





Exploring on- and off-site waste management practices of informal dwellers in South Africa

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ABSTRACT

Household waste is a major contributor to environmental pollution and health issues. This article explores waste management practices at the household level in low-income informal housing areas in the Western Cape and Eastern Cape provinces of South Africa. The data collection consisted of a waste baseline assessment of household waste management and mapping and analysing illegal dumping spots in the immediate vicinity of the informal areas. Data were analysed using IBM SPSS Statistics 29. None of the municipalities in the study provides outside bins to households in informal areas. Approximately eighty-four percent (83.8%) of households in the study area receive some form of refuse removal, but illegal dumping was found in all areas. The results show that weekly collection of waste is not sufficient due to the limited space available to informal dwellers. Engagement with communities is important to collaboratively co-design locally appropriate ways of managing waste.

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1. Introduction

Due to the ongoing increase in household, urban and industrial waste as well as the complex nature of waste, waste management has become one of modern society's biggest challenges, especially in developing countries (Oteng-Ababio and Nikoi, 2020; Xiao et al., 2020; Volschenk et al., 2021; Eshete et al., 2023; Mor and Ravindra, 2023; Ngalo and Thondhlana, 2023; Wilson, 2023). With the increase in the global population and migration patterns, the amount of waste generated by households, as well as urban and industrial waste, continues to rise (Rodseth et al., 2020; Niyobuhungiro and Schenck, 2021; Viljoen et al., 2021; Eshete et al., 2023; Ngalo and Thondhlana, 2023). The World Bank predicts a 70% increase in worldwide rubbish creation by 2050 (Goh et al., 2022; UNEP, 2024).

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On average, global waste generation is estimated to be approximately 0.74 kg per person per day, ranging from 0.11 kg to 4.54 kg (Hoornweg et al., 2015; World Bank, 2018; Chen et al., 2020; Wilson, 2023). In 2016, the sub-Saharan Africa (SSA) region generated 174 million tonnes of waste, equivalent to 0.46 kg per person per day, which is expected to triple by 2050 (UNEP, 2018; World Bank, 2018; UNEP, 2024). It is concerning that 33% of globally generated waste is not managed in an environmentally safe manner (Wilson and Velis, 2015; World Bank, 2018; Wilson, 2023). In SSA countries, only 40–70% of the waste generated is collected, despite a 20–50% municipal budgetary allocation to urban waste management (Alhassan et al., 2020). The World Bank (2018) and Wilson (2023) estimated that more than half of all waste not collected is then openly dumped. In South Africa, municipal waste collection declined from 69% in 2021 to 66.3% in 2022 (StatsSA, 2022, 2023).

In developing countries, ineffective and inappropriate waste management at the municipal level is often visible when open dumping, illegal or indiscriminate dumping and open burning of waste are present (Adeleke et al., 2021; Mangoro and Kubanza, 2023). Illegal dumping in SSA is associated with limited operational and maintenance costs; population growth; cross-border migration and immigration; corruption; political interference; low public awareness; political conflicts and instability within countries; poor, ineffective and inappropriate service delivery; weak legislation; and lack of law enforcement (Godfrey, 2019; Adeleke et al., 2021; Fadhullah et al., 2022; Niyobuhungiro & Schenck, 2020; Mangoro & Kubanza, 2023; Modiba, 2023). Several South African researchers (Haywood et al., 2021; Isandla Institute, 2023; Schenck et al., 2023a) emphasise that one of the major reasons for the dumping and burning of waste is that service delivery does not respond to the living conditions and the needs of communities in informal settlements, particularly those in informal dwellings.

Solid waste management has often been regarded as a basic service that generally goes unnoticed if done well; however, if it is not managed properly, it can become a threat to the population's health and well-being, the economy and the environment (Rodić & Wilson, 2017). The improper management of waste leads to health, economic, social and environmental problems, amongst other concerns, not only for the local community, but also for the broader ecosystem, as waste can and does leak into rivers and oceans (Gilbreath & Kass, 2006; Arafat et al., 2015; Istrate et al., 2021; Ngalo & Thondhlana, 2023; WasteAid, 2023). Ineffective waste management and disposal expose the surrounding environment to multiple air, water and soil pollution issues (Olukanni et al., 2020; Hirpe & Yeom, 2021; Viljoen et al., 2021; Abubakar et al., 2022; Mor & Ravindra, 2023). There is an increase in evidence showing that exposure to waste due to ineffective or unmanaged waste disposal is leading to public health issues, including physical, psychosocial, biological and non-communicable diseases (Fadhullah et al., 2022; Immurana et al., 2022). The danger of open dumpsites lies in the fact that they are not maintained, contain uncovered and mixed waste and have no boundaries (Gilbreath & Kass, 2006). Increasingly, studies show that inadequate local waste disposal is also associated with an increased risk of childhood stunting (Vilcins et al., 2018).

By presenting evidence of the self-reported waste management practices employed by households residing in informal dwellings, this study aims to strengthen the existing understanding of the barriers to waste management experienced by these households. This may assist municipalities in delivering appropriate and effective waste management

services to these households and, in so doing, improve their health and the health of the environment, thereby reducing the aforementioned negative health impacts associated with improper waste management and disposal.

