Community-focused greywater management in two informal settlements in South Africa

N. P. Armitage, K. Winter, A. Spiegel and E. Kruger

ABSTRACT

South Africa is struggling to provide services to the millions of poor people migrating to the major centres and living in informal settlements (shanty towns). Whilst the local authorities are generally able to provide potable water from the municipal network to communal taps scattered around the settlements, there is usually inadequate provision of sanitation and little or no provision for the drainage of either stormwater or greywater. This paper describes an investigation into ways of engaging with community structures in the settlements with a view to encouraging “self-help” solutions to greywater management requiring minimal capital investment as an interim “crisis” solution until such time that local and national government is able to provide formal services to everyone. The work was carried out in three settlements encompassing a range of different conditions. Only two are described here. It has become clear that the management of greywater has a low priority amongst the residents of informal settlements. The lack of effective political structures and the breakdown in communication with Ward Councillors and local government officials have contributed to the lack of progress. As the project progressed it became evident that greywater cannot be considered separately from stormwater, sanitation and refuse removal.

Key words | adaptive decision making process, community-focused solutions, greywater management, informal settlements, participatory action research, urban drainage

INTRODUCTION

In common with many middle and low-income countries, South Africa is struggling to provide services to the millions of poor people migrating to the major centres. By way of example, the City of Cape Town (CCT) alone has a housing backlog in the order of 300,000 units in 2007, including some 150,000 in an estimated 220 informal – and generally illegal – settlements, implying that some half-a-million people, out of an estimated total population of 3.27 million (City of Cape Town 2008), were living in flimsy shacks built out of whatever materials they can find, frequently on land unsuitable for development. This number is rapidly increasing through natural population growth and as migrants move to the cities in search of economic opportunities from rural areas in South Africa and neighbouring countries. Whilst local authorities are generally able to provide potable water from the municipal network to communal taps scattered around the settlements, there is usually no formal provision for the drainage of either stormwater or greywater. Communal sanitation may be provided, generally on the periphery of the site, but it is frequently dysfunctional for various reasons. Lacking adequate sanitation, the inhabitants usually resort to using buckets which are then emptied on a daily basis at any convenient point – or they simply defecate on open ground. Although the South African government is committed to providing basic services to all of its citizens by 2010, it is clear that it lacks the resources to achieve this with the current housing policy. It is consequently likely that many people will
continue living in the degrading conditions of informal settlements (here taken to be unplanned whether legal or not) for quite some time to come.

In 2006, the Water Research Commission of South Africa appointed the University of Cape Town (UCT) to investigate ways of working with community structures within informal settlements. The goal was to seek to improve greywater management with minimum capital investment as an interim “crisis” solution until such time that the government is able to provide formal services to everyone. Greywater from informal settlements is usually highly polluted as small quantities of water are frequently used for a number of domestic purposes before eventual disposal. It is frequently further contaminated by litter (solid waste) and even faeces. Water quality analyses carried out in another project indicate COD ranging between 1,500 and 8,500 mg/l (average 4,700 mg/l), Oil & Grease ranging between 30 and 2,000 mg/l (average 730 mg/l), and Conductivity ranging between 50 and 1,500 mS/m (average 360 mS/m) respectively with bacteriological counts often similar to that of raw sewage (Carden et al. 2007). In the absence of formal drainage structures the greywater mixes with stormwater during wet periods. The work was carried out in three settlements situated within three local authorities in the Western Cape Province. Only the work carried out in two of these settlements is described here. The project came to an end at the beginning of 2009.

METHOD

The research method was based on the Adaptive Decision-Making Process (ADMP) which seeks to develop a procedure for formulating and implementing a course of action that explicitly takes into account social, political, economic, and institutional factors (Lal et al. 2001). ADMP is a problem-focused, action-oriented participatory process aimed at producing management strategies that stakeholders agree with and feel they can own. It acknowledges the need for discursive decision-making and recognises that multiple stakeholders have different values and knowledge systems and decisions must be achieved through collaboration, co-operation and consensus. It was acknowledged at the outset that agreement between the multiple stakeholders might be hard to obtain.

The process of implementing ADMP consists, in principle, of: Subsystem Identification, Reflection, Action and Adaptive Learning. Although a four-phase ADMP is recommended, the boundary between one phase and the next is flexible, and more than one phase may be undertaken at the same time. In this study, the ADMP process was adapted as follows.

Phase 1: Identification and assessment

Study settlement selection was achieved through consultation with local authorities, field visits and in some cases an evaluation of previous studies conducted at these settlements. Efforts were made to identify other stakeholders such as non-government and community-based organisations who might have an interest or involvement in the settlement.

