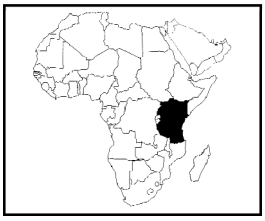


Waiting at the tap: changes in urban water use in East Africa over three decades

John Thompson, Ina T. Porras, Elisabeth Wood, James K. Tumwine, Mark R. Mujwahuzi, Munguti Katui-Katua and Nick Johnstone

John Thompson is Director of the Sustainable Agriculture and Rural Livelihoods Programme at the International Institute for Environment and Development, 3 Endsleigh Street, London, WC1H ODD, UK.

Ina T Porras is a visiting researcher at the Environmental Economics Programme, International Institute for Environment and Development, 3 Endsleigh Street, London, WC1H ODD, UK.

Libby Wood is a research associate at the Environmental Economics Programme, International Institute for Environment and Development, 3 Endsleigh Street, London, WC1H ODD, UK.

James K Tumwine is a senior lecturer at the Department of Paediatrics and Child Health, Makerere Medical School, PO Box 7072, Kampala, Uganda.

Mark R Mujwahuzi is a professor at the Institute of Resource Assessment, University of Dar es Salaam, PO Box 49039, Dar es Salaam, Tanzania.

Munguti Katui-Katua is Director of the Community Management and Training Services (East Africa), Park Place, Magadi Road, Langata, PO Box 292 Kiserian, Nairobi, Kenya.

SUMMARY: This paper reports on changes in water supplies in 16 sites in nine East African urban centres (including Nairobi and Dar es Salaam) between 1967 and 1997. The sites included both low-income and affluent neighbourhoods. In most sites, water supplies had deteriorated. For sites that already had piped water in 1967, most received less water per day in 1997 and had more unreliable supplies. For households without piped supplies, the average time spent collecting water in 1997 was more than three times that in 1967. One of the most notable changes when comparing 1997 to 1967 was the much greater importance of private water vending through kiosks or vendors; these had become a booming business in many of the low- and middle-income sites. But on average, those using kiosks were spending almost 2 hours a day collecting water and the water from kiosks was nearly twice the price of piped supplies.

I. INTRODUCTION

THE BENEFITS AND costs of providing a safe, convenient and reliable water supply to households in the developing world have been the subject of a vast and wide-ranging research effort for at least four decades. Most of this research has focused on the relationship between water and disease,(1) on the efficacy of water supply projects in improving health,(2) on the causes and consequences of differential access and control of water resources(3) (particularly with regard to gender and wealth) and on the financing of water supply infrastructure.(4)

Despite this plethora of research, relatively little is known about a number of key aspects of domestic water use. In particular, knowledge is scarce about the long-term trends and changes in household water use in any part of the world. This is because of the lack of quality baseline information and because of the cost and complexity of undertaking longitudinal and repeat studies. Thus, most research on household water use is limited to one season or year, or is carried out within the narrow confines of a donor-funded project or programme. Where studies have attempted to examine changes over time, they have tended to be limited in scope, frequently concentrating on a single locality. Consequently, the dynamics and determinants of domestic water use remain only partly understood. Among the regions of the world, these research gaps are most acute for sub-Saharan Africa, the region whose population has the least access to improved water supply.(5)

II. LEARNING FROM THE PAST, LOOKING TO THE FUTURE - "DRAWERS OF WATER" REVISITED

THIS PAPER REPORTS the findings of a large-scale, long-term, repeat, cross-sectional study of domestic water use and environmental health in East Africa, based on the landmark book *Drawers of Water* by Gilbert F. White, David J. Bradley and Anne U. White.(6) It concentrates on changes in domestic water use over three decades in 16 sites in nine towns and cities in Kenya, Tanzania and Uganda that reflect the diversity of urban environments, living conditions and water service levels found in the region (see Table 1). Changes in urban water use are examined in terms of mean per capita water use levels at site and country level. The findings reveal both positive and negative changes in water use in East Africa, in terms of levels and types of use, reliability, access and cost. The results indicate that while measurable improvements have been achieved in some quarters, there have been significant declines in others. As urban populations continue to grow rapidly, placing added pressure on already overstretched municipal services, the long-term prospects for increasing per capita water use in the region appear limited. Only through concerted action by international external support agencies, in partnership with municipal and national governments, local communities and water service providers, will these trends be reversed or at least slowed.

"Drawers of Water" was the first large-scale assessment of domestic water use and environmental health in Africa. A recent wide-ranging review of the literature on household water resources and rural produc-

Nick Johnstone is a senior researcher at the Pollution Prevention and Control Division, Environment Directorate, Organization for Economic Cooperation and Development, 2 rue Andre Pascal, Paris 75016, France.

1. See, for example, WHO (1999), *World Health Report 1999*, World Health Organization, Geneva; also Noda, S et al (1997), "Effect of piped water supply on human water contact patterns in a *Schistosoma haematobium* endemic area in Coast Province, Kenya", American Journal of Tropical Water and Hygiene Vol 56, No 2, pages 118-126; Okun, D A (1987), "The value of water supply and sanitation in development: an assessment of health related interventions", WASH Technical Report No 43, Environmental Health Project, Washington DC; and Bradley, D (1977), "Health aspects of water supplies in tropical

Table 1a: Urban Sites General Description Unpiped Households, Same Sites as DOW I

	% of Households		Average per capita WU (litres)		Average cost (1997 US cents/litre)		Principal water source		Average time per trip (minutes)		Average distance to water source (metres)	
	DOW II	DOW I	DOW II	DOW I	DOW II	DOW I	DOW II	DOW I	DOW II	DOW I	DOW II	DOW I
Urban Households												
Kenya	12.1	18.3	22.9	11.3	0.14	0.32	Kiosk	Hydrant	33.1	11.0	400.3	384.0
Tanzania	18.2	34.6	25.1	17.8	0.12	0.12	Hydrant, Kiosk	Hydrant	34.4	13.9	152.6	236.5
Uganda	69.7	47.1	23.5	14.3	0.16	0.16	Hydrant, Well	Hydrant	15.2	6.1	182.6	177.2
Total	100	100	23.7	15.4	0.15	0.17			21.4	9.3	204.2	222.4
Total Observations	**99**	**104**										
Sites												
Karuri, Kenya	11.1	9.6	22.3	9.3	0.12	0.19	Kiosk	Hydrant	36.1	13.5	436.6	288.0
Nairobi, Kenya-Mathare Valley	1.0	8.7	29.8	11.3	0.43	0.46	Vendor	Hydrant	0.0	11.0	0.0	384.0
Moshi, Tanzania	6.1	14.4	19.3	13.3	0.16	0.04	Kiosk	Hydrant	33.2	9.3	118.3	270.1
Dodoma, Tanzania	12.1	20.2	28.3	21.0	0.10	0.17	Other, Neighbour	Hydrant	35.1	20.7	171.3	186.2
Iganga, Uganda	31.3	17.3	22.2	13.8	0.21	0.11	Hydrant	Hydrant	14.7	3.7	117.4	114.9
Kamuli, Uganda	26.3	15.4	25.8	16.0	0.08	0.20	Well	Hydrant	16.4	5.9	293.7	221.9
Mulago, Uganda	12.1	14.4	21.6	13.1	0.18	0.17	Hydrant	Spring	13.7	9.9	104.5	233.5
Total	**100.0**	**100.0**	**23.7**	**14.8**	**0.15**	**0.17**			**21.4**	**9.8**	**204.2**	**230.2**