For the purposes of this paper, informal dwellings are defined as informal structures found both in backyards or in informal settlements, usually built from iron, wood or non-durable materials, and including caravans and tents (Children's Institute, 2023). An informal dwelling is a 'makeshift structure not erected according to approved architectural plans' (HDA, 2012:5). Backyard dwellers are persons who live in informal structures, often in overcrowded conditions, within formal developed areas – typically in an informal dwelling at the back of a formal house (Brueckner et al., 2019). An informal settlement is defined as '[an] unplanned settlement on land which has not been surveyed or proclaimed as residential, consisting mainly of informal dwellings' (HDA, 2012:5). Informal settlements are characterised by informal structures, overpopulation and deficiencies in service delivery such as water and electricity provision and solid waste management (Gutberlet et al., 2017; Ngema & Mbanga, 2022).

Within the South African context, informal dwellings typically have very little or no sanitation, electricity and waste disposal facilities, which puts inordinate pressure on service delivery and causes environmental pollution (Govender et al., 2011). The most recent statistics estimate that approximately 88.5% of all households in South Africa live in formal housing (StatsSA, 2023).

Backyard rental has become one of the fastest-growing sectors in South Africa (Tshangana, 2014; Isandla Institute, 2023). A shortage of formal housing, caused by a high rate of population growth and rapid urbanisation, has led to the prevalence of backyard dwellers and informal dwellings in urban and peri-urban areas (Schenck et al., 2023b). Between 2007 and 2011, backyard dwellings absorbed two-thirds of new households, twice as many as those absorbed into informal settlements. The number of households living in informal settlements in South African cities declined from 9.8% in 2011 to 8.7% in 2016, whereas those living in backyards increased from 8.9% in 2011 to 13.4% in 2016 (Brueckner et al., 2019). Schenck et al. (2023b) confirm that backyard dwellers and informal dwellings are prevalent in urban and peri-urban areas. Informal settlement dwellers and backyard dwellers often live in deplorable conditions with limited (or no) access to basic services such as water, sanitation and waste management (Brueckner et al. 2019).

Oteng-Ababio and Nikoi (2020) argue that local governments in developing countries address waste issues by embracing or mimicking the methods of developed countries, despite the clear differences between waste management systems in developed and developing countries. Such 'one-size-fits-all' policies and methods arguably perpetuate existing inequalities (Oteng-Ababio & Nikoi, 2020).

This article thus explores the on- and off-site waste management practices by low-income informal dwellers located in the Western Cape and Eastern Cape provinces of South Africa. It reports on the results obtained from a short survey consisting of five questions with their associated qualitative clarifications completed with households, along with a mapping of illegal dumpsites in these communities. Much of the existing related literature focuses on waste management at the household level (Serret & Ferrara, 2008; Hidalgo et al., 2017; Han et al., 2018; Olukanni et al., 2020; Haywood et al., 2021; Viljoen et al., 2021; Modiba, 2023; Ngalo & Thondhlana, 2023); however,

the majority of the research aimed at understanding waste management in rural and low-income areas does not 'zoom in' on actual waste management practices at the household level, which this study aimed to do.

2. Material and methods

Serret and Ferrara's (2008) framework regarding household waste management was used to guide the present research (Figure 1).

According to Serret & Ferrara, (2008), as well as Viljoen et al. (2021), on-site household waste management refers to the composting, recycling, reuse and burning or burying of waste within their own household and yard. Off-site household waste management refers to the disposal of waste elsewhere, such as at landfills, in public receptacles and at drop-off centres. It can also include open burning and illegal dumping on streets, in empty spaces and on riverbanks. Kerbside household waste management includes households' kerbside disposal of mixed waste and separated or sorted recyclables for collection by the municipality and/or other collectors. After collection, the disposal of the waste becomes the responsibility of the municipality or designated collector (Haywood et al., 2021).

This article presents the results derived from an ongoing broader multi-disciplinary study (the Building Healthier Communities or BHC study) that explores the impact of moving from informal housing to a formal house on child health and development. To estimate the impact of the move, the broader BHC study focuses both on low-income households who are living in informal dwellings and have applied to access formal houses in government-funded social housing schemes (colloquially referred to as RDP houses) as well as on households who have already moved into their government-subsidised formal houses. The broader BHC study aims to determine whether exposure to formal housing will improve various aspects of children's health such as stunting, nutrition, self-reported health exposure to pathogens within the home (including through the air), caregiver well-being (physical and mental health), income and employment.

As part of the broader BHC study, challenges linked to household waste management in the selected low-income households were explored. In this article, we report on the results from data collected as part of the first phase of the BHC study. This first phase consisted of data collected from 117 households in informal dwellings.¹

The 117 households were situated in five informal settlements: four in the Western Cape (WC) and one in the Eastern Cape (EC). The Borchers Quarry and Zimbabwe informal areas in the Nyanga township, as well as Fisantekraal, fall under the City of Cape Town, while the Swartland informal settlement falls under the Swartland Municipality in the Western Cape. In the Eastern Cape, the study was carried out in the Cenyuland informal settlement of the Amahlati (Stutterheim) Municipality.

The criteria for participants to be included in the study were that they should: (a) be living in an informal dwelling, (b) qualify to access government-funded formal housing in the near future and be on the waiting list of the municipality and (c) be older than 18 years of age. The households earmarked for moving to formal areas were identified by the

¹The subsequent phases also included households in formal areas.

