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The spatial extent, practices, and impacts of illegal solid waste dumping across an income gradient in Makhanda and Knysna, South Africa

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Abstract

The disposal of household solid waste (HSW) through illegal dumping has become a widespread issue globally, especially in developing countries. The problem has been exacerbated by several factors such as rapid population growth, urbanization, poor infrastructure, poor enforcement of bylaws, mismanagement, poor municipal service delivery, and lack of funding, resulting in most urban residents resorting to illegal solid waste dumping (ISWD). Illegal solid waste dumping by urban residents in most developing countries is becoming a standard occurrence particularly along roadsides, vacant plots, riverbanks, forests edges, and in commonages near and within human settlements. In most South African towns and cities, the practice of ISWD is an immense social, economic, and environmental problem. The practice has led to nationwide environmental pollution and has posed significant socio-economic and health risks to urban residents particularly the urban poor, who reside in areas where ISWD is more pronounced. Studies on ISWD in South Africa are mostly within metropolitans and cities neglecting medium-sized towns like Makhanda and Knysna where such information is needed to improve municipal household solid waste (HSW) management plans and policies. Using street surveys, illegal dumpsite mapping, waste categorization templates, and household survey interviews the study examined the spatial extent, composition, dumpsite sizes, as well as residents' practices and perceived causes and impacts of ISWD across different income groups in two medium-sized towns of Makhanda and Knysna, South Africa. The results showed that more dumpsites were enumerated in Makhanda (155) than in Knysna (60), however, the occurrence, size and prevalence of illegal dumpsites were unevenly distributed, with most dumpsites being in low-income compared to high-income neighbourhoods. In both towns, most of the dumpsites were within open access areas such as roadsides, vacant plots, and commonages. The composition of waste within dumpsites consisted mostly of household waste (Makhanda = 42% and Knysna = 49%), garden waste (Makhanda = 37% and Knysna = 30%), and construction waste (Makhanda = 21% and Knysna = 21%). More residents in low-income than in high-income neighbourhoods reported dumping, attributing it primarily to poor municipal services (Makhanda= 59% and Knysna= 54%). Within both towns, environmental impacts of ISWD were experienced by residents from both income groups, with over 50% of the respondents citing visual pollution as the most serious impact. The health impacts of ISWD were exclusively reported by low-income residents with over 30% reporting TB and Rashes as the key health impacts. Overall, the research concluded that ISWD distribution, prevalence, dumpsite sizes and impacts were unevenly distributed across low-income and high-income neighbourhoods with the former disproportionately facing

an overall higher occurrence of illegal dumpsites and subsequent health risks. The occurrence of more dumpsites in low-income areas seem to suggest that factors like socio-economic inequalities, historical legacies, lack of education and awareness, and poor municipal services in these areas are at play and need to be addressed to mitigate ISWD. To tackle the problem of ISWD a collaborative approach is recommended, one that incorporates stakeholders, households and municipal efforts and improvements. Such solutions could include improved municipal funding to develop an efficient service delivery system, solid waste awareness campaigns in communities, and provisioning of bins along open access areas.

Keywords : domestic solid waste; illegal dumping sites; low- and high-income neighbourhoods; socio-economic inequalities; environmental pollution; municipal service delivery.

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CHAPTER ONE: INTRODUCTION

1.1 General introduction

Illegal solid waste dumping (ISWD) is a global problem, particularly within the Global South where illegal dumpsites have emerged as common features occupying roadsides, riverbanks, forests edges, commonages, and vacant plots, particularly in urban areas (Alves, 2023; Ferronato and Torretta, 2019; Syafrudin et al., 2023). The practice of ISWD is also referred to as indiscriminate dumping, fly-tipping, fly-dumping, or midnight dumping (Niyobuhungiro and Schenck, 2021; Dixon et al., 2022; Ozymy and Ozymy, 2023). The term ISWD is described as the deliberate and unlawful disposal of solid waste (SW) materials i.e., garbage or refuse in a public or private space that has not been designated as a site for waste disposal i.e., waste drop-off facility, collection point or landfill (Liu et al.,2017). Solid waste (SW) refers to any discarded material that the holder no longer considers as being of any use, it comprises of organic, inorganic, hazardous and non-hazardous materials (Bundhoo, 2018; Eberhard, 2018; Kimani, 2020; Rao et al., 1995). Studies have reported that solid waste (SW) materials generated at a municipal level from household, agricultural, institutional, and industrial activities are the most prominently dumped solid waste material types (Eberhard, 2018; NEMA: WA, 2014; NWA, 1998; Webb et al., 2016). For example, it is estimated that around 13% of produced food is lost between harvest and retail and an additional 17% is turned into food waste and dumped by households worldwide (FAO, 2022).

Currently municipal solid waste (MSW) products generated by households have emerged as a global crisis resulting in significant environmental and human health risks due to the practice of ISWD (Kaza, 2018; Valavanidis, 2023; Zhao et al., 2023). By 2050 household solid waste (HSW) generation is expected to outpace population growth by more than double, this increase in waste generation is likely going to exacerbate the current ISWD problem occurring within urban areas worldwide particularly across towns and cities within developing countries (Abubakar et al, 2023; Alves, 2023; Kaza et al., 2018; UN-HABITAT, 2010). The factors leading to ISWD are vast and differ across geographical regions. However, studies have identified poor waste management systems as being a key contributor to the practice especially in urban areas within underdeveloped and developing countries (Alves, 2023; Godfrey et al., 2020; Kalina et al., 2023; Kimani, 2020; Ngalo and Thondhlana, 2023). Šedová (2016) argues that the practice of ISWD is one of the symptoms of struggling waste management systems.

Ferrara (2008) concurs and states that ISWD is due to two main reasons, namely poor municipal services, and individual/household behaviours regarding dispersal of household waste.

Aside from issues pertaining to individual behaviours and municipal failures, several other factors have been put forward to explain why ISWD is on the rise globally (Kaza et al., 2018; UN-HABITAT, 2010; Valavanidis, 2023). These factors include population growth, rapid urbanisation, high waste production, socio-economic inequalities, and uneven socio-economic inequalities that limit the urban poor's options regarding HSW management (Abubakar et al., 2023). Globally between seven to 9 billion tonnes of solid waste are produced annually, and 2 billion tonnes of this waste comprise of MSW materials (Chen et al, 2020). Only 33% of global MSW is managed in an environmentally safe manner i.e., recycled, reused and/or composted (Chen et al, 2020; Kaza et al., 2018; Wilson and Velis, 2015). Most of the MSW products (over 50%) end up in landfills or in illegal dumpsites with the latter being more prevalent across underdeveloped and developing countries (Alves, 2023; Grobler et al., 2022; Kimani, 2020; Valavanidis, 2023). Current trends suggest that the illegal dumping of MSW products is increasing globally. In Europe, ISWD of MSW products has been on the rise in countries such as Poland, Slovakia, Romania, and Hungary despite the tight policies that the European Union has in place regarding MSW management i.e., Directive 2008/98/EC of the European Parliament on waste management (Bronska, 2021; European Union, 2008; Šedová, 2016; Tiseo, 2023).

In Shanghai, China it is estimated that close to 61 404.5 tonnes of MSW are illegally dumped inside and outside of the central district areas in just eight months (Yang et al., 2019). In the USA, Law et al. (2020) reported that although a lot of USA residents have access to waste recycling and collection points, illegal dumping remains widespread in most states. The problem of ISWD is exacerbated in third world countries in contrast to first and second world countries due to poor waste management systems and historical legacies of spatial segregation and uneven social development i.e., low-income communities colloquially termed townships inhabited by the urban poor are often characterised by poor and inaccessible infrastructure which impedes municipalities ability to render waste collection services and thus often leads to residents resorting to ISWD as a method of HSW disposal (Abubakar et al., 2022; Khumalo et al., 2021; Grangxabe et al., 2023; Mekonnen et al., 2020). Grangxabe et al. (2023) reported that the apartheid spatial planning laws in most urban areas of South Africa could be contributing to

ISWD as most poor communities do not have accessible roads for municipalities to collect household refuse bags. Besides accessibility, most municipalities in South Africa are failing to provide basic services like waste collection as they are underfunded, corrupt, understaffed and often dysfunctional (Grangxabe et al., 2023). This has resulted in most residents in townships areas resorting to ISWD and burning as it is a cost-free method of HSW disposal (Abel, 2014; Kimani, 2020). Studies conducted in other Sub-Saharan African countries have reported similar findings for example studies done in Kenya (Rotich et al., 2006), Nigeria (Ichipi and Senekane 2023), and Zimbabwe (Khumalo et al., 2021) all showed ISWD prevalence predominately in low-income areas and attributed this to poor governance and poverty.

In South Africa, the practice of ISWD is a social, economic, and environmental problem that presents numerous challenges for local municipalities and poses significant risks to human and environmental health (Abel, 2014; Kubanza, 2021; Niyobuhungiro and Schenck; 2020). Studies conducted across most towns and cities in South Africa have reported that ISWD is on the rise across residential neighbourhoods and thus leading to problems such as polluted rivers, diseases like diarrhoea, land degradation through soil contamination and livestock deaths (Kubanza, 2021; Ngalo and Thondhlana, 2023; Ngeleka, 2010; Viljoen et al., 2021). The practice of ISWD within South Africa is considered a violation of constitutional rights (South African Government, 2022). The Bill of Rights stipulates that everyone is guaranteed the right to access an environment that is not harmful to their health and well-being and to have it protected for the benefit of current and future generations (South African Government, 2022). Apart from that, ISWD directly contravenes the National Waste Management: Waste Act 59 of 2008 and the Local Government: Municipal Systems Act 32 of 2000 (South African Government, 2022) which both prohibit the dumping of waste within undesignated spaces. Despite these above-mentioned pieces of legislation condemning ISWD, the practice remains rampant in South African urban areas to warrant more scientific research to understand the causes and extent of the problem, in order to develop effective solutions for the successful eradication of the practice (Godfrey et al., 2022; Rasmeni and Madyira, 2019; Polasi et al., 2020).

1.2 Rationale of the study

The rationale of the study was to fill the knowledge gap on ISWD in South Africa, particularly on issues related to spatial extent, household practices, and perceived impacts of ISWD. Given the legislative acts that prohibits ISWD in South Africa, it is necessary to investigate why the problem persists and is on the rise. The practice of ISWD within South Africa is a nationwide problem and a huge risk to human and environmental health (Bangani, 2023; Haywood et al., 2021; Rasmeni and Madyira, 2019; Rodseth et al., 2020). Most of the available literature on ISWD in South Africa primarily focus on the occurrence and prevalence of the practice in low-income neighbourhoods situated in large cities and metropolitans (Kubanza and Simatele, 2020), thus neglecting small and medium-sized towns where such information will be useful for municipalities. For example, studies by Abel (2014), Bangani et al. (2023), Kubanza and Simatele (2020), Ngobani (2020), Kimani (2020) were all conducted in low-income neighbourhoods in large cities and metropolitans in provinces such as Gauteng, Western Cape, and Eastern Cape. These studies are important, but their recommendations and findings might not be applicable to small and medium-sized towns as size and municipal financial capabilities differ, thus the need for more studies conducted in small and medium-sized towns. Studies on ISWD within the context of small and medium-sized towns are needed if town specific recommendations are to be developed.

As stated above, the bulk of the studies on ISWD in South African towns are in low-income areas, neglecting comparisons with high-income areas. The spatial segregation in South African towns resulted in the creation of low-income and high-income neighbourhoods, the former being white dominated and the latter being black African and/or coloured dominated. Such spatial segregation has implications on urban planning and management. Several studies have reported that waste collection and social development are disproportionate across income groups, yet this has not been tested within medium-sized towns (Haywood et al., 2021; Ngalo and Thondhlana 2023). The disparities in waste management between low-income and high-income areas need to be interrogated beyond examining occurrence only, but to also factor in human perceptions. Gathering views and human perceptions on ISWD can assist in developing recommendations that can address attitudes, beliefs, and behaviours linked to waste dumping. This is important since social norms have been reported to explain ISWD occurrence and prevalence within previous studies (Abel, 2014; Kimani, 2020; Sotamenou et al., 2019).

This study aimed to provide a unique perspective of the ISWD narrative and explored the practice from a dynamic viewpoint that sought to understand some of the underlying issues of ISWD such as its spatial extent and perception across an income gradient within and between two medium-sized towns. This is important because the practice of ISWD and its subsequent impacts transcend geographical locations and socio-economic class. Most small and medium-sized towns in South Africa have financial problems, thus issues of waste management, although important, tends to receive little to no attention. This is evident by the increased number of service delivery protests in the country (Enaifoghe, 2022). To address these challenges, a detailed assessment of ISWD's extent (dumpsite distribution, density, and location), household practices and perceptions are needed to develop effective measures to address such challenges.

1.3 The study context: Municipal solid waste management in South Africa

Approximately 79 million tonnes of solid waste are produced annually in South Africa, of which 46 million tonnes are generated at municipal level (Roberts, 2018; Polasi et al., 2020). Of these 46 million tonnes 12.7 million tonnes are produced by households and over 3 million tonnes go uncollected and often illegally dumped (Polasi et al., 2020). The South African National Environmental Management: Waste Act 59 of 2008which was amended in 2014 defines solid waste as any substance, material, or object that is unwanted, rejected, abandoned, or disposed of that the holder of the material considers to be of no use or because of the inability of the material to be reused or recycled (NEM: WA, 2008). The same act also classifies some solid waste materials as potentially hazardous and this includes organic and inorganic elements or compounds that can change their chemical composition or emit toxins after exposure to other elements when not treated properly (NEM: WA, 2014). Such solid waste materials have a detrimental effect on human and environmental health due to their contamination properties and toxicological impacts (NEMA: WA, 2014). With households generating the bulk of solid waste in urban areas, illegally dumped HSW can lead to environmental pollution and subsequently result in illnesses and even death within communities residing near dumpsites (Bangani et al., 2023). This therefore makes the problem of ISWD vital enough to require urgent attention to avert potential human health and environmental impacts.

In South Africa, the local government structures and municipalities have the responsibility to manage solid waste removal and disposal in areas that fall under their jurisdiction. Although

most municipalities provide waste removal services themselves several larger metropolitan and district municipalities often outsource this function to authorised waste management contractors (Johnson, 2004; Polasi, 2018). For example, the City of Johannesburg municipality outsources waste removal services to Pikitup, a waste management service provider which collects refuse in all formal households and businesses (City of Johannesburg, 2018). Although waste collection regularity varies from town to town, most towns in South Africa collect waste on a weekly basis, although this is not the case for poor struggling towns particularly within economically underdeveloped provinces such as Eastern Cape, Limpopo, and Mpumalanga provinces (Stats SA, 2017). Waste collection frequency is important if issues of ISWD are to be managed given that failure to collect waste timeously might result in households opting to dispose waste illegally.

Municipalities in South Africa face several challenges when it comes to waste management. Firstly, most municipalities struggle financially to collect waste regularly as they lack financial resources to develop proper waste collection structures (Rasmeni and Madyira, 2019). The problem is linked to few funding allocations from the national government as well as increasing urban population that results in urban expansion, thus the increase in urban spatial area necessitates a higher demand for municipal basic services provision. For example, Todes (2012) and more recently Polasi (2020) reported that the city of Johannesburg is rapidly expanding with new suburban nodes and edge cities developing. This spatial increase is a trend in most South African cities thus leading to increases in municipal services requirements and demand (Irvine et al.,2021). Besides, the lack of funding and increasing urban population and spatial extent, most municipalities struggle with resources such as waste collection vehicles as well as human resources (Chireshe et al., 2023). All these challenges result in ISWD, however, it is important to note that the challenges are more in small and medium-sized towns in contrast to large cities and metropolitan municipalities, perhaps because large municipalities have significantly large budgets and can make autonomous decisions (Stats SA, 2017).

There is a strong and direct correlation between households' satisfaction and socio-economic development, meaning that households located in underdeveloped areas under dysfunctional municipalities will likely express dissatisfaction regarding basic municipal service provision and vice versa (Stats SA, 2021; Polasi et al., 2020). A report by Stats SA (2016) indicates that approximately 75% of households in South Africa reported dissatisfaction and municipal

incompetency regarding basic municipal service provision i.e., waste collection services, infrastructural development, electricity, and sanitation. Issues pertaining to service delivery in South Africa have been ongoing, with service delivery protests occurring frequently across various provinces since 1994 (Alexander, 2010; Chikulo, 2016; Ndasana et al., 2022; Pieterse and Van Donk, 2013; Twala, 2014). A substantial number of these protests are in low-income neighbourhoods and are related to water and waste services (Chikulo, 2016; Kalina et al., 2023). In comparison, high-income areas are often better serviced or in most cases residents in these areas have the financial means to outsource waste services by paying private contractors to collect their waste (Alexander, 2012; Chikulo, 2016; Kalina et al., 2023; Mamokhere, 2019; Ngcamu, 2019). Therefore, issues related to waste management is South Africa are also linked to affordability, thus socio-economic aspects of the residents in a town. To address these challenges, the National Policy for the Provision of Basic Removal Services (DEA, 2010) was implemented to ensure waste removal services to indigent households at no cost, however the success of this policy varies across different provinces and municipalities (Polasi et al., 2020). The overall success of municipal solid waste management in South Africa relies heavily on several issues such as good governance, public participation, collaboration in policy making and sustainable attitudes and behaviours within households (Kimani, 2020; Mangoro and Kubanza, 2023; Ma and Hipel, 2016; Okot-Okumu, 2012; Polasi et al., 2020). Issues related to solid waste management at a municipal level within South Africa and around the world are complex, as waste generation is an inevitable process and individual/community behaviours, and attitudes are difficult to control thus presenting significant challenges to municipalities and communities alike.

1.4 Study area

1.4.1 Location, climate, and vegetation

The study was conducted in two South African towns, namely Makhanda (formally Grahamstown) located in the Eastern Cape province and Knysna located in the Western Cape province (Figure 1.1). Both towns were established during the 18th century. Makhanda (33°18′36″S 26°31′36″E) is an inland town situated northwest of Gqeberha (formerly Port Elizabeth) and southwest of East London. It was established as a military garrison in 1812 during the Anglo-Boer war and in 1820 the town was later established by English settlers (Reynolds and Reynolds, 1974). The town of Makhanda covers an estimated area of 65.1 km²

and is at an altitude of 550 m above sea level with warm and temperate climatic conditions and mean annual rainfall of 590mm (Botai et al., 2018). The vegetation type within Makhanda consists of subtropical thicket biome, with patches of South Coast Renosterveld, Afromontane Forest, Grasslands and Nama Karoo around the periphery of the town (McConnachie et al., 2008).

Knysna (34°02′08″S 23°02′56″E) is a coastal town located east of George and west of Plettenberg Bay within the Garden Route Area (Knysna Municipality, 2023). The town was established in the late 18th Century by English settlers who purchased the land from 17th century Dutch settler farmers (Parkes and Williams, 2004). Knysna covers an area of 108.77 km², at an altitude of 140.29 m above sea level with temperate climatic conditions and a mean annual rainfall of 875 mm (Martin and Burgess, 2023). The vegetation in Knysna consists mostly of indigenous forests, vast pine plantation forests, shrublands and sandstone fynbos biome (Knysna Municipality, 2020).

