THE IMPACT OF PRICING OF RAW WATER ON COST OF TREATMENT AND ULTIMATELY ON THE COST OF POTABLE WATER

FAO Otieno and B Dzwairo

Tshwane University of Technology, Faculty of Engineering and the Built Environment, Private Bag X680, Pretoria 0001, South Africa, Tel +27 12 3825120, Fax +27 12 3825568, Email: otienofao@tut.ac.za

The Department of Water Affairs and Forestry (DWAF) sells raw water to water boards, generally at a fixed price determined annually. The cost of this water does generally not take into account the quality that the water boards receive. Water boards are then expected to treat this water to a certain specified standard for distribution to local authorities which then supply consumers. Consumers are charged based on the volume they consume, presumably a charge that would recover the cost of treatment and other associated overheads, which are agreed upon in advance. The result of this could be one of two things, namely that the consumers in different parts of the country pay different rates or that the water boards may be operating at a loss.

Based on recent and ongoing research in the Vaal River system, this paper looks at the implications of this on the final cost of treatment and ultimately on the cost to consumers and suggests ways in which raw water could be priced to ensure fairness and spread of burden to the consumers based on quality requirements.

INTRODUCTION

According to DWAF (1), water quality in the Vaal River and in some tributaries downstream of Vaal Dam is highly impacted by urban and industrial effluents as well as mining return flows. This condition continues to persist despite the fact that the river system supports sprawling urban and industrial areas (2, 3) that account for about 60% of South Africa's economic activities. Demand for water in this part of the country has long exceeded the exploitable potential of the river. As more water gets used and re-used, and as quantities get scarcer and feedback loops get even tighter, it is quality that begins to take on a dominant role.

A very important point to note is that the Upper Vaal water management area (UVWMA) forms a central component of a river which extends over several water management areas including the Middle and Lower Vaal. Large quantities of water are transferred into the UVWMA and similarly large quantities are transferred out to three other water management areas (WMAs), which are dependent on water from the UVWMA to meet much of their requirements (1). Impacts of these transfers, both in terms of quantity and quality, extend beyond the four adjoining WMAs, eventually involving a total of ten

WMAs and all the neighbouring countries of South Africa. Control of this system is thus at a national level (1). The challenge is then of managing the ecological system towards some optimal sustainable state, taking cognizance of its special biodiversity and socio-economic values.

A pricing strategy for raw water charges allows DWAF (as the custodian of national water resources) to sell raw water to water boards (bulk potable water treatment utilities), generally at a fixed price determined annually. The cost of this water does, generally, not take into account the quality of water that the water boards receive. Water boards are then expected to treat this water to specified standard for distribution to local authorities which then supply consumers. Consumers are charged based on the volume they consume, presumably a charge that would recover the cost of treatment and other associated overheads, which are agreed upon in advance. The charge, in essence, also incorporates an internalised cost of potable water treatment due to diminished water quality and this represents an important component of societal costs of water pollution (4). Setting the tariff structures to offset the cost of production is a traditional practice when polluted water is treated to potable water quality standards.

The result of this could be one of two things, namely that upstream and downstream consumers pay different rates or that the water boards may be operating at a loss. Based on recent and ongoing research in the Vaal catchment, this paper discusses the implications of this on the final cost of treatment, especially as water along the Vaal River is highly saline and generally of poor quality due to large quantities of effluent and urban runoff that is discharged into the river in the UVWMA (1). Management of water quality especially in the MVWMA is further severely affected by urban and industrial development in the UVWMA, where the main sources of impact on water quality are located (1).

STUDY AREA

Vaal Dam outlet located in the UVWMA and Bloemhof dam inlet located in the MVWMA (Figures1, 2 and 3) formed the research upstream and downstream boundaries, respectively. The research included level 1 water quality monitoring points as described for strategic water quality monitoring points (3). These were VS7 to VS15. Level 2 water quality monitoring points were located on Vaal River tributaries impacted by the following major wastewater treatment plants: Suikerbosrand (Benoni, Rynfield & JP Marais, Daveyton, Jan Smuts & Tsakane, Ancor & McComb, Bickley, Marievale & Grundlingh, Heidelberg); Klip (Dekema & Rondebult, Vlakplaats, Waterval, Meyerton); Vaal main stem (Leeukuil); Mooi (Potchefstroom); Schoonspruit (sewage works near Johan Neser Dam), Vals (Welkom), as well as a sewage plant along Sedibeng Water pipeline (near the pipeline at Wolmaranstad).

