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Self supply systems: Urban dug wells in Abeokuta, Nigeria

Grace Oluwasanya, Jennifer Smith and Richard Carter

ABSTRACT

Self supply systems are privately owned household water sources. The systems are generally perceived as playing a role in water service delivery to the rural poor. The systems' yielding safe drinking-water also receives little attention in literature and policy, relative to public and communal sources. This paper assessed urban self supply wells and argues that self supply is a coping water supply strategy of not only the rural poor, but also of the unserved in the cities. The assessment included inventory and classification of sources, forms of access to sources, types and number of users in Abeokuta, Nigeria. Ninety eight percent of the self supply sources in the study area are hand dug wells. The design and construction features vary from protected, semi-protected to unprotected well structures. Forty five percent of the urban population is found to have access to either a restricted or free access hand dug well. The paper emphasizes the need to see self supply sources as the third angle, which completes the water supply triangle with the public and communal water systems as the other angles.

Key words | self supply systems, water supply management, hand dug wells, urban area

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INTRODUCTION

The population unserved by either the public and/or communal water systems in the developing countries, depend on water supply initiatives that they develop for themselves (Sutton 2004a; Carter 2006). These private water supply initiatives are referred to as self supply systems. Private ownership distinguishes self supply systems from communal or public systems. In contrast to the common connotation of the word 'private' however, self supply systems are always used by a group, which goes beyond the individual(s) who initiated and paid for the construction (Carter 2006). The upkeep is the responsibility of the person or people who developed the water source with little or no support from the wider user group. Examples include boreholes, hand dug wells, scoop holes and rainwater harvesting.

Compared with other parts of the world, Sub-Saharan Africa reports the least coverage rate for safe water (JMP 2005). In the region, it is suggested that self supply remained a coping strategy at the household level for millions of unserved population (Morgan 1997, 2003; Sutton 2004b, c; Carter *et al.* 2005; Foster 2008). Sutton (2007) emphasise that the potential for self supply systems in Sub-Saharan Africa is huge and hand dug wells in particular, exist in large numbers (millions) throughout Africa. Workneh *et al.* (2009), Munkonge & Harvey (2009), and Osbert & Sutton (2009) reported similar claim through their work on self supply systems in Ethiopia, Zambia, and Mali respectively. The notion and application of self supply systems is however usually limited to rural water supply. There is also limited documentation on the practice and concept of urban self supply systems.

Given the importance and potential of self supply systems as a key management issue in groundwater development in Sub-Saharan Africa (Foster 2008); this paper assessed urban hand dug wells in Abeokuta, Nigeria. It details the inventory, classifications and types of wells. The paper further describes the forms of access to dug wells, and estimates the number of users. Lastly, the paper argues the role of self supply systems in urban water supply management.

THE STUDY AREA

Abeokuta is the capital city of Ogun State in south-western Nigeria (Figure 1). Abeokuta is an ancient township that is gradually being transformed into a modern urban city. Based on the 2006 national population survey, the city has