1.4.2 Population and demography

In Makhanda the town's population is approximately 70 000 people with 13 427 households and a population density of 1000 people per km² (Stats SA, 2021). In Knysna the population is approximately 73 835 people, with 16 374 households and a population density of 470 to 1000 people per km² (Knysna Municipality, 2023). The racial makeup of Makhanda consists of 79% black Africans, 11% coloured, 9% white, 1% Indian/southeast Asian identifying people (Stats SA, 2021). In Knysna, the racial make-up consists of 43% black Africans, 33% coloured and 24% white, identifying people (South African Municipalities, 2023). Regarding first languages spoken within the two towns in Makhanda most of the people 72% speak isiXhosa, 14% Afrikaans, 11% English and 3% other languages (Stats SA, 2021). In Knysna the majority 46% of people speak Afrikaans, 34% isiXhosa, 15% English and 5% speak other languages (Stats SA, 2021). Currently the only available statistics for population age groups and education level within both towns was recorded in the 2011 Census. According to the 2011 census report, 71% of Makhanda's population consisted of working age groups (15-64 years), 23% consisted of minors (0-15 years) and lastly 6% consisted of the elderly people (65+), (Stats SA, 2011). In Knysna 67% of the population consisted of working aged people (15-64 years), 25% consisted of minors (0-15 years) and 8% consisted of elderly people (65+). Education levels in Makhanda

consisted of 55% of people with primary education, 24% with secondary education, 15% with tertiary education and lastly 6% with no formal education, while in Knysna 71% of people had primary education, 13% with secondary education,13% with tertiary education and lastly only 3% with no formal education (Stats SA, 2011).

1.4.3 Economic structure and employment

The two towns' economic structures are significantly different. In Makhanda the economy is supported by private and public academic institutions including Rhodes University, Kingswood College, St Andrews and Diocesan School for Girls, tourism (National Arts Festival, Sasol Science Festival, The Standard Bank Youth Jazz Festival and The Grahamstown Foundation Festival), and private game reserves (Amakhala and Pumba game reserves) situated on the outskirts of the town (Hoefnagels et al., 2022; Makana Municipality, 2013). In contrast, Knysna's economy is centred on local service businesses, tourism (Boat cruises, forest tours, wine tastings, Whale and Dolphin watching) and exclusive private estates (Pezula, Fernwood, Westford, and Belvidere estates), making the town the epicentre of the Garden Route Area (Knysna Municipality, 2023). Unemployment within the broader local municipalities is higher in Makhanda than in Knysna. The unemployment rate within the Makana municipality is currently at 33% (Makana Municipality, 2022), compared Knysna's 26% (Knysna Municipality, 2022).

1.4.4 Residential area structure

Typical to Post-Apartheid South Africa, urban landscapes are segregated across income groups (Irvine, 2021; Unterhalter et al., 2004). Spatial segregation is a common feature of urban landscapes in South Africa due to the historical legacies of the Groups Urban Areas Act 41 of 1950, which forced urban residents to reside in strictly same racial and subsequently same income group areas (Horrell, 1963; Sithole et al., 2015). Within Makhanda, high-income residential neighbourhoods are situated in Makhanda West (Somerset Heights, Oatlands North, Sunnyside) near the Central Business District (CBD), whilst low-income neighbourhoods are situated in Makhanda East (Joza, Fingo, eRhini) on the periphery of the town far from the CBD (Hoefnagels et al., 2022; Kalina, 2023). Similarly, in Knysna high-income neighbourhoods (Thesen Island, Leisure Island, Brenton-on-Sea) are situated in the Southeastern and Southwestern parts of the town along the coastline near the CBD, and low-income

neighbourhoods (Concordia East and West, Rhobololo, Xolweni) are situated in the North Eastern outskirt regions of the town within the edge of forests and pine plantations (Strauss, 2019). Low-income residential areas within both towns are characterised by small residential plots, small gardens, dilapidated green infrastructure, untarred and undermaintained roads. Across both towns and consistent with most urban areas in South Africa, accessibility to low-income neighbourhoods is limited due to poor roads and congestion (Irvine et al., 2022).

1.4.5 Governance and basic service provision

The town of Makhanda is governed by the Makana local municipality within the Cacadu district municipality, Eastern Cape province (Makana Municipality, 2013). Makana municipality has a long standing record of poor and weak governance oversight characterised by allegations of corruption, bribery, appointment of corrupt and incompetent senior officials and maladministration, which have all culminated into poor service provision i.e., poor waste collection services, poor infrastructural development i.e., dilapidated roads, rundown buildings, and undermaintained water infrastructure (Kalina, 2021; Kalina et al., 2023; Irvine et al., 2021; Mxube, 2023). The municipality faces ongoing challenges related to refuse collection and between 2019 to 2021 the residents of Makhanda East conducted protests which resulted in court cases against the municipality (Mahr, 2019). Knysna is governed by the Knysna local municipality within Garden Route district municipality, Western Cape province (Knysna Municipality, 2023). The Knysna municipality has a record of good governance as seen in clean Auditor General audits and comparatively high levels of service delivery, which is typical for Western Cape province municipalities which are ranked the best nationwide (Western Cape Government, 2023). The waste collection rate within the Knysna municipality is currently 91% (Knysna Municipality, 2022). The municipality also provides services such as a garden waste drop-off points (Old Place Refuse site), wheelie bins, colour coded refuse bags (blue-garden waste, clear-recyclable, black-non-recyclables) (Knysna Municipality, 2023).

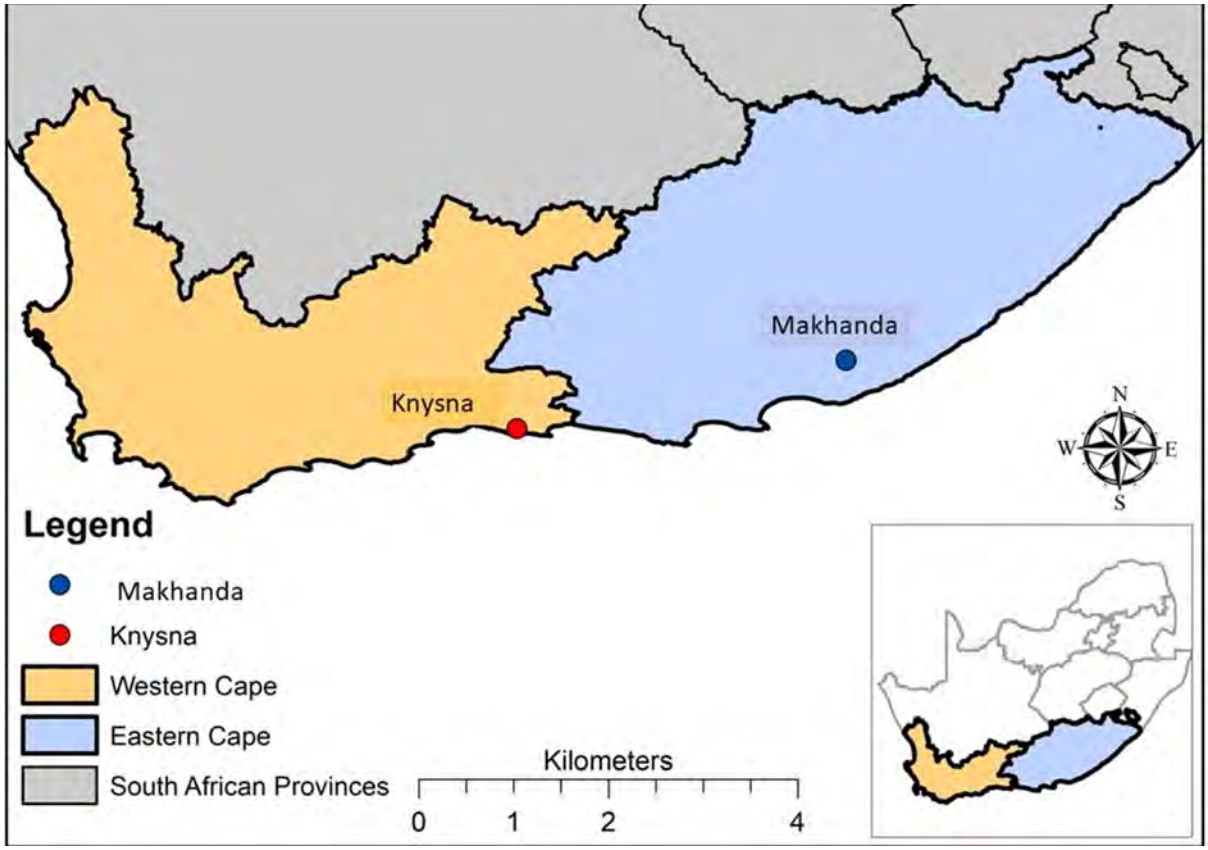

Figure 1.1. Map showing the location of Makhanda in the Eastern Cape province and Knysna in the Western Cape province of South Africa

1.5 Research aim and key questions

1.5.1 Research aims

The main aim of the study was to assess the spatial distribution, density, size, and composition of illegal dumpsites across and between low-income and high-income neighbourhoods in Makhanda and Knysna, South Africa. The study also examined households' practices regarding solid waste management and perceived causes and impacts of the practice on human and environmental health across low-income and high-income neighbourhoods within and between Makhanda and Knysna, South Africa.

1.5.2 Research questions

The key questions of the study included:

1. What is the spatial distribution, density, and size of density of illegal solid waste dumps in Makhanda and Knysna and how does this vary across low-income and high-income neighborhoods?
2. What is the composition of solid waste materials in illegal dumpsites in both Makhanda and Knysna?
3. What are households' practices, perceived causes and impacts of ISWD and how do they vary across low-income and high-income residents in Makhanda and Knysna?

1.6 Thesis structure

This thesis consists of five chapters. Chapter 1 provides the introduction, study context, rational of the study, and research questions. Chapter 2 provides a critical review of the literature, including key research themes related to ISWD. Chapters 3 and 4 address the specific objectives of the study, and each of the results chapters are written in the form of a manuscript that is ready for submission to a journal outlet. Therefore, the two results chapters consist of an introduction, study area, research methods, results, discussion, and conclusion. Chapter 5 provides conclusions and recommendations for the study. All references are at the end of the thesis. Given the journal paper manuscript style adopted in research Chapters 3 and 4, the Study area section is repeated to maintain journal requirements and reading flow. It should be noted that the study area section within Chapters 3 and 4 have been edited and shortened to only include relevant information to the arguments presented in each chapter.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Improper waste disposal is a complicated social, economic, and environmental problem that can most effectively be dealt with by recognising its underlying causes and subsequent impacts (Chireshe et al., 2023; Webb et al.,2016). Illegal solid waste dumping is a global challenge that is being faced by communities and governments globally (Valavandis, 2023). Waste generation is an inevitably human process, an estimated 2 billion metric tonnes of municipal solid waste (0.74kgs per day) are generated globally, and by 2050 it is expected to increase by 70% (Abubakar et al., 2023; Alves, 2023). Projected increases in solid waste generation will most likely lead to severe consequences especially within underdeveloped and developing countries where issues pertaining to waste mismanagement are more significant (Godfrey et al., 2022). A key challenge is that most of the waste will be disposed illegally thus causing economic losses and challenges as well as human and environmental health risks and challenges. Given the financial challenges faced by the global South, the impacts of ISWD are likely to be huge in less underdeveloped and developing countries than in developed countries. Several definitions have been put forward to define ISWD, and these include disposal of unwanted materials in inappropriate areas (Malinowski et al., 2015; Shabani et al., 2023). It is also viewed as the act of disposing waste at a non-permitted disposal area or site. Regardless of the definition, ISWD is an illegal act of disposing waste material. Most studies have shown that ISWD frequently occurs in open spaces, footpaths, along river riparian zones, street corners, commonages, and forest edges (Yang et al, 2019; Nagpure 2019).

2.2 Causes of illegal solid waste dumping

2.2.1 Rapid urban population growth

Currently the world's population is estimated to be approximately 7.6 billion people, by 2030 it is projected to reach 9 billion and in 2050 over 10 billion people of which more than 50% will consist of urban area populates (United Nations Department of Economic and Social Affairs, 2024). Currently 56% of the world's population lives in urban areas, and by 2045 global urban population will make up over 70% of the world's population (The World Bank, 2024). The speed and scale of current urbanisation and urban population growth presents numerous challenges for local and national governments. Such challenges include an accelerated demand for affordable housing, viable infrastructure (roads and public facilities) as well as increased

demand for basic services (waste removal, electricity, water, and sanitation), (United Nations Department of Economic and Social Affairs, 2024). There is an intrinsic relationship between waste generation, ISWD and rapid urban population growth (Abubakar et al., 2022; Sharholy et al., 2008; Tsheleza et al., 2019; Ugwuanyi and Isife, 2012; Valavandis, 2023). High urban population numbers subsequently result in larger volumes of waste generation particularly within households (Alam and Qiao, 2020). However, despite population growth and solid waste generation being a common trend globally increases in urban population within urban areas in the Global South in contrast to the Global North often presents more significant challenges related to waste management for local governments thus leading to ISWD prevalence (Abubakar et al., 2022; Fernando and Zutshi, 2023). Therefore, as population increases in urban areas, waste generation is likely to increase, thus increasing the chances of ISWD as waste management by municipalities becomes constrained. For example, a study conducted in Kano Metropolis in Nigeria found that high population density within the metropolis was one of the key factors contributing to prominence of ISWD (Naibbi and Umar, 2017). The above-mentioned study showed that within Kano Metropolis the rise in urban residents' population resulted in overwhelming volumes of municipal HSW generation, thus overwhelming the municipality services, and resulting in residents opting for ISWD (Naibbi and Umar, 2017). Rapid increases in urban population growth significantly impacts local municipalities specifically those in developing countries' ability to render consistent and sufficient waste collection services thus resulting in ISWD (Chen, 2010; Chireshe et al., 2023; Ichipi and Senekane, 2022;Valavanidis, 2023). A study conducted by Henry et al. (2006) within five cities in Kenya, namely Nairobi, Mombasa, Kisumu, Nakuru and Eldoret, showed that rapid urban population growth within these cities was leading to increased household solid waste generation and ISWD. A recent study by Toure et al. (2022) in the urban municipality of Gao in Mali showed similar findings and attributed ISWD to increased household population numbers and increased volumes of domestic waste being produced. Similar findings were also shown in India where an urban population growth of over 2000% in Delhi and Bangalore resulted in increased household waste generation and ISWD (Shahab and Anjun, 2022).

Within the context of South Africa, the management of municipal solid waste has been challenging due to population influxes specifically within low-income areas, which have drastically increased in post-apartheid and make up a significant portion of urban residents nationwide (Haywood et al., 2021; Ngema and Mbanga, 2022; Mangoro and Kubanza, 2023;

Muheriwe et al., 2023). Low-income settlements across South Africa are typically extremely congested and often difficult when it comes to accessibility if municipalities want to render waste management services (Department of Water and Forestry, 1994; Kalina, 2020). The geographical location of these settlements and their considerable number of occupants have provided municipalities with new challenges including the provision of sufficient waste collection services due to their inaccessibility (Department of Water Affairs and Forestry, 1994; Grangxabe et al., 2023; Haywood et al., 2021; Ngema and Mbanga, 2022). For example, a study conducted in the township of Clermont in KwaZulu Natal, South Africa, found urban congestion and high population density as being key factors leading to the prominence of ISWD within and around the area (Ngeleka, 2010). A study by Tsheleza et al. (2019) conducted in Mthatha, Eastern Cape, South Africa showed similar findings and attributed the prominence of ISWD particularly in low-income areas to high population and urban congestion. A recent study by Grangxabe et al. (2023), concurs and showed that ISWD within South Africa was most prominent in densely populated urban settlements specifically low-income settlements in contrast to sparsely populated high-income settlements. The prominence of ISWD in low-income settlements within South Africa and across the world is tied to issues related to socio-economic and environmental inequalities and injustices.

2.2.2 Socio-economic inequalities

Illegal solid waste dumping is often directly correlated with socio-economic inequalities which are often correlated with environmental injustices (Kubanza and Simatele, 2016). These inequalities are predominately faced by low-income residents worldwide which consist of majority previously marginalised social, economic, and political groups of people (Kalina et al., 2023). For example, in the United States studies on the intersection between ecological hazards and social inequality concluded that environmental racism in communities nationwide is tied to unsustainable solid waste management behaviours i.e., the practice of ISWD (Bullard, 2018; Byrne et al.,2012; Pellow, 2004). Within the United States, communities of previously marginalised people such as African Americas, Hispanics, and immigrants are disproportionality burdened by a range of environmental hazards including ISWD and polluting industries (Pellow, 2004). A study by McKinney (2017) in Palo Alto, California and San Francisco, United States showed that ISWD was prevalent within low-income neighbourhoods inhabited by previously marginalised groups due to service delivery discrimination and poor infrastructural development.

Dreau (2022) argues that the world's vulnerable communities continue to experience differential access to basic services, good infrastructure, and economic opportunities, thus limiting their options regarding solid waste management. A study by Nagpure (2019) conducted in Delhi, India showed that between 10-50% of waste generated by majority urban poor population groups is not collected by the government and thus ends up illegally dumped in vacant spaces and forested areas. Within an Africa context a study by Kubanza and Simatele (2016) conducted in Kinshasa, Democratic Republic of Congo highlighted the interconnection between socio-economic inequalities and ISWD. The study showed that marginalised urban poor communities of Kinshasa faced social and ecological challenges associated with poor waste collection services. The study revealed that the urban poor in Kinshasa lived in locations subjected to social and environmental inequalities including lack of waste removal services and poor infrastructure such as untarred roads (Kubanza and Simatele, 2016). Due to these socio-economic inequalities the practice of ISWD within low-income areas in Kinshasa was often employed as a method of waste disposal.

In South Africa, socio-economic inequalities are directly correlated to historical legacies of spatial segregation and systemic discrimination regarding municipal service provision (Abel, 2014; Polasi, 2018; Kimani, 2020; Haywood et al., 2021). The political and socio-economic landscape of South Africa is characterised by massive socio-economic disparities which include high unemployment rates, low education, and urban congestion among low-income previously marginalised populations (Turpie et al.,2008). South Africa's long-standing history of institutionalised racism exists in the form of the legacies left by colonialism and apartheid, this means that the effects of systematic discrimination against black African and coloured communities are still present in post-apartheid South Africa (Kalina, 2023; Kimani, 2020; Niyobuhungiro and Schenck, 2022). The forms of systematic discrimination experienced by previously marginalised groups in South Africa can be seen in how waste is managed within specific communities. Coloured and Black communities in South Africa are affected by poverty, unemployment, weak infrastructure, and poor service delivery, which all contribute to ISWD in low-income urban communities (Kimani, 2020; Ngalo and Thondhlana, 2023; Poswa, 2010). For example, an investigation into solid waste management in townships in Clermont KwaZulu Natal by Ngeleka (2010) found that townships were rife with illegal solid waste dumpsites due to poor service provision, poor infrastructure, and poverty. The study also noted that previously these communities had been marginalised and had little to no services including

waste collection services during apartheid (Ngeleka, 2010). Post-apartheid waste collection systems and services have remained inconsistent and ineffective within Clermont townships in comparison to high-income suburbs within the same town (Ngeleka, 2010). Recent studies by Bangani et al. (2023), Haywood et al. (2021), Ngalo and Thondhlana (2023) and Niyobuhungiro and Schenck (2022), all show similar findings that the historical legacies of systemic discrimination regarding socio-economic development and municipal service provision were some of the factors leading to the prominence of ISWD within low-income neighbourhoods inhabited by majority urban poor previously marginalised population groups. Most South Africans live in abject poverty, with most people struggling to afford essential goods, hence the income to buy refuse bags and to pay for private refuse removal services is often a challenge for households in low-income areas as compared to those in high-income areas (Abel, 2014; Haywood et al., 2021; Polasi, 2018).

2.2.3 Poor waste management systems

Solid waste management at a municipal level is an immense challenge that continues to be exacerbated by rapid urban population growth and subsequent increases in waste generation particularly within developing countries (Valavandis, 2023). Issues pertaining to solid waste management are a global problem experienced by both developed and developing countries (Valavandis, 2023). For example, in Naples Italy from 1994 to 2014 the Naples metropolitan area experienced long-running problems with municipal solid waste management and struggled to find an effective and satisfactory permanent solution for waste treatment and disposal resulting in a periodic crisis of ISWD (Triassi et al., 2015). In 2013 to effectively address the issues related to ISWD an incinerator was built in Acerra, near Naples, which processed 650 000 tonnes of household solid waste annually thus significantly reducing and subsequently leading to the discontinuation of ISWD across residential areas in Naples metropolitan areas (Triassi et al., 2015). Unfortunately, issues related to potential improvements regarding municipal waste collection services within underdeveloped and developing countries are more complex and difficult to address due to numerous issues including severe financial constraints (Bundhoo, 2018).