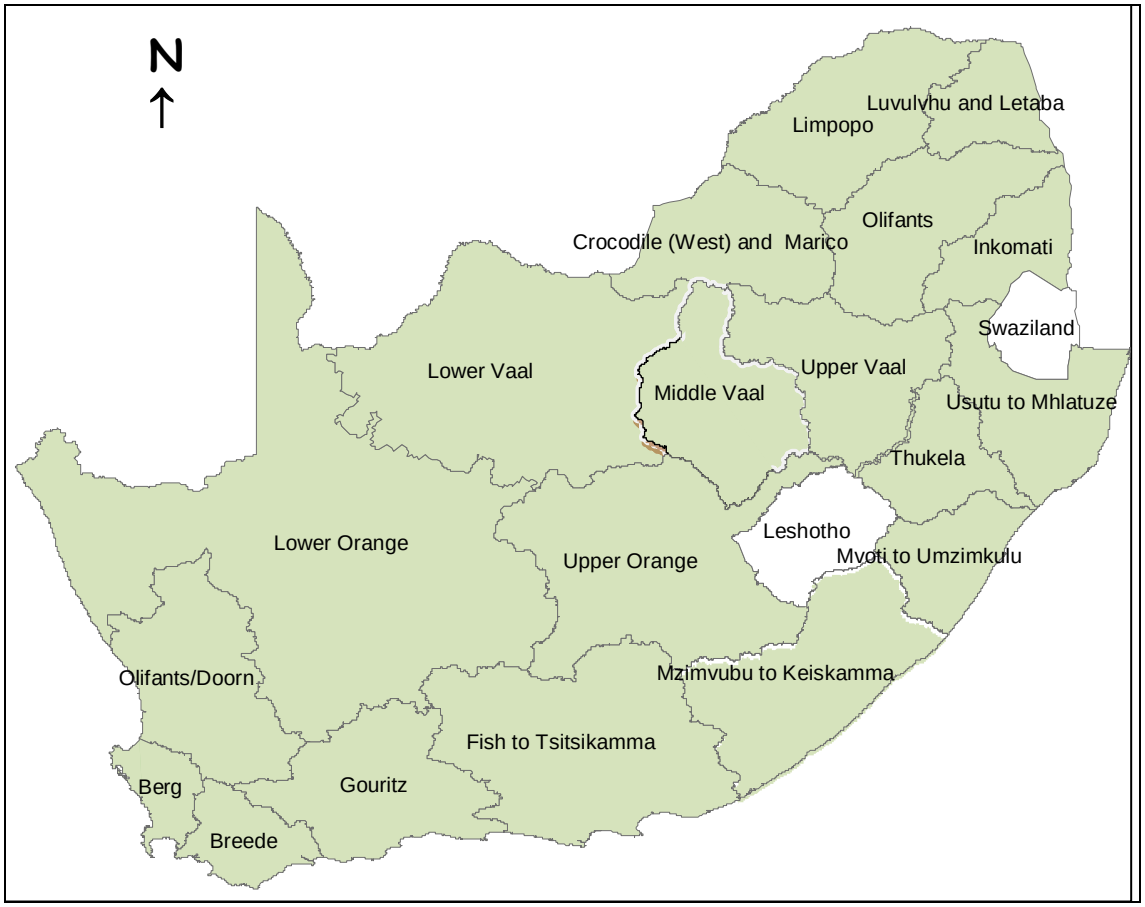

Figure 1 South Africa's Water Management Areas

RESEARCH APPROACH

Overall on-going research aims at developing a multi-year tariff model for surface raw water of variable quality, in order to predict cost of treatment using historical data and Artificial Neural Network modelling tool. Specific objectives are; to apply pollutant tracer hydrochemistry to specific reaches of the Vaal River between Vaal dam outlet and Bloemhof dam inlet, to develop a variable-quality based water classification system that incorporates a multi-year raw water tariff model for surface raw water, and to apply the model on two potable water treatment plants located upstream and downstream of each other within the U&MVWMA.

