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Valuing water services: A review of what water pricing and demand management would mean for Nairobi city

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Abstract

This article provides an overview of key economic concepts in water services with a focus on price-based strategies for demand management in the face of resource scarcity using the case of Nairobi city water services. The paper starts by first presenting key issues and concepts in water economics then looks into detail issues of water pricing and concludes by providing recommendations to the city utility on a novel approach for price-based demand management of scarce water resources.

Three **key messages** emerge from this brief review. First is that water pricing has been used more as an instrument for achieving financial sustainability of the supplier rather than an economic allocation instrument. The message is that if the service provider is not able to maintain the system adequately because of charging the wrong price, the quality of services will deteriorate. Eventually the system collapses leaving people more vulnerable to water-related diseases. Second is that the quality of water governance depends on two factors-the public value that citizens place on water and what they are willing to pay for it and the quality of the relationship between citizens, the state and the managing entity of the service. The Third message is that contrary to conventional economic theory, an increase in price of water doesn't always signal the consumer to reduce consumption and demand. Research shows that most urban households don't know the price they pay for water since it makes a very small portion of their budget, so prices don't affect them much especially when the billing structure is complicated and information not available to users. This calls for urban utilities to increase awareness on the value and cost of water through proper structuring and presentation of water bills to consumers.

Water supply deficit in Nairobi City

Nairobi's first water supply system was built and managed by Uganda Railways in the early 1900s tapping the resource from Kikuyu springs (Blomkvist & Nilsson, 2017). By 2017, the city's

demand was projected as 750,000m³/day against a supply of about 500,000m³/day, this presents a significant deficit of about 250,000m³/day. Figure 1 shows a schematic of the city's water supply system as of today. As the population of the city rapidly increases, the problem of water scarcity (increasing demand and declining supply) remains one of the key challenges that must be addressed to guarantee future expansion of the city. Significant investments have been made to bolster the supply including the 293 million US \$ Northern Collector Tunnel project targeted to bring in 300,000m³/day to the city. This is a typical "traditional" approach to bridging the water supply-demand gap. Zhu (2015) observes that before the 1970s, water scarcity management was solely focused on increasing the water supply, mainly by means of engineering solutions such as the Nairobi Northern Collector Corridor. An emerging trend in the 21st century for bridging the supply-demand gap is through water conservation and demand management measures such as water pricing to provide incentives for conservation and limit water use.



Figure 1: Schematic of Nairobi water supply system

The Kenya Water Services Regulatory Board, a state agency responsible for regulation of water and sanitation services has instituted policy mechanisms using water pricing through regulated tariffs both as a measure of demand management as well as a consumer protection measure. Faced with acute water scarcity sometimes occasioned by recurrent droughts, NCWSC has relied mostly on non-price demand management strategies such as water rationing since it has less control on the prices it charges for water supplied. Currently the city uses an increasing block tariff structure to price the water it supplies as shown in figure 2.

1.0 WATER TARIFF STRUCTURE FOR YEAR 2015/16, 2016/17 AND 2017/18

Type of customer	Approved tariff per M ^{3 (} Ksh)
Domestic/Residential	
Consumption Block	
0-6	Flat rate 204
7 - 60.	53.00
>60	64.00
Commercial / Industrial	
Consumption Block	
0-6.	Flat rate 204
7 - 60.	53.00
>60	64.00

Figure 2: Nairobi City water and sewerage company Ltd tariff structure, (NCSWC, 2017)

Economics of water governance; Who bears the cost?

The Dublin conference on water and the environment in 1992 initiated the formal proclamation that water should be treated as an economic good (United Nations, 1992). While Opschoor (2006) questions whether private sector and economic market mechanism can be relied upon to allocate the right price for water, Perry, Rock, & Seckler (1997) assert that whether water is an economic good or not isn't the question but rather the concern is whether water allocation should be left to market forces as an economic good or a public good to be allocated by government. This conundrum, they say, is purely a value question which varies across contexts depending on the dominant values, customs and societal beliefs. Perry et.al's view is corroborated by Shiva (2002)

who talks about a culture and value clash in relation to the economic treatment of water. One culture sees water as a free sacred gift and treats its provision as a duty for preservation of life while another culture sees water as a commodity to be traded based on ownership rights. Van Dijk (2014) on the other hand makes a strong case that active private sector involvement in water allocation is feasible and desirable under certain conditions which are transparent tendering and accountability, strong regulatory framework to safeguard against abuse of consumer rights, cost recovery systems in place, realistic tariffs and real competition occasioned by sufficiency of private operators.