Phase 2: Reflection and establishing of shared goals

The aim of this phase was to identify problems associated with existing greywater management practices, emphasising the potential of these practices (or their absence) to influence health and the environment. Clear understanding of the underlying management issues and general agreement of desired outcomes is critical to any decisions that might lead to intervention and ultimately solutions. Stakeholders were encouraged to prioritise their various greywater management concerns. Once agreement was reached with the stakeholders with respect to the scope and extent of the problem, the research team facilitated discussions to establish a shared vision of greywater management.

Phase 3: Action

In this phase, the stakeholders, having agreed on various greywater management options in the previous phase, commenced with the implementation of the proposed management strategies and technical interventions with the assistance of the research team.
Phase 4: Adaptive learning

Adaptive learning is critical to provide assurance of the long-term sustainability of the study's outcomes. It treats the prospective management strategies as a series of management policy experiments. The management strategies and possible technical interventions selected in the Action Phase were monitored in an attempt to indicate the extent of success. Regardless of how the results are interpreted, this phase is one of adaptive (or experimental) learning in which feedback promotes reflection and adaptation of the intervention strategies. This phase was also intended to support capacity building and empowerment of settlement-resident level stakeholders who were willing to engage in the process, and who were prepared to implement changes with the support of the local authority and, where appropriate, elected ward councillors. In theory there is no reason why feedback from various interventions cannot lead to further reflection and new adaptation. In practice, the number of iterations was limited by various obstacles to the process and the duration of the investigation.

RESULTS AND DISCUSSION

Phase 1: Identification and assessment of study settlements

The selection criteria for the study settlements were broadly:

1. A formal water supply with either no formal sanitation or dry sanitation systems.
2. Greywater disposal currently having health and/or environmental impacts.
3. Some form of local-level organisational structure in place.
4. Accessible and “safe” for researchers.
5. A range of settlement densities.
6. Within reasonable travelling distance from UCT.
7. Inclusion of settlements both in- and outside of the CCT (to give an indication of possible differences between city and more rural environments).
8. No immediate prospect of formal development.

The following four sites, all from the south-western part of South Africa, were initially chosen for inclusion in the project:

1. Langrug, Franschhoek (Stellenbosch Municipality).
2. Waterworks, Grabouw (Theewaterskloof Municipality).
3. Hangberg, Hout Bay (CCT).

This paper focuses on the work carried out in the first two settlements. Kanana had to be dropped when the City of Cape Town withdrew its support for the research in this settlement soon after work had commenced. Hangberg is an unusual settlement in a number of ways and will not be discussed here. Figure 1 indicates the location of the three eventual study sites.

It should be noted that all the informal settlements in this part of the South Africa are situated within municipalities that are relatively well resourced by South African standards with functional engineering departments. By way of contrast, in 2005, 83 out of 284 South African municipalities had no technical personnel at all, whilst a further 46 had only a single person of low technical qualification (Lawless 2005). This could have a bearing on the applicability of the findings to less well-resourced regions.

Langrug, Franschhoek (Stellenbosch Municipality)

Langrug informal settlement is situated on a 1:12 slope of talus material comprising loamy sand and clay soils. It is approximately 5 km north-west of the town centre of Franschhoek and about 50 km north-east of Cape Town city centre. The first shack dwellings were erected here in 1993. By 2006 the population of Langrug was approximately 5,000. Most (approximately 89%) of the residents are native IsiXhosa speakers and are recent immigrants to the Western Cape. Unemployment is widespread; those who are employed work mostly in the local construction industry or as seasonal agricultural workers. The informal shack dwellings are variously constructed of corrugated iron, wood, plastic sheeting and a variety of other scrap materials such as billboards and packing cases. There is one central street that goes directly up the hillside with narrower parallel streets on either side linked together by various...
paths of different widths, all access routes having bare earth or gravel surfaces.

All municipal water services are communal and comprise six tapstands and 40 flush toilets. The municipality provides potable water for free at these points. From ongoing field observations, many of the existing facilities are persistently dysfunctional; for example, most tapstands and toilets do not drain properly, whilst some water-supply pipes have been disconnected. Although residents can easily collect water in buckets, they are frequently forced to urinate and/or defecate on any available open ground. There is no provision for the disposal of household water – other than at the communal facilities – so excess water is tossed on the street. There is no formal stormwater drainage system. Consequently, a mixture of black and grey water runs continuously down the streets – and sometimes into residents’ homes – even during extended dry periods (Figure 2). The situation is exacerbated by rubbish strewn all over the settlement. Rubbish collection skips (hoppers), provided at three points within the settlement are supposedly cleared three times weekly, but abundant evidence shows the system is not working.