Within this framework, this paper covered one pre-requisite towards the overall research aim and this was to analyse and highlight issues as they related to pricing raw water of variable quality and its implications on potable water pricing.

Water Use Charges within the raw water pricing strategy were meant to off-set costs of monitoring and management, investigation and planning, protection of water resources,

and other management and conservation actions. Within these charges, a water resources management charge (WRMC) covered some of the costs of water management within a management area. For the Vaal catchment, water boards paid a Trans-Caledon-Tunnel-Authority charge (TCTAC) which went towards costs associated with the complex water transfer scheme in the Vaal catchment. The raw water abstraction tariff (RWAT) was charged for direct water use by the water boards, based on volume.

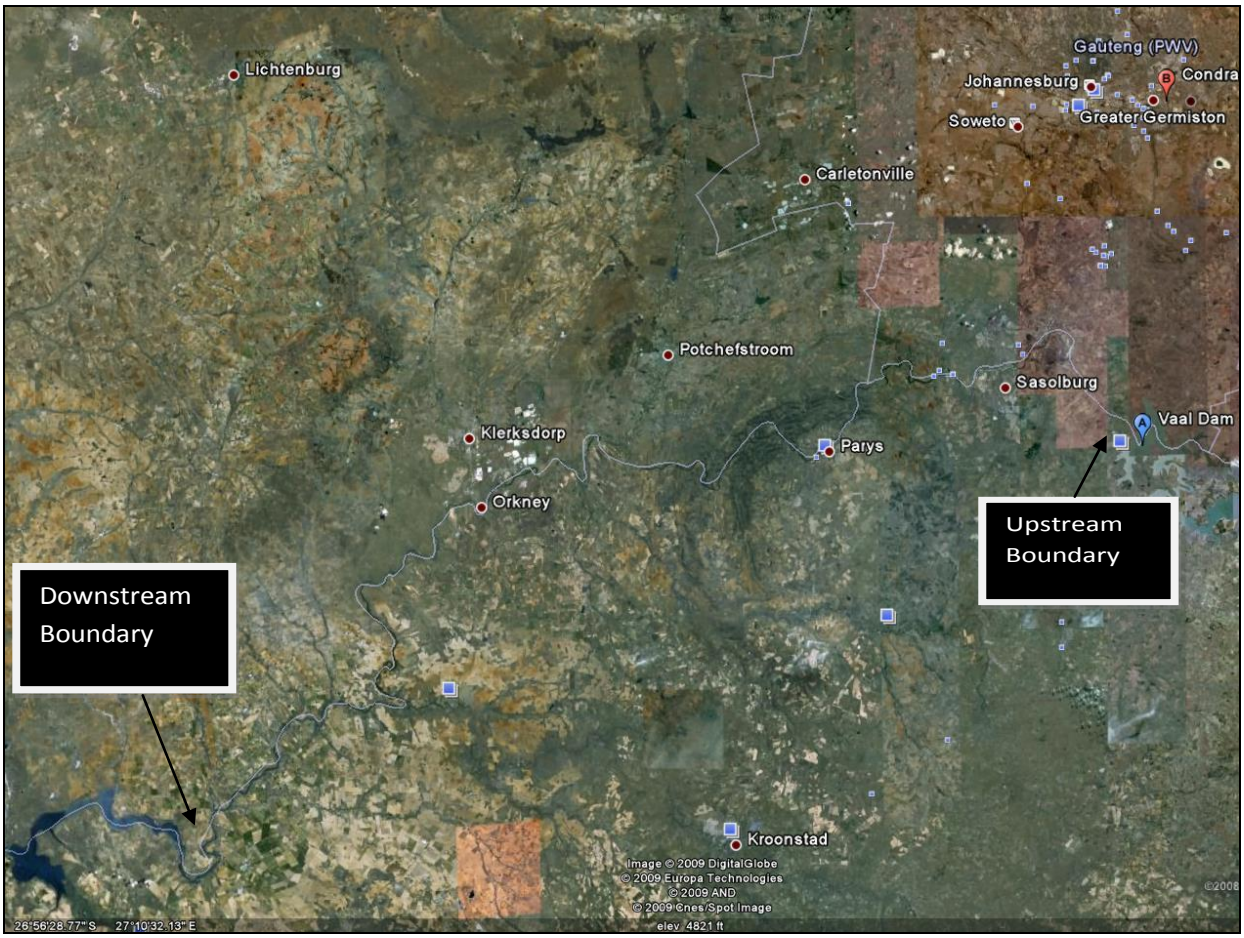

Figure 2 Spatial view of study area (Google earth map accessed 5 March 2009)

