Chapter 2 – Water resource use and allocation in SA and the case study area

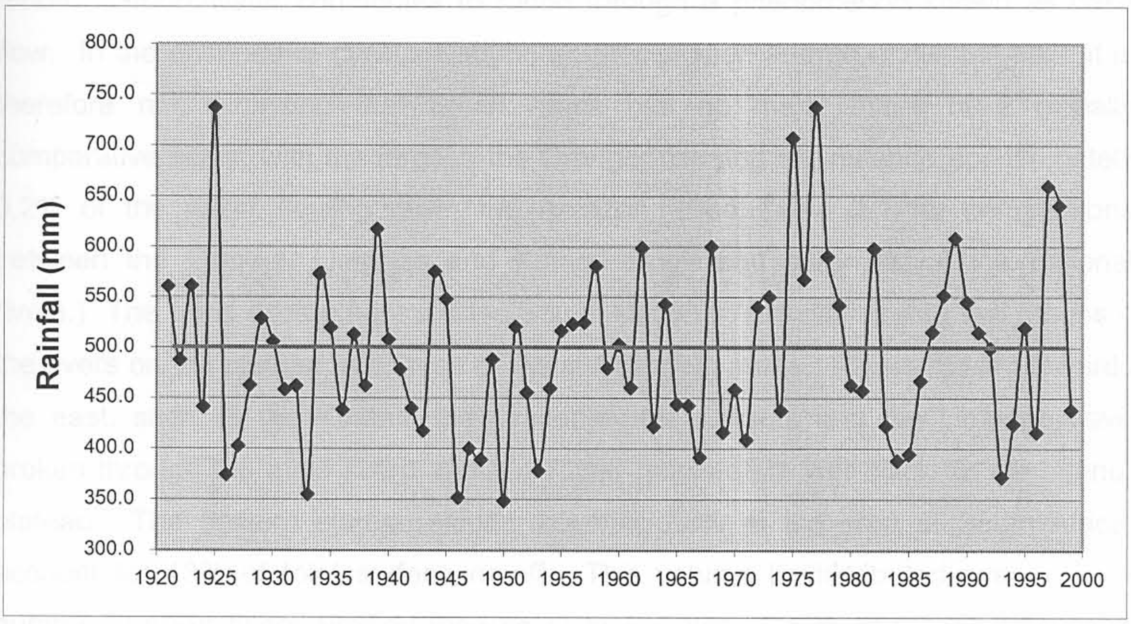
2.1 Water resources in SA

2.1.1 Water availability in South Africa

South Africa depends on two sources of fresh water for annual consumption: **precipitation** and **groundwater**. These two sources interact in a complex hydrological system of evaporation, transpiration, seepage, base flow and run-off (river flow). On average, approximately 90% of the country's precipitation is used in a process of evapotranspiration and deep seepage, while the remaining 10% is available as run-off in rivers (DWAF 2000a).

The average **precipitation** for the country is just over half of the world average at about 500mm per annum. In addition to low levels of precipitation (relative to global average precipitation), rainfall is also highly variable. Over the interior northern regions of South Africa rainfall follows an annual cycle and is almost entirely a summer phenomenon. In the southwestern Cape precipitation occurs in winter. In contrast to the winter rainfall region, the narrow southern Cape coastal belt and interior regions receive precipitation uniformly throughout the year. The arid western-central regions receive rain in a weak semi-annual cycle. Inter-annual variability ranges from more than 40% (year on year rainfall difference) over the drier Northern Cape (where the probability of receiving precipitation of below 100mm/a is 90%) to less than 20% in the wetter eastern parts (where the probability of receiving precipitation of between 600 and 800 mm/a is 90%). Precipitation also varies in a temporally oscillating pattern with an estimated 18-year wet-spell / dry-spell fluctuation (Tyson, 1986). Figure 2.1 shows the annual average rainfall for South Africa for the period 1922 to 2000.

Figure 2.1: Precipitation for South Africa (1922-1999)



Source: SA weather Bureau (2000)

South Africa is poorly endowed with **groundwater** as the country is mainly underlain by hard rock formations that do not contain any major groundwater aquifers (DWAF, 1986). Groundwater occurs in either *primary* or *secondary aquifers*. *Primary aquifers* consist of deposits of sand, gravel and pebbles, which are capable of bearing volumes of water varying between 5% and 30% of the gross volume of the formation. Primary aquifers may cover thousands of square kilometres and vary in thickness from several hundred to more than a thousand metres. *Secondary aquifers*, on the other hand, are weathered and fractured rocks, which lie directly beneath the surface to depths of less than 50 metres. At greater depths, unweathered rock formations occur, which contain very little groundwater because of their dense nature. Across more than 80% of the area of South Africa, groundwater occurs in secondary aquifers. South Africa's groundwater resources can therefore be visualized as being contained in a multitude of mostly secondary and localised aquifer systems with limited quantities of extractable groundwater (DWAF, 1986). The annual groundwater usage in South Africa is estimated to be 1,4 billion m^3/a (DWAF, 2000a).

The maximum quantity of groundwater that would be practically and economically feasible to develop is assessed at approximately 5,4 billion m^3/a (DWAF, 2000a).

Approximately 10% of South Africa's annual precipitation flows down river systems as runoff. Groundwater contributes to runoff through a phenomenon known as base flow. In the absence of constant abundant precipitation and groundwater yield, it is therefore not surprising that South Africa has no major rivers of a globally comparative scale, with the largest, the Orange, carrying for instance approximately 0,2% of the water flowing down the Amazon. (See Table 2.1 for comparisons between the Orange, Limpopo and Komati rivers and some major international rivers.) The great escarpment divides South African river systems into two groups – the rivers on the plateau and those of the surrounding areas. Rivers flowing towards the east, such as the Komati, the Crocodile, the Olifants and the Limpopo have broken through the main scarp and have their headwaters well back on the interior plateau. The eastern plateau slopes, covering 13% of the area of South Africa, account for 43% of total surface runoff. This volume is distributed over a large number of short rivers, limiting the use of their water. South of the Vaal-Limpopo divide, which runs east to west along the Witwatersrand, almost the entire plateau (approximately half of the surface area of South Africa) is drained by the Orange River system, which contributes about 23% of the total annual runoff. In the Southern Cape, the major rivers are the Gamtoos, Gouritz, Breede, Berg and Olifants, which extend in the order given, from a year-round rainfall, to a winter rainfall area.

