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"So Connected yet so Distant": Integrated Sanitation Action in Campinas to Meet the SDGs

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Abstract

Research shows that improving sanitation brings wide-ranging benefits across multiple sectors, contributing not only to the success of UN Sustainable Development Goal (SDG) 6—focused on clean water and sanitation—but also to the broader objectives of the 2030 Agenda. However, many people living in Brazil's urban areas still lack adequate sanitation and essential services, with these deficiencies being especially prevalent in informal settlements. This article is an output from a participatory research project that explored the links between sanitation and the SDGs, which focused on the municipality of Campinas in São Paulo state with an emphasis on informal settlements because they are disproportionately affected by service provision inadequacies. Findings highlight multiple synergies between sanitation action and the achievement of targets across SDGs, whereby residents are likely to experience wide-ranging benefits from adequate sanitation. They further point to the need for multi-sectoral, participatory, and context-specific policies, plans, and interventions to overcome interconnected risks associated with inadequate sanitation. The authors advocate for a transdisciplinary approach to dealing with complex societal problems and conclude by presenting opportunities for integrated policies and action across key stakeholders. The article further offers valuable reflections and lessons learned for how we approach development and engage with complex challenges post-2030.

Keywords

Brazil; informal settlements; participatory research; sanitation; São Paulo; sustainable development goals

1. Introduction

In 2010, access to clean water and sanitation was recognised by the UN as a fundamental human right. Five years later, sanitation became a distinct human right requiring separate treatment from water to address sanitation-specific challenges (Office of the United Nations High Commissioner for Human Rights, 2015), an important milestone that raises the profile of sanitation internationally. Also, 2015 marks the launch of the UN 2030 Sustainable Development Agenda which member states have committed to through an interrelated set of 17 Sustainable Development Goals (SDGs) with 169 targets. SDG6—the goal for water, sanitation, and hygiene—specifically aims to achieve by 2030 "access to adequate and equitable sanitation and hygiene for all, and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations" (United Nations, 2015, SDG target 6.2).

While the benefits for public health are widely acknowledged (e.g., see Mara et al., 2010), adequate sanitation further plays a crucial role in relation to several other aspects of sustainable development. This is evidenced in a growing body of work examining the relationship between sanitation and the SDGs. A global study by a multidisciplinary team from University College London (UCL), identified numerous SDG targets that necessitate action on sanitation and further highlights synergistic linkages between sanitation and more than two-thirds of SDG targets, which implies that sanitation action can support the achievement of a target and vice versa (Parikh et al., 2021). Similar results emerged when the group of researchers applied the same methodology to the context of Brazil (Diep et al., 2020). Both studies clearly emphasise the need for more localised, context-specific explorations of linkages to develop integrated policy and action. Yet, siloed approaches prevail, and sanitation continues to be sidelined and under-funded despite its importance in the water supply, sanitation, and hygiene sector and the wider benefits of sanitation improvements for urban development and sustainability (Bobbins et al., 2023; Norman et al., 2021; Schertenleib et al., 2021; Scott et al., 2019). This goes hand in hand with a general persistence of siloed policy and planning approaches even though "almost every social or political problem has multiple components" that do not fall "clearly into any one discipline's exclusive domain. Therefore, to gain a complete appreciation of the phenomenon, many relevant orientations must be utilized and integrated" (DeLeon & Vogenbeck, 2006, pp. 4–5). Cole and Low (2023) argue for a need to rethink how we address complex challenges to prevent unjust outcomes that perpetuate inequity and exclusion, in this case in reference to climate-related concerns. Both align with the principles of transdisciplinarity that aim to bridge academic and societal knowledge to address complex problems. Lang et al. (2012, pp. 26–27) define transdisciplinarity as a "reflexive, integrative, method-driven scientific principle aiming at the solution or transition of societal problems and concurrently of related scientific problems by differentiating and integrating knowledge from various scientific and societal bodies of knowledge." It is thus oriented towards solutions that are aimed at transformation. Policy sciences offer an approach that is based on such principles as it is grounded in problem-focused analysis and action, rather than guided by disciplinary theories and methods, and consequently relies on integrated inputs from multiple disciplines and sectors (Faria, 2018). Although Brazil has seen increasing legitimisation and institutionalisation of policy sciences across academic, governmental, and societal spheres, there remains a significant journey to transition fully from multidisciplinary approaches to transdisciplinarity in policy and practice (Faria, 2018). Facilitating and guaranteeing inputs from all communities of knowledge proves challenging. All too often, broadening participation in a way that enables active and meaningful engagement of all actors, particularly with regard to less powerful and more marginalised groups, remains difficult, including in the sanitation sector (Lang et al., 2012; Tippett & How, 2020).

Since 1988, the Brazilian Federal Constitution has recognised access to basic sanitation as a fundamental right, thereby requiring all levels of government to take responsibility for improving sanitation services and play a key role in delivering the SDGs, particularly at the local level (Bilsky et al., 2021; de Barcellos, 2014). Yet, according to the National Information System on Sanitation (Sistema Nacional de Informações sobre Saneamento) approximately 35 million people still lack access to drinking water supply services and 100 million to sewage collection, with significant challenges regarding treatment (Sistema Nacional de Informações sobre Saneamento, 2023). With deficits for both water supply and sanitation unevenly distributed, municipalities across Brazil tend to prioritise water supply networks over sanitation improvements (Marcon & Philippi, 2010). In urban areas, service shortfalls are especially severe in informal settlements, and progress to improve access has been slow. This is partly due to a constitutional tension between the right to property and the right to water supply and sanitation. Legally, formal service providers are only allowed to serve households with proof of ownership. While advances have been made for provisional water supply connections in the absence of formal tenure, sanitation provision is more complex and thus informal dwellers largely rely on local, and often inadequate, sanitation solutions (Hylton & Charles, 2018; Narzetti & Marques, 2021). Access to services in informal settlements is assumed to be below official statistics but disaggregated data to understand intra-urban disparities, particularly in informal settlements, is limited (Narzetti & Marques, 2021; Snyder et al., 2013). Informal settlements are characterised by unplanned urbanisation and a concentration of low-income dwellers with reduced access to education, the labour market, and financial credit, largely because they lack proof of residence. According to the 2022 census carried out by the Brazilian Institute of Geography and Statistics, there are more than 6,300 irregular settlements in the country, corresponding to around three million households and approximately 11 million residents; of these, around 88% are concentrated in metropolitan regions (Instituto Brasileiro de Geografia Estatística, 2022). These are defined as "clandestine, irregular or where it has not been possible to carry out land titling for their occupants" (Government of Brazil, 2020).

