



Access to Water in Nairobi: mapping the inequities beyond the statistics

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This report is the result of a partnership project developed by the Global Water Operators' Partnerships Alliance (GWOPA) and the French Institute for Research in Africa (IFRA).

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Acronyms

AFD	Agence Française de Développement
AWSB	Athi Water Services Board
CBD	Central Business District
CBOs	Community Based Organizations
GIS	Geographical Information System
GRUBS	Geo-Referenced Utility Benchmarking System
GWOPA	Global Water Operators' Partnerships Alliance
IBT	Increasing Block Tariff
IFRA	Institut Français de Recherche en Afrique
IWS	Intermittent Water Supply
JMP	Joint Monitoring Programme
KENSUP	Kenya Slum Upgrading Project
KES	Kenya Shilling
KISIP	Kenya Informal Settlements Improvement Project
KPIs	Key Performance Indicators
MDG	Millennium Development Goals
MWI	Ministry of Water and Irrigation
NCC /CCN	Nairobi City Council
NCWSC	Nairobi City Water and Sewerage Company
NGO	Non-Governmental Organization
NIC	No Individual Connection
NRW	Non Revenue Water
NWIS	National Water Integrity Study
O&M	Operation and Maintenance
PSP	Private Sector Participation
SPA	Service Provision Agreement
TWL	Tower Water Level
UfW	Unaccounted-for-Water
UN	United Nations
USD	United States Dollar
WASREB	Water Services Regulatory Board
WaSSIP	Water and Sanitation Service Improvement Project
WB	World Bank
WHO	World Health Organisation
WS	Water and Sanitation
WSB	Water Services Board
WSD	Water and Sewerage Department
WSP	Water Service Providers
WSS	Water and Sanitation Service
WSTF	Water Service Trust Fund

Rates of exchange: At the time of the study (March 2010): 1 USD = 86 KES and 1 EURO = 120 KES

1. Introduction: The need for disaggregated data to understand inequities

GWOPA

The Global Water Operators' Partnerships Alliance (GWOPA) is a network of partners, led by UN-Habitat and committed to **helping water operators help one another** to improve their capacity and provide water and sanitation services for all. The Alliance's overall aim is to help developing countries reach the water and sanitation targets of the Millennium Development Goals (MDGs) by 2015, and to realize the Right to Water that was declared by the United Nations General Assembly in 2010.

GWOPA was initiated in 2006 by the UN Secretary General's Advisory Board on Water and Sanitation (UNSGAB) and formally founded by UN-Habitat in 2009. It promotes Water Operators' Partnerships (WOPs) or peer-support arrangements between two or more water supply and sanitation (WSS) operators, carried out on a not-for-profit basis. Through WOPs the Alliance is helping to raise the capacity of WSS operators in the cities and towns where much of the world's population now lives and where 80% will live by 2050. GWOPA promotes and support South-South, as well as North-South, partnerships between water and sanitation operators linking some of the world's best urban WSS operators in Europe, North America, and Asia to operators in the developing world who face many problems and challenges.

To know more about GWOPA: www.gwopa.org

Within a WOP partnership framework, stronger ("mentor") operators can help weaker ("mentee") operators to acquire the knowledge, skills, and capacity to deliver improved services. It should be noted that there are many variations on the partnership theme. Successful WOPs in many countries confirm our core belief that WOPs are a potent means to improve performance capacity amongst WSS operators, thereby improving service delivery especially for the benefit of the poor.

BENCHMARKING

Benchmarking is a powerful and well-known process for measuring and comparing water operators' performance against key indicators such as service coverage, cost, water quality, and so on. It has been widely used in recent years to help WSS operators compare their performance, identify strengths and weaknesses, set goals and track performance changes over time. Governments can use it to set and monitor policies and programmes, and regulators can use it to ensure compliance with rules and regulations and that consumers get value for money. Moreover, civil society can use benchmarking data to express concerns about service provision, and international agencies can use it to identify viable investment priorities and opportunities. There is recent interest in how benchmarking can be used to improve governance and how straightforward physical indicators, such as service coverage and water losses, can be expanded to include issues such as transparency, accountability, and participation.

For GWOPA benchmarking is a key tool for *matchmaking*, i.e. pairing mentor and mentee operator utilities together in a WOP arrangement. This means that benchmarking data is used to know who among participating operators needs support, or mentorship, in what. This means also identifying

potential mentors, categorizing their knowledge, skills, and special areas of excellence that would be transferred to the potential mentees. GWOPA ideally needs to know not only the capability of a potential mentor operator but also their motivation and potential factors needed to attract and sustain the mentor throughout the WOP process. Using performance benchmarking data is a prime way to address these issues objectively.

The same applies to mentees, though to a lesser extent because weaker operators often lack high quality data. For mentees the approach is usually focussed more on diagnosis. Using benchmarking data as a basis for diagnosing improvement areas can greatly help WOP partners to prepare robust Performance Improvement Plans (PIPs) for the mentee operator. However, the performance data available within prospective mentee operators is often deficient because, among other things, they may for example lack bulk and consumer meters while financial information may be distorted due to low collection rates. In these cases it is better to allocate time and resources at an early preparatory stage to gathering missing data before firming up a performance improvement plan that forms the fundamental structure of many WOPs. A clear initial performance database is also essential for establishing the baseline necessary for proper monitoring.

On the other hand, in order to fulfil its vision of universal access to sustainable WSS services for all sectors of society, WOPs facilitated by GWOPA are always *pro-poor focused*. In the urban context this entails expanding services to poor sections of the population, including inhabitants of informal settlements and disadvantaged groups. Since, as mentioned above, potential mentee operators' performance data is usually too general to enable a pro-poor focus, it is necessary to disaggregate the data down to show the status of WSS services in neighbourhoods where the poor populations are located. Consequently, GWOPA felt the need to disaggregate average benchmarking data of service coverage data to the neighbourhood level and combine this data with geographic and socio-economic mapping so that it could support WSS operators in their efforts to extend their services to the poor sectors of their clientele.

NAIROBI PILOT STUDY 'ACCESS TO WATER: MAPPING THE INEQUITIES BEYOND THE STATISTICS'

In October 2011, GWOPA together with the French Institute for Research in Africa (IFRA) entered in a pioneering partnership to take benchmarking to a new level. Our aim was to disaggregate average conventional benchmarking data to the neighbourhood level using geographic and socio-economic information layers and maps describing how water and sanitation operators perform at the sub-city level. The first step was to develop a methodology. The second step was to apply this methodology to provision of WSS services in Nairobi, the capital of Kenya, and to analyse the results, especially in terms of equity and accessibility.

The purpose was to demonstrate how utility performance can be disaggregated and visualised. By putting conventional Watsan performance data alongside a set of physical and socio-economic maps we were able to highlight many inequities affecting poorer people. Information on water and sanitation accessibility – including the performance against main indicators such as coverage – is often aggregated at the city level presenting only a general idea of the operator's performance. The reality may be that pockets of poverty with inadequate or non-existent services exist alongside wealthier areas in which operators perform well. This turns out to be particularly true in Nairobi where the study exposed the

city's acute social segregation. The findings of the study are presented in two main reports on our website. The first report covers the methodology developed and applied while the second sets out and analyses the findings of the study and presents recommendations to stakeholders.

GWOPA hopes that the findings and recommendations of this study will help relevant local and international stakeholders – including Nairobi City Water and Sewerage Company, the Government of Kenya, as well as various donors and development organizations – by informing both their technical capacity building and investment plans for the Watsan services in Nairobi. GWOPA also believes that this innovative approach has good potential for replication elsewhere in African cities and across the world. This approach also helps directly in three key aspects of GWOPA's operational WOPs support work, namely matchmaking, diagnosis, and ensuring a pro-poor focus.

THE NAIROBI STUDY - REPORT 1: METHODOLOGY

The first report on the Nairobi Study describes the methodology that was developed by the team. This initial step was to utilise information gained from remotely sensed satellite data. This was used to generate maps showing land uses and residential patterns. The maps showed physical data such as built-up areas, housing density, types of roofing, tree cover etc. The team then undertook an extensive household survey which reported on various themes - WSS services accessibility, land tenure, socio-economic factors such as income, education levels and so on. The study then made the links between the remotely sensed data and the data from the household survey. A typology of residential patterns was used to extrapolate findings from areas studied to other areas. The result was a series of maps of Nairobi clearly showing the inequities and disparities in services and how these are connected to the socio-economic status of groups within the city's population.

THE NAIROBI STUDY - REPORT 2: ANALYSIS

The second report describes and analyses the WSS situation in Nairobi using the information gathered from satellite data and a household survey. The team explored the disparities in water coverage between middle and high-income neighbourhoods and poor areas. They were able to show that certain households, especially those depending on alternative suppliers, water kiosks, tankers etc., pay highly inflated prices for their water. The poor pay more than the wealthy resulting in a situation where "the high water demand of a relatively small percentage of the population creates a water shortage, the cost of which is mainly borne by less economically privileged people". The report describes the historical, political and legislative context and considers how better demand management might help. There are one or two encouraging signs for the future but much still needs to be done. The conclusions and recommendations point to the need for a new dialogue between stakeholders using the study findings as a platform.

The 2 reports are accessible online on the GWOPA website (<http://access-to-water-in-nairobi.gwopa.org/>)

First this report will carefully describe the water and sanitation situation in Nairobi as depicted in the maps (Chapter 2). In order to do so, it will address three main questions: Who has access to piped water? Who pays how much? Does everyone get their share? The report will then analyze a series of key reasons which all have a role to play in explaining inequality of service. The report will look into contextual factors like the urban setting of Nairobi (Chapter 3) and the institutional framework guiding the water sector (Chapter 4). It will then discuss key factors directly affecting water supply in the city: the raw water supply (Chapter 5), the distribution network (Chapter 6), and water demand management (Chapter 7).

2. Water and Sanitation in Nairobi: Are all residents serviced equally?

Note: the following chapter refers to GRUBS maps which may be accessed online via the GWOPA Website

2.1. Who has access to piped water?



**See maps on the
online report**

[http://access-to-water-
in-nairobi.gwopa.org/](http://access-to-water-in-nairobi.gwopa.org/)

*Piped water coverage : % of
households with piped
connection*

There are great disparities in water coverage. Around 64% of the population of Nairobi has access to an individual tap or a yard tap as their main source of water. But some neighborhoods have universal coverage while others have hardly any at all. Between those two extremes, there is evidence that the piped network is also deficient in some places. Most middle and high-income class neighbourhoods have close to universal connections to the piped water network (coverage 85-95%) although some areas still experience problems. In the lower income areas coverage is far from universal: high proportions of households rely on other water sources (coverage 70%). Finally, in very low-income areas coverage is nearly non-existent (coverage 12%). This strikingly low figure shows the level of infrastructural neglect found in such areas.

An estimated 64% of the population has access to an individual tap or a yard tap as their main source of water in Nairobi [3]. This figure is very close to the value indicated by NWSC which is 63%.

As anticipated, this value is only representative of the overall situation in Nairobi. In reality, some neighborhoods have universal coverage while others have hardly any at all. Between those two extremes, the piped network can also be inadequate in certain areas.

Most middle and higher income neighbourhoods boast universal connection to the piped water network. Areas with many high tenement buildings also enjoy good coverage despite being less wealthy. Interestingly, although most of these areas have nearly universal coverage (95%), a significant number of households in the higher income areas reported not relying on the piped network as their main source of water (coverage: 85%). Those households are generally able to access expensive alternative sources such as tankers or private boreholes for their water supply.

Most of the lower income areas towards the east end of the city, in planned low quality housing neighbourhoods (Dandora or Kayole) and in the peripheries of Kawangware and Ruai reported high proportions of households relying on other sources (coverage: 70%).

The lack of universal coverage in those areas can be explained by the fact that though the plan and the tenure are formal, the evolution of the actual building and development has diverted from plans over time.

Finally, there are two types of areas where coverage is almost non-existent: the old institutional housing neighbourhoods near the city centre (e.g., Kaloleni, Makongeni) and the informal settlements where only 12% of households reported having direct connections to the network.

Compared with the rest of the city where a majority of people access water through individual or communal connections, these areas display very low figures of coverage showing high levels of neglect.

2.2. Cost of Water: Who pays how much?



See maps on the online report

<http://access-to-water-in-nairobi.gwopa.org/>

- *“Average Cost of Water (KES / Cubic Meter)”*
- *“Characteristics of the water sources”*

Some households unfairly pay high prices for water. Households that cannot access water with a metered NCWSC connection on the Increasing Block Tariff (IBT: subsidized rate of 18.71 KES for each of the first 10 m³, then increase by block up a maximum of 53.80 KES per m³) must rely on alternative suppliers that are much more expensive: water kiosk tariffs fluctuate in the range of 400 KES/m³, handcarts in the range of 1,000 KES/m³ and tankers and private boreholes are even more costly. The result of unreliable or inaccessible WS service is inflation of the water cost.

The poor pay more than the wealthy. In higher and middle-income areas users usually pay the regulated NCWSC tariff, although there are some who rely on tankers and private boreholes. In low-income neighbourhoods, many households are not connected. And even those who are do not get reliable service: so they must use alternative water suppliers, handcarts in particular. As a result, the average real cost of water can be up to ten times that of the lifeline NCWSC tariff. In very-low income areas (i.e. slums and old colonial African quarters) water is almost entirely provided by water kiosks that tend to hike the price up to 25 times the subsidized rate, despite the fact NCWSC operates a special rate for water kiosks.

Cost of water is a fundamental indicator of the performance of the utility in meeting the Right to Water for every Kenyan. It is unfair that lower income earners pay a higher price for water than higher income earners. Nevertheless, the real cost of water is not an indicator on which utilities are commonly benchmarked.

It is estimated that 93% of the water consumed by households in Nairobi comes directly or indirectly from the distribution system [4]. However, piped water coverage is clearly unequal across the city:

households do not have the same access to water from the piped water network. Some simply do not have a connection (either individual or communal), or their connection does not allow them access to all the water needed (e.g. because of intermittent supply). So to meet their demand such households must access water from the distribution network *via* other means.

In Nairobi alternative water suppliers are water kiosks, handcarts, and tankers. Those sources are more expensive than NWSC but rely on the city's distribution network for their bulk water. Alternative water providers make their profit from the failure of the water utility (NCWSC and AWSB together) to provide enough water at the fixed tariff. Since alternative suppliers are not forced to provide water at a fixed price, they can charge a price which is closer to the real value of water and much higher than the NCWSC tariff.

NWSC delivers water through an Increasing Block Tariff (IBT). The lowest price block, called the Lifeline Block is a subsidized rate of 18.71 KES for each of the 10 first m³. The increasing tariff eventually reaches a ceiling price of 53.80 KES per m³ which is the highest legal tariff in Nairobi. In comparison, water kiosk tariffs are around 400 KES/m³, handcarts around 1000 KES/m³ while tankers and private boreholes are even more costly. Alternative free sources include roof and river catchments. Only a small proportion of households, however, make use of them.

The map displays the average cost of water in Nairobi. As a general rule, the poorer the service delivery, the more heavily the customers will rely on alternative sources. The more households are forced to rely on alternative sources, the higher the average cost of water in their area.

As shown on the piped water coverage map, high and middle income neighbourhoods usually have universal coverage. When accessing water from the network is problematic, especially in the upper regions of Karen, or Lavington, households rely on boreholes or water tankers. (Note that our quantitative data did not allow us to assess the prevalence of those water providers across the city. The figures displayed on the maps reflect the price paid to NWSC only).

In low-income neighbourhoods, piped water is also provided to some extent to individual taps but communal yard taps are also very common. Service does not always seem satisfactory for the connected households as many of them also use alternative water suppliers to compensate for lack of available water. As a result the average price is inflated.

Among low-income areas, high-density tenement buildings areas and the more recent institutional housing estates are better-off, with large populations using individual taps (both 42%) and even larger numbers using communal yard taps (respectively 73% and 60%). Handcart retailers seem to be particularly active in the high-density tenements areas and even though they provide a relatively small amount of water, their prices contribute to inflating the average cost of water to around 10 times the lifeline NCWSC tariff.

The planned low-quality housing estates have a relatively smaller proportion of households using individual taps (18%) and communal yard taps (60%) although reliance on alternative suppliers does not seem to be more acute in such areas. This suggests that there is little willingness to pay for the expensive service offered by alternative suppliers in order to access more water. As a consequence,

average consumption of water tends to be lower. The western areas of low quality housing with rural characteristics (Kawangware), present the same profile as the low-quality housing estates mentioned above. A specific characteristic of those areas is the presence of shallow wells that are an alternative and cheap source of water but very insecure health-wise.

In the slums very few households reported the use of an individual tap (12%). Slum dwellers rely heavily on water kiosks (82%) or communal yard taps (24%). Handcarts are also present but in smaller proportions.