Table 1b: Urban Sites General Description Piped Households, Same Sites as DOW I

	% of households		Average number of years of education		Average per capita WU (litres)		Average cost of water (1997 US cents/litre)		Receive 24-hour supply (% of households)		Principal alternative source if piped system breaks down	
	DOW II	DOW I	DOW II	DOW I	DOW II	DOW I	DOW II	DOW I	DOW II	DOW I	DOW II	DOW I
Kenya	27.8	22.8	12.0	10.6	47.4	121.6	0.102	0.070	80	87.5	Kiosk	Well
Tanzania	46.1	50.3	14.1	9.8	80.2	141.8	0.100	0.077	32.5	100	Vendor	Rain
Uganda	26.1	26.9	14.4	10.0	64.7	108.3	0.082	0.080	72.5	100	Well	Rain
Total (percent)	100	100	13.6	10.0	65.8	128.1	0.095	0.077	55.7	97		
Total observations	**349**	**312**										
By site (all urban)												
Karuri, Kenya	6.0	4.8	12.0	14.1	28.4	28.5	0.043	0.125	24	0	Kiosk	Well
Moshi, Tanzania	5.2	8.0	11.2	8.8	40.7	108.2	0.111	0.032	0	96	Spring	Spring
Dodoma, Tanzania	10.0	15.1	13.8	8.6	62.1	72.1	0.041	0.095	11.4	100	Other	Rain
Iganga, Uganda	1.4	6.1	10.4	7.4	34.2	78.7	0.058	0.089	0	100	Kiosk	Rain
Kamuli, Uganda	5.4	7.4	12.7	9.8	32.4	76.2	0.182	0.106	0	100	Well	Rain
Tororo, Uganda – L	11.2	8.7	15.7	12.8	110.7	160.9	0.065	0.059	97	100	Other	Rain
Tororo, Uganda – M H	8.0	4.8	14.4	8.3	27.8	100.1	0.053	0.069	100	100	Reservoir	Rain
Nairobi, Kenya – Parklands, M L	7.4	5.1	13.3	10.3	60.9	176.9	0.138	0.053	100	100	Kiosk	Well
Nairobi, Kenya – Pangani, M H	8.6	9.6	11.9	9.9	52.9	167.3	0.129	0.056	93	100	Well	Stream
Nairobi, Kenya – Makadara, H	5.7	3.2	10.6	7.3	41.6	26.3	0.071	0.058	90	100	Vendor	Hydrant
DeS, Tanzania – Oyster Bay, L	8.6	9.9	17.2	14.0	164.3	243.9	0.327	0.081	70	100	Vendor	Well
DeS, Tanzania – Upanga, M L	8.6	8.3	14.7	9.4	n/a	157.7	0.350	0.081	73	100	Vendor	Stream
DeS, Tanzania – Changombe, M H	8.0	7.1	14.7	9.4	43.7	161.1	0.127	0.081	11	100	Vendor	Spring
DeS, Tanzania – Temeke, H	5.7	1.9	12.6	6.8	64.4	153.5	0.134	0.083	10	100	Vendor	Hydrant

countries" in Feachem, R D, M McGarry and D Mara (editors), *Water, Wastes and Health* in *Hot Climates*, John Wiley and Sons, London.

2. For more information, see Esrey, S A (1996), "Water, waste and well-being: a multi country study", *American Journal of Epidemiology* Vol 143, No 6, pages 608-623; also Esrey, S A et al (1991), "Health benefits from improvements in water supply and sanitation", WASH Technical Report No 66, Environmental Health Project, Washington DC; Cairncross, S (1988), "Domestic water supply in Africa" in Rimmer, D (editor), *Rural Transformation in Tropical Africa*, Belhaven, London; and see reference 1, Feachem et al (1977).

tivity in sub-Saharan Africa carried out by Harvard University,[7] describes the continuing relevance and broad influence of that pioneering research:

"Knowledge of household water supply and productivity in..... Africa is limited to a handful of original studies which continue to be cited and recycled in the literature. Foremost among them is Drawers of Water..... *[It] remains the most comprehensive and compelling account available of..... water use in Africa.."* (emphasis added)

The study looked at the use of water for consumption, hygiene and amenities in domestic life. It also examined the direct cost of water use in monetary terms as well as the social cost of water measured in terms of energy and time expenditure. Information on per capita and total household water use was recorded and factors affecting variations in use were assessed.

In 1997, a comprehensive reassessment of domestic water use and environmental health in East Africa was launched,[8] building on the original "Drawers of Water" data from the late 1960s. At its most basic level, this research set out to answer five fundamental questions:

- How has people's use of water changed over the past three decades?
- How have their sources of water and service levels changed?
- What internal and external factors contributed to these changes?
- What effect have these changes had on people's water use and well-being?

- What are the implications of these trends and changes for future policies and programmes in the water and health sectors?

These research questions shaped the first phase of household survey research which ended in mid-1998 and guided the second phase of participatory research which was completed one year later. In addition, site-specific and issue-specific questions were developed to examine various social, institutional, environmental, technical and health dimensions of domestic water use and environmental health in the selected research sites.

By using the "Drawers of Water" data as its baseline and by employing a range of formal and participatory research methods to carry out detailed historical analyses of a spectrum of rural and urban communities, this study attempted to "fill in the blanks" of the past three decades and chart the major trends and changes that have occurred in the domestic water and environmental health sectors in East Africa. Given the wide range of policies formulated and implemented, the multiplicity of programmes and projects initiated, and the diversity of institutional actors involved in water development in the region over the past 30 years, this research may be likened to a kind of "archaeology" of water and health strategies and impacts, requiring the meticulous excavation and reassembling of the available evidence.