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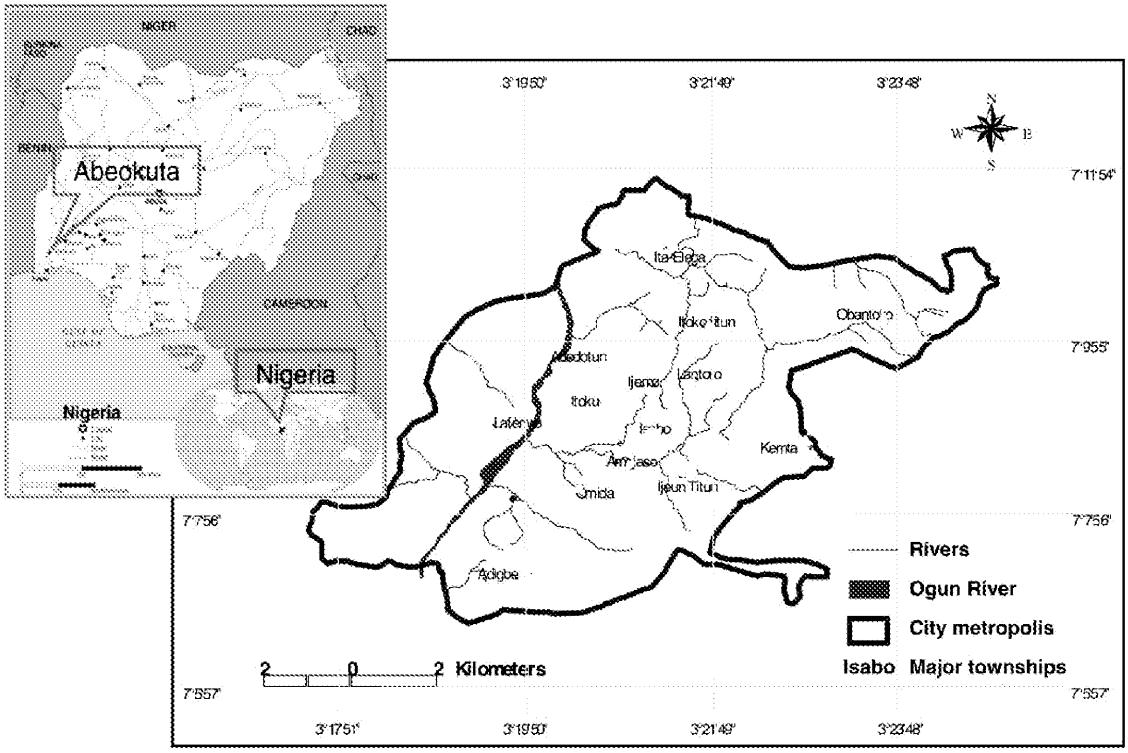

Figure 1 | Map of Abeokuta, Nigeria.

about 250,000 people inhabiting more than 50 heterogeneous townships (Onakomaiya *et al.* 1992). Abeokuta is located in the humid tropics with seven to eight months of bi-modal peak rainy season and an average annual rainfall of 1,200 mm. The area is underlain by the crystalline Basement Complex consisting of igneous and metamorphic rocks. Groundwater occurrences in crystalline rocks are either in the weathered portion of the rocks overlying fresh basement, in decomposed veins within the basement, or in fractured rocks (Martins 2001). Hand dug wells can however only tap from the regolith aquifers in the weathered portion and the decomposed veins within the basement (Martins *et al.* 2000).

The available water supply ranges from government water supply – tap water- to self supply. Tap water is distributed in the Government Reserved Area (GRA), where self supply systems are not allowed, into nearly every area of the city, with the exception of newly developed areas. Households living in the GRA of the city are allowed only the public supply and nothing else. That is they are not allowed to construct a well or borehole. This is particularly valid for the first generation GRA, e.g., the one located at Ibara, Abeokuta. The supply of tap water to the GRA is on an average of once per week and this distribution is fairly consistent. During the dry season however, it reduces to once in 2 weeks. To cater for the shortfalls, the strategy of the users is to procure big storage tanks, usually plastic surface tanks and drums to store water for use until the next time the tap water is released.

Water distribution pattern to other areas of the city, which also should be at least once per week, is very erratic. The households that desired and were able to, got connected to the mains but they also depend on other water sources; particularly self supply hand dug wells and/or boreholes. It is common practice for property owners to provide a hand dug well on their properties. Residential properties are usually blocks of flats or rooms with individual flat or rooms inhabited by different households. Where households find the quality of hand dug well water questionable, water for drinking is sourced from boreholes, tap water, bottled and/or sachet water. Generally, rainwater harvesting and the use of streams as a water source are almost completely absent.

MATERIALS AND METHODS

Self supply sources were located (house-to-house) and geo-referenced with the aid of a geographical positioning

system tool – Garmin GPS 12 (Serial number 36306200). The type of design, construction features and operations was directly observed and recorded. Life pictures through systematic observation and recording were taken with a digital camera. Estimate number of users was derived in two ways. The first is based on mathematical calculation of population figure and the derived number of wells from conducted inventory. The second validates the mathematical estimates with water user interviews. Semi-structured interviews were conducted using open ended questions. The field study took place between March and July 2007.

