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Managing stormwater in South African neighbourhoods: when engineers and scientists need social science skills to get their jobs done

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ABSTRACT

Stormwater harvesting via managed aquifer recharge in retrofitted infrastructure has been posited as a method for resource augmentation in Cape Town. However, the existing guidelines on stormwater retrofits are technically inclined, occidental, and generally misaligned with the realities and socio-economic contexts of developing nations like South Africa. Water and urban practitioners from developing nations cannot just 'copy and paste' existing guidelines as different socio-economic dimensions and colonial histories typically hinder 'traditional' approaches. This paper assesses how a transdisciplinary team navigated these realities in a case study of a retrofitted pond in Mitchells Plain, Cape Town. We applied a framework by Trisos *et al.* (2021) for reflection and thematic content analysis. The framework was used to unpack how the team encountered, addressed, and learned from the challenges during retrofit process. We found that the retrofit process within a context of under-resourced South African communities can be viewed as developmental work with a strong emphasis on continuous community engagement. Thus, we suggest that in the South African context, water practitioners should consider, at the fore, interaction with local communities, including awareness of racialised histories, to ensure projects are successfully implemented and completed.

Key words: community engagement, interdisciplinary research, stormwater harvesting

HIGHLIGHTS

- Multi-use in stormwater ponds in Southern context.
- Community involvement in retrofit process.
- Social science reflection among technical team.
- Considerations of local context key to stormwater retrofit and multi-use success.
- Engineers, water professionals and all those involved in water management and design can engage in ethical ecology that works to improve practice, and address past environmental injustices.

INTRODUCTION

The City of Cape Town's (CoCT) New Water Programme (NWP) – a response to increasing regional water scarcity and the recent 2015–2018 drought period (CoCT 2019) – includes a commitment to augment its water supplies. The programme objectives include sustainable groundwater abstraction from the Cape Flats Aquifer (CFA) – one of the CoCT's three main aquifers. The aquifer's sustainability will be secured by combining this abstraction with managed aquifer recharge (MAR) – the practice of intentionally injecting or infiltrating water into an aquifer (Dillon *et al.* 2009). The CoCT's MAR process involves injecting highly treated wastewater effluent via recharge wells. However, water augmentation could also be increased by harvesting Cape Town's stormwater using retrofitted infrastructure like detention ponds via MAR (Okedi 2019).

Stormwater retrofitting is installing alternative stormwater management systems where none previously existed or improving existing ones (Digman *et al.* 2012). These alternative stormwater management processes have the potential to provide additional benefits within a Sustainable Drainage Systems (SuDS) framework (Fletcher *et al.* 2015). The additional SuDS benefits include water quality improvement (pollution reduction), water quantity management (including flood mitigation

and water supply augmentation), amenities for local communities, and the enhancing, promoting, and sustaining of biodiversity (Digman *et al.* 2010).

Several retrofitting guidelines are available globally, each with a different emphasis depending on the intended benefit. These guidelines generally suggest four steps to consider when implementing stormwater infrastructure retrofits, namely: (1) a retrofit strategy, (2) an inventory and prioritisation of identified sites, (3) design and construction advice, and (4) proposals for maintenance and monitoring to ensure the required quality and quantity of water. In addition, some guidelines recommend some form of community/stakeholder participation, especially if the retrofit is highly visible to the public (Department of Environment & Swan River Trust 2006; Pennsylvania Environmental Council 2012). Unfortunately, while the cited guidelines and supporting manuals apply in most contexts on the technical side, they are quite occidental regarding some socio-economic assumptions that are misaligned with the realities in developing nations like South Africa.

As one of the most unequal countries in the world – with an income Gini coefficient of 0.67 (Díaz Pabón *et al.* 2021) – South Africa has faced long-term economic instability, exacerbated by the Covid-19 pandemic, leading to a 32.4% unemployment rate in 2021 (StatsSA 2021). The slow rollout of the public housing programme and significant rural-to-urban migration has increased the number of informal settlements (Brown-Luthango *et al.* 2017). These challenges mean that jobs, housing, and basic sanitation are still inaccessible for many people, creating social disgruntlement, including distrust of the government and high crime rates (Parikh *et al.* 2020). Furthermore, there are significant challenges in obtaining a neighbourhood's informed consent to any intervention, often due to local competing interests driven by increasing job competition or political ambitions (Adato *et al.* 2005) and magnified by Apartheid's leftover racialised practices and policies.