III. THIRTY YEARS OF CHANGE IN DOMESTIC WATER USE IN URBAN AREAS

a. Per Capita Water Use: Changes in the "Consumption Gap"

THE FIRST AND most striking change in domestic water use in urban areas of East Africa is the dramatic decline in per capita use, which decreased on average from 98.7 litres per day in 1967 to only 54.9 litres per day 30 years later (see Table 2). Tanzania and Uganda show the highest and lowest consumption levels for both time periods, respectively.

Table 2: Per Capita Water Use in Urban Sites (Litres per Day)

	All households		Piped		Unpiped	
	DOW I	DOW II	DOW I	DOW II	DOW I	DOW II
Kenya	104.7	45.2	116.9	47.4	11.3	27.7
Tanzania	113.8	70.5	136.4	76.5	17.8	25.1
Uganda	73.7	47.0	108.3	64.7	14.3	23.5
East Africa	98.7	54.9	124.3	64.2	15.4	24.3

The original "Drawers of Water" study examined a total of 34 field sites which were defined as being either "unpiped" or "piped",[9] which corresponded roughly to their location in rural and urban areas. Rural households tended to obtain their water from outside the dwelling whilst most urban households used piped supplies. The repeat study found that this distinction no longer holds true for all households in all study sites. Several of the sites once categorized as unpiped now have a number of

3. See, for example, Makule, D E (1997), "Water and sanitation – a gender perspective", Proceedings of the 23rd WEDC Conference, online: http://www.lboro.ac.uk/departments/cv/wedc/23conts.htm ; also WHO (1995), *Why Women Cannot be Healthy without Water and Sanitation,* Rural Environmental Health Unit, World Health Organization, Geneva; Sangodoyin, A Y (1993), "Women's role in rural water supply and development: trends and expectations in Nigeria, *The Environmentalist* Vol 13, No 4, pages 255-261; Hardoy, J E, S Cairncross and D Satterthwaite (1990), *The Poor Die Young: Housing and Health in Third World Cities,* Earthscan, London; Elmendorf, M and R B Isley (1982), "Water and sanitation related health constraints on women's contributions to the economic development of communities" in Aguwa, M I (editor), *Conference on Women, Health and International Development,* Michigan State University, East Lansing, M I; and White, A U (1977), "Patterns of domestic water use in low-income communities" in Feachem, et al (1977), see reference 1.

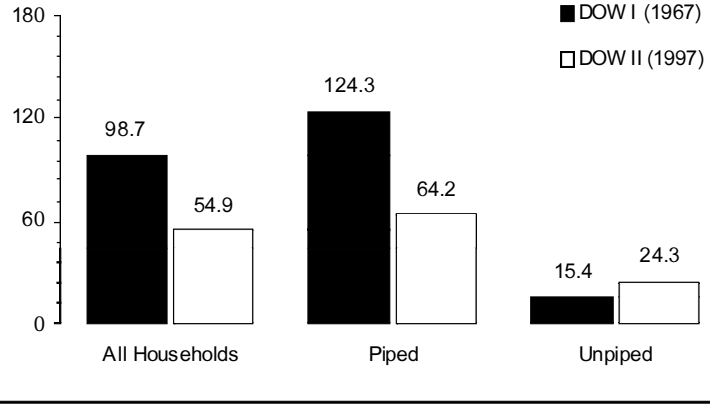
4. For more details, refer to Sharma, N P et al (1996), "African water resources: challenges and opportunities for sustainable development", World Bank Technical Paper No 331, African Technical Department Series, The World Bank, Washington DC.; also Nakagawa, H et al (1994), "Twenty-first century water challenges in Kenya", paper presented at the 20th WEDC Conference on Affordable Water Supply and Sanitation, Colombo, Sri Lanka; Postel, S (1993), *The Last Oasis: Facing Water Scarcity,* Earthscan, London; Therkildsen, O (1988), *Watering White Elephants? Lessons from Donor Funded Planning and Implementation of Rural Water Supplies in*

households with reliable piped connections. In some sites originally classified as piped, such as Iganga in Uganda and Makadara and Temeke in Dar es Salaam, Tanzania, significant numbers of unpiped households now exist. In these latter cases, the physical infrastructure is still in place but water supply services no longer function properly, forcing families to either collect water from unprotected external sources or purchase water from private vendors or kiosks, frequently at relatively high prices.

The most important factor affecting urban water use in East Africa is whether or not a household has access to a functioning piped system.[10] In the late 1960s, individuals who had access to piped water were found to be consuming, on average, 124.3 litres per day while those without a piped connection used only 15.4 litres per day (see Figure 1). Thus the "consumption gap" between piped and unpiped households stood at a ratio of 8:1, that is, for every eight litres used by an individual in a piped household, only one litre was used by a person in an unpiped household.

Three decades later, the pattern remains the same but the ratios have changed dramatically. Today, mean daily per capita water use in a typical piped urban household in the region stands at only 64.2 litres, or about half the 1967 level. At the same time, members of unpiped urban households have seen their per capita water use increase to 24.3 litres, a rise of almost nine litres per day. Kenya has experienced the biggest changes, with mean daily per capita water use increasing by 16 litres in unpiped households and decreasing by 70 litres in piped households. The good news is that, as a result of these changes, the consumption gap among urban households across the region has been reduced to a ratio of only 2.6:1. The bad news is that the closing of this gap is mostly a consequence of the collapse of municipal piped systems rather than major improvements in unpiped or alternative water systems for large portions of the region's urban poor.

Figure 1: Mean per Capita Water Use in Urban Areas of East Africa (Litres per Day)



Based on 237 observations for the sub-sample discussed here, piped households living in previously unpiped sites reported mean daily per capita water use of 40.6 litres, which is less than the amount used by previously piped sites. The same applies for unpiped households living in sites that had functioning piped connections in the 1960s, where the observed

Tanzania, Centre for Development Research Publications No 7, Scandinavian Institute of African Studies, Uppsala; and Saunders, R J and J J Warford (1976), *Village Water Supply: Economics and Policy in Developing Countries*, Johns Hopkins University for The World Bank, Baltimore, MD.

5. Cosgrove, W J and F R Rijsberman for the World Water Council (2000), *World Water Vision: Making Water Everybody's Business*, Earthscan, London; also WSSCC (1999), "Vision 21: a shared vision for water supply, sanitation and hygiene and a framework for future action", UN Water Supply and Sanitation Collaborative Council, Geneva; Rosen, S and J R Vincent (1998), "Household water resources and rural productivity in sub Saharan Africa: a review of the literature", draft paper, Harvard Institute for International Development, Harvard University; Cambridge, MA; and see reference 4, Sharma, et al (1996).

