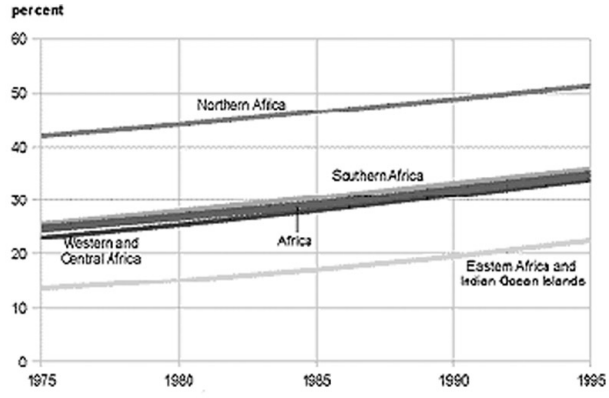
Chapter 7:

Water and Urban Environments

At the start of the 20th century, 95 per cent of Africans lived in rural areas. Even in the 1960s, Africa remained the least urbanized continent, with an urban population of 18.8 per cent. By 1996 this had doubled, and at least 43 per cent of the population is expected to live in urban areas by 2010 (UNFPA, 1997). Average annual urban growth rates in Africa from 1970-2000 were the highest in the world at more than 4 per cent, and these are projected to decrease slightly to about 3 per cent from 2020-2025 (UNFPA, 1997).

In North Africa, more than half the population now lives in cities while in southern, western and central Africa, urbanization levels are still at about 33-37 per cent. Eastern Africa is the least urbanized sub region, at 23 per cent (UNFPA, 1997). The differences in urbanization rates are even greater among countries. In a few, such as Algeria, DRC, Djibouti, Libya, Mauritania, South Africa and Tunisia, more than 50 per cent of the population now lives in urban areas, while in Rwanda and Burundi the urbanization levels are only 6 to 8 per cent (UNFPA, 1997). Major cities in Africa are experiencing rapid growth. Nairobi, Dar es Salaam, Lagos and Kinshasa grew seven-fold from 1950-1980, mainly because of rural-urban migration (Johns Hopkins 1998). From 1950-1995, the population of Cairo quadrupled from 2.4 million to 9.7 million. Lagos, Nigeria, is now even bigger, with 10.3 million inhabitants (UNFPA, 1997). In 1997, the largest cities in 24 African countries had populations of more than one million each (UNDP, 1997), nearly half of them in western and central Africa (Figure 7.1). Rapid urbanization is expected to continue for decades (GEO-2000).

Figure 7.1: Urban Population Growth by Sub Region in Africa



Source: GEO-2000

An estimated 81 per cent of urban residents have access to safe water and 66 per cent to sanitation facilities. The situation is worse in the rural areas where only 47 per cent of the people have access to safe water (GEO-2000). However, the urban statistics combine the richest and poorest residents in a single average, thereby disguising the daily reality of the poor majority in large slums who lack reasonable access to safe water. For their small share of water, the urban poor pay an unfair price, usually at least four and sometimes as much as ten times more per litre than the metered rates of those living in the elite residential areas (GEO-2000).

"Improved" vs. "adequate" provision of water and sanitation

Millions of urban dwellers have inadequate provision of water, sanitation and drainage, contributing to very large disease burdens and thousands of premature deaths each year. Less than half the population in most urban centres in Africa, Asia and Latin America have water piped to their homes, and less than one third have proper sanitation. Those living in large cities are generally better served than those in smaller urban centres. Low-income urban dwellers are often paying high prices for very inadequate water provision – for instance, purchasing water from vendors at 2-50 times the price per litre paid by higher income groups, who receive heavily subsidized water piped into their homes (Water and Sanitation in the World's Cities, 2003).

Targets

Millennium Development Goals (MDGs)
- Target 10: To halve, by 2015, the proportion of people without sustainable access to safe drinking water.
- Target 11: To achieve, by 2020, a significant improvement in the lives of at least 100 million slum dwellers.

The World Summit on Sustainable Development in 2002
- To halve, by 2015, the proportion of people who do not have access to basic sanitation.

The problem is not necessarily one of government's lack of funds. In many cities and smaller urban centres, it is possible to improve provision for water and sanitation in low-income settlements while charging their inhabitants less than they currently pay for inadequate provision. Governments and international agencies need to recognize that urban areas have particular needs for water and sanitation that are distinct from rural areas, and they also have particular advantages over rural settlements. It is still common for the same definition of what constitutes 'adequate' or 'improved' access to water to be applied to all urban and rural areas.