Within developing countries waste collection rates are often low and irregular thus forcing most residents particularly the urban poor to resort to illegal practices such as illegal dumping or

open burning of waste (Bundhoo, 2018; Ferranto and Torretta, 2019; Medina, 2012). One of the reasons for low collection rates in developing countries is the lack of funding, resulting in either insufficient numbers of refuse collection vehicles or if there are collection vehicles, they suffer from poor maintenance, regular breakdown (punctured tyres, lack of fuel) and are often out of service (Ferranto and Torretta, 2019; Godfrey et al., 2019; Tas and Belon, 2014). Within Africa a substantial amount of waste over 70% is generated in Sub-Saharan African countries, and approximately 55% of this waste is collected or treated formally, the remaining 45% goes uncollected, burned, dumped onto roadsides, footpaths, open fields, stormwater drains and riverbanks (Godfrey et al., 2019; Scarlet et al., 2015). For example, in Yaoundé, Cameroon poor waste collection services within the capital were reported as a key contributor to the prevalence of ISWD particularly within and around areas inhabited by the urban poor (Sotamenou et al., 2019). Similar findings were also shown by Din and Cohen (2016) in the Democratic Republic of the Congo, were ISWD is common due to municipal struggles related to waste collection service provision and budgetary constraints. Similar findings were also shown in studies conducted in large cities and capitals in Sub-Saharan countries such as Nigeria, Zimbabwe, Ethiopia, and Ghana were ISWD was attributed to inconsistent and in some cases non-existent municipal waste management systems (Lissah et al., 2021; Ichipi et al., 2023; Mlilo et al., 2021; Tassie et al., 2019).

Within the context of South Africa waste collection services are the responsibility of local municipalities who are required by the national government to supply waste removal services and disposal infrastructure such as drop-off facilities (South African Government, 2022). The Municipal Systems Act states that municipalities are responsible for the social and economic upliftment of local communities, and for ensuring universal access to essential services that are affordable to all (Local Government: Municipal Systems Act 32 of 2000). Municipalities according to the above-mentioned act must provide households with refuse bags and solid waste collection services on a weekly or biweekly basis. Although the Act stipulates that municipalities are responsible for providing these services often local municipalities have not been consistent and are arguably ineffective regarding solid waste management services (Nlaya, 2011). This has resulted in the rise ISWD in South African towns and cities (Abel, 2014; Haywood et al., 2021; Niyobuhungiro and Schenck, 2022).

Although some municipalities such as The Durban's eThekwini municipality has been reported to be providing households with refuse collection bags regularly, recent reports seem to suggest that residents in low-income neighbourhoods are receiving poor quality refuse bags which ultimately renders the bags ineffective for households to use (Tsinde, 2021). Residents also reported service delivery inconsistency and noted that the municipality often did not follow the waste collection service schedules and thus resulting in some households disposing their waste is nearby vacant areas (Tsinde, 2021). Similar findings were also shown in a study by Ngalo and Thondhlana (2023), conducted in Komani, Eastern Cape which reported that 48% of the household respondents attributed ISWD within the area to poor waste collection services. Polasi et al. (2020) argued that municipal failures regarding waste collection services are nuance and often tied to limited budgets that are not sufficient to fund waste collection systems i.e., purchasing more waste collection vehicles, wheelie bins and refuse bags for households particularly those in congested urban settlements. These failures in providing consistent and sufficient services force household to resort to alternative methods of waste disposal which often include unsustainable practices such as ISWD and burning (Abel, 2014; Dlamini et al., 2018; Kimani, 2020; Polasi, 2018).

2.2.4 High disposal costs

The costs of outsourcing private waste removal services are a luxury that very few residents can afford, particularly within underdeveloped and developing countries where most residents live within or just above the poverty line (United Nations, 2023). In 2019, extreme poverty was ranked exceedingly high, with over 8% of the world's population, 659 million people to be exact living in extreme poverty (United Nations, Economic and Social Council, 2023). In 2020, the disruptions caused by the COVID-19 pandemic led to an increase in extreme poverty for the first time in more than two decades and currently an estimated 1.1 billion out of 6.1 billion people across 110 countries surveyed by the United Nations were reported to be living in multidimensional poverty in 2023 (United Nations, 2023). Matos et al. (2012) argued that the greater the costs are of outsourcing waste removal services the greater the motivation for individuals to unlawfully dispose of their waste and the lower the incentive for disposing of waste appropriately. Within South Africa although municipalities are obligated to provide waste collection services, the services provided are often inconsistent and within some cases non-existent thus households often resort to alternative waste disposal methods (Haywood et al., 2021). To hire a Skip (larger portable dumpster) currently costs ZAR1150 per three days for

small skips and upwards of ZAR7500 for larger skips (Local Pros, 2024). Services such as those rendered by private companies such as RefuseMan (Cape Town), and Ght Recycling (Makhanda) can cost residents fees ranging from ZAR100-500 a month just for household solid waste collection. Some of the aforementioned services deal with specific waste categories and therefore residents in some situations must outsources different waste collection services from multiple providers, for example, Ght Recycling in Makhanda only collects recyclable waste products i.e., glass, paper, cans etc (Ght Recycling, 2019). These costs can only be afforded by a select few and most residents due to limited household income often adopt cost-free waste disposal methods such as ISWD (Abel, 2014).

2.2.5 Corruption

Issues regarding municipal failures to provide sufficient waste collection services particularly within developing countries are tied to corrupt government structures. According to Kimani, (2020) bribing and corruption play a key role in contributing to improper waste disposal. Large corporations and sometimes municipalities have been reported to strip funds from budgets and reduce the number of workers or even bribe them thus affecting the overall quality and efficiency of basic service provision include waste removal services (Abarte et al., 2018; Matsumoto and Takeuchi, 2018). For example, a study by Romano et al. (2021), in Italy, analysed the correlation between the environmental performance of waste management systems and the occurrence of corruption and maladministration. The results from the above-mentioned study found that provinces which had prominent levels of corruption and maladministration also had higher volumes of mismanaged urban waste per capita. Within an African context a survey conducted by Machel and Coombes (2011) across five Southern African countries namely Zimbabwe, South Africa, Malawi, Democratic Republic of Congo, and Mozambique, showed that over 60% of respondents confirmed that corruption was getting worse within their local and national government structures and added that bribery has become a standard practice when citizen and companies alike come in contact with government service agencies. Corruption and misadministration lead to significant impacts particularly for the urban poor who often experience the harsher end of incompetent, inefficient and in some instances non-existent government services (Kimani, 2020). In South Africa corruption within local and provincial government structures regarding basic service provision has been reported and directly impacts solid waste management systems (South African Government, 2022).

2.2.6 Social norms and lack of awareness

In most countries, particularly those within the Global South ISWD is often regarding as a minor issue by many people due to the social normalisation of dumpsite occurrence along roadsides, within vacant plots, vegetated areas, and riverbanks (Ichipi et al., 2023; Faure and Visser, 2014; Grobler et al., 2022; Yang et al., 2019). Social norms or social behaviours are influenced significantly by individual and community perceptions of certain behaviours. Perceptions can be defined as ideas or understandings of something; therefore, they can be regarded as the way in which something is understood or interpreted by someone based on their lived experiences (Huo and Khoo, 2022). Community perceptions of solid waste management and methods of waste disposal employed are often complicated (Kimani, 2020). Illegal solid waste dumping has become a socially normalised behaviour thus accelerating its occurrence across urban areas, particularly in low-income areas occupied by majority urban poor (UNEP, 2012). Humans are thought to be significantly affected by the people they often associate with (Emery and Watson, 2014). This implies that an individual is more likely to perceive improper waste disposal as an acceptable way of getting rid of their refuse when their close friends and community members do not perceive it as a critical concern or if their close friends deliberately take part in improper disposal (Kimani, 2020). Therefore, social expectations and the actions of people nearest to an individual play a critical role in deciding how probable it is that a person will embrace or oppose improper solid waste disposal i.e., ISWD and burning (Shinkuma and Managi, 2018).

When dumping waste in a specific spot in a neighbourhood is perceived as acceptable and permissible, it may lead to more people dumping waste illegally (Kimani, 2020). The social disorganization theory is often employed to example human behaviours particularly the social normalisation of unsustainable practices. The theory of social disorganisation works to enhance understanding of why certain societies experience issues related to high crime rates and high rates of environmental pollution caused by ISWD (Huisman and Van Erp, 2013). Increased crime rates and the prominence of illegal dumpsites often characterise socially disorganised societies (Massari and Monzini, 2004). However, it should be noted that in most cases this disorganisation in societies is also shaped by other factors such as poor municipal services, poverty, lack of education and historical legacies of socio-economic and spatial discrimination (Sahramäki et al., 2015). Communities which have high unemployment rates, poverty, and low education levels are unlikely to be concerned with issues of community cleanliness and

community milieu, mainly because livelihoods take precedent therefore activities like ISWD become a social norm (Abel, 2014, Kalina, 2020). Barnett and Mencken (2002) argue that communities with low-income levels do not have the financial means and human capital to protect community values, principles, and interests. A socially disorganised community often does not have the capacity to stop or prevent crime from taking place, mainly because of poor communication and a sense of lack of duty imbedded within community members on the proper management of solid waste (Brandt, 2017). Perpetrators of crimes such as illegal dumping, for instance, might exploit this aspect within a community and these crimes may go unchecked due to social disorganisation (Kimani, 2020).

A study conducted in Egypt by Lashari et al. (2021) showed that households within Ward 32 in Quetta city, were occasionally observed dumping their household waste along roadsides and even within streets, residents were reported to not have regarded these practices as improper or even unlawful. Similar findings were shown in a study by Tahulela, (2017) which was conducted in Khayelitsha, Western Cape, the results of the study showed that residents reported ISWD as being a result of social norms and a lack of care amongst communities regarding the promotion of clean spaces. Similar findings were also shown within recent studies by Bangani et al. (2023) and Ngalo and Thondhlana, (2023), both in the urban areas in the Eastern Cape, which reported significant numbers of household respondents stating that ISWD was because of social norms and lack of awareness regarding sustainable waste management behaviours. Hasan (2004) argued that public awareness and education are key to waste management but only when they are combined with effective legislation, strong technical support, and adequate funding and concludes that sustainable waste management in general is a complex and holistic process.

2.3 Illegally dumped solid waste composition

Most of the solid waste generated within urban areas is created at a household level (Sharma and Jain, 2020). The major components of municipal household solid waste include food waste, paper, plastic, rags, metal, and glass, although demolition and construction debris often are included in collected waste, as are small quantities of hazardous waste, such as electric light bulbs, batteries, automotive parts, and discarded medicines and chemicals (Sharm and Jain, 2020; UN-HABITAT, 2010). Municipal solid waste generated at household level can be categorised into four types based on solid waste material composition (Eberhard, 2018). These

four types are namely recyclable waste (e.g., paper, glass, plastic, and metals), compostable/organic waste (e.g., food waste, fruit, and vegetable waste), toxic waste (e.g., paints, pesticides, medicines, used batteries) and lastly hazardous waste (e.g., blood-stained cotton, disposable syringes, and sanitary napkins) (Eberhard, 2018). When untreated within formal sectors i.e., collected and safely disposed of in landfills or incinerated, solid waste materials generated within households pose significant often negative impacts to environments, humans, and economic structures (Kimani, 2020).

Knowledge in household solid waste composition is important as it can inform the designing of effective waste management plans (Suthar and Singh 2015). A study in Dehradun city in India reported that household waste ranged from 24.5 to 4147.1 grams per day (Suthar and Singh 2015). In Botswana, Dikole and Letshwenyo (2020) reported low waste generation rates of 0.038 kg per day in low-income areas compared to 0.364 kg per day in high-income areas. In the same study, composition food waste was 46% in low-income areas compared to 80% in high-income areas per week. In Hanoi city of Vietnam, the largest waste composition was food and garden waste followed by plastic and paper (Phuong et al., 2021). All these studies seem to confirm that households in urban areas generate a lot of waste, but composition is mainly of food and garden waste. This is expected since most urban residents are in residential areas, thus explaining why food and garden waste dominate waste composition.

2.4 Impacts of illegal solid waste dumping

The impacts of ISWD are varied, however they are mostly categorised as environmental (ecosystem health and services), social (human health and wellbeing), and economic (related to costs of clean-ups) impacts (Kimani, 2020).

2.4.1 Environmental impacts of ISWD

The waste in illegal dumpsites has severe impacts on the surrounding environment. Gahill (2020) argues that the practice of ISWD has severe consequences for the soil at the dumpsites by altering the soil's pH and polluting groundwater and surface water. Frequent ISWD is identified as causing abnormal concentrations of heavy metals, hydrocarbons, nitrogen, and volatile organic compounds, such as solvents or gasoline, in the surrounding soils and water (Glanville and Chang, 2015). Dumpsites contaminate soils, pollute water, change vegetation

composition, and thus affect the functionality of ecosystems leading to land degradation (Vaverková et al., 2019). Illegal dumpsites disturb the growth and composition of plant species and create space for synanthropic and invasive plant species (Dąbrowska et al., 2018; Koda et al., 2018). These often spread beyond dumpsites and end up affecting the species composition of natural ecosystems. A study by Vaverková et al. (2019) attributed invasive plant species prominence and land degradation within Malé Leváre, Malacky District, Bratislava Region, Slovak Republic, to illegal dumpsites and illegal landfills across the area.

Illegal dumpsites containing household solid waste materials have also been shown to lead to severe surface water and air pollution (Triassi et al., 2019). A study in Gwagwalada area, Nigeria showed that ISWD within residential suburbs in the area resulted in the severe pollution of the Usuma river and thus leading to outbreaks of waterborne diseases (Ozoh et al., 2021). Similar findings were also shown in a study by Malinowski et al. (2015) which showed that the rapid occurrence of ISWD across the city of Krosno, Poland was leading to the contamination of watercourses. A recent study by Bangani et al. (2023), reported that ISWD within low-income areas in Mthatha, Eastern Cape, resulted in changes in water temperature, oxygen levels, pH, nitrite content, conductivity, and Escherichia coli levels. Dumpsite presence also significantly impacts air quality, as dumpsites contain organic materials that when decomposition processes occur, they release harmful toxins. A study by Park et al. (2013) conducted in the metropolitan area of Seoul, South Korea found that illegal dumpsites emitted PM_{10}, $PM_{2.5}$, and PAHs, which are particles that are microscopic and can pass through the throat and nose enter the lungs leading to life-threatening diseases.

2.4.2 Human health impacts of ISWD

Illegal dumped SW materials not only affect natural environments and lead to environmental contamination but also impact the health and wellbeing of communities residing in areas where the practice is prevalent. Data collected by the United Nations showed that diarrhoea and acute respiratory infections were significantly higher for children living in households near solid waste dumps (Matheson and Mooji, 2019; UN-HABITAT, 2010). Dumpsites generates various externalities that affect the quality of human life by polluting land, air, and water as mentioned in the subsection above. In 1994 a major flood occurred in India, resulting in an outbreak of a plague-like disease, and this was linked to uncollected and illegally dumped waste which

blocked drains resulting in the flood (UN-HABITAT, 2009). Annual floods in urban environments in East and West Africa are often attributed to uncollected and illegally dumped household waste materials containing non-biodegradable materials such as plastics which often lead to drain blockages (UN-HABITAT, 2009). In 2011 in Accra, Ghana, a massive flood occurred due to uncollected plastic materials that were washed up during heavy rains and ended up clogging gutters and storm drains. This flood resulted in the death of fourteen people and affected 43,000 people and destroyed approximately 17,000 homes (UNEP, 2011). More recently within the context of Southern Africa studies by Mutemani et al. (2020) and Ndebele-Murisa et al. (2020) conducted in Zimbabwe reported that flooding in cities such as Harare, Bulawayo and Chitungwiza were mostly due to municipal solid waste mismanagement.

Illegal dumpsites also offer a breeding ground for pests and diseases (Chen, 2010; Chireshe et al., 2023; Lethbridge, 2017). Pests such as rats are a common occurrence within illegal dumpsites (Ruffel and Dawson, 2019). Pests such as rats and mosquitos can transmit life-threatening diseases to humans such as rat fever, rabbis, yellow fever, malaria, and encephalitis (Kimani, 2020; Ruffel and Dawson, 2019). Rats are also a nuisance within households because of their destructive nature and can cause significant property damage through gnawing and burrowing, in ceilings and walls (Centre of Disease Control and Prevention, CDC, 2010). Dumpsites prevalent across residential areas also expose residents to transmittable infectious diseases. Dumpsites often contain sharp objects, such as used needles, razors and glass shards which can inflict deep wounds in people and potentially lead to the transmission of various diseases and bacterial infections (Kimani, 2020). Unfortunately, there are no studies of the potential transmission of infectious diseases from cuts inflicted by objects within dumpsites. However, it can be speculated that dumpsite materials such as used syringes have the potential to result in the spread of infectious diseases.

2.4.3 Economic impacts of ISWD

Illegal dumpsites prevalence affects the natural scenery of a landscape and causes negative aesthetic impacts, thus leading to a reduction in property value (Kimani, 2020). Dumpsite prevalence also leads to economic losses associated with the tourism sectors and costs associated with dumpsite clean-ups (Hayati et al., 2020). The pollution of marine ecosystems by illegally dumped solid waste materials affects marine life and leads to the loss of

biodiversity within freshwater and saltwater aquatic systems (Corraini et al., 2018). Waste materials from illegal dumpsites are often washed into waterways and these materials have been reported to lead to considerable damage to fishing boats thus resulting in losses within the fishing industries (Hayati et al., 2020). Aside from damaging fishing equipment due to the presence of foreign objects in water ways ISWD also leads to decreases in overall fish populations due to water pollution which as previously mentioned alters water pH and oxygen levels thus limiting the ability of most fish species to survive (Abubakar et al., 2022; Bangani et al., 2023; Joubert, 2021). In 2017 the United Nations estimated that ISWD pollution accounted for worldwide economic losses of US$622 million per year from tourism and US$51 million per year from fishing fleets (Department of Environment and Science, Queensland, 2021).

The presence of illegal dumpsites within urban areas often leads to significant economic costs associated with dumpsite clean-ups. The United Kingdom Environmental Agency estimated that £100-150 million of government revenue was used annually for cleaning up illegally dumped waste annually (Ichninose and Yamamoto, 2011). In 2017 the cost of clearing up illegal solid waste dumpsites in San Francisco was over $20 million (Baltimore City Department of Public Works, 2017). Within South Africa, municipalities spend millions of rands worth of costs associated with illegal dumpsite clean-ups (Polasi, 2018). The City of Johannesburg CoJ municipality was reported to spend upwards of R58 million every year on cleaning up illegal solid waste dumpsites (Polasi, 2018; Polasi et al., 2020). The costs associated with illegal dumpsite clean-ups are not only faced by municipalities but also by landowners, companies, and NGOs (Becker, 2013). Sewerage companies spend approximately US$2 million annually on fixing cleaning equipment damaged by inappropriate materials blocking drains these materials are mostly from washed up illegal dumpsites (Jacques, 2020). Taken all together, the social, economic, and environmental impacts of ISWD are substantial, and interventions are needed to minimise the challenges associated with them. Therefore, the following chapters explore not only the spatial extent but practices and perceptions regarding ISWD across low- and high-income areas within two medium-sized South African towns. But first the subsection below will explore some measures that have been taken to try and mitigate the ISWD crisis, and their effectiveness or lack thereof.