The 2020 Legal Framework for Basic Sanitation (Law 14026/2020) has transformed Brazil's sanitation sector by promoting private sector participation to attract investments but without a clear pro-poor legal direction for universal access in low-income informal settlements (Narzetti & Marques, 2021). Historically, Brazilian policies, including those related to sanitation, have largely overlooked informal settlements and failed to address their specific needs (Ministério do Desenvolvimento Regional, 2019). Although the National Basic Sanitation Plan does not treat sanitation merely as infrastructure, placing emphasis on the quality of services and acknowledging the impact of socio-economic and cultural factors in sanitation shortcomings, Table 1 shows that these do not influence how access to services is categorised and monitored.

As will be elaborated below, inadequate sanitation in informal settlements has affected inhabitants negatively in multiple ways. At the same time, the provision of adequate sanitation has the potential to enhance different aspects of people's lives. This article offers a localised examination of the links between sanitation and the SDGs in a municipality of São Paulo state as a basis to advance safe and inclusive sanitation solutions through integrated action. Specifically, it focuses on the municipality of Campinas with particular emphasis on informal settlements where sanitation deficits and their implications are more pronounced. It seeks to promote the development of integrated strategies—encompassing policies, programmes, and initiatives—to enhance access to sanitation and advance sustainable urban development. Research findings highlight the wide-ranging benefits of improved sanitation, such as better public health, increased resilience to climate change and disasters, and a reduction in social inequalities. They further

Table 1. Characterisation of service provision deficits adopted by the National Basic Sanitation Plan.

Component	Adequate provision	Deficit	
		Inadequate provision	No provision
Drinking water supply	Uninterrupted supply from the network or by well, spring, or cistern	• Among the group with water supply connected to the network, or well, or spring, the proportion of households that: (a) have no internal plumbing; (b) receive water that does not meet drinking water standards; and (c) have intermittent supply • Use of cisterns for rainwater, which provides water that is detrimental to health, or in insufficient quantity to protect health • Use of a tank supplied by a water tanker	All situations that do not fall within the scope of the guidelines and that constitute practices considered inadequate
Sanitation	• Sewerage connection with treatment • Use of septic tank	• Sewerage connection without treatment • Use of unimproved pit latrines	

Source: Adapted from Ministério do Desenvolvimento Regional (2019, p. 35).

identify context-specific risks associated with the current provision of sanitation services that need addressing. Considering the integrative nature of the SDGs, and the extensive benefits of sanitation action, the article advocates for transdisciplinarity to foster collaborative policies and action between various stakeholders.

Section 2 presents the methodology adopted, followed by contextual information about the municipality of Campinas and the provision of services, with a specific focus on informal settlements. Section 3 discusses the identified synergies and risks between sanitation and the SDGs followed by a discussion on the potential for integrated sanitation action in informal settlements. Section 6 presents potential avenues to foster transdisciplinary approaches for integrated policies and action and offers valuable reflections and lessons learned for how we approach development and engage with complex challenges post-2030.

2. Methodology

This article is the outcome of a collaborative research between the Bartlett Development Planning Unit at UCL and the Fundação Escola de Sociologia e Política de São Paulo. It builds on the above-mentioned work at UCL exploring the linkages between sanitation and the SDGs (Diep et al., 2020; Parikh et al., 2021). The research directly responds to the need for localised case studies to aid the development of context-specific action. Methodologically, the SDGs form part of an analytical framework that is based on an approach developed by the UCL team in collaboration with eThekwini municipality for a study in Durban, South Africa, which constitutes the first localised mapping of linkages between sanitation and the SDGs. It adds the mapping of contextual risks associated with the provision of sanitation infrastructure and services to the original methodology, which focused on synergies and trade-offs between sanitation and the

SDGs (for further details, see Carbonell et al., 2023). The identification of risks helps to reveal the implications of inadequate sanitation systems that require attention in future sanitation interventions.

The research underpinning this article focused specifically on the context of informal settlements where sanitation action is most pressing. The municipality of Campinas was chosen as the case study due to ongoing efforts by the public utility company Sociedade de Abastecimento de Água e Saneamento S/A (SANASA) to enhance service provision in informal settlements and a keen interest to link their work to the SDGs. As discussed in more detail in Section 3.1 below, SANASA has put considerable effort into improving service provision in informal settlements, particularly water supply. Regarding the SDGs, as a signatory to the UN Global Compact since 2012 (an international corporate sustainability initiative geared towards advancing human rights and societal goals—https://unglobalcompact.org), the utility has issued yearly sustainability reports since 2012. The most recent report shows how SANASA uses the SDGs as a framework to monitor and communicate how their actions not only support the achievement of SDG6 but further contribute to meeting all 17 SDGs (see SANASA, 2025, pp. 136–137). The aim of the research was threefold: (a) to explore localised synergies between sanitation and the SDGs that can be harnessed through more integrated sanitation interventions; (b) to identify contextual risks associated with inadequate sanitation systems; and (c) to use the insights from (a) and (b) to reflect on the potential for more integrated policy and practice in Campinas and beyond. The team selected six priority SDGs for in-depth examination with relevance for informal settlements: health and well-being (SDG3), gender equality (SDG5), clean water and sanitation (SDG6), reduction of inequalities (SDG 10), sustainable cities and communities (SDG 11) and action against climate change (SDG 13). We adopted a definition of sanitation aligned with SDG 6.2 (see Section 1 above) acknowledging that ensuring adequate and equitable access for all goes beyond infrastructure alone and requires the safe management of sanitation across the entire service chain. While the basic definition of sanitation in Brazil encompasses water supply and solid waste management, this article adopts a more internationally recognised definition. We limit sanitation to the provision of facilities and services for the management and disposal of liquid waste, including human urine, faeces, sewage, and wastewater (see Diep et al., 2020). Thus, we further distinguish between water supply and sanitation. The article uses "sanitation" as an umbrella term to cover various aspects while referring to specific elements of sanitation when necessary.

The research was conducted between November 2022 and February 2023, involving the collection and analysis of both primary and secondary data. The secondary data review encompassed scientific literature, NGO publications, news articles, policy documents, municipal plans, and legal texts. This process aimed to identify existing synergies between sanitation and the SDGs across various policies, plans, and interventions, while also drawing attention to the consequences of disjointed or conflicting approaches. Evidence from informal settlements primarily served to examine contextualised risks associated with sanitation infrastructure and services. This was complemented by primary data collection involving: two meetings with the public utility company; a focus group discussion (FGD) with representatives of the utility, the Housing Department, the Health Department, and the Environmental Department; two visits to the informal settlement of Sítio Paraíso, including a transect walk; and a FGD with a mixed group of 20 residents and an interview with representatives of the Housing Department. Sítio Paraíso was selected for primary data collection as it displays a variety of sanitation solutions and practices. The article draws on a previously developed policy brief presenting research findings and evidence-based recommendations that is available in English and Portuguese.