Table 7.1: Adequacy of Urban Water Supply in Selected African Countries

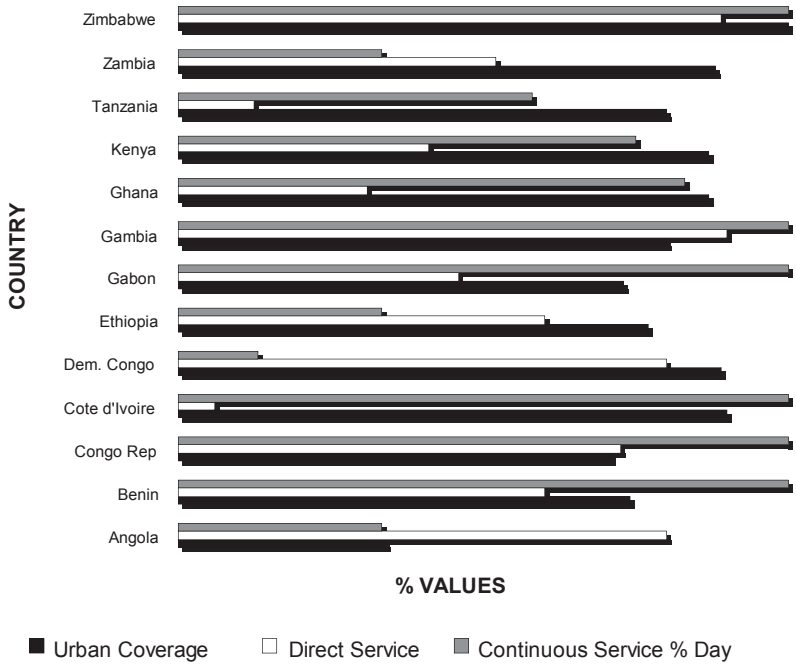
	Urban Coverage	Direct Service	Continuous Service % Day
Angola	34	80	33.3
Benin	74	60	100
Congo Rep	71	72.5	100
Cote d'Ivoire	90	5.9	100
Dem. Congo	89	80	13
Ethiopia	77	60	33.3
Gabon	73	46	100
Gambia	80	90	100
Ghana	87	31	83
Kenya	87	41	75
Tanzania	80	12.4	58
Zambia	88	52	33.3
Zimbabwe	100	89	100

Source: WHO

For instance, some governments classify everyone with a water source within 200 metres of their home as having adequate provision for water. But having a public tap within 200 metres of your home in a rural settlement with 200 persons per tap is not the same as having a public tap within 200 metres of your home in an urban squatter settlement with 5000 persons per tap. Urban settlements with large numbers of people concentrated in small areas present particular problems for avoiding faecal contamination if there are no sewers or other means to remove household and human waste. Many urban households have so little space per person that there is no room to fit toilets into each person's home. But urban settlements also provide more opportunities for high quality provision for water and sanitation, because unit costs are generally lower and urban dwellers often have more capacity to pay.

It is difficult to reconcile definitions of 'adequate' water and sanitation provision from a health perspective with definitions that allow data on provision to be easily collected. It would be easy to meet international targets for improving water and sanitation provision if the definition of 'improved provision' were to be set to low. In a sense, 100 per cent of urban (and rural) dwellers already have access to water and sanitation. No one can live without water. No city develops where there is no water. Virtually all livelihoods (and the economic activities that underpin them) also depend on water, directly or indirectly. The issue is not whether they have provision for water and sanitation, but whether they have adequate provision (Water and Sanitation in the World's Cities, 2003).

Figure 7.2: Adequacy of Water Supply Coverage



Data Source: WHO Regional Office for Africa

Any assessment of provision for water and sanitation has to be based on some implicit understanding or explicit definition of 'adequate'. In urban areas in high-income countries, 'adequacy' for water is considered as water that can be safely consumed, piped into each home, distributed by internal plumbing to toilets, bathrooms and kitchens, and available 24 hours a day. 'Adequacy' for sanitation means at least one water-flushed toilet in each house or apartment, a wash basin in the toilet or close by where hands can be washed, and facilities for personal hygiene – hot water and a bath or shower. And, of course, there must be an income level that allows all this to be paid for, or provisions to ensure supplies for those unable to meet their bills. If these are used as the criteria for 'adequate provision', most of Africa's urban population would have inadequate provision (Table 7.1 and Figure 7.2). Indeed, most have levels of provision far below this standard. In many urban centres in these regions, no one has this level of provision, because even piped water supplies to the richest households are intermittent and of poor quality. Most urban centres in Africa and Asia have no sewers, and in most of those that do, only a small proportion of the population is connected (Water and Sanitation in the World's Cities, 2003).

It can be argued that every urban dweller has a right to a standard of water and sanitation provision that matches the standards in high-income nations. Certainly, this level of provision produces great health benefits. It virtually eliminates diarrhoeal diseases and many other water-related diseases as

significant causes of death. It brings many other benefits too – including improved nutrition and often-higher real incomes and more employment opportunities for many of the poorest urban households. But it is unrealistic to set this standard in most low-income nations, since, with limited resources and limited institutional capacities, getting better provision for everyone is more important than getting very good provision for the minority. If the focus is on getting very good provision, the beneficiaries are likely to belong to the richer and more politically powerful groups. If we take 'adequate' water to mean a regular piped supply available within the home or in the yard, at least half of the urban population of sub-Saharan Africa (and perhaps substantially more than this) has inadequate provision . If we take 'adequate' sanitation to mean an easily maintained toilet in each person's home with provision for hand-washing and the safe removal and disposal of toilet waste, a very large proportion of the urban population of sub-Saharan Africa is likely to have inadequate provision (Water and Sanitation in the World's Cities, 2003).

Agenda 21

a. By the year 2000, to have ensured that all urban residents have access to at least 40 litres per capita per day of safe water and that 75 per cent of the urban population are provided with on-site or community facilities for sanitation;
b. By the year 2000, to have established and applied quantitative and qualitative discharge standards for municipal and industrial effluents; and
c. By the year 2000, to have ensured that 75 per cent of solid waste generated in urban areas are collected and recycled or disposed of in an environmentally safe way.

