities and the private sector are emerging as they find ways to assist each other in their river health and water resource management concerns. These are exciting achievements for the provincial team and they will be looking to build on these. Part of this process will be concerned with overcoming challenges and capitalising on opportunities along the way.

- One of the main challenges for the provincial team will be to strengthen capacity within the biomonitoring network. When the existing network loses a single person who assists with biomonitoring, it has serious impacts on the continuity of data collection and has wider consequences in terms of training new staff and the time it takes to get new people 'up to speed'. Leveraging capacity for biomonitoring is not a trivial task, but can be supported by wider buy-in and commitment to the programme, especially by the private sector. However, for this to happen effectively, new partners will have to understand their roles and see explicit benefits from their involvement before they will enter into a formal agreement. In some areas, such as the Sand-Vet, catchment forums have been an effective mechanism to help forge these relationships and encourage trust and joint understanding of each others' water resource-related needs and goals. The team has expressed a particular need for the agricultural and mining communities to become more involved.

- Initially, the provincial team prioritised and focused their biomonitoring efforts on the Free State rivers that suffer the most serious impacts. Now that these are covered by the programme, the team would like to expand their efforts and networks to include the less impacted systems, such as the Kraai River. The aim is for biomonitoring on such rivers to provide proactive inputs into managing the protection and responsible development for these river systems. River systems such as the Kraai are perceived to provide valuable river services to society, services that are different (e.g. recreation and tourism opportunities) to those offered by rivers that are already highly impacted (e.g. the Mooi River) where services such as the assimilation and transport of waste and effluent are important. Again, partnerships and resource commitment (human and financial) flowing from these, are critical for mobilising the full suite of players required to extend and sustain a strong biomonitoring network.



The State-of-Rivers poster of the Modder River. (January 2002).

- The third challenge relates to turning river health results into management actions. Sometimes, biomonitoring results are available but do not drive management decisions. The River Health Programme does not have legal "teeth" and even though the programme is strongly supported by legislation, the use of biomonitoring data relies on the perceived value of this information to resource managers.

One method for solving this problem is the adaptive management cycle (p 11). This cycle would enable the management and biomonitoring teams to jointly integrate new information from monitoring with decision-making and operational management. The Free State is very fortunate that at regional level, there is already a strong relationship between the biomonitoring champion, DTEEA and the resource manager, DWAF.

In summary, the Free State River Health team has laid a sound platform for achieving their vision and this vision is in many ways already being realised. In order to sustain and enhance this momentum and to overcome some of the obstacles mentioned here, the provincial team may consider the following:

- Develop formal partnerships to strengthen the network of river health champions and actively address the challenges presented by shortage of capacity for biomonitoring.

- Engage all partners in the strategic adaptive management cycle to facilitate a closer integration of functions and goals between those responsible for biomonitoring, those who manage the water resource and those who use it.

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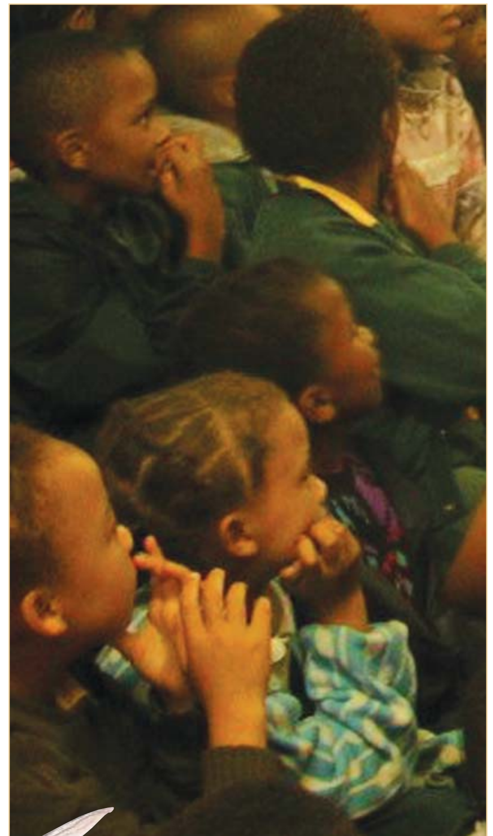

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Water Research Commission

Free State Province

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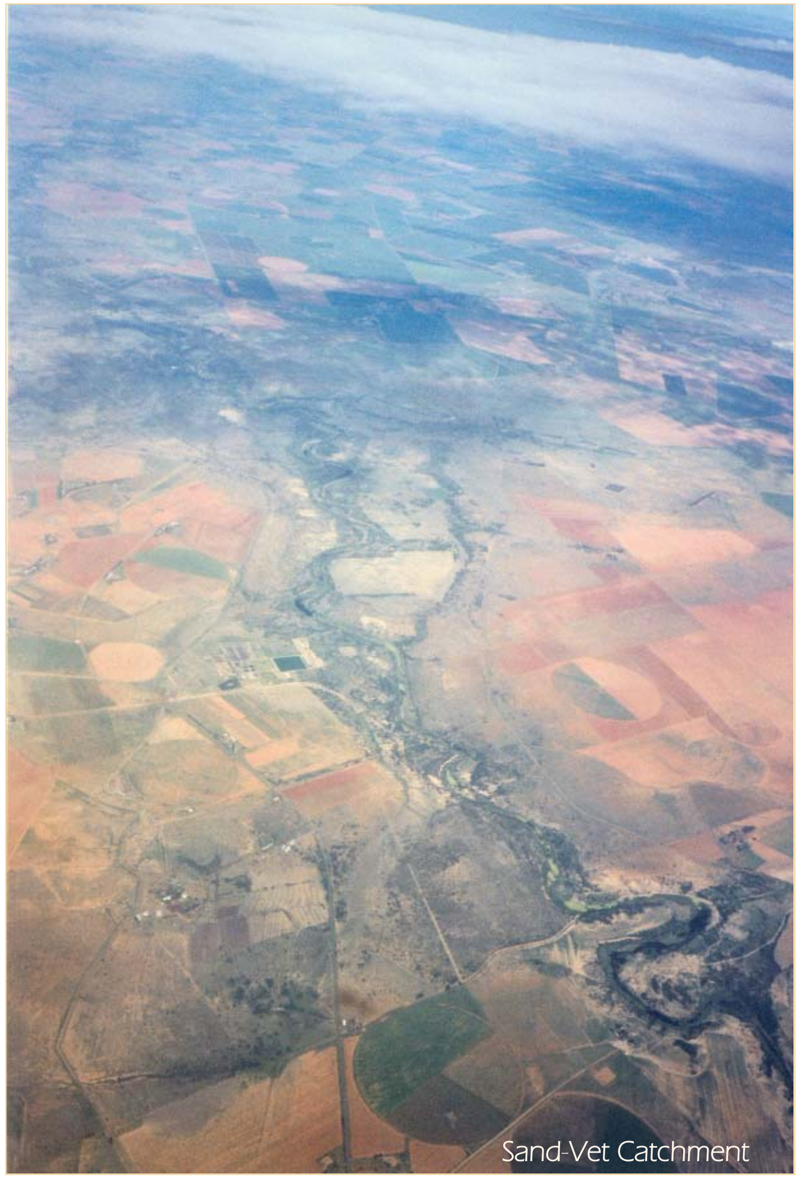
Sand-Vet Catchment

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