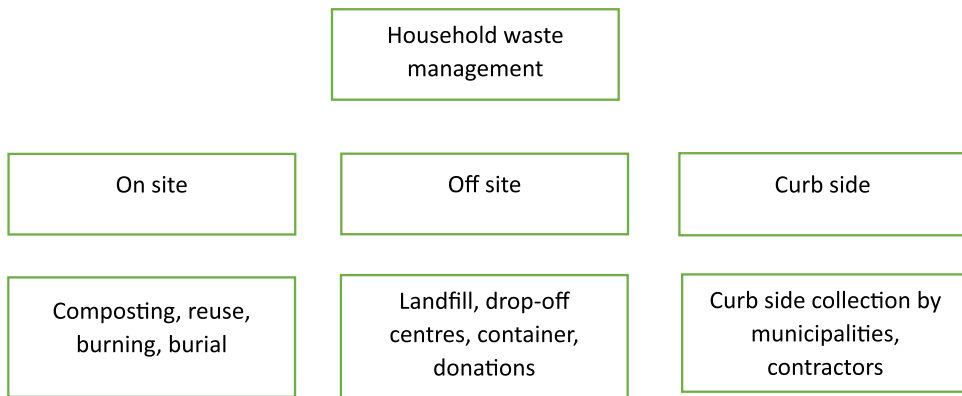


Figure 1. Household waste management framework (Serret & Ferrara, 2008).

local municipalities. Participation was entirely voluntary, and persons were free to decline the invitation to take part in the study. Participants were also free to withdraw from the study at any point, even if they had initially agreed to take part.

The data collection consisted of two phases:

Phase 1 of the research was a waste baseline assessment of the on-site management of household waste. Data were collected by trained fieldworkers, recruited from the respective areas and able to speak the local languages. The comprehensive questionnaire of the broader study was completed by the fieldworkers on an electronic device covering all aspects under investigation in the broader study. The data were directly captured in MS Excel. The participants were visited on appointment considering their availability. The waste management section of the questionnaire used for this study consisted of five questions, followed by open-ended clarification questions linked to each of the questions, which yielded valuable insights.

The distribution of the 117 households across the four sites was as follows: Borchers Quarry (39), Fisantekraal (35), Swartland (20), Zimbabwe (19) and Cenyuland (4).

The surveys were conducted in November 2022. The questionnaire was available in English, isiXhosa and Afrikaans to accommodate the diversity of the participants included in the study. A pilot run of the questionnaire was conducted with a small sample size of 20 persons in Fisantekraal. The participants in the pilot run did not form part of the sample reported on in this study.

Phase 2 consisted of mapping and analysing the off-site illegal dumping spots in the immediate vicinity of the informal areas.

The mapping of illegal dumping in the areas aimed to determine the cleanliness of the area, what type of waste was being dumped and which waste fractions the community struggled to manage, and to understand why dumping is part of the waste management practices of the community.

The researchers drove about the study areas to identify illegal dumpsites. They then identified and listed the waste types present at the dumpsites, took photos and mapped the dumpsites using the GPS Field Area Measure app (downloaded on their smartphones from the Google Play Store or the Apple App Store). The coordinates and size of each illegal dumpsite were captured.

Data were analysed by the third author using IBM SPSS Statistics 29. Frequency tables and cross-tabulations were constructed to summarise the information, per community, regarding methods of household waste disposal, waste collection options available and perceptions of the cleanliness of their environment.

This study was approved by the Health Research Ethics Committee at Stellenbosch University (reference number: 22726).

3. Results

First, the descriptive statistics from the survey will be discussed. [Table 1](#) displays the distribution of the respondents in the five sampled communities.

All of the respondents lived in informal dwellings, as per the sample criteria, with the implication that they did not have access to water or toilets inside their dwellings, to legal electricity connections or to kerbside waste collection services. Furthermore, as mentioned, the selected participants were eligible to move into government-subsidised housing in the near future.

3.1. Household rubbish bins: Location and accessibility

Living in an informal dwelling implies limited or no space for rubbish bins. The first question in the questionnaire was related to having access to a bin and its location inside or outside the dwelling. Households in formal housing areas usually have access to a waste bin inside the house and, when full, that bin is emptied outside the house into a large rubbish bin provided by the municipality – that is, if they are linked to a municipal account or pay for services – which is then emptied by the municipality (Haywood et al., 2021). Both the City of Cape Town and Swartland Municipality do not provide outside bins to households in informal settlements that are not linked to a municipal account. Trucks are also unable to move through informal areas to pick up waste from bins, as [Figure 2](#) clearly depicts.

In this research, access to bins generally refers to small household bins or containers that households use inside or outside their dwellings and which they have probably obtained themselves. The results show that, of the 117 households interviewed, the majority (57 households, i.e. 48.7%) kept their rubbish bin outside their dwelling due to the limited space available inside the dwelling. Only 11 households (9.4%) kept their bins inside their dwellings, three (2.6%) reported keeping bins both inside and outside, while 45 households (38.5%) did not use waste bins but instead used bags. A study by Govender et al. (2011) conducted with households living in backyard informal dwellings found that 68% of the households did not have any form of bin or access to bins, and waste was dumped in the streets, open spaces and into toilets.

