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Title of Paper: **Let's fix it: Managing greywater in shanty settlements, South Africa**

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The character of greywater in South Africa's informal, shanty settlements varies considerably, often dark grey in appearance and generated from all forms of household activities and only formally excluding water from the toilet. Since options for disposal are limited in non-sewered settlements, residents resort to the most convenient method of disposing it on the ground alongside their shack dwellings. While some municipalities have provided simple technologies to assist in disposal, all too often these well-intentioned initiatives fail: officials are convinced that failures are caused by the users; while local residents claim that the government does too little to address their basic need for a clean, healthy environment. This paper identifies some of the reasons why existing drainage structures have failed and identifies the social and institutional challenges for greywater management in non-sewered settlements. The cause of poor services in shanty settlements is complex since it is woven into a history of socio-economic injustice and of the state's present capacity and policies. While not ignoring the complexity, this paper argues that effective solutions to managing drainage lie largely in the development of co-operative partnerships between users, elected local councilors and municipal officials. The paper describes a study that applies ideas about Adaptive Decision Making Processes to implement various low-cost technologies as interim solutions that seek to reduce the impact of wastewater on human health and the environment. The approach begins with stakeholder consultation followed by participant surveys, observations, workshops, opportunities for collaborative decision-making, and finally intervention and adaptive learning. Thus far the study has achieved mixed results, the greatest challenge being to strengthen partnerships and trust between stakeholders. The prospects for sustainable service delivery lie in developing human capacity and effective governance rather than the technology.

Introduction

The title of this paper originates from a television programme currently being aired in South Africa. During the programme viewers are invited to nominate a person or institution needing some form of assistance. The presenter then contacts various sponsors for financial support, including their time and expertise in order to 'fix' the problem. Fixing problems in this way provides good television entertainment, but in reality conditions in South Africa's shanty settlements makes fixing a lot less glamorous where the challenge is of a particularly high order of magnitude.

Since 1994 the South African government has committed itself to delivering basic access to water by 2008 (25 litres per capita per day, *l./c.d*) and basic sanitation by 2010 (on-site dry latrines) throughout the country (DWAF, 1994). Basic access to water means the provision of potable water (usually from a communal standpipe) to within 200m walking distance of a household. Basic sanitation is understood to comprise provision of toilets that are safe, clean, reliable and environmentally sound and each of which is shared by no more than five families (Department of Housing, 2004). There has been remarkable progress in the provision of potable water, but 20 million people are still without access to on-site sanitation (Statistics South Africa, 2005). Most importantly for the present paper, in the absence of a formal reticulation system, greywater generated from household activities is frequently observed to flow together with spillages and leaks from toilet water. This typically results in an increase in the total pollution load on surfaces and has the potential for a toxic mix of black- and grey water to infiltrate soils and also to flow as runoff into surrounding water bodies.

Greywater is defined broadly as the wastewater that is generated from a variety of household activities without input from toilets. It accounts for virtually all water consumption in non-sewered areas except for that which is used for drinking purposes, cooking and that which remains on the surfaces of washed articles. Alcock (2002) estimated that water consumption for South African informal housing households with a standpipe in the yard is between 30 and 80 *l*/c.d, whereas mean consumption ranges from 9 to 50 *l*/c.d when the water is carried from an external source (250m to 3km to the source). The relatively low volume of greywater generated in non-sewered areas might easily be dismissed as having negligible impact on health and the environment. However, observations and data collected from local residents suggest that the contrary is the case and that greywater management is a pressing issue.

In 2006 the Water Research Commission of South Africa appointed the Urban Water Management research group of the University of Cape Town (UCT) to investigate ways of working with community structures to improve greywater management in non-sewered settlements until such time that government might be able to provide formal services for all. This paper identifies some of the problems involved in managing greywater in three selected shanty settlements, and describes current progress toward fixing these problems as an interim measure and using low cost technologies. The project is due to be completed in 2009.

Method

The research design explicitly proposed what Lal et al (2007) described as an Adaptive Decision-Making Process (ADMP) which seeks to encourage a variety of stakeholders to participate in reaching decisions jointly through collaboration, co-operation and consensus. In this study the four phases of ADMP were adapted as follows:

Phase 1: Identification and assessment

The selection of the study settlements was achieved through consultation with local authorities, field visits and in some cases based on experience of previous studies conducted at these settlements.