Table 2.1: Comparison of three SA rivers with major international rivers

River Basin	Basin Area (km^2)	River Length (km)	Mean Annual Runoff (Mm^3/a)	(mm)
Orange (SA)	850,000	2,300	11,500	14
Limpopo (SA)	415,000	1,750	5,500	13
Komati (SA)	50,000	480	3,500	70
Nile	2,800,000	6,700	86,000	31
Zambezi	1,400,000	2,650	94,000	67
Mississippi	3,100,000	3,780	460,000	148
Zaire	3,800,000	4,700	1,260,000	332
Amazon	6,000,000	6,470	5,600,000	933

Sources: Pallet (1997); Encyclopaedia Britannica (2001)

Naturally perennial rivers occur over only one-quarter of South Africa's surface, mainly the southern and south western Cape and on the eastern plateau slopes.

Rivers that flow only periodically are found over a further quarter of the surface. Over the entire western interior, rivers are episodic and only flow after infrequent storms. In the absence of lakes and permanent snowfields to stabilize flow, even perennial rivers flow irregularly and are often strongly seasonal (DWAF, 1986).

2.1.2 Water supply interventions in South Africa

Economic development, and its associated human presence, is often guided by factors other than natural water availability. Civil construction interventions are therefore made to ensure sufficient water supply. Most of the main metropolitan and industrial growth centres of South Africa have developed around mineral deposits and harbour sites, and are situated in areas remote from major river courses. Some irrigation developments are also located in sub-optimal regions with respect to water use efficiency, having been established during times when water was still relatively abundant. Consequently, in several river catchments, the water requirements already far exceed the natural availability of water. This is especially pronounced in the dry central parts of the country.

Water supply and use balances have thus far been achieved through large water resource development projects and extensive inter basin transfers of approximately 4,5 billion m^3/a of raw water, potable water and effluent between more than 100 catchment areas (DWAF, 2000a). South Africa's total *storage capacity* of more than 35 billion m^3 has been created by the construction of major dams, holding more than half the mean annual runoff (MAR) of 55 billion m^3/a for the country (DWAF, 2000a). It was estimated that approximately 20 billion m^3/a of the MAR and groundwater were already being utilized in 1996, with an additional 15 billion m^3/a potentially available for use through the storage provision. The remaining approximately 20 billion m^3/a represents in-stream flow requirements, water lost to evaporation from reservoirs and conveyance systems, as well as spillage of floodwaters to the ocean (DWAF 1986; DWAF 1997; DWAF 2000a).

2.1.3 An overview of water use in South Africa

For the purpose of this study, water use can be divided into three categories: social, environmental and value adding.

People need relatively little water for survival. Twenty-five litres per person per day is considered *theoretically* sufficient for the so-called basic human requirement of drinking, cooking and washing (DWAF 2000c). The **social use** consists of the basic human requirement and the additional water used by households.

The **environment** requires water for ecosystems to function. The bulk of this water is used as evapotranspiration by natural flora and fauna, above and below the soil surface. The rest of the water journeys to the sea as runoff. Estuaries, lakes, wetlands, nature reserves and riverine habitat require a large amount of this runoff for survival. This water need, the so-called in-stream-flow requirement (IFR), is still being investigated, but is currently estimated to be approximately 30% of the mean annual runoff (MAR) in SA (DWAF, 2000a).

Water is also consumed for **value adding purposes** such as agriculture, industry, and energy generation. Estimations done by the Department of Water Affairs and Forestry (DWAF, 1997a) showed that water use in South Africa is dominated by **irrigation**, using more than half of the total water use. **Domestic and general urban** use of water constituted approximately one tenth of total water use, while **mining and large industries** used a little less than one tenth. Water use by dry-land activities is measured as the additional consumption of water over and above the natural flora it has replaced, which is observable through its reduction of stream flow (run-off). This is also referred to as incremental consumption or induced evapotranspiration and was estimated to be one tenth of water used.

On average, ***social*** and ***value adding water use*** amounted to 4% and 26% of MAR, respectively, in 1998, which is a high volume compared to a **projected** global average of only 9% in 2025 (Seckler, 1999). ***Value adding use*** can be classified into three groups: induced evapotranspiration activities (incremental consumption of dry land agriculture or stream flow reduction); strategic use, and irrigation & industrial use. ***Induced evapotranspiration*** is attributed to the water use of certain dry-land farming activities and evaporation. Induced evapotranspiration is therefore the incremental water use due to these activities (which are associated with value adding activities) as opposed to the natural state of the environment. Induced evapotranspiration activities effectively reduce the MAR by 5%. These activities are most apparent in the wetter Water Management Areas (WMA's). MAR for ***strategic use*** is reserved mainly for activities such as power generation, which amounts to 1% of MAR. Water use by ***irrigation & industrial activities*** amounts to 19% of MAR (Crafford et al. 2001).

Table 2.2: Relative water use in South Africa in 1998

Major water users		Water use as a percentage of mean annual runoff (MAR)
Social water use		4%
Value adding water use	Induced evapotranspiration	5%
	Strategic use	1%
	Irrigation & industrial activities	19%