Management problems

For any metropolitan city, one of the basic and essential services by all standards is efficient service of water supply. Unless and until this demand is efficiently met, the health of the community and development activities will be highly affected. The inefficient organization of many water supply agencies is a serious deficiency. If the organizational structure does not promote or allow efficient operation then the overall management will function poorly. The key issues contributing to poor performance of water supply facilities were identified as (O&M Working Group, 2002):

- Inadequate data on operation and maintenance;
- Insufficient and inefficient use of funds;
- Poor management of water supply facilities;
- Inappropriate system design;
- Low profile of operation and maintenance;
- Inadequate policies, legal frameworks and overlapping responsibilities; and
- Political interference.

Typical management problems include:

- Inefficient organizational structures;
- Absence of career structures for staff;
- Low salaries; and
- Poor relationships between the users and management.

The constraints identified as contributing to or causing the failure of water supply systems include:

- Poor organizational structures in the responsible agency;
- Lack of spare parts;
- Inappropriate technology;
- Lack of trained staff;
- Tied aid;
- Absence of career opportunities;
- Insufficient funds;
- Legal framework problems;
- Lack of motivation by sector personnel;
- Non-involvement of the users;
- The low profile of operation and maintenance in the sector in general;
- Inadequate tariff and collection systems; and
- Negative political interference.

Water supply and sanitation sustainability involves:

- Ensuring the continuous availability of sufficient quantities of water of sufficient quality, within adequate institutional frameworks; and
- Applying sound management practices, appropriate technologies, and full-cost accounting; and
- Effectively maintaining facilities and equipment.

In developing countries, however, management of water supply and sanitation systems is often poor, resulting in interruptions in the provision of services and sometimes in the complete collapse of systems, which could oblige users to resort to traditional water sources that may be contaminated. Contamination of distribution pipelines due to intermittent supply, low water pressure in the distribution network, inadequate wastewater collection systems and leaking pipes are also common problems in developing countries. If contaminated water penetrates distribution mains, water that has already been treated and disinfected may become recontaminated (O&M Working Group, 2002).

Technical problems of urban water supply systems in Africa

Unaccounted-for water is a major water supply problem in many African cities (Table 7.4). Most of this water is lost through leaking pipes or overflowing service reservoirs after abstraction, pumping or treatment, or during distribution. Those who suffer most from this inefficiency are populations living in the impoverished, outlying urban areas. But if measures to ensure the sustainability and organization of facilities were implemented, extension of coverage to the fringe and poor areas of large cities will be possible. This would bring about considerable improvements in health. At the same time, the need to expand treatment and distribution facilities would be minimized, in effect releasing resources for other development activities. One of the most crucial problems facing the sector is the lack of sustainability of sanitation services. Despite huge efforts made in the past years, there is still a great need for considerable work on definition of principles, generation of political will, formulation of strategies and a search for new technological, financial and institutional solutions.

Health impacts

Urbanization can be an important source of health problems: nearly half of the world's population will live in urban centres by the end of the 20th century, but currently 30-60 per cent of the urban population are in low-income countries, and lack adequate housing with sanitary facilities, drainage systems, and piping for clean water (UNCHS, 1996). This number is expected to increase since local and city authorities often lack the resources, knowledge, trained personnel and financial capacity needed to meet their responsibilities in providing services and amenities essential for healthy living. Increased exposure to biological and chemical health risks in urban areas is particularly harmful to children. Children suffer the greatest number of deaths due to diarrhoeal diseases (2.5 million deaths per year). Prevalence of asthma, often exacerbated by air pollutants, has also increased among children (Woolcock and Peat, 1997).

Studies suggest a quantitative relationship between atmospheric carcinogen levels and lung cancer, and WHO has estimated that 50 per cent of the global burden of chronic respiratory illnesses is associated with air pollutants (WHO, 1997b). As the global population continues to grow, there is increasing pressure to develop agriculture, roads and transportation systems in previously unsettled areas. This kind of land conversion can encourage the spread of diseases harmful to human health. For example, leishmaniasis, an infectious disease transmitted through a sandfly bite, has increased to 12 million cases (WHO, 1998) each year alongside increasing land development in Africa, Latin America and West Asia (WHO, 1997b). Forest clearance in particular is associated with higher incidence of diseases such as malaria.

Table 7.2: Production Characteristics of City Water Utilities in some African Countries