3. Context-Setting

The municipality of Campinas is the capital of the metropolitan region of Campinas in the state of São Paulo with a population of 1,139,047 inhabitants (Instituto Brasileiro de Geografia Estatística, 2022). It is one of the wealthiest and most important cities in the country with a diversified economy and one of the most advanced technological centres. At the same time, the city is characterised by informal land and housing development in a state with the largest housing deficit in absolute terms, forcing low-income households to settle in environmentally sensitive areas with heightened exposure to multiple risks (da Silva & Samora, 2021). The 2022 census indicates that 140,784 inhabitants, equivalent to 12.4% of the population, live in informal settlements, significantly higher than the national percentage of 8.1 (Instituto Brasileiro de Geografia Estatística, 2022). The Municipal Housing Department (Secretaria Municipal de Habitação [SEHAB]) has registered and categorised 327 informal settlements on a visual platform (see Figure 1). Accordingly, 236 settlements are classified as areas of social interest, 72 settlements as areas of specific interest, and the rest are unclassified (Velloso, 2023). While both refer to informal urban centres, the former are occupied primarily by low-income dwellers for whom self-building and cohabitation with deficient

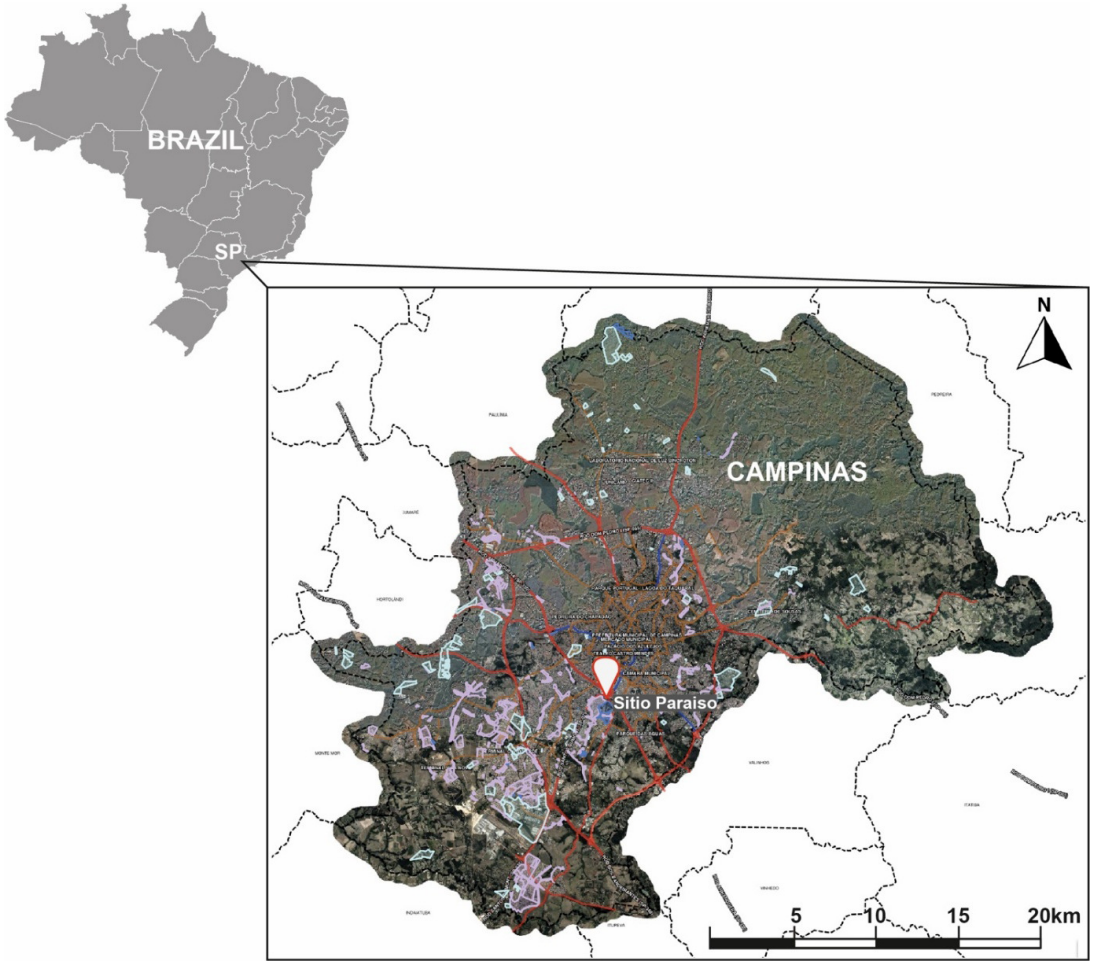

Figure 1. Map of informal settlements in Campinas and location of Sítio Paraíso. Notes: Purple signifies areas of social interest and turquoise areas of special interest; blue areas are not classified. While Sítio Paraíso is the commonly used name, the settlement is registered here as "Taubaté Farm, Remnant Area, Part 1." There is also Part 2, which is another settlement located below Part 1. Source: SEHAB (2020).

infrastructure are a common reality (da Silva & Samora, 2021). Areas of specific interest house middle- to higher-income groups. Each settlement type is considered under separate modalities of the urban land regularisation programme (REURB), with the Programa de Regularização Fundiária de Interesse Social (REURB-S) focused on areas of social interest exempting residents from any fees associated with regularisation (Araujo & Silva, 2022). While SEHAB oversees this process, it is the Companhia de Habitação Popular de Campinas (COHAB), a public company that operates under the broader framework of SEHAB, that implements specific housing projects and programmes, including REURB.

Since 1974, SANASA has been responsible for drinking water supply and the collection, treatment, and disposal of sewage in Campinas. According to available statistics (see Table 2), service provision is well above the average for the state of São Paulo and Brazil and puts Campinas third among the 100 largest cities in the country (Trata Brasil, 2024).

Table 2. Water supply and sanitation services in Campinas, the State of São Paulo, and Brazil.

	Water supply	Sewage collection	Sewage treatment
Brazil	84.92%	56%	52.23%
State of São Paulo	95.21%	90.54%	71.44%
Campinas	99.69%	95.89%	80.32%

Source: Sistema Nacional de Informações sobre Saneamento (2023).

According to the New Legal Framework for Basic Sanitation, which stipulates universal access by December 2033 (measured as 99% for water and 90% for sewage collection and treatment; Government of Brazil, 2020), Campinas has reached its target for water supply and sewage collection but falls short regarding sewage treatment. While the framework allows a 10% deficit for sanitation, SANASA and the municipality aim for 100% access and treatment by 2026 (SANASA, 2024). Nevertheless, sanitation deficits remain a reality in many of Campinas' informal settlements. Research found that 38% of community leaders in informal settlements view access to sanitation as critical, unstable, or concerning, primarily due to inadequate water supply and sewerage services (FEAC, 2020).