6. White, G F, D B Bradley and A U White (1972), *Drawers of Water: Domestic Water Use in East Africa*, University of Chicago Press, Chicago and London.

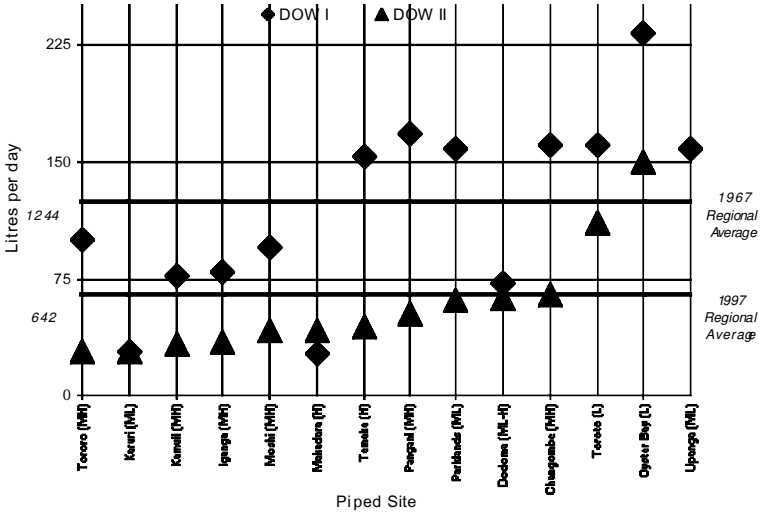
7. See reference 5, Rosen and Vincent (1998), page 3.

8. "Drawers of Water II" is a collaborative research project of the International Institute for Environment and Development (IIED), UK, Community Management and Training Services Ltd (CMTS-EA), Kenya, the Institute of Resource Assessment (IRA) of the University of Dar es Salaam, Tanzania, and the Department of Paediatrics and Child Health (DPCH), Makerere Medical School, Uganda, with assistance from the African Medical and Research Foundation (AMREF), Kenya, and the Uganda Community Based

per capita water use was 23 litres per day. Although changes for these groups are considered here, direct comparisons of water use are made only for similar types of households (i.e. piped vs. piped or unpiped vs. unpiped) in each site.

The water use situation varies widely from site to site, with some urban centres showing only marginal declines in water use while others experienced large decreases (see Figure 2). In Karuri, Kenya, for example, the research shows that there has been no change in domestic water use over the last three decades and that, on average, individuals use just under 30 litres of water per day, regardless of the type of connection. This result is, however, more the exception than the rule, as the general trend has been towards significantly lower levels of water use. For instance, in Iganga, Uganda, individual water use decreased on average from 79 to 34 litres per day, while in Moshi, Tanzania, the reduction was from 95 to 41 litres per day.

Figure 2: Mean Daily per Capita Water Use, by Site (Litres per Day)



Not surprisingly, poorer urban households are the ones most affected when conditions change for the worse. Although the more affluent study sites, such as Parklands in Nairobi, Oyster Bay and Upanga in Dar es Salaam, and Tororo in Uganda also experienced a decrease in water use levels, mean daily per capita water use has remained well above the regional averages (a range of 159-232 litres per capita daily (pcd) in 1967 versus 61-150 litres pcd in 1997). At the same time, areas where population concentration and housing density are high and household incomes are relatively low, such as Pangani and Makadara in Nairobi, Changombe and Temeke in Dar es Salaam, and a second site in Tororo, Uganda, registered significant declines in water use levels. In these poor, densely populated, urban and peri-urban sites, daily per capita water use has dropped well below the mean for the region (a range of 100-167 litres pcd in 1967 versus only 28-64 litres pcd in 1997).[11]

Health Care Association (UCBHCA). The research was coordinated by Dr John Thompson (IIED), Mr Munguti Katui-Katua (CMTS), Professor Mark R Mujwahuzi (IRA) and Dr James K Tumwine (DPCH). Financial support for the project was provided by the Department for International Development (DFID), UK, the Ministry of Foreign Affairs (DGIS), The Netherlands, the Swedish International Development Cooperation Agency (Sida), and the Regional Office for East and Southern Africa of the Rockefeller Foundation. The ideas and opinions expressed in this paper are those of the authors and do not reflect the views or positions of any of the partner or donor agencies.

9. "Piped" households are those with access to functioning direct connections in the home or compound whilst "unpiped" households are those that carry water or have water delivered from an external source located outside the home.

10. In this study, a "functioning" piped system is one from which a household could satisfy its basic water needs during most of the year.

11. An exception to this is Makadara in Nairobi, where average per capita water consumption for piped households increased from 26 to 42 litres per day.

b. Changes in Types of Water Use

A typical urban East African household uses water for a broad range of purposes, from the small quantities needed for drinking and cooking to larger volumes used for bathing, cleaning, washing, gardening and beer-brewing. Broadly speaking, these water use activities can be divided into three categories: consumption, hygiene and amenities.

"Drawers of Water II" found the levels of water used for consumption purposes (i.e., drinking and cooking) to be the same (in statistical terms) for all individuals in all households regardless of the type of connection, level of wealth or other important variables such as urban/rural location or country of residence. The mean per capita water used for drinking and cooking was estimated to be a little over four litres per day, with very little variation across the sample population. This appears to be the minimum daily amount required to sustain human life in the region.

It is important to recall that one of the most notable contributions the original Drawers of Water study made to the water policy literature regarded the understanding of the relationship between water and health. Through careful analysis and persuasive argument, White, Bradley and White demonstrated that, in many cases, water quantity is more important for improving people's health and well-being than water quality. They showed that the incidence and severity of many "water-washed" diseases can be reduced simply by increasing the availability of water without necessarily increasing its quality.[12] Diarrhoeal diseases are enormously important in the tropics as a cause of death and morbidity, especially among very young children. Epidemiological research since the 1960s demonstrates that fewer than half the cases are fecal-oral in nature (i.e., water related infections that yield pathogenic microbes, such as cholera and typhoid fever) and it seems clear that many of these infections can be prevented or reduced simply by improving water-related hygiene behaviour.[13]

The significant decline in the amount of water available per capita in urban East Africa since the 1960s suggests that people's health and hygiene will be affected negatively. Less water in the home means less water available for washing hands after defecating, for cleaning utensils after cooking and eating, and for regular bathing of both adults and children. Given this background, the significant drops in water use for hygiene purposes over the past three decades among lower-income urban dwellers in East Africa should raise serious concerns among policy makers and health professionals. The findings suggest that unpiped households suffer from lower levels of hygiene as a consequence of not having access to a regular supply of piped water. For both bathing and washing (e.g., dishes, clothes, house, etc.), these households used less than half the amount of water as those with piped connections (see Figure 3).