Phase 2: Reflection and establishing of shared goals

The aim of this phase was to identify problems associated with existing greywater management practices with an emphasis on current practices, and on the impacts on human health and the environment. Once agreement was reached, the researchers facilitated a number of workshops with residents in order to establish plans and options for greywater management.

Phase 3: Action

In this phase, the residents commenced with the implementation of the proposed management strategies and technical interventions.

Phase 4: Adaptive Learning

This phase provides an analysis of the long-term sustainability of the study. Adaptive (or experimental) learning is used for reflection and modification of the intervention strategies as a joint activity by residents and researchers.

Results and Discussion

Phase 1: Identification and Assessment of Study Settlements

The broad selection criteria for the study settlements were that shanty settlements had to be without formal on-site water supply and sanitation systems. In addition, the sites had to offer a range of densities; some form of a local-level organization that represented the inhabitants; and have no immediate prospects for development of settlements in the short term. A brief description of the three selected settlements is described below.

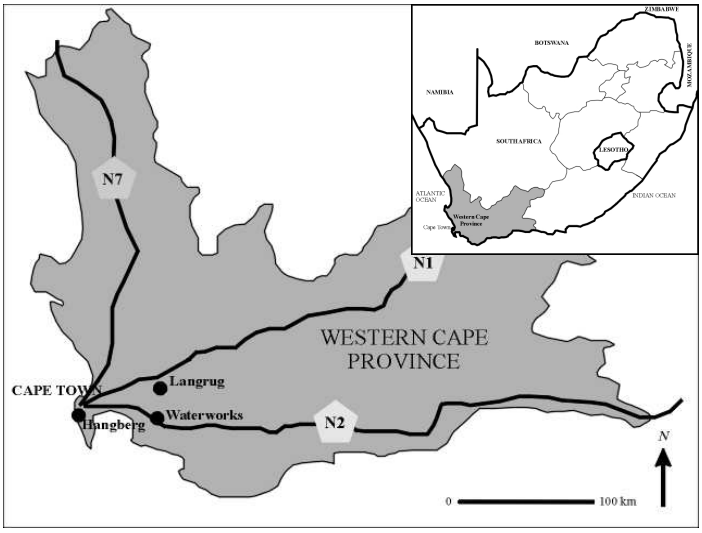

Figure 1. Location of selected settlements within the Western Cape Province.

Langrug, Franschhoek (Stellenbosch Municipality)

Langrug informal settlement is situated on a 1:12 slope consisting of sandy and clayey soils. The first shack dwellings were erected here in 1993. By 2006 the population of Langrug had reached 5,000. Unemployment is widespread. Those who are employed work mostly in the local construction industry or as seasonal workers on nearby farms. The informal shack dwellings are constructed of corrugated iron, wood, plastic sheeting and a variety of other scrap materials such as billboards and packing cases. Municipal water services comprise of six communal standpipes, 40 flush toilets and 14 washbasins. From ongoing field observations, many of the existing facilities are persistently dysfunctional, for example, most standpipes and toilets do not drain properly, whilst some have been permanently disconnected. As there is no formal wastewater reticulation or stormwater drainage system a mix of black to dark grey water runs continuously down streets and pathways and sometimes flows into residents' homes.

Waterworks, Grabouw (Theewaterskloof Municipality)

Waterworks informal settlement is located on a gently sloping hillside with surfaces consisting of coarse sandy soils and sandstone outcrops. Migrants invaded this open piece of land in the late 1980s. The area now comprises over 1,000 shacks constructed from wood, plastics and corrugated iron. Most people work on nearby farms when seasonal employment is available. Communal standpipes are poorly maintained and most are inoperable resulting in leakages. Residents assert that the most pressing problem is near absence of any functional toilet facilities. The municipality installed some 20 toilet units, 6 communal standpipes and approximately 12 washbasins, but numerous site visits revealed that fewer than five toilets were ever found to be in a fit state, most were filthy and blocked with excrement and paper.

Hangberg, Hout Bay (City of Cape Town Municipality)

Hangberg informal settlement lies on steep slopes covered in rocky and sandy soils (1: 3 to 1:5). In 1956 the Apartheid regime unleashed the notorious Group Areas Act No.41 of 1950 to declare Hout Bay a 'white' suburb. A mere two percent of the suburb's land was demarcated for the 'coloured' population who were allocated a small area close to the fishing harbour. By the early 1970s, fishing activities there had intensified and attracted labour to the area, in turn prompting the City Council to build residential flats for the 'coloured' fishers in an area called Hangberg. Soon, however, these facilities became overcrowded and family members invaded open ground immediately behind and uphill from the Council-owned buildings, giving rise to an informal settlement. In 2001 Cape Town City Council attempted to meet the needs of over 360 households that had sprung up there by installing 39 communal flush toilets and 37 water standpipes.

