

# **Doctorate of Philosophy – Development Studies**

## **Research Proposal**

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**Discipline: Development Studies**

**School: Development Studies**

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### **1. Short Descriptive Title**

Developmental Pricing of Residential Water Use in South Africa

### **2. Background & Outline of Research Problem**

In South Africa, historically, water has been managed through supply-side measures. The demand for the resource was estimated and government responded by constructing infrastructure to supply the amount of water required (Lumby et al, 2005: 84). With increased focus on the limited supply of water resources, as well as the inequitable allocation of existing water resources to South Africa's population, the first democratically elected government sought to address these issues through legislative reform (Reed & de Wit, 2003: 51).

After 1994, the existing legislative framework had to be transformed in order to ensure that access to water resources was both sustainable and equitable. In 1996, the Department of Water Affairs and Forestry (DWAF) embarked on an extensive consultation process as the result of

which the Water Law Principles were drafted. These key principles then formed the basis of the Water Policy released by DWAF in 1997 and of the promulgation of the National Water Act No. 36 of 1998 (NWA) (Mackay, 2003: 52).

The NWA created provisions for the pricing of water such that the underlying economic value of water resources would be adequately reflected within the price of water; the practical implementation of this principle was translated into water pricing models that were initially – from 1994 - based on the principle of ‘full’ cost recovery (Mackay, 2003: 64). In order to attempt to fulfil the Constitutional right to access to water, demand-side management of water resources was combined with a revision of the South African pricing schedule in 2001, in which a universal free water allocation of 6,000 litres per household per month was granted. Water consumption that exceeds the free allotment is subject to an increasing block tariff. Therefore, the higher the level of luxury water use, the higher the price charged. This amounts to cross-subsidisation from high to low income households (Metcalf-Wallach, 2007: 3).

This research will critically analyse both the existing pricing model as well as the actual step tariffs that have been implemented based on the model. The fundamental critique of the current South African water pricing model is twofold; firstly, the free allocation is insufficient because double that amount – on average 50 litres per person per day - has been recommended by the World Health Organisation (WHO) as necessary for long term survival and a dignified life (Bond, 2008: 48). Secondly, the factors that determine the actual increases in the step tariff beyond the free allocation may be too narrowly defined as a typical tariff curve is based solely

on municipalities' need for cost recovery. In particular, the free allocation is typically followed by a steep increase in the tariff level, making the price curve upwardly convex (Bond, 2004: 17). These two critiques combined, result in households quickly exhausting their free allocation, and thereafter, being subjected to unaffordable water tariffs.

To date, aside from a single study of price elasticity in Durban (Bailey & Buckley, 2004), little is known of the effects of water prices on household consumption behaviour, in particular, how households change their consumption in order to respond to the increasing block tariff model that is currently used. As such, the existing model does not set the block tariffs in line with expected consumer behaviour and therefore omits the impact of marginal price increases on the well being of households of different income groups.

This research will review the existing water pricing model used within several leading South African metropolitan areas and provide a critical analysis of the efficacy of the model in attempting to achieve sometimes conflicting goals of equity, efficiency and sustainability. The research will initially review the legislative and regulatory background framework that exists for the pricing of water as a benchmark for water provision as well as an overview of the pricing models used in South Africa. The research will then seek to quantify the effects of the existing block tariffs by estimating the price elasticity of demand for water for various income groups. The three metropolitan municipalities in Gauteng will be used as case studies (the City of Joburg, City of Tshwane and Ekurhuleni) whereby inferences can be made specifically in respect of water pricing for residential use in an urban setting.

Gauteng is an illustrative example of the mismatch between the location of a large part of the country's population and the water resources required to sustain it, which has resulted from human settlement patterns being centred on the location of mineral resources (Metcalf-Wallach, 2007: 1). As such, water demand in Gauteng is met through inter-basin transfers from the Lesotho Highlands Water Project (LHWP) whereby South Africa purchases water from the eastern part of the Orange River in Lesotho and transfers it to the Vaal River (Day, 1998: 7). The LHWP entails massive capital outlays and increases the average costs of supplying water to households in Gauteng. This research will examine the underlying cost structure for water services infrastructure from the source, throughout the distribution network in order to identify potential improvements in water costing at municipal level.