c. Changes in the Reliability of Piped Water Supplies

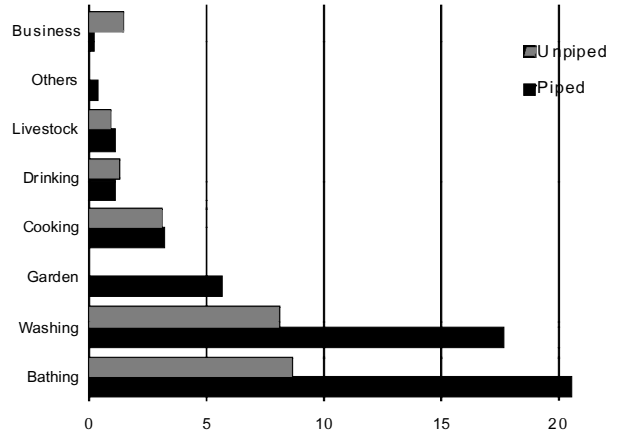
Deterioration of Piped Water Supplies

The reliability of piped water supplies has declined significantly over the last three decades in most of the study sites. Different factors contribute to this situation, including a lack of system maintenance and the stress placed on existing network capacity by an ever-increasing urban population. Whilst in 1967 practically all sample piped households received 24-hour service delivery, today only 56 per cent of them benefit from the same level of service, almost 40 per cent receive less than 12 hours service

12. "Water-washed" diseases are those where a necessary part of the lifecycle of the infecting agent takes place in an aquatic animal. They fall into two categories, namely, those affecting the gastrointestinal tract, often leading to diarrhoea, such as Shigella dysentery, and those affecting the skin and body surface, such as trachoma and scabies. Approximately 1.5 billion cases of diarrhoea occur annually in children under the age of five, with some 3.3 million deaths (WHO 1999).

13. van der Hoek, W, F Konradsen and W A Jehangir (1999), "Domestic use of irrigation water: health hazard or opportunity?", *Water Resources Development* Vol 15, No 1-2, pages 107-19; also WHO (1999), *World Health Report 1999,* World Health Organization, Geneva; and see reference 2, Esrey (1996).

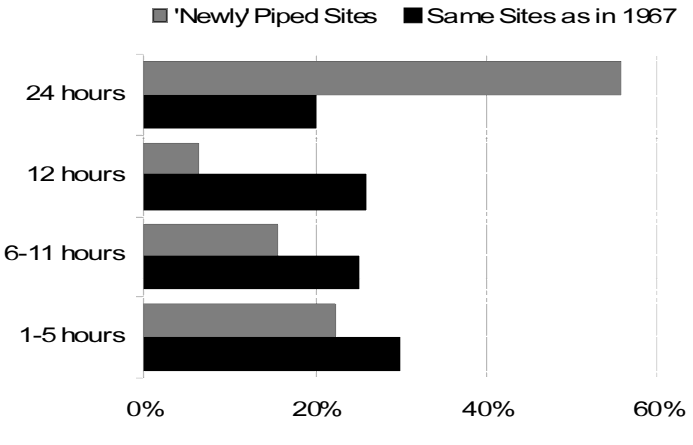
Figure 3: Per Capita Water Used by Type (Litres per Day), 1997



and roughly 20 per cent get one to five hours service per day (see Figure 4). Not surprisingly, more affluent areas such as Parklands in Nairobi, Kenya, Oyster Bay in Dar es Salaam, Tanzania, and Tororo in Uganda all enjoy virtually continuous 24-hour water supply while high-density, low-income areas such as Karuri in Kenya and Dodoma in Tanzania can count on a maximum of only five hours service per day.

In 1997 piped water supply was available in some urban areas that were totally unpiped in 1967. Urban centres located in some less affluent areas, such as Mathare Valley in Kenya, Dodoma in Tanzania and Mulago in Uganda, are included in this group. Although water is now being piped to these communities, only 20 per cent of households regularly receive 24-hour service, while 30 per cent obtain five hours or less of water per day. Iganga, a small urban centre in south-central Uganda, offers a typical case in point (see Box 1).

Figure 4: Mean Hours of Water Supply Service, 1997



When the System Fails: Alternatives to Piped Supply

The unpredictability of piped water supply in urban East Africa forces many households to take precautions, which is evidenced by the increased number of sample households who store water at home (from only 3 per cent in 1967 to 90 per cent in 1997). In many cases, households need to rely on these secondary and tertiary sources of water to cater for both short and longer-term shortages and the intermittent failure of their primary piped systems.

Although in 1967, piped households were less reliant on other sources, approximately 50 per cent reported that they would use a rain-fed pot or cistern as their alternative source if they encountered a water shortage. Today, in areas such as Dodoma in Tanzania and Iganga and Tororo in Uganda, all local respondents must collect water from various sources and store it at home to ensure an adequate supply because their piped systems are so unreliable. Improved facilities such as wells and hydrants are used by slightly more than 32 per cent of all households as their alternative source in cases of piped supply failure. Unprotected surface sources such as springs or seeps were used by over 18 per cent of piped households, most of them located in high-density, low- and middle-income centres such as Pangani in Nairobi, Kenya, and Changombe in Dar es Salaam, Tanzania.

By 1997, the nature of alternative water sources had changed significantly (see Table 3). Hydrants were rarely reported as secondary sources, except in "newly" piped sites, but more than 18 per cent of sample households used local (often private) wells (in areas such as Kamuli and Makadara, the figure rose to over 75 per cent). Surface sources were used by approximately 20 per cent of sample households. This figure includes a large proportion of households from richer areas such as Parklands in Nairobi, Kenya, and Oyster Bay in Dar es Salaam, Tanzania, who obtain their piped supplies from nearby protected reservoirs. This is in contrast

Box 1: Changes in Municipal Water Service Reliability in Iganga, Uganda

When the original "Drawers of Water" study was conducted in Iganga, an urban site in south central Uganda with very high population density, investigators found that all sample households received adequate supplies of water 24 hours a day. Thirty years later, however, the municipal water system had deteriorated to such a degree that only 13 per cent of households received piped water. Even for this minority, water supply is inadequate, trickling from pipes for only a few hours each day. The supply is also highly irregular and some households report being without piped water for up to three days at a time.