In these neighbourhoods, water delivery is almost entirely provided by alternative water providers. Even though water is provided by NWSC to certain water kiosks at a special low price of 15 KES/m³, this does not keep the price down. As a result, slum dwellers cannot benefit from the subsidized tariffs offered by NWSC: they pay a very high price for water, ranging from 200 and 400 KES/m³, averaging up to 25 times the subsidized rate. Slum households spent a disproportionate share of their income on water (11%), twice as much as the average population in Nairobi (6%) and almost 40 times more than high-income earners (0.3%). The old institutional housing estates also have virtually no individual connections. They have communal access to taps but only a quarter of the population use them. Again most of these households rely heavily on alternative water suppliers such as handcarts (60%) and the average price of water can be higher than in the slums.

2.3. Daily Consumption: does everyone get their share?



See maps on the online report

<http://access-to-water-in-nairobi.gwopa.org/>

▪ *Average Daily Consumption of Water per Capita (Lpcd)*"

Consumption patterns also show striking disparities. Residents of more affluent neighbourhoods tend to consume 200 to 300 litres of water per day per capita (lpcd), whereas, a slum dweller typically only uses 15 lpcd. Between these extremes: a middle class customer generally consumes a quantity of water (130 lpcd) close to European norms; lower income customers, if individually connected, can expect 50 lpcd, otherwise they must cope with less than 30 lpcd.

The sharing of available water is both unequal and inequitable.

Different households have different types of access to water, different lifestyles and different water needs. So it is normal and to be expected that the water supply system is designed in a way that provides more water to some households than others. In Nairobi, however, the most affluent residents consume more than their designated share and the poor get less than their designated share. 40% of distributed water is supplied to the 7% who are the biggest consumers while only 15% of the total water available goes to the 45% of population comprising the smallest consumers. In Nairobi the high water demand of a relatively small percentage of the population creates a water shortage the cost of which is mainly borne by poorer people.

The map of the daily consumption of water per capita represents the amount of water that was consumed and paid for by customers regardless of water supplier. Water consumption per capita should

be regarded as a fundamental indicator of the utility's performance in meeting the Right to Water for every Kenyan. Minimum consumption level, however, is not a commonly benchmarked indicator.

This map reveals important disparities in consumption of water between neighbourhoods. Residents of better-off neighbourhoods tend to consume 200 to 300 litres of water per day per capita (lpcd), while a slum dweller will typically only use 15 lpcd. Between these two extremes, different scenarios can be noted.

A middle class customer consumes a comfortable quantity of water (average 130 lpcd), while the rest of city dwellers consume less than the equivalent of two jerry cans a day (average 40 lpcd).

Better off households in tenement building areas consume 35 lpcd, those in new areas of development, or more recent institutional housing units consume 30 lpcd. In the planned low-quality housing areas, a person usually uses a little more than one jerry can of water per day (average 23 lpcd). These figures must be moderated as they only represent an average of the overall population of an area: households connected to the network have higher consumption (50 lpcd) as they benefit from NCWSC tariffs. In the rural areas to the west, consumption tends to be around 25 lpcd.

Table 1 - Correlations between water consumption and selected variables

	Consum. Water*	Average Price of Water*	Income*	Habitable Rooms per capita*	House Ownership	Size of Garden*	Build-Up Ratio*
Consumption Water*		-22%	54%	58%	35%	50%	-31%
Average Price of Water*	-22%		-20%	-16%	-11%	-8%	23%
Income*	54%	-20%		48%	36%	60%	-32%
Habitable Rooms per capita*	58%	-16%	48%		34%	45%	-30%
House Ownership	35%	-11%	36%	34%		36%	-27%
Size of Garden*	50%	-8%	60%	45%	36%		-49%
Build-Up Ratio*	-31%	23%	-32%	-30%	-27%	-49%	

*The variable is transformed into a natural logarithm. Correlations are all significant at the 0.01 level. NB: A high and positive value indicates a direct and strong relation between the two variables, a low and negative value a weak and inverse relation.

Average consumption of water per capita results from many different factors as displayed in Table 1. The economic theory of supply and demand suggests that the water quantity demand is inversely related to its price. The purchasing power of the customer, which is linked to income, increases as price falls resulting in higher demand. This relation is visible in the correlation table: consumption is inversely linked to price (average price regardless of the supplier), and positively linked to income (and other income-related variables like number of habitable rooms per capita, home ownership, or size of garden).

Nevertheless in the context of Nairobi the supply-demand model is constrained. On one hand, the operator applies a subsidized fixed rate for water which is much lower than what would obtain in a free market. On the other hand, supply cannot easily be increased by the operator in order to satisfy demand and increase profit. These two facts contribute to (1) creating a situation of water shortage and rationing (2) the emergence of a market for non-regulated alternative suppliers with higher rates and (3) reliance on coping mechanisms such as storage tanks that accentuate the differential of access. This results in a water market where those with lower incomes are not only naturally limited by their lower

purchasing power but by having to face higher and unregulated prices for water (price inversely linked to income) as displayed on the cost map.

Water consumption is also related to the specific needs of different consumer profiles. As shown in Table 1, larger consumers tend also to have bigger gardens and houses. This means they also possess more water consuming devices (e.g. lawn sprinklers, car washing hoses, showers, and flush toilets).

Lower income customers, often constrained by the limited supply, develop strategies to make greater use of what is available: bucket showers, pour-flush toilets and they re-use of water for multiple purposes. The poorest households reduce consumption to “strict necessities”. What represents a strict necessity is debatable. Policy makers have not yet defined a threshold to allow monitoring. WHO suggests that 40 lpcd is a decent amount to live a very simple life, but even that is beyond the reach of many poor consumers in Nairobi.

2.4. From inequality to inequity

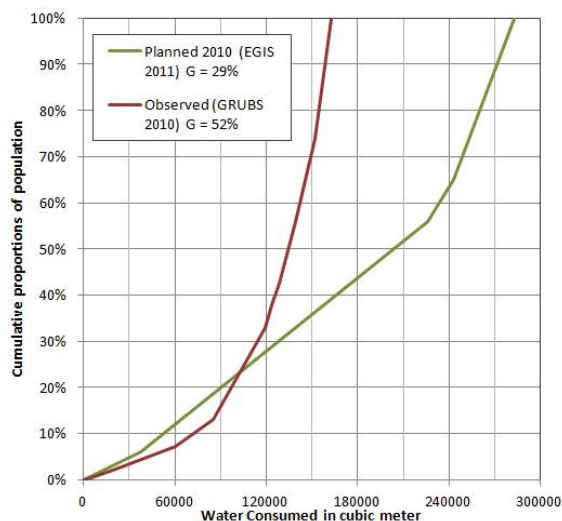


Figure 2 - Share of Water among different customers in Nairobi (Source EGIS 2011, GRUBS 2011)

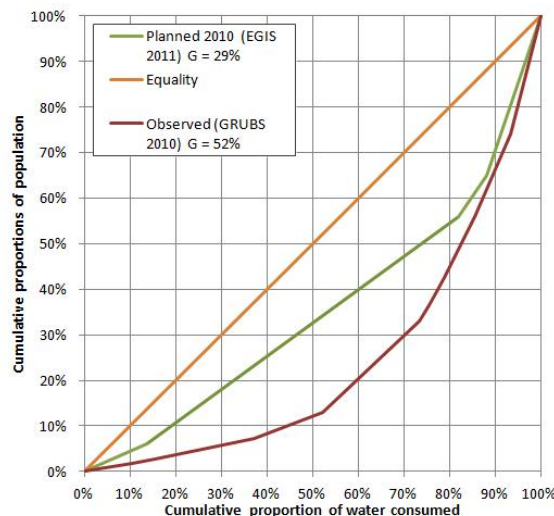


Figure 1 – GINI Index (G) Curve of Water Distribution in Nairobi (Source EGIS 2011, GRUBS 2011)

These two diagrams represent allocation of water in Nairobi to various customer profiles. Under the design demand put forward by the consultant EGIS [5] (see **Table 2**), Figure 2 shows that the entire population demand would require that slightly more than 275,000 m³ of water is delivered to households (excluding NRW). But, in fact, taking actual bulk water supply and the amount of NRW in account, this amount cannot be supplied. We have estimated that only 163,000 m³ can effectively be delivered. This represents nearly a 40% deficit of supply. The curve shows that not all water consumers face this deficit in the same manner.

Table 2 - EGIS 2011 Design Demand	Lpcd
High Income	250
Middle Income	150
Connected Low Income	75
Non Connected Low Income	30

Figure 1 shows that the highest consumers tend to consume more than the amount the system has designed for them. 40% of distributed water is supplied to the 7% biggest consumers. So the consumption profile of this small population means they require an additional 20% of the available supply over what was designed. Some of the middle-income earners demand actually matches the design. But whereas EGIS assumes a middle-income population to represent 50% of Nairobi's total, only 7% of them actually access middle-income standards (those who consume 133 lpcd or 15% of supply). The next 20% of the population access quantities corresponding to EGIS standards for connected low-income and consume 20% of supply, another 33% have to deal with 30 lpcd or less (and accessing 10% of supply). The other 45% of the population shares the remaining 15% of water available. This segment of the population must usually cope with only a 20l jerry can per person per day or less in the slums (15 lpcd).

This pattern of allocation is clearly unequal. As displayed by the EGIS Gini curve, the design demand already takes into account a certain amount of inequality that can be explained by differences of lifestyle and water sources. However, the observed consumption Gini Curve shows that due to water

shortages, the allocation is much more unequal than the intentioned design. In a situation of water shortage, allocation of water should be directed in a way that favors vital needs over marginal uses. Poor households should be provided a minimum volume of water daily. However, it can be seen that because the rich households tend to have an excessive demand, poor households are forced to reduce their already very low consumption. So allocation is not only unequal; it is unfair and inequitable since the cost of water shortage is not shared equally across customers. It could be said that a measure of this inequity is the difference between the Gini Coefficients of the design demand (in this case 29%) and the observed consumption pattern (52%). Indeed, if the design demand matched real needs, and if each customer reduced consumption equally to face water shortages, the two coefficients would be equal.

3. Nairobi: the fast growing ‘city in the sun’

Note: the following chapter refers to GRUBS maps which can be accessed online via the GWOPA Website

Nairobi: a fast growing, segregated, and informal city. A key factor underlying all the urban problems facing Nairobi is its growth rate which is one of the highest in the world. In a hundred years a simple colonial railway depot has turned into a metropolis with a population of three million people. Such rapid growth puts tremendous pressure on all public amenities: housing, roads and WS infrastructure alike. Furthermore, the racial segregation of the old colonial administration has persisted through independence and is reflected in today’s socio-economic segmentation of the city. The wealthy occupy the upper, forested areas, whereas the lower plain is more densely populated. Although different social classes do not occupy the same physical spaces, the lifestyle and privileges of the wealthy have a direct impact on the resources of less privileged classes. This applies both to land-use and access to water resources. Informal settlements or slums are widespread in Nairobi due to weak urban planning and ineffective enforcement of building bylaws. This has not helped the development of WS infrastructure. Upgrading WS in slums comes with substantially greater costs to the authorities.

3.1. The many faces of Nairobi



**See maps on the
online report**

[http://access-to-water-
in-nairobi.gwopa.org/](http://access-to-water-in-nairobi.gwopa.org/)

“Residential Typology”

“Household Income”

“Population Density”

Nairobi is a city where dwellers coming from very different backgrounds share a common yet extremely diverse and segregated space. What strikes the keen observer looking at the city from the sky is the multitude of sharply delineated urban forms. The Kenyan capital has been sliced in two: the lush suburbs of the west on the one hand and the more densely populated popular eastern areas on the other. But various gradients exist between many different urban areas and dividing



Photo 1 - Gradient of Density in Pipeline Estate

barriers may be the only features shared in common. High density neighborhoods find themselves next to low, detached mansionettes. This picture (Photo 1) taken in Pipeline Estate possibly displays one the steepest gradients of density in the world. These visible constructed differences are not only built upon variations of socio-economic conditions, but upon a series of forces, constraints, and deficiencies that have driven the growth of Nairobi.

To understand the geography of water and sanitation in Nairobi one must consider the character of different neighborhoods and how they developed over the time. The role that institutions have played under British and Kenyan rule in planning and controlling the urbanization process is also important to

recognize. As administrations often failed to deliver a centralized and coherent urban strategy, local development was largely left to the discretion of the surveyor, developer, or the owner. Contemporary Nairobi is the result of that informality.

An Upper and Lower Colonial City

A century before becoming a busy metropolis with 3 million residents, Nairobi was merely a quiet piece of wilderness where Masai herders watered their cattle. As it happened, this was the site where, after conquering nearly 500km of savanna, the Ugandan Railway Company decided to install a major workshop as a logistic link between the plains and the rift escarpment. The location provided not only water to steam the engines, but cool and fresh sites to build engineers' residences.

The partition of the different social groups in the first days of the city was dictated by the constraints and amenities offered by the landscape. The dominant class of white engineers, executives and administrative staff occupied higher areas whereas the African blue-collar workers were housed below in the plain behind the station. Middle class Indian merchants and managers occupied an intermediary position in the northern part of town. This allocation of land according to the landscape and social status would be consolidated and perpetuated through the various city development plans up to the 21st century.

Classes 110, 120, 130, 250 Today the upper class still largely occupies the upper west areas characterized by low built-up density and high density of vegetation. The location of Nairobi's two remaining significant woodlands in those areas reinforces that character. Individual houses occupy large plots that border quiet avenues. The largest properties are found in Karen, at the southwest end of the municipality, in Muthaiga between the Mathare River



Photo 4 - Class 110

and Karura Forest and in Lavington on the hills between Nairobi and the Ngong Rivers (110). However, the recent growth of the upper-middle class is changing the face of those neighbourhoods through sub-divisions into smaller lots as in the northeast of Karen, along Ngong Forest; (and north of Karura Forest where this type of houses occupy today large amounts of land (120). This new mode of development includes the transformation of colonial pavilions into large terraces and apartment buildings as in the south-eastern periphery of Lavington, Kileleshwa, and Kilimani areas (130, 250).



Photo 2 - Class 250

Class 220, 230, 240: Under colonial rule immigration to the city, housing and the labor of Africans were strictly regulated by the authorities. Housing was



Photo 3 - Class 220

always planned by public authorities like the Railway Company or the City Council and provided to individual male workers under "pass laws" allowing them to work in town. Such "African quarters" are still present today in the areas just east of the CBD between the Nairobi River and the railway. Largely influenced by the Garden City Movement, they are composed of small communal pavilions or blocks of communal dormitories in which African workers were allocated a single room



Photo 5 - Class 240

in relatively green surroundings. This applies to neighborhoods such as Bahati, Makongeni, Kaloleni and more recent estates like Ofafa Jericho. The old Indian quarters: Ngara, Pangani and Eastleigh have been mostly deserted by their original occupants and are changing quickly today.

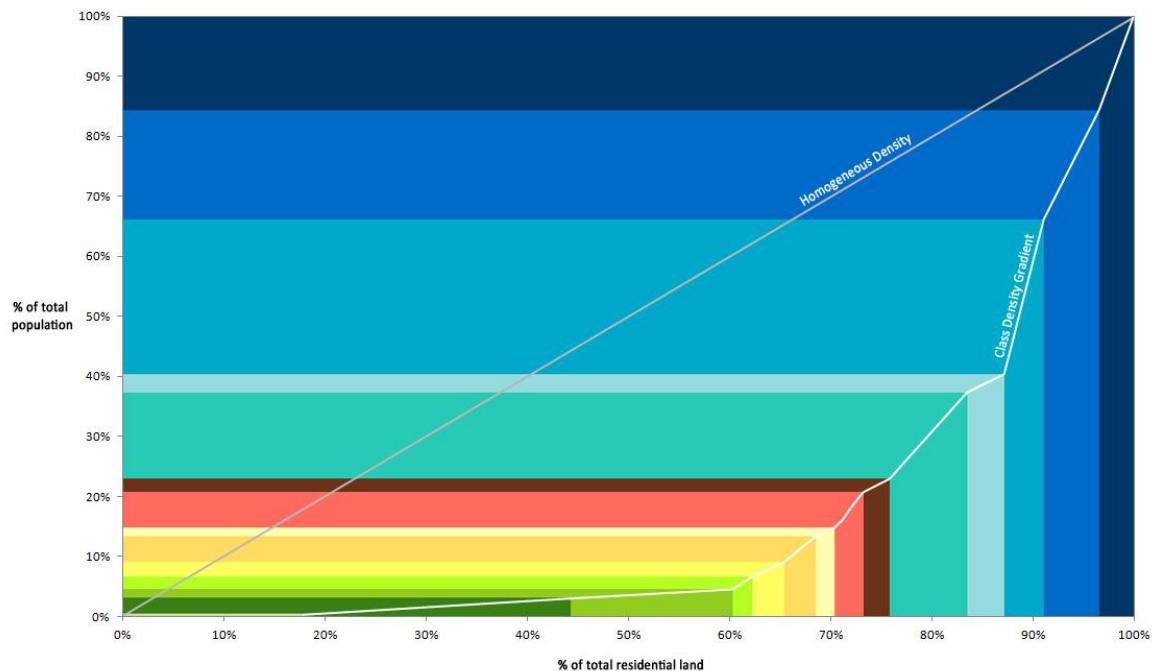


Figure 3 - Share of the Residential Land and associated Gini Curve

Figure 3 shows the proportions of residential lands occupied by different residential types. It can readily be seen that the East-West dichotomy from the origins of Nairobi is still very much present. The three higher income residential classes represented in green are under 10% of the population yet claim more than 60% of the land, mostly elevated, greener areas (Upper Area). These classes also tend to consume a disproportionate share of the available water. This results in a problem for the water operator who struggles to pump enough water up from the Lower Area.

