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MAXIMIZING THE BENEFITS FROM WATER AND ENVIRONMENTAL SANITATION

The sub-Saharan potential for household level water supply improvement

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Promoting only community-based water supply may mean that we are omitting a major asset which can contribute to MDGs. Many people in sub-Saharan Africa are investing in their own supplies, and appear interested to retain ownership and invest more. In the case of groundwater sources the facility may be privately owned but is generally shared to provide a communal service. In addition there is a growing culture of water treatment which stems partly from seasonal anti-cholera chlorination campaigns and which can reduce health risks of such traditional supplies. Building on these two household level initiatives offers a complementary approach especially for smaller communities, and those with plentiful traditional water supplies, where communal supplies often face problems of sustainability. Combined with rainwater harvesting especially for areas with scarce freshwater, household supply improvements can reduce the financial burden on governments, and yet allow them to respond to community and household demands.

Introduction

Over the past twenty years the emphasis within rural water supply in developing countries has been largely one of building up community water supplies. This has brought many advantages in terms of greater ownership and reduced burden of maintenance on government centralised systems which could seldom provide adequate service. However it has also perpetuated and increased a dependence on donor funding (usually 70-90% of capital investment), relying as it does on technologies whose capital costs rural people cannot afford, and may in many cases even be unable to cover the recurrent costs. It also appears that donor funding is generally inadequate to reach Millennium Development Goals in water and sanitation in sub-Saharan Africa, and over-emphasis on these goals rather than the wider role which water can play in contributing to goals such as poverty reduction, and infant mortality has led to adoption of a very limited range of relatively expensive options.

As a result, there is little or no promotion of ways in which people can improve their own situation in progressive steps, rather than waiting a generation or more for accepted standards of supply of questionable sustainability (almost 40% of sub-Saharan handpumps are not working).

At the same time it is becoming increasingly apparent from studies (e.g. van der Zee et al 2002, WSP 2002, WSP 2004) of unprotected sources that people are using, that there is considerable personal investment (Self Supply) of both effort and cash by those rural poor seeking to improve their situation and obtain safer, more convenient and reliable supplies. The limitations appear to be more from lack of information and of available low cost options than from the financial constraints of the rural poor. Yet there seems to be considerable demand for improvement and willingness to pay for it at household and small community levels.

A major part of private investment in groundwater sources is shared beyond the owners household, either free or at cost both in peri-urban and rural areas. It is a widely held belief that water is a common good, and is therefore shared with neighbours within a radius defined by comparative distance to other sources. This provision of essentially communal supplies can augment donor and government efforts and allow them to concentrate more in problematic areas, so maximizing the benefits of rural water supply and reaching a wider range of rural communities.

Elements of self supply

Private investment in water supply may take several forms. These include construction of water supply (rainwater harvesting and unprotected wells), and supply improvement (water treatment and source protection). The Self Supply Concept aims to create an enabling environment within which people can invest in water supply, in a structured and well-informed way. In this way, over time and using progressive steps, they will have access to water of an improved quality and quantity which ultimately may equal that of conventionally protected communal supplies. The difference is in ownership and sustainability.

Most private supplies remain the property of individuals, allowing them to make decisions, take direct benefit, and to form linkages with local artisans who can maintain systems at minimum cost. The level of technology is that which the owner feels able to sustain either on his own or with government subsidy or support from neighbours. In the case of a peri-urban point supply, such technology may be an electric submersible pump and elevated storage tank; for a rural farmer an unlined well with rope and a bucket , but with possibilities to progress to lining and well head protection, a windlass or pulley and then to a low cost pump.

Water treatment varies from sachet or measured chlorination of stored water in the house (Reller et al 2002, Sobsey 2002) to sand or ceramic filtration (Clasen 2004) (with or without silver as a bactericide), or SODIS solar disinfection Conroy et al 2001) using easily available soft drinks bottles.

Rainwater harvesting at household level is mainly confined to the capture of water of roofs, and storage in above- or below- ground cisterns or jars. In limited cases harvesting also includes making micro-catchments on the ground leading water to below surface storage, or to crops.

