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Socio-Technical Innovations for Effective Water Conservation and Demand Management in Mzinti, South Africa

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Abstract. Socio-technical innovations for effective water conservation and demand management over the years *suffer from technical know-how* where technical applications by civil and water engineers take place, by *ignoring social know-how and know-what*. Problems of water conservation and demand management are *social and technical* in nature, *and need collective know-how* for solution findings in rural and urban centres.
The *aims of this study* are to identify technical and social challenges causing unaccounted for water and non-revenue water losses. The study is to organize and train community members for data gathering, skills transfers and to conduct water audits.
The *research model* is to forecast water demand from 2010 to 2020 to unveil impending water problems. The research *methods* include random and purposive sampling involving familiarization tour, desk study, and data gathering using questionnaires and water audit transcripts. It includes interviews with key informants and community animators, continuous observations and step-by-step fieldworks.
The *results* show 35 per cent of 3.5 megalitres of unaccounted for water and 65 per cent of non-revenue water losses in Mzinti with water abstraction from Komati River using Tonga Treatment Works.
These create needs for swift removal of informal connections and implementation of byelaws, tariff and credit policies, payment and billing. It is to give systematic training and transfer skills to improve water conservation and demand management for household participants.

Keywords: Socio-technical innovations, water conservation, demand management, Mzinti, South Africa

1. Introduction

"Resolving water problems needs active experts, functional leaders and farmers in decisions affecting environmental planning and water policy formulation"—Adama Kenyengo, African Farmer,1980.

Water gives life to all living and non-living things that need it for environmental, industrial, social, technological and technical reasons. Water plays active role in socio-technical innovations for water conservation and demand management. [1] Savenije and van der Zaag (2000) caution that socio-technical hydraulic information shows South Africa as water stressed nation. Water conservation and demand management innovations are new ideas to Mzinti, South Africa. Since fixings of water supply fixtures in 2000, no customer pays for any water services, despite its growing population, impending water problems, and political motivation for willingness to pay for water services.

Rural and urban areas in South Africa including Mzinti, a rural community, are finding it difficult to understand social-technical innovations for effective water conservation and demand management. Water service providers find it difficult to give water services to customers on sustainable and consistent basis, as [2] World Water Assessment Programme (2003) shows.

Poor water services often cause social hazards. Also, poor institutional capacity, political unwillingness, informal connections and lack of innovative skills transfers add to these problems. Poor planning and policy making, unclear information, poor priorities and unsuitable goals add to water conservation and demand management problems as in [3] Gumbo, Juizo, and van der Zaag (2003). The paper argues that ward councillors, community leaders, municipal officials and local water users should together find lasting

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solution for water conservation and demand management. This will help remove socio-technical challenges for effective water services to consumers and improve economic development, as [4] Biswas (2004) suggests strong global water policy implementation be part of these multilevel solution findings to water problems.

2. Study Area

The study area is Mzinti, a rural community in Mpumalanga Province, one of the nine provinces in South Africa. It is under Nkomazi Local municipality close to Tonga, Ntunda and Mangweni. Nkomazi municipality has an area of 3,240.37 kilometre square and boarders with Mozambique to the East, Swaziland to the south, Mbombela Local Municipality to the west and Kruger National Park to the north. Mpumalanga means "Place where the sun rises" in SiSwati, a major language in the area. The area has semiarid lowveld vegetation suitable for cattle rearing and farming. However, Mzinti engages in civil services, receiving government unemployment grants and petty trading along Komati River catchments.

It is about 103 kilometres from Mbombela (Nelspruit), the Mpumalanga provincial capital, and 43 kilometres from Malelane, the municipal capital. It is 34 kilometres to Komatipoort, a border town to Mozambique. Mbombela and Malelane are on route N4 to Mozambique, neighbouring the Kruger National Park. Geographical coordinates of Mzinti is 25 degrees 41 minutes south of the Equator and 33 degrees 44 minutes east of Prime Meridian.

Tonga Water Treatment Works supplies 18 megalitres a day of water using the main water source from Komati River. It gives 3.5 megalitres volume of water a day to Mzinti through pump station storing 0.15 megalitres in high steel tank and 2.9 megalitres in ground concrete reservoirs.

3. The Objective

The *objectives* are to identify technical and social challenges creating unaccounted for water in the local networks, and non-revenue water losses. The study is to organize and train community members for data gathering, skills transfers and conduct water audit from treatment works through distribution networks.

4. Research Model

The model extrapolates demand to show impending water shortages facing Mzinti by 2020. The model is:

$$\mathbf{P_1=P_0\ (1+r)^n}$$

Where P_1=water demand in the future, P_0=water demand now, r=rate of demand, and n=number of years for projecting water demand. The projections in this paper would use existing 2002 growth rate of 7.14 per cent.