3.1. Basic Service Provision in Informal Settlements

Although Brazilian law forecloses utility companies to provide services in settlements without legal land tenure (Narzetti & Marques, 2021), some utilities sought an informal municipal agreement to regularise water supply in informal settlements without changing land tenure status (see Hylton & Charles, 2018, on the Agua Legal programme in the state of São Paulo). This includes an initiative by SANASA in unregularised settlements that connects multiple households to the closest public network through a shared meter. The collective water bill is evenly split among all households, regardless of the number of occupants or how much water each household uses. SANASA has implemented these since 2012 as a temporary improvement measure in settlements awaiting regularisation. They further aim to minimise clandestine connections and avoid water losses and contamination. This pro-poor mechanism applies a social tariff that is less than 25% of the standard water tariff. According to Resolution No. 473–2022 by the regulatory authority for the Piracicaba, Capivari, and Jundaí river basins (Agência Reguladora dos Serviços de Saneamento das Bacias dos rios Piracicaba, Capivari e Jundiaí), the standard tariff for the first 10 m^3 is BRL45.94 while the social tariff is BRL10.87 (£7.49 and £1.77 respectively; Agência Reguladora dos Serviços de Saneamento das

Bacias dos rios Piracicaba, Capivari e Jundiaí, 2022). In 2023, Campinas had installed 1,415 collective meters serving 13,202 families, which corresponds to 52,808 people (an average of 9.3 families per meter; SANASA, 2024). Although this accounts for only an estimated 5% of the municipal population, it constitutes a significant form of improved water supply in informal settlements. However, unauthorised connections made within these collective systems, which exist in some areas, are not included in the official figures. As part of the land regularisation process, SANASA has a programme to convert collective connections into individual ones for improved water access. By 2022, they established 2,660 individual connections with plans for another 2,000 in 2024 (SANASA, 2024).

Tensions between land tenure rights and the right to water and sanitation have significantly hindered the delivery of utility services in Brazil's informal settlements, particularly in relation to sanitation (Hylton & Charles, 2018; Narzetti & Marques, 2021). Consequently, the majority of residents in these areas rely on a range of alternative, often basic, sanitation solutions, as identified through fieldwork in Sítio Paraíso, including the following:

1. Informal household discharge of untreated wastewater into the environment;
2. Informal decentralised sewerage network connecting a group of houses, with untreated discharge into a stream;
3. Septic tanks of varying quality, sometimes shared by more than one household;
4. Simple pits with different construction techniques and of varying quality.

To support onsite sanitation in informal settlements, SANASA runs a complimentary septic tank emptying service for vulnerable or low-income households, provided their water bills are up to date.

4. Findings: Synergies and Interconnected Risks

As per the Brazil study, integrated sanitation action, especially in informal settlements, brings far-reaching benefits across all 17 SDGs (Diep et al., 2020). Yet, such synergistic links are often not realised and there are various risks associated with the current provision of sanitation infrastructure and services that need addressing. This section discusses in detail the (potential) synergies between sanitation and the SDGs in Campinas while also highlighting contextual risks identified in informal settlements. Figure 2 emphasises the interconnectedness of the risks identified between sanitation and the priority goals mentioned in Section 2. It is not exhaustive of all possible risks but rather aims to illustrate interlinkages that are frequently overlooked, as elaborated below.

4.1. Water, Sanitation, Health, and Beyond

Several municipal plans acknowledge the synergistic link between health and improved sanitation (e.g., Prefeitura Municipal de Campinas, 2013b, 2016; SANASA, 2024). Accordingly, SANASA's free septic tank emptying service is an attempt to support safe sanitation practices within legal limits but it does not support the full spectrum of sanitation arrangements in informal settlements. Fieldwork further confirmed that not all informal dwellers know about the service. In Sítio Paraíso, FGD participants never heard of or used it and mainly employ a range of individual and collective self-help initiatives to cope with sanitation inadequacies, many of which are characterised by considerable and interrelated risks. For instance, several households

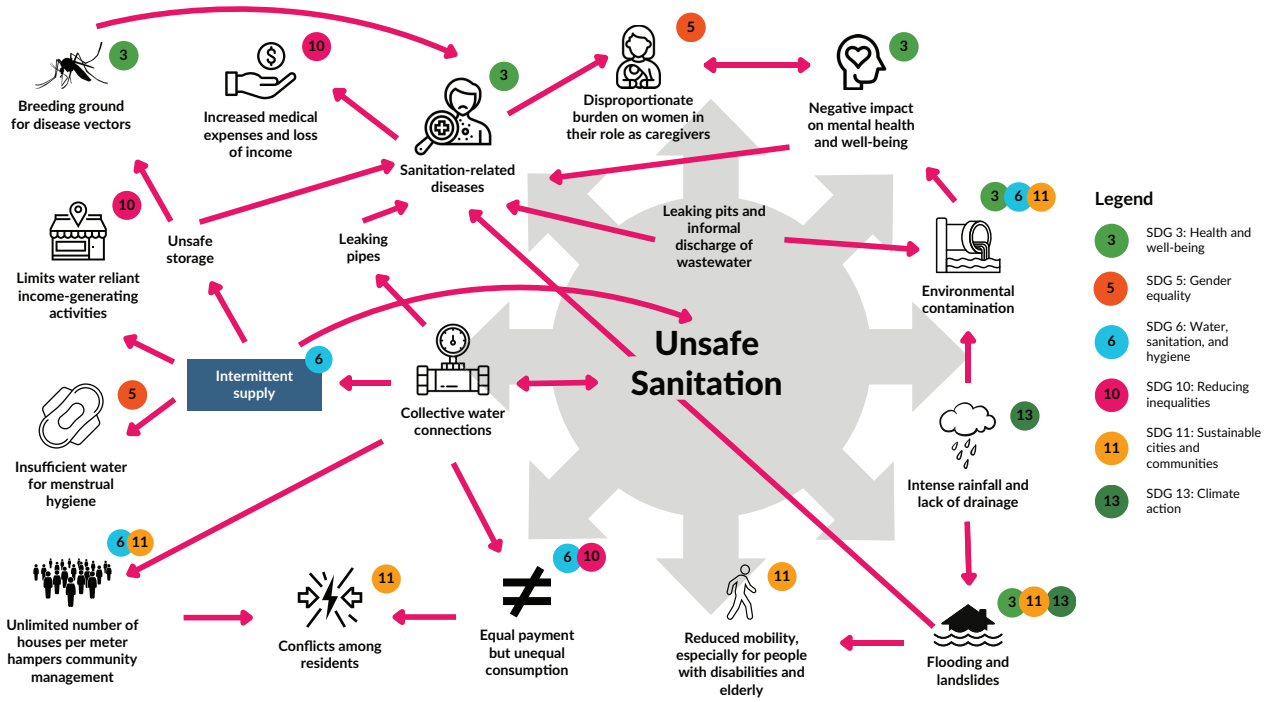

Figure 2. Mapping of contextualised risks associated with unsafe sanitation categorised in relation to SDGs.

