Demand management, a possible alternative to augmentation? A South African Case Study

by
Steve Gillham and Mike Haynes,
Umgeni Water, South Africa

Abstract

In South Africa, water is a limiting factor to economic growth. As a semi-arid country with a highly variable climate, it is predicted that there will be a national water crisis in South Africa by 2025. To address this, and other water related issues, the government has embarked upon a comprehensive overhaul of existing water legislation. The new Water Act recognises that there are limits to the development of new dams and water transfers and strongly advocates water conservation and demand management.

The task of water resource planners is to reconcile demand and supply. A case study within the province of KwaZulu-Natal is used to demonstrate how the projected demand of this region will be met through the application of multiple strategies of demand management, integrated catchment management and conventional augmentation. The extent to which the proposed major augmentation scheme can be delayed through demand management, and the implications that this will have on all consumers within the region, are considered.

It is concluded that effective demand management is desirable even in a relatively wet area such as KwaZulu-Natal. It is further concluded that such a strategy should be undertaken as a supplementary strategy to conventional augmentation schemes, but cannot replace these schemes totally.

1. Introduction

Water resources planners are continually faced with the challenge of reconciling water demand and supply. In a situation of abundant resources, the conventional approach has always been to develop more dams. Growing global water shortages and opposition to large dams from the environmental lobby have, however, called into question the strategy of applying a conventional water resources development philosophy. Both the Asian Development Bank and the World Commission on Dams are currently evaluating a number of large dam projects to determine the extent to which consideration was given to alternatives to the project, the extent to which the project has achieved its objectives, and whether environmental mitigation was successfully achieved. The current drive for transparency is leading to far greater scrutiny of the need for large water resource development schemes, and demanding greater accountability in decision making.

The intention is to demonstrate a holistic, multiple strategy planning approach to the efficient use and development of limited water resources. Through the use of a South African case study, the following strategies are discussed within the context of a revised water legislative framework:

- Resource management, which applies the principles of integrated catchment management to the problem of catchment development and its impacts on runoff;

- Conventional water resources development, which includes the construction of dams and inter-basin transfer schemes to address water availability from a supply perspective;
- Water demand management, which focuses on the efficient use of water by consumers and which can be used to delay the implementation of costly water resource infrastructure.

It will be demonstrated that an exclusive focus on a single strategy is unlikely to achieve an optimal economic balance of efficiency, sustainability and equity in the use of water resources.

2. Changes in legislation: A new paradigm for water management in South Africa

South Africa's previous water law applied the same rules of the well-watered colonising countries of Europe to the arid and variable climate of South Africa. It has, however, been recognised that privileged access to land and economic power has resulted in an inequitable distribution of water rights. With the end of the Apartheid era, South Africa's water law has been replaced with a new National Water Act, which was promulgated in 1998.

The new water policy recognises that there are limits to the development of new dams and water transfers. To provide for growth and development of the South African economy in the 21st century, attention is being paid to current water usage which is often wasteful and inefficient. There has thus been a paradigm shift in approach to water management: away from an exclusive focus on building more dams, to one which encompasses water conservation.

Key principles underpinning the policy proposals for future water management in South Africa, and germane to the issue of water quantity, include:

- Treatment of all water in the water cycle as a common resource, subject to common approaches to water resource management;
- Guaranteeing as a right, a "reserve" of water required to meet basic human needs, and maintain environmental sustainability;
- Allocation of water that promotes use which is optimal for the achievement of equitable and sustainable economic and social development;
- The development of a binding water use, conservation, and protection policy by all major water use sectors;

- The recognition of river catchments as water management areas, and the provision for the phased establishment of catchment management agencies, to undertake water resource management in these areas.

Farming, including dry-land agriculture and forestry plantations accounts for about half the nation's water use. New legislation will regulate the impact of these sectors on water resources.

3. Water resources situation in South Africa

South Africa is a semi-arid country with a mean annual rainfall of about 475mm, which is well below the world average of 860mm. The rainfall is unevenly distributed across the country leading to periodic droughts which are both severe and prolonged.