Class 250: The most notable exception to this Upper-Rich/Lower-Popular dichotomy is the presence beyond the rich neighborhoods of Lavington of a large semi-rural area of lower-income earners constituted by Kawangware, Kangemi, and Riruta. Parts of the former old Colonial Kikuyu Reserve, these areas include a mix of different social and housing qualities that coexist with agricultural land.



Photo 6 - Class 250

Post Independence Explosion – the housing crisis

After independence, the repeal of the rural-to-urban restriction laws caused a tremendous population boom in Nairobi fed by both family reunions and the natural expansion rate based on the normalization of the sex-ratio [6] (See Figure 4). As a result of this population explosion, housing stock was under serious stress. The housing market responded formally via public and private initiatives and informally via the creation of unplanned settlements unable to comply with the municipal bylaws.

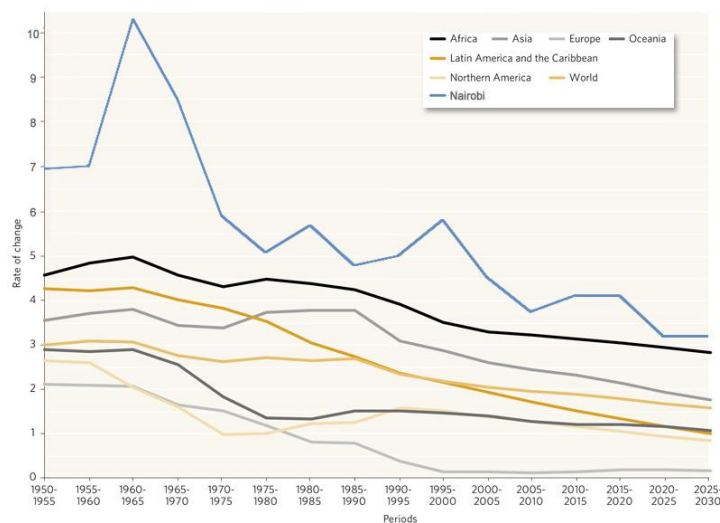


Figure 4 – Urban Growth per Region compared to Nairobi
(Source: adapted from UN, 2006)

Classes 211, 212, 330: Many formal public and private large-scale initiatives have provided housing for the emerging middle and lower income classes. Vast areas of land were opened to urbanisation by the expansion of the city boundaries just after independence and important lots were made available for

large-scale real estate projects. When targeting the middle class, these large projects took the form of small gated communities/estates composed of mainly single attached red-tiled houses with an adjoining courtyard. Their location followed the natural direction of the expansion of the city to the east (e.g. Buru-Buru, Umoja I, and Komarocks) or to intermediate undeveloped areas to the south of the City (Langata, Nairobi West, Nairobi South). Many owners have illegally turned their courtyards into extra dwellings.

Class 270: The far east of the town towards Ruai has also been privately developed and is now characterized by low-density individual housing.

Class 313: Other formal projects such as the Sites-and-Services development scheme launched by the City Council and funded by the World Bank targeted lower-income tenants. These projects promoted collaboration between authorities and selected beneficiaries. Plots, material loans, and land-lease were provided by the City Council while beneficiaries were in charge of the design and the construction of the dwellings. In some of these schemes collective water and sanitation infrastructure was provided prior to the construction of the houses by the new owners. Strict building bylaws and short-term profitability often meant that the beneficiaries of those schemes to quickly re-sold their properties, thus promoting the interests of landlords and limiting the schemes' benefits for the initial target population. The common evolution of this particular residential type into multi-storey districts, often not complying with bylaws, tends to make them fairly informal. Kariobangi, Dandora and Kayole are all examples of such schemes.



Photo 7 - Class 211/212



Photo 8 - Class 270



Photo 9 - Class 313

Despite these initiatives from the 1970's through to the early 1990's, the formal housing sector has never managed to meet housing demand. In fact, throughout this period the housing market has in mostly been served by the growth of informal development. The continuing housing crisis is the result of a mixture of factors that the government has failed to address, either deliberately or by default. At the root of the problem is the fact that the majority of Nairobi dwellers are very poor. Because of this they cannot afford to access formal housing where high construction costs, high interest rates, scarcity of land, and building by-laws all apply. This in turn creates a high demand for low quality rental housing that serves the informal housing sector.

Class 312: The most common kind of informal housing is found in the “informal settlements” or “slums” where both land tenure and structures are in are informal. They occupy spaces that are normally non-constructible: along rivers, swampy areas, dumpsites, strategic zones alongside airports or between industries, and even public parks (i.e. Deep Sea). Houses are communal units built with low quality materials and often use iron sheet as roofing. Land-use intensity is very high: public space such as streets and open areas is minimal (sometimes as little as 8% of space [3]). Informal settlements usually do not expand vertically and most plots are built up to maximize use of space (plot cover = 100%). Despite the numerous people living in these informal neighbourhoods, slum dwellers occupied less than 4% of total of residential land in Nairobi. This is in stark contrast with the 45% of residential land occupied by Nairobi's wealthiest 7%. Population density in the slums is high (130,000 inhabitants per square kilometre, more than five times the Nairobi average and eighty times the average for the wealthier areas). Well known slums include Korogocho, Kiambiu, Mukuru, Mathare and Kibera.



Photo 10 - Class 312

There is no simple solution to the multiple problems regarding water, sanitation, health, education, security, employment, etc. from continued unchecked growth and poor conditions in the slums. Some see certain stakeholders as the main obstacles. Government may argue that improving and legalising the slums would simply attract more migrants to the city. Some landlords, who may have accessed slum properties through political patronage, would see their lucrative profits hit. The cartels who make substantial profits from others' poverty through the reselling of water or forced security fees may prefer things to continue as they are. Although essentially parasitic, there is no doubt that the slums' economy favours survival. Slums provide space for many diverse informal activities and livelihoods. Moreover, slum locations, although haphazard and dangerous, often allow walking access to employment nearby.

Class 321: Single storey slums are the most notorious and common form. But another type of informal urbanisation is currently growing rapidly in Nairobi: large-scale, multi-storey tenement buildings. While land tenure is generally more secure in tenement buildings than in the slums, their informality lies in the general non-compliance with building bylaws regarding layout and number of floors. In an attempt to maximize profits, developers strive to make the most out of their buildings that can reach up to ten floors high and often do not respect street layouts. When combined with unregulated maximization of unit numbers per floors, it is estimated that densities of population in such tenement areas can reach 5,000 people per hectare. For comparison nineteenth century New York – thought then to be overcrowded – reached a level of about



Photo 11 - Class 321

1,250 people per hectare [7]. This kind of urban form is now endemic in certain places like Huruma, Pipeline, Umoja Inner Core, and Eastleigh and multi-storey tenement buildings are now emerging in many parts of Nairobi including some Site-and-Service Scheme areas (notably Kayole) that were supposed to be owned by low income individuals rather than profit seeking landlords.

Class 311: Other areas of the city, most of which were not initially allocated for housing, are currently developing into lower quality housing areas. Built plots are usually scattered among bare plots, or plots covered only by house foundations in an attempt by the grabber/owner to secure the property. These plots are most likely to develop into new slums (312) or lower quality plan housing (313) depending on the physical and socio-economic conditions of the areas.



Photo 12 - Class 311

3.2. Planning and enforcing city planning

Since 1948 and *The Nairobi Master Plan for a Colonial City*, Nairobi's urbanization has evolved without any comprehensive master-plan. The absence of any such strategic document has allowed for heterogeneity, incoherence, and fragmentation between the different functions of the city: transport, water, housing, community facilities, social infrastructure, economic development, etc.

Today, planning and enforcement are based on the Nairobi Metropolitan Growth Strategy which was created forty years ago in 1973 [8, 9]. This document draws on the post-independence land situation and roughly determines 20 geographical zones, with broad land-use guidelines and building by-laws (minimum plot area, ground cover, plot ratio). The directions remain general and not very constraining at the local level except when housing is formally banned in a zone. This helps explain informality in some places (e.g. Mukuru in the industrial area; Kiambiu in the airport zone; Deep Sea in the public park zone).

Coordination is lacking between the different departments in charge of city development. The Lands Department fails to deliver a coherent overall land division plan or a warranty of property rights. The Physical Planning Department, in charge of long-term planning, does not consider land tenure issues while the Department of Development Control simply fails to enforce bylaws prescribed by other departments. This lack of integration promotes bad governance and corruption.

Lack of coordination also exists between city departments and the water and sanitation utilities such as NCWSC. Without coordination, development of infrastructure cannot be harmonized with the growth of the city and policies on areas of future growth. Even if the various departments were to collaborate, lack of building regulation and enforcement would allow the spatial and demographic growth of the different districts to exceed the capacity of the service networks.

In the absence of a strong, centralized planning strategy, planning tends to be decentralized to various land stakeholders. This can partly explain why public land generally benefits from large-scale planning. And, although slums may be considered as unplanned, they are still in reality the result of a certain planning strategies either of the inhabitants or landlords seeking to maximize their profits. This also

explains why completely opposing residential developments such as multi-storey buildings and low-density detached housing can be found next to one another.



**See maps on the
online report**

[http://access-to-water-
in-nairobi.gwopa.org/](http://access-to-water-in-nairobi.gwopa.org/)

"Informality"

Weak enforcement of the building regulations can induce uncontrolled growth of neighborhoods. This causes enormous pressure on public infrastructure such as water and sanitation. Today most quarters of Nairobi are characterized by some form of informal settlement. Even middle-income areas, districts like Buru-Buru or Umoja One are well-known known for adding illegal extensions and converting courtyards into houses. In upper middle

class areas apartment buildings often have one or two extra floors illegally added to increase profitability.

3.3. Informality and Service delivery

Another way to look at the cost implications of informality on service delivery is the PSBO/OBSP concept. Conventional urban formal development follows the sequence of planning-servicing-building-occupation (PSBO). This sequence allows working out all the costs, and making sure in advance that the infrastructure and other public amenities match the needs of the area, with few interventions from the future occupants [10].

In Nairobi, the reverse sequence OBSP is often observed in the slums. Land is first occupied and built on informally. Then dwellings are serviced later with infrastructure. This means that some formal planning is superimposed on existing informal patterns to allow installation of conventional technology. To try to make this work requires interacting with the many occupants living in the area who often have conflicting interests regarding development plans.

This concept can help us understand the failure of the state since independence to provide for slum dwellers. A top-down approach would result in the destruction of slums and relocation of slum dwellers. A bottom-up approach, in the shape of slum improvement, would give slum dwellers legitimacy and would tend to secure their location. Most of the water and sanitation service initiatives in slums have been small-scale, private enterprises run on an informal basis. Other service providers in the slums include community-based organisations supported by donors. These organisations commonly fund construction of toilets and water points that are then operated by the CBOs.

Since 1988, under the influence of the World Bank, the government has advocated slum upgrading as part of its housing policy. Practical examples of such a policy have remained few until 2004 when the bottom up approach took shape under the Kenya Slum Upgrading Programme (KENSUP) and recently the Kenya Informal Settlements Improvement Project (KISIP). These programmes marked a break with institutional denial of informality and are trying to come up with creative solutions involving the different stakeholders of the slums. This new approach to slum upgrading is still strewn with obstacles and will require great strength and will from the authorities in order to succeed.

4. Institutional framework: formalizing the rules of the game

A Water Act to reform a poorly performing Kenyan water sector. By the mid-1990's the Kenyan water sector had become completely unsustainable. A new institutional framework was put in place through the Water Act of 2002 to address the downward spiral of service delivery. The main ideas were to decentralize water management from the Ministry of Water and Irrigation and to promote corporate governance and commercial orientation. The regulatory role was handed to the Water Services Regulatory Board (WASREB). The responsibilities for service delivery and asset holding were passed to eight regional water services boards. In Nairobi AWSB took over from NCC. The Act specified that operations and maintenance of WS assets must be contracted to a company operating according to commercial principles. In Nairobi this was NCWSC not NCC. Despite the new framework, however, at the time of this report both the water company and the assets remained under NCC control. The financial agreements between AWSB, NCWSC, and NCC concerning use of the assets were inefficient and several disagreements between the WSB and WSP have resulted in ambiguous legal responsibility.

The overall water sector in Nairobi is framed by an institutional set of norms and prescriptions. This institutional framework gives roles and responsibilities to different organizations and defines the way they financially relate and are accountable to each other. The rules of this institutional framework define the perceived incentives (commercial, regulatory, and political) that organizations have, on the one hand, to preserve the status quo or, on the other, to promote change.

Analyzing this framework allows us to understand the trajectories of the utilities, their ability to introduce and manage change, and the nature of the goals towards which they strive.

4.1. The Former Institutional Setting

The 1972 Water Act updated water legislation that had been in place since 1935. All water resources were vested in the Ministry of Water and Irrigation (MWI), but provision of water and sanitation services in the major towns was delegated to local authorities.

The MWI formally appointed the Nairobi City Council (NCC) to provide water and sanitation services to its citizens under its regulation [11, 12]. A dedicated department responsible for planning, design, operations, and billing was created within the Nairobi City Council – the Water and Sewerage Department (WSD).

In terms of financial integrity and sustainability, the CCN had the authority to dispose of its own budget, unlike the WSD which shared finances with the NCC [13]. The NCC initially collected enough revenue in the early 1970s to generate a substantial budget surplus, taking into account operations and maintenance (O&M) and capital costs [14]. But by the end of the 1990s, a large billing backlog had developed. Many accounts had huge arrears, there were many illegal connections, and NRW had soared to 52%. The NCC was reported to be financially unsustainable and was only kept from insolvency by subsidies from the Government [15].

By the mid-1990s, the situation had become completely unsustainable, and water sector reforms were initiated to deal with the sub-standard performance of the sector at large. The Government's Water Policy of 1999 declared an intention to make the water sector more commercially oriented and to

separate policy from operations. A new formal institutional framework was then put in place through the Water Act of 2002.

4.2. The Water Act of 2002

In 2002, after decades of poor performance, a new Water Act was introduced with the goal of improving the sector's financial and operational sustainability. Unfortunately, it was eight years later that the Right to Water to every Kenyan was declared *via* the adoption of the New Constitution. Hence, if the new water sector framework had the goal of improving efficiency and profitability of the sector, the question of the universal Right to Water still had some way to go before making its way into the regulatory framework (Figure 5) [16].

The 2002 reforms had three main features: separation, decentralization, and participation [12, 17].

First, although the Act kept the responsibility for all water vested in the MWI, it limited MWI's role to policy formulation. The regulatory role for WS service delivery was passed on to a separate regulatory organization: the Water Services Regulatory Board (WASREB).

Second, the Act decentralized the responsibility for service delivery to eight organizations corresponding to the main river catchment areas in Kenya. The idea was in order to provide more effective planning and supervision of services than the centralized system of the past. These regional bodies, called Water Service Boards (WSB), are responsible for asset holding but not for the actual service delivery. The boards must contract separate Water Service Providers (WSPs) who sign Service Provision Agreements (SPAs) and operate and maintain the system.

The WSPs can be owned but not run by local authorities. They are obliged by the Act to operate in autonomy according to commercial practices and plough back reinvest water revenues to finance operations and maintenance.

Third, the importance of consumer participation was mentioned. In addition, the Water Service Trust Fund (WSTF) was created to assist in financing development of marginalized areas through the channeling of international aid.