RESULTS AND DISCUSSION

Self supply systems – the Abeokuta example

Within Abeokuta in Nigeria, self supply systems included hand dug wells and boreholes. There are 2, 280 dug wells and 38 boreholes as at April 2007 (Figure 2). The average water table depth in hand dug wells is 4.5 m. Thirty seven of the 38 borehole owners did not know the depth of their borehole. The one owner who did know reported a depth of 30 m. This agrees with information supplied by a local driller who reported that most boreholes are drilled to a depth between 30 to 45 m, usually tapping 6–10 m depth of water.

Hand dug well classifications

Hand dug wells classification is based on the structure of the well and the mode of operation (Table 1). The wells are protected, un-protected or semi-protected (Figure 3). A protected well (Figure 3(a)) is one equipped with a dedicated pump (manual or motorised), concrete lining and platform (or apron), head wall, cover, and drainage channel. The definition of 'protection' is similar to the one given by Murcott (2007) and based on the WHO and UNICEF (JMP 2009). An un-protected well (Figure 3(b)) is without any of the features above and a semi-protected well (Figure 3(c)) may have one or more of the features found in a protected well. For example, a well that is not lined is classified as semi-protected if it has a cover and an apron.

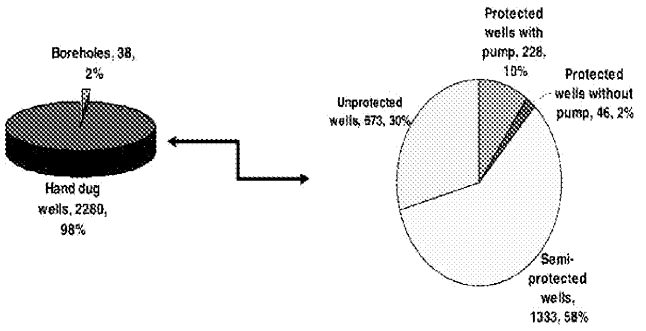

Figure 2 | Self supply sources in Abeokuta, Nigeria.

Table 1 | Hand dug well classifications based on structure and mode of operation

	Hand dug well structures[a]				
Well operations	**LCAD**	**LAD**	**CAD**	**LC**	**None**
Pump	P^+	S	S	P^-	U
Bucket/Rope	P^-	S	S	S	U

[a]Based on existing practices; L: Lining; C: Cover; A: Apron; D: Drainage; P: Protected well; +: best practice; - Lower level than best practise; S: Semi-protected or missing one or more construction features; U: Unprotected or missing most of/no protective feature.

As described above, the principle of hand dug well technology in Abeokuta is simple but the source design and construction features vary from protected, semi-protected to unprotected well structures. In this regard, 12% of the hand dug wells in the study area are categorised as protected (Figure 2). However, the water quality from protected wells can be impaired if the well is poorly operated. For example, for water abstraction, it is better to have a dedicated pump rather than a bucket and rope. In Abeokuta city, 10% of the hand dug wells have a dedicated pump, and 90% have bucket and rope (Figure 2). Most (58%) of the hand dug wells are however classified as semi-protected.

Types and number of users

Three types of well users were identified in the study area; source owners (SO), resident users (RU), and non-resident users (NRU). Calculating the number of users per well is not however a straight-forward exercise. Two approaches were used to derive an estimate for the number of well users. A first quick estimate was derived by dividing the human population figures with the number of wells in Abeokuta. The second method validates the derived estimate through interviews.

From the first approach, an average of 110 people is derived. The estimate is calculated from year 2006 census figure (250,278) of Abeokuta population and the number of hand dug wells (2,280) obtained in Figure 1.

During the interviews the numbers of non-resident users in particular were estimated by respondents. In the following discussion the total number of interviewees is 28 and denoted by N. The numbers in parenthesis represent the serial number of the respondents.

Figure 3 | Examples of protected, un-protected, and semi-protected hand dug wells in Abeokuta, Nigeria.

Four respondents (25, 26, 28, & 16) out of 28 were able to give precise number of non-resident users (Table 2). Three (25, 26 & 28) of these 4 respondents gave actual numbers of NRU. It was possible for these respondents to give the actual number of NRU because NRU did not use their wells. The fourth respondent (16) gave actual number of NRU because neighbouring houses have wells, but there are a number of food vendors who are allowed access to well.