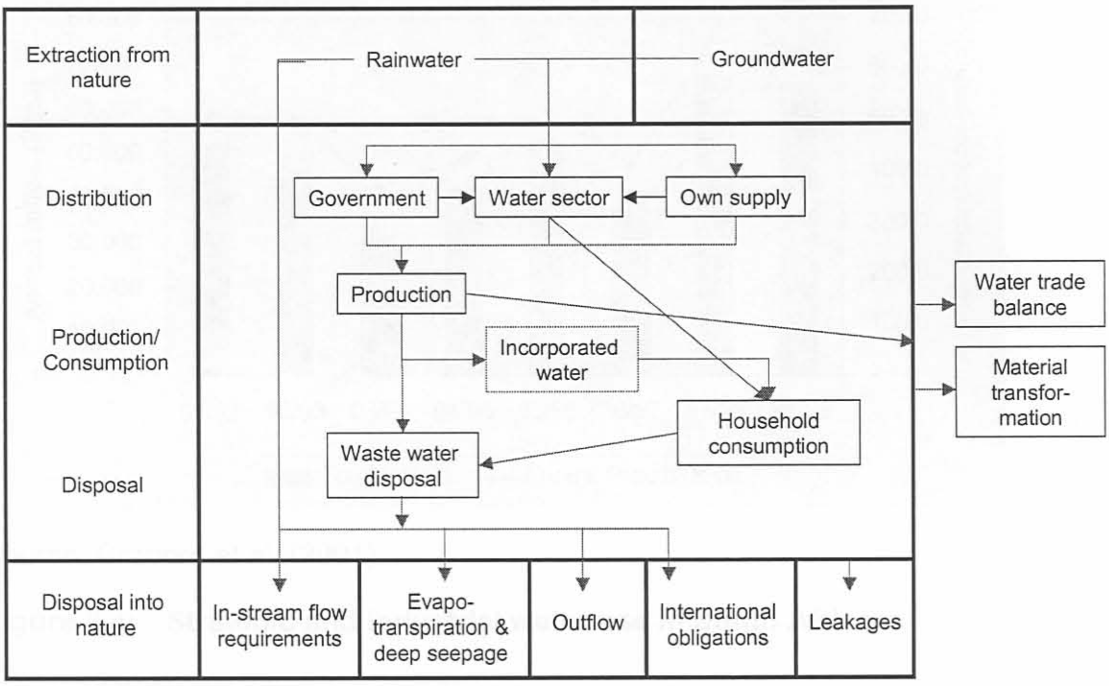
Source: Crafford et al. (2001)

The balance of the MAR is either stored in water supply structures (dams) or flows down rivers. Considering that the dam storage capacity of SA being 57% of MAR, current water use is approximately 30% of MAR, and assuming that current water use and economic development patterns continue, South Africa as a country is headed towards a situation of absolute water scarcity during the period 2025-2030. Absolute water scarcity is defined as a situation where water demand exceeds water supply. Many individual catchments however, are already much closer to situations of absolute water scarcity.

2.1.4 Water Pathways Analysis

Water follows a hydrological pathway of precipitation, flow, transpiration and evaporation, part of which involves human activities. Figure 2.2 shows the pathway water follows from precipitation and groundwater sourcing, through its water supply distribution network, to environmental, social and value adding use, and finally to its disposal back into nature.

Figure 2.2: Simplified water pathways analysis for South Africa

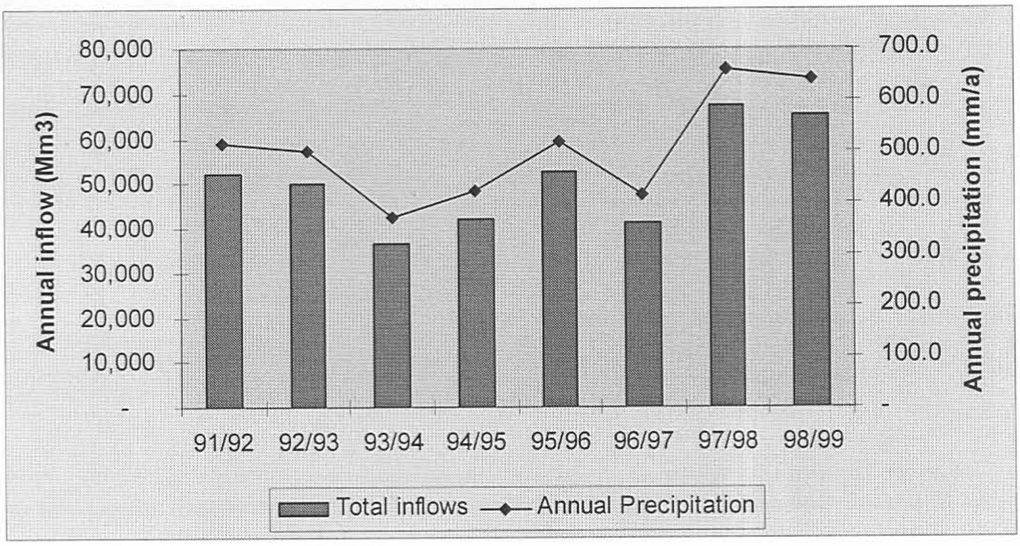


Source: Crafford et al. (2001)

Three important features of the water pathway for SA are worth mentioning:

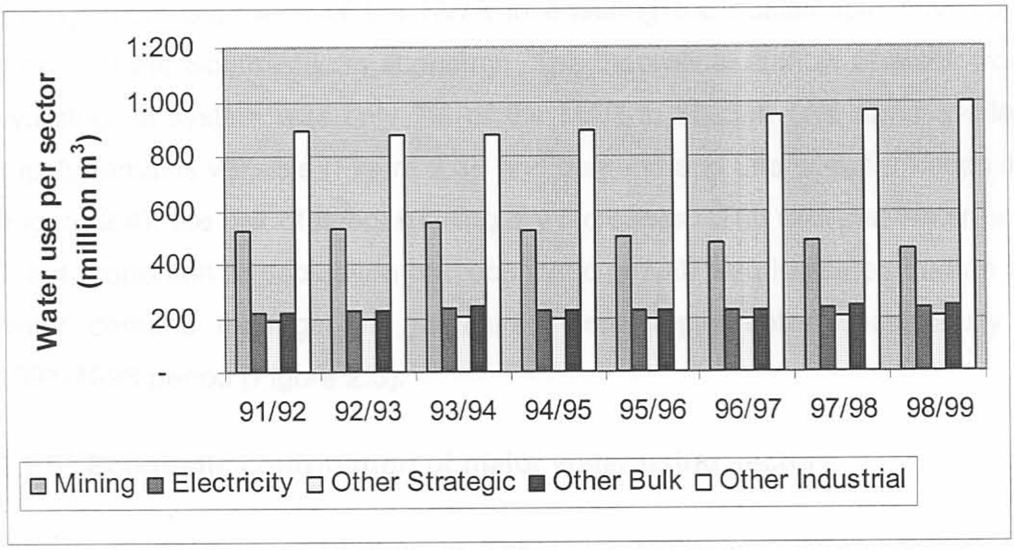
- Water availability is, as can also be seen from Figure 2.3, very dependent on annual precipitation. This is especially evident in drier years (e.g. 93/94). Water availability and consequently also water supply, is therefore highly influenced by the unpredictable and variable rainfall patterns.
- All sectors, excluding the environment (in-stream flow requirements) and mining, display an increasing water use (Figure 2.4). The environmental use stays constant, while the mining sector was the only sector that did not display an increasing water demand. Aggregate demand for water therefore has been constantly increasing at an average annual rate of 1.7% per year for the 1991-1998 period. In the case of irrigation, water use is already limited by water availability.
- GDP growth and increased water usage are to a large extent directly proportional, with the GDP/water use ratio remaining fairly constant around R25/m^3 (Figure 2.5).