These challenges suggest that water and urban practitioners from developing nations cannot just 'copy and paste' guidelines, as the different socio-economic dimensions and colonial histories typically hinder the 'traditional' retrofit approaches.

This paper leverages insights from an ongoing research study conducted by a transdisciplinary team in Cape Town, South Africa. The research site is a retrofitted detention pond located in Rondevlei Park in Mitchells Plain, a middle to low-income suburb in the Cape Flats area of Cape Town. The Cape Flats area is characterised by gang strongholds with high levels of unemployment and violent crime (StatsSA 2021). One key aspect of the Mitchells Plain study is investigating how the proposed approach can be implemented in a neighbourhood with significant socio-economic challenges.

In this paper, the authors seek to establish and advance how alternative stormwater infrastructure can be successfully retrofitted in South African neighbourhoods. Herein, they explore how the challenges faced by technical practitioners involved in retrofitting SuDS can be mitigated by adopting social science-based approaches within a South African context; as such technical practitioners, city officials, and citizens benefit from this research. This paper will be most beneficial to Water Sensitive Urban Design (WSUD) practitioners and city planners aiming to undertake similar efforts. Drawing on decolonial thinking to practice 'a more ethical ecology' (Trisos *et al.* 2021), the authors engage with Mguni *et al.* (2016) and Bichai & Cabrera Flamini (2018) suggestions that 'exporting occidental SuDS approaches to developing contexts without contextual understanding and adjustments, provide little opportunity for two-way conversations, and are likely to fail.'

The authors posit that retrofitting within a South African context requires an adjusted approach in (1) the selection of the infrastructure to be retrofitted, (2) interaction with local communities, (3) selecting construction materials, and (4) construction of the retrofitted basins. This paper chiefly focuses on the interaction with local communities (2) and the construction of the retrofitted basins (4) in an under-resourced community. The research efforts are assessed from a transdisciplinary viewpoint with lessons learned. The selection of the infrastructure to be retrofitted (1) and the selection of construction materials (3) in the above-mentioned altered approach will be discussed elsewhere. In this paper, the authors first describe the methods employed in addressing the research objective. They then contextualise the research approach by providing an overview of the Mitchell Plain pond retrofit – the case study of the project. Finally, they draw on Trisos *et al.* (2021) to unpack the engagement approach and lessons learned while attending to some challenges arising in transdisciplinary work in this post-Apartheid context of extreme inequality.

METHODS

As stated above, this study sought to establish and advance how alternative stormwater infrastructure can be successfully retrofitted in South African neighbourhoods, considering current socio-economic challenges. To that end, the authors drew on social science approaches that a multidisciplinary team applied. The insights in this paper are derived from desktop analysis and an unstructured participatory approach – using field notes, group debriefings/discussions, critical reflections, interviews,

and participant observation – from the Mitchells Plain pond retrofit case study between 2019 and 2022. Findings from the desktop assessment of local engineering course curricula supported the thematic analysis.

The analysis follows the suggestions of Trisos *et al.* (2021), 'Decoloniality and anti-oppressive practices for a more ethical ecology' as a framework for reflection and thematic content analysis. To this end, the research team reflected on how their practice engaged with Trisos *et al.* (2021) five key areas: 1. Decolonising their minds – which the authors suggest starts with thinking beyond researchers' institutional training and epistemic approaches; 2. Knowing (and attending to) the local histories – outlined in the project through self-reflection and learnings and the construction approach explicitly aimed at addressing concerns raised in the local context; 3. Decolonising access – in this case, working with citizens to build the interventions, group learning and creating new green spaces; 4. Decolonising expertise – approaching residents as experts in their own lives; and 5. Practising ethical ecology in inclusive teams, an approach the authors suggest, takes time and the cultivation of meaningful relationships.