Potential for construction or improvement of groundwater sources

Development of groundwater sources may be of springs, scoopholes or unlined wells. At present, basing estimates on an analysis of most recent coverage data (undertaken by the author in Feb 2005) converted to the numbers of people using such sources suggests that there are over 1.5 million such supplies in sub-Saharan Africa alone. The combination of the need for regular replacement in areas of poorly consolidated ground, and of an increasing demand for convenient supplies means that there are probably at least 150,000 new supplies being excavated every year

Source improvement includes both the construction of new supplies nearer to users and greater protection of existing sources. These sources of supply are all those using shallow groundwater (within 15-20metres of the surface). The BGS review of groundwater for rural water supply in sub-Saharan Africa (MacDonald 2000) (see Table 1) relates abstraction to basic aquifer type, but not unfortunately to depth to water, and assumes both users of surface and groundwater to be dependent on groundwater. It suggests that approximately half of rural people live in basement complex areas, with only some 15% on unconsolidated sediments. This may reflect something of the difficulty of finding water over large areas, but within basement complex areas there is often a concentration of people and of sources in narrow alluvial areas associated with streams and rivers at scales too small to be identified by such a study. Otherwise shallow wells tend to tap perched water tables and the shallow weathered zone, while boreholes can penetrate to deeper fissures into which they may drain. Data on drinking water source types (from most recent DHS surveys and national statistics) suggests that some 33% of rural people (over 140 million) use shallow groundwater[1], and a further 31% (around 135 million) use surface water which could usually also be accessed by in situ filtration using river bank or lakeside alluvial deposits. All those using unprotected groundwater are potential candidates for source improvement, or in areas of unreliable shallow aquifers, for source replacement with boreholes.

Table 1. BGS Analysis of sub Saharan population and aquifers

Aquifer	Millions	%age
Basement	220	51%
Volcanic	40	9%
Consolidated sed	110	25%
Uncons sedimentary	65	15%

Concentrating initially on unlined wells, which tend to be more highly contaminated than scoopholes and springs, it is apparent that, when numbers rather than percentages are considered, two countries dominate the situation. These are Nigeria and DR Congo (see Table 2).

It should be noted that whilst Ethiopia is in the same league in terms of numbers using unprotected supplies, there is a lesser tradition of well-digging over much of the country (as well perhaps as fewer areas of shallow groundwater), so that many more obtain their water from springs and surface water. However local artisans, trained in well-digging, by encouraging households to commission them, at their own expense, to dig family wells have given rise to the construction of more than 50,000 new wells in one year in one province, emphasising that lack of wells may sometimes be a result of lack of traditional skills rather than of suitable shallow aquifers. This is also true where soils are very sandy and there is no tradition of well lining to stop sides from caving in. Training and introduction of simple new lining technology can bring rapid change.

Inclusion of the factor of distance to water source helps to identify those areas where supplies are shared by relatively small numbers of people and with a tendency for private ownership. Distances of less than 15 minutes to collect water are taken to indicate such a situation, whilst in Table 2 the proportion of functioning handpumps is added as a 'push factor' encouraging personal or small group investment.

Ownership of supplies

Table 2 indicates Mali as a country of very high potential, with over 5 million people using traditional wells and 65% with supply within 15 minutes of their home. This interpretation of statistics is born out by a government survey (DNH 2004) which identifies almost 200,000 unprotected shallow wells in the country (one per 30 un-served people), with a large proportion of these being privately owned. In Zambia a survey in 1995 (CMMU 1996) found around 8,000 unprotected wells in two provinces, and a subsequent study (Sutton 2002) found that in a sample of 800 unprotected wells two-thirds of supplies were managed privately and one third communally (although in one province, Luapula, 94% are privately owned).

Ownership is an important issue as slightly different strategies in terms of social marketing are likely to be needed to encourage improvements to supplies regarded as communal rather than private, and more time needed to obtain community rather than individual response. The personal incen-

Table 2. Countries with highest proportion of rural people using traditional wells