constructed their own pits or septic tanks, and some joined forces to establish a local sewerage network that discharges into a nearby stream. Inadequate sanitation has led to a number of diseases, including arboviral diseases such as dengue, with implications beyond people's health. Specifically, residents in Sítio Paraíso explained how sanitation-related diseases impact household finances: "The boss does not care if you are sick. Getting sick due to lack of sanitation affects productivity at work, lost days, and extra costs for medicine" (SDG targets 3.3, 3.d, 10,1). This in turn weakens the capacity to invest in sanitation improvements and might put families in a vicious poverty cycle, particularly with the increasing number of single-headed households (da Silva & Samora, 2021). Inadequate sanitation is therefore both a contributing factor to, and a consequence of, persistent vulnerabilities, as previously highlighted by Diep et al. (2020).

In Campinas, sanitation-related diseases are connected to both inadequate sanitation infrastructure and unsafe sanitation practices. We found evidence of both improperly constructed sanitation facilities (e.g., un-lined, leaking pits) and unsafe management of sewage and wastewater (e.g., informal discharge of untreated faecal sludge and wastewater; SDG targets 3.3, 3.9, 6.3, 10.1, 10.2, 11.4). A FGD participant admitted that emptying pits informally into the environment is not uncommon. She resorted to such practice as she could not afford the service fee of BRL400 (£65.14), putting not only her family but also others in the neighbourhood at risk of exposure to faecal waste.

Impacts of inadequate sanitation are not felt equally within and across settlements, as it is to some extent shaped by where people live but also depends on intersecting identity characteristics and relations (Hofmann, 2022). For instance, uncontrolled discharge of sewage and wastewater in Sítio Paraíso predominantly affects households in lower-lying areas of the settlement who lack control over the practices of residents living higher up. Moreover, women and girls are disproportionately affected by sanitation inadequacies. The growing number of single-mother families in informal settlements, predominantly headed

by black women, are particularly vulnerable and overburdened as they juggle their productive and reproductive roles (da Silva & Samora, 2021; Moser, 1989). This demonstrates how gender, race, and class intersect and shape people's experiences of service inadequacies and their capacity to cope (Hofmann, 2022). Female residents in Sítio Paraíso shared specific concerns about menstrual hygiene in the absence of adequate toilet facilities, including insufficient water supply to meet menstrual hygiene needs. However, since menstrual hygiene continues to be a taboo topic, women and girls feel uncomfortable to elaborate and speak openly about it. Following intense mobilisation by civil society and women parliamentarians, efforts to tackle period poverty have progressed and led to a change in law for the enactment of the Programme for the Protection and Promotion of Menstrual Health, which provides free sanitary napkins and other basic menstrual health care to vulnerable and low-income women and girls (Government of Brazil, 2021). In Campinas, where synergies between sanitation and sexual and productive health are generally well established, the programme has led to municipal campaigns to improve access to sanitary products. Yet, health and sanitation-related municipal policies and plans fail to acknowledge gender-specific needs. Female residents raised concerns about the impact of poor sanitation on mental health and well-being but also on productivity given their naturalised role as caregivers (SDG targets 5.1, 5.4, 10.1, 10.2). Covid-19 demonstrated how disasters and crises exacerbate pre-existing gender inequalities and reinforce power hierarchies. The pandemic put an extra burden on women expected to look after the sick and support children and the elderly with their water and sanitation needs (da Silva & Samora, 2021). Women in Sítio Paraíso were acutely aware of gendered sanitation inequalities whereby men can easily use the bushes to relieve themselves when water for flushing is unavailable, while it is culturally unacceptable and potentially unsafe for women to do the same. Initiatives to address period poverty constitute significant achievements but do not tackle inadequate toilet facilities or the sustained stigma and taboos associated with sanitation, including menstruation (Bassoli & Ribeiro, 2021; "Pobreza menstrual atinge 19,7," 2023). Brazil overall lacks adequate awareness-raising and education for a broader shift in policy and practice towards gender equality (Maschette, 2021).

Sanitation is key to the provision of safe drinking water as much as access to sufficient water quantities is crucial to meet sanitation and hygiene needs. Collective water connections have evidently enhanced access to water and provided minimum citizenship guarantees (SANASA, 2018). Nevertheless, due to legal impediments collective connections are provisional and thus simple appendices to the public network that often lack sufficient water pressure, leading to intermittent supply. Where increasing demand leads to more households sharing a connection, this heightens the frequency of intermittent supply. While the minimum number of households per collective connection is five, in Sítio Paraíso, some connections serve up to 80 houses. Shared connections are further characterised by disparities in water consumption and payment across households, which is not surprising given the diversity within the settlement. Some households use their home as a workplace, either by carrying out informal activities or by establishing a small home-based business and income-earning opportunities that rely on water are not uncommon. Several residents feel disadvantaged and complain about the excessive water consumption of others. The lack of a shared user ethos combined with a uniform tariff pose a challenge to the management of these connections. Water availability further tends to decrease with the elevation of a house, and the distance to the water meter. The government encourages water storage practices to deal with intermittent supply, but there is varying capacity among residents to do this safely. In Sítio Paraíso, inhabitants cope by using buckets and tanks, but these practices are not always safe. Haphazard storage solutions have raised concerns in the Municipal Health Department as they offer a breeding ground for disease-transmitting insects and have led to

recurring dengue outbreaks in Campinas, most recently in April 2023 (SDG targets 3.3, 3.d). As articulated by the Head of the Municipal Health Department during a Focus Group Discussion (2023): "The more people are afraid of running out of water and the more they save water, the worse it is for us. The worst epidemics in the municipality occur at times of scarcity or fear of scarcity." Yet, the municipal approach to tackling disease outbreaks does not include a specific focus on water and sanitation improvements (see Prefeitura Municipal de Campinas, 2022).

While data on service provision in Campinas is available, the lack of a dedicated baseline for sanitation in informal settlements makes it difficult to determine how sanitation is accessed and by whom (e.g., who uses simple pit latrines, how wastewater is managed, etc.). The Municipal Sanitation Plan (PMSB) does not provide a disaggregated analysis of service arrangements within or between settlements, limiting the understanding of varying levels of vulnerability. As a result, the Water Service Coverage Indicator used in PMSB does not distinguish between individual and shared water connections, treating both as adequate (Prefeitura Municipal de Campinas, 2013b). This approach obscures significant shortcomings and disparities within settlements and might explain a lack of specific sanitation strategies for informal settlements (SDG target 10.3).