2.5 Illegal solid waste dumping management

Several initiatives have been put in place to try and address the problem of ISWD. The US, Environmental Protection Agency (1996) formulated a guiding handbook to tackle the problem of ISWD. The guidebook proposed four different interventions for ISWD, and these are as follows: (i) leadership and support by local municipal officials, (ii) cooperation among authorities, communities, and industries, (iii) publicising successes, and lastly (iv) integrated approaches that involve site maintenance and control, community outreach and involvement, targeted enforcement, and frequent program measurement (US, Environmental Protection Agency, 1996). However, at the onset, specifically within the context of developing countries the enactment of laws and legislation is important when it comes to managing the problem of ISWD. South Africa has several laws and policies that try to address the problem of ISWD. For example, the National Environmental Management: Waste Act of 2008, amended in 2014 is the main legislation that governs how waste should be managed in South Africa. The Act promotes integrated management of waste based on a waste management hierarchy that include waste reduction of waste and safe waste dispersal and treatment (NEM: WA, 2014).

Apart from laws and legislations, knowledge dissemination is important. Illegal dumping of waste is a social problem that can sometimes be managed through information dissemination to communities. This could be in the form of awareness campaigns, pamphlets, and even media communication via social media platforms, new broadcasts, newspaper articles and or radio. Ngalo and Thondhlana (2023) reported that dumping was also linked to lack of information and suggested that the municipality should play a role in awareness raising campaigns to inform residents about the dangers of ISWD. Although fines and penalties can be used to discourage ISWD, some studies have suggested that penalties only work if dumping resources such as dumping bins are available in an area. In China, Hao, and Xu (2023) reported that penalties seem to have enforced a culture of waste separation and positive influence when it comes to waste, a trait that might results in reduced ISWD. The study also reported that penalties had a direct impact on waste behaviour amongst residents. Therefore, penalties and fines can be used with mixed results when it comes to managing ISWD. The use of installing bins on strategic dumping areas can be an effective ISWD management strategy because waste dumping is also associated with time and financial resources to drive to dumpsites.

Robinson (2023) reported that the increase in disposal bins in an area has a convenience effect of waste disposal behaviour thus such it can prevent dumping. Linked to increasing waste disposal bins as a management strategy is the issue of clean-up campaigns as an effective measure to manage ISWD. For example, the Department of Environmental Quality in Oregon state USA (2024) utilizes various clean-up techniques as interventions for ISWD. The Oregon government has multiple programs in place including but not limited to Adopt a dump, river, neighbourhood, and street programs as well as Stop littering and vandalism volunteering programs that are all targeted to minimise and eradicate ISWD (Oregon Government, 2024). However, it is important to note that clean-up campaigns are a post-reaction strategy as compared to awareness and addition of bins which are pre-reaction strategies. All these strategies need human and financial resources for them to be successful. Municipal personal must also be willing to implement these strategies, thus political stability and overall competency is extremely crucial in formulating interventions for ISWD.

CHAPTER THREE : THE SPATIAL EXTENT AND COMPOSITION OF ILLEGAL SOLID WASTE DUMPS ACROSS AN INCOME GRADIENT IN MAKHANDA AND KNYSNA, SOUTH AFRICA

3.1 Introduction

Amidst rapid urban population growth, limited budgets, and poor infrastructural development within urban areas, solid waste (SW) management is becoming a global challenge, particularly within cities in the Global South (Viljoen et al., 2021; Sujauddin et al., 2008; Zohoori and Ghani, 2017). Research has shown that the rapid increases in urban populations has led to substantial increases in SW generation amongst urban residents subsequently leading to a rise in illegal solid waste dumping (ISWD) (Amasumo and Baird, 2016; Henry et al., 2006; Naibbi and Umar, 2017). The term ISWD is used to describe the unlawful and deliberate disposal of rubbish on public and private land that has not been designated as a site for waste disposal (Bangani et al., 2023; Kimani, 2020; US EPA, 1998). The practice of ISWD is also referred to as indiscriminate dumping, fly tipping, fly dumping, and midnight dumping (Dladla et al, 2016; Mississippi Department of Environmental Quality, 2023; Niyabuhungiro and Schenck, 2021; Ozoh et al., 2021). Despite global efforts to tackle ISWD through various initiatives such as developing national policies, municipal bylaws and public awareness campaigns, the practice remains persistent within urban areas thus causing social, economic, and environmental challenges (Haywood et al., 2021; Kimani, 2020; Kumar et al., 2017). Household solid waste materials have been reported as one of the most prominently dumped solid waste materials globally (Valavanidis, 2023).

Globally, it has been projected that by 2050 the amount of SW generated by urban households will outpace population growth by more than double (Alves, 2023; Kaza et al., 2018). The above-mentioned projection is likely to exacerbate the problem of ISWD particularly within developing countries across the Global South (Alves, 2023; Kaza et al., 2018;). For example, only 33% of global municipal household waste is managed sustainability, an astounding 67% of municipal waste ends up within landfills or in illegal dumpsites (Alves, 2023; Chen et al., 2020; Kaza et al., 2018). The factors leading to ISWD are vast and vary across geographical regions (Valavandis, 2023). For example, studies done within developing countries, found that factors such as poor municipal services, dysfunctional national and local governments, poor

education, and convenience to mention but just a few have been reported to lead to the practice of ISWD (Abel, 2014; Haywood et al., 2021; Kuermerle, 2021; Ngcamu, 2019; Sethunya and Mlambo, 2022; Tsheleza et al., 2019). Studies conducted within African countries such as Zimbabwe, Nigeria, Kenya, South Africa, and Cameroon corroborate the above-mentioned factors causing ISWD (Dzwanda and Moyo, 2022; Ichipi and Senekane, 2023; Kathambi and Ogutu, 2022; Ngalo and Thondhlana, 2023; Sotamenou et al., 2019).

Illegally dumped household solid waste (HSW) consists of a variety of materials, that when not treated properly pose significant impacts on economies as well as human, animal and environmental health and functionality (Haywood et al., 2021). Household solid waste composition consists of four main waste type categories, namely recyclable, non-recyclable, compostable and hazardous waste (Eberhard, 2018). Previous studies within urban areas have reported that the typical waste materials encountered within illegal dumpsites vary but mostly include food scraps, garden trimmings, plastics, and construction debris (Dikole and Letshwenyo, 2020; Mbiba, 2020; Nell et al., 2022). Data collected by the United Nations showed that long term exposure to illegal dumpsites caused diarrhoea and acute respiratory infections within children (UN-HABITAT, 2010). Similarly, a study conducted by Bangani et al. (2023) in Mthatha, Eastern Cape province, South Africa reported that residents living close to dumpsites experienced illnesses related to high E. coli and nitrate levels in the Mthatha river, due to water contamination from illegal dumpsites. The practice and of ISWD particularly within urban and peri-urban areas across Southern Africa has also been reported to result in livestock illness and subsequent death (Kimani, 2020). Studies conducted in Botswana and South Africa reported livestock death, particularly cattle, goats, and donkeys, from ingesting plastics and other toxic compounds present in illegal dumpsites (Kimani, 2020; Muzenda et al., 2019; Nongcula et al., 2020). The practice of ISWD also leads to significant economic losses for example the Johannesburg city municipality in South Africa spent R58 million on cleaning ISWD in 2018 (Polasi, 2018). The avoidable use of copious quantities of municipal funds to tackle ISWD negatively impacts local and national economies as it leads to tax raises and budget cuts within other sectors (Ferronato and Torretta, 2019). From a social standpoint, dumpsites prevalence within low-income areas have also been reported to lead to increases in crime as dumpsites offer coverage for criminals to attack unsuspecting residents at night (Haywood et al., 2021; Kimani, 2020; Niyobuhungiro and Schenck, 2022; Ruffel and Dawson, 2019).

The causes and impacts of ISWD are vast and therefore require closer examination especially from a spatial perspective that examines dumpsite location, distribution, size, vicinity, and waste composition across different income group areas within South African towns. There is extraordinarily little knowledge on ISWD spatial extent, occurrence, and composition across an income gradient (low- and high-income areas) in post-apartheid South African towns. Most studies on ISWD in South Africa have been conducted in large metropolitans such as Johannesburg and Cape Town and such studies were exclusively conducted within low-income areas, thus a comparison across different income groups in medium-sized towns is needed (Haywood et al., 2021; Kubanza, 2021; Muzenda et al., 2019; Ngeleka, 2010; Polasi, 2018; Omotoya et al., 2020). The few available studies on ISWD within medium-sized towns have primarily focused on its prominence in low-income areas, yet none of the studies have examined ISWD's potential occurrence and impacts in high-income areas (Etengeneng, 2012; Niyobuhungiro and Schenck, 2022; Ngalo and Thondhlana, 2023). Thus, the motivation of the study was to fill the current gap in academic literature on ISWD within the context of the spatial extent, distribution, location, composition, and dumpsite sizes across and between two medium-sized towns' low- and high-income residential neighbourhoods.

Examining ISWD through an income gradient perspective is crucial because there is an intrinsic relationship between sustainable and unsustainable HSW management behaviours and socio-economic status specifically amounts of HSW generated and the methods of disposal employed (Khan et al., 2016). Although high-income residents generate larger volumes of waste, they also have the socio-economic advantage of having regular waste collection services and can afford private waste removal services in the event of municipal failures to provide consistent services (Abel, 2014; Kalina, 2023; Nell et al., 2022). However, it should also be noted that this is a general perception and therefore the study looked at the validity of the argument that high-income households have the economic advantage regarding household waste management options. Unfortunately, the same however cannot be said for low-income households who disproportionately experience poverty, reside in congested neighbourhoods, have high unemployment rates, and poor infrastructure which significantly impacts residents' capacity to explore other methods of waste disposal thus leading to ISWD (Abel, 2014; Haywood et al., 2021; Kimani, 2020). Therefore, the study examined the spatial extent of ISWD across different income neighbourhoods within and between Makhanda and Knysna, South Africa.

3.2 Study area

The study was conducted in two medium-sized South African towns, namely Makhanda (formally Grahamstown) located in the Eastern Cape province and Knysna located in the Western Cape province (Figure 3.1). Makhanda is an inland town situated northwest of Gqeberha (formerly Port Elizabeth) and southwest of East London (33°18′36″S 26°31′36″E). The town of Makhanda is governed by the Makana local municipality within the Cacadu district municipality, in the Eastern Cape province of South Africa (Makana Municipality, 2013). In contrast Knysna (34°02′08″S 23°02′56″E) is a coastal town located east of George and west of Plettenberg Bay within the Garden Route Area (Knysna Municipality, 2023). Knysna is governed by the Knysna local municipality within the Garden Route district municipality, Western Cape province (Knysna Municipality, 2023). The town of Makhanda covers an estimated area of 65.1 km² and is at an altitude of 550m above sea level with warm and temperate climatic conditions and mean annual rainfall of 590mm (Botai et al., 2018). In contrast Knysna covers an area of 108.77km² and is at an altitude of 140.29m above sea level with temperate climatic conditions with a mean annual rainfall of 875mm (Martin and Burgess, 2023). The vegetation type within Makhanda consists of subtropical thicket biome, with patches of South Coast Renosterveld, Afromontane Forest, Grasslands and Nama Karoo around the periphery of the town (McConnachie et al., 2008). Vegetation cover in Knysna consists mostly of indigenous forests, vast pine plantation forests, shrublands and sandstone fynbos biome (Knysna Municipality, 2020).

Makhanda's population is approximately 70 000 people with 13 427 households and a population density of 1000 people per km² (Stats SA, 2021). Knysna's population is approximately 73 835 people, with 16 374 households and a population density of 470 to 1 000 people per km² (Knysna Municipality, 2023). The towns' economic structures are significantly different. In Makhanda the town's economy is supported by renowned private and public academic institutions (Rhodes University, Kingswood college, St Andrews, and Diocesan School for Girls), tourism (National Arts Festival, Sasol Science Festival, The Standard Bank Youth Jazz Festival and The Grahamstown Foundation Festival), and private game reserves (Hoefnagels et al., 2022; Makana Municipality, 2013). Knysna's the economy is built on local service businesses, tourism (Boat cruises, forest tours, wine tastings, Whale and Dolphin watching) and exclusive private estates such as Pezula, Fernwood, Westford, and Belvidere,

making the town the epicentre of the Garden Route Area (Knysna Municipality, 2023). Unemployment within the broader local municipalities is higher in Makhanda (33%) than in Knysna (26%).

Consistent with post-apartheid South African urban landscapes, both towns' residential areas are segregated across income group lines (Irvine, 2021; Unterhalter et al., 2004). Spatial segregation is a common feature of urban landscapes in South Africa due to the historical legacies of the Groups Urban Areas Act 41 of 1950, which forced urban residents to reside in strictly same racial and subsequently same income group areas (Horrell, 1963; Sithole et al., 2015). Within Makhanda, high-income residential neighbourhoods are situated in Makhanda West (Somerset Heights, Oatlands North, and Sunnyside) near the Central Business District (CBD), whilst low-income neighbourhoods are situated in Makhanda East (Joza, Fingo and eRhini) on the periphery of the town (Hoefnagels et al., 2022; Kalina, 2023). Similarly, in Knysna high-income neighbourhoods such as Thesen Island, Leisure Island and Brenton-on-Sea are situated in the Southeastern and Southwestern parts of the town along the coastline near the CBD, and low-income neighbourhoods (Concordia East and West, Rhobololo and Xolweni) are situated in the North Eastern outskirt regions of the town within the edge of forests and pine plantations (Strauss, 2019). Low-income residential areas within both towns are characterised by small residential plots, small gardens, dilapidated green infrastructure, untarred and undermaintained roads. Across both towns like most urban areas in South Africa accessibility to low-income neighbourhoods is limited due to poor roads and congestion (Irvine et al., 2022).

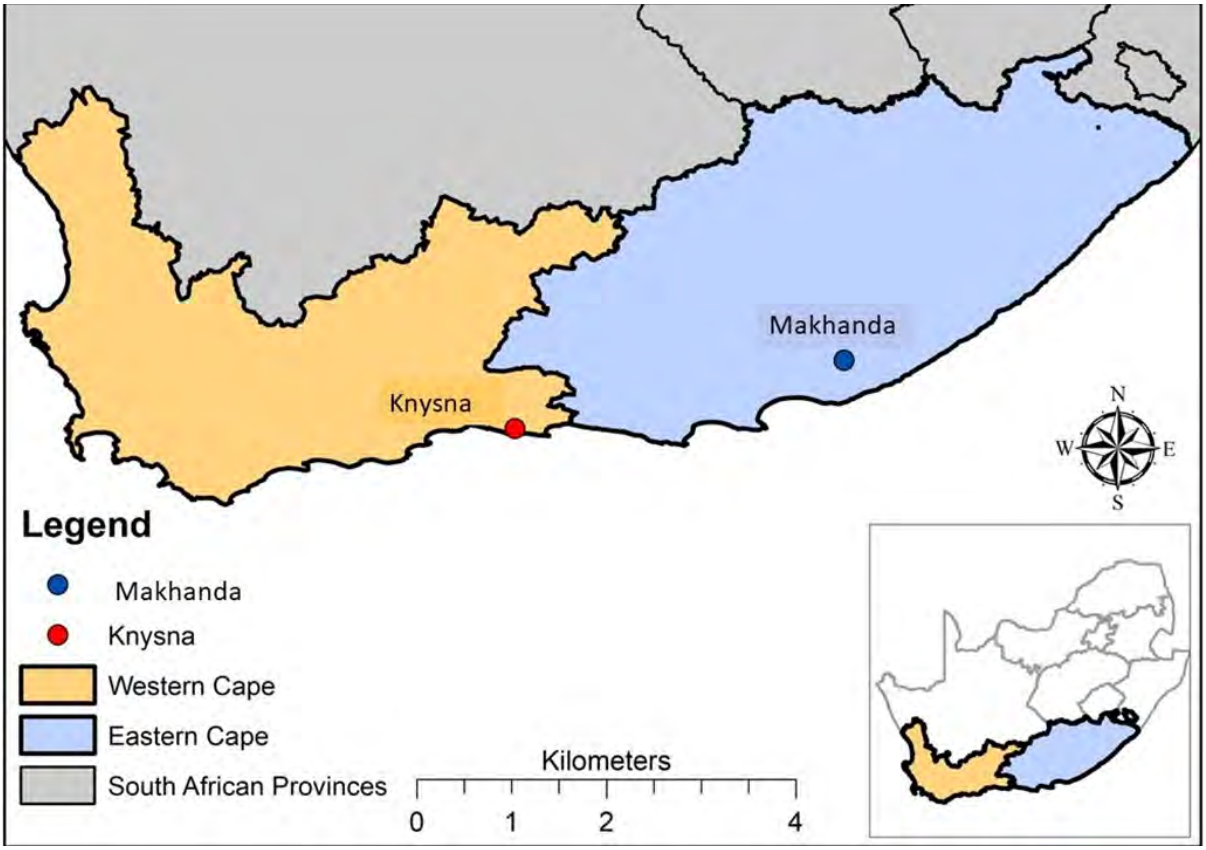

Figure 3.1. Location of Makhanda and Knysna in the Eastern and Western Cape provinces of South Africa

3.3 Research methods

3.3.1 Data collection

Street and off-street surveys with the aid of dumpsite waste categorisation templates were used to collect data on dumpsite location, sizes, vicinity, and composition across the study town's low- and high-income residential areas. Street and off-street surveys were conducted through driving and observing both sides of the road in each residential area to identify dumpsites. Upon encountering a dumpsite, a survey template was employed to capture dumpsite information. Before commencing street and off-street surveys, Google Earth Pro satellite imagery was used to identify accessible roads across the two towns' low- and high-income residential areas. In this study all accessible street and roads were surveyed in both towns. Street and off-street surveys were employed to collect data on dumpsites because the method is more accurate compared to using satellite imagery which is not sufficient to accurately identify dumpsites especially in areas with dense vegetation and steep terrains.

At each identified dumpsite, the following information was captured, (1) the dumpsite geographic coordinates (using a global positioning system-GPS device), (2) dumpsite size (categorised as small, medium, large), (3) features near/within the vicinity of dumpsites (categorised as school, shop, housing, electric mast, roadside, commonage, wetland, and valley), and (4) dumpsite solid waste composition (categorised as household, garden, construction waste). Dumpsite size measurements were done using visual estimates and categorised as small, medium, and large following estimates suggested by Kimani (2020) and Malinoswki and Wolny-Koladka (2015). The visual estimates used a length scale with dumpsites categorised as small (below 10 m), medium (10-30 m) and large (above 30 m). Dumpsite waste composition was recorded based on three commonly used waste material categories of household, garden, and construction waste (Eberhard, 2018). At each dumpsite, visual on-site observations were done to categorise the dumpsite waste composition. In addition, dumpsite photography was captured using a camera and the photos were used to visually identify the dumpsite waste composition. Household waste materials included single-use plastics, food scraps, sanitary products, diapers, plastic bottles, cardboard, paper, and glass (Fadhullah et al., 2022; Sharm and Jain, 2020; Yoada et al., 2014). Garden waste materials included grass clippings, branches, flowers, and other organic materials (Eberhard, 2018). Construction waste included materials such as cement, concrete, tile fragments and flooring materials (Kimani, 2020). Data related to landmark features near dumpsites was captured, e.g., proximity to public spaces such as schools, shops, housing, electric mast, clinics, wetlands, commonages, and valley. In addition, activities occurring near and within dumpsites such as children playing, livestock grazing, domestic pets foraging, and evidence of burning/fire were also recorded on the survey template.

3.3.2 Data analysis

Quantum Geographic Information System (QGIS) software was used to generate high resolution maps of dumpsite location, distribution, and sizes. The task was performed through the creation of attribute tables using Microsoft Excel for each study town. The tables consisted of information on dumpsite location, geographic coordinates, activities, and size. The table data sets were then layered over a satellite image base map of Makhanda and Knysna's residential areas. Heat maps were created to analyse dumpsite density across different income areas within and between the two towns. Dumpsite size distribution was analysed through the creation of dumpsite size maps, recorded small, medium and large dumpsites were plotted on to satellite imagery base maps of the two towns using three distinctive colours to depict different sized

dumpsite distribution across the towns' low- and high-income areas. A Pearson Chi-squared test was performed to compare differences in dumpsite location, sizes, and distribution within different income areas and between the two towns. All statistical analyses were performed using STATISTICA version 14 (TIBCO, 2022).