The decline of the system has taken place over a number of years. As one respondent explained: "During the 1960s and early 1970s the situation was good, but from the late 1970s the supply of water began to deteriorate. The situation worsened in the 1980s when water pumps and most of the distribution lines broke down. Of the four pumps operating in the 1960s, only one was still working by 1980."

In addition to the shortage of functioning pumps, it was reported that water storage tanks were rusty and tended to leak, as did the distribution lines which date back to the 1960s. According to one urban water officer:

"Most of the revenue collected from water bills is spent on repairing the pipes and pumps. Moreover, since the water pumps run off electricity and are subject to frequent power cuts, water supply is unreliable. It is really beyond our control."

By the late 1980s in an attempt to compensate for these problems, alternative sources were developed. Private individuals began to drill boreholes and establish their own water kiosks. In 1998, these private sources were supplemented by kiosks built by Iganga town council. At the time of the study, piped supply had also improved a little as a result of repairs to the non-functioning pumps. In light of the success of these improvements, inhabitants expressed optimism about the future.

Table 3: Main Alternative Source Used in Case of a Shortage in Piped Supply

	DOW I	DOW II	
	%	Site Piped in 1967 %	"Newly" Piped Site %
Rain-fed cistern	49.3	1	0
Improved facilities	32.3	18	11
Surface sources	18.4	22	36
Vendor/porter/kiosk	0	38	42
Other	0	22	11
Total(a)	**100**	**100**	**100**

(a) Totals may not equal 100 per cent because numbers have been rounded off.

to households in Moshi, Tanzania, and Tororo, Uganda, where 50 per cent and 20 per cent, respectively, rely on springs or seeps as back-up. Surface sources are still the primary water source for most of the households living in sites that were unpiped at the time of "Drawers of Water I."

The single most important change in the nature of secondary water supplies is the introduction of private sources such as kiosks and vendors, which are used by almost 40 per cent of piped sample households. These private sources are particularly important in low-income areas such as Changombe and Temeke in Dar es Salaam, Tanzania, and Iganga in Uganda, where over 60 per cent of piped households use vendors as their primary source.

The continuing unreliability of many municipal supplies and services, combined with the growing demand for water in most urban centres in East Africa, has contributed to the rapid rise of private water-vending, which is now a booming business in many of the low- and medium-income study sites. Despite frequently costing considerably more per litre than public supplies, private kiosks were seen in a positive light by some respondents because of their convenient locations, reliable supply, good water quality and positive customer relations. Vendors who delivered water directly to the home were also viewed positively, despite the added expense of this service, as they offered both convenience and reliability.

Cost per litre does, however, have a very real impact on per capita consumption so, despite improved service, these private sources should not be viewed as the best or only alternative to the way many public systems are operated. Many sample households reported that they chose private suppliers not because they wanted to or felt they provided a superior level of service but, rather, because they had no choice. Moreover, researchers encountered several instances where public supplies were sabotaged, leaving local residents no alternative but to purchase water from private vendors. Whether the private suppliers had an actual hand in these disruptions could not be corroborated (except in one instance in Tanzania) but they certainly benefited from the collapse of the "competition".

d. Urban Households without Piped Supply

Changes in Sources and Types of Use

Households in East Africa without access to piped water supply rely on different sources to obtain their water than those households with piped

supplies. Unpiped sources range from springs and streams to standpipes and hydrants or to water supplied by vendors or kiosks. These sources can be grouped into three broad categories:

- unprotected or surface sources, such as springs, seeps, streams, rivers and lakes;
- protected or improved sources, such as wells, standpipes and hydrants;
- private sources, such as vendors and kiosks, and water supplied by neighbours.

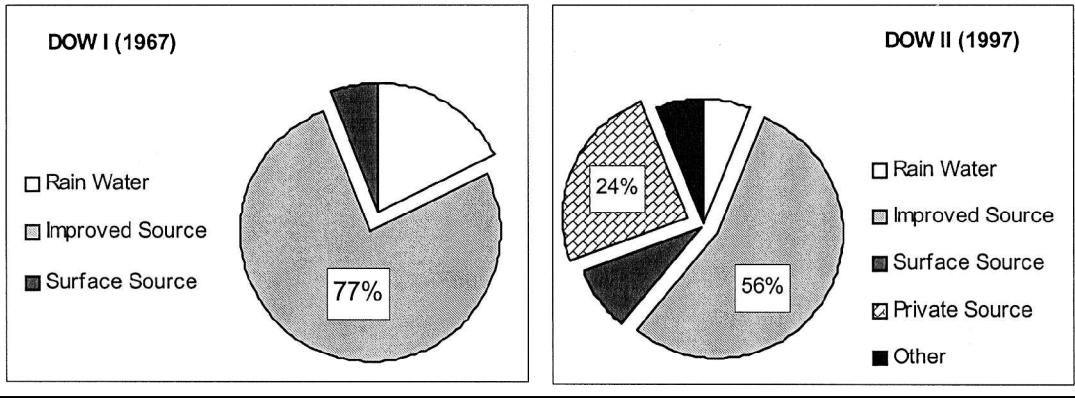
In general, unprotected sources tend to be highly seasonal, leaving households prone to water shortages in dry seasons. Although generally free of charge, they are usually open to contamination and therefore carry health risks. Protected sources tend to be a better alternative in terms of quality, accessibility and, to a degree, reliability. They are, however, susceptible to technical failures and in many cases are used by a large number of households. Thus users frequently encounter lengthy waiting times at the point of collection. While reliable and generally of better quality, private sources tend to be the most expensive in monetary terms and may be prohibitively expensive for poorer households.

The types of water sources used by urban East Africans have varied considerably over the past three decades. But, as one might expect, surface or unprotected sources such as springs, seeps, rivers or channels are far more limited than in rural areas. Less than 10 per cent of households in the sample used any of these sources as their primary water source (5.3 per cent and 8 per cent in DOW I and DOW II, respectively) (see Figure 5).

In 1967, more than three-quarters of unpiped sample households living in urban areas obtained their water from protected sources such as hydrants or standpipes. That figure rose to almost 100 per cent in low-income areas such as Mathare Valley in Nairobi, and Dodoma and Moshi in Tanzania. Thirty years later, partly due to a combination of poor operation and maintenance, increasing demand and the privatization of formerly public facilities, many water systems are no longer available to these households. Today, only 56 per cent of households in the sample used standpipes or hydrants as their primary source of water (although in areas like Kamuli, Uganda, the introduction of wells and other facilities favoured households, who switched from rain and unprotected sources, with over 80 per cent of unpiped households using improved facilities).