Although the research will focus on the pricing of water for residential use, industrial pricing and water demand will also be examined as the potential for cross-subsidisation from industrial users to households could provide further scope for improving the residential pricing model. The overarching aim of the research will be to present an alternative water pricing model that adequately accounts for household consumption behaviour and developmental needs.

### **3. Preliminary Literature Review**

A preliminary review of the literature has been conducted with a view to locate the proposed research within the broader field of study on water resource management. The literature that will be utilized falls into two broad categories; firstly, literature that relates to the economic theoretical framework for the pricing of water resources and secondly, empirical literature that provides socio-economic context for the design of the water pricing model.

This research will draw significantly on the water tariff modeling exercise undertaken by Bailey & Buckley (2004) for the Durban Metropolitan Municipality (DMM). This study draws on municipal household consumption data that is pooled into high, middle and low income groups. The authors use this data to perform econometric estimation of the price elasticity of demand for each of the three income groups. The study then makes use of the Ramsey pricing methodology in order to present an alternative tariff structure that incorporates the demand elasticity of households in DMM.

To date, this is the only study of its kind in South Africa and the proposed research will undertake a similar exercise with specific focus on the dynamics at play within Gauteng. The proposed research will also present an alternative to the existing water pricing model that is specific to the three metropolitan municipalities in Gauteng. The proposed research will provide a theoretical contribution by showing that the basis for modeling block tariffs is in order to adequately capture consumer responses to price changes in order to enhance societal welfare.

The case of water pricing in Gauteng is significant from a policy perspective as it has been the site of social unrest in response to the implementation of a range of cost-recovery measures at municipal level (Bond & Dugard, 2008a: 5). Providing a measure of consumer responses to price changes in Gauteng will contribute to the existing body of literature and to policy debate, because such consumption patterns will enable one to analyse whether existing water pricing models enable the achievement of the legislative goals of equity, efficiency and sustainability. Research conducted by Krystall (2003) identifies the need for further research on the price elasticity of demand for residential water use in Johannesburg, numerous interviews and research

conducted with officials from the CoJ revealed the lack of elasticity data and the need to make use of such data in setting water tariffs.

In the case of the City of Johannesburg (CoJ), the installation of pre-paid water meters has been the underlying cause of social unrest in respect of water services. Pre-paid meters were installed in some of the poorest areas in Johannesburg as a cost-recovery mechanism. This sparked controversy when, in 2005, two children in Phiri (one of the poorest areas in Soweto) were burned to death in a shack fire after neighbours struggled to extinguish the fire as water supply from the pre-paid water meter automatically disconnected as there was insufficient credit available (Bond & Dugard, 2008: 1).

In 2009, after three years of litigation in both the High Court and the Supreme Court of Appeal, a number of Phiri residents lodged an application with the South African Constitutional Court against the CoJ, Johannesburg Water (a private company that is wholly owned by the CoJ) and DWAF. The application was in respect of two issues that questioned; firstly, the constitutionality of the free basic water policy as implemented by the CoJ and the actual free allotment of six kilolitres of free water per month to every accountholder. And secondly, the lawfulness of the installation of pre-paid water meters in Phiri (*Mazibuko et al vs. the City of Johannesburg Judgement*, 2009: 4). The Constitutional Court judgment was granted in favour of the respondents, primarily because it was deemed inappropriate for a court to determine the policy measures that are appropriate for achieving social and economic rights (*Mazibuko et al vs. the City of Johannesburg Judgement*, 2009: 30). This judgement was the culmination a wave of social protest and the outcome has elevated the need for policy reform, especially in light of the

largely body of evidence that exists regarding the insufficient FBW allocation and the upwardly convex tariff curve which imposes too high a tariff increase once the free allocation is exhausted (Bond & Dugard, 2008a, 2008b; Bond, 2004, 2008, 2009; Harvey, 2007). The proposed research is therefore strategically placed to inform water pricing policy by questioning the composition of the current pricing models and their consistency in applying the theoretical components that form the basis of increasing block tariffs.