Country	*Utility*	*Water Coverage* *%*	*Water Production* *lpcd*	*Water Production* *m3/c/m*	*Total Water Consumption* *m3/c/m*	*Unaccounted-for Water* *%*		*Metering Level* *%*	*Pipe Breaks* *breaks/ km/yr*
Benin	SBEE	36.94%	23.15	24.56				100.00%	0.27
Benin	SBEE	37.99%	25.33	24.08				100.00%	0.27
Burkina Faso	ONEA	18.83%	32.24	45.01	34.86	22.57%	0.33	100.00%	0.44
Burkina Faso	ONEA	18.90%	27.70	37.65	36.52	3.00%	0.04	99.99%	0.57
Burkina Faso	ONEA	18.97%	33.64	44.72	35.93	19.66%	0.29	100.00%	
Cote d'Ivoire	SODECI	36.54%	58.89	28.79	27.01	6.17%	0.06	100.00%	
Cote d'Ivoire	SODECI	37.82%	58.70	28.50	24.98	12.37%	0.12	100.00%	
Cote d'Ivoire	SODECI	39.34%	56.67	27.74	23.04	16.94%	0.15	100.00%	
Morocco	ONEP	48.89%	120.03	107.62	97.87	9.06%	0.32	100.00%	0.03
Morocco	ONEP	49.48%	125.09	101.27	91.11	10.04%	0.33	100.00%	0.03
Morocco	ONEP	52.00%	120.39	99.62	89.88	9.78%	0.32	100.00%	0.05
Namibia	WINDHOEK	100.00%	290.76	45.18	41.01	9.23%	0.14	100.00%	0.06
Namibia	WINDHOEK	100.00%	231.64	36.67	32.56	11.21%	0.14	100.00%	0.05
Namibia	WINDHOEK	100.00%	194.00	31.55	27.33	13.38%	0.14	100.00%	0.06
Nigeria	KdSWB	35.00%	122.52	85.44	40.16	53.00%	1.49	3.13%	
Nigeria	KdSWB	35.00%	119.81	81.36	46.45	42.91%	1.15	3.79%	
Nigeria	KtSWB	17.59%	60.76	70.93	52.70	25.69%	0.60	1.05%	
Nigeria	KtSWB	17.73%	59.94	65.67	52.89	19.46%	0.42	0.95%	
Senegal	SDE	46.28%	69.85	34.94	24.45	30.03%	0.35	100.00%	7.08
Senegal	SDE	46.29%	65.65	31.57	22.71	28.06%	0.29	100.00%	8.24
South Africa	RAND WATER	94.74%	313.85	80,446.32	80446.32	0.00%	0.00	100.00%	0.04
South Africa	RAND WATER	94.87%	266.86	70,302.75	70302.75	0.00%	0.00	100.00%	0.04
South Africa	RAND WATER	95.00%	278.88	75,452.56	75452.56	0.00%	0.00	100.00%	0.02
Togo	RNET	30.70%	66.81	55.16	39.88	27.70%	0.50	100.00%	
Togo	RNET	29.47%	67.47	54.65	41.42	24.21%	0.43	100.00%	2.53
Togo	RNET	28.59%	58.14	46.25	34.61	25.16%	0.38	100.00%	3.15

Source: http://www.iwa.hq.org.uk/IWA performance indicators.htm

In search of performance indicators

A transition from traditional familiar terminology and methods is never easy to accomplish, and a commitment is needed from all water suppliers in Africa to effect some important changes. For example, the terms 'Non-Revenue Water' and 'Water Losses' should replace the familiar (but often vague) term 'Unaccounted-for Water' – since, with modern techniques, it is now possible to account for virtually all water entering a water distribution system (Alegre, H et al., 2000). The use of percentages to express real losses is now also recognized internationally as being potentially misleading when used as a measure of the efficiency of managing real losses (leakage and overflows) from distribution systems with different levels of consumption (Asnake Berhane, 2003).

The simple traditional Technical Performance Indicators for Real Losses most widely used to make comparisons of the annual volume of Real Losses are (O&M Working Group, 2002):

- As a per cent of Input Volume;
- As a figure per length of mains per day or hour;
- As a figure per service connection per day or hour;
- As a figure per property per day or hour; and
- As a figure per length of system per day or hour.

(Where length of system = length of mains + length of service connections up to point of customer metering).

It should be particularly noted that "number of connections" should be used, rather than "number of properties". This is because the Real Losses occur on service connection, and it is not unusual for the service connection to split into several separate pipes serving individual properties at or after the first metering point. The Water Loss Task Force of the International Water Association (IWA) has recommended that percentages are unsuitable for assessing the efficiency of management of Real Losses in distribution systems (Alegre, H et al., 2000).

Technical Indicator for Real Losses (TIRL)

The IWA Task Force recommended that the basic TIRL should be the annual volume of Real Losses divided by the number of service connections (NC), allowing for the % of the year for which the system is pressurized, i.e.

TIRL = Current Annual Volume of Real Losses/NC
(Litres/service connection/day when the system is pressurized)

A more detailed interpretation of TIRL values can be obtained by comparing the TIRL value with a best estimate of Unavoidable Average Real Losses (UARL) that allows for local conditions of

connections density, location of customers and average operating pressure, if all aspects of leakage control were being managed to the highest technical standards (Alegre, H et al., 2000).

Unavoidable Average Real Losses (UARL)

It is recommended that the calculation of the UARL in litres/service connection/day be based on the following equation (Alegre, H et al., 2000):

UARL = (A* Lm/Nc + B + C * Lp/Nc) * P
(Litres/service connection/day when the system is pressurized)

The equation and its parameters, A, B, C, are based on a statistical analysis of international data, including 27 different water supply systems in 20 countries. As a result, the IWA Task Force for Operation and Maintenance Work fixed appropriate values for **A (18), B (0.80)** and **C (25)**.

This approach recognizes the separate influences of Real Losses from length of mains (Lm in km), number of service connections (NC), total length of service connections from the edge of the street to the customer meters (Lp in km), and average pressure (P in meters) when the system is pressurized.

Table 7.3: Unavoidable Annual Real Losses (UARL) in litres/service connection/day for customer meters located at the edge of street

Density of Connections Nc/Lm (per Km mains)	Average Operating Pressure (P in Meters)				
	20	40	60	80	100
20	34	68	112	146	170
40	25	50	75	100	125
60	22	44	66	88	110
80	21	41	62	82	103
100	20	39	59	78	98

Source: http://www.iwa.hq.org.uk/IWA performance indicators.htm

Note: Where customer meters are located on underground pipes with an average length of 'M' meters per service connections after the edge of the street, add the term [0.025*M*P] litres/service connection/day to table 2 values, where P is the average operating pressure in meters.