**Waterworks, Grabouw (Theewaterskloof Municipality)**

The Waterworks informal settlement is located on a hillside comprising coarse sand thinly covering outcrops of Table Mountain sandstone. It is situated some 50 km east of the centre of Cape Town, near the centre of the town of Grabouw in the centre of a farming district noted for its deciduous fruits – particularly apples. The settlement is adjacent to middle income residential housing separated only by a two-lane road. Invasion of the land by migrants, mostly IsiXhosa speaking people from the Eastern Cape Province of South Africa, commenced some 20 years ago. The area now comprises over 1,000 shacks constructed...
from wood, plastics and corrugated iron. Most employed residents work seasonally on nearby farms. The Grabouw Town Management (part of the larger district municipality of Theewaterskloof) claims to have provided one tapstand per 25 families and one pit latrine per 5 families, but there are many problems with these services. Taps have been poorly maintained and many are broken – in some cases leaking substantial quantities of water resulting in erosion channels through the settlement.

A bigger problem is the sanitation facilities. According to residents, the facilities, which are a mix of flush toilets near the access road and Ventilated-Improved Pit (VIP) latrines elsewhere, are not regularly maintained. During the course of numerous site visits fewer than 5 toilets were ever found to be operable (for a population in the order of 3,000!); most were filthy – filled with faeces and paper. Those that were serviceable had nearly always been “claimed” by nearby residents who had then – illegally – locked the doors to prevent their use by other residents. A sewer pipe conveying sewage from a formal residential area situated higher up the hill was frequently found to be blocked – discharging raw sewage through the settlement via the lid of a manhole (Figure 3). No data on the general standard of health were gathered for either Waterworks or Langrug, but informal settlements in South Africa are generally associated with high levels of infection from waterborne diseases which contribute to a high infant mortality rate. According to Mara (2001), about 43,000 people, mainly children under the age of 5 years, die from diarrheal diseases in South Africa each year. Tuberculosis, frequently associated with poor living conditions, is another major problem in the Western Cape – the situation exacerbated by some of the highest HIV prevalence rates in the world resulting in severely compromised immune systems for those infected.

Phase 2: Reflection and establishing of shared goals

Langrug, Franschhoek (Stellenbosch Municipality)

Numerous site visits took place during 2007. Their primary aim was to identify local social structures such as street or block committees, NGOs and church groups working in Langrug. Immediate difficulties were encountered with weak social structures. Problems were also encountered with the establishment of a partnership with the local authority officials responsible for the settlement and the elected Ward Councillor. Stellenbosch Municipal Engineering Department officials expressed interest in helping the research on various occasions, but over the period of the research their only substantive contribution was to organise a truck-load of stones to assist in the construction of drainage structures. The Ward Councillor for the area including the settlement seemed more concerned about the researchers stirring up the residents than actually trying to solve the many problems identified – by residents or the research team. Meanwhile, the local residents were hesitant to get involved – expressing exasperation with the current situation and a sense that the local authority did not listen to them. There are no street committees (a common form of political organisation in South Africa), and residents do
not believe they may call meetings without permission. In general, almost all meetings are arranged by the Ward Councillor and are infrequent, albeit generally well-attended. The research team did however identify a number of individuals within the settlement who were prepared to cooperate in the project, including one who was particularly proactive in trying to channel wastewater away from his house and the nearby local crèche.

Waterworks, Grabouw (Theewaterskloof Municipality)

From the beginning, the research team were pleasantly surprised by the individual awareness that these residents had of the problem of waste water and the means to address these issues. Unlike Langrug, the research team were able to identify a functional street committee, but whilst this committee was prepared to mediate in inter-household conflicts, it was not that helpful in co-ordinating the project. As with Langrug, the local authority pledged support for the project, but consistently failed to do more than the barest minimum for Waterworks residents. There are plans to upgrade the settlement in the near future but it is not clear how soon that will be and the residents appeared to be largely unaware of the proposals. As is so often the case in South Africa, poor people generally have different ethnic affiliations, and support different political parties, to their more affluent neighbours. This is particularly noticeable in Waterworks where the interests of the Ward Councillor – whose unavailability was also a result of chronic ill health – and the Town Engineer have little in common with those of the settlements’ inhabitants, and possibly as a consequence, the levels of trust between them are low. Local residents nevertheless showed considerable interest in the project with abundant evidence of individuals taking initiative for actions such as the use of greywater for vegetable gardens and the channelling of wastewater away from the shacks.