Table 1. Distribution of sampled communities.

Community	N	Percent
Borcherds Quarry	39	33.3
Fisantekraal	35	29.9
Swartland	20	17.1
Zimbabwe	19	16.3
Cenyuland	4	3.4
Total	117	100



Figure 2. Informal area in Cape Town.

Figure 3 shows that the majority of those who had bins kept them outside, probably due to lack of space inside the dwelling and for hygienic reasons. A large proportion of the interviewees (83.8%) did not have access to bins provided by the municipality. The majority of respondents indicated that they used refuse or shopping plastic bags (87.2%). Furthermore, of the five informal areas in the study, Zimbabwe had the

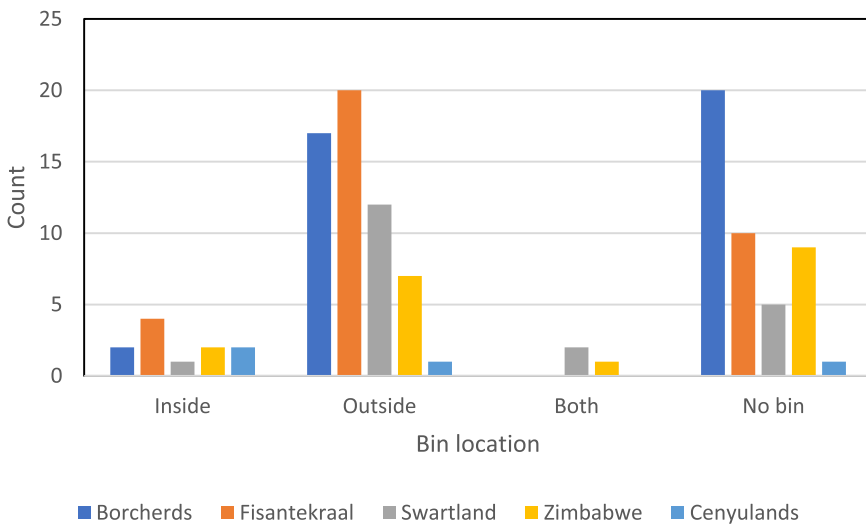


Figure 3. Household rubbish bin location.

highest proportion of households that did not have access to municipal rubbish bins (18 out of 19, i.e. 94.7%), followed by Borchers Quarry (35 out of 39, i.e. 89.7%), Swartland (16 out of 20, i.e. 80%) and Fisantekraal (25 out of 35, i.e. 71.4%). In the case of Cenyuland, where only four respondents took part in the survey, one household did not use a municipal bin. Although not explored, we assume that all these households would keep their waste in small bags until they could dispose of it. Molefe (2016) also found that informal dwellers do not keep open waste bins inside single-room dwellings, as people generally believe waste should not be kept in the same space as people, particularly if children live in the dwellings.

3.2. Bins and lids

Bins with lids provide protection against odours and contamination (Govender et al., 2011). However, in this study, 51.8% of respondents who have household bins indicated that their bins did not have lids.

Table 2 below shows the number of households in each community that used bins with or without lids or who did not use bins at all.

More than 50% of households used alternative receptacles such as shopping bags, for waste and not bins.

Table 3 captures households' access to municipal waste disposal facilities. Respondents had to select all the applicable options, as many households had access to more than one waste facility. In total, there were 170 responses from the 117 participants.

Table 2. Household bin usage.

		With lid	Without lid	No bin	Total
Borchers Quarry	Count	6	11	22	39
	% within community	15.4%	28.2%	56.4%	100%
Fisantekraal	Count	10	8	17	35
	% within community	28.6%	22.9%	48.6%	100%
Swartland	Count	7	6	7	20
	% within community	35%	30%	35%	100%
Zimbabwe	Count	3	2	14	19
	% within community	15.8%	10.5%	73.7%	100%
Cenyuland	Count	1	2	1	4
	% within community	25.0%	50.0%	25.0%	100%
Total	Count	27	29	61	117
	% within community	23.1%	24.8%	52.1%	100%

Source: Research data.

Table 3. Waste disposal options.

	Bins	Bags	Skips	Drop-off area	None	Other	Don't know	Total responses (from 117 respondents)
Borchers Quarry	4	34		23	1	1		63
Fisantekraal	10	28		6	2			46
Swartland	4	15	3	4	4			30
Zimbabwe	1	19		7				27
Cenyuland					3		1	4
Total	19	96	3	40	10	1	1	170

Source: Research data.

The majority of households (82.1%) had access, at the very least, to bags. A further 34.2% (40 respondents) indicated that they had access to a dedicated drop-off area for waste, while 16.2% (19 respondents) had access to bins. Eleven households (9.4%) indicated no access to any of the listed waste disposal facilities.

3.3. Household refuse collection and frequency

Overall, 89.7% of households (105 respondents) indicated receiving some form of refuse removal service. Similar trends were observed regarding the frequency of refuse collection. The statistics show that 65.8% of the respondents had their refuse removed weekly, while 13.7% indicated daily refuse removal. The City of Cape Town offers weekly waste removal in formal and informal areas, although different methods are employed. Formal areas are provided with wheelie bins while informal areas may receive blue refuse bag. The researchers therefore assume that those who indicated daily refuse removal referred to facilities such as mini drop-offs and skips where they can dispose of their waste on a daily basis.