Thirteen respondents (one, five, six, 9, 13, 14, 15, 17, 18, 21, 22, 23, & 24) out of 28 provided an estimated number of well users (Table 2). Three (4, 17, 21) of the 13 respondents gave estimated numbers of NRU. One (6) provided an estimated number of RU and 9 of the 13 interviewees gave estimated total number of users.

Three (3, 4, 10) of the 28 respondents did not attempt to give any estimate of either RU or NRU. Sixteen (one, two, five, 7, 8, 11, 12, 16, 17, 19, 20, 21, 25, 26, 27, & 28) of 28 respondents however were able to count the number of RU and provide actual or precise figures (Table 2).

The average number of users per well derived from the numeric figures (actual and estimate numbers) reported by the respondents in Table 2, is 56 people per well. The derived average number of user from Table 2 is however underestimated when viewed in line with the actual answers given by the respondents (Table 3).

In Table 3, 21 of 28 respondents use the word 'many' or a word that connotes equal meaning to 'many' (e.g. lots) to indicate the number of well users. Nine of the 21 respondents who used the word 'many' gave an indication of what they meant by the word. One (21) of the nine respondents explained 'many' to be about 20. Two respondents (9, 17) claimed 'many' to be more than 50. Another respondent (13) said 'many' is about 70. Five respondents (one, 14, 15, 22, & 23) however made 'many' to mean more than 100 people. The implication of the various interpretations of the word 'many' is that the average number of users per hand dug well may vary from as few as 20 to more than 100 user. The upper band – more than 100 user per well – agrees with the estimated number (110 user per well) derived through the first approach that is described above.

Again from Table 3 two types of access to hand dug wells are observed. These are free access and restricted

Table 2 | Respondents' estimates of the number of hand dug well users ($N = 28$).

SN	Resident status of respondents	Number of users RU	NRU	Total
1	RU	56		100[a]
2	RU	168		168
3[b]	SO			
4[b]	RU			
5	RU	12	4[a]	16
6	RU	30[a]		30
7	RU	11		11
8	RU	25		25
9	RU			50[a]
10[b]	NRU			
11	SO	10		10
12	RU	27		27
13	RU			70[a]
14	RU			100[a]
15	SO			100[a]
16	RU	12	5	17
17	RU	10	50[a]	60
18	SO			200[a]
19	RU	17		17
20	RU	20		20
21	SO	15	20[a]	35
22	RU			100[a]
23	SO			100[a]
24	SO			50[a]
25	RU	14	0	14
26	RU	40	0	40
27	RU	19		19
28	SO	10	0	10
Average number of users per well				56

RU: Resident user; NRU: Non-resident user; SO: Source owner
[a]Numbers based on respondents guess or estimate
[b]Respondents did not provide any estimate

access. While free access to wells is implicit in the responses of the respondents in Group A, restricted access is evident from the answers of the respondents in Group B. By super-imposing Table 3 on Table 2, the number of user per access type is inferred. When non-resident users are declined access to the well (i.e. restricted access), the number of user per well is less than 50. When non-resident users are however allowed access (Free access), the number of users per well is generally more than 50 people.

Table 3 | Actual responses to the question 'how many people use the well'? ($N = 28$)

SN	Respondents number	Responses
Group A – Free access		
1	1	'They are many, up to 100 ….'
2	2	'Many'
3	3	'The well is for the entire neighbourhood ….'
4	4	'A lot, the entire households around here (12 houses)'
5	5	'They are many if there is no tap water'
6	6	'We are many ….'
7	7	'Around 4 houses and people from the general hospital'
8	8	'Lots of people particularly when there is no public tap'
9	9	'We are many, up to 50; even people who come for parties use the well'
10	10	'I can't say, when there is no tap water, many people come here for water'
11	11	'No I can not give an estimate; they are many'
12	13	'About 70 people …'
13	14	'About a 100 people …'
14	15	'I can not give you precise figure, people are always here from morning till evening and they will be more than 100'
15	17	'You can say that more than 50 people come from outside ….'
16	18	'The well was constructed as a community well for people of Omida market and environs'
17	19	'Many'
18	21	'… more than 20 people from outside come to fetch water here'
19	22	'The whole community comes here …> 100 or even 1000 …'
20	23	'They should be more than 100 if counted'
21	24	'People from all these houses (5 houses) come here to fetch water; they will be more than 50'
Group B – Restricted access		
1	25	'Nobody comes from outside, it is strictly a 'mind-your-own business' house ….'
2	26	'The well is for only those living in the house'
3	27	'We have very few; 1 or 2 non-residents coming occasionally'
4	28	'No non-resident users'