Phase 3: Action

Initially it had been hoped that the development of greywater management options would arise during workshops within the study settlements. It soon became evident that this was naïve; although various individuals had made some attempt to manage their greywater, it was clear that they were, in general, unaware of the range of opportunities open to them. The research team therefore indentified interested groups of residents, presented some simple greywater management options, and invited individuals to try them out. Although six options were originally presented to the residents, only two types of soakaway were actually trialled, the more successful of these being nicknamed the “crate” soakaway by the research team (Figure 4).

The crate soakaway is best suited to settlements situated on permeable soils where there is sufficient space between houses, e.g. a corridor between houses of at least $4 \text{ m} \times 1 \text{ m}$. 

![Figure 3](https://iwaponline.com/wst/article-pdf/59/12/2341/435421/2341.pdf)
It was deliberately designed to be constructed of low cost materials. An upturned plastic milk crate with perforated sides and bottom is the greywater disposal point. It is covered with a porous plastic cloth (known locally as “shade-cloth” and commonly used in plant nurseries) to prevent food matter entering the soakaway. The shade-cloth is held in place with stones laid flush with the surrounding ground level. The crate is located at one end of a trench of nominal dimensions; 3.5 m long by 1 m wide by 1 m deep. In most cases the trench was lined along the bottom and sides with a 4 mm thick polyethylene sheet secured to the crate using string or thin wire. The other end is left open. The trench is then filled with small stones (e.g. 19 mm crushed stone such as that used for road construction) and covered with infill from the hole. Reeds, ornamental flowers or rooted crops such as fruit trees or vegetables may be planted over the soakaway to aid in nutrient removal and promote evapotranspiration. The lining is an attempt to reduce the impact of the poor quality greywater on the groundwater by providing an opportunity for some primary treatment and evapotranspiration. It also acts as a geomembrane reducing the migration of fines into the trench material. Where there is inadequate evapotranspiration (e.g. during the winter months when precipitation generally exceeds evaporation), the porosity of the soakaway provides for roughly two weeks storage of greywater generated by a typical dwelling. After this temporary storage, surplus greywater seeps out of the exit into the surrounding substrate.

The second option comprised of standard large plastic rubbish bins (commonly used in South Africa for domestic refuse disposal) with their bottoms removed, partially filled with stones and placed on the ground. The lids were perforated with a number of small diameter holes and placed upside-down on top of the bins. This meant that the slight concave-up shape of the lids acted as basins into which greywater could be poured. From there it drained through the holes into the bins below. The greywater was stored in the bins until it eventually infiltrated into the permeable soil underneath. Immediate problems were encountered with the bins being used as a convenient disposal point for waste from the surrounding community – including offal from chickens slaughtered within the settlement. A combination of overflows resulting from exceeding the infiltration capacity of the soil combined with the stink caused by putrefying waste – which also attracted flies – soon provoked requests from the neighbours to have these devices removed.

The other four options (not tested) included:

1. Constructing open drainage channels lined with low-grade concrete where necessary to reduce erosion.
2. Improving the communal washing areas to better manage greywater disposal.
(3) Irrigating flowerbeds with the greywater (the greywater is too polluted to safely use for food production).
(4) Treating the greywater in constructed wetlands.

Phase 4: Adaptive Learning

Langrug, Franschhoek

During the course of the study eight soakaways were constructed by the research team. The team had hoped that there would be willingness on the part of residents to install their own drains rather than simply expect the researchers to do the work for them, but this did not really happen. Also, at least half of the installations failed because of excessive volumes of greywater that could not drain fast enough into the clayey soil. This was in part due to the fact that a successful installation at one shack attracted the attention – and use – of other residents to its ultimate detriment. In one instance, a system was ruined by a municipal road grader that rode over a plastic crate located close to the edge of the road.

On return visits the research team were able to modify three of the soakaways following discussions with the users. In all cases the users were able to suggest ways to improve the alignment and design of the system. This process of modifying the system best represents the ideal of adaptive learning where insight and experience leads to improved designs that suit the needs of the user.

One resident told the research team that the municipality had once appealed to residents to dig holes in their yards to dispose of their grey water, but there had been no follow up on this. She said, “People are stubborn and don’t do what they are told, they don’t think it’s important. They will ask you why they should do something, and they might tell you that the holes will get clogged. If you go door to door to discuss [these things] it may help.” When asked why people do not intuitively dig channels to drain water from taps, for example, the research team were told, “They are not getting paid. They will get hungry if they do this work, and go home hungry and go to sleep”.