The striking change in types of water sources has been the develop-

Figure 5: Water Sources for Unpiped Households, 1967 and 1997



ment of private vendors and kiosks which, despite their higher cost, supply water to nearly a quarter of unpiped households living in urban areas in the region. Private sources are particularly important in lower-income communities such as Karuri, Mathare Valley, Dodoma and Moshi, where over half the sampled households view them as their primary source of water.

A further change is that today many households rely on more than one source to satisfy their water needs, often differentiating between sources for different types of use. For example, water used for washing clothes and cleaning the house might come from a different source than water used for drinking and cooking. In 1967 approximately 73 per cent of households indicated that they used a second water source but, for 70 per cent of those households, the second source was rainwater collected from the roof in a pot or cistern. By the late 1990s almost 60 per cent of unpiped households regularly used a secondary source for water some distance from the home, most of which were hydrants, wells or standpipes (70 per cent) or private sources (13 per cent). However, the quantity of water drawn from these secondary sources remains relatively small in relation to the per capita daily amount of water (an average of only 4.2 litres out of 24.3 litres pcd for the region).

Waiting at the Tap: Changes in Distance and Queuing Times at Water Sources

The average distance that unpiped households walked to obtain their water did not change significantly between 1967 and 1997 (222 and 204 metres, respectively) although a slight decrease was noted. In 1997 households walked, on average, approximately 300 metres to unprotected sources to obtain water (60 metres more than in 1967), 180 metres to protected or improved facilities (a significant decrease of almost 100 metres since 1967) and 230 metres to kiosks and other private sources (vendors not included).

The number of trips to the source has increased from an average of 2.61 per day in 1967 to 3.96 per day in 1997. This means that, on average, unpiped households living in urban areas in East Africa have increased the total distance they walk daily to and from the water source from 0.63 kilometres in 1967 to 0.98 kilometres in 1997. This increase has taken place regardless of the type of connection and has ranged between 0.7 and 1.1 kilometres both in 1967 and 1997.

In theory, time spent collecting water should be closely related to the distance to the source. In practice, however, this was shown not to be the case for unpiped households living in urban areas in East Africa. Whilst the increase in daily distance to the source was not significant, the total time spent collecting water at the source each day increased more than three times, from 27.7 minutes in the late 1960s to 91.7 minutes 30 years later (see Table 4).

Part of the reason for this change is the greater number of trips the drawer has to make to cater for a higher per capita water use, but the most important explanatory factor is the increase in time spent queuing for water. The average return time to the source (time spent walking to and from the source plus time waiting at the source) increased from 9.3 minutes in 1967 to 21.4 minutes in 1997.

Households using private sources, such as kiosks, to obtain their water reported the longest time collecting water. Each trip to a kiosk required, on average, about half an hour in 1997, which means that the average

Table 4: Changes in Average Collection Times

	Average return trip (minutes)		Total daily time per household (minutes)	
Type of source	DOW I	DOW II	DOW I	DOW II
Unprotected or surface source	8.8	19.2	36.6	73.1
Protected or improved source	12.5	16.2	35.6	85.1
Private source(a)	3.8	32.7	14.0	115.1
Total	**9.3**	**21.4**	**27.9**	**91.7**

(a) Does not include vendors, whose average time is "0", since they deliver water directly to the home.

drawer of water spent almost 2 hours per day collecting water required for the household. For water drawn from other sources, such as wells and standpipes, households required approximately 15 minutes per return trip (four minutes more than in 1967) or almost one and a half hours per day collecting water, almost one hour more than in the original study. Thus the opportunity cost of obtaining water has gone up, as services have become more variable and families have been forced to seek alternative sources away from the home, some of which are severely oversubscribed.

e. The Changing Cost of Water

Deriving a Methodology for Comparing Changes in Cost

The nature and complexity of the costs faced by both piped and unpiped urban households in obtaining water differ greatly. Households with piped water supply simply pay a fee to the service provider, which could be a block or flat rate, a proportional rate (according to consumption) or a residential rate.

Estimating the cost of water is a more complex situation for households without piped connections. It usually involves a direct cash price paid at the source, as well as the time and energy expended travelling to and from the source, queuing for water and carrying it home. In addition, there is the opportunity cost of activities that individuals could be doing if they were not collecting water for as much as two hours per day for those drawers collecting water from kiosks.

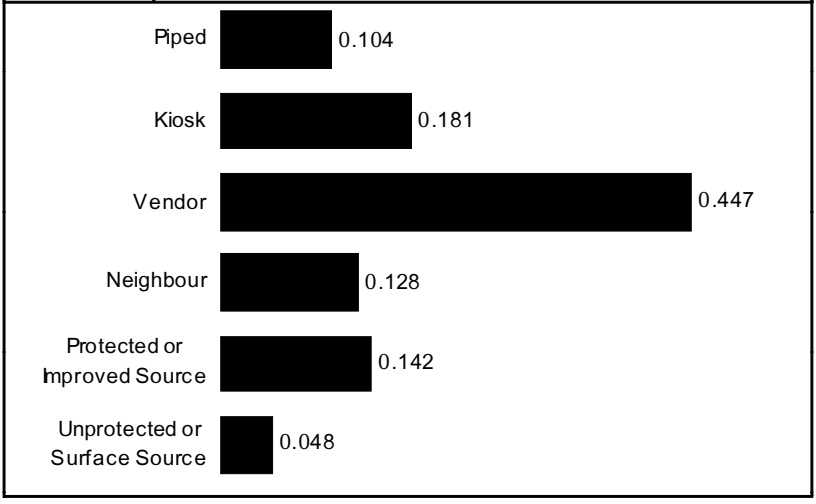
Converting these costs into a comparable cash value is difficult. In "Drawers of Water I", a cash value was derived by estimating the amount of energy used by each household to fetch water, determining the amount of a staple food (maize) required to supply this energy and then calculating the price required to purchase that amount of food. The authors referred to this as the "social cost of obtaining water". This method was repeated for "Drawers of Water II" to enable direct comparison of the cost of water for piped and unpiped households and the assessment of how the cost of water has changed over the past three decades.[14]

The Cost of Water in Urban Areas in 1997

In the late 1990s, the average cost of water in urban centres in East Africa was found to be approximately 0.14 US cents per litre, over 50 per cent more than the cost of water in rural areas. Low-income urban households who do not have access to piped water supplies pay the highest cost per

14. The methodology developed by "Drawers of Water I" to estimate the cash price of water for unpiped households has a number of shortcomings, making its reliability questionable. For example, the opportunity cost of time is not included and the use of the average price of staple foods masks seasonal and inter-household variations. Despite these limitations, the 1997 study used the same methodology in order to allow comparison with the 1967 results.