Theoretically, the current water pricing model in South Africa is based on the principle of second-best pricing which was first devised by Ramsey (1927). In terms of this principle, the elasticity of demand and marginal costs are both incorporated into the price of water. A range of authors have since devised improvements to the second-best pricing model and essentially built on the foundation provided by Ramsey, some of whom include Kim (1995), Elnaboulsi (2001) and Schuck & Green (2002).

Another part of the framework for the pricing of water are the theoretical underpinnings for making use of market differentiation in which non-linear pricing is applied in the form of increasing block tariffs. Boiteux (1960) provides one of the first examples of market differentiation for public utilities by applying differential pricing as a response to demand variations during peak times. Wilson (1993) provides a comprehensive review of the various non-linear pricing models that are of particular relevance to public utilities in which marginal cost pricing is not typically financially sustainable. Barkatullah (1999) delves into the theoretical underpinnings of demand analysis and pricing using water utilities as a specific application.

NEDLAC (2007) and Eberhard (2009) provide a descriptive overview of the current pricing framework at national level. Both papers outline the institutional set-up within the water services sector in South Africa. Malzbender *et al* (2009) provide a comprehensive review of the regulations within the water services sector in South Africa.

#### **4. Research Problems and Objectives**

The central research question that is to be answered is – *how should a water pricing model be designed in order to ensure that the goals of equity, efficiency and sustainability are achieved?*

This research is further narrowed by posing this question specifically in respect of water is the used for residential use within an urban setting. Some other descriptive, casual and evaluative research questions are as follows:

- What is the policy and regulatory framework that currently exists for the pricing of water in South Africa? Specific reference will be made to the transition of water management from supply to demand management with the finalisation of the White Paper on Water in 1994 and the promulgation of the NWA in 1998.
- What is the trend in respect of household access to water services since 1994? This will include a broad analysis of access trends for CoJ, CoT and Ekurhuleni that will include a demographic component.
- What is the nature of water supply in Gauteng and how is the water services sector characterised? What is the composition of water use in Gauteng? What is the underlying cost structure of supplying water in Gauteng and how is water infrastructure financed? This will include a value chain analysis of water as well as the costs associated with the

negative externalities from water pollution during mining production and other industrial processes.

- What are the positive and negative externalities that influence water consumption? How can these externalities be internalised and reflected within the water pricing model?
- How is water for industrial use priced? Is water use in the industrial sector enhancing equity, efficiency and sustainability? Is there scope for cross-subsidisation from industry to households? These questions will be posed generally but will also be analysed for Gauteng specifically. This may require a sectoral analysis that could be conducted using the Gauteng Computable General Equilibrium (CGE) Model, which will enable an analysis of the national and provincial impact of cross-subsidisation on both households and industry.
- What pricing policies and models are currently being implemented in Gauteng? Have these policies been effective in achieving the goals of equity, efficiency and sustainability?
- What are the theoretical underpinnings of increasing block tariffs? And how have households in metropolitan regions in Gauteng changed their consumption patterns in response to changes in water prices? This section will require econometric estimation of the price elasticity of demand for water for households that reside within CoJ, CoT and Ekurhuleni.

## **5. Theoretical Framework**

The theoretical framework will be based on economic theories that are used in the pricing of public utilities. Public utilities represent a unique case for pricing as they are characterised by relatively high initial investment in infrastructure, with marginal costs being much lower than average costs (Coase, 1970). As such, consumer surplus can be enhanced by applying price discrimination so that the amount consumed is closely matched to a corresponding price. This research will primarily be based on the principle of non-linear pricing as devised by Ramsey (1927) whereby both cost and demand elasticity are used as the determinants of price. The application of this theoretical framework would enable the use of water pricing as a tool to influence consumption behaviour so that the goals of equity, efficiency and sustainability can be achieved.

This research will provide an alternative water pricing model that is developmental in nature. As such, the theoretical framework that will be used is rooted in Sen's (1999: 3) conceptualisation of development as 'a process of expanding the real freedoms that people enjoy.' Sen argues that good health has an enabling effect on people, whereby an individual's capability can be directly influenced by their relative freedom or deprivation (1999:5).