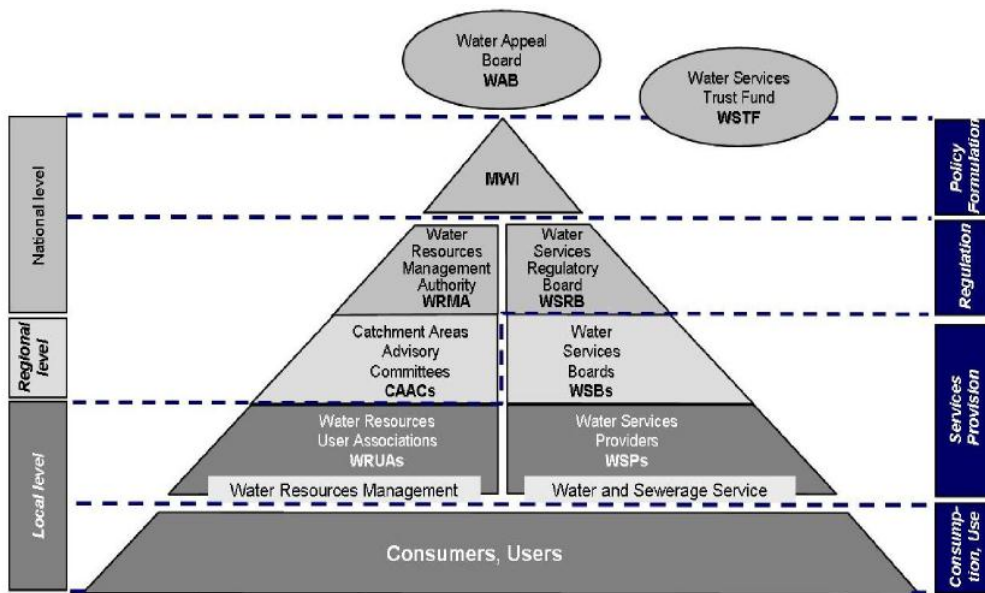


Figure 5 - Sector structure under the Water Act 2002 (Source: Republic of Kenya, 2007)

4.3. Implementing the Act in Nairobi

The Customers: The utility estimates that in 2010 there were 3,555,553 dwellers in its jurisdiction, of which 2,250,607 (63%) were served formally by the piped network [18]. However, the 1999 Kenyan census estimated that virtually the entire population (93%) sources its water from the network in one way or another. Each of these customers is granted the “Right to Water and Sanitation” by the new Kenyan Constitution adopted in August 2010 [19]. However, this right is not translated in the Water Act, and does not affect the terms of the contract between customers and the utility.

Nairobi City Water and Sewerage Company Ltd (NCWSC or “Nairobi Water”): Following the passing of the Act, Nairobi Water was created in 2003 as a private commercially-driven company wholly owned by the City Council. Nairobi Water took over the provision of water and sewerage services from CCN’s water and sewerage department (WSD). The CCN transferred its operation and maintenance assets to the new company (i.e. reservoirs, treatment plants, vehicles, and buildings). Along with these, NWSC inherited a backlog of billing errors, a considerable debt (18% of total assets), poor perceptions of customer service, and a large unskilled workforce. Nairobi Water was contracted by Athi Water Services Board, responsible for WSS in Nairobi’s jurisdiction, to provide WSS on its behalf. In practical terms, since NCWSC does not own the distribution network, its role focuses mainly on the actual operations, maintenance and billing. But since the company has on-the-ground knowledge of the system and its requirements, it is also made responsible for developing and expanding the system on behalf of AWSB (provided AWSB gives express permission) [20]. Supply and distribution assets remained wholly owned by the CCN (i.e. dams, transmission lines, and distribution mains).



Nairobi City Council (CCN): As a local government unit, the CCN is forbidden to provide services under the Water Act. Nevertheless, it fully controls and owns NCWSC assets along with all other supply and distribution system assets in Nairobi. The distinction



between CCN and NCWSC is sometimes hazy. In 2009 WASREB issued “corporate governance guidelines” for all WSP’s in order to reduce influence from local politicians [21]. The CCN ignored these guidelines and remained adamant that it should have full authority to appoint the Board of Directors of the NCWSC. In June 2010, the entire Board was replaced following intervention by the Minister for Water and the Prime Minister [22]. The legality of the Minister’s intervention has been questioned in the media; in any event there is little doubt that the company is still subject to political influence from the CCN [23].

Athi Water Services Board (AWSB): AWSB is the state organ licensed by WASREB to be legally responsible for water supply and sewerage in the greater Nairobi jurisdiction under the Water Act. Its main operational function under the license consists of long-term planning and development of water and sewerage assets. It is nevertheless also responsible for contracting WSPs to provide WSS and supervise their performance (in this case NCWSC). AWSB does not own the water and sewerage assets under its mandate though it holds and controls these assets. AWSB pays lease fees to the CCN, as a percentage of the lease fees it receives from NCWSC. Since its inception, AWSB has been involved in large-scale capital investment in WS infrastructure such as the rehabilitation of Sasumua Dam and the upcoming Fourth Nairobi Water Supply Project. AWSB is the organization that deals with funding agencies, such as the International Development Association (part of the World Bank) and Agence Française de Développement (AFD).



Water Services Regulation Board (WASREB): WASREB is the Regulator responsible for enforcing the Water Act. WASREB has an influence on all the stakeholders involved in the formal water sector (WSBs, WSPs, and customers). The Regulator is responsible for setting and enforcing standards, issuing licenses to Water Services Boards, customer protection, tariff setting, and developing performance agreements between WSBs and WSPs. WASREB’s enforcement component consists of collecting and analyzing self-reported performance data of the AWSB and the NCWSC. It publishes this data in the annual “Impact Report”.



The Ministry of Water and Irrigation (MWI): MWI is responsible for policy formulation under the terms of the Water Act, and is the overall authority of the water sector in Kenya. Although the Act was intended to create an institutional framework free of political interference, the Kenyan Government remains involved, with ministerial sign-off required prior to sourcing any substantial new funding or subsidy [20] or appointing board members of the WSBs. It has also, for instance, intervened in August 2009 to dissolve the NCWSC Board [24].



Donors: Financing in the sector includes grants and loans, disbursed through bilateral or multilateral programs or through international organizations such as IFAD, AFD and WB. These funds are conditioned on the inclusion of a pro-poor strategy in the funded projects. The Water Service Trust Fund was created under the Water Act to channel international funding towards areas in need and deals directly with WSPs.

4.4. Financial arrangements and the Tripartite Agreement

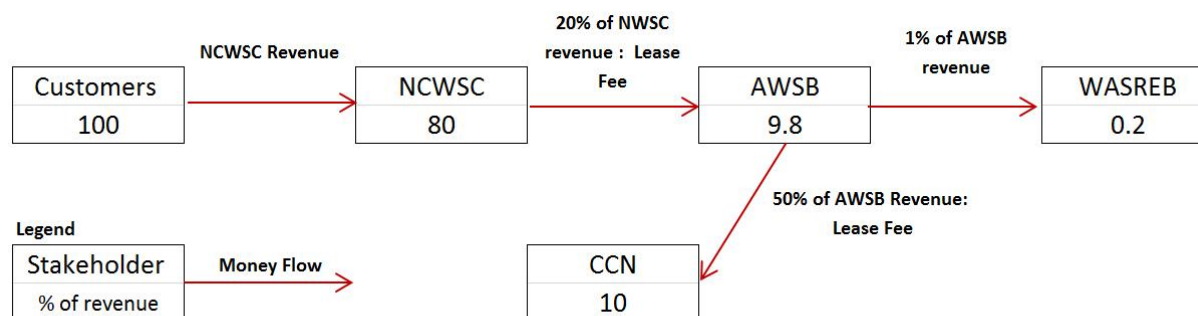


Figure 6 - Financial Arrangements of the Nairobi Water Sector (Source: GCR [15])

WS assets are mostly owned by the City Council while AWSB is responsible for their development and management and NCWSC is responsible for operating and maintaining the infrastructure. The operational framework linking the three entities is defined in a tripartite agreement. AWSB pays a lease fee of 50% of its revenue to the City Council for using its assets. It also gives out 1% of revenue to the Regulator which is then supposed to be self-financing. AWSB takes a 20% share of NCWSC's revenue as a lease fee for operating the system.

This framework has several weaknesses that make it inefficient, especially for AWSB. First, ceding 50% of the Board's revenue to the City Council can be considered a serious constraint on AWSB's financial and operational sustainability. Although it owns the assets the City Council does not use this revenue for developing or funding the assets [20]. The City Council, however, is prevented from earning dividends from its company under the Water Act.

Second, Nairobi Water often carries out maintenance on the system under AWSB approval and is paid for these services. But for reasons due to time and work pressure work is often carried out without express permission. This has resulted in resulting in disputes over payments. Due to the concentration of AWSB's revenue being derived from the NCWSC (96%), there is a risk that NCWSC may withhold these payments, thus putting further financial pressure on the Board.

Third, despite the fact that Athi Water Services Board has carried out consequent capital investment in upgrading the system (e.g. the Sasumua Dam rehabilitation in 2011), the lease fee paid to the City Council remains unchanged. This reflects a lack of knowledge of the total value of the fixed assets in Nairobi which in turn leads to an inability to understand what a reasonable lease fee might be. [25]. The Water Act 2002 anticipated this issue with the "Transfer Plan", issued by the Government of Kenya in 2005. Under the Transfer Plan, all WSS assets were supposed to be transferred to the Water Service Boards at no cost, but this has not yet been implemented.

Finally, it can be noted that the terms of this contract are not dependent on the performance of the utility. The idea of performance incentives has only recently been promoted by the World Bank which is

now said to favor the creation of a stronger incentive framework where contracted companies should not only be paid for delivering services but also for meeting certain performance indicators [26].

4.5. Accountability and Monitoring

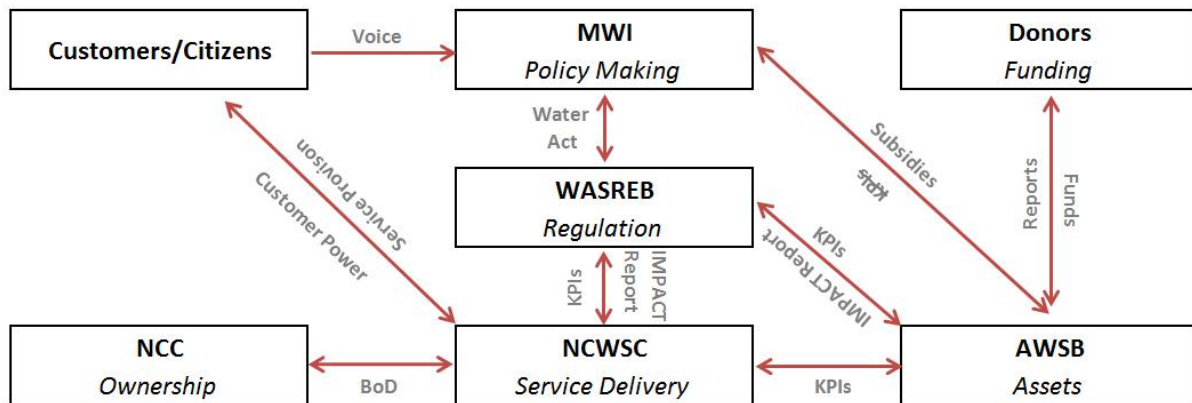


Figure 7 - Accountability Framework in Nairobi Water Sector

Customers/Citizens: Customers have a constitutional right to water. Although this right is not clearly defined in practical terms, the institutional framework designed by MWI should provide for that right.

There are two common ways customers can make the utility accountable for their rights, sometimes referred to as “short and the long routes” of accountability [17]. In the “short route” customers make use of their client power to put pressure on the water service provider. Customers can complain if unsatisfied with the service but cannot directly sanction the operator by choosing another water company, due to the monopolistic nature of the water sector. In the “long route”, customers, who are also citizens, can use their political voice to influence policies and regulations through the politicians and bureaucrats who create the rules and incentives. These issues are important because the consumer is relatively disconnected from the organization that is legally responsible for service delivery.

The right to water is also conditioned by the terms of the contract between the customers and the utility. Customers also have responsibilities: they must access water through a registered metered connection and they must pay fees and their monthly water bill according to the tariff. Illegal connections will not only be removed but be punished by a heavy fine and the utility has the right to cut off water supply for non-payment (within 14-days including a 7-days notice of disconnection).

NWSC: Besides being accountable to its customers, the NCWSC is accountable to the AWSB under the Service Provision Agreement (SPA) to provide a certain quality of service in the Nairobi jurisdiction. This is supposed to be ensured via reporting of Key Performance Indicators (KPIs) [27] which are measured against “minimum service levels” or performance targets. The AWSB does not have any means to create incentives for hitting targets or to levy sanctions against NCWSC in case of non-compliance other than resigning from the SPA. In fact, perhaps surprisingly, the SPA for the NCWSC expired in 2009. A new agreement is still being negotiated today and has not yet been signed. Hence, the NCWSC has not had a legal basis for operating for several years [24].

The NCWSC is also accountable to WASREB to which it must report on KPIs annually. WASREB analyzes ranks and publishes the performance data of all Kenyan WSPs and WSBs in order to “name and shame” poorly performing utilities. Apart from this system, weak though it clearly is, WASREB has little means of sanctioning poor performance or rewarding good performance.

Finally, the NCWSC is also accountable to its owner, the City Council which appoints about half of the Board of directors. The Water Act, however, forbids paying out dividends to WSP owners.

AWSB: Just like the NWSC, the AWSB is accountable to the WASREB under its license for its performance and must report on the same KPIs at the aggregated level of its jurisdiction. The AWSB is also required to fulfill certain conditions such as monitoring WSPs, developing a strategic plan to achieve the national objective of increasing water access to households, developing a pro-poor strategy, and promoting low cost technology for the provision of water services.

AWSB is also accountable to the MWI, which appoints its Board members. The Ministry can also deliver potential subsidies to the WSB. WASREB [18], however, reported that *“the Ministry continues to subsidize some WSPs without any regard to their performance. This subsidy is counterproductive to improving self-reliance and the sustainability of their operations. Therefore, subsidies could be construed to go against the spirit of sector reforms.”*

WASREB: WASREB is accountable to the MWI for regulating the water sector under the Water Act provisions. It is also partly funded by the MWI although it is supposed to work independently. This creates a potential conflict situation in which they must act sensibly to avoid “getting their fingers burned” [28].

MWI: The Ministry is accountable to the citizen for putting in place an institutional and regulatory framework that will create the right incentives for achieving certain goals, ensuring the efficiency of the sector and respecting citizens’ rights.

Donors: Donors often demand a high level of accountability for the funds provided. For instance, during preparation of the Second Nairobi Water Supply project, the World Bank demanded that the City Council include a component for water services to informal settlements. [29]. The monitoring of donor-financed projects and programs is generally carried out by independent consultants. Many reports from the 1970s up to the 2000s on attempts to improve water services in informal settlements in Nairobi point to a general lack of success. [30]. Poor water sector accountability to donors resulted in a decline of donor financing in the 1990’s, but interest and investment picked up again after sector reforms got underway [24]. The WSTF works in informal areas on the basis of proposals from WSPs and monitoring by independent consultants. Reportedly, WSTF has only had one single investment project directly with NCWSC and that project had a poor outcome. [31].

4.5.1. Key Performance Indicators (KPIs)

The accountability framework for the Kenyan water sector is built on a monitoring system that relies on a set of Key Performance Indicators (KPIs). The role of the KPIs regarding incentives can be considered as weak: at most they contribute to “naming and shaming” by WASREB; they are almost never correlated with financial incentives or sanctions. However, the choice of the KPIs can still promote certain aspects of water management.

Table 3 - WASREB KPIs for WSPs		
Collection Efficiency	Hours of Supply	Staff/1000 Connections
Water Quality	O&M Cost Coverage	Metering Ratio
NRW*	Water Coverage*	Sanitation Coverage
* direct impact on the poor		

Table 3 displays the nine KPIs used by WASREB to monitor and rank NCSWC performance [32]. Of these, only water coverage is directly related to more service to the poor. Indeed, in the current situation in Nairobi, any improvement in coverage implies expanding the system in the informal settlements. Although improvement on reducing NRW can also affect the poor, only a pro-active improvement of service to poorer areas would be beneficial; a reduction of service to reduce leaks would actually be counterproductive for the poor. The remaining KPIs are related to commercial and operational efficiency. The NCWSC has, however, adopted internal performance targets for improving service in informal areas. These targets are quite modest. On an annual basis, the NCWSC aims to construct around 10km of small-size reticulation, 1km of sewer line, and 25 public toilets/ablution blocks in informal settlements [33].

In addition to those KPIs, the AWSB is also rated on its monitoring of WSPs, transparency with the regulator, and efficiency of investments. Only one pro-poor indicator is present in the scoring scheme: i.e. whether or not the Board has a pro-poor strategy in place. This can earn the AWSB 3 points out of 120 in the rating system. So it can be clearly seen that the main criteria on which the performance of both WSPs and WSBs are based focus on commercial and operational efficiency and not on equity and provision of minimum services to the poor.

The data on which the system is based are provided by the WSPs themselves. This self-assessment poses questions about the independence of the data. Also, the performance indicators are always based on utility performance and not on the actual service delivery to the customer. There is no compulsion for the utility to offer minimum service standards to customers or specific areas. Because of this, by way of illustration, it is possible to know how much water was delivered across the whole city, but not if all residents have received enough water for their daily needs.

Several projects are dealing with these specific questions that are not addressed in the formal accountability framework. **GRUBS city-level** is of course one of them, displaying the differentials of performance across the city of Nairobi. **MajiData** also aims to explore the “invisible segment” of the water sector by collecting data in low-income urban areas of Kenya. Both of these initiatives have the potential to help the Regulator and the utilities, if the will is there, to be more accountable in meeting the citizens’ Right to Water.