4.2. Sanitation as a Prerequisite for Climate Change Adaptation and Resilient Settlements (SDG11 and SDG13)

According to the Brazilian Panel on Climate Change (Painel Brasileiro de Mudanças Climáticas, 2014), the Southeast region is expected to experience more frequent, intense, and unpredictable extreme weather events. These include heavy rainfall over short periods, which will heighten the risks of flooding, waterlogging, and landslides, especially in densely populated areas. In February 2023, a disaster on the Northern coast of São Paulo resulted in deaths, injuries, and displacement due to flooding and building collapse caused by heavy rainfall. This event highlights how informal settlements are especially vulnerable to the impacts of severe weather events, largely due to poor urban planning (Bozzi, 2023). Women are particularly vulnerable and, according to the UN, 14 times more likely to die during a disaster due to socio-economic and cultural factors related to various forms of gender violence, in relation to rights, access to resources, and cultural norms, which are often highly gendered (UN Office for Disaster Risk Reduction, 2012, as cited in da Silva & Samora, 2021). An increase in the intensity and frequency of rains in Campinas has augmented the damages to the water and sewerage network and shows the inadequacy of existing infrastructure to withstand disaster and climate change (Rosa & Morel, 2023). Clandestine rainwater discharge into the sewerage network, which is a separate system from the city's stormwater drains, further exacerbates the problem. Separate sewer systems are common in over 50% of municipalities in Brazil as they are considered more suitable to deal with the country's tropical and subtropical climates (Borges et al., 2022; Volschan, 2020). Concurrently, the Brazilian Panel on Climate Change warns about a possible intensification of water scarcity in the region that could aggravate events like the 2013–2015 regional water shortage which particularly affected poor racialised neighbourhoods and spiked cases of dengue and dysentery due to disproportionate rationing (Cohen, 2018). Such events show the entrenchment of social inequalities and further emphasise the significance of safe local storage solutions as vital coping mechanisms. In Sítio Paraíso, lack of access to adequate toilets and the improper management of faecal sludge, wastewater, and drainage have aggravated the impact of flooding contributing to the increased spread of diseases (and the related healthcare costs), restricting local mobility, and causing damage to property, particularly in low-lying areas. Nevertheless, issues related to water supply and sanitation remain insufficiently integrated into disaster risk

management plans (Prefeitura Municipal de Campinas, 2013a, 2017). A study by ICLEI – Local Governments for Sustainability, a global network of local and regional governments, demonstrates that conventional water supply and sanitation systems are less effective than natural infrastructure in managing the rise of extreme weather events and are more costly in terms of wastewater treatment (Tramontin et al., 2022).

Coping mechanisms of informal settlement dwellers tend to be insufficient to break the vicious cycle of risks and vulnerabilities. The state of São Paulo's *Climate Resilience and Adaptation Guide for Municipalities and Regions* acknowledges the cascade of consequences resulting from inadequate sanitation in informal settlements and consistently calls for actions to reduce these risks (Governo do Estado de São Paulo, 2021). The document particularly highlights water contamination during flooding in areas with inadequate toilets and improper faecal sludge management leading to an increase in diseases, particularly among children, loss of income, higher demand for health care, increased poverty, and food insecurity. The Municipal Policy for Coping with the Impacts of Climate Change and Air Pollution of Campinas (Law 16.022/2020) offers a useful framework emphasising the transversal and multidisciplinary nature of climate actions and promoting the integration of adaptation and mitigation into other sectoral policies, including sanitation (Prefeitura Municipal de Campinas, 2020). Moreover, the Campinas Resilience Plan considers the PMSB as crucial for promoting the design of resilient urban development. However, both fail to acknowledge challenges to adaptive risk management specific to informal settlements. For instance, they do not consider the limitations of collective connections and water rationing measures in times of scarcity. Campinas' upcoming Local Climate Action Plan provides scope to build on municipal guidance and integrate sanitation improvements along the sanitation service chain specific to the context of informal settlements.

SDG6 and SDG11 explicitly emphasise the need to enhance community participation. Public participation is anchored as a right of all citizens in the Federal Constitution and flagged in all of Campinas' policies and plans (Bazzaneze et al., 2022). Nevertheless, this right is often unfulfilled due to a lack of clear guidance on how to engage citizens, especially those living in informal settlements. Existing mechanisms include public hearings and virtual workshops, with the latter gaining popularity in a post-pandemic environment, but with little scope for informal settlement dwellers to engage. This is due to how information about these events is shared, along with factors such as their format, scheduling, and location. Events reliant on internet access or travelling to distant venues, combined with time and money constraints can prevent certain groups from exercising their right to participate. Local authorities therefore need to remove existing obstacles, e.g., push for technological advances to make virtual events more inclusive, and allow for effective public participation (Bazzaneze et al., 2022).

Evidence from Brazil demonstrates that involving low-income communities has enhanced both the implementation and sustainability of sanitation initiatives (Diep et al., 2020). During the Covid-19 pandemic, women-led grassroots efforts in two informal settlements in Campinas further highlight the power of collective action in responding to crises, as well as the pivotal role of women's leadership in local decision-making and community mobilisation (da Silva & Samora, 2021). Although the informal, decentralised sewer systems in Sítio Paraíso may not yet offer a fully safe sanitation solution, they reflect strong community-driven efforts to address localised challenges. These self-help initiatives further show that informal communities would benefit from government support to ensure that local infrastructure and services are safe. Although SANASA provides technical guidance on the conscious consumption of water (SANASA, 2022), limited community involvement and capacity development in managing collective water connections have led to the above-mentioned disparities and fuelled conflict among households.