The subsequent section provides the contextual background by providing an overview of the Mitchells Plain case study.

THE PAWS PROJECT APPROACH

Okedi (2019) advanced that stormwater harvesting (SWH) in Cape Town could be implemented in some City detention ponds via MAR but stopped short of suggesting how this could practically be achieved. Consequently, the Pathways to Water Resilient South African Cities (PaWS) research team sought to investigate the potential for retrofitting stormwater detention ponds for SWH via MAR in Cape Town. To this end, the researchers engaged the CoCT to identify dry detention ponds to repurpose. The ponds had to fit the following criteria: location above an unconfined aquifer, at least one metre above the maximum water table, removed from existing groundwater abstraction points (in case of contamination) and safety (many parts of Cape Town have reported high crime levels). A multi-criteria selection tool was developed, and two suitable ponds were found, but only one was selected due to budgetary constraints: the 'School Pond' located next to a school (Figure 1: Top).

The PaWS team engaged the school principal and the local ward councillor to begin the outreach process and obtain local buy-in. Two public consultations were held on either side of the Covid-19 hard lockdowns. As a result, a pond committee was established comprising elected community members and the ward councillor. Interested community members shared their visions for the pond with the researchers. These insights were translated into initial landscape designs (Käppeli 2020), which were then modified due to constraints such as the geohydrology (the site has a high winter water table contrary to the desktop study and preliminary surveys), practicality and a limited budget. The key considerations for the new designs were erosion control, sediment and litter management, groundwater recharge via infiltration, and water quality monitoring with limited landscaping. The desired infiltration was facilitated by detaining incoming stormwater behind a sandbag berm in front of the two pond inlets and along an identified contour – that, at the time, provided at least 0.6 m of infiltration depth after a particularly wet winter following a 1 in 300-year drought – (Figure 1: Bottom). Finally, the new design was presented to interested community members.

One of the researchers (an engineering PhD candidate) was embedded in the construction period and supervised the retrofit, which was completed in 25 working days. After consultation with residents highlighting the budget available for pond retrofitting, locals demanded that they be hired as the construction crew on a weekly rotational basis to give as many opportunities to earn and learn as possible. The embedded researcher trained three people involved in the retrofit construction to use a Dumpy level (Figure 1: Bottom, b), and lunchbreak discussions focused on sandbag construction and MAR.

RESULTS AND CASE STUDY – RETROFITTING A STORMWATER POND

The School Pond was successfully retrofitted in 2021, and the researchers monitored the water quantity and quality while continually engaging with the community throughout 2021 and 2022. The literature review and findings from this pond retrofit suggest that in the South African context, an altered approach in (1) the selection of the infrastructure to be retrofitted requires consideration not only of the engineering/water table needs but should consider, at fore, (2) interaction with local communities: in conducting these interactions, dedicated consideration of the local context regarding access to resources, employment situations and local residential/stakeholder dynamics, including awareness for racialised histories are necessary to ensure projects do not meet resistance. Relatedly, through meaningful relationship building, including ample time to develop trust, key aspects for the success of the intervention become clear. For example, in this context (3),