4.6. Derived Set of Institutional Incentives in Nairobi

The institutional incentives favor operational and financial efficiency, not the Right to Water. According to the Act the water company must operate on a commercial basis. This means it has an incentive to maximize profits by increasing sales (expanding coverage), increasing revenue (lowering NRW, increasing collection and metering efficiency, raising the tariff) and reducing O&M costs (by staffing efficiency). Both AWSB and NCWSC are regulated by WASREB which collects, analyses, ranks, and publishes data on Key Performance Indicators (KPIs). The regulator has limited financial means for rewards or sanctions; it can only “name and shame” the good and bad operators in a yearly report called “IMPACT”. The selected KPIs mainly focus on commercial and operational efficiency. Very few of them reflect access to water for the poor, and those that do are given little attention in the weighting scheme. As a result, the regulatory framework tends to reinforce commercial priorities rather than providing incentives for better service to the poor.

The Water Act defined an institutional framework from which a set of incentives - commercial, regulatory and political - is derived. These incentives are intended to drive the utility towards certain performance goals. We will look at how that framework promotes the customers’ Right to Water and overall equity. First, we will examine this at the level of the NCWSC and then for the AWSB.

4.6.1. Incentives for the Nairobi City Water and Sewerage Company

Commercial incentives: The Company is obliged to operate on a commercial basis and to be financially sustainable. It could be said that this component is the backbone of the Water Act. This fits with the underpinning notion so strongly promoted by the World Bank: *“partnership between the private and the public sectors is a promising way to improve the performance of public water utilities, expand service coverage and raise the quality of service, increase operating efficiency, provide alternative mechanisms of financing infrastructure investment, and reduce the burden on public budgets”* [30].

Commercial incentives are the strongest incentives for the NCWSC. On the ground it means that the operator is incentivized to maximize profit by increasing sales (expanding coverage), increasing revenue (lowering NRW, increasing collection and metering efficiency, increasing the tariff) and reducing O&M costs (by reducing staff). Operators like NCWSC are not empowered to expand hours of supply. The NWSC is developing its own internal incentives in order to reward the parts of the business that operate well and are commercially efficient [34].

Regulatory incentives: The regulatory incentives put in place by the Water Act for the NCSWC are weak and not pro-poor oriented. As already observed, the accountability framework centred on WASREB does not provide strong incentives based on financial rewards. The strongest sanctions available consist of resigning from the SPA (which in practice is ineffectual in a monopolistic market) or shaming through a poor rating in the IMPACT report.

The performance rankings of the WSPs by WASREB do not currently recognize any pro-poor efforts. On the contrary, regulatory incentives seem to reinforce the obligation of the utility to operate on a commercial basis that emphasizes only efficiency. Maybe this is understandable in the wake of the 1990’s period which was marked by such colossal inefficiency. But it is contended that an over-

commercial orientation has long-lasting negative effects on equity of services and delivery of the Right to Water.

Political incentives: Political incentives to improve services in low-income areas appear weak. So far there have been few efforts to create more accountability and to amplify consumers' voices. But new mechanisms for "the long route of accountability" are slowly being put in place in Nairobi through initiatives such as the Citizen's Report Card and Water Action Groups [17].

In the absence of strong accountability structures there are few political incentives to change the focus of service provision from high-income to low-income areas. After all, most politicians and policy-makers themselves live in affluent areas of Nairobi, which would be disadvantaged by allocating more water to low-income areas. For policy-makers to give up their own privileges there must be strong incentives and/or very strong political will.

4.6.2. Incentives for Athi Water Services Board

Commercial incentives: The AWSB is not supposed to operate on a commercial basis. The financial incentives available to the Board are weak so they do not make for a positive environment for the Board to carry out efficient capital investment.

First, Government subsidies are not linked to performance. This creates no incentives for AWSB to improve performance, let alone operate according to commercial principles [25]. Furthermore, the lease fees defined in the tripartite agreement (See chapter 4.4) are not directly related to actual capital cost or asset stock. Thus there are no incentives for AWSB to increase its asset base since it is not linked to the revenue they receive from the operator [35]. If AWSB incurs debts for investments in infrastructure there is no safe way for the Board to recoup the financial cost. In fact, the same kind of disincentive for investments was common before the reform, when allocation of funds between different local government departments was determined on a purely political basis [11, 12, 36].

Regulatory incentives: The regulatory incentives for the AWSB put in place by the Water Act are generally weak and only slightly pro-poor oriented. In addition, the constitutional rights such as the Right to Water are still only vaguely articulated.

WASREB's accountability does not provide a strong incentive and sanction framework to enhance performance. The strongest sanctions available are the withdrawal of licenses, "reshuffling" boards of directors and the possible shame of being poorly rated in the IMPACT report.

The framework focuses only on operational and investment efficiency and fails to give any weight to the concerns of the poor. Indeed among all the KPIs used to rate performance of the Board there is only one that is pro-poor oriented - whether or not a pro-poor strategy is in place. This KPI accounts for about 2.5% of the ranking scheme! There are no incentives to provide the Right to Water and there is a general lack of monitoring mechanisms.

Political incentives: Although AWSB is the state body responsible for services to consumers it is far removed from them in terms of accountability: the "long route of accountability" is indeed very long! The terms and conditions of AWSB operations are formulated in the license from the Regulator but the

modalities of accountability between consumers/citizens and the AWSB are poorly articulated and require intervention of the Ministry and the Regulator.

Political control over the distribution of subsidies may make WSBs sensitive to influence from the Ministry, albeit indirectly. But it is noted that the AWSB depends on external donors for investments. So if and when donors give priority to informal settlements, AWSB will have an incentive to factor this in to their strategic work programmes.

5. Water supply: the struggle of watering a thirsty city

5.1. Keeping pace with the city

Nairobi's water supply has always struggled to keep pace with fast rising demand. Nairobi is situated at a relatively high elevation, at the top of a small tributary basin of the Athi River with only small amounts of water harvestable locally. Since the creation of the city there has been a constant struggle to expand water supply by sourcing more from further river basins and at a quickening pace to accommodate the needs of a fast growing population. Despite the three large scale consecutive Nairobi Water Supply Projects completed by 1995 (total design capacity of supply: 524,800 m³/day), demand in Nairobi already outstripped supply sometime in 2007. At the time of writing Nairobi is already in a situation of structural water shortage. This fact has tremendous impact on all aspects of water management. The implication is that in effect water has to be rationed. Without another major expansion of the system the water situation in Nairobi will deteriorate further. The "Northern Collector" project is in the design stage and should gradually bring the total raw water supply up to 1.3 Million m³/day by 2035.

Nairobi was once associated with the availability of abundant water. Its original Masai name 'Enkare Nairobi' means a 'place of cold waters'. By 1899, the Uganda railway had crossed the vast plains from Mombasa and was now facing the escarpment of the Rift Valley. Nairobi was a strategic location with plenty of water needed for the steam engines' ascent up the escarpment and descent into the Rift Valley where water is scarce. These are among the reasons why Nairobi was considered a suitable site for a major railway depot [37, 38].

While the available water was thought adequate in 1899 by the railway engineers, this "place of cold waters" was never intended to accommodate a metropolis of three million people. Indeed, the city is situated relatively high, at the top of a small tributary basin of the Athi River that flows down to the southeast. Only a fairly small amount of water can be harvested locally so to provide for Nairobi's development water had to be brought from other river basins. As a result, since its creation, the history of water supply in Nairobi has been a constant struggle to expand the supply to meet the increasing demands of a fast-growing city. The graph below shows the way in which the expansion and the pace of expansion increased. (Figure 8).

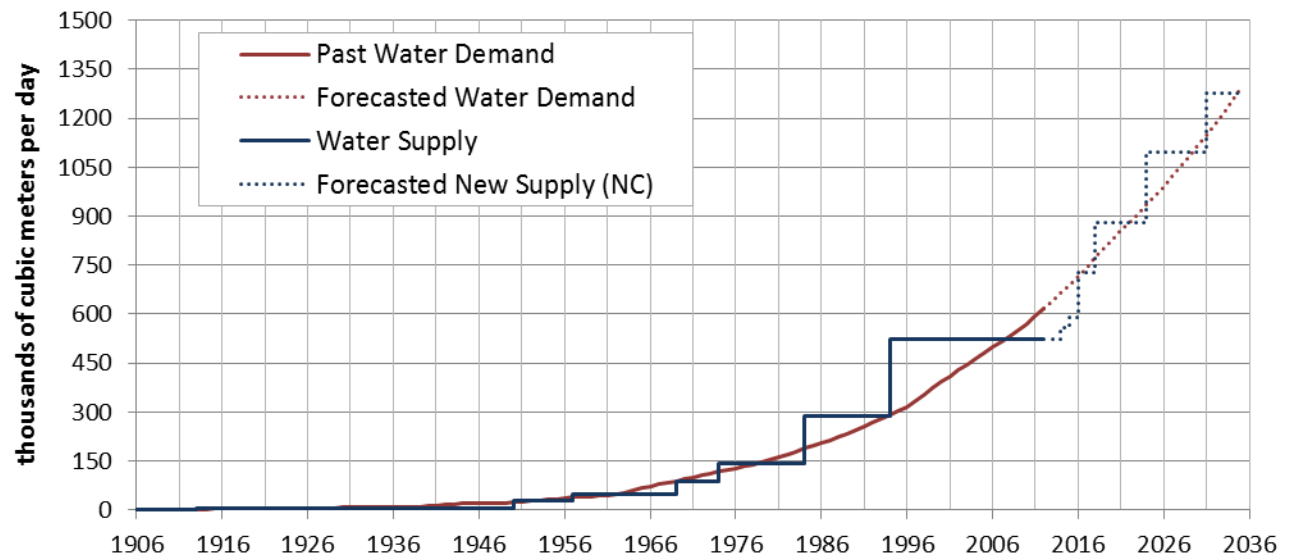


Figure 8 – Evolution of Water Supply and Demand in Nairobi since 1906
(Source compiled from WB, 1996 – AWSB, 2011)

In the early days of the city, water supply was available but did not exceed 40 lpcd for the population. Despite the new source at Kikuyu springs that was exploited from 1913, the city saw perennial water shortages through the following decade. In 1926, there was not even enough water to supply fire hydrants, and fire fighting was compromised on several occasions. Conservation measures and restrictions were developed, including prohibitions on the use of hosepipes and the watering of gardens.

As early as 1928, the Council decided to tap into the more distant Tana River Basin by implementing a scheme to draw water from the Ruiru River. The new source at Ruiru was complemented with a treatment plant at Kabethe, which was officially opened in 1938. Through exploiting this new source of water it was hoped that Nairobi would “be free from the periodical bogey of water shortage,” as the Mayor of Nairobi, Lady Delamere, said at the opening ceremony of the scheme.

Nevertheless, by 1945 Nairobi was investigating prospects for securing water supplies for the coming 20 years. The option of the Chania River, even more distant, was now being considered. By early 1946, the “bogey of water shortage” was back to haunt Nairobi due to a drought. As an emergency measure, the Nairobi dam was built on the outskirts of the city to store water from the Ngong River. In 1950, the Ruiru intake was complemented with a dam structure. As a more long-term solution, the decision to build the Sasumua dam on the Chania River was taken, and that project was completed in 1956.

The capacity of the Sasumua dam was augmented in 1968. The total capacity was thereby increased to 88,000 m³/day, well above the estimated demand of 61,000 m³/day. But the city was still growing rapidly. The Nairobi City Council then in charge of WSS calculated that capacity would soon be outstripped by demand. At this stage, the City Council turned to the World Bank to finance and implement three major projects over the next thirty years: the First (WS I: 1970-1977), Second (WS II : 1978-1984) and Third [39] (WS III: 1985 – 1995) Nairobi Water Supply projects [30]. These projects also featured major upgrades of the distribution system.

WS I tapped further into the Chania River to the east and downstream from Sasumua. A new treatment station was also built at Ngethu near the new intake. WS II expanded the Ngethu system built during the First Project, while WS III (in association with the African Development Bank) finally brought the greatest upgrade to Nairobi supply: the construction of Thika Dam, some 50 km north of Nairobi. The three projects combined quintupled the raw water supply in Nairobi with about 85% of Nairobi's water coming through the Ngethu system.

Despite the large scale of the three consecutive Nairobi Water Supply Projects completed in 1995 that brought the design capacity of supply to 524,800 m³/day, demand in Nairobi again outstripped supply some time in 2007 [40]. So by the time of this study, Nairobi was already in a situation of structural water shortage and yet another major expansion of the system is needed. Unless and until significant measures are taken, it is likely that the water situation in Nairobi will deteriorate.

In the 1990s, plans had been drawn up for tapping into even more distant sources north of Thika dam, through a system of collector tunnels known as the "Northern Collector" (NC). In 2011, the Athi Water Services Board conducted a feasibility study for the scheme that aims to bring the total raw water supply up to 1.3M m³/day by 2035. Even the most optimistic scenarios predict that supply will not catch up with estimated demand before the first phase of the NC is completed in 2016. Nevertheless, the shortage should temporarily be relieved as smaller-scale groundwater well-fields of Kikuyu and Ruiru also become operational in 2014 and 2015 [40].

5.2. Design Demand: Equity at the planning stage

Design of the new supply considers the needs of the poor more than previously. The demand calculations made during the planning stages for the new supply system take into account a projected increase of population and the varying needs of different customer profiles. Since Independence, high-income earners have always been allowed large volumes of water (250 lpcd) whereas lower income earners, who are assumed to be disconnected from the network, have never been allocated more than 20 lpcd (WHO recommends 40 lpcd for basic needs). This allocation pattern, formalized in a MWI manual, was based on consumption patterns of different income groups in the 1960's but its social bias was never discussed. In any event policies based on that mode of thinking tended to perpetuate an unequal situation and consign an entire group into 'designed' inequality. The consultant in charge of the Northern Collector has decided to increase the allocation of water for very low income earners to 30 lpcd and has further assumed that many will connect to the network in the near future and then be allowed 60 lpcd.

In planning the scale of new expansion of the WS system, engineers must estimate the amount of water customers are expected to use. This estimate is usually based on a population growth forecast to which

is assigned a design demand factor that allocates a daily amount of water usage to various customer profiles.

Interviews held with various stakeholders in the water sector in Nairobi revealed that design demand is normally taken as “a given,” an engineering norm rather than a variable [41]. In practice, design demand is usually based on existing metering records and the conditions in which the metering took place (water prices and scarcity) are usually not discussed [42]. Although it does not guarantee equity of access to water, an equitable water design demand should estimate the patterns of consumption of different customer profiles under certain assumptions. A well-designed supply will provide enough water to the entire population and ensure the continuity of supply. Failure to do so will see demand quickly exceed supply resulting in an intermittent supply and resulting negative side effects.

Water demand refers to the volume of water consumers can afford to consume in a context of unrestricted supply and under a certain demand management strategy. Usually lifestyle impacts on design demand. A garden to be watered, the number of showers, bathtubs, and cars to be washed all impact on consumption. Among lower income earners demand will be lower if bucket showers are used, in the absence of a flush toilet, or when water saving strategies are in place. Also considered in design demand is the type of water source: being connected to an individual or shared connection has a strong impact on consumption. Generally unconsidered in the design demand is the influence of different water demand management measures such as water pricing: low pricing can translate into excessive demand [43, 44].

In Nairobi, the stark socio-economic differences that exist between higher and lower income earners result in very different water needs. The operator is not accountable for these socio-economic variations but is nevertheless accountable for *servicing all customers equally according to their needs*. From the perspective of the Right to Water, the volume of water that is allocated to the customers at the bottom of the pyramid should reflect the operating philosophy of the water sector as a whole. According to the WHO (Figure 9), the quantities which have been traditionally allowed for unconnected poor households can only cater for a “short term – survival” way of life [45]. To live a decent, yet simple life that includes personal and clothes washing, it is recognized that 40 to 50 lpcd are required [46]. It is a fundamental right granted by the Kenyan Constitution that this class of the population is catered for with appropriate amounts of water planned for at the design stage.

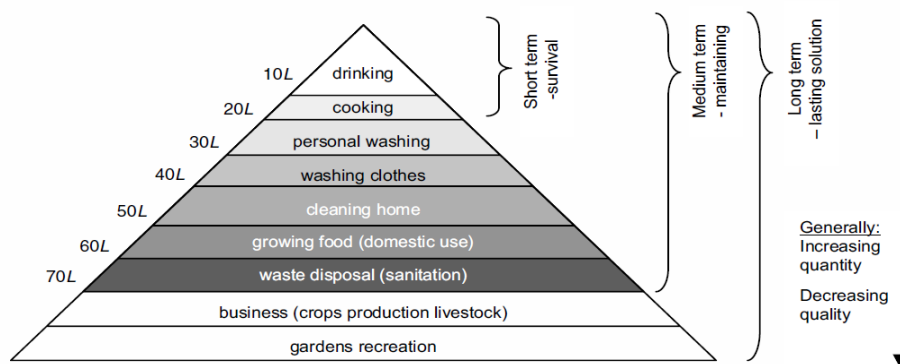


Figure 9 - Hierarchy of water requirements for domestic use (Source WHO)

Under British rule design demand was based on race. In 1945, for instance,

225 lpcd was planned for Europeans, 135 for Indians, and 112 for Africans. After independence, racial

discrimination lingered in the water legislation for many years [36]. However, in Nairobi, the design demand is now apparently now based on income classes rather than race.