Setback: Most water supply networks in Africa are still not digitized to take advantage of fast, computer-oriented analyses on the state and function of the systems.

The intricate situation of urban slums

Target 11 of Millennium Development Goal 7 – To "significantly improve" the lives of at least 100 million slum dwellers by the year 2020

The world's slums are growing, with the number of people living in such dire conditions now at the 1 billion mark – making up 32 per cent of the global urban population. A report entitled *The Challenge of Slums*, says the crisis is such that the world will see this figure double in the next 30 years unless a concerted effort is undertaken to alleviate the situation. "The locus of global poverty is moving to cities, a process now recognized as the urbanisation of poverty," says United Nations Secretary General Kofi Annan, in a Foreword to the Report. "Without concerted action on the part of the municipal authorities, national governments, civil society actors and the international community, the number of slum dwellers is likely to increase in most developing countries. And if no serious action is taken, the number of slum dwellers worldwide is projected to rise over the next 30 years to about 2 billion."

In developing regions, slum dwellers account for 43 per cent of the population in contrast to about 6 per cent in more developed regions. In sub-Saharan Africa, the proportion of urban residents in slums is the highest and estimated at 71.9 per cent. The world's rural population has reached its peak, and almost all further population growth will be absorbed by urban settlements – a critical situation recognized by very few governments, cities and agencies. (UN-HABITAT's Global Report on Human Settlements 2003).

The problem of water supply and sanitation facilities for the urban poor is very complex. First and foremost, a distinction must be made between urban centres with declining water distribution systems due to inadequate, aging and overloaded networks and the issue of peri-urban dwellers. There is an obvious connection between the two. It is precisely the lack of such social amenities as water and electricity, which drives the poor urban and rural youth to the larger, relatively prosperous urban centres for illusive job opportunities and better living conditions. At its initial stages, governments, in an attempt to discourage such influx of people, either disregarded the phenomenon or intentionally refused to cater for their needs. These urban settlements are therefore devoid of any planning schemes.

It is in this unplanned physical environment that water service providers are being called upon to supply water and sanitation amenities. For such an exercise not to fall into the usual trap of *ad hoc* interventions, there should be the political will to recognize these areas as part of the urban set up and hence initiate urgently needed physical and urban planning arrangements. The level of unaccounted-for water in most of the water supply distribution systems is very high in almost all urban centres in Africa, at best around 50%. This loss has two components, the physical water losses and non-revenue losses. The service providers can therefore extend services to the outlying peripheries where most of the urban poor reside by recovering the unaccounted-for water and

revenue. This task has become arduous in many countries due to lack of capital investment for modernization of the distribution network and also for an effective metering system.

The urban poor population must not be considered as a static homogeneous social entity since it comprises people of different social extractions. We need to understand that the poor from the informal settlements are the hardest working, since they provide the labour in many industries, offices and services, and yet when they return home, water and sanitation are nonexistent. An Agenda for the urban poor has to be set up, bearing in mind that the per capita water demand within the sectors of the urban poor could be quite variable. It is sufficient for a household to install a shower and a water closet to substantially modify its water needs. It is, therefore, necessary to consider tariffs in correspondence to expected standards of living.

Box 7.1 Slums of Kisumu, Kenya

Over 50% of Kisumu residents live in informal settlements. The existing municipal supply is inefficient. The production is less than it is supposed to be and the amount supplied covers only 40% of the demand. The sewerage system is also overloaded, as it is undersized. This water supply is not extended to the informal settlements with connections, for several reasons; some residents would not pay and would even harass the municipal workers who went there to disconnect the meters. Secondly, there are several water kiosks that are allegedly owned by very influential people. The water kiosk owners sell water to both vendors and individuals and will even go to the extent of inciting water shortages by damaging pipes. Thus, the urban poor resident is faced with two options, to purchase water from the vendor whose cost is 66% more than that of the municipal supply, or dig shallow wells which are common in many households as the water level is quite high. The danger with these wells is the water quality. Being that the slums are extremely crowded and sanitation facilities not far away, not to mention the groundwater pollution faced by industrial towns, the repercussions are devastating, with very rampant waterborne diseases, especially typhoid.

Sanitation facilities on the other hand are very few. Most landlords/ladies would rather build an extra housing room than a latrine. This leads to most tenants using the bush and/or open spaces.

As these informal settlements keep growing, the municipal to date has no clear plans for water supply to these areas. The water supply is not even sufficient for the town's core, considering that the system was set up in the 1970s mainly for domestic use and since then with industries coming up and more people settling in, the system has NEVER been expanded. Municipal water losses are abundant, both from leaks and illegal connections, and even for the metered connections, only 33% of what is billed is remitted to the council.

Privatization has been discussed, but there still remains the feeling of groping with no direction. Partnerships with existing NGOs could be an option that has not been regarded as no NGOs have seriously embarked on water and sanitation in urban Kisumu.

Source: Yvonne Wangui, E-Conference on Toolkit for Improved Water Supply and Sanitation Services among the Urban Poor, 2002.

Box 7.2 Domestic Water Purification for Small Settlements in Zambia

A field trial of a new household water treatment and storage intervention was implemented in Kitwe, Zambia, between March and June 1998. The intervention included three elements: water treatment at the point of use with sodium hypochlorite solution produced locally; safe water storage in 20 litre durable plastic containers referred to as special vessels with a lid and spigot; and community education. This intervention had been successfully implemented in Latin America and this project represents its first field trial in Zambia and indeed in Africa.