Respondents in the informal areas of Borchers Quarry and Zimbabwe, which are located adjacent to each other, reported both weekly and daily waste collection. However, municipal cleaners maintained that the skips and containers were emptied twice per week. We assume that the discrepancy of the viewpoints is due to the fact that the household can dispose of their waste daily, although cleaned by the municipality twice per week. All 20 Swartland respondents specified that their refuse was removed weekly.

3.4. The prevalence and composition of illegal dumping

In this section, the number of illegal dumpsites as well as the types of waste dumped is presented.

The dumping of waste was evaluated in the four communities in the Western Cape. Dumpsites in Cenyuland were not mapped, due to the small number of participants in this area. In Nyanga (encompassing both Borchers Quarry and Zimbabwe informal areas, as they are adjacent to each other), 6 dumpsites were found; 11 were found in Fisantekraal and 31 in Swartland.

The mapping of illegal dumpsites in Borchers Quarry and Zimbabwe, shown in [Figure 4](#), indicates that there are few such sites in this area: only two in Borchers Quarry and four in the Zimbabwe settlement. Even the waste containers in these areas were clean to the point that cleaners from the City of Cape Town were happy to sit in the containers.

[Figure 4](#) shows that dumping took place along the main road, as there were no other open spaces for dumping. The researchers also learned that there were public taps for water in Borchers Quarry, but not in Zimbabwe. However, in Zimbabwe there were shared toilets (in general, one toilet was shared among three families). Because there is no water infrastructure in Zimbabwe, residents dumped their used water as well as the ash from the charcoal used to braai (barbecue) meat (for example, sausages and sheep's heads, to be sold on the streets) in the roads. The dumped ash and braai waste resulted in waste water being black, and multiple piles of the residue of dry black ash



Figure 4. Illegal dumpsites in Nyanga (Zimbabwe and Borchers Quarry).

were found along the edges of the roads. However, in Borchers Quarry, an informal dumpsite of general waste could be found at every public tap.

In both Borchers Quarry and Zimbabwe, the illegal dumpsites mainly consisted of construction and demolition waste, garden waste, mixed domestic waste, glass, discarded tyres and braai waste (charcoal and ashes). [Figure 5](#) shows (a) construction and demolition waste next to dwellings and (b) waste water, tyres and other household waste.

In the Swartland area, 31 dumpsites were mapped. [Figure 6](#) shows that waste dumping took place both in the built-up area among houses as well as on the periphery of the area and in open spaces. Dumpsites were also found next to an overflowing skip and in a concrete stormwater channel.

Seven different types of waste were noted at the dumpsites in Swartland, as shown in [Figure 7](#).

The most common waste type disposed of at the dumpsites in the Swartland informal area was domestic waste, which was found at 25 (81%) of the dumpsites. This waste type was made up of items such as disposable diapers (which made up the bulk of at least six of the 25 sites), textiles (clothes, curtains, linen), shoes, plastic packaging and braai waste, such as ash. Dog excrement and dog carcasses, glass and metal waste were also found in large quantities. There were sizable heaps of organic or garden and construction and demolition waste; these are often the first types of material to be dumped in an open piece of land, and are then followed by domestic waste. Similar patterns were found by Ngalo and Thondhlana (2023). Of specific concern is the disposal of hazardous construction material containing asbestos found at four of the dumpsites.



Figure 5. Illegal dumping in Nyanga (Borcherds Quarry and Zimbabwe informal areas).

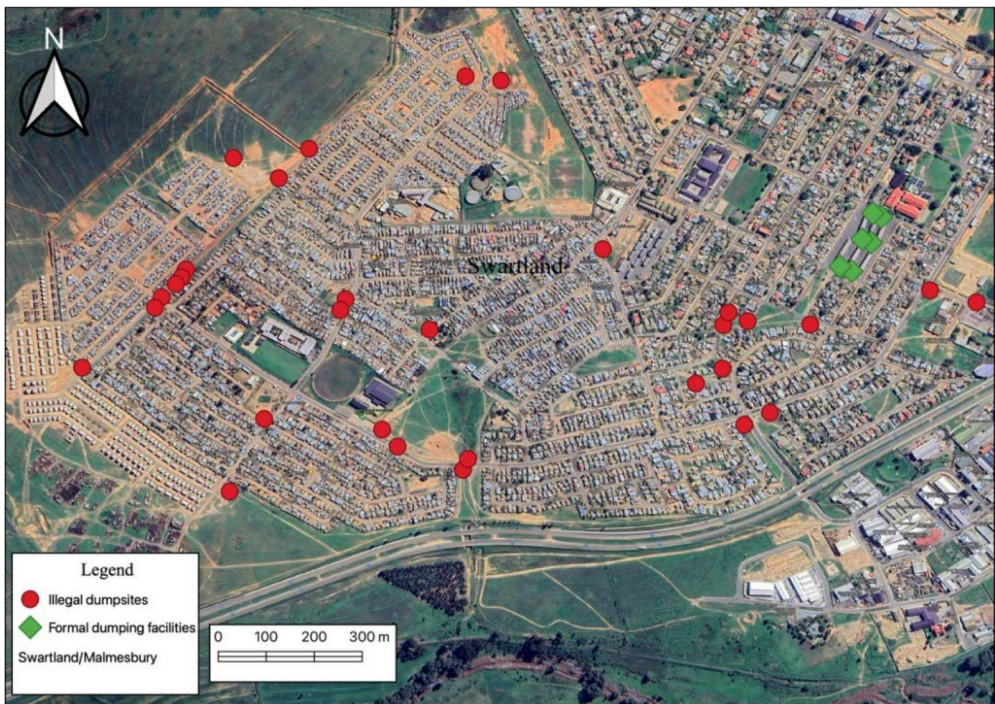


Figure 6. Illegal dumping in the Swartland informal area.