A pricing model that adequately accounts for the developmental needs of people must include the costs and benefits associated with both negative and positive externalities that occur from the delivery of water services. This approach necessitates the use of Cost-Benefit Analysis (CBA) principles first advocated by Dupuit (1844) in which the net social gains of a capital investment

project were calculated in order to gauge the change in welfare. Applying these principles to the water sector would involve the creation of a pricing model where the developmental externalities are captured within the price determination process.

## **6. Research Design & Methodology**

The proposed research is empirical in nature and will make use of secondary numeric data as well as primary qualitative data in the form of industry interviews. The research will contain case studies of three metropolitan municipalities in order to frame the analysis within the context of residential water use within an urban setting.

The research will be contextualised by providing an outline of each of the metropolitan municipalities. As such, demographic and income profiles for each of the metropolitan municipalities will be sourced from these municipalities directly where possible or, alternatively, from Statistics South Africa (Stats SA), Quantec and Global Insight<sup>1</sup>.

Aggregated data on cost structures will be obtained from the Gauteng Treasury, whereas disaggregated data will be obtained directly from each of the water management institutions in the CoJ, CoT and Ekurhuleni. Both historical and current data on the cost of water services infrastructure within the province which could serve as the basis from which a value chain

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<sup>1</sup> Quantec and Global Insight are reputable private data providers that disaggregate provincial data down to municipal level in the absence of data from the official data provider (Stats SA). These data providers are also recognised, and used by national, provincial and local government.

analysis could be formed. In order to construct this type of analysis, data from municipalities will be supplemented with industry interviews within the municipalities and more broadly.

Data on industrial water consumption can also be obtained from municipal water management institutions; however, at this stage the level of disaggregation of this data is unclear. In order to assess the impact of industrial cross-subsidisation of water for residential use, the Gauteng CGE model will be used with the Gempack software. However, this model will have to be extended to include industry-specific equations that will reflect the relative water consumption of each sector. Such an extension will make use of the input-output tables generated by Stats SA in the *Water Accounts for South Africa* (2006).

Data from each of the municipalities will be collected on their existing pricing structures i.e. their increasing block tariffs that are currently in place. Municipal interviews will also be used to gather qualitative data on the determinants contained within the pricing model and the underlying structure thereof. The price elasticity of demand for water will be calculated using municipal billing data for each of the three metropolitan municipalities which is available on a monthly basis. In order to isolate the effect of price changes on various different income groups it is essential to obtain *both* consumption and spatial data, therefore, the billing data would have to retain the actual monetary information linked with a corresponding geographical location of the user. There may be municipal restrictions for providing access to such specific data that may compromise the anonymity of municipal customers. This challenge could be circumvented by obtaining data that is more aggregated geographically, which could then be used in combination

with average income levels obtained from another data source for that specific area or with data on relative property prices, which could be used as a proxy for income levels. The actual econometric estimation of the demand elasticity will be conducted using regression techniques contained in the Eviews software package.

## **7. Draft Structure of the Dissertation**

### **Chapter 1 – Introduction**

- 1.1. Research Question & Objectives
- 1.2. Scope
- 1.3. Methodology
- 1.4. Limitations
- 1.5. Overview

### **Chapter 2 – Theoretical Framework**

- 2.1. Approach to the Pricing of Utilities
- 2.2. Non-linear Pricing Models
- 2.3. Pricing for Residential and Industrial Water Use
- 2.4. Developmental Framework
- 2.5. Externalities and Cost-Benefit Analysis

### **Chapter 3 – Historical Context and Legislative Environment**

- 3.1. Water Demand & Supply in South Africa
- 3.2. Legislative Framework & Transition
- 3.3. Integrated Water Management & Policy Environment

### **Chapter 4 – Municipal Context and Value Chain Analysis**

- 4.1. Profile of the Municipalities
- 4.2. Municipal Policy Framework

4.3. Local Pricing Models in Practice

4.4. The Water Pipeline

4.5. Costing & Financial Sustainability

## **Chapter 5 – Developmental Pricing Model**

5.1. Household Demand Elasticities for Water Use

5.2. Cross-Subsidisation from Industry

5.3. Alternative Pricing Model

5.4. Alternative Block Tariff Structure

5.6. Developmental Outcomes

## **Chapter 6 – Conclusion & Recommendations**

## 8. Preliminary References

Bailey, W.R. & Buckley, C.A. 2004. Modelling Domestic Water Tariffs. Presented at the 2004 Water Institute of Southern Africa (WISA) Biennial Conference, Cape Town, 2<sup>nd</sup> – 6<sup>th</sup> May 2004.