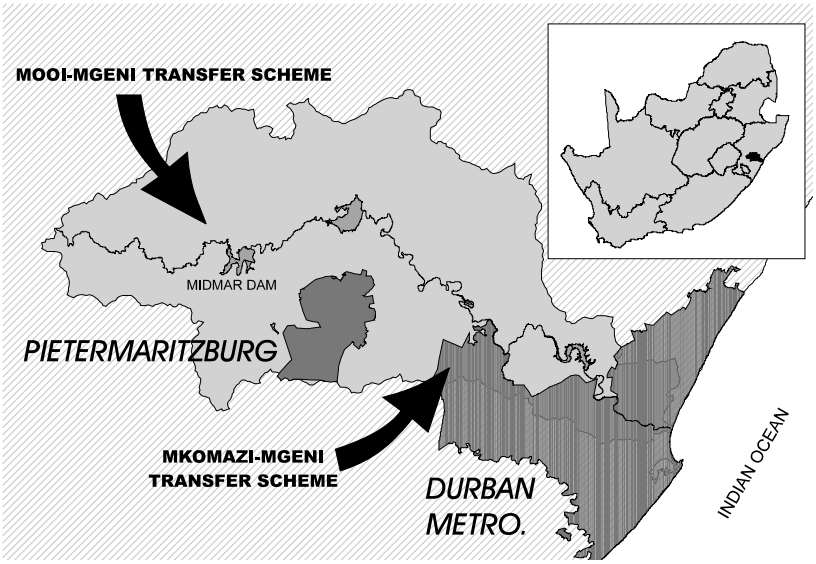
According to Perkins (1998), figures released by the United Nations rank South Africa as 11th from the bottom on an index of 50 Countries in the World with the least annual renewable water availability per capita. South Africa is already below the water stress level of 1 700 m^3/capita/annum, deteriorating from 3 500 m^3/capita/annum in 1955 to 1 200 m^3/capita/annum in 1990 and it is predicted that by 2025 the level will be about 700 m^3/capita/annum which is below the water critical threshold of 1 000 m^3/capita/annum.

4. Water resource situation in case study area

Although the province of KwaZulu-Natal receives about twice as much rainfall as the other provinces in South Africa and has about 40% of the country's rainfall runoff, it too is not immune from periodic droughts, and with the highest population density in the country faces regular water shortages.

The Umgeni region, the subject of this paper, is positioned on the eastern coastline within the province of KwaZulu-Natal, and encompasses the metropolitan city of Durban, the 3rd largest city in South Africa, and the city of Pietermaritzburg (refer Figure 1). This region had a GGP for 1998 of approximately R 52 900 million (US$8 820 million) which constitutes about 70% of the GGP for the province and about 18% for the country.

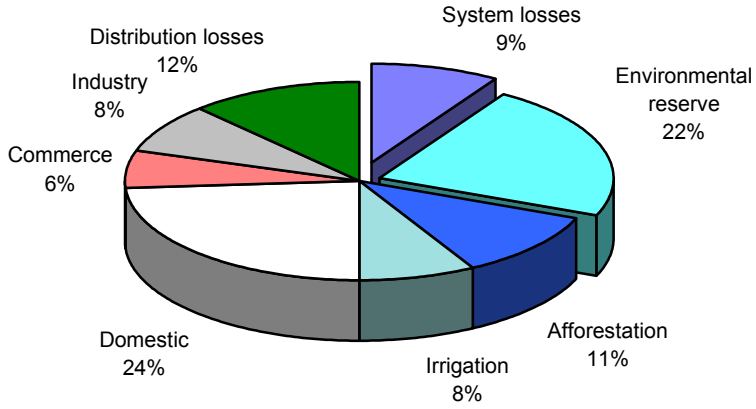
Figure 1: Locality map of the Umgeni region



4.1 Water demands on the Umgeni system

The total water demands for the region can be broadly divided into diffuse demands (comprising of system losses, environmental reserve, afforestation and irrigation), and urban and industrial demands (comprising of industry, commerce, domestic and distribution losses) which each constitute 50% of the total (refer Figure 2). Of the diffuse demands, the system losses and environmental reserve, which together account for 31%, are fixed components which cannot be manipulated in any way.