4.3. Sanitation Inequalities and the Marginalisation of Informal Settlements (SDG10 and SDG11)

Municipal plans and supply indicators display a tendency to treat the city and its inhabitants in a standardised manner, overlooking the prevalence of alternative sanitation solutions and associated risks in informal settlements. No policy or plan considers the heterogeneity of the population and the diverse and context-specific needs of particular groups to address intersecting inequalities, despite the emphasis across SDGs (SDG targets 3.9, 6.2). While PMSB and the Municipal Water Resource Plan emphasise the need to combat pollution in all its forms for environmental protection, they disregard the challenges within and across informal settlements, e.g., links between sanitation and informal land tenure (Prefeitura Municipal de Campinas, 2013b, 2016). The only plan that acknowledges the importance of sanitation in informal settlements is the Municipal Housing Plan (Prefeitura Municipal de Campinas, 2011) through its REURB and social housing programme. The municipality regards informal land tenure as core obstacle to adequate sanitation provision, with unregularised settlements facing a greater deficit. REURB-S envisages essential infrastructure works, including drinking water supply and sewer systems alongside the process of land regularisation. To address the above-mentioned housing deficit, the Municipal Housing Plan aims to "regularise all irregular/clandestine and precarious settlements and favelas or land occupations" (Prefeitura Municipal de Campinas, 2011, p. 390) but the programme faces several obstacles. Although Law 13.465/2017 permits infrastructure works to begin before, during, or after regularisation, sewerage connections, unlike individual water connections, tend to happen only at the end (Government of Brazil, 2017). Sewerage connections necessitate a multidisciplinary technical assessment, encompassing urban planning, environmental, and legal considerations. Additionally, a detailed plan is required to guide the installation of the public sewerage network and utilities are only prepared to proceed once regularisation is guaranteed. Recent collaboration between SANASA and COHAB is a welcome development, but these processes are time-consuming and constrained by limited institutional resources, further accentuated by the dire need for affordable and adequate housing and infrastructure. Sítio Paraíso is only at the beginning of the REURB-S process due to ongoing disputes over land, which are not uncommon (Walker & de Alarcón, 2018). Disputes partly arise out of opposing agendas between municipal departments that delay the process and consequently impede sanitation improvements. For example, to pursue its conservation agenda, the Environmental Department has earmarked certain settlements for relocation that are already being considered for regularisation. Tensions between the constitutional right to housing and the right to an ecologically balanced environment are thus stalling not only the regularisation process but further impeding sanitation improvements with significant implications for public and environmental health, and urban sustainability more broadly (Walker & de Alarcón, 2018). Informal settlements deemed as areas of risk, e.g., those near railway lines or with disputes over land, may remain in limbo for years. This situation can foreclose access to basic public services as doing so might be perceived as authorisation for permanent residency. Opportunities for relocation are significantly limited by Campinas' social housing deficit. Therefore, tying sanitation improvements solely to REURB-S drastically reduces and prolongs the prospect of adequate access to sanitation for many informal settlement dwellers. However, broadening the scope of sanitation interventions beyond sewerage connections would require collaborative arrangements beyond SANASA and SEHAB and necessitate agreements with other municipal departments. At present, interactions with departments concerned with health, planning, public services, social assistance, and the environment are irregular and largely unplanned, posing a significant challenge to joined-up and integrated action. An FGD with representatives from different municipal departments and SANASA proves this point:

> We are so connected, yet so distant. We did not even know each other....The challenge of communication is immense. One knows what the other is doing and knows how to seek partnerships, but everyone is working for themselves, and we find it difficult to share what is happening.

Insufficient opportunities to explore and articulate linkages between sanitation and other key issues across plans means that risks cannot be addressed systematically, and synergies are likely to remain untapped.

5. Towards Integrated Sanitation Action in Informal Settlements

The evidence presented demonstrates that adopting sanitation as a cross-cutting principle to drive action in informal settlements can maximise multi-sectoral benefits and foster equitable outcomes. At the same time, certain aspects require consideration (see Figure 3) to address multi-faceted risks associated with inadequate sanitation that span across the SDGs, which are most pronounced in informal settlement contexts.

In Campinas, SANASA has advanced service provision in the municipality through various initiatives. However, efforts to address inadequacies, specifically in informal settlements, have been insufficient, with legal impediments obstructing further improvements. Moreover, limited collaboration across departments has contributed to sanitation not featuring prominently across municipal policies and agendas beyond the utility. Nevertheless, the Housing Department, through REURB-S, has developed a direct relationship with

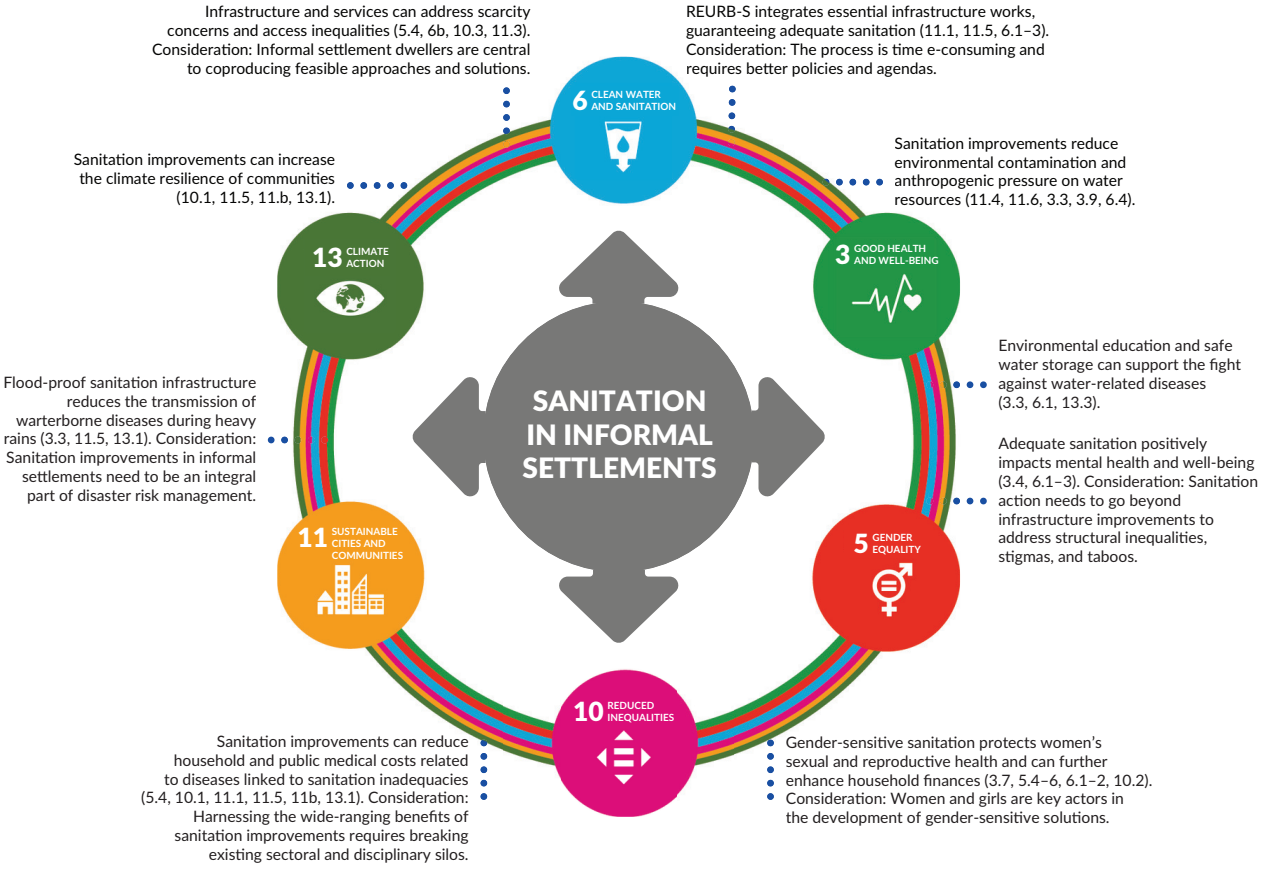

Figure 3. Potential benefits of integrated sanitation action and important considerations.