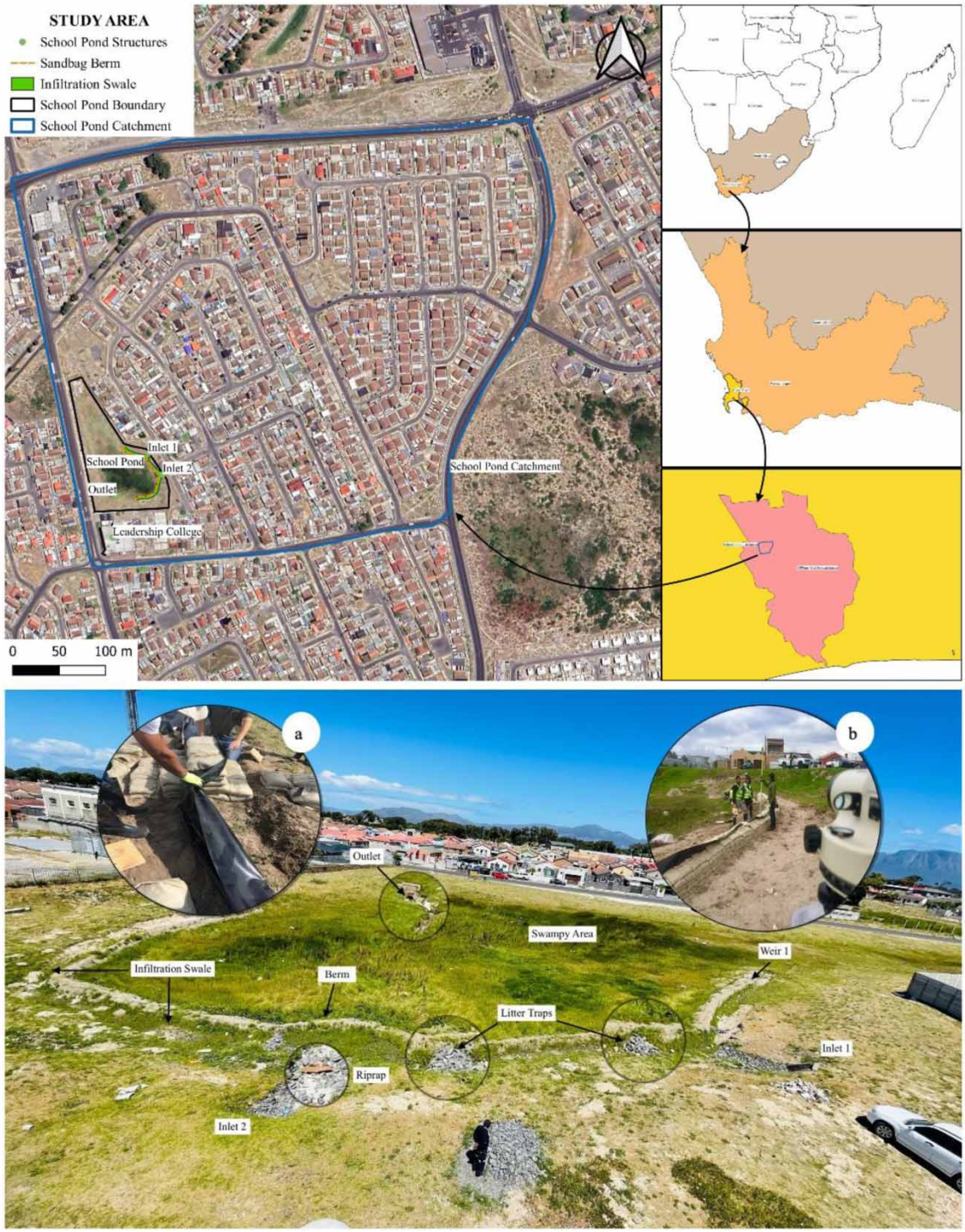

Figure 1 | Top: Location of the School Pond; Bottom: Completed Retrofit and (a) laying the sandbags, (b) level control training.

selecting construction materials that were not going to be dismantled and used for other purposes required careful consideration; only once the embedded researcher and the larger team engaged with residents in several ways over a long period, were they able to move ahead with a locally informed process for the (4) construction of the retrofitted basins. Attending to the five key points raised by Trisos *et al.* (2021) offered the research team ways to reflect across disciplines critically, a process that

appears necessary for this kind of work. These five key points are drawn upon in the following discussion to explain this results summary further and provide contextual guidance for the various components that practitioners [may] need to consider in similar studies.