5. Research Methods

Data gathering takes place on continuous basis across the study period using desk study, questionnaires, familiarization tours, awareness campaigns, fieldworks and water audits. Analyzing and testing data involves transforming data using formulas on consistent basis. [5] Myatt (2007) shows data preparation involves classifying variables into continuous and discrete, nominal, ordinal, interval and ratio numbers. In this study, data gathering commences from July 2010 through January 2011 including input and processing as well as empirical applications of innovative skills. Empirical analysis shows it is important to know and use primary and secondary sources of data. *Interview schedules* involve consultations held with people to seek information through November 2010 involving local members for data gathering. *Field work* took place mainly in September 2010. *Desktop research* shows gathering socio-technical data is relevant and this took place mainly during inception period in July. *Sample size and selection* focus on households as basic units for data gathering. Questionnaire administration involves getting data from households with assistance from survey enumerators, ward councillors and ward committee members. This entails elections involving selecting data gatherers from the community, ward councillors and committee members.

Tribal authorities, leaders and Nkomazi municipal officials participate in elections by picking a paper ticket in black bags necessary for simple random study. Other sampling methods involve purposive sampling. Hence, selection of *primary school pupils* through ward councillors, service providers and other members suggest these pupils should be core audience members. Selecting *businesses and households with 24-hour water flow users* involve votes by hand clearly showing that businesses and households having 24-hour water flows without paying for services. About *elder women and children*, similar sampling methods suggest inclusion of women and children. *Youth formation* sampling methods randomly identifies youths by picking tags having equal designs in black sacks for data gathering.

6. Findings and Data Analysis

Findings show 90 per cent are informal and no formal connections of 32 high-water users with 20 refusing formal connections, 19 churches without connections and 410 standpipes leaks with 15 per cent losses at treatment works, and 35 per cent of unaccounted for water in reticulation networks. [6] Francis (2005) shows no payment for water is historical in the country. No payment for water supplies since 2000 is on record. There is enough supply of 18 megalitres from Tonga treatment works, out of which 3.5 megalitres goes to Mzinti on daily basis, yet customers lack water for economic and domestic uses.

6.1. Unaccounted for water

Mzinti and surrounding towns receive water supply from Tonga treatment works with a capacity of 18 megalitres a day from Komati River. The treatment works has three distribution outlets to Kamaqhekeza, Mangweni and Mzinti. Inflow and outflow bulk meters are in place, bulk meters at ground reservoirs and overhead tank. The conditions of reservoirs are good, but leaks are at the bottom of overhead steel tank, and this needs serious care as water continues to waste. As *social challenges,* Mzinti water users never pay for water services since installation of water fixtures including meters in 2000 causing non-revenue water losses, needing effective solutions from social innovations.

Non-revenue water losses show early assessment of water uses and 65 per cent non-revenue water in Tonga water supply scheme suggests losses are high. This shows 2008 water use benchmarks with non-revenue losses from Tonga water scheme at 5.30 megalitres a day. This equates to 1.93 million metre cube or 1,934.50 megalitres a year at current water uses and running practices. Table 1 shows costing of how unaccounted for water for ward 20 is in millions of rand from 2000 to 2010.

Table 1 Costing unaccounted for water

Year	m^3 per annum	Average cost per m^3	Amount (Rand)
2000	58,847	4.01	235976.47
2001	64,732	4.01	259574.12
2002	71,205	4.01	285531.53
2003	78,325	4.01	314084.68
2004	86,158	4.01	345493.15
2005	94,774	4.01	380042.46
2006	104,251	4.01	418046.71
2007	114,676	4.01	459851.38
2008	126,144	4.01	505836.52
2009	138,758	4.01	556420.17
2010	152,634	4.01	612062.19
Total	**1,090,504**		**4372919.38**

Source: Field Work (2010) ***Note:*** *One megalitre equals 1000 m^3 of water ready for supply or use.*

Out of 2,479 households, some readings from water meters capture 1,089 stands in ward 20, as ward 19 has roughly 1,390 households. Some sample consumption data for ward 20 is in the Table 1. A fair cost estimate of water uses since 2000 show how serious unaccounted for water in ward 20 stands out. Similar estimates can show for ward 19, equating to R4, 372, 919. 38, that shows cost recovery problems since installing meters in ward 20 in 2000 to resolve the 1,090.50 megalitre water losses.

6.2. Water demand projections

The formula for demand projections is $\boldsymbol{P_1=P_0\ (1+r)^n}$, where P_1= water demand in the future, P_0=water demand now, r=rate of demand, and n=number of years for projecting water demand. Demand projections using 2002 growth rate of 7.14 per cent are in Table 2.