informal settlements and gained insights into their circumstances. The online platform mapping informal settlements (see Figure 1) could be an important tool for advancing integrated policies and action in those settings but requires going beyond sporadic interactions between various municipal departments and SANASA. With departmental representatives expressing an interest in more frequent exchanges, there might be a possibility to establish a dedicated informal settlements working group composed of multi-sector representatives. More systematic cross-departmental collaboration could further serve as an opportunity for pooling and leveraging limited resources for integrated action around land regularisation and service improvements to harness multi-sectoral benefits. Findings highlight the importance of delinking sanitation improvements from REURB-S and consideration of sanitation solutions beyond centralised sewers to mirror government efforts in water supply improvements. Some inspiration can be taken from the utility company Companhia de Saneamento Básico do Estado de São Paulo responsible for service provision in São Paulo state. Their Se Liga na Rede (Connect to the Network) programme aimed at improving sanitary conditions and cleaning up rivers connects households in informal settlements to the sewerage system using unconventional solutions (e.g., choosing a mixed rather than unitary system), community mobilisation, and subsidies. The company has developed their own social technology to ensure the participation of concerned communities, and the training of women community leaders as well as the strong commitment of the municipal authority is key (Associação Brasileira das Empresas Estaduais de Saneamento, 2020).

The development of Campinas' Local Climate Action Plan presents another opportunity to mitigate cross-cutting risks associated with inadequate sanitation in informal settlements. The findings demonstrate that progressive improvements in sanitary conditions are integral to risk management and climate action to deal with increasing droughts, heavy rains, and flood events. Such an approach requires programmatic alignment among stakeholders to generate greater policy coherence and resolve conflicting agendas that hinder adequate sanitation provision and vice versa. Furthermore, an integrated approach that maximises the use of limited resources and prevents failed interventions is reliant on collaboration and the formation of partnerships among SANASA and other municipal actors. City actors acknowledged the value of greater integration, highlighting a need to consolidate different types of knowledge to understand the correlation between sanitation and social development indicators. The consolidation of knowledge and an emphasis on interlinkages can, for instance, uncover how dengue outbreaks in informal settlements are linked to inconsistent water supply, or how sanitation access, land ownership, and environmental protection are interrelated. Since residents of informal settlements are both the most impacted by inadequate sanitation and possess direct knowledge of the challenges involved, their active engagement in problem diagnosis, planning, and decision-making about sanitation and related matters is essential. For contexts like informal settlements, where governments tend to be oblivious to service provision inadequacies and their impacts, coproducing a situational diagnosis with residents can feed into the development, implementation, and monitoring of more appropriate and inclusive policies, plans, and interventions and further support leveraging of resources.

Insights into sanitation inadequacies in Sítio Paraíso have revealed their impact on different spheres of social development, which can guide the development of contextualised strategies but would require understanding the diversity of situations in other informal settlements in Campinas. It is crucial to recognise the varied vulnerabilities and capacities that exist within and between informal settlements, shaped by gender and other intersecting categories and relations (Diep et al., 2020; Hofmann, 2022). Meaningful involvement of diverse informal dwellers can challenge the dichotomy in existing approaches that clearly

differentiate between so-called experts and citizens, technical and community knowledge, and foster more inclusive practices (da Silva & Samora, 2021). Findings further show the value of building on existing grassroots mechanisms and initiatives to cope with infrastructure and service inadequacies, such as shared septic tanks or decentralised sewerage networks, but also other forms of collective action with strong women leadership and gender-sensitive approaches. Campinas' master plan and all sectoral policies underline participation in policy and decision-making but require specific emphasis on informal settlements and a commitment to addressing gendered service provision inequalities. Existing community structures such as neighbourhood associations and community leaders can help facilitate this, provided attention is paid to existing power relations and inequalities regarding gender and other intersecting characteristics and relations. Participatory processes require effective and inclusive ways to allow informal settlement dwellers to engage in a meaningful way and involve considering the location and timing of events but also the format and the support some might require. Moreover, the active involvement of communities is essential for the management and maintenance of services. Findings regarding collective water connections identified a need for communities to receive training and guidance on how to manage these connections to foster fair and inclusive access.

6. Conclusions

We are currently at an important crossroads with only five years to achieve the SDGs and a need to start thinking about a post-2030 agenda (Ghosh & Sharma, 2024). The research undertaken offers an opportunity to draw invaluable lessons in that regard and a renewed commitment to a more sustainable and equitable future. It is essential to consider both local dynamics and interlinkages across central concerns as currently addressed through the SDGs, with the potential to identify key entry points that can foster integrated and strategic action. This means adopting a transdisciplinary approach to identify synergistic but also challenging interconnections and ensure that actions in one area support rather than hamper progress in others. Efforts towards a global agenda and agreement cannot undermine the importance of context specificity and this involves understanding particular challenges and opportunities within different communities and regions. Moving forward, more efforts are needed for a localised perspective on global agendas to ensure that strategies are relevant and effective.

The research in Campinas validates the importance of transdisciplinary approaches and knowledge bases with contributions from academia, policy, practice, and inhabitants themselves to promote integrated sanitation action in informal settlements. Strengthening partnerships with research institutions in Campinas, including the Universidade Estadual de Campinas, the Pontifícia Universidade Católica de Campinas and FEAC Foundation, can further foster interdisciplinary and innovative approaches. The SDGs provide an important methodological framework for understanding how people perceive and experience the impacts of public policies, including their success, precariousness, or absence. For them, these issues do not exist in isolation but interact with each other, for better or for worse. In our specific case, precarious access to water and sanitation has raised issues that cut across the SDGs, including land, health disparities, gender inequalities, among others. However, thus far they are rarely tackled in an integrated manner. Knowledge coproduced with multiple stakeholders, including informal dwellers, can form the basis to support a revision of municipal plans, help establish specific targets, and guide the elaboration of policies, programmes, and actions that are appropriate for the context of informal settlements and their diverse inhabitants. Unless the limiting factors for adequate service provision specific to informal settlements are considered in the

development of strategies, current interconnected risks cannot be mitigated and the benefits of sanitation across SDGs will not be harnessed. This research employed the SDGs as part of an analytical framework but there is scope for municipalities to use the methodology for the development of an integrated urban strategy.

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Conflict of Interests

The authors declare no conflict of interests.

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