It was noted that although the Raw Water Pricing Strategy mentioned the different categories of tariffs and how these would be implemented and administered at various tiers of the cost services chain, variability in water quality seemed not to feature. This was so despite common knowledge that quality tended to generally deteriorate downstream (Figure 4), and a pricing system based on sustainable water resource management would have to also address upstream-downstream equity issues. A report by Dearmont *et al* (4) notes that there should be provision for information on the marginal municipal costs of treating polluted water as affected by pollutant volume. This cost could provide a lower bound on the benefits of cleaner water.

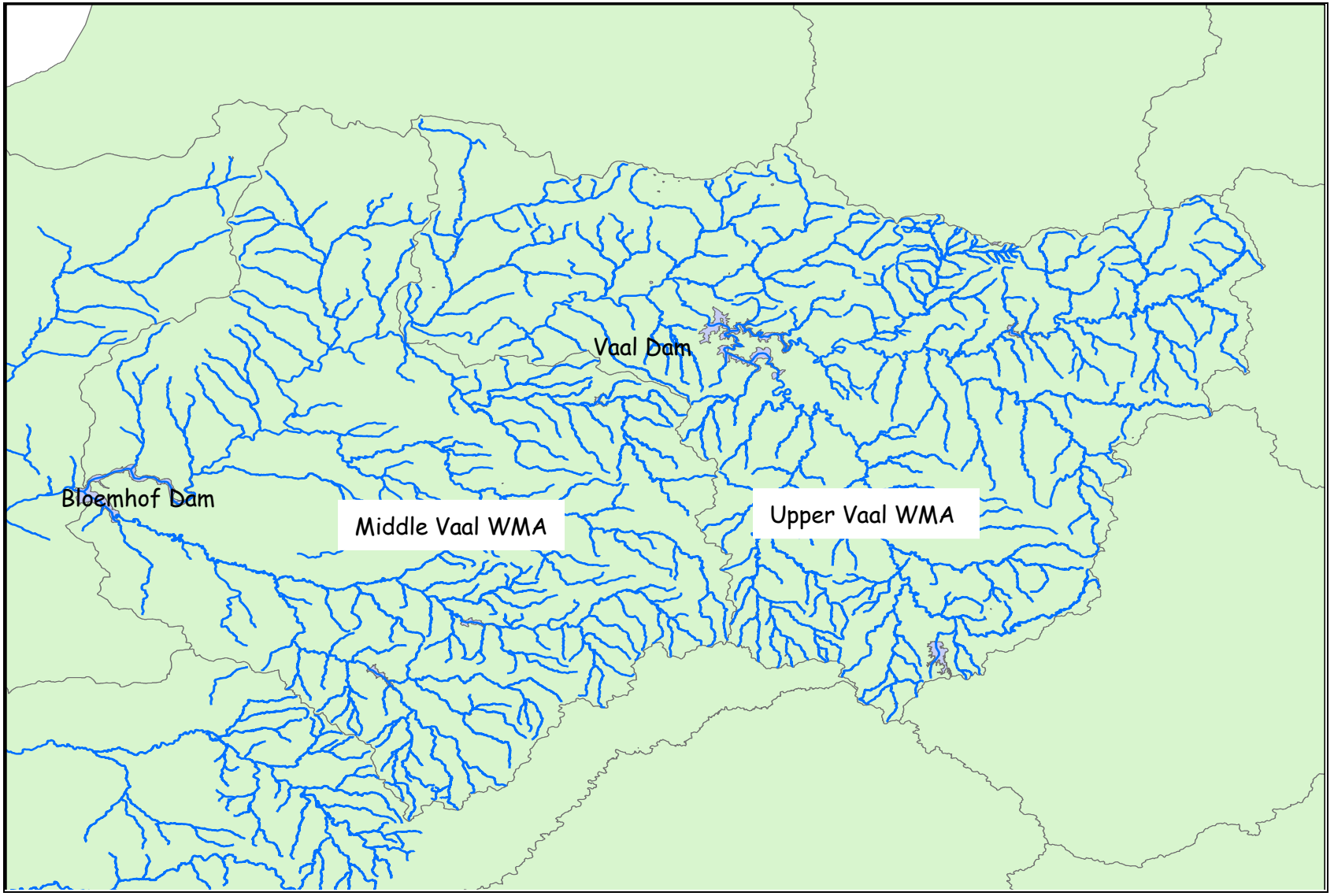

Figure 3 Zooming into the Vaal River spatial research site

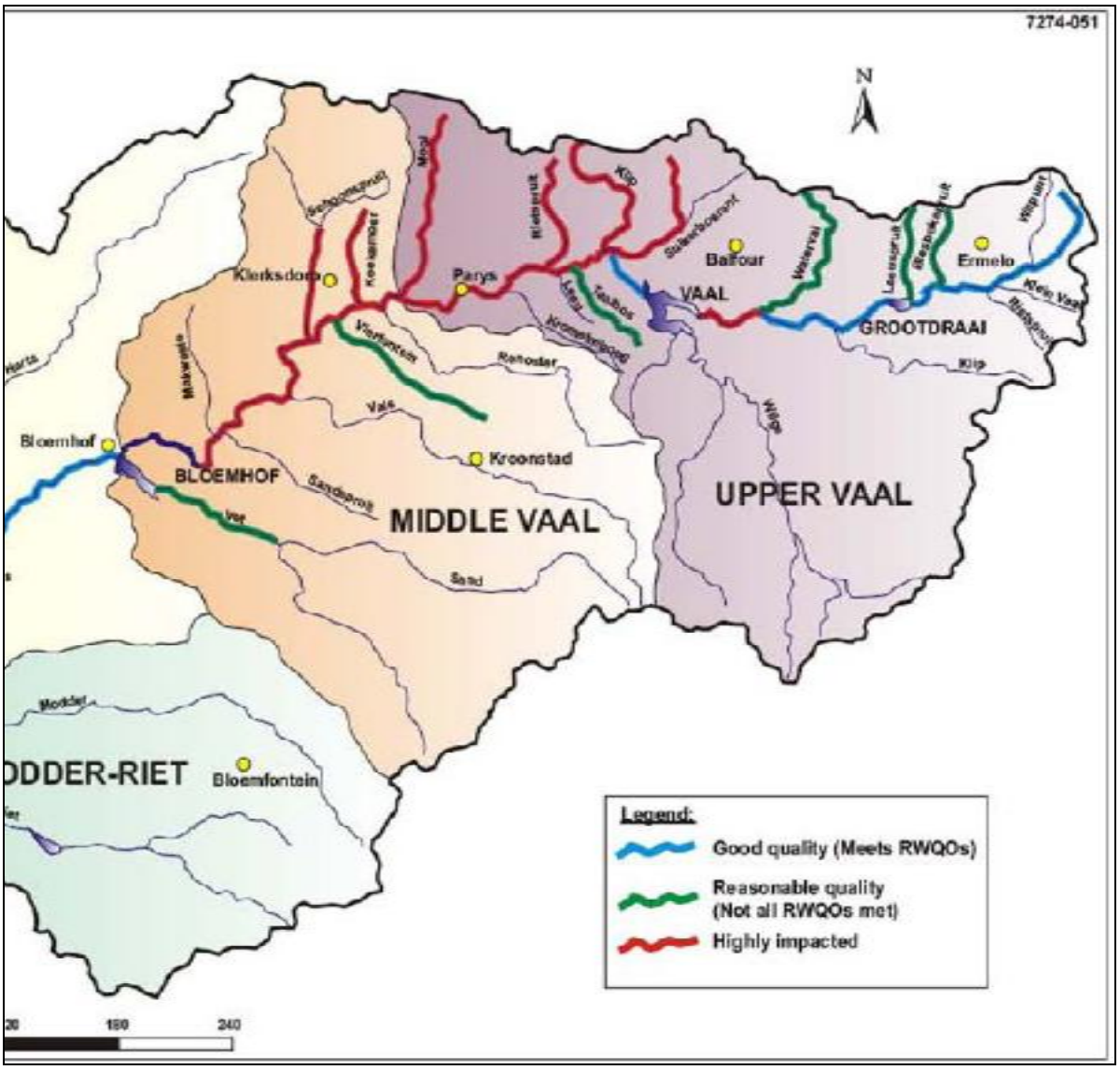

Figure 4 Salinity status of the Vaal river system (Source (3))