3.4 Results

3.4.1 Abundance and Distribution

The findings showed that there were three times more illegal dumpsites in Makhanda (n=155) than in Knysna (n=60). In both towns, more than 80% of the identified dumpsites were in low-income areas in Makhanda, (86%; n=133) and Knysna (87%; n=52), with the remainder located in high-income areas (Figure 3.2). The results show an uneven distribution of dumpsites across the two income areas within both towns.

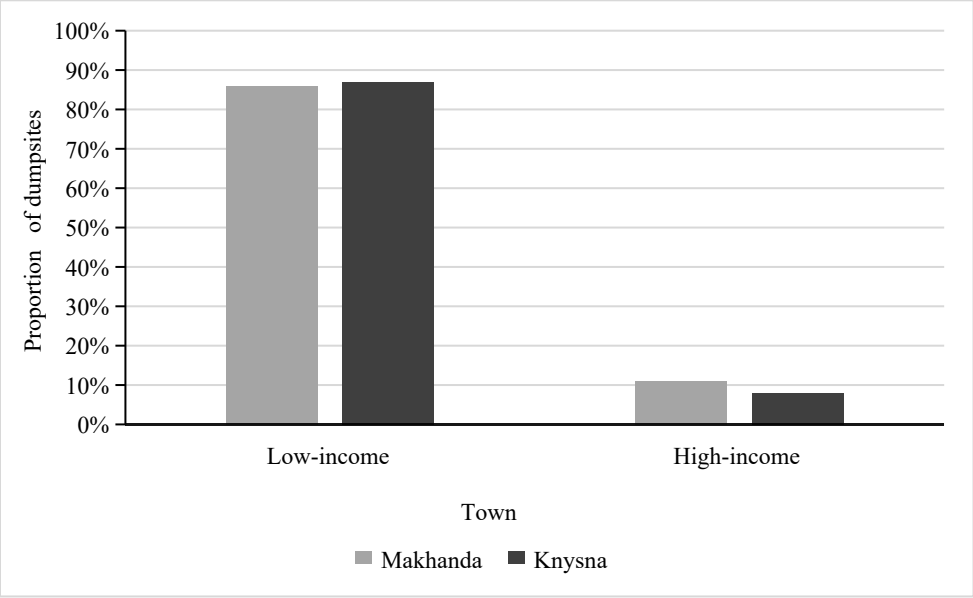

Figure 3.2. Proportion of dumpsites encountered within low- and high-income residential areas in Makhanda and Knysna

In Makhanda, most of the identified dumpsites were densely clustered in the eastern side of the town in low-income areas such as Joza, King Flats and Fingo (Figure 3.3A). Similarly, in Knysna dumpsites were most prominent in the northern areas of the town, in low-income areas such as Rhobololo, Xolweni, Khayalethu and Nekkies (Figure 3.3B). The few dumpsites

encountered in high-income areas in both towns were encountered in neighbourhoods that were near to the Central Business District (CBD) such as Sunnyside and Oatlands in Makhanda and Hornlee and Sunridge in Knysna (Figure 3.3A and B). Statistically, these was a significant difference in the distribution of dumpsites between low-income and high-income areas in both Makhanda (χ^2 =28.8; p< 0.001) and Knysna (χ^2 =28.8; p< 0.001), with more dumpsites being encountered in the low-income areas compared to high-income areas.

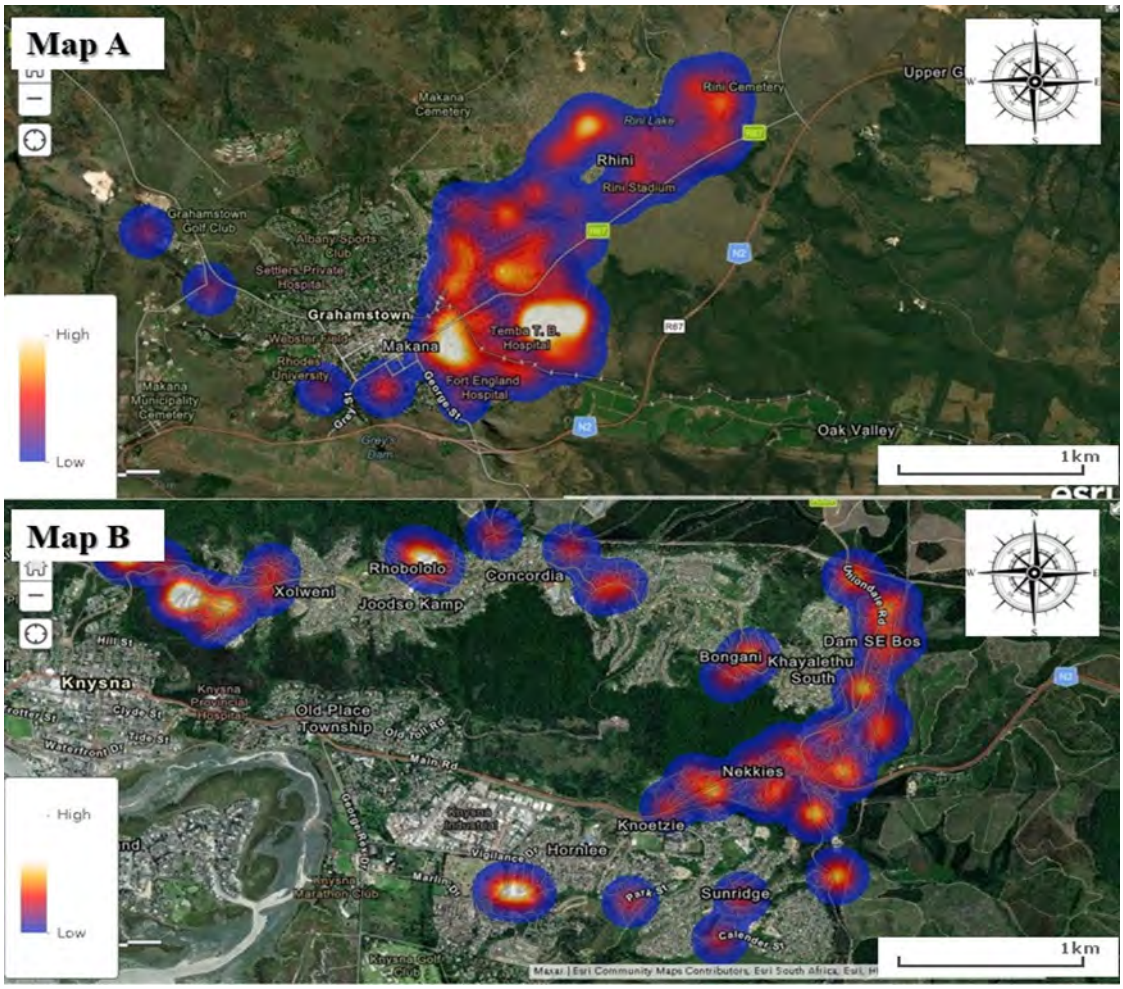

Figure 3.3. Heatmaps of dumpsite distribution and abundance within different income areas of (A) Makhanda and (B) Knysna

3.4.2 Dumpsite activities

Various activities were observed taking place within and near the identified dumpsites (Figure 3.4). In both towns, the presence of animals (livestock and pets) was the most prominent activity observed within dumpsites. In Makhanda, 35% (n=54) of dumpsites had animals present compared to 30% (n=18) in Knysna. Evidence of burning/fire was observed in 12% of the dumpsites in both Makhanda (n=19) and Knysna (n=7) (Figure 3.4B and D). The most

common animals encountered at dumpsites included donkeys, cattle, goats, and pigs. Town comparisons showed that donkeys and cattle were more common in Makhanda dumpsites, whereas goats and pigs dominated Knysna dumpsites. Other animals observed within dumpsites included dogs and domestic chickens which were observed foraging within dumpsites located in both towns.

Figure 3.4. Images illustrating the presence of fire burning and animals within dumpsites in Makhanda (A and B) and Knysna (C and D)

3.4.3 Dumpsite waste composition

Dumpsite waste composition consisted of household waste followed by garden and construction waste. In both towns, close to half of the identified dumpsites were dominated by household waste material of the following proportions, Makhanda (42%; n= 65) and Knysna (49%;n=29) (Figure 3.5). The bulk of the household waste found within dumpsites was composed of single-use plastic food packaging materials, plastic bottles, black plastic refuse bags (Figure 3.6E, F, and H). The second most prominent waste material encountered at dumpsites was garden waste, with a slightly higher frequency in Makhanda (37%; n= 57) than in Knysna (30%; n=18) (Figure 3.5). Lastly, 21% of the dumpsites in both towns had construction waste, Makhanda (n=33) and in Knysna (n=13) (Figure 3.5). The dominant

construction waste material were brick fragments, cement chunks and ceiling boards (Figure 3.6G).

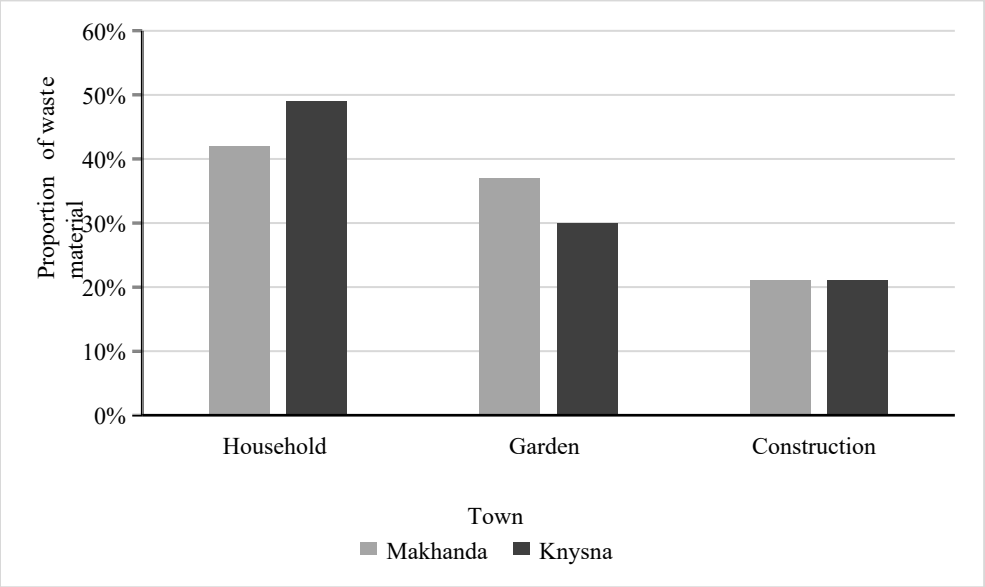

Figure 3.5. Proportions of dumpsite solid waste composition in Makhanda and Knysna

Figure 3.6. Images of dumpsite solid waste composition in Makhanda (E and F) and Knysna (G and H)

3.4.4 Dumpsites location and size distribution

Roadside dumpsites within Makhanda accounted for 48% (n=74) of the identified dumpsites, whilst in Knysna they accounted for 82% (n= 49) (Figure 3.7). Dumpsites encountered in vacant public spaces accounted for 40% (n=62) in Makhanda, and 13% (n=8) in Knysna. The least counted dumpsites were in commonages or grazing areas, constituting 12% (n=19) of dumpsites in Makhanda and just 2 % (n=1) in Knysna (Figure 3.7). In Knysna, a small proportion (less than 2%) of the dumpsites were in valleys and wetlands (Figure 3.7). A chi-squared test conducted across the dumpsite locations showed significant differences for both towns (Makhanda: χ^2 =40.207; p = 0.001 and Knysna: χ^2 =40.207; p = 0.001), with roadsides having more dumpsites than other locations.

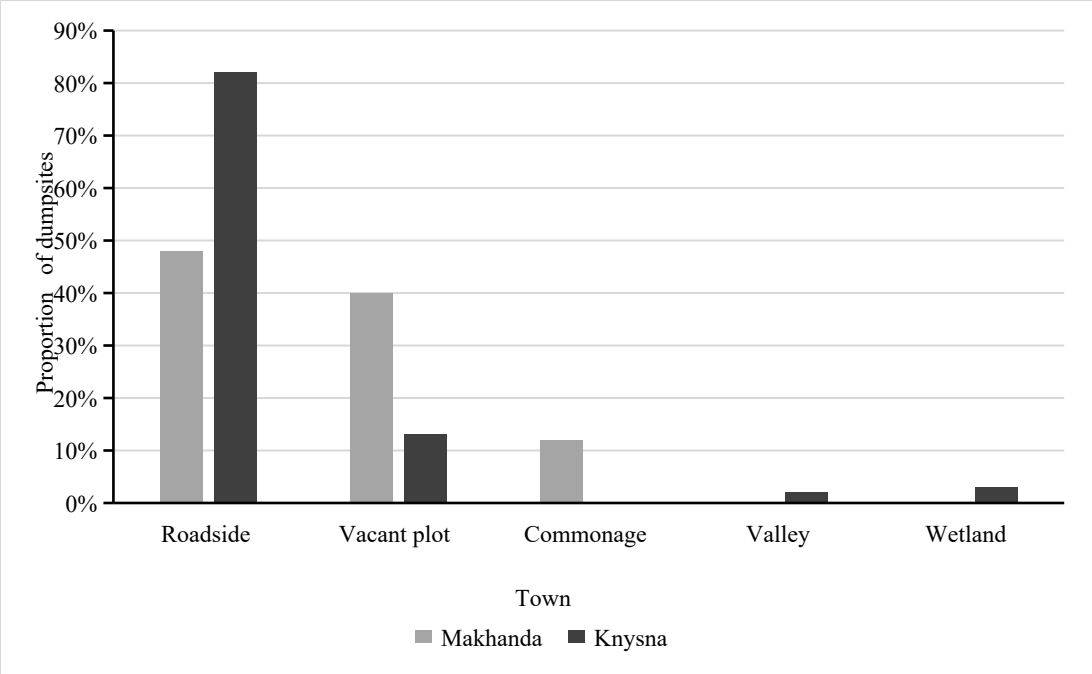

Figure 3.7. Location of illegal dumpsites encountered in Makhanda and Knysna

Within both towns, most of the dumpsites were found within residential neighbourhoods thus making them close to homesteads (Table 3.1). In Makhanda, 43% (n=67) of dumpsites were encountered near homes, compared to 48% (n=29) in Knysna. More than 30% of the dumpsites in both towns were in urban forested and vegetated public spaces with a fairly similar proportion in Makhanda (34%; n=53) and Knysna (36%; n=21) (Table 3.1). Above 10% of dumpsites were within the vicinity of communication and electrical masts, with a low but slightly higher proportions in Makhanda (14%; n=22) than Knysna (10%; n=6). Less than 10% of the encountered dumpsites within both towns were near shops, (4% (n=6) in Makhanda and

1% (n=1) in Knysna . Fewer dumpsites (2% within both towns) were near schools, whereas only 3% were found near river streams, in Makhanda (n=4) and in Knysna (n=2).

Table 3.1. Proportion of dumpsites located within public areas in Makhanda and Knysna

Public area/ environment	Makhanda (n=155)	Knysna (n=60)
Housing	43%	48%
Forest	34%	36%
Communication mast	14%	10%
Shop	4%	1%
School	2%	2%
Along streams	3%	3%

A greater proportion of the dumpsites in Makhanda (48%; n=74) and Knysna (57%; n=34) were categorised as small dumpsites (Table 3.2). Medium-sized dumpsites constituted about 33% (n=52) of all dumpsites in Makhanda compared to 12% (n=12) in Knysna. Less than a quarter of the dumpsites in both towns were categorised as large, but with a slightly high proportion in Makhanda (19%; n=29) than in Knysna (23%; n=14) (Table 3.2).

Table 3.2. Proportion of dumpsite sizes encountered within Makhanda and Knysna

Dumpsite size	Makhanda (n=155)	Knysna (n=60)
Small	48%	57%
Medium	33%	20%
Large	19%	23%

In both towns a considerable number of small dumpsites were in low-income neighbourhoods (Figure 3.8A and B). Within high-income neighbourhoods in Makhanda, most dumpsites were small to medium-sized, however a few large dumpsites were also encountered, and these were mostly along the periphery of neighbourhoods specifically along the Belmont valley (Figure 3.8A). In contrast, large dumpsites in Knysna were all within low-income areas, however, some

small to medium-sized dumpsites were within high-income areas (Figure 3.8B). A chi-squared test of dumpsite sizes showed no significant differences between the towns ($\chi^2 = 6.490$; $p = 0.1654$).

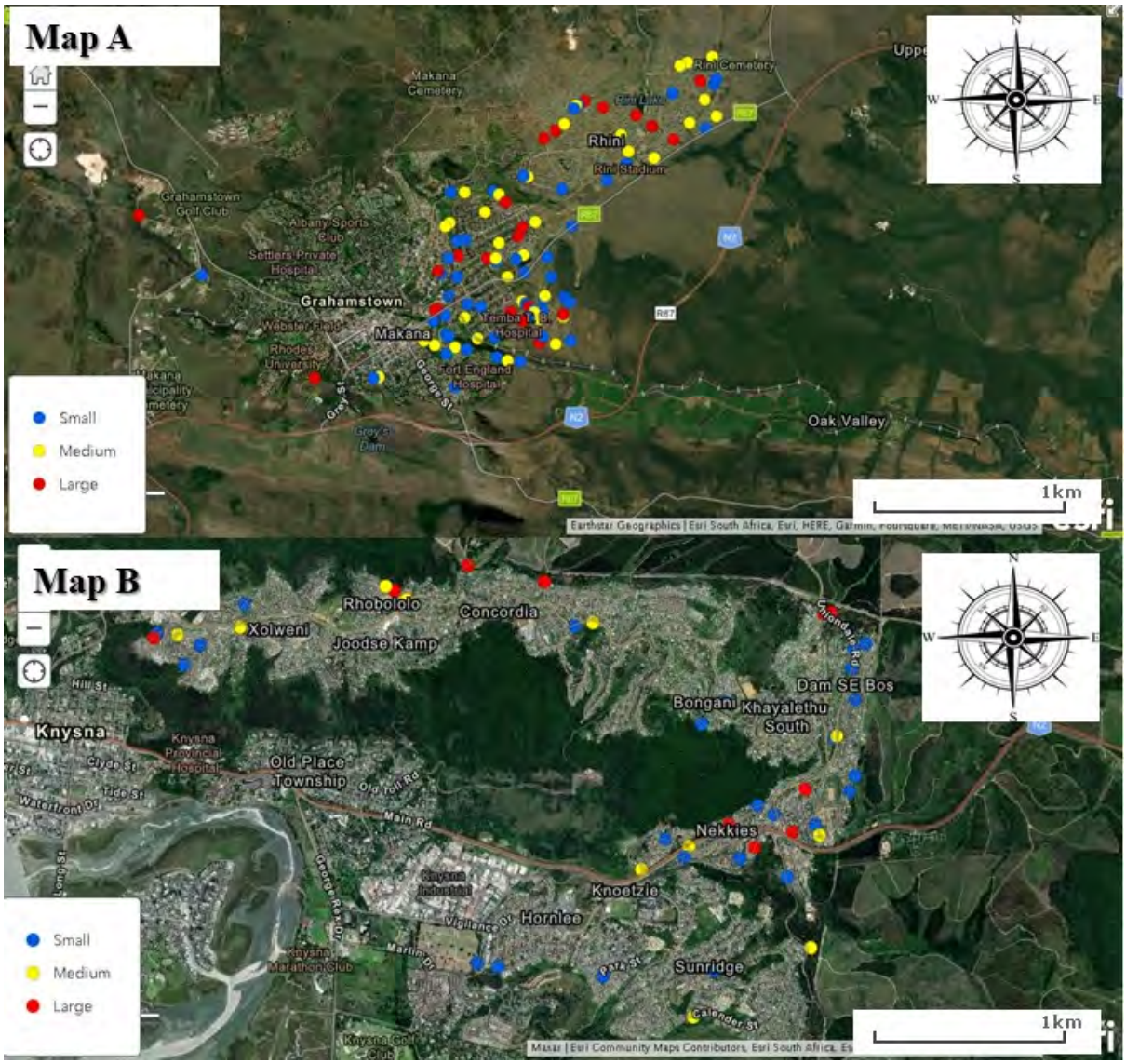

Figure 3.8. Maps depicting dumpsite size distribution across low-income and high-income areas in (A) Makhanda and (B) Knysna

3.5 Discussion

The results of this study showed that ISWD is prevalent in both towns, however it is unevenly distributed with significantly higher occurrences in low-income areas compared to high-income areas. A greater proposition of the identified dumpsites was in poor and low-income neighbourhoods in both towns. These results concur with studies by Kubanza and

Simatele (2016), and Ngalo and Thondhlana (2023) who showed the prevalence of dumpsites in low-income areas. For example, Ngalo and Thondhlana (2023) enumerated 120 dumpsites in low-income areas of Komani in South Africa and attributed the dumping to irregular collection of waste by the municipality and lack of proper disposal facilities. Kubanza and Simatele (2016) reported that lack of socio-economic services by Kinshasa municipality could explain why low-income areas and poor neighbourhoods are dominated by illegal waste dumpsites. Zohoori and Ghani (2017) identified four factors that can explain ISWD in low-income areas in developing countries namely, lack of vehicles for solid waste collection, poor urban infrastructure, inadequate funding, and municipal malfunctioning. Other studies have reported several other factors such as governance (municipal service provision), social development (poor infrastructure), urban congestion, social disorganization and potentially spatial segregation limiting access to drop-off facilities/landfills (Abel, 2014; Dlamini et al., 2017; Haywood et al., 2021; Kimani, 2020; Kubanza, 2021). Although these factors are evident in South Africa, the country's apartheid historical legacies can explain why more illegal dumpsites were observed in low-income as opposed to high-income areas, since the above-mentioned challenges are prevalent in low-income areas than high income areas. For example, municipal service delivery challenges in South Africa are disproportionate, with few challenges in high-income areas as compared to low-income areas (Sartorius and Sartorius 2016). Similarly, the challenge of urban congestion and spatial segregation are more prevalent in low-income areas, thus creating a huge challenge to municipal waste collection which can result in ISWD in low-income areas.