Barkatullah, N. 1999. *Pricing, Demand Analysis and Simulation: An Application to a Water Utility*. Dissertation.com.

Boiteux, M. 1949. 'La tarification des demandes en pointe' in *Revue Générale de l'Électricité* Vol. 58, pp. 321-340. Translated as 'Peak-load pricing' in *Journal of Business*, Vol. 33, pp. 157-179.

Bond, P. 2004. 'Water Commodification and Decommodification Narratives: Pricing and Policy Debates from Johannesburg to Kyoto to Cancun and Back' in *Capitalism Nature Socialism*, The Centre for Political Ecology, Routledge Taylor & Francis Group, Vol. 15, No. 1, March 2004.

Bond, P. 2008. 'Decentralization, Privatization and Countervailing Popular Pressure: South African Water Commodification and Decommodification', in V.Beard, F.Miraftab, and C.Silver (eds), *Decentralization and Planning: Contested Spaces for Public Action in the Global South*, London: Taylor and Francis, pp.36-54.

Bond, P. 2009. 'South Africa's 'rights culture' of Water Consumption: Breaking out of the Liberal Box and into the Commons?' Submitted for publication in *Water, Cultural Diversity & Global Environmental Change: Emerging Trends, Sustainable Futures?*

Bond, P. & Dugard, J. 2008a. 'The Case of Johannesburg Water: What Really Happened at the 'Parish Pump' in *Law, Democracy and Development*, ??

Bond, P. & Dugard, J. 2008b. 'Water, Human Rights and Social Conflict: South African Experiences' in *Law, Social Justice & Global Development Journal*. Issue 1.

Blignaut, J. & van Heerden, J. 2008. 'Is Water Shedding Next?' Presented at the Trade and Industrial Policy Strategies (TIPS) Annual Conference, Cape Town, 29<sup>th</sup> -31<sup>st</sup> October 2008

Day, J., 2008. 'Management of Freshwater Ecosystems in Southern Africa: Comparisons and Contradictions' in *Science in Africa: Emerging Water Management Issues*. <http://www.aaas.org/international/africa/ewmi/jday.htm>. Accessed on: 09/11/2008.

Department of Environmental Affairs and Tourism, 2005. National State of the Environment Report. [http://www.deat.gov.za/Maps/PublishMaps/Maps\\_details.asp?MapID=25](http://www.deat.gov.za/Maps/PublishMaps/Maps_details.asp?MapID=25). Accessed on: 09/11/2008.

Department of Water Affairs and Forestry (DWAF). 2004a. *A History of the First Decade of Water Service Delivery in South Africa: 1994 to 2004*.

Department of Water Affairs and Forestry (DWAF). 2004b. Guidelines for Water Conservation and Water Demand Management in Water Management Areas and in the Water Services Sector, South Africa: Executive Summary, *Integrated Water Resources Management*, Edition 1, March 2004. pp.1-10.

Dupuit, J. 1844. 'On the Management of the Utility of Public Works.' Translated from French in *International Economic Papers*, No. 2, London 1952.

Department of Water Affairs and Forestry (DWAF). 2004c. *National Water Resource Strategy*, First Edition.

Department of Water Affairs and Forestry (DWAF). 2005. A Draft Position Paper for Water Allocation Reform in South Africa: Towards a Framework for Water Allocation Planning, Discussion Document, January 2005.

Department of Water Affairs and Forestry (DWAF). 2001. *Water Conservation and Water Demand Management Strategy for the Water Services Sector*, 15 March 2001.

Easter, K.W. & Hearner, R.R. 1993. 'Decentralizing Water Resource Management: Economic Incentives, Accountability and Assurance' in *Policy Research Working Paper*, 1219, World Bank.

Eberhard, R. 2009. *Administered Prices: Water*. Report for National Treasury. <http://www.treasury.gov.za/publications/other/epir/water.pdf>. Accessed on: 13/11/2009.