Figure 6: Cost of Water in Litres by Source Type in Drawers of Water II (US Cents)



unit of water in the region, which is almost twice the amount paid by piped households. Their average cost of water was estimated at approximately 0.192 US cents per litre, up to a maximum of 0.84 US cents. In contrast, piped households paid on average 0.104 US cents and the maximum value recorded was 0.54 US cents.

While the average cost paid by piped households did not show much variation in Uganda and Tanzania (0.088 and 0.082 US cents), it was significantly higher in Kenya (0.143 US cents) where average water cost for unpiped households was approximately the same. At the same time, unpiped households in Tanzania and Uganda paid considerably more than those living in Kenya (approximately 0.2 US cents compared to 0.143 US cents). Part of the reason for this variation was the introduction of kiosks in Kenya, which supply almost 95 per cent of households in urban areas at a price considered reasonable by the respondents. In Tanzania, more than 65 per cent of unpiped households used a private source of water other than kiosks.

As Figure 6 shows, piped water (usually supplied by public authorities) was cheaper than all other unpiped water sources, with the exception of unprotected sources such as springs or rivers. Vendors charged on average five times more than the average cost per litre for piped households. The distributional and equity issues that this situation implies must be studied in more detail in future, especially when one considers the growing number of unpiped households in urban areas that must rely on private vendors as their primary source of water.

IV. CONCLUSIONS: ONE STEP FORWARD AND TWO STEPS BACK

a. Institutional and Policy Changes

THE CHANGES IN domestic water use and environmental health documented in this study reveal a complex picture of improvement, decline and stasis. This image offers possibilities of hope while leaving much

cause for concern. For every Mathare Valley, a large squatter town in Nairobi where per capita water use has trebled in three decades, there is a Temeke, a low-income quarter of Dar es Salaam, where it has declined by the same order of magnitude over the same period. And even in those sites where considerable improvements in domestic water use have been made, the actual amount available per capita frequently remains well below the minimum standards suggested by national governments and international bodies.[15]

In the span of only three decades, the population of East Africa has gone from roughly 36 million to over 82 million people, an unprecedented increase of over 220 per cent. Much of that increase has occurred in the towns and cities. With this rapid growth in population has come an equally rapid growth in demand for water and other environmental health services. Clearly, with the region's population projected to rise rapidly in the short to medium term, radical changes in both policy and practice will be needed if these demands are to be met. But to move confidently into the future, we must learn from the past.

The 30 years between the first and second "Drawers of Water" studies witnessed a number of important institutional and policy shifts at both national and international levels which have had a profound effect on people's access to efficient, effective and equitable water and health services. Many of these shifts have been chronicled in a set of country-level policy histories that were specially commissioned for this project. These indicate that the quality of water and health services have been influenced by a combination of factors, including the increasing privatization of water and health service delivery and financing, and the growing importance of non-governmental organizations (NGOs) and community-based organizations (CBOs).

Privatization of water and health services in East Africa has taken place on a grand scale since the structural adjustment era of the 1980s, but not in ways that fit easily with World Bank or IMF prescriptions. NGOs and CBOs – not primarily profit-making entrepreneurs – play an increasing role in service provision. Moreover, the links between the voluntary sector and the state are becoming more, not less, important for service provision. Significant parts of water and environmental health services would grind to a halt in Kenya, Tanzania and Uganda if voluntary agencies did not have access to state-provided resources. In fact, much grassroots mobilization of resources (often "in kind" contributions of labour and materials) aims at attracting state support. Similarly, many voluntary organizations are run by or through state employees. This straddling of the state and civil society is a key feature of privatization of water and health service provision in the region. Finally, donors play a growing political and financial role in the water and health sectors. State services depend increasingly on donor resources, particularly in Tanzania and Uganda. The voluntary sector is also driven by donor funds (and donor priorities) to a significant degree. An important facet of privatization of water and environmental health service provision in East Africa is, therefore, not just the increased role of the voluntary sector but also the continued centrality of the state – and foreign donors.

b. Changing Roles and Priorities

It is perhaps surprising that these trends are common to all three countries, since each has followed a very different political trajectory since the

15. Unlike water quality standards, for which there are accepted guidelines and specific targets, no universally agreed standards have been established for water quantity (i.e., the minimum daily water allowance or requirement needed per capita) by the World Health Organization or any other international body. Officials at the Second World Water Forum and Inter-Ministerial Meeting held in The Hague, The Netherlands, in March 2000 failed to address this matter, as they did the contentious demand to make water a basic human right.

heady days of the first East African Community in the 1960s. But past differences between them in the way water and environmental health services were provided are fast disappearing. Today the societal arrangements for service provision are converging under the pressure of political and economic forces that originate both from outside (dependence on donors and global markets) and from within (social differentiation and political struggles).

In the short term, the most certain implication of these trends is that the role of the state and external support agencies is crucial for improving water and environmental health services in East Africa, not only because state provided services are significant in themselves but also because without links to the state and donors, many voluntary sector services would cease to function. Experience from Uganda, where the state collapsed during the civil unrest, shows both the considerable resilience of the voluntary sector (an expansion in operations) and its limitations (widening inequality in access and drastically reduced quality of services).

The long-term implications of privatization for service provision are much more difficult to assess. The optimistic view is that we are witnessing a strengthening of civil society, leading to a democratization that will make the state more transparent, accountable and efficient. Democratization and the successful implementation of market liberalization and structural reform programmes will also promote economic growth. The state, in turn, will establish the enabling environment that allows both the voluntary sector and private enterprise to flourish. Sustainability of services will then be secured. The pessimistic view is that the location of NGOs and CBOs in civil society tells us little about the values and constituencies they represent and, therefore, little about how they operate vis-à-vis the state or their members. In fact, their close links to local élites and their dependence on patronage from the state and donors make their role in fostering "grassroots democracy" ambiguous. Moreover, the long-term prospects for economic growth, which is a precondition for any domestically supported, demand-responsive provision of services, are also in doubt. Thus the sustainability of many water and environmental health services is likely to continue to depend on uncertain donor support for the foreseeable future.

Whatever view proves to be correct, what is clear is that the lessons emerging from "Drawers of Water II" suggest that a new vision of improved access to and use of water and environmental health services in Africa will require a combination of innovative policies and flexible funding arrangements in order to address the water and, with it, the health and hygiene needs of poor people in both rural and urban communities. It will also require strengthened public and private organizations to develop, operate and maintain water systems and services sustainably, and new partnerships between the state, the private sector and civil society that promote market based water development while creating cooperative management arrangements that work for people and the environment.