[7]Matondo (2002) in assessing the status of water demand management demonstrates that many utilities understate or overstate indicators to make them look good to customers and authorities. This suggests effectively managing water demand involves having accurate indicators from knowledge discovery that would foster effective water conservation and demand management. Therefore, table 2 calculations are carefully made to offer accurate answers in answering the purpose of the study.

Table 2 Demand projections (2010-2020)

Year	**Current population**	**Rate (7.14)**	**Future population**	**User rate**	**Demand**	
					(Litres/day)	**(Megalitres/day)**
2010	12,925	1.00	12,925	100	1,292,500	1.29
2011	12,925	1.07	13,830	100	1,382,975	1.38
2012	12,925	1.14	14,735	100	1,473,450	1.47
2013	12,925	1.23	15,898	100	1,589,775	1.59
2014	12,925	1.31	16,932	100	1,693,175	1.69
2015	12,925	1.40	18,095	100	1,809,500	1.81
2016	12,925	1.50	19,388	100	1,938,750	1.94
2017	12,925	1.61	20,809	100	2,080,925	2.08
2018	12,925	1.72	22,231	100	2,223,100	2.22
2019	12,925	1.84	23,782	100	2,378,200	2.38
2020	12,925	1.96	25,333	100	2,533,300	2.53

Source: [8] Statistics South Africa (2010) **Note:** Calculations using Microsoft Excel 2010

Demand projections from 2010 to 2020 show future population rising from 12,925 to 25,333 at current growth rate. This causes increasing demand for water as demand rises from 1.29 megalitres to 2.53 megalitres a day in ten years. *Technical innovations* demand that water treatment works needs upgrades and expansion for water supplies and to adjust needs for population increases. There are needs for overall refurbishment of water fixtures. These including bulk valves, steel reservoirs and thorough check-up on bulk pipelines and fix entire networks for better and consistent services to customers and end-users. *Social innovations* demand removing illegal connections, unwillingness to pay, lack of retrofitting and meter connections, to help reduce unaccounted for water for effective water conservation and demand management.

Further, [1] Savenije and van der Zaag (2000) caution South Africa might become a water scarce society by 2025. It is partly because of high evapotranspiration between wet and dry seasons; real evaporation is 90% and water availability of 1.2 megalitres per person a year. This information is below universally acceptable value of 1.7 megalitres per capita per year, and Mzinti data projections confirm water scarcity by even 2020, [9] Biswas (2005) shows water problem is multi-level and need multiple expert ideas.

7. Conclusion

Understanding socio-technical innovations for resolving water conservation and demand management problems are complex challenges to contend with. People need to understand socio-technical innovations to undo water shortages. Socio-technical innovations help in problem-solving for water conservation and demand management, as these innovations are complementary.

The aim is identifying socio-technical challenges including informal connections and leaks in local networks, organize and train community members for data gathering, and skills transfers. The other aim is conducting water audit from treatment works to reservoirs and networks for helping offer socio-technical innovations in dealing with water conservation and demand management problems.

Major parts of inhabitants are lacking safe drinking water. Socio-technical innovations help in managing livelihood and industrial undertakings. By collectively using socio-technical innovations it is possible to swiftly resolve water conservation and demand management challenges rather than using prevailing and failing technical innovations alone over the years. Hence:

"In the end we will only conserve what we love; we will love only what we understand; and we will understand only what we have been taught"—Baba Dioum, African Ecologist, 1968.

8. Recommendations

Water conservation and demand management should be part of school curriculum to educate kids on water savings, this helps them influence parents on water conservation and demand management;

Train community members—include 50 per cent of women in all training and research happenings;

Encourage users to pay for services—awareness campaigns for encouraging payment for services;

Involve people for development purposes—transfer of knowledge comes from interacting with people;

Seek funds from local government—local government will fund setting-up customer call-in centres;

Remove informal connections—municipality do formal connections and register all users for billing;

Conduct consistent water audit—this will help identify leaks and warn out fixtures and repairs;

Retrofit and repair going wrong water fixtures—these include pumps, taps, standpipes, valves and other fittings that would help in knowing problems in networks and correct them.

Use bye-laws and national standards—use these rules in services to help conserve water; and

Apply credit control and tariff policies—policies guide in financial issues involving pay for services.

Use *methodical analysis* of socio-technical innovations to resolve impending water scarcity in 2020.

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11. Biography

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- *Business unusual: Deleting corporate baggage and excess fat at www.trafford.com/06-2304*

- *My shadow at www.voicesnet.org/displayonepoem.aspx?poemid=82749*
- *Dear tripartite at www.voicesnet.org/displayonepoem.aspx?poemid=98027*
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