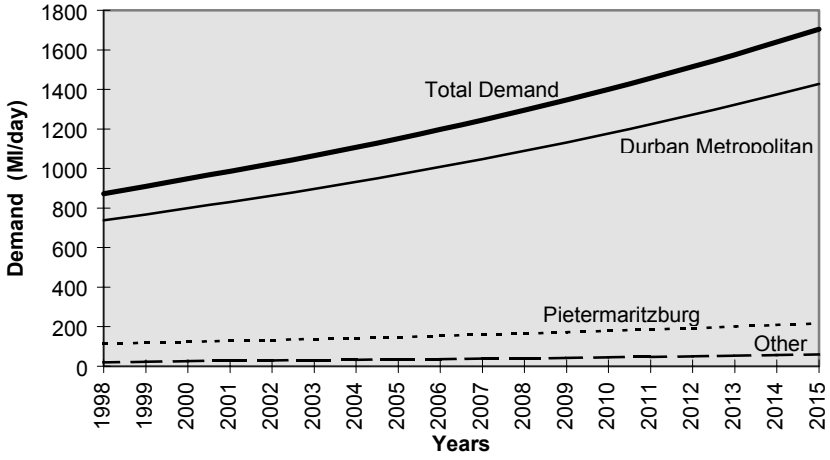
Figure 2: Consumption by Umgeni region



At present the bulk water requirement to meet the urban and industrial demand for the Umgeni Region totals approximately 870 Ml/day, with the Durban Metropolitan area and the Pietermaritzburg area accounting for 83% and 12% of this total respectively. The surrounding areas account for the remaining 5%. The anticipated growth of this demand is illustrated in Figure 3.

The current firm yield of the water supply system within the Umgeni region is estimated at 770 Ml/day (1:100 level of assurance). Steps are currently underway to increase this yield in the short term to about 1050 Ml/day through the raising of the existing Midmar Dam within the region, and by augmenting through the development of a relatively inexpensive transfer scheme from the adjacent Mooi River catchment (refer Figure 1).

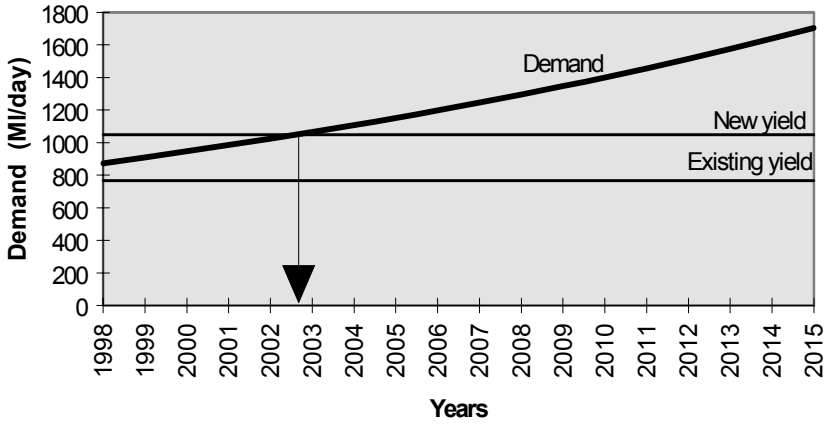
Figure 3: Projected demand of major bulk water consumers



4.2 Projected demands and supply constraints

As shown in Figure 4, the anticipated growth in demand in the region has already exceeded the existing firm 1:100 year yield, and will soon exceed the yield derived from the short term solutions that are being put in place. Clearly, a long term solution is required otherwise the risk of failure to meet the demand will increase to an unacceptable level and economic growth will become constrained.

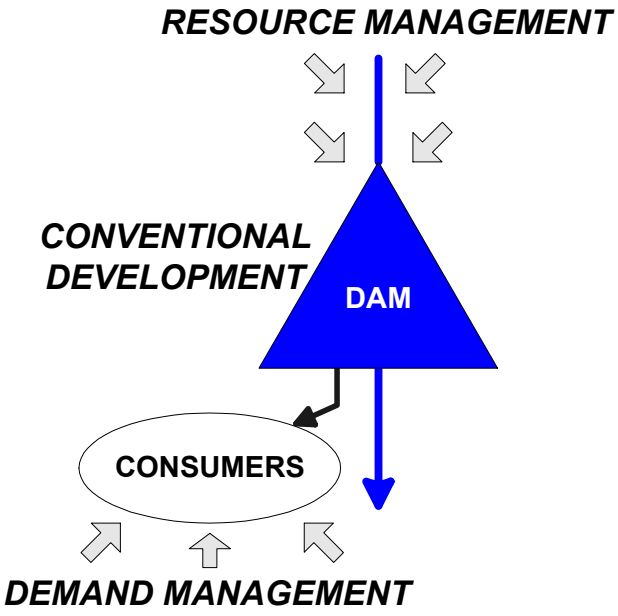
Figure 4: Projected demand vs Current and future yield



5. Reconciling demand and supply

Water resources planners for the study area have been tasked with reconciling demand and supply within the tenets of the new National water Act of 1998. Consequently, a multiple strategy approach has been adopted which considers water resource availability in a holistic sense, as depicted in Figure 5.