Current design demand in Nairobi is based on the metering records from 1969. Indeed, the design demand advocated by the MWI in the Practice Manual of 2005 closely follows those figures [5]. This design allocates a vast amount of water to the upper-income class (250 lpcd) and very little to unconnected, poor households (15 lpcd).

The appropriateness of the consumption pattern described in the 1969 design demand figures has been given little recent discussion. [28]. The 1969 situation represented an inequitable situation where part of the demand, notably for the urban poor, was not met. Designing demand based on that situation will lock an entire group into structural or “designed” inequity. Since 1969 (see Figure 10) lower income groups have been allowed only a very small volume of water, i.e. less than 20 lpcd. As low as this figure is, one must also take into account that water consumption from water kiosks involves other costs such as energy spent fetching or time waiting in line; factors that tremendously limit real access to water. It is totally obvious, therefore, that a good design should build in increased the coverage of piped water to underserved areas.

In designing the Northern Collector, the consultant hired by AWSB (EGIS-2011) made several assumptions which indicate a change in practice. Although similar to the MWI prescriptions (2005), EGIS has increased the *lower income group without individual connection* (NIC) allowance from 20 to 30 lpcd. It also assumes that by 2035, an additional 15% of lower income earners will get individual connections and be allowed 60 lpcd (achieving 80% coverage in the lower income group). In addition, according to consultant sources, 50% of the overall population will be middle income earners with needs of 120 lpcd. Although this definition of the middle-income group seems to encompass a much greater percentage of population than Nairobi’s reality, this optimistic forecast, if borne out by events, would help secure the future of Nairobi’s water supply.

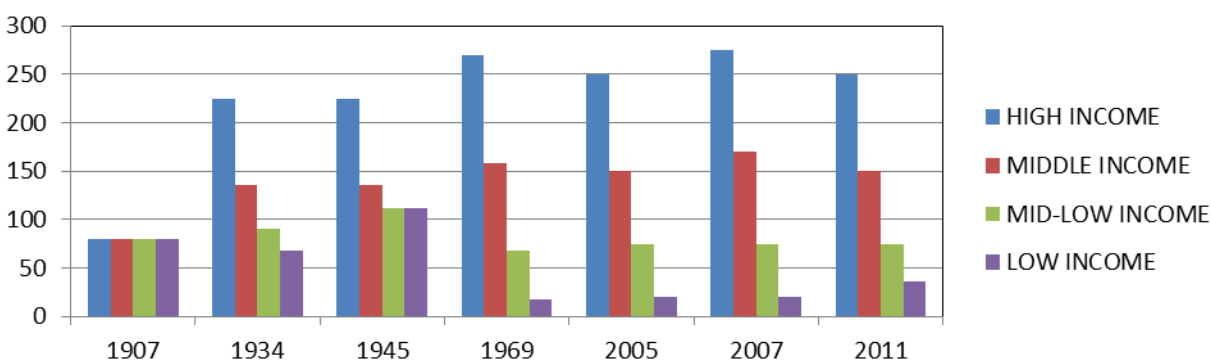


Figure 10 - Design demand (litres per capita per day) for domestic use for different consumer profile in Nairobi between 1907 and 2012. Up to 1945 the classes were based on race, whereas the figures from 1969 are based on economic groups. UfW is constant 25% within the planning period. Sources: Bransby Williams 1907, Colony and Protectorate of Kenya 1934, Colony and Protectorate of Kenya 1945, Nairobi City Council 1969, MWI manual 2005, Seureca 2007, Egis Bceom 2011.

6. Distribution network: A question of pipes

6.1. Design of the network and its legacy

The impact of a dysfunctional network on service delivery. Nairobi is short of water and some demand cannot be met. An equitable rationing scheme should consider the needs of different areas, their respective capacity to store water and their population density. To do this, the operator requires an efficient network. Different pressure zones must be well separated from one another with bulk meters and valves in the right places. However, there are also operational issues affecting efficient operation of an intermittent water supply. Without addressing those issues, areas with better water storage and lower population density will be favored. It is also known that entire residential areas are located too far downstream of the network (east and southeast) and do not receive sufficient pressure. Nevertheless, both of these matters should be tackled with WS IV.

During the colonial period the design of the network reflected the priorities of the ruling colonial elite. Raw water was mainly supplied through the Kabete Scheme where transmission lines meet at Kabete, above the City Centre to the west. Under this scheme only the City Centre and the suburbs in the western elevated areas could efficiently be serviced. Water services were provided in African housing areas, but Nairobi City spent only a small percentage of its budget in African areas which were largely neglected [47, 48].

After Independence the growth of the distribution network came from expansion of water supply under the Chania scheme (or Ngethu System) promoted by the World Bank through the First (WS I: 1970-1977), Second (WS II: 1978-1984) and Third (WS III: 1985 – 1995) Nairobi Water Supply projects. The Chania Scheme brings 85% of the water into Nairobi through transmission lines that meet at Gigiri, nearly a hundred meters lower than Kabete. For the first time water was channeled to the growing eastern region. WS II provided critical new mains, allowing the development of the industrial sections and other residential areas south of the city. The eastern section of the city especially benefitted from WS III, with the construction of a new main that by-passed the city centre from the north and serviced all the new Site-and-Service schemes (Urban I and II) [30, 39].

The configuration of the water supply expansion has a strong influence on the way water is distributed in Nairobi. 85% of the bulk water arrives at Gigiri reservoir (tower water level TWL: 1,711m) and only 15% at the Kabete reservoir which is slightly higher (TWL: 1,818 m). The lower supply area fed from Gigiri, is thus privileged. However, localization in the upper supply area of high-income, high-consumption users creates a demand that is difficult to meet under the present supply setting. Large volumes of water, therefore, have to be pumped up from the lower area (Gigiri) to the water-starved areas fed from Kabete. Despite this topographical disadvantage, the upper areas remain the biggest consumers.

According to the World Bank, one of the most effective improvements has been the zoning of the system undertaken in 1987. This allowed for separate monitoring and managing of the supply of water in 11 distribution zones. Today, however, the network is described as inefficient by NCWSC and despite

the 1987 upgrade it is currently impossible to measure and control how much water flows into the different pressure zones [30]

The network was never designed to operate on an intermittent supply basis [49]. Efficient rationing implies that different water pressure zones are well defined and can be easily made independent by a comprehensive set of valves. In Nairobi, entire regions are poorly serviced because they are dependent on how much water is being consumed in other areas upstream between them and the source. At the local level, rational water allocation is practically impossible because the staff has poor knowledge of the system, there is a lack of bulk meters and many valves do not work. Despite an attempt in 1998 that was not successfully implemented [50], the system has not benefited from any major improvements since WSIII, almost thirty years ago. However, a Kenya Water and Sanitation Service Improvement Project (WaSSIP) is now under preparation and that will aim to tackle this issue [49].

A series of measures should be taken in order to improve the functionality of the network in order to improve water demand management in intermittent supply conditions (Source: NCWSC):

- Providing certain disadvantaged areas (that are distant from the source) with their own independent mains (Embakassi and Ruai).
- Redesigning parts of the network to define clear and independent pressure zones.
- Installing efficient valves and pressure and flow monitoring devices.
- Developing a network model that facilitates rational rationing.

AWSB, however, is legally responsible for managing and improving the network. It looks as if NCWSC is being asked to operate failed infrastructure without the means and resources to carry out the needed replacement and rehabilitation of assets. The operator is dependent on AWSB but the financial arrangements binding NCWSC, AWSB, and the owner of the assets, CCN, do not incentivize AWSB to engage in efficient asset management.

6.2. Obstacles to increasing coverage

Expanding individual connection coverage in slums faces many obstacles. Most of the people still unconnected to the network live in slums. For poor households, the cost of getting connected is a disincentive as it can amount to the cost of one year of water supply. For owners of dwellings upgrading carries risks associated with land tenure and maintenance. For the utility, installing and operating infrastructure costs more in slums than in formal areas. First, with the present inadequate supply, the utility has no room for expansion. Second, investment is risky as land-tenure is unsecured. Third, it is costly: there is little public space left and conventional technology does not suit the physical layout. Fourth, people must be moved and many stakeholders are involved. Moreover, the cost of administering such areas is much greater than in formal areas, with well planned, demarcated, and identified plots.

The percentage of households using a metered water connection, or the Piped Water Coverage, is one of the main performance indicators of an urban water utility. Good access to piped water usually results in higher consumption. The only real solution for improving service to all is to invest in connecting poor

households to the network [51]. This is the only way that such households will get access to formal, cheap, and subsidized water.

Nevertheless, both the customers and the utility face obstacles and disincentives that do not promote expansion of the network in lower-income areas.

6.2.1. Obstacles for households

Individually metered tap water may be the best option for the well being of all households, but it comes at a high price that represents a serious problem for poor households newly connecting. As well as the tariff per volume of water there are other associated charges for the installation of an individual metered connection [52]: these may include connection fees (minimum 2,500 KES), meter rent (min. 50 KES), deposit (min 2,500 KES), and re-connection fees (min. 500 KES). All the costs incurred by the utility to build small reticulation pipes must be paid by the connection owner. Due to unrealistically high standards in planning and in the building code, all this often comes at an unaffordable price. By way of contrast, a household of four persons consuming 20 lpcd at a rate of 5KES per jerry can for a year will spend only 7,300 KES in total. This suggests that the up-front high real cost of individually metered water is a strong disincentive for households to connect [2].

It is normally the responsibility of the owner to pay the charges for connection. But in informal settings, land and housing structures are insecure so capital investment is risky. Landlords are unwilling to invest because of concerns about infrastructure cost and maintenance. Tenants are generally unwilling to connect because their investments would constitute an upgrade of the landlord's property. Finally, poor households often have fluctuating incomes that make a formal monthly billing system problematic. In conclusion, individual connections are not the preferred option in informal settings. Informal water vendors can, therefore, appear more appropriate to consumers: although pricier on the basis of volume, they carry fewer transaction and set-up costs and so offer more flexibility and reliability [2].

6.2.2. Obstacles for the utility

Informal areas have traditionally been seen as ungovernable and unserviceable by water utilities: it is often thought that illegality and vandalism are rampant and that people are unwilling to pay for improvements. But perceptions are changing and such areas are now being seen more often as a good market for expansion. Indeed, because of their numbers, slum dwellers represent a very large share of the market and their willingness to pay for water is high. This demonstrates that they are bankable. Increasing sales while reducing NRW (especially by legalizing illegal connections) is another commercial incentive to expand coverage.[33].

On the other hand, the utility also faces some obstacles that prevent it from expanding coverage. The first is that NCWSC has little room for expansion in the present situation. NCWSC does not own the assets (the network) and is not legally responsible for them (AWSB is). Secondly, supply is already insufficient so expanding the number of households connected to the network would mean more rationing in other neighborhoods. Expansion in the lower income neighborhoods is only feasible through a reduction of consumption in the higher income segment but this is politically and commercially sensitive.

Another obstacle is that investing in the informal areas implies much higher transaction costs than in formal areas [33, 53]. In these contexts where servicing comes at the last stage of urban development and many occupiers are already in place, it is difficult and costly to put in a new distribution network.

Nairobi slum locations are usually rather inaccessible areas that are unsuitable for construction: land with insecure land tenure status, geologically risky zones (flooding, landslides); near dumpsites, airports, energy transmission lines, railroads, high industrial pollution areas, and even in public parks. The fact that housing should not be allowed in the first place constitutes a risk for the investment of infrastructure by the utility [33, 53]. Nairobi slums' physical structure and layout characteristics also constitute a problems for the implementation of conventional water system [54]. Slums are both densely built and populated, plots are generally entirely built-up and little space is left publicly accessible (on average, only 13% of total space in the slum [3]). As a result, it is sometimes impossible to provide WS facilities because of lack of available space. In addition, high population density means that improvements involve many stakeholders with conflicting interests.

Whether the layout adopted in the informal settlement is orthogonal or spontaneous has a strong impact on the possible improvement of WS conditions [55]:

The orthogonal layout corresponds to a traditional form often adopted in a planned occupation where the topography of the terrain has little influence [56]. Orthogonal layouts are better used on flat land and offer a good base for subsequent improvements [57]. They allow for installation of an orthogonal WS network, with clear subdivision of plots, which makes them more economically, administratively, and operationally efficient to service. In contrast, when this orthogonal frame is applied to steep terrain, road system installation and construction of buildings requires major grading and soil movements which then become a disadvantage [56]. In Nairobi, Mukuru slum and the villages Nyayo Kisumu and Ndogo in Korogocho slum display this kind of layout (Figures 11 and 12).



Figure 11 - Orthogonal layout in Mukuru Slum, Nairobi – Source: Quickbird 2009 Adapted by Flores Fernandez

Spontaneous layout corresponds to a conglomeration of houses where the street layout has developed spontaneously into a labyrinth of internal, winding, and narrow streets without overall planning and is determined by largely by the terrain. On the positive side, this layout highlights the skill and creativity of slum dwellers in the appropriation of land [58] and infrastructure installation on this layout does not require grading of the terrain and heavy earth moving. On the negative side, the organic and labyrinthine shape of the layout makes infrastructure very complex to install, monitor, administrate, operate, and maintain. A conventional network requires superimposing an orthogonal layout on the existing one at the expense of displacing many households.



Figure 12 – Spontaneous layout in Korogocho slum, Nairobi – Source: Ministry of Local Government, 2009

Water kiosks are a more viable option for the utility in the informal context: they do not require an extensive distribution network and their establishment costs are relatively low [59]. But even water kiosks still present obstacles. Investment in water kiosks is often guided and stimulated by NGOs wanting to increase their visibility. This has led to some poor investments, random rather than rational kiosk distribution and some unhealthy competition. Kibera, Nairobi's most publicized slum, has a disproportionately large number of kiosks.

The standards required by the building code for infrastructure development are often unaffordable in slums. This results in pipes of insufficient diameters and poor quality and a high incidence of bursts and breakage in the network. In Kibera, 75% of kiosks use water supply pipes of between $\frac{1}{2}$ and $\frac{3}{4}$ of an inch and this results in discharge rates of less than half that recommended by MWI [59]. Fortunately, building code standards have been relaxed recently, and NCWSC has been able to find pragmatic solutions [53]. The utility has recently developed strategic guidelines for recognising opportunities, obstacles, and coming up with pragmatic solutions for improving service in slums. The utility has a scheme to invest in water kiosks for which they provide water at a subsidized flat rate tariff of 15 KES/m³ while fixing the price of a 20 liters jerry can to 1 shilling (50 KES/m³)[60]. Despite these efforts, NCWSC still maintains its public strategy to construct around 10km of small-size reticulation, 1km of sewer line and 25 public toilets/ablution blocks in informal settlements on an annual basis.

The utility often suffers from poor customer confidence in its meter reading and billing process. Often meter readings are months behind. Bills are issued late and irregularly and the majority of kiosk owners either pay late or not at all [61]. In addition, the utility's water supply efforts can be frustrated because both water supply and water prices are illegally controlled by cartels. Cartels cause artificial water shortages as a way of boosting business, hiking prices to KES 20 per jerry can instead of the authorised KES 1 [62]. Installation of new water points can also involve the bribing of numerous "gatekeepers," costing up to twice the official fee (8,000 Ksh)[63]. These issues indicate some of the difficulties faced by NWSC in trying to operate in a market where competitors can make use of illegal means including violence to achieve their goals.

One of the best examples of successful water kiosk project development is the Kosovo project in Mathare. The project was a partnership between Mathare-Kosovo residents, NCWSC, Pamoja Trust, and financing institutions (Water Services Trust Fund and the Abika Mashinani Trust). Beyond simply providing access to water, the project used participatory capacity development approach to training kiosk operators and Pamoja Trust, a local NGO, developed a loan system (microfinance) for Kosovo residents who wanted individual connections but could not afford the survey and deposit fee [62].

7. Water Demand Management: dealing with available water

Water pricing could promote equity, but instead it promotes waste. In Nairobi, a “pro-poor” Increasing Block Tariff (IBT) should allow high consumers with higher purchasing power and more marginal use of water to subsidize low consumers with lower purchasing power and more vital water needs. But the IBT is actually too low to promote equity. There is also, of course, the fact that most poor cannot access the IBT because of their lack of a metered connection. As a result, price has no effect on demand: the rich consume an excessive amount and strain the supply, leaving little for the poor. The last price hike, which came more than ten years after the last indexation, only allowed the provider company to cover its operation and maintenance costs. There is ample evidence to show that households are willing to pay more to access more water: households are prepared to invest in storage capacity and pumps, and pay higher rates to unregulated alternative suppliers. Pushing the price to a seriously higher level that would lower wealthy consumer demand and bring more water to the poor requires political will.