Figure 2.3: Annual inflow of water depends on the annual precipitation received



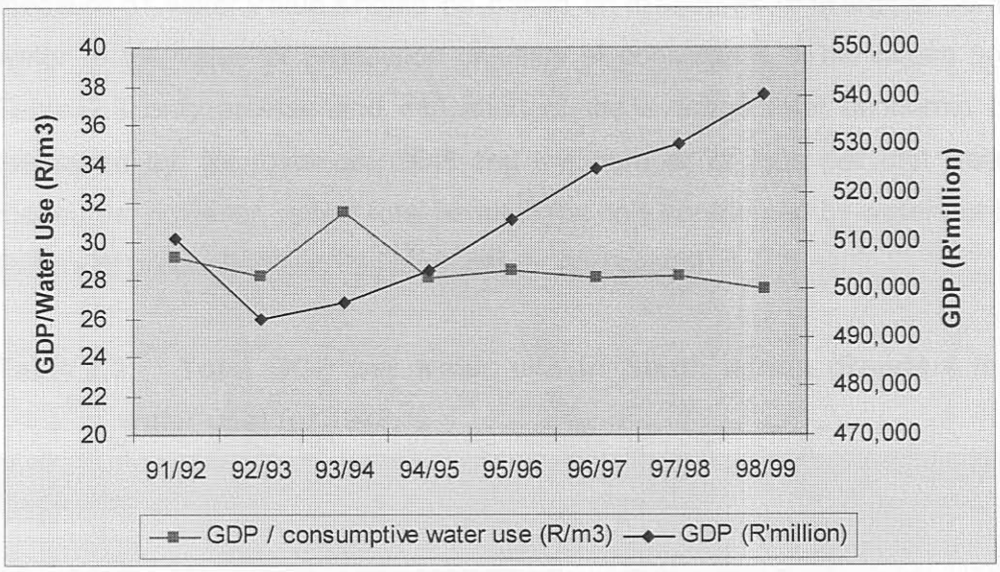
Source: Crafford et al. (2001)

Figure 2.4: Strategic and industrial water use in South Africa



Source: Crafford et al. (2001)

Figure 2.5: The ratio of GDP to water use in South Africa (1991-1998)



Source: Crafford et al. (2001)

The above three features demonstrate the importance of the water demand management approach of the NWA in ensuring the sustainable development and growth of the South African economy: The theoretical outflow of water from the SA hydrological system was only 7% of the MAR in 1993/4. As water availability and supply remains variable (Figure 2.3), and demand and use of water keeps increasing (Figure 2.4), the risk of rivers running dry increases. The fact that water use grew in direct proportion to population and economic growth also indicates that no significant water demand management measures were implemented successfully over the 1991-1998 period (Figure 2.5).

2.1.5 Economic contribution of major water using sectors

The Water Pathways Analysis in Table 2.3 represents information on economic benefits yielded from water use in SA, namely output, GDP, remuneration and gross operating surplus (GOS) expressed per unit of water use. It is clear that the primary sectors, heavily reliant on land and biological processes as economic production factors (e.g. agriculture), have relatively low water beneficiation ratios. Fishing and mining have beneficiation ratios that are two orders of magnitude larger, while the secondary and tertiary sectors (manufacturing and services) are three orders of magnitude larger than primary sectors. It must be emphasized here that these beneficiation ratios do not by any means reflect the value of water. The proper measure of water value should be based on measures of marginal contribution of water to the value of production or utility of consumers. The values presented in Table 2.3 only provide and indication of the average total economic benefits as measured by, for instance, GDP and the number of jobs per unit water. These measures, however, reflect total benefits not only contributed by water but by all other factors of production such as land, labour and capital.

Table 2.3: Total GDP per water use in South Africa (Rands / Incremental water use) for 1998.

Industrial Sector	Value of output/Water (R/m^3)	GDP/Water (R/m^3)	Remuneration /Water (R/m^3)	Gross Operating Surplus/Water (R/m^3)
Agriculture	2.8	1.4	0.5	1.2
Field crops	1.4	0.7	0.3	0.6
Horticultural crops	1.8	0.8	0.3	0.8
Livestock	32.1	15.7	5.7	13.5
Forestry	1.1	0.6	0.2	0.4
Fishing	690	298	161	134
Mining	137	80	42	37
Gold	123	77	44	32
Coal	501	262	126	130
Other	110	62	29	32
Manufacturing	946	296	165	132
Electricity	287	197	56	139
Water	2.0	0.8	0.2	0.6
Construction	779	234	182	50
Wholesale, retail & motor trade; catering & accommodation	442	256	132	117
Transport	328	189	90	97
Communication	545	354	246	110
Finance, real estate, business services	418	277	93	167
Other private services	387	253	206	41
General government services	406	269	238	29
Other (including Government)	162	82	40	39

Source: Crafford et al. (2001)

Trade in virtual water in SA, investigated by Lange and Hassan (2003) indicates that nearly a quarter of SA's water use is exported as virtual water. Put differently, 24.3%

of our water use is consumed to produce products that are eventually exported. Theoretically, if these export products could be substituted by other export goods with lower water consumption, the country could save water.