Figure 5: Managing water resources and consumption to reconcile demand and supply



5.1 Water resources augmentation: A long term strategy

The usual strategy adopted in situations such as that facing the Umgeni region is one of conventional development through the construction of another augmentation scheme to further increase the yield of the system. As discussed earlier, all local resources have been exhausted. The most economical augmentation scheme following these is an inter-basin transfer scheme from the adjacent Mkomazi River catchment (refer Figure 1) which would increase the firm yield initially to 1360Ml/day, and ultimately to 1970 Ml/day with the development of a second phase. This scheme has a preliminary estimated cost of about R 2800 million (US$ 470 million) and requires the construction of significant infrastructure. Based on the scale of the scheme and the early stage of planning, the soonest that the scheme could be commissioned is optimistically estimated at around 2008. Therefore, not only will this relatively expensive scheme result in a large tariff increase for the consumers within the region, but it cannot be implemented soon enough to avert a constraint on economic growth in the region.

5.2 Resource management

The implementation of catchment management to regulate stream flow reduction activities such as commercial afforestation and dryland agriculture, and the management of direct abstraction for irrigation purposes, has limited application within the Umgeni catchment. This is due to the fact that these sectors consume less than 20% of available water, with bulk water demands totalling 50% (refer Figure 2). Such a strategy can, however, be usefully applied in the donor catchments of the Mooi and Mkomazi which will augment the Mgeni system in the medium to long term.

5.3 Demand management

The alternate, or supplementary, strategy to the above long term measures, is to consider measures aimed at reducing the rate of growth of the projected demand and thereby flatten the demand projection curve. This would have the desired effect of delaying the need for augmentation, and meeting the demands at an acceptable level of assurance with existing supply infrastructure for longer. Reducing the rate of growth of demand can best be achieved through a programme of water demand management focused on the urban and industrial sectors in the Durban Metropolitan area.

The Durban Metropolitan Council recognised the possibility of demand management as a strategy to reduce their risk (and improve their assurance of supply) and at the same time delay any large tariff increase for themselves and their consumers. Unaccounted for water has in the past amounted to about 30% of their total water consumption. This is primarily due to leaks and faulty, or lack of, metering, and is further exacerbated by loss of revenue resulting from non-payment of accounts. The Council has recently implemented a strategy to reduce these losses through a structured programme of demand management. Their aim is to reduce losses from the present 30% to 15% over a five year period, maintaining bulk water purchases at a constant level over the next five years, while providing new connections within this period. This will be achieved through the adoption of measures which include: detecting and fixing leaks, increased billing, progressive tariffs, a cut-off policy for non-payment, and waste water recycling.

These savings, aimed at achieving a greater water-use efficiency, can almost certainly be achieved without noticeably affecting or constraining economic growth and development in the region. Other demand measures, such as restrictions and watering bans, which are most often implemented during periods of acute shortages, are only suitable for short periods as they will adversely affect growth and development if implemented for a sustained period of time.

Figure 6 shows the anticipated demand projection if the Durban Metropolitan area is successful with their water demand programme. The extension in the time period before the demands again exceed the supply is clearly evident.

Figure 6: Implication of water demand management measures **Error! Not a valid embedded object.**