7.1. Water Demand Management Mechanisms

Demand management is the implementation of a strategy by a WS provider to control the amount of water needed across its operating system. Demand management is particularly important to achieve sustainability with a limited water supply. Multiple objectives of demand management can include economic efficiency, social development, social equity, environmental protection, or political acceptability [64]. Various techniques are used to manage demand e.g. design demand, operating an intermittent supply, NRW management, water pricing and general water-saving measures.

As in many developing countries, demand management in Nairobi has mainly been operated on a crisis management basis. This means that measures are often not taken as a result of rational and proactive planning but tend to be based on individual manager experiences and customer complaints. However, in the wake of new investments in the WS system and recent institutional reforms, the need for better demand management is making its way into the operating philosophy of the water sector in Nairobi. The need for better pricing, better understanding and management of the distribution network and more efficient management of available water is now starting to be recognized by the water sector as a whole.

But despite recognition of the need for better water management, especially in a situation of water shortage, the utility faces challenges in implementation. The utility must deal with the legacy of years of poor management that has left it with an inefficient distribution system, bad managerial habits, and regular political interference. In addition, new measures must meet the objectives defined in the Water Act. The utility must operate on a commercial basis under the restrictions and conditions set in different legal documents - the Act itself, the AWSB license or the NCWSC SPA. Today, it can be said, commercial incentives are strong and regulatory incentives tend to promote economic and operational efficiency. But the political influences from which the sector was supposed to have been freed in 2002 remain

powerful. If external influences prevail – along with the physical and institutional constraints - then there are risks that water demand management can promote inequity.

7.2. Water Pricing

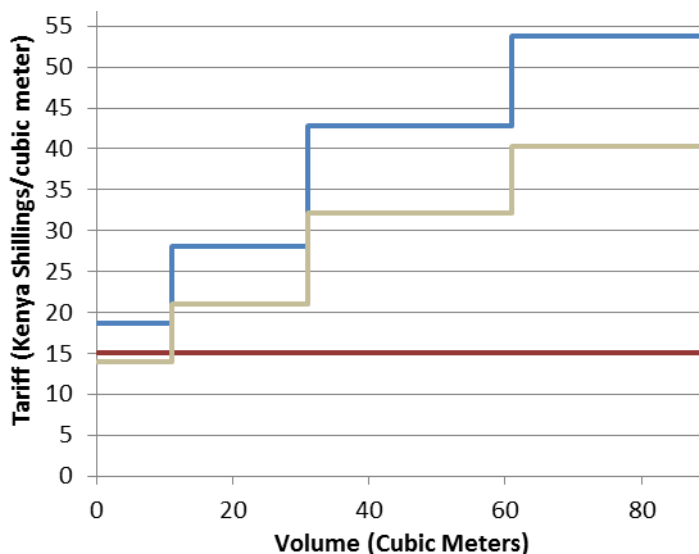
7.2.1. Implications of pricing water

In the past, water was distributed to the users almost free of charge because it was considered a relatively cheap and abundant basic resource. But as communities have grown bigger, distribution has become more challenging and capital intensive. Water pricing is a natural tool to promote equity, efficiency, and sustainability of the water sector. As the general consensus has slowly come to recognize recognizing water as an economic good, economic theory implies that *when the price of water reflects its true value, the resource will be put to its most valuable uses* [65].

The true value of water can be defined to be at least as high as what customers are willing to pay for it [66], though the value of water may be higher for the first few vital cubic meters then diminish as demand is fulfilled and water is used on less valued uses (e.g. washing the car)[67]. Today there is a consensus that the price of water should be “fair” and at least cover the costs pertaining to its production and distribution. Full-cost recovery for the utility consists of covering all the costs of operation and maintenance (O&M) and capital charges. On top of these costs, one might also fairly add others such as opportunity costs and externalities related to the consumption of water.

In a water-scarce system, consumption by some users can deprive other users of water. If those other users place a higher value on the water, then there are some **opportunity costs** experienced by society due to this misallocation of resources. It can be argued that high consumers tend to use water in a way that produces less social and economic value (lawn watering and car washing) as opposed to low consumers that use most of their water for vital activities that are fundamental to their well being. Water allocation can also result in either **positive** or **negative externalities**. It is known that adequate water supplies directly affect health conditions for the whole community and promote its general well being. These externalities should result in additional costs to users who impose them on others.

Figure 13 - IBT in Nairobi



7.2.2. The Increasing Block Tariff structure (IBT)

An Increasing Block Tariff structure (IBT) is used in Nairobi. This tariff structure takes opportunity costs and externalities into consideration to some extent. The IBT stipulates increasing prices for two or more specific blocks of water. The IBT is considered a progressive tariff as it provides for a lifeline block that

targets poor households with a subsidized tariff and charges higher prices to households using more than the minimum volume. This structure therefore allows rich-to-poor cross-subsidies and tends to promote equity (Figure 13 - IBT in Nairobi).

One of the conditions for the Increasing Block Tariff used by NCWSC to be effective and efficient is each household having an individual metered connection. But in Nairobi many people rarely use such a connection as they rely on shared connections such as communal yard taps. Combined consumption through shared connections brings overall water consumption into higher tariff blocks, thus making poorer households pay more shillings per unit of water than privately connected households. Furthermore, in informal settlements and slums very few households have individual metered connections so most users rely on water kiosks which, despite their subsidized rates, are often much more expensive.

7.2.3. Does the IBT promote cost recovery?

Until 2009 when the tariff was last modified, tariffs had remained unchanged (and not indexed to inflation) for over ten years. In 2007, as a result of inflation, the WSP margins had been considerably compressed and the average price charged for water could barely cover operating costs (See Table 4). Furthermore, since those calculations are based on billed water sales and not actual collections, the amount recovered by the service provider was lower.

Table 4 - Tariff Statistics 2007
Average tariff (US\$/m3): 0.41
Average operating cost (US\$/m3): 0.40
Operating cost coverage ratio (OCCR): 1.025
Source: Global Credit Rating Co. 2008

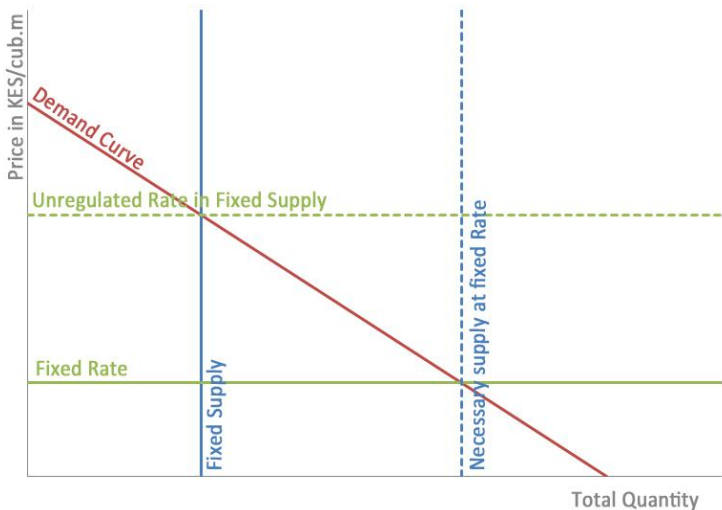


Figure 14 - Simplified Supply & Demand model in restricted tariff and supplies (after CHOE, 1996 [51])

However, a study ordered by the AWSB in 2007 recommended that tariffs in Nairobi should be increased by at least 75% and 300% for water and sewerage respectively and that a tariff indexation policy should be adopted until full cost recovery is achieved [68]. Following this recommendation AWSB increased the tariff of each water block by 56% on the 1st of June 2009 [52]. According to WASREB [18], in 2010 NCWSC achieved an operating cost coverage ratio (OCCR) of around 126% which suggests that the company was under no financial stress.

7.2.4. Does the IBT match the real value of water?

The real value of water is higher than the amounts charged by NCWSC. This is clearly shown by the following demand curve diagram (Figure 14).

On the one hand, the company cannot expand its supply easily (on the diagram the supply curve is a vertical line). On the other hand, it is constrained to operate at a fixed rate. If every customer could freely access water at this fixed rate, the total supply would be much greater. This quantity is what engineers try to estimate in the design demand.

Because demand is in excess of supply, intermittent supply is prevalent in Nairobi. Since customers are willing - and, of course, this is allowed in a free market - to pay more than the fixed rate to access extra water, the unregulated rates charged by alternative water suppliers can reach up to 500 times the lowest tariff block. The money paid to alternative suppliers is called the customer surplus. In economic terms it represents a fund, inaccessible to the utility, that customers are willing to spend on top of the NCWSC rate to access more water than is otherwise available to them.

7.3. Non-Revenue Water

Tackling the issue of high levels of non-revenue water (NRW) could negatively affect the poor. In Nairobi the volume of water not billed is around 40% (leaked or not metered). This means every twelve hours the daily yields of Sasumua and Ruiru dams combined are lost. NCWSC has begun an official crusade to reduce drastically this very high rate of NRW. NCWSC is doing this through capacity building and better management tools: mapping the network and meters, computerized mobile billing, and expansion of the motorbike fleet of meter readers. NCWSC is also acting to reduce illegal connections by investing in problem areas and gaining control over unregulated suppliers. Fewer illegal connections and fewer leaks should translate into more water at a more affordable price. The issue to note is that the utility has an incentive to deliver less water to problematic areas, because they commonly have more illegal connections, more physical leaks, and house less reliable consumers.

Sources indicate that in 2009 around 40% of the bulk of water which enters the city distribution system in Gigiri and Kabete is not billed to the customers [69, 70]. This Non-Revenue Water (NRW) is often referred to as Unaccounted-for Water (UfW) in Kenya. Such water losses are important costs to the water utility and are a strain on the utility's financial stability. Seureca [50] estimated that in 1996, roughly 25% of the supply was lost through physical leaks, another 25% was lost through commercial leaks (see below) and that these rates have dropped to a combined 40% since the corporatization of the utility [71]. To emphasize the importance of controlling water losses, reducing NRW by half would save the equivalent of the yield of Sasumua and Ruiru dams combined every day. Better control over NRW would provide additional supply to meet demand, enhance revenue, promote cost-recovery and possibly help to postpone the need for tariff increases and large capital investments in additional supply.

NRW has three components: physical (or real) losses ([See chapter 7.3.1](#)), commercial (or apparent) losses ([See chapter 7.3.2](#)), and unbilled authorized consumption ([See chapter 7.3.3](#)) [26].

7.3.1. Physical losses

Physical losses refer to all the water that physically leaks out of the system between the input point and customer meters. These leaks could be overflow at the storage facilities or result from burst pipes. But the vast majority of the losses are actually caused by small invisible leaks, which, because they are hard to pinpoint, can leak small amounts over a long period causing more water loss than a dramatic visible burst that leaks a large amount at once.

Using modern asset management tools and available technology for leak detection, repairs and pipe replacements are the first steps in keeping physical losses low. It is also essential to have an efficient control system to detect leaks and repair them as fast as possible. Reducing physical water losses is a laborious activity requiring constant dedication from a skilled staff with adequate capacity, technology and funding. It also requires working in difficult conditions (at night and along roads).

Detailed and up-to-date maps of the locations of pipes in the distribution system are not available. NCWSC is working on developing a GIS database of their system that will improve its management. Based on data from 2004, Sogreah reports an average of three months for fixing a leak. The number of leaks being identified, however, is on the low side. That indicates only visible leaks are being tackled [72]. In Nairobi some of the pipes are now over a hundred years old and have not been replaced since their installation. This is particularly the case in old colonial neighborhoods east of the city center, where poor service performance is reported. In slums, because the infrastructure is often of sub-standard quality, there are bound to be more frequent bursts and leakages.

7.3.2. Commercial losses

Commercial losses refer to all of the water that actually reaches customers but that is not billed. Causes can be legal e.g. when meters are not working or billing is inaccurate. Causes can also be illegal e.g. when individuals make an illegal connection or if meter readers are bribed to take low readings.

The way to reduce commercial losses is to ensure every consumer has a registered metered connection, managed in a sound database that supports an efficient billing system. The utility must allocate staff to install new meters, repair and replace defective meters (with penalties for meter interference), regularize illegal connections and have well trained and equipped metering teams to carry out such work. Working on detecting illegal connections and suspending service for those who don't pay their bills is unpopular, and can be dangerous. Staff may also lack motivation as they can lose substantial additional (though fraudulent) income. [26].

NCWSC has strong incentives to reduce NRW coming both from its commercial orientation and from the regulatory framework. NCWSC is currently working on updating its customer database in a GIS format and improving its billing system. It has introduced new means of payment such as MPesa, it has expanded its motorbike fleet in 2011 (NTVKenya, January 2011) and has intensified campaigns to remove illegal connections and install meters in problematic places [71]. NCWSC has also adopted strategic guidelines on increasing coverage in the slums which should result in more "formal" water distribution in those areas [60]. If commercial losses are fought by increasing formal coverage, this strategy will promote equity as it will provide subsidized access to water as well as extra water supplies. Many obstacles remain, however, to increasing coverage in the informal settlements.

7.3.3. Unbilled authorized consumption

Unbilled authorized consumption includes water used for operational purposes, firefighting, and water provided to certain user groups for free. This component is deemed to be under the control of the utility although it is dictated by political, health, and safety needs.

7.4. Intermittent water supply

Water rationing at the city-level favors the wealthy and at the neighborhood level it disfavors the poor. Water allocation in Nairobi is operated at the city-level through “the corridors” and at the neighborhood level through “the regions” (along with billing, customer care and technical assistance). City-level rationing favors a specific income group in that of the four corridors in the city, only one is never closed: the corridor supplying the upper and wealthier area. The three other corridors servicing the lower area are rationed nearly equally. It is true that to allocate water equitably among neighborhoods, the operator would need to consider their specific population density and water needs and at present it lacks the technical capacity to do this. Also, as mentioned above, there is an incentive to favor certain groups to reduce NRW. So, overall, we see that lack of rational allocation and pro-poor incentives results in inequitable supplies, poor pressure and worsening water quality.

7.4.1. The negative side effects of water shortage

At the time of this study, the city of Nairobi was in a state of structural water shortage and will remain in this situation until 2016 according to even the most optimistic scenario [40]. To cope with scarce water supply conditions, the NWSC operates an intermittent water supply (IWS) and limits consumers’ access to certain time periods. IWS is common in cities of the developing world [73-75]. IWS is regarded as a strong demand management tool to moderate the negative side effects of water scarcity. Utilities accept IWS as a normal constraint: demand exceeds available supply so water must be rationed in some way. But IWS needs to be seen and operated as a water allocation tool otherwise there is a risk of water quality deterioration, poor pressure and inequitable distribution.

Inequitable distribution. In order to access extra units of water, households are willing to spend on coping mechanisms either investing in their own storage capacity or buying water from vendors who have access to storage capacity. This causes inequity because the supply is fixed and increased storage by individuals reduces the supply available to others. Because the affordability of such coping mechanisms varies across income groups, this inequity falls hardest on those who have low investment capacity i.e. the poor. [54, 60] To counter this negative effect, the operator should regulate vendors, regulate storage capacity or regulate the water that flows into the system by different methods of operating the intermittent supply. The negative effects can, of course, also be tackled simply by expanding supply or reducing demand though price increases.

Poor pressure. Access is not only linked to income but also to the specificities of the network. In IWS situations water pressure varies with time. Water systems are usually designed assuming that demand will be spread evenly over the allocation period or based on peak hour demand. But Nairobi demand is usually extremely high just after the restart of the supply, when many households are refilling their storage capacity at once. As the network is designed for continuous supply, it struggles to handle such demand. Also pressure in the system varies according to location both in terms of distance to the source and the altitude relative to reservoirs. Interestingly, informal settlements, often located in depressions of the landscape, are usually the last areas benefiting from residual pressures in the pipes. Often that residual pressure is most used to draw and resell water at a higher price in nearby better-off areas in need of water [76].

Densely populated neighborhoods tend to be disadvantaged. For instance, a high-density neighborhood that shares the same input pressure with a low-density neighborhood (if located parallel to it on the distribution network) will share its pressure with a greater number of households. This is the case for the two neighborhoods of Komarock (low-density) and Kayole (high-density) located in the Embakasi division [34]. Hence, without sensible allocation management, populous neighborhoods, which are also usually poorer, will experience a lower quality of service.

Deterioration of water quality. When the distribution system is empty, unpressurized (or even negatively pressurized when individuals illegally pump water directly from the mains) for a long time, contaminants in surface or sewerage water can enter the pipes through leaks. Although there is no evidence of this in Nairobi, such contamination has been reported elsewhere. Examples include the case of a paratyphoid fever outbreak in 1996 in New Delhi [77] or the general concern in Jakarta which has very low sewerage cover, though Jakarta also has to cope with regular serious flooding which can also bring contaminants into distribution networks. [2].