Country	Level of Coverage	Rural people drinking from traditional wells	People with water within 15 mins	Functioning handpumps
Nigeria	32%	23,626,977	45%	50%
DR Congo	26%	16,675,142		40%
Mozambique	26.8%	6,236,848	31%	65%
Uganda	55%	6,202,289	15%	70%
Mali	33%	5,184,519	65%	65%
Tanzania	62%	4,414,999	26%	70%
Chad	25%	3,643,902	27%	50%
Malawi	61%	2,670,759	28%	60%
Kenya	40%	2,473,632	43%	n/a
Zambia	37%	2,344,231	50%	80%
Ethiopia	11%	2,087,863	21%	n/a
Sierra Leone	21%	1,954,746		65%
Cameroon	42%	1,674,272	42%	n/a
Cote d'Ivoire	35%	1,188,099	66%	<35%

tive to improve one's own supply brings direct benefit and opportunity to widen the uses of water to include income generation. A brief field study by the author of traditional sources in seven African countries (Tanzania, Sierra Leone, Moçambique, Zambia, Zimbabwe, Mali) has come up with four main patterns of ownership as in Table 3.

The first model is rare except in Zimbabwe, since in general there is a strong feeling that water is for the common good and should be shared. Water is seldom sold except in areas/ times of high demand (peri-urban, high density populations with few options, water shortage). Even where it is sold as in peri-urban Dar es Salaam, well owners have usually constructed a supply primarily for their own house, and sell to neighbours to cover costs but generally not as a business investment to make a profit.

It is found that almost all private owners of supplies wanted to improve them, and were prepared to pay all or most of the cost, for options which they felt they could sustain (up to and including low cost pumps). This is true even in poor countries such as Sierra Leone. They are aware of their previous levels of investment (averaging about US$ 100, rising to over $300 for deep wells). However as the communal element becomes stronger (model 3 and sometimes also model 2), users are still keen on improving supply but noticeably less willing to cover the costs. This is especially true where government have become involved in source upgrading, turning private supplies into communal ones, using technologies which are too expensive for other private owners to copy.

Potential for rainwater harvesting[2]

Rainwater harvesting is increasingly being promoted as an option in many parts of the world both at institutional and household level. Within Africa, however, it is less widely applicable than in South-East Asia. In order to provide a household supply of some 20l/hd/day without very large and expensive storage requires a) a roof which can provide maximum catchment capacity (asbestos or zinc) and b) and

Table 3. Ownership and willingness to invest

Ownership models	Construction	Management and maintenance
1. Individual	Construction paid for or undertaken personally, and used only by direct family	Managed personally, high willingness to invest and often to include income generation
2. One household/ individual/ shared without obligation	Construction paid for or undertaken personally , but benefit shared with surrounding community (usually without charge unless using a pump or in times of water shortage)	Managed personally, widespread desire to improve and willingness to do so as far as possible at own cost. Does not wish to ask for help from others in order to retain control/ ownership
3. One household/ shared with joint obligation	Construction undertaken with assistance of neighbours and benefit shared with them and others	Managed personally but improvements/ maintenance carried out with help of neighbours
4. Communal	Constructed as communal effort, or by headman for all	Maintenance carried out communally using traditional community management structure.

Photograph 1. Household RWH system, Inhambane, Moçambique

more than 1600mm a year and only one month with less than 50mm of rain. Providing drinking and cooking water alone (say some 7 litres/head/day) would require two good rainy seasons and still probably require some water carriage for three to four months a year. However it is a solution to contemplate particularly where water carriage is a real problem (eg. HIV/AIDS households and for the elderly, island communities or where long distances to fresh water make even part-year supply beneficial).

Information on roof types is not always available, but for rural areas of Moçambique less than 2% of houses have zinc or asbestos roofs (QUIBB 2001), rising to 45% in Nigeria and 67% in Kenya (DHS Kenya 2003). Catchment capacity lies between 65 and 80% of rainfall on sheet roofs and lower for grass ones for which guttering is difficult to fix. This suggests that for many poorer countries RWH is a solution which is of limited applicability and is most likely to be taken up by richer members of a community. In Mozambique it is miners returning from South Africa with both knowledge of the technology and disposable income who are the main proponents of the practice so far.