Waterworks, Grabouw

Initially the alternative soakaway design employing plastic rubbish bins (Option 2) was installed at the request of the inhabitants. When these failed, the researchers invited willing individuals from selected households at random to participate in a number of Saturday morning workshops to demonstrate the installation of the crate soakaway and eventually four such soakaways were installed.

It is noteworthy that the street committee did not take the lead in encouraging or participating in these workshops – or indeed in the project as a whole. This could have been for a number of reasons. At a community meeting called by the street committee it became clear that crime (predominantly theft), gangsterism and the provision of toilet facilities were the main topics of concern at least in this particular meeting. The chairperson of the street committee informed the research team that the committee had started out as a body to control crime in the settlement, but soon thereafter had shifted its attention to controlling access to land for newcomers entering the settlement. It played the role of an informal judiciary, regulating social harmony and controlling access to job opportunities. The committee also undertook to raise the concerns of residents with the municipality and in one instance had acted as a catalyst for mobilising a protest march against the municipality and the ward councillor around issues of poor service delivery. In reality the street committee had limited power. Residents accused the members of nepotism and being without a mandate, this despite the fact that many street committee members had been re-elected for a number of consecutive years. In response to this, some residents said that they did not participate in these elections or get involved with street committee matters thereby demonstrating a degree of apathy. Street committee members expressed disappointment in the apathy of residents, but they also expressed their disillusionment and distrust in the municipality. Some felt that they could get nowhere with the current municipality. At the same time the researchers were being told by the town manager that no social initiative could have any success without the ‘blessing of the street committee’ emphasising its seeming importance in the eyes of the local authority.

The research team tried to encourage the installation of more soakaways in the settlement but a number of obstacles were encountered. Whilst the municipality had initially seemed to support the research, it proved difficult to get
them to deliver so much as a truck load of stone to help in the construction. It became clear that the relevant officials had little enthusiasm for the greywater management project. They claimed that formal serviced houses were soon going to be built in Waterworks – in spite of little evidence to support this – and thus any attempt to deal with greywater in the short-term was an unnecessary expense. Another obstacle was the proliferation of hard, rocky outcrops in various parts of the settlement. One enthusiastic resident was disappointed to find large rocks just beneath the surface of the soil at the site selected for a soakaway. After about two hours of digging and trying to break the rocks, the resident and research team gave up and filled in the hole. Whilst Waterworks is sited on coarse sand with high permeability, the underlying rock outcrops represent a major barrier to any resident attempting to construct their own drainage system.

CONCLUSIONS

The following observations can be made with respect to the two settlements described in this paper (which are likely to be typical of many in South Africa):

(1) Although there was some degree of co-operation from residents with the research team in the installation of the pilot systems trialled through the project, few took the initiative and constructed their own systems, preferring to wait for the researchers to do the work for them. Lack of access to materials, stone in particular, was a key inhibiting factor. Local conditions (little open space, rocky ground) also made it hard for inhabitants to construct their own drainage structures. The residents were reluctant to do any work – even when clearly in their own interest – without some form of compensation.

(2) Where residents did take individual initiatives it was often to the detriment of downstream neighbours.

(3) Effective political structures were lacking in the settlements. This made it difficult to coordinate efforts across the settlements.

(4) There was mistrust and frequent break-downs in communication between the residents, Ward Councillors, and the local authority’s officials. This inhibited progress.

(5) The local authorities were reluctant to put any substantial effort into improving the services in informal settlements, supposedly because they thought that they would eventually be replaced with formal housing schemes (even if this took many years to come about).

(6) The management of greywater had a low priority amongst the residents of informal settlements. The desire for formal housing, decent sanitation and employment opportunities took precedence. The fear expressed by several residents that any initiatives on their part would lessen the pressure on the local authorities to provide formal housing could also have contributed to the limited success of the project. Whether this fear was well founded or not, perceptions drive behaviour.

(7) As the project progressed, it became increasingly evident that greywater management cannot be considered separately from the management of stormwater, sanitation and refuse removal. It is possible that the project would have been more successful if a more holistic approach had been taken.

(8) It is possible that alternative options might have been more successful than the two that were ultimately trialled. Unfortunately little opportunity was afforded the research team to test this. It is likely that even if the alternatives trialled were technically superior the team would have experienced similar social and institutional constraints.

ACKNOWLEDGEMENTS

The project was 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. Much of the data were collected by students at UCT. The project would not have been possible without the co-operation of inhabitants of the settlements involved and the officials in the associated local authorities.
REFERENCES


City of Cape Town 2008 Personal communication with Mr Craig Haskins, City of Cape Town, February 2008.