(*continued*)

Table 3 | continued

SN	Respondents number	Responses
Group C - Gave actual numbers of both residents and non-resident users		
1	12	
2	16	
3	28	

If 50 people per well is taken as a threshold number, further derivation can be attempted. For instance, as indicated in Table 3, 21 (or 75%) of 28 respondents use a free access hand dug well. By using the threshold number (50 user), a total of 85,500 (75% of 2,280 wells * 50 people) or 34% people may be using free access hand dug wells in Abeokuta while an additional 11% (25% of 2,280 wells * 50 people /250,278 * 100) of users operate restricted access wells. By implication, 45% of the population in the study area may use either a free or restricted access hand dug well.

The preceding estimation is an attempt to relate the number of wells to the proportion of people in the study area. It is however impossible to accurately relate the number of wells to the proportion of Abeokuta relying on them as it is common practice to use more than one supply source for daily water needs. As such an individual may be counted more than once, thereby skewing the results. The estimate however provides a guide indication of the number of users with access to self supply wells.

Intervention and service improvements

The results presented in this study form background data on self supply systems in Abeokuta, Nigeria. Baseline survey of water systems is essential to precede meaningful intervention and helps to plan service improvements. Two key areas are identified; source operation and construction. As reported, while 88% of the urban self supply wells are either semi-protected or unprotected, 90% of the wells in the study area are operated through a bucket and rope system. The operation technique consumes a lot of energy and less convenient, especially for the vulnerable user group like the elderly and pregnant women (Workneh *et al.* 2009). Of importance is also the exposure to the risk of contamination, which can impair on the source water quality. The findings support the need for the introduction and widespread uptake of safe, energy-saving, and affordable well operation devices in the study area. As reported by Workneh *et al.* (2009), more efficient and effective water lifting technologies like the pulley-windlass and rope pumps are being developed. Private sector participation in the development of local and affordable water lifting equipment, complemented with provision of micro-credit facilities to support widespread uptake is however encouraged. Embedded in the large percentage (90%) is high potential demand for improved operation techniques. The need for improvement in design and quality of well construction in the study area is also emphasised.

The role of self supply sources in water supply management

Traditionally, water supply management has been approached in two ways; public and communal water supply. The public water systems option is usually favoured for urban water supply while the communal water systems are generally restricted for use at the rural areas. The two-way method gave rise to a linear management model. The linear water supply management model, which is generally relevant in developed countries, does not necessarily fit the water supply realities in the developing nations.

The study area, Abeokuta is a developing urban city. The water supply situation in Abeokuta as described in this study is typical for many towns and cities in especially the south west region of Nigeria. As estimated, about half the population are not served with treated public water. The unserved rely on self supply water initiatives for their water needs. As such, self supply water initiatives feature among the unserved in the urban areas, and are consequently not restricted to rural areas.

Recognising the appropriate role of self supply systems as the third key player in water supply management along side the public and communal water supply strategies is necessary. Such that self supply systems would be upgraded in mainstream water supply management. Mainstreaming self supply systems as an important water supply management strategy would also spotlight the systems for appropriate source and water safety regulations. As water safety regulation is key to ensuring safe water production of any system type.

CONCLUSIONS

Self supply dug wells exist in considerable numbers and play a role in urban water delivery. Appropriate intervention is required in the areas of operation, design and construction of well features. The number of users with access to urban self supply wells is large enough to mainstream the systems

in urban water supply management, and hence facilitates source and water safety regulation for the systems.

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