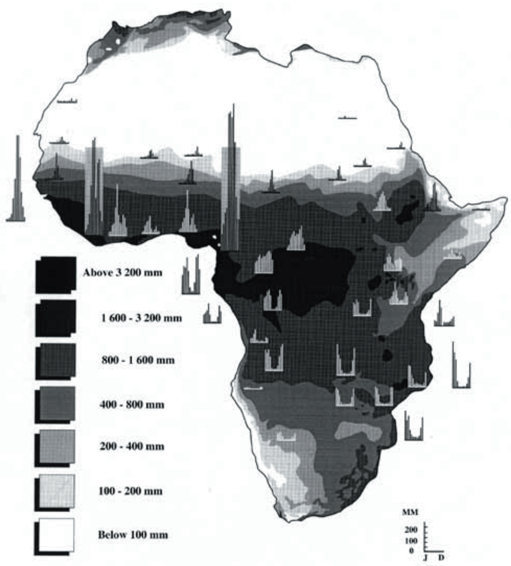

Figure 1. Mean annual rainfall in Africa and monthly distribution

However informal catching of rain in buckets is widely practiced and offers short-term benefit. The most suitable areas of sub-Saharan Africa for RWH are those with two good rainy season most of which lie between 10 degrees North and South of the Equator, and have more than 800mm a year of rain3. This generally rules out countries which are most water short and so most in need of an alternative to groundwater.

Potential for household water treatment

Improving quality at the point of consumption is increasingly being recognized for its value, particularly those most vulnerable to disease through reduced immunity (under 5's, HIV/AIDS, old age).

Significant reduction in diarrhoea, beyond levels previously estimated, suggest that more emphasis needs to be put on encouraging not just good hygiene in water use, but also treatment which further reduces risks. However this is at present a solution most available and affordable to urban dwellers, and the more affluent of these. The rural poor are likely to be the last to benefit from such innovations.

The potential is enormous. Only 39% of urban and 4% of rural people have a supply into their house or compound (author's analysis of most recent country data Feb 2005), leaving some 550 million people in sub-Saharan Africa carrying water to their houses, with associated risks of contamination or further contamination before consumption. To these should also be added all those who suffer from intermittent supplies which are not always of an acceptable quality standard.

Over the past few years, outbreaks of cholera in many countries have meant that there is a growing practice of source or container chlorination, which is sporadically subsidized by governments. Some countries such as Sierra Leone and Liberia have set up widespread networks of trained volunteers to ensure good practice in chlorination, but once the cholera threat is over stocks of chlorine are run down or horded for the following year. The growing acceptance of chlorination, and more importantly, reduced rejection of the taste, mean that it is now a tradition that can be built on.

To date there has been little linkage of the principles of chlorination to prevent cholera in the short term to the same preventive role for diarrhoeal disease in the long term. Thus households do not link the two generally, and chlorine is rarely available for purchase or distribution except when cholera is threatening. There is therefore a good foundation on which to build, in terms of community acceptance of the value of water treatment, and a possible market which traders could be encouraged to serve. This could be built into any strategy for increasing hygiene relating to water use, and risk reduction through water treatment at household level.

An increased potential arises both from the growing user acceptance of linkage between disease and poor water quality, but also from the growing availability of proprietary forms of chlorine and flocculant, and the public/private partnership which is growing between manufacturers, governments and NGOs. Products such as Pur, Sur'eau, Waterguard, Clorin, as well as sand and ceramic filters offer an increasing range of options and decreasing costs. These are being promoted principally in urban areas, where demand is most easily raised and supply most easily effected.

Water treatment does not preclude the need to also improve and make sources more convenient, not least because high faecal coliform loads and turbidity reduce the effectiveness of treatment.

Findings from some existing initiatives

Source up-grading

The number of examples of private investment in improved supplies is growing, and the movement growing stronger, but influence on policy still tends to be weak. Most initiatives are small scale and often NGO-based but their combined experience is positive and deserves wider promotion. As a result, the Rural Water Supply Network (RWSN) has taken self supply as one of its three themes to improve the chances of reaching MDGs. The aim is to collate such experiences, encourage greater exchange of information and develop a good database and research basis for stronger advocacy.

There are some exceptions to the small localized initiatives which give an idea of the impact which may be achieved by encouraging people to improve or construct their own supplies, for their own benefit and that of their community.

