Title	**Developing strategies for the disposal and use of greywater in the non-sewered areas of South Africa**
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Short CV for introduction purposes (100 words max)	Kirsty Carden graduated with a BSc (Chemistry) from UCT in 1984. Her main expertise has been in water quality management (monitoring and modelling) and she has worked in industry, for Government (Department of Water Affairs and Forestry), and as a consultant. She is currently working towards her MSc (Applied Science) in the Department of Civil Engineering at UCT and is involved full-time as a research assistant for the WRC greywater project.
Photograph attached (jpg)	

INTRODUCTION

This paper describes a comprehensive study into the management of greywater in the non-sewered areas of South Africa (SA) in an attempt to develop suitable strategies for greywater use and disposal. In this context greywater has been identified as the wastewater that is produced from household processes (e.g. washing dishes, laundry, bathing) without input from toilets, whilst the non-sewered areas are generally sub-economic or informal settlements without on-site waterborne sanitation, although communities with dysfunctional or inadequate sewerage systems (particularly communal toilet facilities) have also been included in the investigation.

Greywater management initiatives in SA have fast been gaining momentum as the pressures of increasing population growth and poor or inappropriate service provision have resulted in the generation of surface and groundwater pollution which represents potentially major threats to community health and the receiving environment. Management of greywater is dependent on the level of provision of effective services including water supply, sanitation and solid waste removal. Basic adequate services were defined in the Water Supply and Sanitation Policy White Paper (Department of Water Affairs and Forestry, 1994) as a minimum water supply of 25//person/day within 200m of the dwelling, and a Ventilated Improved Pit (VIP) latrine. The connection of sub-economic settlements to municipal water sources has subsequently occurred on a massive scale in SA, frequently without giving adequate attention to greywater management in those areas that are not provided with on-site water-borne sanitation. In the absence of a suitable conveyance system, greywater is generally tossed onto the ground outside the dwelling and the resulting total pollution load, particularly from dense settlements, has the potential to create a host of environmental and health impacts including the compromise of aquatic systems and quality of river habitats. It is therefore important that greywater is properly managed both to eliminate inappropriate disposal as well as possibly providing benefits through controlled reuse.

There are two main outputs envisaged for the project; one at a strategic level and the other at an implementation level. Government policy makers require guidance in the development of strategies for the management of greywater, particularly with respect to the likely impact of changes in the service levels associated with water and sanitation services. Municipal planners and communities need help in determining greywater management options and implementing the solutions required to reduce any negative impacts.

Figures 1 and 2 illustrate typical scenes in informal settlements in SA where the inadequate control of greywater disposal becomes a serious problem.

Figure 1: Communal toilets and washing facility at Kleinmond

Figure 2: Flooding at shacks in Sweet Home Farm

METHODOLOGY

The study aims to evaluate existing greywater management practices in the non-sewered areas of SA and recommend strategic options for best practice, and includes the following objectives:

- Completing a scoping exercise to identify current and historic greywater management initiatives in urban and rural areas, and identifying problem areas / challenges.
- Determining and assessing existing management and disposal practices within South Africa.
- Quantifying the greywater generated by different types of settlement and level of service.
- Quantifying and highlighting potential problems / challenges that pose a risk to human and environmental health.

In order to achieve these objectives, on-site surveys of selected communities throughout the country are being conducted through the use of standardised questionnaires. In each community, social surveys of current and potential greywater management and recycling activities are being carried out, and cultural practices pertinent to water use and management are examined, to determine whether these hinder or promote the adoption of greywater recycling. In the absence of any formal metering, household water consumption habits (volumes, uses, sources of water, storage capacity etc) are studied in order to estimate greywater volumes. General observations are also made of the physical surroundings, climate, topography etc. as well as any environmental considerations related to the settlement, and sampling of typical greywater is undertaken to determine its chemical and microbiological quality.

Selection of sites

It is critically important that the communities surveyed in this project are representative of the different types of settlements to be found in the non-sewered areas of SA. What makes this particularly difficult to achieve is that there are a large number of these communities, spread over a vast geographical area, and there are only resources to survey a limited number of them. The site selection methodology evolved out of experience obtained in the WC province and culminated in a procedure for site selection that could be used for the remainder of the country. The SA National Census data (Census 2001) was used to provide a preliminary indication of those settlements that were likely to generate greywater. This was done by filtering out the relevant data on sanitation (specifically those areas without water-borne sanitation), water supply, dwelling-type, income and race, and producing spreadsheets of the numbers of households per Census area that met the following criteria:

- Toilet type: Pit latrines or Buckets or None
- Water supply: Any water other than inside the house
- Household Income: < R38 400 (± $6000) per annum
- Dwelling type: Informal or Traditional or RDP

Once the spreadsheets had been produced, the information was sorted and ranked (by numbers of households) so that potential sites could be identified in each of the municipal areas of the nine South African provinces. It was found however that the service status, populations, and even the names of settlements in the various provinces, have changed since 2001, due to the large influx of people into the major cities of South Africa, and the consequent “mushrooming” of informal settlements to accommodate their housing needs. This was illustrated in a workshop on Greywater in Informal Settlements, which was held by the City of Cape Town in October 2004. There is a current housing backlog in Cape Town of approximately 240 000 units, and it is estimated that 19 000 additional units are required per annum. About 100 000 of these families are resident in informal settlements in the municipal area, 55 000 of which have no access to water and sanitation services. A working document from the workshop on the current status of informal settlements, with specific details on

service delivery, was ultimately used to inform the choice of "definitive" sites in the Cape Town area, while the Census data acted as a guide only.