DISCUSSION: THE DECOLONISING PROCESS

Decolonising the technical mind – reflecting on the limitations of technical science disciplines in social engagements – thinking beyond our training

Trisos *et al.* (2021) challenge their readers to disrupt comfortable logic and thinking to stretch their minds beyond their training and assumptions. Here the authors outline some reflections from the project team illuminating how this project has begun to challenge and decolonise their thinking:

Landscape Architect: Recognising that engineering elements such as the sandbag weir wall could be part of the landscape – reflected in how the top of [that] wall has, since installation, been used as a pathway by residents … suggest[ing] further opportunities for engineers to work with landscape architects, where the engineered elements are integrated as landscape elements within the open space, expanding the idea of the stormwater pond as multi-functional public open space.

Engineer: … the engineering of these systems – though essential – is often the easiest part, yet engineers are often expected to work outside their field … They are then criticised for not being knowledgeable in these other fields. If the City is to move toward WSC, they must employ people with complementary expertise to assist the engineers.

Urban water management: The importance of really listening and realising that water management in cities needs to be considered as part of the much larger system that comprises people and their aspirations and beliefs, ecosystems, governance processes, politics, and economics.

Human geographer: … Coming from a more homogenous society (Denmark) … Engaging with people who have been forced to relocate, live in areas with gangsterism and have been 'let down so many times'… are all experiences which … play out when meeting outsiders or city officials … [I] learned that communication and involvement across the neighbourhood are key but also that you cannot and maybe should not think that you can make all happy … There are going to be setbacks where both sides are finding out more about each other … It takes time.

Soil and environmental chemist: Before working on this project, I had a very superficial idea about community engagement … while I knew it was important, this project has given me a deeper understanding of the process and how essential … to our work it really is. When we used an experienced drilling company to install monitoring wells, many residents thought they could have done this work and were not impressed that local labour was not employed. Later, after time and engagement happened around the berm construction, we installed an additional monitoring well with residents' help and found out exactly how difficult it is. After many hours, we managed to install one shallow well, but this time allowed for discussions about the soil, water infiltration, and the frogs, and importantly started to build trust.

Urban sustainability researcher: As an urban planner, I often take a system-wide view to urban problems and the potential for transformation first before moving to other perspectives, e.g., bottom-up etc. Working with the community on the pond showed me the importance of taking a bottom-up view as the primary departure point especially in the context of 'deep difference' that is South Africa's cities, if the resilience-building research process is to be truly transformative.

Here you can see that the starting points for these reflections are often spaces where project experiences have undermined assumptions. In many ways, slowly engaging and developing the interventions in a transdisciplinary team has allowed space to start breaking down discipline-based assumptions and facilitate finding common languages and related actions for the project to proceed. While the minds of disciplinary practitioners have not necessarily been decolonised, the quotes above shed light on how the research team has been challenged to expand their thinking beyond their specific fields (and, sometimes, siloed approaches).

Knowing (and attending to) the local histories

Positionality: Here, we offer two reflections using researchers' experiences to illustrate how local histories add to the dynamics of our research interactions.

In at least two instances, community members (leaders) voiced that they did not want outsiders working in their community and would ensure they kept them out. The term used was 'Africans', initially surprising to two African team members (non-South Africans who assumed everyone born in Africa is African). However, the PhD researcher later realised that this term was based on one of the legacies of Apartheid in SA – the Population Registration Act of 1950 (repealed in

1991), the cornerstone of the Apartheid policy. This act categorised South Africans as either White, African (black), Coloured or Indian (Smythe 1992). Therefore, the residents (who primarily identify as Coloured by SA definitions) had meant that they did not want Black Africans employed in their community.

Further, a resident had earlier mentioned that they had been informed that an African (PhD researcher) was spotted [working] in the pond, which prompted them to investigate. In another instance, a resident and community leader made a 'joke' premised on the researcher's complexion, which the other residents picked up on and addressed – after a collective laugh. The repeated cases of 'othering' were a reminder of South Africa's Apartheid history.