Among pricing tools used by DWAF was the tier1 tariff structure for raw water which involved, among other raw water users, bulk water utilities (water boards) that acquired raw water directly from DWAF and treated it to potable standards for further distribution. Lower tiers in the cost chain for water services involved municipalities that treated or distributed treated water, as well as various categories of consumers. Charges at tier1 included Water Resources Management charge (WRMC), Water Research Commission levy (WRCL) which was collected by the water boards; raw water abstraction tariff (RWAT); the Trans-Caledon-Tunnel-Authority charge (TCTAC) for specific catchments, and the bulk water distribution cost (BWDC). Since inputs into the water system differed with respect to the mentioned charges, the most economic solution could be obtained by an appropriate combination of them.

RESEARCH METHODS

Historical surface raw water tariffs for years 2003 to 2008 and supporting documentation were obtained from DWAF, TCTA annual report for 2006 and Rand Water annual reports, among other documents. Clustering of the raw water tariffs was performed and this was related to the water quality trends as discussed in (3) and in Figure 4.

RESULTS AND DISCUSSION

For 2003-2008 the total cost of raw water from DWAF for both upstream and downstream potable water treatments plants in the U&MVWMAs was made up of a WRMC, the TCTAC and the RWAT. According to Table 1 water boards within the Vaal River system paid the same amount for TCTAC/year and a slightly varied amount for the RWAT. However, clustering of the WRMC in cents/m^3 over the research period (Figure 5) indicated a dominance of the UVWMA for the lower clusters of 0.50-1.00 and 1.00-1.50 cents/m^3 while the MVWMA predominantly covered the 1.50-2.00 cents/m^3 cluster.

Table 1 Total cost of raw water in the U&MVWMAs for domestic and industrial use

Starts in April	**WRMC (c/m^3) for Domestic & Industrial**		**RWAT (c/m3)**		**TCTA (Vaal System only, in c/m3)**		**Total Charge (cents/m3)**	
Year	UVWMA	MVWMA	UVWMA	MVWMA	UVWMA	MVWMA	UVWMA	MVWMA
2003	0.75	1.07	0.00	0.00	0.00	0.00	0.75	1.07
2004	0.96	1.07	26.00	26.00	116.10	116.10	143.06	143.17
2005	1.30	0.98	28.30	28.30	122.40	122.40	152.00	151.68
2006	1.42	1.48	26.82	28.30	131.58	131.58	159.82	161.36
2007	1.32	1.55	26.82	26.63	140.83	140.83	168.97	169.01
2008	1.37	1.61	27.81	27.81	147.59	147.59	176.77	177.01

Unfortunately it was inevitable that an increasing trend in cost of raw water over the years also produced a very similar increasing trend in potable water costs as noted in Figure 6 which was discussed in the Parliamentary Monitoring Group (PMG) Rand Water annual report 2006/2007

CONCLUSIONS

It was concluded that a downstream utility paid higher WRMC, within the domestic and industrial category, for more polluted raw water than an upstream utility. It was

recommended that raw water quality variability be incorporated at tier1 of the cost chain for water services to ensure fairness of service delivery and spread of burden to consumers based on quality requirements.

Concerning differing WRMC due to different upstream and downstream water qualities, it was recommended that upstream WMA could reimburse the downstream WMA for additional water quality management costs.

The whole tariff chain meant that the consumer in effect paid for all up-stream water charges. Further, because raw water formed about 50% of a water board's production costs (5), it made economic sense to consider quality impacts in the tariff structure.

Faced with such complexity a researcher's normal response was to reduce it to primary components, analyse and model it, and then test its applicability to the real world (6). A multi-year tariff model that incorporated variability in raw water quality could ensure fairness of price or reimbursement to downstream water users abstracting the more "contaminated" water. A multi-year tariff model was also raised as a necessity by the South African Local Government Association (SALGA) in its presentation to the PMG (7), although correlation to variability in water quality was not part of that presentation.