2.2 Evolution of water policy in SA

The Bill of Rights, as laid out in the Constitution of the Republic of South Africa Act (No. 108 of 1996) (RSA Constitution, 1996), makes provision for *'everyone to have the right of access to sufficient water*' (s27(1)) and for the state to take '*reasonable legislative and other measures, within its available resources, to achieve the progressive realisation of... these rights*' (s27(2)). The Bill of Rights also makes provision for all citizens of South Africa to have an environment 'that is not harmful to their health or well-being; and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that:

- Prevent pollution and ecological degradation
- Promote conservation
- Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development' (s24).

This provides the broad context for water use in South Africa. This section reviews the major changes brought about by the NWA in water resources use and management strategies in SA.

2.2.1 Water supply management

Since the start of South Africa's main economic development at the end of the 19th century, the country has faced water scarcity. The development of the water sector and the supporting water policies have therefore always implicitly been linked with the solution of water scarcity problems. This has resulted in a water supply industry that is structurally well designed and well managed. Historically policy has focussed on providing large infrastructure such as reservoir construction, infrastructure development, inter-basin transfers and trans-boundary schemes, and institutional support systems to supply areas of water scarcity with more water. However, these approaches have become increasingly expensive and less feasible as potential areas of development are difficult to access and often lie great distances from the end user. Supply-side options have also encouraged the overuse of what was perceived to be a relatively 'cheap' resource, abundant in supply and almost a 'free good'. In the NWA however, water demand management has become the favoured approach to meeting growing water use requirements, while water supply interventions focus on providing affordable water for basic household use through water services projects.

2.2.2 Water demand management

Although some of the findings of the Commission of Enquiry into Water Matters in 1970 indicated that South Africa would have to embark on a water demand management (WDM) route in the future, the NWA formally adopted a WDM approach for SA for the first time (DWAF, 1970). Water demand management is required in a situation of water scarcity where competition arises between water users and water supply interventions are no longer adequate. The approach adopted by DWAF for WDM consists of two phases. The first phase plans to improve intra-sectoral allocatable efficiencies through engineering solutions. DWAF is currently actively exploring this phase of water demand management intervention through the development of their Water Demand Management (WDM) strategies, and the implementation of Water Management Plans. Within this context, a lot of emphasis is currently given to improving water use application (e.g. fixing leaks); evaluation of regulation-based water allocation; and good water management practices (e.g. water accounting, best management practices, training). This first phase requires that the full cost of water supply is recovered. This also means that historical subsidies established under prior legislation, are phased out. In the second phase, it is recognised that engineering and other cost recovery solutions no longer sufficiently address water scarcity, and the only way to effectively balance the water budget is to introduce a policy of inter-sectoral allocative efficiency, diverting water from users with low economic return to users with higher return. Water charges or tariffs, as well as market forces through water pricing are used to address water scarcity during this phase.

The Act calls for the development of a National Water Resources Strategy (NWRS) and individual Catchment Management Strategies for the 19 Water Management

Areas into which SA has been divided. These Water Conservation and Demand Management (WC/DM) strategies form the framework within which water demand and supply will be managed in South Africa.

2.2.3 Property rights

Historically, the value of water has been reflected in land prices, as farms and industrial sites near rivers, dams or other water rich areas were priced relatively higher. Although water laws distinguished between public and private water, the riparian rights principle dominated water entitlements. This principle gives exclusive rights to the use of stream water to the owners of the riparian (adjoining) land. Riparian rights were then modified in a series of acts under the pressure to accommodate non-riparian demands from industrial and urban expansions and in recognition of the high variability of water supply. The first of these modifications restricted riparian access to normal flows, while surplus flows were stored and diverted to non-riparian users. This was known as the principle of proportionate apportionment, and significantly increased state involvement in water supply management. Restriction on afforestation in general, and near riparian lands in particular, was also introduced (the Afforestation Permit System) to reduce its water abstraction and stream flow reduction impacts (Hassan, 1998).

Under the NWA, water is regarded as common to all. Government, through the Minister of Water Affairs and Forestry remains the ultimate custodian of the country's water resources, and therefore manages and allocates the rest of the water on behalf of the country, to all water users. Water use is regulated by the Act through the use of licensing and authorizations, which may have conditions attached specifying management practices and general requirements for any water use, including water conservation measures (s29(1)(b)(i) NWA). To this end, DWAF is currently running a water registration and licensing process, to be completed by 2015 (Rademeyer, DWAF). This is a clear abolishment of the riparian rights principle.

In practice however, the flow of water cannot be fully controlled, as the natural environment determines precipitation, evaporation and its flow properties. The above factors therefore make water somewhat more of a quasi-public good, although by law it is a public good, access to water is geographically limited. In addition, due to the complex hydrological system of water distribution, metering of water supply and demand is sometimes impossible and often not economically viable. This has important implications for water demand management implementation, which would be made considerably easier if the assigned licenses and authorizations could be accurately measured. Under the NWA, water measurement is recognised as a great need and large emphasis is placed on this under the water demand management strategies forthcoming from the Act (Wilkinson et al. 2003).

2.2.4 Water management institutions

Prior to the NWA, water management relied mostly on centralised state involvement. This involved central planning of water resources management. State involvement extended to the establishment of irrigation boards and construction of public water supply works for irrigation and other purposes. In a few instances, some of these irrigation boards privatised and developed their own water supply and demand management strategies and systems (Wilkinson et al. 2003). In a number of cases, Water Boards were instituted by the Minister of Water Affairs to determine the existing and future water demands of user groups in water scarce areas, and to provide the infrastructure needed to supply the required water in time and more economically than would otherwise be possible.

There is major departure in the NWA from the above organisational arrangements. A major emphasis of the NWA is on participative governance in order to ensure the participation of interested parties in the development, apportionment and management of water resources (Hassan, 1998). This dictates that DWAF becomes an enabling organisation, rather than an implementing agent. Implementation is decentralised to privatised Catchment Management Agencies (CMAs) and Water Users Associations (WUAs). Local authorities and Water Boards remain important organisational role players through the WUAs. These bodies are to function on private sector business principles, focussing on efficiency, which may have an important effect on reducing the cost of water supply.