Phase 2: Reflection and establishing of shared goals

Langrug

The researchers undertook numerous site visits to Langrug between 2006 to 2008. These aimed at identifying local social structures or organisations such as street or block committees, NGOs and church groups. Immediately difficulties were encountered. Apart from a few pro-active individuals, no community-based structures could be identified. The researchers also encountered difficulties in trying to gain the co-operation of local authority officials and the elected Ward Councillor. Some Municipal Engineering Department officials expressed interest, but their only substantive contribution to date has been the delivery of two pickup-truck loads of stones for use in the construction of low cost drainage systems. A number of individual residents were prepared to install such systems alongside their dwellings, but a collective response was notably absent.

Waterworks

In this settlement the researchers were encouraged by the local inhabitant's individual awareness of wastewater disposal problems. Moreover, unlike Langrug, Waterworks has a functional street committee system and the researchers were able to meet with the committee on several occasions. While local authority officials pledged support for the project initiatives, they consistently failed to deliver even the barest minimum of requests. They used the excuse that, because there were plans to upgrade the settlement in 2009, they were unwilling to invest in the maintenance and installation of further services. Residents explained to researchers that they did not trust the local authority, and had no confidence in the politically elected councillor representing the ward. Yet some took an interest in the research project and a number elected to install a greywater management system next to their dwellings.

Hangberg

In 2004 the National Department of Housing unveiled a new housing strategy aimed at upgrading informal settlements, referred to as National Housing Programme: In Situ Upgrading of Informal Settlements (Department of Housing, 2004). This new strategy

gave municipalities the power to secure "the provision of land, municipal services infrastructure and social amenities" (Department of Housing, 2004 p.4). The programme sets out to achieve security of tenure, health and safety, and the development of social capital. Hangberg residents see this programme as a golden opportunity to improve their living conditions.

By 2007, at the commencement of this study, many households in the informal settlement had already installed their own services by connecting to the water and sewerage reticulation system that had been installed by the local authority. The relative success in achieving these ends, in contrast to the study sites of Langrug and Waterworks, can be explained by a number of factors including:

- A relatively higher average income than in the other two settlements meant that most residents were able to procure equipment needed to connect their dwellings illegally to the local authority's water and sanitation system.
- Those residents living in a dwelling for a reasonable period of time were more likely to have connected to reticulation services. Surveys revealed that more than half the residents had lived in Hangberg (either the formal and/or the informal part) for over 29 years.
- Residents claimed that they had to install toilets and water taps in their homes because the communal toilets were always unhygienic.
- Hangberg is perceived to be a 'close knit community' in which residents were generally prepared to help each other in matters such as sharing their experience in acquiring services in their homes.

The situation in Hangberg exemplifies Field's (2003) and Coleman's (1988) argument that social networks offer poorer people a powerful means to achieve social actions which would otherwise have been impossible or difficult to achieve had individuals acted alone. In addition, Coleman (1988) contends, such networks, being the basis of social capital, provide a means of transferring human capital (skills, knowledge and understanding) from one person to another, usually over an extended period of time. The researchers in Hangberg found evidence that such social capital extended mainly to networks with family members and nearest neighbours, rather than within the entire settlement. Thus most residents who installed water and sanitation services often did so with little regard for the consequences to either their immediate neighbours or the environment. Bathroom and kitchen waste often discharged directly into the stormwater drainage so that water samples collected from stormwater discharging into the sea showed extremely high levels of *E.coli (> 1800 counts/100ml),* while orthophosphate and total nitrogen levels were above 5 mg/l.

Discussion

Numerous conversations with residents, both structured and unstructured, observations from field visits and meetings with street committees and civic associations during the course of 2007/8, provided evidence of a general inadequacy in communication between local residents and officials, particularly in the cases of Langrug and Waterworks where residents appear to have lost confidence in the ability of local

authority to address their service needs. Residents expressed frustration and a sense of hopelessness, and were generally reluctant to engage in self-help initiatives proposed by this project. Poverty remains an over-riding issue.