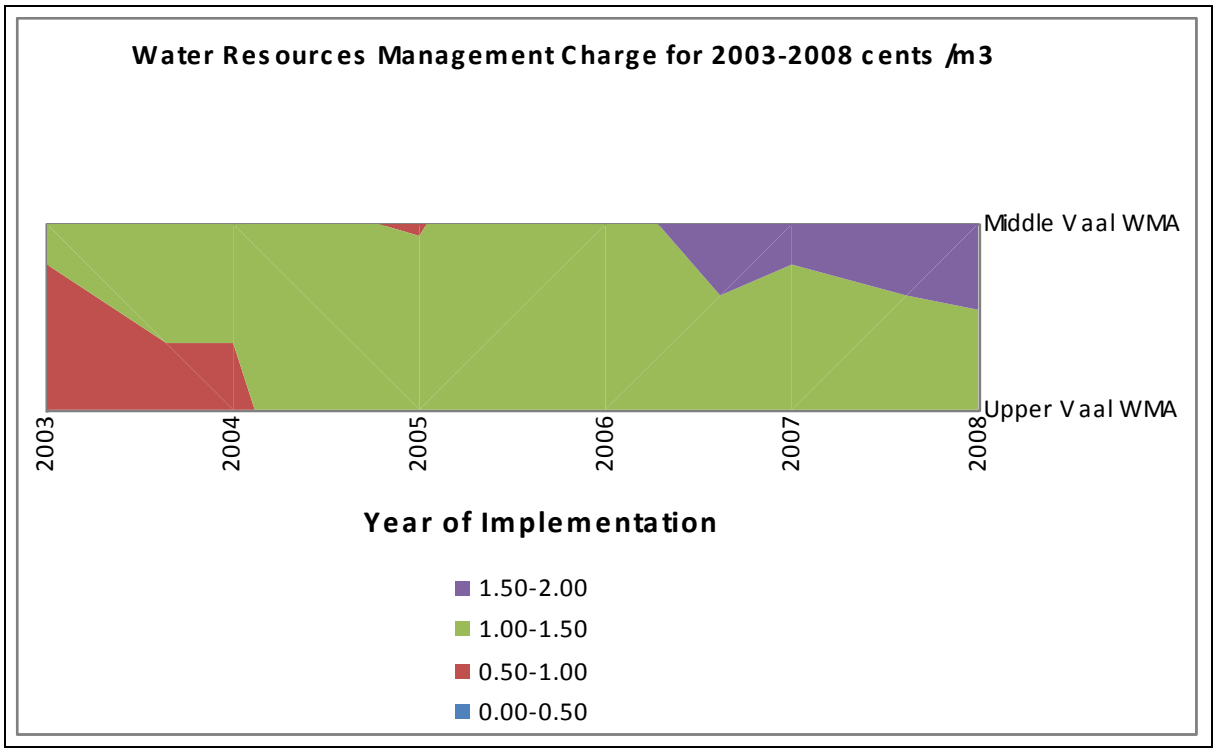

Figure 5 WRMC clusters for U&MVWMAs

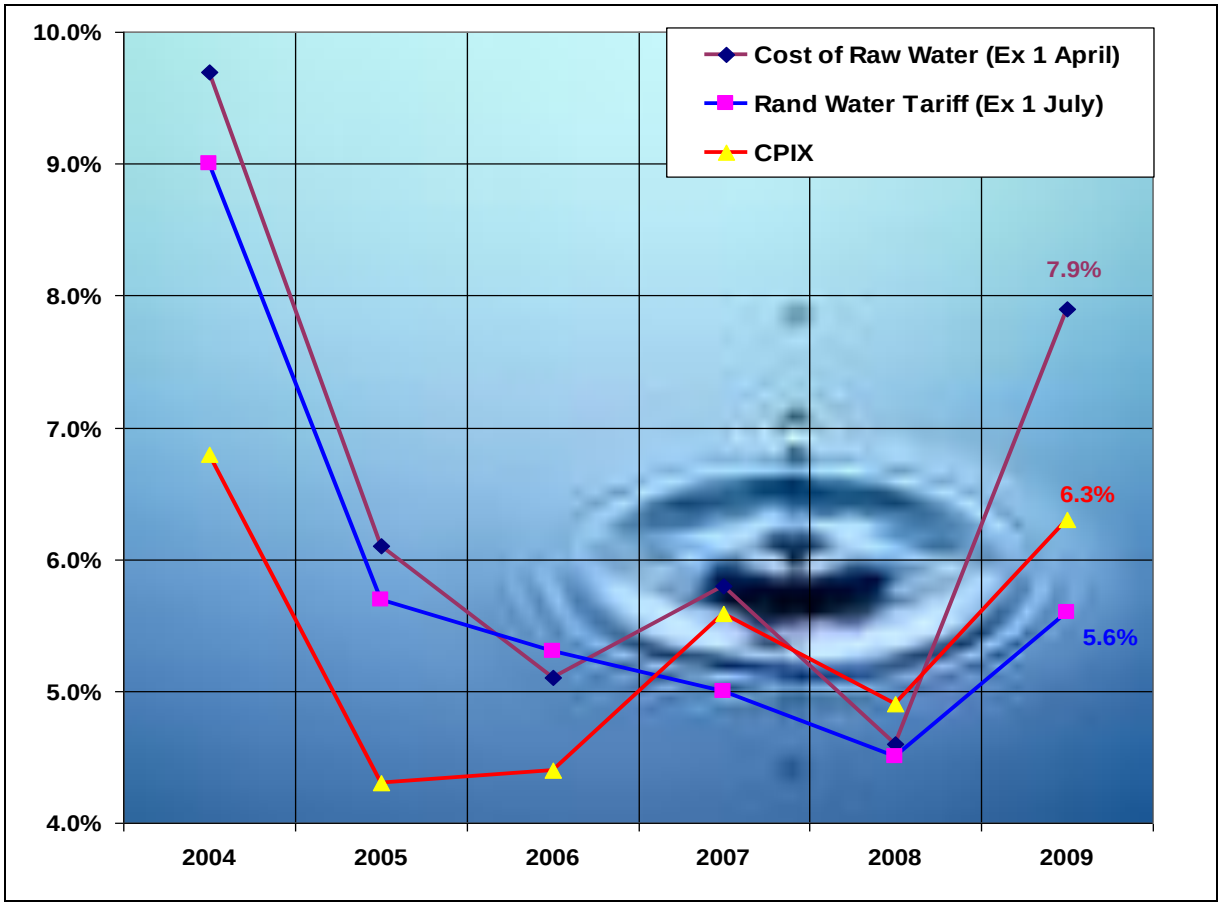

Figure 6 Raw and potable water costs (PMG Rand water annual report 2006/2007)

ACKNOWLEDGEMENTS

The financial assistance of the Department of Labour (DST) is hereby acknowledged. Opinions expressed and conclusions arrived at, are those of the authors and are not necessarily to be attributed to the DST. The authors would also like to thank Tshwane University of Technology for hosting and also funding this research.

REFERENCES

1. DWAF, National water resources strategy: our blue print for survival, Pretoria, South Africa, Department of Water Affairs and Forestry, (2004)
2. DWAF, River Health Programme: state-of-rivers report: *Free State* Region *river systems,* Pretoria, South Africa: Department of Water Affairs and Forestry, (2003)
3. DWAF, Integrated water quality management plan for the Vaal River system, Project steering committee meeting 3, (2007)

4. D Dearmont, BA McCarl, DA Tolman, Costs of water treatment due to diminished water quality: a case study in Texas, *Water Resources Research.* 34, p.849, (1998)
5. F Van Wyk, An integrated manual for the management, control and protection of the Vaal River barrage reservoir, *Geography and Environmental Management*: Rand Afrikaans University, p.15, (2001)
6. S.n., Ecological flow requirements for South African rivers, *South African national scientific programmes,* (ed. AA Ferrar), Pretoria, p.2, (1989)
7. PMG, South African Local Government Association (SALGA) comments on the tariff consultation process and debt owed by municipalities to water utilities, Paliamentary Monitoring Group water boards' annual reports 2006/2007: 7 May 2008, *Portfolio Committee on Water Affairs and Forestry* p.10 (2008)