5.4 The socio-economic consequences of not developing water resources in the long term

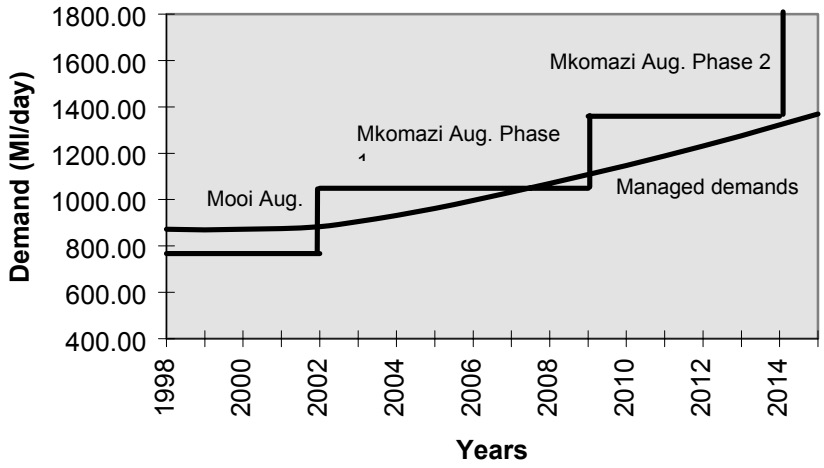
Umgeni Water (1998) investigated the socio-economic impact resulting from the "do-nothing" option, whereby growth is curtailed completely at the point where the managed demand curve intersects the yield line and no additional water is provided, as opposed to an unconstrained growth after the same point where augmentation, as described earlier, would take place. Over a 40 year period it was shown that the cumulative GGP would be 27% lower in the Umgeni region for this constrained scenario than it would otherwise be if the water supply was not constrained. Even more significant is the fact that by 2038, the GGP in the constrained scenario would be less than half that of the unconstrained scenario. Hence, it is economically beneficial for the region to ensure that water supply is not constrained at any time.

These results are based on the assumption that water productivity, as defined by GGP per unit water consumed, remains constant. In the future it is possible that through technological advancement and the increasing scarcity of water that some improvement in water productivity could occur. Umgeni Water (1998) showed that a 10% improvement in water productivity (which might be considered realistic) results in a 7% increase in GGP over the 40 year period when compared to GGP growth without any productivity increase. However, even with a 20% increase in productivity, the cumulative GGP is still 21% below the unconstrained equivalent. Thus an improvement in water productivity is not sufficient on its own to relieve the constraints on economic growth resulting from a shortage in water supply.

5.5 Summary strategies

Figure 7 depicts the combination of strategies required to reconcile demand and supply in the Umgeni region over a long time horizon. The objective of maintaining the available system yield above the projected demand has largely been achieved. This will ensure that a high level of assurance of supply can be maintained within the region, without compromising economic growth.

Figure 7: Combination of strategies



6. Conclusions and recommendations

It may be concluded that the application of specific water management strategies in isolation, will not allow for the reconciliation of demand and supply in KwaZulu-Natal over all time horizons. Water demand management, although essential to meeting deficits in the short to medium term and in delaying the need for costly water resource infrastructure, cannot replace the need for further dams and inter-basin transfer schemes in the longer term. Logistical and financial constraints to the costly development of water resources within the Umgeni area of supply, have consequently demanded a flexible and innovative approach to the problem of reconciling supply and demand.

To meet the criterion of sustainability, long term water resource development has been planned in terms of conventional, hard engineering solutions, with respect to storage, as well as tandem catchment management strategies, which will ensure resource availability in the long term.

The revised South African water legislation supports the exploration and promotion of an optimal mix of conventional and unconventional strategies to meeting water demand, now and in the future. The key to cost effective and environmentally acceptable solutions, is the consideration of focused strategies within a broad planning context. It is suggested that water resources planners in both water rich and particularly water poor countries, could successfully apply the holistic philosophy outlined above and that a cyclical monitoring of both water resource availability and demand over time provides an essential support for well motivated water resource development decisions.

References

1. Department of Water Affairs and Forestry, **Management of the Water Resources of South Africa**, 1986.
2. Umgeni Water, **Socio-economic impact of outcomes relating to the Mkomazi-Mgeni Augmentation Scheme**. Appendix report to the Mkomazi-Mgeni Transfer Scheme Pre-Feasibility Study prepared by Graham Muller Associates. October 1998.
3. Perkins, J.C. , **Water Demand Management - our key to survival**. Paper presented at a Water Demand Management course in Pietermaritzburg, South Africa. October 1998.

Biographies

S W Gillham

Steve Gillham (BSc Eng (Civil); BCom) is a registered professional Civil Engineer. After 14 years with the Department of Water Affairs & Forestry in various divisions, he left to join Umgeni Water (a regional Water Board) as a Planning Engineer in their Water Resources Planning Department.

steve.gillham@umgeni.co.za

M J Haynes

Mike Haynes (BA Hons, Wits, 1986; MA Environmental Science, Cape Town, 1990) currently works as an environmental Planner with Umgeni Water. Previous experience included work as a conservation planner with the Natal Parks Board and as an environmental planning consultant in southern Africa.

michael.haynes@umgeni.co.za