Elnaboulsi, J. 2001. 'Nonlinear Pricing and Capacity Planning for Water and Wastewater Services' in *Water Resources Research*, Vol. 15, No.1, pp. 55-69.

Harvey, E. 2007. 'The Commodification of Water in Soweto and its Implications for Social Justice,' Doctoral Thesis, University of the Witwatersrand, School of Social Sciences, Sociology Department.

Hayek, F. A., 'The Use of Knowledge in Society', *American Economic Review* 35(4): 519-530 (September 1945).

Jønch-Clausen, T. 2004. 'What, Why and How?' in *Integrated Water Resource Management (IWRM) and Water Efficiency Plans by 2005*. Global Water Partnership, January 2004.

Karar, E. 2003. Governance in Water Resources Management: Progress in South Africa. WWF3: INBO Session. Department of Water Affairs and Forestry. 20<sup>th</sup> March 2003.

Kim, H. 1995. 'Marginal Cost and Second-best Pricing of Water Services' in *Review of Industrial Organization*, Vol.10, No.3, pp. 323-338.

Krystall, N. 2003. 'Johannesburg's Water Tariff Structure', Masters Research Report, University of the Witwatersrand, Graduate School of Public and Development Management, Johannesburg.

Lévite, H., Sally, H. & Cour, J. 2002. 'Water Demand Management in a Water-Stressed Basin in South Africa.' International Water Management Institute. Presented at the 3<sup>rd</sup> Waternet Symposium, Arusha, October 2002.

Lumby, A., Matete, M. & Rwelamira, J. 2005. 'The Management of South Africa's Water Resources with Particular Reference to the Period 1956-1998', *South African Journal of Economic History*, 20(2), September 2005. pp. 83-108.

Mackay, H. 2003. 'Water Policies and Practices' in Reed, D. & de Wit, M. (eds) *Towards a Just South Africa: The Political Economy of Natural Resource Wealth*, WWF Macroeconomic Program Office, April 2003. pp. 49-76

Malzbender, D., Earle, A., Deedat, H., Hollingworth, B. & Mkorosi, P. 2009. 'Review of Regulatory Aspects of the Water Services Sector', African Centre for Water Research, Report to the Water Research Commission, No. TT 417/09, November 2009.

*Mazibuko et al vs. City of Johannesburg Judgement*. 2009. Constitutional Court Case, Case CCT 39/09, Johannesburg.

McCartney, M.P., Sally, H. & Senzanje, A. 2004. 'Integrated Water Resources Management and Agriculture in Southern Africa', in Stephenson, D., Shemang, E.M. and Chaoka, T.R. (eds). *Water Resources of Arid Areas*. A.A. Balkema Publishers, Leiden, pp. 493-499.

Metcalf-Wallach, J. 2007. 'Demand-Side Approaches to Water Scarcity and the National Water Act' in *IDEAS Journal: International Development, Environment and Sustainability*, November 2007, p.1-5

Micklin, P.P. 1994. 'The Aral Sea Problem', in *Civil Engineering*, No. 102, pp.114-121.

National Economic Development & Labour Council (NEDLAC). 2007. *Administered Prices Study on Economic Inputs: Water Sector*, Fund for Research into Industrial Development, Growth & Equity (FRIDGE), August 2007.

Oosthuizen, L. K. 2002. 'Land and Water Resources Management in South Africa'. Paper presented at the Working Group on Integrated Land and Water Resources Management (WG-ILWRM), 18<sup>th</sup> Congress, Montreal, Canada. 21<sup>st</sup>-28<sup>th</sup> July 2002.

Ostrom, V. 1962. 'The Water Economy and its Organization' in *Natural Resource Journal*, Vol. 2, April 1962, pp. 55-73.

Parliamentary Monitoring Group (PMG). 2006. *Progress and Challenges to Transformation of Irrigation Boards: Department Briefing*, Minutes of a Meeting of the Water Affairs and Forestry Portfolio Committee, 11 September 2006. Accessed from: [www.pmg.org.za/print/8185](http://www.pmg.org.za/print/8185). Accessed on: 10/08/2009.