The water supply organisational structure under the NWA therefore has a number of levels:

Government - Department of Water Affairs and Forestry (DWAF): The NWA dictates that no private ownership of water exists and that the country owns the resource. DWAF, as the custodian of the water resources of South Africa, dictates policy goals and management objectives in terms of equity, sustainability, and efficiency. It oversees the allocation of raw water rights and large capital expenditure projects such as dams and transfer schemes within and between catchments. Decision-making is then decentralized through Catchment Management Agencies (CMAs), Water User Associations (WUAs), Water Boards and various local governing bodies (DWAF, 1999).

Catchment Management Agencies (CMAs): CMAs are statutory bodies established under the NWA to manage water resources within a defined WMA (water management area). South Africa has been grouped into 19 WMAs, based on watercourse catchment boundaries; social and economic development patterns; efficiency considerations; and communal interests within the area in question (NWA, 1998). CMAs are to be governed by committees representing the interests of water users, potential water users, local and provincial government and environmental interest groups. The role of the CMA will be to prepare and give effect to a catchment management strategy (DWAF, 1999). It is envisaged that the first CMAs will only start operation by 2005, until then, DWAF regional offices will perform the role of CMAs (Karodia, 2000).

Water User Associations: WUAs consist of cooperative associations of local water users who aim to undertake water-related activities that will lead to communal benefit. They enable the pooling of local resources in order to realize local needs and priorities that are not in conflict with the water strategy for the area. A process is currently in place whereby irrigation and water boards are privatising to form WUAs.

Water Boards: Water Boards remain functioning as under the previous water act. They are supplied with raw water in bulk from national water schemes, and/or groundwater sources. They are responsible for water purification and for bulk distribution to different user groups within their areas of jurisdiction. Normally they would not undertake the distribution of water to individual users within the boundaries of the local authority.

Local Government - District Councils & Local Authorities: The management of water resources is further disaggregated to a local area. Local governments oversee all activities that are not carried out at a national or provincial level by government. They cover the authority of district councils and local authorities or municipalities. They generally buy water from their respective water boards and supplement these supplies through some of their own sources, such as municipal storage dams and groundwater supplies. District councils act to ensure that funds are raised to meet the development needs that would benefit more than one local authority. Local authorities however focus particularly on the metering and management of water within their municipal boundaries.

These organisations will be required to make the NWA work and require good information on water resources management scenarios.

2.2.5 Water tariffs and subsidies

Historically, waterworks were constructed as social welfare projects aimed at developing the country, and focused on the irrigation agriculture sector. However, generic water policy (DWAF, 1970), under the recommendation of the Commission of Enquiry into Water Matters recognized that water resources needed to be allocated among different users in such a way that the marginal benefits were the same for all. On the one hand, therefore, all waterworks were financed and operated on the principles of commercial business, aimed at the full cost recovery of all services. On the other hand, allocations made in the interest of national development objectives became dependent on the payments of regularly reviewed subsidies in order to cover their operating expenses (DWAF, 1970; DWAF, 1986).

Under the National Water Act of 1956, it was decided not to recover only the full cost of services for ***irrigation and stock watering***. Tariffs were set to recover operating costs of the scheme. However, households supplied from agricultural systems were charged the full cost. The policy (Water Act of 1956) on water pricing for domestic and industrial use was to supply water at a tariff that recovered the full-allocated cost of the service. Water tariffs historically formed a small portion of production costs in the ***municipal and industrial sectors*** and subsidization of industrial and municipal water schemes was only considered when the unit cost to the consumer rose above a specified level. The tariff was set at a level that recovered the capital, interest charges, and operating costs of the supply scheme, adjusted for inflation and deviations in water sales patterns (DWAF, 1970). A subsidy for the care or construction of ***water works,*** including sewerage treatment works of local authorities, water boards and regional water service corporations was applied at the discretion of the Minister of Water Affairs.

The NWA determines that the administered price paid by major users for water be progressively increased to meet the full financial costs of making it available and to reflect its benefit to society. Therefore, the NWA identifies four policy goals for its (administered) pricing policy: improving social equity, ensuring ecological sustainability, ensuring financial sustainability and improving efficiency. It is also recognized that subsidies should be reviewed on an annual basis, made public and paid annually, based on the annual cost of water supply, so that the annual price of water may fairly reflect the current price-structures and economic conditions within the country.

The pricing policy has three tiers:

- In the first tier, raw water tariffs are set by DWAF, based on catchment management budgets and water use quantities.
- In the second tier, Water Boards administer the wholesale price for much of the water supplied to urban areas in South Africa. These prices are based on management costs.
- In the third tier, local government sets the administered price (Eberhard, 1999).

The National Water Pricing Strategy (DWAF, 2003) proposes that the full financial cost of 1st tier water eventually be recovered from water users. The effect of this policy is evident from analysis of the tariffs for the 1995/6 to 2000/1 period, where real tariffs for ***urban & industrial*** and ***irrigation*** water use increased by 6% and 27% per year, respectively (Crafford et al. 2001).

The Water Trading Accounts (WTA) of DWAF displayed in Table 2.4 indicate that subsidies on bulk water supply decreased from 57% in 1997/98 to 35% of total expenditure by bulk water supply programmes in year 2000 (Hassan and Blignaut, 2003). This can mainly be attributed to the gradual application of the NWA principles, which aim to reduce water subsidies. Nevertheless, the financial subsidy on water services in SA amounted to about US$121 million in the year 2000.

Table 2.4: Water Trading Accounts for SA (1997/98 to 2000/01): R million

Sub-programme	Expenditure outcome		
	Audited 97/98	**Audited 98/99**	**Preliminary outcome 99/00**
Integrated catchment management	224	253	242
Integrated systems	155	989	1 139
Bulk water supply	224	281	291
Water services	845	655	727
Total estimated expenditure	1 448	2 178	2 399
Less: estimated revenue	*618*	*1 458*	*1 560*
Deficit to be voted (subsidy)	*830*	*720*	*839*
Subsidy as % of total expenditure	*57.3*	*33.1*	*35.0*