These events prompted the (PhD) researcher, a project partner, and the site workers to have an informal dialogue about race and point out the instances of racial micro– and macroaggression directed at the researcher. For example, one resident pointed out that their reservations about 'Africans' working in their community were based on their inability to work in 'African' areas, a reality discussed by Brown (2000), who posits that the Apartheid regime purposefully cultivated this mistrust. Another reason was that this (self-identified) Coloured community felt left out by the post-apartheid predominantly Black African government. That assertion was made by some of the community members to the PhD researcher during a conversation on unemployment and the SA economy and echoed some findings by Pirtle (2022) and a topic of discussion in a 2018 BBC documentary (South Africa's coloured community 2018). These admittedly limited and possibly isolated conversations – 7 racial incidents in less than 22 working days – highlighted the importance of considering racial dynamics to the researcher. Considering this specific context, a team whose racial composition mirrors the neighbourhood might have been better received initially. However, where that is not possible, these contextual realities could be addressed at the outset to insulate the 'outside' from micro and macro racial aggressions.

Drawing on the same experiences, another African (non-South African) researcher, upon reflection, suggested that the project forced them to '*contend with*' their potential *'complicity in the perpetuation of Apartheid's legacies as both an academic and an urban planner. At some point, after some rather uncomfortable episodes in the field, I had to step back and re-evaluate how my own idea of self (as performed and innate) was affecting how I understood the context (people, site etc.) and how the context treated me as a black, African, female, foreign, researcher representing the Danish [project] partner … Intersectionality became quite a key construct in how I came to understand my position within the research process … '* She further noted how the project's longer-term engagement '*also threw light on how coming from a hyper post-colonial society like Zimbabwe, such instances of overt racism are rare, … [s]o it became a point for me to also come from a point of empathy, whilst not diminishing the ugliness of racism*.' In the context of research in South Africa, these researchers faced complex identity politics that required their definition of African to be re-assessed. Suddenly being African meant very different things, and exploring the local (colonial and Apartheid) histories and experiences became central to finding ways to make the project work. This finding and process mirrors advances by Whitehead (2019), who avers that conversational analysis is often required to identify and establish the social [and racial] categories that may become relevant in naturally occurring interactions – like pond retrofits in this case.

Decolonising access

While decolonising access was not the specific aim, the team's practice of inclusive, ethical ecology meant they approached spending the intervention budget transparently with residents. In following their desire to access as much of the budget as possible, the team worked with 20+ residents, sharing knowledge on, for example, sandbag construction, dumpy level use, and indigenous plants. More generally, the PaWS intervention created a new kind of space that residents highlighted as a biodiversity hotspot – a vital access point to green spaces in a context where these are limited (often to wealthy neighbourhoods).

Decolonising expertise

Decolonising expertise calls for attention to other ways of knowing spaces beyond those entrenched in academia, policy, or practice. Following the notion that residents are experts in their own lives, the research team quickly learned other ways of knowing first-hand. For example, one researcher realised that, while civil engineering knowledge was useful, community members had a better understanding of the local ecology and long-term understanding of the elements that were/are changing: '*I had no prior experience of finches and other birds and how they prefer reeds, but one of the residents mentioned this when explaining how he felt cutting the grass [in the pond] had led to fewer birds coming … that interaction was evidence that the area is not devoid of knowledge and to think otherwise would be erroneous.*' This reflection highlights how notions of

knowledge and expertise that position the academic as a critical knowledge holder must be rethought – and were, in this project.

Practising ethical ecology in inclusive teams

A genuine transition to water-sensitive cities in South Africa will necessitate upgrading informal settlements and providing functioning water and sanitation services. The upgrading of informal settlements must be community-oriented and involved (Thwala 2006) and will likely present many political and socio-economic challenges, requiring technical practitioners to be empathetic and patient. Some of these challenges and the impact thereof can already be seen in some South African infrastructure projects. These challenges necessitate a different approach to project implementation and management, and this paradigm shift has seemingly occurred faster than the engineering syllabi's evolution. To that end, the civil engineering curriculum from four leading South African universities was analysed, and it was found that these skills are not emphasised in classrooms. Less than 5% of the civil engineering curricula focus on social/humanities courses where a student might gain an appreciation of the required social science skills. This creates a gap, resulting in engineering graduates being underprepared for the new arena wherein they find themselves.