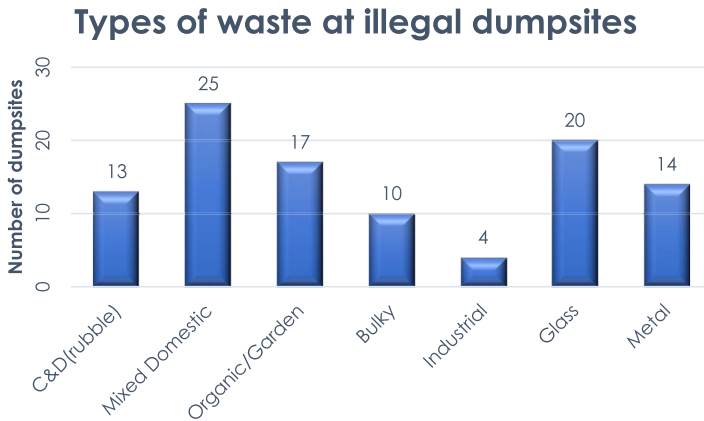


Figure 7. Types of waste found at illegal dumpsites in the Swartland informal area.

Bulky waste found at the dumpsites consisted of items such as large pieces of construction wood, carpets, mattresses and couches. Bulky waste is a problematic waste stream for low-income areas as access to transport might not be available to remove it to a formal landfill site (Schenck et al., 2023b). Industrial waste at the dumpsites consisted of discarded car oil, and medical waste consisted of mainly unused and discarded diabetes medication. Waste tyres, apparently from an informal tyre seller trading nearby, were also found.

The disposal of waste next to skip bins indicates that the skip is not monitored and cleaned or removed regularly enough (Figure 8).



Figure 8. Dumped waste next to a skip (note that the skip is full).

In Fisantekraal (Figure 9), dumping of waste took place mainly within the built-up area and adjacent to informal areas.

All 11 dumpsites in Fisantekraal were located in a park or open space, and six of these were in direct proximity to informal dwellings (Figure 10).

Eight different types of waste were observed at these illegal dumpsites: construction and demolition waste (i.e. builders' rubble), mixed domestic waste, organic or garden waste, bulky waste, industrial waste (such as paint), glass and metal waste and some other types (see Figure 11).

The most common waste type disposed of at these dumpsites was mixed domestic waste and organic or garden waste; both fractions were found in 10 of 11 (91%) dumpsites. The mixed waste fraction was clearly dominated by plastic waste (Figure 12). Organic or garden waste was mostly made up of branches and grass.

Glass was also found in large quantities. Construction and demolition waste was dumped in four locations, with one heap containing asbestos waste. Electric and electronic waste or e-waste was also found at two dumpsites.

As mentioned, illegal dumping was not mapped in Cenyuland, as only a few households participated in this research; however, all four respondents indicated that they burned their uncollected waste.

Communities in rural areas more often than not experience inadequate waste management facilities, poor infrastructure and a very obvious lack of treatment facilities, which all contribute to littering and dumping, open burning of waste, as well as uncontrolled abandoning of waste and improper storage of unused resources, as highlighted by Niyobuhungiro and Schenck (2020) and Hidalgo et al. (2017).

