



Post Doctoral Research Fellowship

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Tshwane University
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**VAAL AND UMGENI BASIN RESERVOIR PROFILES: IMPLICATIONS
FOR WATER BOARD ACTIVITIES: ANNATORIA CHINYAMA**



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Proposal submitted in partial fulfilment of the requirements for the
degree

DOCTOR TECHNOLOGIAE

in the

Department of Civil Engineering

FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT

TSHWANE UNIVERSITY OF TECHNOLOGY

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Key Stakeholder Organisations



- Umgeni Water
- Rand Water Board
- Tshwane University of Technology
- Durban University of Technology





Background

- Provision of sufficient & good quality potable water to communities a challenge in South Africa.
- Rainfall over much of South Africa seasonal (Schumann & Pearce, 1997:124).
- South Africa's rivers highly regulated by impoundments to conserve water for domestic use, industry and agriculture (Roos & Pieterse, 1994:1; Bath *et al.*, 1997:EX11; Schumann & Pearce, 1997:124; Oberholster & Ashton, 2008:2).





Background...

- Vaal and Umgeni river basins e.g.s of highly regulated river systems & large populations rely on them for their domestic water supply
 - (Tollow, 2004:504; Mckenzie & Wegelin, 2009:171; Dzwairo, 2011:5). Vaal dam and Inanda dam chosen for this study.
- Significant water quality challenges in river systems:
 - biological (faecal pollution)
 - chemical (gold mining and industrial impacts through sulphates, sodium, iron, manganese and heavy metals)
 - eutrophication;
 - suspended solids (soil erosion).





Research Problem

- Quality of raw water abstracted for potable water production influences the cost of treating that water to set standards.
- Quality of raw water in impounded reservoirs influenced by stratification, & pollution generated by human activities.
- Quality of raw water abstracted from reservoir varies according to season, water depth and flow dynamics at that point.





Research Problem...

- Reservoir profiles of different water quality parameters used to characterise the water quality of impounded lakes.
- For potable use, assessing the quality of the raw water in the reservoirs without linking it to the production of potable water not enough for the management of the water quality of the reservoirs for this use.





Benefits

- Predictive tools required to support decision making in selective abstraction of raw water for potable use.
- Water quality models found to have predictive qualities that can be useful in water quality management (Bath *et al.*, 1997; Van der Helm & Reitveld, 2002; Westphal *et al.*, 2003; Rietveld & Dudley, 2006; McCartney, 2007).





Benefits...

- This study seeks to develop decision support tool that would aid the Water Boards (WBs) to predict & plan for impacts of variable raw water quality abstracted from the reservoirs on the production of potable water.
- Significance of this study is the development of a tool that will inform WBs on abstraction points for raw water of optimum quality.
- The tool will be tested on two river systems with different catchment characteristics.





Objectives of the Project

- *Main Objective*

- To develop a decision support tool that would aid WBs to predict and plan for impacts of variable raw water quality abstracted from reservoirs for production of potable water based on particular reservoir profiles.





Objectives of the Project...

- *Specific Objectives:*

- To profile the temporal and spatial variability of the surface raw water quality in the Vaal dam and Inanda dam reservoirs.
- To analyse the impacts of specific reservoir profiles on potable water production.
- To develop a tool that models optimum abstraction points on the reservoirs





Constraints and Assumptions

- ***Constraints:***
 - Availability of data from the water boards
 - Availability of meteorological and hydrological data
 - Limitations of the models to be used.
- ***Assumptions:***
 - It is assumed that effects of climate change are negligible
 - It is assumed that land use patterns in the catchments of the dams will remain constant for the study period.





Deliverables

- Reservoir profiles showing the temporal and spatial variability of the surface raw water quality in the Vaal dam and Inanda dam reservoirs.
- ***Methodology***
 - Data collected from the Water Boards used to model the profiles
 - data collected and analysed during the course of study over a period of one year to cover all the seasons of the year will be used to validate the model
 - Temporal variations will be investigated climatically season by season.
 - For spatial variability; along the depth of the reservoir & along the stretch of the reservoir.





Deliverables...

- Reservoir profiles showing the temporal and spatial variability of the surface raw water quality in Vaal and Inanda dam reservoirs...
- ***Methodology***
 - Sampling points selected to coincide with epilimnion and hypolimnion zones in the reservoirs as well as the existing abstraction points for drinking water supply.
 - Dissolved oxygen, temperature, turbidity, suspended solids and dissolved solids are some of the parameters that will be profiled.
 - Selection of profiling parameters to be used based on the knowledge of the data requirements of existing models as well as availability of data from the Water Boards.
 - 3D model to be used in profiling





Deliverables...

- Analysis of the impacts of specific reservoir profiles on potable water production
- ***Methodology***
 - Hydrologic, hydraulic and ecological simulations integrated to investigate the effect of the temporal and spatial variability of the raw water on the production of potable water.
 - Choice of production processes limited by the raw water quality parameters investigated.
 - Reservoir profiles determined initially modeled against the cost of production of potable water as well as against optimization of selected treatment processes.





Deliverables...

- Analysis of the impacts of specific reservoir profiles on potable water production...
- ***Methodology***
 - Systems to be modeled will include abstraction points and chemical dosage requirements.
 - Most appropriate model selected from the following models; DYRESM, CEQUAL-W2, MINLAKE.
 - These hydrodynamic models have been applied to South African reservoirs in previous studies and have been found to be applicable (e.g. Bath *et al.*, 1997).





Deliverables...

- Decision support tool
- ***Methodology***
 - The raw water quality characterized using a water quality index developed by Dzwauro (2011).
 - The reservoir profiles will be mapped across the extent of the reservoir using a geographical information system (GIS) showing the variability of the raw water.





Deliverables contd...

- Decision support tool...
- ***Methodology***
 - A tool will be developed that models the location of an abstraction point with the optimum raw water characteristics.
 - This will be achieved by simulating the abstraction process at points represented by the reservoir profiles and predicting the quality of raw water abstracted to identify the point with optimum water quality.





Preliminary Summary Milestone Schedule

Milestone	Deadline
1. Data Collection	30-Apr-14
2. Data Analysis	30-Jun-14
3. Model development, testing and validation	30-Sept-14
4. Decision support tool	30-Sept-14
5. Completed Draft report	31-Oct-14
6. Completed Final report	31-Dec-14





Preliminary Budget Requirements

Line item	Units	Quantity	Unit cost (Rands)	Amount (Rands)
Travel for data collection	Return Trips	15	1800	27000
Accommodation and subsistence	nights	36	1500	54000
Laptop for data capturing and analysis	No.	1	6500	6500
Software purchases and licensing	Lump sum		15000	15000
Data Storage devices (external hard drive)	No.	1	800	800
Contingencies	lump sum		15000	15000
Conferences	No.	2	15000	30000
Production of final report	Copies of report	5	200	1000
TOTAL				149300





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