These underprepared but technically-sound engineers then struggle to reorient themselves when involved in community-based projects, which exist in an environment with limited resources to assist professionals working in low-income areas. This means that the skills required for developmental work – most suited for low-income and community-oriented areas – are often lacking in the field. This skills mismatch has resulted in many engineering projects and guidelines promoting top-down design approaches, often disregarding the supposed project beneficiaries (Gilbert *et al.* 2015). Concerningly, neglecting the public's opinions and user experiences contradicts the purpose of the field, i.e., civil[ian] engineering – a field that has traditionally been responsible for designing and constructing civilian infrastructure (Chrimes & Bhogal 2001).

The PaWS project exposed a civil engineering PhD student to these South African realities. Fortunately, the researcher had prior experience with development work and could apply some of those principles but was cognizant that this would have been difficult without knowledge of stakeholder analysis (covered in the syllabus) and stakeholder engagement (not covered). Eventually, prolonged and sustained contact (2+ years) enabled the trust to develop, indicating that research advocating for slow science/slow ecology (Stengers 2018) holds credence, especially in this type of setting. This study emphasised the need for more social science and work-oriented training for South African engineers to equip graduates with relevant skills to practice in a South African landscape.

At the same time, this research process offered Northern collaborators insights into a different type of engagement context. A human geographer team member with engagement experience notes that this project was a good eye-opener for better understanding, being '*… unfamiliar with the more 'demanding' communities' … I am more used to local communities [that] do not fight back … our team is not just working across disciplines but also 'cross-country'. … '*. With this in mind, and considering that current guidelines, authored primarily in occidental contexts, gloss over the engagement aspects, the process highlighted the centrality and importance of local engagement/buy-in. Keeping in mind the difficulty of exporting these guidelines to developing contexts – a process that obscures local realities – the team member's comment above highlights how occidental assumptions about local engagements are not developed with a South African reality in mind.

CONCLUSION

This study sought to establish and advance how technical practitioners can successfully retrofit alternative stormwater infrastructure in South African neighbourhoods. The study leveraged findings from a retrofit case study where the authors found that successful pond retrofits rely on establishing good relationships with local stakeholders and obtaining their buy-in and informed consent. These particular finding is not unique to this study and has been reported by scholars in both the global north and global South – see Sharma *et al.* (2012); Fitchett (2014) and Pérez Rubi & Hack (2021). However, this paper adds to the conversation on the practical approach to engagement and the impact thereof.

After juxtaposing the results with those from two SuDS-centred studies from the global South, one from Costa Rica (Chapa *et al.* 2020) and the other from South Africa (Fitchett 2017), the authors reiterate that socio-political and economic challenges negatively impact the implementation of SuDS in communities. These challenges can be tackled but require ample time to understand and build local relationships.

The authors also found that practitioners should aim to maintain these relationships through an ongoing process sensitive to the viewpoints of the different actors in the area and can identify and navigate competing interests. Notably, the buy-in

process often takes a long time and requires expertise not found in the 'everyday' water manager (practitioner) but is required for these spaces to be sustainable.

The researchers thus propose that these skills should be developed at best, at university level and at worst at an institutional level to better prepare practitioners for the existing challenges. Further and related to the previous point, the authors aver that there is utility in applying Trisos *et al.* (2021) framework to developmental work like pond retrofits in South Africa as such frameworks go a long way in facilitating the type of thinking and approach to interactions necessary for successful stormwater infrastructure retrofits. The authors posit that the lessons from this paper and the analysis framework have broader application beyond South Africa and can apply to developing nations in the global South that have similar challenges and seek to implement technical leaning but community-centred projects.

Finally, the key findings from this paper were limited to observations from one case study and, thus, could be case specific. However, a second phase of the PaWS project –initiated at the beginning of 2023 – aims to apply the findings from this paper to another SuDS retrofit case and thus add to this emerging work.

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

CONFLICT OF INTEREST

The authors declare there is no conflict.

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