The choice of sites in the remaining provinces was therefore been based more on the available information on local conditions and interactions with relevant municipal officials than on Census data alone. However, owing to the fact that not every non-sewered site in the country can be surveyed, the Census data will be used as the basis for calculating overall quantities of greywater for the management thereof, once it has been modified by an estimate of the changes since 2001.

Information management

Greywater management is affected by sociological, environmental and spatial factors and this necessitates the collection of large quantities of data combined with specialist knowledge obtained from various experts including environmentalists, social anthropologists, engineers and geographers. A methodology has thus been developed for information flow management (both external and internal) that ensures information sharing and allows for feedback between the different profession specialities. All data that is collected by way of the on-site survey questionnaires, sampling, observations, interviews etc, is related to a spatial location, which then becomes the information identifier in a geographic information system. A central database has been established to house this data and the output of the database will comprise reports, statistical summaries, maps and other spatial information that will lead to informed strategies regarding greywater management.

DATA GATHERING

By the end of March 2005, data had been collected from 8 settlements in the Western Cape, 13 sites in the provinces of Mpumalanga and Limpopo, and 7 sites in the Eastern Cape – bringing the number of sites surveyed (in 4 of the 9 provinces in SA) to a total of 28 in a period of about 8 months.

Most of the sites surveyed in the Western Cape were informal settlements, ranging in size from about 170 households in Fairyland (Paarl) to 1800 structures in Sweet Home Farm (Philippi). Water is generally provided by way of communal standpipes, and sanitation services, if present at all, comprise container toilets, pit latrines or communal toilet blocks connected to foul sewers – which were mostly found to be non-functioning. At least three of the sites (Fairyland, Kleinmond and Masiphumelele) were positioned close to sensitive river and/or wetland systems and the environmental impact of greywater disposal into these systems has not yet been determined. 40 household interviews were conducted during the surveys and 38 water samples were taken. Many of the respondents in the surveys complained of the possible health implications of mosquito infestations, stagnant water and smells that result from inadequate sanitation services and greywater disposal practices in the settlements.

Several towns were also visited in the neighbouring provinces of Mpumalanga and Limpopo during one survey period - 48 interviews were conducted and 32 water samples were taken. Sites were chosen based on information gained from local residents regarding non-sewered settlements with no means of greywater disposal. Most of the sites that were visited were in rural or communal authority areas and had typical erf sizes of 80 – 100m^2 with well-established shacks and some small-scale agriculture (usually maize). Water supply was found to be generally from groundwater and was well managed although it often was not within the recommended distance of 200m from the houses. Some interesting attitudes towards the use of greywater were noted during the interviews:

- Most people were very mistrustful and would not consider using it at all
- There was an experienced group who were aware of the dangers but used greywater selectively on plants (not maize, which has been found to be intolerant to greywater)

- There was a more astute group who would consider recycling in a “managed” environment

The on-site surveys in the Eastern Cape took place in the region between East London, Umtata and Queenstown, and included some rural villages as well as urban informal settlements. The rural villages were scattered and had low population densities, which meant that the disposal of greywater onto the ground in front of the houses did not appear to be a problem. Altogether 28 people were interviewed during the surveys and 14 water samples were tested. Similar complaints to those given during the Western Cape surveys were voiced with respect to the problems associated with greywater disposal, i.e. mosquitoes, smells etc, although little evidence of actual health impacts was found. Greywater reuse initiatives were generally viewed with suspicion as the water was considered “dirty” and “harmful” to plants.

Further surveys have been scheduled for the remaining provinces during June/July 2005, after which all the information will be processed and final strategies formulated.

Greywater quality and quantity

Average values for water consumption have been determined for the various settlements surveyed. It was not possible to accurately measure the volumes of greywater being disposed of in each community, and figures for water consumption were based on estimates given by the occupants themselves (usually determined by the number of buckets of water collected during each day). It is assumed that consumptive use of water (for drinking, cooking and that which remains on the surface of laundry) is relatively low, and that a large proportion of the water used during any one day is discarded as greywater (estimated to be between 75 and 80%). The water consumption figures obtained however show close agreement with those quoted in SA studies by Wood et al (2003) and Alcock (2002).