Two peri-urban communities in Kitwe were selected for evaluation: Ipusukilo, for the intervention group and Luangwa, for the control group. Baseline surveys of demographic and socio-economic two communities. Water quality testing was performed in a sub sample of the intervention and control groups. Active diarrhoea surveillance, consisting of weekly household visits to inquire about illness in the prior 7 days, was conducted from March 16 to 12 April 1998. The intervention was implemented in the week of 13 April. Special vessels were offered for sale at a discount to intervention families, who also received free bottles of sodium hypochlorite during the study. A follow up survey and a second round of water quality testing were performed at the end of the evaluation period. A field trial of a behaviour change intervention, involving a new technique called motivational interviewing, was also conducted during the study.

A total of 260 families with 1584 individuals, for a mean of 6.1 persons per family, participated in the study. There were 166 intervention and 94 control families, with similar family sizes, demographic and socioeconomic characteristics. All households used shallow wells as their source of drinking water. Water testing revealed that over 90% of the wells were contaminated with E. coli, a marker for faecal contamination. Stored drinking water samples had higher rates of faecal contamination than well water samples. There was no difference in source and stored water quality between intervention and control group.

During the intervention phase of the study, 67 (40.3%) of 166 families bought special vessels. Compliance with sodium hypochlorite use in drinking water measured as detectable chlorine in drinking water ranged from 72 to 90% during the course of the study. During the follow up of water quality testing, stored water quality was significantly better in the intervention than in the control group, with 69% of intervention families having water free of E.coli contamination ($p<0.001$). During the baseline phase of the study, there was no difference in diarrhoea rates between intervention and control families. However, despite the fact that diarrhoea rates were low and declining as the rainy season ended, there was a borderline statistically significant difference in diarrhoea rates between intervention and control families, with intervention families experiencing 45% decreased risk of illness (relative risk =0.55, 95% confidence intervals, 0.3 0.99). Knowledge of diarrhoea transmission and prevention increased during the course of the study. To date, the micro enterprise at Ipusukilo Clinic has sold nearly 300 000 bottles of disinfectant.

Finally, this field trial showed a high rate of compliance with the intervention, with a marked improvement of stored water quality and a reduction in diarrhoeal disease. Underpinning this project was a social marketing programme that was commissioned the following year.

Note:
Case study presented by Chilufya Kaminsa on Domestic Water Chlorination for Peri-Urban Communities – The Zambian Experience, at the first International Advanced Course on Integrated Water Resources Management at WAAREDOC, Univ. for Foreigners, Perugia, Italy.

Urban water needs in the Democratic Republic of Congo

In 1992, the urban population in the Deomcratic Republic of Congo was estimated at 1,264.9 million people. Water demand assessed on the basis of 50 l/day/per capita was then 63,245 m3/day. The Société Nationale de Distribution

d'Eau (SNDE) annual total production in the six urban cities that year was 36.400 million m3, which corresponds to a daily production amounting to 97 726 m3. Given that 22% of SNDE total production was consumed by industries and commerce (great consumers) and SNDE technical output being 65%, the directly consumed volume by the population was 49 550 m3, that is 39 litres per capita per day. The evolution of the gaps between the volumes produced and those really sold until 1992 is shown in Table 7.4.

Table 7.4: Dynamics of Unaccounted-for Water

Year	1987	1988	1989	1990	1991	1992
Volume produced	28.205	29.720	37.400	30.845	32.553	36.400
Volume sold	21.290	19 320	24 310	20 050	21 160	23.660
Unaccounted for Water %	35	35	35	35	35	35

Source: AWDR National Report, 2003 (SNDE)

Statistics on the sold volumes are not available. However, the estimated average technical output is 65%.

Table 7.5: Urban Cities Demographic Growth in Million Persons

Cities	Population 1995	Population 2000	Population 2001	Population 2002
Brazzaville	826 000	999 400	1 027 800	1 057 300
Pointe Noire	415 000	502 100	516 400	531 300
Dolisie	69 700	84 300	86 700	89 200
Nkayi	53 500	64 200	66 100	67 900
Mossendjo	21 900	26 500	27 400	28 200
Ouesso	17 600	21 200	21 800	22 400
Total	1 403 700	1 697 700	1 746 200	1 796 300

Source: AWDR National Report (CNSEE)

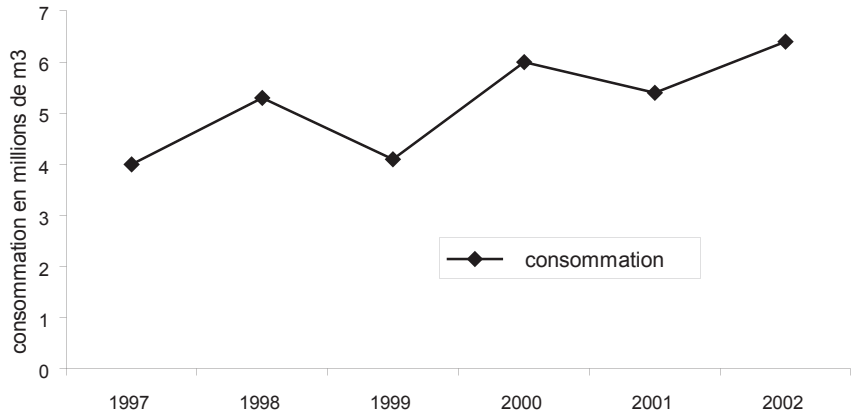
In 2002, the urban population was 1,796,300 inhabitants (Table 7.5) and the SNDE total production in the six urban cities was 39.80 million m3. If technical losses are taken into account with an estimated level of 35%, the consumed water volume was 39.5 litres per capita per day. The volume that takes into account other water uses (industry and commerce) proves that in 2002 the overall water demand was far from being satisfied. The quantity of unaccounted-for water is not easily measurable because of the use of an all-in-one tariff system on the one hand and because of the lack of metering and water measurement on the other hand. The technical outputs currently admitted amount to 65%.