The Waterworks street committee appeared to be in a state of paralysis since it had no public mandate to deal with issues arising in the settlement. Some municipal officials had tried to work with the street committee but in so doing had made unnecessary demands on them. By contrast, residents of Hangberg present a very different picture. Here members of the project committee, which was established in 2007 to manage the *in situ* upgrade of the settlement, were elected so that one person represented each of six blocks of households, each consisting of between 30 and 40 shacks. Meetings and workshops were held regularly, often with the support and guidance of the Development Action Group, a non-government organization with a long history of involvement in the development of housing for the poor in Cape Town.

Phase 3: Action – fixing problems

Initially it was hoped that the development of greywater management options would emerge from project-driven workshops with the various local communities within the study settlements. This has proved to be a naïve assumption, especially in the case of Langrug and Waterworks. Although a few residents had already made some attempts to manage their greywater disposal, they were generally unaware of the range of options available. The researchers thus adapted their strategy slightly and held various workshops to present a range of greywater management options and to invite individuals to try them out. Three different types of options were implemented at Waterworks and Langrug, while a shallow pipe condominial system was installed over a period of 3 or 4 years at Hangberg. In that case, the installations had occurred prior to the commencement of this study. Each of the four technologies is described briefly.

Shallow "crate" soakaway

It is suggested that this technology is best suited to settlements where there is sufficient space between houses, for example, in a corridor where at least 4 x 1 metres of space is available. The soakaway is constructed using an upturned plastic milk crate which acts as a grate which is then covered by a crude filter of woven nylon cloth (locally known as 'shade cloth'). The dimensions of the trench are approximately 3.5m long x 1m wide x 1m deep. The trench is filled with small stones (25mm diameter) and covered with infill from the hole. Grass, reeds, ornamental flowers or rooted crops may be planted on top of the soakaway to improve the rate of evapo-transpiration and adsorption of nutrients (Figure 2).

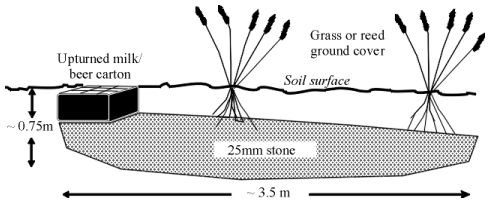

Figure 2. A cross section of a typical shallow crate soakaway.

Soakaway attached to a washbasin

At Langrug the researchers observed several small bore pipes (30mm diameter) that regularly discharged wastewater onto gravel roads and pathways. On tracing their sources, the researchers found that a number of households had connected small pipes to wash basins and bath tubs and were using these as makeshift arrangements to dispose their wastewater. In one case the outlet pipe spanned a distance of over 80 metres. One occupant agreed to change his arrangements and opted to construct a soakaway alongside his home and to connect this to a washbasin outlet pipe. In this case the trench was lined with a 4mm polyethylene sheet and then filled with coarse stone (25mm diameter). A 50mm diameter perforated pipe was placed onto the bed of stones and then covered with 10cm of stone and infill (Figure 3).

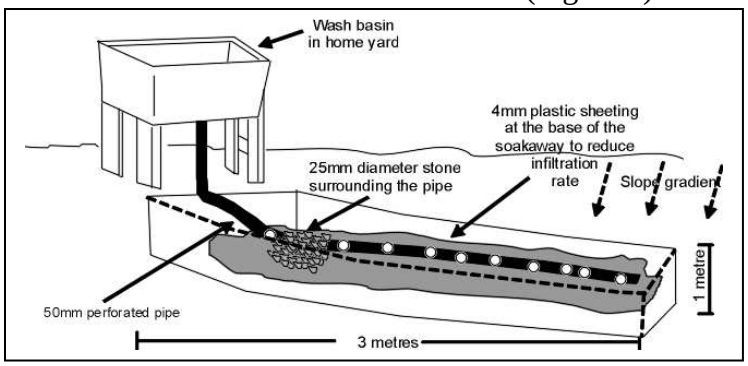

Figure 3. Schematic diagram of the soakaway attached to a washbasin.