Economists have traditionally segregated between private goods and public goods. Public goods are said to be those that are non-rival in consumption meaning consumption by one does not reduce the quantity available for someone else's consumption and non-excludable in the sense that no one can be excluded from using it once it has been provided (Anderson & Coate, 2000; Cornes & Sandler, 1999; Cowen, 2001). Water in this sense qualifies to be both a public good given its necessity to support life and the externalities it creates in the society (Savenije & Van der Zaag, 2002; Hellegers, 2011) and a private good since consumption by one person makes it unavailable for the next person to consume (Van Dijk, 2014; Zetland, 2014). The practice of Welfare economics contends that economic goods should be allocated in such a way that the highest level of welfare is attained. Rogers (2002), Young (2012) and Hellegers (2011) cite three reasons for pricing water and other environmental goods in general. First is to finance operation, maintenance and expansion costs, secondly is to make deductions on water users valuation of the good through pricing information and thirdly pricing can be used as an incentive for demand management leading to sustainable use and less wastage. Boland and Whittington (2000) on the other hand, considers the wider social welfare and define five objectives for pricing water services; To achieve revenue sufficiency, to attain welfare economic efficiency, to ensure equity and fairness in the society, to organize income redistribution, to achieve resource conservation. Briscoe (1996) state that like any other good, water has a value to users who are willing to pay for it. He uses the demand and supply functions shown in figure 3 to demonstrate how underpricing water leads to deadweight loss to society.



Figure 3: Deadweight loss if water is underpriced (Briscoe, 1996)

Figure 3(a) shows optimal price and consumption when water is allocated at marginal cost while figure 3(b) shows that when consumers are charged a price lower than the marginal cost of supply, there will be a corresponding loss of net benefits to society. Briscoe's conclusion is that welfare is maximized when water is priced at its marginal cost and water is used until the marginal cost is equal to the marginal benefit. Weber (2013), having a contrary opinion to Briscoe discusses three faults of marginal cost pricing approach which he says under prices water. First is that the cost only factors in costs related to capital, infrastructure development, operations and maintenance without factoring in the externalities caused by the services. These additional costs caused by externalities he says are borne by customers not the suppliers. Secondly, the cost does not pay for using the public's natural capital. The price only depicts permit abstraction fees and supply costs but not costs of the raw material itself. His argument is that if water is so scarce and valuable, then it shouldn't be offered for free as it is currently. Weber builds his argument from the perspective that the price of water is elastic to demand variables. In times of drought, customers continue to pay at cost price. He argues that if prices could respond to supply, quantity demanded would drop to meet quantity supplied at a market clearing price thus reduce stress on the environment and the public values of the water resources. He goes ahead to propose a new accounting system in determining water costs factoring in both full-cost recovery fees as well as costs of using the natural capital. Similarly, Rogers, Bhatia, & Huber (1999) illustrates in figure 4 the various components that true constitute the cost of water. They distinguish between full supply costs and

economic costs. Supply costs are the financial costs related to production, operations and Management and the costs of investments. The full economic costs include the opportunity costs of depriving the other next best users of water like irrigation and the cost of repairing the environmental damage (cost of externalities). Marsden, Jacob, & Michelson (2004) also demonstrate that marginal cost charging of water fails on the criterion of revenue adequacy. Their argument is that bulk water utilities have substantial fixed costs and economies of scale and as a result marginal costs ends up being much lower than average costs leading to under recovery of costs and ultimate failure of utilities. They instead advocate for the sue of long-run marginal costs that incorporates variations in fixed capital costs which are often kept constant when using the short-run marginal costs in determining water prices.





Savenije & Van der Zaag (2002) makes a strong argument that water pricing is not an instrument for economic water allocation but rather it's more of an instrument to achieve financial sustainability of the supplier. Their thesis is that if the service provider is not able to maintain the system adequately because of charging the wrong price, the quality of services will deteriorate. Eventually the system collapses, low income people resort to drinking unsafe water or pay excessive amounts of money to informal water vendors, while wealthy and influential people continue to receive piped water directly into their houses. Hanemann (2006) defines three distinctive features of water that complicates its governance and management;(1) It's bulky and expensive to transport relative to its value per unit (2) it's capital intensive to produce (3) the components of water supply enjoy significant economies of scale. These features create a situation where water supply has heavy fixed costs thus making it more likely that there will only be one monopoly provider in a specific context. Thus, competitive market signaling prices don't apply for water services.