Figure 7.3 Domestic consumption evolution

Source: AWDR National Report

Evolution of industry and commerce consumption is shown in Figure 7.4.

Figure 7.4: Industry and commerce consumption evolution



Source: AWDR National Report

Meeting urban water supply needs in Nigeria

The population in Nigerian cities has increased tremendously, more so with the steady migration of unemployed youths from the rural areas to the major cities and towns. In the same manner, many semi-urban towns have grown into urban cities with the creation of new States and local governments. JICA (1995) defined cities or urban towns as towns that have a population of over 20,000. At independence in 1960, the major cities in Nigeria comprised mostly of the regional capitals of Enugu, Kaduna, Ibadan and Lagos, including other subordinate urban towns. With the creation of the twelve State structures in 1967, the number of urban cities in Nigeria had risen

to over 250. Considering the present 36 State capitals, including the Federal Capital Territory (FCT), and the fact that each local Government headquarter has a potential to develop into a city, Nigeria, for planning purposes, could be said to have up to 600 cities, a far cry from the estimated 250 cities at independence (Table 7.6).

Table 7.6: Number of Local Governments in Nigeria by State

S/N	State	No. of LGA	S/N	State	No. of LGA
1	Akwa Ibom	24	17	Ondo	26
2	Anambra	16	18	Oyo	25
3	Adamawa	16	19	Plateau	23
4	Bauchi	23	20	Rivers	24
5	Edo	14	21	Sokoto	29
6	Benue	18	22	Abia	17
7	Borno	21	23	Delta	19
8	Cross River	14	24	Enugu	19
9	Imo	21	25	Jigawa	21
10	Kaduna	18	26	Kebbi	16
11	Kano	34	27	Kogi	23
12	Katsina	26	28	Taraba	12
13	Kwara	12	29	Yobe	13
14	Lagos	15	30	Ogun	23
15	Niger	19	31	FCT	4
16	Ogun	15			

Source: AWDR National Report (FGN Official Gazette No. 25 Vol.84, 1997).

The 250 towns or cities housed about 22% of the countries population in 1976. With the increase in the number of cities to about 600, the population should double and so should the water demand (Table 7.7). The development of most cities in Nigeria is associated with the establishment of commercial institutions and medium- and large-scale industries that obtain much of their water supply from the public sources. The daily water demand estimated to include the need of such establishments is about 150 liters per person per day.

Table 7.7: The Projected Urban Water Demand

STATE	Year 1991				2000				2020			
	X 1000 POP	Demand			Pop. X1000	Demand			Pop x 1000	Demand		
		MLD	Lcd	Service Pop. X 1000		MLD	Lcd	Serv Pop.		MLD	Lcd	Serv Pop
Rivers	2461	217.9	89	1230(49%)	3284	342.2	104	59.9% 1970	5429	988.7	182	4343 79.9%
Akwa Ibom	1246	99.2	80	623(50%)	1662	156.6	94	59.9% 1997	2748	458.2	167	2199 80%
Cross River	872	81.4	93	436(50%)	1164	129.0	111	59.9% 698	1924	363.8	189	1539 79.9%
Imo	1710	130.7	76	855(50%)	2282	202.8	89	59.9% 1369	3773	605.3	160	3018 79.9%
Abia	1318	128.9	98	659(50%)	1759	123.1	117	59.9% 1055	2907	571.3	197	2326 80%
Anambra	1836	167.8	91	918(50%)	2450	262.8	107	60% 1470	4051	751.1	185	3241 80%
Enugu	1989	186.9	94	995(50%)	2655	291.1	110	60% 1593	4389	823.3	188	3511 79.9%
Oyo	2269	33.8	147	1133(50%)	3025	541.7	179	60% 1815	5001	1424	285	4001 80%
Osun	1624	168.9	104	812(50%)	2167	256.7	118	59.9% 1300	3583	736.9	206	2866 (79.99%)
Ondo	2457	226.0	92	1228(49%)	3279	360.8	110	59.9% 1967	5421	1003.7	185	4336 79.9%
Edo	1382	120.7	87	691(50%)	1844	191.1	104	59.9% 1106	3048	543.7	178	2438 79.9%
Lagos	5568	1048.7	188	2784(50%)	7430	1718	231	60% 44.59	12284	4435.4	361	9827 79.9%
Ogun	1645	185.1	113	823(50%)	2195	281.9	128	60% 1317	3630	807.1	222	2904 80%
Delta	1610	132.8	82	805(50%)	2148	218.6	102	60% 1289	3552	618.8	174	2841 79.9%
Benue	883	77.3	88	441(49%)	1234	128.3	104	60% 741	2226	397.9	179	1781 80%
Adamawa	995	84.8	85	497(49%)	1390	140.9	101	60% 834	2507	443.0	177	2006 80%
Plateau	1669	169.6	102	835(50%)	2334	285	122	59.9% 1400	4210	856.5	203	3368 80%
Taraba	487	37.8	78	244(50%)	681	61.5	90	60% 409	2507	443	177	2006 80%
Kogi	767	63.6	83	383(49%)	1023	100.6 2285.7*	98	60% 614	1852	315.6	170	1482 80%
Kaduna	2737	291	106	1368(49%)	3652	466.9	128	59.9% 2191	6614	1412	214	5291 80%
Niger	1191	104.5	88	595(49%)	1589	165.4	104	59.9% 953	2878	516	179	2802 97%
Kwara	1033	132	128	516(49%)	1379	215	156	59.9% 827	2497	620	248	1998 80%
Bauchi	1496	118.6	79	748(50%)	1659	146.4	88	59.9% 995	2516	389.2	155	2013 80%
Yobe	391	33.1	85	169(43%)	434	44.5	103	59% 260	658	115.2	175	526 80%
Borno	1520	150.9	99	760(50%)	1686	203.9	121	60% 1012	2557	518.4	203	2046 80%
Kano	2615	315.3	121	1307 (49.9%)	2900	422.7	146	60% 1740	4399	1045.7	238	3519 79.9%
Jigawa	815	60.9	75	407(49%)	903	78.4	87	60% 542	1370	215.6	157	1096 80%
Katsina	1738	155.8	90	869(50%)	1905	202.6	106	60% 1143	2864	522.8	183	2292 80%
Kebbi	658	51.1	78	329(50%)	721	65.3	91	59.9% 432	1084	176.1	162	867 79.89%
Sokoto	1866	167.6	90	933(50%)	2045	217.3	106	60% 1227	3074	563.5	183	2460 80%
FCT	213	36.1	169	107(50%)	284	57.7	203	60% 171	515	164.7	320	412 80%
Total for Year		4978.8 MLD				7895,329				22846.1		