7.4.2. Water Rationing at NCWSC

Water allocation/rationing in Nairobi is operated at two levels: at the city-level through “the corridors” and at the neighborhood level through “the regions” where billing, customer care, and technical assistance are also managed. As mentioned earlier, water rationing in Nairobi is mainly operated on a crisis management basis and is highly constrained by the poor design of the network.

At the city-level, water is intermittently supplied from the headquarters in Gigiri to four main water “corridors” corresponding to the principal water mains of the city. Maps are not available but a broad

description is as follows: three main lower corridors together service the eastern and lower parts of the city and one corridor services the Upper Area in the western and higher parts of the city. These corridors correspond to the two main supply areas centered on the Gigiri Reservoir (Lower Area) and the Kabete Reservoir (Upper Area).

The three lower corridors are all rationed and allocated three or four days of supply per week. Certain areas like Embakassi or Ruai are more likely to experience water problems as they are located at the ends of the corridors. But the fourth corridor, supplying the Upper Area, is never closed down. This distinction in treatment is explained by the operator's will to supply for the very high demand characterising these upper and wealthier areas. Not only is the Upper Area is never rationed, but the operator actually strives to provide it with enough water. Sogreah (2007) estimated that the water deficit for the upper area could be as high as 49% [72]. The operator's problem is due to the specific design of the network which brings most of the water into the system at a lower altitude from which it must then be pumped upwards to level out the demand. It is interesting though perhaps not surprising that the first upgrade (presently underway) of the network designed in the Fourth Nairobi Supply Project is a doubling of the pumping capacity from Gigiri to Kabete to feed the demand of the Upper Area.

At the regional level, the available water coming from the corridors (sometimes from several corridors) is redistributed and allocated to different neighbourhoods by regional managers. The decision-making process is not transparent. Although it does not appear openly to discriminate against lower income earners it fails to address the differences of access to storage capacity. One of the results of shared pressure is that there can be inequitable distribution between households or entire neighbourhoods. Allocation is also often operated by regional managers in response to customer complaints; this favours those who are able to complain, generally the more educated groups.[33, 41].

7.5. Allocating water for more equity or more efficiency?

In Nairobi, allocation of water and performance monitoring is operated at the regional level. NRW and other performance indicators such as volume of water billed, collection ratio, and operating cost coverage play a key role in the allocation process. Although the operator may lack the capacity to allocate water rationally to well-defined distribution areas there are incentives in the regulatory framework and internal to the NCWSC which reward the favoring of certain service areas [34, 78]. By managing pressure and duration of the water supply, the operator can to some extent control the amount of physical losses through leaks or target certain sectors of the market [79] and this can lead to unequal allocation of water.

Water Pricing: Because NCWSC is obliged to work with a below cost-recovery tariff and at the same time required to be commercially and financially efficient, it has a strong incentive to target the parts of the market which are more economically profitable. High income earners consume more, and consume in the higher tariffs block of the IBT. **This favors higher income earners.**

NRW #1: leaks: Informal and slum neighborhoods have a higher number of illegal connections and more physical leaks due to sub-standard quality infrastructure. As a result NCWSC has a disincentive to

deliver large amounts of water in such neighborhoods as this reduces revenue and increases water losses. **This favors the formally planned neighborhoods and higher income earners.**

NRW #2: billing: Customer reliability can vary greatly across Nairobi. The more formal the neighborhood, the easier it is to identify addresses and specific water meters. In addition, consumers who buy more water incur less administrative cost per unit of water sold. On the other hand, the vast majority of lower income earners in Nairobi are tenants. Billing is operated through landlords who seldom live among their tenants. This creates an inefficiency and accountability loop: it is the landlord's duty to pay the bills, but he is not directly affected by disconnections so he is not incentivized to pay. **This favors the formally planned neighborhoods and higher income earners.**

Allocation: Without rational and transparent allocation of water that takes into account socio-economic characteristics, population densities and differences in storage capacity and variations in population the result will always be unequal access to available water: **This favors lower density neighborhoods and higher income earners.**

8. Conclusion: Achieving equity on the supply or demand side?

Is the inequity of service in Nairobi planned or inherited?

There are some factors outside the utility's control. The rapid uncontrolled growth of Nairobi and various forms of informal settlement have put pressure on water infrastructure and inflated operating costs. Over time a minority of wealthy people have accumulated privileges. Increasing supply in line with booming demand is not an easy matter: constructing dams is costly and requires time. But for the first time the up-coming water supply scheme for Nairobi at least includes some design decisions that consider the poor.

Some of the reasons are due to failure to act. These include failures to –

Design an institutional framework that considers the right to water for all (especially the poor) not only commercial orientation and operational efficiency.

Propose an efficient water demand management framework that allows the poor to get their share.

Adopt a real pro-poor water tariff to lower the demand from high consumers, discourage wasteful use of water and allow more water to the poor.

Ensure the benefits resulting from NRW reduction are converted into effective investments in problem areas.

Allocate available water equitably considering people's needs, neighborhood population density and water storage capacity.

Some of the reasons are openly discriminatory. Although the physical configuration of the supply and distribution system favors the lower and more popular areas, the operator constantly strives to pump more water to the never-rationed upper and high consuming areas. The doubling of the pumping capacity from Gigiri to Kabete is the first major upgrade of the system and is a clear priority for the operator. This clearly shows that despite recent apparent concerns for the poor, servicing the wealthy high consumers who consume and pay more and are more politically influential is still prioritized.

Nairobi is short of water. So it follows that some of the demand by residents cannot be met. At present better-off sections of the community are able to benefit from high consumption rates. This imposes a water stress on the rest of the population who get less than they need and often consume well below the recommended amount for living a decent life. At the same time low consumers pay disproportionately more for water because they have to rely more on alternative, unregulated water providers. In Nairobi's water scarce context where water has, in effect, to be rationed, and where alternative suppliers are unregulated, inequities can easily rise. Customers with higher capacity to access and store water take a larger share of the resource so increasing stress on the rest of the community. Unless the water utility takes action to counteract these negative side effects of water scarcity, even greater inequities are likely over time.

There are two common approaches to deal with such inequities. One seeks to expand the supply in order to meet the unmet demand. If there is always enough water in the system, coping mechanisms become unnecessary and every customer can access the water needed. If it is to work, this option must

also bring improved coverage so that even poor households can access water from an individual or communal tap at the subsidized rate. The other approach consists of managing demand in order to share the available supply equitably while taking into account varying abilities to store water. This implies using tools of demand management such as water pricing, NRW reduction and intermittent supply management.

In Nairobi water supplies have always been supply driven and demand management has never really been put into practice. The history of water supply in Nairobi can be described as a constant struggle to expand supplies to meet the increasing demand of a growing city. Today the strategy continues and the struggle is still going on. The latest up-coming expansion will use a design demand that will secure the supply for quite a while. Will it get rid of all inequities? Everyone hopes so and it should bring some relief to the water shortages in Nairobi for a time. But if Nairobi does not learn to manage, allocate and share its water equitably via demand management, water shortages will inevitably come back and inequity rise once again.

Furthermore any supply driven solution must be complemented by an improvement of access to tap water at a regulated, subsidized rate in the poor areas. It is a necessary condition for improving equity: it allows households to access the IBT, hence promoting affordability. It also reduces illegal connections and NRW and allows more formal water sales. Although the operator has developed strategic guidelines to improve services in informal settlements, many obstacles still and outcomes have so far been limited. For slum households, technology may be unaffordable to some local people and/or undesirable to others. For the utility, investing in these areas is risky for legal reasons and because vandalism and cartels or gangs are endemic. Furthermore, installation of infrastructure in such areas is costly, as informal settlements are highly populated, generally have little space for public installations, and often have layouts that do not match well with conventional infrastructure. It seems minds are slowly changing, foreshadowing a brighter future for the slums but real change on the ground still awaits political will and pragmatic action.

In addition, following a series of major water supply expansions, it is high time to redesign and clarify the legal and financial arrangements which bind Athi Water Services Board, Nairobi Water and Nairobi City Council. NCWSC operates a dysfunctional distribution network but cannot easily upgrade, expand it or maintain it because it is not responsible for it. On the other hand AWSB, responsible for the assets, also cannot do these jobs for lack of financial capacity and knowledge of the network. Meantime the City Council, owner of the assets, receives a lease fee for these assets but does not maintain or expand them...

On the demand management side there seem to be very few new initiatives. Water demand management is not as politically attractive as water supply management: it may be seen to affecting the lifestyle of affluent and there are no ribbon-cutting ceremonies as for the opening of a dam. Water prices are clearly too low to reduce higher income earners consumption, yet increasing the price would be unpopular and lead to an outcry.

Non-Revenue Water reduction has come to the top of the NCWSC's agenda. Reducing physical losses could contribute to supplying more water to residents and relieving the water shortage. However, the network is aging and has been poorly maintained. NCWSC lacks proper management tools such as

accurate maps and fixing leaks remains a troublesome undertaking. Reducing commercial leaks will allow the utility to increase its revenue, though it does not seem to be lacking in that area. It should also allow the utility to control over illegal connections that often supply unregulated water resellers. NRW reduction if properly directed could promote the availability of water through regulated and subsidized rates and improve service to all. Yet an all-out drive on NRW reduction could exacerbate inequity as it may make the utility reluctant to deliver more water in areas that are notorious for illegal connections.

Possibilities certainly exist for the operator to allocate water rationally and equitably in a way that accounts for people's needs. Nevertheless, allocating water in such a way requires both will and capacity. The level of willingness is dictated by the rules and incentives derived from the institutional framework. Although regulation and accountability are weak, the reforms induced by the Water Act in 2002 created a set of incentives that strongly promote operational and financial efficiency but not equity or maintaining minimum levels of service. While the institutional framework may not explicitly promote inequity it certainly fails to prevent it. It favours commercial orientation over social welfare. Allocating more water to the higher-income earners is incentivized through increased revenue, lower administrative costs and reduced physical and commercial leaks.

In terms of capacity, it might be argued that rational allocation of water is not achievable by the operator because the network was not designed to operate on an intermittent supply basis. This may be one reason why the strategies for dealing with water problems in Nairobi have always tended towards increasing supply as opposed to demand management solutions. The allocation of water at the local level fails to take into account differences of population density, socio-economic profiles, and capacity for water storage. This results in a differential in quality of services related to the level of wealth of the neighbourhoods. Allocation at the regional level within the system is often driven by customer complaints. This also tends to favour better off customers, usually the ones who complain.

The only really open and clear difference in servicing happens between the upper areas, which are constantly serviced, and the lower areas, which are always rationed. This aspect of water demand management in Nairobi is designed to fulfil the demand of the higher consumer. The doubling of the pumping capacity from Gigiri to Kabete is the first major upgrade of the distribution system in 30 years. It was prioritized over all other possible improvements of the network. This is totally contrary to the goal of *fair* water demand management under which a utility should strive to reduce the high consumption of a minority to benefit the majority of customers. Unfortunately, in Nairobi supplying the better off has been made a priority.

The poor design of the network cannot take all the blame for inequitable distribution. How can the network work efficiently when the city grows without proper planning and often against regulations? Nairobi is characterised by the informality of its development which constrain and put pressure on the utility's performance: the slums which have grown without formal infrastructure, seven-storey buildings which are reported to pump water straight from the mains and middle-class gated communities which have far outgrown their nominal approved densities with numerous extensions.

The only strategies so far pursued to alleviate Nairobi's water problems have been supply oriented. Demographic pressure on the infrastructure means water shortages chronically affect the city. There is no historical evidence that more water in Nairobi's water system leads to more water for the poor. Social segmentation of the population between a minority of high income earners and a majority of poor people was inherited from colonization, consolidated after independence and remains strong in Nairobi today. Little has yet been done to counteract inequities of access to water between the poor and the rich. Water management strategies which could result in more equitable allocation of water have never been implemented in Nairobi, partly because of lack of capacity, but also for lack of will: the water operator in the city tends to focus only on supplying the demands of high consumers while many poor people struggle to access even half of the amount they need to live a decent life.

9. Recommendations

RECOMMENDATIONS

On how to promote more equity of service in Nairobi:

By operating a shift from traditional "supply based" to "demand based" management: Nairobi has traditionally relied on new sources of supply to alleviate water shortages. An example is the planned Northern Collector project. However, as population and demand grow, the city should learn to use demand management to temper the negative effects of water shortages which will inevitably recur over time.

By sharpening the regulatory incentives for equity: The constitutional Right to Water has not yet been translated into the regulatory framework. Though the Water Act has brought improvements by promoting commercial and operational efficiency, it still needs to be amended to promote equity. The regulator should be given more powerful 'sticks and carrots', including through financial sanctions and rewards. The 'naming and shaming' strategies are ineffective.

By strengthening accountability: The WSBs are responsible for service delivery, yet customers have hardly any influence on them. The board should be held accountable by the promotion of tools to amplify customer voices such as Citizen Report Cards, GRUBS City-level, or MajiData.

By engaging in a debate on fair water pricing: Water pricing should be the subject of a debate on increasing the price for the biggest consumers in order to strengthen the cross-subsidies of the IBT.

By promoting technological change and investments in the network: The network should be upgraded to allow more efficient and equitable water allocation. Innovative financial and technological solutions should also be found to overcome the obstacles specific to problematic areas like the slums.

1. **Shift from the traditional “supply-based” to “demand-based” management.** Although the new Northern Collector scheme is coming, Nairobi will probably experience more water shortages in the near future. Kenya is classified as a water scarce country by the UN. Rainfall in Nairobi is unpredictable and some believe droughts may worsen under global climate change [80]. Nairobi water supplies are under great pressure from an ever-increasing population and consistently growing demand. There is increased criticism of the over reliance on supply-driven urban water supplies [75]. The real cost per cubic meter of water doubles with each new generation of water supply expansion projects as new sources are located further afield. The AWSB and the NCWSC should initiate a strategic shift and embrace the potential benefits of demand management to allow efficient use and equitable allocation of available water. This will not only improve the social welfare of the city as a whole, but it will postpone the need for even more expensive capital investments, hence saving money for the utility and the entire population.
2. **Sharpen the regulatory incentives for equity.** Since the new Kenyan Constitution was approved in August 2010, the Right to Water was granted to every citizen. Nevertheless, this right, and equity in general, are absent from the regulatory framework of the water sector in Kenya. Compared with financial and operational efficiency, equity is given very little attention under WASREB monitoring. To counterbalance the negative side effects of a commercially focused water sector, the Right to Water should be translated into real policy and regulatory incentives. This means that WASREB needs to integrate indicators for equity and pro-poor activities in its performance rankings of WSBs and of WSPs, and to give equity much more weight in the rankings. These indicators could measure inequity in the overall population based on the concept of the GINI Index or measure to what extent the Right to Water is achieved in sensitive areas such as the informal settlements. WASREB should also include stronger ‘sticks and carrots’ for performance on equity and MWI and donors should allocate grants and subsidies in relation to WSBs’ track records and performance on equity. The lease fees arrangements between the WSB and the WSP should also be reviewed and possibly linked to performance.
3. **Strengthen the “long route to accountability.”** The preferences and opinions of citizens and consumers should have a way through the policymakers of being translated into improved services. Presently, customers can only use their buying power to influence the WS Provider. It is, however, the WS Board that is legally responsible for WS delivery and customers must use their political voices through the Ministry to influence the Board. This “long route of accountability” is too long and too weak in Nairobi. The formation of local Water Action Groups and other user associations should be encouraged. Access to information is vital to make these groups effective. The Nairobi City-Level GRUBS study could be an interesting opportunity for those groups to enter into a dialogue with AWSB, NCWSC, and the City Council. Another initiative which could

help promote accountability of the sector to its customers is the MAJI data promoted by WSTF.

4. **Engage in a debate on fair water pricing.** Regulated water prices specified in the Increasing Block Tariff in Nairobi are too low to affect higher-end consumers. On the other hand, other customers that cannot access their daily water needs because of water shortages must pay inflated, unregulated prices to alternative water suppliers. Water prices should be subject to a debate involving representatives across civil society to increase the price for the highest consumers in order to strengthen the IBT cross-subsidies for the poor. In parallel, alternative water suppliers should be more strictly regulated in terms of price, water quality and water sources. Installation of storage and pumping devices should be subject to much stricter rules in order to prevent individuals from acquiring disproportionate amounts of water at the expense of less fortunate users.
5. **Equity requires technological change and investments in the network.** In order to achieve more equitable service provision in Nairobi there must be technological improvements. The water distribution system does not allow for rational allocation of water in conditions of water shortage. The network needs improvements to allow efficient and equitable rationing. In addition, the operator needs proper tools to manage the network with regard to the evolving population densities and socio-economic characteristics of different areas. Better services in the informal settlements must go hand in hand with increasing coverage. Strong obstacles exist for the dwellers to connect and for the utility to invest in those areas. Obstacles that are specific to such areas must be overcome by special public aid. This kind of aid should be driven by the realization that slums will remain until they receive full recognition, attention, and involvement of the public sector.

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