Giordano, Mussari, & Caputo (2014) somewhat provides a way out of this who pays for water debate. They make two propositions. First that the quality of governance of water depends on first the public value that citizens place on water and what they are willing to pay for it and secondly that performance of water services management is influenced greatly by the quality of the relationship between citizens, the state and the managing entity of the service. D'Arcy (2014), Julie (2014), caution that most often, users will hide their true valuation of water so as to free-ride or exaggerate their valuation in absence of monetary consequences. This, according to Miller & Hammond (1994) leads to undersupply as is the case most often. As such, Meijerink & Ruijs (2003) advocates that social equitability and ecological sustainability should be two other significant criterions used in water allocation decisions. This they say, may call for provision for some level of transfers or social insurances so that those whose valuation of water is high but don't have the ability to pay are not excluded from access. Giordano et. al's (2014) position is supported by Bruijn & Dicke (2006) who asserts that the performance of water service delivery is dependent on the governance dynamics at play. Beecher (2013) concluded that what matters to performance in managing the services, theoretically and pragmatically is governance. OECD asserts that the water crisis is largely a crisis of governance (OECD, 2011). As such, O'Flynn (2005) argues that the debate in the water sector should involve the various actors weighing which management model will work best under what circumstance.

Demand management challenges

Most public water supplies use tariffs as a conservation measure base on the assumption that price can influence customers to purchase just enough to satisfy needs without being wasteful. The primary objective of the increasing block rates apart from enforcing social equity considerations is to use it as a price signal to the consumer. The theory is that as the consumption increases, the price increases as well signaling the consumer to reduce consumption. This in turn reduces system peaking resulting in reduced capital needs and a decrease in additional water sources requirement (American Water Works Association, 2012). Traditionally, the case has been that most managers of water supply organizations are often engineers. Engineers tend to favor non-price based demand management strategies such as use of water saving low-fixtures devices or increasing supply sources over price-based strategies. This prominence of non-price measures are based on the belief that consumers do not respond to price changes (Mehan & Kline, 2012). That view is contradicted by Olmstead & Stavins (2007) who showed that a 10% increase in marginal price is expected to diminish demand in residential urban sector by 3 and 4 %. Their assertion was that these can be mutually exclusive and complimentary. Stavin (2009) highlights two common misconceptions in water pricing; one is that "because water prices are low, price cannot be used to manage demand." This misconception that low prices somehow hinder the use of price as an incentive for water conservation may stem from economists' definition of a price response in the range observed for water demand as "inelastic." He bases this argument on the theory that there is a difference inelastic demand and unresponsiveness to price. Inelastic demand will decrease by less than one percent for every one percent increase in price. In contrast, if demand is truly unresponsive to price, the same quantity of water will be demanded at any price. Starvin asserts that fifty years of economic analyses have demonstrated that water demand is responsive to price changes, both in the short term, as individuals and firms respond by making do with less, and in the long term, as they adopt more efficient devices in the home and workplace. For example, he provides evidence to his claims using the case of Boulder town in Colorado which when shifted from unmetered to metered systems saw water use dropped by 40%. Cavanagh, Hanemann, & Stavins (2011) gives three reasons why water demand is relatively insensitive to price. First is that water has no substitutes being a necessity for life so it has perfect elasticity. Secondly marginal cost of water is very low due to huge fixed capital infrastructure investment costs hence responses to prices changes is correspondingly very small.

Price levels that are sufficient to induce significant water savings are politically not acceptable thus utilities are often forced to rely on non-price demand management strategies to induce conservation in face of scarcity. This is why Nairobi water periodically rations water supply to various parts of the city in times of scarcity. But how effective are those non-price based approaches?

Conclusion and recommendations for research

The public good nature of water and its critical linkages to poverty eradication and food security has brought equity dimensions to its allocation leading it to being treated not as a pure economic

good but more as a social good managed by the public administration. Such conceptualization of water has more often led to financial burdens on the state resulting in unsustainability of the supply system in the long-run (Reddy, n.d). From conventional economic theory, an increase in price should signal the consumer to reduce demand. This is not the case for water consumption. Cavanagh, Hanemann, & Stavins (2011) claims that most households don't know the price they pay for water since it makes a very small portion of their budget so prices don't affect them much especially when the billing structure is complicated and information not available to users. This claim poses a significant policy question for Nairobi city water managers that should be empirically tested to inform evidence-based policy and programmatic action. Policy makers need to determine whether increasing water bill influences residential water consumption patterns especially among the middle- class and high-end residents of the city. The hypothesis that increasing block tariff has no impact on the quantity of water demanded controlling for price levels needs to be tested so as to inform price-based demand management strategies. Findings from such a study will answer the research question seeking to know whether increasing block tariffs provides an incentive for water conservation. Unsubstantiated claims show that most consumers in Nairobi are not aware of the exact price they are paying for water because the billing system is not well structured to inform the user. Such a state creates a situation where price changes are not sufficient to signal demand changes. This claims needs to be empirically tested and evidence-based conclusions derived to inform action which could include increasing awareness on the exact cost of water through proper structuring and presentation of water bills to consumers.

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