Source: AWDR National Report

Table 7.8: Percentage Distribution of Households by Source of Drinking Water and by State

STATE	PIPED	PUBLIC TAP	HAND PUMP	PROT. D/WELL	UNPROT D/WELL	POND	VENDOR	OTHER	TOTAL
ABIA	5.0	9.0	37.2	0.5	3.4	36.6	7.3	1.1	100
ADAMAWA	6.3	4.4	14.4	19.6	2.7	51.5	0.0	1.0	100
A/IBOM	9.6	6.4	0.0	4.8	8.2	70.9	0.0	0.0	100
ANAMBRA	8.9	4.4	13.1	13.3	15.2	33.3	11.8	0.0	100
BAUCHI	2.4	0.4	14.8	31.1	38.6	12.2	0.6	0.0	100
BENUE	2.2	1.0	1.4	25.7	2.6	65.8	0.0	1.2	100
BORNO	4.7	26.2	19.7	0.0	40.6	7.9	0.4	0.4	100
C/RIVER	1.7	5.0	26.5	2.5	0.2	64.1	0.0	0.0	100
DELTA	9.4	12.6	18.2	28.1	20.4	10.8	0.5	0.0	100
EDO	28.8	10.3	1.8	31.6	11.4	16.0	0.0	0.0	100
ENUGU	5.0	12.3	17.6	2.3	10.0	47.2	5.5	0.0	100
IMO	3.8	15.0	3.6	1.0	18.0	48.1	3.8	6.8	100
JIGAAWA	11.3	18.3	25.4	6.2	33.1	5.6	0.2	0.0	100
KADUNA	29.4	5.0	1.2	48.4	6.9	8.5	0.6	0.0	100
KANO	9.9	8.2	9.3	13.6	47.2	7.8	0.2	3.7	100
KATSINA	8.1	9.6	1.5	48.5	23.4	8.4	0.5	0.0	100
KEBBI	3.5	0.3	2.3	57.1	25.7	10.3	0.5	0.3	100
KOGI	8.5	13.1	2.7	5.6	16.8	48.8	4.5	0.0	100
KWARA	25.6	25.0	19.0	3.7	8.5	17.3	0.8	0.0	100
LAGOS	11.6	33.2	38.4	1.7	0.7	0.0	11.4	3.1	100
NIGER	4.2	3.1	22.1	19.8	13.9	34.6	0.3	1.9	100
OGUN	7.9	13.1	29.5	14.4	2.0	33.1	0.0	0.0	100
ONDO	2.4	17.9	0.6	23.7	26.4	29.0	0.0	0.0	100
OSUN	14.9	25.0	4.6	23.3	14.8	16.6	0.9	0.0	100
OYO	14.1	22.8	7.2	37.2	5.2	12.8	0.7	0.0	100
PLATEAU	6.6	7.6	0.7	19.4	7.0	58.1	0.7	0.0	100
RIVERS	2.9	17.3	5.3	11.1	9.1	54.4	0.0	0.0	100
SOKOTO	0.8	2.0	3.9	11.3	70.1	11.3	0.2	0.4	100
TARABA	0.2	0.0	9.2	28.0	10.3	47.3	5.1	0.0	100
YOBE	6.7	14.2	1.0	25.3	43.1	9.5	0.0	0.2	100
ABUJA(FCT)	58.4	16.1	0.0	1.0	0.3	23.9	0.3	0.0	100
NIGERIA	9.4	11.4	11.6	18.6	17.4	29.2	1.8	0.6	100

Source: AWDR National Report (UNICEF, 1995)

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