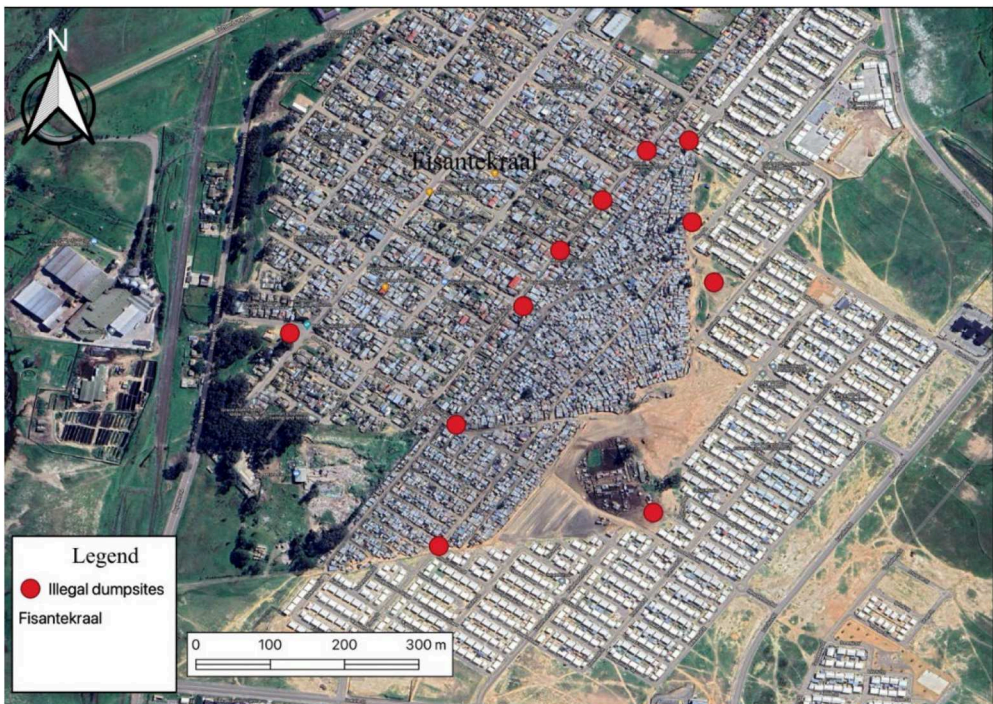


Figure 9. Illegal dumping in Fisantekraal.



Figure 10. Waste disposed of directly adjacent to informal dwellings.



Figure 11. Types of waste found at illegal dumpsites in Fisantekraal.

Inside an informal dwelling, bags filled with waste become a health and stench problem, in particular if nappies are involved (Schenck et al., 2023b). However, bags also cannot be left outside an informal dwelling as they will be ripped apart by stray dogs and other free-roaming animals (Schenck et al., 2023a, 2023b). Residents mentioned storing rubbish bags on the roofs of their informal dwellings until the bags could be disposed of. Only a small number of households in all five researched communities indicated accessing drop-off facilities, which led to the question: ‘Where do people dispose of filled rubbish bags?’ This question will be answered in the following section relating to refuse removal and frequency.

3.5. Waste disposal preferences

The respondents were requested to indicate all the applicable options they would consider in their efforts to manage uncollected waste or waste which they could not keep until the next collection. Nine respondents selected two options, resulting in 126 responses from the 117 respondents.



Figure 12. Dumped garden waste (left) and dumped mixed domestic waste (right).

The argument that residents turn to illegal dumping when waste removal is insufficient (Haywood et al., 2021) is confirmed by the results in Table 4. The table shows that the majority of respondents in all five communities (64.1%) disposed of their waste at the ‘municipal’ dumpsites when waste was not collected, while a further 20.5% kept it until it was collected and 7.7% burned their waste. During the mapping of the informal dumpsites, it was observed that residents believed that dumping waste close to municipal waste facilities was not illegal, and households believed it to be the municipality’s responsibility to remove such dumped waste (Moh & Abd Manaf, 2017; Niyobuhungiro & Schenck, 2021; Zikali et al., 2022). Furthermore, informal interactions with some residents in this study, as well as the study by Haywood et al. (2021), revealed that some households chose not to leave their municipality-provided bins outside due to the risk of bin theft; instead, they resorted to illegal dumping despite having access to regular (weekly) collection services by the municipality.

Table 4 shows that all four households in Cenyuland burned uncollected waste. However, in other communities, waste was also buried and dumped. Overall, researchers have established that burning, dumping and burying are the methods employed to

Table 4. Community waste disposal options.

	Burn	Bury	Dump (close to home)	Dump within 100 m of house	Dump at municipal dump site	Keep until collected	Other	Total no of responses (117 respondents)
Borcherds Quarry	1			4	30	3	5	43
Cenyuland	4							4
Fisantekraal	4	1		1	24	8	1	39
Swartland			1		6	13	1	21
Zimbabwe		1			15		3	19
Total	9	2	1	5	75	24	10	126

Source: Research data.

manage waste in the absence of regular, reliable and appropriate fit-for-purpose municipal waste management services (Puling, 2004; Kawamoto & Urashima, 2006; Rasmeni & Madyira, 2019; Oteng-Ababio & Nikoi 2020; Schenck et al., 2022; Zikali et al., 2022; Kalina et al., 2023; Ngalo & Thondhlana, 2023).

3.6. Material being burned, buried or dumped

As a follow-up to the previous question, the respondents were asked which used items were burned, buried or dumped (Table 5).

A few respondents indicated that they burned old clothes, carpets, plastic and paper. However, as was to be expected, burning as a form of waste management was not commonly considered feasible, as living in a densely populated informal settlement is not conducive to burning waste. It is noteworthy that no respondents mentioned burning nappies, as it is generally considered impossible to burn them (Schenck et al., 2023b). Similarly, burying nappies, food and tins was mentioned by only a few respondents, possibly due to a lack of space. Dumping waste and the reuse of certain types of items was mentioned by all respondents. All types of waste were dumped, while reused items included shopping bags, ice cream and butter or margarine tubs, shoeboxes, dishwasher bottles, glass bottles, water bottles and two-litre plastic bottles. Each household indicated reusing some products, either for the same purpose (refilling) or for different purposes and, in so doing, contribute to the circular economy.

The list of waste types mentioned as being dumped was confirmed by the dumped items observed by the researchers at the mapped dumpsites.