The best known instance is probably the Family Wells Program in Zimbabwe (WSP Aug 2002), which started as a small initiative of the Ministry of Health, with minimum subsidy, but grew to be taken up by more than 50,000 well owners (benefiting around half a million people at minimum cost). It began in areas where unprotected family wells already existed, encouraging brick lining, protected head-works, use of a windlass, with family management and pride in having a convenient and safer facility which can also generate income from irrigation (many people have added cisterns to allow easier irrigation see photo below). In Bikita annual gross incomes per family rose by US$20-100 (Mathew 2003), whilst Morgan (WSP Aug 2002) estimates that a farmer with a well using a rope and bucket can earn around $75 per year, but that a low cost pump (such as a rope pump) quickly pays for itself by allowing expansion of cultivation and income of as much as $600. User satisfaction has meant that soon people in areas without a tradition of well-digging picked up the idea also. The result has been the development of numerous sustainable supplies which continue to operate and provide both safer and more productive water, at no cost to government.

In Zambia the research and piloting of community or household led water supply improvement was undertaken with Ministries of Energy and Water Development as well as with Health (Nyundu 2001). Emphasis was on monitoring the impact of improvements on water quality with 200 piloted improvements with an average cost of under $250 each. (This compares with an average household investment in well excavation of $100-350). Prior to improvement only 35% of wells had water with less than 10 FC/100ml. Afterwards 94% of improved partially lined wells contained water with less than 10 FC/100ml, and actually exhibited less risk than conventionally constructed lined and fully protected wells costing more than ten times as much.

All six district councils involved in piloting took up the idea and subsequently obtained funds to continue, and demand for improvement far exceeded capacity to respond. Initial piloting of 60 scoophole improvements resulted in over one thousand being improved by communities with small help from Ministry of Health, whilst source up-grading in general became incorporated into the national rural water supply strategy. The experience of the two countries shows that where an enabling environment exists a small amount of

Photograph 2. Zimbabwe improved well, with cistern for irrigation

demonstration and piloting can lead to rapid and widespread changes which can be promoted by local private sector and not just as a government-led community mobilization.

Other countries such as Sierra Leone and Mali are beginning to encourage source up-grading. In the case of Sierra Leone over 3,500 sources having been protected with top lining and covers, but not usually with apron and drainage which Zambian monitoring showed to be vital for long term water quality. In Mali government has a staged community contribution for different technology options, with traditional well up-grading as the cheapest. However here, as in Tanzania, the subsequent requirement that what were private wells be then owned and managed communally tends to threaten sustainability and also make well-owners less eager to opt for up-grading.

Household water treatment

Initial results from several studies on household water treatment have been impressive, and refer to chlorination (Reller 2002) and to solar disinfection (Conroy 2001, 2002). Impact is especially high on under 5's, and probably particularly children under 2, as they tend to be given a lot of untreated water to drink and have yet to build up resistance. Studies are tending to suggest higher significance of drinking water quality to health than proposed by Esrey (Esrey 1990). However this perception has a strong research bias, and the challenge will be to transmit the potential benefits to people who have many other priorities which we may not fully appreciate.

Whilst manufacturers tend to quote how low costs are, much production and distribution is still subsidized and it may be questioned how affordable regular outlay on consumables may be. Certainly a study in Madagascar (Rakotomahanina 2004) found significant decrease in up-take when subsidies were reduced. For rural populations in particular, sand or ceramic filters, and especially low cost solar disinfection may well offer more sustainable solutions. Even these will require people to identify what may be only small changes in water quality to be of sufficient priority for them to purchase materials and manage filters and disinfection in an effective fashion.

Hygiene education

In both source improvement and household water treatment a major element of success lies with hygiene education. Most of the studies of water treatment found that a large proportion of the impact on diarrhoeal disease came from hygiene education, disinfection generally adding an additional percentage of risk reduction (Makutsa 2004) so that overall reduction in diarrhoeal incidence may reach 40-50%.

With source protection it also seems that it is management and norms set for behaviour during water collection which much affect water quality. Thus the most important element would seem not to be a technical one but more a question of behaviour change. This comes back to the linkages with sanitation and hand-washing. Water quality was found in the Zambian study to be much improved when drawers of water washed their hands before filling containers. There was no correlation with whether people had latrines or not, but a significant increase in risk of contamination where people had been educated to wash hands after defecation but had not been made aware of the need to draw the required water before, rather than afterwards when they required the water and their hands were already dirty.