Most of the identified dumpsites in low-income areas were small and located along roadsides and vacant green spaces. Ngalo and Thondhlana (2023) reported similar trends in Komani town of South Africa with half (45%) of the dumpsites being in green spaces like urban parks and vacant street edges. This study also noted that dumpsites were mostly near houses and forests, which contradicts recent observations by Ngalo and Thondhlana (2023) who reported significant dumpsites observation near public infrastructure sites (e.g., electrical transformer), empty residential areas, and public schools and clinic edges. Despite the notable differences with previous studies related to dumpsite locations, a key observation was that dumping is evident in prohibited areas, an indication that city bylaws are being ignored. For example, South Africa's waste management municipal bylaws state that any person who generates waste must store it inside their yard and away from the public as it awaits collection by the

municipality. The prevalence of ISWD in these two study towns suggests that either residents are not abiding by these municipal bylaws, or the municipality has failed to provide collection services to the extent that residents have created illegal dumpsites. A closer look at the results suggests that these municipal bylaws are differently applied by the two towns in this study and across income group areas. For example, we observed few counts of illegal dumpsites in Knysna than in Makhanda and few dumpsites in high-income than in low-income areas. The Makana municipality governing Makhanda has been reported to have poor service delivery compared to the Knysna municipality governing the town of Knysna, which likely explains the disparities between the two towns regarding illegal dumpsite occurrences (Irvine, 2021). Therefore, dumpsite prevalence in Makhanda could be related to poor governance which has been identified in previous studies highlighting the dysfunctionality of the local municipality (Irvine, 2021; Hoefnagels et al., 2022; Kalina et al., 2023; Nicholas, 2018; Nomenge, 2022). In contrast, Knysna is classified as a functional municipality, which is ranked one of the best municipalities in South Africa (Good Governance Africa, 2021), which perhaps explains why they were fewer dumpsites encountered across both low-income and high-income neighbourhoods in the town. During field work, researchers observed waste drop-off points in Knysna but not in Makhanda an indication that provision of waste support infrastructure can curb ISWD.

Illegal dumping of waste along public open spaces such as roadsides and public infrastructure has been reported in other studies (Mngomezulu et al., 2020; Niyobuhugiro and Shcenck 2021). Although several factors could explain why people illegally dump in public places, a key explanation is linked to behavioural and social norms, where some individuals view illegal dumping as an acceptable way of getting rid of the waste (Shinkuma and Managi, 2012). This is normally imbedded in how communities view illegal dumping, with dumping being acceptable if close friends and neighbours see other people doing it, thus perceive it as socially and morally acceptable to dump (Shinkuma and Managi, 2012). Linked to social norms is personal factors such as laziness, which likely explains why most illegal dumpsites were located near houses or along roadsides. Ichinose and Yamamoto (2011) reported that the lack of adequate waste dumping facilities in low-income areas could trigger some people to dump illegally due to laziness to drive or walk to the facility as they might be far. Laziness is also linked to issues of time, where individuals prefer to dump illegally due to reluctancy to time spent walking or driving to landfills and waste drop-off points. Although these above-mentioned factors were

not assessed in this study, it is possible that they could explain ISWD observed in this study. Indeed, issues related to availability of individual resources and time to deal with household waste are likely to be more in low-income areas than in high-income areas. For example, high-income households tend to have financial resources (e.g., cars and money) that even without regular waste collection or support infrastructure such as skips and bins, they can drive to and dump household waste at designated drop-off points and landfills.

The bulk of the identified illegal dumpsites consisted of household and garden waste, a finding that has been reported in previous studies (Nagpure, 2019; Nell et al., 2022; Ngalo and Thondhlana 2023). This study was conducted in towns that are relatively medium-sized compared to metropolitans in South Africa, thus the household land area cover size in these towns tend to be high. This likely explains why household waste was high. Households tend to generate a substantial proportion of waste in any urban area globally (Kumar, 2016). Oelofe et al. (2018) reported that approximately 10 % of Johannesburg waste comes from household food waste, and this is likely to increase as urban population increases. Increased household food waste is also linked to current human consumption patterns, with estimates suggesting that a third of the food produced globally is lost or wasted (UNEP, 2021). Generally, all this household food waste will end up in illegal dumpsites, particularly in developing countries where dumping is prevalent. Joel and Fansen (2014) reported that waste composition tends to vary based on location and income group, something we did not observe in both towns. This could be because this study used a standard SW categorisation approach that examined dumpsite composition as household waste (food, sanitary, plastic and paper waste), garden waste (weeds, grass clipping and branches) and construction waste (brick fragments, cement, and tile fragments). These quantities were not measured across different income group areas (Abel, 2014; Haywood et al., 2021; Kimani, 2020; Ngalo and Thondhlana, 2023).

The proximity of illegal dumpsites to houses and schools, albeit with a low percentage, could have socio-economic and health impacts on local residents. Dumpsites contain materials which include plastics, chemicals, sharp objects, blood-stained items, dead animals, and diapers, all these can cause human health effects, potentially leading to the spread of diseases (Matherson and de Mooji, 2019). A study by the United Nations reported that people leaving near dumpsites particularly the elderly and children suffered from diarrhoea and acute respiratory

infections (Matheson and de Mooji, 2019; UN-HABITAT, 2010). Another study by Bangani et al. (2023) in Mthatha, in the Eastern Cape Province of South Africa showed that residents that reside next to dumpsites tended to report illnesses such as diarrhoea and respiratory infections due proximity to ISWD contaminated waterways. Sharma et al. (2018) showed that dumpsites contain materials that can contaminate soils, particularly altering the soil pH, which subsequently affects plants that grow within and next to dumpsites, mostly invasive alien plants that proliferate on disturbed areas (Plaza et al., 2018). Therefore, increases in ISWD could trigger secondary problems like invasion by invasive alien plants, although this is yet to be proven (Plaza et al., 2018). Changes in soil properties at dumpsites have also been reported in Bydgoszcz, Poland where significant changes in soil phosphorus content, phosphate activity, physiochemical and microbiological parameters were noted in soils near dumpsites (Lemanowicz et al., 2016).

Other studies have also shown that dumpsites with HSW cause abnormal concentrations of heavy metals, hydrocarbons, nitrogen, and volatile organic compounds in surrounding soils and surface water (Cetin et al., 2022; Glanville and Chang, 2015; Somani, 2023). Dumpsites offer a breeding ground for rats and mosquitos that can transmit diseases such as lice, rabies, and malaria to humans residing in the vicinity of dumpsites (Ruffel and Dawson, 2019). Apart from dumpsites prevalence affecting human and environmental health, dumpsites also result in economic challenges and costs associated with clean-ups. Economic costs associated with dumpsite clean-ups are not only a Global South country problem but also affected Global Northern countries. For example, the UK Environmental Agency estimated that £100-150 million of government revenue is used annually for cleaning up dumpsites (London Government, 2023). In 2017, the Baltimore municipality in the USA spent approximately $21 million on dumpsites clean-ups (Baltimore City Department of Public Works, 2017). Within South Africa, municipalities spend millions of Rands on costs associated with dumpsite clean-ups (Polasi, 2018). For example, the City of Johannesburg and Cape Town municipality spent more than ZAR50 million annually cleaning dumpsites (Londt, 2022; Polasi, 2018).

Altogether, the negative socio-economic and environmental effects of ISWD are likely to affect low-income areas more than high-income areas, simply because dumpsites are prevalent there. Firstly, this is because residents in low-income areas are heavily dependent on municipalities

for waste collection, thus failure by the municipality imply more ISWD thus more negative effects. Secondly, low-income households have limited resources to find alternative waste management strategies, thus ISWD seems free and the way to go thus resulting in negative effects to them. Lastly, households in low-income areas have fewer financial savings to manage disservices linked to illegal dumping, thus negative effects will affect them relatively more than to high-income residents who have the financial means to hire contractors to clean-up any emerging dumpsites. The above-mentioned three points seem to suggest that ISWD is part of the poverty cycle because low-income households are trapped by mechanisms that are beyond their control when it comes to dumping and can only exit with outside assistance. Therefore, assistance linked at reducing ISWD should prioritise low-income areas compared to high-income area who seem to have clean suburbs and have the means and resources to manage their waste. More studies are needed to assess the role of ISWD in the poverty cycle.

3.6 Conclusion

The study showed that ISWD is prevalent and unevenly distributed in the two towns. In both Makhanda and Knysna it was more prevalent in low-income compared to high-income areas. This shows how low-income residents are disproportionately burdened by solid waste mismanagement compared to residents in high-income areas. However, given the transboundary nature of the impacts of ISWD such as water pollution and land pollution, it is plausible to argue that ISWD will affect everyone hence concerted efforts are needed to mitigate it. Although most of the dumpsites were small, results also showed that most of them occurred in public green spaces and vacant land. This shows that dumping has a behavioural dimension as people dump in areas that are close to houses and public facilities. The composition of the waste observed was dominated by household and garden waste materials, also highlighting issues pertaining to municipal service delivery failures.

Addressing ISWD issues in these towns and generally in South Africa requires more researchers to evaluate not only social and governance issues but also how historical legacies impact waste disposal and management behaviours. Good government systems are essential for maintaining clean urban environments for all despite geographical location or income level. Addressing ISWD will prevent any potential risks to human, animal and the environmental health and wellbeing. The prevention of ISWD will potentially have knock-on effects on municipal budgets, i.e., resulting in more municipal funds being spent on waste collection and

initiating dumpsite clean-ups. Overall factors resulting in ISWD are complex and dynamic so are the risks associated with ISWD, particularly for low-income households. The results from the study could be the first step needed to address ISWD from a spatial, governance and income gradient perspective.

Lastly, the data collected from this study can be used by local municipalities in Makhanda and Knysna to re-evaluate their integrated waste management plan (IWMP), Local Economic Development plans (LED) and Integrated Development Plans (IDP) to focus on improving waste collection services, improving infrastructure such as roads, bin provision and clean ups within low-income areas where most dumpsites were encountered. Both the Makana and Knysna municipalities can also use the data on dumpsites location and size to identify hotspot areas and initiate clean-up programmes, or preventative measures through erecting waste drop-off points in areas with prevalent ISWD. Other potential interventions that could be employed by municipalities may include sustainable waste management workshops or programmes in low-income areas where ISWD was most prominent. Beyond addressing social and environmental impacts, addressing ISWD should be considered a social justice imperative, given the persistent effects of apartheid policies that supported segregated development.

CHAPTER FOUR: PERCEPTIONS AND PRACTICES REGARDING ILLEGAL SOLID WASTE DUMPING ACROSS AN INCOME GRADIENT IN MAKHANDA AND KNYSNA, SOUTH AFRICA

4.1 Introduction

Illegal solid waste dumping (ISWD) is described as the unlawful and deliberate disposal of rubbish in a public or private environment that has not been designated as a site for waste disposal (Bangani et al., 2023; Kimani, 2020). It is a widespread and major urban sustainability challenge globally, particularly in developing countries (Dreau, 2022; Ngalo and Thondhlana, 2023; Triassi et al., 2015). Other terms used to refer to ISWD include indiscriminate dumping, fly tipping, fly dumping, and midnight dumping (Dladla et al., 2016; Mississippi Department of Environmental Quality, 2023; Niyabuhungiro and Schenck, 2021; Ozoh et al., 2021). The practice of ISWD poses significant health risks to the surrounding natural environments and communities residing in areas where ISWD is prevalent (Abel, 2014; Haywood et al., 2021; Kimani, 2020). Research shows that the rapid increases in urban populations has resulted in rapid increases in household solid waste (HSW) generation amongst urban residents (Amasumo and Baird, 2016; Henry et al., 2006; Naibbi and Umar, 2017). It has been projected that globally by 2050 the amount of solid waste materials generated within urban communities at a municipal level will outpace population growth by more than double (Kaza et al., 2018; Tiseo, 2023). This projection is substantial and will likely exacerbate the challenges faced by municipalities especially in developing countries (Kaza et al., 2018; Tiseo, 2023).

Despite numerous global efforts to tackle the growing problem of waste generation and ISWD through legislation such as the Plastic Bag Law of Rwanda (March et al., 2022) and the Waste Act of South Africa (South African Government, 2008), as well as the framing of sustainable consumption and production through interventions for reducing, reusing, and recycling waste, ISWD still remains prevalent (Kaza et al., 2018; UNDP, 2023). Therefore, it is crucial to look at the factors prompting this practice, particularly how varied perceptions of HSW management prompt sustainable or unsustainable waste disposal behaviours (Chu, 2021; Triassi et al., 2015). Within many African countries household solid waste management is a social, economic, and environmental problem faced by communities and governments at large (Godfrey et al., 2020). Data collected between 2012 and 2015 on waste generation in African countries showed that

125 million tonnes of municipal solid waste (MSW) were generated annually with more than half of these waste products emerging from household sources (Scarlat et al., 2015). It is projected that by 2050 municipal waste generation in Africa will grow to 244 million tonnes per year (Scarlat et al., 2015). This rapid increase of waste generation is detrimental to human and ecosystem health as only 45% of municipal solid waste generated within African countries is collected or treated in formal sectors (Tsheleza et al., 2019). Most municipal solid waste materials 55% (68 million tonnes) remain uncollected, and often illegally dumped along roadsides, street corners, forests, and riverbanks (Scarlat et al., 2015; Tsheleza et al., 2019). Unfortunately, the impacts of ISWD disproportionately affect the urban poor, often residing in low-income and poorly serviced residential areas (Kuermele, 2021; Ngalo and Thondhlana, 2023).

The factors behind ISWD within urban landscapes in post-colonial African countries are varied and differ across geographical regions. Studies show that inconsistent waste collection services, urban congestion, lack of awareness, inadequate municipal budgets, political instability, and social disorganization are key factors behind ISWD within urban environments particularly amongst the urban poor (Abel, 2014; Godfrey et al., 2020; Kaza et al., 2018; Kimani, 2021; Kubanza, 2021; Ngalo and Thondhlana, 2023). In Sub-Saharan African urban areas, the practice of ISWD is also attributed to the historical legacies of colonialism and apartheid (Grangxabe et al., 2023). Such legacies include socio-economic inequalities, discriminatory geographies through spatial segregation, and poor municipal service provision which disproportionately affect low-income communities (Godfrey et al., 2020; Haywood et al., 2021). Waste collection rates across Southern African countries have been reported to be below 50% and are one of the main factors behind unsustainable HSW management practices (Dladla et al., 2016; Godfrey et al., 2020; Simatele and Etambakonga, 2015; UNEP, 2012).

Beyond external factors, other reasons for ISWD are attributed to individual factors. For example, Ferrara (2008) highlights the existence of negative externalities in an individual's decision-making over waste generation and method of disposal, suggesting that household solid waste management behaviours are perpetuated at an individual level and influenced by individual's perceptions (Ferrara, 2008). Perceptions are defined as ideas, opinions, or the ways in which something is understood or interpreted by an individual based on their lived

experiences (Huo and Khoo, 2022). For example, within developing countries ISWD is often not treated as a significant problem amongst the urban poor due to the social normalisation of this practice thus resulting in the frequent occurrence of ISWD in built and natural environments (Faure and Visser, 2014; UNEP, 2012). Human beings are social in nature and therefore they are significantly influenced by the people around them (Emery and Watson, 2004). This means that social expectations and the actions of people nearest to an individual play a critical role in deciding how that the probability a person will embrace or oppose improper community practices such as ISWD (Shinkuma and Managi, 2018). Numerous studies conducted in Southern and West African countries have concluded that residents' lack of concern and negative perceptions towards solid waste management are key factors prompting ISWD behaviours particularly amongst the urban poor (Kimani, 2020; Mangoro, 2020; Niyobuhungiro and Schenck, 2022; Suleman et al., 2015; Wandoya and Perera, 2018).

In South Africa, evidence suggests that ISWD is a growing urban sustainability concern (Abel, 2014; Kalina, 2023; Kubanza et al., 2020; Haywood et al., 2021; Ngalo and Thondhlana, 2023) but there is little empirical evidence to inform interventions for promoting urban sustainability. Illegal solid waste dumping is a violation of numerous legislations including the Bill of Rights Section 24 of Chapter 2 of 1996 and the National Waste Management Act 59 of 2008 (South African Government, 2022). The constitution of South Africa enshrines the right of everyone to clean and safe urban environments via the Municipal Systems Act 32 of 2000 (South African Government, 2022), consistent with Sustainable Development Goals 11 (Sustainable cities and communities and 12 (responsible consumption and production). The act requires that municipalities supply waste collection and disposal infrastructure such as drop-off facilities to all residents, regardless of geographical location, and ethnicity (South African Government 2022). However, despite these legislations and policies the practice of ISWD is rapidly becoming a common occurrence within urban areas nationwide especially within low-income settlements and the reasons for this as previously mentioned above are nuance.

The practices of ISWD within urban areas poses significant risks to human, animal, and environmental health (Kaza et al., 2018; Mangoro, 2020; Matheson and Mooji, 2019). Gahill (2020) argues that ISWD contaminates soils and surface water. Frequent ISWD of HSW materials also releases toxic compounds and leads to abnormal concentrations of heavy metals

and toxic compounds that negatively impact human health, and physical environments (Glanville and Chang, 2015). Data collected by the United Nations showed that diarrhoea and acute respiratory infections were significantly higher in children residing in areas where ISWD is widespread (UN-HABITAT, 2010; Matheson and Mooji, 2019). The presence of heavy metals and gaseous toxins due to ISWD have been reported to cause illness such as anaemia and high blood pressure within humans of all ages with the young, sick, and elderly being affected more adversely (Duruibe et al., 2007; Kampa and Castana, 2008). Toxic compounds present within dumpsites are also transported through food chains when ingested by living organisms and thus result in negative externalities within entire social ecological systems (Maselli et al., 2010). A study conducted by Sotanenou et al. (2019) reported the presence of high PCBs (Polychlorinated biphenyl) in goat milk from goats that grazed within and lived near an illegal solid waste dumpsite, raising concerns that the of consumers of the goat milk and meat were directly at risk of developing various kinds of cancers from ingesting toxic PCBs. In South Africa, ISWD is associated with asthma, tuberculosis (TB), rashes within children, livestock death as well as water, air, and land pollution (Dladla et al., 2016; Kimani, 2020; Niyobuhungiro and Schenck, 2021; Polasi et al., 2018; Tsheleza et al., 2019; Ngalo and Thondhlana, 2023).