3.7. Respondents' perceptions regarding the cleanliness of the environment

Lastly, the residents were asked to rate their perceptions in respect of the cleanliness of their areas on a Likert scale from 1 to 10, with 1 being 'very dirty' and 10 'very clean'. Only one respondent refused to answer the question. Table 6 shows the perceptions which respondents from each community had regarding their area.

More than a third of respondents (37.1%) rated the cleanliness of their area as below 5 (i.e. as dirty); another 36.3% rated their area as neither clean nor dirty (5 and 6 on the scale); 24% rated their environment as relatively clean. Only 2.6% of respondents believed they lived in very clean surroundings.

Table 5. Different ways of handling uncollected waste.

Burned	Buried	Dumped	Feeding animals	Products reused
Clothes	Disposable nappies (referred to as 'pampers')	All waste, food, paper, nappies, plastics, boxes, old plastic bags, wood, expired chemicals	Leftover food Rotten food Bones	Shopping bags
Carpets				Plastic tubs
Plastic				Ice cream/margarine tubs
Paper				Yoghurt tubs
				Tins
				Dishwasher bottles, Water bottles
				2-litre plastic bottles, Glass bottles
				Peanut butter jars, Spray bottles, Coffee containers, Shoe boxes

Table 6. Cleanliness of the areas according to respondents' perceptions.

	Very dirty	2	3	4	5	6	7	8	9	Very clean
Borcherds Quarry	2	8	5	6	12	1	1	4	0	0
Cenyulands	0	0	0	0	0	2	2	0	0	0
Fisante- kraal	0	6	3	4	2	3	6	3	5	2
Swartland	0	0	0	2	6	8	4	1	1	0
Zimbabwe	0	3	3	3	6	2	0	1	0	1
Total	2	17	11	13	26	16	13	9	6	3
Percentage	1.7%	14.7%	9.5%	11.2%	22.4%	13.85%	11.2%	7.6%	5.2%	2.6%

In Borcherds Quarry, 21 of the 39 respondents (53.8%) thought that the area was dirty, and only 5 (12.8%) maintained that the area was clean. This perception was echoed by the 19 respondents from Zimbabwe, which is adjacent to Borcherds Quarry: 47.4% rated the area as dirty and 1% rated it as clean.

In Fisantekraal, almost half of the 34 respondents (16, or 47.1%) rated the area as clean, while 13 (38.2%) thought the area was dirty.

In the Swartland community, interestingly enough, the majority of respondents (14 of 22, or 63.6%) were neutral about the cleanliness of their surroundings, one third rated the area as clean and a mere 9.1% rated it as dirty.

Thus, it was only in Swartland and Fisantekraal that many respondents considered their environment to be clean. This applied to Cenyuland as well, though the latter had only four respondents.

4. Discussion and conclusion

The results from this study present the behaviour of households in informal settlements in the Western Cape and Eastern Cape provinces in South Africa in managing their solid waste in the absence of sufficient waste removal by authorities. The results indicate that living in informal dwellings with limited space poses many challenges with regard to on-site waste management for the households interviewed. Only 11.9% of the participants had bins inside their dwellings and 38.8% had no access to any bins, neither inside nor outside their dwelling, due to financial constraints, space limitations, feral dogs and theft of bins. Participants indicated using bags to store waste that needs to be discarded daily, and these are stored in places safe from feral dogs, such as on the roof of the informal dwelling. Participants also indicated that rubbish bags are taken to drop-off sites (if available and accessible) or are dumped at what some regarded as 'municipal dumpsites'. The residents' conception of 'municipal dumpsites' is based on the fact that municipalities do clean these sites regularly and burn waste in the open, even though they are technically illegal dumpsites.

It is noteworthy that many of the participants indicated resorting to reusing items as a method of saving money. With the exception of the small sample in Cenyuland, the other four areas received waste collection more frequent than weekly in some or other form, be it via collection of rubbish bags, cleaning of mini drop-offs or cleaning of illegal dumpsites. The mapping of the illegal dumpsites clearly showed that dumping and burning waste has become a method of 'off-site' waste management for when a household needs to dispose of waste-filled bags regularly, sometimes even daily. Despite the presence of multiple dumpsites, many of them in the vicinity of their homes, the majority of the households interviewed regarded their area as 'fairly clean'. Perhaps they had

grown used to dumpsites and the fact that these are cleaned weekly – making the situation acceptable to the residents.

To achieve the United Nations' Sustainable Development Goals (SDGs), in particular that of improving the health and well-being of the community and the environment, many researchers (Rodić & Wilson, 2017; Oteng-Ababio & Nikoi, 2020; Adeleke et al., 2021; Schenck et al., 2022; Mangoro & Kubanza, 2023; Wilson, 2023) recommend that waste collection in developing countries should be transformed and revamped to become financially sustainable, more engaged with the communities and relevant to local conditions. The results of this study show that 83.8% of the households interviewed did receive some form of waste collection; however, clearly this waste collection is not sufficient and does not meet either the on-site or the off-site needs of the households – thus it is not sufficiently relevant to local conditions.

The results highlight the fact that appropriate and effective municipal actions and positive household waste behaviour are needed (Viljoen et al., 2021). In summary, to address the SDGs, we have to collaboratively create well-functioning and liveable neighbourhoods through understanding waste management at the household level, and address it with locally and co-created innovative solutions.

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