The water quality figures obtained correlate with the ranges of values quoted in literature (e.g. Eriksson et al, 2002), and indicate high levels of pollution emanating particularly from the use of household chemicals and detergents. Of particular interest is the fact that Phosphate levels seemed to be higher in greywater samples where lower-priced detergents were used, although this assumption has not fully been tested as yet. Limited microbiological testing was conducted and generally showed high levels of faecal contamination in the greywater samples, thereby limiting the potential for reuse. Table 1 shows the range of values obtained for the water quantity and quality indicators during the surveys in the four provinces visited.

Table 1: Range of values for water quantity and quality indicators

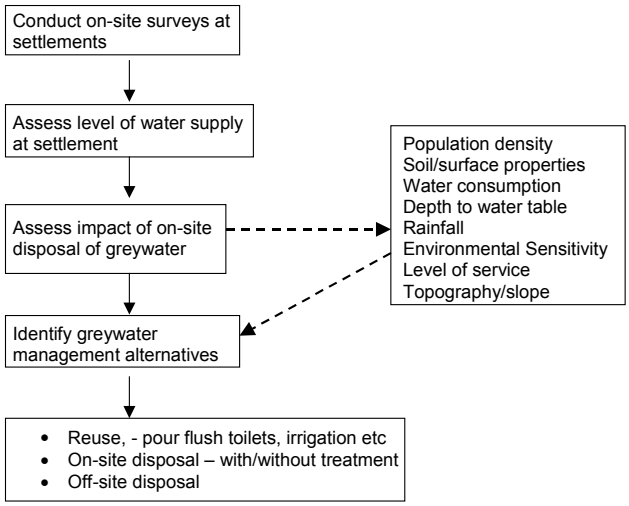
Indicator	Minimum	Maximum	Average	SA General Standard for treated sewage effluent discharges
Ave household water use (*l*/day)	10	200	108	-
Ave water use per person (*l*/c/d)	5	100	24	-
COD (mg/*l*)	1161	11289	4260	75
Total Kjeldahl Nitrogen (mg/*l*)	7	279	74	-
Phosphate (mg/*l*)	1.0	>5	2.9	-
Ammonia (mg/*l*)	0.5	>3	1.8	10
Conductivity (mS/m)	314	1893	890	250
PH	6.5	10.9	8.4	5.5 – 9.5
Oil & Grease (mg/*l*)	8	706	150	2.5
Sodium (mg/*l*)	96	1700	970	90 above intake

DEVELOPMENT OF GREYWATER MANAGEMENT STRATEGIES

It has become apparent that greywater is not the primary cause for concern amongst most residents of sub-economic settlements, and that the provision of toilets, houses, water and electricity are deemed to be far more important. Reuse initiatives are therefore not well supported with most people suspicious of the quality of the greywater and the possible associated health impacts.

The research thus far has shown that population density (number of households per settlement) and levels of water consumption are the key factors in determining whether greywater can be disposed on- or off-site. Once the other factors, like site characteristics and the levels of service have been determined, the management options can then be implemented. There are a limited number of choices with respect to greywater management in non-sewered areas; these are summed up in Figure 3, which gives a brief overview of the steps to be followed and the most critical factors that need to be evaluated in the process.

Figure 3: Flowchart for management of greywater



Although work in the other provinces may raise new issues, the information about household situation, water consumption, use of detergents as well as attitudes towards greywater reuse that has been collected thus far is sufficiently adequate to make some general conclusions regarding the management of greywater. National Government needs to take greywater management into account in their specification of minimum levels of service to poor communities, particularly in high-density settlements. Implementation must however be done at the local level, with municipalities being specifically tasked with the responsibility of managing greywater problems in cooperation with the communities themselves. The required tools for both assessing and managing greywater disposal options at this level will be one of the outputs of this project, and it is evident that multi-criteria decision-making is an appropriate tool for this purpose.

FINDINGS TO DATE

The following findings will be examined further during the remainder of the project:

1. Water management has been complicated by the way in which the communities perceive the problem of water service levels in relation to government promises and service provision in more affluent areas. There appears to be a sense of entitlement emanating from the understanding that Government will provide fully serviced houses (with waterborne sanitation) for residents of informal settlements.

2. The management of greywater should be included at the planning stage for the provision of water services to low-income settlements in collaboration with the affected communities. It appears that the management of greywater is frequently neglected in areas with reduced levels of service.
3. Methods of reducing levels of P and Na in greywater need to be investigated, possibly by discouraging the use of high Phosphate detergents.
4. Recipient communities should ideally be involved in the decision-making process, as well as in the implementation and operation of the water systems, in order to ensure "buy-in" and thereby enhance the likely success of the service delivery. This will involve education and training so that communities are able to take responsibility of the systems.

The key to successful management appears to lie with the attitude of the communities towards the greywater problem as well as the level of commitment by the local authority concerned. It is essential that greywater be properly managed to reduce health risks by eliminating inappropriate disposal, as well as to provide benefits in terms of reuse.

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