- Rahaman, M. M. & Varis, O. 2005. 'Integrated Water Resources Management: Evolution, Prospects and Future Challenges in Sustainability' in *Science, Practice & Policy*. Vol. 1(1) Spring 2005, Pp.15-21.
- Ramsey, F. P. 1927. 'A Contribution to the Theory of Taxation' in *The Economic Journal*, Vol. 37, No. 145, March 1927, pp. 47-61.
- Republic of South Africa (RSA). 1996. *Constitution of the Republic of South Africa*, No. 108 of 1996.
- Republic of South Africa (RSA). 1998. *National Water Act*, No. 36 of 1998.
- Schreiner, B. & Van Koppen, B. 2002. 'Catchment Management Agencies for Poverty Eradication in South Africa' in *Physics and Chemistry of the Earth*, Vol. 27. pp. 969-976.
- Schuck, E. & Green, G. 2002. 'Supply-based Water Pricing in a Conjunctive Use System: Implications for Resource and Energy Use' in *Resource and Energy Economics*, Vol.24 No.3, pp 175-192.
- Sen, A. 1999. *Development as Freedom*. New York: Random House.
- Statistics South Africa (Stats SA). 1996-2008. *Mid-year Population Estimates*.
- Statistics South Africa (Stats SA). 2006. *Natural Resource Accounts: Updated Water Accounts for South Africa 2000*. Discussion Document, December 2006.
- Turton, A.R. 1999. 'Water Demand Management (WDM): A Case Study from South Africa', *MEWREW Occasional Paper No. 4*, Presented to the Water Issues Study Group, School of Oriental and African Studies, 18 January 1999
- United Nations. 1992. *The Dublin Statement on Water and Sustainable Development*. Presented at the International Conference on Water and the Environment, Dublin, 31 January 1992
- United Nations Development Programme (UNDP). 2003. *Human Development Report 2003*, New York: UNDP.
- United Nations Educational, Scientific and Cultural Organization (UNESCO). 2006. *2<sup>nd</sup> UN World Development Report*, New York: Berghahn Books.
- Wall, K & Manus, A. 2007. *National Water Services Asset Management Strategy for South Africa*. Water Management and Technology Applications in Developing Countries, International Conference, Kuala Lumpur, Malaysia, 14-16 May 2007.
- Wilson, R.B. 1993. *Non-linear Pricing*. Electric Power Research Institute, New York: Oxford University Press.

Woodhouse, P. 2008. 'Water Rights in South Africa: Insights from Legislative Reform' in *BWPI Working Paper 36*, Institute for Development policy and Management, University of Manchester, UK.

Yepes, G. 1999. *Do Cross-Subsidies Help the Poor to Benefit from Water and Wastewater Services? Lessons from Guayaquil*. UNDP-World Bank Water and Sanitation Program, February 1999.

## 9. Research Schedule

<b>Time Period</b>	<b>Duration</b>	<b>Activity</b>	<b>Outcome</b>
January – February 2010	2 months	Preliminary Literature Review	Preliminary list of literature
February– March 2010	2 months	Drafting Research Proposal	Complete research proposal
April – August 2010	5 months	Extensive Literature Review	Detailed list of literature
April – May 2010	2 months	Develop Interview Schedule	List of interviews required and interview questionnaire completed
June – August 2010	3 months	Conduct Interviews	Interview times scheduled and all interviews conducted
September 2010	1 month	Transcribe Interviews	Complete transcription
April – September 2010	6 months	Identify Data Sources and Obtain Access to Data	Municipal databases for the three metro's with both consumption and spatial/income data.
October – December 2010	3 months	Data cleaning and validation. Model definition, design and specification for elasticity calculation. Extension of the Gauteng CGE model.	Clean, complete database and model design complete. Gauteng CGE model extended with water-specific variables.
January – April 2011	4 months	Model estimation and CGE simulation.	Estimated elasticities by income level and

			industry/household simulation complete.
May – June 2011	2 months	Data Analysis and interpretation of results	Write-up of initial interpretation
July – November 2011	6 months	Writing of thesis	First draft of thesis complete
December 2011 – January 2012	2 months	Feedback from supervisor and other contributors	First draft with extensive comments
February - March 2012	2 months	Addressing comments	Final draft of thesis
April 2012	1 month	Final editing of draft	Final thesis complete