The drum filter

The drum filter was conceived as a possible solution in more densely populated settlements where space is limited and where sandy soil could offer a reasonably porous substrate. A 300 litre plastic drum (commonly sold as a municipal solid waste domestic bin) is perforated with holes drilled through both the base of drum and the lid. The drum is then filled with course sand to approximately a quarter of the volume, while course stones (25mm diameter) fill the drum to the three quarter mark. The perforated lid is turned upside down so as to act as an inverted cone thereby temporarily detaining the water while it drains into the drum filter (Figure 4).

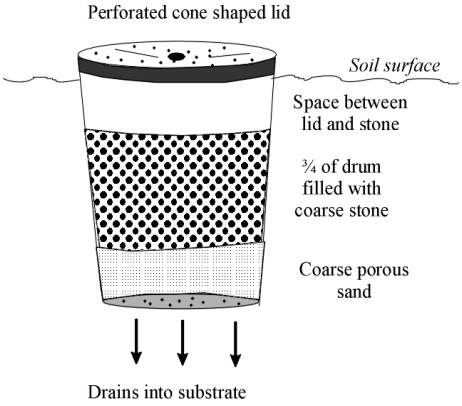

Figure 4. A cross-section of a drum filter.

Shallow sewer network

Soon after 2001 when Cape Town City Council had installed communal standpipes and toilets in Hangberg, the residents began to connect illegally to these facilities. The local authority had laid the water and sewerage pipelines in shallow trenches as a temporary measure, and they were thus easily exposed and readily accessible to residents. By 2008 nearly 40% of all shack dwellers had installed waterborne toilets and sewerage infrastructure in their homes, connecting these to the shallow pipe system. Most of these homes now have separate bathroom and kitchen facilities. A very small percentage, as yet undetermined, chose to dispose of their greywater too via the sewerage pipeline. However, most greywater continues either to be discarded into the stormwater system or directly into the substrate alongside the home. Concerns about the impact of contaminated stormwater being discharged into the marine environment nearby were highlighted earlier.

Phase 4: Evaluation and adaptive learning

In this project, efforts to shift the *status quo* towards a sustainable outcome appear to lie largely in the development of social capital and in building human capacity. This is the central lesson learnt at Hangberg in which residents have managed to circumvent the limitations of formal service delivery, although there are obvious concerns about the legal and environmental implications resulting from such actions. These residents have at least managed to secure their immediate service needs and have done so with the support of family, friends and neighbours. The history and socio-economic circumstances at Hangberg are different from that of the two other informal settlements in the study so comparisons are not meaningful. What is evident is that residents of Waterworks and Langrug have developed very limited social capital and consequently have made poor progress toward managing greywater and other services.

Researchers are currently evaluating the low cost drainage systems that have been installed, through regular monitoring and discussions with users. At least four limitations have been recognized: in some cases the porous material in certain soakaways became clogged with grease and fats over a period of less than twelve weeks; the capacity of these filters is often inadequate for the volume of water being poured into the system; only kikuyu grasses have been grown successfully on top of some soakaways; space constraints limit the potential to install a significant number of soakaway system, as do inadequacy of local government contributions in the form of materials such as crushed stone; and finally, environmental contamination of substrates and groundwater remains undetermined. In consultation with users and after further monitoring, many soakaway and drum filter systems have either had to be removed or modified. Refinements have included increasing the volume of trenches; increasing the gradient within the trench; and changing the direction of flow by rearranging the alignment of the trench relative to the slope (trenches along the contour have proved better in clay soils than those across the contour).

Conclusions

It is too early for the project team to make any definitive conclusions, but it has become evident that some key findings emanate from the research to date. Residents of Waterworks and Langrug have generally shown limited initiative to manage excess flow of wastewater. Security of land tenure is one reason that undermines the motivation of individuals to engage in self-help projects, but there are plenty of other complex factors associated with the general state of South Africa's shanty settlements. Of immediate concern is the poor communication between residents and local authority structures, together with a lack of trust in the politically elected councilors, all of which is likely to affect the further development.

The relatively high level of social capital development in Hangberg partially explains why residents are able to access services in their own dwellings. The social organisation and leadership in the settlement has also proven central in processes contributing toward the upgrade of the settlement. Social capital is drawn from within the settlement and also from outside the community in the form of services of an NGO and local authority officials. Hangberg residents are presently, therefore, in a far better position to install and manage services as compared to the two other settlements discussed in this paper.

Acknowledgements

The project is being funded by the Water Research Commission (WRC) of South Africa under Contract No. K5/1654: Sustainable options for community-level management of greywater in settlements without on-site waterborne sanitation.

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