Numerous studies have been conducted on ISWD's perceptions, practices, prevalence and impacts on human and environmental health in South African urban areas (Gumbi, 2015; Ichinose et al., 2011; Kubanza and Simatele, 2016; Niyobuhungiro and Schenck, 2022; Polasi, 2018; Ngalo and Thondhlana, 2023). However, most of these studies have focused only on low-income households perhaps due to environmental and social justice imperatives aimed at addressing the disproportionate social and environmental impacts on poor households (Southall et al., 2018). Further, though it is generally believed that municipal governance is central to municipal service delivery (Resnick, 2014; Mamokhere, 2022), there are limited comparative studies between municipalities under different governance regimes to develop empirical standing to support such claims. Therefore, due to the complex history and structure of South Africa's urban landscapes an examination of different income group areas' household perceptions and practices regarding ISWD is required. Urban areas in South Africa have a long standing and arguably persistent history of systemic racism and classism which continues to be disproportionately experienced by the urban poor majority black African and coloured population groups nationwide (Abel, 2014; Kimani, 2020; Strauss, 2019). This systematic

discrimination is highlighted by the poor municipal service delivery which is experienced by the urban poor majority previously marginalised communities, thus prompting ISWD prevalence within their residential areas (Abel, 2014; Kalina, 2023; Niyobuhungiro and Schenck, 2022).

Recent studies on ISWD in post-apartheid South African urban areas in provinces such as Eastern Cape, Western Cape, KwaZulu Natal and Gauteng found that ISWD was more prevalent in low-income areas inhabited by black African and coloured racial groups due to the persistent uneven municipal waste collection service delivery between different income group areas (Kalina, 2023; Kimani, 2020; Ngalo and Thondhlana, 2023; Polasi, 2018). Low-income neighbourhood residents in South Africa mostly live below the poverty line and therefore lack the financial means to outsource waste removal services when municipal services are poor or in some instances non-existent (Kalina, 2022; Ngeleka, 2010; Oluwatobi et al., 2021; Sithole and Ntsako, 2015). Given this background, the aim of this study was to examine households' perceptions and practices regarding ISWD across a low- and high-income neighbourhoods located within two medium-sized South African towns. The key questions of the study included (1) what are residents' perceptions of the prevalence and causes of ISWD (2); what are the reported household solid waste disposal practices and how do they differ across different income group neighbourhoods (3) what are residents' perceptions of the impacts of ISWD and their proposed potential interventions.

4.2 Study area

The study was conducted in two medium-sized South African towns, namely Makhanda (formally Grahamstown) located in the Eastern Cape Province and Knysna located in the Western Cape province (Figure 3.1). Makhanda is an inland town situated northwest of Gqeberha (formerly Port Elizabeth) and southwest of East London (33°18′36″S 26°31′36″E). The town of Makhanda is governed by the Makana local municipality within the Cacadu district municipality, Eastern Cape province (Makana Municipality, 2013). In contrast Knysna (34°02′08″S 23°02′56″E) is a coastal town located east of George and west of Plettenberg Bay within the Garden Route Area (Knysna Municipality, 2023). Knysna is governed by the Knysna local municipality within the Garden Route district municipality, Western Cape province (Knysna Municipality, 2023). The town of Makhanda covers an estimated area of 65.1 km² and

is at an altitude of 550m above sea level with warm and temperate climatic conditions and mean annual rainfall of 590mm (Botai et al., 2018). In contrast Knysna covers an area of 108.77km² and is at an altitude of 140.29m above sea level with temperate climatic conditions with a mean annual rainfall of 875mm (Martin and Burgess, 2023). The vegetation type within Makhanda consists of subtropical thicket biome, with patches of South Coast Renosterveld, Afromontane Forest, Grasslands and Nama Karoo around the periphery of the town (McConnachie et al., 2008). Vegetation cover in Knysna consists mostly of indigenous forests, vast pine plantation forests, shrublands and sandstone fynbos biome (Knysna Municipality, 2020).

Makhanda'spopulation is approximately 70 000 people with 13 427 households and a population density of 1000 people per km² (Stats SA, 2021). Knysna's population is approximately 73 835 people, with 16 374 households and a population density of 470 to 1000 people per km² (Knysna Municipality, 2023). The town's economic structures are significantly different. In Makhanda the town's economy is supported by renowned private and public academic institutions (Rhodes University, Kingswood college, St Andrews, and Diocesan School for Girls), tourism (National Arts Festival, Sasol Science Festival, The Standard Bank Youth Jazz Festival and The Grahamstown Foundation Festival), and private game reserves (Hoefnagels et al., 2022; Makana Municipality, 2013). Knysna's the economy is built on local service businesses, tourism (Boat cruises, forest tours, wine tastings, Whale and Dolphin watching) and exclusive private estates such as Pezula, Fernwood, Westford, and Belvidere, making the town the epicentre of the Garden Route Area (Knysna Municipality, 2023). Unemployment within the broader local municipalities is higher in Makhanda (33%) than in Knysna (26%).

Consistent with Post-Apartheid South African urban landscapes, both town's residential areas are segregated across income group lines (Irvine, 2021; Unterhalter et al., 2004). Spatial segregation is a common feature of urban landscapes in South Africa due to the historical legacies of the Groups Urban Areas Act 41 of 1950, which forced urban residents to reside in strictly same racial and subsequently same income group areas (Horrell, 1963; Sithole et al., 2015). Within Makhanda, high-income residential neighbourhoods are situated in Makhanda West (Somerset Heights, Oatlands North, and Sunnyside) near the Central Business District (CBD), whilst low-income neighbourhoods are situated in Makhanda East (Joza, Fingo and

eRhini) on the periphery of the town (Hoefnagels et al., 2022; Kalina, 2023). Similarly, in Knysna high-income neighbourhoods such as Thesen Island, Leisure Island and Brenton-on-Sea are situated in the Southeastern and Southwestern parts of the town along the coastline near the CBD, and low-income neighbourhoods (Concordia East and West, Rhobololo and Xolweni) are situated in the Northeastern outskirt regions of the town within the edge of forests and pine plantations (Strauss, 2019). Low-income residential areas within both towns are characterised by small residential plots, small gardens, dilapidated green infrastructure, untarred and undermaintained roads. Across both towns like most urban areas in South Africa accessibility to low-income neighbourhoods is limited due to poor roads and congestion (Irvine et al., 2022).

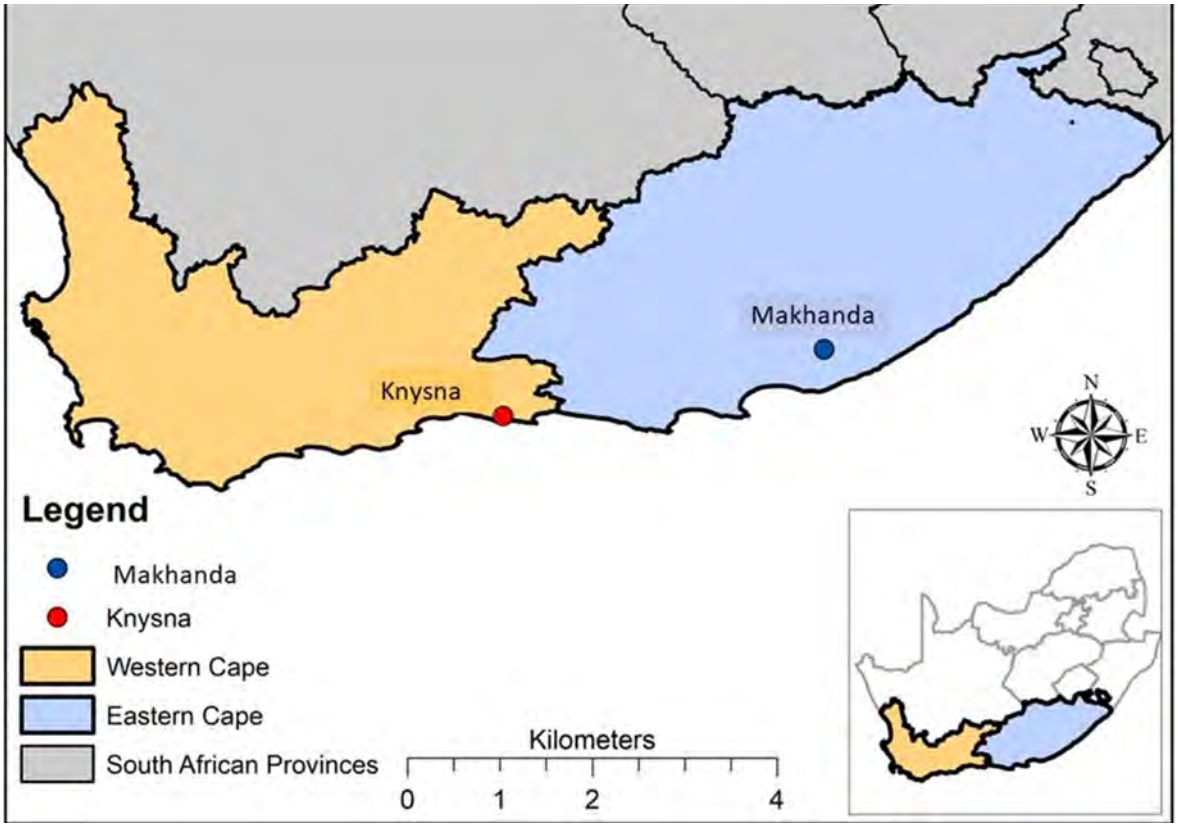

Figure 4.1. Location of Makhanda in the Eastern Cape and Knysna in the Western Cape provinces of South Africa

4.3. Research methods

4.3.1 Data collection

Data collection took place over a period of six months. A household questionnaire survey was administered to households in Makhanda and Knysna. A stratified random sampling approach was employed to selected households in each income group (low-income and high-income). The randomisation process was carried out using Google Maps to record the number of households on each street in low-income and high-income residential areas within both towns. The recorded households were entered on a Microsoft Excel spreadsheet and a simple selection of target households was conducted using the RANDBETWEEN (1,2) function in Microsoft Excel. Selected households were then plotted on a base map of each town's residential area and used to identify the randomly selected households in the field. In cases where it was difficult to get respondents in randomly selected households, the decision was made to interview the next available household. In total, 94 households participated in the study in Makhanda consisting of 64 low-income and 30 high-income households. In Knysna, 99 households participated in the study consisting of 86 low-income and 13 high-income households. The response rate for high-income households was generally low, due to difficulty in accessibility and low interest. Particularly in Knysna, high-income households tend to live in exclusive gated communities which are difficult to access. In most cases, high-income households are gainfully employed and are unlikely to be in their homes during daytime when research field work was undertaken. Further, due to growing crime rate in South Africa, many high-income households tend to view 'researchers' with suspicion for fear of crime.

The questionnaire used for interviews was semi-structured, with both closed and open-ended questions (Appendix 2). Household survey interviews gathered data on residents' socio-demographic profiles, method of waste disposal (municipal collection, backyard disposal, burning, recycling, and composting), frequency of disposal, perceived factors behind ISWD, perceived impacts of ISWD and potential interventions for ISWD. Direct observations were also used to assess the location of illegal solid waste dumpsites and the general topography of residential areas. At each household, the household head was targeted for the interviews, and the eldest member of the household where the household head was unavailable. The interviews were conducted in the respondent's preferred language, either IsiXhosa, Afrikaans or English, and each interview took between 30 and 45 minutes to complete. Ethical clearance for the study was granted by the Rhodes University Human Research Ethics Committee (Approval Number 2023-5963-7421).

4.3.2 Data analysis

Descriptive statistics were used to analysis the demographic profiles of household participants and their households, frequency of household waste disposal, waste disposal methods, perceived factors contributing to ISWD, and perceived impacts of ISWD. A thematic analysis was used to identify reoccurring themes on factors that contribute to ISWD, the perceived impacts of ISWD and the potential interventions proposed by households. Comments made by household participants were also analysed to identify new insights that might not have been captured through the semi-structured survey questionnaire. Direct quotes were used to support claims and express meaning.

A potential limitation of this study relates to sample-selection bias, and inability to generalise the findings (Smith and Noble, 2014), due to the non-probability sampling strategy employed following failure to get randomly selected households. Given, the homogeneity within different demographic groups in South Africa, it is not expected that the sampling approach would have missed important dynamics on household waste management and ISWD. Thus, despite these limitations the study still offers potentially useful and transferable insights on perceptions, practices and impacts regarding ISWD across an income gradient in South Africa.

4.4 Results

4.4.1 Social demographic profile of the respondents

In both towns, there was a slightly higher representation of females than males, in Makhanda (55%) and in Knysna (56%) and low-income groups in each study town showed a higher female representation than high-income groups. Education levels in both towns were generally high with at least half of the respondents having attained secondary education in Makhanda (50%) and Knysna (67%). Three times more respondents in Makhanda (40%) than in Knysna (13%) had a tertiary level education. Comparisons by income group showed that high-income households compared to low-income households in both study towns had tertiary level education. Unemployment level in the two towns was exceedingly high with a rate of 34% in Makhanda and 40% in Knysna, respectively. The main sources of income in both study towns were wages and social grants but analysis by income group showed that a higher proportion of

low-income households than high-income households depended on social grants, suggestive of high poverty levels and lack of employment for this income group. The average household monthly income amongst low-income respondents was mostly under R2000.

Table 4.1. Summaries of the socio-demographic profile of the surveyed respondents

Attribute	Makhanda			Knysna		
	Low income (n=64)	High income (n=30)	Total (n=94)	Low income (n=86)	High income (n=13)	Total (n=99)
Sex of respondents						
Female	55%	43%	51%	56%	31%	53%
Male	45%	57%	49%	44%	69%	47%
Education level						
No formal education	5%	-	3%	9%	15%	10%
Primary	9%	-	7%	10%	-	10%
Secondary	66%	23%	50%	74%	31%	67%
Tertiary	20%	77%	40%	7%	54%	13%
Source of income						
Wages	28%	50%	35%	36%	46%	43%
Social grants	39%	7%	29%	41%	-	30%
Government pension	23%	-	16%	9%	8%	10%
Private pension	2%	30%	10%	-	31%	4%
Own business	8%	13%	10%	14%	15%	13%
Employment status						
Employed	30%	40%	33%	30%	38%	31%
Self-employed	9%	10%	10%	13%	15%	13%
Pensioned	19%	33%	23%	14%	38%	16%
Unemployed	42%	17%	34%	43%	9%	40%
HH monthly income <2,000	42%	7%	33%	44%	-	36%
2,000-6,000	36%	7%	24%	40%	-	35%
6,001-15,000	16%	17%	16%	15%	23%	15%
15,001-30,000	6%	23%	12%	1%	69%	10%
>30,000	-	46%	15%	-	8%	4%

Most low-income households in Makhanda (78%) and Knysna (84%) reported average household monthly income below <R6 000, while at least three-quarters of high-income households in both towns reported average incomes ranging between R15 000 and >R30 000.

4.4.2 Solid waste disposal practices of the respondents

Table 4.2 summaries the methods of household solid waste disposal used by residents within low- and high-income group areas in both towns. Over 90% of respondents from both income groups in both towns stated that they received municipal waste collection services. However, low-income residents in Makhanda also stated that although the Makana municipality has a designated waste collection schedule for each neighbourhood with Makhanda East, the quality of services is often poor and inconsistent.

Table 4.2. Summaries of the methods of solid waste disposal used by household respondents

Solid waste disposal	Makhanda		Knysna	
	Low-income (n=64)	High-income (n=30)	Low-income (n=86)	High-income (n=13)
Municipal waste collection services				
Services provided	94%	97%	92%	100%
No Services	6%	3%	8%	-
Solid waste disposal costs				
Cost	17%	57%	3%	31%
No costs	83%	43%	97%	69%
Methods of solid waste disposal				
Burning of waste	61%	-	26%	-
Backyard disposal	12%	-	22%	-
Open land dumping	27%	-	52%	-
Composting	-	46%	-	50%
Recycling	-	42%	-	50%
Landfill	-	12%	-	-

Nearly 60% of high-income respondents in Makhanda incurred waste collection costs from own private arrangements illustrating poor waste collection service and affordability, compared to only 31% in Knysna. Regarding waste disposal practices, the findings show that burning of waste was reported by more respondents in Makhanda (61%) than in Knysna (26%), but only low-income households reported the practice in both towns. Most respondents in Knysna's low-income areas (52%) practiced open-land dumping as their main method of waste disposal as compared to only 27% in Makhanda. Nearly half of the high-income respondents in

Makhanda (46%) composted their organic waste, while 42% recycled their HSW. A slightly high but comparative proportion in Knysna's high-income respondents (50%) composted and recycled their waste.

4.4.3 Factors contributing to illegal solid waste dumping

Table 4.3 summaries the perceived factors behind the practice of ISWD. Within both towns poor municipal services followed by social norms were stated as the main factors behind ISWD by mostly low-income respondents.

Table 4.3. Summaries of the reasons for illegal solid waste dumping

Reasons	Makhanda			Knysna		
	Low-income (n=64)	High-income (n=30)	Total (n=94)	Low-income (n=86)	High-income (n=13)	Total (n=99)
Poor municipal services	59%	42%	54%	54%	-	45%
Social norms	35%	25%	32%	35%	10%	29%
Lack of bins	6%	-	8%	11%	-	11%
Informal waste picking	-	33%	6%	-	90%	15%

A sizeable proportion of respondents across the study towns attributed ISWD to poor municipal services but more respondents in Makhanda (54%) than in Knysna (45%) reported so. A respondent from Makhanda said, "The municipality's services are often irregular, and not dependable they spend upwards of two to three weeks without coming so we have given up and decided to just privately outsource waste collection services." Commenting on the perceived lack of solid waste removal in Knysna, a low-income respondent said, "The municipality does not come and collect waste at our homes due to the steep terrain they make us drop-off our refuse bags on the street corner on the main highways which is too far and not easy to reach whilst carrying refuse bags." During data collection it was observed that within the fringe of formal settlements they were informal settlements that were hard to access with any sized vehicle especially difficult for a large municipal waste collection vehicle. The second most cited reason behind ISWD was social norms. Analysis by income group showed that 35% of low-income respondents in Makhanda and Knysna reported social norms as an explanatory

factor behind ISWD citing socialisations and normalisation of unsustainable household solid waste management practices, fewer respondents from high-income areas in Makhanda (25%) and Knysna (10%) reported social norms. Other reasons for ISWD reported by household participants include lack of waste/refuse bins and informal waste picking but the latter was cited by high-income respondents only in both Makhanda (33%) and Knysna (90%). Referring to informal waste picking as a contributing factor to ISWD in Knysna one high-income respondent said, "Municipal waste collection services delays lead to informal waste pickers taking refuse bags and dumping their contents in vacant spaces in search of recyclables and sometimes edible food scraps."

4.4.4 Perceived impacts of illegal solid waste dumping

Table 4.4 summaries the perceived negative impacts of ISWD reported household by the study respondents. Visual pollution was the most cited environmental impact in both towns and across income groups.