In Sierra Leone, the linking of chlorination and up-grading through hygiene education by community volunteers has led to increased demand for chlorine and a willingness to pay towards improvements. In all countries visited, it was the possibility of installing low cost pumps which most excited well owners and also the women who draw most of the water. However it should also be noted that having a well within the confines of a household has another benefit in that it seems to mean that men can draw water without embarrassment and so reduce burden on women. This change was also promoted as part of hygiene education in Zambia, linking to the change to closable jerry cans and use of bicycles to carry water, which led to an increase in water carried by men of 25% (S.Sutton 2001).

Barriers to household self Supply Initiatives

Some positive results are beginning to come from encouraging more local and personal investment in water supply. At present, however the barriers to progress are quite formidable. They arise particularly from a fear of 'going backwards' and of sacrificing standards. Politicians are looking for prestige developments which can be given a high profile, and which generally are easy to administer because they use funds under large contracts which avoid large volumes of paperwork and small scale monitoring. At present inadequate attention is given to cost effectiveness and sustainability is seldom (if ever) achieved according to the WEDC study on handpumps (Harvey, P.A. and Reed, R.A., 2004).

There is also usually reluctance to provide any subsidy to private initiatives, even though they generally result in communal benefit. Governments do not like to pay money to individuals, because the system is open to abuse. Meanwhile for communal supplies they are generally providing a subsidy of some $40-50 per head, yet people who have gone some way to try and solve their own problems are required to cover all their own costs. The aim of self supply is therefore more to build on people's demonstrated wish to improve supply by providing a more enabling environment with well-trained local artisans, freely available information and low cost technology options for local purchase, rather than to provide the 90-95% subsidies given to those qualifying for a borehole and handpump.

At present the lack of information and awareness of what householders can do to help themselves, and the lack of necessary supplies, also create barriers to progress. The manufacture of low cost pumps is very limited so far, but the interest found was enormous. The same is true in areas with few well-diggers or no knowledge of methods of lining.

The ineffective supply chains which so hinder the sustainability of handpumps in rural areas area also likely to slow the up-take of activities requiring consumables such as regular chlorination, some filters, and all but the simplest of pumps. However in peri-urban areas with better communication, investment in water supply can reach more sophisticated levels, and the example of some leads to rapid changes among large numbers, because seeing is believing. Thus peri-urban areas can form a starting point which may bring a feeling of progressiveness which will market the ideas in more rural environments.

Existing initiatives show that demand can grow quickly at grass roots level. The difficulty is to bring policy makers, who are often initially antagonistic, into the process of developing this approach in a way that results in a supportive policy environment. This has so far been achieved mainly by introducing self supply concepts and practices through the health rather than the water sector. Health personnel are interested in reducing health risks as part of primary health care, and so can accept more easily the principle of incremental improvement. Such a principle is at present less easily accepted by engineers keen to maintain existing standards even in socio-economic environments where their sustainability must often be questionable. However when the demand and the impact become clear, attitudes have generally been found to change.

Conclusions

The incremental changes being promoted both to water quality through treatment and by source improvement mean that households or communities which are too small to sustain more expensive technologies can still make significant improvements to their supplies and this can be done in replicable ways which allow others to pick up the idea and copy it.

Such changes can be effected largely through increasing awareness and providing technical and possibly short term financial support to households and communities who can then choose their own solutions.

Outside of sub-Saharan Africa water supplies are often very largely a household initiative, especially in rural Indonesia and Bangladesh. In Nicaragua some 25% of rural coverage (Alberts 2003) is now provided by individuals who have dug their own wells and bought their own rope pumps. It is not a new phenomenon, but just one which is seldom recognized for the benefits it can bring.

This brief study of the situation within sub-Saharan Africa, based on national statistics and visits to seven countries, shows that the potential for such an approach within the continent is enormous. What is necessary is good documentation of what has been achieved, piloting to show what can be achieved, greater exchange of experiences and an advocacy strategy which can change attitudes at all levels.

Note/s

1. Figures derived from most recent DHS, MICS and census data from all sub-Saharan African countries.
2. Acknowledgements to Terry Thomas for pers comm. On ‘Roofwater Harvesting and Self Supply’, Uganda Rainwater Harvesting Association April 2005.
3. Map from www.iss.co.za/pubs/monographs/no.6

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