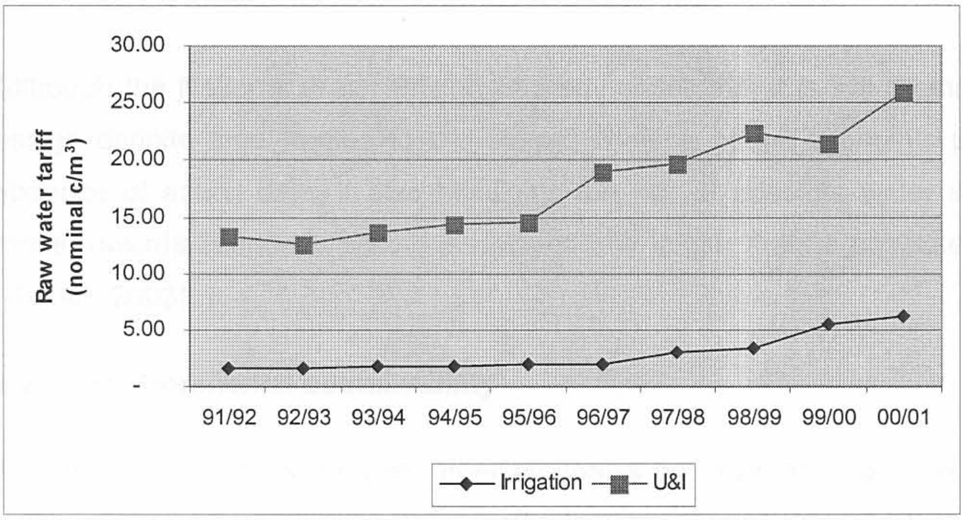
Source: Hassan and Blignaut (2003)

According to the recent water resource accounts in SA, agriculture received the highest financial subsidy on water use reaching more than 80 per cent of delivery costs while other use sectors were subsidized at about 46 per cent of delivery costs (Crafford et al. 2001). However, it is important to note that while large commercial farmers received the biggest share of water subsidies in the past, most of the subsidies in recent years went to extending basic water and sanitation services to previously disadvantaged communities who were excluded from such a service in the past.

Therefore, the planned pricing at full cost recovery for commercial uses and the cost implications for plantations and dry land farming as well as uses of underground water could induce major adjustments in water allocation and water use patterns. This is demonstrated by the increase in average water tariffs charged by DWAF-operated raw water supply schemes as shown in Figure 2.6. Raw water tariffs stayed relative constant until 1995/6, and have since nearly doubled for the urban &

industrial sector and trebled for the irrigation sector. During the 1995/6 to 2000/1 period, tariffs for urban & industrial and irrigation water use increased by 6% and 27% respectively, per year in real (inflation excluded) terms (Crafford et al. 2001).

Figure 2.6: Nominal water tariffs for South Africa (c/m^3)



Source: Crafford et al (2001)

2.2.6 Water Pricing

The approach of the NWA to cost recovery and subsidisation of water supply has an important bearing on water pricing. Flowing from the Act is the National Water Pricing Strategy. This document does not use the term "water price" in an economically correct sense. Its economic definition implies that the price of water is determined by the market clearance of demand and supply in a well functioning market. In layman's terms, therefore we can only talk of a price for water where a market for water exists. The water charges, based on cost of water supply, that is often referred to as water price, is therefore rather an administered price or a tariff. The National Water Pricing Strategy accordingly recognises the role of water pricing in a market system (phase 2 of water demand management) as it states that financial charges (administered prices or tariffs) may be supplemented by an economic charge in water-scarce catchments, in order to reflect the relative scarcity of water as a commodity at a given time and place and thus to promote the efficient allocation and beneficial use of water. These economic charges (water prices) will therefore reflect the long-run marginal cost of supply and distribution, and will prevent water from being overused by those economic sectors that add relatively low marginal economic output. A pricing system whose charges are equal to the marginal costs of providing the water (as would happen in a well-functioning water market) will allocate resources most efficiently. It will encourage the innovation and adoption of new water-saving technologies and processes for which water demand management strives.

Although the National Water Pricing Strategy states that it is still premature to even assign definite time frames to the staged phasing of full economic pricing in the absence of actual data, it also highlights the risk of absolute water scarcity if the move towards economic pricing is delayed any longer than is absolutely necessary (DWAF, 2003).

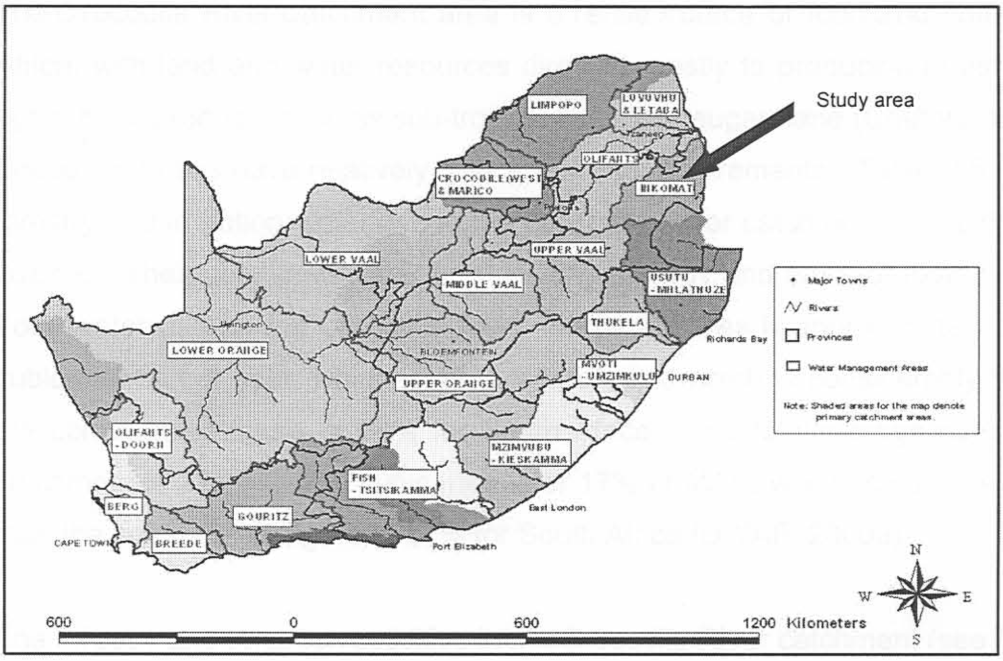
2.2.7 Environmental sustainability

The NWA also places a much larger emphasis on environmental sustainability and water conservation. Historically, water law did control industrial water pollution through permits, however, the NWA aims to set and maintain environmental standards relating to stream flow and groundwater and wetland sources. There is an increased emphasis on correcting environmental externalities and internalising their social costs. This is especially evident in the establishment of water resource quality objectives, and the development in the sector of water ***conservation*** and demand management strategies.