Table 4.4. Summaries of the perceived impacts of ISWD

Impacts	Makhanda			Knysna		
	Low income (n=64)	High income (n=30)	Total (n=94)	Low-income (n=86)	High income (n=13)	Total (n=99)
Environmental impacts						
Visual pollution	95%	92%	73%	92%	100%	67%
Poor air quality	4%	8%	26%	6%	-	31%
Water pollution	1%	-	1%	2%	-	2%
Livestock illness	42%	7%	25%	5%	-	7%
Health impacts						
Asthma	32%	-	25%	27%	-	29%
TB	34%	-	27%	24%	-	19%
Rashes	17%	-	14%	42%	-	7%
Gastrointestinal diseases	17%	-	34%	7%	-	45%

However, the analysis by income group shows that a substantial proportion of high-income households was mainly concerned with visual pollution. Poor air quality and surface water

pollution were also mentioned but by a comparatively low proportion of respondents, with respondents citing bad odours and gaseous toxins in their localities. Livestock illness was also stated as an impact of ISWD but more low-income than high-income households only in Makhanda (42%) and Knysna (5%) reported so. In both towns only low-income households reported health related impacts including Asthma, TB, rashes, and gastrointestinal diseases.

4.4.5 Potential interventions for addressing ISWD

Table 4.5 summaries the potential interventions for ISWD reported by the respondents in the two study towns. Within both towns, a considerable proportion of respondents stated service delivery improvements as a potential intervention for ISWD but more respondents in Makhanda (61%) than Knysna (49%) stated so. Other interventions cited include education and awareness, waste/refuse bin provision and strict penalties on ISWD.

Table 4.5. Summaries of potential interventions regarding ISWD

Attribute	Makhanda			Knysna		
	Low income (n=64)	High-income (n=30)	Total (n=94)	Low-income (n=86)	High-income (n=13)	Total (n=99)
Service delivery improvements	63%	74%	61%	48%	57%	49%
Educating communities	23%	26%	22%	28%	14%	26%
Bin provision	8%	-	10%	16%	-	15%
Strict penalties (bans & fines)	6%	-	7%	8%	29%	10%

4.5 Discussion

4.5.1 Prevalence of ISWD

The South African government has numerous polices and legislations related to HSW management and the promotion of environmental and social cleanliness/sustainability (South African Government, 2022). Despite this the practice of ISWD still remains a huge social, economic, and environmental challenge particularly within low-income areas inhabited by the urban poor (Abel, 2014; Haywood et al., 2021; Kalina, 2023; Kubanza et al., 2020). The results of the study showed that ISWD disproportionately affected low-income household residents compared to high-income households. The results of the study suggest that ISWD is prevalent

predominantly in low-income areas owing to numerous factors such as poor waste collection services, lack of support i.e., infrastructure for waste disposal knowledge and a perceived lack of awareness and behaviour. This is supported by the fact that only low-income respondents reported burning and open-land dumping as a waste disposal practice. High-income respondents showed a prominent level of engagement in environmentally friendly waste disposal practices such as composting and recycling. Given that well-off households generally have bigger gardens, it is plausible to suggest there is a need for organic manure and sufficient space for composting. Further, well-of households might have sufficient awareness about local recycling centres such as Ght Recycling in Makhanda and Old Place Garden waste drop-off point in Knysna, as well as resources to transport recyclable materials to the centres, which low-income households might not have.

4.5.2 Perceived impacts of ISWD and heterogeneity among income groups

Poor municipal waste collection services result in ISWD occurrence and later poses risks to environmental, livestock, and human health. Previously conducted studies in South African urban areas showed that low-income group areas disproportionately faced significant health impacts of ISWD linked to poor municipal service provision and limited income to outsource private waste collection services (Mangoro, 2020; Niyobuhungiro and Schenck, 2022; Polasi, 2018; Kubanza and Simatele, 2020). A recent study by Ngalo and Thondhlana (2023) conducted in Komani in the Eastern Cape province of South Africa showed how poor municipal waste collection services in low-income areas resulted in widespread ISWD and was perceived as posing significant risks to human, livestock, and environmental health. The results of the study showed similar findings as larger proportions of low-income residents perceived that poor municipal service provision was behind ISWD with negative impacts on their health and the environment. The respondents were concerned with illnesses such as TB, Asthma, and gastrointestinal diseases due to exposure to illegal household solid waste dumpsites. Similar findings were also shown in other recent studies conducted in South Africa by Bangani et al. (2023), Haywood et al. (2021), Grangxabe et al. (2023) and Niyobuhungiro and Schenck (2022) to mention a few. A key result related to impacts is the differences in perceptions of impacts of ISWD. Most high-income respondents were concerned with visual pollution that negatively affects aesthetic beauty and recreational activities. This concern is plausible because Knysna is one of the top tourist destinations in South Africa hence ISWD might affect people's ability to enjoy benefits such as walking, running, and swimming. Studies show that debris washed up on coastlines can decrease the aesthetic appeal of seascapes and other marine

environments (Bolívar-Anillo et al., 2023). People's direct interaction with nature is known to result in multisensory experiences of nature, positive mood, and tourism experience (Zabini et al., 2020). Therefore, it is plausible to suggest that ISWD might negatively affect such positive experiences.

4.5.3 Municipal governance and ISWD

Waste collection services are regarded as basic services and in South Africa and are a constitutional right that should be consistently and efficiently provided to all residential areas. Failures to provide these basic services by local governments are an indication of poor or dysfunctional governance structures which disproportionately affect the urban poor who lack sufficient income to outsource waste collection services (Kalina, 2023; Irvine, 2021). In the case of this study municipal waste collection was constrained by the emergence of informal settlements with no proper infrastructure such as roads and bins for waste collection services to be rendered. In the case of Knysna, all informal settlements encountered were on steep terrains with very limited access and untarred roads, such that collection of waste in these areas was nearly impossible. While ISWD was reported in both Makhanda and Knysna, ISWD was common in both low- and high-income areas in Makhanda but only among low-income areas in Knysna. A substantial proportion of high-income households in Makhanda reported costs associated with outsourcing private waste collection services, thus suggestive of poor municipal service provision.

The differences in the prevalence of ISWD suggests that governance is central to municipal service delivery such was waste collection. Municipal service delivery challenges within South African urban areas are quite common and have been reported elsewhere as being inconsistent, inadequate, and unevenly distributed across income group areas (Kalina, 2023; Kanyane, 2014; Netswera, 2014; Schenck et al., 2022; Ngalo and Thondhlana, 2023). Weekly refuse collection rates in the Eastern Cape province where Makhanda is situated were reported to be 38% in 2019 and in contrast in the Western Cape province they were significantly higher approximately 86% (Governance Performance Index: South Africa, 2021). Poor municipal service provision in Makhanda has been an on-going crisis since 2014 (Makana Municipality IDP, 2022). In 2019 residents of Makhanda protested poor municipal waste collection services, residents barred roads with their uncollected household solid waste bags (Mahr, 2019). The Makana municipality following the protest has had many legal battles with residents from Makhanda

East who filed complaints against the municipality to the district and provincial government structures (Kalina et al., 2023).

4.6 Conclusion

This study shows that illegal solid waste dumping is an urban sustainability concern in the study towns, but it is variable by municipal governance and income status of the residents. Consistent with studies elsewhere, poor municipal services, is central to the problem of ISWD but this is compounded by a historical legacy of separate development policies, rapid rate of urbanisation as seen in the growth of informal settlements and individual level practices. While ISWD affects everyone, the disproportionate impact on low-income households is real and should be factored in developing strategies for addressing ISWD. For example, equitable approaches to waste collection might mean that waste collection frequency should be higher in low-income areas than well-off areas due to high densities of people and the propensity to generate more waste, and limited options for dealing with solid waste in the former. The study also contributes to debates on service delivery in general by highlighting the key role of municipal governance and good administration in providing basic services to residents.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

Increasing domestic solid waste (SW) generation is a global problem, particularly in developing countries where illegal solid waste dumping (ISWD) has become a standard practice due to numerous factors (Bundhoo, 2018). Current literature on ISWD suggests that the practice is on the rise and will likely exacerbate the current social, economic, and environmental impacts, being faced worldwide (Alves, 2023; Bundhoo, 2018; Kaza et al., 2018; Syrafudin et al., 2023; Viljoen et al., 2021). The factors leading to the practice of ISWD, and its subsequent impacts are vast and vary across geographical regions (Nanda et al., 2021; Yang et al., 2019). Some identified key factors leading to the practice of ISWD include rapid population growth, urbanisation, economic growth, consumerist culture, poor waste management systems, high disposal costs, socio-economic inequalities, historical legacies, and social norms (Abubakar et al., 2022; Haywood et al., 2021; Syrafudin et al., 2023). The prominence or lack thereof of ISWD across different income group areas is influenced by geographical location, residents' lifestyle, income levels (low or high), lived experiences, and community norms/behaviours (Abel, 2014; Abubakar et al., 2022; Guerrero et al., 2013; Yang et al., 2019). Studies conducted in developing countries have shown ISWD as occurring prevalently in low-income areas in contrast to high-income areas, because of but not limited to poor municipal services, high disposal cost and socio-economic inequalities which are disproportionately experienced by low-income residents (Bundhoo, 2018; Oteng-Ababio et al., 2013; Valavandis, 2023).

The practice of ISWD within residential areas poses significant risks to environmental, animal, and human health (Eberhard, 2018; Sharm and Jain, 2020). Households generate various kinds of waste materials and when not treated properly can lead to the contamination of soils, air and water sources thus posing significant risks to human and animal health (Gahill, 2020; Siddiqua et al., 2022; Sharm and Jain, 2020). Indeed, several studies have reported social, economic, environmental and health effects linked to ISWD (Bangani et al., 2023; Kimani, 2020; Ngalo and Thondhlana, 2023; Ngeleka, 2010; Sharm and Jain, 2020; Siddiqua et al., 2022). Action needs to be taken to develop effective interventions if the consequences of ISWD are to be managed. To develop effective interventions, information regarding ISWD location, sizes,

composition, and household practices and perceptions is needed. This project aimed to do that by using both quantitative and qualitative techniques to assess dumpsites in two medium-sized towns of Makhanda and Knysna which are in Eastern and Western Cape provinces of South Africa, respectively. Specifically, the research project aimed to address the following key questions, (i) What is the spatial extent (location, density, and distribution) of ISWD in the two towns across low- and high-income neighborhoods? (ii) What is the composition of solid waste materials present within encountered illegal dumpsites in the two towns? (iii) What are households' practices and perceptions of causes and impacts of ISWD across low- and high-income neighbourhoods within the two towns? (iv) What are household's perceived potential interventions for addressing the issue of ISWD and how do they vary across low-income and high-income neighbourhood residents within and between the two towns?

5.2 Summary of key findings

5.2.1 Uneven distribution of illegal dumpsites

Results of this study showed that ISWD was unevenly distributed across different income neighbourhoods within the two towns. Within both towns, dumpsites were predominantly located in low compared to high-income neighbourhoods. Although the prevalence of dumpsites in low-income areas has been reported in some studies (Kalina, 2023; Kubanza, 2021; Ngalo and Thondhlana, 2023; Polasi, 2018), a key result from this study is the confirmation that high-income areas have fewer dumpsites occurrence. The uneven distribution of dumpsites across different income group areas can be attributed to several factors such as poor municipal waste collection services in low-income areas, existing spatial segregation in South Africa which emanates from historical discriminatory apartheid laws, limited financial resources by low-income households that prevents residents from acting like hiring private disposal companies, and social norms within communities. The above-mentioned factors that could explain the study results have been reported in the past (Kalina, 2023; Godfrey et al., 2020; Reddy and Mncwango, 2021). A key result in this study is that the household interviews also observed similar patterns with more households in low-income areas reporting the problem of dumpsites as compared to their counterparts in high-income areas. This is important as the social data confirmed the observed ecological mapping data.

5.2.2 Dumpsite size and distribution across different income neighbourhoods

Apart from occurrence of dumpsites being high in low-income areas compared to high-income areas, the large dumpsites identified were also predominately in low-income areas, and this pattern was observed in both towns. Most of these dumpsites were in open spaces like roadsides, commonages, and along riparian zones. Indeed, dumping is most common in open public spaces as has been reported in the past (Abel, 2014; Kimani, 2020; Ngalo and Thondhlana 2023). Some of these open areas are ecologically sensitive areas like riparian zones, thus ISWD raises the issues of both environmental and human health issues. Indeed, most interviewed households in low-income areas raised the issue of health risks like TB, asthma, and skin rashes. The fact that residences in low-income areas raised these health issues could be linked to the high number of dumpsites in their communities and lack of financial resources to deal with health-related issues potentially caused by ISWD as compared to their counterparts in high-income areas who mostly have stable financial resources and only reported visual pollution as the most prominent impact of ISWD (Table 4.4).

5.2.3 Dumpsite waste composition

Solid waste composition within dumpsites in both towns consisted predominately of household and garden waste materials. This result aligns with suggestions that urban solid waste is dominated by household waste given the high number of households in cities and towns (Nagpure, 2019). With increased urbanisation and food consumption levels, the reported ISWD composition seem to indicate that the problem might increase in future thus triggering more health and environmental contamination impacts. This speaks to the broader issues of educating communities beyond the issues of dumping to include issues of consumption patterns and sustainable ways to reduce food waste.

5.2.4 Reasons for ISWD

Households reported that poor municipal services, social norms, and lack of resources such as public bins are key reasons for dumping. It is important to note that most of these reasons were reported in Makhanda as compared to Knysna an indication that perhaps Knysna is taking some action to address some of these ISWD drivers. This broadly speaks to issues of municipal efficiencies within Knysna being better than Makhanda. These mentioned drivers seem to

imply that interventions need to counter these by addressing them directly. For example, poor municipal services can be addressed by improving municipal waste management plans or budgets and the adoption of pro-poor waste management initiatives. Similarly, factors like social norms can be addressed by educational campaigns in communities.

Taking everything together some key themes emerging for this study, firstly, results of this study show that ISWD is happening in the two towns and that the problem is more pronounced in low- than high-income areas. Secondly, the composition of identified waste mirrors consumption patterns in urban areas with more household waste products such as food and plastic waste products. Thirdly, the problem of ISWD has several drivers but the key driver raised by participants within both towns was the poor services by municipalities. Fourthly, given that medium-sized municipalities in South Africa are generally struggling, results of this study are applicable in other medium-sized towns. Fifth, South Africa's apartheid legacy of spatial segregation could explain some of these results, especially the observation that more dumpsites are in low-income areas in contrast to high-income areas. Lastly, and conclusively social, and behavioural norms could also be at play when it comes to ISWD in the two towns, as residents particularly from low-income neighbourhoods stated during household interviews that social norms and a lack of societal care were contributing to ISWD within their localities.

5.3 Recommendations

Based on these results, the following recommendation are made.

- Municipalities in South Africa need to improve waste management and come up with effective plans that have potential to reduce illegal dumping. This could be in the form of increased waste collection frequency and erecting bins in public spaces. To achieve this, financial funding for waste management needs to be available or sources from the national government. Given that corruption is a problem in South African, financial resources allocated for waste management or any other service delivery issue need to be effectively managed and audited.
- Municipalities need to invest in interventions meant to reduce ISWD. These could be in the form of erecting waste drop-off points, municipal or communal Skips (large garbage storing containers) and providing bins to people so that they can store their waste as they await collection. For example, a study conducted in Ash Road, within the Liverpool Council showed that investing in erecting accessible landfills, recycling and drop-off

points had a significant impact on reducing ISWD and preventing crime within the area (Crofts et al., 2010).

- Awareness and education campaigns need to be prioritised by municipalities or NGOs that deal with waste in urban areas. Besides just educating communities about the negative effects of ISWD, these awareness campaigns should also aim to address behavioural issues linked to dumping. To be effective, education campaigns should use all available media channels to reach a wide audience. Examples could be community radio, television, and social media platforms like X and Facebook. The Oregon government in the United States for example has utilised various programs (Adopt a neighbourhood or Street program) using social media platforms and their municipal online site to raise awareness on ISWD, and these educational campaigns have been reported by the Oregon Department of Waste Reduction as being exceptionally successful (Oregon Government, 2024).
- Given that the problem of ISWD is already happening, an immediate recommendation is to plan clean-up campaigns to remove existing dumpsite. Clean-up campaigns can be expensive therefore other organisations like NGOs, churches and private companies can be approached and assist as part of their social responsibility.
- There already exist municipal by-laws that prohibit ISWD, therefore municipalities must start to enforce these by-laws. To further strengthen them fines and penalties linked to ISWD could be introduced, since fines tend to deter certain activities like dumping. However, where penalties are used, poor households should be considered as they might not be able to pay fines given their limited financial resources. Therefore, penalties or fines need community/stakeholder engagement before they are implemented. For example, In China, Hao and Xu (2023) reported that the strict enforcement of penalties and fines spearheaded a culture of sustainable solid waste management amongst citizens and led to drastic decreases in ISWD occurrence.
- Lastly, further studies on ISWD must consider the following areas: (i) assessing the magnitude of illegal waste dumping at national, provincial and district levels, (ii) studies on the environmental and human health related effects of illegal waste dumping, (iii) assessment of the financial effects of ISWD to municipalities and other related industries like tourism, and (iv) lastly, an assessment of the potential income and employment opportunities linked to informal waste picking and recycling.

APPENDIX 1. Street survey and waste categorisation template

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Household solid waste street survey and categorization template

Town:

Dump No.:

#	Information	Description			
1	Street name				
2	Coordinates				
3	Residential type	High density-township	Medium density-suburb		Low density-suburb
4	Dump size-subjective measurement	Small	Medium		Large
5	Location	Roadside	Vacant plot	Commonage	River/Stream
6	Area/vicinity	School	Housing	Industrial area	Other
7	Any direct observations e.g., fires, livestock				

Household waste categorisation template

#	Waste material	Estimated volume %
1	Household	
2	Garden	
3	Construction	

APPENDIX 2. Household Questionnaire survey

Questionnaire no: _____ Date: _____

Field worker name: _____

Town: _____

Neighborhood : Low density [] Medium density [ ] High density township [ ]

Random sample point no._____

****

SECTION A: RESIDENTS' PRACTICES OF SOLID WASTE DISPOSAL

1) How does your household dispose solid waste materials?

a) Open land dumpsites
b) Burning of waste
c) Composting
d) Backyard disposal
e) Recycling
f) Landfill
g) Other

2) Person(s) primarily responsible for disposing of solid waste in the household?

_____
_____
_____

3) Frequency of disposal?

a) Daily
b) Weekly
c) Twice a week
d) Monthly
e) Twice Monthly
f) Other

4) Is there money spent on the disposal method? Yes [ ] No [ ] If yes, how much is spent and for what?

_____

5) Does the municipality offer waste collection services in the area? Yes [ ] No [ ]

If yes, how frequent is this service? _____

SECTION B: PERCEPTIONS ON THE DISTRIBUTION AND IMPACTS OF SOLID WASTE DISPOSAL

6) What impact does poor SWD practices have on the surrounding environment?

_____

_____

_____

7)What consequences has solid waste dumping had on people living in your area? For example, health, livelihoods, livestock, investment?

_____

_____

_____

8)What kind of health consequences have you experienced or are aware of from poor management of solid waste?

_____

_____

_____

9) Who would you say is responsible for the disposal of solid waste?

a) Municipal authorities
b) Private companies
c) Households
d) NGOs
e) Other

10) From your perspective, what factors contribute to illegal solid waste dumping?

_____

_____

_____

11) What could solve the problem of illegal solid waste dumping?

_____

_____

12)Would you be open to learning about environmentally friendly solid waste disposal practices? Yes [ ] No [ ]

SECTION C: RESPONDENT'S PROFILE

13) How long have you lived in this town? _____
14) What year were you born? _____
15) What is your highest level of education? _____
16) What is your home language? isiXhosa [ ] isiZulu [ ] Afrikaans [ ] English[ ] Other [ ]
17) Gender? Female [ ] Male [ ] Non-binary [ ] Other [ ]

Number of people in the household? _____

18) What is your employment status? Employed [ ] Self-employed [ ] Unemployed [ ] Pensioned [ ]

19) What is the biggest source of your household income?

Wages [ ] Social grants [ ] Private pensions [ ] Own business [ ]

20) Please indicate the broad range of your household monthly income (Rands)

<2,000 [ ] 2,000 – 6,000 [ ] 6,000 – 15,000 [ ] 15,000 – 30,000 [ ] > 30,000 [ ]

21) Are you a member of any environmental society/agency/NGO? Yes [ ] No [ ]

Comments

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