2.3 Water resource use and allocation in the study area: the Crocodile River Catchment

The Crocodile River catchment forms part of the Inkomati Water Management Area within the Mpumalanga province (Figure 2.7). It is located approximately 300 km east of Johannesburg, and covers an area of approximately 10 500 km^2 (14% of the land area of Mpumalanga). The Crocodile River is the largest tributary of the Komati River, and joins the Komati River shortly before it enters Mozambique, although the Komati does not form part of the catchment area. The Crocodile River basin comprises the X200 drainage region as defined by the DWAF Quaternary Drainage Regions Map (Olbrich and Hassan, 1999).

Figure 2.7: Water Management Areas of South Africa.



The Crocodile River catchment receives a mean annual precipitation (MAP) of approximately 865mm, which is 13% of the total precipitation in the province, and carries nearly 17% of the province's runoff. Rainfall is the major source of water supply in the catchment. In addition to eight major dams, with capacity ranging from 0,85 to 161 million m^3, there are over 200 small farm dams within the catchment (Olbrich and Hassan, 1999).

Table 2.5: Runoff availability and water use in South Africa, Mpumalanga, and the Crocodile Catchment.

	Total precipitation (10^6 m^3 yr^{-1})	MAP** (mm yr^{-1})	MAR*** (10^6 m^3 yr^{-1})	Water Use (10^6 m^3 yr^{-1})			
				Households	Forestry	Irrigation	Industrial*
South Africa	611,601	500	54,677	2,026	1,610	9,026	1,973

Mpumalanga	66,173	883	7,509	213	736	1,503	462
Crocodile	8,614	865	1,263	19	230	243	37

*Industrial, mining, commercial, strategic, other

** Mean Annual Precipitation

*** Mean Annual Runoff

Source: Crafford et al. (2002)

The Crocodile River catchment area is a fertile source of food and fibre for South Africa, with land and water resources directed mostly to producing forest and other agricultural products such as sub-tropical fruits and sugar cane (Crafford et al. 2002). These land uses have relatively high water use requirements. Table 2.5 shows that forestry and irrigation water use in the Crocodile River catchment are fairly similar in volume. Their combined water use[3] is 37% of MAR and 5,5% of total precipitation. Total water use for the Crocodile River catchment area is approximately 529 million cubic metres per year, which is 42% of MAR, and which is considerably higher than the comparative figure of 28% for South Africa. The total storage capacity in the catchment is 221,7 million cubic metres or 17% of MAR, which is considerably lower than the comparative figure of 57% for South Africa (DWAF, 2000a).

The forestry and irrigation activities in the Crocodile River catchment (see Figure 2.8) produce round wood, sugar cane and sub-tropical fruit. These commodities are extremely important to the Mpumalanga economy as they support extensive forward-linked sectors, contribute substantially to GDP and employment creation, have large amounts of capital invested and contribute positively to the national balance of payments (see Table 2.6). Mpumalanga contributed 8.2% to the national GDP in 1994 (DBSA, 1998).

[3] The hydrological impact of plantation forestry is measured as incremental use. This can be described as the difference in evapotranspiration between the forestry plantation and the natural vegetation it has replaced. The hydrological impact of irrigation is measured as direct abstraction from the river.

Table 2.6: A comparison of major water using sectors and their associated value chains in Mpumalanga (R 'Million) for 1998 (unless otherwise indicated).

	Agriculture			Manufacturing	
	Forestry	Sugar cane	Sub-tropical fruit*	Wood & Paper Products	Food & Beverages
Total Output (R' million)	R1 258[4]	R225[10]	R350[10]	R1 657[5]	R1 843[10]
GGP Contribution (R' million)	R686[6]	R77[11]	R110[11]	R943[10]	R632[10]
Land area (ha)	647 570[7]	32 520[12]	11 200[12]	na	na
Employment (number)	54 275[8]	10140[13]	na	18 110[10]	11 084[10]

The Mpumalanga economy is divided into three sub-regions by the DBSA (1998): Lowveld, Highveld and Eastveld. The GGP at factor cost in 1994 was R5 304M, R10 865M and R15 372M, respectively, in each of these regions (see Table 2.7). The Highveld and Eastveld regions are dominated by mining, manufacturing and energy generation activities, associated mainly with the extensive coal mining activities of these regions. The study area for this research project is concentrated within the Lowveld region, where agriculture plays a much larger role. The Nelspruit magisterial district, where the bulk of manufacturing and commerce takes place, dominates the Lowveld economy. The other nine magisterial districts have mainly agriculture-based economies. No additional economic data for the Crocodile River catchment were available.

[4] Estimate, based on national average production

[5] in 1994, DBSA, 1998

[6] Estimate, based on Total Production and Supply & Use Tables (StatsSA, 2000)

[7] Estimate, based on Total Production and national yield values

[8] Estimate, based on Total Production and national employment values

Table 2.7: The GGP at factor cost and current prices (1994) in the regional economy of Mpumalanga

	Lowveld		Highveld		Eastveld		Total Mpumalanga	
Agriculture	711	13%	633	6%	1,118	7%	2,462	8%
Mining	360	7%	2,672	25%	3,337	22%	6,369	20%
Manufacturing	1,426	27%	1,459	13%	4,963	32%	7,848	25%
Energy	98	2%	2,987	27%	3,306	22%	6,391	20%
Construction	176	3%	255	2%	235	2%	665	2%
Commerce	739	14%	824	8%	681	4%	2,245	7%
Transport	331	6%	482	4%	363	2%	1,176	4%
Finance	458	9%	535	5%	480	3%	1,472	5%
Services	1,005	19%	1,020	9%	890	6%	2,916	9%
Total	5,304		10,865		15,372		31,544	

Source: DBSA (1998)

Figure 2.8: Land use in the Crocodile River catchment.